GENERAL INFORMATION

Diagnostic Connector (DLC) Locations

DOMESTIC CARS

CHRYSLER GROUP LLC

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

CHRYSLER GROUP LLC - DOMESTIC CARS

Application	Connector Location
Acclaim	
1989-90	Under Left Side Of Dash
1991-92	On Left Front Fender Panel, Near Shock Tower
1993-94	Near Battery
1995	Behind Left Side Of Dash, Near Fuse Block
Aries, Caravelle, Dynasty, E Class, Executive Sedan, LeBaron Sedan, New Yorker, Reliant, Town & Country, 400 & 600	
1984-85	On Left Fender Apron, Behind Battery (2.2L Only)
1986-87	On Front Of Right Shock Tower (2.2L & 2.5L Only)
1988-89	On Left Fenderwell
1990	Under Left Side Of Dash
1991-92	On Left Front Fender Panel, Near Shock Tower
1993 (Except New Yorker)	Near Battery
1993 (New Yorker)	On Left Fender Panel Near PCM
Avenger (1995-00)	Under Center Of Dash, Near Center Console
Breeze, Cirrus & Stratus (1995)	Left Of Steering Column, On BCM
Charger, Horizon, Omni, Rampage, Scamp & Turismo	
1985-89	
2.2L Carbureted	On Left Fender Apron
2.2L Turbo	On Front Of Right Shock Tower
Concorde, Intrepid, LHS, New Yorker, Vision & 300M	
1993-95	Behind Left Side Of Dash
1996-97	Under Left Side Of Dash, Near Center Console
Daytona	

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1984-87	On Front Of Right Shock Tower
1988-89	On Left Fenderwell
1990-92	On Left Front Fender Panel, Near Shock Tower
1993	On Left Front Inner Fender Or Under Steering Column
Dynasty	
1990	Under Left Side Of Dash
1991-93	On Left Fender Panel, Near SBEC/PCM
Fifth Avenue	
1990	Under Left Side Of Dash
1991-93	On Left Fender Panel Near SBEC/PCM
Horizon & Omni (1989-90)	Under Left Side Of Dash
Imperial	
1981-83	CCC Connector Left Of Air Cleaner
1990	Under Left Side Of Dash
1991-93	On Left Fender Panel Near SBEC/PCM
LeBaron Coupe & Convertible	
1985-87	On Right Front Shock Tower
1988-89	On Left Fenderwell
1990-92	On Left Front Fender Panel, Near Shock Tower
1993	On Left Front Inner Fender Or Under Steering Column
1994	Near Battery
1995	Behind Left Side Of Dash, Near Fuse Block
Lancer	
1985-87	On Right Front Shock Tower
1988-89	On Left Fenderwell
Laser	
1990-94	Above Left Kick Panel, Near Fuse Block
1995	Under Left Side Of Dash, Near Center Console
Monaco & Premier	
1990	On Right Front Fender Panel
1991-92	On Left Fender Panel, Next To SBEC
Neon (1995)	Under Headlight Switch, Under Left Side Of Dash
Shadow	
1985-87	On Right Front Shock Tower
1988	On Left Fenderwell
1989	Under Dash, To Right Of Steering Column

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1990	On Left Fender Front Panel, Near SBEC
1991-92	On Left Front Fender Panel, Near Shock Tower
1993-94	Near Battery
Spirit & Sundance	
1985-87	On Right Front Shock Tower
1989-90	Under Left Side Of Dash
1991-92	On Left Front Fender Panel, Near Shock Tower
1993-94	Near Battery
1995	Behind Left Side Of Dash, Near Fuse Block
Talon	
1990-94	Above Left Kick Panel, Near Fuse Block
1995-98	Under Left Side Of Dash, Near Center Console

FORD MOTOR CO.

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

FORD MOTOR CO. - DOMESTIC CARS

Application	Connector Location
Bobcat & Pinto	On Center Of Right Fender Apron
Capri	
1980-85	On Center Of Left Front Fender Apron
1986	On Left Rear Corner Of Engine Compartment
Continental	
1984-89	On Right Rear Corner Of Engine Compartment
1990-91	On Right Rear Corner Of Firewall, On Electronic Assembly Cover
1992	On Right Fender Apron
1993-94	VIP Connectors (2) On Right Rear Of Engine Compartment, On PCM Cover
Contour & Mystique	
1995	On Left Rear Corner Of Engine Compartment
Cougar & Thunderbird	
1982-90	On Left Fender Apron
1991	On Rear Of Right Front Fender Panel
1992	Front Of Right Shock Tower
1993	2 Connectors In Right Rear Corner Of Engine Compartment

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1994	On Right Side Of Engine Compartment & Below Glove Box
1995	
3.8L	On Right Side Of Engine Compartment & Below Glove Box
4.6L	Behind Right Side Of Dash, Below Glove Box
1996	Lower Right Side Of Dash, Below Glove Box
Crown Victoria, Grand Marquis & Lincoln Town Car	
1983 & 1987	On Right Fender Apron
1985-86 & 1988-90	On Left Fender Apron
1992	On Left Front Fender Panel
1993-94	On Top Of Left Front Wheelwell
Escort, EXP, Lynx & Tracer	
1985-90	On Right Fender Apron Near Firewall
1991	On Left Rear Of Engine Compartment
1992	On Right Rear Of Engine Compartment, Near Cowl
1993-95	On Left Side Of Firewall
LTD & Marquis	
1983	On Left Fender Apron
1984-86	On Left Rear Corner Of Engine Compartment
Mark VII	
1984-87	On Right Rear Corner Of Engine Compartment
1988-90	Front Of Right Fender Apron
1991	On Right Side Of Engine Compartment, Near Thermactor Solenoids
Mark VIII	
1993-96	On Top Of Left Wheelwell
Mustang	
1980-85	On Center Of Left Front Fender Apron
1986-91	On Left Rear Corner Of Engine Compartment
1992	On Left Shock Tower, Near Ignition Coil
1993	2 Connectors On Right Front Strut Tower
1994-95	Behind Right Front Strut Tower & Right Of Steering Column
Probe	
1991-92	On Left Rear Corner Of Engine Compartment
1993	DLC - Behind Left Side Of Dash; STI Connector - On Left Inner Fender Panel
1994-95	On Left Front Inner Fender Panel
Sable & Taurus	
1986-87 (3.0L Only)	Near Alternator
1988-90	
2.5L	On Engine Harness Near PCV Hose
3.0L	On Right Rear Corner Of Engine Compartment

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1991	On Right Rear Corner Of Engine Compartment, On ECA Cover
1992	On Right Rear Corner Of Engine Compartment, Below MAP Sensor
1993-95	Right Rear Of Engine Compartment
Tempo & Topaz	
1984-92	On Right Rear Corner Of Engine Compartment
1993-94	In Engine Compartment, On Left Strut Tower

GENERAL MOTORS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

GENERAL MOTORS - DOMESTIC CARS

Application	Connector Location
Allante	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
Bonneville (1980-81)	ECU Connector On Upper Right Kick Panel
Brougham (1987-92)	Bottom Center Of Instrument Panel
Camaro & Firebird (1980)	Diagnostic Ground Lead Connector On Right Shroud Above ECM
Caprice Classic	
1980-81	ECU Connector On Upper Right Kick Panel
1982-88	Under Center Of Instrument Panel
Catalina	ECU Connector On Upper Right Kick Panel
Cavalier (1982-88)	On Side Of Fuse Block
Cimarron	On Side Of Fuse Block
Century	Under Left Of Dash Ashtray
Corvette (1980-83)	In Center Console, Under Ashtray
Custom Cruiser	
1980-81	ECU Connector On Upper Right Kick Panel
1982-88	Under Center Of Instrument Panel
DeVille (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Delta 88	ECU Connector On Upper Right Kick Panel
Eldorado (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Electra (1980-81)	ECU Connector On Upper Right Kick Panel
Estate Wagon	ECU Connector On Upper Right Kick Panel
Fiero	Under Ashtray Or Cigar Lighter Panel Within Center Console
Firenza	On Side Of Fuse Block

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Fleetwood (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Fleetwood Brougham	On Bottom Center Of Dash, Near Ashtray
Impala (1982-88)	Under Center Of Instrument Panel
LeMans	ECM Connector On Right Kick Panel Or Under Left Side Of Dash
LeSabre (1980-81)	ECU Connector On Upper Right Kick Panel
LeSabre Wagon (1982-88)	Under Center Of Instrument Panel
Monza	Under Right Side Of Dash
Ninety-Eight (1980-81)	ECU Connector On Upper Right Kick Pane
Nova	Behind Right Strut Tower
Parisienne	Under Center Of Instrument Panel
Reatta	
1988-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
1991-93	Above Parking Brake Pedal
Riviera	
1980-85 (Carbureted)	Under Left Or Center Of Dash
1986-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
Safari	Under Center Of Instrument Panel
Seville (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Skyhawk	Under Right Side Of Dash
Starfire	Under Right Side Of Dash
Sunbird	On Side Of Fuse Block, Under Right Side Of Dash
Toronado	
1980-85 (Carbureted)	Under Left Or Center Of Dash
1986-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
Trofeo	
1988-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
1991-93	Above Parking Brake Pedal
2000	On Side Of Fuse Block

DOMESTIC LIGHT TRUCKS & VANS

CHRYSLER GROUP LLC

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

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CHRYSLER GROUP LLC - DOMESTIC LIGHT TRUCKS & VANS

Application	Connector Location
Caravan, Grand Caravan, Grand Voyager, Mini Ram Van, Town & Country, & Voyager	
1984-92	On Left Side Fender Apron
1993	On Left Fender Front Fender Panel, Near SBEC
1994-95	On Wiring Harness, On Center Of Firewall
Dakota	
1987-88	On Right Side Fender Apron
1989	On Left Side Of Firewall
1990-92	On Right Side Of Firewall
1993-95	On Right Rear Corner Of Engine Compartment
Jeep	
Cherokee (1992-95)	On Left Front Fender Apron, Behind Air Cleaner
Comanche	On Left Front Fender Apron, Behind Air Cleaner
Grand Cherokee & Wagoneer	
1993-95	
PCM	On Right Rear Of Engine Compartment, Near PCM
TCM	Behind Left Side Of Instrument Panel
Wrangler (1992-95)	On Left Side Of Firewall, Near PCM
Pickup & Ramcharger	
1985-90	On Left Side Of Firewall
1991-93	On Left Front Fender Panel, Next To SBEC/PCM
1995 Pickup	On Right Side Of Firewall
Ram Wagon & Van	
1985-90	On Left Side Of Firewall
1991-95	On Center Of Firewall, Near SBEC/PCM

FORD MOTOR CO.

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

FORD MOTOR CO. - DOMESTIC LIGHT TRUCKS & VANS

Application	Connector Location
Aerostar	
1986-90	On Left Front Fender
1991	Near Starter Relay
1992	On Left Front Inner Fender Panel
1993-95	On Left Side Of Firewall

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Bronco	
1982-85	
6-Cylinder	On Left Front Fender
V8	On Right Inner Fender Panel
1986-87	On Right Front Fender, Near Starter Relay
1988-92	On Left Fender Apron
1993-95	2 Connectors In Left Rear Of Engine Compartment, On Bracket
1996-	Below Glove Box
Bronco II	
1983-85	On Right Front Inner Fender Panel (2.3L Only)
1986-90	On Right Front Fender Apron
Excursion	Behind Center Of Dash
Explorer & Mountaineer (1991-94)	On Right Rear Of Engine Compartment, Near A/C-Heater Blower
Pickup	
1982-85	
6-Cylinder	On Left Front Fender
V8	On Right Inner Fender Panel
1986-87	On Right Front Fender, Near Starter Relay
1988-92	On Left Fender Apron
1993-95	2 Connectors In Left Rear Of Engine Compartment, On Bracket
1996-	Below Center Of Instrument Panel
Pickup (F250 Heavy Duty & F350)	Under Right Side Of Dash
Ranger	
1983-85	On Right Front Inner Fender Panel (2.3L Only)
1986-90	On Right Front Fender Apron
1991	Behind Engine Compartment Fuse/Relay Block
1992	On Left Front Inner Fender Panel
1993-95	On Rear Of Engine Compartment Fuse/Relay Block
Van	
1986-92	On Right Fender Apron
1993-95	On Left Front Corner Of Engine Compartment
1996	
5.8L (49 State, Over 8600 GVW) & 7.5L (Except Calif.)	On Left Front Corner Of Engine Compartment

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All Others	Under Left Side Of Dash
1997-98	
Diesel	Under Left Side Of Dash
All Others	Left Front Corner Of Engine Compartment
Villager (1993)	On Left Side Of Engine Compartment, Below Coolant Reservoir

GENERAL MOTORS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

GENERAL MOTORS - DOMESTIC LIGHT TRUCKS & VANS

Application	Connector Location
Astro & Safari Van (1986-87)	Under Left Corner Of Cowl
"S" & "T" Series Blazer, Bravada, Envoy, Jimmy, Pickup & Sonoma	
1982-85	
1.9L	Under Left Side Of Dash, Behind ECM
2.0L & 2.8L	Under Ashtray
2.5L	Under Left Side Of Dash
1986-87	Under Ashtray
Van ("G" Series) (1982-87)	Under Driver's Seat

IMPORTED CARS & TRUCKS

ACURA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

ACURA - IMPORTED CARS & TRUCKS

Application	Connector Location
Integra	
1991-93	Behind Right Kick Panel
1994-97	Behind Glove Compartment
1998-02	Behind Right Side Of Center Console
Legend	
1991-93	Under Right Side Of Dash, Above PGM-FI ECU/PCM
1994-95	Behind Glove Compartment
NSX (1997-01)	Under Glove Compartment

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SLX	Behind Lower Left Corner Of Dash, Behind Cover
Vigor	
1992-93	Under Right Side Of Dash, Near Center Console
1994	Behind Glove Compartment
2.2CL & 2.3CL	In Front Of Shift Lever, Behind Ashtray
2.5TL	In Front Of Shift Lever, Behind Ashtray
3.0CL	In Front Of Shift Lever, Behind Ashtray
3.2TL & 3.5RL	In Front Of Shift Lever, Behind Ashtray

AUDI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

AUDI - IMPORTED CARS & TRUCKS

Application	Connector Location
A4	
1996	Next To Rear Ashtray
1997-01 (1.8L Turbo)	Behind Cover, Under Left Side Of Steering Column
1997-99 (2.8L V6)	Under Cover, Next To Rear Ashtray
1997-	Under Left Side Of Dash, Behind Cover
A6	
1995	Under Ashtray, In Front Storage Compartment Of Center Console
1996-97	Under Cover, Next To Parking Brake Handle
Cabriolet	
1994-96	In Fuse/Relay Block, On Left Side Of Dash
1997-98	Under Ashtray, At Rear Of Center Console
Coupe GT, 4000S & 4000S Quattro	In Fuse Socket, On Fuel Pump Relay
80	In Fuse Socket, On Fuel Pump Relay
90	
1988-92	In Fuse Socket, On Fuel Pump Relay
1993	In Main Fuse/Relay Block, On Plenum Tray
1994-95	In Fuse/Relay Block, On Left Side Of Dash
100	
1989-91	Under Left Side Of Dash
1992-94	In Auxiliary Relay Station No. 1, On Left

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	Rear Of Engine Compartment
5000CS Quattro, 5000CS Turbo & 5000S	In Fuse Socket, On Fuel Pump Relay

BENTLEY

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

BENTLEY - IMPORTED CARS & TRUCKS

Application	Connector Location
1996-00	
All Models	In Glove Compartment
2001-04	
Arnage	Below Left Side Of Dash
2001-	
Azure Convertible	In Glove Compartment
Continental	In Glove Compartment

BMW

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

BMW - IMPORTED CARS & TRUCKS

Application	Connector Location
Z3	Behind Cover, On Right Side Of Center Console
Z4 & Z8	Under Left Side Of Dash, Left Of Steering Column, Behind Cover
318 & 325	
1991	On Bracket, Above Thermostat Housing
1992-95	On Right Rear Of Engine Compartment
1996	Under Left Side Of Dash, Behind Panel Labeled OBD
330	Behind Cover, On Right Side Of Center Console
524t	On Top Rear Of Engine
525i & 535i	
1990-91 (Black 20-Pin Connector)	Left Rear Corner Of Engine Compartment

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1992-95	Outside Of Engine Compartment Fuse/Relay Block
528e	On Intake Manifold Bracket, Behind Thermostat Housing
635CSi	On Bracket, Next To Fuse/Relay Block
735i	
1986-87	On Bracket, On Top Of Engine
1988-92	On Right Side Of Engine Compartment, On Shock Tower
740 & 750	Under Left Side Of Dash, Behind Panel Labeled OBD
740i & 740iL (1993-01)	Behind Cover On Lower Left Corner Of A/C Control Panel
750iL	Behind Cover On Lower Left Corner Of A/C Control Panel

DAIHATSU

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

DAIHATSU - IMPORTED CARS & TRUCKS

Application	Connector Location
Charade	At Upper Section Of Transmission
Rocky	On Right Front Fender Panel

CHRYSLER GROUP LLC

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

CHRYSLER GROUP LLC - IMPORTED CARS & TRUCKS

Application	Connector Location
Colt & Summit	
1986-87	Above Inside Of Glove Compartment
1988	On Left Rear Corner Of Engine Compartment
1989-98	Under Left Side Of Dash, Near Fuse/Relay Block
Colt Vista	
1987	Behind Glove Compartment

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1988-89	Under Left Side Of Dash, Near Hood Release Handle
1990-96	Under Right Side Of Dash
Conquest & Starion	Behind Glove Compartment
Expo	Under Left Side Of Dash, Near Fuse/Relay Block
Medallion	On Left Side Of Firewall
Pickup	Under Left Side Of Dash, Near Fuse/Relay Block
Ram-50	Under Left Side Of Dash, Near Fuse/Relay Block
Sigma	In Glove Compartment
Stealth	
1991-98	Under Left Side Of Dash, On Fuse/Relay Block
1999	Under Left Side Of Dash, Left Of Center Console
Summit Wagon	Under Right Side Of Dash
Vista Wagon	Under Right Side Of Dash

FERRARI

FERRARI - IMPORTED CARS & TRUCKS

Application	Connector Location
All Models	
1996-	Behind Left Side Of Dash

FORD MOTOR CO.

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

FORD MOTOR CO. - IMPORTED CARS & TRUCKS

Application	Connector Location
Aspire	
1994-95	On Left Rear Corner Of Engine Compartment
1996-97	Under Left Side Of Dash
Capri	
1991	Behind Right Side Of Dash, Behind Glove Compartment
1992	
1.3L	On Left Rear Corner Of Engine

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	Compartment
1.6L	On Right Rear Corner Of Engine Compartment
1993-94	On Right Rear Corner Of Engine Compartment
Festiva	
1992-93	
1.3L	On Left Rear Corner Of Engine Compartment
1.6L	On Right Rear Corner Of Engine Compartment
Merkur XR4Ti	On Right Front Fender Apron, Near Battery
Scorpio	On Right Rear Corner Of Engine Compartment
Tracer	On Left Rear Corner Of Engine Compartment

GENERAL MOTORS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

GENERAL MOTORS & GEO - IMPORTED CARS & TRUCKS

Application	Connector Location
LeMans	Behind Right Kick Panel, Above ECM
Metro	
1989-95	Under Left Side Of Dash, Near Fuse Block
1996	Under Right Side Of Dash, Near Center Console
1997-01	Under Left Side Of Dash
Prizm & Prizm LSi	
1989-95	On Left Front Strut Tower
1996-02	Under Left Side Of Dash
Spectrum	Under Right Side Of Dash, Above A/C-Heater Blower Motor
Sprint	On Left Front Shock Tower, Near Battery
Storm	
1990-91	Behind Right Side Of Dash, Above A/C-Heater Blower Motor
1992-93	Behind Right Kick Panel
Tracker	
1989-95	Under Left Side Of Dash, Near Fuse Block
1996	In Engine Compartment, Near MAP Sensor
1997-	Under Left Side Of Dash

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HONDA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

HONDA - IMPORTED CARS & TRUCKS

Application	Connector Location
Accord	
1990-95	Behind Right Side Of Dash, Above Kick Panel
1996-97	Behind Ashtray In Center Console
Civic (1992-95)	Behind Right Side Of Dash, Near PGM-FI ECM
Civic Del Sol	
1992-95	Behind Right Side Of Dash, Near PGM-FI ECM
1996-97	Under Removable Cover On Right Side Of Center Console
CR-V	Behind Passenger Side Of Center Console
Element	
2003-11	Above Gas Pedal, Below Fuse Block
Insight (2010-11)	Below Left-of-Center Of Dash
Odyssey	
1995	Behind Right Side Of Dash, Above Kick Panel
1996-98	Behind Passenger Side Of Center Console
Passport (1995)	Behind Left Kick Panel
Prelude	
1992-95	Behind Center Console
1996	Under Beverage Holder In Center Console
1997-02	Under Removable Cover On Right Side Of Center Console
S2000	Behind Right Side Of Center Console

HYUNDAI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

HYUNDAI - IMPORTED CARS & TRUCKS

Application	Connector Location
Accent (1995)	In Coin Box
Sonata	
1989	Under Left Side Of Dash, In Fuse Block
1990	
W/Passive Seat Belt Restraints	In Fuse Block

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W/O Passive Seat Belt Restraints	On Lower Left Of Steering Column

INFINITI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

INFINITI - IMPORTED CARS & TRUCKS

Application	Connector Location
G20 (1993-95)	In ECCS Control Unit, Behind Center Console
I30 (1995)	Beside Fuse Box
J30	
1993	Under Left Side Of Dash
1994-95	In ECM, Behind Right Kick Panel
1996-98	Under Left Side Of Dash
M30	Under Left Side Of Dash, Near Fuse Block
Q45	
1990-93	Under Left Side Of Dash, Near Fuse Block
1994-95	In ECM, Behind Right Kick Panel

ISUZU

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

ISUZU - IMPORTED CARS & TRUCKS

Application	Connector Location
Amigo & Pickup	
1986-89	Under Left Side Of Dash
1990-95	Behind Left Kick Panel, Near ECM
1998-00	Lower Left Corner Of Dash, Behind Small Cover
Hombre	Under Lower Left Side Of Dash, Behind Cover
Impulse	
1986-89	Under Left Side Of Dash, Above ECU
1990-92	Behind Right Kick Panel
1993-95	Behind Left Kick Panel, Near ECM
I-Mark	Behind Right Side Of Dash, Above A/C-Heater Blower Motor
Oasis	Behind Right Side Of Center Console

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Rodeo	
1991-95	Behind Left Kick Panel
1996-	Lower Left Side Of Dash, Behind Small Cover
Stylus	Behind Right Kick Panel
Trooper & Trooper II	
1986	Under Left Side Of Dash
1987-91	Under Center Console
1992	
DOHC	Behind Center Of Dash, Right Of Steering Column
SOHC	Under Left Side Of Dash
1993-95	Under Left Side Of Dash, Right Of Steering Column
1996-02	Lower Left Side Of Dash, Behind Small Cover
VehiCROSS	Under Left Side Of Dash

JAGUAR

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

JAGUAR - IMPORTED CARS & TRUCKS

Application	Connector Location
XJR (1995-97)	Near Center Console
XJS	
1992	On Left Rear Trunk Wheel Arch, Behind Trim Panel
1993-94	Under Battery Tray, On Right Front Of Luggage Compartment
1995-96	Near Center Console
XJ6	
1992	On Left Rear Of Engine Compartment
1993-94	Under Battery Tray, On Right Front Of Luggage Compartment
1995-97	Under Left Side Of Dash, Near Center Console
XJ12	Near Center Console

KIA

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NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

KIA - IMPORTED CARS & TRUCKS

Application	Connector Location
Sephia	
1994	On Center Of Firewall
1995 & 1996	
1.6L	Under Center Of Dash, Mounted On Floorboard
2.0L	Under Right Side Of Dash, Near Kick Panel
Sportage	
1994	On Center Of Firewall
1995 & 1996	
1.6L	Under Center Of Dash, Mounted On Floorboard
2.0L	Under Right Side Of Dash, Near Kick Panel

LAND ROVER

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

LAND ROVER - IMPORTED CARS & TRUCKS

Application	Connector Location
Defender 90	Behind Fuse Cover, In Center Of Console
Range Rover	Under Right Side Of Dash, In Footwell

LEXUS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

LEXUS - IMPORTED CARS & TRUCKS

Application	Connector Location
ES Series	
1990-91	
DLC	Near Left Shock Tower

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Total Diagnostic Communication Link Connector	Under Left Side Of Dash
1992-94	
DLC No. 1	On Bracket, Behind Right Front Strut Tower
DLC No. 2 & 3	Under Left Side Of Dash
1995-97	In Fuse Box At Lower Left Of Dash
GS Series	
1990-95	
DLC No. 1	On Bracket, On Top Of Engine
DLC No. 2	Under Left Side Of Dash
1996-00	In Fuse Box At Lower Left Of Dash
LS Series	
1990-94	
DLC No. 1	On Bracket, On Top Of Engine
DLC No. 2	Under Left Side Of Dash
1995-00	In Fuse Box At Lower Left Of Dash
SC Series	
1992-95	
DLC No. 1	On Bracket, Behind Right Front Strut Tower
DLC No. 2 & 3	Under Left Side Of Dash
1996-00	In Fuse Box At Lower Left Of Dash

MAZDA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

MAZDA - IMPORTED CARS & TRUCKS

Application	Connector Location
B-Series	
1987-88	On Right Front Fender Apron
1989-93	
Engine Control Check Connector (Black 6-Pin)	Near Windshield Washer Motor
Trouble Codes Connector (Green 1-Pin)	Near Black 6-Pin Connector (Engine Control)
1994-95	On Right Front Fender Panel
Miata (1990-95)	On Left Rear Of Engine Compartment, Near Master Cylinder
MPV (1989-95)	
Engine Control Unit (Green 6-Pin & 1-Pin	On Left Side Of Engine Compartment, Near

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Connectors)	Inner Fender Panel
MX-3	Mounted On Bracket, On Left Front Strut Tower
MX-6 & 626	
1988	Behind Left Front Shock Tower
1989	On Left Front Corner Of Engine Compartment
1990-91	At ECU Connector Terminal
1992	On Left Rear Corner Of Engine Compartment
1993	On Side Of Fuse/Relay Block, Near Battery
1994-95	On Left Front Fender Apron
Navajo	
1991-93	On Right Rear Corner Of Engine Compartment
1994-95	On Right Front Fender Panel
Protege	
1987-89	On Passenger's Footwell (Left Foot Area)
1990-95	On Left Side Of Firewall, Near Wiper Motor
RX7	
1986-88 (3 Check Connectors)	At Left & Right Corners Of Engine Compartment
1989-91 (Green 6-Pin Connector)	Behind Ignition Coil
1993-95	On Bracket, On Left Front Strut Tower
323	
1986-88	Front Left Of Engine Compartment, Near Ignition Coil
1989 (Green 6-Pin & Green 1-Pin Connectors)	On Left Side Of Firewall
1990-95	On Left Side Of Firewall, Near Wiper Motor
929	
1989	Near Air Cleaner
1990-91 (Green 6-Pin Connector)	In Left Front Corner Of Engine Compartment
1992-93	Mounted On Air Cleaner Housing
1994-95	On Left Front Strut Tower

MERCEDES-BENZ

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

MERCEDES-BENZ - IMPORTED CARS & TRUCKS

Application	Connector Location
C-Class (1994)	On Right Rear Of Engine Compartment

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E-Class	
1994-97	On Right Rear Of Engine Compartment
G-Class	Under Left Side Of Dash, Behind Cover
ML-Class	Under Left Side Of Dash, Behind Cover
S-Class	
140 Platform (1994-99)	On Right Rear Of Engine Compartment
190 Series	
1986-87	On Left Rear Of Engine Compartment
1988-93	
All Models	In Engine Compartment, On Left Front Fender
California (OBD)	On Right Side Of Firewall, Near Battery
1994	On Right Rear Of Engine Compartment
260E	
1987	On Left Front Fender Apron, Next To Ignition Control Module
1988-89	
All Models	In Engine Compartment, On Left Front Fender
California (OBD)	On Right Side Of Firewall, Near Battery
300 Series	
1986-87	On Left Front Fender Apron, Next To Ignition Control Module
1988-92	
All Models	In Engine Compartment, On Left Front Fender
California (OBD)	On Right Side Of Firewall, Near Battery
1993	
Except 300E	Left Fender Apron
300E	Right Rear Corner Of Engine Compartment
1994-95 (All Models)	On Right Rear Of Engine Compartment
400 & 500 Series	
1993	
12-Pin Connector	On Rear Of Left Front Inner Fender Panel
38-Pin (Impulse Readout)	In Module Box, On Right Rear Of Engine Compartment
1994-95	On Right Rear Of Engine Compartment
420SEL & 560 Series (Except 2.2L)	
1986-89	
All Models	In Engine Compartment, On Left Front Fender

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California (OBD)	On Right Side Of Firewall, Near Battery
1990-91	In Engine Compartment, On Left Front Fender
560 Series (2.2L)	On Lower Left Side Of Engine Connector

MITSUBISHI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

MITSUBISHI - IMPORTED CARS & TRUCKS

Application	Connector Location
Diamante (1992-98)	Under Left Side Of Dash, Near Fuse/Relay Block
Expo	Under Left Side Of Dash, Near Fuse/Relay Block
Montero	
1986-88	Left Rear Corner Of Engine Compartment
1989-91	Behind Glove Compartment
Pickup	Under Left Side Of Dash, Near Fuse/Relay Block
Raider	
1987-88	Left Rear Corner Of Engine Compartment
1989	Behind Glove Compartment
3000GT	
1991-98	Under Left Side Of Dash, On Fuse/Relay Block
1999	Under Left Side Of Dash, Left Of Center Console

NISSAN

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

NISSAN - IMPORTED CARS & TRUCKS

Application	Connector Location
Altima	
1993-94	On Driver-Side Of Center Console, Above Accelerator Pedal
1995-96	Below Fuse Box

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Maxima	
1989-94	Under Left Side Of Dash
1995-96	Below Fuse Box
NX & Sentra	Under Left Side Of Dash, Near Fuse Block
Pulsar NX	
1986	Above Right Side Of Dash, Below Wiper Motor
1987	Above Steering Column
Quest (1993-95)	
CONSULT Tester Connector	On Driver-Side Of Center Console, Above Accelerator Pedal
Self-Test Connector	Located Near Starter
Stanza	Below Center Of Dash, Near Center Console
Van	On Right Side Of Engine Compartment, Behind Fuel Filter
200SX (1995-96)	Below Fuse Box
240SX	
1991-94	Under Left Side Of Dash, Below Fuse Block
1995-96	In Glove Box
300ZX (1990)	Near Parking Brake

PEUGEOT

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

PEUGEOT - IMPORTED CARS & TRUCKS

Application	Connector Location
505 Series	On Lower Left Side Of Engine Connector

PORSCHE

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

PORSCHE - IMPORTED CARS & TRUCKS

Application	Connector Location
911 Series	
1992-95	In Passenger's Footwell
1996	Left Side Of Center Console

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928S	Top Front Of Engine
944 Series	On Left Side Of Engine Compartment

RENAULT

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

RENAULT - IMPORTED CARS & TRUCKS

Application	Connector Location
Sportwagon	
Engine Diagnostic	On Center Of Firewall
Fuel Injection Diagnostic	Right Rear Of Engine Compartment, Behind Airflow Meter

ROLLS-ROYCE

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

ROLLS-ROYCE - IMPORTED CARS & TRUCKS

Application	Connector Location
All Models	
1996-00	In Glove Compartment
2001-	Under Left Side Of Dash

SAAB

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

SAAB - IMPORTED CARS & TRUCKS

Application	Connector Location
900 Series	
1986-90	In Front Of Fuse/Relay Panel
1991-93	Under Back Seat, On Right Side
1994	
Convertible	Under Rear Seat
Hatchback	Under Steering Column
All Others	Under Right Front Seat

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9000 Series	
1990	On Left Side Of Engine Compartment
1991-92	Under Passenger's Seat
1993	On Left Of Firewall
1994-95	Under Right Front Seat

SUBARU

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

SUBARU - IMPORTED CARS & TRUCKS

Application	Connector Location
Brat, Coupe, Hatchback, Sedan & Wagon	
1987	
Read Memory Connector	Under Left Side Of Dash, Next To MFI/SMFI Control Unit
Test Mode Connector	
MFI	On Left Side Of Dash, Next To MFI Control Unit
Sequential MFI	On Left Side Of Firewall
1988-89	On Left Side Of Dash, Next To ECU
Forester	Under Left Side of Dash, Behind Cover
Justy	
1987-88	
Read Memory Connector (Factory)	On Right Front Fender, Near Strut Tower
Test Mode Connector	On Driver-Side Kick Panel Or ECU
1989-95	
Read Memory Connector (Factory)	Under Left Side Of Dash
Test Mode Connector	On Driver-Side Kick Panel Or ECU
Legacy	
1990-94	
Check Connector (Black Connector)	Behind Right Side Of Steering Column, Near Heater Case
Diagnostic Connector (Black 4-Pin Connector)	Behind Right Side Of Steering Column, Near Heater Case
Read Memory Connector (Black Connector)	Behind Knee Panel, Right Of Steering Column
Select Monitor Connector (Yellow Connector)	Behind Right Side Of Steering Column, Near Heater Case
Test Mode Connector (Green Connector)	Behind Knee Panel, Right Of Steering Column

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1995-	Under Left Side Of Dash, Behind Cover
Loyale	
1990-91	
MFI (5-Pin Connector)	In Front Of ECU
SMFI (Yellow 9-Pin & Black 13-Pin Connectors)	Near Brake Booster
1992-95	
Diagnostic Check Connector (Yellow 9-Pin & Black 13-Pin Connectors)	Behind Brake Booster
Diagnostic Read-Memory Connector (2-Single Wire Connectors)	Behind Left Front Strut Tower
Outback & Outback Sport	Under Center Of Dash
SVX	
1992-96	Under Left Side Of Dash
1997	Right Of Steering Column, On Center Console

SUZUKI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

SUZUKI - IMPORTED CARS & TRUCKS

Application	Connector Location
Esteem (1995)	Near Battery
Samurai	
1986-90	Under Right Side Of Dash, Behind Glove Compartment
1991-92	On Right Side Of Firewall
1993-95	Under Left Side Of Dash, In Fuse Block
Sidekick & X90	
1989-91	Under Left Side Of Dash, In Fuse Block
1992-93	
ALDL Connector	Under Left Side Of Dash
Engine Connector	Under Left Side Of Dash, Near Fuse Block
1994-96	In Engine Compartment, Near Battery
Swift	
1989-91	Under Left Side Of Dash, In Fuse Block
1992	
ALDL Connector	Under Left Side Of Dash

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Diagnostic Test Terminal	In Fuse Block
1993-95	Under Left Side Of Dash, In Fuse Block

TOYOTA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

TOYOTA - IMPORTED CARS & TRUCKS

Application	Connector Location
Camry	
1983-90	Next To Brake Master Cylinder
1991	Near Left Front Shock Tower
1992-95	
4-Cylinder	Near Wiper Motor
V6	Under Left Side Of Dash
Celica	
1983-84	Next To Battery
1985-95	Behind Left Front Shock Tower
Celica Supra	Rear Of Battery, Near Relay Panel (2-Pin Connector)
Corolla	
Front Wheel Drive	
1987	Side Of Left Front Shock Tower (2-Pin Connector)
1988-94	Behind Left Front Shock Tower
Rear Wheel Drive	
1985-86	Side Of Right Front Shock Tower (2-Pin Connector)
1987	Right Rear Corner Of Engine Compartment
Cressida	
1988-93	
Check Connector	On Left Front Shock Tower
Total Diagnostic Communication Link Connector	Under Left Side Of Dash
Land Cruiser (1988-94)	Near Wiper Motor
MR2	
1986-90	Near Airflow Meter
1992-95	On Right Rear Of Engine Compartment, Near MAP Sensor
Paseo (1992-95)	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery

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Pickup	
1984-86	Near Ignition Coil, Near Master Cylinder (2-Pin Connector)
1987-90	Right Front Inner Fender Panel, Near Relay Block
1992-94	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
Previa	
1992-93	Under Front Of Driver's Seat
1994	
Except Supercharged	Under Center Console, Near Parking Brake Lever
Supercharged	Under Cover, On Top Center Of Instrument Panel
1995-97	On Top Center Of Instrument Panel
RAV4	Under Dash, Near Center Console
Starlet	
1981-82	On Instrument Panel Fuse Block, On Top Of Dash
1983-84	Right Rear Of Engine Compartment
Supra	
1986-90	Rear Of Battery, Near Relay Panel
1991-92	On Left Front Shock Tower
1993-94	
DLC No. 1	On Right Side Of Firewall
DLC No. 2	Under Left Side Of Dash, Near Kick Panel
Tacoma & T100	
1993	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
1994-95	
Except OBD-II DLC	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
OBD-II DLC	Under Left Side Of Dash
Tercel	
1987-90	In Engine Compartment, Next To Master Cylinder
1991-94	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
1995-98	Near Steering Column
Van	Near Airflow Meter
4Runner	
1985-86	Near Ignition Coil, Next To Master Cylinder (2-Pin Connector)

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1987-95	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery

VOLKSWAGEN

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

VOLKSWAGEN - IMPORTED CARS & TRUCKS

Application	Connector Location
Cabrio	
1996	In Center Console, Below Tachometer
1997-02	On Center Dash, Behind Panel Near Ashtray
Corrado	Under Center Console Trim Plate
Fox	Under Center Console, Near Shift Lever
Golf	
1993	On Center Of Dash, Below A/C-Heater Control Knobs
1994	Under Center Console
1998-03	In Center Console
Golf III 2.0L	
1995-96	Below A/C-Heater Control Panel
1997-98	On Center Dash, Behind Panel Adjacent To Ashtray
GTI	
1993	On Center Of Dash, Below A/C-Heater Control Knobs
1994	Under Center Console
GTI 2.8L	On Center Dash, Behind Panel Adjacent To Ashtray
Jetta	
1993	On Center Of Dash, Below A/C-Heater Control Knobs
1994	Under Center Console
Jetta III 2.0L	
1995-96	Below A/C-Heater Control Panel
1997-98	On Center Dash, Behind Panel Adjacent To Ashtray
Jetta/Jetta III 2.8L	On Center Dash, Behind Panel Adjacent To Ashtray
New Beetle	Lower Part of Dash, In Front Of Shift Lever

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Passat	
1992-94	Under Center Console, Forward Of Shift Lever
1995-97	On Center Dash, Behind Panel Near Ashtray

VOLVO

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

VOLVO - IMPORTED CARS & TRUCKS

Application	**Connector Location**
C30	Under Left Center Of Dash
C70	Behind Cover, Below Parking Brake Lever
S40	Under Left Center Of Dash
S70	Behind Cover, Below Parking Brake Lever
S90	Behind Cover, Below Parking Brake Lever
V40	Under Left Center Of Dash
V70 (1997-00)	Behind Cover Below Parking Brake Lever
V90	Behind Cover, Below Parking Brake Lever
240	
1986-92	Left Rear Corner Of Engine Compartment
1993	Behind Left Front Strut Tower
740 & 760	
1986-92	
Ignition System	On Left Front Fender Apron
Fuel Injection (1990-92 Only)	Left Rear Corner Of Engine Compartment
780	On Left Front Fender, Behind Air Cleaner Housing
850	
1993	On Center Console, Forward Of Shift Lever & Near ECM
1994-95	
Non-Turbo	On Right Front Strut Tower
Turbo	Behind Cover, Forward Of Shift Lever
1996-97	Behind Cover, Forward Of Shift Lever
940	
1991-93	
Ignition System	On Left Front Fender Apron
Fuel Injection	Left Rear Corner Of Engine Compartment

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1994-95	Behind Left Front Strut Tower
960	
1992-95	On Left Front Strut Tower
1996	In Center Console, To Right Of Parking Brake Lever
1997	Behind Cover, Forward Of Shift Lever

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2010 ENGINE PERFORMANCE

Emission Applications - General Motors - Chevrolet Camaro

EMISSION APPLICATIONS

CAMARO

Year, Engine & Fuel System	(1) Emission Control Systems & Devices
2010	
3.6L (217") V6 SFI	**PCV, (2) EVAP, TWC, FR, (2) SPK, (3) HO2S, CEC, (2) MIL,** EVAP-CPCSV, EVAP-CVCSV, EVAP-FVTS, EVAP-ORVR, EVAP-VC
6.2L (376") V8 SFI	**PCV, (2) EVAP, TWC, FR, (2) SPK, (3) HO2S, CEC, (2) MIL,** EVAP-CPCSV, EVAP-CVCSV, EVAP-FVTS, EVAP-ORVR, EVAP-VC

(1) Major emission control systems and devices are listed in bold type; components and other related devices are listed in light type.

(2) PCM-controlled.

(3) Equipped with 4.

ABBREVIATIONS

CEC

Computerized Engine Controls

EGR

Exhaust Gas Recirculation System

EVAP

Fuel Evaporative System

EVAP-CPCSV

EVAP Canister Purge Control Solenoid Valve

EVAP-CVCSV

EVAP Canister Vent Control Solenoid Valve

EVAP-FTPS

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EVAP Fuel Tank Pressure Sensor

EVAP-ORVR

EVAP On-Board Refueling Vapor Recovery

EVAP-PSSV

EVAP Pressure Switching Solenoid Valve

EVAP-RV/FTPS

EVAP Rollover Valve/Fuel Tank Pressure Sensor

EVAP-VC

EVAP Vapor Canister

EVAP-VCF

EVAP Vapor Canister Filter

EVAP-VSOL

EVAP Ventilation Solenoid

FR

Fill Pipe Restrictor

FTPS

Fuel Tank Pressure Sensor

HO2S

Heated Oxygen Sensor

MIL

Malfunction Indicator Light

PCV

Positive Crankcase Ventilation

SFI

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Sequential Fuel Injection

SPK

Spark Controls

TWC

Three-Way Catalytic Converter

WU-TWC

Warm-Up TWC

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

DESCRIPTION AND OPERATION

AIR INTAKE SYSTEM DESCRIPTION

The MAF sensor measures the amount of air coming into the engine. This direct airflow measurement is more accurate than the calculated airflow information obtained from the other sensor inputs. The MAF sensor also houses an integrated intake air temperature (IAT) sensor. The MAF sensor uses the following circuits:

- An ignition voltage circuit
- A signal circuit
- A ground circuit
- An IAT signal circuit
- An IAT low reference circuit

The MAF sensor that is used on this vehicle is a hot film type and is used in order to measure the air flow rate. The air flow through the sensor passes over a temperature sensor, is then heated, and then passes over another temperature sensor. The difference in air temperature before and after the heater is measured. The air temperature difference is proportional to the amount of air flow. This air temperature difference also allow for determination of whether the air is flowing in the forward or reverse directions. As the air flow increases the delta temperature between the two sensors increases. The MAF sensor converts the temperature difference into a frequency signal that the ECM monitors. The ECM calculates the air flow based on this signal.

The ECM monitors the MAF sensor signal frequency and can determine if the sensor signal is too low or too high. The ECM can also detect airflow that is inappropriate for a given operating condition based on the signal frequency.

The scan tool displays the MAF sensor value in grams per second (g/s) and hertz (Hz). Values should change rather quickly on acceleration, but should remain fairly stable at any given engine speed. If the ECM detects a condition with the MAF sensor circuits, the following DTCs set:

- P0100 Mass Air Flow (MAF) Sensor Circuit
- P0101 Mass Air Flow (MAF) Sensor Performance
- P0102 Mass Air Flow (MAF) Sensor Circuit Low Voltage
- P0103 Mass Air Flow (MAF) Sensor Circuit High Voltage

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

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Fig. 1: Camshaft Actuator System Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Camshaft Actuator Vane
2	Timing Chain Sprocket
3	Engine Oil Pressure-For retarding the camshaft
4	Camshaft
5	Input Signals from Engine Sensors
6	Engine Control Module (ECM)
7	Camshaft Actuator Solenoid
8	Engine Oil Pump
9	Engine Oil Pressure Supply
10	Engine Oil Drain
11	Engine Oil Pressure-For advancing the camshaft
12	Camshaft Actuator Rotor
13	Camshaft Position Sensor Reluctor
14	Camshaft Actuator Lock Pin
15	Camshaft Actuator Housing

The camshaft actuator system enables the engine control module (ECM) to change camshaft timing of all 4 camshafts while the engine is operating. The CMP actuator assembly (15) varies the camshaft position in

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response to directional changes in oil pressure. The CMP actuator solenoid valve controls the oil pressure that is applied to advance or retard a camshaft. Modifying camshaft timing under changing engine demand provides better balance between the following performance concerns:

- Engine power output
- Fuel economy
- Lower tailpipe emissions

The CMP actuator solenoid valve (7) is controlled by the ECM. The crankshaft position (CKP) sensor and the CMP sensors are used to monitor changes in camshaft positions. The ECM uses the following information in order to calculate the desired camshaft positions:

- The engine coolant temperature (ECT) sensor
- The calculated engine oil temperature (EOT)
- The mass air flow (MAF) sensor
- The throttle position (TP) sensor
- The vehicle speed sensor (VSS)
- The volumetric efficiency

Operation

The CMP actuator assembly has an outer housing that is driven by an engine timing chain. Inside the assembly is a rotor with fixed vanes that is attached to the camshaft. Oil pressure that is applied to the fixed vanes will rotate a specific camshaft in relationship to the crankshaft. The movement of the intake camshafts will advance the intake valve timing. The movement of the exhaust camshafts will retard the exhaust valve timing. When oil pressure is applied to the return side of the vanes, the camshafts will return to 0 crankshaft degrees, or top dead center (TDC). The CMP actuator solenoid valve directs the oil flow that controls the camshaft movement. The ECM commands the CMP solenoid to move the solenoid plunger and spool valve until oil flows from the advance passage (11). Oil flowing thru the CMP actuator assembly from the CMP solenoid advance passage applies pressure to the advance side of the vanes in the CMP actuator assembly. When the camshaft position is retarded, the CMP actuator solenoid valve directs oil to flow into the CMP actuator assembly from the retard passage (3). The ECM can also command the CMP actuator solenoid valve to stop oil flow from both passages in order to hold the current camshaft position.

The ECM operates the CMP actuator solenoid valve by pulse width modulation (PWM) of the solenoid coil. The higher the PWM duty cycle, the larger the change in camshaft timing. The CMP actuator assembly also contains a lock pin (14) that prevents movement between the outer housing and the rotor vane assembly. The lock pin is released by oil pressure before any movement in the CMP actuator assembly takes place. The ECM is continuously comparing CMP sensor inputs with CKP sensor input in order to monitor camshaft position and detect any system malfunctions. If a condition exists in either the intake or exhaust camshaft actuator system, the opposite bank, intake or exhaust, camshaft actuator will default to 0 crankshaft degrees.

CMP Actuator System Operation

Driving Condition	Change in Camshaft Position	Objective	Result
Idle	No Change	Minimize Valve Overlap	Stabilize Idle Speed

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Light Engine Load	Retard Valve Timing	Decrease Valve Overlap	Stable Engine Output
Medium Engine Load	Advance Valve Timing	Increase Valve Overlap	Better Fuel Economy with Lower Emissions
Low to Medium RPM with Heavy Load	Advance Valve Timing	Advance Intake Valve Closing	Improve Low to Mid-range Torque
High RPM with Heavy Load	Retard Valve Timing	Retard Intake Valve Closing	Improve Engine Output

ELECTRONIC IGNITION SYSTEM DESCRIPTION

The electronic ignition (EI) system produces and controls a high-energy secondary spark. This spark is used to ignite the compressed air/fuel mixture at precisely the correct time. This provides optimal performance, fuel economy, and control of exhaust emissions. This ignition system uses an individual coil for each cylinder. The ignition coils are mounted in the center of each camshaft cover with short integrated boots connecting the coils to the spark plugs. The driver modules within each ignition coil are commanded ON/OFF by the engine control module (ECM). The ECM primarily uses engine speed, the MAF sensor signal, and position information from the crankshaft position and the camshaft position sensors. This controls the sequence, dwell, and timing of the spark. The EI system consists of the following components:

Crankshaft Position Sensor

The crankshaft position sensor works in conjunction with a 58 tooth reluctor wheel on the crankshaft. The engine control module (ECM) monitors the voltage frequency on the crankshaft position sensor signal circuit. As each reluctor wheel tooth rotates past the sensor, the sensor creates a digital ON/OFF pulse. This digital signal is processed by the ECM. The reluctor wheel teeth are 6 degrees apart. Having only 58 teeth leaves a 12 degree span that is uncut. This creates a signature pattern that enables the ECM to determine the crankshaft position. The ECM uses the signal to determine which pair of cylinders is approaching top dead center based on the crankshaft position signal alone. The camshaft position sensor signals are used in order to determine which of these 2 cylinders is on a firing stroke, and which is on the exhaust stroke. The ECM uses this to properly synchronize the ignition system, the fuel injectors, and the knock control. This sensor is also used in order to detect misfire.

Camshaft Position Sensor

This engine uses camshaft position sensor for each camshaft. The camshaft position sensor signals are a digital ON/OFF pulse, output 4 times per revolution of the camshaft. The camshaft position sensor does not directly affect the operation of the ignition system. The camshaft position sensor information is used by the engine control module (ECM) to determine the position of the camshaft relative to the crankshaft position. By monitoring the camshaft position and crankshaft position signals the ECM can accurately time the operation of the fuel injectors. The ECM supplies the camshaft position sensor with a 5 V reference circuit and a low reference circuit. The camshaft position sensor signals are an input to the ECM. These signals are also used to detect camshaft alignment with the crankshaft.

Knock Sensor

The knock sensor system enables the control module to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation, also known as spark

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knock. The knock sensor system uses one or 2 flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency are dependant upon the level of knock that the knock sensor detects. The control module receives the knock sensor signal through the signal circuit. The knock sensor ground is supplied by the control module through the low reference circuit.

The control module learns a minimum noise level, or background noise, at idle from the knock sensor and uses calibrated values for the rest of the RPM range. The control module uses the minimum noise level to calculate a noise channel. A normal knock sensor signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal knock sensor signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the control module only uses knock sensor signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

If the control module has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The control module will always try to work back to a zero compensation level, or no spark retard. An abnormal knock sensor signal will stay outside of the noise channel or will not be present. knock sensor diagnostics are calibrated to detect faults with the knock sensor circuitry inside the control module, the knock sensor wiring, or the knock sensor voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

Ignition Coils

Each ignition coil contains a solid state driver module as its primary element. The engine control module (ECM) signals the coil driver to initiate a firing event by applying ignition control (IC) circuit voltage for the appropriate time, or dwell. When the voltage is removed the coil fires the spark plug.

Engine Control Module (ECM)

The engine control module (ECM) controls all ignition system functions, and constantly corrects the spark timing. The ECM monitors information from various sensor inputs that may include the following components, if applicable:

- The throttle position sensor
- The engine coolant temperature (ECT) sensor
- The mass air flow (MAF) sensor
- The intake air temperature (IAT) sensor
- The vehicle speed sensor (VSS)
- The transmission gear position or range information sensors
- The engine knock sensors
- Ambient pressure sensor (BARO)

ENGINE CONTROL MODULE DESCRIPTION

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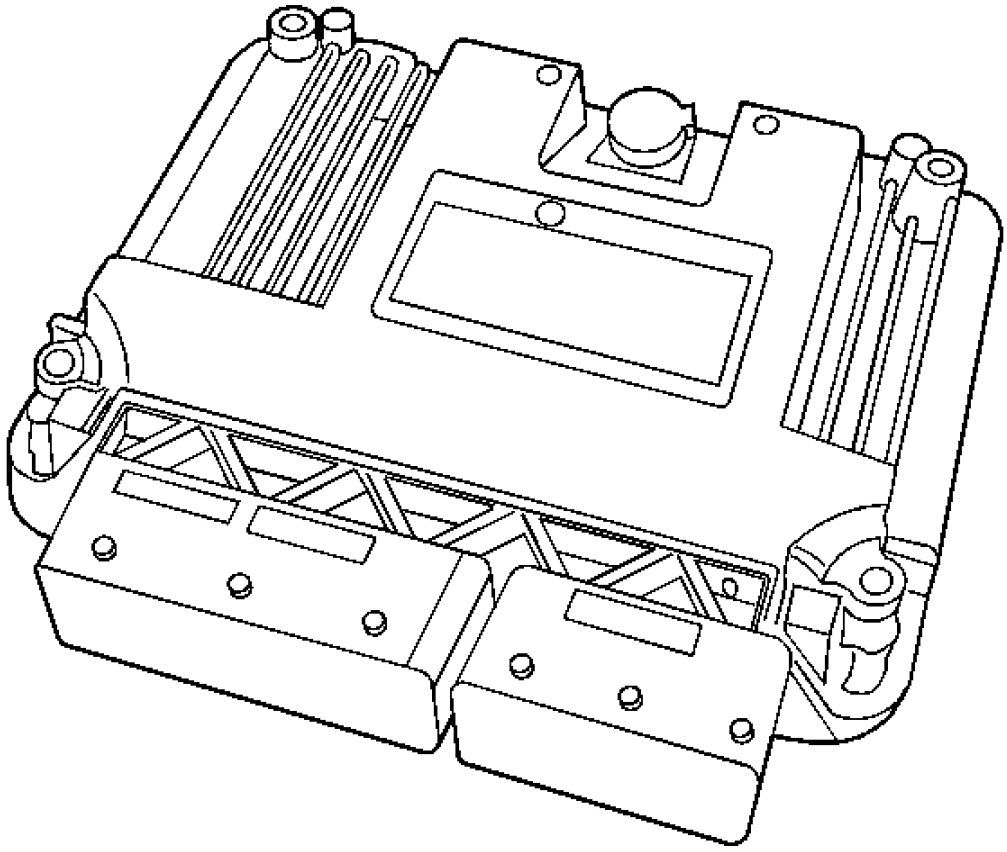


Fig. 2: View Of Engine Control Module
Courtesy of GENERAL MOTORS CORP.

The Engine Control Module (ECM) interacts with many emission related components and systems, and monitors emission related components and systems for deterioration. OBD II diagnostics monitor the system performance and a diagnostic trouble code (DTC) sets if the system performance degrades.

Malfunction indicator lamp (MIL) operation and DTC storage are dictated by the DTC type. A DTC is ranked as a Type A or Type B if the DTC is emissions related. Type C is a non-emissions related DTC.

The ECM is in the engine compartment. The ECM is the control center of the engine controls system. The ECM controls the following components:

- The fuel injection system
- The ignition system
- The emission control systems

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- The on-board diagnostics
- The A/C and fan systems
- The throttle actuation control (TAC) system

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect vehicle performance and emissions. The ECM also performs diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the MIL. When the ECM detects a malfunction, the ECM stores a DTC. The condition area is identified by the particular DTC that is set. This aids the technician in making repairs.

ECM Function

The ECM can supply 5 V or 12 V to various sensors or switches. This is done through pull-up resistors to regulated power supplies within the ECM. In some cases, even an ordinary shop voltmeter will not give an accurate reading because the resistance is too low. Therefore, a DMM with at least 10 megaohms input impedance is required in order to ensure accurate voltage readings.

The ECM controls the output circuits by controlling the ground or the power feed circuit through transistors or a device called an output driver module.

EEPROM

The electronically erasable programmable read only memory (EEPROM) is a permanent memory that is physically part of the ECM. The EEPROM contains program and calibration information that the ECM needs in order to control powertrain operation.

Special equipment, as well as the correct program and calibration for the vehicle, are required in order to reprogram the ECM.

Theft Deterrent System Frequency Code Programming

This vehicle is equipped with a theft deterrent system which interfaces with the ECM. If the ECM is replaced, program the new ECM with the frequency code of the theft deterrent module that is currently on the vehicle. The vehicle will not start until this procedure is completed.

Knock Sensor Module

The ECM employs an internal integrated circuit to continuously monitor the knock control evaluation circuit. The knock sensor module contains circuitry that allows the ECM to utilize the knock sensor signals and diagnose the knock sensors and circuitry. If the ECM detects a fault in the ability of the knock sensor module to sample these signals, a DTC sets.

Data Link Connector (DLC)

The data link connector (DLC) is a 16-pin connector that provides the technician a means of accessing serial data for aid in diagnosis. This connector allows the technician to use a scan tool in order to monitor various serial data parameters, and display DTC information. The DLC is located inside the driver's compartment,

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underneath the dash.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) is inside the instrument panel cluster (IPC). The MIL is controlled by the ECM and illuminates when the ECM detects a condition that affects vehicle emissions.

ECM Service Precautions

The ECM, by design, can withstand normal current draws that are associated with vehicle operations. However, care must be used in order to avoid overloading any of these circuits. When testing for opens or shorts, do not ground or apply voltage to any of the ECM circuits unless the diagnostic procedure instructs you to do so. These circuits should only be tested with a DMM.

Emissions Diagnosis For State I/M Programs

This OBD II equipped vehicle is designed to diagnose any conditions that could lead to excessive levels of the following emissions:

- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Oxides of nitrogen (NOx)
- Evaporative emission (EVAP) system losses

Should this vehicle's on-board diagnostic system (ECM) detect a condition that could result in excessive emissions, the ECM turns ON the MIL and stores a DTC that is associated with the condition.

Aftermarket (Add-On) Electrical And Vacuum Equipment

CAUTION: Do not attach add-on vacuum operated equipment to this vehicle. The use of add-on vacuum equipment may result in damage to vehicle components or systems.

CAUTION: Connect any add-on electrically operated equipment to the vehicle's electrical system at the battery (power and ground) in order to prevent damage to the vehicle.

Aftermarket, add-on, electrical and vacuum equipment is defined as any equipment installed on a vehicle after leaving the factory that connects to the vehicle's electrical or vacuum systems. No allowances have been made in the vehicle design for this type of equipment.

Add-on electrical equipment, even when installed to these strict guidelines, may still cause the powertrain system to malfunction. This may also include equipment not connected to the vehicle electrical system, such as portable telephones and radios. Therefore, the first step in diagnosing any powertrain condition is to eliminate all of the aftermarket electrical equipment from the vehicle. After this is done, if the problem still exists, the problem may be diagnosed in the normal manner.

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Electrostatic Discharge (ESD) Damage

NOTE: In order to prevent possible electrostatic discharge damage to the ECM, DO NOT touch the connector pins on the ECM.

The electronic components that are used in the control systems are often designed to carry very low voltage. These electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 V of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4,000 V for a person to even feel the zap of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat.

Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore, it is important to use care when handling and testing electronic components.

Emissions Control Information Label

The underhood Vehicle Emissions Control Information Label contains important emission specifications and setting procedures. In the upper left corner is the exhaust emission information. This identifies the year, the manufacturing division of the engine, the displacement of the engine in liters, the class of the vehicle, and type of fuel metering system.

This label is located in the engine compartment of every General Motors vehicle. If the label has been removed, it can be ordered from GM service parts operations (GMSPO).

Underhood Inspection

NOTE: This inspection is very important and must be done carefully and thoroughly.

Perform a careful underhood inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a condition without further steps. Use the following guidelines when performing an inspection:

- Inspect all of the vacuum hoses for correct routing, pinches, cuts, or disconnects.
- Inspect any hoses that are difficult to see.
- Inspect all of the wires in the engine compartment for the following conditions:
  - Burned or chafed spots
  - Pinched wires
  - Contact with sharp edges
  - Contact with hot exhaust manifolds

Basic Knowledge Required

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CAUTION: Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in incorrect diagnostic performance or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge.

A basic understanding of hand tools is necessary in order to effectively use this section of the Service Manual.

You must be familiar with some of the basics of engine operation and electrical diagnosis in order to use this section of the service manual.

- Basic electrical circuits-You should have an understanding of basic electricity and know the meaning of voltage (V), current (A), and resistance (ohms). You should understand what happens in a circuit with an open or a shorted wire, and you should be able to identify a shorted or open circuit by using a DMM. You should be able to read and understand a wiring diagram.
- Use of digital multimeter-You should be familiar with the DMM, particularly the essential tool. You should be able to use the meter in order to measure voltage (V), resistance (ohms), current (A), intermittents (min/max), and frequency (hz).
- Use of circuit testing tools-You should not use a test lamp to diagnose the engine controls system unless you are specifically instructed to do so. You should know how to use jumper wires in order to test components and allow DMM readings without damaging terminals. You should know how to use the **EL 35616 or J 35616:** GM Approved Terminal Test Kit connector test adapter kit and use the kit whenever the diagnostic procedures call for front probing any connector.

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

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Fig. 3: Typical Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Evaporative Emissions (EVAP) Purge Solenoid Valve
2	EVAP Canister
3	EVAP Vapor Tube
4	Vapor Recirculation Tube
5	Fuel Tank Pressure Sensor
6	Fuel Filler Cap
7	Fuel Fill Pipe Inlet Check Valve
8	Fuel Tank
9	EVAP Canister Vent Solenoid Valve
10	Vent hose
11	EVAP Purge Tube
12	Purge Tube Check Valve, Turbo-Charged Applications
13	EVAP Canister Purge Tube Connector

EVAP System Operation

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The evaporative emission (EVAP) control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the EVAP vapor tube, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent hose and EVAP canister vent solenoid valve to the atmosphere. The EVAP canister stores the fuel vapors until the engine is able to use them. At an appropriate time, the engine control module (ECM) will command the EVAP purge solenoid valve ON, allowing engine vacuum to be applied to the EVAP canister. With the normally open EVAP canister vent solenoid valve OFF, fresh air is drawn through the vent solenoid valve and the vent hose to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge tube and EVAP purge solenoid valve into the intake manifold to be consumed during normal combustion. The control module uses several tests to determine if the EVAP system is leaking or restricted.

Purge Solenoid Valve Leak Test

If the evaporative emission (EVAP) purge solenoid valve does not seal properly fuel vapors could enter the engine at an undesired time, causing driveability concerns. The ECM tests for this by commanding the EVAP purge solenoid valve OFF and the canister vent solenoid valve ON which seals the system. With the engine running, the ECM then monitors the fuel tank pressure sensor for an increase in vacuum. The ECM will log a fault if a vacuum develops in the tank under these test conditions.

Large Leak Test

This diagnostic creates a vacuum condition in the EVAP system. When the enabling criteria has been met, the control module commands the normally open EVAP canister vent solenoid valve closed and the EVAP purge solenoid valve open, creating a vacuum in the EVAP system. The ECM then monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time. Failure to achieve the expected level of vacuum indicates the presence of a large leak in the EVAP system or a restriction in the purge path. The ECM will log a fault if it detects a weaker than expected vacuum level under these test conditions.

Canister Vent Restriction Test

If the evaporative emission (EVAP) vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The control module tests this by commanding the EVAP purge solenoid valve ON while commanding the EVAP canister vent solenoid valve OFF, and then monitoring the fuel tank pressure sensor for an increase in vacuum. If the vacuum increases more than the expected amount, in a set amount of time, a fault will be logged by the ECM.

Small Leak Test

The engine off natural vacuum diagnostic is the small-leak detection diagnostic for the evaporative emission (EVAP) system. The engine off natural vacuum diagnostic monitors the EVAP system pressure with the ignition OFF. Because of this, it may be normal for the control module to remain active for up to 40 minutes after the ignition is turned OFF. This is important to remember when performing a parasitic draw test on vehicles equipped with engine off natural vacuum.

When the vehicle is driven, the temperature rises in the tank due to heat transfer from the exhaust system. After the vehicle is parked, the temperature in the tank continues to rise for a period of time, then starts to drop. The

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engine off natural vacuum diagnostic relies on this temperature change, and the corresponding pressure change in a sealed system, to determine if an EVAP system leak is present.

The engine off natural vacuum diagnostic is designed to detect leaks as small as 0.51 mm (0.020 in).

EVAP System Components

The evaporative emission (EVAP) system consists of the following components:

EVAP Canister Purge Solenoid Valve

The EVAP canister purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. The purge solenoid valve opens when commanded ON by the control module. This normally closed valve is pulse width modulated (PWM) by the control module to precisely control the flow of fuel vapor to the engine. The valve will also be opened during some portions of the EVAP testing when the engine is running, allowing engine vacuum to enter the EVAP system.

Purge Tube Check Valve

Turbocharged vehicles have a check valve in the purge tube between the EVAP purge solenoid valve and the EVAP canister to prevent pressurization of the EVAP system under boost conditions. Note that the presence of this one-way check valve prevents pressure testing the EVAP system for leaks at the EVAP canister purge tube connector.

EVAP Canister

The canister is filled with carbon pellets used to absorb and store fuel vapors. Fuel vapor is stored in the canister until the control module determines that the vapor can be consumed in the normal combustion process.

Vapor Recirculation Tube

A vapor path between the fuel fill pipe and the vapor tube to the carbon canister is necessary for Vehicle Onboard Diagnostics to fully diagnose the EVAP system. It also accommodates service diagnostic procedures by allowing the entire EVAP system to be diagnosed from the either end of the system.

Fuel Tank Pressure Sensor

The fuel tank pressure sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. The control module provides a 5 V reference and a ground to the fuel tank pressure sensor. Depending on the vehicle, the sensor can be located in the vapor space on top of the fuel tank, in the vapor tube between the canister and the tank, or on the EVAP canister. The fuel tank pressure sensor provides a signal voltage back to the control module that can vary between 0.1-4.9 V. A high fuel tank pressure sensor voltage indicates a low fuel tank pressure or vacuum. A low fuel tank pressure sensor voltage indicates a high fuel tank pressure.

Fuel Fill Pipe Check Valve

The check valve on the fuel fill pipe is there to prevent spit-back during refueling.

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EVAP Canister Vent Solenoid Valve

The EVAP vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The canister vent solenoid valve is closed only during EVAP system tests performed by the ECM.

Fuel Fill Cap

The fuel fill cap is equipped with a seal and a vacuum relief valve.

FUEL SYSTEM DESCRIPTION

Fuel System Overview

The fuel system is an electronic returnless on-demand design. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the primary fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the high pressure fuel pump. The high pressure fuel pump supplies fuel to a variable-pressure fuel rail. Fuel enters the combustion chamber through precision multi-hole fuel injectors. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the engine control module (ECM).

The primary fuel pump module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel pump module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

Electronic Returnless Fuel System

The electronic returnless fuel system is a microprocessor controlled fuel delivery system which transports fuel from the tank to the fuel rail. It functions as an electronic replacement for a traditional, mechanical fuel pressure regulator. A pressure relief regulator valve within the fuel tank provides an added measure of over pressure protection. Desired fuel pressure is commanded by the engine control module (ECM), and transmitted to the fuel pump flow control module via a GMLAN serial data message. A liquid fuel pressure sensor provides the feedback the fuel pump flow control module requires for Closed Loop fuel pressure control.

Fuel Pump Flow Control Module

The fuel pump flow control module is a serviceable GMLAN module. The fuel pump flow control module receives the desired fuel pressure message from the engine control module (ECM) and controls the fuel pump located within the fuel tank to achieve the desired fuel pressure. The fuel pump flow control module sends a 25 KHz PWM signal to the fuel pump, and pump speed is changed by varying the duty cycle of this signal. Maximum current supplied to the fuel pump is 15 A. A liquid fuel pressure sensor provides fuel pressure feedback to the fuel pump flow control module.

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Fuel Pressure Sensor

The fuel pressure sensor is a serviceable 5 V, 3-pin device. It is located on the fuel feed line forward of the fuel tank, and receives power and ground from the fuel pump flow control module through a vehicle wiring harness. The sensor provides a fuel pressure signal to the fuel pump flow control module, which is used to provide Closed Loop fuel pressure control.

Fuel Tank

The fuel tank stores the fuel supply. The fuel tank is located in the rear of the vehicle. The fuel tank is held in place by 2 metal straps that attach to the frame. The fuel tank is molded from high-density polyethylene.

The fuel tank is a saddle configuration in order to provide space for a driveshaft through the center area of the fuel tank. Because of the saddle shape of the tank, two fuel pump modules are required.

Fuel Fill Pipe

The fuel fill pipe has a built-in restrictor in order to prevent refueling with leaded fuel.

Fuel Filler Cap

The fuel fill pipe has a tethered fuel filler cap. A torque-limiting device prevents the cap from being over-tightened. To install the cap, turn the cap clockwise until you hear audible clicks. This indicates that the cap is correctly torqued and fully seated.

Fuel Pump Module

An electric turbine style fuel pump attaches to the primary fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the high pressure fuel pump. The fuel pump module contains a reverse flow check valve. The check valve maintains fuel pressure in the fuel feed pipe in order to prevent long cranking times.

Primary Fuel Pump Module

The primary fuel pump module is located inside of the right side of the fuel tank. The primary fuel pump module consists of the following major components:

- The fuel level sensor
- The fuel pump and reservoir assembly
- The fuel filter
- The pressure relief regulator valve
- The fuel strainer
- The primary jet pump
- The secondary jet pump

Secondary Fuel Pump Module

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The secondary fuel pump module is located inside of the left side of the fuel tank. The secondary fuel pump module consists of the following major components:

- The fuel level sensor
- The fuel pick-up

Fuel Level Sensor

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in correspondence with the position of the float arm. The engine control module (ECM) sends the fuel level information via the High Speed CAN-Bus to the body control module (BCM). The BCM then sends the fuel level percentage via the Low Speed CAN-Bus to the instrument cluster in order to control the fuel gauge. The control module monitors the signal circuits of the primary fuel level sensor and the secondary fuel level sensor in order to determine the fuel level.

Fuel Pump

The fuel pump is mounted in the fuel pump module reservoir. The fuel pump is an electric pump. Fuel is pumped to the high pressure fuel pump at a pressure that is based on feedback from the fuel pressure sensor. The fuel pump delivers a constant flow of fuel even during low fuel conditions and aggressive vehicle maneuvers. The fuel pump flex pipe acts to dampen the fuel pulses and noise generated by the fuel pump.

Fuel Filter

The fuel filter is located in the primary fuel pump module. The paper filter element traps particles in the fuel that may damage the fuel injection system. The filter housing is made to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Pressure Relief Regulator Valve

The pressure relief regulator valve replaces the typical fuel pressure regulator used on a mechanical returnless fuel system. The pressure relief regulator valve is closed during normal vehicle operation. The pressure relief regulator valve is used to vent pressure during hot soaks and also functions as a fuel pressure regulator in the event of the fuel pump flow control module defaulting to 100% pulse width modulation (PWM) of the fuel pump. Due to variation in the fuel system pressures, the opening pressure for the pressure relief regulator valve is set higher than the pressure that is used on a mechanical returnless fuel system pressure regulator.

Fuel Strainer

The fuel strainer attaches to the lower end of the primary fuel pump module. The fuel strainer is made of woven plastic. The functions of the fuel strainer are to filter contaminants and to wick fuel. The fuel strainer normally requires no maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment or contamination.

Primary and Secondary Jet Pumps

The primary jet pump is located in the primary fuel pump module. Fuel pump flow loss, caused by vapor

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expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel pump module.

The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the transfer pipe, to the primary side of the fuel tank.

Fuel Feed Pipes

The low pressure fuel feed pipe carries fuel from the fuel tank to the high pressure fuel pump.

The fuel feed pipe assembly located in the engine compartment connects the chassis fuel pipe to the high pressure fuel pump. This pipe contains the fuel pulse dampener and the fuel pressure service valve, and is constructed of stainless steel.

The fuel feed intermediate pipe is a high pressure pipe that carries fuel from the high pressure fuel pump to the fuel rail. The fuel feed intermediate pipe is constructed of stainless steel.

Nylon Fuel Pipes

WARNING: In order to reduce the risk of fire and personal injury observe the following items:

- **Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes**
- **Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.**
- **Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115°C (239°F) for more than one hour, or more than 90°C (194°F) for any extended period.**
- **Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)**

Nylon pipes are constructed to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Heat resistant rubber hose or corrugated plastic conduit protect the sections of the pipes that are exposed to chafing, high temperature, or vibration.

Nylon fuel pipes are somewhat flexible and can be formed around gradual turns under the vehicle. However, if nylon fuel pipes are forced into sharp bends, the pipes kink and restrict the fuel flow. Also, once exposed to

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fuel, nylon pipes may become stiffer and are more likely to kink if bent too far. Take special care when working on a vehicle with nylon fuel pipes.

Quick-Connect Fittings

Quick-connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. O-rings, located inside the female connector, provide the fuel seal. Integral locking tabs inside the female connector hold the fittings together.

High Pressure Fuel Pump

The high pressure fuel pump is a mechanical one-cylinder design driven by an additional three lobe cam on the exhaust camshaft of bank 2. High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a magnetic actuator which controls the inlet valve of the high pressure fuel pump. The ECM provides battery voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled and the inlet valve is held open with spring pressure. When activated, the actuator low control circuit driver connects the low control circuit to ground, and the actuator high control circuit driver pulse-width modulates the high control circuit. The ECM uses the camshaft and the crankshaft position sensor inputs to synchronize the actuator with the position of each of the three camshaft lobes. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the fuel rail. The high pressure fuel pump also contains an integrated pressure relief valve.

Fuel Rail Assembly

The fuel rail assembly attaches to each cylinder head. The fuel rail distributes high pressure fuel to the fuel injectors. The fuel rail assembly consists of the following components:

- The direct fuel injectors
- The fuel rail pressure sensor

Fuel Injectors

The fuel injection system is a high pressure, direct injection, returnless on-demand design. The fuel injectors are mounted in the cylinder head beneath the intake ports and spray fuel directly into the combustion chamber. Direct injection requires high fuel pressure due to the fuel injector's location in the combustion chamber. Fuel pressure must be higher than compression pressure requiring a high pressure fuel pump. The fuel injectors also require more electrical power due to the high fuel pressure. The ECM supplies a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit. The ECM controls each fuel injector with 65 V. This is controlled by a boost capacitor in the ECM. During the 65 V boost phase, the capacitor is discharged through an injector, allowing for initial injector opening. The injector is then held open with 12 V.

The fuel injector assembly is an inside opening electrical magnetic injector. The injector has six precision machined holes that generate a cone shaped oval spray pattern. The fuel injector has a slim extended tip in order to allow a sufficient cooling jacket in the cylinder head.

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Fuel Injection Fuel Rail Fuel Pressure Sensor

The fuel rail pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

Fuel Pulse Dampener

The fuel pulse dampener is a part of the low pressure fuel feed pipe assembly. The fuel pulse dampener is diaphragm-operated, with fuel pump pressure on one side and with spring pressure on the other side. The function of the dampener is to dampen the fuel pump pressure pulsations.

Engine Fueling

The engine is fueled by six individual injectors, one for each cylinder, that are controlled by the ECM. The ECM controls each injector by energizing the injector coil for a brief period once every other engine revolution. The length of this brief period, or pulse, is carefully calculated by the ECM to deliver the correct amount of fuel for proper driveability and emissions control. The period of time when the injector is energized is called the pulse width and is measured in milliseconds, thousandths of a second.

While the engine is running, the ECM is constantly monitoring the inputs and recalculating the appropriate pulse width for each injector. The pulse width calculation is based on the injector flow rate, mass of fuel the energized injector will pass per unit of time, the desired air/fuel ratio, and actual air mass in each cylinder, and is adjusted for battery voltage, short term, and long term fuel trim. The calculated pulse is timed to occur as each cylinders intake valves are closing to attain the largest duration and most vaporization.

Fueling during a crank is slightly different than fueling during an engine run. As the engine begins to turn, a prime pulse may be injected to speed starting. As soon as the ECM can determine where in the firing order the engine is, the ECM begins pulsing the injectors. The pulse width during the crank is based on the coolant temperature and the engine load.

The fueling system has several automatic adjustments in order to compensate for the differences in the fuel system hardware, the driving conditions, the fuel used, and the engine aging. The basis for the fuel control is the pulse width calculation that is described above. Included in this calculation are an adjustment for the battery voltage, the short term fuel trim, and the long term fuel trim. The battery voltage adjustment is necessary since the changes in the voltage across the injector affect the injector flow rate. The short term and the long term fuel trims are fine and coarse adjustments to the pulse width that are designed in order to maximize the driveability and emissions control. These fuel trims are based on the feedback from the oxygen sensors in the exhaust stream and are only used when the fuel control system is in a Closed Loop operation.

Under certain condition, the fueling system will turn OFF the injectors for a period of time. This is referred to as fuel shut-off. Fuel shut-off is used in order to improve traction, save fuel, improve emissions, and protect the vehicle under certain extreme or abusive conditions.

In case of a major internal problem, the ECM may be able to use a back-up fuel strategy for limp in mode that will run the engine until service can be performed.

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Sequential Fuel Injection

The ECM controls the fuel injectors based on information that the ECM receives from several information sensors. Each injector is fired individually in the engine firing order, which is called sequential fuel injection. This allows precise fuel metering to each cylinder and improves the driveability under all of the driving conditions.

The ECM has several operating modes for fuel control, depending on the information that has been received from the sensors.

Starting Mode

When the ECM detects reference pulses from the crankshaft position sensor, the ECM will enable the fuel pump. The fuel pump runs and builds up pressure in the fuel system. The ECM then monitors the mass air flow (MAF), intake air temperature (IAT), engine coolant temperature (ECT), and the throttle position sensor signal in order to determine the required injector pulse width for starting.

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the Clear Flood Mode can be manually selected. To select Clear Flood Mode, push the accelerator to wide open throttle (WOT). With this signal, the ECM will completely turn OFF the injectors and will maintain in this stage as long as the ECM indicates a WOT condition with engine speed below 1,000 RPM.

Run Mode

The run mode has 2 conditions called Open Loop and Closed Loop. When the engine is first started and the engine speed is above 480 RPM, the system goes into Open Loop operation. In Open Loop operation the ECM ignores the signals from the oxygen sensors and calculates the required fuel rail pressure and injector pulse width based primarily on inputs from the MAF, IAT, and ECT sensors.

In Closed Loop, the ECM adjusts the fuel rail pressure and injector pulse width for each bank of injectors based on the signals from each oxygen sensor.

Acceleration Mode

The ECM monitors the changes in the throttle position and the MAF sensor signals in order to determine when the vehicle is being accelerated. The ECM will then increase the fuel rail pressure and injector pulse width in order to provide more fuel for improved performance.

Deceleration Mode

The ECM monitors changes in the throttle position and MAF sensor signals to determine when the vehicle is being decelerated. The ECM will then decrease fuel rail pressure and injector pulse width or even shut-off injectors for short periods to reduce exhaust emissions, and for better, engine braking, deceleration.

Battery Voltage Correction Mode

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The ECM can compensate in order to maintain acceptable vehicle driveability when the ECM sees a low battery voltage condition. The ECM compensates by performing the following functions:

- Increasing the injector pulse width in order to maintain the proper amount of fuel being delivered
- Increasing the idle speed to increase the generator output

Fuel Shut-Off Mode

The ECM has the ability to completely turn OFF all of the injectors or selectively turn OFF some of the injectors when certain conditions are met. These fuel shut-off modes allow the ECM to protect the engine from damage and also to improve the vehicles driveability.

The ECM will disable all of the six injectors under the following conditions:

- Ignition OFF-Prevents engine run-on
- Ignition ON but no crankshaft position signal-Prevents flooding or backfiring
- A high engine speed-Above the red line
- A high vehicle speed-Above the rated tire speed
- Closed throttle coast down-Reduces the emissions and increases engine braking.

The ECM will selectively disable the injectors under the following conditions:

- The torque management enabled-Transmission shifts or abusive maneuvers.
- The traction control enabled-In conjunction with the front brakes applying

KNOCK SENSOR SYSTEM DESCRIPTION

You can diagnose all of the sensors and most of the input circuits with a scan tool. Within this section is a short description of how to use a scan tool wherever possible to diagnose these circuits. You can also use the scan tool to compare the values for an engine that is running normally with the engine you are diagnosing.

The knock sensor (KS) system detects engine knocking or pinging. The ECM will retard the spark timing based on the signals from the KS system. The KS produce an AC voltage that is sent to the engine control module (ECM). The amount of the AC voltage produced is proportional to the amount of knock.

The ECM monitors the voltage of the sensors after each cylinder has fired.

If knock occurs in any of the cylinders, the ignition will be retarded for that particular cylinder. If the knocking then stops, the ignition will be restored to what it was before in steps.

Should knocking continue in the same cylinder in spite of the ignition being retarded, the ECM will retard the ignition an additional steps, and so on, up to a maximum of 12 degrees of retard. The ignition will also be retarded at high ambient temperatures in order to counteract knocking tendencies provoked by high intake air temperatures.

Should either bank 1 or bank 2 sensor fail to work, or should an internal circuit problem occur, the ignition

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timing will then use a default strategy. The default strategy will retard the ignition the maximum allowed amount to protect the engine from possible damage.

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

Fig. 4: Throttle Actuator Control (TAC) System
Courtesy of GENERAL MOTORS CORP.

The engine control module (ECM) is the control center for the throttle actuator control (TAC) system. The ECM determines the driver's intent based on input from the accelerator pedal position sensors, then calculates the appropriate throttle response based on the throttle position sensors. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the throttle actuator motor. The throttle blade is spring loaded in both directions, and the default position is slightly open.

Modes Of Operation

Normal Mode

During the operation of the TAC system, several modes, or functions, are considered normal. The following modes may be entered during normal operations:

- Minimum pedal value-At key-up, the ECM updates the learned minimum pedal value.
- Minimum throttle position values-At key-up, the ECM updates the learned minimum throttle position value. In order to learn the minimum throttle position value, the throttle blade is moved to the Closed position.
- Ice break mode-If the throttle blade is not able to reach a predetermined minimum throttle position, the ice break mode is entered. During the ice break mode, the ECM commands the maximum pulse width several times to the throttle actuator motor in the closing direction.

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- Minimum pedal value-At key-up, the ECM updates the learned minimum pedal value.
- Battery saver mode-After a predetermined time without engine RPM, the ECM commands the Battery Saver mode. During the Battery Saver mode, the TAC module removes the voltage from the motor control circuits, which removes the current draw used to maintain the idle position and allows the throttle to return to the spring loaded default position.

Reduced Engine Power Mode

When the ECM detects a condition with the TAC system, the ECM may enter a reduced engine power mode. Reduced engine power may cause one or more of the following conditions:

- Acceleration limiting-The ECM will continue to use the accelerator pedal for throttle control, however, the vehicle acceleration is limited.
- Limited throttle mode-The ECM will continue to use the accelerator pedal for throttle control, however, the maximum throttle opening is limited.
- Throttle default mode-The ECM will turn OFF the throttle actuator motor, and the throttle will return to the spring loaded default position.
- Forced idle mode-The ECM will perform the following actions:
  - Limit engine speed to idle positioning the throttle position, or by controlling the fuel and spark if the throttle is turned OFF.
  - Ignore the accelerator pedal input.
- Engine shutdown mode-The ECM will disable fuel and de-energize the throttle actuator.

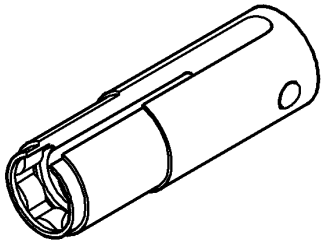
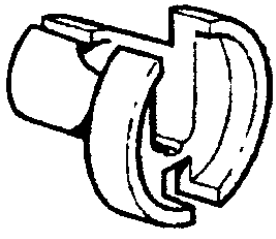
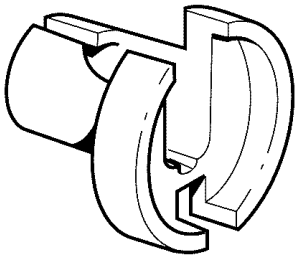
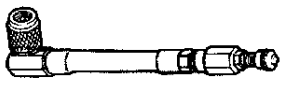
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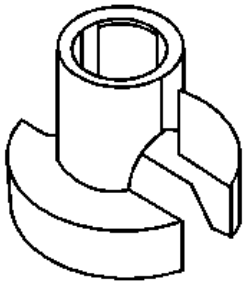
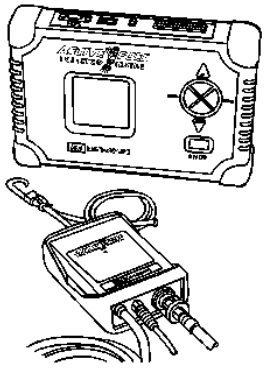
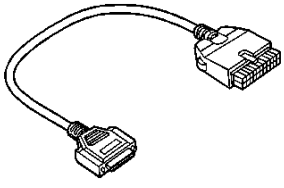
Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

SPECIAL TOOLS AND EQUIPMENT

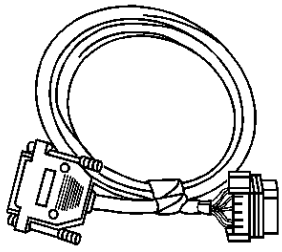
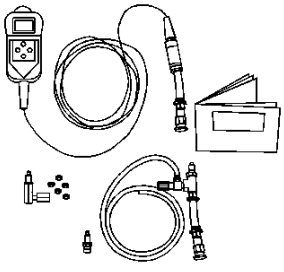
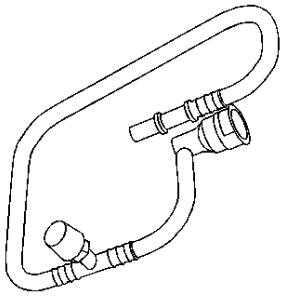
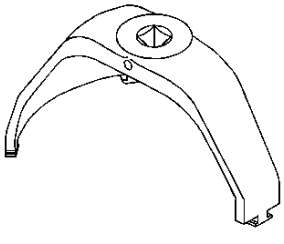
SPECIAL TOOLS

Illustration	Tool Number/Description
	CH 39194-C Oxygen Sensor Remover/Installer
	CH 41769-1 Fuel Line Quick Connect Separator 3/8
	CH 41769-2 Fuel Line Quick Connect Separator 5/16
	CH 42242 Fuel Pressure Test Hose Adapter

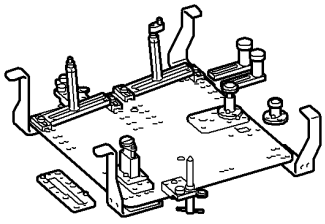
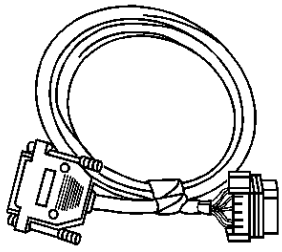
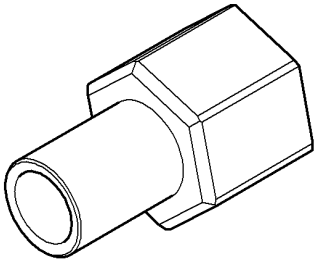
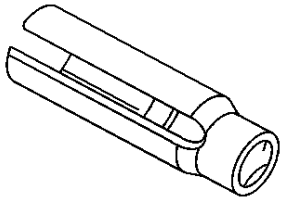
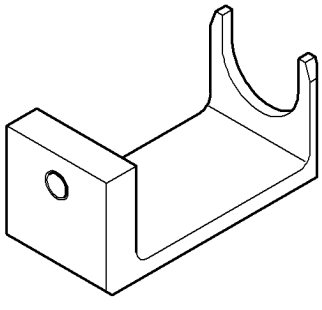
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	CH 47831 Fuel Line Disconnect Tool
	CH 47976 Active Fuel Injector Tester
	CH 47976-60 AFIT Harness Adapter
	CH 47976-75 Fuel Injector Harness Adapter

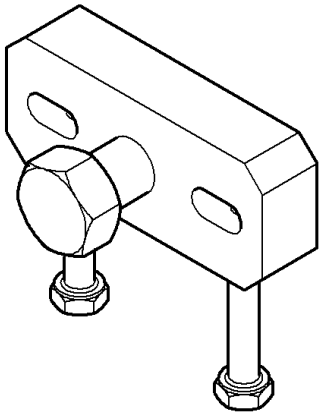
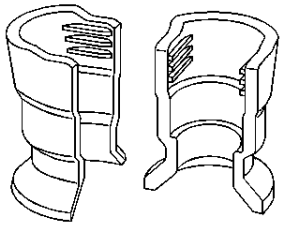
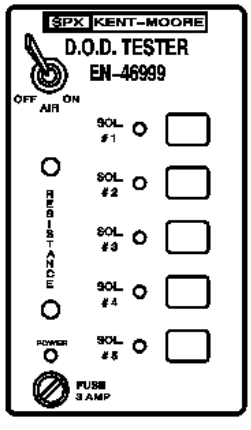
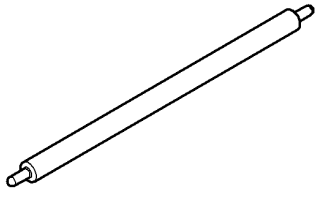
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	CH 48027 Digital Pressure Gauge
	CH 48096 EVAP Service Access Port Tool
	CH 48482 Fuel Sender Lock Ring Wrench
	CH 49290

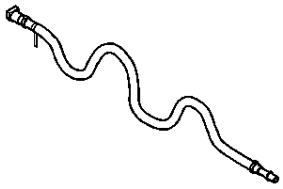
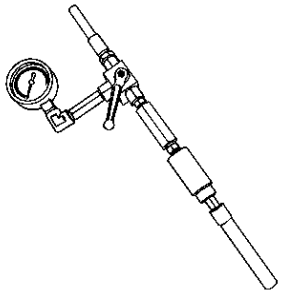
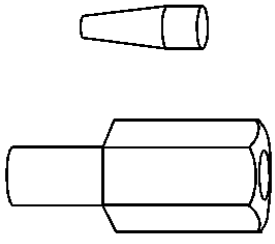
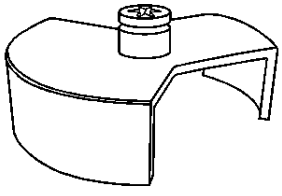
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	Centering Adapter Engine Subframe
	EL 39021-460 Fuel Injector Test Adapter
	EN 32 025 012 Sliding Hammer Adapter
	EN 46577 Oxygen Sensor Remover/Installer
	EN 46786 (32 025 013) Injector Removal Tool

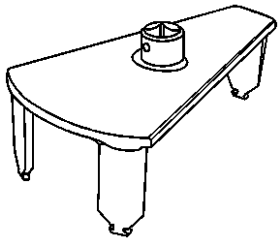
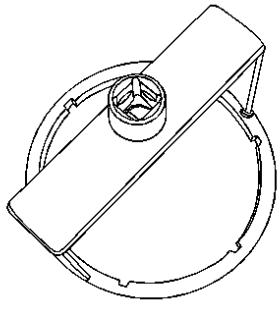
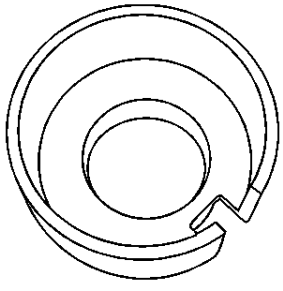
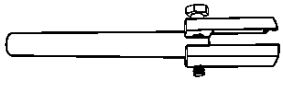
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	EN 46790 (32 025 005) Puller
	EN 46843 Quick Connect Release Tool
	EN 46999 Displacement On Demand Electric Tool
	EN 47632 (32 025 010) Cleaning Tool

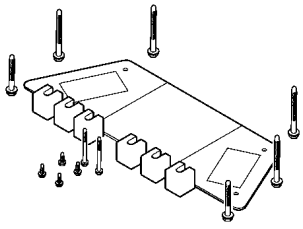
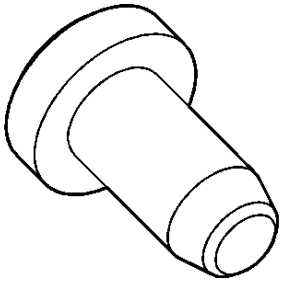
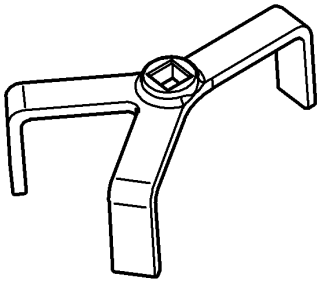
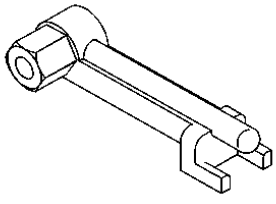
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	EN 47969 Fuel Supply Diagnostic Hose
	EN 48248 Cylinder Compression Pressure Gauge
	EN 48266 Injector Seal Installer/Sizer
	EN 48278 Sub Fuel Pump Locking Ring Remover/Installer
	EN 48279 Main Fuel Pump Locking Ring Remover/Installer

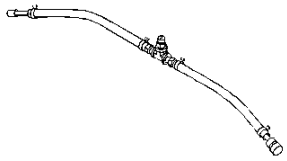
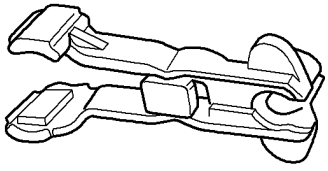
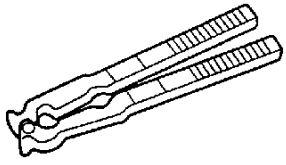
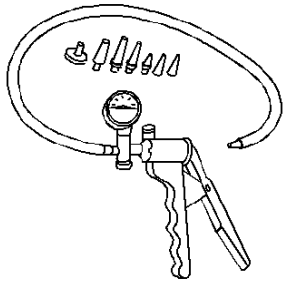
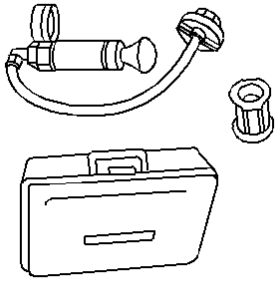
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	EN 48303 Fuel Filter Housing Holder
	EN 48304 Fuel Filter Locker Installer/Remover
	EN 48357 Injector Remover
	EN 48536 Frame Support Tool (Engine Lower 65 mm Kit)

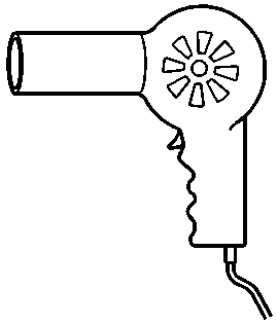
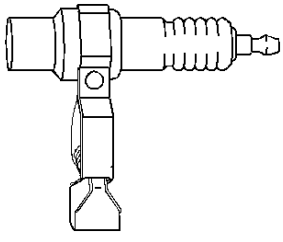
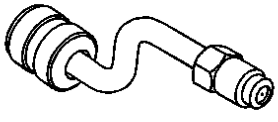
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	EN 48565 EGR Test Harness
	EN 48896 HP Fuel Pump Installation Alignment Gauge
	EN 49232 Fuel Pump Lock Ring Remover
	EN 49774 Fuel Injector Remover

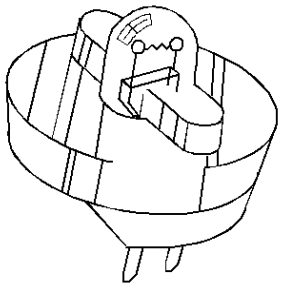
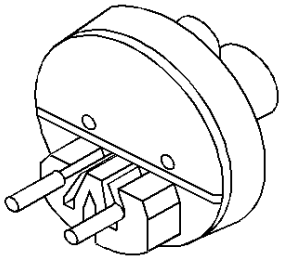
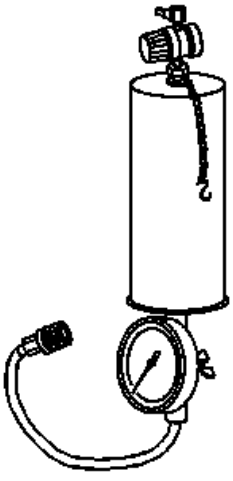
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	EN 49799 Fuel Pressure Gauge Adapter
	EN 83 95 261 Fuel Line Tool
	J 22610 Keystone Clamp Pliers
	J 23738-A (GE 23738-A) Vacuum Pump
	J 24460-A Cooling System Pressure Tester

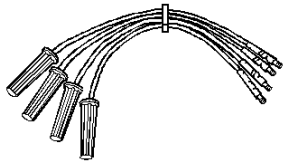
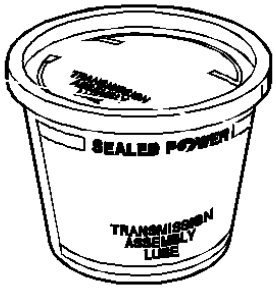
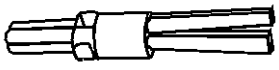
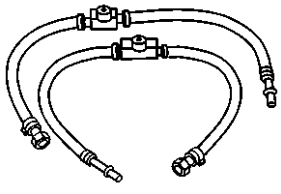
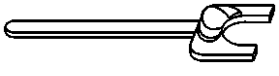
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	J 25070 Heat Gun 260-399°C (500-750°F)
	J 2619-01 (DT 2619-01) Slide Hammer
	J 26792 (EL 26792) HEI Spark Tester
	J 34730-262 (CH 34730-262) Fuel Pressure Test Gauge Adapter
	J 34730-375 Injector Test Lamp

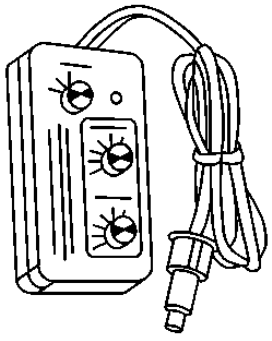
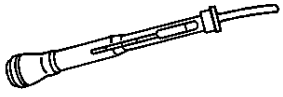
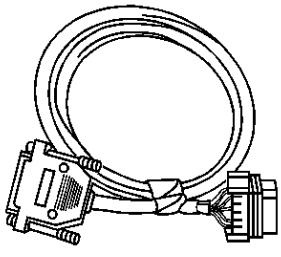
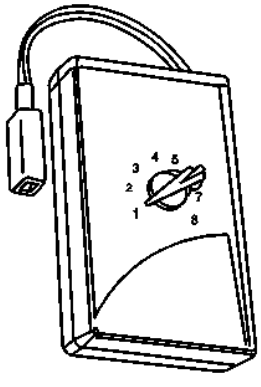
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	J 34730-405 (EL 34730-405) Injector Test Lamp
	J 35800-A (CH 35800-A) Fuel Injector Cleaner
	J 36012-A Ignition System Diagnostic Harness

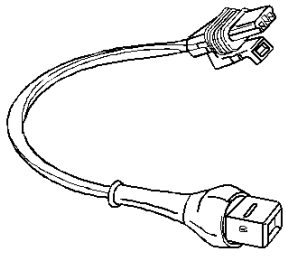
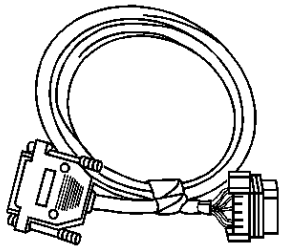
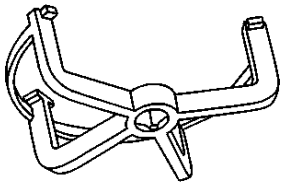
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	J 36850 (DT 36850) Transjel Lubricant
	J 37281-A (EN 37281-A) Injector Remover
	J 37287 (EN 37287) Fuel Line Shut-Off Adaptors (Flex Fuel)
	J 38491 Spark Plug Boot Removal Tool

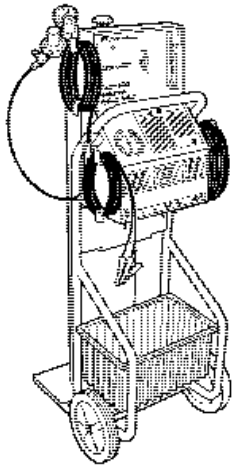
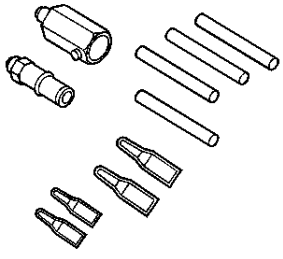
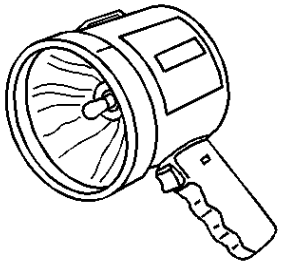
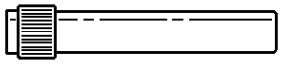
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	J 38522 (EN 38522) Variable Signal Generator
	J 38641-B (CH 38641-C) Diesel Fuel Quality Tester
	J 39021 (EL 39021) Fuel Injector Coil and Balancer Tester
	J 39021-210 (EL 39021-210) Injector Tester Adapter Box

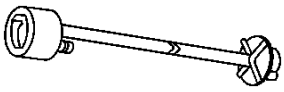
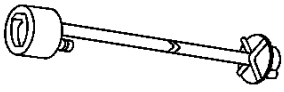
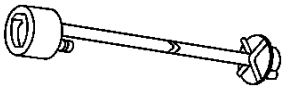
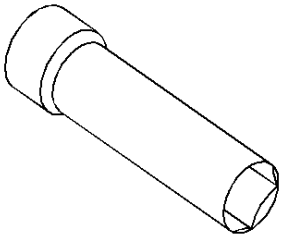
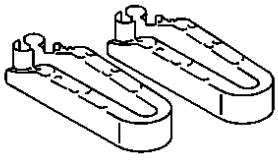
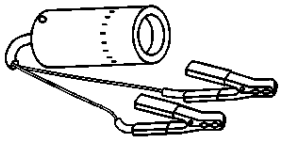
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	J 39021-380 (CH 39021-380) Fuel Injector Harness Adapter
	J 39021-450 (CH 39021-450) Fuel Injector Harness Adapter
	J 39765 Fuel Sender Locknut Wrench
	J 41413-200 (GE 41413-200) Evaporative Emissions System Tester (EEST)

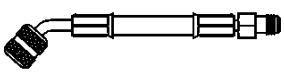
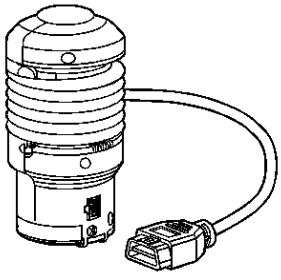
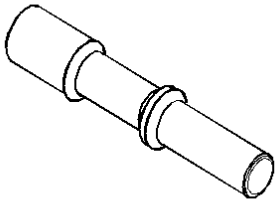
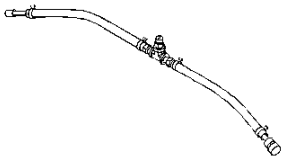
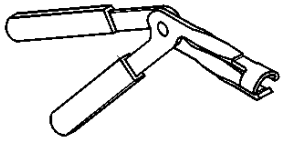
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	J 41413-300 (GE 41413-300) EVAP Cap and Plug Kit
	J 41413-SPT (GE 41413-SPT) High Intensity White Light
	J 41413-VLV (EN 41413-VLV) EVAP Service Port Vent Fitting

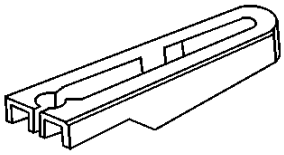
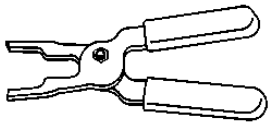
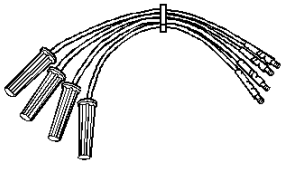
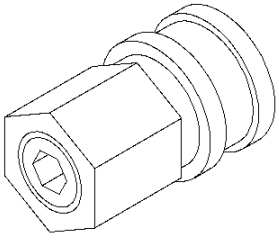
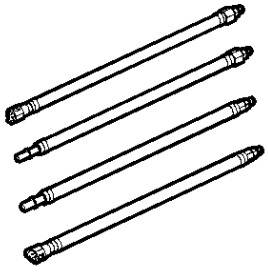
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	J 41415-30 Fuel Tank Cap Adapter
	J 41415-40 (GE 41415-40) Fuel Tank Cap Adapter
	J 41415-50 (GE 41415-50) Fuel Tank Cap Adapter
	J 41515-A Glow Plug Socket
	J 41769 (EN 41769) (KM J 41769) Fuel Line Disconnect Tool Set
	J 42220 (CH 42220) Universal 12-Volt Leak Detection Lamp
	J 42242 (CH 42242)

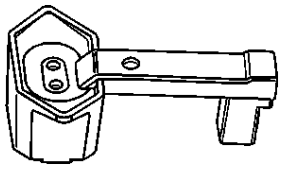
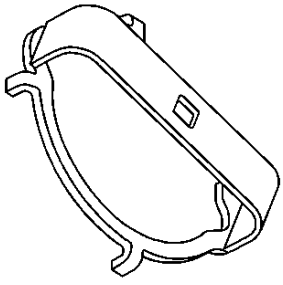
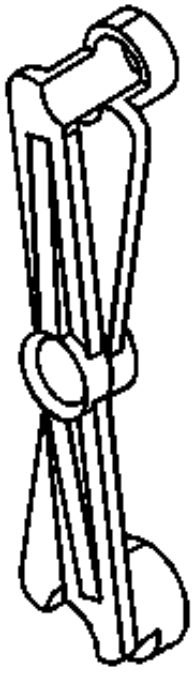
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	Fuel Pressure Gauge Adapter
	J 42598-B Vehicle Data Recorder
	J 42960-2 (CH 42960-2) Fuel Flapper Door Holder
	J 42982 (CH 42982) Fuel Pressure Gauge Adapter
	J 43094 Spark Plug Boot Puller
	J 43178 (CH 43178) Fuel Line Disconnect Tool

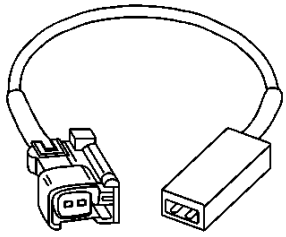
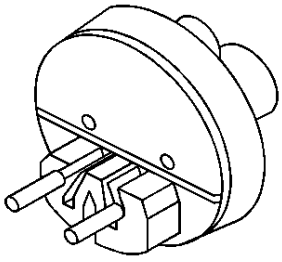
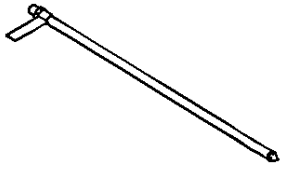
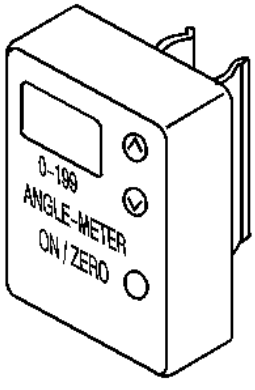
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	J 43244 (EL 43244) Relay Puller Pliers
	J 43883 Ignition System Diagnosis Harness
	J 43936 (EN 43936) Fuel Pressure Adapter Cap
	J 43937 (EN 43937) Fuel Pressure Adapter Lines

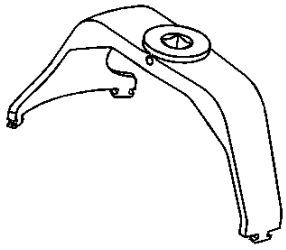
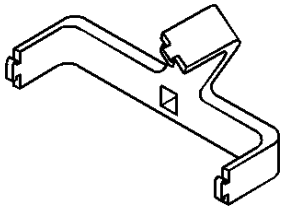
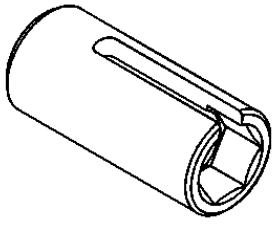
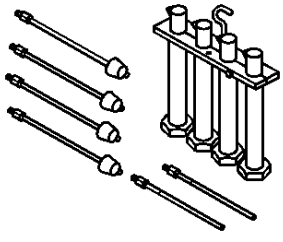
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	J 44175 (CH 44175) Fuel Composition Tester
	J 44402 Fuel Tank Sending Unit Wrench
	J 44581 (CH 44581) Fuel Line Disconnect Tool

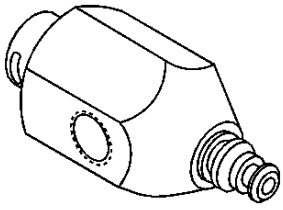
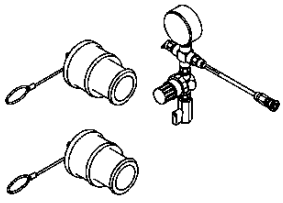
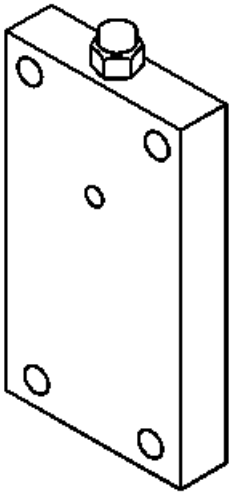
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	J 44602 (EN 44602) Injector Test Adapter
	J 44603 (CH 44603) Injector Test Lamp
	J 45004 (CH 45004) Fuel Tank Drain Hose
	J 45059 Angle Meter

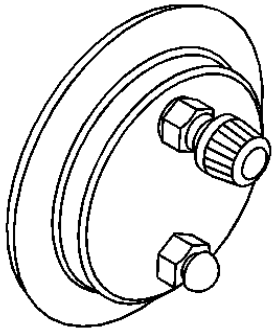
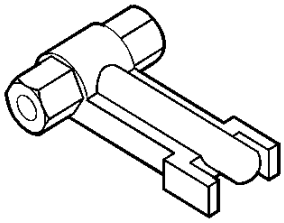
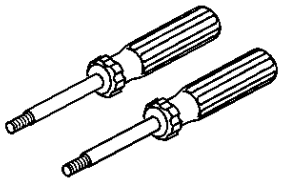
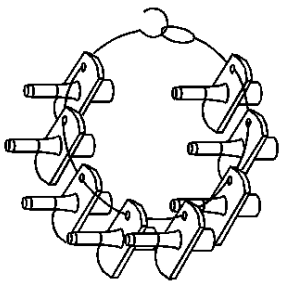
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	J 45722 (CH 45722) Fuel Sender Lock Ring Wrench
	J 45747 (CH 45747) Wrench, Fuel Sending Unit
	J 45861 (CH 45861) ECT Sensor Socket
	J 45873 (CH 45873) Fuel Return Volume Test Kit
	J 45873-30 (EN 45873-30) Injector Flow Test Adapter

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	J 46091 (EN 46091) Charge Air Cooler Tester
	J 46091-5 (EN 46091-5) Charge Air Cooler Tester Adapter
	J 46091-15 (EN 46091-15) Engine Pressure Test Adapter

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	J 46594 (EN 46594) Fuel Injector Puller
	KM 6009 Remover/Installer
	KM 807 Closure Plugs

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE - ENGINE COOLANT TEMPERATURE SENSOR

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Engine Coolant Temperature (ECT)		
-40/-40	40,490	50,136
-20/-4	14,096	16,827
-10/14	8,642	10,152
0/32	5,466	6,326
20/68	2,351	2,649
25/77	1,941	2,173
40/104	1,118	1,231
60/140	573	618
80/176	313	332
100/212	182	191
120/248	109	116
140/284	068	074

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Intake Air Temperature (IAT) Sensor		
-40/-40	35,140	43,760
-20/-4	12,660	15,120
-10/14	7,943	9,307
0/32	5,119	5,892
20/68	2,290	2,551
25/77	1,900	2,100
40/104	1,096	1,238
60/140	565	654
80/176	312	370
100/212	184	222
120/248	114	141
140/284	74	93

ALTITUDE VERSUS BAROMETRIC PRESSURE

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Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (psi)
Determine your altitude by contacting a local weather station or by using another reference source.			
4 267	14,000	56-64	8.1-9.3
3 962	13,000	58-66	8.4-9.6
3 658	12,000	61-69	8.8-10.0
3 353	11,000	64-72	9.3-10.4
3 048	10,000	66-74	9.6-10.7
2 743	9,000	69-77	10.0-11.2
2 438	8,000	71-79	10.3-11.5
2 134	7,000	74-82	10.7-11.9
1 829	6,000	77-85	11.2-12.3
1 524	5,000	80-88	11.6-12.8
1 219	4,000	83-91	12.0-13.2
914	3,000	87-95	12.6-13.8
610	2,000	90-98	13.1-14.2
305	1,000	94-102	13.6-14.8
0	0 Sea Level	96-104	13.9-15.1
-305	-1,000	101-105	14.6-15.2

IGNITION SYSTEM SPECIFICATIONS

Application	Specification	
	Metric	English
Firing Order	1-2-3-4-5-6	
Spark Plug Gap (non-adjustable)	1.10 mm	0.044 in
Spark Plug Torque	20 N.m	15 lb ft
Spark Plug Type	AC 41-990	

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Accelerator Pedal Position (APP) Sensor to Body Retaining Bolt	9 N.m	80 lb in
Air Cleaner Lower Housing to Body Retaining Bolt	10 N.m	89 lb in
Camshaft Position (CMP) Actuator Solenoid Valve to Engine Front Cover Retaining Bolt	9 N.m	80 lb in
Camshaft Position (CMP) Sensor to Engine Front Cover Retaining Bolt	10 N.m	89 lb in
Crankshaft Position (CKP) Sensor to Engine Block	10 N.m	89 lb in

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Retaining Bolt		
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft
Evaporative Emission (EVAP) Canister to Underbody Retaining Bolt	6 N.m	53 lb in
Fuel Pipe Stone Guard to Underbody Retaining Nut	5 N.m	44 lb in
Fuel Rail to Lower Inlet Manifold Retaining Bolt	10 N.m	89 lb in
Fuel Tank Hose to Filler Tube Clamp	4 N.m	35 lb in
Fuel Tank Strap to Underbody Retaining Bolt	30 N.m	22 lb ft
Filler Tube Support Bracket to Body Retaining Bolt	9 N.m	80 lb in
Heated Oxygen Sensor (HO2S)	42 N.m	31 lb ft
Ignition Coil to Camshaft Cover Retaining Bolt	10 N.m	89 lb in
Intake Manifold Runner Control Solenoid to Upper Intake Manifold Retaining Bolt	10 N.m	89 lb in
Knock Sensor to Engine Block Retaining Bolt	23 N.m	17 lb ft
Mass Airflow Sensor with Intake Air Temperature (MAF) Sensor to Air Cleaner Upper Housing Retaining Screw	4 N.m	35 lb in
Rear Frame to Underbody Retaining Bolt		
• First pass	65 N.m	48 lb ft
• Final pass	+ 120 Degrees	
Spark Plug		
• Fit New Spark Plug	20 N.m	15 lb ft
• Refit Existing Spark Plug	18 N.m	13 lb ft
Throttle Body to Upper Intake Manifold Retaining Bolt	10 N.m	89 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
All Purpose Parts Cleaner	Cleaner	12378553	88900920
Anti-Seize Compound	Lubricant	88862477	88862478
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Engine Oil	5W-30 Oil	12345610	993193
Fuel Injection Fuel Rail Bolts	Threadlock	12345382	10953489
Intake Air Temperature Sensor Threads	Sealant	12346004	10953480

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

SYMPTOMS - ENGINE CONTROLS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

SYMPTOMS DESCRIPTION

Driveability symptoms do not set DTCs. The driveability symptoms are defined below. Certain conditions can cause multiple symptoms. These conditions are listed together. Additional conditions that may only cause certain symptoms are listed separately. Perform the Symptoms Testing before using the Additional Symptoms Tests.

SYMPTOMS DEFINITION

Backfire

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Hard Start

Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

Hesitation, Sag, Stumble

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Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Poor Fuel Fill Quality

Difficulty when refueling the vehicle.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

Surges/Chuggles

Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

SYMPTOMS VERIFICATION

- The engine control module (ECM) and the malfunction indicator lamp (MIL) are operating correctly.
- There are no DTCs stored.
- The scan tool data is within the normal operating range.
- Bulletins are not available for the current symptom.
- The ECM grounds are clean, tight, and in the correct locations.
- The vehicle tires are correctly inflated and meet original equipment specifications.
- The air filter element is not restricted.
- If equipped, inspect the hydro-carbon (HC) absorber in the air cleaner assembly for ruptures that would leak charcoal into the air intake, contaminating the sensing element of the mass air flow (MAF) sensor.

SYMPTOMS TESTING

1. Test for the following conditions:
    - The fuel system for the following:

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  - Correct fuel pressure-Refer to **Fuel System Diagnosis**.
  - Fuel injectors that are leaking or improper operation-Refer to **Fuel Injector Solenoid Coil Test**.
  - Contaminated or a poor fuel quality condition-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)**.
- The ignition system for the following:
  - Spark plugs for incorrect heat range or an abnormal condition-Refer to **Spark Plug Inspection** .
  - For diagnosis of coolant or oil fouled spark plugs-Refer to **Loss of Coolant** or **Oil Consumption Diagnosis** .
  - Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
  - Weak spark using the **J 26792** Spark Tester-Refer to **Electronic Ignition System Diagnosis**.
- The operation of the transmission torque converter clutch (TCC)-The scan tool should indicate an engine speed drop when the TCC is commanded ON.
- The operation of the A/C compressor
- Items that can cause an engine to run lean or rich-Refer to **DTC P2177, P2179, P2187, or P2189 (LLT)** .
- The crankshaft position (CKP) sensor for an intermittent condition-Observe the scan tool CKP Resync parameter. The Resync parameter should remain at 0 during all operating conditions, and when moving the related harnesses and connectors between the CKP sensor and the ECM.
- The engine for the following mechanical failures-Refer to **Symptoms - Engine Mechanical** .
  - Excessive oil in the combustion chamber or leaking valve seals
  - Incorrect cylinder compression
  - Sticking or leaking valves
  - Worn camshaft lobes
  - Incorrect valve timing
  - Broken valve springs
  - Excessive carbon buildup in the combustion chambers-Clean the chambers with top engine cleaner. Follow the instructions on the can.
  - Incorrect engine parts
- Vacuum hoses for splits or kinks
- Knock sensor (KS) system for excessive spark retard activity-Observe the Knock Retard parameter for activity greater than 0°.
- The exhaust system components for the following:
  - Physical damage or possible internal failure
  - The three-way catalytic converters for a restriction

  For more information, refer to **Symptoms - Engine Exhaust** .

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- Electromagnetic interference (EMI) on an ignition control circuit can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuits if a condition exists.
- Inspect the positive crankcase ventilation (PCV) system and all connections for leaks or restrictions.
- Evaporative emission (EVAP) canister purge solenoid that is stuck open
- The engine cooling system for the following conditions:
  - The thermostat is the correct heat range-Refer to **Thermostat Diagnosis** .
  - Proper engine coolant level-Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

ADDITIONAL SYMPTOMS TESTS

Detonation/Spark Knock

Test the engine for an overheating condition. Refer to **Engine Overheating** .

Poor Fuel Economy

Inspect for foreign material accumulation in the throttle bore, and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

Rough, Unstable, or Incorrect Idle and Stalling

Inspect the engine mounts. Refer to **Engine Mount Inspection** .

Surges/Chuggles

Test the heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a driveability condition.

Hard Start

- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within ± 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specification, test the ECT

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circuits for a high resistance.

- Test the fuel pump operation. The fuel pump should turn ON for 2 s when the ignition is turned ON. Refer to **Fuel System Diagnosis**.

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to **Fuel System Diagnosis**.
- Test the generator. Refer to **Symptoms - Engine Electrical** . Repair the charging system if the generator output voltage is less than 9 V or more than 16 V.

Poor Fuel Economy

- Heavy loads being carried or towed
- Acceleration rate too much or too often
- Inspect for foreign material accumulation in the throttle bore, and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

POOR FUEL FILL QUALITY

Problem	Causes
DEFINITION: During the fueling process a continual, occasional or no fuel nozzle shut-off condition has occurred.	
Difficult to fill	• Fuel fill limiter vent valve stuck closed • Evaporative emission (EVAP) canister restricted • EVAP vent valve stuck closed • Hose between canister and canister vent solenoid twisted or kinked if applicable • High fuel temperature • Fuel filler hose is kinked • Faulty dispensing nozzle • Ignition switch ON, vent valve closed
Over fill	• Fill limiter vent valve stuck open or leaking • Fuel inlet check valve stuck open
Pre-mature shut-off of the fuel dispensing nozzle occurs immediately after engaging dispensing nozzle, tank empty	• Restricted vapor lines or fuel fill pipe • High fuel temperature • Inlet check valve at tank stuck closed, fill pipe full of fuel • Fuel tank full, gauge not accurate
Pre-mature shut-off of the fuel dispensing nozzle, more than 1/8 of tank capacity dispensed	• Kinked, pinched or plugged lines in fuel tank vent system • EVAP vent valve stuck closed or restricted • EVAP canister restricted

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	• Fuel limiting vent valve stuck closed or obstruction at top of fuel tank
Fuel Spitback	• Restricted EVAP canister • High fuel temperature • Ignition switch ON, EVAP vent valve closed

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example, a failure condition exists if the ECM detects low voltage when the MIL is commanded OFF, or high voltage when the MIL is commanded ON.

REFERENCE INFORMATION

Schematic Reference

- **Instrument Cluster Schematics**
- **Engine Controls Schematics**

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

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CIRCUIT/SYSTEM VERIFICATION

NOTE: Any MIL requesting DTCs that may be set should be diagnosed first.

1. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
2. Ignition ON, command the MIL ON and OFF with a scan tool while observing the following control circuit status parameters:
   - MIL Control Circuit Low Voltage Test Status
   - MIL Control Circuit Open Test Status
   - MIL Control Circuit High Voltage Test Status

   Each parameter should toggle between OK and Not Run or Not Run and OK.

CIRCUIT/SYSTEM TESTING

1. If any other IPC indicators or gauges are inoperative, refer to **Instrument Cluster Gauges Inoperative** .
2. Ignition OFF, disconnect the K20 ECM harness connectors. Ignition ON, the MIL should not illuminate.
   - If the MIL is illuminated, test the MIL control circuit terminal X2-21 for a short to ground. If the circuit tests normal, replace the P16 IPC.
3. Ignition ON, connect a 3 A fused jumper wire between the MIL control circuit terminal X2-21 and ground. The MIL should illuminate.
   - If the MIL does not illuminate, test the MIL control circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the P16 IPC/bulb.
4. If all circuits/connections test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Instrument Cluster Replacement**
- **Control Module References** for ECM replacement, setup, and programming

ENGINE CRANKS BUT DOES NOT RUN

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes

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the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

DIAGNOSTIC AIDS

Inspect for any of the following conditions:

- The Immobilizer system is not designed to have the key FOB folded 90 degrees when attempting to start the engine. This may cause an intermittent no start condition. If you receive a customer complaint of an intermittent no start condition, verify that the customer is not folding the key while attempting to start the engine. The fob must be parallel to the key to function properly.
- The engine control module (ECM) uses the camshaft position (CMP) sensors to determine engine speed and position when there is a crankshaft position (CKP) sensor condition.
- The engine will operate with a CKP sensor condition only if the ECM has stored the learned reference position of the camshafts in memory. With a CKP sensor condition in the signal circuit, the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from one of the CMP sensors.
- The fuel pump flow control module (FPCM) controls and monitors the operation of the in-tank fuel pump. If the FPCM detects a fault, a DTC sets in the FPCM. The FPCM will then send a serial data message to the engine control module (ECM) requesting the illumination of the malfunction indicator lamp (MIL).
- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition. Refer to **Fuel Injector Solenoid Coil Test**.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK, and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Inspect the engine for good secure electrical grounds.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 minutes in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- A vehicle that starts and runs after being brought to the repair shop for a no start condition, may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to check for an engine starting or will not stay running concern.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48027:** Digital Pressure Gauge
- **J 26792:** Spark Tester
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

NOTE: This diagnostic assumes the following:

- **The battery is completely charged. Refer to Battery Inspection/Test .**
- **The engine cranking speed is acceptable. Refer to Engine Cranks Slowly .**
- **There is adequate fuel in the fuel tank.**

1. Attempt to start the engine. Observe the DTC information with a scan tool. Verify that DTC P0116, P0118, P0119, P0335, P0336, P0338, P0513, P0601, P0602, P0603-P0606, P062B, P0627, P0628, P0629, P0633, P0685, P0690, P069E, P1631, P1649, P167D, P1682, P2105, or U0109 does not set.
   - If any of the listed DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, observe the Theft Deterrent parameter with a scan tool. The parameter should display Disabled.
   - If Enabled is displayed, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Test the ignition system for spark. Refer to **Electronic Ignition System Diagnosis**.
4. Ignition ON, command the fuel pump ON with a scan tool. You should hear the fuel pump turn ON.
   - If the fuel pump does not turn ON, refer to **Fuel System Diagnosis**.

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5. Ignition OFF, install the **CH 48027:** Digital Pressure Gauge.

NOTE:

- **The fuel pump may need to be commanded ON a few times, in order to obtain the highest possible fuel pressure.**
- **Do NOT start the engine for this test.**

6. Ignition ON, command an increase in the fuel line pressure with a scan tool. The fuel line pressure should increase to greater than 410 kPa (60 psi) as commanded.
   - If the fuel pressure is not within range, refer to **Fuel System Diagnosis**.
7. Verify that the following conditions do not exist:
   - Disconnect the MAF sensor. The engine control module (ECM) will ignore the MAF sensor and default to the calculated air flow.
   - If disconnecting the MAF sensor corrects the condition and the connections are OK, replace the B75 MAF sensor. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
8. Collapsed air intake duct to the throttle body
9. Restricted air filter element
10. Spark plugs for being gas or coolant fouled
11. A skewed engine coolant temperature (ECT) sensor-Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** .
12. Exhaust system restricted-Refer to **Restricted Exhaust** .
13. Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)**.
14. Engine mechanical condition, for example, worn timing chain and gears, low compression-Refer to **Symptoms - Engine Mechanical** .

   - If you find any of the above conditions, repair as necessary.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

FUEL PUMP ELECTRICAL CIRCUIT DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DIAGNOSTIC FAULT INFORMATION

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Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
Fuel Pump High Signal	P0231	P023F	P0232	P023F, P2635
Fuel Pump Low Signal	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for two seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

Ignition ON, command the fuel pump ON and OFF using the scan tool ECM output control. The fuel pump should turn on and off.

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CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Ignition ON, command the G12 fuel pump ON and OFF using a scan tool ECM fuel pump output control. The test lamp should turn ON and OFF, as commanded.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the G12 fuel pump ON using a scan tool. The test lamp should illuminate.
    - If the test lamp does not illuminate, test the low reference circuit terminal 1 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. If all circuits test normal, replace the G12 fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

FUEL SYSTEM DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The fuel system is an electronic returnless on-demand design. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the primary fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the high pressure fuel pump. The high pressure fuel pump supplies fuel to a variable-pressure fuel rail. Fuel enters the combustion chamber through precision multi-hole fuel injectors. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the engine control module (ECM).

The primary fuel pump module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the primary jet pump and the

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secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel pump module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

REFERENCE INFORMATION

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48027:** Digital Pressure Gauge
- **J 37287:** Fuel Line Shut-off Adapter

CIRCUIT/SYSTEM VERIFICATION

NOTE:

- **Repair all fuel system related DTCs before performing this diagnostic.**
- **Inspect the fuel system for damage or external leaks before proceeding.**
- **Verify that adequate fuel is in the fuel tank before proceeding.**
- **The Fuel Pump Enable may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.**

1. Ignition OFF, all accessories OFF, install a **CH 48027:** Gauge. Refer to **Fuel Pressure Gauge Installation and Removal** .

NOTE: **High fuel pressure readings may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase to the setting of the pressure relief regulator valve, approximately 580 kPa (84 psi).**

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2. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool. Verify the fuel pressure is between 276-448 kPa (40-65 psi) and does not decrease more than 34 kPa (5 psi) in 1 min.
3. Engine idling at normal operating temperature, verify the scan tool Fuel Pump Control Module Fuel Pressure Sensor parameter is between 276-324 kPa (40-47 psi).

CIRCUIT/SYSTEM TESTING

NOTE:

- **The Fuel Pump Enable may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **DO NOT start the engine.**
- **High fuel pressure readings may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase to the setting of the pressure relief regulator valve, approximately 580 kPa (84 psi).**

1. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool and observe the fuel pressure gauge while the fuel pump is operating. Verify the fuel pressure is between 276-448 kPa (40-65 psi).
    - If the fuel pressure is less than the specified range, test, inspect, and repair the items listed below. If all items test normal, replace the primary fuel pump module.
        - Restricted fuel feed pipe
        - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
2. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 min.
    - If the fuel pressure decreases more than the specified value, perform the following procedure:
        1. Ignition OFF, relieve the fuel pressure. Refer to **Fuel Pressure Relief** .
        2. Install the **J 37287:** Adapter between the chassis fuel feed hose and the engine compartment fuel feed pipe.
        3. Open the valve on the **J 37287:** Adapter.
        4. Ignition ON, command the Fuel Pump Enable ON with a scan tool and bleed the air from the **CH 48027:** Gauge.
        5. Command the Fuel Pump Enable ON and then OFF with a scan tool.
        6. Close the valve on the **J 37287:** Adapter.
        7. Monitor the fuel pressure for 1 min.
            - If the fuel pressure does not decrease more than 34 kPa (5 psi) within the specified time, replace the primary fuel pump module.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify that the fuel pressure does not decrease more than 14 kPa (2 psi) in 5 min.
    - If the fuel pressure decreases more than the specified value, replace the primary fuel pump module.
4. Operate the vehicle within the conditions of the customer's concern while monitoring the fuel pressure with the **CH 48027:** Gauge. The fuel pressure should not drop off during acceleration, cruise or hard cornering.
    - If the fuel pressure drops off, test, inspect, and repair the items listed below. If all items test normal, replace the primary fuel pump module.

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- Restricted fuel feed pipe
- Inspect the harness connectors and the ground circuits of the fuel pump for poor connections

5. If the fuel system tests normal, refer to **Symptoms - Engine Controls**.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Feed Pipe Replacement**
- **Fuel Line Replacement - Chassis**
- **Fuel Tank Fuel Pump Module Replacement - Right Side**

FUEL INJECTOR SOLENOID COIL TEST

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit. The ECM controls each fuel injector with 65 V. This is controlled by a boost capacitor in the ECM. During the 65 V boost phase, the capacitor is discharged through an injector, allowing for initial injector opening. The injector is then held open with 12 V. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

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COMPONENT TESTING

NOTE:

- **The resistance test must be performed at the fuel injector or mis-diagnosis will occur.**
- **The DMM and test leads must be calibrated to 0 ohms in order to prevent mis-diagnosis.**

Verify the resistance of each Q17 fuel injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each Q17 fuel injector should be 1.25-1.75 ohms.
  - If not within the specified range, replace the Q17 fuel injector.
- If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each Q17 fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 0.45 ohms.
  - If the difference is more than 0.45 ohms, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the Q17 fuel injector that displays the greatest difference above or below the average.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Fuel Injector Replacement

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (WITH SPECIAL TOOL)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with greater than 10 percent ethanol could result in driveability conditions such as hesitation,

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lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

TEST PROCEDURE

1. Test the fuel composition using **J 44175** Fuel Composition Tester and J44175-3 Instruction Manual. See **Special Tools** .
2. If water appears in the fuel sample clean the fuel system, refer to **Fuel System Cleaning** .
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample. Refer to the examples in the Fuel Composition Test Examples table.
4. If the fuel sample contains greater than 15 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
5. Test the fuel composition.
6. If testing shows the ethanol percentage is still greater than 15 percent, replace the fuel in the vehicle. Refer to **Fuel Tank Draining** .

Fuel Composition Test Examples

-	Frequency (Hz)	Subtract 50	Ethanol Percent
Example A	50 Hz	-50	0
Example B	65 Hz	-50	15
Example C	129 Hz	-50	79

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (WITHOUT SPECIAL TOOL)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel rail, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust, or deterioration.

Alcohol concentrations greater than 10 percent in the fuel can be detrimental to fuel system components. Alcohol contamination may cause fuel system corrosion, deterioration of rubber components, and subsequent fuel filter restriction. Fuel contaminated with alcohol may cause driveability conditions such as hesitation, lack of power, stalling, or no start. Some types of alcohol are more detrimental to fuel system components than others.

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ALCOHOL IN FUEL TESTING PROCEDURE

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If alcohol contamination is suspected then use the following procedure to test the fuel quality.

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.34 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation.

If alcohol is present in the fuel, the volume of the lower layer, that now contains both alcohol and water, will be greater than 10 ml (0.37 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

PARTICULATE CONTAMINANTS IN FUEL TESTING PROCEDURE

The fuel sample should be drawn from the bottom of the tank so that any contaminants present in the tank will be detected. The sample should be bright and clear. If the sample appears cloudy or contaminated with water as indicated by a water layer at the bottom of the sample, use the following procedure to diagnose the fuel.

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the cylinder on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination.

Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles. If particles are found, clean the entire fuel system thoroughly. Refer to **Fuel System Cleaning** .

EVAPORATIVE EMISSION SYSTEM DIAGNOSIS

OPERATING INSTRUCTIONS FOR THE EVAPORATIVE EMISSION SYSTEM TESTER (EEST)

Vehicle Setup

NOTE: A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow enough time, at least 15 minutes, for the vehicle temperature to adjust to the shop temperature. Refer to Temperature Variation Instructions for more

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information about vehicle versus shop temperatures.

1. Engine OFF, open the hood. Position a large fan to blow air under the vehicle onto the fuel tank area.
2. Connect the red battery clip from the tester to the positive battery terminal.

NOTE: The vehicle battery must be fully charged for optimum tester performance.

3. Connect the black battery clip from the tester to chassis ground.

FLOWMETER TEST - LEAK DETECTION

1. Open the Nitrogen tank valve and turn the NITROGEN/SMOKE valve on the front control panel to NITROGEN.
2. Connect the hose to the correct test orifice on the bottom front of the tester. For orifice size, refer to the GM Service manual for the vehicle being tested. The vehicle specific information can be found in service procedures for DTCs that relate to evaporative emission (EVAP) system leaks.
3. Press and release the remote switch to activate the tester.
4. Position the sliding red flag on the flowmeter to align with the floating indicator. When the red flag is set, press and release the remote switch to deactivate the tester.
5. Remove the hose from the test orifice and install the hose onto the vehicle. For proper connection location, and the special tool numbers for any adapters that may be required, refer to the service procedures for DTCs that relate to EVAP system leaks.
6. Ignition ON, seal the EVAP system per instructions in the service procedures for DTCs that relate to EVAP system leaks. Most systems can be sealed using a scan tool output control for the EVAP canister vent solenoid valve, other systems require that the vent system be plugged.

NOTE:

- **Larger volume fuel tanks, and/or those with lower fuel levels, may require several minutes to fill with nitrogen.**
- **Static buildup may cause the float indicator to stick. It may be necessary to tap on the flowmeter to free up the float.**

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Compare the stable floating indicator position to the red flag.
   - ABOVE the red flag, the result is UNACCEPTABLE, FAIL-Go to Smoke Procedure
   - BELOW the red flag, the result is ACCEPTABLE, PASS-Test complete
9. Press and release the remote switch to deactivate the tester.

SMOKE PROCEDURE - LOCATE THE LEAK

NOTE: It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.

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1. Turn OFF any fans that may cause air movement around or near the vehicle.

NOTE: Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap. Consult the service procedures for DTCs that relate to evaporative emission (EVAP) system leaks for vehicle specific instructions regarding connection location and adapters.
3. Open the nitrogen tank valve and turn the NITROGEN/SMOKE valve on the control panel to SMOKE.

NOTE: The remote switch operates in a push ON, push OFF fashion.

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected. When injecting smoke at the service port, remove the fuel fill cap, or temporarily leave the EVAP canister vent valve open, until smoke is observed. Then close the system and continue testing. If using a special tool fuel fill cap adapter at the filler neck, vent the system at the service port until smoke is observed then close the system to continue with the test.

NOTE: Inject smoke in less than 2-minute cycles for optimum tester performance.

6. Press and release the remote switch to deactivate the tester.

NOTE: For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.

7. Introduce smoke into the system for an additional 60 seconds. Continue introducing smoke at 15-second intervals, as necessary.
8. Using the a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke. Introduce smoke at 15-second intervals, as needed, until leak source is identified.

TEMPERATURE VARIATION INSTRUCTIONS

The Concern

Ideal circumstances for conducting the EVAP Flowmeter Test require equal temperatures between the nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the Evaporative Emissions System Tester is stored indoors, approximately 21°C (70°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures -40 to +43°C (-40 to +110°F).

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For Example

NOTE: With no temperature difference between the nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 inches H2O once pressurized, providing no leaks are present.

When the EVAP Flowmeter Tests are performed with significant differences in temperature between the nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flowmeter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flowmeter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the nitrogen gas before conducting the Flowmeter Test.

ELECTRONIC IGNITION SYSTEM DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The ignition system on this engine uses individual ignition coils and ignition control (IC) circuits for each cylinder. Ignition voltage is supplied to each bank of ignition coils. The engine control module (ECM) controls the ignition system operation. The ECM controls each coil using the IC circuits. The ECM commands the IC circuit low when a spark event is requested. The sequencing and timing are controlled by the ECM.

DIAGNOSTIC AIDS

- The ignition coils for each bank are fused separately. If a fuse opens or the ignition voltage circuit opens between the fuse and the splice, all the ignition coils for one bank of the engine would be inoperative. If the ground circuit opens at the engine block, the ignition coils would be inoperative for one bank of the engine.
- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause a condition with the ignition coils.

REFERENCE INFORMATION

Schematic Reference

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Engine Controls Schematics

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 26792** Spark Tester. See **Special Tools** .
- **J 43244** Relay Puller Pliers. See **Special Tools** .

CIRCUIT/SYSTEM TESTING

NOTE: Do not perform this diagnostic procedure if you were not sent here from a misfire DTC or the Engine Cranks but Does Not Run diagnostic.

1. Ignition OFF, disconnect the harness connector of the T8 ignition coil.
2. Ignition ON, load test for battery voltage between the ignition voltage circuit terminal D and ground.
    - If less than B+, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition voltage circuit and replace as necessary.
3. Crank or start the engine. Test for 200-400 mV between the appropriate IC circuit terminal C and ground.
    - If less than the specified value, test the IC circuit for a short to ground or an open/high resistance. If the circuit/connection tests normal, replace the K20 ECM.
    - If greater than the specified value, test the IC circuit for a short to voltage. If the circuit/connection tests normal, replace the K20 ECM.
4. Connect a test lamp between the each of the ground circuits terminal A, and terminal B, and B+. The test lamp should illuminate on each circuit.
    - If the test lamp does not illuminate, test the suspected circuit for an open/high resistance.
5. If all circuits/connections test normal, replace the T8 ignition coil.

REPAIR PROCEDURES

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Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**

INSPECTION/MAINTENANCE SYSTEM CHECK

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that complies with the local area requirements. While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the MIL ON, and is stored in non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or erasable by disconnecting power to the controller. The I/M Test DTCs will be supported by all emissions related ECUs such as ECMs, TCMs, FPCMs, etc. An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.

CONDITIONS FOR UPDATING THE I/M SYSTEM STATUS

Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a diagnostic trouble code (DTC). A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the malfunction indicator lamp (MIL). Once all of the tests are completed, the I/M System Status display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.

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- The control module DTCs have been cleared as part of a service procedure.

CONDITIONS FOR CLEARING I/M TEST DTCS

1. Only the OBD II System can erase the I/M Test DTC. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:
    - If the MIL goes out due to 3 passing drive cycles, scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.
    - If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, the DTC must PASS and not FAIL. The I/M Test DTC is erased at power down of the drive cycle.
    - If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.
2. For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur:
    - Cumulative time of engine run time is greater than 600 s.
    - Cumulative vehicle operation above 41 kPa (25 mph) for over 300 s.
    - Continuous vehicle idle for greater than 30 s.
    - Turn ignition OFF for 5 s and allow the code to clear.

MONITORED EMISSION CONTROL SYSTEMS

The OBD II system monitors all emission control systems that are on-board. Not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring-Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

For the specific DTCs required for each system, refer to **Inspection/Maintenance System DTC Table**. Systems such as misfire and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

DIAGNOSTIC AIDS

The I/M System Status display provides an indication of when the control module has completed the required

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tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The I/M System Status information may be useful for a technician to determine if diagnostics have run when verifying repairs.

CIRCUIT/SYSTEM VERIFICATION

Review the I/M System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

CIRCUIT/SYSTEM TESTING

NOTE: Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the I/M System Status indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Observe the Engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
    - If a control module re-program or other repair is required, perform the **Inspection/Maintenance Complete System Set Procedure**.
3. Observe the I/M System Status indicators.
    - If any I/M System Status indicators report NO, perform the **Inspection/Maintenance Complete System Set Procedure**.
4. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set and all of the I/M System Status indicators are Yes, there is no need to perform the Complete System Set Procedure. Diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to Conditions for Clearing the I/M Test DTCs.
    - If an I/M Test DTC is set and the I/M System Status indicators are NO, diagnosis the DTC and perform the **Inspection/Maintenance Complete System Set Procedure**.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

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- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

The purpose of the Inspection/Maintenance (I/M) complete system set procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the trips for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the Inspection/Maintenance (I/M) Complete System Set Procedure if any I/M System Status indicators are set to NO.

CONDITIONS FOR MEETING A COLD START

- The ignition voltage between 10 and 15 V.
- The barometric pressure (BARO) is more than 75 kPa (10.9 psi).
- The engine coolant temperature (ECT) at start-up is less than 42°C (108°F).
- The intake air temperature (IAT) is between 2-32°C (36-90°F).
- The engine is OFF for greater than 6 hours or the following conditions must be met:
  - The start-up IAT minus start-up ECT are within 12°C (22°F).
  - The start-up ECT minus start-up IAT are within 50°C (90°F).
- Fuel level is between 25 and 75 %.

CIRCUIT/SYSTEM VERIFICATION

Review the Inspection/Maintenance (I/M) System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

INSPECTION/MAINTENANCE (I/M) SYSTEM SET PROCEDURE

1. Ensure that the vehicle meets the conditions for a cold start listed above.
   - If the EVAP I/M System Status indicator displays NO, perform the EVAP Service bay test if applicable.
2. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc., and open the hood.
3. Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.
4. Start and idle the engine for 2 min.

WARNING: Refer to Road Test Warning .

5. Close the hood, release the parking brake and Accelerate at part throttle to 72-80 km/h (45-50 mph) with this speed maintained until the engine reaches operating temperature, 8-10 min.
6. Continue operation under these conditions for an additional 6 min.

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7. Accelerate at part throttle to 90 km/h (55 mph) with this speed maintained for 2 min.
8. Release the accelerator pedal for at least 10 s. This will allow the vehicle to enter the decel fuel cut off.

NOTE: Do NOT touch the accelerator pedal until told to do so. A change in TP Sensor angle or an increase in engine speed may invalidate this portion of the test.

9. Safely stop the vehicle, with the engine in drive for automatic or neutral with the clutch pedal depressed and parking brake applied for manual. Allow the vehicle to idle for 2 min.
10. Shift the vehicle to park for automatic and neutral for manual. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45 min.
11. Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.
    - If the EVAP I/M System Status indicator displays NO, turn OFF the ignition, ensure that the vehicle meets the conditions for a cold start, and repeat steps 6-11 three more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance System DTC Table** to identify the DTCs that did not run.
    - If any of the I/M System Status indicators display NO, refer to the **Inspection/Maintenance System DTC Table** for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator.

NOTE: An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing, which occurs 5 s after ignition OFF.

12. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set, diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to **Inspection/Maintenance System Check**.
13. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set, diagnose using the **Diagnostic Trouble Code (DTC) List - Vehicle** . After repairs, perform the **Inspection/Maintenance Complete System Set Procedure** to verify no further DTCs are set.

INSPECTION/MAINTENANCE SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the **Inspection/Maintenance System Check**, review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs, which if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Catalyst	**DTC P0420 or P0430**
EVAP	• **DTC P0442**

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	• **DTC P0446** • **DTC P0455 or P0497** • **DTC P0496**
Oxygen Sensor	• **DTC P0130 or P0150** • **DTC P0131 or P0151** • **DTC P0132 or P0152** • **DTC P0133 or P0153 (w/LLT)** • **DTC P0137, P0138, P0140, P0157, P0158, or P0160** • **DTC P2096 or P2098** • **DTC P2097 or P2099** • **DTC P2232 or P2235** • **DTC P2270 or P2272** • **DTC P2271 or P2273**
Oxygen Sensor Heater	• **DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058** • **DTC P0135, P0141, P0155, or P0161**

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

DESCRIPTION AND OPERATION

ENGINE CONTROL MODULE DESCRIPTION

The powertrain has electronic controls to reduce exhaust emissions while maintaining excellent driveability and fuel economy. The engine control module (ECM) is the control center of this system. The ECM monitors numerous engine and vehicle functions. The ECM constantly monitors information from various sensors and other inputs, and controls the systems that affect vehicle performance and emissions. The ECM also performs diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the malfunction indicator lamp (MIL). When the ECM detects a malfunction, the ECM stores a diagnostic trouble code (DTC). The problem area is identified by the particular DTC that is set. The control module supplies a buffered voltage to various sensors and switches. Review the components and wiring diagrams in order to determine which systems are controlled by the ECM.

Malfunction Indicator Lamp (MIL) Operation

The malfunction indicator lamp (MIL) is located in the instrument panel cluster. The MIL will display as either SERVICE ENGINE SOON or one of the following symbols when commanded ON:

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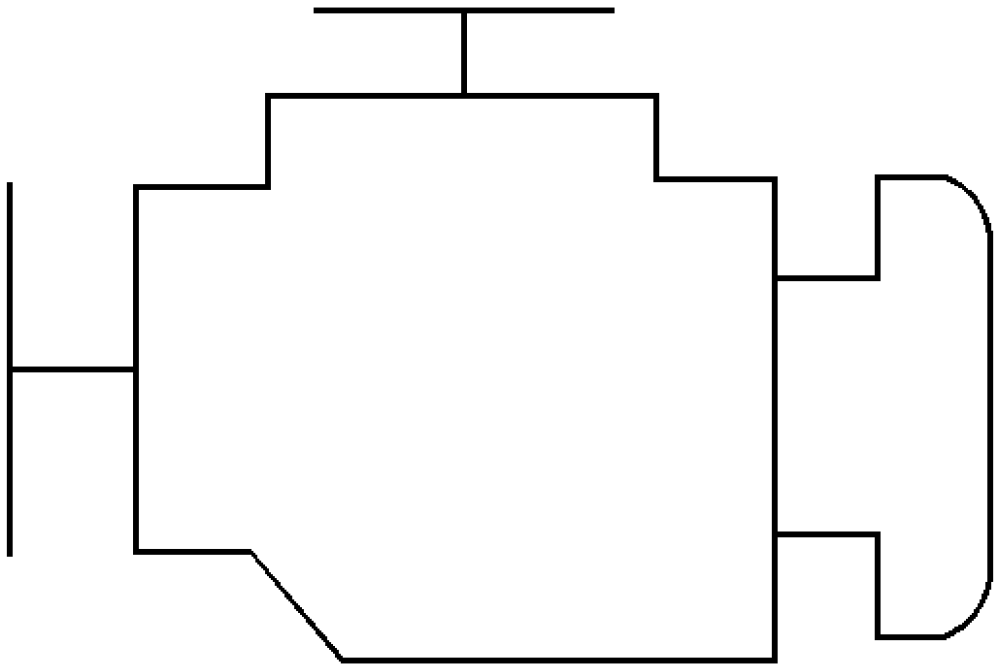


Fig. 1: MIL Symbol On Instrument Cluster
Courtesy of GENERAL MOTORS CORP.

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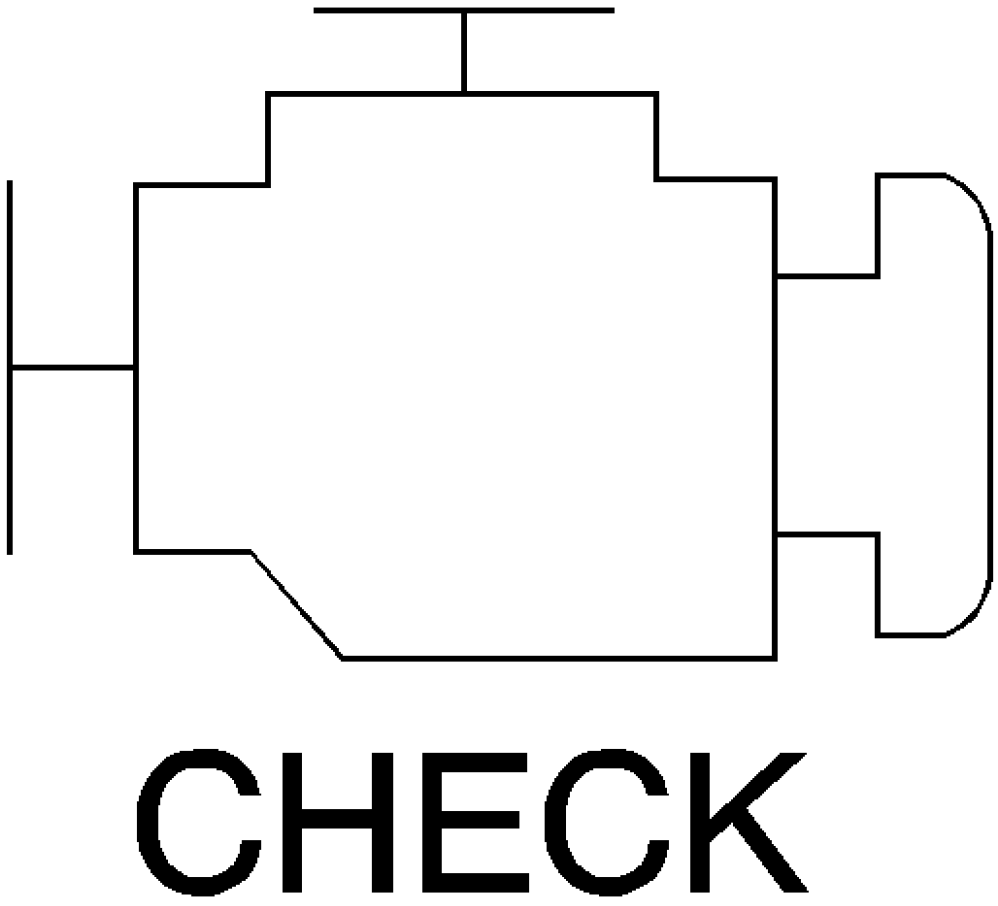


Fig. 2: Check Engine Light Symbol
Courtesy of GENERAL MOTORS CORP.

The MIL indicates that an emissions related fault has occurred and vehicle service is required.

The following is a list of the modes of operation for the MIL:

- The MIL illuminates when the ignition is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate.
- The MIL turns OFF after the engine is started if a diagnostic fault is not present.
- The MIL remains illuminated after the engine is started if the control module detects a fault. A diagnostic trouble code (DTC) is stored any time the control module illuminates the MIL due to an emissions related fault. The MIL turns OFF after three consecutive ignition cycles in which a Test Passed has been reported for the diagnostic test that originally caused the MIL to illuminate.

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- The MIL flashes if the control module detects a misfire condition which could damage the catalytic converter.
- When the MIL is illuminated and the engine stalls, the MIL will remain illuminated as long as the ignition is ON.
- When the MIL is not illuminated and the engine stalls, the MIL will not illuminate until the ignition is cycled OFF and then ON.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION

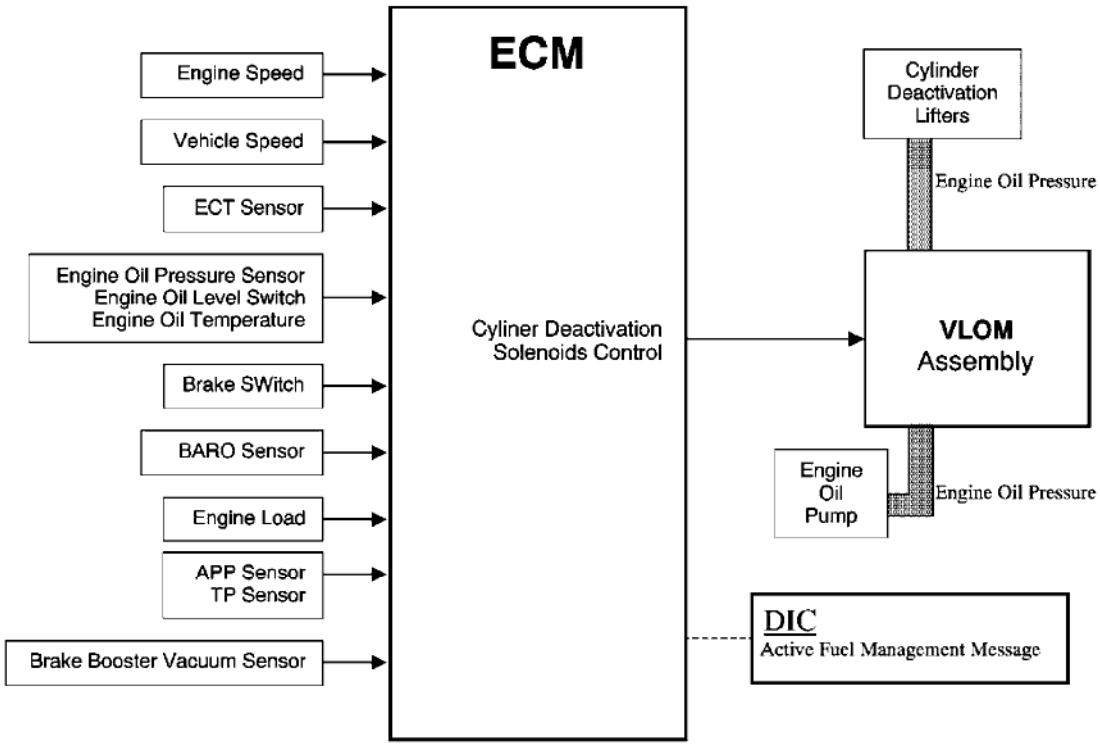


Fig. 3: Cylinder Deactivation (Active Fuel Management) System
Courtesy of GENERAL MOTORS CORP.

To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the cylinder deactivation system ON to deactivate engine cylinders 1, 7, 6, and 4, switching to a V4 mode. The engine will operate on 8 cylinders, or V8 mode, during engine starting, engine idling, and medium to heavy throttle applications.

When cylinder deactivation is commanded, the ECM will determine what cylinder is firing and begin deactivation on the next closest deactivated cylinder in firing order sequence. For example, if cylinder number 1 is on its combustion event when cylinder deactivation is commanded ON, the next cylinder in the firing order sequence that can be deactivated is cylinder number 7. If cylinder number 5 is on its combustion event when cylinder deactivation is commanded ON, then the next cylinder in the firing order sequence that can be deactivated is cylinder number 4.

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Cylinder deactivation is accomplished by not allowing the intake and exhaust valves to open on the selected cylinders by using special valve lifters. The deactivation lifters contain spring loaded locking pins that connect the internal pin housing of the lifter to the outer housing.

The pin housing contains the lifter plunger and pushrod seat which interfaces with the pushrod. The outer housing contacts the camshaft lobe through a roller. During V8 mode, when all cylinders are active, the locking pins are pushed outward by spring force, locking the pin housing and outer housing together causing the lifter to function as a normal lifter. When cylinder deactivation is commanded ON, the locking pins are pushed inward with engine oil pressure directed from the valve lifter oil manifold (VLOM) assembly solenoids. When the lifter pin housing is unlocked from the outer housing, the pin housing will remain stationary, while the outer housing will move with the profile of the camshaft lobe, which results in the valve remaining closed. One VLOM solenoid controls both the intake and exhaust valves for each deactivating cylinder. There are 2 distinct oil passages going to each cylinder deactivation lifter bore, one for the hydraulic lash-adjusting feature of the lifter, and one for controlling the locking pins used for cylinder deactivation.

Although both intake and exhaust valve lifters are controlled by the same solenoid in the VLOM, the intake and exhaust valves do not become deactivated at the same time. Cylinder deactivation is timed so that the cylinder is on an intake event. During an intake event, the intake cam lobe is pushing the valve lifter upwards to open the intake valve against the force of the valve spring. The force exerted by the valve spring is acting on the side of the lifter locking pins, preventing them from moving until the intake valve has closed. When the intake valve lifter reaches the base circle of the camshaft lobe, the valve spring force is reduced, allowing the locking pins to move, deactivating the intake valve. However, when cylinder deactivation is commanded ON, the exhaust valve for the deactivated cylinder is in the closed position, allowing the locking pins on the valve lifter to move immediately, and deactivate the exhaust valve.

By deactivating the exhaust valve first, this allows the capture of a burnt air/fuel charge, or exhaust gas charge, in the combustion chamber. The capture of exhaust gases in the combustion chamber will contribute to a reduction in oil consumption, noise and vibration levels, and exhaust emissions when operating in V4 mode cylinder deactivation mode.

During the transition from V8 to V4 mode, the fuel injectors will be turned OFF on the deactivated cylinders. To help prevent spark plug fouling, the ignition system secondary voltage or spark is still present across the spark plug electrodes on the deactivated cylinders. If all enabling conditions are met and maintained for cylinder deactivation operation, the ECM calibrations will limit cylinder deactivation to a cycle time of 10 minutes in V4 mode, then return to V8 mode for 1 minute.

Switching between V8 and V4 modes is accomplished in less than 250 milliseconds, making the transitions seamless and transparent to the vehicle operator. The 250 milliseconds includes the time for the ECM to sequence the transitions, the response time for the VLOM solenoids to energize, and the time for the valve lifters to deactivate, all within 2 revolutions of the engine crankshaft.

Valve Lifter Oil Manifold (VLOM) Assembly

The cylinder deactivation system uses an electro-hydraulic actuator device called the valve lifter oil manifold (VLOM) assembly. The VLOM is bolted to the top of the engine valley, below the intake manifold assembly. The VLOM consists of 4 electrically operated normally closed solenoids. Each solenoid controls the application of engine oil pressure to the intake and exhaust valve lifters on the cylinders selected to deactivate. Engine oil pressure is routed to the VLOM assembly from an internal oil passage on the rear of the cylinder block.

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All 4 VLOM solenoids are connected in parallel to a fused ignition 1 voltage circuit, supplied by the powertrain relay. The ground or control circuit for each solenoid is connected to a low side driver internal to the engine control module (ECM).

When all enabling conditions are met for cylinder deactivation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the solenoid windings. With the coil windings energized, the solenoid valve opens, redirecting engine oil pressure through the VLOM into 8 separate vertical passages in the engine lifter valley. The 8 vertical passages, 2 per cylinder, are connected to the valve lifter bores of the cylinders to be deactivated. When vehicle-operating conditions require a return to V8 mode, the ECM will turn OFF the control circuit for the solenoids, allowing the solenoid valves to close. With the solenoid valves closed, engine oil pressure in the control ports is exhausted through the body of the solenoids into the engine block lifter valley. The housing of the VLOM incorporates several bleeds in the oil passages to purge any air trapped in the VLOM or engine block.

To help control contamination to the hydraulic circuits, a small replaceable oil screen is located in the VLOM oil inlet passage, below the oil pressure sensor. The oil pressure sensor is a 3-wire sensor which provides oil pressure information to the ECM.

During service, use extreme care in keeping the VLOM assembly free of any contamination or foreign material.

Cylinder deactivation may be inhibited for many reasons including the following:

- Engine coolant temperature out of range for cylinder activation
- Engine vacuum out of range
- Brake booster vacuum out of range
- Transmission gear incorrect or shift in progress
- Accelerator pedal out of range or rate of pedal application to fast
- Engine oil pressure and temperature out of range
- Engine speed of range
- Vehicle speed out of range
- Minimum time in V8 mode not met
- Maximum V4 mode time exceeded
- Decel fuel cutoff active
- Reduced engine power active
- Torque management active
- Catalytic converter over temperature protection active
- Piston protection active, knock detected
- Cylinder deactivation solenoid driver circuit faults

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

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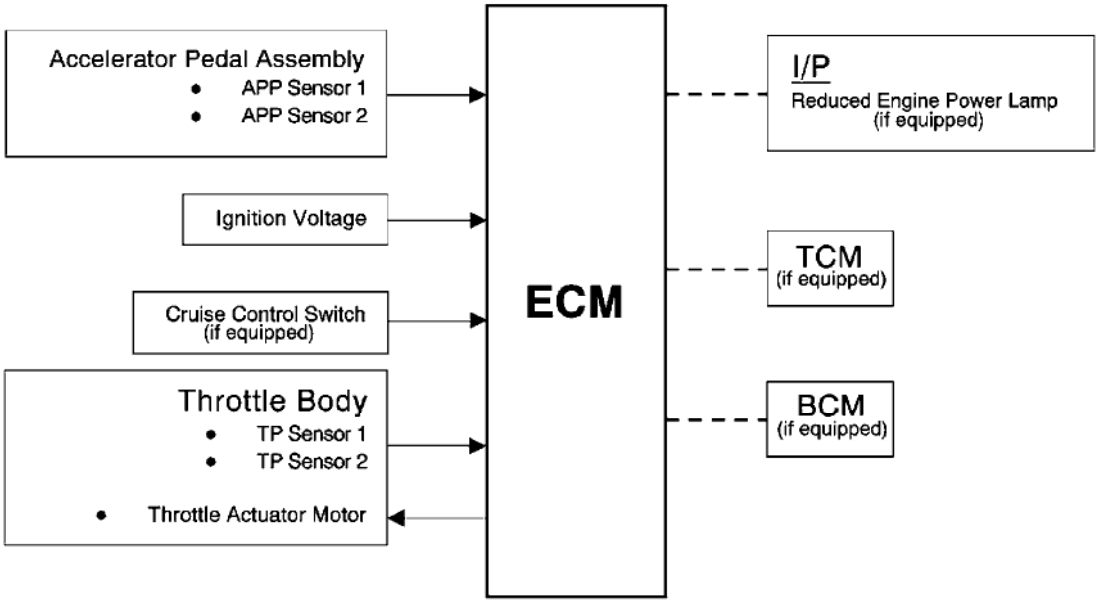


Fig. 4: Throttle Actuator Control (TAC) System
Courtesy of GENERAL MOTORS CORP.

The engine control module (ECM) is the control center for the throttle actuator control (TAC) system. The ECM determines the driver's intent based on input from the accelerator pedal position sensors, then calculates the appropriate throttle response based on the throttle position sensors. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the throttle actuator motor. The throttle blade is spring loaded in both directions, and the default position is slightly open.

Modes Of Operation

Normal Mode

During the operation of the TAC system, several modes, or functions, are considered normal. The following modes may be entered during normal operations:

- Minimum pedal value-At key-up, the ECM updates the learned minimum pedal value.
- Minimum throttle position values-At key-up, the ECM updates the learned minimum throttle position value. In order to learn the minimum throttle position value, the throttle blade is moved to the Closed position.
- Ice break mode-If the throttle blade is not able to reach a predetermined minimum throttle position, the ice break mode is entered. During the ice break mode, the ECM commands the maximum pulse width several times to the throttle actuator motor in the closing direction.
- Minimum pedal value-At key-up, the ECM updates the learned minimum pedal value.
- Battery saver mode-After a predetermined time without engine RPM, the ECM commands the Battery Saver mode. During the Battery Saver mode, the TAC module removes the voltage from the motor control circuits, which removes the current draw used to maintain the idle position and allows the throttle to return to the spring loaded default position.

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Reduced Engine Power Mode

When the ECM detects a condition with the TAC system, the ECM may enter a reduced engine power mode. Reduced engine power may cause one or more of the following conditions:

- Acceleration limiting-The ECM will continue to use the accelerator pedal for throttle control, however, the vehicle acceleration is limited.
- Limited throttle mode-The ECM will continue to use the accelerator pedal for throttle control, however, the maximum throttle opening is limited.
- Throttle default mode-The ECM will turn OFF the throttle actuator motor, and the throttle will return to the spring loaded default position.
- Forced idle mode-The ECM will perform the following actions:
  - Limit engine speed to idle positioning the throttle position, or by controlling the fuel and spark if the throttle is turned OFF.
  - Ignore the accelerator pedal input.
- Engine shutdown mode-The ECM will disable fuel and de-energize the throttle actuator.

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

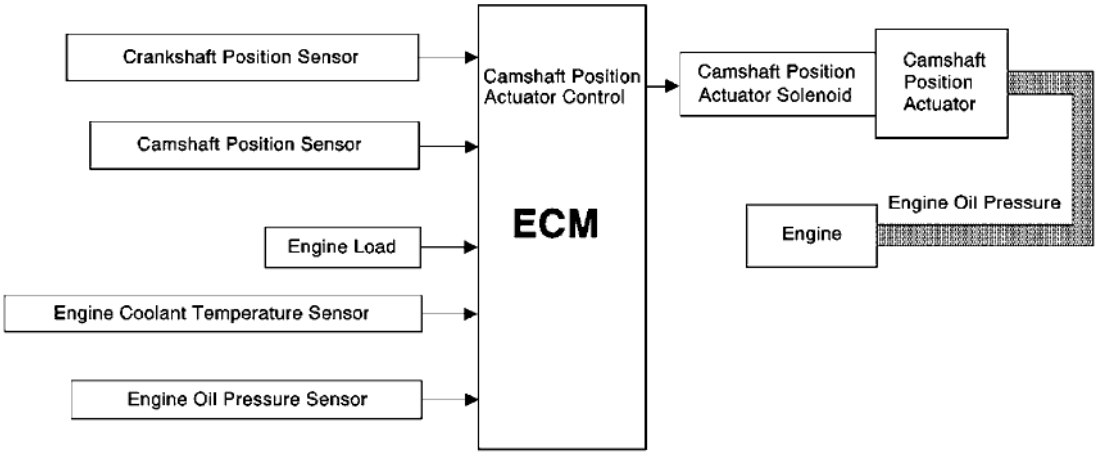


Fig. 5: Camshaft Actuator System
Courtesy of GENERAL MOTORS CORP.

Camshaft Position Actuator System

The camshaft position actuator system is an electro-hydraulic operated device used for a variety of engine performance and operational enhancements. These enhancements include lower emission output through exhaust gas dilution of the intake charge in the combustion chamber, a broader engine torque range, and improved fuel economy. The camshaft position actuator system accomplishes this by, changing the angle or timing of the camshaft, relative to the crankshaft position. The camshaft position actuator simply allows earlier or later intake and exhaust valve opening, during the four stroke engine cycle. The camshaft position actuator cannot vary the duration of valve opening, or the valve lift.

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During engine OFF, engine idling, and engine shutdown conditions, the camshaft actuator is held in the park position. Internal to the camshaft position actuator assembly is a return spring and a locking pin. During non-phasing modes of the camshaft, the return spring rotates the camshaft back to the park position, and the locking pin retains the camshaft position actuator sprocket to the camshaft. The engine control module (ECM) can only command the camshaft position actuator to retard the valve timing from the park position, or advance the valve timing back to the park position.

Camshaft Position Actuator System Operation

The camshaft position actuator system is controlled by the engine control module (ECM). The ECM sends a pulse width modulated, 12 V signal to the camshaft position actuator solenoid to control the amount of pressurized engine oil, into the camshaft position actuator. A low reference circuit, or ground wire between the camshaft position actuator solenoid and the ECM completes the electrical circuit. The frequency of the pulse width modulated signal is fixed at 150 Hz. To regulate the pressurized engine oil into the camshaft position actuator, the solenoid uses electromagnetic force on the solenoid pintle to pulse the oil control spool valve. The pressurized engine oil is sent to unseat the locking pin, and to the vane and rotor assembly of the camshaft position actuator, to either retard or advance the valve timing. The ECM will control the amount of ON time applied to the solenoid, through the 12 V signal from the ECM.

The ECM uses the following inputs to calculate the optimum valve timing before assuming control of the camshaft position actuator:

- Engine speed
- Manifold absolute pressure
- Throttle position angle
- Camshaft position sensor
- Crankshaft position sensor
- Crankshaft/camshaft correlation
- Engine coolant temperature
- Closed loop fuel control
- Engine oil pressure
- Engine oil level
- Camshaft position actuator solenoid circuit state

Camshaft Position Actuator Solenoid Circuit Diagnostics

The engine control module (ECM) monitors the control circuit of the camshaft position actuator solenoid for electrical faults. The control module has the ability to determine if a control circuit is open, shorted high, or shorted low. If the control module detects a fault with the camshaft position actuator solenoid control circuit, DTC P0010 will set.

Camshaft Position Actuator System Performance Diagnostic

The engine control module (ECM) monitors the performance of the camshaft position actuator system by monitoring the calibrated desired position, and the actual position of the camshaft, through the 4X signal of the

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camshaft position sensor. If the difference between the actual and desired position is greater than a calibrated angle, for more than a calibrated amount of time, DTC P0011 will set.

For the system descriptions covering the hydraulic/mechanical part of the camshaft position actuator, refer to **Camshaft Position Actuator and Solenoid Valve Description** .

FUEL SYSTEM DESCRIPTION

Fuel System Overview

The fuel system is an electronic returnless on-demand design. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the primary fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the fuel injection system. The fuel pump module contains a reverse flow check valve. The check valve maintains fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

The primary fuel pump module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel pump module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

Electronic Returnless Fuel System

The electronic returnless fuel system is a microprocessor controlled fuel delivery system which transports fuel from the tank to the fuel rail. It functions as an electronic replacement for a traditional, mechanical fuel pressure regulator. A pressure relief regulator valve within the fuel tank provides an added measure of over pressure protection. Desired fuel pressure is commanded by the engine control module (ECM), and transmitted to the fuel pump flow control module via a GMLAN serial data message. A liquid fuel pressure sensor provides the feedback the fuel pump flow control module requires for Closed Loop fuel pressure control.

Fuel Pump Flow Control Module

The fuel pump flow control module is a serviceable GMLAN module. The fuel pump flow control module receives the desired fuel pressure message from the engine control module (ECM) and controls the fuel pump located within the fuel tank to achieve the desired fuel pressure. The fuel pump flow control module sends a 25 KHz PWM signal to the fuel pump, and pump speed is changed by varying the duty cycle of this signal. Maximum current supplied to the fuel pump is 15 A. A liquid fuel pressure sensor provides fuel pressure feedback to the fuel pump flow control module.

Fuel Pressure Sensor

The fuel pressure sensor is a serviceable 5 V, 3-pin device. It is located on the fuel feed line forward of the fuel tank, and receives power and ground from the fuel pump flow control module through a vehicle wiring harness.

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The sensor provides a fuel pressure signal to the fuel pump flow control module, which is used to provide Closed Loop fuel pressure control.

Fuel Tank

The fuel tank stores the fuel supply. The fuel tank is located in the rear of the vehicle. The fuel tank is held in place by 2 metal straps that attach to the frame. The fuel tank is molded from high-density polyethylene.

The fuel tank is a saddle configuration in order to provide space for a driveshaft through the center area of the fuel tank. Because of the saddle shape of the tank, two fuel pump modules are required.

Fuel Fill Pipe

The fuel fill pipe has a built-in restrictor in order to prevent refueling with leaded fuel.

Fuel Filler Cap

The fuel fill pipe has a tethered fuel filler cap. A torque-limiting device prevents the cap from being over-tightened. To install the cap, turn the cap clockwise until you hear audible clicks. This indicates that the cap is correctly torqued and fully seated.

Primary Fuel Pump Module

The primary fuel pump module is located inside of the right side of the fuel tank. The primary fuel pump module consists of the following major components:

- The fuel level sensor
- The fuel pump and reservoir assembly
- The fuel filter
- The pressure relief regulator valve
- The fuel strainer
- The primary jet pump
- The secondary jet pump

Secondary Fuel Pump Module

The secondary fuel pump module is located inside of the left side of the fuel tank. The secondary fuel pump module consists of the following major components:

- The fuel level sensor
- The fuel pick-up

Fuel Level Sensor

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in

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correspondence with the position of the float arm. The engine control module (ECM) sends the fuel level information via the High Speed CAN-Bus to the body control module (BCM). The BCM then sends the fuel level percentage via the Low Speed CAN-Bus to the instrument cluster in order to control the fuel gauge. The control module monitors the signal circuits of the primary fuel level sensor and the secondary fuel level sensor in order to determine the fuel level.

Fuel Pump

The fuel pump is mounted in the primary fuel pump module reservoir. The fuel pump is an electric pump. Fuel is pumped to the fuel injection system at a pressure that is based on feedback from the fuel pressure sensor. The fuel pump delivers a constant flow of fuel even during low fuel conditions and aggressive vehicle maneuvers. The fuel pump flex pipe acts to dampen the fuel pulses and noise generated by the fuel pump.

Fuel Filter

The fuel filter is located in the primary fuel pump module. The paper filter element traps particles in the fuel that may damage the fuel injection system. The filter housing is made to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Pressure Relief Regulator Valve

The pressure relief regulator valve replaces the typical fuel pressure regulator used on a mechanical returnless fuel system. The pressure relief regulator valve is closed during normal vehicle operation. The pressure relief regulator valve is used to vent pressure during hot soaks and also functions as a fuel pressure regulator in the event of the fuel pump flow control module defaulting to 100% pulse width modulation (PWM) of the fuel pump. Due to variation in the fuel system pressures, the opening pressure for the pressure relief regulator valve is set higher than the pressure that is used on a mechanical returnless fuel system pressure regulator.

Fuel Strainer

The fuel strainer attaches to the lower end of the primary fuel pump module. The fuel strainer is made of woven plastic. The functions of the fuel strainer are to filter contaminants and to wick fuel. The fuel strainer normally requires no maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment or contamination.

Primary and Secondary Jet Pumps

The primary jet pump is located in the primary fuel pump module. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel pump module.

The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the transfer pipe, to the primary side of the fuel tank.

Nylon Fuel Pipes

WARNING: In order to reduce the risk of fire and personal injury observe the

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following items:

- **Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes**
- **Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.**
- **Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115°C (239°F) for more than one hour, or more than 90°C (194°F) for any extended period.**
- **Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)**

Nylon pipes are constructed to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Heat resistant rubber hose or corrugated plastic conduit protect the sections of the pipes that are exposed to chafing, high temperature, or vibration.

Nylon fuel pipes are somewhat flexible and can be formed around gradual turns under the vehicle. However, if nylon fuel pipes are forced into sharp bends, the pipes kink and restrict the fuel flow. Also, once exposed to fuel, nylon pipes may become stiffer and are more likely to kink if bent too far. Take special care when working on a vehicle with nylon fuel pipes.

Quick-Connect Fittings

Quick-connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. O-rings, located inside the female connector, provide the fuel seal. Integral locking tabs inside the female connector hold the fittings together.

Fuel Rail Assembly

The fuel rail assembly attaches to engine intake manifold. The fuel rail assembly performs the following functions:

- Positions the injectors in the intake manifold
- Distributes fuel evenly to the injectors

Fuel Injectors

The fuel injector assembly is a solenoid device controlled by the engine control module (ECM) that meters

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pressurized fuel to a single engine cylinder. The ECM energizes the injector solenoid to open a normally closed ball valve. This allows the fuel to flow into the top of the injector, past the ball valve, and through a director plate at the injector outlet. The director plate has machined holes that control the fuel flow, generating a spray of finely atomized fuel at the injector tip. Fuel from the injector tip is directed at the intake valve, causing the fuel to become further atomized and vaporized before entering the combustion chamber. This fine atomization improves fuel economy and emissions.

Engine Fueling

The engine is fueled by individual injectors, one for each cylinder, that are controlled by the ECM. The ECM controls each injector by energizing the injector coil for a brief period once every other engine revolution. The length of this brief period, or pulse, is carefully calculated by the ECM to deliver the correct amount of fuel for proper driveability and emissions control. The period of time when the injector is energized is called the pulse width and is measured in milliseconds, thousandths of a second.

While the engine is running, the ECM is constantly monitoring the inputs and recalculating the appropriate pulse width for each injector. The pulse width calculation is based on the injector flow rate, mass of fuel the energized injector will pass per unit of time, the desired air/fuel ratio, and actual air mass in each cylinder, and is adjusted for battery voltage, short term, and long term fuel trim. The calculated pulse is timed to occur as each cylinders intake valves are closing to attain the largest duration and most vaporization.

Fueling during a crank is slightly different than fueling during an engine run. As the engine begins to turn, a prime pulse may be injected to speed starting. As soon as the ECM can determine where in the firing order the engine is, the ECM begins pulsing the injectors. The pulse width during the crank is based on the coolant temperature and the engine load.

The fueling system has several automatic adjustments in order to compensate for the differences in the fuel system hardware, the driving conditions, the fuel used, and the engine aging. The basis for the fuel control is the pulse width calculation that is described above. Included in this calculation are an adjustment for the battery voltage, the short term fuel trim, and the long term fuel trim. The battery voltage adjustment is necessary since the changes in the voltage across the injector affect the injector flow rate. The short term and the long term fuel trims are fine and coarse adjustments to the pulse width that are designed in order to maximize the driveability and emissions control. These fuel trims are based on the feedback from the oxygen sensors in the exhaust stream and are only used when the fuel control system is in a Closed Loop operation.

Under certain conditions, the fueling system will turn OFF the injectors for a period of time. This is referred to as fuel shut-off. Fuel shut-off is used in order to improve traction, save fuel, improve emissions, and protect the vehicle under certain extreme or abusive conditions.

In case of a major internal problem, the ECM may be able to use a back-up fuel strategy for limp in mode that will run the engine until service can be performed.

Sequential Fuel Injection

The ECM controls the fuel injectors based on information that the ECM receives from several information sensors. Each injector is fired individually in the engine firing order, which is called sequential fuel injection. This allows precise fuel metering to each cylinder and improves the driveability under all of the driving conditions.

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The ECM has several operating modes for fuel control, depending on the information that has been received from the sensors.

Starting Mode

When the ECM detects reference pulses from the crankshaft position sensor, the ECM will enable the fuel pump. The fuel pump runs and builds up pressure in the fuel system. The ECM then monitors the mass air flow (MAF), intake air temperature (IAT), engine coolant temperature (ECT), and the throttle position sensor signal in order to determine the required injector pulse width for starting.

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the Clear Flood Mode can be manually selected. To select Clear Flood Mode, push the accelerator to wide open throttle (WOT). With this signal, the ECM will completely turn OFF the injectors and will maintain in this stage as long as the ECM indicates a WOT condition with engine speed below 1,000 RPM.

Run Mode

The run mode has 2 conditions called Open Loop and Closed Loop. When the engine is first started and the engine speed is above 480 RPM, the system goes into Open Loop operation. In Open Loop operation the ECM ignores the signals from the oxygen sensors and calculates the required injector pulse width based primarily on inputs from the MAF, IAT, and ECT sensors.

In Closed Loop, the ECM adjusts the injector pulse width for each bank of injectors based on the signals from each oxygen sensor.

Acceleration Mode

The ECM monitors the changes in the throttle position and the MAF sensor signals in order to determine when the vehicle is being accelerated. The ECM will then increase the injector pulse width in order to provide more fuel for improved performance.

Deceleration Mode

The ECM monitors changes in the throttle position and MAF sensor signals to determine when the vehicle is being decelerated. The ECM will then decrease the injector pulse width or even shut-off injectors for short periods to reduce exhaust emissions, and for better, engine braking, deceleration.

Battery Voltage Correction Mode

The ECM can compensate in order to maintain acceptable vehicle driveability when the ECM sees a low battery voltage condition. The ECM compensates by performing the following functions:

- Increasing the injector pulse width in order to maintain the proper amount of fuel being delivered
- Increasing the idle speed to increase the generator output

Fuel Shut-Off Mode

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The ECM has the ability to completely turn OFF all of the injectors or selectively turn OFF some of the injectors when certain conditions are met. These fuel shut-off modes allow the ECM to protect the engine from damage and also to improve the vehicles driveability.

The ECM will disable all of the injectors under the following conditions:

- Ignition OFF-Prevents engine run-on
- Ignition ON but no crankshaft position signal-Prevents flooding or backfiring
- A high engine speed-Above the red line
- A high vehicle speed-Above the rated tire speed
- Closed throttle coast down-Reduces the emissions and increases engine braking.

The ECM will selectively disable the injectors under the following conditions:

- The torque management enabled-Transmission shifts or abusive maneuvers.
- The traction control enabled-In conjunction with the front brakes applying

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

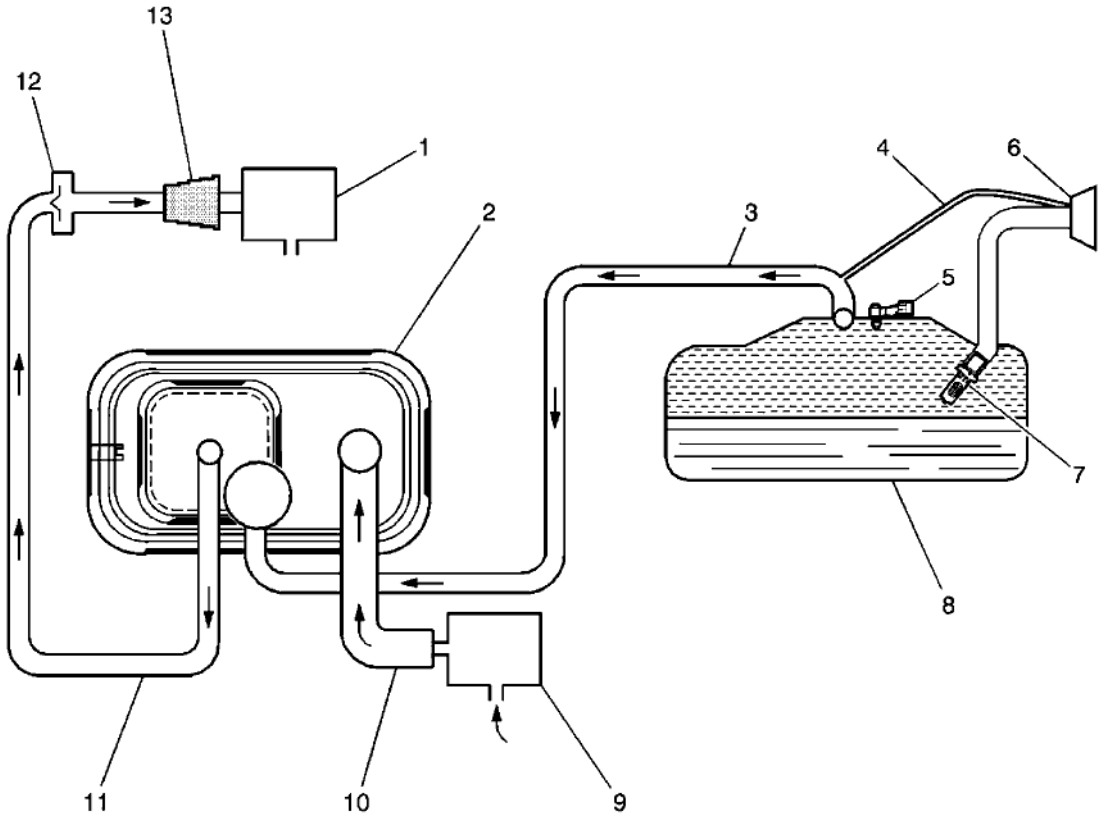


Fig. 6: Typical Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
1	Evaporative Emissions (EVAP) Purge Solenoid Valve
2	EVAP Canister
3	EVAP Vapor Tube
4	Vapor Recirculation Tube
5	Fuel Tank Pressure Sensor
6	Fuel Filler Cap
7	Fuel Fill Pipe Inlet Check Valve
8	Fuel Tank
9	EVAP Canister Vent Solenoid Valve
10	Vent hose
11	EVAP Purge Tube
12	Purge Tube Check Valve, Turbo-Charged Applications
13	EVAP Canister Purge Tube Connector

EVAP System Operation

The evaporative emission (EVAP) control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the EVAP vapor tube, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent hose and EVAP canister vent solenoid valve to the atmosphere. The EVAP canister stores the fuel vapors until the engine is able to use them. At an appropriate time, the engine control module (ECM) will command the EVAP purge solenoid valve ON, allowing engine vacuum to be applied to the EVAP canister. With the normally open EVAP canister vent solenoid valve OFF, fresh air is drawn through the vent solenoid valve and the vent hose to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge tube and EVAP purge solenoid valve into the intake manifold to be consumed during normal combustion. The control module uses several tests to determine if the EVAP system is leaking or restricted.

Purge Solenoid Valve Leak Test

If the evaporative emission (EVAP) purge solenoid valve does not seal properly fuel vapors could enter the engine at an undesired time, causing driveability concerns. The ECM tests for this by commanding the EVAP purge solenoid valve OFF and the canister vent solenoid valve ON which seals the system. With the engine running, the ECM then monitors the fuel tank pressure sensor for an increase in vacuum. The ECM will log a fault if a vacuum develops in the tank under these test conditions.

Large Leak Test

This diagnostic creates a vacuum condition in the EVAP system. When the enabling criteria has been met, the control module commands the normally open EVAP canister vent solenoid valve closed and the EVAP purge solenoid valve open, creating a vacuum in the EVAP system. The ECM then monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time. Failure to achieve the expected level of vacuum indicates the presence of a large leak in the EVAP system or a restriction in the purge path. The ECM will log a fault if it detects a weaker than expected vacuum level under these test conditions.

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Canister Vent Restriction Test

If the evaporative emission (EVAP) vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The control module tests this by commanding the EVAP purge solenoid valve ON while commanding the EVAP canister vent solenoid valve OFF, and then monitoring the fuel tank pressure sensor for an increase in vacuum. If the vacuum increases more than the expected amount, in a set amount of time, a fault will be logged by the ECM.

Small Leak Test

The engine off natural vacuum diagnostic is the small-leak detection diagnostic for the evaporative emission (EVAP) system. The engine off natural vacuum diagnostic monitors the EVAP system pressure with the ignition OFF. Because of this, it may be normal for the control module to remain active for up to 40 minutes after the ignition is turned OFF. This is important to remember when performing a parasitic draw test on vehicles equipped with engine off natural vacuum.

When the vehicle is driven, the temperature rises in the tank due to heat transfer from the exhaust system. After the vehicle is parked, the temperature in the tank continues to rise for a period of time, then starts to drop. The engine off natural vacuum diagnostic relies on this temperature change, and the corresponding pressure change in a sealed system, to determine if an EVAP system leak is present.

The engine off natural vacuum diagnostic is designed to detect leaks as small as 0.51 mm (0.020 in).

EVAP System Components

The evaporative emission (EVAP) system consists of the following components:

EVAP Canister Purge Solenoid Valve

The EVAP canister purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. The purge solenoid valve opens when commanded ON by the control module. This normally closed valve is pulse width modulated (PWM) by the control module to precisely control the flow of fuel vapor to the engine. The valve will also be opened during some portions of the EVAP testing when the engine is running, allowing engine vacuum to enter the EVAP system.

Purge Tube Check Valve

Turbocharged vehicles have a check valve in the purge tube between the EVAP purge solenoid valve and the EVAP canister to prevent pressurization of the EVAP system under boost conditions. Note that the presence of this one-way check valve prevents pressure testing the EVAP system for leaks at the EVAP canister purge tube connector.

EVAP Canister

The canister is filled with carbon pellets used to absorb and store fuel vapors. Fuel vapor is stored in the canister until the control module determines that the vapor can be consumed in the normal combustion process.

Vapor Recirculation Tube

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A vapor path between the fuel fill pipe and the vapor tube to the carbon canister is necessary for Vehicle Onboard Diagnostics to fully diagnose the EVAP system. It also accommodates service diagnostic procedures by allowing the entire EVAP system to be diagnosed from the either end of the system.

Fuel Tank Pressure Sensor

The fuel tank pressure sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. The control module provides a 5 V reference and a ground to the fuel tank pressure sensor. Depending on the vehicle, the sensor can be located in the vapor space on top of the fuel tank, in the vapor tube between the canister and the tank, or on the EVAP canister. The fuel tank pressure sensor provides a signal voltage back to the control module that can vary between 0.1-4.9 V. A high fuel tank pressure sensor voltage indicates a low fuel tank pressure or vacuum. A low fuel tank pressure sensor voltage indicates a high fuel tank pressure.

Fuel Fill Pipe Check Valve

The check valve on the fuel fill pipe is there to prevent spit-back during refueling.

EVAP Canister Vent Solenoid Valve

The EVAP vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The canister vent solenoid valve is closed only during EVAP system tests performed by the ECM.

Fuel Fill Cap

The fuel fill cap is equipped with a seal and a vacuum relief valve.

ELECTRONIC IGNITION SYSTEM DESCRIPTION

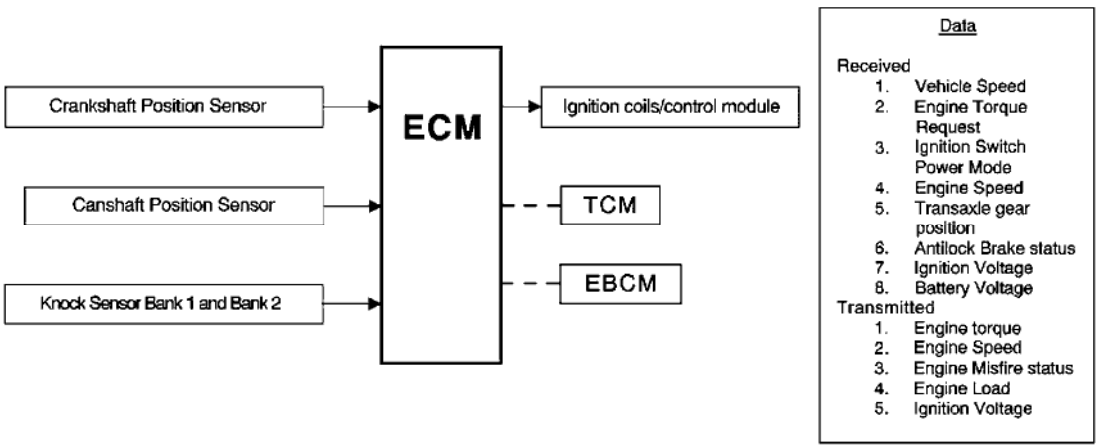


Fig. 7: Electronic Ignition (EI) System Theory
Courtesy of GENERAL MOTORS CORP.

Electronic Ignition System Operation

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The electronic ignition system produces and controls the high energy secondary spark. This spark ignites the compressed air/fuel mixture at precisely the correct time, providing optimal performance, fuel economy, and control of exhaust emissions. The engine control module (ECM) primarily collects information from the crankshaft position and camshaft position sensors to control the sequence, dwell, and timing of the spark.

Crankshaft Position Sensor

The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of the reluctor wheel on the crankshaft. The reluctor wheel is spaced at 60-tooth spacing, with two missing teeth for the reference gap. The reference gap is used to identify the crankshaft position at each start-up. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The crankshaft position sensor sends a digital signal to the ECM as each tooth on the reluctor wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses crankshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

Camshaft Position Sensor

The sensor detects magnetic flux changes between the four narrow and wide tooth slots on the reluctor wheel. The camshaft position sensor provides a digital ON/OFF DC voltage of varying frequency per each camshaft revolution. The ECM will recognize the narrow and wide tooth patterns to identify camshaft position, or which cylinder is in compression and which is in exhaust. The information is then used to determine the correct time and sequence for fuel injection and ignition spark events.

Knock Sensor

The knock sensor system enables the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation, also known as spark knock. The knock sensor system uses one or two flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency are dependant upon the level of knock that the knock sensor detects. The ECM receives the knock sensor signal through two isolated signal circuits for each knock sensor.

The control module learns a minimum noise level, or background noise, at idle from the knock sensor and uses calibrated values for the rest of the RPM range. The control module uses the minimum noise level to calculate a noise channel. A normal knock sensor signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal knock sensor signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the control module only uses knock sensor signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

If the control module has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The control module will always try to work back to a zero compensation level, or no spark retard. An abnormal knock sensor signal will stay outside of the noise channel or will not be present. knock sensor diagnostics are calibrated to detect faults with the knock sensor circuitry inside the control module, the

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knock sensor wiring, or the knock sensor voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

Ignition Coils

Each ignition coil has an ignition 1 voltage feed and a ground circuit. The engine control module (ECM) supplies a low reference and an ignition control circuit. Each ignition coil contains a solid state driver module. The ECM will command the ignition control circuit ON, which allows the current to flow through the primary coil windings. When the ECM commands the ignition control circuit OFF, this will interrupt current flow through the primary coil windings. The magnetic field created by the primary coil windings will collapse across the secondary coil windings, which induces a high voltage across the spark plug electrodes.

Engine Misfire Detection

The crankshaft position sensor is used to determine when an engine misfire is occurring. The camshaft position sensor is used to determine which cylinder is misfiring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above a predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. Under certain driving conditions, a misfire rate can be high enough to cause the 3-way catalytic converter to overheat damaging the converter. The malfunction indicator lamp (MIL) will flash ON and OFF when converter overheating, damaging conditions are present.

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0010	P0010: Camshaft Position Actuator Solenoid Valve Control Circuit
DTC P0011	P0011: Camshaft Position System Performance
DTC P0016	P0016: Crankshaft Position - Camshaft Position Not Plausible
DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161	P0030: HO2S Heater Control Circuit Bank 1 Sensor 1 P0036: HO2S Heater Control Circuit Bank 1 Sensor 2 P0050: HO2S Heater Control Circuit Bank 2 Sensor 1 P0053: HO2S Heater Resistance Bank 1 Sensor 1 P0054: HO2S Heater Resistance Bank 1 Sensor 2 P0056: HO2S Heater Control Circuit Bank 2 Sensor 2 P0059: HO2S Heater Resistance Bank 2 Sensor 1 P0060: HO2S Heater Resistance Bank 2 Sensor 2 P0135: HO2S Heater Performance Bank 1 Sensor 1 P0141: HO2S Heater Performance Bank 1 Sensor 2 P0155: HO2S Heater Performance Bank 2 Sensor 1 P0161: HO2S Heater Performance Bank 2 Sensor 2
DTC P0068 or P0121	P0068: Throttle Body Airflow Performance P0121: Throttle Position Sensor 1 Performance
DTC P0101 or P1101	P0101: Mass Air Flow Sensor Performance P1101: Intake Air Flow System Performance
DTC P0102 or P0103	P0102: Mass Air Flow Sensor Circuit Low Frequency P0103: Mass Air Flow Sensor Circuit High Frequency
DTC P0106	P0106: Manifold Absolute Pressure (MAP) Sensor Performance
DTC P0107 or P0108	P0107: Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage P0108: Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
DTC P0112 or P0113	P0112: Intake Air Temperature (IAT) Sensor Circuit Low Voltage P0113: Intake Air Temperature (IAT) Sensor Circuit High Voltage
DTC P0116	P0116: Engine Coolant Temperature (ECT) Sensor Performance
DTC P0117 or P0118	P0117: Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage P0118: Engine Coolant Temperature (ECT) Sensor Circuit High Voltage
DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135	P0120: Throttle Position Sensor 1 Circuit P0122: Throttle Position Sensor 1 Circuit Low Voltage P0123: Throttle Position Sensor 1 Circuit High Voltage P0220: Throttle Position Sensor 2 Circuit P0222: Throttle Position Sensor 2 Circuit Low Voltage P0223: Throttle Position Sensor 2 Circuit High Voltage P2135: Throttle Position Sensor 1-2 Correlation
DTC P0128	P0128: Engine Coolant Temperature (ECT) Below Thermostat

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	Regulating Temperature
DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158	P0131: HO2S Circuit Low Voltage Bank 1 Sensor 1 P0132: HO2S Circuit High Voltage Bank 1 Sensor 1 P0137: HO2S Circuit Low Voltage Bank 1 Sensor 2 P0138: HO2S Circuit High Voltage Bank 1 Sensor 2 P0151: HO2S Circuit Low Voltage Bank 2 Sensor 1 P0152: HO2S Circuit High Voltage Bank 2 Sensor 1 P0157: HO2S Circuit Low Voltage Bank 2 Sensor 2 P0158: HO2S Circuit High Voltage Bank 2 Sensor 2
DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153	P0133: HO2S Slow Response Bank 1 Sensor 1 P013A: HO2S Slow Response Rich to Lean Bank 1 Sensor 2 P013B: HO2S Slow Response Lean to Rich Bank 1 Sensor 2 P013C: HO2S Slow Response Rich to Lean Bank 2 Sensor 2 P013D: HO2S Slow Response Lean to Rich Bank 2 Sensor 2 P013E: HO2S Delayed Response Rich to Lean Bank 1 Sensor 2 P013F: HO2S Delayed Response Lean to Rich Bank 1 Sensor 2 P014A: HO2S Delayed Response Rich to Lean Bank 2 Sensor 2 P014B: HO2S Delayed Response Lean to Rich Bank 2 Sensor 2 P0153: HO2S Slow Response Bank 2 Sensor 1 P1133: HO2S Insufficient Switching Bank 1 Sensor 1 P1153: HO2S Insufficient Switching Bank 2 Sensor 1
DTC P0134, P0140, P0154, or P0160	P0134: HO2S Circuit Insufficient Activity Bank 1 Sensor 1 P0140: HO2S Circuit Insufficient Activity Bank 1 Sensor 2 P0154: HO2S Circuit Insufficient Activity Bank 2 Sensor 1 P0160: HO2S Circuit Insufficient Activity Bank 2 Sensor 2
DTC P0171, P0172, P0174, or P0175	P0171: Fuel Trim System Lean Bank 1 P0172: Fuel Trim System Rich Bank 1 P0174: Fuel Trim System Lean Bank 2 P0175: Fuel Trim System Rich Bank 2
DTC P018B-P018D	P018B: Fuel Pressure Sensor Performance P018C: Fuel Pressure Sensor Circuit Low Voltage P018D: Fuel Pressure Sensor Circuit High Voltage
DTC P0197 or P0198	P0197: Engine Oil Temperature (EOT) Sensor Circuit Low Voltage P0198: Engine Oil Temperature (EOT) Sensor Circuit High Voltage
DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208	P0201: Cylinder 1 Injector Control Circuit P0202: Cylinder 2 Injector Control Circuit P0203: Cylinder 3 Injector Control Circuit P0204: Cylinder 4 Injector Control Circuit P0205: Cylinder 5 Injector Control Circuit P0206: Cylinder 6 Injector Control Circuit P0207: Cylinder 7 Injector Control Circuit P0208: Cylinder 8 Injector Control Circuit
DTC P0230	P0230: Fuel Pump Relay Control Circuit
DTC P0231, P0232, or P023F	P0231: Fuel Pump Control Circuit Low Voltage P0232: Fuel Pump Control Circuit High Voltage P023F: Fuel Pump Control Circuit

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DTC P025A	P025A: Fuel Pump Control Module Enable Circuit
DTC P0300-P0308	P0300: Engine Misfire Detected P0301: Cylinder 1 Misfire Detected P0302: Cylinder 2 Misfire Detected P0303: Cylinder 3 Misfire Detected P0304: Cylinder 4 Misfire Detected P0305: Cylinder 5 Misfire Detected P0306: Cylinder 6 Misfire Detected P0307: Cylinder 7 Misfire Detected P0308: Cylinder 8 Misfire Detected
DTC P0315	P0315: Crankshaft Position (CKP) System Variation Not Learned
DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333	P0324: Knock Sensor Module Performance P0325: Knock Sensor Circuit Bank 1 P0326: Knock Sensor Performance P0327: Knock Sensor Circuit Low Voltage Bank 1 P0328: Knock Sensor Circuit High Voltage Bank 1 P0330: Knock Sensor Circuit Bank 2 P0332: Knock Sensor Circuit Low Voltage Bank 2 P0333: Knock Sensor Circuit High Voltage Bank 2
DTC P0335	P0335: Crankshaft Position Sensor Circuit
DTC P0336	P0336: Crankshaft Position Sensor Performance
DTC P0340	P0340: Camshaft Position Sensor Circuit
DTC P0341	P0341: Camshaft Position Sensor Performance
DTC P0351-P0358	P0351: Ignition Coil 1 Control Circuit P0352: Ignition Coil 2 Control Circuit P0353: Ignition Coil 3 Control Circuit P0354: Ignition Coil 4 Control Circuit P0355: Ignition Coil 5 Control Circuit P0356: Ignition Coil 6 Control Circuit P0357: Ignition Coil 7 Control Circuit P0358: Ignition Coil 8 Control Circuit
DTC P0420 or P0430	P0420: Catalyst System Low Efficiency Bank 1 P0430: Catalyst System Low Efficiency Bank 2
DTC P0442	P0442: Evaporative Emission System Small Leak Detected
DTC P0443 or P0449	P0443: Evaporative Emission Purge Solenoid Valve Control Circuit P0449: Evaporative Emission Vent Solenoid Valve Control Circuit
DTC P0446	P0446: Evaporative Emissions Vent System Performance
DTC P0451-P0454	P0451: Fuel Tank Pressure Sensor Performance P0452: Fuel Tank Pressure Sensor Circuit Low Voltage P0453: Fuel Tank Pressure Sensor Circuit High Voltage P0454: Fuel Tank Pressure Sensor Intermittent
DTC P0455	P0455: Evaporative Emission System Large Leak Detected
DTC P0496	P0496: Evaporative Emission (EVAP) System Flow During Non-Purge
DTC P0506 or P0507	P0506: Idle Speed Low P0507: Idle Speed High

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DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 (ECM)	P0601: Control Module Read Only Memory Performance P0602: Control Module Not Programmed P0603: Control Module Long Term Memory Reset P0604: Control Module Random Access Memory Performance P0606: Control Module Processor Performance P0607: Control Module Performance P060D: Control Module Accelerator Pedal (APP) Position System Circuitry Performance P062F: Control Module Long Term Memory Performance P2610: Control Module Ignition Off Timer Performance
DTC P0601-P0604, P0606, or P062F	P0601: Control Module Read Only Memory (ROM) P0602: Control Module Not Programmed P0603: Control Module Long Term Memory Reset P0604: Control Module Random Access Memory (RAM) P0606: Control Module Internal Performance P062F: Control Module Long Term Memory Performance
DTC P0641 or P06A6	P0641: 5-Volt Reference Circuit P06A6: 5-Volt Reference Performance
DTC P0641 or P0651 (ECM)	P0641: 5 V Reference 1 Circuit P0651: 5 V Reference 2 Circuit
DTC P0650	P0650: Malfunction Indicator Lamp (MIL) Control Circuit
DTC P0685 or P0690	P0685: Engine Controls Ignition Relay Control Circuit P0690: Engine Controls Ignition Relay Feedback Circuit High Voltage
DTC P069E	P069E: Fuel Pump Control Module Requested MIL Illumination
DTC P0700	P0700: Transmission Control Module (TCM) Requested MIL Illumination
DTC P1255 or P064A	P064A: Fuel Pump Control Module Performance P1255: Fuel Pump Control Module Driver Over-temperature
DTC P1258	P1258: Engine Coolant Temperature Over - Protection Mode Active
DTC P1380 or P1381	P1380: Misfire Detected and Rough Road Data Not Available P1381: Misfire Detected and No Communication with Brake Control Module
DTC P1400	P1400: Cold Start Emission Reduction Control System
DTC P1516, P2101, P2119, or P2176	P1516: Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance P2101: Throttle Actuator Position Performance P2119: Throttle Closed Position Performance P2176: Minimum Throttle Position Not Learned
DTC P1682	P1682: Ignition 1 Switch Circuit 2
DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138	P2120: Accelerator Pedal Position (APP) Sensor 1 Circuit P2122: Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage P2123: Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage P2125: Accelerator Pedal Position (APP) Sensor 2 Circuit P2127: Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage P2128: Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage P2138: Accelerator Pedal Position (APP) Sensor 1-2 Correlation

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DTC P219A or P219B	P219A: Fuel Trim Cylinder Balance Bank 1 P219B: Fuel Trim Cylinder Balance Bank 2
DTC P2270 or P2272	P2270: HO2S Signal Stuck Lean Bank 1 Sensor 2 P2272: HO2S Signal Stuck Lean Bank 2 Sensor 2
DTC P2271 or P2273	P2271: HO2S Signal Stuck Rich Bank 1 Sensor 2 P2273: HO2S Signal Stuck Rich Bank 2 Sensor 2
DTC P2534	P2534: Ignition 1 Switch Circuit Low Voltage
DTC P2544	P2544: Transmission Torque Request Circuit P2544: Transmission Torque Request Signal Message Counter Incorrect
DTC P2548	P2548: Vehicle Dynamics System Torque Request Signal Message Counter Incorrect
DTC P2635	P2635: Fuel Pump Flow Performance
DTC P3400	P3400: Cylinder Deactivation System Performance
DTC P3401, P3425, P3441, or P3449	P3401: Cylinder 1 Deactivation Solenoid Control Circuit P3425: Cylinder 4 Deactivation Solenoid Control Circuit P3441: Cylinder 6 Deactivation Solenoid Control Circuit P3449: Cylinder 7 Deactivation Solenoid Control Circuit

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

DTC P0010

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0010

Camshaft Position Actuator Solenoid Valve Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid High Control	P0010	P0010	P0010	P0011
Low Reference	-	P0010, P0011	-	-

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the Camshaft Position Actuator Magnet duty cycle by controlling the amount of ON time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position. The total range of valve timing command is 26 degree as measured at the camshaft or 52 degree as measured at the crankshaft.

The ECM controls the Camshaft Position Actuator Magnet by suppling a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

CONDITIONS FOR RUNNING THE DTC

- The ignition switch is in the crank or run position.
- The system voltage is between 11-18 V.

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- The ECM has commanded the CMP actuator solenoid ON.
- DTC P0010 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0010 is a Type B DTC.
- The camshaft position actuator is commanded to the park position.

CONDITIONS FOR CLEARING THE DTC

DTC P0010 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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CIRCUIT/SYSTEM VERIFICATION

NOTE: If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.

1. Ignition ON, observe the DTC information with a scan tool. Verify DTC P0335, P0336, P0340, and P0341 is not set.
   - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Engine idling, command the Camshaft Position Actuator to 10° while observing the following control circuit status parameters with a scan tool:
   - The Camshaft Position Actuator Solenoid Valve Control Circuit Open test status
   - The Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage test status
   - The Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage test status

   Each parameter should display OK or Not Run
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the Q6 Camshaft Position Actuator Magnet harness connector X109.

NOTE: Testing for steps 2-4 is performed on the ECM side of the harness connector X109.

2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminal E and ground.
   - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE: A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, B+ on the control circuit is normal.

3. Ignition ON, engine OFF, verify that a test lamp does not illuminate between the control circuit terminal D and ground.
   - If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Connect the DMM black lead to the control circuit terminal D. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
   - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.

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NOTE: Testing for steps 5 and 6 is performed on the engine side of the harness connector X109.

5. Ignition OFF, test for infinite resistance between the control circuit terminal D and ground.
   - If not the specified value, repair the control circuit for a short to ground.
6. Test for 5.0-9.0 ohms between the control circuit terminal D and the low reference circuit terminal E.
   - If less than the specified range, test for a short between the control circuit and the low reference circuit. If the circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Magnet.
   - If greater than the specified range, test the control circuit and the low reference for an open/high resistance. If the circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Magnet.
7. If all circuits test normal, repair the poor connection at the camshaft position sensor jumper wire harness.

COMPONENT TESTING

Static Test

1. Ignition OFF, remove the Q6 Camshaft Position Actuator Magnet.
2. Test for 5.0-9.0 ohms between the solenoid control terminal 2 and the low reference terminal 1 at the Q6 Camshaft Position Actuator Magnet.
   - If not within the specified range, replace the Q6 Camshaft Position Actuator Magnet.
3. Test for infinite resistance between each terminal ot the magnet and the magnet housing.
   - If not the specified value, replace the Q6 Camshaft Position Actuator Magnet.

Dynamic Test

1. Remove the Q6 Camshaft Position Actuator Magnet.

NOTE:
- **The Camshaft Position Actuator Magnet pintle should be facing downward for this test.**
- **Do not allow electrical current to flow through the Camshaft Position Actuator Magnet for greater than 1-2 s.**

2. Install a 20 A fused jumper wire between the control circuit terminal 2 and B+. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.
   - If the function does not perform as specified, replace the Q6 Camshaft Position Actuator Magnet.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Magnet Replacement**

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- **Control Module References** for ECM replacement, setup, and programming

DTC P0011

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0011

Camshaft Position System Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid High Control	P0010	P0010	P0010	P0011
Low Reference	-	P0010, P0011	-	-

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the Camshaft Position Actuator Magnet duty cycle by controlling the amount of ON time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position. The total range of valve timing command is 26 degree as measured at the camshaft or 52 degree as measured at the crankshaft.

The ECM controls the Camshaft Position Actuator Magnet by suppling a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

CONDITIONS FOR RUNNING THE DTC

- DTC P0010, P0016, P0335, P0336, P0340, or P0341 is not set.
- The engine is running.
- The system voltage is between 11-18 V.
- The camshaft position actuator is enabled and commanded greater than 0 degrees.

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- The power take off (PTO) is not active - If equipped.
- The desired camshaft position does not vary greater than 7.5 degrees for 2 s.
- DTC P0011 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects the difference between the desired camshaft position angle and the actual camshaft position angle is greater than 8 degrees for 20 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0011 is a type B DTC.
- The camshaft position actuator is commanded to the park position.

CONDITIONS FOR CLEARING THE DTC

DTC P0011 is a type B DTC.

DIAGNOSTIC AIDS

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE:

- **The engine oil level and the oil pressure are critical to the correct operation of the camshaft position (CMP) actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.**
- **If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.**

1. Ignition ON, observe the scan tool DTC information. Verify that none of the following DTCs are set. DTC P0335, P0336, P0340, P0341, P0521, P0522, P0523, P1516, P2101, P2119, or P2176.
   - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling at the normal operating temperature. Monitor the engine oil pressure parameter with a scan tool. The engine oil pressure should be greater than the minimum hot oil pressure values. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
3. Command the camshaft position actuator solenoid to 20° with a scan tool. The Desired Camshaft Position parameter should match the Camshaft Position parameter.
4. Observe the Camshaft Position Variance parameter with a scan tool. The Camshaft Position Variance will increment for several seconds, until the Camshaft Position value matches the Desired Camshaft Position value. The Camshaft Position Variance value should return to 0°.
5. Operate the vehicle within the Conditions for Running the DTC, to verify the DTC does not reset. You may also operate the vehicle within the conditions that are captured in the Freeze Fame/Failure Records Data List.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the Q6 Camshaft Position Actuator Magnet harness connector X109.

NOTE: **Testing for steps 2-4 is performed on the ECM side of the harness connector X109.**

2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminal E and ground.

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- If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE: A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, B+ on the control circuit is normal.

3. Ignition ON, engine OFF, verify that a test lamp does not illuminate between the control circuit terminal D and ground.
   - If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Connect the DMM black lead to the control circuit terminal D. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
   - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: Testing for steps 5 and 6 is performed on the engine side of the harness connector X109.

5. Ignition OFF, test for infinite resistance between the control circuit terminal D and ground.
   - If not the specified value, repair the control circuit for a short to ground.
6. Test for 5.0-9.0 ohms between the control circuit terminal D and the low reference circuit terminal E.
   - If less than the specified range, test for a short between the control circuit and the low reference circuit. If the circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Magnet.
   - If greater than the specified range, test the control circuit and the low reference for an open/high resistance. If the circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Magnet.
7. Remove the Q6 Camshaft Position Actuator Magnet. Perform the **Camshaft Position Actuator Magnet Cleaning and Inspection** . The Camshaft Position Actuator Magnet should pass the inspection.
   - If the inspection fails, replace the Q6 Camshaft Position Actuator Magnet.
8. Perform the **Camshaft Position Actuator Solenoid Valve Inspection (Off-Vehicle)** or **Camshaft Position Actuator Solenoid Valve Inspection (On-Vehicle)** . The Camshaft Position Actuator Solenoid Valve should pass the inspection.
   - If the inspection fails, replace the Camshaft Position Actuator Solenoid Valve.
9. If all circuits and components test normal, replace the mechanical Camshaft Position Actuator.

COMPONENT TESTING

Static Test

1. Ignition OFF, remove the Q6 Camshaft Position Actuator Magnet.
2. Test for 5.0-9.0 ohms between the solenoid control terminal 2 and the low reference terminal 1 at the Q6

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Camshaft Position Actuator Magnet.

- If not within the specified range, replace the Q6 Camshaft Position Actuator Magnet.

3. Test for infinite resistance between each terminal ot the magnet and the magnet housing.
   - If not the specified value, replace the Q6 Camshaft Position Actuator Magnet.

Dynamic Test

1. Remove the Q6 Camshaft Position Actuator Magnet.

NOTE:

- **The Camshaft Position Actuator Magnet pintle should be facing downward for this test.**
- **Do not allow electrical current to flow through the Camshaft Position Actuator Magnet for greater than 1-2 s.**

2. Install a 20 A fused jumper wire between the control circuit terminal 2 and 12 V. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.
   - If the function does not perform as specified, replace the Q6 Camshaft Position Actuator Magnet.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Replacement**
- **Camshaft Position Actuator Solenoid Valve Replacement**
- **Camshaft Position Actuator Magnet Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0016

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0016

Crankshaft Position - Camshaft Position Not Plausible

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses the crankshaft position (CKP) sensor and the camshaft position (CMP)

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sensor pulses to monitor the correlation between the crankshaft and the camshaft position. The CKP sensor works in conjunction with a 58X reluctor wheel that is attached to the crankshaft. Each tooth on the reluctor wheel is spaced 6 degrees apart with one span having a 12 degree space. The ECM uses the 12 degree space to determine top dead center (TDC) for cylinders 1 and 6. The camshaft reluctor wheel has 4 teeth, 2 narrow, and 2 wide. The 4 trailing edges of each tooth are evenly spaced at 90 degrees apart around the circumference of the camshaft sprocket. With the engine running, and the CMP actuator in the parked position - if equipped, the ECM expects the camshaft signal pulses to occur 36 crankshaft degrees before top dead center (BTDC) for cylinder number 1, and every 90 degrees thereafter.

CONDITIONS FOR RUNNING THE DTC

- DTC P0335, P0336, P0340, P0341, P0641, or P0651 is not set.
- The engine is running.
- The engine speed is less than 1,200 RPM - Without HD L96.
- The crankshaft and camshaft position signals are synchronized.
- The camshaft position actuator is commanded to the parked position - If equipped.
- DTC P0016 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects the camshaft to crankshaft misalignment by monitoring the camshaft position sensor pulses. The ECM detects one of the following conditions:

- The ECM detects that the CMP sensor pulses occur greater than 11 degrees before or after the nominal position for 4 out of 5 camshaft revolutions while the engine is operating - With HD L96.
- The ECM detects that the CMP sensor pulses occur greater than 11 degrees before or after the nominal position for 4 out of 5 camshaft revolutions while the starter is engaged - Without HD L96.
- The ECM detects that the CMP sensor pulses occur greater than 11 degrees before or after the nominal position for 24 out of 30 camshaft revolutions while the engine is operating - Without HD L96.

ACTION TAKEN WHEN THE DTC SETS

DTC P0016 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0016 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Component Connector End Views

Description and Operation

- **Camshaft Actuator System Description**
- **Electronic Ignition System Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Idle the engine at normal operating temperature. Observe the DTC information with a scan tool. DTC P0016 should not set.
    - If a DTC sets, inspect for the following conditions:
        - The correct installation of the camshaft sensor
        - The correct installation of the crankshaft sensor
        - A timing chain tensioner condition
        - An incorrectly installed timing chain
        - Excessive play in the timing chain or sprockets
        - A timing chain that jumped teeth
    - If you find a condition, repair as necessary.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Timing Chain and Sprocket Cleaning and Inspection**
- **Camshaft Timing Chain and Sprocket Replacement (LS3)** - Without Cam Actuator

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- **Timing Chain, Crankshaft Sprocket, Camshaft Position Actuator, and Solenoid Valve Replacement** - With Cam Actuator

DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, OR P0161

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0030

HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0036

HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit Bank 2 Sensor 1

DTC P0053

HO2S Heater Resistance Bank 1 Sensor 1

DTC P0054

HO2S Heater Resistance Bank 1 Sensor 2

DTC P0056

HO2S Heater Control Circuit Bank 2 Sensor 2

DTC P0059

HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060

HO2S Heater Resistance Bank 2 Sensor 2

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DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0036, P0050, P0056, P0135, P0138, P0141, P0155, P0158, P0161 Opens fuse	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0056	P0053, P0054, P0059, P0060, P0138, P0140, P0158, P0160	P0030, P0036, P0050, P0056, P0135, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0151, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Current/HO2S Sensor 2 Current

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.3-1.5 A			
HO2S Heater Low Control	0 A	0 A	0 A
HO2S Heater Fused Supply	0 A	0 A	0.3-1.5 A

CIRCUIT/SYSTEM DESCRIPTION

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the

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time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

CONDITIONS FOR RUNNING THE DTC

P0030, P0036, P0050, or P0056

- The ignition 1 voltage is between 11-18 volts.
- The engine speed is greater than 400 RPM.
- The DTCs run continuously when the above conditions are met for 1 second.

P0053, P0054, P0059, or P0060

- DTCs P0112, P0113, P0117, P0118, or P2610 are not set.
- The engine run time is greater than 3 seconds.
- The ignition voltage is less than 18 volts.
- The ignition is OFF for greater than 8 hours.
- The engine coolant temperature (ECT) is between -30 to +45°C (-22 to +113°F) at engine start-up.
- The ECT and the intake air temperature (IAT) are within 8°C (14°F) at engine start-up.
- The DTCs run once per drive cycle when the above conditions are met.

P0135, P0141, P0155, or P0161

- DTCs P0116, P0117, P0118, P0125, or P0128 are not set.
- The ignition 1 voltage is between 10-18 volts.
- The HO2S is at operating temperature.
- The HO2S is commanded ON.
- The DTCs run once per drive cycle when the above conditions are met for 120 seconds.

CONDITIONS FOR SETTING THE DTC

P0030, P0036, P0050, or P0056

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

P0053, P0054, P0059, or P0060

The ECM detects the HO2S heater is not within a specified resistance range at engine start-up for greater than 1 second.

P0135 or P0155

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The ECM detects that the HO2S 1 heater current is greater than 3.1 amps, or less than 0.3 amps for greater than 8 seconds.

P0141 or P0161

The ECM detects that the HO2S 2 heater current is greater than 2.9 amps, or less than 0.3 amps for greater than 8 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141. P0155, and P0161 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141. P0155, and P0161 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

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1. Engine idling, command the appropriate B52 HO2S heater to 100 % and 0 % with a scan tool while observing the B52 HO2S Heater Circuit Test Status parameter. The parameter should display OK or Not Run.
2. Engine idling at operating temperature, observe the scan tool B52 HO2S Heater parameter. The amperage should be within 0.3-1.5 A.
3. Engine idling at operating temperature, move the related wiring and connectors while observing the B52 HO2S Heater parameter with a scan tool. The parameter should not change with movement.
    - If movement affects the parameter, repair the appropriate harness or connector.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
    - If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B52 HO2S heater circuit fuse is open, test all components connected to the fuse and replace as necessary.
3. Probe the appropriate control circuit terminal listed below with a test lamp connected to B+. Verify that the test lamp does not illuminate.
    - B52 HO2S 1 terminal E
    - B52 HO2S 2 terminal C
    - If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Engine idling, the test lamp should illuminate, or flash.
    - If the test lamp does not illuminate, or flash, test the control circuit for a short to voltage, or an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.

NOTE:

- **Less than 10 ohms on the ignition voltage circuit, or control circuit may set a DTC. If there is resistance on a circuit the driver will remain ON and the scan tool will display greater than 0.00 amp.**
- **Performing this test may set additional DTCs.**

5. Ignition OFF, connect a 10 A fused jumper wire between the control circuit terminal listed below and the ignition voltage circuit terminal D.
    - B52 HO2S 1 terminal E
    - B52 HO2S 2 terminal C
6. Engine idling, observe the appropriate B52 HO2S Heater parameter. The scan tool should display 0.00 A.
    - If greater than the specified value, test the control circuit and the ignition voltage circuit for high resistance.

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7. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0068 OR P0121

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0068

Throttle Body Airflow Performance

DTC P0121

Throttle Position Sensor 1 Performance

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- The throttle position
- The barometric pressure (BARO)
- The manifold absolute pressure (MAP)
- The intake air temperature (IAT)
- The engine RPM

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CONDITIONS FOR RUNNING THE DTC

P0068

- DTCs P0641, P0651, P1516, P2101, P2119, P2176 are not set.
- The engine is running.
- DTC P0068 run continuously when the above conditions are met.

P0121

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0315, P0335, P0336 are not set.
- The engine speed is greater than 450 RPM.
- DTC P0121 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0068

The ECM detects that the throttle position and the indicated engine load do not correspond with the expected load and throttle position for less than 1 s.

P0121

The predicted air flow and the predicted MAP combined are outside a calibrated range for greater than 3 s.

ACTION TAKEN WHEN THE DTC SETS

P0068

- DTC P0068 is a Type A DTC.
- The control module commands the throttle actuator control (TAC) system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

P0121

DTC P0121 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTC P0068 is a Type A DTC.
- DTC P0121 is a Type B DTC.

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REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Inspect for the following conditions:
   - Vacuum hoses for splits, kinks, and proper connections as shown on Vehicle Emission Control Information label
   - Inspect thoroughly for any type of leak or restriction
   - Air leaks at Q38 throttle body mounting area and intake manifold sealing surfaces
   - Inspect Q38 throttle body for dirt, debris, and coking. Refer to **Throttle Body Cleaning** .
2. Allow the engine to reach operating temperature. Observe the Manifold Absolute Pressure (MAP) Sensor Voltage parameter with a scan tool. Voltage should be greater than 0.8 V and less than 4 V.
   - If greater than 4 V or less than 0.8 V, refer to **DTC P0106**.
3. Idle the engine. Observe the MAP Sensor kPa/psi parameter with a scan tool. Increase the engine speed slowly and then back to idle. The MAP sensor kPa/psi should change smoothly and gradually as engine speed is increased and returned to idle.
   - If the MAP sensor kPa does not change, refer to **DTC P0106** for further diagnosis.
4. Take a snapshot of the engine data list while performing the actions listed below. The mass air flow (MAF) sensor should change smoothly and gradually as the engine speed is increased and is returned to idle.
   - Idle the engine.

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- Increase the engine speed slowly to 3,000 RPM, then back to idle.
- Exit from the snapshot and review the data.
- Observe the Mass Air Flow (MAF) Sensor parameter frame by frame with a scan tool. The MAF sensor should change smoothly and gradually as the engine speed is increased and is returned to idle.
  - If the MAF sensor does not change smoothly and gradually as the engine speed is increased and is returned to idle refer to **DTC P0101 or P1101**.

5. Inspect the Q38 throttle body for the following conditions:
   - Loose or damaged throttle blade
   - Broken throttle shaft
   - Any throttle body damage
     - If any of these conditions exist, replace the Q38 throttle body assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Body Assembly Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0101 OR P1101

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0101

Mass Air Flow Sensor Performance

DTC P1101

Intake Air Flow System Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open /High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101	-	P0101, P0103

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MAF Sensor Signal	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0102	-	P0102

TYPICAL SCAN TOOL DATA

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 2,000-9,500 Hz			
Ignition 1 Voltage	0 Hz	0 Hz	-
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

CIRCUIT DESCRIPTION

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), throttle position sensor, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.
- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the Throttle Position Performance Test parameter.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the throttle position sensors and to each other to determine the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance	MAP Performance	MAP Performance	Throttle Position Performance		

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Test	Test 1	Test 2	Test	DTCs Passed	DTCs Failed
-	-	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Malfunction	OK	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	OK	P0106, P0121, P1101	P0101
OK	Malfunction	Malfunction	OK	P0101, P0121, P1101	P0106
Malfunction	Malfunction	Malfunction	OK	P0121, P1101	P0101, P0106
-	-	OK	Malfunction	P0101, P0106, P1101	P0121
OK	OK	Malfunction	Malfunction	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	Malfunction	P0101, P0106, P0121	P1101
-	Malfunction	Malfunction	Malfunction	P0101, P0106, P0121	P1101

CONDITIONS FOR RUNNING THE DTCS

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335, P0336 are not set.
- The engine speed is between 450-5,800 RPM.
- The IAT Sensor parameter is between -20 to +125°C (-4 to +257°F).
- The ECT Sensor parameter is between 69-125°C (156-257°F).
- This DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and throttle position sensors are not within range of the calculated airflow that is derived from the system of models for more than 0.5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0101 and P1101 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0101 and P1101 are Type B DTCs.

DIAGNOSTIC AIDS

- A steady or intermittent high resistance of 15 ohms or greater on the ignition 1 voltage circuit will cause

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the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.

- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will increase or decrease the MAF sensor signal that is interpreted by the ECM. Additionally it may cause a rapid fluctuation in the IAT Sensor parameter.
- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance** .

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 38522:** Variable Speed Generator
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0641 or P0651 is not set.

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- If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

2. Verify that restrictions do not exist in the exhaust system. Refer to **Restricted Exhaust** .
3. Engine running at idle, observe the scan tool MAF Sensor parameter. The reading should be between 2,000-3,900 Hz depending on the ECT.
4. A wide open throttle (WOT) acceleration from a stop should cause the MAF Sensor parameter on the scan tool to increase rapidly. This increase should be from 4-9 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.
5. Use the scan tool and compare the MAF Sensor parameter to a known good vehicle under various operating conditions.
6. Ignition ON, observe the MAP sensor pressure parameter and compare to the **DTC P0106** table. The MAP sensor reading should be within the specified range.
   - If the MAP sensor pressure is not within the specified range, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for DTC P0106 for further diagnosis.
7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
   - Any damaged components
   - Loose or improper installation
   - An air flow restriction
   - Any vacuum leak
   - Water intrusion
   - In cold climates, inspect for any snow or ice buildup
   - The MAF sensor element for contamination
2. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
3. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the ground circuit terminal B and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
   - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
   - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition OFF, connect the red lead of the **J 38522:** Generator to the signal circuit terminal A at the B75B MAF/IAT sensor harness connector. Connect the battery voltage supply to B+. Connect the black lead to

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ground.

7. Set the **J 38522:** Generator Signal switch to 5 V, the Frequency switch to 5K, and the Duty Cycle switch to Normal.
8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
    - If the MAF Sensor parameter is not within the specified range, replace the K20 ECM.
9. If the circuits test normal, test or replace the B75B MAF/IAT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0102 OR P0103

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0102

Mass Air Flow Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow Sensor Circuit High Frequency

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101, P0102	P0102	-	P0101, P0103
MAF Sensor Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0102	P0102	-	P0102

TYPICAL SCAN TOOL DATA

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MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 2,000-9,500 Hz			
Ignition 1 Voltage	0 Hz	0 Hz	-
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

CIRCUIT/SYSTEM DESCRIPTION

The mass air flow (MAF) sensor is integrated with the intake air temperature (IAT) sensor. The MAF sensor is an air flow meter that measures the amount of air entering the engine. The engine control module (ECM) uses the MAF sensor signal to provide the correct fuel delivery for all engine speeds and loads. A small quantity of air entering the engine indicates a deceleration or idle condition. A large quantity of air entering the engine indicates an acceleration or high load condition.

The ECM applies 5 V to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a frequency based on the inlet air flow through the sensor bore. The frequency varies within a range of near 2,000 Hz at idle to near 9,700 Hz at maximum engine load.

CONDITIONS FOR RUNNING THE DTC

- The engine is running for greater than 1 s.
- The engine speed is greater than 300 RPM.
- The ignition 1 signal is greater than 8 V.
- The above conditions are met for greater than 1 s.
- These DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0102

The ECM detects that the MAF Sensor parameter is less than 1,126 for greater than 5 s.

P0103

The ECM detects that the MAF Sensor parameter is greater than 14,500 Hz for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0102 and P0103 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0102 and P0103 are Type B DTCs.

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DIAGNOSTIC AIDS

- Verify the integrity of the air induction system by inspecting for the following conditions:
  - Any water intrusion in the induction system
  - Any contamination or debris on the sensing elements of the MAF sensor
  - Damaged components
- Verify that any electrical aftermarket devices are properly connected and grounded. Refer to **Checking Aftermarket Accessories** .

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 38522: Variable Signal Generator

For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

- Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2,000-3,900 Hz, depending on the engine coolant temperature (ECT).
- A wide open throttle (WOT) acceleration from a stop should cause the MAF sensor parameter on the scan

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tool to increase rapidly. This increase should be from 4-9 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.

- Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.
    - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Ignition OFF, connect the red lead of the **J 38522:** Generator to the signal circuit terminal A at the B75B MAF/IAT sensor harness connector. Connect the battery voltage supply to B+. Connect the black lead to ground.
6. Set the **J 38522:** Generator switch to 5 V, the Frequency switch to 5K, and the Duty Cycle switch to Normal.
7. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
    - If the MAF Sensor parameter is not within the specified range, replace the K20 ECM.
8. If the circuits test normal, test or replace the B75B MAF/IAT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0106

DIAGNOSTIC INSTRUCTIONS

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- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0452, P0522, P0532, P0641	P0106, P0107	P0107	P0106, P0108, P0453, P0533, P0641	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0106, P0108*	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0106, P0108	*	P0106, P0108
*ECM or sensor damage may occur if the circuit is shorted to B+					

TYPICAL SCAN TOOL DATA

MAP Sensor

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
5 V Reference	-	10 kPa (1.5 psi)	10 kPa (1.5 psi)	104 kPa (15.1 psi)
MAP Sensor Signal	12-103 kPa (1.7-14.9 psi)	10 kPa (1.5 psi)	10 kPa (1.5 psi)	104 kPa (15.1 psi)
Low Reference	-	-	80-103 kPa (11.6-14.9 psi)	-

CIRCUIT DESCRIPTION

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), throttle position sensor, intake air

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temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.

- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the Throttle Position Performance Test parameter.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the throttle position sensors and to each other to determine the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance Test	MAP Performance Test 1	MAP Performance Test 2	Throttle Position Performance Test	DTCs Passed	DTCs Failed
-	-	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Fault	OK	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	OK	P0106, P0121, P1101	P0101
OK	Fault	Fault	OK	P0101, P0121, P1101	P0106
Fault	Fault	Fault	OK	P0121, P1101	P0101, P0106
-	-	OK	Fault	P0101, P0106, P1101	P0121
OK	OK	Fault	Fault	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	Fault	P0101, P0106, P0121	P1101
-	Fault	Fault	Fault	P0101, P0106, P0121	P1101

CONDITIONS FOR RUNNING THE DTC

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335, P0336 are not

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set.
- The engine is running.
- The IAT Sensor is between -20 and +125°C (+4 and +257°F).
- The ECT Sensor is between 70-125°C (158-257°F).
- This DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The engine control module (ECM) detects that the MAP sensor pressure is not within range of the calculated pressure that is derived from the system of models for more than 0.5 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0106 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0106 is a Type B DTC.

DIAGNOSTIC AIDS

- A wide open throttle (WOT) acceleration from a stop should cause the MAP sensor parameter on the scan tool to increase rapidly to near the BARO parameter at the time of the 1-2 shift.
- A skewed or stuck engine coolant temperature (ECT) sensor or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance** .
- The barometric pressure (BARO) that is used by the ECM to calculate the air flow models is initially based on the MAP sensor at the ignition ON. When the engine is running, the ECM will continually update the BARO value near WOT using the MAP sensor and a calculation. A skewed MAP sensor will cause the BARO value to be inaccurate.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 35555:** Metal Mityvac
- **J 23738:** Mityvac
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. If DTCs P0641 or P0651 are set, refer to **DTC P0641 or P0651 (ECM)** .
2. Verify that restrictions do not exist in the exhaust system. Refer to **Restricted Exhaust** .
3. Verify that the engine is in good mechanical condition. Refer to **Symptoms - Engine Mechanical** .
4. Ignition OFF for 90 seconds, determine the current vehicle testing altitude. Ignition ON, observe the scan tool BARO parameter. Compare the parameter to the **Altitude Versus Barometric Pressure** table. The BARO parameter should be within the specified range indicated in the table.
5. A skewed MAP sensor will also cause the first and second intake manifold models to disagree with the actual MAP sensor measurements. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions. The readings should be within 3 kPa (0.4 psi) of the known good vehicle.
6. Ignition ON, observe the scan tool MAP Sensor parameter. Start the engine. The MAP Sensor parameter should change.
7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B74 MAP sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal 2 and ground.
    - If greater than the specified value, test the low reference circuit for an open/high resistance. If the

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circuit tests normal, replace the K20 ECM.

3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Verify the scan tool MAP Sensor parameter is less than 12 kPa (1.7 psi).
    - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 103 kPa (14.9 psi).
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the B74 MAP sensor.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing in order to verify the integrity of the MAP sensor circuits before proceeding with the Component Testing.

Erratic Signal Test

1. Turn ON the ignition, with the engine OFF, and remove the B74 MAP sensor.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 and the corresponding terminal of the B74 MAP sensor.
3. Install a jumper wire between the low reference circuit terminal 2 of the MAP sensor and ground.
4. Install a jumper wire at the MAP sensor signal circuit terminal 3.
5. Connect a DMM between the jumper wire from the MAP sensor signal circuit and ground.
6. Install the **J 35555:** Metal Mityvac to the MAP sensor vacuum port. Slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 0-5.2 V without any spikes or dropouts.
    - If the voltage is not within the specified range or is erratic, replace the B74 MAP sensor.

Skewed Sensor Test

1. Using the following steps and referencing the table below will determine if the MAP sensor is skewed.
2. Ignition ON, engine OFF, observe the MAP Sensor scan tool parameter.
3. Use the observed MAP Sensor scan tool parameter that is closest to a value that is indicated in the first column.

   THEN

4. Using the **J 23738:** Mityvac or the **J 35555:** Metal Mityvac to apply 5 in Hg of vacuum to the B74 MAP

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sensor, the parameter in the first column should decrease by 17 kPa (2.5 psi). The acceptable range is indicated in the second column.

5. Using the **J 23738:** Mityvac or the **J 35555:** Metal Mityvac to apply 10 in Hg of vacuum to the B74 MAP sensor, the parameter in the first column should decrease by 34 kPa (4.9 psi). The acceptable range is indicated in the third column.
    - If not within the specified range, replace the MAP sensor.

Ignition ON, Engine OFF, MAP Sensor Parameter	MAP Sensor Parameter With 5 Inches of Vacuum Applied	MAP Sensor Parameter With 10 Inches of Vacuum Applied
100 kPa (14.5 psi)	79-87 kPa (11.5-12.6 psi)	62-70 kPa (9-10.2 psi)
95 kPa (13.8 psi)	74-82 kPa (10.7-11.9 psi)	57-65 kPa (8.3-9.4 psi)
90 kPa (13.1 psi)	69-77 kPa (10-11.2 psi)	52-60 kPa (7.5-8.7 psi)
80 kPa (11.6 psi)	59-67 kPa (8.6-9.7 psi)	42-50 kPa (6.1-7.3 psi)
70 kPa (10.2 psi)	49-57 kPa (7.1-8.3 psi)	32-40 kPa (4.6-5.8 psi)
60 kPa (8.7 psi)	39-47 kPa (5.7-6.8 psi)	22-30 kPa (3.2-4.4 psi)

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Manifold Absolute Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0107 OR P0108

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

	Short to	High		Short to	Signal

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Circuit	Ground	Resistance	Open	Voltage	Performance
5 V Reference	P0107, P0452, P0522, P0532, P0641	P0106, P0107	P0107	P0106, P0108, P0453, P0522, P0533, P0641	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0106, P0108*	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0106, P0108	*	P0106, P0108
*ECM or sensor damage may occur if the circuit is shorted to B+					

TYPICAL SCAN TOOL DATA

MAP Sensor

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
5 V Reference	-	10 kPa (1.5 psi)	10 kPa (1.5 psi)	104 kPa (15.1 psi)
MAP Sensor Signal	12-103 kPa (1.7-14.9 psi)	10 kPa (1.5 psi)	10 kPa (1.5 psi)	104 kPa (15.1 psi)
Low Reference	-	-	80-103 kPa (11.6-14.9 psi)	-

CIRCUIT DESCRIPTION

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, and barometric pressure (BARO). A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 V to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the highest pressure that can exist in the intake manifold is equal to BARO. This occurs when the vehicle is operated at wide-open throttle (WOT) or when the ignition is ON while the engine is OFF. Under these conditions, the ECM uses the MAP sensor to determine the current BARO. The lowest manifold pressures occur when the vehicle is idling or decelerating. MAP can range from 10 kPa (1.5 psi), when pressures are low, to as much as 104 kPa (15.1 psi) when pressures are high, depending on the BARO. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

CONDITIONS FOR RUNNING THE DTC

P0107

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- DTCs P0641, P0651, P1516, P2101, P2125, P2135, P2138, P2176 are not set.
- The engine speed is greater than 400 RPM.
- The throttle angle is greater than 0 % when the engine speed is less than 800 RPM.

OR

- The throttle angle is greater than 13 % when the engine speed is greater than 800 RPM.
- This DTC runs continuously when the above conditions are met.

P0108

- DTCs P1516, P2101, P2125, P2135, P2138, P2176 are not set.
- The engine has been running for a period of time that is determined by the start-up engine coolant temperature (ECT). The time ranges from 8 s at colder than -30°C (-22°F) to 3 s at warmer than 30°C (86°F).
- The throttle angle is less than 1% when the engine speed is less than 1,200 RPM.

OR

- The throttle angle is less than 20 % when the engine speed is greater than 1,200 RPM.
- This DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0107

The ECM detects that the MAP sensor voltage is less than 0.1 V for greater than 4 s.

P0108

The ECM detects that the MAP sensor voltage is greater than 4.9 V for greater than 4 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0107 and P0108 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0107 and P0108 are Type B DTCs.

DIAGNOSTIC AIDS

Verify the integrity of the MAP sensor system by inspecting for the following conditions:

- Intake manifold vacuum leaks

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- Any damage to the MAP sensor housing
- Any damage to the MAP sensor seal
- A loose or improperly installed MAP sensor
- A restriction in the vacuum source of the MAP sensor

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 35555:** Metal Mityvac
- **J 23738:** Mityvac
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

- Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions.
- Use the scan tool and compare the MAP Sensor parameter at ignition ON, with the engine OFF, to the Altitude vs Barometric Pressure table. Refer to **Altitude Versus Barometric Pressure** .

CIRCUIT/SYSTEM TESTING

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NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B74 MAP sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Verify the scan tool MAP Sensor parameter is less than 12 kPa (1.7 psi).
    - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 103 kPa (14.9 psi).
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the B74 MAP sensor.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing in order to verify the integrity of the MAP sensor circuits before proceeding with the Component Testing.

1. Turn ON the ignition, with the engine OFF, and remove the B74 MAP sensor.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 and the corresponding terminal of the B74 MAP sensor.
3. Install a jumper wire between the low reference circuit terminal 2 of the MAP sensor and ground.
4. Install a jumper wire at the B74 MAP sensor signal circuit terminal 3.
5. Connect a DMM between the jumper wire from the B74 MAP sensor signal circuit terminal 3 and ground.
6. Install the **J 35555:** Metal Mityvac to the B74 MAP sensor vacuum port. Slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 0-5.2 V without any spikes or dropouts.
    - If the voltage is not within the specified range or is erratic, replace the B74 MAP sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

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- **Manifold Absolute Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0112 OR P0113

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0112

Intake Air Temperature (IAT) Sensor Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open /High Resistance	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112	P0113	P0113*	-
Low Reference	-	P0113	P0113*	-
*ECM or sensor damage may occur if the circuit is shorted to B+				

TYPICAL SCAN TOOL DATA

IAT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine running **Parameter Normal Range:** Varies with intake air temperature			
IAT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

CIRCUIT/SYSTEM DESCRIPTION

The intake air temperature (IAT) sensor, a part of the mass air flow (MAF) sensor assembly, is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 V to the IAT signal

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circuit, and a ground for the IAT low reference circuit.

CONDITIONS FOR RUNNING THE DTC

P0112

- DTCs P0117, P0118, P0722, P0723 are not set.
- The engine is running for greater than 10 s.
- The engine coolant temperature (ECT) is colder than 150°C (302°F).
- This DTC runs continuously when the above conditions are met.

P0113

- DTCs P0101, P0102, P0103, P0117, P0118, P0722, P0723 are not set.
- The engine is running for greater than 10 s.
- The ECT is warmer than -40°C (-40°F).
- The MAF Sensor parameter is less than 512 g/s.
- This DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0112

The ECM detects that the IAT is warmer than 150°C (302°F) for greater than 5 s.

P0113

The ECM detects that the IAT is colder than -39°C (-38°F) for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0112 and P0113 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0112 and P0113 are Type B DTCs.

DIAGNOSTIC AIDS

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor will gradually increase the scan tool IAT Sensor parameter. This is due to the heat that is generated by the mass air flow (MAF) sensor heating elements.
- Depending on the ambient temperature, an IAT sensor signal circuit or low reference circuit that is shorted to the MAF sensor signal circuit can cause a DTC P0113 to set. This condition causes a rapid fluctuation in the IAT Sensor parameter.

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- An IAT sensor signal circuit that is shorted to the MAF sensor ignition circuit can cause a DTC P0113 to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine running, observe the scan tool IAT Sensor parameter. The reading should be between -38 to +120°C (-38 to +248°F), depending on current ambient temperature and vehicle operation conditions.
2. Operate the vehicle with the Conditions for Running the DTC to verify that the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the IAT harness connector at the B75B MAF/IAT sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the low reference circuit terminal D and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the

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circuit tests normal, replace the K20 ECM.

3. Ignition ON, verify the scan tool IAT Sensor parameter is colder than -39°C (-38°F).
    - If warmer than the specified range, test the signal circuit terminal E for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal E and a good ground. Verify the scan tool IAT Sensor parameter is warmer than 149°C (300°F).
    - If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B75B MAF/IAT sensor.

COMPONENT TESTING

Measure and record the resistance of the B75B IAT sensor at various ambient temperatures, and then compare those measurements to the Temperature vs Resistance Table. Refer to **Temperature Versus Resistance** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0116

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118	P0118*	P0116, P0128
Low Reference	-	P0118	P0118	P0118*	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+					

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TYPICAL SCAN TOOL DATA

ECT Sensor Temperature

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or engine running **Parameter Normal Range:** Varies with coolant temperature				
ECT Sensor Signal	-39 to +120°C (-38 to +248°F)	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT signal circuit and supplies a ground to the low reference circuit.

The ECM uses this high side coolant rationality diagnostic to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the ignition is OFF. If the calibrated ignition OFF time is met at start-up, the ECM will compare the temperature difference between the ECT and the intake air temperature (IAT), to determine if the temperatures are within an acceptable operating range of each other.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0112, P0113, P0117, P0118, P0502, P0503, P0601, P0603, P062F, P2610 are not set.
- The vehicle has had a minimum ignition OFF time of 10 h.
- The ignition is ON.
- The start-up IAT is greater than -7°C (+19°F)
- The Fuel Level Sensor parameter is greater than 5%.
- This DTC runs once per ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 30°C (54°F) greater than the IAT sensor.

  OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 10°C (18°F) greater than the IAT sensor, and the time spent cranking the engine is greater than 10 s, when the fuel level is greater than 5%.

  OR

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- With the power-up IAT greater than -7°C (+19°F), the ECM detects a temperature difference at power-up that indicates that the ECT sensor is 20°C (36°F) greater than the IAT sensor. Then the vehicle must be driven for greater than 6 min and 40 s at greater than 40 km/h (25 mph). If the IAT sensor then decreases greater than 4°C (7°F), an engine block heater was detected and the test is aborted. If the IAT sensor does not decrease, an engine block heater was not detected and DTC P0116 will set.

ACTION TAKEN WHEN THE DTC SETS

DTC P0116 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0116 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. If the ignition has been OFF for 8 h or more, the ECT and the IAT, should be within 6°C (11°F) of each other and also the ambient temperature. Turn ON the ignition, with the engine OFF, and use a scan tool to observe the IAT and the ECT sensor parameters. Compare those sensor parameters to each other and also to the ambient temperature. A slight to moderate resistance in the IAT signal or low reference circuit, can widen the spread between the two sensors and cause this DTC to set.

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2. An IAT sensor that is skewed lower at various ambient temperatures, due to more resistance than is normal, can widen the spread between the two sensors and cause this DTC to set. Measure and record the resistance of the IAT sensor at various ambient temperatures, and then compare those measurements to the Temperature vs Resistance Table. Refer to **Temperature Versus Resistance** .
3. Inspect the ECT sensor terminals for corrosion, and for engine coolant leaking through the sensor.

WARNING: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

4. Turn OFF the ignition.
5. Inspect the cooling system surge tank for the proper engine coolant level. Refer to **Cooling System Leak Testing** and **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.
2. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal A and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
   - If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor parameter is greater than 149°C (300°F).
   - If less than the specified range, test the signal circuit terminal B for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

Measure and record the resistance of the B34 ECT sensor at various ambient temperatures, then compare those measurements to the Temperature vs Resistance Table. Refer to **Temperature Versus Resistance** .

REPAIR PROCEDURES

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Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0117 OR P0118

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118	P0118*	P0116, P0128
Low Reference	-	P0118	P0118	P0118*	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+					

TYPICAL SCAN TOOL DATA

ECT Sensor Temperature

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or engine running **Parameter Normal Range:** Varies with coolant temperature				
ECT Sensor Signal	-39 to +120°C (-38 to +248°F)	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine

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coolant. The engine control module (ECM) supplies 5 V to the ECT signal circuit and supplies a ground to the low reference circuit.

CONDITIONS FOR RUNNING THE DTC

P0117

- The engine is running for greater than 10 s.

  OR

- The ignition is ON when the intake air temperature (IAT) is colder than 50°C (122°F).
- This DTC runs continuously when the above conditions are met.

P0118

- The engine is running for greater than 10 s.

  OR

- The ignition is ON when the IAT is greater than 0°C (32°F).
- This DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0117

The ECM detects that the ECT is warmer than 149°C (300°F) for greater than 5 s.

P0118

The ECM detects that the ECT is colder than -39°C (-38°F) for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0117 and P0118 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0117 and P0118 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

WARNING: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

1. Turn OFF the ignition.
2. Inspect the cooling system surge tank for the proper engine coolant level. Refer to **Cooling System Leak Testing** and **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .
3. Turn ON the ignition, with the engine OFF.
4. Use the scan tool to verify the proper operation of the engine cooling system fans.
5. Turn OFF the ignition.
6. Verify the proper heat range, and the operation of the thermostat. Refer to **Thermostat Diagnosis** .

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

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2. Ignition OFF, all vehicle systems OFF, (this may take up to 2 minutes), test for less than 5 ohms between the low reference circuit terminal A and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
    - If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor parameter is warmer than 149°C (300°F).
    - If colder than the specified range, test the signal circuit terminal B for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If warmer than the specified range, test the signal circuit terminal B for a short to voltage. If circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

Measure and record the resistance of the B34 ECT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** . Verify that the resistance is within 5% of the specification.

- If greater than the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0120, P0122, P0123, P0220, P0222, P0223, OR P2135

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0120

Throttle Position Sensor 1 Circuit

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DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0220

Throttle Position Sensor 2 Circuit

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P2135

Throttle Position Sensor 1-2 Correlation

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0122, P0222	P0122, P0222, P2135	P0123, P0223	-
Throttle Position Sensor 1 Signal	P0122	P0122, P2135	P0123	P0068, P0121
Throttle Position Sensor 2 Signal	P0222	P0223, P2135	P0223	P0068, P0121
Low Reference	-	P0123, P0223, P2135	-	-

TYPICAL SCAN TOOL DATA

Throttle Position Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF **Normal Range:** 3.31-3.71 V			
5 V Reference	0 V	0 V	5 V
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

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Throttle Position Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF **Parameter Normal Range:** 1.25-1.65 V			
5 V Reference	0 V	5 V	5 V
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

CIRCUIT/SYSTEM DESCRIPTION

The throttle body assembly contains 2 throttle position (TP) sensors. The TP sensors are mounted to the throttle body assembly and are not serviceable. The TP sensors provide a signal voltage that changes relative to throttle blade angle. The engine control module (ECM) supplies the TP sensors with a common 5-volt reference circuit, a common low reference circuit, and two independent signal circuits.

The TP sensors have opposite functionality. TP sensor 1 signal voltage decreases and TP sensor 2 signal voltage increases as the accelerator pedal increases to wide open throttle (WOT).

CONDITIONS FOR RUNNING THE DTC

- DTC P0641 or P0651 is not set.
- The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.
- The ignition is ON or the engine is operating.
- DTC P0120, P0122, P0123, P0220, P0222, P0223, and P2135 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0120

The ECM detects that the throttle position sensor 1 voltage is less than 0.325 V or greater than 4.75 V for greater than 1 s.

P0122

The ECM detects that the throttle position sensor 1 voltage is less than 0.325 V for greater than 1 s.

P0123

The ECM detects that the throttle position sensor 1 voltage is greater than 4.75 V for greater than 1 s.

P0220

The throttle position sensor 2 voltage is less than 0.25 V or greater than 4.59 V for greater than 1 s.

P0222

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The ECM detects that the throttle position sensor 2 voltage is less than 0.25 V for greater than 1 s.

P0223

The ECM detects that the throttle position sensor 2 voltage is greater than 4.59 V for greater than 1 s.

P2135

The difference between the throttle position sensor 1 and throttle position sensor 2 exceeds a predetermined value for greater than 1 s.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.

DIAGNOSTIC AIDS

A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0641 or P0651 are not set.
   - If a DTC is set, refer to **DTC P0641 or P0651 (ECM)** for further diagnosis.
2. Ignition ON, observe the scan tool TP sensor 1 voltage parameter. The reading should be between 4.75-0.33 V and change with accelerator pedal input.
3. Ignition ON, observe the scan tool TP sensor 2 voltage parameter. The reading should be between 0.25-4.59 V and change with accelerator pedal input.
4. Observe the scan tool TP Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
   - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
   - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.

   The TP Sensor 1 and 2 Agree/Disagree parameter should display Agree.
5. Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC or within the conditions that you observed from the Freeze Frame/Failure Records.
6. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0120 or P0220 are not the only TP sensor DTCs set.
   - If DTC P0120 or P0220 are the only DTCs set, replace the ECM.
7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the Q38 throttle body.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminal C and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal E and ground.
   - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high

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resistance. If the circuit tests normal, replace the K20 ECM.

- If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.

4. Test for less than 1 V between the TP sensor 1 signal circuit terminal D and ground.
   - If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between TP sensor 1 signal circuit terminal D and the 5-volt reference circuit terminal E. Verify the scan tool TP sensor 1 voltage parameter is greater than 4.8 V.
   - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. Test for 4.8-5.2 V between the TP sensor 2 signal circuit terminal F and ground.
   - If less than specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
   - If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. If all circuits and connections test normal, replace the Q38 throttle body assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Body Assembly Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0128

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118	P0118*	P0116, P0128

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Low Reference	-	P0118	P0118	P0118*	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+.					

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop **Parameter Normal Range:** Varies with coolant temperature				
ECT Sensor Signal	-39 to +120°C (-38 to +248°F)	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and supplies a ground to the low reference circuit.

The purpose of this diagnostic is to analyze the performance of the thermostat by using the ECT sensor to determine if the engine coolant will increase at the correct rate, and also to meet the calibrated target temperatures under various operating conditions.

The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, and engine run time are also factored in, to determine if the ECT does increase normally, and reach the calibrated target temperatures.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0220, P0221, P0223, P0502, P0503, P1516, P2101, P2119 are not set.
- The start-up IAT is warmer than -7°C (+19°F).
- The start-up ECT is colder than 70°C (158°F), when the IAT is above 10°C (50°F).
- The start-up ECT is colder than 50°C (122°F), when the IAT is below 10°C (50°F).
- The engine run time is between 90 s and 22 min.
- The vehicle has traveled more than 2.4 km (1.5 mi) at greater than 8 km/h (5 mph).
- The accumulated airflow is between 20-75 g/s, with the minimum average airflow greater than 10 g/s.
- The fuel ethanol percentage is less than 87%.
- This DTC runs once per ignition cycle within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

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The ECM detects that the minimum ECT of 75°C (167°F) has not been met, when the IAT is warmer than 10°C (50°F).

OR

The ECM detects that the minimum ECT of 55°C (131°F) has not been met, when the IAT is colder than 10°C (50°F).

ACTION TAKEN WHEN THE DTC SETS

DTC P0128 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0128 is a Type B DTC.

DIAGNOSTIC AIDS

- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- Inspect the ECT sensor terminals and the ECT harness connector for corrosion. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- This diagnostic runs in a specific range. Measure and record the resistance of the ECT sensor at various ambient temperatures between -7 and +80°C (+19 and +176°F), then compare those measurements to the **Temperature Versus Resistance** .
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit which is interpreted by the ECM as a colder ECT.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition OFF, inspect the cooling system surge tank for the proper coolant level. Refer to **Cooling System Leak Testing** and **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

   WARNING: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

2. Ignition OFF for 8 h or greater.
3. Ignition ON, observe the scan tool IAT Sensor and ECT Sensor parameters. The ECT, IAT, and ambient temperatures should be within 6°C (11°F) of each other.

   NOTE: A critical analysis of the operation of the thermostat is necessary to properly diagnose these DTCs.

4. Use the scan tool to verify the proper operation of the engine cooling system fans.
5. Verify the proper heat range and the operation of the thermostat. Refer to **Thermostat Diagnosis** .
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.
2. Ignition OFF for 90 s, test for less than 5 ohms between the low reference circuit terminal A and ground.
   - If greater than the specified range, test the low reference circuit terminal B for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).

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    - If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor parameter is warmer than 149°C (300°F).
    - If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

Measure and record the resistance of the B34 ECT sensor at various ambient temperatures, then compare those measurements to the Temperature vs Resistance Table. Refer to **Temperature Versus Resistance** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Engine Coolant Thermostat Replacement (LLT)** or **Engine Coolant Thermostat Replacement (L99/LS3)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, OR P0158

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0131

HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0132

HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0137

HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138

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HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0151

HO2S Circuit Low Voltage Bank 2 Sensor 1

DTC P0152

HO2S Circuit High Voltage Bank 2 Sensor 1

DTC P0157

HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158

HO2S Circuit High Voltage Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P013A, P013B, P013C, P013D, P013E, P013F, P0131, P0132, P0133, P0134, P0137, P0138, P0140, P0151, P0152, P0153, P0154, P0157, P0158, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P013A, P013B, P013C, P013D, P013E, P013F, P0133, P0134, P0140, P0153, P0154, P0160, P1133, P1153
HO2S Low Signal	P0131, P0137, P0151, P0157	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P013A, P013B, P013C, P013D, P013E, P013F, P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	-

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage/HO2S Sensor 2 Voltage

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Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Signal	455 mV	Approximately 450 mV	Approximately 445 mV

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

P0131, P0137, P0151, or P0157

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The throttle position (TP) is between 3-70 %.
- The DTCs run continuously when the above conditions are met for 2 s.

P0132, P0138, P0152, or P0158

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.

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- The throttle position (TP) is between 0-70 %.
- The DTCs run continuously when the above conditions are met for 2 s.

CONDITIONS FOR SETTING THE DTC

P0131, P0137, P0151, or P0157

- The ECM detects that the HO2S voltage is less than 50 mV.
- The DTCs set within 100 s when the above condition is met.

P0132, P0138, P0152, or P0158

- The ECM detects that the HO2S voltage is greater than 1,050 mV.
- The DTCs set within 15 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0131, P0132, P0137, P0138, P0151, P0152, and P0158 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0131, P0132, P0137, P0138, P0151, P0152, and P0158 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Heated Oxygen Sensor Wiring Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
   - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal A and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the appropriate scan tool B52 HO2S parameter is approximately 450 mV.
   - If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
   - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the appropriate scan tool B52 HO2S parameter is less than 60 mV.
   - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**

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- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, OR P1153

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0133

HO2S Slow Response Bank 1 Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Bank 1 Sensor 2

DTC P013C

HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013D

HO2S Slow Response Lean to Rich Bank 2 Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Bank 1 Sensor 2

DTC P014A

HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

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DTC P014B

HO2S Delayed Response Lean to Rich Bank 2 Sensor 2

DTC P0153

HO2S Slow Response Bank 2 Sensor 1

DTC P1133

HO2S Insufficient Switching Bank 1 Sensor 1

DTC P1153

HO2S Insufficient Switching Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P013C, P013D, P0131, P0132, P0133, P0134, P0137, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P013C, P013D, P0133, P0134, P013A, P013B, P013E, P013F, P0140, P0153, P0154, P0160, P1133, P1153, P2A00, P2270, P2271, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0131, P0132, P0133, P0134, P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P013C, P013D, P0131, P0132, P0133, P0134, P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	-

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range

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of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

P0133, P0153, P1133, or P1153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The engine run time is greater than 160 s.
- The engine speed is between 1,200-3,000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 20-55 g/s.
- The fuel system is in Closed Loop.
- The throttle position (TP) is greater than 5 %.
- The DTCs run once per drive cycle when the above conditions are met.

P013A P013C, P013E, or P014A

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition 1 voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10 %.
- The engine run time is equal to or greater than 5 minutes.

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- The accelerator pedal (APP) is steady.
- The torque converter clutch (TCC) is applied.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B P013D, P013F, or P014B

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.
- Before the ECM can report DTC P013F, or P014B failed, DTCs P013A, P013C, P013E, P014A, P2270, P2271, P2272, and P2273 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition 1 voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10 %.
- The engine run time is equal to or greater than 5 minutes.
- The DTCs run once per ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0133 or P0153

- The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 100 s when the above condition is met.

P013A or P013C

The ECM detects that the accumulated mass air flow monitored during rich-to-lean transitions between 450-150 mV is greater than 75 grams.

P013B or P013D

The ECM detects that the accumulated mass air flow monitored during lean-to-rich transitions between 350-650 mV is greater than 75 grams.

P013E or P014A

The ECM detects that the O2 sensor voltage has not decreased below 450 mV within 42 grams of accumulated air flow.

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P013F or P014B

The ECM detects that the O2 sensor voltage has not increased above 350 mV within 200 grams of accumulated air flow.

P1133 or P1153

- The ECM detects that the HO2S 1 rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- The DTCs set within 100 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, and P1153 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, and P1153 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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CIRCUIT/SYSTEM VERIFICATION

- Observe the DTC information with a scan tool. Verify there are no B52 HO2S heater or fuel trim DTCs set.
  - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
- Engine idling at operating temperature, observe the appropriate B52 HO2S parameter with a scan tool. Verify the following:
  - The B52 HO2S 1 value should vary from below 200 mV to above 800 mV and respond to fueling changes.
  - The B52 HO2S 2 value should change greater than 200 mV when the throttle is quickly cycled 3 times from closed to wide open and back to closed after running the engine at 1,500 RPM for 30 s.
- Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify none of the following conditions exist:
   - Lean or rich fuel injectors-Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)**
   - Water intrusion in the B52 HO2S harness connector
   - Low or high fuel system pressure-Refer to **Fuel System Diagnosis**
   - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)**
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks near the B52 HO2S
   - Engine vacuum leaks
   - Engine oil consumption-Refer to **Oil Consumption Diagnosis**
   - Engine coolant consumption-Refer to **Loss of Coolant**
   - If you find any of the above conditions, repair as necessary.
2. If all conditions test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**

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- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0134, P0140, P0154, OR P0160

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0134

HO2S Circuit Insufficient Activity Bank 1 Sensor 1

DTC P0140

HO2S Circuit Insufficient Activity Bank 1 Sensor 2

DTC P0154

HO2S Circuit Insufficient Activity Bank 2 Sensor 1

DTC P0160

HO2S Circuit Insufficient Activity Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P013C, P013D, P0131, P0132, P0133, P0134, P0137, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P013A, P013B, P013C, P013D, P013E, P013F, P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P013C, P013D, P0133, P0134, P013A, P013B, P013E, P013F, P0140, P0153, P0154, P0160, P1133, P1153, P2A00, P2A03
		P0131, P0132, P0133, P0134,	P013C, P013D, P0131, P0132,		

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HO2S Low Signal	-	P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133	P0133, P0134, P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160	-

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Reference	455 mV	Approximately 450 mV	Approximately 445 mV

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ignition 1 voltage is between 10-32 V.
- The engine run time is greater than 300 s.
- The fuel system is in Closed Loop.
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

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P0134 or P0154

The ECM detects that the HO2S 1 voltage is between 350-550 mV for at least 50 s.

P0140 or P0160

The ECM detects that the HO2S 2 voltage is between 410-490 mV for at least 74 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0134, P0140, P0154, and P0160 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0134, P0140, P0154, and P0160 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

- Ignition ON, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
  - If a HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

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- Run the engine for more than 5 minutes.
- Engine idling at operating temperature, observe the appropriate B52 HO2S parameter with a scan tool. Verify the following:
  - The B52 HO2S 1 value should vary from below 200 mV to above 800 mV and respond to fueling changes.
  - The B52 HO2S 2 value should fluctuate at less than 380 mV or greater than 520 mV. The values should not remain within 380 mV and 520 mV.
- Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal A and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the appropriate scan tool B52 HO2S parameter is approximately 450 mV.
   - If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
   - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the appropriate scan tool B52 HO2S parameter is less than 60 mV.
   - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**

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- **Control Module References** for ECM replacement, setup, and programming

DTC P0171, P0172, P0174, OR P0175

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0171

Fuel Trim System Lean Bank 1

DTC P0172

Fuel Trim System Rich Bank 1

DTC P0174

Fuel Trim System Lean Bank 2

DTC P0175

Fuel Trim System Rich Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. Fuel delivery is controlled differently during Open Loop and Closed Loop (CL). During Open Loop, the ECM determines fuel delivery based on sensor signals without heated oxygen sensor (HO2S) input. During CL, the ECM adds HO2S inputs and level of purge to calculate the short and long term fuel trim (FT) adjustments. If the HO2S indicates a lean condition, the fuel trim values will be above 0 %. If the HO2S indicates a rich condition, the FT values will be below 0 %. The short term FT values change rapidly in response to the HO2S voltage signals. The long term FT makes coarse adjustments in order to maintain an optimum air/fuel ratio. A block of cells contain information arranged in combinations of engine RPM and engine load for a full range of vehicle operating conditions. The long term FT diagnostic is based on an average of cells currently being used. The ECM selects the cells based on the engine speed and load. The FT diagnostic will conduct a test to determine if a rich failure actually exists or if excessive vapor from the evaporative emission (EVAP) canister is causing a rich condition.

If the ECM detects an excessively lean condition, DTC P0171 or P0174 sets. If the ECM detects an excessively rich condition, DTC P0172 or P0175 sets.

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CONDITIONS FOR RUNNING THE DTC

- DTCs P0030, P0036, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0117, P0118, P0120, P0121, P0128, P0130, P0131, P0132, P0133, P0134, P0135, P0136, P0137, P0138, P0140, P0141, P0201-P0208, P0220, P0300, P0301-P0304, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P1106, P1107, P1114, P1115, P1133, P1516, P2101, P2119, P2120, P2125, P2135, P2138, P2176 are not set.
- The engine is in Closed Loop status.
- The engine coolant temperature (ECT) is between -40 and +150°C (-40 and +302°F).
- The intake air temperature (IAT) is between -20 and +150°C (-4 and +302°F).
- The manifold absolute pressure (MAP) is between 10-255 kPa (1.45-37 psi).
- The vehicle speed is less than 134 km/h (83 mph).
- The engine speed is between 375-7,000 RPM.
- The mass air flow (MAF) is between 1-510 g/s.
- The barometric pressure (BARO) is more than 70 kPa (10.2 psi).
- The fuel level is more than 10 %.
- This diagnostic runs continuously when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

- The average long term FT weighted average value is more or less than a calibrated value.
- The above condition is present for approximately 3 min after the Conditions for Running the DTC have been met.

ACTION TAKEN WHEN THE DTC SETS

The ECM records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the ECM stores this information in the Failure Records. If the diagnostic reports a failure on the second ignition cycle the ECM records the operating conditions at the time of the failure. The ECM writes the operating conditions to the Freeze Frame and updates the Failure Records. The ECM illuminates the malfunction indicator lamp (MIL) when one of the following occur:

- The ECM detects the same fuel trim failure during 2 consecutive trips.
- The ECM detects any fuel trim failure during any subsequent trip if the conditions at the time of failure meet the following criteria:
  - The engine load is within 20 % of the previous test that failed.
  - The engine speed is within 375 RPM of the previous test that failed.
  - The engine coolant temperature is in the same range of the previous test that failed.

CONDITIONS FOR CLEARING THE MIL/DTC

- The ECM turns OFF the malfunction indicator lamp (MIL) at the beginning of the fourth ignition cycle, after 3 ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.

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- A history DTC and related Freeze Frame data clears after 40 warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

REFERENCE INFORMATION

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

- Disregard any transmission symptoms, antilock brake system (ABS) indicators, and traction control system (TCS) indicators until any fuel trim faults are repaired. A fuel trim fault may cause default actions such as harsh shifts and illumination of the ABS/TCS indicators.
- E85 compatible engine only-Over estimation of the ethanol content will result in a rich shift of fuel trim values, and under-estimation will result in a lean shift of fuel trim values. A fuel trim DTC may set if the learned alcohol content, Fuel Alcohol Content parameter on the scan tool, is different than the measured alcohol content in the vehicle such that fuel trim values exceed failure threshold values.
- Verify that other DTCs are not set.
  - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.
  - If the value does not vary from approximately 40 mV to approximately 900 mV, refer to **DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158**, or **DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153**.

NOTE: EVAP purge enablement may cause the FT to be momentarily outside the normal range.

- The normal Short Term FT parameter should be between +10 % and -10 %, with near 0 % the optimum, with the engine running at operating temperature.
- The Long Term FT parameter should be between +10 % and -10 %, with near 0 % the optimum, with the engine running at operating temperature.
- Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure

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Records data.

CIRCUIT/SYSTEM TESTING

P0171 or P0174

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The reading should be between 0-19 %.

- If not within the specified range, inspect for the following:

- With the ignition ON and the engine OFF, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor pressure should be within the range specified for your altitude. Refer to **Altitude Versus Barometric Pressure** .
  - Refer to **DTC P0106** if the MAP sensor does not indicate the correct barometric pressure.
- With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.
  - Refer to **DTC P0101 or P1101** or **DTC P0102 or P0103** if the MAF sensor parameter is not within 2-6 g/s at idle.
- Vacuum hoses for splits, kinks, and improper connections
- Insufficient fuel in the tank
- Low fuel pressure-Refer to **Fuel System Diagnosis** .
- Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
- Malfunctioning fuel injectors-Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)** .
- Missing, loose, or leaking exhaust components from the HO2S forward-Refer to **Symptoms - Engine Exhaust** .
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings
- The air induction system and the air intake ducts for leaks or for a missing air filter element
- A cracked EVAP canister
- Evaporative pipes obstructed or leaking
- The crankcase ventilation system for leaks
- The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
- The HO2S signal circuit open, shorted to ground, or shorted to the low reference circuit
- Malfunctioning engine components-Refer to **Symptoms - Engine Mechanical** .

P0172 or P0175

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The reading should be between -19 and 0 %.

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- If not within the specified range, inspect for the following:

- With the engine idling and the transmission in the Park or Neutral position, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor parameter should be between 19-42 kPa.
  - Refer to **DTC P0106** if the MAP sensor parameter is not between 19-42 kPa.
- With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.
  - Refer to **DTC P0101 or P1101** or **DTC P0102 or P0103** if the MAF sensor parameter is not within 2-6 g/s at idle.
- Vacuum hoses for splits, kinks, and improper connections
- The air intake duct for being collapsed or restricted
- The air filter for being dirty or restricted
- Objects blocking the throttle body
- Excessive fuel in the crankcase due to leaking fuel injectors
- The evaporative emissions control system for improper operation
- Excessive fuel pressure-Refer to **Fuel System Diagnosis** .
- Malfunctioning fuel injectors-Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)** .
- Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
- The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
- The HO2S signal circuit shorted to voltage

REPAIR PROCEDURES

- **Air Cleaner Assembly Replacement**
- **Air Cleaner Element Replacement**
- **Evaporative Emission Canister Replacement**
- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Evaporative Emission Line Replacement - Engine**
- **Fuel Line Replacement - Chassis**
- **Fuel Injector Replacement**
- **Fuel System Cleaning**
- **Fuel Tank Draining**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1** and **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Manifold Absolute Pressure Sensor Replacement**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**

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- **Throttle Body Assembly Replacement**

REPAIR VERIFICATION

NOTE:

- **After repairs, use the scan tool Fuel Trim Reset function in order to reset the Long Term Fuel Trim.**
- **To verify the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to DTC P0420 or P0430 .**

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Turn ON the ignition, with the engine OFF.

NOTE: DO NOT clear codes with the engine running. The codes may reset in the same ignition cycle.

4. Clear the DTCs.
5. Turn OFF the ignition for 60 s.
6. Start the engine.
7. Duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets, or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.

DTC P018B-P018D

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

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Fuel Pressure Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641	P0641, P06A6	P0641	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

CIRCUIT/SYSTEM DESCRIPTION

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The fuel pump flow control module monitors the voltage signal from the fuel pressure sensor.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- DTC P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The engine has been running for at least 5 seconds.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module does not detect a change in the fuel pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel pressure sensor performance diagnostic provides a means to detect fuel pressure sensor output that is stuck within the normal operating range of the sensor.

ACTION TAKEN WHEN THE DTC SETS

DTC P018B, P018C and P018D are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P018B, P018C and P018D are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

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Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

NOTE: Verify that the fuel tank is not empty. Only perform this diagnostic if there is at least 2 gallons of fuel in the fuel tank. Clear the DTC, and start and run the engine. Verify that the DTC P018B resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.

1. Ignition OFF, disconnect the harness connector at the B47 fuel pressure sensor.
2. Ignition OFF, test for less than 1 ohms between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
3. Ignition ON, test for 4.8-5.2 V between the B47 fuel pressure sensor 5 V reference circuit terminal 3 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
4. Verify the scan tool 5 V reference is less than 1 V.

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    - If greater than the specified range, test the signal circuit terminal 1 for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3. Verify the scan tool 5 V reference is greater than 4.8 V.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
6. If all circuits test normal, replace the B47 fuel pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pressure Sensor Replacement**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P0197 OR P0198

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0197

Engine Oil Temperature (EOT) Sensor Circuit Low Voltage

DTC P0198

Engine Oil Temperature (EOT) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage
EOT Sensor Signal	P0197	P0198	P0198	P0198
EOT Low Reference	-	P0198	P0198	-

TYPICAL SCAN TOOL DATA

Engine Oil Temperature Sensor

	Short to

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Circuit	Ground	High Resistance	Short to Voltage
Operating Conditions: Engine running **Parameter Normal Range:** Varies with engine oil temperature			
EOT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

The engine oil temperature (EOT) sensor is a variable resistor that measures the temperature of the engine oil. The engine control module (ECM) supplies 5 volts on the EOT signal circuit, and a ground to the low reference circuit.

Monitoring the engine oil temperature is necessary for optimal control of the cam phasers. The oil temperature is monitored from dual function oil level switch and temperature sensor located in the oil pan.

CONDITIONS FOR RUNNING THE DTC

P0197

- The engine run time is greater than 20 seconds.

  OR

- The ECT sensor is less than 150°C (302°F).
- The DTC runs continuously when the above enable conditions are met.

P0198

- The engine run time is greater than 20 seconds.

  OR

- The ECT sensor is greater than -40°C (-40°F).
- The DTC runs continuously when the above enable conditions are met.

CONDITIONS FOR SETTING THE DTC

P0197

The EOT sensor is greater than 162°C (324°F) for greater than 25 seconds.

P0198

The EOT sensor is less than -60°C (-76°F) for greater than 25 seconds.

ACTION TAKEN WHEN THE DTC SETS

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DTCs P0197 and P0198 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0197 and P0198 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Definitions

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: Perform this verification procedure only if the ignition has been OFF for 10 hours or more.

1. Ignition ON, observe the scan tool IAT Sensor, Engine Oil temperature Sensor, and ECT Sensor parameters. The readings should be within 15°C (27°F) of each other and also the ambient temperature.
2. Operate the vehicle within the Conditions for Running the DTC to verify that the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the EOT sensor.
2. Ignition OFF for 90 seconds, test for less than 5 ohms of resistance between the low reference circuit

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terminal C and ground.

- If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

3. Ignition ON, verify the scan tool Engine Oil temperature Sensor parameter is colder than -39°C (-38°F).
   - If greater than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.

NOTE: If the 3 A fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal C. Verify the scan tool EOT Sensor parameter is warmer than 149°C (300°F).
   - If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance, if the circuit tests normal, replace the ECM.
5. Ignition OFF, disconnect the harness connectors at the ECM.
6. Test for infinite resistance between the oil temperature sensor signal circuit terminal B and the oil level switch signal circuit terminal A.
   - If less than the specified range, repair the short circuit between the oil temperature sensor signal circuit and the oil level switch signal circuit.
7. If all circuits test normal, replace the engine oil level sensor and/or switch assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Oil Level Sensor and/or Switch Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, OR P0208

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

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Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0205

Cylinder 5 Injector Control Circuit

DTC P0206

Cylinder 6 Injector Control Circuit

DTC P0207

Cylinder 7 Injector Control Circuit

DTC P0208

Cylinder 8 Injector Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300	P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300	-	-
Fuel Injector 1 Control	P0201	P0201	P0201	-
Fuel Injector 2 Control	P0202	P0202	P0202	-
Fuel Injector 3 Control	P0203	P0203	P0203	-
Fuel Injector 4 Control	P0204	P0204	P0204	-
Fuel Injector 5 Control	P0205	P0205	P0205	-
Fuel Injector 6 Control	P0206	P0206	P0206	-
Fuel Injector 7 Control	P0207	P0207	P0207	-
Fuel Injector 8 Control	P0208	P0208	P0208	-

CIRCUIT/SYSTEM DESCRIPTION

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The control module enables the appropriate fuel injector pulse for each cylinder. Ignition voltage is supplied to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. The control module monitors the status of each driver.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- The ignition voltage is greater than 11 V.
- DTC P0201-P0208 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are Type B DTCs.

DIAGNOSTIC AIDS

Performing the Fuel Injector Diagnosis may help isolate an intermittent condition. Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)** .

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 34730-405** Injector Test Lamp
- **J 43244** Relay Puller Pliers
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the following control circuit status parameters for each fuel injector:
   - Cyl 1-8 Injector Ckt Short Gnd Test Status
   - Cyl 1-8 Injector Ckt Open Test Status
   - Cyl 1-8 Injector Ckt Short Volts Test Status

   Each parameter should display OK or Not Run.
2. Engine running, observe the DTC information with a scan tool. DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207 or P0208 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the affected fuel injector harness connector at the Q17 fuel injector.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal A and ground.
   - If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test or replace the Q17 fuel injector.
3. Connect the **J 34730-405** between the control circuit terminal B and the ignition voltage circuit terminal A.
4. Pulse the fuel injector with a scan tool. The test lamp should flash ON and OFF when commanded.
   - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests

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normal, replace the K20 engine control module (ECM).

- If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.

5. If all circuits test normal, test or replace the Q17 fuel injector.

COMPONENT TESTING

NOTE: The engine coolant temperature (ECT) sensor must be between 10-32°C (50-90° F) for an accurate measurement.

Measure for 11-14 ohms between the terminals of the fuel injector.

- If not within the specified range, replace the fuel injector.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Injector Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0230

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0230

Fuel Pump Relay Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump Relay Control	P0230	P0230	P0230	-

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) sends the fuel enable signal to the fuel pump control module (FPCM). The control module monitors the voltage on the fuel pump relay control circuit. If the control module detects an

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incorrect voltage on the fuel pump relay control circuit, a fuel pump relay control DTC sets.

The control module monitors the voltage on the fuel pump relay control circuit. If the control module detects an incorrect voltage on the fuel pump relay control circuit, a fuel pump relay control DTC sets.

CONDITIONS FOR RUNNING THE DTC

- The ignition voltage is between 9-18 V.
- DTC P0230 runs continuously when the above condition is met.

CONDITIONS FOR SETTING THE DTC

- The control module detects that the commanded state of the driver and the actual state of the control circuit do not match.
- The above condition is met for a minimum of 2.5 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0230 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0230 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

With the ignition ON, engine OFF, command the fuel pump ON and OFF several times using the scan tool output control function. You should either hear or feel the fuel pump with each command.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the K27 FPCM.
2. Install a test lamp between the fuel pump control circuit terminal 20 and ground. Verify the test lamp turns ON and OFF as the ignition is turned ON.
    - If the test lamp does not illuminate, test the control circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify that a test lamp does not stay illuminated between the fuel pump control circuit terminal 20 and ground.
    - If the test lamp stays illuminated, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. If all circuits test normal, test or replace the K27 FPCM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM and FPCM replacement, setup, and programming

DTC P0231, P0232, OR P023F

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

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Fuel Pump Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

P0231, P023F

The ignition voltage is between 9-18 V.

P0232

The control enable voltage signal supplied for the ECM to fuel pump control module is inactive for 4 seconds after engine has been shut off.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects a fault on the fuel pump voltage circuit that is less than 11 V or greater than 18 V.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0231, P0232, and P023F are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0231, P0232, and P023F are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

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Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

Ignition ON, command the fuel pump ON and OFF using the scan tool ECM fuel pump output control. The fuel pump should turn ON and OFF.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Ignition ON, command the G12 fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF, as commanded.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the G12 fuel pump ON with a scan tool. The test lamp should illuminate.

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- If the test lamp does not illuminate, test the low reference circuit terminal 2 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.

6. If all circuits test normal, replace the fuel tank G12 fuel pump module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Tank Fuel Pump Module Replacement - Right Side**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P025A

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P025A

Fuel Pump Control Module Enable Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
FPCM Control	P025A	P025A	-	-

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

The ignition is ON.

CONDITIONS FOR SETTING THE DTC

The GMLAN serial data message from the ECM to the fuel pump control module does not agree with the state

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of the control enable voltage signal supplied from the ECM to the fuel pump control module for more than 2 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P025A is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P025A is a Type A DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module.
2. Ignition OFF, connect a test lamp between the control circuit terminal 20 and ground.
3. Ignition ON, command the fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

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- If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.

4. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM or fuel pump control module replacement, setup, and programming

DTC P0300-P0308

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

DTC P0305

Cylinder 5 Misfire Detected

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DTC P0306

Cylinder 6 Misfire Detected

DTC P0307

Cylinder 7 Misfire Detected

DTC P0308

Cylinder 8 Misfire Detected

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses information from the crankshaft position sensor in order to determine when an engine misfire is occurring, and uses information from the camshaft position sensor in order to determine which cylinder is misfiring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. If the ECM detects a misfire rate sufficient to cause emission levels to exceed mandated standards, DTC P0300 sets. Under certain driving conditions, a misfire rate can be high enough to cause the catalytic converter to overheat, possibly damaging the converter. The malfunction indicator lamp (MIL) will flash ON and OFF when catalytic converter overheating conditions are present and DTC P0300 is set. DTCs P0301-P0308 corresponds to cylinders 1-8. If the ECM is able to determine that a specific cylinder is misfiring, the DTC for that cylinder will also set.

CONDITIONS FOR RUNNING THE DTC

- DTC P0010, P0011, P0016, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0220, P0222, P0223, P0335, P0336, P0606, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P3401, P3425, P3441, and P3449 are not set.
- The engine speed is between 375-5,800 RPM and DTC P0315 is not set.

OR

- The engine speed is greater than 1,000 RPM and DTC P0315 is set.
- The ignition voltage is between 9-18 V.
- The engine coolant temperature (ECT) is between -7 and +125°C (+19 and +257°F).
- If the ECT is less than -7°C (+19°F) at startup this diagnostic will not run until the ECT is more than +21°C (+69°F).
- The fuel level is more than 10 %.
- The antilock brake system (ABS) and the traction control system are not active or detecting rough road.
- The power management is not active.
- The ECM is not in fuel shut-off, or decel fuel cut-off mode.
- Excessive drive wheel slip is not detected.
- The power take-off (PTO) is disabled.

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- The cylinder deactivation is not in progress.
- A manual transmission with a throttle position less than 95 %.
- DTCs P0300-P0308 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

DTC P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed mandated standards.

DTC P0301, P0302, P0303, P0304, P0305, P0306, P0307, or P0308

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0300-P0308 are Type B DTCs.
- When the MIL is flashing the fuel injector may be disabled for the misfiring cylinder to protect the catalytic converter.
- Depending on the conditions that set the DTC, the engine may go into Open Loop.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P0300-P0308 are Type B DTCs.
- The DTC must run and pass under the same operating conditions that were present when the DTC failed.

DIAGNOSTIC AIDS

- Ensure that each fuel injector is connected to the proper fuel injector harness connector.
- A misfire may only occur when the engine is operating under a load or when the engine is cold.
- A high resistance condition on any ignition control circuit can cause an engine misfire P0300-P0308 DTC to set without setting an ignition control circuit P0351-P0358 DTC.
- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to **Battery Inspection/Test** .
- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect the following for possible sources of vibration:
  - A tire or wheel that is out of round or balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft
  - Certain rough road conditions
  - A damaged accessory drive component or belt

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- A damaged reluctor wheel
- The Crankshaft Position System Variation Learn procedure may need to be performed.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 26792** HEI Spark Tester
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that no other DTCs are set.
   - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling, verify there is no abnormal engine noise.
   - If there is an abnormal engine noise, refer to **Symptoms - Engine Mechanical** .
3. Observe the Cylinder 1-8 Current Misfire Counters with a scan tool. The Current Misfire Counters should not be incrementing. Random misfires that are not steadily incrementing may be normal.
4. Operate the vehicle within the Conditions for Running the DTC to verify that the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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CIRCUIT/SYSTEM TESTING

NOTE: You must perform the Circuit/System Verification first.

