

2006 Chevrolet HHR LT

2006 ENGINE Engine Controls - 2.2L (L61) - Introduction (2 Of 2) - HHR

2006 ENGINE

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SPECIFICATIONS

TEMPERATURE VS RESISTANCE

Temperature vs 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 VS BAROMETRIC PRESSURE

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Altitude vs Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

IGNITION SYSTEM SPECIFICATIONS

Ignition System Specifications

Application	Specification	
	Metric	English
Ignition Type	Waste Spark Cassette W/Compression Sense	
Firing Order	1-3-4-2	
Spark Plug Type	GM P/N 12569190 A/C/ DELCO P/N 41-981	
Spark Plug Torque	20 N.m	15 lb ft
Spark Plug Gap	1.08 mm	0.043 in

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

	Specification	

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Application	Metric	English
Accelerator Pedal Position Sensor Nut	10 N.m	89 lb in
Air Cleaner Bolt	10 N.m	89 lb in
Air Cleaner Outlet Duct Clamp	5 N.m	44 lb in
Air Cleaner Screw	4 N.m	35 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N.m	89 lb in
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft
EVAP Canister Purge Valve Bracket Nut	18 N.m	13 lb ft
EVAP Canister Bolt	10 N.m	89 lb in
Fuel/EVAP/Brake Line Bracket Nut	10 N.m	89 lb in
Fuel Fill Pipe to Fill Pipe Housing Bolt	1.5 N.m	13 lb in
Fuel Fill Pipe Hose Clamp	4.5 N.m	40 lb in
Fuel Fill Pipe Lower Bolt	10 N.m	89 lb in
Fuel Rail Bolt	10 N.m	89 lb in
Fuel Tank Strap Bolt	45 N.m	33 lb ft
Heated Oxygen Sensor (HO2S)	42 N.m	31 lb ft
Ignition Coil Housing Bolt	10 N.m	89 lb in
Ignition Control Module Screw	1.5 N.m	13 lb in
Knock Sensor (KS)	25 N.m	18 lb ft
Mass Air Flow (MAF) Sensor Screws	10 N.m	89 lb in
Spark Plug	20 N.m	15 lb in
Throttle Body Bolt	10 N.m	89 lb in

DIAGNOSTIC TROUBLE CODE (DTC) TYPE DEFINITIONS

Emissions Related DTCs

Action Taken When the DTC Sets - Type A

The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Action Taken When the DTC Sets - Type B

The control module illuminates the MIL on the second consecutive ignition cycle that the diagnostic runs and fails.

Conditions for Clearing the MIL/DTC - Type A or Type B

- The control module turns OFF the MIL after 3 consecutive 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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- Use a scan tool in order to clear the MIL and the DTC.

Non-Emissions Related DTCs

Action Taken When the DTC Sets - Type C

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the DTC - Type C

- A last test failed, or current DTC, clears when the diagnostic runs and passes.
- Use a scan tool in order to clear the DTC.

Conditions for Clearing the DTC - Type X

This DTC is available in the PCM software, but has been disabled, or turned OFF. In this case, the diagnostic does not run, no DTCs are stored, and the MIL does not illuminate. Type X DTCs are used primarily for export vehicles that do not require MIL illumination or DTC storing.

DIAGNOSTIC TROUBLE CODE (DTC) TYPE(S)

Diagnostic Trouble Code (DTC) Type(s)

Diagnostic Trouble Code (DTC)	Auto	Manual
P0030	B	B
P0036	B	B
P0068	A	A
P0101	B	B
P0102	B	B
P0103	B	B
P0106	B	B
P0107	B	B
P0108	B	B
P0112	B	B
P0113	B	B
P0116	B	B
P0117	B	B
P0118	B	B
P0120	A	A

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P0121	B	B
P0122	A	A
P0123	A	A
P0125	B	B
P0128	B	B
P0130	B	B
P0131	B	B
P0132	B	B
P0133	B	B
P0134	B	B
P0135	B	B
P0136	B	B
P0137	B	B
P0138	B	B
P0140	B	B
P0141	B	B
P0171	B	B
P0172	B	B
P0201-P0204	B	B
P0220	A	A
P0222	A	A
P0223	A	A
P0300	Type B EMISSION Type A CATALYST	B
P0315	B	B
P0325	B	B
P0326	B	B
P0327	B	B
P0335	B	B
P0336	B	B
P0340	B	B
P0341	B	B
P0411	B	B
P0412	B	B
P0418	B	B
P0420	A	A
P0442	A	A

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P0443	B	B
P0446	A	A
P0449	B	B
P0451	A	A
P0452	A	A
P0453	A	A
P0454	A	A
P0455	B	B
P0496	B	B
P0506	B	B
P0507	B	B
P0601	A	A
P0602	A	A
P0603	C	C
P0604	A	A
P0606	A	A
P0607	C	C
P060D	A	A
P0641	A	A
P0650	B	B
P0651	A	A
P0700	A	A
P1101	B	B
P1106	C	C
P1107	C	C
P1111	C	C
P1112	C	C
P1114	C	C
P1115	C	C
P1133	B	B
P1134	B	B
P1516	A	A
P1682	C	C
P2101	A	A
P2119	C	C
P2120	A	A
P2122	A	A
P2123	A	A
P2125	A	A

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	A	A
P2127	A	A
P2128	A	A
P2135	A	A
P2138	A	A
P2176	A	A
P2430	B	B
P2431	B	B
P2432	B	B
P2433	B	B
P2440	B	B
P2444	A	A

SCHEMATIC AND ROUTING DIAGRAMS

EMISSION HOSE ROUTING DIAGRAM

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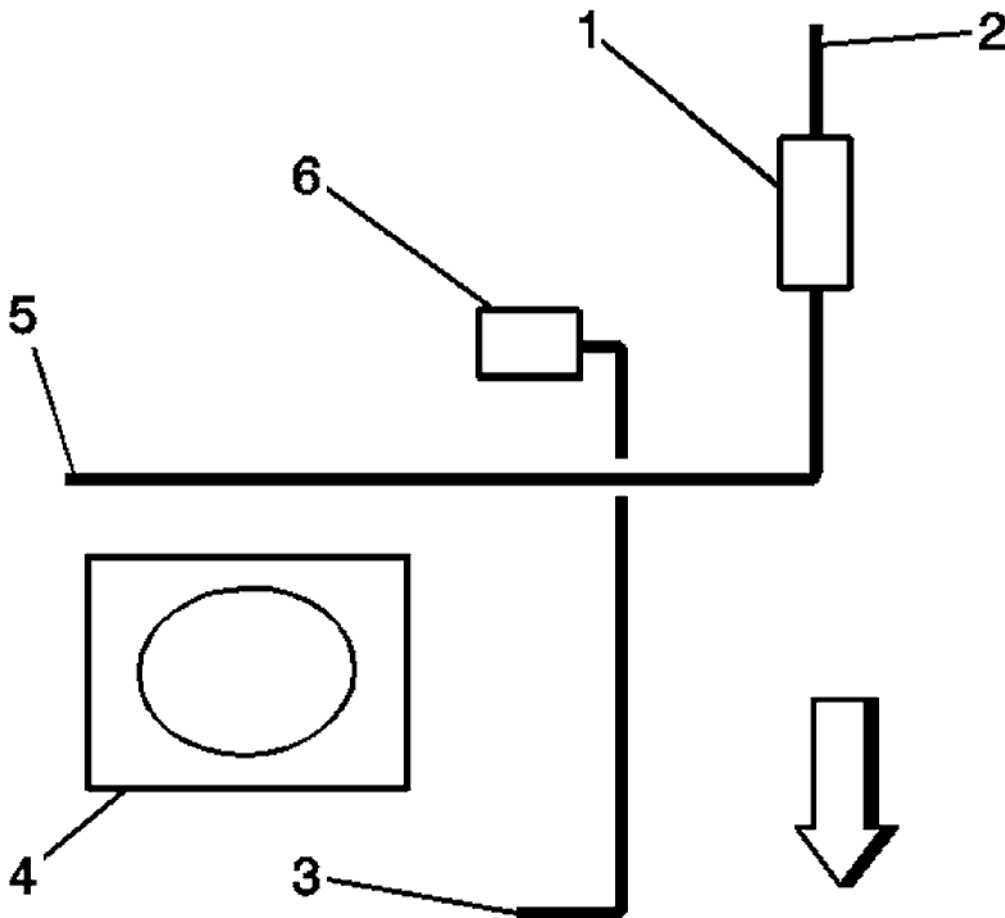


Fig. 1: Emission Hose Routing Diagram
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 1

Callout	Component Name
1	EVAP Canister Purge Solenoid Valve
2	To EVAP Canister
3	To Pre-Plenum
4	Throttle Body
5	To Intake Manifold
6	Fuel Pressure Regulator

EVAPORATIVE EMISSIONS (EVAP) HOSE ROUTING DIAGRAM

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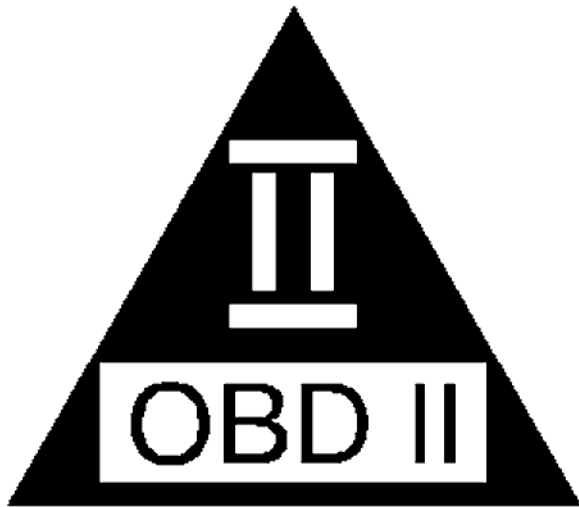
Callout	Component Name
1	Fuel Tank Pressure (FTP) Sensor
2	Fuel Tank
3	Evaporative Emission (EVAP) Vent Solenoid Valve
4	EVAP Canister
5	EVAP Service Port
6	EVAP Purge Solenoid Valve
7	Fill Limit Vent Valve (FLVV)
8	Grade Vent Valve

Engine Controls Schematic Icons

Icon	Icon Definition
	NOTE:

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The OBD II symbol is used on the circuit diagrams in order to alert the technician that the circuit is essential for proper OBD II emission control circuit operation. Any circuit which fails and causes the malfunction indicator lamp (MIL) to turn ON, or causes emissions-related component damage, is identified as an OBD II circuit.

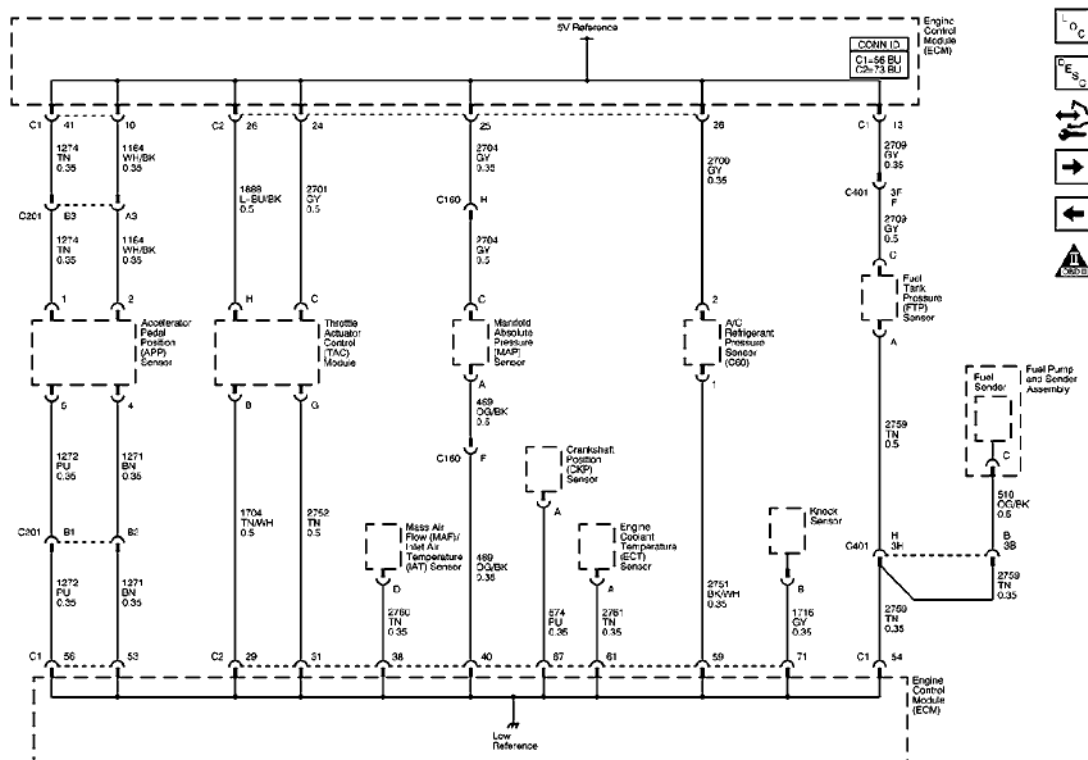


IMPORTANT:

Twisted-pair wires provide an effective shield that helps protect sensitive electronic components from electrical interference. If the wires were covered with shielding, install new shielding. In order to prevent electrical interference from degrading the performance of the connected components, you must maintain the proper specification when making any repairs to the twisted-pair wires shown :

- The wires must be twisted a minimum of 9 turns per 31 cm (12 in) as measured anywhere along the length of the wires
- The outside diameter of the twisted wires must not exceed 6.0 mm (0.25 in)

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Fig. 4: Engine Data Sensors - 5-Volt Reference Bussing
Courtesy of GENERAL MOTORS CORP.

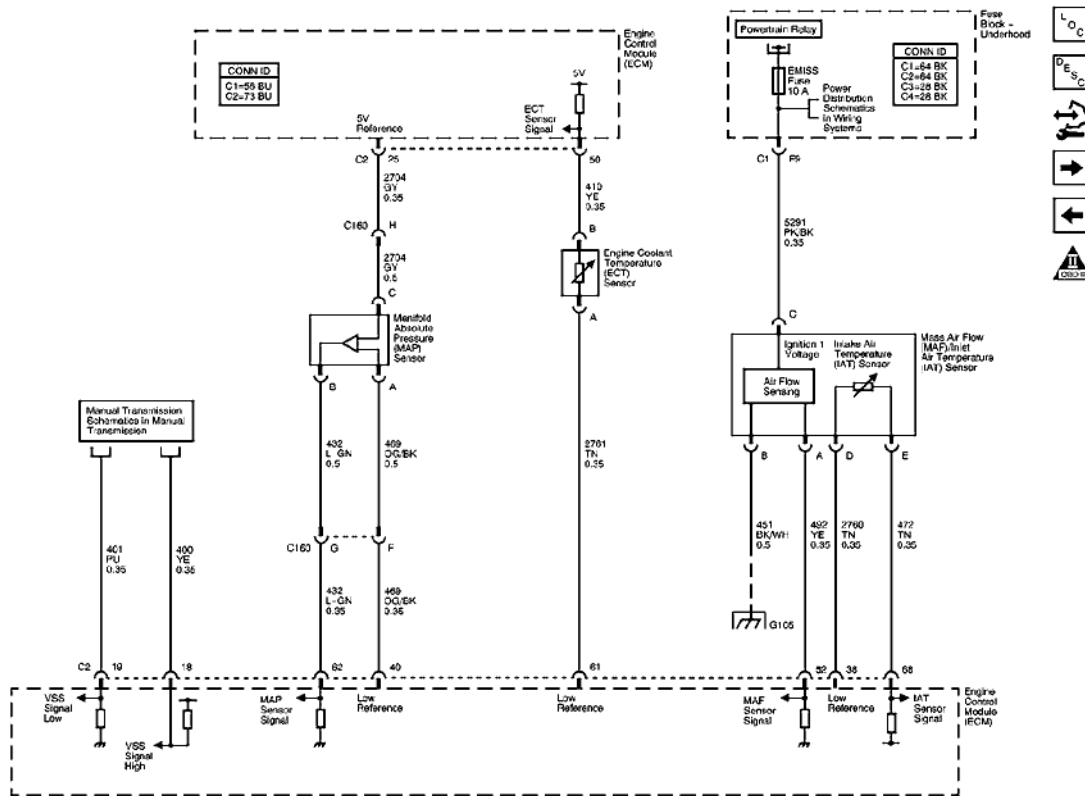


Fig. 5: Engine Data Sensors - Pressure, Temperature, and MAF/IAT
Courtesy of GENERAL MOTORS CORP.

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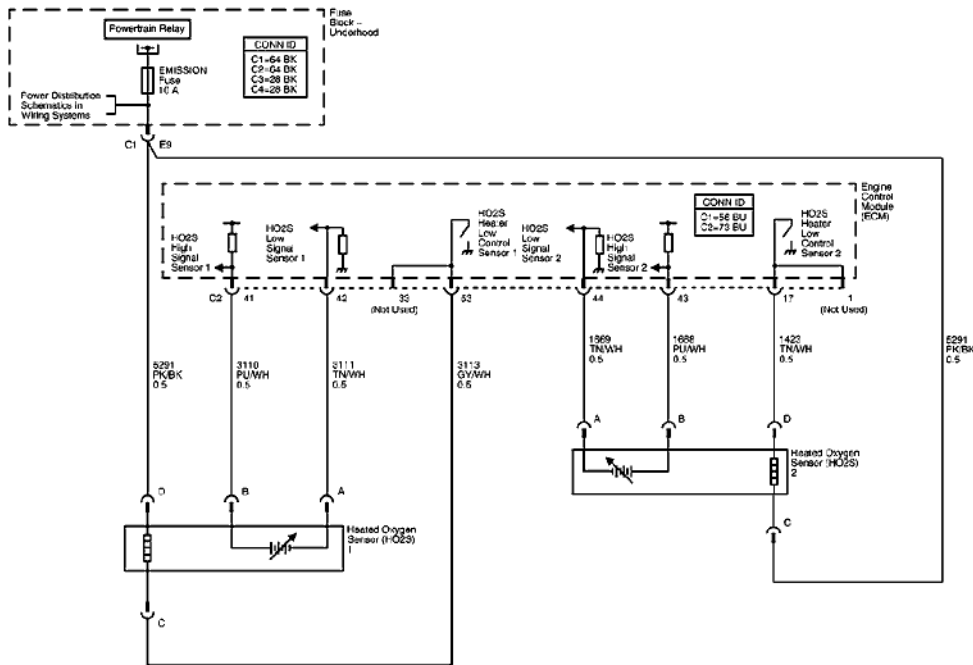


Fig. 6: Engine Data Sensors - HO2S
Courtesy of GENERAL MOTORS CORP.

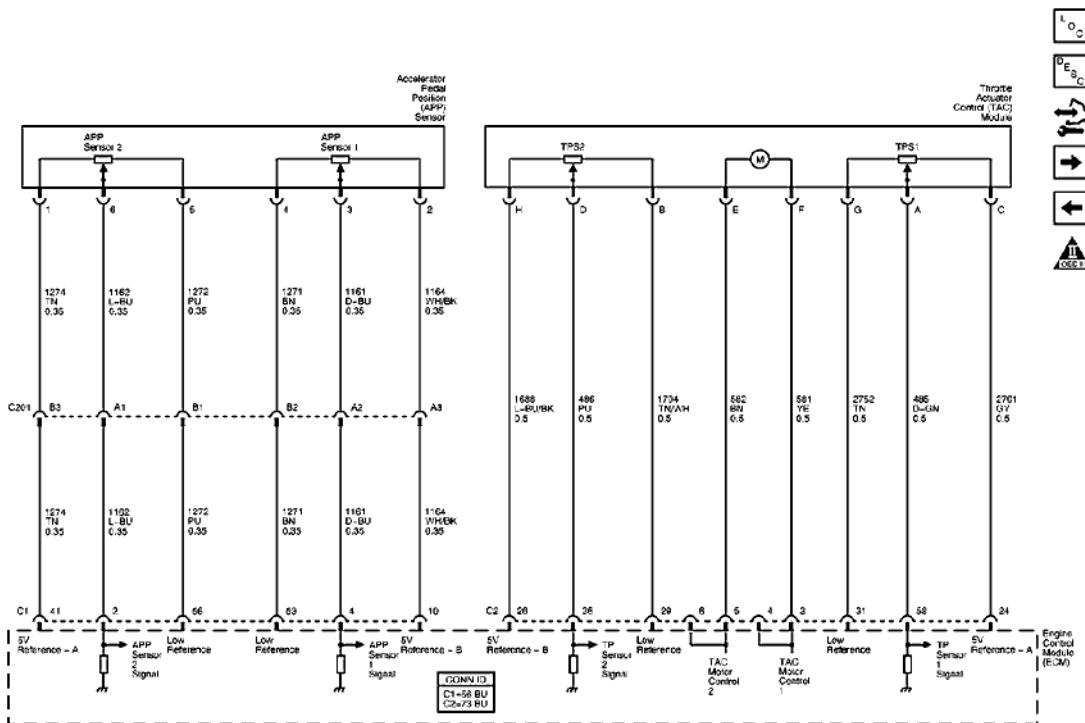


Fig. 7: Engine Data Sensors - APP and TAC
Courtesy of GENERAL MOTORS CORP.

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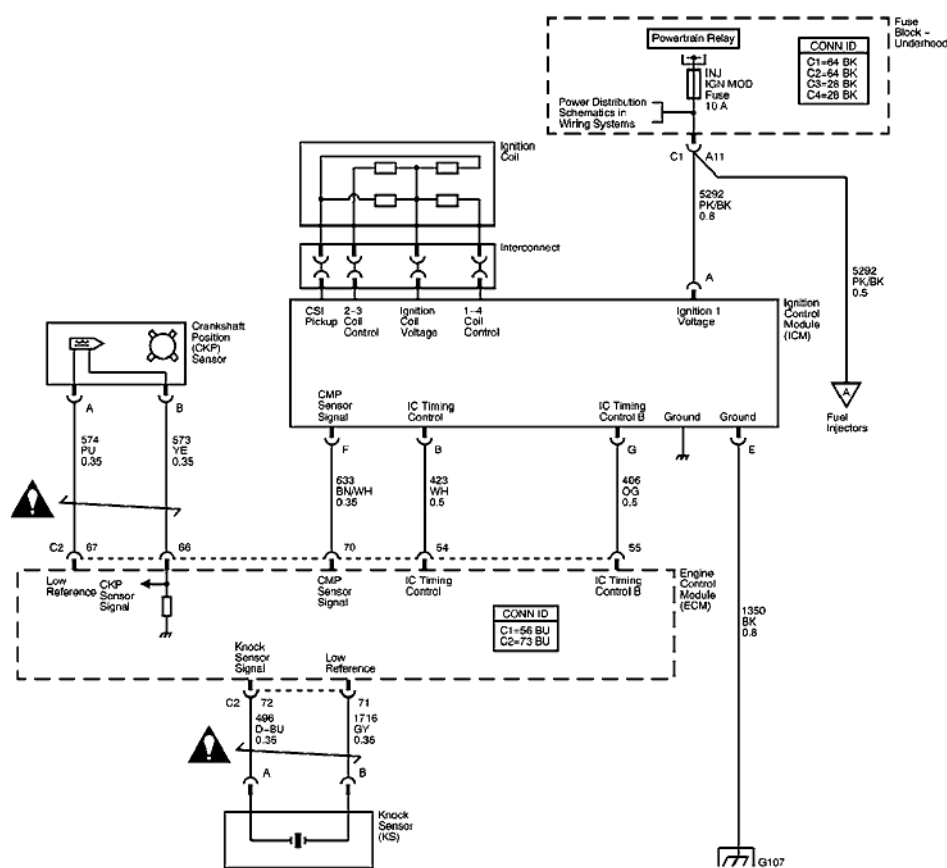


Fig. 8: Ignition Controls
Courtesy of GENERAL MOTORS CORP.

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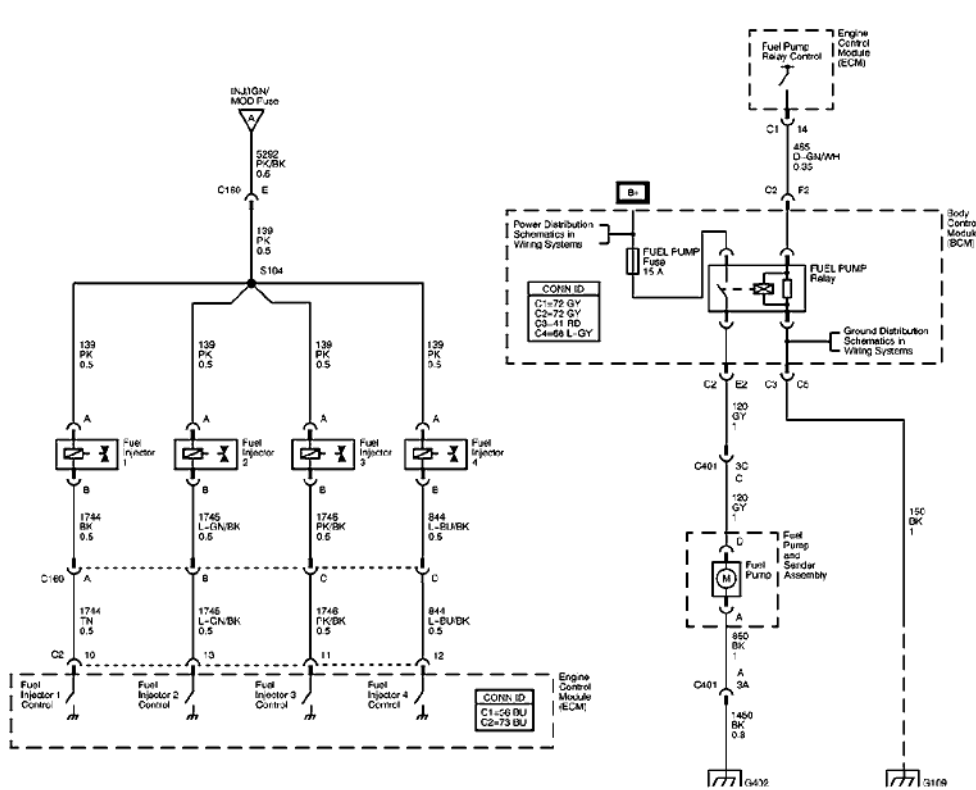


Fig. 9: Fuel Controls
Courtesy of GENERAL MOTORS CORP.

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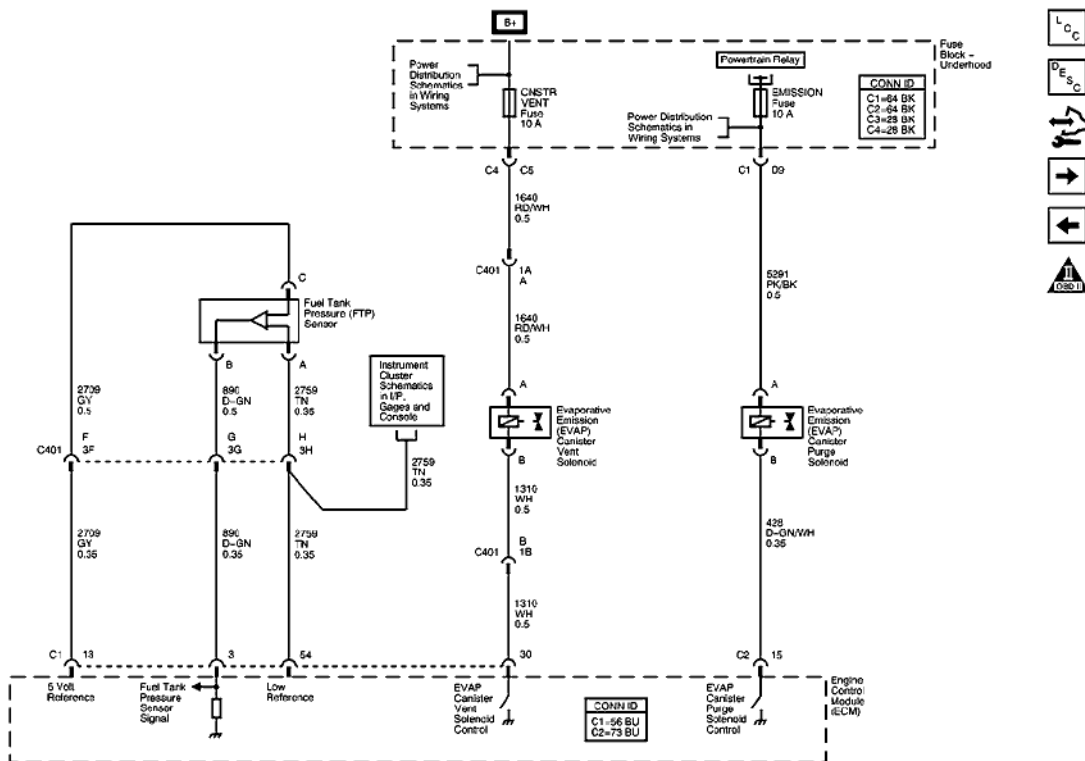


Fig. 10: EVAP Controls
Courtesy of GENERAL MOTORS CORP.

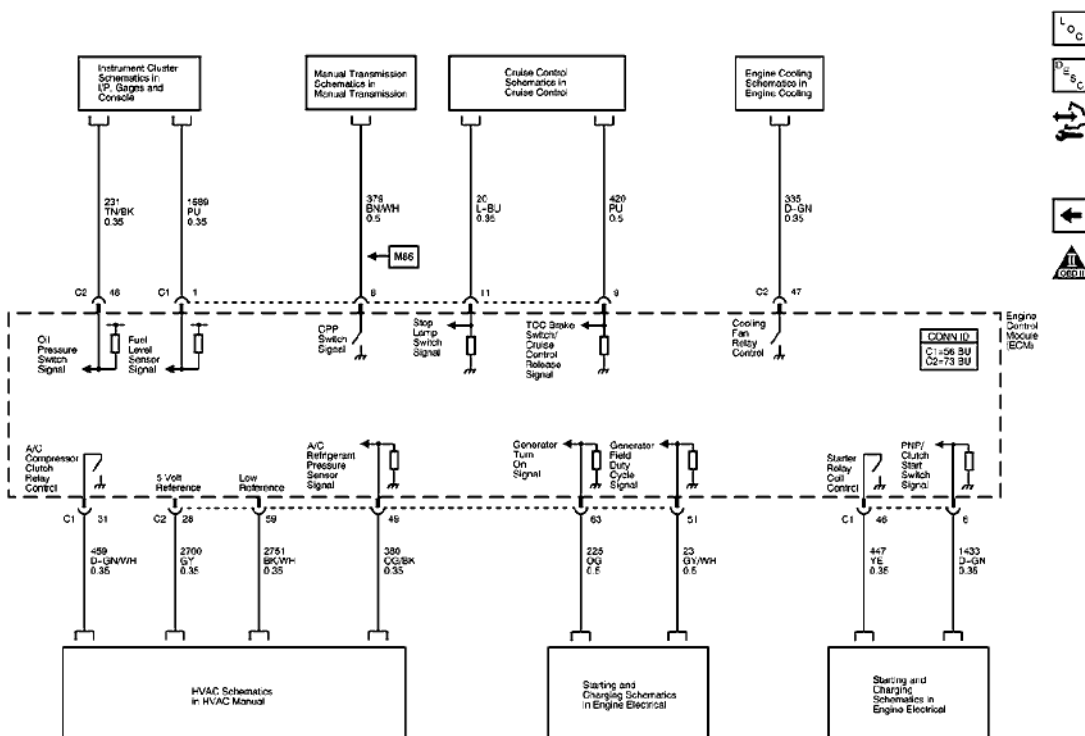


Fig. 11: Controlled/Monitored Subsystem References
 Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

ENGINE CONTROLS COMPONENT VIEWS

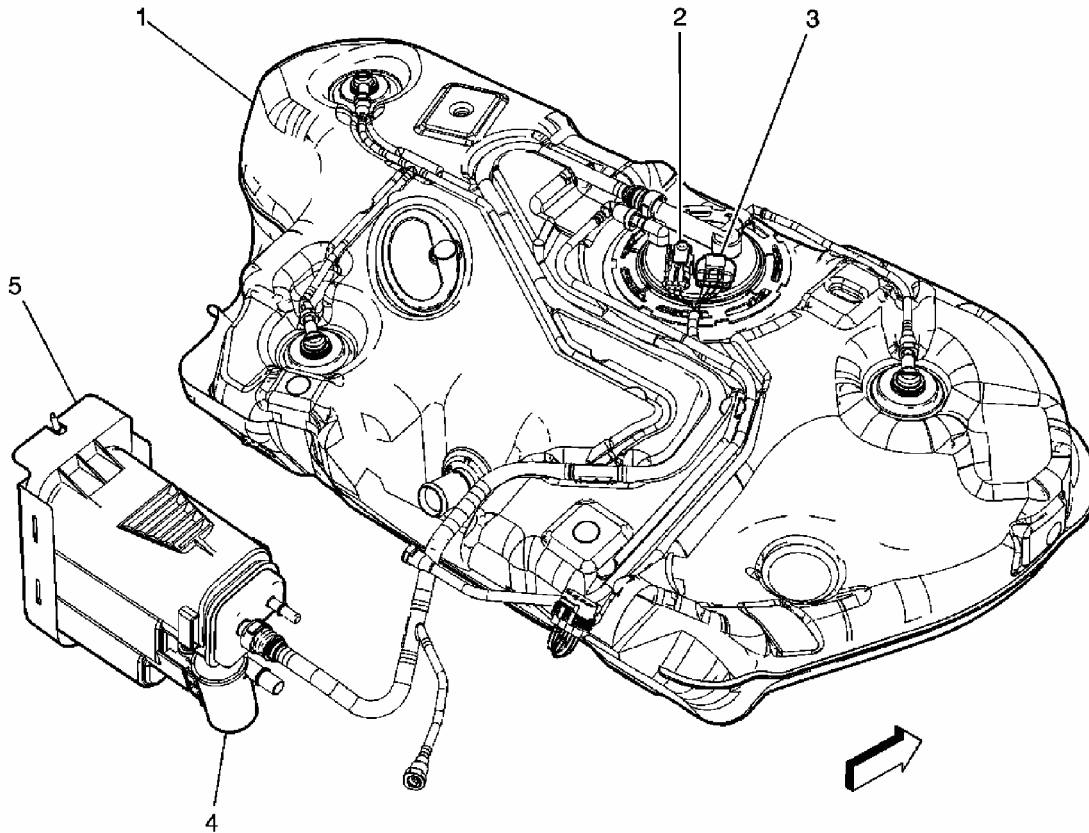


Fig. 12: Fuel Tank Components
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 12

Callout	Component Name
1	Fuel Tank
2	Fuel Pump and Sender Assembly
3	Fuel Tank Pressure Sensor
4	Evaporative Emission (EVAP) Canister Vent Solenoid Valve
5	Evaporative Emission (EVAP) Canister

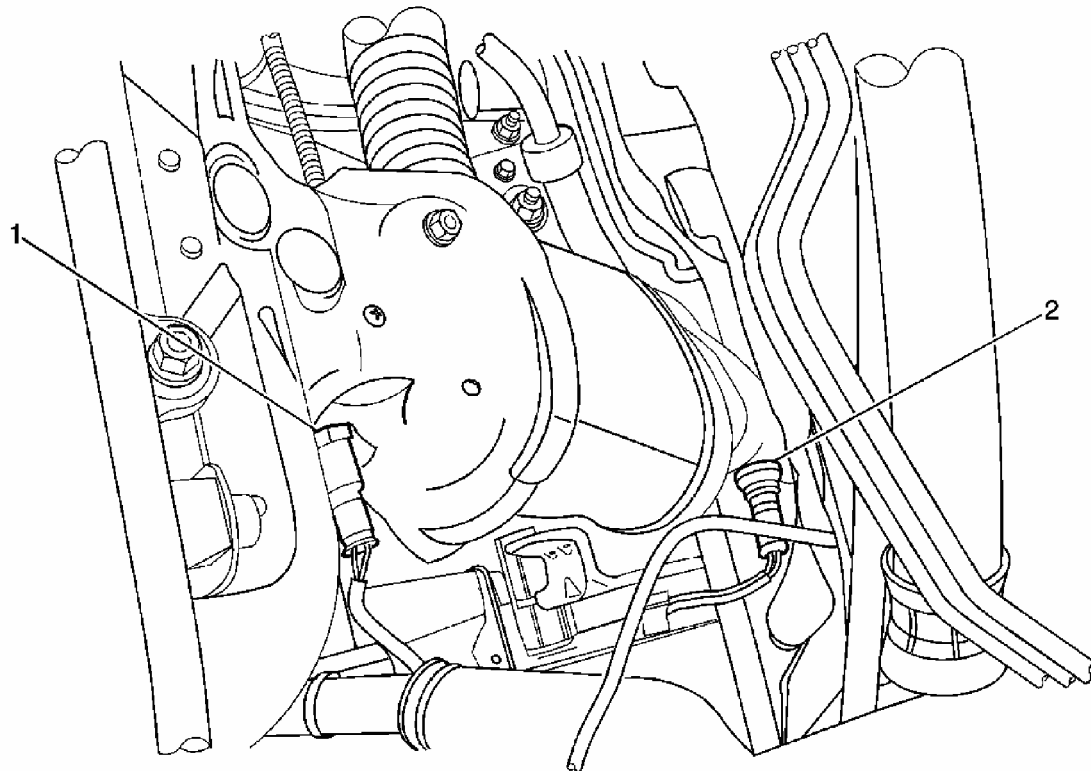


Fig. 13: View Of Rear of Engine - L61
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 13

Callout	Component Name
1	Heated Oxygen Sensor (HO2S) 1
2	Heated Oxygen Sensor (HO2S) 2

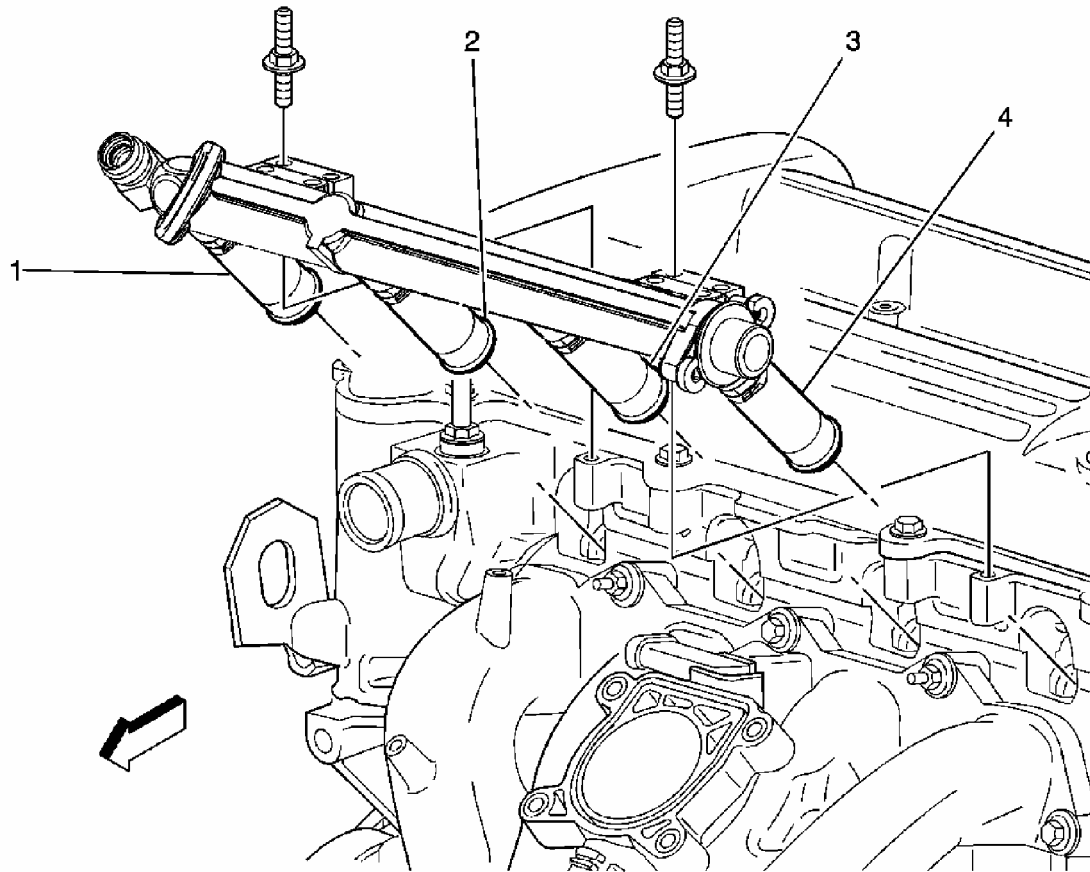


Fig. 14: Top Front Of Engine Component View
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 14

Callout	Component Name
1	Fuel Injector 1
2	Fuel Injector 2
3	Fuel Injector 3
4	Fuel Injector 4

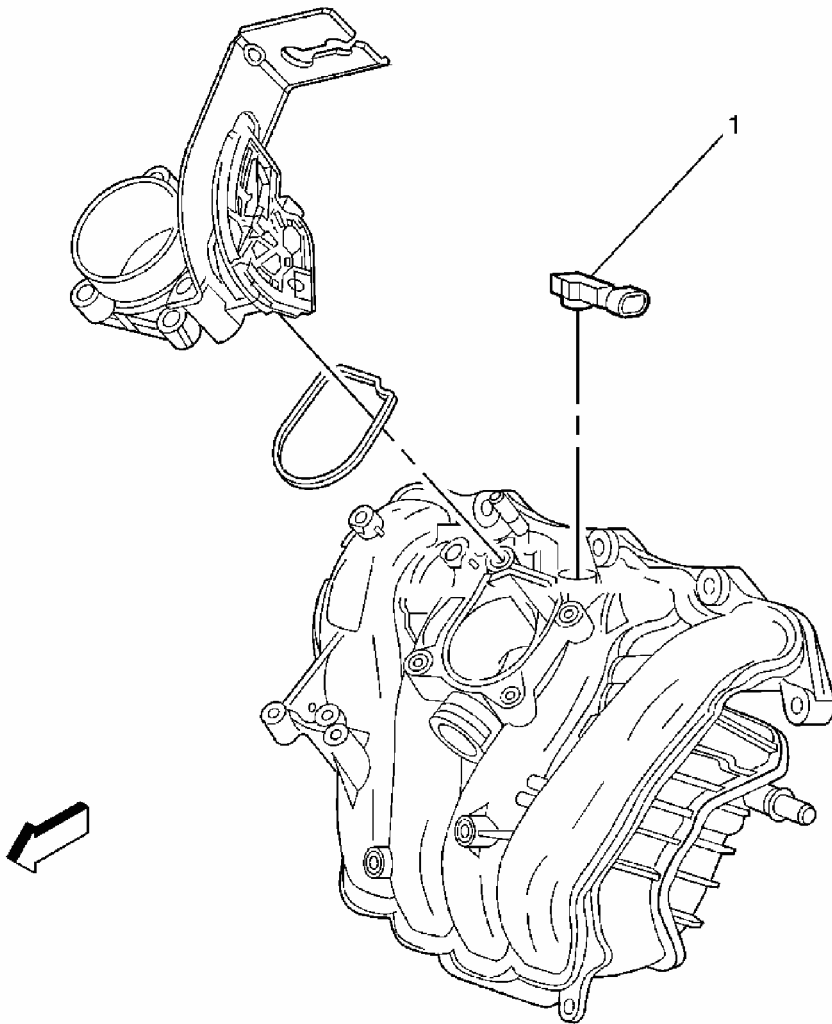


Fig. 15: Manifold Absolute Pressure (MAP) Sensor (L61)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 15

Callout	Component Name
1	Manifold Absolute Pressure (MAP) Sensor

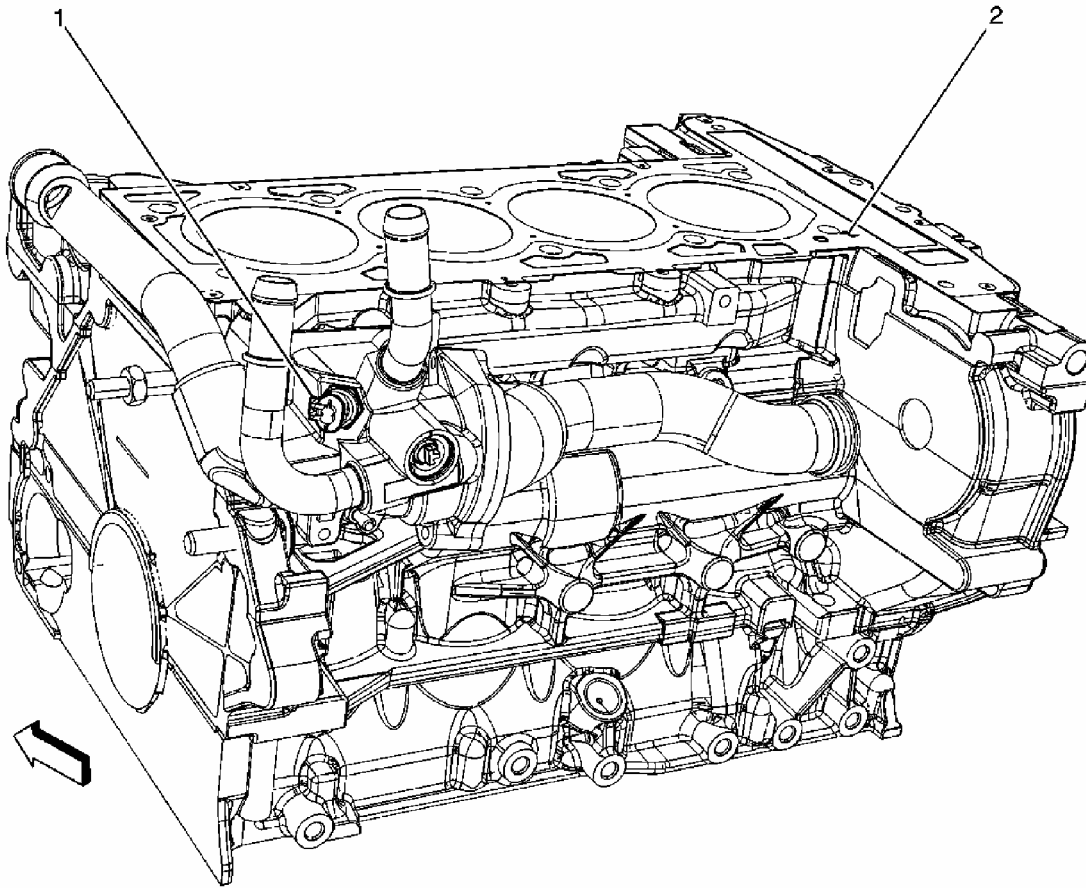


Fig. 16: Rear of the Engine Block (L61)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 16

Callout	Component Name
1	Engine Coolant Temperature (ECT) Sensor
2	Engine Block

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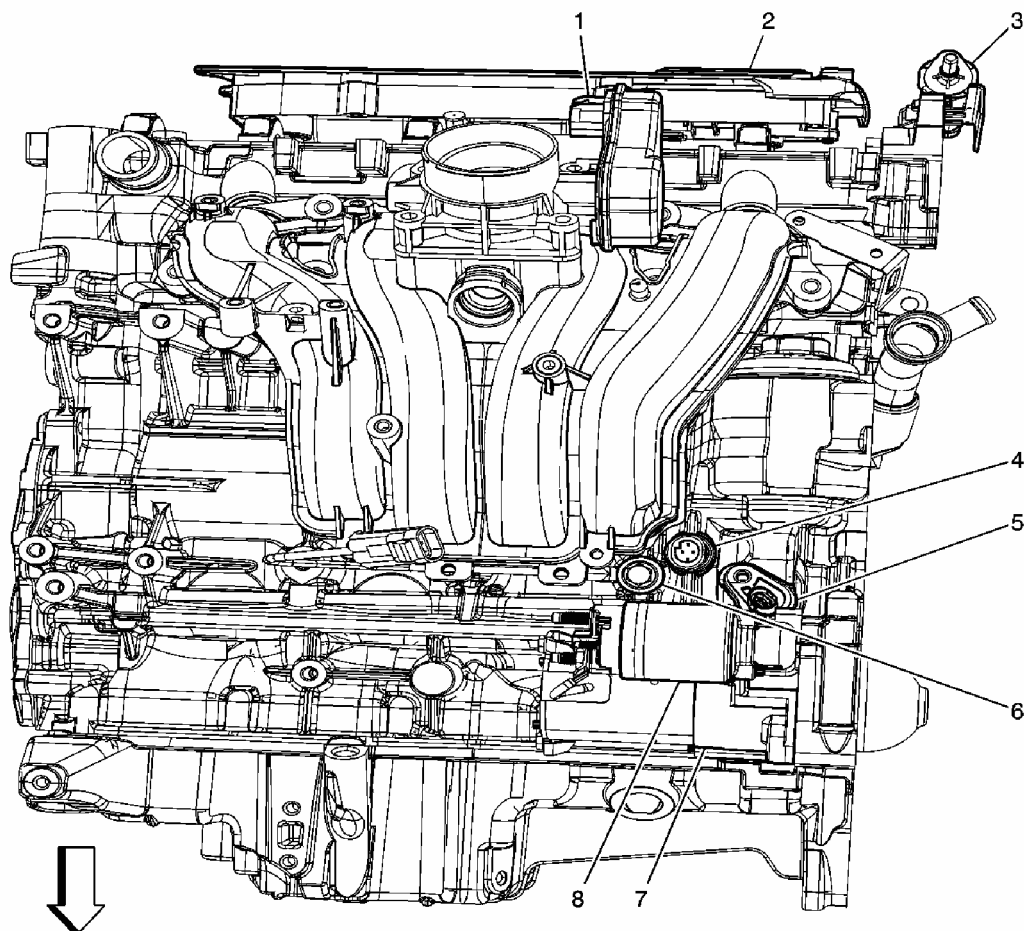


Fig. 17: Front of the Engine (L61)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 17

Callout	Component Name
1	Throttle Actuator Control (TAC) Module
2	Ignition Control Module (ICM)
3	Evaporative Emission (EVAP) Canister Purge Solenoid
4	Engine Oil Pressure (EOP) Switch
5	Crankshaft Position (CKP) Sensor
6	Knock Sensor (KS)
7	Starter
8	Starter Solenoid

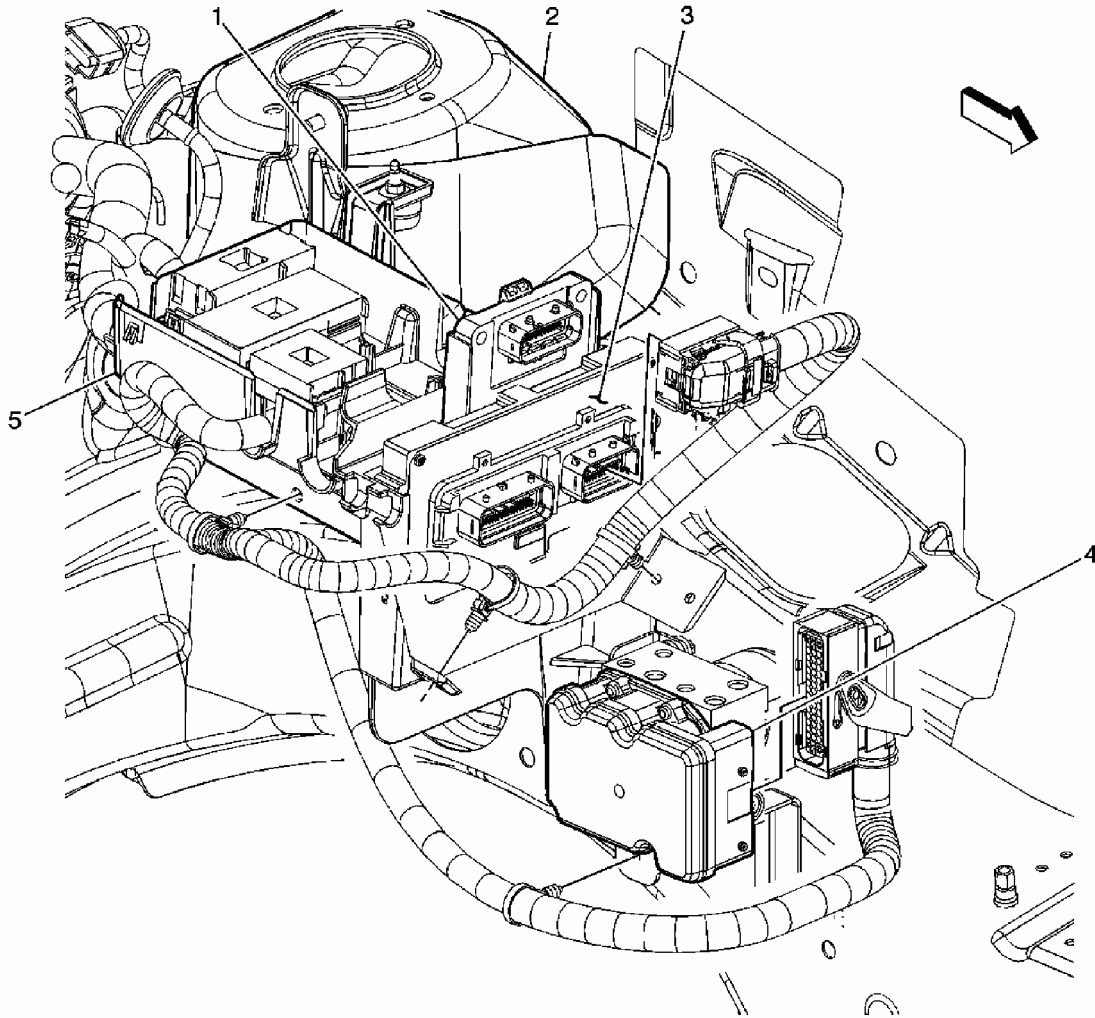


Fig. 18: Left Side of the Engine Compartment
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 18

Callout	Component Name
1	Transmission Control Module (TCM) (MN5)
2	LF Strut Tower
3	Engine Control Module (ECM) (L61)
4	Electronic Brake Control Module (EBCM) (JM4/JL9)
5	Fuse Block - Underhood Bracket

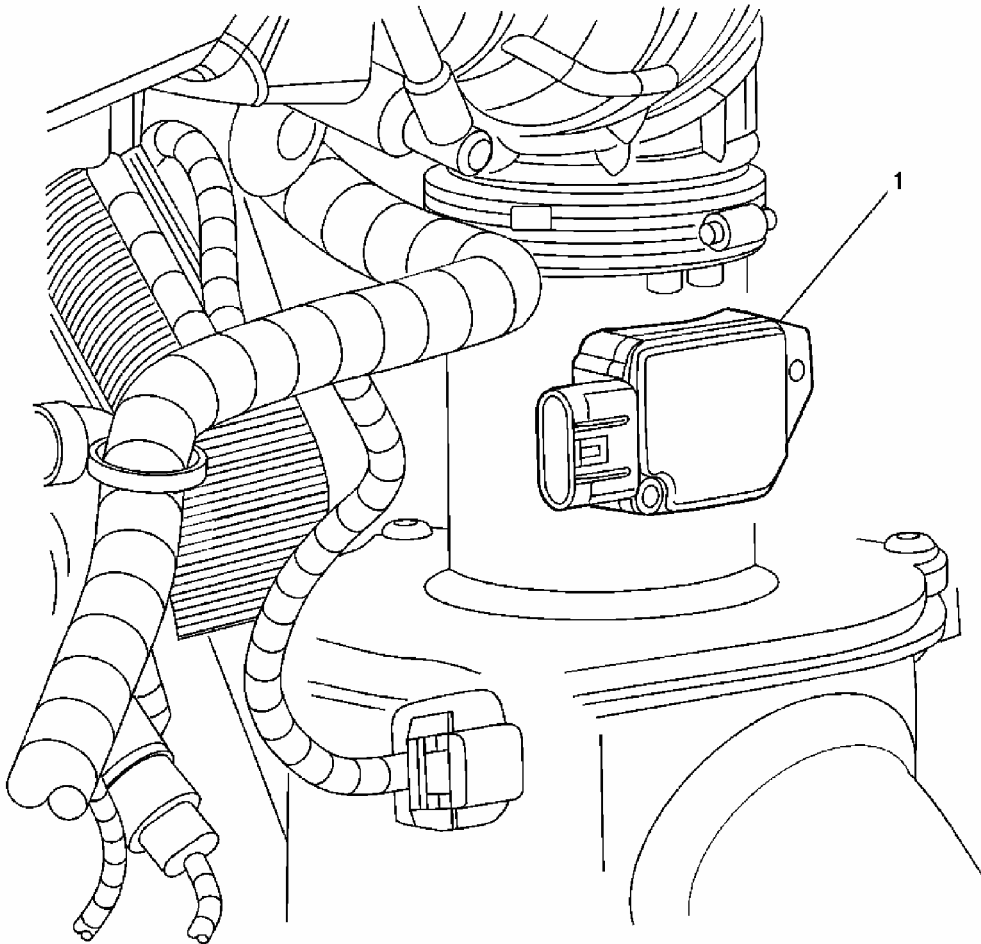


Fig. 19: Mass Air Flow (MAF)/Inlet Air Temperature (IAT) Sensor
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 19

Callout	Component Name
1	Mass Air Flow (MAF)/Inlet Air Temperature (IAT) Sensor

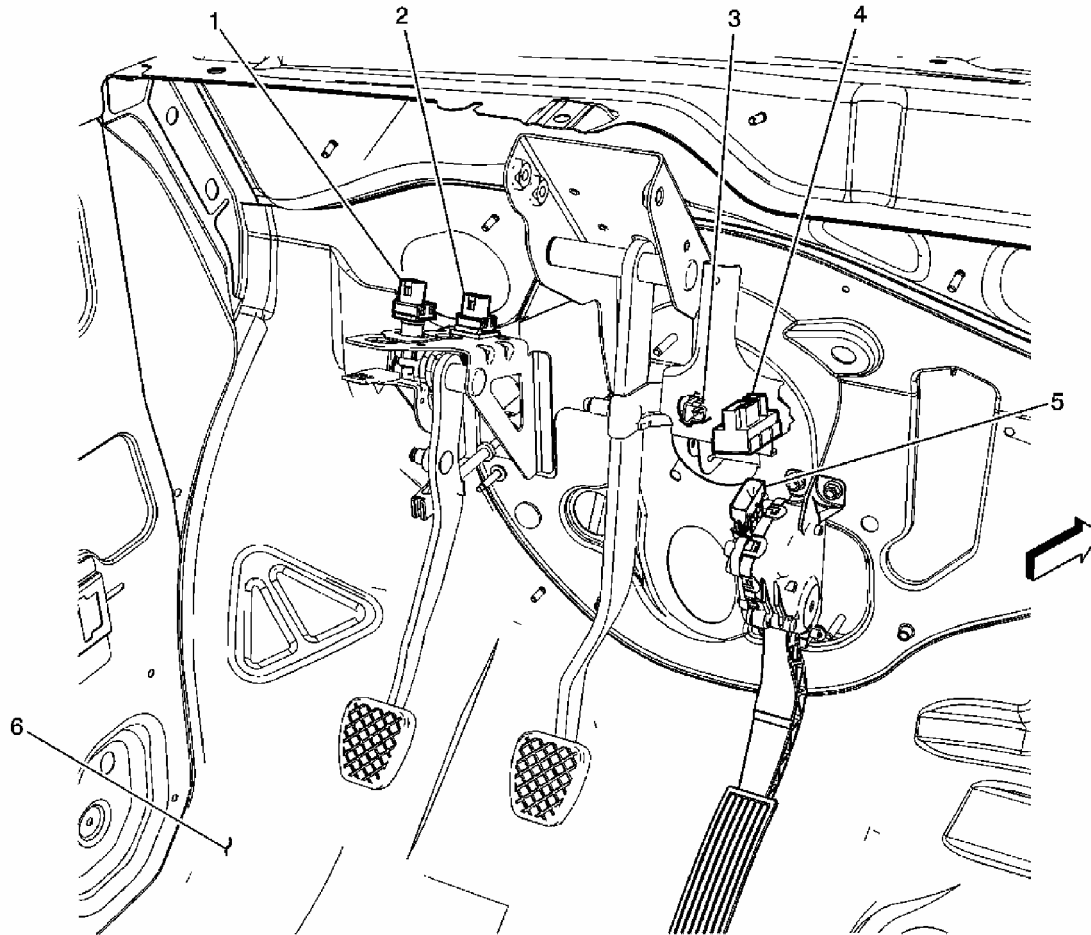


Fig. 20: Pedal Assemblies
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 20

Callout	Component Name
1	Clutch Pedal Position (CPP) Switch (M86)
2	Clutch Start Switch (M86)
3	Stop Lamp Switch
4	Stop Lamp / Torque Converter Clutch (TCC) Switch / Cruise Release Switch
5	Accelerator Pedal Position (APP) Sensor
6	Floor Panel

ENGINE CONTROL MODULE (ECM) CONNECTOR END VIEWS

Engine Control Module (ECM) C1

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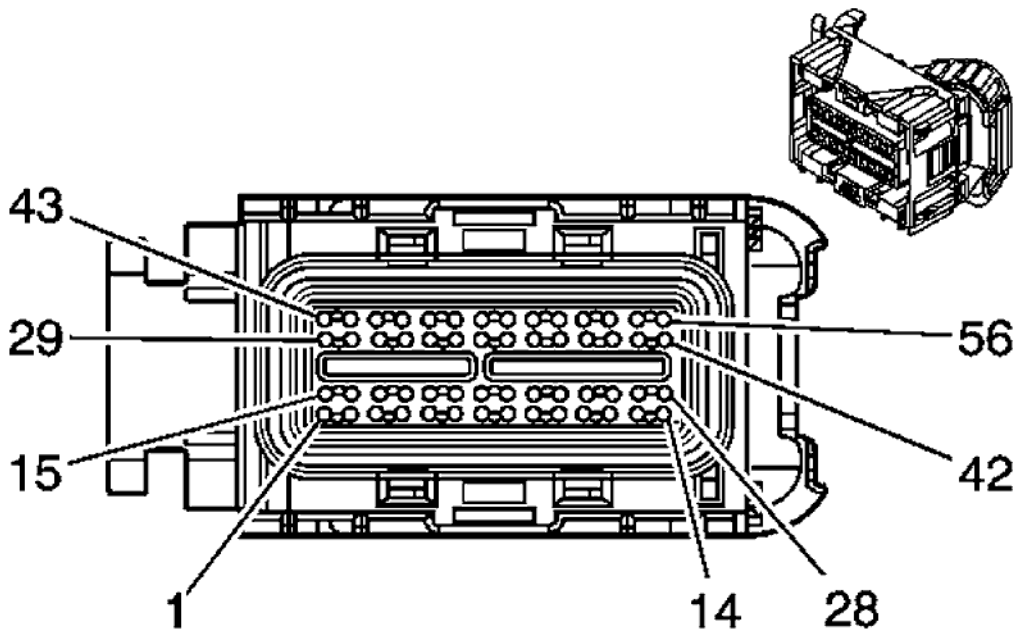


Fig. 21: Powertrain Control Module (PCM) C1 & C3 Connector End View
Courtesy of GENERAL MOTORS CORP.

Engine Control Module (ECM) Connector End Views

Connector Part Information

- OEM: 15452125
- Service: 88953346
- Description: 56-Way F Micro-Pack 64 Series (BU)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Engine Control Module (ECM) C1

Pin	Wire Color	Circuit No.	Function
1	PU	1589	Primary Fuel Level Sensor Signal
2	L-BU	1162	Accelerator Pedal Position Signal (2)
3	D-GN	890	Fuel Tank Pressure Sensor Signal

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4	D-BU	1161	Accelerator Pedal Position Signal (1)
5	-	-	Not Used
6	D-GN	1433	Clutch Start Switch Signal
7	-	-	Not Used
8	BN/WH	379	Cruise Control Clutch Pedal Position Switch Signal (w/M86)
9	PU	420	Torque Converter Clutch Brake Switch Signal
10	WH/BK	1164	Accelerator Pedal Position 5-Volt Reference (1)
11	L-BU	20	Stop Lamp Supply Voltage
12	BN	4	Accessory Voltage
13	GY	2709	Fuel Tank Pressure Sensor 5-Volt Reference
14	D-GN/WH	465	Fuel Pump Primary Relay Control
15-17	-	-	Not Used
18	BN	5069	Engine Main Relay Coil Control
19-27	-	-	Not Used
28	PK	1039	Run/Crank Ignition 1 Voltage
29	-	-	Not Used
30	WH	1310	EVAP Canister Vent Solenoid Control
31	D-GN/WH	459	A/C Compressor Clutch Relay Control
32-40	-	-	Not Used
41	TN	1274	Accelerator Pedal Position 5-Volt Reference (2)
42-44	-	-	Not Used
45	BN/WH	419	Check Engine Indicator Control
46	YE	447	Starter Relay Coil Control
47-51	-	-	Not Used
52	RD/WH	840	Battery Positive Voltage
53	BN	1271	Accelerator Pedal Position Low Reference (1)
54	TN	2759	Fuel Tank Pressure Sensor Low Reference
55	-	-	Not Used
56	PU	1272	Accelerator Pedal Position Low Reference (2)

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Engine Control Module (ECM) C2

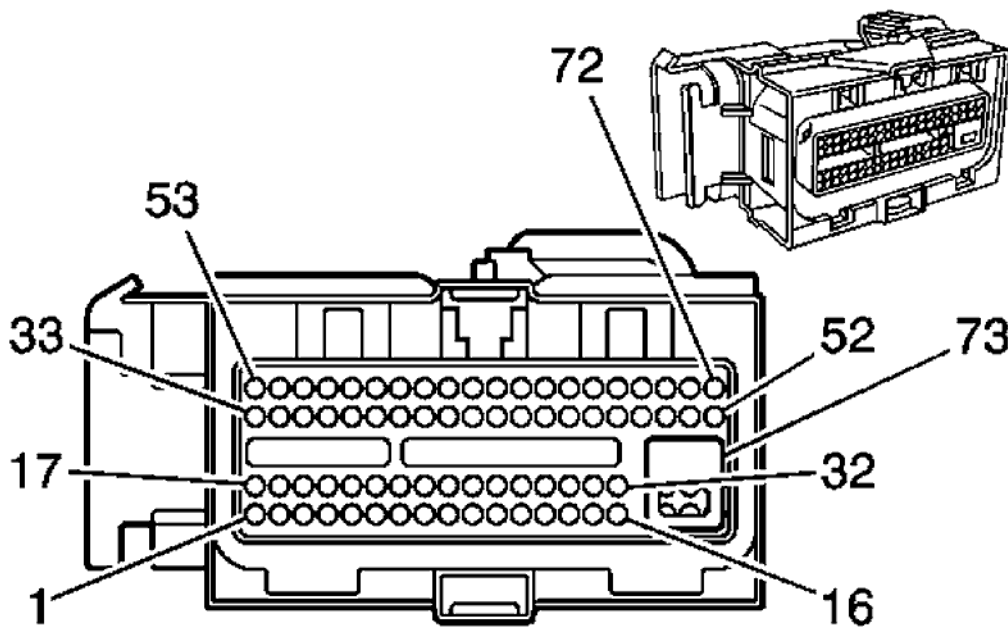


Fig. 22: ECM C2 Connector

Courtesy of GENERAL MOTORS CORP.

Engine Control Module (ECM) Connector End Views

Connector Part Information

- OEM: 15471385
- Service: 88953274
- Description: 73-Way F Micro-Pack 64 Series (BU)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Engine Control Module (ECM) C2

Pin	Wire Color	Circuit No.	Function
1-2	-	-	Not Used

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3	YE	581	Throttle Actuator Control Open
4	-	-	Not Used
5	BN	582	Throttle Actuator Control Close
6-9	-	-	Not Used
10	TN	1744	Fuel Injector Control (1)
11	PK/BK	1746	Fuel Injector Control (3)
12	L-BU/BK	844	Fuel Injector Control (4)
13	L-GN/BK	1745	Fuel Injector Control (2)
14	-	-	Not Used
15	D-GN/WH	428	EVAP Canister Purge Solenoid Control
16	-	-	Not Used
17	TN/WH	1423	Heated Oxygen Sensor Heater Low Control Bank 1 Sensor (2)
18	YE	400	Vehicle Speed Sensor Signal (w/M86)
19	PU	401	Vehicle Speed Sensor Low Reference (w/M86)
20-23	-	-	Not Used
24	GY	2701	Throttle Position Sensor 5-Volt Reference
25	GY	2704	Manifold Absolute Pressure Sensor 5-Volt Reference
26	L-BU/BK	1688	5-Volt Reference
27	-	-	Not Used
28	GY	2700	A/C Pressure Sensor 5-Volt Reference
29	TN/WH	1704	Sensor Low Reference
30	-	-	Not Used
31	TN	2752	Throttle Position Sensor Low Reference
32-33	-	-	Not Used
34	PK/BK	5290	Engine Main Relay Fused Control (1)
35	-	-	Not Used
36	PU	486	Throttle Position Sensor Signal (2)
37	-	-	Not Used
38	TN	2760	Intake Air Temperature Sensor Low Reference
39	-	-	Not Used

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40	OG/BK	469	Manifold Absolute Pressure Sensor Low Reference
41	PU/WH	3110	Heated Oxygen Sensor High Signal Bank 1 Sensor 1
42	TN/WH	3111	Heated Oxygen Sensor Low Signal Bank 1 Sensor 1
43	PU/WH	1668	Heated Oxygen Sensor High Signal Bank 1 Sensor 2
44	TN/WH	1669	Heated Oxygen Sensor Low Signal Bank 1 Sensor 2
45-46	-	-	Not Used
47	D-GN	335	Low Speed Cooling Fan Relay Control
48	TN/BK	231	Oil Pressure Switch Signal
49	OG/BK	380	A/C Refrigerant Pressure Sensor Signal
50	YE	410	Engine Coolant Temperature Sensor Signal
51	GY	23	Generator Field Duty Cycle Signal
52	YE	492	Mass Air Flow Sensor Signal
53	GY/WH	3113	Heated Oxygen Sensor Heater Low Control Bank 1 Sensor (1)
54	WH	423	Ignition Control Timing Control (1)
55	OG	406	Ignition Control Timing Control (2)
56-57	-	-	Not Used
58	D-GN	485	Throttle Position Sensor Signal (1)
59	BK/WH	2751	Signal Ground
60	-	-	Not Used
61	TN	2761	Coolant Temperature Sensor Low Reference
62	L-GN	432	Manifold Absolute Pressure Sensor Signal
63	OG	225	Generator Turn On Signal
64	TN/BK	2500	High Speed GMLAN Serial Data (+)
65	TN	2501	High Speed GMLAN Serial Data (-)
66	YE	573	Crankshaft Position Sensor Signal (1)
67	PU	574	Crankshaft Position Sensor Low Reference (1)
68	TN	472	Intake Air Temperature Sensor Signal

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69	-	-	Not Used
70	BN/WH	633	Camshaft Position Sensor Signal
71	GY	1716	Knock Sensor Low Reference (1)
72	D-BU	496	Knock Sensor Signal (1)
73	BK/WH	451	Signal Ground

ENGINE CONTROLS CONNECTOR END VIEWS

Accelerator Pedal Position (APP) Sensor

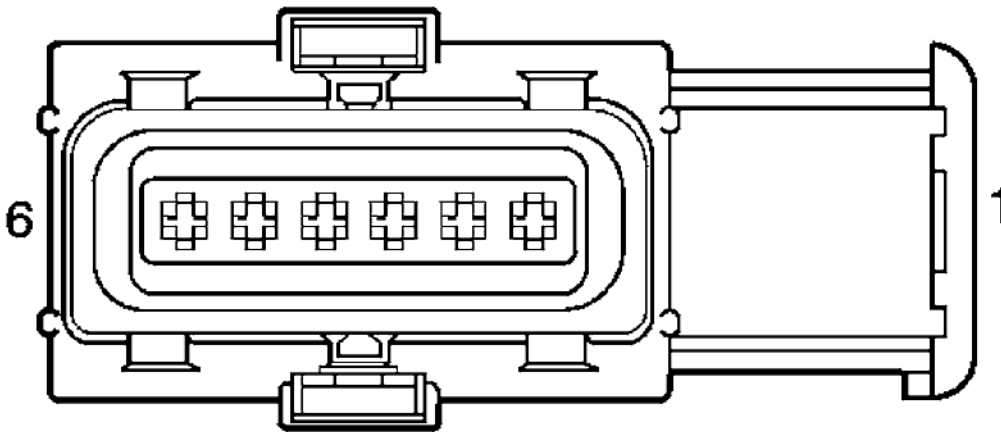


Fig. 23: Accelerator Pedal Position (APP) Sensor Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 6-929264-1
- Service: 89046653
- Description: 6-Way F MT2 Housing (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

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Accelerator Pedal Position (APP) Sensor

Pin	Wire Color	Circuit No.	Function
1	TN	1274	Accelerator Pedal Position 5 Volt Reference (2)
2	WH/BK	1164	Accelerator Pedal Position 5 Volt Reference (1)
3	D-BU	1161	Accelerator Pedal Position Signal (1)
4	BN	1271	Accelerator Pedal Position Low Reference (1)
5	PU	1272	Accelerator Pedal Position Low Reference (2)
6	L-BU	1162	Accelerator Pedal Position Signal (2)

Crankshaft Position (CKP) Sensor

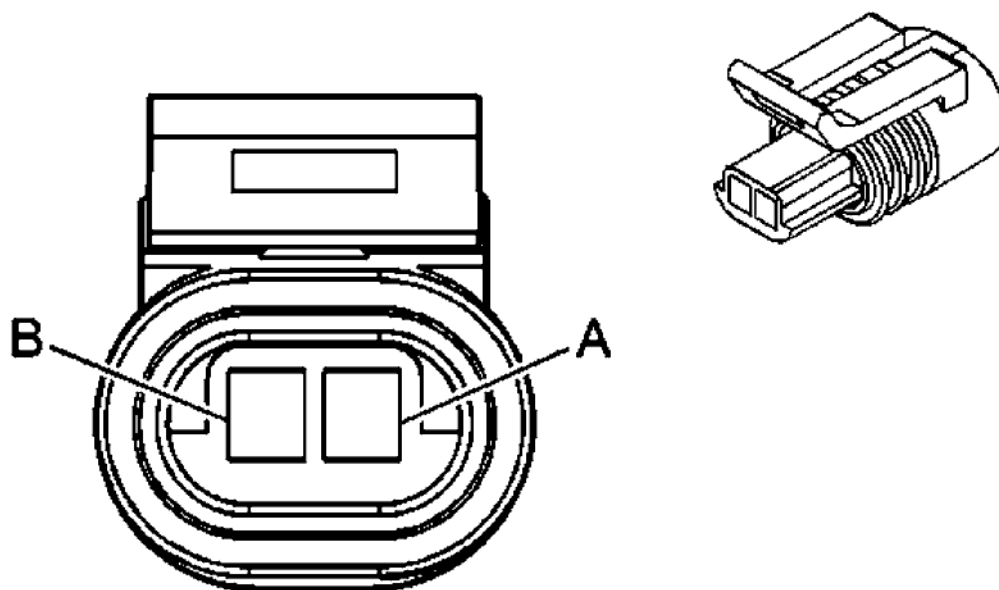


Fig. 24: Crankshaft Position (CKP) Sensor Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15449028

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- Service: 88987978
- Description: 2-Way F GT 150 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Crankshaft Position (CKP) Sensor

Pin	Wire Color	Circuit No.	Function
A	PU	574	Crankshaft Position Sensor Low Reference (1)
B	YE	573	Crankshaft Position Sensor Signal (1)

Engine Coolant Temperature (ECT) Sensor

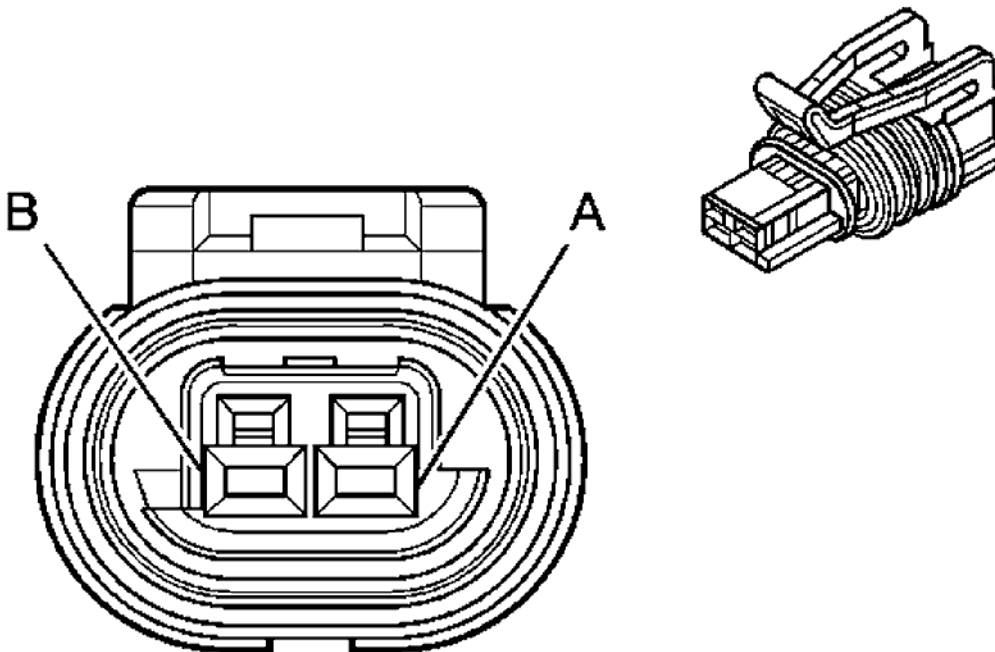


Fig. 25: Engine Coolant Temperature (ECT) Sensor Connector
Courtesy of GENERAL MOTORS CORP.

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Engine Controls Connector End Views

Connector Part Information

- OEM: 15449028
- Service: 88987978
- Description: 2-Way F 150 GT Series Sealed (BK)

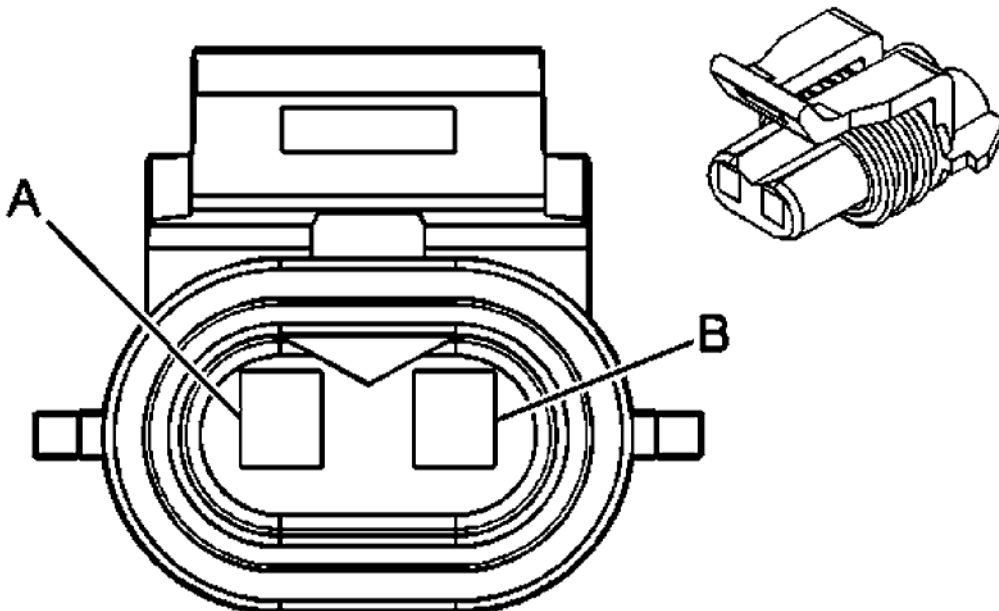
Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Engine Coolant Temperature (ECT) Sensor

Pin	Wire Color	Circuit No.	Function
A	TN	2761	Coolant Temperature Sensor Low Reference
B	YE	410	Engine Coolant Temperature Sensor Signal

Evaporative Emission (EVAP) Canister Purge Solenoid Valve



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Fig. 26: Evaporative Emission (EVAP) Canister Purge Solenoid Valve Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 12052643
- Service: 12101858
- Description: 2-Way F Metri-Pack 150 Series Sealed (RD)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Evaporative Emission (EVAP) Canister Purge Solenoid Valve

Pin	Wire Color	Circuit No.	Function
A	PK/BK	5291	Engine Main Relay Fused Control (2)
B	D-GN/WH	428	EVAP Canister Purge Solenoid Control

Evaporative Emissions (EVAP) Canister Vent Solenoid Valve

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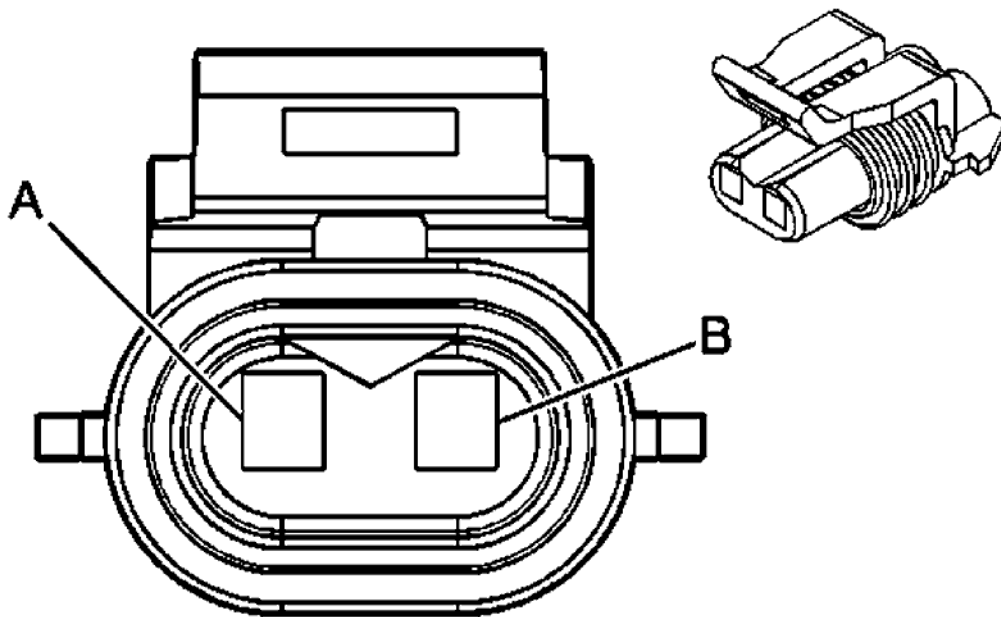


Fig. 27: EVAP Canister Vent Solenoid Valve Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 12052643
- Service: 12101858
- Description: 2-Way F Metri-Pack 150 Series Sealed (RD)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Evaporative Emissions (EVAP) Canister Vent Solenoid Valve

Pin	Wire Color	Circuit No.	Function
A	RD/WH	1640	Battery Positive Voltage
B	WH	1310	EVAP Canister Vent Solenoid Control

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Fuel Injector 1

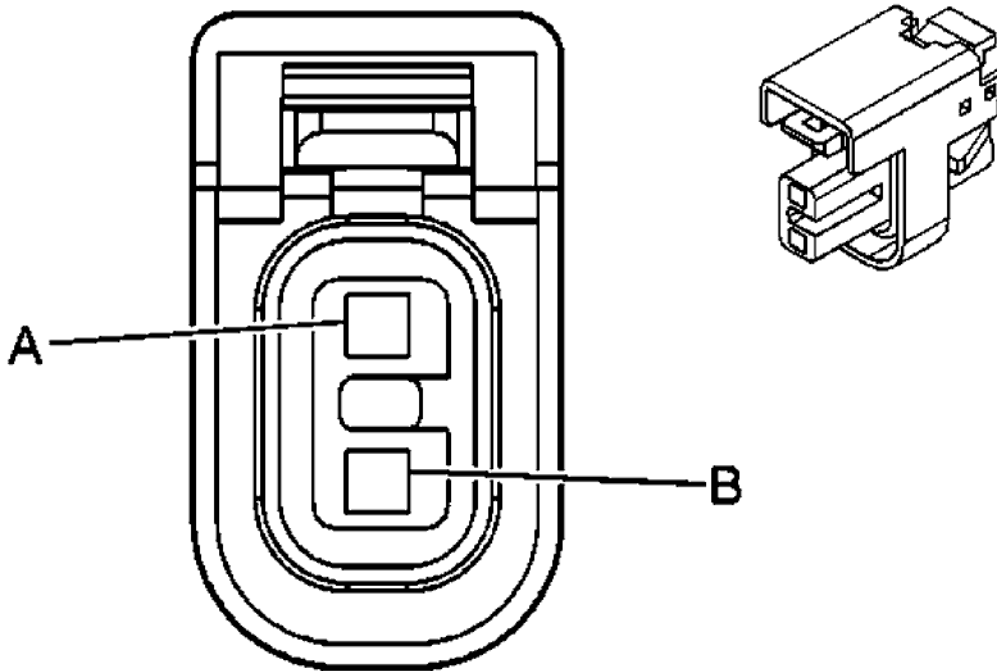


Fig. 28: Fuel Injector 1 Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15326181
- Service: 15306160
- Description: 2-Way F Micro-Pack 064 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Fuel Injector 1

Pin	Wire Color	Circuit No.	Function

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A	PK	139	Run/Crank Ignition 1 Voltage
B	BK	1744	Fuel Injector Control (1)

Fuel Injector 2

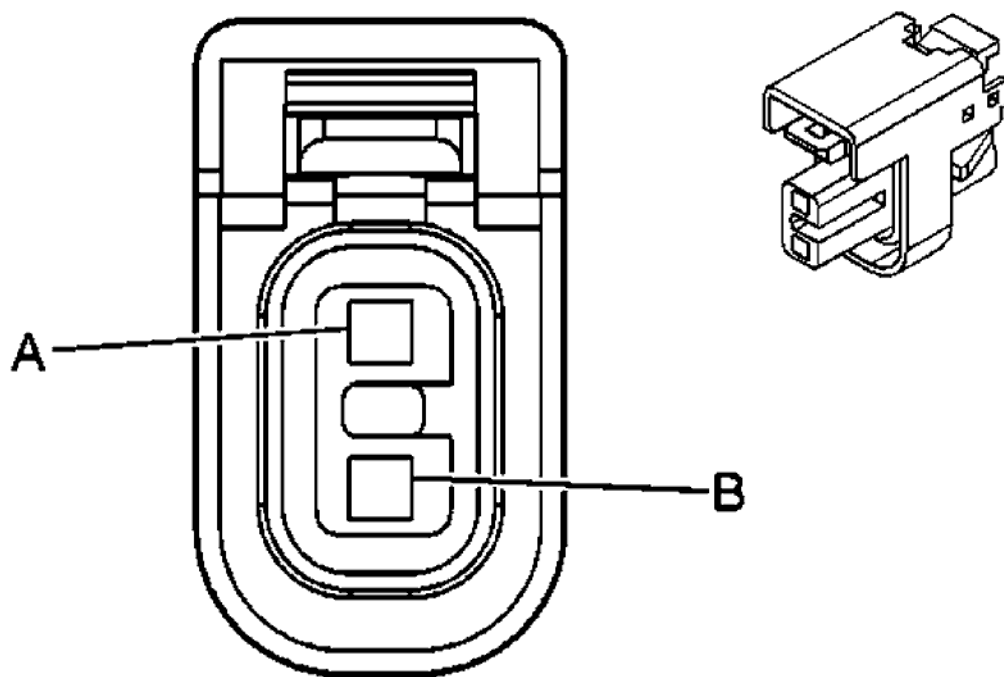


Fig. 29: Fuel Injector 2 Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15326181
- Service: 15306160
- Description: 2-Way F Micro-Pack 064 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

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Fuel Injector 2

Pin	Wire Color	Circuit No.	Function
A	PK	139	Run/Crank Ignition 1 Voltage
B	L-GN/BK	1745	Fuel Injector Control (2)

Fuel Injector 3

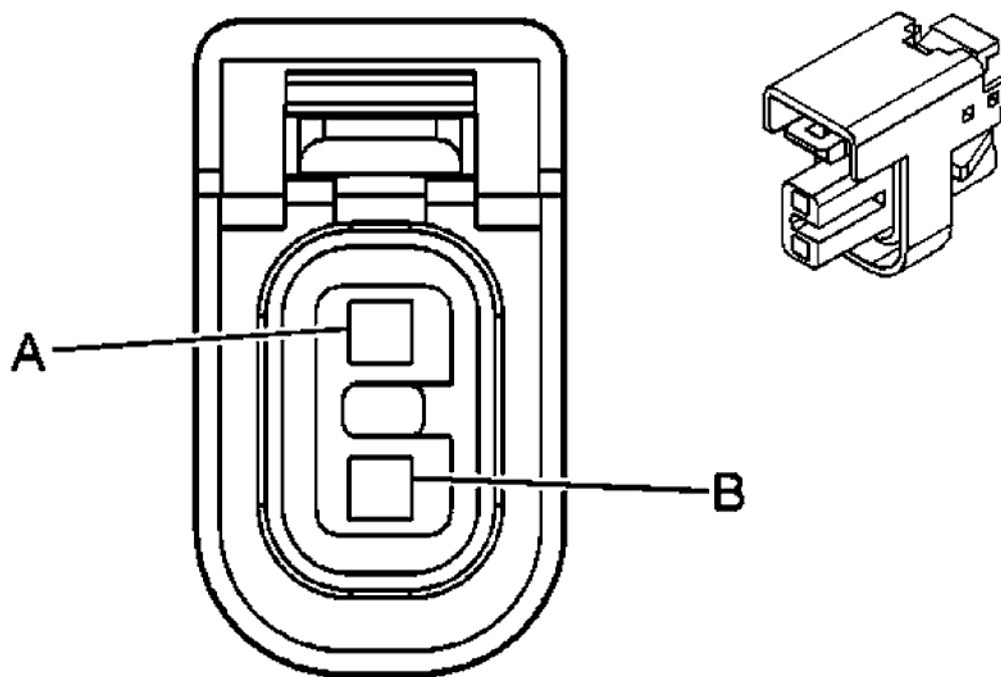


Fig. 30: Fuel Injector 3 Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15326181
- Service: 15306160
- Description: 2-Way F Micro-Pack 064 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:

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- Core/Insulation Crimp:
- Release Tool/Test Probe:

Fuel Injector 3

Pin	Wire Color	Circuit No.	Function
A	PK	139	Run/Crank Ignition 1 Voltage
B	PK/BK	1746	Fuel Injector Control (3)

Fuel Injector 4

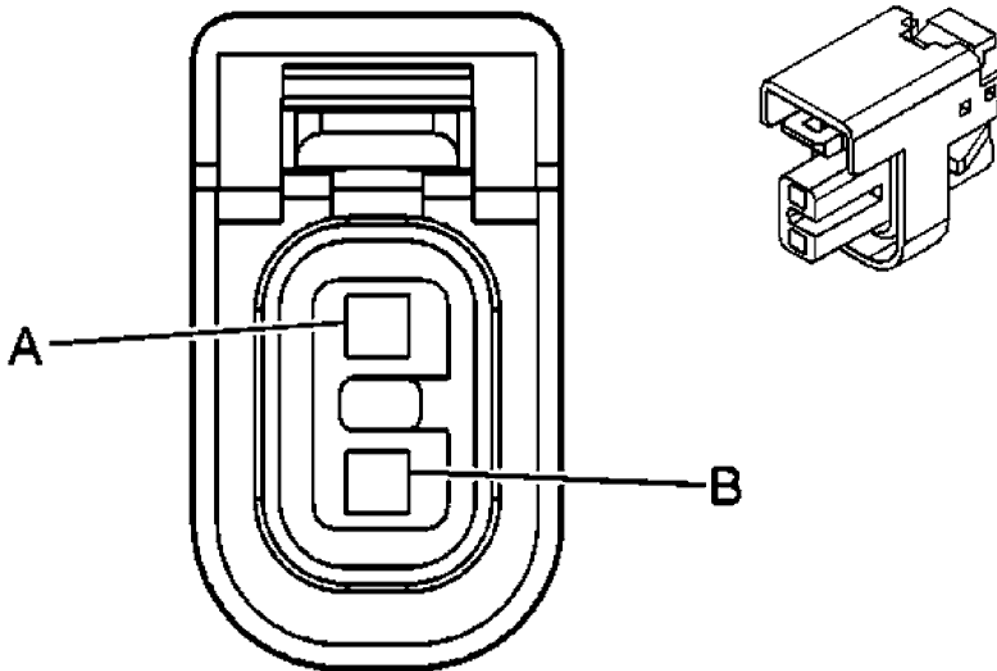


Fig. 31: Fuel Injector 4 Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15326181
- Service: 15306160
- Description: 2-Way F Micro-Pack 064 Series Sealed (BK)

Terminal Part Information

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- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Fuel Injector 4

Pin	Wire Color	Circuit No.	Function
A	PK	139	Run/Crank Ignition 1 Voltage
B	L-BU/BK	844	Fuel Injector Control (4)

Fuel Pump and Sender Assembly

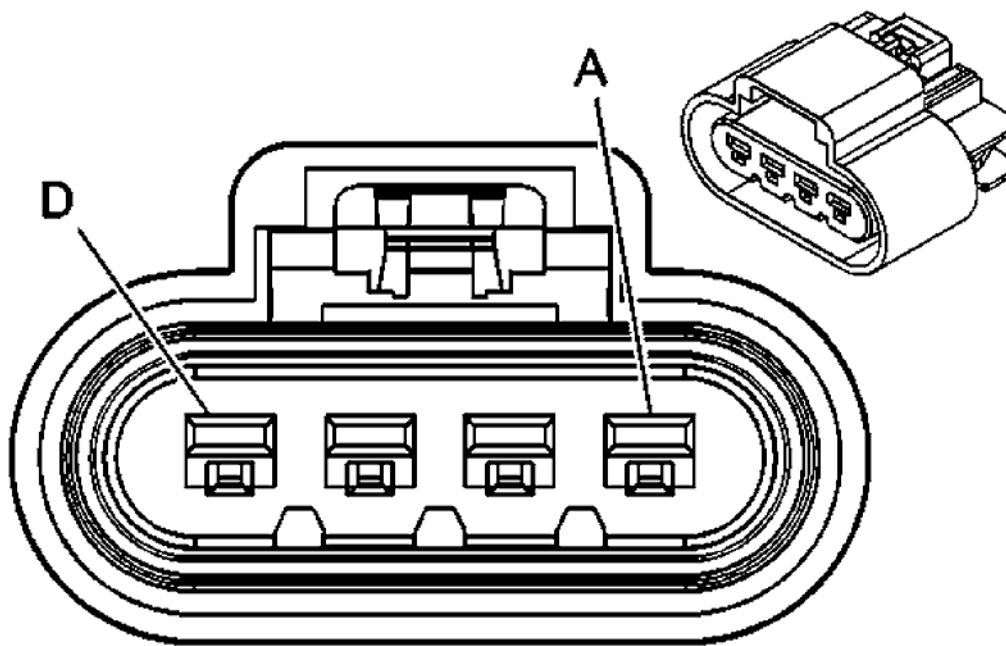


Fig. 32: Fuel Pump and Sender Assembly Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15326631
- Service: 15306360

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- Description: 4-Way F GT 280 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Fuel Pump and Sender Assembly

Pin	Wire Color	Circuit No.	Function
A	BK	850	Ground
B	PU	1589	Primary Fuel Level Sensor Signal
C	OG/BK	510	Fuel Sender Low Reference
D	GY	120	Fuel Pump Supply Voltage

Fuel Tank Pressure Sensor

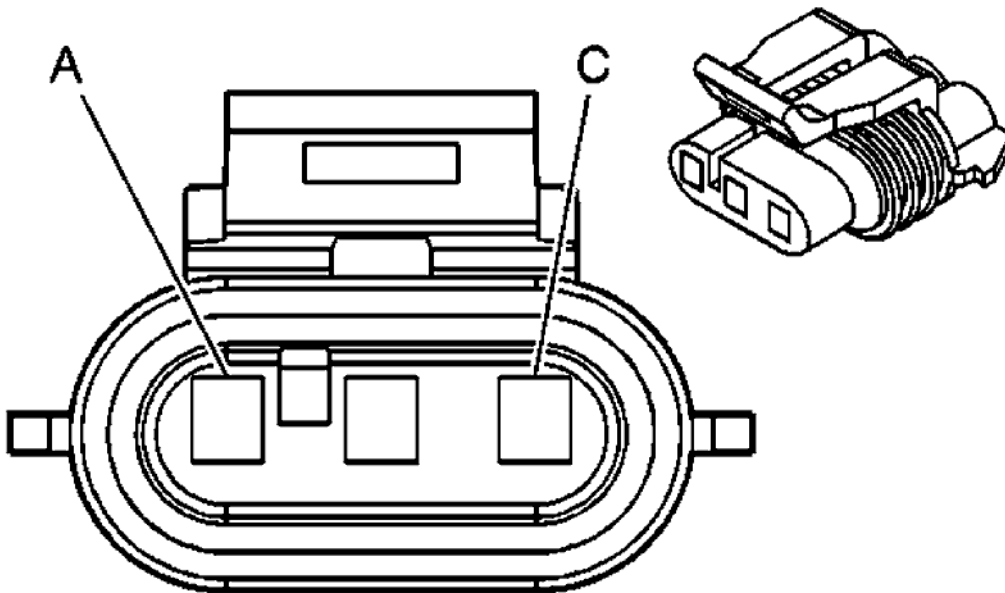


Fig. 33: Fuel Tank Pressure Sensor Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

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- OEM: 12059595
- Service: 88986451
- Description: 3-Way F Metri-Pack 150 Series Sealed (BK)

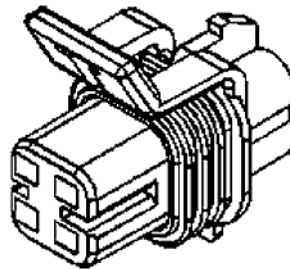
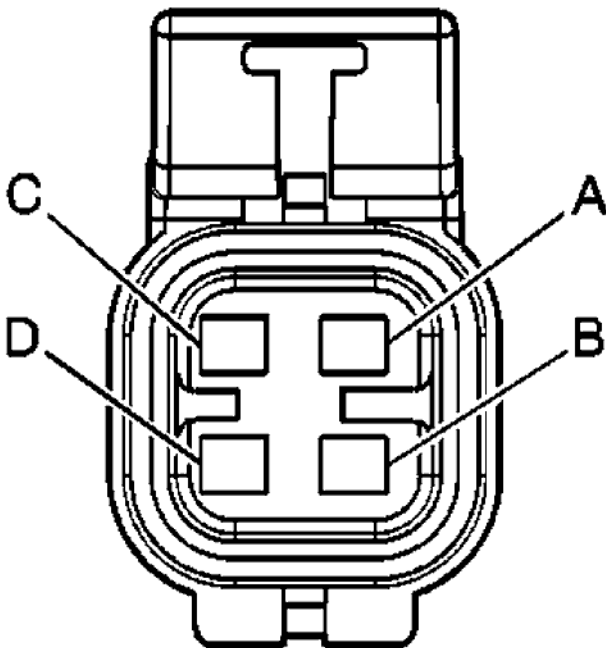
Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Fuel Tank Pressure Sensor

Pin	Wire Color	Circuit No.	Function
A	TN	2759	Fuel Tank Pressure Sensor Low Reference
B	D-GN	890	Fuel Tank Pressure Sensor Signal
C	GY	2709	Fuel Tank Pressure Sensor 5-Volt Reference

Heated Oxygen Sensor (HO2S) 1



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Fig. 34: Heated Oxygen Sensor (HO2S) 1 Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 12176897
- Service: 15305960
- Description: 4-Way F Metri-Pack 150 Series Sealed (GY)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Heated Oxygen Sensor (HO2S) 1

Pin	Wire Color	Circuit No.	Function
A	TN/WH	3111	Heated Oxygen Sensor Low Signal Bank 1 Sensor 1
B	PU/WH	3110	Heated Oxygen Sensor High Signal Bank 1 Sensor 1
C	GY/WH	3113	Heated Oxygen Sensor Heater Low Control Bank 1 Sensor 1
D	PK/BK	5291	Engine Main Relay Fused Control (2)

Heated Oxygen Sensor (HO2S) 2

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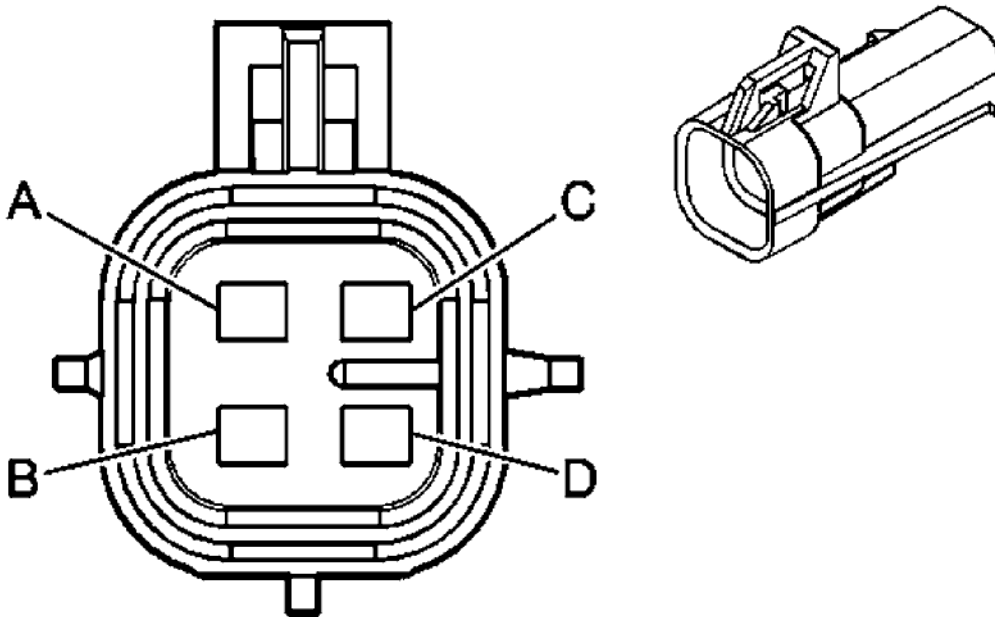


Fig. 35: Heated Oxygen Sensor (HO2S) 2 Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 12160825
- Service: 15305801
- Description: 4-Way M Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Heated Oxygen Sensor (HO2S) 2

Pin	Wire Color	Circuit No.	Function
A	TN/WH	1669	Heated Oxygen Sensor Low Signal Bank 1 Sensor 2
			Heated Oxygen Sensor High Signal

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B	PU/WH	1668	Bank 1 Sensor 2
C	PK/BK	5291	Engine Main Relay Fused Control 2
D	TN/WH	1423	Heated Oxygen Sensor Heater Low Control Bank 1 Sensor (2)

Ignition Control Module

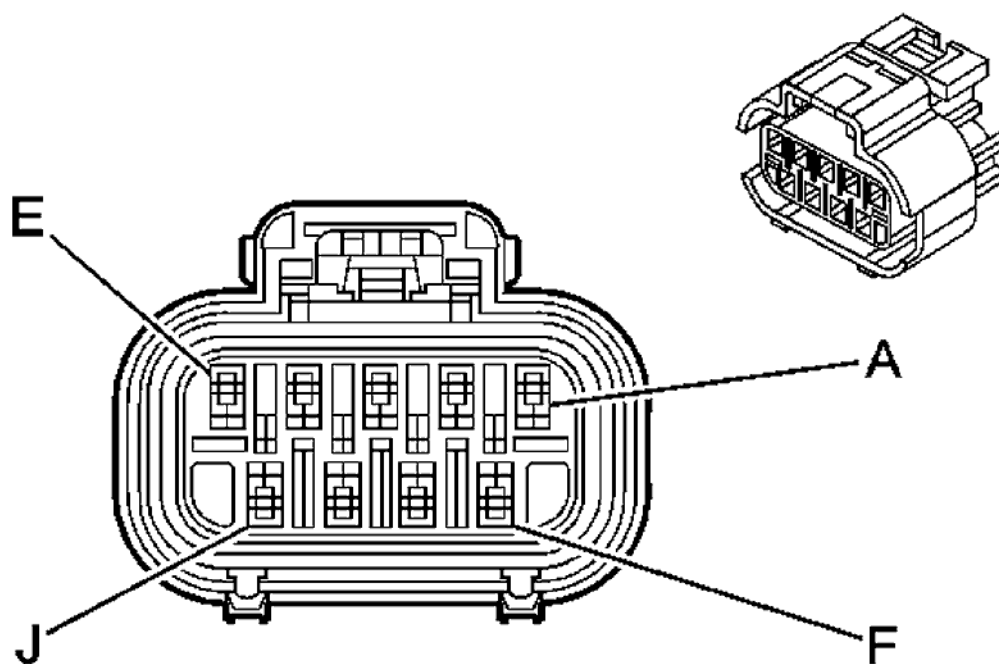


Fig. 36: Ignition Control Module Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15464996
- Service: 88987910
- Description: 9-Way F

Terminal Part Information

- Pins:
- Terminal:

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- Core/Insulation Crimp:
- Release Tool/Test Probe:

Ignition Control Module

Pin	Wire Color	Circuit No.	Function
A	PK/BK	5292	Engine Main Relay Fused Control (3)
B	WH	423	Ignition Control Timing Control (1)
C-D	-	-	Not Used
E	BK	1350	Ground
F	BN/WH	633	Camshaft Position Sensor Signal
G	OG	406	Ignition Control Timing Control (2)
H-J	-	-	Not Used

Knock Sensor (KS)