1. Verify that the following conditions do not exist:
   - The fuel injector wire harness electrical connectors are connected to the wrong fuel injectors. Refer to **Engine Controls Schematics** .
   - Engine vacuum leaks
   - Fuel pressure that is too low or too high-Refer to **Fuel System Diagnosis** .
   - Contaminated fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
   - Restricted exhaust system-Refer to **Restricted Exhaust** .
   - If you find any of the above conditions, repair as necessary.
2. Verify that there is no misfire on cylinders 1, 4, 6, or 7 due to cylinder deactivation-Refer to **Cylinder Deactivation (Active Fuel Management) System Diagnosis** .
3. Ignition OFF, install the **J 26792:** Tester to the spark plug wire boot of the misfiring cylinder.

   NOTE: An erratic or weak spark is considered a no spark condition.

4. Attempt to start the engine and observe the **J 26792:** Tester. The spark tester should spark.
   - If there is no spark, test the spark plug wire for the correct resistance, refer to **Ignition System Specifications** and **Spark Plug Wire Inspection** .
   - If the spark plug wire tests normal, refer to **Electronic Ignition System Diagnosis** for diagnosis of the ignition coil.
5. Ignition OFF, remove the spark plug from the misfiring cylinder. Verify that the following conditions do not exist with the spark plug:
   - Gas, coolant, or oil fouled
   - Cracked, worn, or incorrectly gapped-Refer to **Spark Plug Inspection** .
   - If there is a condition with the spark plug, replace the spark plug.
6. Exchange the suspected spark plug with another cylinder that is operating correctly.
7. Operate the engine under the conditions in which the misfire occurred. This may include putting the engine under a load or allowing the engine to return to a cold condition. Observe the Misfire Current Counters with a scan tool. The misfire should not follow the spark plug exchange.
   - If the misfire follows with the spark plug, replace the spark plug.
8. If all conditions test normal, test or inspect for the following:
   - A lean or rich fuel injector-Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)** .
   - An engine mechanical condition-Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

- **Spark Plug Wire Replacement**

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- **Spark Plug Replacement**

REPAIR VERIFICATION

1. Install any components that have been removed or replaced during diagnosis.
2. Clear the DTCs.
3. Turn OFF the ignition for 60 seconds.
4. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.
5. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to **DTC P0420 or P0430** .

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

DTC P0315

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0315

Crankshaft Position (CKP) System Variation Not Learned

CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position (CKP) system variation learn feature is used to calculate reference period errors caused by slight build tolerance variations in the CKP sensor, crankshaft, and CKP sensor position. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wide range of engine speeds and load conditions. The ECM stores the Crankshaft Position System Variation values after a learn procedure has been performed. If the actual crankshaft position variation is not stored within the CKP compensating value look up table, then DTC P0300 may set. If the CKP system variation values are not stored in the ECM memory, or a proper ECM power down does not occur after completing the CKP Learn Procedure, then DTC P0315 sets.

CONDITIONS FOR RUNNING THE DTC

The diagnostic runs continuously.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the CKP system variation values are not stored in memory.

ACTION TAKEN WHEN THE DTC SETS

DTC P0315 is a Type A code.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0315 is a Type A code.

DIAGNOSTIC AIDS

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This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to **Battery Inspection/Test** .

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

IMPORTANT: The CKP System Variation Learn Procedure may have to be repeated up to 5 times before the procedure is learned.

1. Perform the CKP System Variation Learn Procedure. Refer to **Crankshaft Position System Variation Learn** .
2. If the CKP System Variation Learn Procedure cannot be performed successfully, inspect for the following conditions:
    - Any worn crankshaft main bearings
    - A damaged or misaligned reluctor wheel
    - Excessive crankshaft runout
    - A damaged crankshaft-Refer to **Crankshaft and Bearing Cleaning and Inspection** .
    - Interference in the signal circuit of the CKP sensor
    - The ignition switch is left in the ON position, until the battery is discharged
    - An ECM power disconnect, with the ignition ON, that may have erased the CKP system variation values and set DTC P0315
    - Any debris between the CKP sensor and the reluctor wheel
    - If the ECM is still unable to complete the learn procedure, replace the ECM.

REPAIR PROCEDURES

- Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.
- **Control Module References** for ECM replacement, setup, and programming

DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, OR P0333

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

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- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0324

Knock Sensor Module Performance

DTC P0325

Knock Sensor Circuit Bank 1

DTC P0326

Knock Sensor Performance

DTC P0327

Knock Sensor Circuit Low Voltage Bank 1

DTC P0328

Knock Sensor Circuit High Voltage Bank 1

DTC P0330

Knock Sensor Circuit Bank 2

DTC P0332

Knock Sensor Circuit Low Voltage Bank 2

DTC P0333

Knock Sensor Circuit High Voltage Bank 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor Signal Bank 1	P0327, P0328	P0325	P0328	P0326
Knock Sensor Signal Bank 2	P0332, P0333	P0330	P0332	P0326

CIRCUIT/SYSTEM DESCRIPTION

The knock sensor (KS) system enables the engine control module (ECM) to control the ignition timing for the

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best possible performance while protecting the engine from potentially damaging levels of detonation. The ECM monitors 2 separate KS, one on each side of the engine block. Each KS produces an AC voltage that varies, depending on the vibration levels detected during engine operation. The ECM receives the KS signal through 2 isolated signal circuits for each KS. The ECM adjusts the spark timing based on the amplitude and frequency of each KS signal. The ECM learns a minimum noise level for each sensor at idle speeds, and uses calibrated noise level values for the rest of the RPM range. The ECM should monitor a normal KS signal within the noise channel.

CONDITIONS FOR RUNNING THE DTC

P0324

- DTC P0325, P0326, P0327, P0328, P0330, P0332, or P0333 are not set.
- The engine speed is at least 400 RPM.
- DTC P0324 runs continuously when the above conditions are met.

P0325 and P0330

- DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 are not set.
- The engine speed is at least 400 RPM.
- The engine coolant temperature (ECT) is warmer than -40°C (-40°F).
- The engine run time is at least 2 s.
- DTCs P0325 and P0330 run continuously when the above conditions are met.

P0326

- DTC P0068, P0606, P1516, P2101, P2135, or P2176 are not set.
- The engine speed is at least 400 RPM.
- The MAP is at least 10 kPa.
- DTC P0324 runs continuously when the above conditions are met.

P0327, P0328, P0332, and P0333

- The engine coolant temperature (ECT) is warmer than -40°C (-40°F).
- The engine run time is at least 2 s.
- DTCs P0327, P0328, P0332, and P0333 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0324

The ECM has detected an internal circuitry fault.

P0325 or P0330

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The knock sensor signal circuits are open or shorted together for 5 s.

P0326

- The knock sensor signal indicates an engine knock is present.
- The ECM has commanded the spark retard to a value which is more than the calibrated valve, for a specific engine load and speed.
- The above conditions exist for more than 5 s.

P0327, P0328, P0332, and P0333

The knock sensor signal circuits are shorted to voltage or ground.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0324, P0325, P0326, P0327, P0328, P0330, P0332, and P0333 are Type B codes.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

CONDITIONS FOR CLEARING THE DTC

DTCs P0324, P0325, P0326, P0327, P0328, P0330, P0332, and P0333 are Type B codes.

DIAGNOSTIC AIDS

- Inspect the knock sensor for physical damage. A knock sensor that is dropped or damaged may cause a DTC to set.
- Inspect the knock sensor for proper installation. A knock sensor that is loose or over-torqued may cause a DTC to set.
- The knock sensor mounting surface should be free of burs, casting flash, and foreign material.
- The KS must be clear of hoses, brackets, and engine electrical wiring.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 35616** GM Approved Terminal Test Kit
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Engine at operating temperature, observe DTC information with a scan tool. DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE:

- **Perform the Diagnostic System Check - Vehicle prior to using these diagnostic procedures.**
- **If an engine mechanical noise can be heard, repair the condition before proceeding with this diagnostic. Refer to Symptoms - Engine Mechanical .**

P0324

NOTE: If DTC P0325, P0326, P0327, P0328, P0330, P0332, or P0333 are also set, diagnose those DTCs first.

DTC P0324 indicates an internal control module circuitry failure. Replace the ECM.

P0325, P0326, P0327, P0328, P0330, P0332, P0333

1. Ignition OFF, disconnect the affected B68 KS.
2. Ignition OFF. Connect a DMM to both KS signal circuits, terminals A and B, at the affected B68 KS. Set

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the DMM to the 400 mV AC scale, select the Hz mode. Let the reading stabilize at 0 Hz.

NOTE: DO NOT tap on plastic engine components.

3. Tap on the engine block with a non-metallic object near the affected B68 KS and observe the DMM for a fluctuating frequency.
    - If the DMM does not display a fluctuating frequency while tapping on the engine block then replace the affected B68 KS.
4. Verify the affected B68 KS is properly tightened, refer to **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** .
5. Ignition OFF, with appropriate length jumper wires, connect the KS1 harness to the B68 KS2 sensor and the KS2 harness to the B68 KS1 sensor.
6. Monitor the DTCs using a scan tool. Operate the vehicle within the conditions for running the DTC. Verify the fault does not follow the sensor in question.
    - If the fault follows the sensor in question, replace the appropriate B68 KS.
7. Ignition OFF, remove the jumper wires from the previous step.
8. Measure for 2-3 volts between each of the following circuits and ground on the ECM side of the harness connector:
    - The B68 KS signal circuit, terminal A
    - The B68 KS signal circuit, terminal B
    - If less than the specified range, test the circuits for a short to ground or an open/high resistance. If the circuits test normal, replace the K20 ECM.
    - If greater than the specified range, test the circuits for a short to voltage. If the circuits test normal, replace the K20 ECM.
9. Test for intermittent or poor connections at the K20 ECM, B68 KS, and in-line connectors where present.
10. If all circuits test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Control Module Programming and Setup (LS3, L99)** or **Engine Control Module Programming and Setup (LLT)**
- **Engine Control Module Replacement**
- **Knock Sensor Replacement (Bank 1)** or **Knock Sensor Replacement (Bank 2)**

DTC P0335

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

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- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0335

Crankshaft Position Sensor Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0651	P0335	P0651, P2135	-
Crankshaft Position Signal	P0335	P0335	P0335	P0336
Low Reference	-	P0335	P0335	-

CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses crankshaft position sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the camshaft position actuator if equipped.

CONDITIONS FOR RUNNING THE DTC

- DTC P0101, P0102, P0103, P0340, P0341, P0641, or P0651 is not set.
- The engine is cranking or running.
- The airflow into the engine is greater than 3 g/s.
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the starter is commanded on and the engine has been cranking for more than 4 s without a crankshaft position sensor pulse.
- The ECM detects that the engine is running, but has not received a crankshaft position sensor pulse for 2

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of 10 engine cycles.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0335 is a Type A DTC.
- The camshaft position actuator if equipped is commanded to the parked position.

CONDITIONS FOR CLEARING THE DTC

DTC P0335 is a Type A DTC.

DIAGNOSTIC AIDS

With this DTC set, the engine may crank for an extended period of time during start-up.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

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1. Engine idling, observe the scan tool Crankshaft Position Active Counter parameter. The parameter should be incrementing.
2. Engine idling, observe the DTC information with a scan tool. DTC P0335 should not set.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the B26 crankshaft position sensor.
2. Ignition OFF, vehicle systems OFF, this may take 2 minutes, test for less than 1 ohms between the low reference circuit, terminal B, and ground.
    - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit, terminal C and ground.
    - If less than the specified range, test the 5 V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
    - If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal A.
6. Ignition ON, momentarily touch the other end of the fused jumper wire to the battery negative post. The Crankshaft Position Active counter, should increment.
    - If the Crankshaft Position Active counter increments, test or replace the B26 crankshaft position sensor.
    - If the Crankshaft Position Active counter does not increment, replace the K20 ECM.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the crankshaft position sensor for correct installation. Remove the B26 crankshaft position sensor from the engine and inspect the sensor O-ring for damage.
    - If the sensor is loose, incorrectly installed, or damaged, replace the B26 crankshaft position sensor.
2. Connect the crankshaft position sensor harness connector to the B26 crankshaft position sensor.

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3. Ignition ON, observe the Crankshaft Position Active counter parameter with a scan tool while passing a flat steel object across the tip of the sensor repeatedly. The Crankshaft Position Active counter parameter should increment with each pass of the steel object.
    - If the function does not perform as specified, replace the B26 crankshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0336

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0336

Crankshaft Position Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0651	P0335	P0651, P2135	-
Crankshaft Position Signal	P0335	P0335	P0335	P0336
Low Reference	-	P0335	P0335	-

CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with two missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position

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signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses crankshaft position sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the camshaft position actuator if equipped.

CONDITIONS FOR RUNNING THE DTC

- DTC P0101, P0102, P0103, P0340, P0341, P0641, or P0651 is not set.
- The engine is cranking or running.
- The airflow into the engine is greater than 3 g/s.
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the engine is running, but receives less than 53 or more than 63 crankshaft position sensor pulses, during each engine revolution, for 8 of 10 engine revolutions.
- The ECM detects that the engine is running, but more than 25 crankshaft resyncs have occurred within 20 s.
- The ECM detects that the engine has been running, but the crankshaft does not sync for 0.4 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0336 is a Type A DTC.
- The camshaft position actuator if equipped is commanded to the parked position.

CONDITIONS FOR CLEARING THE DTC

DTC P0336 is a Type A DTC.

DIAGNOSTIC AIDS

With this DTC set, the engine may crank for an extended period of time during start-up.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

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Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the scan tool Crankshaft Position Active Counter parameter. The parameter should be incrementing.
2. Engine idling, observe the DTC information with a scan tool. DTC P0336 should not set.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the B26 crankshaft position sensor.
2. Ignition OFF, vehicle systems OFF, this may take 2 minutes, test for less than 1 ohms between the low reference circuit, terminal B, and ground.
    - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit, terminal C and ground.
    - If less than the specified range, test the 5 V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
    - If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests

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normal, replace the K20 ECM.

5. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal A.
6. Ignition ON, momentarily touch the other end of the fused jumper wire to the battery negative post. The Crankshaft Position Active counter, should increment.
    - If the Crankshaft Position Active counter increments, test or replace the B26 crankshaft position sensor.
    - If the Crankshaft Position Active counter does not increment, replace the K20 ECM.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the crankshaft position sensor for correct installation. Remove the B26 crankshaft position sensor from the engine and inspect the sensor O-ring for damage.
    - If the sensor is loose, incorrectly installed, or damaged, replace the B26 crankshaft position sensor.
2. Connect the crankshaft position sensor harness connector to the B26 crankshaft position sensor.
3. Ignition ON, observe the Crankshaft Position Active counter parameter with a scan tool while passing a flat steel object across the tip of the sensor repeatedly. The Crankshaft Position Active counter parameter should increment with each pass of the steel object.
    - If the function does not perform as specified, replace the B26 crankshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0340

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0340

Camshaft Position Sensor Circuit

DIAGNOSTIC FAULT INFORMATION

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0452, P0522, P0532, P0641	P0340	P0641	-
Camshaft Position Signal	P0340	P0340	P0340	P0341
Low Reference	-	P0340	P0340	-

CIRCUIT/SYSTEM DESCRIPTION

The 4X camshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with two narrow, and two wide output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control the camshaft position actuator if equipped, and for limp-home operation.

CONDITIONS FOR RUNNING THE DTC

- The mass air flow (MAF) is greater than 3 grams per second.
- DTC P0101, P0102, P0103, P0335, P0336, P0641, or P0651 is not set.
- The engine is cranking or running.
- DTC P0340 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the starter is commanded on and the engine has been cranking for more than 4 s without a camshaft position sensor pulse.
- The ECM detects that the engine has started, but did not receive a camshaft position sensor pulse during the first engine revolution.
- The ECM detects that the engine is running, but does not receive a camshaft position sensor pulse for 800 of 1000 engine cycles.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0340 is a Type B DTC.
- The camshaft position actuator if equipped is commanded to the parked position.

CONDITIONS FOR CLEARING THE DTC

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DTC P0340 is a Type B DTC.

DIAGNOSTIC AIDS

With this DTC set, the engine may crank for an extended period of time during start-up.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the scan tool Camshaft Position Active Counter parameter. The parameter should be incrementing.
2. Engine idling, observe the DTC information with a scan tool. DTC P0340 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

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1. Engine idling, move the related harnesses/connectors of the B23 camshaft position sensor while monitoring the scan tool Camshaft Position Variance parameter. The Camshaft Position Variance parameter should not change when moving the harness/connectors.
    - If the above condition exists, repair the harness/connectors as necessary.
2. Ignition OFF, inspect the B23 camshaft position sensor for correct installation.
    - If the B23 camshaft position sensor is loose, inspect the sensor and the O-ring for damage and replace, as necessary.
3. Ignition OFF, disconnect the harness connector at the B23 camshaft position sensor.
4. Ignition OFF, all vehicle systems OFF, this may take 2 minutes, test for less than 5 ohms between the low reference circuit terminal B and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Test for 4.8-5.2 V between the signal circuit terminal C and ground.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. Ignition OFF, connect a 3 A fused jumper wire to the camshaft position signal circuit terminal C.
8. Ignition ON, momentarily touch the end of the fused jumper wire to ground while monitoring the scan tool camshaft position active counter. The camshaft position active counter should increment.
    - If the camshaft position active counter does not increment, replace the K20 ECM.
9. If all circuits test normal, replace the B23 camshaft position sensor.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the camshaft position sensor for correct installation. Remove the B23 camshaft position sensor from the engine and inspect the sensor O-ring for damage.
    - If the sensor is loose, incorrectly installed, or damaged, replace the B23 camshaft position sensor.
2. Connect the camshaft position sensor harness connector to the B23 camshaft position sensor.
3. Ignition ON, observe the Camshaft Position Active counter parameter with a scan tool while passing a flat steel object across the tip of the sensor repeatedly. The Camshaft Position Active counter parameter should increment with each pass of the steel object.
    - If the function does not perform as specified, replace the B23 camshaft position sensor.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0341

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0341

Camshaft Position Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0452, P0522, P0532, P0641	P0340	P0641	-
Camshaft Position Signal	P0340	P0340	P0340	P0341
Low Reference	-	P0340	P0340	-

CIRCUIT/SYSTEM DESCRIPTION

The 4X camshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with two narrow, and two wide output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control the camshaft position actuator if equipped, and for limp-home operation.

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CONDITIONS FOR RUNNING THE DTC

- DTC P0335, P0336, P0641, or P0651 is not set.
- The engine is cranking or running.
- DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the engine was started, but has received less than 2 or more than 8 camshaft position sensor pulses during the first engine resolution.
- The ECM detects that the engine has started and is running, but receives less than 398 or more than 402 camshaft position pulses per 100 engine cycles in 800 of 1000 engine cycles.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0341 is a Type B DTC.
- The camshaft position actuator if equipped is commanded to the parked position.
- The ignition system defaults to a failed camshaft position sensor limp home mode.

CONDITIONS FOR CLEARING THE DTC

DTC P0341 is a Type B DTC.

DIAGNOSTIC AIDS

With this DTC set, the engine may crank for an extended period of time during start-up.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition OFF, inspect the engine wiring harness carrying the camshaft position sensor circuits for the following conditions:
    - Close routing of aftermarket electrical equipment
    - Close to solenoids, motors, and relays.
    - If any of these are determined to be a possible source of electrical interference, correct any wire harness routing or component placement conditions.
2. Engine idling, observe the scan tool Intake and Exhaust Camshaft Position Active Counter parameters. Both parameters should be incrementing.
3. Engine idling, observe the DTC information with a scan tool. DTC P0341 or P0366 should not set.
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Engine idling, move the related harnesses/connectors of the B23 camshaft position sensor while monitoring the scan tool Camshaft Position Variance parameter. The Camshaft Position Variance parameter should not change when moving the harness/connectors.
    - If the above condition exists, repair the harness/connectors as necessary.
2. Ignition OFF, inspect the B23 camshaft position sensor for correct installation.
    - If the B23 camshaft position sensor is loose, inspect the sensor and the O-ring for damage, and replace as necessary.
3. Disconnect the harness connector at the B23 camshaft position sensor.
4. Ignition OFF, all vehicle systems OFF, this may take 2 minutes, test for less than 5 ohms between the low reference circuit terminal B and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit

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tests normal, replace the K20 ECM.

6. Test for 4.8-5.2 V between the signal circuit terminal C and ground.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. Ignition OFF, connect a 3 A fused jumper wire to the camshaft position signal circuit terminal C.
8. Ignition ON, momentarily touch the end of the fused jumper wire to ground while monitoring the scan tool camshaft position active counter. The camshaft position active counter should increment.
    - If the camshaft position active counter does not increment, replace the K20 ECM.
9. If all circuits test normal, replace the B23 camshaft position sensor.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the camshaft position sensor for correct installation. Remove the B23 camshaft position sensor from the engine and inspect the sensor O-ring for damage.
    - If the sensor is loose, incorrectly installed, or damaged, replace the B23 camshaft position sensor.
2. Connect the camshaft position sensor harness connector to the B23 camshaft position sensor.
3. Ignition ON, observe the Camshaft Position Active Counter parameter with a scan tool.
4. Pass a flat steel object across the tip of the sensor repeatedly. The Camshaft Position Active Counter parameter should increment with each pass of the steel object.
    - If the function does not perform as specified, replace the B23 camshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0351-P0358

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

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DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P0355

Ignition Coil 5 Control Circuit

DTC P0356

Ignition Coil 6 Control Circuit

DTC P0357

Ignition Coil 7 Control Circuit

DTC P0358

Ignition Coil 8 Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	1	2	-	-
Ignition Coil 1 Control Circuit	P0300, P0351	P0300, P0351	P0300, P0351	-
Ignition Coil 2 Control Circuit	P0300, P0352	P0300, P0352	P0300, P0352	-
Ignition Coil 3 Control Circuit	P0300, P0353	P0300, P0353	P0300, P0353	-
Ignition Coil 4 Control Circuit	P0300, P0354	P0300, P0354	P0300, P0354	-
Ignition Coil 5 Control Circuit	P0300, P0355	P0300, P0355	P0300, P0355	-
Ignition Coil 6 Control Circuit	P0300, P0356	P0300, P0356	P0300, P0356	-
Ignition Coil 7 Control Circuit	P0300, P0357	P0300, P0357	P0300, P0357	-
Ignition Coil 8 Control Circuit	P0300, P0358	P0300, P0358	P0300, P0358	-

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Low Reference	-	P0351, P0358	-	-
1. The Engine Cranks But Does Not Run and opens the fuse that supplies voltage to the ignition coils. 2. The Engine Cranks But Does Not Run				

CIRCUIT/SYSTEM DESCRIPTION

The ignition system on this engine uses an individual coil/module for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the eight individual ignition control circuits. When the ECM commands the ignition control circuit ON, electrical current will flow through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM will command the ignition control circuit OFF, interrupting current flow through the primary winding. The magnetic field created by the primary winding will collapse across the secondary coil windings, producing a high voltage across the spark plug electrodes. The ECM uses information from the crankshaft position sensor, and the camshaft position sensor for sequencing and timing of the spark events.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- The ignition voltage is greater than 6 V.
- DTC P0351-P0358 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0351-P0358 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0351-P0358 are Type B DTCs.

DIAGNOSTIC AIDS

A high resistance condition on any ignition control circuit can cause an engine misfire without setting DTC P0351-P0358.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine running, observe the following scan tool control circuit status parameters for the appropriate cylinder T8 ignition coil:
   - Ignition Coil 1-8 Control Circuit Low Voltage Test Status
   - Ignition Coil 1-8 Control Circuit Open Test Status
   - Ignition Coil 1-8 Control Circuit High Voltage Test Status

   Each parameter should display Not Run or OK.
2. Engine idling, observe the DTC information with a scan tool. DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357, or P0358 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate T8 ignition coil.
2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all the systems to power down. Test for less than 5 ohms between the ground circuit terminal A and ground.
   - If greater than the specified range, repair the ground circuit for an open/high resistance.
3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal B and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.

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- If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.

5. Engine idling at operating temperature, test for 0.200-0.500 V between the appropriate ignition control circuit terminal C and ground.
   - If less than the specified range, test the ignition control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
   - If greater than the specified range, test the ignition control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the T8 ignition coil.

REPAIR PROCEDURES

- **Ignition Coil Replacement**
- **Control Module References** for ECM replacement, setup, and programming

REPAIR VERIFICATION

NOTE: An ignition control circuit fault condition will result in an engine misfire, and under certain driving conditions could possibly overheat the 3-way catalytic converter.

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn the ignition OFF for 60 s.
5. If the repair is related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.
6. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430.

DTC P0420 OR P0430

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

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DTC P0420

Catalyst System Low Efficiency Bank 1

DTC P0430

Catalyst System Low Efficiency Bank 2

CIRCUIT/SYSTEM DESCRIPTION

NOTE: A new converter with less than 100 mi on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 h may correct the condition.

A 3-way catalytic converter controls emissions of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The catalyst within the converter promotes a chemical reaction, which oxidizes the HC and the CO that are present in the exhaust gas. This process converts the HC and the CO into water vapor and carbon dioxide (CO2), and reduces the NOx, converting the NOx into nitrogen. The catalytic converter also stores oxygen. The engine control module (ECM) monitors this process by using a heated oxygen sensor (HO2S) that is in the exhaust stream after the 3-way catalytic converter. The HO2S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO2S 2. When the catalyst is functioning properly, the HO2S 2 response to the extra fuel is slow compared to the response of the HO2S 1, which is located before the 3-way catalytic converter. When the HO2S 2 response is near that of the HO2S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0030, P0031, P0036, P0037, P0038, P0068, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0130, P0131, P0132, P0133, P0134, P0135, P0136, P0137, P0138, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0300, P0315, P0326, P0327, P0336, P0340, P0341, P0442, P0446, P0452, P0453, P0455, P0496, P0500, P0502, P0506, P0507, P0601, P0602, P0606, P0641, P0722, P0723, P1133, P1134, P1516, P1621, P2135, P2138, P2176 are not set.
- Before the ECM performs the idle test, the vehicle must be driven under the following conditions:
  - The engine speed is greater than 1,300 RPM.
  - The engine run time is greater than 100 s.
  - Both conditions exist for greater than 16 s.
- The vehicle speed is less than 1.6 km/h (1 mph).
- The throttle position is less than 2 %.
- The mass air flow (MAF) is between 2-21 g/s.
- The engine is operating in Closed Loop.
- The fuel trim learn is enabled.

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- The engine coolant temperature (ECT) is between 45-129°C (113-264°F).
- The barometric pressure (BARO) is greater than 70 kPa.
- The Catalytic Converter Calculated Temperature parameter is between 600-900°C (1,112-1,652°F) for greater than 6 min.
- The intake air temperature (IAT) is between -20 and +250°C (-4 and +482°F).
- The battery voltage is greater than 11 V.
- The transmission is in Drive Range-Automatic transmissions only.
- The short term fuel trim is between -10 and +10 %.
- The engine is idling for less than 50 s.
- This diagnostic attempts one test during each valid idle period when the above conditions have been met. This diagnostic attempts up to 8 tests during each drive cycle.

CONDITIONS FOR SETTING THE DTC

The ECM has determined the catalyst efficiency has degraded below a calibrated threshold.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0420 and P0430 are Type A DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0420 and P0430 are Type A DTCs.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Electrical Information Reference

Diagnostic Trouble Code (DTC) List - Vehicle

CIRCUIT/SYSTEM VERIFICATION

1. Verify that no other DTCs are set.
    - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Operate the vehicle within the Conditions for Running the DTC while observing the scan tool Catalyst monitor Not At Idle Test Conditions Met parameter. The parameter will change to Yes when the OFF Idle Conditions have been met.
    - If not the specified value, operate the vehicle within the OFF Idle Conditions.
3. When the parameter has changed to Yes and the conditions are safe, stop and idle the vehicle in gear.
4. Apply the service brake.

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5. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.
6. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
7. When the test has completed, the Catalyst Monitor Test Counter Bank 1 or Bank 2 parameter will increment by one and the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter will indicate Pass, Fail, or No Decision.
    - If no decision has been made, repeat steps 2-6 until the Test Result parameter indicates a Pass or Fail.

CIRCUIT/SYSTEM TESTING

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

NOTE: A new converter with less than 161 km (100 mi) on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 h may correct the condition.

1. Engine idling, observe the DTC information with a scan tool. Verify there are no HO2S or misfire DTCs set.
    - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnosis the applicable DTC before proceeding with this diagnostic procedure.
2. Verify the following conditions do not exist with the catalytic converter:
    - Dents
    - A severe discoloration caused by excessive temperatures
    - An internal rattle caused by damaged catalyst substrate
    - Restrictions-Refer to **Restricted Exhaust** .
    - If a condition is found, replace the catalytic converter.
3. Verify the following conditions do not exist with the exhaust system:
    - Leaks-Refer to **Exhaust Leakage** .
    - Physical damage
    - Loose or missing hardware
    - Improperly torqued HO2S
    - If a condition is found, repair the exhaust system.
4. Verify the following conditions do not exist with the HO2S 2:
    - A grounded wiring harness
    - Damage
    - If a condition is found, replace the HO2S 2.
5. If no physical condition is detected and the HO2S 2 is as active as the HO2S 1 after operating the engine at 1,500 RPM for 1 min and then returning to a stabilized idle, then replace the catalytic converter.

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REPAIR PROCEDURES

NOTE: A new converter with less than 161 km (100 mi) on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 hour may correct the condition.

- **Exhaust Manifold Replacement - Left Side (LLT)** or **Exhaust Manifold Replacement - Left Side (L99/LS3)**
- **Exhaust Manifold Replacement - Right Side (LLT)** or **Exhaust Manifold Replacement - Right Side (L99/LS3)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Exhaust Leakage**
- **Restricted Exhaust**

REPAIR VERIFICATION

1. Verify that no other DTCs are set.
    - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Operate the vehicle within the Conditions for Running the DTC while observing the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter. The parameter will change to Yes when the OFF Idle Conditions have been met.
    - If not the specified value, operate the vehicle within the OFF Idle Conditions.
3. When the parameter has changed to Yes and the conditions are safe, stop and idle the vehicle in gear.
4. Apply the service brake.
5. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.
6. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
7. When the test has completed, the Catalyst Monitor Test Counter Bank 1 or Bank 2 parameter will increment by one and the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter will indicate Pass, Fail, or No Decision.
    - If no decision has been made, repeat steps 2-6 until the Test Result parameter indicates a Pass or Fail.

DTC P0442

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

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DTC DESCRIPTOR

DTC P0442

Evaporative Emission System Small Leak Detected

CIRCUIT/SYSTEM DESCRIPTION

The engine off natural vacuum test is the small leak detection diagnostic for the evaporative emission system. This diagnostic tests the evaporative emission system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the evaporative emission system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the ECM using the fuel tank pressure sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0222, P0223, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0461, P0462, P0463, P0464, P0496, P0502, P0503, P0608, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 are not set.
- The ignition 1 voltage is between 10-16 V.
- The barometric pressure (BARO) is greater than 74 kPa.
- No fuel filling during the engine off natural vacuum test period.
- The fuel level is between 10-90 percent.
- The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are between 0-40°C (32-104°F).
- The barometric pressure (BARO) is more than 74 kPa.
- The engine run time before engine shut-off was greater than 10 minutes.
- The drive distance before engine shut-off was more than 5 kilometers (3.1 miles).
- The ignition is OFF.
- The ambient air temperature at the end of the drive cycle is between 0-32°C (32-93°F).
- DTC P0442 runs once per drive cycle during the hot soak period after the ignition is turned OFF and may require up to 45 minutes to complete. The controller will not make more than 2 test attempts per day. The time since the last completed engine off natural vacuum test must be at least 17 hours

CONDITIONS FOR SETTING THE DTC

- The ECM detects a leak in the evaporative emission system that is greater than a calibrated amount.
- The ECM must complete several engine off natural vacuum tests before the diagnostic can turn the MIL on or off.

ACTION TAKEN WHEN THE DTC SETS

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DTC P0442 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0442 is a Type A DTC.

DIAGNOSTIC AIDS

- The evaporative emission system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. When injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed then close the system and continue testing.
- To help locate intermittent leaks using the **J 41413-200:** EEST, move all evaporative emission components while observing smoke with the **J 41413-SPT:** White Light.
- Individual components can be isolated and tested using adapters in the **J 41413-300:** Kit.
- A condition may exist where a leak in the evaporative emission system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the evaporative emission system and then observe the fuel tank pressure parameter for vacuum decay.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Description and Operation

Evaporative Emission Control System Description

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096:** Evaporative Emissions Service Access Port Tool
- **J 41413-200:** Evaporative Emissions System Tester (EEST)
- **J 41413-300:** Evaporative Emissions Cap and Plug Kit
- **J 41413-SPT:** High Intensity White Light
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM TESTING

NOTE:

- **Refer to the J 41413-200: EEST operation manual for detailed instructions**

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in Evaporative Emission System Diagnosis .

- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize.**
- **Ensure that the underbody temperature of the vehicle and the tester are similar.**

1. Disconnect the purge tube at the quick connector on the evaporative emission canister side of the Q12 evaporative emission canister purge solenoid valve and install the **CH 48096:** Port Tool.
2. Connect the **J 41413-200:** EEST to the **CH 48096:** Port Tool.
3. Ignition ON, using a scan tool close the evaporative emission canister vent solenoid valve to seal the evaporative emission system.
4. Use the flow meter on the **J 41413-200:** EEST, calibrated to 0.51 mm (0.020 in) to determine that there is no leak in the evaporative emission system.
    - If a leak is detected, use the **J 41413-200:** EEST to apply smoke to the evaporative emission system at the purge tube until the leak is located using the **J 41413-SPT:** White Light.

REPAIR VERIFICATION

1. Seal the evaporative emission system and use the flow meter on the **J 41413-200:** EEST, calibrated to 0.51 mm (0.020 in) to determine that there is no leak in the evaporative emission system.
2. Clear DTCs.

DTC P0443 OR P0449

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0443

Evaporative Emission Purge Solenoid Valve Control Circuit

DTC P0449

Evaporative Emission Vent Solenoid Valve Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance

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Ignition 1 Voltage - Purge Supply	P0443	P0443	P0443	-	-
Battery Positive - Vent Supply	P0449	P0449	P0449	-	-
Evaporative Emission Purge Solenoid Valve Control	P0443	P0443	P0443	P0443	-
Evaporative Emission Vent Solenoid Valve Control	P0449	P0449	P0449	P0449	-

CIRCUIT/SYSTEM DESCRIPTION

An ignition voltage is supplied directly to the evaporative emission (EVAP) canister purge solenoid valve. The engine control module (ECM) grounds the evaporative emission canister purge solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. The evaporative emission canister purge solenoid valve is pulse width modulated (PWM). A scan tool will display the amount of ON time as a percentage.

Battery voltage is supplied to the evaporative emission canister solenoid valve. The ECM grounds the evaporative emission canister vent solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. A scan tool will display the commanded state of the evaporative emission canister vent solenoid valve as ON or OFF.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- The system voltage is between 9-18 V.
- DTCs P0443 and P0449 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0443 and P0449 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0443 and P0449 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Description and Operation

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Evaporative Emission Control System Description

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Troubleshooting with a Test Lamp**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

P0443

1. Ignition ON, engine OFF, you should hear a clicking sound when the evaporative emission canister purge solenoid valve is commanded to 50 % with a scan tool. The clicking sound should stop when the evaporative emission canister purge solenoid valve is commanded to 0 %. The rate at which the valve cycles should increase when the commanded state is increased, and decrease when the commanded state is decreased.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

P0449

1. Ignition ON, engine OFF, command the evaporative emission vent solenoid valve to Not Venting and Venting with a scan tool.
2. Listen for a click when the valve operates. Verify that both the Venting and the Not Venting states are commanded.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

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1. Ignition OFF, disconnect the harness connector at the Q12 evaporative emission canister purge or the Q13 vent solenoid valve.
2. Ignition ON, verify that a test lamp illuminates between the voltage supply circuit terminal and ground.
    - If the test lamp does not illuminate, test the voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and the voltage supply circuit fuse is open, test or replace the evaporative emission canister purge solenoid valve.
3. Connect a test lamp between the voltage supply circuit terminal and the control circuit terminal.
4. Command the EVAP canister purge solenoid valve to 50 % with a scan tool, or the EVAP canister vent solenoid valve Venting and Not Venting. The test lamp should respond to the command.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, replace the appropriate solenoid valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0446

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0446

Evaporative Emissions Vent System Performance

TYPICAL SCAN TOOL DATA

Fuel Tank Pressure Sensor Signal Voltage	Fuel Tank Pressure
1.5 V	Atmospheric Pressure/BARO
Less than 1.5 V	Positive Pressure
More than 1.5 V	Negative Pressure/Vacuum

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CIRCUIT/SYSTEM DESCRIPTION

This DTC tests the evaporative emission system for a restricted or blocked evaporative emission vent path that would cause excess amounts of vacuum to be developed in the evaporative emission system. With the purge valve open and the canister vent valve open, if the evaporative emission system vacuum goes above a calibrated threshold, the test will fail.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0442, P0443, P0449, P0451, P0452, P0453, P0454, P0464, P0496, P0608, P0609, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 are not set.
- The ignition voltage is between 11-18 V.
- The barometric pressure (BARO) is more than 74 kPa.
- The fuel level is between 15-85 %.
- The engine coolant temperature (ECT) is less than 35°C (95°F).
- The intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0446 runs once per cold start when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The fuel tank vacuum is greater than -12 inches H2O vacuum for 5 s.

  OR

- The fuel tank pressure is less than -2.5 inches H2O or more than +5 inches for 60 s after a cold start.

ACTION TAKEN WHEN THE DTC SETS

DTC P0446 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0446 is a Type B DTC.

DIAGNOSTIC AIDS

- An intermittent condition could be caused by a damaged evaporative emission vent housing, a temporary blockage at the evaporative emission canister vent solenoid valve inlet, or a pinched vent hose. A blockage in the vent system will also cause a poor fuel fill condition.
- An evaporative emission canister filter that is restricted can cause this DTC to set.

REFERENCE INFORMATION

Schematic Reference

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Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON and fuel cap removed, verify that the Fuel Tank Pressure Sensor parameter is between 1.3-1.7 V.
    - If not within the specified range, go to the fuel tank pressure sensor section in Circuit/System Testing.
2. Install the fuel cap.
3. With the engine running, the EVAP canister vent solenoid valve open, use a scan tool to command the EVAP canister purge solenoid valve to 100 %. The fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H2O).
    - If the fuel tank vacuum is greater than the specified range, go to the restriction section in Circuit/System Testing.
4. Using the scan tool, decrease the canister purge duty cycle from 100 % to 0 %. The vacuum should decrease to near zero.
    - If the fuel tank vacuum does not return to zero or appears to decrease too slowly go to the restriction section in Circuit/System Testing.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

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NOTE: Perform the Circuit/System Verification before proceeding with the Circuit/System Testing.

Restriction

1. With the engine running, the EVAP canister vent solenoid valve open, and the EVAP canister purge solenoid valve commanded to 100 %, the fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H2O).
    - If the fuel tank vacuum is greater than the specified value, isolate the restriction by disconnecting one component at a time while the EVAP canister purge solenoid valve is commanded to 100 % and the vent valve is open.
2. Using the scan tool, decrease the canister purge duty cycle from 100 % to 0 %. The vacuum should decrease to near zero.
    - If the fuel tank vacuum does not return to zero, or appears to decrease too slowly, inspect the components in the EVAP vent system for a restriction.

Fuel Tank Pressure Sensor

1. Ignition OFF, disconnect the harness connector at the B150 fuel tank pressure sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the fuel tank pressure sensor.

REPAIR PROCEDURES

- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Evaporative Emission Canister Replacement**
- **Fuel Tank Pressure Sensor Replacement**
- **Control Module References**

REPAIR VERIFICATION

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

With the engine running, the evaporative emission canister vent solenoid valve open and the evaporative emission canister purge solenoid valve commanded to 100 %, the fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H2O).

DTC P0451-P0454

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

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- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0451

Fuel Tank Pressure Sensor Performance

DTC P0452

Fuel Tank Pressure Sensor Circuit Low Voltage

DTC P0453

Fuel Tank Pressure Sensor Circuit High Voltage

DTC P0454

Fuel Tank Pressure Sensor Intermittent

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Tank Pressure Sensor 5 V Reference	P0452, P0532, P0641	P0451	P0446, P0452	P0453, P0641	-
Fuel Tank Pressure Sensor Signal	P0452	P0451	P0452, P0453	P0453	P0451, P0454
Fuel Tank Pressure Sensor Low Reference	-	P0446, P0451	P0446	-	P0451

TYPICAL SCAN TOOL DATA

Fuel Tank Pressure Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF **Parameter Normal Range:** 1.3-1.7 V			
Fuel Tank Pressure Sensor 5 V Reference	0 V	0 V	4.2-5 V
Fuel Tank Pressure Sensor Signal	0 V	0 V	5 V
Fuel Tank Pressure Sensor Low Reference	-	4.5 V	-

CIRCUIT/SYSTEM DESCRIPTION

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The fuel tank pressure sensor measures air pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5 V reference and a low reference circuit to the fuel tank pressure sensor. The fuel tank pressure sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this fuel tank pressure signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

CONDITIONS FOR RUNNING THE DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0-2 per engine-off period. The length of the test can be up to 10 min.

P0452 and P0453

DTC P0452 and P0453 run continuously when the ignition is ON.

P0454

- DTC P0454 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- This test can run once per engine-off period. The length of the test can be up to 10 min.
- A refueling event is not detected.

CONDITIONS FOR SETTING THE DTC

P0451

This DTC will set if the controller is unable to re-zero the fuel tank pressure sensor voltage within a calibrated range during the engine-off small leak test, P0442.

P0452

The fuel tank pressure sensor voltage is less than 0.1 V for more than 5 s.

P0453

The fuel tank pressure sensor voltage is more than 4.9 V for more than 5 s.

P0454

If, during the engine-off natural vacuum small leak test, P0442, the ECM detects an abrupt fuel tank pressure signal change, other than a refueling event, this DTC will set. An abrupt change is defined as a change of 0.45 inch H2O in the span of 1 s.

ACTION TAKEN WHEN THE DTC SETS

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- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

DIAGNOSTIC AIDS

P0451 and P0454

- A restriction in the EVAP canister or vent lines could prevent fuel vapor pressure from bleeding off fast enough. If the vent system cannot bleed off pressure fast enough, the re-zero procedure may not complete successfully, which could cause this code to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- An fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this code to set. Scan tool output controls, snapshot, and plot functions can help detect erratic sensor response. To test the sensor signal under vacuum conditions, use the Quick Snapshot and the Purge/Seal functions to capture data while commanding purge to 20 %, then plot the data to look for erratic sensor operation. A similar test can be done for the pressure side of the sensor operation by applying pressure with the **J 41413-200:** EEST while taking a snapshot.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information

Special Tools

- **J 41413-200:** Evaporative Emission System Tester (EEST)
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Remove the fuel cap.
2. Ignition ON, engine OFF.
3. Observe the Fuel Tank Pressure Sensor parameter with a scan tool.
4. The fuel tank pressure Sensor parameter should be 1.1-1.7 V.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B150 fuel tank pressure sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms of resistance between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool B150 fuel tank pressure sensor parameter is less than 0.2 V.
    - If greater than the specified range, test the signal circuit terminal 1 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3. Verify the scan tool fuel tank pressure sensor parameter is greater than 4.7 V.
    - If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the B150 fuel tank pressure sensor.

REPAIR PROCEDURES

- **Fuel Tank Pressure Sensor Replacement**
- For DTC P0452 or P0453, always perform the **Diagnostic Repair Verification** after completing the diagnostic procedure
- For DTC P0451 or P0454, clear DTCs with a scan tool
- **Control Module References** for ECM replacement, setup, and programming

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DTC P0455

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0455

Evaporative Emission System Large Leak Detected

CIRCUIT/SYSTEM DESCRIPTION

The ECM tests the Evaporative Emission (EVAP) System for a large leak or restrictions to the purge path in the EVAP system. When the enabling criteria has been met the ECM commands the evaporative emission canister vent solenoid valve ON and the evaporative emission canister purge solenoid valve ON, allowing vacuum into the evaporative emission system. The ECM monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0455 failed, DTC P0496 must run and pass.
- DTCs P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0442, P0443, P0449, P0451, P0452, P0453, P0454, P0464, P0496, P0608, P0609, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 are not set.
- The ignition voltage is between 11-18 V.
- The barometric pressure (BARO) is more than 74 kPa.
- The fuel level is between 10-90 %.
- The engine coolant temperature (ECT) at start-up is less than 35°C (95°F).
- The intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0455 runs once per cold start when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The evaporative emission system is not able to achieve or maintain a calibrated level of vacuum within a set amount of time.

ACTION TAKEN WHEN THE DTC SETS

DTC P0455 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

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DTC P0455 is a Type B DTC.

DIAGNOSTIC AIDS

- Inspect for a loose, missing, damaged, or incorrect fuel fill cap.
- Inspect for a damaged fuel filler neck seal surface.
- A blockage or restriction in the evaporative emission purge solenoid valve, purge pipe, evaporative emission canister, or vapor pipe, can cause this DTC to set.
- The evaporative emission system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. Close the system once smoke is observed.
- To help locate intermittent leaks using the **J 41413-200:** EEST, move all evaporative emission components while observing smoke with the **J 41413-SPT:** White Light.
- Individual components can be isolated and tested using adapters in the **J 41413-300:** Kit.
- A condition may exist where a leak in the evaporative emission system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the evaporative emission system and then observe the fuel tank pressure parameter for vacuum decay.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information

Special Tools

- **CH 48096:** Evaporative Emissions Service Access Port Tool
- **J 41415-30:** Fuel Tank Adapter
- **J 41413-200:** Evaporative Emissions System Tester (EEST)
- **J 41413-300:** Evaporative Emissions Cap and Plug Kit
- **J 41413-311:** Evaporative Emissions Plug
- **J 41413-SPT:** High Intensity White Light
- **J 41413-VLV:** Evaporative Emissions Service Port Vent Tool
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM TESTING

NOTE:

- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize.**
- **Refer to the J 41413-200: EEST operation manual for detailed instructions in Evaporative Emission System Diagnosis .**

1. Disconnect the purge tube at the quick connector on the evaporative emission canister side of the Q12 evaporative emission canister purge solenoid valve. Install the **CH 48096:** Port Tool between the disconnected purge tube and the purge solenoid valve. Connect the **J 41413-200:** EEST to the service access port tool.
2. Ignition ON, use a scan tool to seal the evaporative emission system.
3. Use the flow meter on the **J 41413-200:** EEST, calibrated to 0.51 millimeter (0.020 inch) to determine that there is no leak in the evaporative emission system.
    - If a leak is detected, use the **J 41413-200:** EEST to apply smoke to the evaporative emission system at the purge tube until the leak is located using the **J 41413-SPT:** White Light.
4. To test for a restriction, connect the **J 41413-200:** EEST nitrogen/smoke hose to the to the **J 41413-311:** Evaporative Emission Plug brass cone adapter. Disconnect the hose at the fuel cap end of the **J 41415-30:** Adapter. Connect the **J 41413-311:** Evaporative Emission Plug to the disconnected hose on the **J 41415-30:** Adapter. Install the **J 41415-30:** Adapter filler neck end only to the vehicle.
5. Allow the engine to idle.
6. Use the Purge/Seal function to seal the system with a scan tool.
7. Command the EVAP Purge Solenoid Valve to 30 %.
8. The vacuum/pressure gauge on the **J 41413-200:** EEST and the fuel tank pressure parameter on the scan tool should both show vacuum.
    - If the vacuum/pressure gauge shows vacuum, but the fuel tank pressure parameter does not show vacuum, replace the fuel tank pressure sensor.
    - If neither the fuel tank pressure parameter nor the vacuum/pressure gauge shows vacuum, repair the restriction in the purge path.

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9. Verify that the vacuum increases to the abort limit on the scan tool or more than 3.2 V, and the values are similar between the scan tool and the vacuum/pressure gauge on the **J 41413-200:** EEST.
    - If the values are not similar, or the voltage did not reach 3.2 V, replace the B150 fuel tank pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Fuel Tank Pressure Sensor Replacement

DTC P0496

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0496

Evaporative Emission (EVAP) System Flow During Non-Purge

CIRCUIT/SYSTEM DESCRIPTION

This DTC tests for undesired intake manifold vacuum flow to the evaporative emission (EVAP) system. The engine control module (ECM) seals the EVAP system by commanding the EVAP canister purge solenoid valve OFF and the EVAP canister vent solenoid valve ON. The ECM monitors the fuel tank pressure sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is more than a predetermined value within a predetermined time, this DTC sets.

The following table illustrates the relationship between the ON and OFF states, and the Open or Closed states of the EVAP canister purge and vent solenoid valves.

Control Module Command	EVAP Canister Purge Solenoid Valve	EVAP Canister Vent Solenoid Valve
ON	Open	Closed
OFF	Closed	Open

CONDITIONS FOR RUNNING THE DTC

- DTCs P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0464, P0608, P0609, P0641, P0651,

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P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 are not set.
- The ignition voltage is between 11-18 volts.
- The barometric pressure (BARO) is more than 74 kPa.
- The fuel level is between 15-85 percent.
- The engine coolant temperature (ECT) at start-up is less than 35°C (95°F).
- The intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0496 runs once per cold start when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects more than 10 inch H2O vacuum for 5 seconds during a non-purge condition.

ACTION TAKEN WHEN THE DTC SETS

DTC P0496 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0496 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Troubleshooting with a Test Lamp**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, engine OFF, seal the EVAP system using the Purge/Seal function with a scan tool.
2. Start the engine.
3. Observe the fuel tank pressure sensor with a scan tool. The Fuel Tank Pressure Sensor parameter should be less than 1.7 volts after 90 seconds.
    - If the Fuel Tank Pressure Sensor parameter is greater than the specified range, go to Circuit/System Testing.
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition ON, engine OFF.
2. Seal the EVAP system using the Purge/Seal function with a scan tool.
3. Start the engine.
4. Observe the fuel tank pressure sensor with a scan tool. The Fuel Tank Pressure Sensor parameter should be less than 1.7 volts after 90 seconds.
    - If the Fuel Tank Pressure Sensor parameter is greater than the specified range, replace the Q12 EVAP canister purge solenoid valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Evaporative Emission Canister Purge Solenoid Valve Replacement

DTC P0506 OR P0507

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0506

Idle Speed Low

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DTC P0507

Idle Speed High

CIRCUIT/SYSTEM DESCRIPTION

The throttle actuator control (TAC) motor is controlled by the engine control module (ECM). The DC motor located in the throttle body drives the throttle blade. In order to decrease idle speed, along with spark and fuel delivery changes the ECM commands the throttle closed reducing air flow into the engine and the idle speed decreases. In order to increase idle speed, the ECM commands the throttle plate open allowing more air to pass the throttle plate.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0120, P0122, P0123, P0171, P0172, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0221, P0222, P0223, P0230, P0300, P0336, P0442, P0446, P0449, P0452, P0453, P0455, P0462, P0463, P0496, P1516, P2101, P2135, P2176 are not set.
- The engine has been running for greater than 60 s.
- The engine is idling for greater than 10 s.
- The AC mode state has not changed.
- The power steering load state has not changed.
- The transmission gear selector state has not changed.
- The engine coolant temperature (ECT) is greater than -60°C (-76°F).
- The intake air temperature (IAT) is greater than -20°C (-4°F).
- The barometric pressure (BARO) is greater than 70 kPa.
- The system voltage is between 11-18 V.
- The vehicle speed is less than 4.8 km/h (2 mph).
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0506

- The actual idle speed is approximately 100 RPM lower than the desired idle speed.
- The above condition is present for 15 s.

P0507

- The actual idle speed is approximately 200 RPM greater than the desired idle speed.
- The above condition is present for 15 s.

Action Taken When the DTC Sets

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DTCs P0506 and P0507 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0506 and P0507 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: The engine must first be running for greater than 60 s, then idle at a steady state for an additional 10 s before comparing the actual and desired engine idle speed parameters.

1. Ignition ON, observe the DTC information with a scan tool. Verify there are no other DTCs set.
   - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Idle the engine at the normal operating temperature. Compare the Desired Idle Speed to the actual Engine Speed with a scan tool. The actual Engine Speed should not be less than 100 RPM of the Desired Idle Speed or 200 RPM greater than the Desired Idle Speed.
3. Allow the engine to idle within the Conditions for Running the DTC. DTCs P0506 or P0507 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You

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may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

Verify none of the following conditions exist:

P0506

- Excess deposits in the Q38 throttle body. Refer to **Throttle Body Cleaning** .
- Restricted exhaust
- Mechanical conditions that limits engine speed
- Parasitic load on the engine--For example, a transmission condition, a belt driven accessory condition.
    - If a condition is found, repair as necessary.

P0507

- Vacuum leaks
- A throttle valve that does not close correctly
- Verify the correct operation of the crankcase ventilation system. Inspect for the following conditions:
    - The routing of the positive crankcase ventilation (PCV) system
    - Vacuum leaks in the PCV system--Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
    - If a condition is found, repair as necessary.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Throttle Body Cleaning

DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, OR P2610 (ECM)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each of the diagnostic category.

DTC DESCRIPTORS

DTC P0601

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Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P0607

Control Module Performance

DTC P060D

Control Module Accelerator Pedal (APP) Position System Circuitry Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P2610

Control Module Ignition Off Timer Performance

CIRCUIT/SYSTEM DESCRIPTION

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM) and the throttle actuator control (TAC) system. This diagnostic also addresses if the ECM is not programmed.

The ECM monitors its ability to read and write to the memory. It also monitors a timing function. The ECM and the TAC processors are used to monitor the TAC system data. Both processors monitor the other processors data to verify that the indicated APP calculation is correct. The ECM performs an intrusive test in order to confirm that the APP signals are not shorted together. The ECM accomplishes this by pulling the APP sensor 2 low momentarily and looking for sensor 1 to also be pulled low.

CONDITIONS FOR RUNNING THE DTCS

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P0601, P0604

- The ignition switch is in Run or Crank.
- These DTCs run continuously when the above condition is met.

P0602, P0603, P062F

- The ignition switch is in Run or Crank.
- These DTCs run once per ignition cycle.

P0606, P0607, P060D

- The ignition switch is in Run or Crank.
- The system voltage is more than 6.0 V.
- Reduced Engine Power is not active.
- These DTCs run continuously when the above conditions are met.

P2610

- The intake air temperature is between -40 to +125°C (-40 to +257°F).
- DTC P2610 runs once per ignition cycle on ECM power down.

CONDITIONS FOR SETTING THE DTCS

The ECM detects an internal failure or incomplete programming for more than 10 s.

ACTIONS TAKEN WHEN THE DTC SETS

- DTCs P0601, P0602, P0603, P0604, P0606, P060D, and P062F are Type A DTCs.
- DTC P0607 is a Type C DTC.
- DTC P2610 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P060D, and P062F are Type A DTCs.
- DTC P0607 is a Type C DTC.
- DTC P2610 is a Type B DTC.

DIAGNOSTIC AIDS

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set.

- Verify that the battery cables are clean and tight, and the battery is fully charged. Refer to **Battery Inspection/Test** .

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- Verify the ECM ground circuits do not have an open or high resistance.
- Verify the ECM power circuits do not have an open, short to ground, or high resistance.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Observe the DTC information with a scan tool.
    - If DTC P0602 is set, attempt to program the K20 ECM before replacing the K20 ECM. Refer to **Control Module References** for K20 ECM replacement, setup, and programming.
    - If DTC P0602 resets, replace the K20 ECM.
2. Observe the DTC information with a scan tool. DTC P0601, P0603, P0604, P0605, P0606, P0607, P060D, P062F, or P2610 should not set.
    - If a DTC failed this ignition, replace the K20 ECM.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, programming and setup

DTC P0601-P0604, P0606, OR P062F

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0601

Control Module Read Only Memory (ROM)

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory (RAM)

DTC P0606

Control Module Internal Performance

DTC P062F

Control Module Long Term Memory Performance

CIRCUIT/SYSTEM DESCRIPTION

The internal fault detection is handled inside the fuel pump control module. No external circuits are involved.

CONDITIONS FOR RUNNING THE DTC

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The fuel pump control module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module has detected an internal malfunction.

ACTION TAKEN WHEN THE DTC SETS

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

REFERENCE INFORMATION

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

CIRCUIT/SYSTEM VERIFICATION

NOTE: This DTC may be stored as a history DTC without affecting the operation of the module. If stored only as a history DTC and not retrieved as a current DTC, do not replace the module.

1. Verify that DTC P0602 is not set.
    - If the DTC is set, program the K27 fuel pump control module.
2. Verify that DTCs P0601, P0603, P0604, P0606, and P062F are not set.
    - If the DTCs are set, program the K27 fuel pump control module. If the DTCs reset, replace the K27 fuel pump control module.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

DTC P0641 OR P06A6

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0641

5-Volt Reference Circuit

DTC P06A6

5-Volt Reference Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641	P0641, P06A6	P0641	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

CIRCUIT/SYSTEM DESCRIPTION

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The fuel pump control module monitors the voltage signal from the fuel pressure sensor.

CONDITIONS FOR RUNNING THE DTC

The ignition is on.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects that the fuel pressure 5 V reference is above or below a predetermined voltage threshold.

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ACTION TAKEN WHEN THE DTC SETS

DTCs P0641 and P06A6 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0641 and P06A6 are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect harness connector of the B47 fuel pressure sensor.

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2. Ignition OFF, test for less than 1.0 ohms between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
4. If all circuits test normal, replace the B47 fuel pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pressure Sensor Replacement**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P0641 OR P0651 (ECM)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0641

5 V Reference 1 Circuit

DTC P0651

5 V Reference 2 Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Accelerator Pedal Position (APP) Sensor 1 5 V Reference 2 Circuit	P0122, P0222, P0651, P0807, P2122, P2138	P2122, P2138	P0123, P0223, P0651, P0808, P2123, P2138
Accelerator Pedal Position (APP) Sensor 2	P0107, P0452, P0522, P0532,	P2127, P2138	P0106, P0108, P0453, P0523,

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5 V Reference 1 Circuit	P0641, P2127, P2138		P0641, P2128, P2138
Air Conditioning (A/C) Refrigerant Pressure Sensor 5 V Reference 1 Circuit	P0107, P0452, P0522, P0532, P0641, P2127, P2138	P0532	P0106, P0108, P0453, P0523, P0641, P2128, P2138
Brake Booster Vacuum Sensor 5 V Reference 2 Circuit	P0122, P0222, P0651, P0807, P2122, P2138	P0557	P0106, P0108, P0453, P0523, P0641, P2128, P2138
Camshaft Position Sensor 5 V Reference 1 Circuit	P0107, P0452, P0522, P0532, P0641, P2127, P2138	P0340	P0106, P0108, P0453, P0523, P0641, P2128, P2138
Clutch Pedal Position Sensor 5 V Reference 2 Circuit, if equipped	P0122, P0222, P0651, P0807, P2122, P2138	P0807	P0123, P0223, P0651, P0808, P2123, P2138
Crankshaft Position Sensor 5 V Reference 2 Circuit	P0122, P0222, P0651, P0807, P2122, P2138	P0335	P0123, P0223, P0651, P0808, P2123, P2138
Engine Oil Pressure Sensor 5 V Reference 1 Circuit	P0107, P0452, P0522, P0532, P0641, P2127, P2138	P0522	P0106, P0108, P0453, P0523, P0641, P2128, P2138
Fuel Tank Pressure Sensor 5 V Reference 1 Circuit	P0107, P0452, P0522, P0532, P0641, P2127, P2138	P0446, P0452	P0106, P0108, P0453, P0523, P0641, P2128, P2138
Manifold Absolute Pressure (MAP) Sensor 5 V Reference 1 Circuit	P0107, P0452, P0522, P0532, P0641, P2127, P2138	P0106, P0107	P0106, P0108, P0453, P0523, P0641, P2128, P2138
Throttle Position Sensor 1 and 2 5 V Reference 2 Circuit	P0122, P0222, P0651, P0807, P2122, P2138	P0122, P0222, P2135	P0123, P0223, P0651, P0808, P2123, P2138

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) has 2 internal 5 V reference busses called 5 V reference 1 and 5 V reference 2. Each reference bus provides 5 V reference circuits for more than one sensor. Therefore, a fault condition on one 5 V reference circuit will affect the other 5 V reference circuits connected to that reference bus. The ECM monitors the voltage on the 5 V reference busses.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0601, P0602, P0603, P0604, P0605, P0606, P060D, P062F and P2610 are not set.

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- The ignition is ON.
- The ignition voltage is greater than 5.23 V.
- DTCs P0641 and P0651 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects a voltage out of tolerance condition on the 5 V reference 1 or 2 bus for more than 0.5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0641 and P0651 are Type A DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0641 and P0651 are Type A DTCs.

DIAGNOSTIC AIDS

- The 5 V reference 1 bus provides 5 V to the following sensors:
  - B74 manifold absolute pressure (MAP) sensor
  - B150 fuel tank pressure sensor
  - B107 accelerator pedal position (APP) sensor 2
  - B37B engine oil pressure sensor
  - B1 air conditioning (A/C) refrigerant pressure sensor
  - B23 camshaft position sensor
- The 5 V reference 2 bus provides 5 V to the following sensors:
  - B107 APP sensor 1
  - Q38 throttle position sensor 1 and 2
  - B26 crankshaft position sensor
  - B19B brake booster vacuum sensor
  - B25B clutch pedal position sensor, if equipped
- It may be possible to locate the fault by disconnecting one component at a time from the affected 5 V reference circuit while viewing the 5 V Reference Circuit Status parameter on the scan tool. The scan tool parameter will change from Fault to OK when the source of the fault is disconnected. If all 5 V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the scan tool 5 V reference 1 circuit status and the 5 V reference 2 circuit status parameters. Verify the parameters display OK.
2. Ignition ON, observe the DTC information with a scan tool. DTCs P0641 and P0651 should not set on this ignition cycle.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: A short to voltage on the signal circuit of certain components may cause this DTC to set.

1. Ignition OFF, disconnect the harness connector of all the sensors for the applicable DTC. Refer to Diagnostic Aids for the appropriate sensors.
2. Ignition ON, measure for 4.8-5.2 V between the 5 V reference circuit of each component and ground.
    - If less than the specified range, test for a short to ground or an open/high resistance on the 5 V reference circuits of each component. If all circuits test normal, replace the K20 ECM.
    - If greater than the specified range, test for a short to voltage on the 5 V reference circuit of each component. If all circuits test normal, replace the K20 ECM.
3. Connect each component associated with the 5 V reference circuit, one at a time, while monitoring the voltage. Verify the voltage remains between 4.8-5.2 V.
    - If not within the specified range when a component is connected, test the signal circuit for a short to voltage. If the circuit tests normal, replace the appropriate component.

REPAIR PROCEDURES

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Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accelerator Pedal Position Sensor Replacement**
- **Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement (LLT)** or **Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement (LS3, L99)**
- **Fuel Tank Pressure Sensor Replacement**
- **Manifold Absolute Pressure Sensor Replacement**
- **Throttle Body Assembly Replacement**
- **Engine Oil Pressure Sensor and/or Switch Replacement (L99/LS3)**
- **Camshaft Position Sensor Replacement**
- **Clutch Pedal Position Sensor Replacement**
- **Crankshaft Position Sensor Replacement**
- **Power Brake Booster Vacuum Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0650

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open	Short to Voltage	Signal Performance
MIL Voltage Supply	P0650	P0650	-	-
MIL Control	P0650*	P0650	P0650	-
*The MIL Remains ON				

CIRCUIT/SYSTEM DESCRIPTION

The malfunction indicator lamp (MIL) is located on the instrument panel cluster. The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded states of the MIL. For example, a failure condition exists if the ECM detects low voltage when the MIL is

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commanded OFF, or high voltage when the MIL is commanded ON.

CONDITIONS FOR RUNNING THE DTC

- The ignition is in the Run or Crank position.
- The ignition voltage is between 11-18 V.
- The ECM has commanded the MIL ON and OFF at least once during the ignition cycle.
- DTC P0650 runs continuously when the ignition is ON.

CONDITIONS FOR SETTING THE DTC

The ECM detects an open, a short to ground, or a short to voltage on the circuit that controls the MIL.

ACTION TAKEN WHEN THE DTC SETS

DTC P0650 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0650 is a Type B DTC.

DIAGNOSTIC AIDS

- A MIL control circuit that is shorted to voltage will only set DTC P0650 when the ECM attempts to command the MIL lamp ON.
- If the condition is intermittent, move the related harnesses and connectors with the engine operating. Monitor the scan tool Circuit Test Status parameters for the component. The Circuit Test Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

- **Instrument Cluster Schematics**
- **Engine Controls Schematics**

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
2. Ignition ON, command the MIL ON and OFF with a scan tool while observing the following control circuit status parameters:
   - MIL Control Circuit Low Voltage Test Status
   - MIL Control Circuit Open Test Status
   - MIL Control Circuit High Voltage Test Status

   Each parameter should toggle between OK and Not Run or Not Run and OK.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. If any other IPC indicators or gauges are inoperative, refer to **Instrument Cluster Gauges Inoperative** .
2. Ignition OFF, disconnect the K20 ECM X1 harness connector. Ignition ON, the MIL should not illuminate.
   - If the MIL is illuminated, test the MIL control circuit terminal X1-68 for a short to ground. If the circuit tests normal, replace the IPC.
3. Ignition ON, connect a 3 A fused jumper wire between the MIL control circuit terminal X1-68 and ground. The MIL should illuminate.
   - If the MIL does not illuminate, test the MIL control circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the IPC/bulb.
4. If all circuits/connections test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM and instrument cluster replacement, setup, and programming

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DTC P0685 OR P0690

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Supply Voltage - Coil	P0685	P0685	-	-
Battery Supply Voltage - Armature	-	-	-	-
Relay Control Circuit	P0685	P0685, P1682	P0685, P0690, P1682, P2101	-
Relay Feedback Circuit	-	-	P0690	-

TYPICAL SCAN TOOL DATA

Engine Controls Ignition Relay Feedback Signal

Display Parameters	Normal Range	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, with the engine OFF, powertrain relay commanded ON				
Engine Controls Ignition Relay Control Circuit Test Status	OK/Not Run	Short to GRD/Open	Short to GRD/Open	Short to B+
Engine Controls Ignition Relay Command	ON	ON	ON	ON
Engine Controls Ignition Relay Feedback Signal	12-12.9 V	0.0 V	0.0 V	12-12.9 V

CIRCUIT/SYSTEM DESCRIPTION

The engine controls ignition relay or powertrain relay is a normally open relay. The relay switch is held in the open position by spring tension. Battery positive voltage is supplied directly to the relay coil and the switch

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contact at all times. The engine control module (ECM) supplies the ground path to the relay coil control circuit via an internal integrated circuit called an output driver. When the ECM commands the powertrain relay ON, ignition voltage is supplied to several fuses in the under-hood fuse block.

The ignition voltage that is supplied to the ECM through the powertrain relay provides power to the internal ECM circuits associated with the throttle actuator control (TAC) operation. The ECM also monitors the voltage level on the ignition voltage circuit to confirm that the powertrain relay contacts have closed.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- The ignition voltage is between 11-18 V.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0685

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

P0690

- The ECM detects the engine controls ignition relay feedback circuit is greater than 2 V when the relay is commanded OFF.
- The ECM detects the engine controls ignition relay feedback circuit is greater than 18 V when the relay is commanded ON.
- The condition is present for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0685 and P0690 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0685 and P0690 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

- **Engine Controls Schematics**
- **Power Distribution Schematics**

Connector End View Reference

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Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**
- **Probing Electrical Connectors**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE:

- **A short to voltage on other components may cause DTC P0690 to set. If other DTCs are set, diagnose those DTCs first.**
- **If you were sent here from Engine Cranks But Does Not Run, proceed to Circuit/System Testing.**

1. Ignition ON, command the Engine Controls Ignition Relay ON and OFF with a scan tool while observing the following Engine Controls Ignition Relay control circuit status parameters:
   - Engine Controls Ignition Relay Control Circuit Low Voltage Test Status
   - Engine Controls Ignition Relay Control Circuit Open Test Status
   - Engine Controls Ignition Relay Control Circuit High Voltage Test Status

   Each parameter should toggle between OK and Not Run or Not Run and OK.
2. Ignition ON, view the DTC information with a scan tool. DTC P0685 or P0690 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, disconnect the KR75 powertrain relay.

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2. Verify a test lamp illuminates between both of the following relay battery voltage circuit terminals and ground:
    - Terminal 85
    - Terminal 30
    - If the test lamp does not illuminate, test the relay battery voltage circuit for an open/high resistance or a short to ground.

NOTE: The ignition voltage circuit is between the powertrain relay and the ECM. The ignition voltage circuit is a feedback circuit.

3. Ignition OFF, verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.
    - If the test lamp illuminates, test the ignition voltage circuit for a short to voltage.
4. Connect a 20 A fused jumper wire between the relay switch B+ circuit terminal 30 and the relay switch ignition voltage circuit terminal 87.
5. Ignition ON, observe the scan tool Engine Controls Ignition Relay Feedback Signal parameter. The ECM should communicate, and the parameter should display 9-14 V.
    - If not the specified range, or the ECM does not communicate, test the ignition voltage circuit between the powertrain relay and the ECM for a short to ground or for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
6. Ignition OFF, verify that a test lamp does not illuminate between the control circuit terminal 86 and B+.
    - If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
7. Connect a DMM set to the diode setting between the control circuit terminal 86 and ground.
8. Ignition ON, verify the DMM does not display OL.
    - If the DMM displays OL, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
9. If all circuits test normal, replace the KR75 powertrain relay.

COMPONENT TESTING

NOTE: Depending on the application, the relay coil resistance will be within one of the following ranges.

1. Test for one of the following resistance specifications between terminals 85 and 86 of the KR75 powertrain relay:
    - 70-110 ohms
    - 200-250 ohms
    - If not within the specified range, replace the KR75 powertrain relay.
2. Test for infinite resistance between the following terminals of the KR75 powertrain relay:
    - 30 and 86
    - 30 and 87

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- 30 and 85
- 85 and 87
  - If not the specified value, replace the KR75 powertrain relay.

3. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
   - If greater than the specified range, replace the KR75 powertrain relay.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P069E

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

CIRCUIT/SYSTEM DESCRIPTION

The fuel pump control module uses the serial data network to signal the engine control module (ECM) that the fuel pump control module is requesting malfunction indicator lamp (MIL) illumination. A DTC is set in the fuel pump control module, and the request for MIL illumination is sent when the fuel pump control module determines that a failure that affects emissions has occurred in the fuel pump control system. When the ECM receives the message from the fuel pump control module, DTC P069E will set in the ECM.

CONDITIONS FOR RUNNING THE DTC

The ignition is ON, or the engine is running.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module requests the ECM to illuminate the MIL.

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ACTION TAKEN WHEN THE DTC SETS

- DTC P069E is a Type A DTC.
- DTC P069E will continue to be current or active as long as the fuel pump control module is requesting MIL illumination.

CONDITIONS FOR CLEARING THE DTC

DTC P069E is a Type A DTC.

DIAGNOSTIC AIDS

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the fuel pump control module will cause the fuel pump control module to request DTC P069E to be set in the ECM.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

CIRCUIT/SYSTEM VERIFICATION

NOTE: Correct any engine controls and communication DTCs before diagnosing fuel pump control module DTCs.

1. DTC P069E is an informational DTC. If there are no engine controls or communication DTCs, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for diagnosis of fuel pump control module DTCs.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P0700

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

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- **Diagnostic Procedure Instructions** provides an overview of each of the diagnostic category.

DTC DESCRIPTOR

DTC P0700

Transmission Control Module (TCM) Requested MIL Illumination

CIRCUIT/SYSTEM DESCRIPTION

The diagnostic trouble code (DTC) indicates that an emission related transmission DTC set in the transmission control module (TCM). The engine control module (ECM) receives the TCM information over the serial data circuit. The ECM turns ON the malfunction indicator lamp (MIL) when the TCM sends a message over the serial data circuit requesting MIL illumination. The DTC information for the ECM will only display DTC P0700, but the Freeze Frame/Failure Records data will display the transmission DTC that set.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON or the engine is operating.
- DTC P0700 runs continuously.

CONDITIONS FOR SETTING THE DTC

The ECM receives a serial data message from the TCM requesting the ECM to turn ON the MIL lamp.

ACTION TAKEN WHEN THE DTC SETS

DTC P0700 is a Type A DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0700 is a Type A DTC.

DIAGNOSTIC AIDS

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the TCM can cause the TCM to request DTC P0700 to be set in the ECM.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

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CIRCUIT/SYSTEM VERIFICATION

NOTE: Correct any engine controls and communication DTCs before diagnosing TCM DTCs.

1. DTC P0700 is an informational DTC. If there are no engine controls or communication DTCs, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for diagnosis of TCM DTCs.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

DTC P1255 OR P064A

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P064A

Fuel Pump Control Module Performance

DTC P1255

Fuel Pump Control Module Driver Over-temperature

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

The engine is running.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects an over-temperature fault.

ACTION TAKEN WHEN THE DTC SETS

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DTCs P064A and P1255 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P064A and P1255 are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify that DTC P0231, P0232 or P023F are not set.
    - If any of those codes are set, refer to **DTC P0231, P0232, or P023F** .
2. Ensure that the entire undercarriage of the vehicle is clean, especially around the area where the K27 fuel

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pump control module is located. Clear all codes from the K27 fuel pump control module and test drive the vehicle. Verify that DTC P1255 or P064A do not set.

- If DTC P1255 or P064A reset, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

DTC P1258

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P1258

Engine Coolant Temperature Over - Protection Mode Active

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses the engine coolant temperature (ECT) sensor to monitor the engine for an over-termperature condition. This condition occurs when the coolant temperature is above a calibrated value for a calibrated length of time. The ECM will disable half of the cylinders by turning OFF the fuel injectors. By disabling half of cylinders, the ECM is able to reduce the temperature of the coolant.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- DTC P0117 or P0118 are not set.

CONDITIONS FOR SETTING THE DTC

Coolant temperature warmer than 132°C (270°F) for greater than 10 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P1258 is a Type A DTC.
- The engine will operate in the Overheated Engine Protection Operating Mode.
- The engine coolant temperature indicator lamp, if equipped, will illuminate.

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- The driver information center, if equipped, may display a message.

CONDITIONS FOR CLEARING THE DTC

DTC P1258 is a Type A DTC.

REFERENCE INFORMATION

Description and Operation

- **Cooling System Description and Operation**
- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**
- **Audible Warnings Description and Operation**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: If DTC P1482 is set, diagnose that DTC first.

1. Observe the engine coolant level. The engine coolant level should be within operating range. Refer to Capacities - Approximate Fluid, and Engine Coolant in the Owner's Manual.
2. Ensure that the vehicle has the correct engine coolant, with correct concentration, and is not old, contaminated or contains additives. Refer to Recommended Fluids and Lubricants in the Owner's Manual.
3. Inspect the cooling system for the following:
    - Leaks
    - Kinked or pinched hoses, especially at the radiator
    - Loose, missing, or damaged radiator air seals or deflectors
    - The radiator and A/C condenser for any air flow obstructions or bent fins-Refer to **Symptoms - Engine Cooling** .

    NOTE: A small delay occurs before the ECM changes the cooling fan speed.

4. Command the cooling fan speed from 0% to 100% with a scan tool.
    - If the fan speed does not transition with the commanded states, refer to **Cooling Fan Inoperative** .

CIRCUIT/SYSTEM TESTING

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1. Test the thermostat for correct operation. Refer to **Thermostat Diagnosis** .
2. Test the engine cooling system for overheating. Refer to **Engine Overheating** .
3. Inspect the water pump and coolant flow for correct operation. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** .
4. Inspect the engine for worn/leaking/cracked cylinder heads and engine block. Refer to **Coolant in Combustion Chamber** and **Coolant in Engine Oil** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

DTC P1380 OR P1381

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P1380

Misfire Detected and Rough Road Data Not Available

DTC P1381

Misfire Detected and No Communication with Brake Control Module

SYSTEM DESCRIPTION

The engine control module (ECM) detects engine misfire by detecting variations in crankshaft deceleration between firing strokes. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. If the ABS is malfunctioning and cannot detect rough roads, the misfire diagnostic will continue to run; however, if an engine misfire DTC sets, this DTC also sets indicating that rough road data was not available, or there was no communication with the brake control module during the misfire calculation due to an ABS malfunction.

CONDITIONS FOR RUNNING THE DTC

- The vehicle speed is greater than 8 km/h (5 MPH).
- The engine speed is less than 8,192 RPM.
- The engine load is less than 60%.
- Engine misfire is detected and DTC P0300 sets with the MIL illuminated.
- DTCs P1380 and P1381 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P1380

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- The ABS controller sends a message to the ECM indicating that a failure has occurred in the ABS module.
- Engine misfire is detected and DTC P0300 set.

P1381

- An ABS malfunction exists for more than 10 s, preventing the K20 ECM from receiving rough road detection data.
- Engine misfire is detected and DTC P0300 set.

ACTION TAKEN WHEN THE DTC SETS

DTCs P1380 and P1381 are Type C DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P1380 and P1381 are Type C DTCs.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: If an UXXXX DTCs are set, diagnose those first.

1. Engine idling, observe the EBCM DTC information with a scan tool. EBCM DTCs should not set.
   - If a DTC sets, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
   - If there are no EBCM DTCs set, refer to **Symptoms - Antilock Brake System** .
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P1400

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DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P1400

Cold Start Emission Reduction Control System

CIRCUIT/SYSTEM DESCRIPTION

The catalytic converter must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalytic converter. During a cold start, the engine idle speed is elevated and spark timing is retarded to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Engine speed
- Spark advance
- Throttle position
- Engine airflow
- Engine coolant temperature
- Engine runtime
- Park/neutral position
- Vehicle speed

The actual model is then compared to the expected exhaust energy model.

CONDITIONS FOR RUNNING THE DTC

- The engine is running, and a cold start has been detected.
- Vehicle speed is less than 2 km/h (1 MPH).
- The engine is at idle with no input from the accelerator pedal.
- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0335, P0336, P0351, P0352, P0353, P0501, P0502, P0506, P0507, P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P0641, P0651, P1101, P1516, P1682, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2610 are not set.

This DTC runs for 15 s within the first 2 min of start-up. This diagnostic runs once per trip when a cold start has been determined.

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CONDITIONS FOR SETTING THE DTC

The actual exhaust energy model does not match the expected exhaust energy model.

ACTION TAKEN WHEN THE DTC SETS

DTC P1400 is a Type A DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P1400 is a Type A DTC.

REFERENCE INFORMATION

Description and Operation

Engine Control Module Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

DIAGNOSTIC AIDS

Any loading of the engine that lowers engine RPM, such as with partial application of the clutch, A/C cycling etc., during the first 120 s of engine run time may set this DTC.

CIRCUIT/SYSTEM VERIFICATION

1. Allow the engine to cool.
2. Start and idle the engine for at least 2 min.
3. DTC P1400 should run and pass.

CIRCUIT/SYSTEM TESTING

- Inspect the air intake system for the following:
  - Damage, restriction, or modification
  - Dirty or deteriorating air filter element
  - Crankcase ventilation system for correct operation-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
  - Water intrusion

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    - Vacuum leak and other un-metered air downstream of the mass air flow B75 (MAF) sensor
    - Intake manifold leak
- Inspect the exhaust system for the following:
    - Water intrusion
    - Exhaust leak
    - Damaged, restricted, modified or enhanced exhaust system-Refer to **Symptoms - Engine Exhaust** .
- Inspect the engine mechanical for items that could alter the air flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P1516, P2101, P2119, OR P2176

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P1516

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

DTC P2101

Throttle Actuator Position Performance

DTC P2119

Throttle Closed Position Performance

DTC P2176

Minimum Throttle Position Not Learned

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance

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Motor Control 1	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176
Motor Control 2	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

CONDITIONS FOR RUNNING THE DTC

P1516 and P2101

- The ignition voltage is greater than 11 V.
- The system is not in the Battery Save mode.
- The engine is running.
- DTC P0068 is not set.
- DTCs P1516 and P2101 run continuously when the above conditions are met.

P2119

- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The system is in the Battery Save mode.
- DTC P2119 runs continuously when the above conditions are met.

P2176

- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The system is not in the Battery Save mode.
- DTCs P0068, P0120, P0122, P0123, P0220, P0222, P0223 are not set.
- DTC P2176 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P1516

The indicated throttle position does not match the predicted throttle position for greater than 0.5 s.

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P2101

The indicated throttle position does not match the predicted throttle position for greater than 0.3 s.

P2119

The ECM determines that the throttle blade did not return to the rest position within 0.720 s.

P2176

The difference between the predicted and the actual throttle position is greater than a calibrated amount for greater than 1.5 s.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P1516, P2101, and P2176 are Type A DTCs.
- DTC P2119 is a Type C DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P1516, P2101, and P2176 are Type A DTCs.
- DTC P2119 is a Type C DTC.

DIAGNOSTIC AIDS

- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: A low battery voltage or charging system condition may cause a DTC to set.

1. Ignition ON, observe the DTC information with a scan tool. DTC P0120, P0122, P0123, P0220, P0222, P0223, P0562, P0621, P0622, or P2135 should not set.
    - If a DTC sets, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Slowly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release the pedal. Repeat the procedure several times. DTC P1516, P2101, P2119, or P2176 should not set.
3. Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release the pedal. Repeat the procedure several times. DTC P1516, P2101, P2119, or P2176 should not set.
4. Engine idling, observe the TAC Command parameter with a scan tool. The reading should display greater than 0 %.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

1. Ignition OFF, verify the following conditions do not exist with the Q38 throttle body assembly:
    - A throttle blade that is not in the rest position
    - A throttle blade that is binding open or closed
    - A throttle blade that is free to move open or closed without spring pressure

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- If a condition is found, replace the Q38 throttle body assembly.

NOTE: Disconnecting the throttle body harness connector may cause additional DTCs to set.

2. Ignition OFF, disconnect the harness connector at the Q38 throttle body assembly.
3. Ignition ON, verify that a test lamp does not illuminate between each motor control circuit listed below and ground.
   - Motor control circuit terminal A
   - Motor control circuit terminal B
   - If test lamp illuminates, test the motor control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, verify that a test lamp does not illuminate between each motor control circuit listed below and B+.
   - Motor control circuit terminal A
   - Motor control circuit terminal B
   - If the test lamp illuminates, test the motor control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
5. Ignition OFF, set the DMM to the 40 V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms.

NOTE:
- **The DMM Min/Max Recording Mode and the response time of 1 ms must be reset after testing each circuit.**
- **The ignition must be OFF and the ECM completely powered down before testing each circuit.**

6. Ignition OFF, measure the voltage using the DMM Min/Max Recording Mode function on each circuit listed below as the ignition is turned ON. The Max voltage should be within 1 V of B+.
   - Motor control circuit terminal A
   - Motor control circuit terminal B
   - If not within the specified range, test the circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If all circuits and connections test normal, replace the Q38 throttle body assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Body Assembly Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P1682

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DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P1682

Ignition 1 Switch Circuit 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Engine Controls Ignition Relay Feedback Signal, Powertrain Relay	P1682	P1682	P0690
Ignition 1 Signal, Run/Crank Relay	1	1	2
1. A short to ground or open/high resistance will cause a No Crank condition. 2. A short to voltage will cause the engine to continue to run with ignition OFF.			

TYPICAL SCAN TOOL DATA

Ignition Scan Tool Data

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF, and run/crank and powertrain relay are commanded ON			
Ignition 1 Signal, Run/Crank Relay	0 V	0 V	12 V
Engine Controls Ignition Relay Feedback Signal, Powertrain Relay	0 V	0 V	12 V

CIRCUIT/SYSTEM DESCRIPTION

There are 2 ignition voltage circuits supplied to the engine control module (ECM). The first ignition circuit is provided by the powertrain relay, through a fuse. This ignition voltage circuit supplies power to all the internal ECM circuits associated with the throttle actuator control (TAC) operation. The second ignition voltage circuit is supplied by the run/crank relay through a fuse, and is used to power the remaining internal ECM circuits. If the ECM detects a voltage difference between the 2 ignition voltage circuits, DTC P1682 will set.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- System voltage is more than 7 V.
- The powertrain relay is commanded ON.

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- DTC P1682 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition 1 voltage circuits for less than 1 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P1682 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P1682 is a Type A DTC.

DIAGNOSTIC AIDS

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to **Battery Inspection/Test** .

REFERENCE INFORMATION

Schematic Reference

- **Engine Controls Schematics**
- **Power Distribution Schematics**

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Probing Electrical Connectors**
- **Electrical Center Identification Views**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information

Special Tools

J 35616 GM-Approved Terminal Test Kit

CIRCUIT/SYSTEM VERIFICATION

NOTE: On the scan tool, the powertrain relay is referred to as the Engine Controls ignition relay.

1. If DTCs P0685, P0689, or P0690 are set, diagnose those DTCs first.
2. Ignition ON, engine OFF, observe both the Ignition 1 Signal and the Engine Control Ignition Relay Feedback Signal parameters on the scan tool. There should be no more than 3 V difference between the 2 parameters.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition ON, observe the Ignition 1 Signal and the Engine Controls Ignition Relay Feedback scan tool parameter to determine which is more than 3 V lower than the other.

   NOTE: The Ignition 1 Signal is supplied by the Run/Crank relay. The Engine Controls Ignition Relay Feedback signal is supplied by the powertrain relay.

2. Ignition OFF, remove the relay that corresponds to the scan tool parameter that is more than 3 V lower.

   NOTE: A resistance of 6 ohms or greater in the circuit/underhood fuse block will cause the DTC to set.

3. Connect a 20 A fused jumper wire between B+ and the applicable ignition voltage circuit terminal 87. Ignition ON, verify that the applicable scan tool parameter displays between 9-14 V.
   - If less than the specified value, test the ignition voltage circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Ignition OFF, connect a DMM set to the diode setting between the control circuit terminal 86 and ground. Verify the DMM displays OL.
   - If not the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, verify the DMM displays less than 1 V.

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    - If not the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, replace the appropriate relay.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P2120, P2122, P2123, P2125, P2127, P2128, OR P2138

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2120

Accelerator Pedal Position (APP) Sensor 1 Circuit

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2125

Accelerator Pedal Position (APP) Sensor 2 Circuit

DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

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DTC P2138

Accelerator Pedal Position (APP) Sensor 1-2 Correlation

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
APP Sensor 1 5 V Reference	P0335, P0651, P2122, P2138	P2122, P2138	P0651, P2123, P2138	P2120, P2138
APP Sensor 1 Signal	P2122	P2122, P2138	P2123	P2120, P2138
APP Sensor 1 Low Reference	-	P2123, P2138	-	P2120, P2138
APP Sensor 2 5 V Reference	P0452, P0532, P0641, P2127, P2138	P2127, P2138	P0641, P2138	P2125, P2138
APP Sensor 2 Signal	P2127	P2127, P2138	P2138	P2125, P2138
APP Sensor 2 Low Reference	-	P2128	-	P2125, P2138

TYPICAL SCAN TOOL DATA

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF **Parameter Normal Range:** 0.78-1.18 V			
5 V Reference	0 V	0 V	4.98 V
Signal	0 V	0 V	4.98 V
Low Reference	-	5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF **Parameter Normal Range:** 0.39-0.59 V			
5 V Reference	0 V	0 V	4.98 V
Signal	0 V	0 V	4.98 V
Low Reference	-	4.98 V	-

CIRCUIT/SYSTEM DESCRIPTION

The accelerator pedal assembly contains two accelerator pedal position (APP) sensors. The APP sensors are mounted in the pedal assembly and are not serviceable. The APP sensors provide a signal voltage that changes relative to the position of the accelerator pedal. The engine control module (ECM) supplies each sensor with a signal circuit, 5 V reference circuit, and a low reference circuit.

CONDITIONS FOR RUNNING DTC

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P2120, P2122, P2123, P2125, P2127, P2128

- DTC P0641 or P0651 is not set.
- The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.
- The ignition is ON or the engine is operating.
- DTC P0120, P0122, P0123, P0220, P0222, P0223, and P2135 run continuously when the above conditions are met.

P2138

- DTC P0641, P0651, P2120, P2122, P2123, P2125, P2127 or P2128 are not set.
- The ignition is ON or the engine is operating.
- The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.
- DTC P2138 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING DTC

P2120

The ECM detects that the APP sensor 1 voltage is less than 0.463 V or greater than 4.75 V for less than 1 s.

P2122

The ECM detects that the APP sensor 1 voltage is less than 0.463 V for less than 1 s.

P2123

The ECM detects that the APP sensor 1 voltage is greater than 4.75 V for less than 1 s.

P2125

The ECM detects that the APP sensor 2 voltage is less than 0.325 V or greater than 2.6 V for less than 1 s.

P2127

The ECM detects that the APP sensor 2 voltage is less than or equal to 0.325 V for less than 1 s.

P2128

The ECM detects that the APP sensor 2 voltage is greater than 2.6 V for less than 1 s.

- The ECM detects that APP sensor 1 and APP sensor 2 disagree greater than 10 percent for less than 1 s.

  Or

- The ECM detects that both APP sensor 1 and APP sensor 2 are 5 percent greater than the learned

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minimum position for less than 1 s.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P2120, P2122, P2123, P2125, P2127, P2128, and P2138 are Type A DTCs.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P2120, P2122, P2123, P2125, P2127, P2128, and P2138 are Type A DTCs.

DIAGNOSTIC AIDS

A high resistance condition on the accelerator pedal sensor circuits could cause a DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify DTC P0641 or P0651 are not set.
    - If a DTC is set, refer to **DTC P0641 or P0651 (ECM)** for further diagnosis.
2. Observe the scan tool APP sensor 1 and 2 voltage parameters. The reading should be between 0.46-4.75 V for APP 1 and 0.325-4.75 V for APP 2, and change with accelerator pedal input.
3. Observe the scan tool APP Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
    - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
    - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.

    The APP Sensor 1 and 2 Agree/Disagree parameter should display Agree.
4. Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC or within the conditions that you observed from the Freeze Frame/Failure Records.
5. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P2120 or P2125 are not the only APP sensor DTCs set.
    - If DTC P2120 or P2125 are the only DTCs set, replace the ECM.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B107 accelerator pedal. Allow at least 60 s for the ECM to power down. This can be verified by a loss of communication message on the scan tool.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the appropriate low reference circuit terminal listed below and ground.
    - APP sensor 1 terminal D
    - APP sensor 2 terminal A
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the appropriate 5-volt reference circuit terminal listed below and ground.
    - APP sensor 1 terminal F
    - APP sensor 2 terminal C
    - If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
    - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.

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4. Verify the scan tool APP sensor 1 and 2 voltages are less than 0.2 V.
    - If greater than the specified range, test the APP sensor 1 and 2 signal circuits terminals B or E for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between the APP sensor 1 signal circuit terminal E and the 5-volt reference circuit terminal F. Verify the APP sensor 1 voltage parameter is greater than 4.8 V.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
6. Install a 3 A fused jumper wire between the APP sensor 2 signal circuit terminal B and the 5-volt reference circuit terminal F. Verify the APP sensor 2 voltage parameter is greater than 4.8 V.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
7. If all circuits/connections test normal, test or replace the B107 Accelerator Pedal Position Sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accelerator Pedal Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P219A OR P219B

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P219A

Fuel Trim Cylinder Balance Bank 1

DTC P219B

Fuel Trim Cylinder Balance Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The Fuel Trim Cylinder Balance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance in each bank. The diagnostic monitors the pre-catalyst heated oxygen sensor (HO2S) signal's frequency and amplitude characteristics by calculating an accumulated voltage over a predetermined sample period. An imbalance is indicated when multiple samples of the accumulated voltage are consistently higher than the

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desired value.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0030, P0036, P0050, P0053, P0059, P0101, P0102, P0103, P0106, P0107, P0108, P0117, P0118, P0128, P0131, P0132, P0133, P0134, P0135, P0151, P0152, P0153, P0154, P0155, P0201-P0206, P0300, P0301-P0306, P0411, P0412, P0418, P0442, P0443, P0446, P0449, P0452, P0453, P0454, P0455, P0496, P1133, P1153, P1516, P2101, P2119, P2120, P2125, P2135, P2138, P2176, P2431, P2432, P2433, P2440, P2A00, P2A03 are not set.
- The device control is not active.
- The intrusive diagnostics are not active.
- The engine overspeed protection is not active.
- The power take-off (PTO) is not active.
- The traction control is not active.
- The fuel control is in air-fuel Closed Loop.
- The system voltage is more than 10V, or less than 18V.
- The engine run time is greater than 120 seconds.
- The engine coolant temperature (ECT) is warmer than -20°C (-4°F).
- The engine speed is greater than 425 RPM, but less than 2,500 RPM.
- The mass air flow is greater than 15 g/s, but less than 65 g/s.
- The ethanol content is less than 87 percent.

CONDITIONS FOR SETTING THE DTC

Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

ACTION TAKEN WHEN THE DTC SETS

DTCs P219A and P219B are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P219A and P219B are Type B DTCs.

DIAGNOSTIC AIDS

- The fuel trim cylinder balance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may set a false DTC.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.

REFERENCE INFORMATION

Schematic Reference

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Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Troubleshooting with a Test Lamp**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Read and record the Freeze Frame/Failure Records data taking note of the speed and load at which the DTC set.
2. Diagnose any other DTCs that are set. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. With the engine idling and the transmission in the Park or Neutral position, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor parameter should be between 19-42 kPa.
    - If the MAP sensor parameter is not between 19-42 kPa, refer to **DTC P0106** or **DTC P0107 or P0108** .
4. Inspect the air induction system for modified, damaged, leaking, or restricted components.
5. Inspect the crankcase ventilation system for improper operation.
6. Inspect the vacuum hoses for splits, kinks, and improper connections.
7. Inspect for vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
8. Test for a restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to **Symptoms - Engine Exhaust** .
9. Test the fuel injectors for improper operation. Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)** .
10. Test for fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
11. Test for excessive fuel in the crankcase due to leaking injectors.
12. Test the ignition system for improper operation. Refer to **Electronic Ignition System Diagnosis** .
13. Test the engine for any mechanical conditions such as sticking valves, lifters, etc., which could alter the

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flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure. Verify the repair under the same speed and load as noted in the Freeze Frame/Failure Records data recorded during testing.

DTC P2270 OR P2272

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2270

HO2S Signal Stuck Lean Bank 1 Sensor 2

DTC P2272

HO2S Signal Stuck Lean Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S Signal	P0131, P0132, P0137, P0140, P0151, P0152, P0157, P0158, P1133	P0131, P0132, P0133, P0134, P0137, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0133, P0134, P013A, P013B, P013E, P013F, P0140, P0153, P0154, P0160, P1133, P1153, P2270, P2271
HO2S Low Reference	-	P0131, P0132, P0133, P0134, P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160,	P0131, P0132, P0133, P0134, P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160,	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	-

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		P1133	P1133, P1153		

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Reference	455 mV	Approximately 450 mV	Approximately 445 mV

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition 1 voltage is between 10-18 volts.
- The engine run time is greater than 5 minutes.
- The engine speed is between 1,100-2,500 RPM.
- The mass air flow (MAF) is between 3-20 g/s.
- The vehicle speed is between 50-120 km/h (31-75 mph).
- The fuel level is greater than 10 percent.
- The fuel system is in Closed Loop.
- The catalytic converter temperature is between 550-900°C (1,022-1,652°F).
- The DTCs run once per ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P2270

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The ECM does not detect a HO2S voltage greater than 805 mV before accumulated mass air flow exceeds 550 grams.

P2272

The ECM does not detect a HO2S voltage greater than 775 mV before the accumulated mass air flow exceeds 82 grams.

ACTION TAKEN WHEN THE DTC SETS

DTCs P2270 and P2272 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P2270 and P2272 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify that no B52 HO2S heater DTCs are set.

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- If any B52 HO2S heater DTCs are set, perform those diagnostics first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

2. Engine idling, move the appropriate B52 HO2S 2 harness connector and the engine control module (ECM) harness connector while monitoring the B52 HO2S 2 voltage parameter with a scan tool. Verify that the B52 HO2S parameter does not change abruptly while moving the related harnesses.
   - If the B52 HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.
3. Engine idling at operating temperature, observe the appropriate B52 HO2S 2 parameter with a scan tool. Verify the following:
   - The B52 HO2S 1 value should vary from below 200 mV to above 800 mV and respond to fueling changes.
   - The B52 HO2S 2 should fluctuate at less than 380 mV or greater than 520 mV. The values should not remain within 380 mV and 520 mV.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal A and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the appropriate scan tool B52 HO2S parameter is approximately 450 mV.
   - If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
   - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool HO2S parameter is less than 60 mV.
   - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuits test normal, replace the ECM.
5. Verify none of the following conditions exist:
   - Lean fuel injectors-Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)**
   - Water intrusion in the B52 HO2S harness connector
   - Low fuel system pressure-Refer to **Fuel System Diagnosis**
   - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)**

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- Exhaust leaks near the B52 HO2S
- Engine vacuum leaks
- Contaminated B52 HO2S - Silicon
- An engine mechanical condition- **Symptoms - Engine Mechanical**
  - If you find any of the above conditions, repair as necessary.

6. If all circuits test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P2271 OR P2273

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2271

HO2S Signal Stuck Rich Bank 1 Sensor 2

DTC P2273

HO2S Signal Stuck Rich Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
	P0131, P0132,	P0131, P0132, P0133, P0134, P0137, P013C,	P0131, P0132, P0133, P0134, P0137, P013C,	P0132, P0134,	P0133, P0134, P013C, P013D,

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HO2S High Signal	P0137, P0140, P0151, P0152, P0157, P0158, P1133	P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0140, P014A, P014B, P0153, P0154, P0160, P1133, P1153, P2272, P2273
HO2S Low Signal	-	P0131, P0132, P0133, P0134, P0138, P013C, P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0158, P0160, P1133	P0131, P0132, P0133, P0134, P0138, P013C, P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	-

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Signal	455 mV	Approximately 450 mV	Approximately 445 mV

CIRCUIT/SYSTEM DESCRIPTION

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. Heating elements inside the HO2S minimize the time required for the sensors to reach operating temperature. The control module supplies the HO2S with a reference, or bias, voltage of about 450 mV. When the engine is first started, the control module operates in Open Loop, ignoring the HO2S voltage signal. Once the HO2S reaches operating temperature and Closed Loop is achieved, the HO2S generates a voltage within a range of 0-1,000 mV that fluctuates above and below bias voltage. High HO2S voltage indicates a rich exhaust stream. Low HO2S voltage indicates a lean exhaust stream.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P2271, or P2273 failed, DTCs P013A, P013C, P013E, P014A, P2270, and P2272 must run and pass.
- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition 1 voltage is between 10-18 volts.
- The engine speed is between 500-5,000 RPM.

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- The mass air flow (MAF) is between 3-50 g/s.
- The vehicle speed is between 24-132 km/h (15-82 mph).
- The fuel level is greater than 10 percent.
- The fuel system is in Closed Loop.
- The engine run time is equal to or more than 5 minutes.
- The accelerator pedal position (APP) is steady.
- The torque converter clutch is TCC is applied.
- The DTCs run once per ignition cycle, during decel fuel cut-off, when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P2271

The ECM does not detect an HO2S voltage less than 150 mV before accumulated mass air flow exceeds 550 grams.

P2273

The ECM does not detect an HO2S voltage less than 100 mV before the accumulated mass air flow exceeds 76 grams.

ACTION TAKEN WHEN THE DTC SETS

DTCs P2271 or P2273 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P2271 or P2273 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

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- **Heated Oxygen Sensor Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify that no B52 HO2S heater DTCs are set.
    - If any B52 HO2S heater DTCs are set, perform those diagnostics first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling, move the appropriate B52 HO2S 2 harness connector and the engine control module (ECM) harness connector while monitoring the B52 HO2S 2 voltage parameter with a scan tool. Verify that the B52 HO2S parameter does not change abruptly while moving the related harnesses.
    - If the B52 HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.
3. Engine idling at operating temperature, observe the appropriate B52 HO2S 2 parameter with a scan tool. Verify the following:
    - The B52 HO2S 1 value should vary from below 200 mV to above 800 mV and respond to fueling changes.
    - The B52 HO2S 2 should fluctuate at less than 380 mV or greater than 520 mV. The values should not remain within 380 mV and 520 mV.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal A and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the appropriate scan tool B52 HO2S parameter is approximately 450 mV.
    - If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests

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normal, replace the K20 ECM.

4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool B52 HO2S parameter is less than 60 mV.
   - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuits test normal, replace the K20 ECM.
5. Verify none of the following conditions exist:
   - Rich fuel injectors-Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)**
   - Water intrusion in the B52 HO2S harness connector
   - High fuel system pressure-Refer to **Fuel System Diagnosis**
   - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)**
   - Fuel saturation of the evaporative emission (EVAP) canister
   - If you find any of the above conditions, repair as necessary.
6. If all circuits test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P2534

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P2534

Ignition 1 Switch Circuit Low Voltage

DIAGNOSTIC FAULT INFORMATION

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Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
IGN Voltage	P2534	P2534	-	-

CIRCUIT/SYSTEM DESCRIPTION

The fuel pump control module monitors the ignition voltage circuit in order to determine if the voltage is within the normal operating range.

CONDITIONS FOR RUNNING THE DTC

The engine is running.

CONDITIONS FOR SETTING THE DTC

The FPCM detects that the IGN voltage is less than 6.0 V.

ACTION TAKEN WHEN THE DTC SETS

DTC P2534 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P2534 is a Type A DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify that DTC P0562 is not set.
   - If DTC P0562 is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the harness connector of the K27 fuel pump control module.
3. Ignition ON, test for greater than 11 V between the IGN voltage circuit terminal 21 and ground.
   - If less than the specified voltage, test the IGN voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the MAF/CCC fuse is open, test the voltage circuit for a short to ground. If the circuit tests normal, test or replace the Run/Crank relay.
4. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P2544

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for a overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2544

Transmission Torque Request Circuit

DTC P2544

Transmission Torque Request Signal Message Counter Incorrect

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CIRCUIT/SYSTEM DESCRIPTION

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with information regarding it's request for modifying engine speed or torque. The serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

CONDITIONS FOR RUNNING THE DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

CONDITIONS FOR CLEARING THE DTC

DTC P2544 is a Type B DTC.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

CIRCUIT/SYSTEM VERIFICATION

1. DTC P2544 is an informational DTC. Diagnose all other engine control DTCs prior to DTC P2544. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If there are no other engine controls DTCs, diagnosis is accomplished by looking for an intermittent CAN circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

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Control Module References for TCM replacement, setup, and programming.

DTC P2548

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P2548

Vehicle Dynamics System Torque Request Signal Message Counter Incorrect

CIRCUIT/SYSTEM DESCRIPTION

The electronic brake control module (EBCM) and the engine control module (ECM) simultaneously control the vehicle performance launch. During a performance launch the EBCM sends a serial data message to the ECM requesting torque reduction. If the ECM receives corrupt data from the EBCM, DTC P2548 will set in the ECM. The ECM then sends a serial data message to the EBCM that torque reduction is not allowed.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- Ignition voltage is greater than 8 V.

CONDITIONS FOR SETTING THE DTC

The ECM detects a corrupted data message from the EBCM.

ACTION TAKEN WHEN THE DTC SETS

- DTC P2548 is a Type B DTC.
- The EBCM disables the TCS for the duration of the ignition cycle.
- The Traction Off indicator turns ON.
- The DIC displays the Service Traction Control message.
- The ABS remains functional.

CONDITIONS FOR CLEARING THE DTC

DTC P2548 is a Type B DTC.

REFERENCE INFORMATION

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Schematic Reference

- **Engine Controls Schematics**
- **Antilock Brake System Schematics**

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Checking Aftermarket Accessories**
- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Testing for Electrical Intermittents**
- **GMLAN Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for Scan Tool Information

CIRCUIT/SYSTEM VERIFICATION

1. Verify there are no communication DTCs set.
   - If any DTC of this type is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

Inspect the serial data circuits and connections at the ECM and the EBCM. They should be free from sources of electromagnetic interference and the connections should be clean and tight.

- If a condition is found with the serial data circuits or connections, refer to **Symptoms - Data**

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Communications .

- If no condition is found with the serial data circuits or connections, replace the EBCM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup, and programming

DTC P2635

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P2635

Fuel Pump Flow Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump High Control	P0231	P023F	P0232	P023F, P2635
Fuel Pump Low Control	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The system voltage is greater than 11 V.
- The engine has been running for more than 30 seconds.

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- Low fuel level warning not present.

CONDITIONS FOR SETTING THE DTC

This DTC sets when the fuel pump control module detects a predetermined fuel pressure performance degradation between the desired fuel rail pressure and the current fuel rail pressure.

ACTION TAKEN WHEN THE DTC SETS

DTC P2635 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P2635 is a Type B DTC.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify that DTCs P018C, P018D, P0231, P0232, or P023F are not set.
    - If the DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
3. Ignition OFF, test for less than 5.0 ohms between the G12 fuel pump low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the G12 fuel pump low reference circuit for a high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, install a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. Perform the **Fuel System Diagnosis** to verify proper fuel pressure.
    - If the fuel pressure is not normal, replace the G12 fuel pump.
7. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Tank Fuel Pump Module Replacement - Right Side**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P3400

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P3400

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Cylinder Deactivation System Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102, P069E, P3401, P3425, P3441, P3449	P3400, P3401, P3425, P3441, P3449	-	P3400
Cylinder 1 Deactivation Solenoid Control Circuit 1	P0300, P3401	P0300, P3400, P3401	P0300, P3401	P3400
Cylinder 4 Deactivation Solenoid Control Circuit 2	P0300, P3425	P0300, P3400, P3425	P0300, P3425	P3400
Cylinder 6 Deactivation Solenoid Control Circuit 3	P0300, P3441	P0300, P3400, P3441	P0300, P3441	P3400
Cylinder 7 Deactivation Solenoid Control Circuit 4	P0300, P3449	P0300, P3400, P3449	P0300, P3449	P3400

CIRCUIT/SYSTEM DESCRIPTION

The cylinder deactivation system is used to deactivate 4 cylinders of the engine under light load driving conditions. The engine control module (ECM) commands the cylinder deactivation solenoids ON to deactivate engine cylinders 1, 7, 6, and 4, switching to 4 cylinders or V4 mode. The cylinder deactivation solenoids controls the oil flow to the appropriate valve lifters. The engine operates on 8 cylinders or V8 mode, during engine starting, engine idling, and medium to heavy throttle conditions.

Ignition voltage is supplied directly to the 4 cylinder deactivation solenoids. The engine control module (ECM) controls the 4 cylinder deactivation solenoids by grounding the control circuit with a solid state device called a driver.

The Cylinder Deactivation System Performance diagnostic is a test of the internal mechanical condition of the engine, during operation in V4 mode. The engine control module (ECM) determines the internal mechanical condition of the engine through the actual measured values of the mass airflow (MAF) sensor, the intake manifold absolute pressure (MAP) sensor, and the throttle position sensor. The actual measured values of the 3 sensors are then compared to the calculated values for V4 mode, stored in the ECM. If the measured values are incorrect for V4 mode, the ECM will set DTC P3400, and will return to V8 mode operation.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, P0336, P0340, P0341, P0502, P0503, P0521, P0522, P0523, P0556, P0557, P0558, P0685, P0686, P0687, P0689, P0690 P3401, P3425, P3441, or P3449 are not set.
- The engine speed is between 450-5,800 RPM.
- The ECT Sensor parameter is between 70-125°C (158-257°F).
- The IAT Sensor parameter is between -20 to +125°C (-4 to +257°F).
- The engine is not in reduced power.

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- DTC P3400 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the actual measured values from the MAF sensor, MAP sensor, and throttle position sensor, are not within the range of the calculated values for V4 mode.

ACTION TAKEN WHEN THE DTC SETS

- DTC P3400 is a Type B DTC.
- The engine will return to V8 mode.

CONDITIONS FOR CLEARING THE DTC

DTC P3400 is a Type B DTC.

DIAGNOSTIC AIDS

- This DTC will not set during engine idling conditions. The vehicle will need to be driven for the DTC to set.
- The valve lifter oil manifold solenoids are assigned to the following engine cylinders:
  - Solenoid #1 = Cylinder #1
  - Solenoid #2 = Cylinder #4
  - Solenoid #3 = Cylinder #6
  - Solenoid #4 = Cylinder #7

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EN-46999 Displacement On Demand Tester

For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

NOTE: The engine oil level and the oil pressure are critical to the correct operation of the Cylinder Deactivation System. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic. Refer to Oil Pressure Diagnosis and Testing . Inspect the Valve Lifter Oil Filter for a restriction or blockage. Refer to Valve Lifter Oil Filter Replacement .

1. Ignition ON, observe the scan tool DTC information. Verify that DTC P0201-P0208, P0351-P0358, P3401, P3425, P3441, or P3449 is not set.
   - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Engine idling at the normal operating temperature. Verify there is no abnormal engine noise.
   - If there is an abnormal engine noise, refer to **Symptoms - Engine Mechanical** for further diagnosis.
3. Perform the **Cylinder Deactivation (Active Fuel Management) System Compression Test** . The Cylinder Deactivation System should pass the compression test.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, remove the Q43 valve lifter oil manifold assembly ignition fuse from the underhood fuse block.

NOTE: Probe each terminal at the underhood fuse block with a test lamp connected to ground to determine what terminal to connect the DMM. The test lamp should not illuminate on the circuit that needs to be tested.

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2. Connect a DMM between the ignition circuit fuse terminal going to the Q43 valve lifter oil manifold assembly and the ECM housing.
3. Ignition ON, command each Cylinder 1, 4, 6, and 7 Deactivation solenoid ON and OFF with the scan tool. Verify the resistance of each solenoid is between 11-18 ohms with the solenoid commanded ON.
    - If greater than the specified range for all cylinder deactivation solenoids, test the ignition circuit for an open/high resistance.
    - If greater than the specified range for one or more but not all cylinder deactivation solenoids, test both the control circuit and ignition circuit for an open/high resistance or an open/high resistance in the cylinder deactivation solenoid. If the circuits and solenoid test normal replace the K20 ECM.
4. If all circuits and components test normal, refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing** for further mechanical diagnosis of Q43 valve lifter oil manifold assembly.

COMPONENT TESTING

Static Test

1. Ignition OFF, disconnect the harness connector at the Q43 valve lifter oil manifold assembly.
2. Connect the harness that is labeled resistance from the displacement on demand (DOD) tester to the Q43 valve lifter oil manifold connector.
3. Connect the power leads from the DOD tester to B+ and ground. Test for 11-18 ohms on each Q43 valve lifter oil manifold solenoid.
    - If not within the specified range for each solenoid, replace the Q43 valve lifter oil manifold assembly.
4. Test for infinite resistance between each Q43 valve lifter oil manifold circuit terminal listed and the Q43 valve lifter oil manifold housing.
    - If less than infinite resistance, replace the Q43 valve lifter oil manifold assembly.

Dynamic Test

1. Ignition OFF, disconnect the harness connector at the Q43 valve lifter oil manifold assembly.
2. Connect the cable that is labeled power from the displacement on demand DOD tester to the connector.
3. Connect the power leads from the DOD tester to B+ and ground.
4. Command each valve lifter oil manifold solenoid ON and OFF using the DOD tester. You should be able to hear each solenoid turn ON and OFF.
    - If the function does not perform as specified, replace the valve lifter oil manifold assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Valve Lifter Oil Manifold Replacement**
- **Control Module References** for ECM replacement, setup, and programming

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DTC P3401, P3425, P3441, OR P3449

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P3401

Cylinder 1 Deactivation Solenoid Control Circuit

DTC P3425

Cylinder 4 Deactivation Solenoid Control Circuit

DTC P3441

Cylinder 6 Deactivation Solenoid Control Circuit

DTC P3449

Cylinder 7 Deactivation Solenoid Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102, P069E, P3401, P3425, P3441, P3449	P3400, P3401, P3425, P3441, P3449	-	P3400
Cylinder 1 Deactivation Solenoid Control Circuit 1	P0300, P3401	P0300, P3400, P3401	P0300, P3401	P3400
Cylinder 4 Deactivation Solenoid Control Circuit 2	P0300, P3425	P0300, P3400, P3425	P0300, P3425	P3400
Cylinder 6 Deactivation Solenoid Control Circuit 3	P0300, P3441	P0300, P3400, P3441	P0300, P3441	P3400
Cylinder 7 Deactivation Solenoid Control Circuit 4	P0300, P3449	P0300, P3400, P3449	P0300, P3449	P3400

TYPICAL SCAN TOOL DATA

Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open, Low and High Voltage Test

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Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage Test • Component ON - Not Run for Open/Low Voltage Test and OK for High Voltage Test			
Ignition Voltage	Malfunction	Malfunction	-
Cylinder 1, 4, 6, or 7 Deactivation Solenoid Control	Malfunction	Malfunction	Not Run

Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open, Low and High Voltage Test
Status - Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage Test • Component ON - Not Run for Open/Low Voltage Test and OK for High Voltage Test			
Ignition Voltage	Not Run	Not Run	-
Cylinder 1, 4, 6, or 7 Deactivation Solenoid Control	Not Run	Not Run	Malfunction

CIRCUIT/SYSTEM DESCRIPTION

The cylinder deactivation system is used to deactivate 4 cylinders of the engine under light load driving conditions. The engine control module (ECM) commands the cylinder deactivation solenoids ON to deactivate engine cylinders 1, 7, 6, and 4, switching to 4 cylinders or V4 mode. The cylinder deactivation solenoids controls the oil flow to the appropriate valve lifters. The engine operates on 8 cylinders or V8 mode, during engine starting, engine idling, and medium to heavy throttle conditions.

Ignition voltage is supplied directly to the 4 cylinder deactivation solenoids. The engine control module (ECM) controls the 4 cylinder deactivation solenoids by grounding the control circuit with a solid state device called a driver.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 400 RPM.
- The ignition voltage is between 11-18 V.
- DTCs P3401, P3425, P3441, and P3449 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

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The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P3401, P3425, P3441, and P3449 are Type B DTCs.
- The engine will return to V8 mode.
- The ECM disables the fuel injector for the cylinder that set a cylinder deactivation DTC, resulting in an engine misfire.

CONDITIONS FOR CLEARING THE DTC

DTC P3401, P3425, P3441, and P3449 are Type B DTCs.

DIAGNOSTIC AIDS

The valve lifter oil manifold solenoids are assigned to the following engine cylinders:

- Solenoid #1 = Cylinder #1
- Solenoid #2 = Cylinder #4
- Solenoid #3 = Cylinder #6
- Solenoid #4 = Cylinder #7

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EN-46999 Displacement On Demand Tester

For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

NOTE: DTC P3401, P3425, P3441, and P3449 sets with an open ignition circuit fuse.

1. Ignition ON, command the appropriate cylinder deactivation solenoid ON and OFF while observing the following status parameters with a scan tool:
   - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open Test Status
   - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Low Voltage Test Status
   - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit High Voltage Test Status

   Each parameter should display OK or Not Run
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, remove the intake manifold. Refer to **Intake Manifold Replacement** .
2. Disconnect the harness connector at the Q43 valve lifter oil manifold assembly.
3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal E and ground.
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
4. Verify that a test lamp does not illuminate between the ignition circuit terminal E and the appropriate cylinder deactivation solenoid control circuit terminal listed below.
   - Cylinder deactivation solenoid valve 1 terminal C
   - Cylinder deactivation solenoid valve 2 terminal A
   - Cylinder deactivation solenoid valve 3 terminal B
   - Cylinder deactivation solenoid valve 4 terminal D
   - If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal,

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replace the K20 ECM.

5. Remove the test lamp.
6. Command the appropriate cylinder deactivation solenoid ON with a scan tool. Verify the scan tool Cylinder Deactivation Solenoid Valve Control Circuit High Voltage Test Status parameter displays OK.
    - If not the specified value, test the appropriate control circuit listed below for a short to voltage. If the circuit tests normal, replace the K20 ECM.
    - Cylinder deactivation solenoid valve 1 terminal C
    - Cylinder deactivation solenoid valve 2 terminal A
    - Cylinder deactivation solenoid valve 3 terminal B
    - Cylinder deactivation solenoid valve 4 terminal D
7. Install a 3 A fused jumper wire between the appropriate control circuit terminal listed below and the ignition circuit terminal E. Command the appropriate cylinder deactivation solenoid ON with a scan tool. Verify the scan tool Cylinder Deactivation Solenoid Valve Control Circuit High Voltage Test Status parameter displays Malfunction.
    - Cylinder deactivation solenoid valve 1 terminal C
    - Cylinder deactivation solenoid valve 2 terminal A
    - Cylinder deactivation solenoid valve 3 terminal B
    - Cylinder deactivation solenoid valve 4 terminal D
    - If not the specified value, test the control circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
8. If all the circuits test normal, test or replace the Q43 valve lifter oil manifold assembly.

COMPONENT TESTING

Static Test

1. Ignition OFF, disconnect the harness connector at the Q43 valve lifter oil manifold assembly.
2. Connect the harness that is labeled resistance from the displacement on demand (DOD) tester to the Q43 valve lifter oil manifold connector.
3. Connect the power leads from the DOD tester to B+ and ground. Test for 11-18 ohms on each Q43 valve lifter oil manifold solenoid.
    - If not within the specified range for each solenoid, replace the Q43 valve lifter oil manifold assembly.
4. Test for infinite resistance between each Q43 valve lifter oil manifold circuit terminal listed and the Q43 valve lifter oil manifold housing.
    - If less than infinite resistance, replace the Q43 valve lifter oil manifold assembly.

Dynamic Test

1. Ignition OFF, disconnect the harness connector at the Q43 valve lifter oil manifold assembly.
2. Connect the cable that is labeled power from the displacement on demand DOD tester to the connector.
3. Connect the power leads from the DOD tester to B+ and ground.

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4. Command each valve lifter oil manifold solenoid ON and OFF using the DOD tester. You should be able to hear each solenoid turn ON and OFF.
    - If the function does not perform as specified, replace the valve lifter oil manifold assembly.

REPAIR PROCEDURES

- **Valve Lifter Oil Manifold Replacement**
- **Control Module References** for ECM replacement, setup, and programming

REPAIR VERIFICATION

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 s.
5. Engine running, command each cylinder deactivation solenoid ON and OFF with a scan tool, while observing the cylinder deactivation circuit status parameters. The circuit status parameters should change from OK to NOT Run or Not Run to OK.
    - If another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

REPAIR INSTRUCTIONS

ENGINE CONTROL MODULE REPLACEMENT

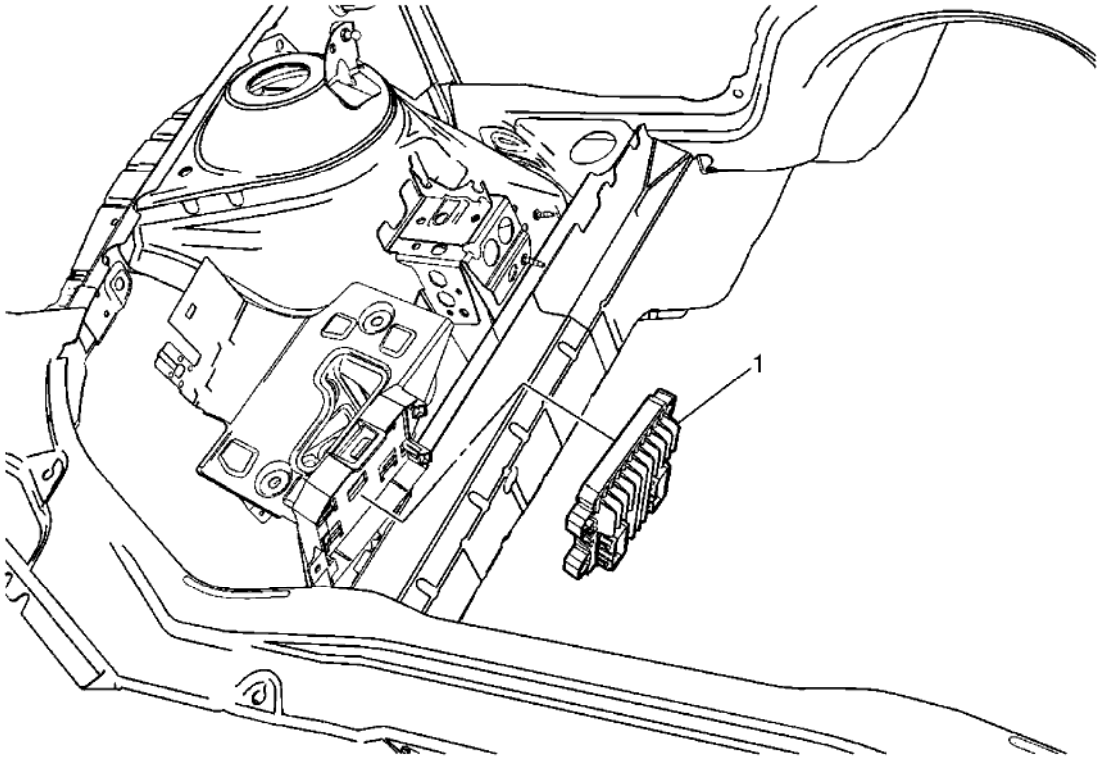


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .**	
	Electronic Control Module **WARNING:** **Refer to Safety Glasses Warning .** **CAUTION:** **Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.**

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1	**Procedure** 1. Record the current engine oil life percentage and the automatic transmission fluid life percentage and use a scan tool to update the NEW ECM, if replacing. 2. Disconnect the electrical connectors. 3. Release the retaining tabs. 4. If replacing, program the ECM. Refer to **Control Module References** .

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

NOTE: The Crankshaft Position System Variation Learn procedure is also required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- **An engine replacement**
- **A engine control module (ECM) replacement**
- **A crankshaft balancer replacement**
- **A crankshaft replacement**
- **A crankshaft position sensor replacement**
- **Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.**

NOTE: The ECM monitors certain component signals to determine if all the conditions are met to continue with the crankshaft position System Variation Learn Procedure.

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P0315, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
3. Select the Crankshaft Position System Variation Learn Procedure with a scan tool and perform the following:

IMPORTANT: Close the hood.

IMPORTANT: The engine must be at operating temperature.

1. Block drive wheels.
2. Set parking brake.
3. DO NOT apply brake pedal.
4. Cycle ignition from OFF to ON.
5. Apply and hold brake pedal for the duration of the procedure.

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6. Start and idle engine.
7. Turn the air conditioning (A/C) OFF.
8. The vehicle must remain in Park or Neutral.

NOTE: While the learn procedure is in progress, release the throttle immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

9. Accelerate to wide open throttle (WOT) and release when the fuel cut-off occurs.

4. The scan tool displays Test In Progress.
5. The scan tool displays Learn Successful.
6. Verify DTC P0315 ran and passed This Ignition Cycle.
   - If DTC P0315 failed or did not run This Ignition Cycle, or another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
7. Once the Learn Procedure has successfully completed, and in order to store the crankshaft position system variation values in the ECM, turn OFF the ignition and verify all vehicle systems are OFF. This may take up to 2 minutes.

THROTTLE/IDLE LEARN

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

A vehicle that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to learn out the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

Conditions for Running the Throttle Learn Procedure

With Scan Tool - Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

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Without Scan Tool - Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- The engine speed is between 450-4,000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition 1 voltage is greater than 10 V.

Throttle Learn

With Scan Tool - Reset Procedure

1. Ignition ON, engine OFF, with a scan tool, perform the Idle Learn Reset in Module Setup.
2. Start the engine, monitor the TB Idle Airflow Compensation parameter. The TB Idle Airflow Compensation value should equal 0% and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Without Scan Tool - Learn Procedure

NOTE: Do NOT perform this procedure if DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

1. Start and idle the engine in PARK for 3 min.
2. With a scan tool, monitor desired and actual RPM.
3. The ECM will start to learn the new idle cells and Desired RPM should start to decrease.
4. Ignition OFF for 60 s.
5. Start and idle the engine in PARK for 3 min.
6. After the 3 min run time the engine should be idling normal.

NOTE: During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.

   - If the engine idle speed has not been learned the vehicle will need to be driven at speeds above 70 km/h (44 mph) with several decelerations and extended idles.

7. After the drive cycle, the engine should be idling normally.
   - If the engine idle speed has not been learned, turn OFF the ignition for 60 s and repeat step 6.
8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

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ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

Removal Procedure

1. Turn OFF the ignition.

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Drain the engine coolant below the level of the engine coolant temperature (ECT) sensor. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .
4. Lower the vehicle.

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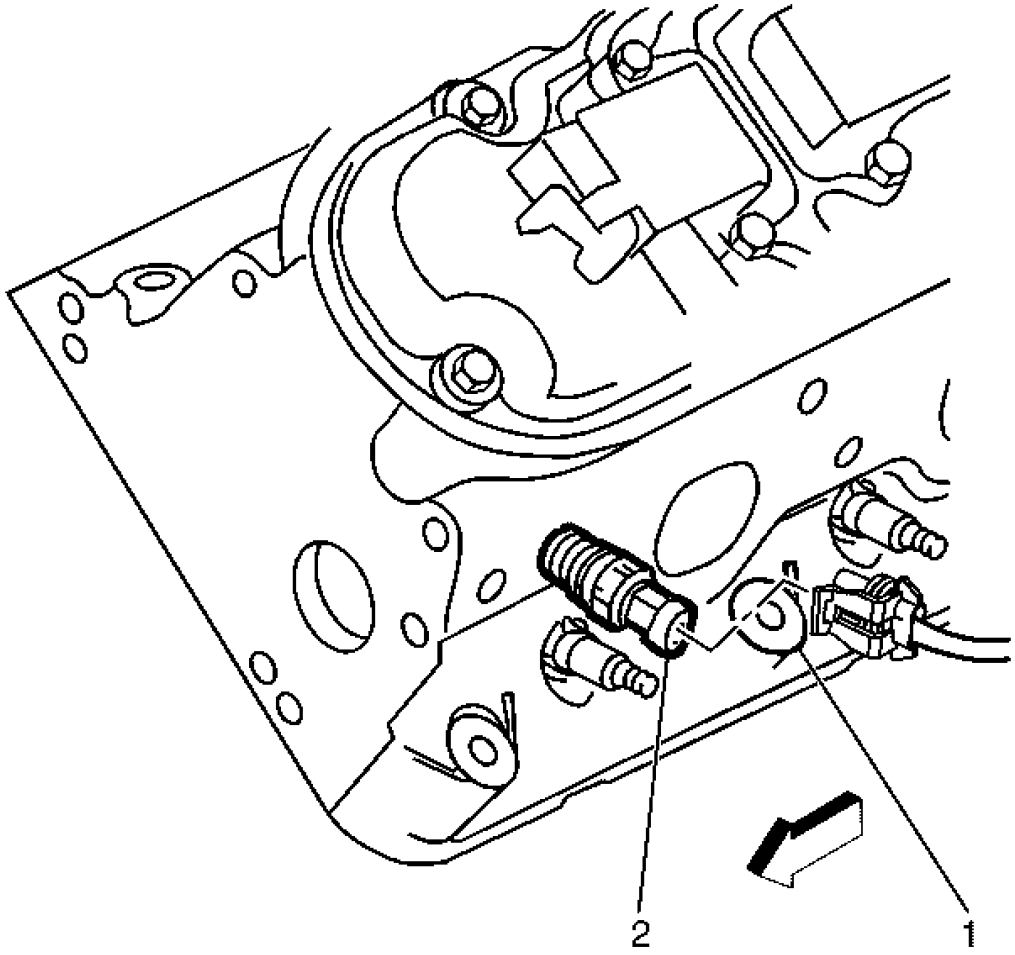


Fig. 2: Identifying ETC Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the ETC wiring harness connector (1) from the ECT sensor.

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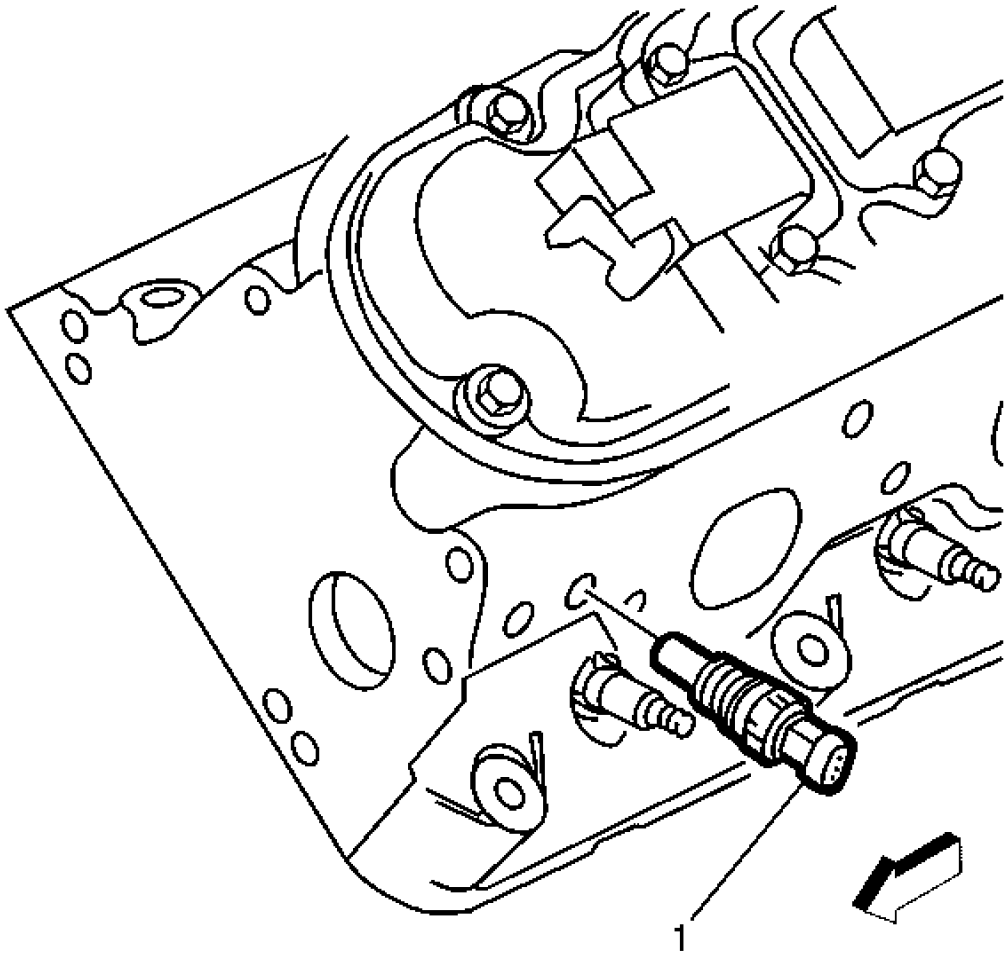


Fig. 3: Identifying ECT Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

6. Remove the ECT sensor (1) from the cylinder head.

Installation Procedure

CAUTION: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified

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in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.

CAUTION: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

1. Coat the ECT sensor threads with sealer or the equivalent.

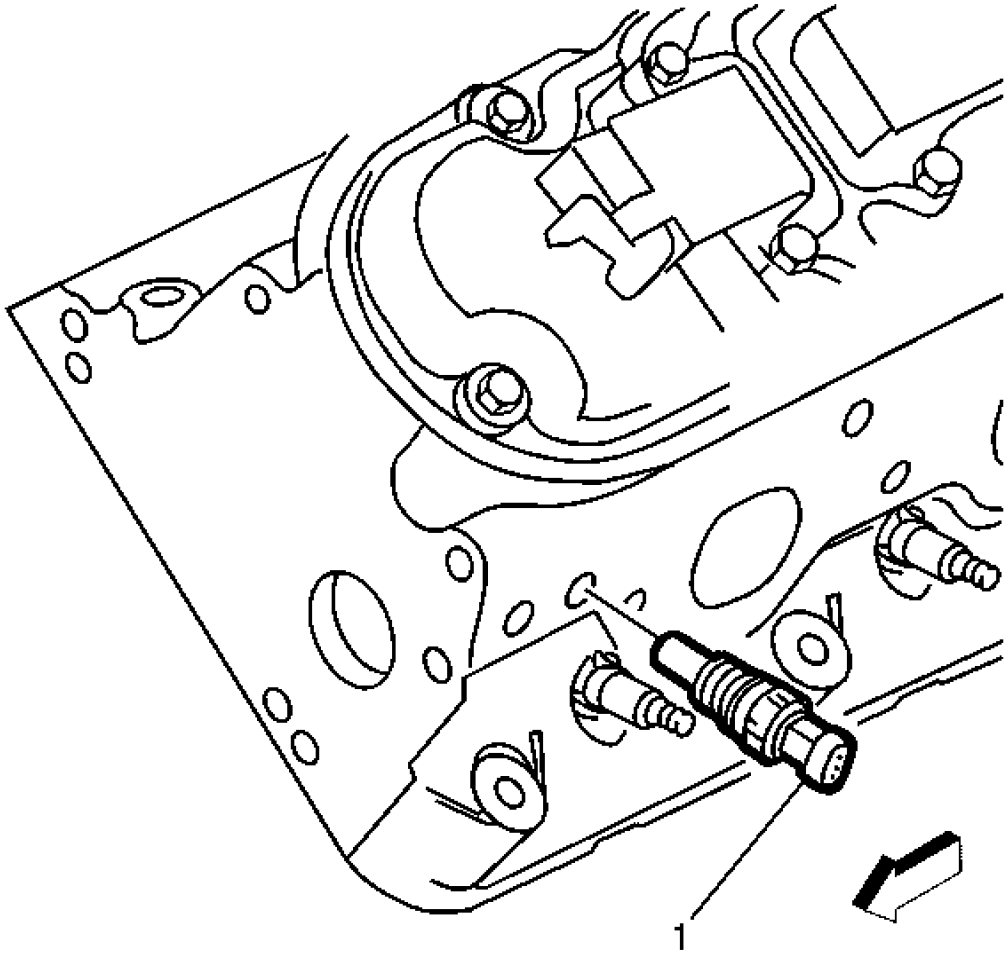


Fig. 4: Identifying ECT Sensor

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Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the ECT sensor (1) to the cylinder head and tighten to 20 N.m (15 lb ft).

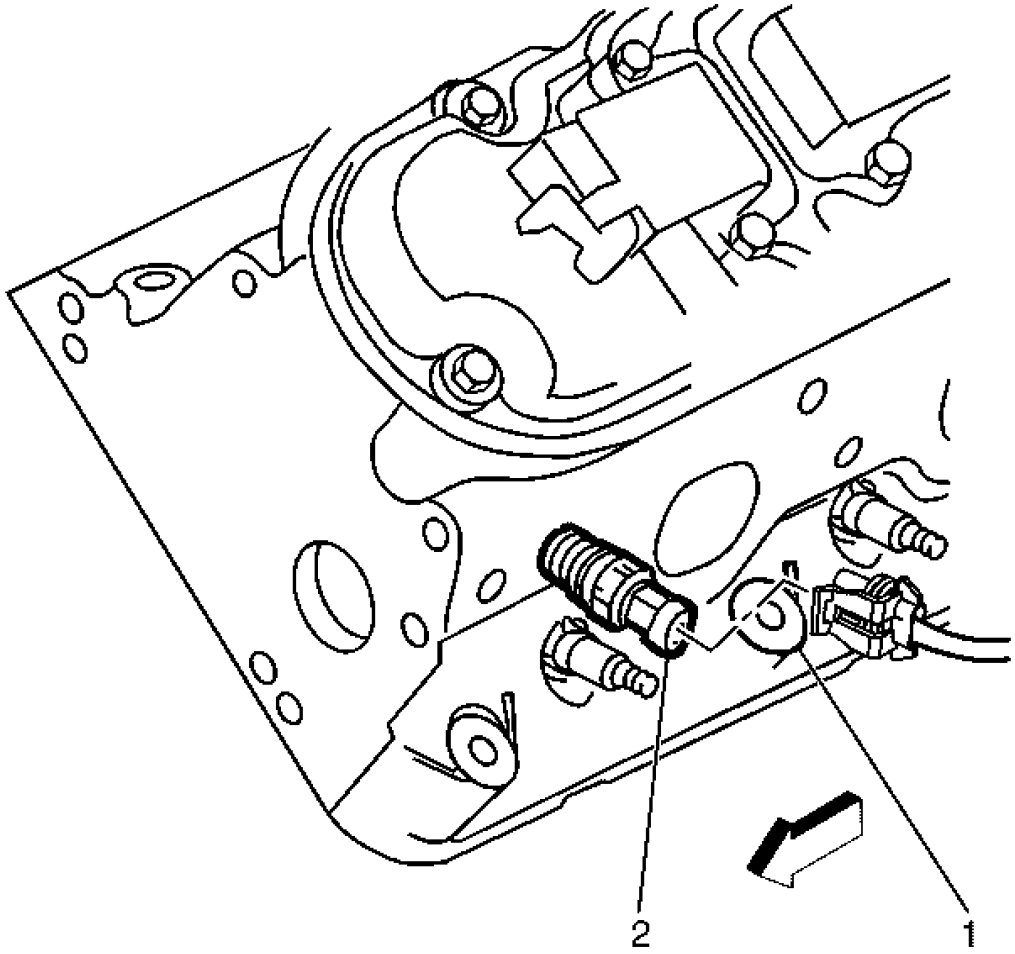


Fig. 5: Identifying ETC Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the ETC wiring harness connector (1) ECT sensor.
4. Refill the engine coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE**

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47716) .

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

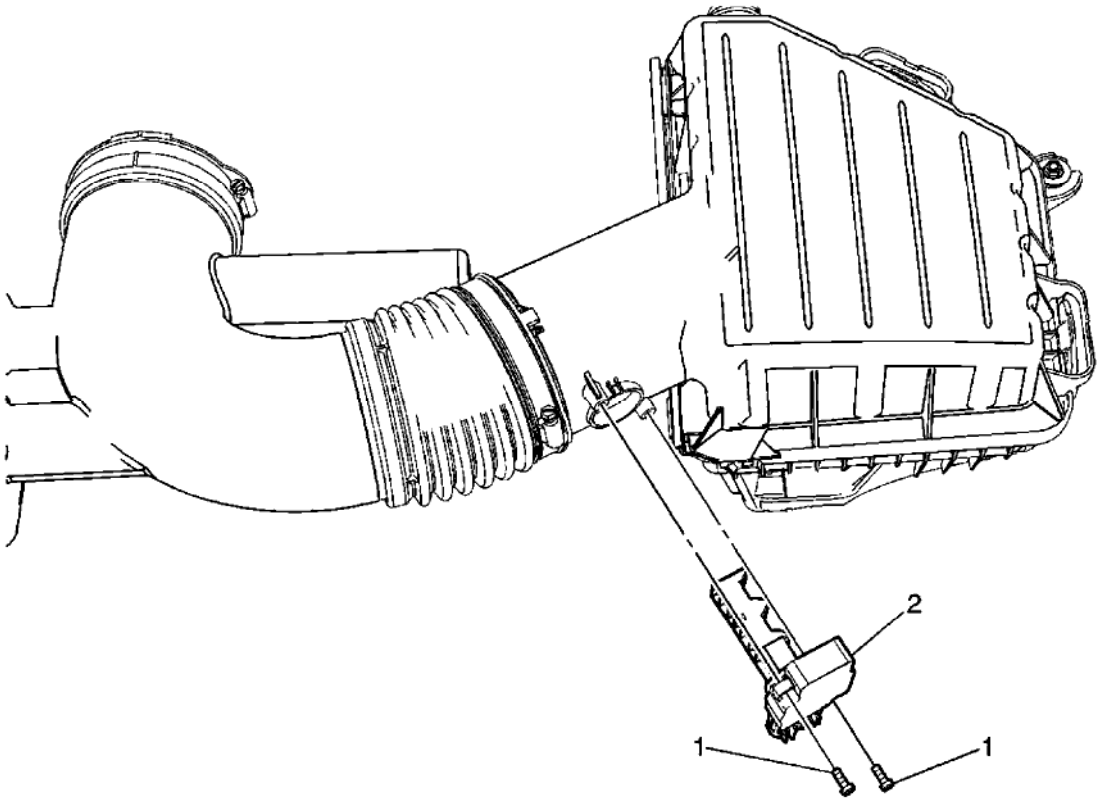


Fig. 6: Mass Airflow Sensor With Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Mass Airflow with Intake Air Temperature Sensor Fasteners (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** .6 N.m(5 lb in)
2	Mass Airflow with Intake Air Temperature Sensor **Procedure:** Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

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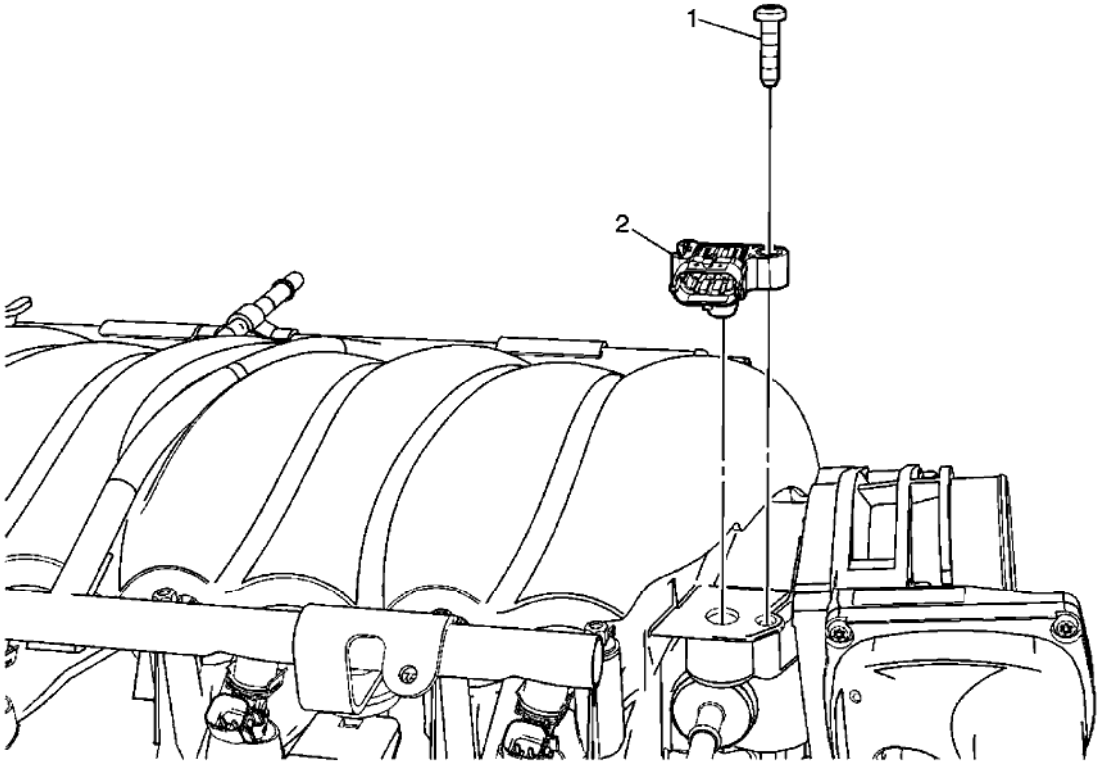


Fig. 7: Manifold Absolute Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the engine cover. Refer to Engine Cover Replacement .**	
1	Manifold Absolute Pressure Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 5 N.m(44 lb in)
2	Manifold Absolute Pressure Sensor **Procedure:** Disconnect the electrical connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

Removal Procedure

WARNING: Refer to Exhaust Service Warning .

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WARNING: Refer to Protective Goggles and Glove Warning .

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

CAUTION: Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

1. Ignition OFF.

WARNING: Refer to Battery Disconnect Warning .

2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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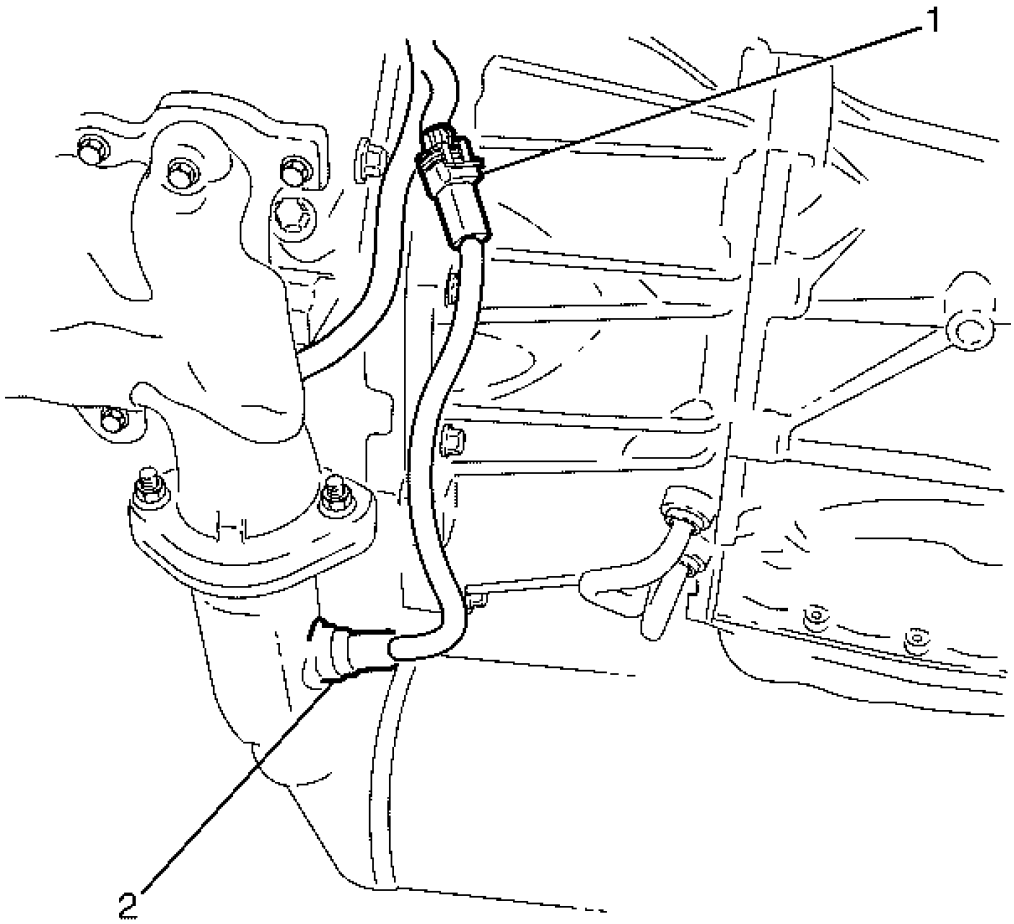


Fig. 8: Heated Oxygen Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

CAUTION: Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

5. Remove the HO2S (2) from the right catalytic converter.

Installation Procedure

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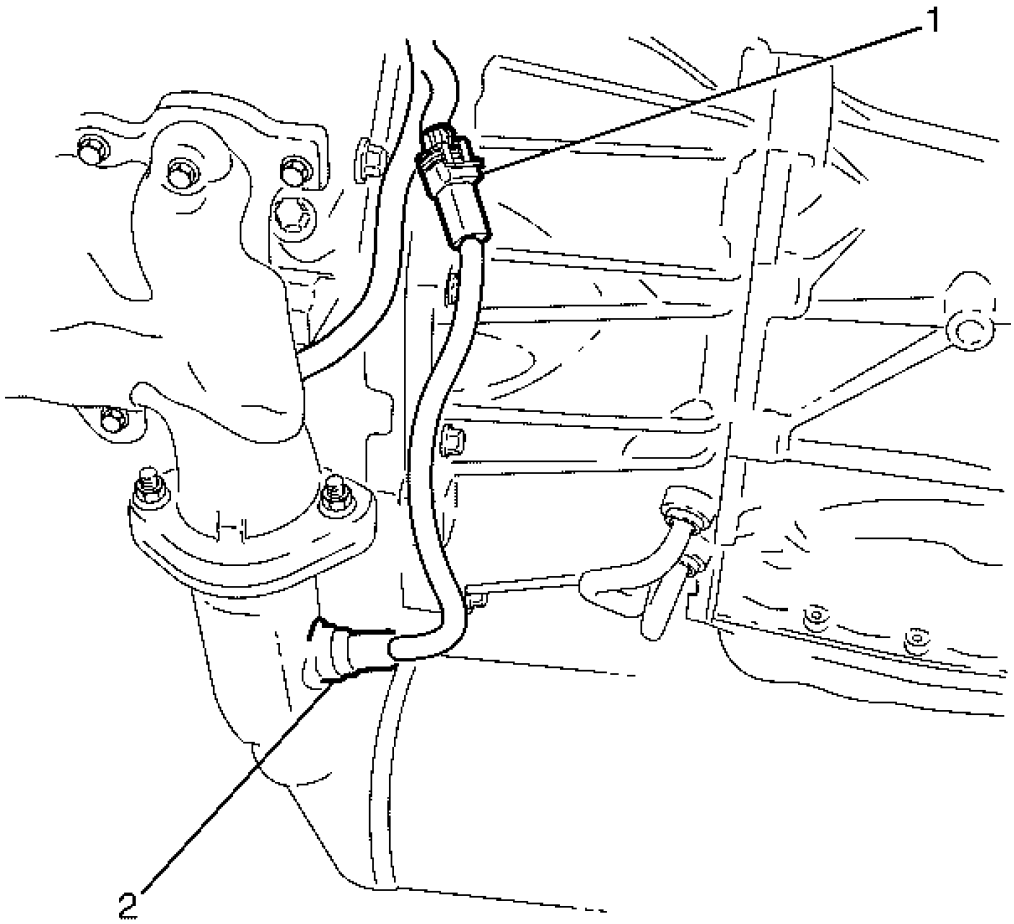


Fig. 9: Heated Oxygen Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

1. Install the HO2S (2) to the right catalytic converter and tighten to 42 N.m (31 lb ft).
2. Connect the HO2S electrical connector (1).
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

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Removal Procedure

WARNING: Refer to Exhaust Service Warning .

WARNING: Refer to Protective Goggles and Glove Warning .

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

CAUTION: Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

1. Ignition OFF.

WARNING: Refer to Battery Disconnect Warning .

2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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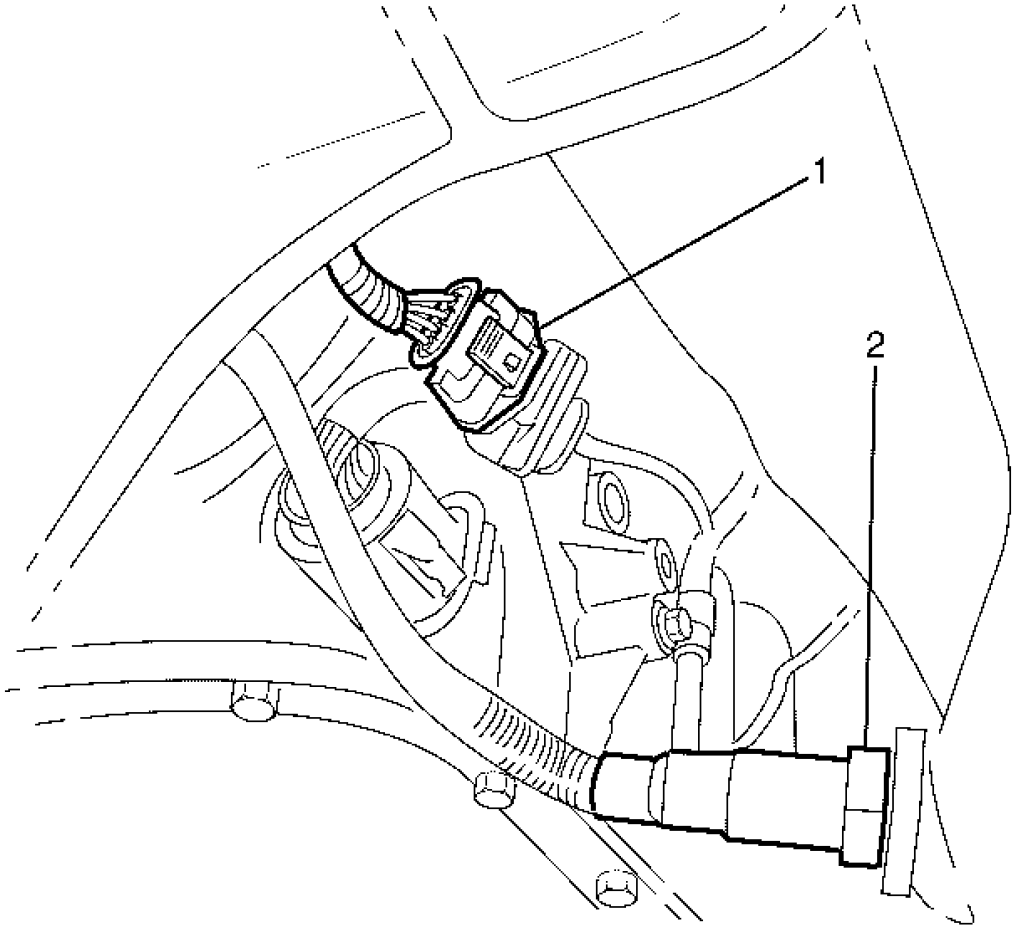


Fig. 10: Identifying Oxygen Sensor & Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

CAUTION: Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

5. Remove the HO2S (2) from the exhaust crossover pipe assembly.

Installation Procedure

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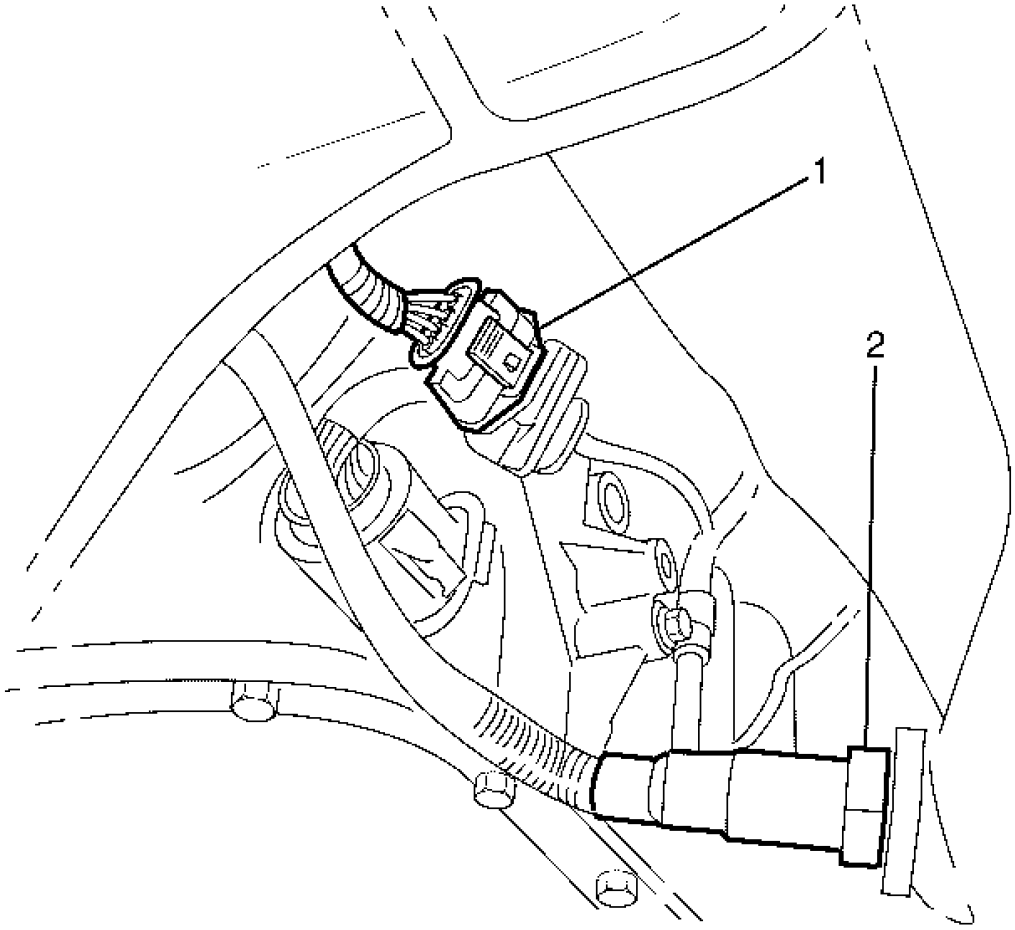


Fig. 11: Identifying Oxygen Sensor & Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

1. Install the HO2S (2) to the exhaust crossover pipe assembly and tighten to 42 N.m (31 lb ft).
2. Connect the HO2S electrical connector (1).
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

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Removal Procedure

WARNING: Refer to Exhaust Service Warning .

WARNING: Refer to Protective Goggles and Glove Warning .

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

CAUTION: Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

1. Ignition OFF.

WARNING: Refer to Battery Disconnect Warning .

2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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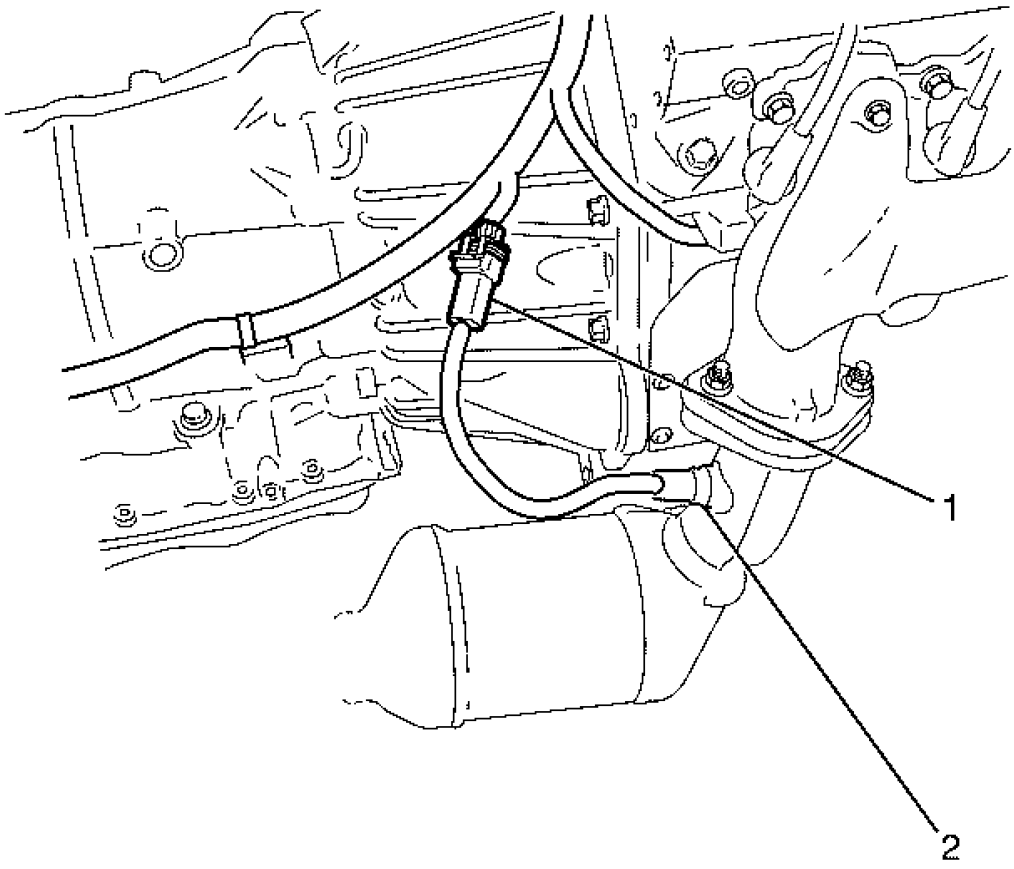


Fig. 12: Identifying Oxygen Sensor & Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

CAUTION: Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

5. Remove the HO2S (2) from the left catalytic converter.

Installation Procedure

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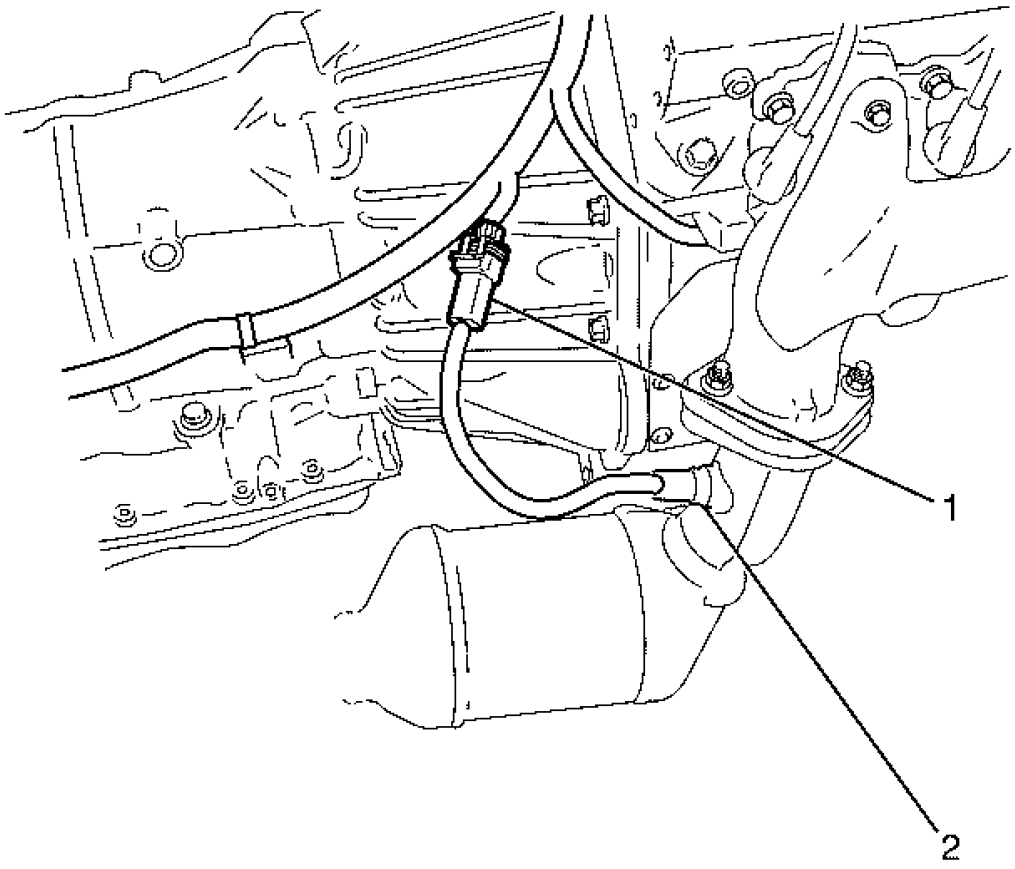


Fig. 13: Identifying Oxygen Sensor & Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

1. Install the HO2S (2) to the left catalytic converter and tighten to 42 N.m (31 lb ft).
2. Connect the HO2S electrical connector (1).
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

Removal Procedure

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WARNING: Refer to Exhaust Service Warning .

WARNING: Refer to Protective Goggles and Glove Warning .

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

CAUTION: Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

1. Ignition OFF.

WARNING: Refer to Battery Disconnect Warning .

2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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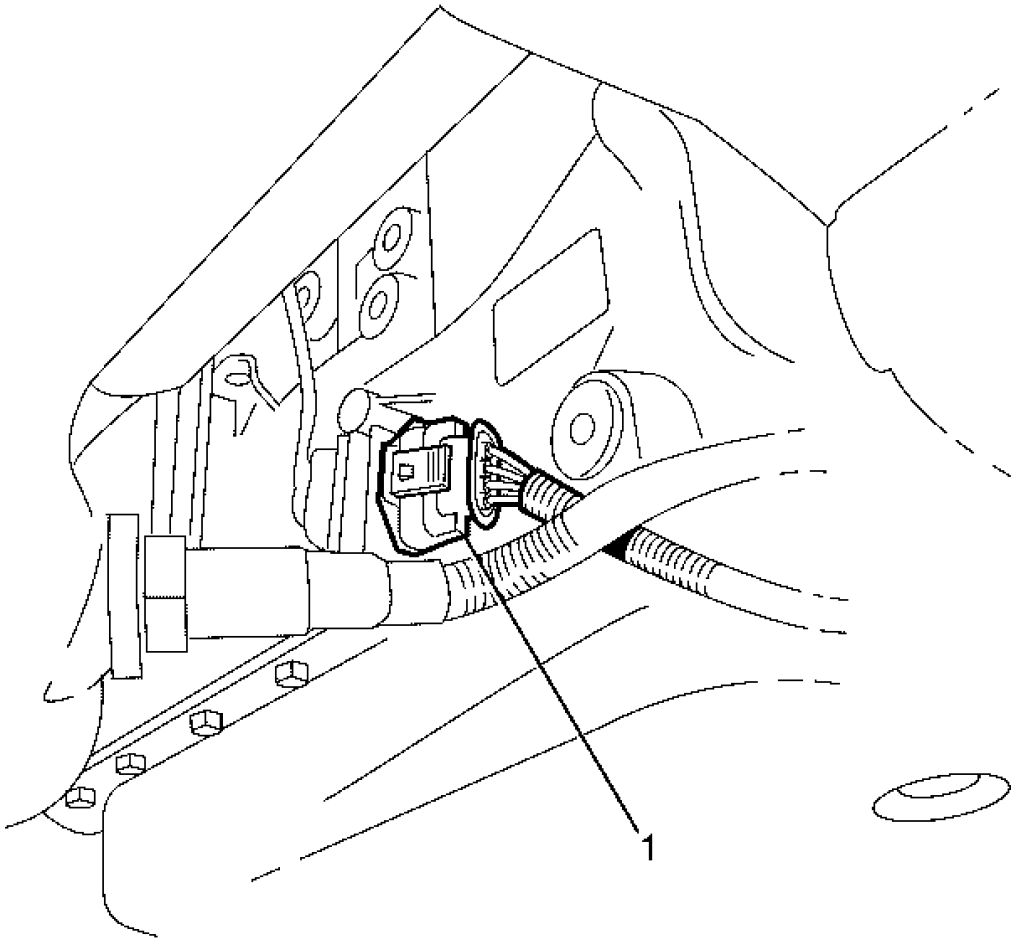


Fig. 14: Identifying HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

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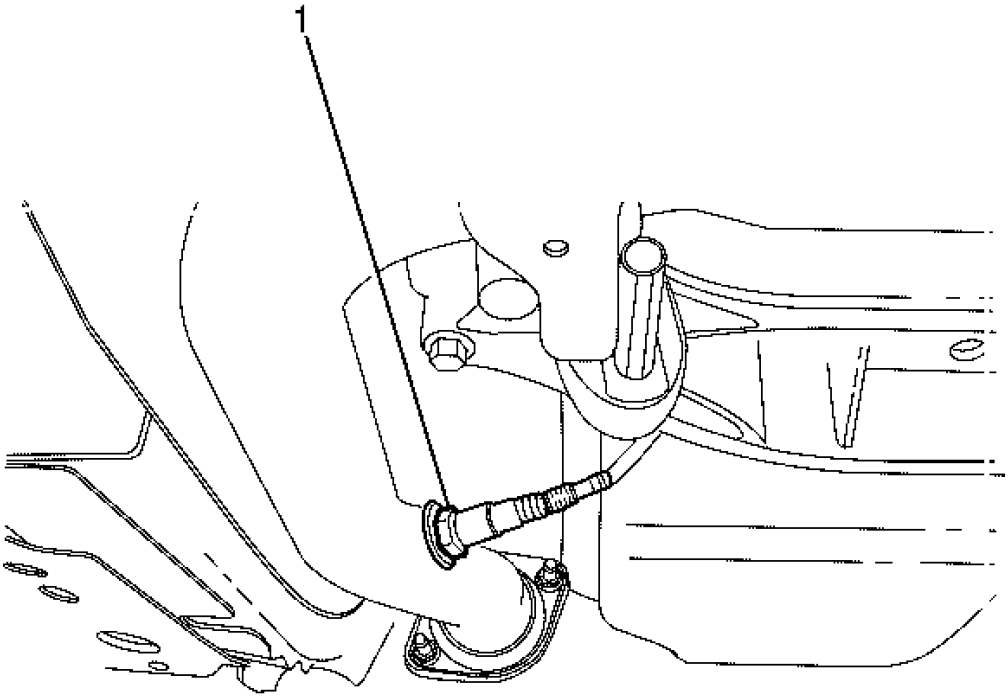


Fig. 15: Locating HO2S
Courtesy of GENERAL MOTORS CORP.

CAUTION: Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

5. Remove the HO2S (1) from the exhaust crossover pipe assembly.

Installation Procedure

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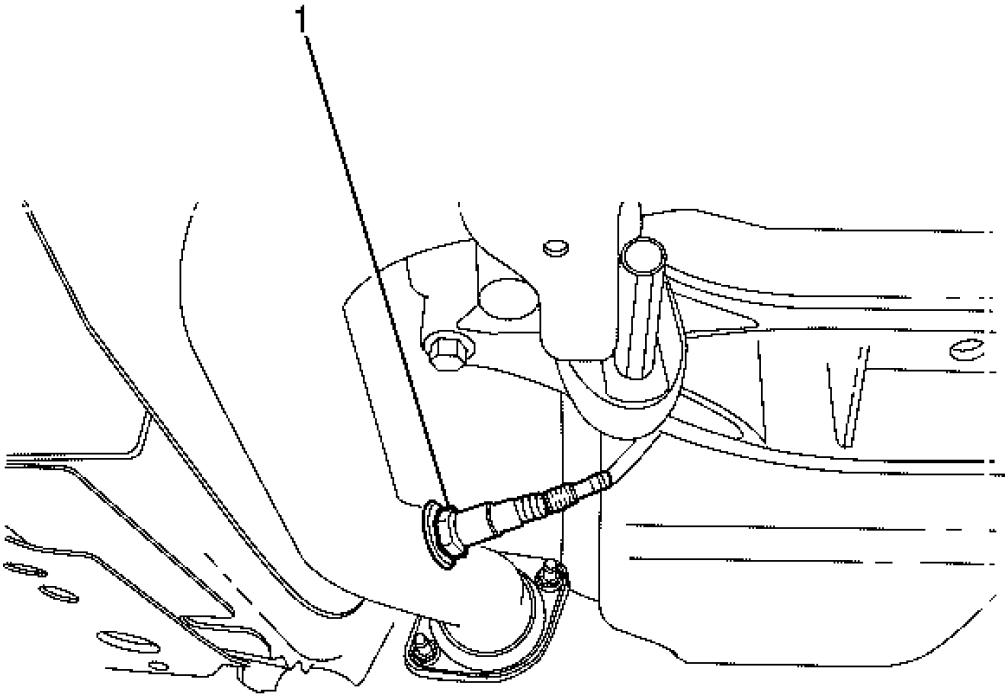


Fig. 16: Locating HO2S
Courtesy of GENERAL MOTORS CORP.

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

1. Install the HO2S (1) to the exhaust crossover pipe assembly and tighten to 42 N.m (31 lb ft).

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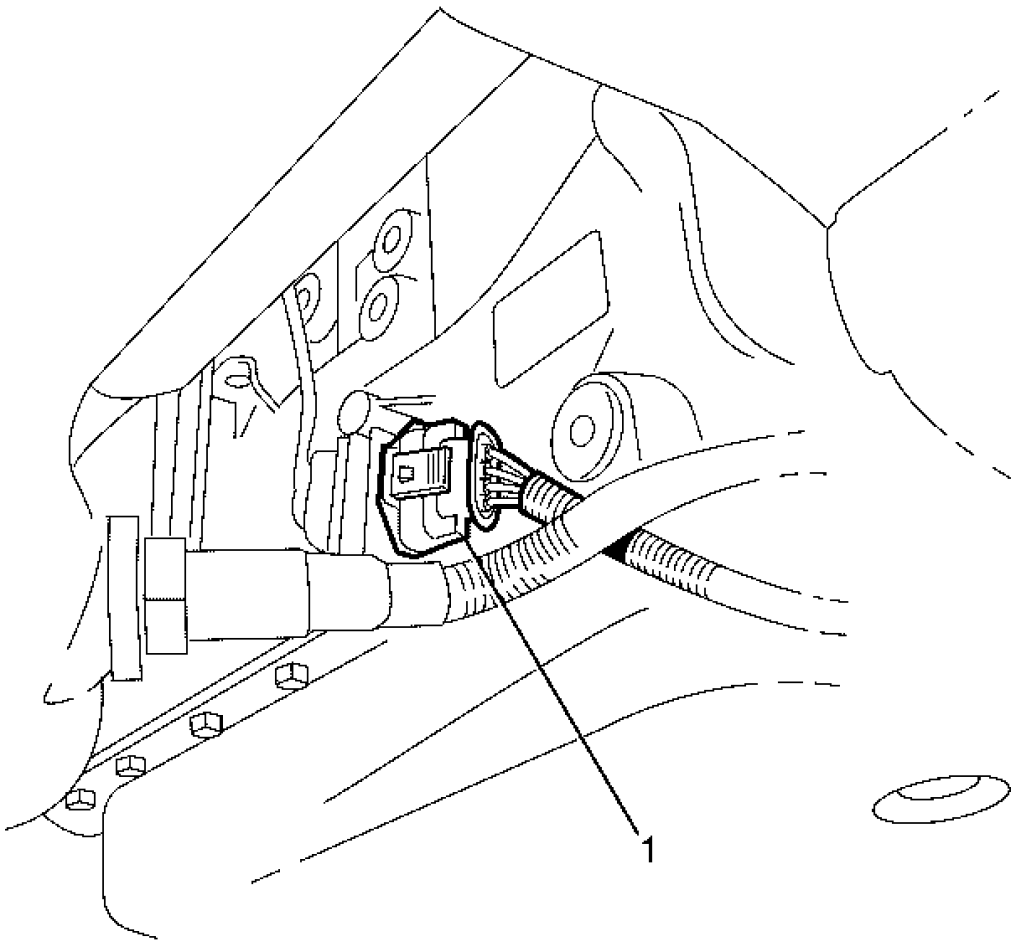


Fig. 17: Identifying HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Connect the HO2S electrical connector (1).
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

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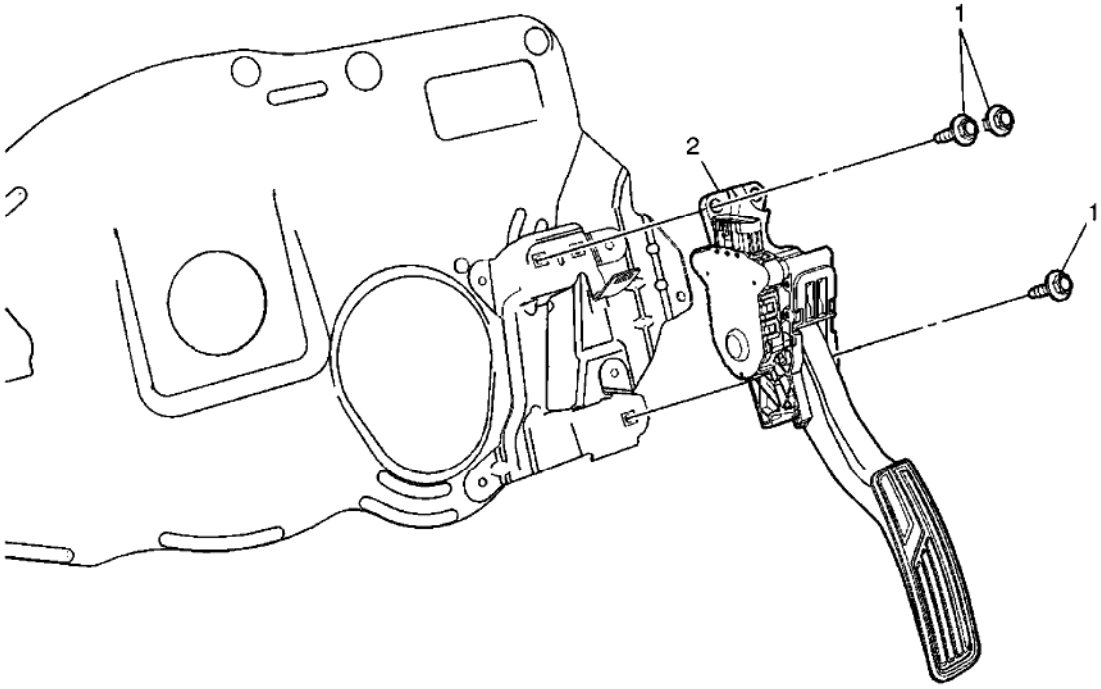


Fig. 18: Accelerator Pedal Position Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Accelerator Pedal Position Sensor Fastener (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 9 N.m (80 lb in)
2	Accelerator Pedal Position Sensor **Procedure:** Disconnect the electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**.

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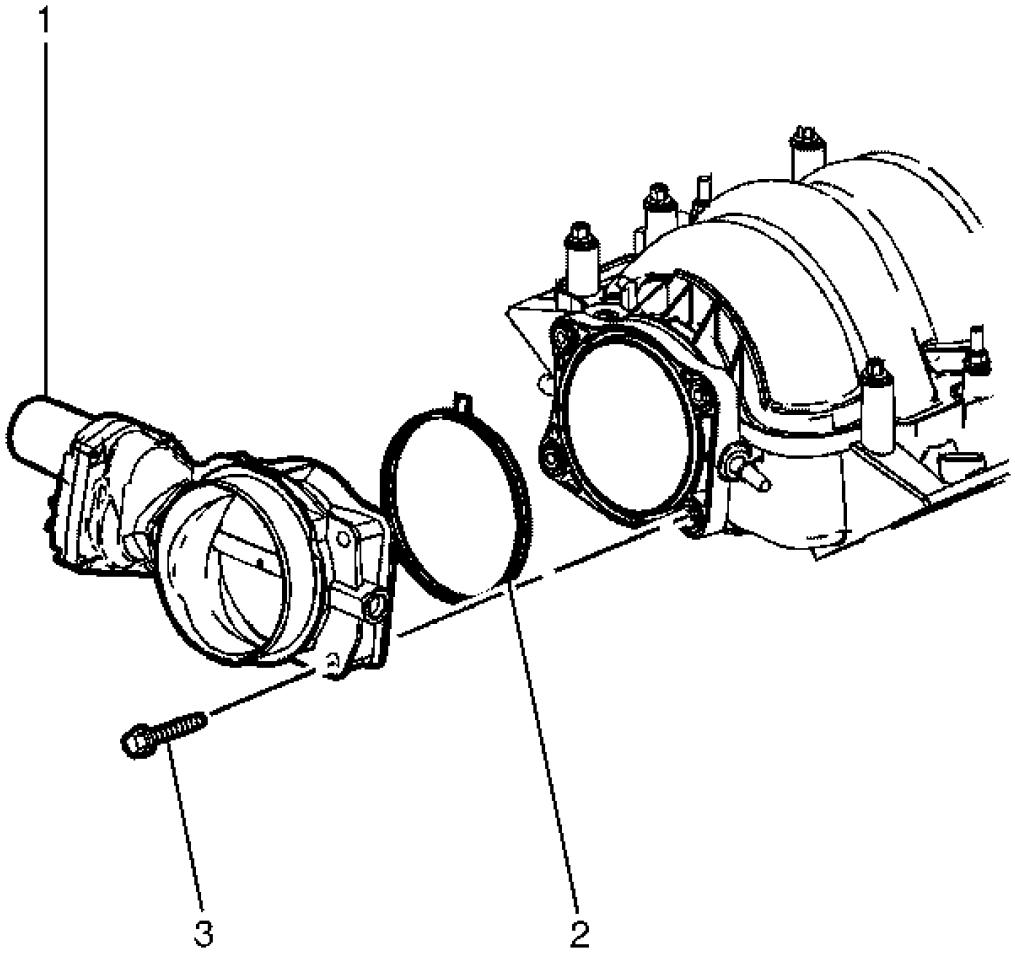


Fig. 19: Identifying Throttle Body To Intake Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

CAUTION: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

NOTE: The intake manifold, throttle body, fuel injection rail, and fuel injectors

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may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

2. Remove the electrical wire harness connector from the throttle body.
3. Remove the throttle body to intake manifold retaining bolts (3).
4. Remove the throttle body (1).

NOTE: The throttle body gasket is a single use part. The gasket must be discarded after removal.

5. Remove the throttle body to intake manifold gasket (2), and discard.

   Discard the throttle body gasket

6. Clean the throttle body and intake manifold mating surfaces.

Installation Procedure

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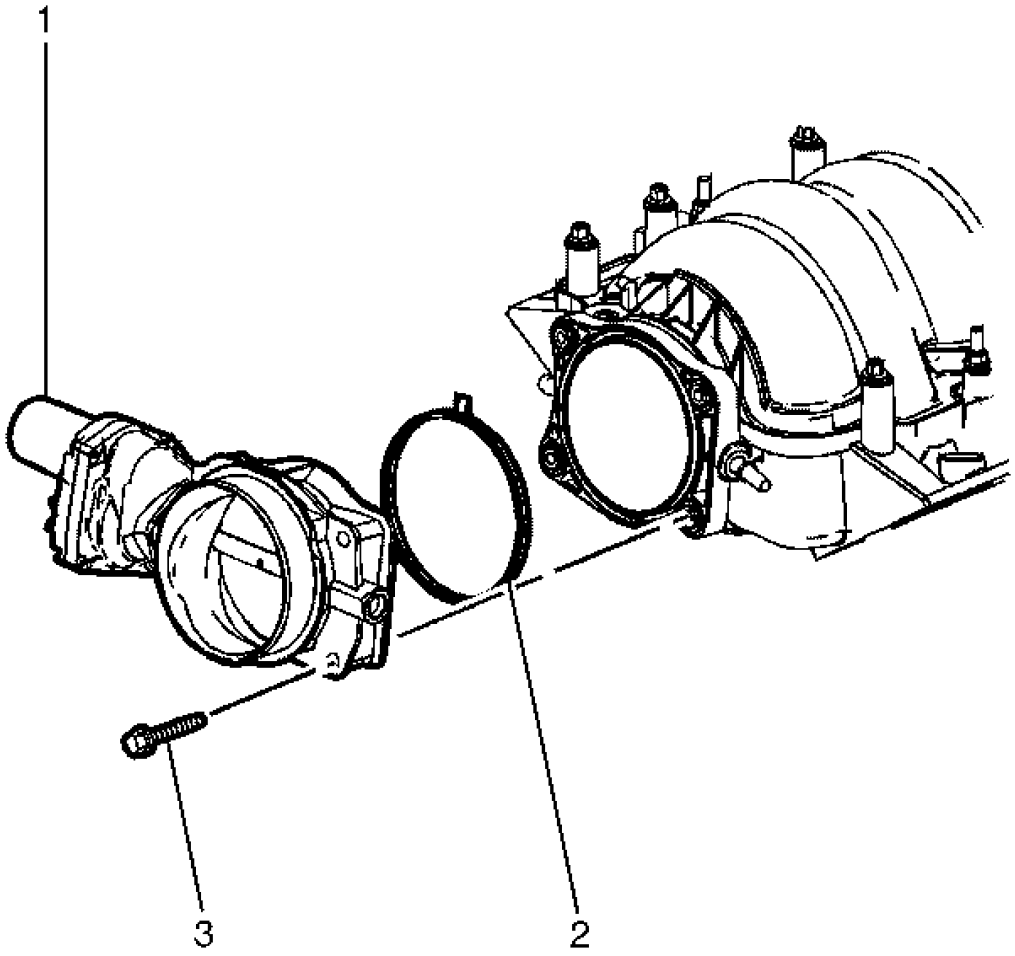


Fig. 20: Identifying Throttle Body To Intake Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

1. Install a new throttle body to intake manifold gasket (2). Align the locating tab of the gasket with the notch in the manifold.
2. Install the throttle body (1) to the intake manifold.

CAUTION: Refer to Fastener Caution .

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3. Install the throttle body to intake manifold retaining bolts (3) and tighten to 12 N.m (106 lb in).
4. Install the electrical wire harness connector from the throttle body.
5. Install the outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**.
6. Perform the throttle learn procedure. Refer to **Throttle/Idle Learn**.

THROTTLE BODY CLEANING

NOTE: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. Occasionally the deposit may accumulate to a point where perceived pedal effort is affected. This procedure should not be performed on vehicles with low mileage, under 80 450 kilometers (50,000 miles).

CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

1. Remove the outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**.
2. Inspect the throttle body bore and inspect the throttle valve plate for deposits. The throttle valve must be opened in order to inspect all surfaces.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with an approved top engine cleaner.
4. Install the outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**.
5. Perform the throttle/idle learn procedure. Refer to **Throttle/Idle Learn**.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH-48027 Digital Pressure Gauge

Installation Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the

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connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

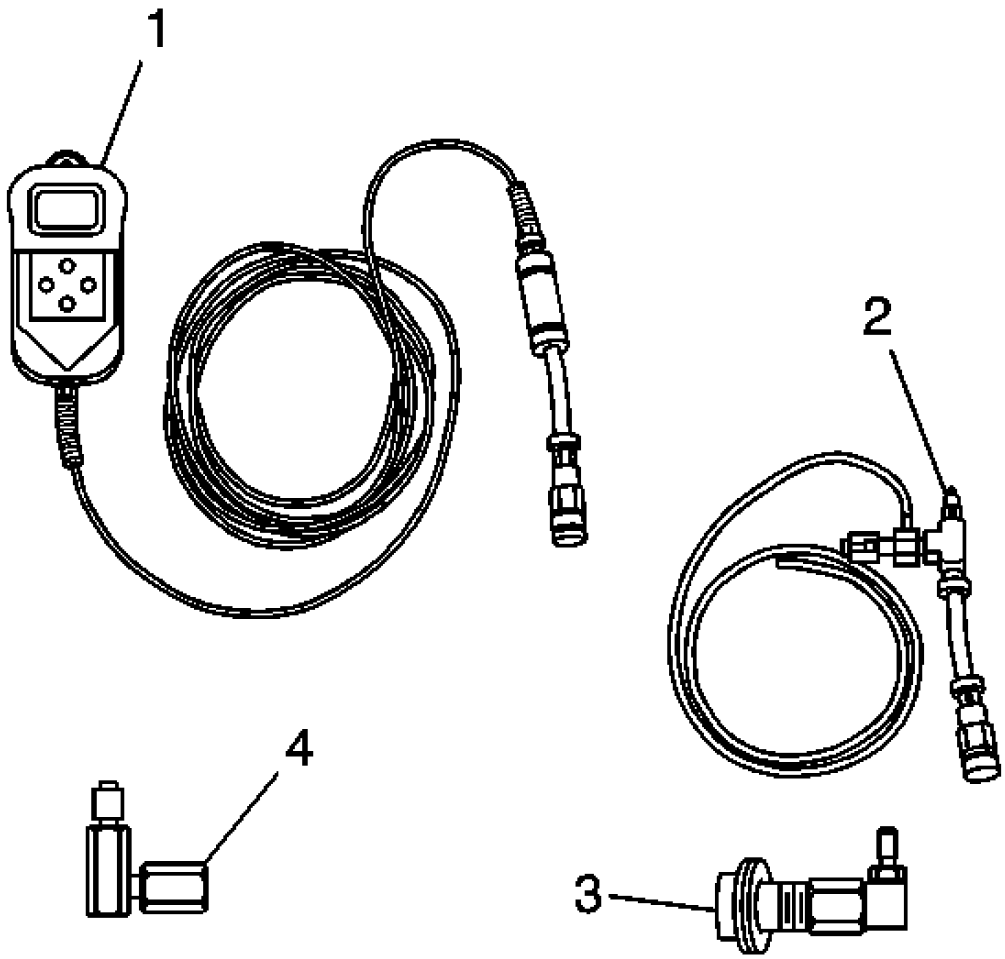


Fig. 21: View Of Digital Pressure Gauge & Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

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4. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH-48027** , refer to the manufacture's directions.

Removal Procedure

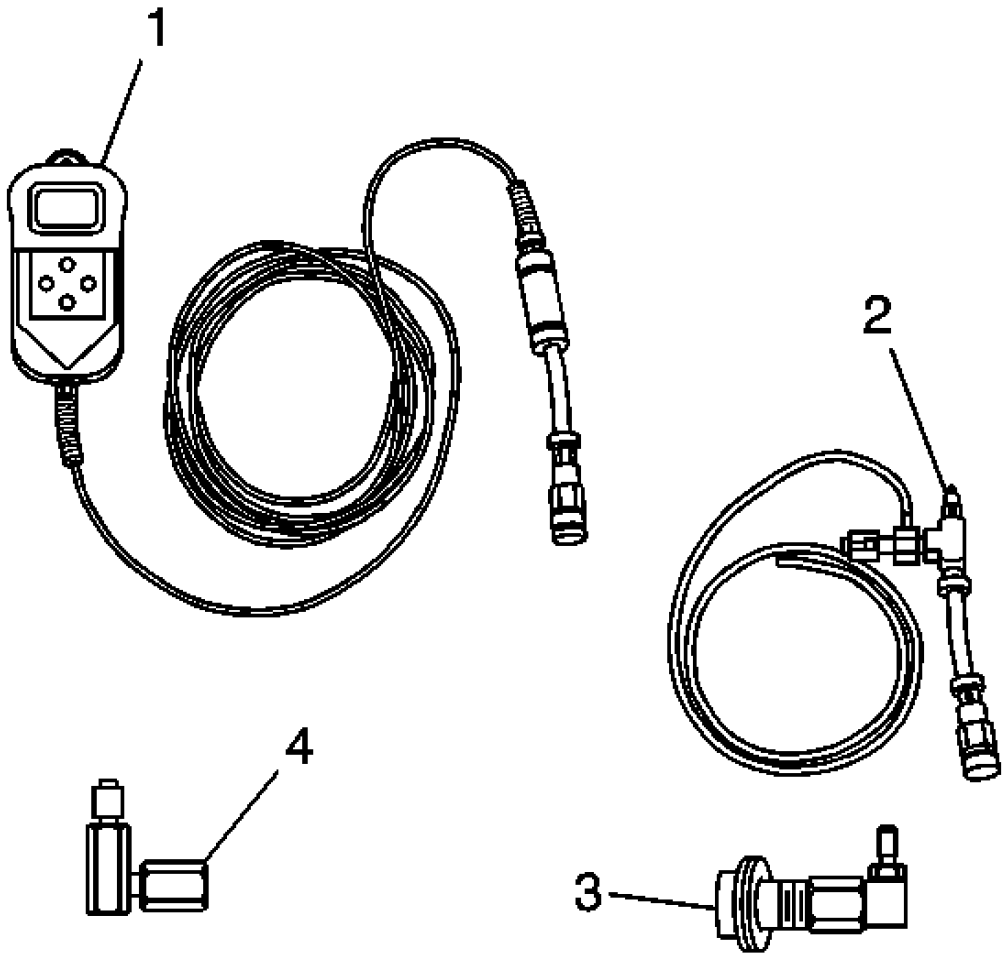


Fig. 22: View Of Digital Pressure Gauge & Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure, if required. Perform the following steps:

WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection

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of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

1. Wrap a shop towel around the fuel rail service port.
2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the CH-48027-2 (2).
5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

2. Disconnect the CH-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
4. Disconnect the CH-48027-3 (4) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Tighten the fuel fill cap.

FUEL PRESSURE RELIEF

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

NOTE: If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

1. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel pump to shut off.
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

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METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **7370** Fuel Line Quick Connect Separator
- **7371** Quick Connect Release Tool
- **J 41769** Fuel Line Quick Disconnect Tool
- **J 41623-B** Cooler Quick Connect Tool

Removal Procedure Quick Connect Fitting Type 1

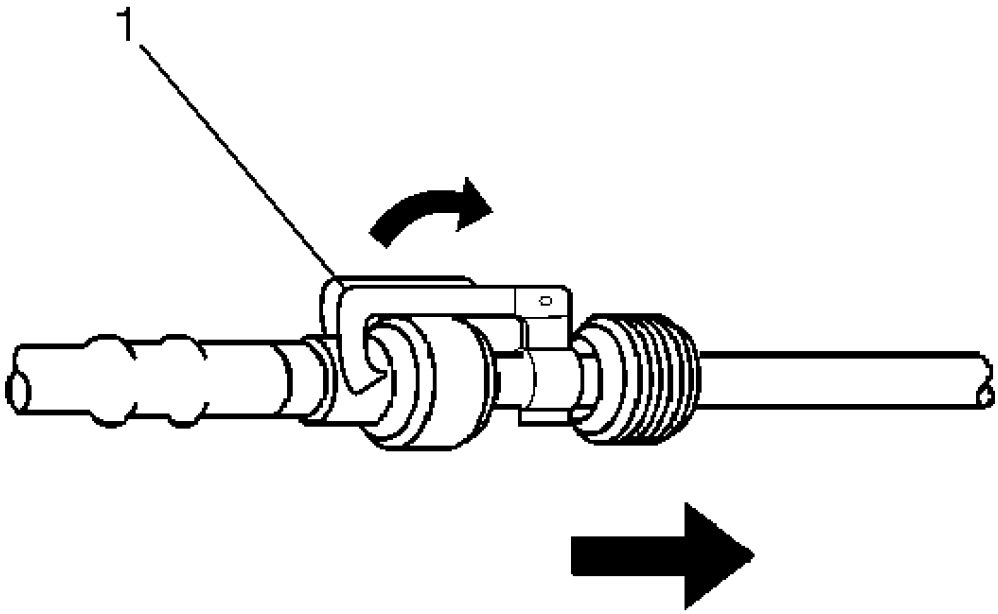


Fig. 23: Identifying Fuel Hose Clip Verifier
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to the **Fuel Pressure Relief** .
2. Slide the dust cover from the quick-connect fitting if a dust cover is fitted.
3. Clean any grime from the metal collar quick connect fitting.
4. Detach the metal collar quick connect fitting verifier clip (1).

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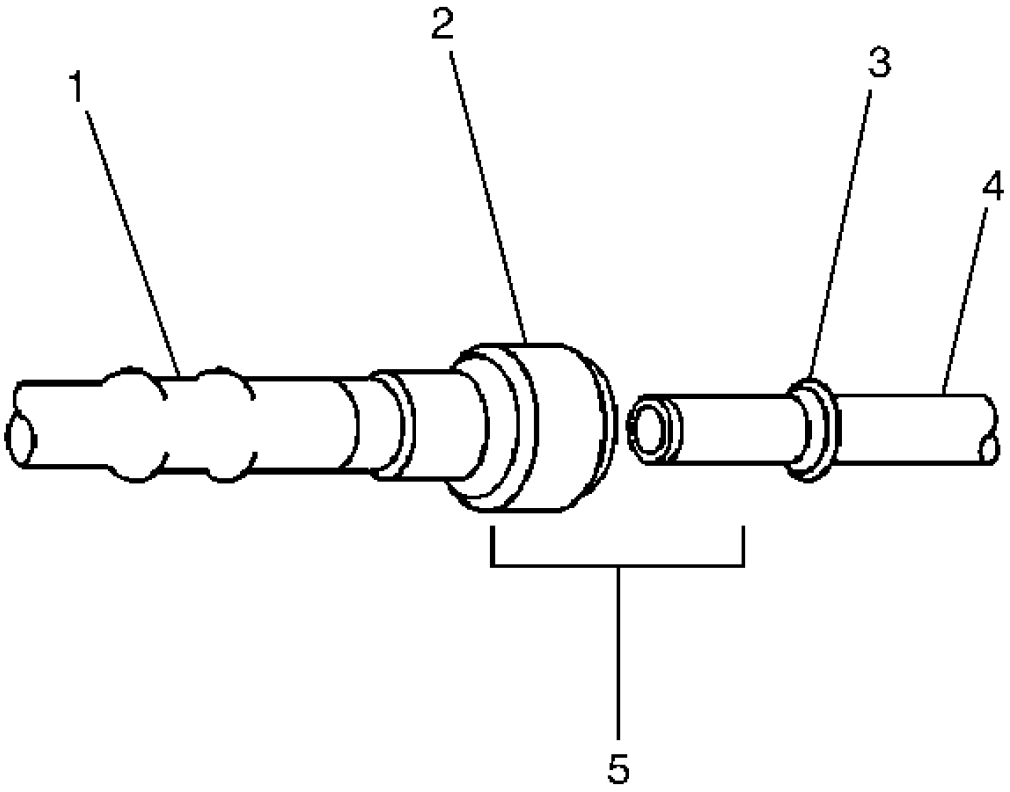


Fig. 24: Separating Connector Pipes
Courtesy of GENERAL MOTORS CORP.

5. Choose the correct special tool and install the special tool onto the male connector pipe (4).
6. Apply suitable pressure and push the special tool into the female connector (2) to release the retaining tabs.
7. Pull the female connector pipe (1) away from the male connector pipe (4).
8. Remove the special tool from the metal collar quick connect fitting.

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

9. Clean the metal collar quick connect fittings using a clean shop towel.

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10. Inspect the metal collar quick connect fittings for damage. Replace any damaged metal collar quick connect fittings.

Installation Procedure Quick Connect Fitting Type 1

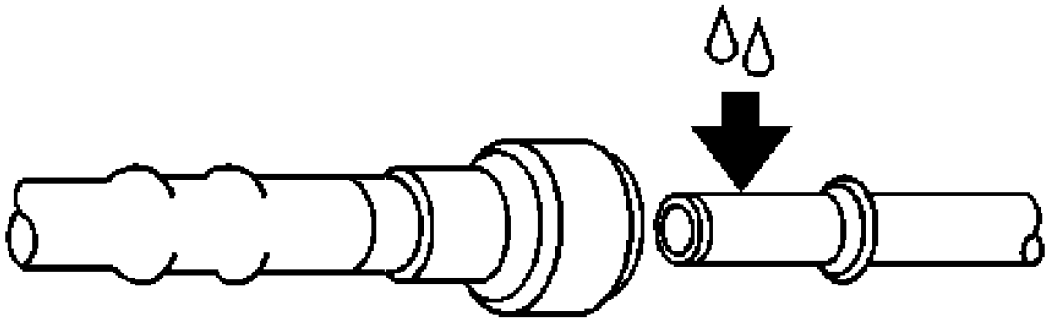


Fig. 25: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS CORP.

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings in order to reduce the risk of fire and personal injury. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the metal collar quick connect fitting.

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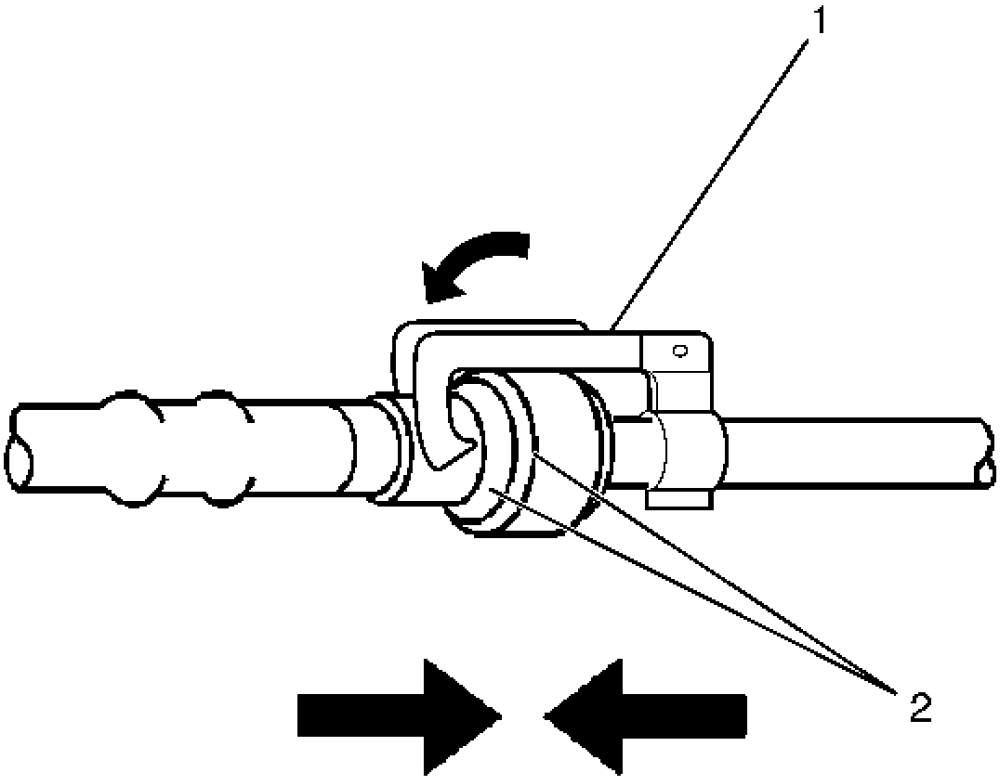


Fig. 26: Connecting Metal Collar Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

NOTE: Apply suitable pressure to both ends of the metal collar quick connect fitting to make sure that the retaining tabs snap into place.

NOTE: Listen for an audible click to confirm the correct installation of the metal collar quick connect fitting.

2. Connect the metal collar quick connect fittings (2).
3. Install the metal collar quick connect fitting verifier clip (1).
4. Slide the dust cover into position if fitted.

Removal Procedure Quick Connect Fitting Type 2

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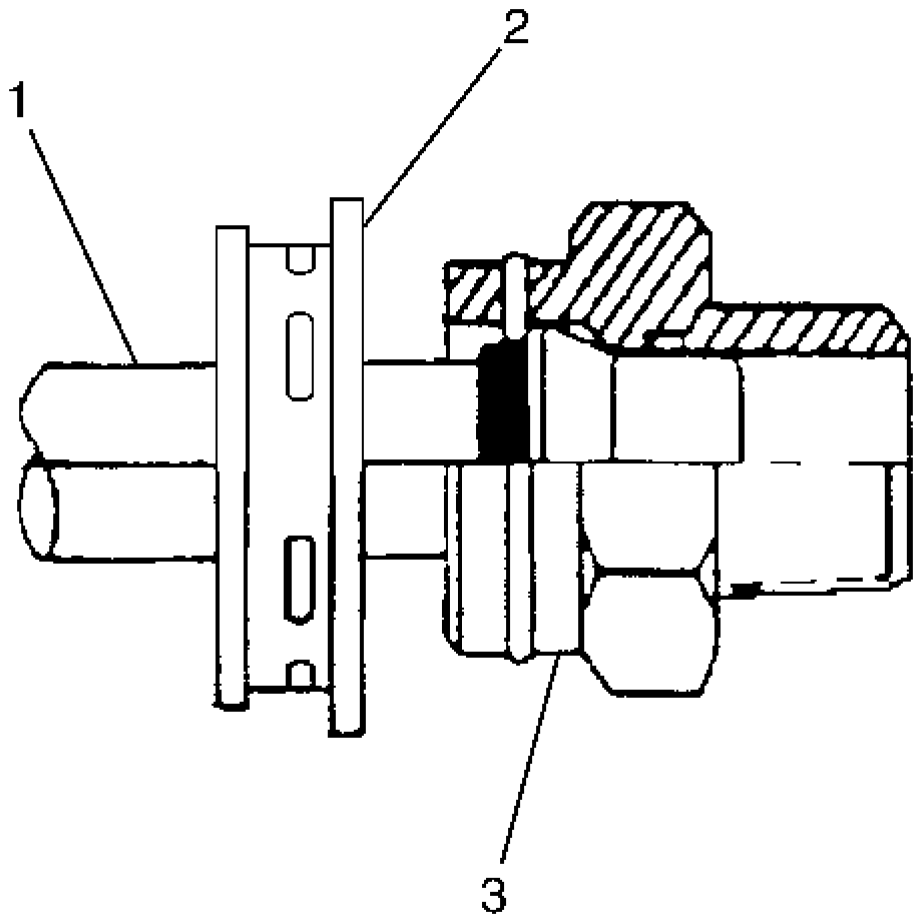


Fig. 27: Verifier Cap & Male Connector Pipe
Courtesy of GENERAL MOTORS CORP.

1. Detach the verifier cap (2) by pulling the verifier cap back along the male connector pipe (1).

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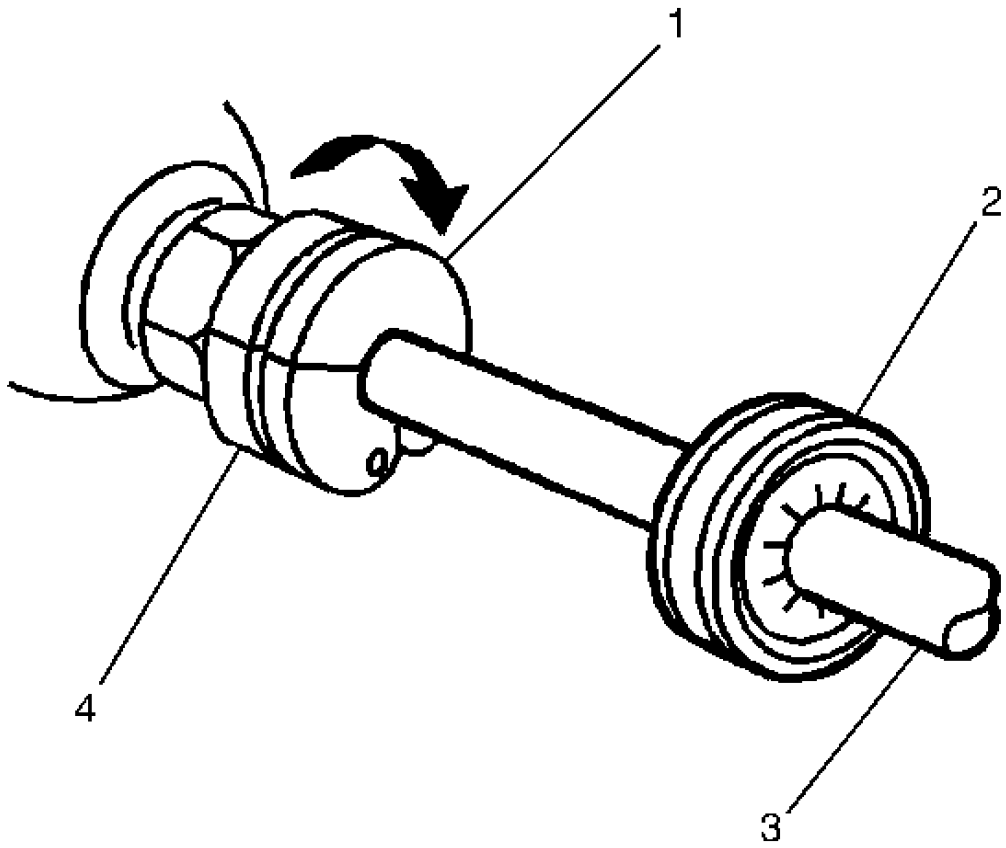


Fig. 28: Disconnecting Male & Female Connectors
Courtesy of GENERAL MOTORS CORP.

2. Install the quick connect release tool **J 41623-B** (1) onto the male connector pipe (3).
3. Apply suitable pressure while pushing and turning the quick connect release tool **J 41623-B** into the female connector (4) to release the retaining tabs.
4. Pull the male connector pipe (3) away from the female connector (4).
5. Remove the quick connect release tool **J 41623-B** from the male connector pipe (3).

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

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6. Clean the metal collar quick connect fittings using a clean shop towel.

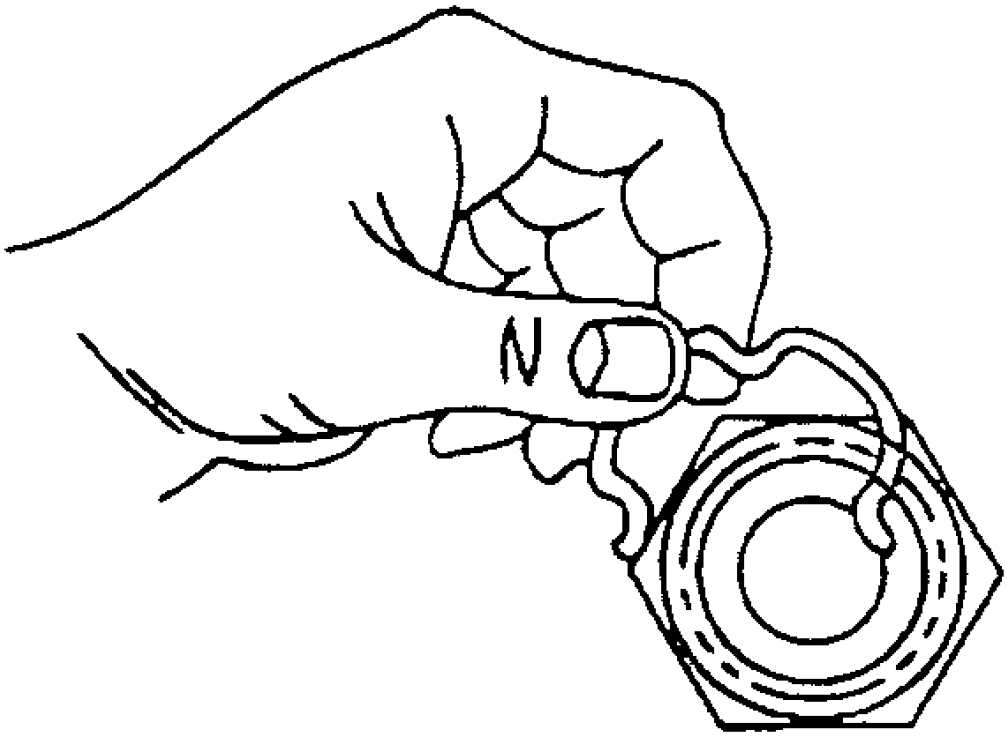


Fig. 29: Quick Connect Retainer
Courtesy of GENERAL MOTORS CORP.

7. Remove the quick connect retainer if required.
8. Inspect the metal collar quick connect fittings for damage. Replace any damaged metal collar quick connect fitting components.

Installation Procedure Quick Connect Fitting Type 2

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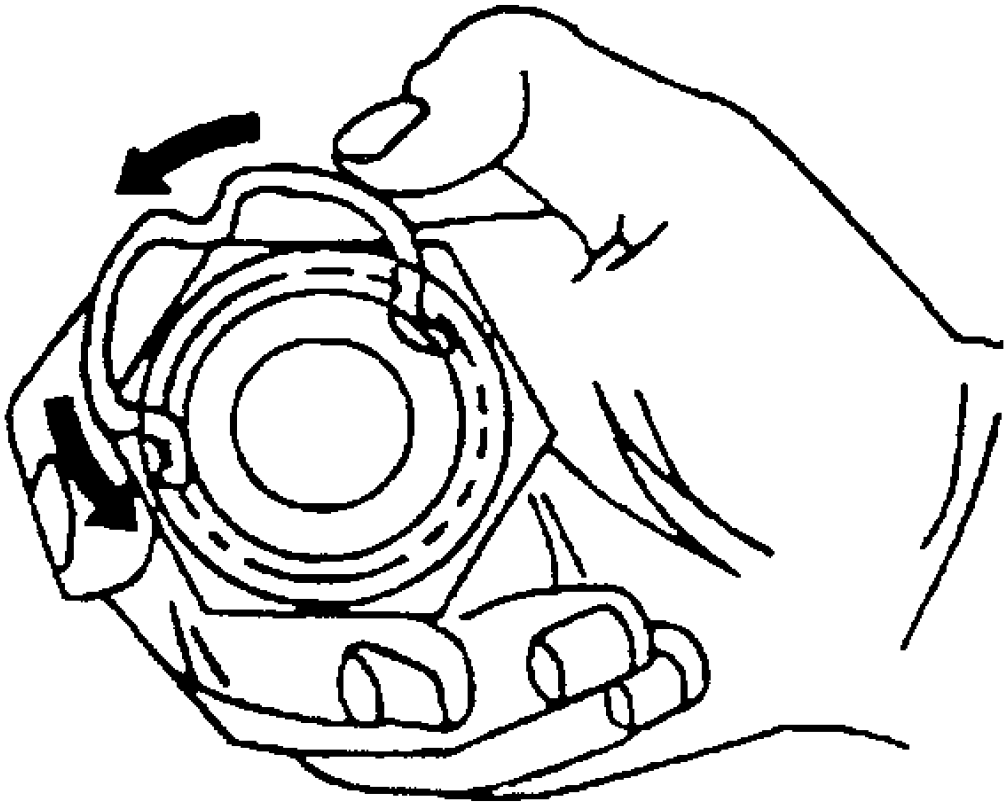


Fig. 30: Rotating Retaining Ring Around Fitting
Courtesy of GENERAL MOTORS CORP.

NOTE: The new quick connect retainer should align with the three slots of the quick connect fitting.

1. If required, install a new quick connect retainer by rotating the new quick connect retainer around the fitting until the new quick connect retainer is seated correctly.

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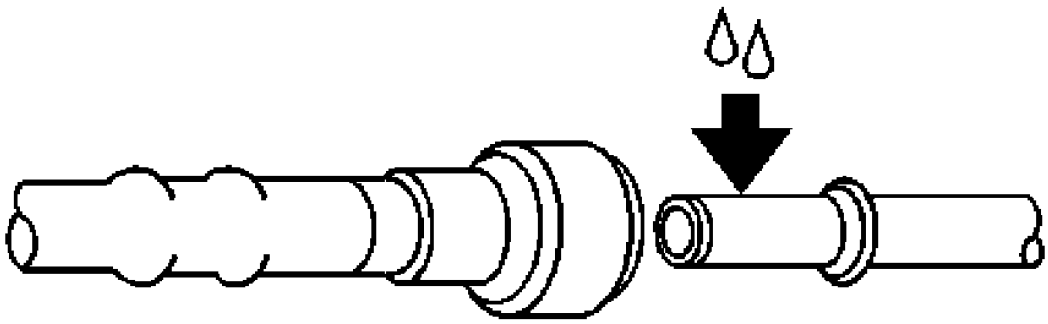
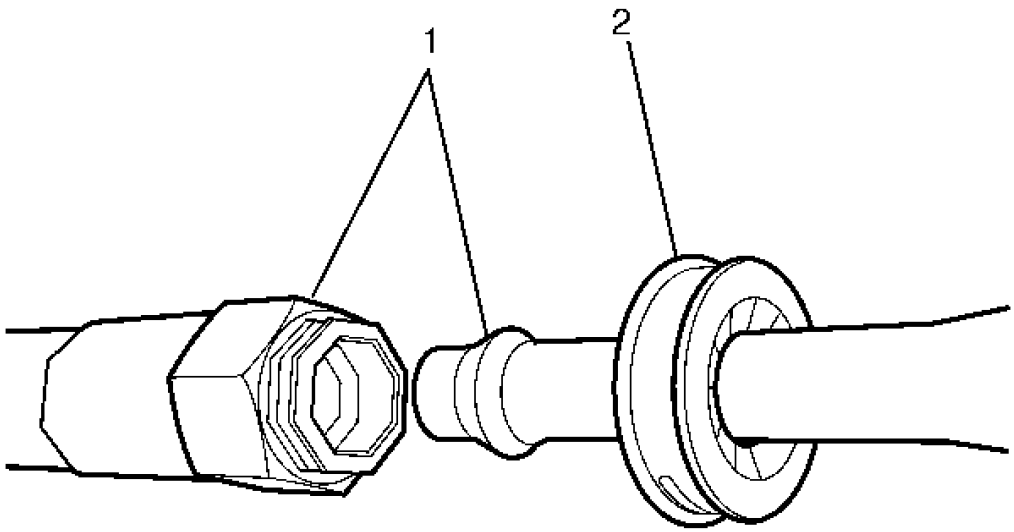


Fig. 31: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS CORP.

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings in order to reduce the risk of fire and personal injury. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

2. Apply a few drops of clean engine oil to the metal collar quick connect fitting.



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Fig. 32: Connecting Metal Collar Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

NOTE: Apply suitable pressure to both ends of the metal collar quick connect fitting to make sure that the retaining tabs snap into place.

NOTE: Listen for an audible click to confirm the correct installation of the metal collar quick connect fitting.

3. Connect the metal collar quick connect fittings (1).

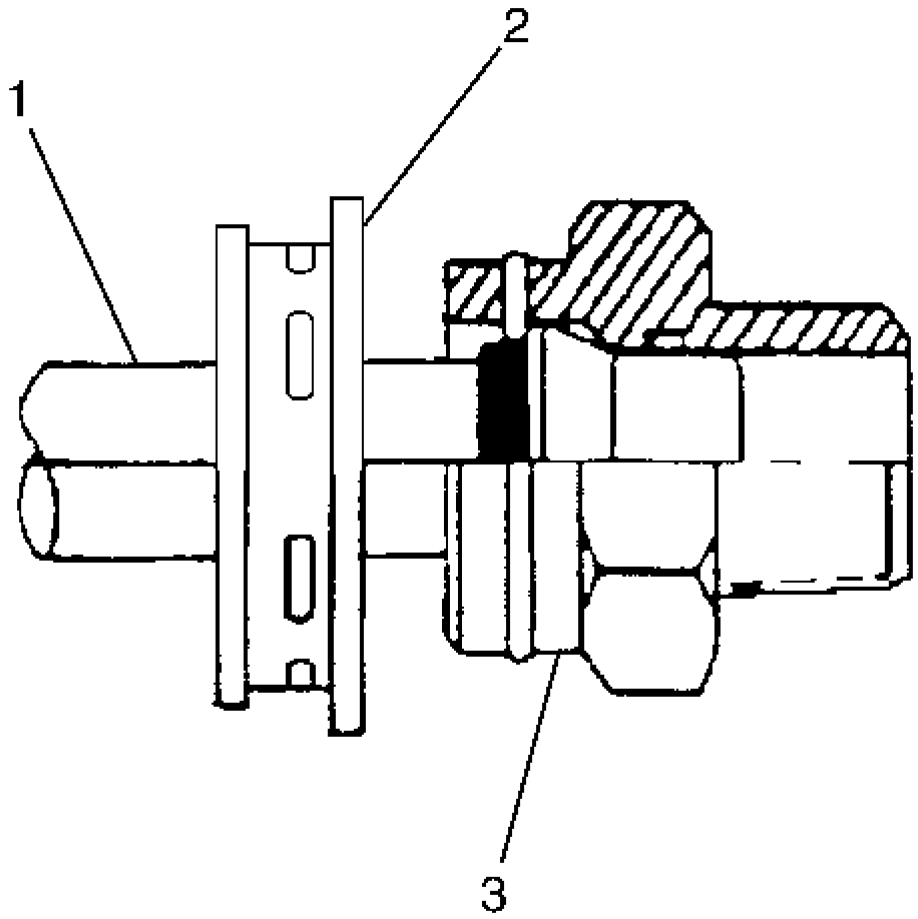


Fig. 33: Verifier Cap & Male Connector Pipe
Courtesy of GENERAL MOTORS CORP.

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NOTE: To Instal the metal collar quick connect fitting verifier cap (2), slide the metal collar quick connect fitting verifier cap (2) along the pipe.

4. Install the metal collar quick connect fitting verifier cap (2) to the metal collar quick connect fitting (3).

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

AU-533 Quick Connect Release Tool

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Blow dirt out of the fitting using compressed air.

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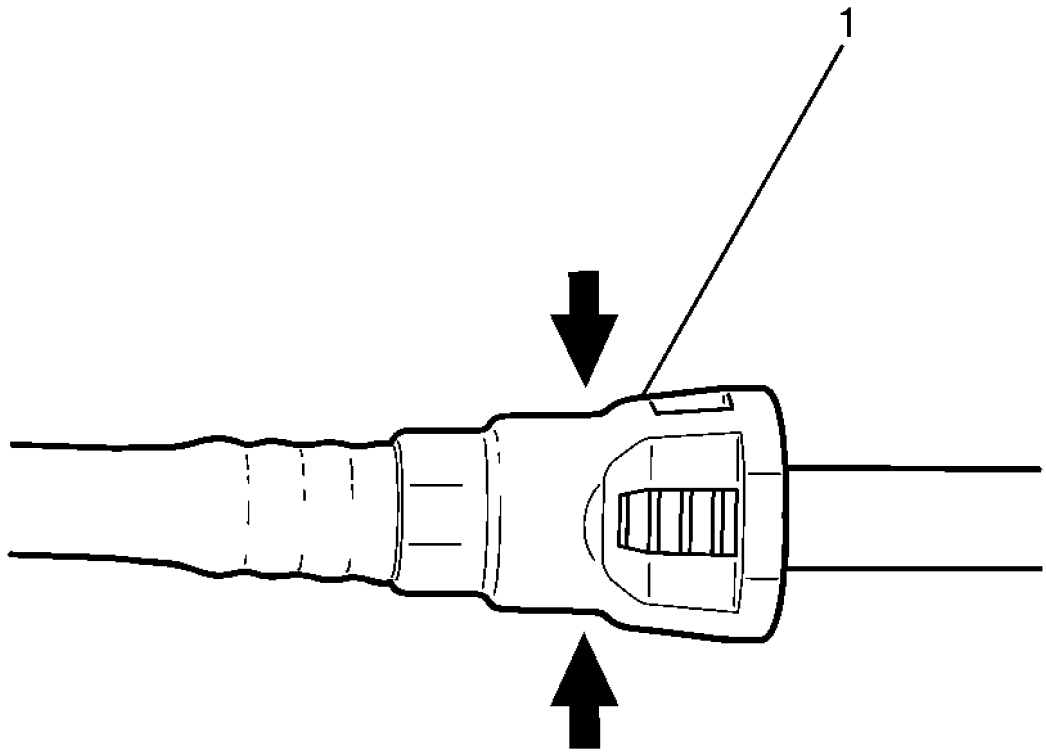


Fig. 34: Identifying Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

3. Install the quick connect tool over the quick connect fitting (1).

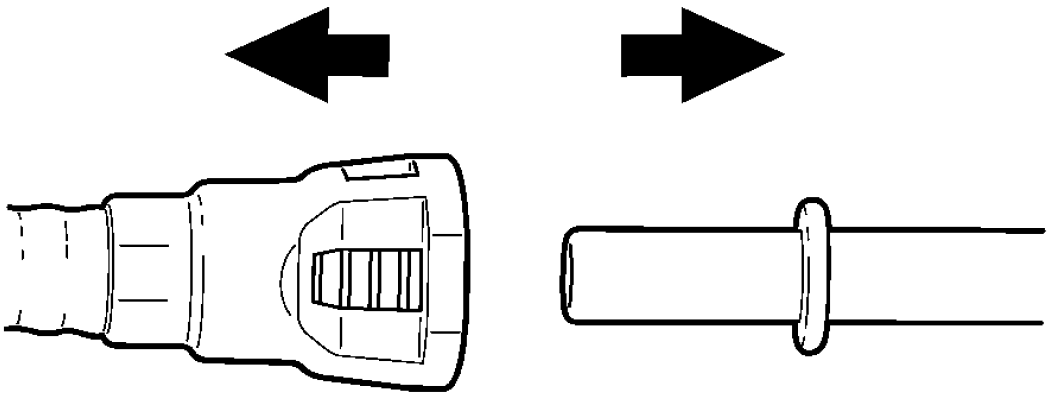


Fig. 35: Pulling Connection apart

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Courtesy of GENERAL MOTORS CORP.

4. Pull the connection apart.
5. Using a clean shop towel, wipe off the male pipe end.
6. Inspect both ends of the fitting for dirt and burrs.
7. Clean or replace the components as required.

Installation Procedure

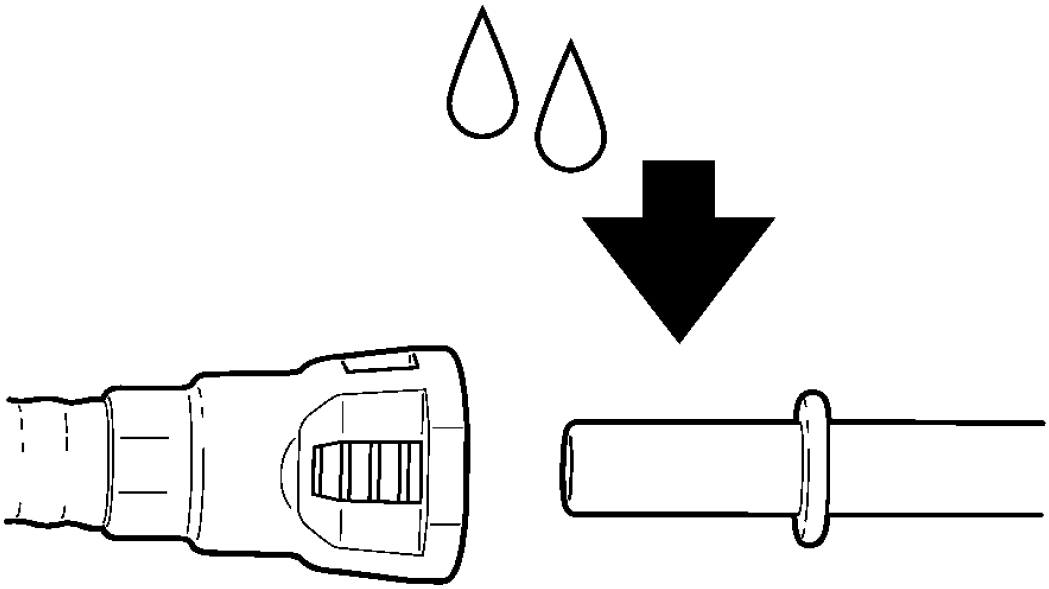


Fig. 36: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS CORP.

WARNING: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.
This will ensure proper reconnection and prevent a possible fuel leak.
During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.

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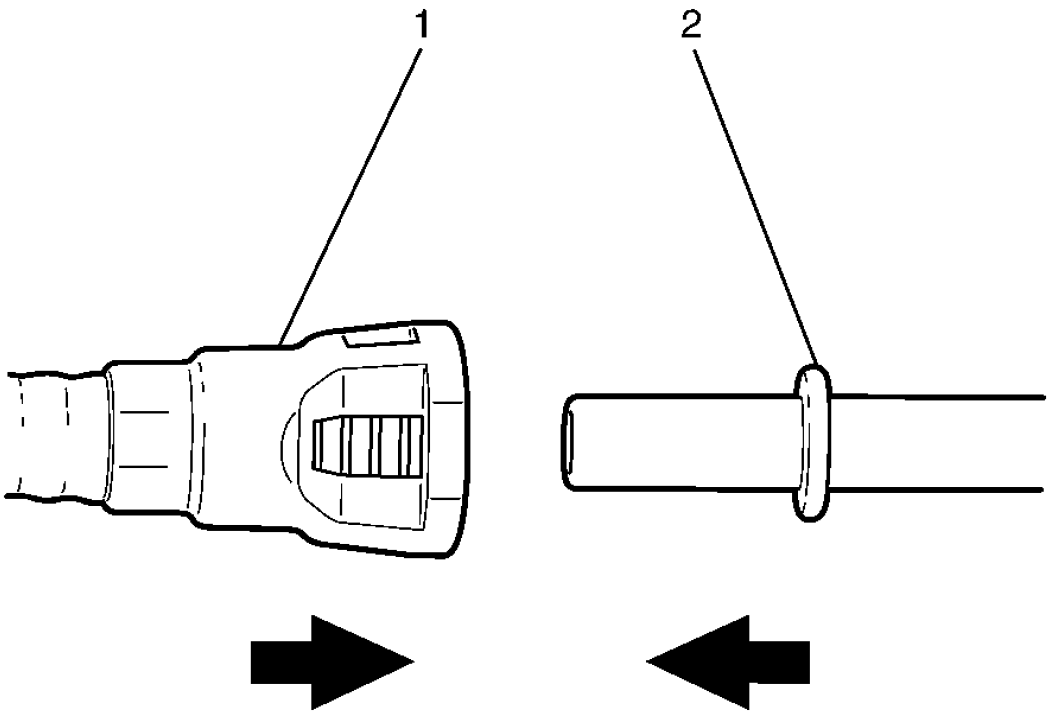


Fig. 37: Pushing Quick-Connect Fitting Together
Courtesy of GENERAL MOTORS CORP.

2. Push both sides (1 and 2) of the quick-connect fitting together to cause the retaining tabs/fingers to snap into place.

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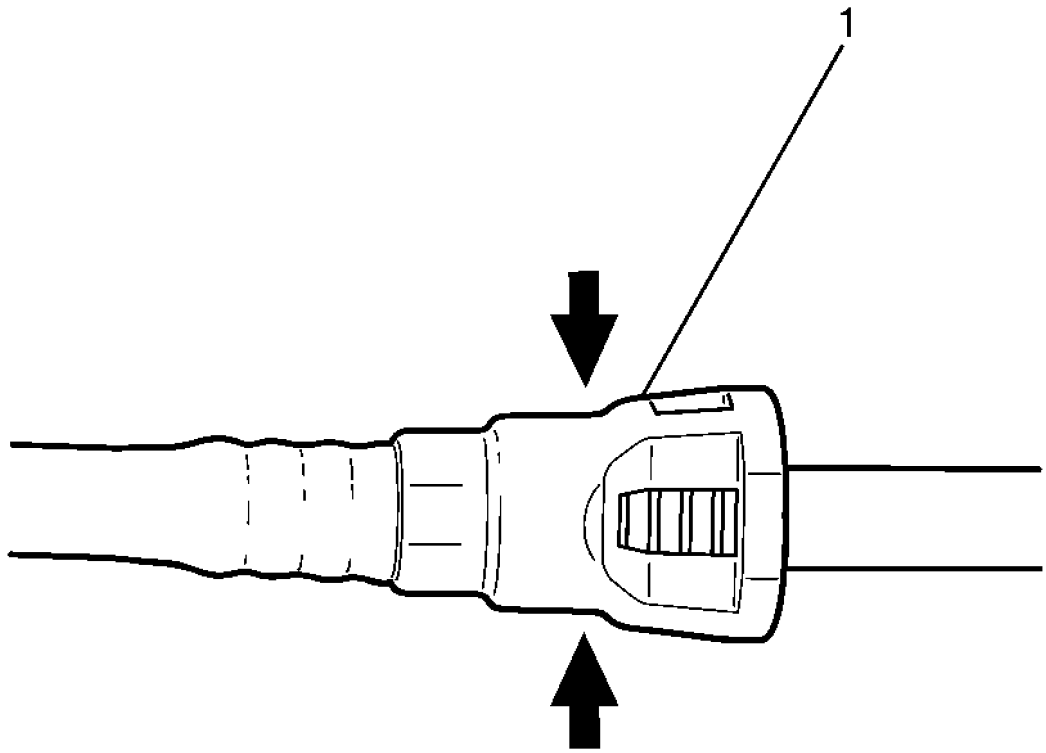


Fig. 38: Identifying Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

3. Pull on both sides of the quick-connect fitting (1) to make sure the connection is secure.
4. Inspect for leaks using the following procedure:
    1. Turn the ignition ON, with the engine OFF for 2 seconds.
    2. Turn the ignition OFF, for 10 seconds.
    3. Turn the ignition ON, with the engine OFF for 2 seconds.
    4. Turn the ignition OFF.
    5. Inspect for leaks.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

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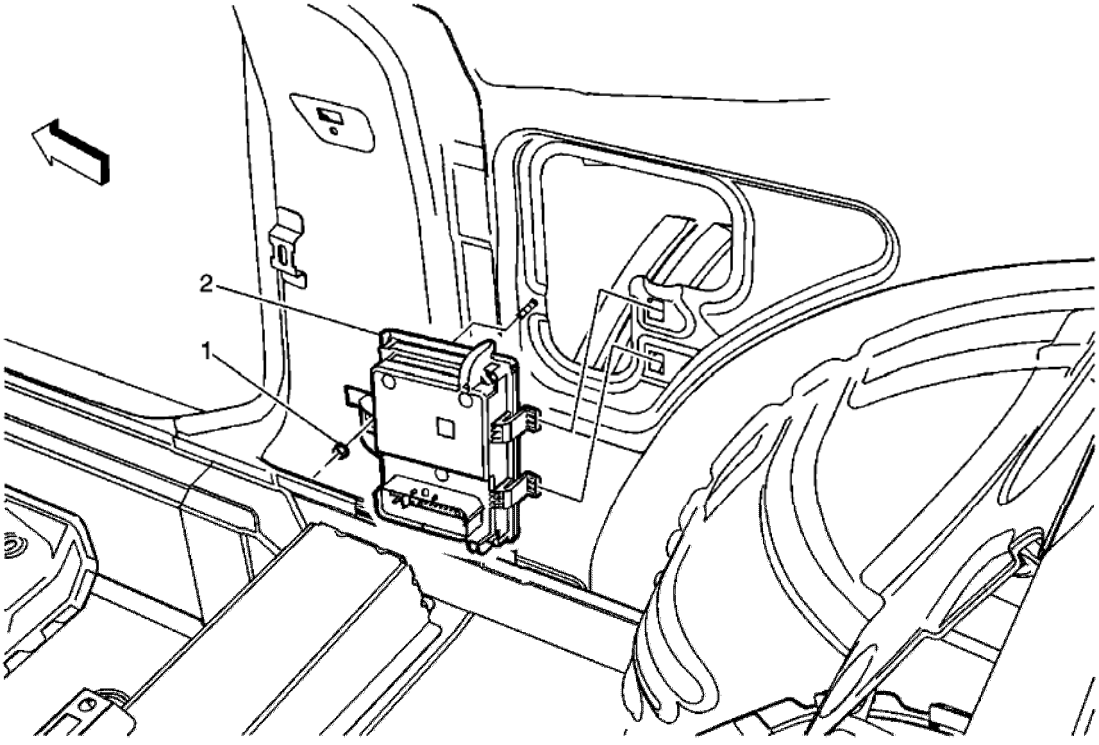


Fig. 39: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the right side quarter trim panel. Refer to **Quarter Trim Panel Replacement** .	
1	Fuel Pump Flow Control Module Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 3 N.m (27 lb in)
2	Fuel Pump Flow Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to **Control Module References** .

FUEL TANK DRAINING

Special Tools

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- **J 42960-2** Fuel Flapper Door Holder
- **J 45004** Fuel Tank Drain Hose
- Commercially Available Fuel Pump

Fuel Tank Draining Method 1

1. Ignition OFF.

   WARNING: Refer to Battery Disconnect Warning .

2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

   WARNING: To avoid any vehicle damage, serious personal injury or death, always use the jackstands to support the vehicle when lifting the vehicle with a jack.

   WARNING: Refer to Safety Glasses Warning .

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .

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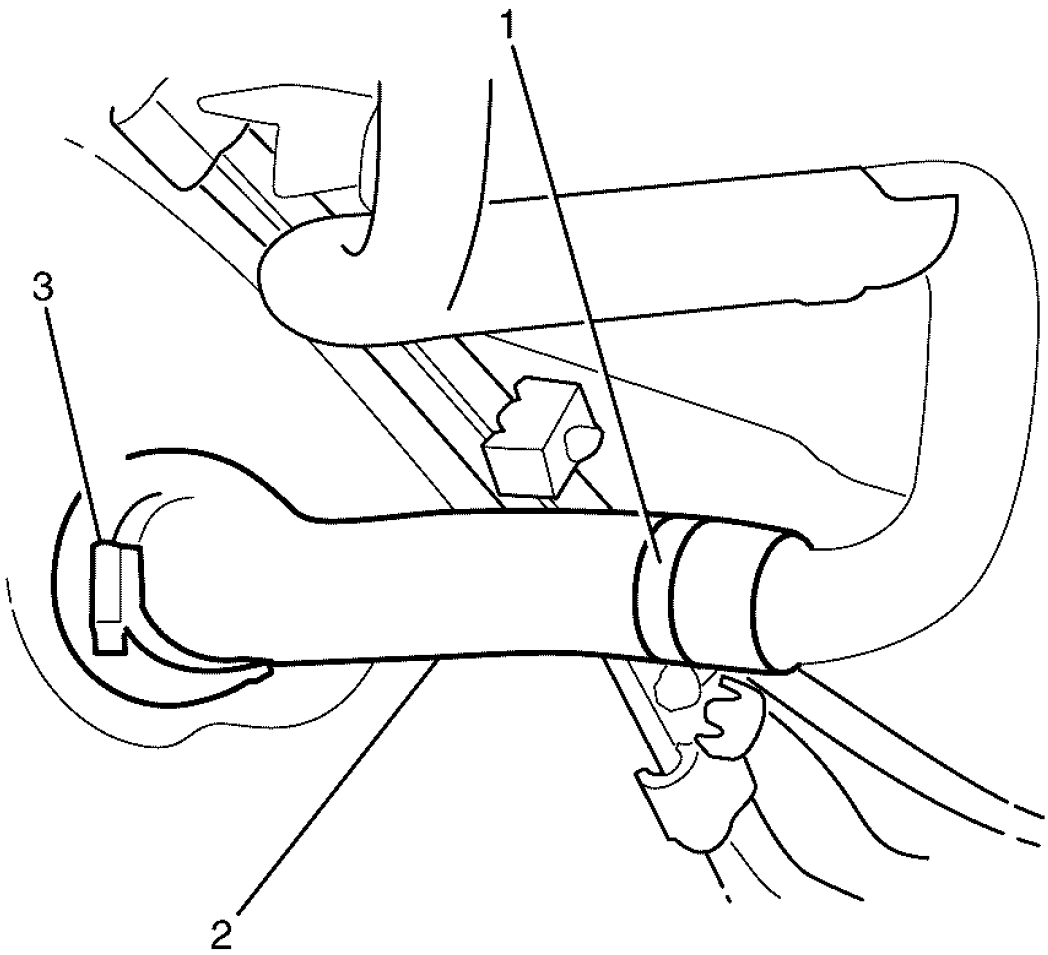


Fig. 40: Fuel Filler Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

5. Remove the retaining hose clamp (1) from the fuel filler hose (2).
6. Remove the retaining hose clamp (3) from the fuel filler hose (2).
7. Remove the fuel filler hose (2) from the vehicle.

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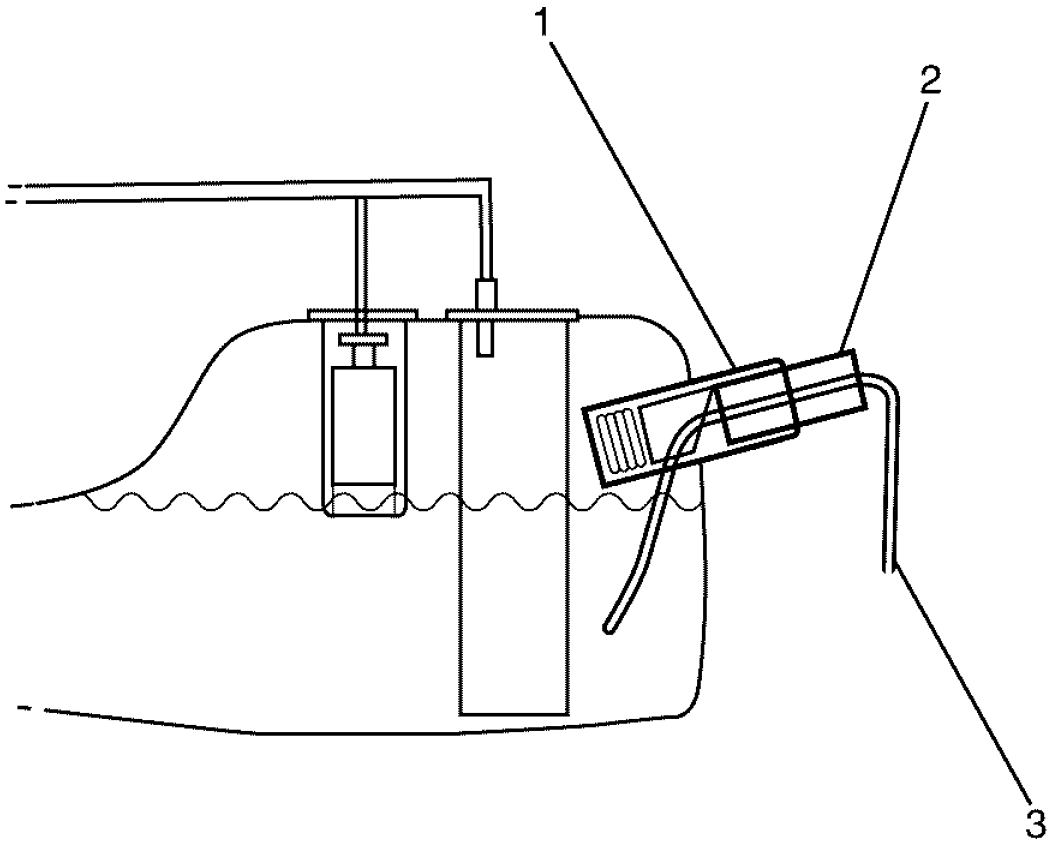


Fig. 41: Identifying Fuel Tank Draining Equipment
Courtesy of GENERAL MOTORS CORP.

NOTE: Up to approximately 36 litres (8 gallons) of residual fuel may remain in the secondary side of the fuel tank.

NOTE: The fuel flapper door holder (2) J 42960-2 is used to keep the roll over anti spill valve open.

8. Install the fuel flapper door holder (2) **J 42960-2** to the fuel tank fuel filler pipe (1).
9. Insert the fuel tank drain hose (3) **J 45004** through the fuel flapper door holder (2) **J 42960-2** until the fuel tank drain hose (3)**J 45004** reaches the bottom of the tank.
10. Use a commercially available pump to drain the fuel from the fuel tank.

Adding The Drained Fuel to The Fuel Tank for Method 1

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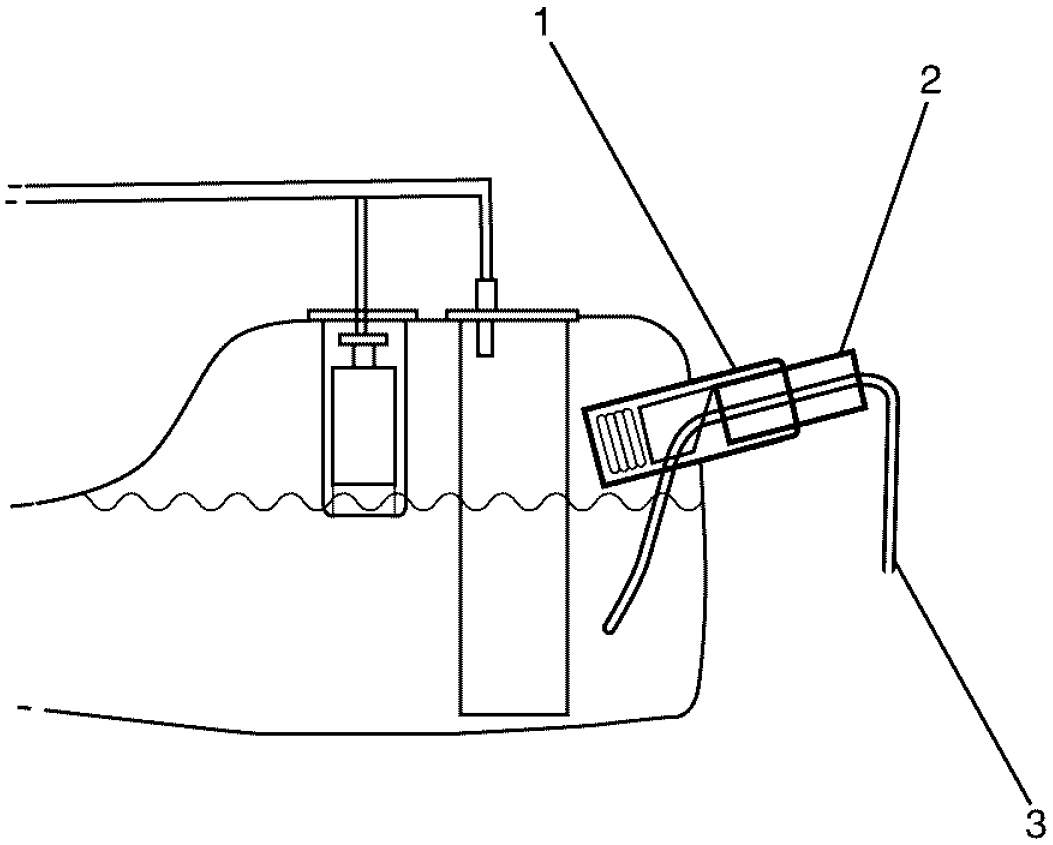


Fig. 42: Identifying Fuel Tank Draining Equipment
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel tank drain hose (3) **J 45004** from the fuel flapper door holder (2) **J 42960-2** .
2. Remove the fuel flapper door holder (2) **J 42960-2** from the fuel tank fuel filler pipe (1).

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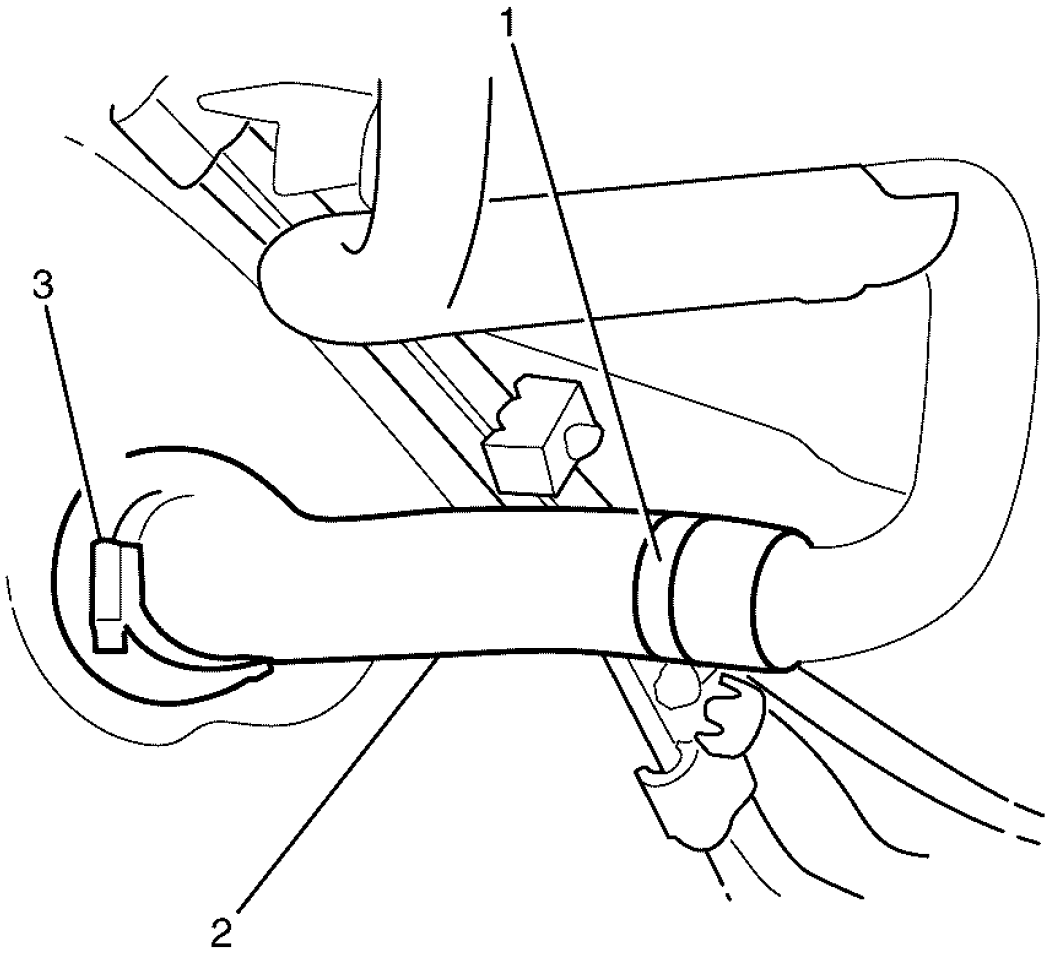


Fig. 43: Fuel Filler Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

3. Install the fuel filler hose (2) to the vehicle.

CAUTION: Refer to Fastener Caution .

4. Install the retaining hose clamp (3) to the fuel filler hose (2) and tighten to 4 N.m (35 lb in).
5. Install the retaining hose clamp (1) to the fuel filler hose (2) and tighten to 4 N.m (35 lb in).

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6. Install the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
7. Lower the vehicle to the ground. Refer to **Lifting and Jacking the Vehicle** .
8. Add the drained fuel to the fuel tank.
9. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

Fuel Tank Draining Method 2

1. Install the fuel pressure gauge to the vehicle. Refer to **Fuel Pressure Gauge Installation and Removal** .
2. Place the bleed hose of the fuel pressure gauge into a suitable container.

NOTE: Do not leave the vehicle unattended when performing this procedure.

3. Command the fuel pump ON with a scan tool.

NOTE: Do not fully open the bleed valve on the fuel pressure gauge. To drain both sides of the fuel tank simultaneously there should be a restriction on the flow rate at the bleed hose.

4. Open the bleed valve on the fuel pressure gauge just enough to cause a restriction to the flow of the fuel rate at the bleed hose.

NOTE: To avoid damage to the fuel pump do not allow the fuel pump to run dry while the fuel pump is in the ON state.

5. Command the fuel pump OFF with the scan tool as soon as it is observed that no more fuel is coming out of the bleed hose.
6. Remove the fuel pressure gauge from the vehicle. Refer to **Fuel Pressure Gauge Installation and Removal** .

Adding The Drained Fuel to The Fuel Tank for Method 2

1. Lower the vehicle to the ground. Refer to **Lifting and Jacking the Vehicle** .
2. Add the drained fuel to the fuel tank.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

1. Remove the fuel filler cap.

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and

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strap the vehicle to the hoist.

WARNING: Refer to Safety Glasses Warning .

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Drain the fuel tank below the level of the fuel filler hose. Refer to **Fuel Tank Draining** .
4. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the right rear wheelhouse liner. Refer to **Rear Wheelhouse Panel Liner Replacement** .
6. Remove the rear bumper fascia. Refer to **Rear Bumper Fascia Replacement** .

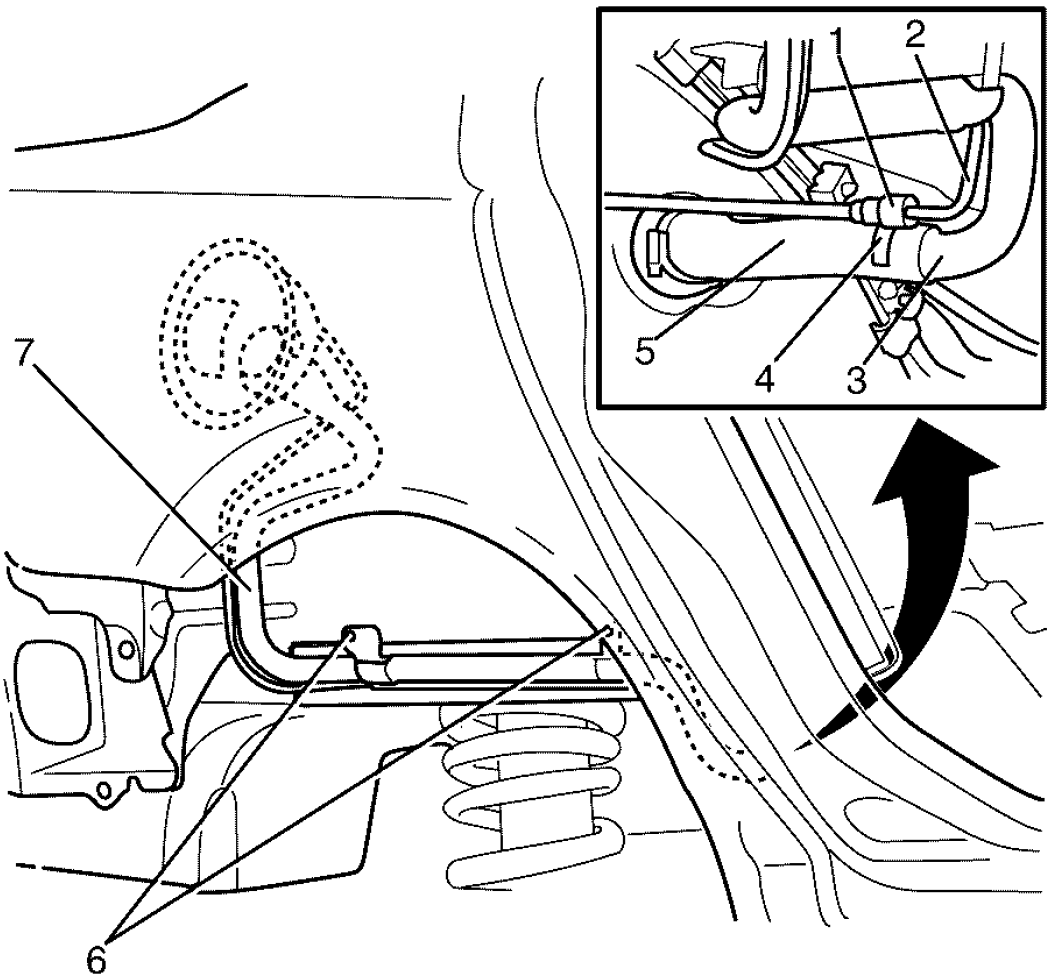


Fig. 44: View Of Quick Connect Fitting, EVAP Line, Fuel Filler Tube & Hose With Clamp
Courtesy of GENERAL MOTORS CORP.

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7. Remove the filler tube to chassis retaining bolts (6).
8. Disconnect the evaporative emission (EVAP) line (2) from the quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
9. Remove the retaining hose clamp (4).
10. Disconnect the fuel filler tube (3) from the fuel filler hose (5).
11. Manoeuvre the fuel filler tube (7) and remove from the vehicle.

Installation Procedure

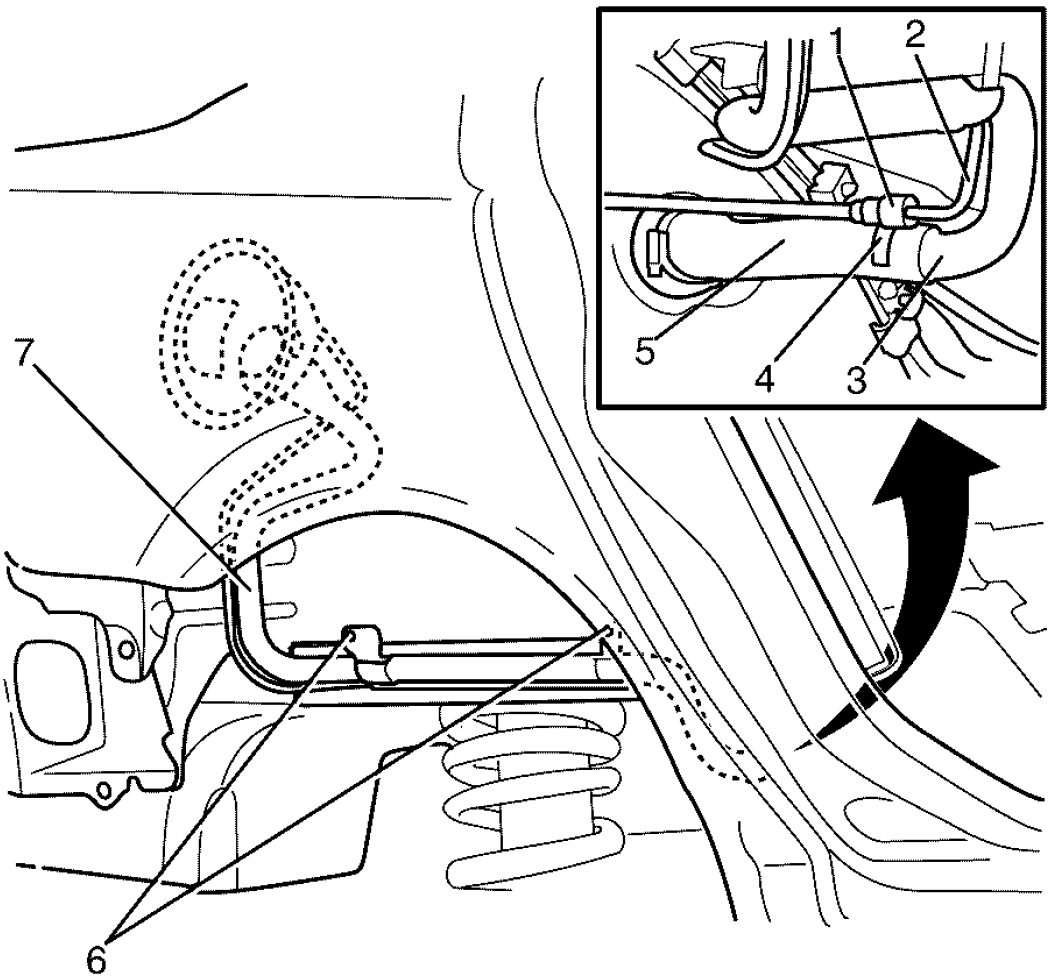


Fig. 45: View Of Quick Connect Fitting, EVAP Line, Fuel Filler Tube & Hose With Clamp
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel filler tube (7) to the vehicle.
2. Connect the fuel filler tube (3) to the fuel filler hose (5).

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CAUTION: Refer to Fastener Caution .

3. Install the retaining hose clamp (4) the fuel filler tube hose clamp (3) to 3.5 N.m (31 lb in).

NOTE: Listen for an audible click to confirm correct installation.

4. Connect the evaporative emission (EVAP) line (2) to the quick connect fitting (1).
5. Install the filler tube to chassis retaining bolts (6) and tighten to 9 N.m (80 lb in).
6. Install the rear bumper fascia. Refer to **Rear Bumper Fascia Replacement** .
7. Install the right rear wheelhouse liner. Refer to **Rear Wheelhouse Panel Liner Replacement** .
8. Install the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .

FUEL TANK REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to **Fuel Pressure Relief** .
2. Drain the fuel tank. Refer to **Fuel Tank Draining** .
   - Support the rear suspension with a jack stand.
   - Remove the front support bolts.
   - Loosen the rear support bolts in order to slide the fuel tank out.
   - For tightening specifications, refer to **Rear Suspension Support Replacement** .

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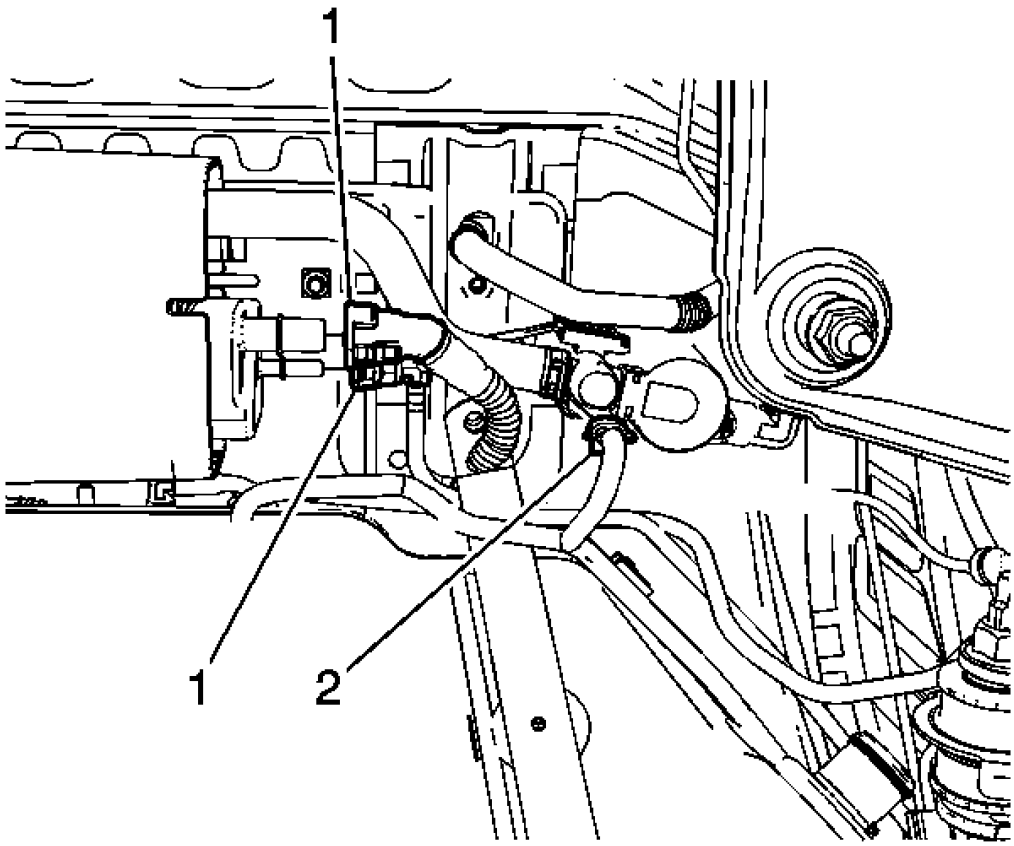


Fig. 46: Evaporative Emission Lines & Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the evaporative emission lines (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
4. Disconnect the vent solenoid electrical connector (2).

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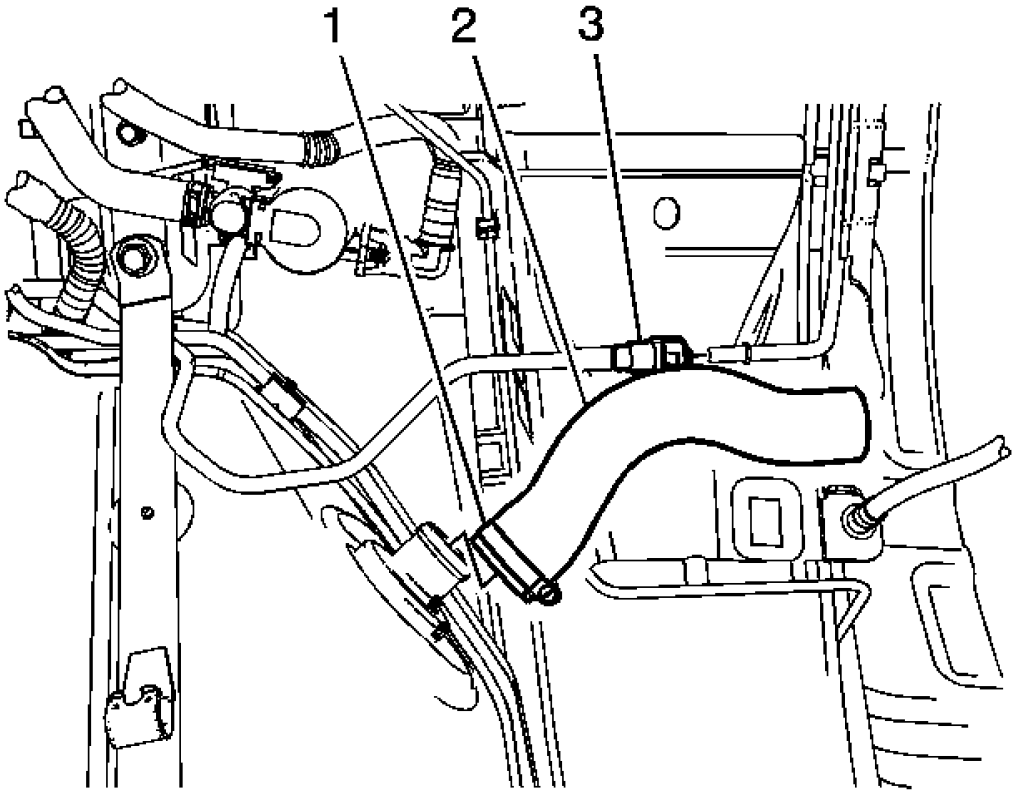


Fig. 47: Hose Clamp, Filler Tube & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

5. Loosen the hose clamp (1) and remove the filler tube (2).
6. Disconnect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service** .

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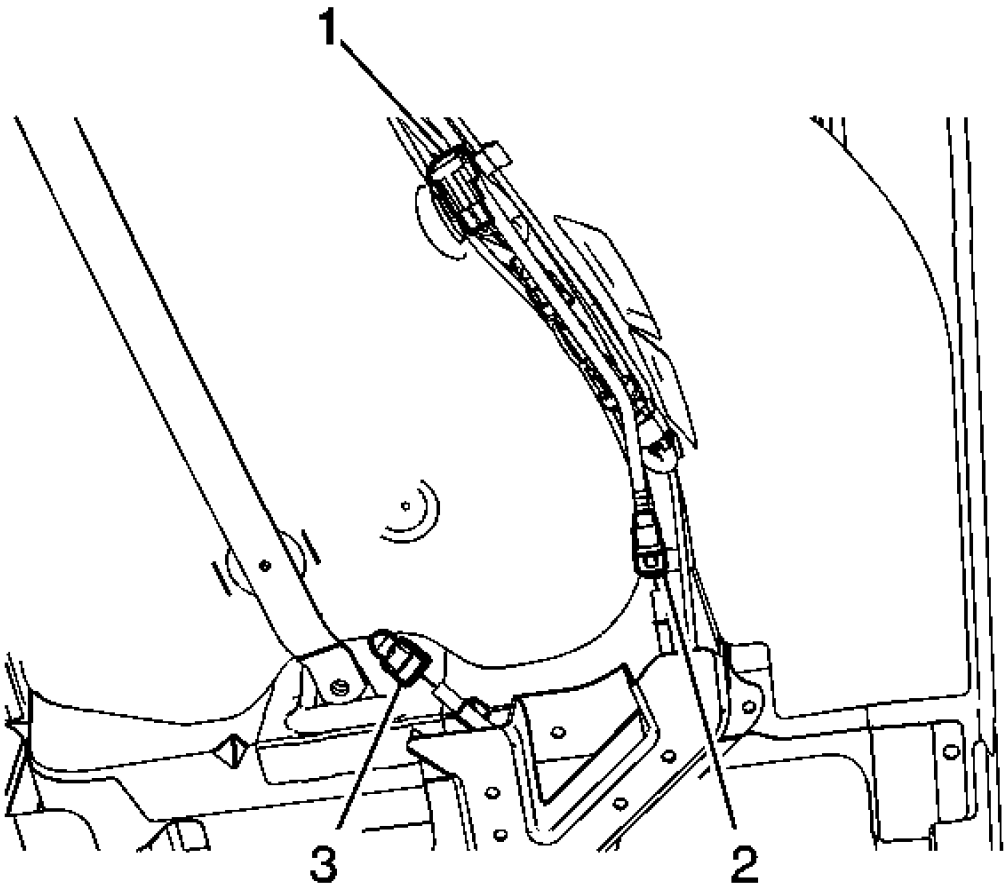


Fig. 48: Fuel Tank Electrical Connector, Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the fuel tank electrical connector (1).
8. Disconnect the fuel feed line (3) and evaporative emission line (2). Refer to **Plastic Collar Quick Connect Fitting Service** and **Metal Collar Quick Connect Fitting Service** .

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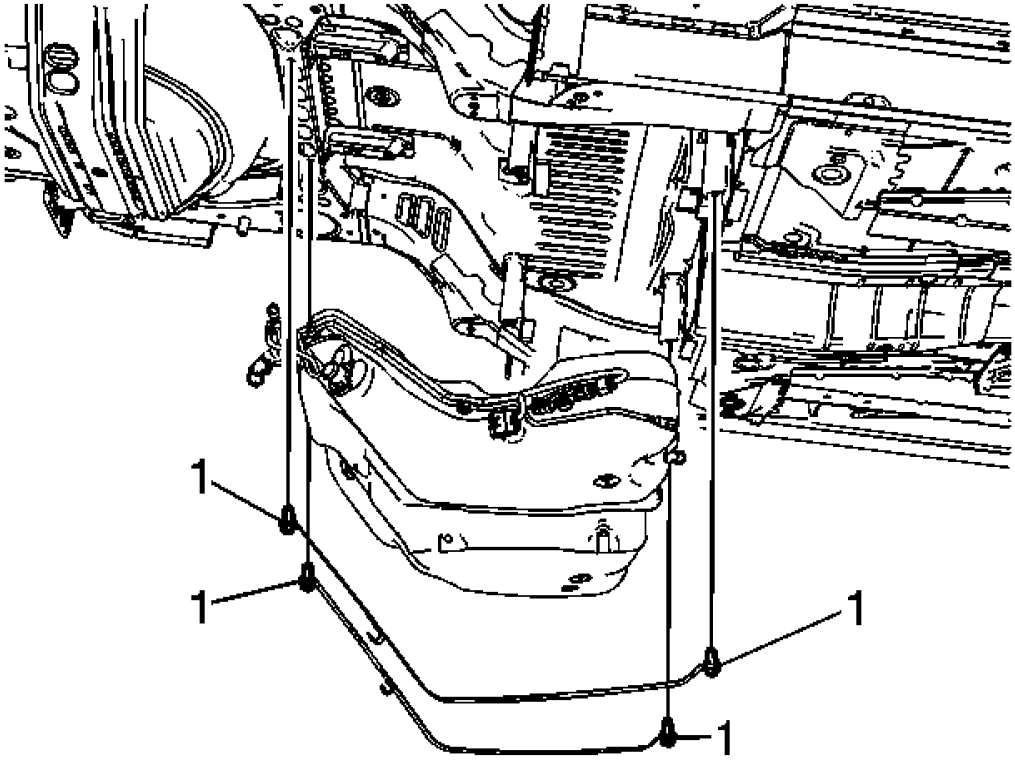


Fig. 49: Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS CORP.

9. Support the fuel tank with a suitable jack.
10. Remove the fuel tank strap bolts (1).
11. Remove the fuel tank.
12. Remove the following components if replacing just the fuel tank.
    1. Fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** .
    2. Fuel level sensor. Refer to **Fuel Level Sensor Replacement - Left Side** .
    3. Transfer components as necessary.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
    1. Fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** .
    2. Fuel level sensor. Refer to **Fuel Level Sensor Replacement - Left Side** .

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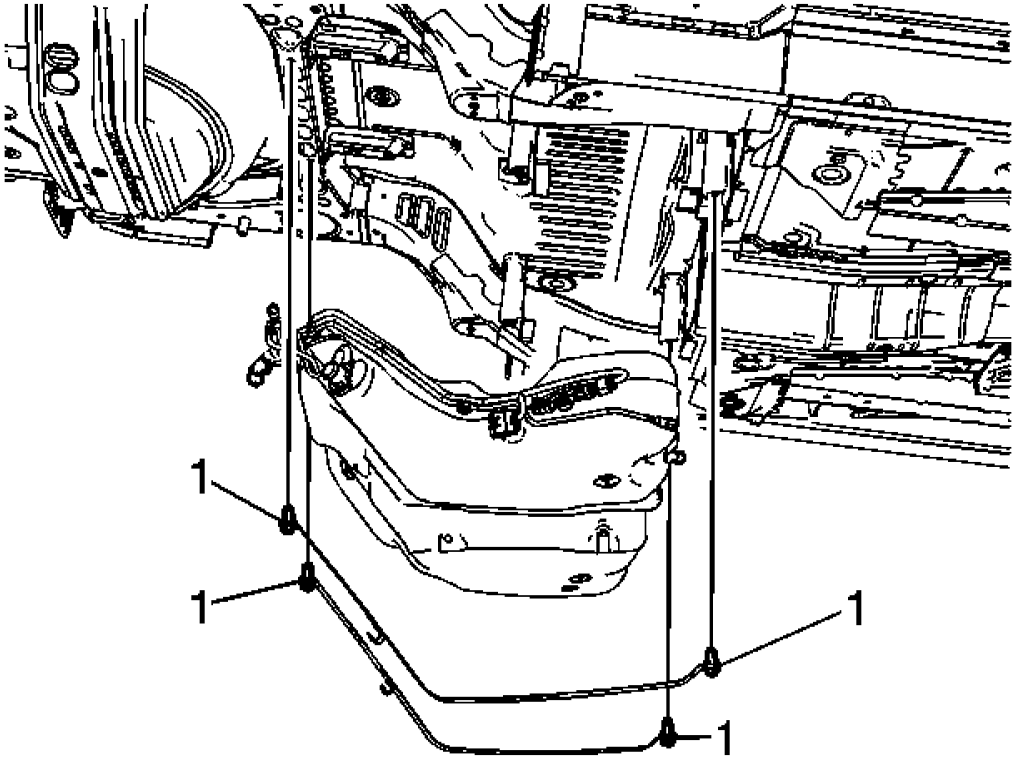


Fig. 50: Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Use a suitable jack and install the fuel tank.
3. Install the fuel tank strap bolts (1) and tighten to 50 N.m (37 lb ft).

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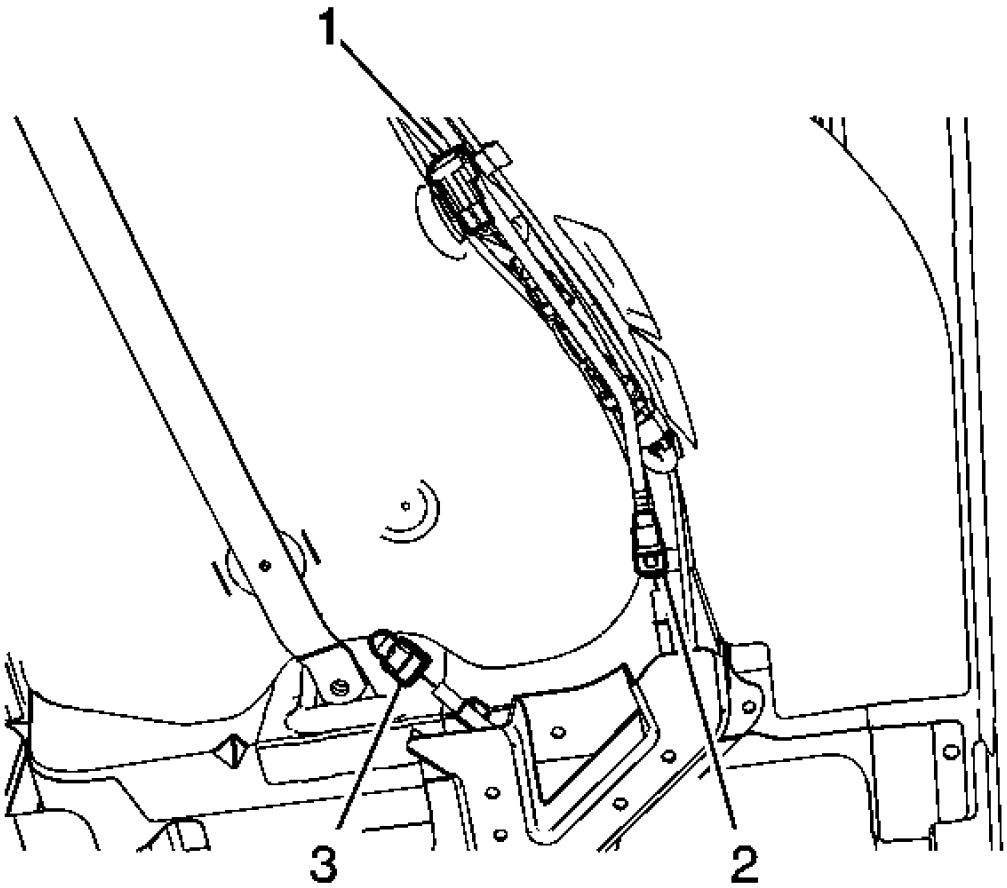


Fig. 51: Fuel Tank Electrical Connector, Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel tank electrical connector (1).
5. Connect the fuel feed line (2) and evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service** and **Metal Collar Quick Connect Fitting Service** .

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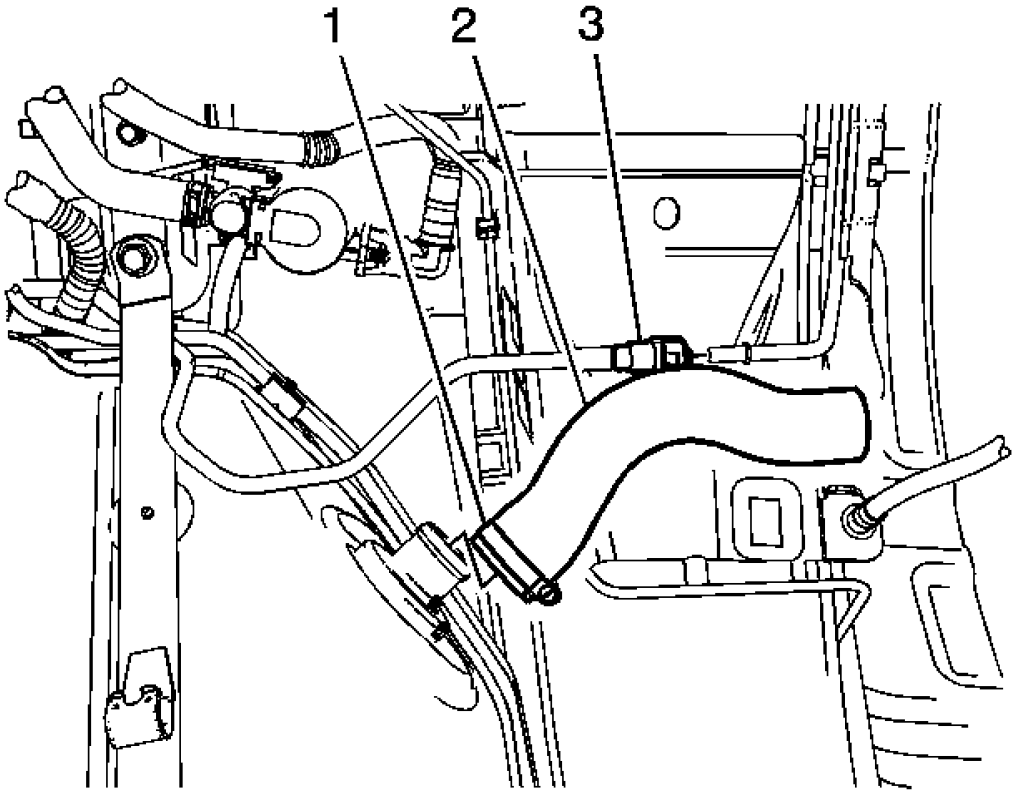


Fig. 52: Hose Clamp, Filler Tube & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

6. Install the filler tube (2) and tighten the hose clamp (1) to 4 N.m (35 lb in) and remove the filler tube (2).
7. Connect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service** .

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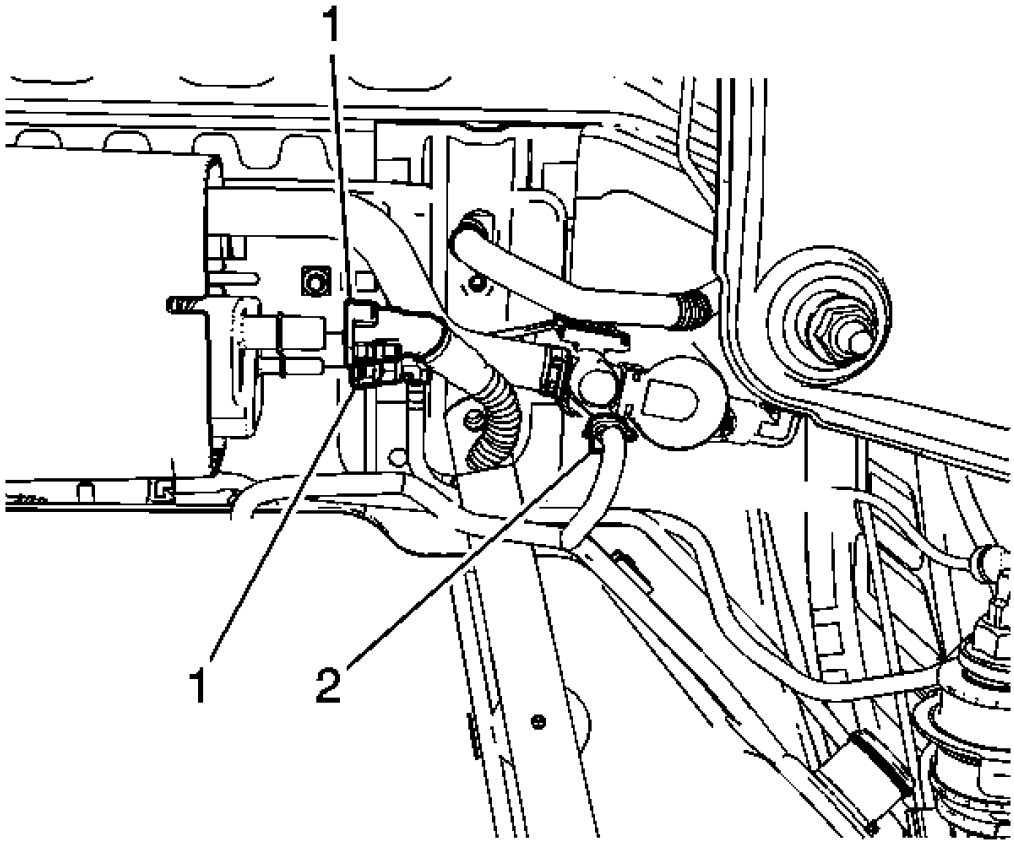


Fig. 53: Evaporative Emission Lines & Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Connect the evaporative emission lines (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
9. Connect the vent solenoid electrical connector (2).
10. Connect the parking brake cables at the calipers. Refer to **Parking Brake Rear Cable Replacement** .
11. Install the rear suspension support and tighten to specifications. Refer to **Rear Suspension Support Replacement** .
12. Refill the fuel tank.
13. Inspect for fuel leaks.