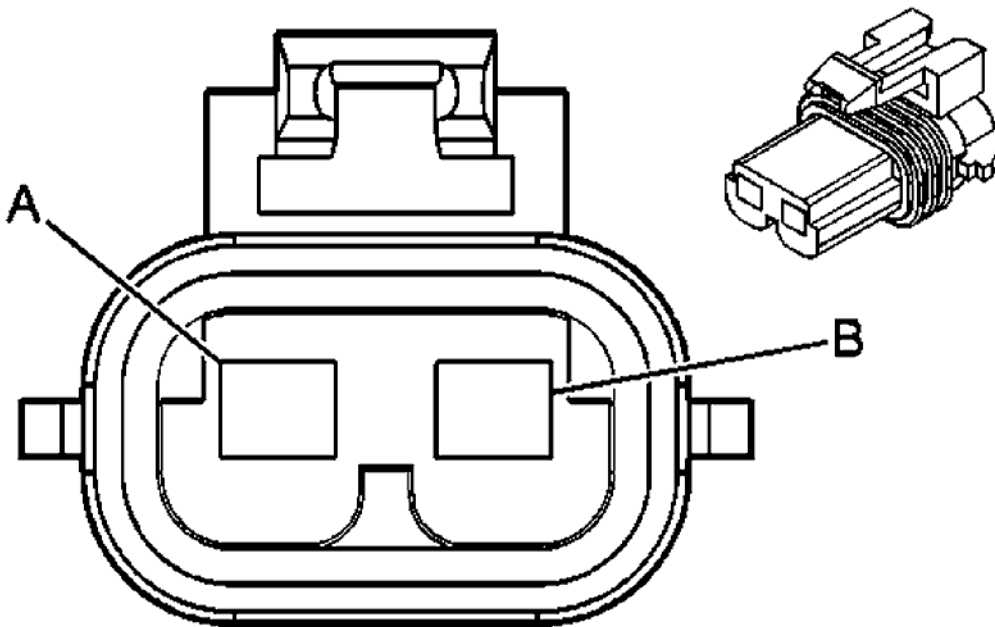


Fig. 37: Knock Sensor (KS) Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

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- OEM: 12077900
- Service: 12116247
- Description: 2-Way F Metri-Pack 280 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Knock Sensor (KS)

Pin	Wire Color	Circuit No.	Function
A	D-BU	496	Knock Sensor Signal (1)
B	GY	1716	Knock Sensor Low Reference (1)

Manifold Absolute Pressure (MAP) Sensor

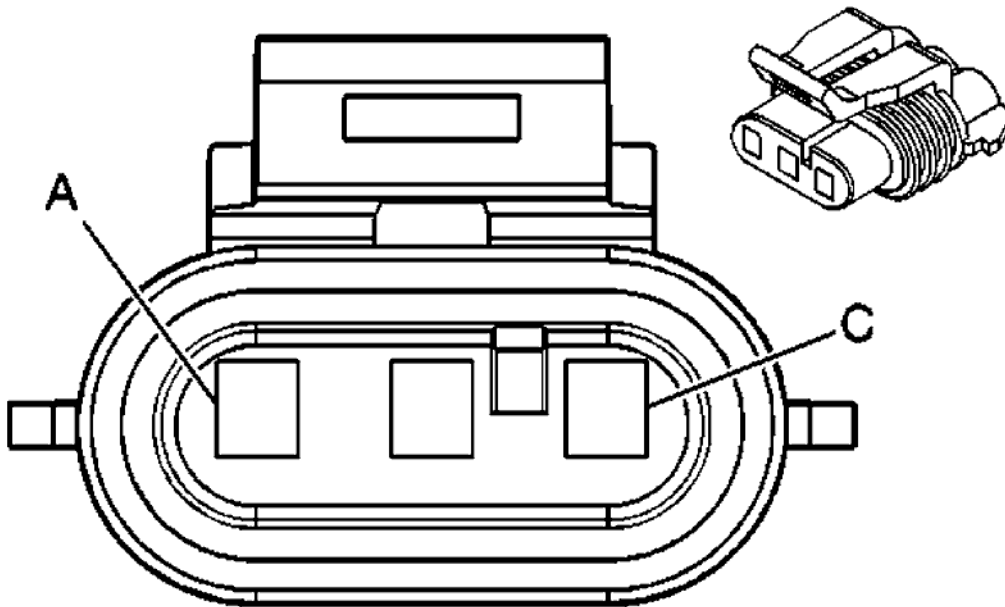


Fig. 38: Manifold Absolute Pressure (MAP) Sensor Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

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Connector Part Information

- OEM: 12129946
- Service: 88987997
- Description: 3-Way F Metri-Pack 150 Series Sealed (GY)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Manifold Absolute Pressure (MAP) Sensor

Pin	Wire Color	Circuit No.	Function
A	OG/BK	469	Manifold Absolute Pressure Sensor Low Reference
B	L-GN	432	Manifold Absolute Pressure Sensor Signal
C	GY	2704	Manifold Absolute Pressure Sensor 5-Volt Reference

Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor

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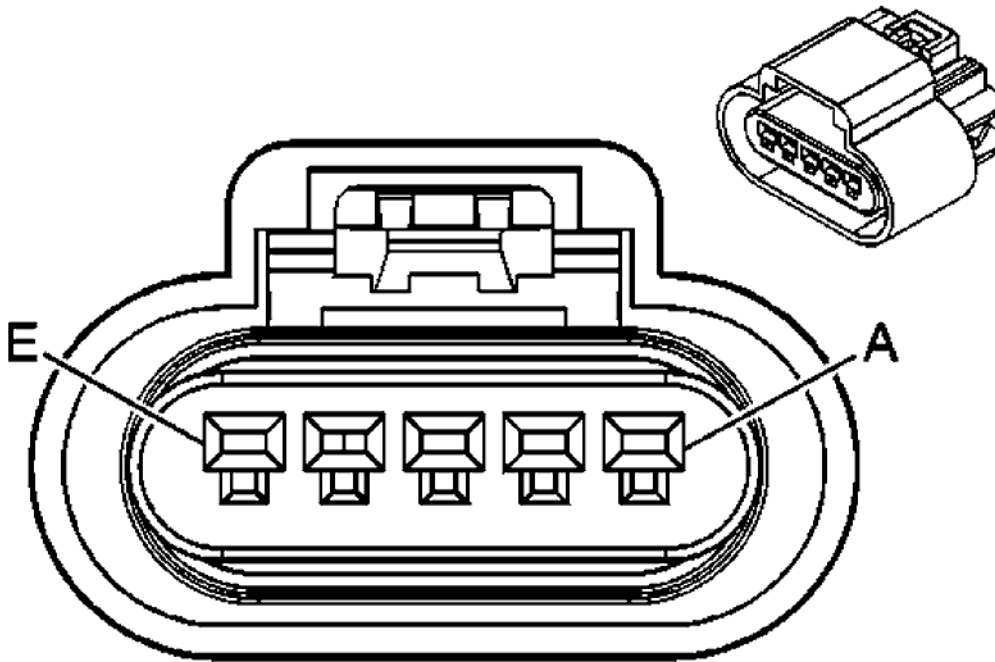


Fig. 39: MAF/IAT Sensor Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15326822
- Service: 88987186
- Description: 5-Way F GT 150 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor

Pin	Wire Color	Circuit No.	Function
A	YE	492	Mass Air Flow Sensor Signal
B	BK/WH	451	Signal Ground

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C	PK/BK	5291	Engine Main Relay Fused Control (2)
D	TN	2760	Intake Air Temperature Sensor Low Reference
E	TN	472	Intake Air Temperature Sensor Signal

Throttle Actuator Control (TAC) Module

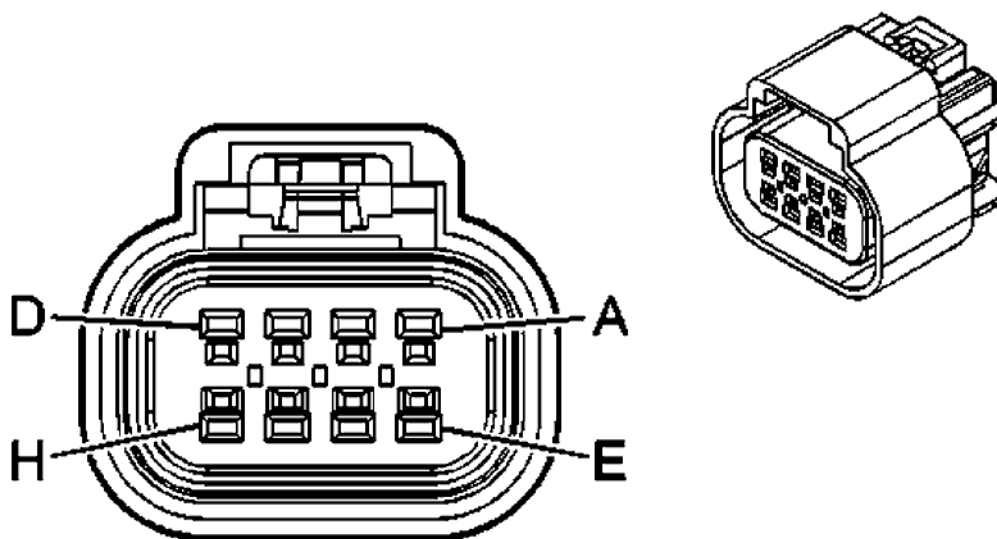


Fig. 40: Throttle Actuator Control (TAC) Module Connector
Courtesy of GENERAL MOTORS CORP.

Engine Controls Connector End Views

Connector Part Information

- OEM: 15326835
- Service: 88986452
- Description: 8-Way F GT 150 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

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Throttle Actuator Control (TAC) Module

Pin	Wire Color	Circuit No.	Function
A	D-GN	485	Throttle Position Sensor Signal (1)
B	TN/WH	1704	Sensor Low Reference
C	GY	2701	Throttle Position Sensor 5-Volt Reference
D	PU	486	Throttle Position Sensor Signal (2)
E	BN	582	Throttle Actuator Control Close
F	YE	581	Throttle Actuator Control Open
G	TN	2752	Throttle Position Sensor Low Reference
H	L-BU/BK	1688	5-Volt Reference

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0030 or P0036	** MULTIPLE VALUES **
DTC P0068	Throttle Body Airflow Performance
DTC P0101	Mass Air Flow (MAF) System Performance
DTC P0102	Mass Air Flow (MAF) Sensor Circuit Low Frequency
DTC P0103	Mass Air Flow (MAF) Sensor Circuit High Frequency
DTC P0106	Manifold Absolute Pressure (MAP) Sensor Performance
DTC P0107	Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage
DTC P0108	Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
DTC P0112	Intake Air Temperature (IAT) Sensor Circuit Low Voltage
DTC P0113	Intake Air Temperature (IAT) Sensor Circuit High Voltage
DTC P0116	**DESCRIPTION NOT COLLECTED **
DTC P0117	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage
DTC P0118	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage
DTC P0120	Throttle Position (TP) Sensor 1 Circuit
DTC P0121	Throttle Position (TP) Sensor 1 Performance
DTC P0122	Throttle Position (TP) Sensor 1 Circuit Low Voltage
DTC P0123	Throttle Position (TP) Sensor 1 Circuit High Voltage

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<u>DTC P0125</u>	Engine Coolant Temperature (ECT) Insufficient For Closed Loop Fuel Control
<u>DTC P0128</u>	Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
<u>DTC P0130</u>	Circuit Sensor 1
<u>DTC P0131</u>	Circuit Low Voltage Sensor 1
<u>DTC P0132</u>	Circuit High Voltage Sensor 1
<u>DTC P0133</u>	Slow Response Sensor 1
<u>DTC P0134</u>	HO2S Circuit Insufficient Activity Sensor 1
<u>DTC P0135</u>	**DESCRIPTION NOT COLLECTED **
<u>DTC P0136</u>	HO2S Circuit Sensor 2
<u>DTC P0137</u>	HO2S Circuit Low Voltage Sensor 2
<u>DTC P0138</u>	HO2S Circuit High Voltage Sensor 2
<u>DTC P0140</u>	HO2S Circuit Insufficient Activity Sensor 2
<u>DTC P0141</u>	**DESCRIPTION NOT COLLECTED **
<u>DTC P0171</u>	Fuel Trim System Lean
<u>DTC P0172</u>	Fuel Trim System Rich
<u>DTC P0201-P0204</u>	** MULTIPLE VALUES **
<u>DTC P0220</u>	Throttle Position (TP) Sensor 2 Circuit
<u>DTC P0222</u>	Throttle Position (TP) Sensor 2 Circuit Low Voltage
<u>DTC P0223</u>	Throttle Position (TP) Sensor 2 Circuit High Voltage
<u>DTC P0230</u>	Fuel Pump Relay Control Circuit
<u>DTC P0300</u>	Engine Misfire Detected
<u>DTC P0315</u>	Crankshaft Position (CKP) System Variation Not Learned
<u>DTC P0325</u>	Knock Sensor (KS) Circuit
<u>DTC P0326</u>	Knock Sensor (KS) Performance
<u>DTC P0327</u>	Knock Sensor (KS) Circuit Low Voltage
<u>DTC P0335</u>	Crankshaft Position (CKP) Sensor Circuit
<u>DTC P0336</u>	Crankshaft Position (CKP) Sensor Performance
<u>DTC P0340</u>	**DESCRIPTION NOT COLLECTED **
<u>DTC P0341</u>	**DESCRIPTION NOT COLLECTED **
<u>DTC P0420</u>	**DESCRIPTION NOT COLLECTED **
<u>DTC P0442</u>	Evaporative Emissions (EVAP) System Small Leak Detected
<u>DTC P0443</u>	Evaporative Emission (EVAP) Purge Solenoid Control Circuit
<u>DTC P0446</u>	Evaporative Emissions (EVAP) Vent System Performance
<u>DTC P0449</u>	Evaporative Emission (EVAP) Vent Solenoid Control Circuit

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<u>DTC P0451</u>	Fuel Tank Pressure (FTP) Sensor Performance
<u>DTC P0452</u>	P0452 Fuel Tank Pressure (FTP) Sensor Circuit Low Voltage
<u>DTC P0453</u>	Fuel Tank Pressure (FTP) Sensor Circuit Voltage
<u>DTC P0454</u>	Fuel Tank Pressure (FTP) Sensor Circuit Intermittent
<u>DTC P0455</u>	Evaporative Emission (EVAP) System Large Leak
<u>DTC P0496</u>	Evaporative Emission (EVAP) System Flow During Non-Purge
<u>DTC P0506</u>	Idle Speed Low
<u>DTC P0507</u>	Idle Speed High
<u>DTC P0601-P0607, P060E, P1600, P1621, P1627, P1681, P1683, or P2610</u>	** MULTIPLE VALUES **
<u>DTC P060D</u>	Control Module Accelerator Pedal Position (APP) System Performance
<u>DTC P0641</u>	5-Volt Reference 1 Circuit
<u>DTC P0650</u>	Malfunction Indicator Lamp (MIL) Control Circuit
<u>DTC P0651</u>	5-Volt Reference 2 Circuit
<u>DTC P0700</u>	Transmission Control Module (TCM) Requested MIL Illumination
<u>DTC P1101</u>	Intake Air Flow System Performance
<u>DTC P1106</u>	Manifold Absolute Pressure (MAP) Sensor Circuit Intermittent High Voltage
<u>DTC P1107</u>	Manifold Absolute Pressure (MAP) Sensor Circuit Intermittent Low Voltage.
<u>DTC P1111</u>	Intake Air Temperature (IAT) Sensor Circuit Intermittent High Voltage
<u>DTC P1112</u>	Intake Air Temperature (IAT) Sensor Circuit Intermittent Low Voltage.
<u>DTC P1114</u>	Engine Coolant Temperature (ECT) Sensor Circuit Intermittent Low Voltage
<u>DTC P1115</u>	Engine Coolant Temperature (ECT) Sensor Circuit Intermittent High Voltage
<u>DTC P1133</u>	HO2S Insufficient Switching Sensor 1
<u>DTC P1400</u>	**DESCRIPTION NOT COLLECTED **
<u>DTC P1516</u>	Throttle Actuator control (TAC) Module Throttle Actuator Position Performance
<u>DTC P1682</u>	Ignition 1 Switch Circuit 2
<u>DTC P2101</u>	Throttle Actuator Position Performance

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<u>DTC P2119</u>	Throttle Closed Position Performance
<u>DTC P2120</u>	Accelerator Pedal Position (APP) Sensor 1 Circuit
<u>DTC P2122</u>	Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage
<u>DTC P2123</u>	Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage
<u>DTC P2125</u>	Accelerator Pedal Position (APP) Sensor 2 Circuit
<u>DTC P2127</u>	Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage
<u>DTC P2128</u>	Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage
<u>DTC P2135</u>	Throttle Position (TP) Sensor 1-2 Correlation
<u>DTC P2138</u>	Accelerator Pedal Position (APP) Sensor 1-2 Correlation
<u>DTC P2176</u>	Minimum Throttle Position Not Learned

REPAIR INSTRUCTIONS

ENGINE CONTROL MODULE (ECM) REPLACEMENT

Removal Procedure

- NOTE:** In order to prevent any possible electrostatic discharge damage to the ECM, do not touch the connector pins or the soldered components on the circuit board.
- NOTE:** Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.
- IMPORTANT:** It is necessary to record the remaining engine oil life. If the replacement module is not programmed with the remaining engine oil life, the engine oil life will default to 100%. If the replacement module is not programmed with the remaining engine oil life, the engine oil will need to be changed at 5000 km (3,000 mi) from the last engine oil change.

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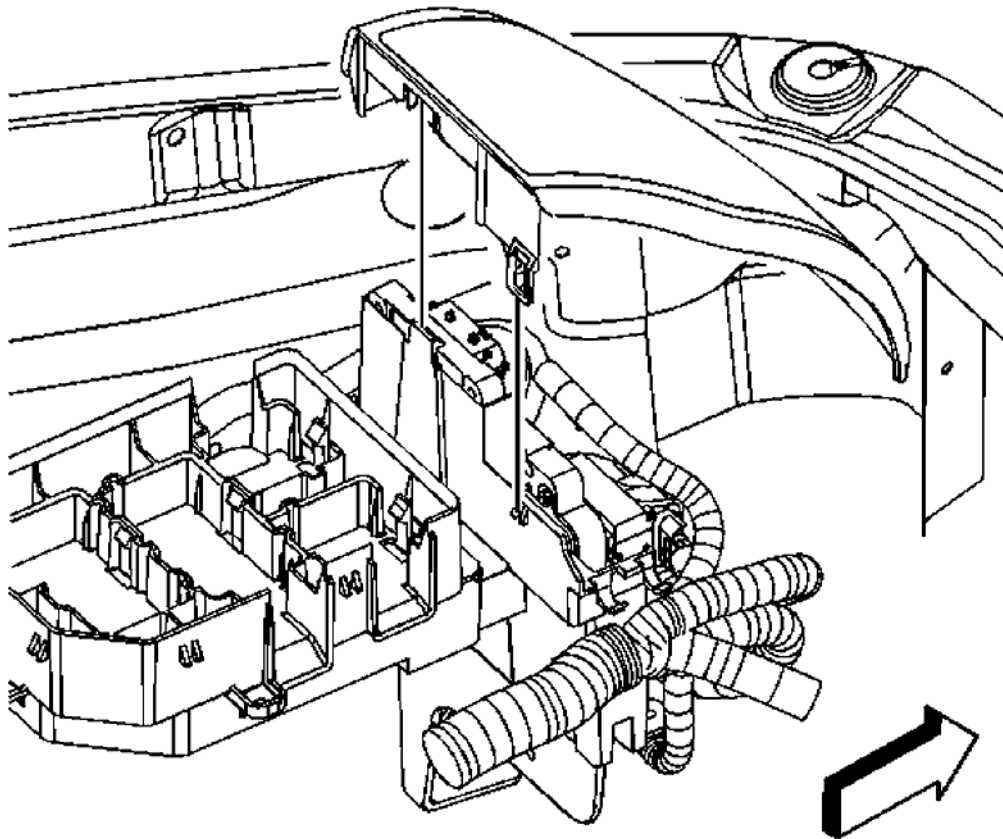


Fig. 41: ECM Replacement
Courtesy of GENERAL MOTORS CORP.

1. Using a scan tool, retrieve the percentage of remaining engine oil. Record the remaining engine oil life.
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
3. Remove the engine control module (ECM)/transaxle control module (TCM) cover.

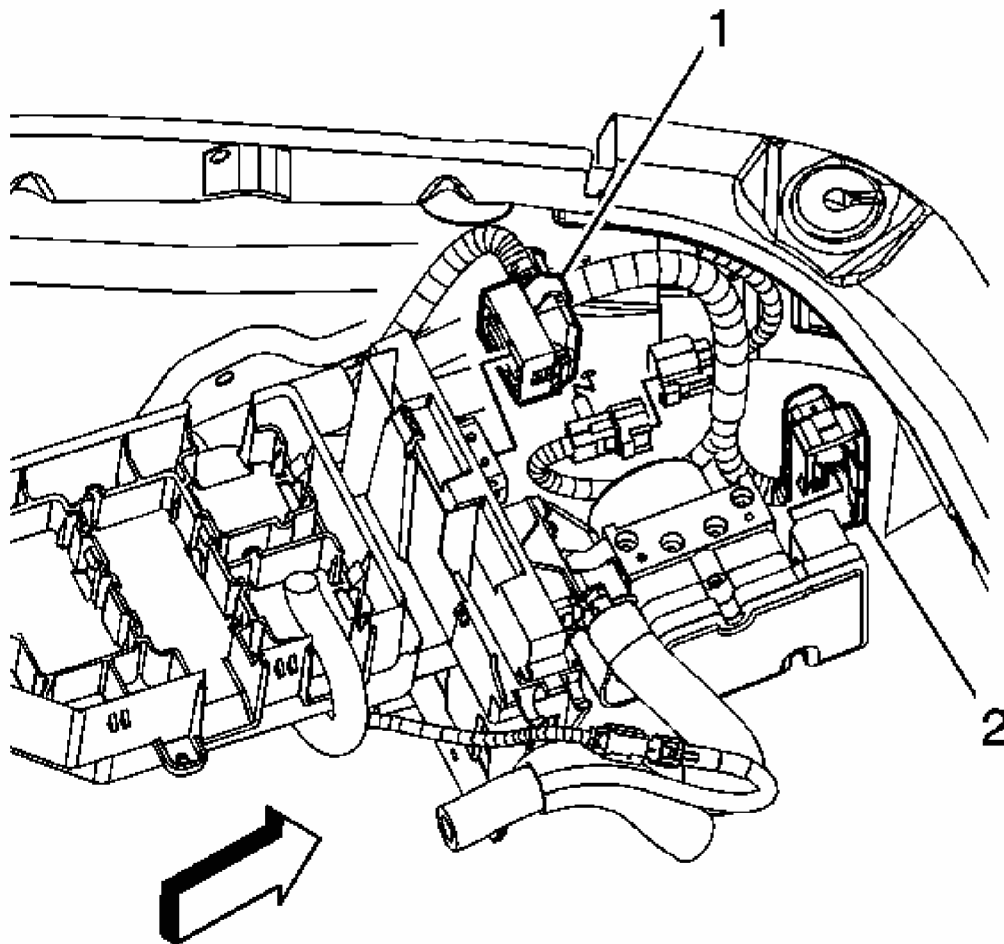


Fig. 42: ECM Body Harness Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the body harness electrical connector (1) from the ECM.

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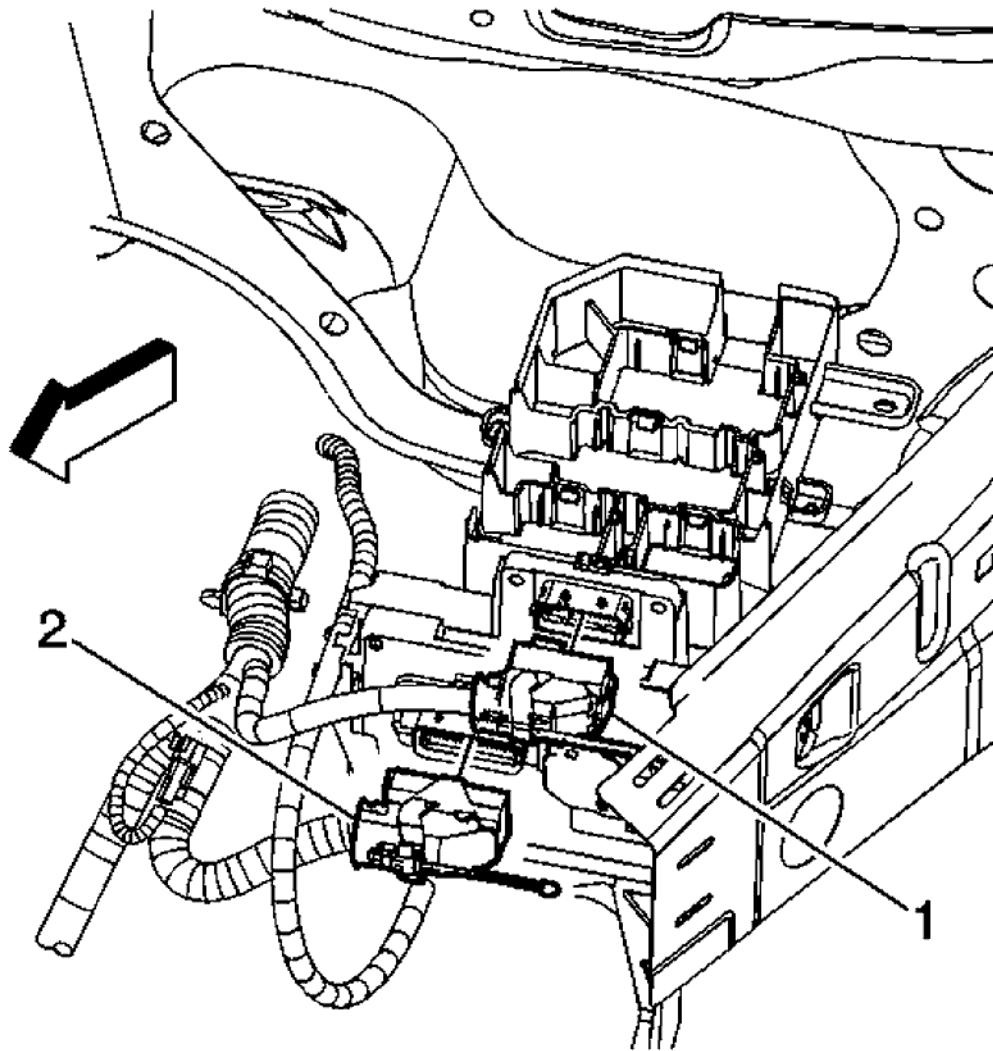


Fig. 43: ECM Engine Harness Connector
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the engine harness electrical connector (2) from the ECM.

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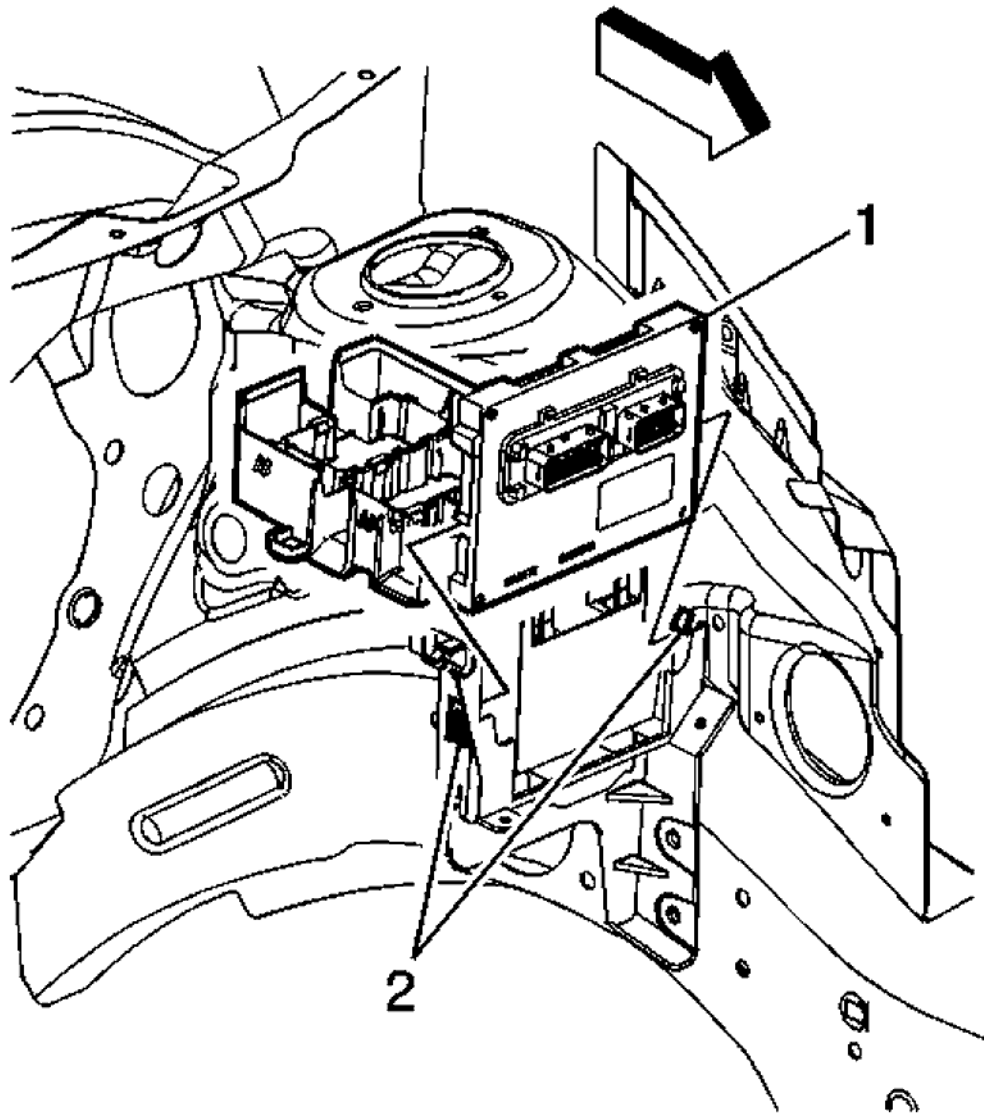


Fig. 44: ECM Retaining Tabs
Courtesy of GENERAL MOTORS CORP.

NOTE: Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables or when charging the vehicles battery.

6. Disengage the retaining tabs (2) on the sides of the ECM/TCM bracket in order to

remove the ECM (1).

Installation Procedure

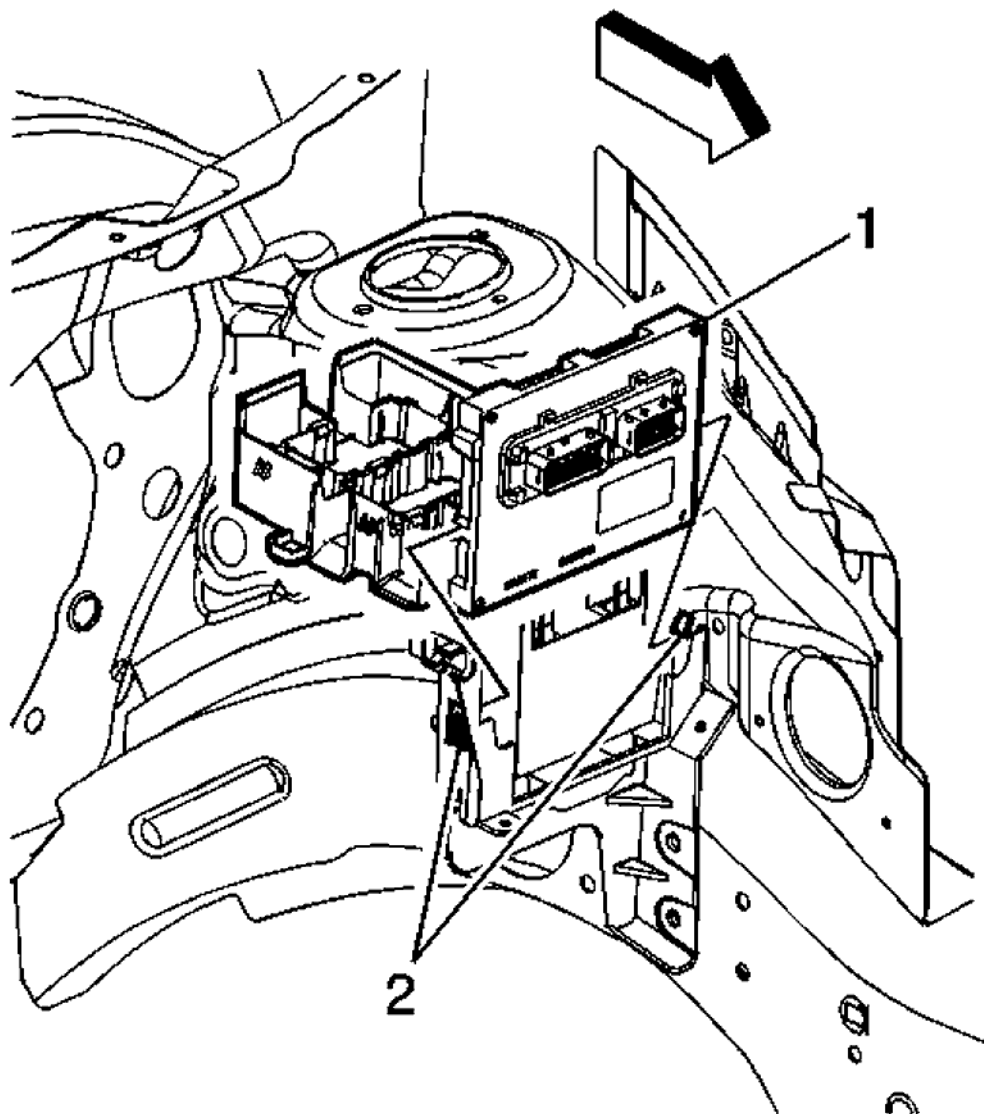


Fig. 45: ECM Retaining Tabs
Courtesy of GENERAL MOTORS CORP.

NOTE: Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control

module, using battery booster cables or when charging the vehicles battery.

1. Slide the ECM (1) into the ECM/TCM bracket until the retaining tabs (2) engage the ECM.

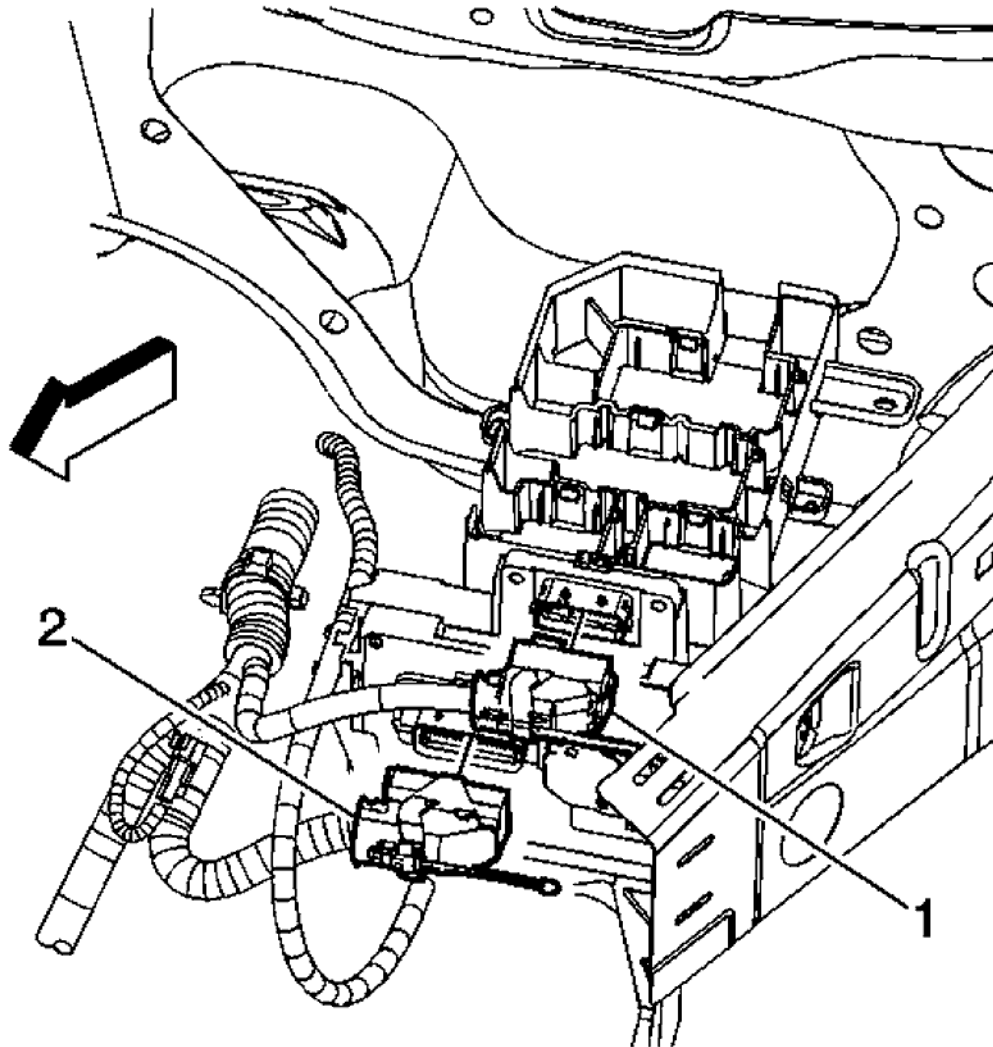


Fig. 46: ECM Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Connect the engine harness electrical connector (2) to the ECM.

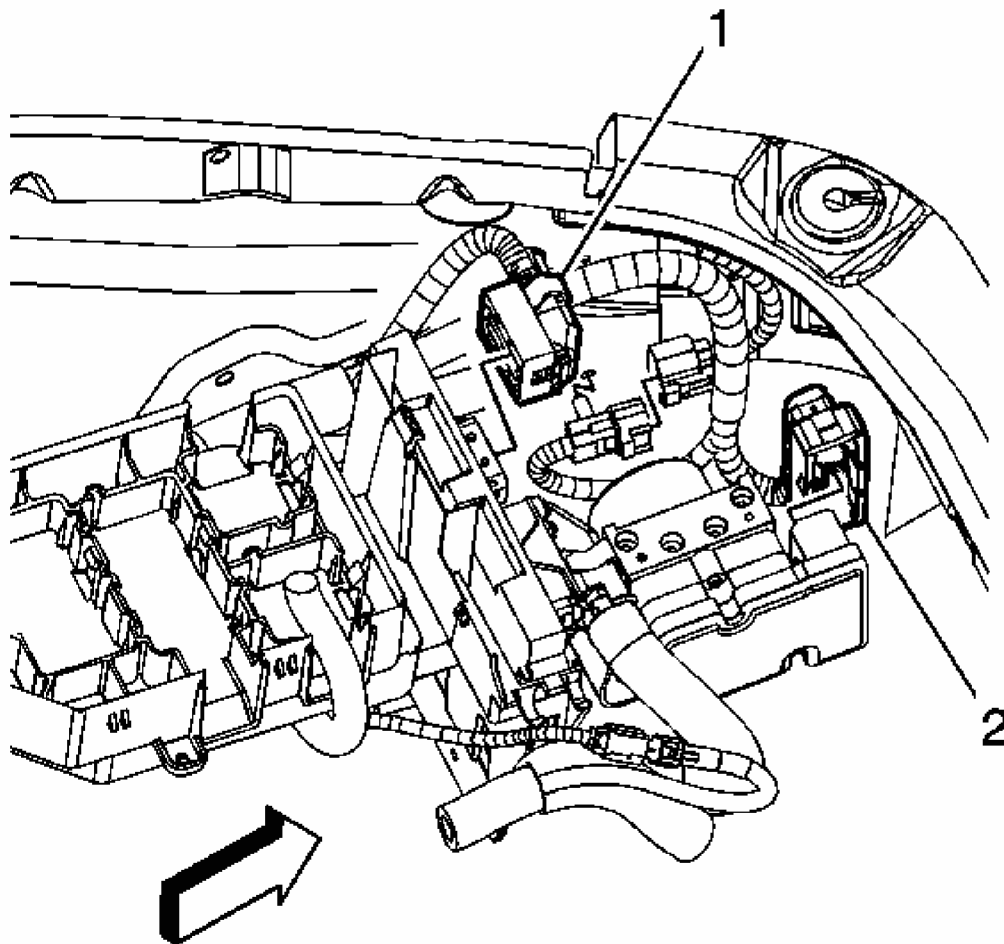


Fig. 47: ECM Body Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the body harness electrical connector (1) to the ECM.

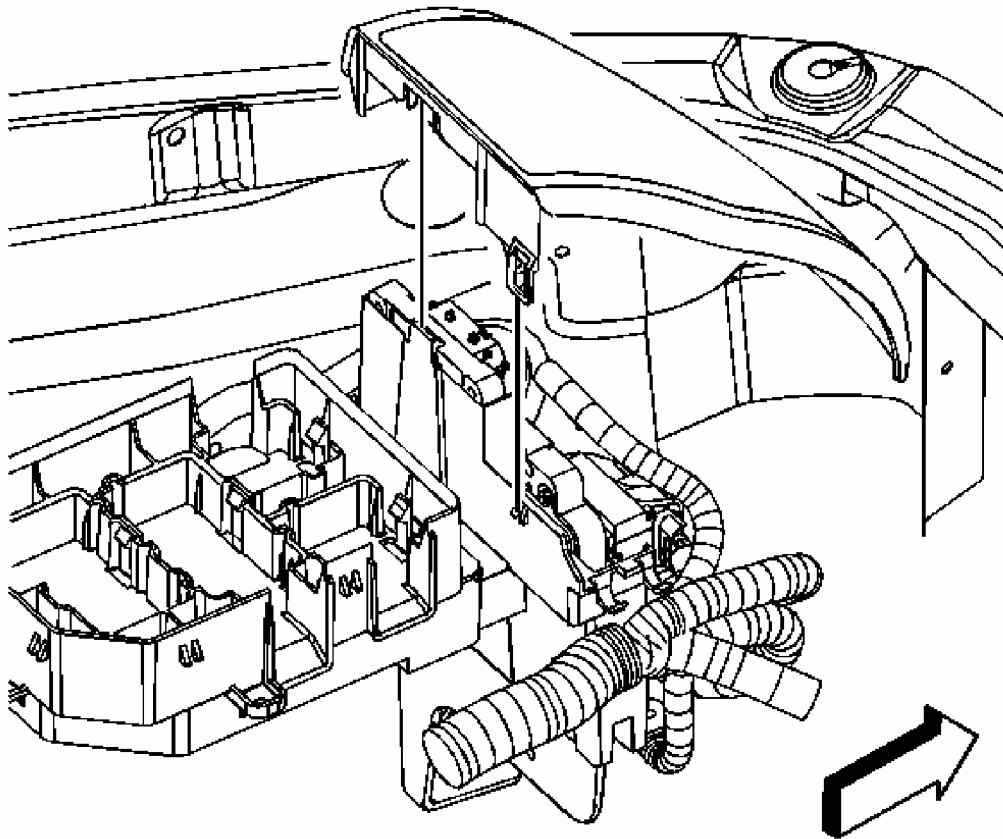


Fig. 48: ECM/TCM Cover
Courtesy of GENERAL MOTORS CORP.

4. Install the ECM/TCM cover.
5. Connect the negative battery cable. Refer to Battery Negative Cable Disconnect/Connect Procedure .
6. Program the ECM. Refer to Control Module References .

CKP SYSTEM VARIATION LEARN PROCEDURE

IMPORTANT: The crankshaft position (CKP) system variation learn procedure is required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- Engine replacement
- ECM replacement
- Crankshaft damper replacement

- Crankshaft replacement
- CKP sensor replacement
- Any engine repairs which disturb the crankshaft to CKP sensor relationship

IMPORTANT: The scan tool monitors certain component signals to determine if all the conditions are met to continue with the CKP system variation learn procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool monitors the following components:

- CKP sensor activity - If there is a CKP sensor condition, refer to the applicable DTC that set.
- Camshaft position (CMP) signal activity - If there is a CMP signal condition, refer to the applicable DTC that set.
- Engine coolant temperature (ECT) - If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

1. Install a scan tool.
2. Monitor the engine control module (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. With a scan tool, select the CKP system variation learn procedure within the Special Functions menu and perform the following:
 1. Observe the fuel cut-off for the applicable engine.
 2. Block the drive wheels.
 3. Set the parking brake.
 4. Place the vehicle's transmission in Park or Neutral.
 5. Turn the air conditioning (A/C) OFF.
 6. Cycle the ignition from OFF to ON.
 7. Apply and hold the brake pedal for the duration of the procedure.
 8. Start and idle the engine.
 9. Accelerate to wide open throttle (WOT). The engine should not accelerate beyond the calibrated fuel cut-off RPM value noted in step 3.1. Release the throttle immediately if the value is exceeded.

IMPORTANT: 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.

10. Release the throttle when fuel cut-off occurs.
4. The scan tool displays Learn Status: Learned this Ignition. If the scan tool indicates that DTC P0315 ran and passed, the CKP variation learn procedure is complete. If the scan tool indicates DTC P0315 failed or did not run, refer to **DTC P0315** . If any other DTCs set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
5. Turn OFF the ignition for 30 seconds after the learn procedure is completed successfully.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR REPLACEMENT

Removal Procedure

NOTE: **Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.**

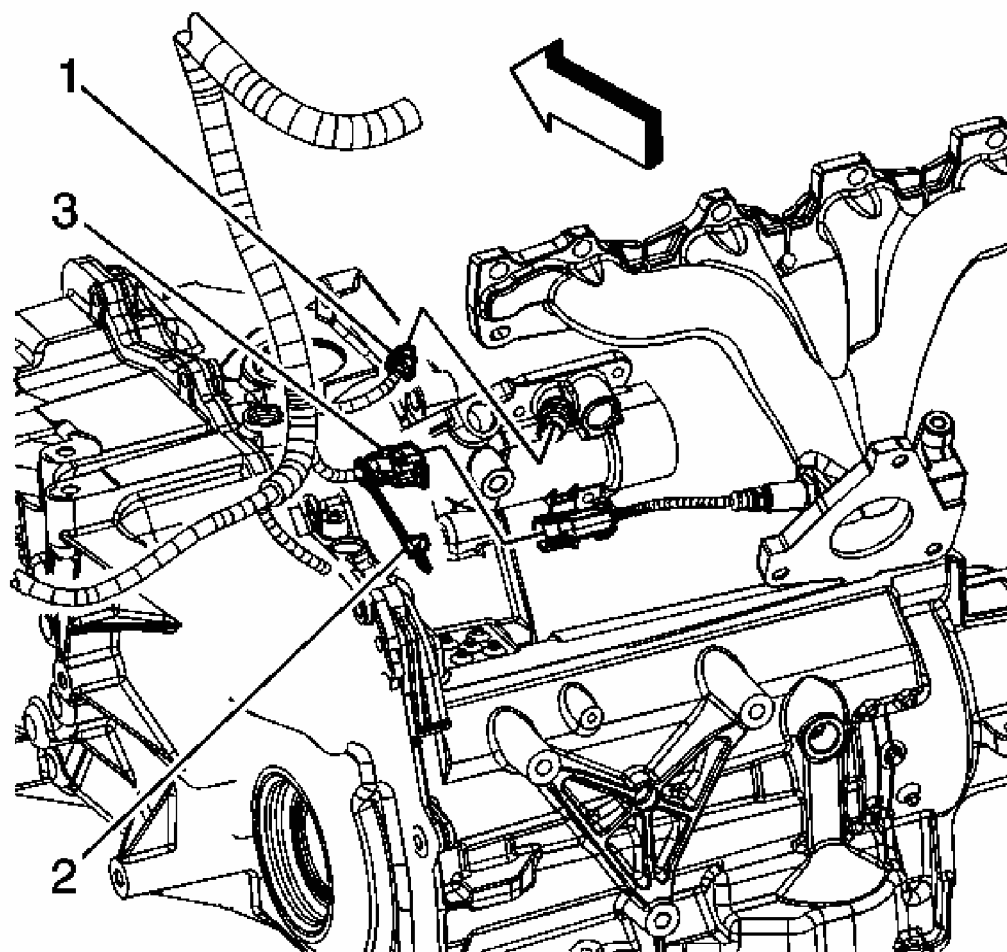


Fig. 49: ECT Sensor

Courtesy of GENERAL MOTORS CORP.

1. Drain the coolant system to below the engine coolant temperature (ECT) sensor. Refer to **Draining and Filling Cooling System (Static Fill)** or **Draining and Filling Cooling System (GE 47716 Fill)**.
2. If equipped with a automatic transaxle, disconnect the engine coolant temperature (ECT) sensor electrical connector (1).

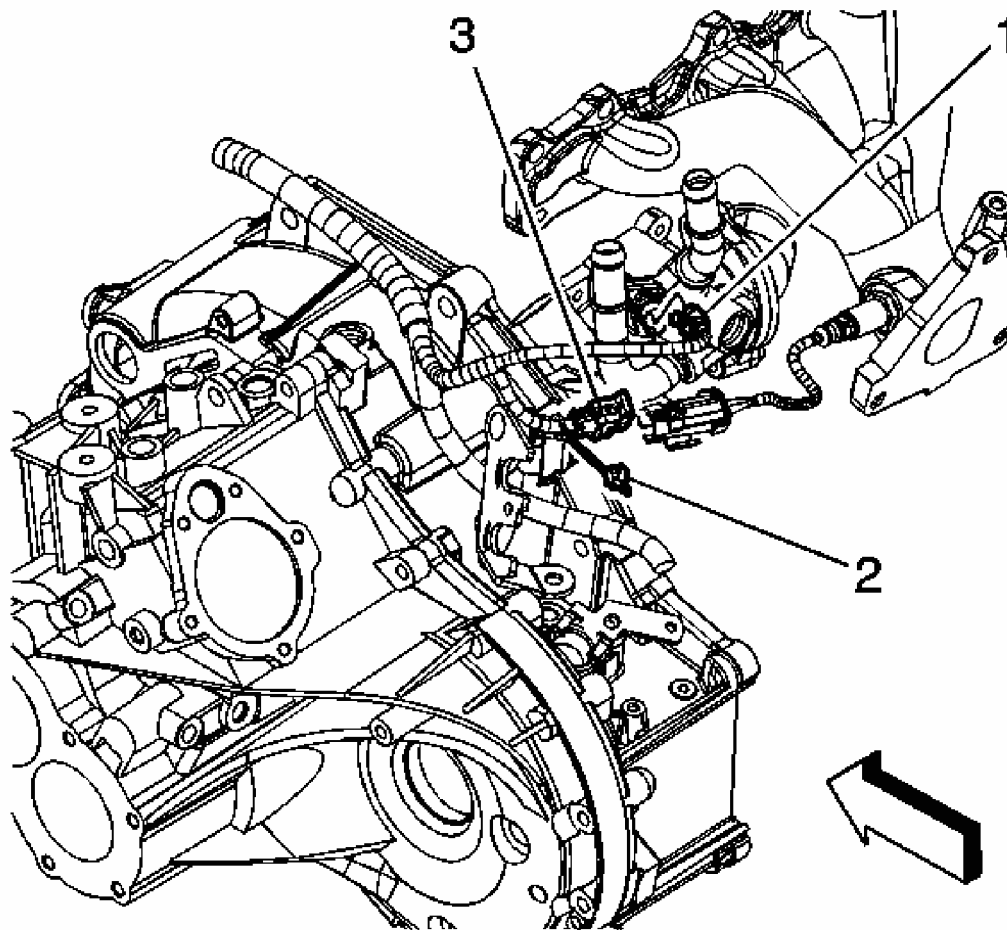


Fig. 50: ECT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. If equipped with a manual transaxle, disconnect the ECT sensor electrical connector (1).

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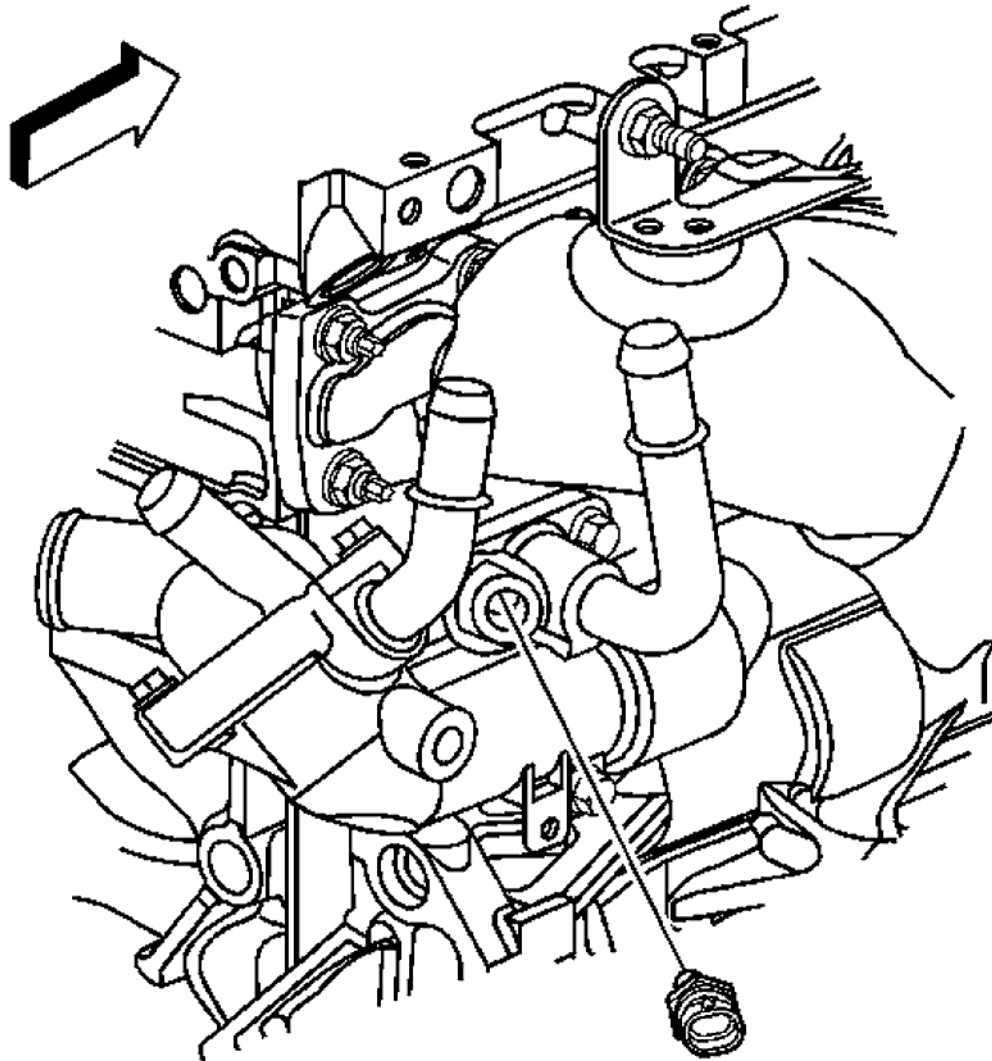


Fig. 51: ECT Sensor
Courtesy of GENERAL MOTORS CORP.

4. Remove the ECT sensor.

Installation Procedure

NOTE: 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 in the service procedure. Some replacement components may come with these coatings already applied. Do

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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.

NOTE: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

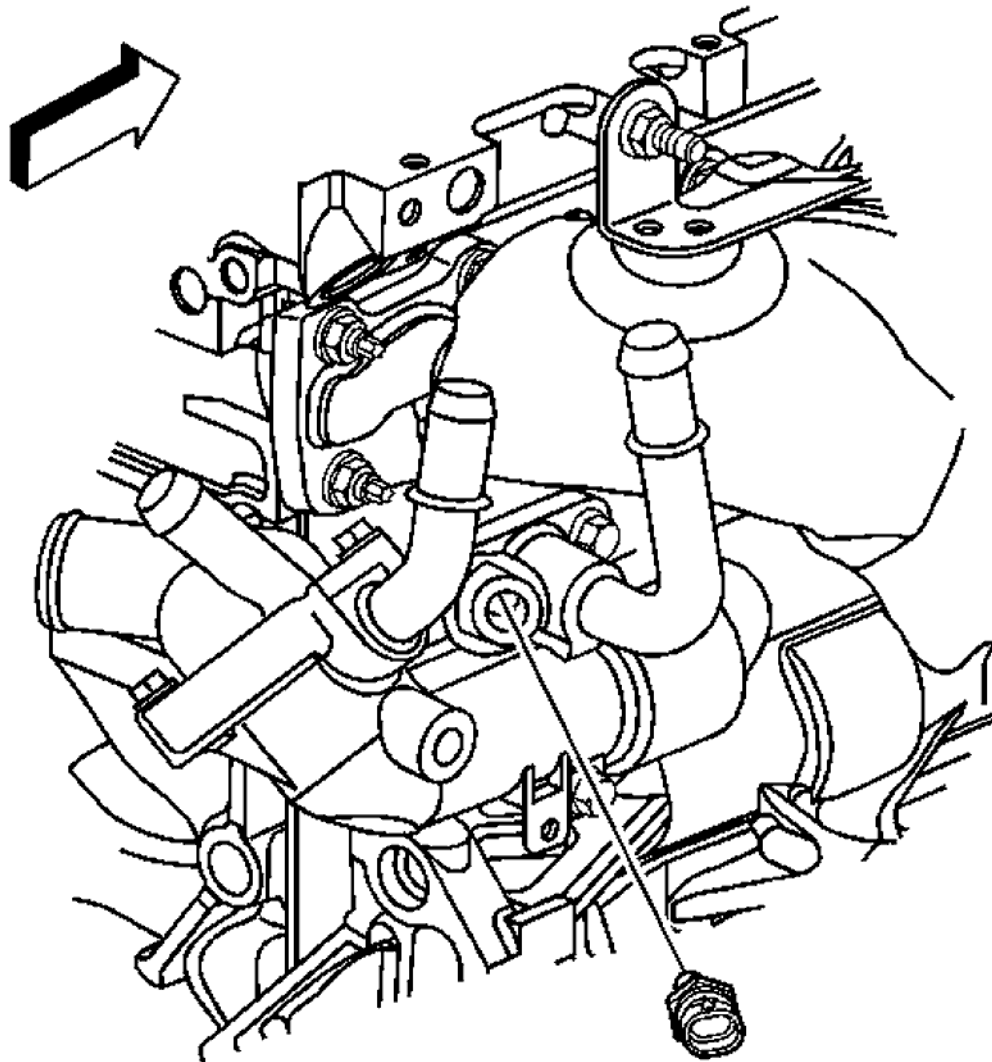


Fig. 52: ECT Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the ECT sensor.

Tighten: Tighten the sensor to 20 N.m (15 lb ft).

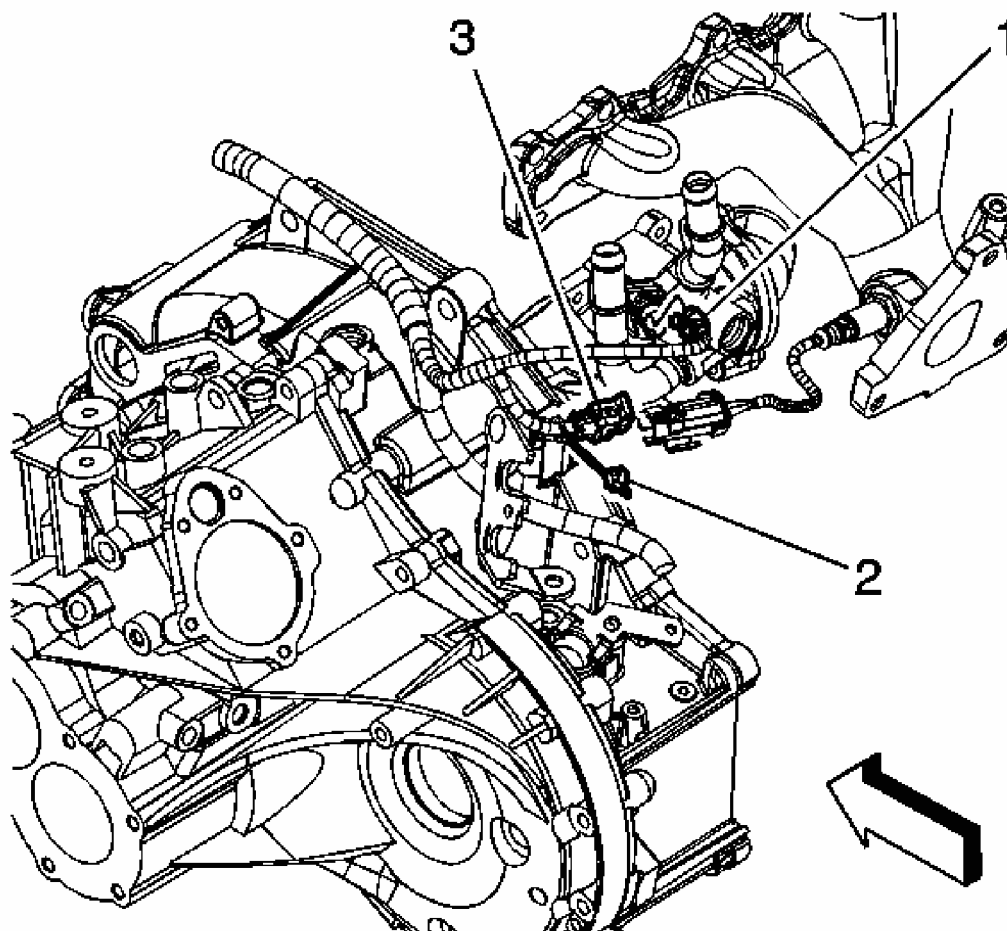


Fig. 53: ECT Sensor Electrical Connector (M/T)
Courtesy of GENERAL MOTORS CORP.

2. If equipped with a manual transaxle, connect the ECT sensor electrical connector (1).

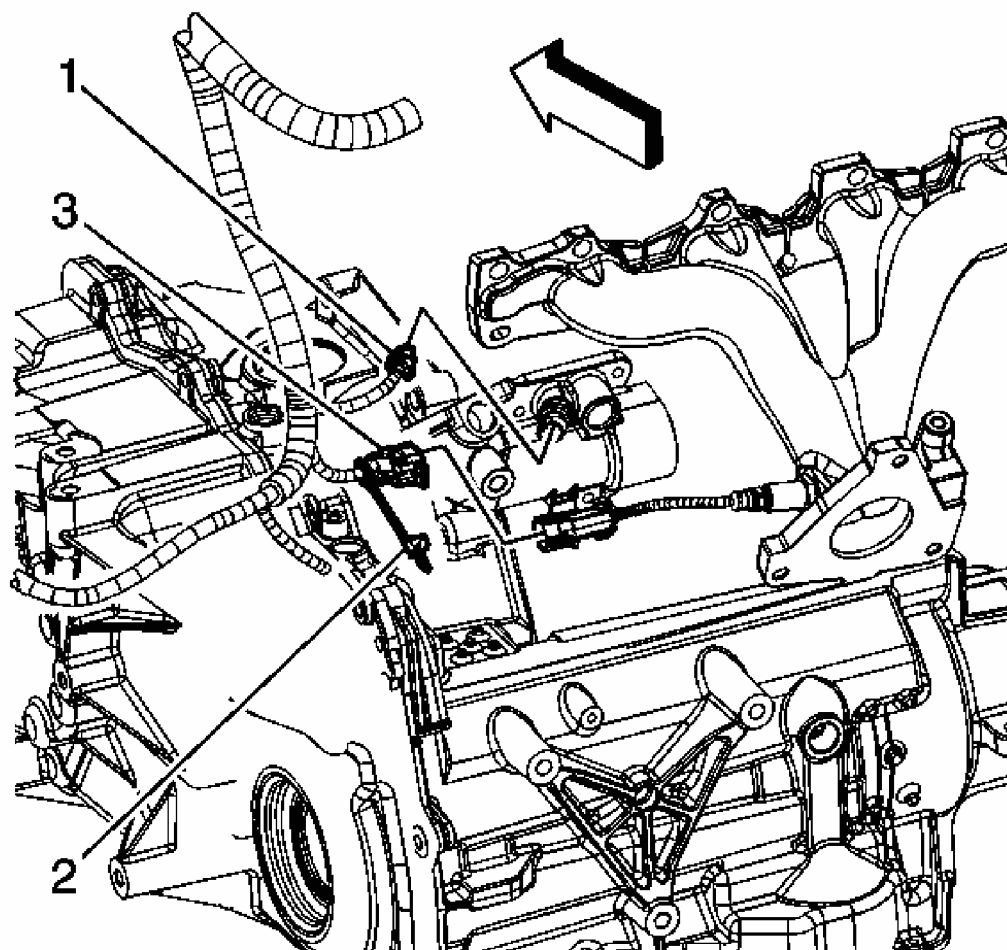


Fig. 54: ECT Sensor Electrical Connector (A/T)
Courtesy of GENERAL MOTORS CORP.

3. If equipped with a automatic transaxle, connect the ECT sensor electrical connector (1).
4. Fill the cooling system. Refer to **Draining and Filling Cooling System (Static Fill)** or **Draining and Filling Cooling System (GE 47716 Fill)** .

MASS AIR FLOW (MAF) SENSOR REPLACEMENT

Removal Procedure

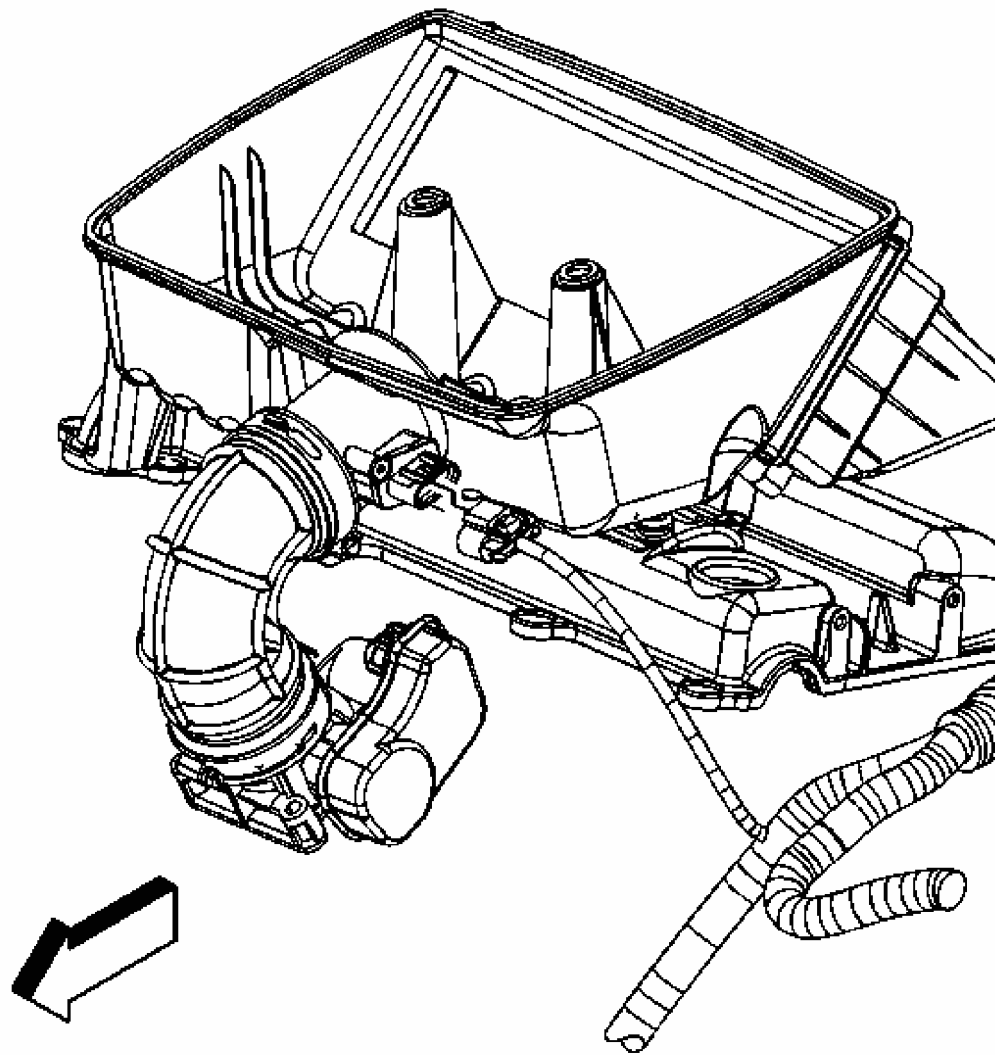


Fig. 55: MAF Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the mass airflow (MAF) sensor electrical connector.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.

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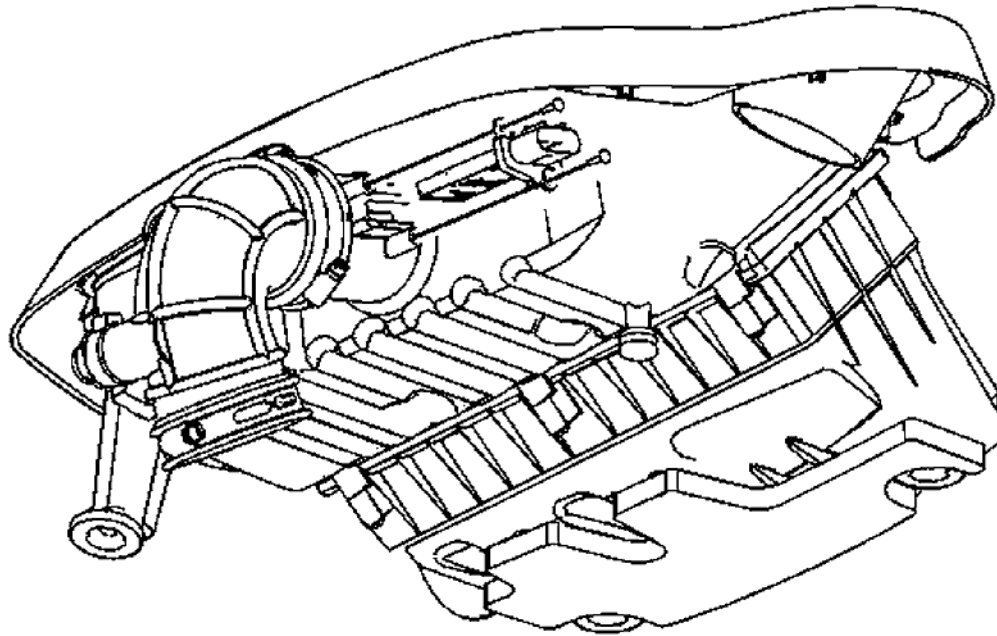


Fig. 56: MAF Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the MAF sensor screws.
4. Remove the MAF sensor.

Installation Procedure

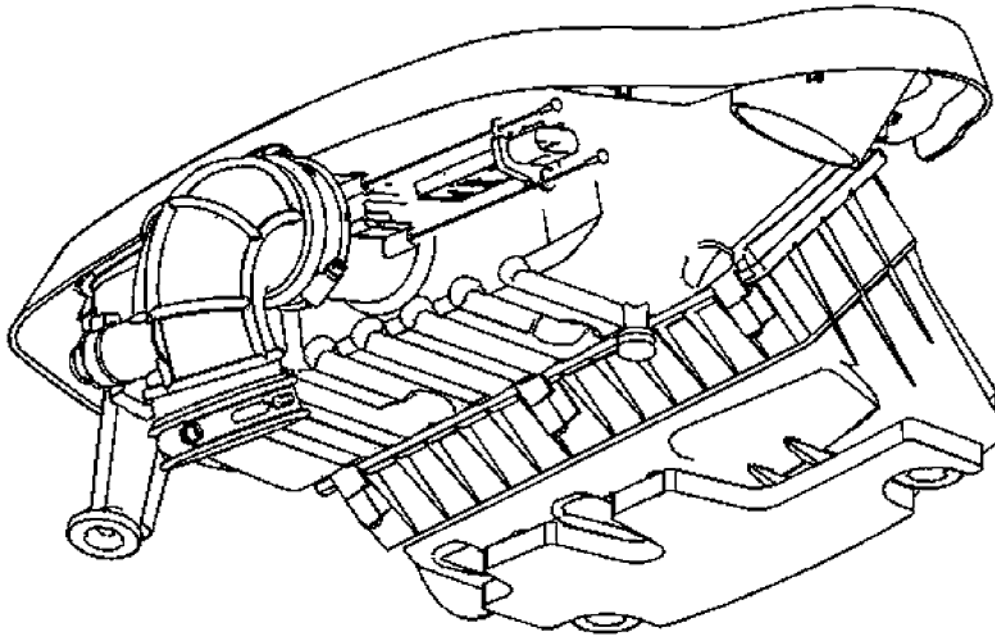


Fig. 57: MAF Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the MAF sensor.

NOTE: Refer to Fastener Notice .

2. Install the MAF sensor screws.

Tighten: Tighten the screws to 10 N.m (89 lb in).

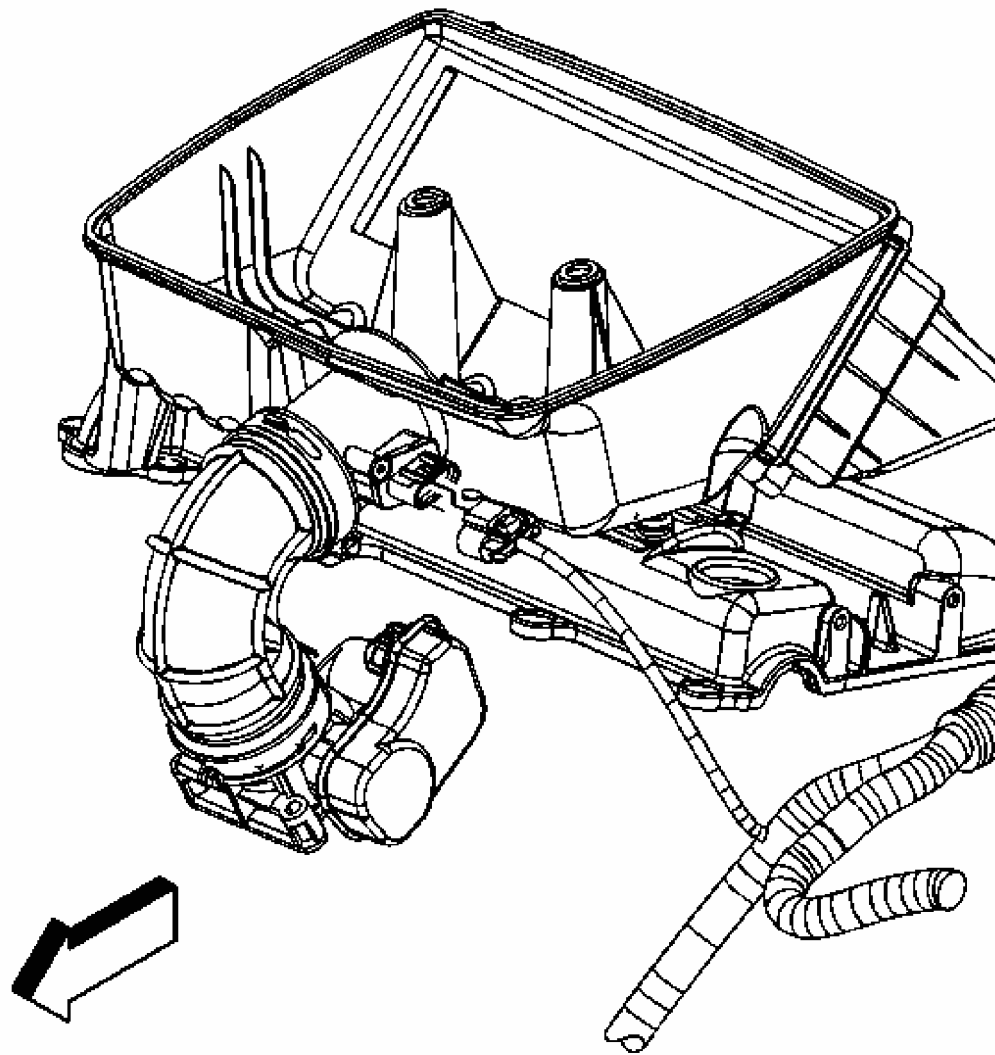


Fig. 58: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
4. Connect the MAF sensor electrical connector.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR REPLACEMENT

Removal Procedure

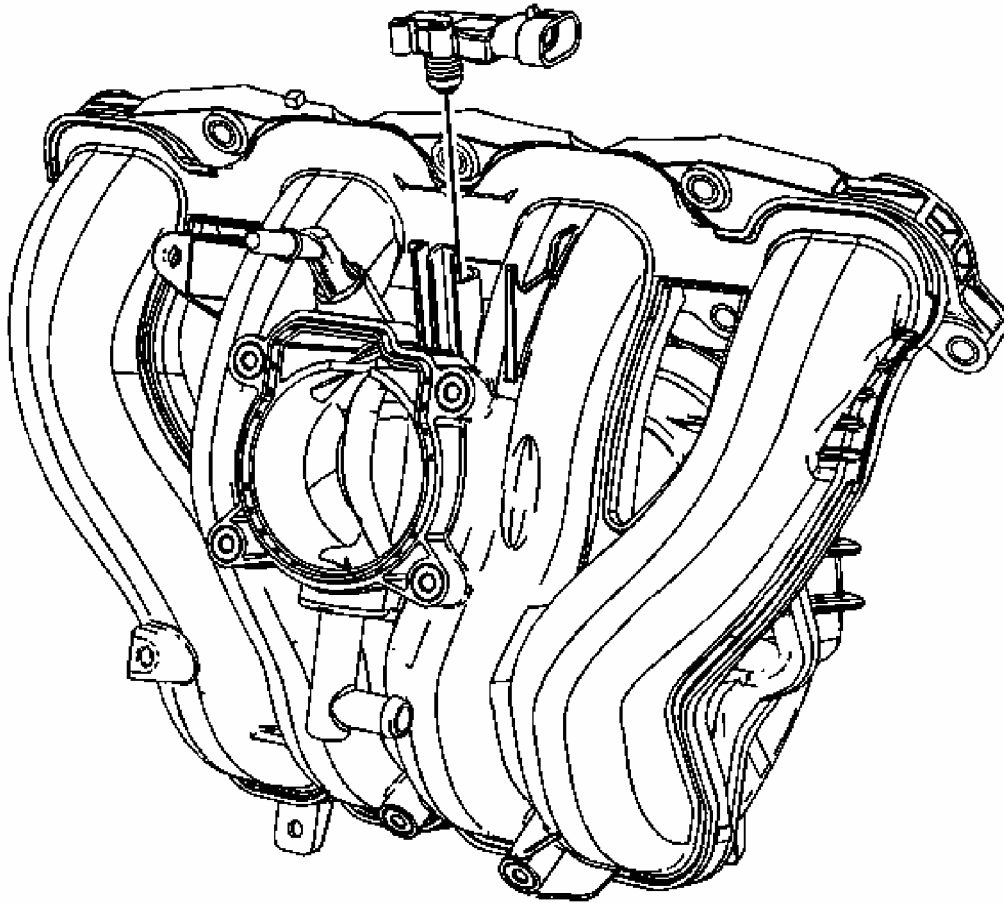


Fig. 59: MAP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the throttle body. Refer to **Throttle Body Assembly Replacement**.
2. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.
3. Remove the MAP sensor.

IMPORTANT: If the MAP sensor seal is damaged, the MAP sensor must be replaced.

4. Inspect the seal for damage.

Installation Procedure

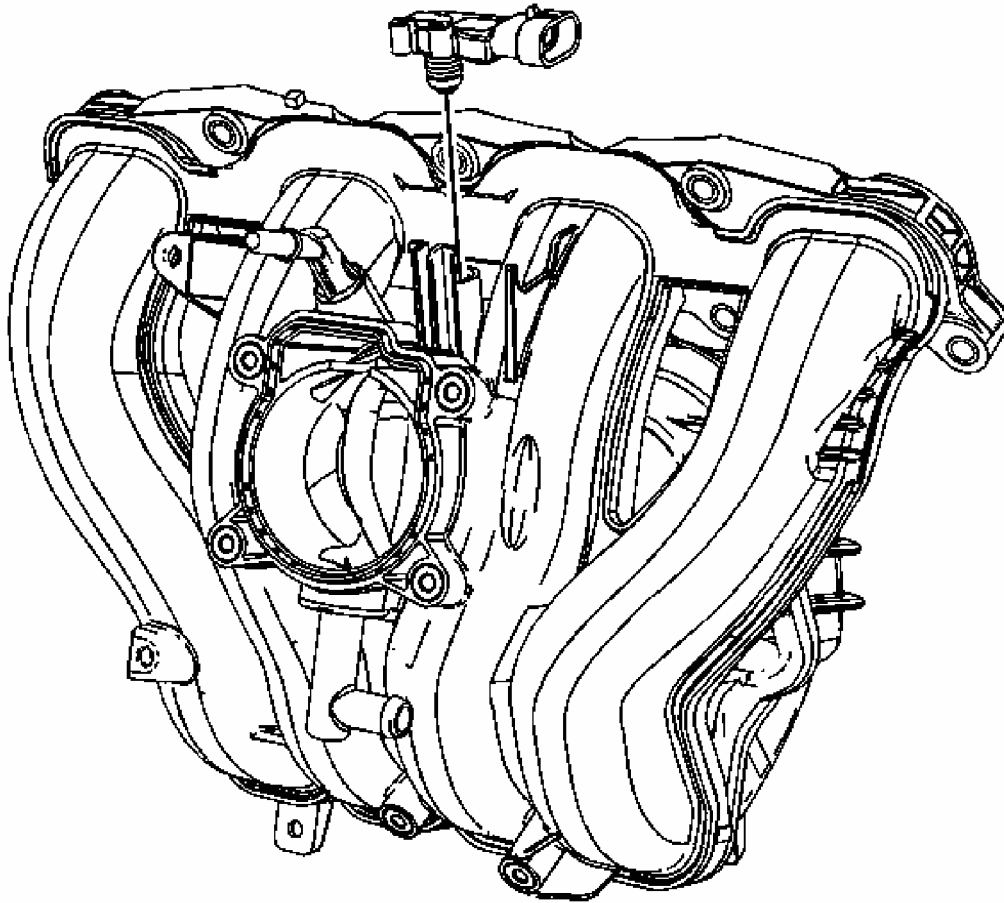


Fig. 60: MAP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW MAP sensor seal, if required.
2. Install the MAP sensor.
3. Connect the MAP sensor electrical connector.
4. Install the throttle body. Refer to **Throttle Body Assembly Replacement**.

HEATED OXYGEN SENSOR REPLACEMENT - POSITION 1

Removal Procedure

NOTE: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor.

NOTE: The use of excessive force may damage the threads in the exhaust manifold/pipe.

IMPORTANT: The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S).

IMPORTANT: The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F).

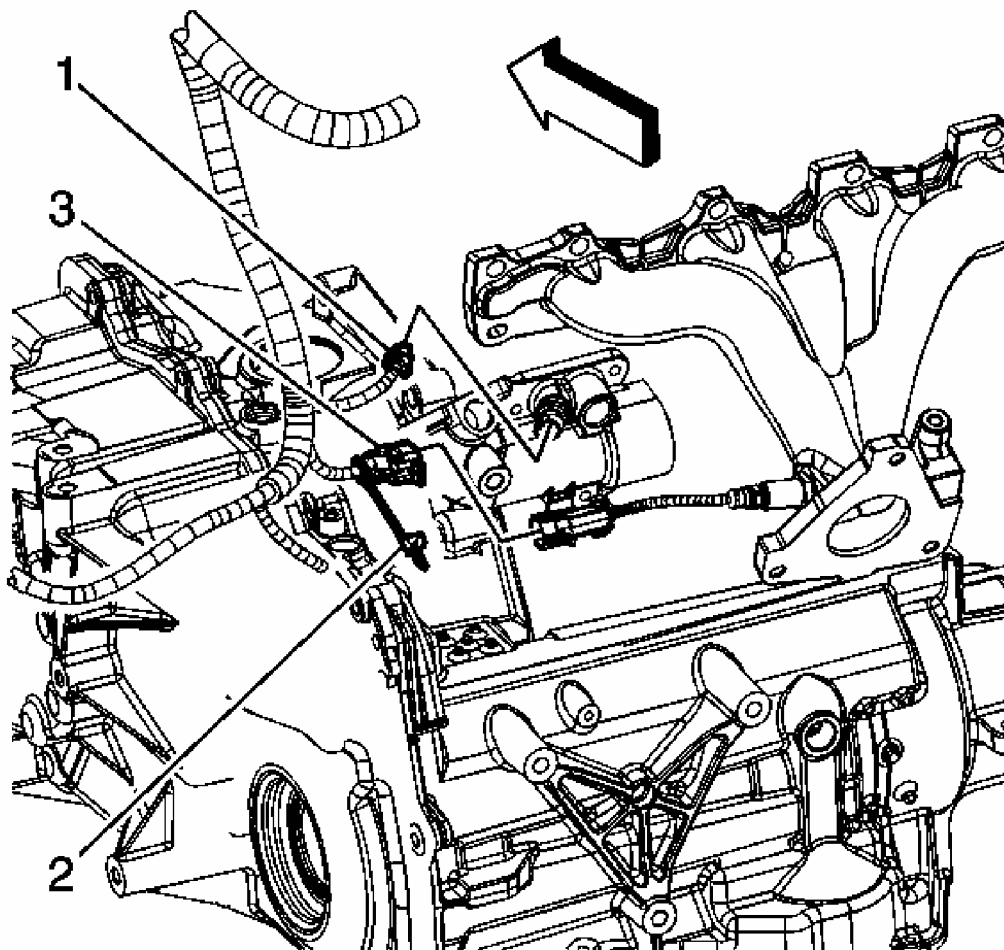


Fig. 61: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Replacement** .
2. If equipped with a automatic transaxle, perform the following steps, remove the connector position assurance (CPA) retainer (2).
3. Disconnect the engine harness electrical connector (3) from the HO2S.

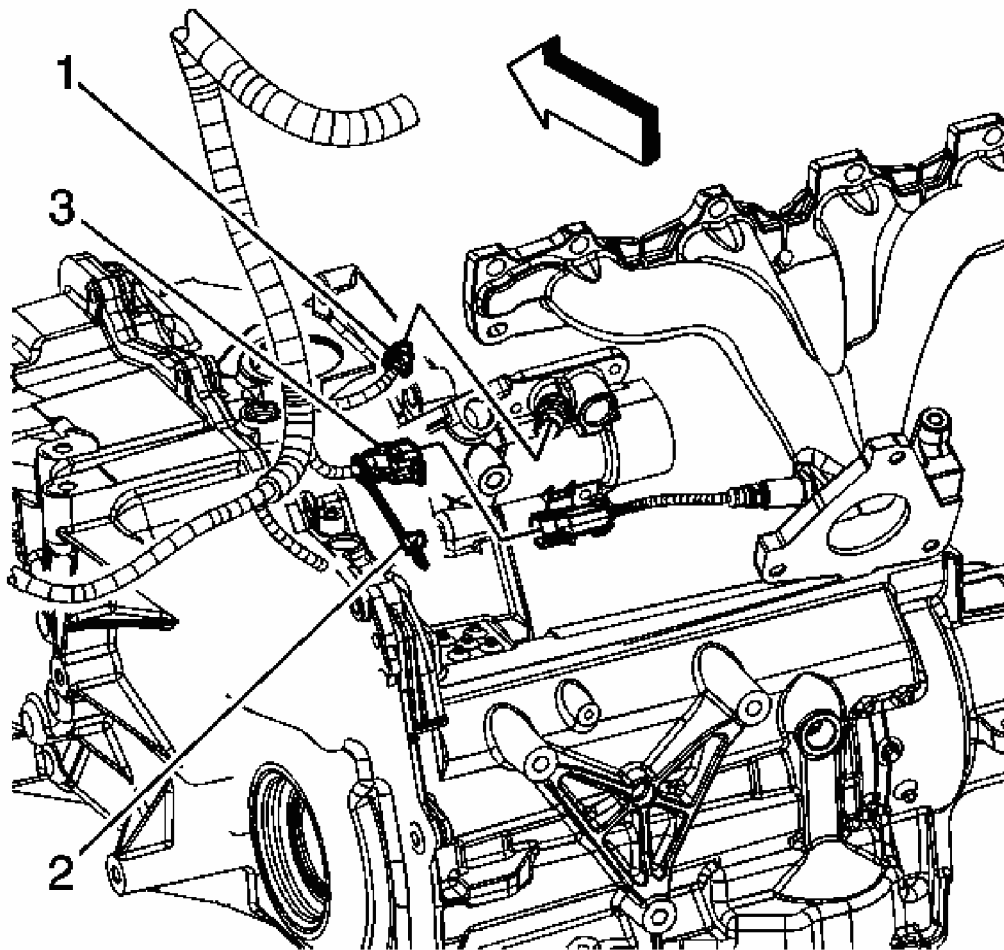


Fig. 62: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. If equipped with a manual transaxle, perform the following steps, remove the CPA retainer (2).
5. Disconnect the engine harness electrical connector (3) from the HO2S.

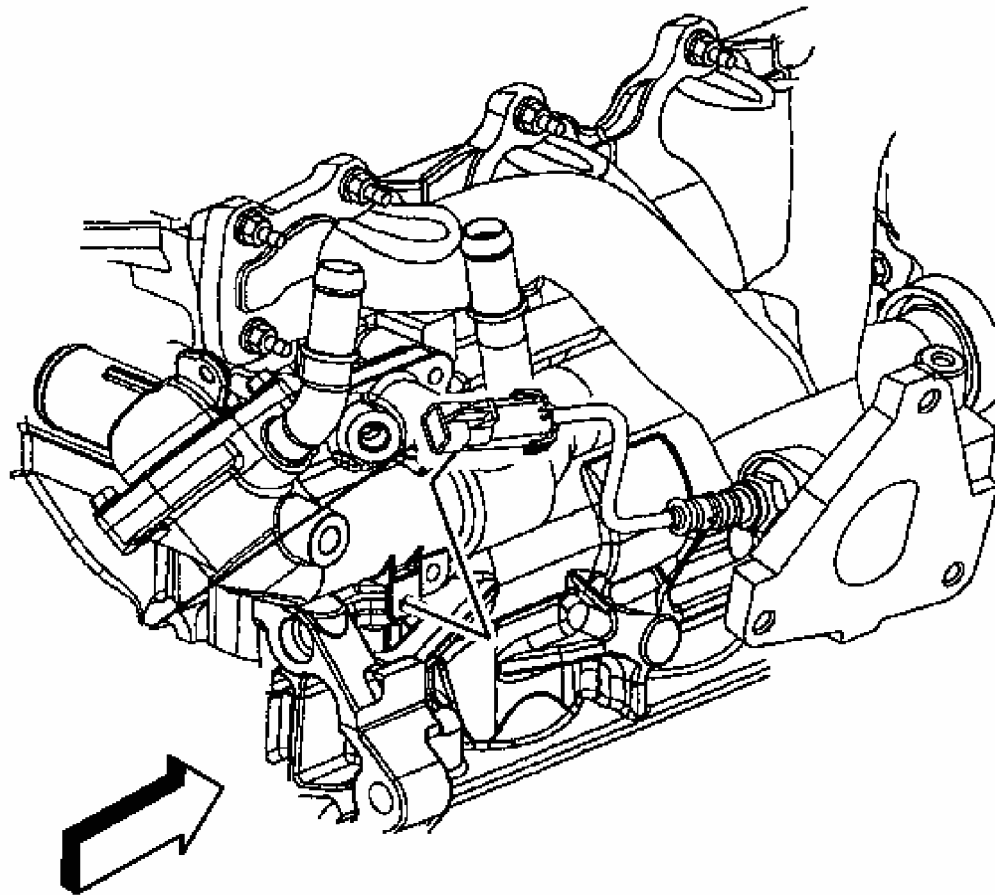


Fig. 63: Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

6. Remove the HO2S electrical connector clip from the thermostat housing.

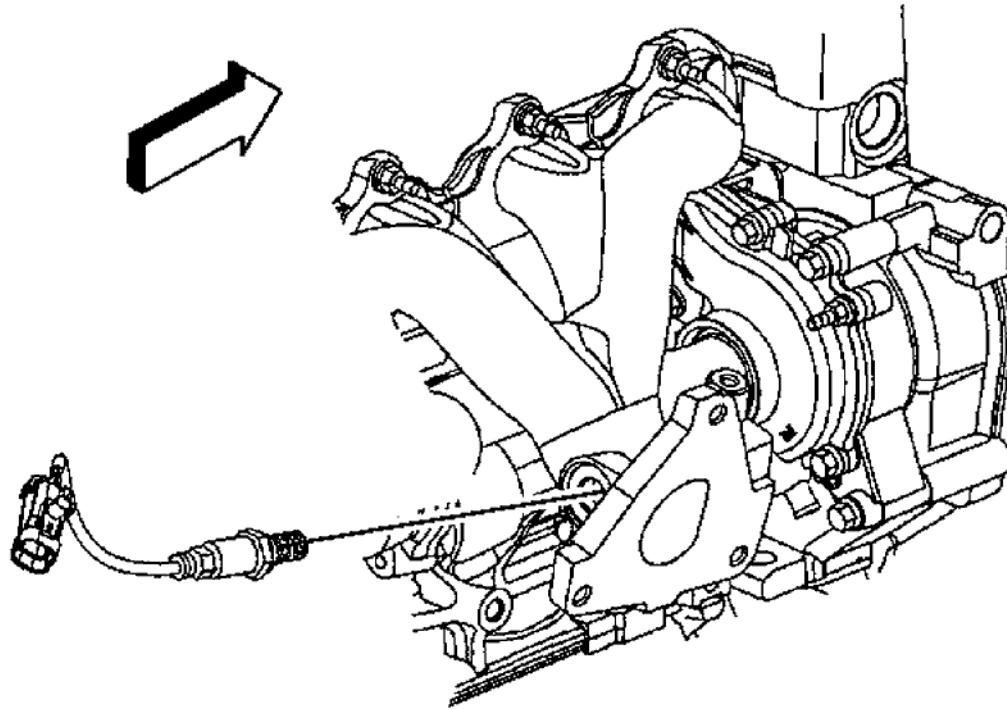


Fig. 64: HO2S

Courtesy of GENERAL MOTORS CORP.

7. Remove the HO2S.

Installation Procedure

IMPORTANT: A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation.

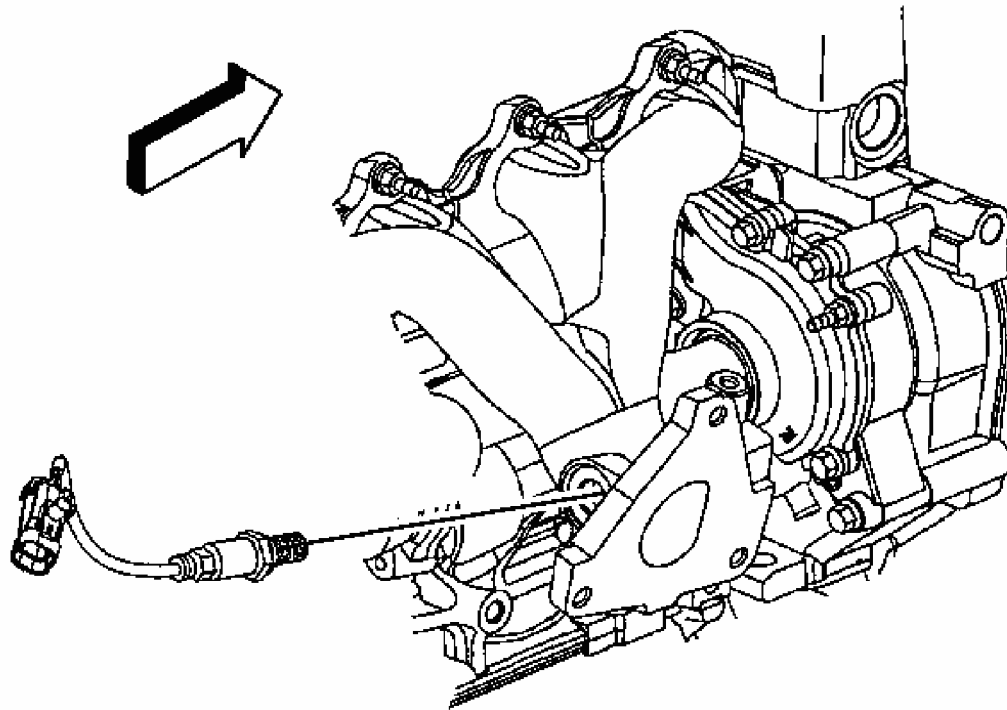


Fig. 65: HO2S

Courtesy of GENERAL MOTORS CORP.

1. If reinstalling the old HO2S, coat the threads with anti-seize compound GM P/N 12377953 or equivalent.

NOTE: Refer to Fastener Notice .

2. Install the HO2S.

Tighten: Tighten the sensor to 42 N.m (31 lb ft).

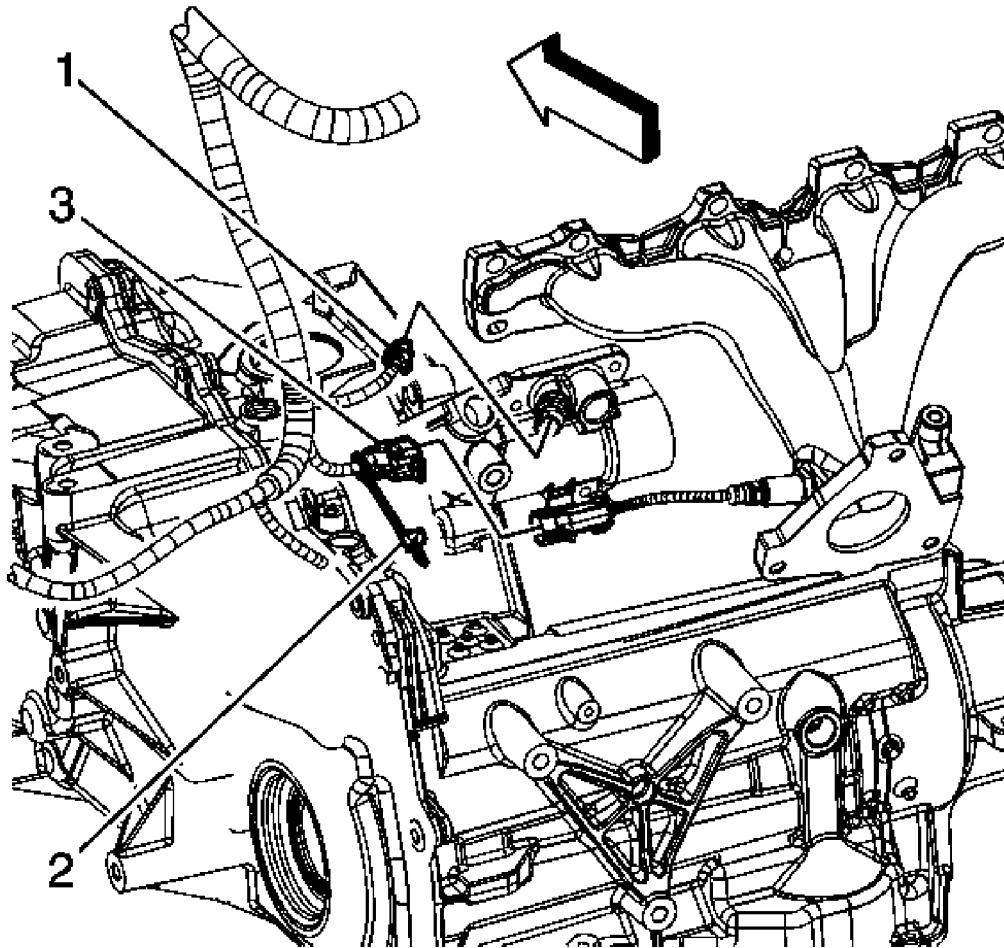


Fig. 66: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. If equipped with a manual transaxle, perform the following steps, connect the engine harness electrical connector (3) to the HO2S.
4. Install the CPA retainer (2).

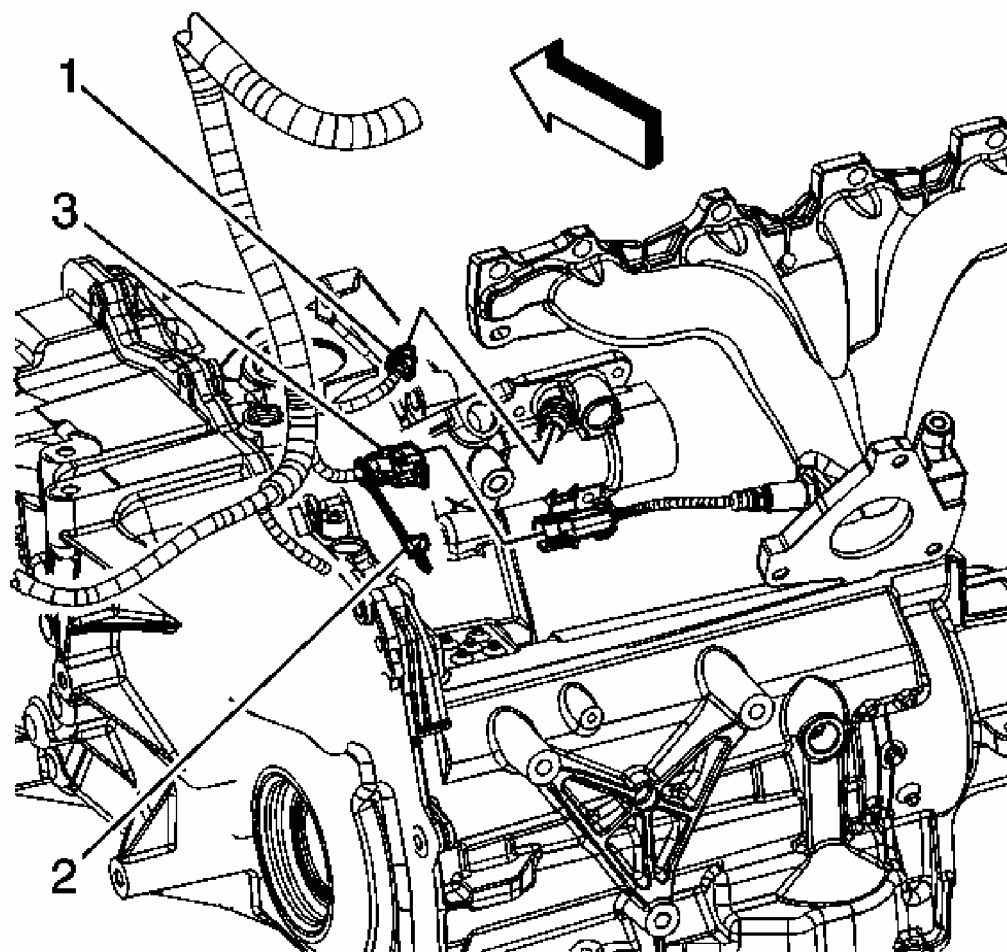


Fig. 67: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. If equipped with a automatic transaxle, perform the following steps, connect the engine harness electrical connector (3) to the HO2S.
6. Install the CPA retainer (2).

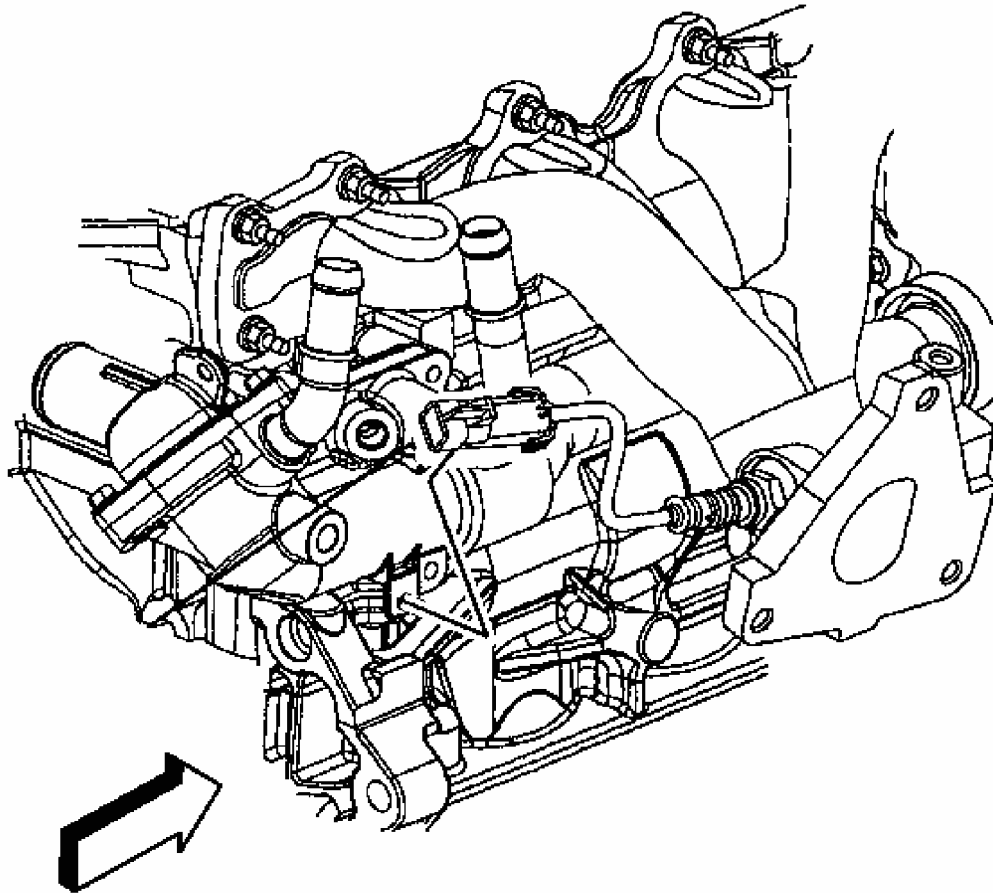


Fig. 68: Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

7. Install the HO2S electrical connector clip to the thermostat housing.
8. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Replacement** .

HEATED OXYGEN SENSOR REPLACEMENT - POSITION 2

Removal Procedure

NOTE: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor.

NOTE: The use of excessive force may damage the threads in the

exhaust manifold/pipe.