FUEL TANK PRESSURE SENSOR REPLACEMENT

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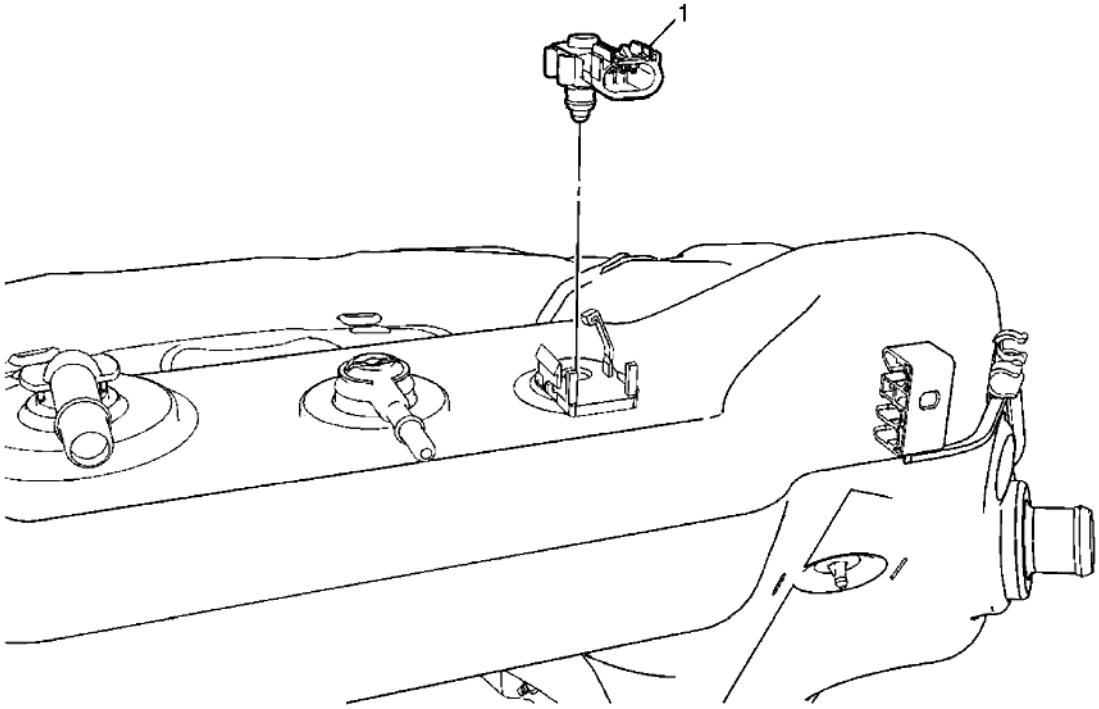


Fig. 54: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the fuel tank. Refer to Fuel Tank Replacement .**	
1	Fuel Tank Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Release the retaining tab.

FUEL TANK FUEL PUMP MODULE REPLACEMENT - RIGHT SIDE

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

Removal Procedure

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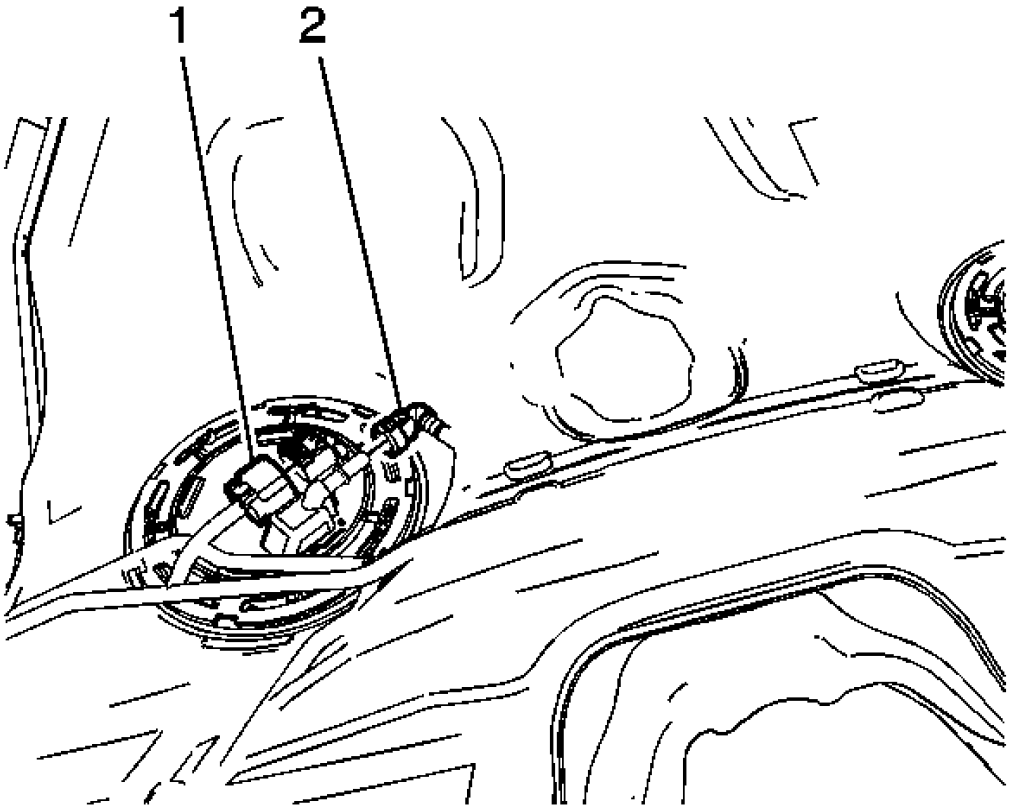


Fig. 55: Fuel Pump Electrical Connector & Fuel Feed Line
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement** .
2. Disconnect the fuel pump electrical connector (1) and the fuel feed line (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

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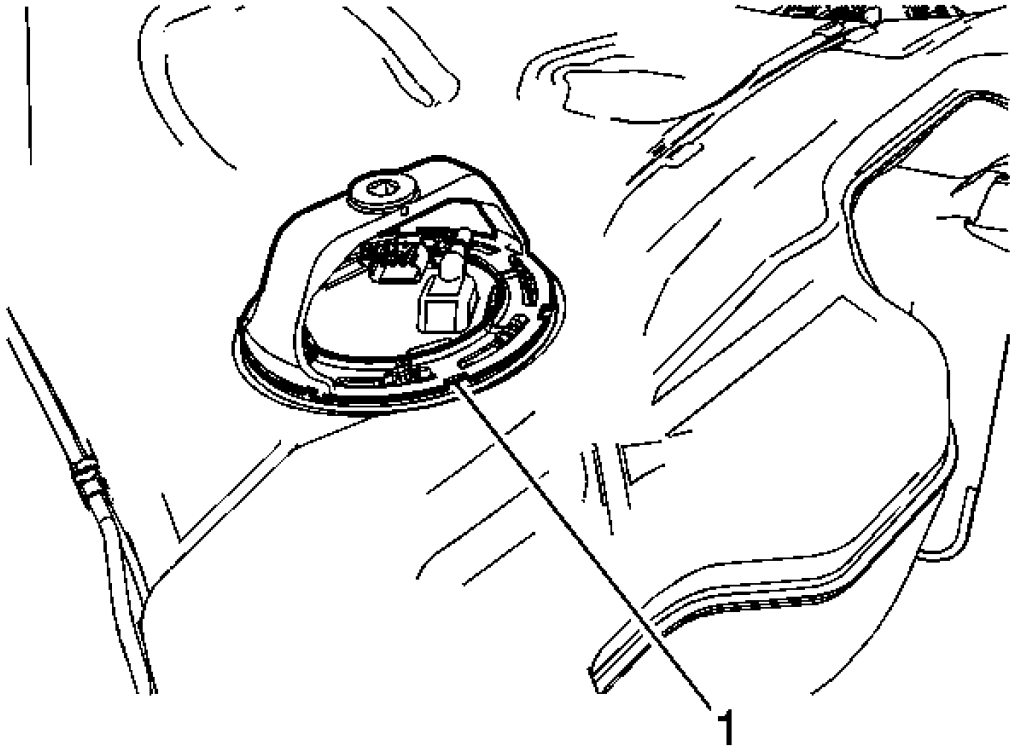


Fig. 56: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 45722:** wrench by turning counter clockwise and remove the lock ring (1).

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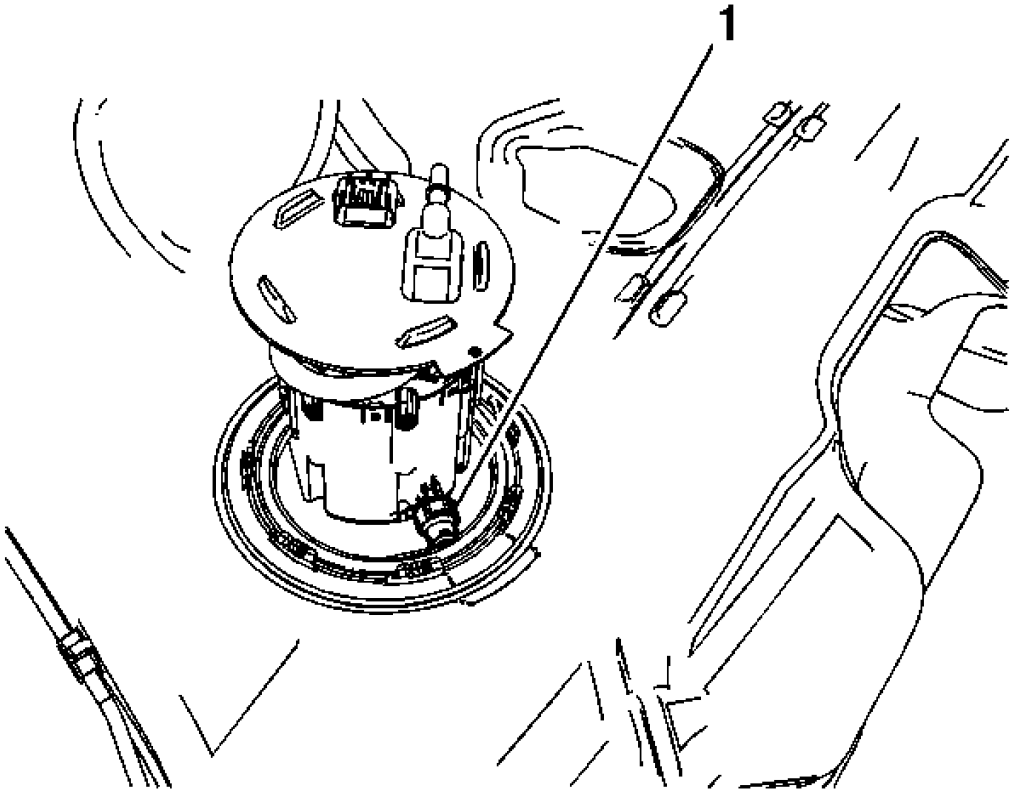


Fig. 57: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Partially remove the primary fuel tank module in order to disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

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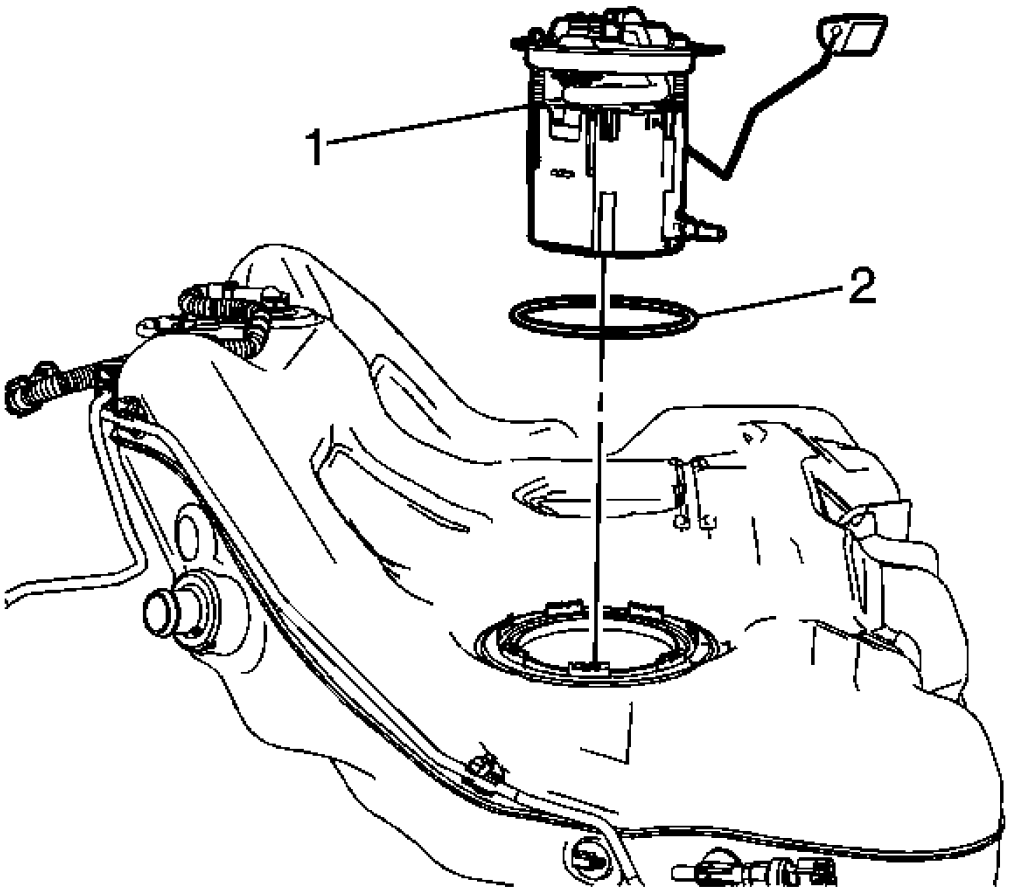


Fig. 58: Primary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the primary fuel tank module (1) and seal (2) from the fuel tank.

Installation Procedure

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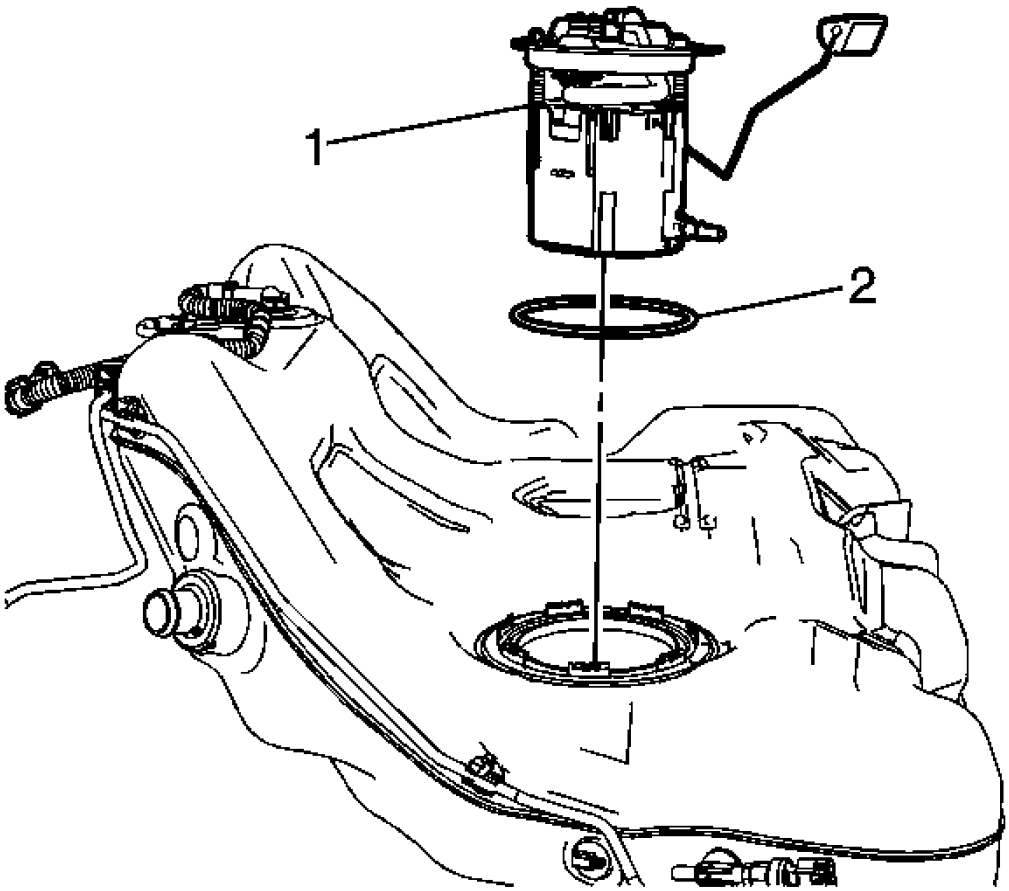


Fig. 59: Primary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW seal (2) and partially install the primary fuel tank module (1).

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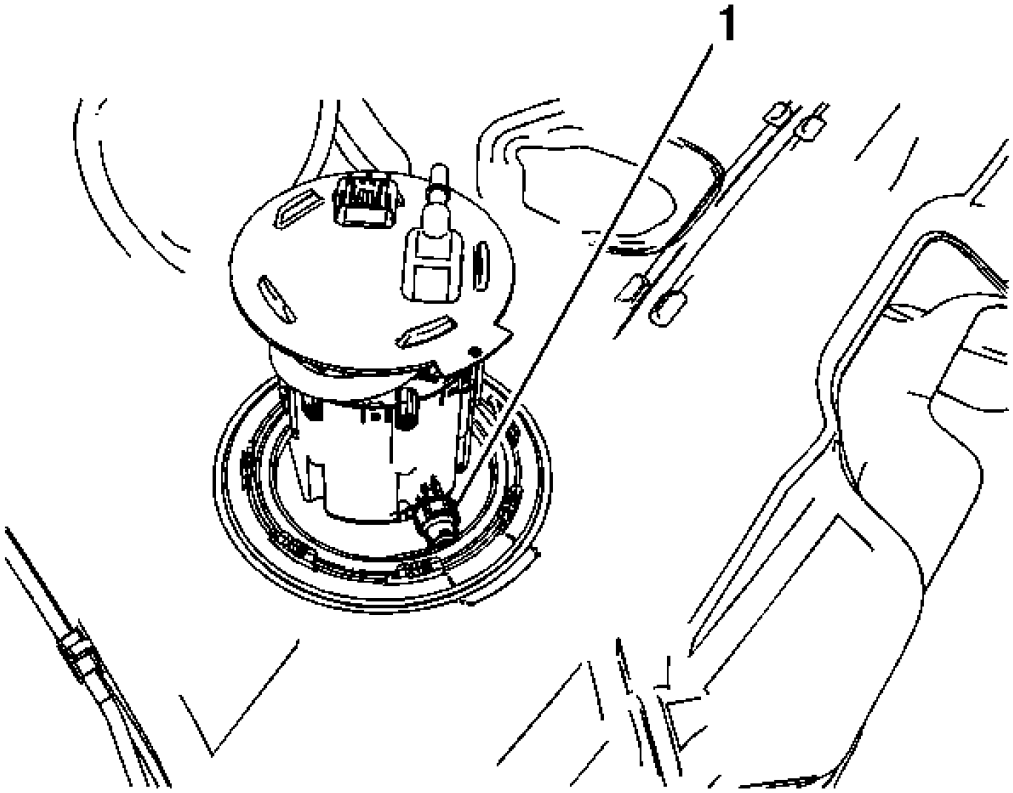


Fig. 60: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

2. Connect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

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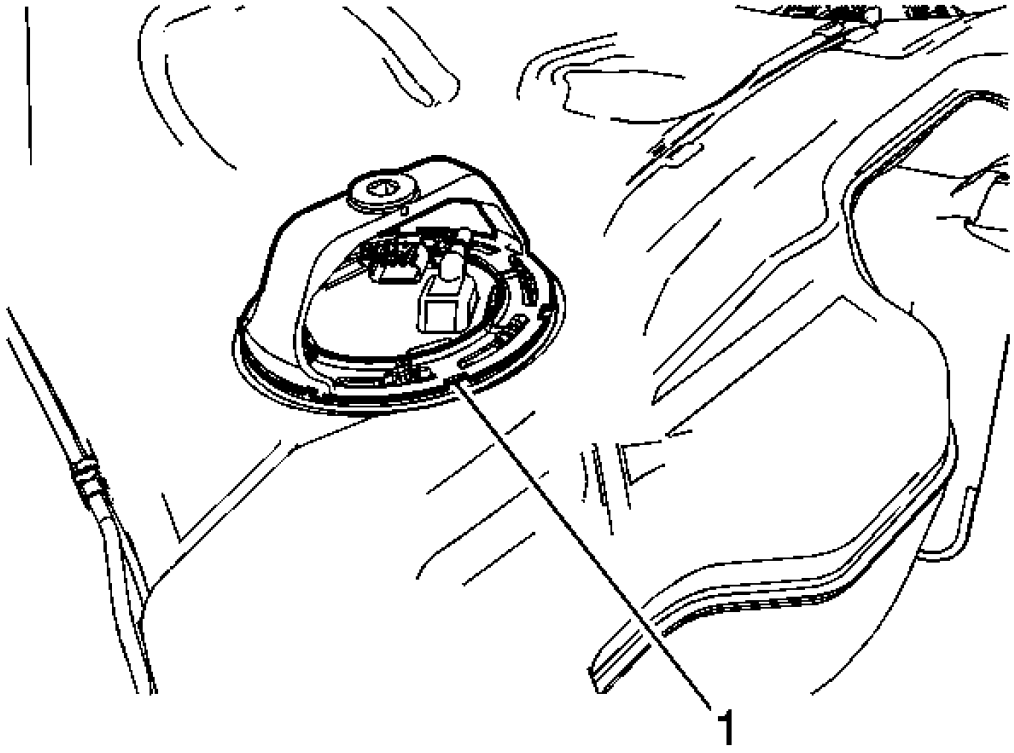


Fig. 61: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 45722:** wrench by turning clockwise and install the lock ring (1).

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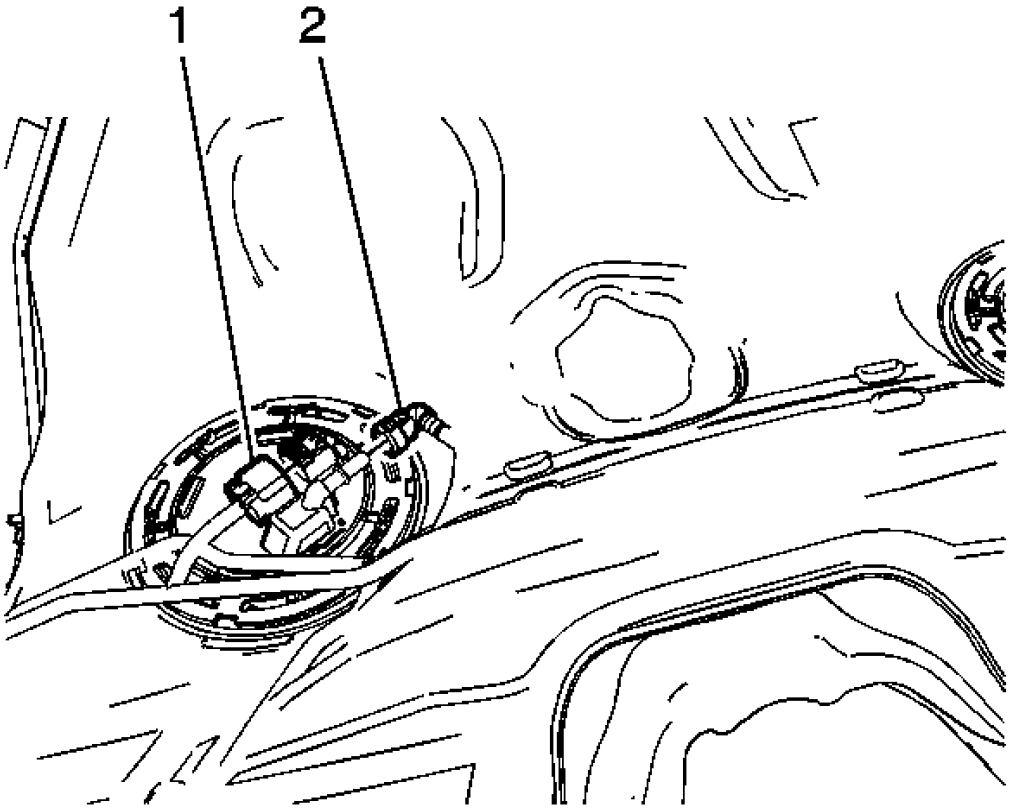


Fig. 62: Fuel Pump Electrical Connector & Fuel Feed Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel pump electrical connector (1) and the fuel feed line (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
5. Install the fuel tank. Refer to **Fuel Tank Replacement** .

FUEL LEVEL SENSOR REPLACEMENT - LEFT SIDE

Special Tools

CH 48482: Fuel Sender Lock Wrench

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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1. Remove the fuel tank. Refer to **Fuel Tank Replacement** .

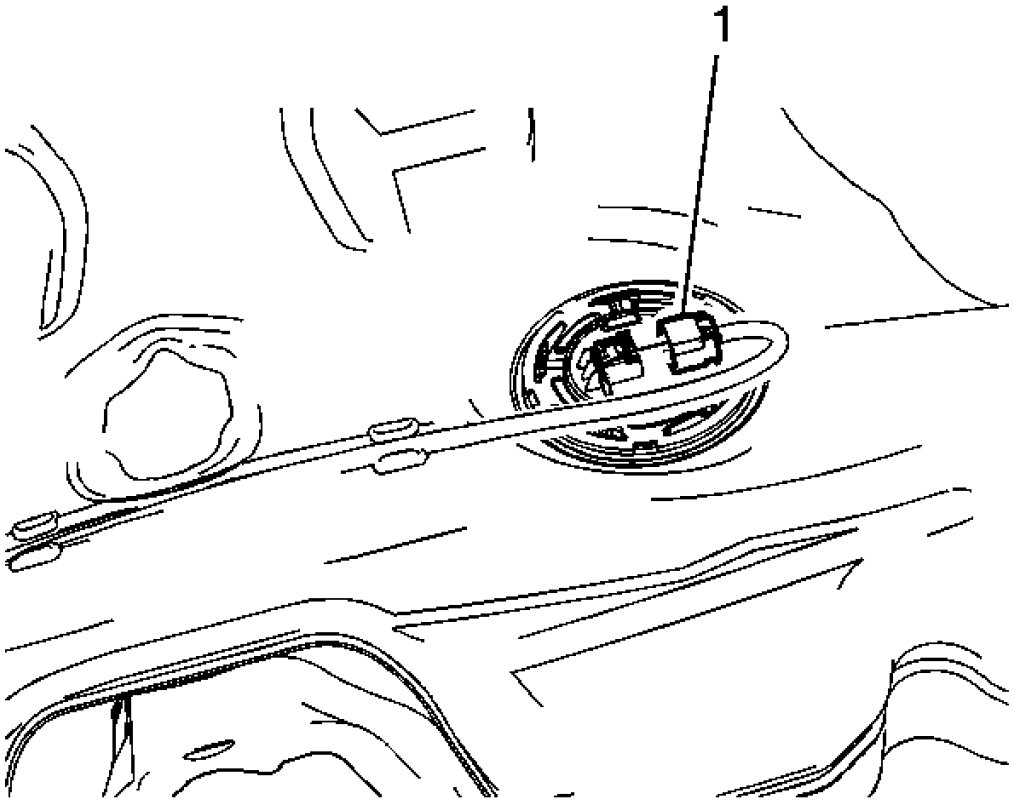


Fig. 63: Secondary Fuel Tank Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the secondary fuel tank module electrical connector (1).

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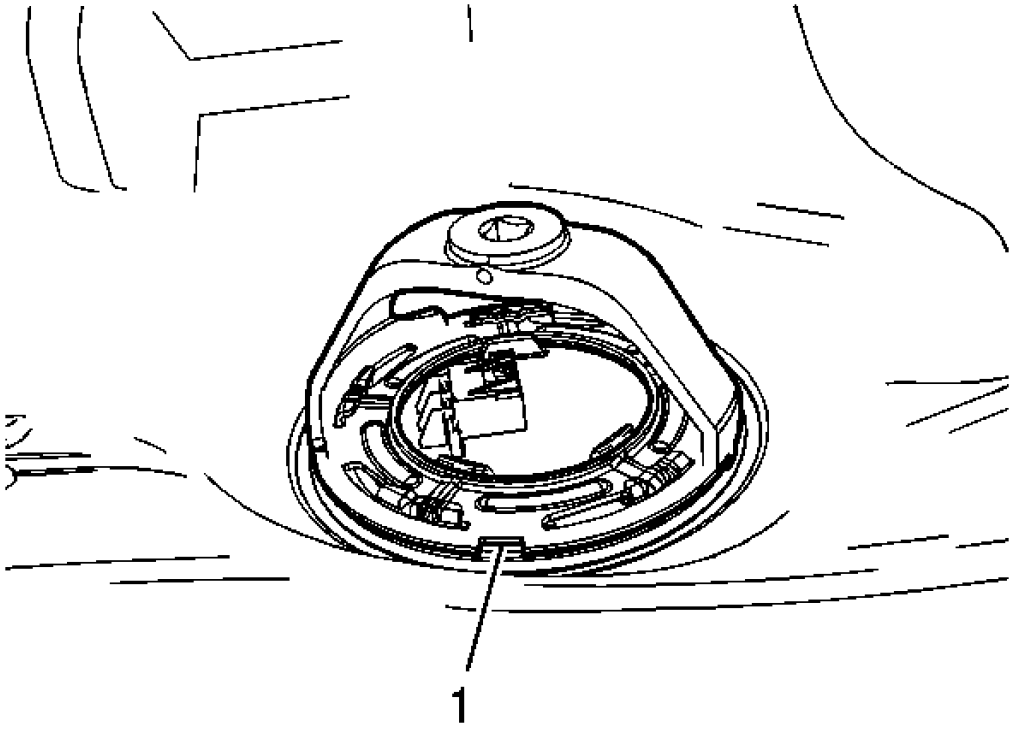


Fig. 64: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Rotate the lock ring (1) counterclockwise using the **CH-48482:** wrench and remove the lock ring.

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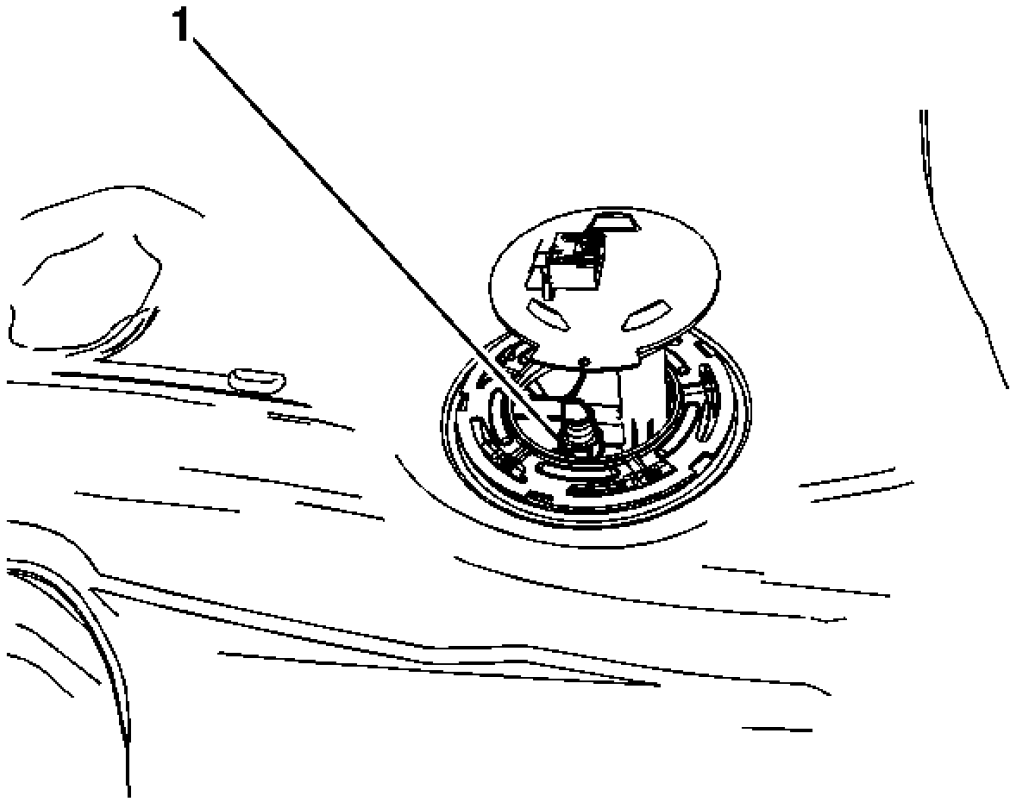


Fig. 65: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Partially remove the primary fuel tank module in order to disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

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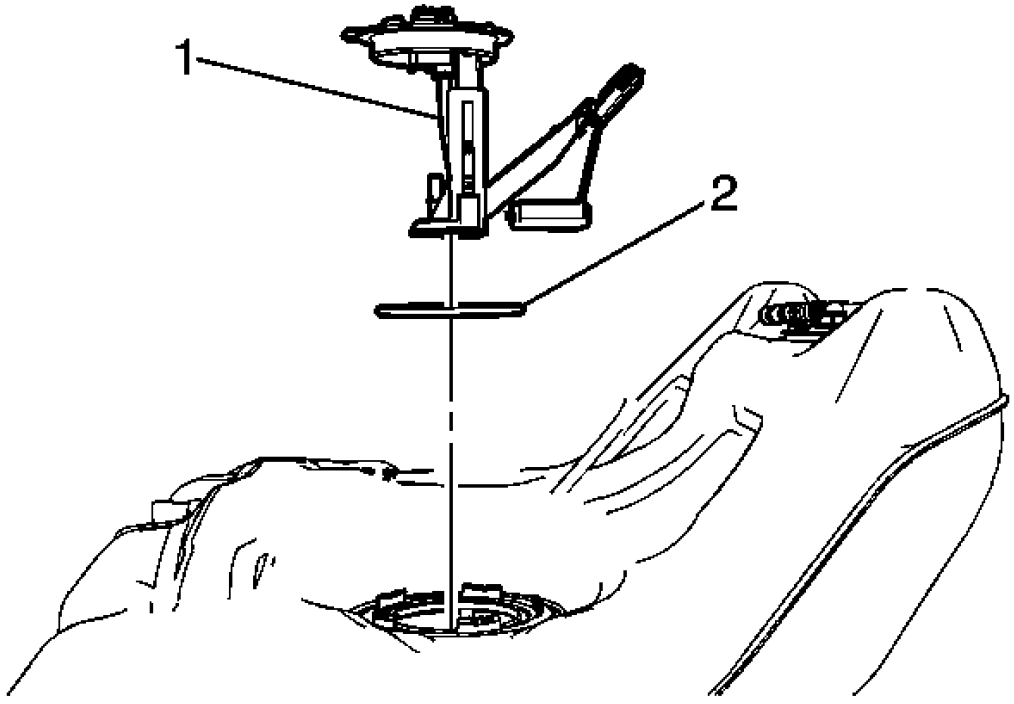


Fig. 66: Secondary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the secondary fuel tank module (1) and the seal (2).

Installation Procedure

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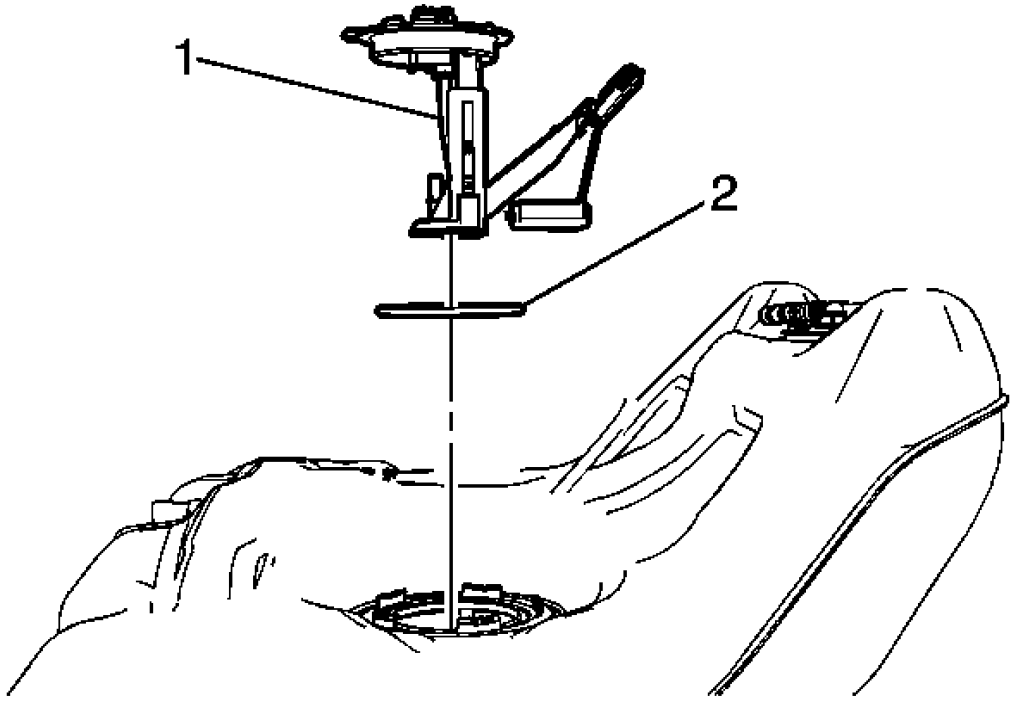


Fig. 67: Secondary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW seal (2).

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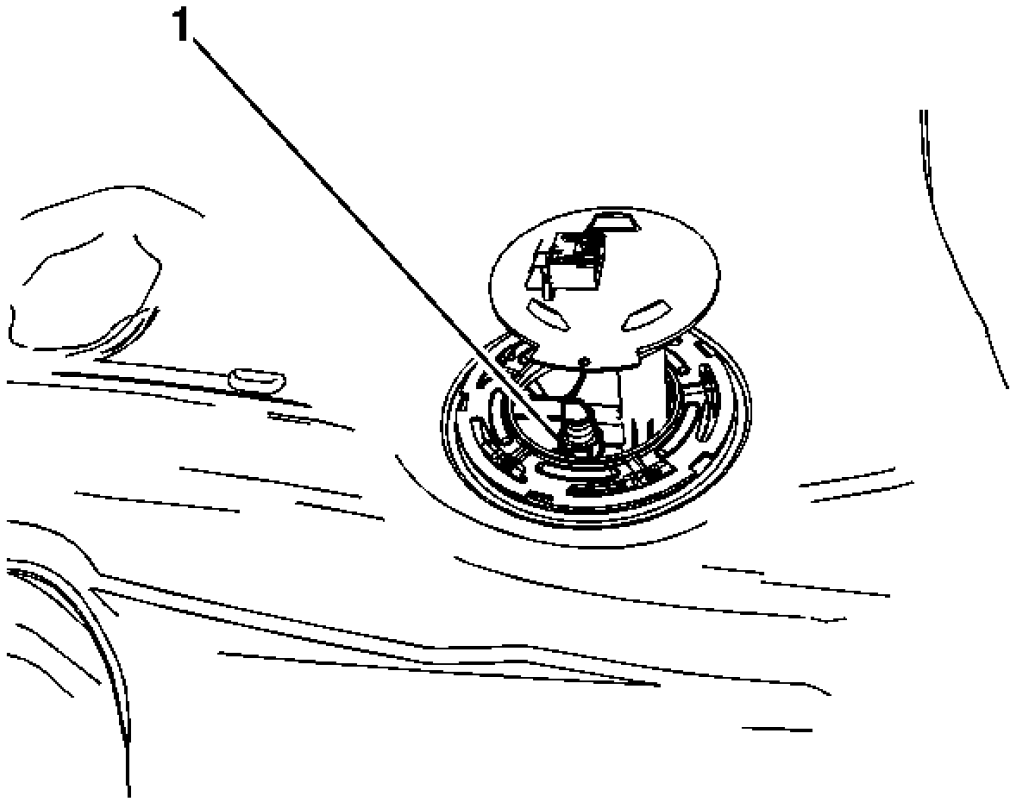


Fig. 68: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

2. Partially install the secondary fuel pump module in order to connect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

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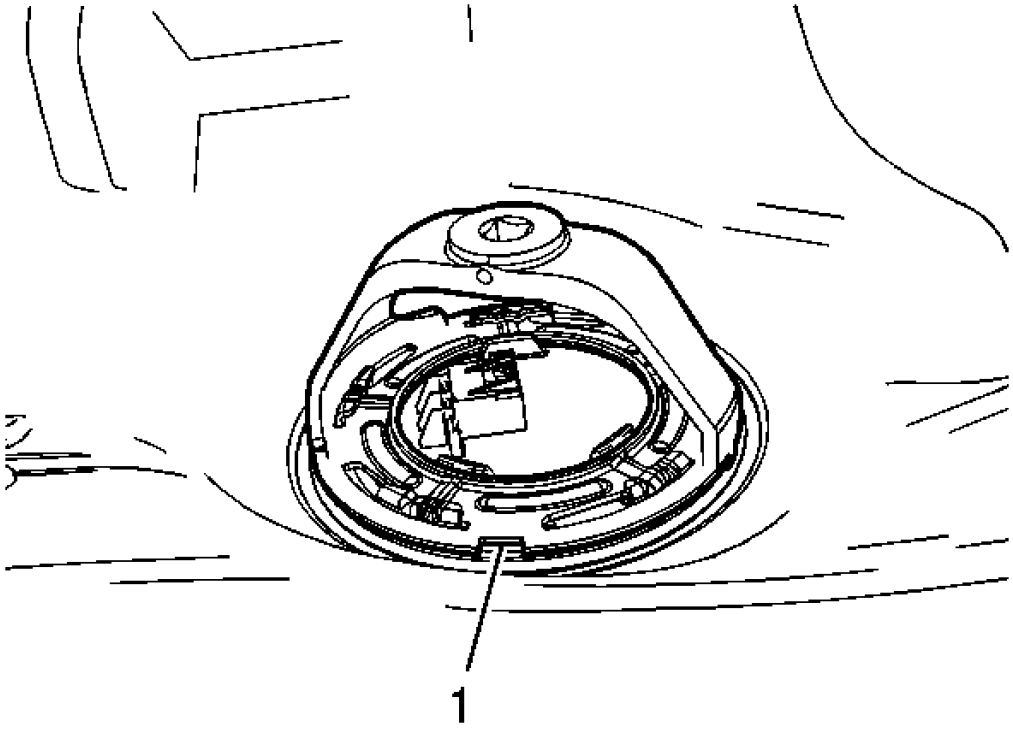


Fig. 69: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Rotate the lock ring (1) clockwise using the **CH-48482:** wrench and install the lock ring.

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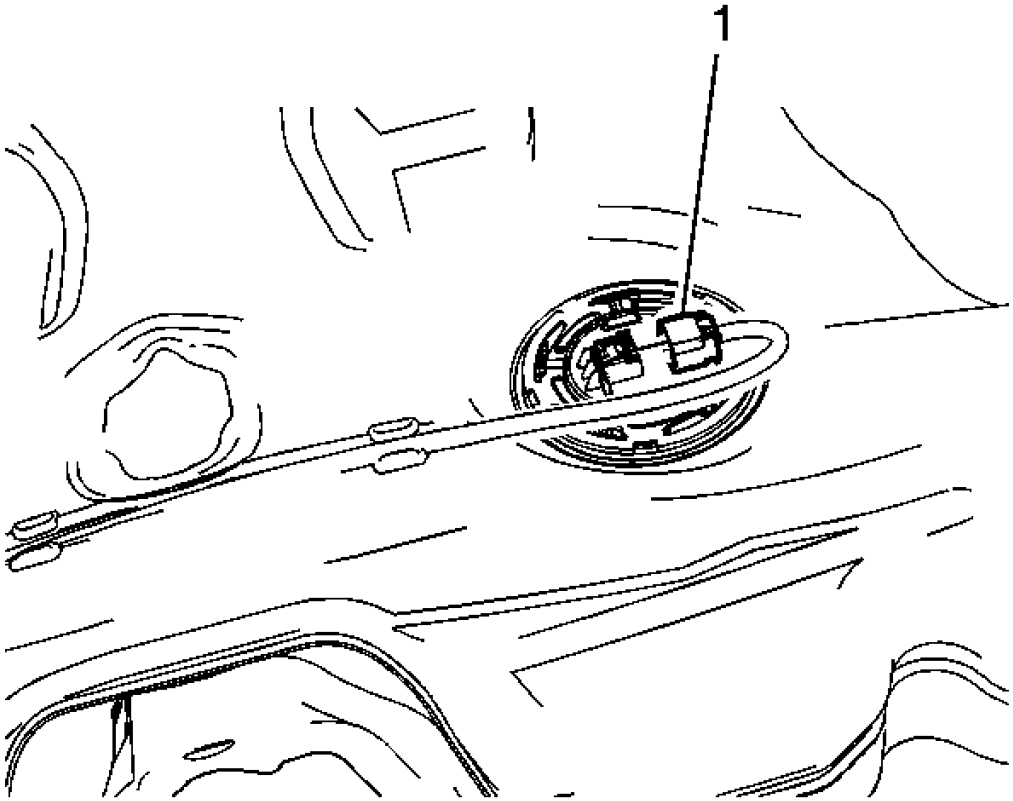


Fig. 70: Secondary Fuel Tank Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the secondary fuel tank module electrical connector (1).
5. Install the fuel tank. Refer to **Fuel Tank Replacement** .

FUEL LEVEL SENSOR REPLACEMENT - RIGHT SIDE

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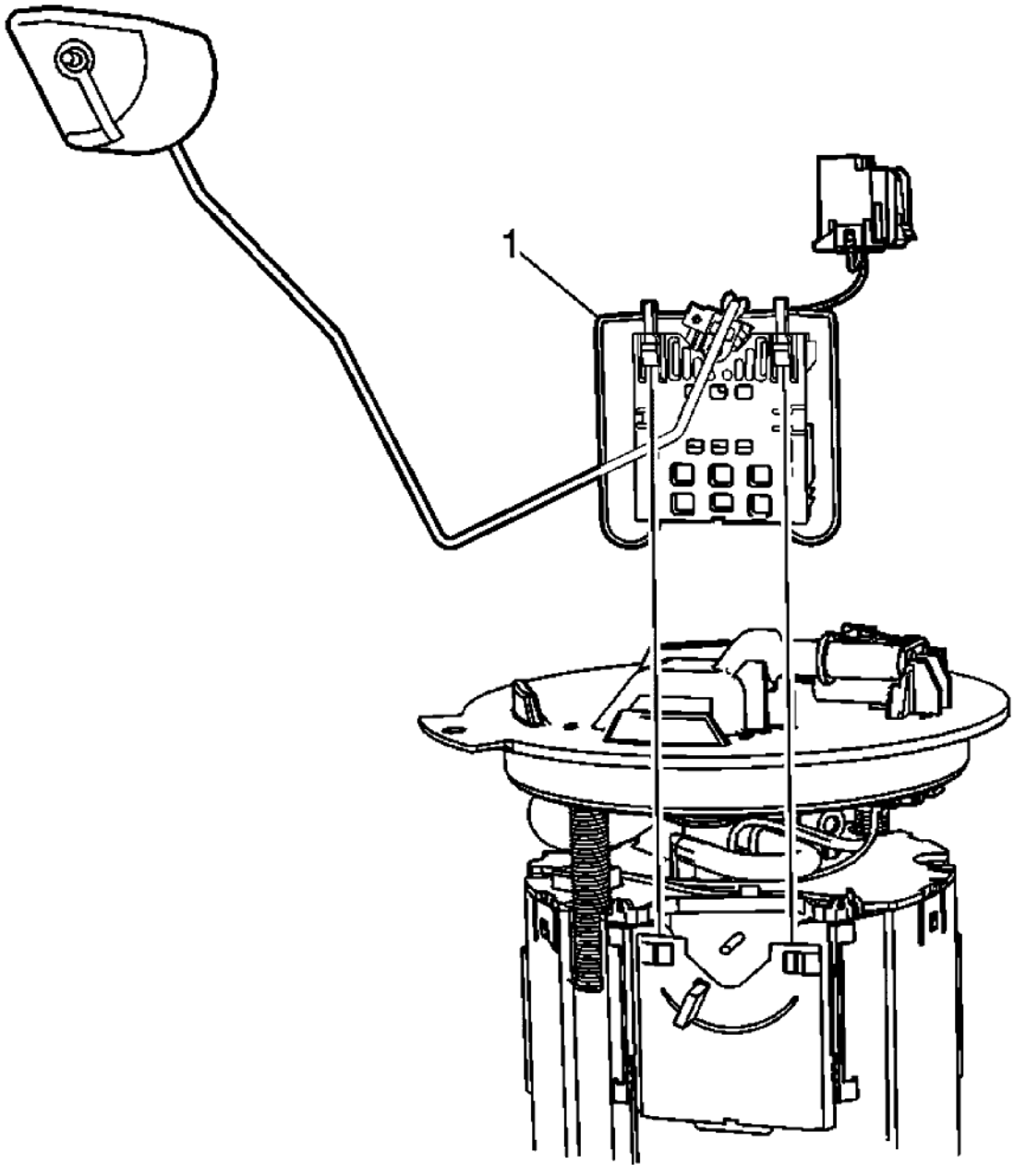


Fig. 71: Fuel Level Sensor - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel pump module-right side. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** .	
	Fuel Level Sensor

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1	**Procedure** 1. Push the plastic tabs forward and simultaneously pull upwards. 2. Disconnect the electrical connector.

FUEL LINE REPLACEMENT - ENGINE

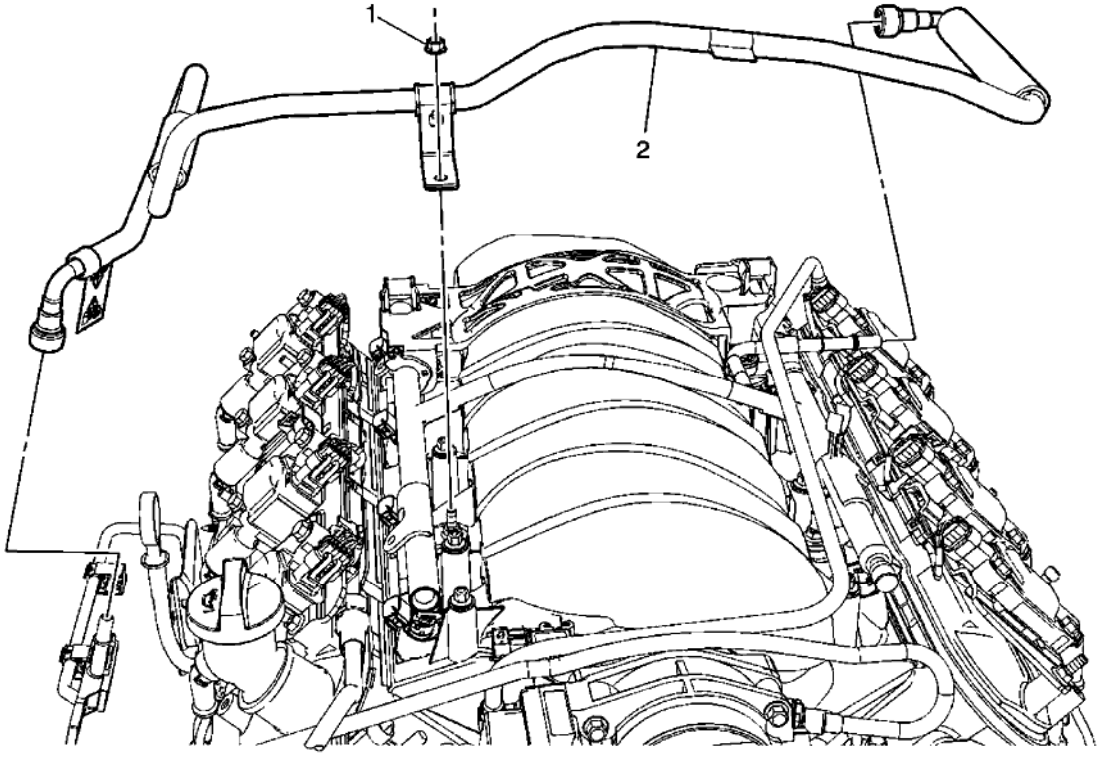


Fig. 72: Fuel Line - Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure **1. Remove the engine cover. Refer to Engine Cover Replacement .** **2. Disconnect the quick connects. Refer to Metal Collar Quick Connect Fitting Service .**	
1	Fuel Line Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m(89 lb in)
2	Fuel Line - Engine Compartment

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FUEL LINE REPLACEMENT - CHASSIS

Removal Procedure

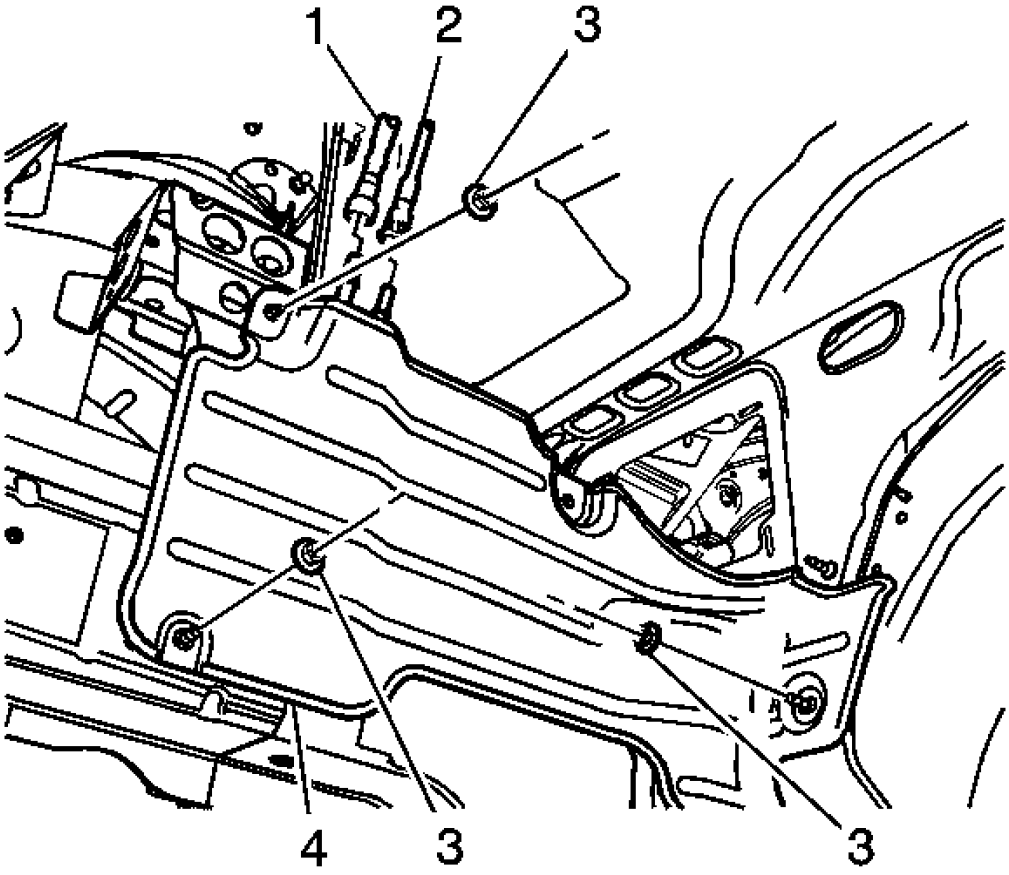


Fig. 73: Fuel Feed Connector, Evaporative Emission Connector, Exhaust Heat Shield Fasteners & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Disconnect the fuel feed connector (1) and the evaporative emission connector (2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service** .
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the exhaust heat shield fasteners (3) and the exhaust heat shield (4).

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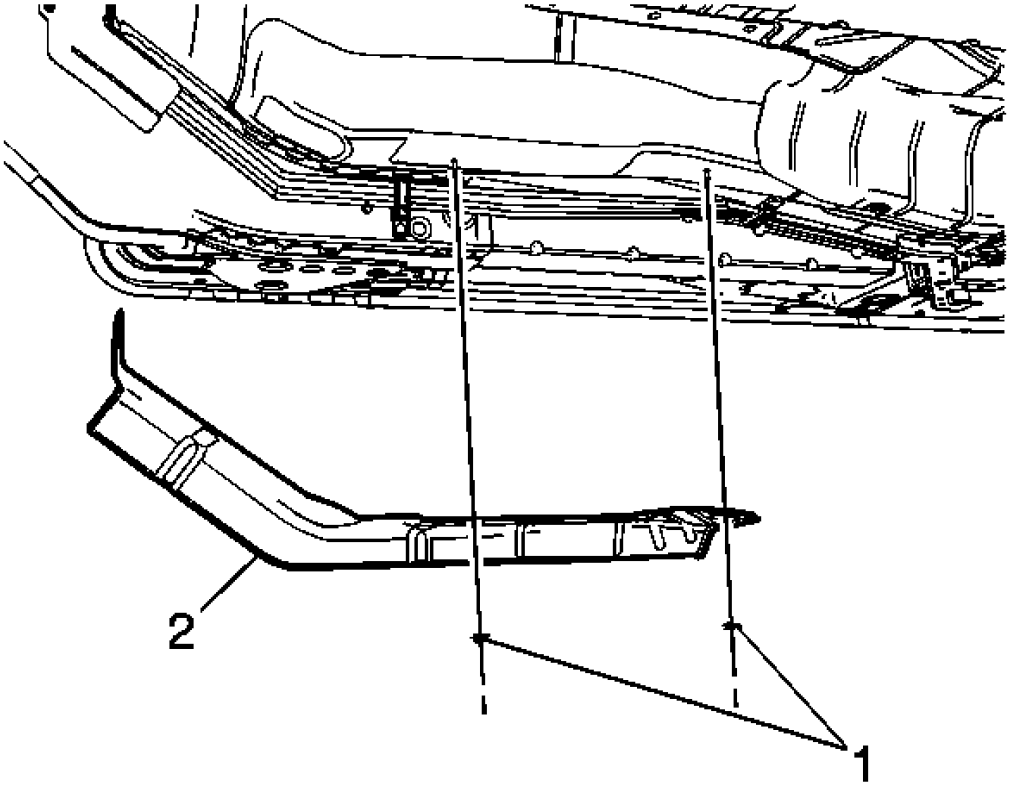


Fig. 74: Exhaust Heat Shield Fastener & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

5. Remove the exhaust heat shield fastener (1) and the exhaust heat shield (2).

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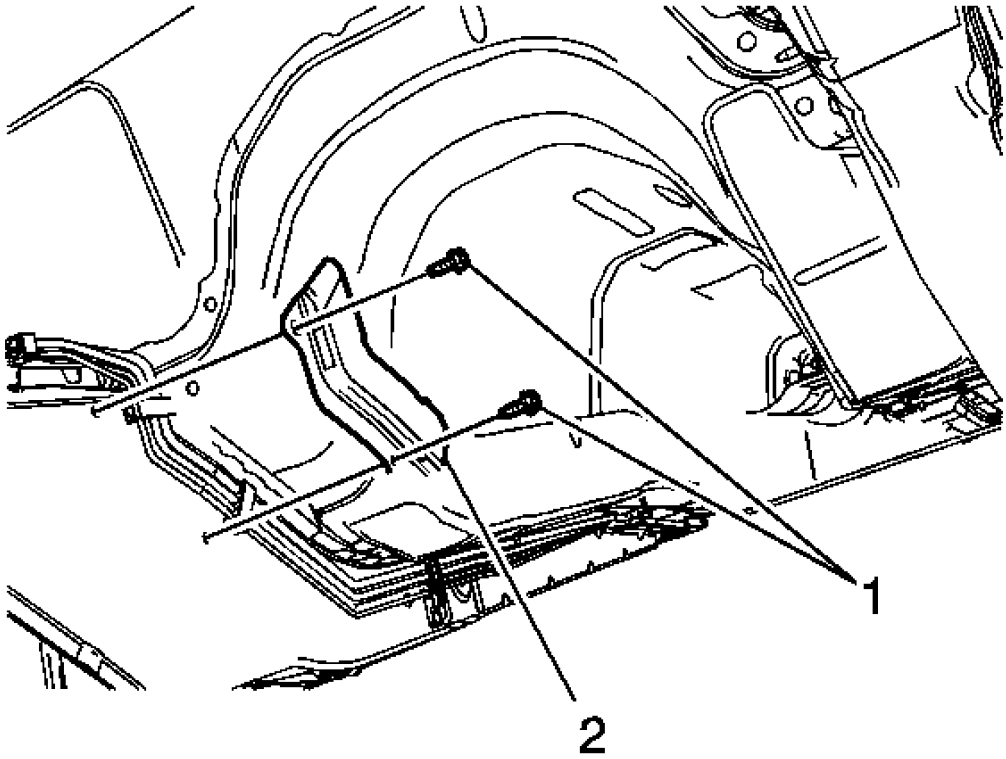


Fig. 75: Brake Pipe Heat Shield Fastener & Heat Shield
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake pipe heat shield fastener (1) and the heat shield (2).

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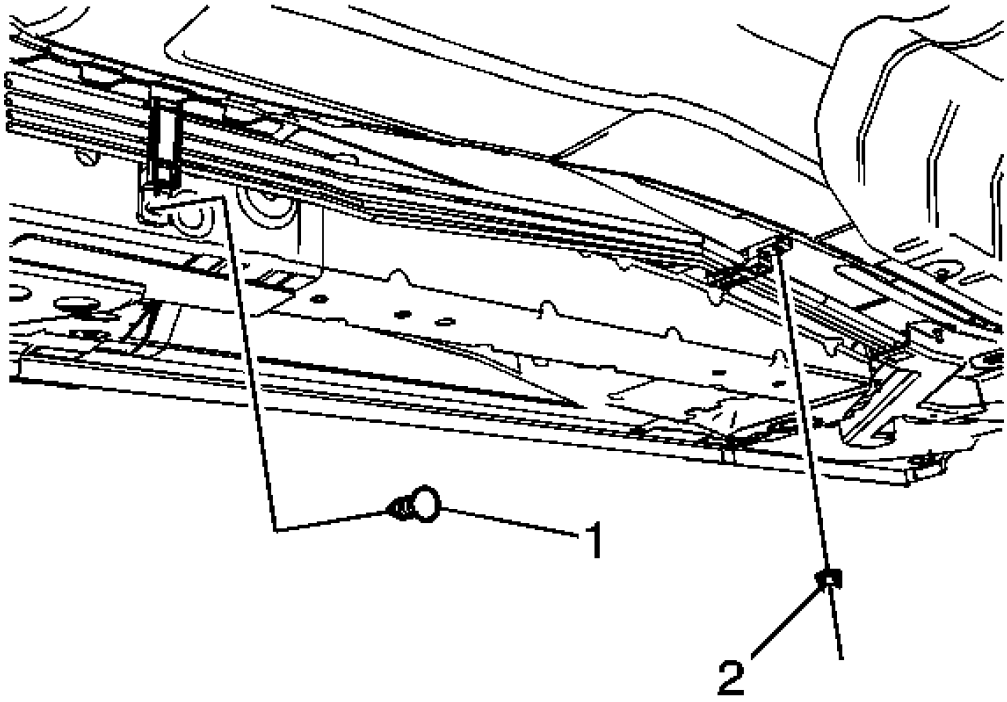


Fig. 76: Plastic Retainer & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the plastic retainer (1) and the retaining nut (2).

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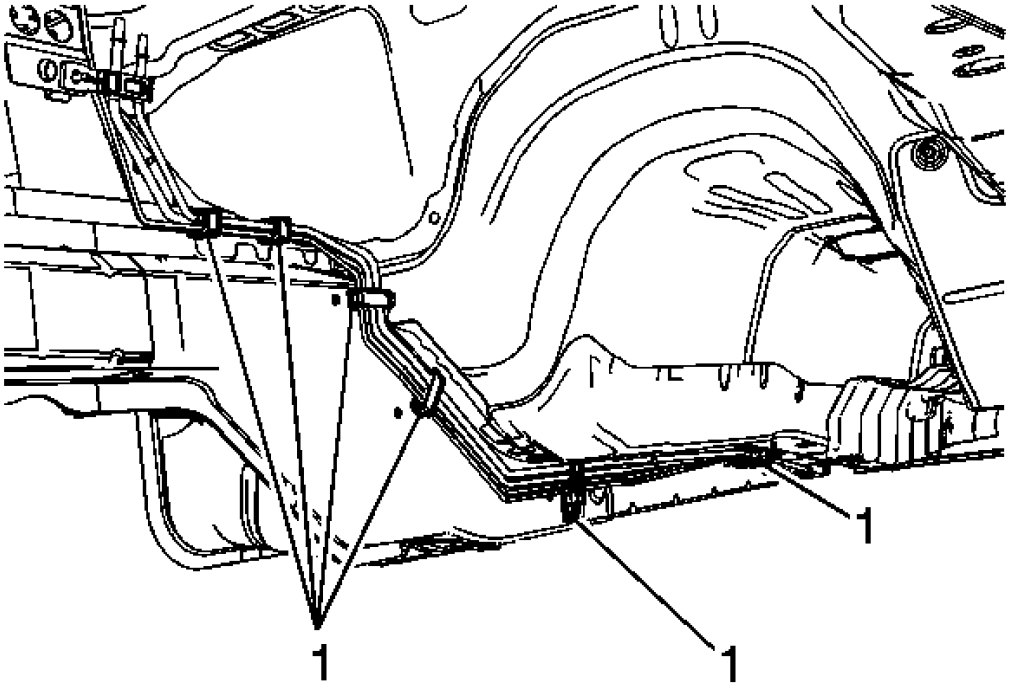


Fig. 77: Fuel Feed Line & Evaporative Emission Line Clips
Courtesy of GENERAL MOTORS CORP.

8. Separate the fuel feed line and the evaporative emission line from the clips (1).

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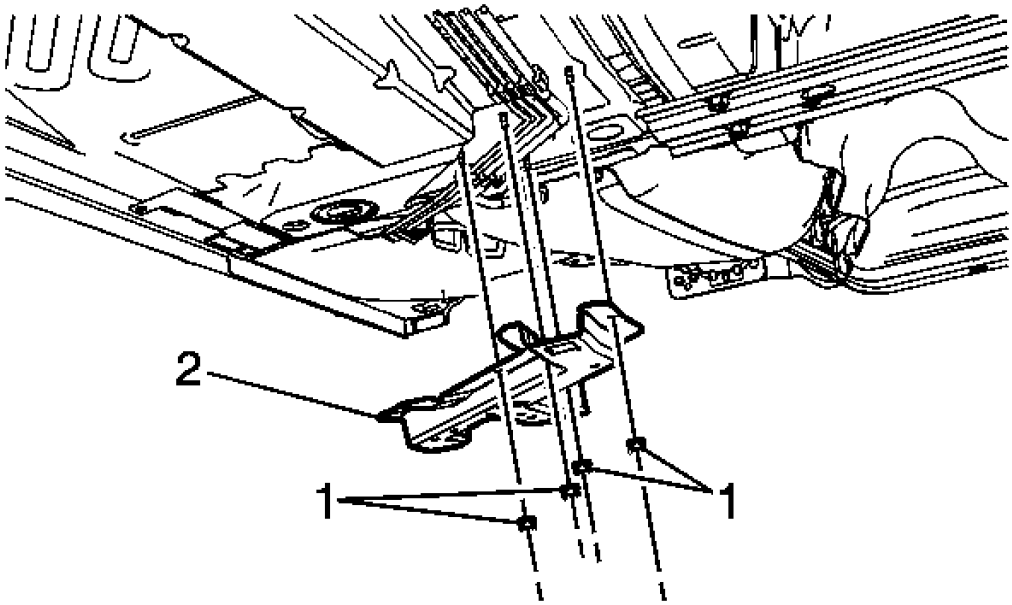


Fig. 78: Protector Bracket Fasteners & Bracket
Courtesy of GENERAL MOTORS CORP.

9. Remove the protector bracket fasteners (1) and remove the bracket (2).

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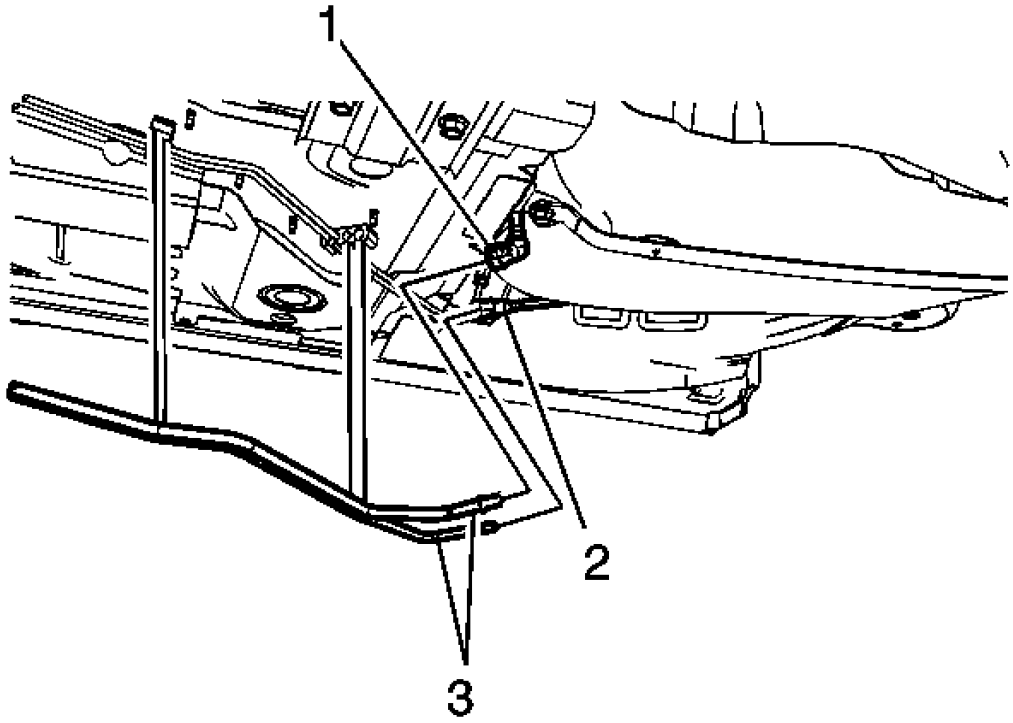


Fig. 79: Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel feed line (1) and the evaporative emission line (2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service** .
11. Remove the pipes (3) from the vehicle.

Installation Procedure

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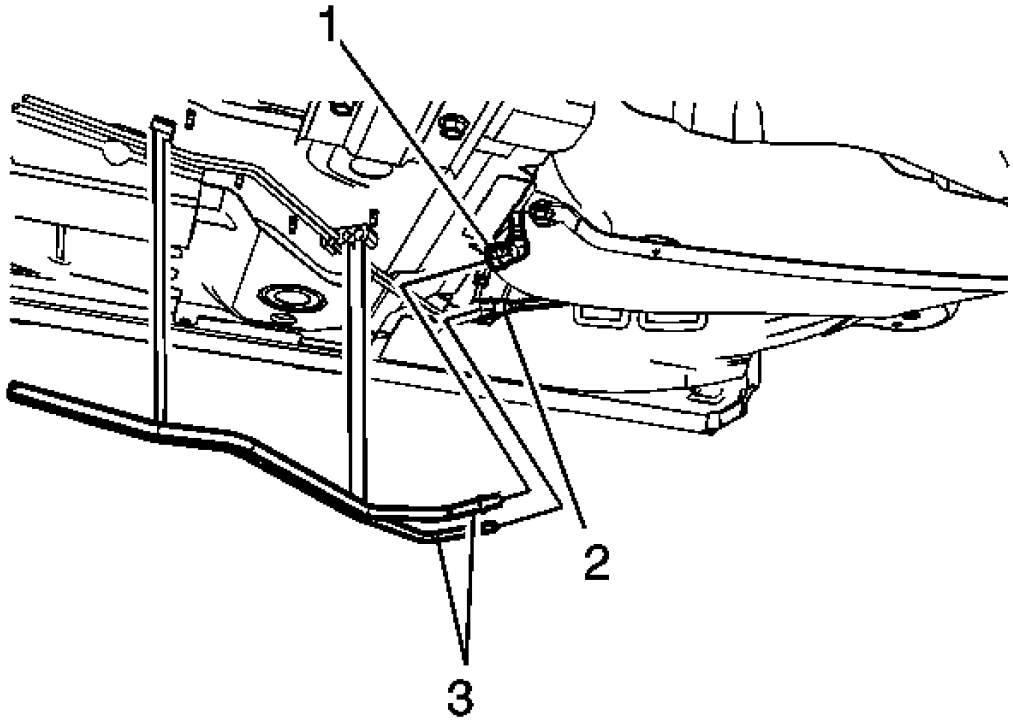


Fig. 80: Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

1. Install the pipes (3) to the vehicle and connect the evaporative emission line (2) and the fuel fed line (1) Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service** .

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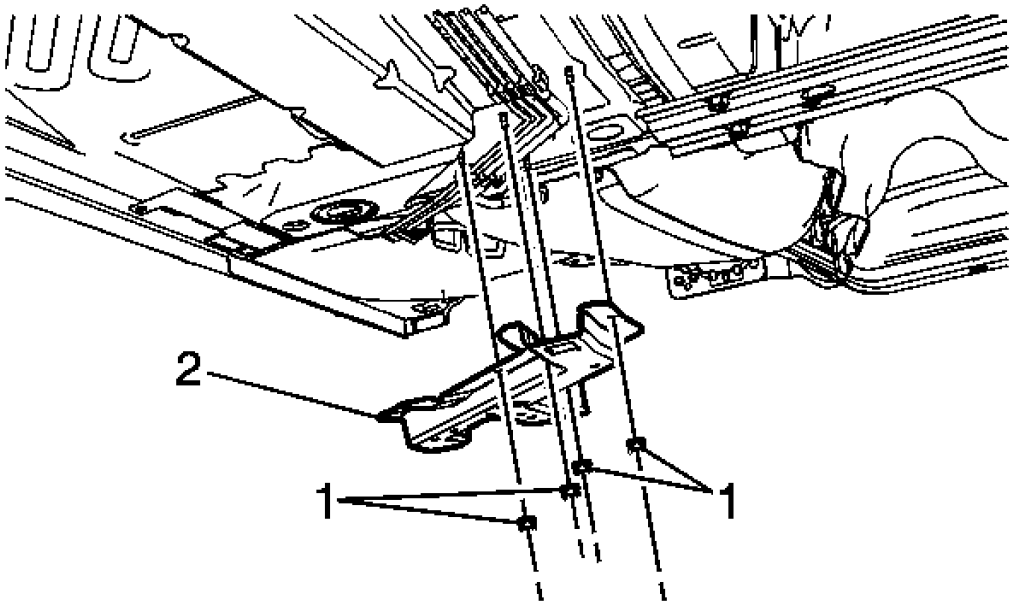


Fig. 81: Protector Bracket Fasteners & Bracket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the protector bracket (2) and the bracket fasteners (1) then tighten to 3 N.m(27 lb in).

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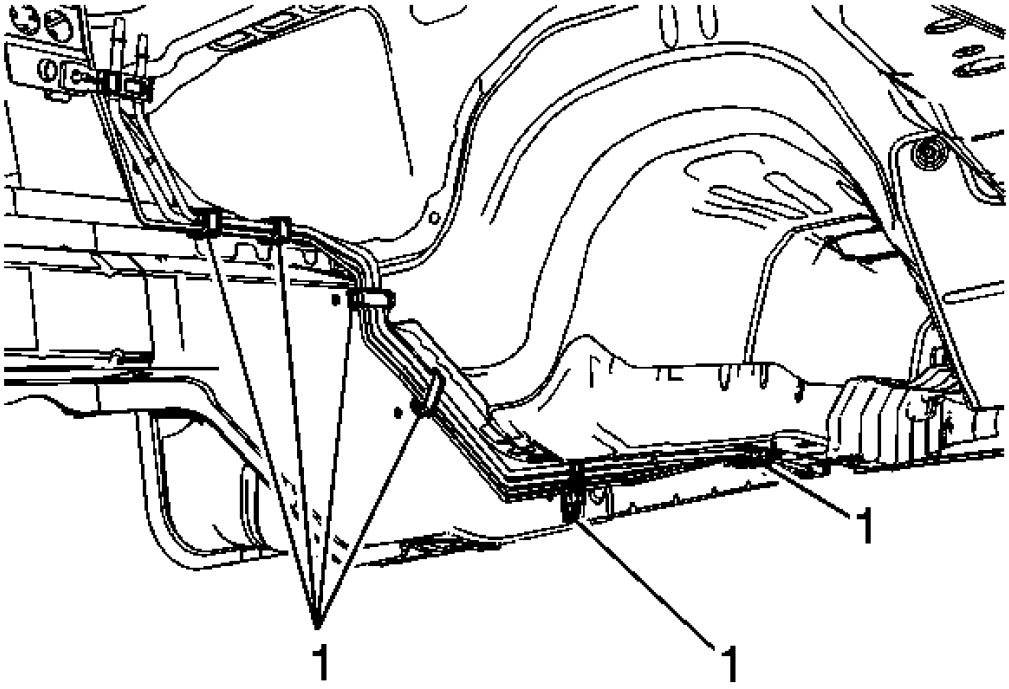


Fig. 82: Fuel Feed Line & Evaporative Emission Line Clips
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel feed line and the evaporative emission line to the clips (1).

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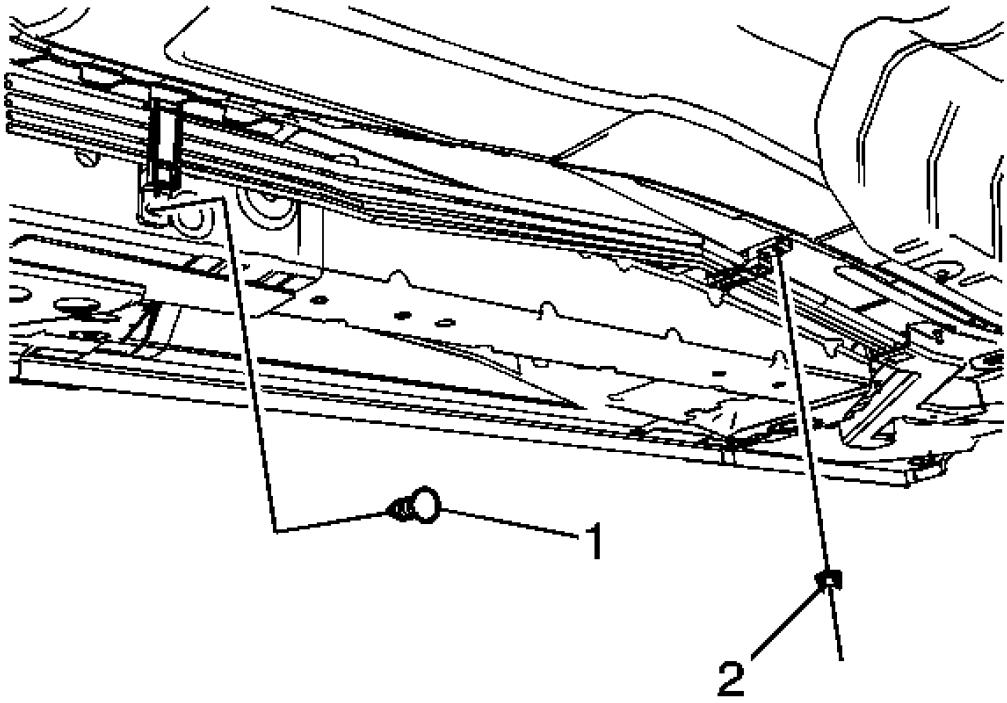


Fig. 83: Plastic Retainer & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

4. Install the plastic retainer (1) and the retaining nut (2), then tighten to 3 N.m (27 lb in).

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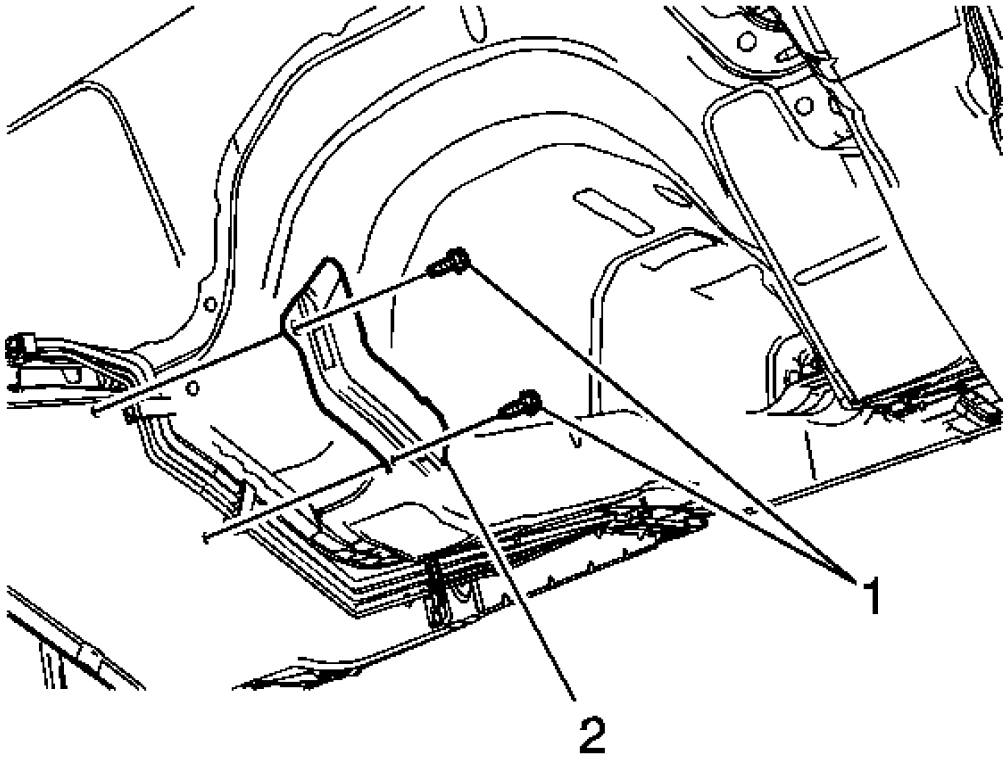


Fig. 84: Brake Pipe Heat Shield Fastener & Heat Shield
Courtesy of GENERAL MOTORS CORP.

5. Install the heat shield (2) and the brake pipe heat shield fastener (1), then tighten to 22 N.m (16 lb ft).

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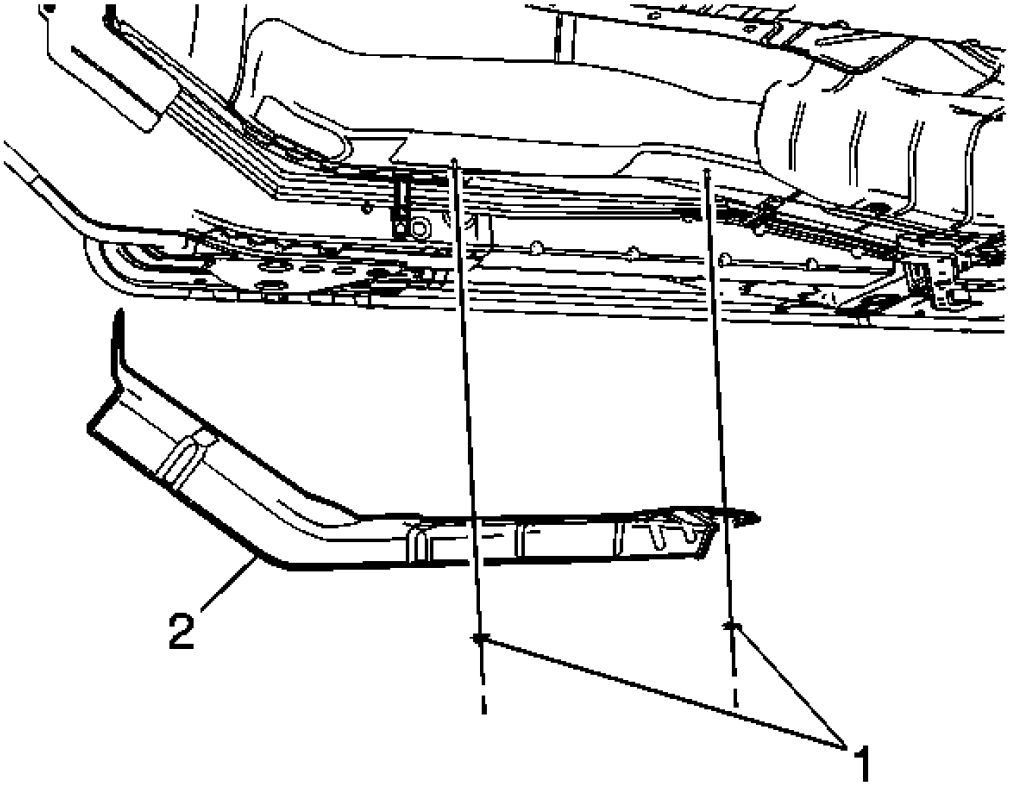


Fig. 85: Exhaust Heat Shield Fastener & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

6. Install the exhaust heat shield (2) and the exhaust heat shield fastener (1), then tighten to 3 N.m (27 lb in).

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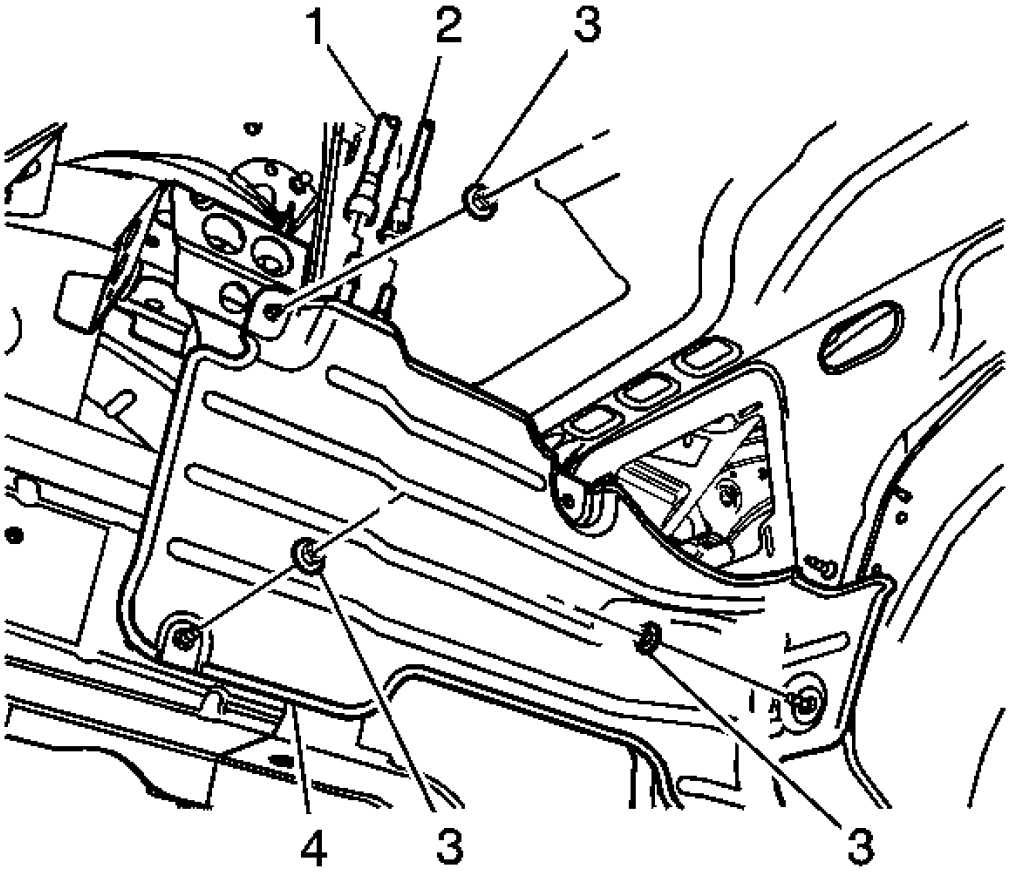


Fig. 86: Fuel Feed Connector, Evaporative Emission Connector, Exhaust Heat Shield Fasteners & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

7. Install the exhaust heat shield (4) and the exhaust heat shield fasteners (3), then tighten to 6 N.m (53 lb in).
8. Connect the fuel feed connector (1) and the evaporative emission connector (2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service** .
9. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.

FUEL PRESSURE SENSOR REPLACEMENT

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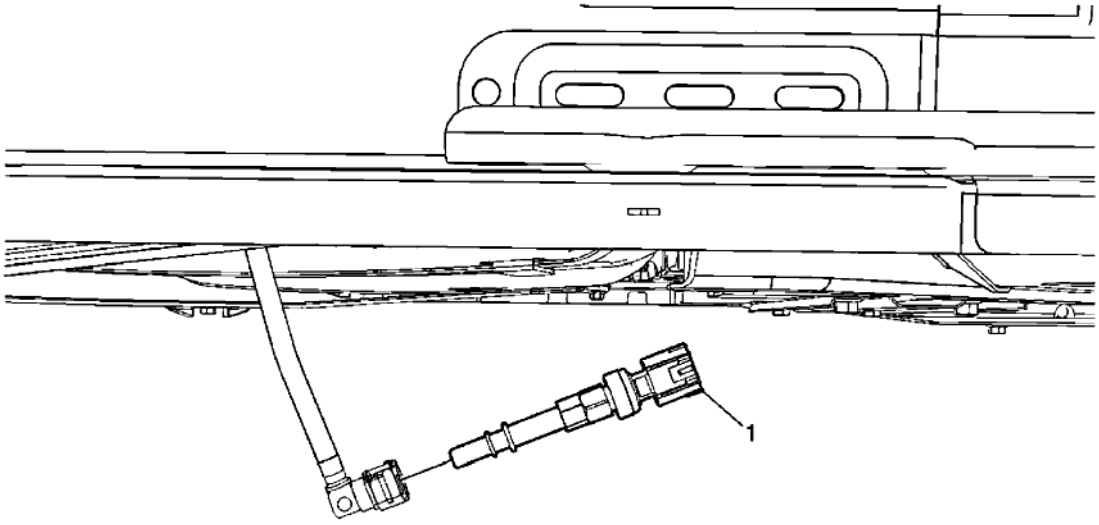


Fig. 87: Fuel Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .**	
1	Fuel Pressure Sensor **Procedure** 1. Remove the sensor from the plastic retainer. 2. Disconnect the quick connector. Refer to **Plastic Collar Quick Connect Fitting Service** . 3. Disconnect the electrical connector.

FUEL SYSTEM CLEANING

Special Tools

- **J 45722** Fuel Sender Lock Ring Wrench
- **CH-48482** Fuel Sender Lock Ring Wrench
- **J 45004** Fuel Tank Drain Hose

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

NOTE:

- **The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is**

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contaminated, the fuel system can be cleaned. You can usually determine the extent of the fuel system contamination during the disassembly.

- **If the fuel filter is plugged, the fuel tank should be inspected internally and cleaned if necessary.**

1. Remove the fuel tank. Refer to **Fuel Tank Draining**.
2. Remove the fuel module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** and **Fuel Level Sensor Replacement - Left Side** .
3. Locate the tank in a suitable work area away from any heat, any flame, or any other source of ignition.
4. Perform the following procedures:
   - Inspect the fuel sender strainer. Replace the primary fuel tank module if the strainer is contaminated.
   - Inspect the secondary fuel tank module for debris. Clean the secondary fuel tank module if debris is found.

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

NOTE: Only use oil-free compressed air to blow out the fuel pipes.

   - Use compressed air in order to apply air pressure to the transfer tube.

NOTE: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all applicable local, state, and federal laws and regulations.

5. Flush the fuel tank with running hot water for at least 5 minutes. Pour the water out of the fuel sender assembly opening. Rock the tank in order to make sure that the removal of the water from the tank is complete.
6. Refer to **Metal Collar Quick Connect Fitting Service** to disconnect the following quick connect fittings from the fuel rail:

   The feed hose/pipe

NOTE: Only use oil-free compressed air to blow out the fuel pipes.

7. Use compressed air in order to apply air pressure to the fuel lines in the opposite direction from the normal fuel flow.
8. Remove the fuel injectors and fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.
9. Clean and inspect the fuel injectors and fuel rail.

Installation Procedure

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1. Assemble the fuel system as follows:

   Install the fuel injectors and fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.

2. Install the fuel module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** and **Fuel Level Sensor Replacement - Left Side** .
3. Refer to **Metal Collar Quick Connect Fitting Service** to connect the following quick connect fittings to the fuel rail:

   The feed hose/pipe

4. Install the fuel tank. Refer to **Fuel Tank Replacement** .

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Relieve the fuel system pressure. Refer to the **Fuel Pressure Relief** .
3. Clean the fuel rail assembly before disconnection the fuel connections.

CAUTION:

- **Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.**
- **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.**

4. Disconnect the fuel feed pipe from the fuel rail. Refer to **Fuel Line Replacement - Engine**.

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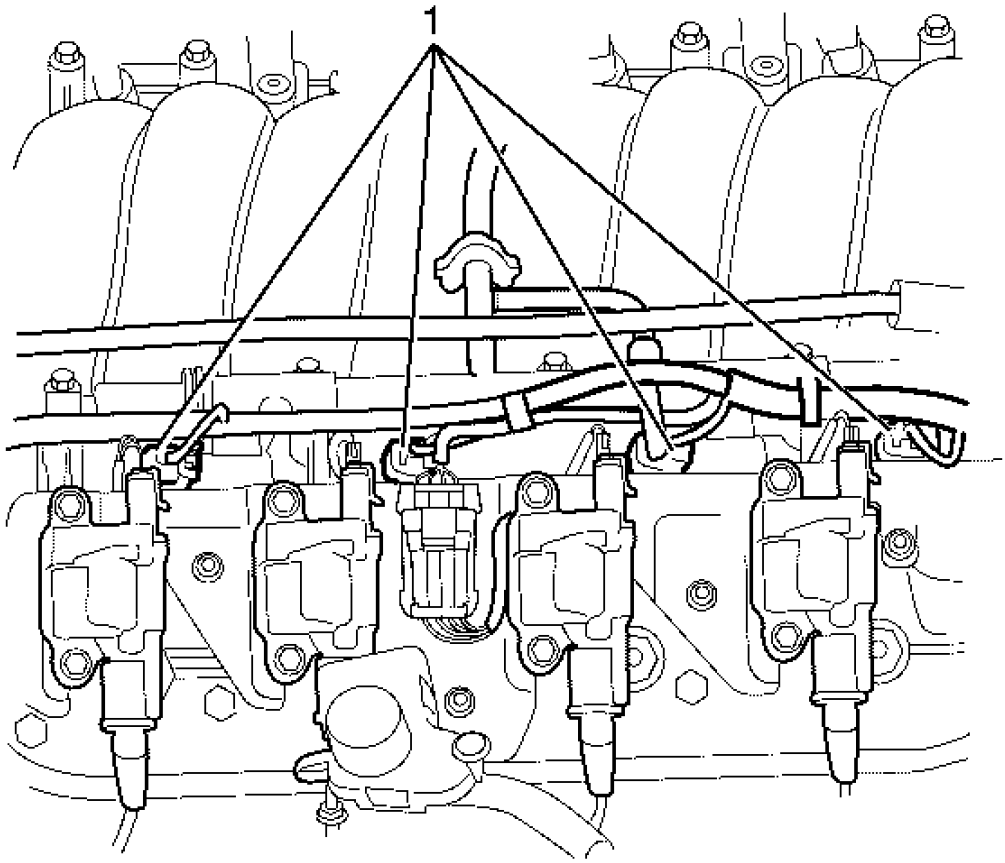


Fig. 88: Identifying Injector Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

NOTE: Observe the order sequence of the fuel injector electrical connectors (1).

5. Disconnect the fuel injector electrical connectors (1) from the fuel injectors.

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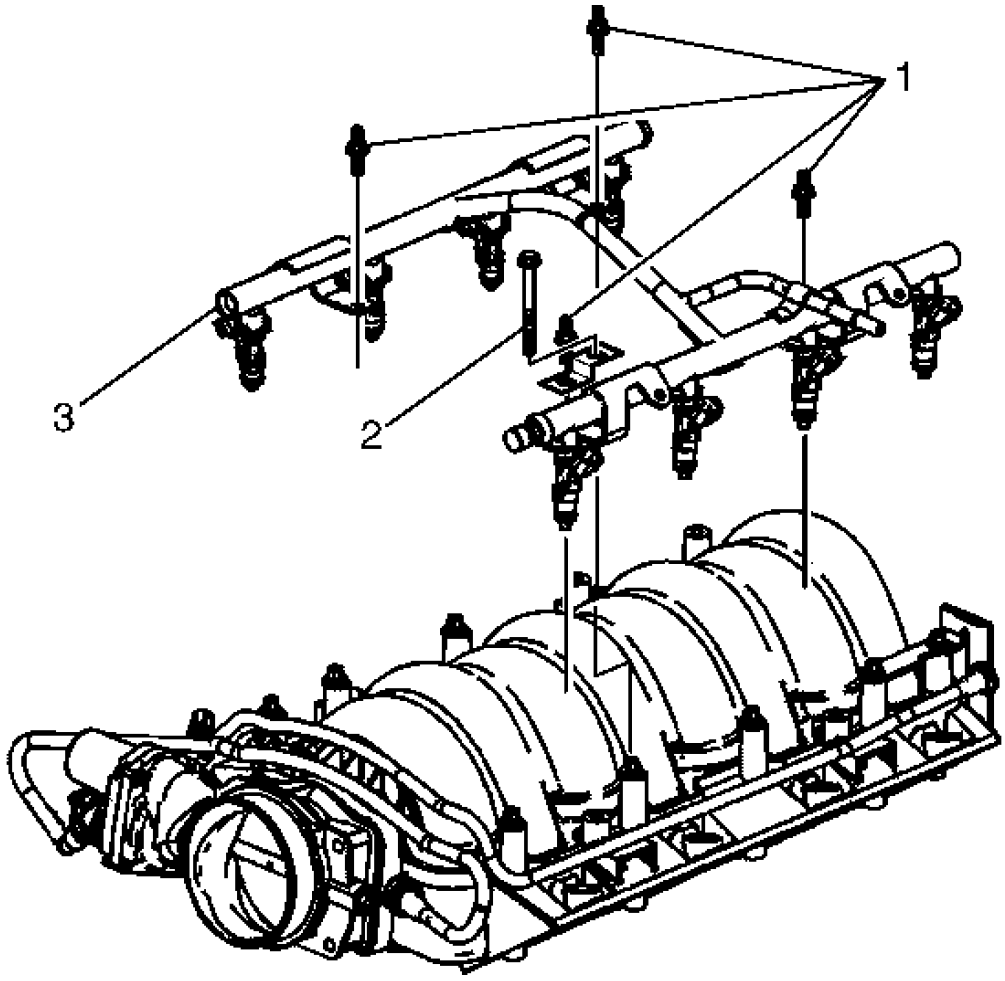


Fig. 89: Fuel Rail Components
Courtesy of GENERAL MOTORS CORP.

6. Using a suitable tool detach the engine electrical wiring harness from the fuel rail.
7. Remove the fuel rail ground strap to intake manifold retaining bolt (2).
8. Remove the fuel rail to intake manifold retaining bolts (1).
9. Simultaneously lift both sides of the fuel rail (3) and remove the fuel rail assembly from the intake manifold.

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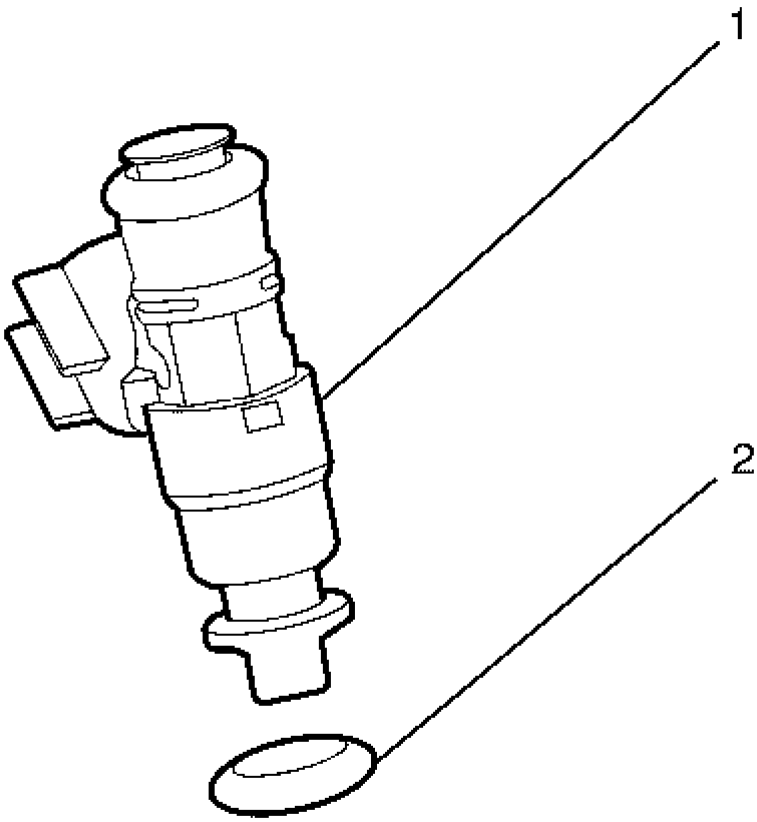


Fig. 90: Identifying Fuel Injector O-Ring Seals
Courtesy of GENERAL MOTORS CORP.

NOTE: The fuel injector seals are single use items and must be replaced after the fuel injectors has been removed.

10. Remove the fuel injector seals (2) from the fuel injectors (1) and discard.

Installation Procedure

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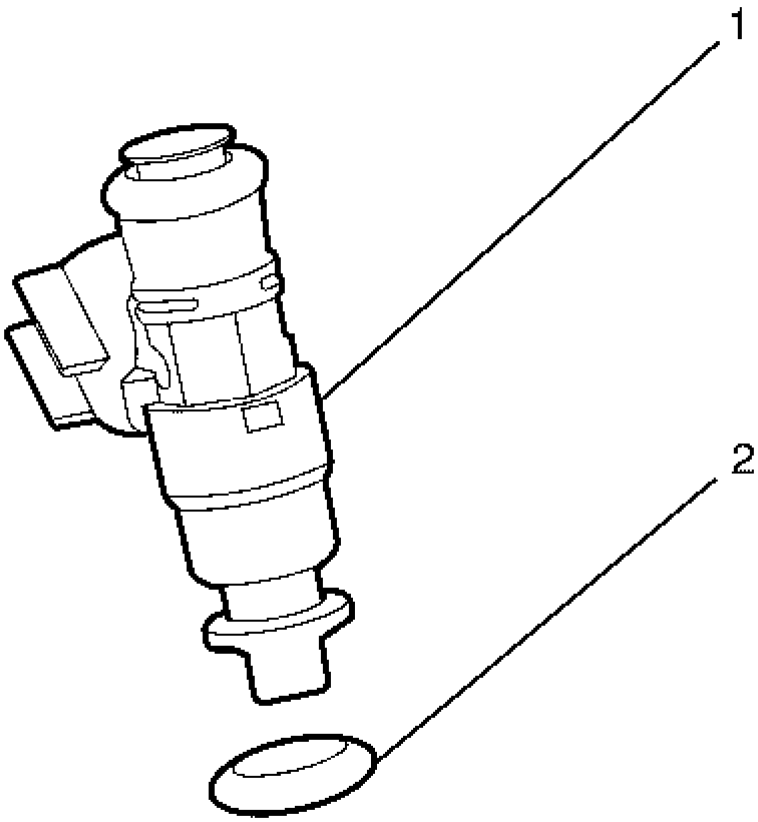


Fig. 91: Identifying Fuel Injector O-Ring Seals
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the NEW fuel injector seals (2) with clean engine oil.
2. Install the NEW fuel injector seals (2) to the fuel injectors (1).

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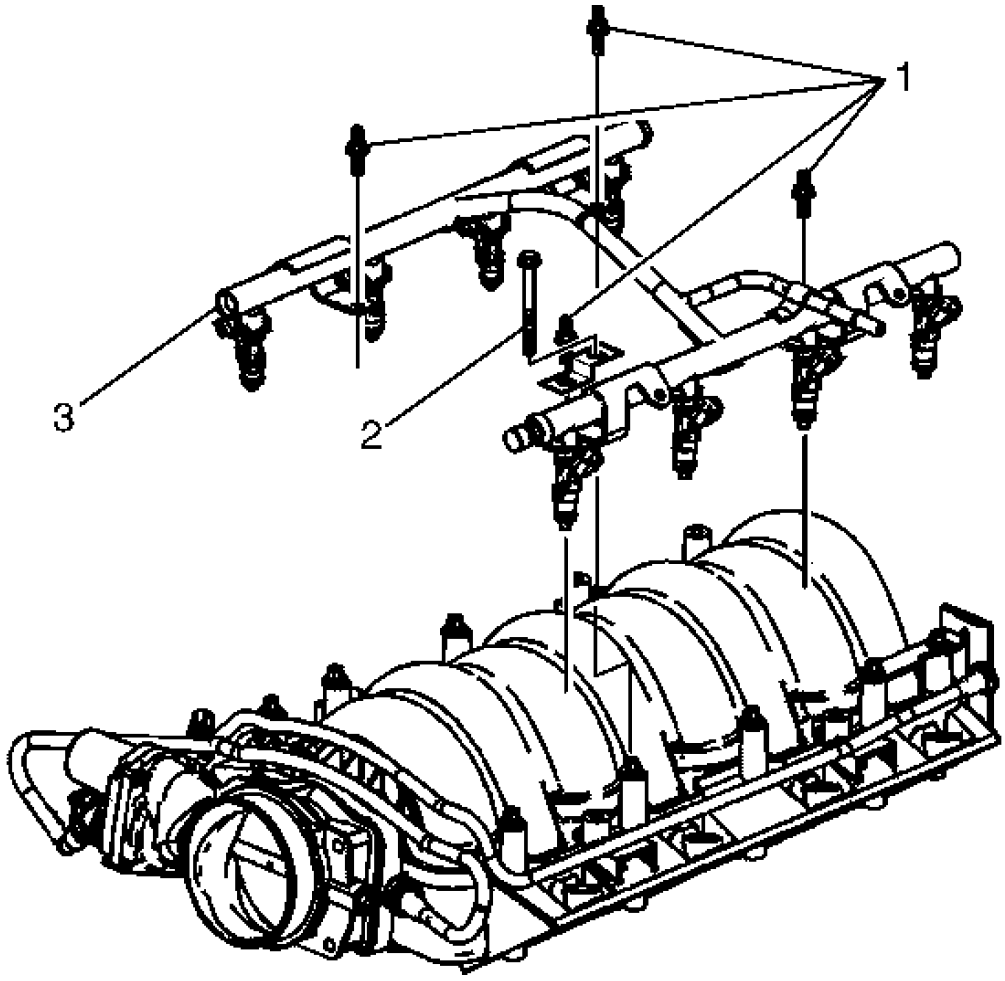


Fig. 92: Fuel Rail Components
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel rail assembly (3) to the intake manifold.
4. Apply a 0.5 mm (0.02 in) band of GM approved threadlock to the threads of the fuel rail retaining bolts (1).

CAUTION: Refer to Fastener Caution .

5. Install the fuel rail to intake manifold retaining bolts (1) and tighten to 10 N.m (89 lb in).

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6. Install the fuel rail ground strap to intake manifold retaining bolt (2) and tighten to 10 N.m (89 lb in).

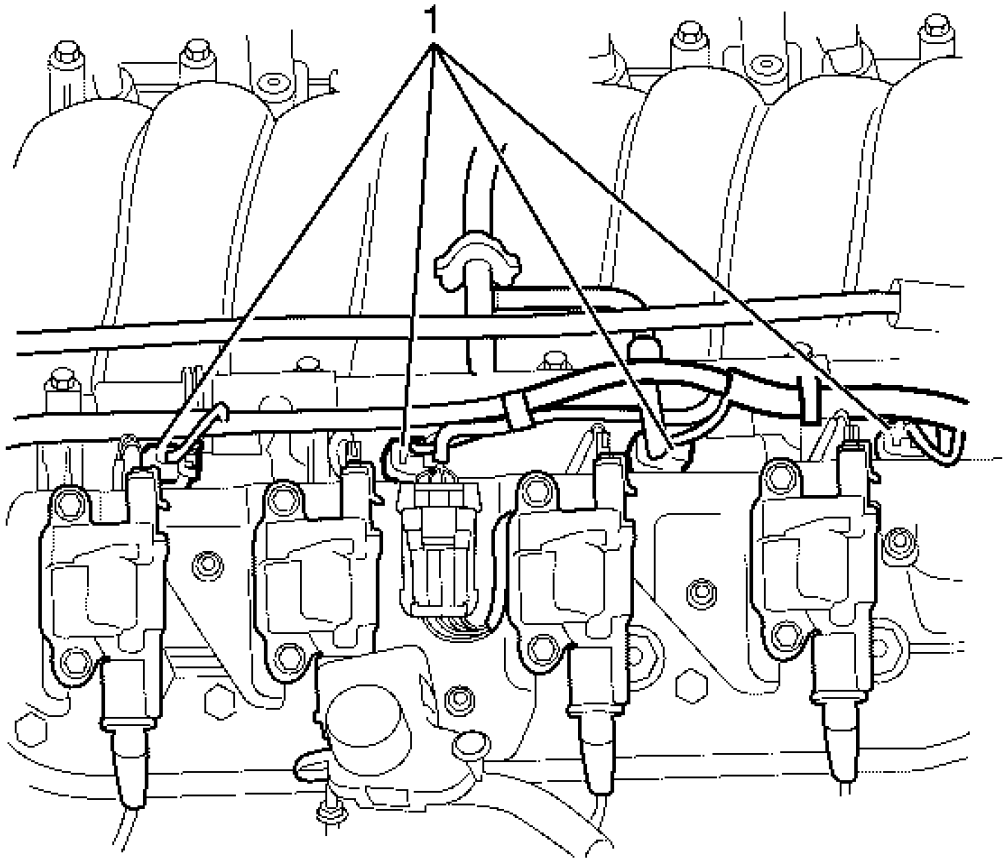


Fig. 93: Identifying Injector Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not damage the engine wiring harness.

NOTE: Observe the order sequence of the fuel injector electrical connectors (1).

7. Connect the fuel injector electrical connectors (1) to the fuel injectors.
8. Install the engine wiring electrical harness to the fuel rail.
9. Connect the fuel feed pipe to the fuel rail. Refer to **Fuel Line Replacement - Engine**.
10. Connect the negative battery cable.
11. Inspect for leaks.

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1. Turn ON the ignition for 2 seconds.
2. Turn OFF the ignition for 10 seconds.
3. Turn ON the ignition.
4. Inspect for fuel leaks.

12. Install the engine cover. Refer to **Engine Cover Replacement** .

FUEL INJECTOR REPLACEMENT

Removal Procedure

1. Remove the fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.

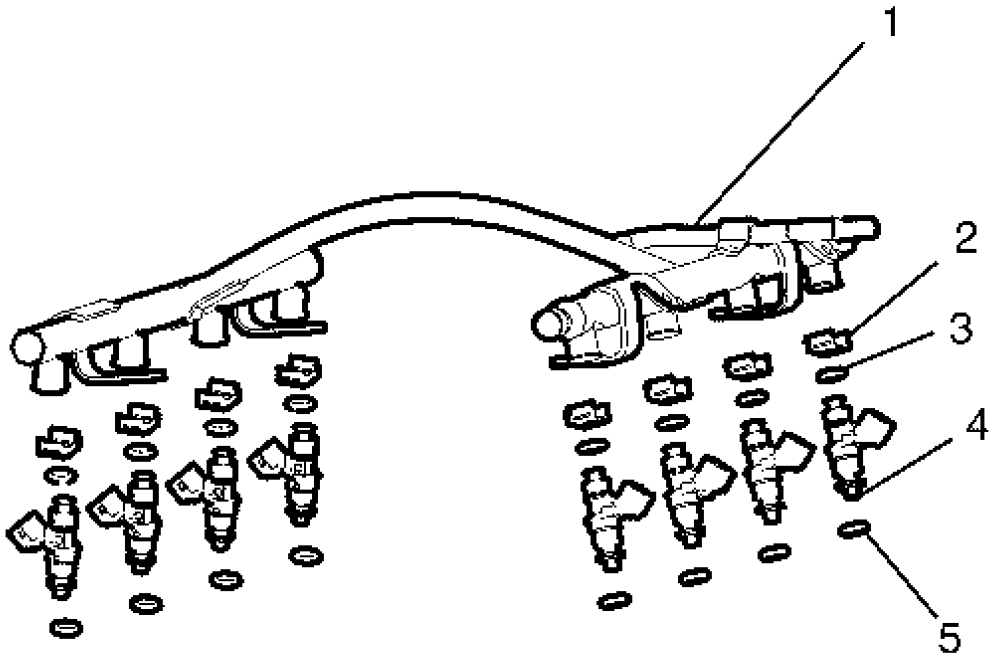


Fig. 94: Identifying Fuel Injector, Fuel Rail Assembly, O-Ring Seals & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

2. Remove the fuel injector to fuel rail assembly retaining clips (2).

CAUTION: Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles.

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Do not immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.

3. Remove the fuel injector (4) from the fuel rail (1).
4. Remove the injector lower O-ring seal (5) from the spray tip end of each injector and discard.

   Discard the O-ring seals.

5. Remove the injector upper O-ring seal (3) from the fuel rail end of each injector and discard.

   Discard the O-ring seals.

Installation Procedure

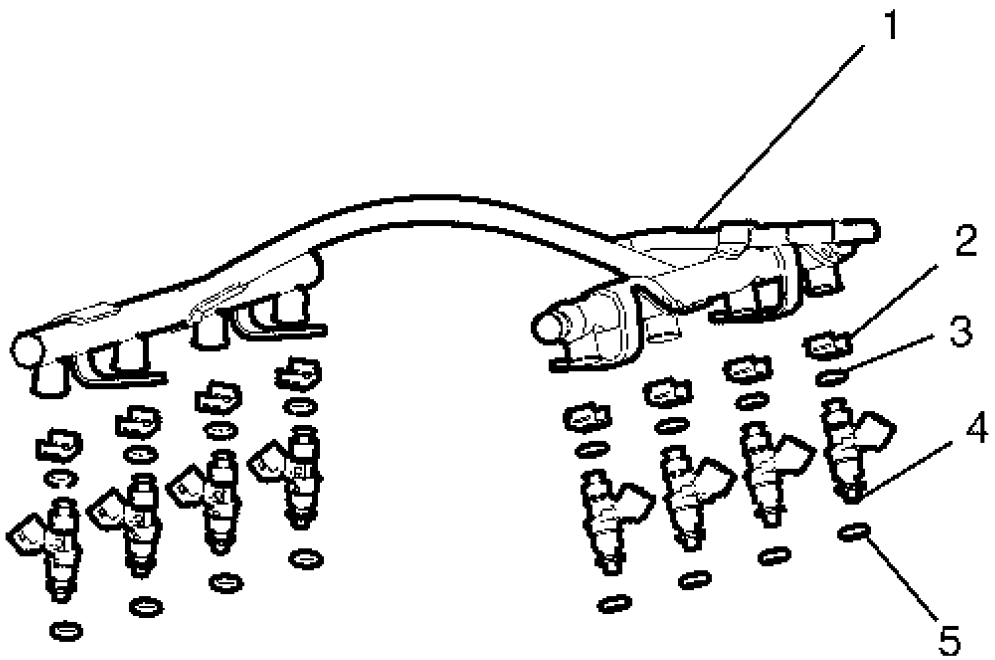


Fig. 95: Identifying Fuel Injector, Fuel Rail Assembly, O-Ring Seals & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

1. Apply a small amount of clean motor oil to the O-rings (3) and (5), before installing the new fuel injector.
2. Install the NEW injector upper O-ring seals (3) to the injectors.

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3. Install the NEW injector lower O-ring seals (5) to the injectors.
4. Install the fuel injector (4) in the fuel rail (1).
5. Install the retaining clips for the fuel injector (3).
6. Install the fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.
    1. Turn the ignition switch ON for 2 seconds.
    2. Turn the ignition switch OFF for 10 seconds.
    3. Turn the ignition switch ON.
    4. Inspect for fuel leaks.

FUEL INJECTOR CLEANING

Special Tools

- **J 37287** Fuel Line Shut-Off Adapters
- **J 35800-A** Fuel Injector Cleaner
- **J 42873-1** 3/8 Fuel Line Shut-Off Valve
- **J 42873-2** 5/16 Return Pipe Shut-Off Valve
- **J 42964-1** 3/8 Fuel Pipe Shut-Off Valve
- **J 42964-2** 5/16 Fuel Pipe Shut-Off Valve

CAUTION:

- **GM Upper Engine and Fuel Injector Cleaner is the only injector cleaning agent recommended. DO NOT USE OTHER CLEANING AGENTS AS THEY MAY CONTAIN METHANOL, WHICH CAN DAMAGE FUEL SYSTEM COMPONENTS.**
- **Under NO circumstances should the GM Upper Engine and Fuel Injector Cleaner be added to the vehicle fuel tank, as it may damage the fuel pump and other system components.**
- **Do not exceed the recommended cleaning solution concentration. Higher concentrations may damage fuel system components. Testing has demonstrated that exceeding the recommended cleaning solution concentration does not improve the effectiveness of this procedure.**

NOTE: **Vehicles with less than 160 km (100 mi) on the odometer should not have the injectors cleaned. These vehicles should have the injectors replaced.**

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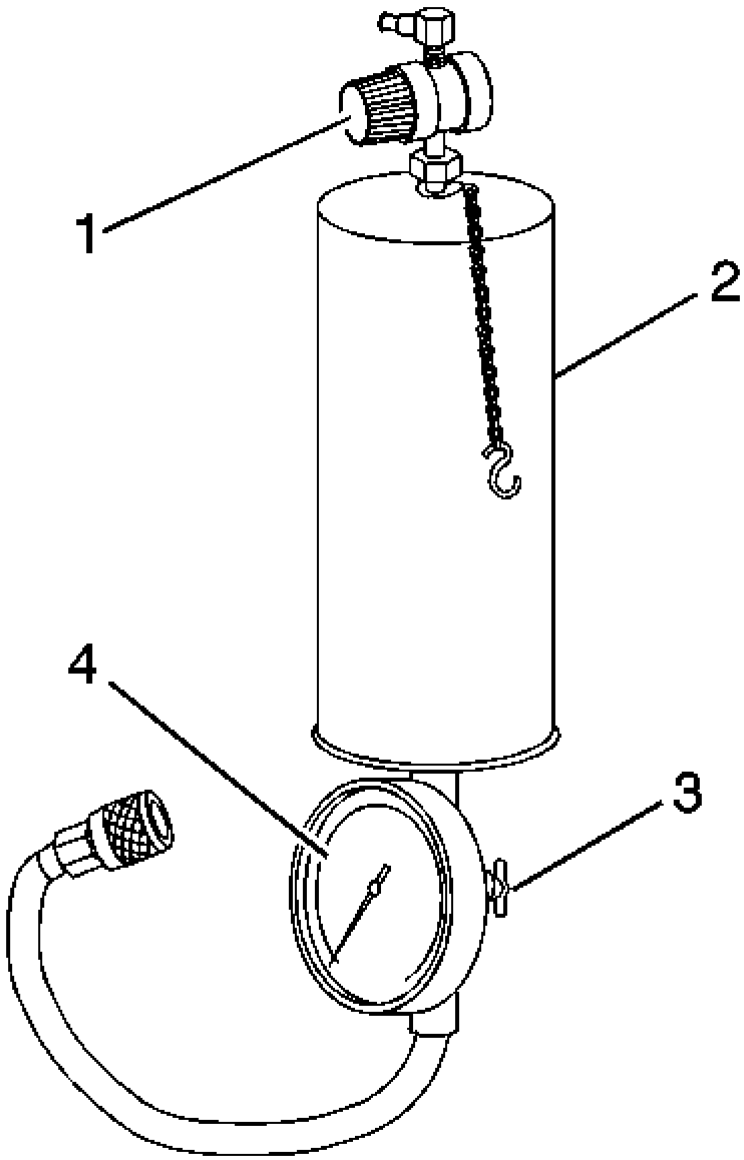


Fig. 96: Identifying Fuel Injector Cleaner
Courtesy of GENERAL MOTORS CORP.

1. Obtain **J 35800-A** (2).

NOTE: Make sure the valve at the bottom of the canister (3) is closed.

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2. For 4, 5, and 6 cylinder engines, empty 2 of the 30 ml (1 oz) reservoirs of the GM Upper Engine and Fuel Injector Cleaner twin reservoir container into the **J 35800-A** , injector cleaning tank, then add 420 ml (14 oz) of regular unleaded gasoline. If you are using any other brand of cleaning tank, you will need a total of 60 ml (2 oz) of GM Upper Engine and Fuel Injector Cleaner mixed with 420 ml (14 oz) of regular unleaded gasoline.
3. For 8 cylinder engines, empty 2 of the 30 ml (1 oz) reservoirs of the GM Upper Engine and Fuel Injector Cleaner twin reservoir container into the **J 35800-A** , injector cleaning tank, then add 420 ml (14 oz) of regular unleaded gasoline. If you are using any other brand of cleaning tank, you will need a total of 60 ml (2 oz) of GM Upper Engine and Fuel Injector Cleaner mixed with 420 ml (14 oz) of regular unleaded gasoline.

   This procedure will need to be repeated for an 8 cylinder engine. The 8 cylinder engines receive 960 ml total fluid-120 ml (4 oz) of GM Upper Engine and Fuel Injector Cleaner and 840 ml (28 oz) of gasoline.

4. Fill the injector cleaning tank with regular unleaded gasoline. Be sure to follow all additional instructions provided with the tool.
5. Electrically disable the vehicle fuel pump by removing the fuel pump relay and disconnecting the oil pressure switch connector, if equipped.
6. Disconnect the fuel feed and return line, if equipped, at the fuel rail. Plug the fuel feed and return line, if equipped, coming off the fuel rail with **J 37287** , or **J 42964-1** , and **J 42964-2** or **J 42873-1** , and **J 42873-2** as appropriate for the fuel system.
7. Connect the **J 35800-A** to the vehicle fuel rail.
8. Pressurize the **J 35800-A** to 510 kPa (75 psi).
9. Start and idle the engine until it stalls due to lack of fuel. This should take approximately 15-20 minutes.
10. Turn the ignition to the OFF position.
11. Injectors should be flow-tested at this point. If further cleaning is needed, a repeat of the above procedure should be done.

    When the injector restriction returns to zero, proceed to step 12.

12. Disconnect the **J 35800-A** from the fuel rail.
13. Reconnect the vehicle fuel pump relay and oil pressure switch connector, if equipped.
14. Remove the **J 37287** , or **J 42964-1** and **J 42964-2** , or **J 42873-1** and **J 42873-2** and reconnect the vehicle fuel feed and return lines.
15. Start and idle the vehicle for an additional two minutes to ensure residual injector cleaner is flushed from the fuel rail and fuel lines.
16. Pour the entire contents of GM Fuel System Treatment Plus, GM P/N 88861011 (Canadian P/N 88861012) into a nearly empty tank and advise the customer to refuel with up to 76 L (20 gal) of fuel.
17. Advise the customer to use only a Top Tier Detergent gasoline and to add a bottle of GM Fuel System Treatment Plus to the fuel tank at every oil change.

    Regular use of GM Fuel System Treatment Plus should keep the customer from having to repeat the injector cleaning procedure.

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18. Road test the vehicle to verify that the customer concern has been corrected.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

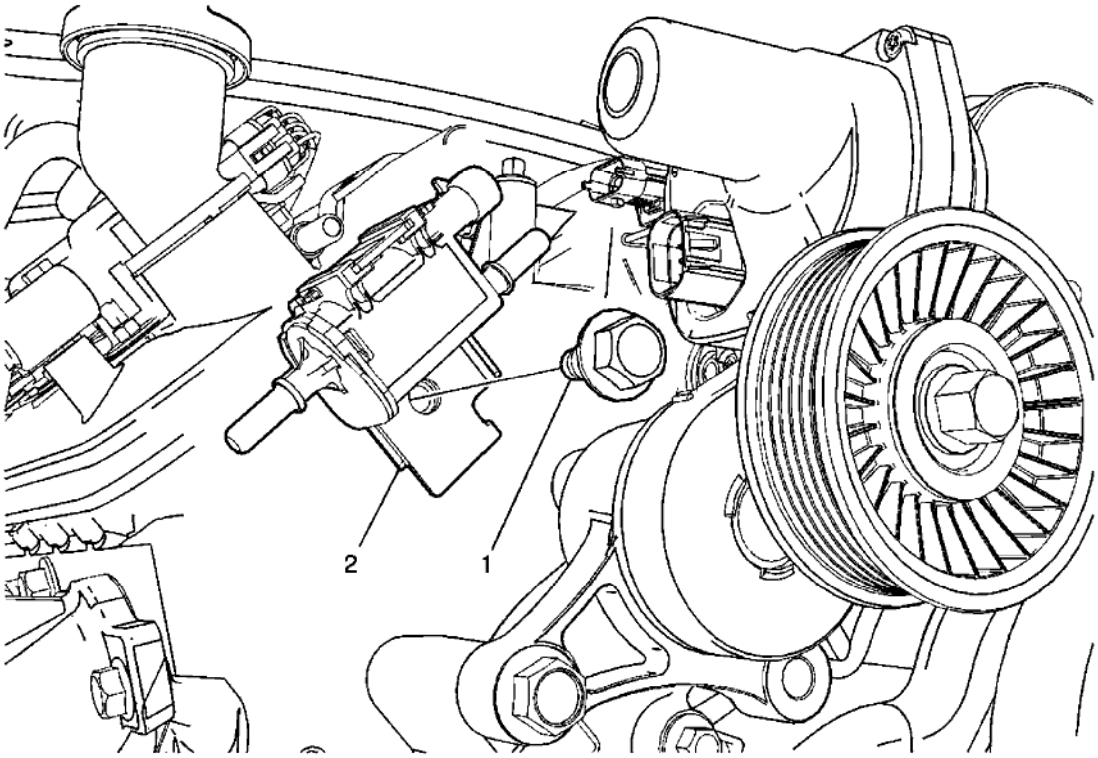


Fig. 97: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the engine cover. Refer to **Engine Cover Replacement** . 2. Disconnect the quick disconnects. Refer to **Plastic Collar Quick Connect Fitting Service**.	
1	Evaporative Emission Canister Purge Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 20 N.m (15 lb ft)
2	Evaporative Emission Canister Purge Solenoid Valve **Procedure:** Disconnect the electrical connector.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

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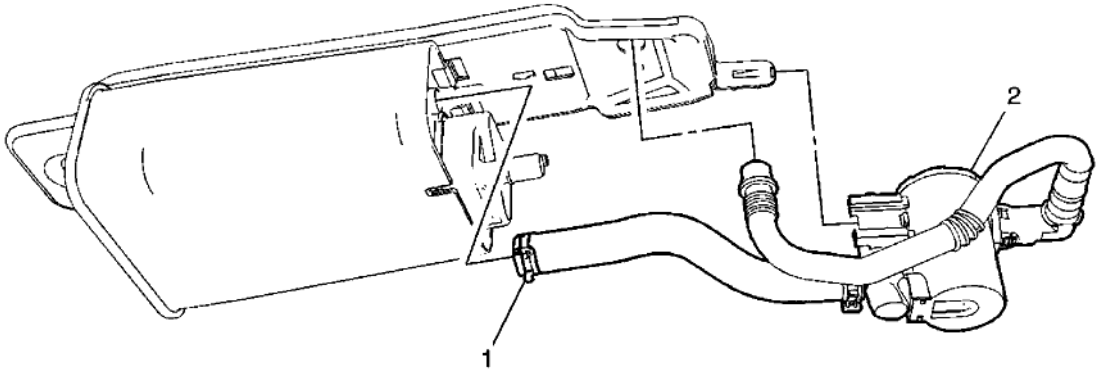
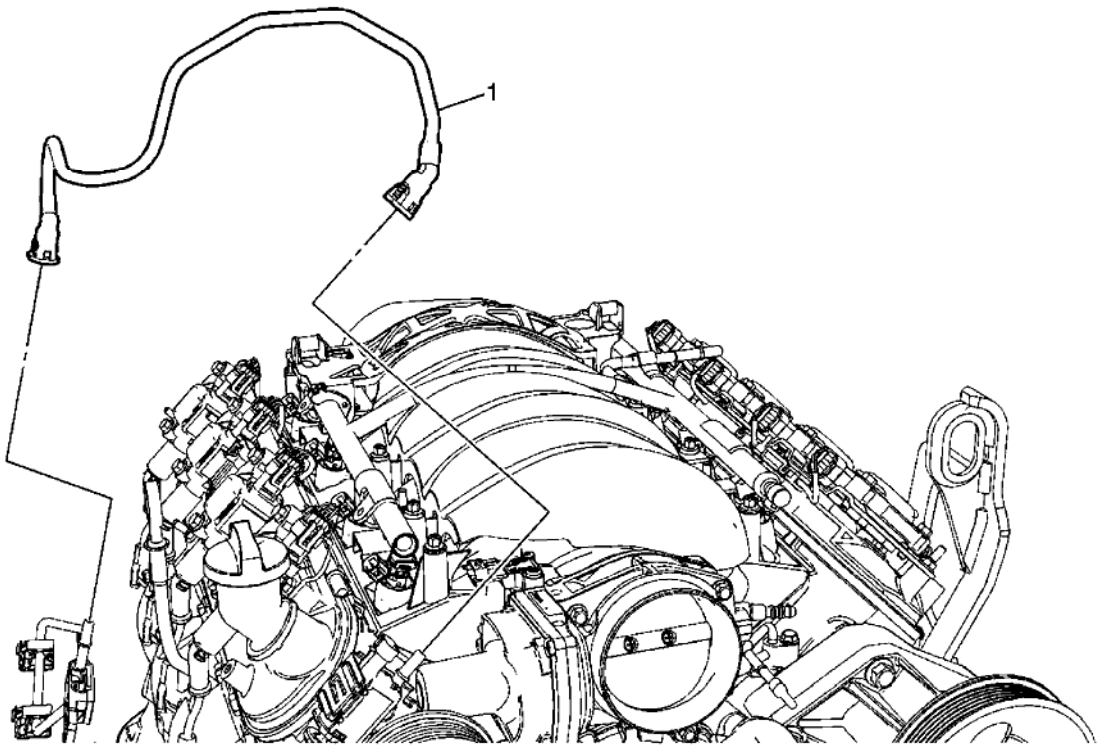


Fig. 98: Evaporative Emission Canister Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the evaporative emission canister. Refer to **Evaporative Emission Canister Replacement** .	
1	Evaporative Hose Clamp
2	Evaporative Emission Canister Vent Solenoid Valve

EVAPORATIVE EMISSION LINE REPLACEMENT - ENGINE



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Fig. 99: Evaporative Emission Line - Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure **1. Remove the engine cover. Refer to Engine Cover Replacement .** **2. Disconnect the quick connects. Refer to Plastic Collar Quick Connect Fitting Service , and Metal Collar Quick Connect Fitting Service.**	
1	Evaporative Emission Line - Engine Compartment

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

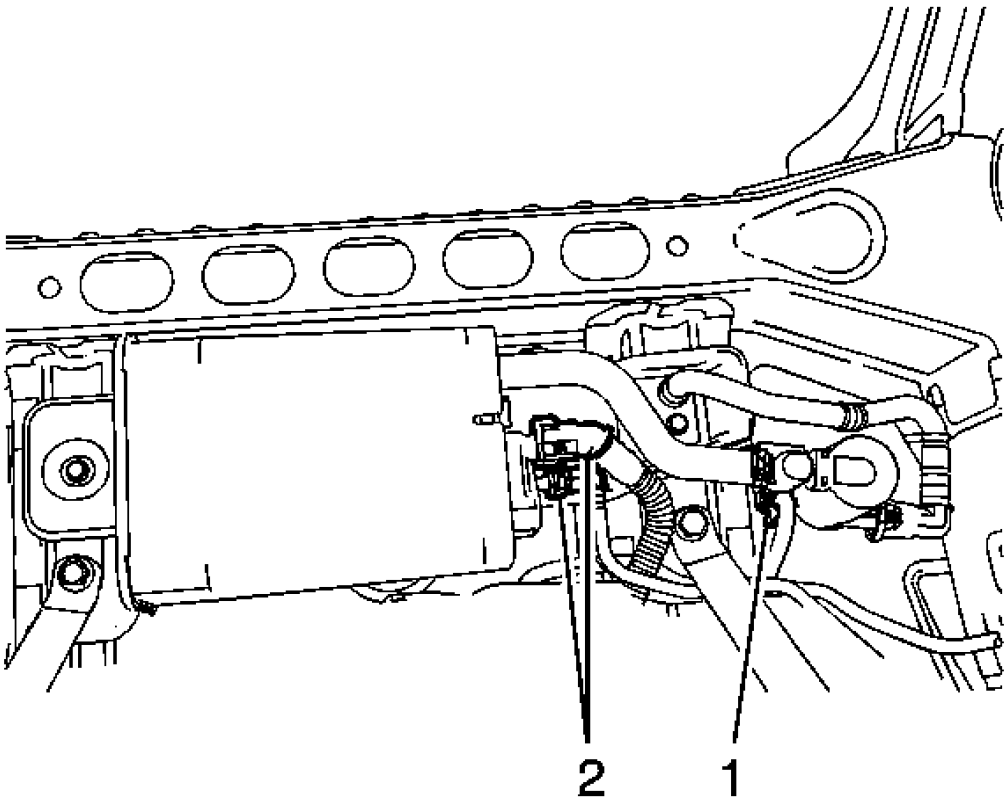


Fig. 100: Vent Solenoid Electrical Connector & Evaporative Emission Hoses
Courtesy of GENERAL MOTORS CORP.

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1. Remove the rear suspension support. Refer to **Rear Suspension Support Replacement** .
2. Disconnect the vent solenoid electrical connector (1).
3. Disconnect the evaporative emission hoses (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

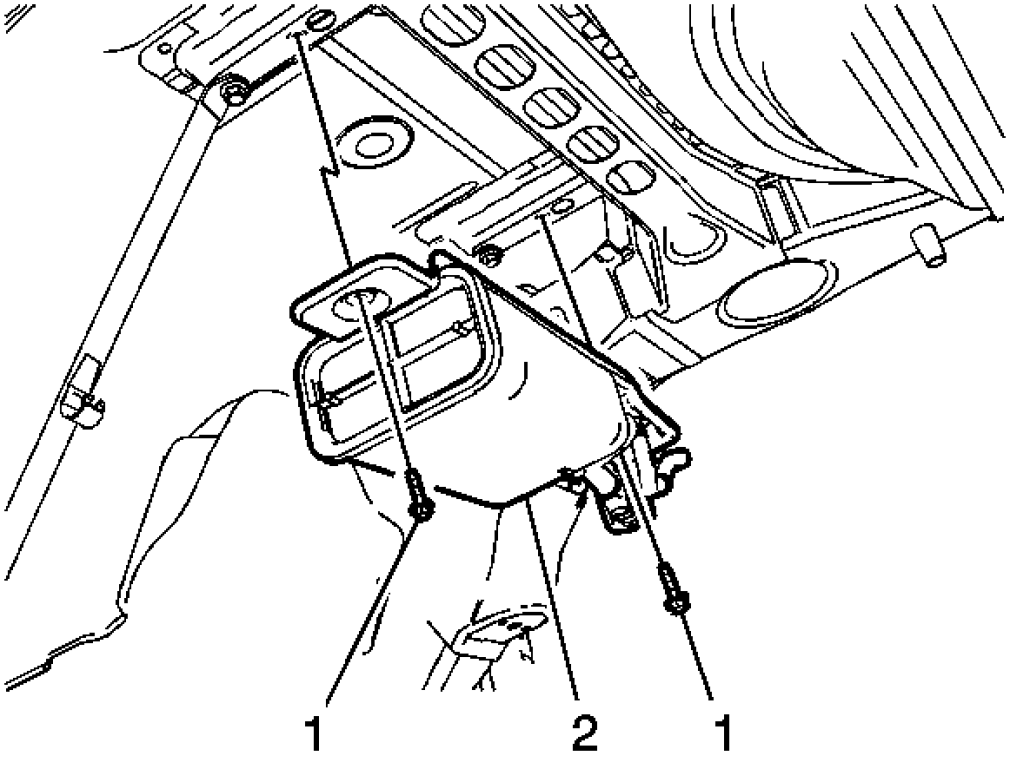


Fig. 101: Evaporative Emission Canister & Fasteners
Courtesy of GENERAL MOTORS CORP.

4. Remove the evaporative emission canister fasteners (1) and the evaporative emission canister (2).

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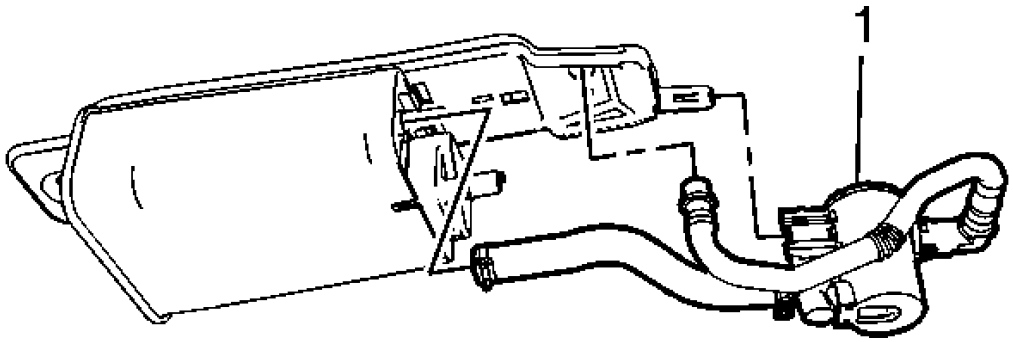


Fig. 102: Evaporative Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

5. Remove the evaporative vent solenoid valve (1) from the carbon canister.

Installation Procedure

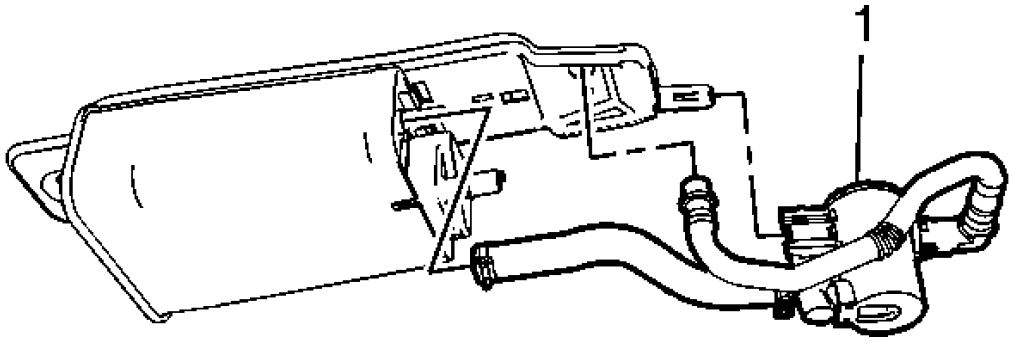


Fig. 103: Evaporative Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the evaporative vent solenoid valve (1) to the carbon canister.

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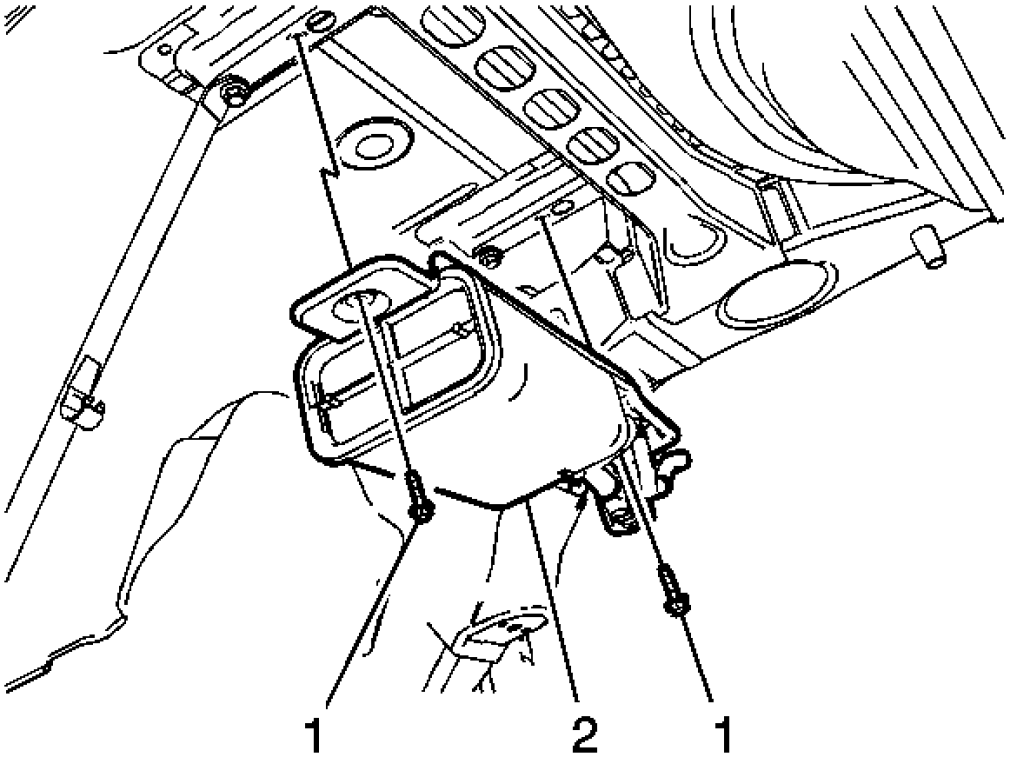


Fig. 104: Evaporative Emission Canister & Fasteners
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the evaporative emission canister (2) and tighten the fasteners (1) to 9 N.m (80 lb in).

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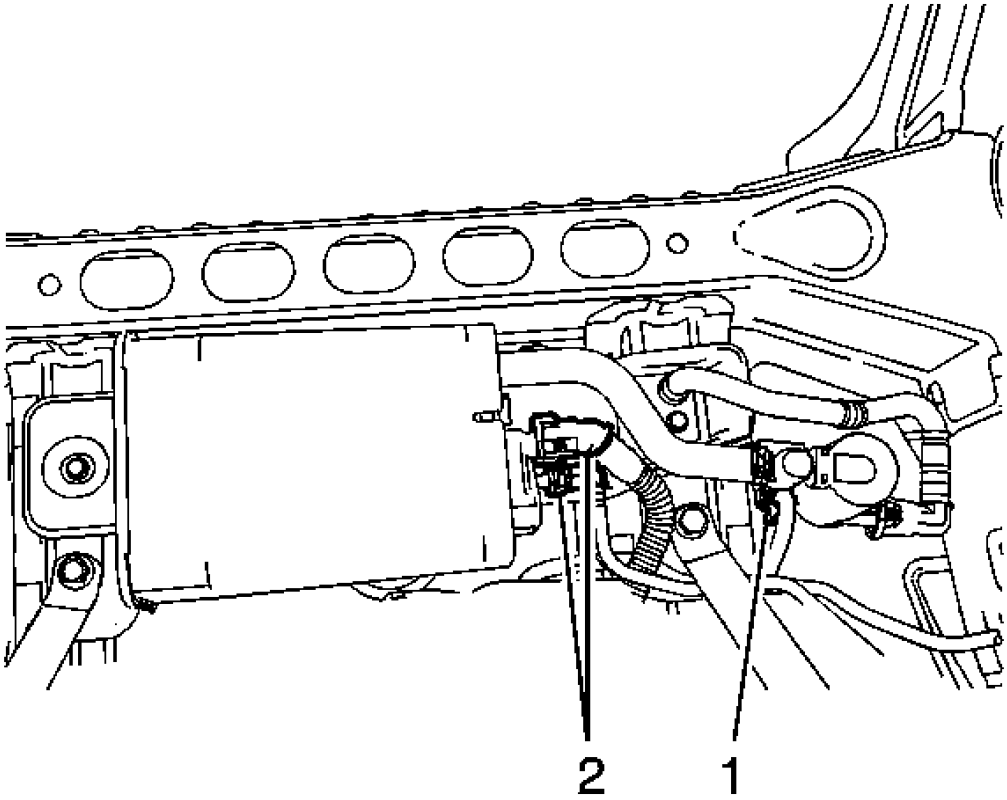


Fig. 105: Vent Solenoid Electrical Connector & Evaporative Emission Hoses
Courtesy of GENERAL MOTORS CORP.

3. Connect the evaporative emission hoses (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
4. Connect the vent solenoid electrical connector (1).
5. Install the rear suspension support. Refer to **Rear Suspension Support Replacement** .

IGNITION COIL REPLACEMENT

Removal Procedure

WARNING: Refer to Battery Disconnect Warning .

1. Disconnect the battery ground cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the engine cover. Refer to **Engine Cover Replacement** .

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3. Remove the engine compartment fuel line. Refer to **Fuel Line Replacement - Engine**.
4. If replacing the right side coils, remove the evaporative emission purge pipe. Refer to **Evaporative Emission Line Replacement - Engine**.
5. Reposition the engine wire harness as necessary.

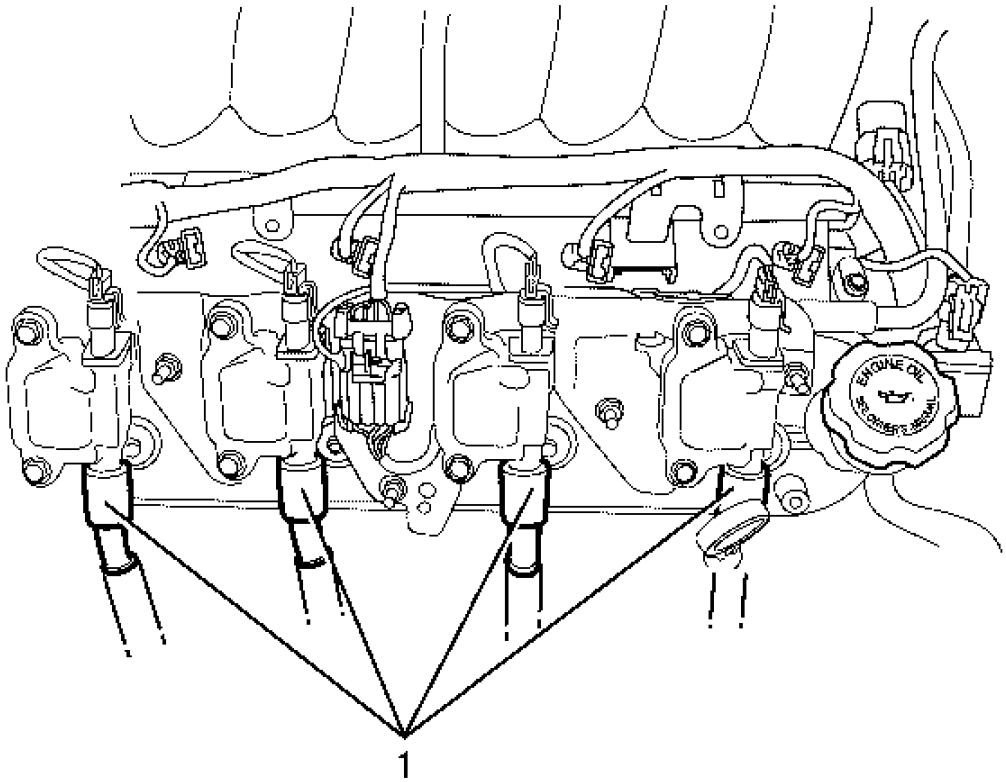


Fig. 106: Identifying Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the spark plug wires (1) from the ignition coils.

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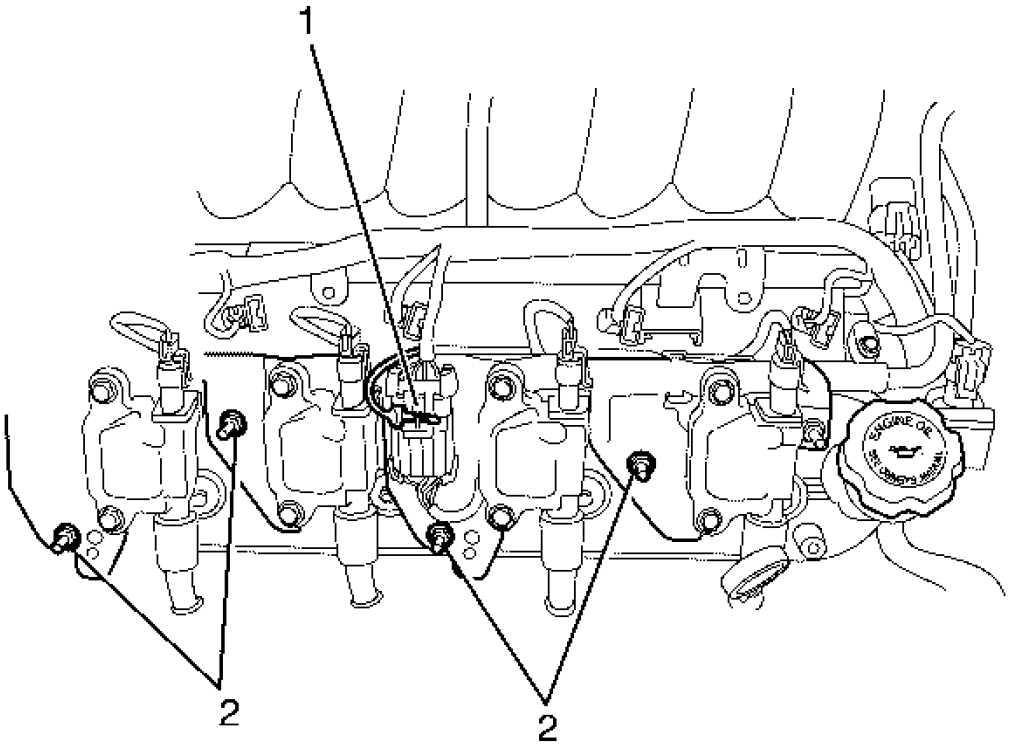


Fig. 107: Identifying Ignition Coil Harness Connector & Assembly To Rocker Cover Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the main ignition coil harness connector (1) from the ignition coil assembly.
8. Remove the ignition coil assembly to rocker cover retaining bolts (2).

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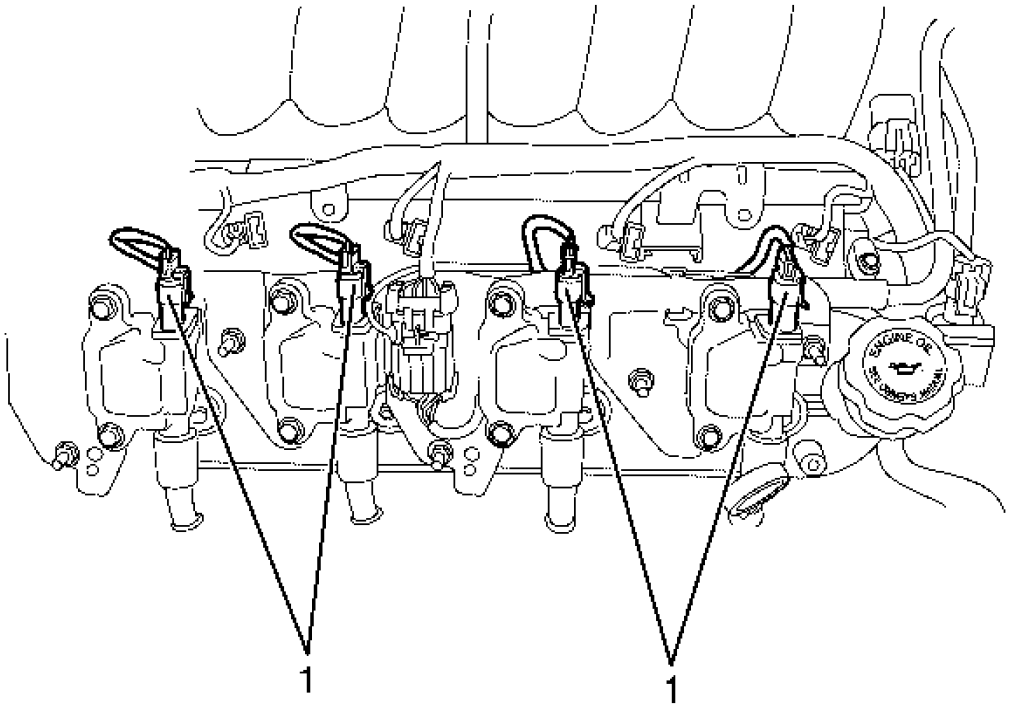


Fig. 108: Identifying Ignition Coil To Ignition Coil Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

9. Remove the ignition coil assembly from the engine.
10. Disconnect the ignition coil to ignition coil wiring harness connectors (1).

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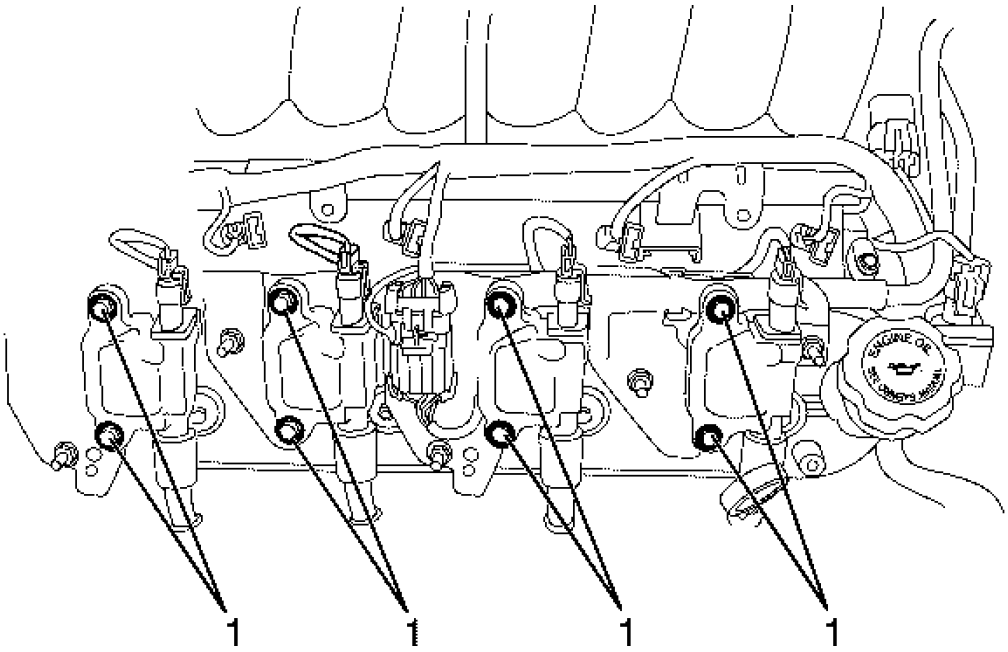


Fig. 109: Identifying Ignition Coil To Ignition Coil Assembly Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

11. Remove the ignition coil to ignition coil assembly retaining bolts (1).
12. Remove the ignition coils from the ignition coil assembly.

Installation Procedure

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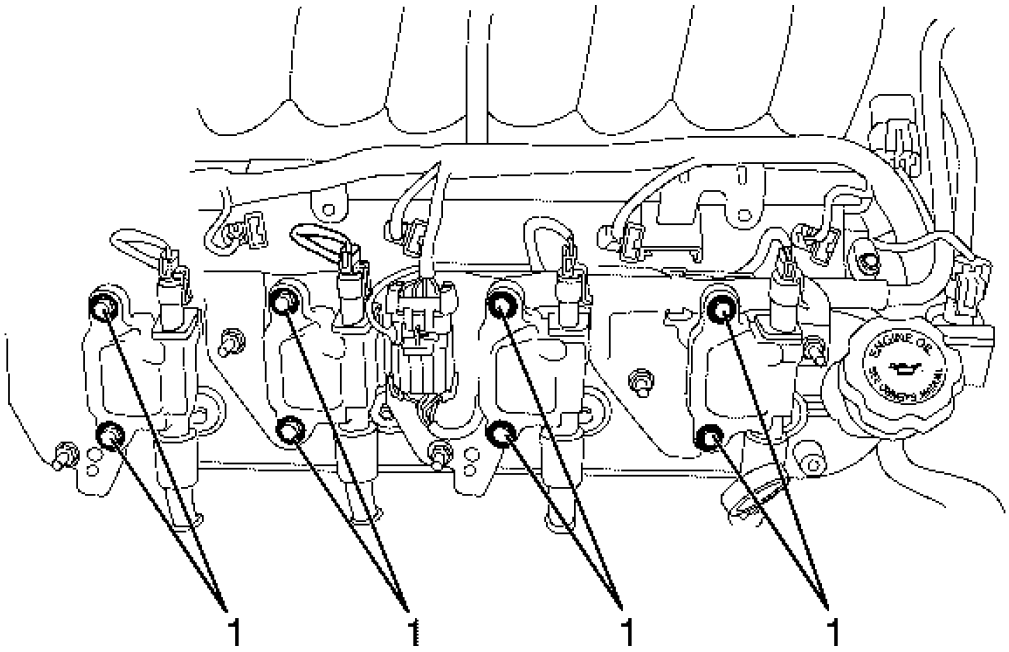


Fig. 110: Identifying Ignition Coil To Ignition Coil Assembly Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil assembly.

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil to ignition coil assembly retaining bolts (1) and tighten to 12 N.m (106 lb in).

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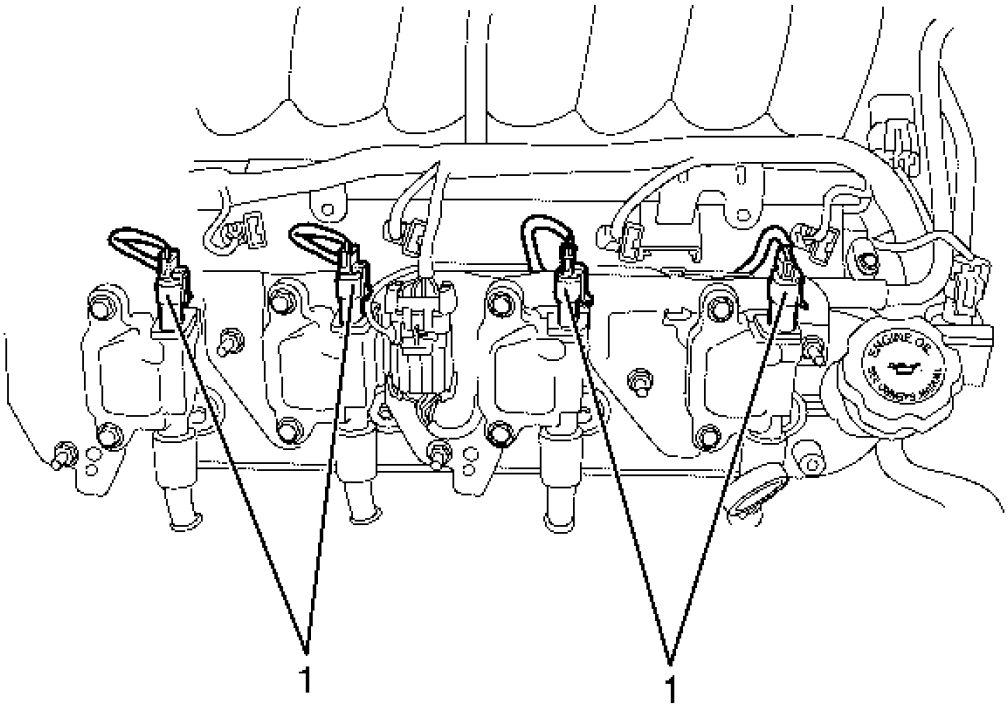


Fig. 111: Identifying Ignition Coil To Ignition Coil Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

3. Connect the ignition coil to ignition coil wiring harness connectors (1).
4. Install the ignition coil assembly to the engine.

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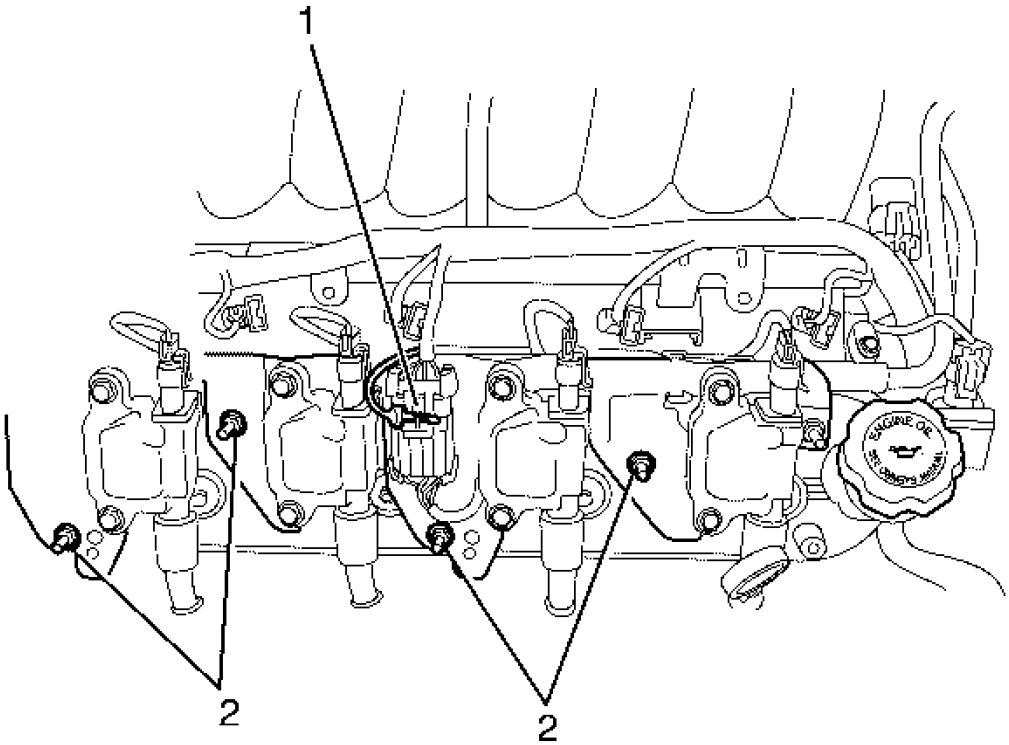


Fig. 112: Identifying Ignition Coil Harness Connector & Assembly To Rocker Cover Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the ignition coil assembly to rocker cover retaining bolts (2) and tighten to 12 N.m (106 lb in).
6. Connect the main ignition coil harness connector (1) to the ignition coil assembly.

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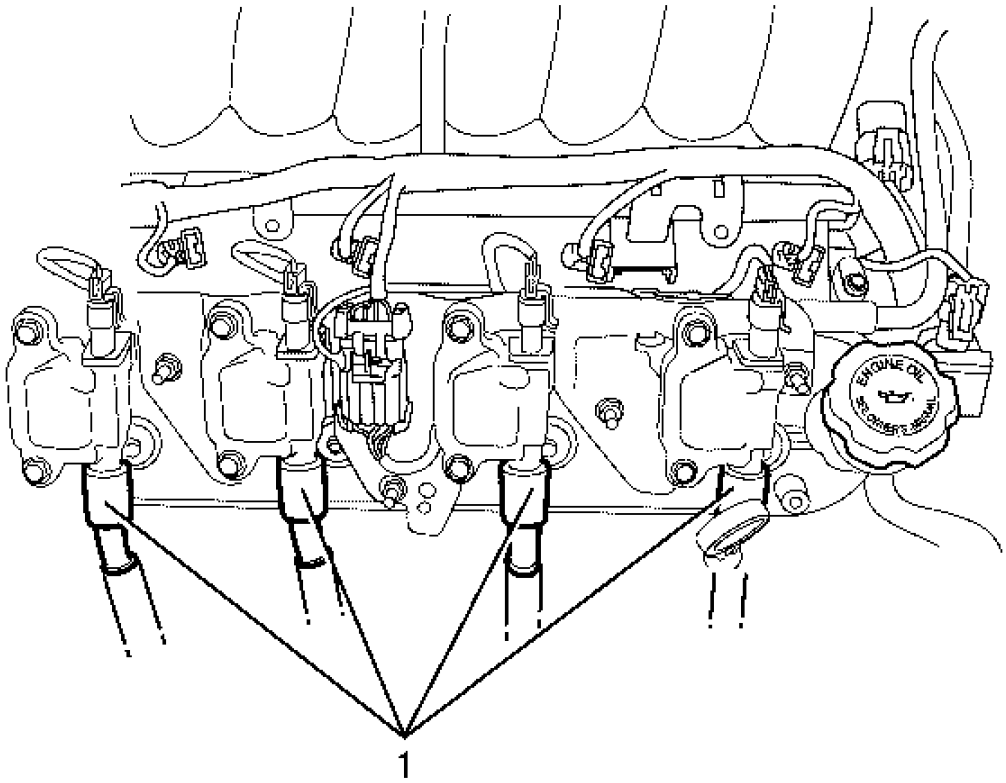


Fig. 113: Identifying Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

7. Connect the spark plug wires (1) to the ignition coils.
8. Install the engine cover. Refer to **Engine Cover Replacement** .
9. Connect the battery ground cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
10. If the right side coils were replaced, install the evaporative emission purge pipe. Refer to **Evaporative Emission Line Replacement - Engine**.
11. Install the engine compartment fuel line. Refer to **Fuel Line Replacement - Engine**.

SPARK PLUG WIRE INSPECTION

IMPORTANT: Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

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1. Correct routing of the spark plug wires. Incorrect routing may cause cross-firing.
2. Inspect for any signs of cracks or splits in the wires.
3. Inspect each boot for the following conditions:
    - Tearing
    - Piercing
    - Arcing
    - Carbon tracking
    - Corroded terminals
4. If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.

SPARK PLUG WIRE REPLACEMENT

Removal Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement** .

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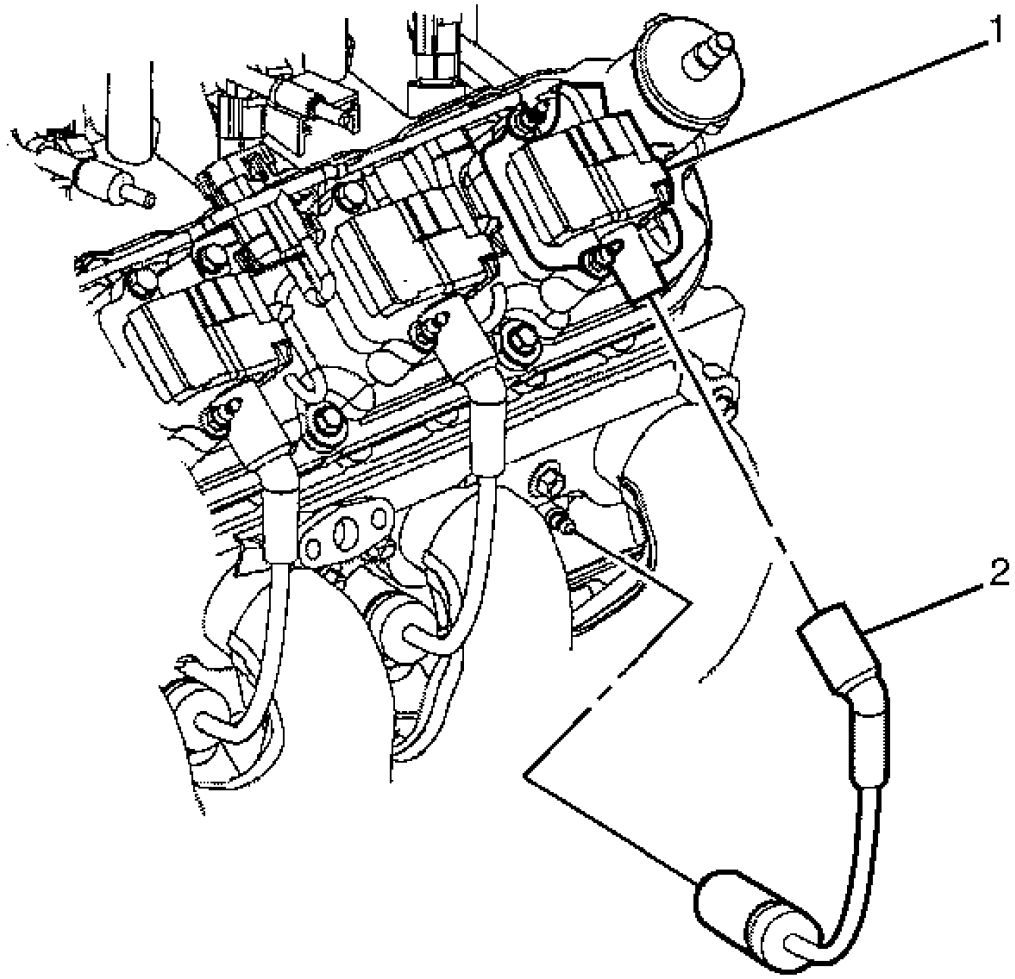


Fig. 114: Identifying Ignition Coil & Spark Plug Wire
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the spark plug wire (2) to the spark plug.
    - Twist each spark plug boot 1/2 turn.
    - Pull only on the boot in order to remove the wire from each spark plug.
3. Disconnect the spark plug wire from the ignition coil (1).
    - Twist each spark plug boot 1/2 turn.
    - Pull only on the boot in order to remove the wire from the ignition coil.

Installation Procedure

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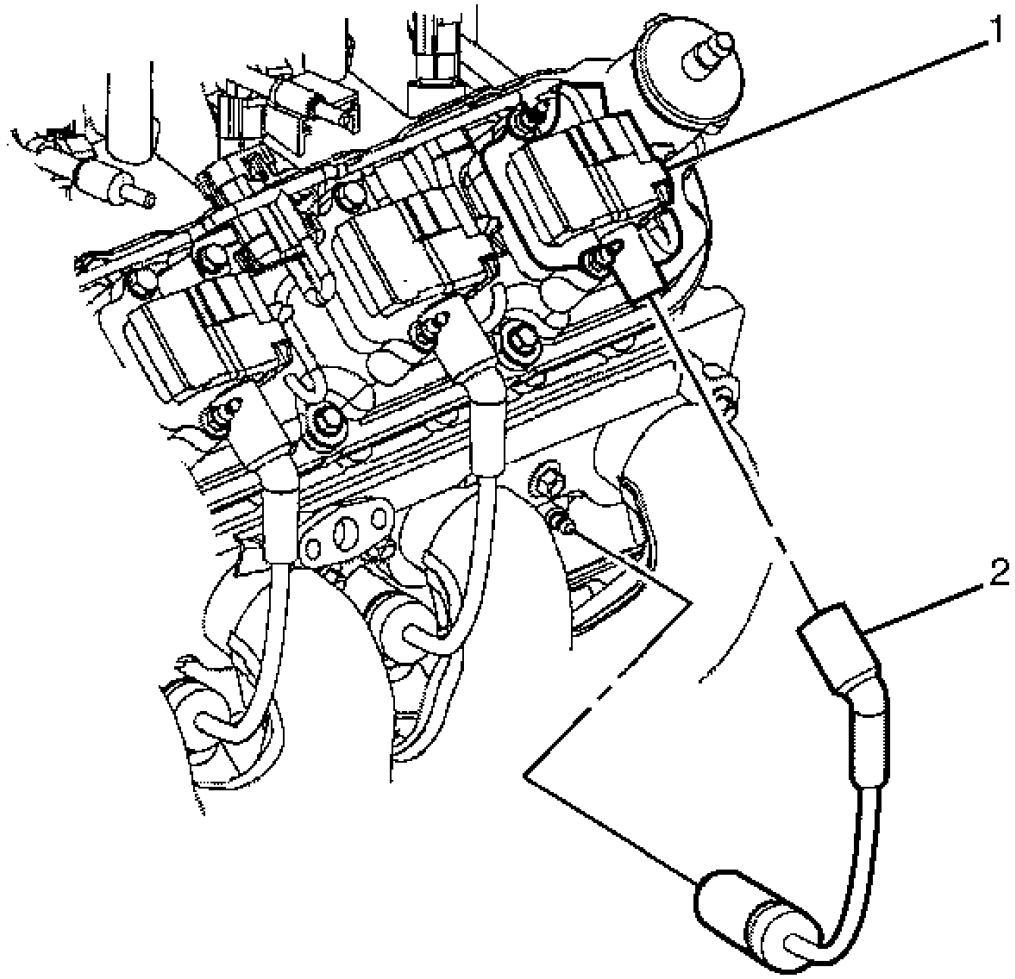


Fig. 115: Identifying Ignition Coil & Spark Plug Wire
Courtesy of GENERAL MOTORS CORP.

1. Install the spark plug wire to the ignition coil (1).
2. Install the spark plug wire (2) to the spark plug.
3. Inspect the spark plug wire for proper installation:
    - Push sideways on each spark plug boot in order to inspect the seating.
    - Reinstall any loose spark plug boot.
4. Install the engine cover. Refer to **Engine Cover Replacement** .

SPARK PLUG INSPECTION

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Spark Plug Usage

- Make sure that the correct spark plug is installed. An incorrect spark plug causes poor driveability conditions. Refer to **Ignition System Specifications** .
- Make sure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
  - Spark plug fouling due to a colder plug
  - A pre-ignition condition, causing spark plug and/or engine damage due to a hotter plug

Spark Plug Inspection

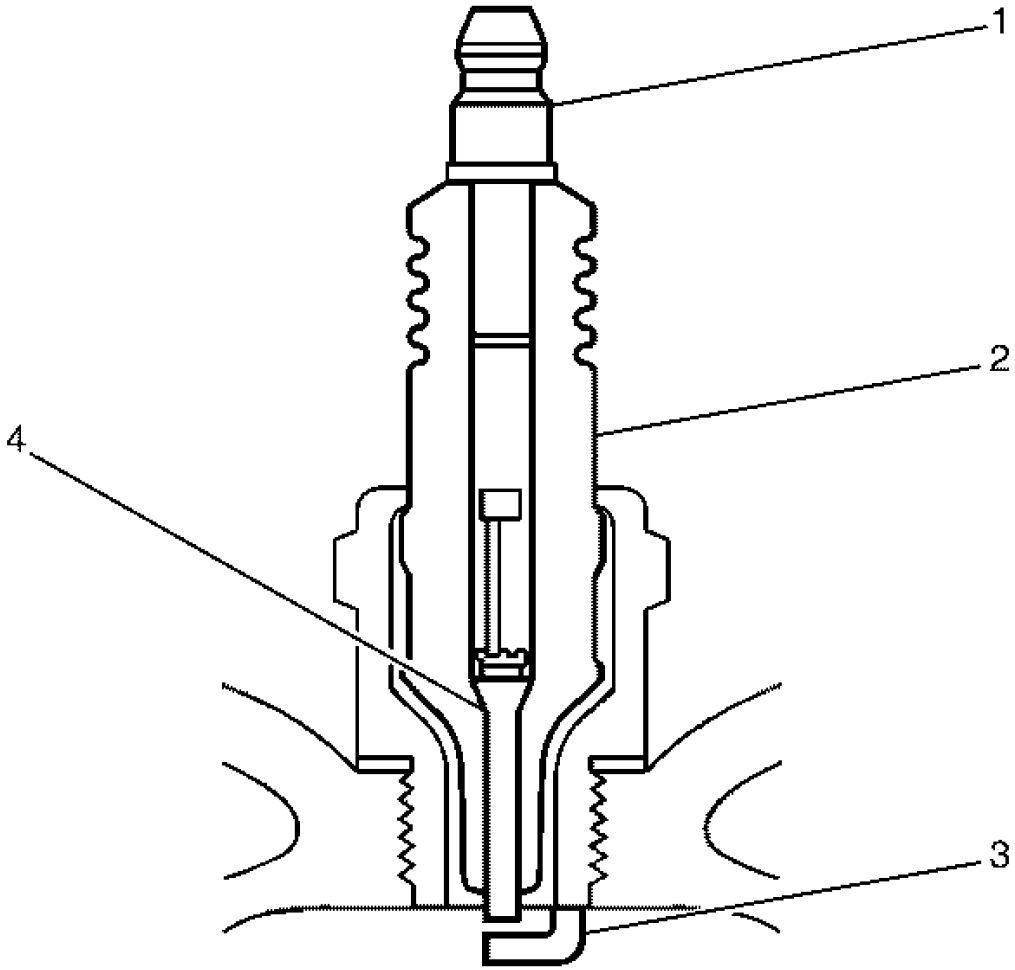


Fig. 116: Identifying Terminal Post & Insulator
Courtesy of GENERAL MOTORS CORP.

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- Inspect the terminal post (1) for damage.
  - Inspect for a bent or broken terminal post (1).
  - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
- Inspect the insulator (2) for flashover or for carbon tracking soot. This condition is caused by the electrical charge travelling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
  - Inspect the spark plug boot for damage.
  - Inspect the spark plug recess area of the cylinder head for moisture from such as oil, coolant, or from water. A saturated spark plug boot causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of through the electrodes (3, 4).
- Inspect for evidence of incorrect arcing.
  - Measure the gap between the centre electrode (4) and the side electrode (3) terminals. Refer to **Ignition System Specifications** .
  - Inspect for the correct spark plug torque. Refer to **Ignition System Specifications** . Insufficient torque can prevent correct spark plug operation. An over-torqued spark plug causes the insulator (2) to crack.
  - Inspect for signs of tracking that occurred near the insulator tip instead of at the centre electrode (4).
  - Inspect for a side electrode (3) that is broken or worn.
  - Inspect for a broken, worn, or loose centre electrode (4) by shaking the spark plug.
    - A rattling sound indicates internal damage.
    - A loose centre electrode (4) reduces the spark intensity.
  - Inspect for bridged electrodes (3 and 4). Deposits on the electrodes reduce or eliminate the gap.
  - Inspect for worn or missing platinum pads on the electrodes (3 and 4), if equipped.
  - Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal operation. Brown to grayish-tan spark plugs, with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- Carbon-fouled plugs. Dry, fluffy black carbon or soot caused by the following conditions:
  - Rich fuel mixtures
    - Leaking fuel injectors
    - Excessive fuel pressure
    - Restricted air filter element
    - Incorrect combustion
  - Reduced ignition system voltage output

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- Weak coils
- Worn ignition wires
- Incorrect spark plug gap

  - Excessive idling or slow speeds during light loads can keep the spark plug temperatures so low that the normal combustion deposits may not burn off.

- Deposit fouling. Oil, coolant, or additives that include substances such as silicone, evidenced by a very white coating, reduces the spark intensity. Most powdery deposits will not affect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

Removal Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the spark plug wires. Refer to **Spark Plug Wire Replacement**.

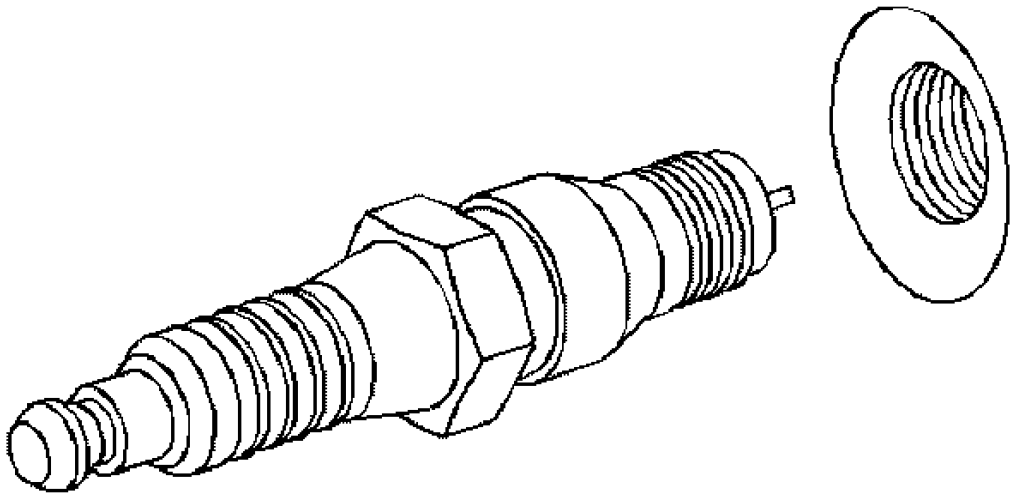


Fig. 117: Spark Plug
Courtesy of GENERAL MOTORS CORP.

3. Loosen each spark plug 1 or 2 turns.
4. Use a brush, or use compressed air in order to remove any dirt from the spark plugs.
5. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

Installation Procedure

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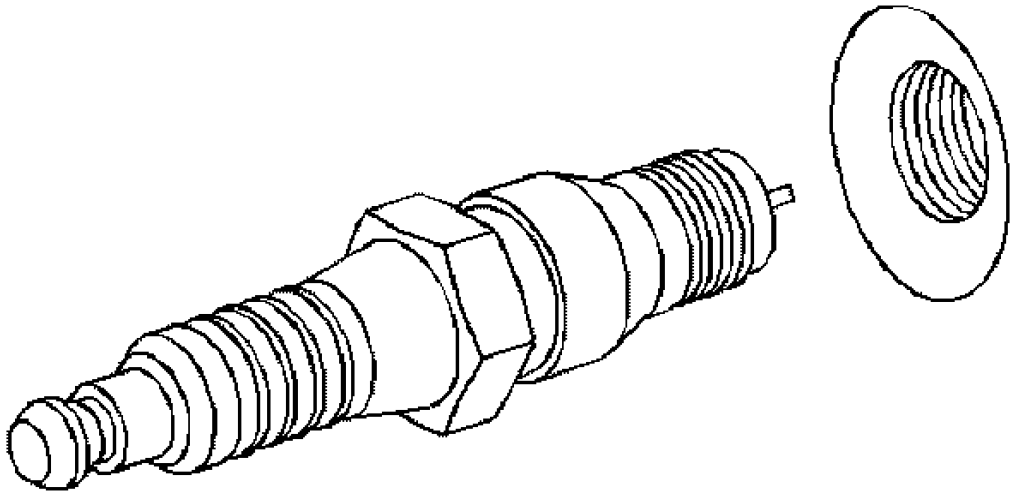


Fig. 118: Spark Plug
Courtesy of GENERAL MOTORS CORP.

1. Inspect each spark plug gap. Adjust each plug as needed.

   Specification: Spark plug gap: 1.524 mm (0.060 in).

2. Hand start the spark plugs in the corresponding cylinders.

   CAUTION: Refer to Fastener Caution .

3. Tighten the spark plugs. Tighten the engine spark plug on a NEW cylinder head to 20 N.m (15 lb ft) and the engine spark plug on subsequent installations to 15 N.m (11 lb ft).
4. Install the spark plug wires. Refer to **Spark Plug Wire Replacement**.
5. Install the engine cover. Refer to **Engine Cover Replacement** .

CRANKSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and

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strap the vehicle to the hoist.

WARNING: Refer to Protective Goggles and Glove Warning .

1. Disconnect the battery ground cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the starter. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

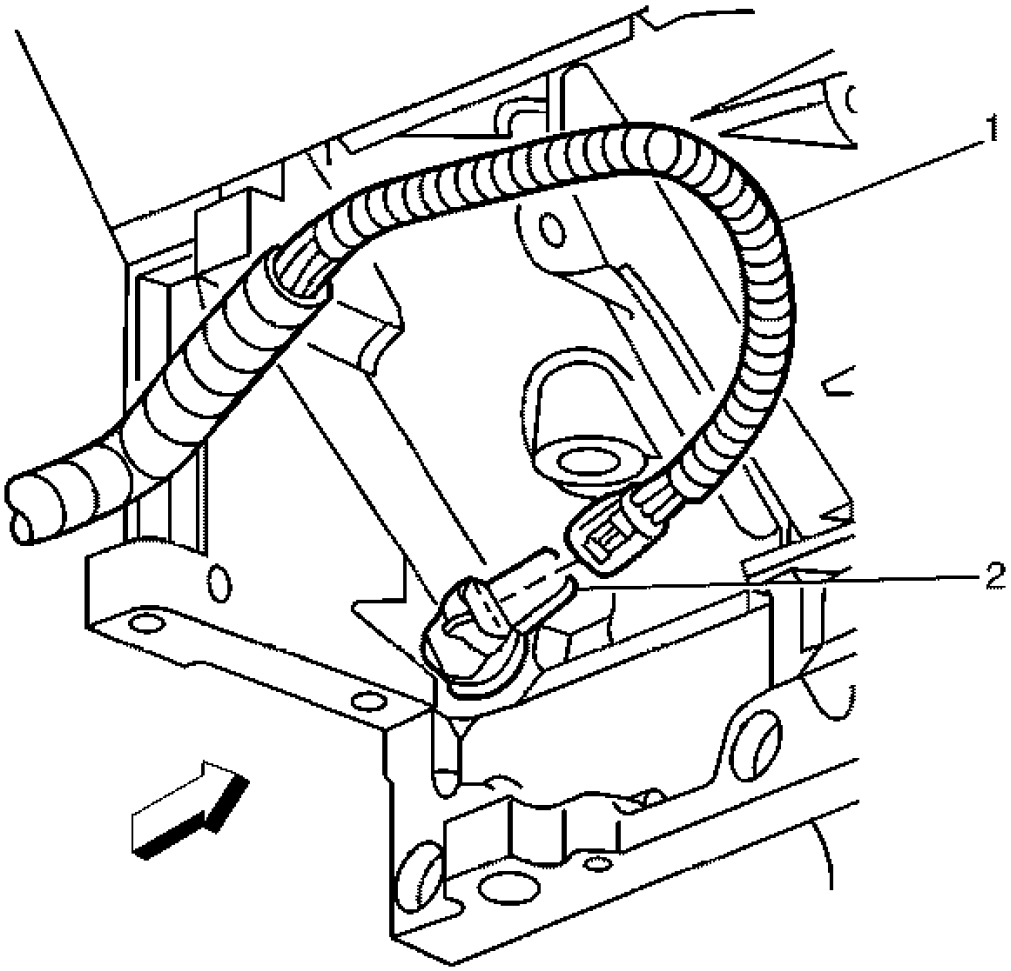


Fig. 119: Identifying CKP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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4. Disconnect the crankshaft position (CKP) sensor electrical connector (2) from the wiring harness (1).

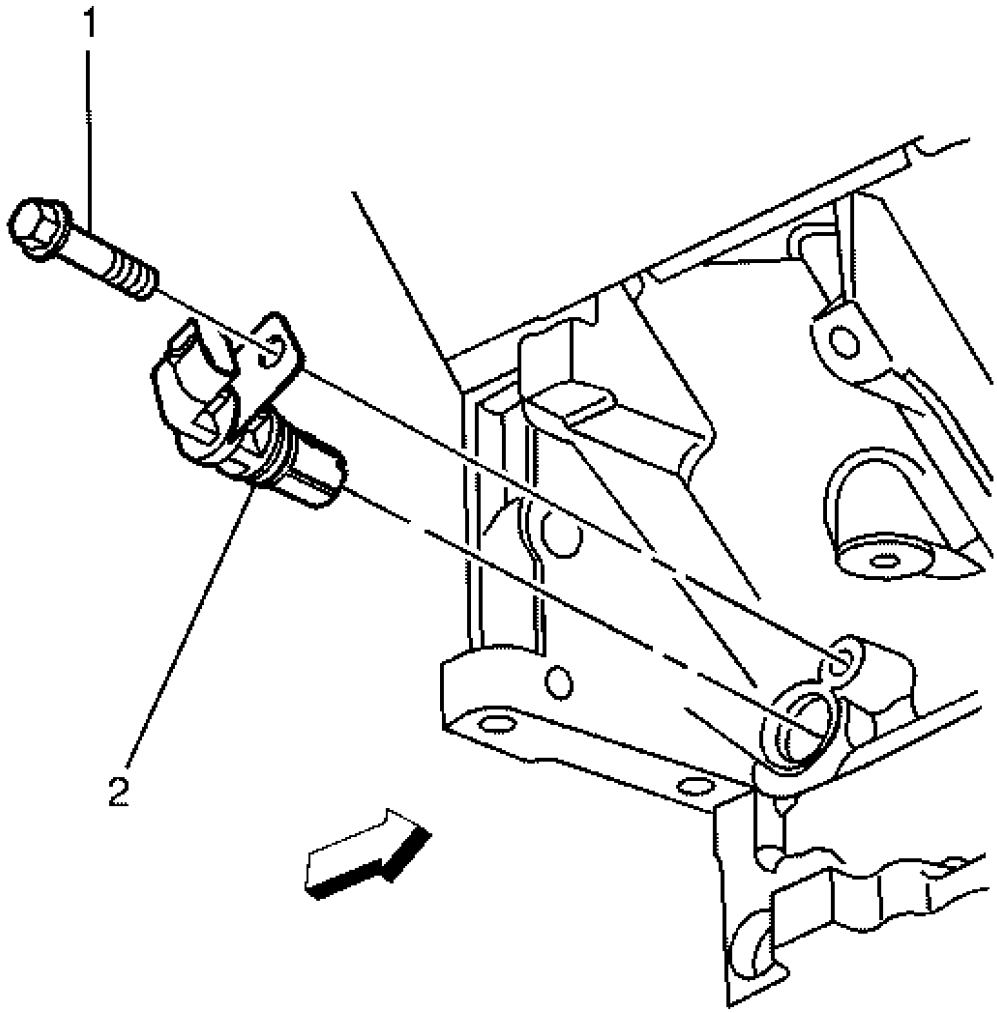


Fig. 120: Identifying CKP Sensor To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the CKP sensor to engine block retaining bolt (1).
6. Remove the CKP sensor (2) from the engine block.

Installation Procedure

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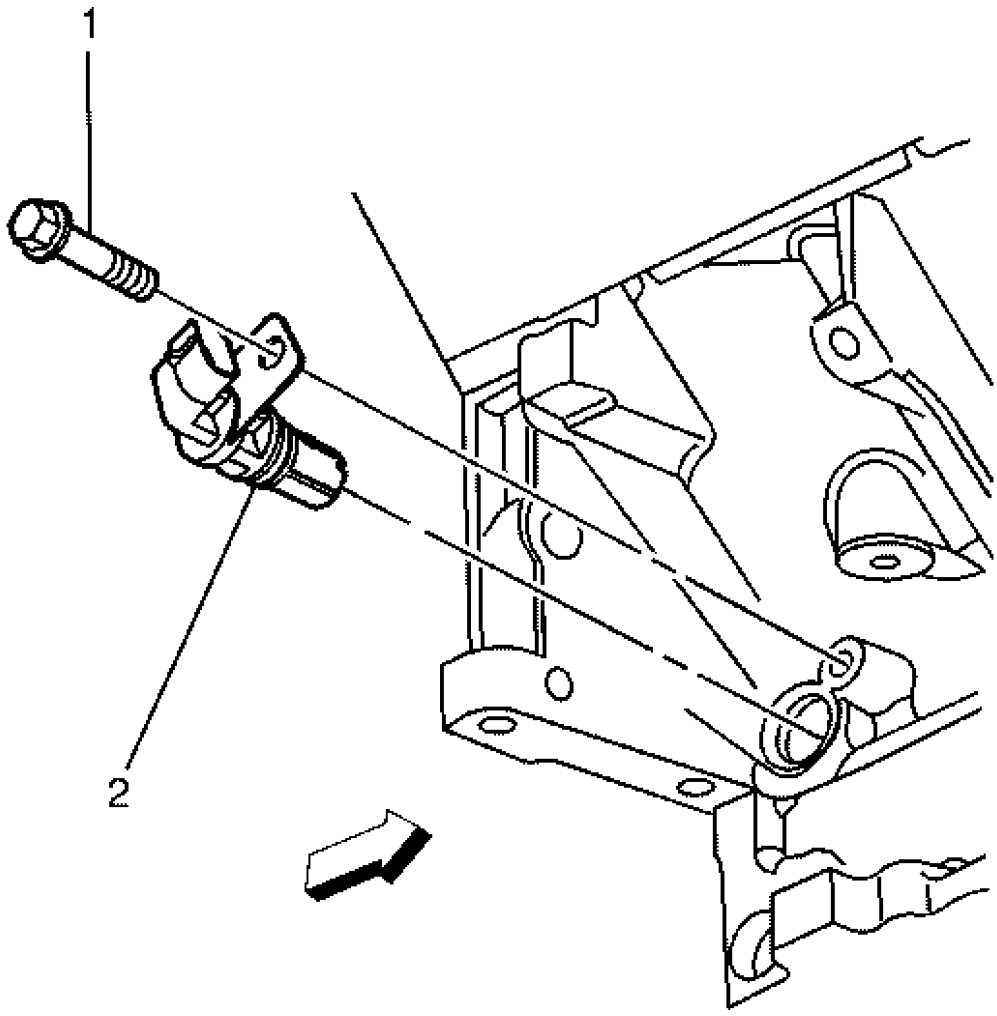


Fig. 121: Identifying CKP Sensor To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the CKP sensor (2) to the engine block.

CAUTION: Refer to Fastener Caution .

2. Install the CKP sensor to engine block retaining bolt (1) and tighten to 25 N.m (18 lb ft).

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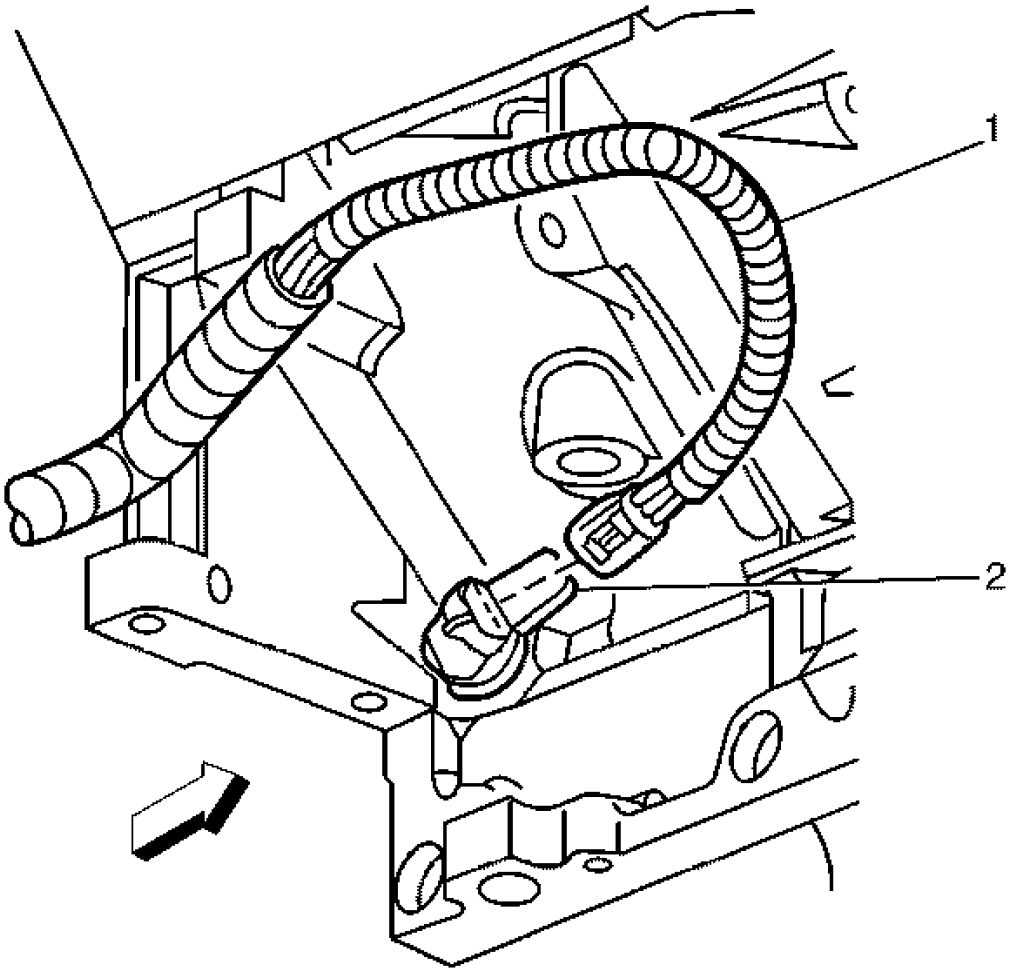


Fig. 122: Identifying CKP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the CKP sensor electrical connector (2) to the wiring harness (1).
4. Install the starter. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .
5. Lower the vehicle.
6. Connect the battery ground cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
7. If re-programming is required. Refer to **Control Module References** .

CAMSHAFT POSITION SENSOR REPLACEMENT

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Removal Procedure

WARNING: Refer to Battery Disconnect Warning .

1. Disconnect the battery ground cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the engine cover. Refer to **Engine Cover Replacement** .

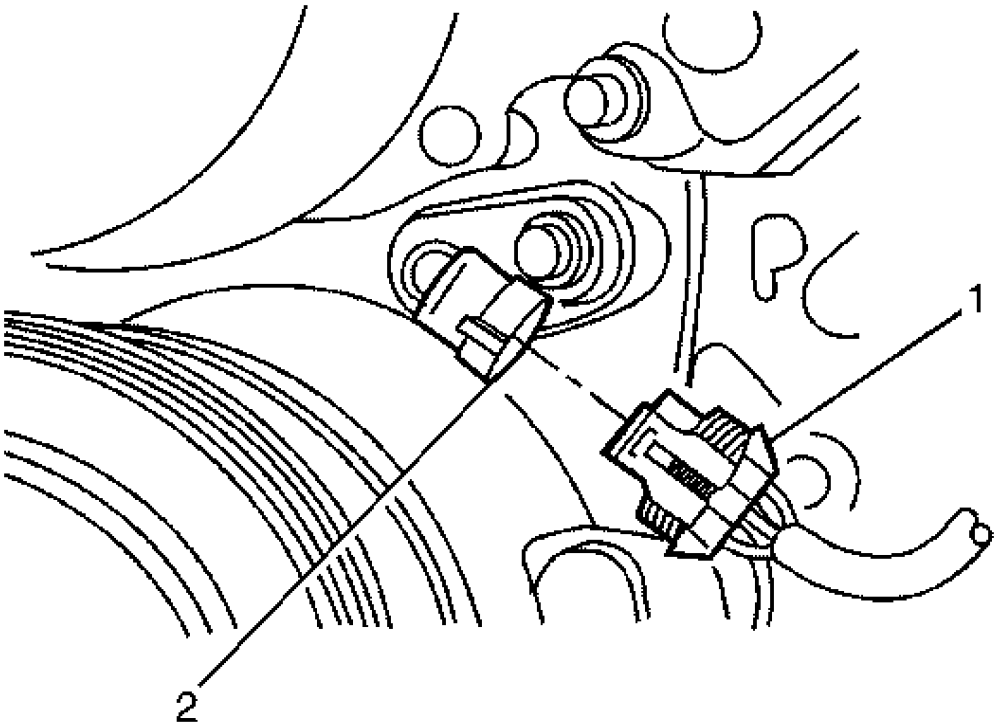


Fig. 123: Identifying Camshaft Position (CMP) Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the camshaft position (CMP) sensor electrical connector (1).

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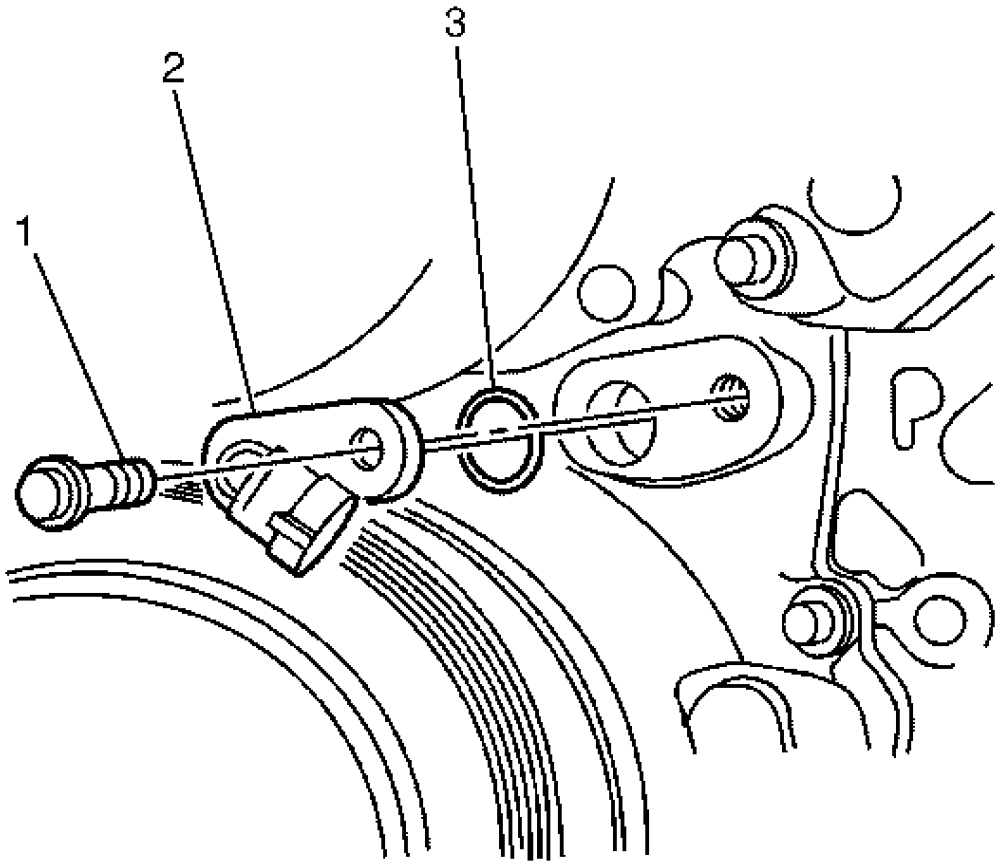


Fig. 124: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor to engine front cover retaining bolt (1).
5. Remove the CMP sensor (2) from the engine front cover.
6. Remove the CMP sensor O-ring (3) from the CMP sensor and discard.

   Discard the O-ring.

Installation Procedure

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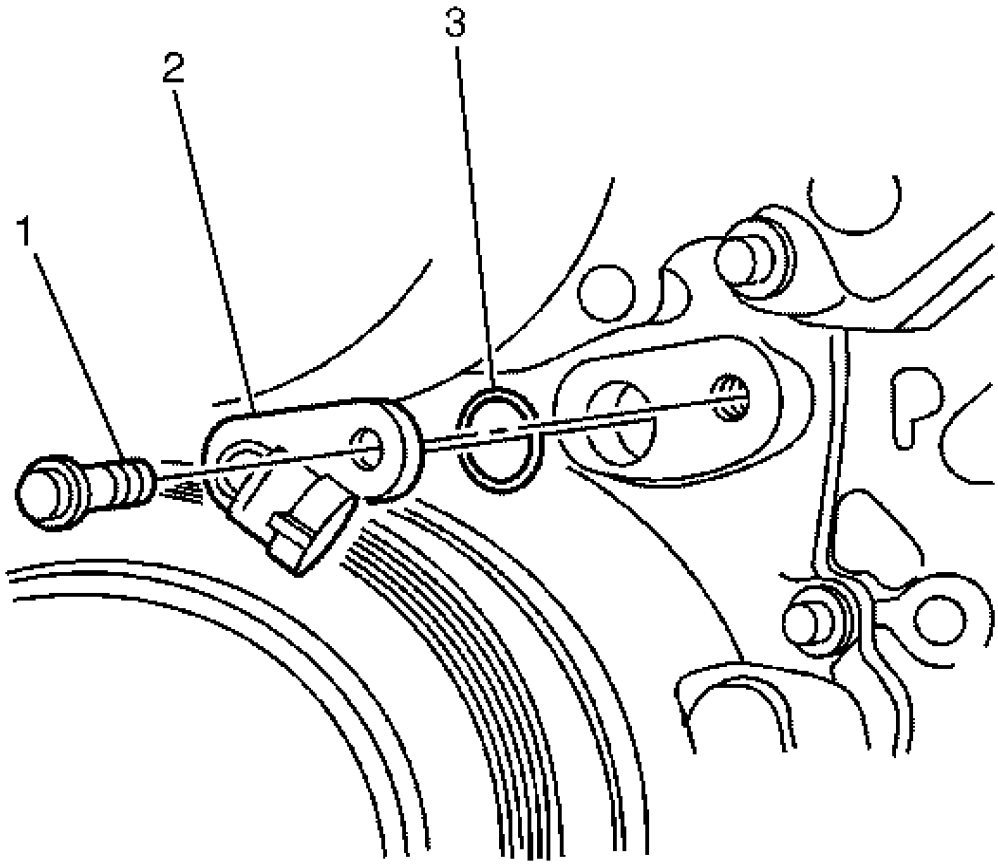


Fig. 125: Identifying CMP Sensor To Engine Front Cover Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Install a NEW O-ring to the camshaft sensor

NOTE: Before installing the camshaft sensor, apply a small amount of clean motor oil to the O-ring (3).

1. Install a NEW O-ring (3) to the CMP sensor.
2. Install the CMP sensor (2) to the engine front cover.

CAUTION: Refer to Fastener Caution .

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3. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to 9 N.m (80 lb in).

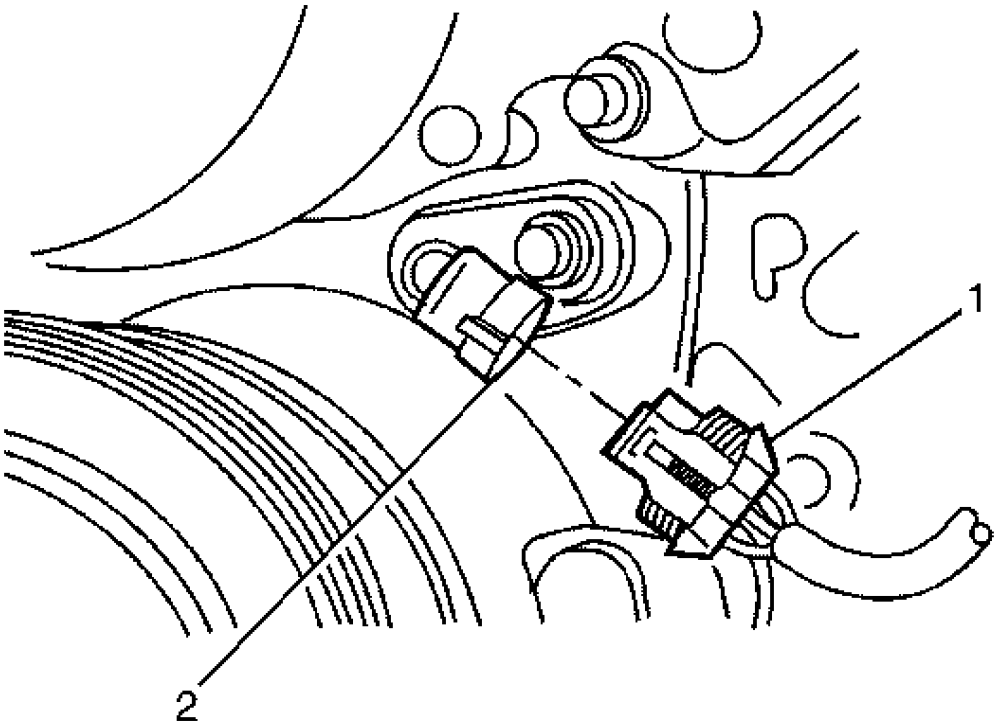


Fig. 126: Identifying Camshaft Position (CMP) Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the CMP sensor electrical connector (1) to wiring harness.
5. Install the engine cover. Refer to **Engine Cover Replacement** .
6. Connect the battery ground cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
7. If re-programming is required, refer to **Control Module References** .

CAMSHAFT POSITION SENSOR WIRE REPLACEMENT

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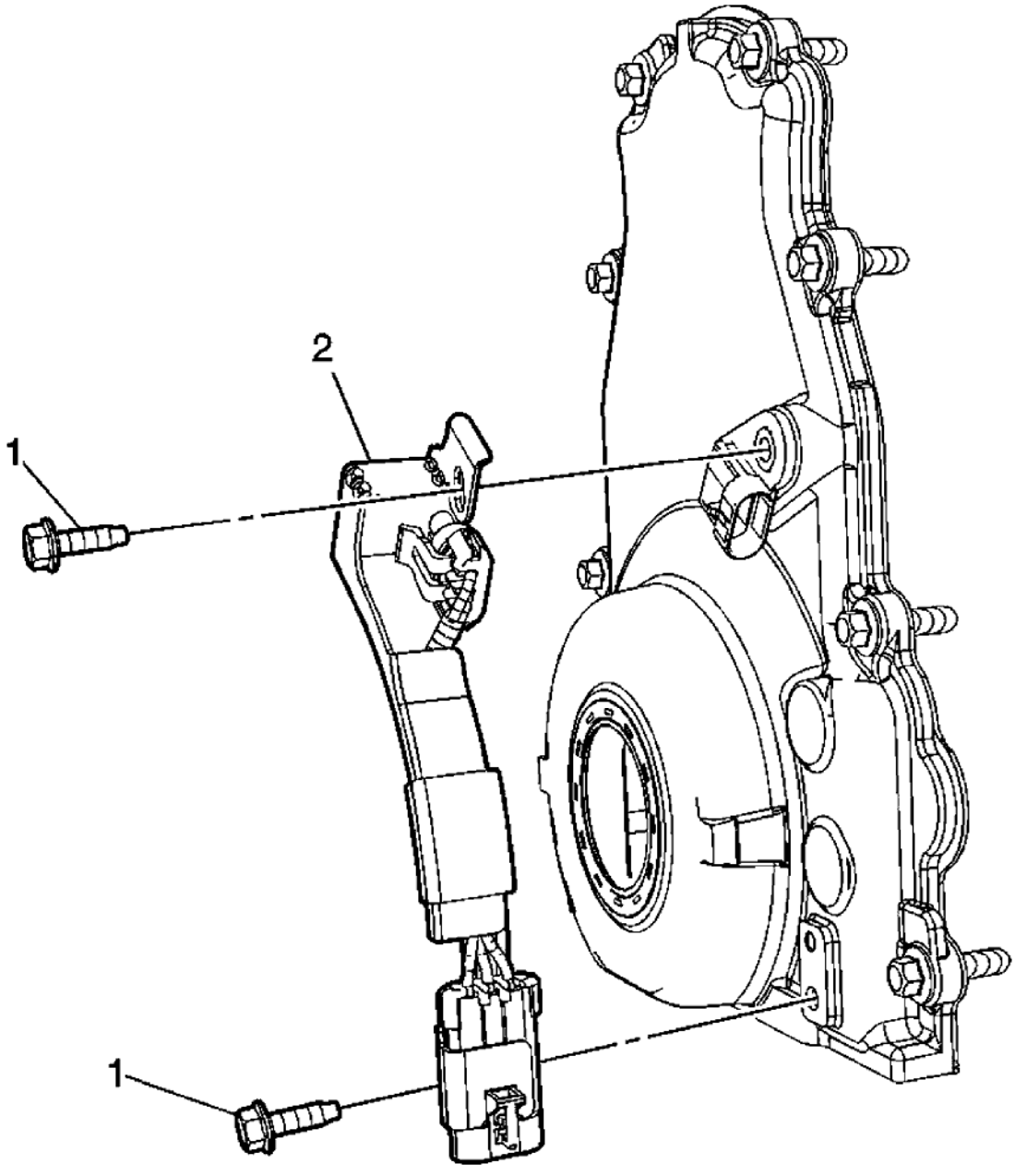


Fig. 127: Camshaft Position Sensor Wire
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Lift and support the vehicle. Refer to Lifting and Jacking the Vehicle .**	
1	Camshaft Position Sensor Wire Assembly Fastener (Qty: 2) **CAUTION:**

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	Refer to Fastener Caution . **Tighten:** 12 N.m (106 lb in)
2	Camshaft Position Sensor Wire Assembly **Procedure:** Disconnect the electrical connectors.

KNOCK SENSOR REPLACEMENT (BANK 1)

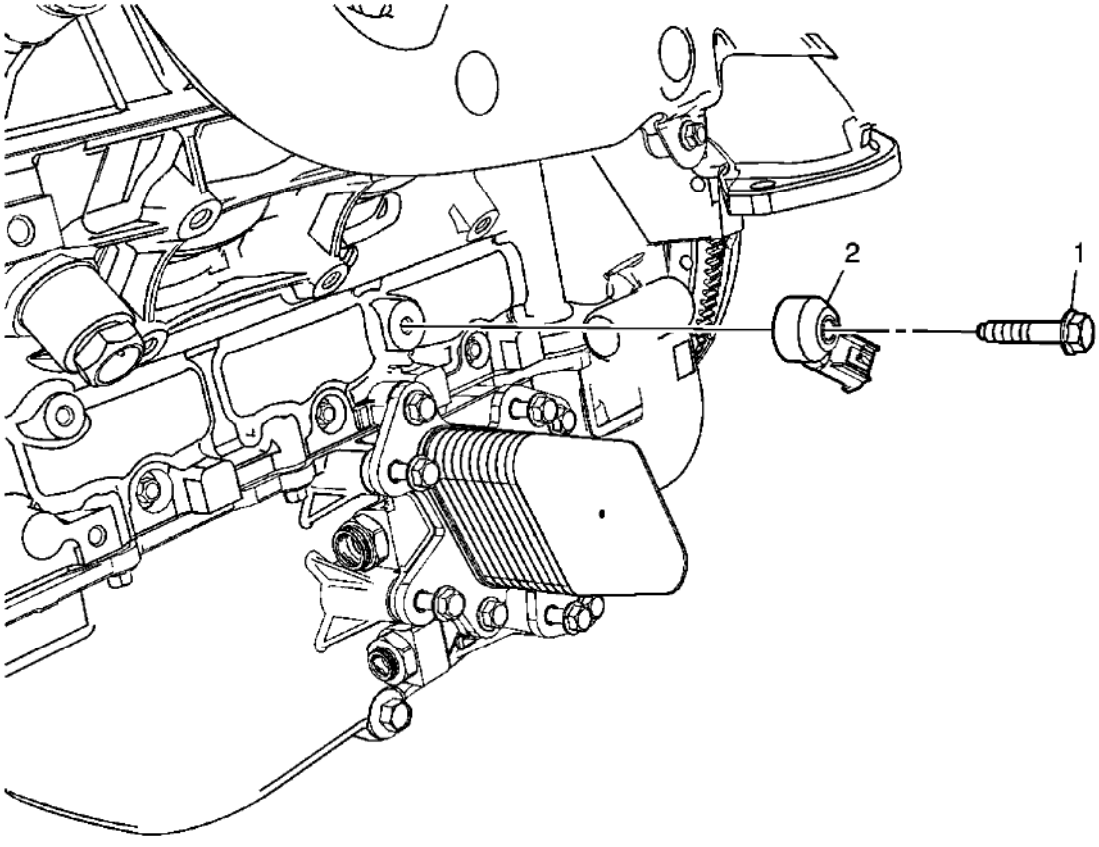


Fig. 128: Knock Sensor (Bank 1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Lift and support the vehicle. Refer to Lifting and Jacking the Vehicle .**	
1	Knock Sensor Fastener **CAUTION:** **Refer to Fastener Caution .**

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	Tighten: 25 N.m (18 lb ft)
2	Knock Sensor **Procedure:** Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT (BANK 2)

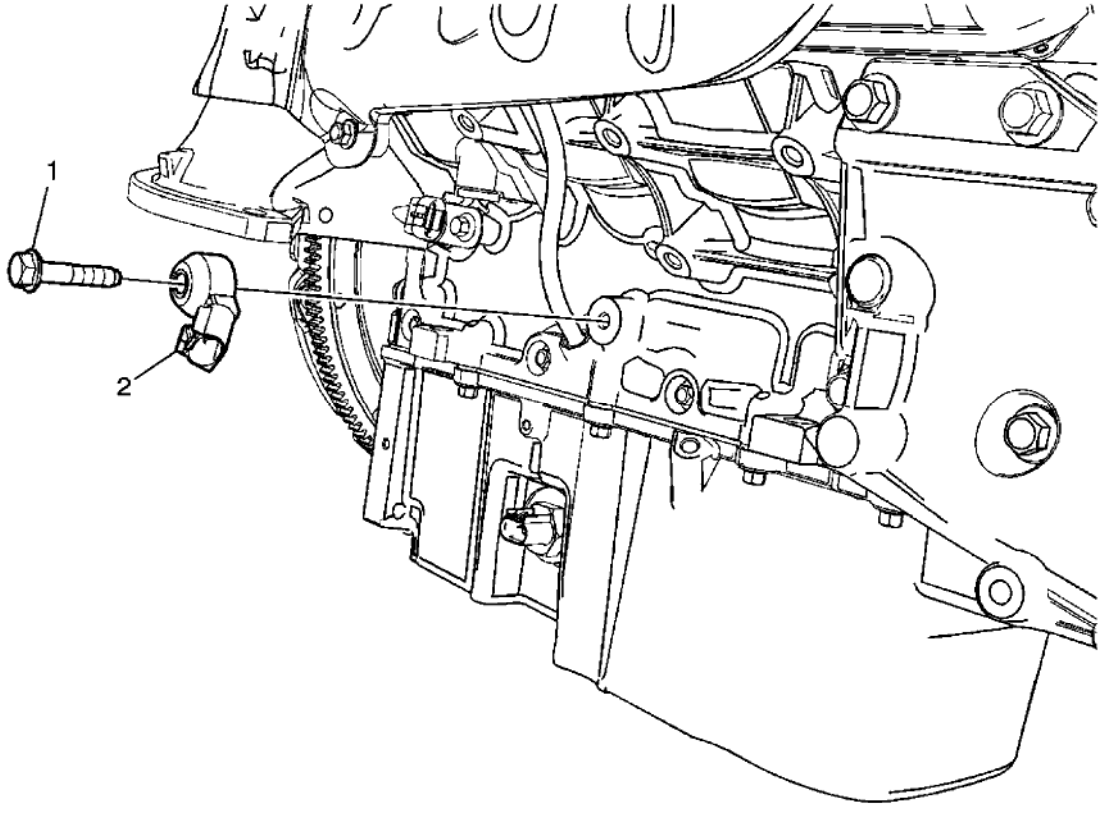


Fig. 129: Knock Sensor (Bank 2)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the starter. Refer to Starter Replacement (LLT) or Starter Replacement (LS3/L99) .**	
1	Knock Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 25 N.m (18 lb ft)
2	Knock Sensor **Procedure:**

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	Disconnect the electrical connector.

AIR CLEANER ELEMENT REPLACEMENT

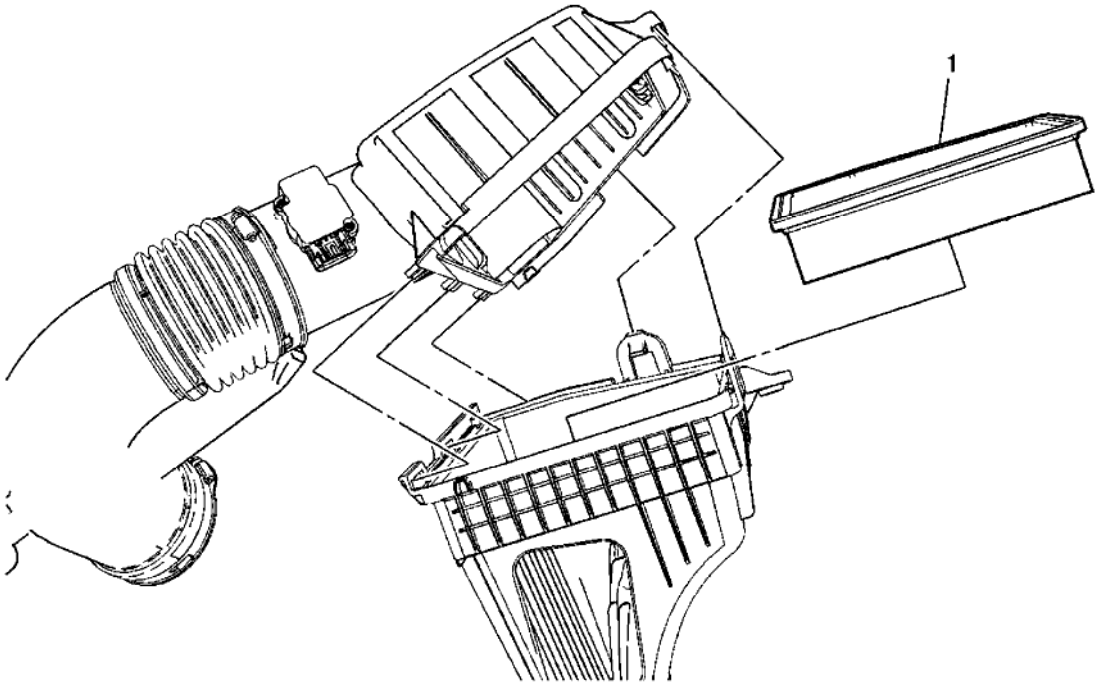


Fig. 130: Air Cleaner Element
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Air Cleaner Element **Procedure:** Push back the retaining tabs.

AIR CLEANER ASSEMBLY REPLACEMENT

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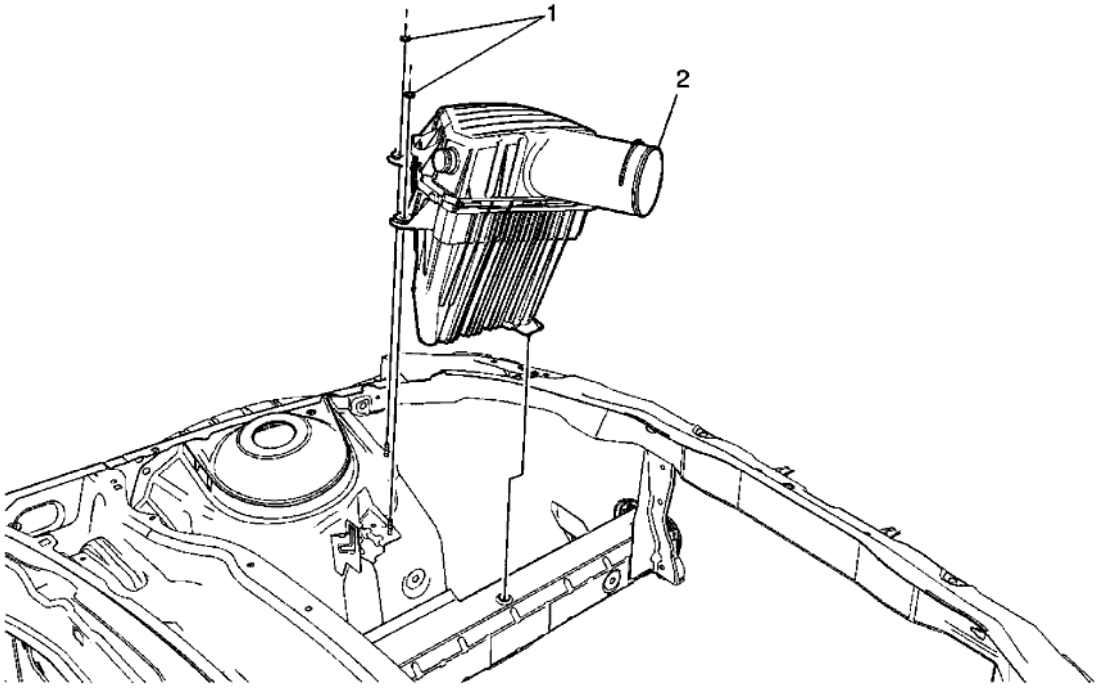


Fig. 131: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the mass airflow sensor. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**. 2. Disconnect the outlet duct from the air cleaner assembly. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**.	
1	Air Cleaner Assembly Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 9 N.m (80 lb in)
2	Air Cleaner Assembly

AIR CLEANER RESONATOR AND OUTLET DUCT REPLACEMENT

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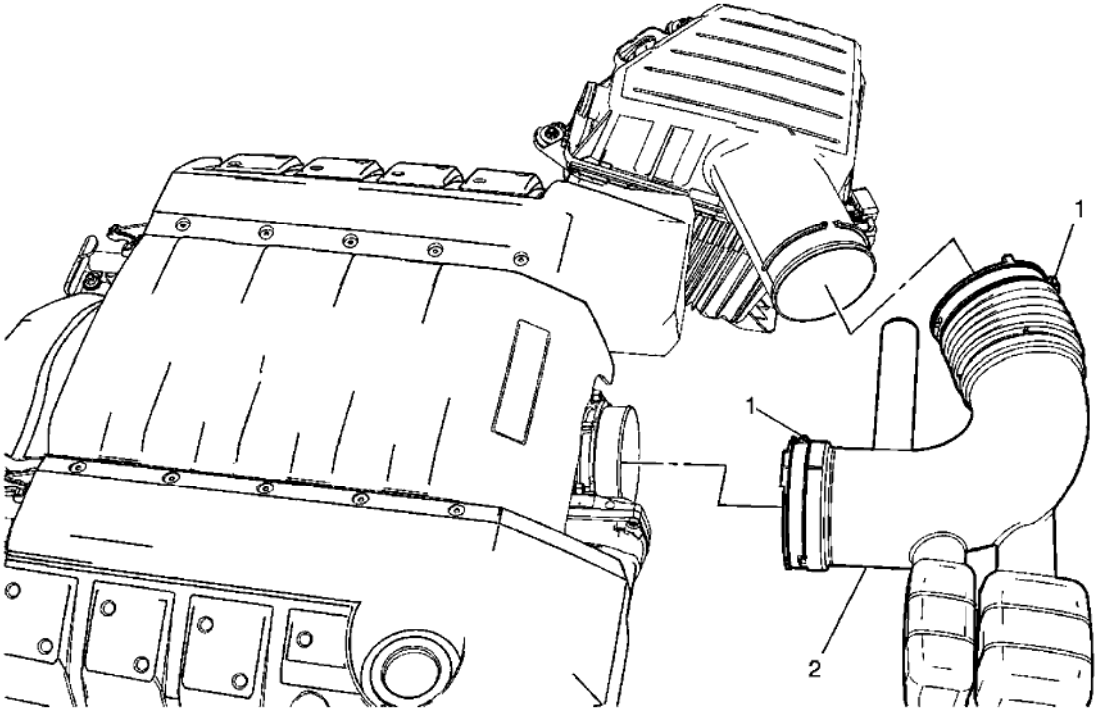


Fig. 132: Air Cleaner Resonator & Outlet Duct
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Disconnect the positive crankcase ventilation tube from the resonator. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement** .	
1	Air Cleaner Resonator and Outlet Duct Hose Clamp (Qty: 2) **CAUTION:** **Refer to Fastener Caution** **Tighten:** 4 N.m(35 lb in)
2	Air Cleaner Resonator and Outlet Duct

FRONT INTAKE AIR DUCT REPLACEMENT

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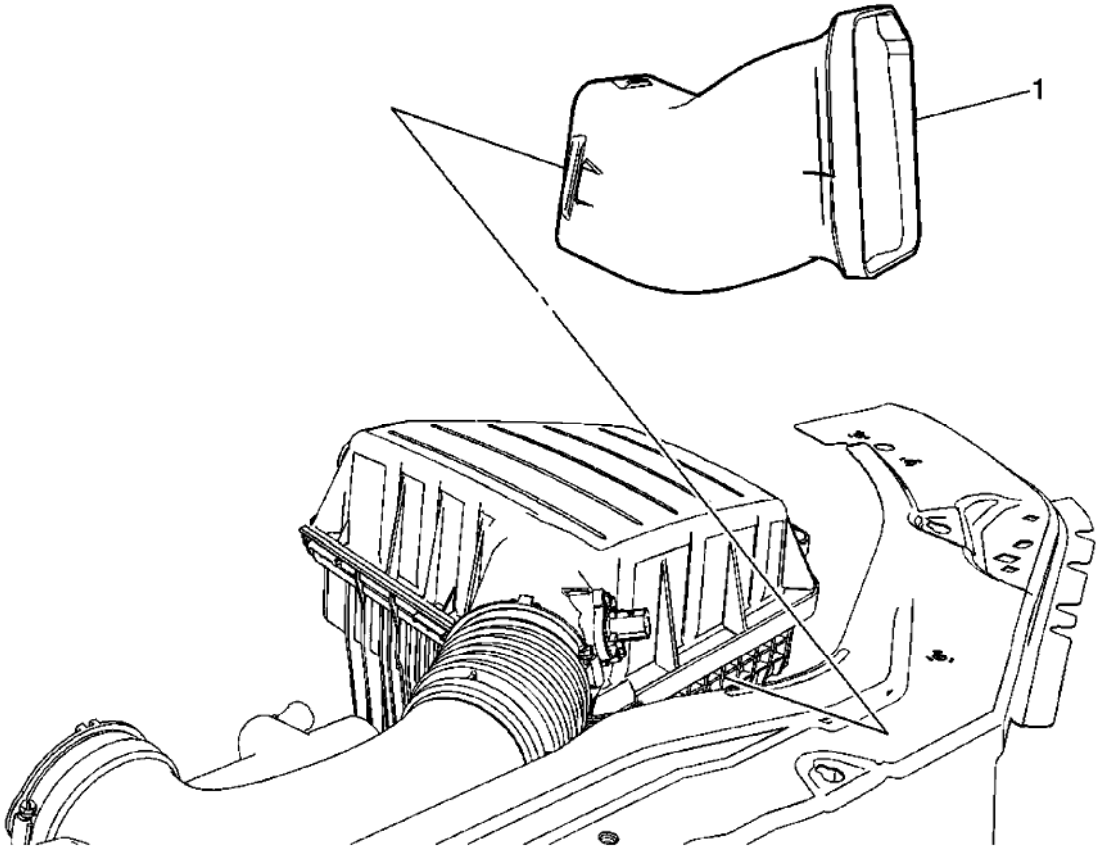


Fig. 133: Front Intake Air Duct
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement**	
1	Front Intake Air Duct

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE CONTROLS SCHEMATICS

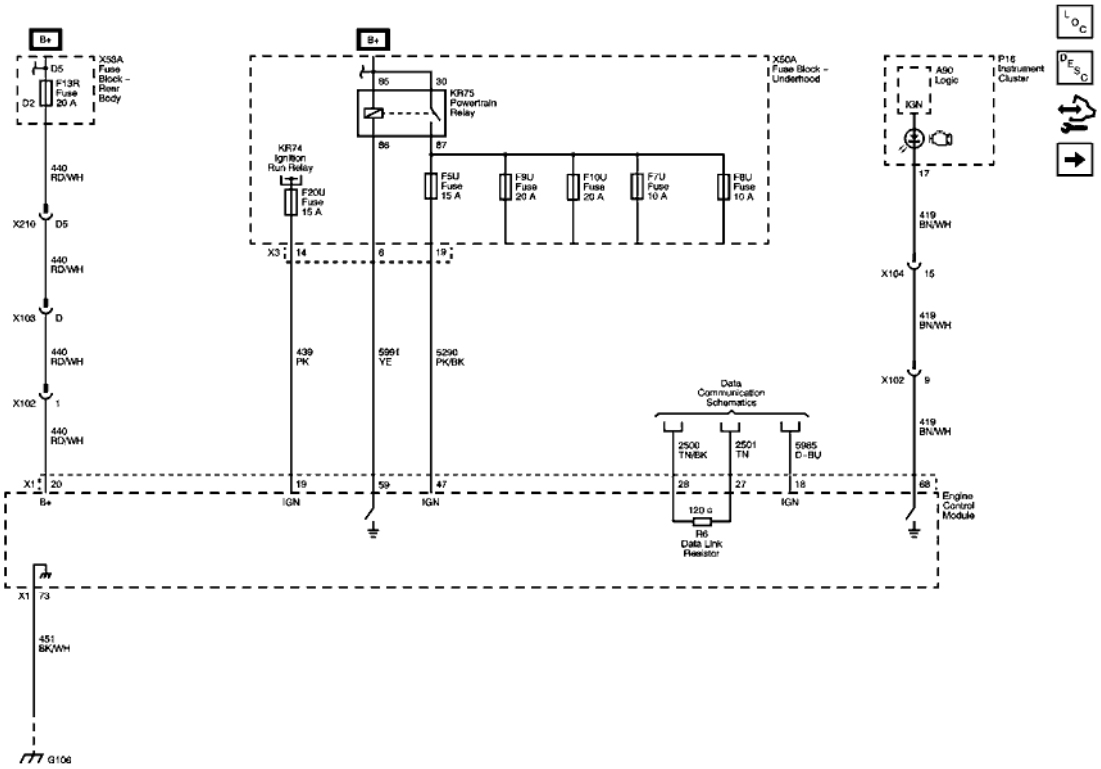


Fig. 1: ECM Power, Ground, MIL, and Serial Data
Courtesy of GENERAL MOTORS CORP.

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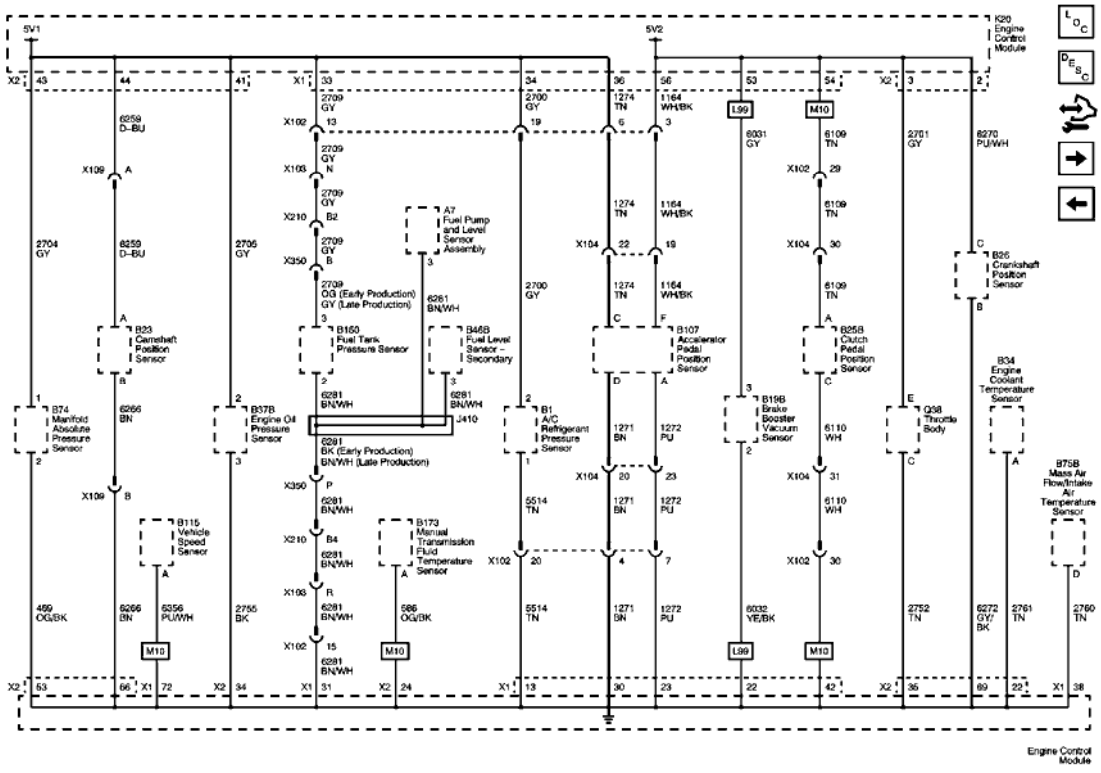


Fig. 2: 5-Volt and Low Reference Bussing
Courtesy of GENERAL MOTORS CORP.

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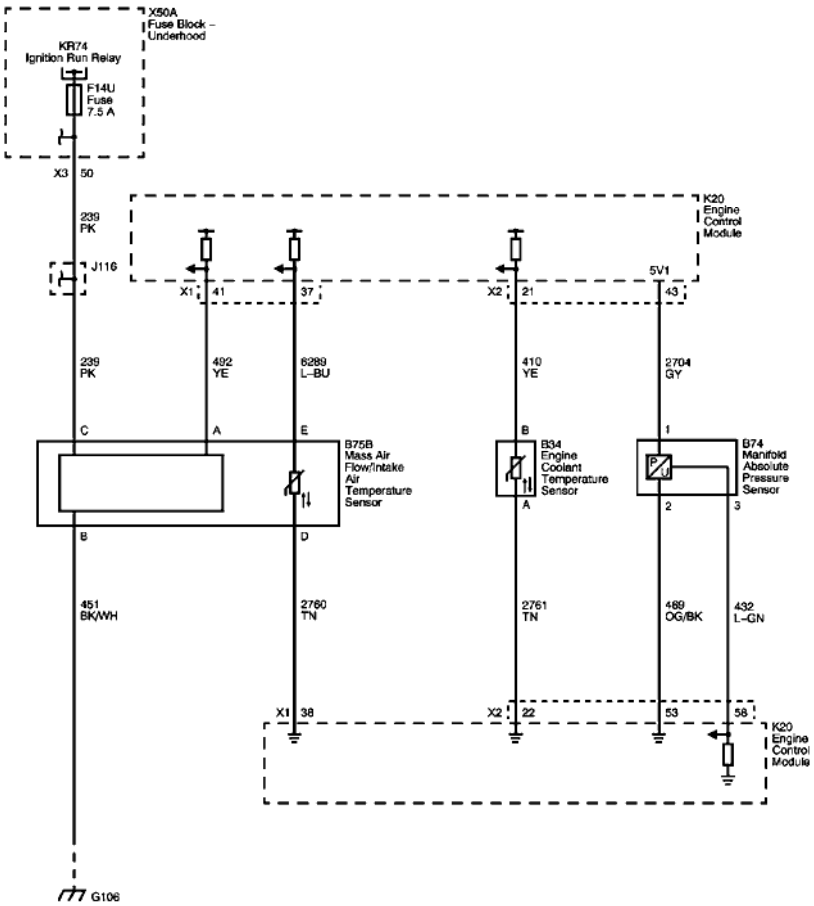


Fig. 3: MAP, ECT, and MAF/IAT Sensors
Courtesy of GENERAL MOTORS CORP.

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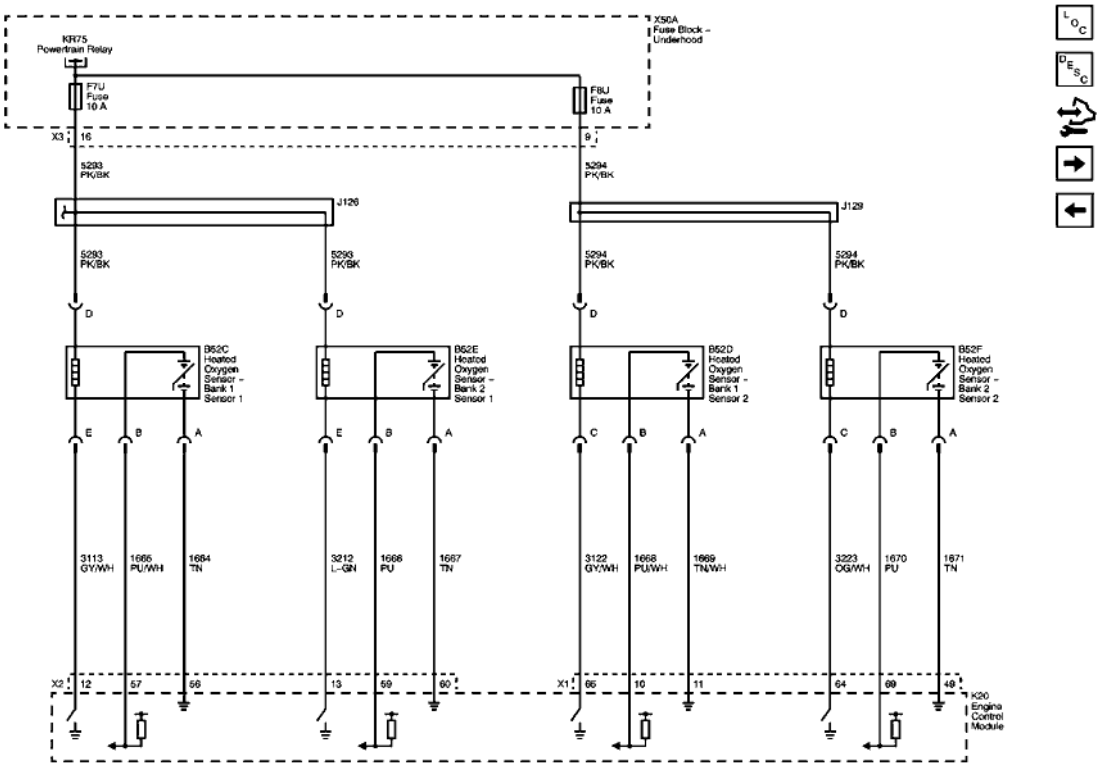


Fig. 4: Heated Oxygen Sensors
Courtesy of GENERAL MOTORS CORP.

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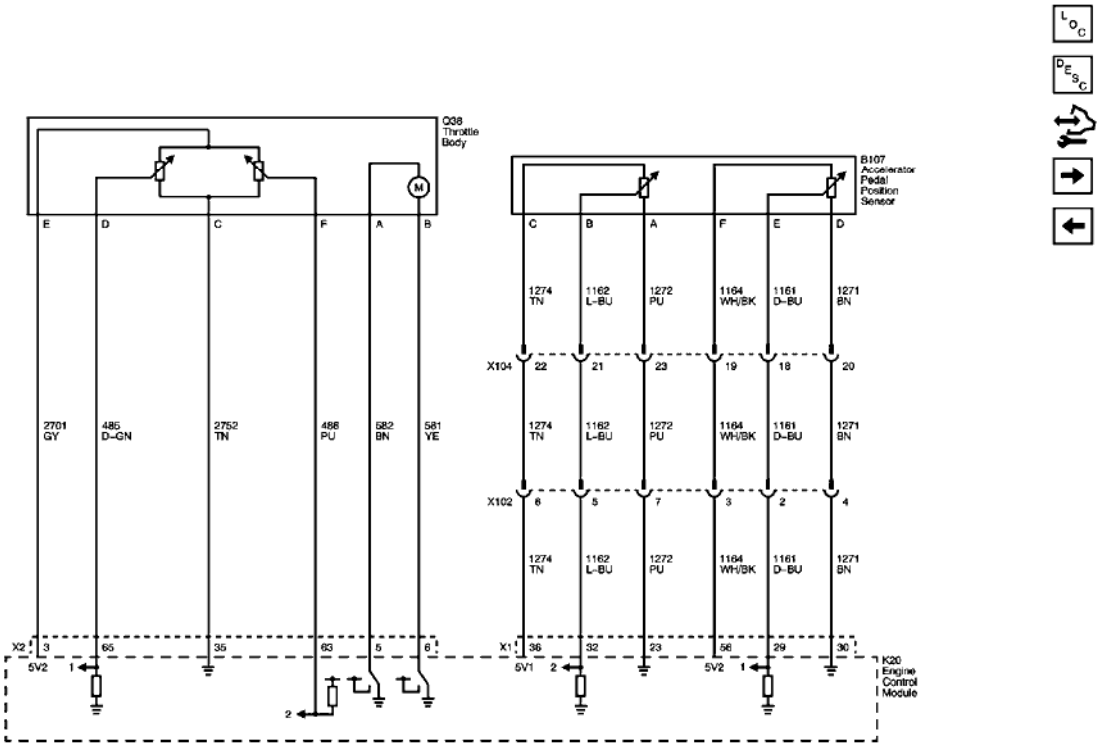


Fig. 5: Electronic Throttle Controls
Courtesy of GENERAL MOTORS CORP.

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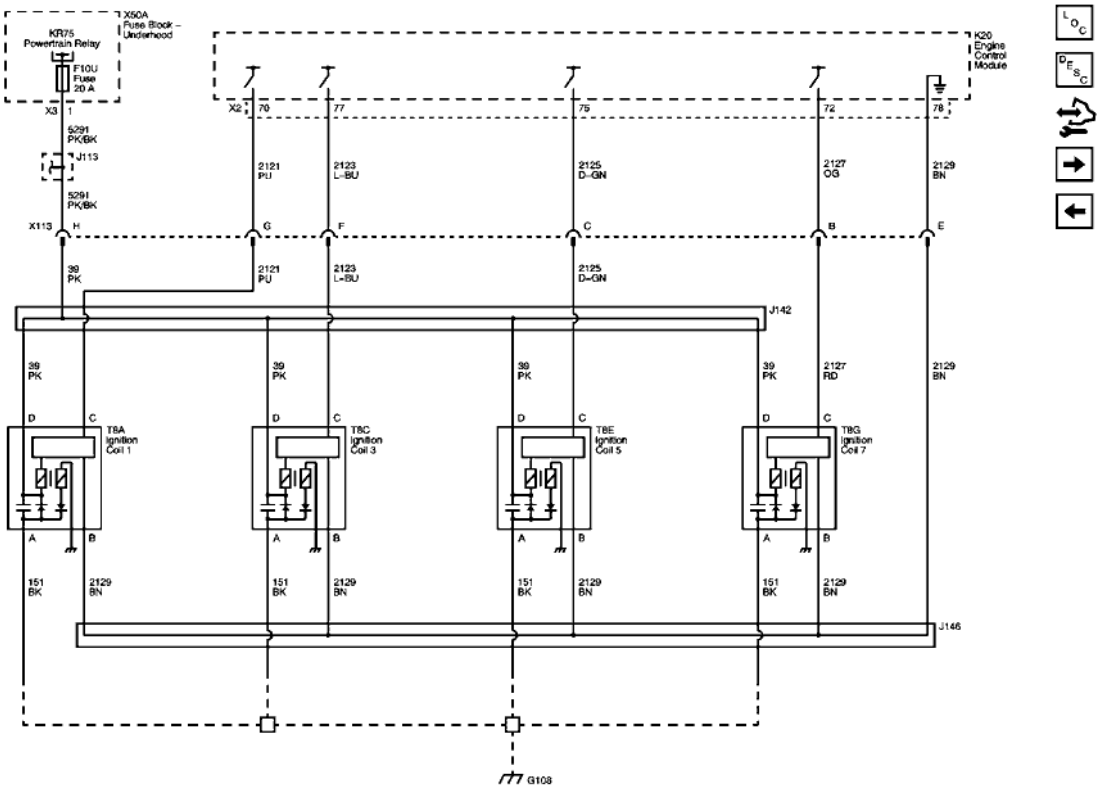


Fig. 6: Ignition Controls Bank 1 (Odd) Ignition Coils
Courtesy of GENERAL MOTORS CORP.

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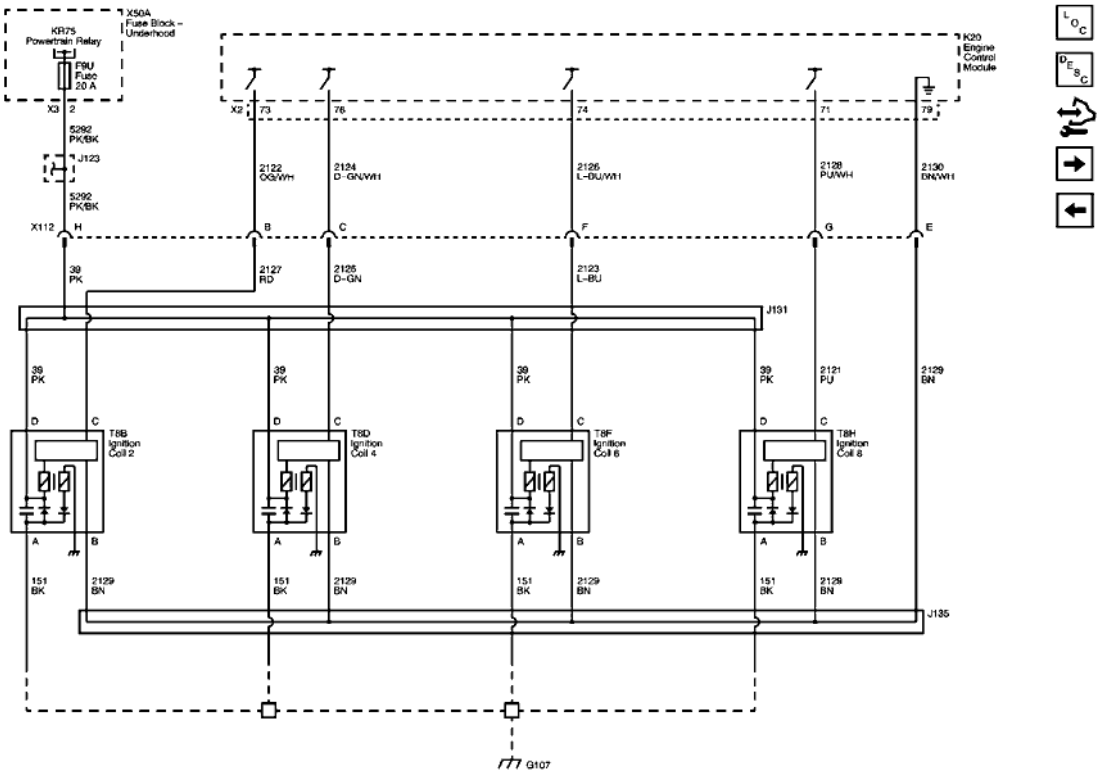


Fig. 7: Ignition Controls Bank 2 (EVEN) Ignition Coils
Courtesy of GENERAL MOTORS CORP.

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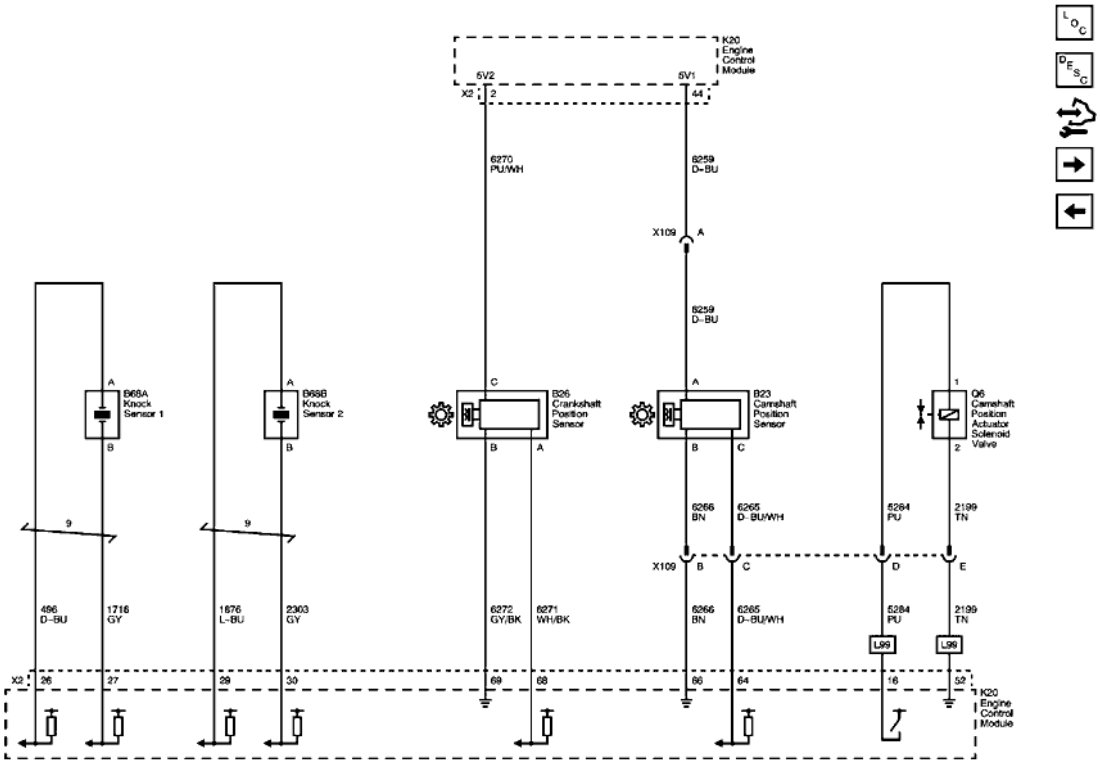


Fig. 8: Ignition Controls, Knock, CMP, and CKP Sensors
Courtesy of GENERAL MOTORS CORP.

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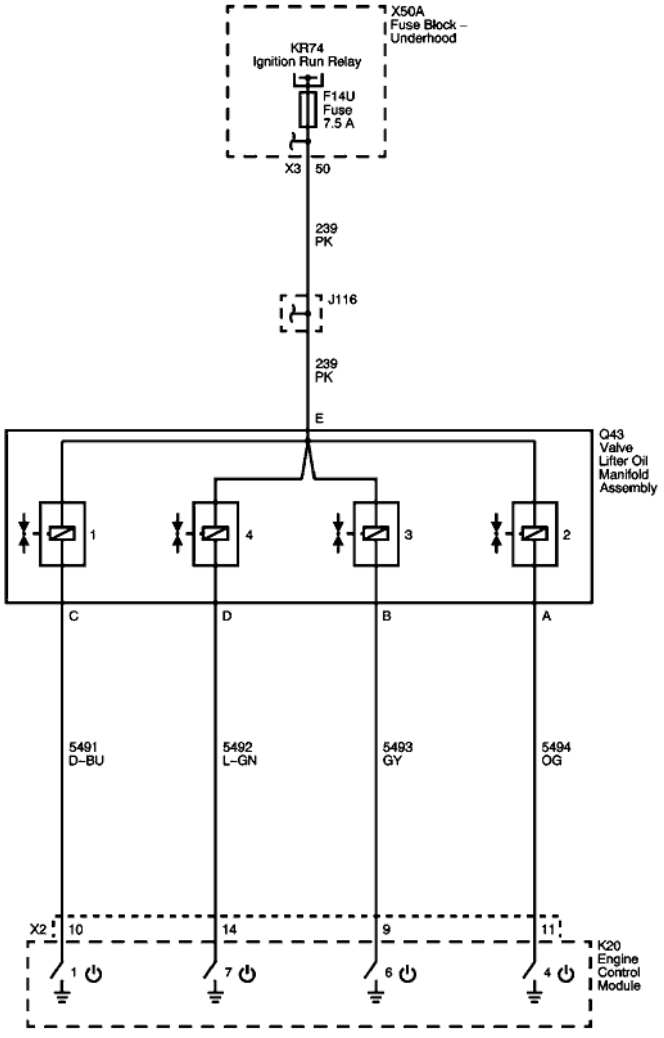


Fig. 9: Valve Lifter Oil Manifold (VLOM) Assembly
Courtesy of GENERAL MOTORS CORP.

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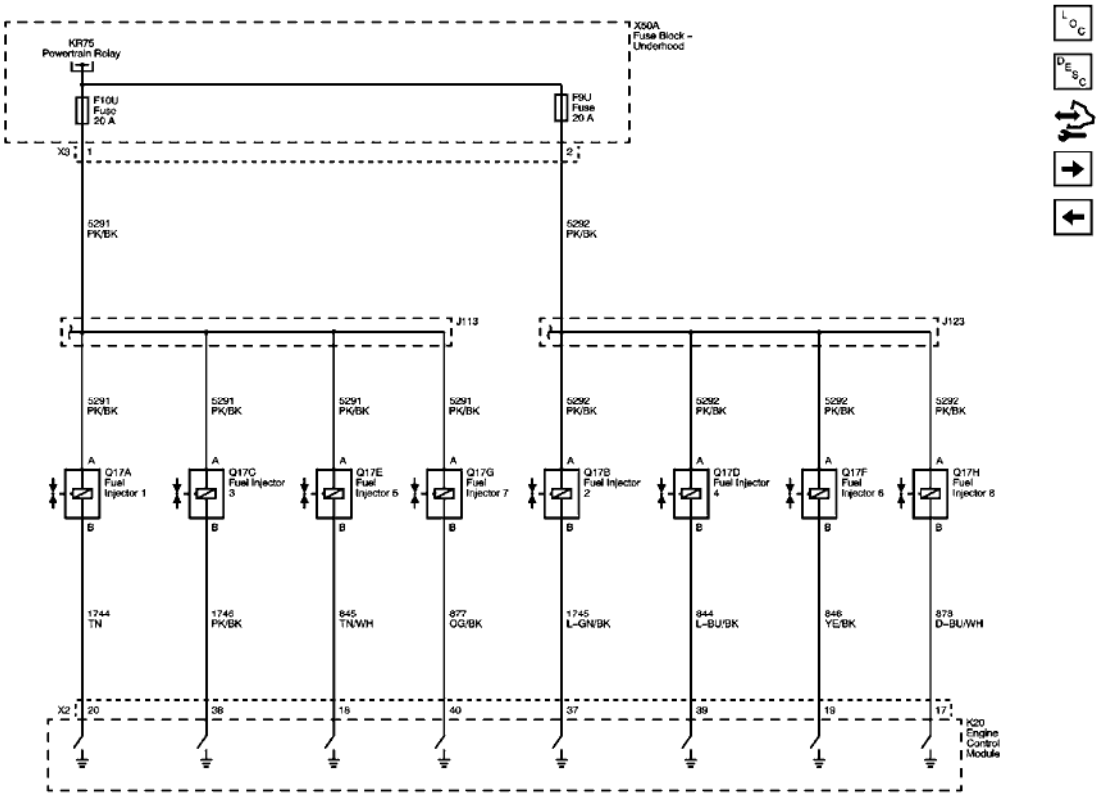


Fig. 10: Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

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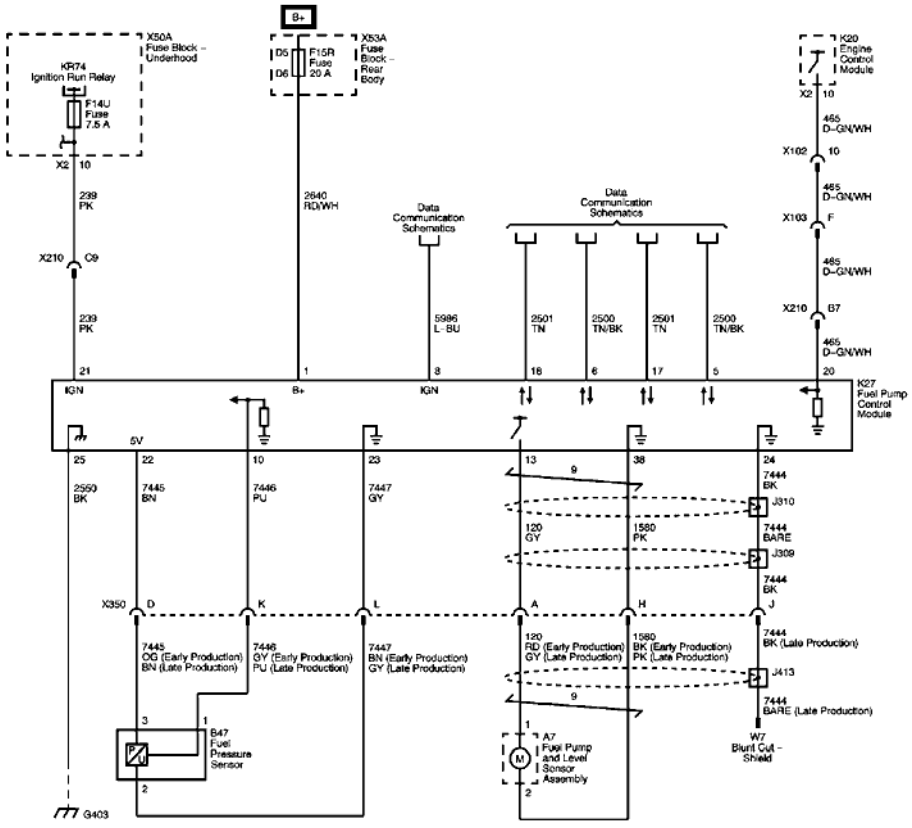


Fig. 11: Fuel Controls - Fuel Pump Flow Control
Courtesy of GENERAL MOTORS CORP.

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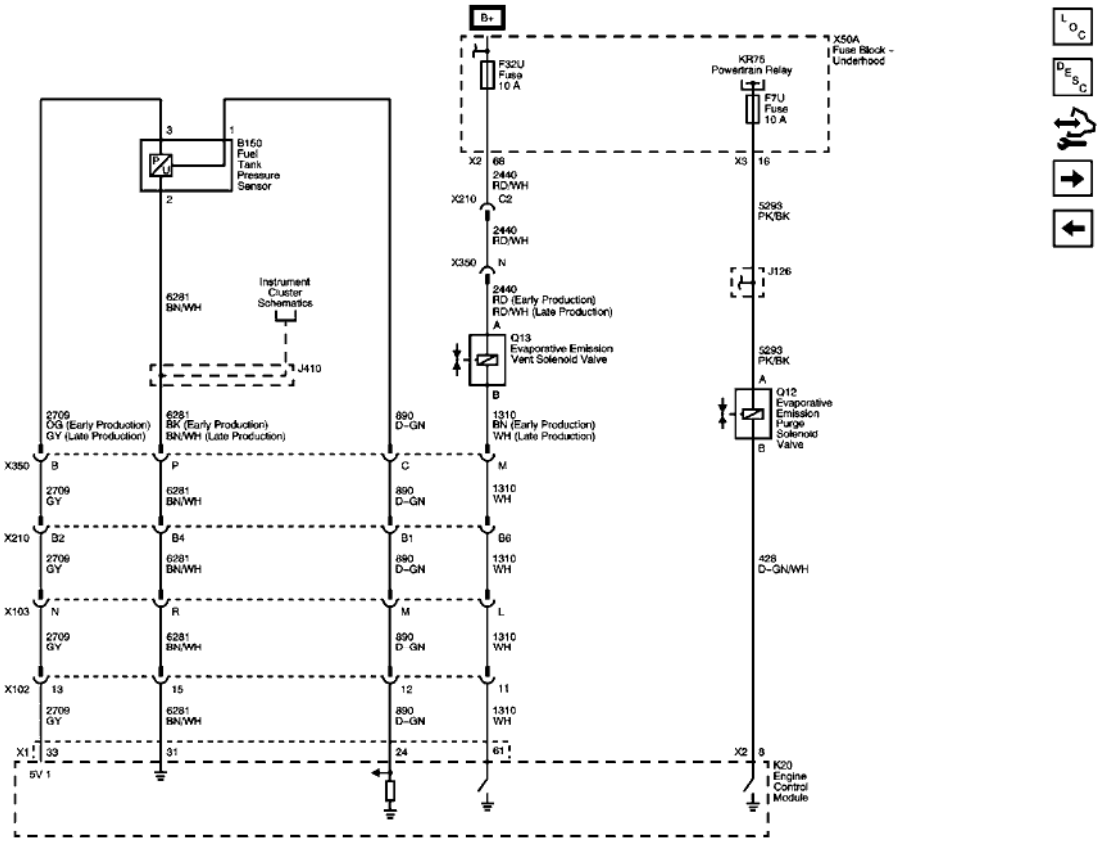


Fig. 12: Fuel Controls - EVAP Controls and Manifold Tuning
Courtesy of GENERAL MOTORS CORP.

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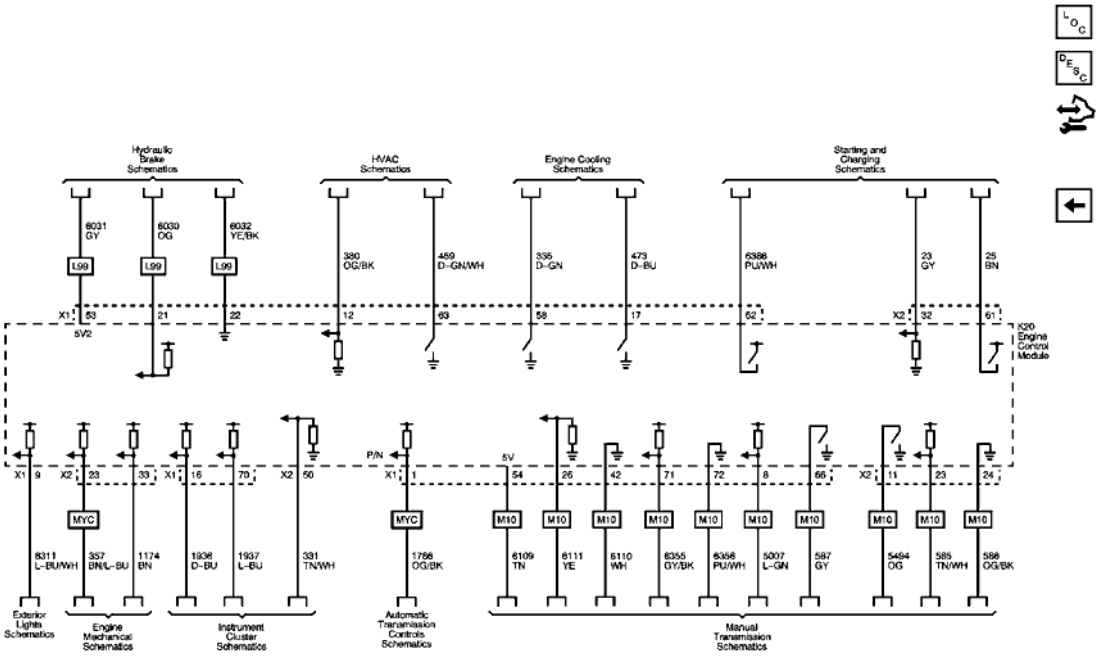


Fig. 13: Controlled/Monitored Subsystem References
Courtesy of GENERAL MOTORS CORP.

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0008 or P0009	P0008: Engine Position System Performance Bank 1 P0009: Engine Position System Performance Bank 2
DTC P000A-P000D, P0011, P0014, P0021, or P0024	P000A: Intake Camshaft Position System Slow Response Bank 1 P000B: Exhaust Camshaft Position System Slow Response Bank 1 P000C: Intake Camshaft Position System Slow Response Bank 2 P000D: Exhaust Camshaft Position System Slow Response Bank 2 P0011: Intake Camshaft Position System Performance Bank 1 P0014: Exhaust Camshaft Position System Performance Bank 1 P0021: Intake Camshaft Position System Performance Bank 2 P0024: Exhaust Camshaft Position System Performance Bank 2
DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095	P0010: Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1 P0013: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1 P0020: Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2 P0023: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2 P2088: Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1 P2089: Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1 P2090: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1 P2091: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1 P2092: Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2 P2093: Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2 P2094: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2 P2095: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2
DTC P0016, P0017, P0018, or P0019	P0016: Crankshaft Position - Intake Camshaft Position Not Plausible Bank 1 P0017: Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 1 P0018: Crankshaft Position - Intake Camshaft Position Not Plausible

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	Bank 2 P0019: Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 2
DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058	P0030: HO2S Heater Control Circuit Bank 1 Sensor 1 P0031: HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 1 P0032: HO2S Heater Control Circuit High Voltage Bank 1 Sensor 1 P0036: Heater Control Circuit Bank 1 Sensor 2 P0037: HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 2 P0038: HO2S Heater Control Circuit High Voltage Bank 1 Sensor 2 P0050: HO2S Heater Control Circuit Bank 2 Sensor 1 P0051: HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 1 P0052: HO2S Heater Control Circuit High Voltage Bank 2 Sensor 1 P0056: HO2S Heater Control Circuit Bank 2 Sensor 2 P0057: HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 2 P0058: HO2S Heater Control Circuit High Voltage Bank 2 Sensor 2
DTC P0087, P0088, or P0089	P0087: Fuel Rail Low Pressure P0088: Fuel Rail High Pressure P0089: Fuel Pressure Regulator Performance
DTC P0090, P0091, or P0092	P0090: Fuel Pressure Regulator 1 Control Circuit P0091: Fuel Pressure Regulator 1 Control Circuit Low Voltage P0092: Fuel Pressure Regulator 1 Control Circuit High Voltage
DTC P0100-P0103	P0100: Mass Air Flow Sensor Circuit P0102: Mass Air Flow Sensor Circuit Low Frequency P0103: Mass Air Flow Sensor Circuit High Frequency
DTC P0101	P0101: Mass Air Flow Sensor Circuit Performance
DTC P0111-P0113	P0111: Intake Air Temperature (IAT) Sensor Performance P0112: Intake Air Temperature (IAT) Sensor Circuit Low Voltage P0113: Intake Air Temperature (IAT) Sensor Circuit High Voltage
DTC P0116 (w/LLT)	P0116: Engine Coolant Temperature (ECT) Sensor Performance
DTC P0117 or P0118 (w/LLT)	P0117: Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage P0118: Engine Coolant Temperature (ECT) Sensor Circuit High Voltage
DTC P0119 (w/LLT)	P0119: Engine Coolant Temperature (ECT) Sensor Circuit Intermittent
DTC P0121-P0123 or P0221-P0223	P0121: Throttle Position Sensor 1 Performance P0122: Throttle Position Sensor 1 Circuit Low Voltage P0123: Throttle Position Sensor 1 Circuit High Voltage P0221: Throttle Position Sensor 2 Performance P0222: Throttle Position Sensor 2 Circuit Low Voltage P0223: Throttle Position Sensor 2 Circuit High Voltage
DTC P0128 (w/LLT)	P0128: Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
DTC P0130 or P0150	P0130: HO2S Circuit Closed Loop (CL) Performance Bank 1 Sensor 1 P0150: HO2S Circuit Closed Loop (CL) Performance Bank 2 Sensor 1
DTC P0131 or P0151	P0131: HO2S Circuit Low Voltage Bank 1 Sensor 1 P0151: HO2S Circuit Low Voltage Bank 2 Sensor 1
DTC P0132 or P0152	P0132: HO2S Circuit High Voltage Bank 1 Sensor 1 P0152: HO2S Circuit High Voltage Bank 2 Sensor 1

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DTC P0133 or P0153 (w/LLT)	P0133: HO2S Slow Response Sensor 1 P0153: HO2S Slow Response Bank 2 Sensor 1
DTC P0134 or P0154	P0134: HO2S Circuit Insufficient Activity Bank 1 Sensor 1 P0154: HO2S Circuit Insufficient Activity Bank 2 Sensor 1
DTC P0135, P0141, P0155, or P0161	P0135: HO2S Heater Performance Bank 1 Sensor 1 P0141: HO2S Heater Performance Bank 1 Sensor 2 P0155: HO2S Heater Performance Bank 2 Sensor 1 P0161: HO2S Heater Performance Bank 2 Sensor 2
DTC P0137, P0138, P0140, P0157, P0158, or P0160	P0137: HO2S Circuit Low Voltage Bank 1 Sensor 2 P0138: HO2S Circuit High Voltage Bank 1 Sensor 2 P0140: HO2S Circuit Insufficient Activity Bank 1 Sensor 2 P0157: HO2S Circuit Low Voltage Bank 2 Sensor 2 P0158: HO2S Circuit High Voltage Bank 2 Sensor 2 P0160: HO2S Circuit Insufficient Activity Bank 2 Sensor 2
DTC P013A, P013C, P013E, or P014A	P013A: HO2S Slow Response Rich to Lean Bank 1 Sensor 2 P013C: HO2S Slow Response Rich to Lean Bank 2 Sensor 2 P013E: HO2S Delayed Response Rich to Lean Bank 1 Sensor 2 P014A: HO2S Delayed Response Rich to Lean Bank 2 Sensor 2
DTC P018B-P018D	P018B: Fuel Pressure Sensor Performance P018C: Fuel Pressure Sensor Circuit Low Voltage P018D: Fuel Pressure Sensor Circuit High Voltage
DTC P0191	P0191: Fuel Rail Pressure (FRP) Sensor Performance
DTC P0192 or P0193	P0192: Fuel Rail Pressure (FRP) Sensor Circuit Low Voltage P0193: Fuel Rail Pressure (FRP) Sensor Circuit High Voltage
DTC P0196, P0197, or P0198	P0196: Engine Oil Temperature Sensor Performance P0197: Engine Oil Temperature Sensor Circuit Low Voltage P0198: Engine Oil Temperature Sensor Circuit High Voltage
DTC P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D	P0201: Cylinder 1 Injector Control Circuit P0202: Cylinder 2 Injector Control Circuit P0203: Cylinder 3 Injector Control Circuit P0204: Cylinder 4 Injector Control Circuit P0205: Cylinder 5 Injector Control Circuit P0206: Cylinder 6 Injector Control Circuit P0261: Cylinder 1 Injector Control Circuit Low Voltage P0262: Cylinder 1 Injector Control Circuit High Voltage P0264: Cylinder 2 Injector Control Circuit Low Voltage P0265: Cylinder 2 Injector Control Circuit High Voltage P0267: Cylinder 3 Injector Control Circuit Low Voltage P0268: Cylinder 3 Injector Control Circuit High Voltage P0270: Cylinder 4 Injector Control Circuit Low Voltage P0271: Cylinder 4 Injector Control Circuit High Voltage P0273: Cylinder 5 Injector Control Circuit Low Voltage P0274: Cylinder 5 Injector Control Circuit High Voltage P0276: Cylinder 6 Injector Control Circuit Low Voltage P0277: Cylinder 6 Injector Control Circuit High Voltage P2146: Cylinder 1 Injector High Control Circuit

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	P2149: Cylinder 2 Injector High Control Circuit P2152: Cylinder 3 Injector High Control Circuit P2155: Cylinder 4 Injector High Control Circuit P216A: Cylinder 5 Injector High Control Circuit P216D: Cylinder 6 Injector High Control Circuit
DTC P0219	P0219: Engine Overspeed Condition
DTC P0231, P0232, or P023F	P0231: Fuel Pump Control Circuit Low Voltage P0232: Fuel Pump Control Circuit High Voltage P023F: Fuel Pump Control Circuit
DTC P025A	P025A: Fuel Pump Control Module Enable Circuit
DTC P029D, P02A1, P02A5, P02A9, P02AD, or P02B1	P029D: Cylinder 1 Injector Leak Detected P02A1: Cylinder 2 Injector Leak Detected P02A5: Cylinder 3 Injector Leak Detected P02A9: Cylinder 4 Injector Leak Detected P02AD: Cylinder 5 Injector Leak Detected P02B1: Cylinder 6 Injector Leak Detected
DTC P0300-P0306	P0300: Engine Misfire Detected P0301: Cylinder 1 Misfire Detected P0302: Cylinder 2 Misfire Detected P0303: Cylinder 3 Misfire Detected P0304: Cylinder 4 Misfire Detected P0305: Cylinder 5 Misfire Detected P0306: Cylinder 6 Misfire Detected
DTC P0324	P0324: Knock Sensor Module Performance
DTC P0326, P0327, P0328, P0331, P0332, or P0333	P0326: Knock Sensor Performance Bank 1 P0327: Knock Sensor Circuit Low Voltage Bank 1 P0328: Knock Sensor Circuit High Voltage Bank 1 P0331: Knock Sensor Performance Bank 2 P0332: Knock Sensor Circuit Low Voltage Bank 2 P0333: Knock Sensor Circuit High Voltage Bank 2
DTC P0335, P0336, or P0338	P0335: Crankshaft Position Sensor Circuit P0336: Crankshaft Position Sensor Performance P0338: Crankshaft Position Sensor Circuit High Duty Cycle
DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393	P0341: Intake Camshaft Position Sensor Performance Bank 1 P0342: Intake Camshaft Position Sensor Circuit Low Voltage Bank 1 P0343: Intake Camshaft Position Sensor Circuit High Voltage Bank 1 P0346: Intake Camshaft Position Sensor Performance Bank 2 P0347: Intake Camshaft Position Sensor Circuit Low Voltage Bank 2 P0348: Intake Camshaft Position Sensor Circuit High Voltage Bank 2 P0366: Exhaust Camshaft Position Sensor Performance Bank 1 P0367: Exhaust Camshaft Position Sensor Circuit Low Voltage Bank 1 P0368: Exhaust Camshaft Position Sensor Circuit High Voltage Bank 1 P0391: Exhaust Camshaft Position Sensor Performance Bank 2 P0392: Exhaust Camshaft Position Sensor Circuit Low Voltage Bank 2 P0393: Exhaust Camshaft Position Sensor Circuit High Voltage Bank 2
DTC P0351-P0356, P2300,	P0351: Ignition Coil 1 Control Circuit

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P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 (w/LLT)	P0352: Ignition Coil 2 Control Circuit P0353: Ignition Coil 3 Control Circuit P0354: Ignition Coil 4 Control Circuit P0355: Ignition Coil 5 Control Circuit P0356: Ignition Coil 6 Control Circuit P2300: Ignition Coil 1 Control Circuit Low Voltage P2301: Ignition Coil 1 Control Circuit High Voltage P2303: Ignition Coil 2 Control Circuit Low Voltage P2304: Ignition Coil 2 Control Circuit High Voltage P2306: Ignition Coil 3 Control Circuit Low Voltage P2307: Ignition Coil 3 Control Circuit High Voltage P2309: Ignition Coil 4 Control Circuit Low Voltage P2310: Ignition Coil 4 Control Circuit High Voltage P2312: Ignition Coil 5 Control Circuit Low Voltage P2313: Ignition Coil 5 Control Circuit High Voltage P2315: Ignition Coil 6 Control Circuit Low Voltage P2316: Ignition Coil 6 Control Circuit High Voltage
DTC P0420 or P0430	P0420: Catalyst System Low Efficiency Bank 1 - Right Side P0430: Catalyst System Low Efficiency Bank 2 - Left Side
DTC P0442	P0442: Evaporative Emissions (EVAP) System Small Leak Detected
DTC P0443, P0458, or P0459	P0443: Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit P0458: Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit Low Voltage P0459: Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit High Voltage
DTC P0446	P0446: Evaporative Emissions (EVAP) Vent System Performance
DTC P0449, P0498, or P0499	P0449: Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit P0498: Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit Low Voltage P0499: Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit High Voltage
DTC P0450 or P0451	P0450: Fuel Tank Pressure Sensor Circuit P0451: Fuel Tank Pressure Sensor Performance
DTC P0452 or P0453	P0452: Fuel Tank Pressure Sensor Circuit Low Voltage P0453: Fuel Tank Pressure Sensor Circuit High Voltage
DTC P0455 or P0497	P0455: Evaporative Emission (EVAP) System Large Leak Detected P0497: Evaporative Emission (EVAP) System No Flow During Purge
DTC P0496	P0496: Evaporative Emissions (EVAP) System Flow During Non-Purge
DTC P0506, P0507, or P050A (Without LF1)	P0506: Idle Speed Low P0507: Idle Speed High P050A: Cold Start Idle Air Control System Performance
DTC P0601-P0604, P0606, P167D, or P2610 (ECM, LLT)	P0601: Control Module Read Only Memory Performance P0602: Control Module Not Programmed P0603: Control Module Long Term Memory Reset

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	P0604: Control Module Random Access Memory Performance P0606: Control Module Processor Performance P167D: Control Module Ignition Coil Internal Circuit P2610: Control Module Ignition Off Timer Performance
DTC P0601-P0604, P0606, or P062F	P0601: Control Module Read Only Memory (ROM) P0602: Control Module Not Programmed P0603: Control Module Long Term Memory Reset P0604: Control Module Random Access Memory (RAM) P0606: Control Module Internal Performance P062F: Control Module Long Term Memory Performance
DTC P0627-P0629	P0627: Fuel Pump Enable Circuit P0628: Fuel Pump Enable Circuit Low Voltage P0629: Fuel Pump Enable Circuit High Voltage
DTC P062B	P062B: Control Module Fuel Injector Control Performance
DTC P0638, P2100, P2101, or P2119	P0638: Throttle Actuator Control (TAC) Command Performance P2100: Throttle Actuator Control (TAC) Motor Control Circuit P2101: Throttle Actuator Position Performance P2119: Throttle Closed Position Performance
DTC P0641 or P06A6	P0641: 5 V Reference Circuit P06A6: 5 V Reference Performance
DTC P0641-P0643, P0651-P0653, or P0697-P0699 (ECM)	P0641: 5 V Reference 1 Circuit P0642: 5 V Reference 1 Circuit Low Voltage P0643: 5 V Reference 1 Circuit High Voltage P0651: 5 V Reference 2 Circuit P0652: 5 V Reference 2 Circuit Low Voltage P0653: 5 V Reference 2 Circuit High Voltage P0697: 5 V Reference 3 Circuit P0698: 5 V Reference 3 Circuit Low Voltage P0699: 5 V Reference 3 Circuit High Voltage
DTC P0650	P0650: Malfunction Indicator Lamp (MIL) Control Circuit
DTC P0685, P0686, P0687, P0689, or P0690 (LE0/LLT/LY7)	P0685: Engine Controls Ignition Relay Control Circuit P0686: Engine Controls Ignition Relay Control Circuit Low Voltage P0687: Engine Controls Ignition Relay Control Circuit High Voltage P0689: Engine Controls Ignition Relay Feedback Circuit Low Voltage P0690: Engine Controls Ignition Relay Feedback Circuit High Voltage
DTC P069E	P069E: Fuel Pump Control Module Requested MIL Illumination
DTC P0700	P0700: Transmission Control Module (TCM) Requested MIL Illumination
DTC P1255 or P064A	P064A: Fuel Pump Control Module Performance P1255: Fuel Pump Control Module Driver Over-temperature
DTC P1380 (w/o LF1)	P1380: Misfire Detected and Rough Road Data Not Available
DTC P1551	P1551: Throttle Valve Rest Position Not Reached During Learn
DTC P2096 or P2098	P2096: Post Catalyst Fuel Trim System Low Limit Bank 1 P2098: Post Catalyst Fuel Trim System Low Limit Bank 2
DTC P2097 or P2099	P2097: Post Catalyst Fuel Trim System High Limit Bank 1

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	P2099: Post Catalyst Fuel Trim System High Limit Bank 2
DTC P2105	P2105: Throttle Actuator Control (TAC) System - Forced Engine Shutdown
DTC P2122, P2123, P2127, P2128, or P2138	P2122: Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage P2123: Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage P2127: Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage P2128: Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage P2138: Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible
DTC P2176	P2176: Minimum Throttle Position Not Learned
DTC P2177, P2179, P2187, or P2189 (LLT)	P2177: Fuel Trim System Lean at Cruise or Acceleration Bank 1 P2179: Fuel Trim System Lean at Cruise or Acceleration Bank 2 P2187: Fuel Trim System Lean at Idle Bank 1 P2189: Fuel Trim System Lean at Idle Bank 2
DTC P2178, P2180, P2188, or P2190 (LLT)	P2178: Fuel Trim System Rich at Cruise or Acceleration Bank 1 P2180: Fuel Trim System Rich at Cruise or Acceleration Bank 2 P2188: Fuel Trim System Rich at Idle Bank 1 P2190: Fuel Trim System Rich at Idle Bank 2
DTC P2227, P2228, or P2229 (LLT)	P2227: Barometric Pressure (BARO) Sensor Performance P2228: Barometric Pressure (BARO) Sensor Circuit Low Voltage P2229: Barometric Pressure (BARO) Sensor Circuit High Voltage
DTC P2232 or P2235	P2232: HO2S Signal Circuit Shorted to Heater Circuit Bank 1 Sensor 2 P2235: HO2S Signal Circuit Shorted to Heater Circuit Bank 2 Sensor 2
DTC P2270 or P2272	P2270: HO2S Signal Stuck Lean Bank 1 Sensor 2 P2272: HO2S Signal Stuck Lean Bank 2 Sensor 2
DTC P2271 or P2273	P2271: HO2S Signal Stuck Rich Bank 1 Sensor 2 P2273: HO2S Signal Stuck Rich Bank 2 Sensor 2
DTC P2534	P2534: Ignition 1 Switch Circuit Low Voltage
DTC P2544	P2544: Transmission Torque Request Circuit
DTC P2635	P2635: Fuel Pump Flow Performance
DTC P2636	P2636: Fuel Transfer Pump Flow Insufficient

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	47
140	284	60
130	266	77
120	248	100
110	230	132
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

ALTITUDE VERSUS BAROMETRIC PRESSURE

Altitude Measured in	Altitude Measured in	Barometric Pressure Measured in	Barometric Pressure Measured in Pounds

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Meters (m)	Feet (ft)	Kilopascals (kPa)	Per Square Inch (psi)
Determine your altitude by contacting a local weather station or by using another reference source.			
4 267	14,000	56-64	8.1-9.3
3 962	13,000	58-66	8.4-9.6
3 658	12,000	61-69	8.8-10.0
3 353	11,000	64-72	9.3-10.4
3 048	10,000	66-74	9.6-10.7
2 743	9,000	69-77	10.0-11.2
2 438	8,000	71-79	10.3-11.5
2 134	7,000	74-82	10.7-11.9
1 829	6,000	77-85	11.2-12.3
1 524	5,000	80-88	11.6-12.8
1 219	4,000	83-91	12.0-13.2
914	3,000	87-95	12.6-13.8
610	2,000	90-98	13.1-14.2
305	1,000	94-102	13.6-14.8
0	0 Sea Level	96-104	13.9-15.1
-305	-1,000	101-105	14.6-15.2

IGNITION SYSTEM SPECIFICATIONS

Application	Specification	
	Metric	English
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Wire Resistance	397-1,337 ohms	
Spark Plug Torque	15 N.m	11 lb ft
Spark Plug Gap	1.02 mm	0.040 in

FASTENER TIGHTENING SPECIFICATIONS

Application	Specifications	
	Metric	English
Accelerator Pedal Position (APP) Sensor to Body Retaining Bolt	9 N.m	80 lb in
Air Cleaner Outlet Duct to Throttle Body Retaining Clamp	4 N.m	35 lb in
Air Cleaner Lower Housing to Body Retaining Bolt	10 N.m	89 lb in
Camshaft Position (CMP) Sensor to Engine Front Cover Retaining Bolt	9 N.m	80 lb in
Crankshaft Position (CKP) Sensor to Engine Block Retaining Bolt	25 N.m	18 lb ft
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft
Evaporative Emission (EVAP) Canister to Underbody Retaining Bolt	6 N.m	53 lb in
Filler Tube Support Bracket to Body Retaining Bolt	9 N.m	80 lb in

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Fuel Filler Pipe to Chassis Retaining Bolt	9 N.m	80 lb in
Fuel Pipe Stone Guard to Underbody Retaining Nut	5 N.m	44 lb in
Fuel Rail Ground Strap To Intake Manifold Retaining Bolt	10 N.m	89 lb in
Fuel Rail to Inlet Manifold Retaining Bolt	10 N.m	89 lb in
Fuel Tank Hose to Filler Tube Clamp	4 N.m	35 lb in
Fuel Tank Strap to Underbody Retaining Bolt	30 N.m	22 lb ft
Heated Oxygen Sensor (HO2S)	42 N.m	31 lb ft
Ignition Coil Bracket to Valve Rocker Arm Cover Retaining Blot	12 N.m	106 lb in
Ignition Coil to Ignition Bracket Assembly Retaining Bolt	12 N.m	106 lb in
Knock Sensor (KS) to Engine Block Retaining Bolt	20 N.m	15 lb ft
Mass Airflow Sensor with Intake Air Temperature (MAF) Sensor to Air Cleaner Outlet Duct Retaining Clamp	2 N.m	18 lb in
Rear Frame to Underbody Retaining Bolt		
• Final Pass	+ 120 Degrees	
• First Pass	65 N.m	48 lb ft
Spark Plug		
• Fit New Spark Plug	20 N.m	15 lb ft
• Refit Existing Spark Plug	15 N.m	11 lb ft
Throttle Body to Intake Manifold Retaining Bolt	12 N.m	106 lb in

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

SYMPTOMS - ENGINE CONTROLS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

SYMPTOMS DESCRIPTION

Symptoms cover conditions that are not covered DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests. Poor Fuel Fill Quality test may be performed separately from the Symptoms Testing and Additional Symptoms Tests procedures.

SYMPTOMS DEFINITION

Backfire

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On

The engine continues to run after the key is turned OFF, but runs very rough.

Hard Start

Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

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Hesitation, Sag, Stumble

Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Poor Fuel Fill Quality

Difficulty when refueling the vehicle.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

Surges/Chuggles

Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

SYMPTOMS VERIFICATION

Before using the Symptom tables, perform the following inspections:

- Ensure that the engine control module and malfunction indicator lamp are operating correctly.
- Ensure that there are no DTCs that are stored.
- Ensure that the scan tool data is within a normal operating range.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement,

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vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is too short or tight.
- Wire insulation that is chaffed or cut.
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

Visual/Physical Check

- Ensure that the control module grounds are clean, tight, and correctly located. Refer to **Wiring Repairs** .
- Ensure that the vacuum hoses are not split, kinked, and properly connected, as shown on the Vehicle Emission Control Information label.
- Ensure that the air filter is clean and free from restrictions.
- Ensure that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the following conditions:
  - Collapsed
  - Damaged areas
  - Looseness
  - Incorrect installation
  - Leaking
- Inspect for air leaks at the throttle body mounting area, the mass air flow sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
  - Poor connections
  - Pinches
  - Cuts

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- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

SYMPTOMS TESTING

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

1. Test for the following conditions:
   - The fuel system for the following:
     - Correct fuel pressure-Refer to **Fuel System Diagnosis**.
     - Fuel injectors that are leaking or improper operation-Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)**.
     - Contaminated or a poor fuel quality condition-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)**.
   - The ignition system for the following:
     - Spark plugs for incorrect heat range or an abnormal condition-Refer to **Spark Plug Inspection** .
     - For diagnosis of coolant or oil fouled spark plugs, refer to **Loss of Coolant** or **Symptoms - Engine Mechanical** .
     - Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
     - Weak spark using the **J 26792** Spark Tester-Refer to **Electronic Ignition System Diagnosis**.
   - The operation of the transmission torque converter clutch -The scan tool should indicate an engine speed drop when the torque converter clutch is commanded ON.
   - The operation of the A/C compressor
   - Items that can cause an engine to run rich or lean.
   - Inspect the heated oxygen sensors. The heated oxygen sensors should respond quickly to different throttle positions.
   - Water intrusion in the heated oxygen sensors connector

   NOTE: The embossed arrows on the mass airflow sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

   - Inspect the mass airflow sensor installation. A mass airflow sensor that is incorrectly installed may cause a hard start. Install the mass airflow in the proper direction. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
   - Inspect the mass airflow sensor connections.
   - Engine oil contaminated by fuel

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- The engine for the following mechanical failures-Refer to **Symptoms - Engine Mechanical** :
  - Excessive oil in the combustion chamber or leaking valve seals
  - Incorrect cylinder compression
  - Sticking or leaking valves
  - Worn camshaft lobes
  - Incorrect valve timing
  - Worn rocker arms
  - Broken valve springs
  - Excessive carbon buildup in the combustion chambers-Clean the chambers with top engine cleaner. Follow the instructions on the can.
  - Incorrect engine parts
- Vacuum hoses for splits or kinks-Verify that the routing and connections are as shown on the Vehicle Emission Control Information label.
- Knock sensor system for excessive spark retard activity-Refer to **DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333** .
- The exhaust system components for the following:
  - Physical damage or possible internal failure
  - The three-way catalytic converters for a restriction

    For more information, refer to **Symptoms - Engine Exhaust** .

- Electromagnetic interference on the reference circuit can cause a misfire condition. You can usually detect electromagnetic interference with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that electromagnetic interference is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- The crankcase ventilation valve for proper operation-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- Evaporative emission canister purge solenoid that is stuck open
- The engine cooling system for the following conditions:
  - The thermostat is the correct heat range. Refer to **Thermostat Diagnosis** .
  - Proper engine coolant level-Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

ADDITIONAL SYMPTOMS TESTS

Detonation/Spark Knock

Test the engine for an overheating condition. Refer to **Symptoms - Engine Cooling** .

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Poor Fuel Economy

Inspect for foreign material accumulation in the throttle bore, and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

Rough, Unstable, or Incorrect Idle and Stalling

Inspect the engine mounts.

Surges/Chuggles

Inspect the heated oxygen sensors. The heated oxygen sensors should respond quickly to a change in throttle position. If the heated oxygen sensors do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The engine control module reduces the amount of fuel delivered to the engine, causing a driveability condition.

Hard Start

- Test the engine coolant temperature sensor. Compare the engine coolant temperature sensor value to the intake air temperature sensor value on a cold engine. The engine coolant temperature and intake air temperature sensor values should be within ± 3°C (5°F). If the engine coolant temperature sensor is out of range with the intake air temperature sensor, test the resistance of the engine coolant temperature sensor. Refer to **Temperature Versus Resistance** for resistance specifications. Replace the engine coolant temperature sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specification, test the engine coolant temperature circuits for a high resistance.
- Test the idle air control system.
- Verify that the fuel system has adequate pressure for engine start-up. With a scan tool, compare the Fuel Pressure Sensor parameter value to the Desired Fuel Pressure parameter value when the ignition key is first turned to ON. Refer to **Fuel System Diagnosis** for additional information.

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to **Fuel System Diagnosis**.
- Test the manifold absolute pressure sensor. Refer to **DTC P0106** .
- Test the generator. Refer to **Symptoms - Engine Electrical** . Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.

Poor Fuel Economy

- Heavy loads being carried or towed.
- Acceleration rate too much or too often.
- Inspect for foreign material accumulation in the throttle bore, and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

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POOR FUEL FILL QUALITY

Test for the following conditions that is applicable to the current symptom.

Difficult to Fill

- Restricted vent lines
- The evaporative emission vent valve is stuck closed
- High fuel temperature
- A condition with the internal components of the fuel tank assembly.

For more information, refer to:

- **Fuel System Description**
- **Evaporative Emission Control System Description**

Fuel Odor

- Saturated evaporative emission canister-Refer to **Evaporative Emission Control System Description** .
- A condition with the internal components of the fuel tank assembly-Refer to **Fuel System Description** .

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example, a failure condition exists if the ECM detects low voltage when the MIL is commanded OFF, or high voltage when the MIL is commanded ON.

REFERENCE INFORMATION

Schematic Reference

- **Instrument Cluster Schematics**
- **Engine Controls Schematics**

Connector End View Reference

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Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: Any MIL requesting DTCs that may be set should be diagnosed first.

1. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
2. Ignition ON, command the MIL ON and OFF with a scan tool while observing the following control circuit status parameters:
   - MIL Control Circuit Low Voltage Test Status
   - MIL Control Circuit Open Test Status
   - MIL Control Circuit High Voltage Test Status

   Each parameter should toggle between OK and Not Run or Not Run and OK.

CIRCUIT/SYSTEM TESTING

1. If any other IPC indicators or gauges are inoperative, refer to **Instrument Cluster Gauges Inoperative** .
2. Ignition OFF, disconnect the K20 ECM harness connectors. Ignition ON, the MIL should not illuminate.
   - If the MIL is illuminated, test the MIL control circuit terminal X1-68 for a short to ground. If the circuit tests normal, replace the P16 IPC.
3. Ignition ON, connect a 3 A fused jumper wire between the MIL control circuit terminal X1-68 and ground. The MIL should illuminate.
   - If the MIL does not illuminate, test the MIL control circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the P16 IPC/bulb.
4. If all circuits/connections test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Instrument Cluster Replacement**

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- **Control Module References** for ECM replacement, setup, and programming

ENGINE CRANKS BUT DOES NOT RUN

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis. This diagnostic assumes the vehicle system voltage levels are adequate for starter motor operation. Refer to **Battery Inspection/Test** and **Engine Cranks Slowly** . The fuel level supply must be adequate, and the fuel quality must be able to sustain the combustion process.

DIAGNOSTIC AIDS

- The Immobilizer system is not designed to have the key FOB folded 90 degrees when attempting to start the engine. This may cause an intermittent no start condition. If you receive a customer complaint of an intermittent no start condition, verify that the customer is not folding the key while attempting to start the engine. The fob must be parallel to the key to function properly.
- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition. Refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)**.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK, and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200-300 RPM while cranking. If erratic values, such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.
- Inspect the engine for good secure electrical grounds.
- If the engine almost starts and then stalls, check for an open in the ground circuits of the crankshaft position sensor and the camshaft position sensor.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 minutes in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.

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- A vehicle that starts and runs after being brought to the repair shop for a no start condition, may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to check for an engine starting or will not stay running concern.
- Use the **J 35616:** Test Kit for any test that requires probing the underhood fuse block terminals, component wire harness terminals, or the ECM wire harness terminals.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 34730-1A:** Fuel Pressure Gauge
- **J 35616:** GM-Approved Terminal Test Kit
- **J 35616-A/BT-8637:** Connector Test Adapter Kit
- **J 43244:** Relay Puller Pliers

CIRCUIT/SYSTEM VERIFICATION

NOTE: This diagnostic assumes the following:

- **The battery is completely charged. Refer to Battery Inspection/Test .**
- **The engine cranking speed is acceptable. Refer to Engine Cranks Slowly .**

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- **There is adequate fuel in the fuel tank.**

Attempt to start the engine. The engine should start and continue to run. An engine that starts and stalls is considered to not run.

- If the vehicle passes the Circuit/System Verification test, refer to **Testing for Intermittent Conditions and Poor Connections** .

CIRCUIT/SYSTEM TESTING

1. Crank the engine while observing the scan tool Vehicle DTC Information.
   - If any of the following DTCs are set, diagnose these DTCs first: DTC P0117, P0118, P0122, P0123, P0201-P0208, P0222, P0223, P0335, P0336, P0351-P0358, P0562, P0563, P0601-P0604, P0607, P062F, P0633, P0685, P0690, P1631, P1682, or P2610. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. With the ignition ON and the engine OFF, test the fuses that are supplied ignition 1 voltage by the powertrain relay. The test lamp should illuminate ON for each test point of the fuses.
   - If the test lamp does not illuminate ON for at least one test point of each fuse, refer to **DTC P0685 or P0690** .
3. Crank the engine while observing the scan tool engine speed parameter.
   - If engine RPM is not indicated, refer to **DTC P0335** .
4. Disconnect the B75B mass airflow (MAF) sensor. Attempt to start the engine. The ECM will ignore MAF sensor input, default to calculated airflow, and the engine should start and run if the MAF sensor is faulted.
   - If the engine starts and runs, and the MAF sensor circuits test OK, replace the B75B MAF sensor.
5. Install a spark plug tester onto one T8 ignition module/coil assembly on each bank of the engine.

NOTE: An erratic or weak spark is considered a no spark condition.

6. Crank the engine while observing both spark plug testers. Both spark plug testers should spark.
   - If spark is not observed, is inconsistent, or weak on either spark plug tester, refer to **Electronic Ignition System Diagnosis**.
7. With the ignition ON and the engine OFF, command the fuel pump ON and OFF with the scan tool. The fuel pump should energize when commanded ON, and de-energize when commanded OFF.
   - If the fuel pump does not turn ON and OFF, refer to **Fuel System Diagnosis**.
8. Turn OFF the ignition.
9. Install the **J 34730-1A:** Gauge Fuel Pressure Gauge. Refer to **Fuel Pressure Gauge Installation and Removal** . With the ignition ON and the engine OFF, command the fuel pump ON several times with the scan tool. Refer to **Fuel System Diagnosis** for the fuel pressure specification.
10. Verify the following conditions do not exist:
    - Restricted air filter element or air intake system
    - Spark plugs for being gas or coolant fouled-Refer to **Spark Plug Inspection**

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- A skewed manifold absolute pressure (MAP) sensor-Refer to **DTC P0106** .
- A skewed engine coolant temperature (ECT) sensor-Refer to **DTC P0116** .
- Exhaust system restricted-Refer to **Restricted Exhaust** .
- Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)**.
- Engine mechanical condition, for example, worn timing chain, sprocket gears, low compression, etc.-Refer to **Symptoms - Engine Mechanical** and **Timing Chain, Crankshaft Sprocket, Camshaft Position Actuator, and Solenoid Valve Replacement** .
  - If any of the above conditions exist, repair as necessary.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

POOR FUEL FILL QUALITY

Problem	Causes
DEFINITION: Difficulty when refueling the vehicle.	
Difficult to fill	• The check valve is stuck closed. • The fill limiter vent valve is stuck closed. • The evaporative emission (EVAP) canister is restricted. • Restricted EVAP pipes. • High Reid vapor pressure. • High fuel temperature. • The fuel filler hose/pipe is pinched, kinked or blocked. • The fuel feed hose, or crossover hose, is pinched, kinked or blocked. • The ignition switch is ON.
Over fill	• The pressure relief valve in the fill limiter vent valve is stuck open. • The pressure relief valve in the fill limiter vent is valve leaking. • The fill limiter vent valve is stuck open. • The fill limiter vent valve is leaking.
Pre-mature shut-off of the fuel dispensing nozzle	• The check valve is stuck closed. • The fill limiter vent valve is stuck closed. • The EVAP canister is restricted. • Restricted EVAP pipes. • High Reid vapor pressure. • High fuel temperature.

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	• The fuel filler hose/pipe is pinched, kinked or blocked. • The fuel feed hose, or crossover hose, is pinched, kinked or blocked. • The ignition switch is ON.
Fuel spit back	• The check valve is stuck open. • The check valve is stuck closed. • The check valve is leaking. • High Reid vapor pressure. • High fuel temperature.
Liquid fuel in the EVAP canister	• The fill limiter vent valve is stuck open. • The fill limiter vent valve is leaking.
Liquid fuel leak	• The pressure relief valve in the fill limiter vent valve is stuck open. • The pressure relief valve in the fill limiter vent valve is leaking. • The fuel filler hose is loose or torn. • The fuel feed hose, or crossover hose, is loose or torn. • The fill limiter vent valve is stuck open.
Fuel odor	• The pressure relief valve in the fill limiter vent valve is stuck open. • The pressure relief valve in the fill limiter vent valve is leaking. • The EVAP canister is saturated.

FUEL INJECTOR DIAGNOSIS (W/J39021 OR W/TECH 2)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The control module enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

When performing the fuel injector balance test, the scan tool is first used to energize the fuel pump relay. The fuel injector tester or the scan tool is then used to pulse each injector for a precise amount of time, allowing a

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measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each injector.

DIAGNOSTIC AIDS

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.
- Perform the fuel injector coil test within the conditions of the customer's concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-48027** Digital Pressure Gauge
- **J 39021** Fuel Injector Coil and Balance Tester
- **J 44602** Injector Test Adapter

COMPONENT TESTING

Fuel Injector Coil Test

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Verify the resistance of each fuel injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each fuel injector should be 11-14 ohms.
  - If the injectors measure OK, perform the Fuel Injector Balance Test - Fuel Pressure Test.
  - If not within the specified range, replace the fuel injector.
- If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 ohms.
  - If the difference is equal to or less than 3 ohms, refer to Fuel Injector Balance Test - Fuel Pressure Test for further diagnosis of the fuel injectors.
  - If the difference is more than 3 ohms, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the fuel injector that displays the greatest difference above or below the average.

NOTE:

- **DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.**
- **Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.**
- **Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.**

Fuel Injector Balance Test-Fuel Pressure Test

1. Install a fuel pressure gauge. Refer to **Fuel Pressure Gauge Installation and Removal** .
2. Turn ON the ignition, with the engine OFF.

NOTE:

- **The fuel pump may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **DO NOT start the engine.**

3. Command the fuel pump ON with a scan tool.
4. Observe the fuel pressure gauge with the fuel pump commanded ON. The fuel pressure should be 345-414 kPa (50-60 psi).
   - If the fuel pressure is not 345-414 kPa (50-60 psi), refer to **Fuel System Diagnosis**.
5. Monitor the fuel pressure gauge for 1 min. The fuel pressure should not decrease more than 34 kPa (5 psi).
   - If the fuel pressure decreases more than 34 kPa (5 psi), refer to **Fuel System Diagnosis**.
6. Perform the Fuel Injector Balance Test with Special Tool or the Fuel Injector Balance Test with Tech 2.

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Fuel Injector Balance Test with Special Tool

1. Set the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5-2.5 amp position.
2. Connect the **J 39021** to a fuel injector with a **J 44602** .
3. Command the fuel pump ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.
4. Command the fuel pump ON one more time and energize the fuel injector by depressing the Push to Start Test button on the **J 39021** at the previously selected pressure.
5. After the injector stops pulsing, select Min from the Display Mode and record the Min pressure.

NOTE: New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

6. Clear the Min/Max results.
7. Select Normal from the Display Mode.
8. Repeat steps 2 and 4 through 7 for each fuel injector.
9. Perform the Pressure Drop Calculation.

Fuel Injector Balance Test with Tech 2

1. Command the fuel pump ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.
2. With a scan tool, select the Fuel Injector Balance Test function within the Special Functions menu.
3. Select an injector to be tested.
4. Press Enter to prime the fuel system.
5. Energize the fuel injector by depressing the Pulse Injector button on the scan tool at the previously selected pressure.
6. After the injector stops pulsing, select Min from the Display Mode on the **CH-48027** and record the Min pressure.

NOTE: New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

7. Clear the Min/Max results on the **CH-48027** .
8. Select Normal from the Display Mode on the **CH-48027** .
9. Press Enter on the scan tool to bring you back to the Select Injector screen.
10. Repeat steps 3 through 9 for each fuel injector.
11. Perform the Pressure Drop Calculation.

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Pressure Drop Calculation

1. Subtract the minimum pressure from the starting pressure for one fuel injector. The result is the pressure drop value.
2. Obtain a pressure drop value for each fuel injector.
3. Add all of the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.
4. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).
    - If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the fuel injector.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Fuel Injector Replacement

FUEL INJECTOR DIAGNOSIS (W/CH47976)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The control module enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

The **CH-47976** , is used to test the fuel pump, fuel system leak down, and the fuel injectors. Following the User Guide, CH 47976-11, and the on screen prompts or selections, will indicate the steps required to perform each of the available tests. The tester will perform all of the tests automatically and display results of the test. The results can also be down loaded for storage and printing.

DIAGNOSTIC AIDS

- Downloading the AFIT test results to the shop TIS terminal will clearly show which injector is at fault by the bar graph turning red.

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- Cleaning the injectors can be performed if the graph shows erratic or values close to the specified values.
- A second test can be performed to verify repair. Compare the first balance test to the second.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Special Tools

CH-47976 Active Fuel Injector Tester

COMPONENT TESTING

Fuel Injector Coil Test

Verify the resistance of each fuel injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each fuel injector should be 11-14 ohms.
  - If the injectors measure OK, perform the AFIT Test Procedure.
  - If not within the specified range, replace the fuel injector.
- If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 ohms.
  - If the difference is equal to or less than 3 ohms, refer to AFIT Test Procedure.
  - If the difference is more than 3 ohms, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the fuel injector that displays the greatest difference above or below the average.

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NOTE:

- **DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.**
- **Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.**

AFIT Test Procedure

1. Turn OFF all accessories.
2. Turn OFF the ignition.
3. Install the AFIT. Refer to the AFIT User Guide.
4. Turn ON the AFIT and select the vehicle.
5. Follow the setup screen on the AFIT.
6. Turn ON the ignition and perform the Injector Test.
    - If the AFIT aborts testing due to fuel pressure or fuel leak down, refer to **Fuel Injector Diagnosis (w/J39021 or w/Tech 2)** or **Fuel Injector Diagnosis (w/CH47976)**.
7. After the test is complete, observe the bar graph on the Balance screen.
    - If any injector on the Balance screen bar graph is greater than the specified values +8 or -8%, replace the clean the faulty injector.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Fuel Injector Replacement

FUEL PUMP ELECTRICAL CIRCUIT DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
Fuel Pump High Signal	P0231	P023F	P0232	P023F, P2635
Fuel Pump Low Signal	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

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The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for two seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

Ignition ON, command the fuel pump ON and OFF using the scan tool ECM output control. The fuel pump should turn on and off.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Ignition ON, command the G12 fuel pump ON and OFF using a scan tool ECM fuel pump output control. The test lamp should turn ON and OFF, as commanded.

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- If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
- If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.

4. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the G12 fuel pump ON using a scan tool. The test lamp should illuminate.
   - If the test lamp does not illuminate, test the low reference circuit terminal 1 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. If all circuits test normal, replace the G12 fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

FUEL SYSTEM DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module (FPCM) when the ECM detects that the ignition is ON. The voltage from the ECM to the FPCM remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the FPCM closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

The fuel system is a returnless on-demand design. The fuel pressure regulator is a part of the fuel pump module, eliminating the need for a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

The fuel tank stores the fuel supply. An electric turbine style fuel pump attaches to the fuel pump module inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel filter and the fuel feed pipe to the fuel injection system. The fuel pump provides fuel at a higher rate of flow than is needed by the fuel injection system. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel pump module. The function of the venturi pump is to fill the fuel pump module reservoir. The fuel pressure regulator, a part of the fuel pump module, maintains the correct fuel pressure to the fuel injection system. The fuel pump module contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in

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the fuel feed pipe and the fuel rail in order to prevent long cranking times.

REFERENCE INFORMATION

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-48027** Digital Pressure Gauge
- **J 37287** Fuel Line Shut-off Adapter

CIRCUIT/SYSTEM VERIFICATION

NOTE:

- **Repair all fuel system related DTCs before performing this diagnostic, unless instructed here from a DTC diagnostic.**
- **Inspect the fuel system for damage or external leaks before proceeding.**
- **Verify that adequate fuel is in the fuel tank before proceeding.**
- **The fuel pump may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.**

1. Ignition OFF, all accessories OFF, install a **CH-48027** . Refer to **Fuel Pressure Gauge Installation and Removal** .
2. Ignition ON, engine OFF, command the fuel pump ON with a scan tool. Verify the fuel pressure is between 345-414 kPa (50-60 psi) and does not decrease more than 34 kPa (5 psi) in 1 min.
3. Engine ON with the engine idling at normal operating temperature, the Fuel Rail Pressure Sensor parameter should read between 296.4-310.3 kPa (35-45 psi).

CIRCUIT/SYSTEM TESTING

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NOTE:

- **The fuel pump may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **DO NOT start the engine.**

1. Ignition ON, engine OFF, command the fuel pump ON with a scan tool and observe the fuel pressure gauge while the fuel pump is operating. Verify the fuel pressure is between 345-414 kPa (50-60 psi).
   - If the fuel pressure is greater than the specified range, replace the fuel pump module.
   - If the fuel pressure is less than the specified range, test, inspect, and repair the items listed below. If all items test normal, replace the fuel pump module.
     - Restricted fuel feed pipe
     - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
2. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 min.
   - If the fuel pressure decreases more than the specified value, perform the following procedure:
     1. Ignition OFF, relieve the fuel pressure. Refer to **Fuel Pressure Relief** .
     2. Install the **J 37287** between the fuel feed pipe and the fuel rail.
     3. Open the valve on the **J 37287** .
     4. Ignition ON, command the fuel pump ON with a scan tool and bleed the air from the **CH-48027** .
     5. Command the fuel pump ON and then OFF with a scan tool.
     6. Close the valve on the **J 37287** .
     7. Monitor the fuel pressure for 1 min.
        - If the fuel pressure decreases more than 34 kPa (5 psi) within the specified time, locate and replace the leaking fuel injector(s).
        - If the fuel pressure does not decrease more than 34 kPa (5 psi) within the specified time, replace the fuel pump module.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify that the fuel pressure does not decrease more than 14 kPa (2 psi) in 5 min.
   - If the fuel pressure decreases more than the specified value, replace the fuel pump module.
4. Operate the vehicle within the conditions of the customer's concern while monitoring the fuel pressure with the **CH-48027** . The fuel pressure should not drop off during acceleration, cruise or hard cornering.
   - If the fuel pressure drops off, test, inspect, and repair the items listed below. If all items test normal, replace the fuel pump module.
     - Restricted fuel feed pipe
     - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections
5. If the fuel system tests normal, refer to **Symptoms - Engine Controls**.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Line Replacement - Chassis**

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- **Fuel Injector Replacement**

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (WITH SPECIAL TOOL)

DESCRIPTION

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with more than 10 percent ethanol could result in driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

TEST PROCEDURE

IMPORTANT: Do not perform this diagnostic procedure unless directed to do so by another diagnostic.

1. Test the fuel composition using **J 44175** Fuel Composition Tester and J44175-3 Instruction Manual.
2. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample. Refer to the examples in the Fuel Composition Test Examples table.
3. If the fuel sample contains more than 15 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
4. Test the fuel composition.
5. If testing shows the ethanol percentage is still more than 15 percent, replace the fuel in the vehicle.

Fuel Composition Test Examples

-	Frequency (Hz)	Subtract 50	Ethanol Percent
Example A	50 Hz	-50	0
Example B	65 Hz	-50	15
Example C	129 Hz	-50	79

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (WITHOUT SPECIAL TOOL)

DESCRIPTION

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust, or deterioration.

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Alcohol concentrations of 10 percent or greater in fuel can be detrimental to fuel system components. Alcohol contamination may cause fuel system corrosion, deterioration of rubber components, and subsequent fuel filter restriction. Some types of alcohol are more detrimental to fuel system components than others. Ethanol is commonly used in gasoline, but in concentrations of no more than 10 percent. Some fuels, such as E85, contain a very high percentage of ethanol. Fuel with more than 10 percent ethanol may cause driveability conditions such as hesitation, lack of power, stalling, or no start.

ALCOHOL IN FUEL TESTING PROCEDURE

IMPORTANT: Do not perform this diagnostic procedure unless directed to do so by another diagnostic.

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If alcohol contamination is suspected then use the following procedure to test the fuel quality.

1. Using a 100 ml (3.4 oz) specified cylinder with 1 ml (0.03 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.4 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation.

If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

PARTICULATE CONTAMINANTS IN FUEL TESTING PROCEDURE

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, use the following procedure to diagnose the fuel.

1. Using an approved fuel container, draw approximately 0.5 liter (0.13 gal) of fuel.
2. Place the cylinder on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination.

Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles. If particles are found clean the entire fuel system thoroughly.

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ELECTRONIC IGNITION SYSTEM DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

This ignition system uses individual ignition module/coil assemblies for each cylinder. The engine control module (ECM) controls the spark events by transmitting the timing pulses on the ignition control circuits to the individual ignition module/coil assemblies in firing order sequence.

DIAGNOSTIC AIDS

- Depending on location in the spliced ignition voltage circuit, a slight resistance can cause a misfire or a crank/no start condition. A voltage drop test on the circuit will pinpoint this condition.
- A slight to moderate resistance on any ignition control circuit can cause a misfire before DTC P0351-P0358 sets.
- Extended engine cranking time may foul the spark plugs with excessive fuel.
- When disconnecting electrical connectors or removing fuses and relays from a fuse block, always inspect both mating electrical terminals for corrosion and terminal tightness.
- Use the **J 35616:** GM-Approved Terminal Test Kit for any test that requires probing the underhood fuse block terminals, component wire harness terminals, or the ECM wire harness terminals.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

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Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate T8 ignition coil/modules.
2. Ignition OFF, all vehicle systems OFF, it may take 2 minutes for all vehicle systems to power down, test for less than 5 ohms between the ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Test for less than 5 ohms between the low reference circuit terminal B and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE: If the ignition fuse is open, it will be necessary to test the spliced ignition circuits and the components for a short to ground.

4. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
    - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
5. Exchange the affected T8 ignition coil/module with the T8 ignition coil/module of a good cylinder.
6. Start the engine and observe the scan tool Cylinder 1-8 Current Misfire Counters.
    - If the misfire transfers with the suspect ignition coil/module, replace as needed. The misfire should not follow the coil exchange.
7. If the circuits test normal, test or replace the spark plugs.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Ignition Coil Replacement**
- **Spark Plug Replacement**

EVAPORATIVE EMISSION SYSTEM DIAGNOSIS

OPERATING INSTRUCTIONS FOR THE EVAPORATIVE EMISSION SYSTEM TESTER (EEST)

Vehicle Setup

NOTE: A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow enough time, at least 15 minutes, for the vehicle temperature to adjust to the shop temperature. Refer to Temperature Variation Instructions for more information about vehicle versus shop temperatures.

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1. Engine OFF, open the hood. Position a large fan to blow air under the vehicle onto the fuel tank area.
2. Connect the red battery clip from the tester to the positive battery terminal.

NOTE: The vehicle battery must be fully charged for optimum tester performance.

3. Connect the black battery clip from the tester to chassis ground.

FLOWMETER TEST - LEAK DETECTION

1. Open the Nitrogen tank valve and turn the NITROGEN/SMOKE valve on the front control panel to NITROGEN.
2. Connect the hose to the correct test orifice on the bottom front of the tester. For orifice size, refer to the GM Service manual for the vehicle being tested. The vehicle specific information can be found in service procedures for DTCs that relate to evaporative emission (EVAP) system leaks.
3. Press and release the remote switch to activate the tester.
4. Position the sliding red flag on the flowmeter to align with the floating indicator. When the red flag is set, press and release the remote switch to deactivate the tester.
5. Remove the hose from the test orifice and install the hose onto the vehicle. For proper connection location, and the special tool numbers for any adapters that may be required, refer to the service procedures for DTCs that relate to EVAP system leaks.
6. Ignition ON, seal the EVAP system per instructions in the service procedures for DTCs that relate to EVAP system leaks. Most systems can be sealed using a scan tool output control for the EVAP canister vent solenoid valve, other systems require that the vent system be plugged.

NOTE:

- **Larger volume fuel tanks, and/or those with lower fuel levels, may require several minutes to fill with nitrogen.**
- **Static buildup may cause the float indicator to stick. It may be necessary to tap on the flowmeter to free up the float.**

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Compare the stable floating indicator position to the red flag.
   - ABOVE the red flag, the result is UNACCEPTABLE, FAIL-Go to Smoke Procedure
   - BELOW the red flag, the result is ACCEPTABLE, PASS-Test complete
9. Press and release the remote switch to deactivate the tester.

SMOKE PROCEDURE - LOCATE THE LEAK

NOTE: It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.

1. Turn OFF any fans that may cause air movement around or near the vehicle.

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NOTE: Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap. Consult the service procedures for DTCs that relate to evaporative emission (EVAP) system leaks for vehicle specific instructions regarding connection location and adapters.
3. Open the nitrogen tank valve and turn the NITROGEN/SMOKE valve on the control panel to SMOKE.

NOTE: The remote switch operates in a push ON, push OFF fashion.

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected. When injecting smoke at the service port, remove the fuel fill cap, or temporarily leave the EVAP canister vent valve open, until smoke is observed. Then close the system and continue testing. If using a special tool fuel fill cap adapter at the filler neck, vent the system at the service port until smoke is observed then close the system to continue with the test.

NOTE: Inject smoke in less than 2-minute cycles for optimum tester performance.

6. Press and release the remote switch to deactivate the tester.

NOTE: For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.

7. Introduce smoke into the system for an additional 60 seconds. Continue introducing smoke at 15-second intervals, as necessary.
8. Using the a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke. Introduce smoke at 15-second intervals, as needed, until leak source is identified.

TEMPERATURE VARIATION INSTRUCTIONS

The Concern

Ideal circumstances for conducting the EVAP Flowmeter Test require equal temperatures between the nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the Evaporative Emissions System Tester is stored indoors, approximately 21°C (70°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures -40 to +43°C (-40 to +110°F).

For Example

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NOTE: With no temperature difference between the nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 inches H2O once pressurized, providing no leaks are present.

When the EVAP Flowmeter Tests are performed with significant differences in temperature between the nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flowmeter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flowmeter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the nitrogen gas before conducting the Flowmeter Test.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT DESCRIPTION

To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the valve lifter oil manifold (VLOM) solenoids ON, to deactivate engine cylinders 1 and 7 on the left bank, and cylinders 4 and 6 on the right bank. The VLOM consists of 4 electrically operated normally closed solenoids, which directs pressurized engine oil to 8 deactivating valve lifters. All 4 VLOM solenoids are connected in parallel to a fused ignition circuit supplied by the powertrain relay. The control circuit for each solenoid is connected to an individual low side driver internal to the ECM. When enabling conditions for V4 mode are met, the ECM will command each low side driver to turn ON, in engine firing order sequence.

DIAGNOSTIC AIDS

The VLOM solenoids are assigned to the following engine cylinders:

- Solenoid #1-Cylinder #1
- Solenoid #2-Cylinder #4
- Solenoid #3-Cylinder #6
- Solenoid #4-Cylinder #7

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REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. If sent here from **DTC P0300-P0308** , continue with testing. If any other DTCs are set, then repair those DTC first. Refer to **Diagnostic System Check - Vehicle** .
2. Start and idle the engine.
3. Allow the engine to reach normal engine operating temperature. The engine should idle smoothly without any misfires.
4. Monitor the cylinder deactivation system data parameters with a scan tool.
5. Road test the vehicle under light throttle and load conditions that will allow the ECM to command V4 mode. If all enabling conditions are met for cylinder deactivation, and if no internal engine hydraulic/mechanical fault conditions are present, the ECM will continue operation in V4 mode.
    - If the vehicle passes the Circuit/System Verification test, then review the active fuel management driving information in the Features and Controls section of the owners manual with the vehicle operator, or instruct the vehicle operator in the proper driving techniques to obtain V4 mode.
    - If the vehicle does not pass the Circuit/System Verification test, then review the cylinder deactivation inhibit reasons listed on the scan tool.

CIRCUIT/SYSTEM TESTING

Electrical System Testing

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Ignition ON and the engine OFF, command each VLOM solenoid ON and OFF using the scan tool. Standing next to the engine compartment, you should be able to hear the solenoid energize and de-energize with each command.

- If you cannot hear each solenoid energize and de-energize, then refer to **DTC P3401, P3425, P3441, or P3449** .

Mechanical System Testing

1. Connect a vacuum gauge to the EVAP vacuum tube fitting on the electronic throttle body. DO NOT use a compound pressure and vacuum gauge. The vacuum gauge on a hand held vacuum pump will work fine for this test.
2. Start the engine. Allow the engine to reach normal operation temperature.
3. With a scan tool, command each VLOM solenoid ON, one at a time. Each time a solenoid is command ON, you should observe a fluctuating drop of intake manifold vacuum, and a misfire on the cylinder that was deactivated.
    - If there is no fluctuating drop in engine vacuum, or the engine does not misfire, then refer to **Cylinder Deactivation (Active Fuel Management) System Diagnosis** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

INSPECTION/MAINTENANCE SYSTEM CHECK

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that complies with the local area requirements. While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the MIL ON, and is stored in non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or erasable by disconnecting power to the controller. The I/M Test DTCs will be supported by all emissions related ECUs such as ECMs, TCMs, FPCMs, etc. An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.

CONDITIONS FOR UPDATING THE I/M SYSTEM STATUS

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Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a diagnostic trouble code (DTC). A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the malfunction indicator lamp (MIL). Once all of the tests are completed, the I/M System Status display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared as part of a service procedure.

CONDITIONS FOR CLEARING I/M TEST DTCS

1. Only the OBD II System can erase the I/M Test DTC. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:
    - If the MIL goes out due to 3 passing drive cycles, scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.
    - If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, the DTC must PASS and not FAIL. The I/M Test DTC is erased at power down of the drive cycle.
    - If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.
2. For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur:
    - Cumulative time of engine run time is greater than 600 s.
    - Cumulative vehicle operation above 41 kPa (25 mph) for over 300 s.
    - Continuous vehicle idle for greater than 30 s.
    - Turn ignition OFF for 5 s and allow the code to clear.

MONITORED EMISSION CONTROL SYSTEMS

The OBD II system monitors all emission control systems that are on-board. Not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system

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- The catalytic converter efficiency
- Comprehensive component monitoring-Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

For the specific DTCs required for each system, refer to **Inspection/Maintenance System DTC Table**. Systems such as fuel delivery, misfire, and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

DIAGNOSTIC AIDS

The I/M System Status display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The I/M System Status information may be useful for a technician to determine if diagnostics have run when verifying repairs.

CIRCUIT/SYSTEM VERIFICATION

Review the I/M System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

CIRCUIT/SYSTEM TESTING

NOTE: Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the I/M System Status indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Observe the Engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
    - If a control module re-program or other repair is required, perform the **Inspection/Maintenance Complete System Set Procedure**.

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3. Observe the I/M System Status indicators.
    - If any I/M System Status indicators report NO, perform the **Inspection/Maintenance Complete System Set Procedure**.
4. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set and all of the I/M System Status indicators are Yes, there is no need to perform the Complete System Set Procedure. Diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to Conditions for Clearing the I/M Test DTCs.
    - If an I/M Test DTC is set and the I/M System Status indicators are NO, diagnosis the DTC and perform the **Inspection/Maintenance Complete System Set Procedure**.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

The purpose of the Inspection/Maintenance Complete System Set Procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the drive cycles for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the Inspection/Maintenance Complete System Set Procedure if any I/M System Status indicators are set to NO.

Inspection/Maintenance Data List

To determine if the inspection/maintenance readiness diagnostic tests can be run this ignition cycle, use a scan tool to observe the inspection/maintenance monitor enabled parameters in the inspection/maintenance Data List.

CONDITIONS FOR MEETING A COLD START

- The ignition voltage between 11-18 volts.
- The barometric pressure is more than 75 kPa.
- The start-up engine coolant temperature is between 4-30°C (39-86°F).
- The start-up intake air temperature is between 4-30°C (39-86°F).
- The difference between the IAT and the ECT is less than or equal to 6°C (10.8°F).
- The ambient air temperature is between 4-30°C (39-86°F).
- The fuel level is between 15-85 percent.

CIRCUIT/SYSTEM VERIFICATION

Review the inspection/maintenance system status indicators with a scan tool. All I/M system status indicators

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should report YES, and no I/M Test DTCs should be present.

INSPECTION/MAINTENANCE SYSTEM SET PROCEDURE

NOTE: Whenever the ignition is turned ON, ignition positive voltage is supplied to the heated oxygen sensor (HO2S) heaters. After verifying the enable criteria, turn OFF the ignition for approximately 5 minutes to allow the sensors to cool before continuing with the test. Once the engine is started, do NOT turn the engine OFF for the remaining portion of the set procedure.

1. Ensure that the vehicle meets the conditions for a cold start listed above.
2. The evaporative emission inspection/maintenance system status indicator should display YES.
    - If the inspection/maintenance system status indicator displays NO, perform the Service Bay Test, if applicable. If the Service Bay Test is NOT available, it may take up to 6 drive cycles, with up to 17 hours between drive cycles, for the inspection/maintenance system status indicator to transition to YES.
3. The O2S Heater inspection/maintenance system status indicator should display YES.
    - If the O2S Heater inspection/maintenance system status indicator displays NO, ensure that the ignition has been turned OFF for at least 10 hours.
4. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
5. Set the vehicle parking brake and ensure the vehicle is in Park for automatic transmission or Neutral for manual transmission.
6. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
7. Start and idle the engine for at least 2 minutes and until 65°C (149°F) is achieved.
8. Run the engine for 6.5 minutes within the following conditions:
    - MAF parameter between 4-30 g/s
    - Engine speed steady between 1,000-3,000 RPM
9. Return the engine to idle for 1 minute.
10. Apply and hold the brake pedal, and shift to Drive for automatic transmission, or apply the clutch pedal for manual transmission and operate the vehicle within the following conditions for 2 minutes:
    - Depress the accelerator pedal until throttle position sensor angle is more than 2 percent.
    - Mass air flow signal between 15-30 g/s
    - RPM steady between 1,200-2,000 RPM

NOTE: DO NOT touch the accelerator pedal during the idle period. A change in throttle position sensor angle or an increase in engine speed may invalidate this portion of the test.

11. Release the accelerator pedal and shift the vehicle to Park for automatic transmission, or Neutral and release the clutch pedal for manual transmission, and allow the engine to idle for 2 minutes.

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12. Quickly depress the accelerator pedal until throttle position sensor angle is more than 8 percent and return to idle, repeat 3 times.
13. Allow engine to idle for at least 2 minutes.

WARNING: Refer to Road Test Warning .

14. Release the parking brake and drive vehicle at 24 km/h (15 mph) or slower for 2 minutes.
15. Continue to drive the vehicle for at least 5.5 miles between 45-112 km/h (28-70 mph) with the vehicle reaching at least 80 km/h (50 mph).
16. Release the accelerator pedal for at least 2 seconds. This will allow the vehicle to enter decel fuel cut-off.
17. Depress the accelerator pedal until the throttle position sensor angle is increased 3-20 percent and maintain a safe speed for 1 minute.
18. Safely stop the vehicle, with the engine in Drive for automatic transmission or in Neutral with the clutch pedal depressed and parking brake applied for manual transmission, idle for 2 minutes.
19. Shift to Park for automatic and apply the parking brake, or neutral and release clutch pedal for manual.

NOTE: Do NOT disturb the vehicle or turn ON the ignition until told to do so. Disturbing the vehicle may invalidate this portion of the test.

20. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 60 minutes.
21. Observe the Inspection/Maintenance System Status with a scan tool. All of the Inspection/Maintenance System Status indicators should display YES.
    - If the evaporative emission Inspection/Maintenance System Status indicator displays NO, turn OFF the ignition for 17 hours, ensure that the vehicle meets the conditions for a cold start, and repeat steps 12-18 six more times, or until the evaporative emission Inspection/Maintenance System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance System DTC Table** to identify the DTCs that did not run. Follow the Conditions for Running the DTC in order to set the evaporative emission Inspection/Maintenance System Status indicator
    - If any of the Inspection/Maintenance System Status display NO, refer to the **Inspection/Maintenance System DTC Table** for the indicator which did not display YES. The Inspection/Maintenance System DTC Table identifies the DTCs associated with each Inspection/Maintenance System Status Indicator. Follow the Conditions for Running the DTC in order to set the associated status indicator.

NOTE: An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.

22. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set, diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to **Inspection/Maintenance System Check** for clearing I/M Test DTCs.
    - If an I/M Test DTC is set and the I/M System Status indicators are NO, diagnosis the DTC and

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perform the **Inspection/Maintenance Complete System Set Procedure** .

23. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set, diagnose using the **Diagnostic Trouble Code (DTC) List - Vehicle** . After repairs, perform the **Inspection/Maintenance Complete System Set Procedure** to verify no further DTCs are set.

INSPECTION/MAINTENANCE SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an inspection/maintenance system status indicator did NOT update to YES during the **Inspection/Maintenance Complete System Set Procedure**, review each indicator and reference this table to determine each DTC associated with the inspection/maintenance system status indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs which, if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the inspection/maintenance system status indicators to transition to YES.	
Catalyst	**DTC P0420 or P0430**
Evaporative Emission	• **DTC P0442** • **DTC P0446** • **DTC P0451-P0454** • **DTC P0455**
Oxygen Sensor	• **DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158** • **DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153** • **DTC P0134, P0140, P0154, or P0160** • **DTC P2270 or P2272** • **DTC P2271 or P2273** • **DTC P219A or P219B**
Oxygen Sensor Heater	**DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161**

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

DTC P0008 OR P0009

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0008

Engine Position System Performance Bank 1

DTC P0009

Engine Position System Performance Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) tests for a misalignment between both camshafts on one bank of the engine and the crankshaft. The misalignment would be at an idler sprocket for either bank or at the crankshaft. Once the ECM learns the position of both camshafts on one bank of the engine, the ECM compares the learned values to a reference value. The ECM will set a DTC if both learned values for one bank of the engine are exceeding a calibrated threshold in the same direction.

CONDITIONS FOR RUNNING THE DTC

- DTC P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095 is not set.
- The engine is operating for greater than 50 seconds.
- The engine coolant temperature is between 0-95°C (32-203°F).
- The calculated engine oil temperature is colder than 120°C (248°F).
- The engine must accelerate such that the CMP actuator system is commanded from the park position to the phased position. This is considered a cam control cycle. There must be a minimum of 2 cam control cycles for at least 2.5 seconds each, in the phased position.
- DTC P0008 and P0009 run continuously once the above conditions are met, approximately 600 seconds.

CONDITIONS FOR SETTING THE DTC

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The ECM detects that both camshafts on either bank of the engine are mis-aligned with the crankshaft for greater than 4 seconds or a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P0008 and P0009 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P0008 and P0009 are type B DTCs.

DIAGNOSTIC AIDS

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed secondary timing chain can cause this DTC to set.
- A single failed camshaft actuator or actuator solenoid will not cause this DTC to set. This diagnostic algorithm is designed to detect an alignment condition between a primary intermediate sprocket and the secondary timing chain, or the alignment between a primary intermediate sprocket and the crankshaft. Either condition would cause the camshaft timing for both cams on one bank to be off an equal number of degrees.
- The presence of DTCs P0008 and P0009 along with P0016, P0017, P0018, and P0019 indicates a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft. Or, the crankshaft reluctor wheel has moved and is no longer referenced to top dead center (TDC).
- Observe the Desired Intake Camshaft Position and the Camshaft Position parameters with a scan tool before a DTC sets. This may help to isolate whether a condition is specific to one camshaft, one bank, or caused by a condition with the primary crankshaft timing.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Clear the DTCs with a scan tool.
2. Allow the engine to reach the normal operating temperature.
3. Idle the engine for 10 minutes or until a DTC sets. Observe the DTC information with a scan tool, DTCs P0008 and P0009 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure

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Records data.

CIRCUIT/SYSTEM TESTING

1. Inspect the timing chains and tensioners for excessive wear or misalignment.
    - If you find a condition with the timing chains or tensioners, repair as necessary.
2. Inspect the crankshaft reluctor wheel for being mis-positioned on the crankshaft.
    - If you find a condition with the crankshaft, repair as necessary.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Timing Chain Alignment Diagram**
- **Camshaft Timing Drive Components Cleaning and Inspection**
- **Crankshaft and Bearing Cleaning and Inspection**

DTC P000A-P000D, P0011, P0014, P0021, OR P0024

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P000A

Intake Camshaft Position System Slow Response Bank 1

DTC P000B

Exhaust Camshaft Position System Slow Response Bank 1

DTC P000C

Intake Camshaft Position System Slow Response Bank 2

DTC P000D

Exhaust Camshaft Position System Slow Response Bank 2

DTC P0011

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Intake Camshaft Position System Performance Bank 1

DTC P0014

Exhaust Camshaft Position System Performance Bank 1

DTC P0021

Intake Camshaft Position System Performance Bank 2

DTC P0024

Exhaust Camshaft Position System Performance Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid signal from the ECM is pulse width modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid ON time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P000A, P000B, P000C, P000D, P0011, P0014, P0021, or P0024 failed, DTCs P0010, P0013, P0020, P0023, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 must run and pass.
- DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 is not set.
- The engine is operating for greater than 1 seconds.
- The engine speed is greater than 520 RPM.
- The engine must accelerate such that the CMP actuator system is commanded from the park position to the phased position. This is considered a cam control cycle. There must be a minimum of 2 cam control cycles for at least 2.5 seconds each in the phased position.
- DTCs P000A, P000B, P000C, P000D, P0011, P0014, P0021, and P0024 run continuously once the above conditions are met for greater than 600 seconds.

CONDITIONS FOR SETTING THE DTC

- The ECM detects the difference between the desired camshaft position angle and the actual camshaft position angle is greater than 7-8 degrees.

  OR

- The ECM detects a slow response, a deviation greater than 1.5 degrees in time greater than 2.5 seconds,

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for the actual camshaft position angle to match the desired position angle during the test.

- Either condition exists for greater than 1 second.

ACTION TAKEN WHEN THE DTC SETS

DTCs P000A, P000B, P000C, P000D, P0011, P0014, P0021, and P0024 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P000A, P000B, P000C, P000D, P0011, P0014, P0021, and P0024 are type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 35616-200:** Test Lamp Kit
- For equivalent regional tools, refer to **Special Tools** .

DIAGNOSTIC AIDS

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- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

CIRCUIT/SYSTEM VERIFICATION

NOTE: The engine oil level and the oil pressure are critical to the correct operation of the camshaft position (CMP) actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.

1. Ignition ON, observe the scan tool DTC information. Verify that none of the following DTCs are set. DTC P0016, P0017, P0018, P0019, P0335, P0336, P0338, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P0521, P0522, P0523, P0638, P2100, P2101, or P2119.
    - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Engine idling, command the appropriate Camshaft Position Actuator from 0 degrees to 40 degrees and back to zero while observing the appropriate scan tool Camshaft Position Variance parameters. The Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Ignition ON, load test for B+ between the ignition circuit terminal 1 and ground.
    - If less than the specified range, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.

NOTE: Use the J 35616-200: Test Lamp for this test. If the J 35616-200: Test Lamp is not available, use a test lamp that measures greater than 20 ohms.

3. Connect a test lamp between the control circuit terminal 2 and B+.
4. Command the appropriate Camshaft Position Actuator Solenoid Valve ON with a scan tool.

NOTE: The voltage must be measured at the control side of the circuit.

5. Load test for less than 1 V between the control circuit terminal 2 and ground.

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- If greater than the specified range, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.

6. Remove the Q6 Camshaft Position Actuator Solenoid Valve. Inspect the Camshaft Position Actuator Solenoid Valve and mounting area for the following conditions:
   - For a torn, restricted, mis-positioned, or missing screens at the solenoid valve
   - For engine oil leaks between the oil sealing lands of the solenoid valve-Inspect the lands of the solenoid for nicks.
   - For oil seepage at the solenoid connector
   - If a condition is found, replace Q6 Camshaft Position Actuator Solenoid Valve.
7. Ignition OFF, swap the Q6 Camshaft Position Actuator Solenoid Valve with a Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.

NOTE: This step is testing the mechanical CMP actuator for the camshaft that set the DTC.

8. Engine idling. Command the appropriate Camshaft Position Actuator from 0 degrees to 40 degrees and back to zero while observing the appropriate scan tool Camshaft Position Variance parameters. The Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
   - If greater than the specified value, replace the mechanical camshaft position actuator.
9. If all circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 7-12 ohms between the control terminal 2 and the ignition terminal 1 of the solenoid.
   - If not within the specified range, replace the Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for infinite resistance between each terminal and the solenoid housing.
   - If not the specified value, replace the Q6 Camshaft Position Actuator Solenoid Valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust**

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- **Control Module References** for ECM replacement, setup, and programming

DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, OR P2095

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0020

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P0023

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2092

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Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2093

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

DTC P2094

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2095

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The Camshaft Position Actuator Solenoid Valve signal from the ECM is pulse width modulated (PWM). The ECM controls the Camshaft Position Actuator Solenoid Valve duty cycle by controlling the amount of solenoid valve ON time. The Camshaft Position Actuator Solenoid Valve controls the advance or the retard of each camshaft. The Camshaft Position Actuator Solenoid Valve controls the oil flow that applies the pressure to advance or retard the camshafts.

Ignition voltage is supplied directly to the Camshaft Position Actuator Solenoid Valve. The ECM controls the solenoid valve by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 volts.
- The ECM has commanded the CMP actuator solenoid ON and OFF at least once during the ignition cycle.
- DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 run continuously once the above conditions are met for greater than 1 second.

CONDITIONS FOR SETTING THE DTC

P0010, P0013, P0020, P0023

The ECM detects an open in the CMP actuator solenoid circuits for greater than 1 second or a cumulative of 5 seconds, when the solenoid is commanded OFF.

P2088, P2090, P2092, P2094

The ECM detects a short to ground in the CMP actuator solenoid circuits for greater than 1 second or a

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cumulative of 5 seconds, when the solenoid is commanded OFF.

P2089, P2091, P2093, P2095

The ECM detects a short to voltage in the CMP actuator solenoid circuits for greater than 1 second or a cumulative of 5 seconds, when the solenoid is commanded ON.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 are type B DTCs.

DIAGNOSTIC AIDS

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit status parameters for the component. The circuit status parameters change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. With the engine at normal operating temperature, raise the engine speed to 2,000 RPM for 10 seconds. DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
    - If the test lamp does not illuminate, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Connect a DMM, set on the diode setting, between the control circuit terminal 2 and ground. Verify the voltage is greater than 2.0 V.
    - If the DMM displays OL, test the control circuit for a short to voltage or an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
    - If less than the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Command the Camshaft Position Actuator Solenoid Valve ON and OFF with a scan tool. The DMM should transition from greater than 2 V when commanded OFF to less than 1 V, when commanded ON.
    - If the circuit voltage does not correspond to the specified values, replace the K20 ECM.
5. If all circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 7-12 ohms between the control terminal 2 and the ignition terminal 1 of the solenoid.
    - If not within the specified range, replace the Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for infinite resistance between each terminal and the solenoid housing.
    - If not the specified value, replace the Q6 Camshaft Position Actuator Solenoid Valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

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- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0016, P0017, P0018, OR P0019

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 1

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 1

DTC P0018

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 2

DTC P0019

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 2

CIRCUIT/SYSTEM DESCRIPTION

This diagnostic monitors the relationship between the crankshaft and the camshafts. The engine control module (ECM) is continuously comparing the CKP sensor signal to the CMP sensor signals. The ECM can detect incorrect camshaft to crankshaft timing. An incorrect position can be caused by either engine timing or incorrect indexing of the camshaft drive chains.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0016, P0017, P0018, or P0019 failed, DTCs P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0335, P0336, P0338, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 must run and pass.

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- The engine is operating for greater than 50 seconds.
- The engine coolant temperature is between 0-95°C (32-203°F).
- The calculated engine oil temperature is less than 120°C (248°F).
- DTC P0016, P0017, P0018, and P0019 run continuously once the above conditions are met for approximately 10 minutes.

CONDITIONS FOR SETTING THE DTC

The ECM detects a deviation in the relationship between a camshaft and the crankshaft. The ECM detects the learned camshaft angle is greater than 10 degrees advanced or 10 degrees retarded in relationship to the crankshaft.

OR

The ECM detects the actual camshaft angle is advanced 15 degrees or retarded 21 degrees in relationship to the crankshaft when the camshafts are commanded to the parked position.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

DIAGNOSTIC AIDS

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, camshaft sensor, crankshaft sensor, or timing chain can cause this DTC to set.
- The presence of DTCs P0008 and P0009 along with P0016, P0017, P0018, and P0019 indicates a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft. Or, the crankshaft reluctor wheel has moved and is no longer referenced to top dead center (TDC).
- Observe the Desired Intake Camshaft Position and the Camshaft Position parameters with a scan tool before a DTC sets. This may help to isolate whether a condition is specific to one camshaft, one bank, or caused by a condition with the primary crankshaft timing.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

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Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition ON, observe the DTC information with a scan tool. Verify that none of the following DTCs are set. DTC P0010, P0013, P0020, P0023, P0335, P0336, P0338, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095.
    - If any of the DTCs listed are set refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Idle the engine at normal operating temperature for 10 minutes. DTCs P0016, P0017, P0018, or P0019 should not set.
    - If a DTC sets, inspect for the following and repair as necessary:
        - The correct installation of the camshaft sensors
        - The correct installation of the crankshaft sensor
        - A timing chain tensioner condition
        - An incorrectly installed timing chain
        - Excessive play in the timing chain
        - A mechanical cam actuator that is stuck in the full advance or retard position.
        - A timing chain that jumped teeth
        - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Timing Chain Alignment Diagram**
- **Camshaft Timing Drive Components Cleaning and Inspection**
- **Crankshaft and Bearing Cleaning and Inspection**

DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, OR P0058

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0030

HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 1

DTC P0036

Heater Control Circuit Bank 1 Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit Bank 2 Sensor 1

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DTC P0051

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 1

DTC P0052

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 1

DTC P0056

HO2S Heater Control Circuit Bank 2 Sensor 2

DTC P0057

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 2

DTC P0058

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0030, P0036, P0050, P0056	P0030, P0036, P0050, P0056	-	P0135, P0141, P0155, P0161
HO2S Heater Control Sensor 1	P0031, P0051	P0030, P0050, P0134, P0154	P0032, P0052	P0135, P0141, P0155, P0161
HO2S Heater Control Sensor 2	P0037, P0057	P0036, P0056, P013A, P013C, P0140, P0160	P0038, P0058	P013E, P0135, P014A, P0141, P0155, P0161

CIRCUIT DESCRIPTION

The heated oxygen sensor (HO2S) heater reduces the time required for the oxygen sensor to reach operating temperature and maintains the operating temperature during extended idle periods. When the ignition is turned to the ON position, ignition voltage is supplied directly to the sensor heater. The engine control module (ECM) controls the heater operation by first modulating the control circuit to ground when the sensors are cold. This prevents the possibility of thermal shock to the sensor, from condensation build-up on the sensor, by controlling the sensors rate of heating. After a predetermined amount of time, the ECM commands the heaters ON continuously. Once the sensor reaches operating temperature, the ECM may modulate the heater control circuit to ground, to maintain a desired temperature.

The ECM controls the heater by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

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CONDITIONS FOR RUNNING THE DTC

P0030, P0031, P0032, P0050, P0051, P0052

- The ignition voltage is between 10-18 V.
- The engine speed is greater than 240 RPM.
- The HO2S heater is commanded ON.
- The DTCs run continuously once the above conditions are met for 5 s.

P0036, P0037, P0038, P0056, P0057, P0058

- The ignition voltage is between 10-18 V.
- The engine speed is greater than 80 RPM.
- The HO2S heater is commanded ON and OFF at least once during the ignition cycle.
- The HO2S 2 is at operating temperature.
- The DTCs run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0030, P0036, P0050, and P0056

The ECM detects an open in the heater circuits of the HO2S when the heater is commanded OFF. The condition exists for greater than 4 s or a cumulative of 30 s.

P0031, P0037, P0051, and P0057

The ECM detects a short to ground in the heater circuits of the HO2S when the heater is commanded OFF. The condition exists for greater than 4 s or a cumulative of 30 s.

P0032, P0038, P0052, and P0058

The ECM detects a short to voltage in the heater circuits of the HO2S when the heater is commanded ON. The condition exists for greater than 4 s or a cumulative of 30 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, and P0058 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, and P0058 are Type B DTCs.

DIAGNOSTIC AIDS

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- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit test status parameters for the component. The circuit test status parameters change from OK or Not Run to Fault if there is a condition with the circuit or a connection.
- An open fuse in the HO2S heater circuit may be caused by the heater element in one of the sensors. The condition may not be present until the sensor operates for a period of time. If no fault is present in the heater circuit, monitor the amperage of each heater using the DMM to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling at operating temperature for at least 30 s. Observe the DTC information, DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, and P0058 should not set.
2. Observe the appropriate scan tool HO2S Heater Circuit Test Status parameter. The parameter should display OK or Not Run.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

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1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.

NOTE: The ignition circuit supplies voltage to other components. Make sure you test all circuits for a short to ground or test all components for being shorted that share the ignition circuit.

2. Ignition ON, verify that a test lamp illuminates between the appropriate ignition circuit terminal and ground.
   - HO2S bank 1 sensor 1 terminal D or 1
   - HO2S bank 2 sensor 1 terminal D or 1
   - HO2S bank 1 sensor 2 terminal C or 1
   - HO2S bank 2 sensor 2 terminal C or 1, with manual transmission
   - HO2S bank 2 sensor 2 terminal D or 1, with automatic transmission
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Connect a test lamp between the appropriate heater control circuit terminal and B+. The test lamp should not illuminate.
   - HO2S bank 1 sensor 1 terminal E or 2
   - HO2S bank 2 sensor 1 terminal E or 2
   - HO2S bank 1 sensor 2 terminal D or 2
   - HO2S bank 2 sensor 2 terminal D or 2, with manual transmission
   - HO2S bank 2 sensor 2 terminal C or 1, with automatic transmission
   - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit/connections test normal, replace the K20 ECM.

NOTE: The control circuit for the HO2S heater is pulled-up to voltage within the ECM, 2.0-3.0 V on the control circuit is normal.

4. Idle the engine, and verify the test lamp illuminates or flashes.
   - If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
5. Ignition ON, test for 2.0-3.0 V between the appropriate control circuit terminal and ground.
   - HO2S bank 1 sensor 1 terminal E or 2
   - HO2S bank 2 sensor 1 terminal E or 2
   - HO2S bank 1 sensor 2 terminal D or 2
   - HO2S bank 2 sensor 2 terminal D or 2, with manual transmission
   - HO2S bank 2 sensor 2 terminal C or 1, with automatic transmission
   - If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
6. If all circuits/connections test normal, test or replace the B52 HO2S sensor.

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COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B52 HO2S.
2. Test for 5-25 ohms between the appropriate control and the ignition terminals of the B52 HO2S.
    - HO2S bank 1 sensor 1 terminal E or 2 and D or 1
    - HO2S bank 2 sensor 1 terminal E or 2 and D or 1
    - HO2S bank 1 sensor 2 terminal D or 2 and C or 1
    - HO2S bank 2 sensor 2 terminal D or 2, and C or 1, with manual transmission
    - HO2S bank 2 sensor 2 terminal C or 1, and D or 1, with automatic transmission

    - If not within the specified range, replace the B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0087, P0088, OR P0089

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0087

Fuel Rail Low Pressure

DTC P0088

Fuel Rail High Pressure

DTC P0089

Fuel Pressure Regulator Performance

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CIRCUIT/SYSTEM DESCRIPTION

The fuel rail pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit.

High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a solenoid valve. The ECM provides a voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled. When activated, the high control circuit driver energizes the high pressure fuel pump actuator and the low control circuit driver pulse-width modulates (PWM) the low control circuit to ground.

The high pressure mechanical fuel pump is driven by three lobes on the camshaft. The ECM uses the camshaft and crankshaft position sensor inputs to synchronize the high pressure fuel pump actuator with the position of each of the camshaft lobes. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the rail.

The ECM monitors the fuel rail pressure sensor and the high pressure fuel pump actuator to determine if the commanded and actual pressure are within a predetermined range, or if the amount of fuel pressure correction exceeds a calibrated pressure.

CONDITIONS FOR RUNNING THE DTC

- DTC P0090, P0091, P0092, P0191, P0192, or P0193 is not set.
- The ignition voltage is less than 18 V.
- The deceleration fuel cut-off (DFCO) is inactive.
- The engine speed is greater than 25 RPM.
- The air bag is not deployed.
- DTCs P0087, P0088, and P0089 run continuously when the above conditions are met for 5 seconds.

CONDITIONS FOR SETTING THE DTC

P0087

The actual fuel rail pressure is 1.5 MPa (218 psi) less than the desired fuel pressure. The condition exists for greater than 5 seconds.

P0088

The actual fuel rail pressure is 3.6 MPa (522 psi) greater than the desired fuel rail pressure. The condition exists for greater than 5 seconds.

P0089

The high pressure fuel pump actuator command necessary to maintain the desired fuel rail pressure is +/-2.5 MPa (363 psi) of the command expected by the controller. The condition exists for greater than 5 seconds.

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ACTION TAKEN WHEN THE DTC SETS

- DTCs P0087, P0088, and P0089 are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

DTCs P0087, P0088, and P0089 are Type A DTCs.

DIAGNOSTIC AIDS

- A condition with the fuel pump tank module or fuel pump control module (FPCM) will set these DTCs.
- A skewed fuel rail pressure (FRP) sensor, or an intermittent condition in the FRP sensor circuits may set these DTCs.
- A Leaking or restricted fuel injector may set DTC P0089.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

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1. Observe the DTC information with a scan tool. DTC P029D, P02A1, P02A5, P02A9, P02AD, P02B1, P0627, P0628, P0629, P069E, or U0109 should not set.
    - If a DTC is set refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Attempt to start and idle the engine.
3. Observe the DTC information with a scan tool. DTCs P0087, P0088, and P0089 should not set.
4. Engine idling, observe the Fuel Rail Pressure Sensor parameter with a scan tool. The pressure should be approximately 3.5-5.5 Mpa (508-798 psi).
5. Command an increase and decrease in fuel rail pressure with a scan tool. Observe the scan tool Fuel Rail Pressure Sensor parameter. The Fuel Rail Pressure Sensor should increase or decrease with each commanded state.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: Circuit/System Verification must be performed first or misdiagnosis may result.

1. Ignition ON, observe the scan tool fuel pump control module (FPCM) fuel line pressure sensor parameter. Command an increase in the fuel line pressure with a scan tool. Verify the fuel line pressure increases to greater than 410 kPa (60 psi) as commanded.
    - If the less than the specified range, refer to **Fuel System Diagnosis** .

NOTE: As little as 2 ohms on either circuit of the high pressure fuel pump actuator will cause these DTCs to set. Test the circuits of the high pressure fuel pump actuator for a high resistance if you suspect a condition.

2. Remove the Q18 high pressure fuel pump assembly and visually inspect the lobes on the camshaft for unusual wear.
    - If the lobes appear normal, replace the Q18 high pressure fuel pump assembly.
    - If the lobes are worn, replace the camshaft.

COMPONENT TESTING

Static Test

1. Ignition OFF, disconnect the harness connector at the high pressure fuel pump.

NOTE: The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.

2. Test for 0.35-0.6 ohms at 20°C (68°F) between low control circuit terminal 1 and high control circuit

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terminal 2.

- If the resistance is less than 0.3 ohms or greater than 0.6 ohms, replace the high pressure fuel pump.

3. Test for infinite resistance between each terminal and the high pressure fuel pump housing/case.
   - If not the specified value, replace the high pressure fuel pump.

DYNAMIC TEST

Engine idling, command the Fuel Pressure Control to Increase with a scan tool. The Fuel Rail Pressure Sensor parameter should increase with each command.

- If the Fuel Rail Pressure Sensor parameter does not increase with each command, replace the G18 high pressure fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Removal - Left Side (LLT)**
- **Fuel Pump Replacement**

DTC P0090, P0091, OR P0092

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0090

Fuel Pressure Regulator 1 Control Circuit

DTC P0091

Fuel Pressure Regulator 1 Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator 1 Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

	Short to	Open/High	Short to	Signal

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Circuit	Ground	Resistance	Voltage	Performance
High Pressure Fuel Pump Actuator High Control	P0091	P0090	-	-
High Pressure Fuel Pump Actuator Low Control	P0091	P0090	P0092	-

CIRCUIT/SYSTEM DESCRIPTION

High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a solenoid valve. The ECM provides battery voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled. When activated, the high control circuit driver energizes the high pressure fuel pump actuator, and the low control circuit driver pulse-width modulates (PWM) the low control circuit to ground. The ECM monitors the voltage on the circuits to detect a failure.

CONDITIONS FOR RUNNING THE DTC

- DTC P0641, P0642, or P0643 is not set.
- The ignition voltage is between 6-18 V.
- DTCs P0090, P0091, and P0092 run continuously when the conditions above are met for greater than 3 seconds.

CONDITIONS FOR SETTING THE DTC

P0090

- The high pressure fuel pump actuator voltage is between 2.7-4.5 V with the actuator commanded OFF.
- The above condition is present for greater than 5 seconds.

P0091

- The high pressure fuel pump actuator voltage is less than 2.7 V with the actuator commanded OFF.
- The above condition is present for greater than 5 seconds.

P0092

- The high pressure fuel pump actuator voltage is greater than 4.5 V with the actuator commanded ON.
- The above condition is present for greater than 5 seconds.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0090, P0091, and P0092 are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.

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CONDITIONS FOR CLEARING THE DTC

DTCs P0090, P0091, and P0092 are Type A DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the Fuel Rail Pressure Sensor parameter with a scan tool. The pressure should be approximately 3.5-5.5 MPa (508-798 psi).
2. Command an increase and decrease in fuel rail pressure with a scan tool. Observe the scan tool Fuel Rail Pressure Sensor parameter. The Fuel Rail Pressure Sensor should increase or decrease with each command.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

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1. Ignition OFF.
2. Disconnect the harness connector at the high pressure Q18 fuel pump.
3. Engine operating, verify that a test lamp flashes between the high pressure fuel pump actuator low control circuit terminal 1 and B+.
    - If the test lamp is always ON, test the high pressure fuel pump actuator low control circuit for a short to ground. If the circuit tests normal, replace the ECM.
    - If the test lamp is always OFF, test the high pressure fuel pump actuator low control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify that a test lamp illuminates between the high pressure fuel pump actuator high control circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the high pressure fuel pump actuator high control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the high pressure Q18 fuel pump.

COMPONENT TESTING

Static Test

1. Ignition OFF, disconnect the harness connector at the high pressure fuel pump.

NOTE: The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.

2. Test for 0.35-0.6 ohms at 20°C (68°F) between low control circuit terminal 1 and high control circuit terminal 2.
    - If the resistance is less than 0.3 ohms or greater than 0.6 ohms, replace the high pressure fuel pump.
3. Test for infinite resistance between each terminal and the high pressure fuel pump housing/case.
    - If not the specified value, replace the high pressure fuel pump.

DYNAMIC TEST

Engine idling, command the Fuel Pressure Control to Increase with a scan tool. The Fuel Rail Pressure Sensor parameter should increase with each command.

- If the Fuel Rail Pressure Sensor parameter does not increase with each command, replace the G18 high pressure fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for ECM replacement, setup, and programming
- **Fuel Pump Replacement**

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DTC P0100-P0103

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0100

Mass Air Flow Sensor Circuit

DTC P0102

Mass Air Flow Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow Sensor Circuit High Frequency

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0100	P0100	P0100	-	P0101
MAF Sensor Signal	P0100	P0102	P0100	P0102	P0101
Low Reference	-	P0102	P0100	-	P0101

CIRCUIT/SYSTEM DESCRIPTION

The mass air flow (MAF) sensor is located in the air intake duct. The MAF sensor is an airflow meter that measures the amount of air that enters the engine. The MAF sensor uses a hot film that is cooled by air flowing past the sensing film as air enters the engine. The amount of cooling is proportional to the amount of the air flow. As the air flow increases, more current is required in order to maintain the hot film at a constant temperature. The engine control module (ECM) uses the MAF sensor in order to provide the correct fuel delivery for all operating conditions.

CONDITIONS FOR RUNNING THE DTC

- The engine is operating.
- The ignition voltage is greater than 10 volts.
- DTC P0100, P0102 and P0103 run continuously once the above conditions are met for 6 seconds.

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CONDITIONS FOR SETTING THE DTC

P0100

- The ECM detects that the MAF sensor signal is 0.0 Hz.
- The condition exists for 4 seconds or for a cumulative of 30 seconds.

P0102

- The ECM detects that the MAF sensor signal is less than 1135 Hz.
- The condition exists for 4 seconds or for a cumulative of 30 seconds.

P0103

- The ECM detects that the MAF sensor signal is greater than 15,152 Hz.
- The condition exists for 4 seconds or for a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0100, P0102, and P0103 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0100, P0102, and P0103 are Type B DTCs.

DIAGNOSTIC AIDS

- Inspect the harness of the MAF sensor to verify that it is not routed too close to the following components:
  - The secondary ignition wires or coils
  - Any solenoids
  - Any relays
  - Any motors
- Inspect the hydro-carbon (HC) filter, if equipped, in the air cleaner assembly for ruptures that would leak charcoal into the air intake, contaminating the sensing element.
- Inspect for any contamination, water intrusion, or debris on the sensing elements of the MAF sensor. If debris is present, clean the sensor. If the sensor cannot be cleaned, replace the sensor.
- A high resistance may cause a driveability concern before this DTC sets.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

Component Connector End Views

Description and Operation

Air Intake System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 38522:** Variable Signal Generator
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling for 1 minute, observe the DTC information with a scan tool. DTCs P0100, P0102 and P0103 should not set.
2. Verify restrictions do not exist in the exhaust system. Refer to **Restricted Exhaust** .
3. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 1,650-3,500 Hz depending on the ECT.
4. Use the scan tool and compare the MAF Sensor parameter to a known good vehicle under various operating conditions.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
   - Any damaged components

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- Loose or improper installation
- An air flow restriction
- Any vacuum leak
- Water intrusion
- In cold climates, inspect for any snow or ice buildup
- The MAF sensor element for contamination
  - If you find any of the above conditions, repair as necessary.

2. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
3. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the ground circuit terminal 2 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.

CAUTION: Do NOT use the low reference circuit in the component harness connector for this test. Damage to the control module may occur due to excessive current draw.

4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 4 and ground.
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
5. Test for 4.8-5.2 V between the signal circuit terminal 5 and the ground circuit terminal 2.
   - If less than the specified range, test the signal circuit for an open/high resistance or a short to ground. If the circuit/connections test normal, replace the K20 ECM.
   - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
6. Ignition OFF, connect the red lead of the **J 38522:** Variable Signal Generator to the signal circuit terminal 5 at the B75B MAF sensor harness connector. Connect the battery voltage supply to B+, and the black lead to ground.
7. Set the **J 38522:** Variable Signal Generator Signal switch to 5 V, the Frequency switch to 5 K, and the Duty Cycle switch to Normal.

NOTE: If the engine stalls, connect the red lead of the J 38522: Variable Signal Generator to the signal circuit terminal 5 at the B75B MAF sensor harness connector after the engine is already at idle.

8. Engine at idle, observe the scan tool MAF Sensor frequency parameter. The parameter should be between 4,950-5,050 Hz.
   - If not within the specified range, replace the K20 ECM.
9. If all circuits/connections test normal, replace the B75B MAF sensor.

REPAIR PROCEDURES

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Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0101

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0101

Mass Air Flow Sensor Circuit Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0100	P0100	P0100	-	P0101
MAF Sensor Signal	P0100	P0102	P0100	P0102	P0101
Low Reference	-	P0102	P0100	-	P0101

CIRCUIT/SYSTEM DESCRIPTION

The mass air flow (MAF) sensor is located in the air intake duct. The MAF sensor is an airflow meter that measures the amount of air that enters the engine. The MAF sensor uses a hot film that is cooled by air flowing past the sensing film as air enters the engine. The amount of cooling is proportional to the amount of the air flow. As the air flow increases, more current is required in order to maintain the hot film at a constant temperature. The engine control module (ECM) uses the MAF sensor in order to provide the correct fuel delivery for all operating conditions.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0101 failed, DTCs P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0100, P0102, P0103, P0111, P0112, P0113, P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336, P0338, P2088, P2089, P2090, P2091, P2092, P2093, P2094, P2095, P2227, P2228, or P2229 must run and pass.
- DTC P2176 is not set.
- The engine is operating for greater than 1 second.
- The MAF sensor signal is greater than 1.39 grams per second.

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- The ignition voltage is greater than 10 volts.
- The engine coolant temperature (ECT) is greater than 10°C (50°F).
- The long term fuel trim is enabled.
- The throttle angle is steady +/-2 percent.
- The ECM detects greater than 150 revolutions of the crankshaft.
- DTC P0101 runs continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the MAF sensor signal is greater or less than the calculated air flow based on engine load and engine speed.

  OR

- The ECM detects that the MAF sensor signal is greater or less than the calculated air flow, and The ECM detects a significant error in the long term fuel trim at cruising speed.

ACTION TAKEN WHEN THE DTC SETS

DTC P0101 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0101 is a Type B DTC.

DIAGNOSTIC AIDS

- Inspect the harness of the MAF sensor to verify that it is not routed too close to the following components:
  - The secondary ignition wires or coils
  - Any solenoids
  - Any relays
  - Any motors
- Inspect the hydro-carbon (HC) absorber in the air cleaner assembly for ruptures that would leak charcoal into the air intake, contaminating the sensing element.
- Inspect for any contamination, water intrusion, or debris on the sensing elements of the MAF sensor. If debris is present, clean the sensor. If the sensor cannot be cleaned, replace the sensor.
- A high resistance may cause a driveability concern before this DTC sets.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

Component Connector End Views

Description and Operation

Air Intake System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 38522:** Variable Signal Generator
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling for 1 minute, observe the DTC information with a scan tool. DTC P0101 should not set.
2. Verify restrictions do not exist in the exhaust system. Refer to **Restricted Exhaust** .
3. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 1,650-3,500 Hz depending on the ECT.
4. Use the scan tool and compare the MAF Sensor parameter to a known good vehicle under various operating conditions.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Inspect for the following conditions:
    - An engine vacuum leak
    - An air leak in the intake air duct between the mass air flow (MAF) sensor and the throttle body

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- A plugged or collapsed intake air duct
- Objects that block the MAF sensor air inlet
- An air filter element that is restricted
- The hydro-carbon absorber, if equipped, in the air cleaner assembly for ruptures or deterioration.
- A restricted throttle plate or for carbon build-up around the throttle plate
- An unseated engine oil dip stick
- A loose or missing engine oil fill cap
- An over filled crankcase
  - If you find any of the above conditions, repair as necessary.

2. Ignition OFF, disconnect the harness connector at the B75B MAF sensor.
3. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the ground circuit terminal 2 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.

CAUTION: Do NOT use the low reference circuit in the component harness connector for this test. Damage to the control module may occur due to excessive current draw.

4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 4 and ground.
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
5. Test for 4.8-5.2 V between the signal circuit terminal 5 and the ground circuit terminal 2.
   - If less than the specified range, test the signal circuit for an open/high resistance or a short to ground. If the circuit/connections test normal, replace the K20 ECM.
   - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
6. Ignition OFF, connect the red lead of the **J 38522:** Variable Signal Generator to the signal circuit terminal 5 at the B75 MAF sensor harness connector. Connect the battery voltage supply to B+, and ground the black lead.
7. Set the **J 38522:** Variable Signal Generator Signal switch to 5 V, the Frequency switch to 5K, and the Duty Cycle switch to Normal.

NOTE: If the engine stalls, connect the red lead of the J 38522: Variable Signal Generator to the signal circuit terminal 5 at the B75B MAF sensor harness connector after the engine is already at idle.

8. Engine at idle, observe the scan tool MAF Sensor frequency parameter. The parameter should be between 4,950-5,050 Hz.
   - If not within the specified range, replace the K20 ECM.
9. If all circuits/connections test normal, replace the B75B MAF sensor.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0111-P0113

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0111

Intake Air Temperature (IAT) Sensor Performance

DTC P0112

Intake Air Temperature (IAT) Sensor Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112	P0111, P0113	P0113*	P0111
Low Reference	-	P0111, P0113	P0113*	P0111
* Internal ECM or sensor damage may occur if the circuit is shorted to B+				

TYPICAL SCAN TOOL DATA

IAT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. **Parameter Normal Range:** -39 to +134°C (-38 to +274°F) Varies with ambient temperature.			
IAT Sensor Signal	135°C (275°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*

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* Internal ECM or sensor damage may occur if the circuit is shorted to B+

CIRCUIT DESCRIPTION

The intake air temperature (IAT) sensor is an integral part of the mass air flow (MAF) sensor. The IAT sensor is a variable resistor that measures the temperature of the intake air. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

IAT	IAT Resistance	IAT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

P0111 Idle Test

- Before the ECM can report DTC P0111 failed, DTC P0101 must run and pass.
- DTC P0112, P0113, P0116, P0117, P0118, P0119, or P0128 is not set.
- The engine coolant temperature (ECT) at engine start is colder than 110°C (230°F).
- The ECT is warmer than 66°C (151°F).
- The vehicle speed is less than 11 km/h (7 mph).
- The MAF is less than 8 g/s.
- DTC P0111 runs continuously once the above conditions are met for approximately 300 seconds, depending on the drive cycle.

P0111 Cruise Test

- Before the ECM can report DTC P0111 failed, DTC P0101 must run and pass.
- DTC P0112, P0113, P0116, P0117, P0118, P0119, or P0128 is not set.
- The ECT at engine start is colder than 110°C (230°F).
- The vehicle speed is greater than 29 km/h (18 mph).
- The MAF is between 7-67 g/s.
- Decel fuel cut-off (DFCO) is not active.
- DTC P0111 runs continuously once the above conditions are met for approximately 300 seconds, depending on the drive cycle.

P0112 and P0113

- The vehicle speed is less than 3 mph.
- The ECT is warmer than -10°C (14°F).
- The MAF is less than 28 g/s.

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- The DTCs runs continuously once the above conditions are met for greater than 2 seconds.

CONDITIONS FOR SETTING THE DTC

P0111

The ECM detects that the IAT remains steady within 2°C (4°F) during the idle test. Or, the ECM detects that the IAT decreased less than 2°C (4°F) during the cruise test. The condition exists for greater than 4 seconds or for a cumulative of 30 seconds.

P0112

The ECM detects that the IAT sensor voltage is greater than 4.87 volts for greater than 1 second or for a cumulative 10 seconds.

P0113

The ECM detects that the IAT sensor voltage is less than 0.21 volts for greater than 1 second or for a cumulative 10 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0111, P0112, and P0113 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0111, P0112, and P0113 are Type B DTCs.

DIAGNOSTIC AIDS

- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5° F).
- High resistance on either the IAT sensor signal circuit or the IAT sensor low reference circuit may set a DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, DTC P0111, P0112, or P0113 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 min.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

3. Test for less than 5 ohms between the low reference circuit terminal 1 and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
4. Ignition ON, verify that the scan tool IAT sensor parameter is at -40°C (-40°F).
   - If warmer than the specified value, test the signal circuit terminal 3 for a short to ground. If the circuit/connections test normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

5. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal 3 and ground. Verify the IAT sensor parameter is warmer than 134°C (274°F).
   - If colder than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
6. If all circuits/connections test normal, test or replace the B75B MAF/IAT sensor.

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COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.

   NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the IAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** table and verify that the resistance is within 5 % of the specification.
   - If the not within the specified range, replace the B75B MAF/IAT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0116 (W/LLT)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118, P0119	P0118, P0119*	P0116*
Low Reference	-	P0118, P0119	P0118, P0119*	P0116*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+				

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage

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Operating Conditions: Engine operating in Closed Loop. **Parameter Normal Range:** -39 to +142°C (-38 to +288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

CIRCUIT DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and supplies a ground to the low reference circuit. The ECM monitors the mutual performance of the ECT and the intake air temperature (IAT) signals. The ECM monitors the warm up and cool down behavior of the sensors, after a vehicle driven at operating temperature is shut down. If the ECM detects that the ECT is not with in a predetermined range of IAT after a long soak, or the ECT and IAT are not within a range of each other, as compared to a previous cold start, this DTC sets.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

Condition 1

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTC P0112, P0113, P0117, P0118, P0119, or P2610 is not set.
- The engine run time of the previous ignition cycle was greater than 10 minutes.
- The calculated engine cool down of the previous test was greater than 50°C (120°F).
- The ignition was OFF for greater than 330 minutes after the previous engine shut down.
- The accumulated air mass of the previous ignition cycle was greater than 6,000 grams.
- The DTC runs once an ignition cycle when the above conditions are met for greater than 35 seconds.

Condition 2

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTCs P0112, P0113, P0117, P0118, and P0119 are not set.
- The ECT at the previous engine shut down is greater than 82°C (180°F).
- The block heater is not detected.
- The ignition was OFF for greater than 330 minutes after the previous engine shut down.
- DTC runs once an ignition cycle when the above conditions are met.

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CONDITIONS FOR SETTING THE DTC

- The ECM determines the difference between the ECT and IAT at ignition ON is not within 14°C (25°F) of the difference recorded during a previous ignition cycle, when the enable conditions were met.

  OR

- The ECM determines the IAT at ignition ON is within a calibrated range of the ECT and IAT recorded during a previous ignition cycle, but the ECT is not within 14°C (25°F) of the calibrated range.

ACTION TAKEN WHEN THE DTC SETS

DTC P0116 is a Type A/B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0116 is a Type A/B DTC.

DIAGNOSTIC AIDS

- Test the ECT and the IAT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** and **Temperature Versus Resistance - Intake Air Temperature Sensor** .
- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5° F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance in the circuits of either the ECT or IAT sensor could set a DTC.
- A short to ground or voltage through a conductive material or fluid could set this DTC. Inspect the ECT sensor for evidence of engine coolant leaking into the connector body.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0117, P0118, or P0119 is not set.
   - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Inspect the engine coolant level. Verify that the cooling system is operating correctly.
   - If you suspect a condition with engine cooling system, refer to **Loss of Coolant** .
3. Ignition ON, verify the P0116 Freeze Frame Start Up ECT and the Start Up IAT parameters are within 14°C (25°F).
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the K20 ECM.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the K20 ECM.
5. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
   - If warmer than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a

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voltage and the sensor may be damaged.

6. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the ECT sensor parameter is greater than 142°C (288°F).
    - If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature (ECT) sensor.

NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table and verify that the resistance is within 5 percent of the specification.
    - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0117 OR P0118 (W/LLT)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118, P0119	P0118, P0119*	P0116
Low Reference	-	P0118, P0119	P0118, P0119*	P0116
* Sensor or ECM damage may occur if the circuit is shorted to B+				

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. **Parameter Normal Range:** -39 to 142°C (-38 to 288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

CIRCUIT DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

P0117

- The engine is operating.
- The start up intake air temperature (IAT) is less than 72°C (161°F).

OR

- The start up intake air temperature (IAT) is greater than 72°C (161°F).
- The engine run time is greater than 59 seconds.
- The DTC runs continuously once the above conditions are met.

P0118

- The ignition is ON or the engine is operating.

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- The DTC runs continuously once the above condition is met.

CONDITIONS FOR SETTING THE DTC

P0117

The ECM detects that the ECT is greater than 140°C (284°F) for greater than 1 seconds or a cumulative of 10 seconds.

P0118

The ECM detects that the ECT is less than -39°C (-38°F) for greater than 1 seconds or a cumulative of 10 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P0117 and P0118 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0117 and P0118 are Type B DTCs.

DIAGNOSTIC AIDS

- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** .
- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5° F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance in the circuits of either the ECT or IAT sensor could set a DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling for 1 minute. Observe the DTC information with a scan tool. DTCs P0117 and P0118 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the K20 ECM.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the K20 ECM.
5. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
   - If greater than the specified value, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

6. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the ECT sensor parameter is greater than 142°C (288°F).

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- If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.

7. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature (ECT) sensor.

NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table and verify that the resistance is within 5 percent of the specification.
   - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0119 (W/LLT)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0116, P0118, P0119	P0118*, P0119*	P0116*
Low Reference	-	P0116, P0118, P0119	P0118*, P0119*	P0116*

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* Internal ECM or sensor damage may occur if the circuit is shorted to B+

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop **Parameter Normal Range:** -39 to +142°C (-38 to +288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

CIRCUIT DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and supplies a ground to the low reference circuit. The ECM monitors the performance of the ECT sensor. If the ECM detects excessive noise or rapid fluctuations in the ECT signal, this DTC sets.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

- DTC P0117 or P0118 is not set.
- The ignition is ON or the engine is operating.
- DTC P0119 runs continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the ECT changed ±5°C (±9°F) greater than the expected value during a calibrated amount of time.
- The condition exists for approximately 1 minute.

ACTION TAKEN WHEN THE DTC SETS

DTC P0119 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0119 is a Type B DTC.

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DIAGNOSTIC AIDS

- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** .
- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5° F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance on either the ECT sensor signal circuit or the ECT sensor low reference circuit could set a DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the scan tool engine coolant temperature (ECT) sensor parameter, while moving the ECT sensor connector and the K20 ECM connector. The ECT sensor parameter should not fluctuate while moving the related harnesses and connectors.
    - Repair the suspected harness or connection if the ECT parameter fluctuates greater than 3°C (5°F) while moving the related harnesses and connectors.
2. Inspect the engine coolant level. Verify that the cooling system is operating correctly.

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- If you suspect a condition with engine cooling system, refer to **Loss of Coolant** .

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the K20 ECM.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the K20 ECM.
5. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
   - If warmer than the specified value, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

6. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the ECT sensor parameter is greater than 142°C (288°F).
   - If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature (ECT) sensor.

NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table and verify that the resistance is within 5 percent of the specification.
   - If not within the specified range, replace the B34 ECT sensor.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0121-P0123 OR P0221-P0223

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0121

Throttle Position Sensor 1 Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0221

Throttle Position Sensor 2 Performance

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
		P0121, P0122,		

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5-Volt Reference	P0122, P0222, P0698	P0221, P0222, P0697, P2119, P2101	P0123, P0223, P0699, P2101, P2119	P0121, P0221, P0697, P0698, P0699
TP Sensor Signal 1	P0122	P0121, P0122, P2101, P2119	P0123	P0121, P0221, P2119
TP Sensor Signal 2	P0222	P0221, P0223	P0223, P0638, P2128, P2138	P0221
Low Reference	-	P0121, P0123, P0221, P0223, P2119, P2100	P0123, P0223*	P0121, P0221
* Internal ECM or TP sensor damage may occur if the circuit is shorted to B+				

TYPICAL SCAN TOOL DATA

TP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating in closed loop **Parameter Normal Range:** TP Position Sensor 5%/4.2 V			
5-Volt Reference	124%/0.0 V	7%/0.0 V	113%/TP 1 4.98, TP 2, 4.50 V
TP Sensor Signal 1	4%/0.00 V	7%/0.00 V	7%/0.00 V
TP Sensor Signal 2	4%/0.00 V	4%/4.98 V	27%/4.98 V
Low Reference	-	0%/4.98 V	-

CIRCUIT/SYSTEM DESCRIPTION

The throttle body assembly contains 2 throttle position (TP) sensors. The TP sensors are mounted to the throttle body assembly and are not serviceable. The TP sensors provide a signal voltage that changes relative to throttle blade angle. The engine control module (ECM) supplies the TP sensors with a common 5-volt reference circuit, a common low reference circuit, and two independent signal circuits. The TP sensors have opposite functionality. TP sensor 1 signal voltage decreases from greater than 4 volts at idle to less than 1 volt at wide open throttle (WOT). TP sensor 2 signal voltage increases from less than 1 volt at idle to greater than 4 volts at WOT.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON, with the engine OFF, or the engine is operating.
- The ignition voltage is greater than 7 volts.
- DTC P0121 runs continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0121

The ECM detects TP sensor 1 disagrees greater than 9 percent from TP sensor 2 for greater than 1 second.

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P0122

The ECM detects the TP sensor 1 signal voltage is less than 0.18 volt for greater than 1 second.

P0123

The ECM detects the TP sensor 1 signal voltage is greater than 4.6 volts for greater than 1 second.

P0221

The TP sensor 2 disagrees greater than 9 percent from TP sensor 1 for greater than 1 second.

P0222

The ECM detects the TP sensor 2 signal voltage is less than 0.16 vol for greater than 1 second.

P0223

The ECM detects the TP sensor 2 signal voltage is greater than 4.9 volts for greater than 1 second.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0121 and P0221 are Type B DTCs.
- DTCs P0122, P0123, P0222, and P0223 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

- DTCs P0121 and P0221 are Type B DTCs.
- DTCs P0122, P0123, P0222, and P0223 are Type A DTCs.

DIAGNOSTIC AIDS

If there is a condition with the TP sensors the ECM defaults to reduced power mode for the entire ignition cycle, even if the condition is corrected.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

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Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, verify that DTC P0697, P0698, or P0699 is not set.
   - If a DTC is set, refer to **DTC P0641-P0643, P0651-P0653, or P0697-P0699 (ECM)** .
2. Clear the DTC Info with a scan tool.
3. Start the engine, observe the scan tool TP Sensor 1 and 2 voltage parameters. TP sensor 1 should be between 0.17-4.6 V and TP sensor 2 should be between 0.15-4.8 V.
4. Observe the scan tool TP sensor 1 and 2 parameters while performing the tests listed below. The TP sensor 1 and 2 parameter should display Agree.
   - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
   - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
5. Observe the DTC Information with a scan tool. DTCs P0121, P0122, P0123, P0221, P0222, and P0223 should not set.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at Q38 throttle body.
2. Ignition OFF, remove the fuse that supplies B+ to terminal 56 X2 of the K20 ECM.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

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3. Test for less than 5 ohms between the low reference circuit terminal C and ground.
    - If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install fuse that supplies B+ to terminal 56 X2 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal E and ground.
    - If less than the specified range, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, verify that the scan tool TP sensor 1 voltage parameter is less than 0.3 V.
    - If greater than the specified value, test the signal circuit terminal D for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. Connect a 3 A fused jumper wire between the 5 volt reference circuit terminal E and the TP sensor 1 signal circuit terminal D. Verify the scan tool TP sensor 1 voltage parameter is greater than 4.89 V.
    - If less than the specified value, test the signal circuit for an open/high resistance or for a short to ground. If the circuit tests normal, replace the K20 ECM.
8. Verify the scan tool TP sensor 2 voltage parameter is greater than 4.97 V.
    - If less than the specified value, test the signal circuit terminal F for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage.

9. Connect a 3 A fused jumper wire between the TP sensor 2 signal circuit terminal F and the low reference circuit terminal C. Verify the scan tool TP sensor 2 voltage parameter is less than 0.10 V.
    - If greater than the specified value, test the signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
10. If all circuits test normal, replace the Q38 throttle body assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Body Assembly Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0128 (W/LLT)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

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- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

CIRCUIT DESCRIPTION

The engine control module (ECM) monitors the temperature of the engine coolant for engine control and as an enabling criteria for some diagnostics. The amount of air flow into an engine is proportional to the amount of heat an engine generates. The ECM monitors the amount of air flow into the engine to calculate engine coolant temperature (ECT). The ECM uses the calculated temperature to determine if the engine has warmed up to the closed loop temperature or to the thermostat regulating temperature. If the coolant temperature does not increase normally or does not reach the closed loop temperature, diagnostics that use the ECT as enabling criteria, may not run when expected.

CONDITIONS FOR RUNNING THE DTC

P0128

- Before the ECM can report DTC P0128 failed, DTC P0117 and P0118 must run and pass.
- DTCs P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, or P0700 is not set.
- The engine speed is greater than 760 RPM.
- The ECT is colder than 70°C (158°F) at start up.
- The vehicle speed is greater than 8 km/h (5 mph).
- The air flow coming into the engine has accumulated to greater than 1,000 grams.
- DTC P0128 runs continuously once the above conditions have been met for approximately 15 minutes.

OR

- DTCs P0116, P0117, P0118, or P0119 is not set.
- The engine speed is greater than 25 RPM.
- The block heater is not detected.
- DTC P0128 runs continuously once the above conditions have been met for approximately 8 minutes

CONDITIONS FOR SETTING THE DTC

P0128

- The ECM detects that the actual engine coolant temperature is 11°C (20°F) colder than the calculated thermostat regulating temperature of 89°C (192°F), for greater than 4 seconds or for a cumulative of 30 seconds.

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OR

- The ECM detects that the actual engine coolant temperature is 10°C (18°F) colder than the calculated ECT for greater than 1 second or a cumulative of 10 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P0128 is a Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0128 is a Type B DTCs.

DIAGNOSTIC AIDS

An engine that soaks for about 8 hours will help diagnosis the condition. After the cold soak, operate the vehicle at highway speeds for 20 minutes while monitoring the scan tool Calculated ECT - Thermostat parameter. If there is a condition, the calculated temperature will be 10°C (18°F) warmer than the actual engine coolant temperature.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

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1. Verify that the engine coolant level is correct.
   - If the engine coolant is not at the correct level, refer to **Loss of Coolant** .
2. Verify that the engine coolant temperature is at the normal operating temperature.
   - If the engine coolant temperature is colder than the normal operating temperature, refer to **Thermostat Diagnosis** .
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal X2-56 of the K20 ECM.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
   - If greater than specified value, test the circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to circuit terminal X2-56 of the K20 ECM.
5. Ignition ON, observe the scan tool the ECT sensor parameter. Verify that the ECT sensor parameter is at -40°C (-40°F).
   - If warmer than the specified value, test the signal circuit for a short to ground. If the circuit/connections test normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the ECT sensor may be damaged.

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool ECT sensor parameter is warmer than 142°C (288°F).
   - If colder than the specified value, test the signal circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
7. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

NOTE: A thermometer can be used to the used to test the sensor off the vehicle.

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2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table and verify that the resistance is within 5 % of the specification.
    - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0130 OR P0150

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0130

HO2S Circuit Closed Loop (CL) Performance Bank 1 Sensor 1

DTC P0150

HO2S Circuit Closed Loop (CL) Performance Bank 2 Sensor 1

CIRCUIT DESCRIPTION

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. Or, to detect if the HO2S signal voltage switches at the same rate at which the ECM is commanding the heater ON and OFF.

CONDITIONS FOR RUNNING THE DTC

Condition 1 and 2

- Before the ECM can report that DTC P0130 or P0150 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0133, P0135, P0153, and P0155 must run and pass.

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- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The engine is greater than 240 RPM.
- The ignition voltage is greater than 10 V.
- The HO2S 1 heater duty cycle is greater than 90 % for greater than 5 s.
- The DTCs run continuously once the conditions above exist for greater than 60 s.

Condition 3

- Before the ECM can report that DTC P0130 or P0150 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0133, P0135, P0153, and P0155 must run and pass.
- The engine is operating.
- The ignition voltage is greater than 10 V.
- The air flow into the engine has exceeded 10 grams.
- The HO2S 1 heater duty cycle is greater than 70 % or, the calculated exhaust gas temperature is warmer than 600°C (1,112°F).
- Closed loop fuel control is enabled.
- The evaporative emissions system (EVAP) is not performing an intrusive test.
- The DTCs run continuously once the conditions above exist for greater than 30 s.

CONDITIONS FOR SETTING THE DTC

Condition 1

The ECM detects that the HO2S 1 signal voltage increases to greater than 2 V within 4 mS of 4 out of 6 HO2S heater switch OFF samples.

Condition 2

The HO2S 1 voltage is between 520-1,150 mV and the corresponding HO2S 2 voltage is less than 100 mV.

Condition 3

The HO2S 1 voltage is between 60-400 mV and the corresponding HO2S 2 voltage is less than 500 mV.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0130 and P0150 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0130 and P0150 are Type B DTCs.

DIAGNOSTIC AIDS

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- The HO2S 1 voltage should be between 350-550 mV with the ignition ON. If the voltage is greater than the specified value, there is a condition with the HO2S 1 circuits. If the voltage does not change after disconnecting the HO2S, the condition is between the sensor and the ECM. If the voltage is between 350-550 mV after disconnecting the sensor, the condition is with the HO2S 1.
- Inspect the HO2S 1 harness connector for water intrusion. Moisture in a connector may cause voltage to bleed to other circuits within the connector.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the appropriate scan tool HO2S 1 voltage parameter. The HO2S 1 voltage parameter should be less than 1,025 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that the scan tool HO2S 1 voltage parameter is between 350-500 mV.
    - If greater than the specified range, test the signal circuit terminal B or 4 of the HO2S for a short to

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the heater circuit terminal E. If the circuit/connections test normal, replace the K20 ECM.

3. If all circuits/connections test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0131 OR P0151

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0131

HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0151

HO2S Circuit Low Voltage Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
HO2S Bank 1 Sensor 1 Low Reference	-	P0134, P0135	-	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Low Reference	-	P0140, P013A	-	P0140, P013A, P013E

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HO2S Bank 2 Sensor 1 Low Reference	-	P0154, P0155	-	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Low Reference	-	P0160, P013C	-	P0160, P013C, P014A

TYPICAL SCAN TOOL DATA

HO2S 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop **Parameter Normal Range:** Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	-	445-480 mV	1275 mV

CIRCUIT DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

Condition 1

- DTC P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 V.
- The engine speed is greater than 240 RPM.
- The air flow into the engine is greater than 220 grams.
- The HO2S 1 heater duty cycle is greater than 90 % for greater than 5 s.
- The evaporative emissions system (EVAP) is not performing an intrusive test.
- The ECM is not commanding the air/fuel mixture lean.
- DTC P0131 and P0151 run continuously once the conditions above exist for greater than 5 s.

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Condition 2

- DTC P0116, P0117, P0118, P0119, P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 V.
- The engine speed is greater than 240 RPM.
- The conditions for a cold start are present.
- The HO2S 1 heater duty cycle is greater than 90 % for greater than 5 s.
- DTC P0131 and P0151 run continuously once the conditions above exist.

CONDITIONS FOR SETTING THE DTC

Condition 1

The ECM detects that an HO2S 1 signal voltage is less than 60 mV while the corresponding HO2S 2 voltage is greater than 500 mV.

Condition 2

The ECM detects that an HO2S 1 signal voltage is less than 60 mV after a cold start.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0131 and P0151 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0131 and P0151 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the appropriate scan tool HO2S 1 voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that the scan tool HO2S 1 voltage parameter is between 350-500 mV.
    - If less than the specified range, test the signal circuit terminal B or 4 for a short to ground. If the circuit/connections test normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit terminal B or 4 for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
3. Install a 3 A fused jumper wire between the signal circuit terminal B or 4 and ground. Verify the HO2S voltage parameter is less than 60 mV.
    - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and the low reference circuit terminal A or 3. Verify the HO2S voltage parameter is less than 60 mV.
    - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
5. Verify that the following conditions do not exist:
    - Lean condition.
    - Low fuel system pressure-Refer to **Fuel System Diagnosis** .
    - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
    - Exhaust leaks near the HO2S.
    - Engine vacuum leaks.
    - If you find any of the above conditions, repair as necessary.
6. If all circuits/connections test normal, replace the appropriate B52 HO2S.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0132 OR P0152

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0132

HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0152

HO2S Circuit High Voltage Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
HO2S Bank 1 Sensor 1 Low Reference	-	P0134, P0135	-	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Low Reference	-	P0140, P013A	-	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Low Reference	-	P0154, P0155	-	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Low				P0160, P013C,

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Reference	-	P0160, P013C	-	P014A

TYPICAL SCAN TOOL DATA

HO2S 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop **Parameter Normal Range:** Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	-	445-480 mV	1275 mV

CIRCUIT DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

- DTC P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 V.
- The engine speed is greater than 240 RPM.
- The HO2S 1 heater duty cycle is greater than 90 % for greater than 5 s.
- The ECM is not commanding the air/fuel mixture rich.
- DTC P0132 and P0152 run continuously once the conditions above exist for greater than 5 s.

CONDITIONS FOR SETTING THE DTC

The ECM detects that an HO2S 1 signal voltage is greater than 1,150 mV.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0132 and P0152 are Type B DTCs.

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CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0132 and P0152 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the appropriate scan tool HO2S 1 voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that the scan tool HO2S 1 voltage parameter is between 350-500 mV.
    - If less than the specified range, test the signal circuit terminal B or 4 for a short to ground. If the circuit/connections test normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit terminal B or 4 for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.

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3. Install a 3 A fused jumper wire between the signal circuit terminal B or 4 and ground. Verify the scan tool HO2S 1 voltage parameter is less than 60 mV.
    - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and the low reference circuit terminal A or 3. Verify the scan tool HO2S 1 voltage parameter is less than 60 mV.
    - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
5. Verify that the following conditions do not exist:
    - Leaking fuel injectors.
    - High fuel system pressure-Refer to **Fuel System Diagnosis** .
    - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
    - Restricted exhaust.
    - If you find any of the above conditions, repair as necessary.
6. If all circuits/connections test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0133 OR P0153 (W/LLT)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0133

HO2S Slow Response Sensor 1

DTC P0153

HO2S Slow Response Bank 2 Sensor 1

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DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160
Low Reference	-	P0134, P0135, P0154, P0155	-	-

CIRCUIT DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTCS

- Before the ECM can report that DTC P0133 or P0153 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0135, and P0155 must run and pass.
- DTC P0036, P0037, P0038, P0057, P0058, P0130, P0137, P0138, P0140, P0141, P0150, P0157, P0158, P0160, P0161, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0442, P0443, P0455, P0458, P0459, P2096, P2097, P2098, P2099, P2177, P2178, P2179, P2088, P2089, P2090, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- The engine speed is 1,200-2,520 RPM.
- The closed loop fuel control is enabled.
- The engine load is 13-55 percent.
- The exhaust gas temperature is warmer than 350°C (662°F).
- The evaporative purge (EVAP) solenoid is commanded OFF, or is ON for greater than 10 seconds.
- DTC P0133 and P0153 run continuously once the conditions above exist.

CONDITIONS FOR SETTING THE DTCS

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The ECM determines that the length of time for an HO2S 1 to switch from lean to rich and back to lean, which is called a switching cycle, has exceeded a predetermined threshold. The condition exists for 3 cycles out of a 20 cycle test sample.

ACTION TAKEN WHEN THE DTCS SET

DTCs P0133 and P0153 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTCS

DTCs P0133 and P0153 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the scan tool DTC information. Verify no other DTC is not set.
    - If any other DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling, observe the scan tool HO2S 1 voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
3. Observe the DTC information with a scan tool. DTCs P0133 and P0153 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You

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may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify that none of the following conditions exist:
   - Lean or rich fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
   - Water intrusion in the HO2S harness connector
   - HO2S wiring harness damage
   - Incorrect RTV sealant
   - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
   - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks
   - Engine oil consumption
   - Engine coolant consumption
   - If you find any of the above conditions, repair as necessary.
2. If all conditions test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Control Module References** for engine control module replacement, setup, and programming

DTC P0134 OR P0154

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0134

HO2S Circuit Insufficient Activity Bank 1 Sensor 1

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DTC P0154

HO2S Circuit Insufficient Activity Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
HO2S Bank 1 Sensor 1 Low Reference	-	P0134, P0135	-	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Low Reference	-	P0140, P013A	-	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Low Reference	-	P0154, P0155	-	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Low Reference	-	P0160, P013C	-	P0160, P013C, P014A

TYPICAL SCAN TOOL DATA

Bank 1 or 2 HO2S 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop **Parameter Normal Range:** Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	-	445-480 mV	1275 mV

CIRCUIT DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

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The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTCS

Condition 1

- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 V.
- The engine speed is greater than 240 RPM.
- The HO2S 1 heater duty cycle is greater than 90 % for more than 5 s.
- DTCs P0134 and P0154 run continuously once the conditions above exist for greater than 10 s.

Condition 2

- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 V.
- The engine speed is greater than 240 RPM.
- The HO2S 1 is warmed up for greater than 30 s.
- The HO2S 1 heater duty cycle is greater than 68 %.
- DTCs P0134 and P0154 run continuously once the conditions above exist.

Condition 3

- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 V.
- The engine speed is greater than 240 RPM.
- The HO2S 1 is warmed up for greater than 30 s.
- The calculated exhaust temperature is warmer than 600°C (1,112°F).
- DTCs P0134 and P0154 run continuously once the conditions above exist.

CONDITIONS FOR SETTING THE DTCS

Condition 1

The HO2S 1 signal voltage is between 400-520 mV, or 400-550 mV when the calculated exhaust temperature is warmer than 800°C (1,472°F).

Condition 2

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The calculated internal resistance of the HO2S 1 is greater than 40,000 ohms when the calculated exhaust temperature is warmer than 600°C (1,112°F).

Condition 3

A corresponding HO2S 1 and HO2S 2 are greater than 200 mV during a decel fuel cut-off greater 3 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0134 and P0154 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0134 and P0154 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the appropriate scan tool HO2S voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure

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Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal D or 1 and ground.
    - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Ignition OFF, connect a test lamp between the heater control circuit terminal E or 2 and B+.
4. Idle the engine, and verify the test lamp illuminates or flashes.
    - If the test lamp is always OFF, test the heater control circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
5. Ignition ON, verify that the appropriate scan tool HO2S voltage parameter is between 350-500 mV.
    - If less than the specified range, test the signal circuit terminal B or 4 for a short to ground. If the circuit/connections test normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit terminal B or 4 for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
6. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.
    - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and the low reference circuit terminal A or 3. Verify the scan tool HO2S voltage parameter is less than 60 mV.
    - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
8. Verify that none of the following conditions exist:
    - The HO2S is loose
    - Lean or rich condition.
    - Water intrusion in the HO2S harness connector
    - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
    - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
    - Fuel saturation of the evaporative emission (EVAP) canister
    - Exhaust leaks near the HO2S
    - Engine vacuum leaks
    - If you find any of the above conditions, repair as necessary.
9. If all circuits/connections test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

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- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0135, P0141, P0155, OR P0161

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage Supply - HO2S Bank 1 and 2 Sensor 1	P0030, P0031, P0050, P0051	P0050, P0051, P0134, P0135, P0154, P0155	-	-
Ignition Voltage Supply - HO2S Bank 1 and 2 Sensor 2	P0036, P0037, P0056, P0057	P0036, P0037, P0056, P0057, P0140, P0160	-	-
HO2S Bank 1 Sensor 1 Heater Control	P0031	P0030, P0134	P0032	P0135
HO2S Bank 1 Sensor 2 Heater Control	P0037	P0036, P0140	P0038	P0141
HO2S Bank 2 Sensor 1 Heater				

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Control	P0051	P0050, P0154	P0052	P0155
HO2S Bank 2 Sensor 2 Heater Control	P0057	P0056, P0160	P0058	P0161

CIRCUIT DESCRIPTION

The heated oxygen sensor (HO2S) heater reduces the time required for the oxygen sensor to reach operating temperature and maintains the operating temperature during extended idle periods. When the ignition is turned to the ON position, ignition voltage is supplied directly to the sensor heater. The engine control module (ECM) controls the heater operation by first modulating the control circuit to ground when the sensors are cold. This prevents the possibility of thermal shock to the sensor, from condensation build-up on the sensor, by controlling the sensor's rate of heating. After a predetermined amount of time, the ECM commands the heaters ON continuously. Once the sensor reaches operating temperature, the ECM may modulate the heater control circuit to ground to maintain a desired temperature. The ECM controls the heater by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled up to voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

CONDITIONS FOR RUNNING THE DTC

P0135 or P0155

- Before the ECM can report DTC P0135 or P0155 failed, P0030, P0031, P0032, P0050, P0051, and P0052 must run and pass.
- DTC P0130, P0131, P0132, P0134, P0150, P0151, P0152, or P0154 is not set.
- The engine speed is greater than 240 RPM.
- The ignition voltage is 10-18 V.
- The intake air temperature (IAT) is warmer than -30°C (-22°F).
- After the previous ignition cycle the engine OFF time was greater than 0 s.
- The calculated exhaust temperature is colder than 750°C (1,382°F).
- The engine is not in decel fuel cut-off (DFCO).
- The HO2S 1 is warmed up for greater than 10 s.
- The internal HO2S 1 resistance is less than 10,000 ohms.
- The HO2S 1 heater is enabled for greater than 120 s.
- DTCs P0135 and P0155 run continuously once the above conditions are met for approximately 100 s.

P0141 or P0161

- Before the ECM can report DTC P0141 or P0161 failed, DTCs P0036, P0037, P0038, P0056, P0057, and P0058 must run and pass.
- DTCs P0137, P0138, P0140, P0157, P0158, or P0160 are not set.
- The engine is operating.
- The ignition voltage is 10-18 V.

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- The intake air temperature (IAT) is warmer than -30°C (-22°F).
- After the previous ignition cycle the engine OFF time was greater than 0 s.
- The calculated exhaust temperature is 300-700°C (572-1,292°F).
- The engine is not in decel fuel cut-off (DFCO).
- The internal HO2S 2 resistance is less than 10,000 ohms.
- The HO2S 2 heater is enabled for greater than 120 s.
- DTCs P0141 and P0161 run continuously once the above conditions are met for approximately 100 s.

CONDITIONS FOR SETTING THE DTC

P0135 or P0155

The ECM detects that the internal resistance of the HO2S 1 heater is not within the expected range for greater than 12 s.

P0141 or P0161

The ECM detects that the internal resistance of the HO2S 2 heater is not within the expected range for greater than 6 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0135, P0141, P0155, and P0161 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0135, P0141, P0155, and P0161 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: It may take up to 8 min for the DTC to set.

1. Engine at normal operating temperature, operate the engine above 1,200 RPM for 2 min and then allow the engine to idle. DTCs P0135, P0141, P0155, or P0161 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, test for B+ on the HO2S ignition voltage circuit terminal of the HO2S harness connector.
   - HO2S bank 1 sensor 1 terminal D or 1
   - HO2S bank 2 sensor 1 terminal D or 1
   - HO2S bank 1 sensor 2 terminal C or 1
   - HO2S bank 2 sensor 2 terminal C or 1, with manual transmission
   - HO2S bank 2 sensor 2 terminal D or 1, with automatic transmission
   - If less than the specified value, repair the ignition voltage circuit of the HO2S heater for a short to ground or an open/high resistance.
3. Ignition OFF, connect a test lamp between the heater control circuit terminal and B+. The test light should not illuminate.
   - HO2S bank 1 sensor 1 terminal E or 2
   - HO2S bank 2 sensor 1 terminal E or 2
   - HO2S bank 1 sensor 2 terminal D or 2
   - HO2S bank 2 sensor 2 terminal D or 2, with manual transmission
   - HO2S bank 2 sensor 2 terminal C or 1, with automatic transmission
   - If the test lamp illuminates, test the heater control circuit for a short to ground. If the circuit/connections test normal, replace the K20 ECM.
4. Idle the engine, verify the test lamp illuminates or flashes.
   - If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.

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NOTE: The control circuit for the HO2S heater is pulled-up to voltage within the ECM, 2.0-3.0 V on the control circuit is normal.

5. Ignition ON, test for 2.0-3.0 V between the control circuit terminal and ground.
   - HO2S bank 1 sensor 1 terminal E or 2
   - HO2S bank 2 sensor 1 terminal E or 2
   - HO2S bank 1 sensor 2 terminal D or 2
   - HO2S bank 2 sensor 2 terminal D or 2, with manual transmission
   - HO2S bank 2 sensor 2 terminal C or 1, with automatic transmission
   - If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
6. If all circuits/connections test normal, test or replace the appropriate B52 HO2S.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Test for 5-25 ohms between the appropriate control and the ignition terminals of the B52 HO2S.
   - HO2S bank 1 sensor 1 terminal E or 2 and D or 1
   - HO2S bank 2 sensor 1 terminal E or 2 and D or 1
   - HO2S bank 1 sensor 2 terminal D or 2 and C or 1
   - HO2S bank 2 sensor 2 terminal D or 2 and C or 1, with manual transmission
   - HO2S bank 2 sensor 2 terminal C or 1 and D or 1, with automatic transmission

   - If not within the specified range, replace the B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0137, P0138, P0140, P0157, P0158, OR P0160

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

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DTC DESCRIPTORS

DTC P0137

HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138

HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0140

HO2S Circuit Insufficient Activity Bank 1 Sensor 2

DTC P0157

HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158

HO2S Circuit High Voltage Bank 2 Sensor 2

DTC P0160

HO2S Circuit Insufficient Activity Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
HO2S Bank 1 Sensor 1 Low Reference	-	P0134, P0135	-	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Low Reference	-	P0140, P013A	-	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Low Reference	-	P0154, P0155	-	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Low Reference	-	P0160, P013C	-	P0160, P013C, P014A

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TYPICAL SCAN TOOL DATA

Bank 1 or 2 HO2S 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. **Parameter Normal Range:** Fluctuates above and below 350-500 mV.			
Sensor Signal	0-60 mV	400-455 mV	1275 mV
Low Reference	-	400-455 mV	1275 mV

CIRCUIT DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTCS

P0137 and P0157

- DTC P0036, P0037, P0038, P0056, P0057, P0058, P0116, P0117, P0118, P0119, or P0128 is not set.
- The engine speed is greater than 240 RPM.
- The ignition voltage is greater than 10 V.
- The engine coolant temperature is colder than 40°C (104°F) at start-up and the engine coolant temperature was warmer than 60°C (140°F) when the ignition was turned OFF last ignition cycle.
- The calculated exhaust temperature at the HO2S 2 is warmer than 700°C (1,292°F) and the HO2S 2 is warmed up for greater than 90 s.
- The calculated exhaust temperature is colder than 800°C (1472°F) 5 s after engine start.
- DTCs P0137 and P0157 run continuously once the above conditions are met.

P0138, P0140, P0158, and P0160

- The engine speed is greater than 240 RPM.
- The ignition voltage is greater than 10 V.
- The HO2S 2 heater duty cycle is stable and the HO2S 2 is warmed up for greater than 90 s.

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- The calculated exhaust temperature is colder than 800°C (1472°F).
- DTCs P0138 and P0158 run continuously once the above conditions are met for greater than 5 s.
- DTCs P0140 and P0160 run continuously once the above conditions are met for greater than 60 s.

CONDITIONS FOR SETTING THE DTC

P0137 or P0157

The ECM detects the HO2S 2 signal voltage is less than 60 mV for greater than 1 s of for a cumulative of 10 s.

P0138 or P0158

The ECM detects the HO2S 2 signal voltage is greater than 1,150 mV for greater than 1 s or for a cumulative of 10 s.

P0140 or P0160

- The ECM detects that the HO2S 2 signal voltage is between 401-519 mV.

  OR

- The ECM detects that the measured internal resistance of the HO2S 2 is greater than 40,000 ohms, when the calculated exhaust temperature is warmer than 500°C (932°F).
- Either condition exists for greater than 1 s or for a cumulative of 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0137, P0138, P0140, P0157, P0158, and P0160 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0137, P0138, P0140, P0157, P0158, and P0160 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the appropriate scan tool HO2S 2 voltage parameter. The reading should fluctuate above and below the range of 401-519 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that the scan tool HO2S 2 voltage parameter is between 400-520 mV.
    - If less than the specified range, test the signal circuit terminal B or 4 for a short to ground. If the circuit/connections test normal, replace the K20 ECM.
    - If greater than the specified range, test the signal circuit terminal B or 4 for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
3. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.
    - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and the low reference circuit terminal A or 3. Verify the scan tool HO2S voltage parameter is less than 60 mV.
    - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
5. Verify that the following conditions do not exist:
    - Lean, rich, or leaking fuel injectors.
    - A fuel pressure that is too low or too high-Refer to **Fuel System Diagnosis** .
    - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
    - Evidence of water intrusion into the electrical connector of the HO2S
    - The HO2S is loose

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- Exhaust leaks near the HO2S
- Engine vacuum leaks
  - If you find any of the above conditions, repair as necessary.

6. If all circuits/connections test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P013A, P013C, P013E, OR P014A

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P013A

HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013C

HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P014A

HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096,

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				P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
HO2S Bank 1 Sensor 1 Low Reference	-	P0134, P0135	-	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Low Reference	-	P0140, P013A	-	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Low Reference	-	P0154, P0155	-	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Low Reference	-	P0160, P013C	-	P0160, P013C, P014A

CIRCUIT DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTCS

- Before the ECM can reports that DTC P013A, P013C, P013E, or P014A failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0135, and P0155 must run and pass.
- DTC P0036, P0037, P0038, P0056, P0057, P0058, P0137, P0138, P0140, P0141, P0157, P0158, P0160, P0161, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0442, P0443, P0455, P0458, P0459, P2096, P2097, P2098, P2099, P2177, P2178, P2179, P2088, P2089, P2090, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- The ignition voltage is greater than 10 V.
- The HO2S 1 and 2 are in closed loop.
- The HO2S 2 resistance is less than 900 ohms.
- The HO2S 2 has switched from lean to rich during the ignition cycle.
- The calculated exhaust gas mass flow rate is greater than 2.22 g/s.

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- The calculated exhaust temperature for HO2S 2 is warmer than 450°C (842°F).
- The HO2S 1 signal voltage is less than 141 mV
- The HO2S 2 signal voltage is greater than 590 mV at the beginning of decel fuel cut-off - DTC P013E and P014A only.
- The DTCs run continuously once the conditions above exist.

CONDITIONS FOR SETTING THE DTCS

P013A or P013C

The ECM determines that the response time for the HO2S 2 to switch from greater than 400 mV to less than 200 mV is greater than 1 s. The condition exists for greater than 4 s or for a cumulative time of 30 s.

P013E or P014A

- The ECM determines the time for the HO2S 2 to transition from greater than 590 mV to less than 140 mV, during decel fuel cut-off is greater than 4 s. The condition exists for greater than 4 s or for a cumulative time of 30 s.

  OR

- The ECM determines that the air flow into the engine exceeded 15 grams before the HO2S 2 transitions to less than 140 mV, during decel fuel cut-off.

ACTION TAKEN WHEN THE DTCS SET

DTCs P013A, P013C, P013E, and P014A are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTCS

DTCs P013A, P013C, P013E, and P014A are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the scan tool DTC information. Verify no other DTC is set.
   - If any other DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling, observe the appropriate scan tool HO2S voltage parameter. The voltage should fluctuate above and below the range of 401-519 mV.
3. Observe the DTC information with a scan tool. DTC P013A, P013C, P013E, and P014A should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that the scan tool HO2S voltage parameter is between 400-520 mV.
   - If less than the specified range, test the signal circuit terminal B or 4 for a short to ground. If the circuit/connections test normal, replace the K20 ECM.
   - If greater than the specified range, test the signal circuit terminal B or 4 for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
3. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.
   - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal B or 4 and the low reference circuit terminal A or 3. Verify the scan tool HO2S voltage parameter is less than 60 mV.
   - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
5. Verify that none of the following conditions exist:
   - Lean or rich condition.
   - Water intrusion in the HO2S harness connector
   - HO2S wiring harness damage
   - Incorrect RTV sealant

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- Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
- Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks near the HO2S
- Engine vacuum leaks
- Engine oil consumption-Refer to **Oil Consumption Diagnosis** .
- Engine coolant consumption
  - If you find any of the above conditions, repair as necessary.

6. If all conditions test normal, replace the appropriate B52 HO2S.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P018B-P018D

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0641, P06A6	P018C	P018D, P0641, P06A6	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

CIRCUIT/SYSTEM DESCRIPTION

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The fuel pump control module monitors the voltage signal from the fuel pressure sensor.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- DTC P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The engine has been running for at least 5 seconds.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module does not detect a change in the fuel pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel pressure sensor performance diagnostic provides a means to detect fuel pressure sensor output that is stuck within the normal operating range of the sensor.

ACTION TAKEN WHEN THE DTC SETS

DTC P018B, P018C and P018D are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P018B, P018C and P018D are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

NOTE: Verify that the fuel tank is not empty. Only perform this diagnostic if there is at least 2 gallons of fuel in the fuel tank. Clear the DTC, and start and run the engine. Verify that the DTC P018B resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.

1. Ignition OFF, disconnect the harness connector at the B47 fuel pressure sensor.
2. Ignition OFF, test for less than 1 ohms between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
3. Ignition ON, test for 4.8-5.2 V between the B47 fuel pressure sensor 5 V reference circuit terminal 3 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
4. Verify the scan tool fuel pressure sensor voltage is less than 1 V.
    - If greater than the specified range, test the signal circuit terminal 1 for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal

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3. Verify the scan tool 5 V reference is greater than 4.8 V.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
6. If all circuits test normal, replace the B47 fuel pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P0191

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0191

Fuel Rail Pressure (FRP) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0193, P0642	P0193	P0193, P0643	P0191
FRP Sensor Signal	P0192	P0193	P0193	P0191
Low Reference	-	P0193	-	P0191

CIRCUIT/SYSTEM DESCRIPTION

The fuel rail pressure (FRP) sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5-volt reference voltage on the 5-volt reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the FRP sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

CONDITIONS FOR RUNNING THE DTC

Condition 1

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- The engine speed is greater than 25 RPM for greater than 31 seconds.
- DTC P0191 runs once an ignition cycle at engine start up when the condition has been met.

Condition 2 and 3

- The engine speed greater than 25 RPM for greater than 30 seconds.
- The engine coolant temperature (ECT) at the previous engine shut down was warmer than 72°C (162°F).
- The ECT at engine start is colder than 55°C (131°F).
- At engine start, if the ECT is warmer than the intake air temperature (IAT), then the IAT must be within 35°C (63°F) of the ECT.
- At engine start, if the IAT is warmer than the ECT, then the ECT must be within 10°C (18°F) of the IAT.
- The block heater, if equipped, is not active.
- The engine off time since the previous engine shut down is greater than 4.2 hours.
- DTC P0191 runs once an ignition cycle at engine start up when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

Condition 1

DTC P0087, P2187, or P2188 is set, and the fuel pressure at ignition ON is less than 120 kPa (17.4 psi) for greater than 4 seconds or for a cumulative of 30 seconds.

Condition 2

DTC P0088, P2177, or P2187 is set, and the fuel pressure at ignition ON is greater than 1500 kPa (218 psi) for greater than 4 seconds or for a cumulative of 30 seconds.

Condition 3

The fuel pressure at ignition ON is greater than 1500 kPa (218 psi) and a fuel pressure increase of greater than 385 kPa (56 psi) occurs during the fuel pump prime. The condition exists for greater than 4 seconds or for a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0191 is a Type A DTC.
- A message center or an indicator may display Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

DTC P0191 is a Type A DTC.

DIAGNOSTIC AIDS

A condition with the fuel tank module or the fuel pump control module (FPCM) may set this DTC.

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REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the scan tool DTC information, verify DTC P0627, P0628, P0629, P069E or U0109 is not set.
    - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling, observe the scan tool Actual Fuel Rail Pressure parameter. The pressure should be approximately 3.5-5.5 Mpa (508-798 psi).
3. Engine idling, the scan tool Actual Fuel Rail Pressure should be close to the scan tool Desired Fuel Rail Pressure. As the engine speed increases, the Desired Fuel Rail Pressure and the Actual Fuel Rail Pressure should closely match each other.
4. Move related harnesses/connectors of the FRP sensor and verify the engine does not stumble, stall, or change engine speed.
    - If the engine stumbles, stalls, or changes engine speed, test or repair the suspected harness or connection.
5. Observe the DTC information with a scan tool, DTC P0191 should not set.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure

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Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the multi-way harness connector X117 at the rear of the intake manifold.
2. Remove the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.

NOTE: Testing for steps 3 through 7 is performed on the ECM side of the multi-way harness connector.

3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 5 and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal 11 and ground.
   - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
   - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, verify the scan tool FRP sensor voltage parameter is greater than 4.96 V.
   - If less than the specified value, test the signal circuit terminal 12 for a short to ground. If the circuit tests normal, replace the ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal 12 and the low reference circuit terminal 5. Verify the scan tool FRP voltage parameter transitions from greater than 4.96 V to less than 0.02 V.
   - If the parameter does not transition from the maximum to minimum value, test the signal circuit for an open/high resistance or a short to voltage. If the circuit tests normal, replace the K20 ECM.
8. Ignition OFF, remove the intake manifold.
9. Connect the multi-way harness connector X117.

NOTE: Testing for steps 10 through 15 are performed at the FRP sensor connector.

10. Disconnect the B47 FRP sensor connector.
11. Remove the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
12. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 1 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance.
13. Install the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
14. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal 3 and ground.
    - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance.
    - If greater than the specified range, test the 5-volt reference circuit for a short to voltage.

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15. Ignition ON, verify the scan tool FRP sensor voltage parameter is greater than 4.96 V.
    - If less than the specified value, test the signal circuit terminal 2 for a short to ground.
16. Connect a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1. Verify the scan tool FRP voltage parameter transitions from greater than 4.96 V to less than 0.02 V.
    - If the parameter does not transition from the maximum to the minimum value, test the signal circuit for an open/high resistance or a short to voltage.
17. If all circuits test normal, replace the B47 FRP sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**
- **Control Module References** for ECM replacement, setup, and programming

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

DTC P2635

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P2635

Fuel Pump Flow Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The system voltage is greater than 11 V.
- The engine has been running for more than 30 seconds.
- Low fuel level warning not present.

CONDITIONS FOR SETTING THE DTC

This DTC sets when the fuel pump control module detects a predetermined fuel pressure performance

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degradation between the desired fuel rail pressure and the current fuel rail pressure.

ACTION TAKEN WHEN THE DTC SETS

DTC P2635 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P2635 is a Type B DTC.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

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1. Verify that DTCs P018C, P018D, P0231, P0232, or P023F are not set.
    - If the DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
3. Ignition OFF, test for less than 5.0 ohms between the G12 fuel pump low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the G12 fuel pump low reference circuit for a high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, install a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. Perform the **Fuel System Diagnosis** to verify proper fuel pressure.
    - If the fuel pressure is not normal, replace the G12 fuel pump
7. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Tank Fuel Pump Module Replacement - Right Side**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P2636

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P2636

Fuel Transfer Pump Flow Insufficient

CIRCUIT DESCRIPTION

The fuel tank on this vehicle is equipped with 2 fuel level sensors, one for each reservoir of the fuel tank. Fuel is

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transferred from the left side of the fuel tank to the right side of the fuel tank in order to ensure all of the usable fuel volume is available. The fuel pump supplies a small amount of pressurized fuel to the siphon jet pump through the fuel feed pipe. The pressurized fuel creates a venturi action inside the siphon jet pump. The venturi action causes the fuel to be drawn out of the left side of the fuel tank. Fuel is then transferred from the left side of fuel tank to the right side of fuel tank through the internal fuel transfer tube. This diagnostic tests for too large of a difference in fuel level between the left and right side of the fuel tank. The DTC sets if the control module determines that the right side fuel level is less than a predetermined amount of the left side fuel level.

The following table illustrates the difference between temperature, resistance, and voltage:

Fuel Level-Right or Left Sensor	Fuel Level Sensor Resistance	Fuel Level Sensor Voltage
Empty	Low	Low
Full	High	High

CONDITIONS FOR RUNNING THE DTC

- Before the engine control module (ECM) can report DTC P2636 failed, DTCs P0462, P0463, P2067, and P2068 must run and pass.
- The ignition voltage is between 10-18 volts.
- The engine speed is greater than 240 RPM.
- DTC P2636 runs continuously once the above conditions exist for greater than 4 minutes.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the right side fuel level is less than 11 percent and the left side fuel level is greater than 22 percent.

ACTION TAKEN WHEN THE DTC SETS

DTC P2636 is a Type C DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P2636 is a Type C DTC.

DIAGNOSTIC AIDS

Depending on the current fuel level, it may be difficult to locate a malfunctioning fuel level sensor. The condition may only occur when the fuel level is full or near empty. The fuel level sensor unit may need to be removed for further diagnosis. A fuel level sensor that has an intermittent condition causes this DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling for 5 minutes, observe the DTC information with a scan tool. DTC P2636 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector of the left side fuel level sensor.
2. Ignition ON, verify the scan tool Fuel Level Sensor-Left Tank voltage parameter is at 5.0 V.
    - If less than the specified range, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the ECM.
3. Install a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool Fuel Level Sensor-Left Tank voltage parameter is at 0.0 V.
    - If greater than the specified value, test the signal circuit for a high resistance. If the circuit tests normal, replace the ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal D. Verify the scan tool Fuel Level Sensor-Left Tank voltage parameter is at 0.0 V.
    - If greater than the specified value, test the low reference circuit for a high resistance. If the circuit tests normal, replace the ECM.

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5. Remove the fuel tank.
6. Remove the fuel tank primary and secondary modules and inspect for the following conditions:
    - A clogged secondary fuel strainer and pick up
    - A clogged or restricted siphon jet pump
    - Broken, clogged or restricted flex tubes, primary fuel tank module
    - Broken, clogged, disconnected, or restricted fuel transfer tube inside tank
    - If you find any of the above conditions, repair as necessary.
7. If all circuits/connections test normal, test or replace the left/secondary fuel level sensor.

COMPONENT TESTING

1. Ignition OFF, remove the left fuel level sender from the fuel tank.
2. Connect a DMM between terminal A and terminal D.
3. Verify the secondary fuel level sender resistance remains within 40-250 ohms and changes smoothly while moving the float arm from stop to stop.
    - If not within the specified range or changes erratically while moving the float arm from stop to stop, replace the fuel level sender.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Tank Draining**
- **Fuel Tank Replacement**
- **Fuel Tank Fuel Pump Module Replacement - Right Side**
- **Fuel Level Sensor Replacement - Left Side**
- **Fuel System Cleaning**
- **Control Module References** for engine control module replacement, setup, and programming

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

DTC P0192 OR P0193

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0192

Fuel Rail Pressure (FRP) Sensor Circuit Low Voltage

DTC P0193

Fuel Rail Pressure (FRP) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0193, P0642	P0193	P0193, P0643	P0191
FRP Sensor Signal	P0192	P0193	P0193	P0191
Low Reference	-	P0193	P0193, P0643	P0191

CIRCUIT/SYSTEM DESCRIPTION

The fuel rail pressure (FRP) sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5-volt reference voltage on the 5-volt reference circuit and ground on the reference ground circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the FRP sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON or the engine is running.
- The DTCs run continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

P0192

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The ECM detects that the signal circuit voltage is less than 0.3 volt for greater than 4 seconds.

P0193

The ECM detects that the signal circuit voltage is greater than 4.7 volts for greater than 4 seconds.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0192 and P0193 are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

DTCs P0192 and P0193 are Type A DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

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1. Ignition ON, observe the DTC information with a scan tool, DTC P0641, P0642, or P0643 should not be set.
    - If a DTC is set, refer to **DTC P0641-P0643, P0651-P0653, or P0697-P0699 (ECM)** .
2. Engine idling, observe the DTC information with a scan tool. DTC P0192 or P0193 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the multi-way harness connector X117 at the rear of the intake manifold.
2. Remove the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.

NOTE: Testing for steps 3 through 7 is performed on the ECM side of the multi-way harness connector.

3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 5 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal 11 and ground.
    - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
    - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, verify the scan tool FRP sensor voltage parameter is greater than 4.96 V.
    - If less than the specified value, test the signal circuit terminal 12 for a short to ground. If the circuit tests normal, replace the K20 ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal 12 and the low reference circuit terminal 5. Verify the scan tool FRP voltage parameter transitions from greater than 4.96 V to less than 0.02 V.
    - If the parameter does not transition from the maximum to minimum value, test the signal circuit for an open/high resistance or a short to voltage. If the circuit tests normal, replace the K20 ECM.
8. Ignition OFF, remove the intake manifold.
9. Connect the multi-way harness connector X117.

NOTE: Testing for steps 11 through 15 are performed at the FRP sensor connector.

10. Disconnect the B47 FRP sensor connector.
11. Remove the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
12. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 1 and ground.

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    - If greater than the specified range, test the low reference circuit for an open/high resistance.
13. Install the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
14. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal 3 and ground.
    - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance.
    - If greater than the specified range, test the 5-volt reference circuit for a short to voltage.
15. Ignition ON, verify the scan tool FRP sensor voltage parameter is greater than 4.96 V.
    - If less than the specified value, test the signal circuit terminal 2 for a short to ground.
16. Connect a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1. Verify the scan tool FRP voltage parameter transitions from greater than 4.96 V to less than 0.02 V.
    - If the parameter does not transition from the maximum to the minimum value, test the signal circuit for an open/high resistance or a short to voltage.
17. If all circuits test normal, replace the B47 FRP sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0196, P0197, OR P0198

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0196

Engine Oil Temperature Sensor Performance

DTC P0197

Engine Oil Temperature Sensor Circuit Low Voltage

DTC P0198

Engine Oil Temperature Sensor Circuit High Voltage

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DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
EOT Sensor Signal	P0198	P0196, P0197	P0197	P0197	P0196
EOT Low Reference	-	P0196, P0197	P0197	-	P0196

TYPICAL SCAN TOOL DATA

Engine Oil Temperature Sensor

Circuit	Short to Ground	High Resistance	Short to Voltage
Operating Conditions: Engine running **Parameter Normal Range:** Varies with engine oil temperature			
EOT Sensor Signal	172°C (341°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

The engine oil temperature (EOT) sensor is a variable resistor that measures the temperature of the engine oil. The engine control module (ECM) supplies 5 volts on the EOT signal circuit, and a ground to the low reference circuit.

Monitoring the engine oil temperature is necessary for optimal control of the cam actuators. The oil temperature is monitored from the dual function oil level switch and temperature sensor located in the oil pan.

CONDITIONS FOR RUNNING THE DTC

P0196

- The engine speed is greater than 25 RPM.
- The engine oil temperature EOT is between -35 to +170°C (-31 to +338°F).
- The DTC runs continuously when the above enable conditions are met for greater than 10 seconds.

P0197 and P0198

- The ignition is ON, or the engine is operating.
- The DTCs runs continuously when the above enable condition is met for greater than 2 seconds.

CONDITIONS FOR SETTING THE DTC

P0196

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The ECM detects the actual EOT is 40°C (104°F) colder than the calculated EOT of the controller, for greater than 4 seconds or a cumulative time of 30 seconds.

P0197

The ECM detects the EOT is colder than -35°C (-31°F) for greater than 4 seconds or a cumulative time of 30 seconds.

P0198

The ECM detects the EOT is warmer than 170°C (331°F) for greater than 4 seconds or a cumulative time of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0197 and P0198 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0197 and P0198 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Definitions

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

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1. Engine operating, observe DTC information with a scan tool. DTCs P0196, P0197, or P0198 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the EOT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
3. Test for less than 5 ohms between the low reference circuit terminal C and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
5. Ignition ON, verify the scan tool Engine Oil temperature Sensor parameter is colder than -35°C (-31°F).
    - If greater than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

6. Connect a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal C. Verify the scan tool EOT Sensor parameter is warmer than 171°C (340°F).
    - If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance, if the circuit tests normal, replace the ECM.
7. If all circuits test normal, replace the EOT/oil level sensor assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, OR P216D

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

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DTC DESCRIPTORS

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0205

Cylinder 5 Injector Control Circuit

DTC P0206

Cylinder 6 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

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Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P0273

Cylinder 5 Injector Control Circuit Low Voltage

DTC P0274

Cylinder 5 Injector Control Circuit High Voltage

DTC P0276

Cylinder 6 Injector Control Circuit Low Voltage

DTC P0277

Cylinder 6 Injector Control Circuit High Voltage

DTC P2146

Cylinder 1 Injector High Control Circuit

DTC P2149

Cylinder 2 Injector High Control Circuit

DTC P2152

Cylinder 3 Injector High Control Circuit

DTC P2155

Cylinder 4 Injector High Control Circuit

DTC P216A

Cylinder 5 Injector High Control Circuit

DTC P216D

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Cylinder 6 Injector High Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 1 High Voltage Control	P2146	P0201	P2146	-
Fuel Injector 1 Low Voltage Control	P0261	P0201	P0262	-
Fuel Injector 2 High Voltage Control	P2149, P216A	P0202	P2149, P216A	-
Fuel Injector 2 Low Voltage Control	P0264	P0202	P0265	-
Fuel Injector 3 High Voltage Control	P2152, P216D	P0203	P2152, P216D	-
Fuel Injector 3 Low Voltage Control	P0267	P0203	P0268	-
Fuel Injector 4 High Voltage Control	P2155	P0204	P2155	-
Fuel Injector 4 Low Voltage Control	P0270	P0204	P0271	-
Fuel Injector 5 High Voltage Control	P2149, P216A	P0205	P2149, P216A	-
Fuel Injector 5 Low Voltage Control	P0273	P0205	P0274	-
Fuel Injector 6 High Voltage Control	P2152, P216D	P0206	P2152, P216D	-
Fuel Injector 6 Low Voltage Control	P0276	P0206	P0277	-

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage control circuits. The ECM energizes each fuel injector by enabling the high voltage control circuit of the fuel injector. The ECM monitors the status of the injector high voltage control circuits and the fuel injector low control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 8-18 V.
- The injector has been commanded ON and OFF at least once.
- The DTCs run continuously once the above conditions are met.

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CONDITIONS FOR SETTING THE DTC

P0201, P0202, P0203, P0204, P0205, or P0206

The ECM detects the injector high voltage control circuit or the injector low voltage control circuit is open for greater than 4 s or for a cumulative of 30 s.

P0261, P0264, P0267, P0270, P0273, or P0276

The ECM detects the injector low voltage control circuit is shorted to ground for greater than 4 s or for a cumulative of 30 s.

P0262, P0265, P0268, P0271, P0274, or P0277

The ECM detects the injector low voltage control circuit is shorted to voltage for greater than 4 s or for a cumulative of 30 s.

P2146, P2149, P2152, P2155, P216A, or P216D

The ECM detects the injector high voltage control circuit is shorted to ground or shorted to a voltage for greater than 4 s or for a cumulative of 30 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, and P216D are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, and P216D are Type B DTCs.

DIAGNOSTIC AIDS

- The high voltage control circuits of injectors 2 and 5, and injectors 3 and 6, are paired together with a dual high side driver in the controller. A short to ground, or a short to voltage, on one of the paired circuits will set a DTC for the companion injector. The ECM will also disable the high side driver for the affected injectors.
- The high voltage circuits of injectors 1 and 4 are not paired together in the controller.
- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test** .
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Fuel Injector Circuit Test Status parameters. A Fuel Injector Circuit Test Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

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Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information. DTC P062B should not set.
    - If DTC P062B failed this ignition, refer to **DTC P062B** .
2. Observe the scan tool Current Misfire Counter parameters. The Current Misfire Counters should not increment.
3. Engine operating, observe the appropriate scan tool Injector Control Circuit Test Status parameters. Verify the Injector Control Circuit Test Status parameters display OK or Not Run.
4. Engine operating, observe the DTC information with a scan tool. DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D should not set.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition ON, clear the scan tool DTC information.

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2. Ignition OFF, disconnect the appropriate multi-way harness connector X116 or X117, at the rear of the intake manifold.

NOTE: Testing for steps 3 through 5 is performed on the ECM side of the multi-way harness connector.

3. Connect a test lamp between ground and the high voltage control circuit terminal of the appropriate Q17 injector listed below.
   - Fuel Injector 1 terminal 8 X117
   - Fuel Injector 2 terminal 2 X116
   - Fuel Injector 3 terminal 9 X117
   - Fuel Injector 4 terminal 4 X116
   - Fuel Injector 5 terminal 10 X117
   - Fuel Injector 6 terminal 6 X116
4. Crank or start the engine while observing the test lamp. The test lamp should flash several times and then stop when the DTC sets.

NOTE: Four of the injector high voltage control circuits are paired in the controller with a dual driver, refer to Diagnostic Aids.

   - If the test lamp is always ON, test the circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
   - If the test lamp is always OFF, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. Clear the DTC information with a scan tool, then cycle the ignition OFF.
6. Connect a test lamp between B+ and the low voltage control circuit terminal of the appropriate Q17 injector listed below.
   - Fuel Injector 1 terminal 2 X117
   - Fuel Injector 2 terminal 1 X116
   - Fuel Injector 3 terminal 3 X117
   - Fuel Injector 4 terminal 3 X116
   - Fuel Injector 5 terminal 4 X117
   - Fuel Injector 6 terminal 5 X116
7. Ignition ON, the test lamp should not illuminate.
   - If the test lamp is ON, test the low control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
8. Connect a test lamp between ground and the low voltage control circuit terminal of the appropriate Q17 injector listed below.
   - Fuel Injector 1 terminal 2 X117
   - Fuel Injector 2 terminal 1 X116
   - Fuel Injector 3 terminal 3 X117

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- Fuel Injector 4 terminal 3 X116
- Fuel Injector 5 terminal 4 X117
- Fuel Injector 6 terminal 5 X116

9. Ignition ON, the test lamp should not illuminate.
    - If the test lamp is ON, test the low control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
10. Clear the DTC information with a scan tool, then cycle the ignition OFF.
11. Ignition OFF, connect a test lamp between the high voltage control circuit terminal and the low voltage control circuit terminal of the appropriate Q17 injector listed below.
    - Fuel Injector 1 terminal 8 and terminal 2 X117
    - Fuel Injector 2 terminal 2 and terminal 1 X116
    - Fuel Injector 3 terminal 9 and terminal 3 X117
    - Fuel Injector 4 terminal 4 and terminal 3 X116
    - Fuel Injector 5 terminal 10 and terminal 4 X117
    - Fuel Injector 6 terminal 6 and terminal 5 X116
12. Crank or start the engine while observing the test lamp. The test lamp should flash several times and then stop when the DTC sets.
    - If the test lamp does not flash, test the low control circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE: Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.

13. Ignition OFF, measure the resistance between the appropriate high voltage control circuit and ground. The DMM should display OL ohms.
    - If less than the specified range, test the high voltage control and the low voltage control circuit, for a short to ground. If the circuits/connections test normal, test or replace the appropriate fuel injector (s).
14. Test for 1.5-2.5 ohms between the appropriate high voltage control and low voltage control circuit.
    - If less than the specified range, test for a short between the high voltage and low voltage control circuit. If the circuits/connections test normal, test or replace the appropriate fuel injector(s).
    - If greater than the specified range, test the high voltage and low voltage control circuit, for an open/high resistance. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector.

COMPONENT TESTING

1. Remove the intake manifold and disconnect the appropriate Q17 fuel injector.
2. Verify the resistance of each Q17 fuel injector with one of the following methods:
    - If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each fuel injector should be 1.25-1.75 ohms.

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- If not within the specified range, replace the Q17 fuel injector.

3. If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each Q17 fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 0.45 ohms.

- If the difference is more than 0.45 ohms, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the Q17 fuel injector that displays the greatest difference above or below the average.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Injector Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0219

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0219

Engine Overspeed Condition

CIRCUIT/SYSTEM DESCRIPTION

This DTC is used to indicate that the engine speed exceeded the fuel cutoff limit in gear. This DTC may set if the transmission is placed in a low gear while driving down a steep grade or traveling at a high speed.

CONDITIONS FOR RUNNING THE DTC

- The DTC is valid for manual transmissions only.
- The engine is running.
- Ignition voltage is between 10-18 volts.

CONDITIONS FOR SETTING THE DTC

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The ECM detects the engine speed is greater than 7,000 RPM for greater than 1 second.

ACTION TAKEN WHEN THE DTC SETS

DTC P0219 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0219 is a Type A DTC.

CIRCUIT/SYSTEM VERIFICATION

NOTE: This DTC is used for information only. This DTC does NOT indicate there is a condition with the crank sensor or the engine control module (ECM).

DTC P0219 is an informational DTC.

DTC P0231, P0232, OR P023F

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

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CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

P0231, P023F

The ignition voltage is between 9-18 V.

P0232

The control enable voltage signal supplied for the ECM to fuel pump control module is inactive for 4 seconds after engine has been shut off.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects a fault on the fuel pump voltage circuit that is less than 11 V or greater than 18 V.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0231, P0232, and P023F are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0231, P0232, and P023F are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

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Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

Ignition ON, command the fuel pump ON and OFF using the scan tool ECM fuel pump output control. The fuel pump should turn ON and OFF.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Ignition ON, command the G12 fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF, as commanded.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the G12 fuel pump ON with a scan tool. The test lamp should illuminate.
    - If the test lamp does not illuminate, test the low reference circuit terminal 2 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. If all circuits test normal, replace the G12 fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

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- **Fuel Pump Replacement**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P025A

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P025A

Fuel Pump Control Module Enable Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
FPCM Control	P025A	P025A	-	P025A

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

The ignition is ON.

CONDITIONS FOR SETTING THE DTC

The serial data message from the ECM to the fuel pump control module does not agree with the state of the control enable voltage signal supplied from the ECM to the fuel pump control module for more than 2 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P025A is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

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DTC P025A is a Type A DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module.
2. Ignition OFF, connect a test lamp between the control circuit terminal 20 and ground.
3. Ignition ON, command the ECM fuel pump enable command ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

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Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM or fuel pump control module replacement, setup, and programming

DTC P029D, P02A1, P02A5, P02A9, P02AD, OR P02B1

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P029D

Cylinder 1 Injector Leak Detected

DTC P02A1

Cylinder 2 Injector Leak Detected

DTC P02A5

Cylinder 3 Injector Leak Detected

DTC P02A9

Cylinder 4 Injector Leak Detected

DTC P02AD

Cylinder 5 Injector Leak Detected

DTC P02B1

Cylinder 6 Injector Leak Detected

CIRCUIT/SYSTEM DESCRIPTION

The fuel injectors are mounted in the cylinder head beneath the intake ports and spray fuel directly into the combustion chamber. Direct injection requires high fuel pressure due to the fuel injector's location in the combustion chamber. High pressure fuel is regulated by the fuel rail pressure (FRP) regulator, which is a part of the high pressure fuel pump. The engine control module (ECM) monitors the actual fuel rail fuel pressure via the FRP sensor and commands the FRP regulator duty cycle in order to maintain the desired fuel rail pressure. If a fuel injector delivers more fuel than is needed misfire counts will accumulate on that cylinder, and the ECM

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will not be able to maintain the desired fuel rail pressure, indicating a stuck open or leaking fuel injector.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is between 1,520-6,000 RPM
- The engine load is less than 100 percent.
- The misfire monitor is enabled.
- DTCs P029D, P02A1, P02A5, P02A9, P02AD, and P02B1 run continuously once the conditions above have been met for approximately 20 seconds.

CONDITIONS FOR SETTING THE DTC

The ECM detects a specific cylinder misfire rate of greater than 100 counts in less than 17 engine revolutions, and P0087 is set. The condition exists for greater than 4 seconds or for a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P029D, P02A1, P02A5, P02A9, P02AD, and P02B1 are Type A DTCs.
- The control module commands the engine to operate in the Reduced Engine Power mode.
- The message center displays Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

DTCs P029D, P02A1, P02A5, P02A9, P02AD, and P02B1 are Type A DTCs.

DIAGNOSTIC AIDS

A fuel injector leak into the combustion chamber may result in mechanical damage to the cylinder.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

CIRCUIT/SYSTEM VERIFICATION

1. Clear the DTC information with a scan tool.
2. Engine operating, raise the engine speed to 2,000 RPM. Observe the DTC information with a scan tool. DTC P029D, P02A1, P02A5, P02A9, P02AD, or P02B1 should not set.
    - If a DTC failed this ignition, test or replace the appropriate Q17 fuel injector.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Fuel Injector Replacement

DTC P0300-P0306

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

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DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

DTC P0305

Cylinder 5 Misfire Detected

DTC P0306

Cylinder 6 Misfire Detected

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses information from the crankshaft position (CKP) sensor and the camshaft position (CMP) sensors in order to determine when an engine misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. A misfire rate that is high enough can cause 3-way catalytic converter damage. The malfunction indicator lamp (MIL) will flash ON and OFF when the conditions for catalytic converter damage are present. DTCs P0301 through P0306 correspond to cylinders 1 through 6. If the ECM is able to determine that a specific cylinder is misfiring, the DTC for that cylinder will set, and the corresponding fuel injector is disabled. The ECM will re-enable the fuel injector after 4 crankshaft revolutions when the misfire is not current. The ECM will re-enable the fuel injector after 8 crankshaft revolutions when the misfire is not current, if the vehicle is equipped with a manual transmission.

CONDITIONS FOR RUNNING THE DTC

- DTC P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336, or P0338 is not set.
- The engine speed is between 420-7,000 RPM and steady.
- The evaporative emissions (EVAP) leak detection is not active.
- The delivered torque signal is greater than 5 percent at idle.
- The delivered torque signal is between 6-29 percent with the transmission in drive.
- The intake air temperature (IAT) is warmer than -30°C (-22°F).
- The A/C compressor clutch is not changing states.
- The ECM is not receiving a rough road signal.
- The fuel level is greater than 11 percent.
- The ECM is not in fuel cut-off or decel fuel cut-off mode.

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- The increase in engine speed is less than 2,500-4,600 RPM/second.
- DTCs P0300 through P0306 run continuously when the above conditions exist for greater than 1,000 engine revolutions. 200 revolutions after the first failure.

CONDITIONS FOR SETTING THE DTC

P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value.

P0301, P0302, P0303, P0304, P0305, P0306

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0300, P0301, P0302, P0303, P0304, P0305, and P0306 are Type A (MIL flashing) or Type B1 DTCs.
- The ECM disables the fuel injector of the misfiring cylinder when a misfire is present.

CONDITIONS FOR CLEARING THE DTC

DTCs P0300, P0301, P0302, P0303, P0304, P0305, and P0306 are Type A (MIL flashing) or Type B1 DTCs.

DIAGNOSTIC AIDS

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the following possible sources:
  - A tire or wheel that is out of round or out of balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft
  - Certain rough road conditions
  - Transmission operation
  - A damaged accessory drive component or belt
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault if a condition exists.

REFERENCE INFORMATION

Schematic Reference

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Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 26792:** Spark Tester
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling at the normal operating temperature.
    - If there is an abnormal engine noise, refer to **Symptoms - Engine Mechanical** .
2. Verify that DTC P0011, P0014, P0021, P0024, P0087, P0088, P0089, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P029D, P02A1, P02A5, P02A9, P02AD, P02B1, P0335, P0336, P0338, P0351-P0356, P069E, P2088, P2090, P2092, P2094, P2146, P2149, P2152, P2155, P216A, P216D, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 is not set.
    - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Observe the scan tool Misfire Current Cyl. 1-6 parameters. The Misfire Current Counters should not be incrementing.
4. Engine idling, perform the cylinder power balance test with a scan tool to isolate the misfiring cylinder. The engine speed should change when each injector is disabled.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

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1. Verify that the following conditions do not exist:
   - Vacuum hose splits, kinks, and incorrect connections
   - Engine vacuum leaks
   - Crankcase ventilation system for vacuum leaks
   - Fuel pressure that is too low or too high-Refer to **Fuel System Diagnosis** .
   - Contaminated Fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)** .
   - Exhaust system restrictions
   - If you find any of the above conditions, repair as necessary.
2. Ignition OFF, remove the T8 ignition coil of the misfiring cylinder, but leave the electrical connector connected.
3. Inspect the ignition coil boot for the following conditions:
   - Holes
   - Tears
   - Carbon tracking
   - Oil contamination
   - water intrusion
   - If you find any of the above conditions, repair as necessary.
4. Install the **J 26792:** Spark Tester to the boot of the appropriate T8 ignition coil and ground.

NOTE: An erratic or weak spark is considered a no spark condition.

5. Attempt to start the engine and observe the **J 26792:** Spark Tester. The spark tester should spark.
   - If there is no spark, refer to **Electronic Ignition System Diagnosis** for diagnosis of the ignition coil.
6. Ignition OFF, remove the spark plug from the misfiring cylinder. Verify that the spark plug does not exhibit the following conditions:
   - Gas, coolant, or oil fouled-Refer to **Spark Plug Inspection** .
   - Cracked, worn, incorrectly gapped-Refer to **Ignition System Specifications** .
   - If there is a condition with the spark plug, replace the spark plug.
7. Exchange the suspected spark plug with another cylinder that is operating correctly.
8. Engine idling, observe the scan tool Misfire Current Counter parameters. The misfire should not follow the spark plug exchange.
   - If the misfire follows the spark plug, replace the spark plug.
9. If all conditions test normal, test or inspect for the following:
   - A lean or rich Q17 fuel injector.
   - An engine mechanical condition-Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

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- **Spark Plug Replacement**
- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**

REPAIR VERIFICATION

1. If the customer concern was a flashing malfunction indicator lamp (MIL), refer to **DTC P0420 or P0430**.
2. Clear the DTCs with a scan tool.
3. Turn OFF the ignition for 30 seconds.
4. Start the engine.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
    - If the DTC fails this ignition, a misfire still exists.

DTC P0324

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0324

Knock Sensor Module Performance

CIRCUIT/SYSTEM DESCRIPTION

The knock sensor (KS) is a piezoelectric device that produces an AC voltage of different amplitude and frequency depending on the level of engine mechanical vibration. The KS system monitors the knock sensor in order to determine if detonation or spark knock is present. If the KS system determines that excessive knock is present, the engine control module (ECM) retards the spark timing based on the signal from the KS system. The KS produces an AC signal when specific frequencies are detected. The ECM then retards the timing until knock is controlled.

The ECM tests the functionality of the internal knock sensor signal evaluation circuitry. The KS circuitry within the ECM is responsible for receiving, amplifying, filtering, and evaluating the AC voltage and frequency from the knock sensors. The ECM performs three tests that determine if the internal circuitry within the ECM is functioning correctly.

Test One

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The ECM internally turns OFF the knock sensor signal circuits. The ECM then applies different test signals to the internal KS circuitry to verify that each test signal output response is within range. If the ECM detects that any of the test signals are not within range, this DTC sets.

Test Two

The ECM internally turns OFF the knock sensor signal circuits. The ECM then tests for any output response when no test signals are applied. If the ECM detects an output response, this DTC sets.

Test Three

The ECM internally turns OFF the knock sensor signal circuits. The ECM generates an internal test pulse and monitors the return signal. If the return test pulse is less than a calibrated threshold, this DTC sets.

CONDITIONS FOR RUNNING THE DTC

- The ECM is controlling spark.
- The engine coolant temperature is warmer than 60°C (140°F).
- DTC P0324 runs continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects an incorrect response to the self tests performed on the internal KS circuitry.
- The condition exists for greater than 1 second or for a cumulative of 10 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0324 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTCs P0324 is a Type B DTC.

REFERENCE INFORMATION

Description and Operation

Electronic Ignition System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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CIRCUIT/SYSTEM VERIFICATION

NOTE: If you can hear an engine knock, repair the engine mechanical condition before proceeding with this diagnostic. Refer to Symptoms - Engine Mechanical .

1. Observe and record the Freeze Frame/Failure Records for DTC P0324.
   - If DTC P0335, P0336, or P0338 also set, refer to **DTC P0335, P0336, or P0338**.
2. Clear the DTCs with a scan tool.
3. Turn OFF the ignition for 30 seconds.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - If DTC P0324 failed this ignition, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0326, P0327, P0328, P0331, P0332, OR P0333

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0326

Knock Sensor Performance Bank 1

DTC P0327

Knock Sensor Circuit Low Voltage Bank 1

DTC P0328

Knock Sensor Circuit High Voltage Bank 1

DTC P0331

Knock Sensor Performance Bank 2

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DTC P0332

Knock Sensor Circuit Low Voltage Bank 2

DTC P0333

Knock Sensor Circuit High Voltage Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The knock sensor (KS) is a piezoelectric device that produces an AC voltage of different amplitude and frequency depending on the level of engine mechanical vibration. The KS system monitors the knock sensor in order to determine if detonation or spark knock is present. If the KS system determines that excessive knock is present, the engine control module (ECM) retards the spark timing based on the signal from the KS system. The KS produces an AC signal when specific frequencies are detected. The ECM then retards the timing until knock is controlled.

In order to differentiate between normal engine noise and spark knock, the ECM samples the KS signal. The ECM samples the KS signal for a certain length of time under different engine speeds and loads during non-cylinder knock events. This sampling is used to determine a range of acceptable normal engine noise.

CONDITIONS FOR RUNNING THE DTC

P0326 and P0331

- Before the ECM can report DTC P0326 or P0331 failed, DTCs P0324, P0335, P0336, and P0338 must run and pass.
- DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 is not set.
- The engine coolant temperature (ECT) sensor is warmer than 60°C (140°F).
- The engine speed is greater than 2,200 RPM.
- DTCs P0326 and P0331 run continuously once the above conditions are met for approximately 20 seconds.

P0327, P0328, P0332, and P0333

- Before the ECM can report DTC P0327, P0328, P0332, or P0333 failed, DTCs P0324, P0335, P0336, and P0338 must run and pass.
- DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 is not set.
- The engine coolant temperature (ECT) sensor is warmer than 60°C (140°F).
- The increase in engine speed is less than a range of 500-2300 RPM per second.
- The increase in engine load is less than a range of 50-100 kPa per second.
- DTCs P0327, P0328, P0332, and P0332 run continuously once the above conditions are met for approximately 20 seconds.

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CONDITIONS FOR SETTING THE DTC

P0326 and P0331

The ECM detects a short to ground or a voltage on the KS signal circuits in 25 of 250 test samples. The condition exists for greater than 1 second or for a cumulative of 10 seconds.

P0327 or P0332

The ECM detects the KS signal voltage is less than the calculated minimum for a predetermined engine noise level. The condition exists during 2 consecutive tests, for greater 1 second or a cumulative of 10 seconds.

P0328 or P0333

The ECM detects the KS signal voltage is greater than the calculated maximum for a predetermined engine noise level. The condition exists during 2 consecutive tests, for greater 1 second or a cumulative of 10 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0326, P0327, P0328, P0331, P0332, and P0333 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0326, P0327, P0328, P0331, P0332, and P0333 are Type B DTCs.

DIAGNOSTIC AIDS

- Inspect the KS for physical damage. A KS that is dropped or damaged may cause a DTC to set.
- Inspect the KS for proper installation. A KS that is loose or over torqued may cause a DTC to set. The KS should be free of thread sealant. The KS mounting surface should be free of burrs, casting flash, and foreign material.
- The KS must be clear of hoses, brackets, and engine electrical wiring.
- The normal voltage on the KS signal and low reference circuits is 2.43 volts when the KS is disconnected.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine at operating temperature, all accessories OFF. Engine speed greater than 2,000 RPM, observe the appropriate scan tool KS signal voltage parameter. The voltage should be greater than 4 V.
2. Engine idling, move the related harnesses and connectors for the KS circuits while observing the scan tool KS signal voltage parameters. The voltage should remain steady with no abrupt changes.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B68 KS.

   NOTE: If the voltage is not within the specified range on either circuit, test for a wire to wire short, to ground or voltage between the KS circuits.

2. Ignition ON, test for 2-3 V between the signal circuit terminal 1 and ground.
   - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuits/connections test normal, replace the K20 ECM.
   - If greater than the specified range, test the signal circuit for a short to voltage. If the circuits/connections test normal, replace the K20 ECM.
3. Test for 2-3 V between the low reference circuit terminal 2 and ground.
   - If less than the specified range, test the low reference circuit for a short to ground or an open/high resistance. If the circuits/connections test normal, replace the K20 ECM.
   - If greater than the specified range, test the low reference circuit for a short to voltage. If the circuits/connections test normal, replace the K20 ECM.
4. If all circuits/connections test normal, replace the B68 KS sensor.

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REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Knock Sensor Replacement - Bank 1**
- **Knock Sensor Replacement - Bank 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0335, P0336, OR P0338

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

DTC P0338

Crankshaft Position Sensor Circuit High Duty Cycle

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0122, P0222, P0335, P0698, P2127	P0335, P0697	P0335, P0338, P0699	P0336, P0697, P0698, P0699
Crankshaft Position Sensor Signal	P0122, P0222, P0335, P0698, P2127	P0335	P0335, P0338, P0699	P0336, P0698, P0699
Low Reference	P0335	P0335	-	P0336

CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position sensor is located on the rear of bank 1 of the engine block. The crankshaft position

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sensor is a hall effect switch that works in conjunction with a 58X reluctor wheel that is attached to the crankshaft. Each tooth on the reluctor wheel is spaced 6 degrees apart with one span having a 12 degree space. The engine control module (ECM) uses the 12 degree space to determine top dead center (TDC) for cylinders 1 and 4. The ECM determines when cylinder 1 is on the compression stroke by monitoring the crankshaft position sensor and the camshaft position sensors. The ECM can synchronize the ignition timing, fuel injector timing, and spark knock control based on the crankshaft position sensor and the camshaft position sensor inputs.

CONDITIONS FOR RUNNING THE DTC

- The engine is cranking or operating.
- The ECM has detected greater than 12 camshaft revolutions.
- The DTC P0335 and P0336 run continuously once the above conditions are met for greater than 5 s.
- The DTC P0338 runs once each engine revolution once the above conditions are met for greater than 2 s.

CONDITIONS FOR SETTING THE DTC

P0335

- The ECM does not detect a signal from the crankshaft position sensor.

  OR

- The ECM detects a crankshaft position signal without a reference pulse for greater than 6 revolutions.

P0336

- The ECM re-syncs the engine position greater than 2,600 times during an ignition cycle.

  OR

- The ECM detects 28 or more interruptions in the engine speed signal during an ignition cycle.

P0338

The ECM detects a difference of greater than 250 teeth between reference gap position pulses.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0335, P0336, and P0338 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0335, P0336, and P0338 are Type A DTCs.

DIAGNOSTIC AIDS

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The following conditions could also set the DTCs:

- Physical damage to the crankshaft position sensor or the reluctor wheel
- Excessive play or looseness of the crankshaft position sensor or the reluctor wheel
- Improper installation of the crankshaft position sensor or the reluctor wheel
- Foreign material passing between the crankshaft position sensor and the reluctor wheel
- Excessive air gap between the crankshaft position sensor and the reluctor wheel
- The ECM uses the camshaft position sensors to determine engine speed and position when there is a crankshaft position sensor condition.
- The engine will operate with a crankshaft position sensor condition only if the ECM has stored the learned reference position of the camshafts in memory. With a crankshaft position sensor condition the engine will go into a limp home mode after a restart. The ECM then calculates engine speed from one of the camshaft position sensors.
- An intermittent condition in the camshaft position sensor circuits may cause a crankshaft position DTC to set. Inspect the camshaft position sensor, harness connections, and related wiring, if you suspect this condition.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. DTC P0697, P0698, or P0699 should not be set.
    - If a DTC is set, refer to **DTC P0641-P0643, P0651-P0653, or P0697-P0699 (ECM)** .
2. Clear the DTC Info with a scan tool. Attempt to start the engine, observe the DTC information with a scan tool. DTC P0335, P0336, or P0338 should not set.
3. Observe the scan tool Crankshaft Position Resync parameter, the parameter should always display zero. Move the related harnesses/connectors of the crankshaft position sensor while observing the parameter, verify the engine does not stumble, or stall, and the parameter does not increment.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, remove the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
2. Disconnect the harness connector at the B26 crankshaft position sensor.
3. Test for 5 ohms or less between the low reference circuit terminal 1 and ground.
    - If greater than the specified range, test for an open/high resistance in the low reference circuit. If the circuits/connections test normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
5. Ignition ON, test for greater than 4.8 V between the 5 V reference circuit terminal 3 and the low reference circuit terminal 1.
    - If less than the specified value, test the 5 V reference circuit for a short to ground or for an open/high resistance. If the circuits/connections test normal, replace the K20 ECM.
    - If greater than the specified value, test the 5 V reference circuit for a short to voltage. If the circuits/connections test normal, replace the K20 ECM.
6. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
    - If the voltage is greater than specified range, test for a short to voltage in the signal circuit. If circuit/connections test normal, replace the K20 ECM.
    - If the voltage is less than the specified range, test for a short to ground or an open/high resistance in the signal circuit. If circuit/connections test normal, replace the K20 ECM.
7. If all circuits/connections test normal, test or replace the B26 crankshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368,

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P0391, P0392, OR P0393

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0341

Intake Camshaft Position Sensor Performance Bank 1

DTC P0342

Intake Camshaft Position Sensor Circuit Low Voltage Bank 1

DTC P0343

Intake Camshaft Position Sensor Circuit High Voltage Bank 1

DTC P0346

Intake Camshaft Position Sensor Performance Bank 2

DTC P0347

Intake Camshaft Position Sensor Circuit Low Voltage Bank 2

DTC P0348

Intake Camshaft Position Sensor Circuit High Voltage Bank 2

DTC P0366

Exhaust Camshaft Position Sensor Performance Bank 1

DTC P0367

Exhaust Camshaft Position Sensor Circuit Low Voltage Bank 1

DTC P0368

Exhaust Camshaft Position Sensor Circuit High Voltage Bank 1

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DTC P0391

Exhaust Camshaft Position Sensor Performance Bank 2

DTC P0392

Exhaust Camshaft Position Sensor Circuit Low Voltage Bank 2

DTC P0393

Exhaust Camshaft Position Sensor Circuit High Voltage Bank 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Camshaft Position Sensor 5 V Reference	P0343, P0348, P0368, P0393, P0652, P2122, P2138	P0343, P0348, P0368, P0393, P0651	P0653, P2123, P2138	P0341, P0346, P0366, P0391, P0651, P0652, P0653, P2138
Camshaft Position Sensor Signal Intake Bank 1	P0342	P0343	P0343	P0341
Camshaft Position Sensor Signal Intake Bank 2	P0347	P0348	P0348	P0346
Camshaft Position Sensor Signal Exhaust Bank 1	P0367	P0368	P0368	P0366
Camshaft Position Sensor Signal Exhaust Bank 2	P0392	P0393	P0393	P0391
Low Reference	-	P0343, P0348, P0368, P0393	-	P0341, P0346, P0366, P0391

CIRCUIT/SYSTEM DESCRIPTION

Each camshaft is equipped with a camshaft position sensor that the engine control module (ECM) monitors. The camshaft position sensor is a hall effect switch that works in conjunction with a 4X reluctor wheel. The reluctor wheels are mounted to the camshaft position actuators that are mounted to the end of the camshafts. The ECM uses the camshaft position sensor signals in order to determine the position of the camshafts. The ECM supplies 5 V to the camshaft position sensors on the 5 V reference circuits, and supplies a ground on the low reference circuits. The camshaft position sensors provide a signal to the ECM on the signal circuits. If the ECM detects extra or missing camshaft position sensor signal transitions, or a signal voltage that is more or less than the predetermined range, within a certain number of crankshaft revolutions, one of these DTCs sets.

CONDITIONS FOR RUNNING THE DTC

- The ECM detects greater than 10 crankshaft revolutions.
- The engine speed is less than 2,520 RPM.

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- The DTCs run continuously once the above condition is met.

CONDITIONS FOR SETTING THE DTC

P0341, P0346, P0366, P0391

- The ECM detects a signal from the camshaft position sensor, but the number of pulses are less than or greater than what is expected for one crankshaft revolution.

  OR

- The camshaft position sensor does NOT correlate to the crankshaft position.
- Either condition must exist for greater than 1 s, or cumulative of 10 s.

P0342, P0347, P0367, P0392

The camshaft position sensor signal voltage is always low and the ECM detects no pulses from the camshaft position sensor for greater than 1 s, or cumulative of 10 s.

P0343, P0348, P0368, P0393

The camshaft position sensor signal voltage is always high and the ECM detects no pulses from the camshaft position sensor for greater than 1 s or cumulative of 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, and P0393 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, and P0393 are Type B DTCs.

DIAGNOSTIC AIDS

The following conditions can also set the DTC:

- Physical damage to the camshaft position sensor or the reluctor wheel
- Excessive play or looseness of the camshaft position sensor or the reluctor wheel
- Improper installation of the camshaft position sensor or the reluctor wheel
- Foreign material passing between the camshaft position sensor and the reluctor wheel
- Excessive air gap between the camshaft position sensor and the reluctor wheel

REFERENCE INFORMATION

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Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. DTC P0651, P0652 or P0653 should not be set.
   - If a DTC is set, refer to **DTC P0641-P0643, P0651-P0653, or P0697-P0699 (ECM)** .
2. Engine idling, observe the DTC information with a scan tool. DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, remove the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
2. Disconnect the harness connector at the appropriate B23 camshaft position sensor.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to B+ voltage.

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3. Test for less than 5 ohms between the low reference circuit terminal 1 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
5. Ignition ON, test for greater than 4.8 V between the 5 V reference circuit terminal 3 and ground.
    - If less than the specified value, test the 5 V reference circuit for an open/high resistance. If the circuits/connections test normal, replace the K20 ECM.
6. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
    - If greater than specified range, test for a short to voltage in the signal circuit. If circuit/connections test normal, replace the K20 ECM.
    - If less than the specified range, test for a short to ground or an open/high resistance in the signal circuit. If circuit/connections test normal, replace the K20 ECM.
7. If all circuits/connections test normal, replace the B23 camshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, OR P2316 (W/LLT)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

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DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P0355

Ignition Coil 5 Control Circuit

DTC P0356

Ignition Coil 6 Control Circuit

DTC P2300

Ignition Coil 1 Control Circuit Low Voltage

DTC P2301

Ignition Coil 1 Control Circuit High Voltage

DTC P2303

Ignition Coil 2 Control Circuit Low Voltage

DTC P2304

Ignition Coil 2 Control Circuit High Voltage

DTC P2306

Ignition Coil 3 Control Circuit Low Voltage

DTC P2307

Ignition Coil 3 Control Circuit High Voltage

DTC P2309

Ignition Coil 4 Control Circuit Low Voltage

DTC P2310

Ignition Coil 4 Control Circuit High Voltage

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DTC P2312

Ignition Coil 5 Control Circuit Low Voltage

DTC P2313

Ignition Coil 5 Control Circuit High Voltage

DTC P2315

Ignition Coil 6 Control Circuit Low Voltage

DTC P2316

Ignition Coil 6 Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage - Bank 1	P0300-P0306, P2300, P2306, P2312	P0300-P0306, P0351, P0353, P0355	-	P0300, P0301, P0303, P0305
Ignition Voltage - Bank 2	P0300-P0306, P2303, P2309, P2315	P0300-P0306, P0352, P0354, P0356	-	P0300, P0302, P0304, P0306
Ignition Coil 1 Control Circuit	P2300	P0301, P0351	P2301	P0300, P0301
Ignition Coil 2 Control Circuit	P2303	P0302, P0352	P2304	P0300, P0302
Ignition Coil 3 Control Circuit	P2306	P0303, P0353	P2307	P0300, P0303
Ignition Coil 4 Control Circuit	P2309	P0304, P0354	P2310	P0300, P0304
Ignition Coil 5 Control Circuit	P2312	P0305, P0355	P2313	P0300, P0305
Ignition Coil 6 Control Circuit	P2315	P0306, P0356	P2316	P0300, P0306

CIRCUIT/SYSTEM DESCRIPTION

The ignition system on this engine uses individual ignition coils and ignition control (IC) circuits for each cylinder. Ignition voltage is supplied to each bank of ignition coils. The engine control module (ECM) controls the ignition system operation. The ECM controls each coil using the IC circuits. The ECM commands the IC circuit low when a spark event is requested.

The sequencing and timing are ECM controlled.

CONDITIONS FOR RUNNING THE DTC

- The engine is operating.
- The ignition voltage is between 10-18 volts.

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- The engine speed is less than 6,000 RPM.
- The DTCs run continuously once per crankshaft revolution after the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0351-P0356

The ECM detects the ignition control circuit is open for greater than 4 seconds or a cumulative of 30 seconds.

P2300, P2303, P2306, P2309, P2312, or P2315

The ECM detects the ignition control circuit is shorted to ground for greater than 4 seconds or a cumulative of 30 seconds.

P2301, P2304, P2307, P2310, P2313, or P2316

The ECM detects the ignition control circuit is shorted to voltage for greater than 4 seconds or a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, and P2316 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, and P2316 are Type B DTCs.

DIAGNOSTIC AIDS

- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause this DTC to set.
- If the condition is intermittent, moving the related harnesses and connectors, with the engine operating, while monitoring the appropriate scan tool Misfire Current Cylinder, or the IC Circuit Test Status parameter may help to isolate the condition. An IC Circuit Test Status parameter will change from OK or Not Run to Fault if a condition is present.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

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Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Operate the engine for 30 seconds. Observe the DTC information with a scan tool. DTC P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 should not set.
2. Engine operating, observe the scan tool IC Circuit Test Status parameters, the IC Circuit Test Status parameters should display OK or Not Run.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate T8 ignition coil.

   NOTE: The ignition circuit supplies voltage to other components. Make sure you test all circuits for a short to ground or test all components for being shorted that share the ignition circuit.

2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
   - If the test lamp does not illuminate, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition voltage circuit and replace as necessary.
3. Crank or start the engine. Test for 200-400 mV between the appropriate IC circuit terminal C and ground.
   - If less than the specified range, test the circuit for a short to ground or an open/high resistance. If

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the circuit/connection tests normal, replace the K20 ECM.
    - If greater than the specified range, test the circuit for a short to voltage. If the circuit/connection tests normal, replace the K20 ECM.
4. Connect a test lamp between the each of the ground circuits terminal A, and terminal B, and B+. The test lamp should illuminate on each circuit.
    - If the test lamp does not illuminate, test the suspected circuit for an open/high resistance.
5. If all circuits/connections test normal, replace the T8 ignition coil.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0420 OR P0430

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0420

Catalyst System Low Efficiency Bank 1 - Right Side

DTC P0430

Catalyst System Low Efficiency Bank 2 - Left Side

CIRCUIT/SYSTEM DESCRIPTION

A 3-way catalytic converter (TWC) controls emissions of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The catalyst within the converter promotes a chemical reaction, which oxidizes the HC and the CO that are present in the exhaust gas. This process converts the HC and the CO into water vapor and carbon dioxide (CO2), and reduces the NOx, converting the NOx into nitrogen. The catalytic converter also stores oxygen. The engine control module (ECM) monitors this process by using a heated oxygen sensor (HO2S) that is in the exhaust stream after the TWC. The HO2S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while

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monitoring the HO2S 2. When the catalyst is functioning properly, the HO2S 2 response to the extra fuel is slow compared to the response of the HO2S 1, which is located before the TWC. When the HO2S 2 response is near that of the HO2S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0420 or P0430 failed, DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, P0058, P0100, P0101, P0102, P0103, P0121, P0122, P0123, P0131, P0132, P0133, P0135, P0137, P0138, P0140, P0141, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P0221, P0222, P0223, P0335, P0336, P0338, P2096, P2097, P2098, P2099, P2195, P2196, P2197, P2198, P2232, P2235, P2237, P2240, P2243, P2247, P2251, P2254, P2270, P2271, P2272, P2273, P2297, P2298, P2626, and P2629 must run and pass.
- DTC P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0030, P0031, P0032, P0050, P0051, P0052, P0100, P0101, P0102, P0103, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P013A, P013C, P013E, P0130, P0131, P0132, P0133, P0135, P0137, P0138, P014A P0140, P0141, P0150, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P0221, P0222, P0223, P0300, P0301-P0306, P0443, P0455, P0458, P0459, P0496, P0497, P2088, P2089, P2090, P2091, P2092, P2093, P2094, P2095, P2096, P2097, P2098, P2099, P2100, P2101, P2107, P2119, P2122, P2123, P2127, P2128, P2138, P2176, P2177, P2178, P2179, P2180, P2187, P2188, P2189, P2190, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- The engine speed is between 1,040-2,360 RPM.
- The engine load is between 17-60 percent.
- The air flow into the engine is between 4-21 g/s and steady.
- The ambient air temperature is warmer than -30°C (-22°F).
- The HO2S 2 is at operating temperature for greater than a range of 140-210 seconds.
- The engine is operating in Closed Loop.
- The calculated TWC temperature is between 480-760°C (896-1,400°F) and steady for greater than 5 seconds.
- The above conditions exist for approximately 17 minutes.
- DTCs P0420 and P0430 run once a drive cycle. The ECM will attempt to run this diagnostic up to 3 times per drive cycle.

CONDITIONS FOR SETTING THE DTC

The ECM determines the oxygen storage capacity (OSC) of the catalyst has degraded below a calibrated threshold. The DTC sets when the condition exists during the sample period, then a 5 second delay for the MIL.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0420 and P0430 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0420 and P0430 are Type A DTCs.

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DIAGNOSTIC AIDS

Inspect for the following conditions, which may cause a catalytic converter to degrade:

- An engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- A weak or poor spark
- A lean fuel mixture
- A rich fuel mixture
- A damaged oxygen sensor or wiring harness

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Observe the DTC information with a scan tool. Verify there are no HO2S, fuel system, or misfire DTCs set.
    - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnosis the applicable DTC, before proceeding with this diagnostic procedure.
2. Verify the following conditions do not exist with the catalytic converter:

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- Dents
- A severe discoloration caused by excessive temperatures
- Road damage
- An internal rattle caused by damaged catalyst substrate
- Restrictions
  - If a condition is found, repair as necessary.

3. Verify the following conditions do not exist with the exhaust system:
   - Leaks
   - Physical damage
   - Loose or missing hardware
   - Improperly torqued HO2S
     - If a condition is found, repair the exhaust system.
4. Verify the following conditions do not exist with the HO2S 2:
   - A grounded wiring harness
   - Damage
     - If a condition is found, replace the HO2S 2.
5. If no physical condition is detected and the HO2S 2 is as active as the HO2S 1 after operating the engine at 1,500 RPM for 1 minute and then returning to a stabilized idle, then replace the appropriate catalytic converter.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Catalytic Converter Replacement - Left Side (LLT)** or **Catalytic Converter Replacement - Left Side (L99/LS3)**
- **Catalytic Converter Replacement - Right Side (LLT)** or **Catalytic Converter Replacement - Right Side (L99/LS3)**

DTC P0442

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0442

Evaporative Emissions (EVAP) System Small Leak Detected

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CIRCUIT/SYSTEM DESCRIPTION

The engine off natural vacuum (EONV) test is the small leak detection diagnostic for the evaporative emission system. This diagnostic tests the Evaporative Emission (EVAP) system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the engine control module (ECM) using the fuel tank pressure sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

CONDITIONS FOR RUNNING THE DTC

NOTE: The following conditions must be met prior to ignition OFF.

- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0128, P0443, P0446, P0449, P0450, P0451, P0452, P0453, P0455, P0458, P0459, P0496, P0497, P0498, P0499, P0560, P0562, P0563, P0700, P2227, P2228, or P2229 is not set.
- The ignition voltage is greater than 11 V.
- A refueling event is not detected.
- The EVAP purge solenoid valve command is less than 26 %.
- The engine coolant temperature (ECT) during the previous ignition was greater than 74°C (165°F).
- The ambient air temperature (AAT) is between 2-32°C (35-90°F).
- The engine coolant temperature (ECT) is less than 42°C (108°F) at start-up.
- The ECT and the IAT are within 10°C (18°F) of each other at engine start-up.
- The barometric pressure (BARO) is greater than 68 kPa.
- The vehicle has traveled greater than 5 km (3 mi) this trip.
- The fuel level is between 11-88 %.
- The vehicle traveled greater than 8 km (5 mi).
- The engine run time is greater than 10 min.
- DTC P0442 runs once per engine off cycle when the above conditions have been met prior to engine shut down.

CONDITIONS FOR SETTING THE DTC

The control module detects approximately 6 vacuum/pressure changes significantly less than a calibrated amount. The condition exists during the engine OFF test, then a 5 s delay for the MIL after engine start up.

ACTION TAKEN WHEN THE DTC SETS

DTC P0442 is a Type A DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0442 is a Type A DTC.

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DIAGNOSTIC AIDS

- The evaporative emission system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. When injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed then close the system and continue testing.
- To help locate intermittent leaks using the **J 41413-200:** EEST, move all evaporative emission components while observing smoke with the **J 41413-SPT:** White Light.
- Individual components can be isolated and tested using adapters in the **J 41413-300:** Kit.
- A condition may exist where a leak in the evaporative emission system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the evaporative emission system and then observe the fuel tank pressure parameter for vacuum decay.

REFERENCE INFORMATION

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096:** EVAP Service Port Access Tool
- **J 41413-SPT:** High Intensity White Light
- **J 41413-VLV:** EVAP Port Vent Fitting Tool
- **J 41413-200:** Evaporative Emissions System Tester (EEST)
- **J 41413-300:** EVAP Cap and Plug Kit
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM TESTING

NOTE:

- **Refer to the J 41413-200: EEST operation manual for detailed instructions in Evaporative Emission System Diagnosis .**

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- **Larger volume fuel tanks and/or those with lower fuel levels may require several min for the floating indicator to stabilize.**
- **Ensure that the underbody temperature of the vehicle and the tester are similar.**

1. Disconnect the purge tube at the quick connector on the evaporative emission canister side of the Q12 evaporative emission canister purge solenoid valve and install the **CH 48096:** Port Tool.
2. Connect the **J 41413-200:** EEST to the **CH 48096:** Port Tool.
3. Using a scan tool close the evaporative emission canister vent solenoid valve to seal the evaporative emission system.
4. Use the flow meter on the **J 41413-200:** EEST, calibrated to 0.51 mm (0.020 in) to determine that there is no leak in the evaporative emission system.
    - If a leak is detected, use the **J 41413-200:** EEST to apply smoke to the evaporative emission system at the purge tube until the leak is located using the **J 41413-SPT:** White Light.

REPAIR VERIFICATION

1. Seal the EVAP system and use the flow meter on the **J 41413-200:** EEST, calibrated to 0.51 mm (0.020 in) to verify there is no leak in the EVAP system.
2. Clear DTCs.

DTC P0443, P0458, OR P0459

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit

DTC P0458

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit Low Voltage

DTC P0459

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0443, P0458	P0443	-	-
EVAP Canister Purge Valve Control Circuit	P0458	P0443	P0459	-

CIRCUIT/SYSTEM DESCRIPTION

The evaporative emission (EVAP) canister purge valve is used to purge fuel vapor from the EVAP canister to the intake manifold. The EVAP canister purge valve is pulse width modulated (PWM). Ignition voltage is supplied directly to the EVAP canister purge valve. The engine control module (ECM) controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 volts.
- The ECM has commanded the EVAP canister purge valve ON and OFF at least once during the ignition cycle.
- The DTCs run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0443

The ECM detects the EVAP canister purge solenoid control circuit is open. The condition exists for 4 seconds or a cumulative of 30 seconds.

P0458

The ECM detects the EVAP canister purge solenoid control circuit is shorted to ground. The condition exists for 4 seconds or a cumulative of 30 seconds.

P0459

The ECM detects the EVAP canister purge solenoid control circuit is shorted to voltage. The condition exists for 4 seconds or a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P0443, P0458 and P0459 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

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DTC P0443, P0458 and P0459 are Type B DTCs.

DIAGNOSTIC AIDS

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool EVAP Purge Solenoid Circuit Test Status parameters for the component. A circuit test status parameter changes from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, command the EVAP purge solenoid valve to 50 % with a scan tool. You should hear an audible click.
2. Engine operating, observe the scan tool EVAP Purge Solenoid Circuit Test Status parameters. Verify the parameters display OK or Not Run.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the Q12 EVAP purge solenoid Valve.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal 1 and ground.
    - If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.
3. Connect a test lamp between the control circuit terminal 2 and the ignition voltage circuit terminal 1.

NOTE: The control circuit for the EVAP purge solenoid is pulled-up to voltage within the ECM, 2.6-4.6 volts on the control circuit is normal.

4. Command the EVAP purge solenoid valve to 50 % and then to 0 % with a scan tool. The test lamp should illuminate or flash and then go OFF.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. Test for 2.6-4.6 V between the control circuit terminal 2 and the K20 ECM housing.
    - If the voltage is not within the specified range, replace the K20 ECM.
6. If all circuits test normal, test or replace the Q12 EVAP purge solenoid.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the Q12 EVAP purge solenoid valve. Test for 15-20 ohms between the terminals of the Q12 EVAP purge solenoid valve.
    - If not within the specified range, replace the Q12 EVAP purge solenoid valve.
2. Measure the resistance between each terminal of the Q12 EVAP purge solenoid valve and the EVAP purge solenoid valve housing. The DMM should display OL.
    - If less than the specified value, replace the Q12 EVAP purge solenoid.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0446

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

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- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0446

Evaporative Emissions (EVAP) Vent System Performance

CIRCUIT/SYSTEM DESCRIPTION

The control module tests the evaporative emission (EVAP) system for a restricted or blocked vent path. The ECM detects a blockage or restriction by commanding the purge valve ON (open) and the vent valve ON (closed) allowing a vacuum to be applied to the EVAP system. Once a calibrated vacuum level has been reached, the control module commands the purge valve OFF (closed) and the vent valve OFF (open) while monitoring the fuel tank pressure (FTP) sensor for a decrease in vacuum.

The following table illustrates the relationship between the ON and OFF states, and the OPEN or CLOSED states of the EVAP canister purge and vent valves.

Control Module Command	EVAP Canister Purge Valve	EVAP Canister Vent Valve
ON	Open	Closed
OFF	Closed	Open

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0446 failed, DTCs P0450, P0451, P0452, and P0453 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0221, P0222, P0223, P0443, P0449, P0451, P0452, P0453, P0458, P0459, P0496, P0497, P0498, P0499, P0560, P0562, P0563, P0700, P2122, P2123, P2127, P2128 or P2138 is not set.
- The ignition voltage is 10-18 V.
- The Closed Loop fuel control is enabled.
- The engine run time is greater than 10 min or the fuel trim is stable.
- The engine is idling.
- The FTP is between -18.7 and +9.8 mm Hg (-10.0 and +5.2 in. H2O).
- The ambient air temperature (AAT) is between 2-32°C (35-90°F).
- The ECT and the IAT are within 10°C (18°F) of each other at engine start-up.
- The barometric pressure (BARO) is greater than 68 kPa.
- The long term fuel trim remains steady, less than 3 % change in 200 ms over a period of 8 s.
- The fuel level is between 11-88 %.
- The vehicle speed sensor (VSS) is less than 3 km/h (2 mph).
- The above conditions exist for greater than 5 s.

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- DTC P0446 will attempt to run up to 10 times or until the test completes successfully once per ignition cycle.

CONDITIONS FOR SETTING THE DTC

- The FTP is less than -7.5 mm Hg (-4.0 in. H2O).
- The condition is exists for greater than 4 s or a cumulative of 30 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0446 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0446 is a Type B DTC.

DIAGNOSTIC AIDS

An intermittent condition could be caused by a damaged EVAP vent housing, a temporary blockage at the EVAP vent valve inlet or a pinched vent hose. A blockage in the vent system may also cause a poor fuel fill problem.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON and fuel cap removed, verify that the Fuel Tank Pressure Sensor parameter is between 1.3-

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1.7 volts.
    - If not within the specified range, go to the fuel tank pressure sensor section in Circuit/System Testing.
2. Install the fuel cap.
3. With the engine running, the EVAP canister vent solenoid valve open, use a scan tool to command the EVAP canister purge solenoid valve to 100 percent. The fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H2O).
    - If the fuel tank vacuum is greater than the specified range, go to the restriction section in Circuit/System Testing.
4. Using the scan tool, decrease the canister purge duty cycle from 100 percent to 0 percent. The vacuum should decrease to near zero.
    - If the fuel tank vacuum does not return to zero or appears to decrease too slowly go to the restriction section in Circuit/System Testing.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: Perform the Circuit/System Verification before proceeding with the Circuit/System Testing.

Restriction

1. With the engine running, the EVAP canister vent solenoid valve open, and the EVAP canister purge solenoid valve commanded to 100 percent, the fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H2O).
    - If the fuel tank vacuum is greater than the specified value, isolate the restriction by disconnecting one component at a time while the EVAP canister purge solenoid valve is commanded to 100 percent and the vent valve is open.
2. Using the scan tool, decrease the canister purge duty cycle from 100 percent to 0 percent. The vacuum should decrease to near zero.
    - If the fuel tank vacuum does not return to zero, or appears to decrease too slowly, inspect the components in the EVAP vent system for a restriction.

Fuel Tank Pressure Sensor

1. Ignition OFF, disconnect the harness connector at the fuel tank pressure sensor.
2. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the fuel tank pressure sensor.

REPAIR PROCEDURES

Evaporative Emission Canister Vent Solenoid Valve Replacement

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REPAIR VERIFICATION

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

With the engine running, the EVAP canister vent solenoid valve open and the EVAP canister purge solenoid valve commanded to 100 percent, the fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H2O).

DTC P0449, P0498, OR P0499

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0449

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit

DTC P0498

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit Low Voltage

DTC P0499

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0499	P0498	-	-
EVAP Canister Vent Solenoid Valve Control Circuit	P0498	P0449	P0499	-

CIRCUIT/SYSTEM DESCRIPTION

The evaporative emission (EVAP) canister vent valve is used for EVAP system diagnostics. The EVAP canister vent valve is a normally open valve. Battery positive voltage is supplied directly to the EVAP canister vent valve. The engine control module (ECM) controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. If the ECM detects the control circuit voltage is within a predetermined range when the

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circuit is commanded OFF, this DTC sets.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 volts.
- The ECM has commanded the EVAP canister vent valve ON and OFF at least once during the ignition cycle.
- The DTCs runs continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0449

The ECM detects the voltage on the EVAP canister vent valve control circuit is between 2.6-4.6 volts when the driver is commanded OFF. The condition exists for less than 4 seconds or for a cumulative of 30 seconds.

P0498

The ECM detects the voltage on the EVAP canister vent valve control circuit is less than 2.6 volts when the driver is commanded OFF. The condition is present for greater than 4 seconds or for a cumulative of 30 seconds.

P0499

The ECM detects the voltage on the EVAP canister vent valve control circuit is greater than 4.6 volts when the driver is commanded ON. The condition is present for greater than 4 seconds or for a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0449, P0498 and P0499 are Type B DTCs.
- The EVAP system will only purge during open loop.

CONDITIONS FOR CLEARING THE DTC

DTC P0449, P0498 and P0499 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

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Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Command the EVAP vent solenoid valve ON and OFF with the scan tool. An audible click should be heard when changing between the commanded states.
2. Start the engine, observe the scan tool EVAP Vent Solenoid Valve Circuit Test Status parameters. The circuit test status parameters should display OK or Not Run.
3. Engine Idling, observe the DTC information with a scan tool. DTC P0449, P0498, or P0499 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the Q13 EVAP vent solenoid valve harness connector.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal B and ground.
    - If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.
3. Ignition OFF, connect a test lamp between the control circuit terminal A and the ignition voltage circuit terminal B.

NOTE: The control circuit for the EVAP vent solenoid valve is pulled-up to voltage within the ECM, 2.6-4.6 volts on the control circuit is normal.

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4. Ignition ON, command the scan tool EVAP vent solenoid valve ON and OFF. The test lamp should turn ON and OFF.
    - If the test lamp remains ON all the time, test the control circuit for a short to ground. If circuit/connections test normal, replace the K20 ECM.
    - If the test lamp remains OFF all the time, test the control circuit for a short to voltage or an open/high resistance. If circuit/connections test normal, replace the K20 ECM.
5. Test for 2.6-4.6 V between the control circuit terminal 2 and ground.
    - If not within the specified range, replace the K20 ECM.
6. If all circuits/connections test normal, test or replace the Q13 EVAP vent solenoid valve.

COMPONENT TESTING

1. Ignition OFF, disconnect the Q13 EVAP vent solenoid valve harness connector.
2. Test for 20-24 ohms between the terminals of the Q13 EVAP vent solenoid valve.
    - If not within the specified range, replace the Q13 EVAP vent solenoid valve.
3. Measure the resistance between each terminal of the Q13 EVAP vent solenoid valve and the Q13 EVAP vent solenoid valve housing. The DMM should display O.L.
    - If less than the specified value, replace the Q13 EVAP vent solenoid valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0450 OR P0451

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0450

Fuel Tank Pressure Sensor Circuit

DTC P0451

Fuel Tank Pressure Sensor Performance

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TYPICAL SCAN TOOL DATA

FTP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop at idle **Parameter Normal Range:** 0.2-4.8 V			
5 V Reference Voltage	0 V	0 V	5 V
FTP Sensor Signal	0 V	0 V	5 V
Low Reference	-	4.2 V	-

CIRCUIT/SYSTEM DESCRIPTION

The control module monitors the fuel tank pressure (FTP) sensor signal in order to detect vacuum decay and excess vacuum during the evaporative emission (EVAP) diagnostic test. The control module supplies a 5 V reference and a low reference circuit to the FTP sensor. This DTC sets if the engine control module (ECM) detects one of the following conditions:

- The FTP sensor signal voltage is not within a calibrated range on a cold start-up.
- The FTP sensor signal oscillates greater than a calibrated amount when vehicle speed is within a predetermined range.

The following table illustrates the relationship between FTP sensor signal voltage and the EVAP system pressure/vacuum.

FTP Sensor Signal Voltage	Fuel Tank Pressure
High, Approximately 1.5 V or More	Negative Pressure/Vacuum
Low, Approximately 1.5 V or Less	Positive Pressure

CONDITIONS FOR RUNNING THE DTC

P0450

- DTC P0100, P0101, P0102, P0103, P0116, P0117, P0118, P0119, P0443, P0449, P0458, P0459, P0498, P0499, P0506, P0507, P050A, P0700, P2227, P2228, or P2229 is not set.
- The engine is operating.
- The ambient air temperature is greater than -7°C (+19°F).
- The vehicle speed is less than 30 km/h (19 mph).
- The ECM has commanded the EVAP canister vent valve open for greater than 4 s.
- DTC P0450 runs continuously when the above conditions are met for approximately 25 s.

P0451 Condition 1

- DTC P0100, P0101, P0102, P0103, P0116, P0117, P0118, P0119, P0443, P0449, P0458, P0459, P0498, P0499, P050A, P0506, P0507, P0700, P2227, P2228, or P2229 is not set.

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- The engine is operating for greater than 1 s.
- The engine is idling.
- The ambient air temperature is warmer than -7°C (+19°F).
- The vehicle speed is less than 10 km/h (6 mph) for greater than 30 s.
- The BARO is greater than 68 kPa.
- The fuel level is between 11-88 %.
- The ECM has commanded the EVAP canister purge solenoid ON.
- The ECM has commanded the EVAP canister vent valve closed for greater than 4 s.
- DTC P0451 runs continuously when the above conditions are met for approximately 25 s.

P0451 Condition 2

- DTC P0100, P0101, P0102, P0103, P0116, P0117, P0118, P0119, P0443, P0449, P0458, P0459, P0498, P0499, P050A, P0506, P0507, P0700, P2227, P2228, or P2229 is not set.
- The engine is operating.
- The BARO is greater than 68 kPa.
- The ECM has commanded the EVAP canister purge solenoid OFF.
- The ECM has commanded the EVAP canister vent valve open.

OR

- The vehicle speed is between 10-76 km/h (6-47 mph) for greater than 30 s.
- The fuel level is between 11-73 %.
- The EVAP purge solenoid is commanded ON.

OR

- The calculated ambient air temperature is 4-35°C (39-95°F) for greater than 3 s.
- DTC P0451 runs continuously when the above conditions are met for approximately 7 s.

CONDITIONS FOR SETTING THE DTC

P0450

The ECM detects that the FTP sensor signal oscillates greater than 6.09 mm/Hg (3.26 in. H2O) for 4 s, or for a cumulative of 30 s.

P0451

- The ECM detects that the FTP is less than -26.2 mm/Hg (-14.1 in. H2O) or greater than 11.0 mm/Hg (5.9 in. H2O) for 4 s or for a cumulative of 30 s.

OR

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- The ECM detects a change in the zero point of FTP sensor signal greater than +/-5.16 mm/Hg (2.76 in. H2O) from the zero point at start up for 4 s, or a cumulative of 30 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0450 and P0451 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0450 and P0451 are Type B DTCs.

DIAGNOSTIC AIDS

A blocked or clogged EVAP canister vent solenoid valve, or inlet may set these DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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- **J 41413-200:** Evaporative Emissions System Tester (EEST)
- **J 41415-30:** Fuel Tank Adapter
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, remove the fuel fill cap. Connect the **J 41415-30:** Adapter to the fuel tank filler neck. Connect the **J 41413-200:** EEST to the **J 41415-30:** Adapter.
2. Ignition ON, seal the EVAP system using the scan tool Purge/Seal function.
3. Pressurize the EVAP system with nitrogen to 9.33 mm/Hg (5 in/H2O). Compare the scan tool Fuel Tank Pressure Sensor parameter to the **J 41413-200:** EEST pressure/vacuum gage. Verify the scan tool FTP sensor parameter is within +/-0.9 mmHg (+/-0.5 in.H2O) of the pressure/vacuum gauge.
    - If not within the specified range, replace the B150 FTP sensor.
4. Command the Q13 EVAP vent solenoid valve OPEN with a scan tool. Verify the scan tool FTP sensor parameter is -0.9 to +0.9 mmHg (-0.5 to +0.5 in.H2O).
    - If not within the specified range, replace the B150 FTP sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Fuel Tank Pressure Sensor Replacement

DTC P0452 OR P0453

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0452

Fuel Tank Pressure Sensor Circuit Low Voltage

DTC P0453

Fuel Tank Pressure Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

	Short to	Open/High	Short to	Signal

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Circuit	Ground	Resistance	Voltage	Performance
5 V Reference	P0122, P0452, P0642	P0452, P0641	P0453, P0643	P0641, P0642, P0643
FTP Sensor Signal	P0452	P0452	P0453	-
Low Reference	-	P0446	-	-

TYPICAL SCAN TOOL DATA

FTP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop at idle **Parameter Normal Range:** 0.2-4.8 V			
5 V Reference	0 V	0 V	5 V
FTP Sensor Signal	0 V	0 V	5 V
Low Reference	-	4.2 V	-

CIRCUIT/SYSTEM DESCRIPTION

The evaporative emission (EVAP) system is used to store fuel vapors in order to reduce the amount of fuel vapors into the atmosphere. The fuel tank pressure (FTP) sensor is only used for EVAP system diagnostics. The FTP sensor is a transducer that varies resistance according to changes in the fuel tank pressure. The engine control module (ECM) monitors the FTP sensor signal in order to detect vacuum decay and excess vacuum during the EVAP system diagnostic test. The ECM supplies a 5 V reference and a low reference circuit to the FTP sensor.

FTP Sensor Signal Voltage	Fuel Tank Pressure
High, Approximately 1.5 V or More	Negative Pressure/Vacuum
Low, Approximately 1.5 V or Less	Positive Pressure

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 240 RPM.
- The DTCs run continuously once the above conditions are met for 10 s.

CONDITIONS FOR SETTING THE DTC

P0452

The ECM detects the FTP sensor signal voltage is less than 0.2 V for 4 s, or a cumulative of 30 s.

P0453

The ECM detects the FTP sensor signal voltage is greater than 4.85 V for 4 s, or a cumulative of 30 s.

ACTION TAKEN WHEN THE DTC SETS

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DTC P0452 and P0453 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0452 and P0453 are Type B DTCs.

DIAGNOSTIC AIDS

If a shared 5 V reference circuit is shorted to ground or shorted to a voltage, other 5 V reference circuits may be affected.

REFERENCE INFORMATION

Schematic Reference

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. DTC P0641, P0642 or P0643 should not be set.
    - If a DTC is set, refer to **DTC P0641-P0643, P0651-P0653, or P0697-P0699 (ECM)** .
2. Observe the FTP Sensor voltage parameter. The FTP sensor voltage should be between 0.2-4.8 V.

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3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, remove the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
2. Disconnect the multi-way harness connector X305, located near the fuel tank.
3. Test for less than 5 ohms between the low reference circuit terminal P and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 56-X2 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal B and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
6. Observe the scan tool B150 FTP sensor parameter. Verify that the FTP Sensor parameter is less than 5 V.
    - If greater than the specified value, test the signal circuit terminal E for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
7. Install a 3 A fused jumper wire between the signal circuit terminal C and the 5 V reference circuit terminal B. Verify that the scan tool FTP Sensor parameter is greater than 5 V.
    - If less than the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
8. Remove the fuel tank. Refer to **Fuel Tank Replacement** .
9. Disconnect the B150 FTP sensor connector.
10. Inspect the FTP sensor circuits in the fuel tank harness, between the FTP sensor connector and X305 for the following conditions, and repair as necessary:
    - Damaged wiring or terminals
    - Open circuits
    - Short to ground
    - Wire to wire short
11. If all circuits/connections test normal, test or replace the B150 FTP sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Tank Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0455 OR P0497

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DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0455

Evaporative Emission (EVAP) System Large Leak Detected

DTC P0497

Evaporative Emission (EVAP) System No Flow During Purge

CIRCUIT/SYSTEM DESCRIPTION

The control module tests the evaporative emission (EVAP) system for a large leak, or a stuck closed EVAP canister purge valve. The control module monitors the fuel tank pressure (FTP) sensor signal to determine the EVAP system vacuum level. When the conditions for running are met, the control module commands the EVAP canister purge valve OPEN and the EVAP vent valve CLOSED. This allows engine vacuum to enter the EVAP system. At a calibrated time, or vacuum level, the control module commands the EVAP canister purge valve closed, sealing the system, and monitors the FTP sensor input in order to determine the EVAP system vacuum level. If the system is unable to achieve the calibrated vacuum level, or the vacuum level increases too slowly, a DTC sets.

FTP Sensor Signal Voltage	Fuel Tank Pressure
High, Approximately 1.5 V or More	Negative Pressure/Vacuum
Low, Approximately 1.5 V or Less	Positive Pressure

The following table illustrates the relationship between the ON and OFF states, and the OPEN or CLOSED states of the EVAP canister purge and vent valves.

Control Module Command	EVAP Canister Purge Valve	EVAP Canister Vent Valve
ON	Open	Closed
OFF	Closed	Open

Conditions for Running the DTC

- Before the engine control module (ECM) can report DTC P0455 or DTC P0497 failed, DTCs P0446 and P0496 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0443, P0446, P0449, P0450, P0451, P0452, P0453, P0458, P0459, P0496, P0498, P0499, P0560, P0562, P0563, P0700, P2122, P2123, P2127, P2128, P2138, P2227, P2228, or P2229 is not set.

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- The ignition voltage is between 10-18 V.
- The engine run time is greater than 10 min or the fuel trim is stable.
- The FTP is between -18.7 and +9.8 mm Hg (-10.0 and +5.2 in. H2O).
- The Closed Loop fuel control is enabled.
- The engine is idling.
- The barometric pressure (BARO) is greater than 68 kPa.
- The fuel level is between 11-88 %.
- The ambient air temperature (IAT) is between 2-32°C (36-90°F).
- The engine coolant temperature (ECT) is within 10°C (18°F) of the ambient air temperature at engine start.
- The vehicle speed sensor (VSS) is less than 3 km/h (2 mph).
- The above conditions are met for greater than 30 s.
- DTC P0455 or DTC P0497 will attempt to run up to 10 times or until the test completes successfully once per ignition cycle.

CONDITIONS FOR SETTING THE DTC

- The ECM detects the EVAP system is not able to achieve or maintain vacuum during the diagnostic test.
- The condition exists for greater than 4 s or for a cumulative of 30 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0455 is a Type B DTC.
- DTC P0497 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

- DTC P0455 is a Type B DTC.
- DTC P0497 is a Type A DTC.

DIAGNOSTIC AIDS

- A loose, missing, or damaged fuel fill cap can cause this DTC to set.
- A stuck closed, blocked, or restricted EVAP canister purge solenoid valve, can cause this DTC to set.
- A blockage or restriction in the EVAP canister purge solenoid valve vacuum supply hose, EVAP canister purge solenoid valve purge pipe, EVAP canister, or vapor pipe, can cause this DTC to set.
- A temporary blockage in the EVAP canister purge solenoid valve, purge pipe or EVAP canister could cause an intermittent condition. Inspect and repair any restriction in the EVAP system.
- To help locate intermittent leaks, use the **J 41413-200:** EEST to introduce smoke into the EVAP system. Move all EVAP components while observing smoke with the **J 41413-SPT:** White Light. Introducing smoke in 15 s intervals will allow less pressure into the EVAP system. When the system is less pressurized, the smoke will sometimes escape in a more condensed manner.

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- To improve the visibility of the smoke exiting the EVAP system, observe the suspected leak area from different angles with the **J 41413-SPT:** White Light.
- Observe the Freeze Frame/Failure Records vehicle mileage since the diagnostic test last failed may help determine how often the condition occurs that caused the DTC to set. This may assist in diagnosing the condition.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Description and Operation

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DTC Type Reference

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-48096:** EVAP Service Port Access Tool
- **J 41413-200:** Evaporative Emissions System Tester (EEST)
- **J 41413-300:** EVAP Cap and Plug Kit
- **J 41413-SPT:** High Intensity White Light
- **J 41413-VLV:** EVAP Port Vent Fitting Tool
- **J-41415-30:** Fuel Tank Adapter
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify the following conditions do not exist in the EVAP system:
    - Loose, incorrect, missing, or damaged fuel fill cap
    - Loose, missing, or damaged service port schrader valve, if equipped
    - A damaged Q12 EVAP canister purge solenoid valve

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- Disconnected, incorrectly routed, kinked, or damaged EVAP pipes and hoses
- A damaged Q13 EVAP vent solenoid valve or EVAP canister
  - If you find any of the above conditions, repair as necessary.

NOTE: Refer to the J 41413-200: Evaporative Emissions System Tester (EEST) operation manual for detailed instructions.

2. Remove the fuel fill cap. Connect the **J-41415-30:** Adapter to the fuel tank filler neck. Connect the **J 41413-200:** EEST to the **J-41415-30:** Adapter.
3. Calibrate the **J 41413-200:** EEST Flow Meter to 0.51 mm (0.020 in).
4. Command the EVAP vent solenoid valve closed with a scan tool.

NOTE: Larger volume fuel tanks and/or those with lower fuel levels may require several min for the floating indicator to stabilize.

5. Activate the **J 41413-200:** EEST and compare the flow meter's stable floating indicator position to the red flag. The floating indicator should be level with the red flag.
   - If the floating indicator is above the red flag, test for a leak in the EVAP system.
   - If the floating indicator is below the red flag, test for a blockage or restriction in the EVAP system.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

Leak Testing

NOTE:

- **You must start with the Circuit/System Verification before proceeding with Circuit/System Testing.**
- **Ensure that the vehicle underbody temperature is similar to the ambient temperature and allow the surrounding air to stabilize before starting the diagnostic procedure. The system flow will be less with higher temperatures.**

1. Connect the **J-41415-30:** Adapter to the fuel tank filler neck. Connect the **J 41413-200:** EEST to the **J-41415-30:** Adapter.
2. Connect the **CH-48096:** Access Tool between the Q12 EVAP purge solenoid valve and the EVAP purge pipe.
3. Turn the nitrogen/smoke valve on the control panel to SMOKE.
4. Command the Q13 EVAP vent solenoid valve closed with a scan tool.
5. Use the remote switch to introduce smoke into the EVAP system.
6. Use the **J 41413-VLV:** Fitting Tool to open the EVAP service port. Once smoke is observed, remove the **J 41413-VLV:** Fitting Tool.

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NOTE: Introduce smoke at 15 s intervals while testing the system.

7. Verify that smoke is not exiting the entire EVAP system with the **J 41413-SPT:** White Light.

NOTE: The fuel tank may need to be lowered to improve visibility of some of the EVAP system components.

   - If smoke is observed, repair the condition as necessary.
8. Remove the **J 41413-200:** EEST nitrogen supply hose from the **J-41415-30:** Adapter, and remove the **J-41415-30:** Adapter from the filler neck.
9. Install the fuel fill cap.
10. Connect the **J 41413-200:** EEST nitrogen/smoke supply hose to the EVAP service port of the **CH-48096:** Access Tool.
11. Command the Q13 EVAP vent solenoid valve closed with a scan tool.
12. Use the remote switch to introduce smoke into the EVAP system.

NOTE: The fuel tank may need to be lowered to improve visibility of some of the EVAP system components.

13. Verify that smoke is not exiting the entire EVAP system with the **J 41413-SPT:** White Light.
    - If smoke is observed, repair the condition as necessary.
14. Verify individual EVAP system components do not leak using the **J 41413-300:** Kit.
    - If a condition is found replace the affected component.

Blockage/Restriction Testing

1. Connect the **J-41415-30:** Adapter to the fuel tank filler neck. Connect the **J 41413-200:** EEST to the **J-41415-30:** Adapter.
2. Seal the EVAP system using the scan tool EVAP Purge/Seal function.
3. Pressurize the EVAP system with nitrogen to 9.33 mm/Hg (5 in/H2O). Compare the scan tool Fuel Tank Pressure Sensor parameter to the **J 41413-200:** EEST pressure/vacuum gauge. Verify the scan tool FTP sensor parameter is within +/-0.9 mmHg (+/-0.5 in. H2O) of the pressure/vacuum gauge.
    - If not within the specified range, replace the B150 FTP sensor.
4. Command the Q12 EVAP purge solenoid valve to 100 % with a scan tool. Verify the scan tool FTP sensor parameter is -0.9 to +0.9 mmHg (-0.5 to +0.5 in.H2O).
    - If greater than the specified value, disconnect the EVAP pipes listed below one at a time while observing the scan tool FTP sensor parameter. If the FTP sensor parameter drops to within the specified range when a pipe is disconnected, repair the blockage or restriction in one of the following EVAP pipe/hoses:
        - EVAP purge vacuum source from the Q12 EVAP purge solenoid valve
        - EVAP purge pipe from the Q12 EVAP purge solenoid valve
        - EVAP purge pipe at the EVAP canister

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- EVAP vapor pipe at the EVAP canister

5. If a condition with the EVAP system cannot be located, refer to Diagnostic Aids for additional information.

COMPONENT TESTING

1. Seal the EVAP system using the scan tool EVAP Purge/Seal function.
2. Pressurize the EVAP system to 9.33 mm/Hg (5 in/H2O).
3. Compare the scan tool Fuel Tank Pressure sensor parameter to the **J 41413-200:** EEST pressure/vacuum gauge. Verify the scan tool FTP sensor parameter is within +/-0.9 mmHg (+/-0.5 in. H2O) of the pressure/vacuum gauge.
    - If not within the specified range, replace the B150 FTP sensor.
4. Command the Q13 EVAP vent solenoid valve open with a scan tool. Verify the scan tool FTP sensor parameter is -0.9 to +0.9 mmHg (-0.5 to +0.5 in.H2O).
    - If not within the specified range, replace the B150 FTP sensor.

REPAIR PROCEDURES

- **Fuel Tank Pressure Sensor Replacement**
- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Evaporative Emission Canister Replacement**

REPAIR VERIFICATION

1. Turn the nitrogen/smoke valve to nitrogen.
2. Command the Q13 EVAP vent solenoid valve closed with a scan tool.
3. Use the remote switch to activate the **J 41413-200:** EEST.
4. Use the remote switch to introduce nitrogen and fill the EVAP system until the floating indicator stabilizes.
5. Verify the flow meter's stable floating indicator position is at or below the red flag.
6. Remove the **CH-48096:** Access Tool, and connect the purge hose/pipe to the EVAP purge solenoid valve.
7. Clear the DTCs with a scan tool.

DTC P0496

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

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DTC DESCRIPTOR

DTC P0496

Evaporative Emissions (EVAP) System Flow During Non-Purge

CIRCUIT DESCRIPTION

This DTC tests for continuous intake manifold vacuum flow to the Evaporative Emission (EVAP) System. The control module seals the EVAP system by commanding the EVAP canister purge solenoid valve Closed and the EVAP canister vent solenoid valve Closed. The control module monitors the fuel tank pressure (FTP) sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is greater than a predetermined value within a predetermined time, this DTC sets.

FTP Sensor Signal Voltage	Fuel Tank Pressure
High, Approximately 1.5 V or More	Negative Pressure/Vacuum
Low, Approximately 1.5 V or Less	Positive Pressure

CONDITIONS FOR RUNNING THE DTC

- Before the engine control module (ECM) can report DTC P0496 failed, DTCs P0450, P0451, P0452, and P0453 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0443, P0446, P0449, P0450, P0451, P0452, P0453, P0458, P0459, P0498, P0499, P0560, P0562, P0563, P0700, P2122, P2123, P2127, P2128, P2138, P2227, P2228, or P2229 is not set.
- The fuel system is in closed loop.
- The engine run time is greater than 10 min, or the long term fuel trim is stable.
- The vehicle speed sensor (VSS) is less than 3 km/h (2 mph).
- The engine is idling.
- The ignition voltage is between 10-18 V.
- The Closed Loop fuel control is enabled.
- The fuel tank pressure (FTP) is between -10.0 and +5.0 in. H2O (-18.7 and +9.8 mm Hg).
- The ambient air temperature is between 2-32°C (36-90°F).
- The start-up engine coolant temperature (ECT) is within 10°C (18°F) of ambient air temperature
- The fuel tank level is between 11-88 %.
- The barometric pressure (BARO) is greater than 68 kPa.
- The above conditions are met for greater than 30 s.
- DTC P0496 will attempt to run up to 10 times or the test completes successfully once per ignition cycle.

CONDITIONS FOR SETTING THE DTC

- The control module detects vacuum during a non-purge condition.
- The condition exists for greater than 4 s or for a cumulative of 30 s.

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ACTION TAKEN WHEN THE DTC SETS

DTC P0496 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0496 is a Type B DTC.

DIAGNOSTIC AIDS

- Observe the Freeze Frame/Failure Records vehicle mileage since the diagnostic test last failed may help determine how often the condition occurs that caused the DTC to set. This may assist in diagnosing the condition.
- The EVAP system tests run when engine is first started and meets The Conditions for Running the DTC. An intermittent condition could be caused by an improperly installed or damaged EVAP canister purge solenoid valve, or by a temporary blockage or restriction in the EVAP canister purge solenoid valve.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Disconnect the Q12 EVAP purge solenoid valve electrical harness connector.
2. Start the engine.
3. Command the Q13 EVAP vent solenoid valve Closed with a scan tool.
4. Increase the engine speed to 1,200-1,500 RPM.
5. Observe the scan tool fuel tank pressure (FTP) sensor parameter. Verify the scan tool FTP sensor

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parameter is -0.9 to +0.9 mm Hg (-0.5 to +0.5 in. H2O).
    - If not within the specified range, replace the Q12 EVAP purge solenoid valve.
6. Ignition ON, engine OFF, disconnect the EVAP purge hose/pipe at the Q12 EVAP purge solenoid valve.
7. Observe the scan tool FTP sensor parameter. Verify the FTP sensor parameter is -0.9 to +0.9 mm Hg (-0.5 to +0.5 in. H2O).
    - If not within the specified range, replace the B150 FTP sensor.

REPAIR PROCEDURES

- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- **Fuel Tank Pressure Sensor Replacement**
- **Control Module References** for engine control module replacement, setup, and programming

REPAIR VERIFICATION

1. Start the engine.
2. Command the Q13 EVAP vent solenoid valve Closed with a scan tool.
3. Increase the engine idle to 1,200-1,500 RPM.
4. Observe the scan tool FTP sensor parameter. Verify the FTP sensor parameter is -0.9 to +0.9 mm Hg (-0.5 to +0.5 in. H2O).
5. Clear the DTCs with a scan tool.

DTC P0506, P0507, OR P050A (WITHOUT LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

DTC P050A

Cold Start Idle Air Control System Performance

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CIRCUIT/SYSTEM DESCRIPTION

The throttle actuator control (TAC) motor is a DC motor that is part of the throttle body assembly. The TAC motor drives the throttle valve. The engine control module (ECM) controls the TAC motor based on throttle position sensor input. The idle speed is controlled by the ECM based on various inputs. The ECM commands the TAC motor to open or close the throttle valve in order to maintain the desired idle speed. If the ECM detects the actual idle speed is not within a predetermined range of the desired idle speed, this DTC sets.

CONDITIONS FOR RUNNING THE DTC

P0506 and P0507

- DTC P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0221, P0222, P0223, P0442, P0443, P0446, P0455, P0458, P0459, P0496, or P0700 is not set.
- The engine is operating for greater than 4 seconds.
- The engine load is between 32-75 percent, for P0506 or manual transmission only.
- The engine coolant temperature (ECT) is warmer than -11°C (+13°F).
- The intake air temperature (IAT) is warmer than -11°C (+13°F).
- The vehicle speed is 0 km/h (0 mph) and accelerator pedal position (APP) input is at 0 percent.
- The EVAP intrusive leak test is not enabled.
- The cold start idle speed control is not active.
- The evaporative emission (EVAP) canister purge valve command less than 40 percent.
- A vehicle speed was detected prior to the diagnostic running.
- DTC P0506 and P0507 run continuously once the above conditions are met for greater than 10 seconds.

P050A

- DTC P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0221, P0222, P0223, P0442, P0443, P0446, P0455, P0458, P0459, P0496, or P0700 is not set.
- The engine load is between 70-90 percent, for under speed or manual transmission only.
- The vehicle speed is 0 km/h (0 mph) and accelerator pedal position (APP) input is at 0 percent.
- The engine coolant temperature (ECT) is colder than 65°C (149°F).
- The catalyst cold start heating strategy is active.
- DTC P050A runs once an ignition cycle when the conditions above have been met for 7 seconds.

CONDITIONS FOR SETTING THE DTC

P0506

The actual engine speed is less than the desired idle speed by at least 100 RPM for greater than 4 seconds.

P0507

- The actual engine speed is greater than the desired idle speed by at least 200 RPM for greater than 4

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seconds.

OR

- The ECM detects 3 fuel cut-offs due to an engine over speed condition while the vehicle speed is zero.

P050A

The actual engine speed is 100 RPM less or 200 RPM greater than the desired idle speed during a cold start, for greater than 4 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0506, P0507, and P050A are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0506, P0507, and P050A are Type B DTCs.

DIAGNOSTIC AIDS

Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool.
    - If there are any throttle actuator control (TAC), throttle position (TP) sensor, accelerator pedal position (APP) sensor, or fuel rail pressure (FRP) regulator DTCs set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Operate the engine within the conditions for running the DTCs for 1 minute. DTC P0506, P0507, or P050A should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

Engine operating, command the engine speed up to 1,400 RPM, down to 600 RPM, up to 1,400 RPM, and then exit using the scan tool. The engine speed should steadily increase and decrease as commanded.

- If the idle does not increase or decrease steadily, verify that none of the following conditions is present:

- Vacuum leaks
- The throttle valve for the correct operation-A throttle valve that does not close correctly sets this DTC.
- Restricted air intake system
- The throttle body for damage and/or tampering
- Incorrect or malfunctioning PCV system
- Excess deposits in the throttle body
- A parasitic load on the engine-For example, a transmission condition, a belt driven accessory condition
    - Repair the condition as necessary.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P0601-P0604, P0606, P167D, OR P2610 (ECM, LLT)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

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DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P167D

Control Module Ignition Coil Internal Circuit

DTC P2610

Control Module Ignition Off Timer Performance

CIRCUIT/SYSTEM DESCRIPTION

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

CONDITIONS FOR RUNNING THE DTC

P0601 and P0604

These DTCs run once an ignition cycle.

P0602, P0603, P0606

These DTCs run continuously when the ignition is ON.

P167D

- The engine is operating.
- The ignition voltage is between 10-18 V.

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- The engine speed is less than 6,000 RPM.
- DTC P167D runs continuously when the above conditions are met.

P2610

- The engine speed is greater than 240 RPM.
- DTC P2610 runs continuously when the engine is operating and the real time clock is active.

CONDITIONS FOR SETTING THE DTC

P0601

The ECM detects a read only memory (ROM) checksum error at ECM power up. The error is detected 5 times, then a 5 s delay for MIL ON after the fifth detection.

P0602

The ECM detects that programming is incomplete. The condition exists, then a 5 s delay for MIL ON.

P0603

The ECM detects a reset error of the internal software that operates the throttle actuator control (TAC) system, during the shut down path test. The error is detected 3 times, then a 5 s delay for MIL ON.

P0604

The ECM detects random access memory (RAM) errors. The condition exists, then a 5 s delay for MIL ON.

P0606

The ECM detects an internal error of monitoring software for the throttle actuated control (TAC) system. The condition exists, then a 5 s delay for MIL ON.

P167D

The ECM detects a condition with the integrated circuits of the ignition coil driver module.

P2610

The ECM detects the engine off timer signal is missing or not valid.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0601, P0602, P0603, P0604, and P0606 are Type A DTCs.
- DTCs P167D and P2610 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

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- DTCs P0601, P0602, P0603, P0604, and P0606 are Type A DTCs.
- DTCs P167D and P2610 are Type B DTCs.

DIAGNOSTIC AIDS

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set.

- Verify that the battery cables are clean and tight, and the battery is fully charged. Refer to **Battery Inspection/Test** .
- Verify the ECM ground circuits do not have an open or high resistance.
- Verify the ECM power circuits do not have an open, short to ground, or high resistance.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0601, P0602, P0603, P0604, P0606, P167D, or P2610 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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CIRCUIT/SYSTEM TESTING

1. Observe the DTC information with the scan tool.
    - If DTC P0602 is set, attempt to program the K20 ECM before replacing the K20 ECM. Refer to **Control Module References** .
    - If DTC P0602 resets, replace the K20 ECM.
2. Observe the DTC information with a scan tool. DTC P0601, P0603, P0604, P0606, P167D, or P2610 should not set.
    - If a DTC failed this ignition, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for engine control module replacement, setup, and programming

DTC P0601-P0604, P0606, OR P062F

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0601

Control Module Read Only Memory (ROM)

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory (RAM)

DTC P0606

Control Module Internal Performance

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DTC P062F

Control Module Long Term Memory Performance

CIRCUIT/SYSTEM DESCRIPTION

The internal fault detection is handled inside the fuel pump control module. No external circuits are involved.

CONDITIONS FOR RUNNING THE DTC

The fuel pump control module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module has detected an internal malfunction.

ACTION TAKEN WHEN THE DTC SETS

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

REFERENCE INFORMATION

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

CIRCUIT/SYSTEM VERIFICATION

NOTE: This DTC may be stored as a history DTC without affecting the operation of the

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module. If stored only as a history DTC and not retrieved as a current DTC, do not replace the module.

Verify that DTC P0602 is not set.

- If the DTC is set, program the K27 fuel pump control module.

Verify that DTCs P0601, P0603, P0604, P0606, and P062F are not set.

- If the DTCs are set, program the K27 fuel pump control module. If the DTCs reset, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

REPAIR INSTRUCTIONS

ENGINE CONTROL MODULE REPLACEMENT

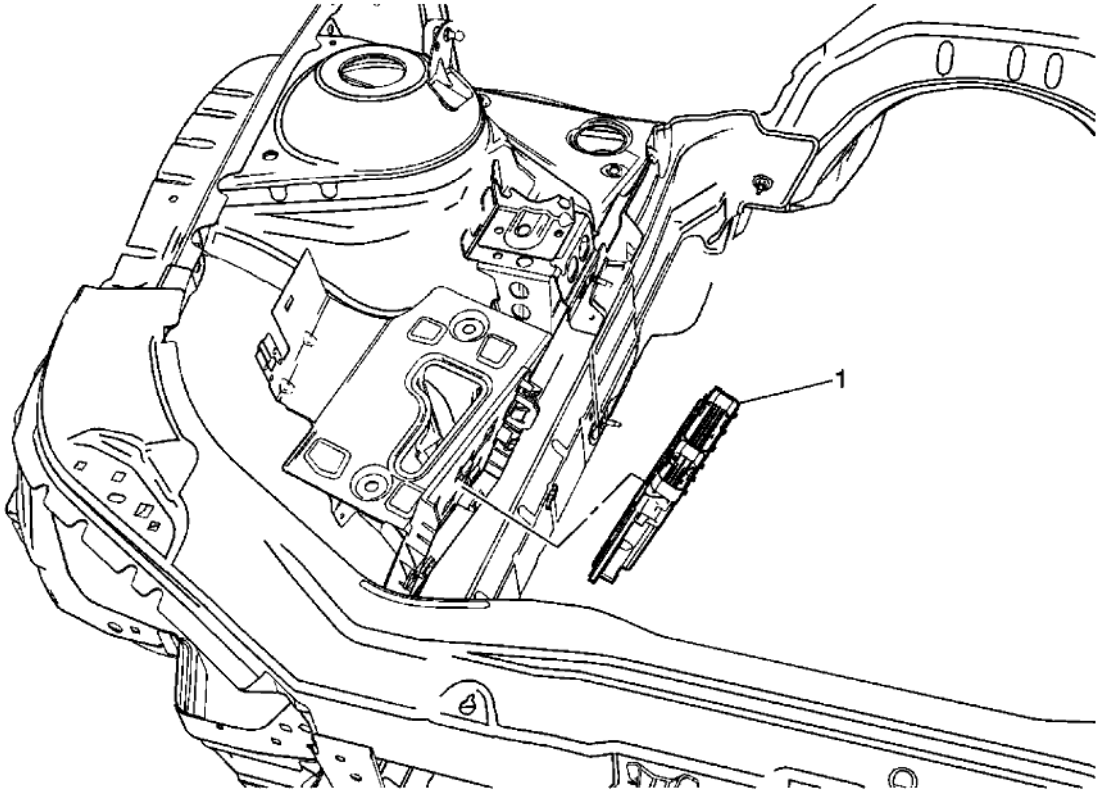


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .**	
	Electronic Control Module **WARNING:** **Refer to Safety Glasses Warning .** **CAUTION:** **Always turn the ignition off when installing or removing the ECM connectors in order to**

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	prevent damage to the components. **Procedure**
1	1. Record the current Engine Oil Life percentage, Transmission Oil Life, and use a scan tool to update the NEW ECM, if replacing. 2. Disconnect the electrical connectors. 3. Release the retaining tabs. 4. If replacing, program the ECM. Refer to **Control Module References** .

THROTTLE/IDLE LEARN (WITHOUT LF1)

Description

The engine control module (ECM) learns the idle position of the throttle body to ensure the correct idle operation. Anytime the ECM or the throttle body is replaced, the ECM must learn the idle position. The engine idle may be unstable or a DTC may set if the idle position is not learned.

Conditions for Running the Idle Learn Procedure

- DTCs P0121, P0122, P0123, P0221, P0222, P0223, P0638, P2100, P2101, P2105, and P2119 are not set.
- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The accelerator pedal position is less than 14.9 percent.
- The ignition 1 voltage is more than 10 volts.
- The engine coolant temperature is between 5-85°C (41-185°F).
- The intake air temperature is between 5-60°C (41-140°F).

Idle Learn Procedure

NOTE:

- **Ensure the above conditions are met before performing with this procedure.**
- **Do not perform this procedure if a throttle position sensor or other throttle actuator control (TAC) system DTCs are set other than P2176. The ECM will not perform the idle learn procedure with a DTC set.**

1. Turn OFF the ignition for 30 seconds.
2. Turn ON the ignition, with the engine OFF for 60 seconds.
3. Turn OFF the ignition.
4. Turn ON the ignition, with the engine OFF.
5. Clear the DTCs with a scan tool.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

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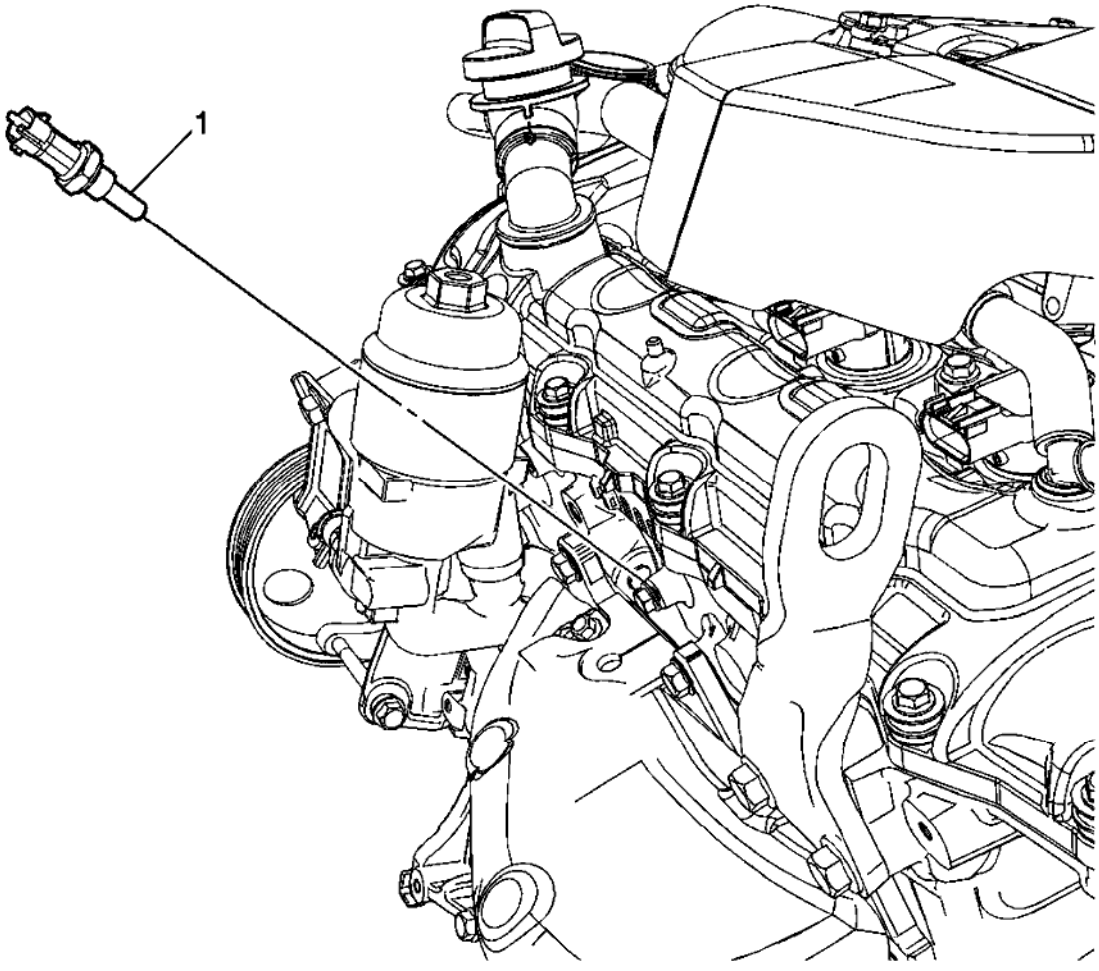


Fig. 2: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .	
1	Engine Coolant Temperature Sensor **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 22 N.m(16 lb ft) **Procedure:** Disconnect the electrical connector.

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MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

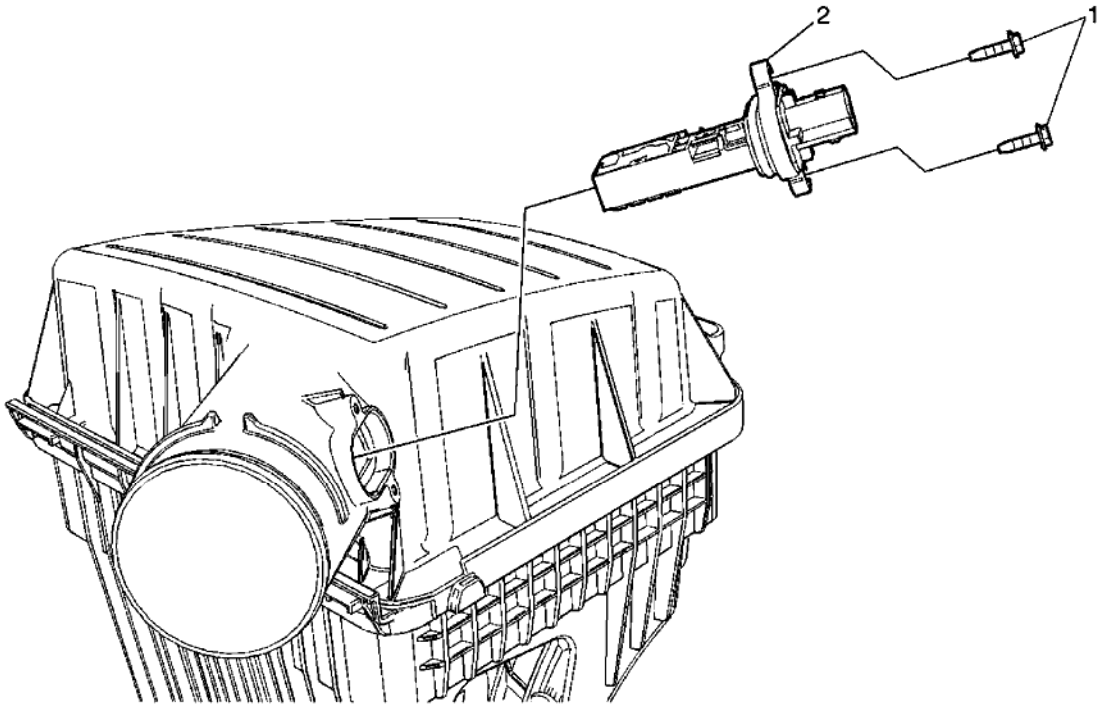


Fig. 3: Mass Airflow Sensor With Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Mass Airflow with Intake Air Temperature Sensor Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Mass Airflow with Intake Air Temperature Sensor **Procedure:** Disconnect the electrical connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the

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sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 1 is the right bank.

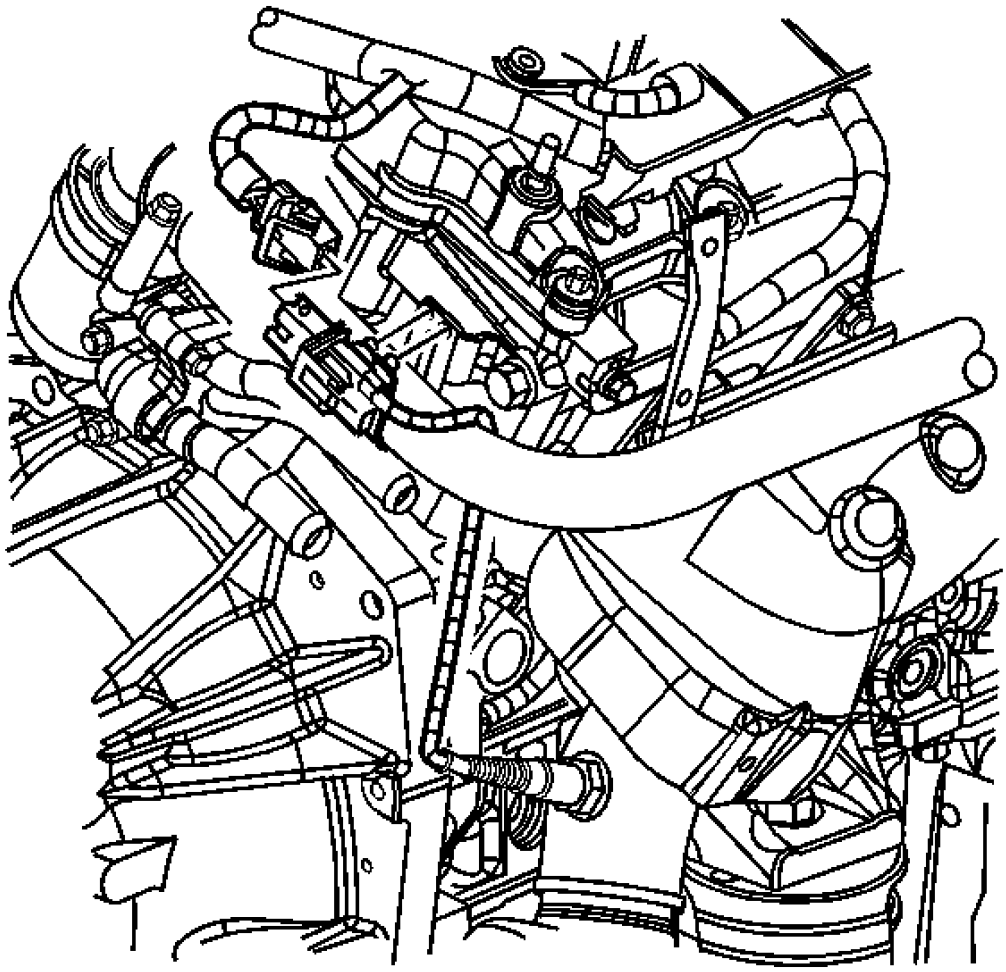


Fig. 4: View Of HO2S Electrical Connector -- Bank 1, Sensor 1
Courtesy of GENERAL MOTORS CORP.

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1. Turn the ignition OFF.
2. Remove the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .
3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S electrical connector from the wiring harness bracket.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

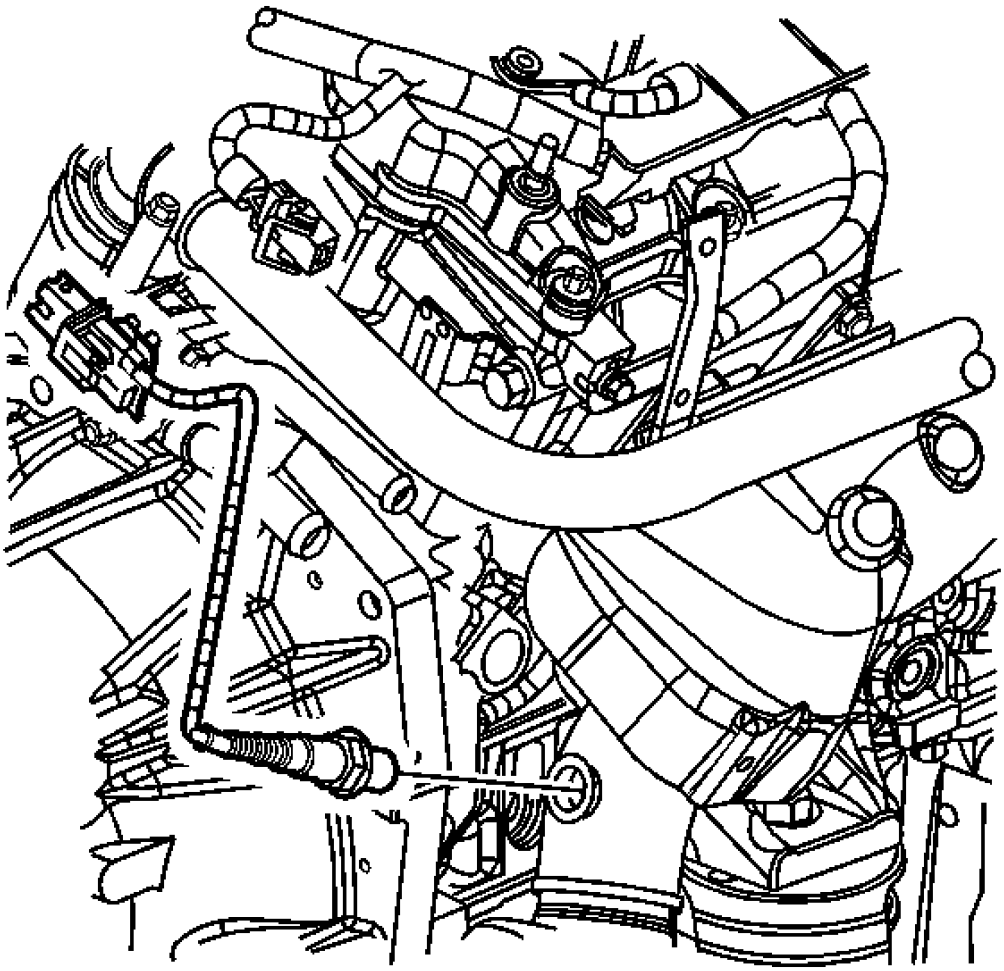


Fig. 5: View Of HO2S - Bank 1, Sensor 1
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

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NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

6. Remove the HO2S from the catalytic converter.

Installation Procedure

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

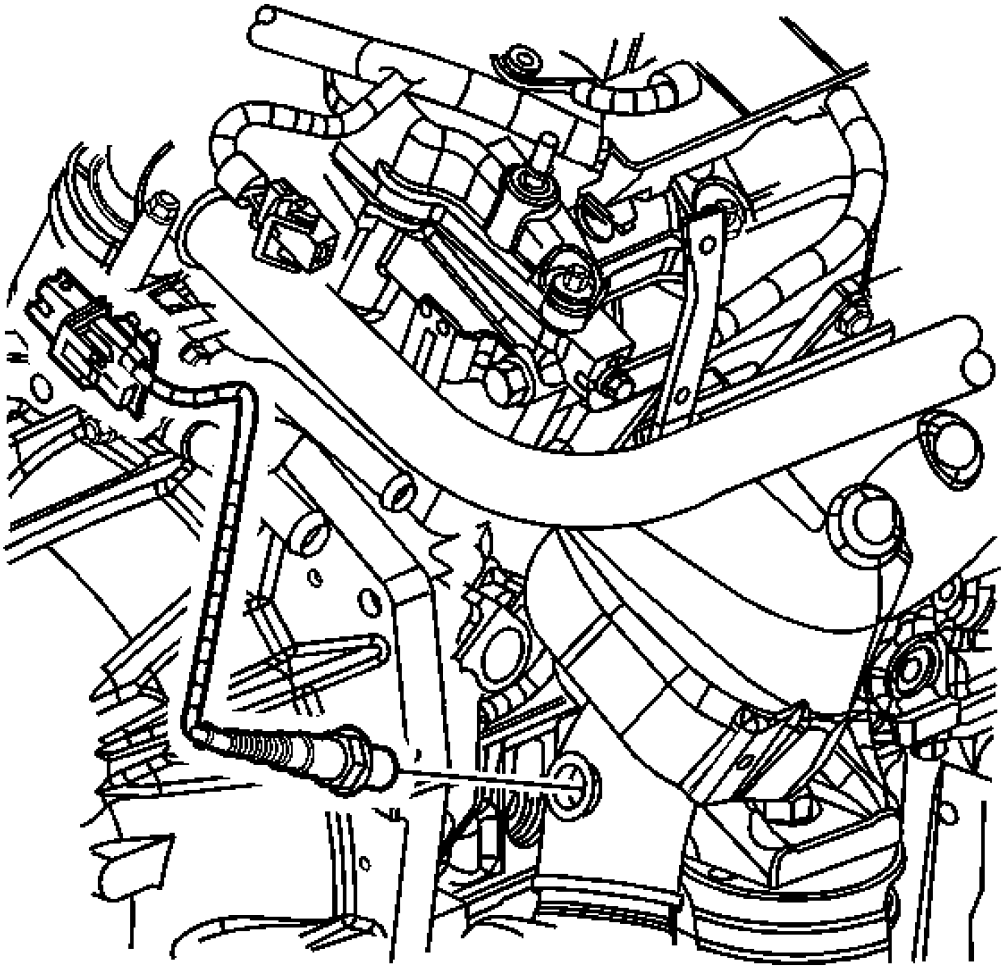


Fig. 6: View Of HO2S - Bank 1, Sensor 1

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Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install the HO2S to the catalytic converter and tighten to 40 N.m (30 lb ft).
2. Lower the vehicle.

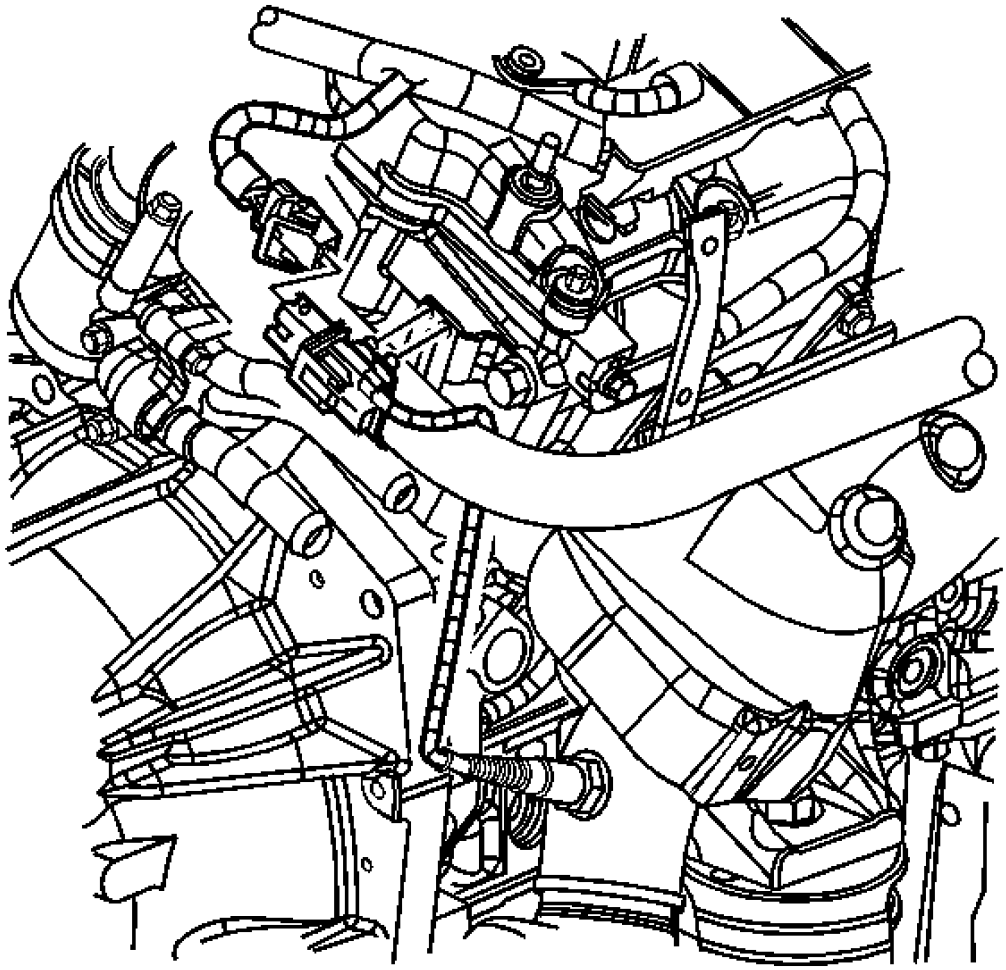


Fig. 7: View Of HO2S Electrical Connector -- Bank 1, Sensor 1
Courtesy of GENERAL MOTORS CORP.

3. Install the HO2S electrical connector to the wiring harness bracket.

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4. Connect the HO2S electrical connector.
5. Install the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 1 is the right side.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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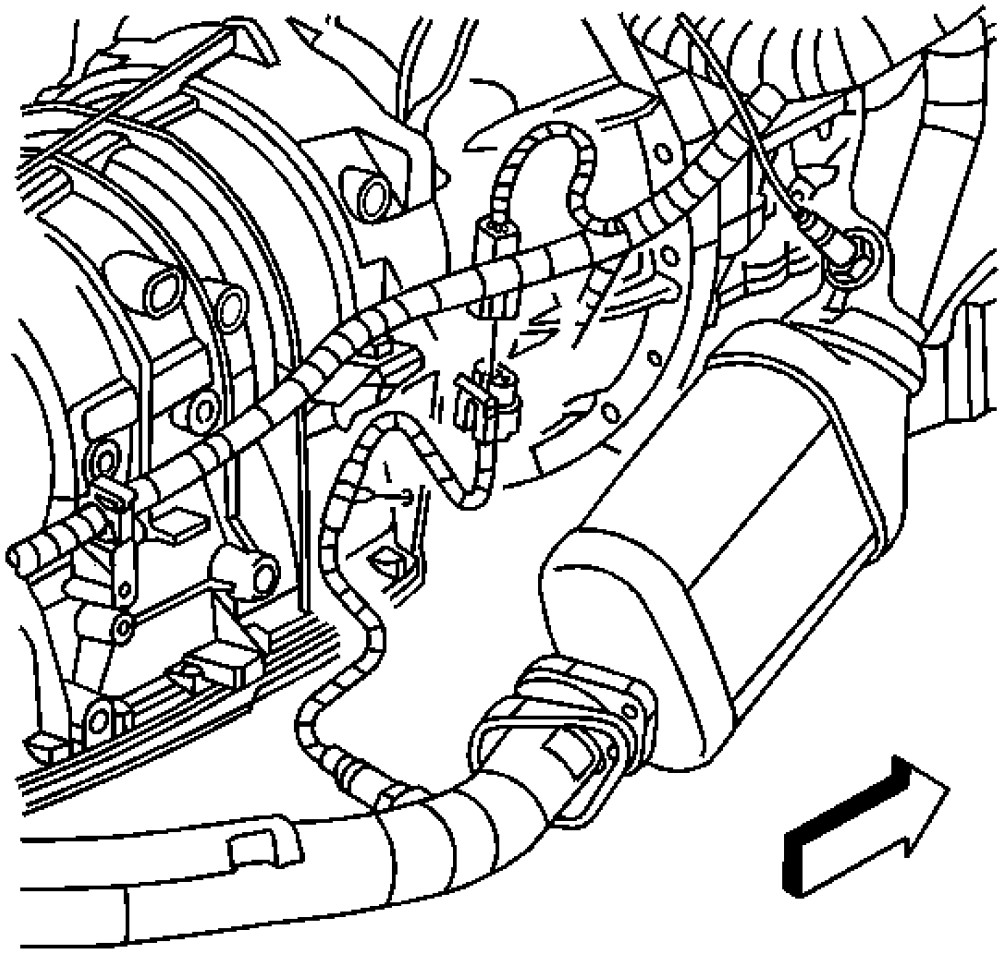


Fig. 8: View Of HO2S Electrical Connector, Sensor 2 (Bank 1 Shown, Bank 2 Similar)
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S wiring harness from the transmission case.

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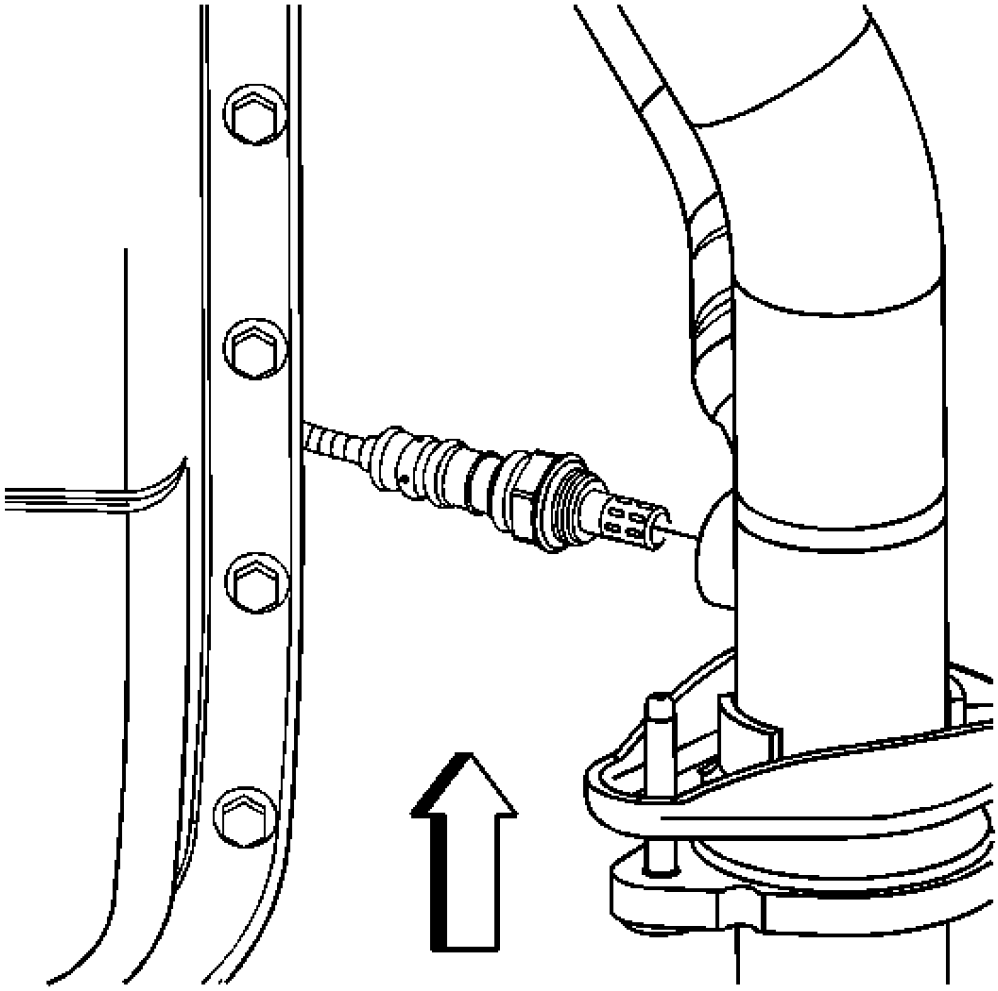


Fig. 9: View Of HO2S - Bank 1, Sensor 2
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

5. Remove the HO2S.

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Installation Procedure

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

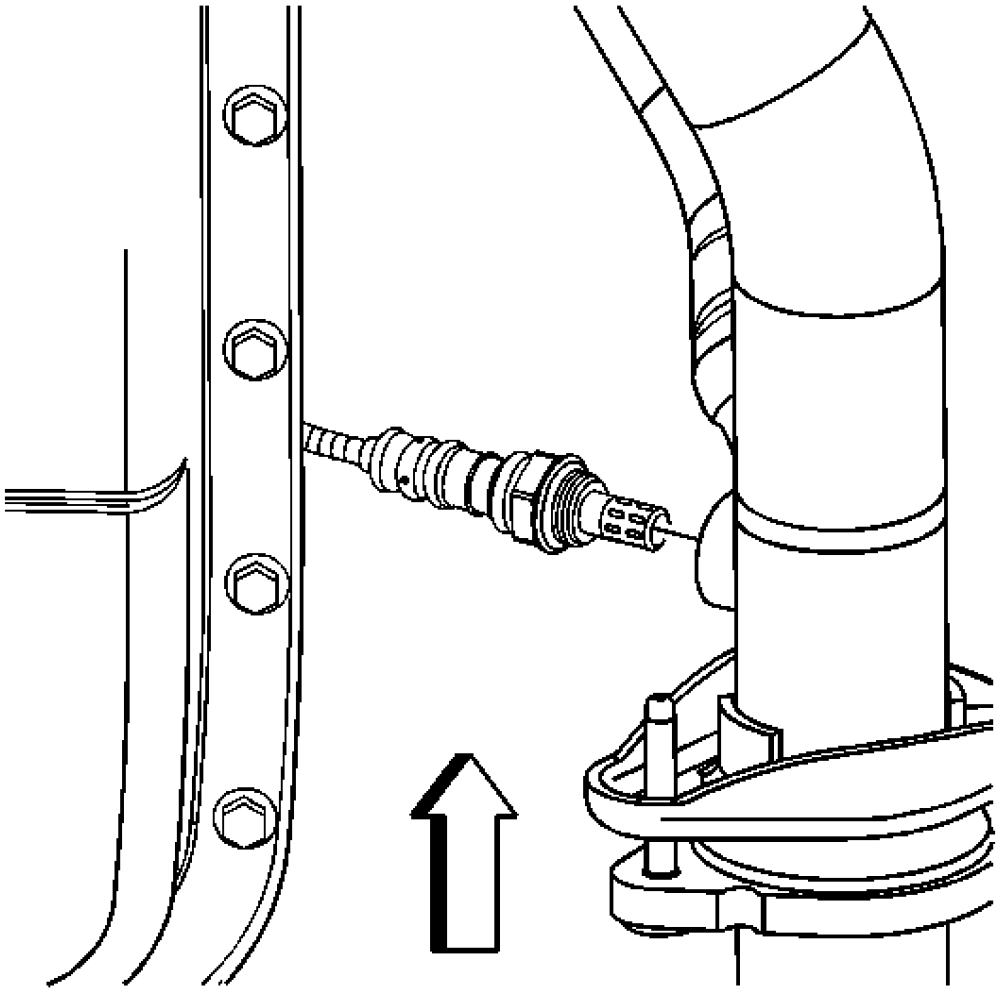


Fig. 10: View Of HO2S - Bank 1, Sensor 2
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Component Fastener Tightening Caution .

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1. Install the HO2S and tighten to 40 N.m (30 lb ft).

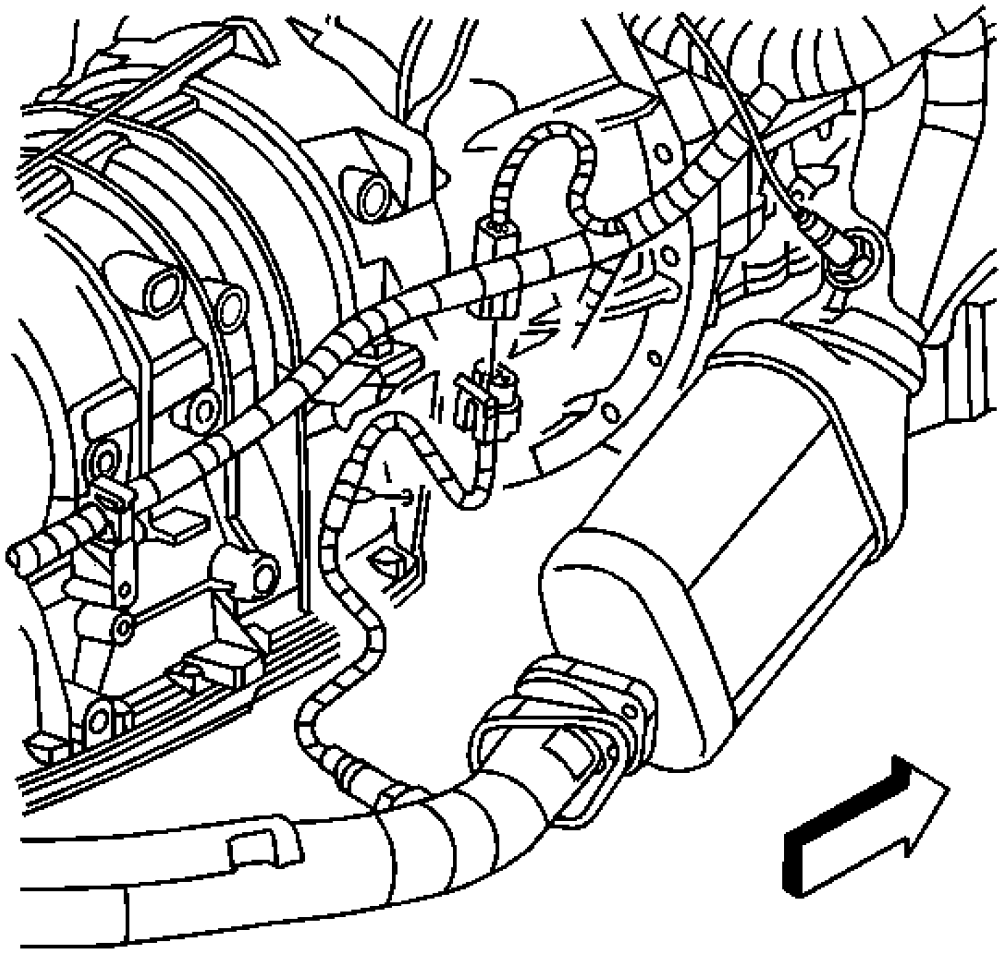


Fig. 11: View Of HO2S Electrical Connector, Sensor 2 (Bank 1 Shown, Bank 2 Similar)
Courtesy of GENERAL MOTORS CORP.

2. Connect the HO2S electrical connector.
3. Install the HO2S wiring harness to the transmission case.
4. Lower the vehicle.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

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Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 2 is the left bank.

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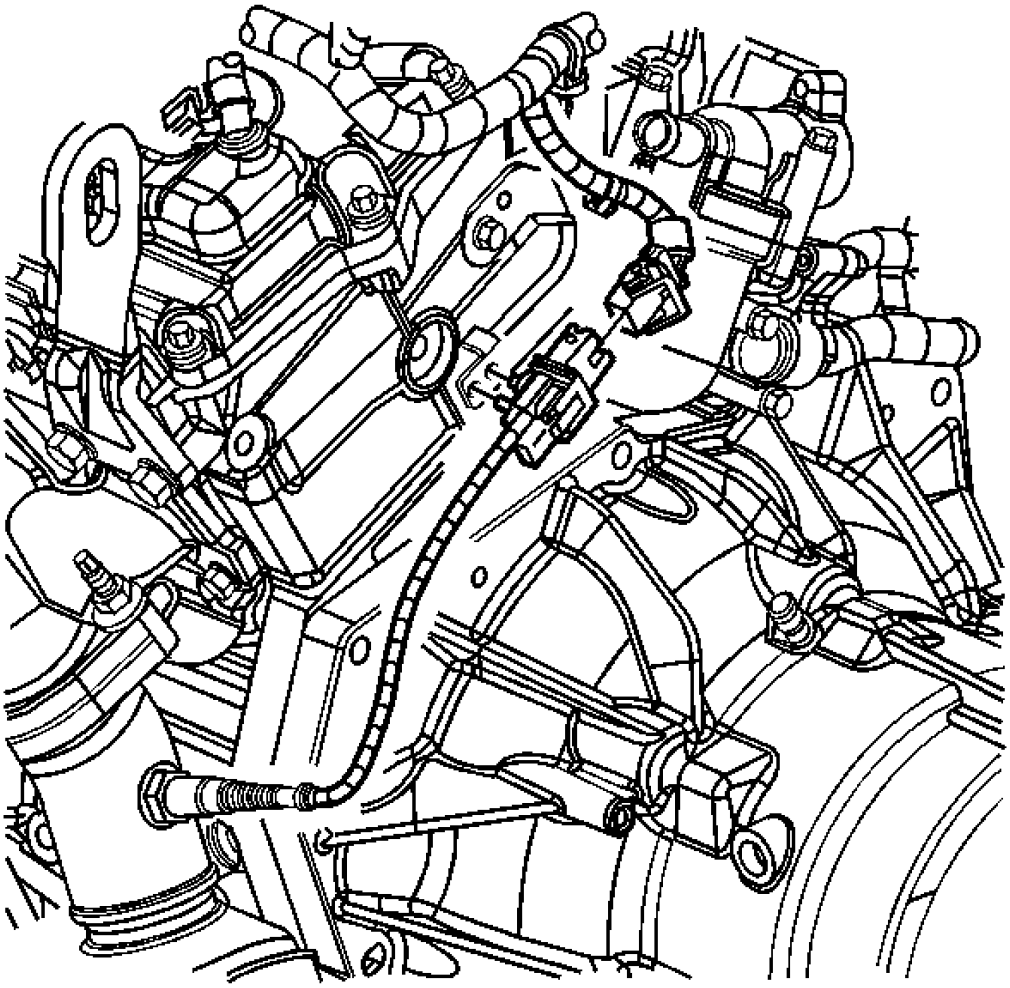


Fig. 12: View Of HO2S Electrical Connector - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .
3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S electrical connector from the wiring harness bracket.

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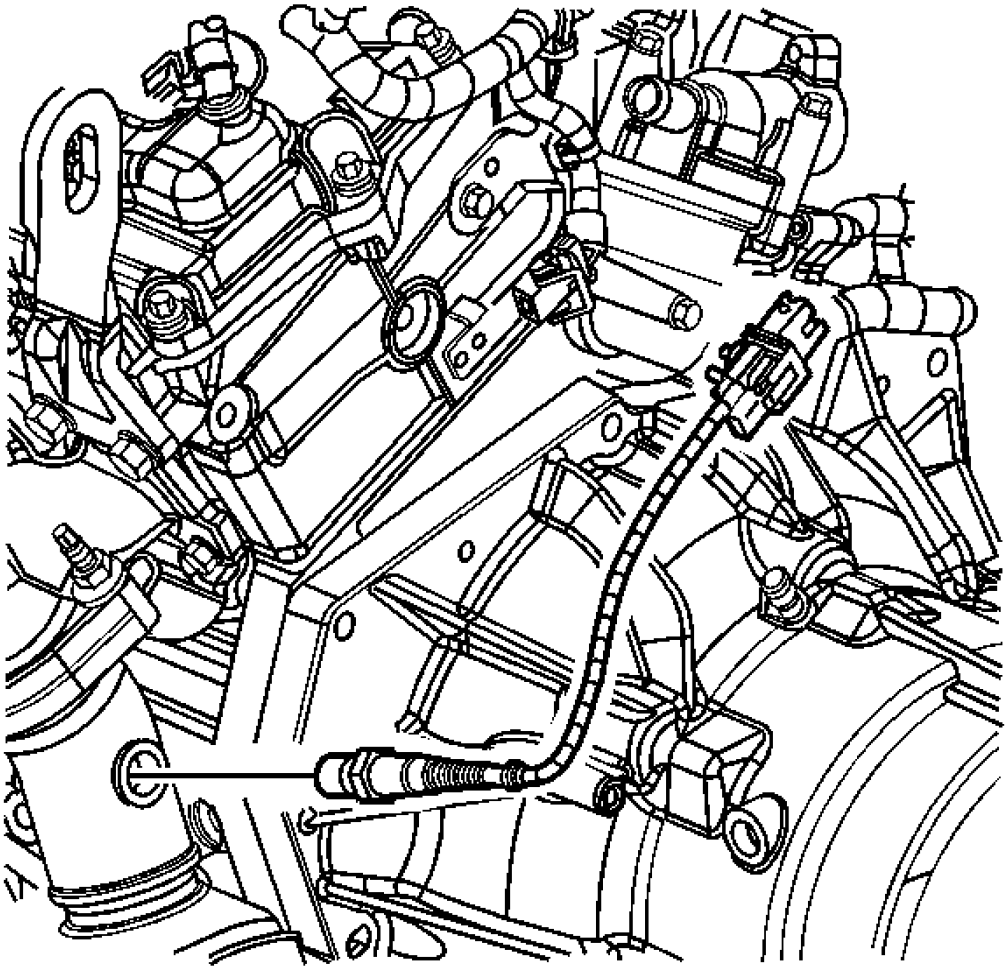


Fig. 13: View Of HO2S - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

5. Remove the HO2S.

Installation Procedure

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CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

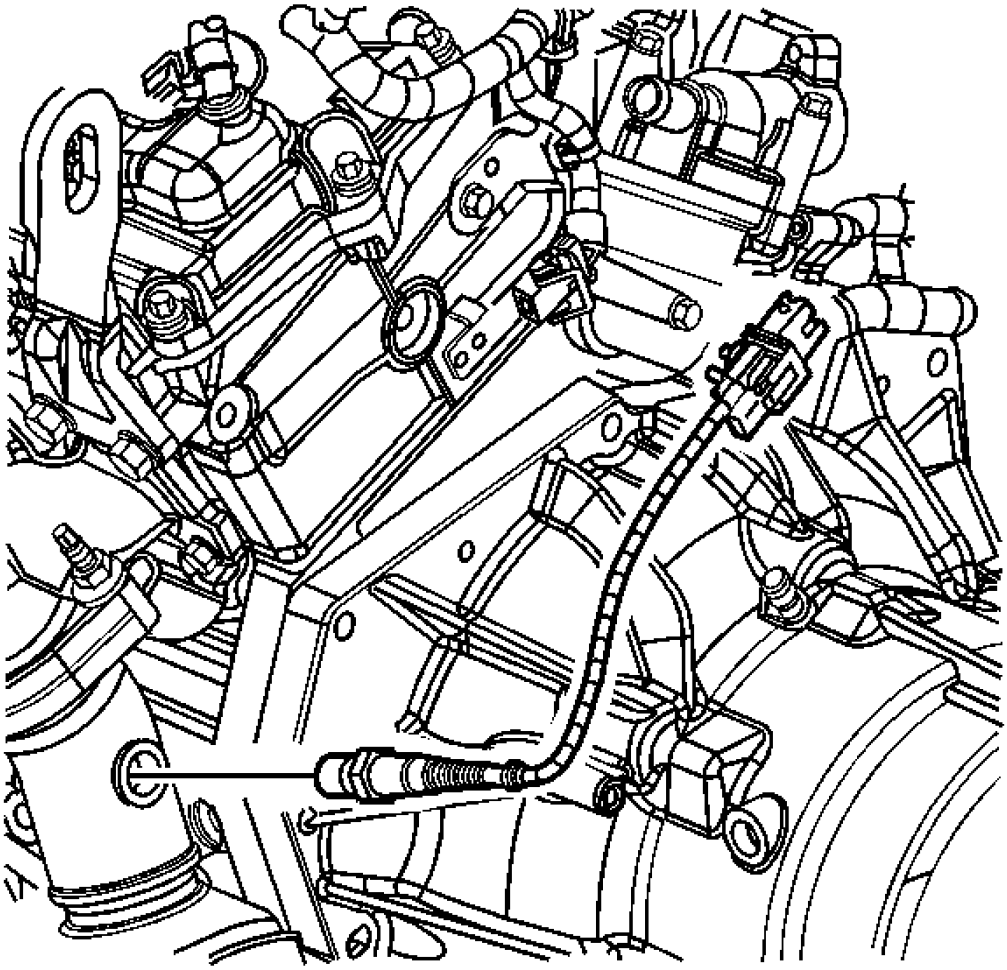


Fig. 14: View Of HO2S - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install the HO2S and tighten to 40 N.m (30 lb ft).

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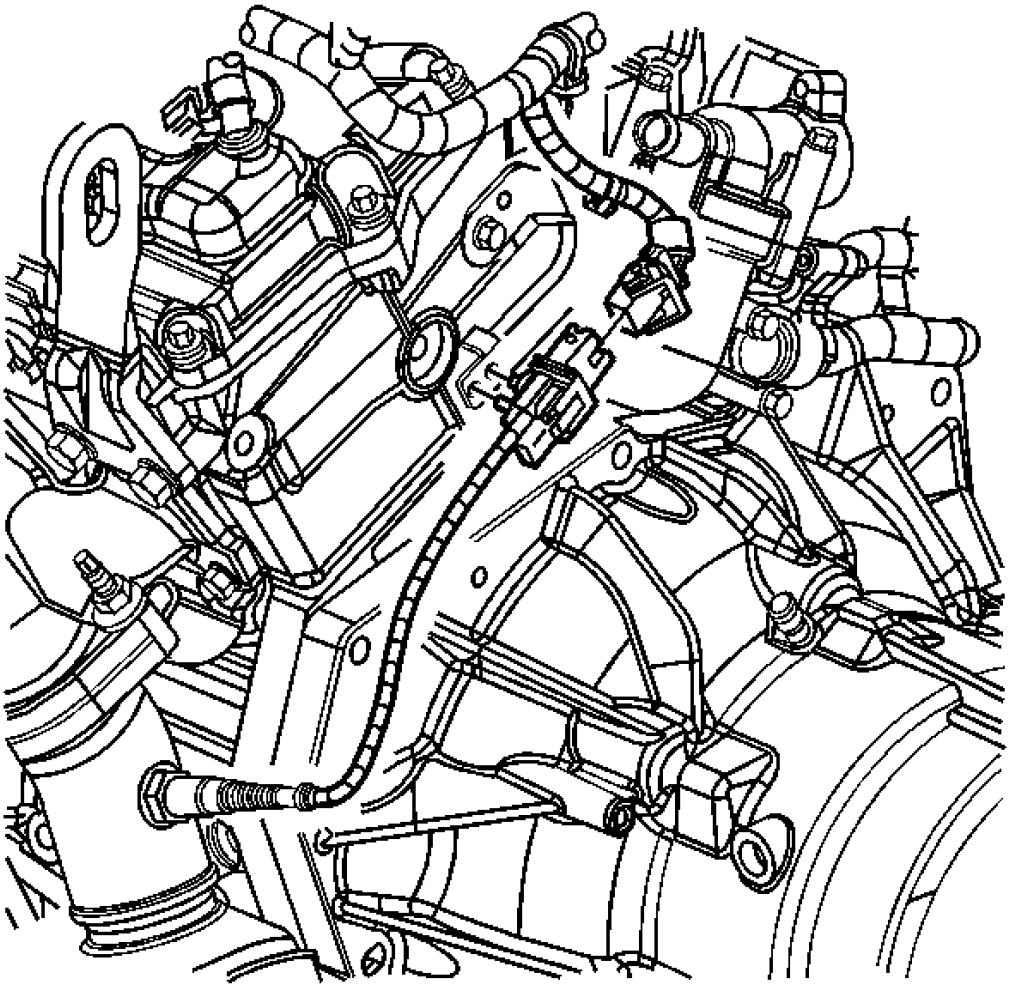


Fig. 15: View Of HO2S Electrical Connector - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

2. Install the HO2S electrical connector to the wiring harness bracket.
3. Connect the HO2S electrical connector.
4. Install the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a

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permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 2 is the left bank.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

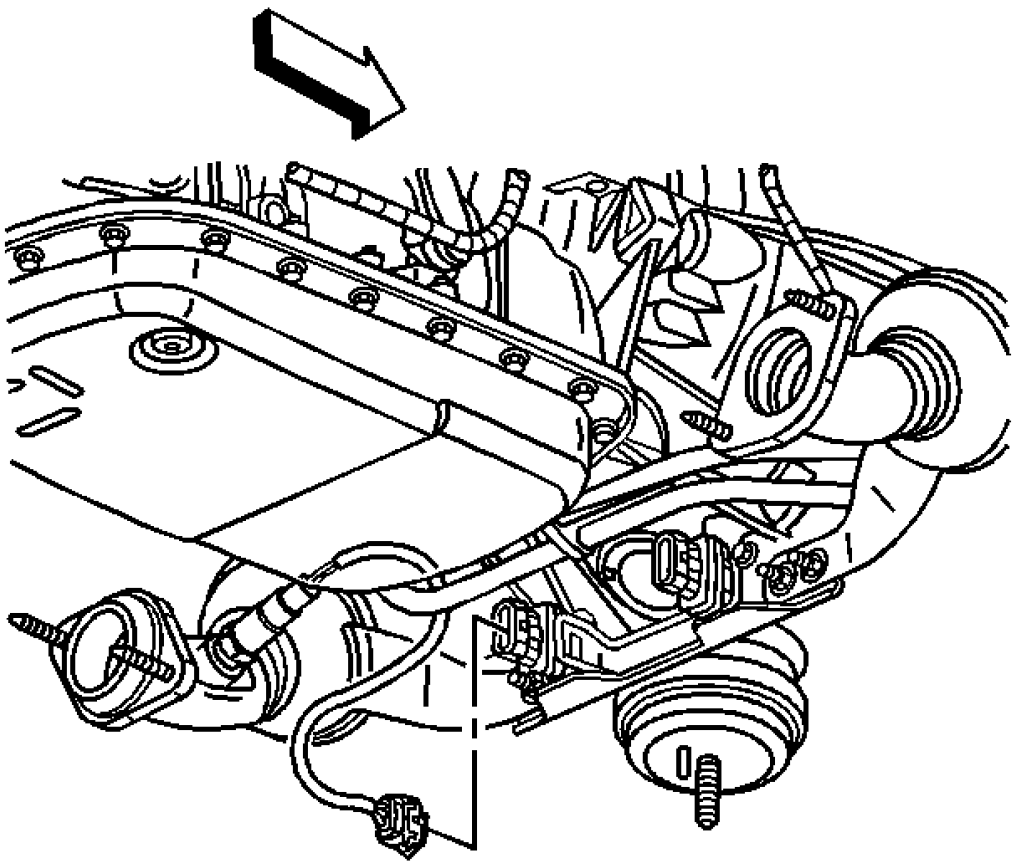


Fig. 16: View Of Heated Oxygen Sensor Electrical Connector - Bank 2 Sensor 2

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Courtesy of GENERAL MOTORS CORP.

3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S wiring harness from the transmission case.