IMPORTANT: The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. **DO NOT** drop or roughly handle the heated oxygen sensor (HO2S).

IMPORTANT: The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F).

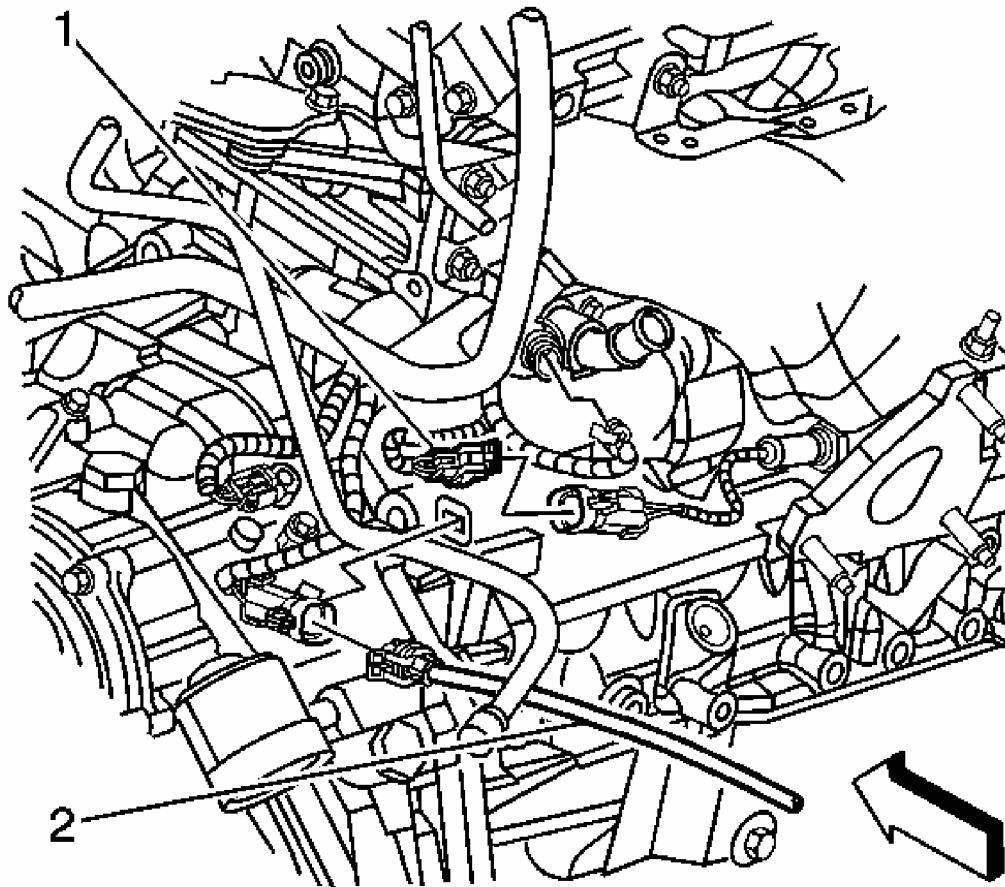


Fig. 69: Locating HO2S (Position 2)
Courtesy of GENERAL MOTORS CORP.

1. Remove the wheel drive shaft heat shield. Refer to **Wheel Drive Shaft Heat Shield Replacement**.
2. If equipped with a automatic transaxle, perform the following steps, remove the

connector position assurance (CPA) retainer (2).

3. Disconnect the engine harness electrical connector (3) from the HO2S.

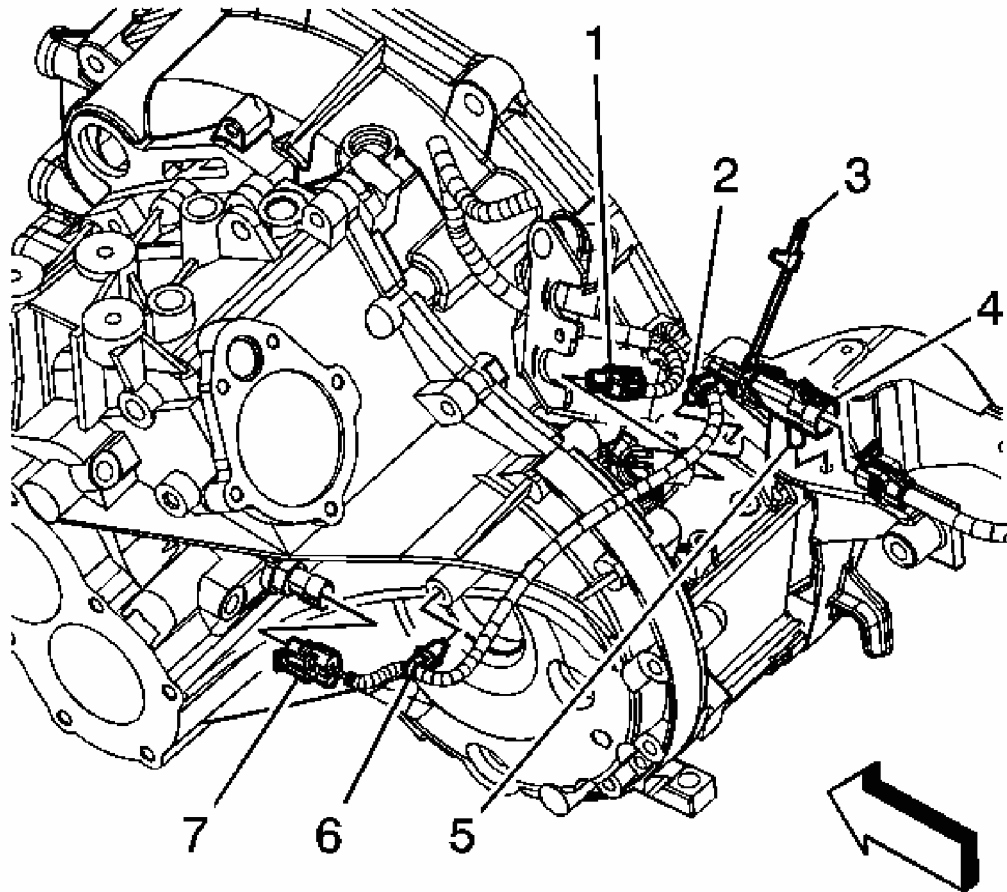


Fig. 70: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. If equipped with a manual transaxle, perform the following steps, remove the CPA retainer (3).
5. Disconnect the engine harness electrical connector (4) from the HO2S.

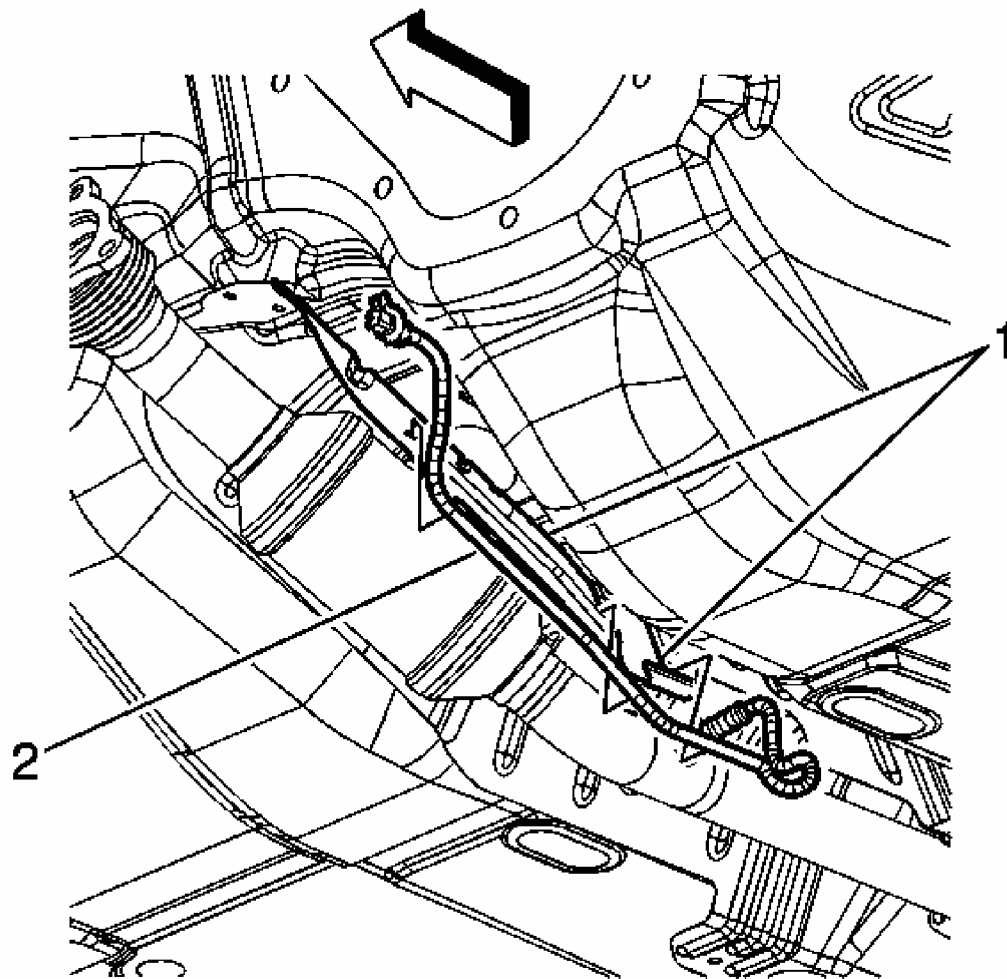


Fig. 71: Trough On Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

6. Bend down the trough (1) on the exhaust heat shield just enough to remove the HO2S electrical harness lead (2).

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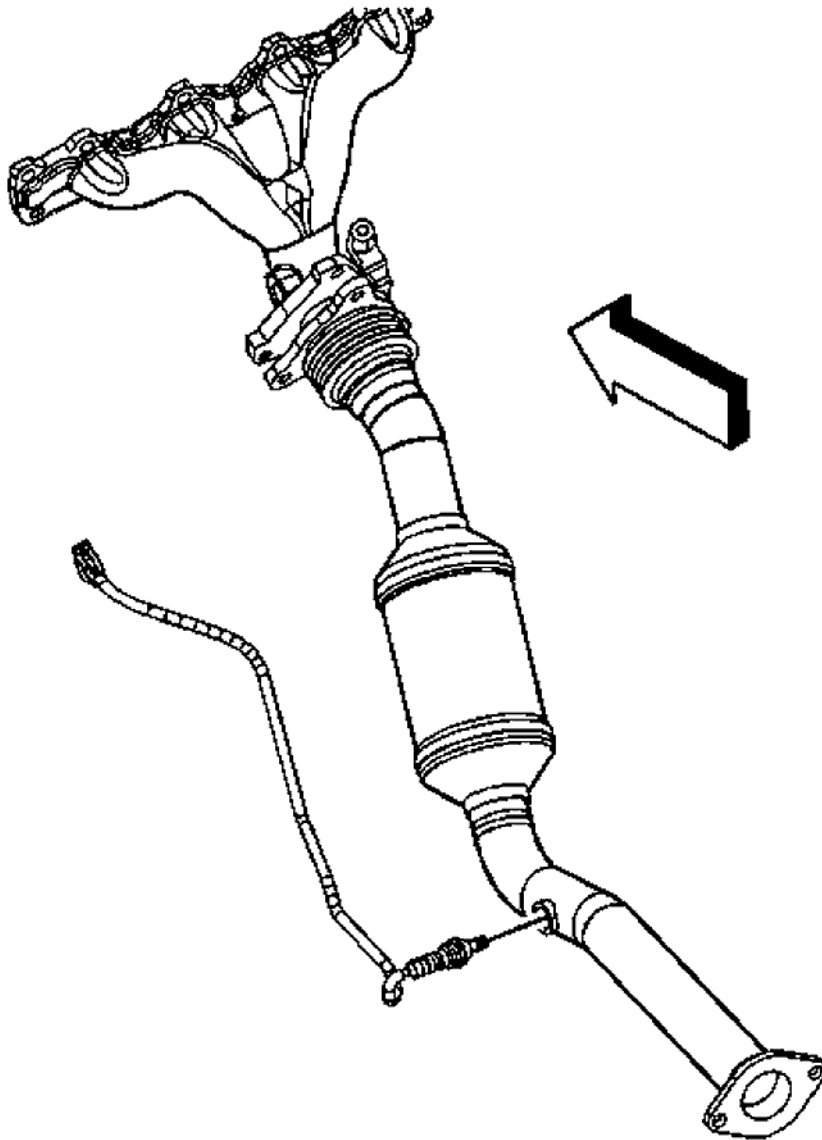


Fig. 72: HO2S

Courtesy of GENERAL MOTORS CORP.

7. Remove the HO2S.

Installation Procedure

IMPORTANT: A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads.

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The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation.

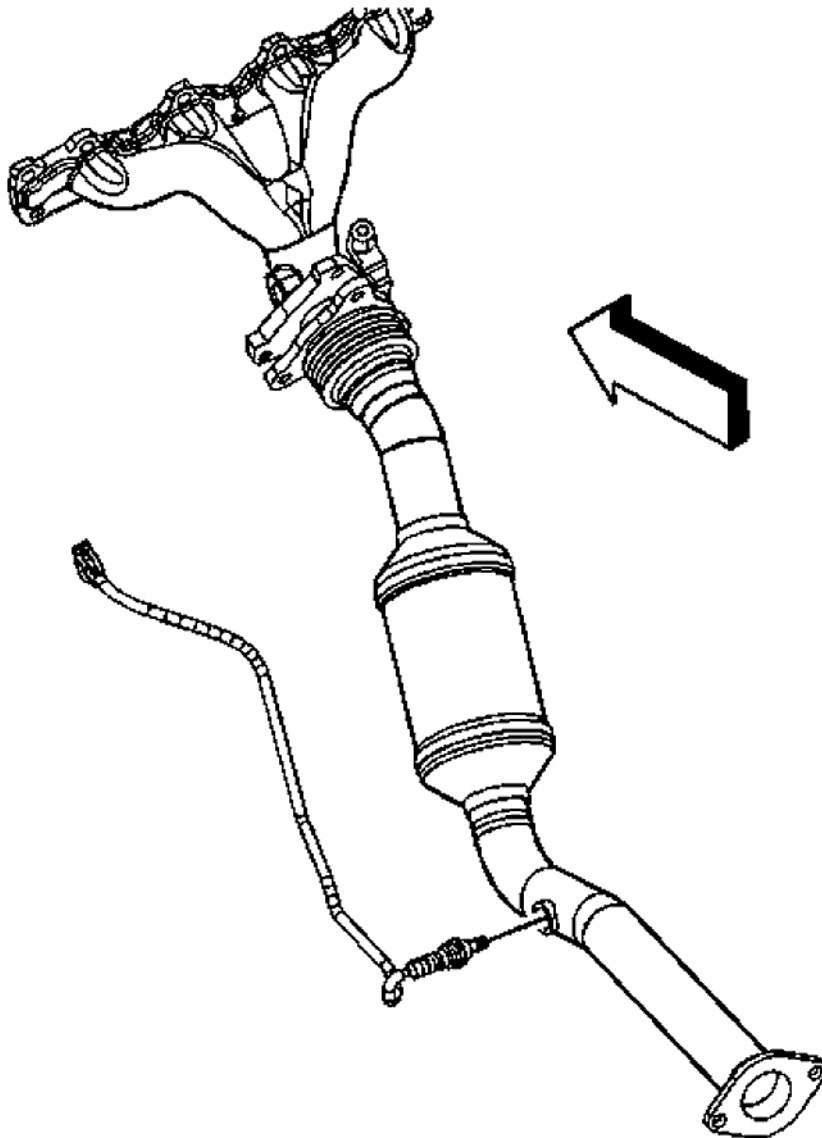


Fig. 73: HO2S

Courtesy of GENERAL MOTORS CORP.

1. If reinstalling the old HO2S, coat the threads with anti-seize compound GM P/N 12377953 or equivalent.

NOTE: Refer to Fastener Notice .

2. Install the HO2S.

Tighten: Tighten the sensor to 42 N.m (31 lb ft).

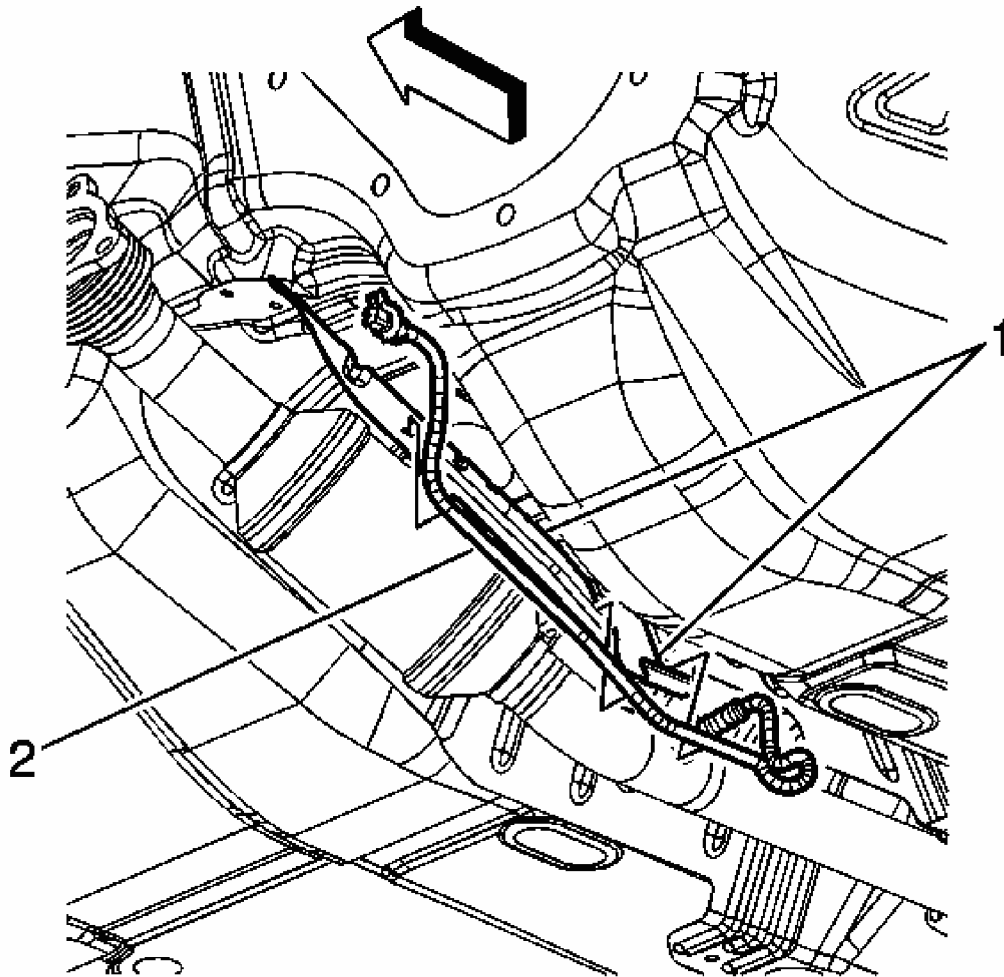


Fig. 74: Trough On Exhaust Heat Shield
Courtesy of GENERAL MOTORS CORP.

3. Install the HO2S electrical harness lead (2) into the trough (1) on the exhaust heat

shield, and bend the trough up slightly.

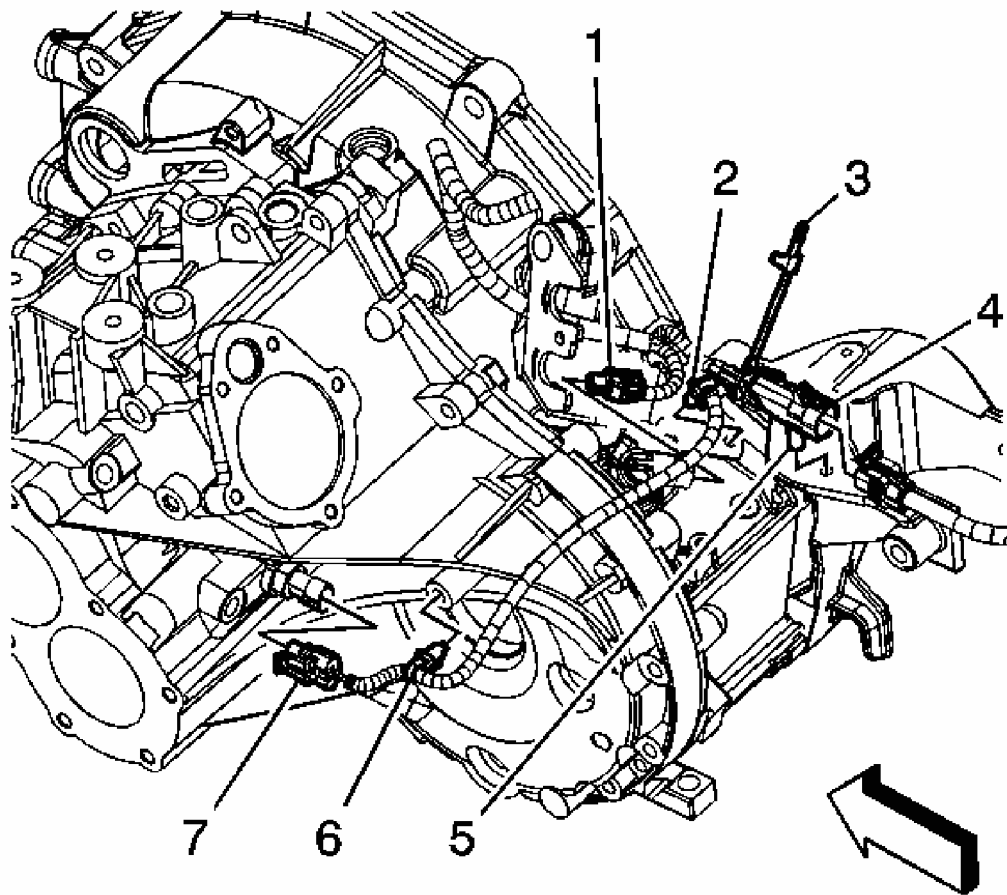


Fig. 75: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. If equipped with a manual transaxle, perform the following steps, connect the engine harness electrical connector (4) to the HO2S.
5. Install the CPA retainer (3).

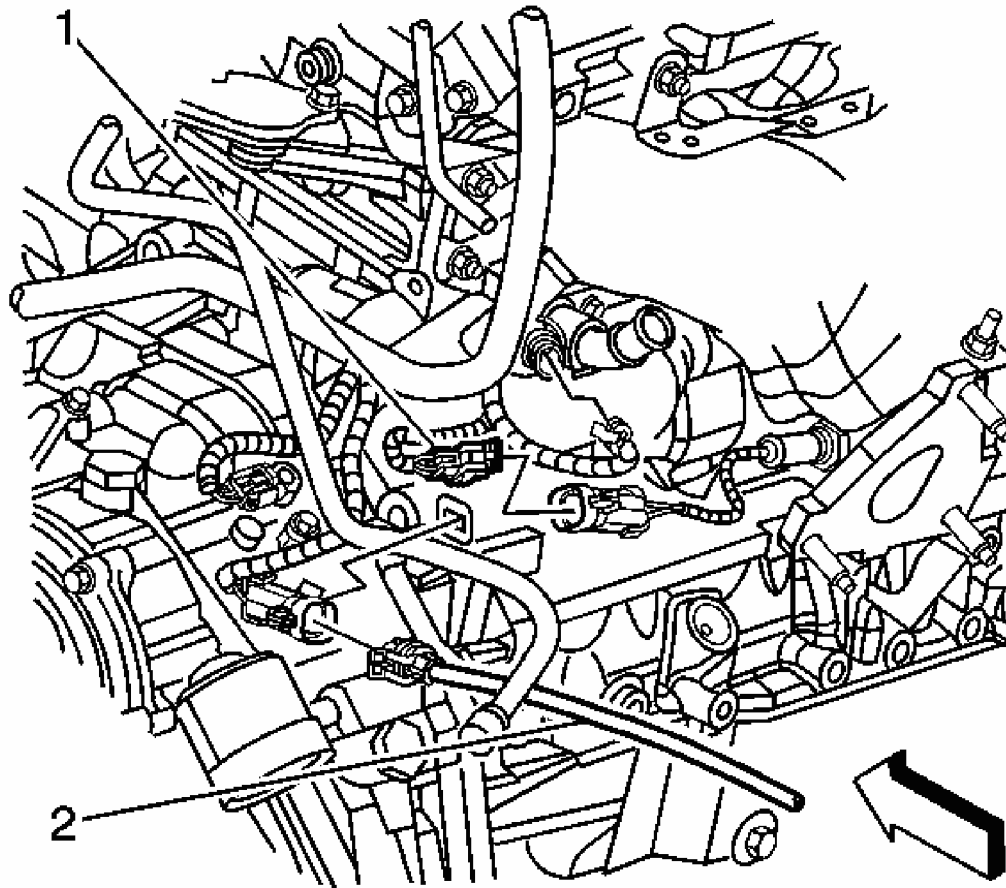


Fig. 76: Locating HO2S (Position 2)
Courtesy of GENERAL MOTORS CORP.

6. If equipped with a automatic transaxle, perform the following steps, connect the engine harness electrical connector (3) to the HO2S.
7. Install the CPA retainer (2).
8. Install the wheel drive shaft heat shield. Refer to **Wheel Drive Shaft Heat Shield Replacement** .

ACCELERATOR PEDAL WITH POSITION SENSOR REPLACEMENT

Removal Procedure

1. Remove the insulator panel. **Insulator Replacement - Instrument Panel (I/P)** .

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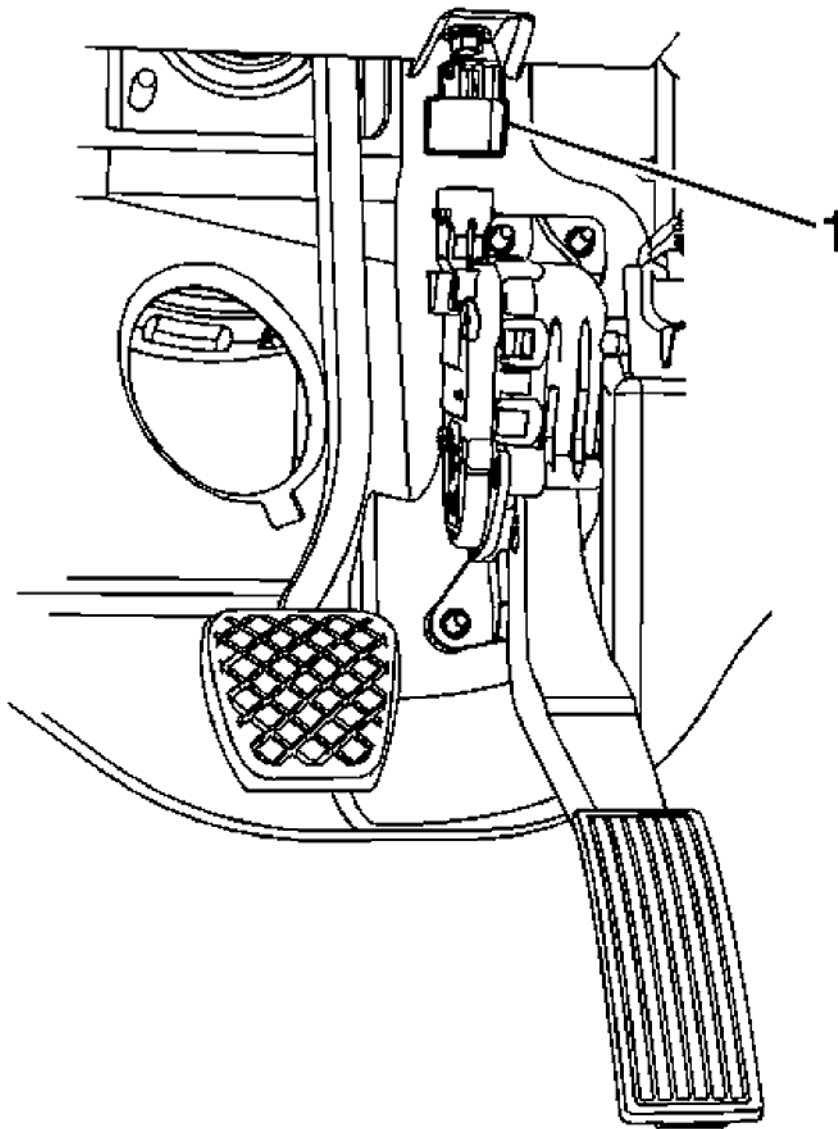


Fig. 77: APP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the accelerator pedal position (APP) sensor electrical connector (1).

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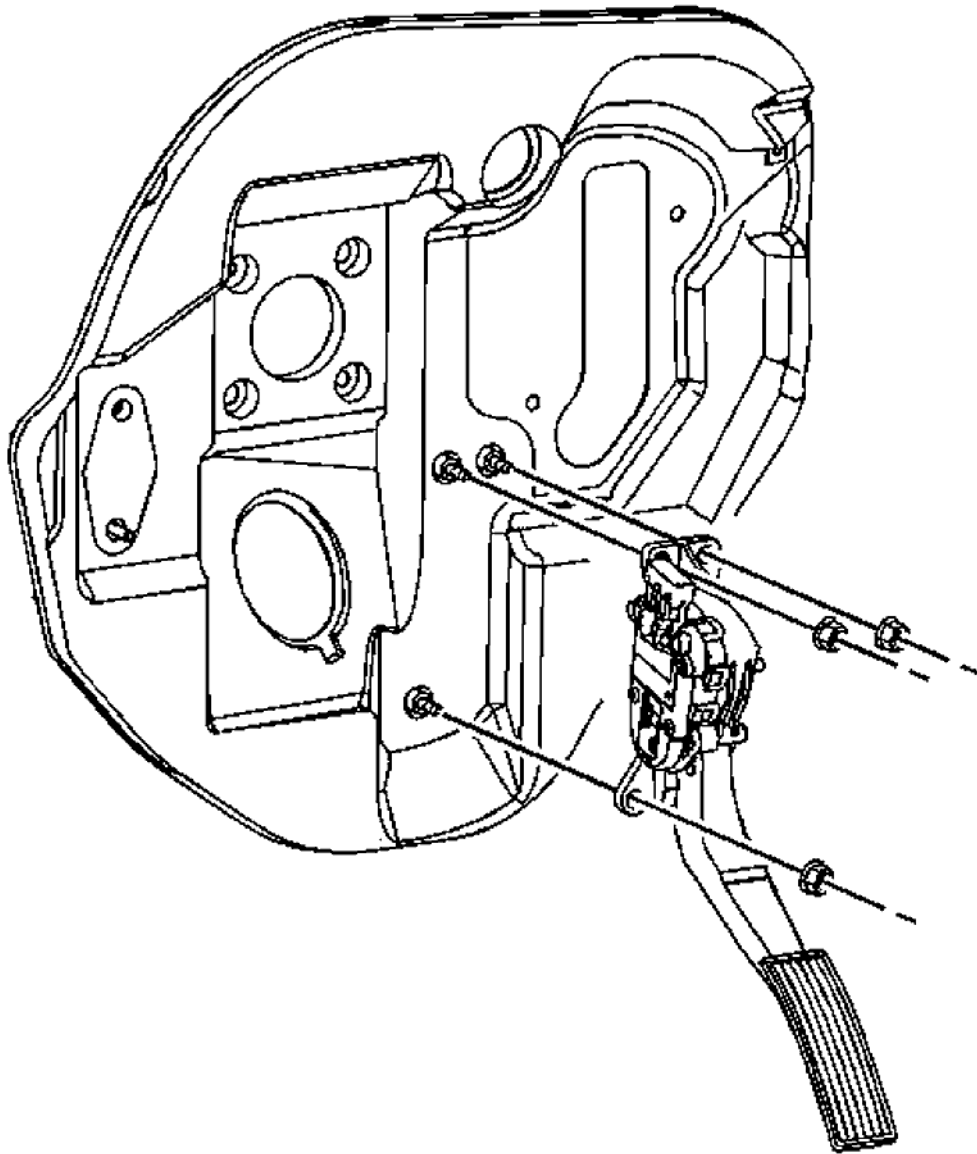


Fig. 78: APP Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the APP sensor nuts.
4. Remove the APP sensor.

Installation Procedure

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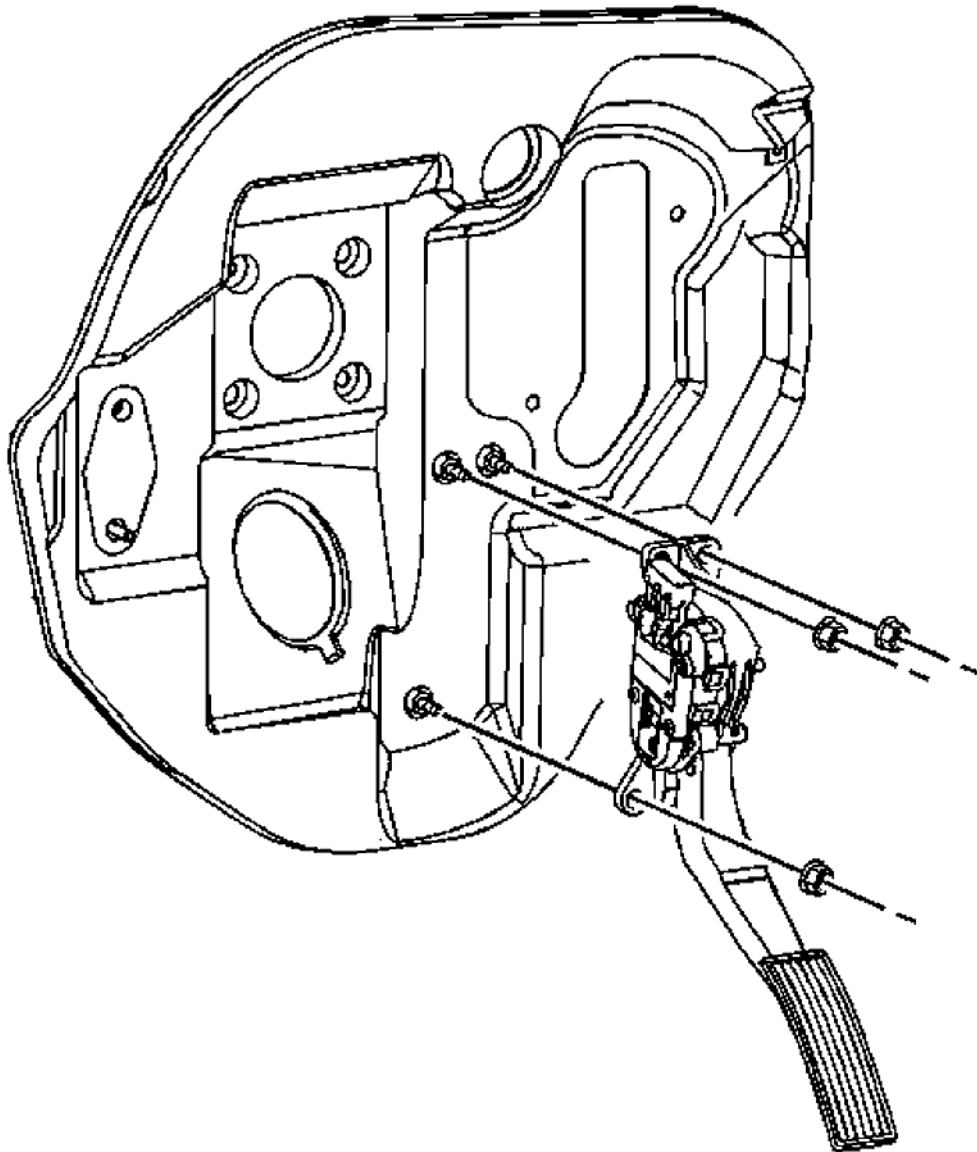


Fig. 79: APP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the APP sensor.

NOTE: Refer to Fastener Notice .

2. Install the APP sensor nuts.

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Tighten: Tighten the nuts to 10 N.m (89 lb in).

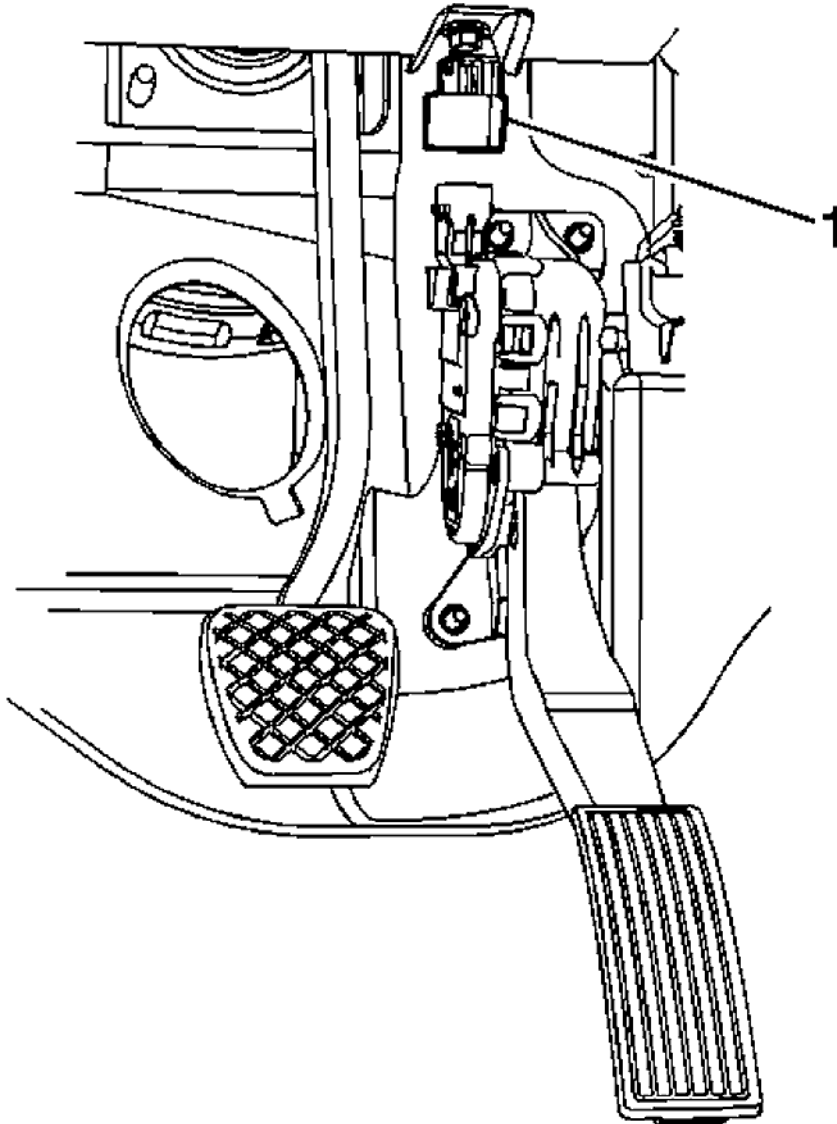


Fig. 80: APP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the APP sensor electrical connector (1).
4. Install the insulator panel. **Insulator Replacement - Instrument Panel (I/P)** .

THROTTLE BODY ASSEMBLY REPLACEMENT

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Removal Procedure

NOTE: Do not use solvent of any type when cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as damage to the gasket surfaces and throttle body assembly may result. Use care in cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as sharp tools may damage the gasket surfaces.

NOTE: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

IMPORTANT: DO NOT prop open the throttle blade with the ignition key in the ON position as it may set a diagnostic trouble code (DTC).

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

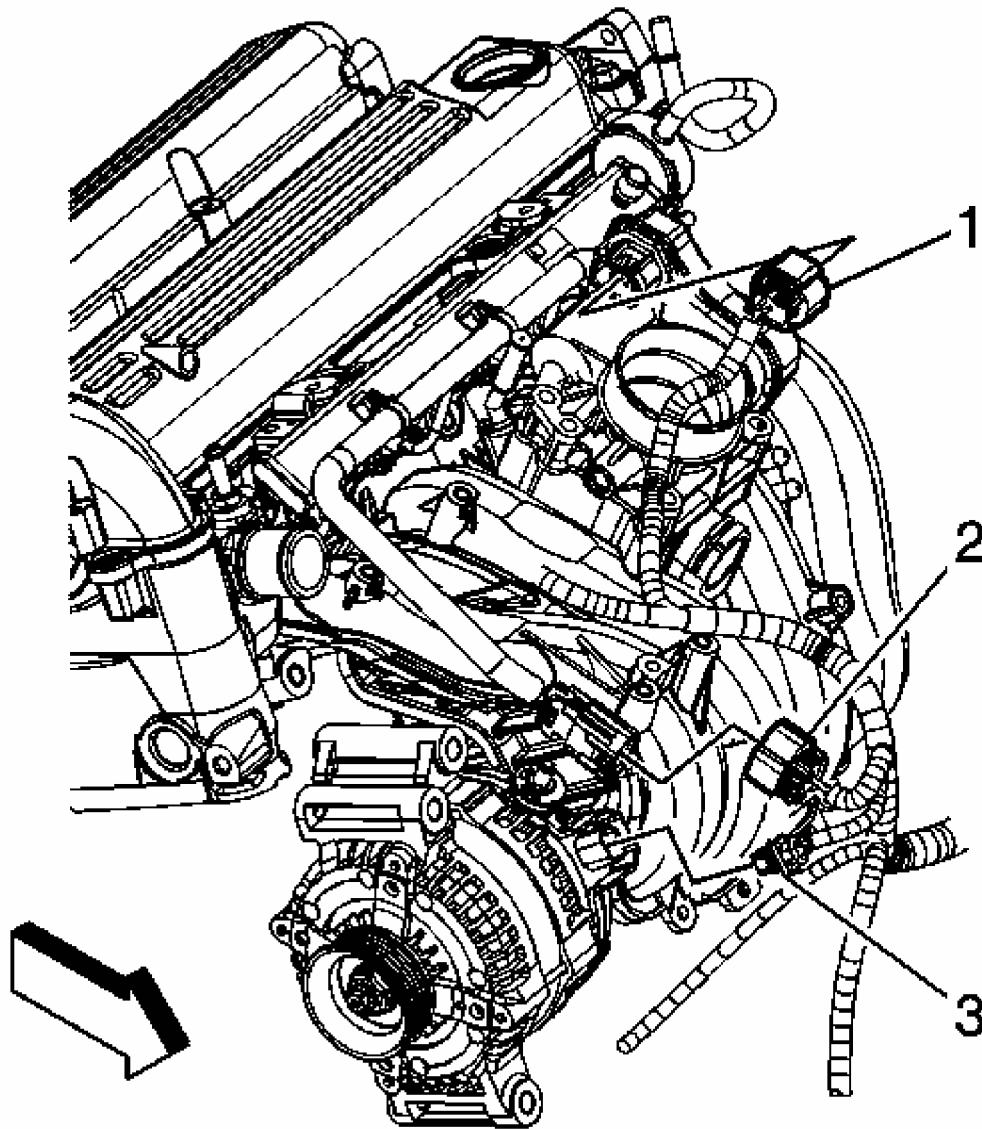


Fig. 81: TAC Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the throttle actuator control (TAC) electrical connector (1).

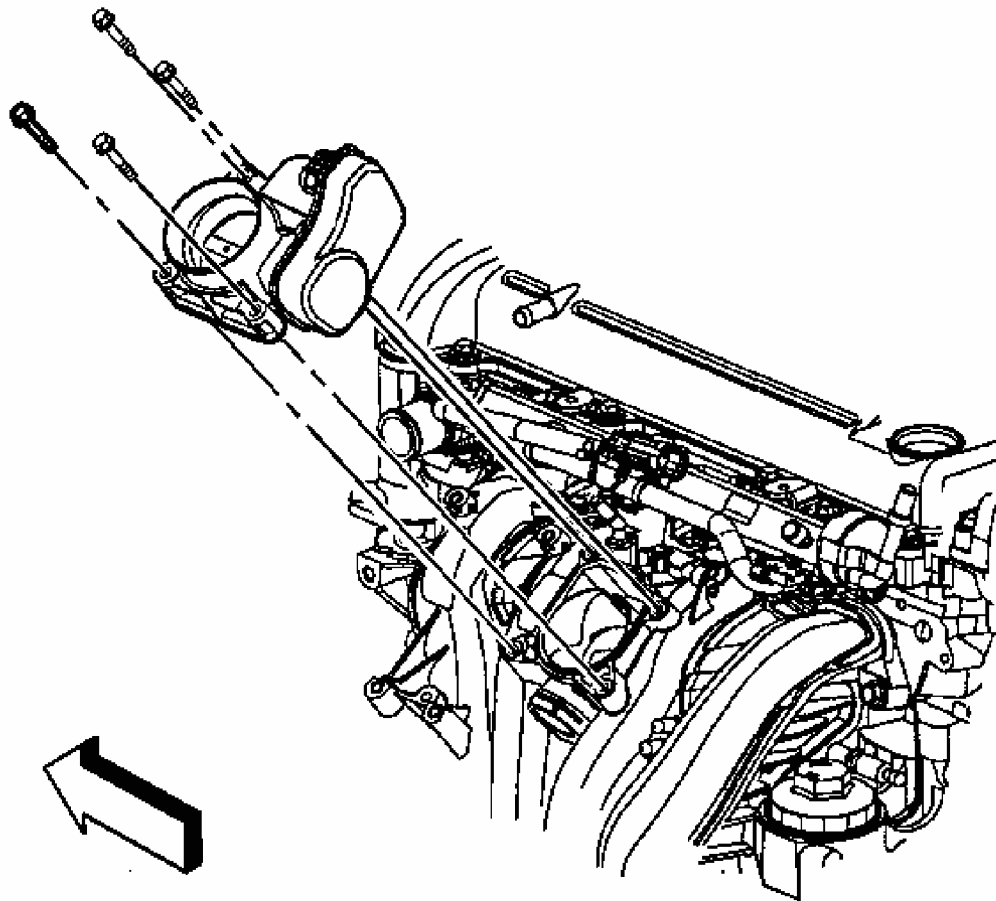


Fig. 82: Throttle Body
Courtesy of GENERAL MOTORS CORP.

3. Remove the throttle body bolts.
4. Remove the throttle body.
5. Inspect the throttle body gasket, and replace if necessary.

Installation Procedure

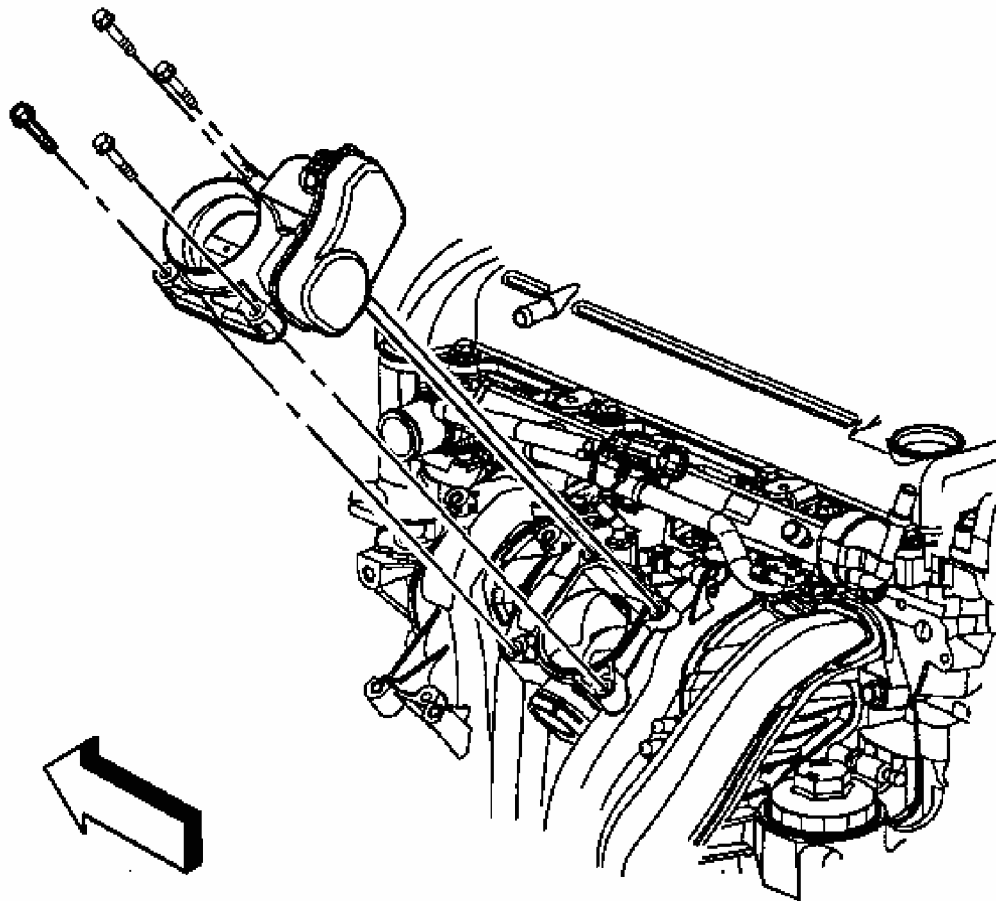


Fig. 83: Throttle Body
Courtesy of GENERAL MOTORS CORP.

1. Install the throttle body.

NOTE: Refer to Fastener Notice .

2. Install the throttle body bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

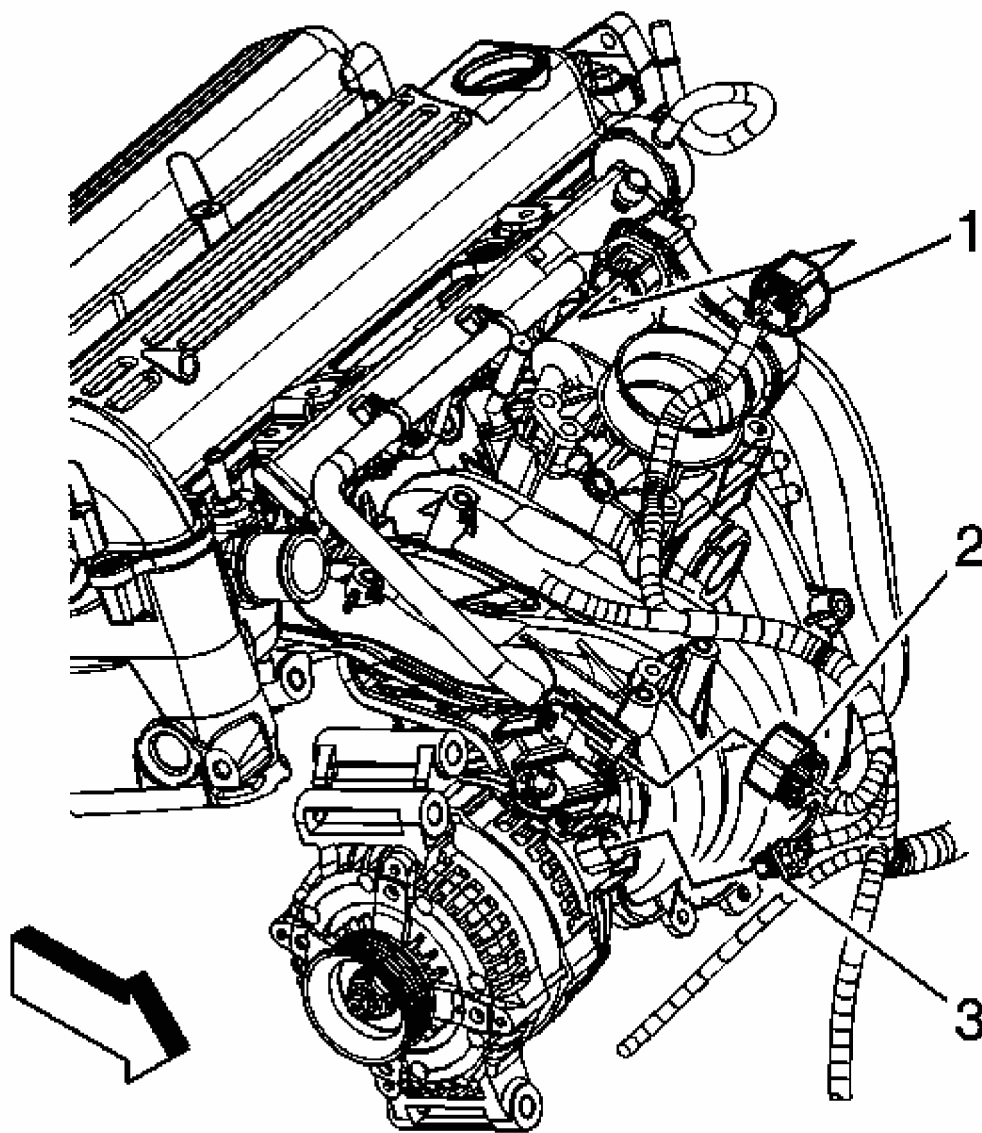


Fig. 84: TAC Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the TAC electrical connector (1).
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

THROTTLE BODY CLEANING PROCEDURE

CAUTION: Turn OFF the ignition before inserting fingers into the

throttle bore. Unexpected movement of the throttle blade could cause personal injury.

NOTE: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

NOTE: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

IMPORTANT: DO NOT prop open the throttle blade with the ignition key in the ON position as it may set a diagnostic trouble code (DTC).