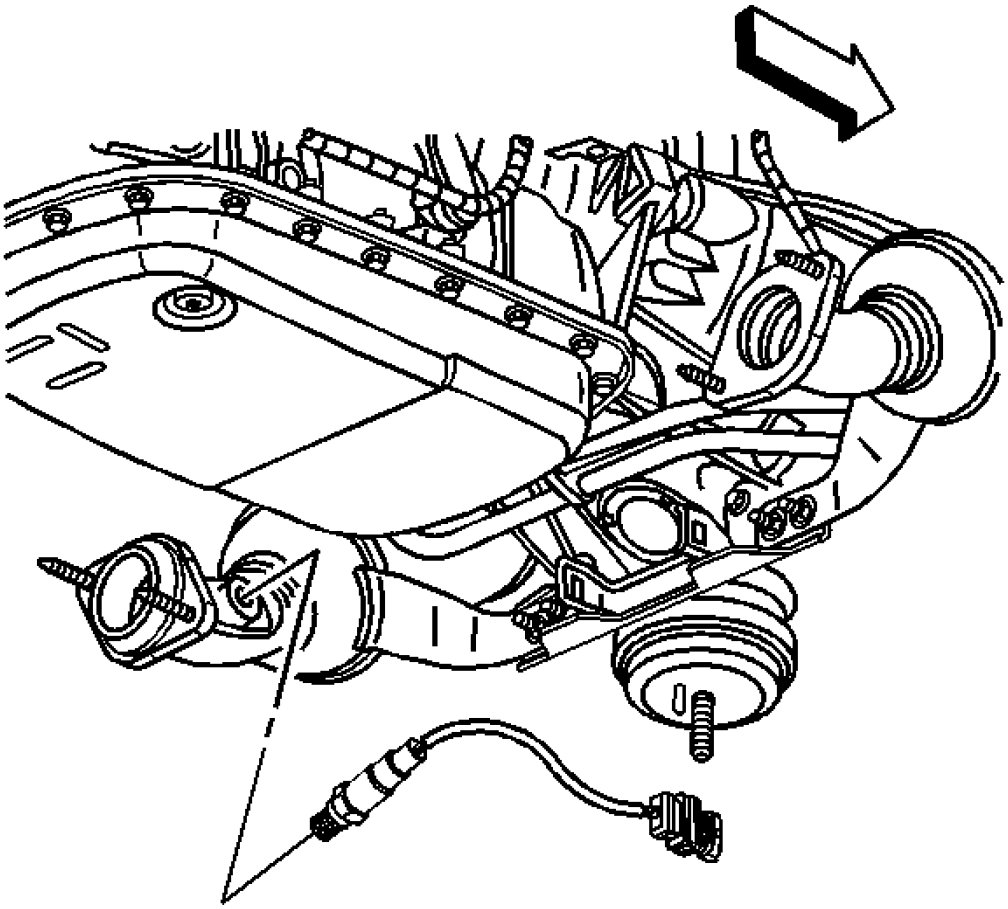


Fig. 17: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

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5. Remove the HO2S.

Installation Procedure

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

CAUTION: Refer to Component Fastener Tightening Caution .

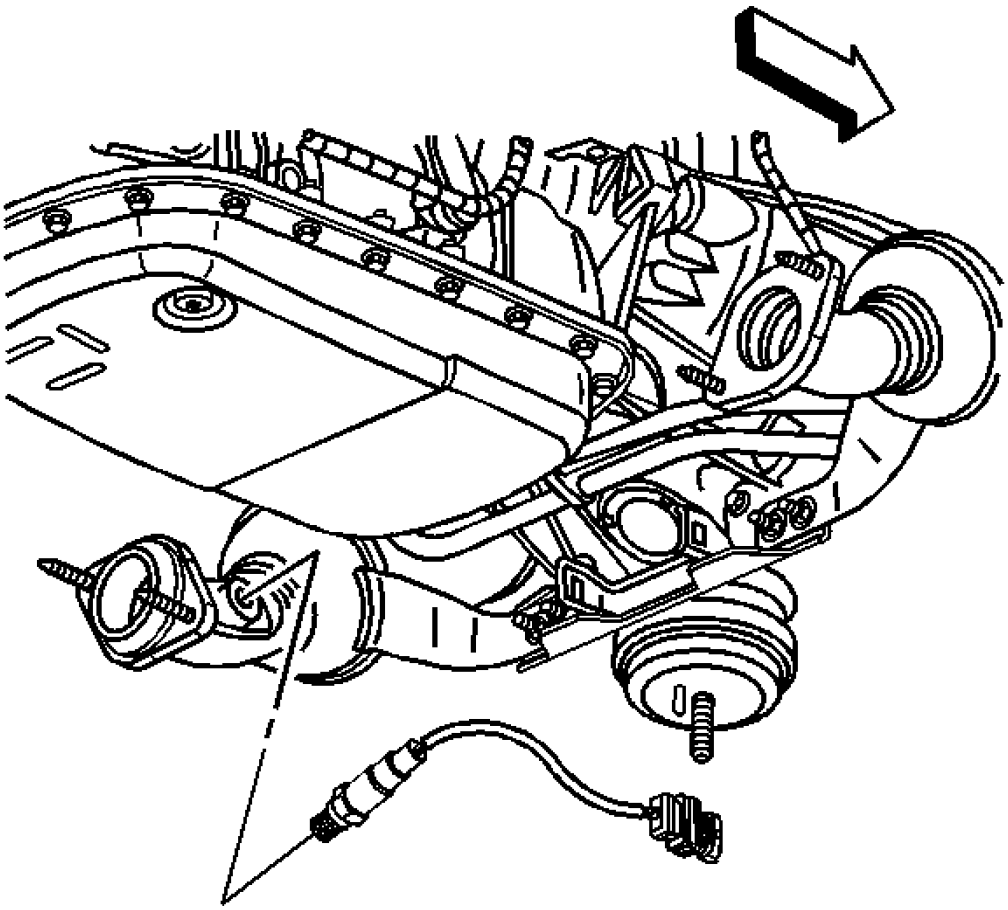


Fig. 18: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

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1. Install the HO2S and tighten to 40 N.m (30 lb ft).

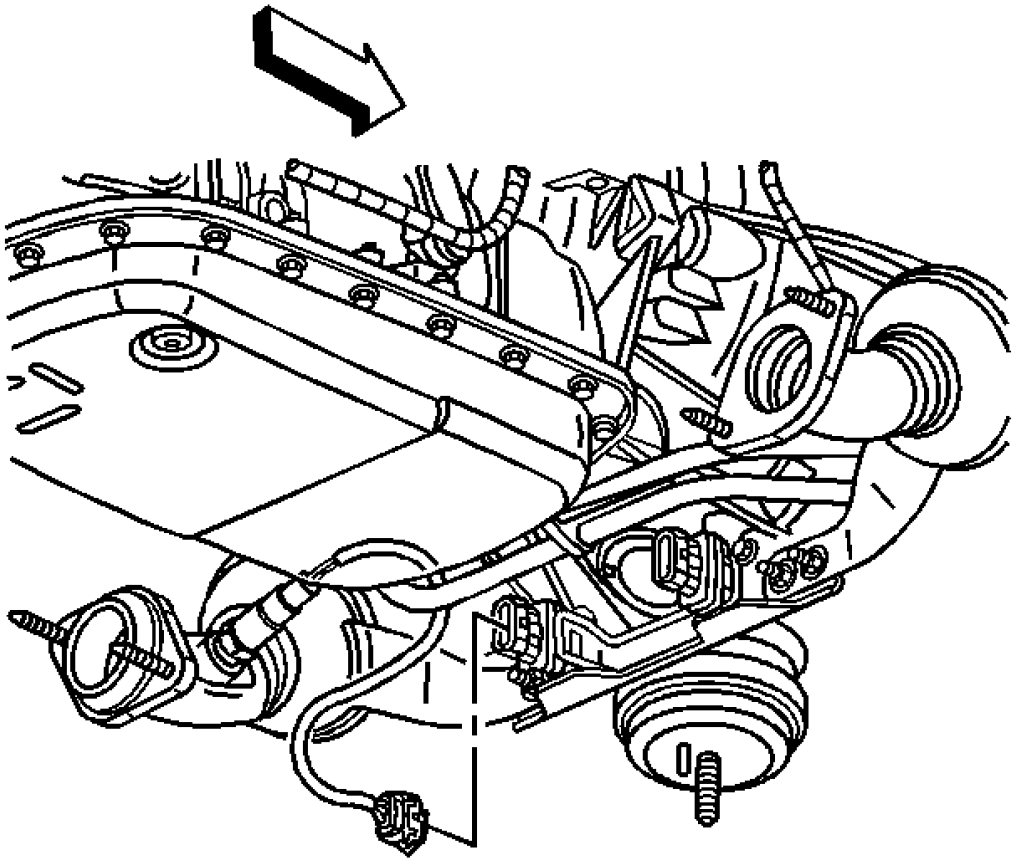


Fig. 19: View Of Heated Oxygen Sensor Electrical Connector - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

2. Connect the HO2S electrical connector.
3. Install the HO2S wiring harness to the transmission case.
4. Lower the vehicle.

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

Removal Procedure

1. Remove the closeout/insulator panel from under the dashboard on the drivers side.

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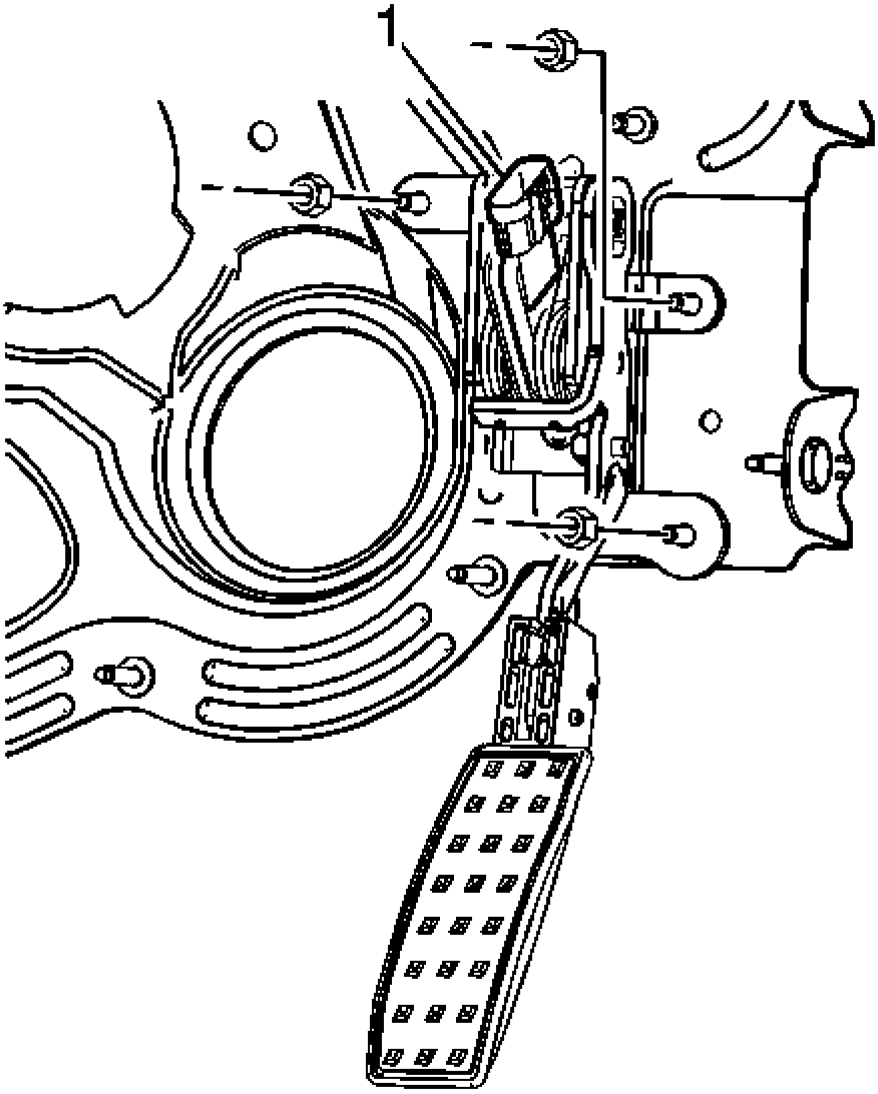


Fig. 20: Locating APP Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

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2. Disconnect the accelerator pedal position (APP) sensor electrical connector from the accelerator pedal module.
3. Remove the nuts from the APP sensor and remove the APP sensor from the front of dash.

Installation Procedure

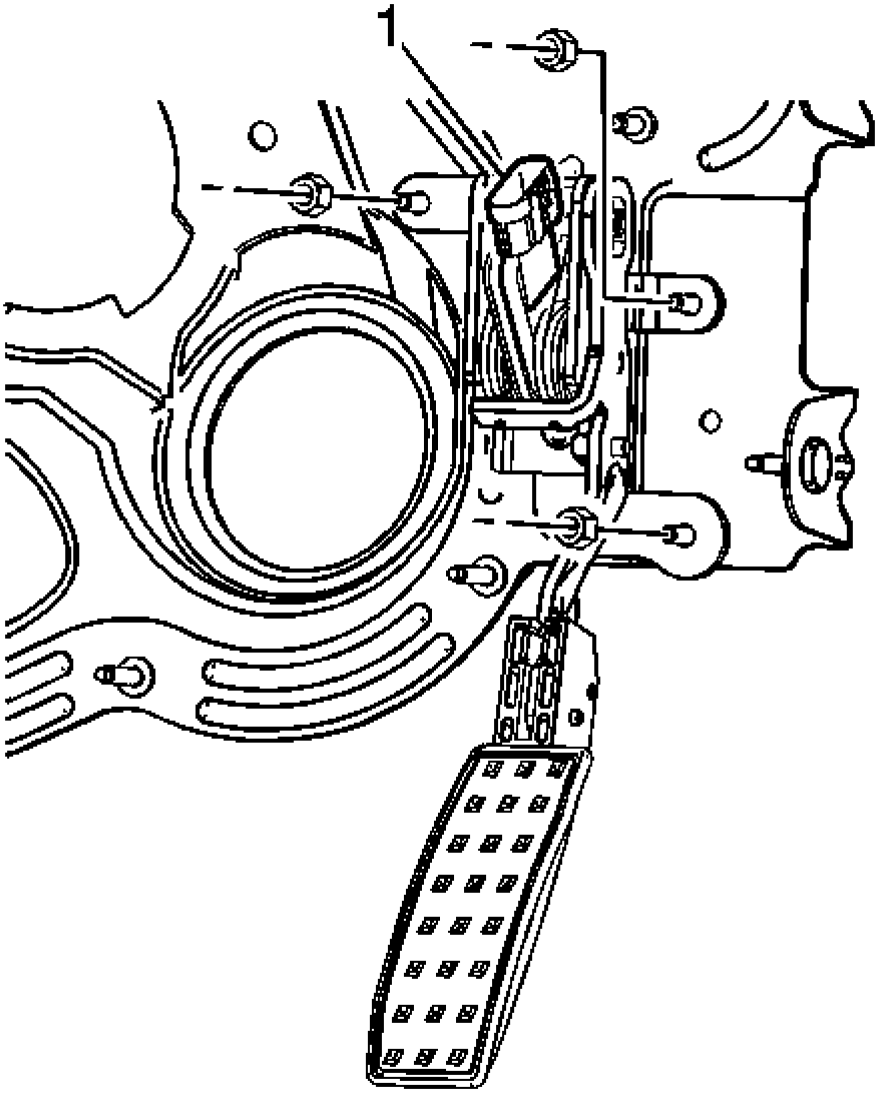


Fig. 21: Locating APP Sensor
Courtesy of GENERAL MOTORS CORP.

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1. Install the APP sensor to the front of dash.

CAUTION: Refer to Fastener Caution .

2. Install the APP sensor mounting nuts and tighten to 9 N.m (80 lb in).
3. Connect the APP sensor electrical connector.
4. Operate the accelerator pedal and observe the APP angles using a scan tool. The accelerator pedal should operate freely, without binding between closed throttle and wide open throttle.
5. Install the closeout/insulator panel.

THROTTLE BODY ASSEMBLY REPLACEMENT

Removal Procedure

1. Turn the ignition OFF.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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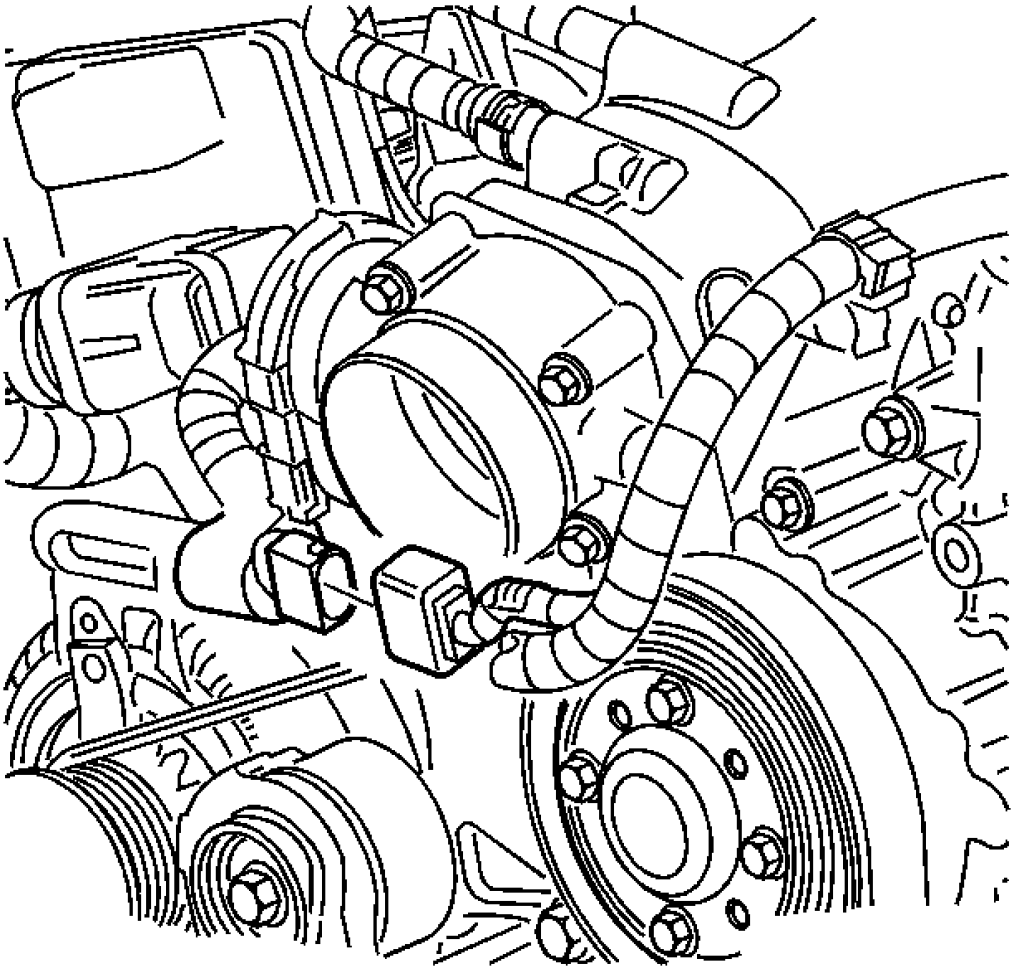


Fig. 22: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Disengaging Connectors Caution .

3. Remove the throttle body electrical connector.

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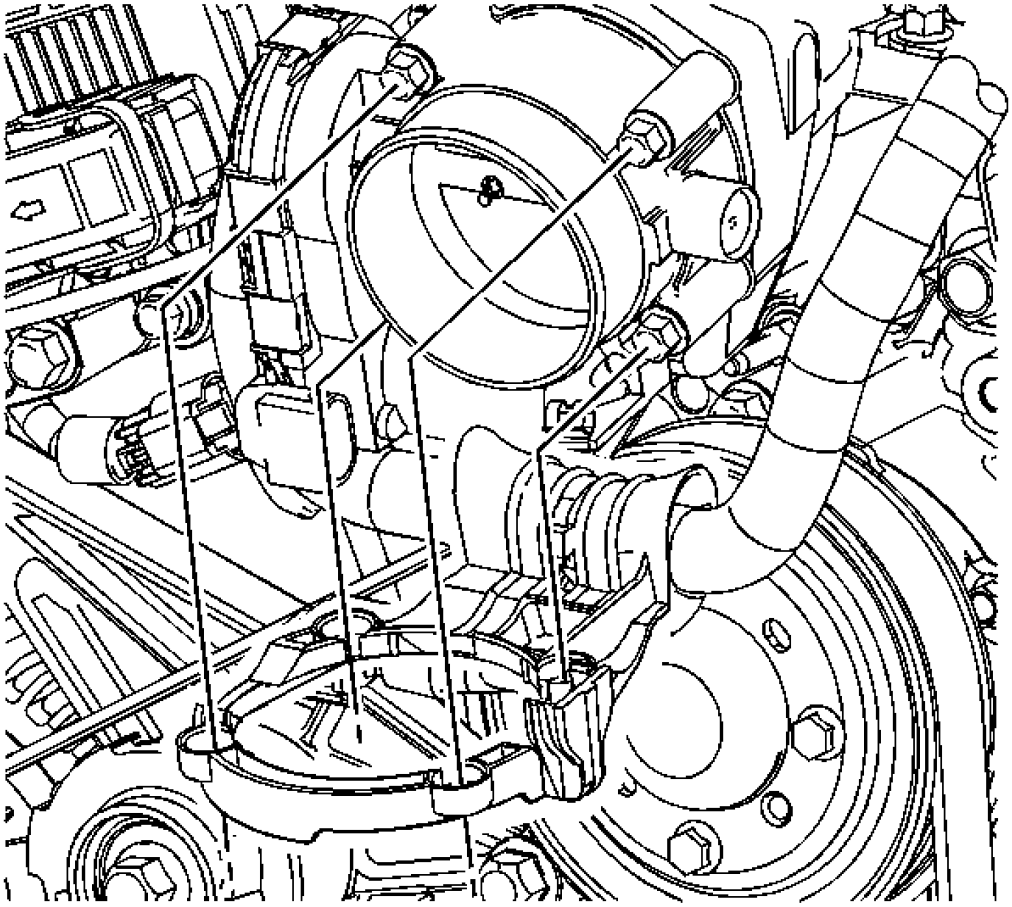


Fig. 23: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

4. Unlock and reposition the wiring harness conduit.

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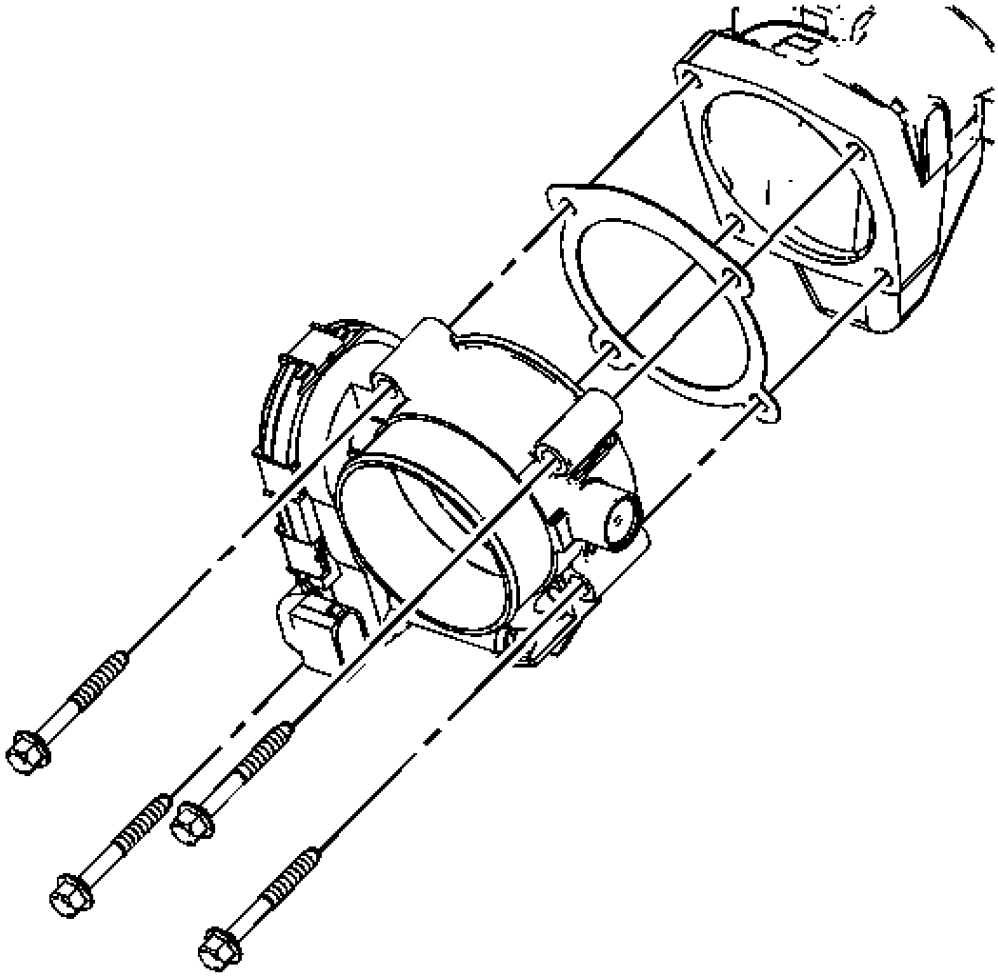


Fig. 24: View Of Throttle Body
Courtesy of GENERAL MOTORS CORP.

5. Remove the throttle body bolts.
6. Remove the throttle body and gasket.

Installation Procedure

1. Carefully clean the throttle body mounting surfaces of any gasket and/or seal material.

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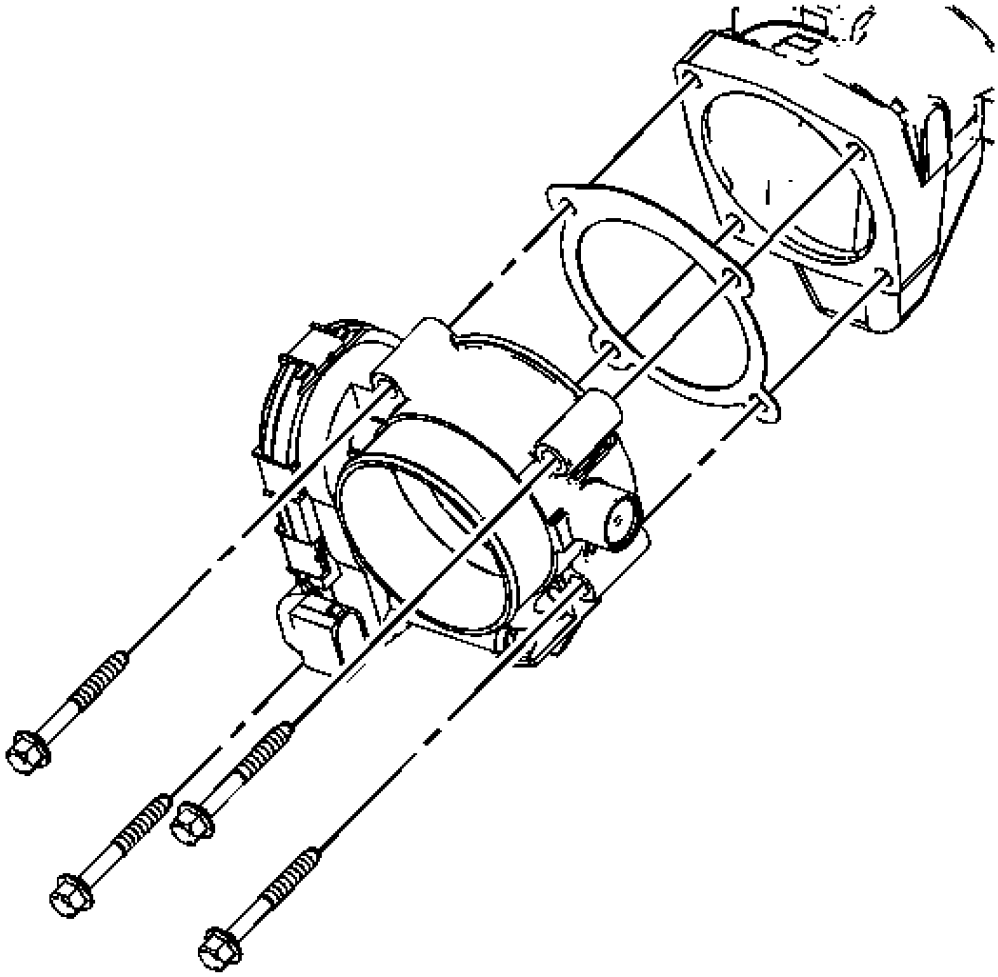


Fig. 25: View Of Throttle Body
Courtesy of GENERAL MOTORS CORP.

2. Install the throttle body and NEW gasket.

CAUTION: Refer to Fastener Caution .

3. Install the throttle body bolts and tighten to 10 N.m (89 lb in).

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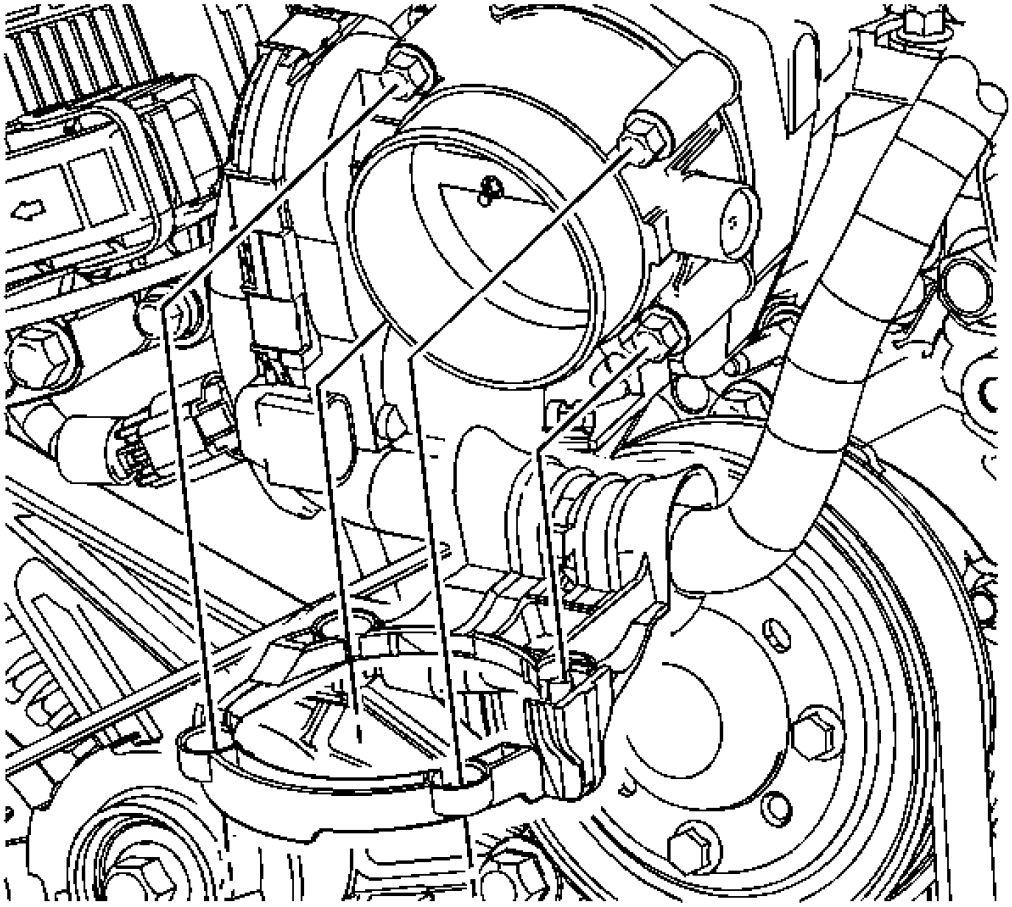


Fig. 26: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

4. Install the wiring harness conduit.

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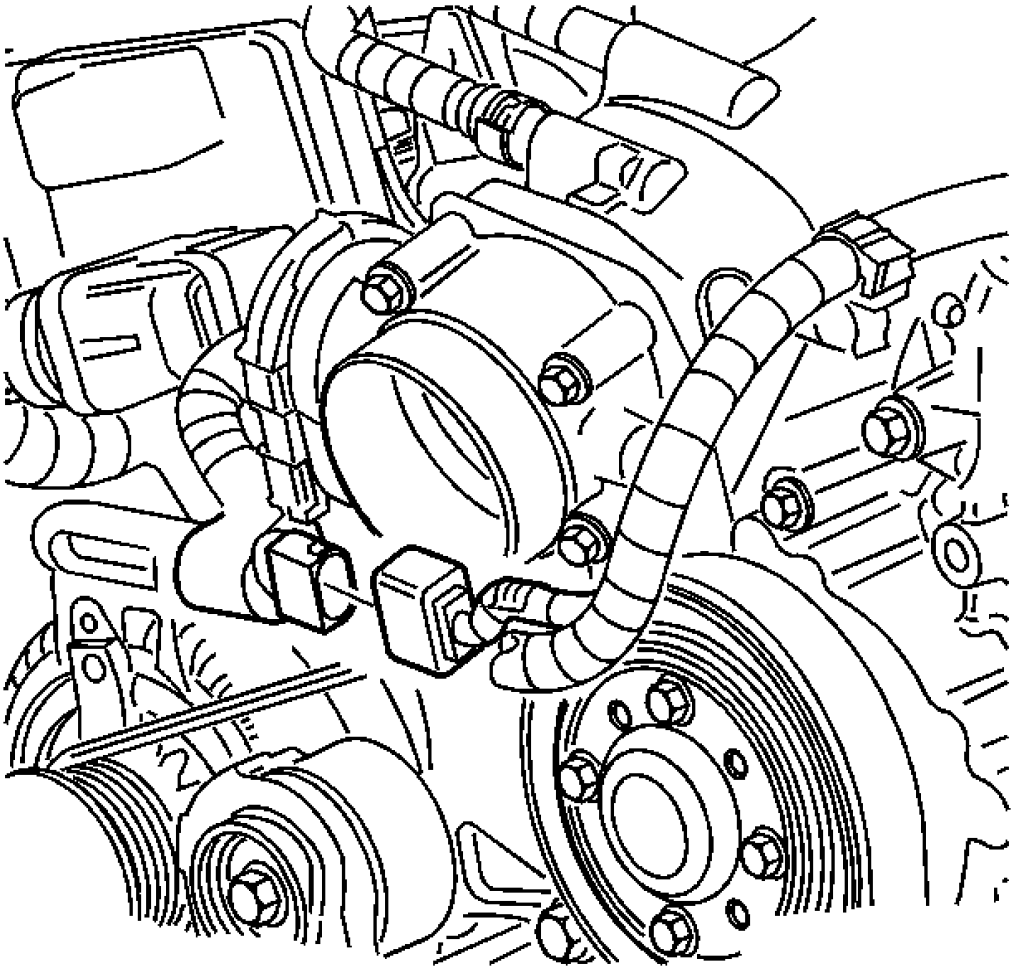


Fig. 27: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Install the throttle body electrical connector.
6. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
7. Perform the throttle learn procedure. Refer to **Throttle/Idle Learn (Without LF1)**.
8. Use the scan tool to clear all DTCs.

THROTTLE BODY INSPECTION AND CLEANING

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
2. Fully open the throttle valve in order to Inspect the throttle body bore and the throttle valve plate for any deposits.

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CAUTION: Do not subject a throttle body assembly which contains the following components to an immersion cleaner or a strong solvent:

- **Throttle position (TP) sensor**
- **Idle air control (IAC) valve**
- **Sealed throttle shaft bearings**

The cleaners will damage the electric components or sensors.
The cleaners will damage some of these components that contain seals or O-rings.
Solvents can wash away or break down the grease used on non-serviceable throttle shaft bearings.
Never use a wire brush or scraper to clean the throttle body. A wire brush or sharp tools may damage the throttle body components.
Do not use a cleaner that contains methyl ethyl ketone. This extremely strong solvent may damage components and is not necessary for this type of cleaning.

3. Use a clean shop towel and Top Engine Cleaner GM P/N 1052626 or equivalent product in order to clean the throttle body bore and the throttle valve plate.

   If necessary, use a parts cleaning brush in order to remove heavy deposits.

4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the throttle learn procedure. Refer to **Throttle/Idle Learn (Without LF1)**.

FUEL PRESSURE RELIEF

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

NOTE: If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

1. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel pump to shut off.
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

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Special Tools

CH-48027 Digital Pressure Gauge. See **Special Tools** .

Installation Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

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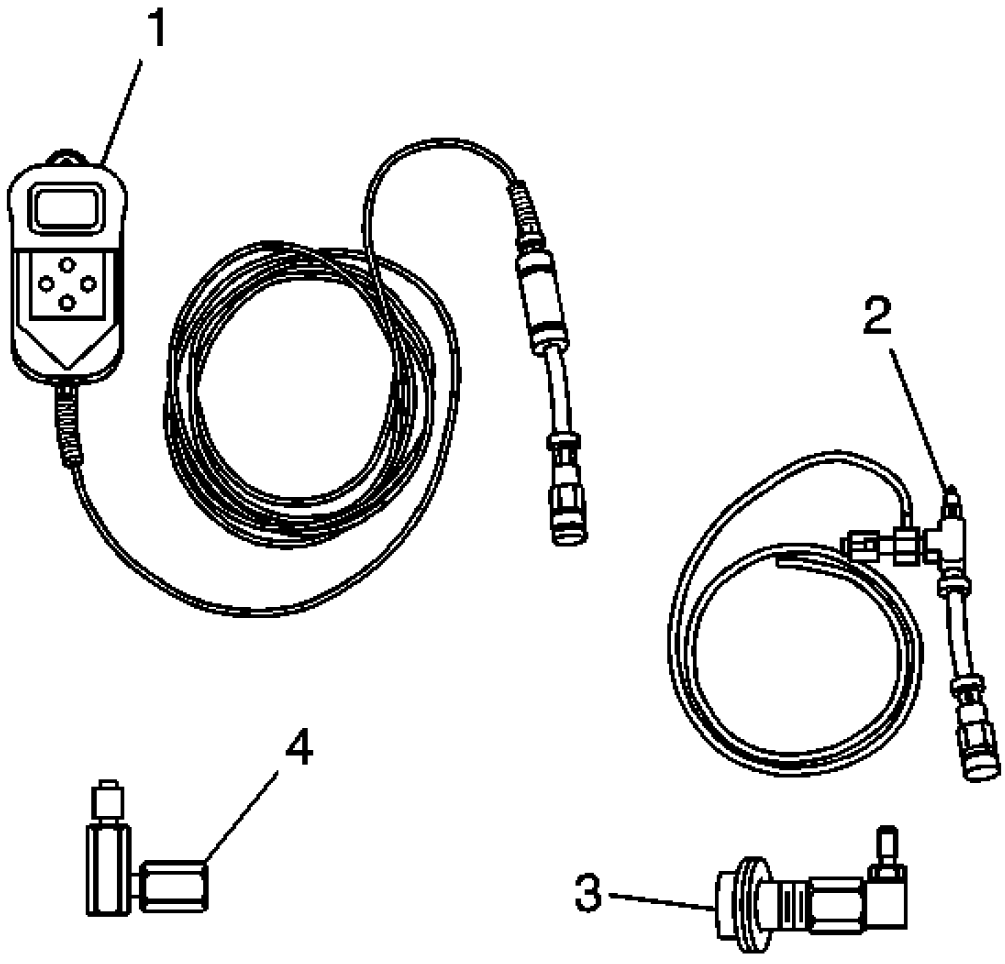


Fig. 28: Identifying Digital Pressure Gauge & Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH-48027** , refer to the manufacture's directions. See **Special Tools** .

Removal Procedure

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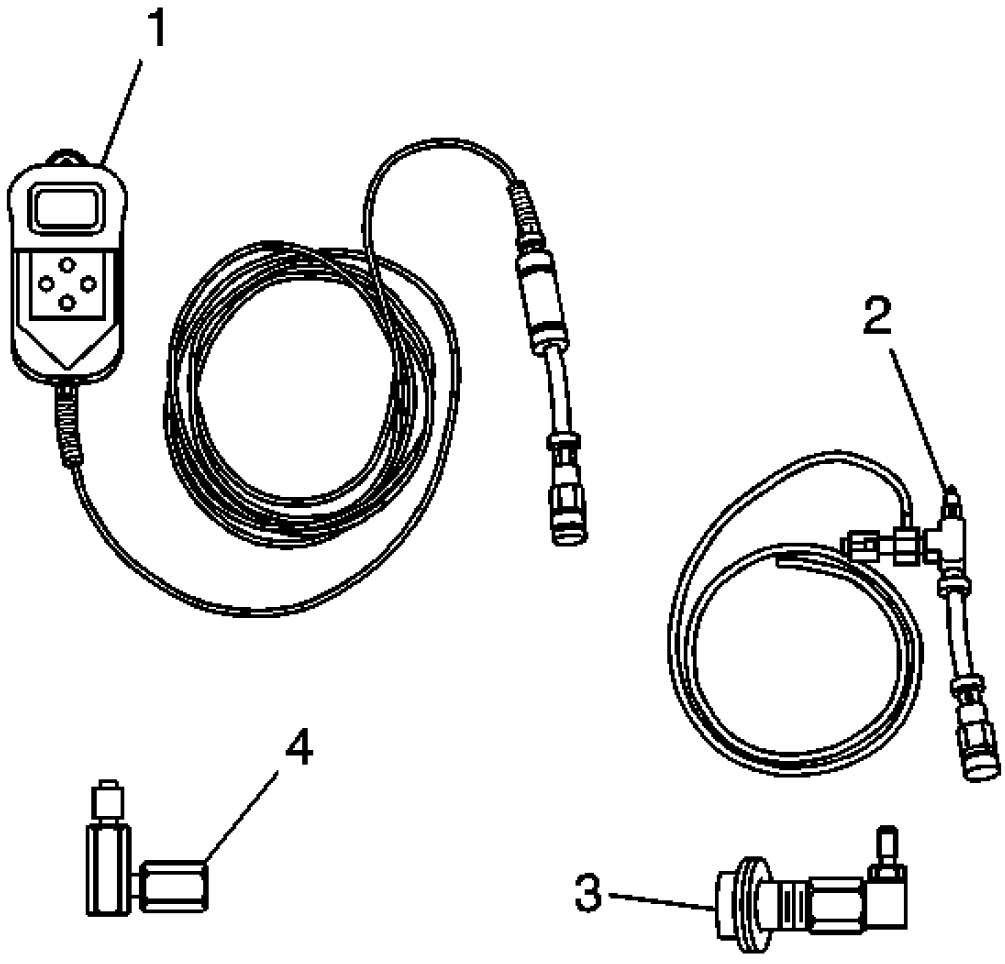


Fig. 29: Identifying Digital Pressure Gauge & Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure, if required. Perform the following steps:

   WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

   1. Wrap a shop towel around the fuel rail service port.

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2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the CH-48027-2 (2).
5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

2. Disconnect the CH-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
4. Disconnect the CH-48027-3 (4) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **J 37088-A** Fuel Line Disconnect Tool Set
- **J 44581** Fuel Line Disconnect Tool. See **Special Tools** .

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

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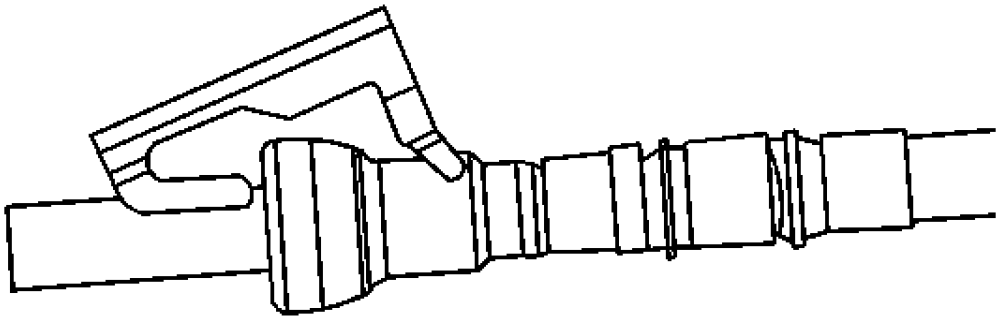


Fig. 30: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

2. Remove the retainer from the quick-connect fitting.

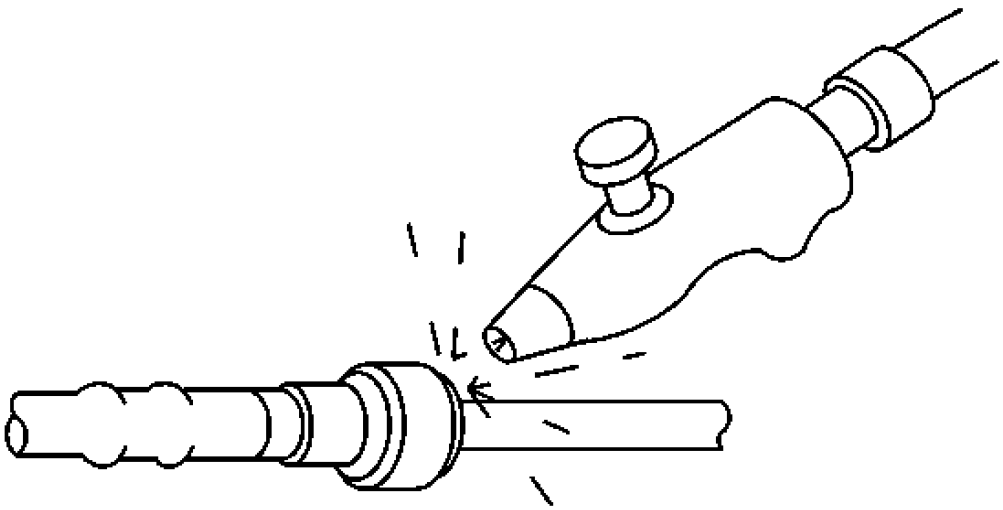


Fig. 31: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Wear safety glasses when using compressed air, as flying dirt

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particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

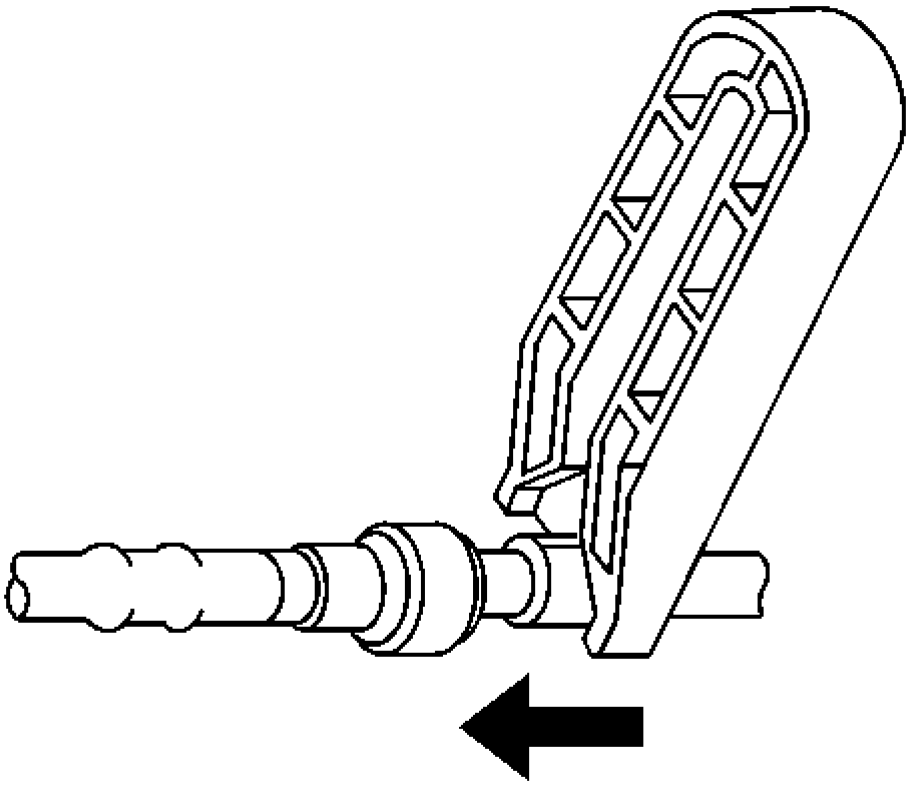


Fig. 32: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **J 37088-A** or **J 44581** . See **Special Tools** . Insert the **J 37088-A** or **J 44581** into the female connector, then push inward to release the locking tabs. See **Special Tools** .

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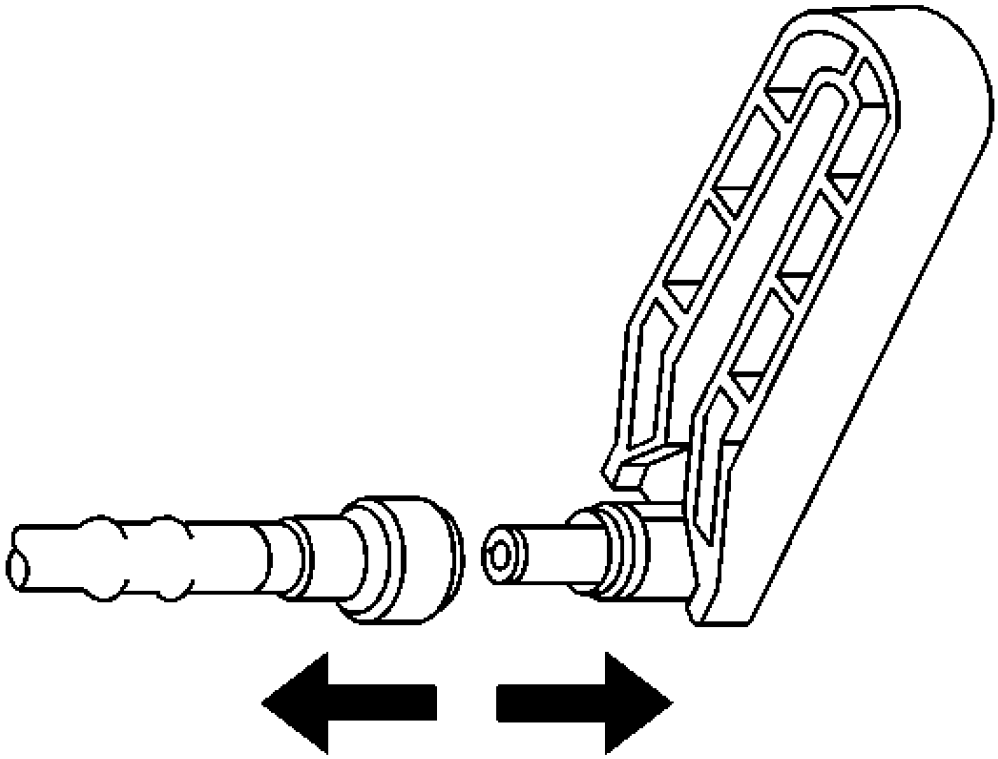


Fig. 33: Pulling Connection Apart
Courtesy of GENERAL MOTORS CORP.

5. Pull the connection apart.

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

6. Using a clean shop towel, wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs.
8. Clean or replace the components as required.

Installation Procedure

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WARNING: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.
This will ensure proper reconnection and prevent a possible fuel leak.
During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

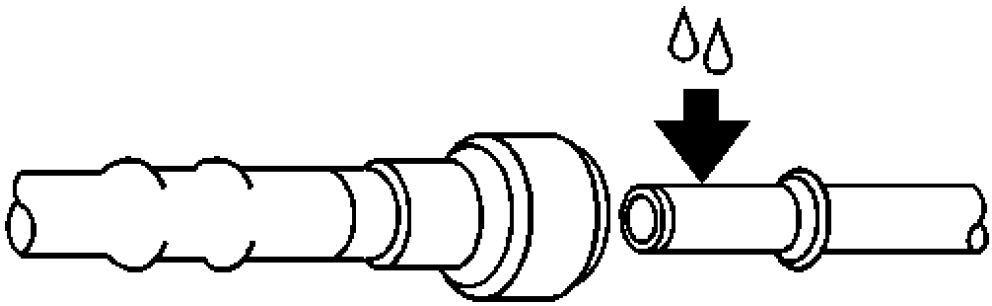
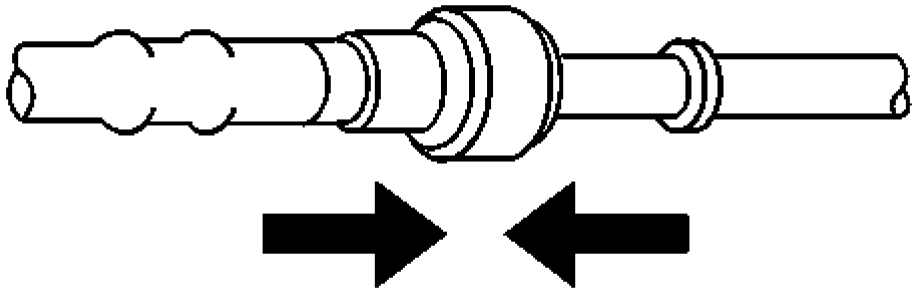


Fig. 34: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

1. Apply a few drops of clean engine oil to the male pipe end.



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Fig. 35: Pushing Fittings Together
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

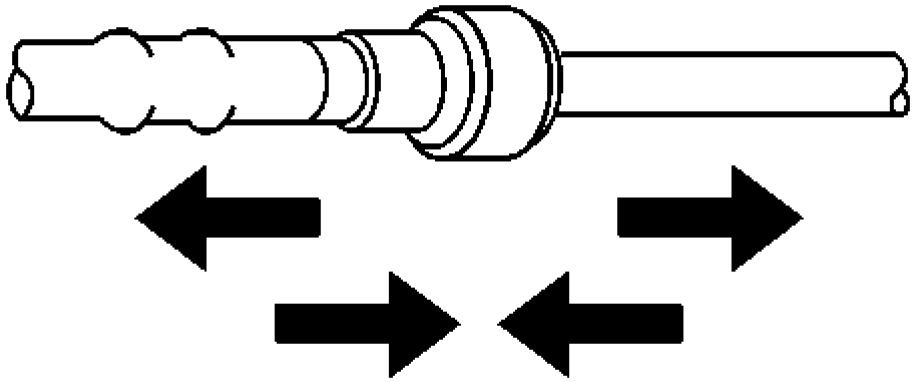


Fig. 36: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS CORP.

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

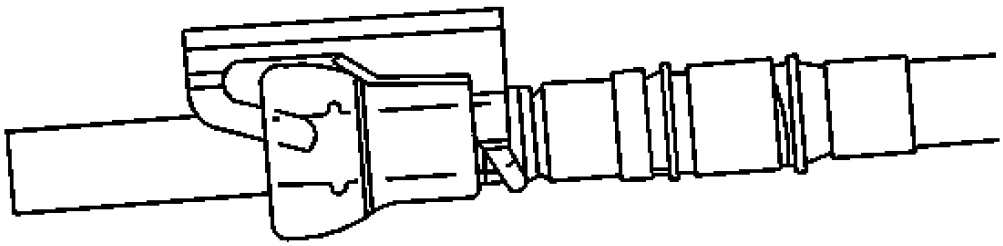


Fig. 37: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

4. Install the retainer to the quick-connect fitting.

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5. Inspect for leaks using the following procedure:
    1. Turn the ignition ON, with the engine OFF for 2 seconds.
    2. Turn the ignition OFF, for 10 seconds.
    3. Turn the ignition ON, with the engine OFF for 2 seconds.
    4. Turn the ignition OFF.
    5. Inspect for leaks.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Disconnect Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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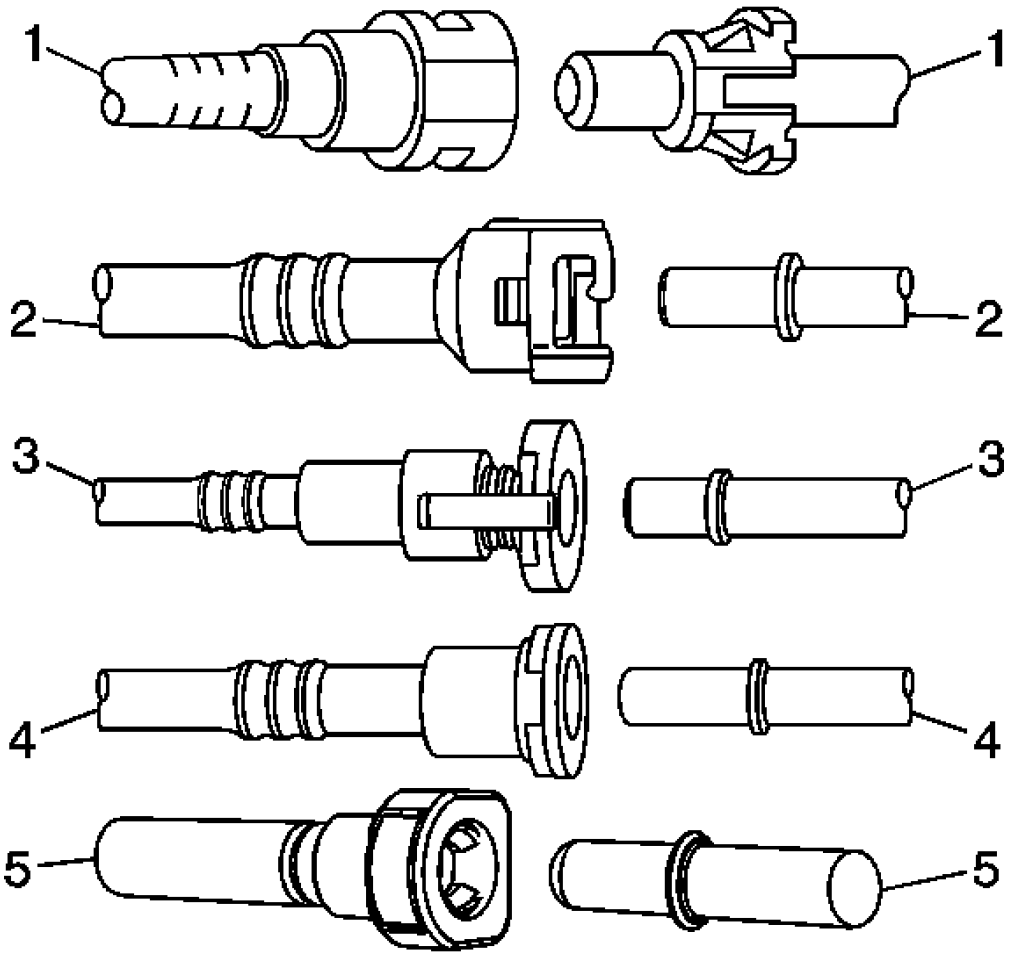


Fig. 38: Identifying Plastic Collar Fuel & Evaporative Emission Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

NOTE: **There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.**

- **Bartholomew (1)**
- **Q Release (2)**
- **Squeeze to Release (3)**
- **Sliding Retainer (4)**
- **Push Down TI (5)**

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The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

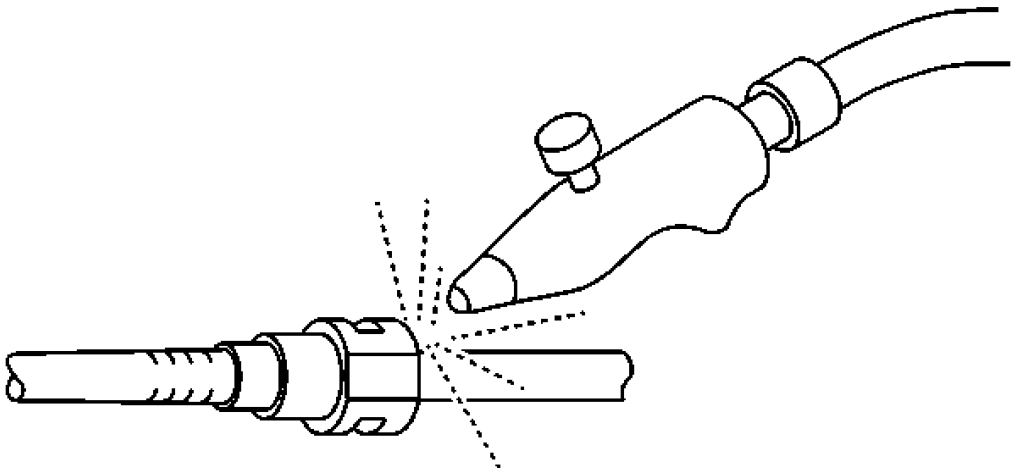


Fig. 39: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

2. Using compressed air, blow any dirt or debris from around the connection.

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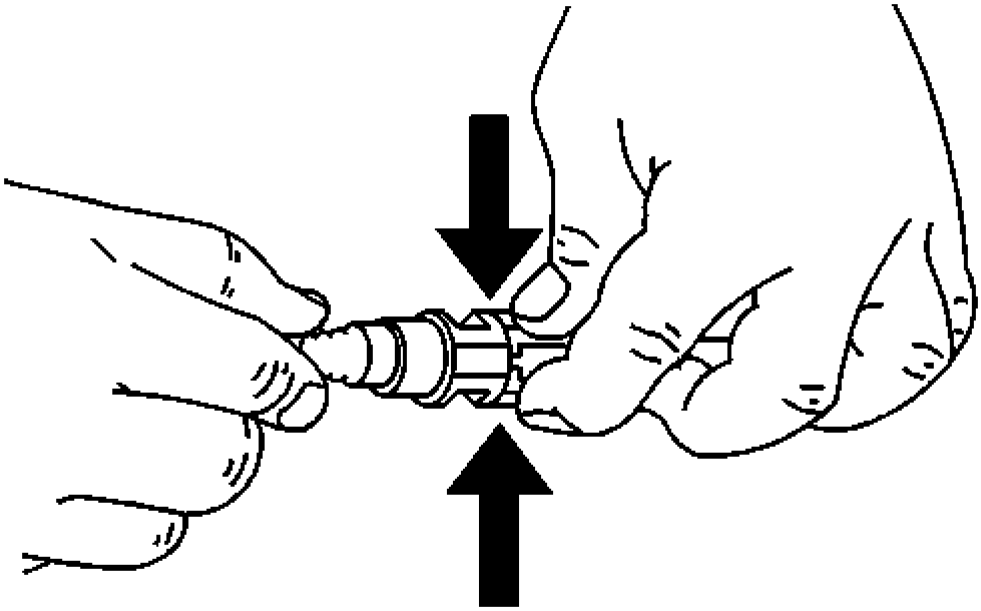


Fig. 40: Squeezing Plastic Quick Connect Fitting Release Tabs -- Bartholomew Style Connector
Courtesy of GENERAL MOTORS CORP.

3. This step applies to Bartholomew style connector ONLY. Squeeze the plastic quick connect fitting release tabs.

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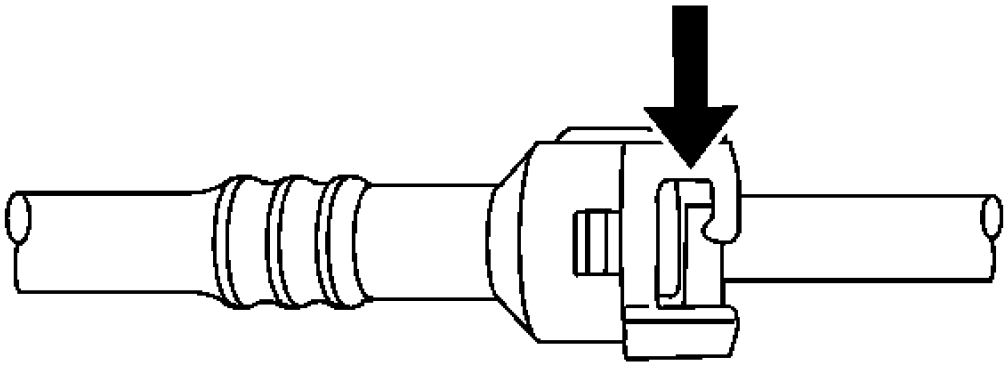


Fig. 41: Releasing Release Tab Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

4. This step applies to Release Tab style connector ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.

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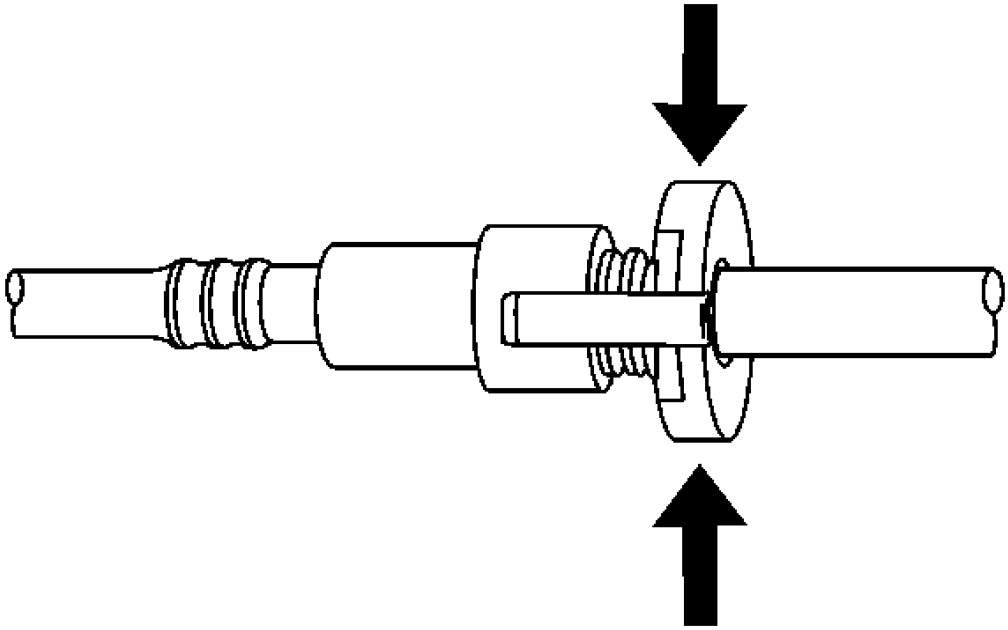


Fig. 42: Disengaging Squeeze To Releasse Style Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

5. This step applies to the Squeeze to Release style connector ONLY. Squeeze where indicated by the arrows shown above on both sides of the plastic ring surrounding the quick connect fitting.

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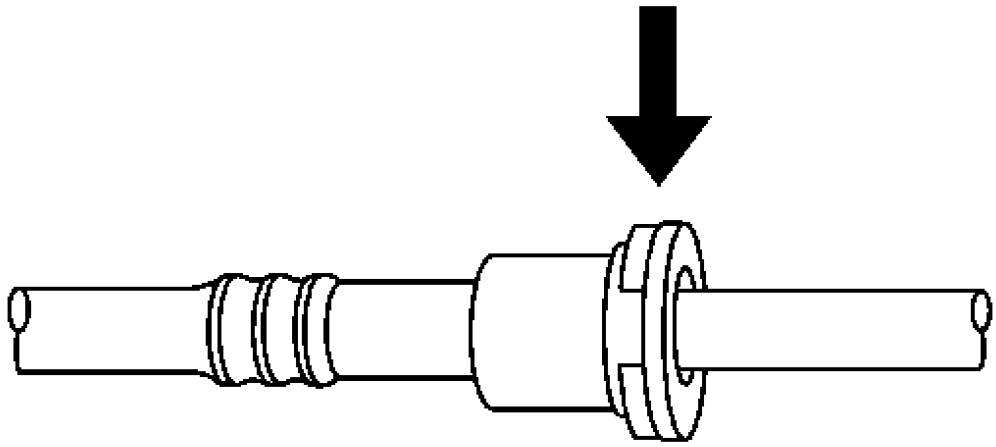


Fig. 43: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS CORP.

6. This step applies to the Sliding Retainer style connector ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab does not move try pressing the tab in from the opposite side. The tab will only move in one direction.

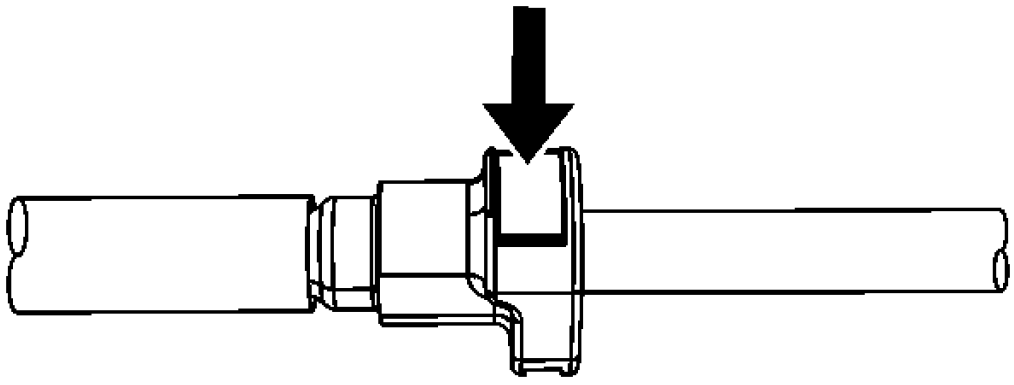


Fig. 44: View Of Push Down TI Style Connector
Courtesy of GENERAL MOTORS CORP.

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7. This step applies to the Push Down TI style connector ONLY. Release the fitting by pressing on the tab indicated by the arrow.

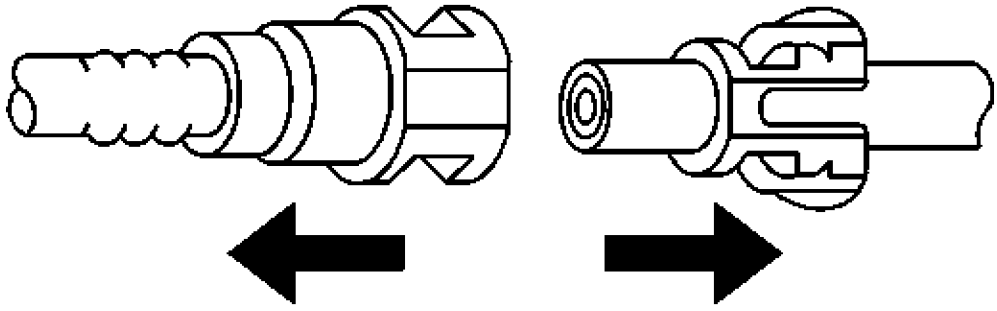


Fig. 45: Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Relieving Fuel Pressure Warning .

8. Pull the connection apart.

Connect Procedure

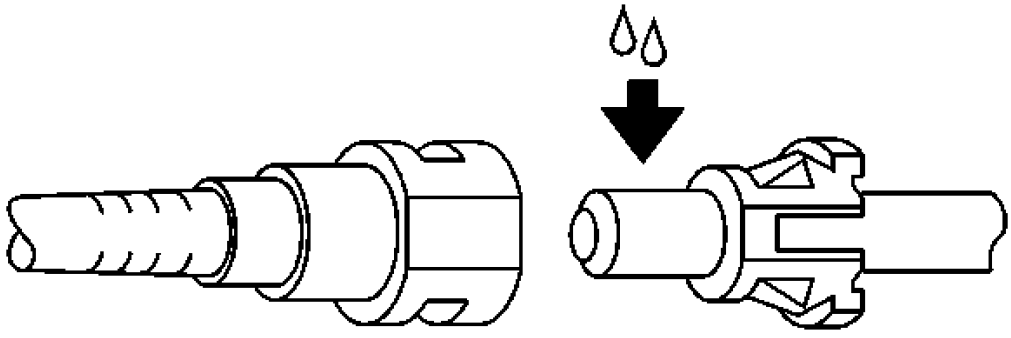


Fig. 46: Lubricating Male Pipe End

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Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Pipe Fitting Warning .

1. Apply a few drops of clean engine oil to the male connection end.

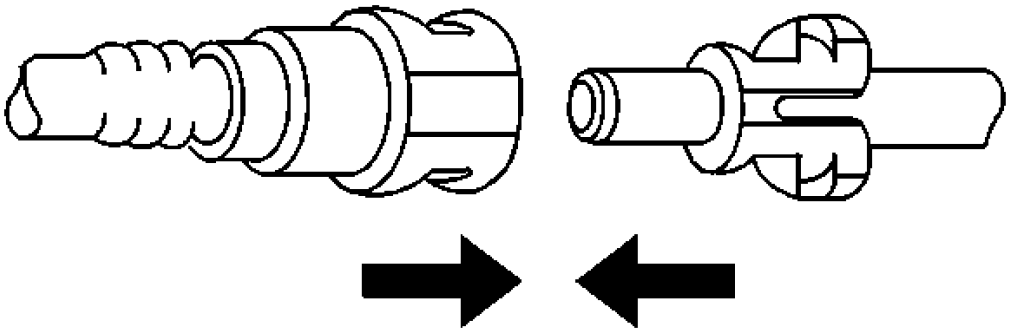


Fig. 47: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

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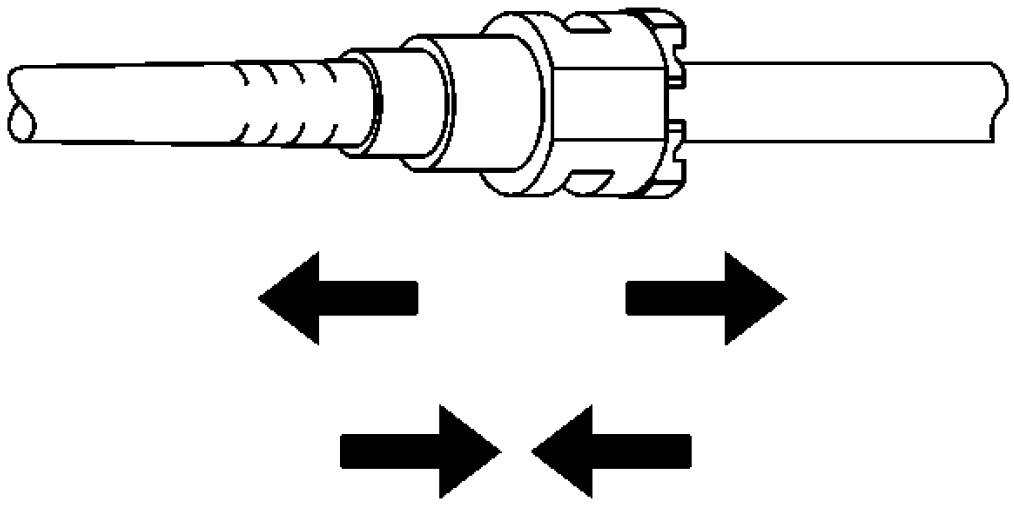


Fig. 48: Ensuring Secure Connection (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

3. Once installed, pull on both sides of the connection in order to make sure the connection is secure.

FUEL TANK DRAINING

Special Tools

- **J 36850** Transjel Lubricant. See **Special Tools** .
- **J 45004** Fuel Drain Hose. See **Special Tools** .

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

1. Remove the fuel filler cap.

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NOTE: Lubricate the fuel drain hose with J 36850 or equivalent to aid in hose insertion and removal. See Special Tools . Do not use an unapproved lubricant.

2. Insert the **J 45004** into the fuel tank until the hose reaches the bottom of the fuel tank. See **Special Tools** .
3. Use an air operated pump device in order to drain the fuel into an approved gasoline container.

   Up to 26 liters (7 gallons) of residual fuel may remain in the secondary side of the fuel tank.

4. Simultaneously twist and pull in order to remove the **J 45004** from the fuel tank. See **Special Tools** .

FUEL TANK REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to **Fuel Pressure Relief**.
2. Drain the fuel tank. Refer to **Fuel Tank Draining**.
   - Support the rear suspension with a jack stand.
   - Remove the front support bolts.
   - Loosen the rear support bolts in order to slide the fuel tank out.
   - For tightening specifications, refer to **Rear Suspension Support Replacement** .

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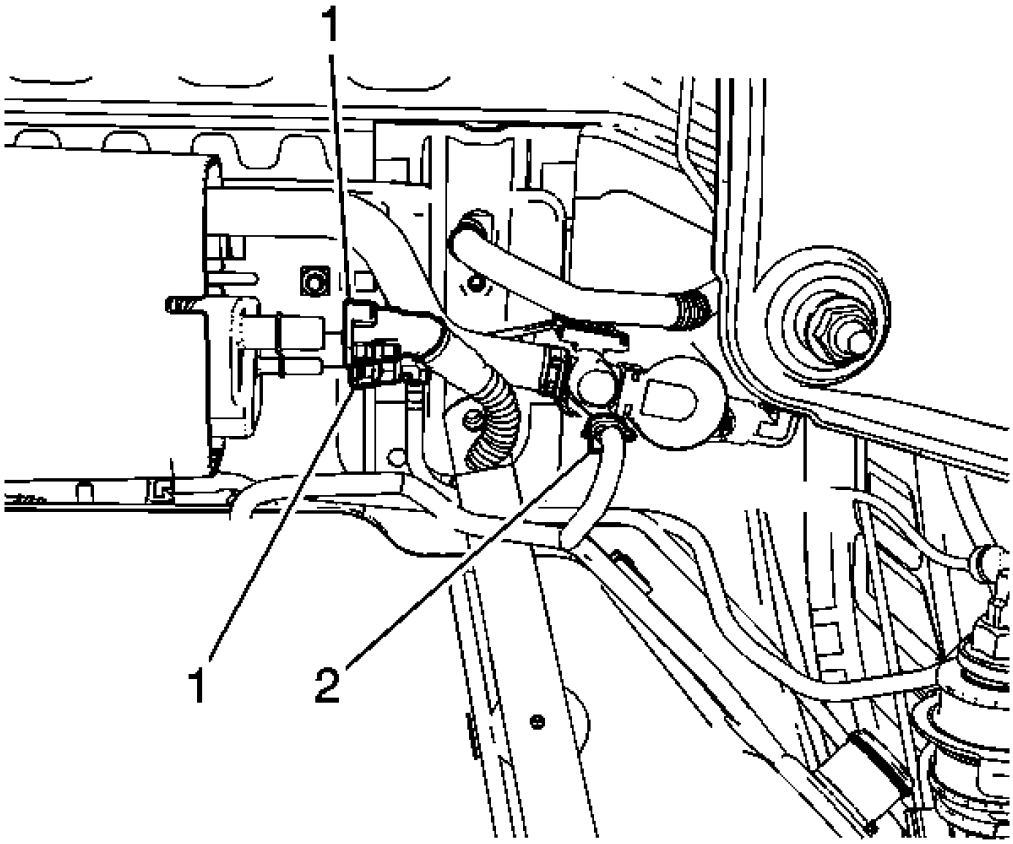


Fig. 49: Evaporative Emission Lines & Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the evaporative emission lines (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Disconnect the vent solenoid electrical connector (2).

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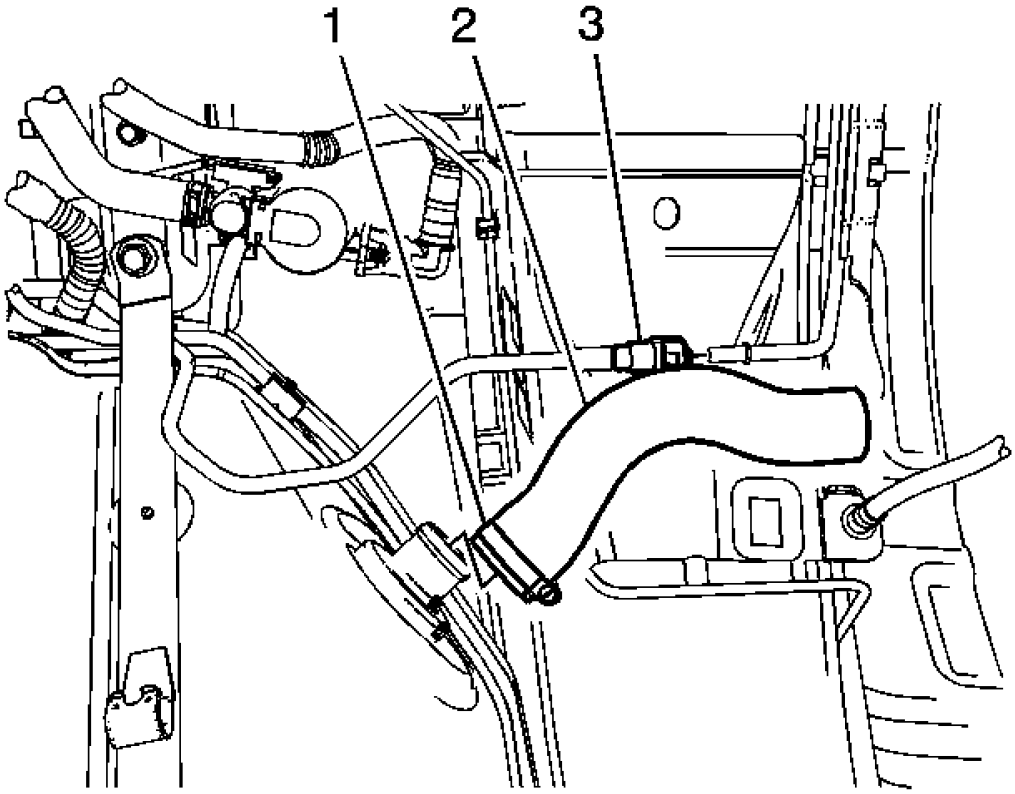


Fig. 50: Hose Clamp, Filler Tube & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

5. Loosen the hose clamp (1) and remove the filler tube (2).
6. Disconnect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

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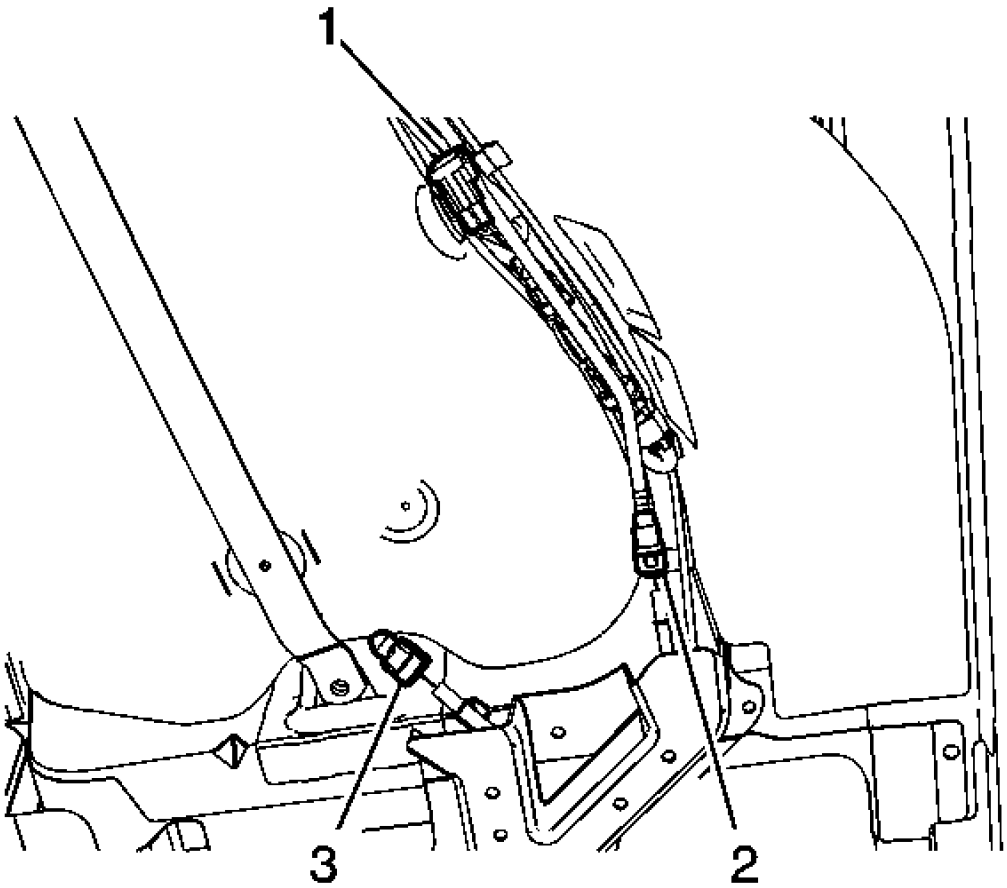


Fig. 51: Fuel Tank Electrical Connector, Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the fuel tank electrical connector (1).
8. Disconnect the fuel feed line (3) and evaporative emission line (2). Refer to **Plastic Collar Quick Connect Fitting Service** and **Metal Collar Quick Connect Fitting Service**.

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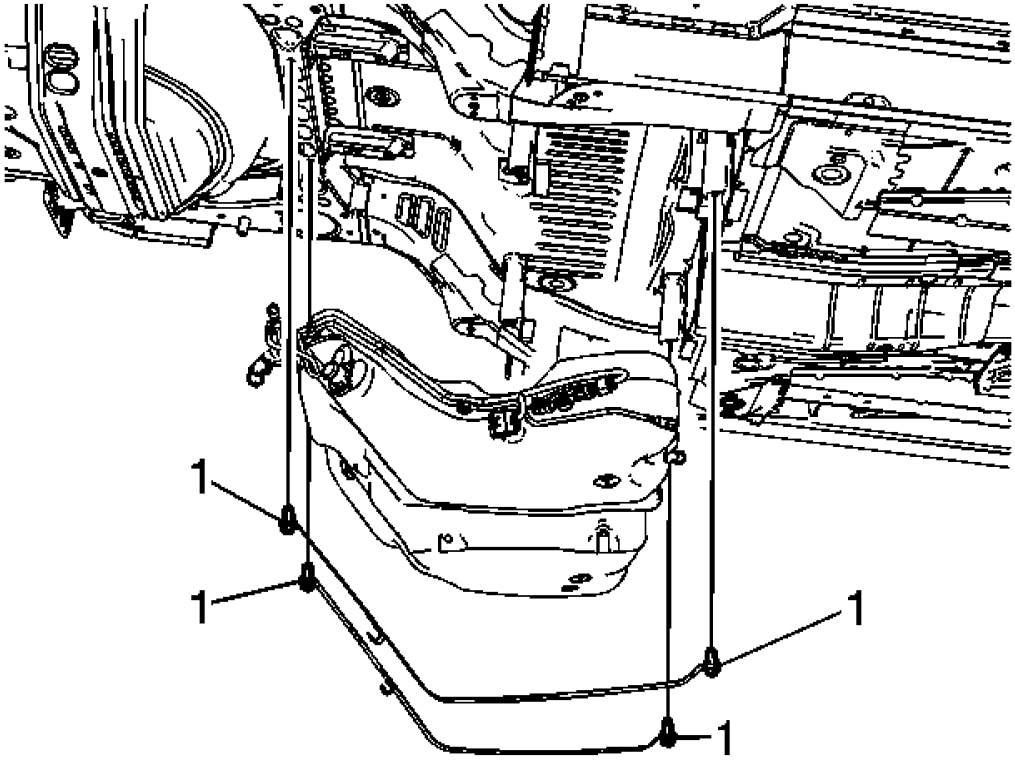


Fig. 52: Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS CORP.

9. Support the fuel tank with a suitable jack.
10. Remove the fuel tank strap bolts (1).
11. Remove the fuel tank.
12. Remove the following components if replacing just the fuel tank.
    1. Fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.
    2. Fuel level sensor. Refer to **Fuel Level Sensor Replacement - Left Side**.
    3. Transfer components as necessary.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
    1. Fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.
    2. Fuel level sensor. Refer to **Fuel Level Sensor Replacement - Left Side**.

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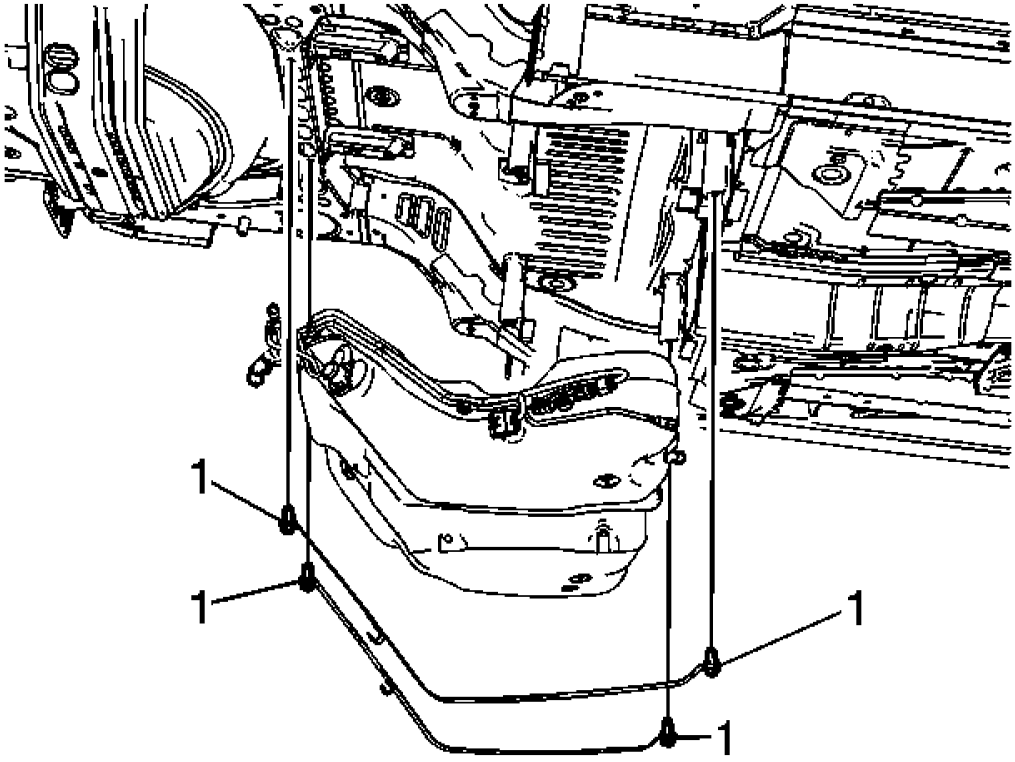


Fig. 53: Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Use a suitable jack and install the fuel tank.
3. Install the fuel tank strap bolts (1) and tighten to 50 N.m (37 lb ft).

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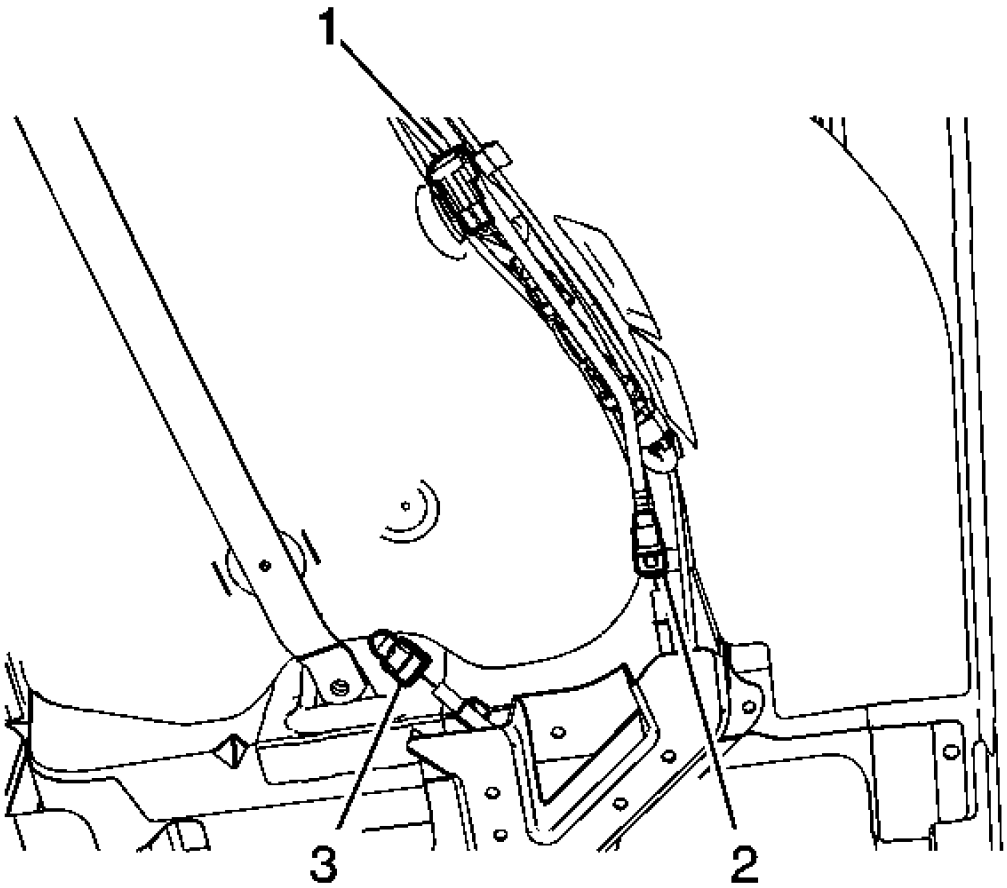


Fig. 54: Fuel Tank Electrical Connector, Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel tank electrical connector (1).
5. Connect the fuel feed line (2) and evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service** and **Metal Collar Quick Connect Fitting Service**.

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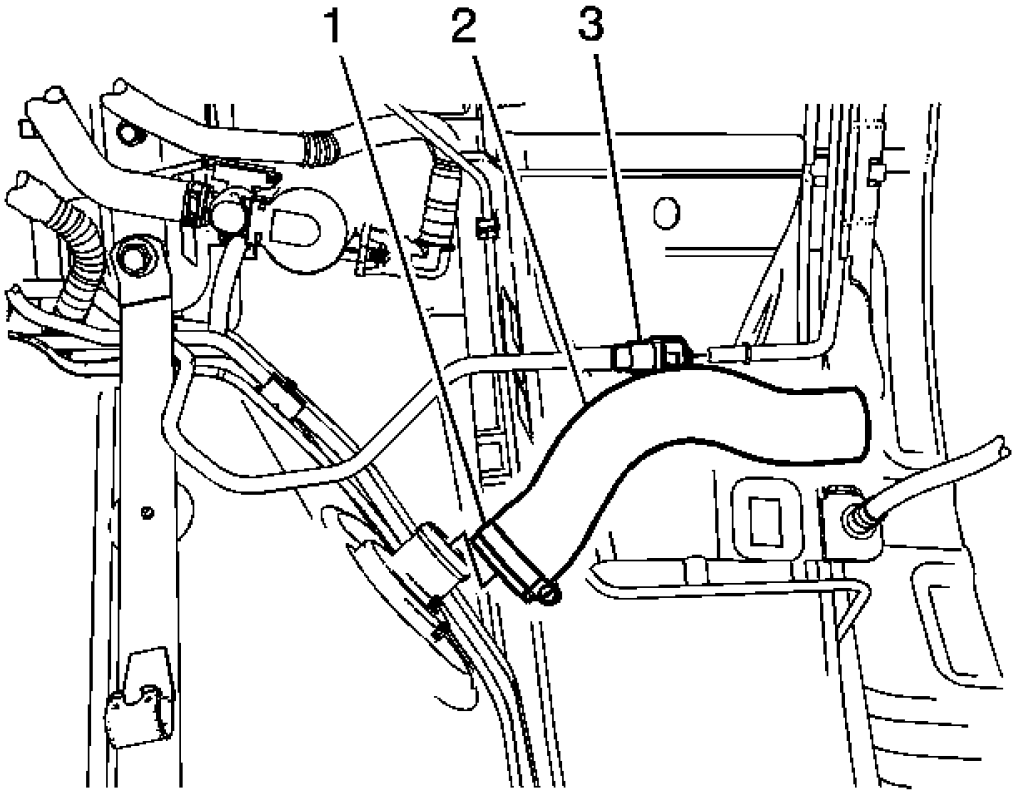


Fig. 55: Hose Clamp, Filler Tube & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

6. Install the filler tube (2) and tighten the hose clamp (1) to 4 N.m (35 lb in) and remove the filler tube (2).
7. Connect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

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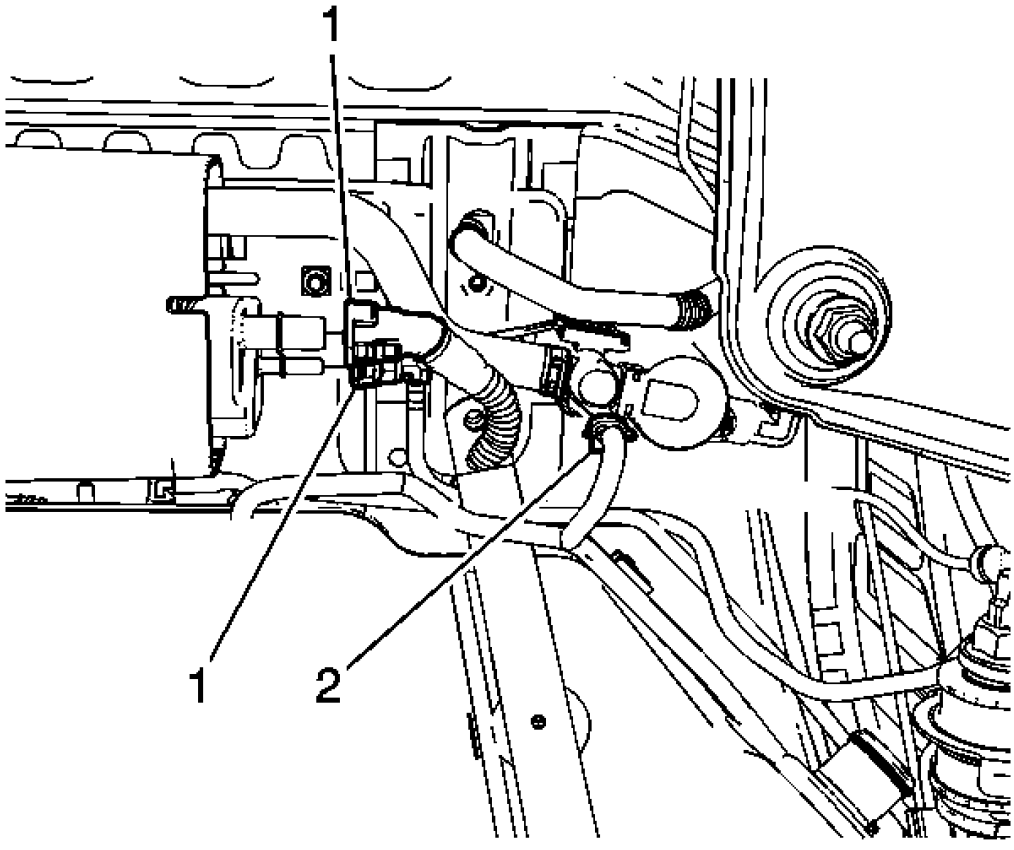


Fig. 56: Evaporative Emission Lines & Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Connect the evaporative emission lines (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Connect the vent solenoid electrical connector (2).
10. Connect the parking brake cables at the calipers. Refer to **Parking Brake Rear Cable Replacement** .
11. Install the rear suspension support and tighten to specifications. Refer to **Rear Suspension Support Replacement** .
12. Refill the fuel tank.
13. Inspect for fuel leaks.

FUEL TANK FUEL PUMP MODULE REPLACEMENT - RIGHT SIDE

Special Tools

J 45722 Fuel Sender Lock Ring Wrench. See **Special Tools** .

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Removal Procedure

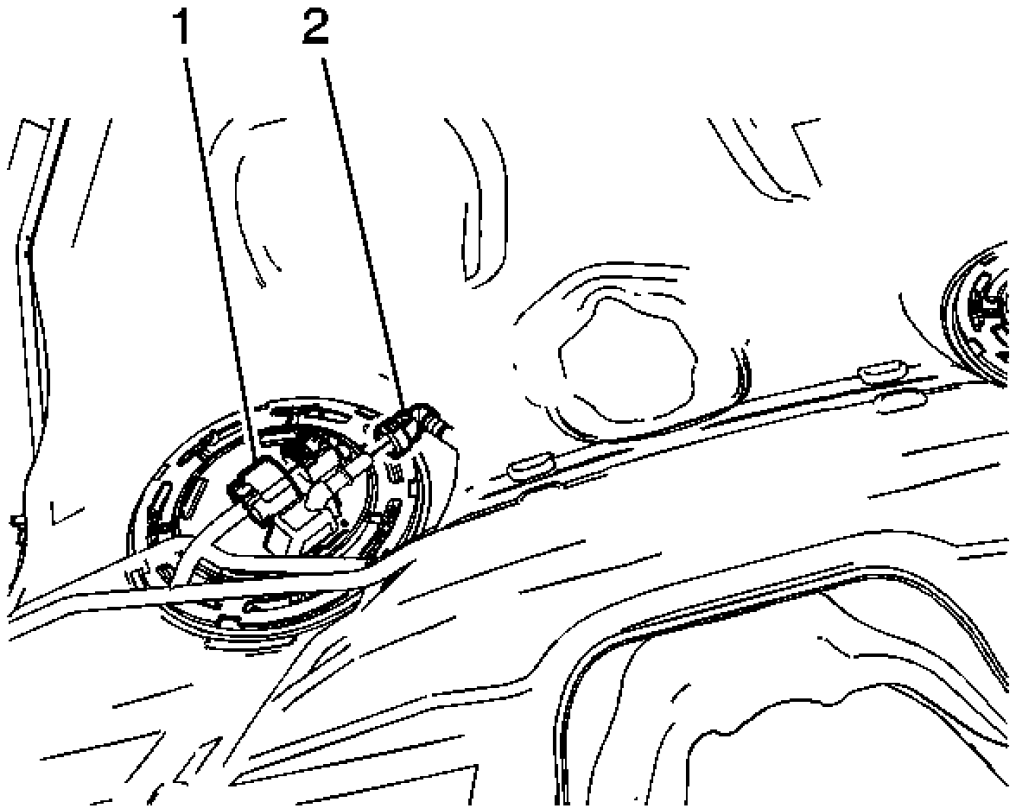


Fig. 57: Fuel Pump Electrical Connector & Fuel Feed Line
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect the fuel pump electrical connector (1) and the fuel feed line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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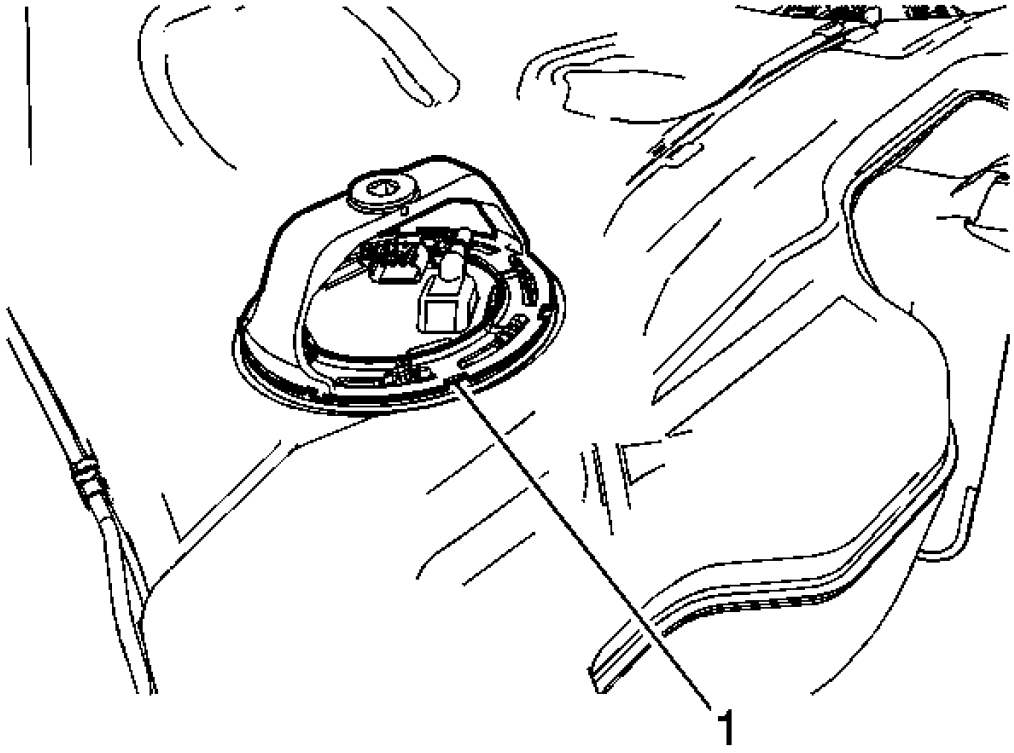


Fig. 58: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 45722:** wrench by turning counter clockwise and remove the lock ring (1).

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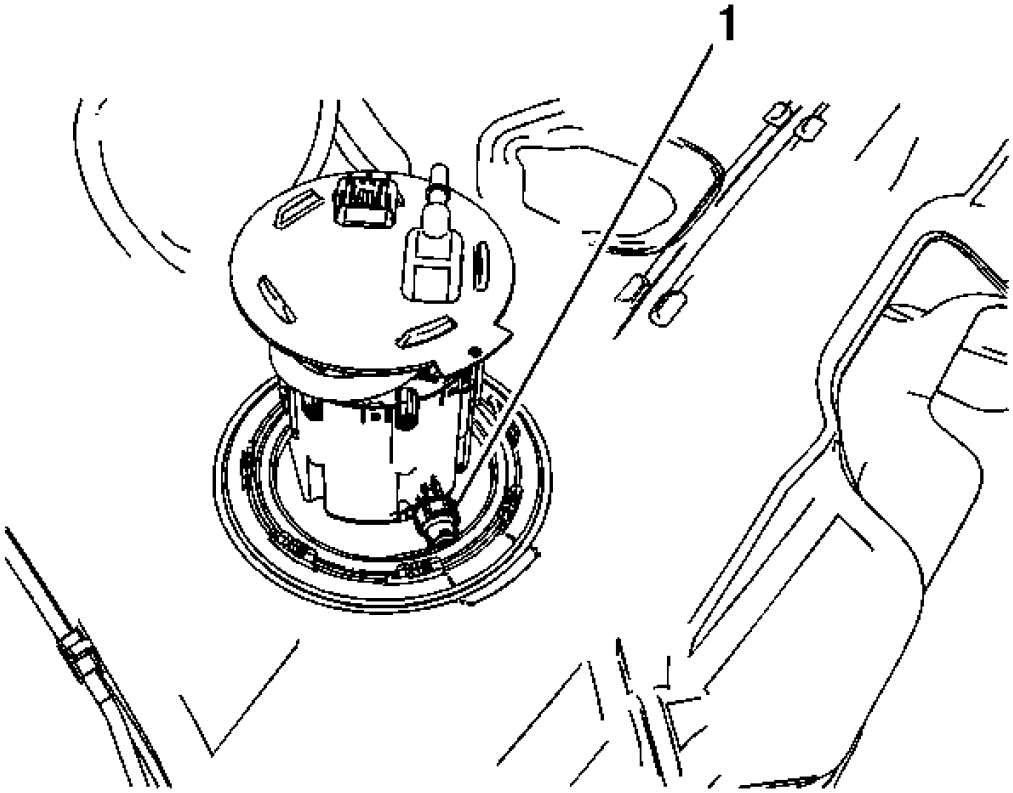


Fig. 59: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Partially remove the primary fuel tank module in order to disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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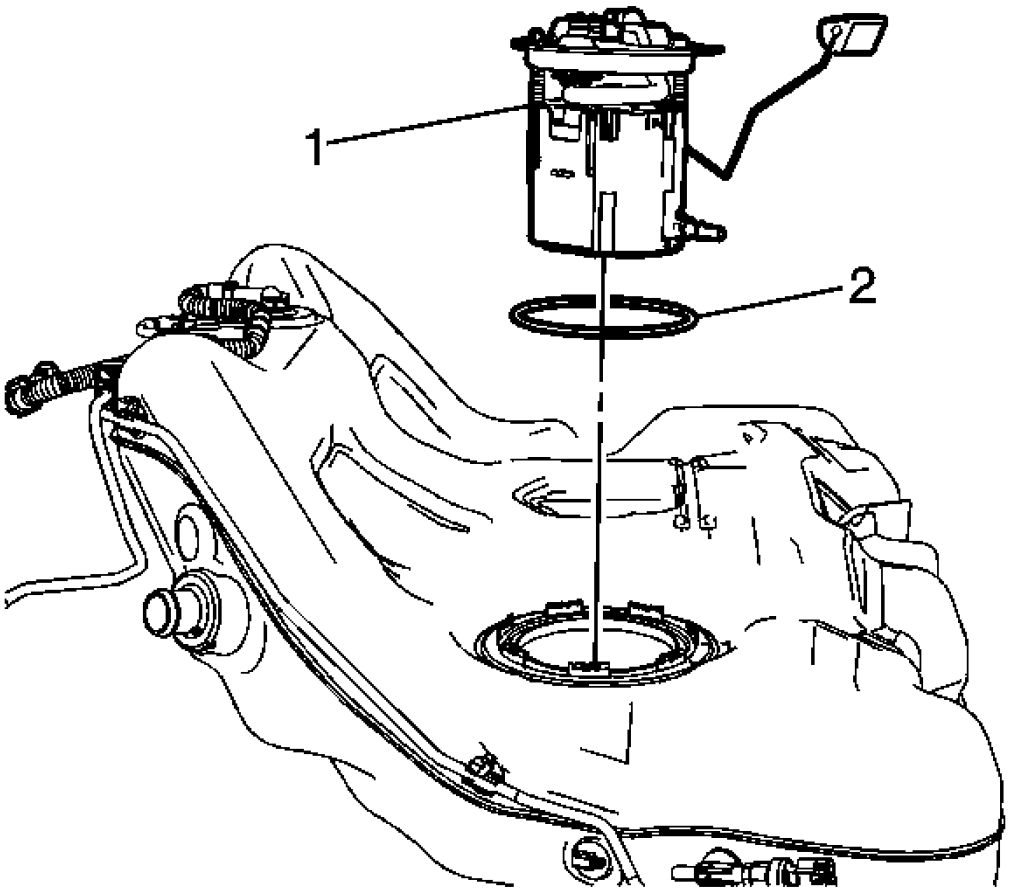


Fig. 60: Primary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the primary fuel tank module (1) and seal (2) from the fuel tank.

Installation Procedure

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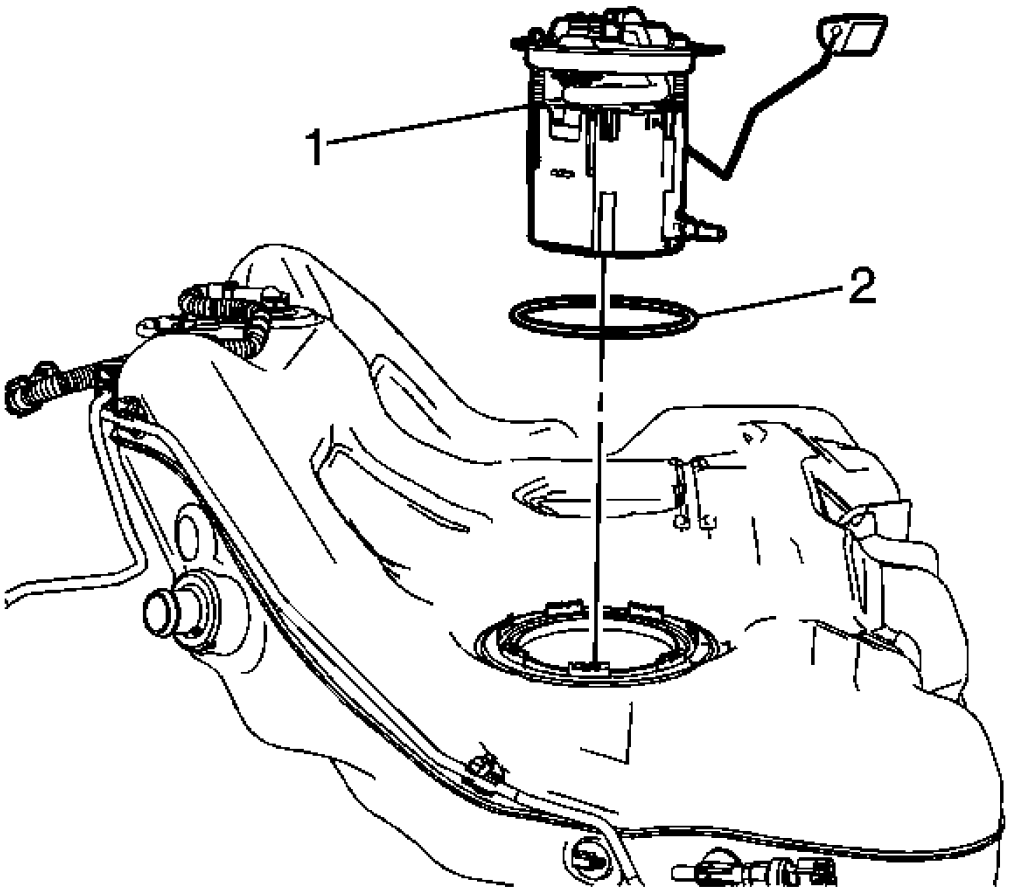


Fig. 61: Primary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW seal (2) and partially install the primary fuel tank module (1).

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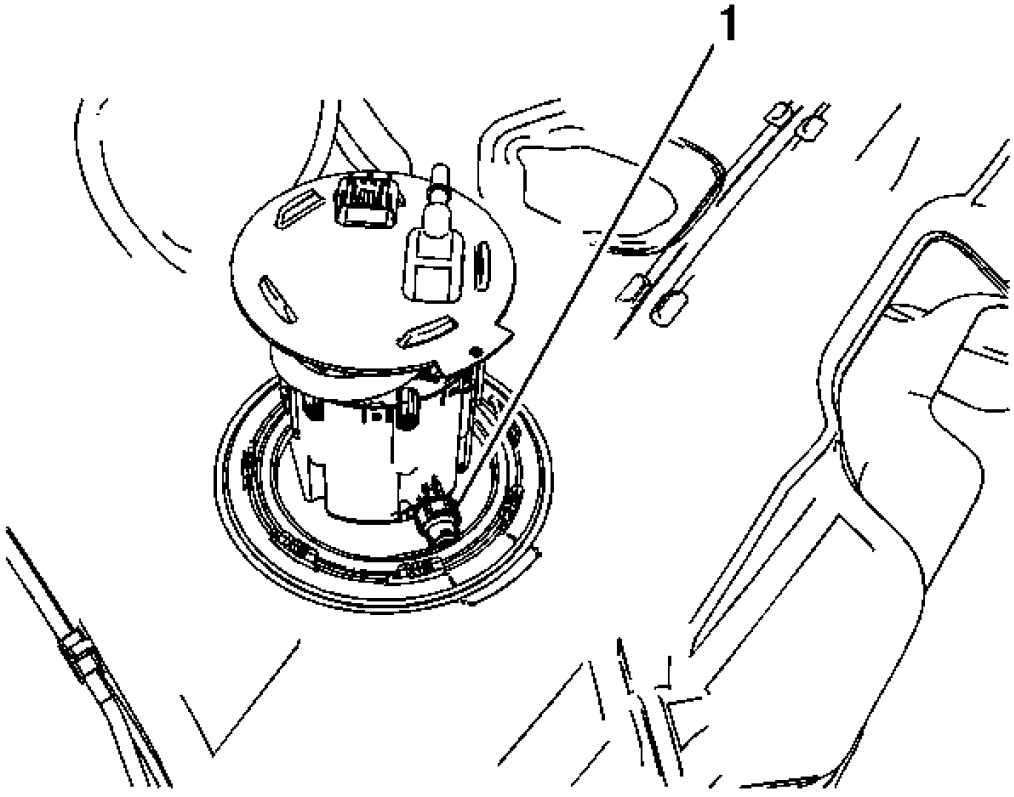


Fig. 62: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

2. Connect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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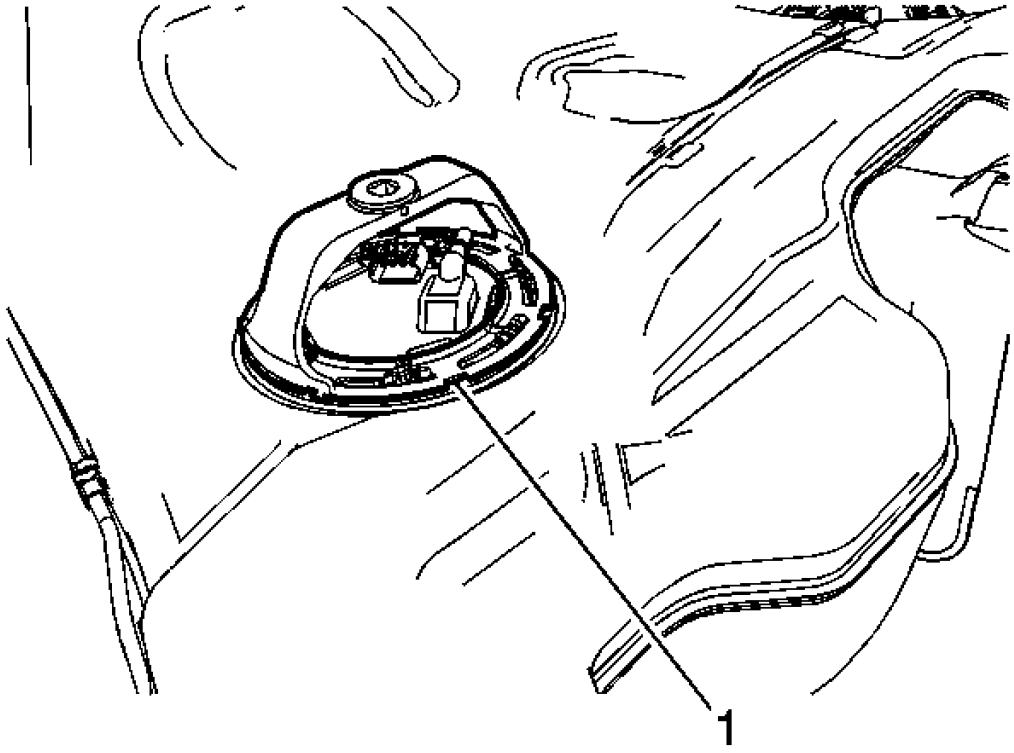


Fig. 63: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 45722:** wrench by turning clockwise and install the lock ring (1).

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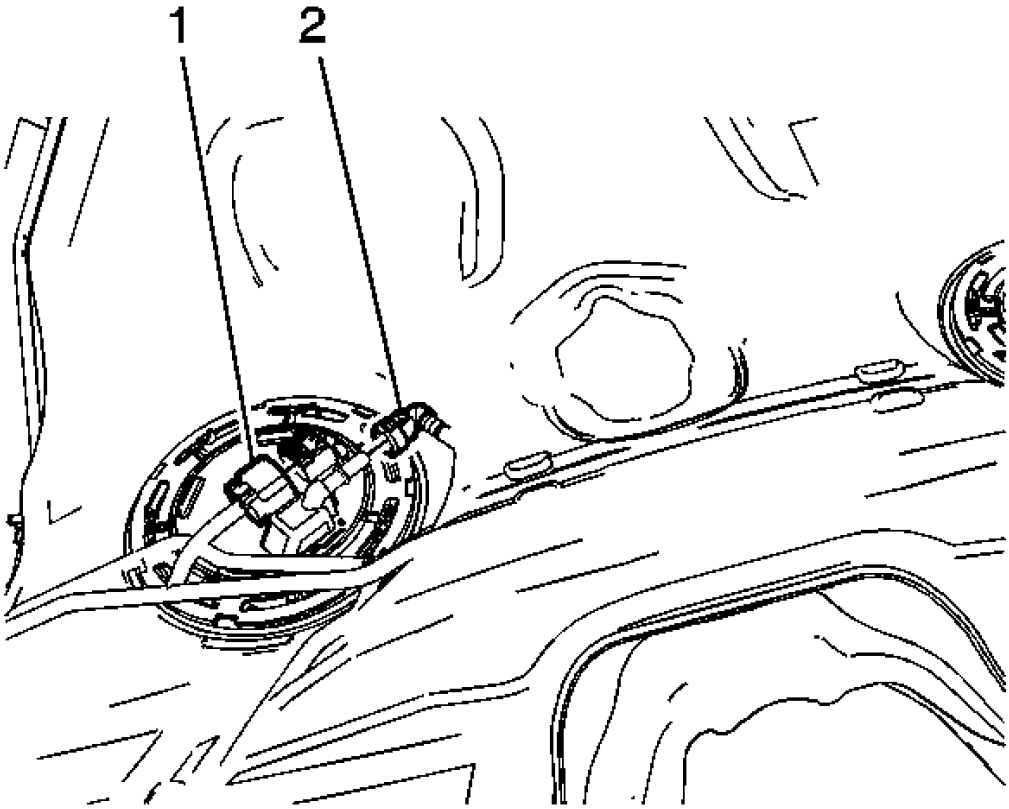


Fig. 64: Fuel Pump Electrical Connector & Fuel Feed Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel pump electrical connector (1) and the fuel feed line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

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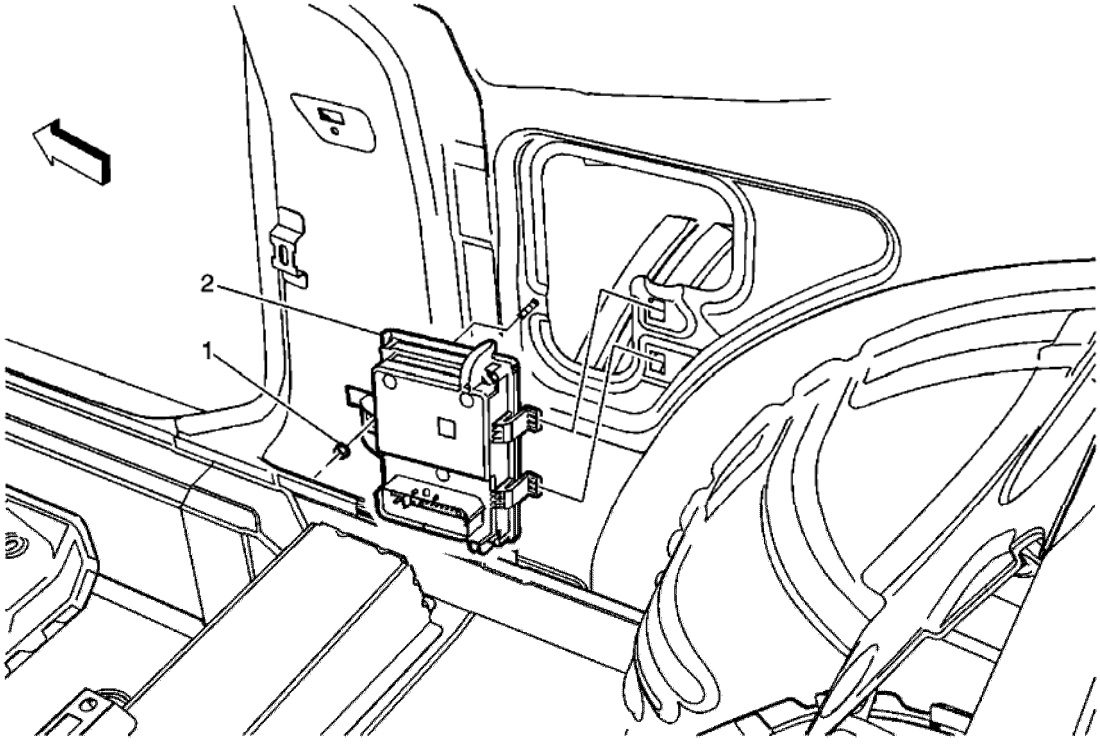


Fig. 65: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the right side quarter trim panel. Refer to **Quarter Trim Panel Replacement** .	
1	Fuel Pump Flow Control Module Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 3 N.m (27 lb in)
2	Fuel Pump Flow Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to **Control Module References** .

FUEL TANK PRESSURE SENSOR REPLACEMENT

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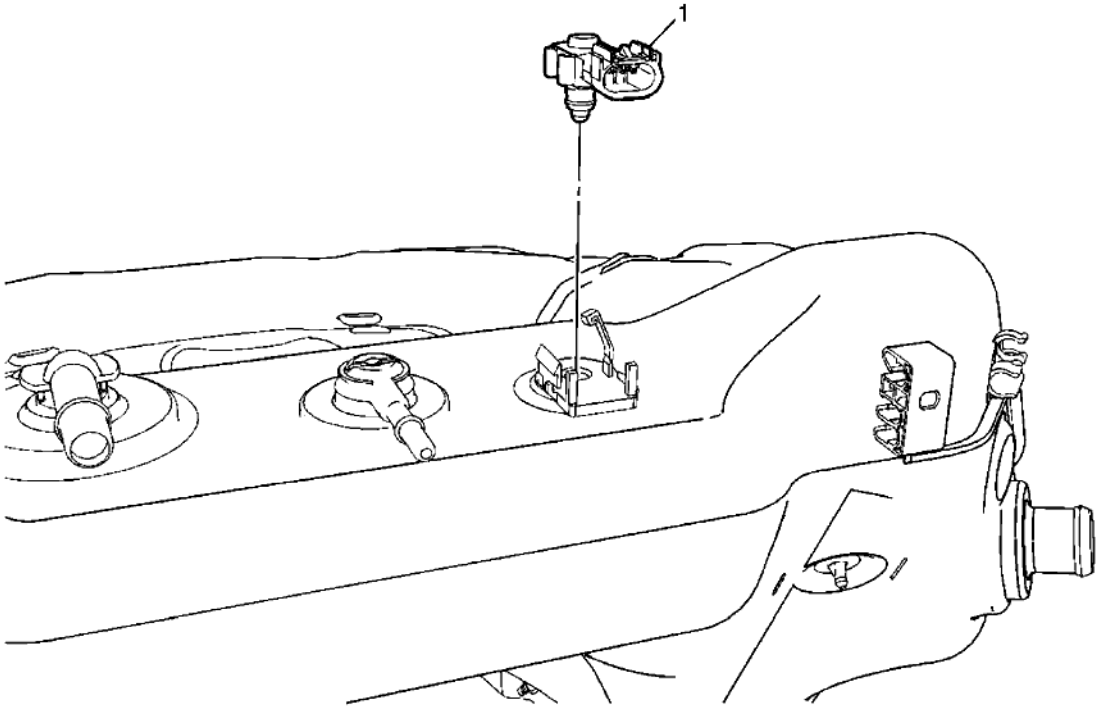


Fig. 66: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the fuel tank. Refer to Fuel Tank Replacement.**	
1	Fuel Tank Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Release the retaining tab.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

1. Remove the fuel filler cap.

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

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WARNING: Refer to Safety Glasses Warning .

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Drain the fuel tank below the level of the fuel filler hose. Refer to **Fuel Tank Draining**.
4. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the right rear wheelhouse Liner. Refer to **Rear Wheelhouse Panel Liner Replacement** .

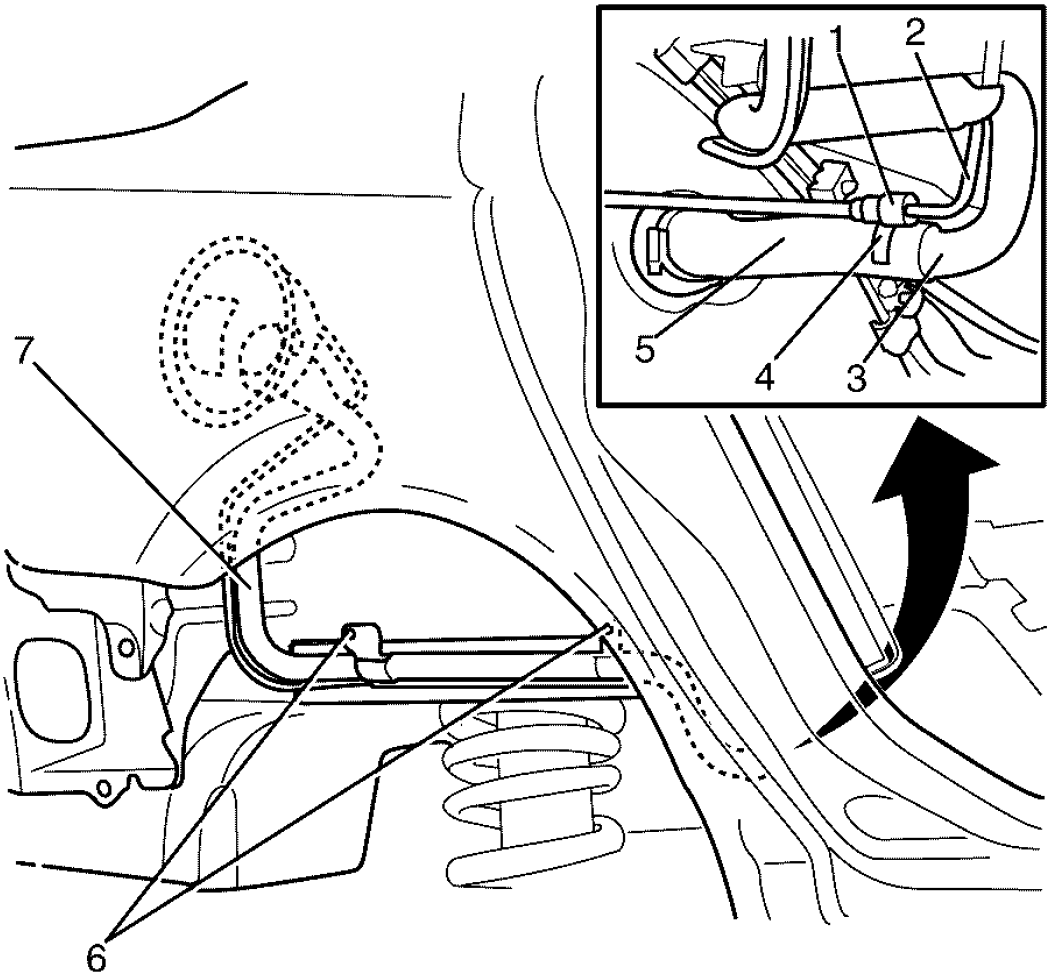


Fig. 67: View Of Quick Connect Fitting, EVAP Line, Fuel Filler Tube & Hose With Clamp
Courtesy of GENERAL MOTORS CORP.

6. Remove the filler tube to chassis retaining bolts (6).
7. Disconnect the evaporative emission (EVAP) line (2) from the quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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8. Remove the retaining hose clamp (4).
9. Disconnect the fuel filler tube (3) from the fuel filler hose (5).
10. Maneuver the fuel filler tube (7) and remove from the vehicle.

Installation Procedure

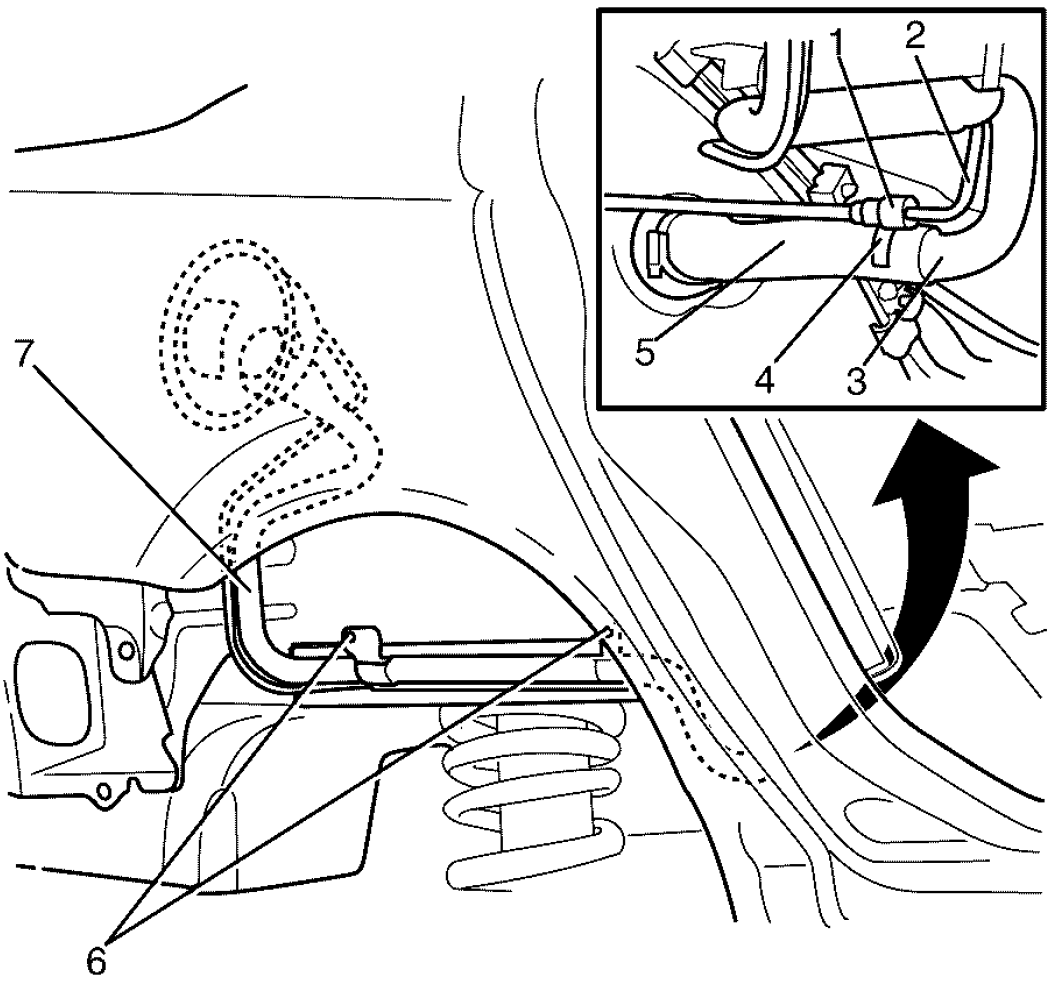


Fig. 68: View Of Quick Connect Fitting, EVAP Line, Fuel Filler Tube & Hose With Clamp
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel filler tube (7) to the vehicle.
2. Connect the fuel filler tube (3) to the fuel filler hose (5).

CAUTION: Refer to Fastener Caution .

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3. Install the retaining hose clamp (4) and tighten the fuel filler tube hose clamp (3) to 3.5 N.m (31 lb in).

NOTE: Listen for and audible click to confirm correct installation.

4. Connect the evaporative emission (EVAP) line (2) to the quick connect fitting (1).
5. Install the filler tube to chassis retaining bolts (6) and tighten to 9 N.m (80 lb in).
6. Install the right rear wheelhouse Liner. Refer to **Rear Wheelhouse Panel Liner Replacement** .
7. Install the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .

FUEL LEVEL SENSOR REPLACEMENT - LEFT SIDE

Special Tools

CH 48482: Fuel Sender Lock Wrench

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

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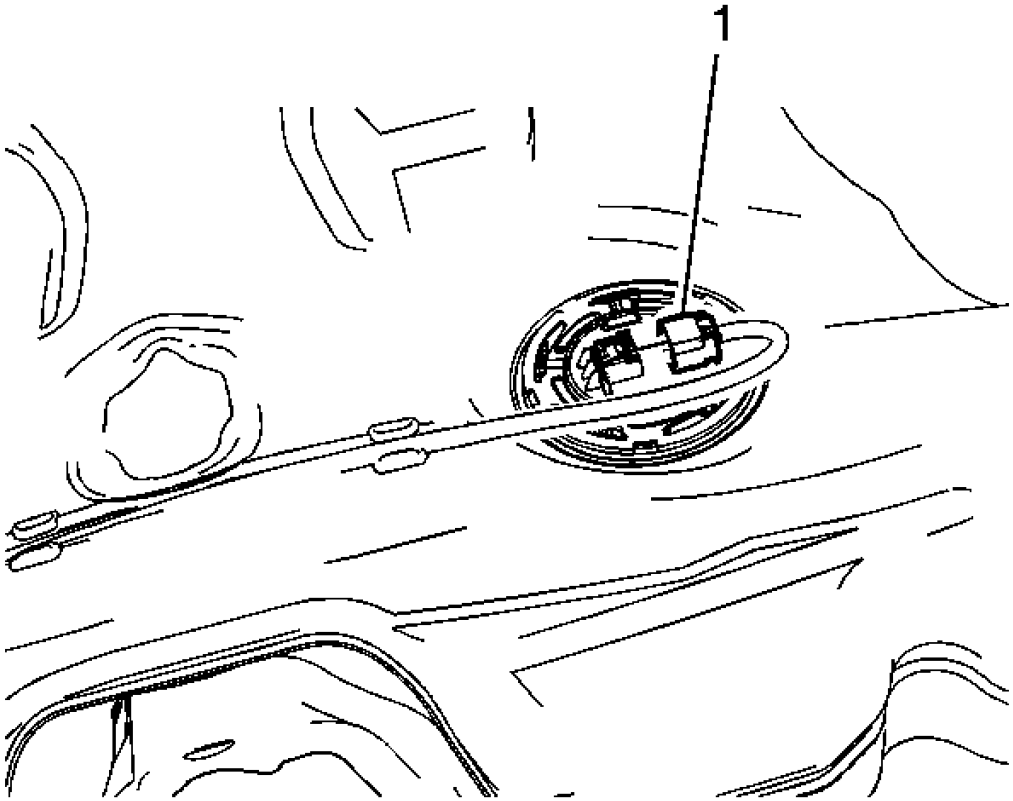


Fig. 69: Secondary Fuel Tank Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the secondary fuel tank module electrical connector (1).

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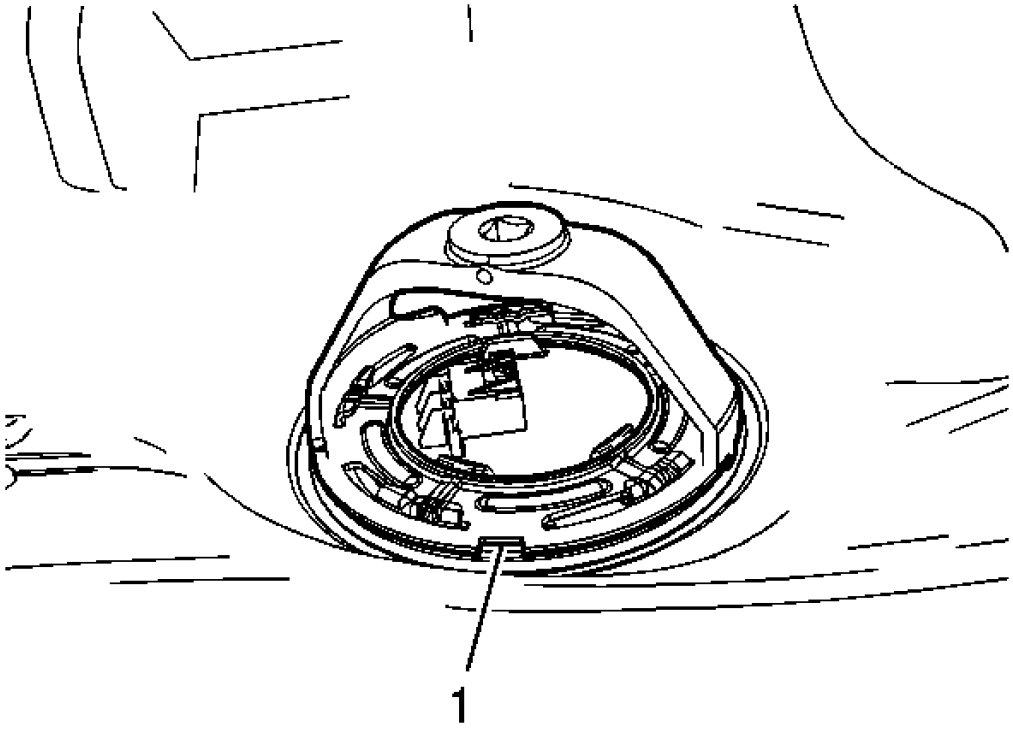


Fig. 70: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Rotate the lock ring (1) counterclockwise using the **CH-48482:** wrench and remove the lock ring.

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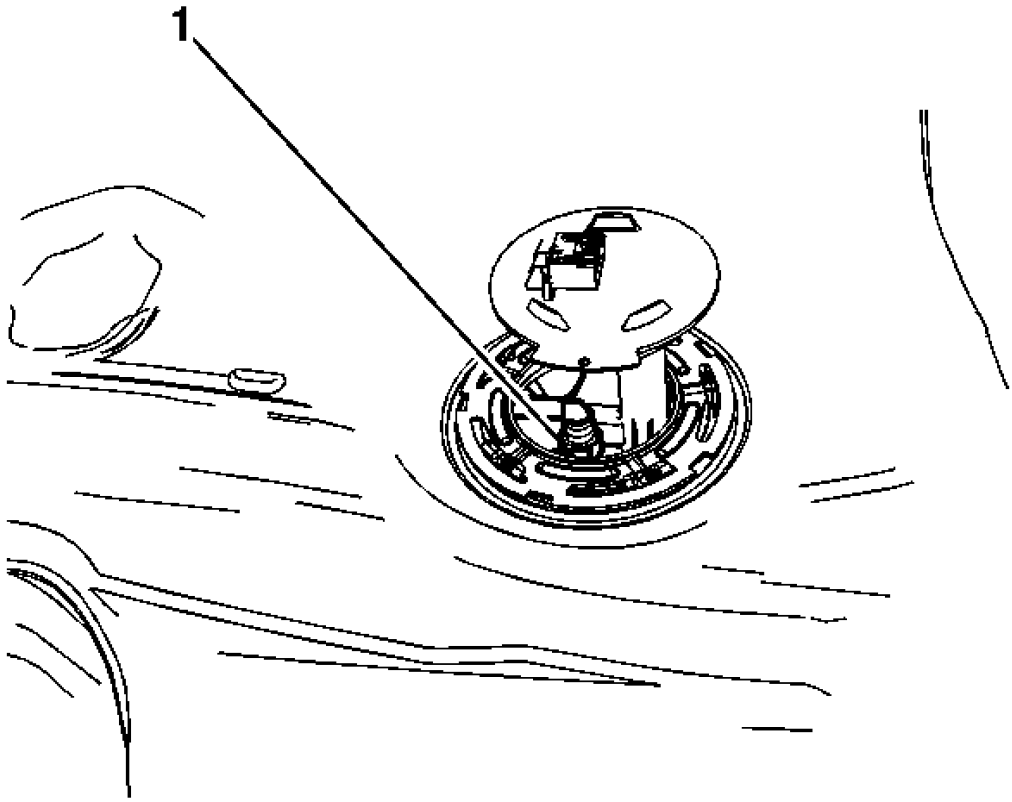


Fig. 71: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Partially remove the primary fuel tank module in order to disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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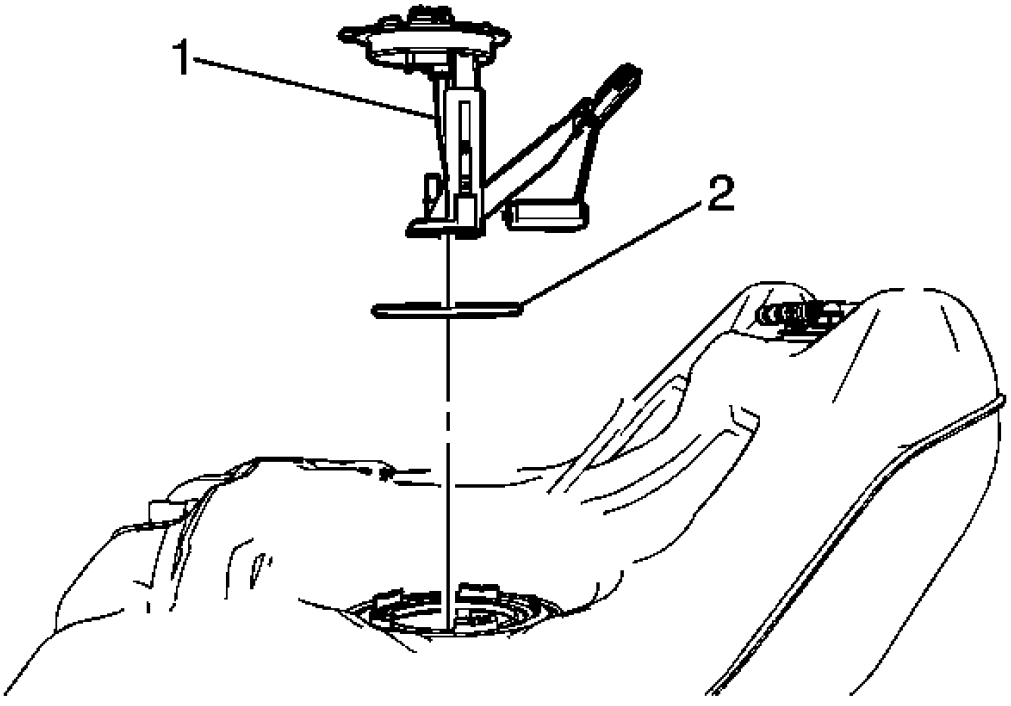


Fig. 72: Secondary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the secondary fuel tank module (1) and the seal (2).

Installation Procedure

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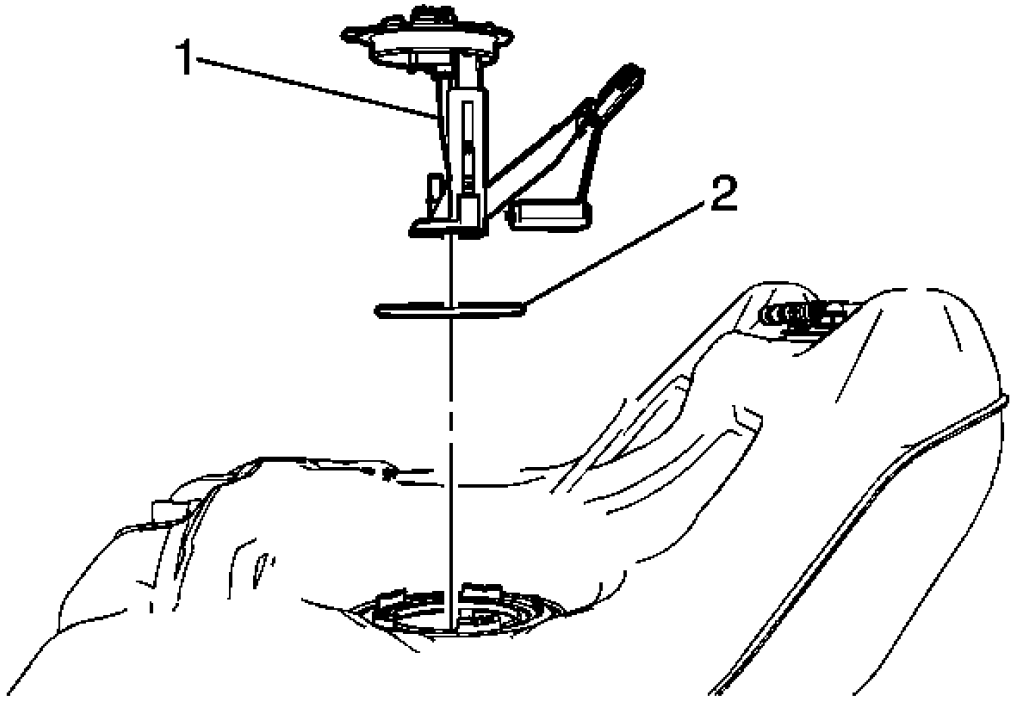


Fig. 73: Secondary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW seal (2).

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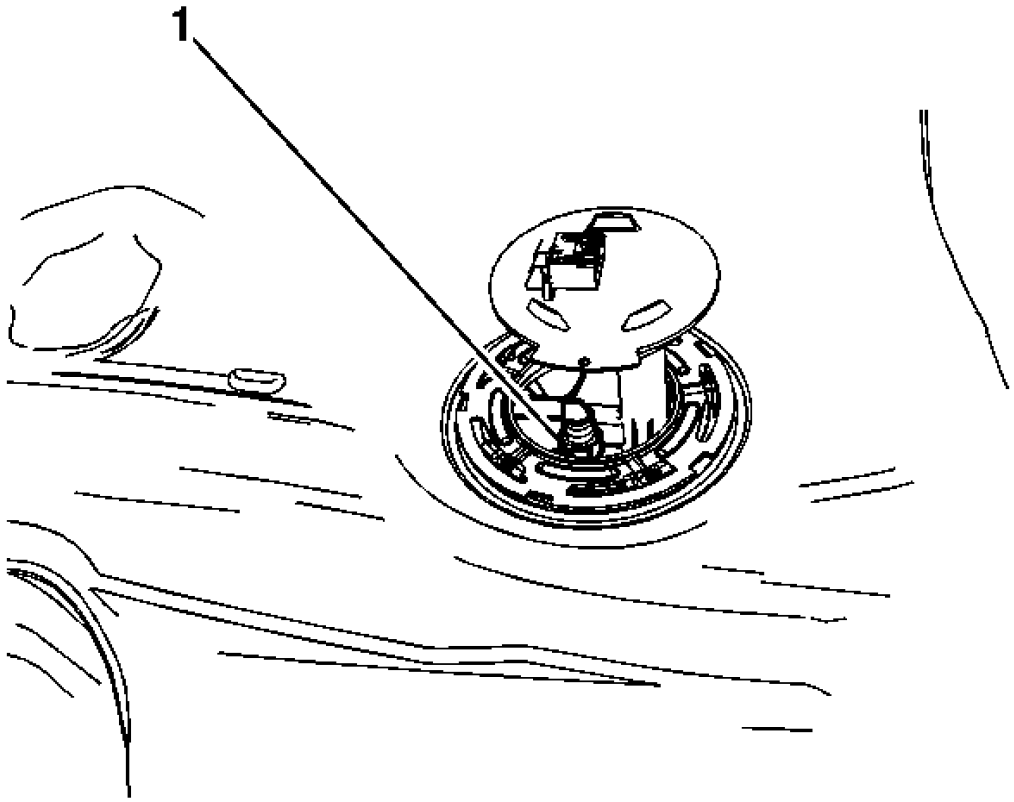


Fig. 74: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

2. Partially install the secondary fuel pump module in order to connect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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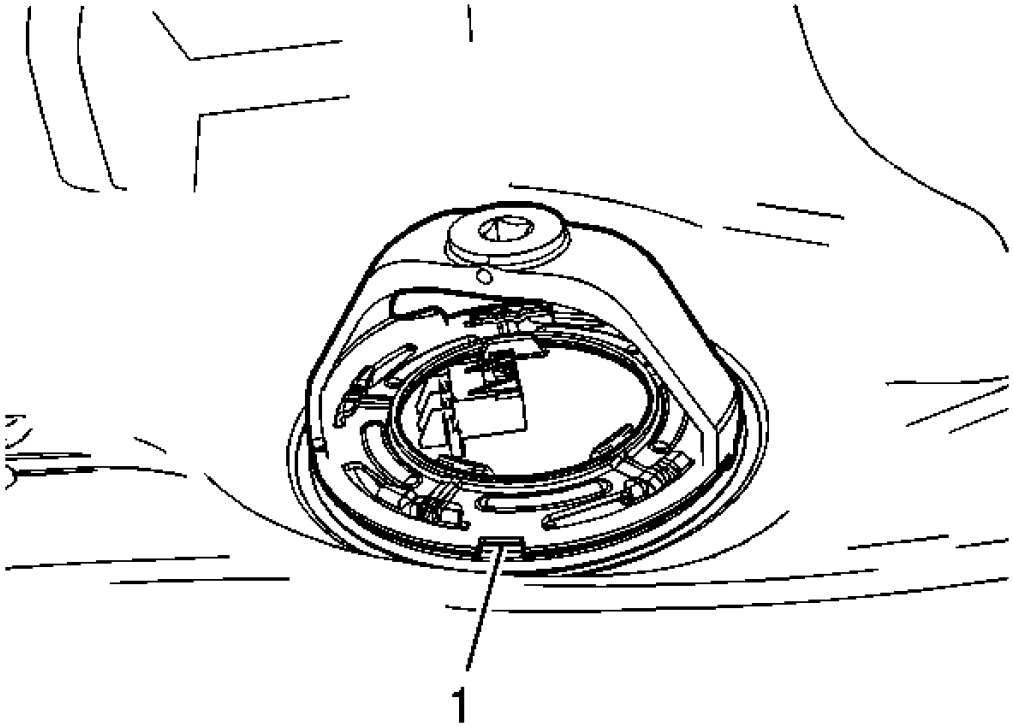


Fig. 75: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Rotate the lock ring (1) clockwise using the **CH-48482:** wrench and install the lock ring.

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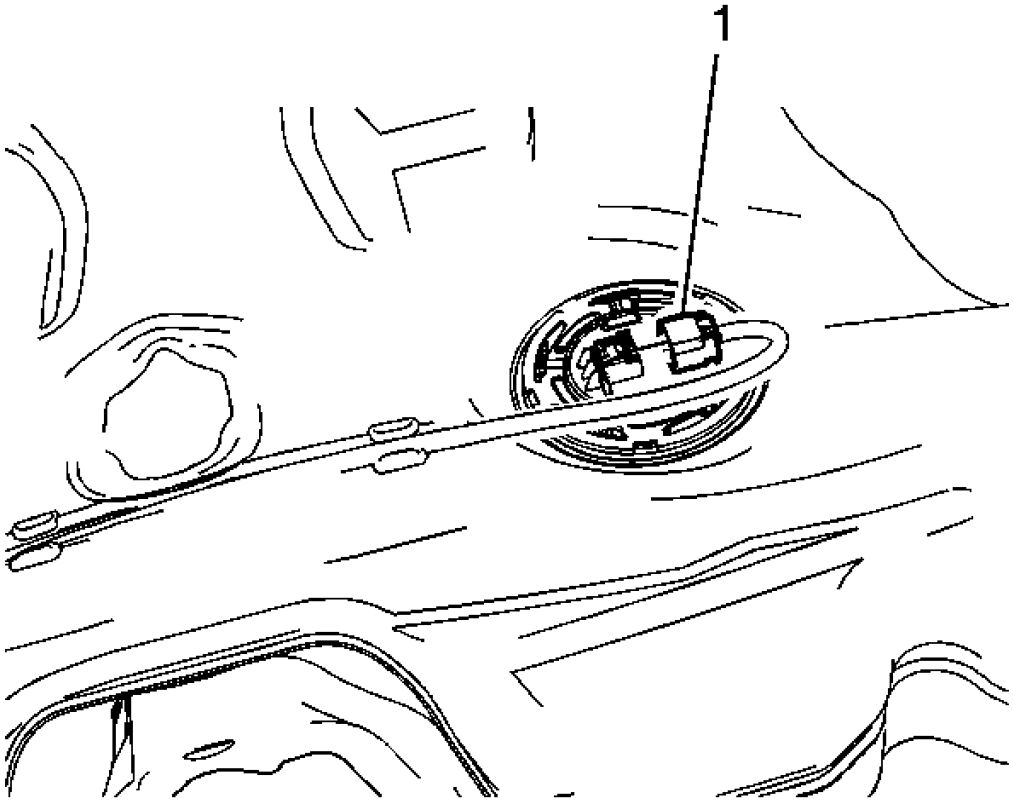


Fig. 76: Secondary Fuel Tank Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the secondary fuel tank module electrical connector (1).
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL LEVEL SENSOR REPLACEMENT - RIGHT SIDE

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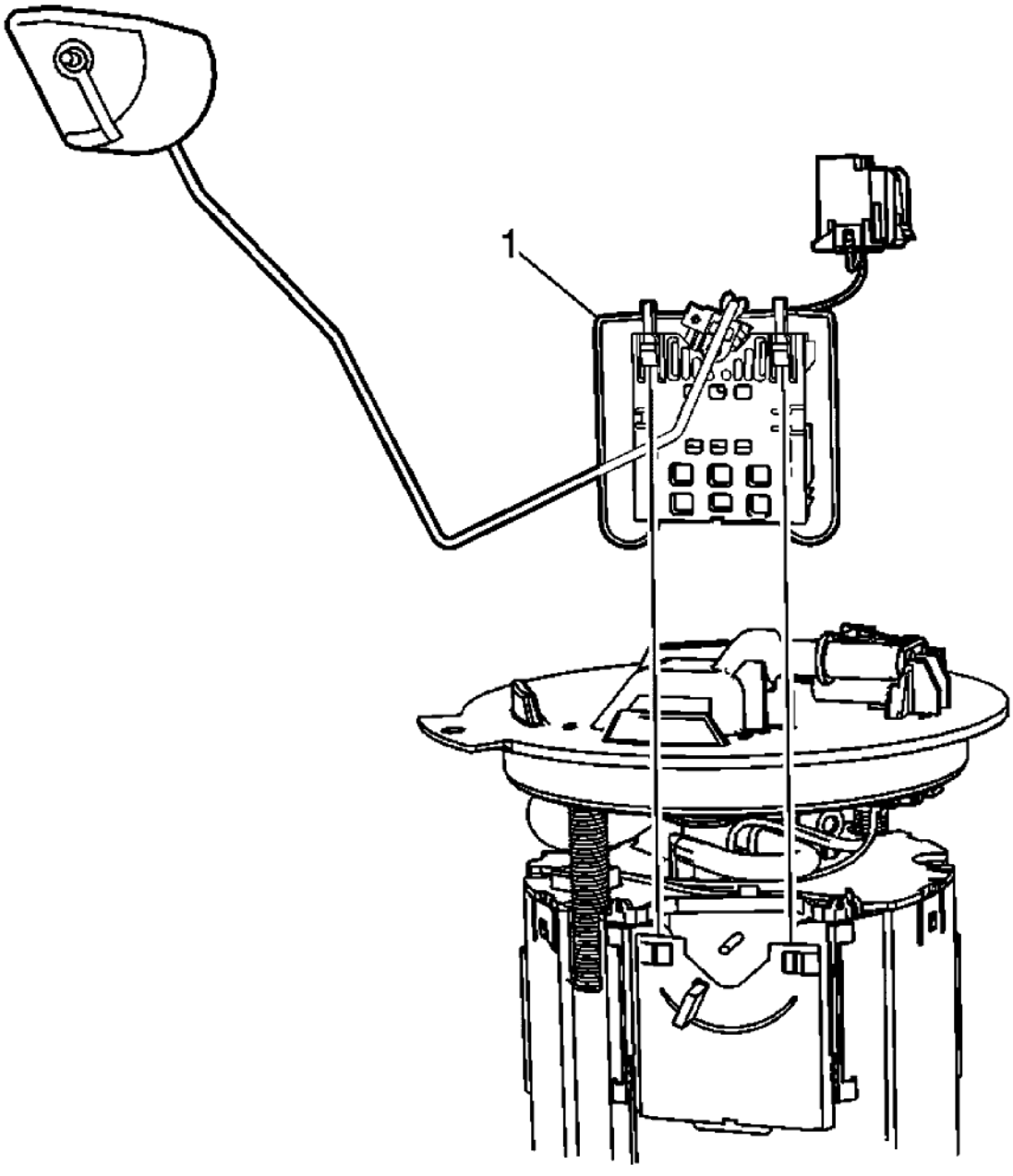


Fig. 77: Fuel Level Sensor - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel pump module-right side. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.	
	Fuel Level Sensor

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1	**Procedure** 1. Push the plastic tabs forward and simultaneously pull upwards. 2. Disconnect the electrical connector.

FUEL LINE REPLACEMENT - CHASSIS

Removal Procedure

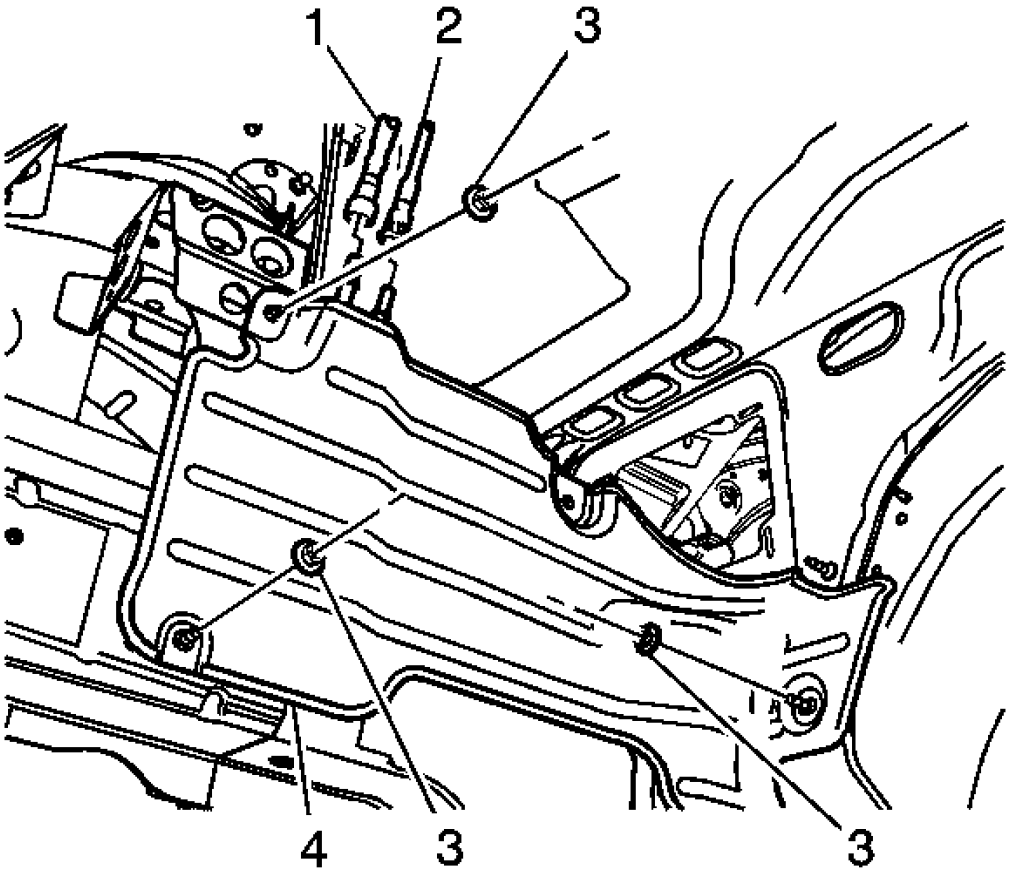


Fig. 78: Fuel Feed Connector, Evaporative Emission Connector, Exhaust Heat Shield Fasteners & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Disconnect the fuel feed connector (1) and the evaporative emission connector (2). Refer to **Metal Collar**

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Quick Connect Fitting Service and **Plastic Collar Quick Connect Fitting Service**.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the exhaust heat shield fasteners (3) and the exhaust heat shield (4).

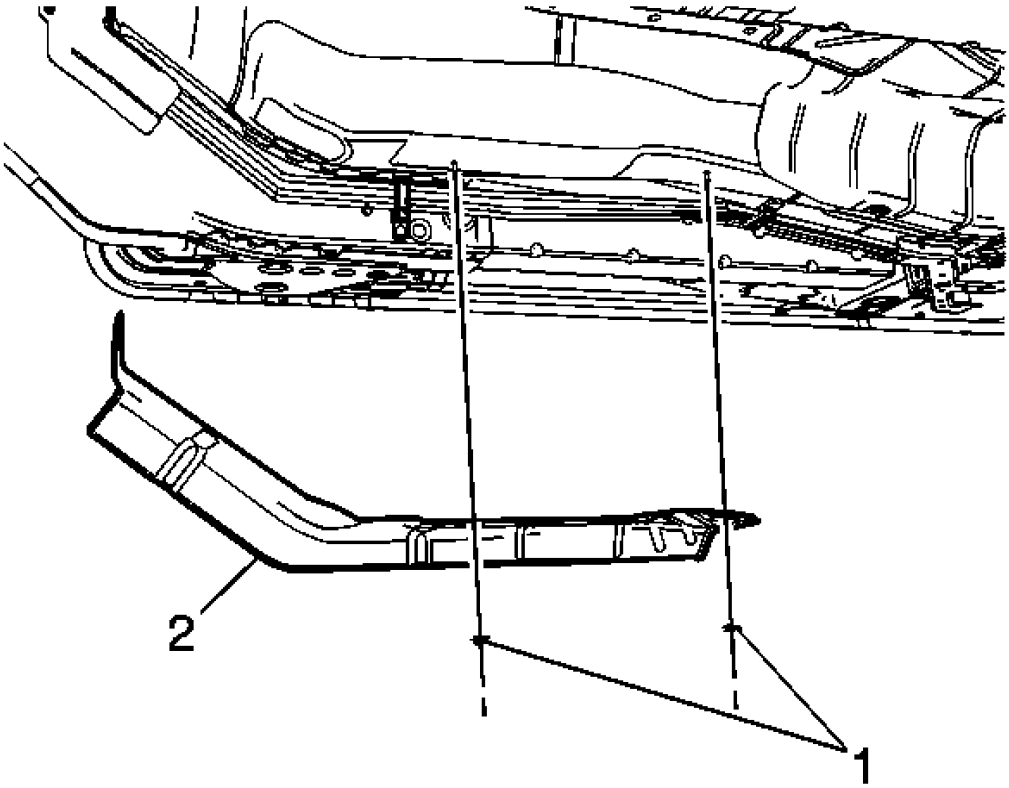


Fig. 79: Exhaust Heat Shield Fastener & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

5. Remove the exhaust heat shield fastener (1) and the exhaust heat shield (2).

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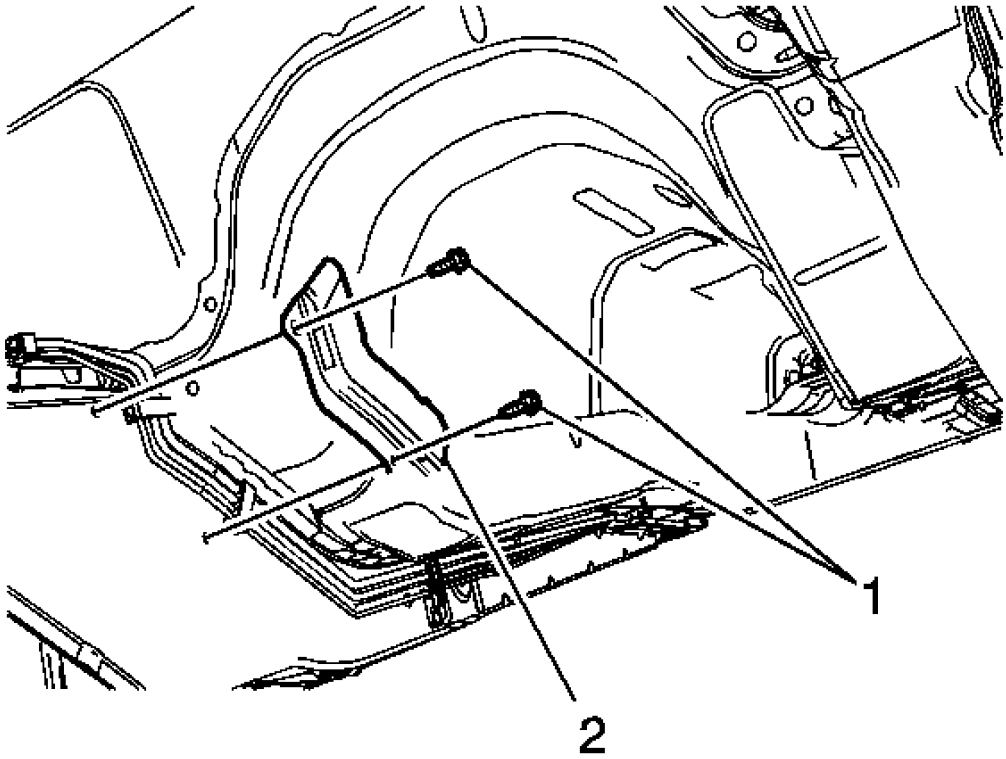


Fig. 80: Brake Pipe Heat Shield Fastener & Heat Shield
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake pipe heat shield fastener (1) and the heat shield (2).

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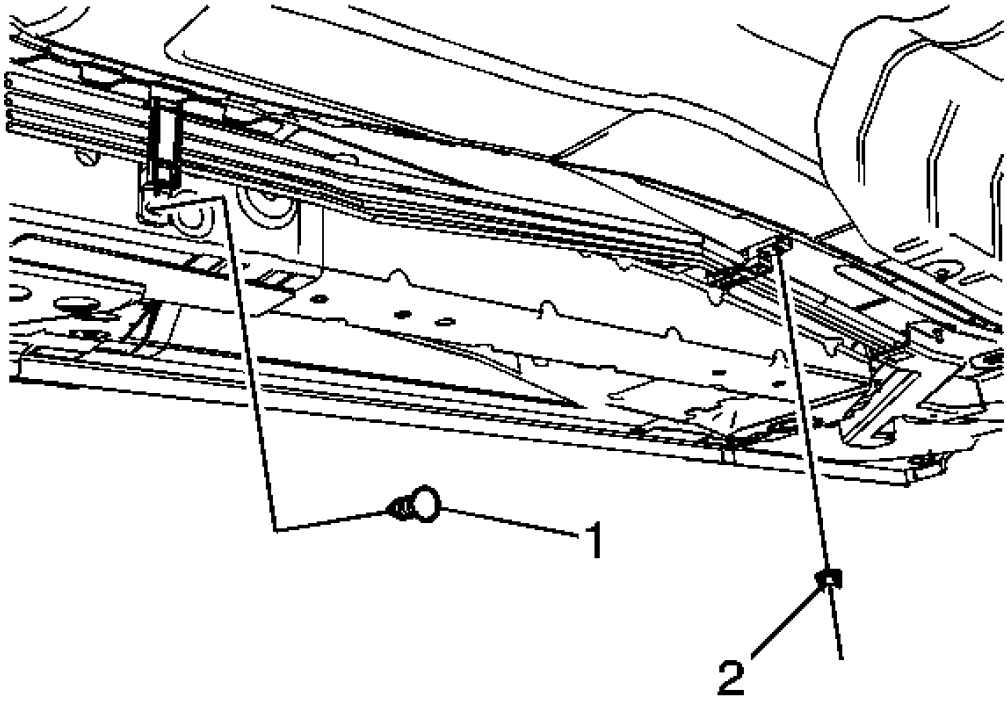


Fig. 81: Plastic Retainer & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the plastic retainer (1) and the retaining nut (2).

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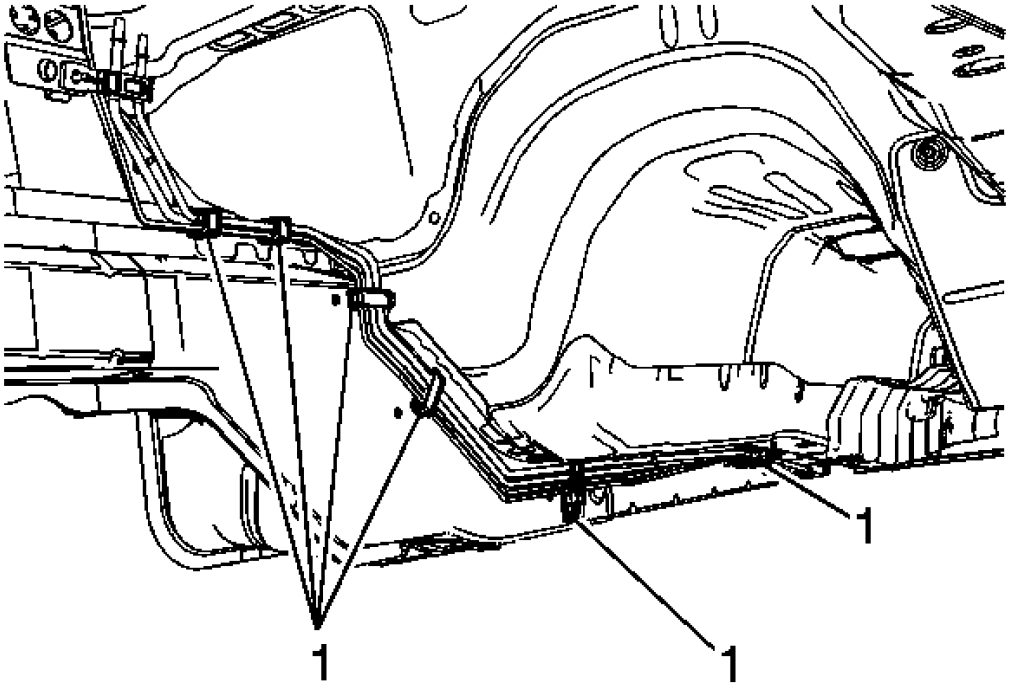


Fig. 82: Fuel Feed Line & Evaporative Emission Line Clips
Courtesy of GENERAL MOTORS CORP.

8. Separate the fuel feed line and the evaporative emission line from the clips (1).

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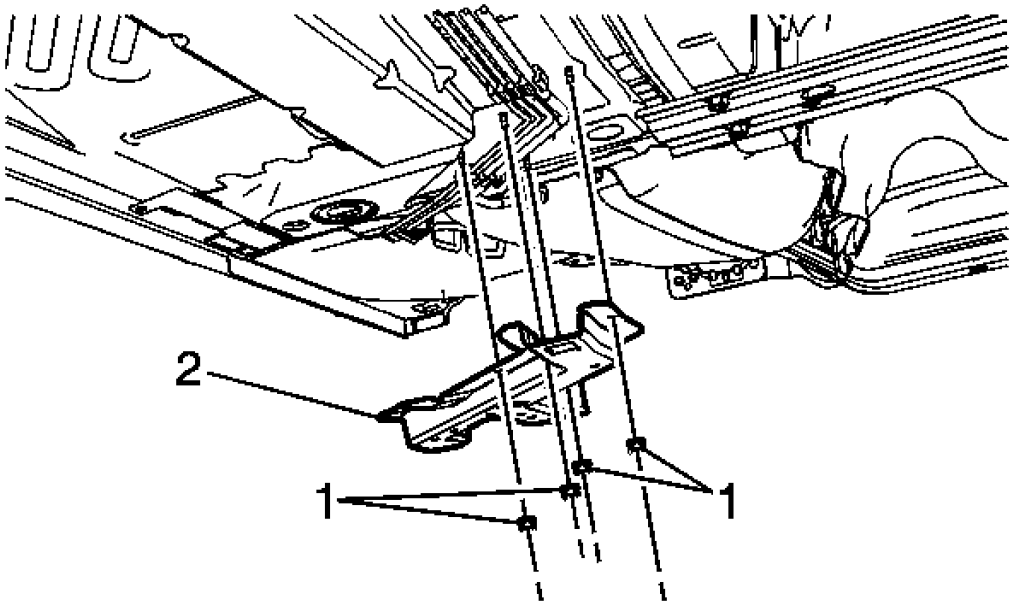


Fig. 83: Protector Bracket Fasteners & Bracket
Courtesy of GENERAL MOTORS CORP.

9. Remove the protector bracket fasteners (1) and remove the bracket (2).

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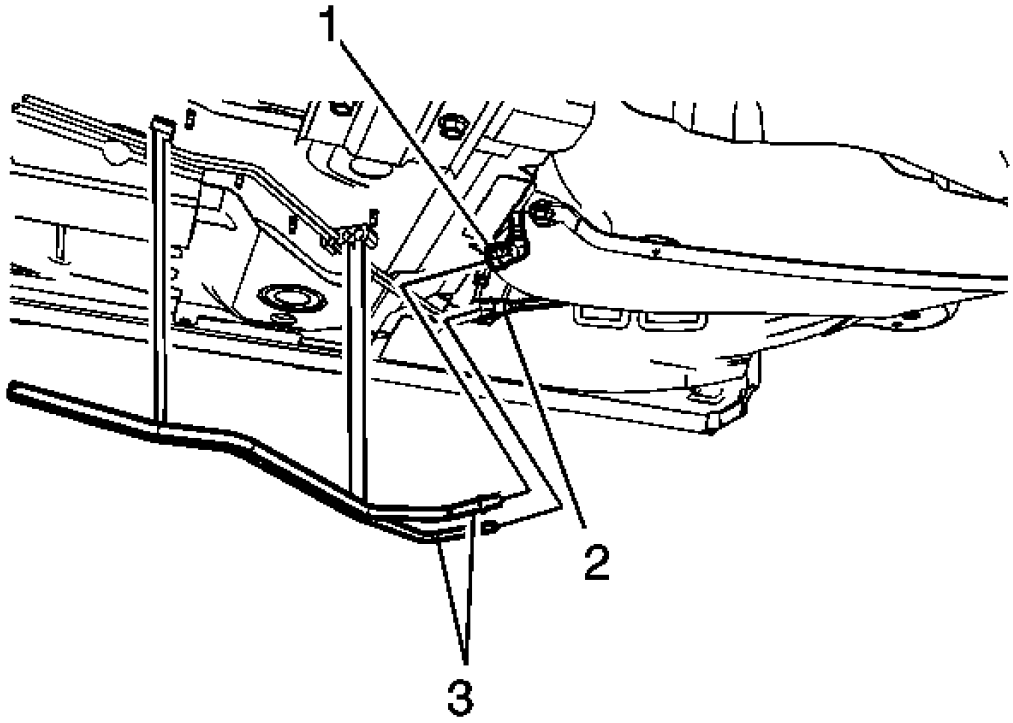


Fig. 84: Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel feed line (1) and the evaporative emission line (2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service**.
11. Remove the pipes (3) from the vehicle.

Installation Procedure

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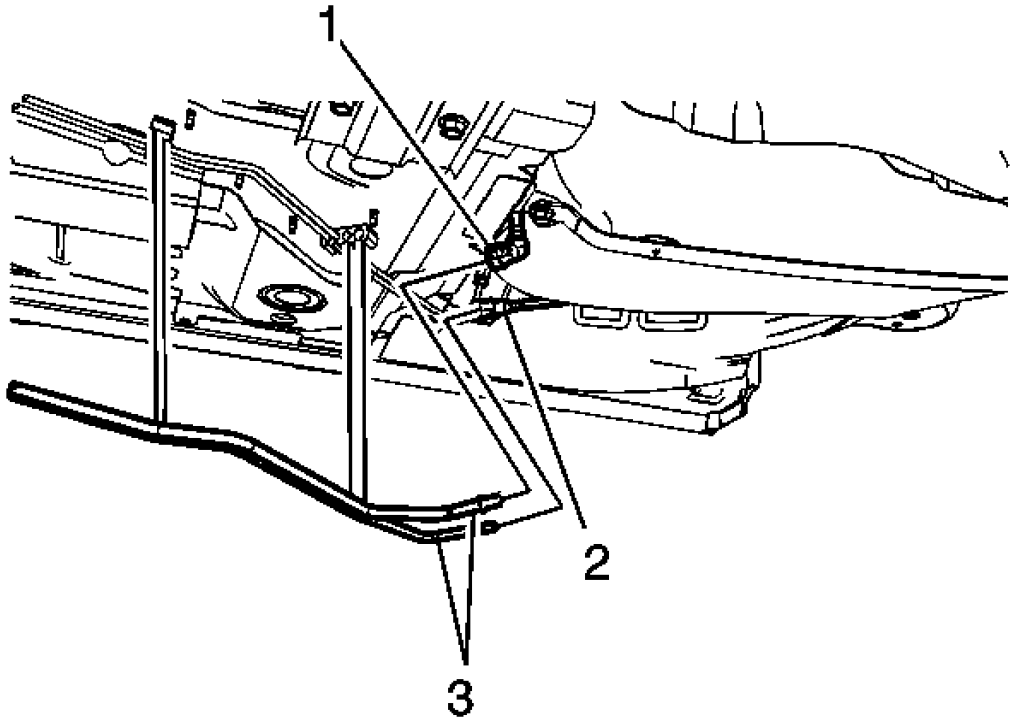


Fig. 85: Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

1. Install the pipes (3) to the vehicle and connect the evaporative emission line (2) and the fuel fed line (1) Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service**.

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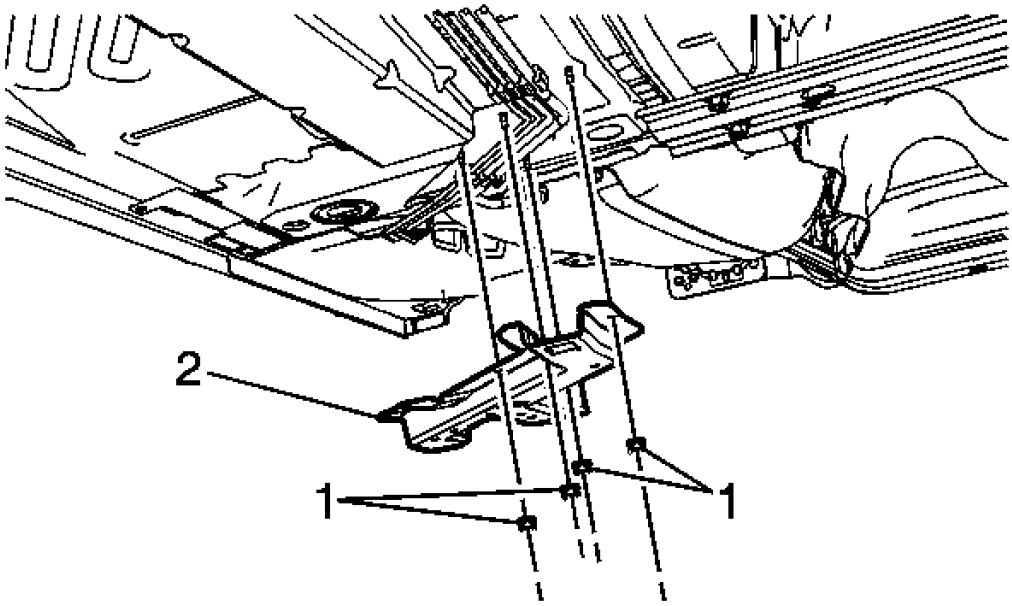


Fig. 86: Protector Bracket Fasteners & Bracket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the protector bracket (2) and the bracket fasteners (1) then tighten to 3 N.m(27 lb in).

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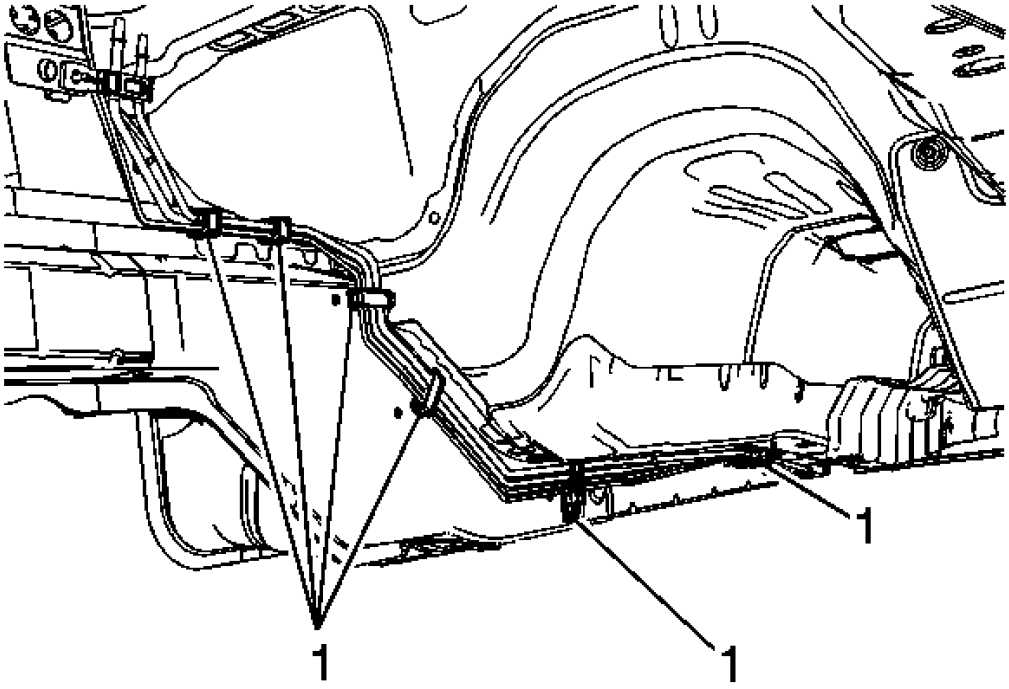


Fig. 87: Fuel Feed Line & Evaporative Emission Line Clips
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel feed line and the evaporative emission line to the clips (1).

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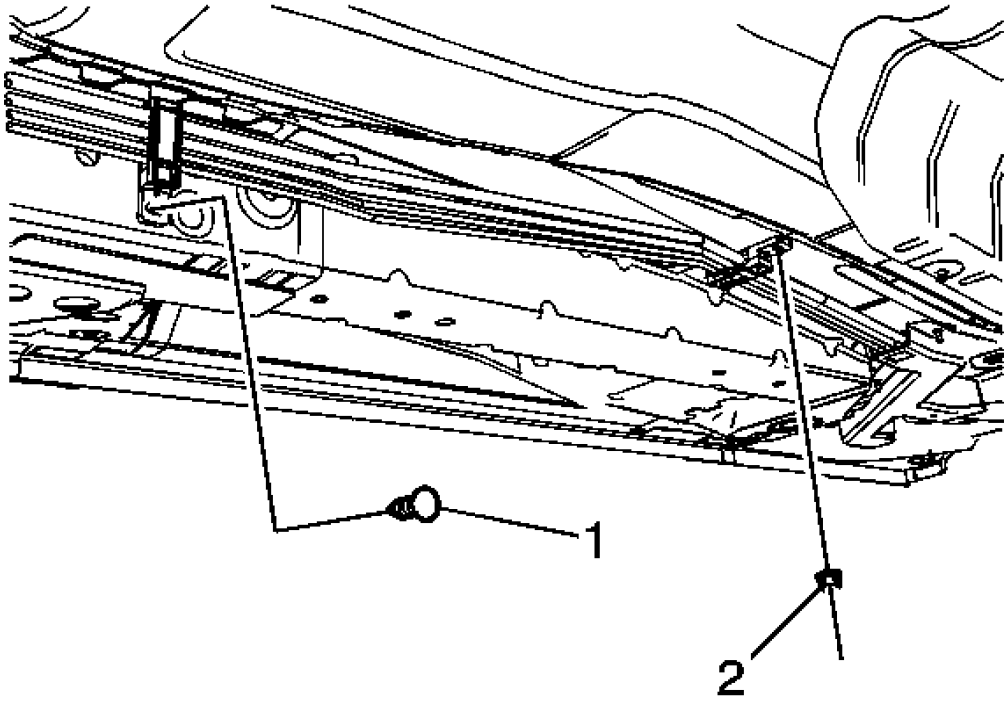


Fig. 88: Plastic Retainer & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

4. Install the plastic retainer (1) and the retaining nut (2), then tighten to 3 N.m (27 lb in).

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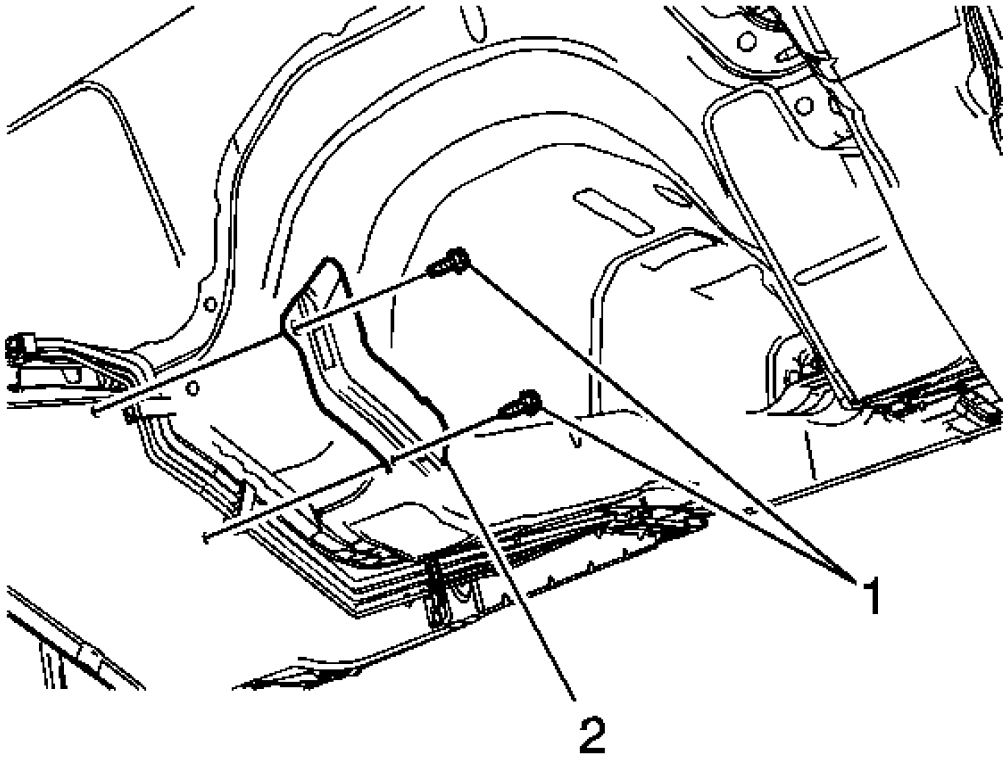


Fig. 89: Brake Pipe Heat Shield Fastener & Heat Shield
Courtesy of GENERAL MOTORS CORP.

5. Install the heat shield (2) and the brake pipe heat shield fastener (1), then tighten to 22 N.m (16 lb ft).

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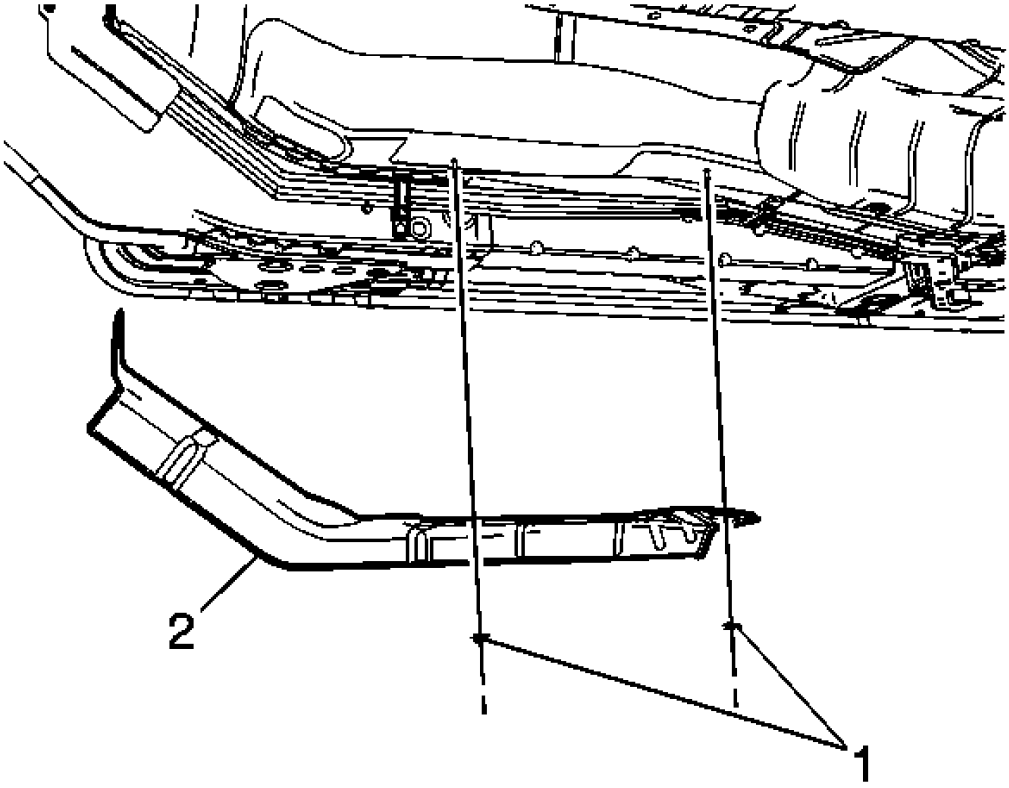


Fig. 90: Exhaust Heat Shield Fastener & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

6. Install the exhaust heat shield (2) and the exhaust heat shield fastener (1), then tighten to 3 N.m (27 lb in).

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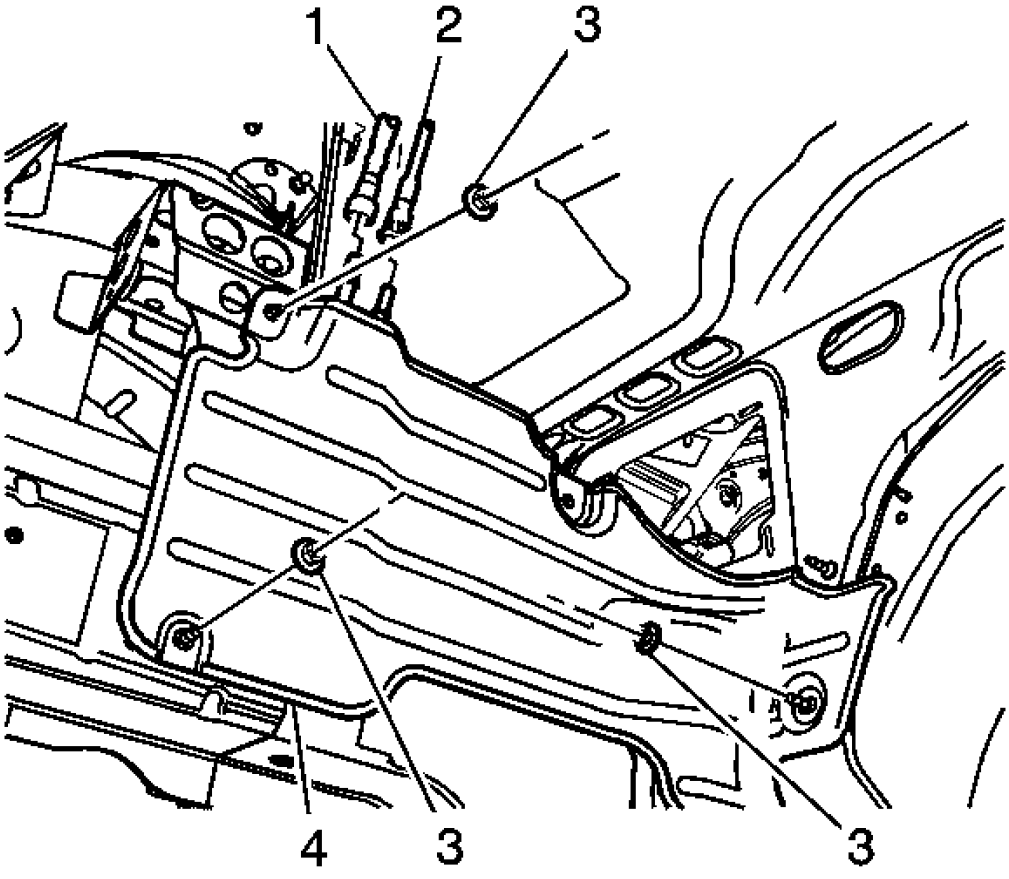


Fig. 91: Fuel Feed Connector, Evaporative Emission Connector, Exhaust Heat Shield Fasteners & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

7. Install the exhaust heat shield (4) and the exhaust heat shield fasteners (3), then tighten to 6 N.m (53 lb in).
8. Connect the fuel feed connector (1) and the evaporative emission connector (2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service**.
9. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

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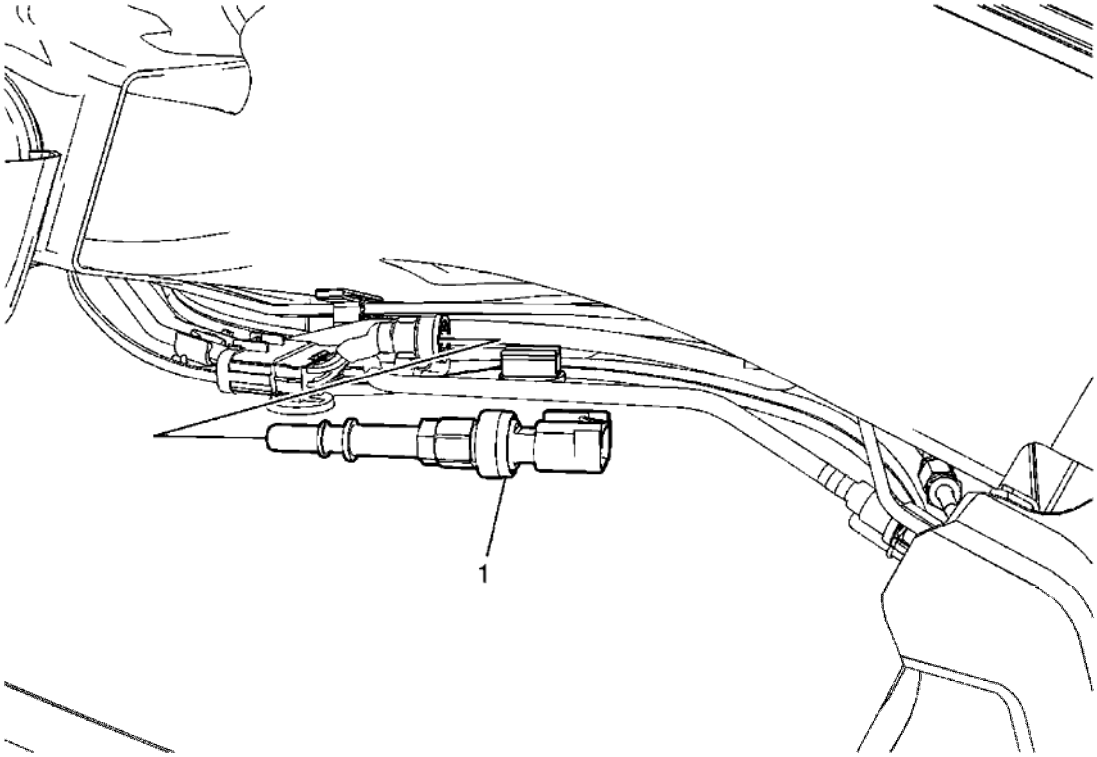


Fig. 92: Fuel Pressure Sensor - Fuel Feed Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel pressure. Refer to **Fuel Pressure Relief**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Fuel Pressure Sensor **Procedure** 1. Disconnect the fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**. 2. Disconnect the electrical connector.

FUEL FEED PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve the low side fuel system pressure. Refer to **Fuel Pressure Relief**.

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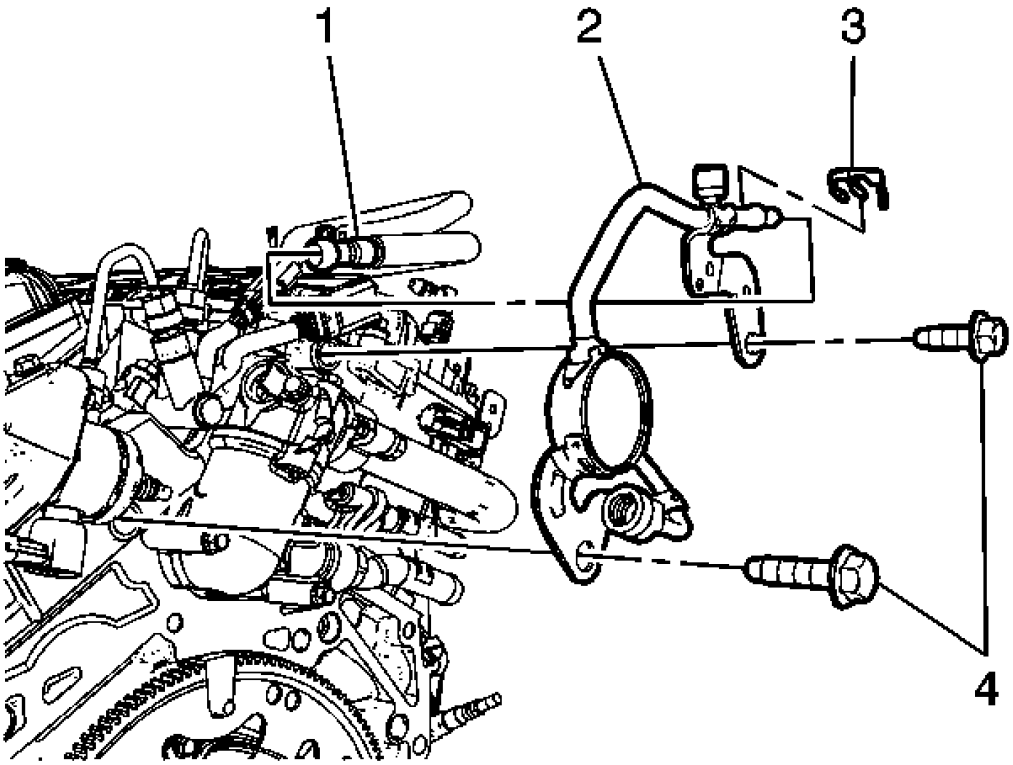


Fig. 93: Identifying Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fuel feed line quick connect fitting from the fuel feed pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**.
5. Loosen the fuel feed pipe fitting to the high pressure fuel pump.
6. Remove the fuel feed pipe bolts (4) from the cylinder heads.
7. Remove the fuel feed pipe from the engine and high pressure fuel pump. Discard the pipe.

Installation Procedure

1. Ensure that the fuel feed pipe and fuel pump fittings are clean and dry prior to assembly.

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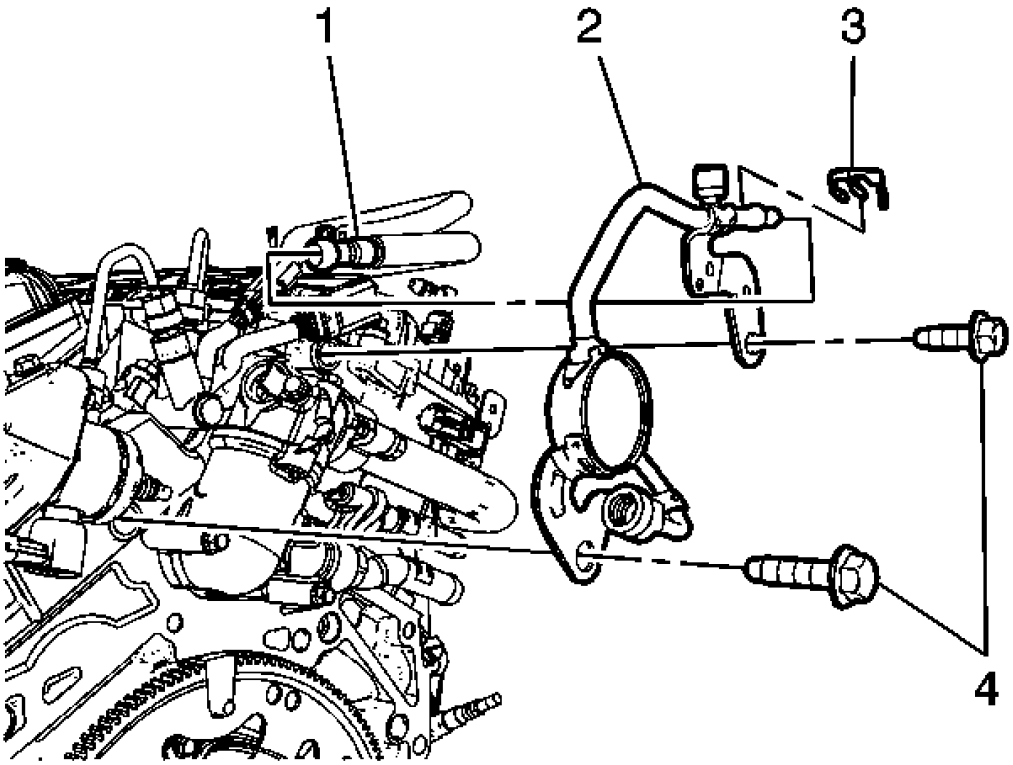


Fig. 94: Identifying Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS CORP.

2. Position the NEW fuel feed pipe (2) to the cylinder head and high pressure fuel pump.
3. Install the fuel feed pipe fitting to the high pressure fuel pump hand tight.

CAUTION: Refer to Fastener Caution

4. Install the fuel feed pipe bolts (4).
    1. Tighten the bolts to 50 N.m (37 lb ft).
    2. Tighten the fitting to 28 N.m (20 lb ft).
5. Connect the fuel feed line quick connect fitting to the fuel feed pipe (2). Refer to **Fuel Pipe Shield Replacement**.

NOTE: If a fuel leak accrues at the high pressure fuel pump, the pump will need to be replaced.

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6. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
7. Install the low side fuel pressure service port cap.
8. Install the fuel tank cap.
9. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
10. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .

FUEL SYSTEM CLEANING

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is contaminated, the fuel system can be cleaned. You can usually determine the extent of the fuel system contamination during the disassembly.

1. Remove the fuel module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** and **Fuel Level Sensor Replacement - Left Side**.
2. Locate the tank in a suitable work area away from any heat, any flame, or any other source of ignition.
3. Perform the following procedures:
    - Inspect the fuel sender strainer. Replace the primary fuel tank module if the strainer is contaminated.
    - Inspect the secondary fuel tank module for debris. Clean the secondary fuel tank module if debris is found.

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

    - Use compressed air in order to apply air pressure to the transfer tube.

NOTE: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all applicable local, state, and federal laws and regulations.

4. Flush the fuel tank with running hot water for at least five minutes. Pour the water out of the fuel sender assembly opening. Rock the tank in order to ensure that the removal of the water from the tank is complete.
5. Refer to **Metal Collar Quick Connect Fitting Service** in order to disconnect the following quick connect fittings from the fuel rail:

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- The feed hose/pipe
- The return hose/pipe

6. Use compressed air in order to apply air pressure to the fuel lines in the opposite direction from the normal fuel flow.
7. Remove the fuel injectors and fuel rail.
8. Clean and inspect the fuel injectors and fuel rail.

Installation Procedure

Assemble the fuel system as follows:

1. Install the fuel injectors and fuel rail.
2. Install the fuel module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** and **Fuel Level Sensor Replacement - Left Side**.
3. Refer to **Metal Collar Quick Connect Fitting Service** in order to connect the following quick connect fittings to the fuel rail:
   - The feed hose/pipe
   - The return hose/pipe

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the cross vehicle brace.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the foam insulator from the fuel rails.

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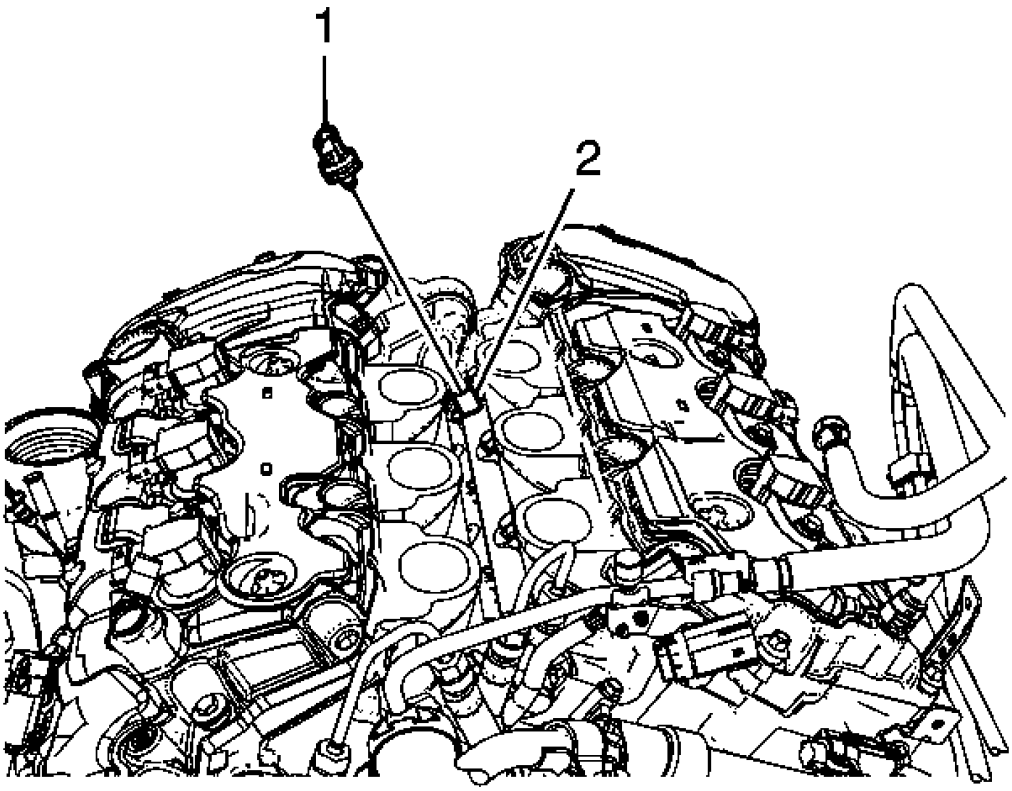


Fig. 95: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

5. Using a 27 mm socket, remove the fuel pressure sensor (1) from the fuel injection fuel rail (2). Discard the fuel pressure sensor.
6. Allow any fuel to drain from the fuel rail and pressure sensor location.
7. Dry the sealing cone in the fuel rail and the area around the sensor joint with a lint free cloth.
8. Inspect the sealing cone in the fuel rail. The surface should be free of fuel, debris, and burrs.

Installation Procedure

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

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NOTE: Ensure that the fuel rail threads have been cleaned of any excess fuel, or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

1. Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
2. Lubricate the threads and sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.

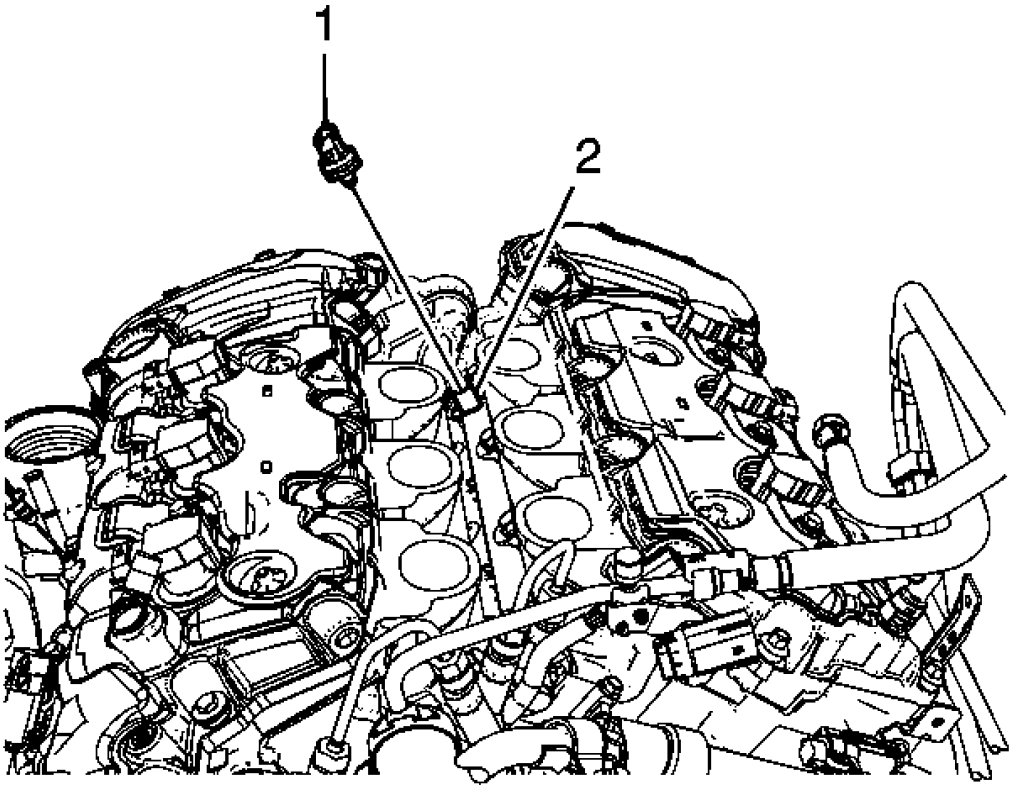


Fig. 96: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) hand tight.
4. Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.

CAUTION: Refer to Fastener Caution .

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5. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) and tighten the sensor to 33 N.m (25 lb ft).
6. Install the foam insulator from the fuel rails.
7. Install the intake manifold. Refer to **Intake Manifold Replacement** .

NOTE: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

8. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
9. Install the cross vehicle brace.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the cross vehicle brace.
3. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
4. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
5. Remove the high pressure fuel pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
6. Remove the fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**. Discard the pipe.
7. Remove the foam insulator from the fuel rails.

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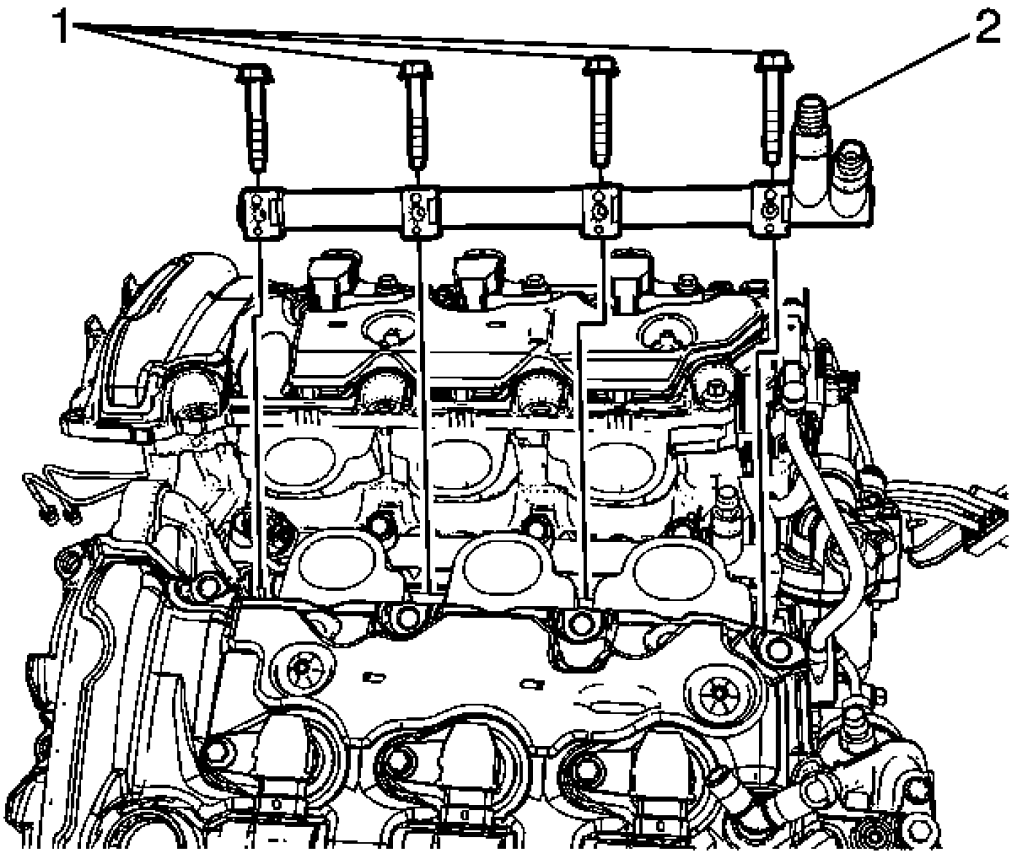


Fig. 97: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the fuel pressure sensor electrical connector and cut the wire harness tie straps.
9. Remove the fuel rail (2) bolts (1).

CAUTION: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

10. Remove the fuel pressure sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.
11. Remove and discard the direct fuel injector hold down clamps.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

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12. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Injector Replacement**.

Installation Procedure

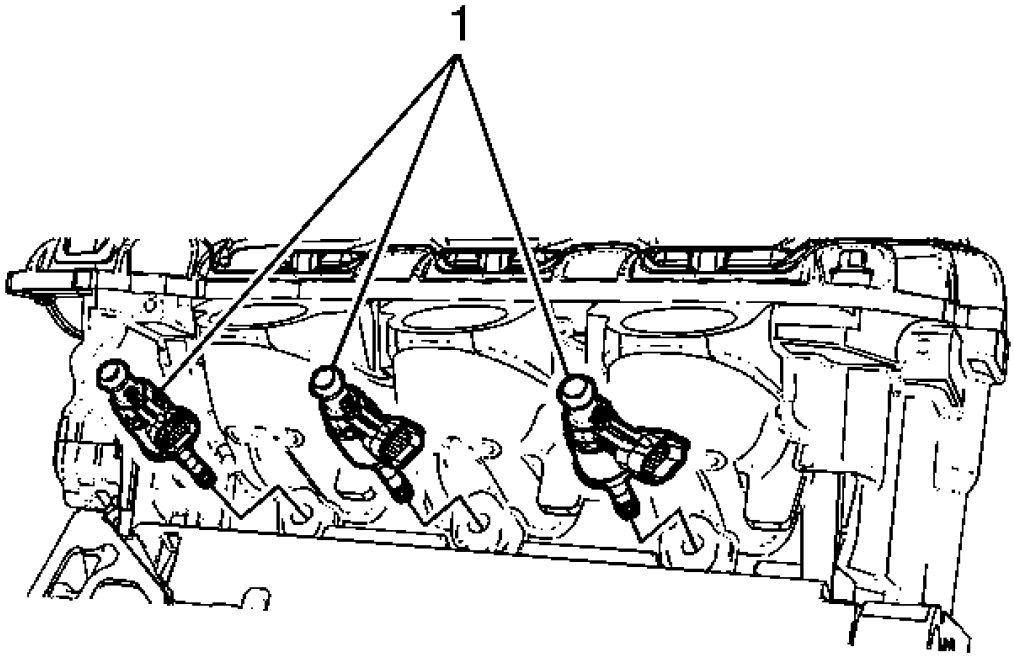


Fig. 98: Identifying Rebuilt Direct Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to **Fuel Injector Replacement**.
2. Install NEW direct injector hold down clamps to the injector.

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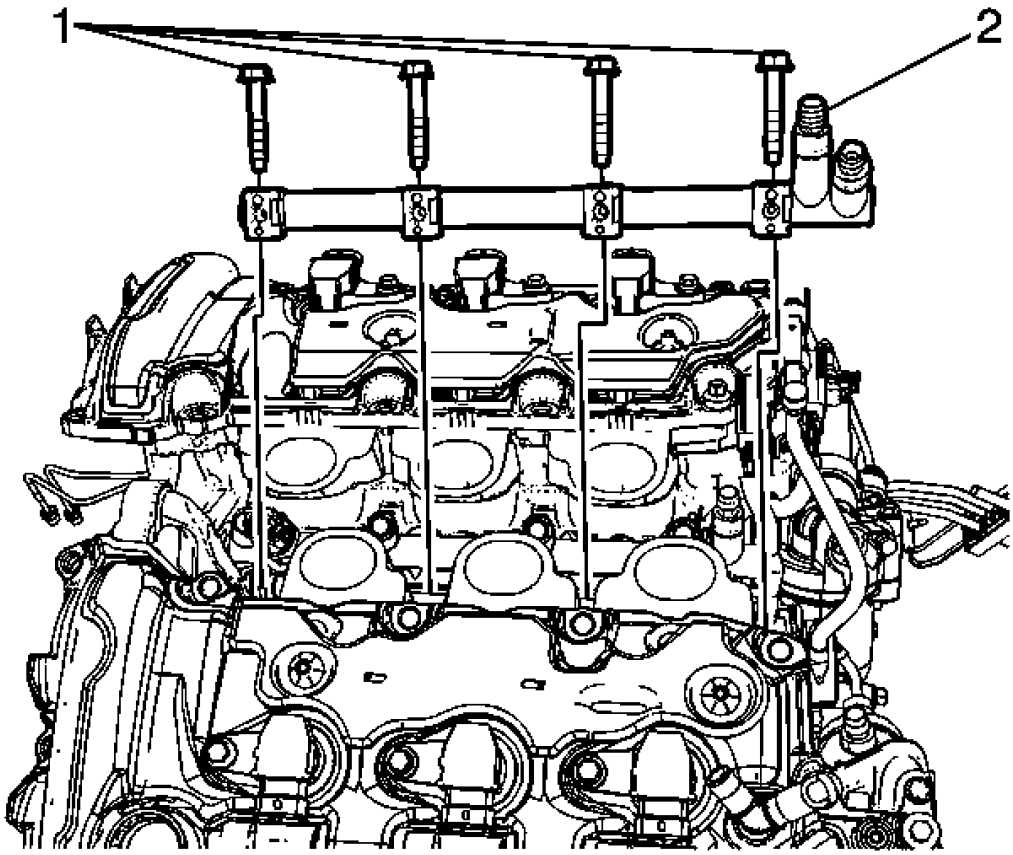


Fig. 99: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

3. On a new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts, and hand tighten.

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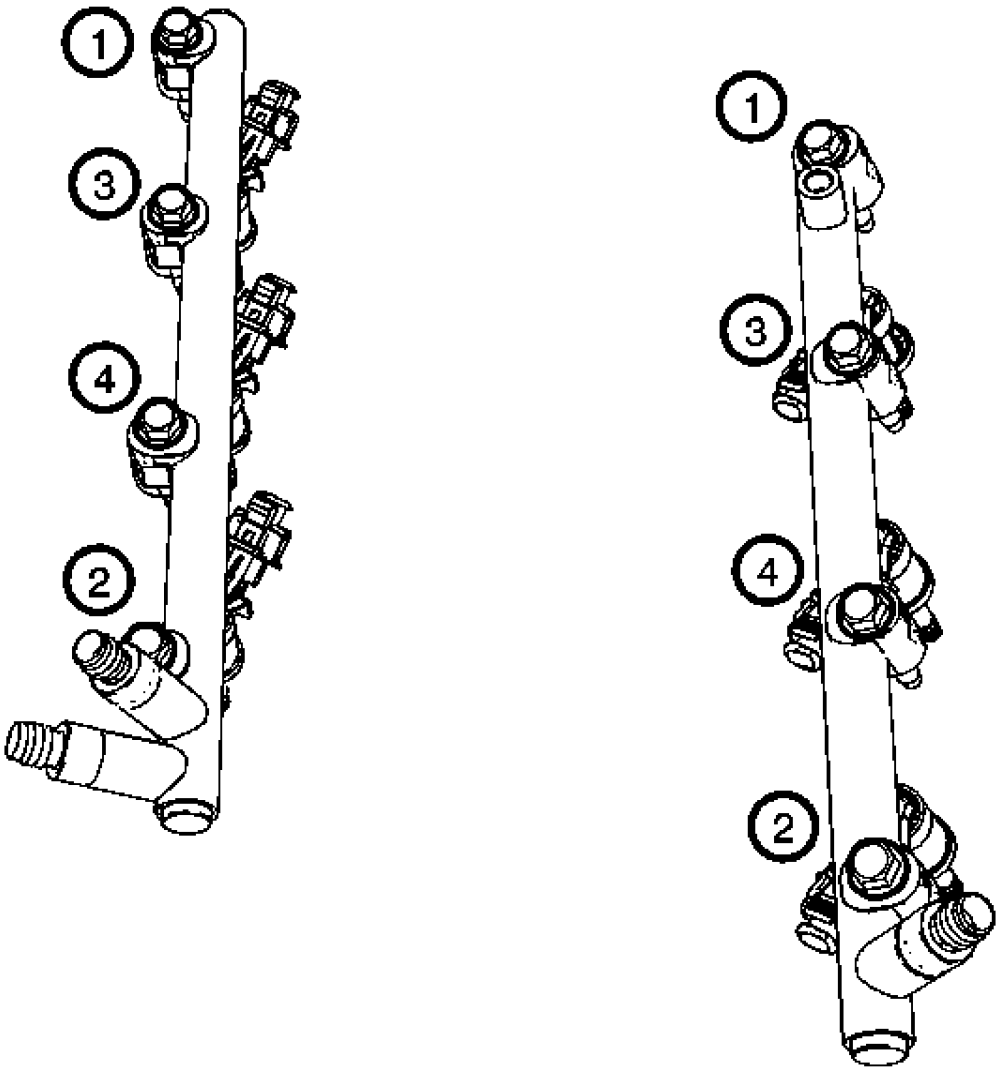


Fig. 100: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the fuel rail bolts in the sequence shown:
   - Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
   - Tighten the Bank 1 fuel rail bolts final pass to 23 N.m (17 lb ft).

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7. Install a NEW fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**.
8. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
9. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.
10. Connect the fuel injector wiring harness electrical connector to the fuel injectors, fuel rail and fuel pressure sensor.
11. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
12. Install the foam insulator from the fuel rails.
13. Install the intake manifold. Refer to **Intake Manifold Replacement** .
14. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
15. Install the low side fuel pressure service port cap.
16. Install the fuel tank cap.
17. Install the cross vehicle brace.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.
4. Remove the fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**. Discard this pipe.

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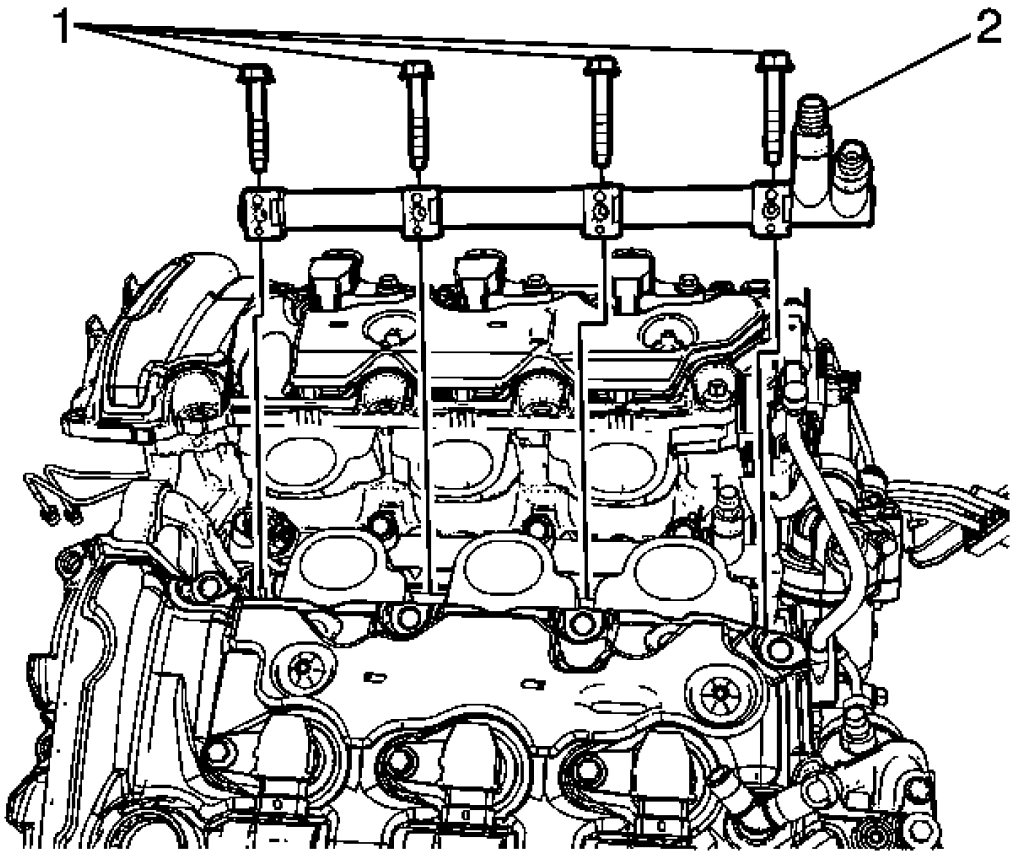


Fig. 101: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel rail bolts (1).
6. Carefully remove the Bank 2 fuel rail (2) from the engine. Lift the rear of the rail to ease removal.
7. Remove and discard the direct fuel injector hold down clamps.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

8. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Injector Replacement**.

Installation Procedure

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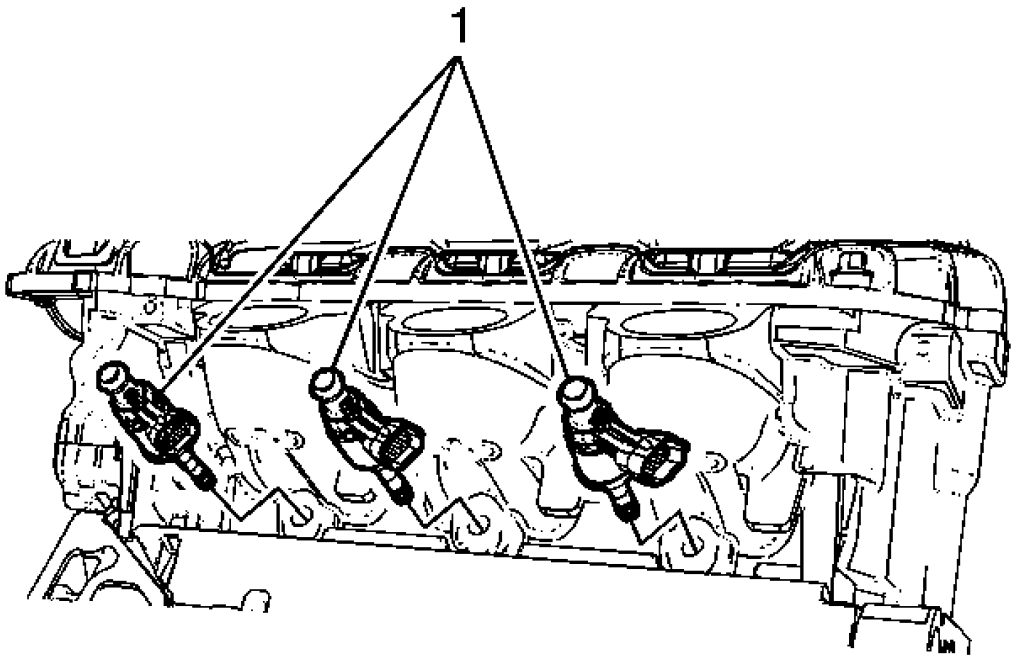


Fig. 102: Identifying Rebuilt Direct Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to **Fuel Injector Replacement**.
2. Install new direct injector hold down clamps to the injectors.

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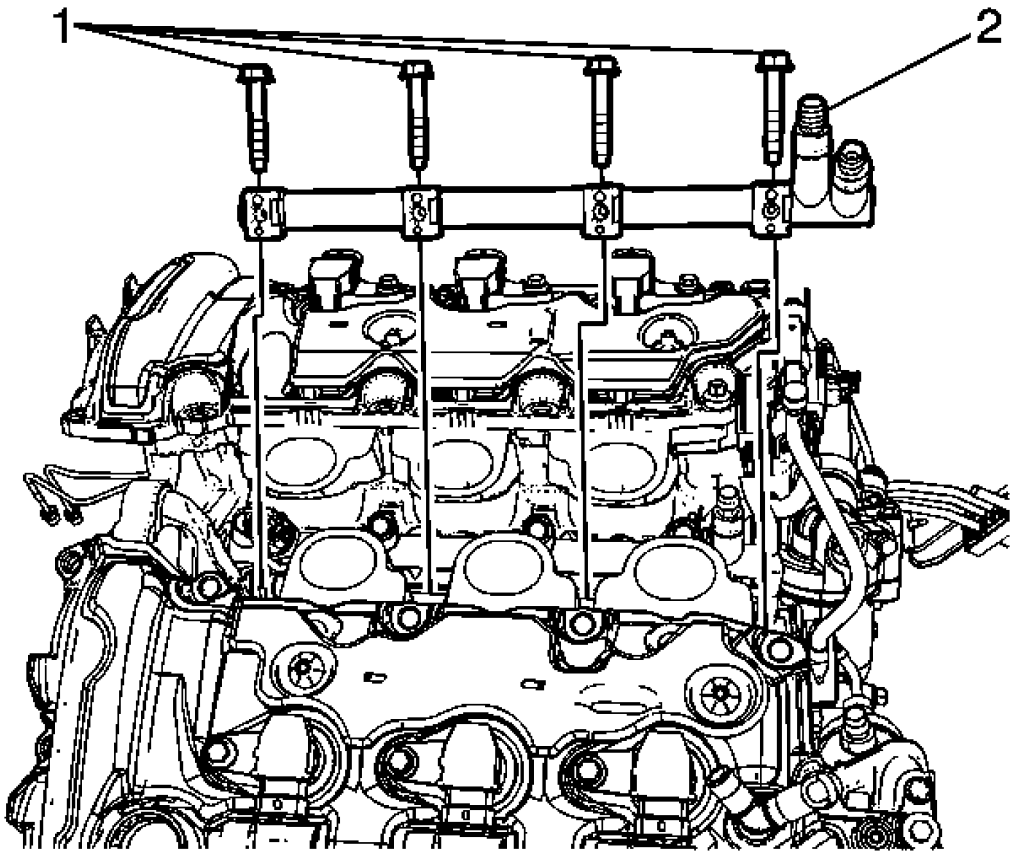


Fig. 103: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

3. On the new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts and hand tighten.

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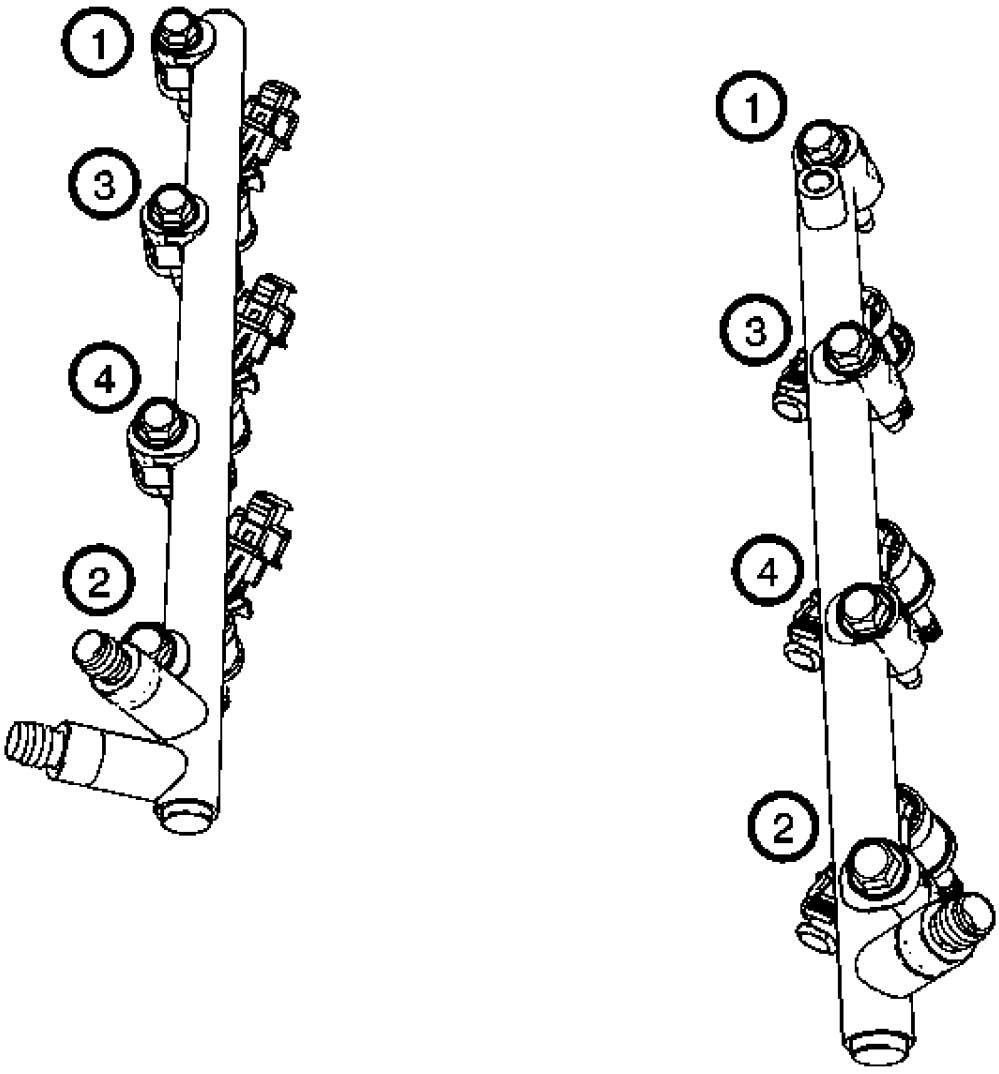


Fig. 104: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the fuel rail bolts in the sequence shown:
   - Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
   - Tighten the Bank 1 fuel rail bolts a final pass to 23 N.m (17 lb ft).

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7. Install a NEW fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**.

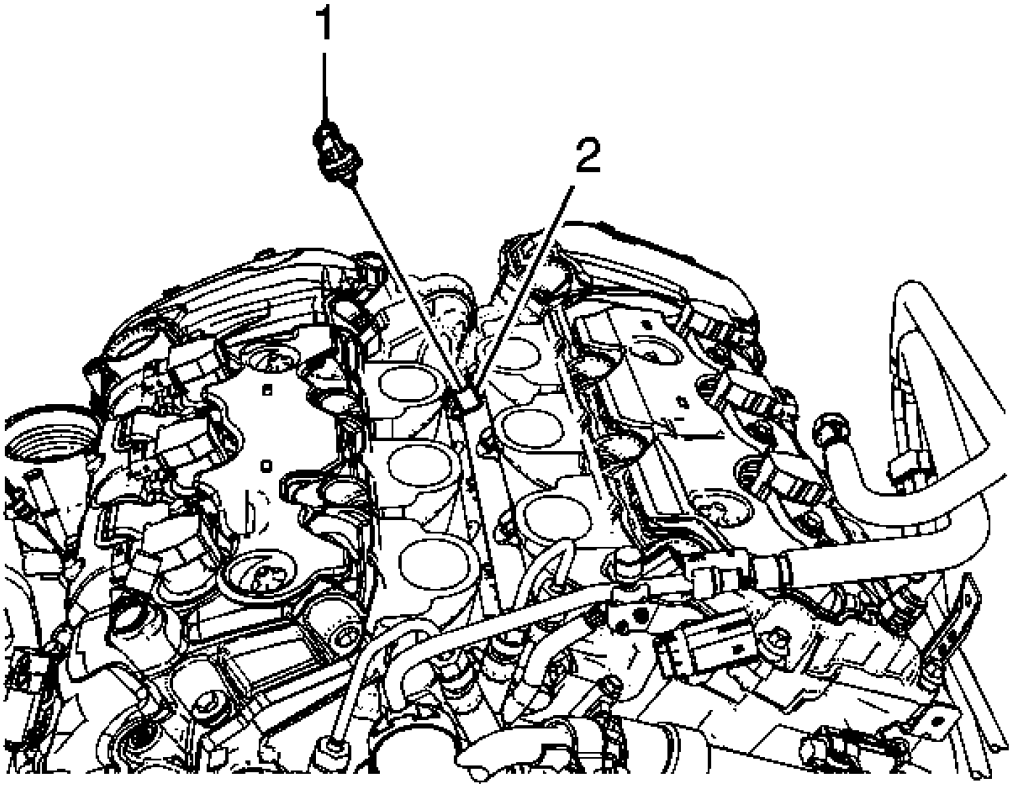


Fig. 105: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

8. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.

CAUTION: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

9. Connect the fuel injector wiring harness electrical connector (1) from the fuel injectors, fuel rail and fuel pressure sensor.
10. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.

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4. Inspect for fuel leaks.
11. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL CROSSOVER TUBE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
4. Remove the intake manifold. Refer to **Intake Manifold Replacement** .

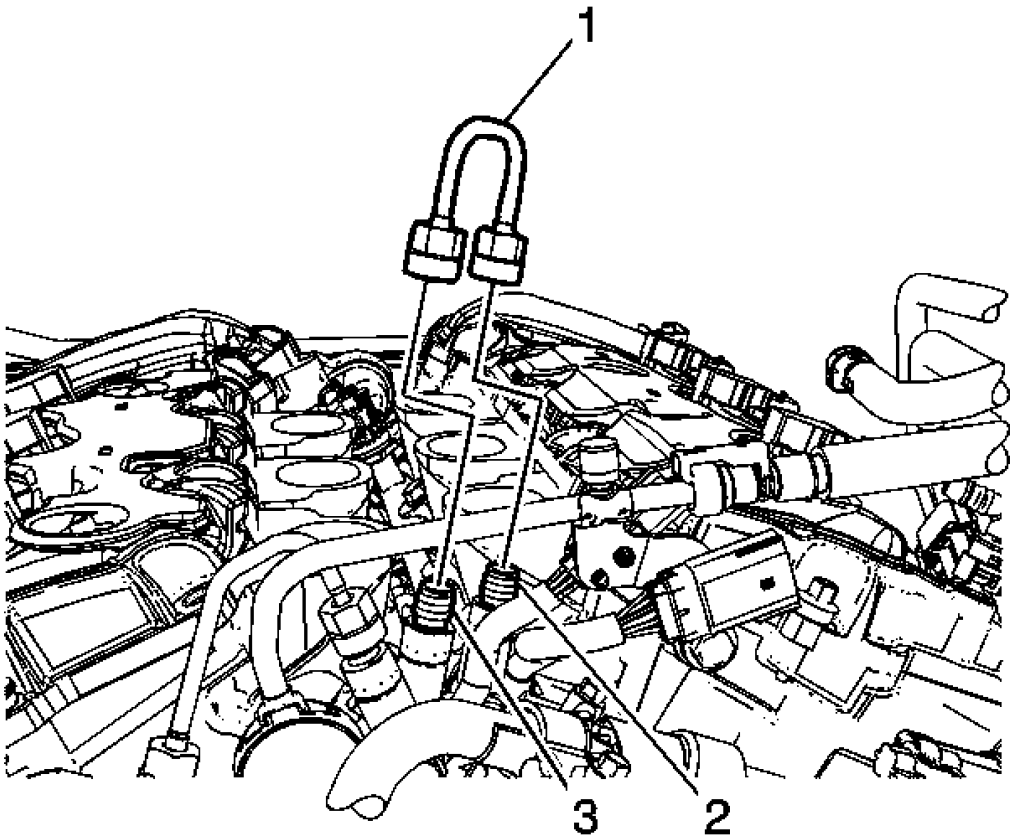


Fig. 106: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
Courtesy of GENERAL MOTORS CORP.

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5. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (2).
6. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (3).
7. Remove the fuel rail crossover pipe (1) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the fuel rail crossover pipe, right fuel rails fittings and left fuel rail fittings are clean and dry prior to assembly.

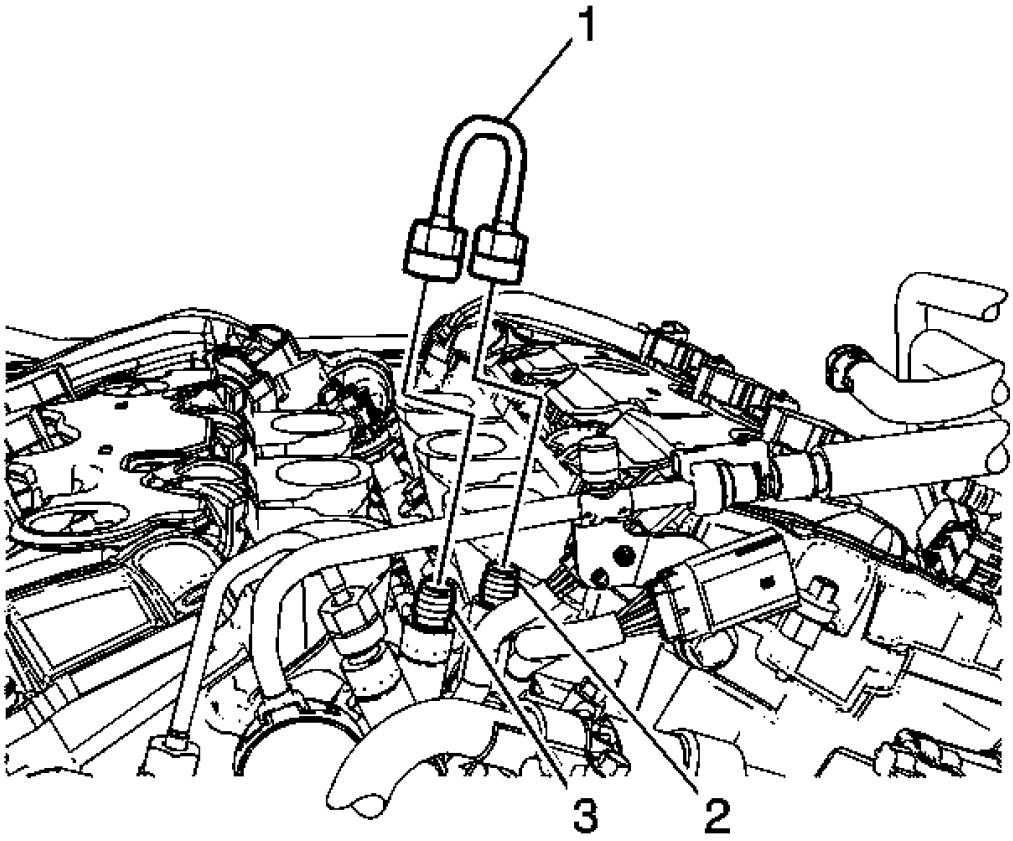


Fig. 107: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
Courtesy of GENERAL MOTORS CORP.

2. Position the fuel rail crossover pipe (1) to the right fuel rails fitting (2) and left fuel rail fitting (3).

CAUTION: Refer to Fastener Caution .

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3. Tighten the fuel rail crossover pipe fittings.
    - Tighten the fittings first pass to 16 N.m (12 lb ft).
    - Tighten the fittings final pass to 32 N.m (24 lb ft).

NOTE: If a fuel leak accrues at the right fuel rail fitting (2) or left fuel rail fitting (3), that component will need to be replaced.

4. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
5. Install the low side fuel pressure service port cap.
6. Install the fuel tank cap.
7. Install the intake manifold. Refer to **Intake Manifold Replacement** .
8. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
9. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve fuel system pressure. Refer to **Fuel Pressure Relief**.

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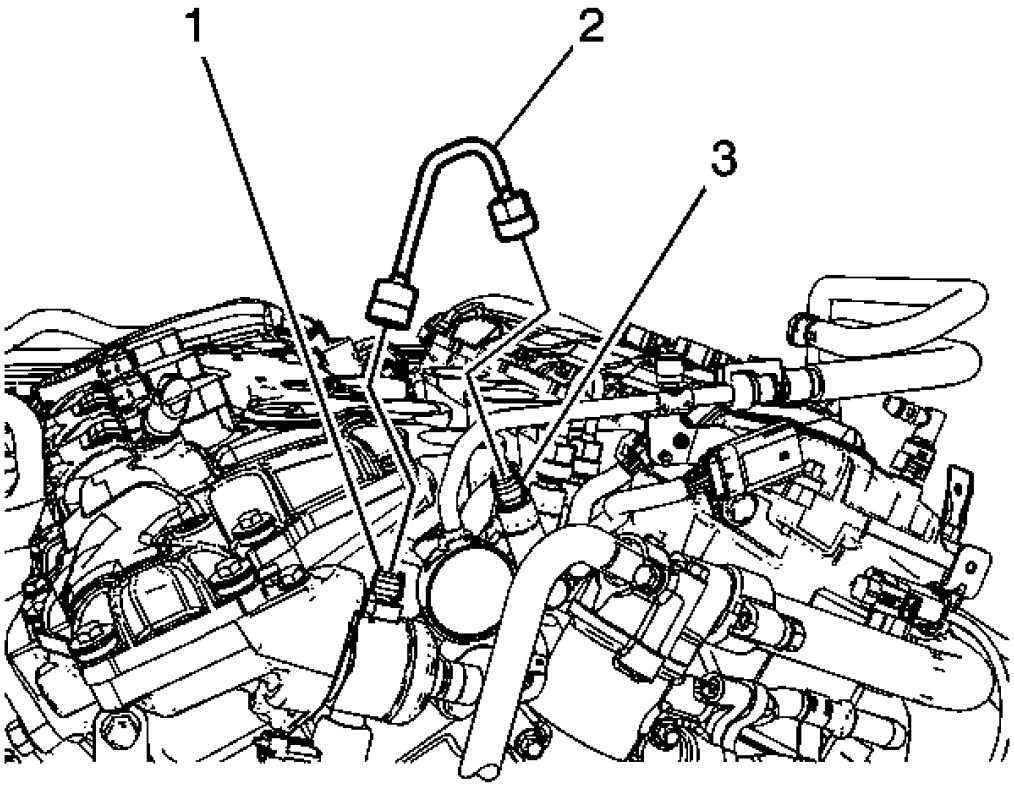


Fig. 108: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe
Courtesy of GENERAL MOTORS CORP.

4. Remove the foam insulator from the pipes.
5. Loosen the high pressure pipe fitting to the high pressure fuel pump (1).
6. Loosen the high pressure pipe fitting to the left fuel rail (3).
7. Remove the high pressure fuel pipe (2) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the high pressure fuel pipe, fuel rail fitting and fuel pump fitting are clean and dry prior to assembly.

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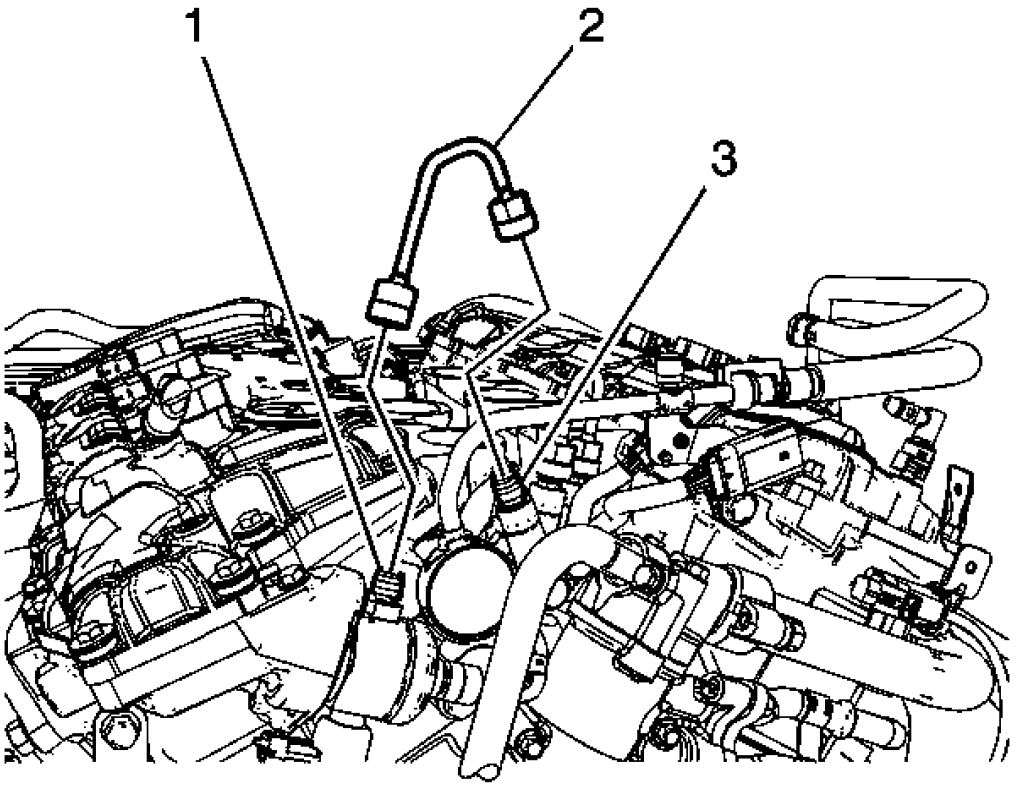


Fig. 109: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe
Courtesy of GENERAL MOTORS CORP.

2. Position the NEW high pressure fuel pipe (2) to the high pressure fuel pump fitting (1) and left fuel rail (3). hand tighten the fitting.

CAUTION: Refer to Fastener Caution .

3. Tighten the high pressure fuel pipe fitting.
   - Tighten the fitting a first pass to 16 N.m (12 lb ft).
   - Tighten the fitting a final pass to 32 N.m (24 lb ft).

NOTE: If a fuel leak accrues at the high pressure fuel pump or the fuel rail, that component will need to be replaced.

4. Inspect for leaks using the following procedure:

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1. Turn ON the ignition, with the engine OFF for 2 seconds.
2. Turn OFF the ignition, for 10 seconds.
3. Turn ON the ignition, with the engine OFF.
4. Inspect for fuel leaks.

5. Install the low side fuel pressure service port cap.
6. Install the fuel tank cap.
7. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

FUEL PIPE SHIELD REPLACEMENT

Removal Procedure

1. Remove the cross vehicle brace.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
3. Remove the intake manifold insulator.
4. Remove the wiper transmission. Refer to **Windshield Wiper Transmission Replacement** .

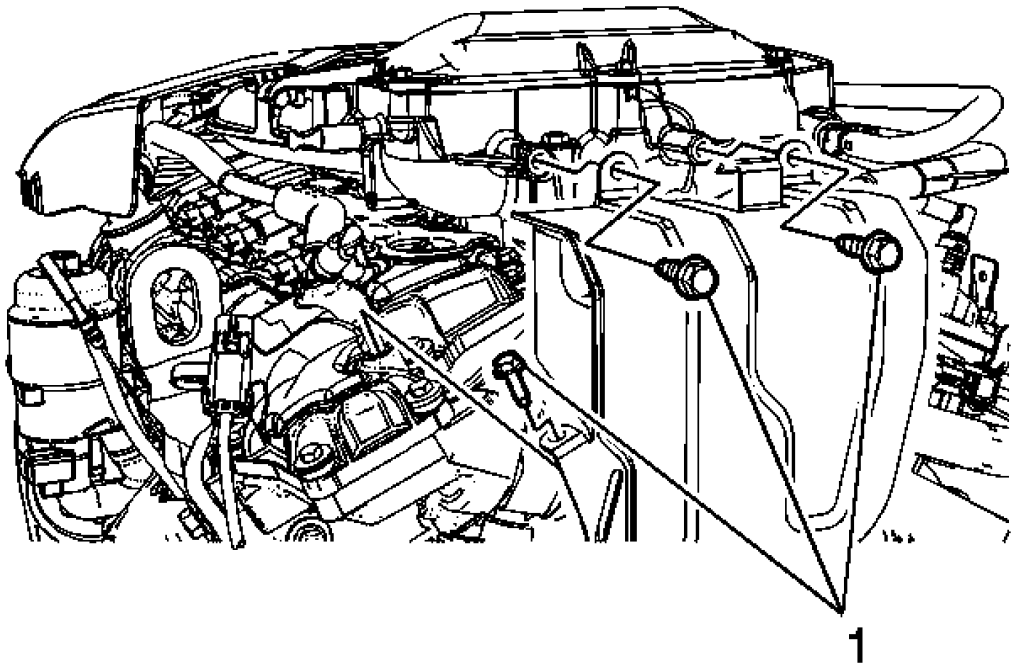


Fig. 110: Removing/Installing Fuel Pipe Shield

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Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel pipe shield to intake manifold bolts (1).
6. Remove the fuel pipe shield to cylinder bolt (1).
7. Carefully remove the fuel pipe shield from the vehicle. Take care not to damage the insulation behind the shield.

Installation Procedure

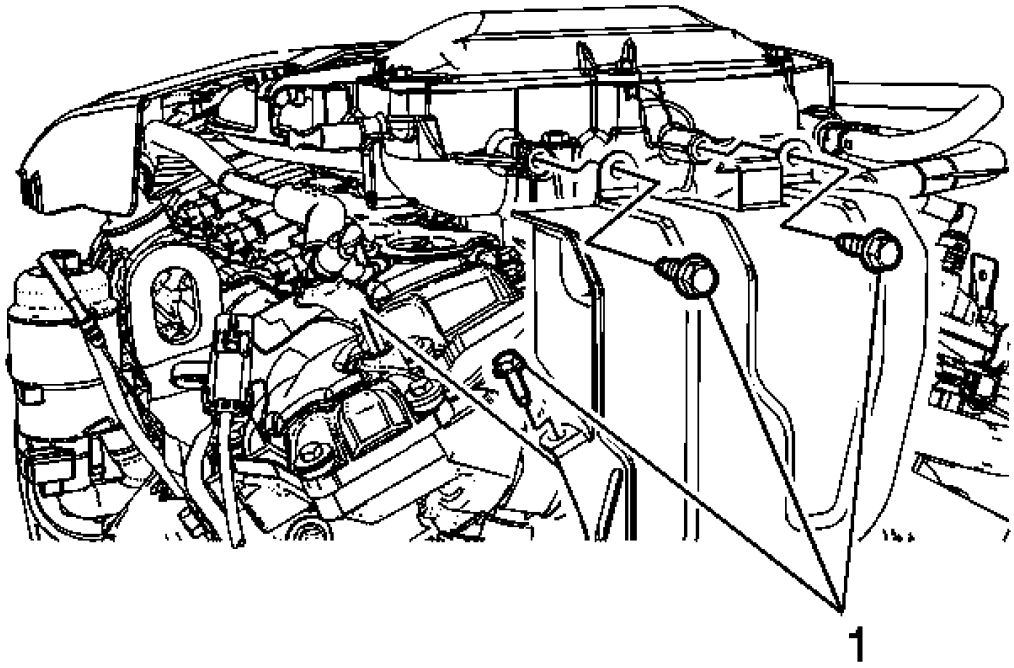


Fig. 111: Removing/Installing Fuel Pipe Shield
Courtesy of GENERAL MOTORS CORP.

1. Position the fuel pipe shield behind the high pressure fuel pump. Take care not to damage the insulation behind the shield.
2. Install the fuel pipe shield to cylinder bolt (1). Hand tighten at this time.

CAUTION: Refer to Fastener Caution .

3. Install the fuel pipe shield to intake manifold bolts (1).

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- Tighten the fuel pipe shield to manifold bolts to 23 N.m (17 lb ft).
- Tighten the fuel pipe shield to head bolt to 10 N.m (89 lb in).

4. Install the wiper transmission. Refer to **Windshield Wiper Transmission Replacement** .
5. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
6. Install the cross vehicle brace.

FUEL PUMP REPLACEMENT

Special Tools

EN-48896 HP Fuel Pump Installation Alignment Gauge. See **Special Tools** .

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the cross vehicle brace.
3. Remove the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement**.
4. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
5. Remove the wiper module. Refer to **Windshield Wiper Motor Replacement** .

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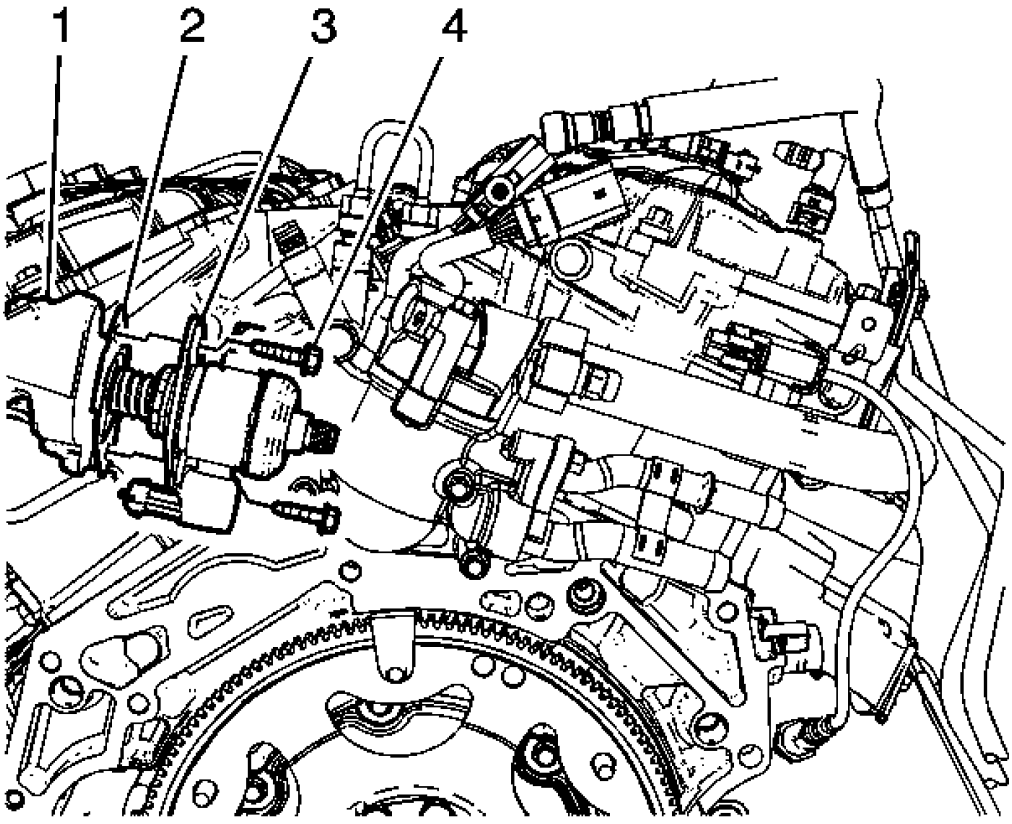


Fig. 112: Identifying High Pressure Fuel Pump & Components
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
7. Remove the radiator surge tank outlet pipe.
8. Remove the low pressure feed pipe.
9. Remove the high pressure pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**. Discard this pipe.
10. Remove and discard the high pressure fuel pump bolts (4).
11. Remove the high pressure fuel pump (3).
12. Remove and discard the high pressure fuel pump gasket (2).
13. Remove and discard the high pressure fuel pump O-ring.
14. Remove the high pressure fuel pump roller lifter.

Installation Procedure

NOTE: The camshaft must be in the base circle position before the high pressure

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fuel pump is installed.

1. Use the **EN-48896** to ensure that the camshaft lobe is in the base circle position. See **Special Tools** . At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube GM P/N 12345501 (Canadian P/N 992704) or equivalent.
3. Install high pressure fuel pump roller lifter.
4. Install a NEW high pressure fuel pump O-ring.

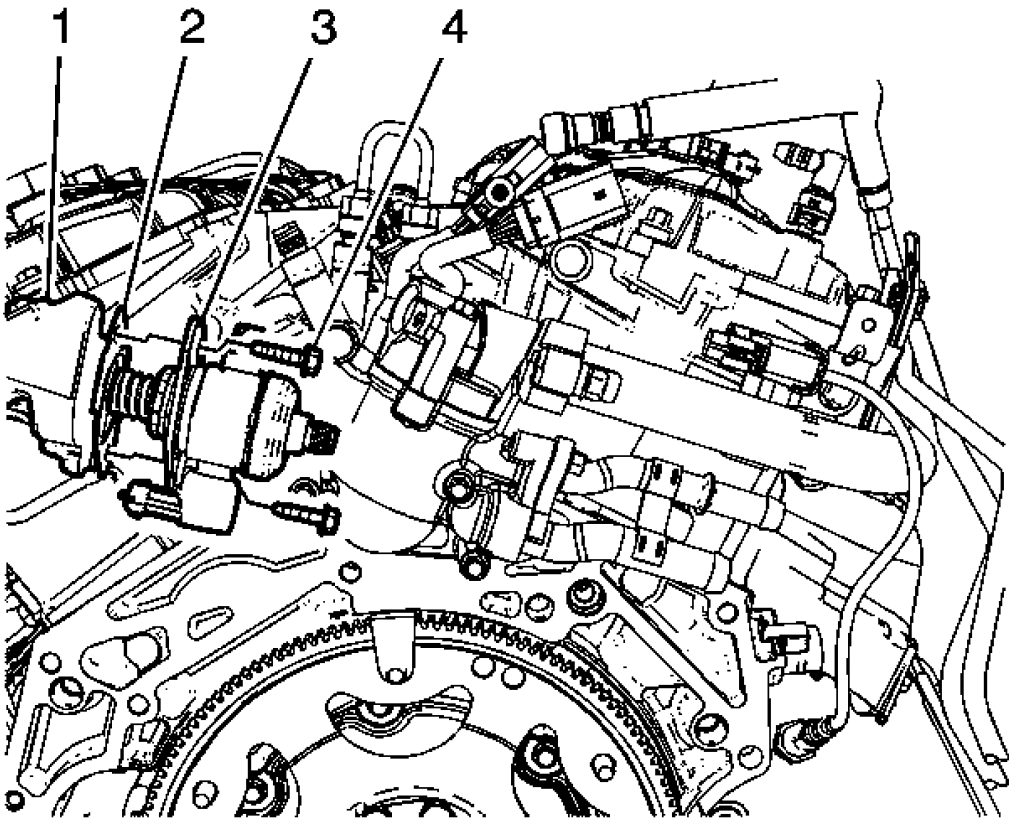


Fig. 113: Identifying High Pressure Fuel Pump & Components
Courtesy of GENERAL MOTORS CORP.

NOTE: The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.

5. Position the NEW high pressure fuel pump gasket (2) and bolts (4) to the fuel pump.

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6. Install the high pressure fuel pump (3) to the cylinder head (1). Force will be required while hand tightening the bolts.

CAUTION: Refer to Fastener Caution .

7. Tighten the high pressure fuel pump retaining bolts to 15 N.m (11 lb ft).
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
10. Install the fuel feed pipe to the high pressure fuel pump.
11. Connect the high pressure fuel pump wiring harness.
12. Install the radiator surge tank outlet pipe.
13. Install the fuel tank cap.

NOTE: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

14. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
15. Install the pressure relief cap to the fuel feed pipe.
16. Install the wiper module. Refer to **Windshield Wiper Motor Replacement** .
17. Install the intake manifold. Refer to **Intake Manifold Replacement** .
18. Install the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement**.
19. Install the cross vehicle brace.

FUEL INJECTOR REPLACEMENT

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-48266** Injector Seal Installer and Sizer. See **Special Tools** .
- **J 2619-01** Slide Hammer. See **Special Tools** .
- **J-37281-A** Injector Remover. See **Special Tools** .
- **J 39313** Spark Plug Port Adapter

Removal Procedure

1. Relieve the high side fuel system pressure. Refer to **Fuel Pressure Relief**.

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NOTE: The fuel injectors have an alignment feature, note the position of the injectors alignment for installation.

2. Remove the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.

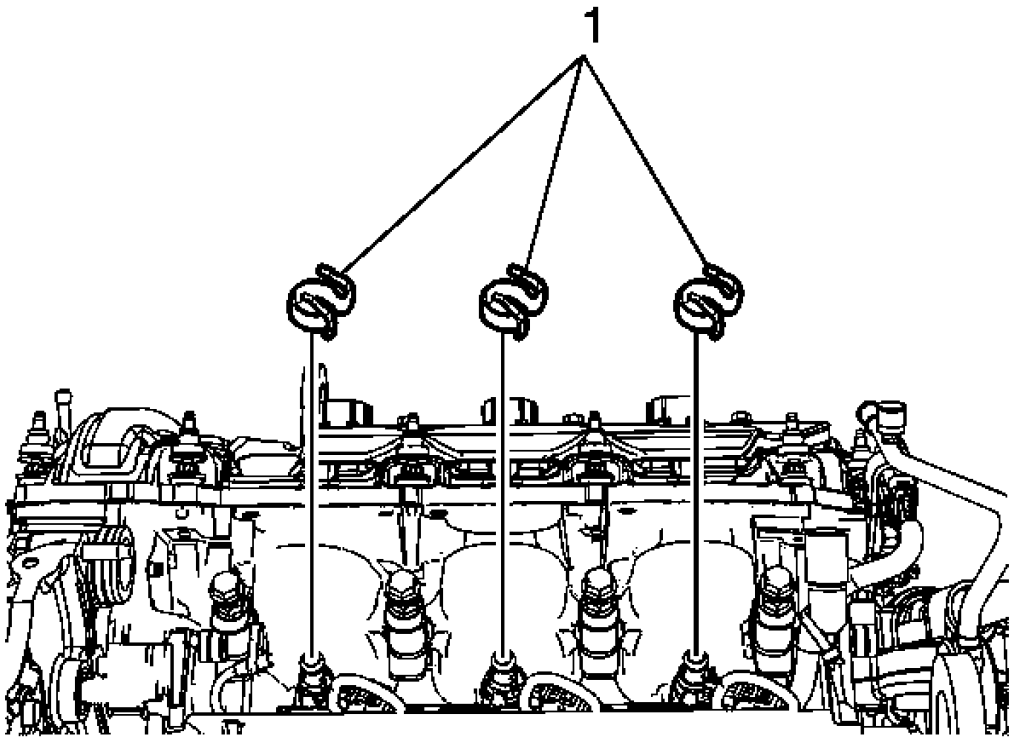


Fig. 114: Identifying Fuel Injector Retaining Rings
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the three fuel injector retaining rings (1).

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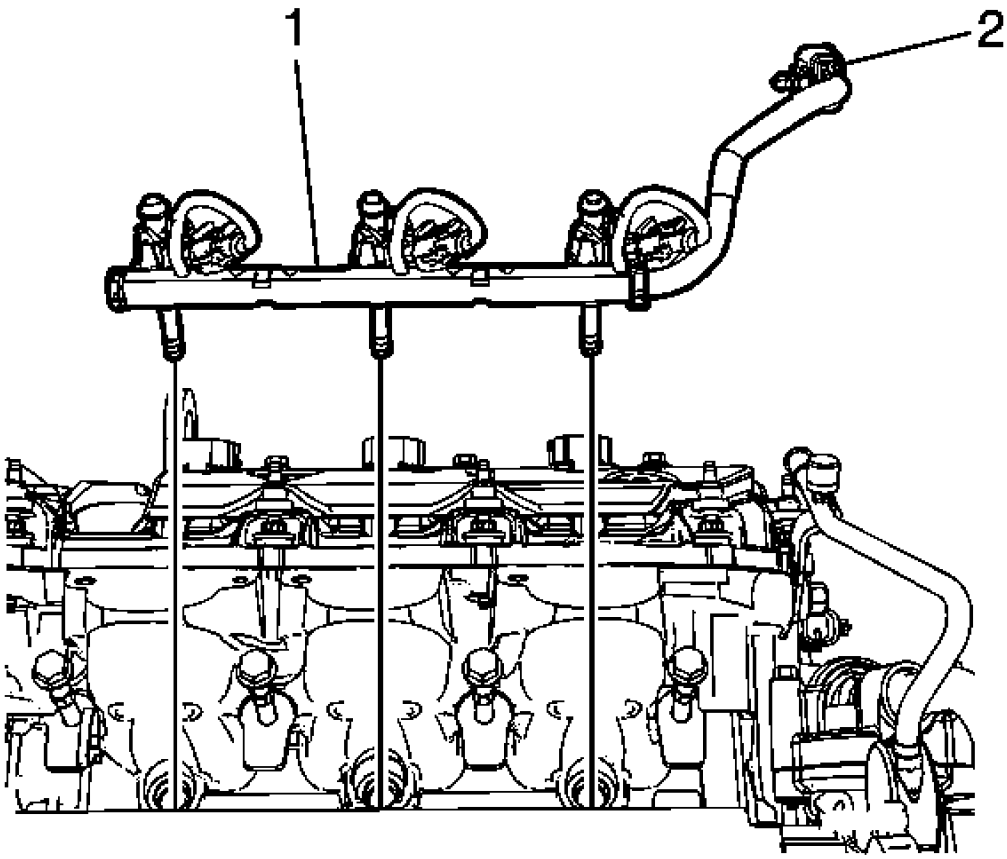


Fig. 115: Identifying Direct Fuel Injector & Harness Assembly
Courtesy of GENERAL MOTORS CORP.

4. Remove the direct fuel injectors and harness (1) as an assembly, and disconnect the electrical connector (2). If necessary, use the **J 2619-01** with the **J-37281-A** in order to remove the direct fuel injectors evenly. See **Special Tools** .

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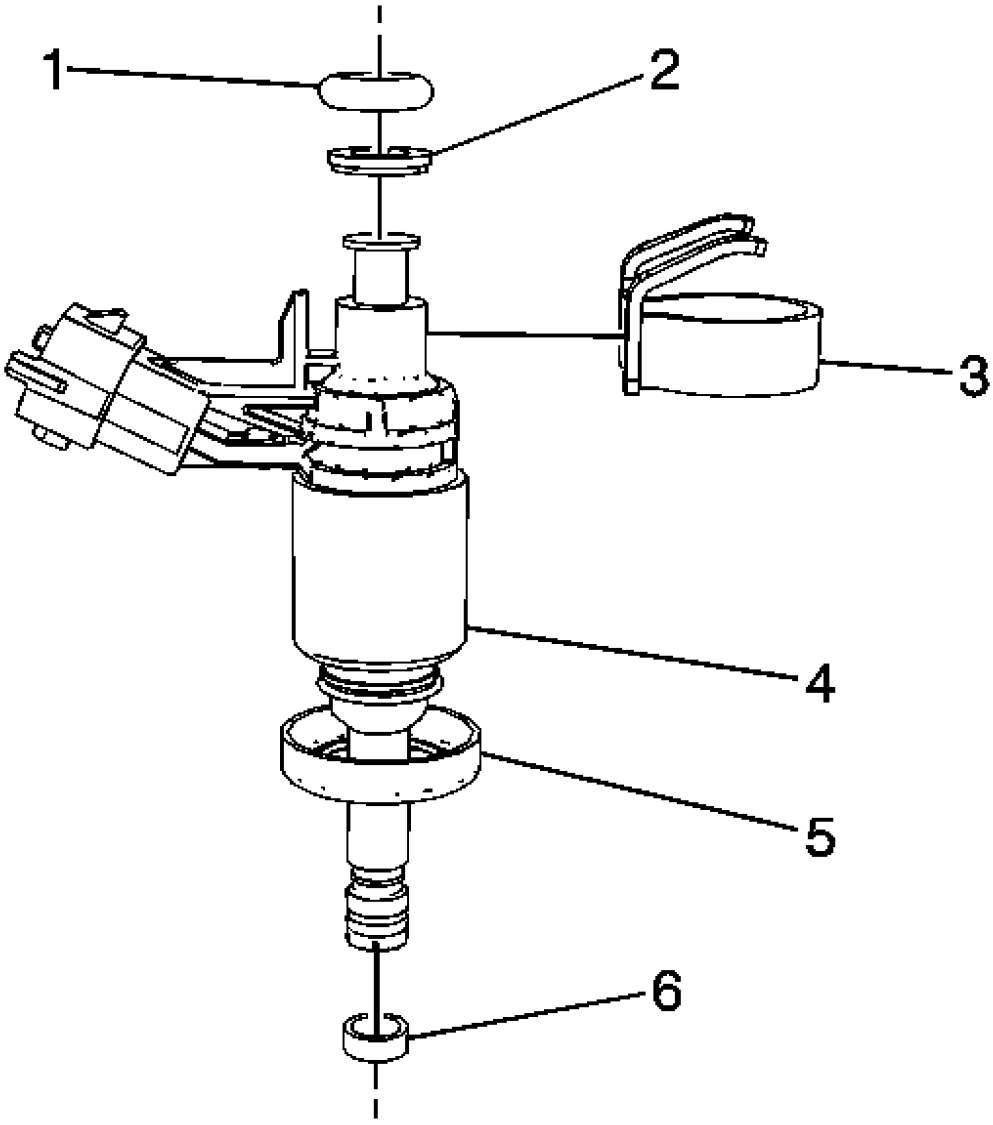


Fig. 116: Identifying Fuel Injector Components
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the following components from the fuel injectors (4).
    - Upper O-ring Seal (1)
    - Plastic Spacer (2)
    - Retaining Ring (3)

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- Isolator Cup (5)
- Teflon Seal (6)

6. Inspect the fuel rail injector bores and clean with **J 39313** , and **EN-47909** , if required.

Installation Procedure

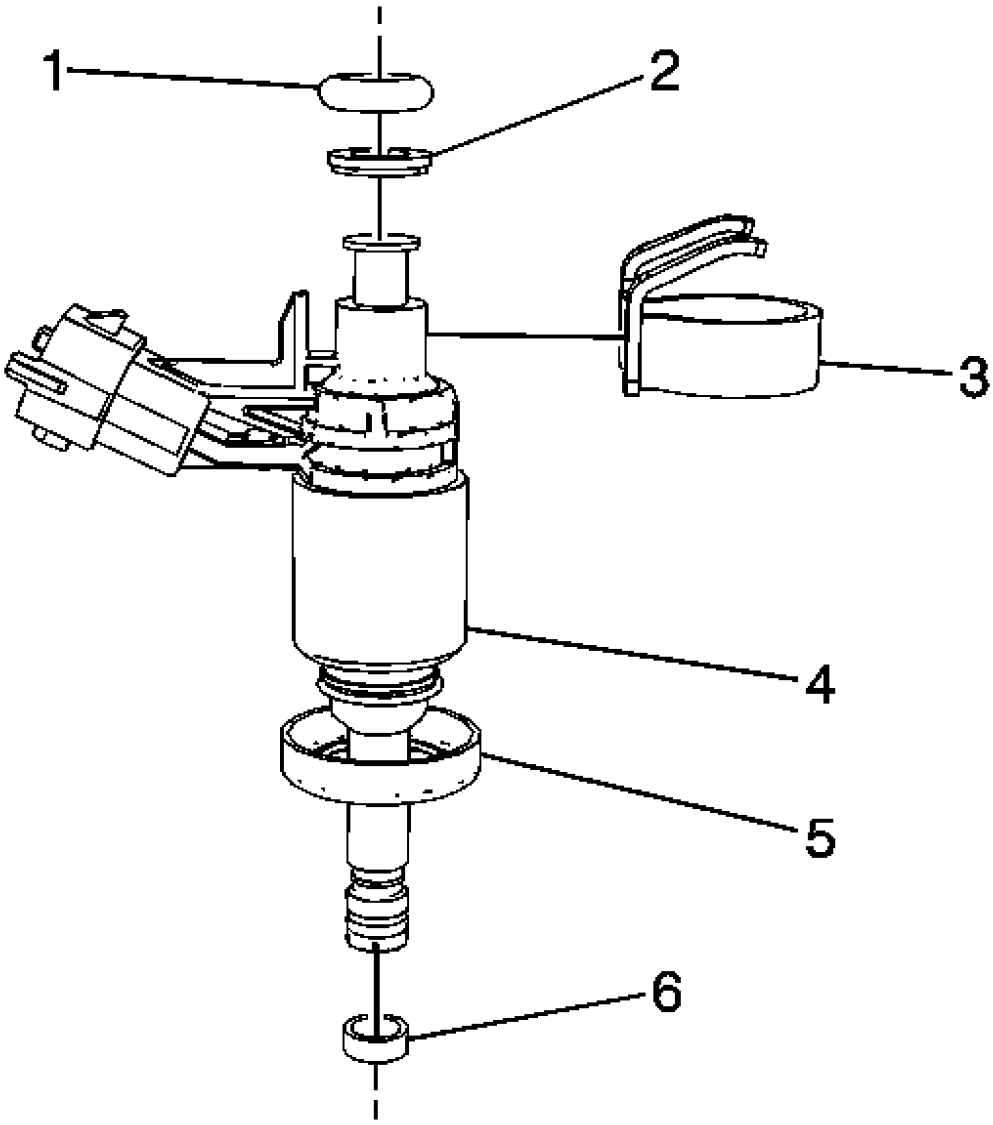


Fig. 117: Identifying Fuel Injector Components
Courtesy of GENERAL MOTORS CORP.

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NOTE: Lubricate a NEW O-ring seal (1) with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.

1. Install the following NEW components to the fuel injectors. Use steps 2 through 8 to install these components.
   - Upper O-ring Seal (1)
   - Plastic Spacer (2)
   - Retaining Ring (3)
   - Isolator Cup (5)
   - Teflon Seal (6)

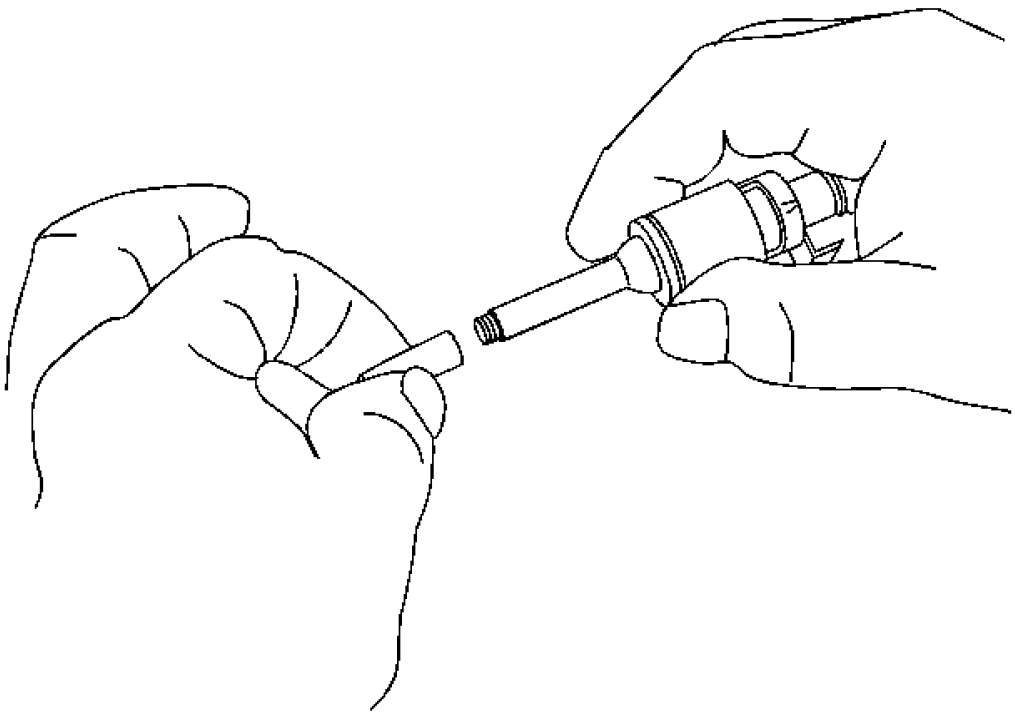


Fig. 118: Injector Tip & EN 48266-1
Courtesy of GENERAL MOTORS CORP.