2. Inspect the throttle body bore and the throttle valve plate for deposits. You must open the throttle valve in order to inspect all of the surfaces.
3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with GM Top Engine Cleaner P/N 1052626 (Canadian P/N 993026) or AC-Delco Carburetor Tune-up Conditioner P/N X66-P, or an equivalent product.
4. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

FUEL PRESSURE RELIEF PROCEDURE

Tools Required

J 34730-1A Fuel Pressure Gage. See Special Tools.

CAUTION: 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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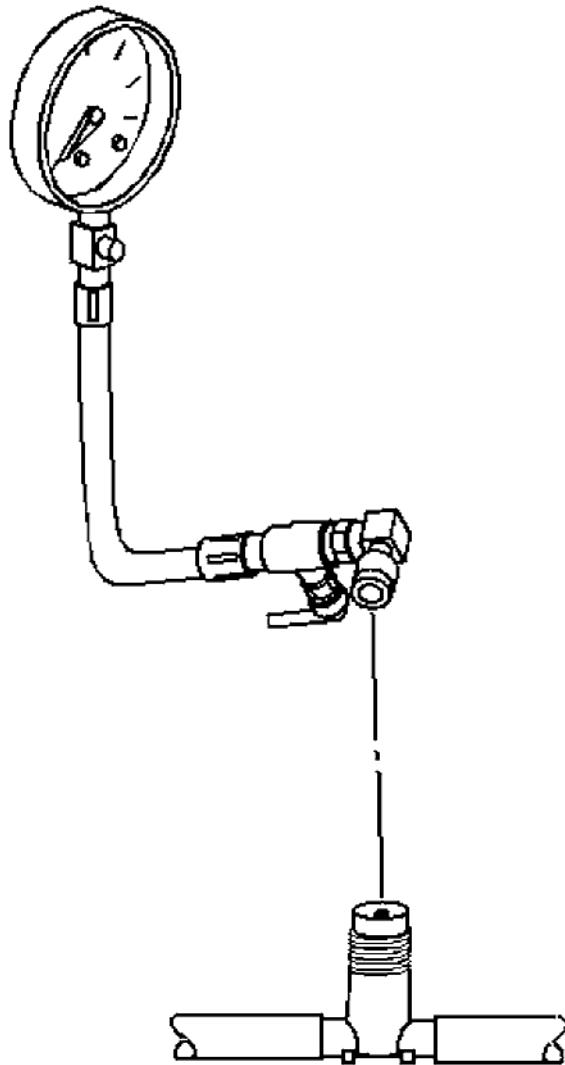


Fig. 85: Identifying Fuel Pressure Gauge J 34730-1A
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
3. Install the **J 34730-1A**. See **Special Tools**. Refer to **Fuel Pressure Gage Installation and Removal**.
4. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
5. Open the valve on the **J 34730-1A** in order to bleed the fuel system pressure. See

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Special Tools. The fuel connections are now safe for servicing.

6. Place a shop towel under the fuel pressure service port in order to catch any remaining fuel spillage.
7. Once the system pressure is completely relieved, remove the **J 34730-1A** . See **Special Tools**.

FUEL PRESSURE GAGE INSTALLATION AND REMOVAL

Tools Required

J 34730-1A Fuel Pressure Gage. See **Special Tools**.

Installation Procedure

NOTE: 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

CAUTION: 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 gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

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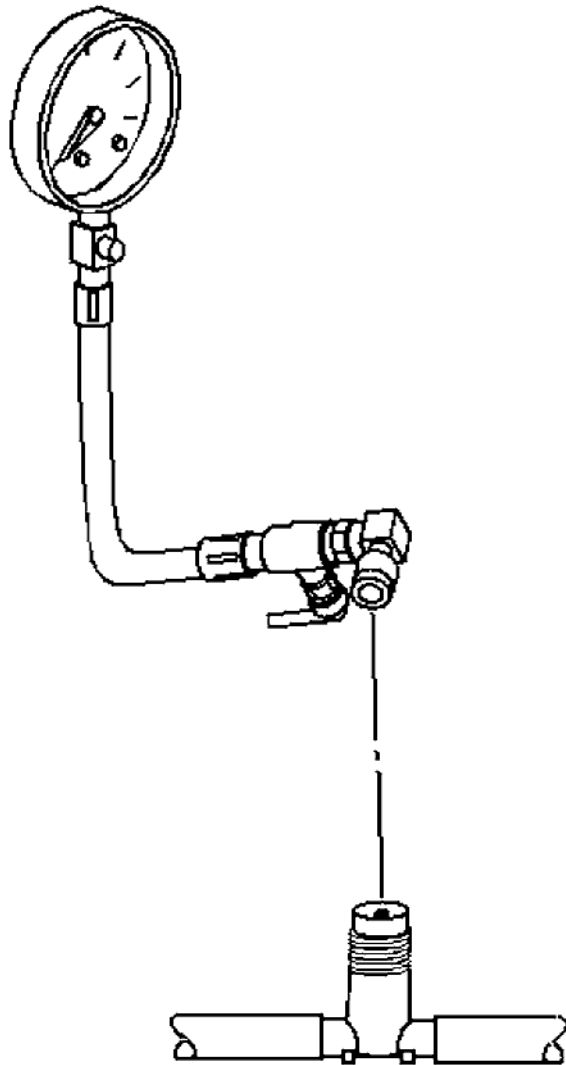


Fig. 86: Identifying Fuel Pressure Gauge J 34730-1A
Courtesy of GENERAL MOTORS CORP.

1. Remove the cap from the fuel pressure service port connection.
2. Install the **J 34730-1A** to the fuel pressure service port located on the fuel rail. See **Special Tools**. Wrap a shop towel around the fitting while connecting the gage to avoid spillage.
3. Turn the ignition ON, with the engine OFF.

CAUTION: Do not drain the fuel into an open container. Never

store the fuel in an open container due to the possibility of a fire or an explosion.

4. Place the bleed hose of the fuel pressure gage into an approved gasoline container.
5. Open the bleed valve on the fuel pressure gage in order to bleed the air from the fuel pressure gage.
6. Command the fuel pump ON with a scan tool.
7. Close the bleed valve on the fuel pressure gage.
8. Inspect for fuel leaks.

Removal Procedure

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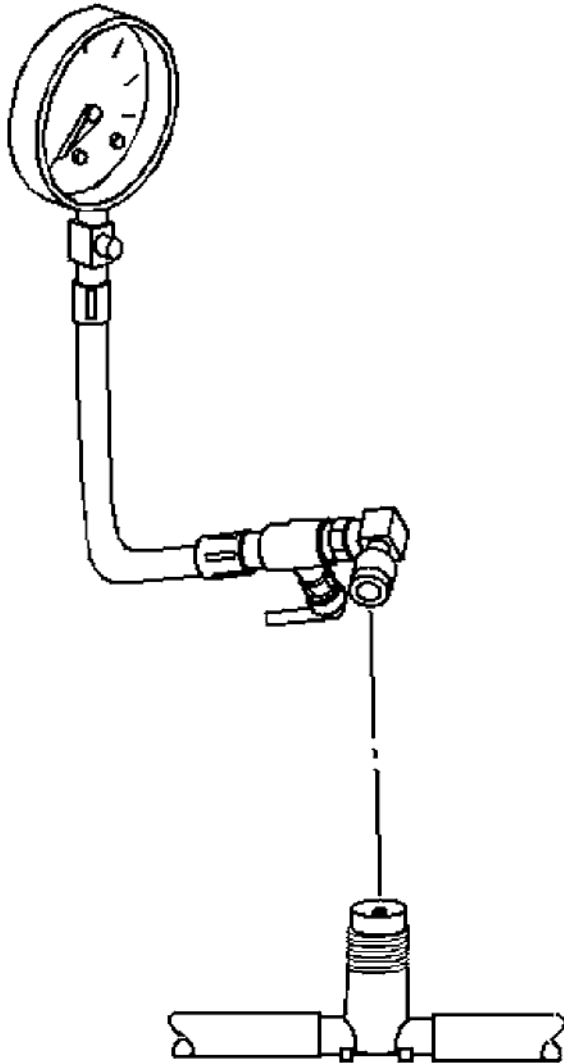


Fig. 87: Identifying Fuel Pressure Gauge J 34730-1A
Courtesy of GENERAL MOTORS CORP.

1. Ensure the fuel pump is OFF.
2. Place the fuel pressure gage bleed hose into an approved container and open the bleed valve in order to bleed off fuel system pressure.
3. Place a shop towel under the fuel pressure gage in order to catch any remaining fuel spillage.
4. Remove the fuel pressure gage from the fuel pressure service port.
5. Drain any fuel remaining in the fuel pressure gage into an approved fuel container.

6. 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.
7. Install the cap on the fuel pressure service port.

QUICK CONNECT FITTING(S) SERVICE (METAL COLLAR)

Tools Required

J 37088-A Fuel Line Disconnect Tool Set. See **Special Tools**.

Removal Procedure

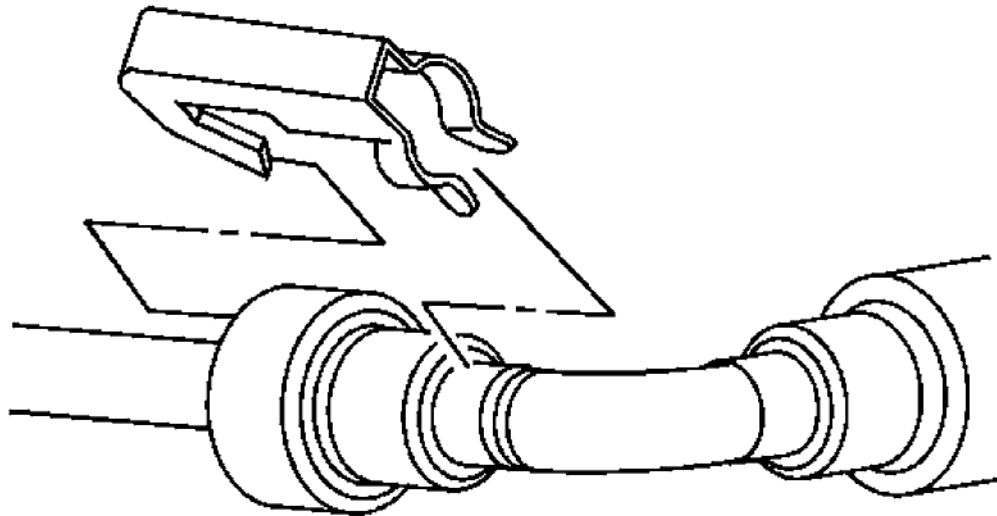


Fig. 88: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to **Fuel Pressure Relief Procedure**.
2. Remove the retainer from the quick connect fitting.

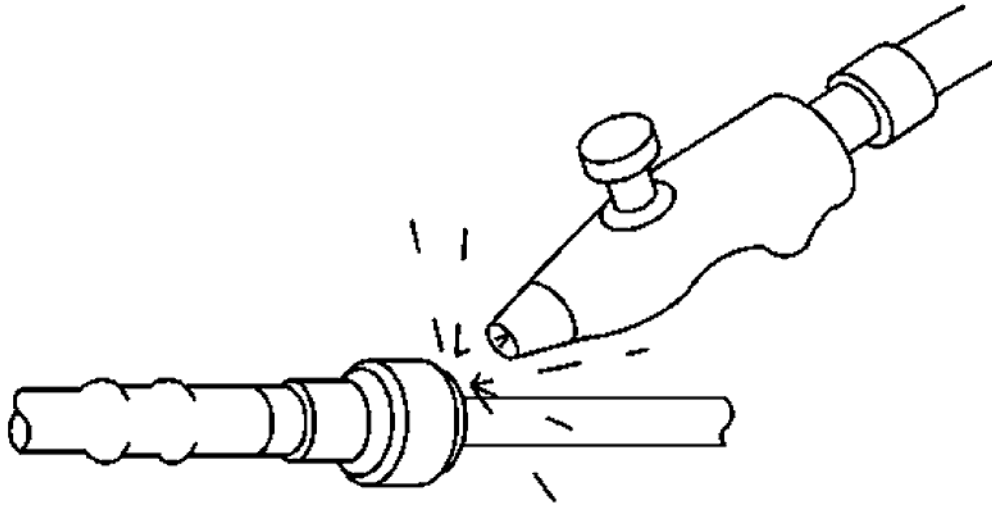


Fig. 89: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

CAUTION: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

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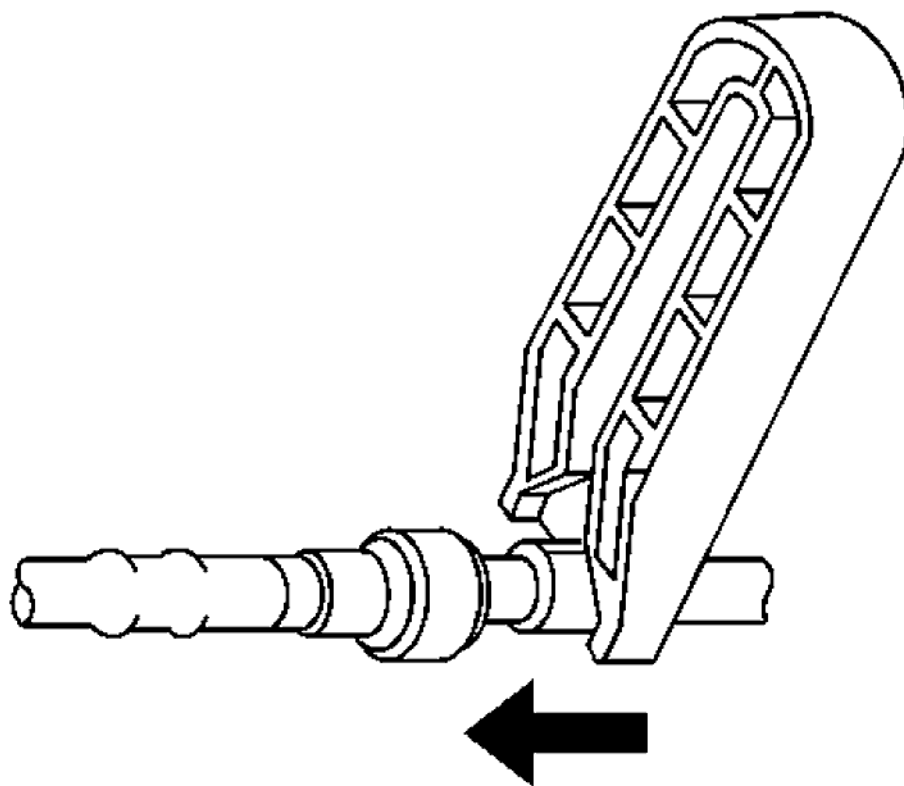


Fig. 90: Releasing Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Choose the correct tool from the **J 37088-A** for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.

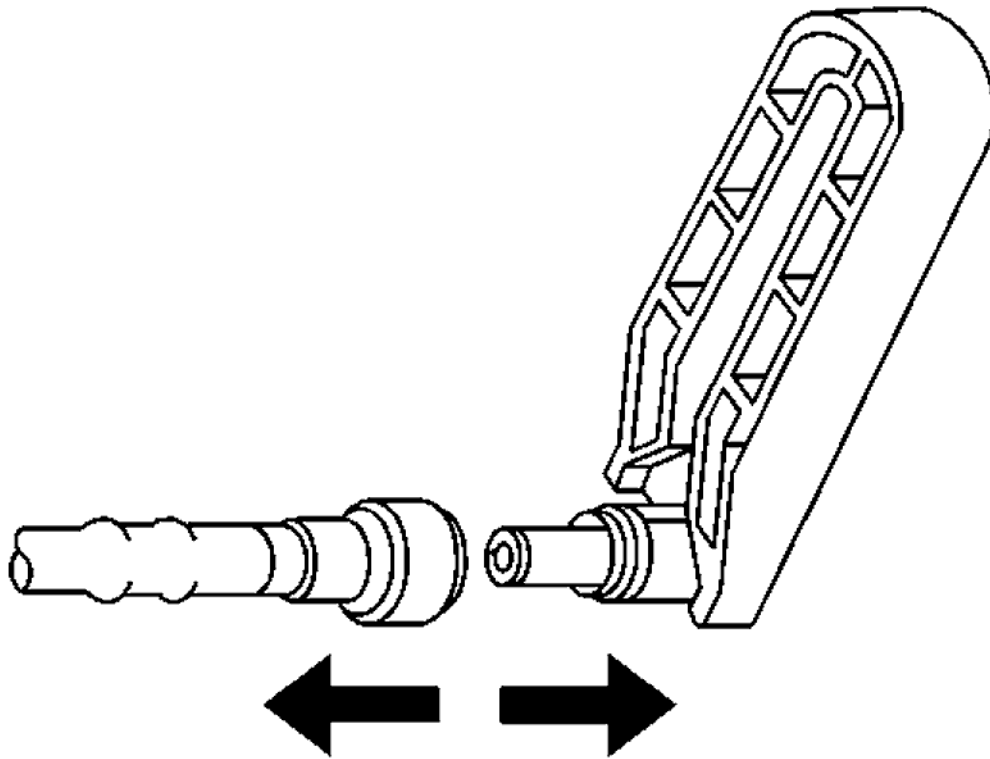


Fig. 91: Releasing Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

5. Pull the connection apart.

NOTE: 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. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

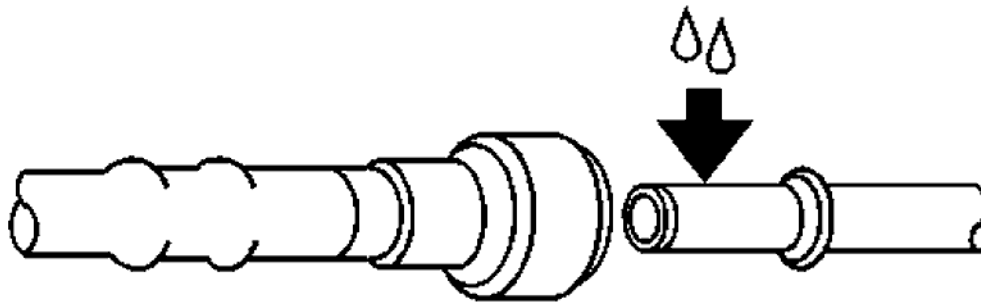


Fig. 92: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

CAUTION: 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.

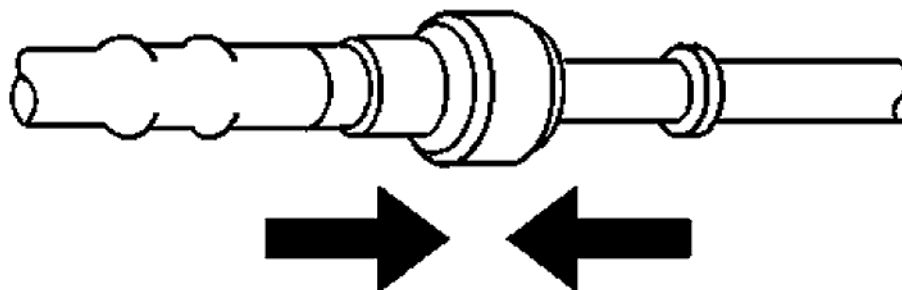


Fig. 93: Assembling Connectors (Metal Collar)

Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the fitting together in order to snap the retaining tabs into place.

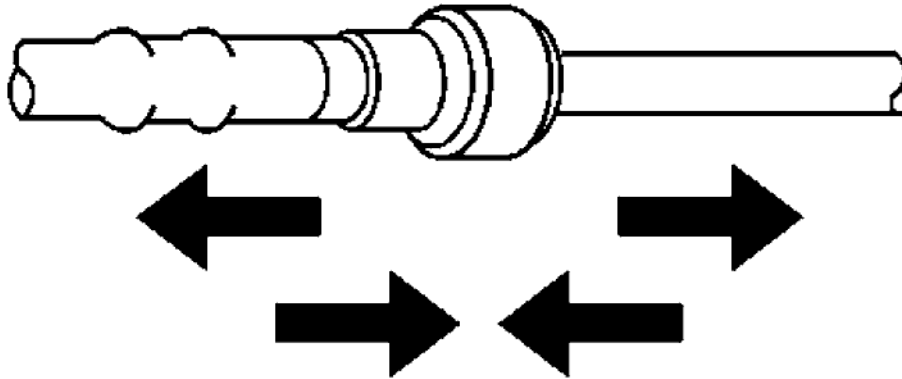


Fig. 94: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS CORP.

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

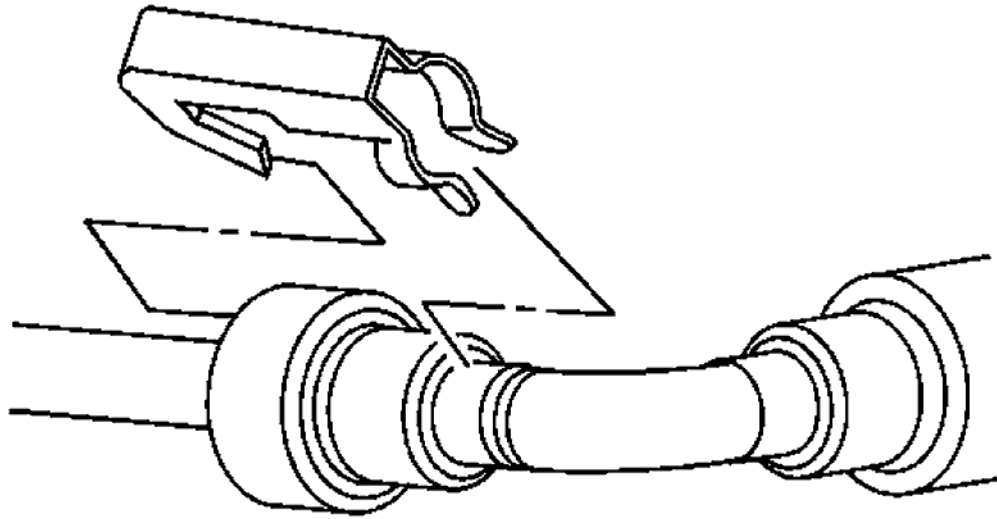


Fig. 95: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Install the retainer to the quick connect fitting.

QUICK CONNECT FITTING(S) SERVICE (PLASTIC COLLAR)

Removal Procedure

CAUTION: Refer to Gasoline/Gasoline Vapors
Caution .

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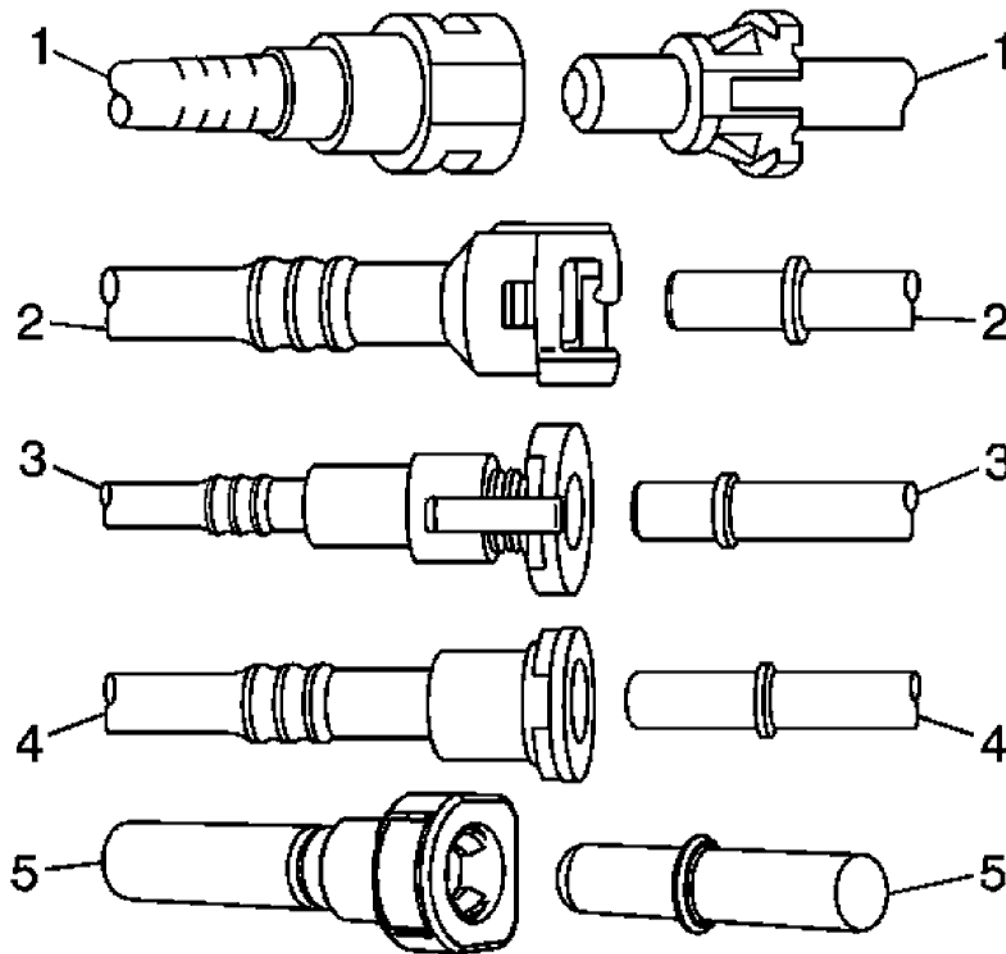


Fig. 96: Identifying Plastic Collar Fuel & Evaporative Emission Quick Connect Fittings

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: There are several types of plastic collar fuel and evaporative emission quick connect fittings that may be used on this vehicle.

- Bartholomew (1)
- Q release (2)
- Squeeze to release (3)
- Sliding retainer (4)
- Push down TI (5)

The following instructions apply to all of these types of fittings except where indicated.

1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief Procedure.

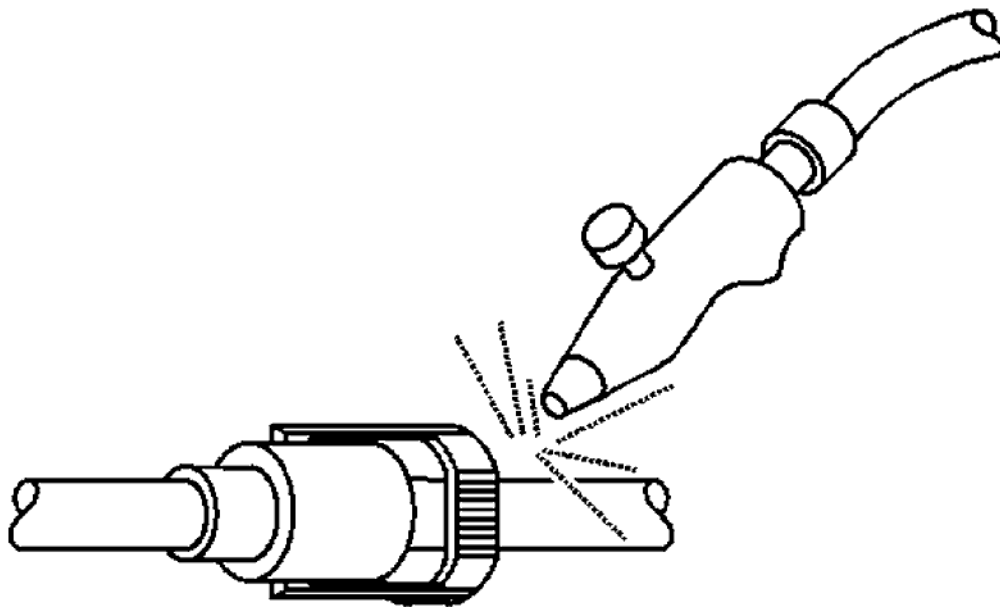


Fig. 97: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

CAUTION: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

2. Using compressed air, blow any dirt out of the quick connect fitting.

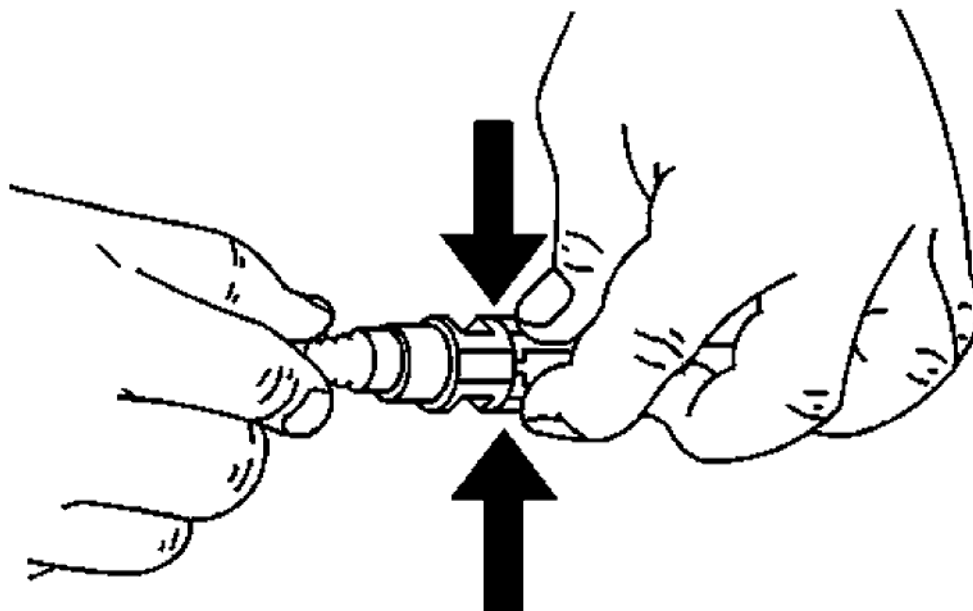


Fig. 98: Squeezing Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

3. This step applies to the Bartholomew style connectors ONLY. Squeeze the plastic quick connect fitting release tabs.

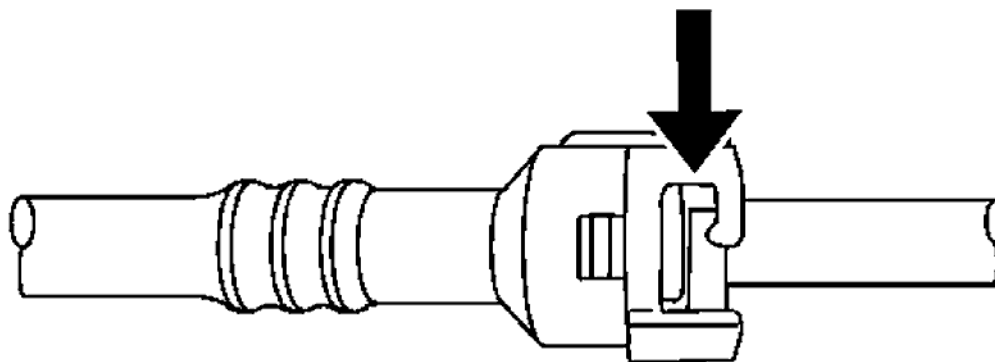


Fig. 99: Releasing Q Release Style Connectors (Plastic Collar)

Courtesy of GENERAL MOTORS CORP.

4. This step applies to the Q release type connectors ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.

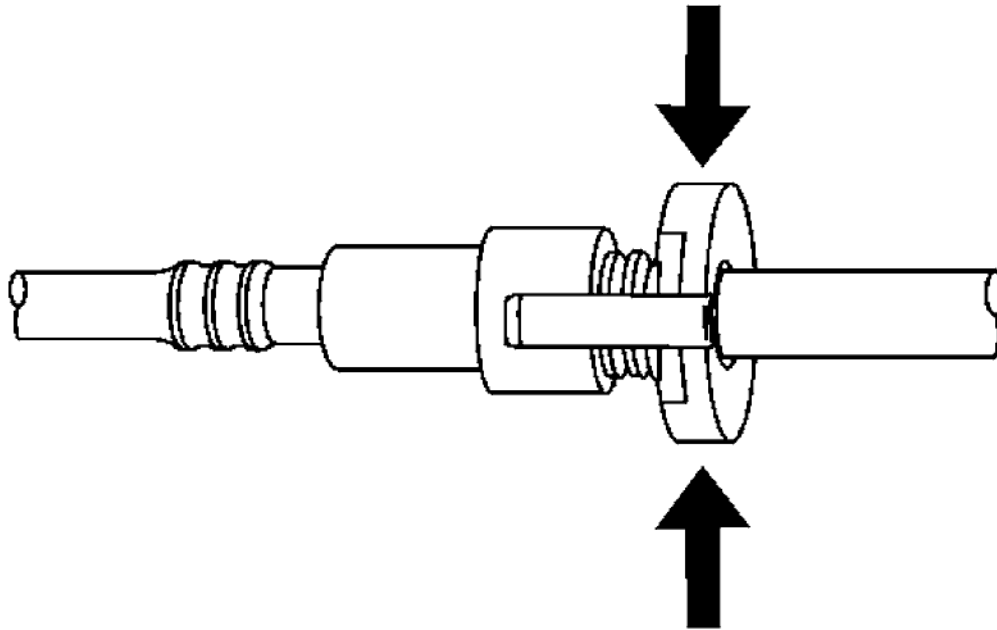


Fig. 100: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

5. This step applies to the Squeeze to release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick connect fitting.

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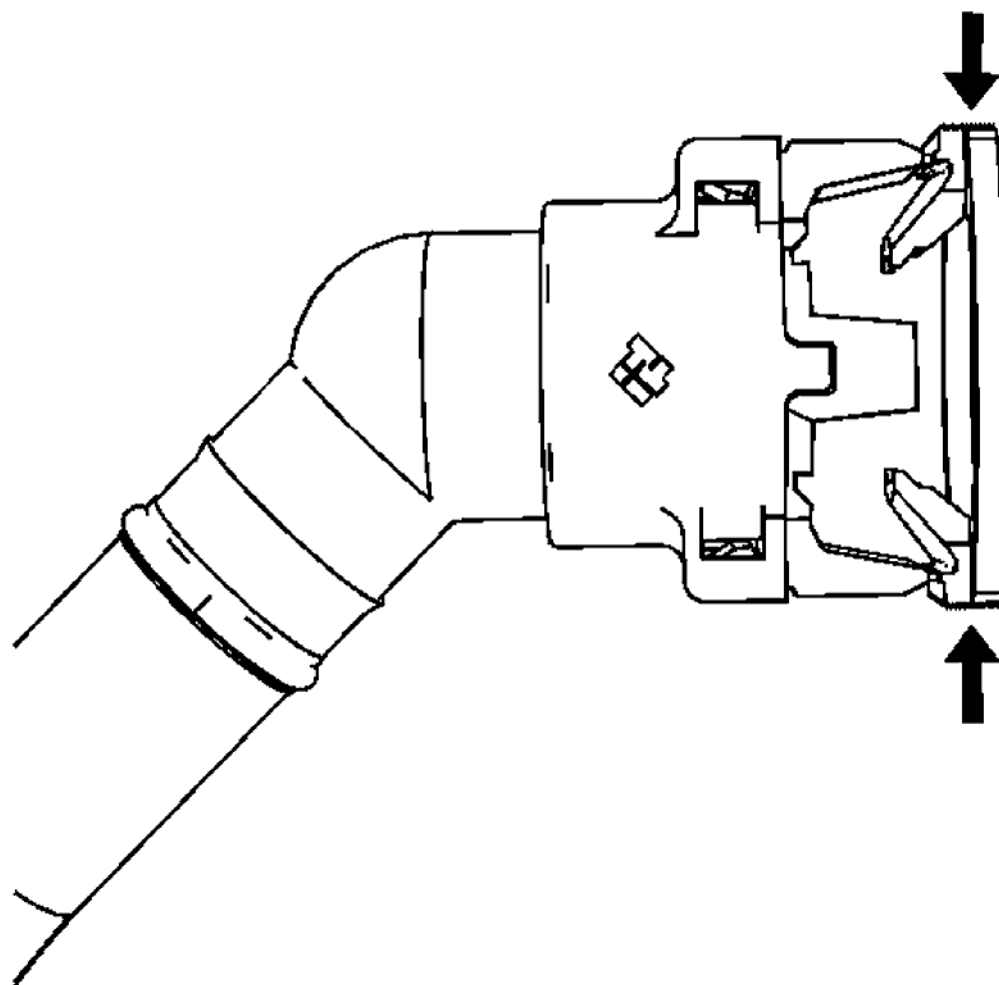


Fig. 101: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

6. This step also applies to the Squeeze to release style connectors ONLY. Squeeze where indicated by the arrows on both sides of the plastic ring surrounding the quick connect fitting.

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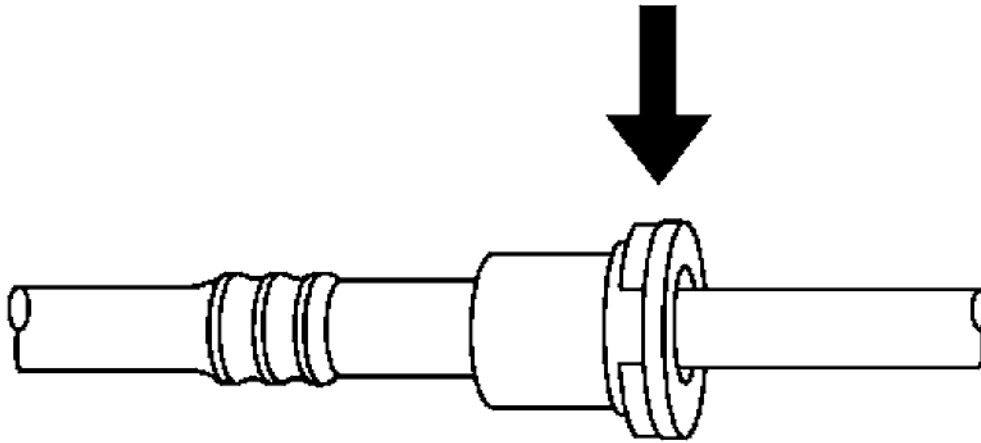


Fig. 102: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS CORP.

7. This step applies to the Sliding retainer style connectors 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.

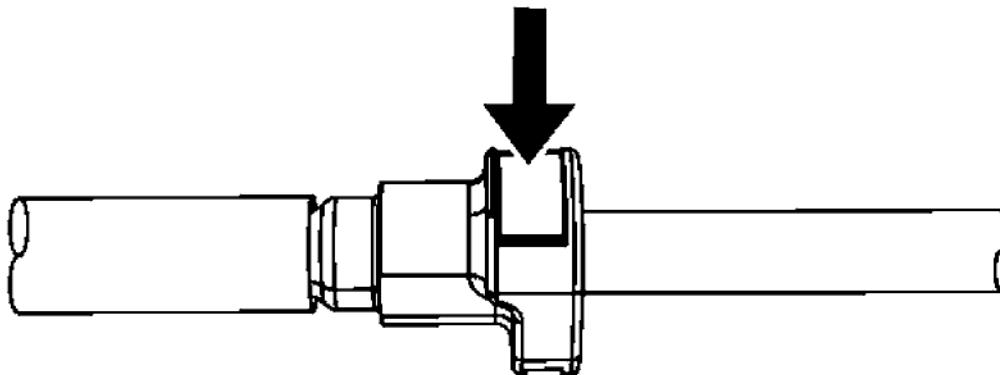


Fig. 103: View Of Push Down TI Style Connector
Courtesy of GENERAL MOTORS CORP.

8. This step applies to the Push down TI style connectors ONLY. Release the fitting by pressing on the tabs indicated by the arrow.

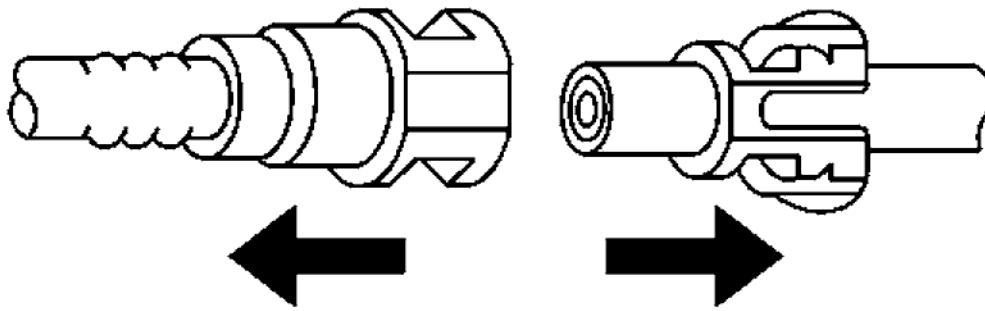


Fig. 104: Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

9. Pull the connection apart.
10. Wipe off the male pipe end using a clean shop towel.
11. Inspect both ends of the fitting for dirt and burrs.
12. Clean or replace the components as required.

Installation Procedure

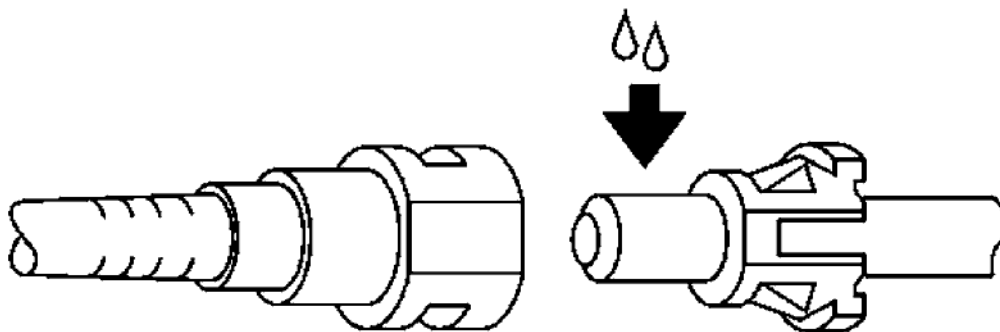


Fig. 105: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS CORP.

1. Apply a few drops of clean engine oil to the male connection end.

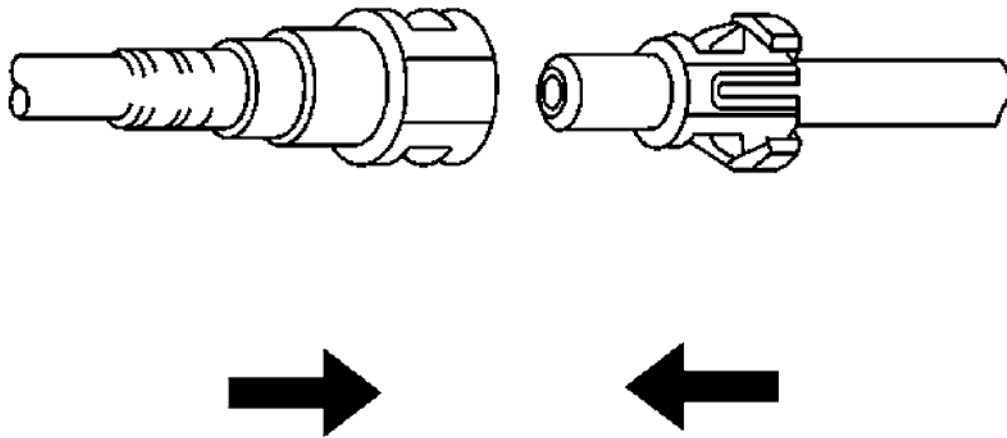


Fig. 106: Connecting Fittings (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick connect fitting together in order to cause the retaining feature to snap into place.

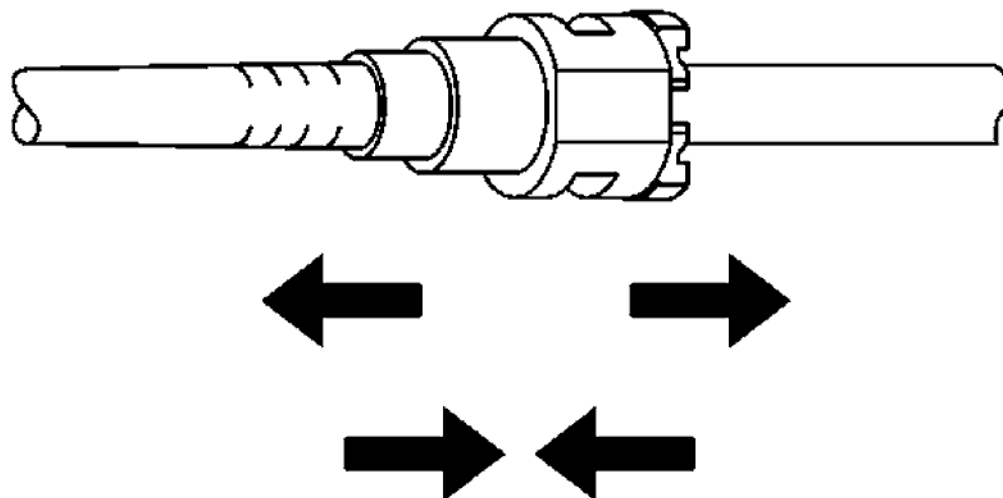


Fig. 107: Ensuring Secure Connection

Courtesy of GENERAL MOTORS CORP.

3. Once installed, pull on both sides of the quick connect fitting in order to make sure the connection is secure.

FUEL TANK DRAINING PROCEDURE

Tools Required

- **J 43290** Fuel Tank Siphoning Hose
- **J 42960-2** Fuel Flapper Door Holder. See Special Tools.

CAUTION: 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.

CAUTION: 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.
2. Install the **J 42960-2** , or equivalent, into the fuel fill pipe in order to hold the door open. See Special Tools.

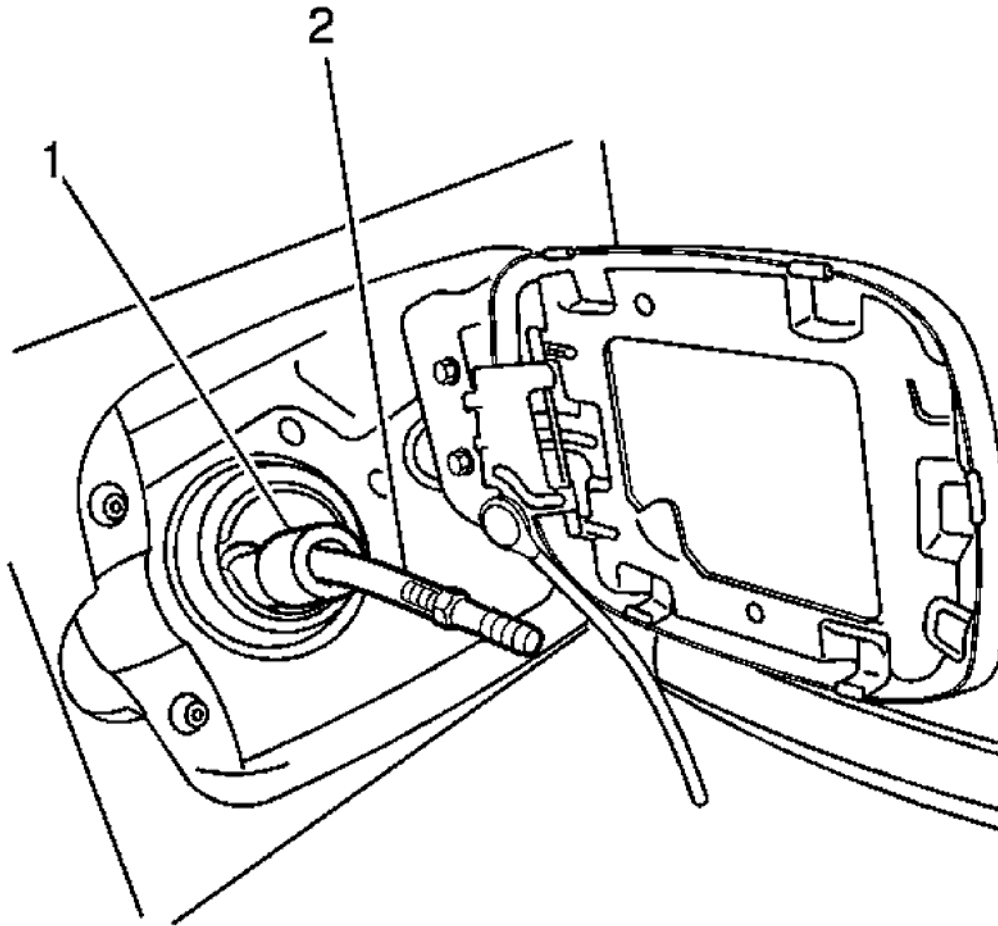


Fig. 108: View Of J 43290 & J 42960-2 Inserted Into Filler Pipe
Courtesy of GENERAL MOTORS CORP.

3. Insert the **J 43290** (2) through the **J 42960-2** (1) and into the fill pipe. See **Special Tools**.
4. Continue to insert the **J 43290** (2) into the fill pipe until the hose exits the valve (1) and reaches the bottom of the tank.
5. Use an air operated pump device in order to drain as much fuel out through the **J 43290** (1) as possible.

FUEL TANK REPLACEMENT

Removal Procedure

CAUTION: Refer to Gasoline/Gasoline Vapors

Caution .

NOTE: Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering the open pipes and passages.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief Procedure**.
2. Drain the fuel tank. Refer to **Fuel Tank Draining Procedure**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

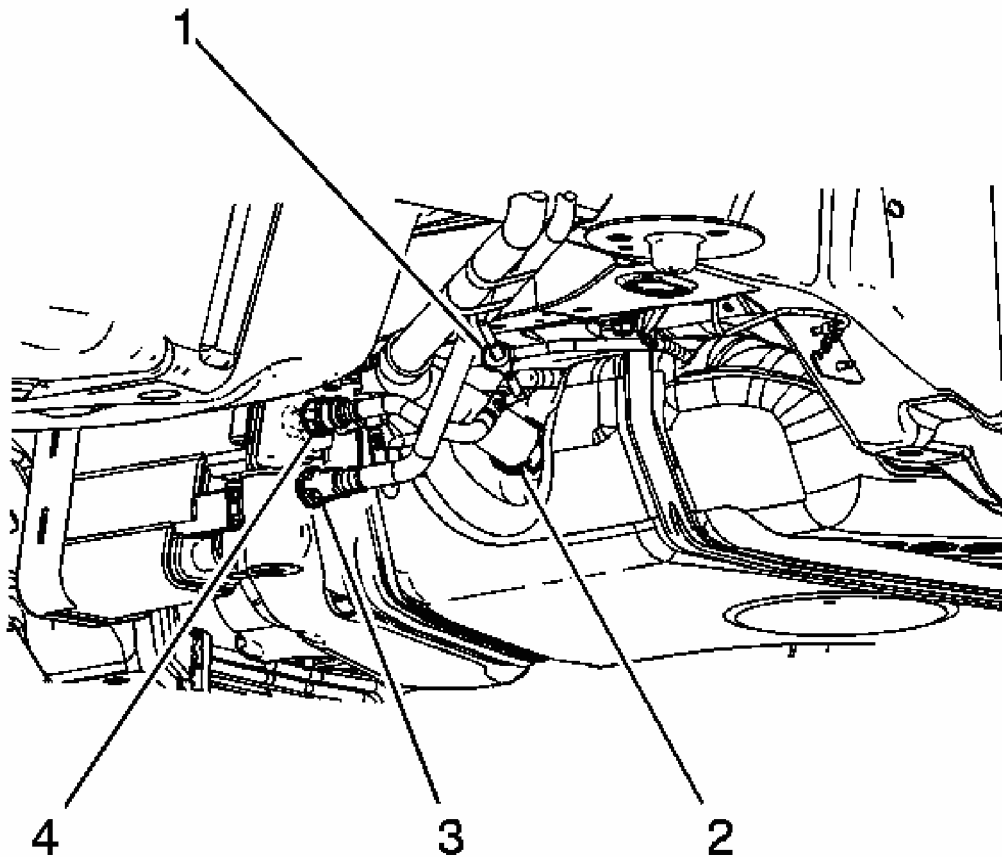


Fig. 109: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fuel tank vent pipe quick connect fittings (1, 4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Loosen the fuel fill pipe hose clamp (2) at the fuel tank.