2. From the **EN-48266** , position the EN 48266-1 to the injector tip. See **Special Tools** .

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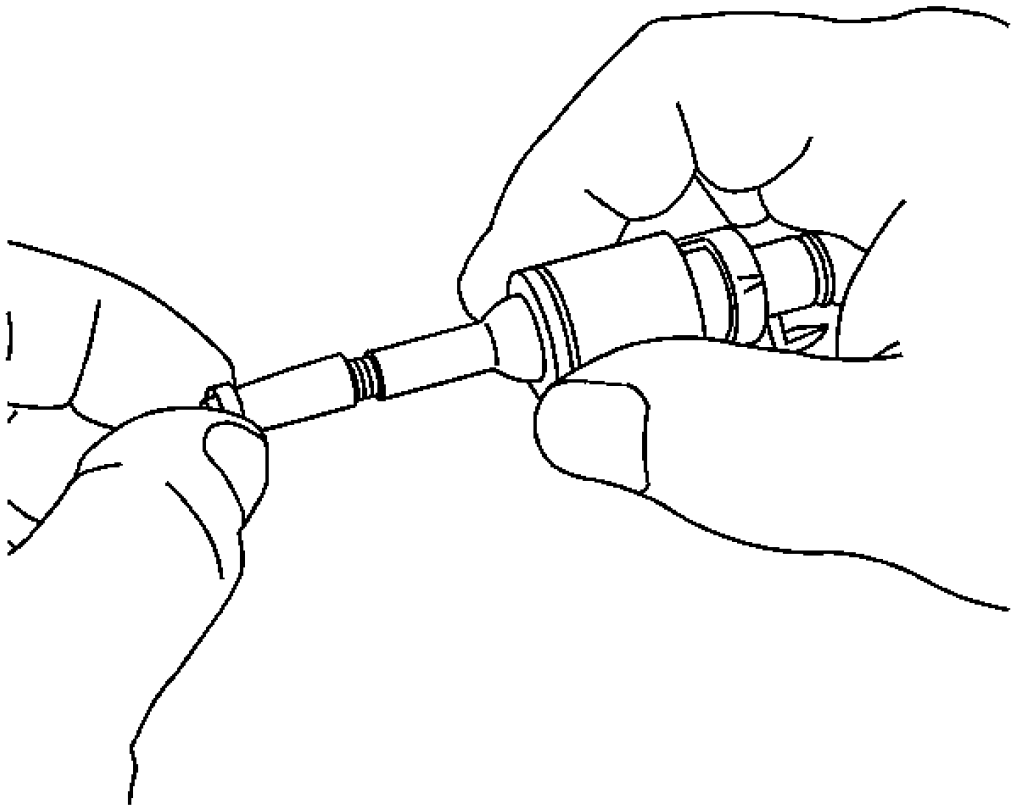


Fig. 119: Using EN 48266-1
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT lubricate the NEW teflon seal.

3. Install a NEW teflon seal onto the EN 48266-1.

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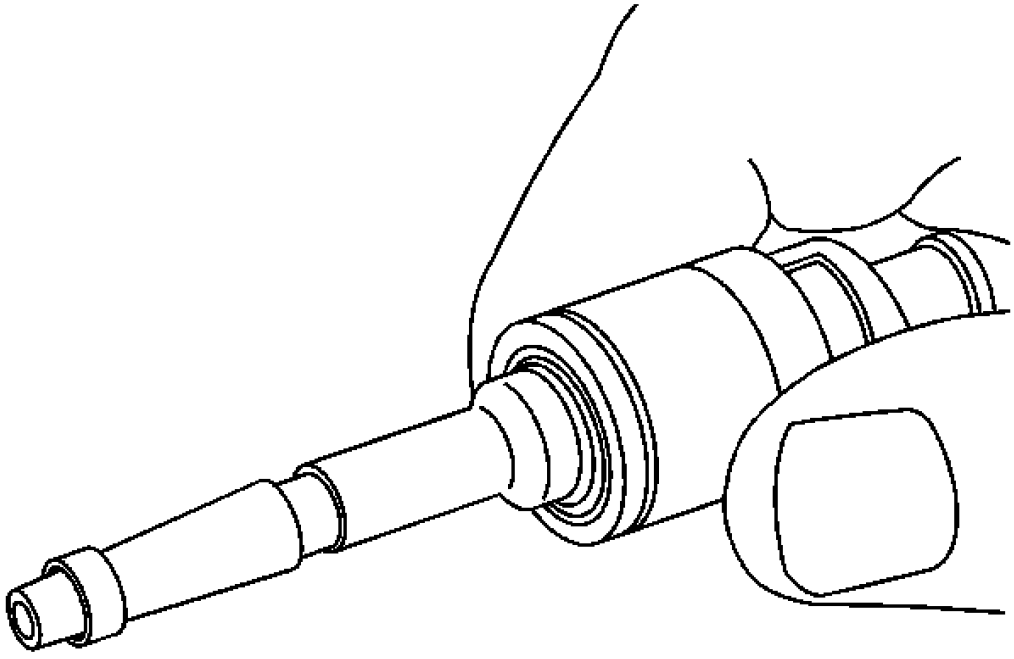


Fig. 120: View Of Teflon Seal
Courtesy of GENERAL MOTORS CORP.

4. Pull the NEW teflon seal by hand over the EN 48266-1 and into the groove in the injector.
5. Remove the EN 48266-1 from the injector tip.

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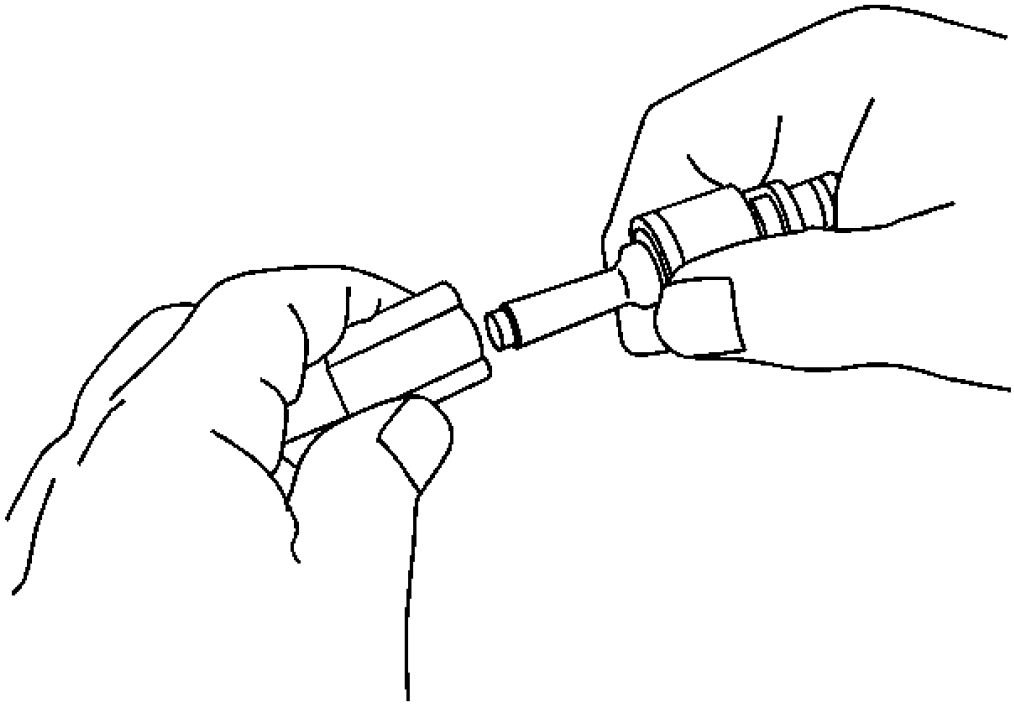


Fig. 121: Injector Tip & EN 48266-2
Courtesy of GENERAL MOTORS CORP.

6. From the **EN-48266** , install the EN 48266-2 to the injector tip. See **Special Tools** .

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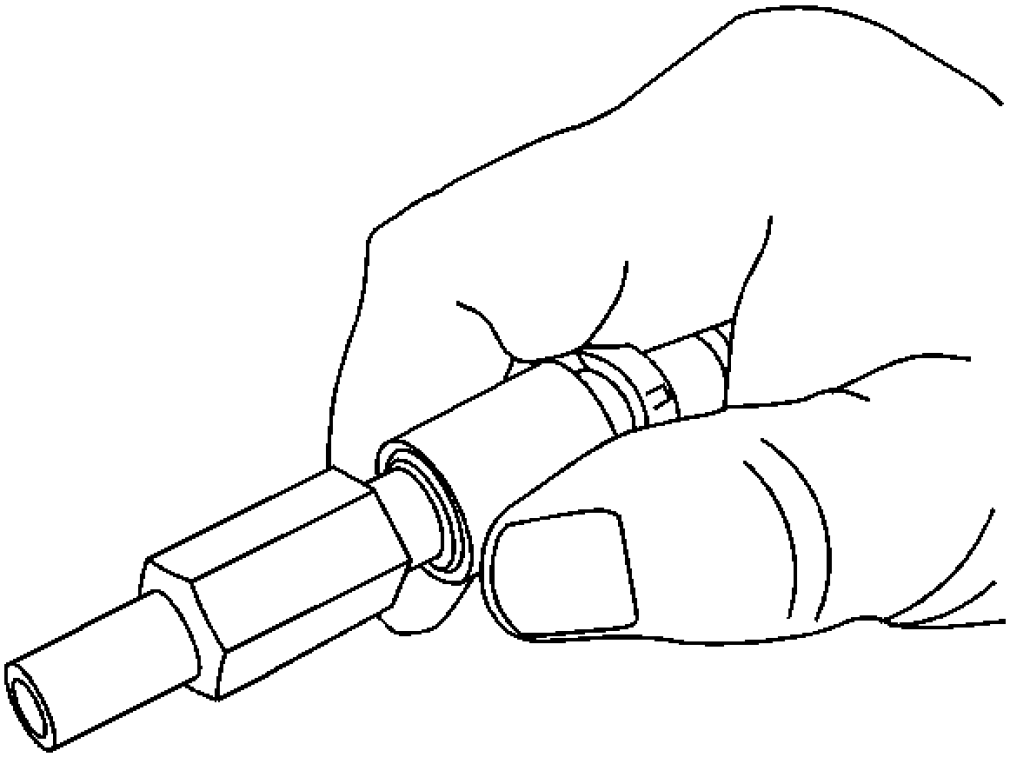


Fig. 122: Resizing Teflon Seal
Courtesy of GENERAL MOTORS CORP.

7. Using the EN 48266-2, resize the teflon seal. Install the EN 48266-2, until it bottoms out against the injector body, and rotate the EN 48266-2 while applying only moderate force 180 degrees in one direction and then 180 degrees back in the other direction.
8. Remove the EN 48266-2.

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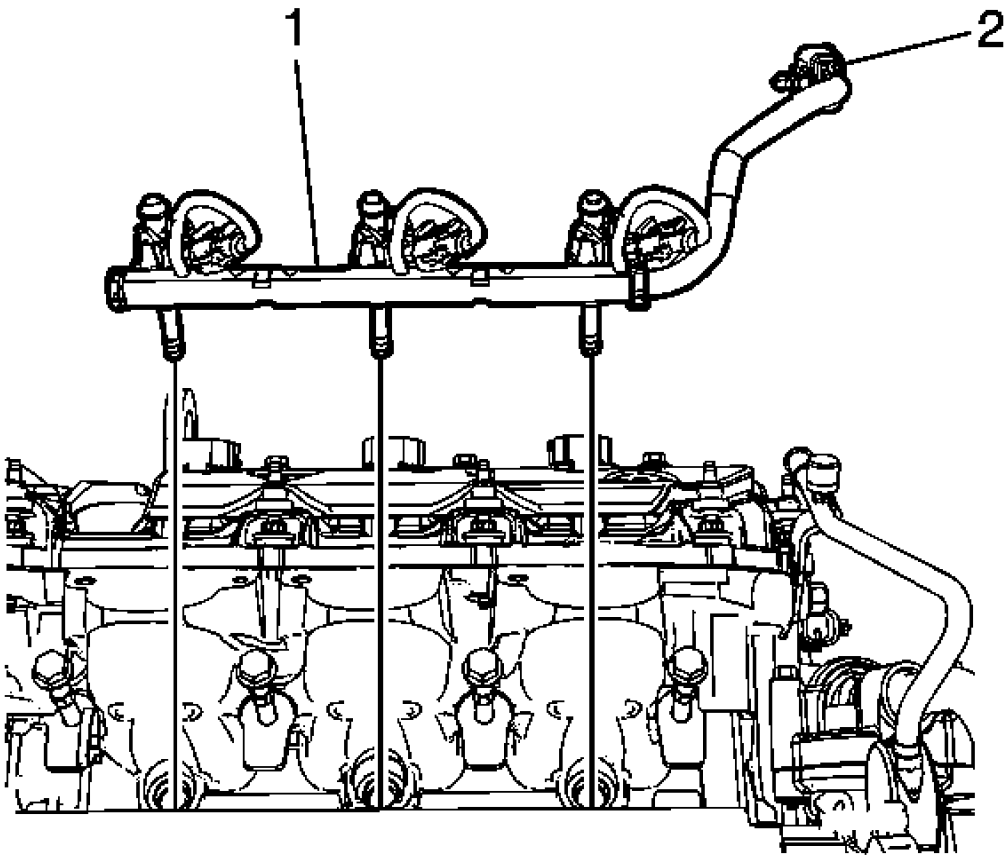


Fig. 123: Identifying Direct Fuel Injector & Harness Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

9. Install the direct fuel injectors and harness (1) as an assembly and connect the electrical connector (2).

NOTE: The fuel injectors have an alignment feature and must be reinstalled as noted during removal.

10. Install the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

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Removal Procedure

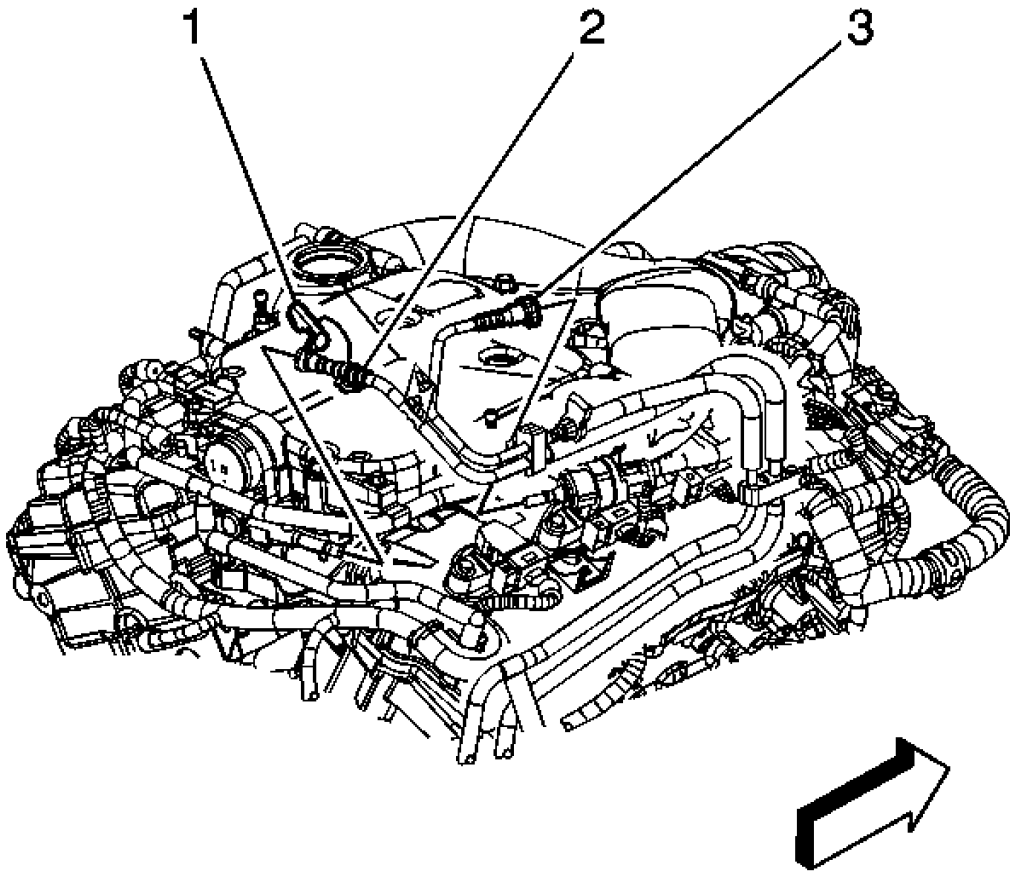


Fig. 124: Identifying Purge Line, Fuel Pipe & Fuel Rail
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .
3. Disconnect the purge line (3) from the purge valve solenoid.

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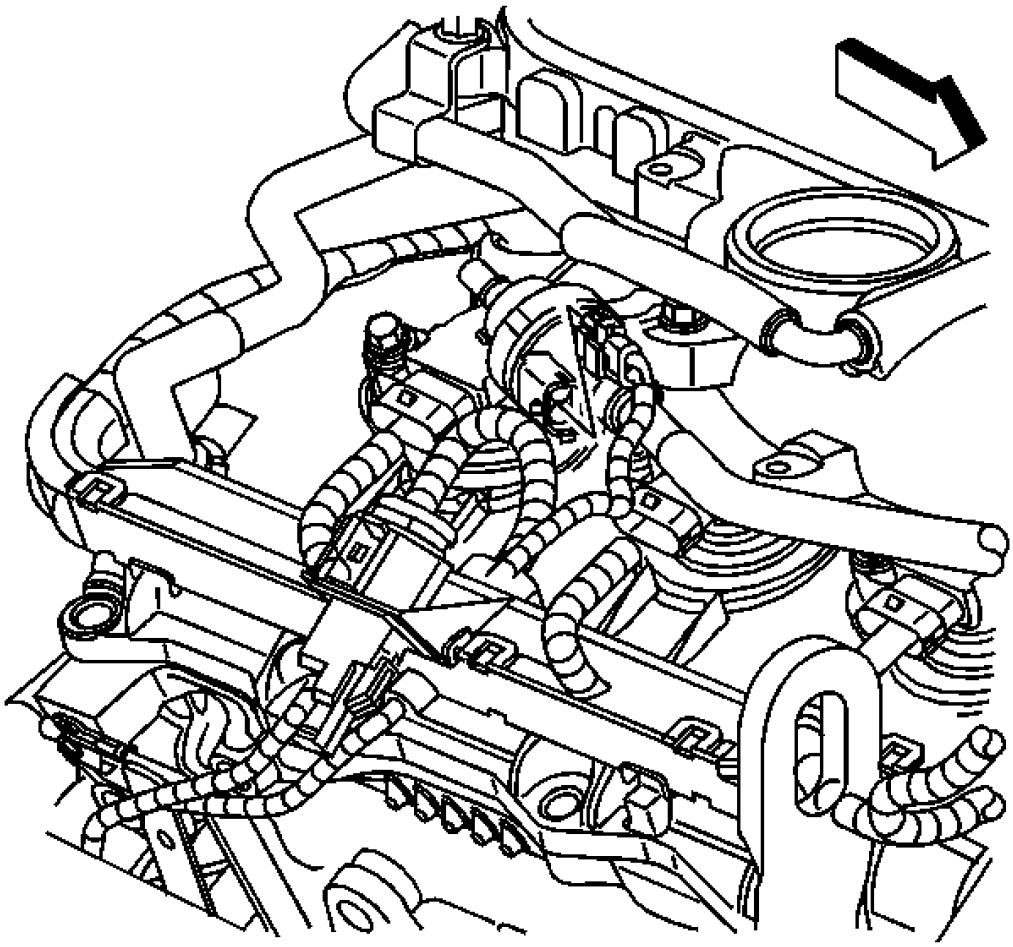


Fig. 125: View Of Purge Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the purge valve solenoid electrical connector.

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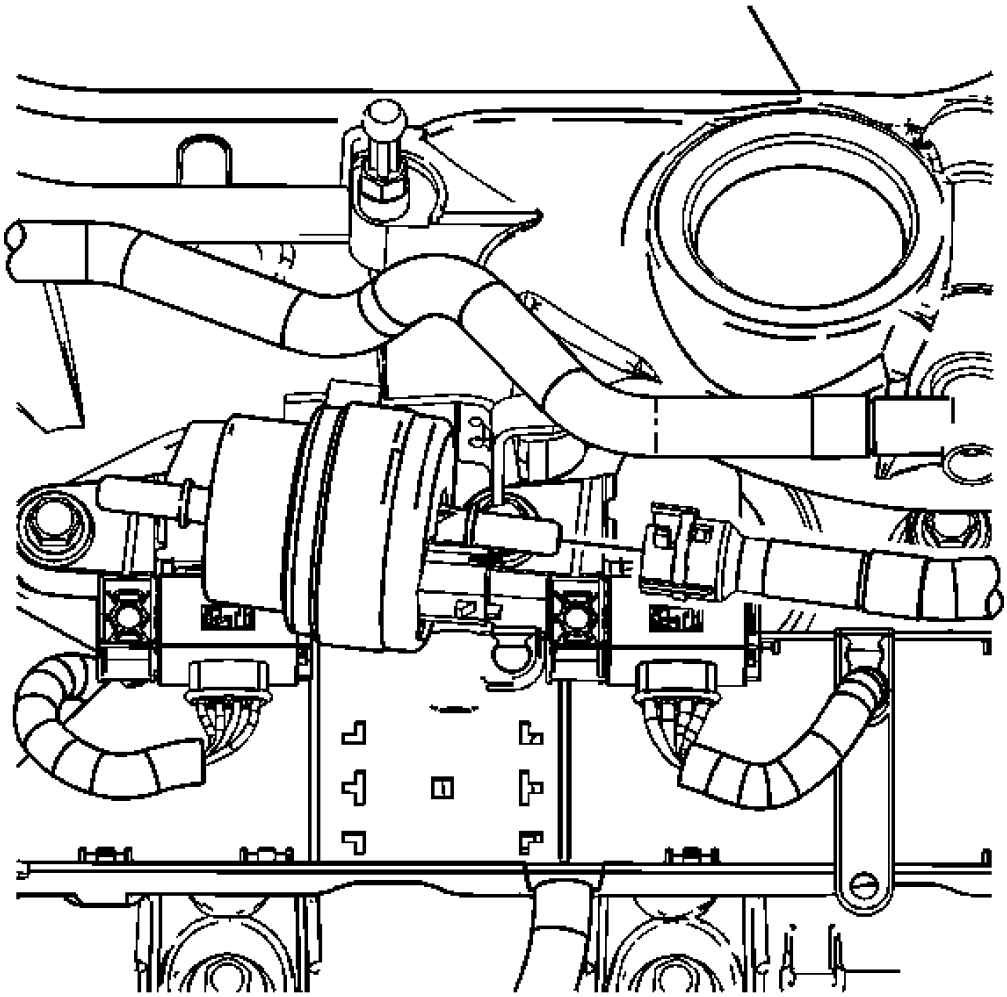


Fig. 126: Locating Purge Line On Manifold Side Of Purge Valve Solenoid
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the purge line from the manifold side of the purge valve solenoid.
6. Remove the purge valve solenoid from the bracket.

Installation Procedure

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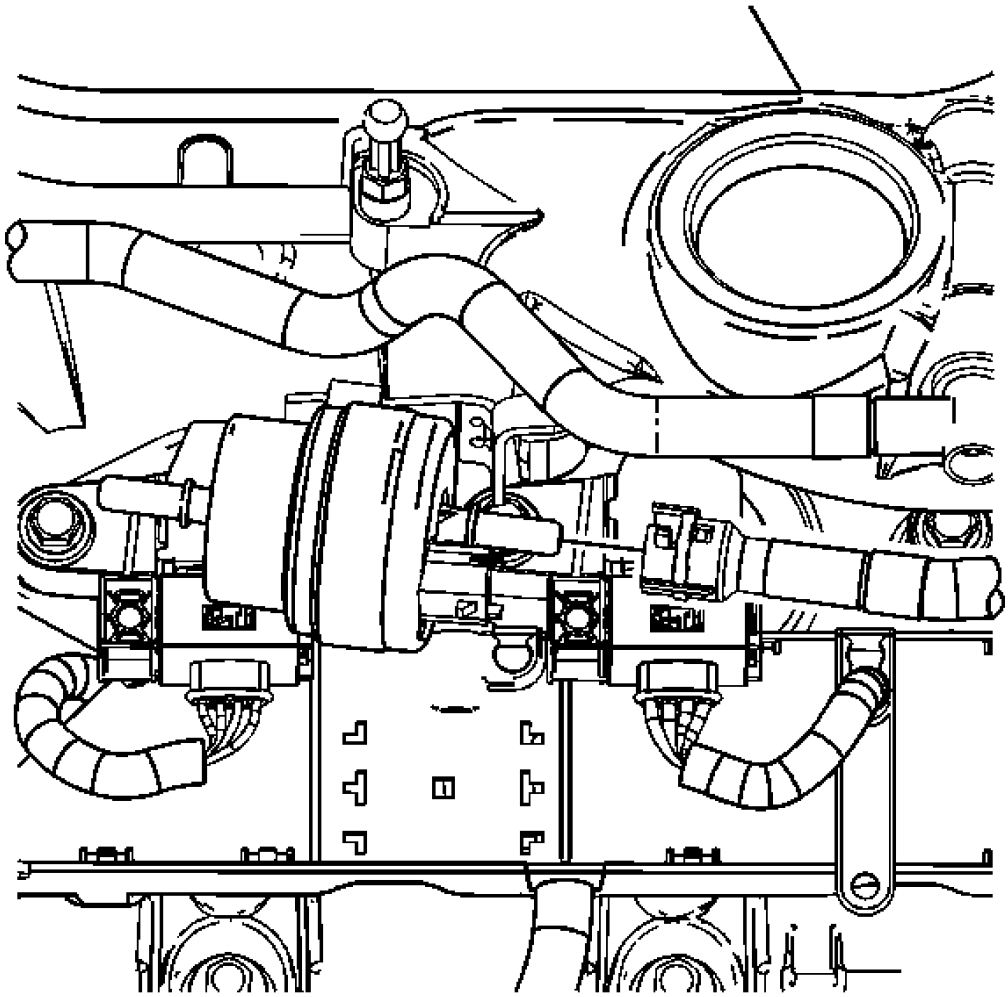


Fig. 127: Locating Purge Line On Manifold Side Of Purge Valve Solenoid
Courtesy of GENERAL MOTORS CORP.

1. Install the purge valve solenoid to the bracket.
2. Disconnect the purge line from the manifold side of the purge valve solenoid.

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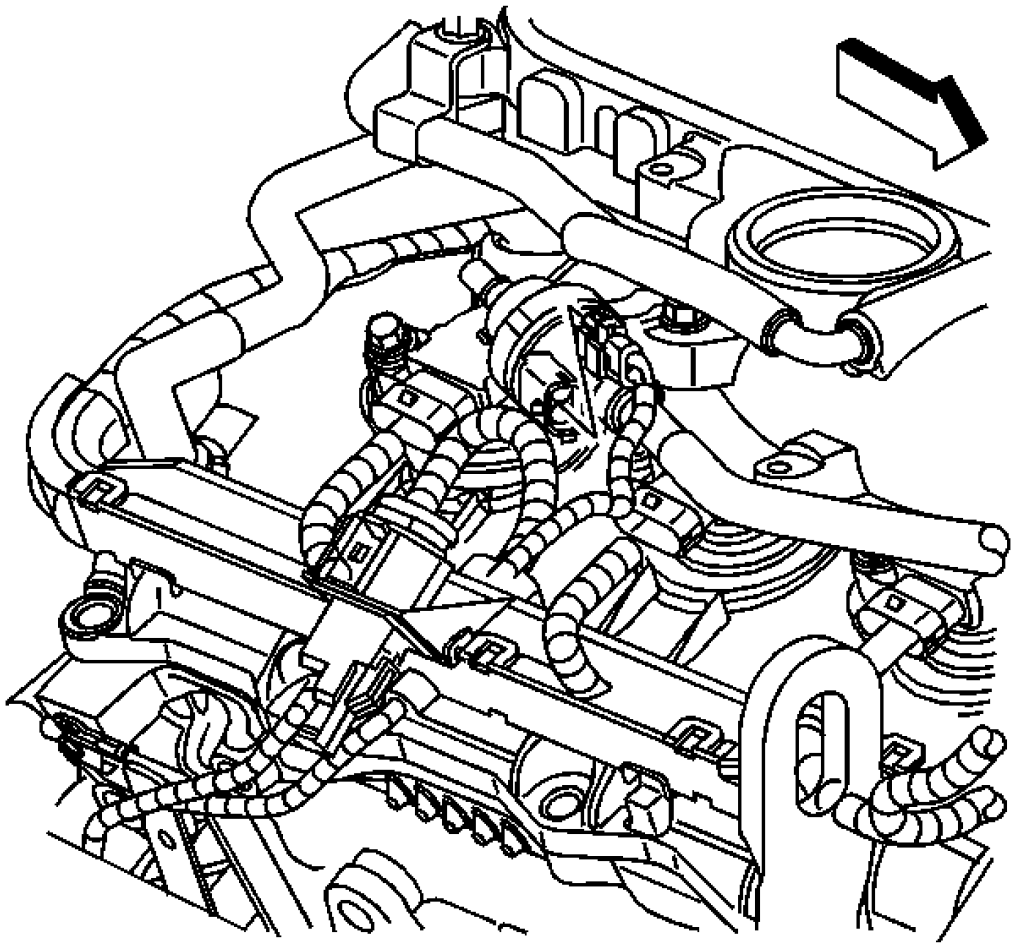


Fig. 128: View Of Purge Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the purge valve solenoid electrical connector.

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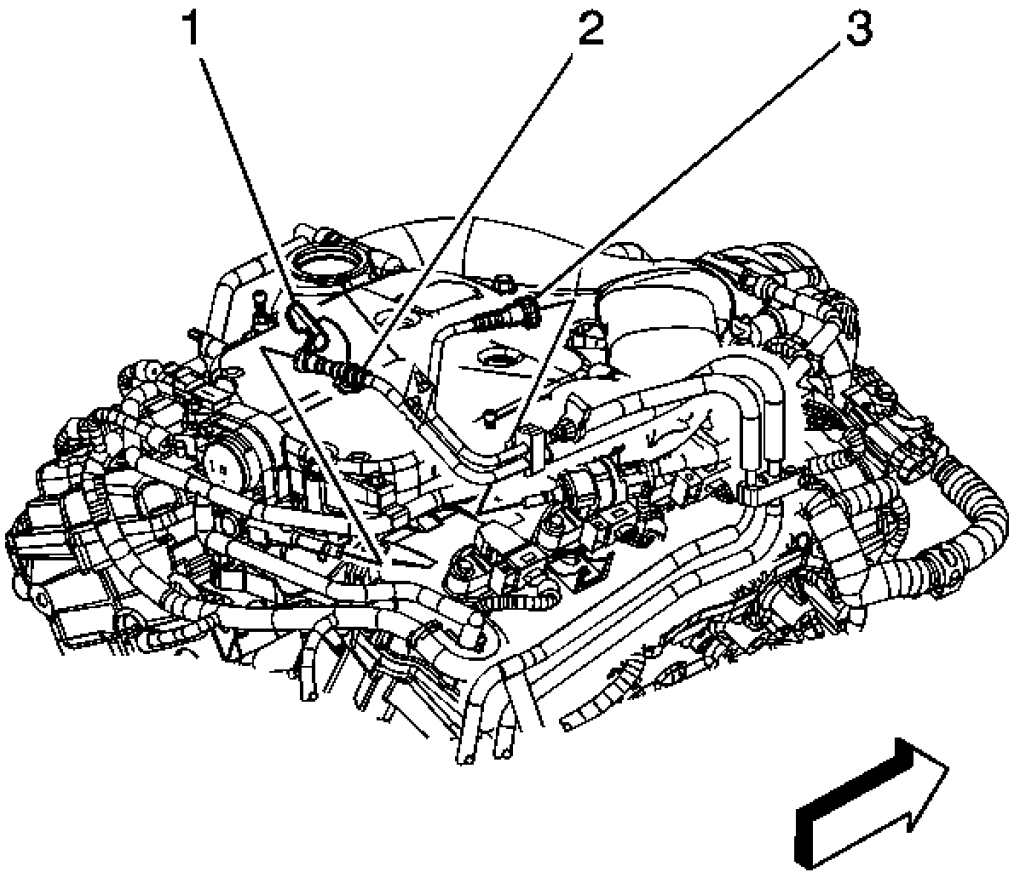


Fig. 129: Identifying Purge Line, Fuel Pipe & Fuel Rail
Courtesy of GENERAL MOTORS CORP.

4. Connect the purge line (3) to the purge valve solenoid.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

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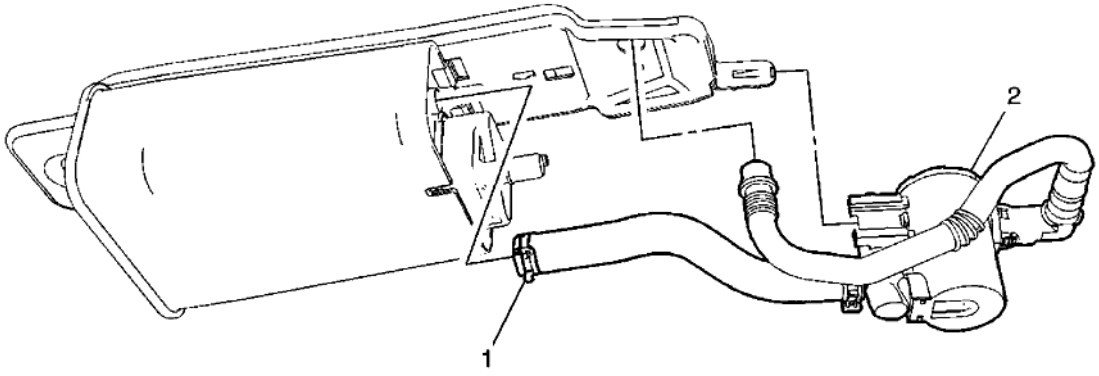


Fig. 130: Evaporative Emission Canister Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the Carbon Canister. Refer to **Evaporative Emission Canister Replacement**	
1	Evaporative Hose Clamp
2	Evaporative Emission Canister Vent Solenoid Valve

EVAPORATIVE EMISSION LINE REPLACEMENT - CHASSIS TO CANISTER

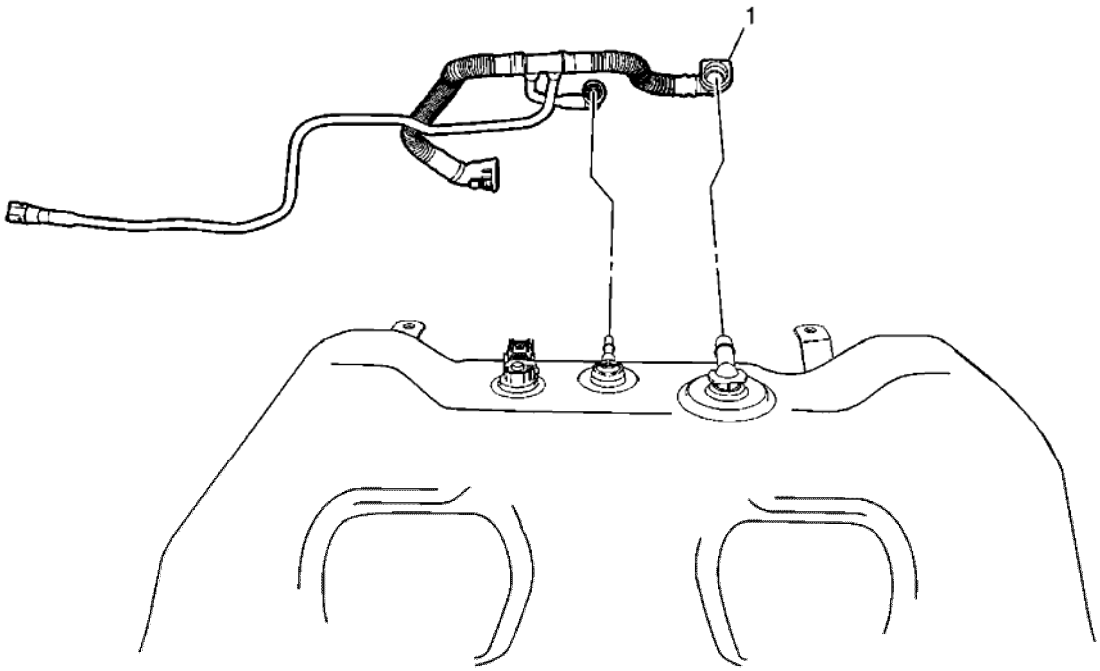


Fig. 131: Evaporative Emission Line - Chassis to Canister
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
Preliminary Procedure 1. Remove the fuel tank. Refer to **Fuel Tank Replacement**. 2. Disconnect the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service**.	
1	Fuel Tank Fill Evaporative Emission Valve Hose

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

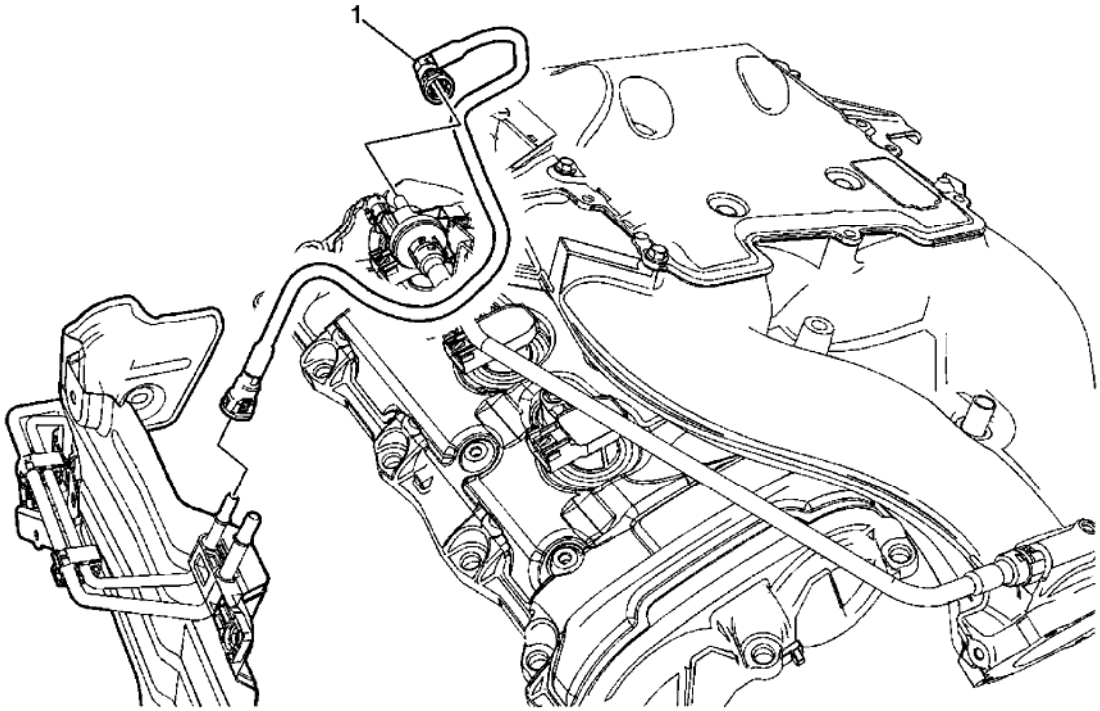


Fig. 132: Evaporative Emission Canister Purge Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** . 2. Disconnect the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service**.	
1	Evaporative Emission Canister Purge Pipe

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

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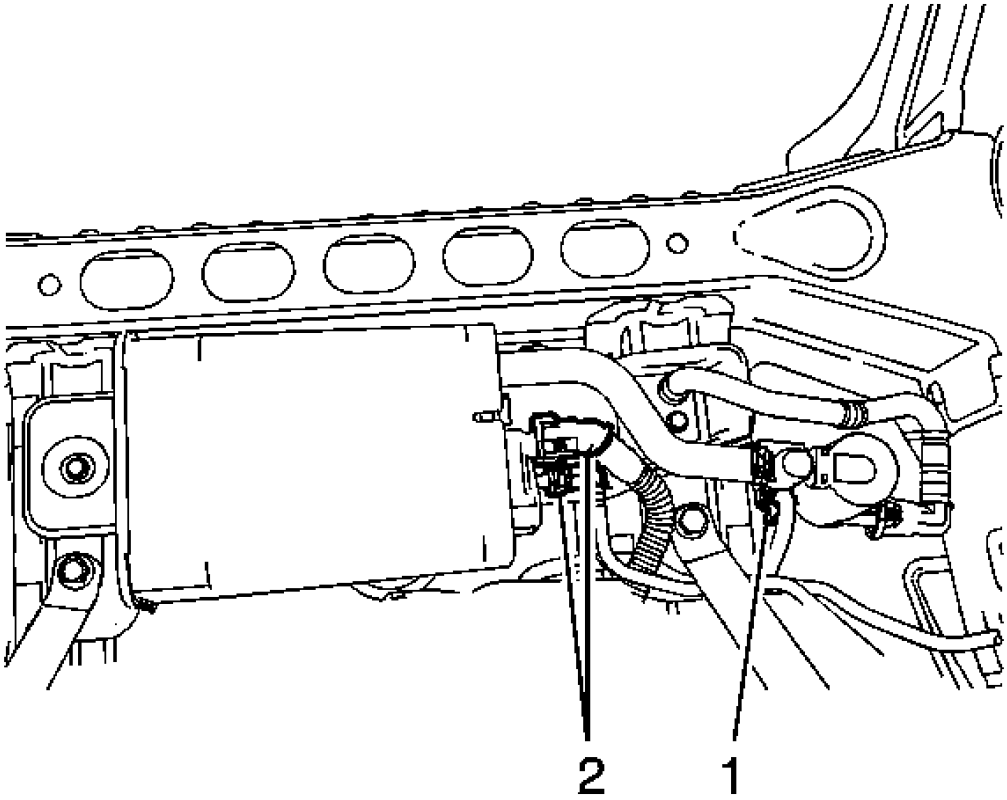


Fig. 133: Vent Solenoid Electrical Connector & Evaporative Emission Hoses
Courtesy of GENERAL MOTORS CORP.

1. Remove the rear suspension support. Refer to **Rear Suspension Support Replacement** .
2. Disconnect the vent solenoid electrical connector (1).
3. Disconnect the evaporative emission hoses (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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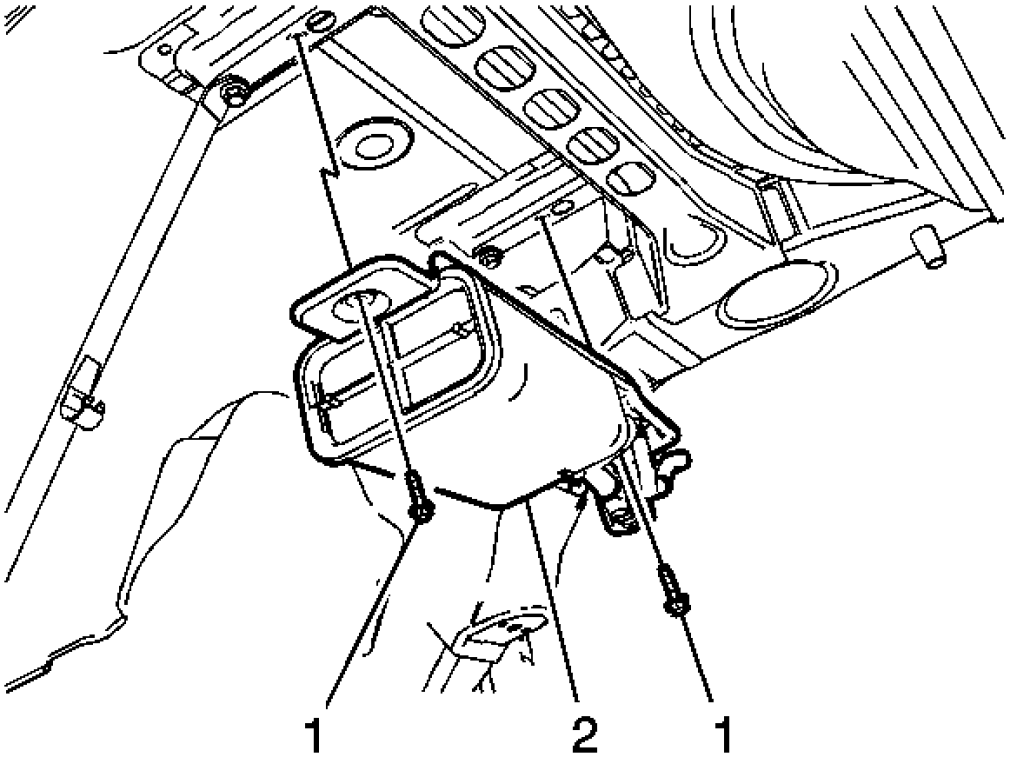


Fig. 134: Evaporative Emission Canister & Fasteners
Courtesy of GENERAL MOTORS CORP.

4. Remove the evaporative emission canister fasteners (1) and the evaporative emission canister (2).

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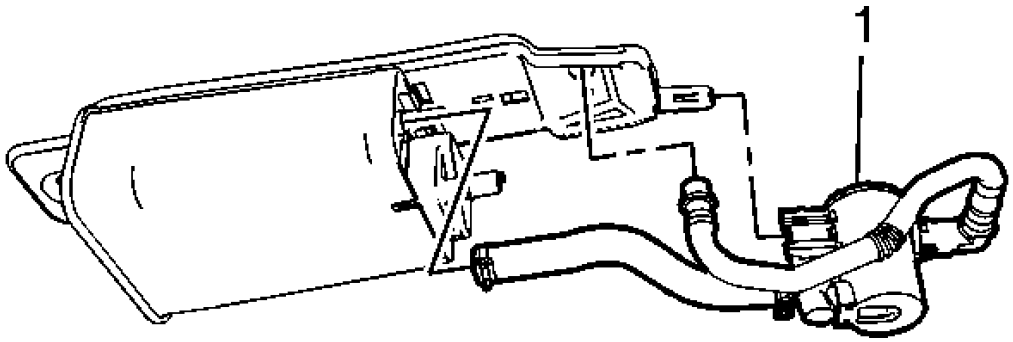


Fig. 135: Evaporative Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

5. Remove the evaporative vent solenoid valve (1) from the carbon canister.

Installation Procedure

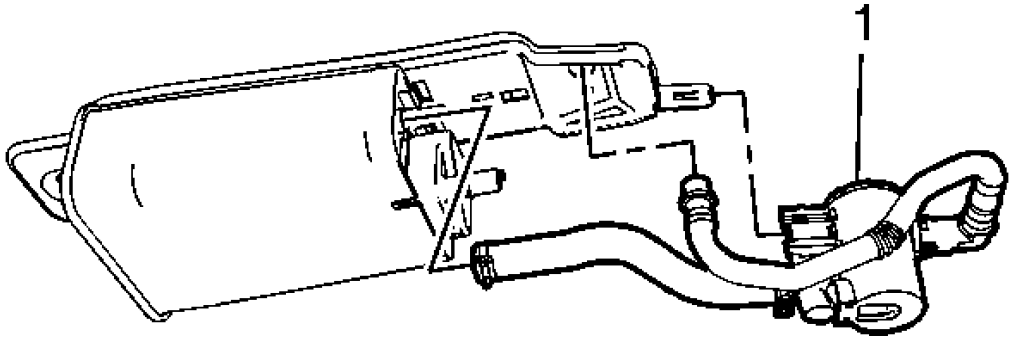


Fig. 136: Evaporative Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the evaporative vent solenoid valve (1) to the carbon canister.

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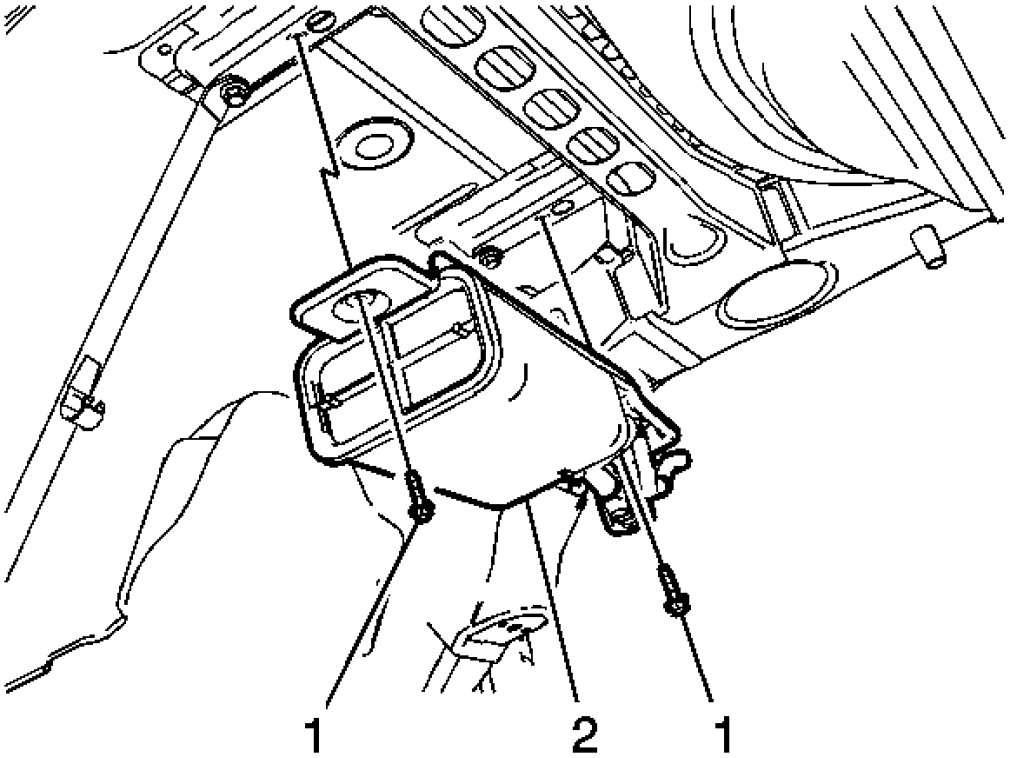


Fig. 137: Evaporative Emission Canister & Fasteners
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the evaporative emission canister (2) and tighten the fasteners (1) to 9 N.m (80 lb in).

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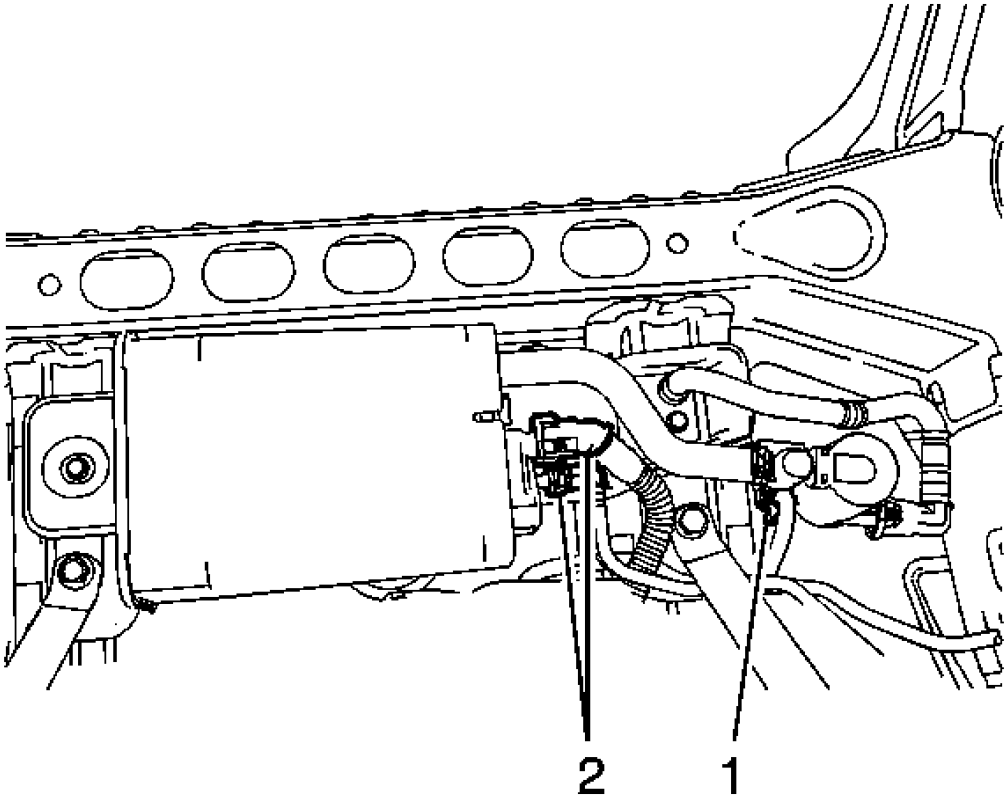


Fig. 138: Vent Solenoid Electrical Connector & Evaporative Emission Hoses
Courtesy of GENERAL MOTORS CORP.

3. Connect the evaporative emission hoses (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Connect the vent solenoid electrical connector (1).
5. Install the rear suspension support. Refer to **Rear Suspension Support Replacement** .

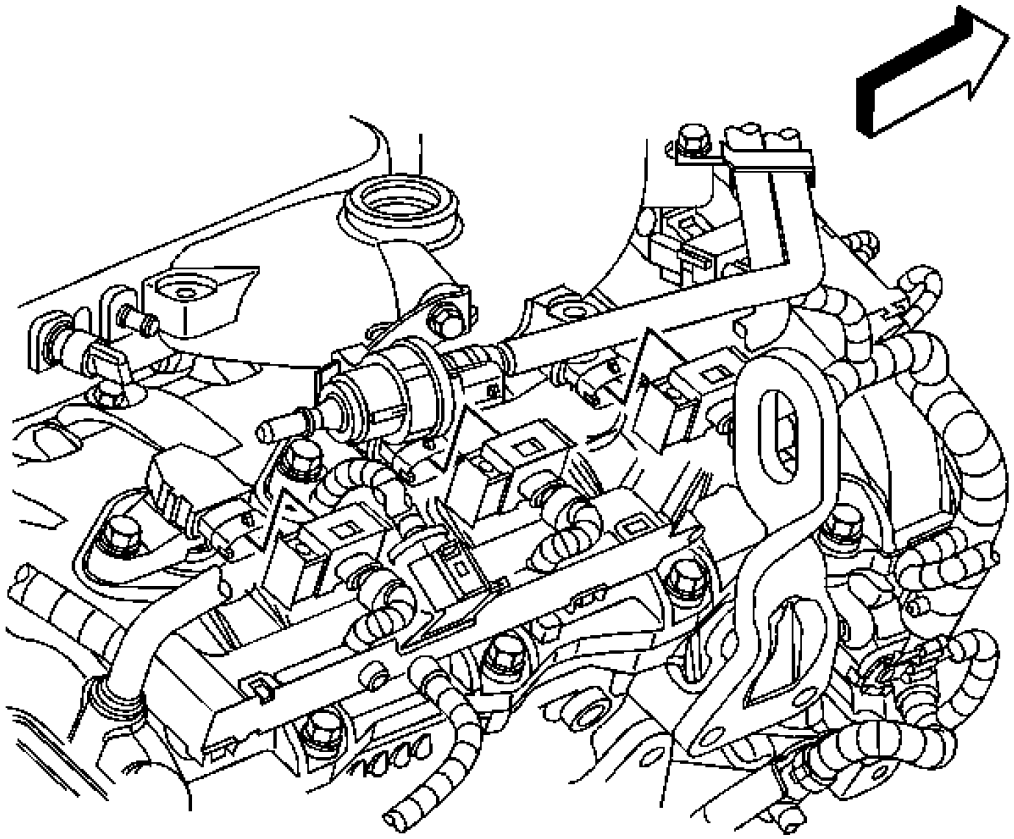
IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

NOTE: Do NOT disconnect the fuel pipes and/or hoses.

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3. _____

Fig. 139: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Remove the ignition coil electrical connector(s).

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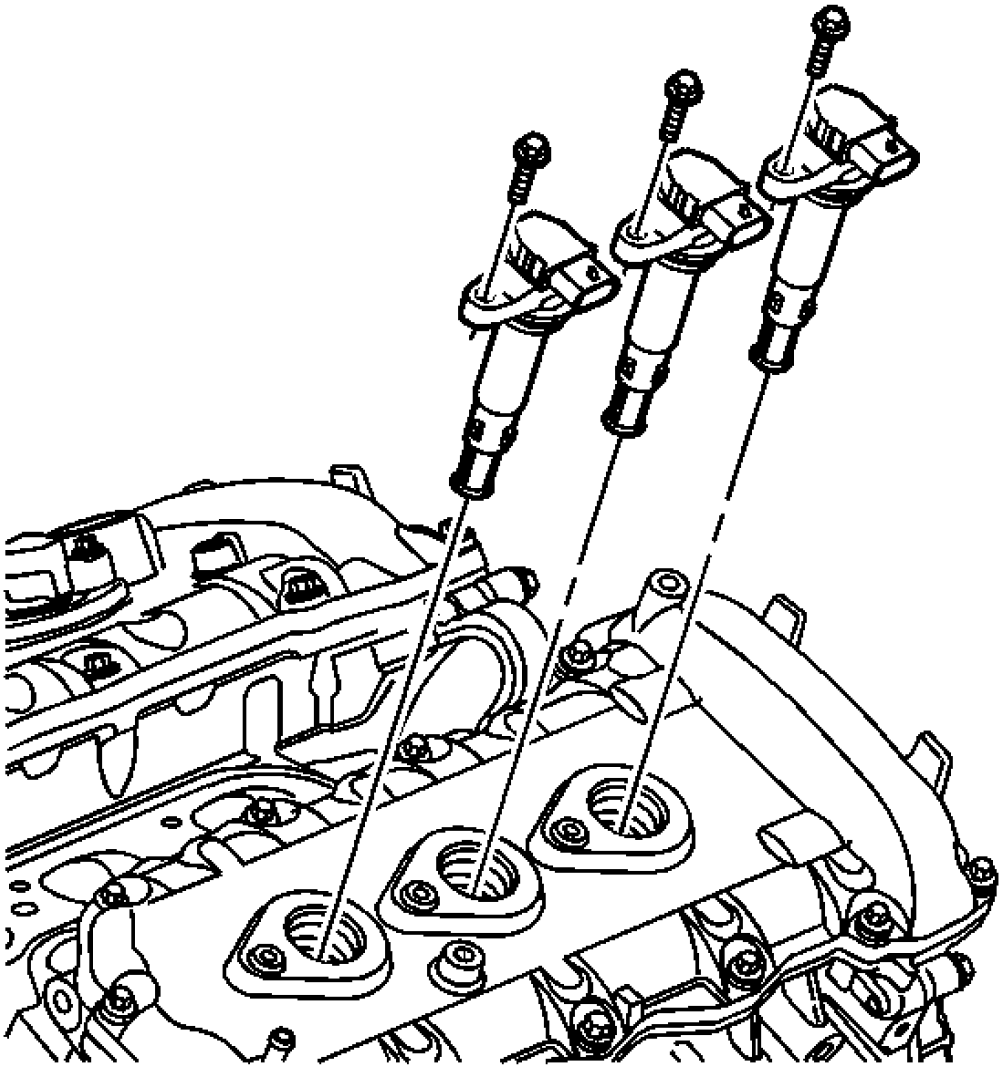


Fig. 140: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

5. Remove the ignition coil bolt(s).
6. Remove the ignition coil(s).

Installation Procedure

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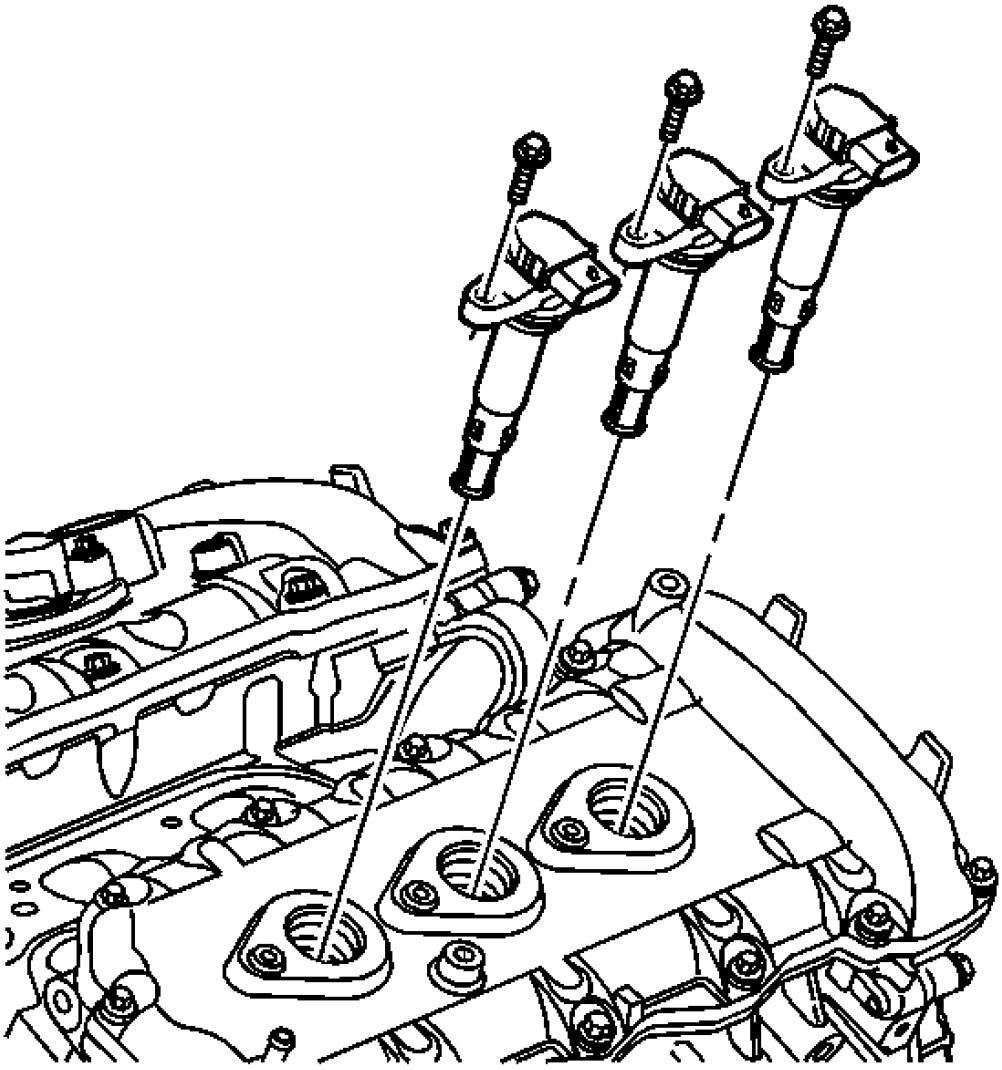


Fig. 141: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) and tighten to 10 N.m (89 lb in).

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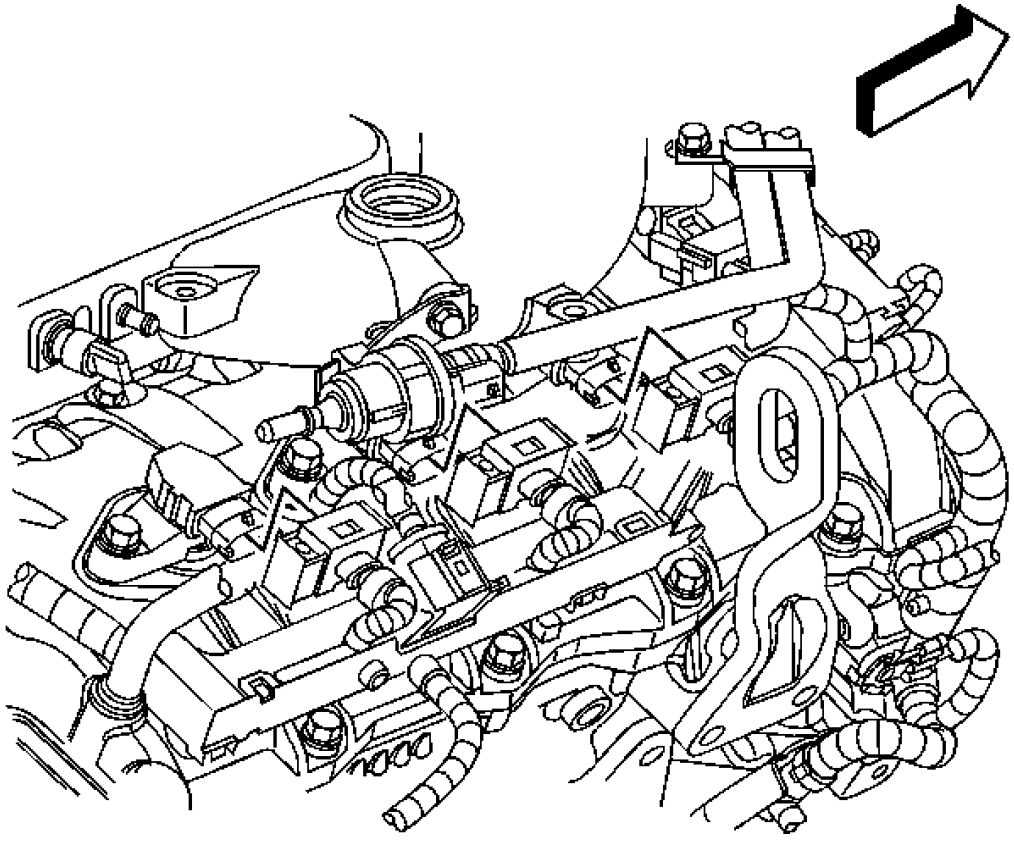


Fig. 142: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coil electrical connector(s).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

NOTE: Do NOT disconnect the fuel pipes and/or hoses.

3. If you are replacing the ignition coil for cylinder 2, remove and reposition the intake manifold. Perform

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the following steps:

1. Disconnect the air cleaner duct from the throttle body.
2. Disconnect the positive crankcase ventilation (PCV) hose from the right bank camshaft cover.

NOTE: Do NOT separate the upper intake manifold from the lower intake manifold.

3. Remove the intake manifold bolts.

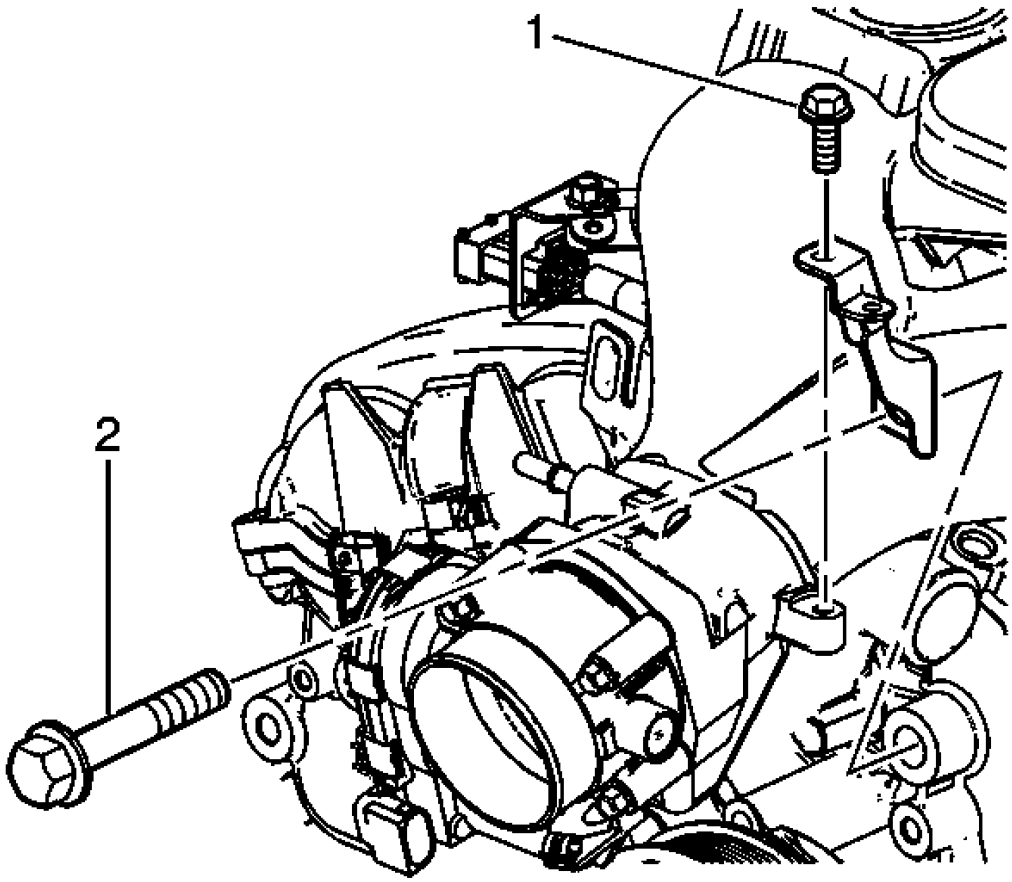


Fig. 143: View Of Intake Manifold Brace & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the intake manifold brace bolts (1 and 2) and the brace.
5. Remove and reposition the upper intake manifold with the lower intake manifold in order to gain sufficient clearance for ignition coil removal.

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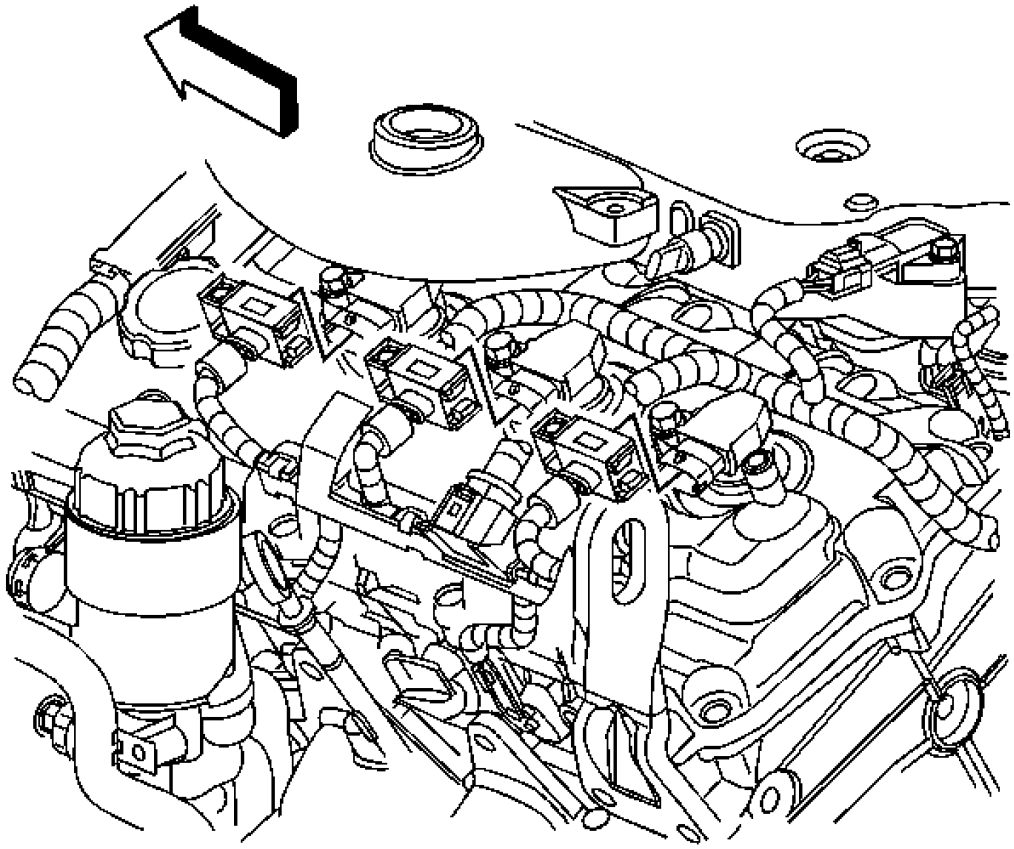


Fig. 144: View Of Ignition Coil Electrical Connectors - Bank 2
Courtesy of GENERAL MOTORS CORP.

4. Remove the ignition coil electrical connector(s).

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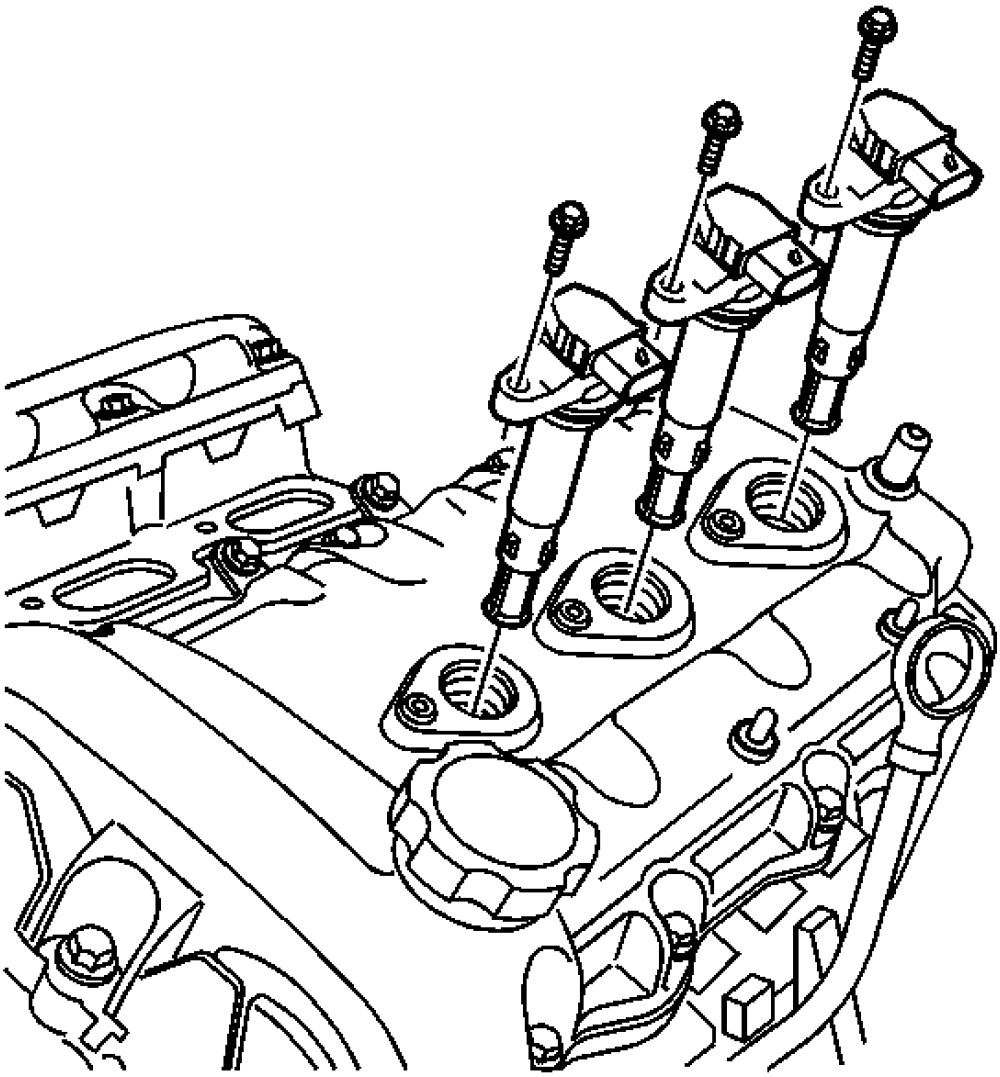


Fig. 145: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS CORP.

5. Remove the ignition coil bolt(s).
6. Remove the ignition coil(s).

Installation Procedure

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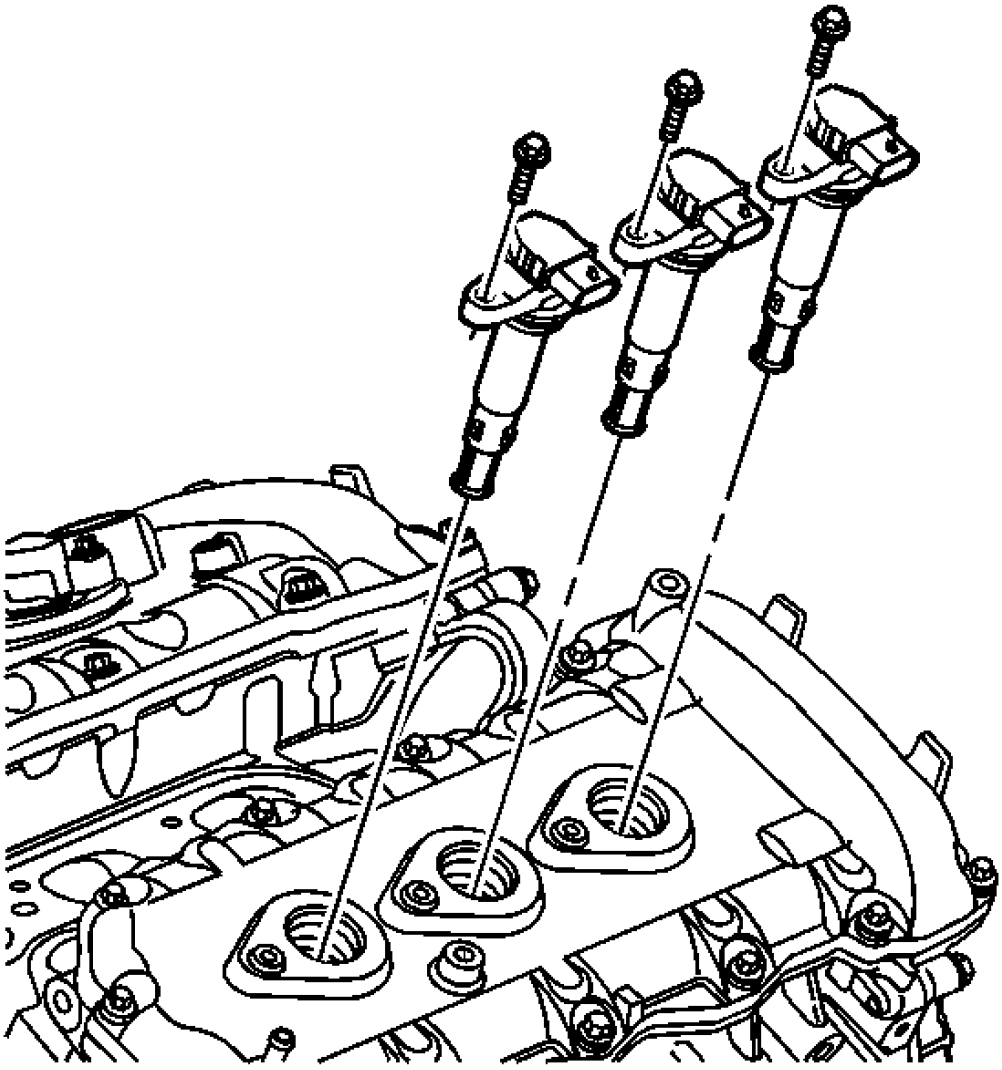


Fig. 146: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) and tighten to 10 N.m (89 lb in).

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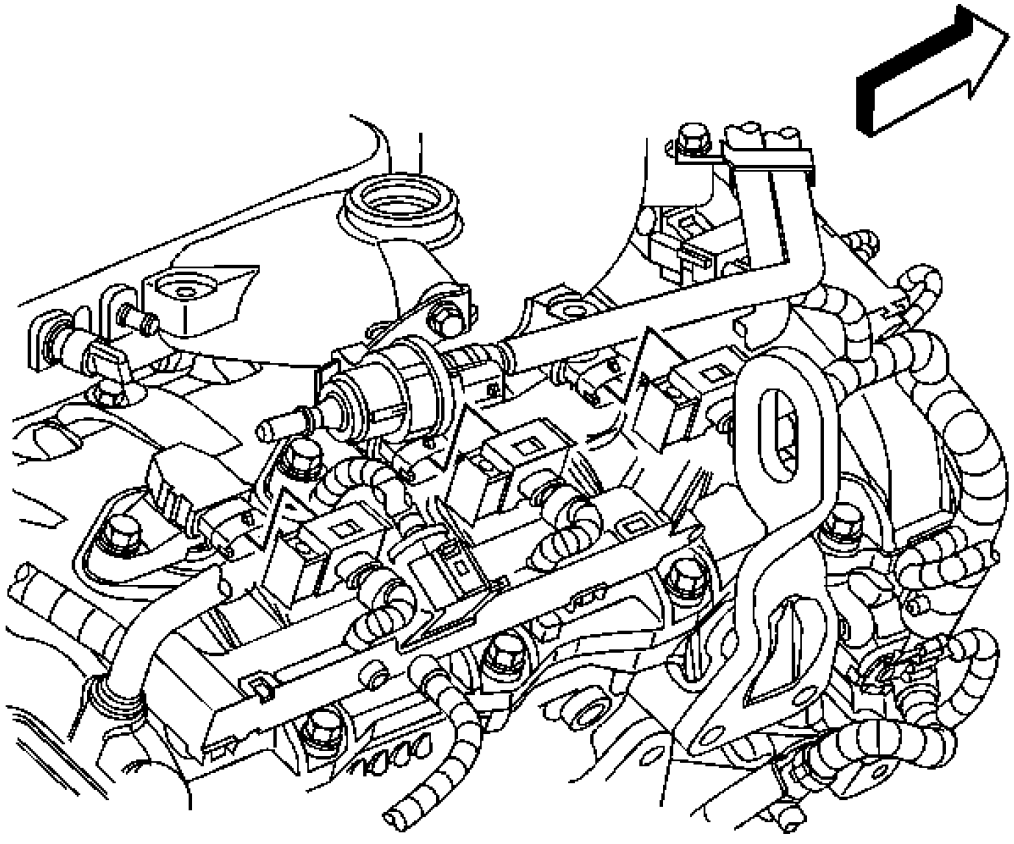


Fig. 147: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coil electrical connector(s).
4. If necessary, install the upper intake manifold.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

SPARK PLUG INSPECTION

Spark Plug Operation

Worn or dirty spark plugs may operate well at idle speeds, but frequently fail at higher load. Bad spark plugs are often responsible for the following conditions:

- Power loss
- Poor fuel economy

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- Loss of speed
- Hard starting
- Poor engine performance

Normal spark plug operation results in brown to grayish tan deposits on the area of the spark plug that enters the cylinder. A small amount of reddish brown, yellow, and white powdery residue may also be present on the insulator tip around the center electrode. These deposits are normal combustion by-products of fuels and lubricating oils which contain additives.

Misfiring is a general term that applies to a poor running engine. With misfiring, the ignition spark is not igniting the air/fuel mixture at the proper time. While other possible causes must be investigated, the spark plugs should be inspected first. Spark voltage should not reach ground before jumping across the gap at the tip of the spark plug. This leaves the air/fuel mixture unburned, causing misfiring. Pre-ignition misfiring occurs when the spark plug tip overheats, igniting the mixture before the spark jumps.

Carbon fouling of the spark plug is indicated by dry carbon deposits on the portion of the spark plug inside of the cylinder. Excess idling and driving at slower speeds under light engine loads can keep the spark plug temperatures so low that these deposits are not burned off. Rich fuels or poor ignition system output may also cause carbon fouling.

Oil fouling of the spark plug appears as wet oily deposits on the portion of the spark plug inside of the cylinder. This may be caused by the following conditions:

- Oil getting past worn piston rings
- Breaking in a new or recently overhauled engine

Deposit fouling of the spark plug occurs when the normal reddish brown, yellow, or white deposits of combustion by-products become sufficient enough to cause misfiring. In some cases, these deposits melt and form a shiny glaze on the insulator around the center electrode. If the fouling is found only in one or two of the cylinders, valve stem clearances or the intake valve seals may be allowing excess lubricating oil to enter the cylinder, particularly if the deposits are heavier on the intake valve side of the spark plug.

Excess gap means that the air space between the center and side electrodes at the bottom of the spark plug is too wide for consistent firing. This may be due to improper gap adjustment or to excess wear of the electrodes during use. A gap that is too small may cause idling instability. Excess gap wear might indicate vehicle operation at continual high speeds or with high engine loads. This causes the spark plugs to run too hot. Excessively lean fuel may also cause the wear.

Improper torque or seating can cause a spark plug to run hot, eventually leading to excess gap wear. In extreme cases, an overtightened or under-tightened spark plug can cause exhaust blow-by. The cylinder head seats must make good contact for sufficient heat transfer and spark plug cooling. Dirty or damaged threads in the head or on the spark plug can keep the spark plug from seating even though the proper torque is applied. Once the spark plugs are properly seated, tighten the spark plugs properly.

Cracked or broken insulators and insulator tips may be the result of improper installation or heat shock. Heat shock is a rapid increase in the insulator tip temperature which causes the insulator material to crack. The upper insulators can be broken when a poorly-fitting tool is used during servicing, or when the spark plug is hit from

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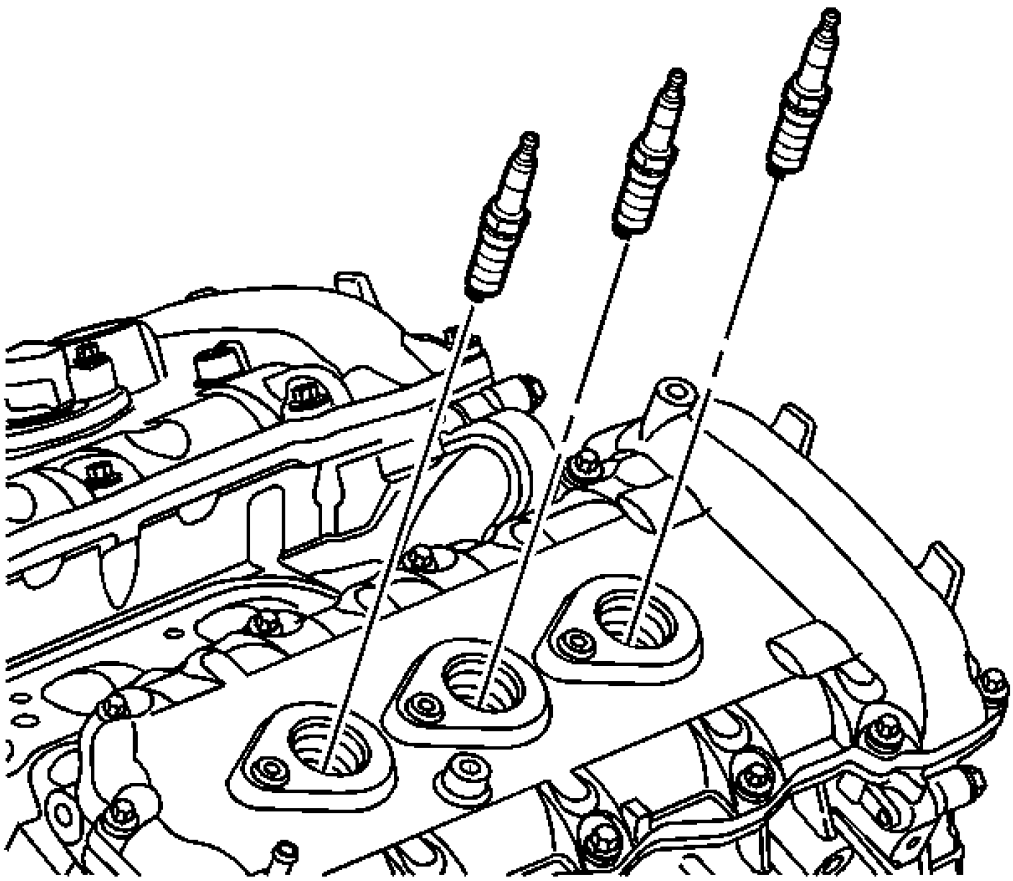
the outside. Cracks in the upper insulator may be inside the shell or invisible. The breakage may not cause problems until oil or water penetrates the crack later. Heat shock breakage in the lower insulator tip generally occurs during severe engine operating conditions such as higher RPM or heavy loading. Over advanced timing or low grade fuels may also cause heat shock breakage. Always replace spark plugs with broken or cracked insulators.

Damage during gapping can occur when the tool is pushed against the center electrode or the surrounding insulator, causing the insulator to crack. When gapping a spark plug, bend only the outside electrode. Keep tools free of any other parts.

Spark plugs with less than the recommended amount of service can sometimes be cleaned and re-gapped, then returned to service. If there is any doubt about the serviceability of a spark plug, replace the spark plug.

SPARK PLUG REPLACEMENT

Removal Procedure



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Fig. 148: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the ignition coil. Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

3. Use compressed air in order to remove debris from the spark plug cavity.

CAUTION: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.

4. Remove the spark plug.

Installation Procedure

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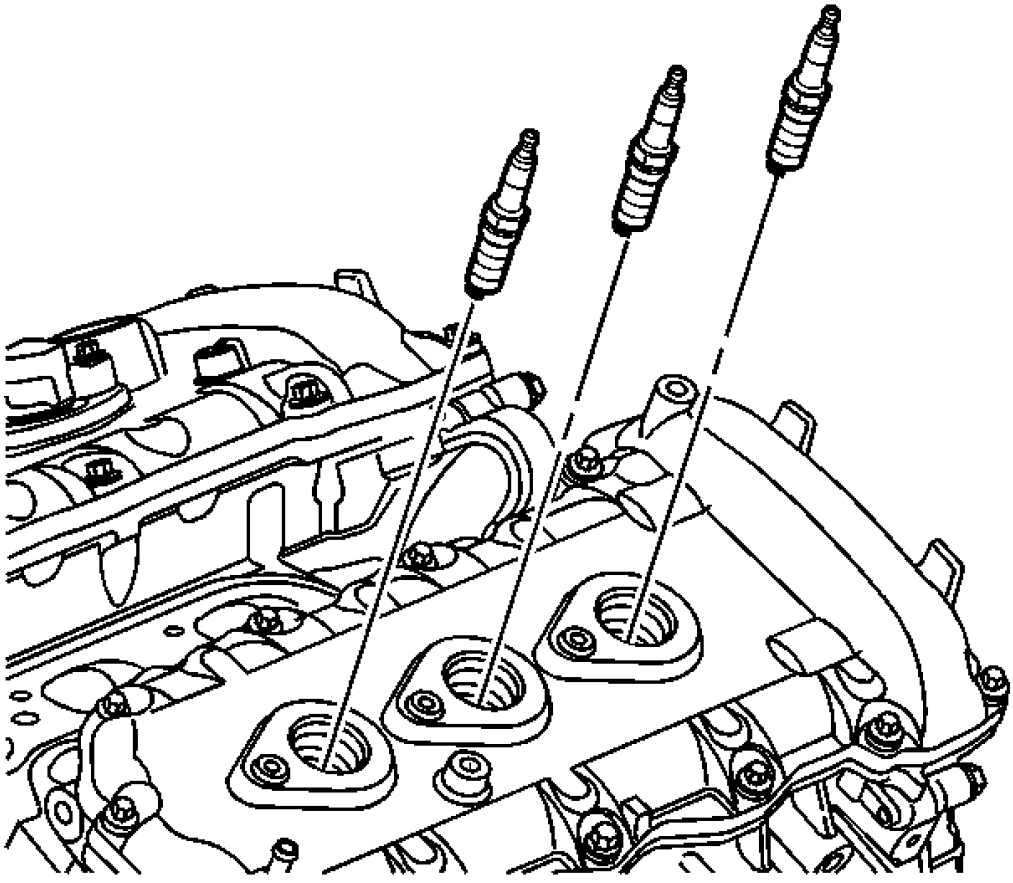


Fig. 149: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

CAUTION: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

CAUTION: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gauge to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to **Ignition System Specifications** .

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CAUTION: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.

2. Install the spark plug and tighten to 20 N.m (15 lb ft).
3. Install the ignition coil. Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

CRANKSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

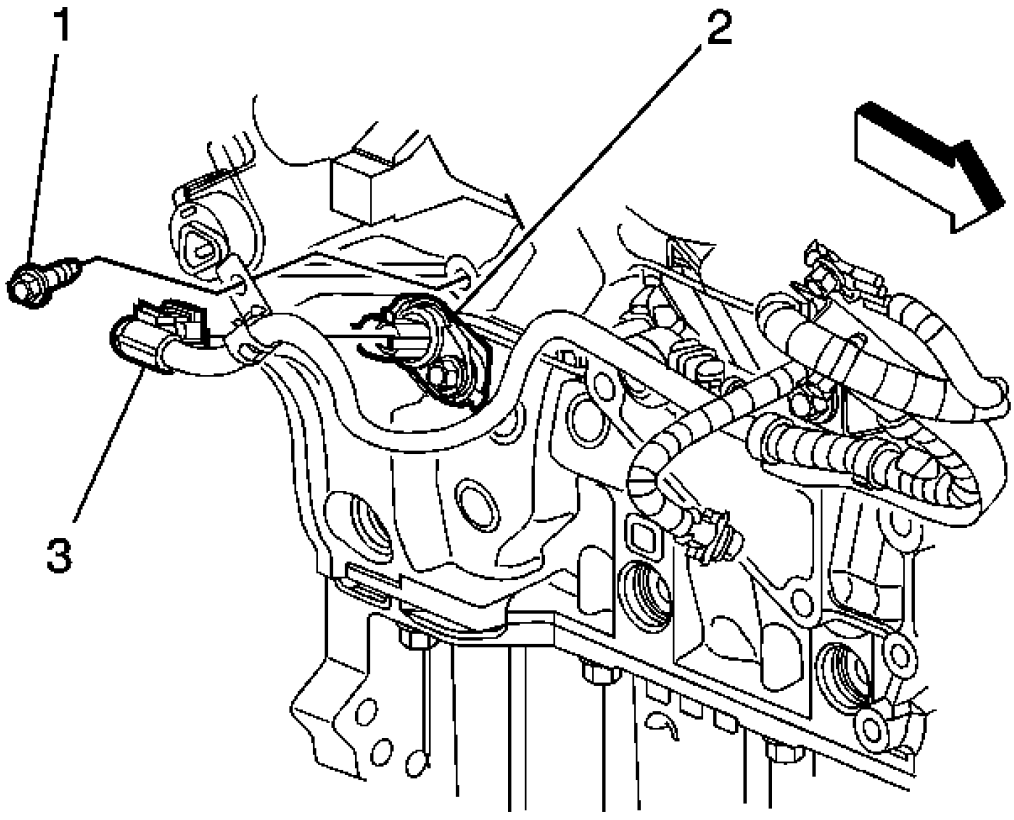


Fig. 150: Locating CKP Electrical Connector

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Courtesy of GENERAL MOTORS CORP.

2. Disconnect the crankshaft position (CKP) electrical connector (3).

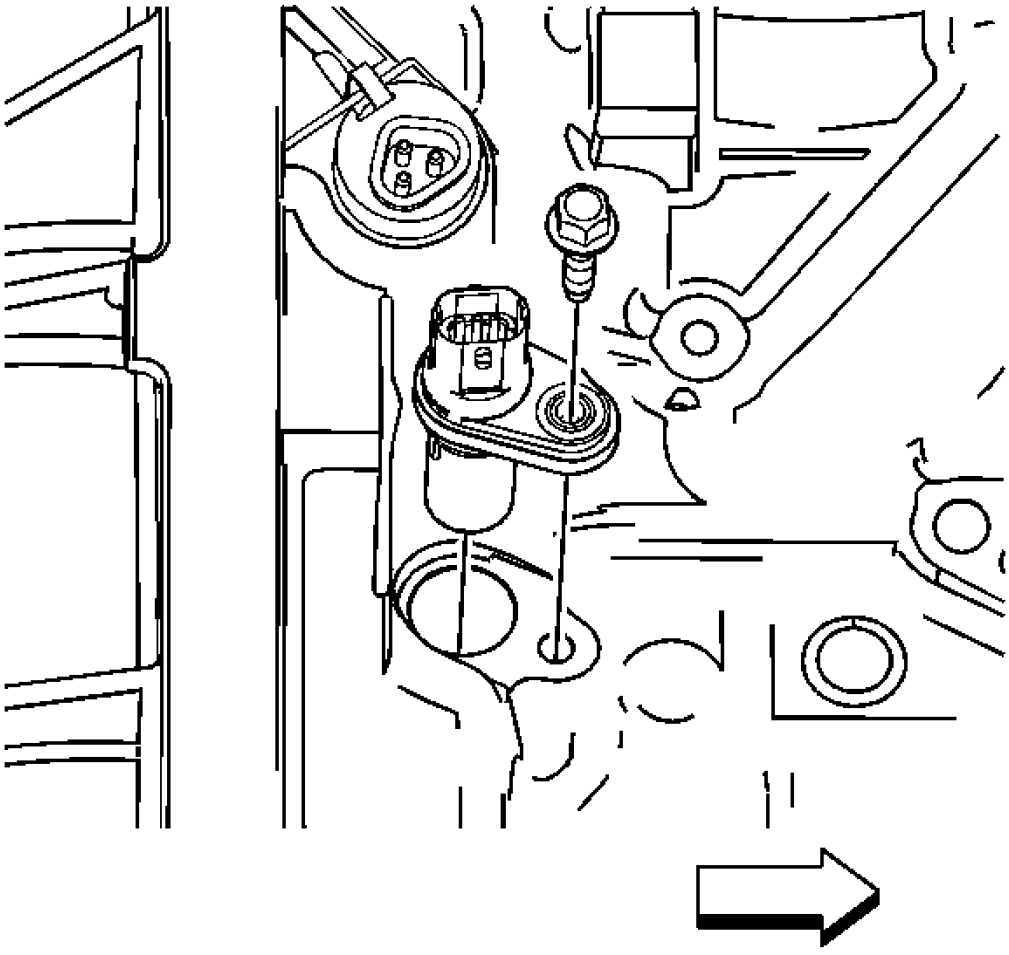


Fig. 151: View Of CKP Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft sensor bolt.
4. Remove the crankshaft sensor.

Installation Procedure

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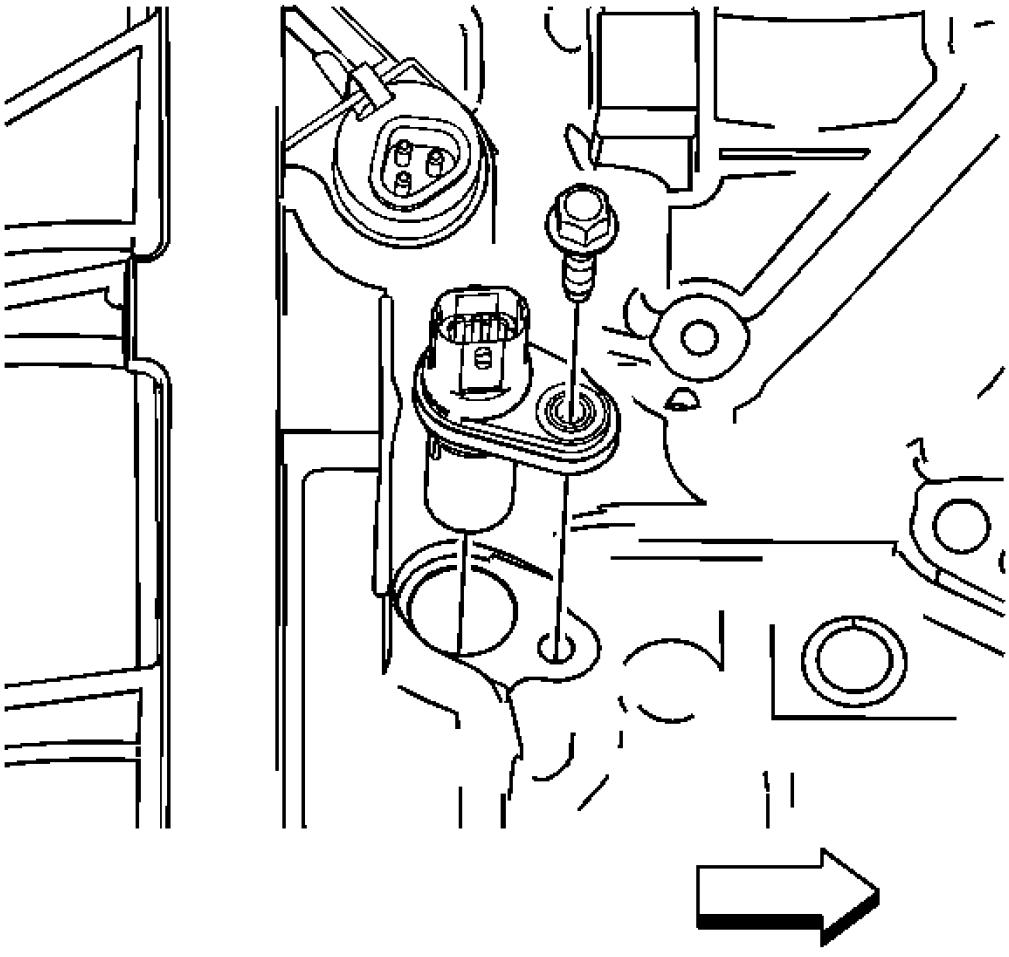


Fig. 152: View Of CKP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft position sensor.

CAUTION: Refer to Fastener Caution .

2. Install the crankshaft position sensor bolt and tighten to 10 N.m (89 lb in).

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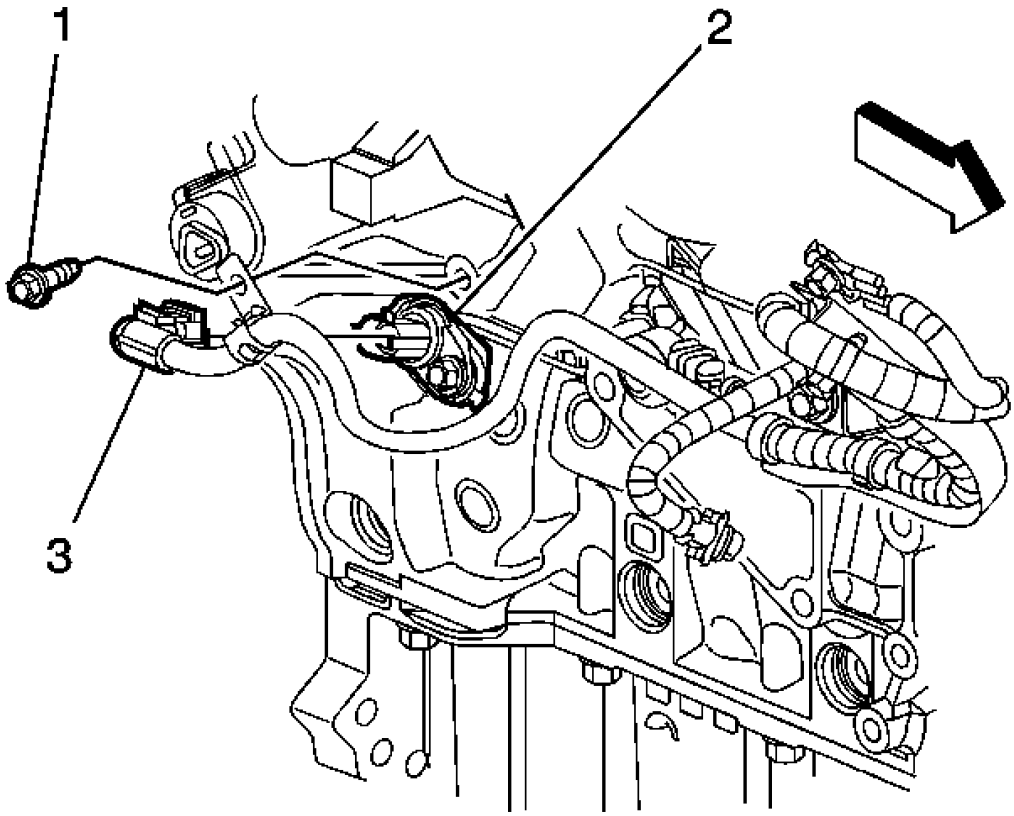


Fig. 153: Locating CKP Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the CKP electrical connector (3).
4. Lower the vehicle.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

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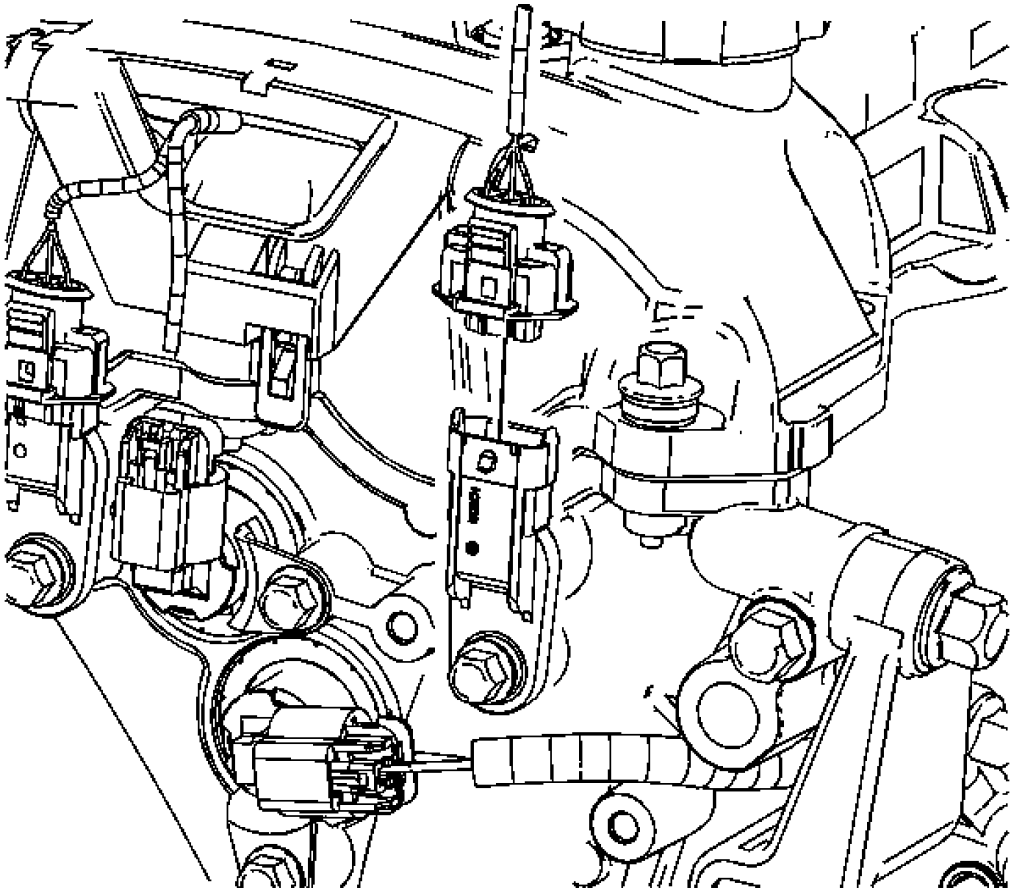


Fig. 154: View Of Left CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) sensor electrical connector.

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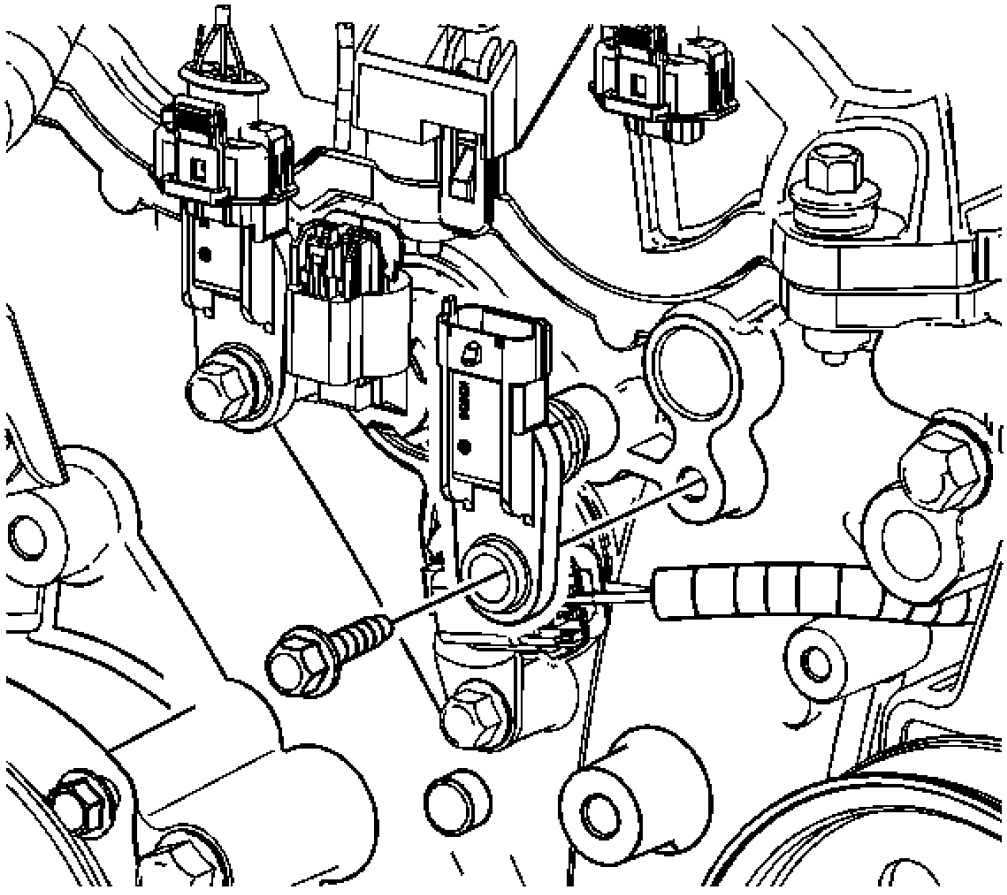


Fig. 155: View Of Left CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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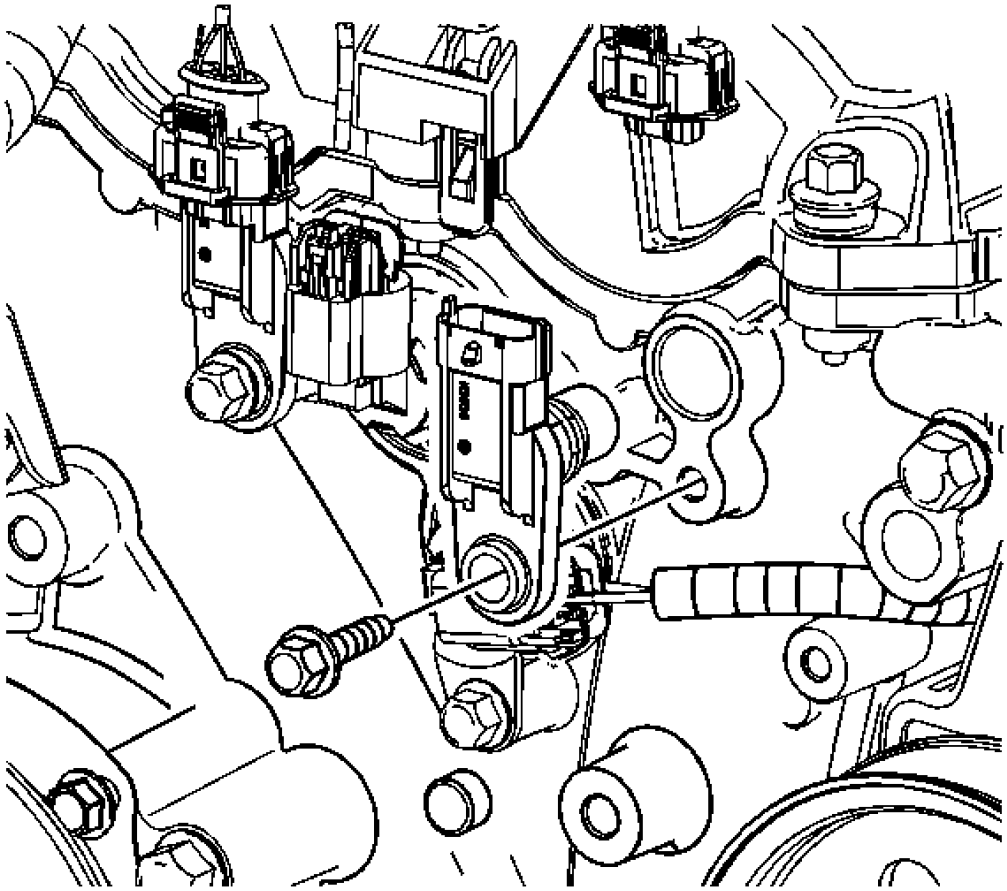


Fig. 156: View Of Left CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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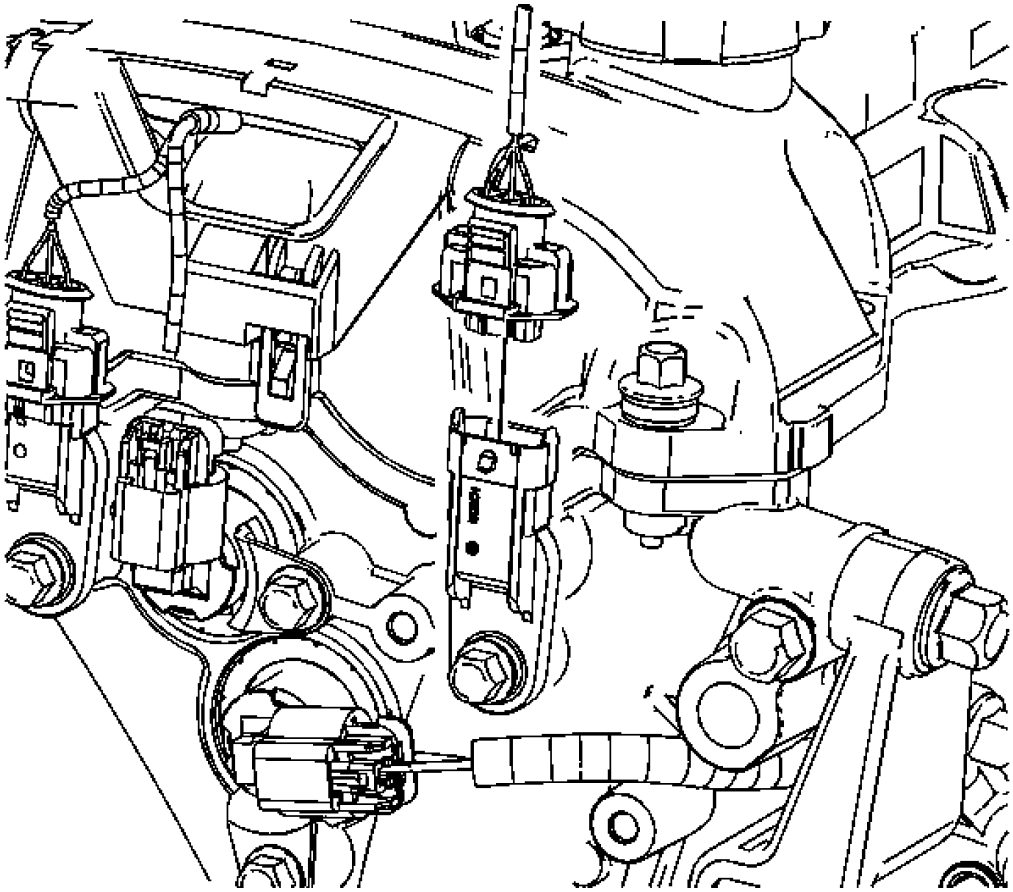


Fig. 157: View Of Left CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Install the CMP sensor electrical connector.
4. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

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2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

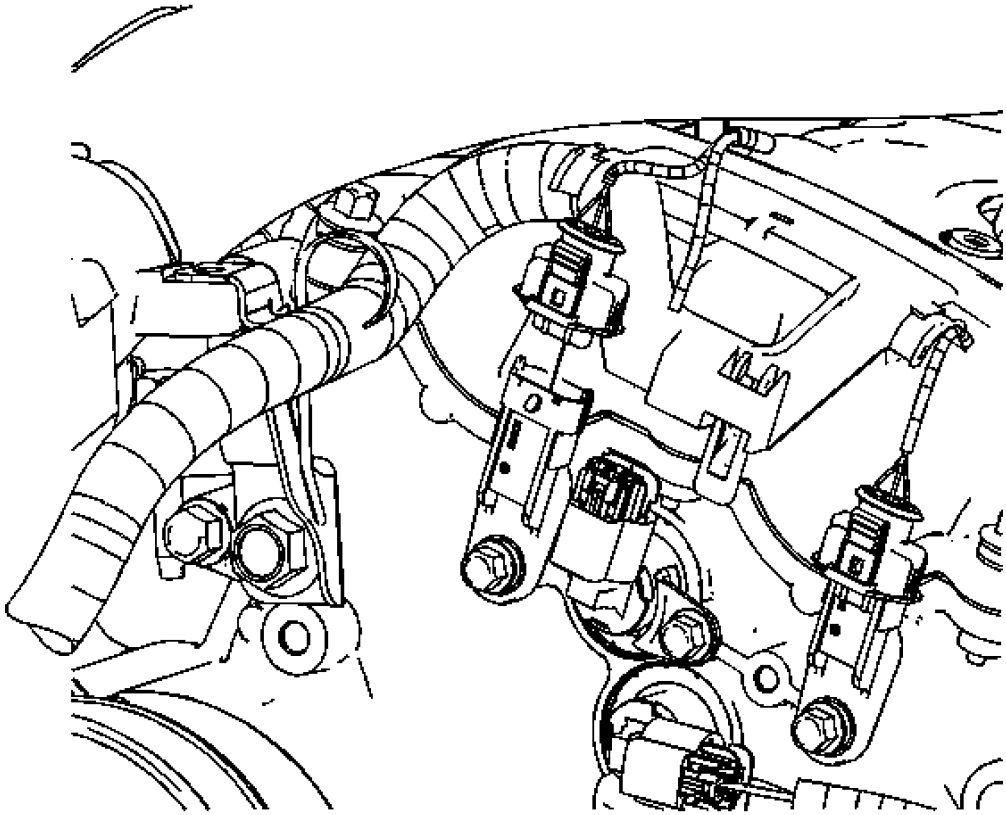


Fig. 158: View Of Left CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) sensor electrical connector.

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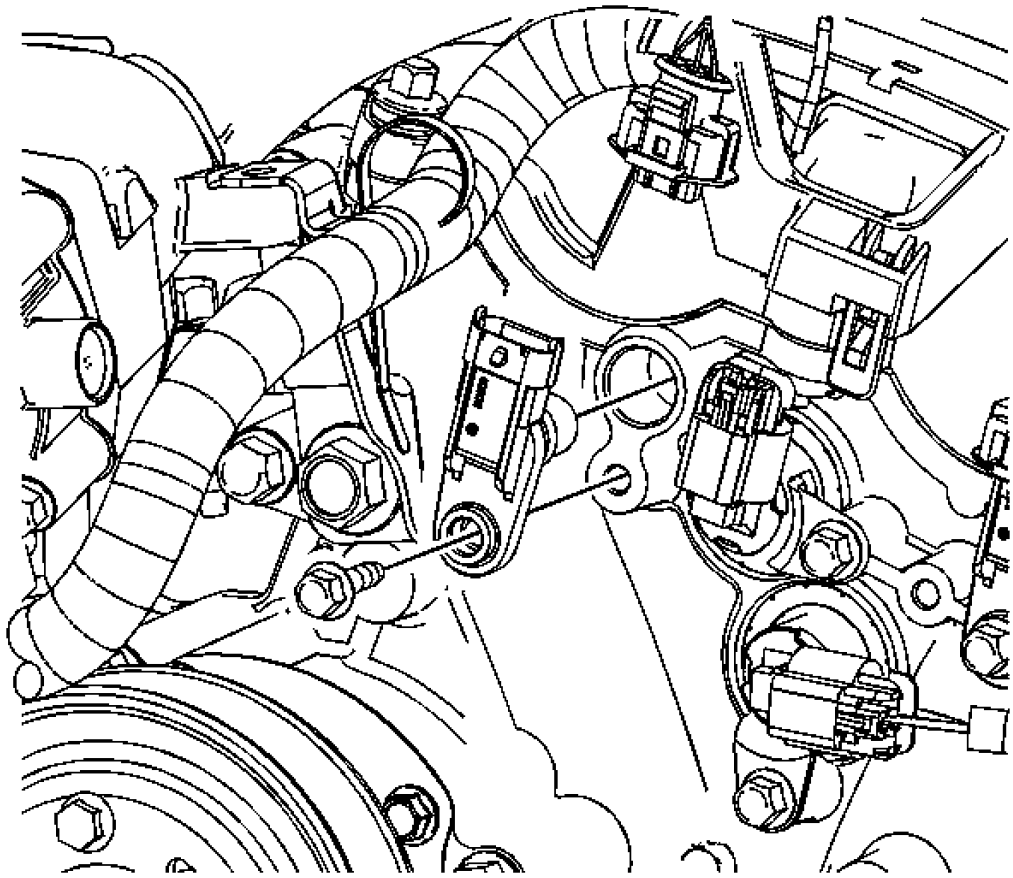


Fig. 159: View Of Left CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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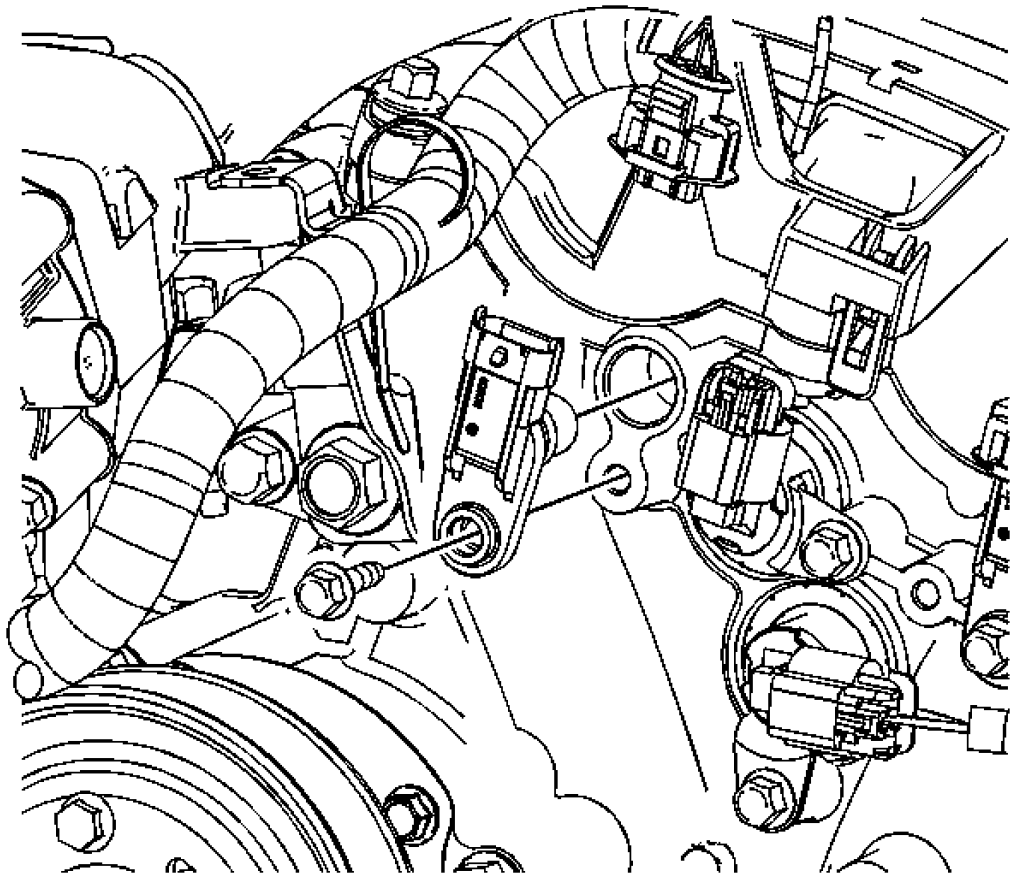


Fig. 160: View Of Left CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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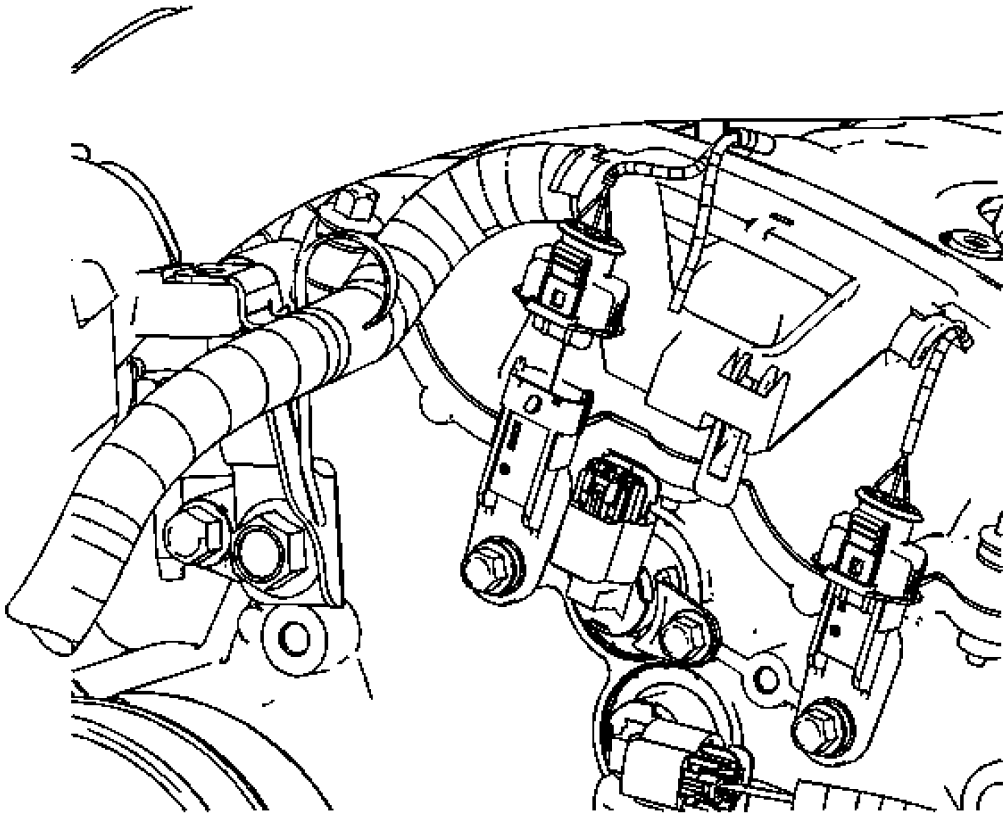


Fig. 161: View Of Left CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Install the CMP sensor electrical connector.
4. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

Removal Procedure

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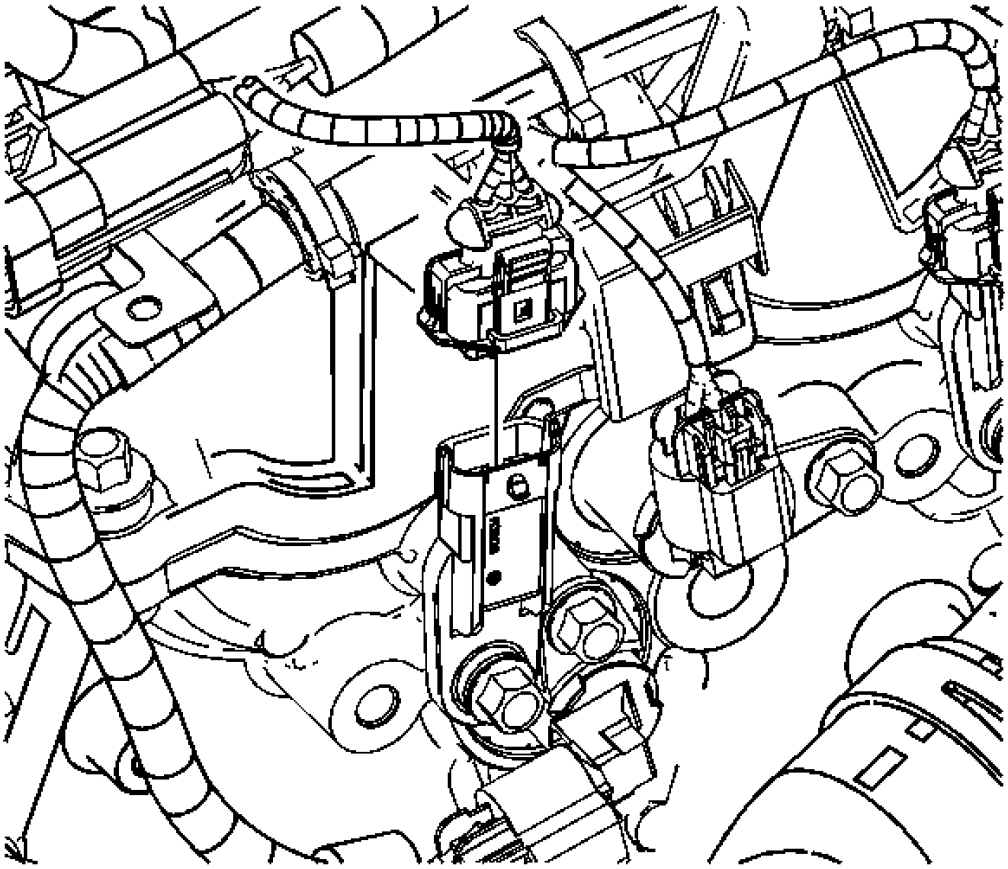


Fig. 162: View Of Right CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) sensor electrical connector.

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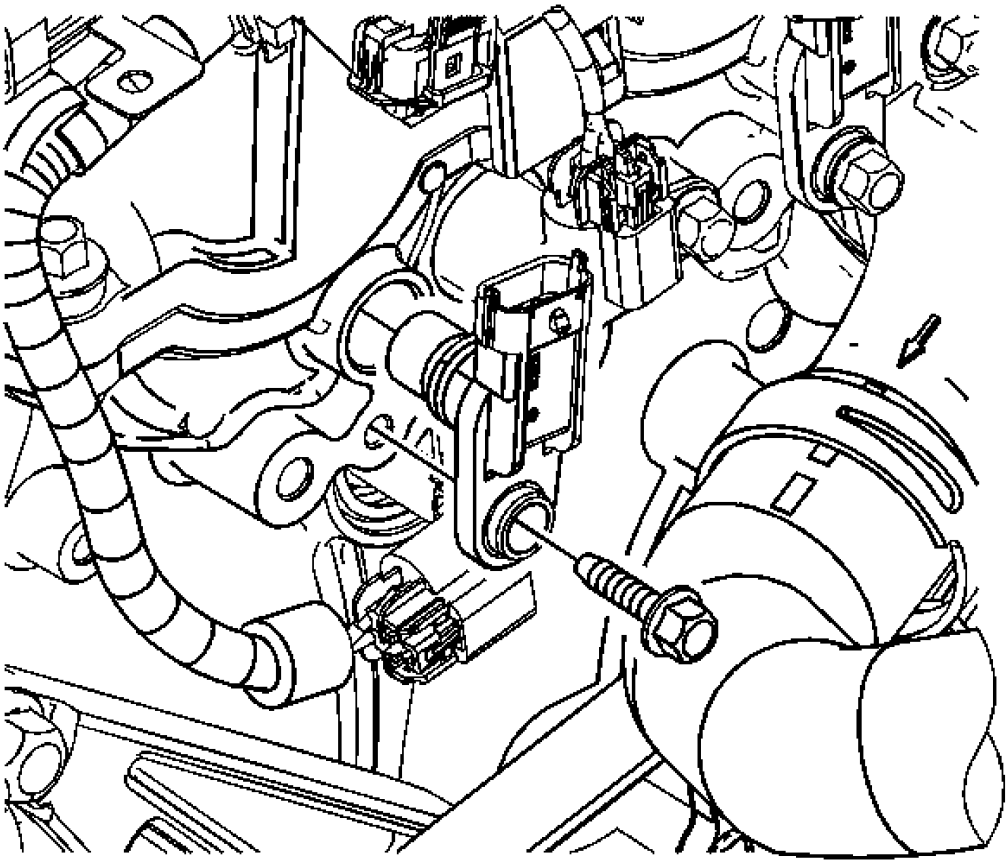


Fig. 163: View Of Right CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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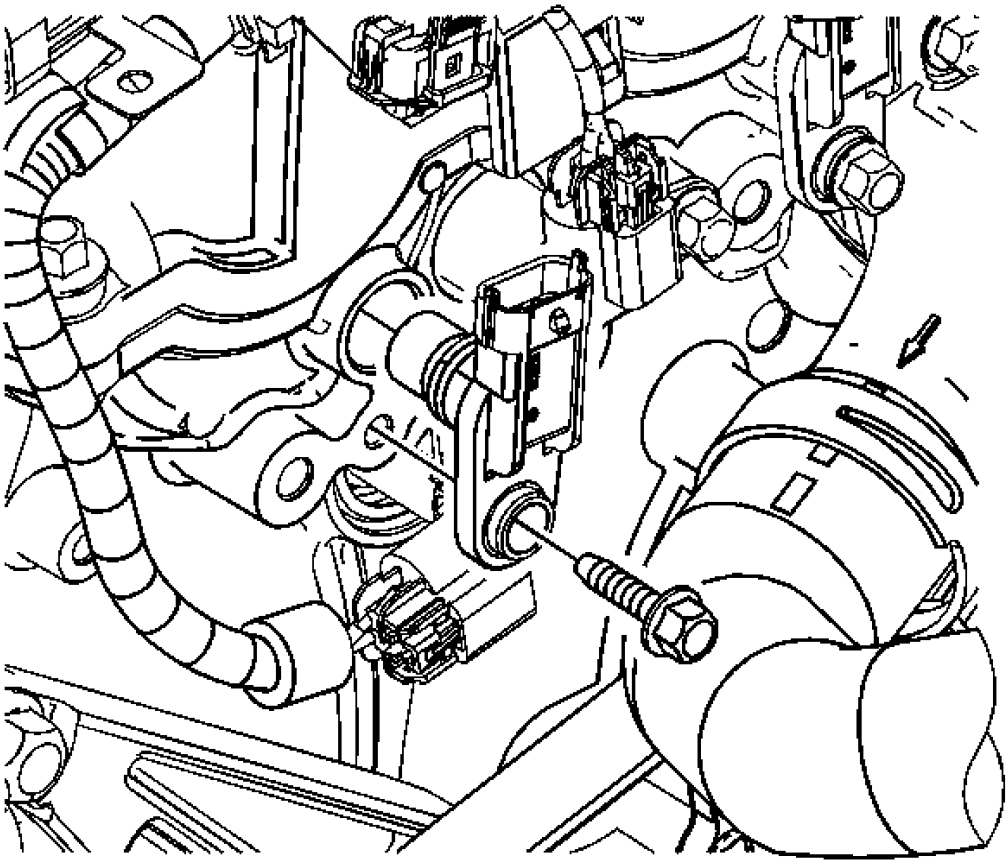


Fig. 164: View Of Right CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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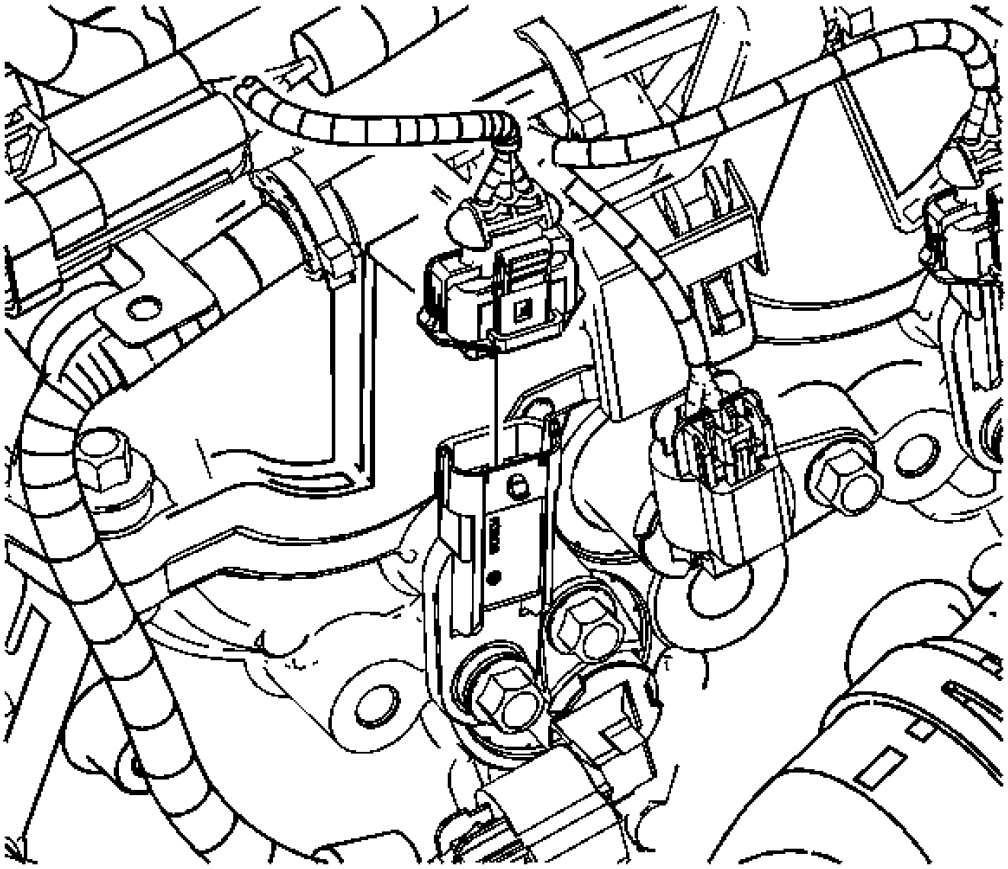


Fig. 165: View Of Right CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Connect the CMP sensor electrical connector.
4. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

Removal Procedure

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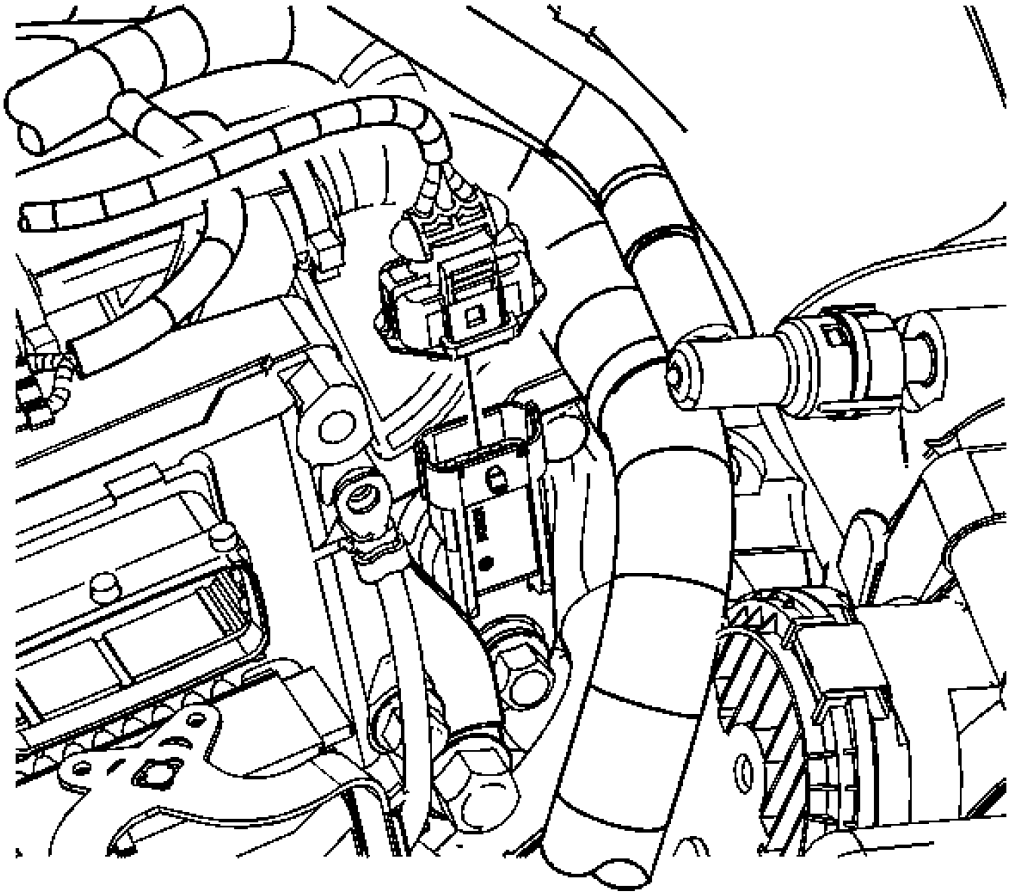


Fig. 166: View Of Right CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) sensor electrical connector.

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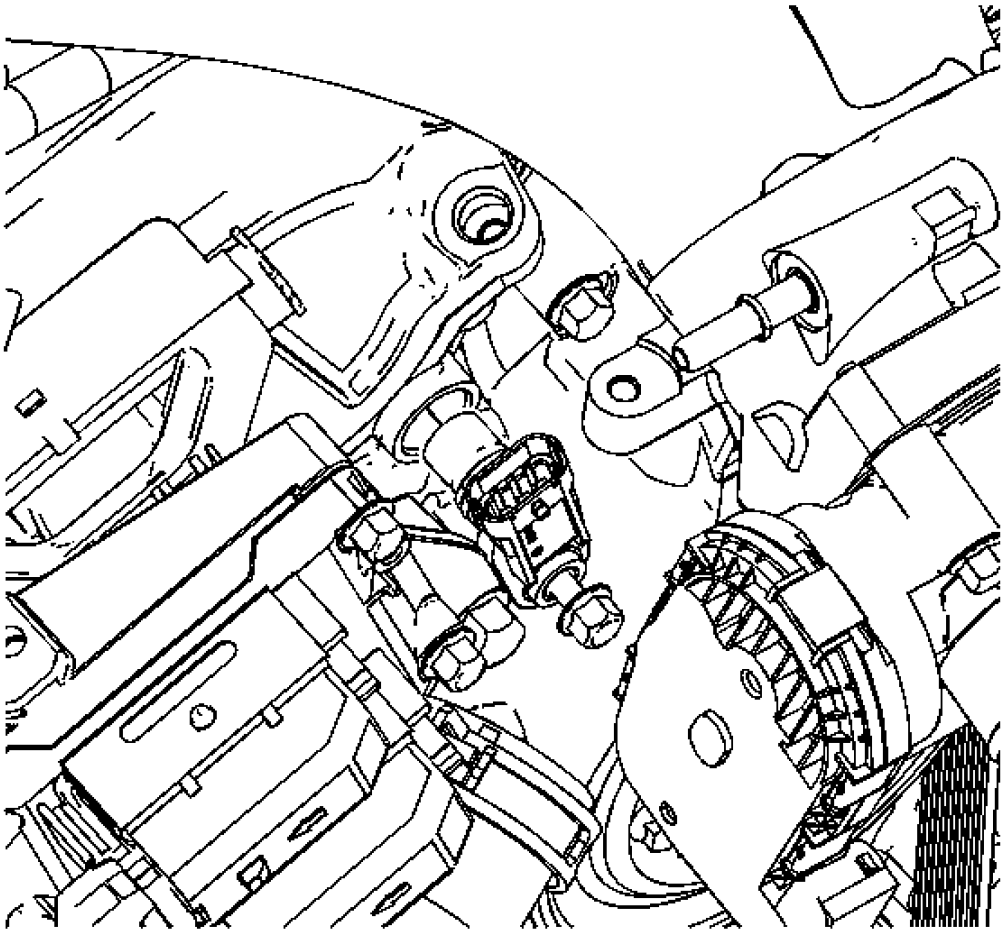


Fig. 167: View Of Right CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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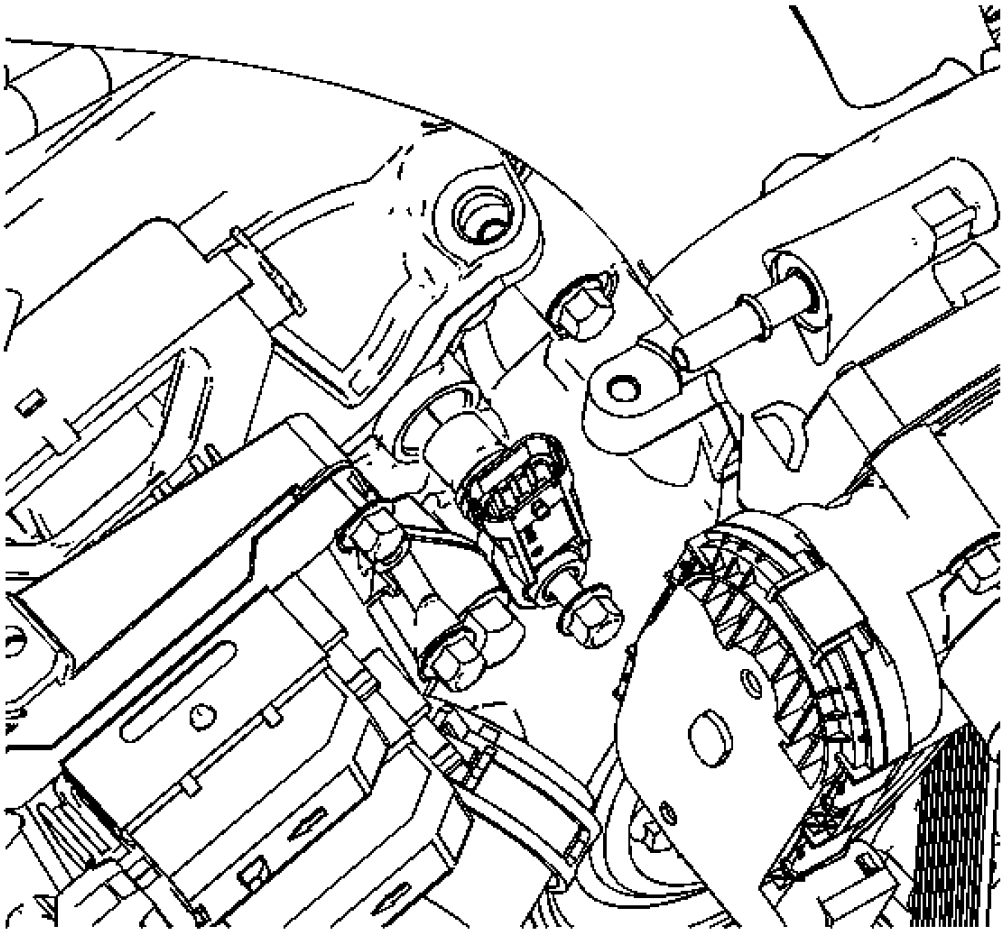


Fig. 168: View Of Right CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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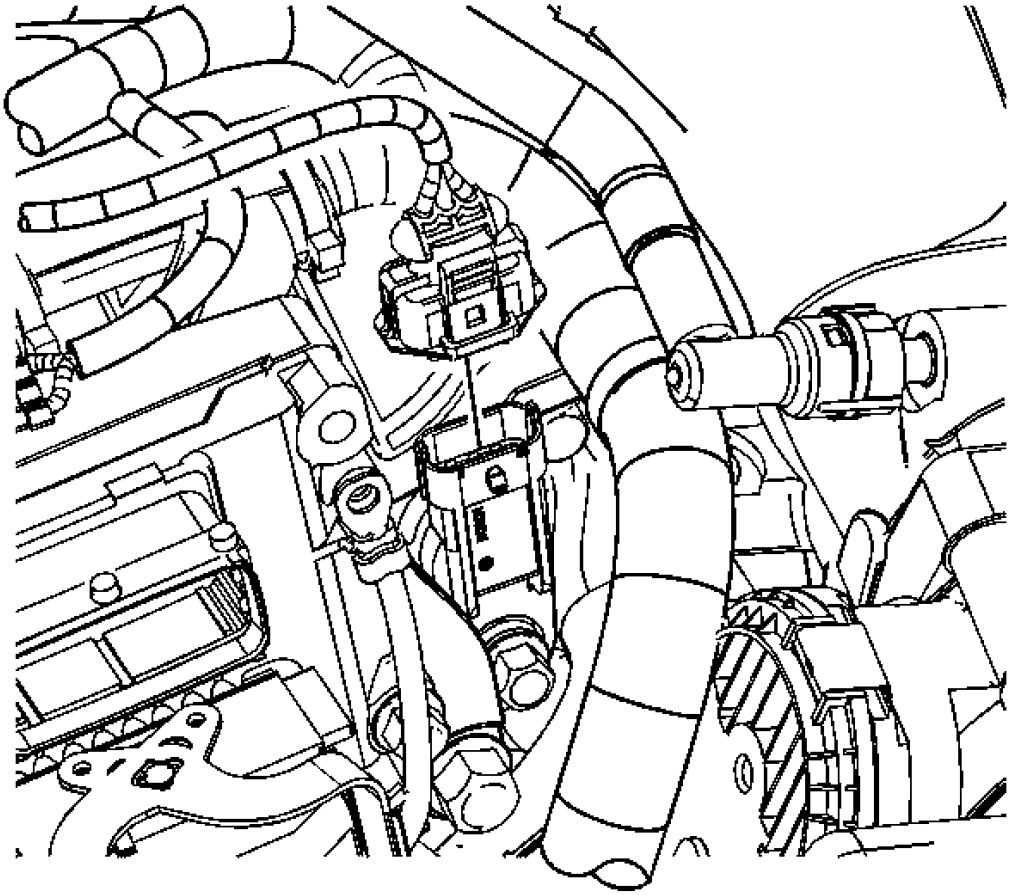


Fig. 169: View Of Right CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Connect the CMP sensor electrical connector.
4. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

Removal Procedure

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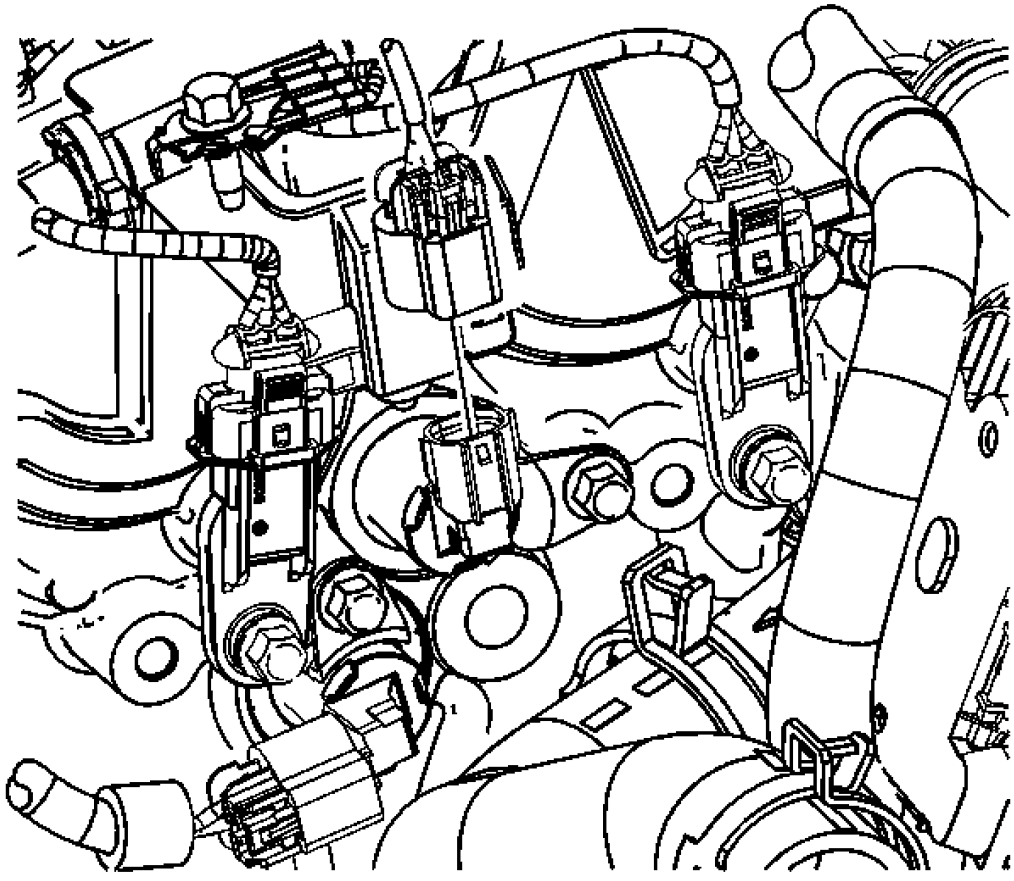


Fig. 170: View Of Right CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) actuator valve electrical connector.

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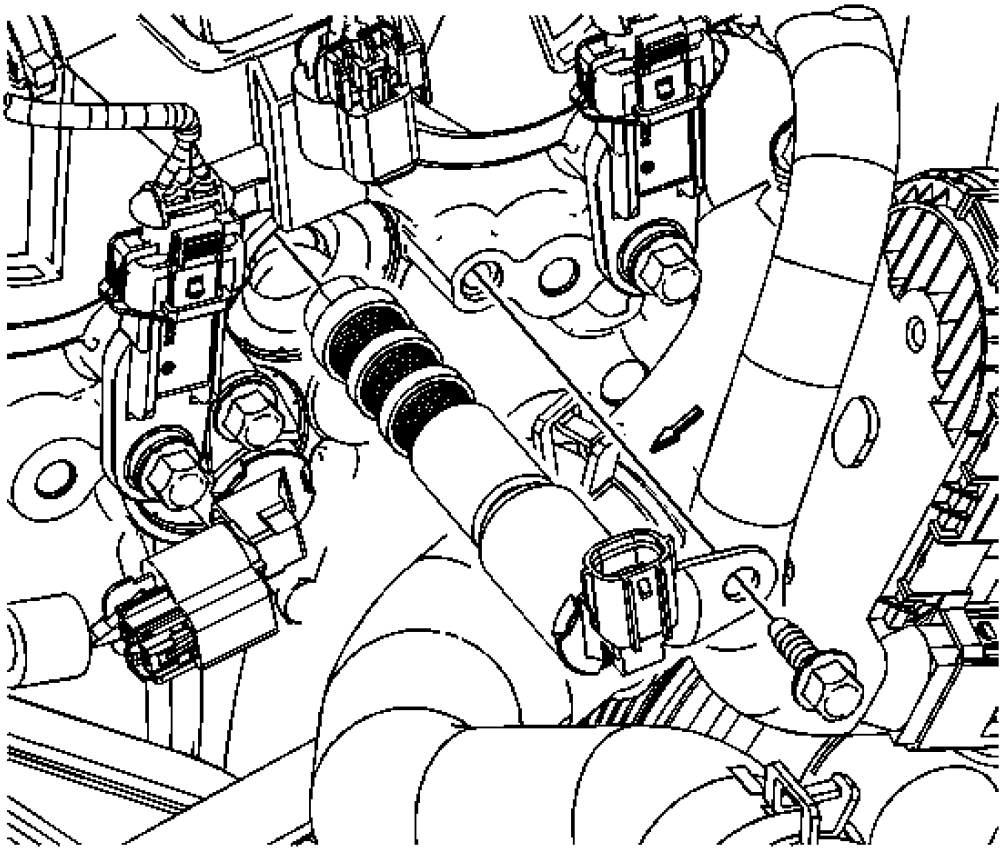


Fig. 171: View Of Right CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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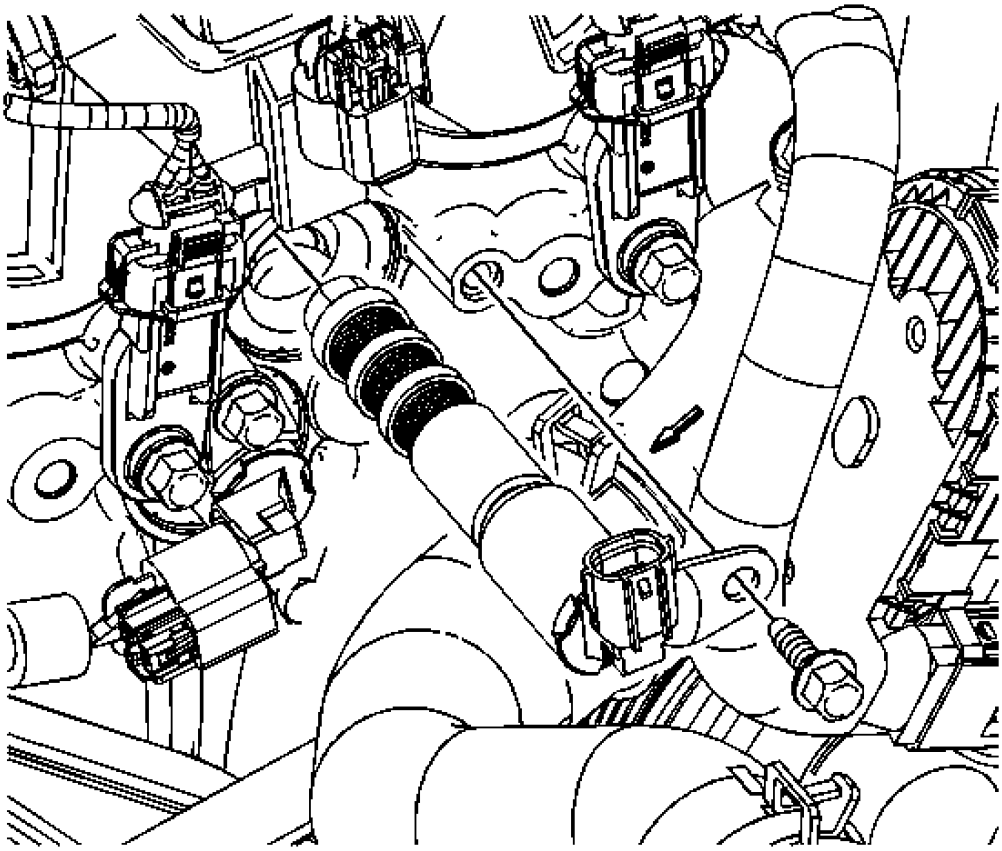


Fig. 172: View Of Right CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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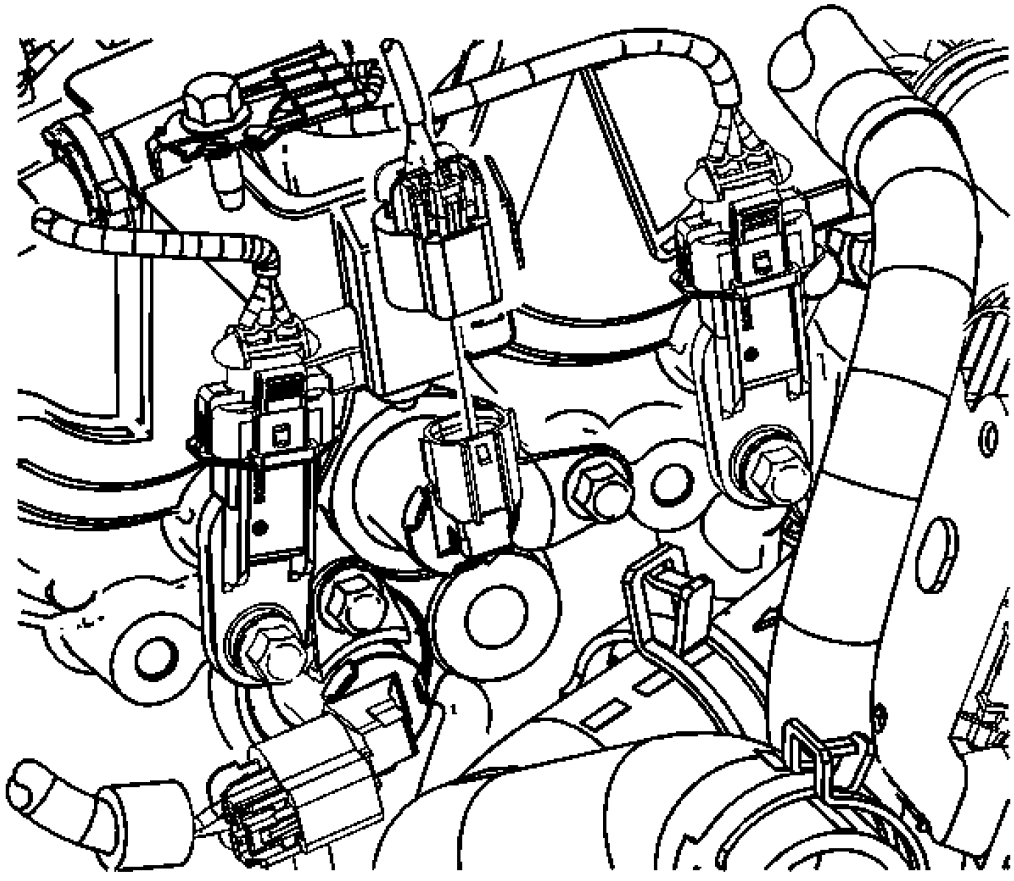


Fig. 173: View Of Right CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

4. Connect the CMP actuator valve electrical connector.
5. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

Removal Procedure

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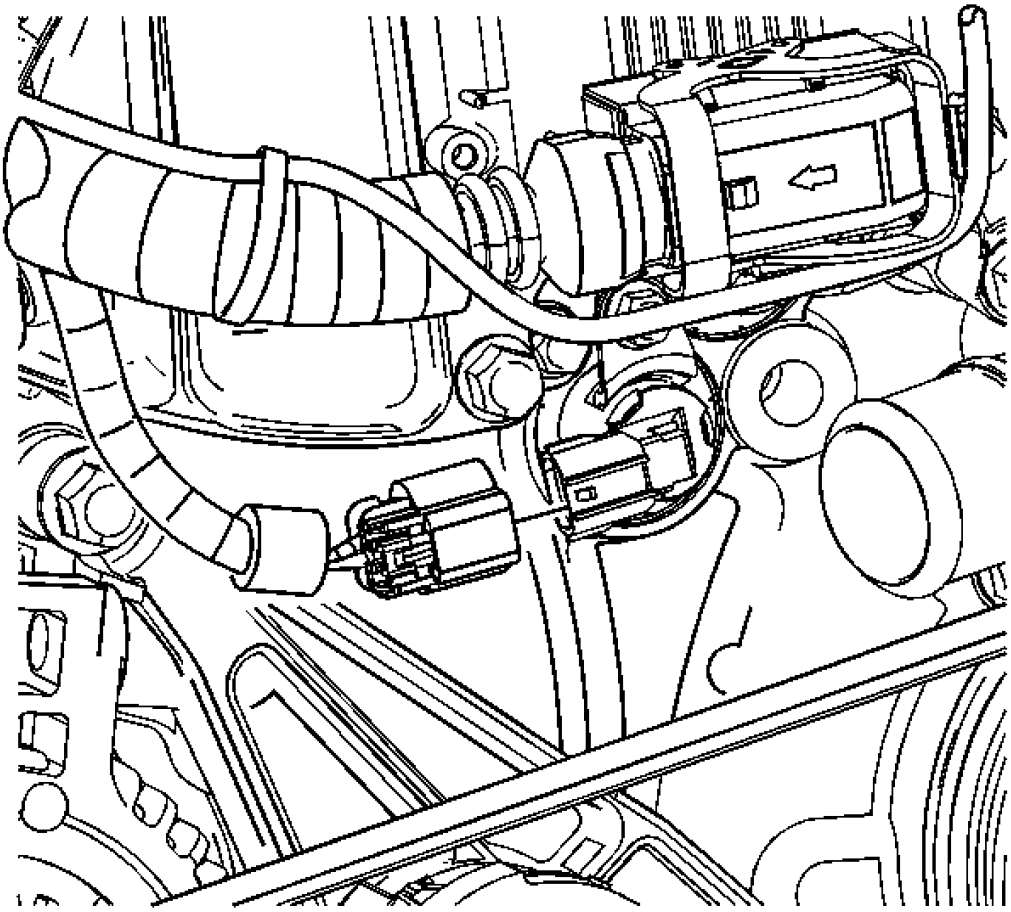


Fig. 174: View Of Right CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) actuator valve electrical connector.

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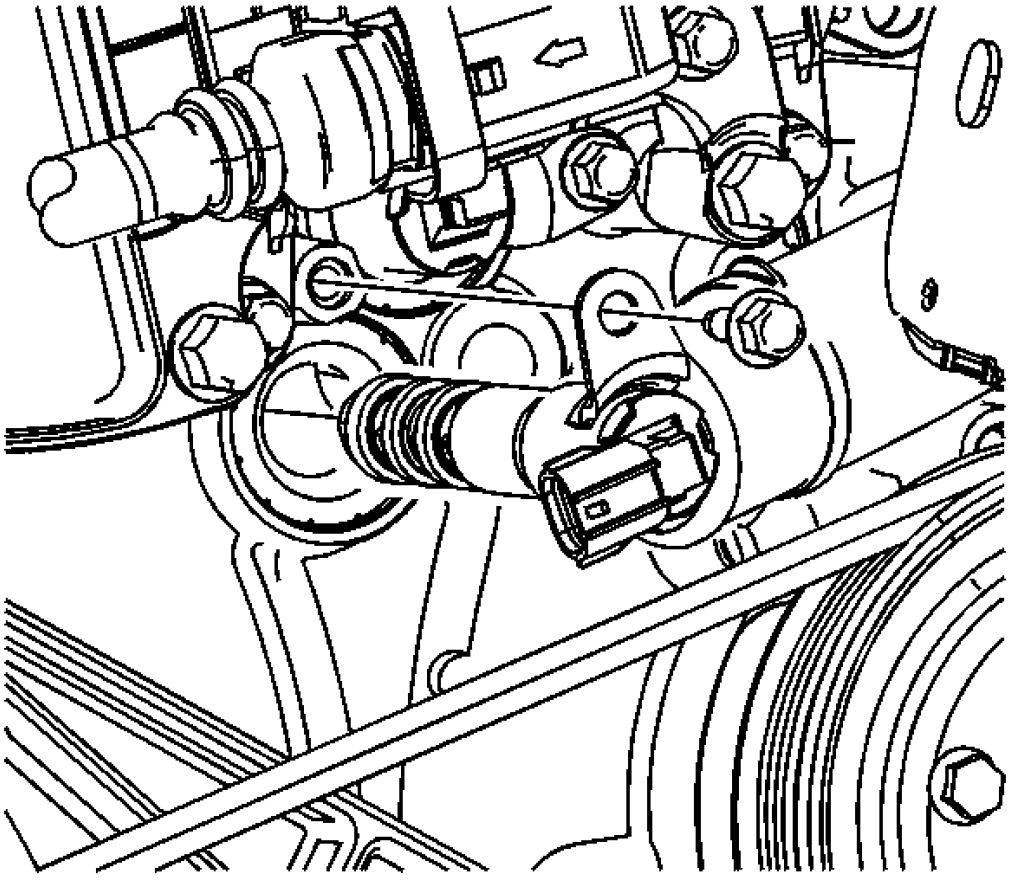


Fig. 175: View Of Right CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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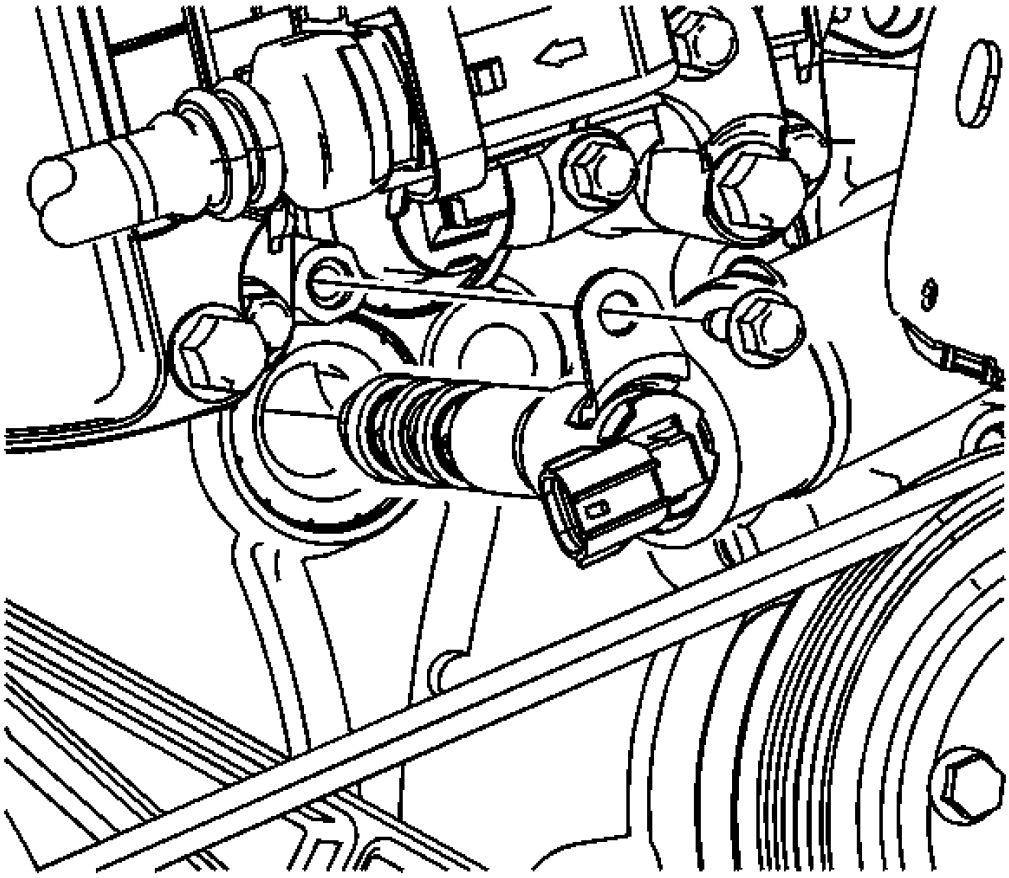


Fig. 176: View Of Right CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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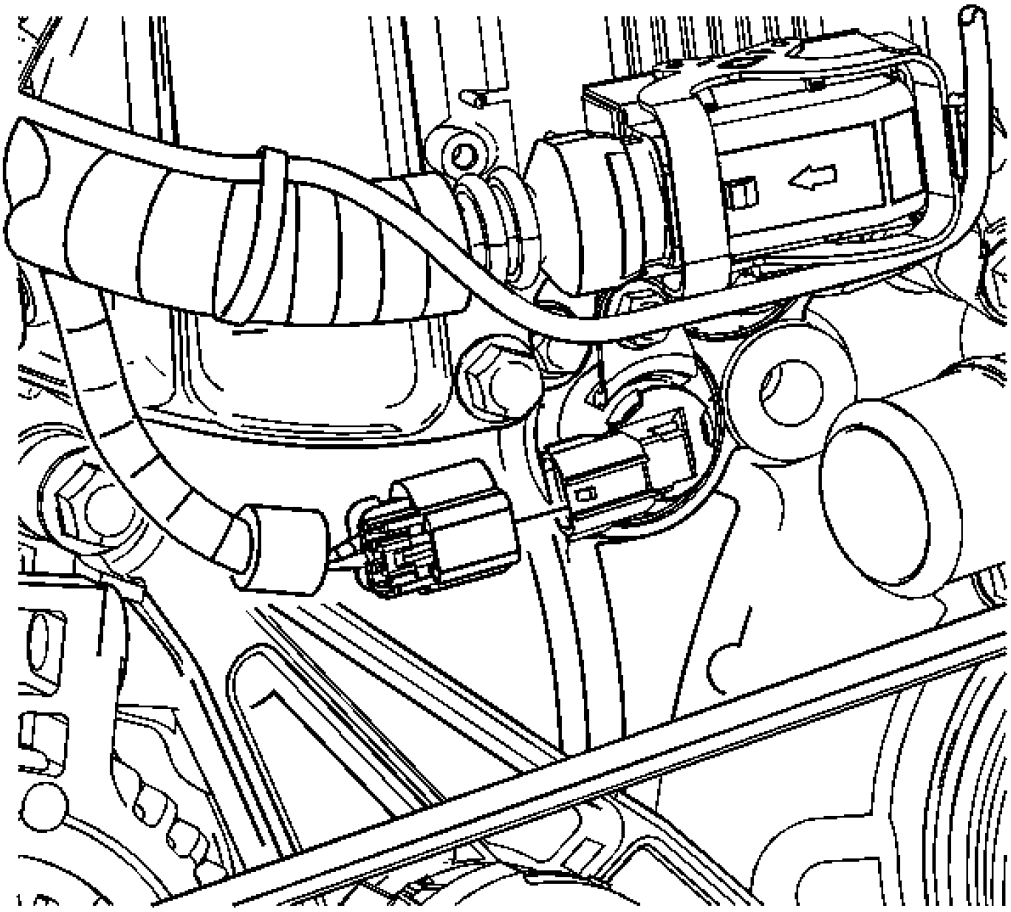


Fig. 177: View Of Right CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Connect the CMP valve electrical connector.
5. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

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2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

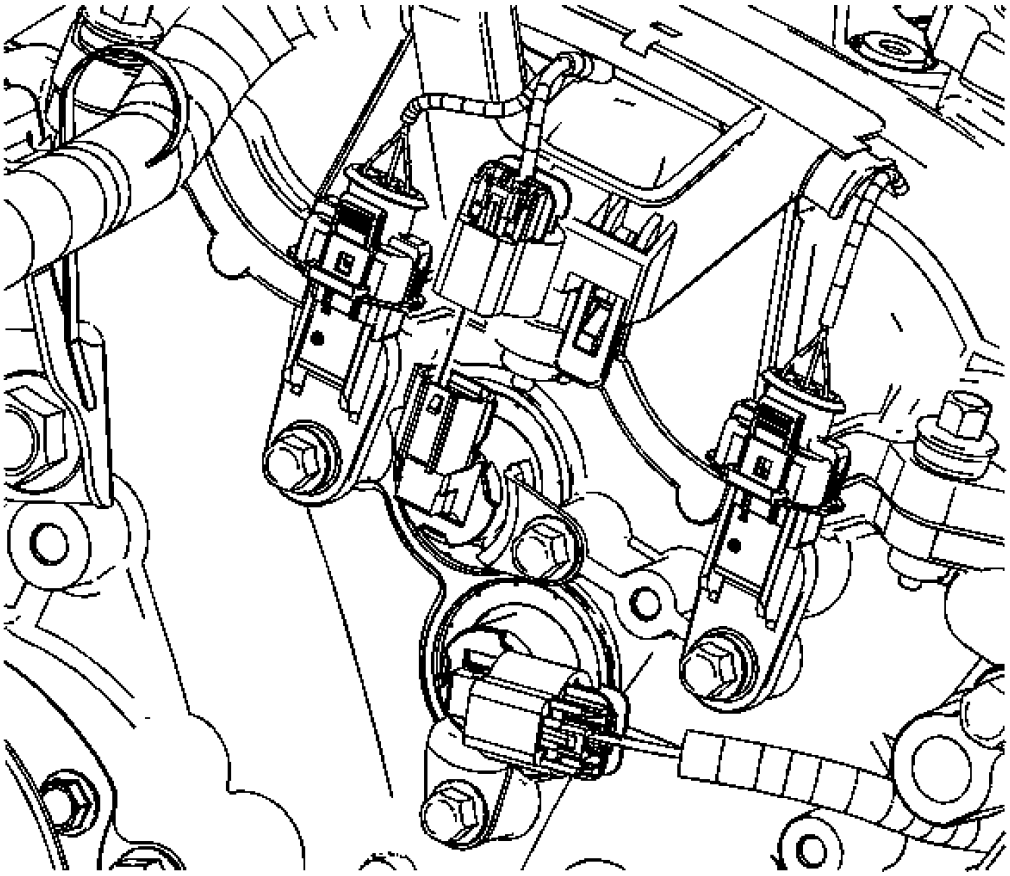


Fig. 178: View Of Left CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) actuator valve electrical connector.

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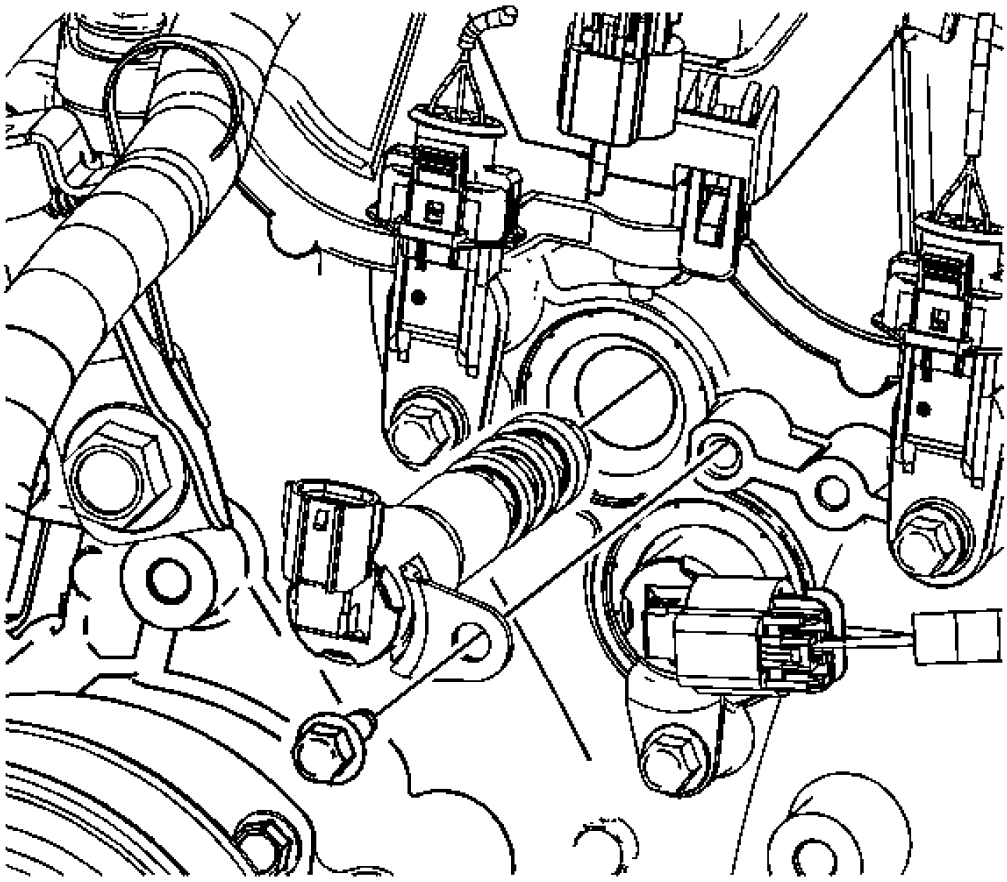


Fig. 179: View Of Left CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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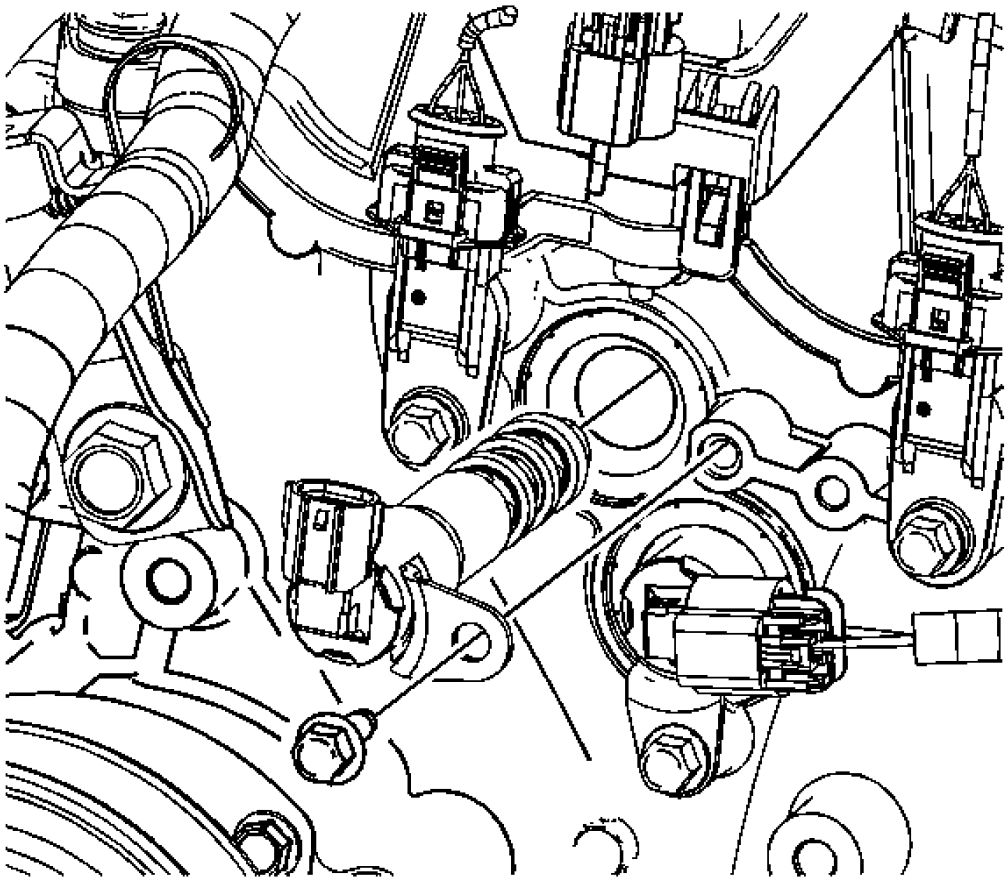


Fig. 180: View Of Left CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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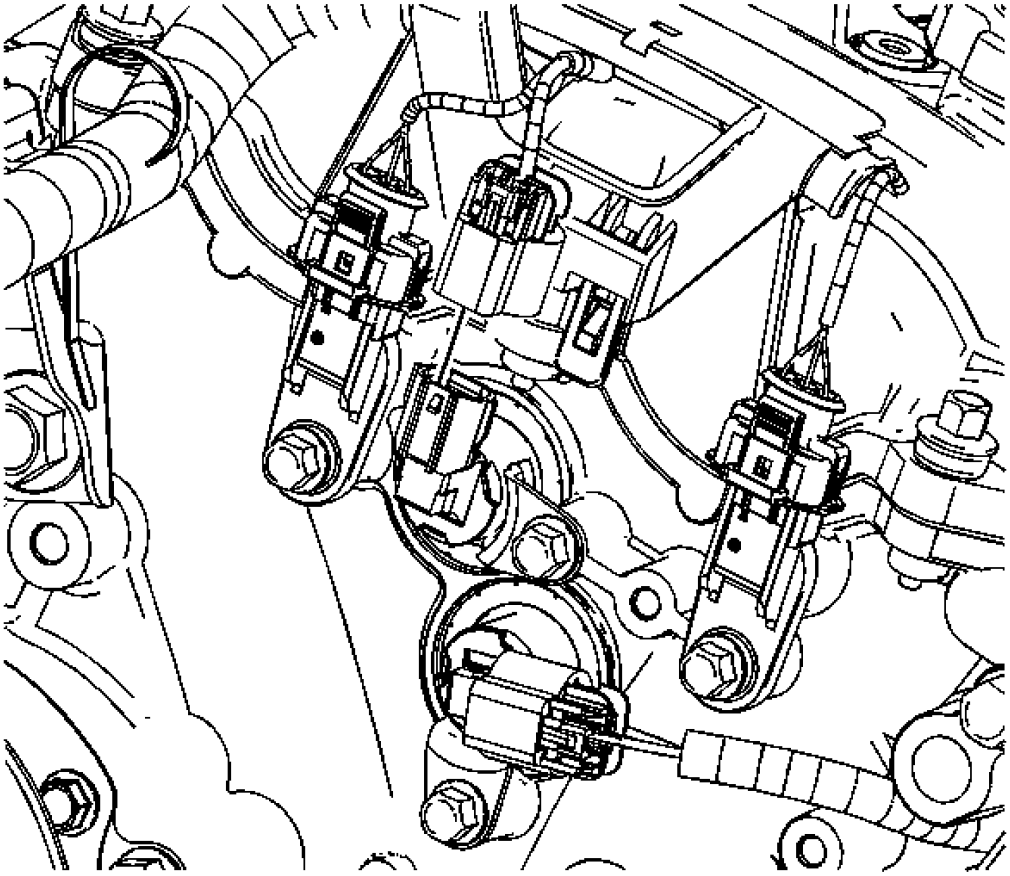


Fig. 181: View Of Left CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

4. Install the CMP actuator valve electrical connector.
5. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

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2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

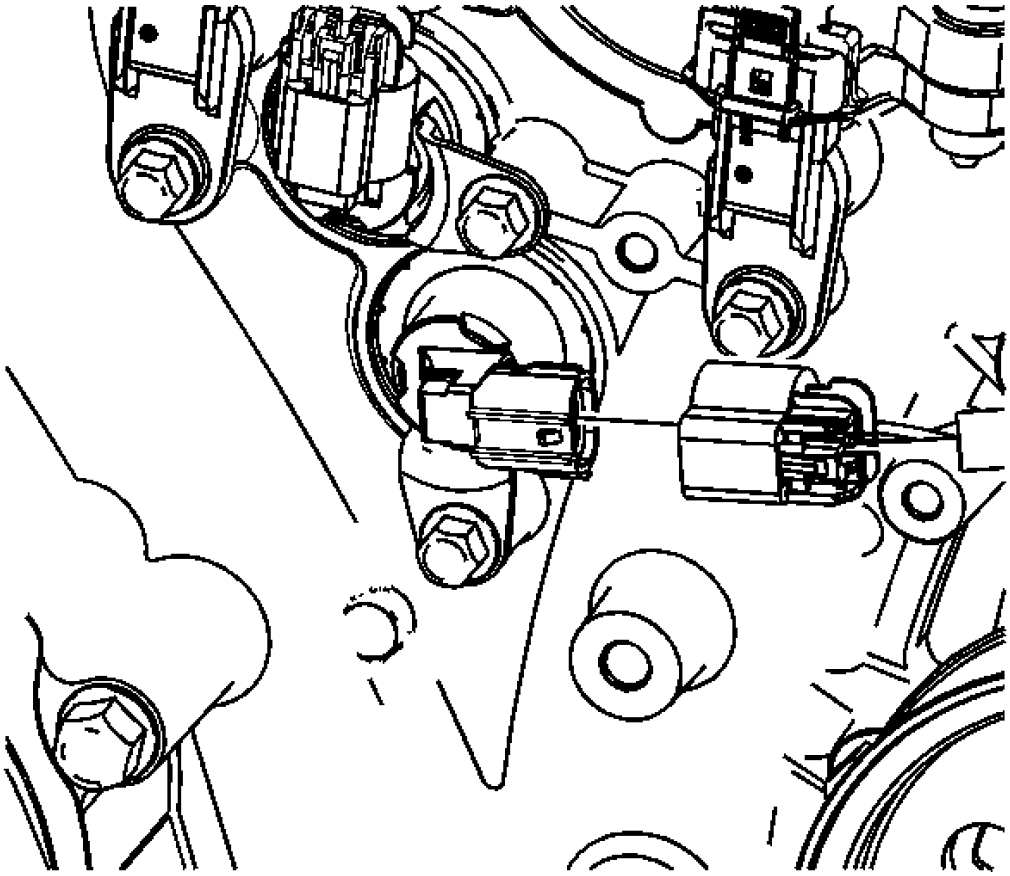


Fig. 182: View Of Left CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) actuator valve electrical connector.

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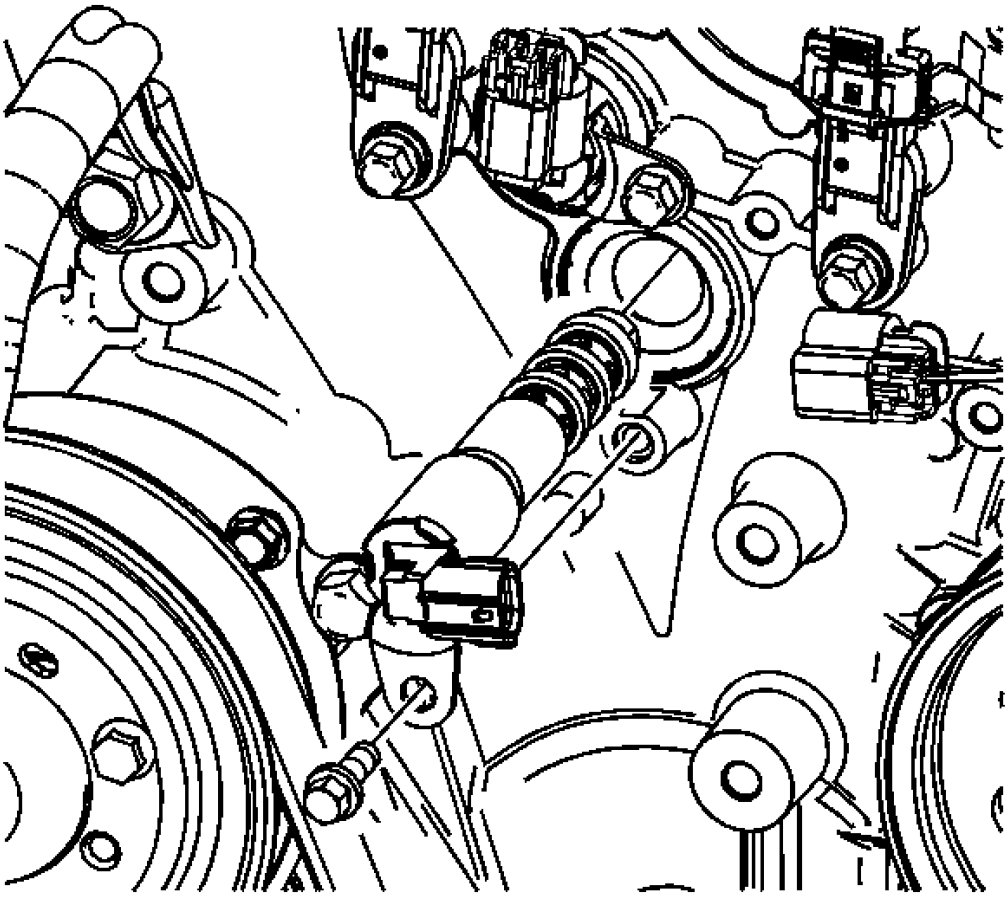


Fig. 183: View Of Left CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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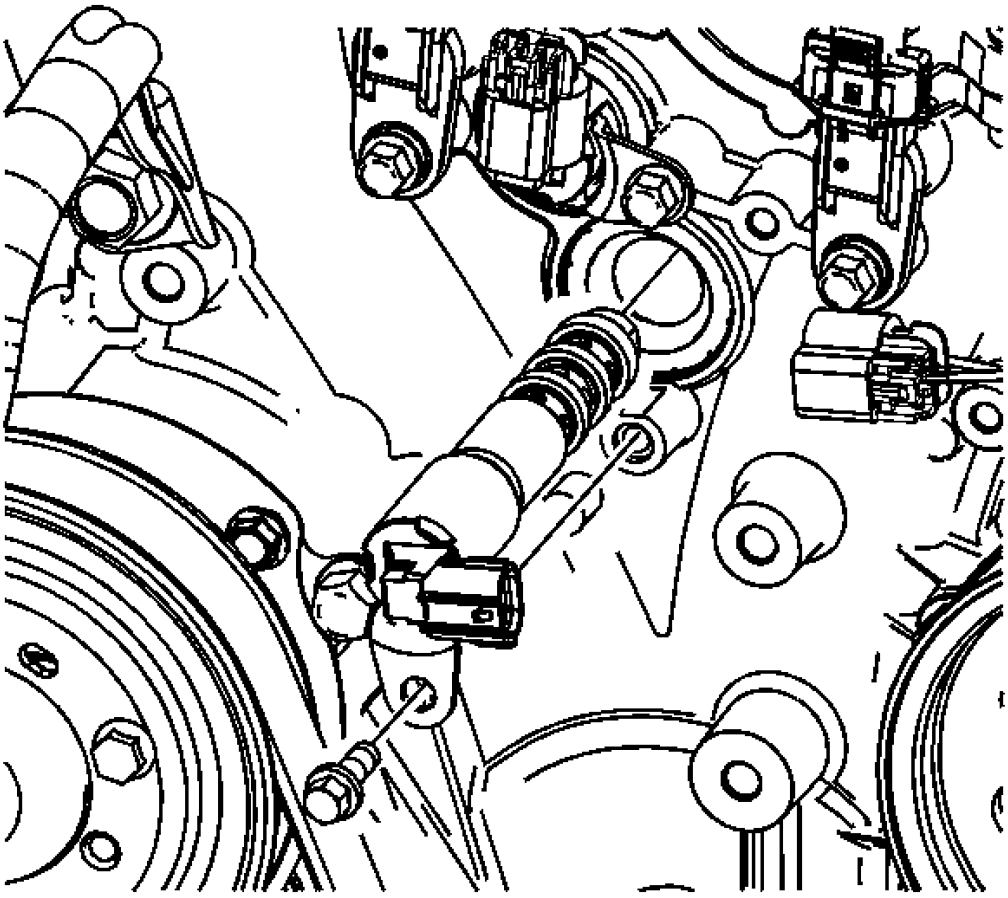


Fig. 184: View Of Left CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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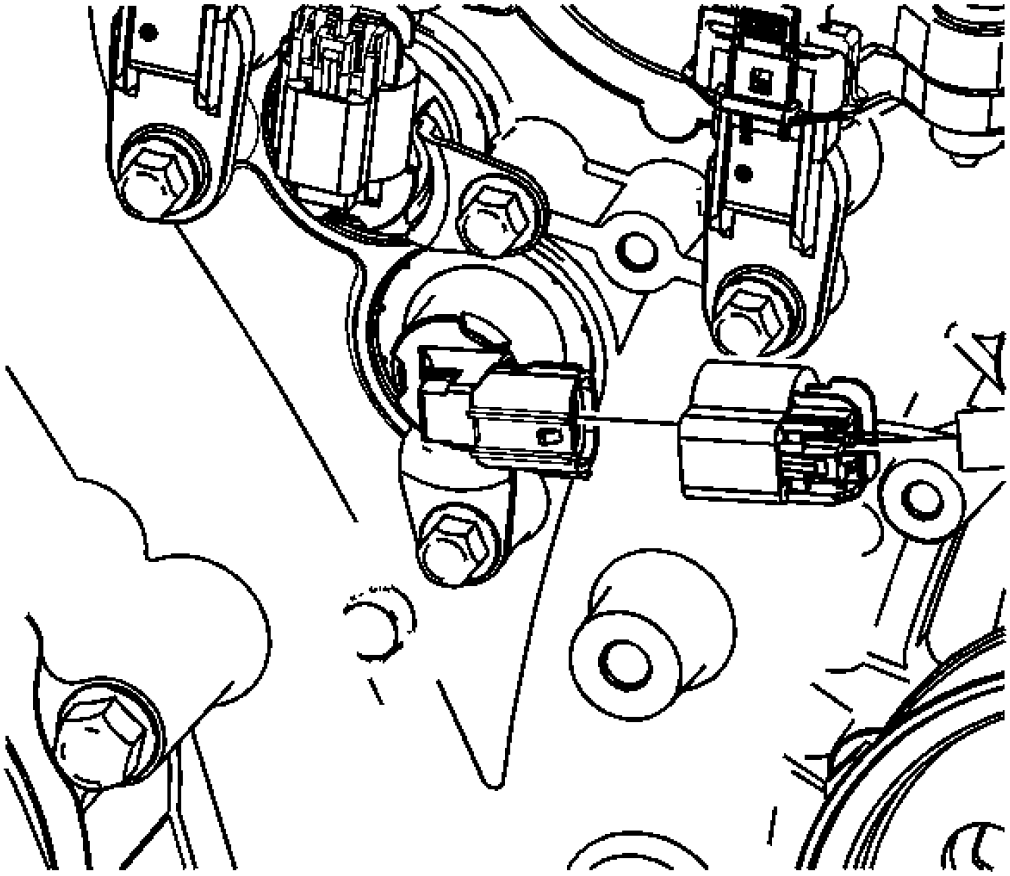


Fig. 185: View Of Left CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Install the CMP actuator valve electrical connector.
5. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

KNOCK SENSOR REPLACEMENT - BANK 1

Removal Procedure

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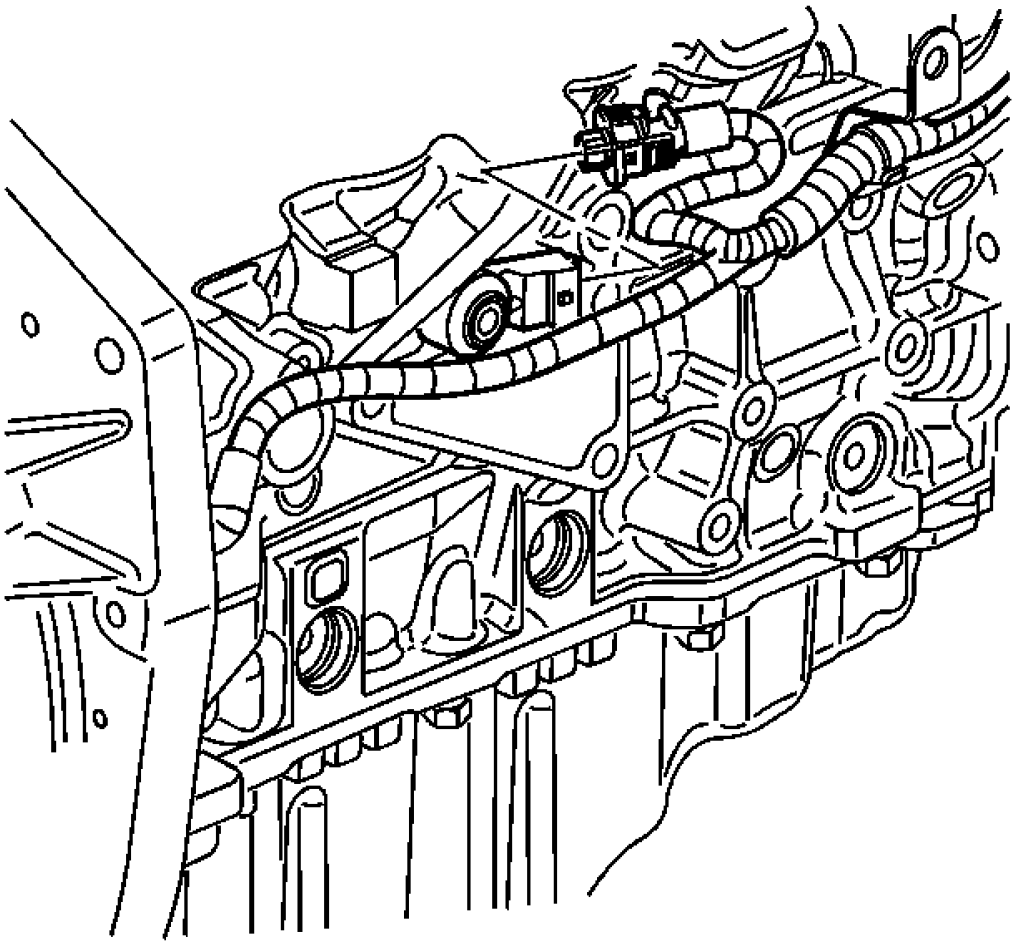


Fig. 186: View Of Right Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Reposition the wiring harness heat shield to obtain access.
4. Remove the knock sensor (KS) electrical connector.

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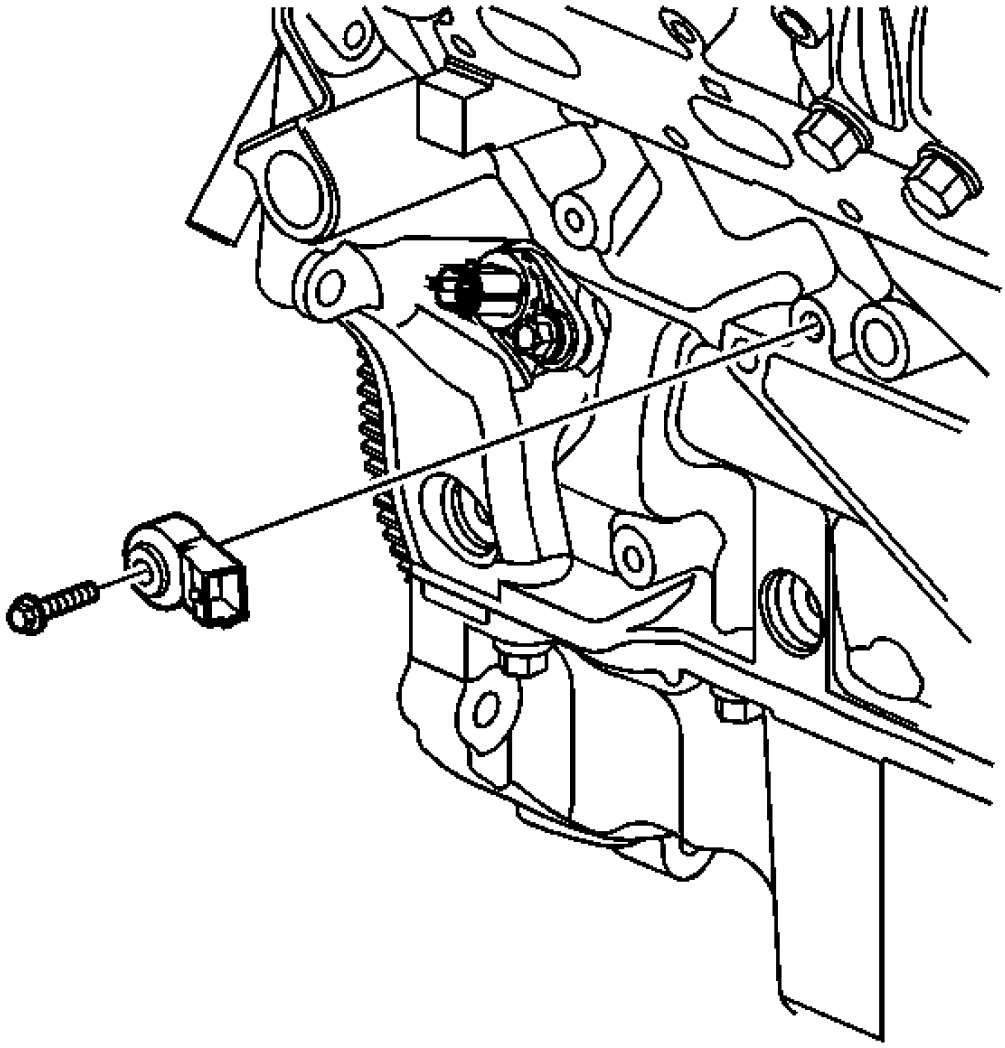


Fig. 187: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the KS bolt.
6. Remove the KS.

Installation Procedure

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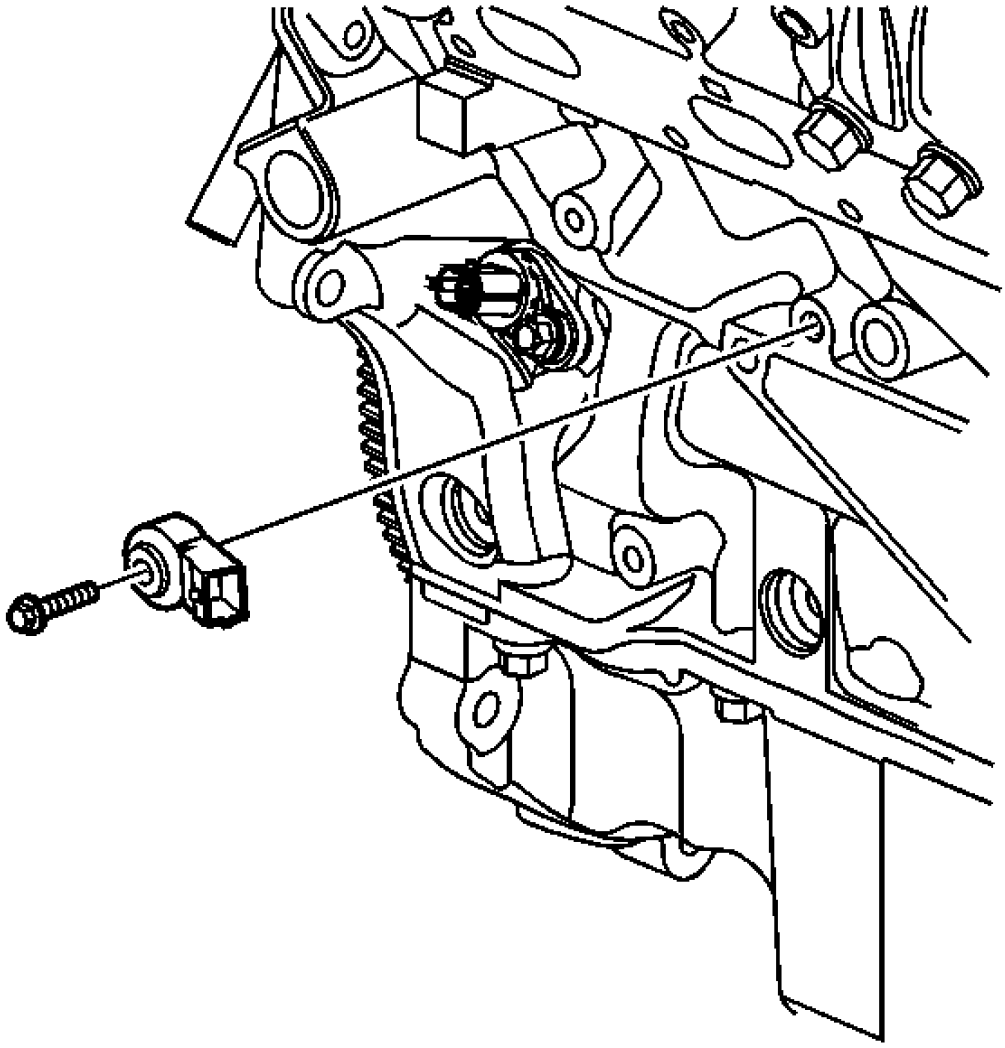


Fig. 188: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the KS.

CAUTION: Refer to Fastener Caution .

2. Install the KS bolt and tighten to 23 N.m (17 lb ft).

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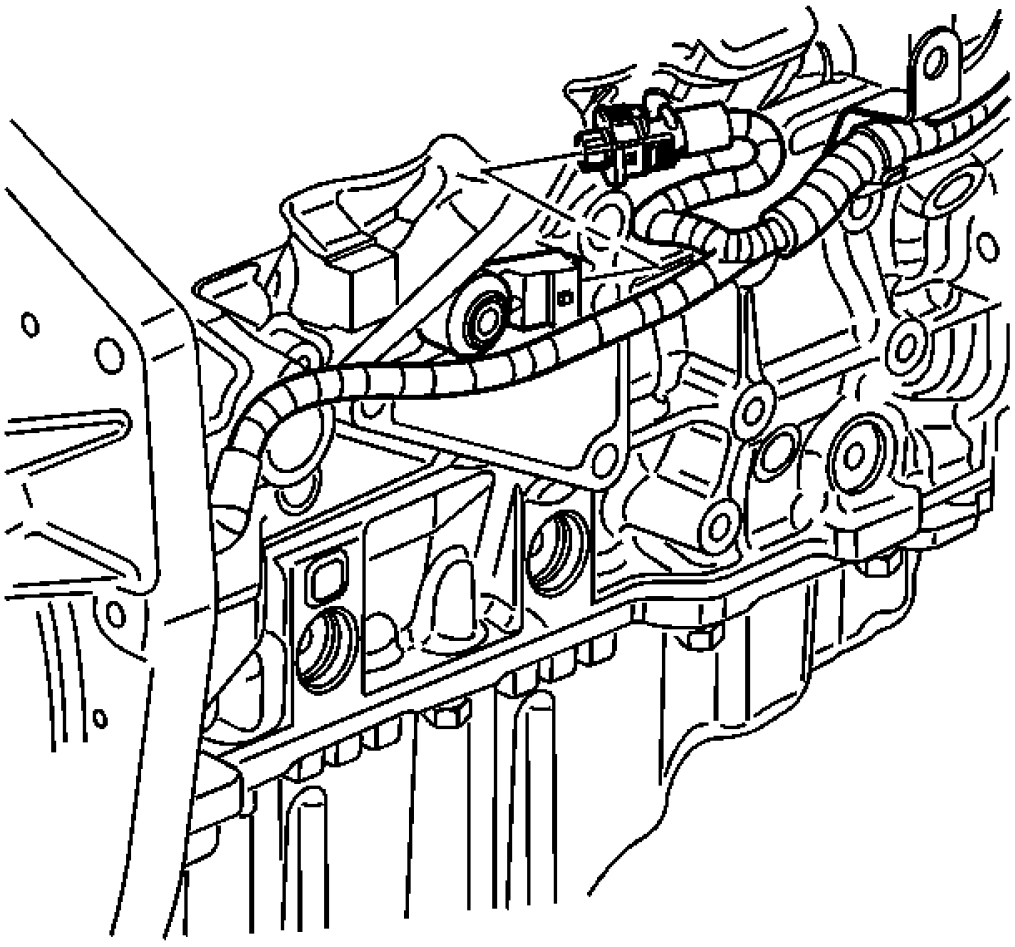


Fig. 189: View Of Right Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the original position.
5. Lower the vehicle.

KNOCK SENSOR REPLACEMENT - BANK 2

Removal Procedure

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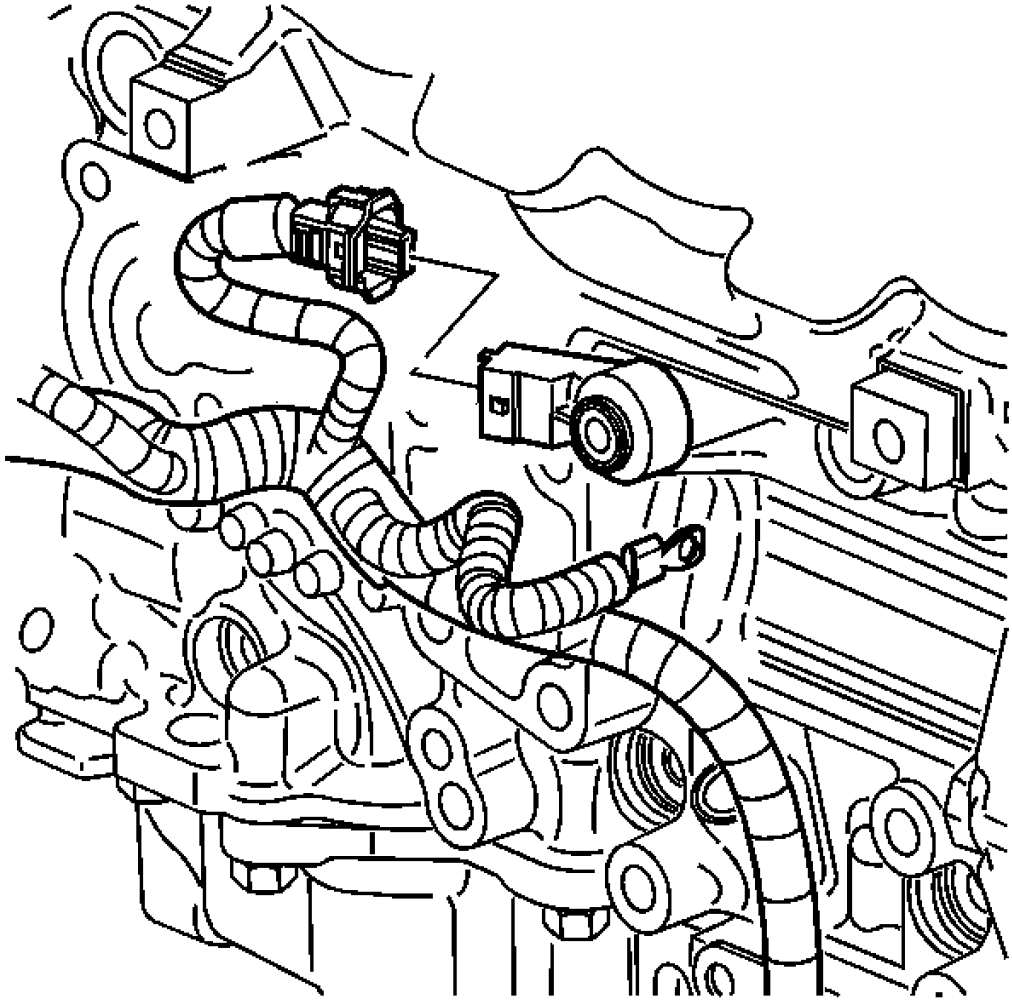


Fig. 190: View Of Left Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the wiring harness heat shield from the oil level indicator tube to gain access.
4. Remove the knock sensor (KS) electrical connector.

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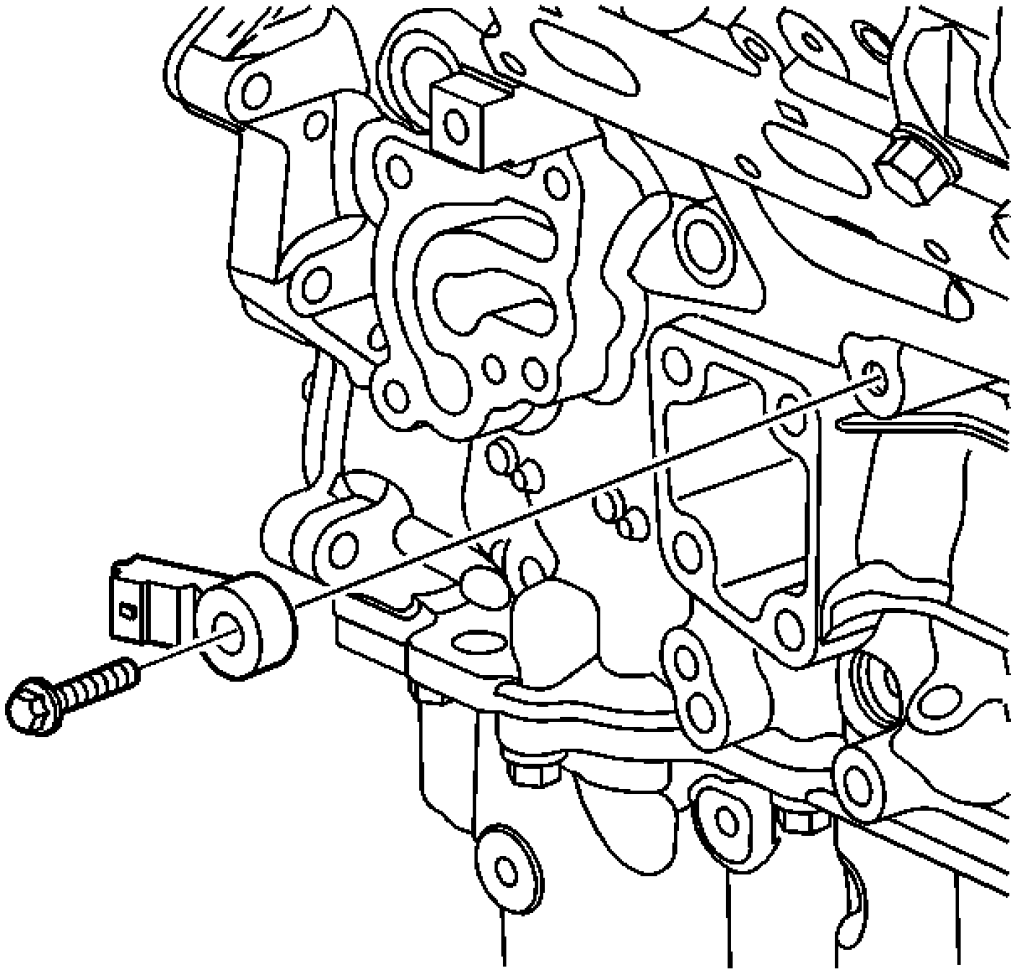


Fig. 191: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS CORP.

5. Remove the KS bolt.
6. Remove the KS.

Installation Procedure

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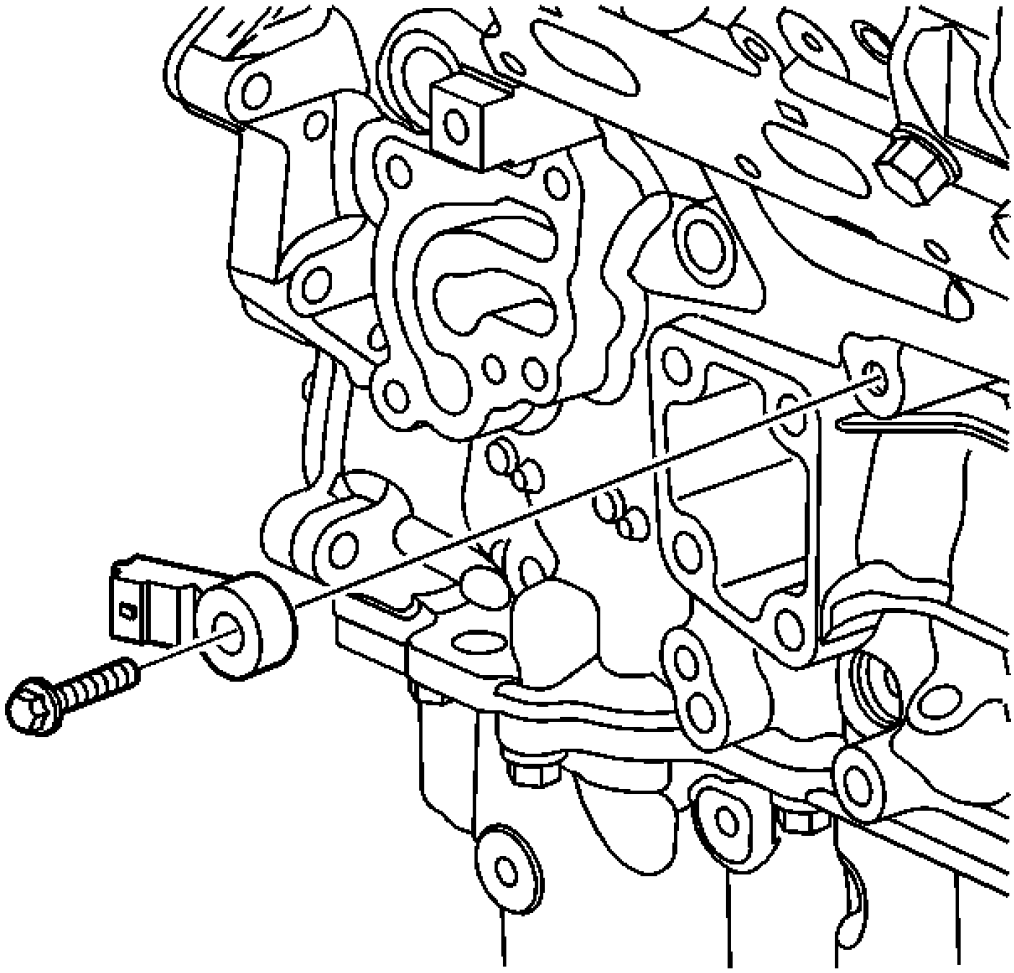


Fig. 192: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the KS.

CAUTION: Refer to Fastener Caution .

2. Install the KS bolt and tighten to 23 N.m (17 lb ft).

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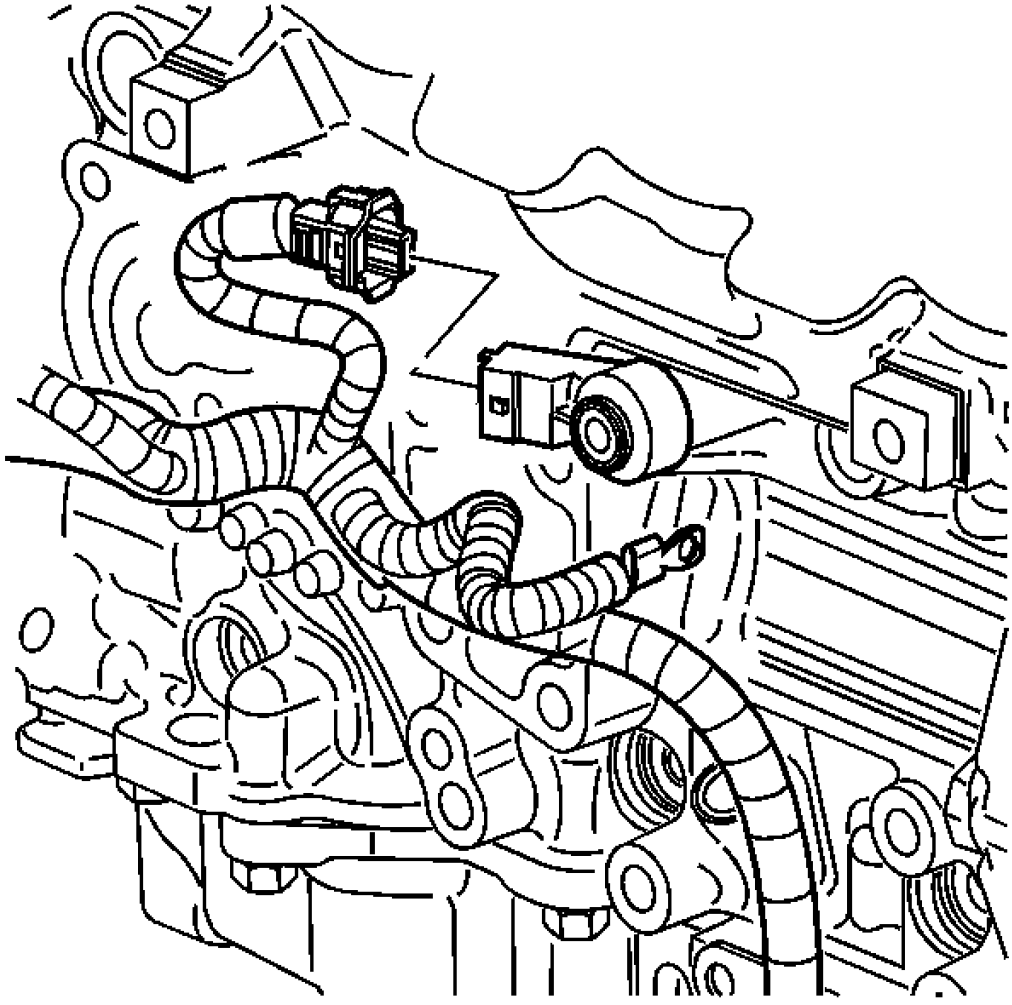


Fig. 193: View Of Left Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the oil level indicator tube.
5. Lower the vehicle.

AIR CLEANER ELEMENT REPLACEMENT

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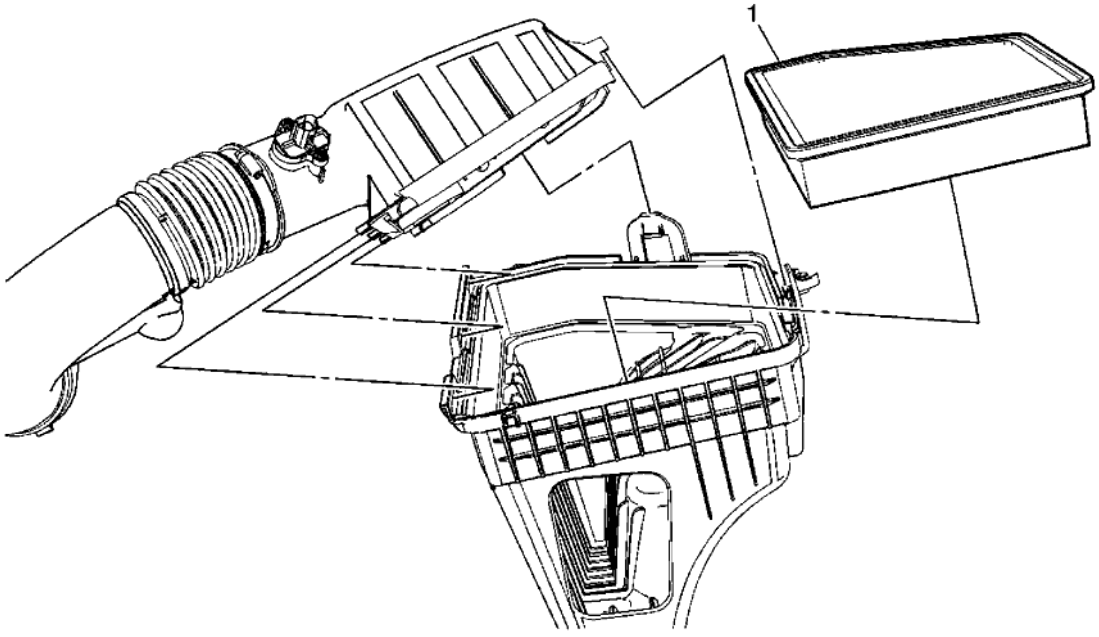


Fig. 194: Air Cleaner Element
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Air Cleaner Element **Procedure** 1. Disconnect the mass airflow electrical connector. 2. Push back the retaining tabs.

AIR CLEANER ASSEMBLY REPLACEMENT

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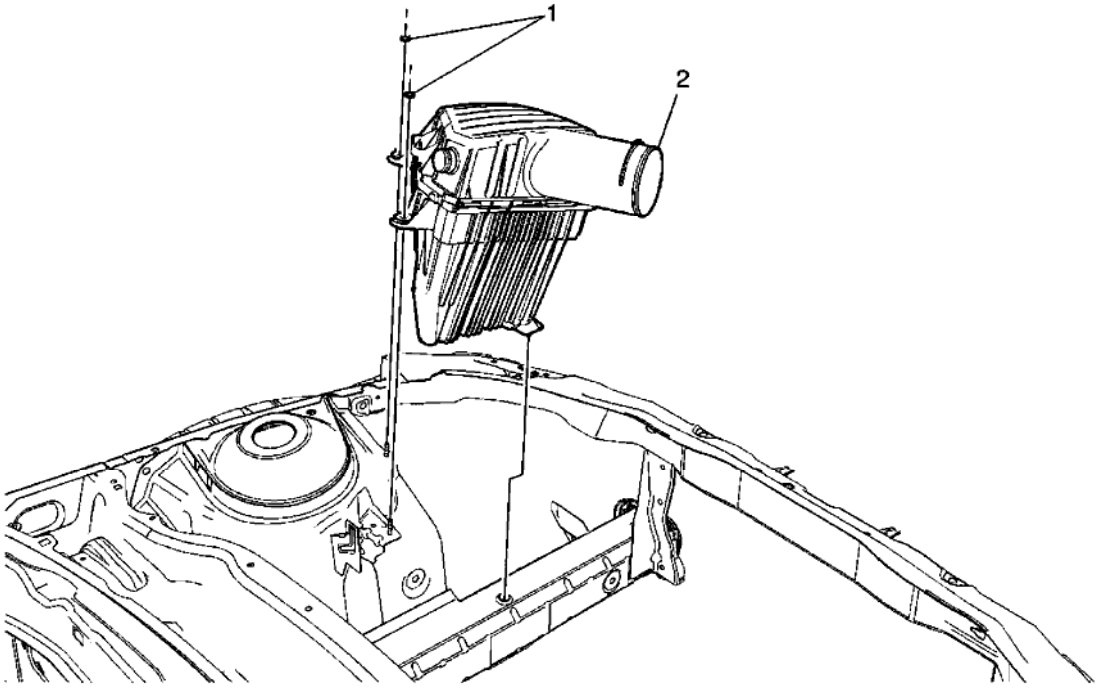


Fig. 195: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the mass airflow sensor. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** . 2. Disconnect the outlet duct from the air cleaner assembly. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .	
1	Air Cleaner Assembly Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 9 N.m (80 lb in)
2	Air Cleaner Assembly

FRONT INTAKE AIR DUCT REPLACEMENT

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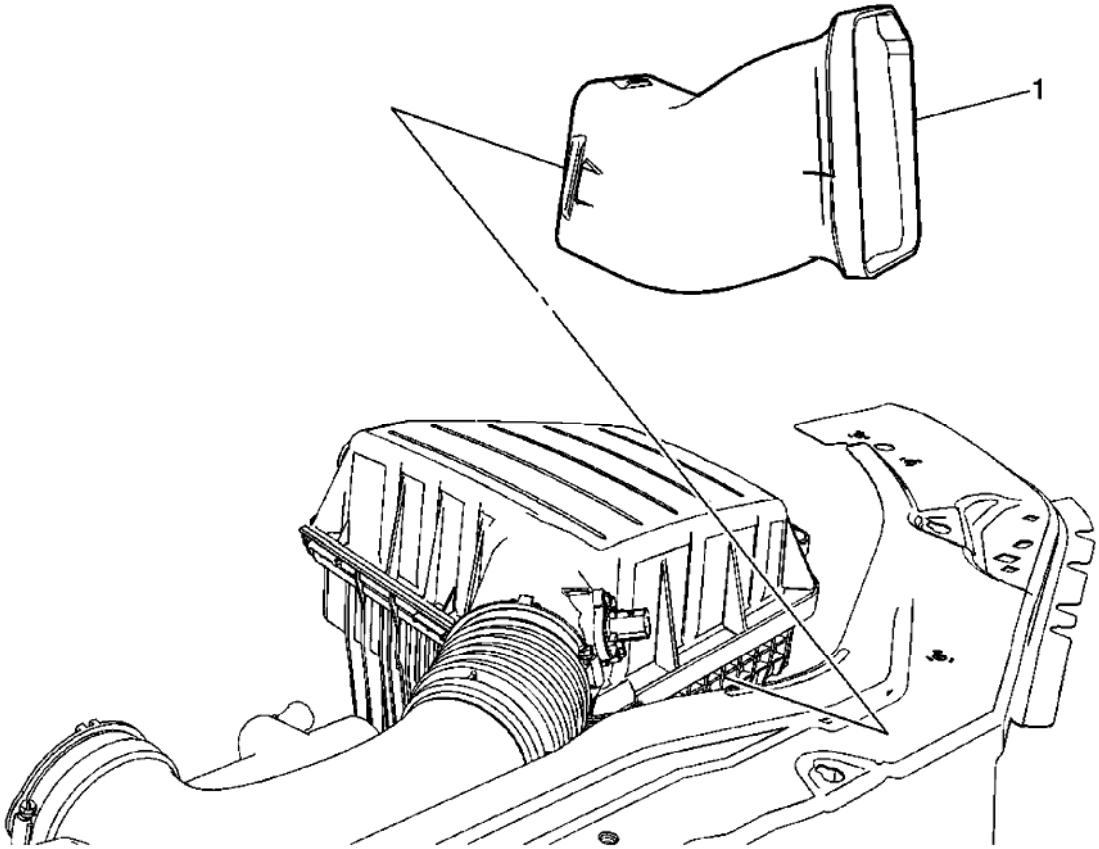


Fig. 196: Front Intake Air Duct
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement**	
1	Front Intake Air Duct

AIR CLEANER OUTLET DUCT REPLACEMENT

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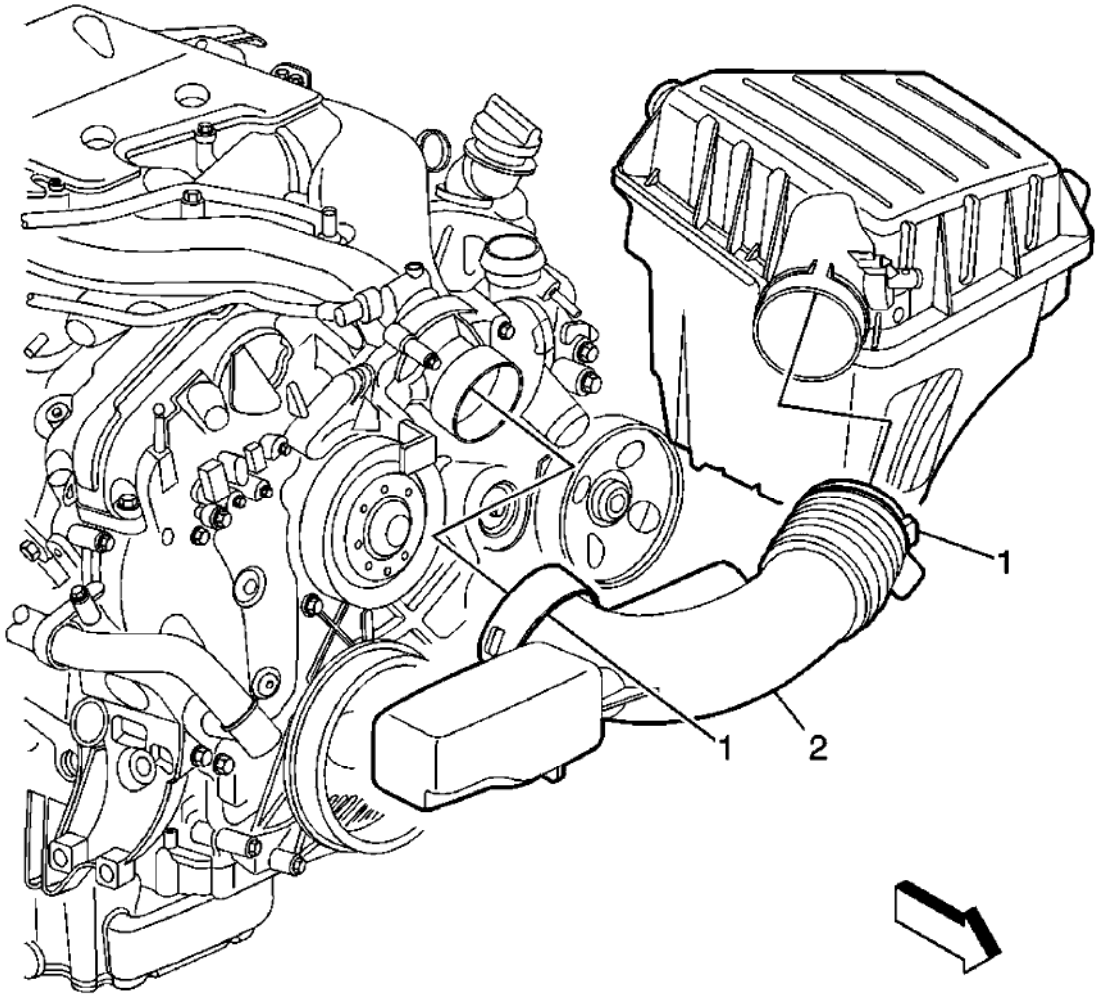


Fig. 197: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**	
1	Air Cleaner Outlet Duct Hose Clamp (Qty: 2) **CAUTION:** **Refer to Fastener Caution** **Tighten:** 4 N.m(35 lb in)
2	Air Cleaner Outlet Duct

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

REPAIR INSTRUCTIONS

ENGINE CONTROL MODULE REPLACEMENT

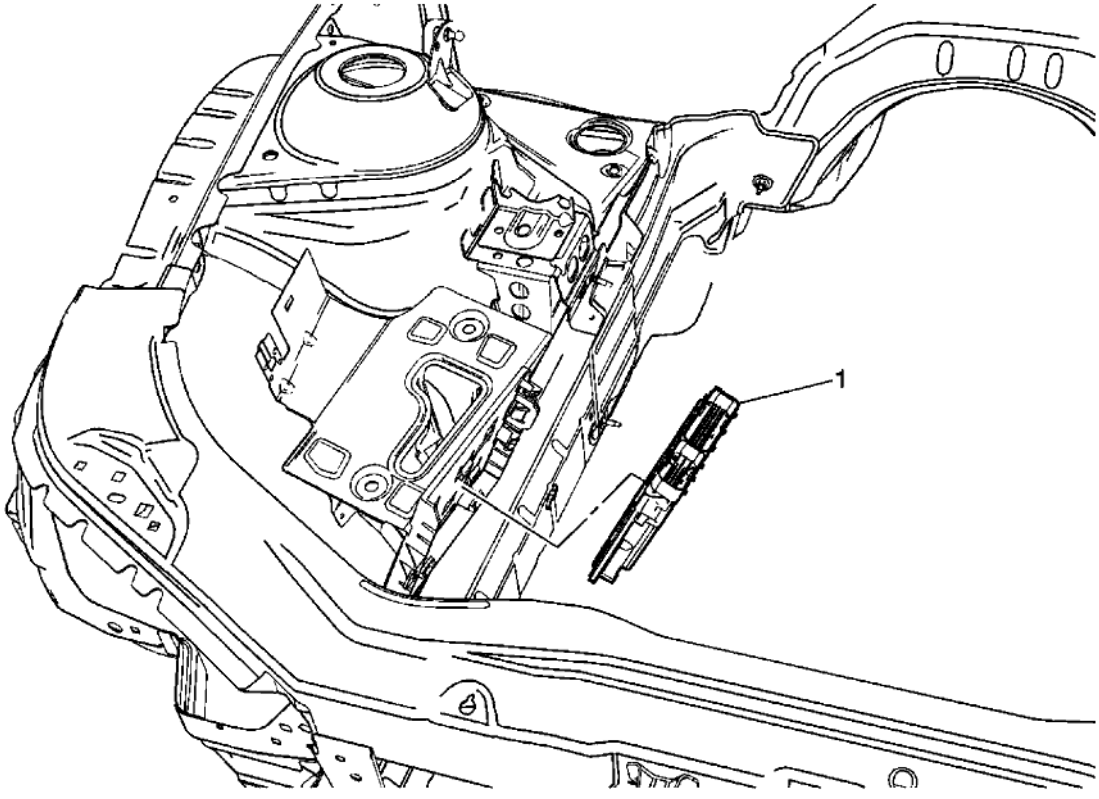


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .**	
	Electronic Control Module **WARNING:** **Refer to Safety Glasses Warning .** **CAUTION:** **Always turn the ignition off when installing or removing the ECM connectors in order to**

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	prevent damage to the components. **Procedure**
1	1. Record the current Engine Oil Life percentage, Transmission Oil Life, and use a scan tool to update the NEW ECM, if replacing. 2. Disconnect the electrical connectors. 3. Release the retaining tabs. 4. If replacing, program the ECM. Refer to **Control Module References** .

THROTTLE/IDLE LEARN (WITHOUT LF1)

Description

The engine control module (ECM) learns the idle position of the throttle body to ensure the correct idle operation. Anytime the ECM or the throttle body is replaced, the ECM must learn the idle position. The engine idle may be unstable or a DTC may set if the idle position is not learned.

Conditions for Running the Idle Learn Procedure

- DTCs P0121, P0122, P0123, P0221, P0222, P0223, P0638, P2100, P2101, P2105, and P2119 are not set.
- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The accelerator pedal position is less than 14.9 percent.
- The ignition 1 voltage is more than 10 volts.
- The engine coolant temperature is between 5-85°C (41-185°F).
- The intake air temperature is between 5-60°C (41-140°F).

Idle Learn Procedure

NOTE:

- **Ensure the above conditions are met before performing with this procedure.**
- **Do not perform this procedure if a throttle position sensor or other throttle actuator control (TAC) system DTCs are set other than P2176. The ECM will not perform the idle learn procedure with a DTC set.**

1. Turn OFF the ignition for 30 seconds.
2. Turn ON the ignition, with the engine OFF for 60 seconds.
3. Turn OFF the ignition.
4. Turn ON the ignition, with the engine OFF.
5. Clear the DTCs with a scan tool.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

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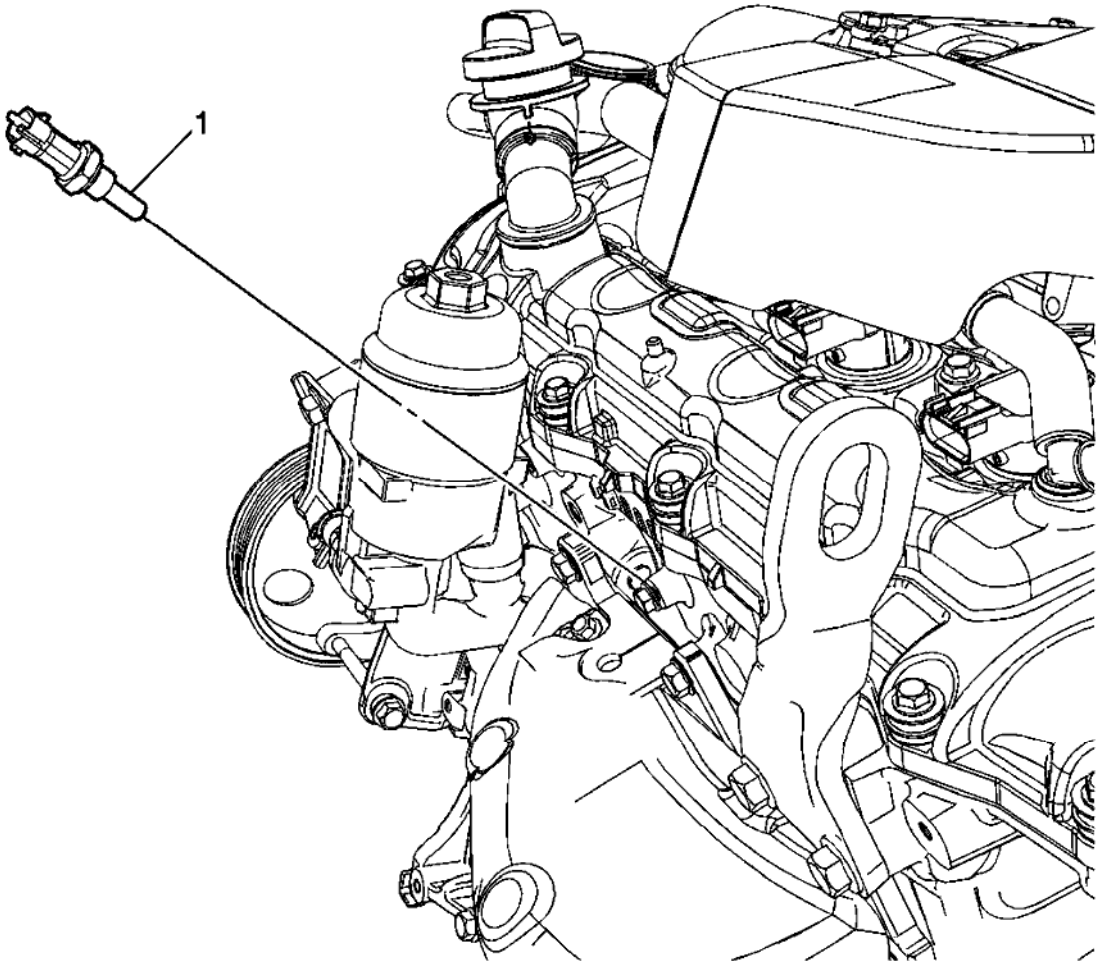


Fig. 2: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .	
1	Engine Coolant Temperature Sensor **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 22 N.m(16 lb ft) **Procedure:** Disconnect the electrical connector.

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MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

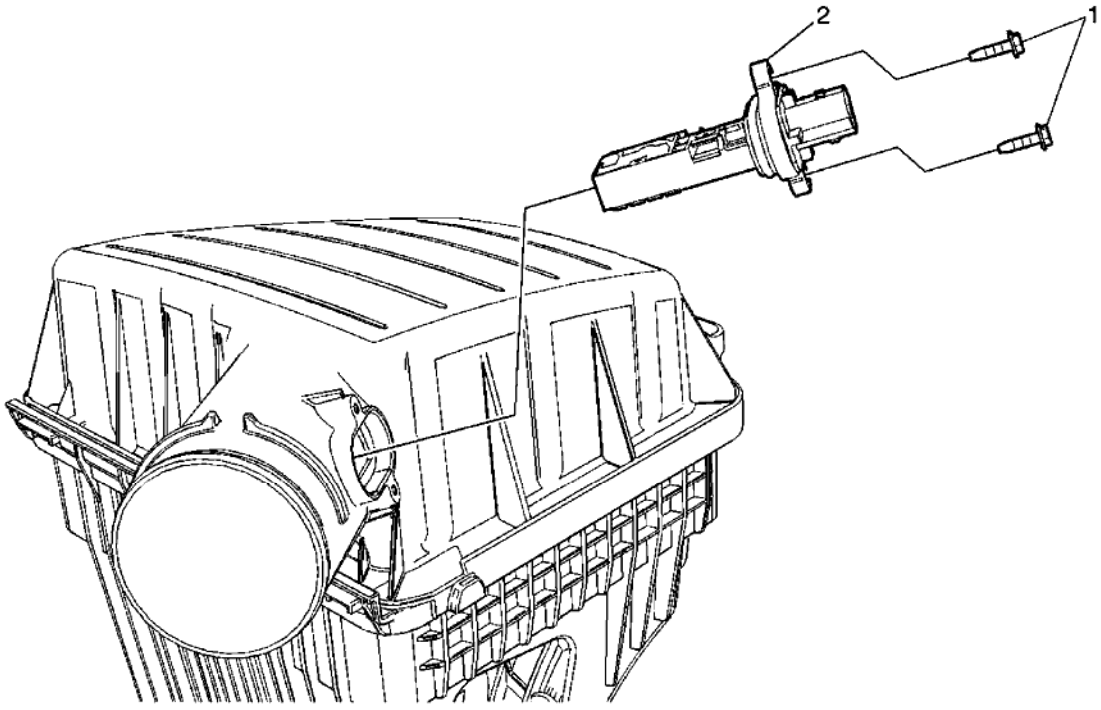


Fig. 3: Mass Airflow Sensor With Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Mass Airflow with Intake Air Temperature Sensor Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Mass Airflow with Intake Air Temperature Sensor **Procedure:** Disconnect the electrical connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the

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sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 1 is the right bank.

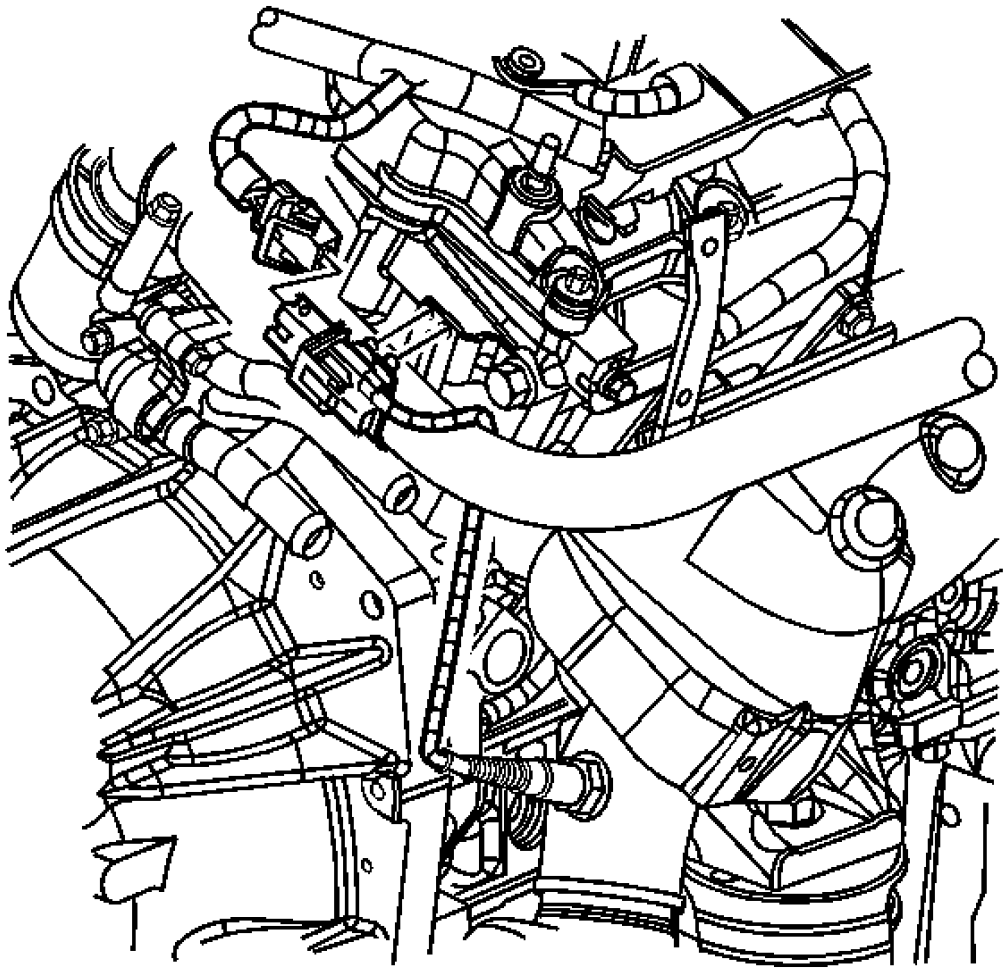


Fig. 4: View Of HO2S Electrical Connector -- Bank 1, Sensor 1
Courtesy of GENERAL MOTORS CORP.

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1. Turn the ignition OFF.
2. Remove the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .
3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S electrical connector from the wiring harness bracket.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

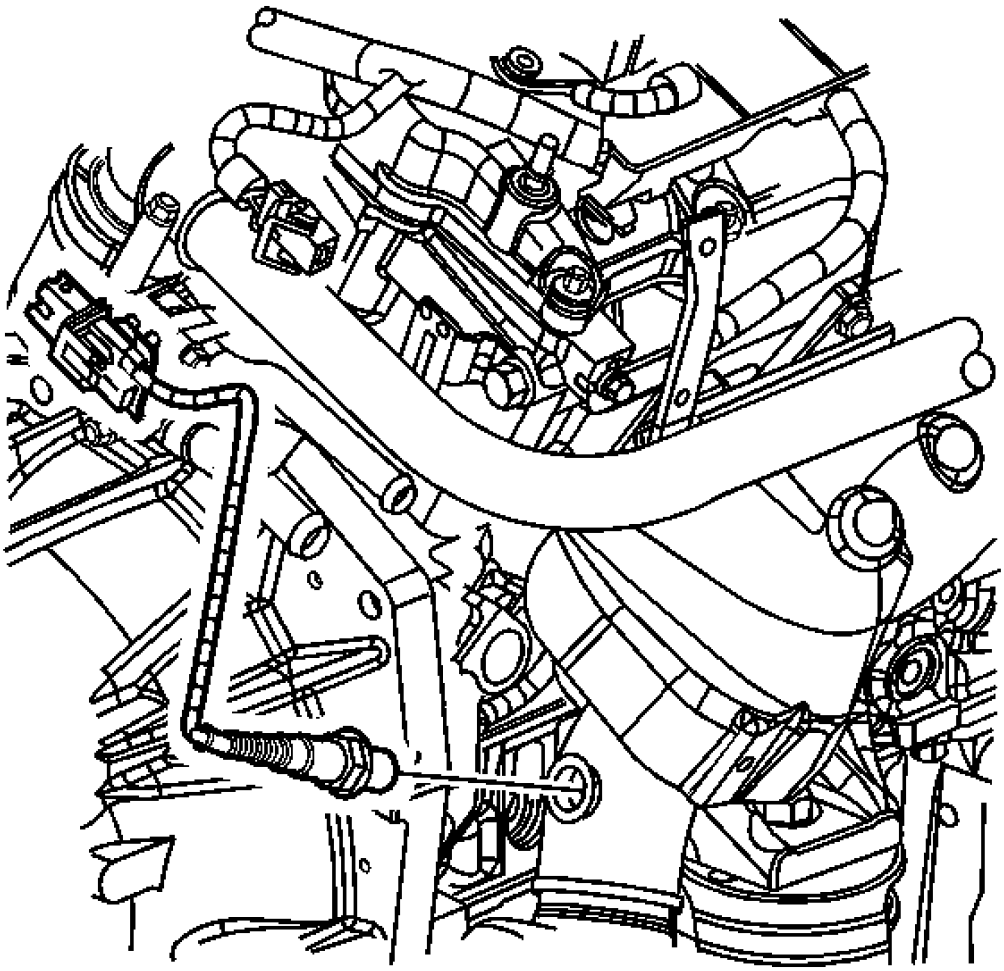


Fig. 5: View Of HO2S - Bank 1, Sensor 1
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

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NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

6. Remove the HO2S from the catalytic converter.

Installation Procedure

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

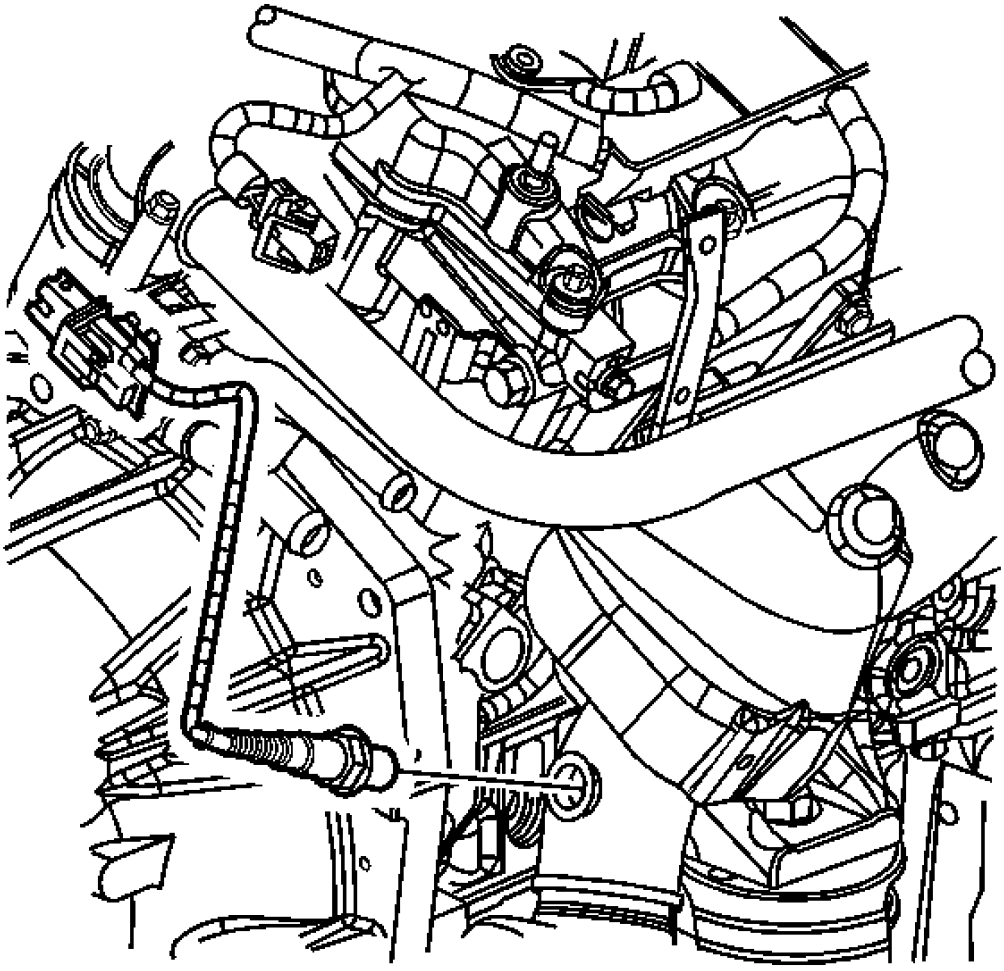


Fig. 6: View Of HO2S - Bank 1, Sensor 1

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Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install the HO2S to the catalytic converter and tighten to 40 N.m (30 lb ft).
2. Lower the vehicle.

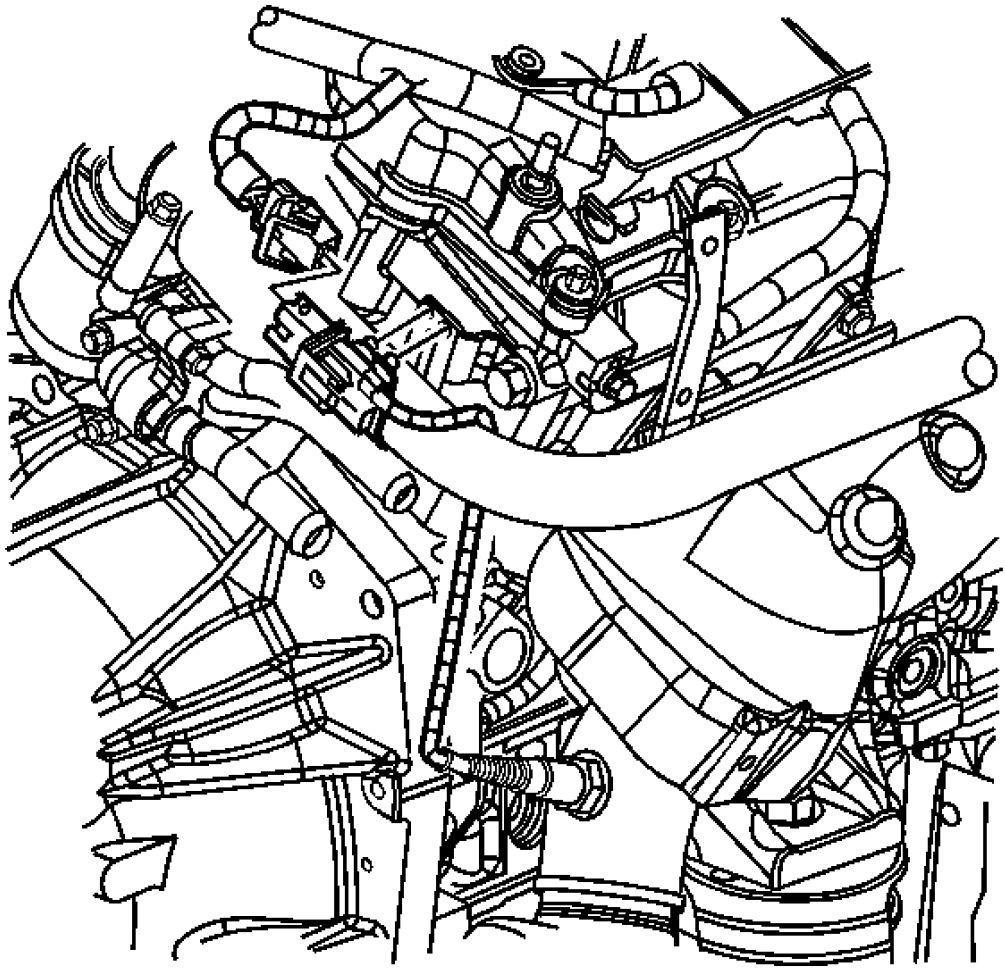


Fig. 7: View Of HO2S Electrical Connector -- Bank 1, Sensor 1
Courtesy of GENERAL MOTORS CORP.

3. Install the HO2S electrical connector to the wiring harness bracket.

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4. Connect the HO2S electrical connector.
5. Install the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 1 is the right side.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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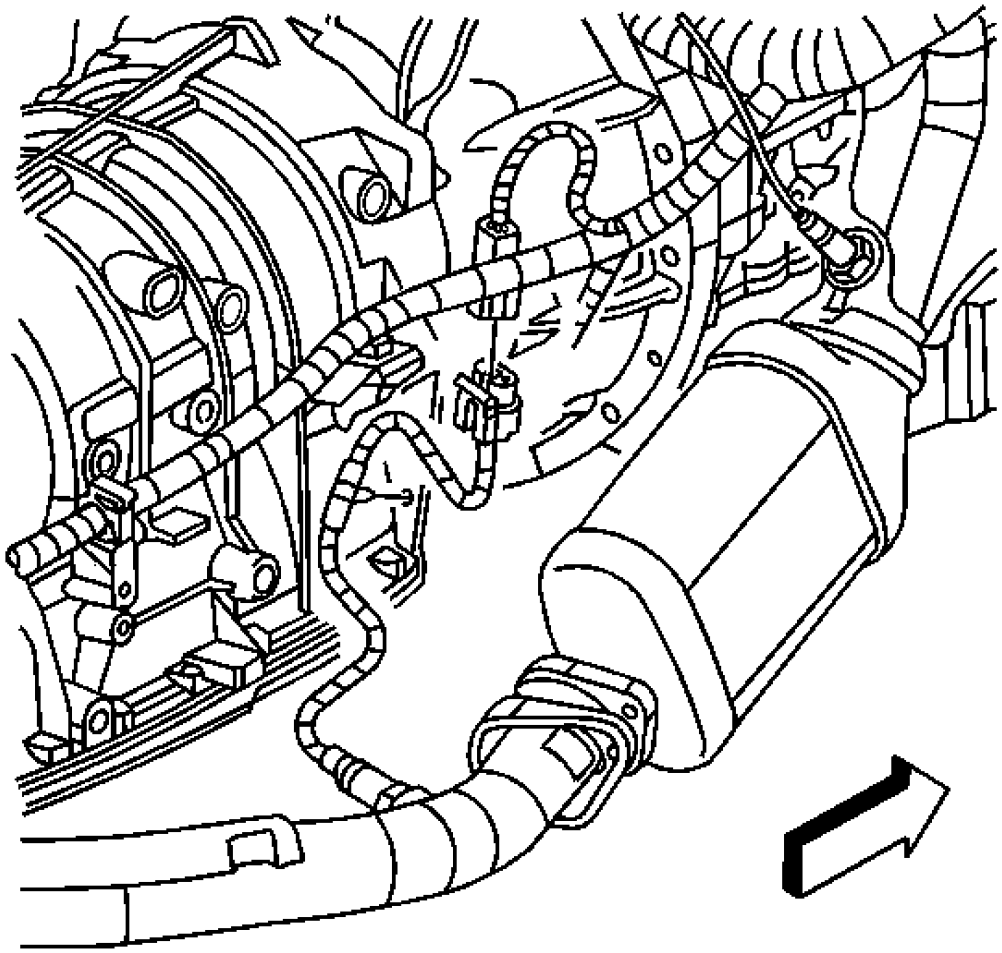


Fig. 8: View Of HO2S Electrical Connector, Sensor 2 (Bank 1 Shown, Bank 2 Similar)
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S wiring harness from the transmission case.

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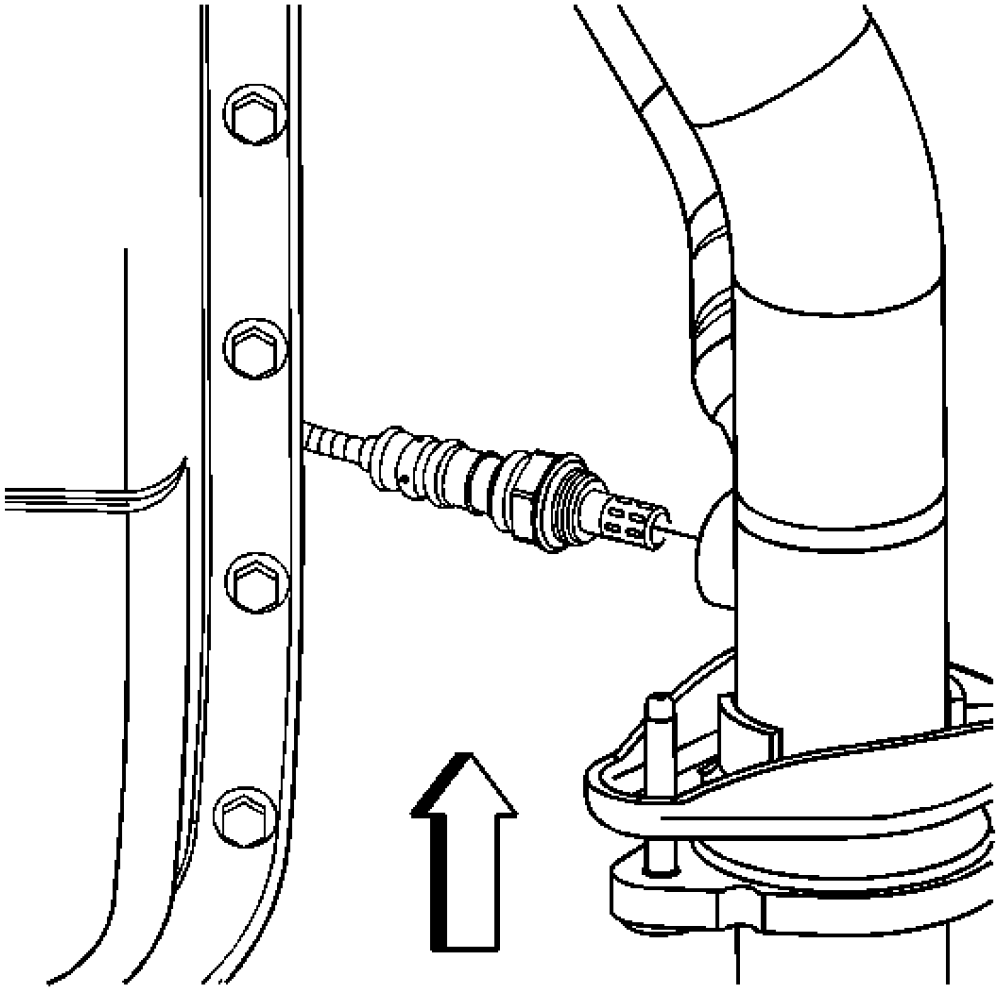


Fig. 9: View Of HO2S - Bank 1, Sensor 2
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

5. Remove the HO2S.

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Installation Procedure

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

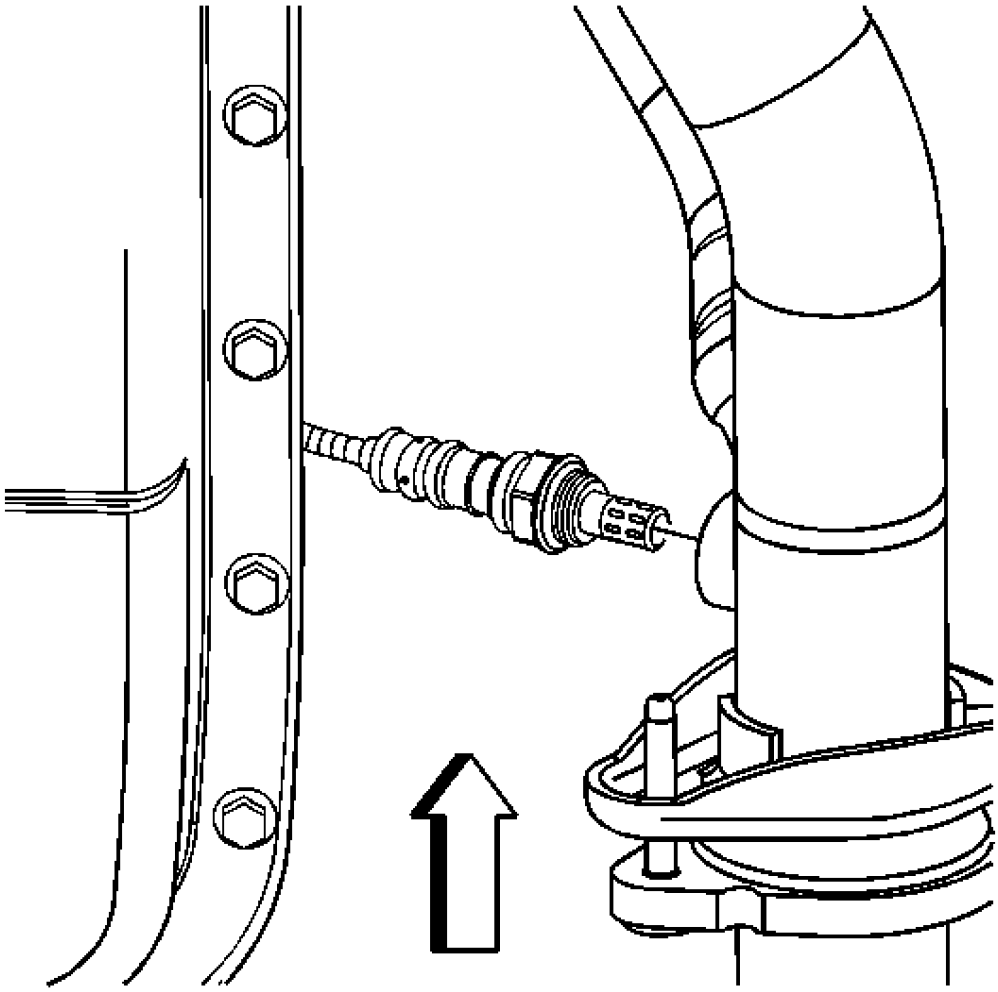


Fig. 10: View Of HO2S - Bank 1, Sensor 2
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Component Fastener Tightening Caution .

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1. Install the HO2S and tighten to 40 N.m (30 lb ft).

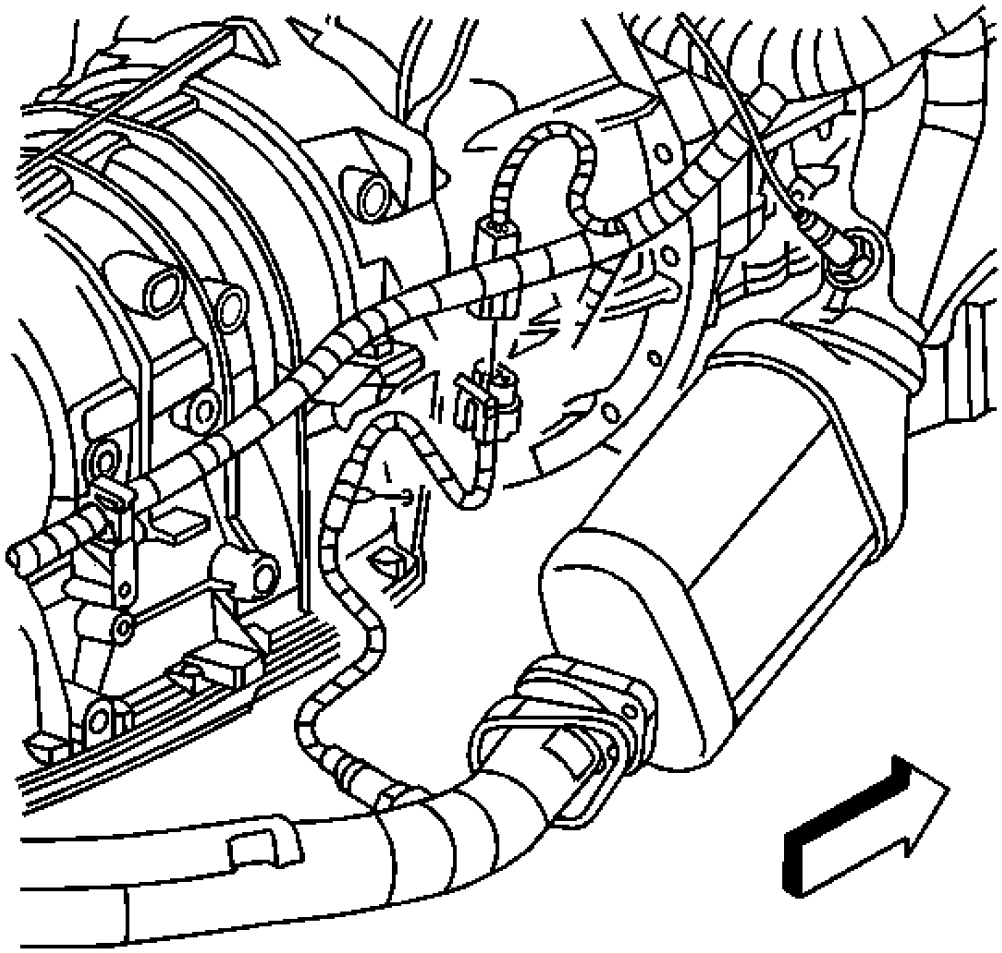


Fig. 11: View Of HO2S Electrical Connector, Sensor 2 (Bank 1 Shown, Bank 2 Similar)
Courtesy of GENERAL MOTORS CORP.

2. Connect the HO2S electrical connector.
3. Install the HO2S wiring harness to the transmission case.
4. Lower the vehicle.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

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Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 2 is the left bank.

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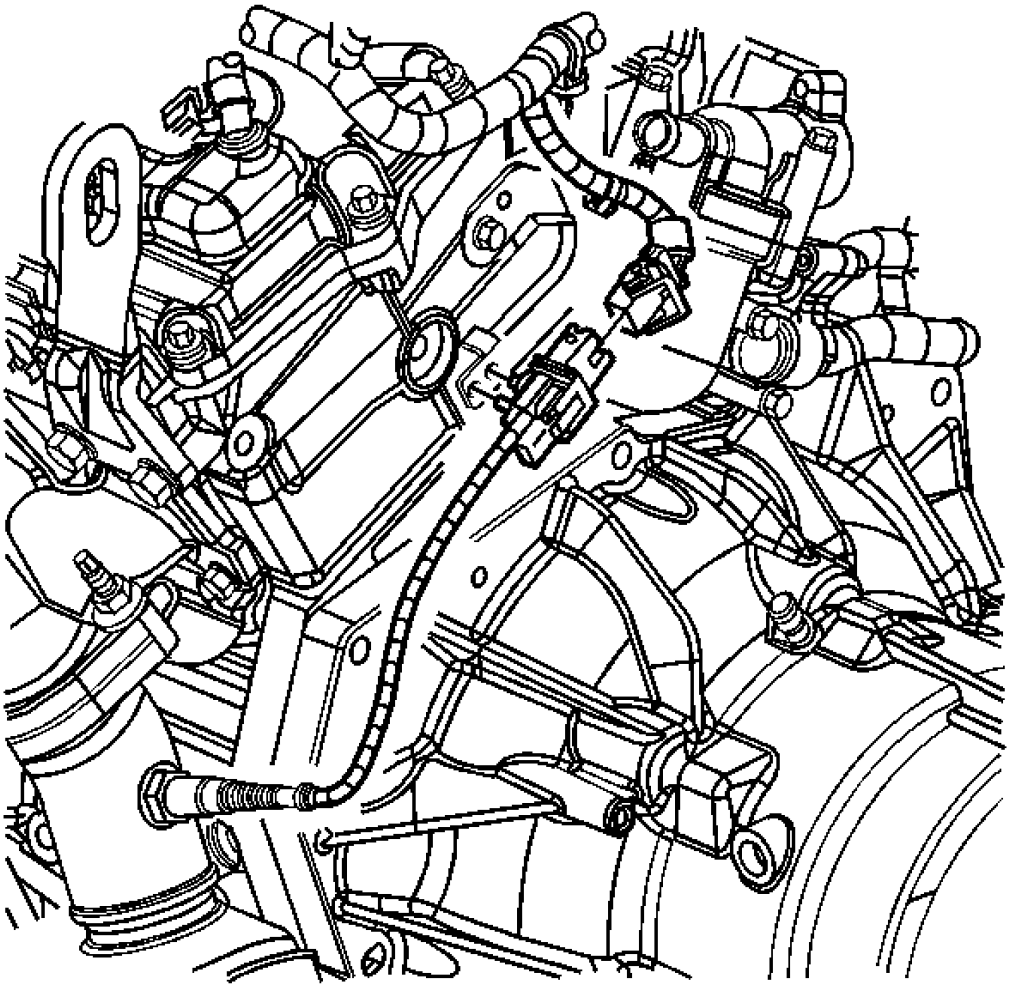


Fig. 12: View Of HO2S Electrical Connector - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .
3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S electrical connector from the wiring harness bracket.

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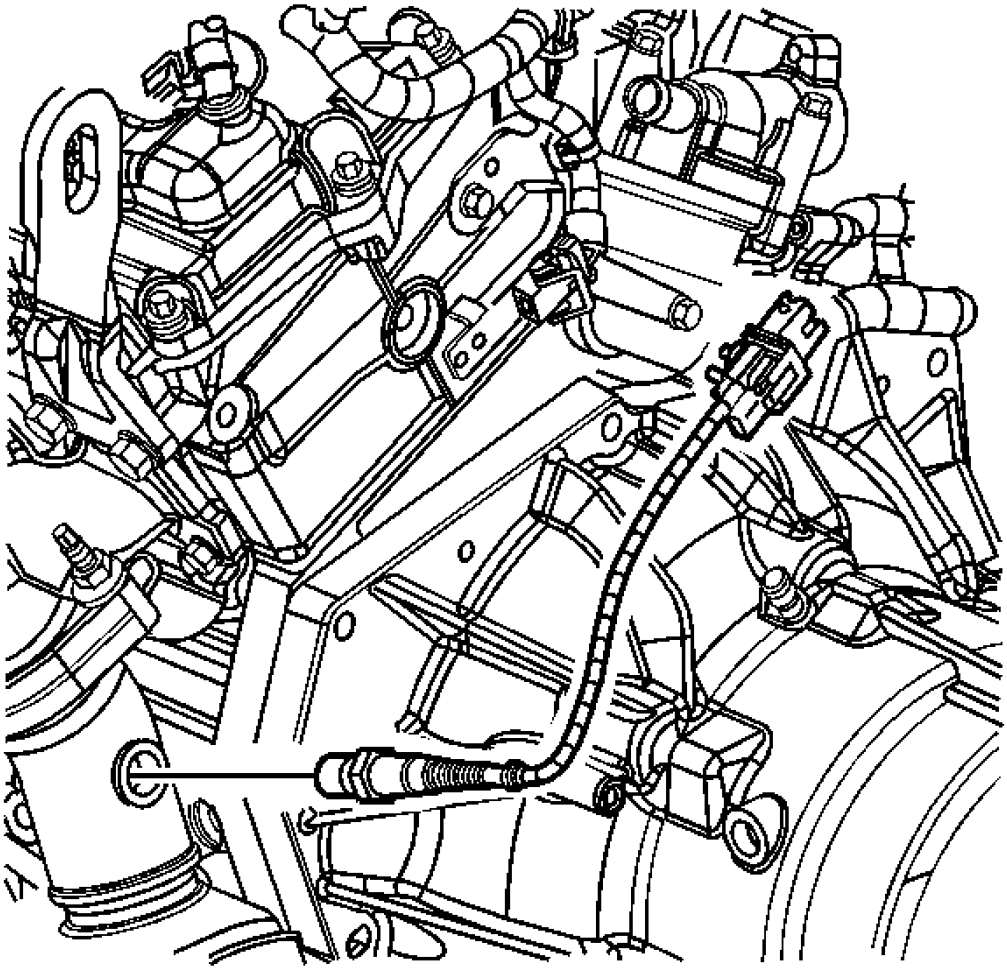


Fig. 13: View Of HO2S - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

5. Remove the HO2S.

Installation Procedure

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CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

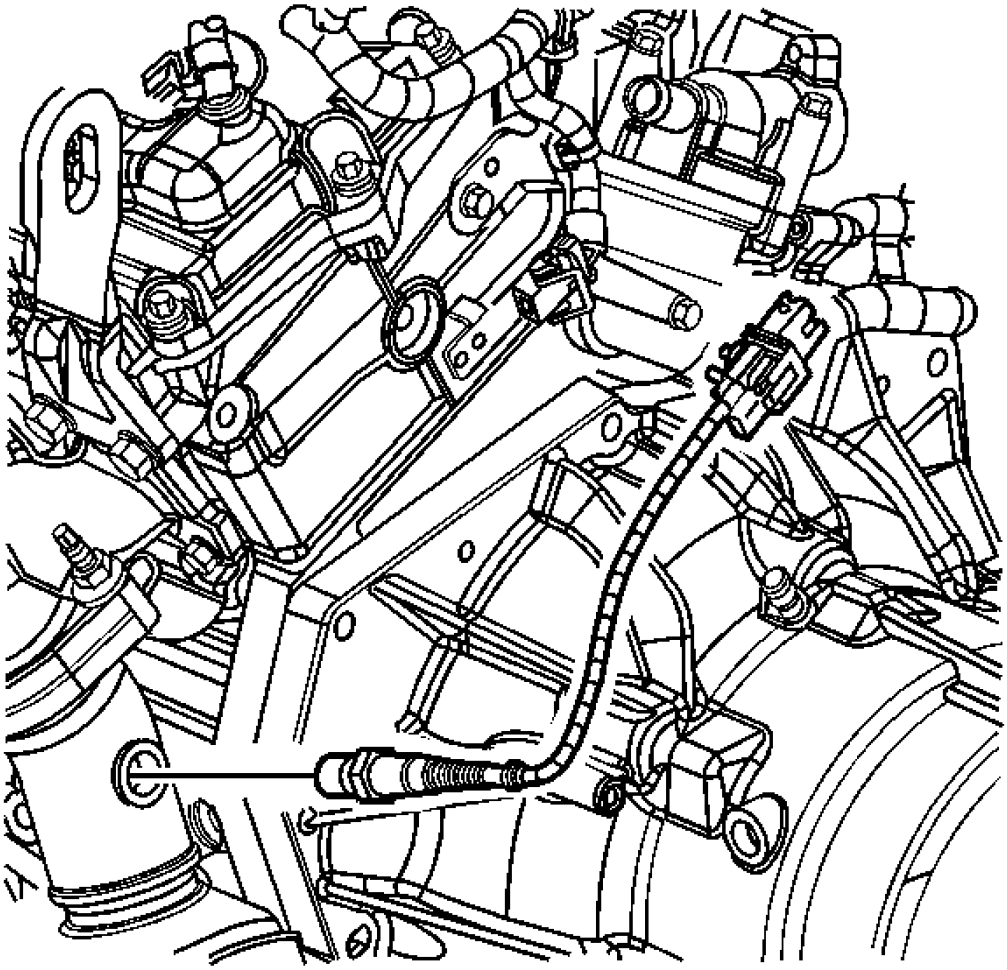


Fig. 14: View Of HO2S - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install the HO2S and tighten to 40 N.m (30 lb ft).