6. Remove the fuel fill pipe hose from the fuel tank.

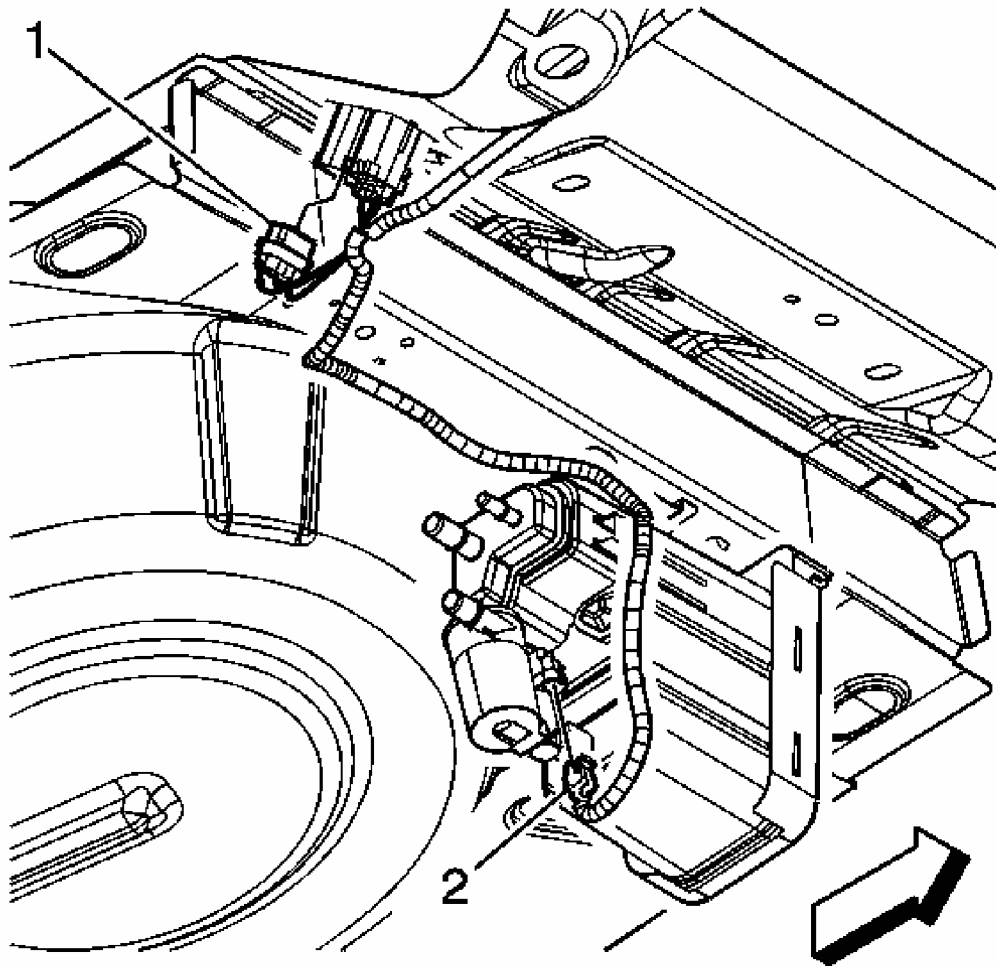


Fig. 110: Fuel Tank Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the fuel tank electrical connector (1) from the pass thru connector.

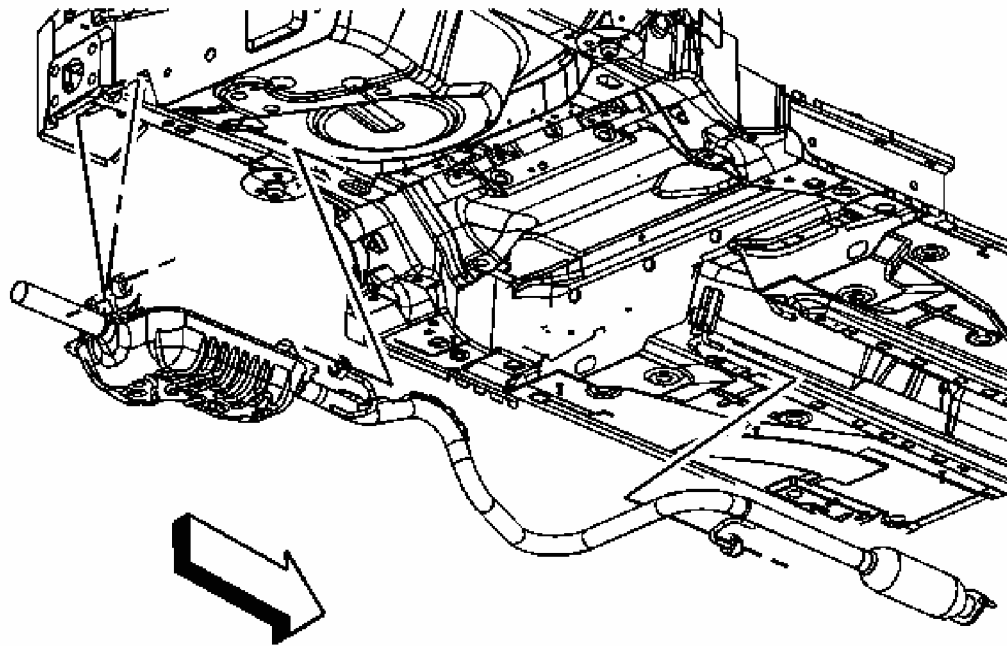


Fig. 111: Exhaust Pipe Insulators
Courtesy of GENERAL MOTORS CORP.

8. Remove the exhaust pipe insulators from the underbody hangers.
9. Remove the muffler insulators from the underbody hanger and slowly lower the exhaust in order to allow it to rest on the rear axle beam.

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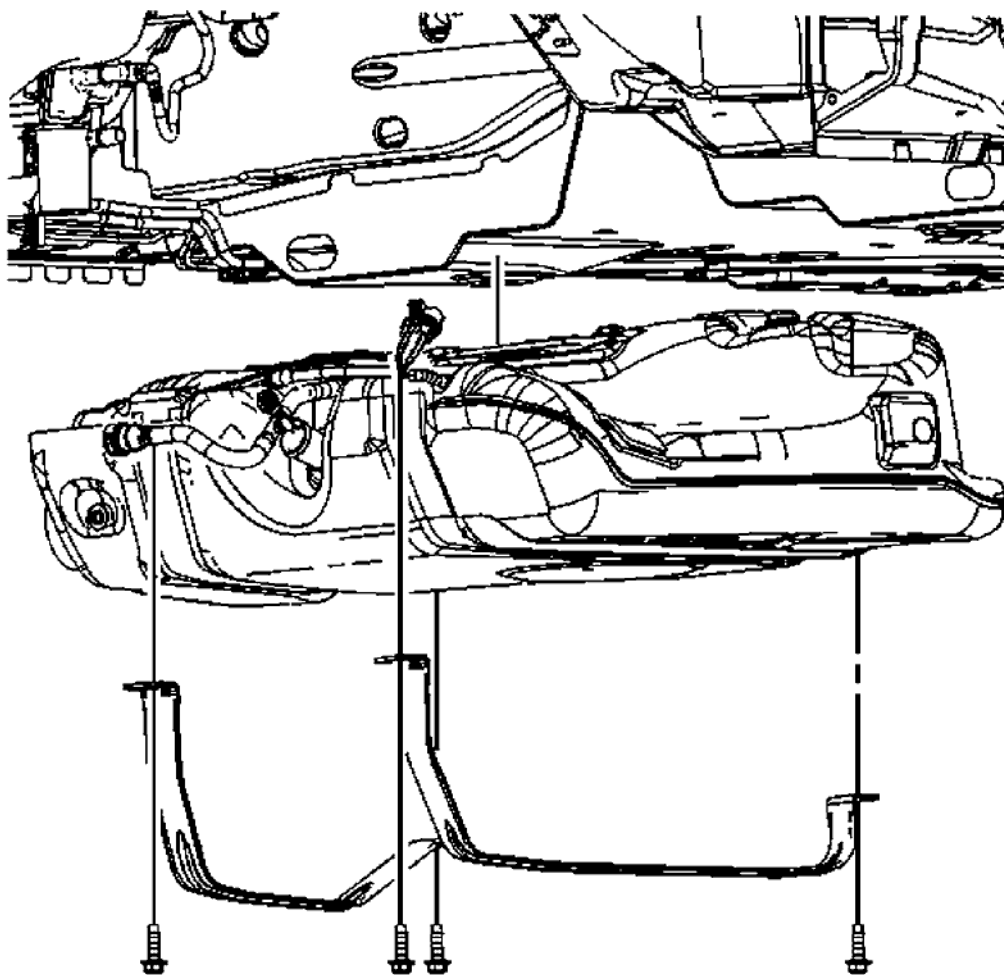


Fig. 112: Fuel Tank & Straps
Courtesy of GENERAL MOTORS CORP.

10. Place an adjustable jack under the fuel tank.
11. Remove the fuel tank strap bolts.
12. Remove the fuel tank straps.
13. Using the adjustable jack, carefully lower the fuel tank away from the vehicle.
14. With the aid of an assistant, place the fuel tank on a suitable work surface.

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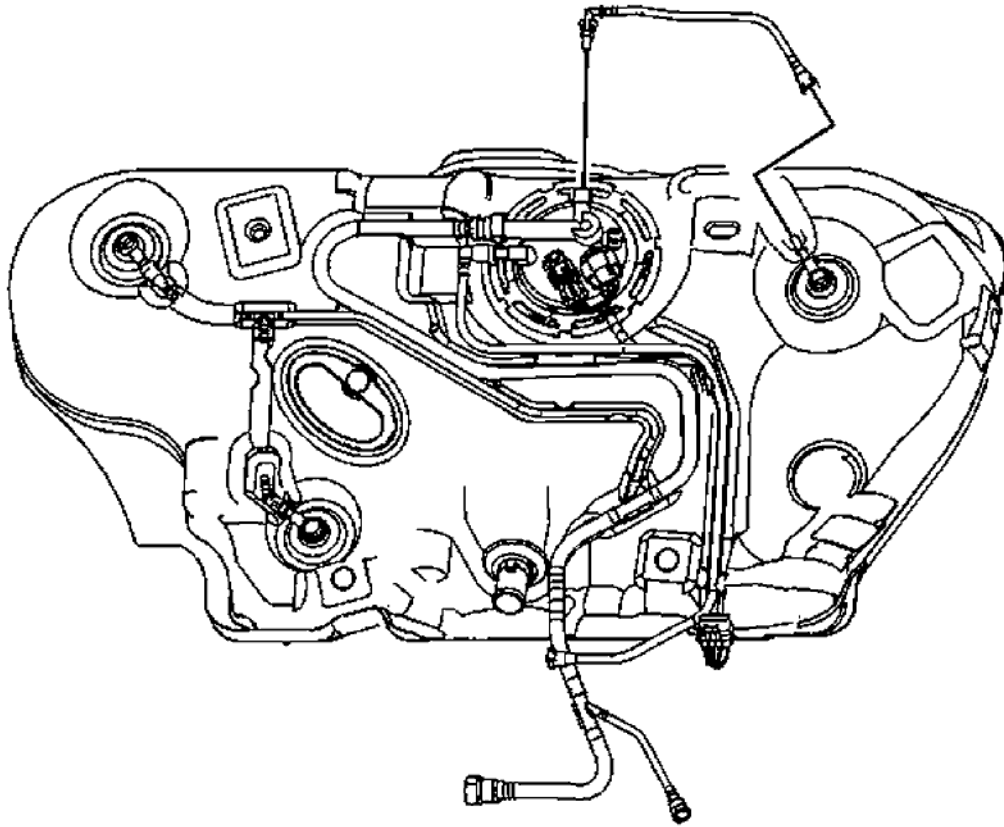


Fig. 113: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

15. If replacing the fuel tank perform the following steps, remove the fuel tank vent pipe. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

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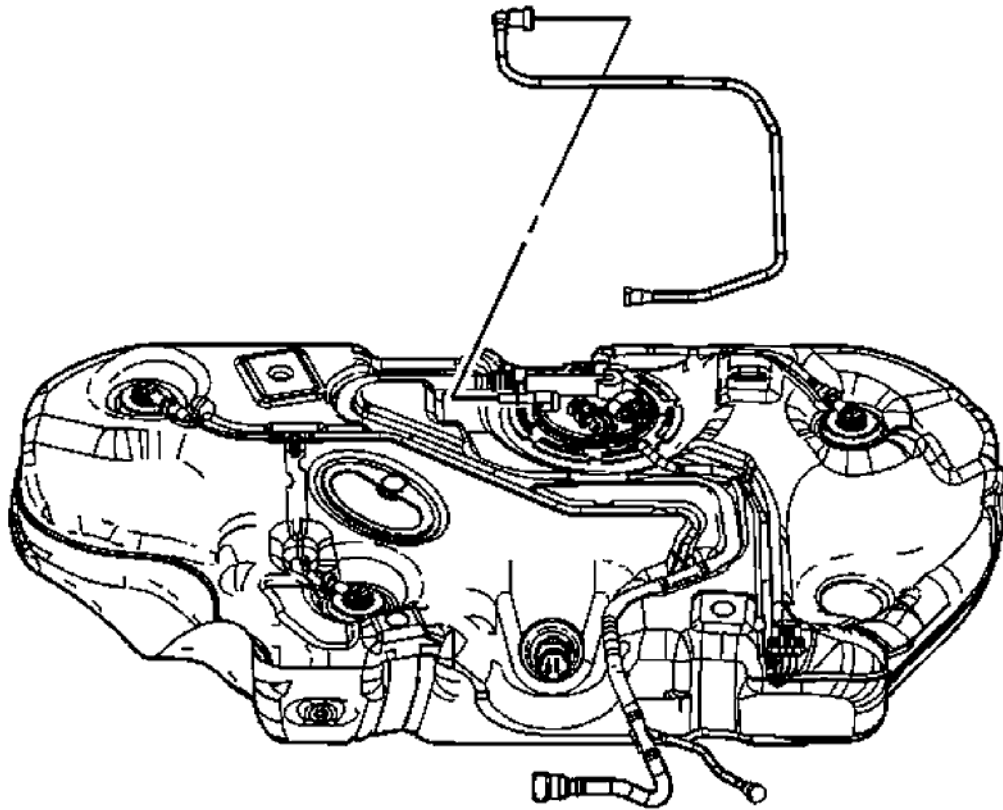


Fig. 114: Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

16. Remove the fuel feed intermediate pipe. Refer to Quick Connect Fitting(s) Service (Plastic Collar).

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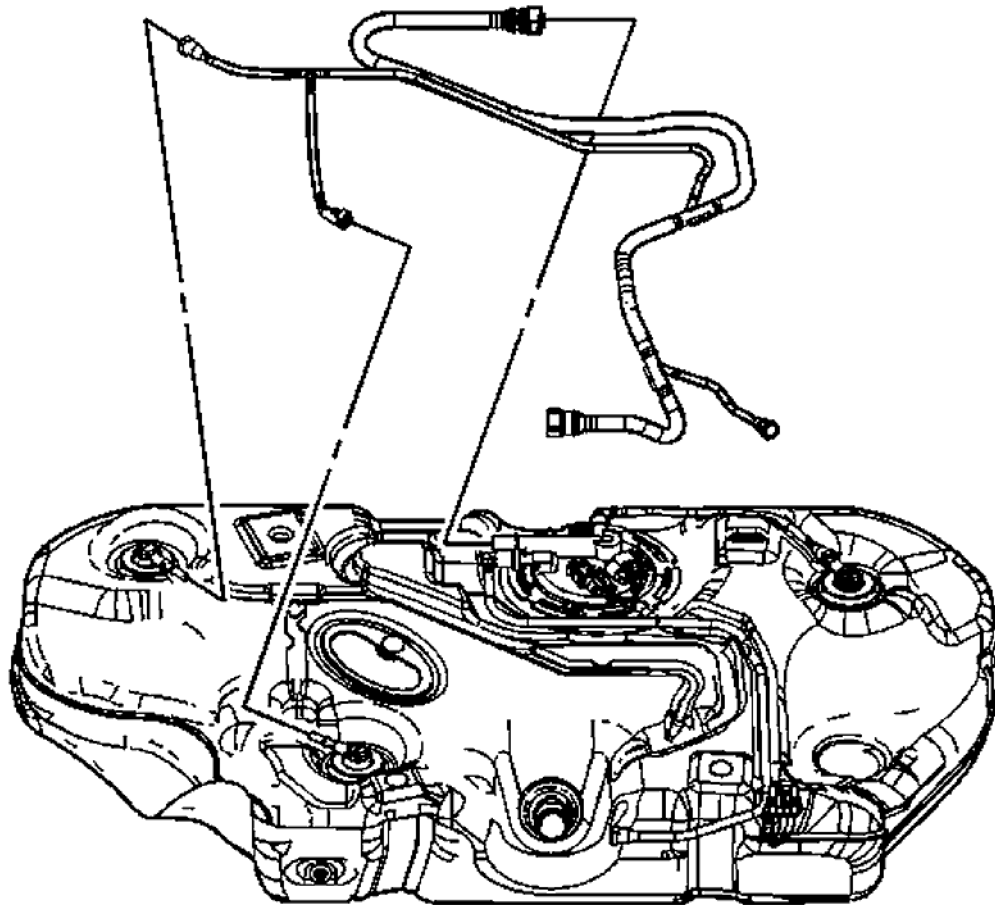


Fig. 115: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

17. Remove the fuel tank vent pipe. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

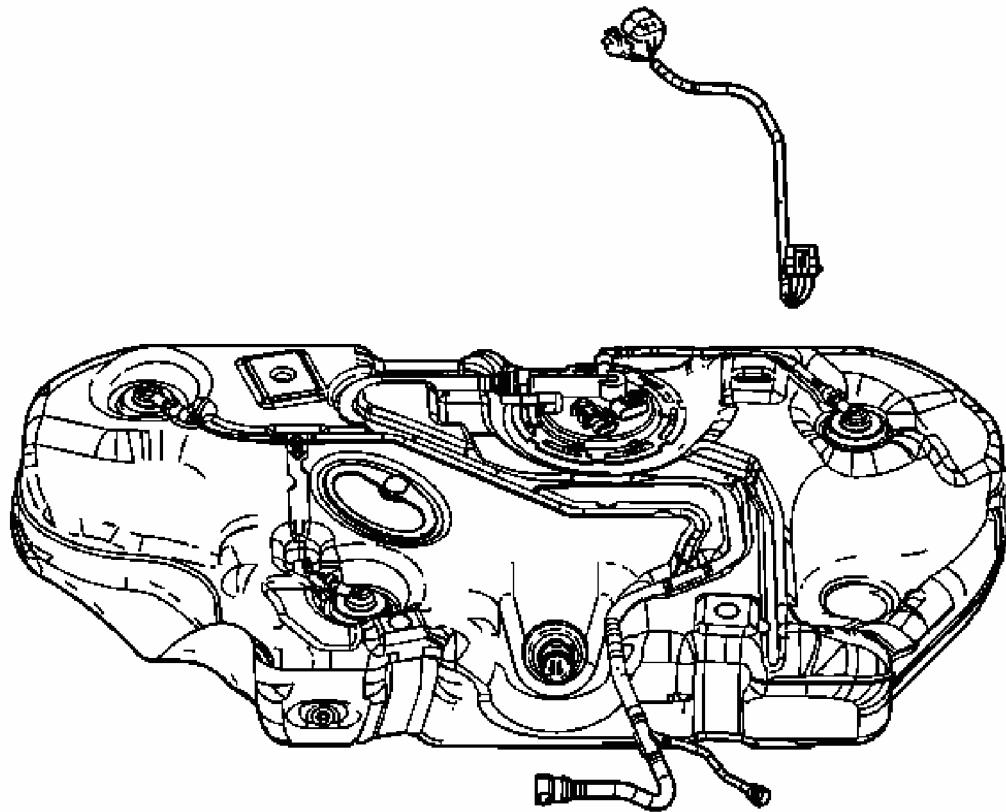


Fig. 116: Fuel Tank Electrical Harness
Courtesy of GENERAL MOTORS CORP.

18. Disconnect and remove the fuel tank electrical harness.
19. Remove the fuel tank module. Refer to **Fuel Pump Module Replacement**.

Installation Procedure

1. If the fuel tank was replaced perform the following steps, install the fuel tank module. Refer to **Fuel Pump Module Replacement**.

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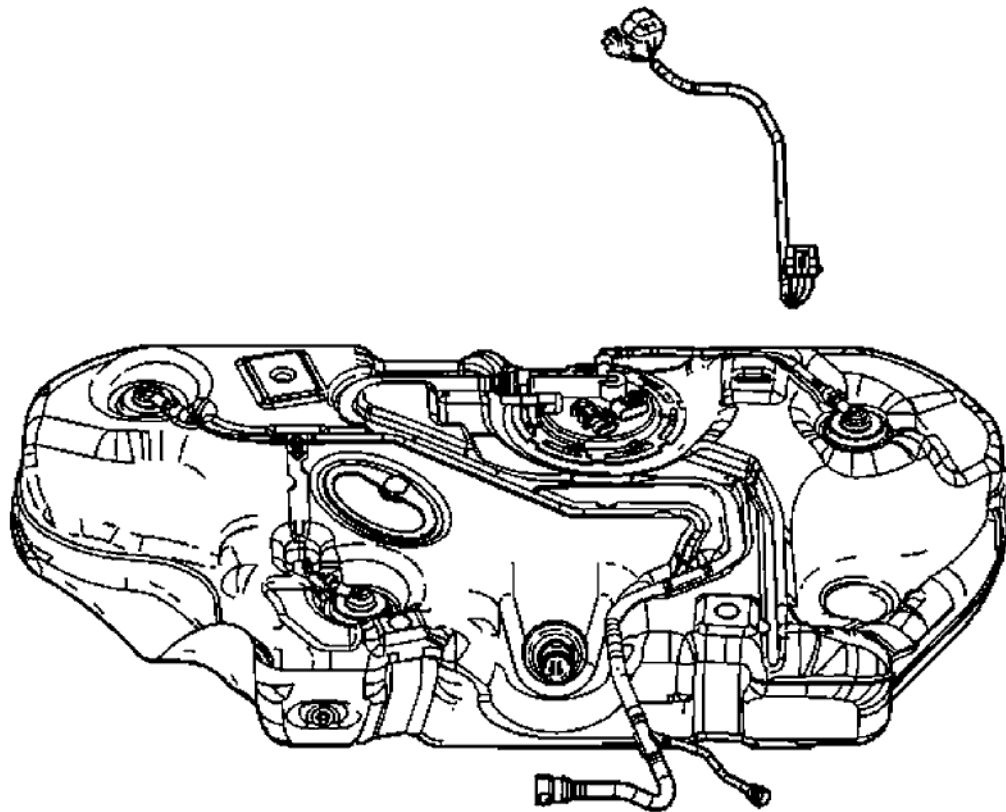


Fig. 117: Fuel Tank Electrical Harness
Courtesy of GENERAL MOTORS CORP.

2. Install and connect the fuel tank electrical harness.

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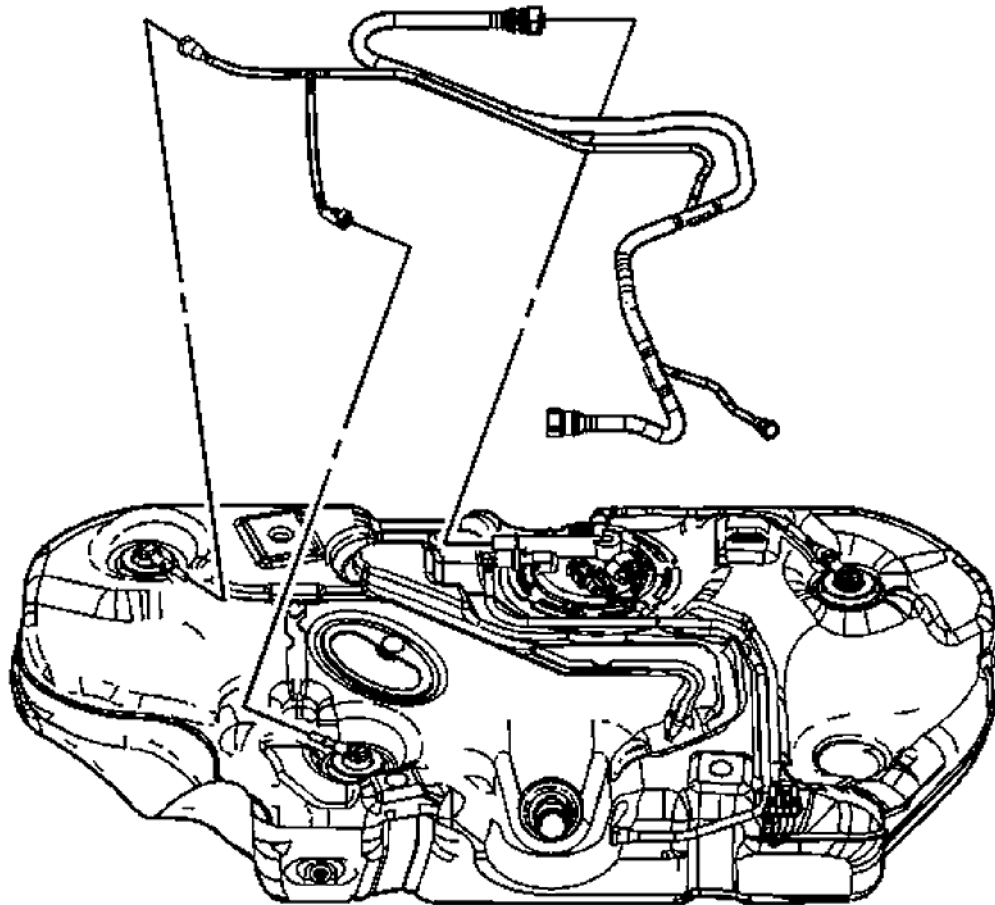


Fig. 118: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel tank vent pipe. Refer to Quick Connect Fitting(s) Service (Plastic Collar).

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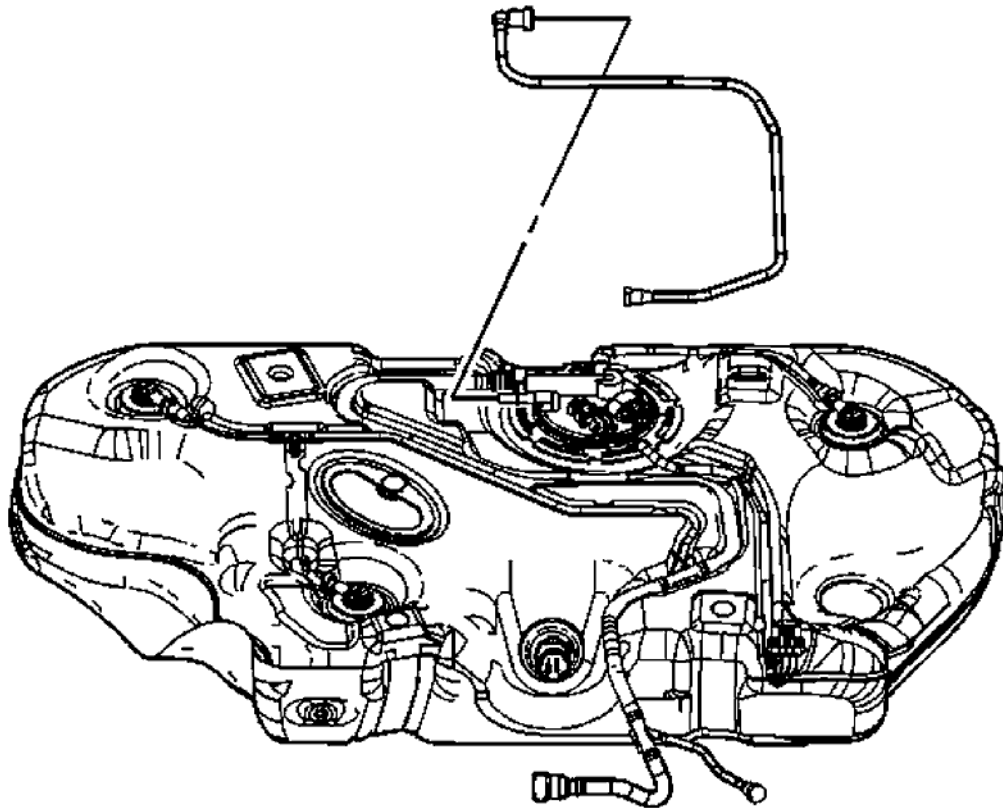


Fig. 119: Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

4. Install the fuel feed intermediate pipe. Refer to Quick Connect Fitting(s) Service (Plastic Collar).

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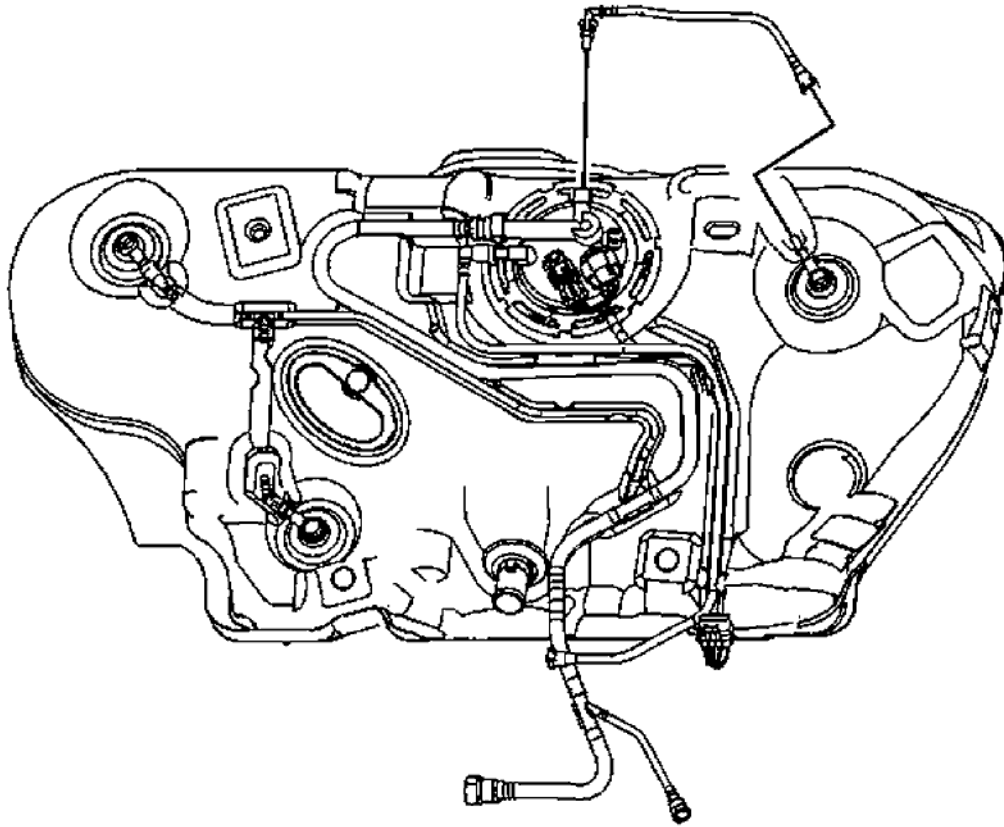


Fig. 120: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

5. Install the fuel tank vent pipe. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

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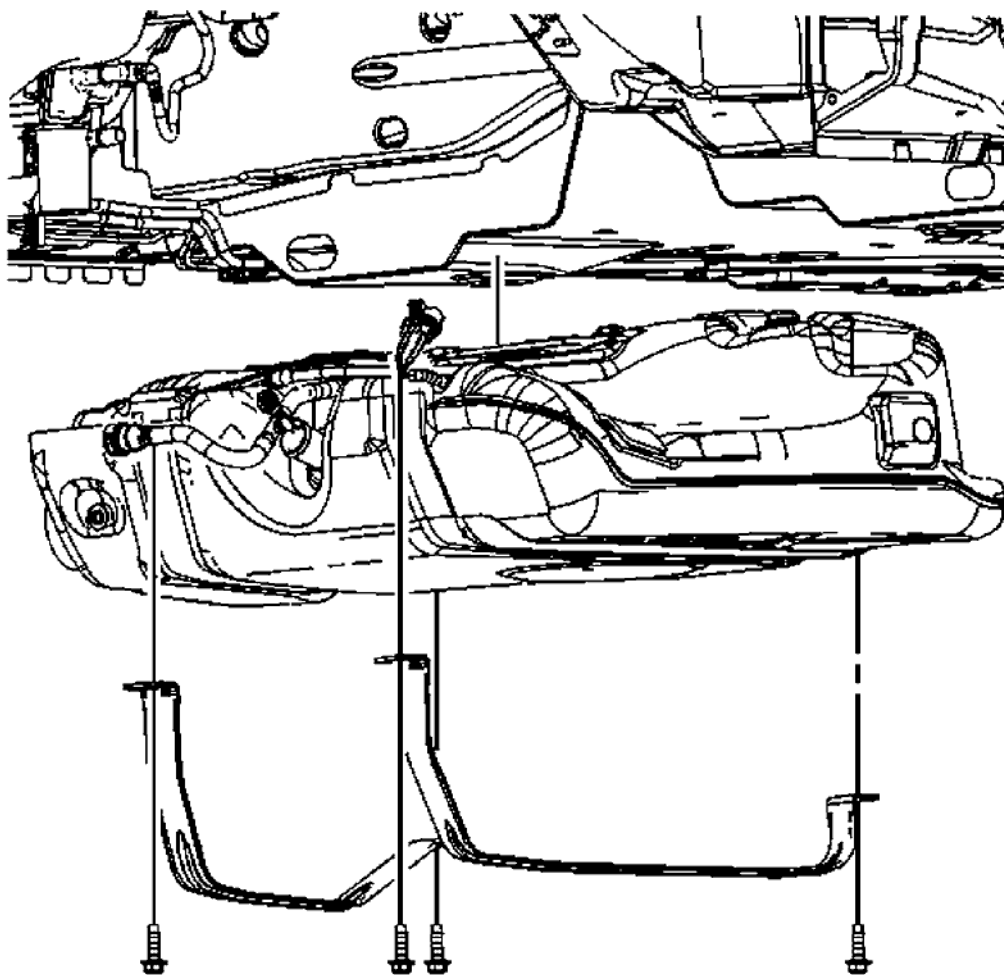


Fig. 121: Fuel Tank & Straps
Courtesy of GENERAL MOTORS CORP.

6. With the aid of an assistant, place the fuel tank on the suitable jack.
7. Using the adjustable jack, carefully raise the fuel tank into position.
8. Position the fuel tank straps.

NOTE: Refer to Fastener Notice .

9. Install the fuel tank strap bolts.

Tighten: Tighten the bolts to 45 N.m (33 lb ft).

10. Remove adjustable jack from under the fuel tank.

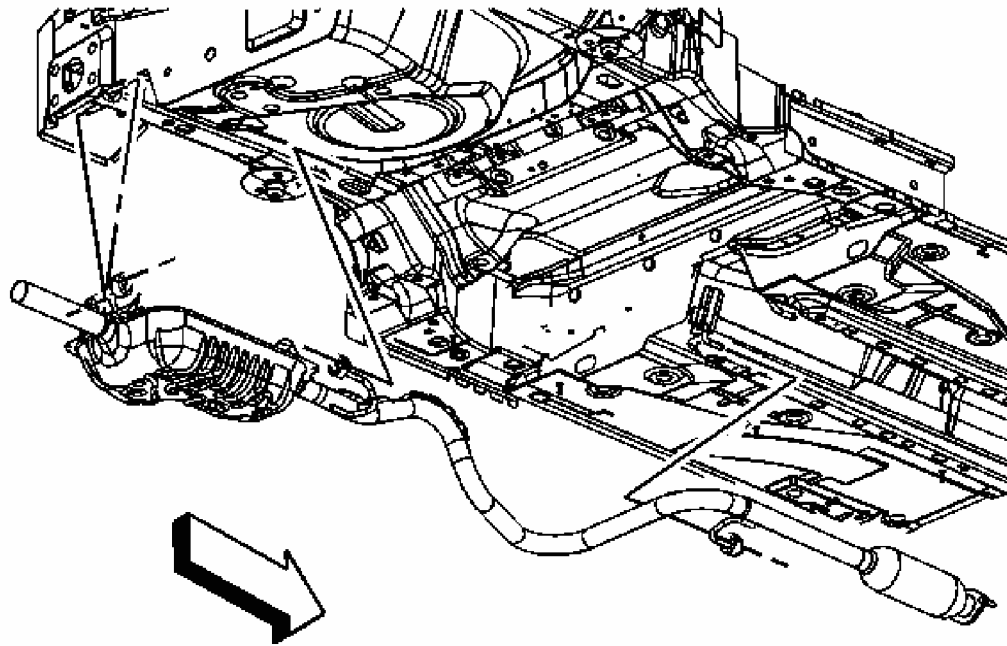


Fig. 122: Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

11. Raise the exhaust and install the muffler insulators to the underbody hangers.
12. Install the exhaust pipe insulators to the underbody hangers.

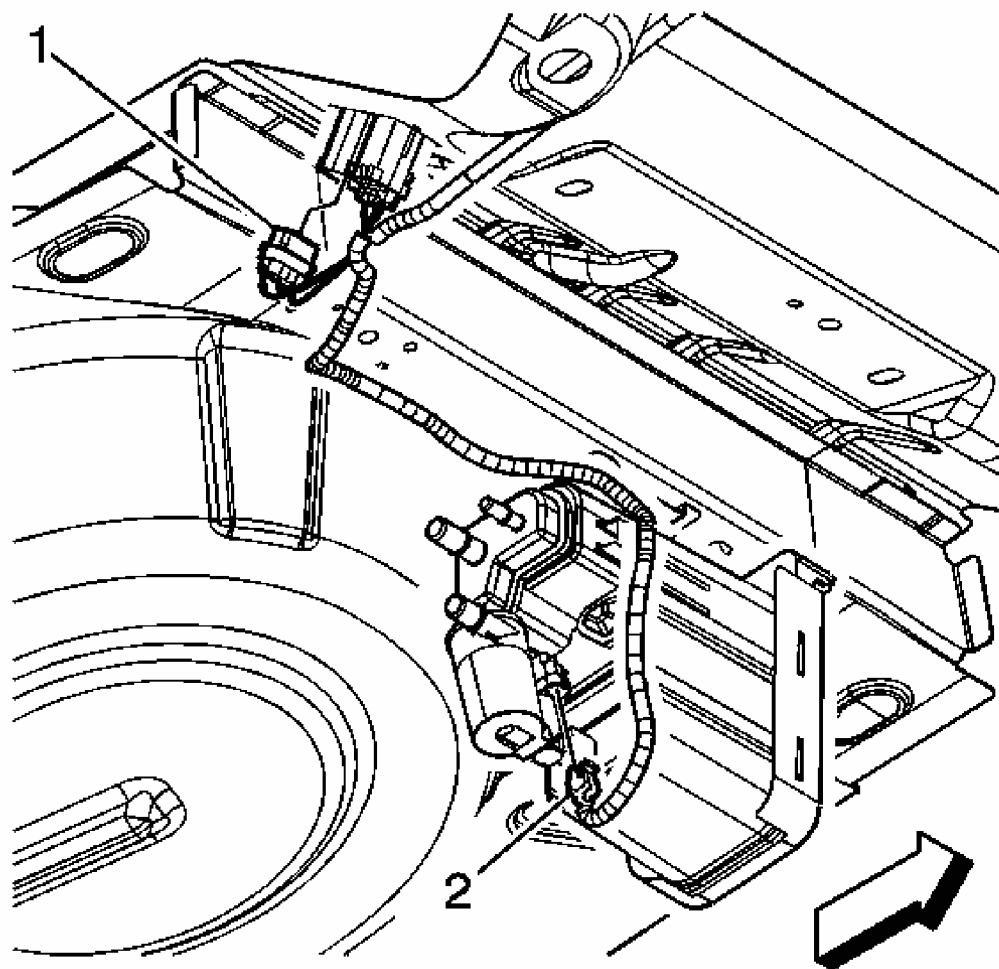


Fig. 123: Fuel Tank Electrical Connector
Courtesy of GENERAL MOTORS CORP.

13. Connect the fuel tank electrical connector (1) to the pass thru connector.

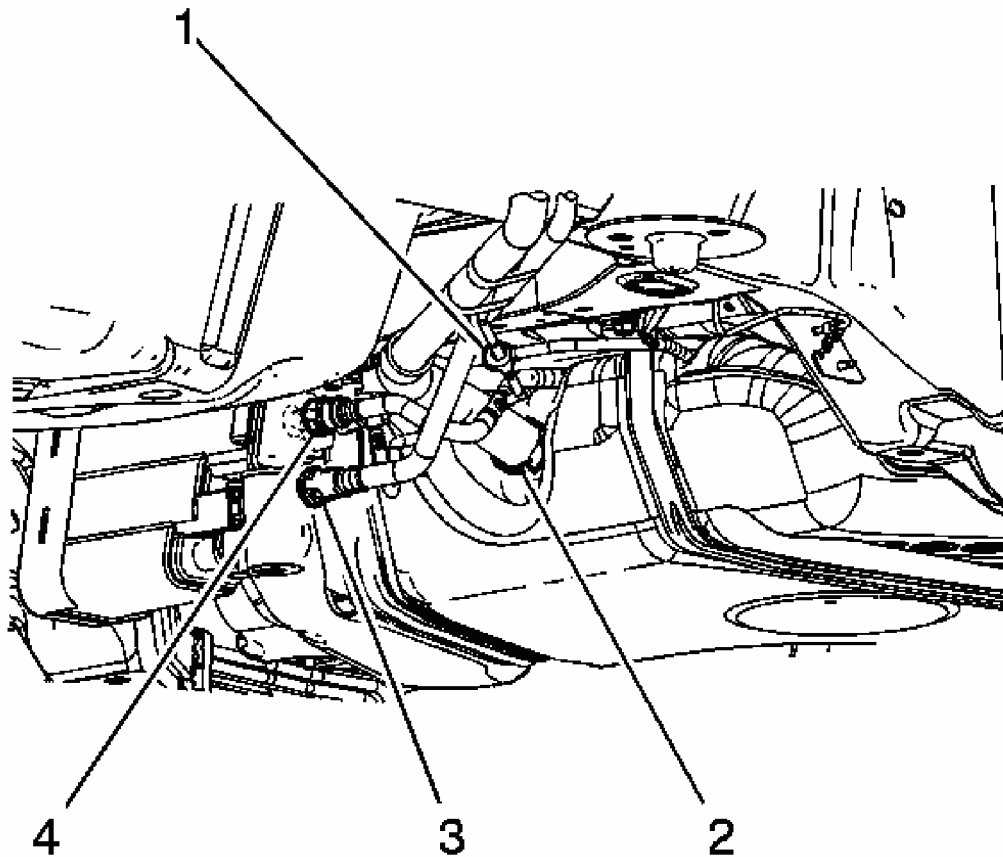


Fig. 124: Fuel Fill Pipe Hose
Courtesy of GENERAL MOTORS CORP.

14. Install the fuel fill pipe hose to the fuel tank.
15. Tighten the fuel fill pipe hose clamp (2) at the fuel tank.

Tighten: Tighten the clamp to 4.5 N.m (40 lb in).

16. Connect the fuel tank vent pipe quick connect fittings (1, 4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
17. Lower the vehicle.
18. Refill the fuel tank.
19. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
20. 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.

FUEL TANK PRESSURE SENSOR REPLACEMENT

Removal Procedure

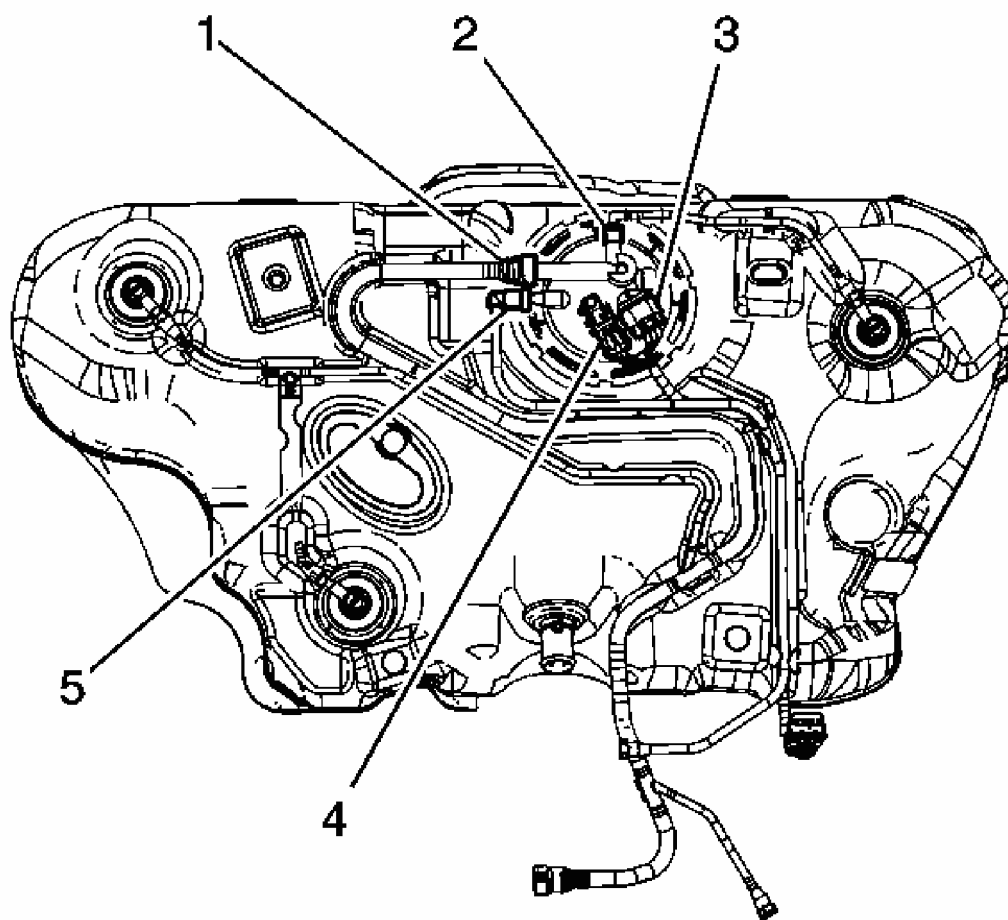


Fig. 125: Fuel Tank & Fuel Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect the fuel pressure sensor electrical connector (4).

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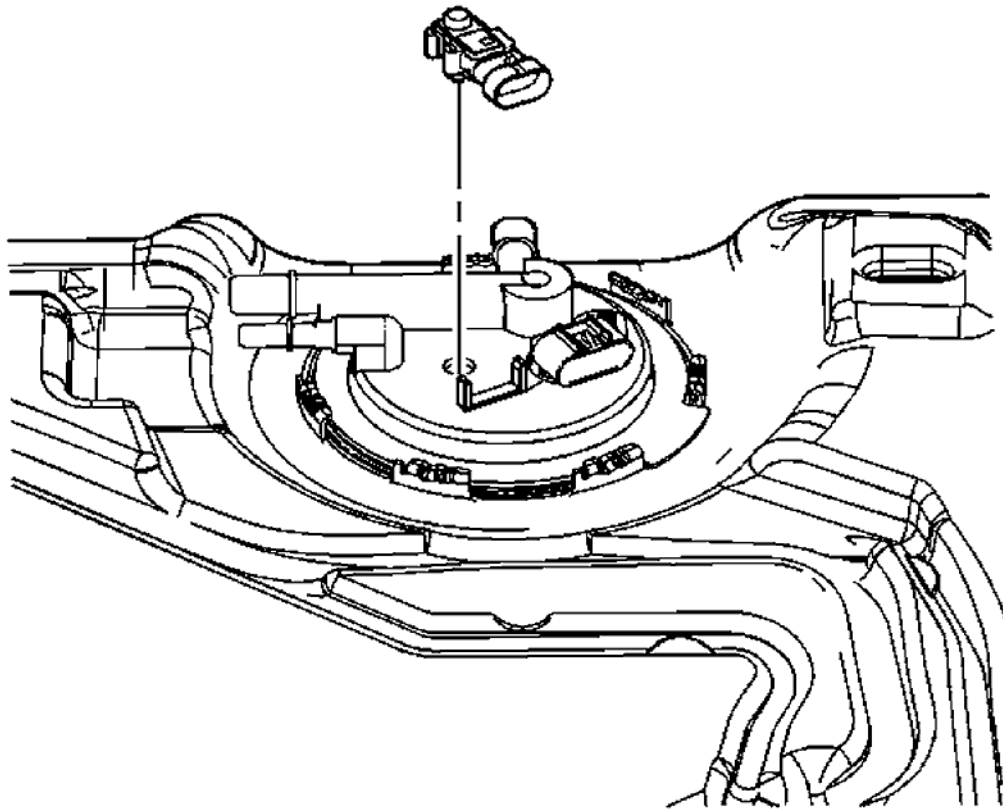


Fig. 126: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Position 2 flat-bladed screwdrivers, one on each side of the sensor, near the vacuum port.
4. Using the screwdrivers as leverage, carefully pry up in order to release the sensor from the module.

Installation Procedure

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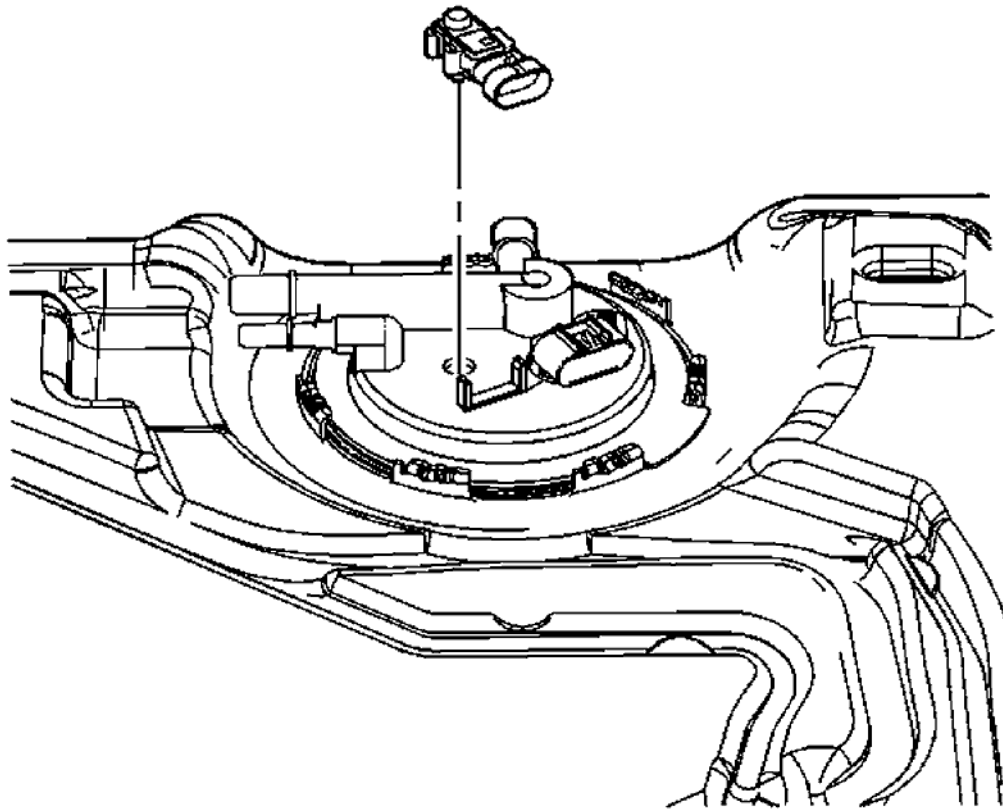


Fig. 127: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel tank pressure sensor to the module. Ensure that the sensor grommet is fully seated in the module.

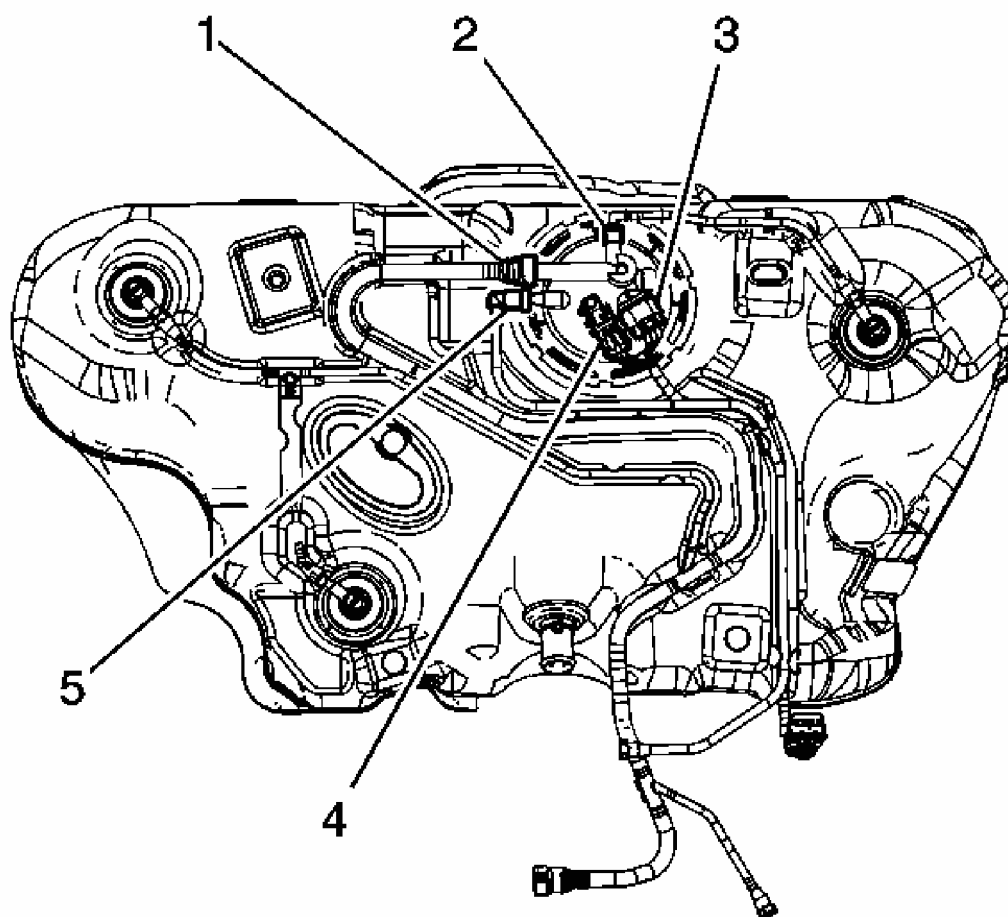


Fig. 128: Fuel Tank Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Connect the fuel pressure sensor electrical connector (4).
3. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

CAUTION: Refer to **Gasoline/Gasoline Vapors Caution** .