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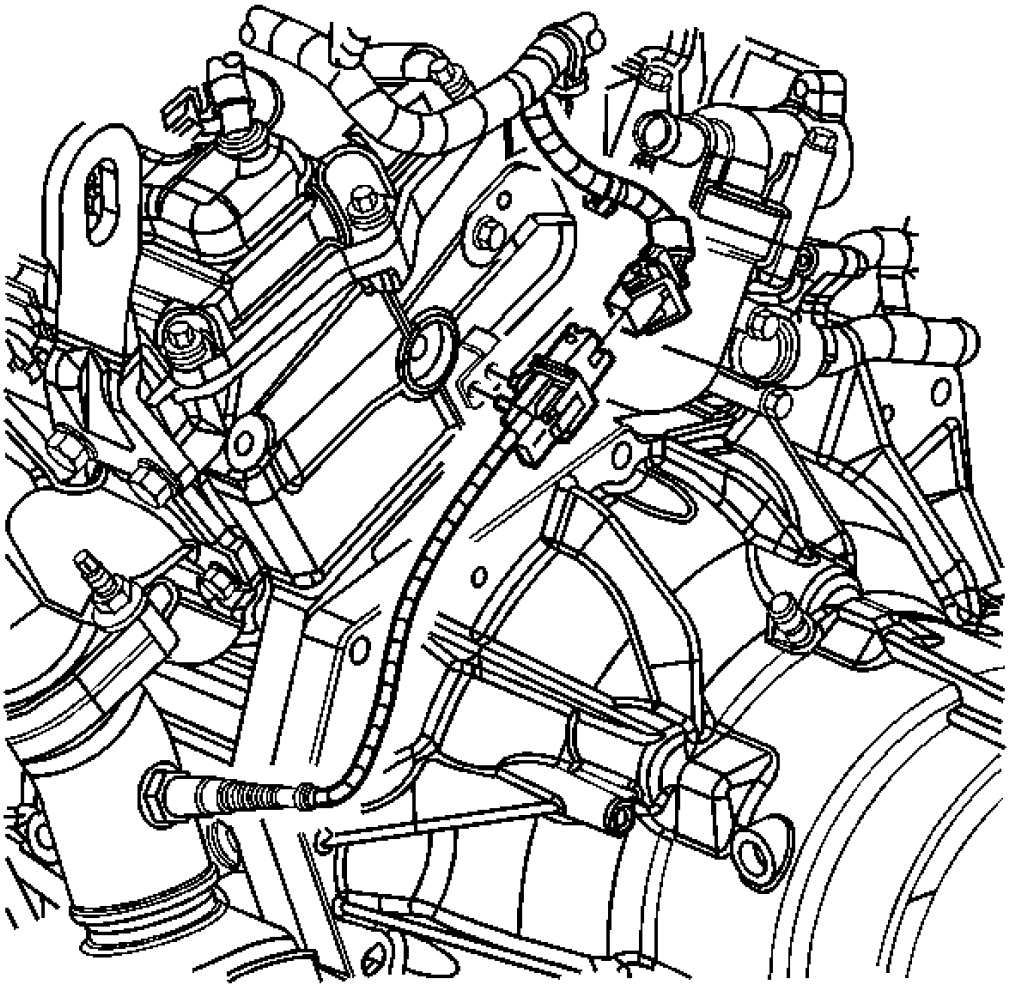


Fig. 15: View Of HO2S Electrical Connector - Bank 2, Sensor 1
Courtesy of GENERAL MOTORS CORP.

2. Install the HO2S electrical connector to the wiring harness bracket.
3. Connect the HO2S electrical connector.
4. Install the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement - Front** .

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

Removal Procedure

CAUTION: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a

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permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

NOTE: Bank 2 is the left bank.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

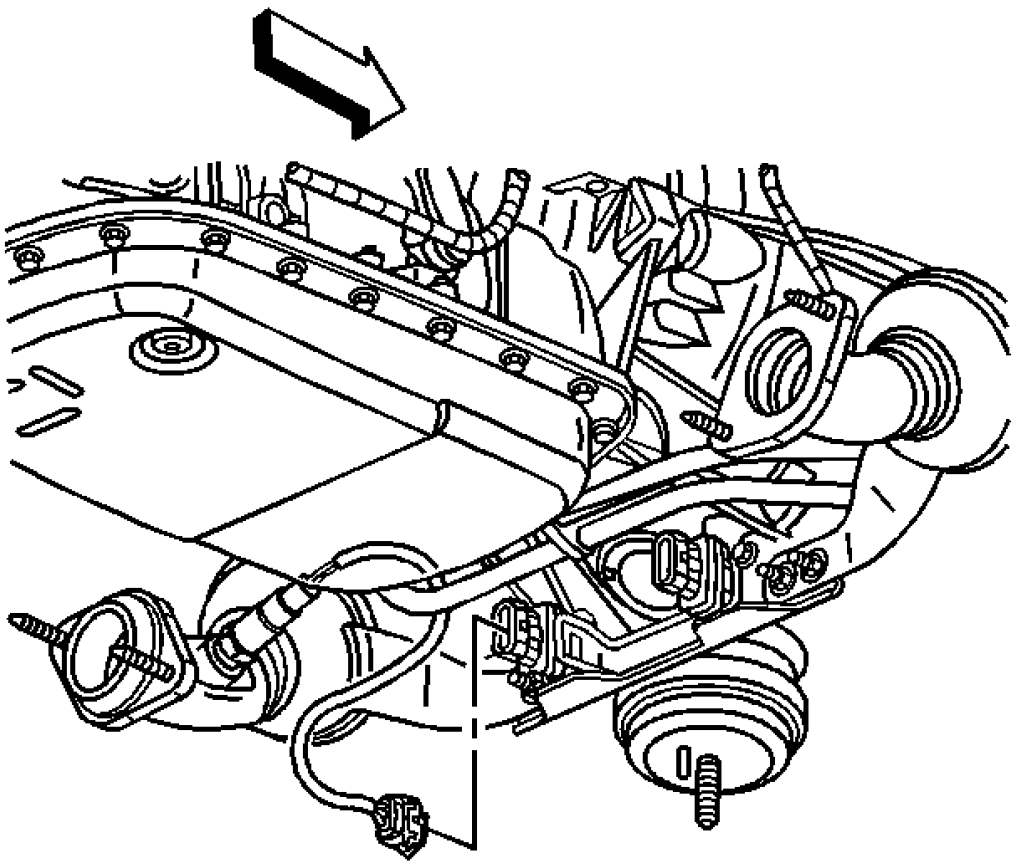


Fig. 16: View Of Heated Oxygen Sensor Electrical Connector - Bank 2 Sensor 2

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Courtesy of GENERAL MOTORS CORP.

3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S wiring harness from the transmission case.

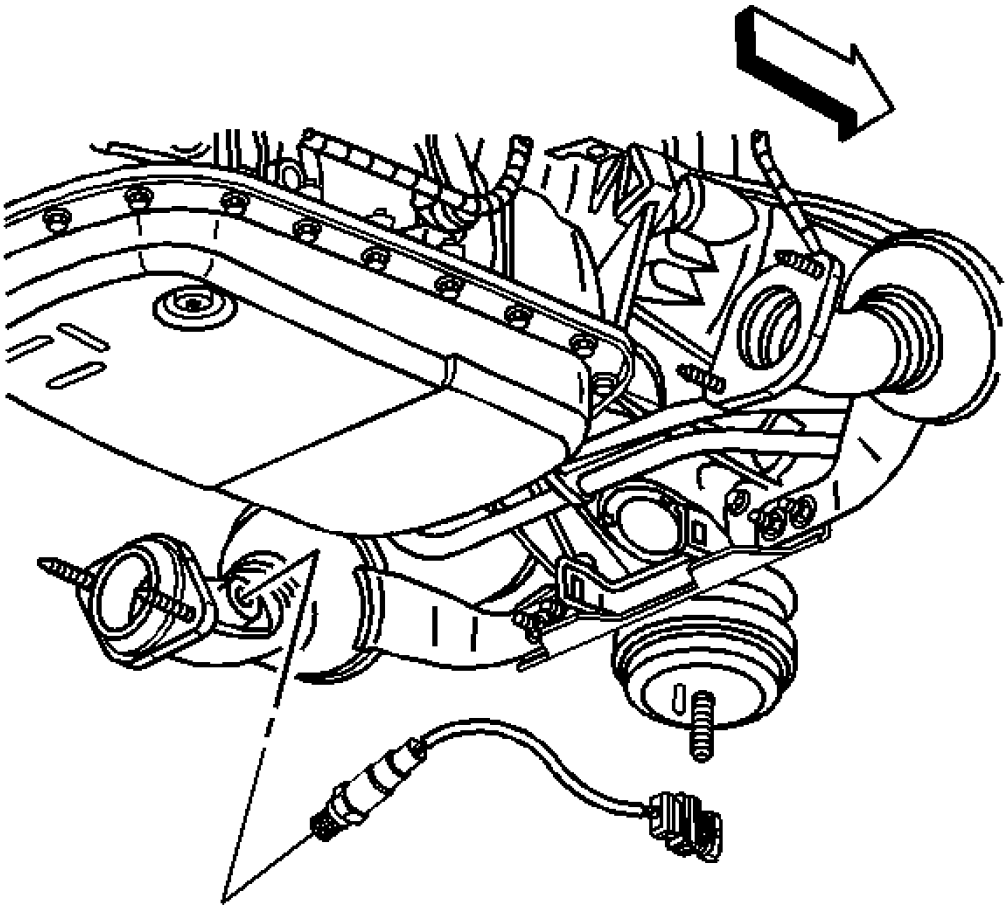


Fig. 17: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Oxygen Sensor Caution .

NOTE: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

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5. Remove the HO2S.

Installation Procedure

CAUTION: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

CAUTION: Refer to Component Fastener Tightening Caution .

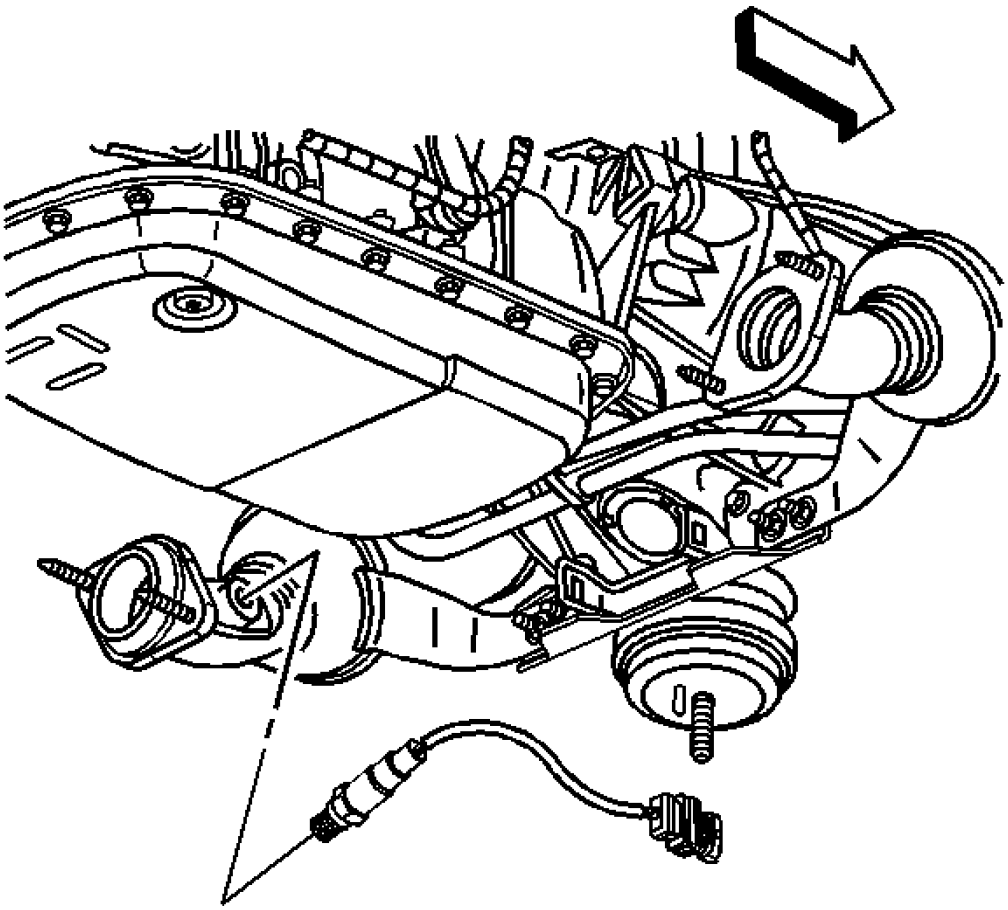


Fig. 18: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

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1. Install the HO2S and tighten to 40 N.m (30 lb ft).

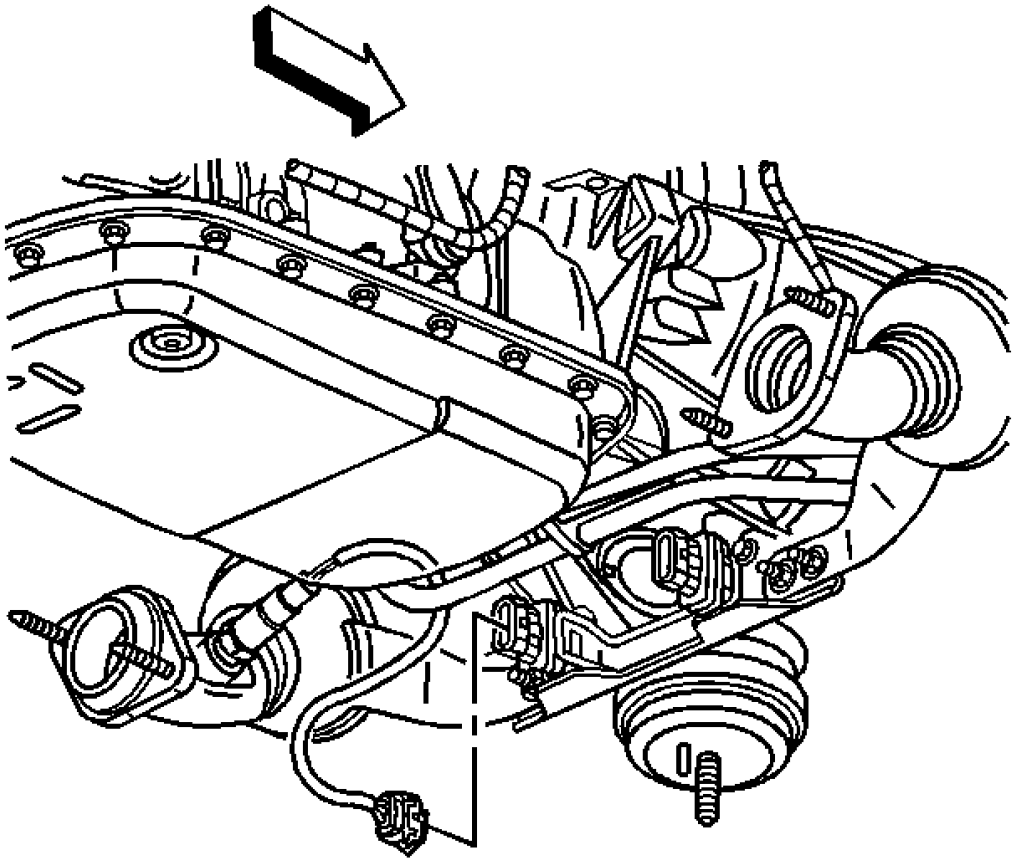


Fig. 19: View Of Heated Oxygen Sensor Electrical Connector - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

2. Connect the HO2S electrical connector.
3. Install the HO2S wiring harness to the transmission case.
4. Lower the vehicle.

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

Removal Procedure

1. Remove the closeout/insulator panel from under the dashboard on the drivers side.

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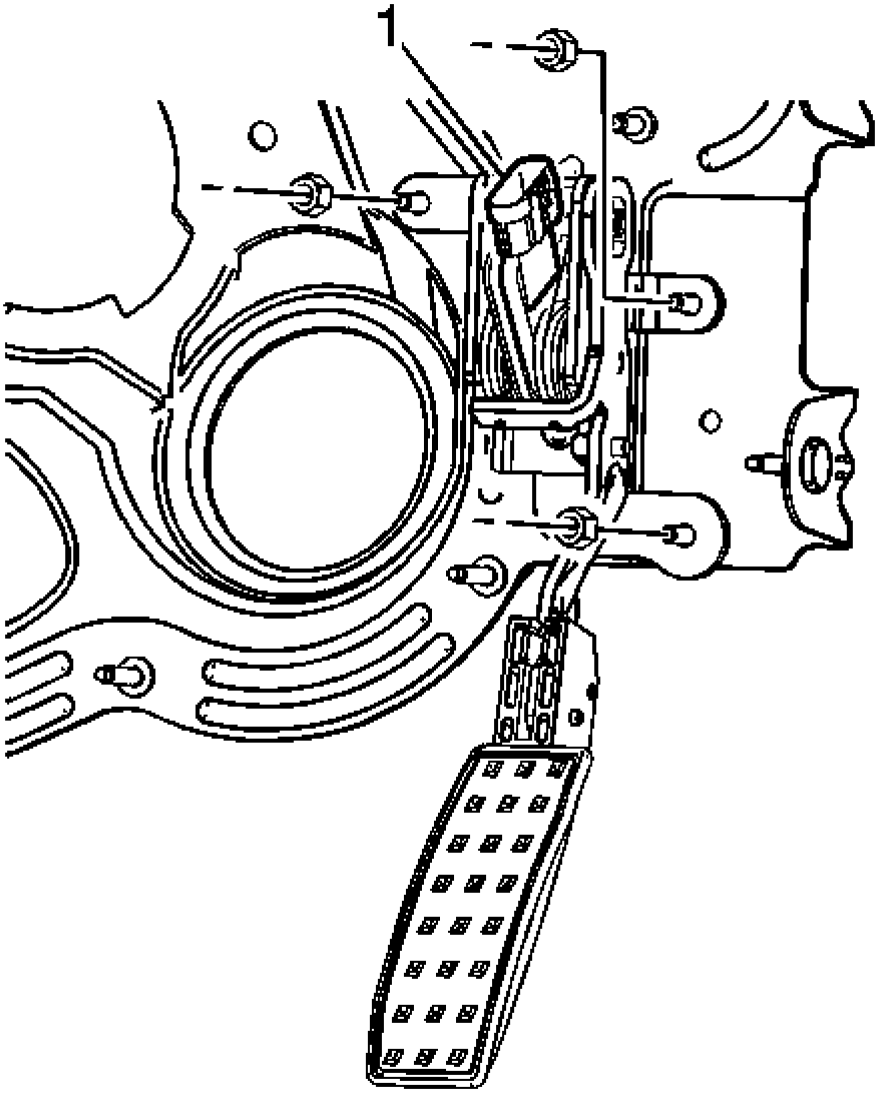


Fig. 20: Locating APP Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

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2. Disconnect the accelerator pedal position (APP) sensor electrical connector from the accelerator pedal module.
3. Remove the nuts from the APP sensor and remove the APP sensor from the front of dash.

Installation Procedure

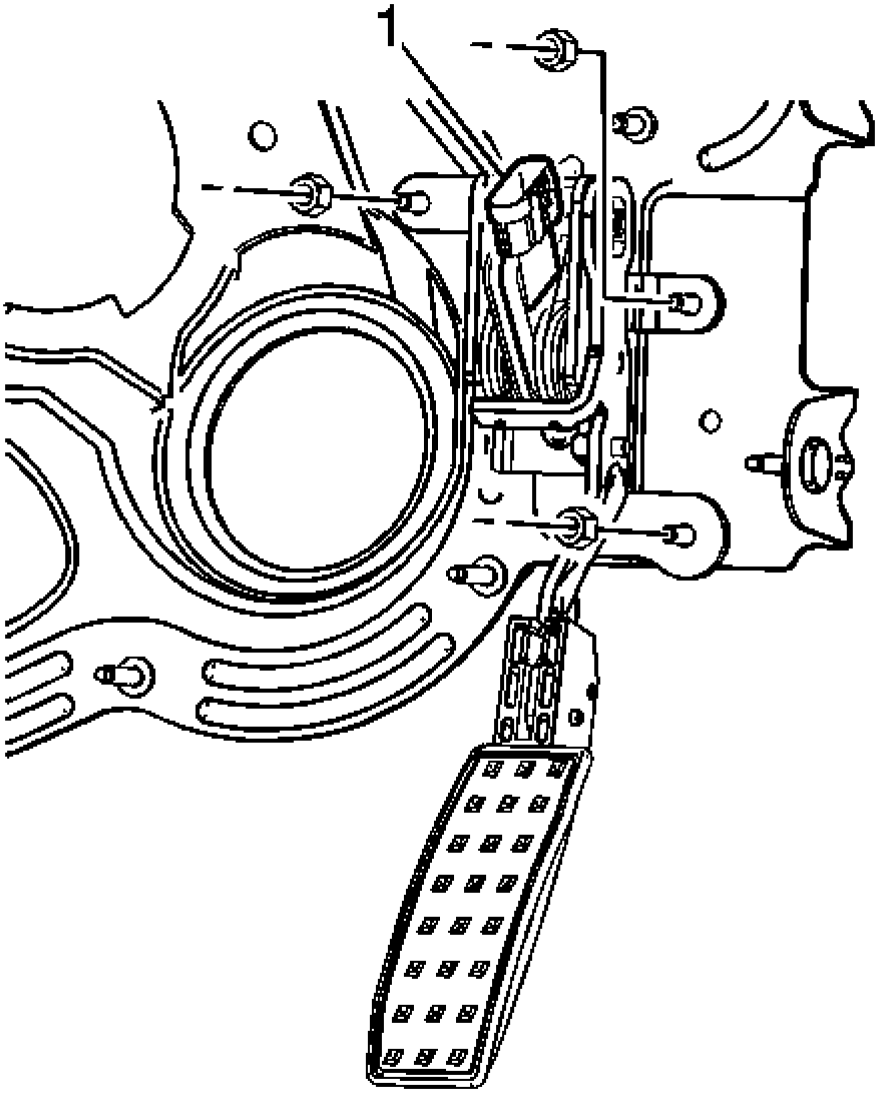


Fig. 21: Locating APP Sensor
Courtesy of GENERAL MOTORS CORP.

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1. Install the APP sensor to the front of dash.

CAUTION: Refer to Fastener Caution .

2. Install the APP sensor mounting nuts and tighten to 9 N.m (80 lb in).
3. Connect the APP sensor electrical connector.
4. Operate the accelerator pedal and observe the APP angles using a scan tool. The accelerator pedal should operate freely, without binding between closed throttle and wide open throttle.
5. Install the closeout/insulator panel.

THROTTLE BODY ASSEMBLY REPLACEMENT

Removal Procedure

1. Turn the ignition OFF.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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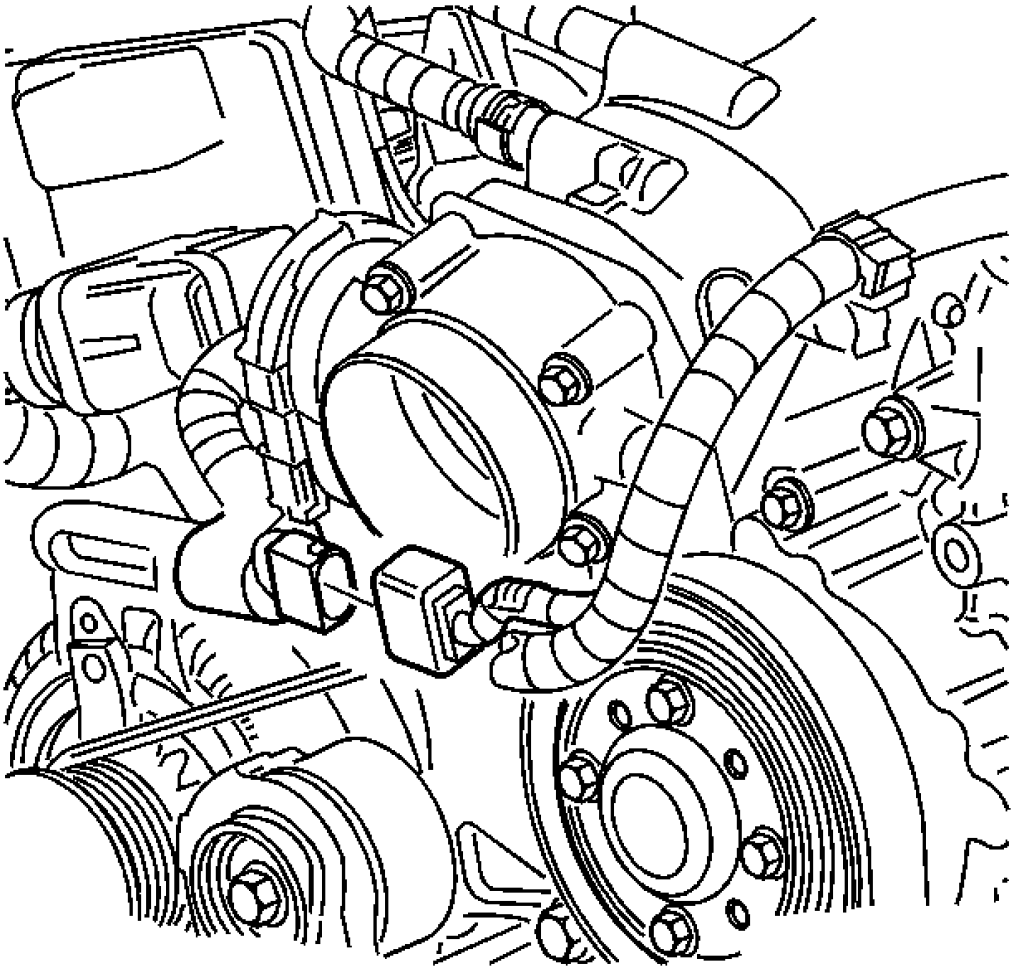


Fig. 22: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Disengaging Connectors Caution .

3. Remove the throttle body electrical connector.

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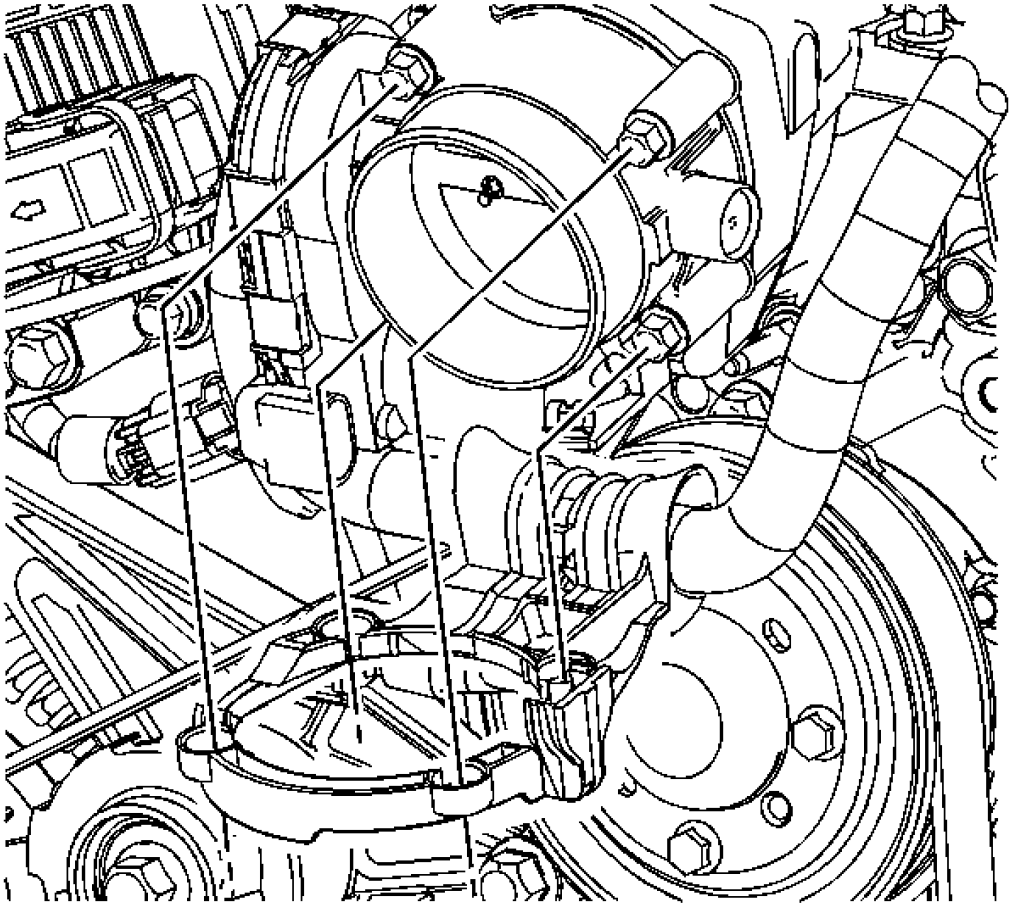


Fig. 23: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

4. Unlock and reposition the wiring harness conduit.

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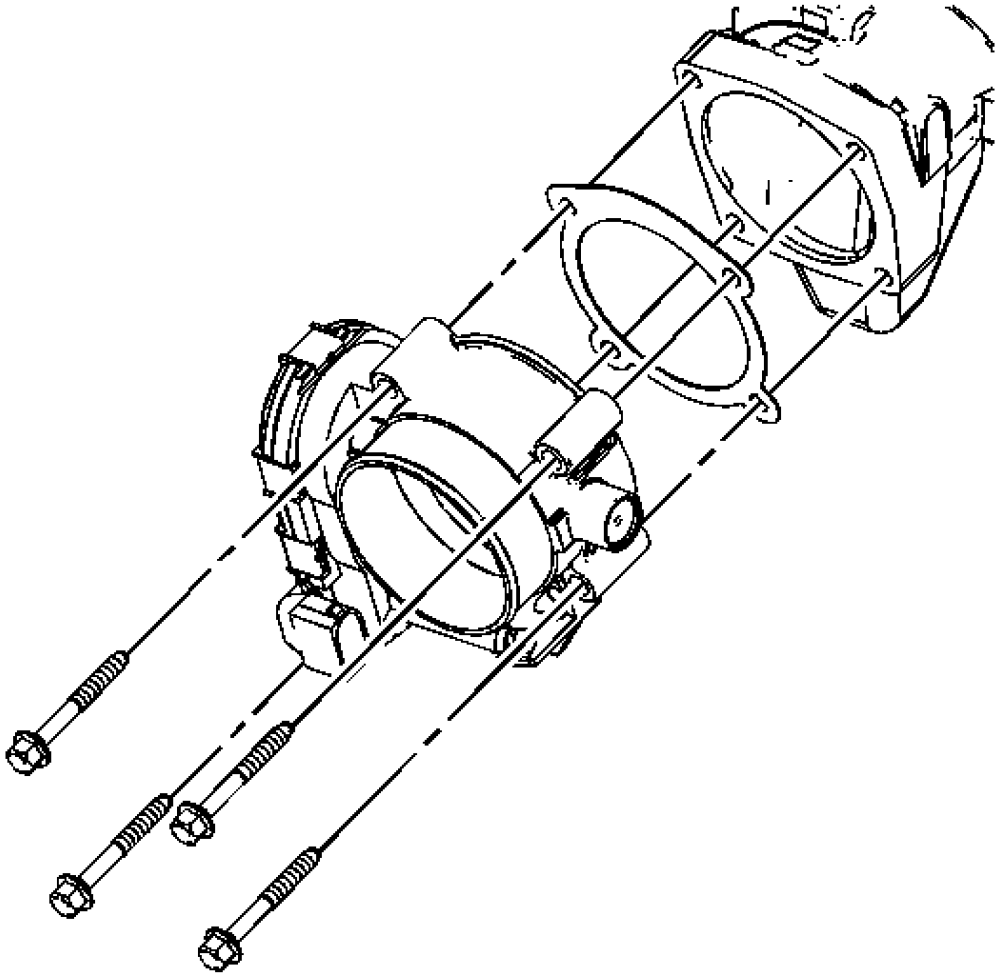


Fig. 24: View Of Throttle Body
Courtesy of GENERAL MOTORS CORP.

5. Remove the throttle body bolts.
6. Remove the throttle body and gasket.

Installation Procedure

1. Carefully clean the throttle body mounting surfaces of any gasket and/or seal material.

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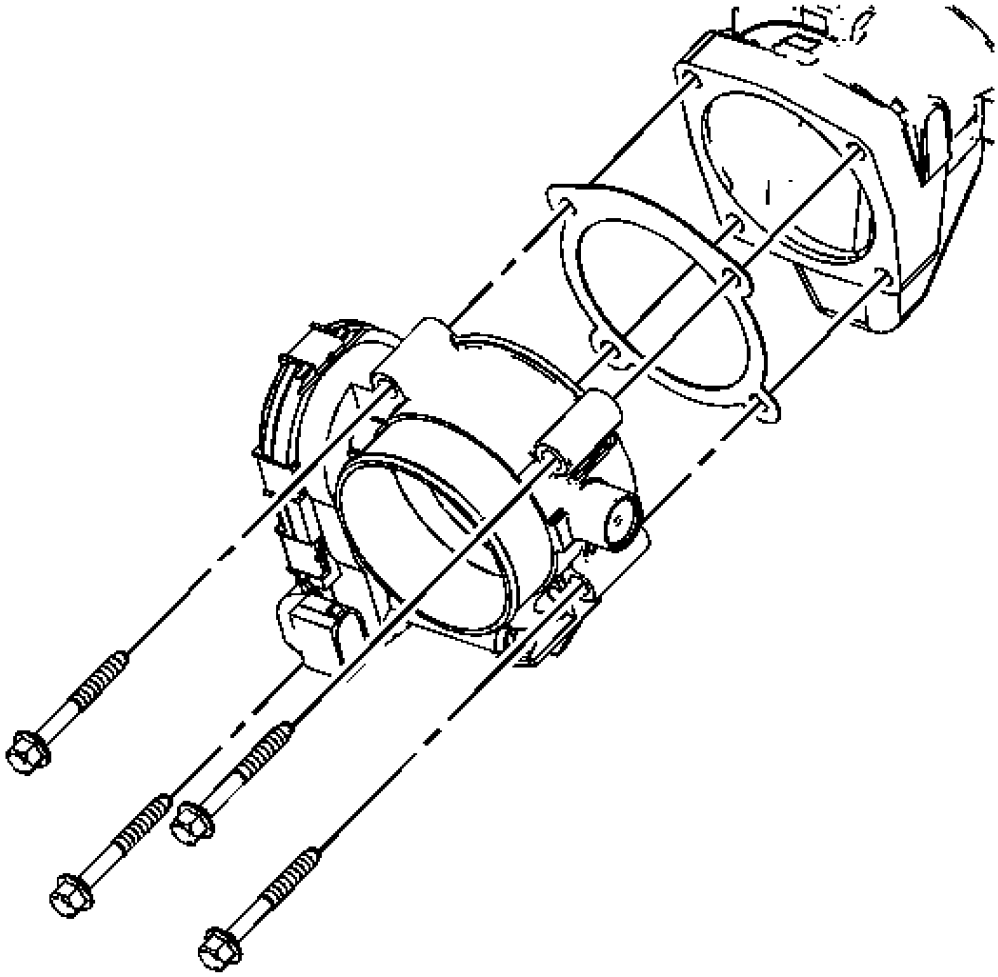


Fig. 25: View Of Throttle Body
Courtesy of GENERAL MOTORS CORP.

2. Install the throttle body and NEW gasket.

CAUTION: Refer to Fastener Caution .

3. Install the throttle body bolts and tighten to 10 N.m (89 lb in).

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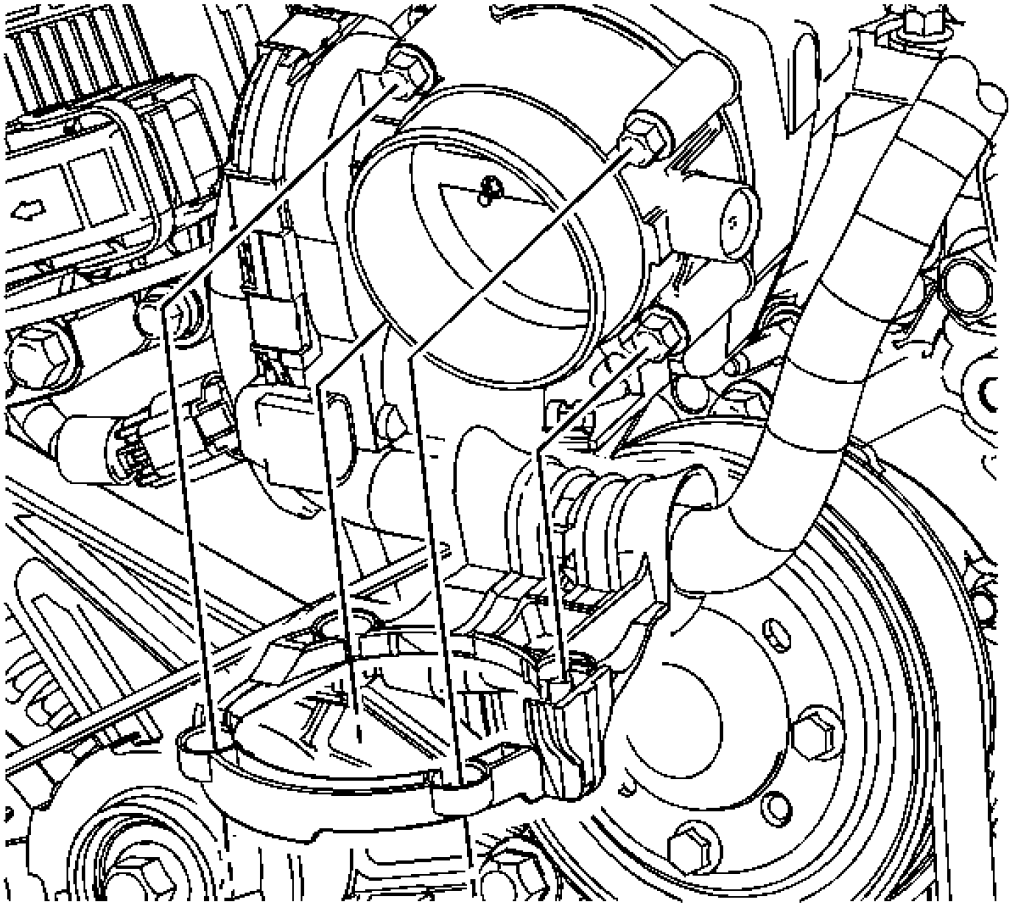


Fig. 26: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

4. Install the wiring harness conduit.

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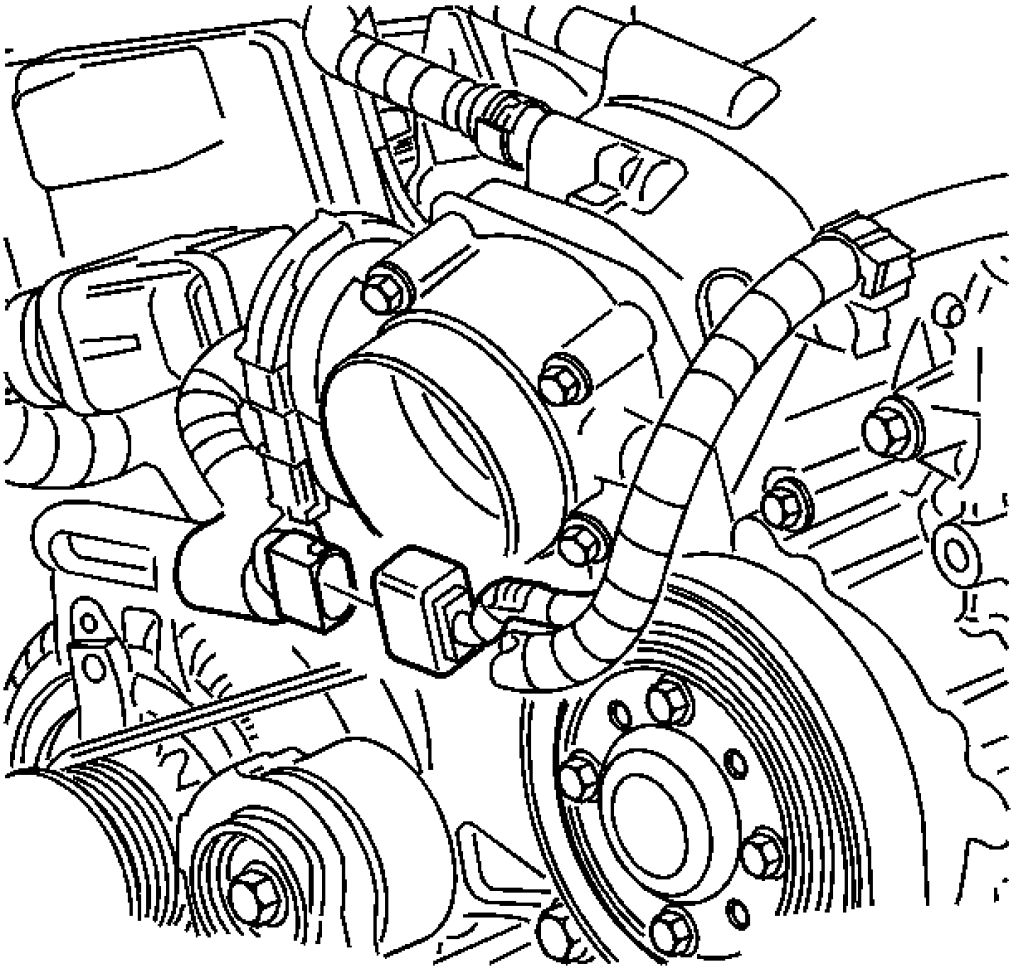


Fig. 27: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Install the throttle body electrical connector.
6. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
7. Perform the throttle learn procedure. Refer to **Throttle/Idle Learn (Without LF1)**.
8. Use the scan tool to clear all DTCs.

THROTTLE BODY INSPECTION AND CLEANING

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
2. Fully open the throttle valve in order to Inspect the throttle body bore and the throttle valve plate for any deposits.

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CAUTION: Do not subject a throttle body assembly which contains the following components to an immersion cleaner or a strong solvent:

- **Throttle position (TP) sensor**
- **Idle air control (IAC) valve**
- **Sealed throttle shaft bearings**

The cleaners will damage the electric components or sensors.
The cleaners will damage some of these components that contain seals or O-rings.
Solvents can wash away or break down the grease used on non-serviceable throttle shaft bearings.
Never use a wire brush or scraper to clean the throttle body. A wire brush or sharp tools may damage the throttle body components.
Do not use a cleaner that contains methyl ethyl ketone. This extremely strong solvent may damage components and is not necessary for this type of cleaning.

3. Use a clean shop towel and Top Engine Cleaner GM P/N 1052626 or equivalent product in order to clean the throttle body bore and the throttle valve plate.

   If necessary, use a parts cleaning brush in order to remove heavy deposits.

4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the throttle learn procedure. Refer to **Throttle/Idle Learn (Without LF1)**.

FUEL PRESSURE RELIEF

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

NOTE: If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

1. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel pump to shut off.
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

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Special Tools

CH-48027 Digital Pressure Gauge. See **Special Tools** .

Installation Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

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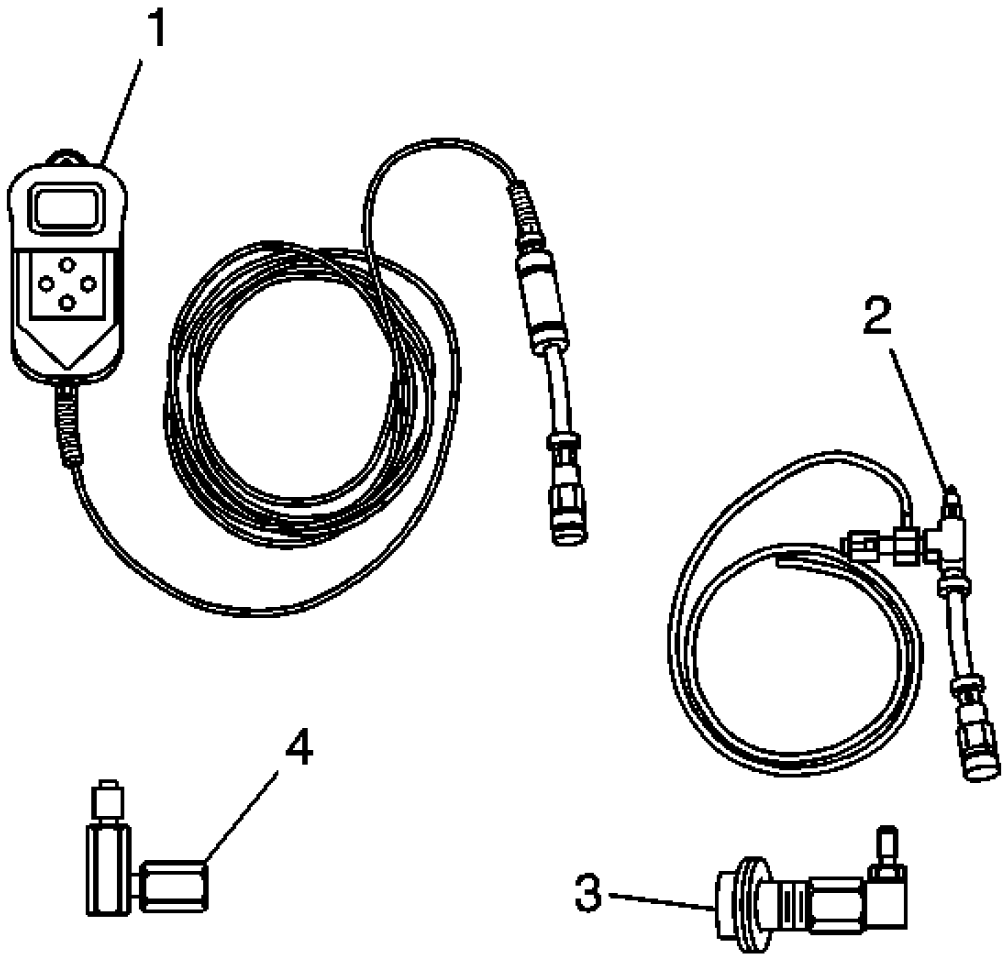


Fig. 28: Identifying Digital Pressure Gauge & Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH-48027** , refer to the manufacture's directions. See **Special Tools** .

Removal Procedure

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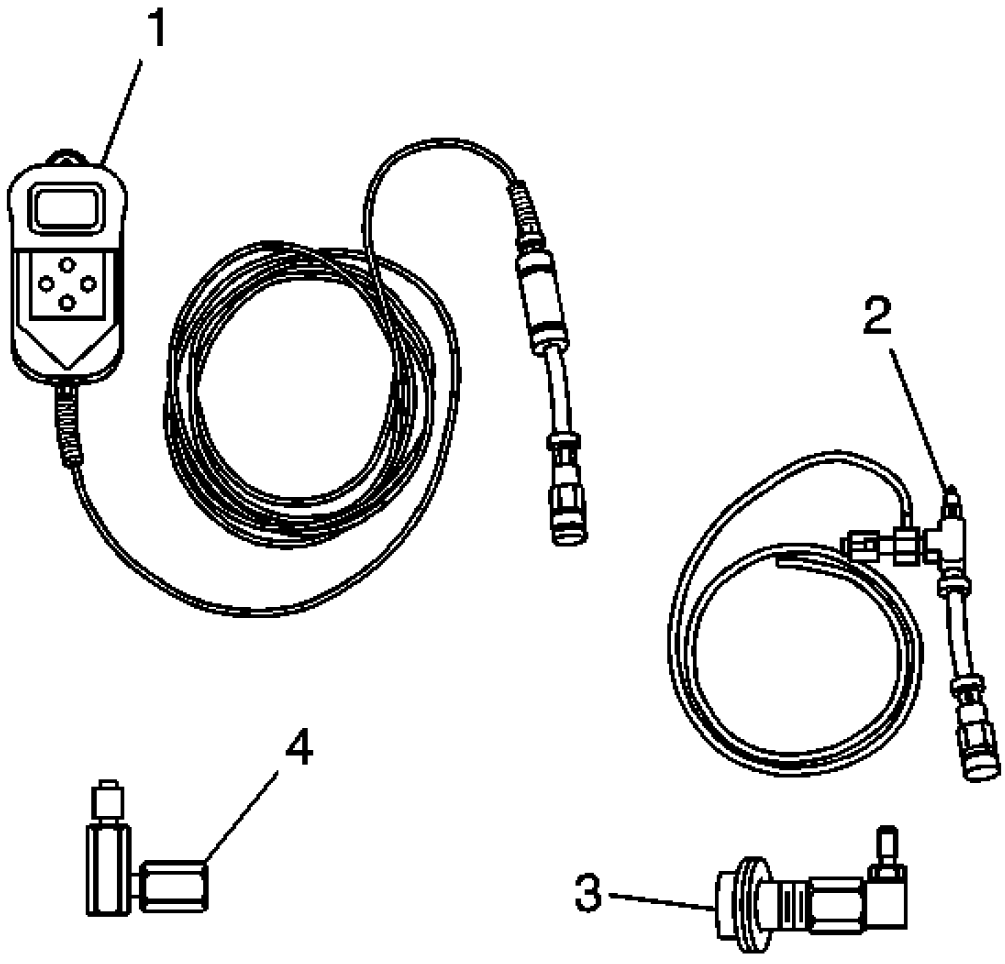


Fig. 29: Identifying Digital Pressure Gauge & Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure, if required. Perform the following steps:

   WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

   1. Wrap a shop towel around the fuel rail service port.

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2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the CH-48027-2 (2).
5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

2. Disconnect the CH-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
4. Disconnect the CH-48027-3 (4) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **J 37088-A** Fuel Line Disconnect Tool Set
- **J 44581** Fuel Line Disconnect Tool. See **Special Tools** .

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

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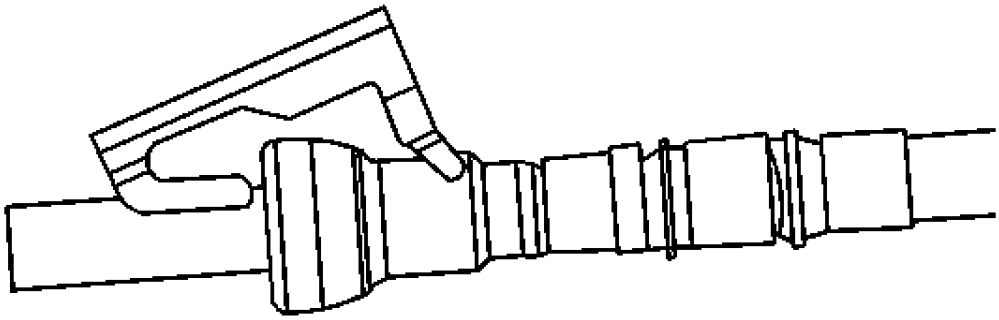


Fig. 30: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

2. Remove the retainer from the quick-connect fitting.

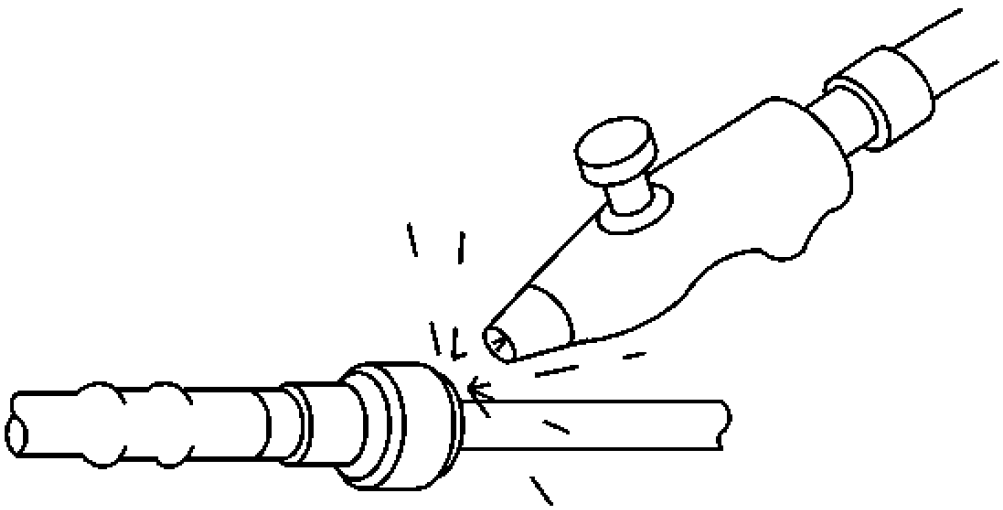


Fig. 31: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Wear safety glasses when using compressed air, as flying dirt

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particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

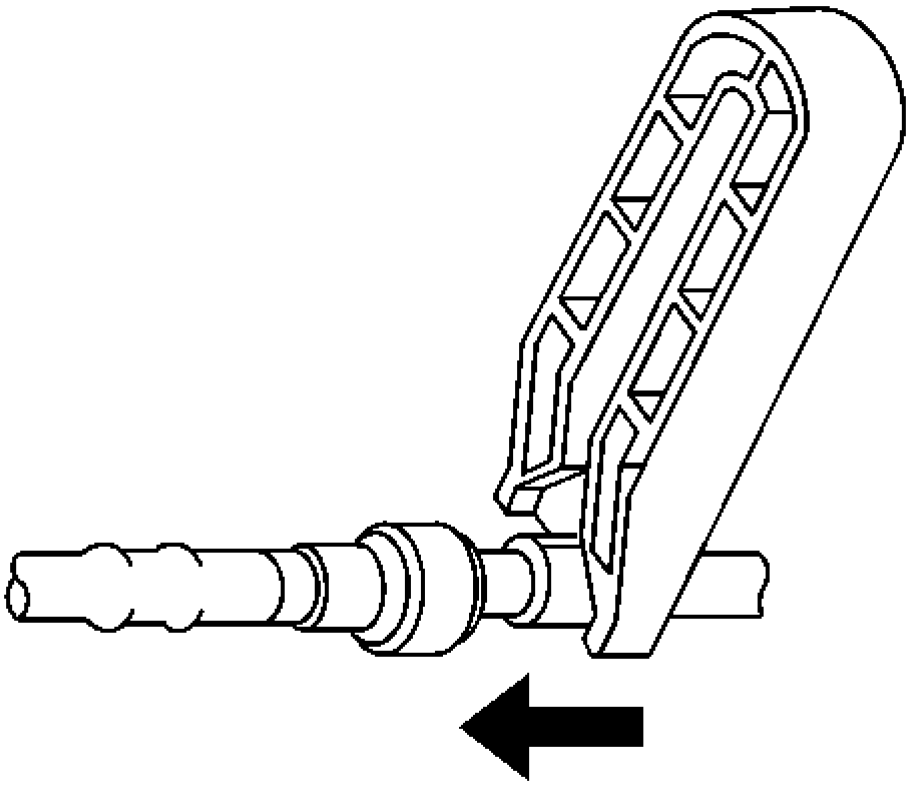


Fig. 32: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **J 37088-A** or **J 44581** . See **Special Tools** . Insert the **J 37088-A** or **J 44581** into the female connector, then push inward to release the locking tabs. See **Special Tools** .

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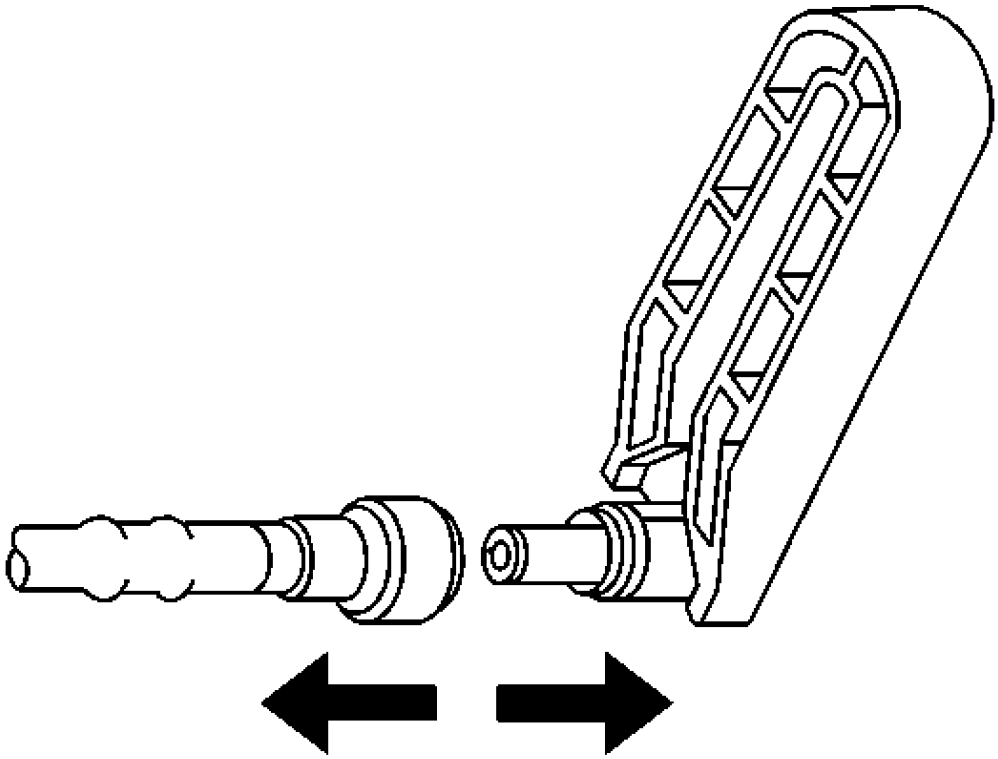


Fig. 33: Pulling Connection Apart
Courtesy of GENERAL MOTORS CORP.

5. Pull the connection apart.

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

6. Using a clean shop towel, wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs.
8. Clean or replace the components as required.

Installation Procedure

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WARNING: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.
This will ensure proper reconnection and prevent a possible fuel leak.
During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

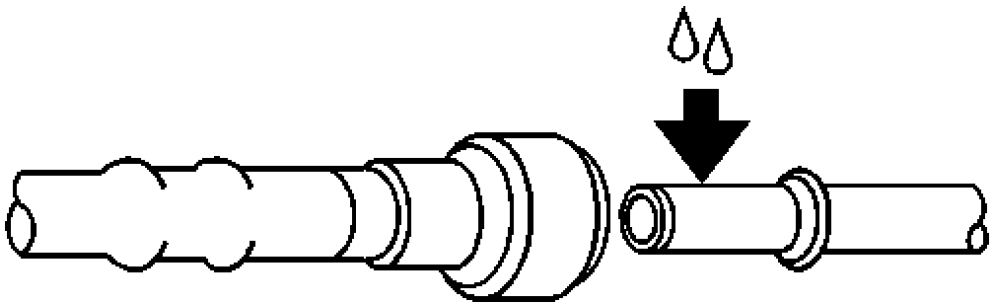
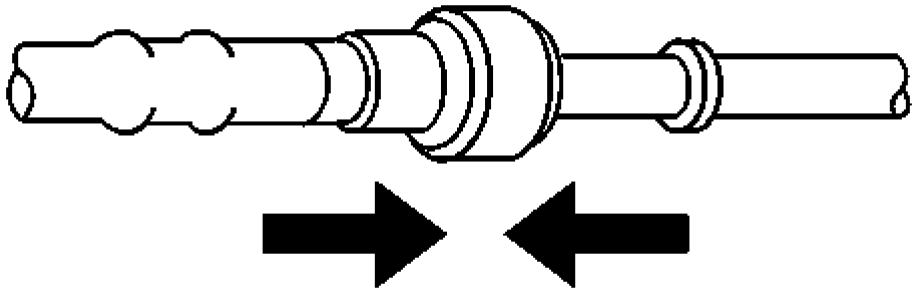


Fig. 34: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

1. Apply a few drops of clean engine oil to the male pipe end.



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Fig. 35: Pushing Fittings Together
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

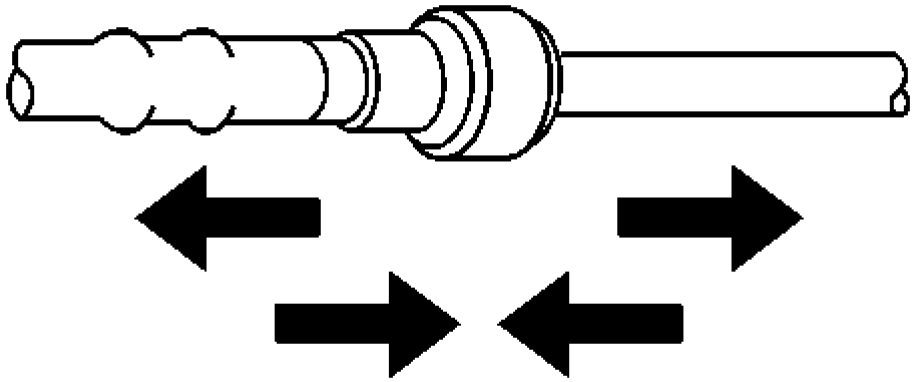


Fig. 36: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS CORP.

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

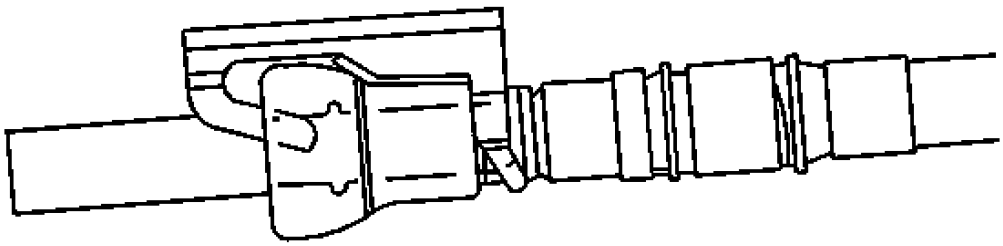


Fig. 37: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

4. Install the retainer to the quick-connect fitting.

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5. Inspect for leaks using the following procedure:
    1. Turn the ignition ON, with the engine OFF for 2 seconds.
    2. Turn the ignition OFF, for 10 seconds.
    3. Turn the ignition ON, with the engine OFF for 2 seconds.
    4. Turn the ignition OFF.
    5. Inspect for leaks.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Disconnect Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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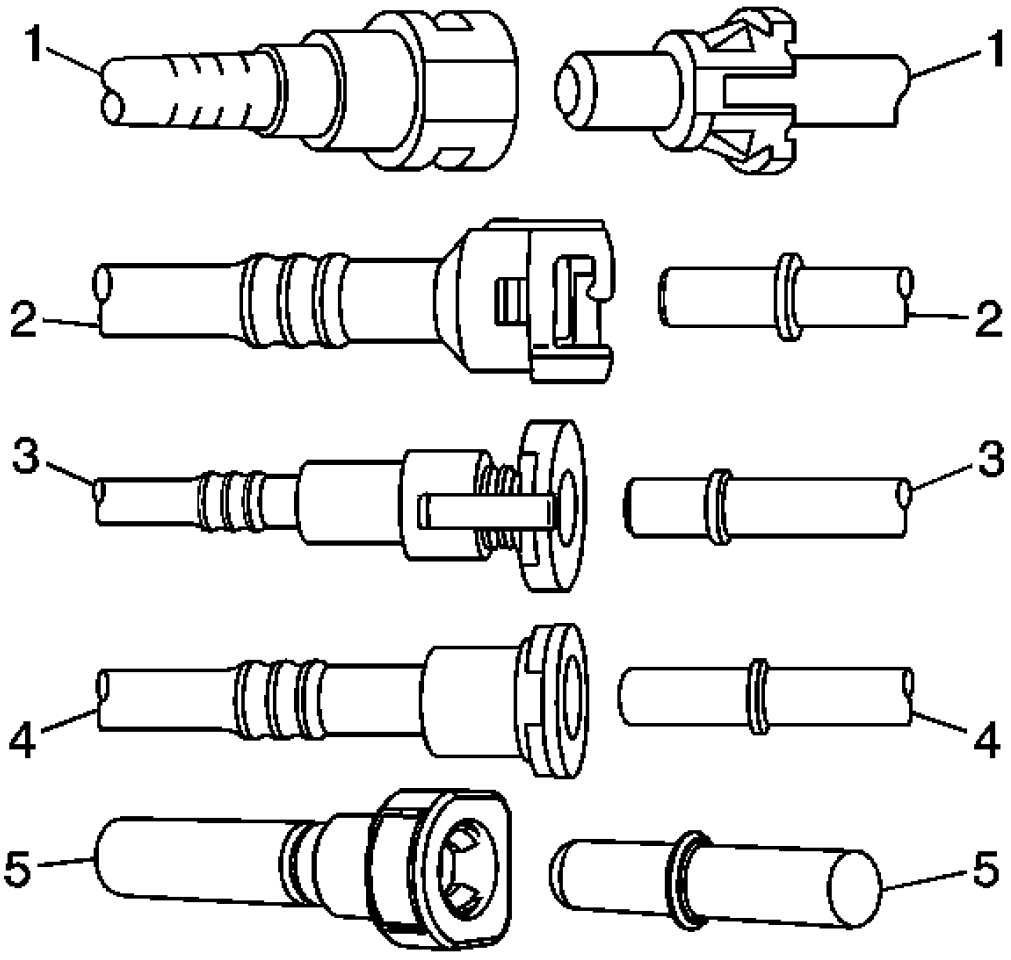


Fig. 38: Identifying Plastic Collar Fuel & Evaporative Emission Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

NOTE: **There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.**

- **Bartholomew (1)**
- **Q Release (2)**
- **Squeeze to Release (3)**
- **Sliding Retainer (4)**
- **Push Down TI (5)**

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The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

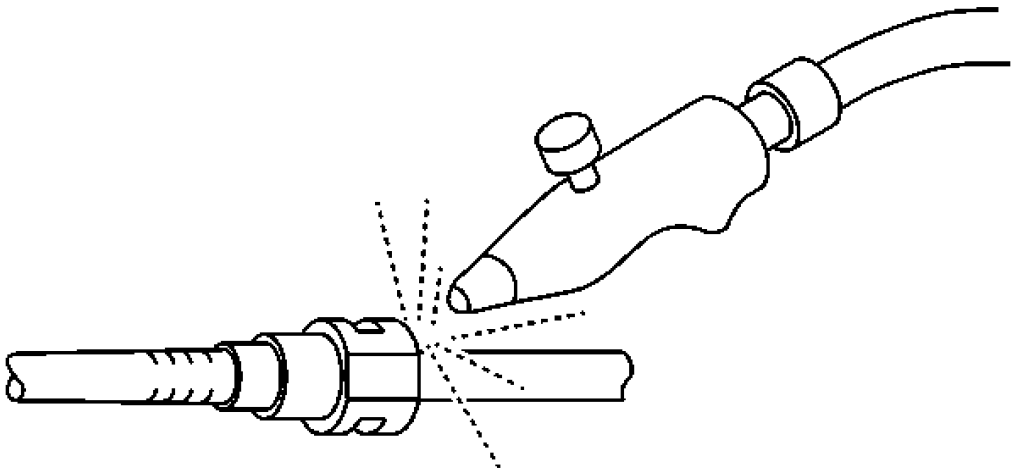


Fig. 39: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

2. Using compressed air, blow any dirt or debris from around the connection.

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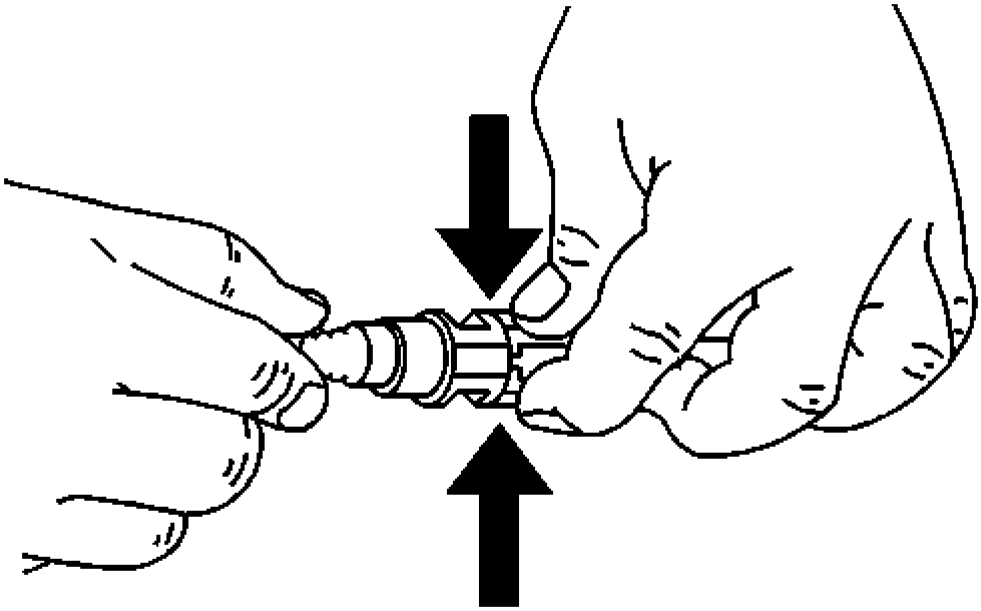


Fig. 40: Squeezing Plastic Quick Connect Fitting Release Tabs -- Bartholomew Style Connector
Courtesy of GENERAL MOTORS CORP.

3. This step applies to Bartholomew style connector ONLY. Squeeze the plastic quick connect fitting release tabs.

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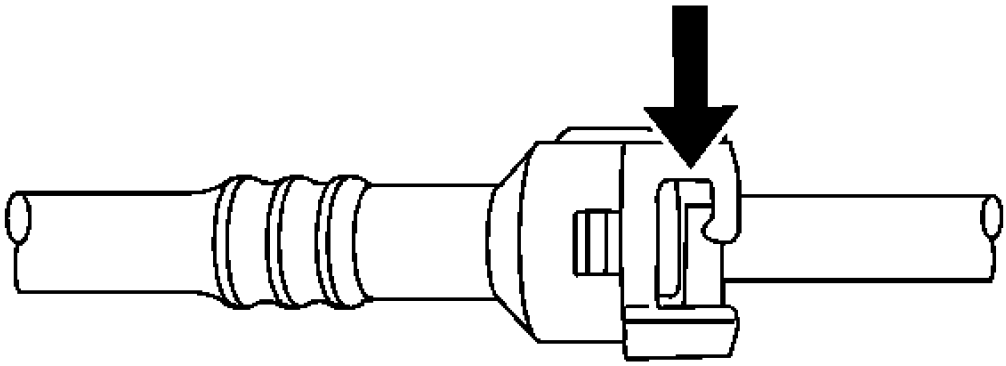


Fig. 41: Releasing Release Tab Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

4. This step applies to Release Tab style connector ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.

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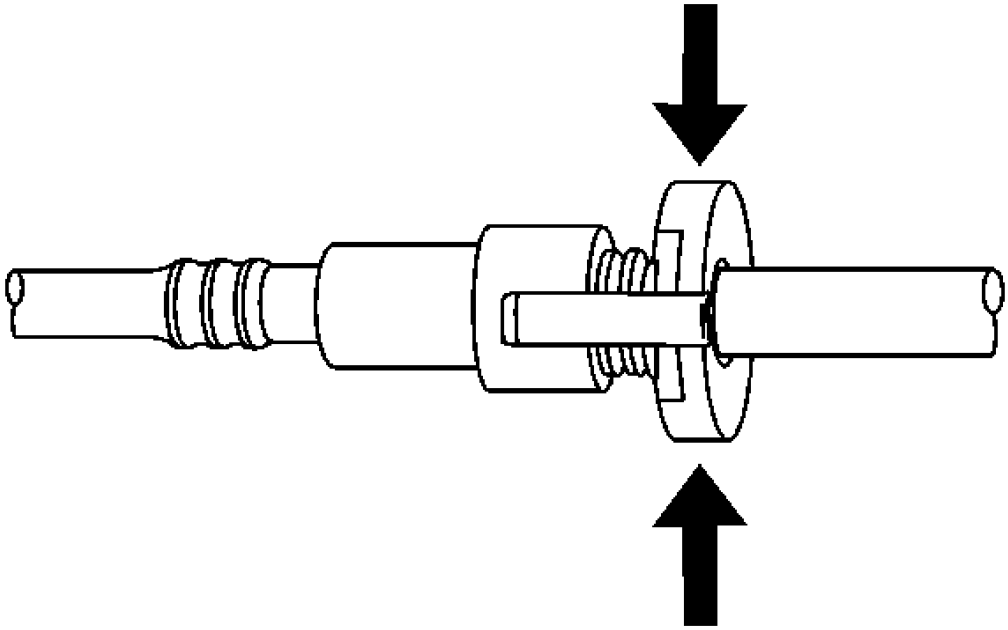


Fig. 42: Disengaging Squeeze To Releasse Style Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

5. This step applies to the Squeeze to Release style connector ONLY. Squeeze where indicated by the arrows shown above on both sides of the plastic ring surrounding the quick connect fitting.

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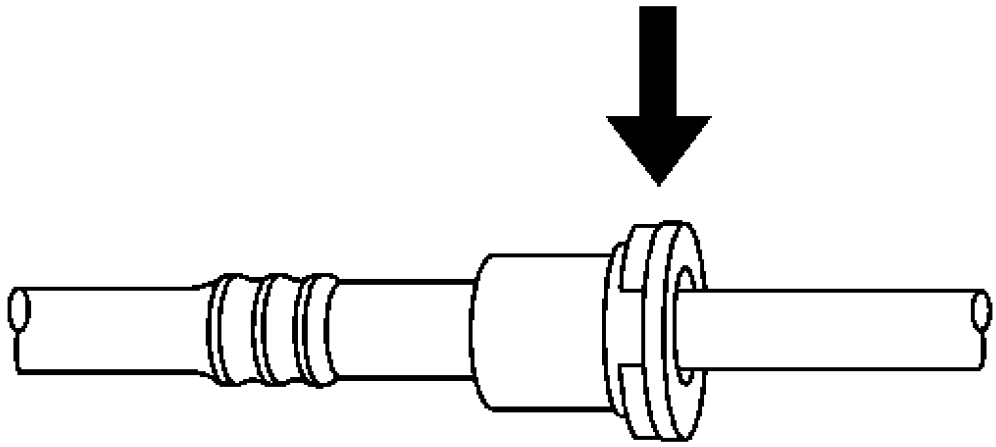


Fig. 43: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS CORP.

6. This step applies to the Sliding Retainer style connector ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab does not move try pressing the tab in from the opposite side. The tab will only move in one direction.

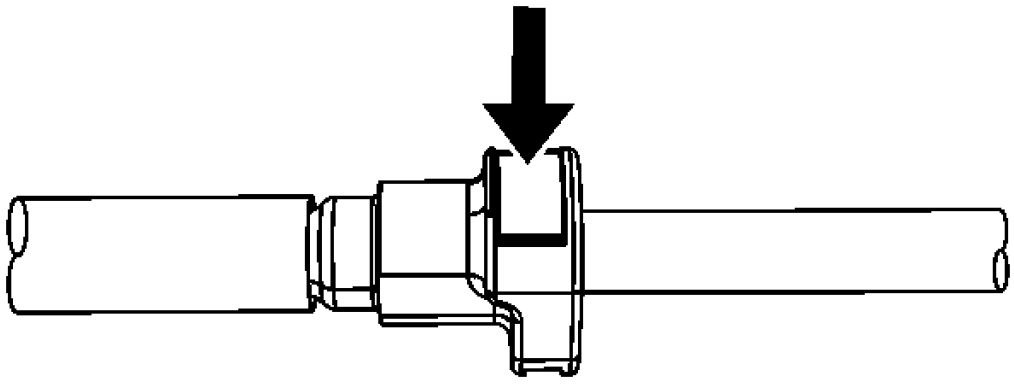


Fig. 44: View Of Push Down TI Style Connector
Courtesy of GENERAL MOTORS CORP.

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7. This step applies to the Push Down TI style connector ONLY. Release the fitting by pressing on the tab indicated by the arrow.

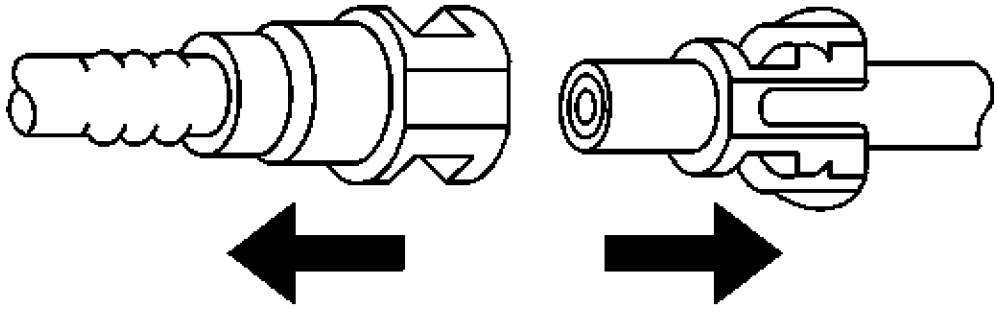


Fig. 45: Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Relieving Fuel Pressure Warning .

8. Pull the connection apart.

Connect Procedure

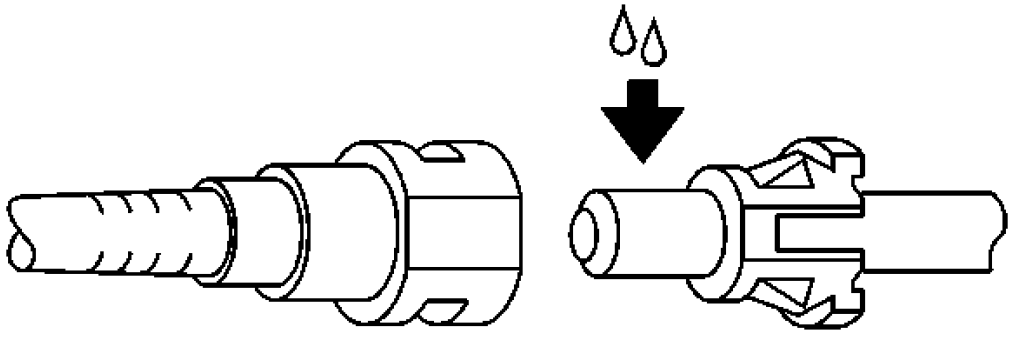


Fig. 46: Lubricating Male Pipe End

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Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Pipe Fitting Warning .

1. Apply a few drops of clean engine oil to the male connection end.

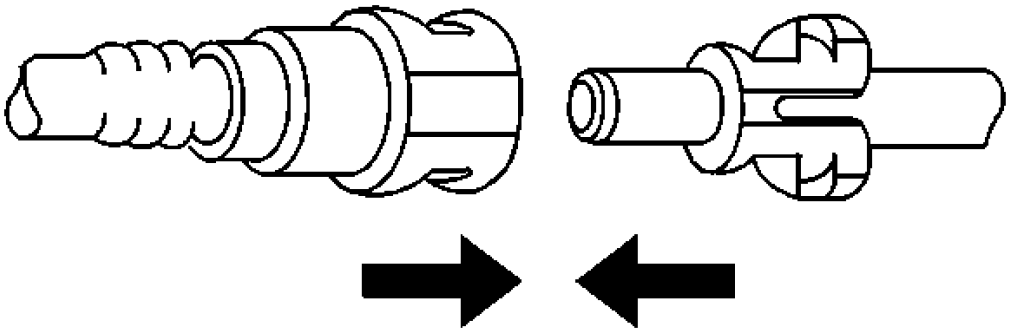


Fig. 47: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

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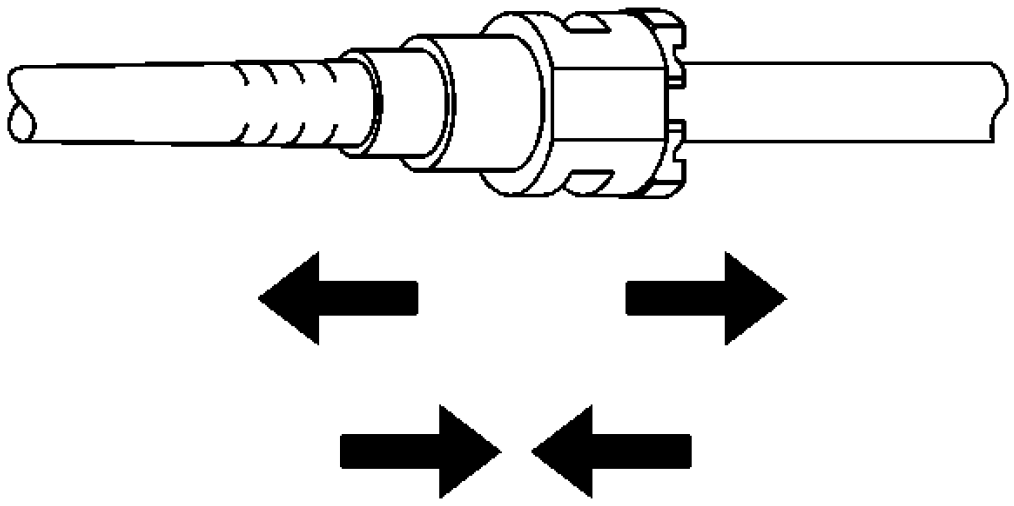


Fig. 48: Ensuring Secure Connection (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

3. Once installed, pull on both sides of the connection in order to make sure the connection is secure.

FUEL TANK DRAINING

Special Tools

- **J 36850** Transjel Lubricant. See **Special Tools** .
- **J 45004** Fuel Drain Hose. See **Special Tools** .

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

1. Remove the fuel filler cap.

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NOTE: Lubricate the fuel drain hose with J 36850 or equivalent to aid in hose insertion and removal. See Special Tools . Do not use an unapproved lubricant.

2. Insert the **J 45004** into the fuel tank until the hose reaches the bottom of the fuel tank. See **Special Tools** .
3. Use an air operated pump device in order to drain the fuel into an approved gasoline container.

   Up to 26 liters (7 gallons) of residual fuel may remain in the secondary side of the fuel tank.

4. Simultaneously twist and pull in order to remove the **J 45004** from the fuel tank. See **Special Tools** .

FUEL TANK REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to **Fuel Pressure Relief**.
2. Drain the fuel tank. Refer to **Fuel Tank Draining**.
   - Support the rear suspension with a jack stand.
   - Remove the front support bolts.
   - Loosen the rear support bolts in order to slide the fuel tank out.
   - For tightening specifications, refer to **Rear Suspension Support Replacement** .

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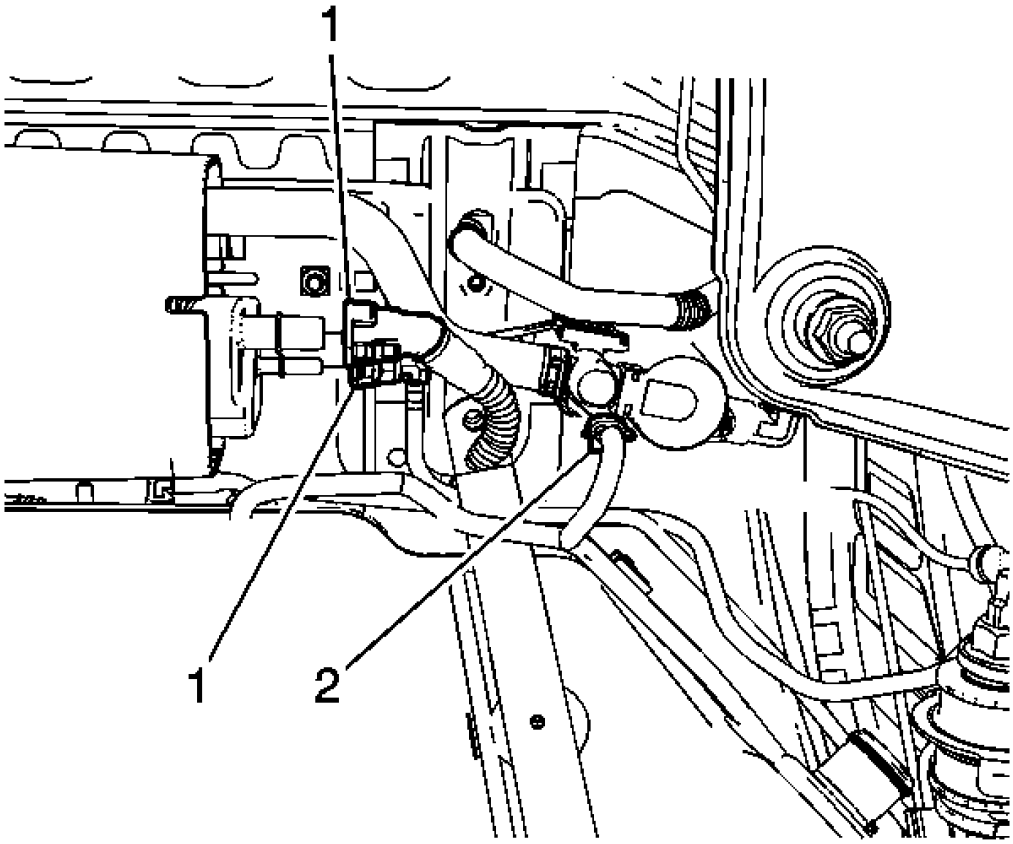


Fig. 49: Evaporative Emission Lines & Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the evaporative emission lines (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Disconnect the vent solenoid electrical connector (2).

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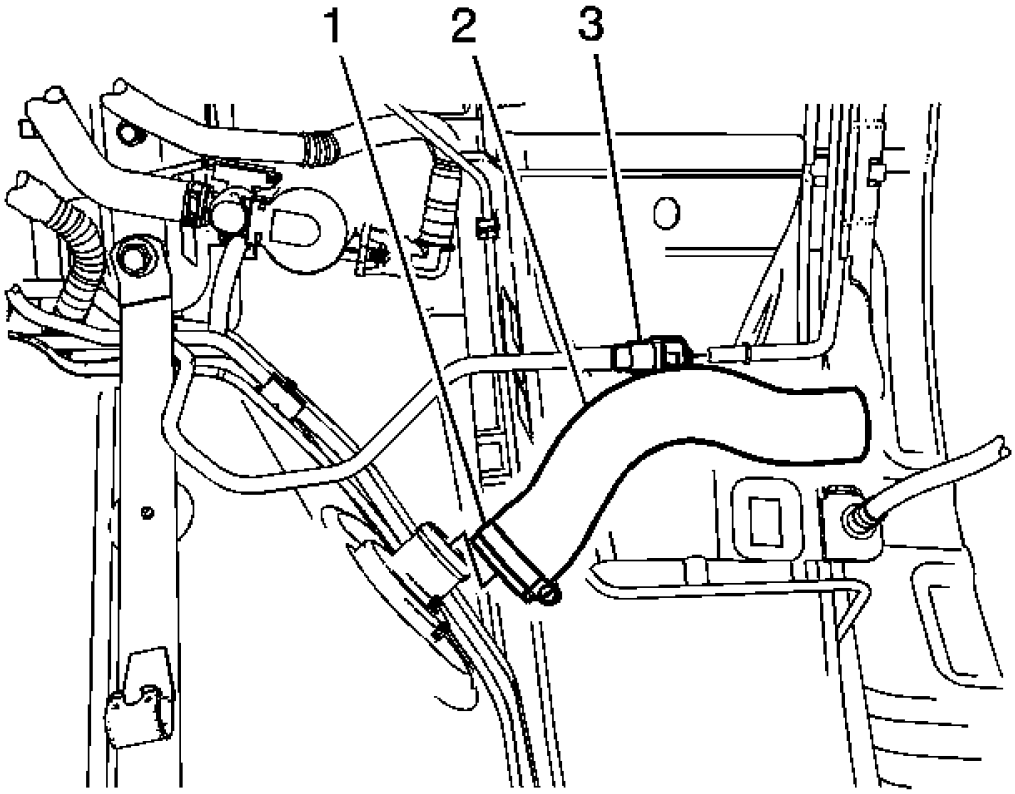


Fig. 50: Hose Clamp, Filler Tube & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

5. Loosen the hose clamp (1) and remove the filler tube (2).
6. Disconnect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

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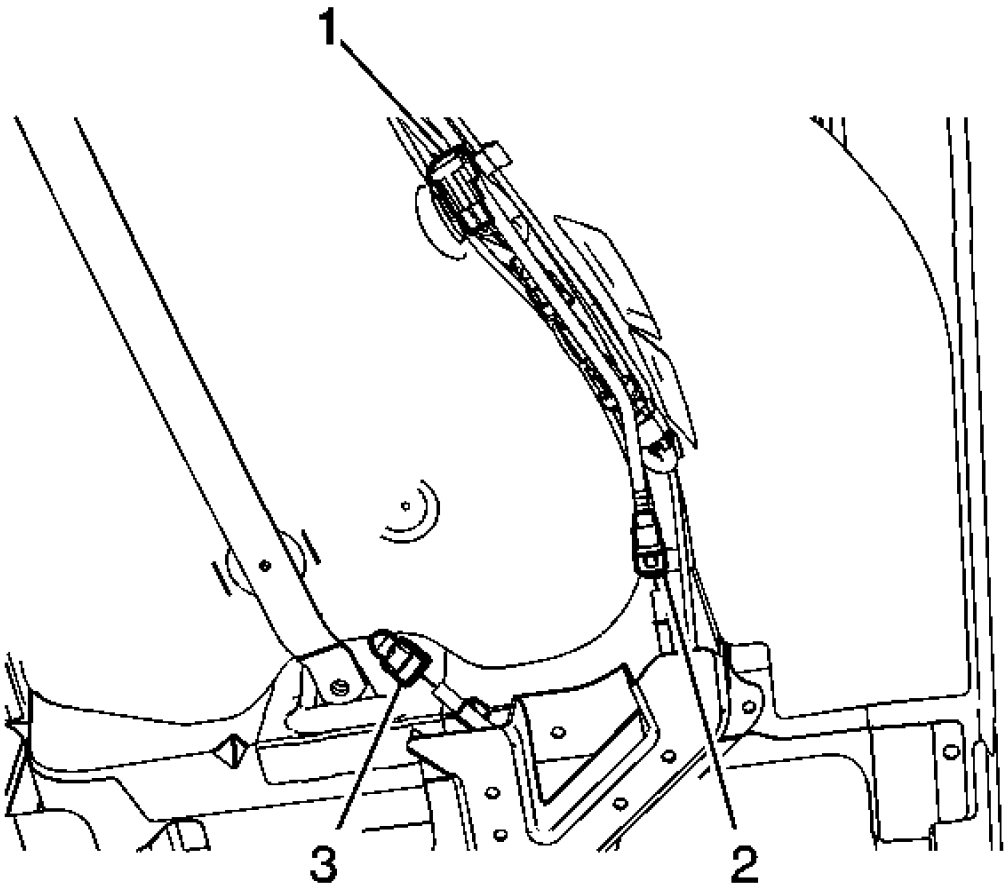


Fig. 51: Fuel Tank Electrical Connector, Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the fuel tank electrical connector (1).
8. Disconnect the fuel feed line (3) and evaporative emission line (2). Refer to **Plastic Collar Quick Connect Fitting Service** and **Metal Collar Quick Connect Fitting Service**.

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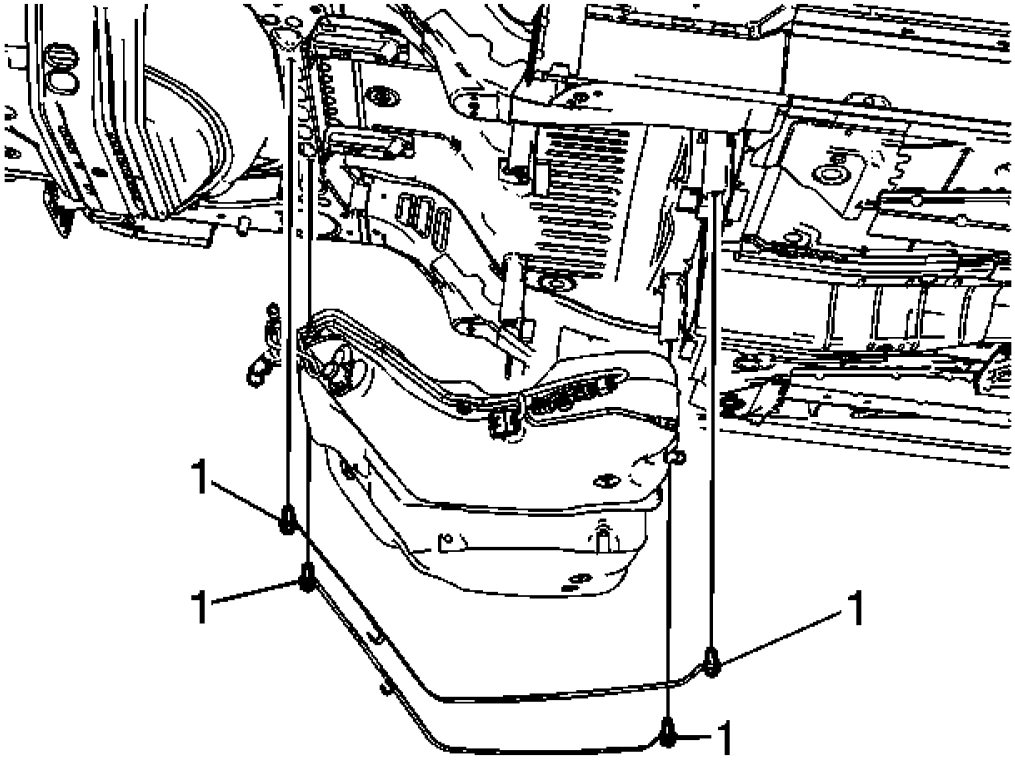


Fig. 52: Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS CORP.

9. Support the fuel tank with a suitable jack.
10. Remove the fuel tank strap bolts (1).
11. Remove the fuel tank.
12. Remove the following components if replacing just the fuel tank.
    1. Fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.
    2. Fuel level sensor. Refer to **Fuel Level Sensor Replacement - Left Side**.
    3. Transfer components as necessary.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
    1. Fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.
    2. Fuel level sensor. Refer to **Fuel Level Sensor Replacement - Left Side**.

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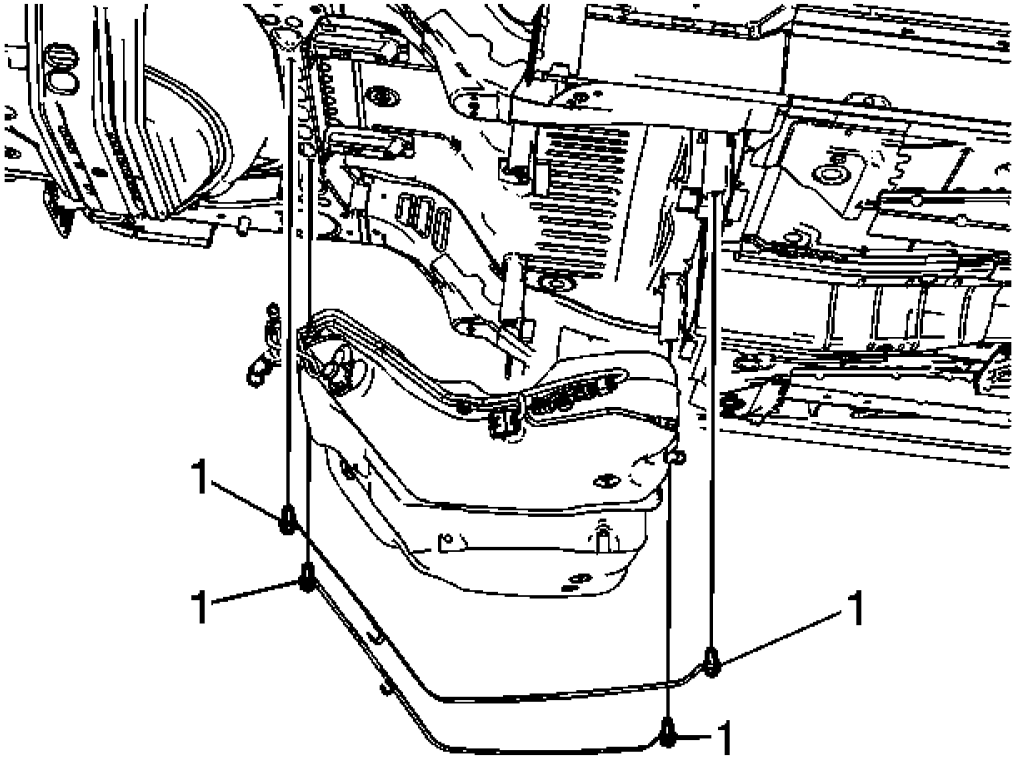


Fig. 53: Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Use a suitable jack and install the fuel tank.
3. Install the fuel tank strap bolts (1) and tighten to 50 N.m (37 lb ft).

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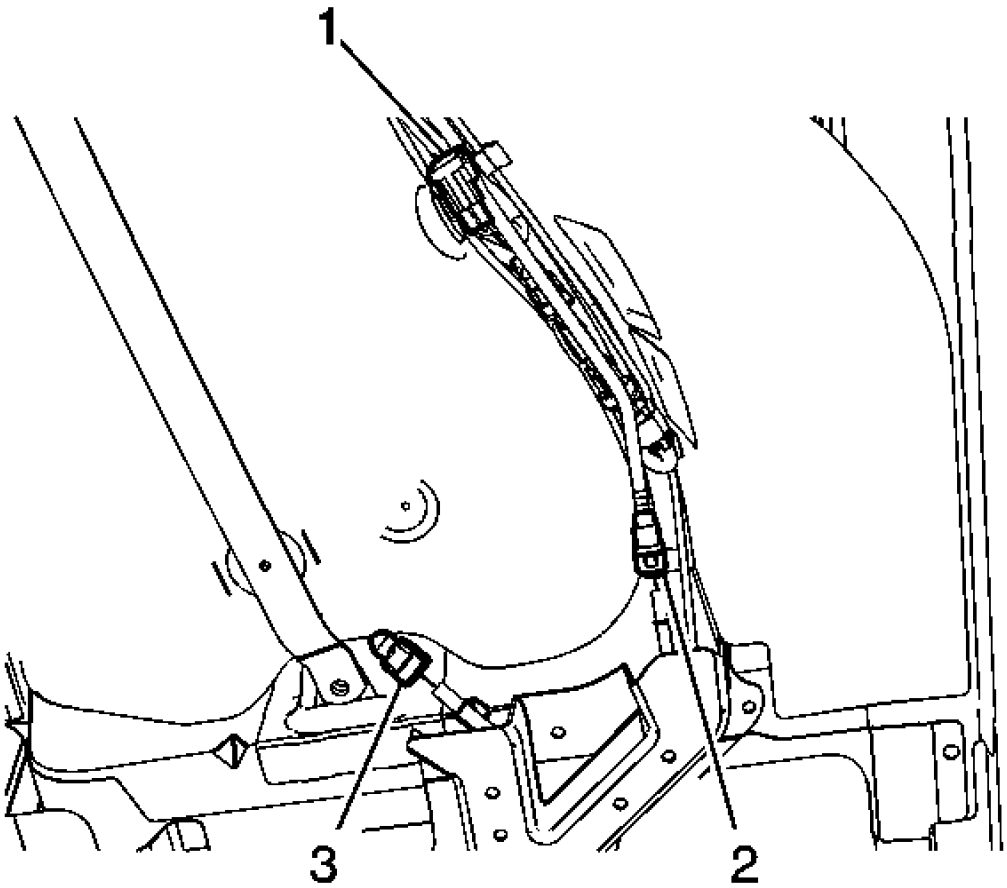


Fig. 54: Fuel Tank Electrical Connector, Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel tank electrical connector (1).
5. Connect the fuel feed line (2) and evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service** and **Metal Collar Quick Connect Fitting Service**.

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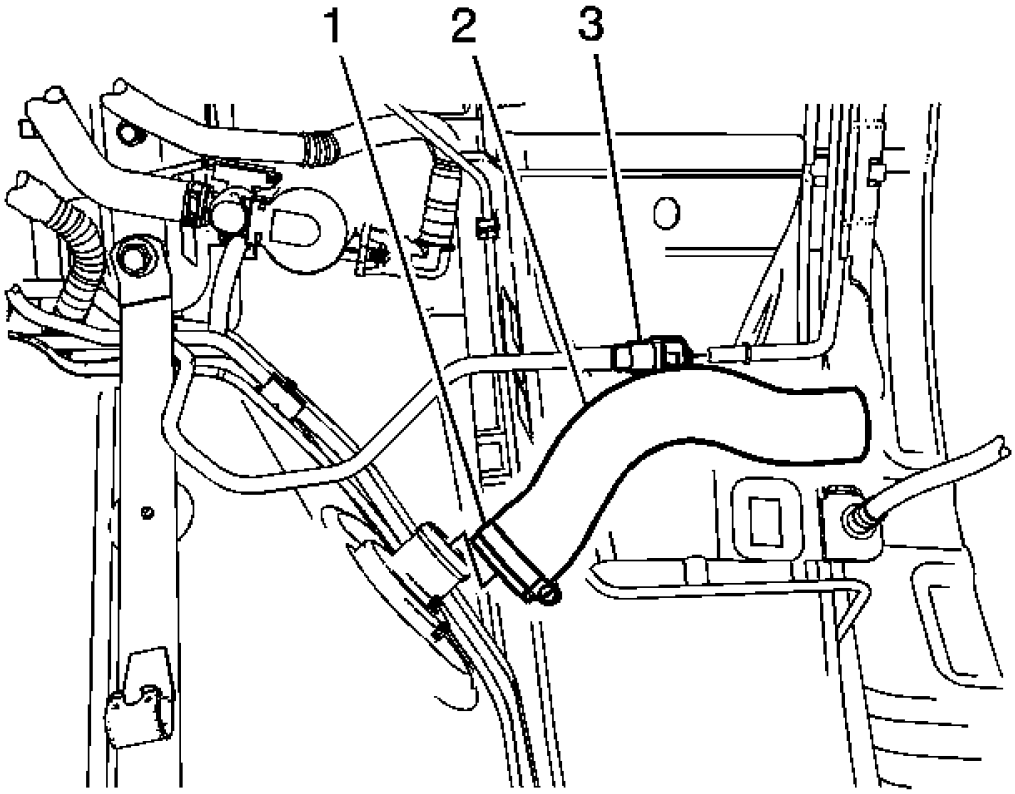


Fig. 55: Hose Clamp, Filler Tube & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

6. Install the filler tube (2) and tighten the hose clamp (1) to 4 N.m (35 lb in) and remove the filler tube (2).
7. Connect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

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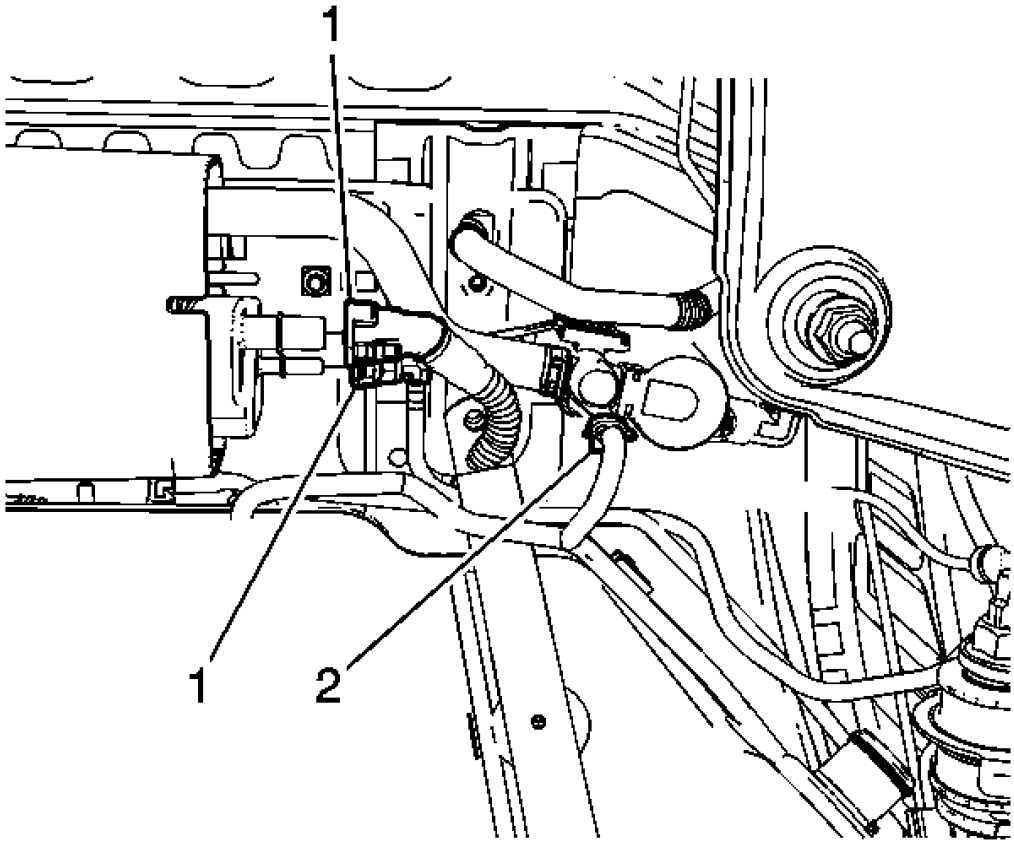


Fig. 56: Evaporative Emission Lines & Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Connect the evaporative emission lines (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Connect the vent solenoid electrical connector (2).
10. Connect the parking brake cables at the calipers. Refer to **Parking Brake Rear Cable Replacement** .
11. Install the rear suspension support and tighten to specifications. Refer to **Rear Suspension Support Replacement** .
12. Refill the fuel tank.
13. Inspect for fuel leaks.

FUEL TANK FUEL PUMP MODULE REPLACEMENT - RIGHT SIDE

Special Tools

J 45722 Fuel Sender Lock Ring Wrench. See **Special Tools** .

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Removal Procedure

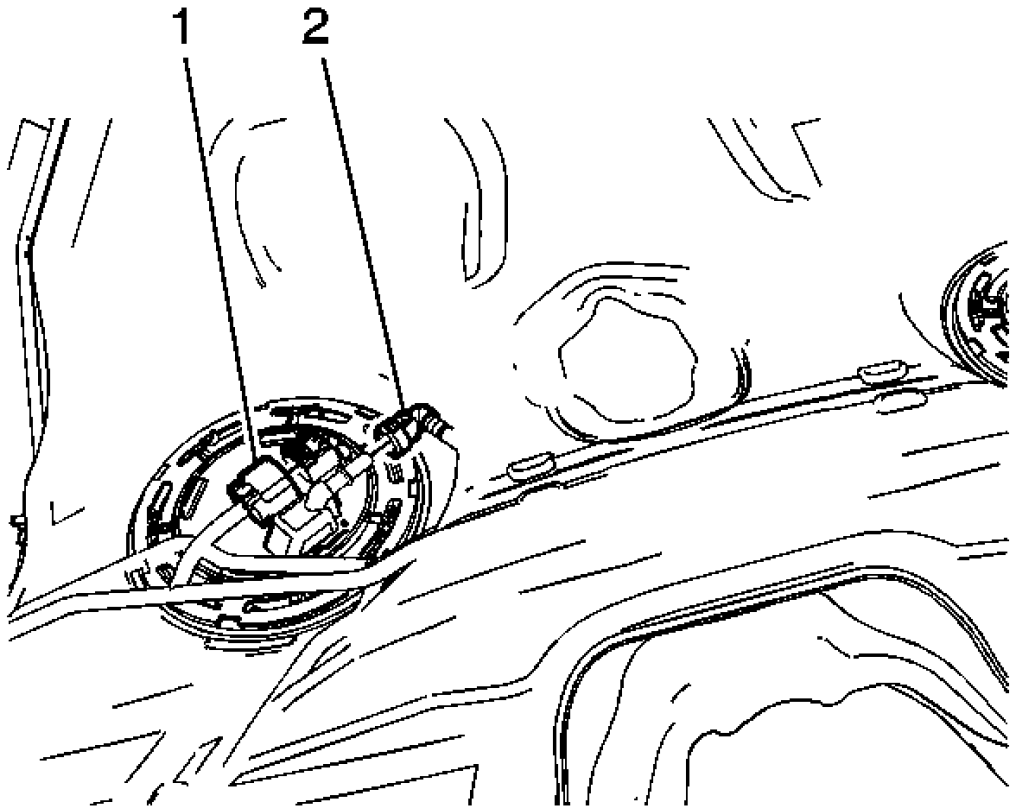


Fig. 57: Fuel Pump Electrical Connector & Fuel Feed Line
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect the fuel pump electrical connector (1) and the fuel feed line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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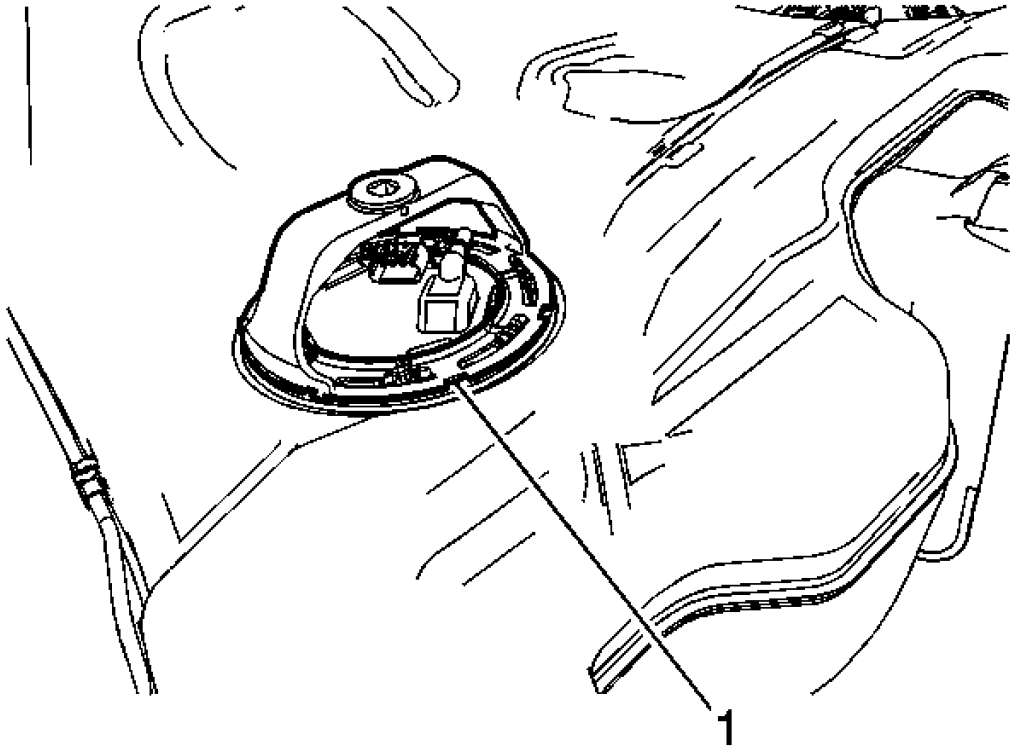


Fig. 58: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 45722:** wrench by turning counter clockwise and remove the lock ring (1).

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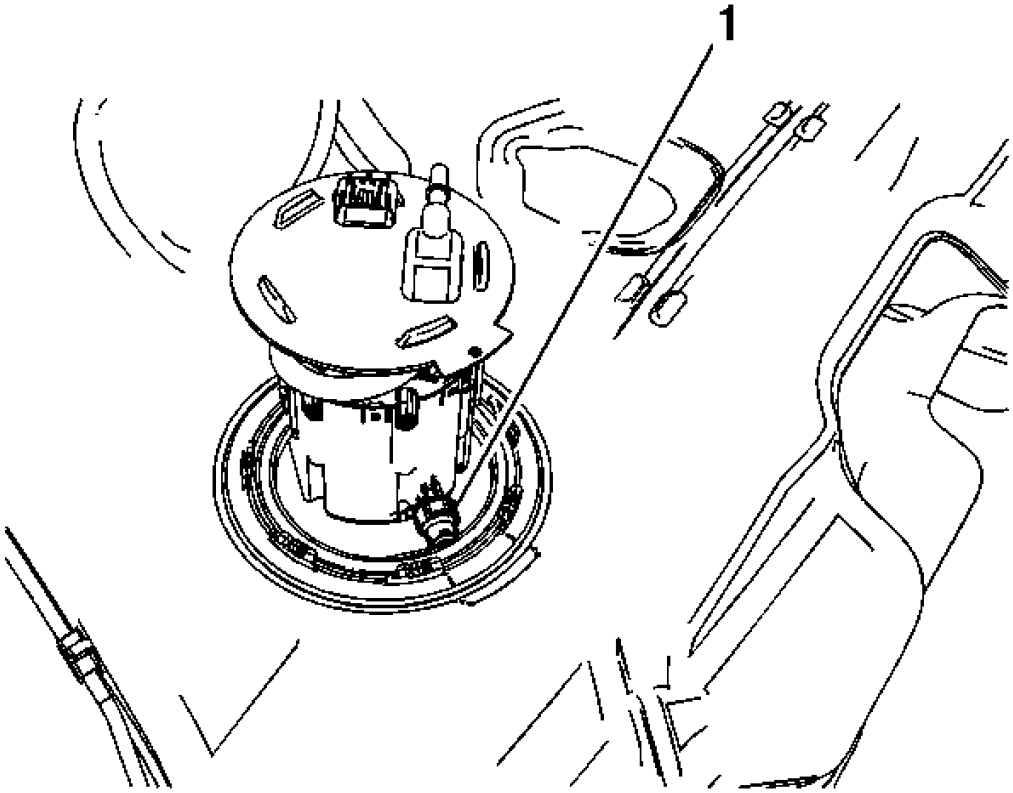


Fig. 59: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Partially remove the primary fuel tank module in order to disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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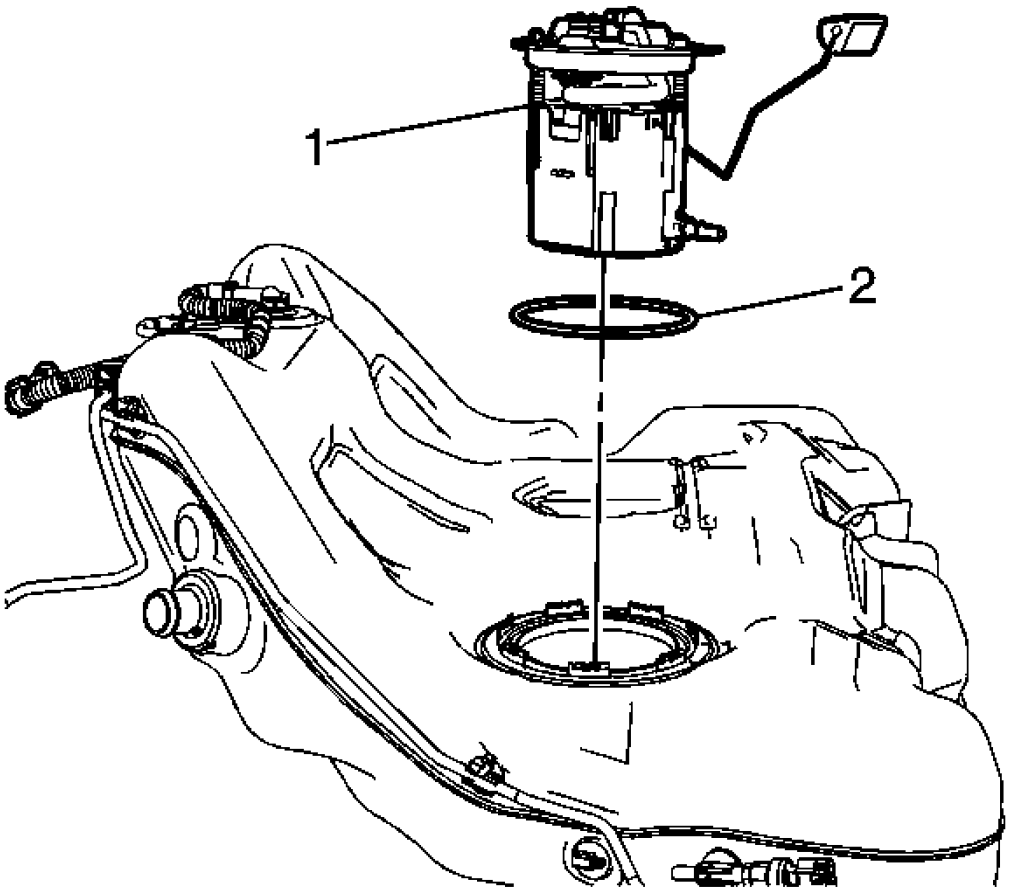


Fig. 60: Primary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the primary fuel tank module (1) and seal (2) from the fuel tank.

Installation Procedure

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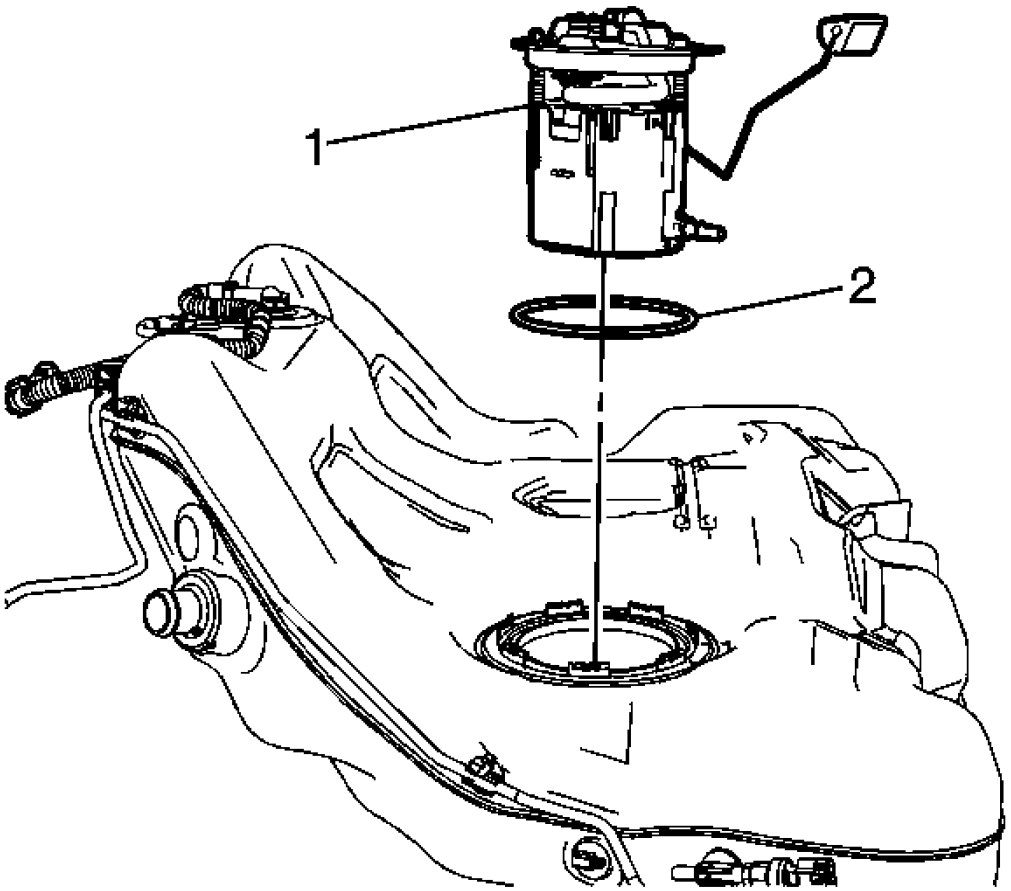


Fig. 61: Primary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW seal (2) and partially install the primary fuel tank module (1).

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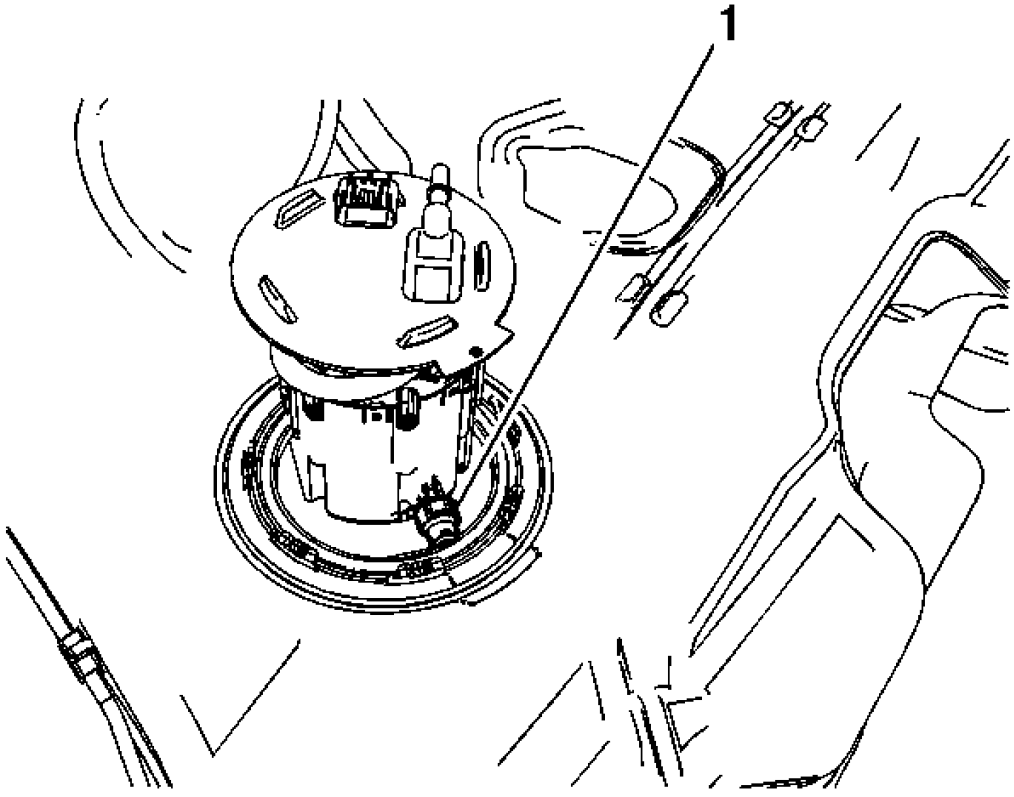


Fig. 62: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

2. Connect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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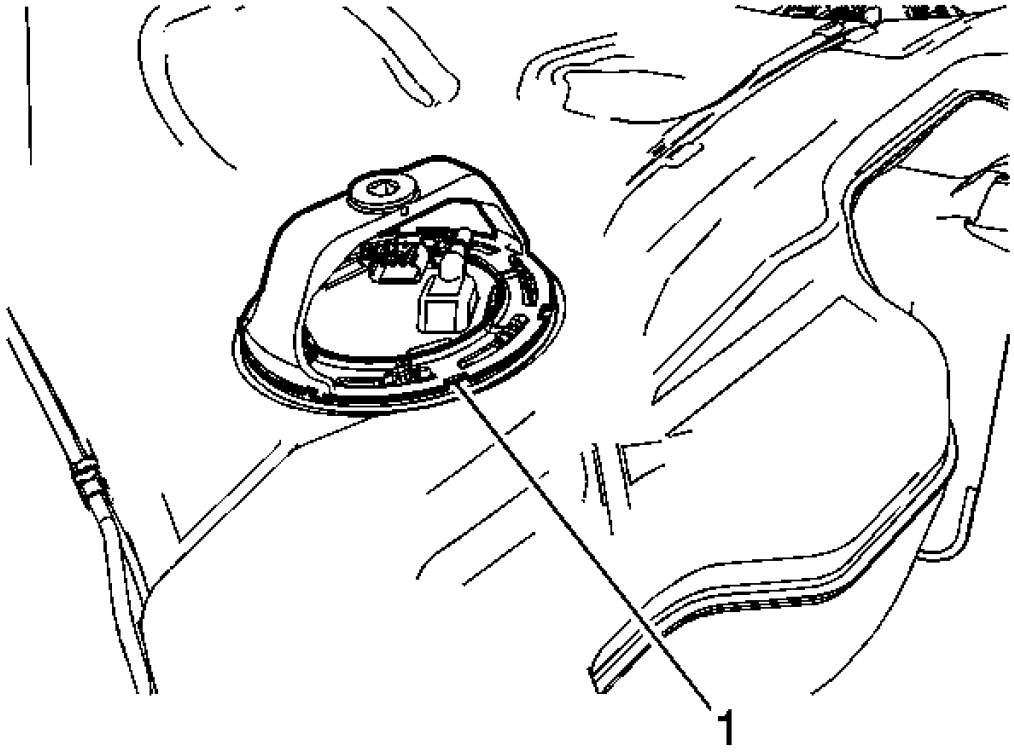


Fig. 63: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 45722:** wrench by turning clockwise and install the lock ring (1).

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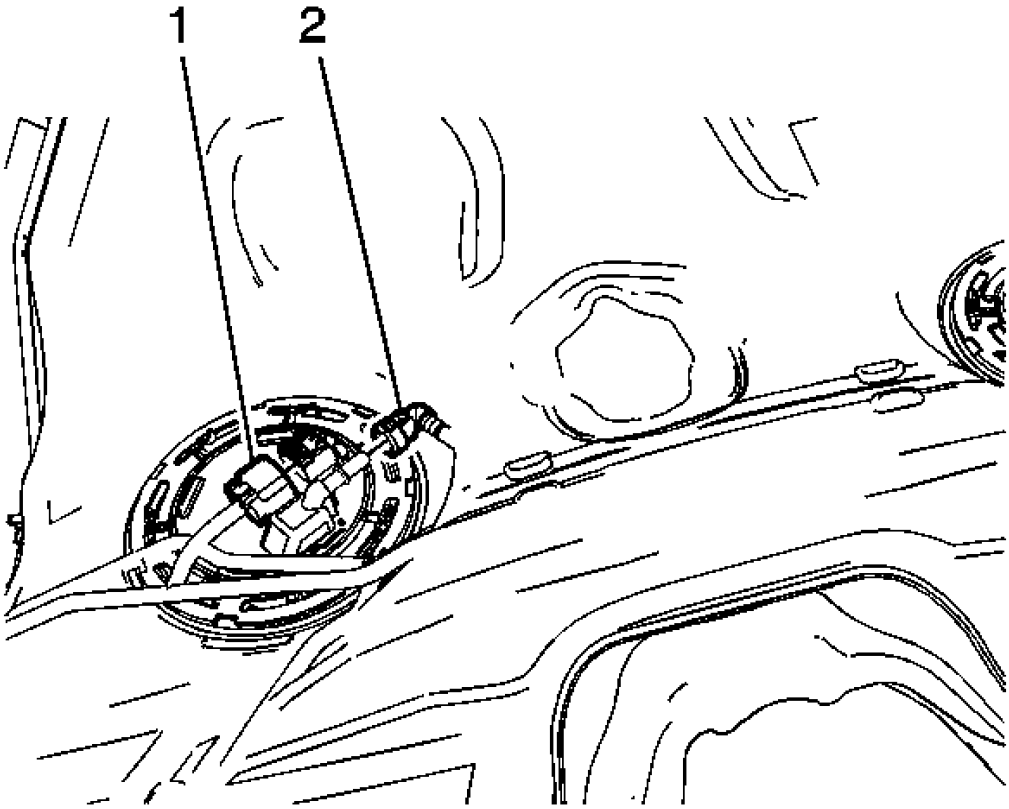


Fig. 64: Fuel Pump Electrical Connector & Fuel Feed Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel pump electrical connector (1) and the fuel feed line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

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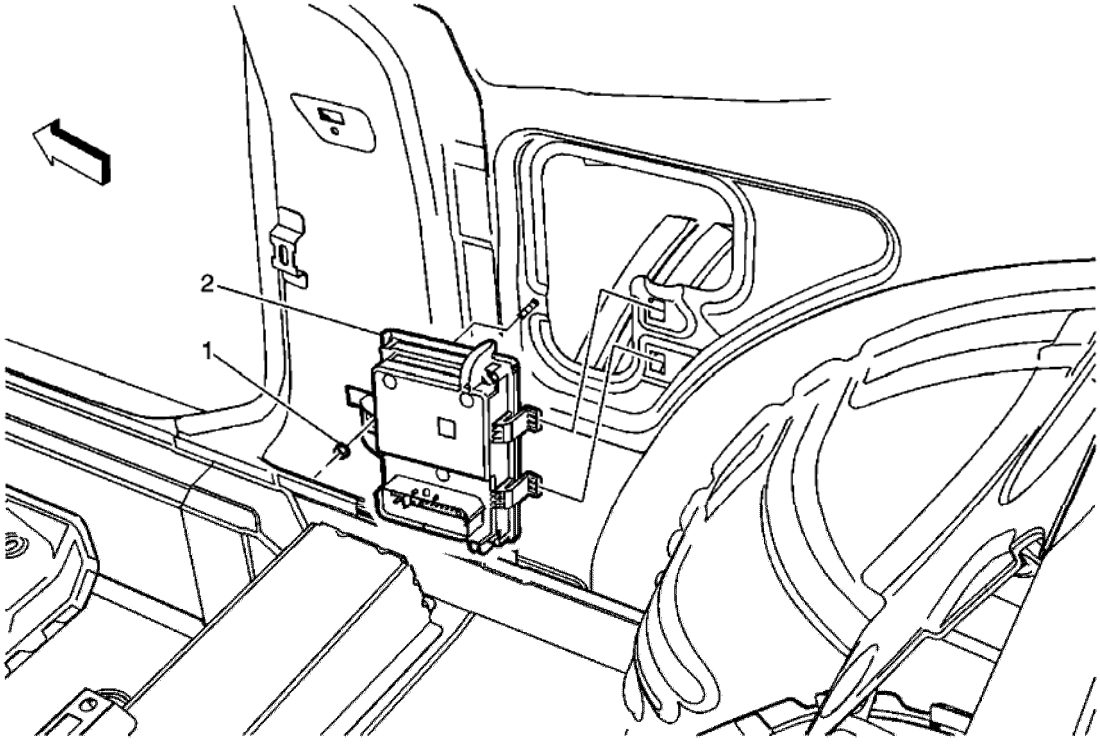


Fig. 65: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the right side quarter trim panel. Refer to **Quarter Trim Panel Replacement** .	
1	Fuel Pump Flow Control Module Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 3 N.m (27 lb in)
2	Fuel Pump Flow Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to **Control Module References** .

FUEL TANK PRESSURE SENSOR REPLACEMENT

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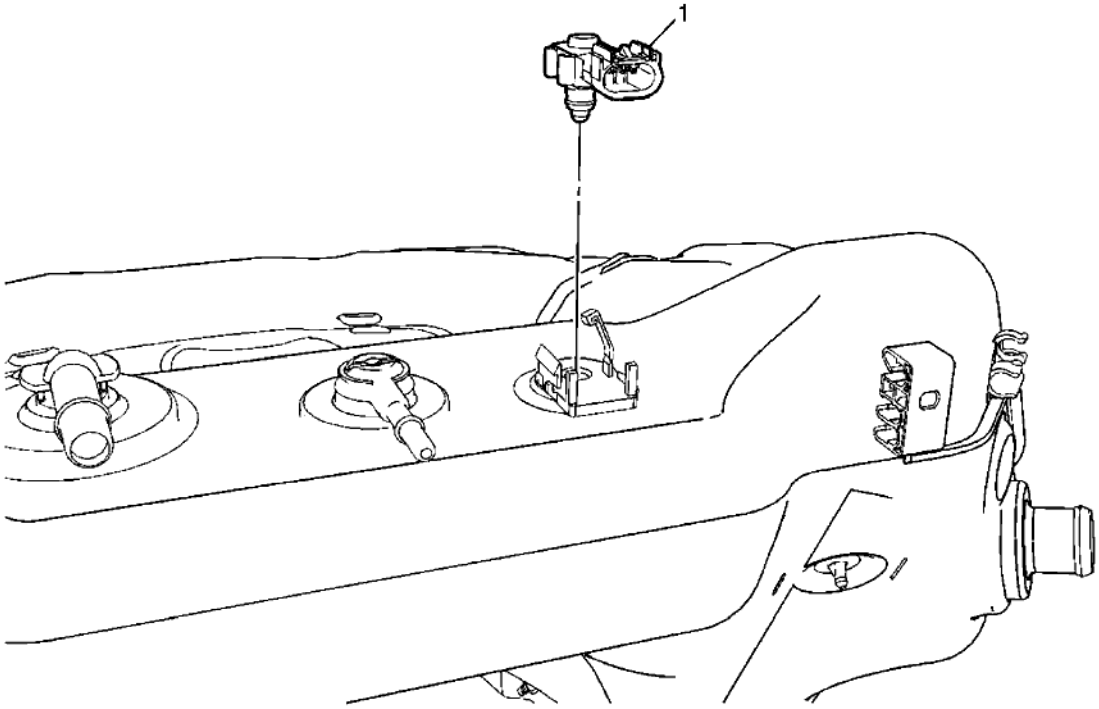


Fig. 66: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the fuel tank. Refer to Fuel Tank Replacement.**	
1	Fuel Tank Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Release the retaining tab.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

1. Remove the fuel filler cap.

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

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WARNING: Refer to Safety Glasses Warning .

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Drain the fuel tank below the level of the fuel filler hose. Refer to **Fuel Tank Draining**.
4. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the right rear wheelhouse Liner. Refer to **Rear Wheelhouse Panel Liner Replacement** .

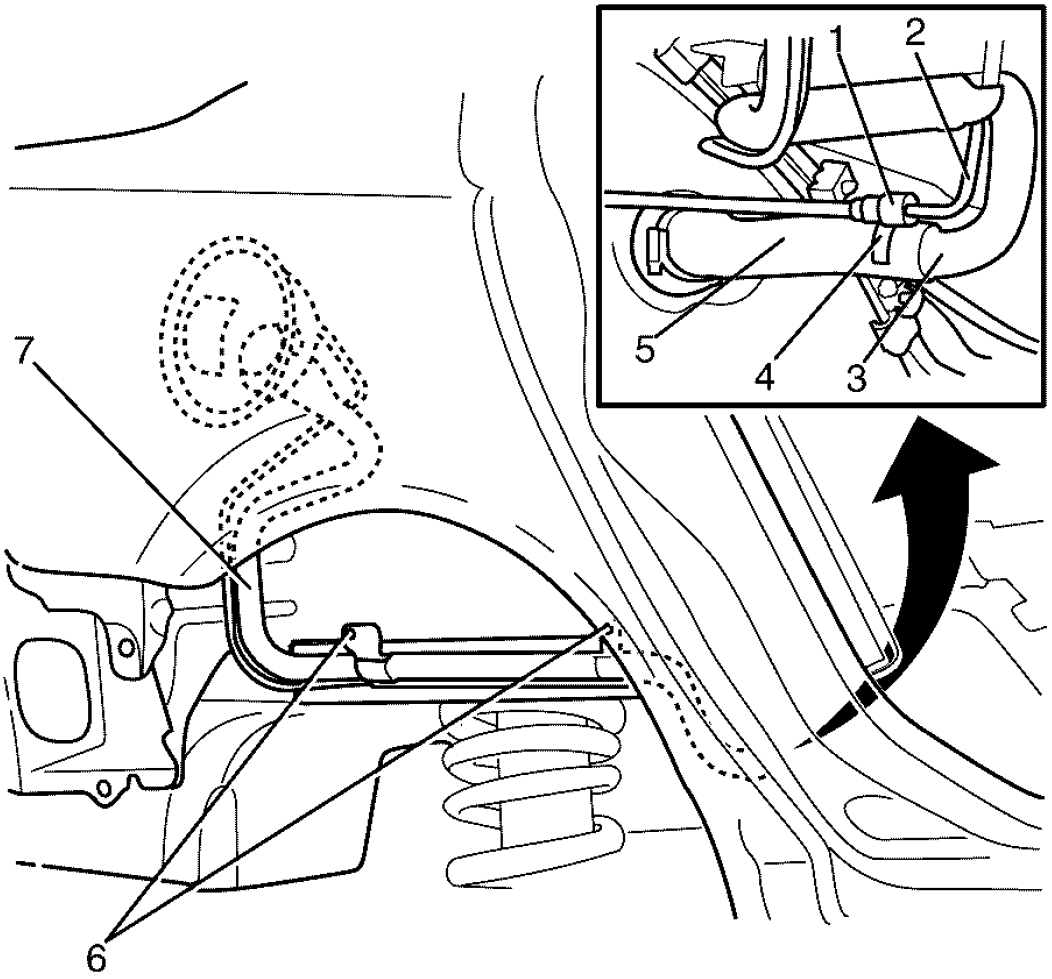


Fig. 67: View Of Quick Connect Fitting, EVAP Line, Fuel Filler Tube & Hose With Clamp
Courtesy of GENERAL MOTORS CORP.

6. Remove the filler tube to chassis retaining bolts (6).
7. Disconnect the evaporative emission (EVAP) line (2) from the quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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8. Remove the retaining hose clamp (4).
9. Disconnect the fuel filler tube (3) from the fuel filler hose (5).
10. Maneuver the fuel filler tube (7) and remove from the vehicle.

Installation Procedure

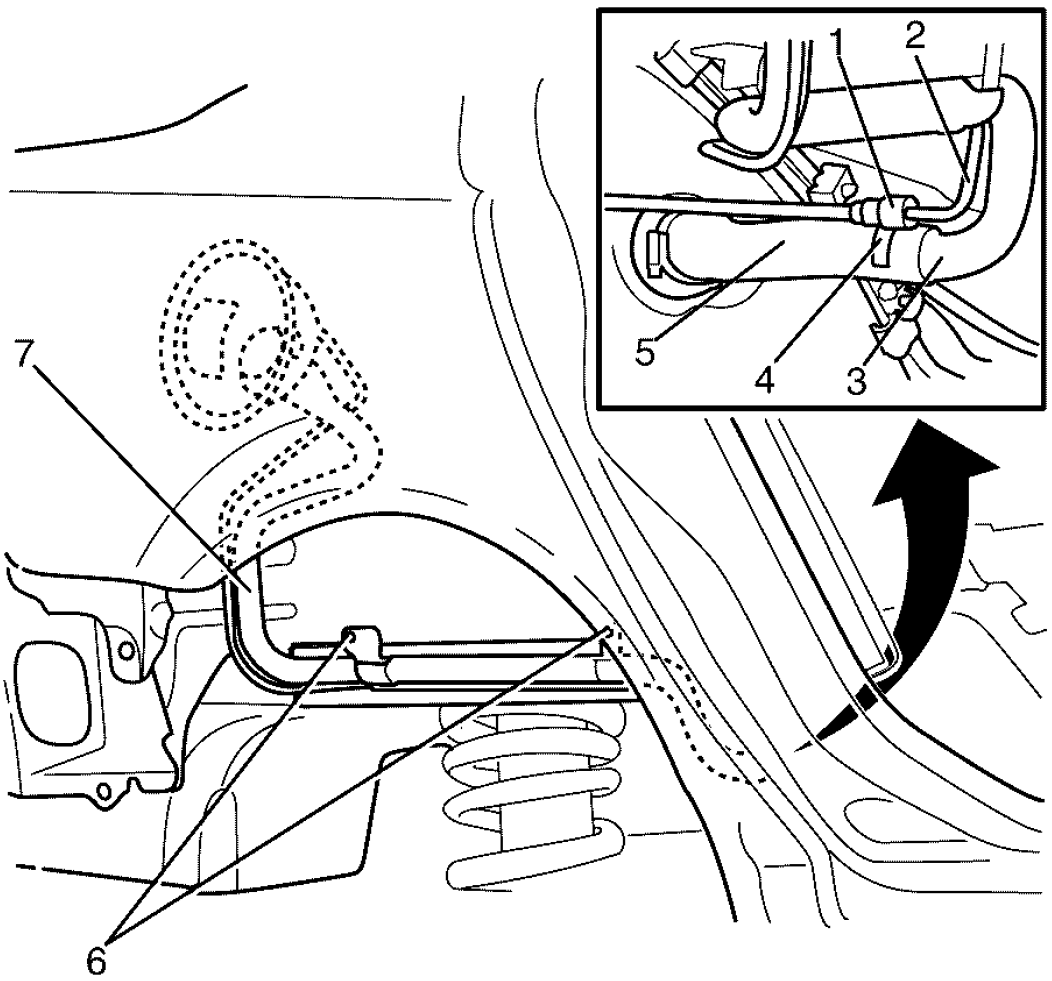


Fig. 68: View Of Quick Connect Fitting, EVAP Line, Fuel Filler Tube & Hose With Clamp
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel filler tube (7) to the vehicle.
2. Connect the fuel filler tube (3) to the fuel filler hose (5).

CAUTION: Refer to Fastener Caution .

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3. Install the retaining hose clamp (4) and tighten the fuel filler tube hose clamp (3) to 3.5 N.m (31 lb in).

NOTE: Listen for and audible click to confirm correct installation.

4. Connect the evaporative emission (EVAP) line (2) to the quick connect fitting (1).
5. Install the filler tube to chassis retaining bolts (6) and tighten to 9 N.m (80 lb in).
6. Install the right rear wheelhouse Liner. Refer to **Rear Wheelhouse Panel Liner Replacement** .
7. Install the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .

FUEL LEVEL SENSOR REPLACEMENT - LEFT SIDE

Special Tools

CH 48482: Fuel Sender Lock Wrench

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

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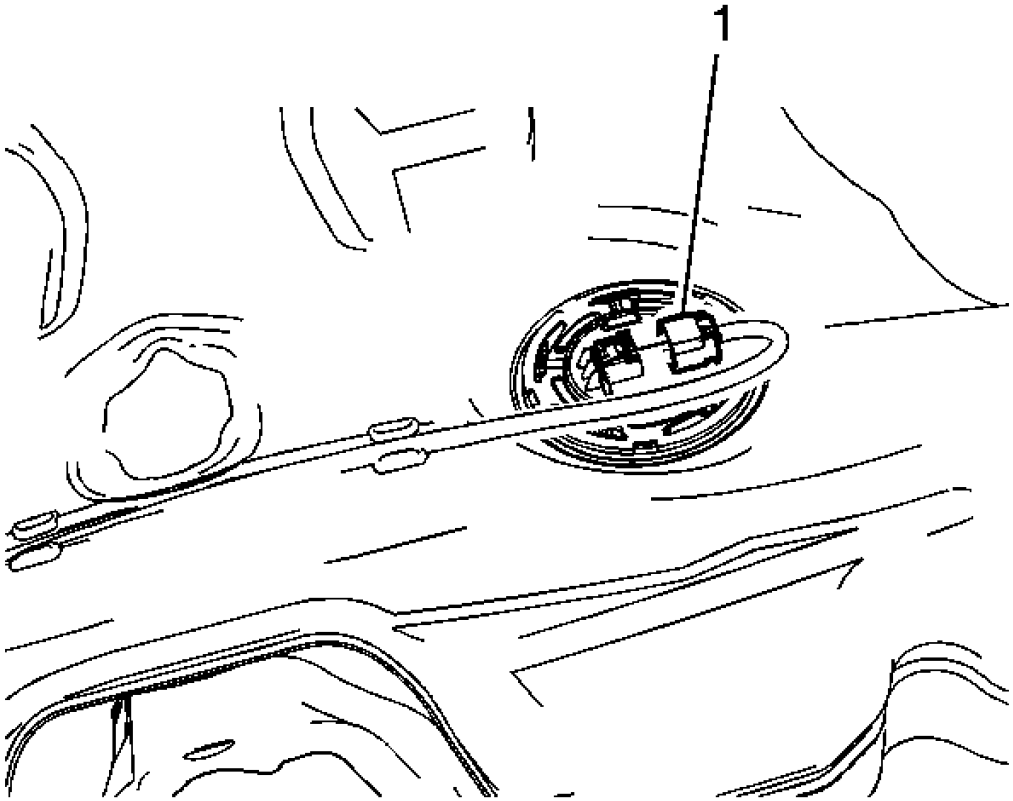


Fig. 69: Secondary Fuel Tank Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the secondary fuel tank module electrical connector (1).

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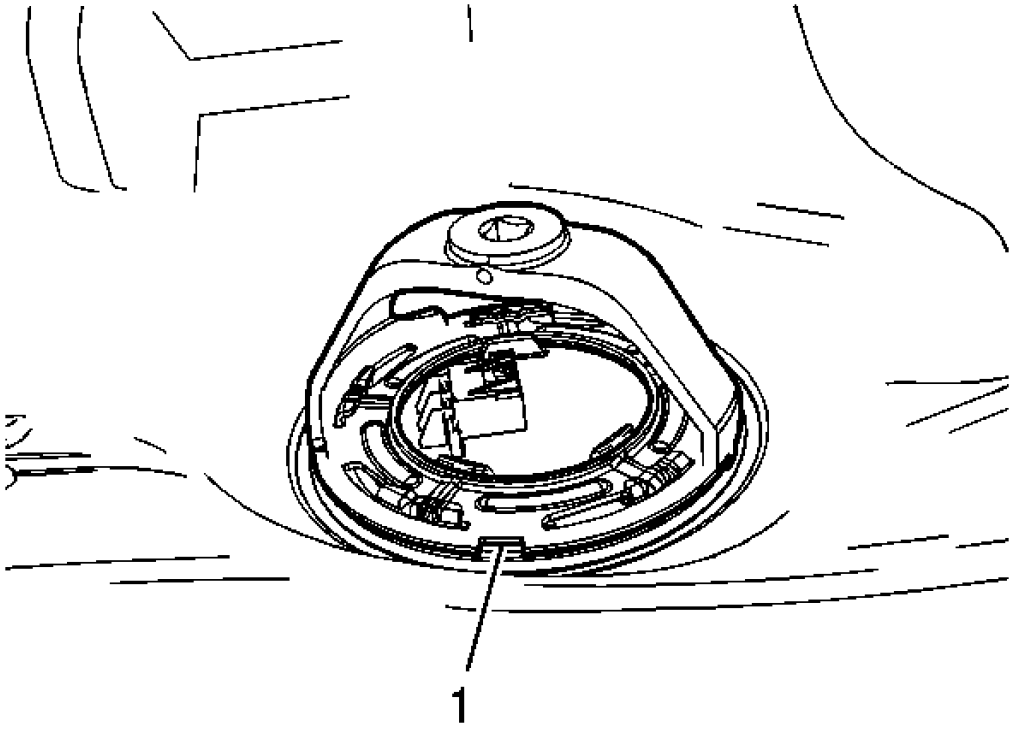


Fig. 70: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Rotate the lock ring (1) counterclockwise using the **CH-48482:** wrench and remove the lock ring.

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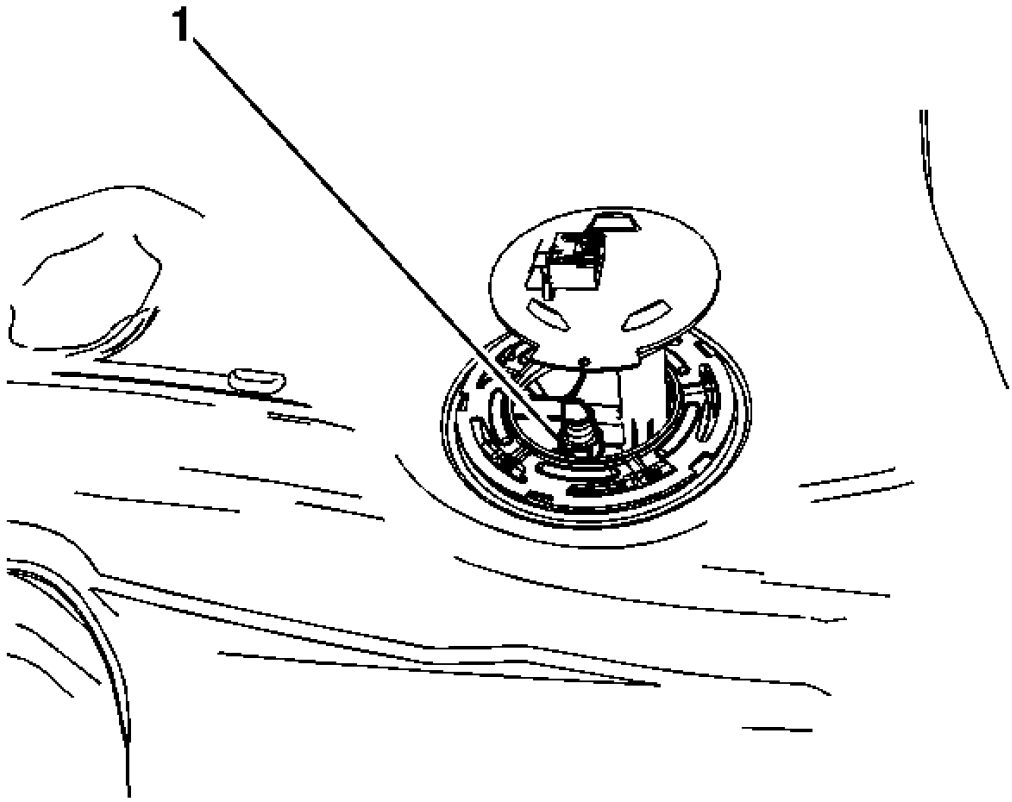


Fig. 71: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Partially remove the primary fuel tank module in order to disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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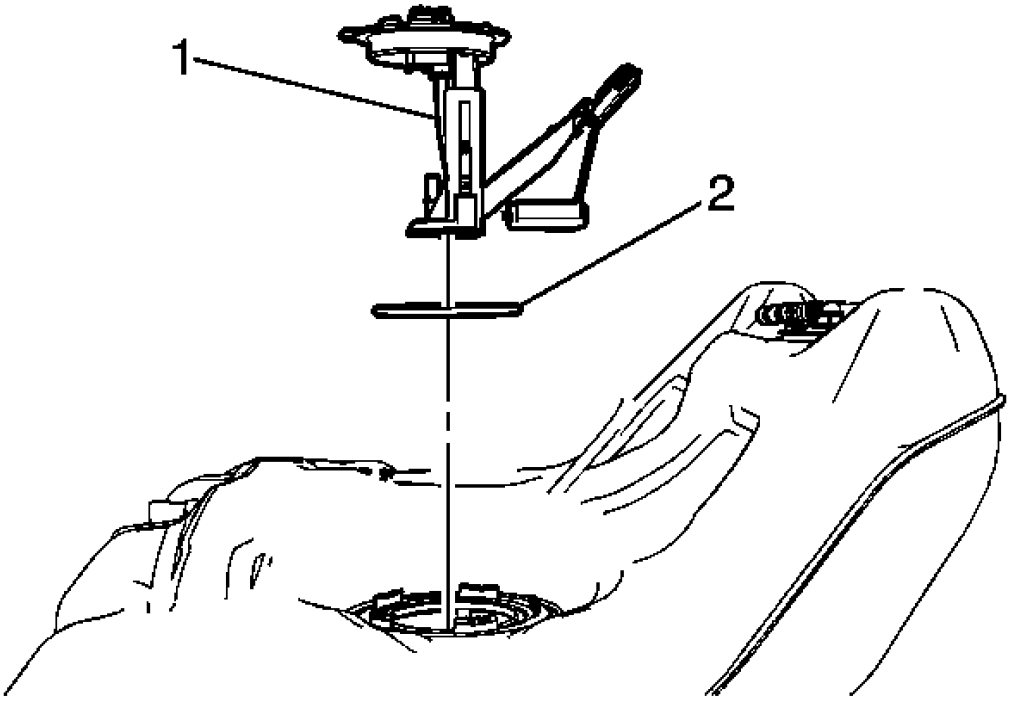


Fig. 72: Secondary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the secondary fuel tank module (1) and the seal (2).

Installation Procedure

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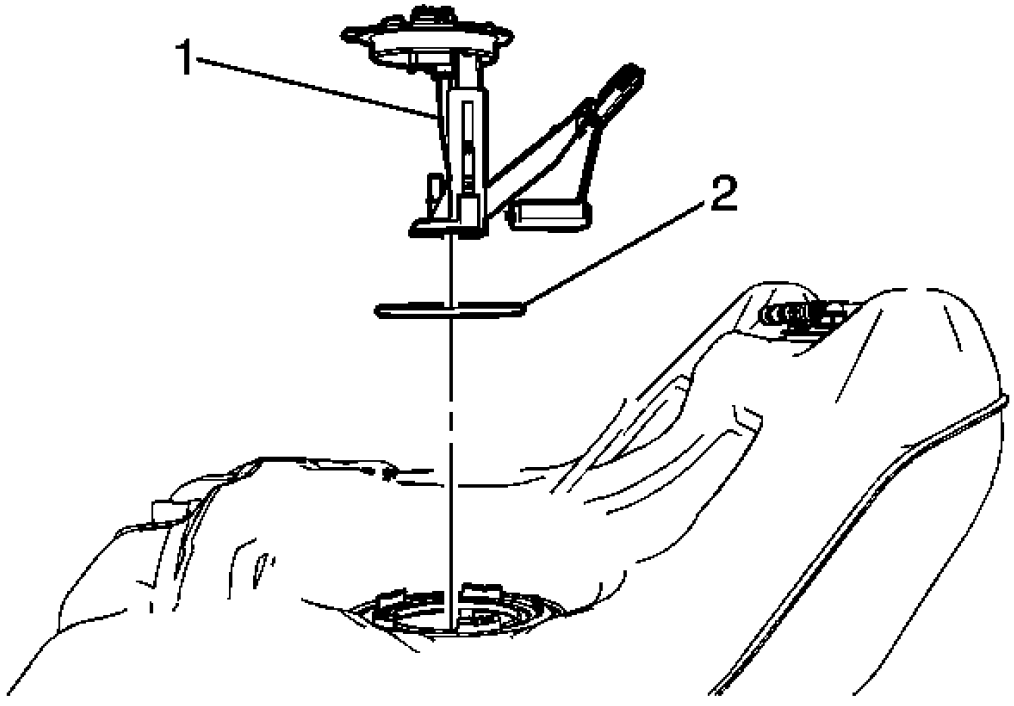


Fig. 73: Secondary Fuel Tank Module & Seal
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW seal (2).

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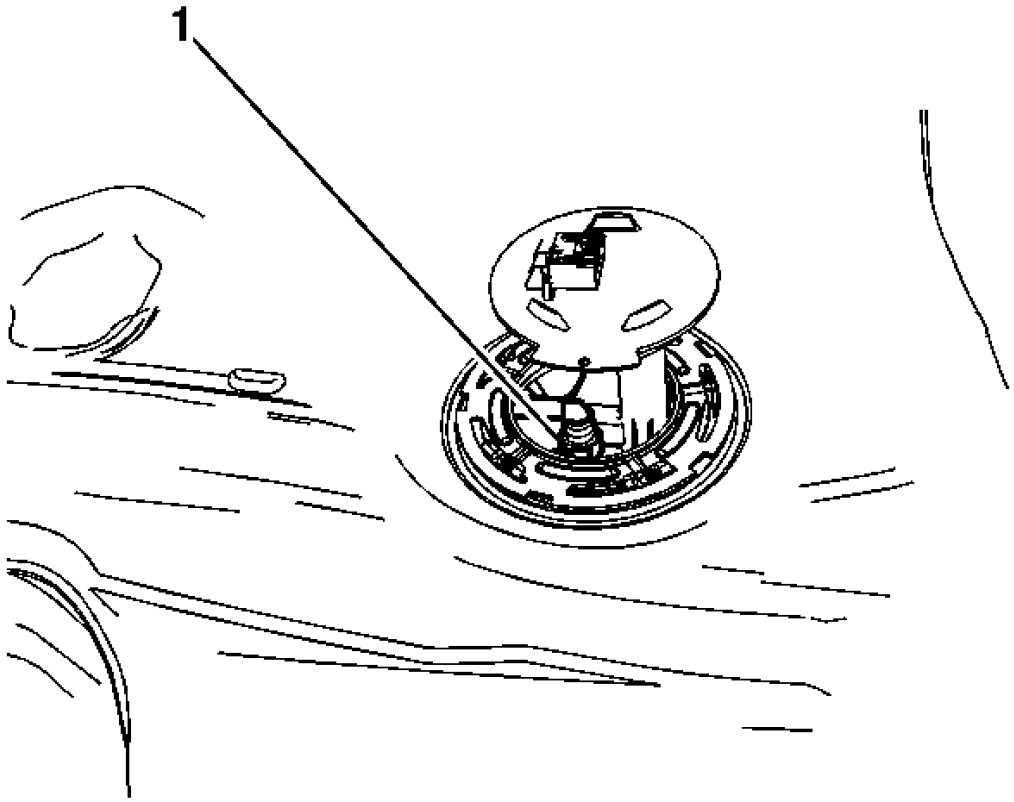


Fig. 74: Fuel Transfer Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

2. Partially install the secondary fuel pump module in order to connect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

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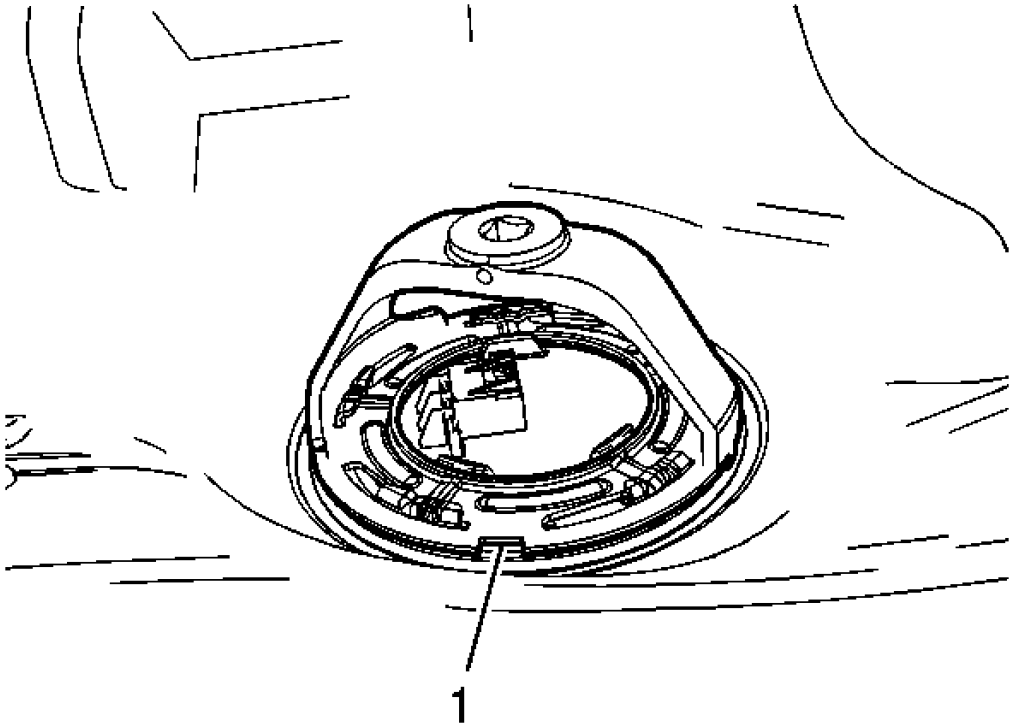


Fig. 75: Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Rotate the lock ring (1) clockwise using the **CH-48482:** wrench and install the lock ring.

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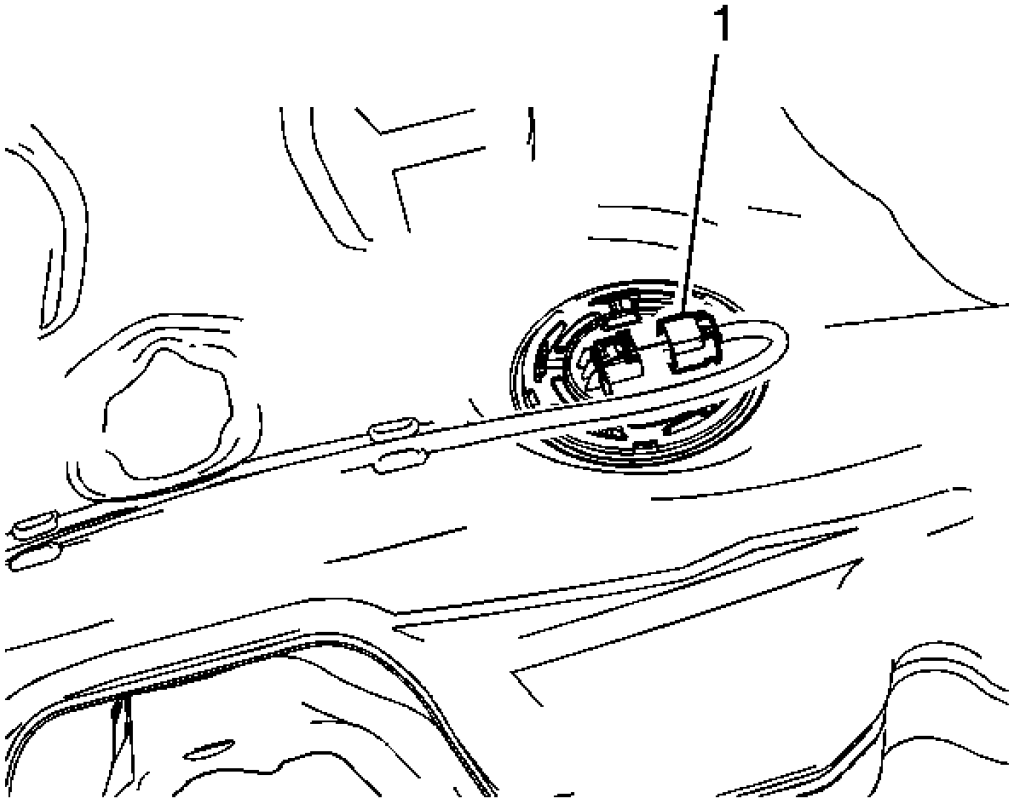


Fig. 76: Secondary Fuel Tank Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the secondary fuel tank module electrical connector (1).
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL LEVEL SENSOR REPLACEMENT - RIGHT SIDE

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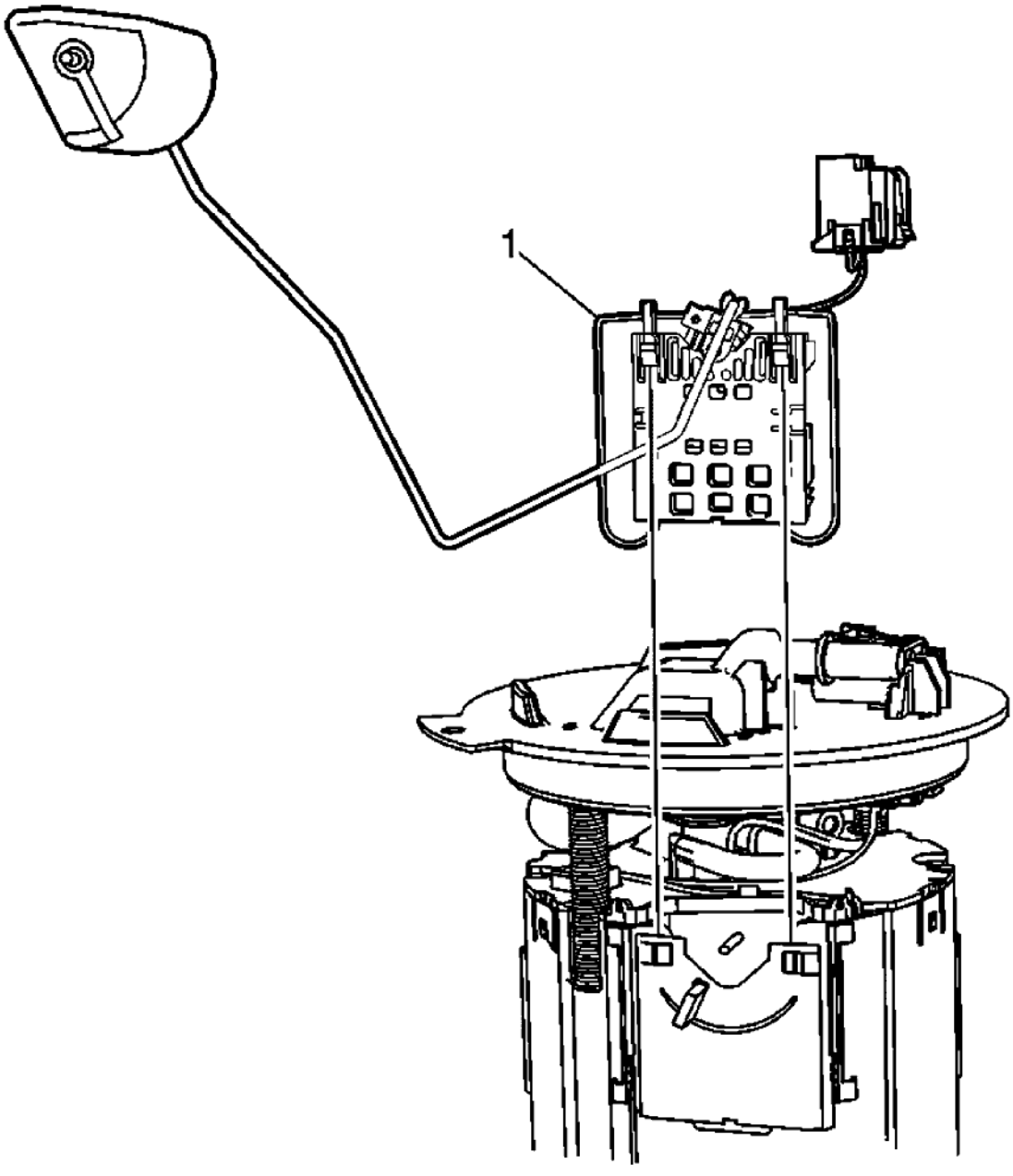


Fig. 77: Fuel Level Sensor - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel pump module-right side. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.	
	Fuel Level Sensor

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1	**Procedure** 1. Push the plastic tabs forward and simultaneously pull upwards. 2. Disconnect the electrical connector.

FUEL LINE REPLACEMENT - CHASSIS

Removal Procedure

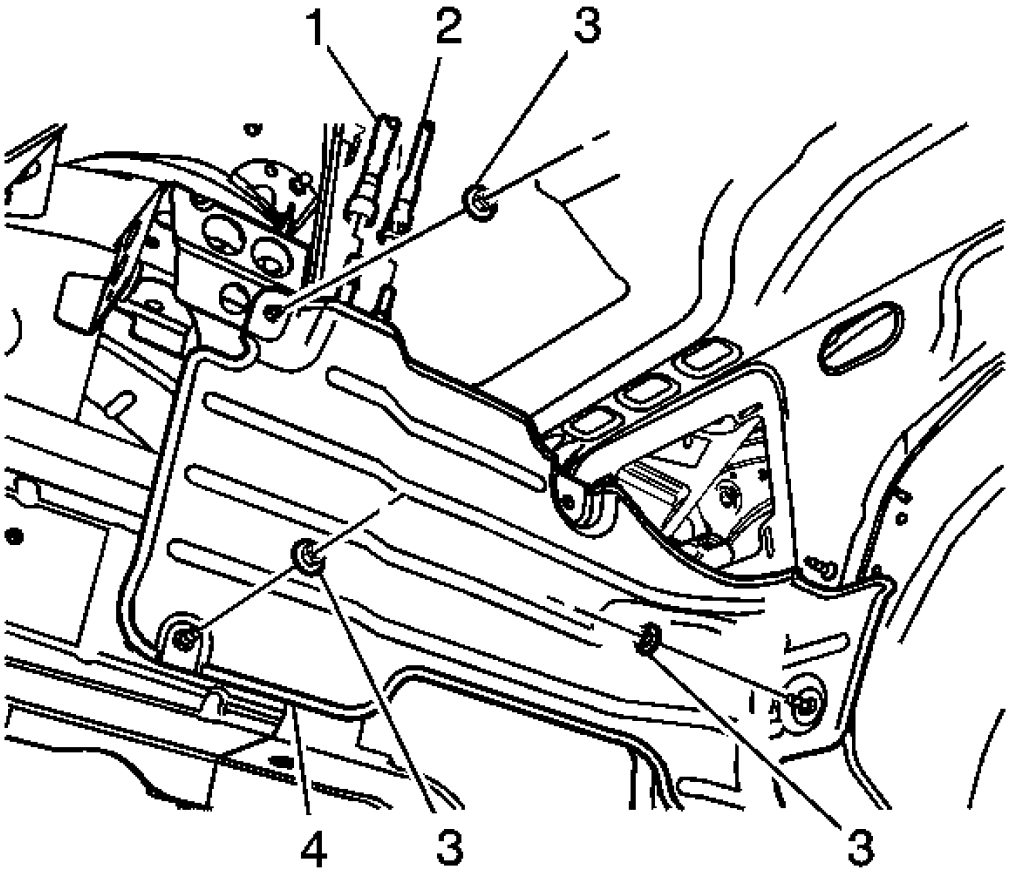


Fig. 78: Fuel Feed Connector, Evaporative Emission Connector, Exhaust Heat Shield Fasteners & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Disconnect the fuel feed connector (1) and the evaporative emission connector (2). Refer to **Metal Collar**

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Quick Connect Fitting Service and **Plastic Collar Quick Connect Fitting Service**.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the exhaust heat shield fasteners (3) and the exhaust heat shield (4).

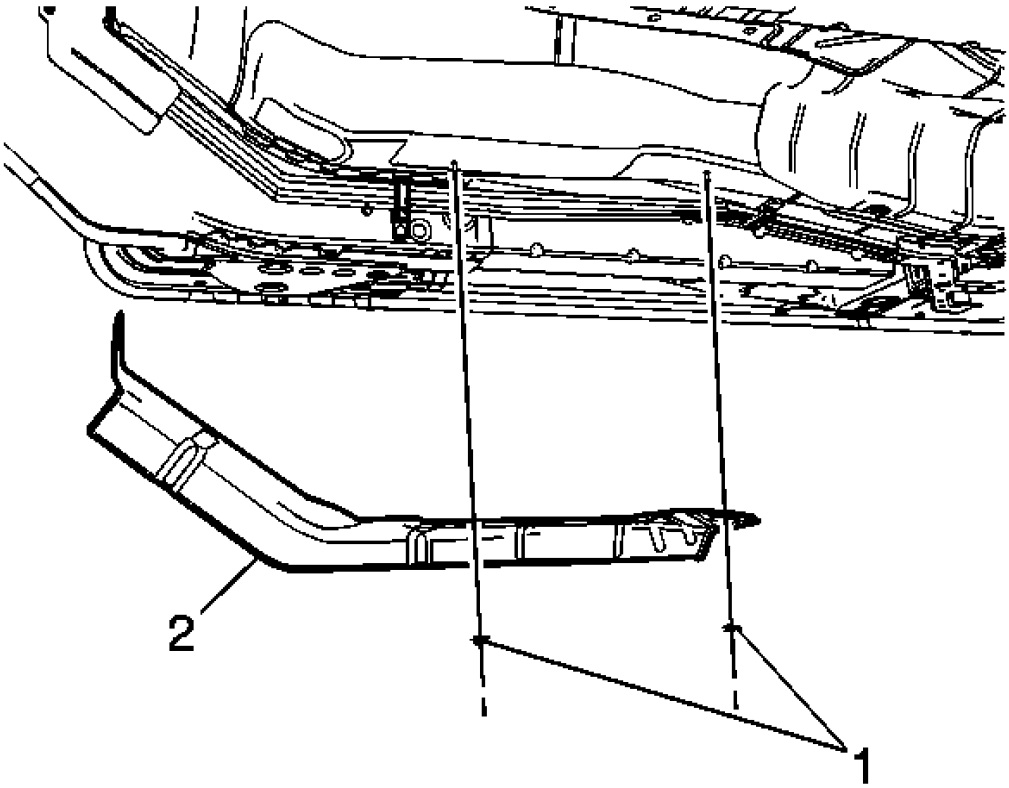


Fig. 79: Exhaust Heat Shield Fastener & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

5. Remove the exhaust heat shield fastener (1) and the exhaust heat shield (2).

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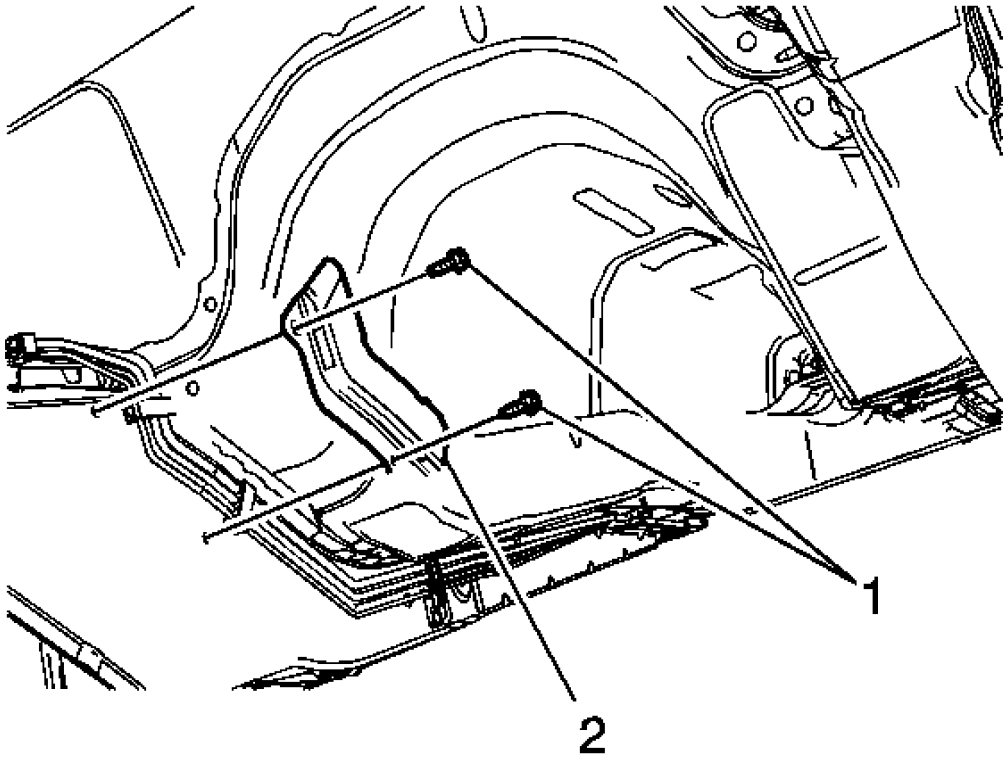


Fig. 80: Brake Pipe Heat Shield Fastener & Heat Shield
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake pipe heat shield fastener (1) and the heat shield (2).

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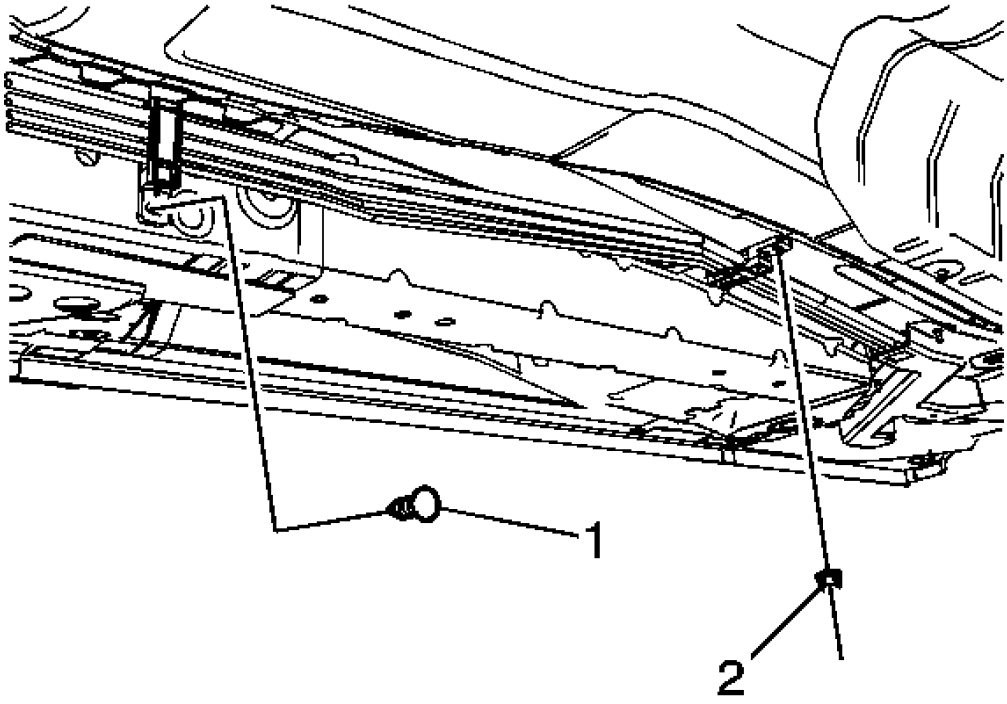


Fig. 81: Plastic Retainer & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the plastic retainer (1) and the retaining nut (2).

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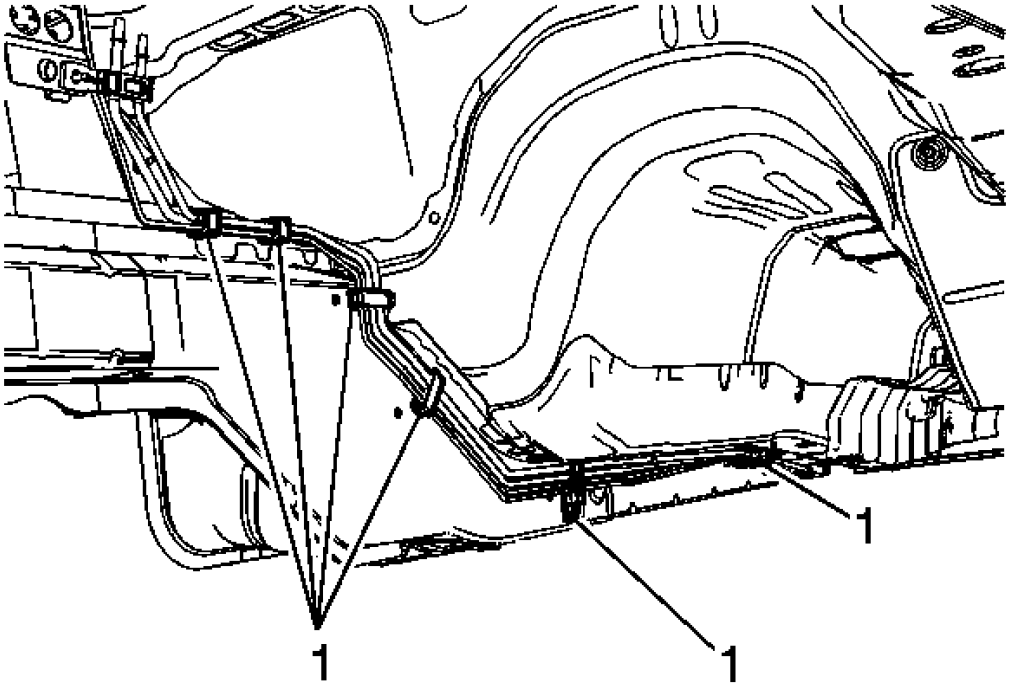


Fig. 82: Fuel Feed Line & Evaporative Emission Line Clips
Courtesy of GENERAL MOTORS CORP.

8. Separate the fuel feed line and the evaporative emission line from the clips (1).

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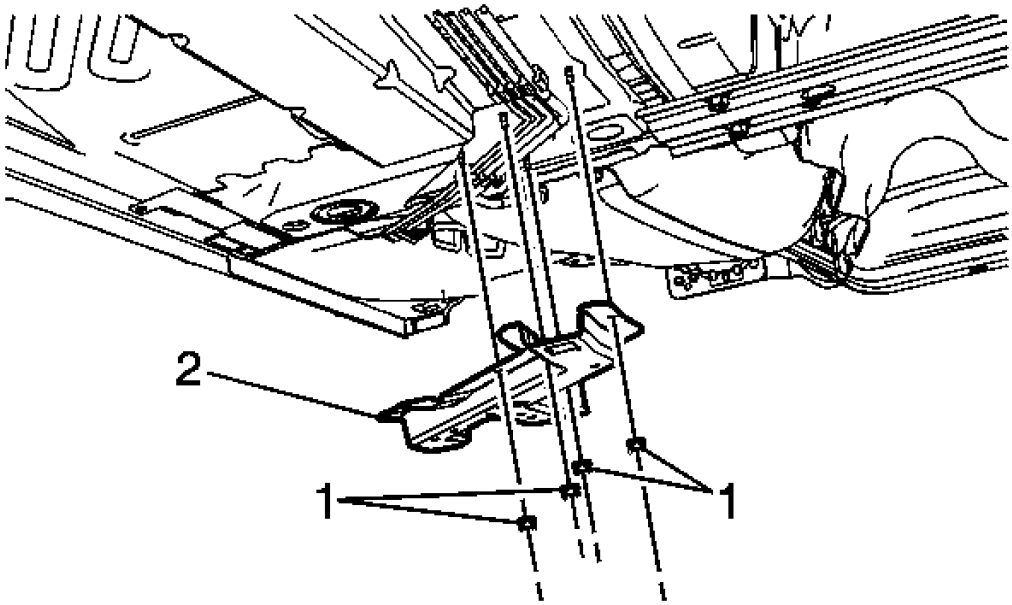


Fig. 83: Protector Bracket Fasteners & Bracket
Courtesy of GENERAL MOTORS CORP.

9. Remove the protector bracket fasteners (1) and remove the bracket (2).

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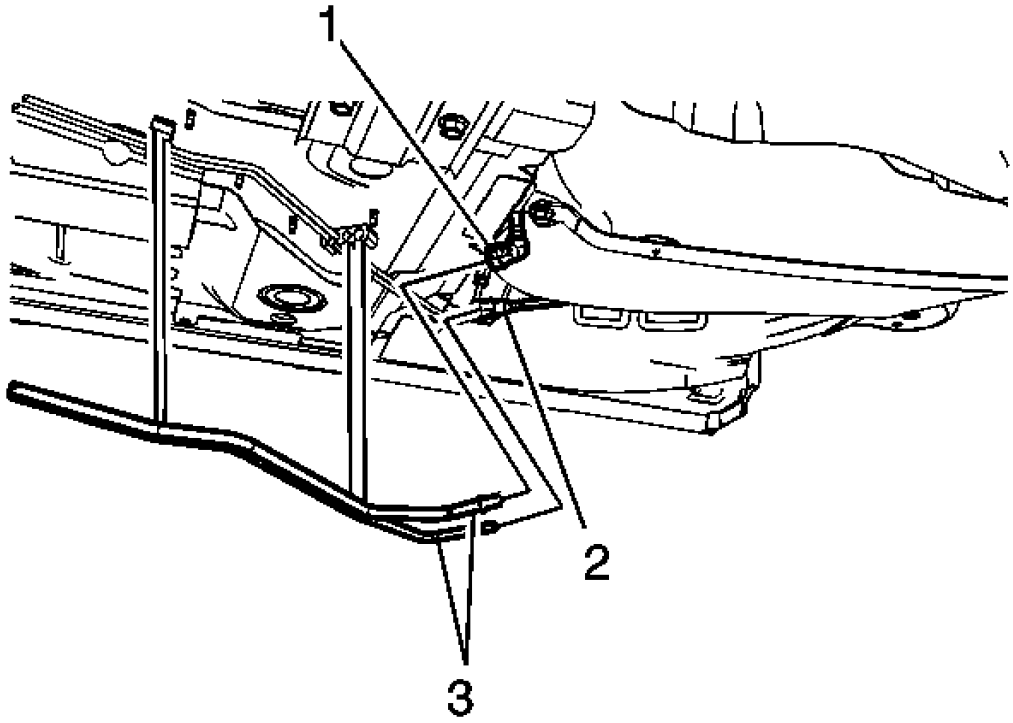


Fig. 84: Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel feed line (1) and the evaporative emission line (2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service**.
11. Remove the pipes (3) from the vehicle.

Installation Procedure

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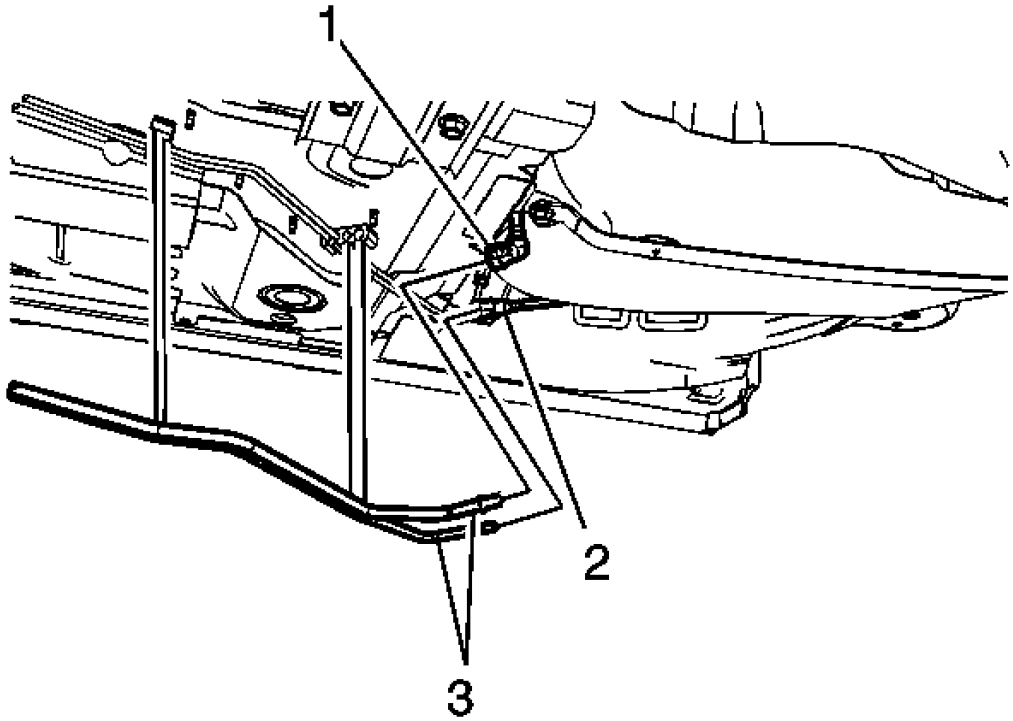


Fig. 85: Fuel Feed Line & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

1. Install the pipes (3) to the vehicle and connect the evaporative emission line (2) and the fuel fed line (1) Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service**.

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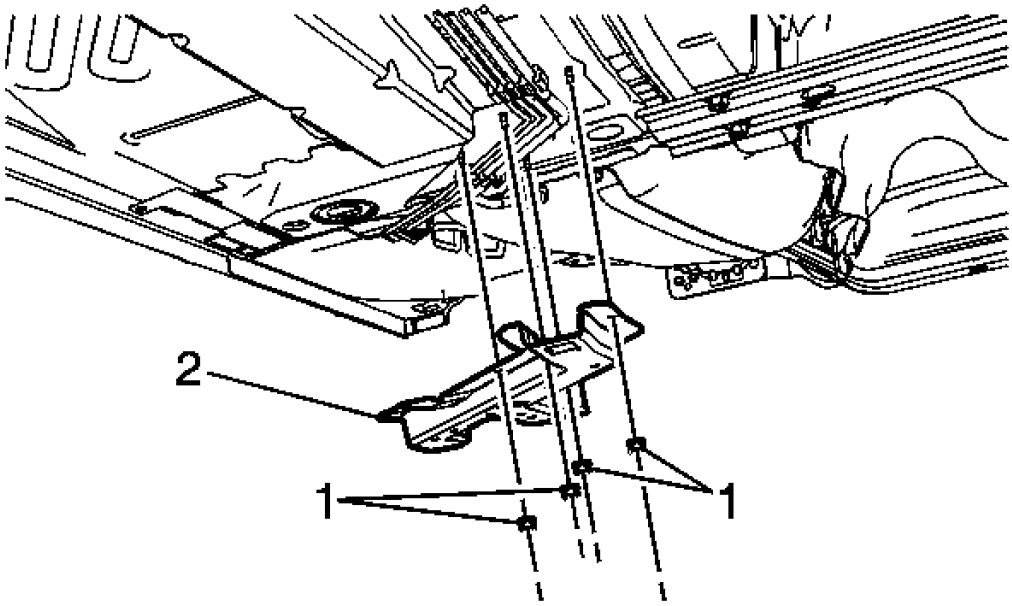


Fig. 86: Protector Bracket Fasteners & Bracket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the protector bracket (2) and the bracket fasteners (1) then tighten to 3 N.m(27 lb in).

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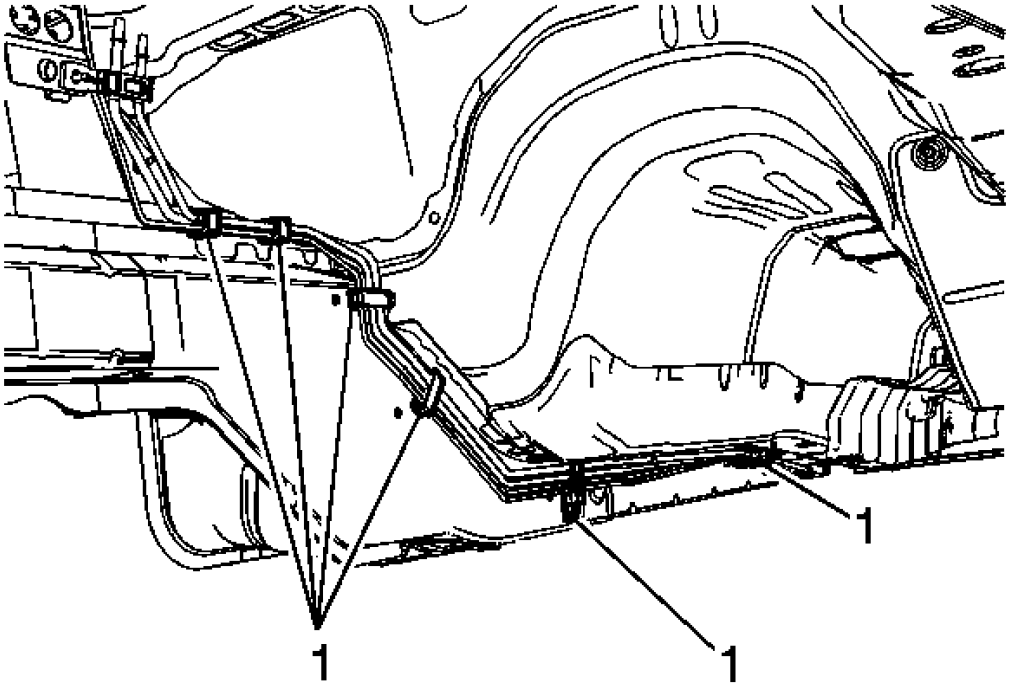


Fig. 87: Fuel Feed Line & Evaporative Emission Line Clips
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel feed line and the evaporative emission line to the clips (1).

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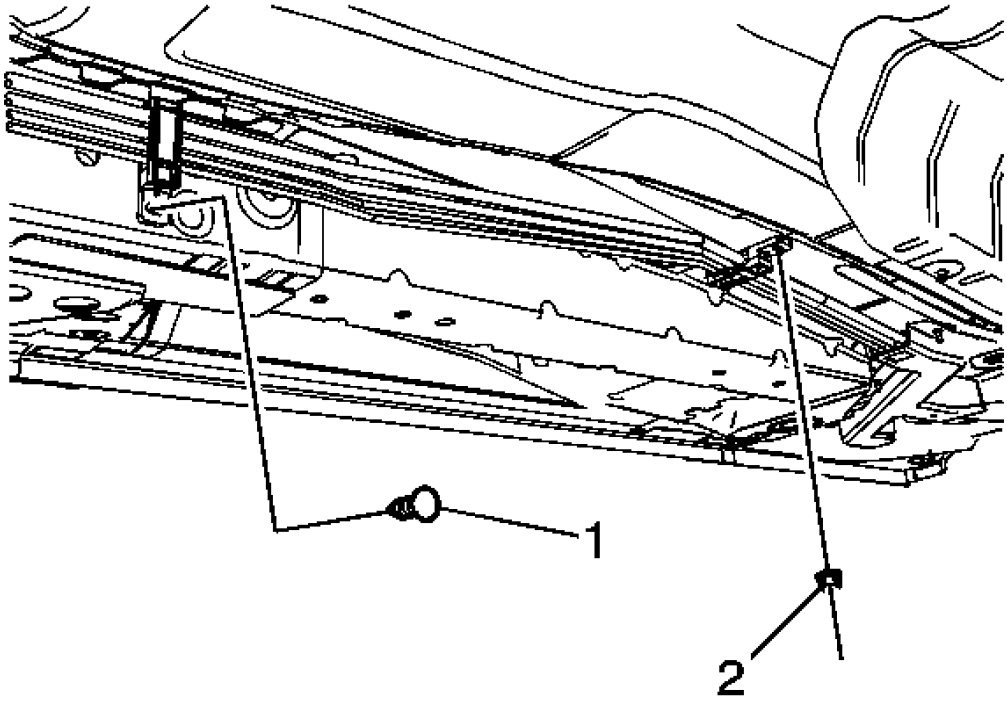


Fig. 88: Plastic Retainer & Retaining Nut
Courtesy of GENERAL MOTORS CORP.

4. Install the plastic retainer (1) and the retaining nut (2), then tighten to 3 N.m (27 lb in).

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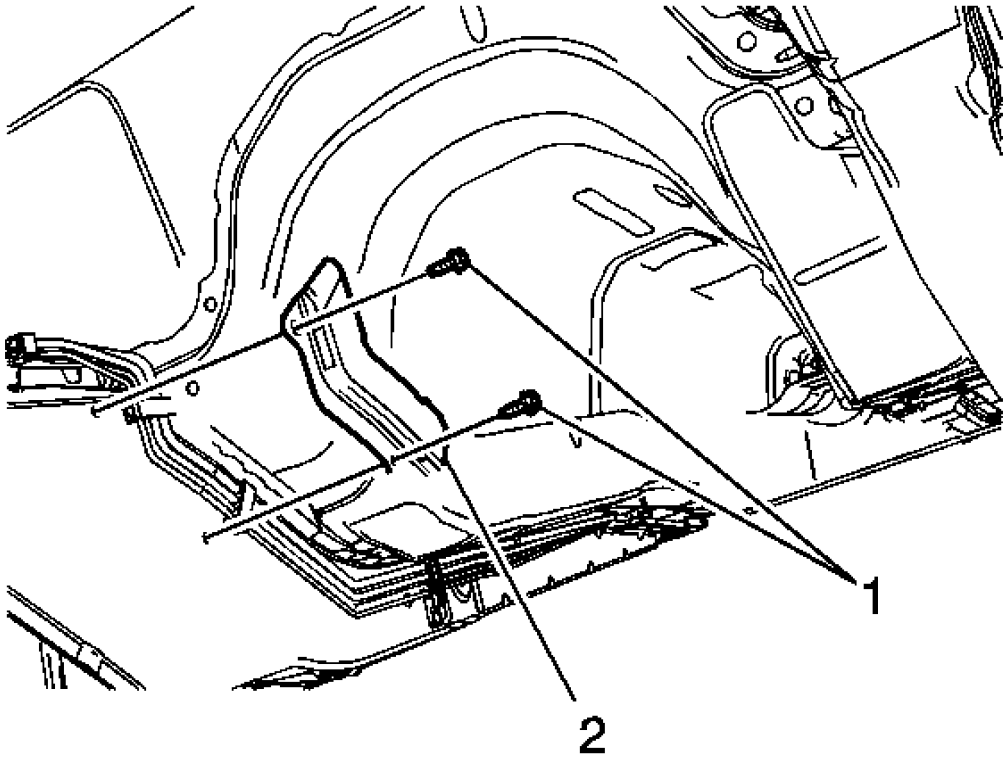


Fig. 89: Brake Pipe Heat Shield Fastener & Heat Shield
Courtesy of GENERAL MOTORS CORP.

5. Install the heat shield (2) and the brake pipe heat shield fastener (1), then tighten to 22 N.m (16 lb ft).

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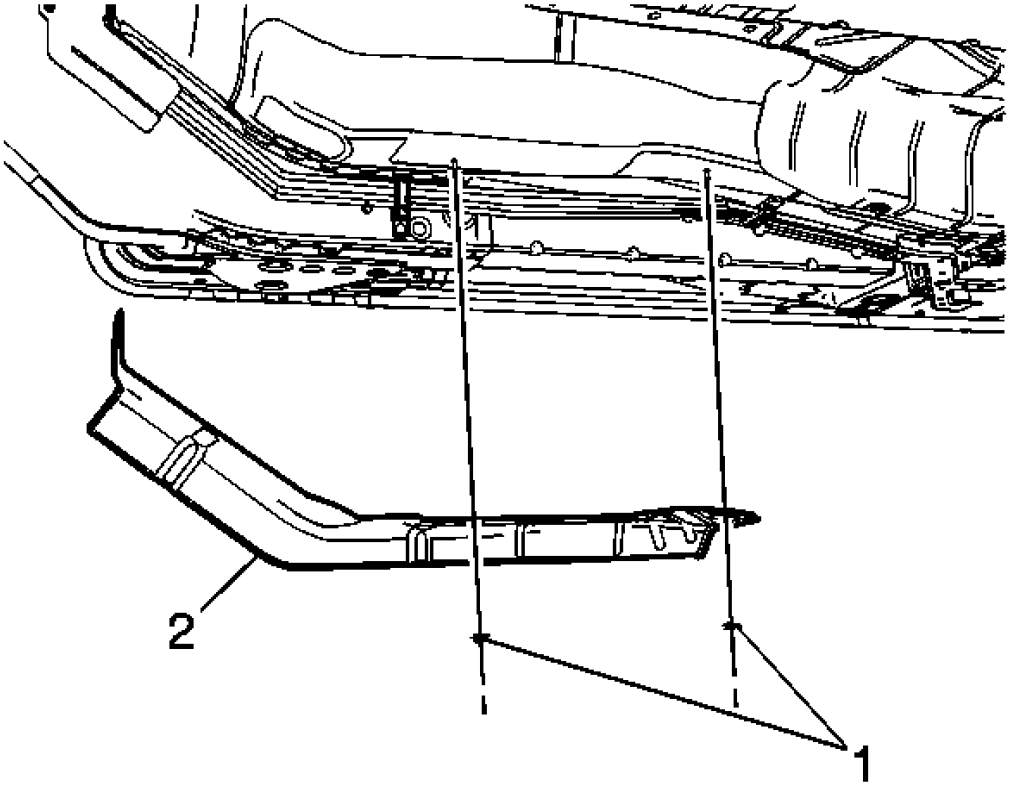


Fig. 90: Exhaust Heat Shield Fastener & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

6. Install the exhaust heat shield (2) and the exhaust heat shield fastener (1), then tighten to 3 N.m (27 lb in).

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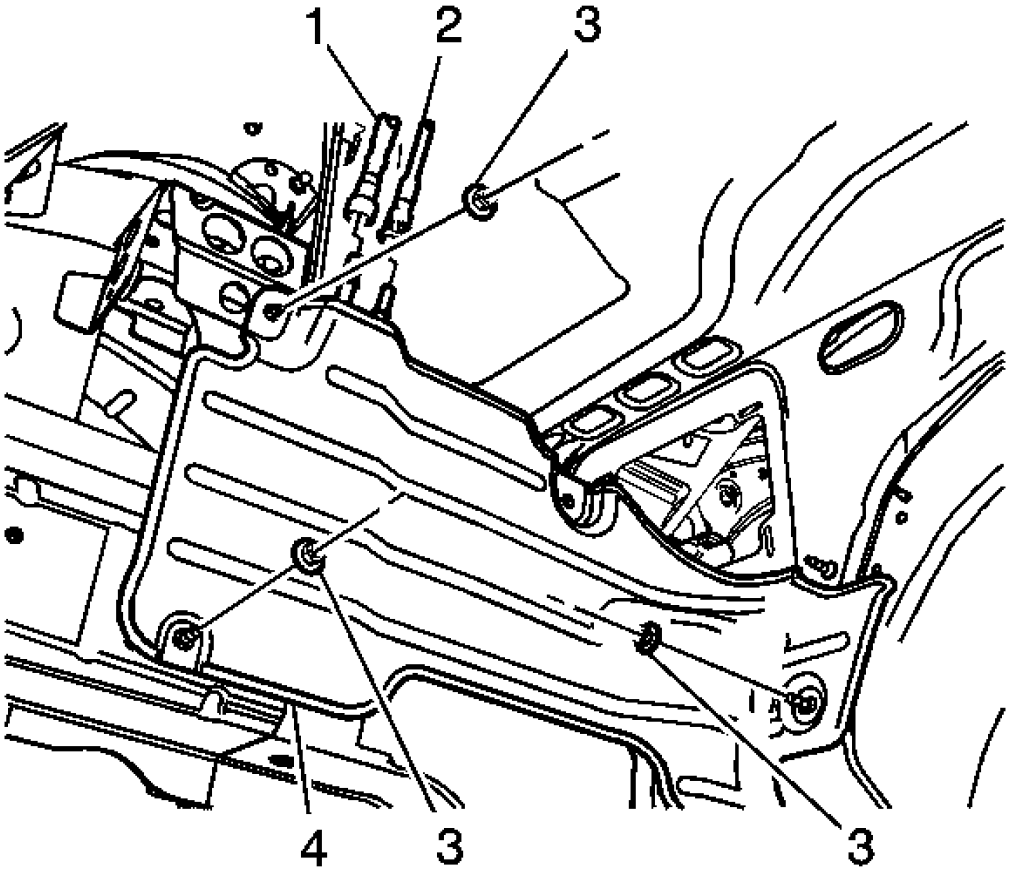


Fig. 91: Fuel Feed Connector, Evaporative Emission Connector, Exhaust Heat Shield Fasteners & Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

7. Install the exhaust heat shield (4) and the exhaust heat shield fasteners (3), then tighten to 6 N.m (53 lb in).
8. Connect the fuel feed connector (1) and the evaporative emission connector (2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service**.
9. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

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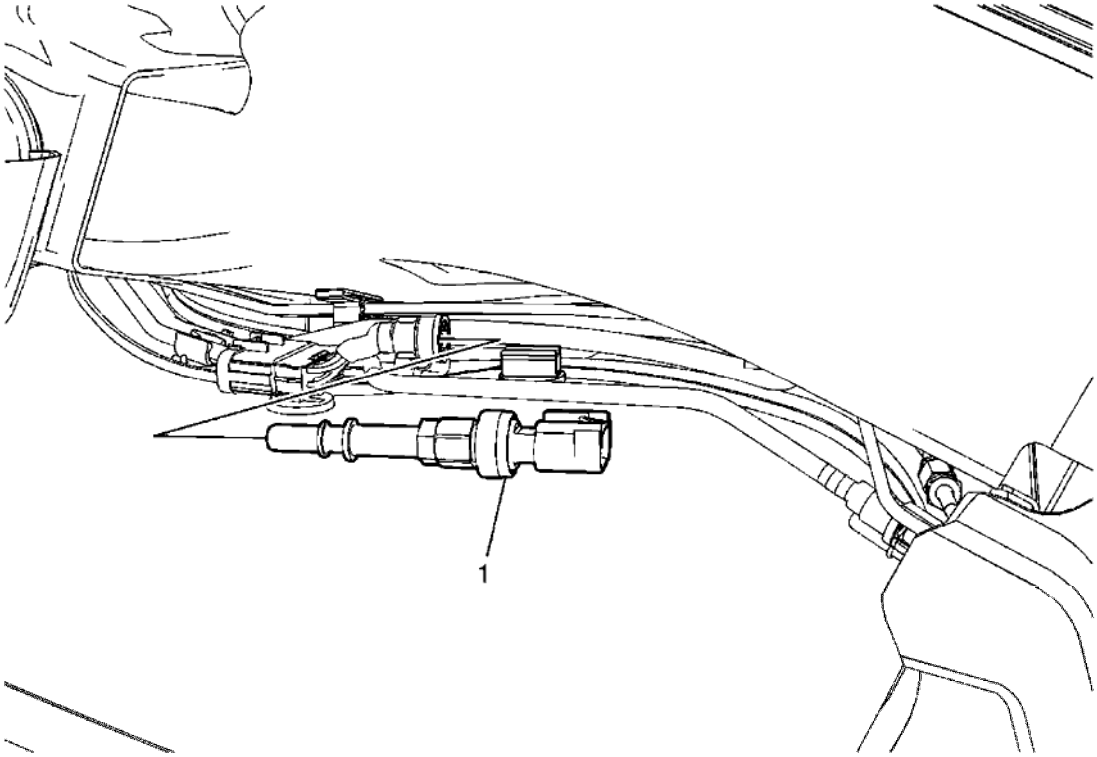


Fig. 92: Fuel Pressure Sensor - Fuel Feed Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel pressure. Refer to **Fuel Pressure Relief**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Fuel Pressure Sensor **Procedure** 1. Disconnect the fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**. 2. Disconnect the electrical connector.

FUEL FEED PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve the low side fuel system pressure. Refer to **Fuel Pressure Relief**.

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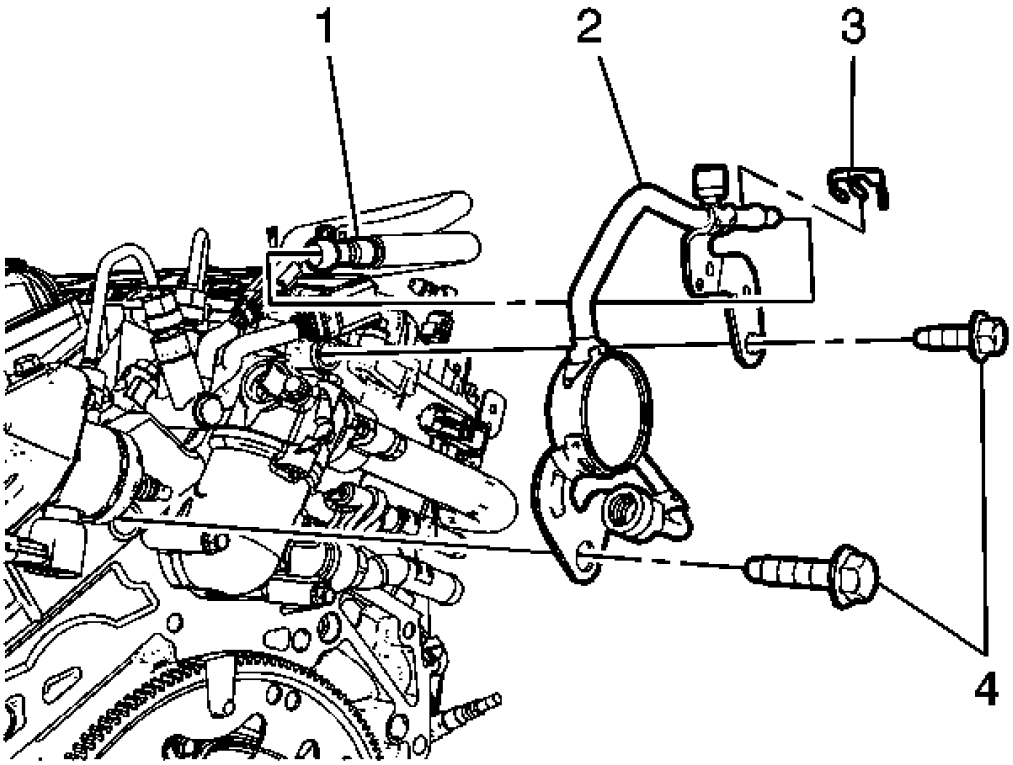


Fig. 93: Identifying Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fuel feed line quick connect fitting from the fuel feed pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**.
5. Loosen the fuel feed pipe fitting to the high pressure fuel pump.
6. Remove the fuel feed pipe bolts (4) from the cylinder heads.
7. Remove the fuel feed pipe from the engine and high pressure fuel pump. Discard the pipe.

Installation Procedure

1. Ensure that the fuel feed pipe and fuel pump fittings are clean and dry prior to assembly.

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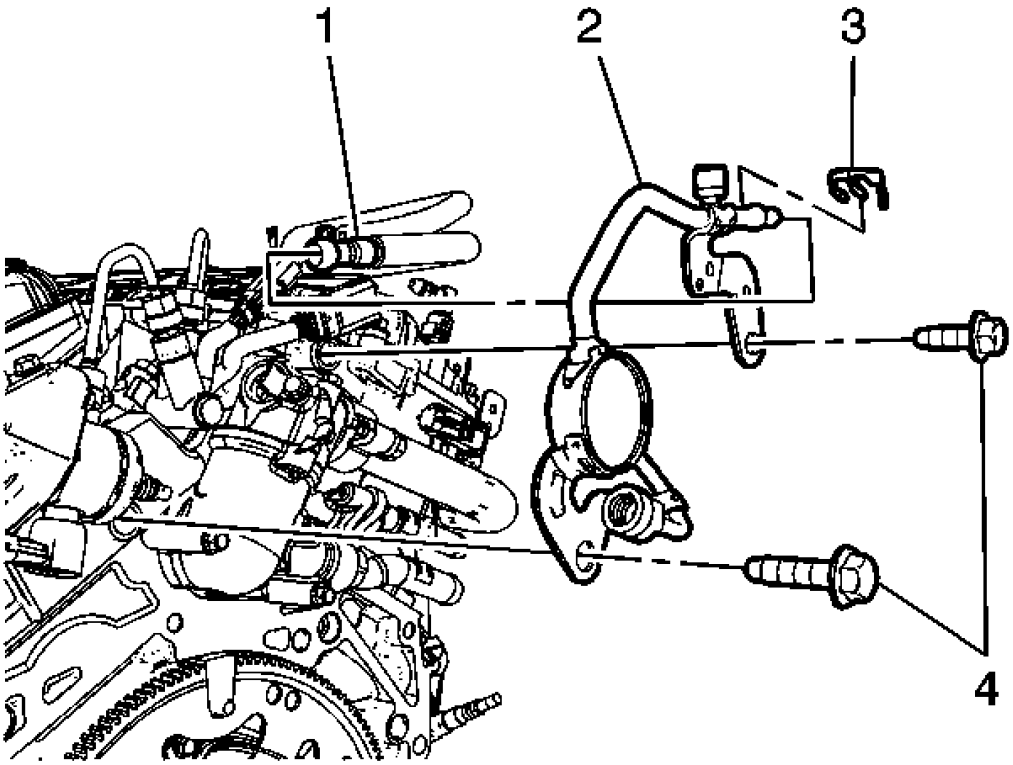


Fig. 94: Identifying Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS CORP.

2. Position the NEW fuel feed pipe (2) to the cylinder head and high pressure fuel pump.
3. Install the fuel feed pipe fitting to the high pressure fuel pump hand tight.

CAUTION: Refer to Fastener Caution

4. Install the fuel feed pipe bolts (4).
    1. Tighten the bolts to 50 N.m (37 lb ft).
    2. Tighten the fitting to 28 N.m (20 lb ft).
5. Connect the fuel feed line quick connect fitting to the fuel feed pipe (2). Refer to **Fuel Pipe Shield Replacement**.

NOTE: If a fuel leak accrues at the high pressure fuel pump, the pump will need to be replaced.

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6. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
7. Install the low side fuel pressure service port cap.
8. Install the fuel tank cap.
9. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
10. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .

FUEL SYSTEM CLEANING

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is contaminated, the fuel system can be cleaned. You can usually determine the extent of the fuel system contamination during the disassembly.

1. Remove the fuel module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** and **Fuel Level Sensor Replacement - Left Side**.
2. Locate the tank in a suitable work area away from any heat, any flame, or any other source of ignition.
3. Perform the following procedures:
    - Inspect the fuel sender strainer. Replace the primary fuel tank module if the strainer is contaminated.
    - Inspect the secondary fuel tank module for debris. Clean the secondary fuel tank module if debris is found.

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

    - Use compressed air in order to apply air pressure to the transfer tube.

NOTE: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all applicable local, state, and federal laws and regulations.

4. Flush the fuel tank with running hot water for at least five minutes. Pour the water out of the fuel sender assembly opening. Rock the tank in order to ensure that the removal of the water from the tank is complete.
5. Refer to **Metal Collar Quick Connect Fitting Service** in order to disconnect the following quick connect fittings from the fuel rail:

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- The feed hose/pipe
- The return hose/pipe

6. Use compressed air in order to apply air pressure to the fuel lines in the opposite direction from the normal fuel flow.
7. Remove the fuel injectors and fuel rail.
8. Clean and inspect the fuel injectors and fuel rail.

Installation Procedure

Assemble the fuel system as follows:

1. Install the fuel injectors and fuel rail.
2. Install the fuel module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side** and **Fuel Level Sensor Replacement - Left Side**.
3. Refer to **Metal Collar Quick Connect Fitting Service** in order to connect the following quick connect fittings to the fuel rail:
   - The feed hose/pipe
   - The return hose/pipe

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the cross vehicle brace.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the foam insulator from the fuel rails.

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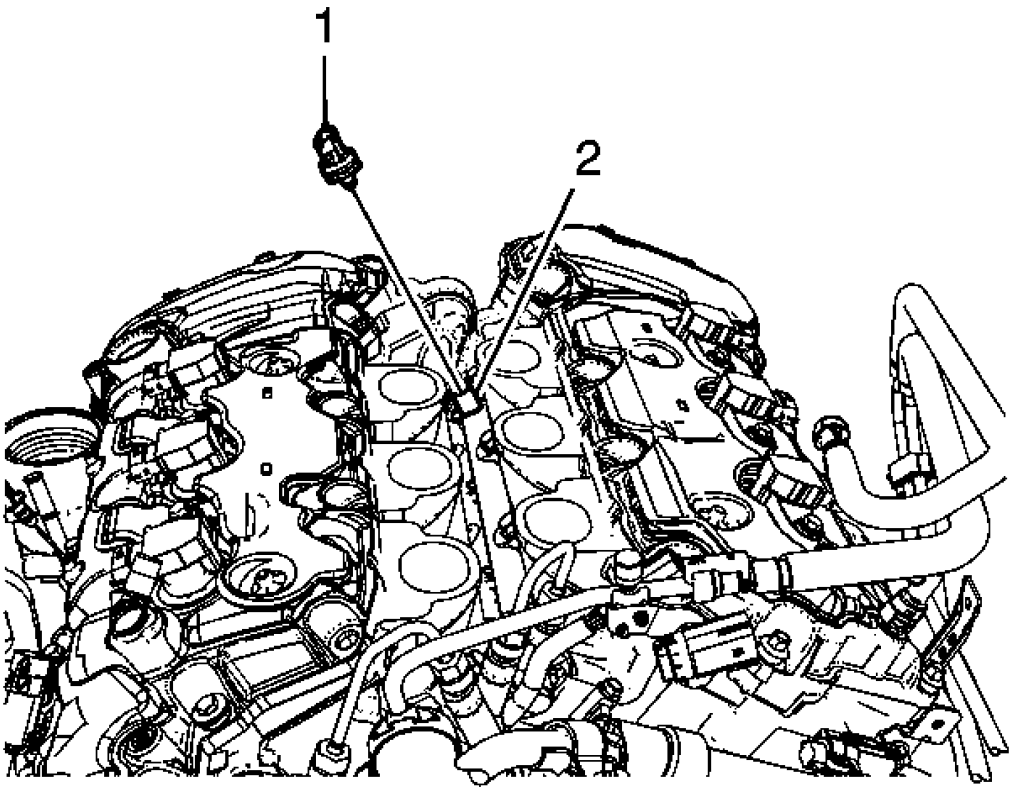


Fig. 95: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

5. Using a 27 mm socket, remove the fuel pressure sensor (1) from the fuel injection fuel rail (2). Discard the fuel pressure sensor.
6. Allow any fuel to drain from the fuel rail and pressure sensor location.
7. Dry the sealing cone in the fuel rail and the area around the sensor joint with a lint free cloth.
8. Inspect the sealing cone in the fuel rail. The surface should be free of fuel, debris, and burrs.

Installation Procedure

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

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NOTE: Ensure that the fuel rail threads have been cleaned of any excess fuel, or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

1. Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
2. Lubricate the threads and sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.

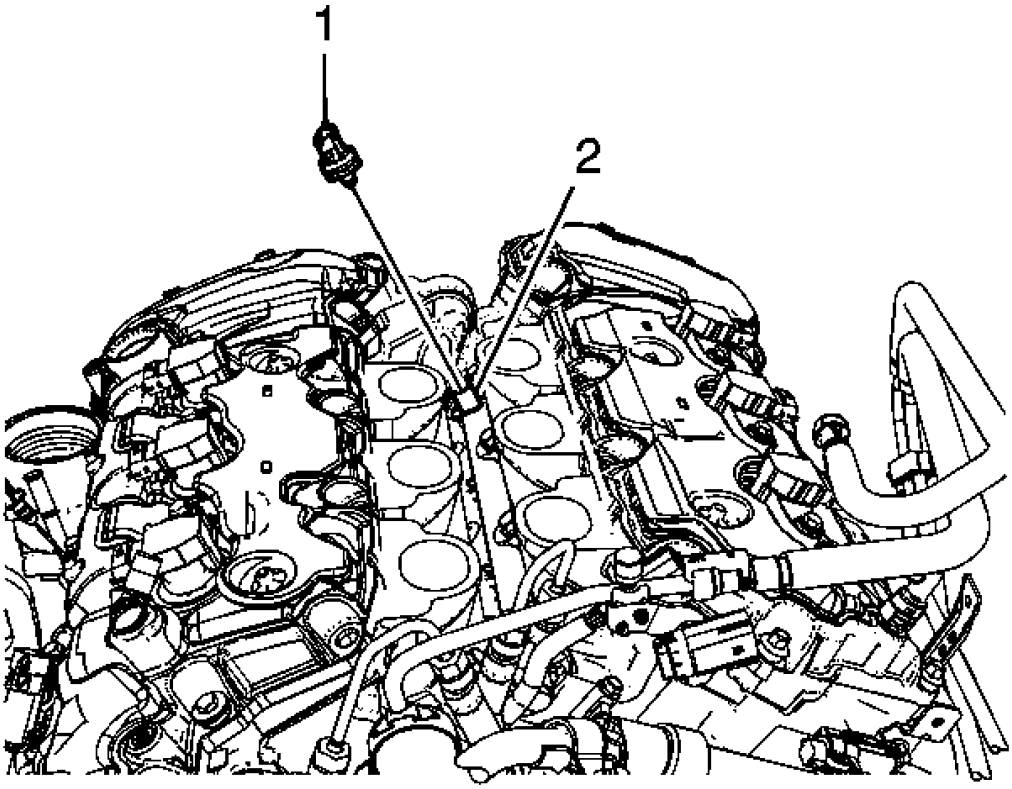


Fig. 96: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) hand tight.
4. Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.

CAUTION: Refer to Fastener Caution .

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5. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) and tighten the sensor to 33 N.m (25 lb ft).
6. Install the foam insulator from the fuel rails.
7. Install the intake manifold. Refer to **Intake Manifold Replacement** .

NOTE: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

8. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
9. Install the cross vehicle brace.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the cross vehicle brace.
3. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
4. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
5. Remove the high pressure fuel pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
6. Remove the fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**. Discard the pipe.
7. Remove the foam insulator from the fuel rails.

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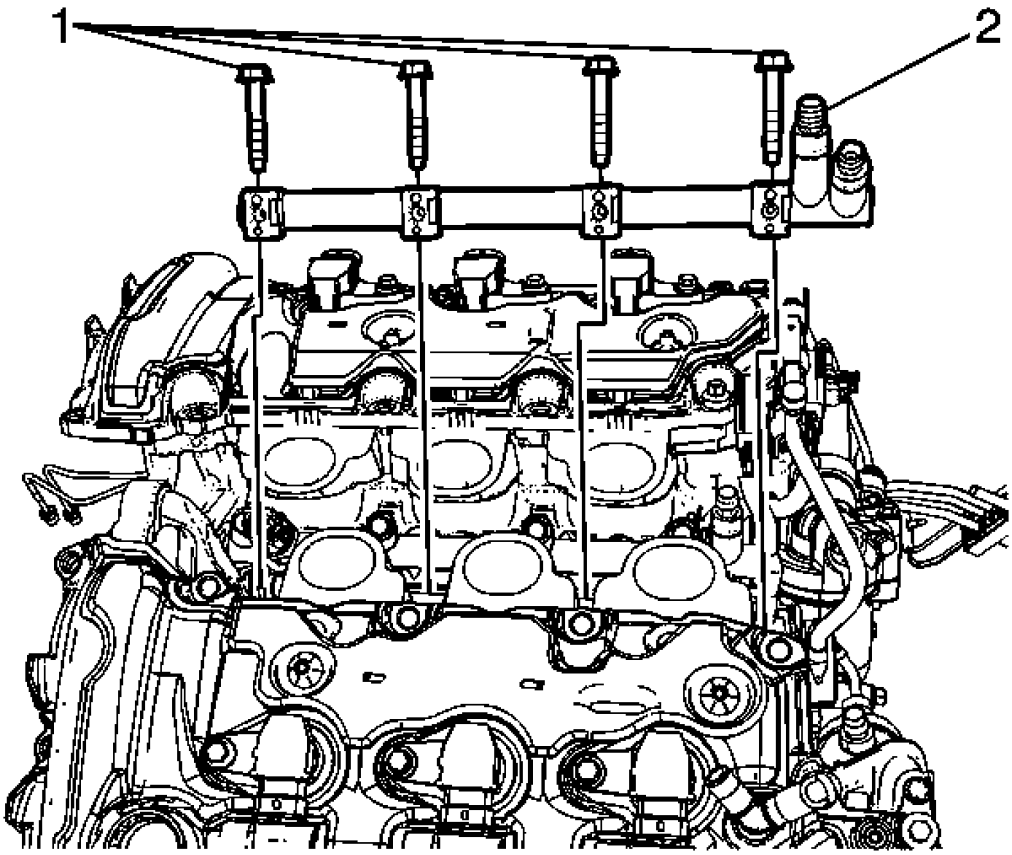


Fig. 97: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the fuel pressure sensor electrical connector and cut the wire harness tie straps.
9. Remove the fuel rail (2) bolts (1).

CAUTION: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

10. Remove the fuel pressure sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.
11. Remove and discard the direct fuel injector hold down clamps.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

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12. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Injector Replacement**.

Installation Procedure

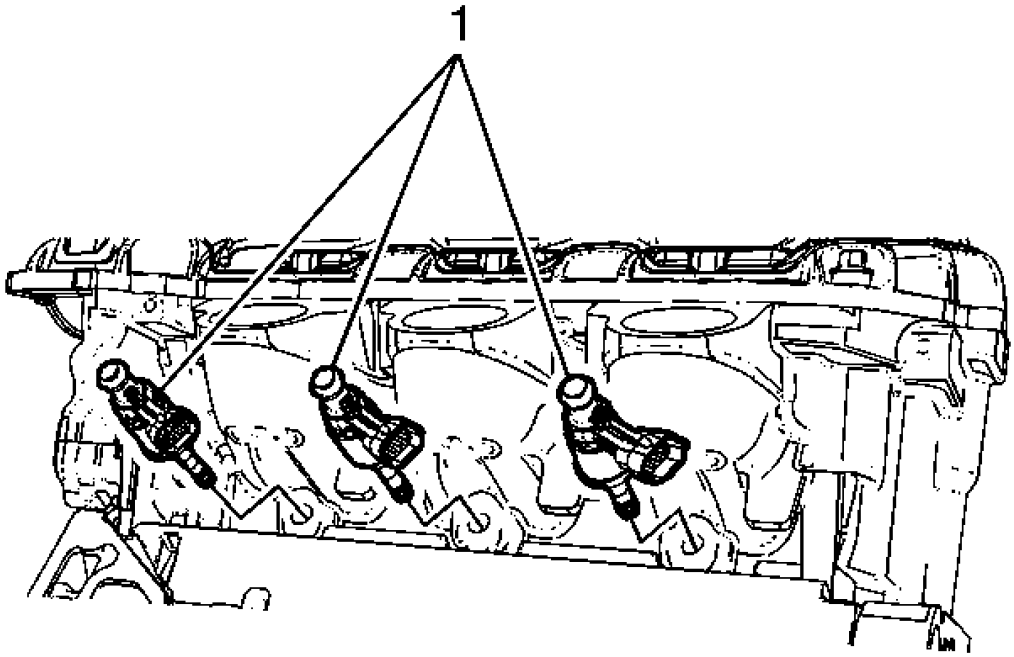


Fig. 98: Identifying Rebuilt Direct Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to **Fuel Injector Replacement**.
2. Install NEW direct injector hold down clamps to the injector.

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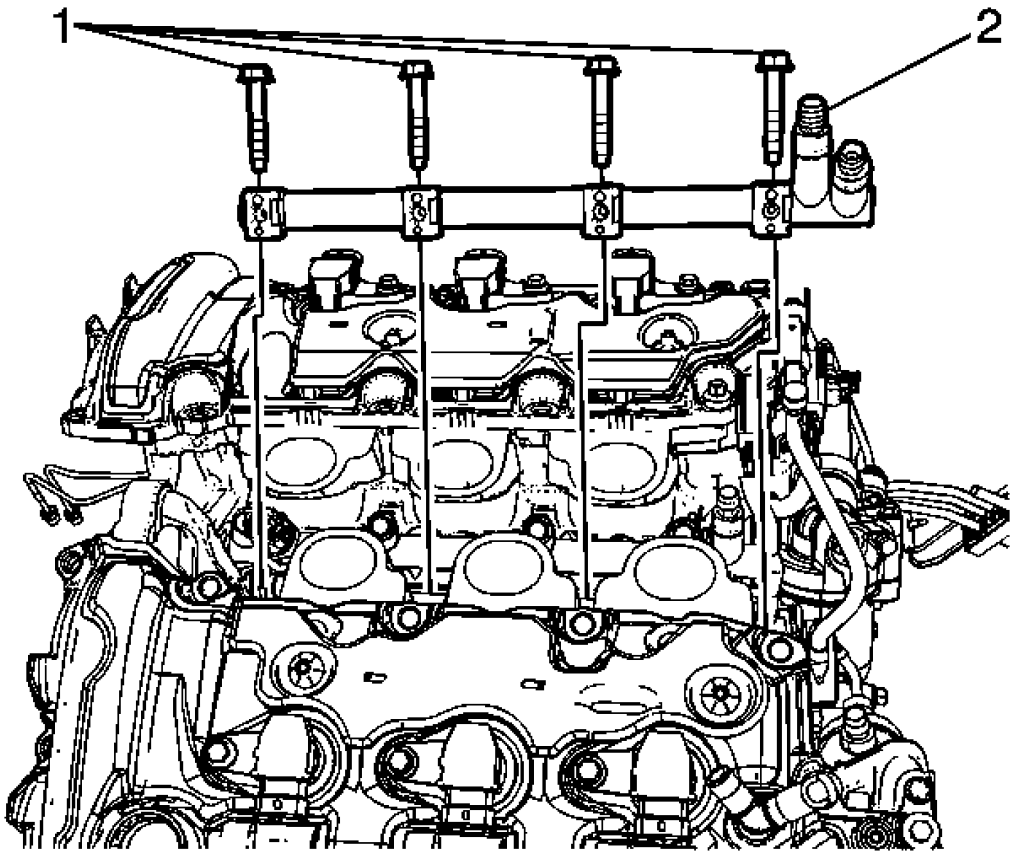


Fig. 99: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

3. On a new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts, and hand tighten.

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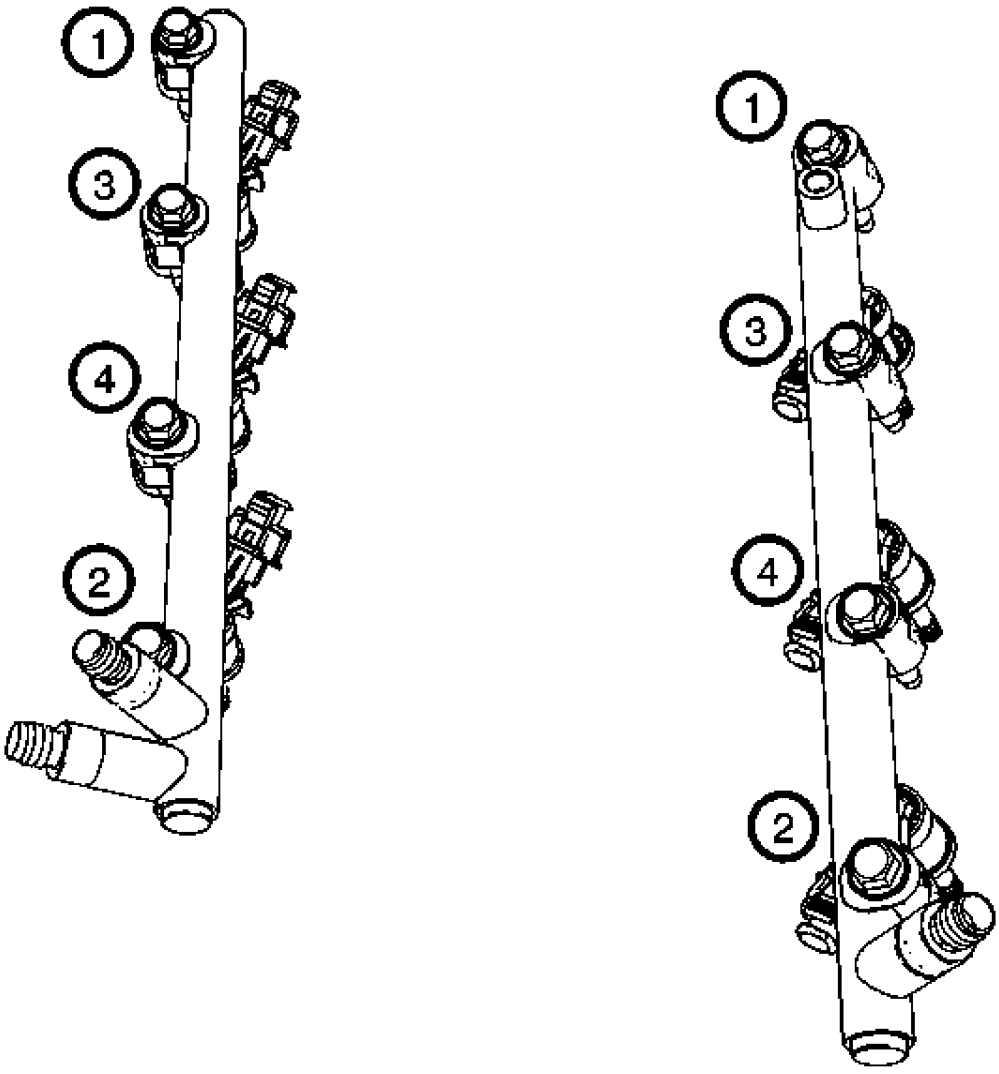


Fig. 100: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the fuel rail bolts in the sequence shown:
   - Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
   - Tighten the Bank 1 fuel rail bolts final pass to 23 N.m (17 lb ft).

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7. Install a NEW fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**.
8. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
9. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.
10. Connect the fuel injector wiring harness electrical connector to the fuel injectors, fuel rail and fuel pressure sensor.
11. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
12. Install the foam insulator from the fuel rails.
13. Install the intake manifold. Refer to **Intake Manifold Replacement** .
14. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
15. Install the low side fuel pressure service port cap.
16. Install the fuel tank cap.
17. Install the cross vehicle brace.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.
4. Remove the fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**. Discard this pipe.

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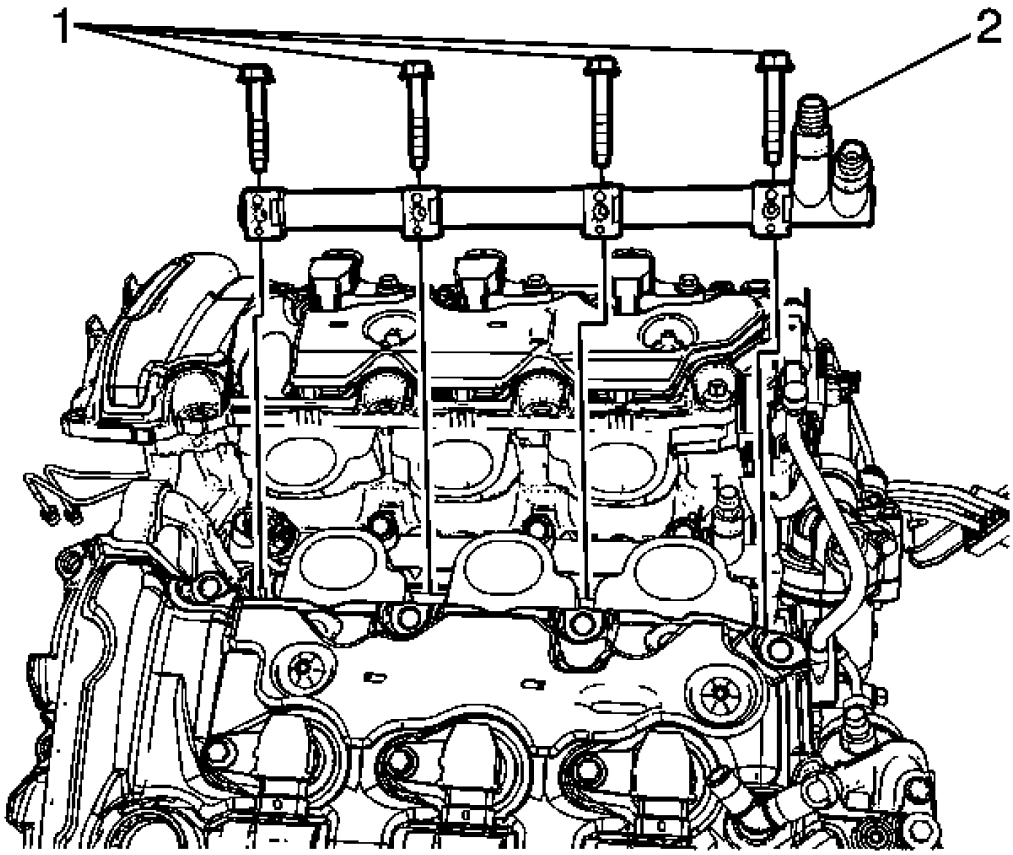


Fig. 101: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel rail bolts (1).
6. Carefully remove the Bank 2 fuel rail (2) from the engine. Lift the rear of the rail to ease removal.
7. Remove and discard the direct fuel injector hold down clamps.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

8. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Injector Replacement**.

Installation Procedure

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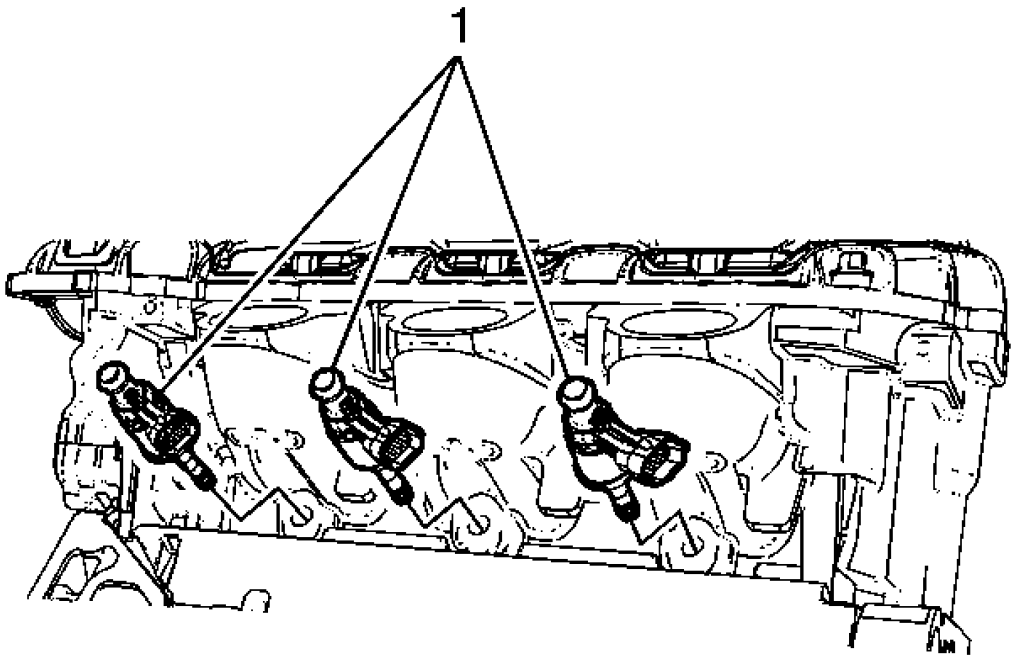


Fig. 102: Identifying Rebuilt Direct Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to **Fuel Injector Replacement**.
2. Install new direct injector hold down clamps to the injectors.

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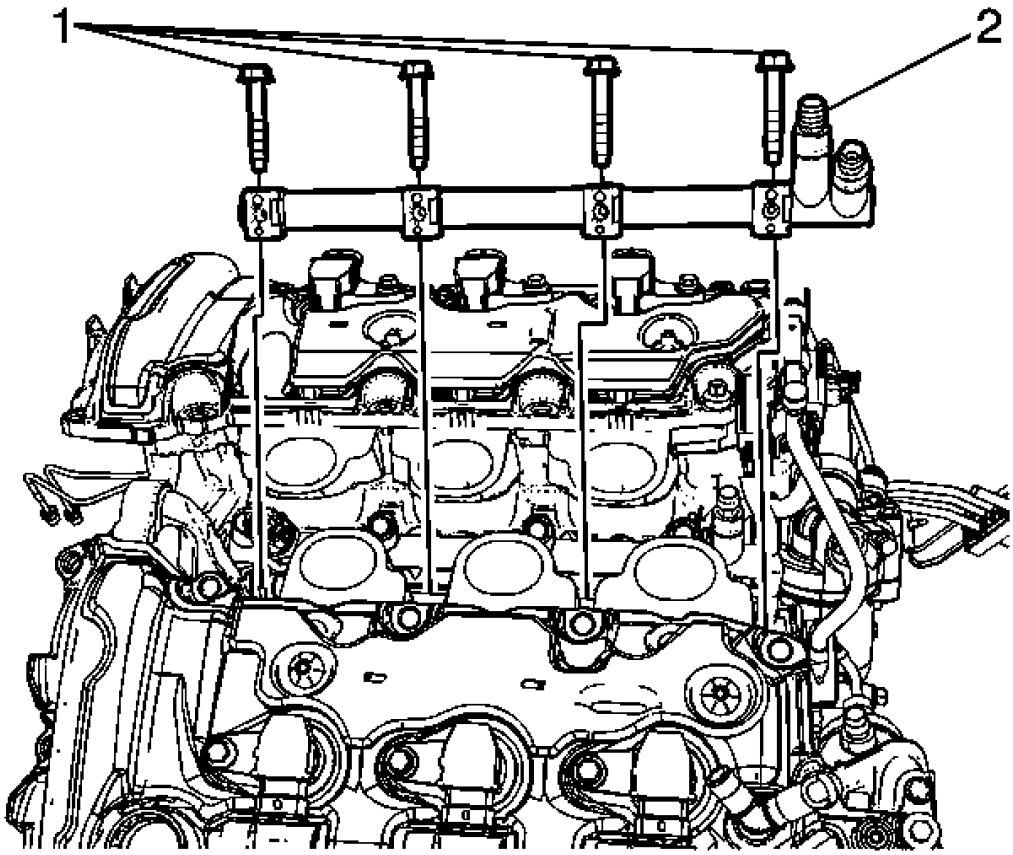


Fig. 103: Identifying Fuel Rail & Bolts
Courtesy of GENERAL MOTORS CORP.

3. On the new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts and hand tighten.

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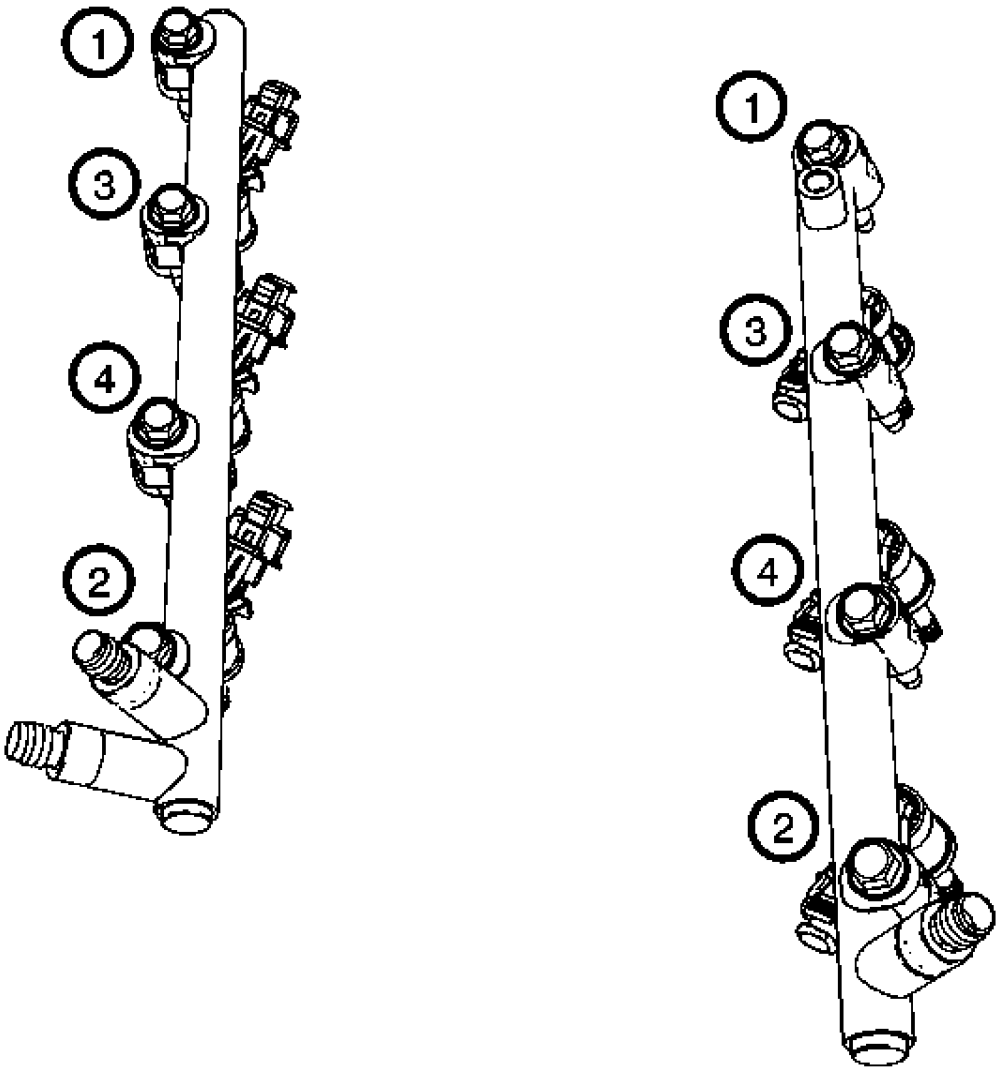


Fig. 104: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the fuel rail bolts in the sequence shown:
   - Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
   - Tighten the Bank 1 fuel rail bolts a final pass to 23 N.m (17 lb ft).

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7. Install a NEW fuel rail crossover pipe. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement**.

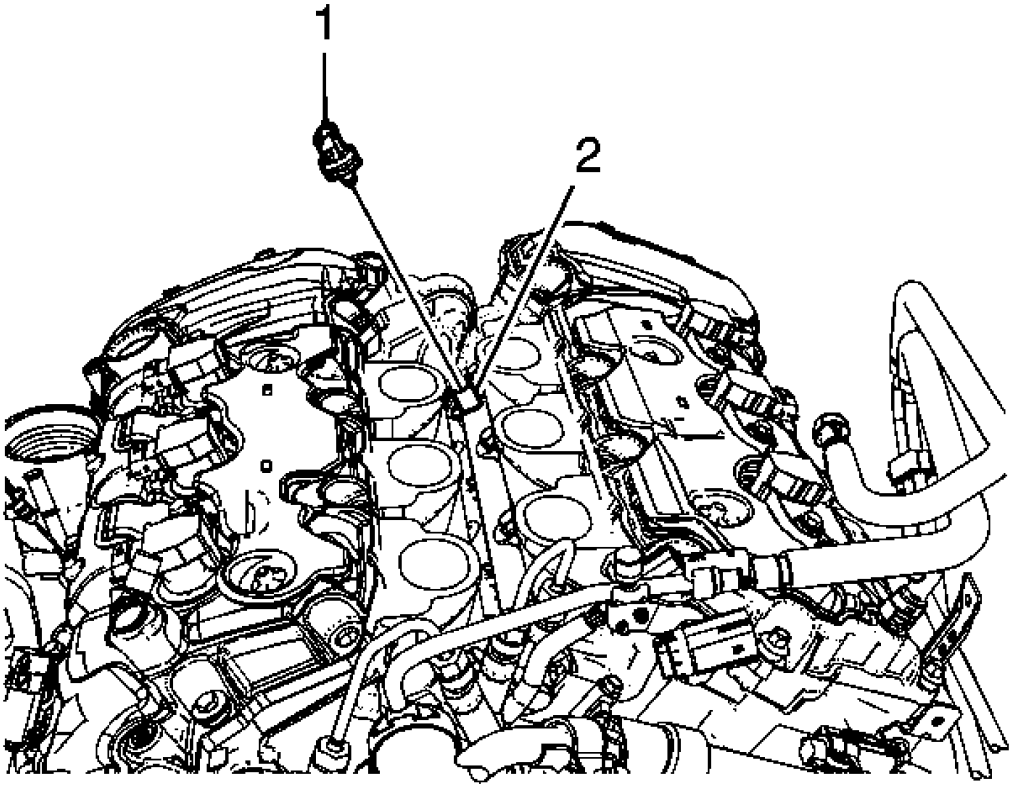


Fig. 105: Identifying Fuel Pressure Sensor & Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS CORP.

8. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**.

CAUTION: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

9. Connect the fuel injector wiring harness electrical connector (1) from the fuel injectors, fuel rail and fuel pressure sensor.
10. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.

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4. Inspect for fuel leaks.
11. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL CROSSOVER TUBE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
4. Remove the intake manifold. Refer to **Intake Manifold Replacement** .

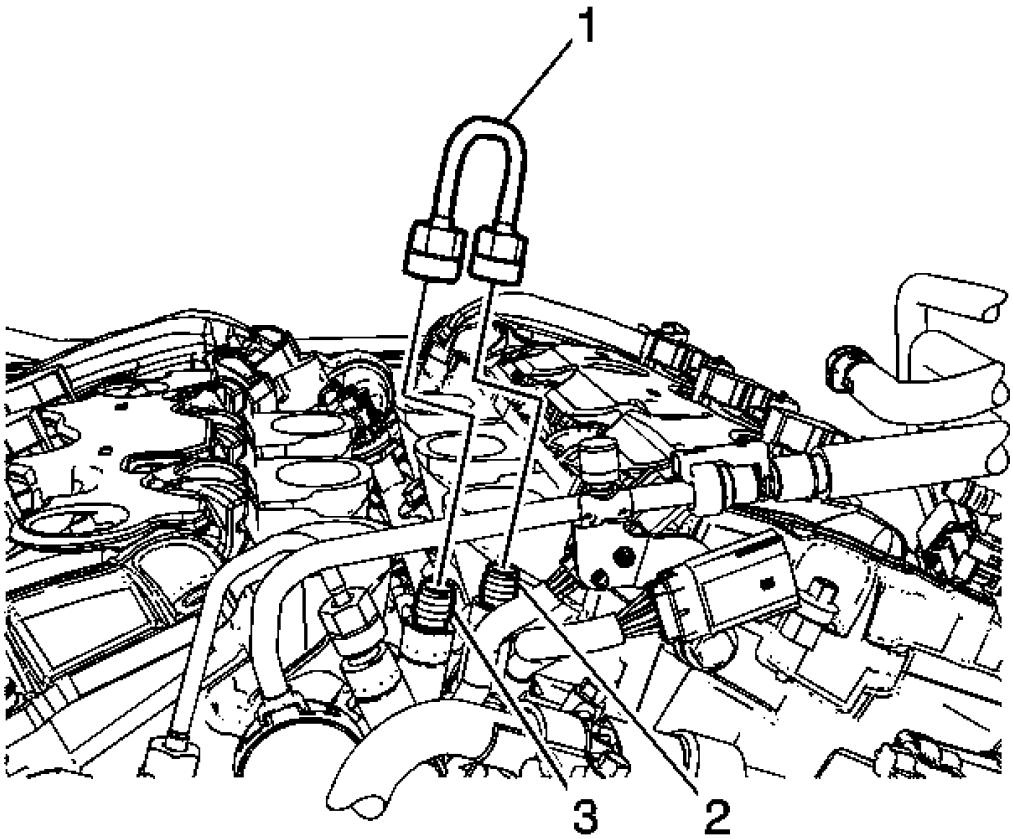


Fig. 106: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
Courtesy of GENERAL MOTORS CORP.

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5. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (2).
6. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (3).
7. Remove the fuel rail crossover pipe (1) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the fuel rail crossover pipe, right fuel rails fittings and left fuel rail fittings are clean and dry prior to assembly.

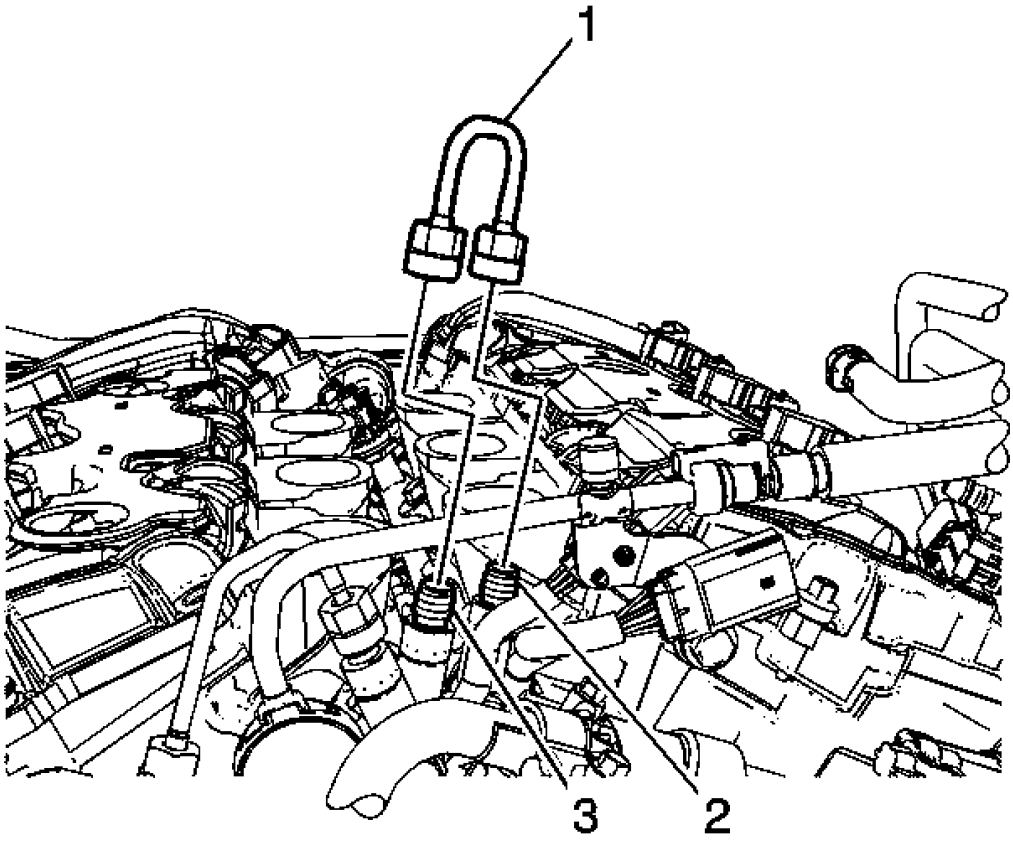


Fig. 107: Identifying Fuel Rail Crossover Pipe & Right Fuel Rail
Courtesy of GENERAL MOTORS CORP.

2. Position the fuel rail crossover pipe (1) to the right fuel rails fitting (2) and left fuel rail fitting (3).

CAUTION: Refer to Fastener Caution .

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3. Tighten the fuel rail crossover pipe fittings.
    - Tighten the fittings first pass to 16 N.m (12 lb ft).
    - Tighten the fittings final pass to 32 N.m (24 lb ft).

NOTE: If a fuel leak accrues at the right fuel rail fitting (2) or left fuel rail fitting (3), that component will need to be replaced.

4. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
5. Install the low side fuel pressure service port cap.
6. Install the fuel tank cap.
7. Install the intake manifold. Refer to **Intake Manifold Replacement** .
8. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
9. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Remove the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
3. Relieve fuel system pressure. Refer to **Fuel Pressure Relief**.

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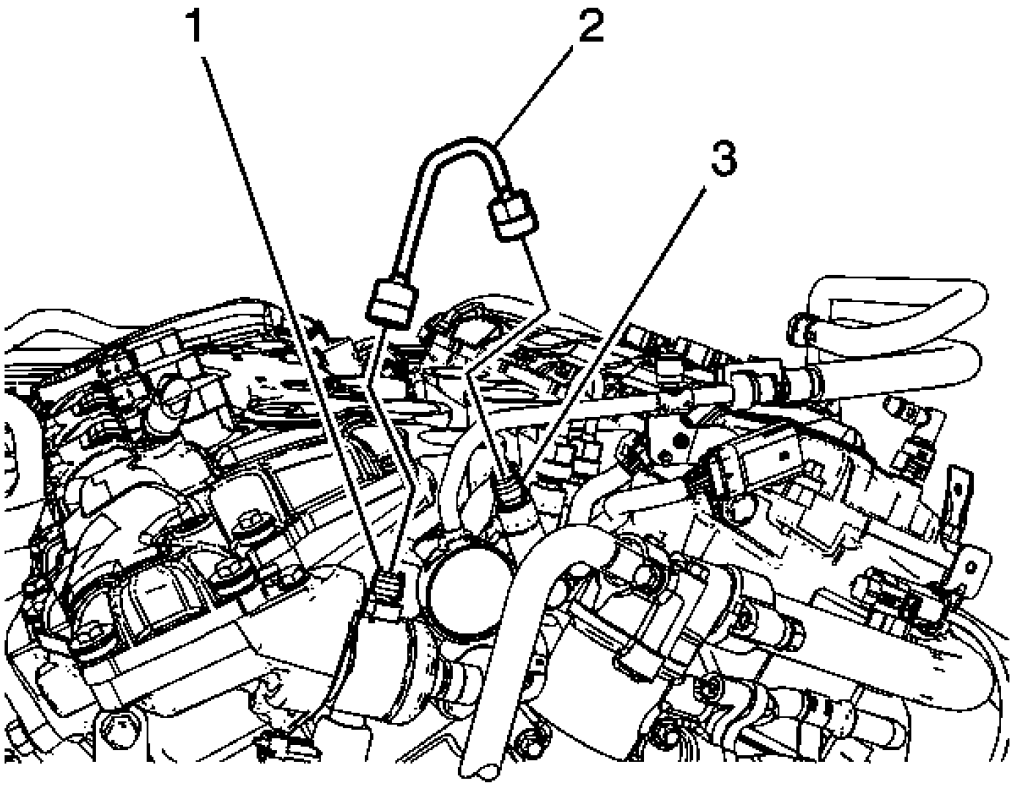


Fig. 108: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe
Courtesy of GENERAL MOTORS CORP.

4. Remove the foam insulator from the pipes.
5. Loosen the high pressure pipe fitting to the high pressure fuel pump (1).
6. Loosen the high pressure pipe fitting to the left fuel rail (3).
7. Remove the high pressure fuel pipe (2) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the high pressure fuel pipe, fuel rail fitting and fuel pump fitting are clean and dry prior to assembly.

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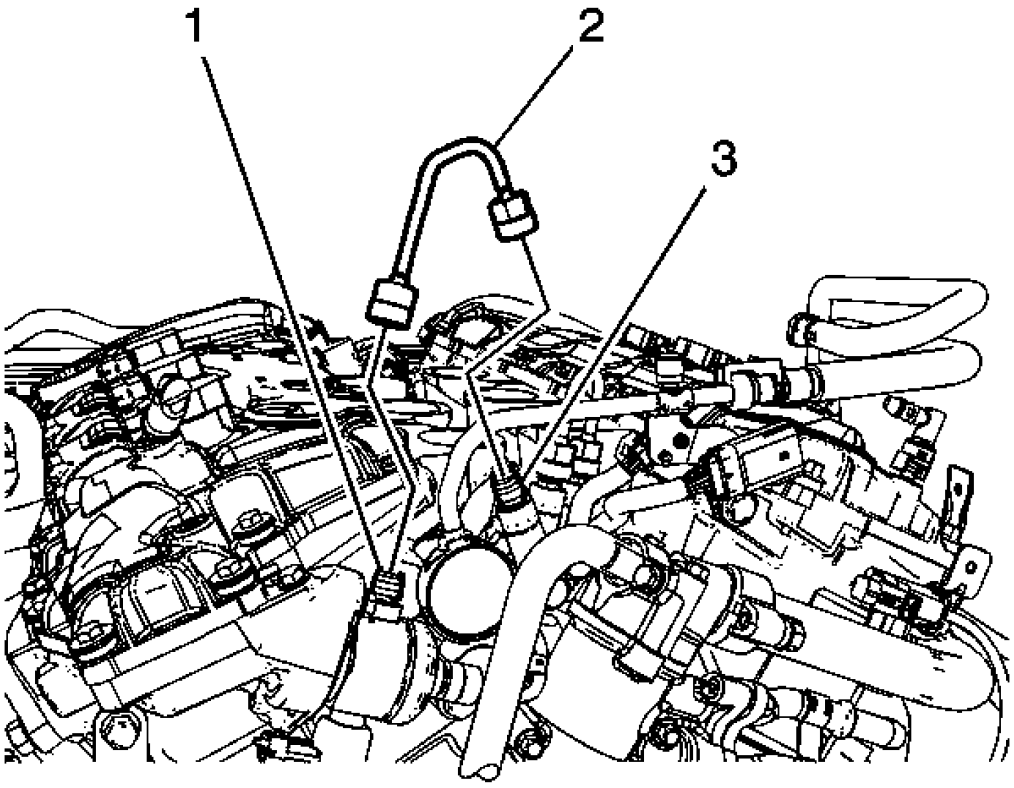


Fig. 109: Identifying High Pressure Pipe Fitting, Left Fuel Rail & High Pressure Fuel Pipe
Courtesy of GENERAL MOTORS CORP.

2. Position the NEW high pressure fuel pipe (2) to the high pressure fuel pump fitting (1) and left fuel rail (3). hand tighten the fitting.

CAUTION: Refer to Fastener Caution .

3. Tighten the high pressure fuel pipe fitting.
   - Tighten the fitting a first pass to 16 N.m (12 lb ft).
   - Tighten the fitting a final pass to 32 N.m (24 lb ft).

NOTE: If a fuel leak accrues at the high pressure fuel pump or the fuel rail, that component will need to be replaced.

4. Inspect for leaks using the following procedure:

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1. Turn ON the ignition, with the engine OFF for 2 seconds.
2. Turn OFF the ignition, for 10 seconds.
3. Turn ON the ignition, with the engine OFF.
4. Inspect for fuel leaks.

5. Install the low side fuel pressure service port cap.
6. Install the fuel tank cap.
7. Install the high pressure pump shield. Refer to **Fuel Pipe Shield Replacement**.
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

FUEL PIPE SHIELD REPLACEMENT

Removal Procedure

1. Remove the cross vehicle brace.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
3. Remove the intake manifold insulator.
4. Remove the wiper transmission. Refer to **Windshield Wiper Transmission Replacement** .

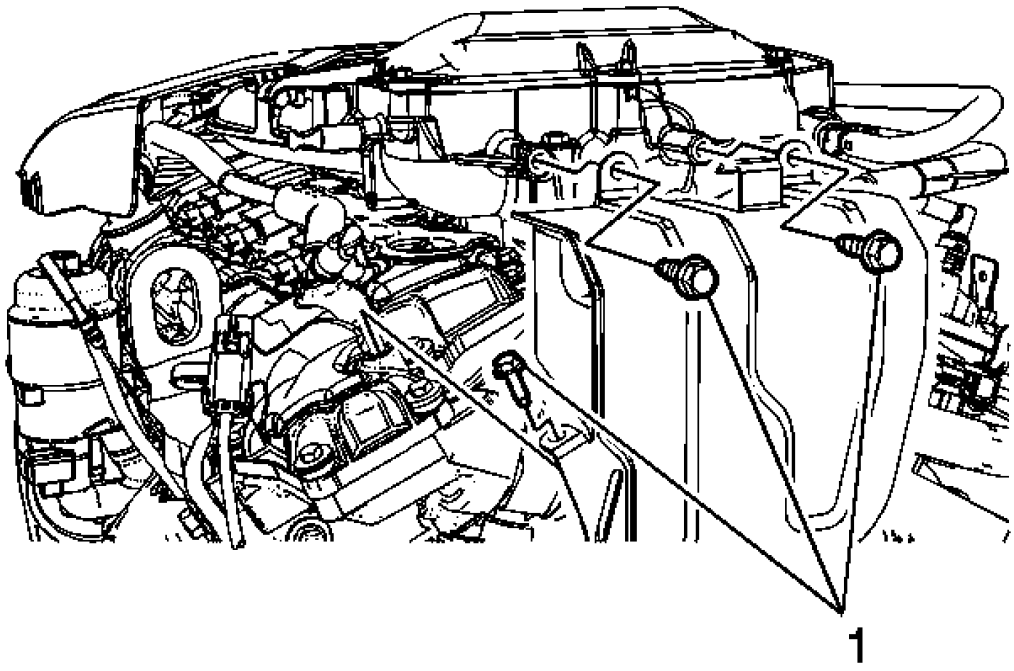


Fig. 110: Removing/Installing Fuel Pipe Shield

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Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel pipe shield to intake manifold bolts (1).
6. Remove the fuel pipe shield to cylinder bolt (1).
7. Carefully remove the fuel pipe shield from the vehicle. Take care not to damage the insulation behind the shield.

Installation Procedure

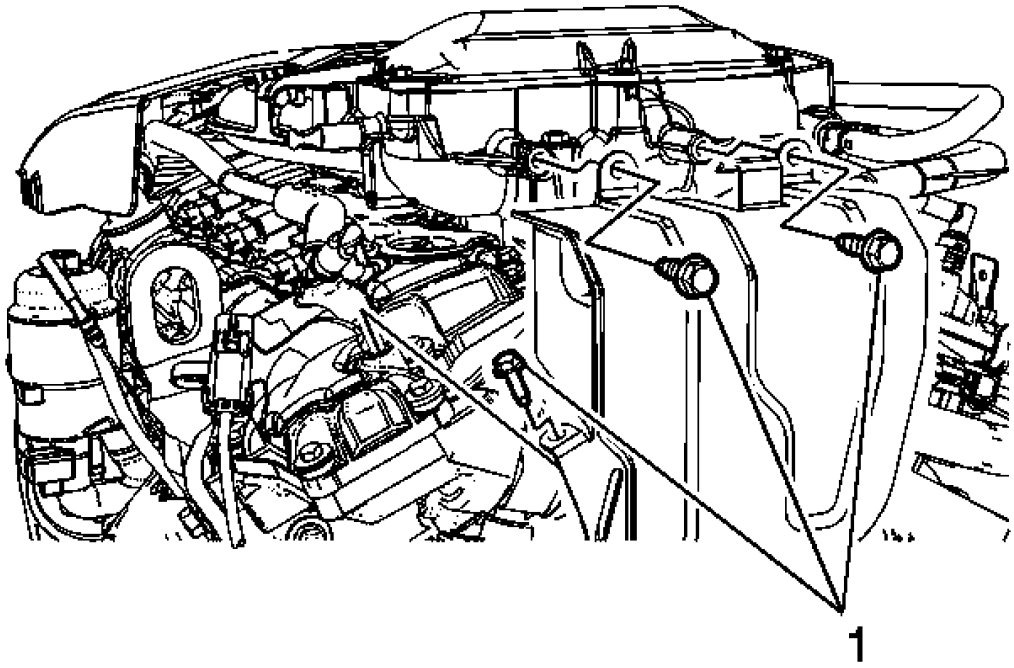


Fig. 111: Removing/Installing Fuel Pipe Shield
Courtesy of GENERAL MOTORS CORP.

1. Position the fuel pipe shield behind the high pressure fuel pump. Take care not to damage the insulation behind the shield.
2. Install the fuel pipe shield to cylinder bolt (1). Hand tighten at this time.

CAUTION: Refer to Fastener Caution .

3. Install the fuel pipe shield to intake manifold bolts (1).

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- Tighten the fuel pipe shield to manifold bolts to 23 N.m (17 lb ft).
- Tighten the fuel pipe shield to head bolt to 10 N.m (89 lb in).

4. Install the wiper transmission. Refer to **Windshield Wiper Transmission Replacement** .
5. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
6. Install the cross vehicle brace.

FUEL PUMP REPLACEMENT

Special Tools

EN-48896 HP Fuel Pump Installation Alignment Gauge. See **Special Tools** .

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the cross vehicle brace.
3. Remove the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement**.
4. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
5. Remove the wiper module. Refer to **Windshield Wiper Motor Replacement** .

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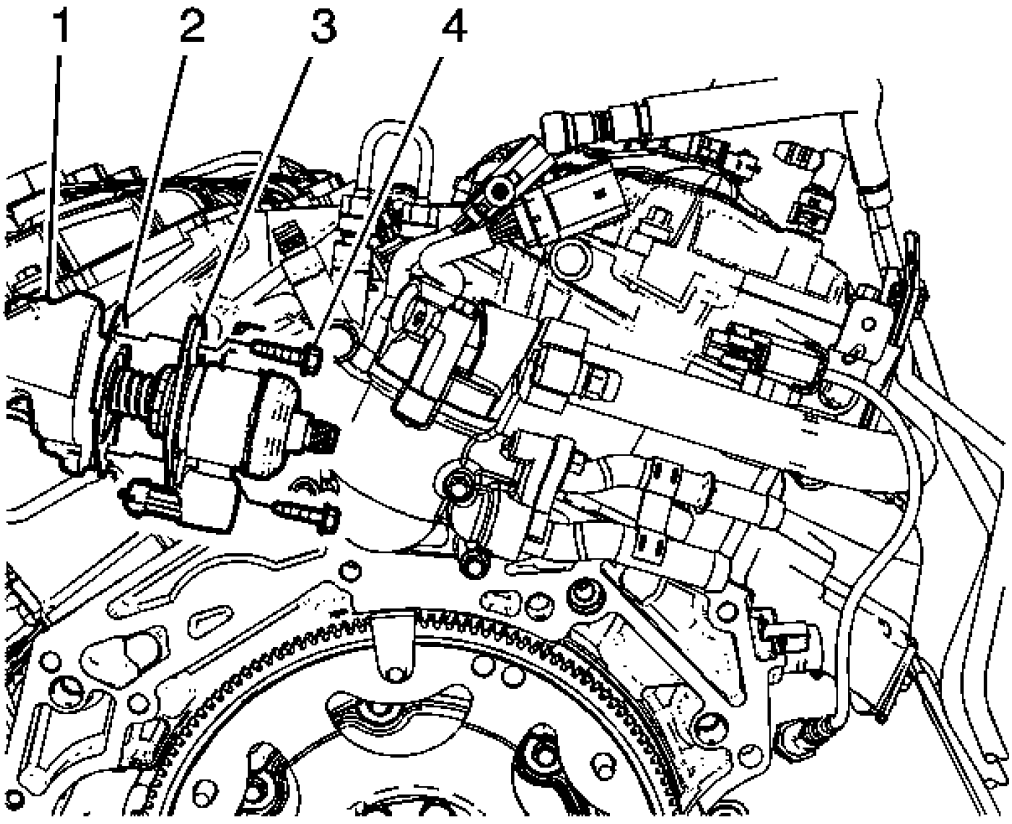


Fig. 112: Identifying High Pressure Fuel Pump & Components
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
7. Remove the radiator surge tank outlet pipe.
8. Remove the low pressure feed pipe.
9. Remove the high pressure pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**. Discard this pipe.
10. Remove and discard the high pressure fuel pump bolts (4).
11. Remove the high pressure fuel pump (3).
12. Remove and discard the high pressure fuel pump gasket (2).
13. Remove and discard the high pressure fuel pump O-ring.
14. Remove the high pressure fuel pump roller lifter.

Installation Procedure

NOTE: The camshaft must be in the base circle position before the high pressure

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fuel pump is installed.

1. Use the **EN-48896** to ensure that the camshaft lobe is in the base circle position. See **Special Tools** . At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube GM P/N 12345501 (Canadian P/N 992704) or equivalent.
3. Install high pressure fuel pump roller lifter.
4. Install a NEW high pressure fuel pump O-ring.

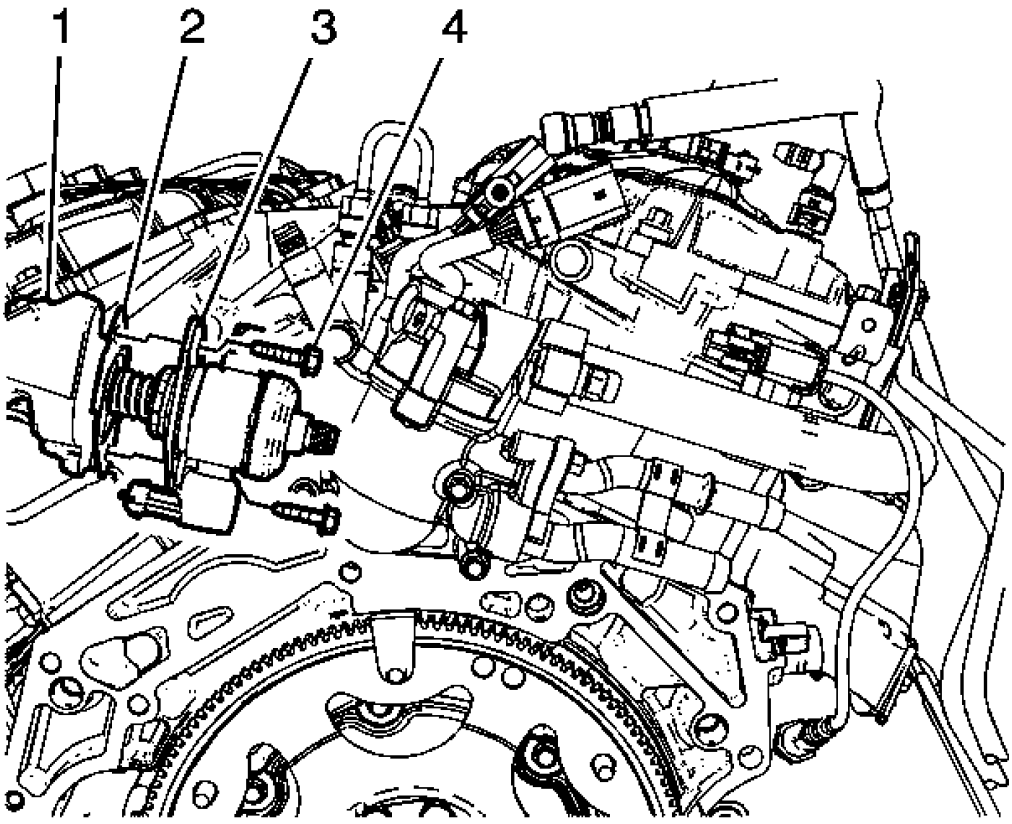


Fig. 113: Identifying High Pressure Fuel Pump & Components
Courtesy of GENERAL MOTORS CORP.

NOTE: The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.

5. Position the NEW high pressure fuel pump gasket (2) and bolts (4) to the fuel pump.

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6. Install the high pressure fuel pump (3) to the cylinder head (1). Force will be required while hand tightening the bolts.

CAUTION: Refer to Fastener Caution .

7. Tighten the high pressure fuel pump retaining bolts to 15 N.m (11 lb ft).
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
10. Install the fuel feed pipe to the high pressure fuel pump.
11. Connect the high pressure fuel pump wiring harness.
12. Install the radiator surge tank outlet pipe.
13. Install the fuel tank cap.

NOTE: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

14. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
15. Install the pressure relief cap to the fuel feed pipe.
16. Install the wiper module. Refer to **Windshield Wiper Motor Replacement** .
17. Install the intake manifold. Refer to **Intake Manifold Replacement** .
18. Install the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement**.
19. Install the cross vehicle brace.

FUEL INJECTOR REPLACEMENT

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-48266** Injector Seal Installer and Sizer. See **Special Tools** .
- **J 2619-01** Slide Hammer. See **Special Tools** .
- **J-37281-A** Injector Remover. See **Special Tools** .
- **J 39313** Spark Plug Port Adapter

Removal Procedure

1. Relieve the high side fuel system pressure. Refer to **Fuel Pressure Relief**.

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NOTE: The fuel injectors have an alignment feature, note the position of the injectors alignment for installation.

2. Remove the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.

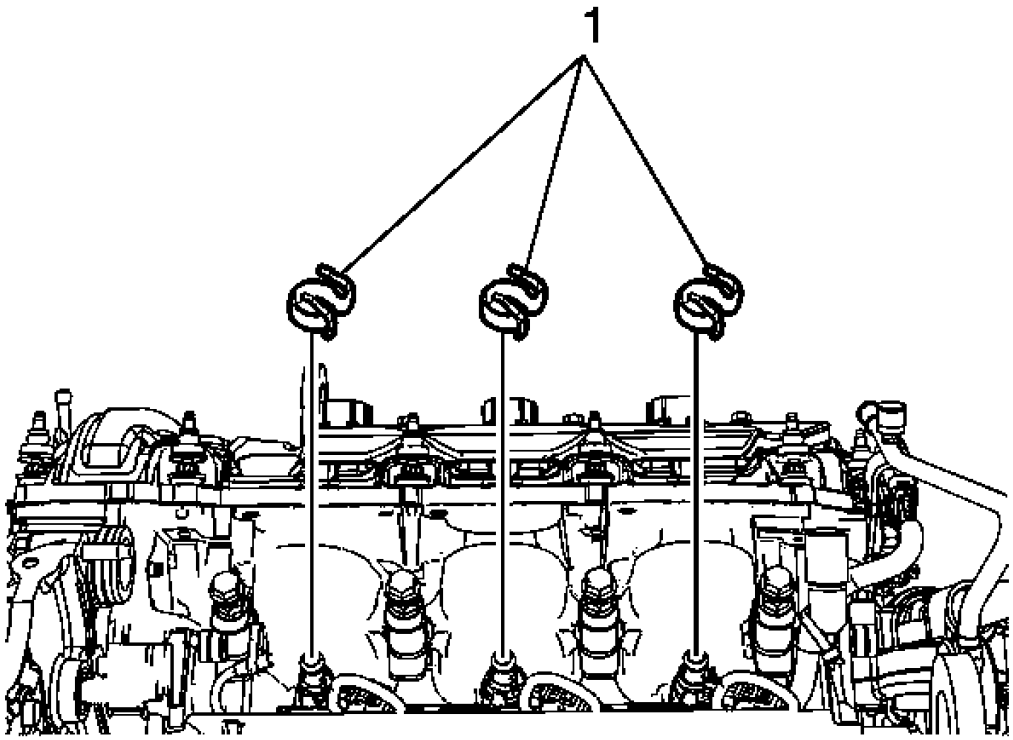


Fig. 114: Identifying Fuel Injector Retaining Rings
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the three fuel injector retaining rings (1).

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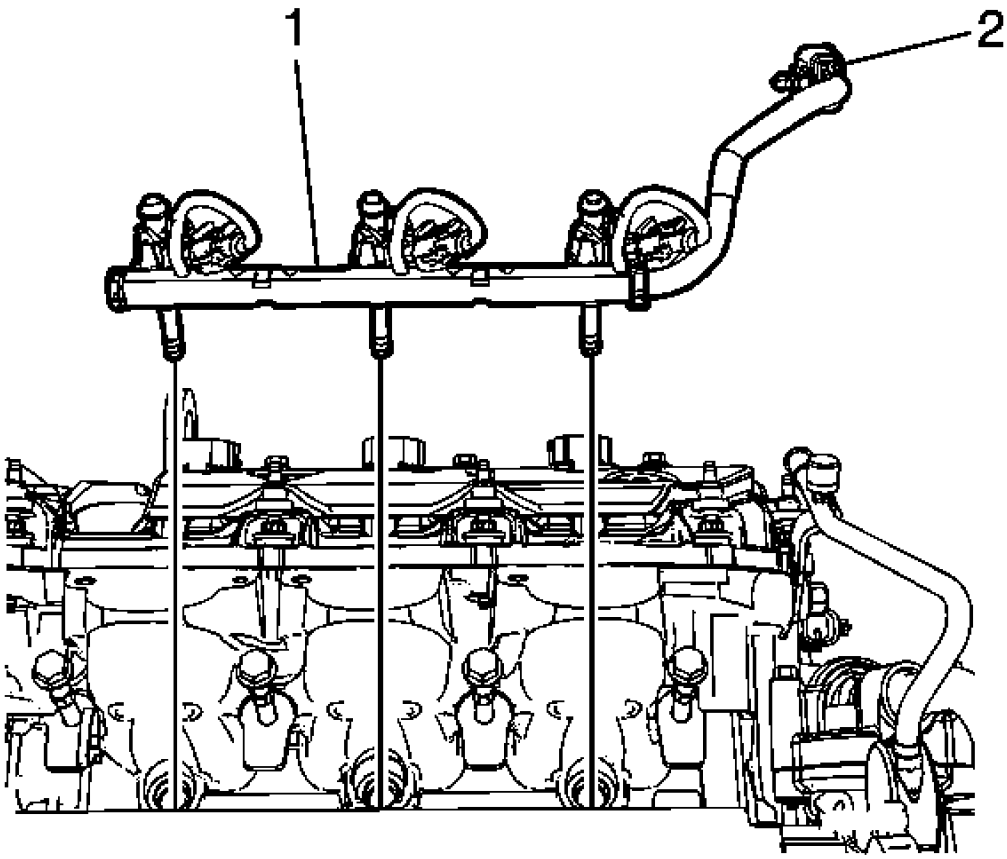


Fig. 115: Identifying Direct Fuel Injector & Harness Assembly
Courtesy of GENERAL MOTORS CORP.

4. Remove the direct fuel injectors and harness (1) as an assembly, and disconnect the electrical connector (2). If necessary, use the **J 2619-01** with the **J-37281-A** in order to remove the direct fuel injectors evenly. See **Special Tools** .

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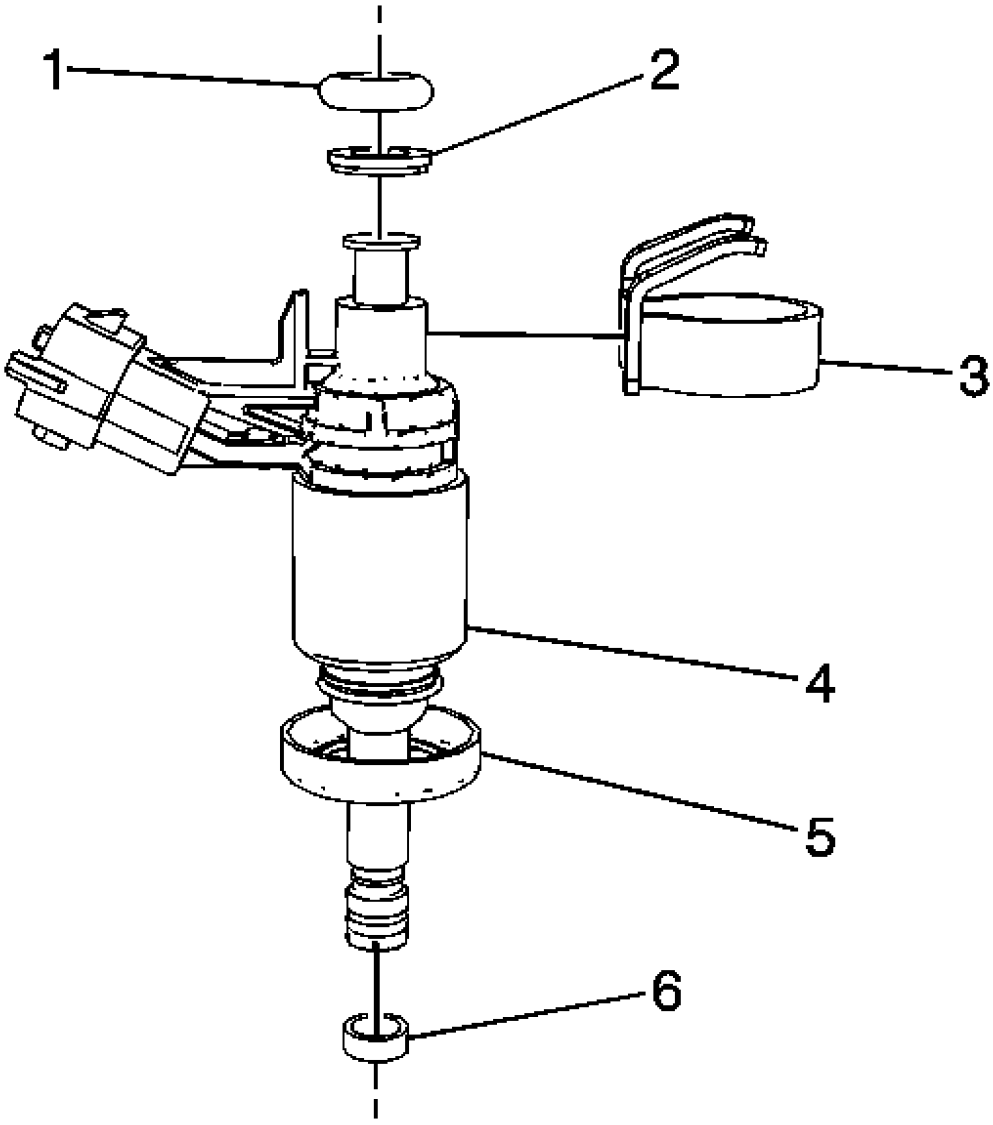


Fig. 116: Identifying Fuel Injector Components
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the following components from the fuel injectors (4).
    - Upper O-ring Seal (1)
    - Plastic Spacer (2)
    - Retaining Ring (3)

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- Isolator Cup (5)
- Teflon Seal (6)

6. Inspect the fuel rail injector bores and clean with **J 39313** , and **EN-47909** , if required.

Installation Procedure

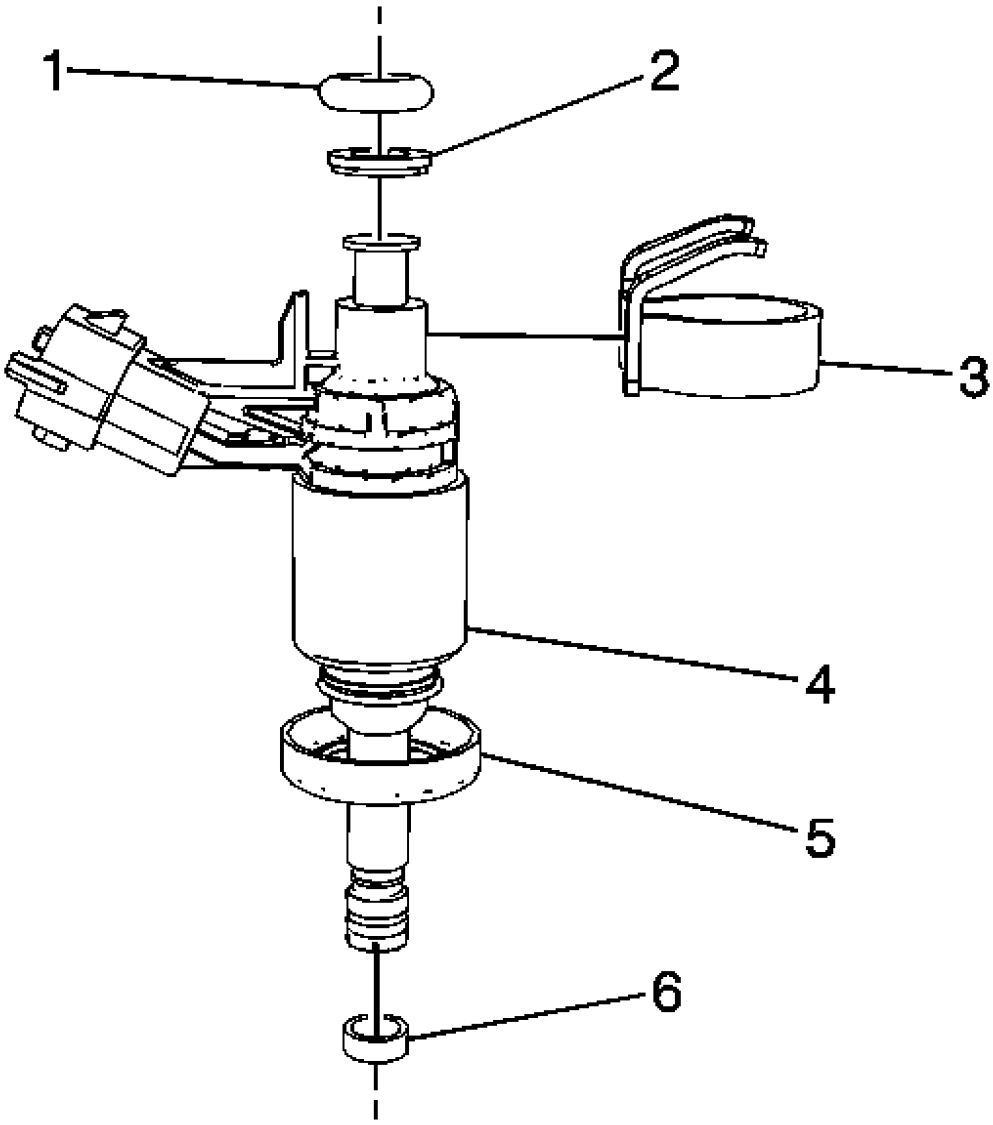


Fig. 117: Identifying Fuel Injector Components
Courtesy of GENERAL MOTORS CORP.

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NOTE: Lubricate a NEW O-ring seal (1) with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.

1. Install the following NEW components to the fuel injectors. Use steps 2 through 8 to install these components.
   - Upper O-ring Seal (1)
   - Plastic Spacer (2)
   - Retaining Ring (3)
   - Isolator Cup (5)
   - Teflon Seal (6)

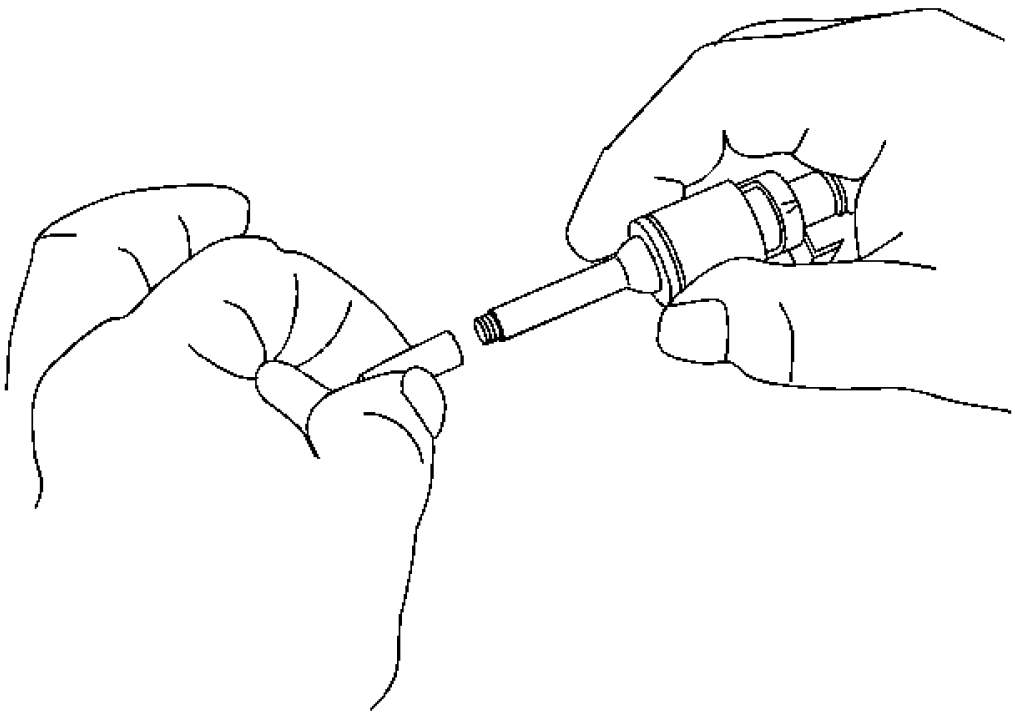


Fig. 118: Injector Tip & EN 48266-1
Courtesy of GENERAL MOTORS CORP.

2. From the **EN-48266** , position the EN 48266-1 to the injector tip. See **Special Tools** .

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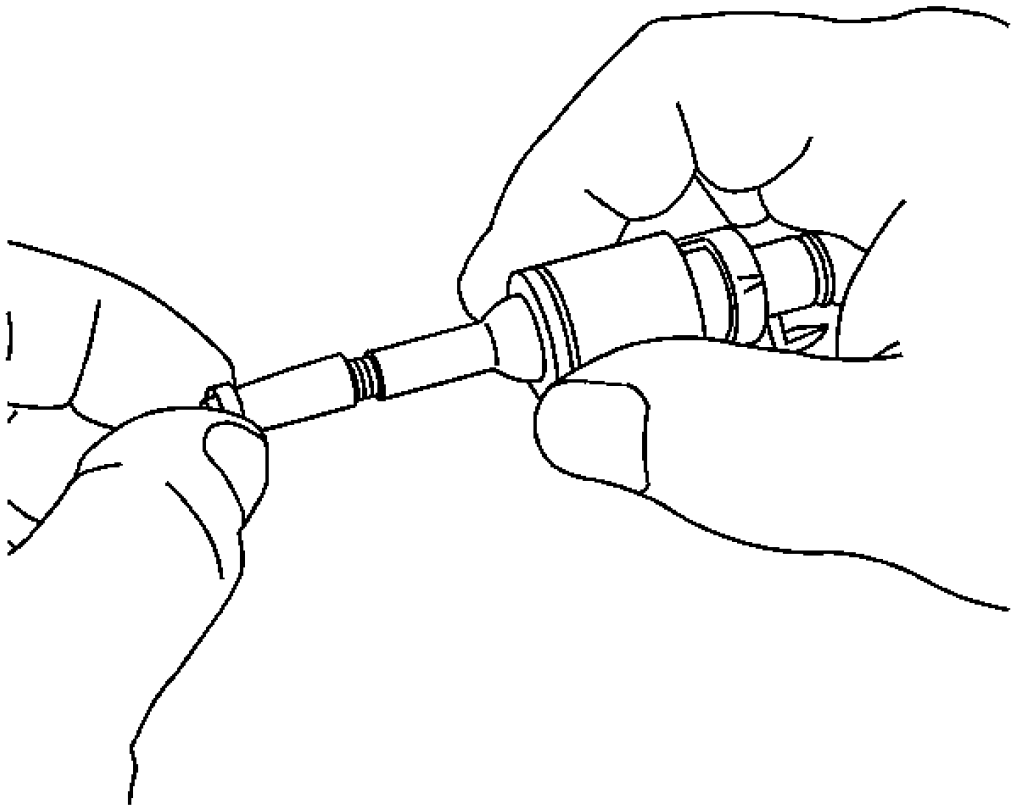


Fig. 119: Using EN 48266-1
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT lubricate the NEW teflon seal.

3. Install a NEW teflon seal onto the EN 48266-1.

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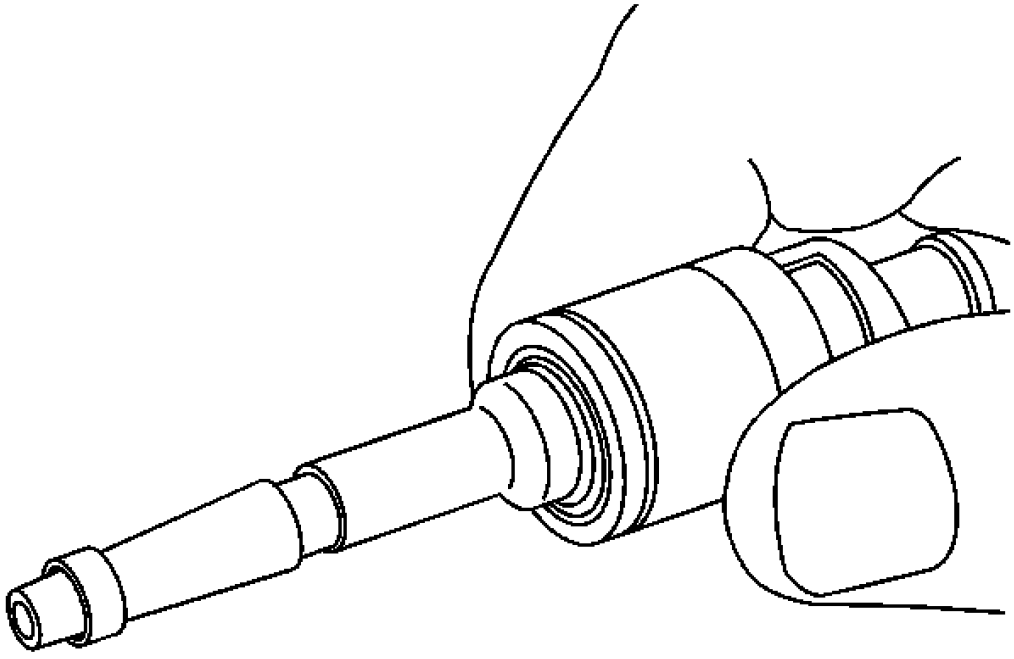


Fig. 120: View Of Teflon Seal
Courtesy of GENERAL MOTORS CORP.

4. Pull the NEW teflon seal by hand over the EN 48266-1 and into the groove in the injector.
5. Remove the EN 48266-1 from the injector tip.

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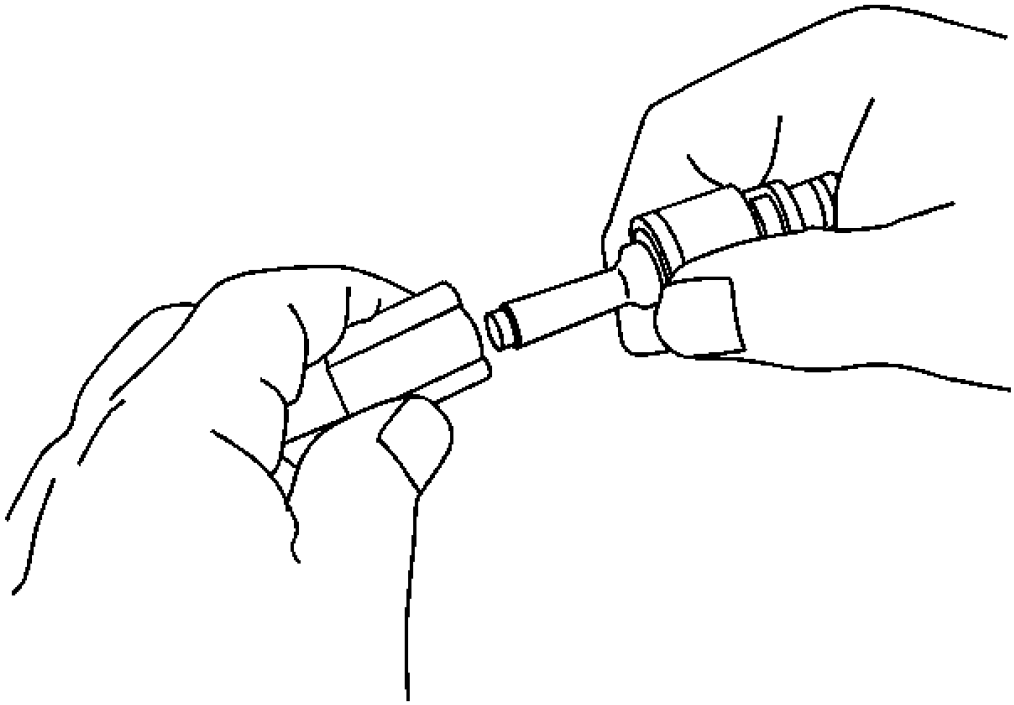


Fig. 121: Injector Tip & EN 48266-2
Courtesy of GENERAL MOTORS CORP.

6. From the **EN-48266** , install the EN 48266-2 to the injector tip. See **Special Tools** .

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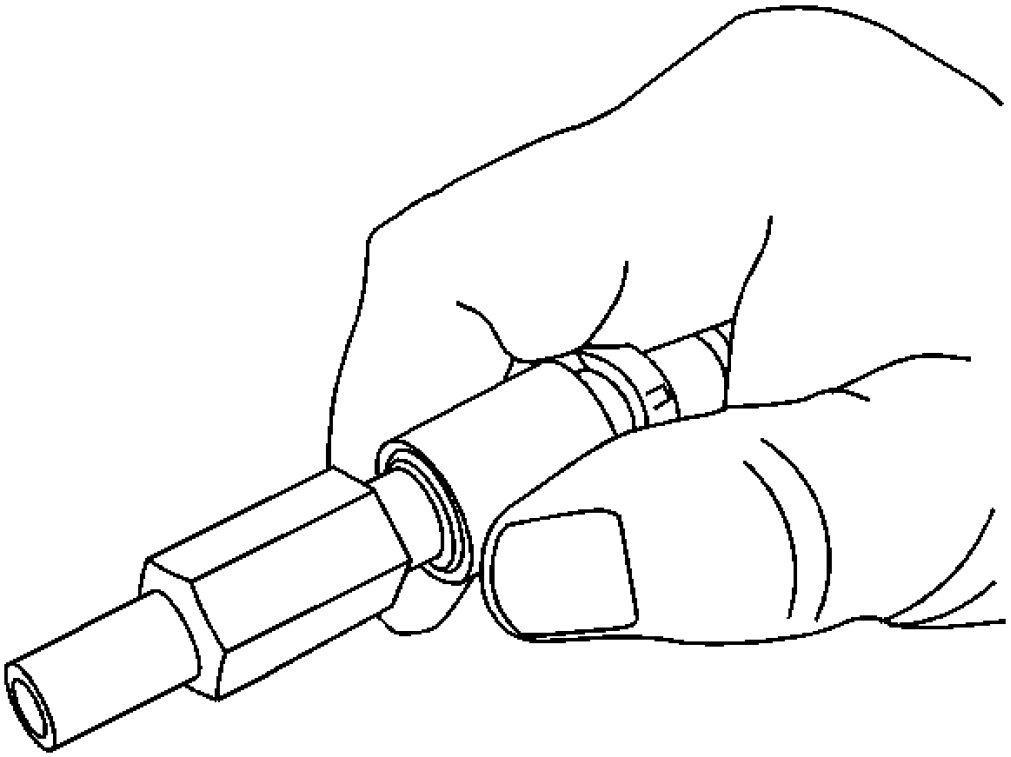


Fig. 122: Resizing Teflon Seal
Courtesy of GENERAL MOTORS CORP.

7. Using the EN 48266-2, resize the teflon seal. Install the EN 48266-2, until it bottoms out against the injector body, and rotate the EN 48266-2 while applying only moderate force 180 degrees in one direction and then 180 degrees back in the other direction.
8. Remove the EN 48266-2.

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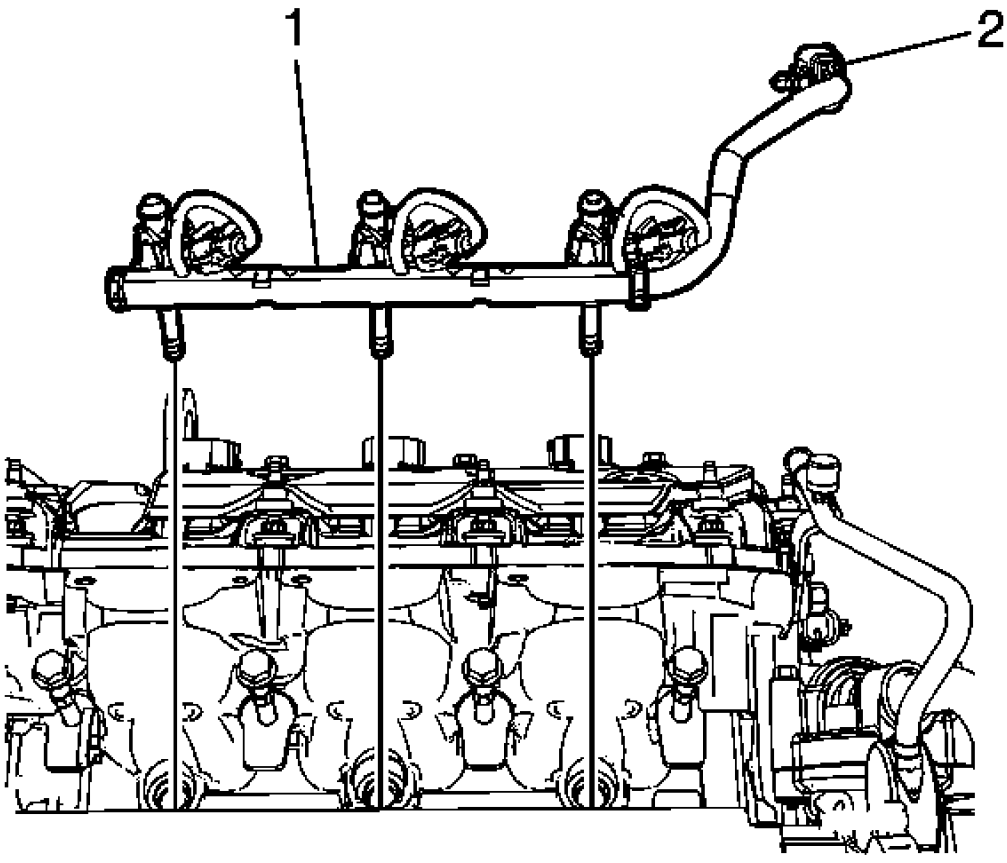


Fig. 123: Identifying Direct Fuel Injector & Harness Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

9. Install the direct fuel injectors and harness (1) as an assembly and connect the electrical connector (2).

NOTE: The fuel injectors have an alignment feature and must be reinstalled as noted during removal.

10. Install the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1** or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

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Removal Procedure

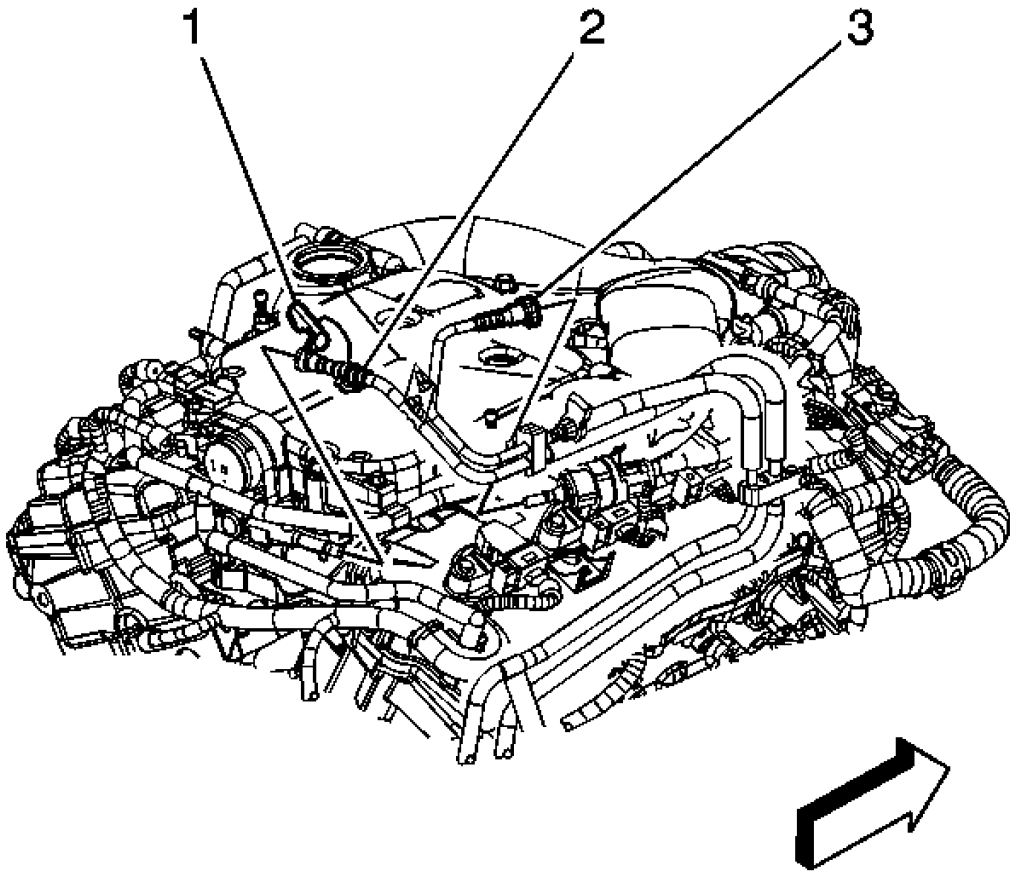


Fig. 124: Identifying Purge Line, Fuel Pipe & Fuel Rail
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .
3. Disconnect the purge line (3) from the purge valve solenoid.

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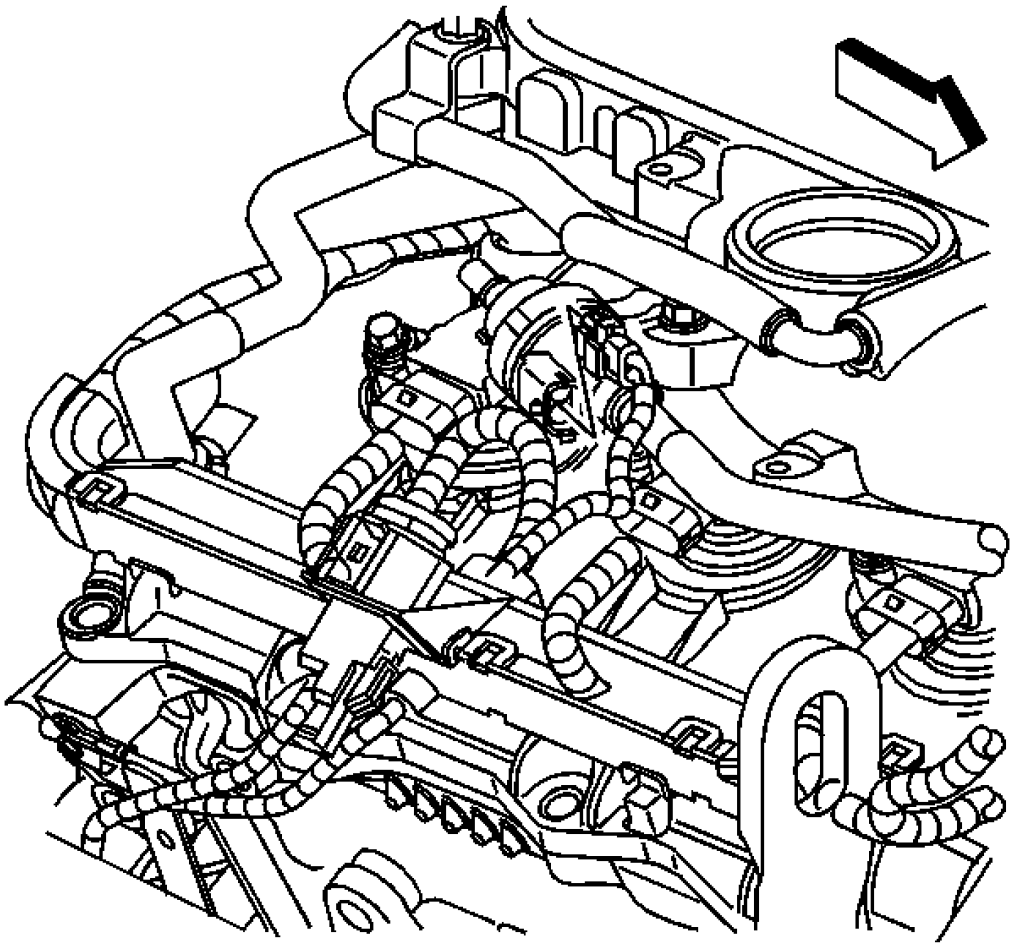


Fig. 125: View Of Purge Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the purge valve solenoid electrical connector.

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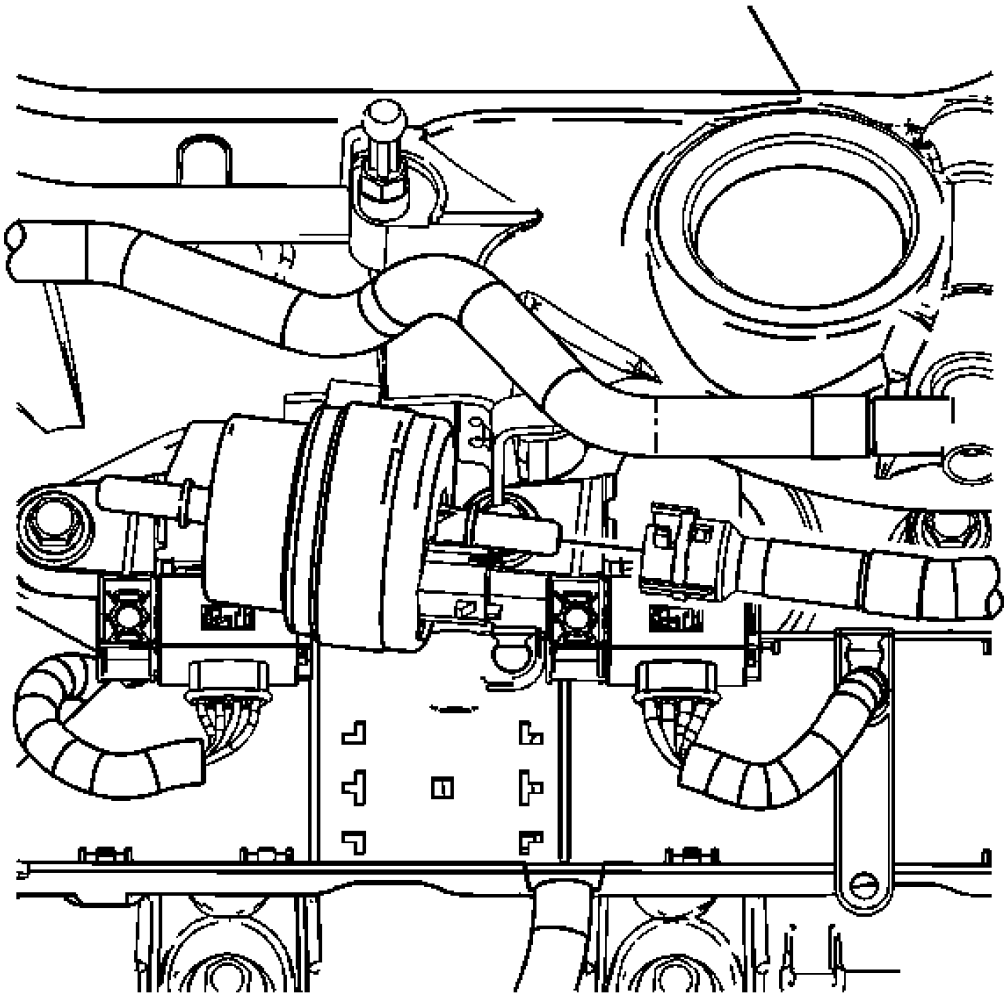


Fig. 126: Locating Purge Line On Manifold Side Of Purge Valve Solenoid
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the purge line from the manifold side of the purge valve solenoid.
6. Remove the purge valve solenoid from the bracket.

Installation Procedure

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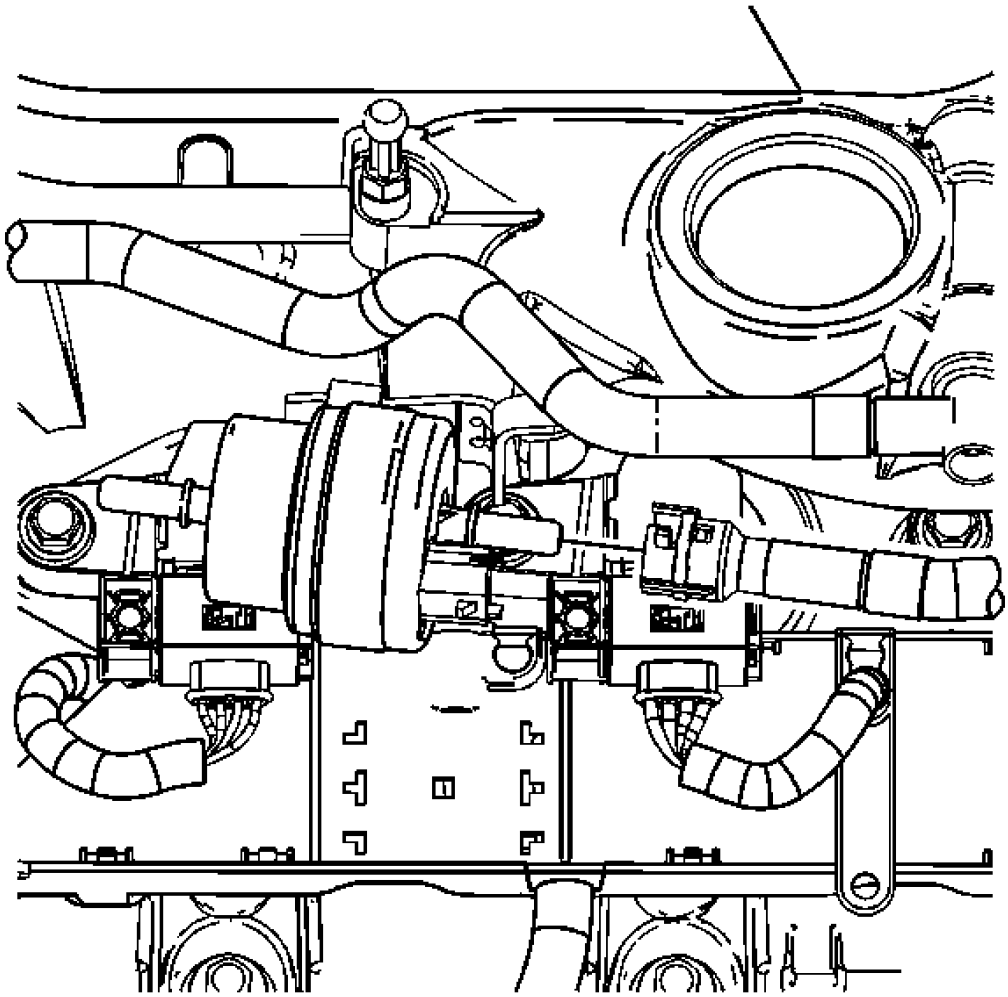


Fig. 127: Locating Purge Line On Manifold Side Of Purge Valve Solenoid
Courtesy of GENERAL MOTORS CORP.

1. Install the purge valve solenoid to the bracket.
2. Disconnect the purge line from the manifold side of the purge valve solenoid.

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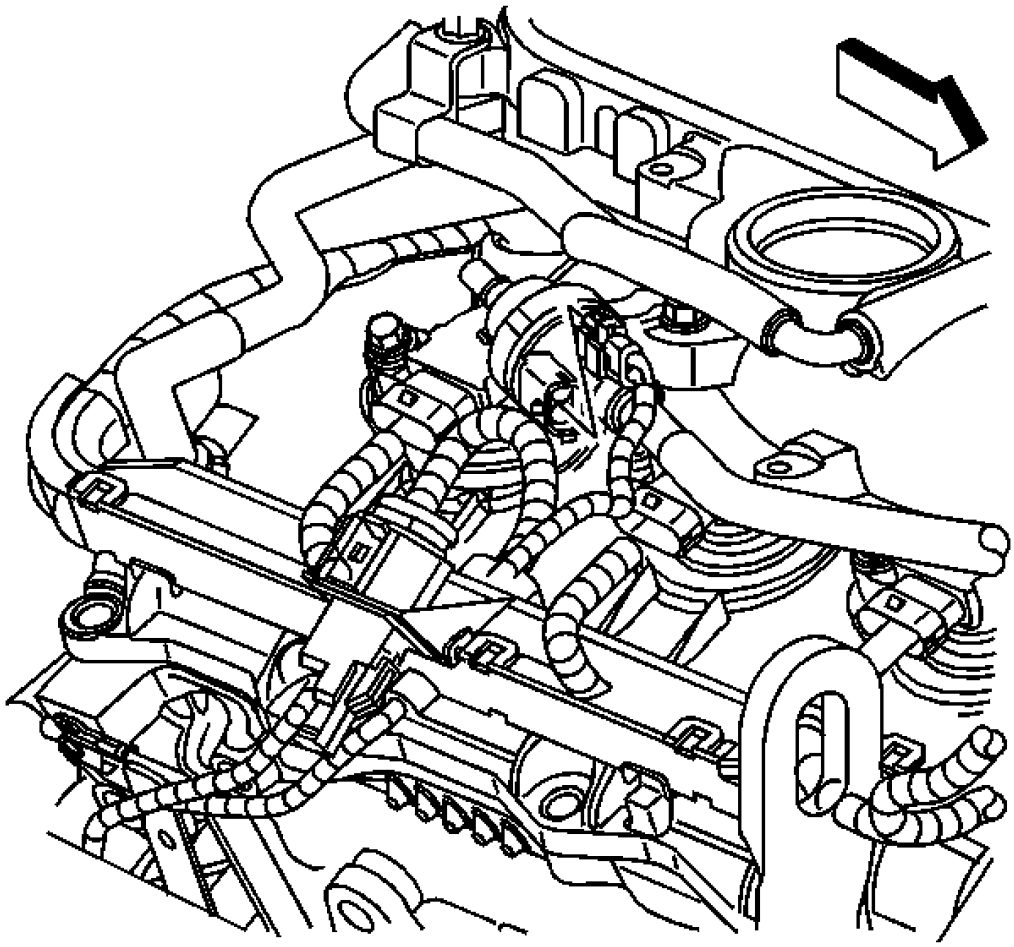


Fig. 128: View Of Purge Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the purge valve solenoid electrical connector.

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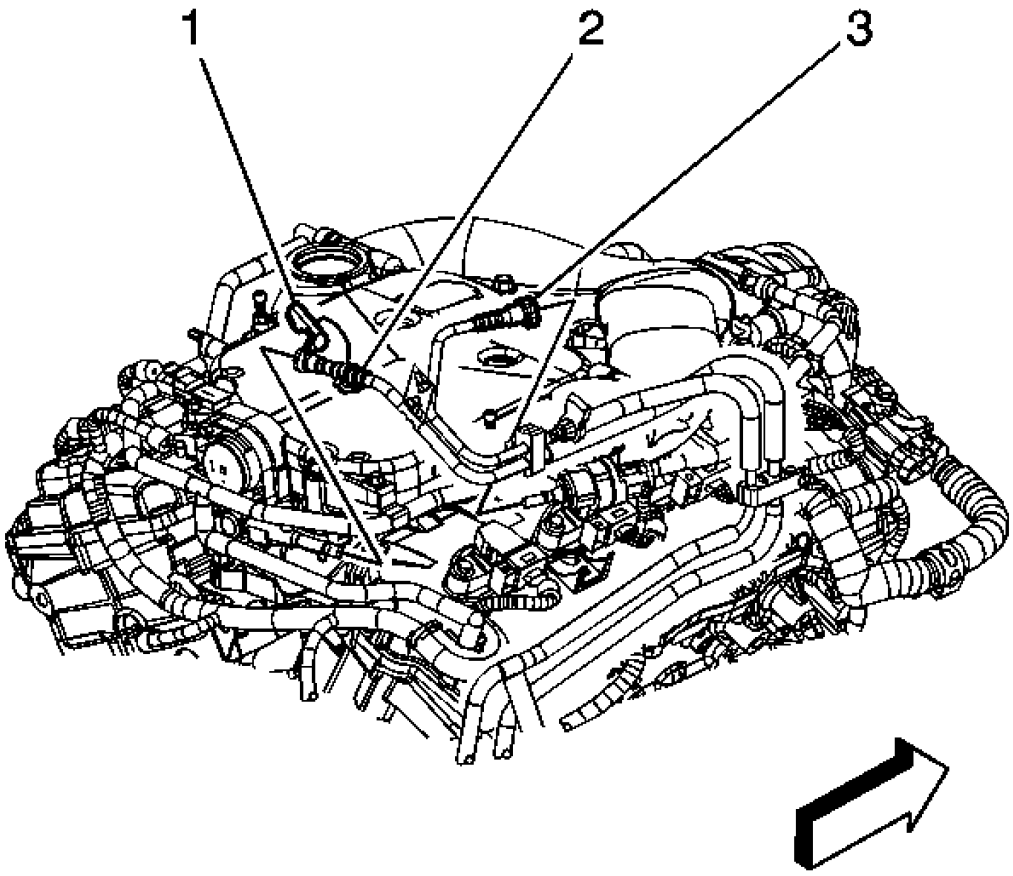


Fig. 129: Identifying Purge Line, Fuel Pipe & Fuel Rail
Courtesy of GENERAL MOTORS CORP.

4. Connect the purge line (3) to the purge valve solenoid.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

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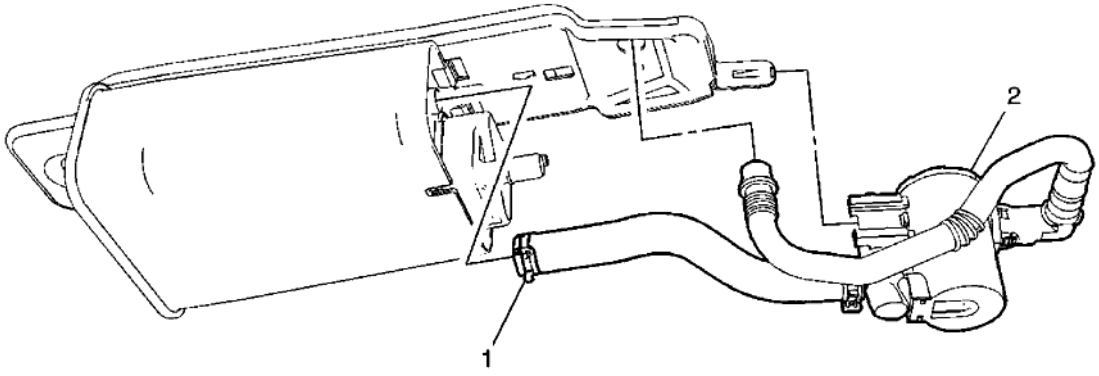


Fig. 130: Evaporative Emission Canister Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the Carbon Canister. Refer to **Evaporative Emission Canister Replacement**	
1	Evaporative Hose Clamp
2	Evaporative Emission Canister Vent Solenoid Valve

EVAPORATIVE EMISSION LINE REPLACEMENT - CHASSIS TO CANISTER

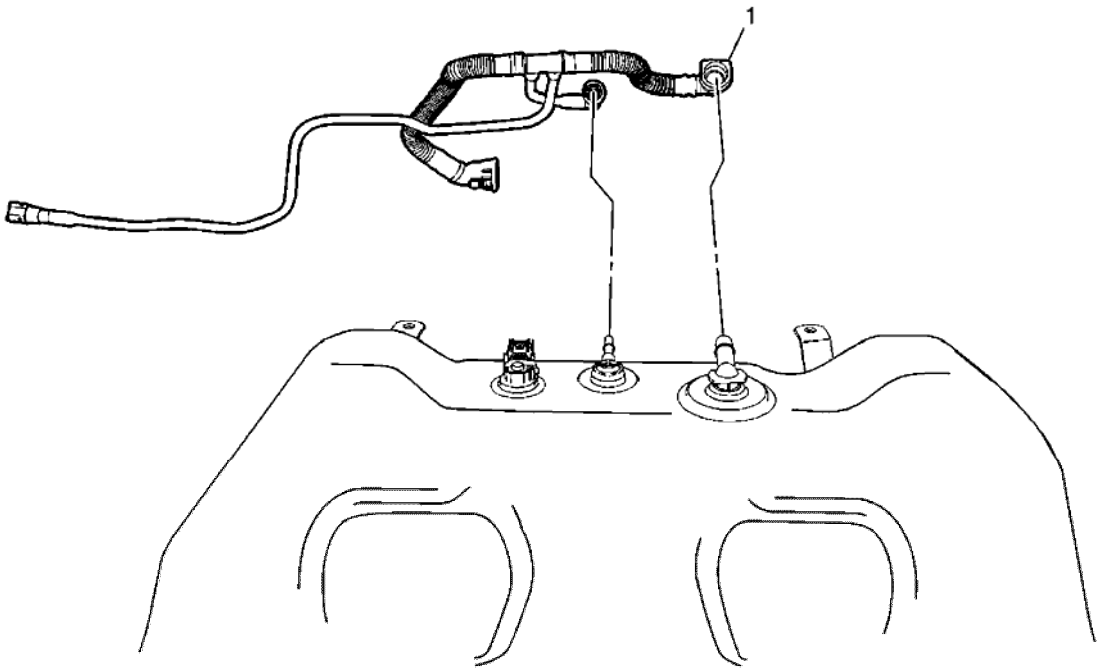


Fig. 131: Evaporative Emission Line - Chassis to Canister
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
Preliminary Procedure 1. Remove the fuel tank. Refer to **Fuel Tank Replacement**. 2. Disconnect the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service**.	
1	Fuel Tank Fill Evaporative Emission Valve Hose

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

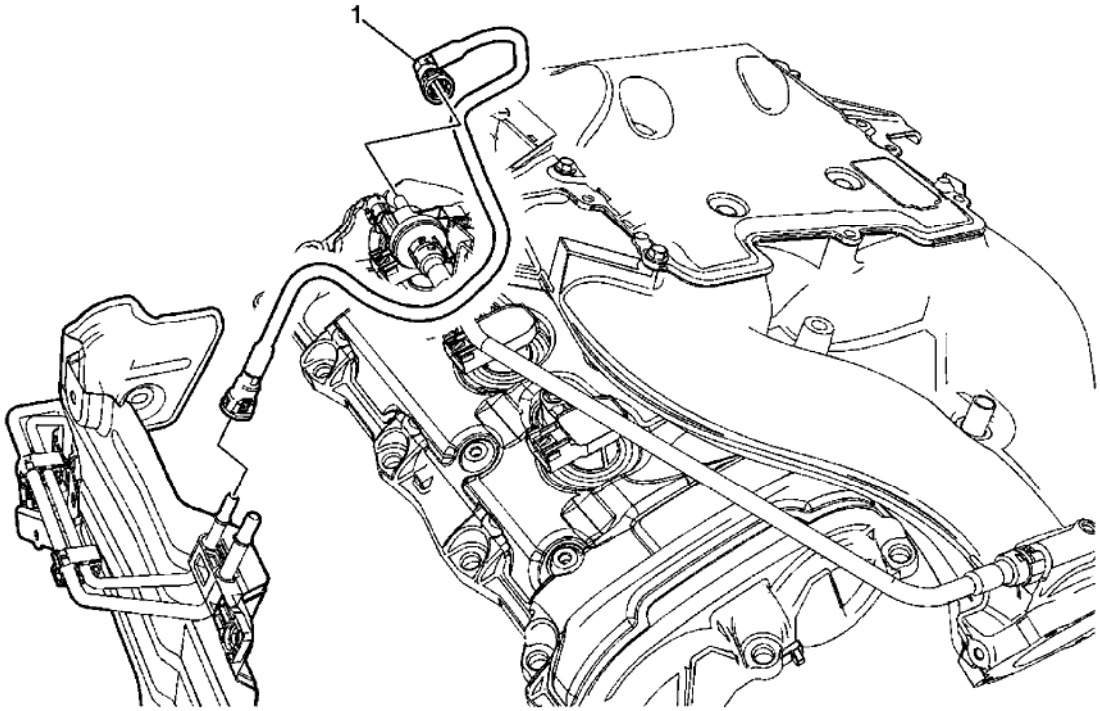


Fig. 132: Evaporative Emission Canister Purge Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** . 2. Disconnect the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service**.	
1	Evaporative Emission Canister Purge Pipe

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

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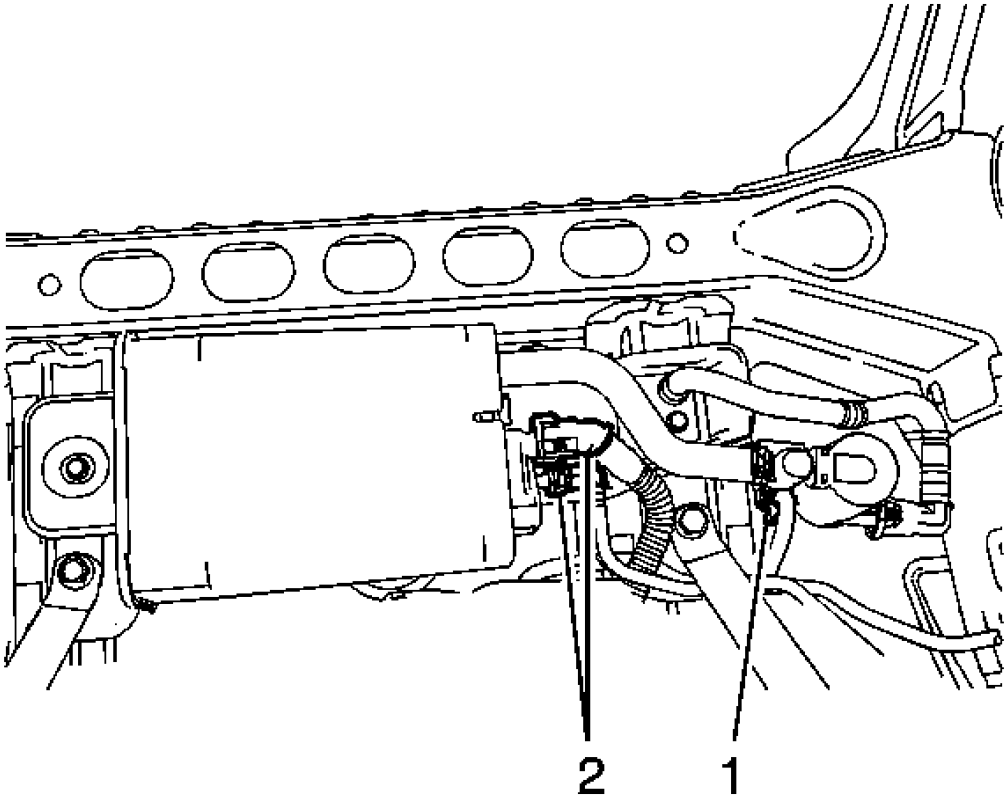


Fig. 133: Vent Solenoid Electrical Connector & Evaporative Emission Hoses
Courtesy of GENERAL MOTORS CORP.

1. Remove the rear suspension support. Refer to **Rear Suspension Support Replacement** .
2. Disconnect the vent solenoid electrical connector (1).
3. Disconnect the evaporative emission hoses (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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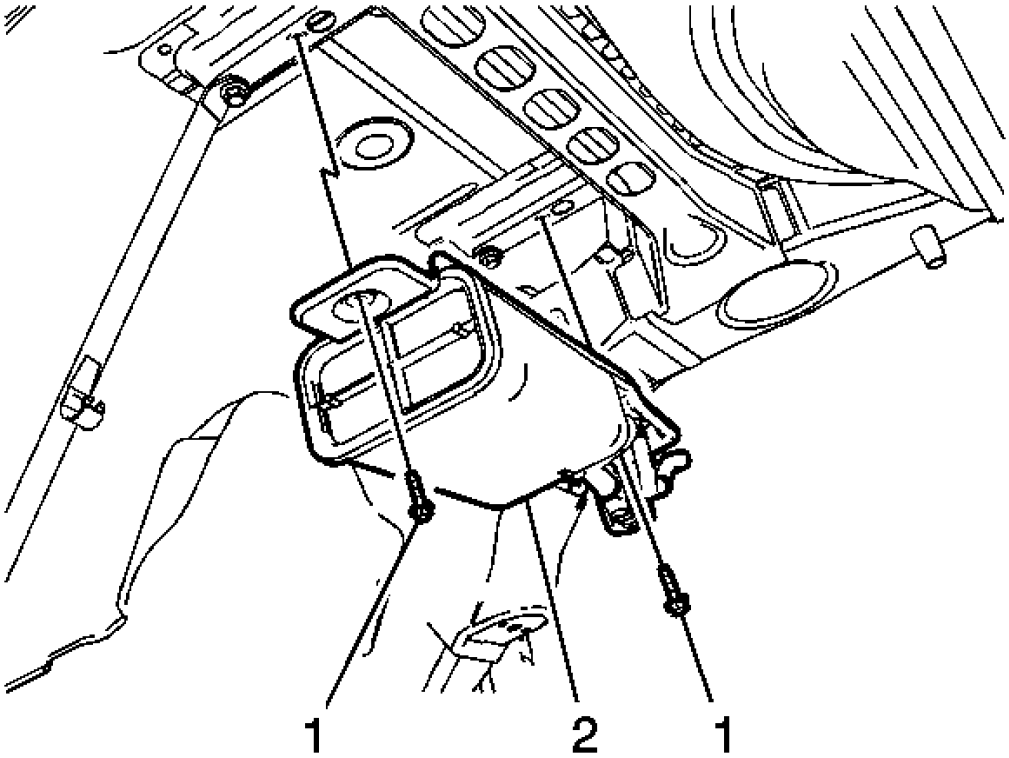


Fig. 134: Evaporative Emission Canister & Fasteners
Courtesy of GENERAL MOTORS CORP.

4. Remove the evaporative emission canister fasteners (1) and the evaporative emission canister (2).

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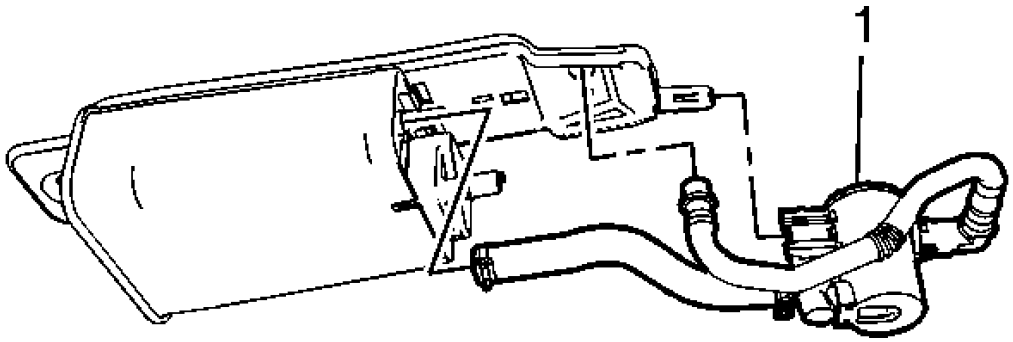


Fig. 135: Evaporative Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

5. Remove the evaporative vent solenoid valve (1) from the carbon canister.

Installation Procedure

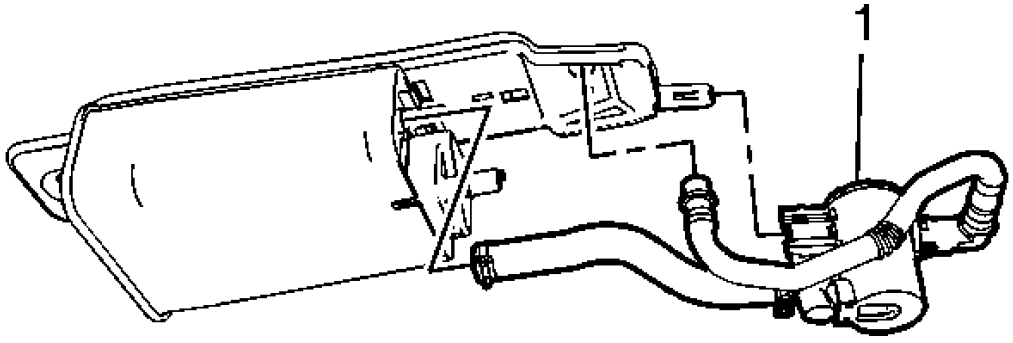


Fig. 136: Evaporative Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the evaporative vent solenoid valve (1) to the carbon canister.

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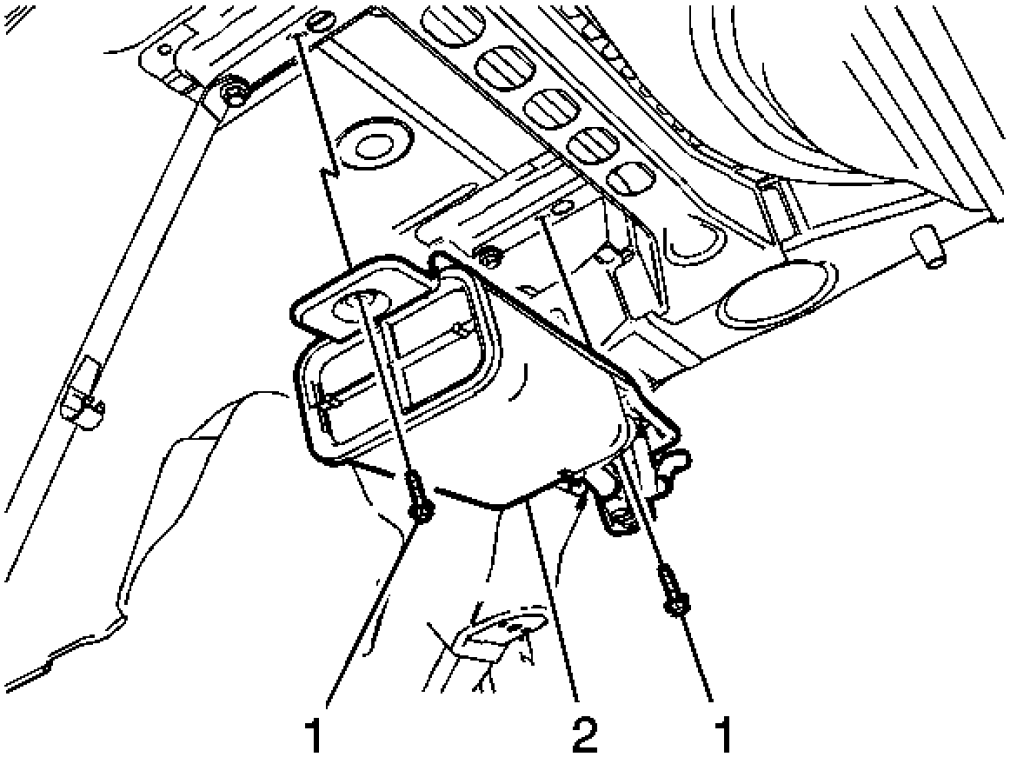


Fig. 137: Evaporative Emission Canister & Fasteners
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the evaporative emission canister (2) and tighten the fasteners (1) to 9 N.m (80 lb in).

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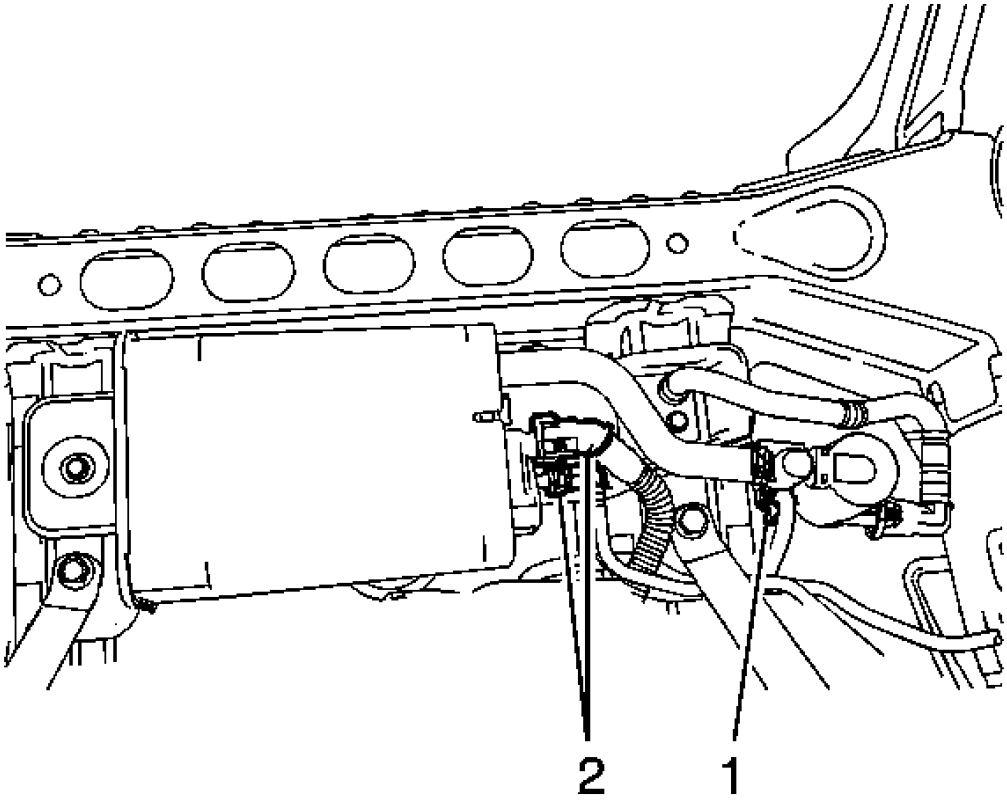


Fig. 138: Vent Solenoid Electrical Connector & Evaporative Emission Hoses
Courtesy of GENERAL MOTORS CORP.

3. Connect the evaporative emission hoses (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Connect the vent solenoid electrical connector (1).
5. Install the rear suspension support. Refer to **Rear Suspension Support Replacement** .

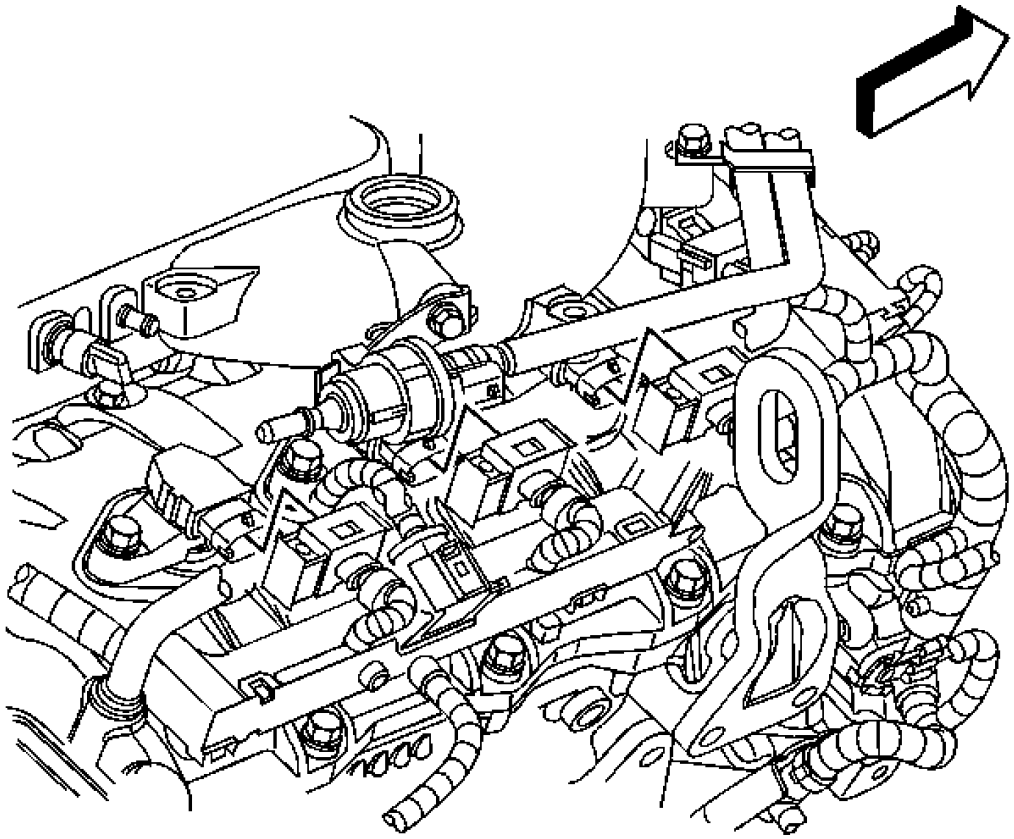
IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

NOTE: Do NOT disconnect the fuel pipes and/or hoses.

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3. _____

Fig. 139: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Remove the ignition coil electrical connector(s).

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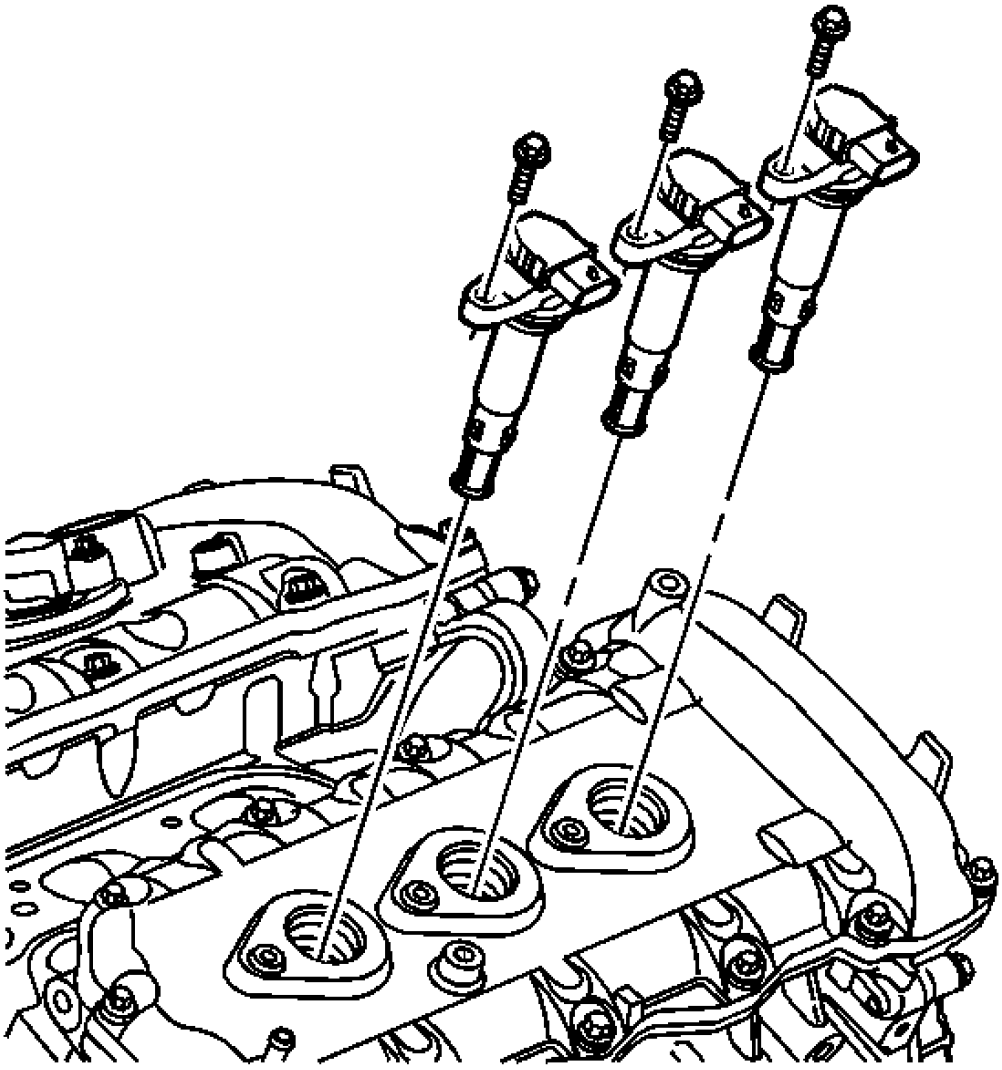


Fig. 140: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

5. Remove the ignition coil bolt(s).
6. Remove the ignition coil(s).

Installation Procedure

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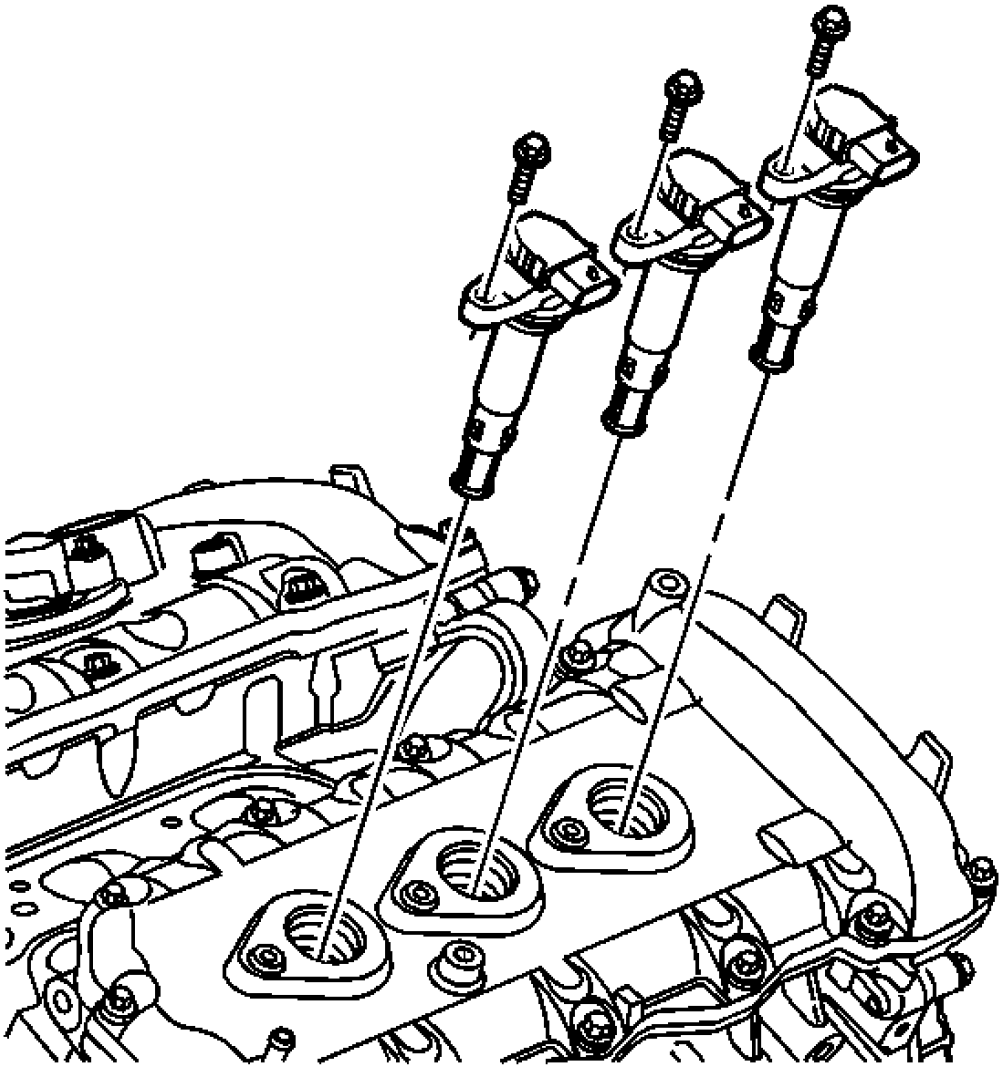


Fig. 141: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) and tighten to 10 N.m (89 lb in).

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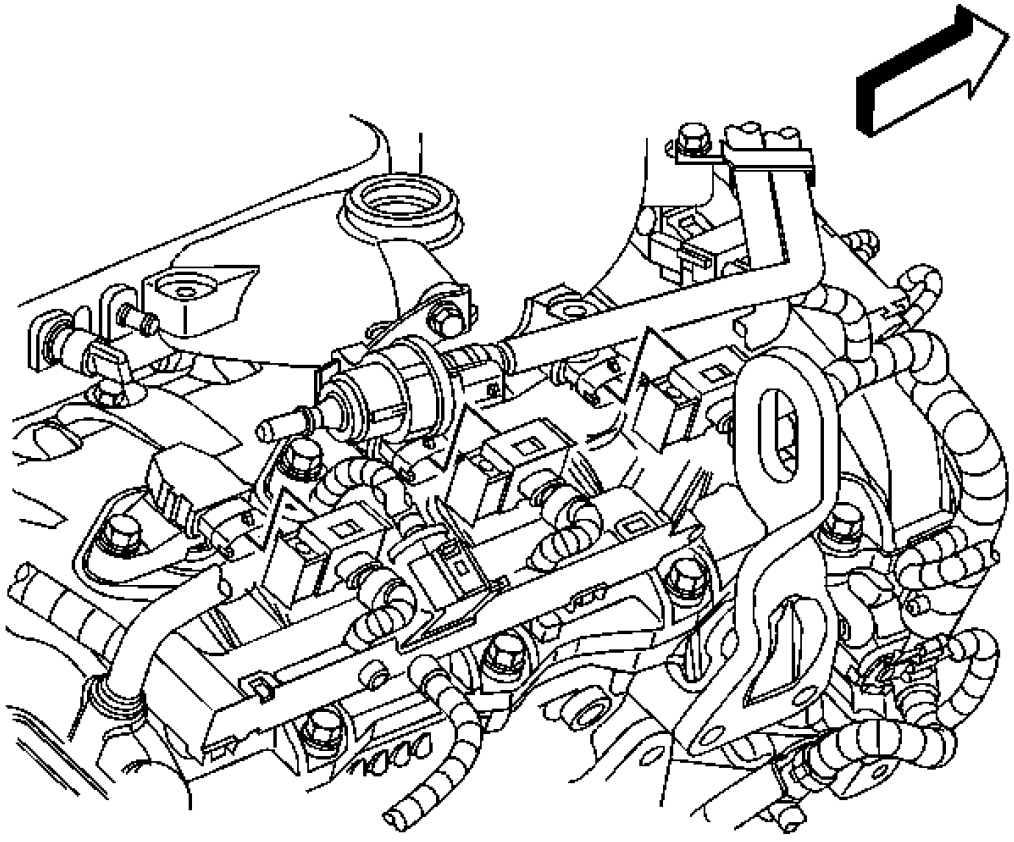


Fig. 142: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coil electrical connector(s).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

1. Turn the ignition OFF.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

NOTE: Do NOT disconnect the fuel pipes and/or hoses.

3. If you are replacing the ignition coil for cylinder 2, remove and reposition the intake manifold. Perform

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the following steps:

1. Disconnect the air cleaner duct from the throttle body.
2. Disconnect the positive crankcase ventilation (PCV) hose from the right bank camshaft cover.

NOTE: Do NOT separate the upper intake manifold from the lower intake manifold.

3. Remove the intake manifold bolts.

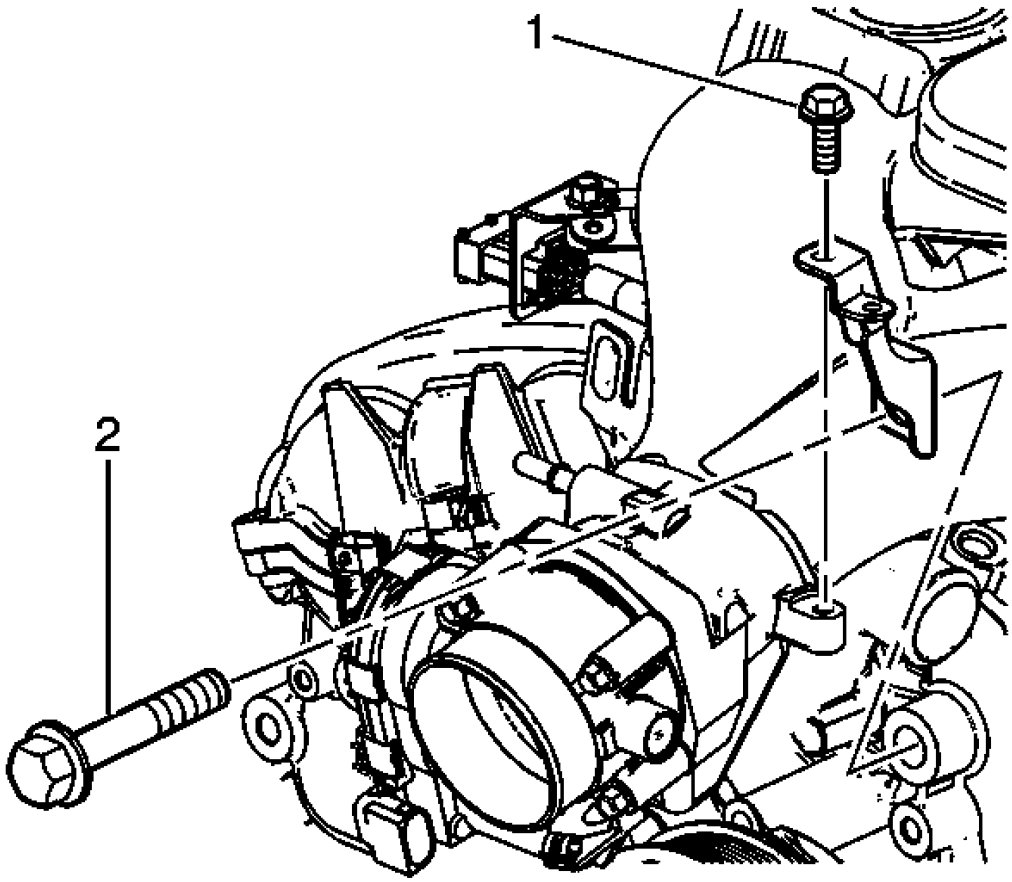


Fig. 143: View Of Intake Manifold Brace & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the intake manifold brace bolts (1 and 2) and the brace.
5. Remove and reposition the upper intake manifold with the lower intake manifold in order to gain sufficient clearance for ignition coil removal.

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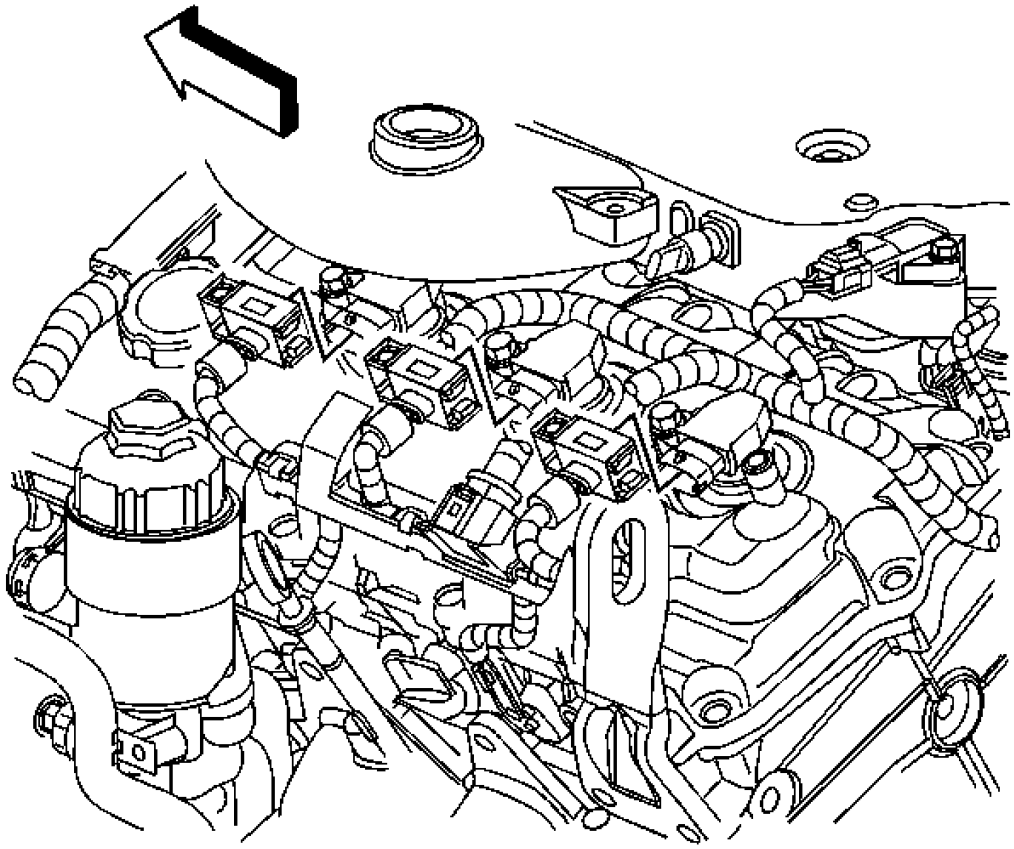


Fig. 144: View Of Ignition Coil Electrical Connectors - Bank 2
Courtesy of GENERAL MOTORS CORP.

4. Remove the ignition coil electrical connector(s).

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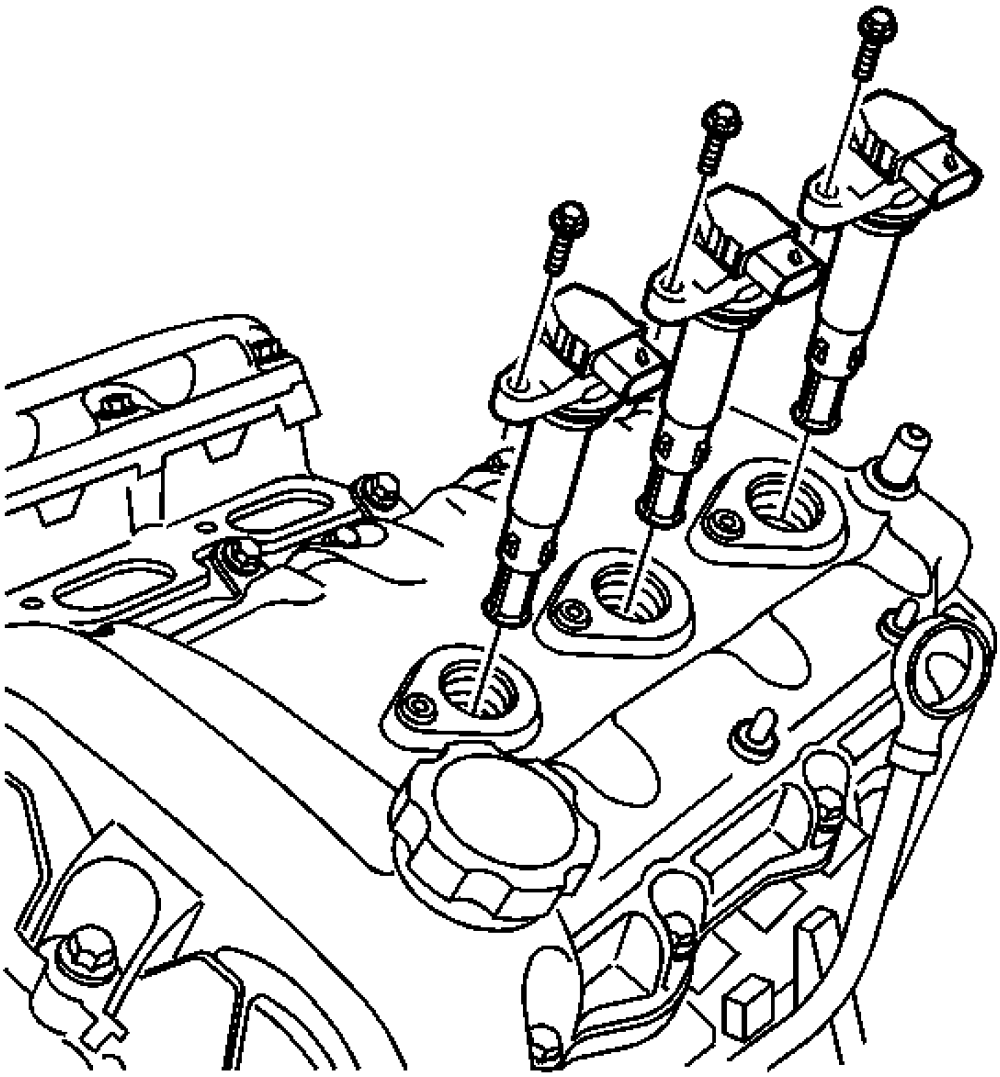


Fig. 145: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS CORP.

5. Remove the ignition coil bolt(s).
6. Remove the ignition coil(s).

Installation Procedure

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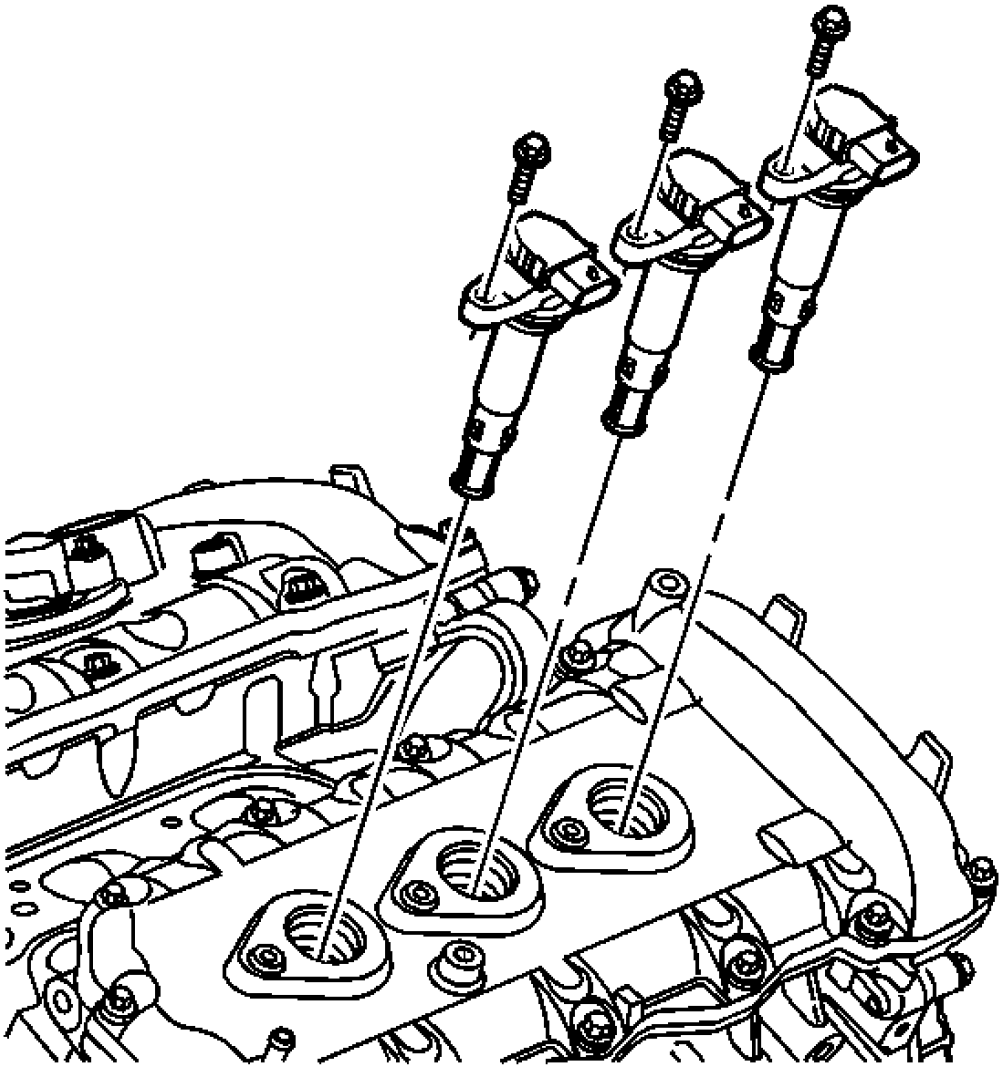


Fig. 146: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) and tighten to 10 N.m (89 lb in).

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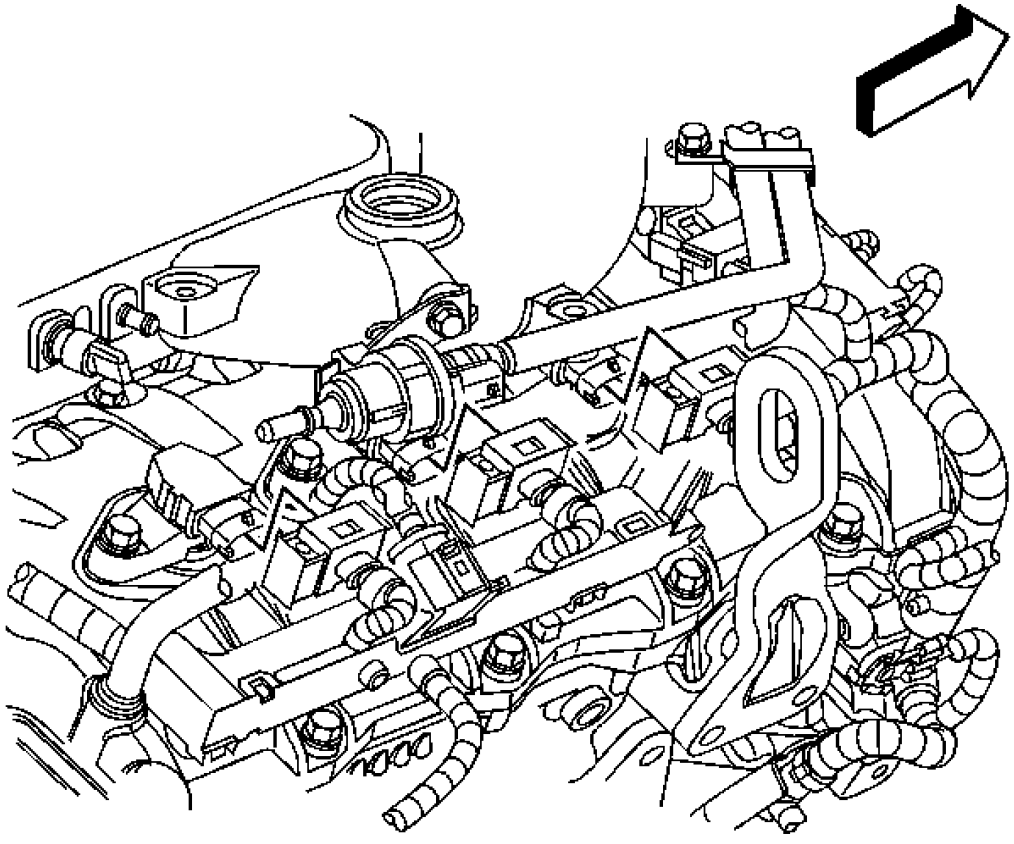


Fig. 147: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coil electrical connector(s).
4. If necessary, install the upper intake manifold.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

SPARK PLUG INSPECTION

Spark Plug Operation

Worn or dirty spark plugs may operate well at idle speeds, but frequently fail at higher load. Bad spark plugs are often responsible for the following conditions:

- Power loss
- Poor fuel economy

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- Loss of speed
- Hard starting
- Poor engine performance

Normal spark plug operation results in brown to grayish tan deposits on the area of the spark plug that enters the cylinder. A small amount of reddish brown, yellow, and white powdery residue may also be present on the insulator tip around the center electrode. These deposits are normal combustion by-products of fuels and lubricating oils which contain additives.

Misfiring is a general term that applies to a poor running engine. With misfiring, the ignition spark is not igniting the air/fuel mixture at the proper time. While other possible causes must be investigated, the spark plugs should be inspected first. Spark voltage should not reach ground before jumping across the gap at the tip of the spark plug. This leaves the air/fuel mixture unburned, causing misfiring. Pre-ignition misfiring occurs when the spark plug tip overheats, igniting the mixture before the spark jumps.

Carbon fouling of the spark plug is indicated by dry carbon deposits on the portion of the spark plug inside of the cylinder. Excess idling and driving at slower speeds under light engine loads can keep the spark plug temperatures so low that these deposits are not burned off. Rich fuels or poor ignition system output may also cause carbon fouling.

Oil fouling of the spark plug appears as wet oily deposits on the portion of the spark plug inside of the cylinder. This may be caused by the following conditions:

- Oil getting past worn piston rings
- Breaking in a new or recently overhauled engine

Deposit fouling of the spark plug occurs when the normal reddish brown, yellow, or white deposits of combustion by-products become sufficient enough to cause misfiring. In some cases, these deposits melt and form a shiny glaze on the insulator around the center electrode. If the fouling is found only in one or two of the cylinders, valve stem clearances or the intake valve seals may be allowing excess lubricating oil to enter the cylinder, particularly if the deposits are heavier on the intake valve side of the spark plug.

Excess gap means that the air space between the center and side electrodes at the bottom of the spark plug is too wide for consistent firing. This may be due to improper gap adjustment or to excess wear of the electrodes during use. A gap that is too small may cause idling instability. Excess gap wear might indicate vehicle operation at continual high speeds or with high engine loads. This causes the spark plugs to run too hot. Excessively lean fuel may also cause the wear.

Improper torque or seating can cause a spark plug to run hot, eventually leading to excess gap wear. In extreme cases, an overtightened or under-tightened spark plug can cause exhaust blow-by. The cylinder head seats must make good contact for sufficient heat transfer and spark plug cooling. Dirty or damaged threads in the head or on the spark plug can keep the spark plug from seating even though the proper torque is applied. Once the spark plugs are properly seated, tighten the spark plugs properly.

Cracked or broken insulators and insulator tips may be the result of improper installation or heat shock. Heat shock is a rapid increase in the insulator tip temperature which causes the insulator material to crack. The upper insulators can be broken when a poorly-fitting tool is used during servicing, or when the spark plug is hit from

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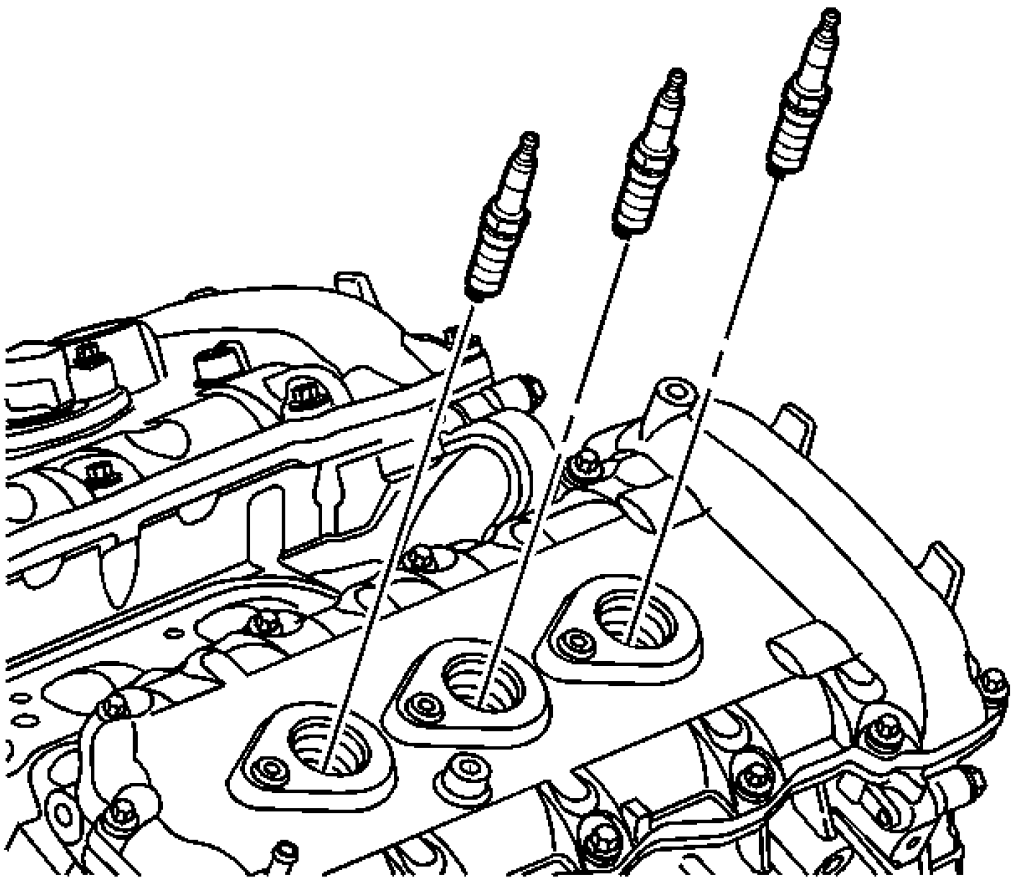
the outside. Cracks in the upper insulator may be inside the shell or invisible. The breakage may not cause problems until oil or water penetrates the crack later. Heat shock breakage in the lower insulator tip generally occurs during severe engine operating conditions such as higher RPM or heavy loading. Over advanced timing or low grade fuels may also cause heat shock breakage. Always replace spark plugs with broken or cracked insulators.

Damage during gapping can occur when the tool is pushed against the center electrode or the surrounding insulator, causing the insulator to crack. When gapping a spark plug, bend only the outside electrode. Keep tools free of any other parts.

Spark plugs with less than the recommended amount of service can sometimes be cleaned and re-gapped, then returned to service. If there is any doubt about the serviceability of a spark plug, replace the spark plug.

SPARK PLUG REPLACEMENT

Removal Procedure



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Fig. 148: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the ignition coil. Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

3. Use compressed air in order to remove debris from the spark plug cavity.

CAUTION: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.

4. Remove the spark plug.

Installation Procedure

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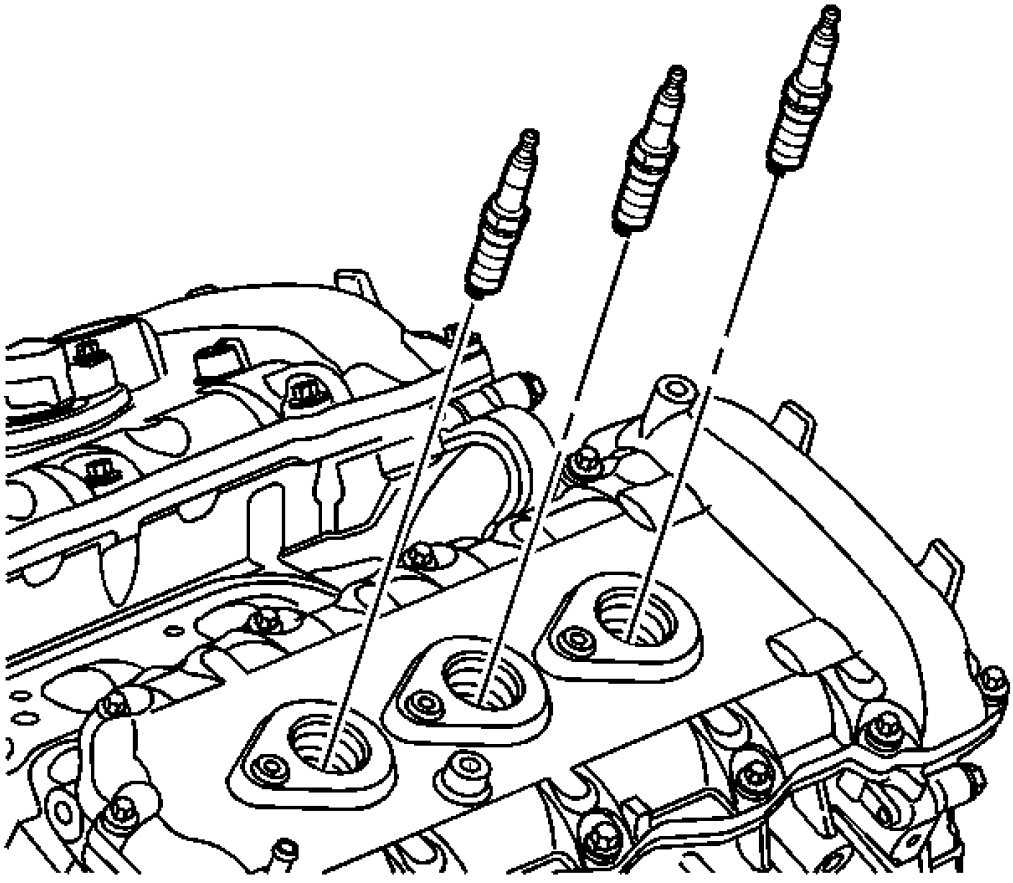


Fig. 149: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

CAUTION: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

CAUTION: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gauge to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to **Ignition System Specifications** .

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CAUTION: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.

2. Install the spark plug and tighten to 20 N.m (15 lb ft).
3. Install the ignition coil. Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

CRANKSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

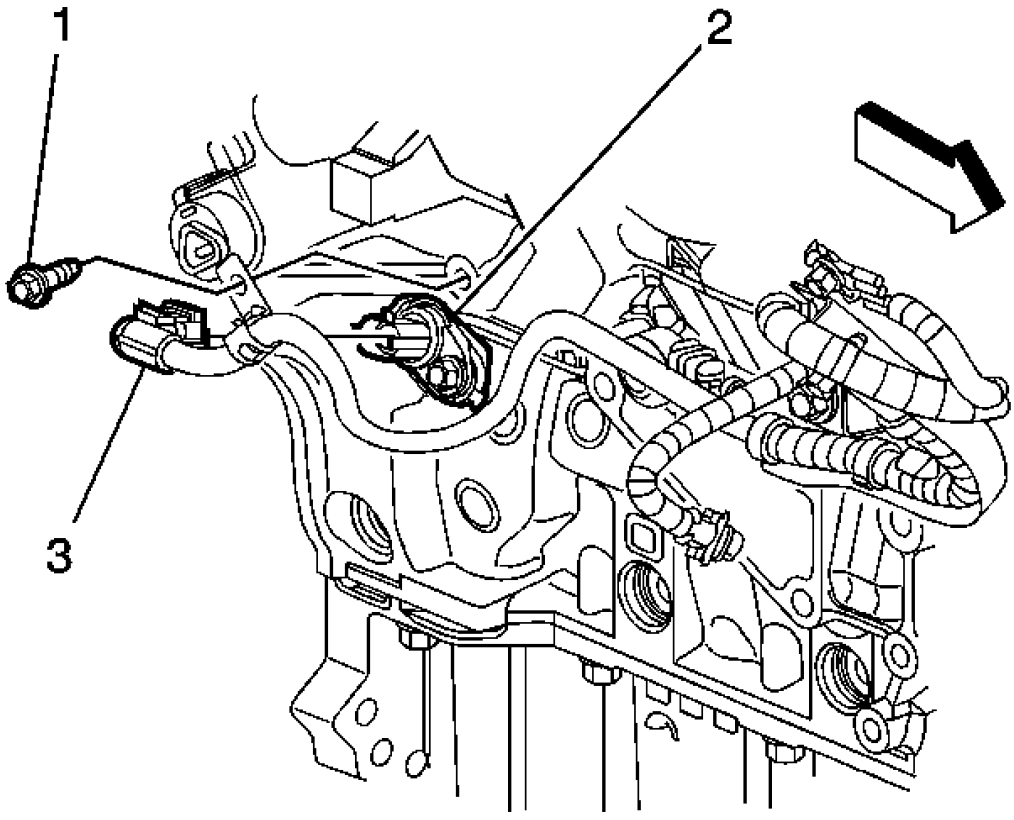


Fig. 150: Locating CKP Electrical Connector

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Courtesy of GENERAL MOTORS CORP.

2. Disconnect the crankshaft position (CKP) electrical connector (3).

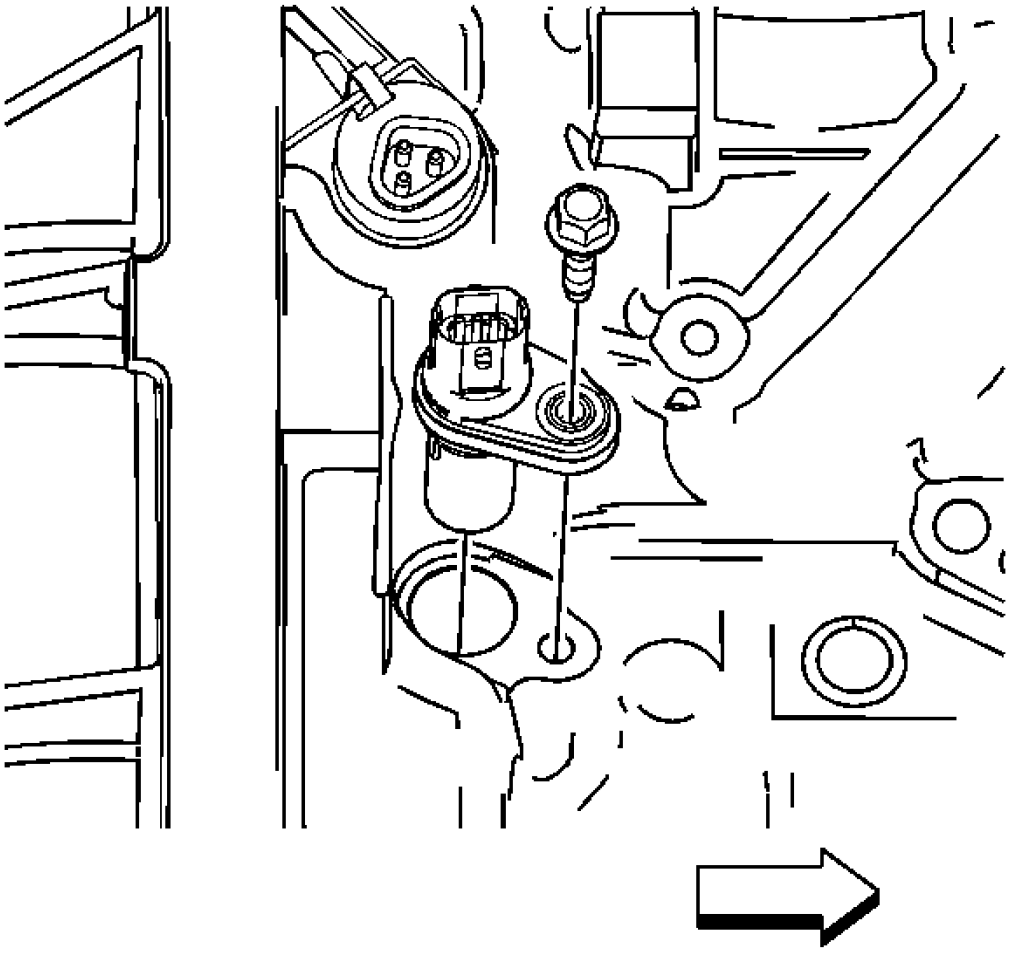


Fig. 151: View Of CKP Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft sensor bolt.
4. Remove the crankshaft sensor.

Installation Procedure

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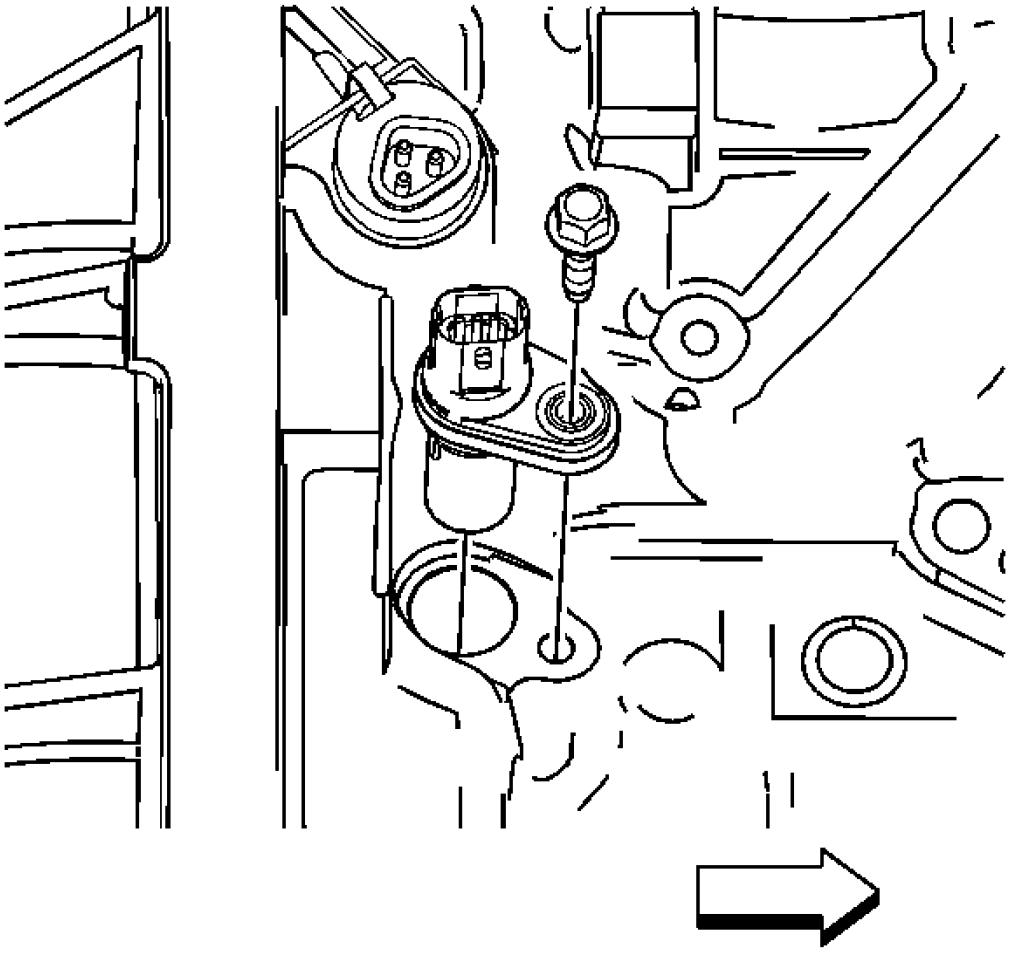


Fig. 152: View Of CKP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft position sensor.

CAUTION: Refer to Fastener Caution .

2. Install the crankshaft position sensor bolt and tighten to 10 N.m (89 lb in).

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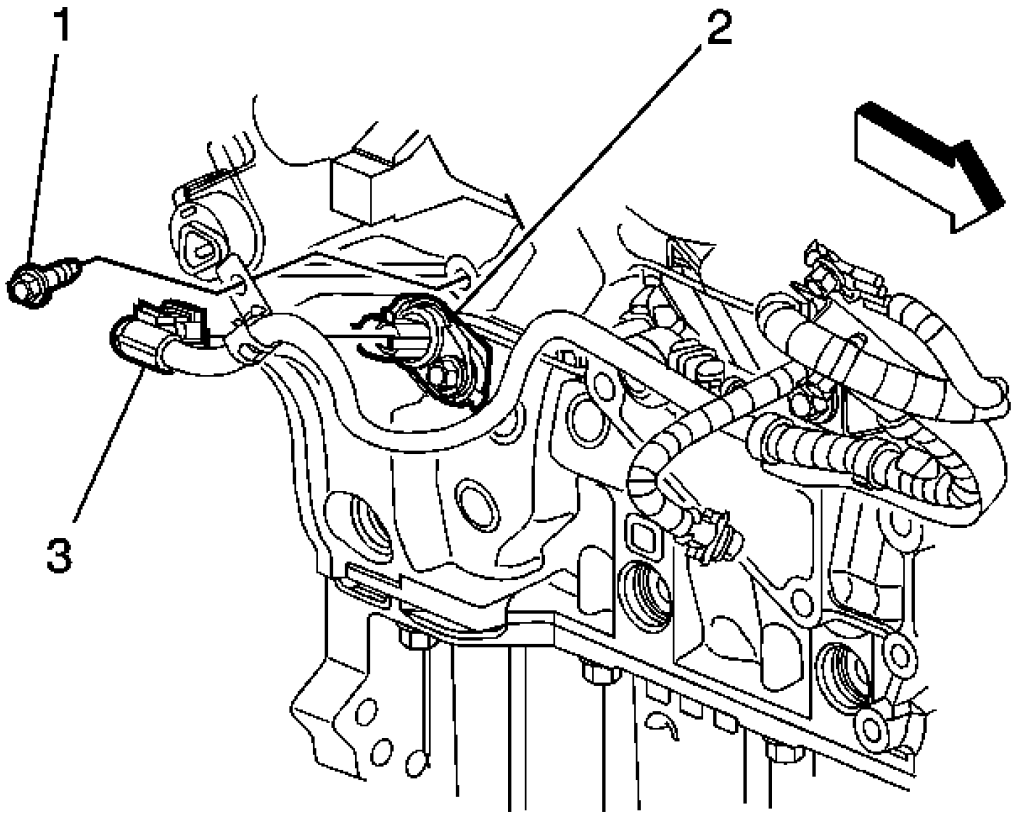


Fig. 153: Locating CKP Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the CKP electrical connector (3).
4. Lower the vehicle.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

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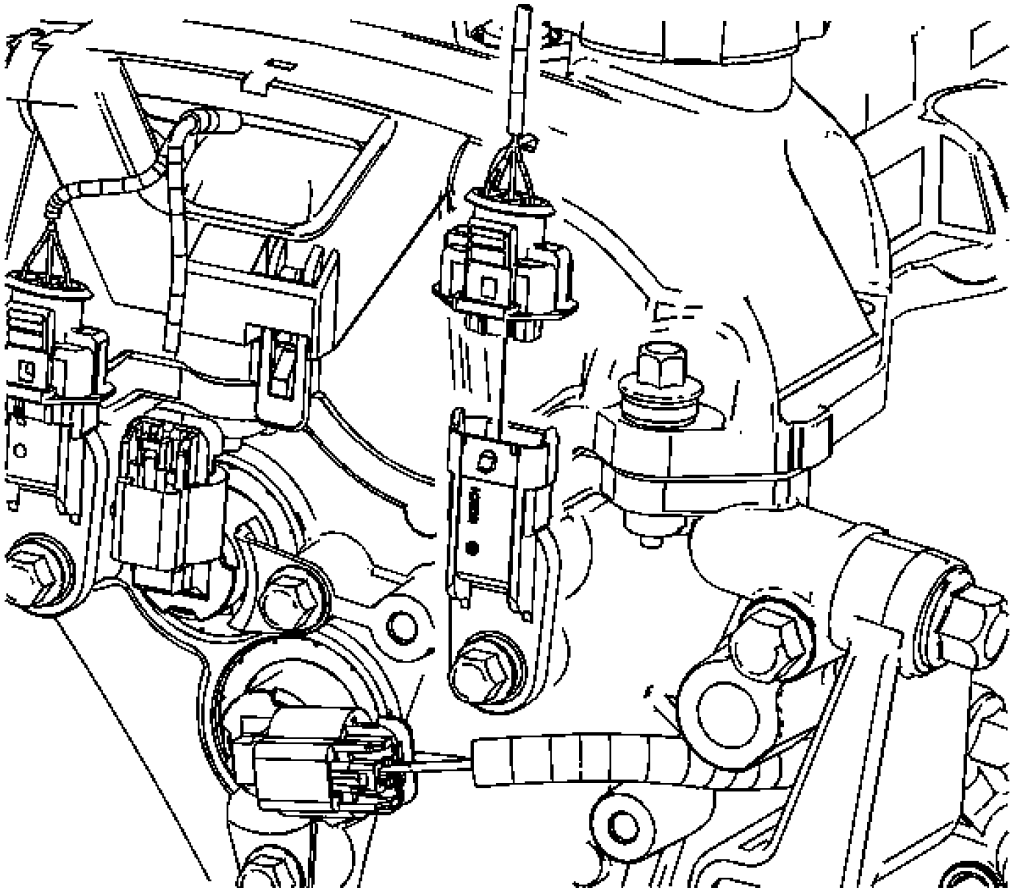


Fig. 154: View Of Left CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) sensor electrical connector.

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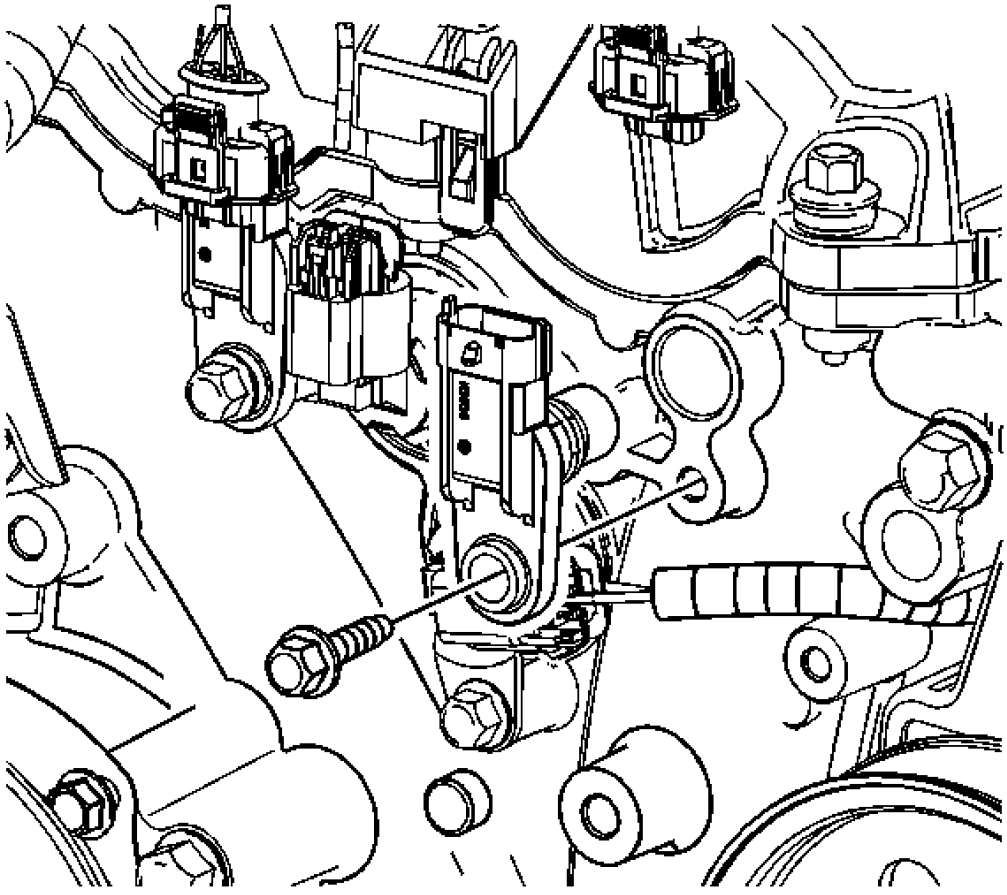


Fig. 155: View Of Left CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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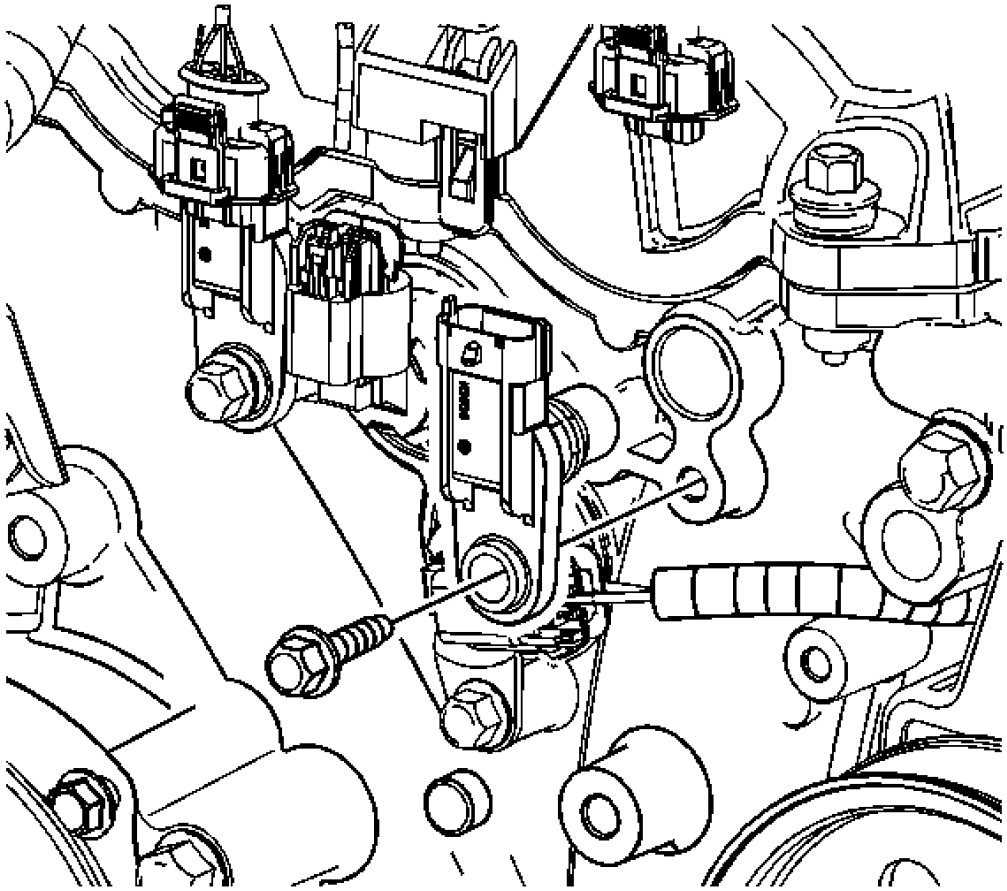


Fig. 156: View Of Left CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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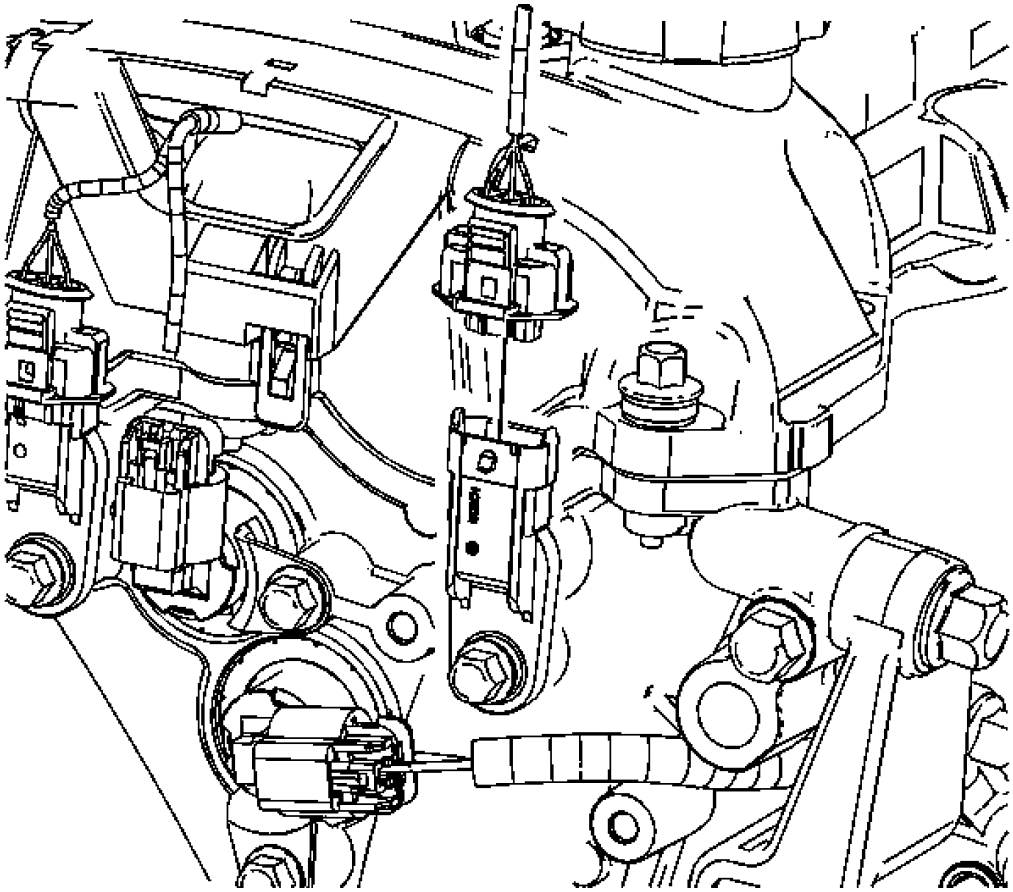


Fig. 157: View Of Left CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Install the CMP sensor electrical connector.
4. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

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2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

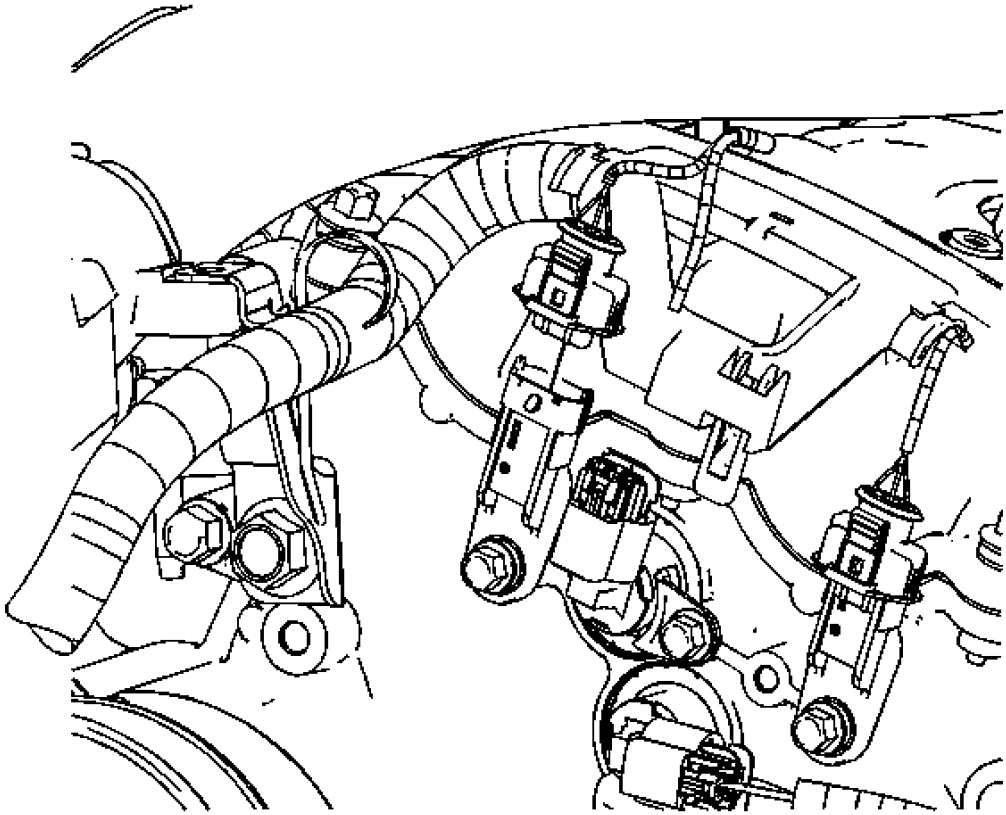


Fig. 158: View Of Left CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) sensor electrical connector.

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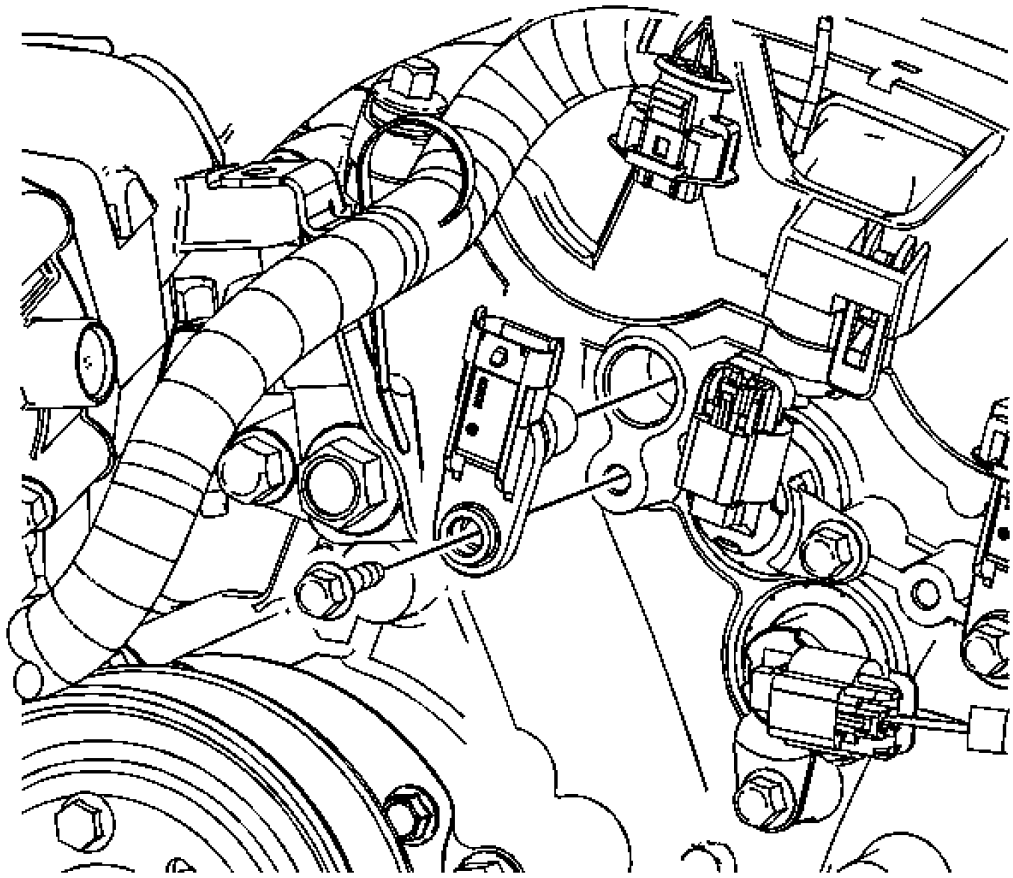


Fig. 159: View Of Left CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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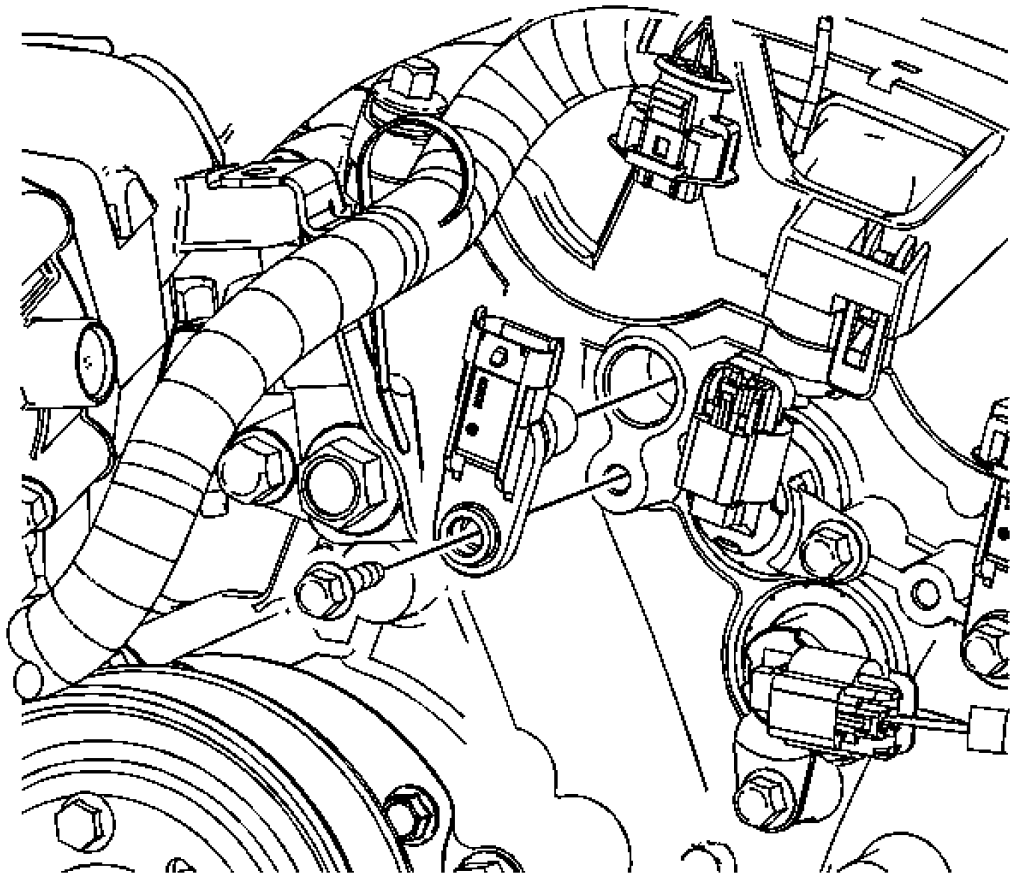


Fig. 160: View Of Left CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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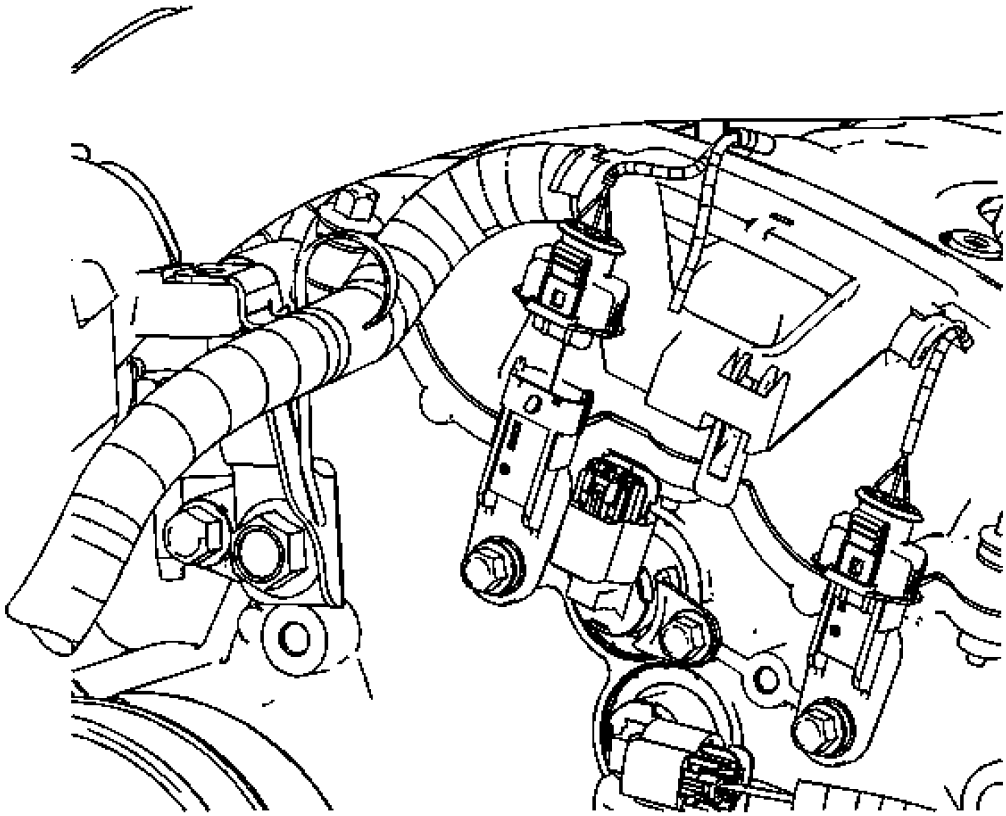


Fig. 161: View Of Left CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Install the CMP sensor electrical connector.
4. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

Removal Procedure

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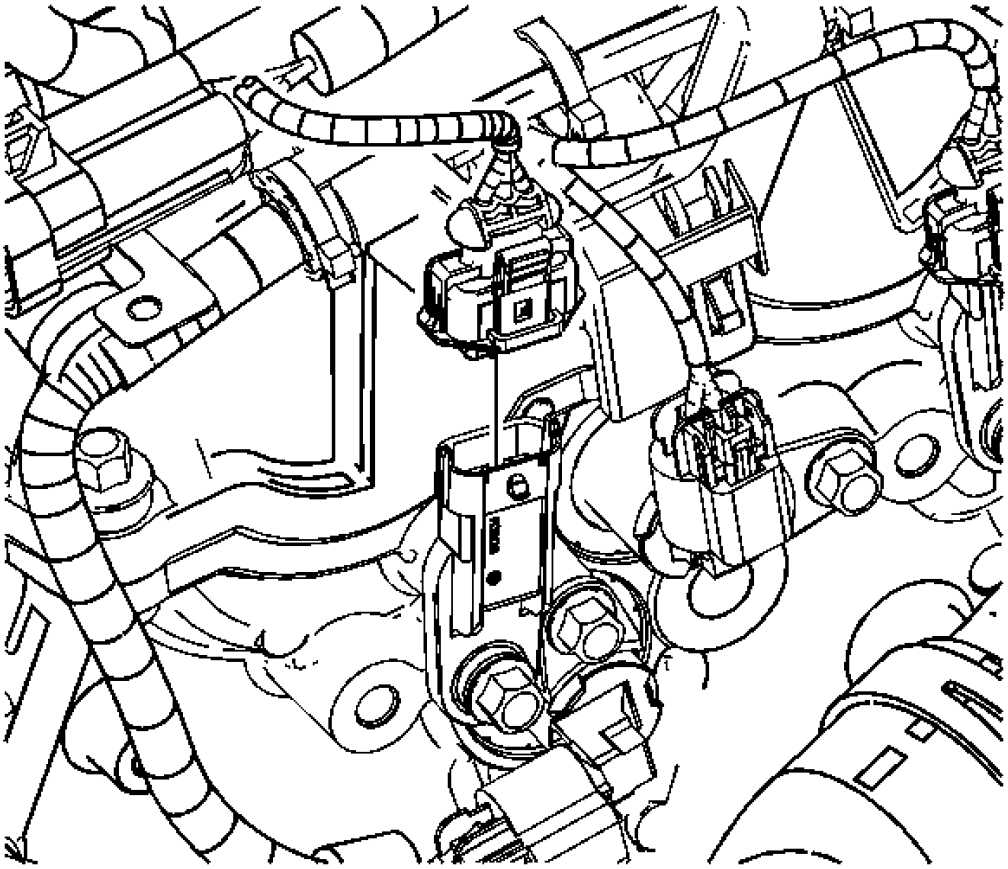


Fig. 162: View Of Right CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) sensor electrical connector.

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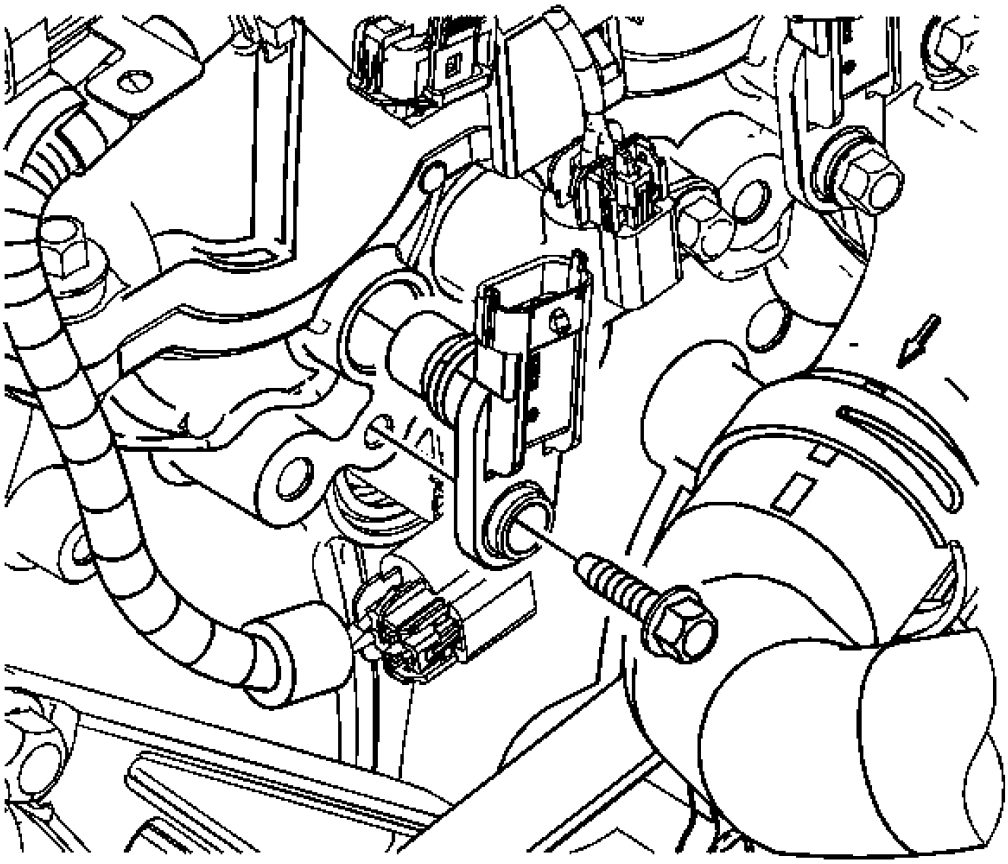


Fig. 163: View Of Right CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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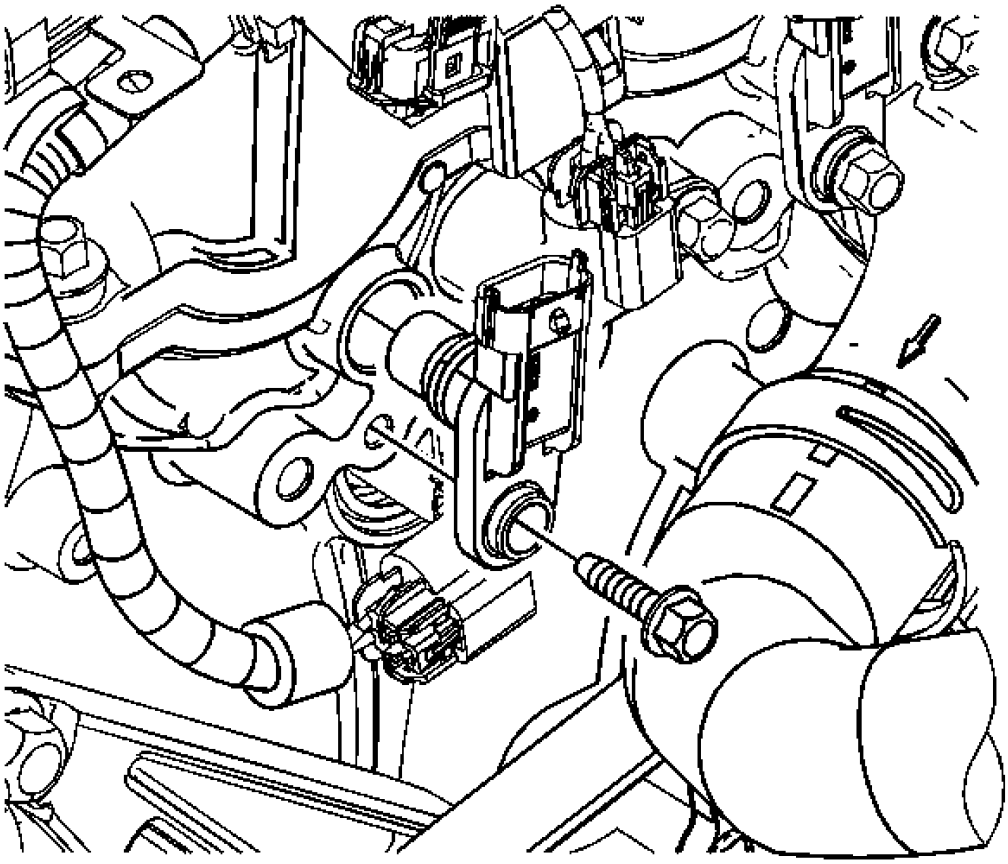


Fig. 164: View Of Right CMP Sensor - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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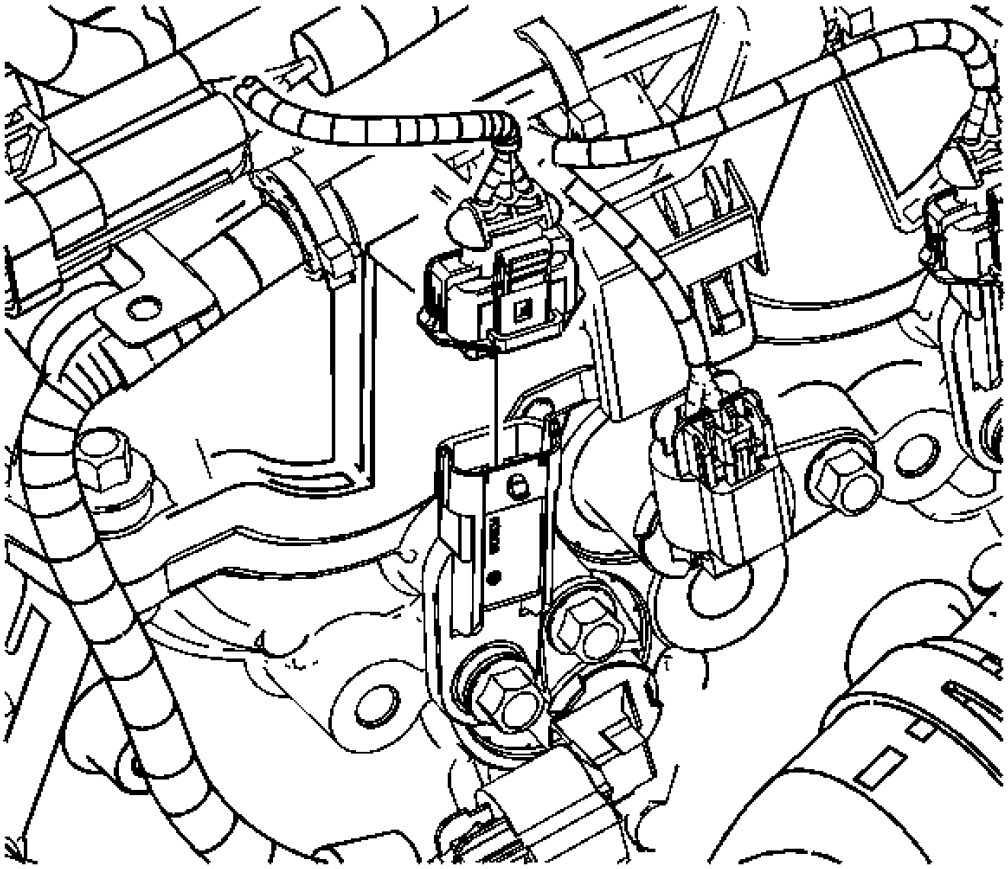


Fig. 165: View Of Right CMP Sensor Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Connect the CMP sensor electrical connector.
4. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

Removal Procedure

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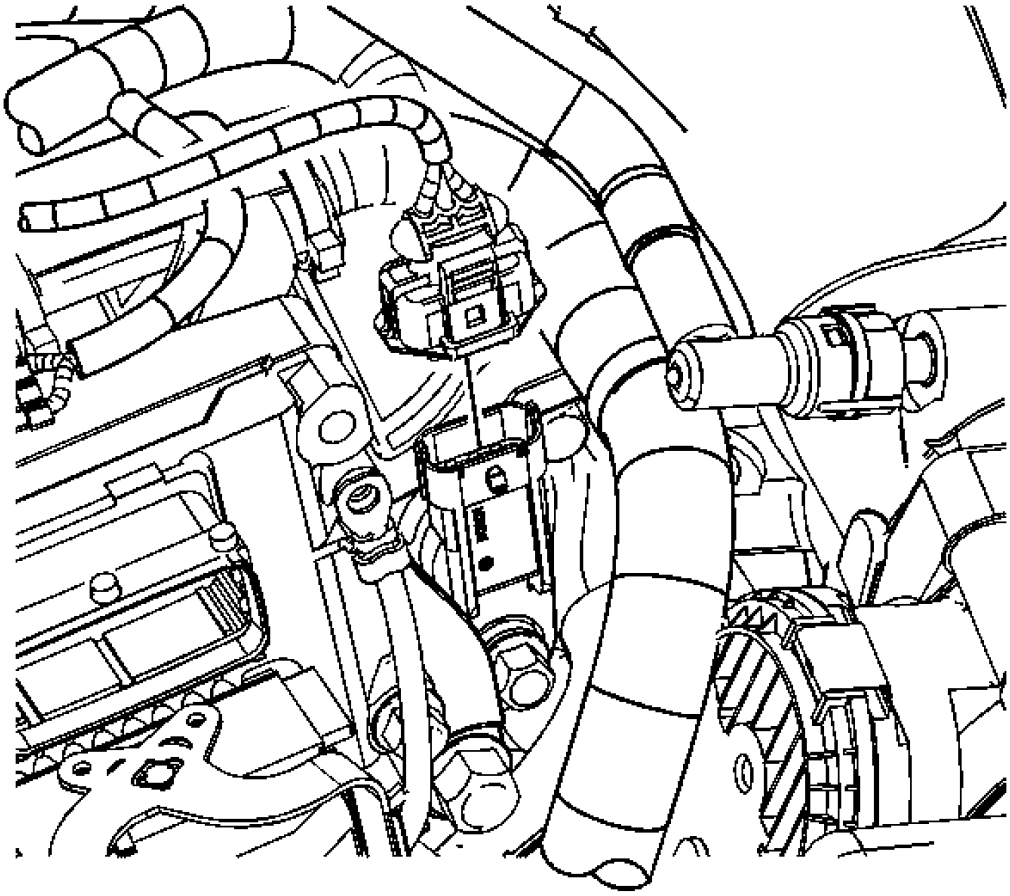


Fig. 166: View Of Right CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) sensor electrical connector.

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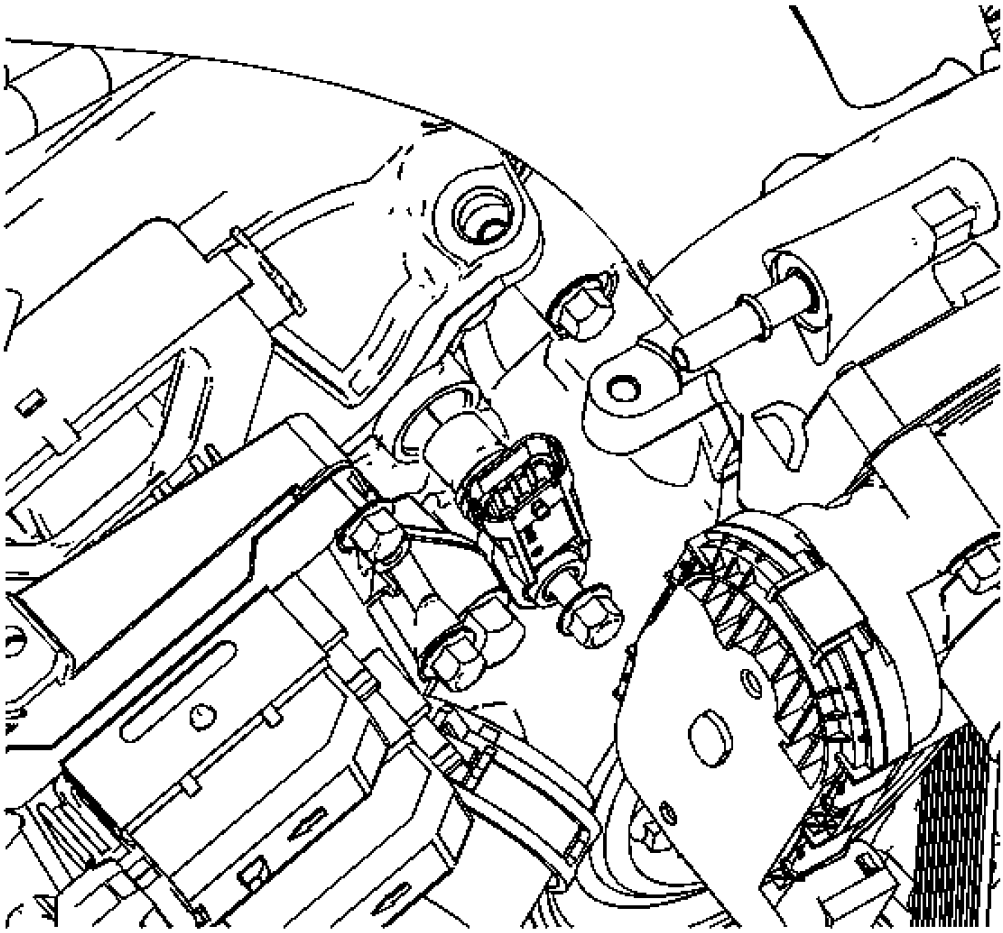


Fig. 167: View Of Right CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

Installation Procedure

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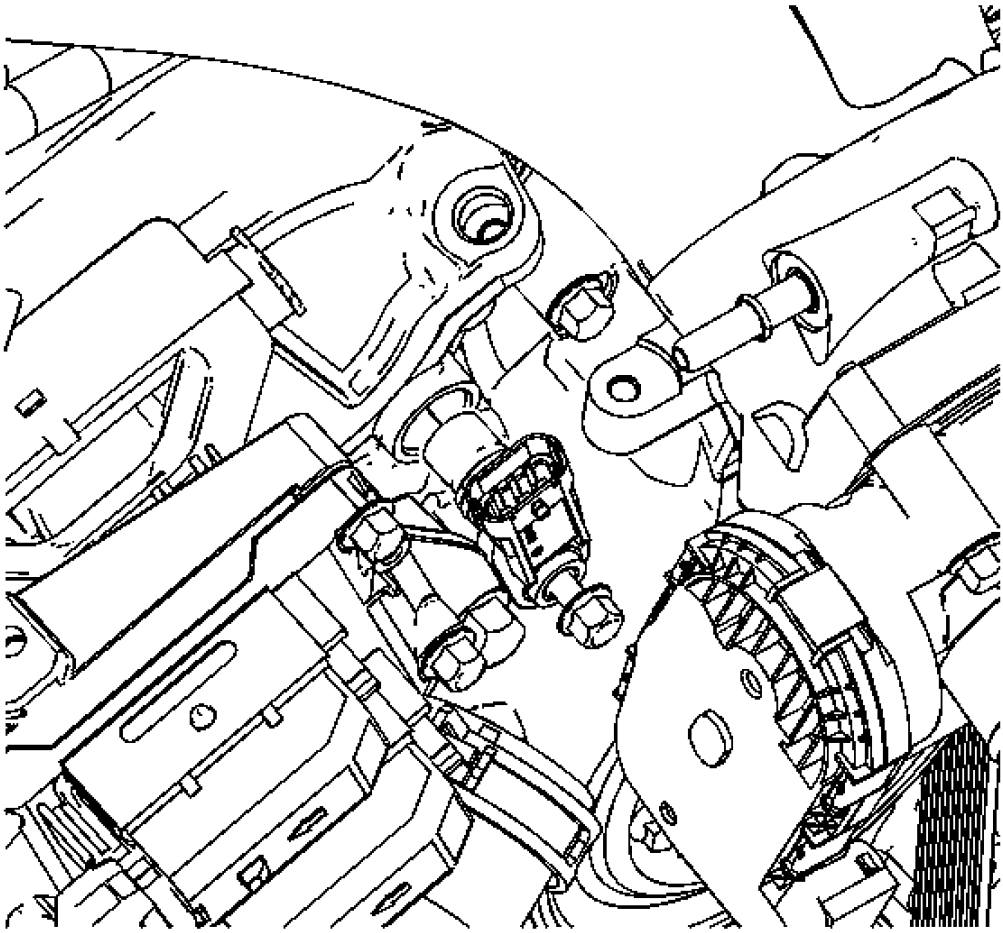


Fig. 168: View Of Right CMP Sensor - Intake
Courtesy of GENERAL MOTORS CORP.

1. Install the CMP sensor.

CAUTION: Refer to Fastener Caution .

2. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

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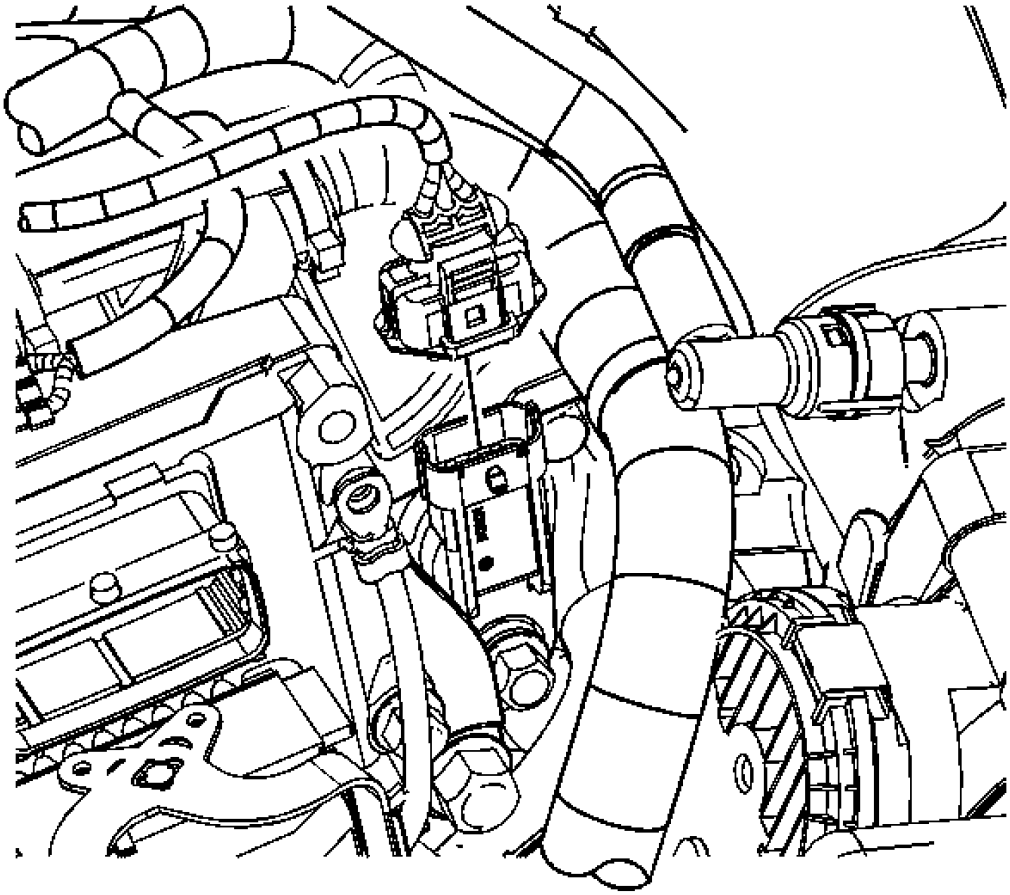


Fig. 169: View Of Right CMP Sensor Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Connect the CMP sensor electrical connector.
4. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

Removal Procedure

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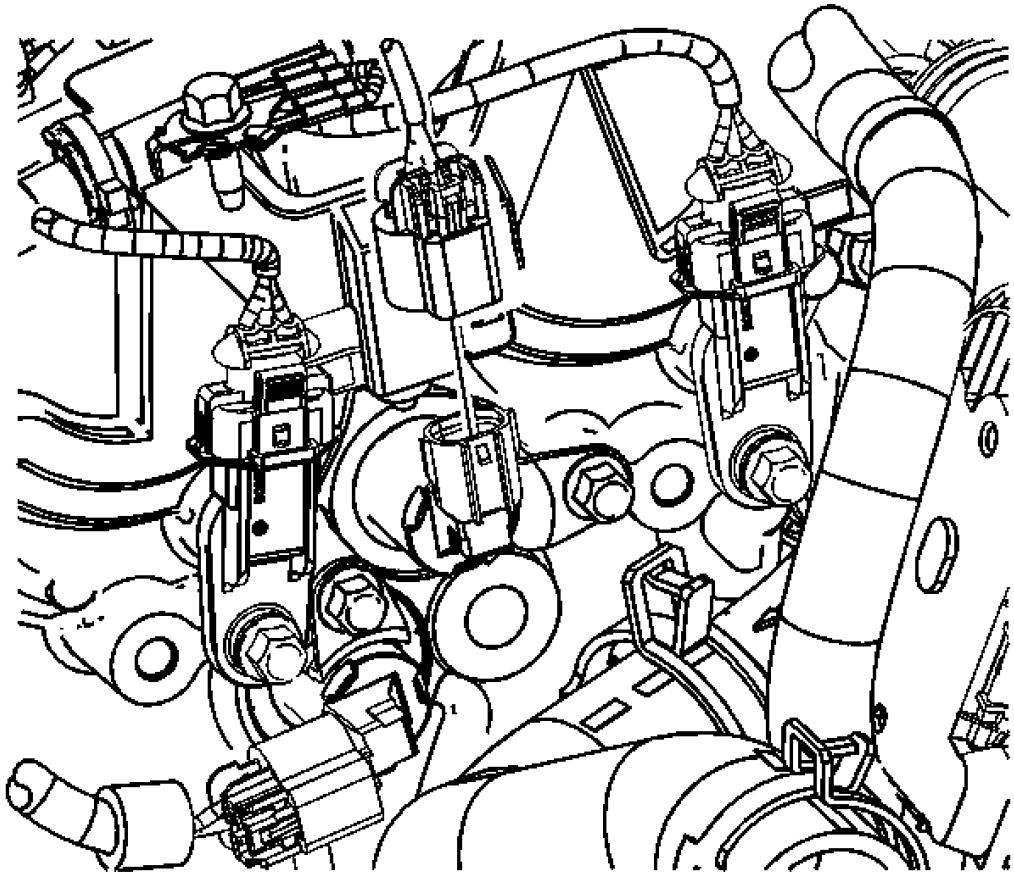


Fig. 170: View Of Right CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) actuator valve electrical connector.

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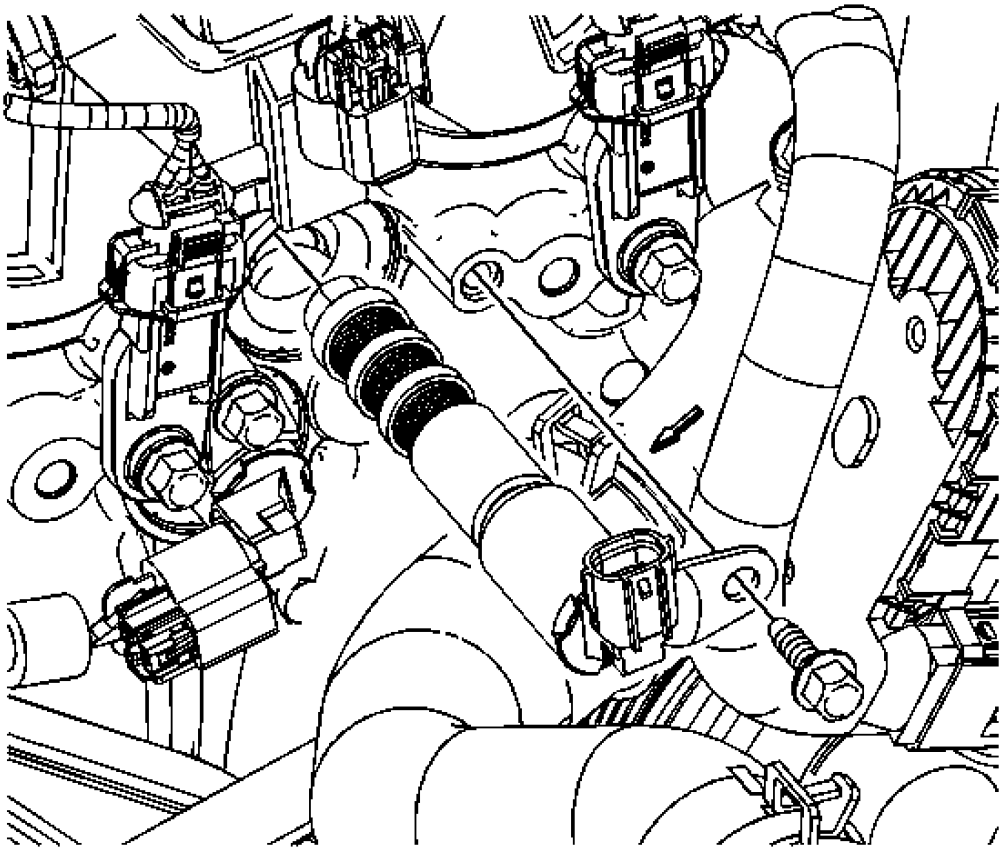


Fig. 171: View Of Right CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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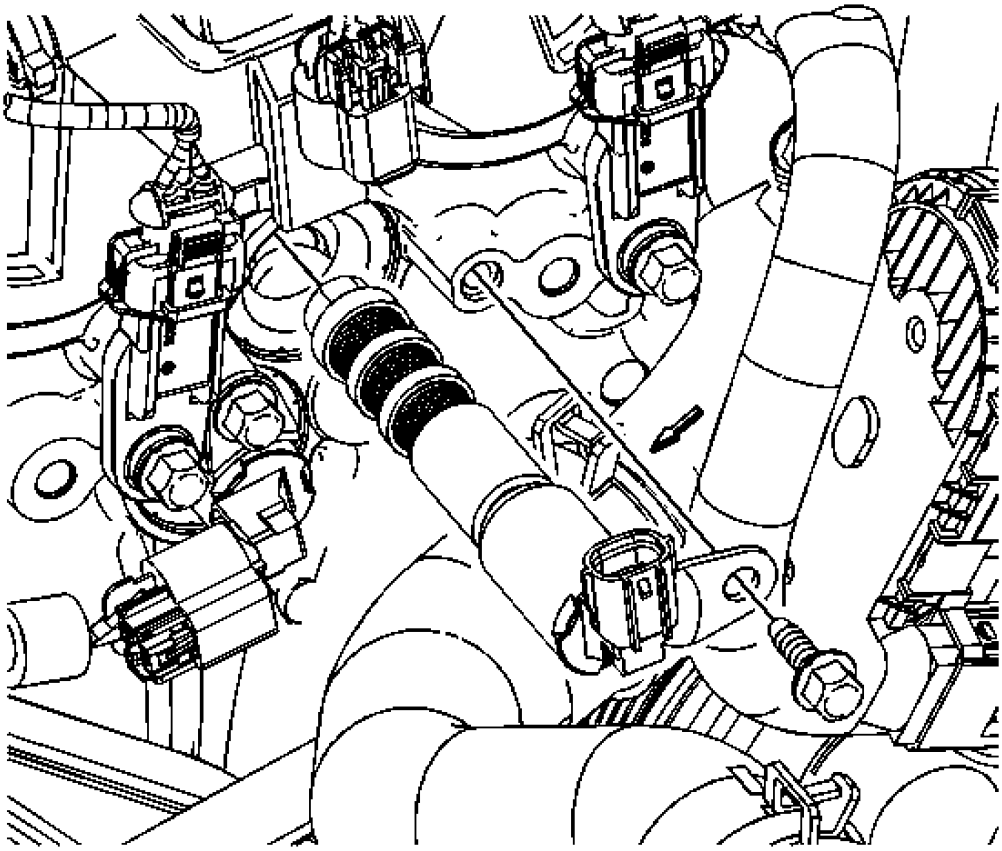


Fig. 172: View Of Right CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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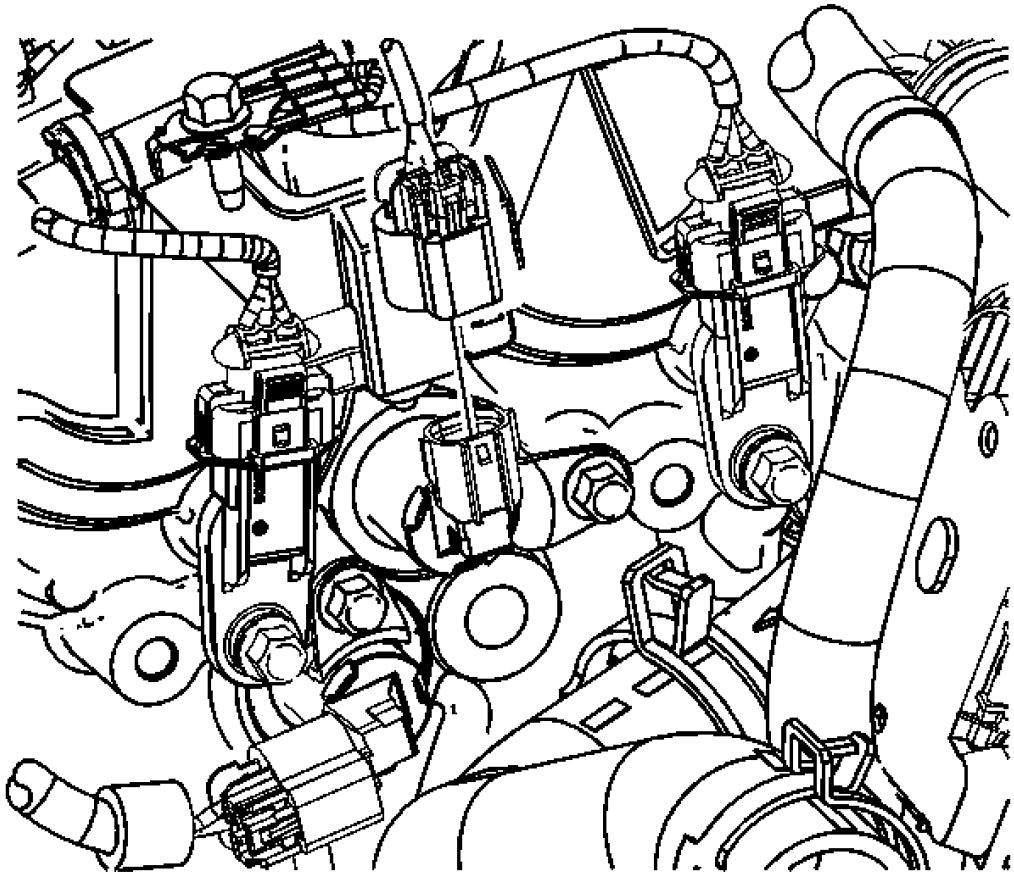


Fig. 173: View Of Right CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

4. Connect the CMP actuator valve electrical connector.
5. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

Removal Procedure

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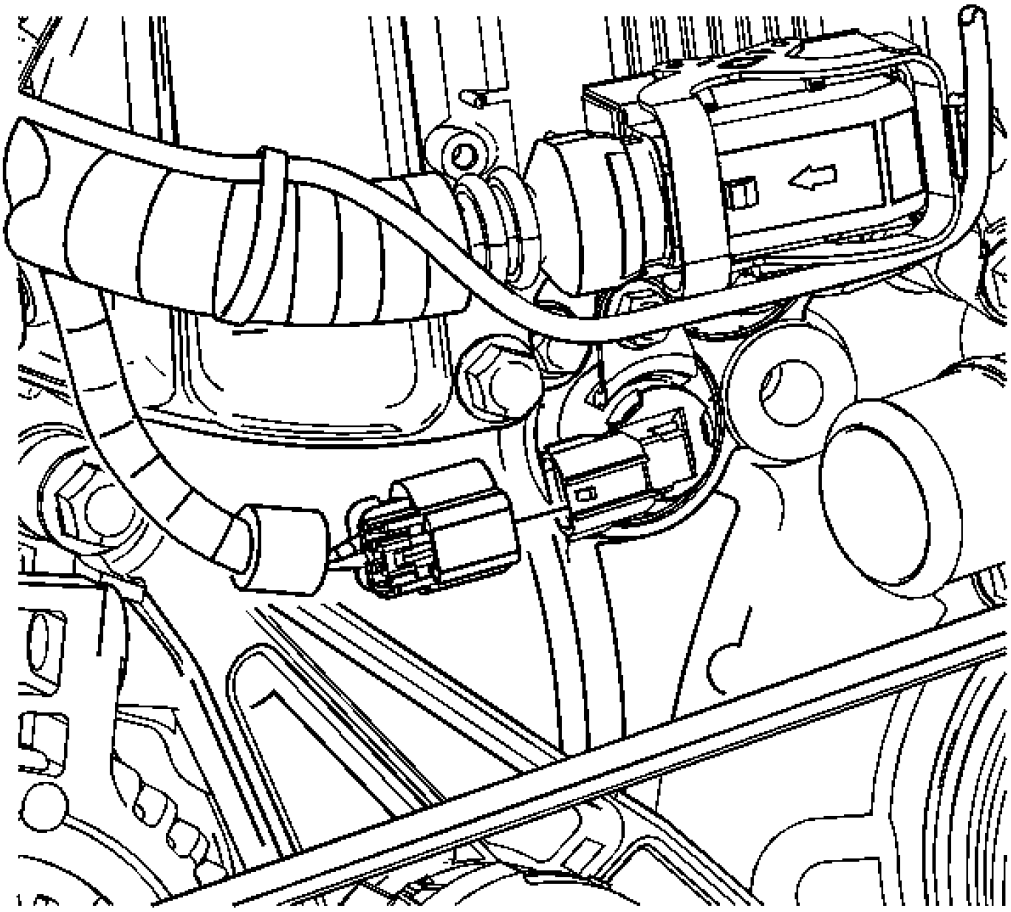


Fig. 174: View Of Right CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary.
3. Disconnect the camshaft position (CMP) actuator valve electrical connector.

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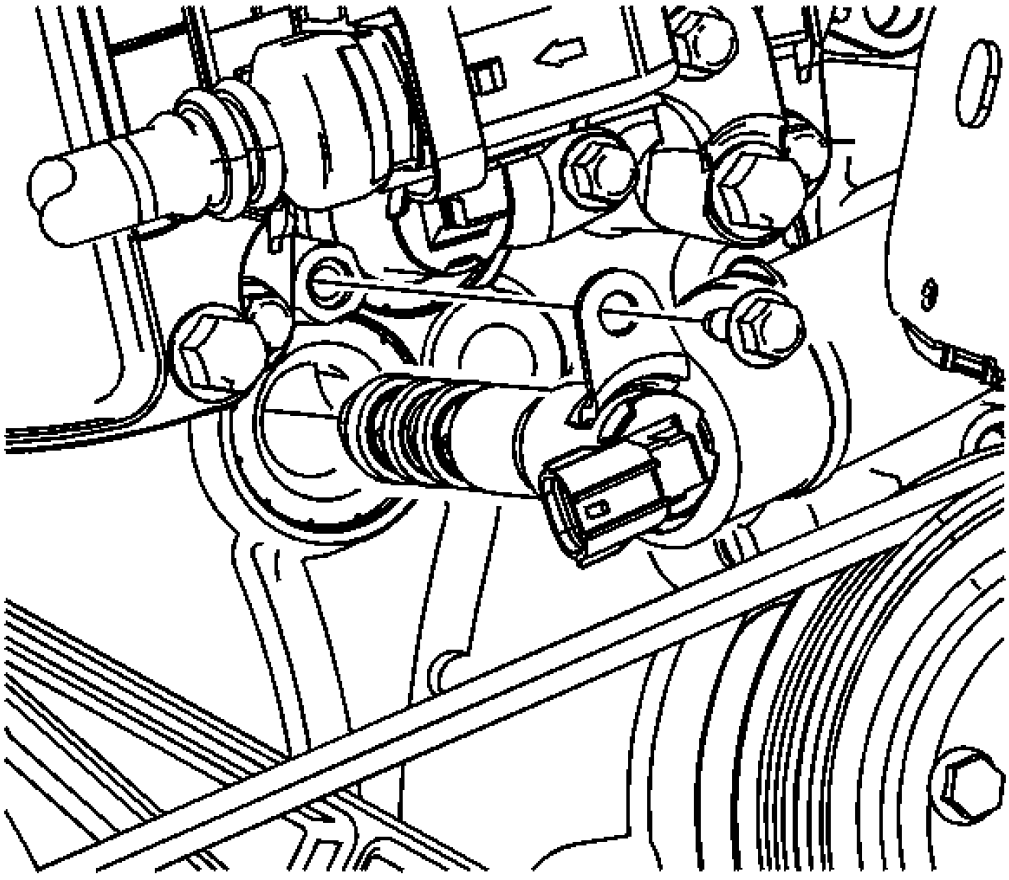


Fig. 175: View Of Right CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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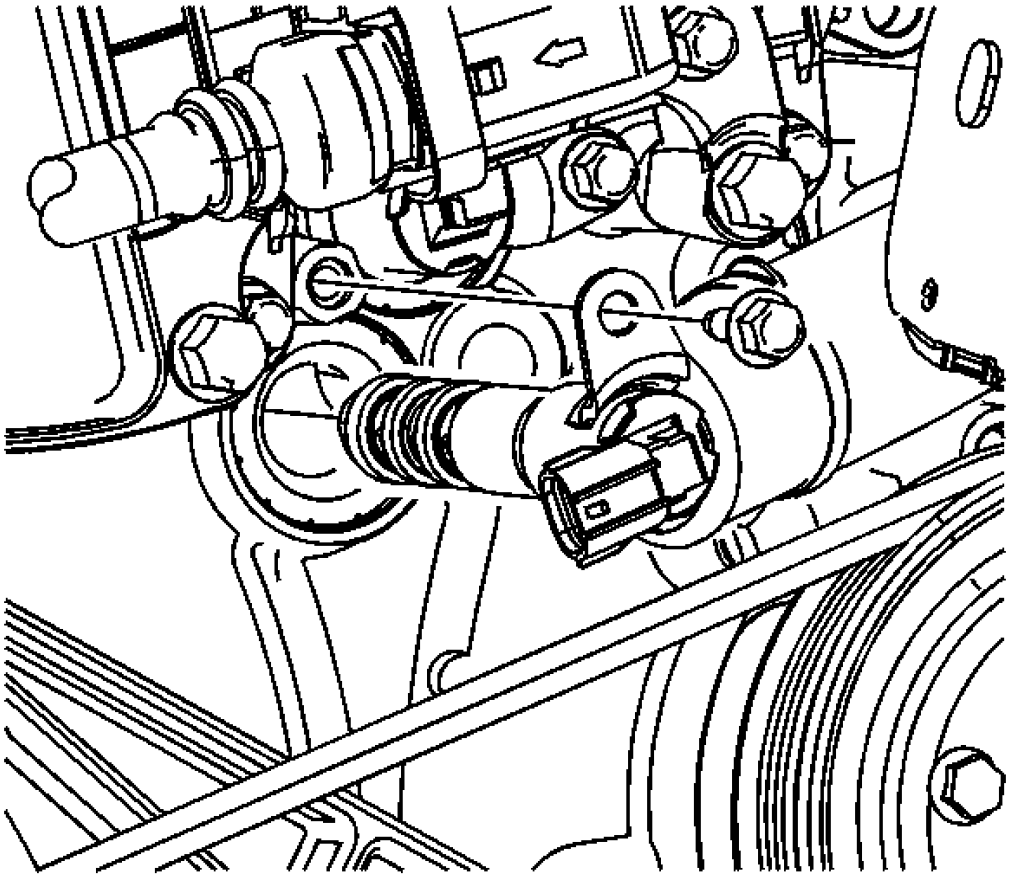


Fig. 176: View Of Right CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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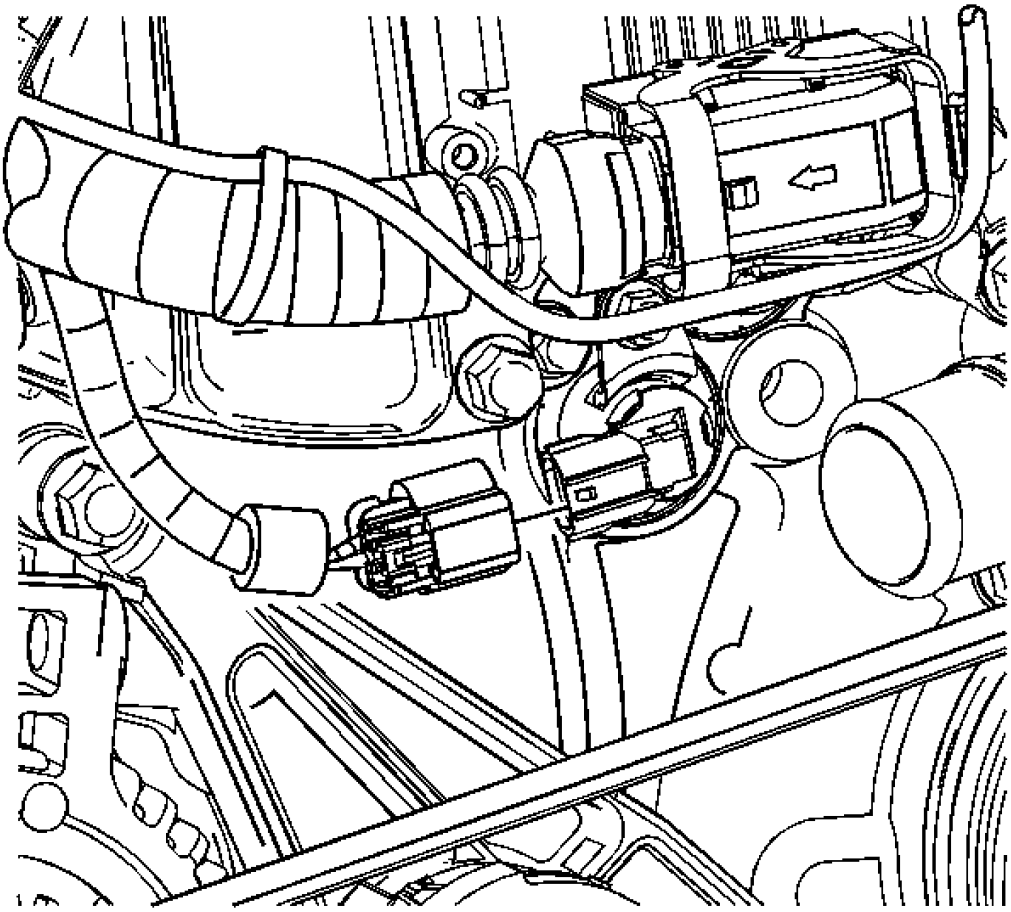


Fig. 177: View Of Right CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Connect the CMP valve electrical connector.
5. Install the front compartment sight shields as necessary.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

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2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

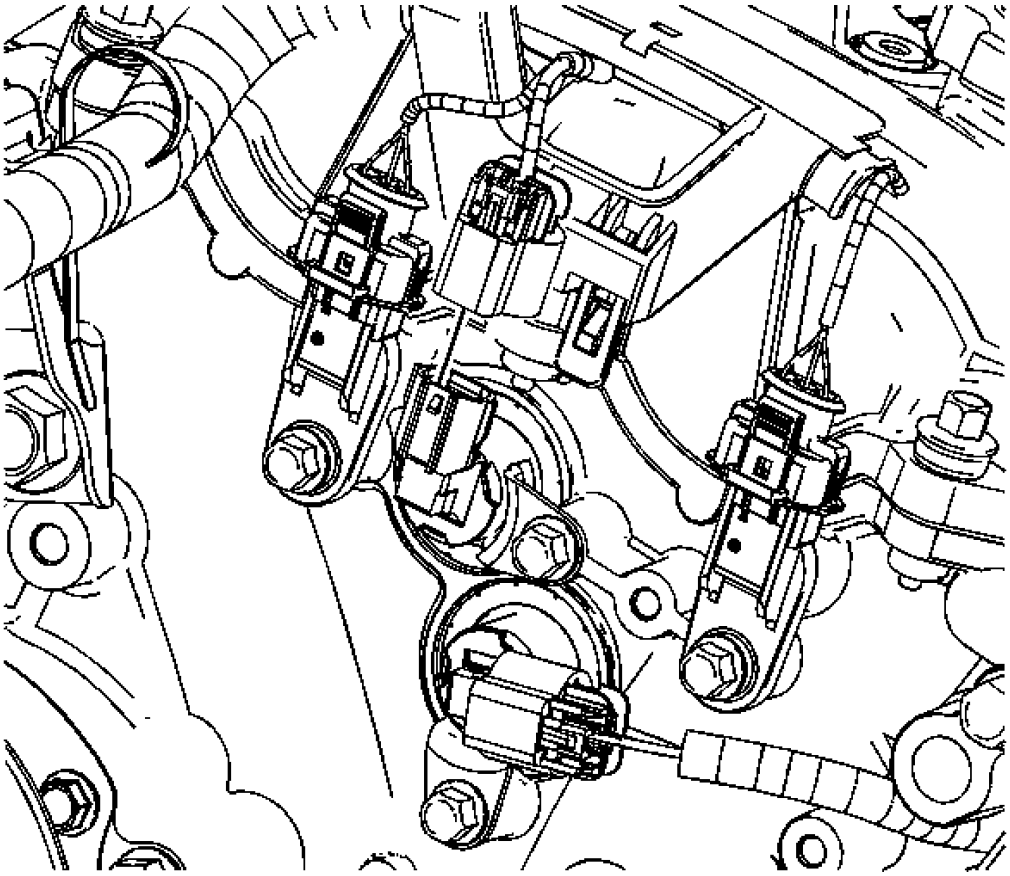


Fig. 178: View Of Left CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) actuator valve electrical connector.

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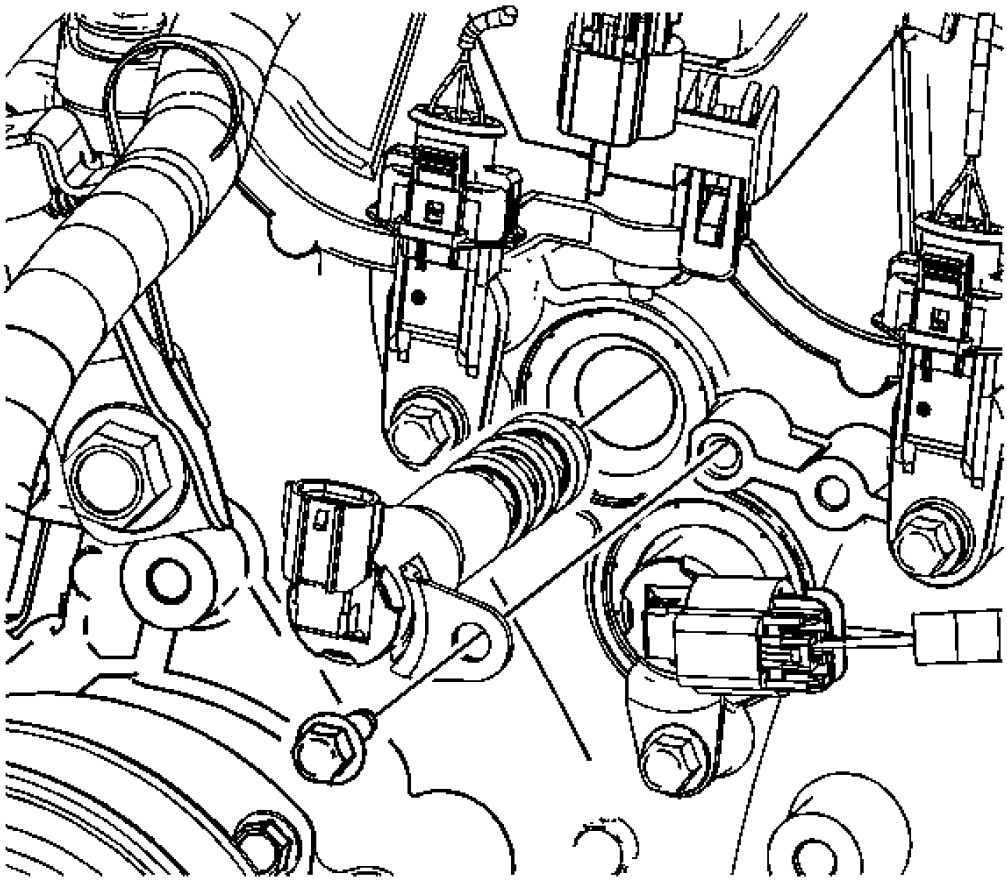


Fig. 179: View Of Left CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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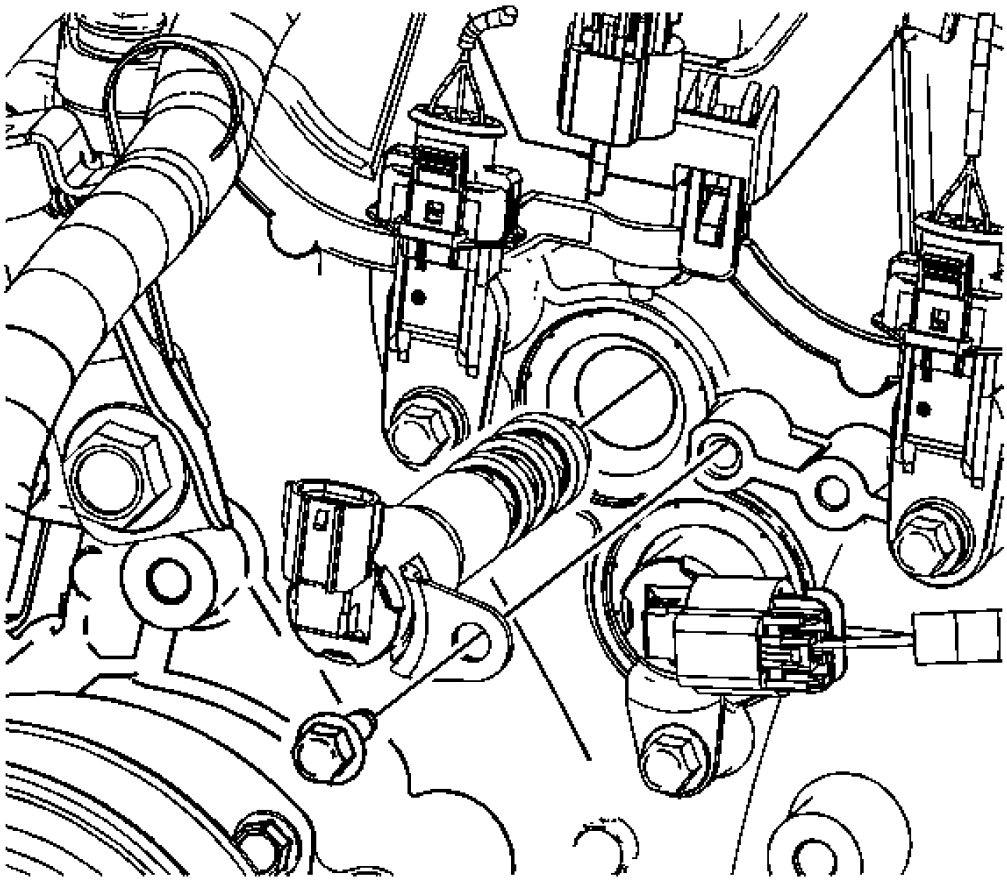


Fig. 180: View Of Left CMP Actuator Valve - Intake
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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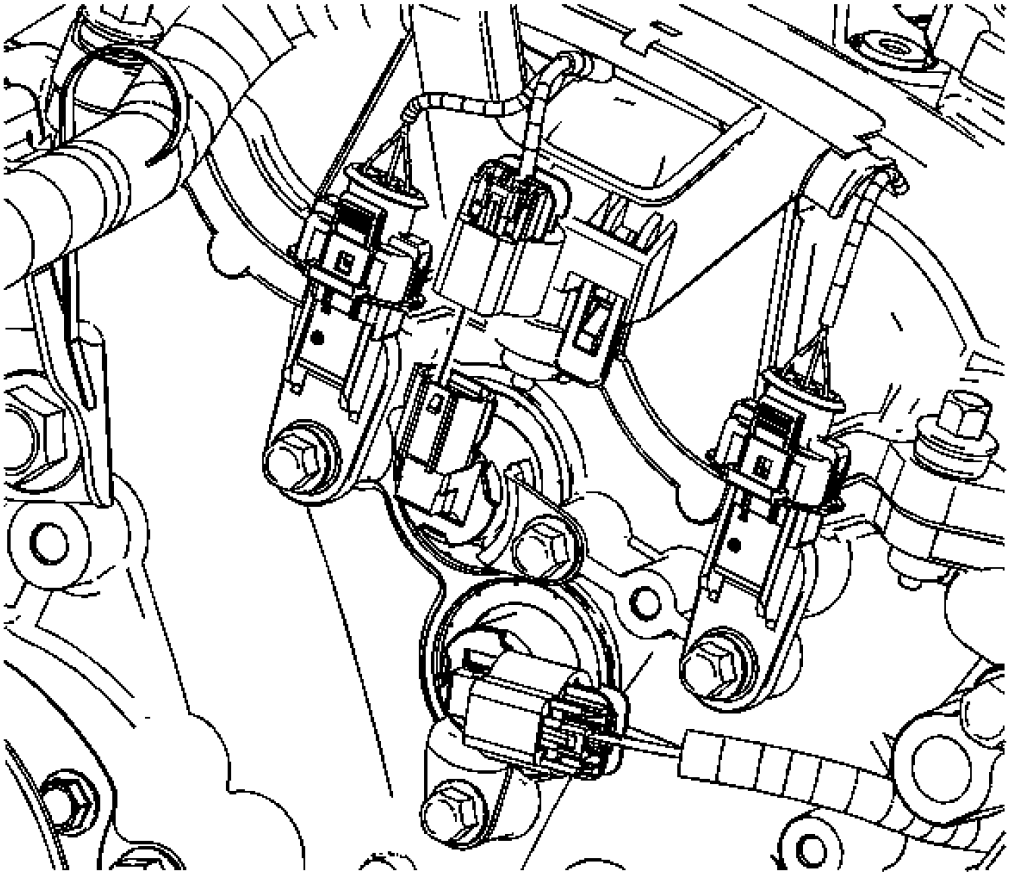


Fig. 181: View Of Left CMP Actuator Valve Electrical Connector - Intake
Courtesy of GENERAL MOTORS CORP.

4. Install the CMP actuator valve electrical connector.
5. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

Removal Procedure

1. Turn the ignition OFF.

NOTE: Do not disconnect the power steering fluid lines/hoses from the reservoir.

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2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

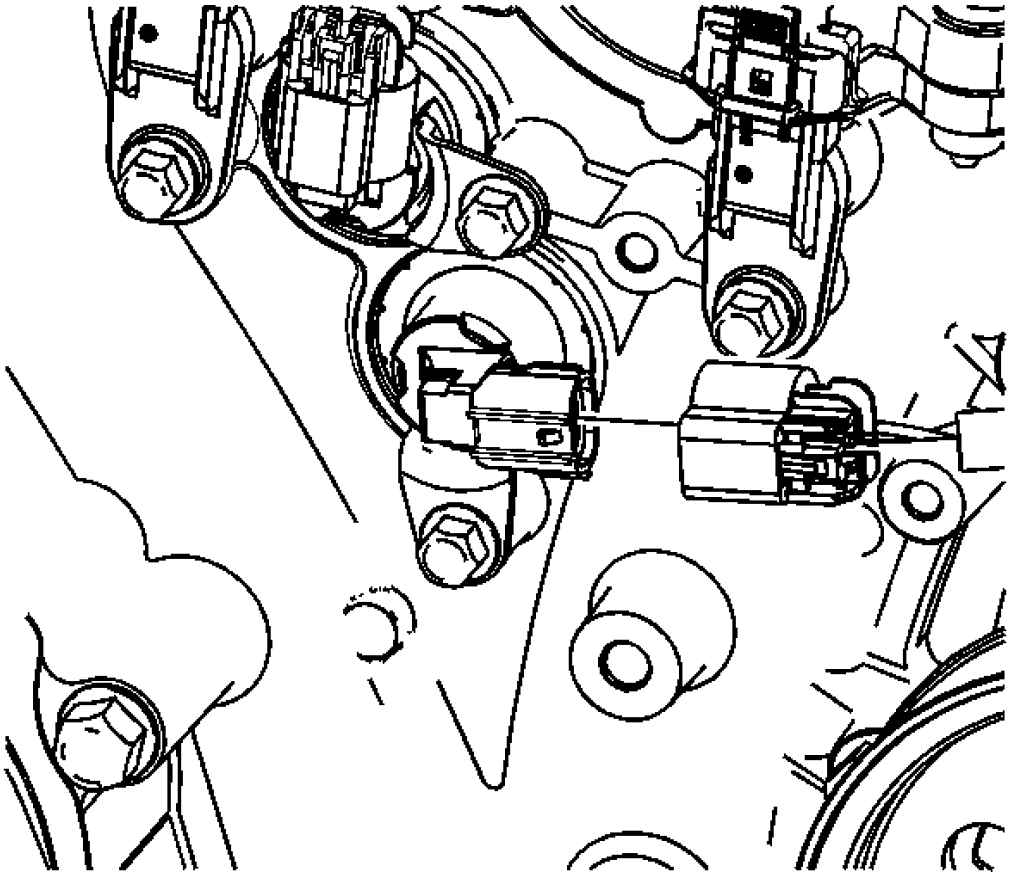


Fig. 182: View Of Left CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position (CMP) actuator valve electrical connector.

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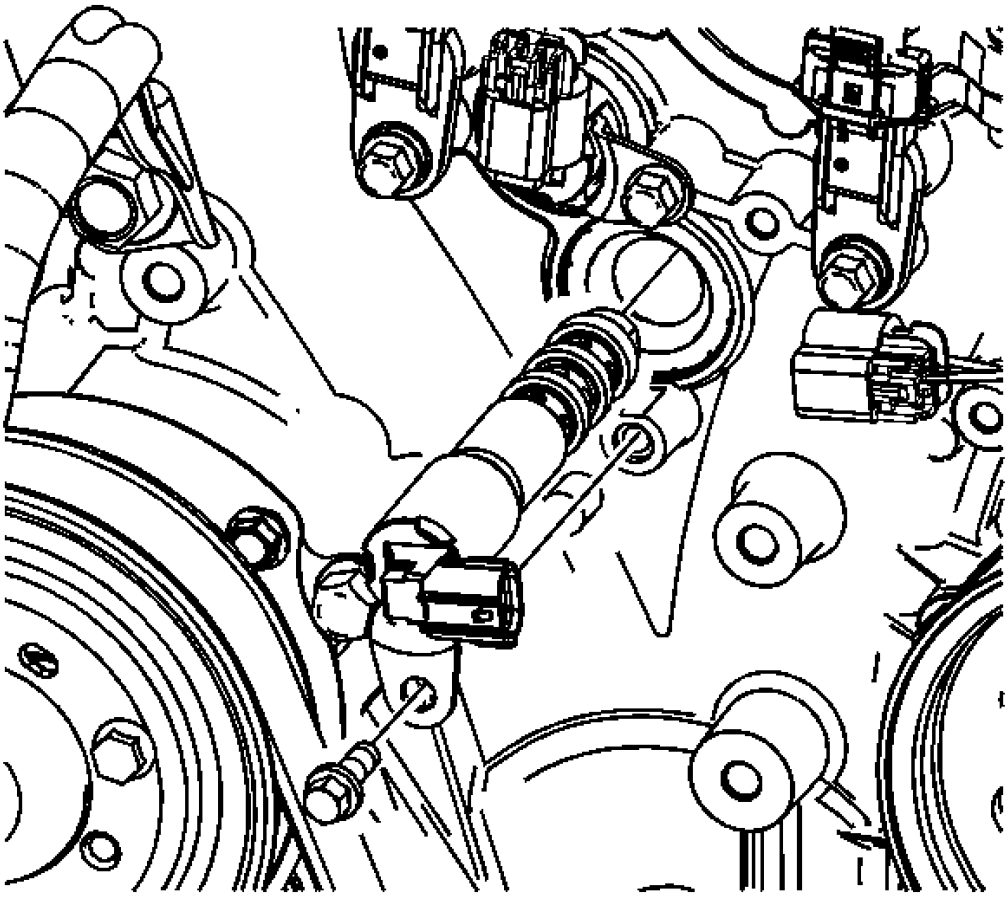


Fig. 183: View Of Left CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

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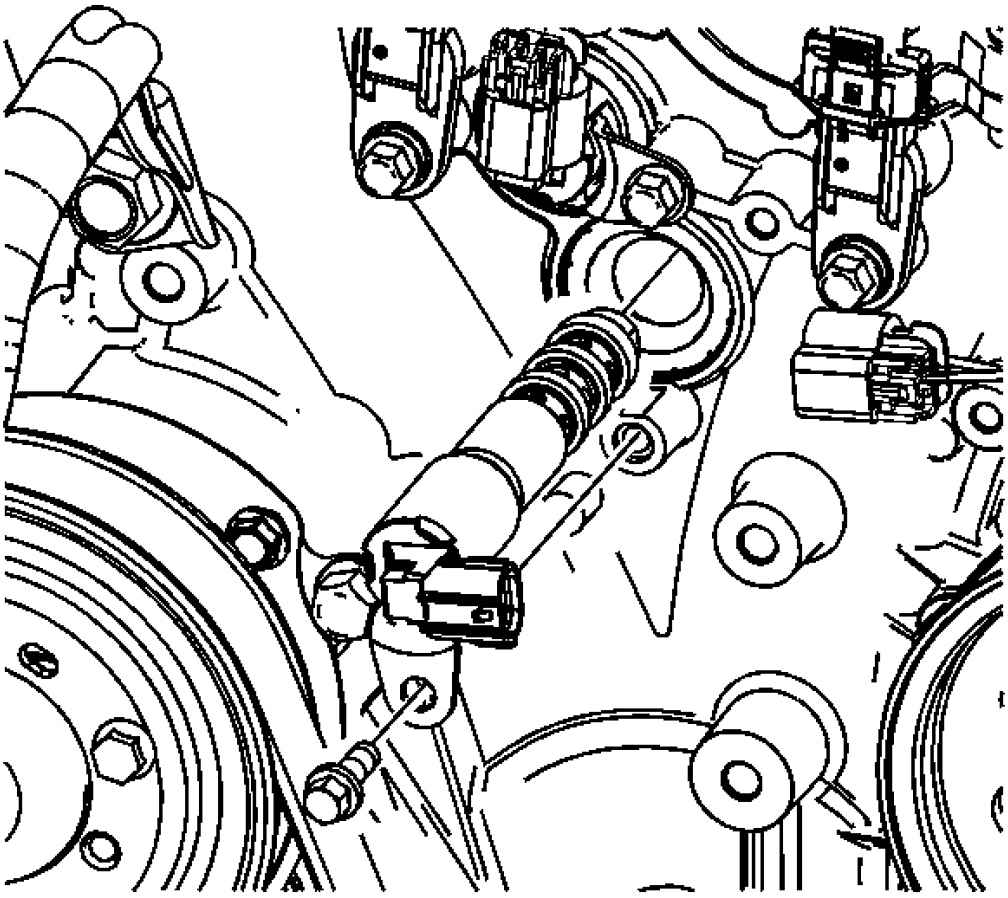


Fig. 184: View Of Left CMP Actuator Valve - Exhaust
Courtesy of GENERAL MOTORS CORP.

2. Install the CMP actuator valve.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator valve bolt and tighten to 10 N.m (89 lb in).

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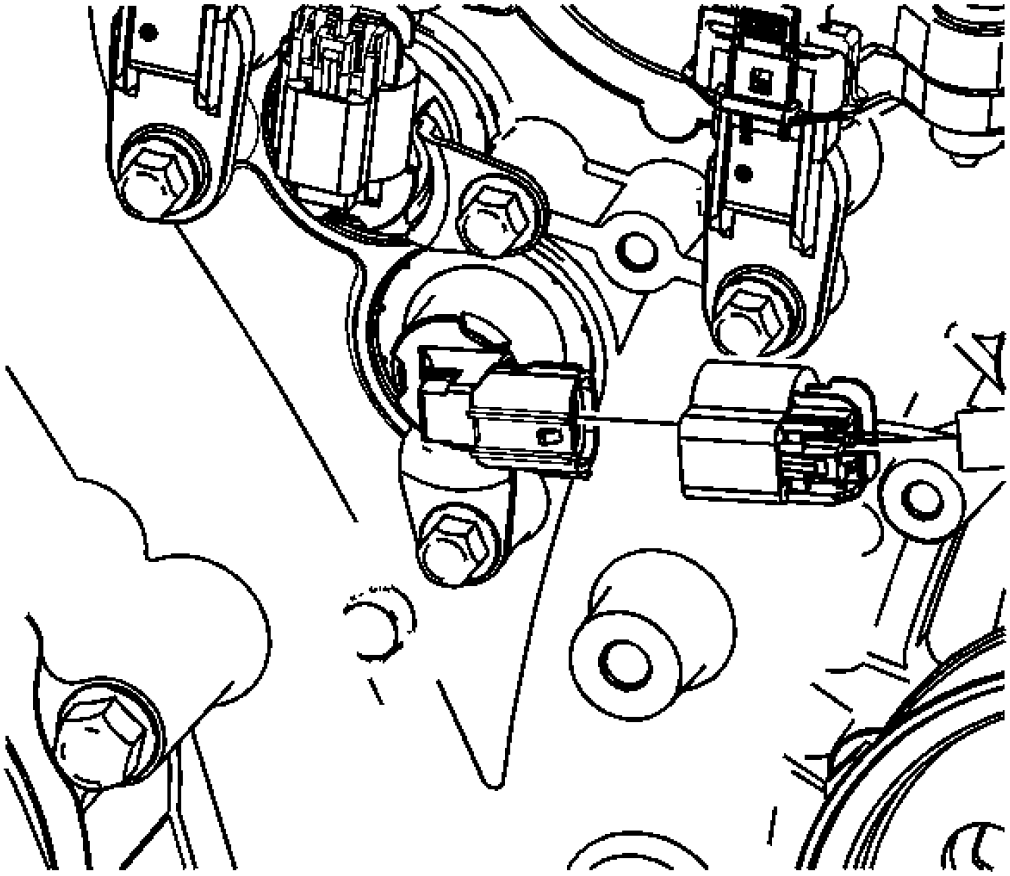


Fig. 185: View Of Left CMP Actuator Valve Electrical Connector - Exhaust
Courtesy of GENERAL MOTORS CORP.

4. Install the CMP actuator valve electrical connector.
5. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .

KNOCK SENSOR REPLACEMENT - BANK 1

Removal Procedure

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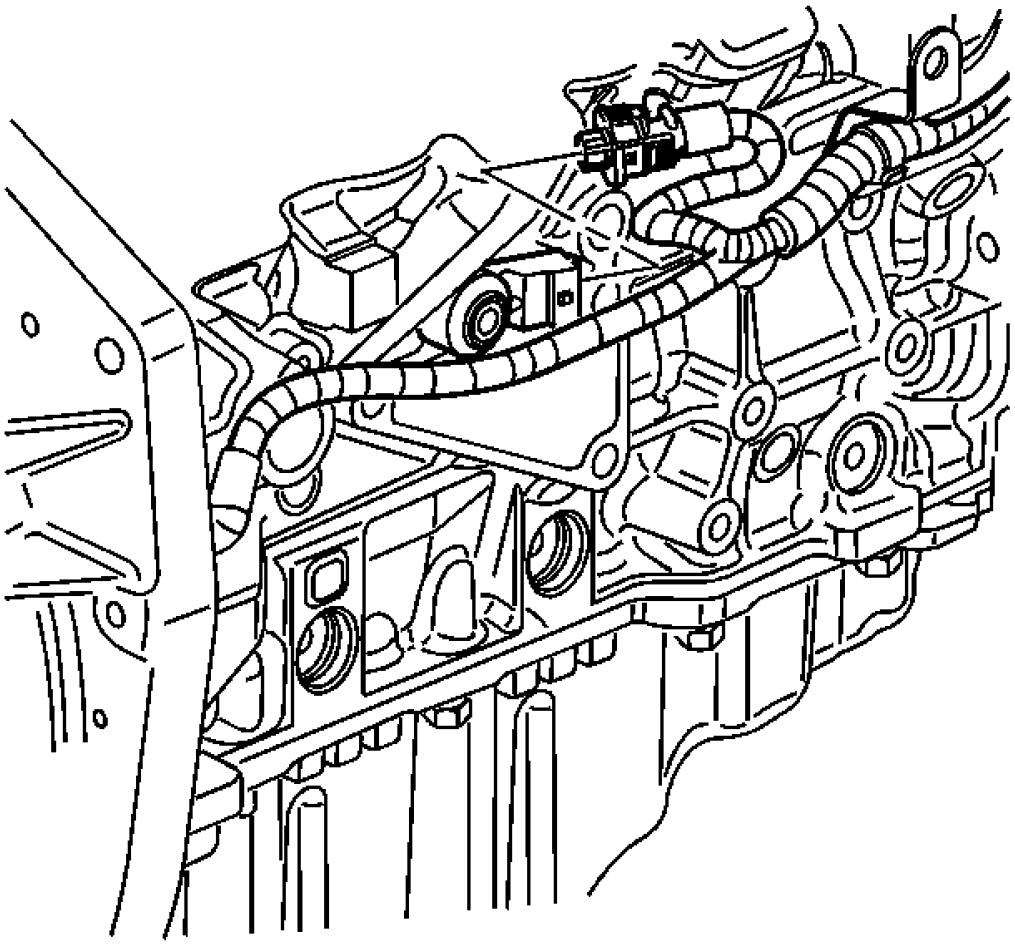


Fig. 186: View Of Right Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Reposition the wiring harness heat shield to obtain access.
4. Remove the knock sensor (KS) electrical connector.

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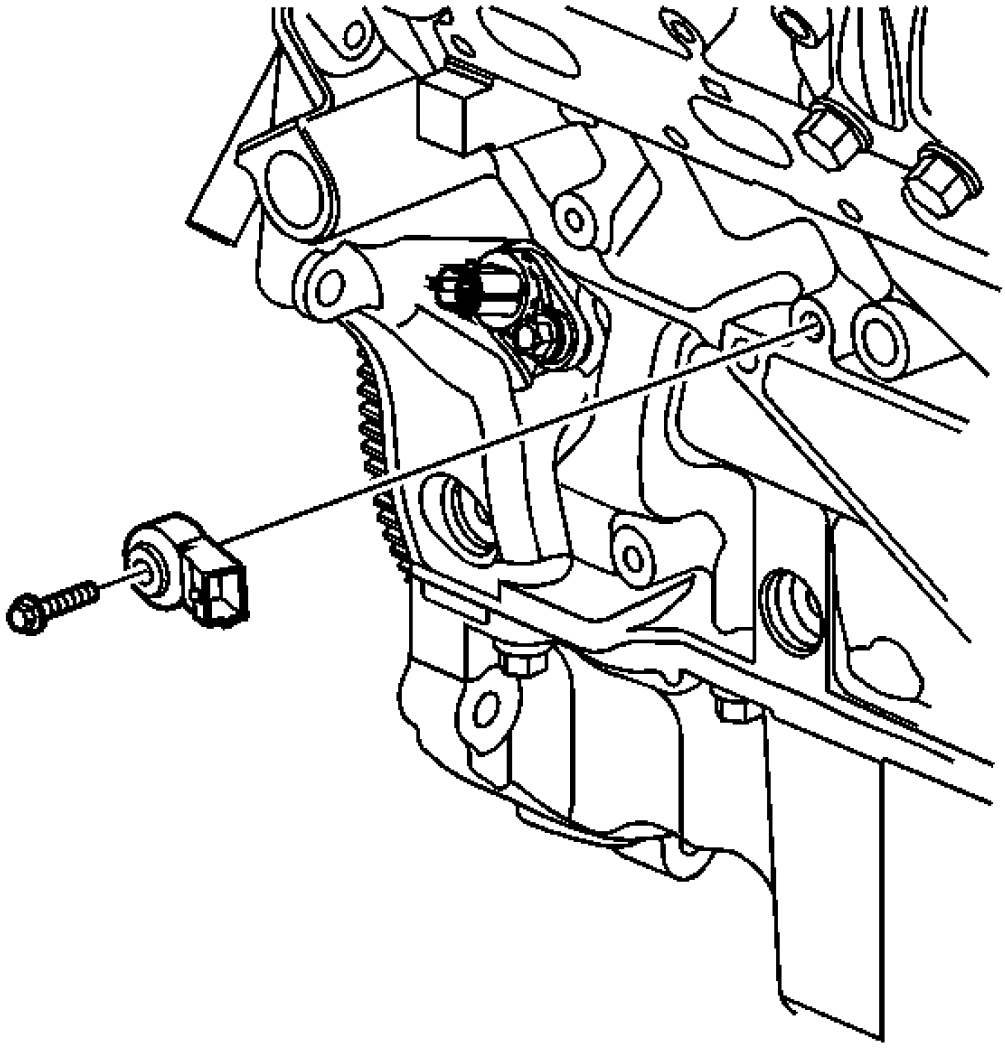


Fig. 187: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the KS bolt.
6. Remove the KS.

Installation Procedure

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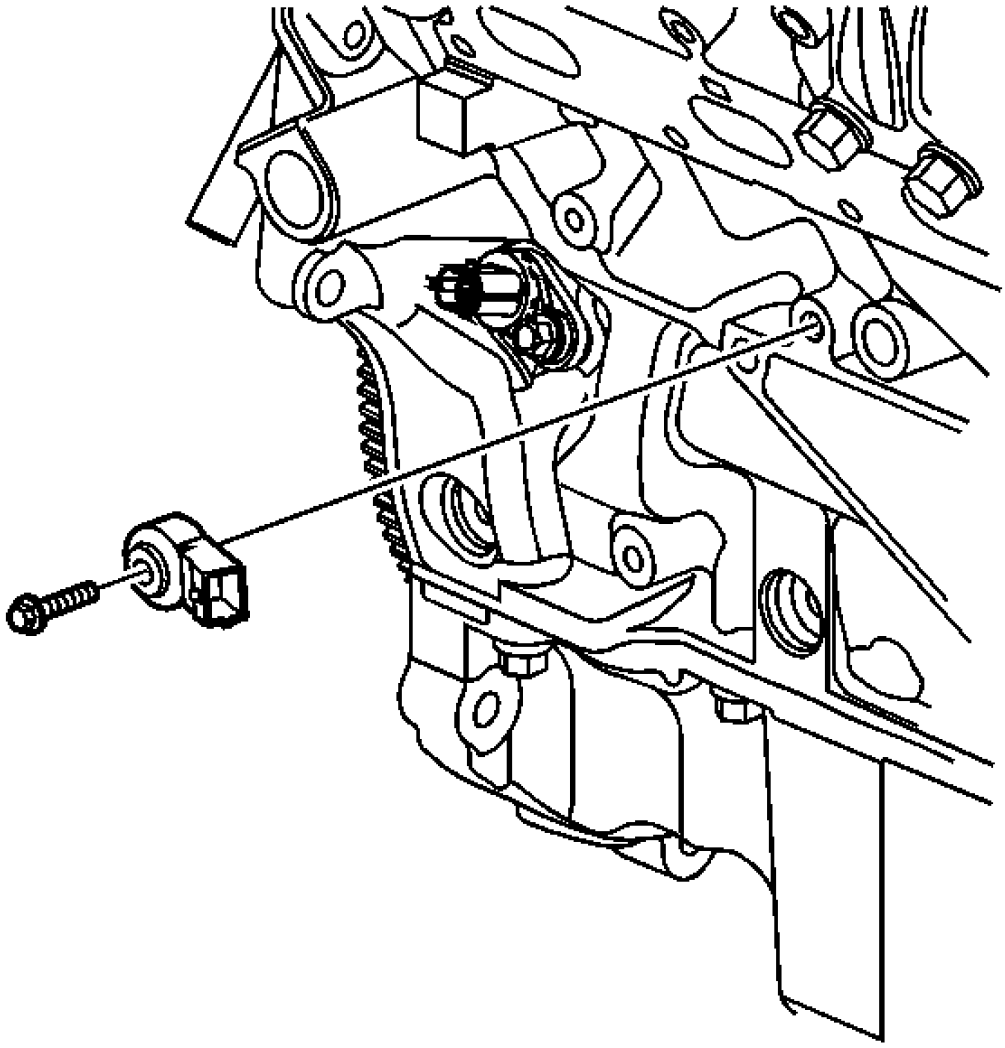


Fig. 188: View Of Right Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the KS.

CAUTION: Refer to Fastener Caution .

2. Install the KS bolt and tighten to 23 N.m (17 lb ft).

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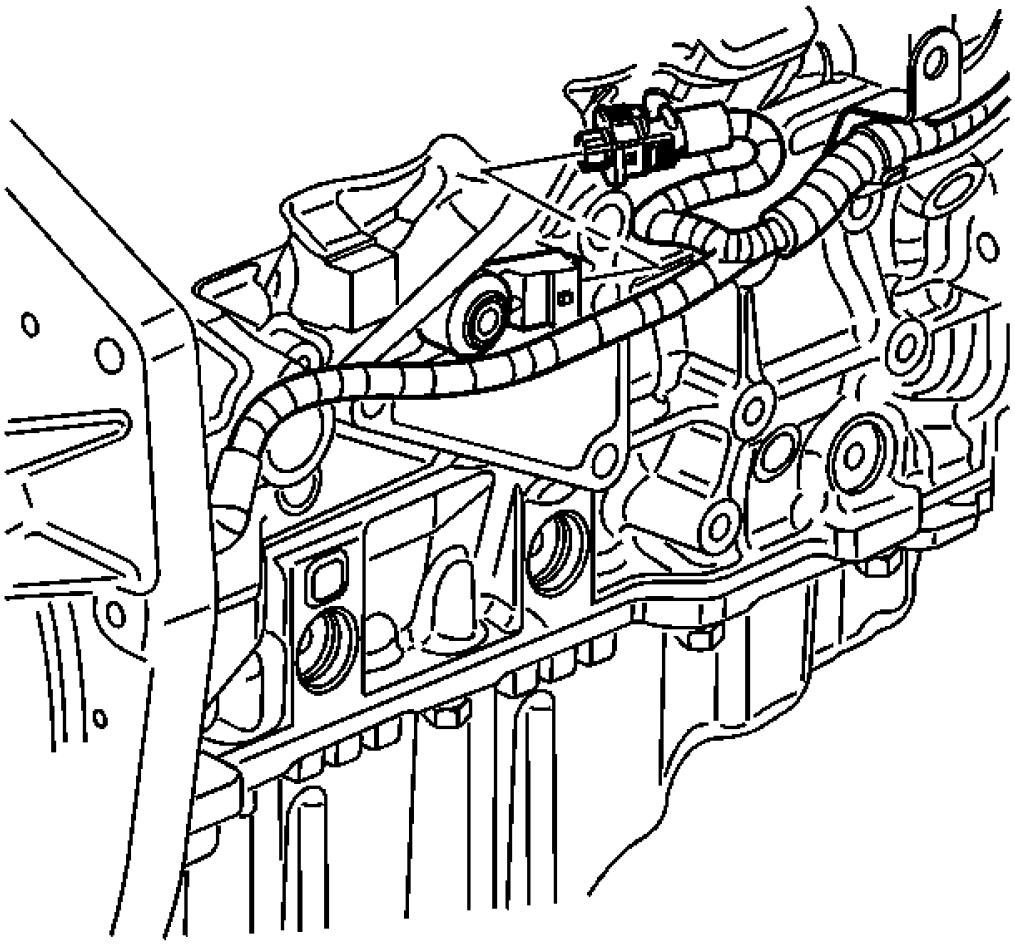


Fig. 189: View Of Right Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the original position.
5. Lower the vehicle.

KNOCK SENSOR REPLACEMENT - BANK 2

Removal Procedure

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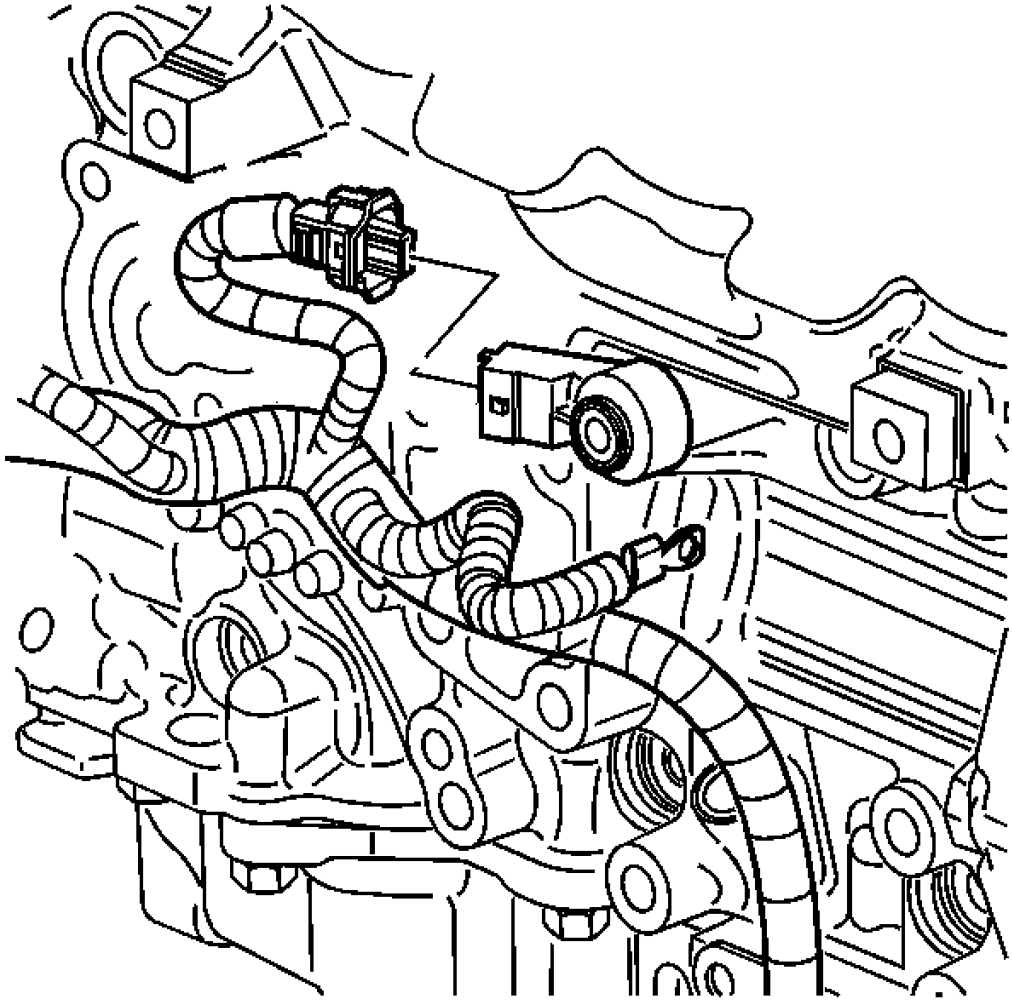


Fig. 190: View Of Left Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the wiring harness heat shield from the oil level indicator tube to gain access.
4. Remove the knock sensor (KS) electrical connector.

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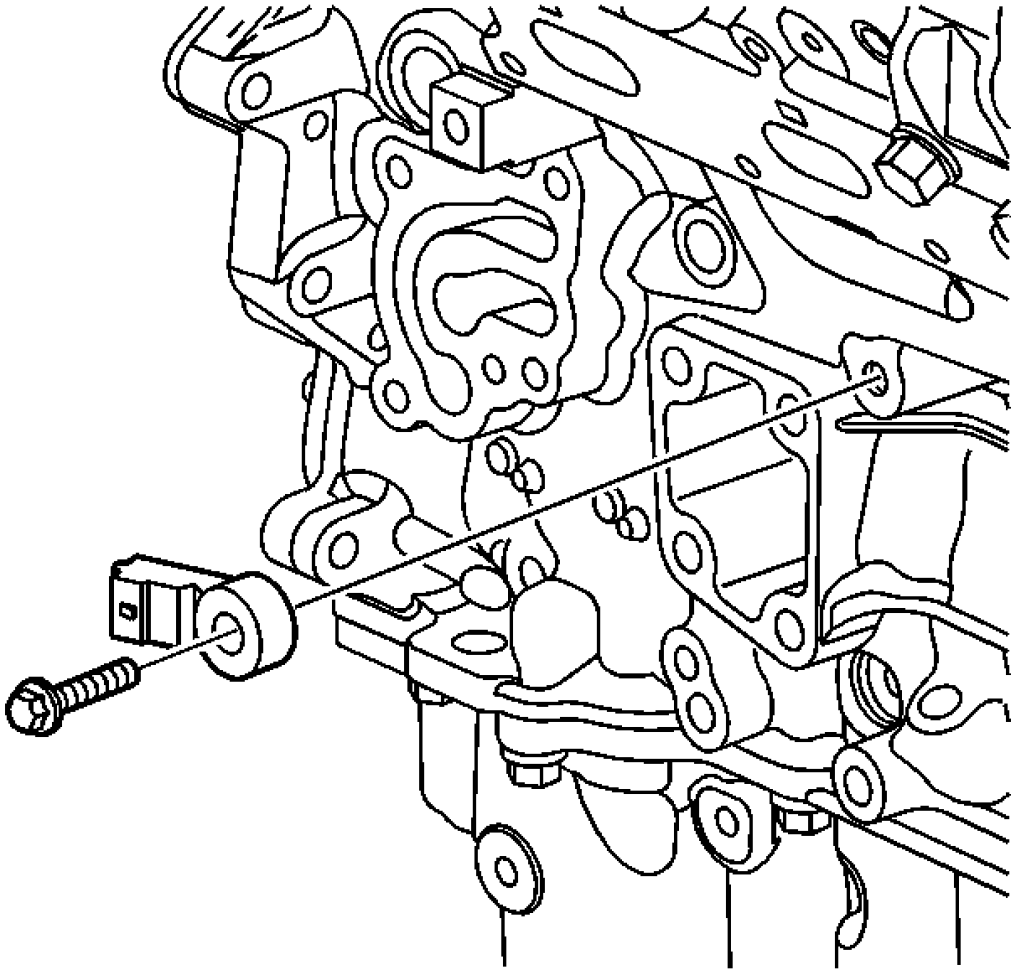


Fig. 191: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS CORP.

5. Remove the KS bolt.
6. Remove the KS.

Installation Procedure

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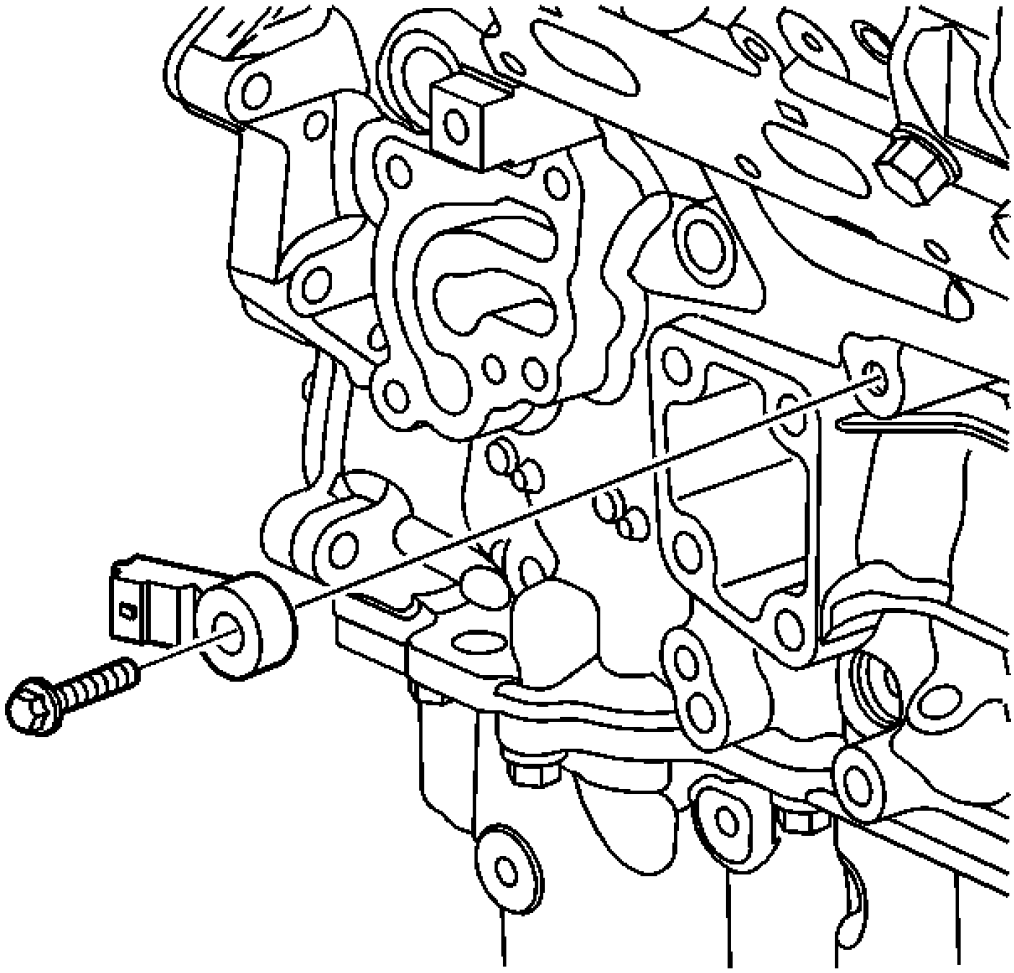


Fig. 192: View Of Left Knock Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the KS.

CAUTION: Refer to Fastener Caution .

2. Install the KS bolt and tighten to 23 N.m (17 lb ft).

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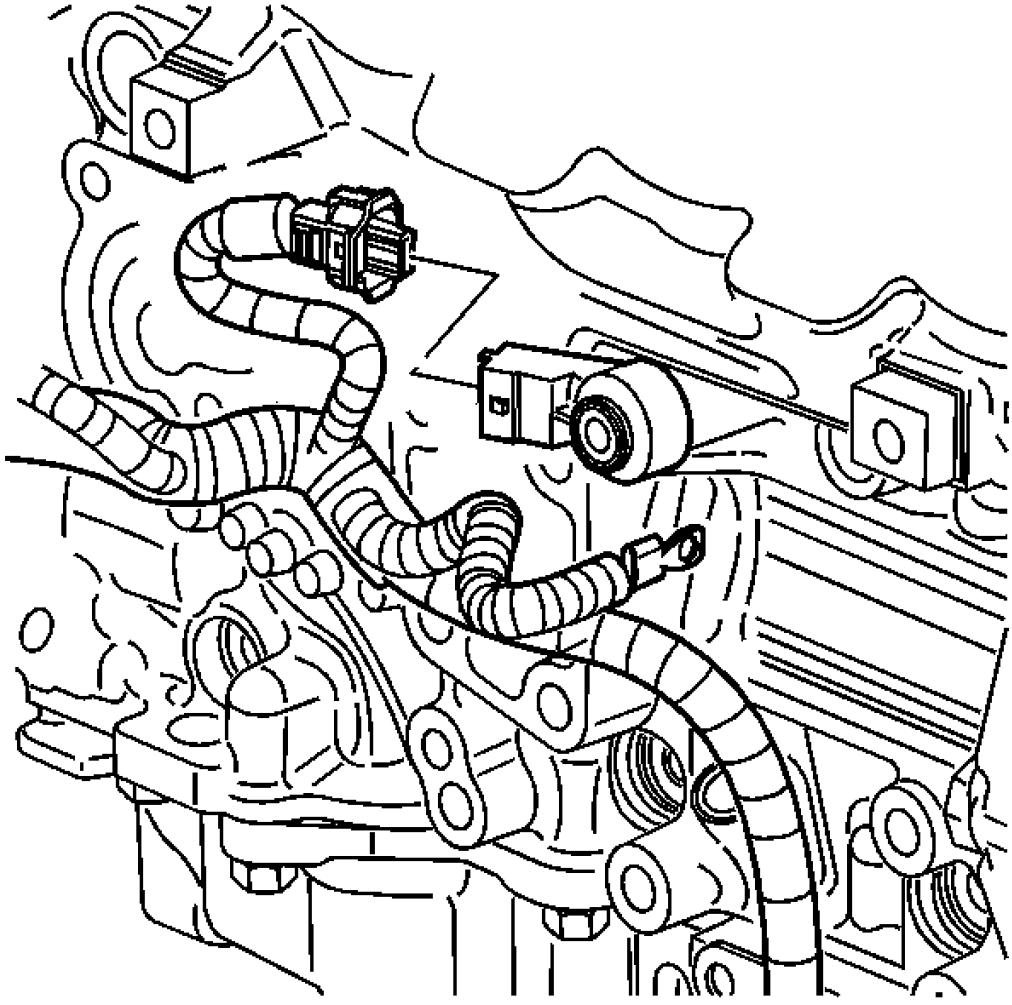


Fig. 193: View Of Left Knock Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the oil level indicator tube.
5. Lower the vehicle.

AIR CLEANER ELEMENT REPLACEMENT

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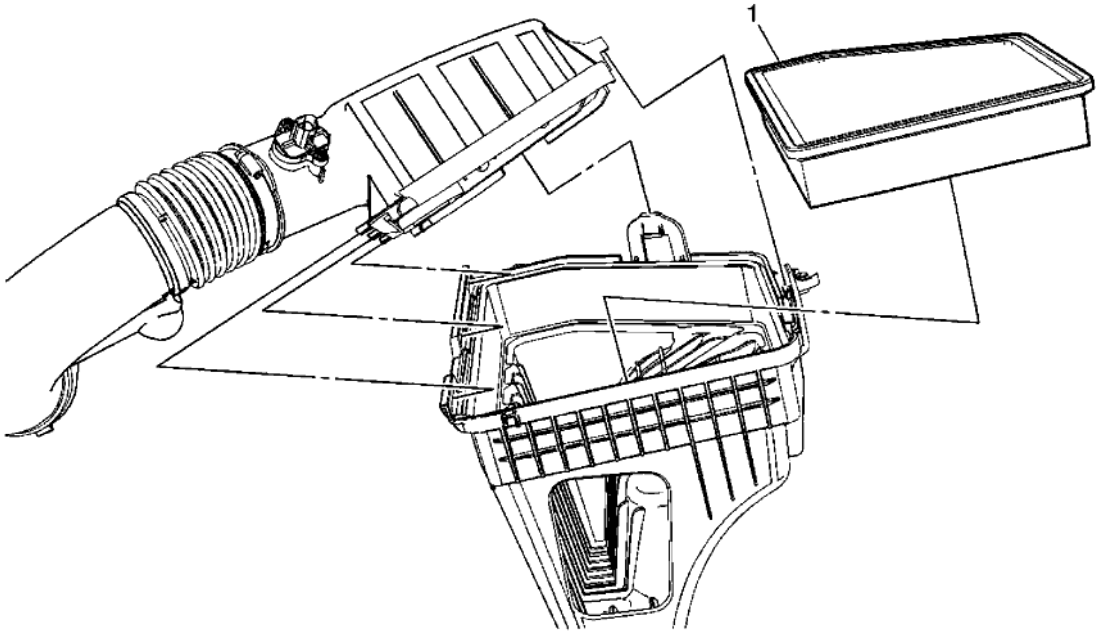


Fig. 194: Air Cleaner Element
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Air Cleaner Element **Procedure** 1. Disconnect the mass airflow electrical connector. 2. Push back the retaining tabs.

AIR CLEANER ASSEMBLY REPLACEMENT

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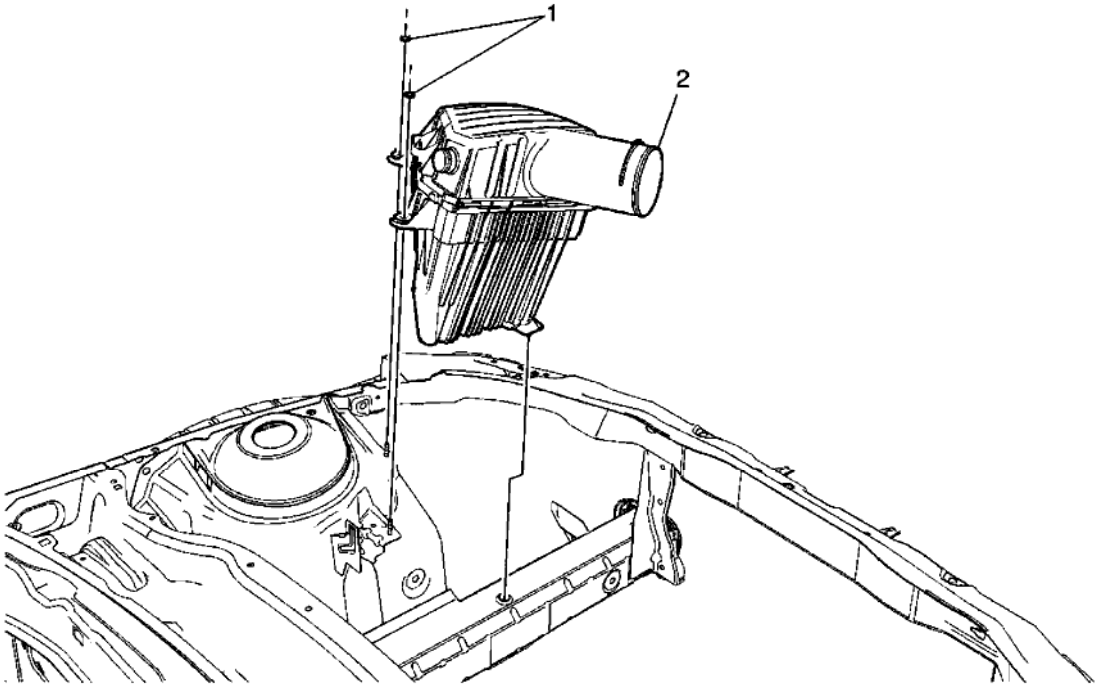


Fig. 195: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the mass airflow sensor. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** . 2. Disconnect the outlet duct from the air cleaner assembly. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .	
1	Air Cleaner Assembly Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 9 N.m (80 lb in)
2	Air Cleaner Assembly

FRONT INTAKE AIR DUCT REPLACEMENT

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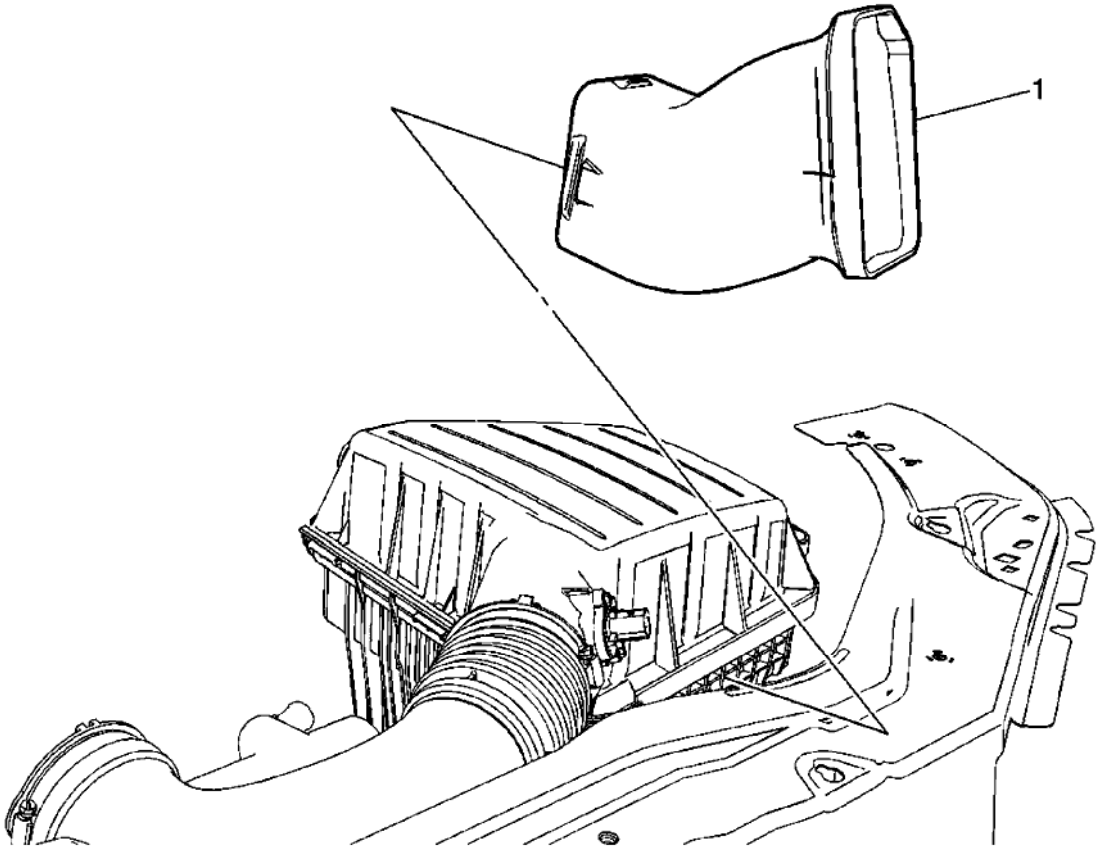


Fig. 196: Front Intake Air Duct
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: **Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement**	
1	Front Intake Air Duct

AIR CLEANER OUTLET DUCT REPLACEMENT

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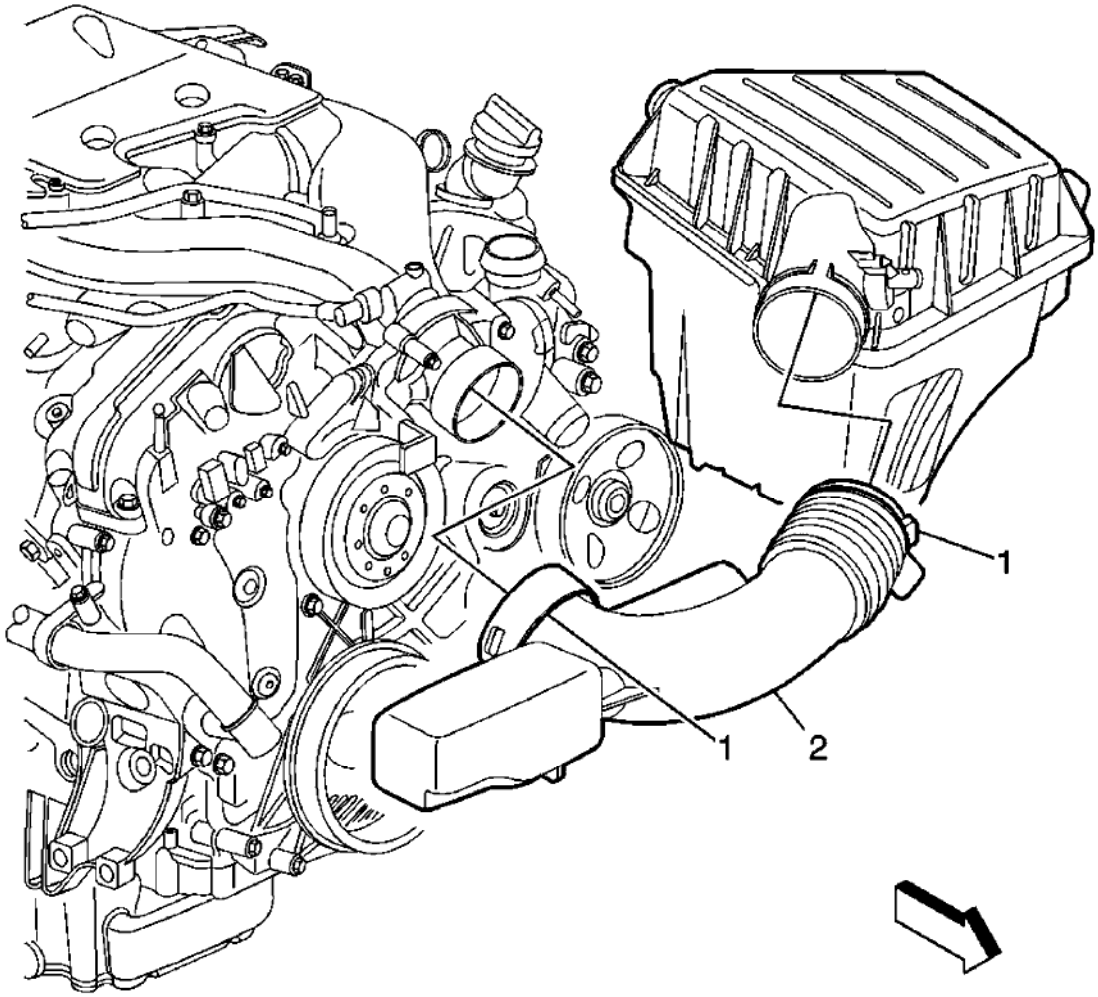


Fig. 197: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**	
1	Air Cleaner Outlet Duct Hose Clamp (Qty: 2) **CAUTION:** **Refer to Fastener Caution** **Tighten:** 4 N.m(35 lb in)
2	Air Cleaner Outlet Duct

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2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE CONTROLS SCHEMATICS

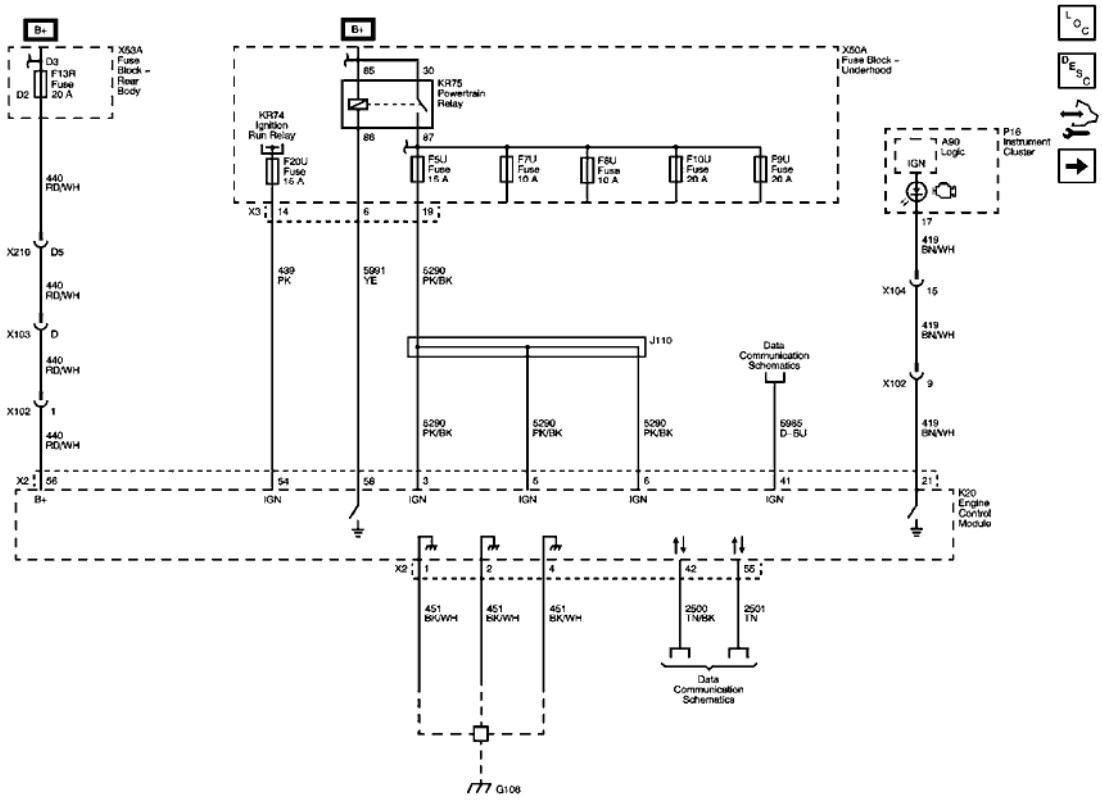


Fig. 1: Module Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS CORP.

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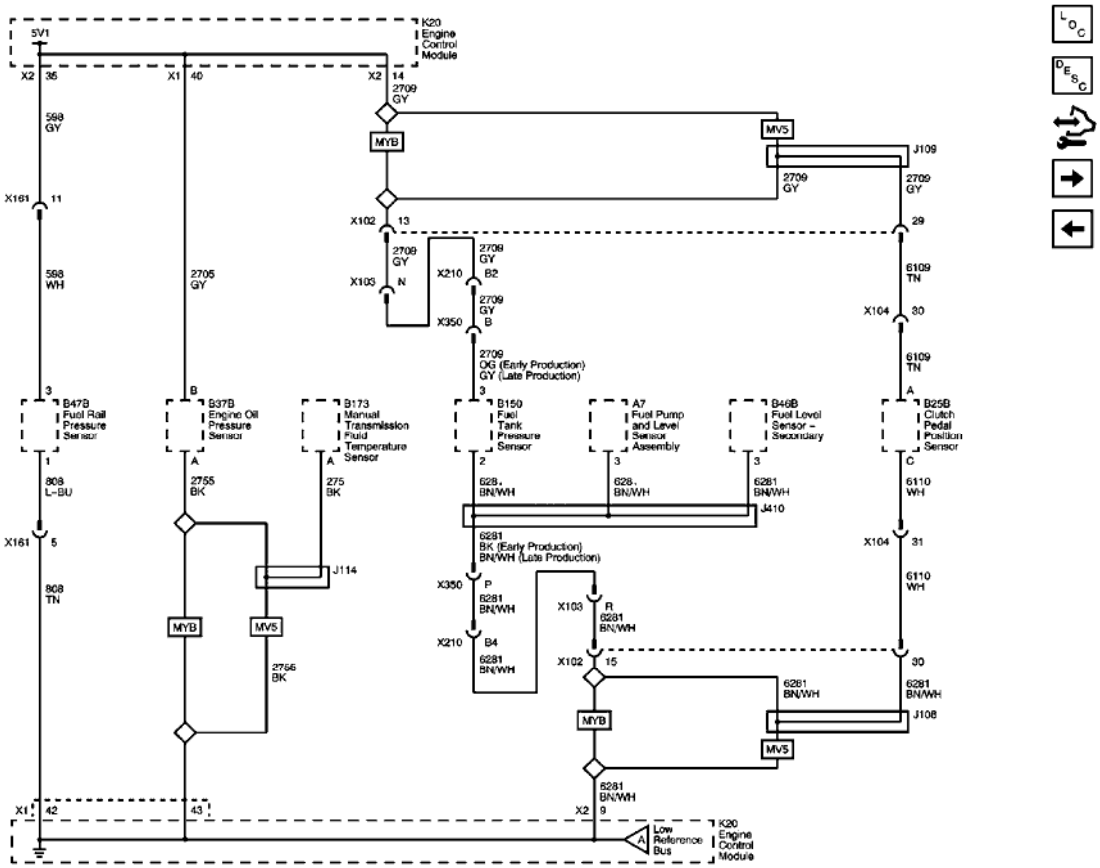


Fig. 2: 5-Volt and Low Reference - 1 of 2
Courtesy of GENERAL MOTORS CORP.

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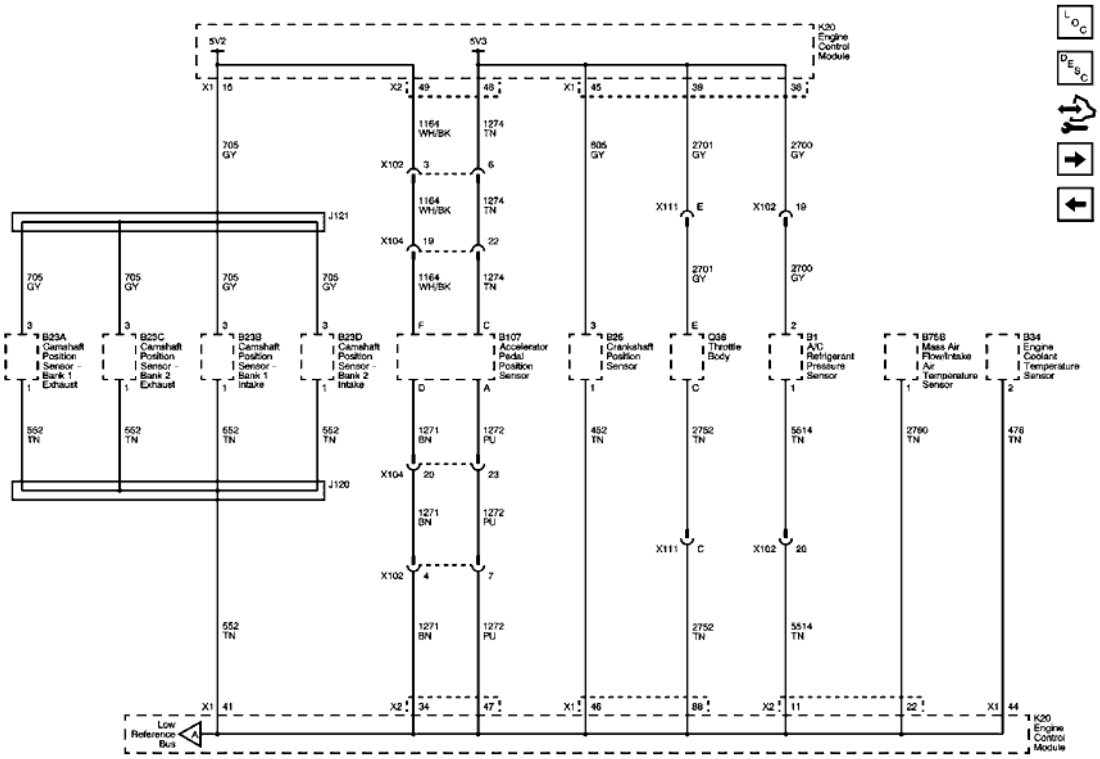


Fig. 3: 5-Volt and Low Reference - 2 of 2
Courtesy of GENERAL MOTORS CORP.

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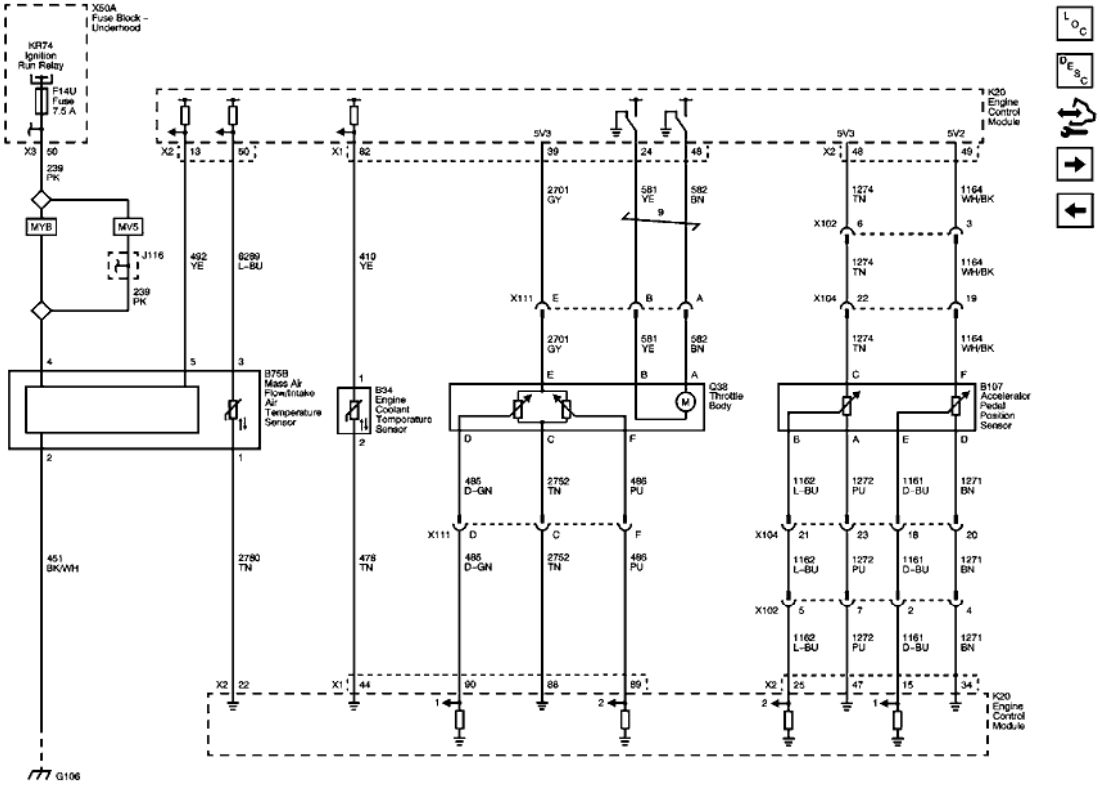


Fig. 4: Engine Data Sensors - Pressure, Temperature, and Throttle Controls
Courtesy of GENERAL MOTORS CORP.

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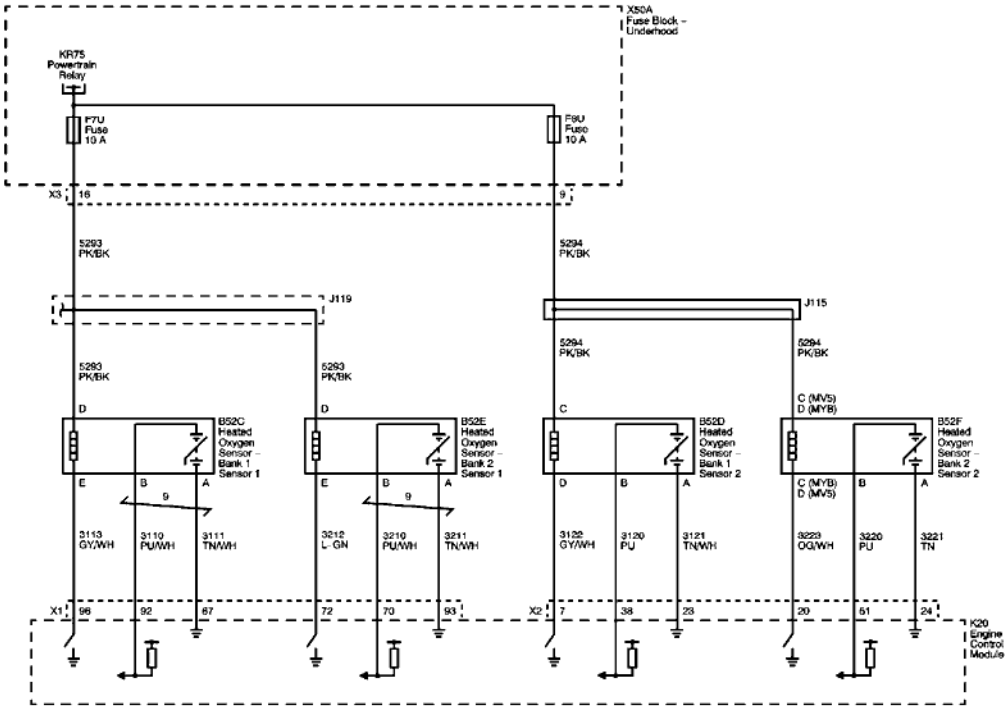


Fig. 5: Engine Data Sensors - Oxygen Sensors
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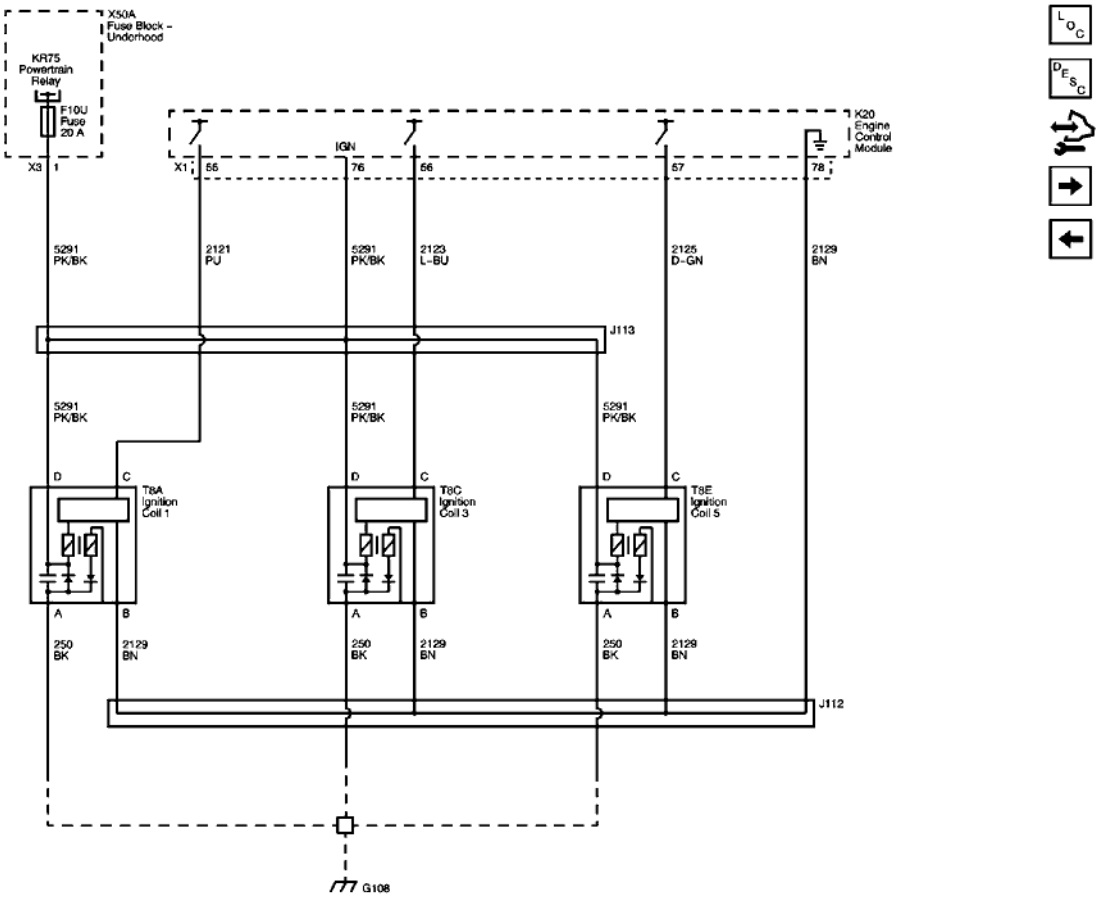


Fig. 6: Ignition Controls - Bank 1 Ignition System
Courtesy of GENERAL MOTORS CORP.

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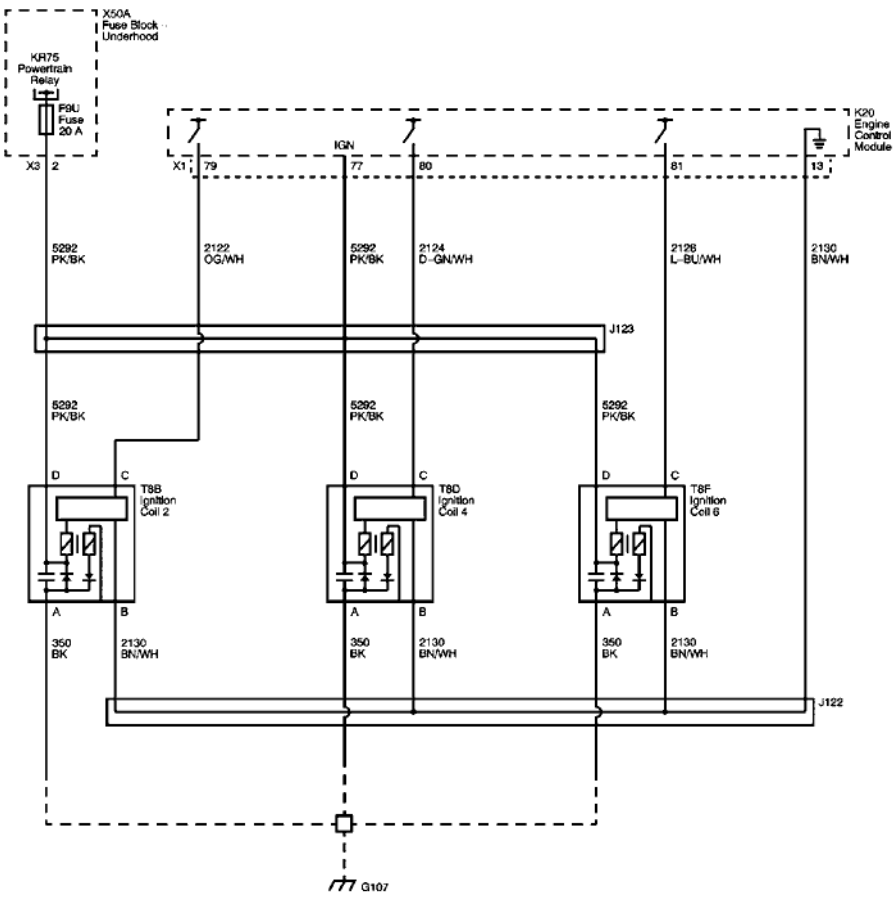


Fig. 7: Ignition Controls - Bank 2 Ignition System
Courtesy of GENERAL MOTORS CORP.

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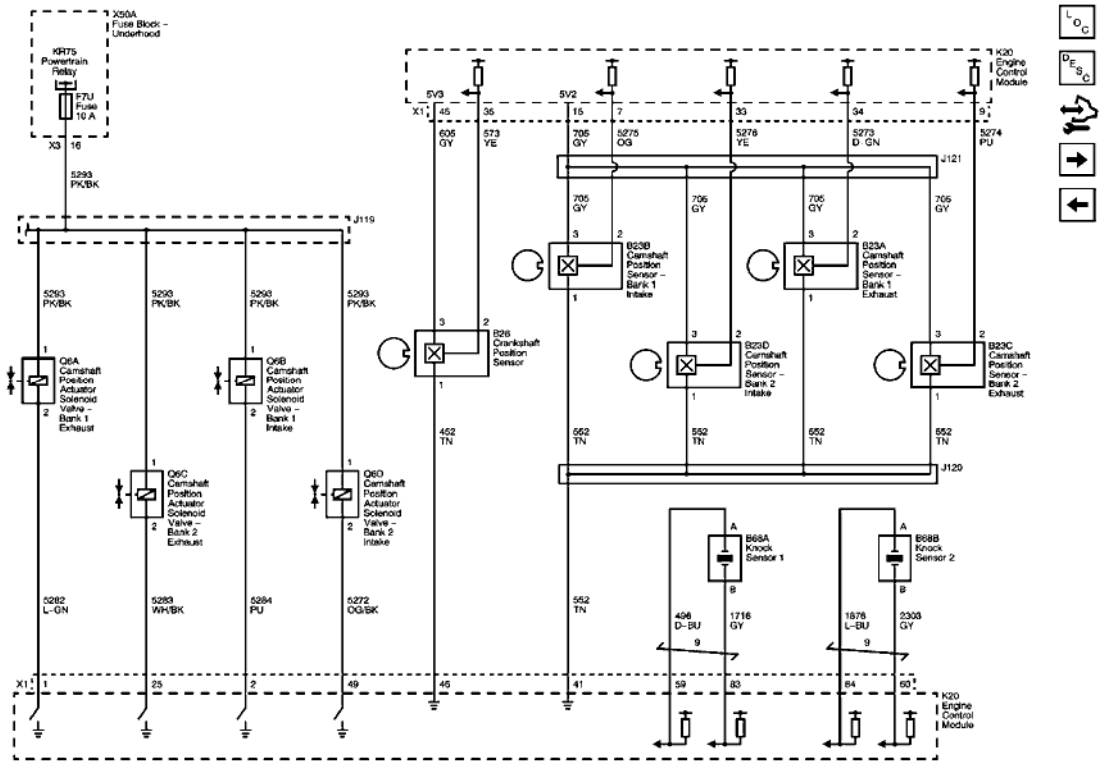
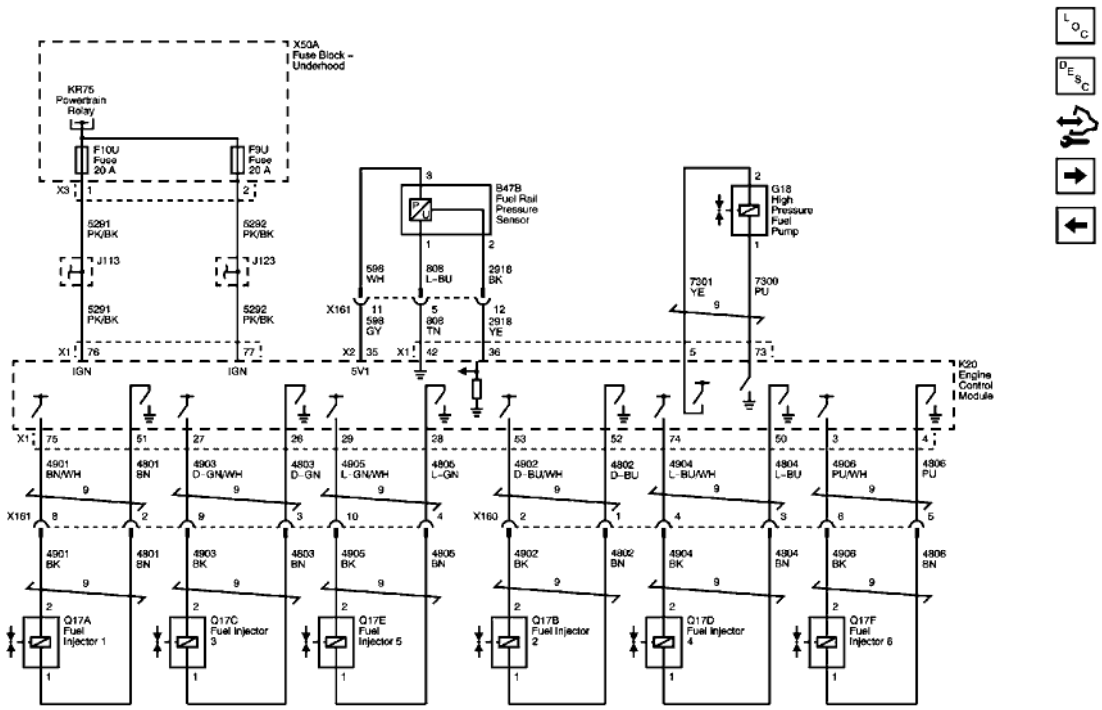


Fig. 8: Ignition Controls - CKP/CMP/KS Sensors and CMP Actuator Solenoids
Courtesy of GENERAL MOTORS CORP.



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Fig. 9: Fuel Controls - Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

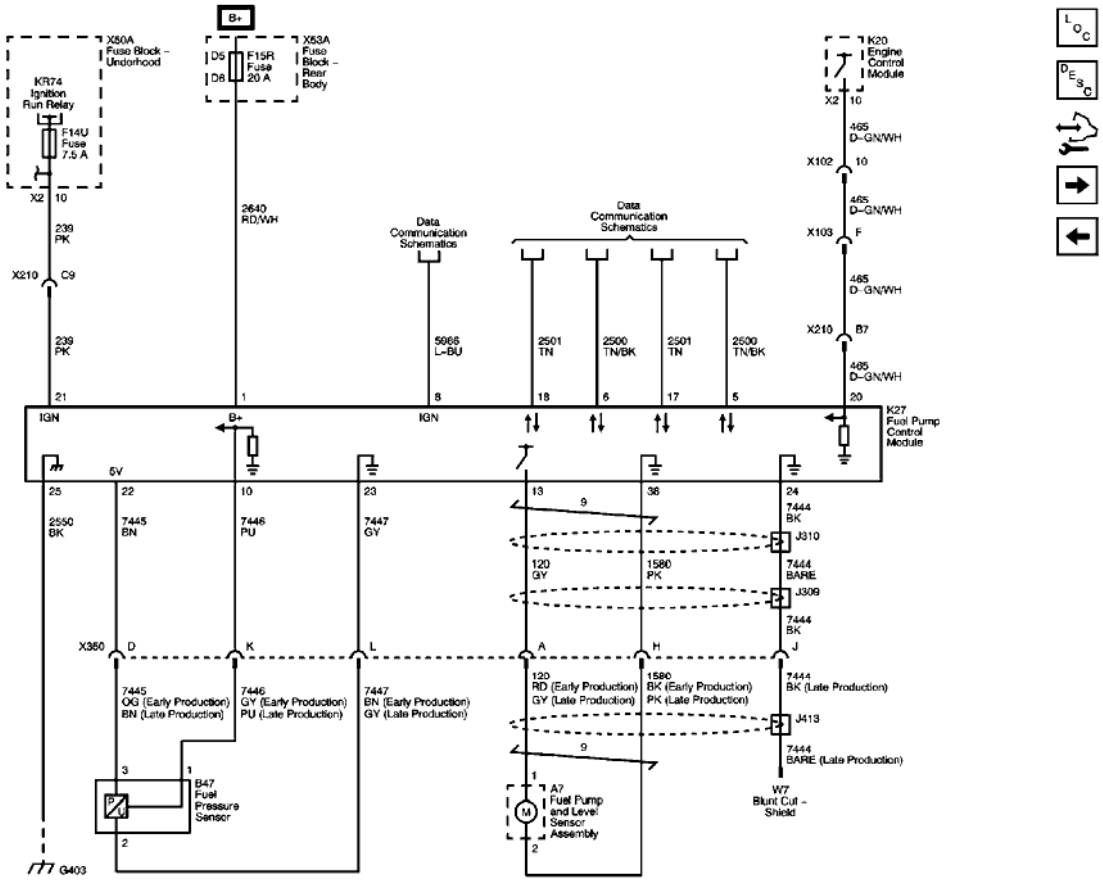


Fig. 10: Fuel Controls - Fuel Pump Flow Control
Courtesy of GENERAL MOTORS CORP.

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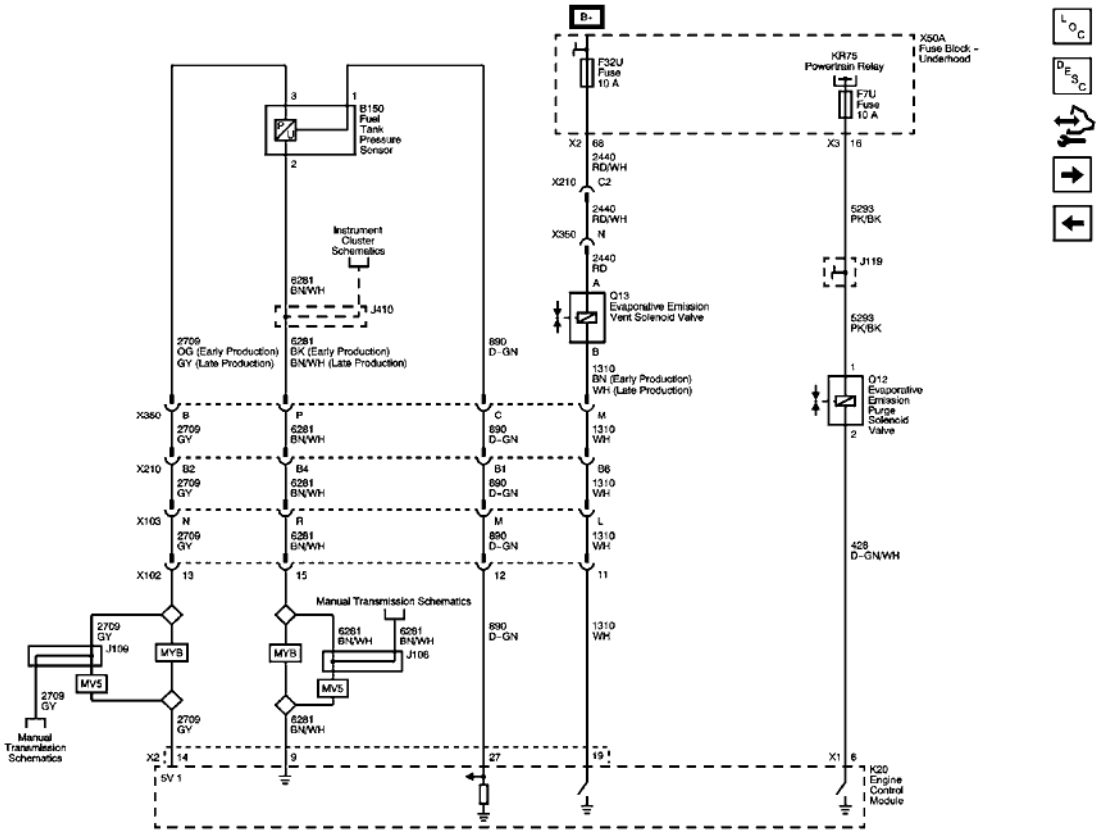


Fig. 11: Fuel Controls - EVAP Controls
Courtesy of GENERAL MOTORS CORP.

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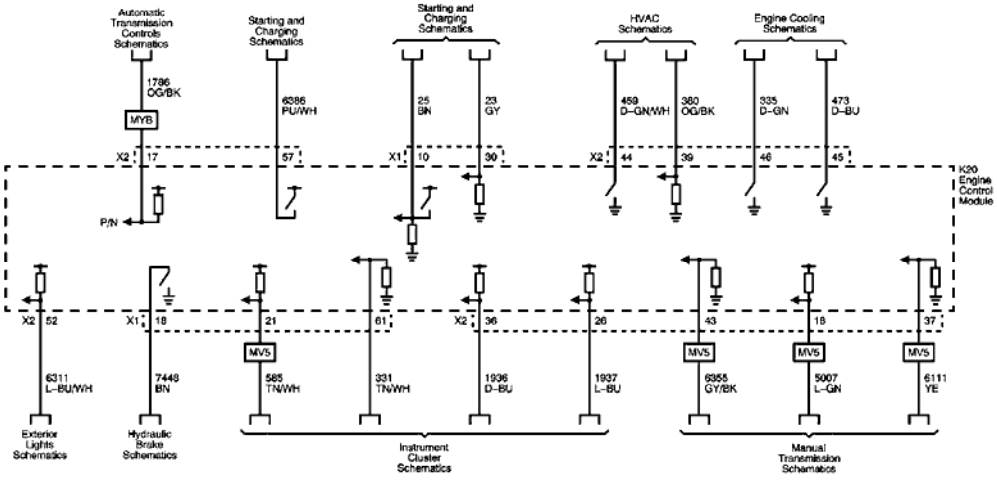


Fig. 12: Subsystem References
Courtesy of GENERAL MOTORS CORP.

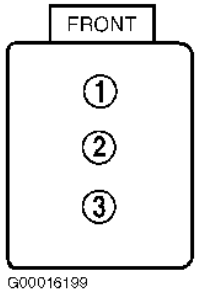
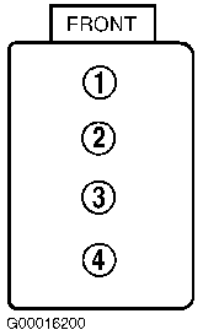
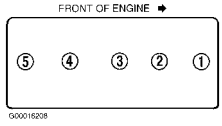
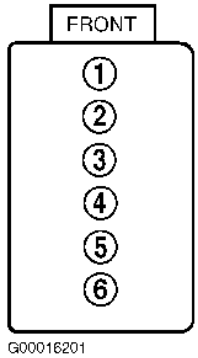
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ENGINE PERFORMANCE

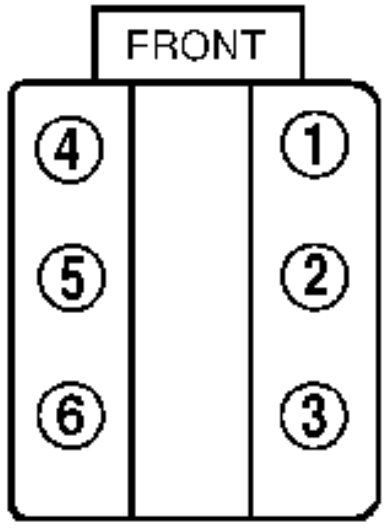
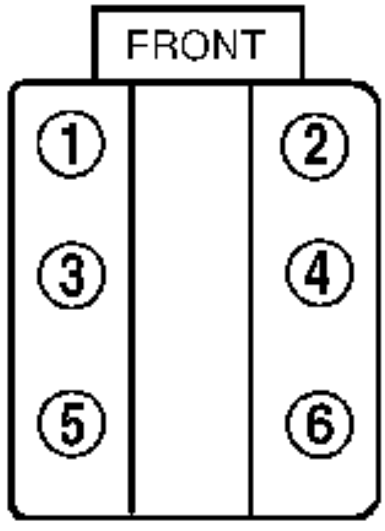
Firing Order & Cylinder Identification - GM, & Saturn - All Models

FIRING ORDER & CYLINDER IDENTIFICATION

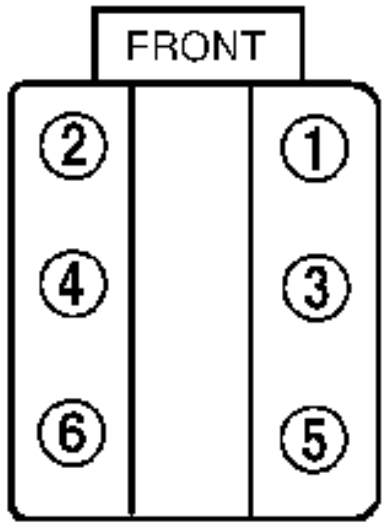
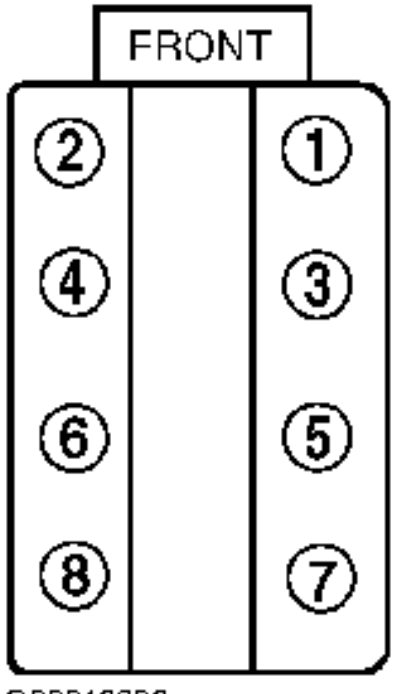
NOTE: **This information is intended as a quick reference for firing order and cylinder identification only. The information provided covers many vehicles and may include some information that does not apply to the vehicle you have currently selected.**

Engine Configuation	Firing Order	Cylinder Identification
In-Line 3	1-3-2	 G00016199
In-Line 4	1-3-4-2	 G00016200
In-Line 5	1-3-5-4-2	 G00016208
In-Line 6	1-5-3-6-2-4	 G00016201

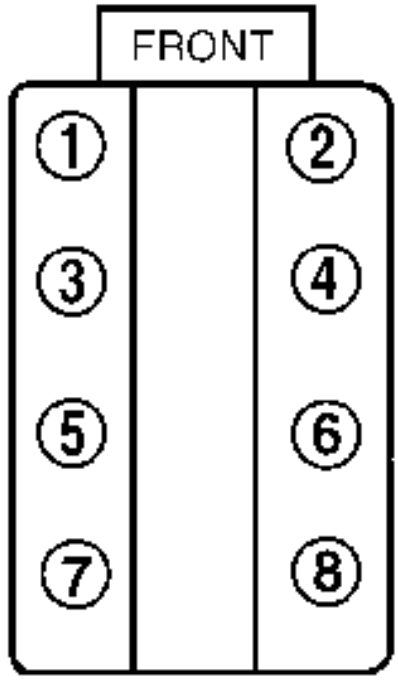
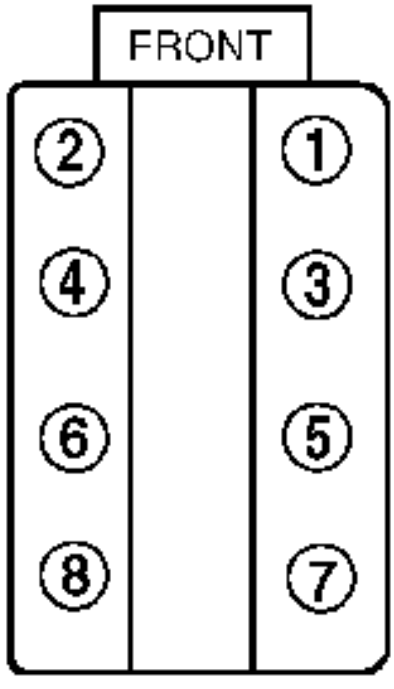
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V6		
3.5L VIN 4	1-4-2-5-3-6	 G00016204
3.8L & 4.3L	1-6-5-4-3-2	 G00016202
All Others	1-2-3-4-5-6	

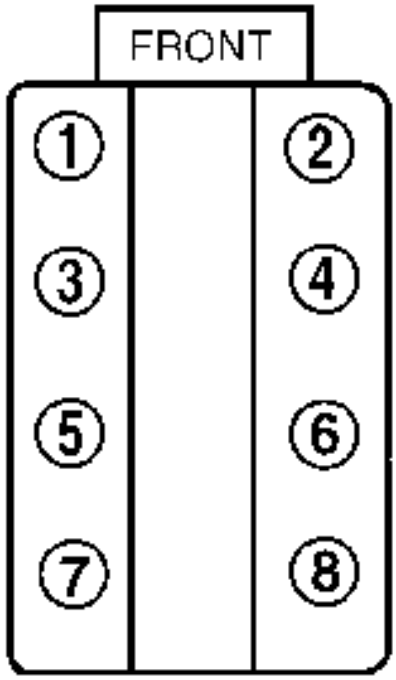
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		 G00016203
V8		
4.0L, 4.4L, 4.6L,	1-2-7-3-4-5-6-8	 G00016206

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5.0L, 5.7L (VIN R & K), 7.4L	1-8-4-3-6-5-7-2	 G00016205
6.6L Diesel	1-2-7-8-4-5-6-3	 G00016206

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All Others	1-8-7-2-6-5-4-3	 G00016205

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