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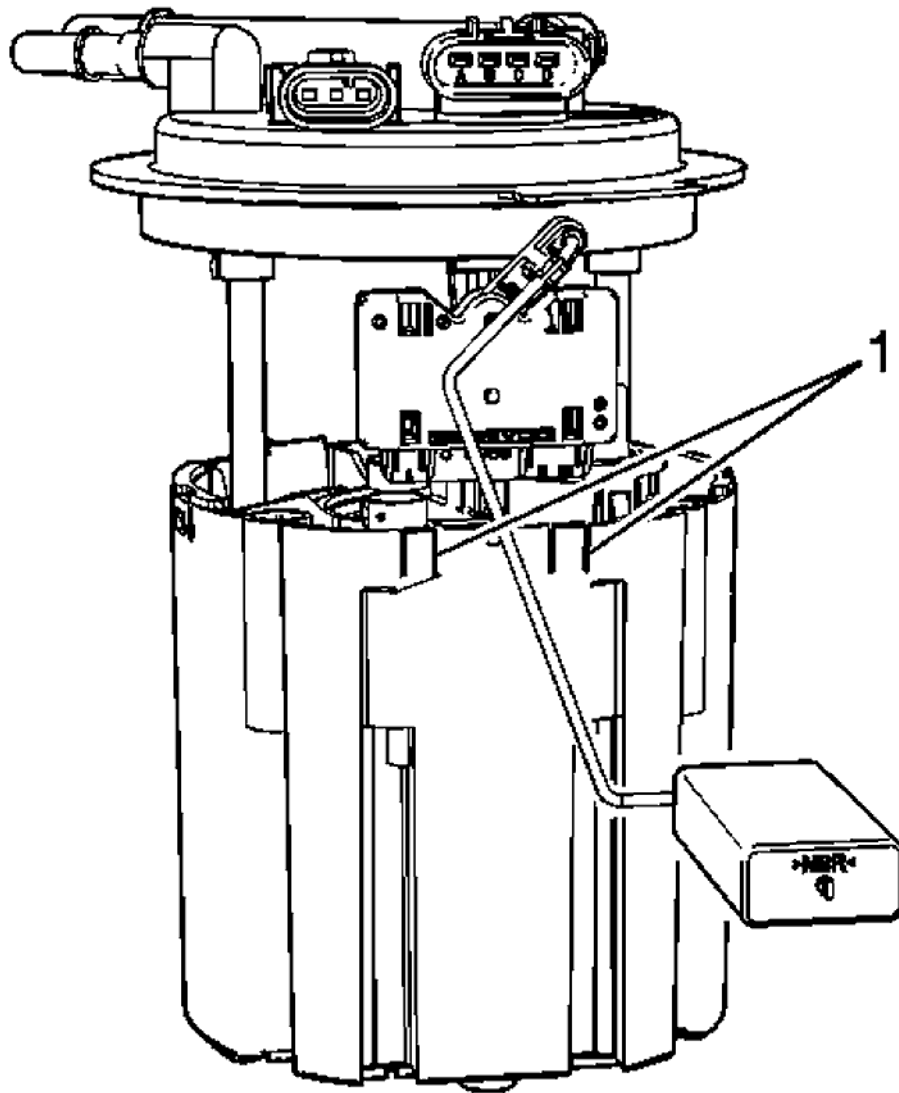


Fig. 129: Fuel Pump Module
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel pump module. Refer to **Fuel Pump Module Replacement**.
2. Release the retaining tabs (2) on the reservoir body and begin to slide the level sensor out away from the reservoir.
3. Carefully slide the level sensor the rest of the way out of the reservoir.

Installation Procedure

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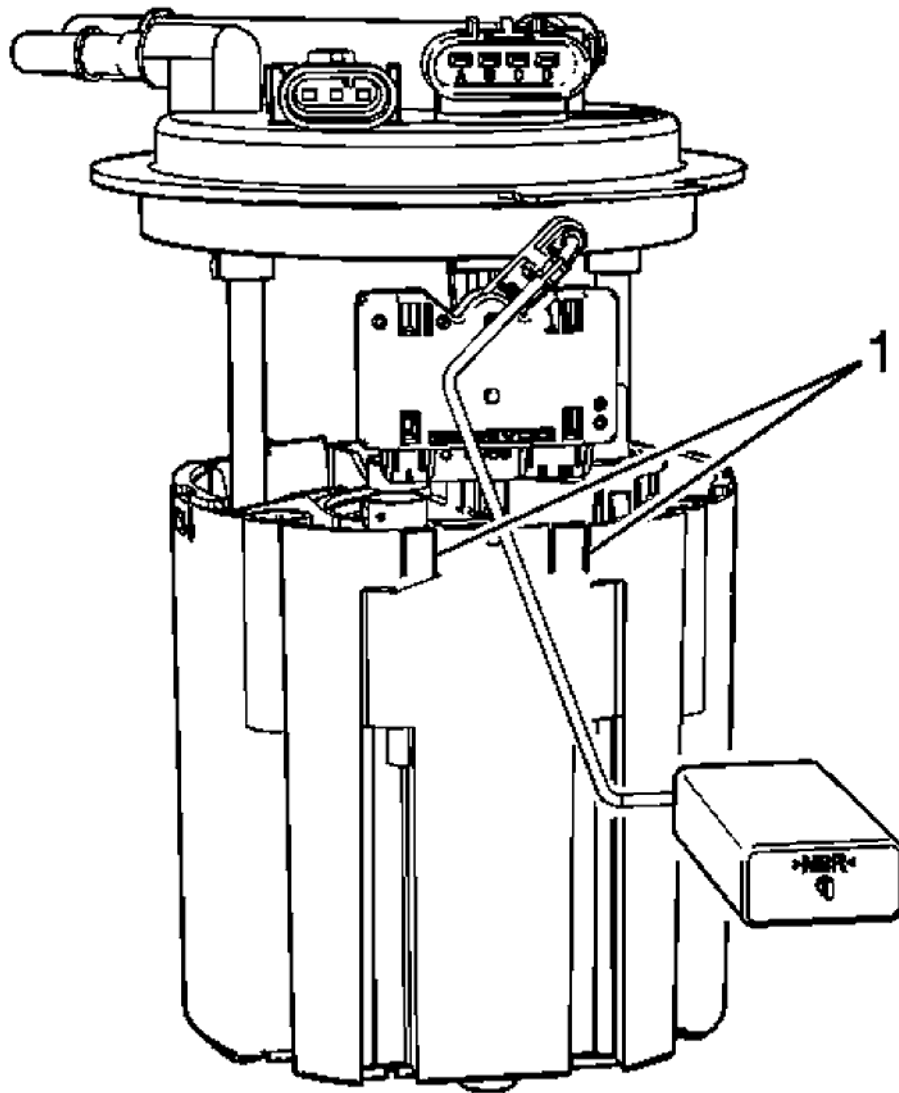


Fig. 130: Fuel Pump Module
Courtesy of GENERAL MOTORS CORP.

1. Carefully slide the fuel level sensor into the slots on the reservoir.
2. Slide the sensor down until the retaining tabs (2) engage the sensor.
3. Install the fuel pump module. Refer to **Fuel Pump Module Replacement**.

FUEL PUMP MODULE REPLACEMENT

Tools Required

J 45722 Fuel Sender Lock Ring Wrench. See Special Tools.

Removal Procedure

CAUTION: Refer to Gasoline/Gasoline Vapors Caution .

CAUTION: In order to reduce the risk of fire and personal injury that may result from a fuel leak, always replace the fuel sender gasket when reinstalling the fuel sender assembly.

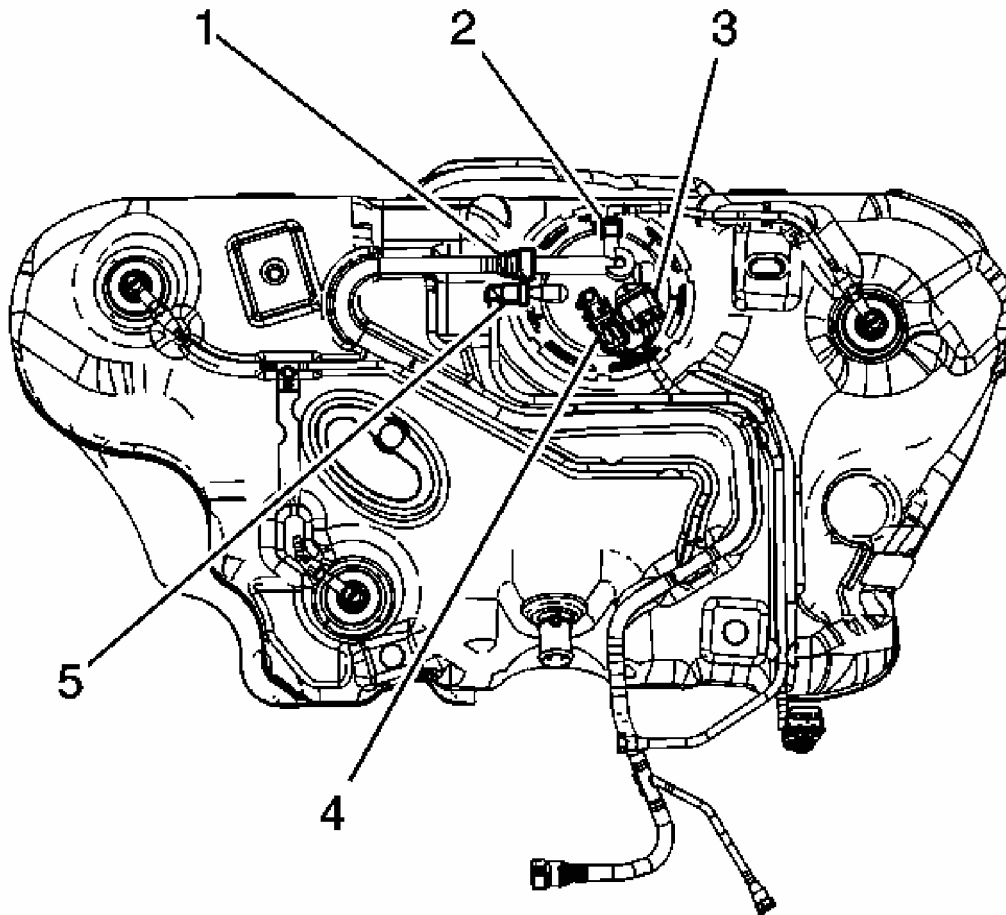


Fig. 131: Fuel Pressure Sensor & Fuel Pump Module Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Disconnect the fuel pressure sensor and fuel pump module electrical connectors (1, 4).

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3. Disconnect the fuel tank vent pipe quick connect fittings (2, 3). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Disconnect the fuel tank feed pipe quick connect fitting (5). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Install the **J 45722** to the lock ring. See **Special Tools**.

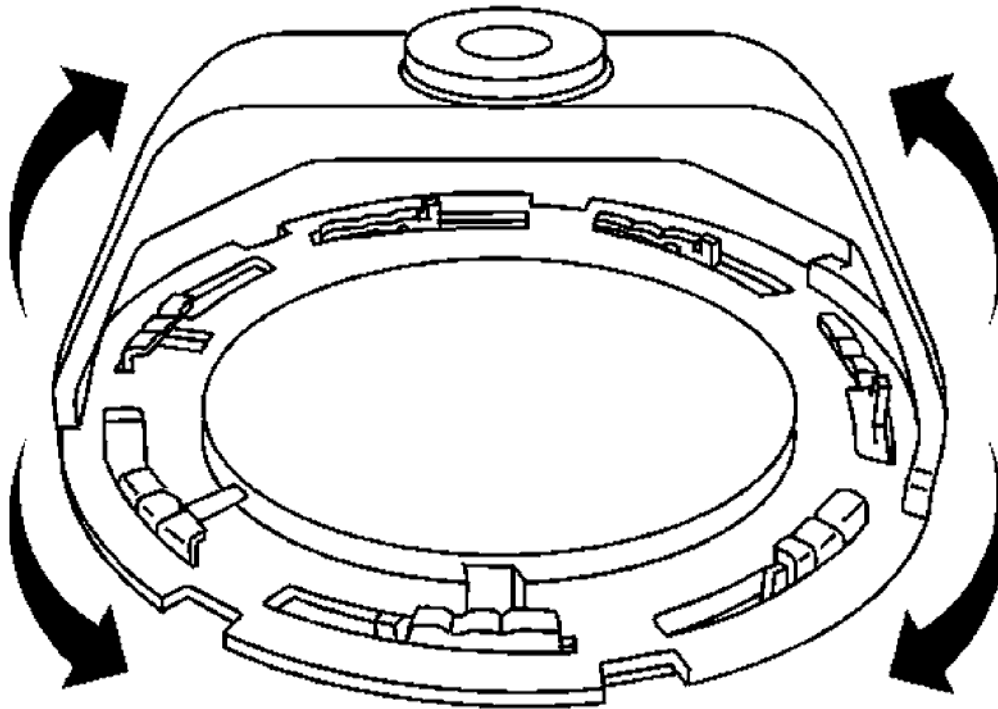


Fig. 132: Identifying Lock Ring
Courtesy of GENERAL MOTORS CORP.

- NOTE:** Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.
- NOTE:** Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.
- IMPORTANT:** Do NOT use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in

order to prevent fuel tank rotation.

6. Use the **J 45722** and a long breaker-bar in order to unlock the fuel sender lock ring. See **Special Tools**. Turn the fuel sender lock ring in a counterclockwise direction.
7. Remove the module lock ring.

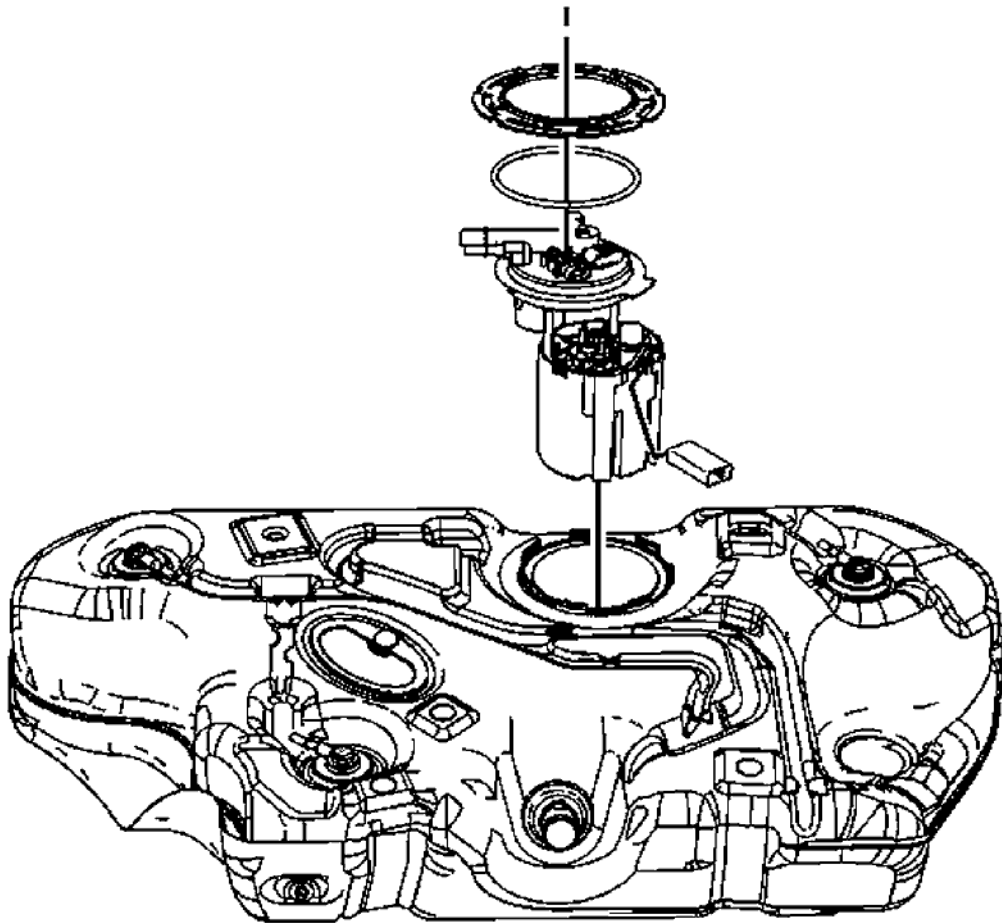


Fig. 133: Fuel Module

Courtesy of GENERAL MOTORS CORP.

8. Slowly raise the module until the fuel level sensor float arm is just visible. Ensure that the fuel level sensor harness connector clears the tank opening.

IMPORTANT: When removing the module from the fuel tank, be aware that the module reservoir bowl is full of fuel. The module must be tipped slightly during removal to avoid bending

the fuel level sensor float arm.

9. Tilt the module toward the rear of the fuel tank to allow the level sensor float arm to clear the tank opening. Remove the module from the tank.
10. Carefully discard the fuel in the module reservoir bowl into an approved fuel container.

IMPORTANT: DO NOT reuse the old fuel pump module seal.

11. Remove and discard the fuel pump module seal.

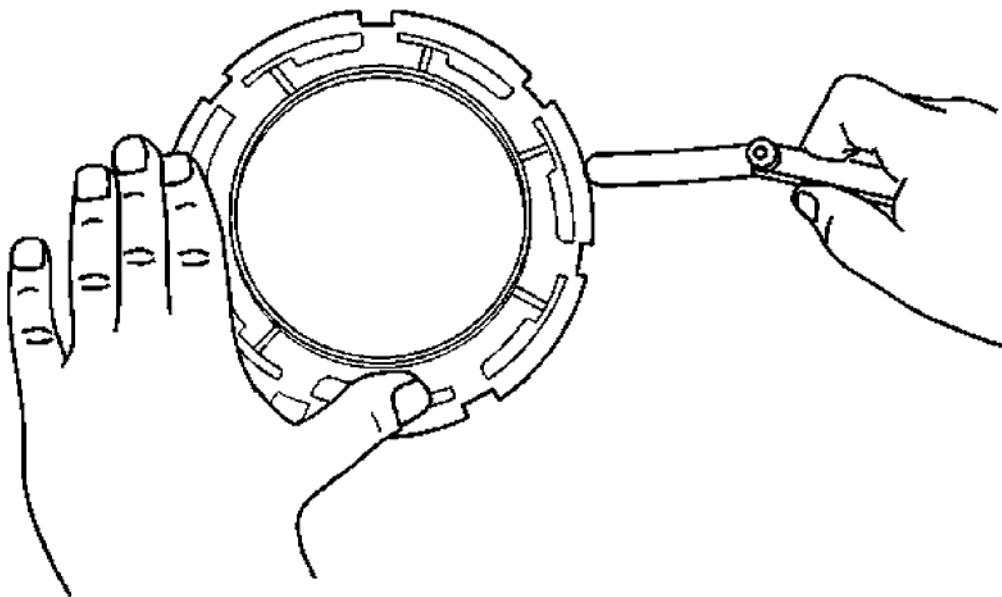


Fig. 134: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Some lock ring were manufactured with DO NOT REUSE stamped into them. These lock rings may be reused if they are not damaged or warped.

IMPORTANT: Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.

IMPORTANT: Check the lock ring for flatness.

12. Place the lock ring on a flat surface. Measure the clearance between to lock ring and the flat surface using a feeler gage at 7 points.
13. If the warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
14. If the warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

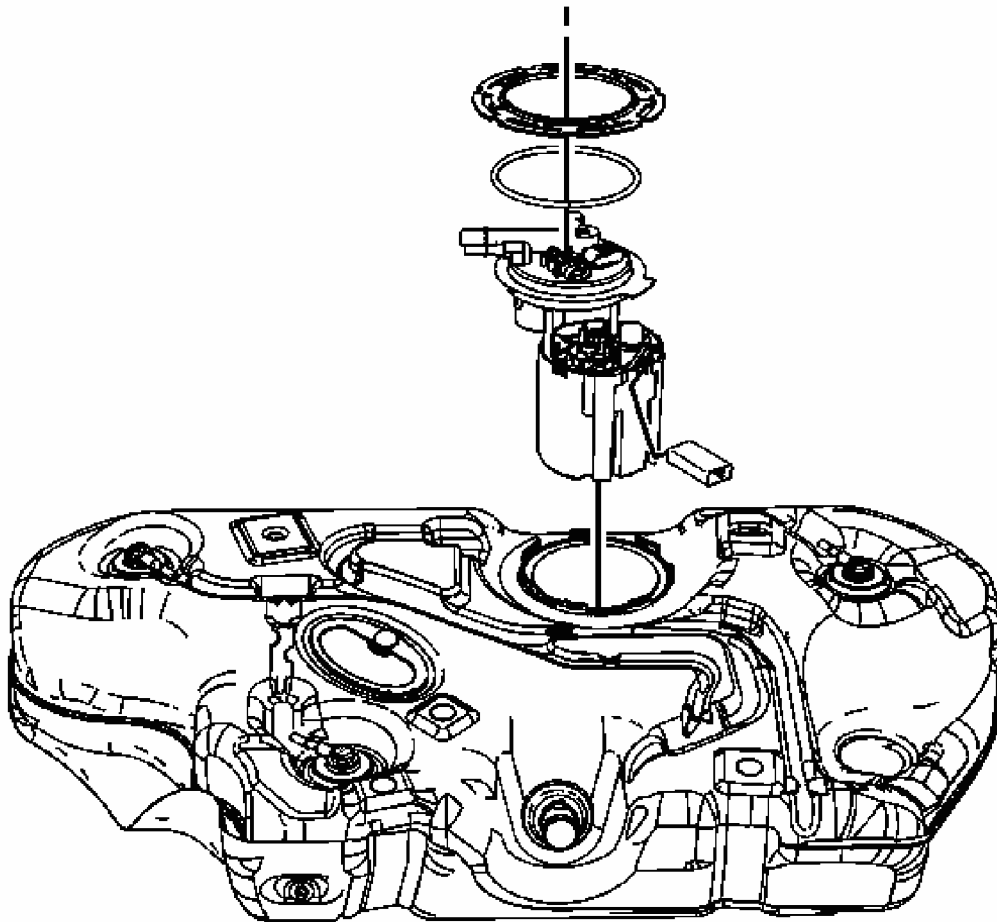


Fig. 135: Fuel Pump Module
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW fuel pump module seal onto the fuel tank.

IMPORTANT: The reservoir must be tipped slightly during installation to avoid bending the fuel level sensor float arm.

2. Tilt the module toward the rear of the fuel tank to allow the fuel level sensor float arm to clear the tank opening. Install the module into the fuel tank.
3. Lower the module assembly into the tank. Ensure that the fuel level sensor harness connector is positioned properly.
4. Install the module lock ring over the module pipes and electrical harness, and into position on the top of the module.

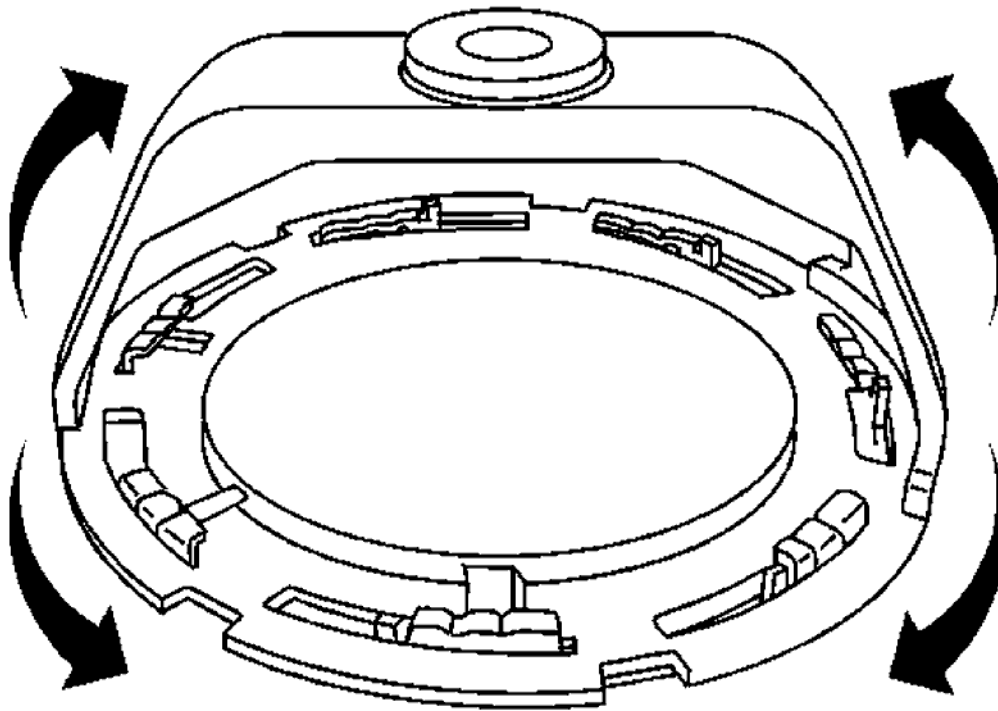


Fig. 136: Identifying Lock Ring
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Always replace the fuel sender seal when installing the fuel sender assembly. Replace the lock ring if necessary. Do not apply any type of lubrication in the seal groove. Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

5. Use the **J 45722** in order to install the fuel sender lock ring. See **Special Tools**. Turn the fuel sender lock ring in a clockwise direction.
6. Remove the **J 45722** from the lock ring. See **Special Tools**.

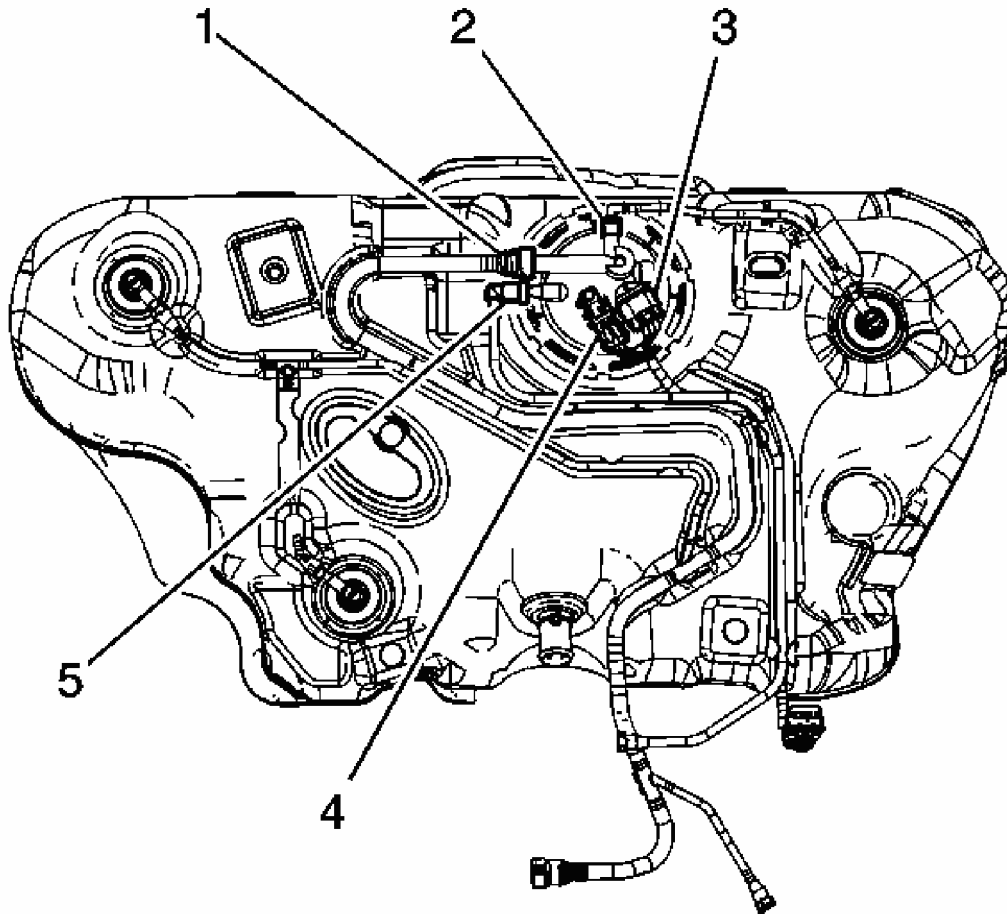


Fig. 137: Fuel Tank & Pipes
Courtesy of GENERAL MOTORS CORP.

7. Connect the fuel tank feed pipe quick connect fitting (5). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
8. Connect the fuel tank vent pipe quick connect fittings (2, 3). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
9. Connect the fuel pressure sensor and fuel pump module electrical connectors (1, 4).
10. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

**CAUTION: Refer to Gasoline/Gasoline Vapors
Caution .**

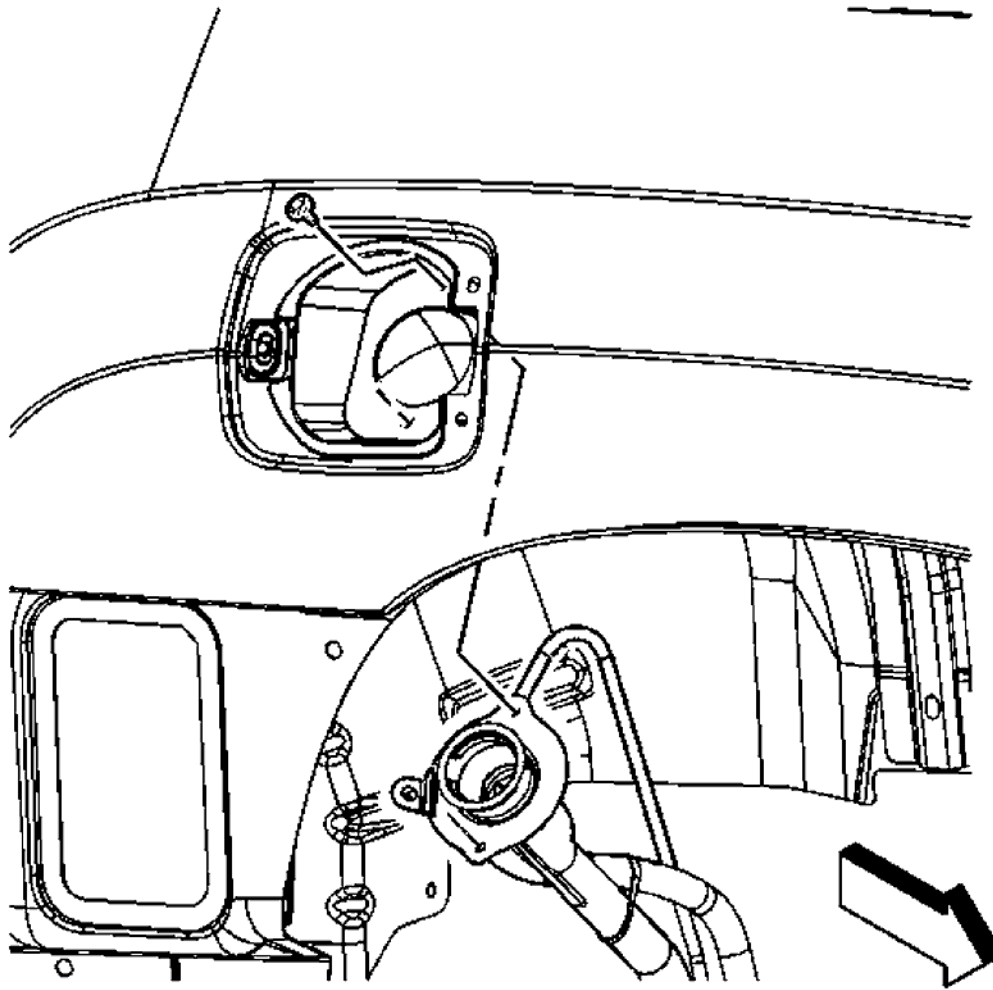


Fig. 138: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS CORP.

1. Drain the fuel tank. Refer to **Fuel Tank Draining Procedure**.
2. Remove the fuel fill pipe to fill pipe housing bolts.
3. Remove the fuel fill pocket. Refer to **Fuel Filler Pocket Replacement** .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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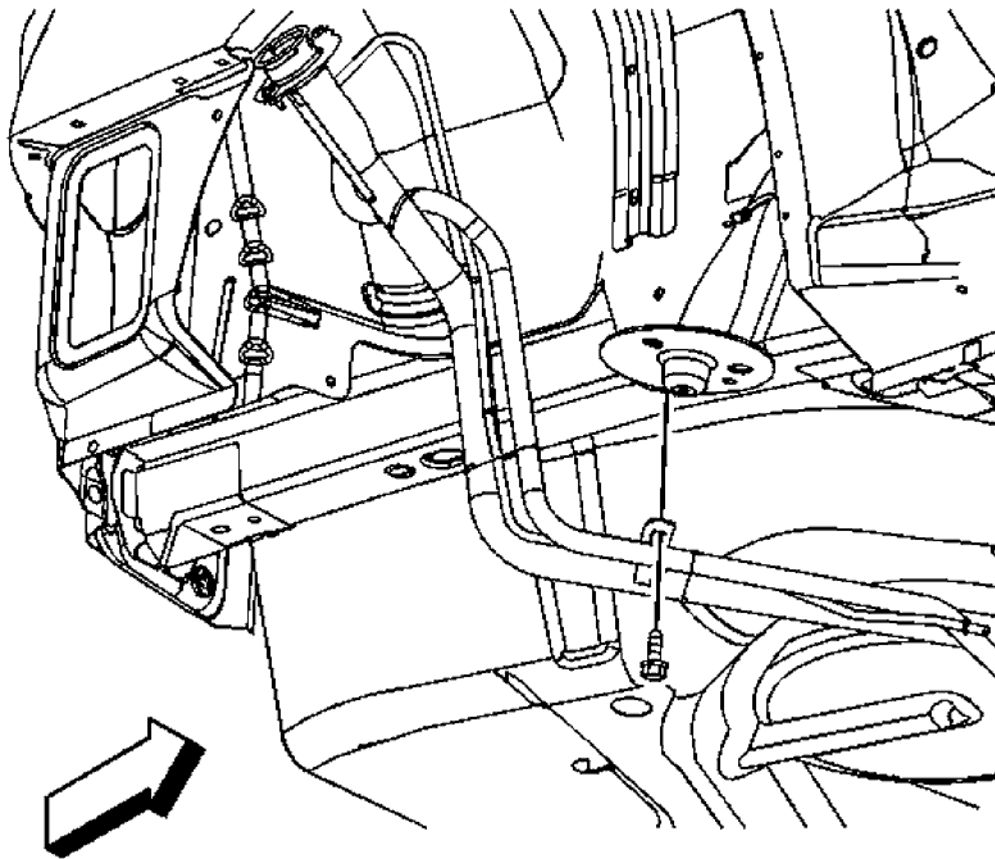


Fig. 139: Fuel Fill Pipe Lower Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel fill pipe lower bolt.

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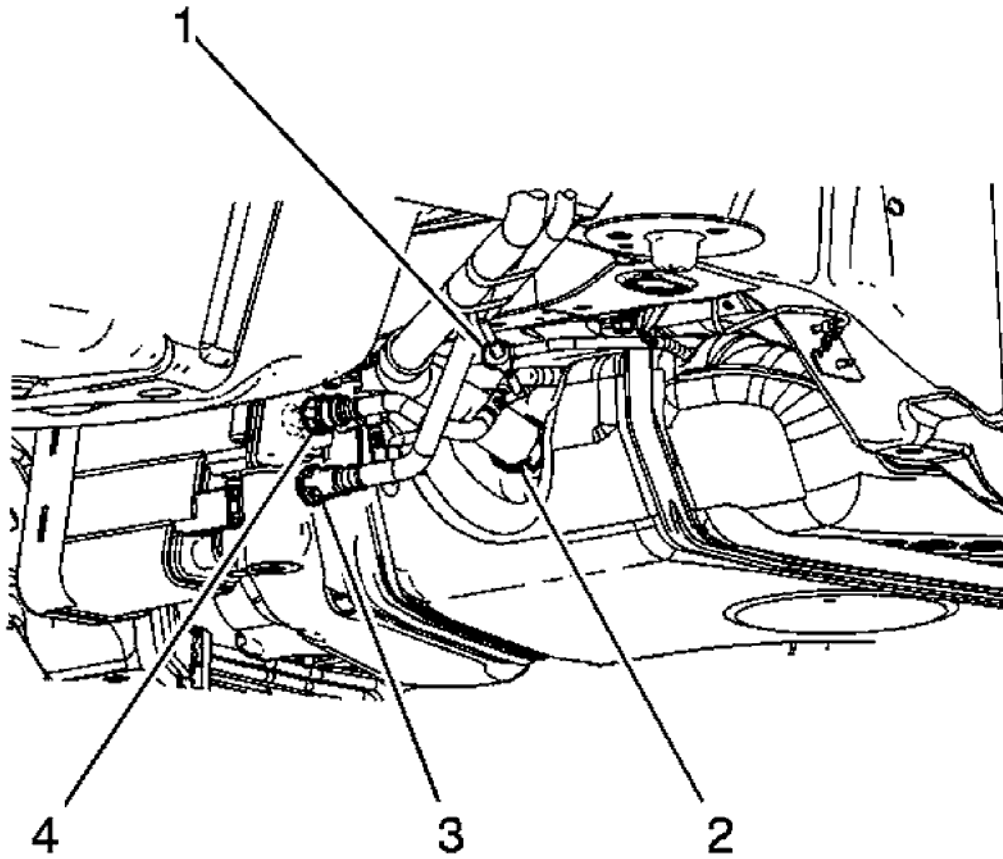


Fig. 140: Fuel Tank Vent Pipe Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the fuel tank vent pipe quick connect fittings (1, 3). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
7. Loosen the fuel fill pipe hose clamp (2) at the fuel tank.
8. Remove the fuel fill pipe hose from the fuel tank.

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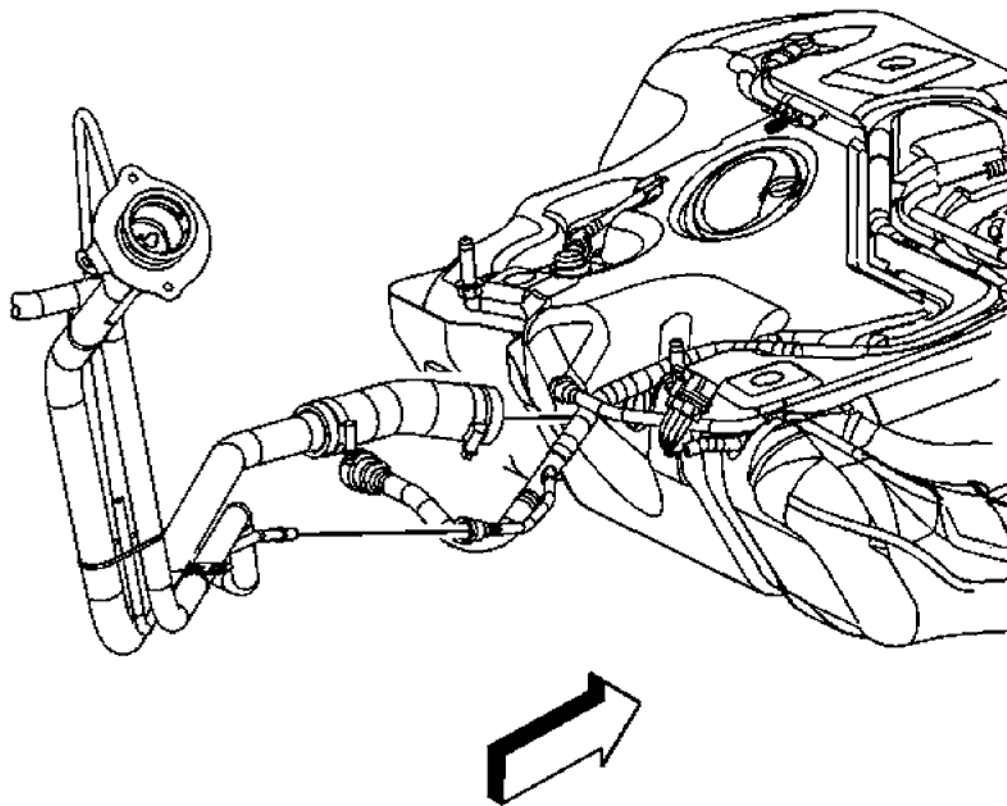


Fig. 141: Fuel Fill Pipe
Courtesy of GENERAL MOTORS CORP.

9. Remove the fuel fill pipe from the vehicle.

Installation Procedure

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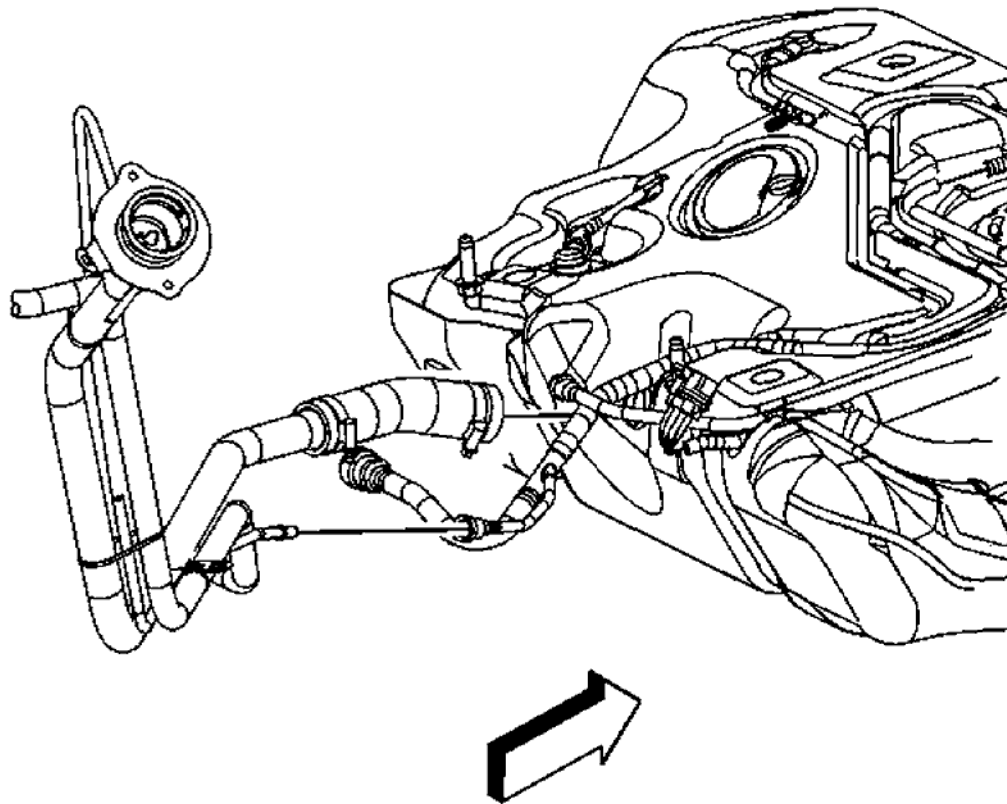


Fig. 142: Fuel Fill Pipe
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel fill pipe to the vehicle.

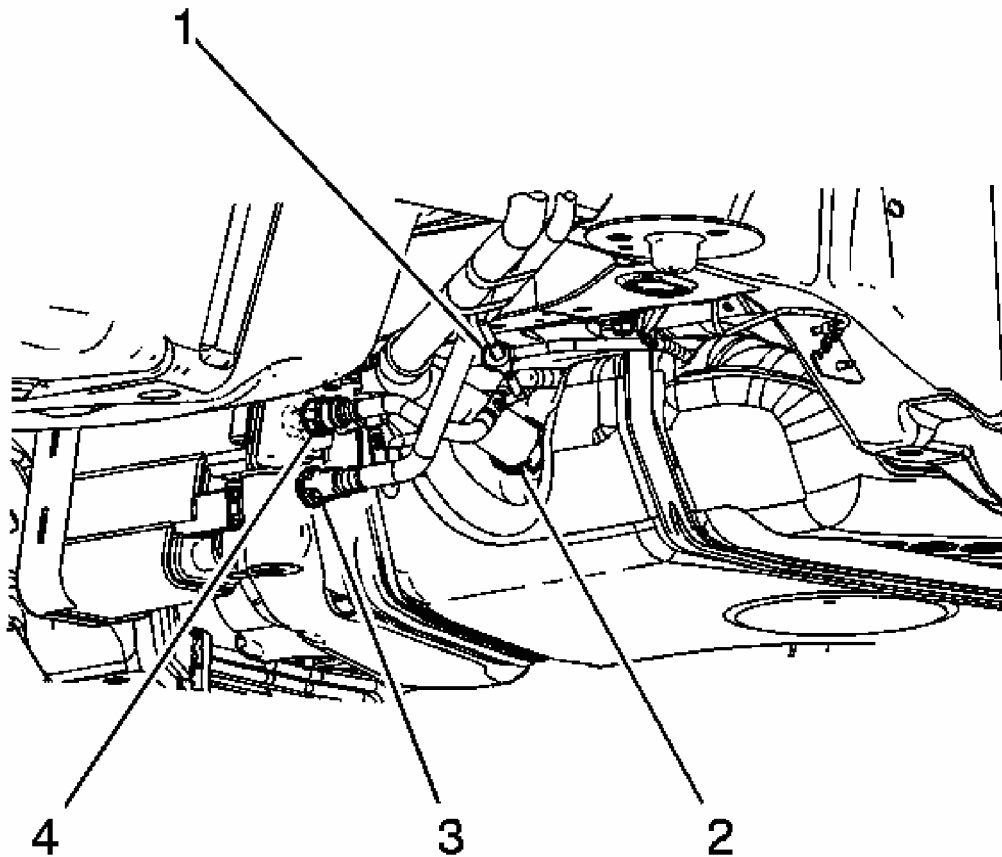


Fig. 143: Fuel Fill Pipe Hose
Courtesy of GENERAL MOTORS CORP.

2. Install the fuel fill pipe hose to the fuel tank.

NOTE: Refer to Fastener Notice .

3. Tighten the fuel fill pipe hose clamp (2) at the fuel tank.

Tighten: Tighten the clamp to 4.5 N.m (40 lb in).

4. Connect the fuel tank vent pipe quick connect fittings (1, 3). Refer to Quick Connect Fitting(s) Service (Plastic Collar).

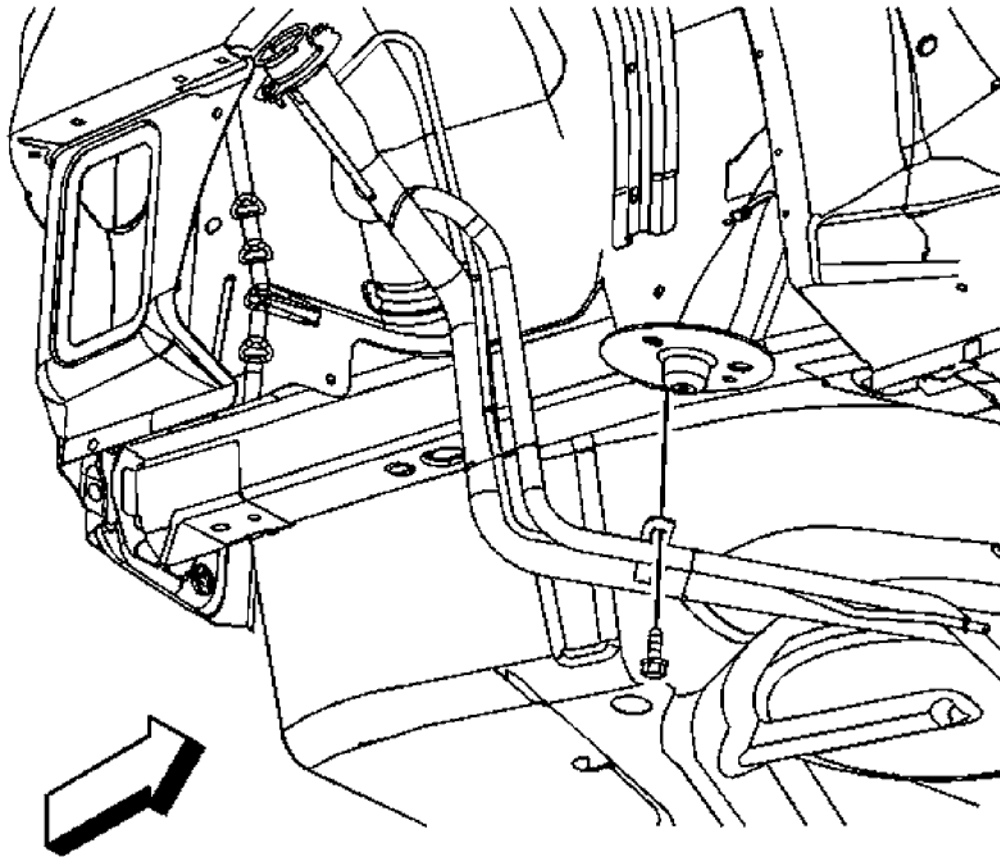


Fig. 144: Fuel Fill Pipe Lower Bolt
Courtesy of GENERAL MOTORS CORP.

5. Instal the fuel fill pipe lower bolt.

Tighten: Tighten the bolt to 10 N.m (89 lb in).

6. Lower the vehicle.
7. Install the fuel fill pocket. Refer to **Fuel Filler Pocket Replacement** .

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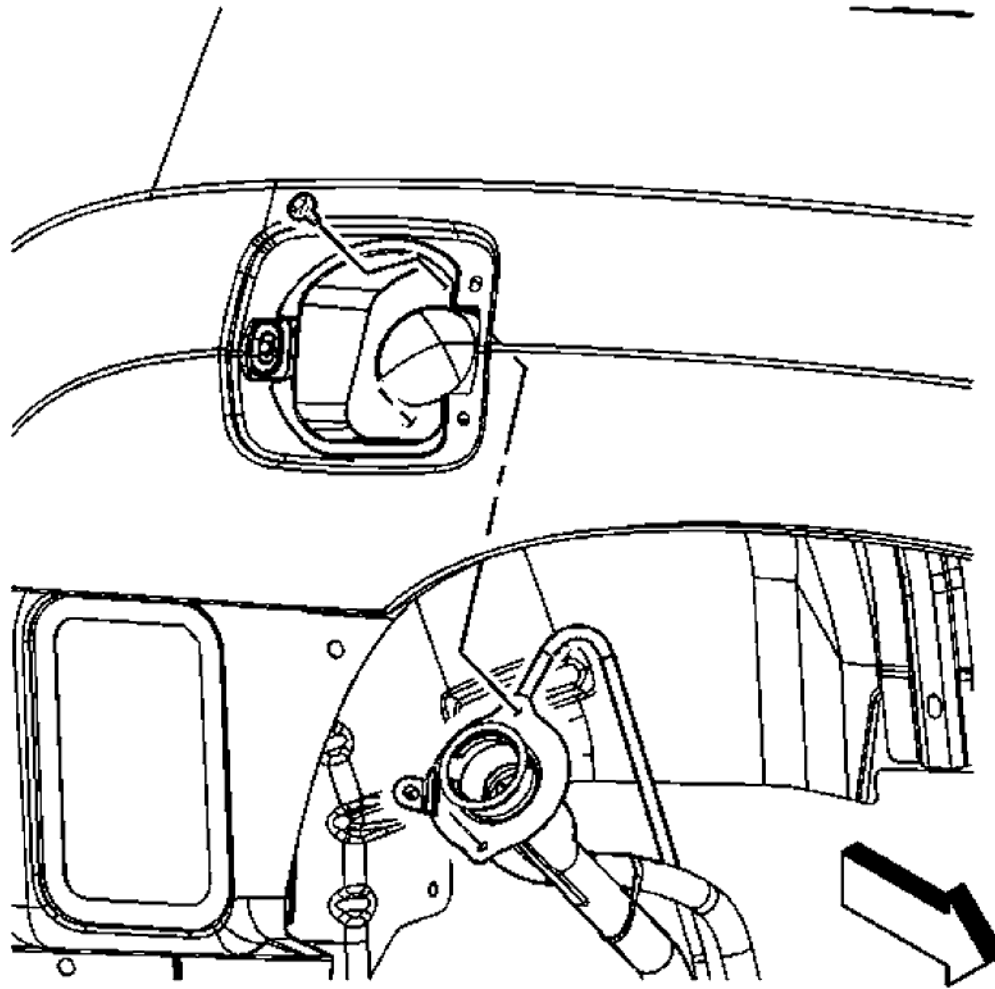


Fig. 145: Fuel Fill Pipe To Fill Pipe Housing Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the fuel fill pipe to fill pipe housing bolts.

Tighten: Tighten the bolts to 1.5 N.m (13 lb in).

9. Refill the fuel tank.
10. Install the fuel fill cap.

FUEL HOSE/PIPES REPLACEMENT - CHASSIS

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief Procedure**.

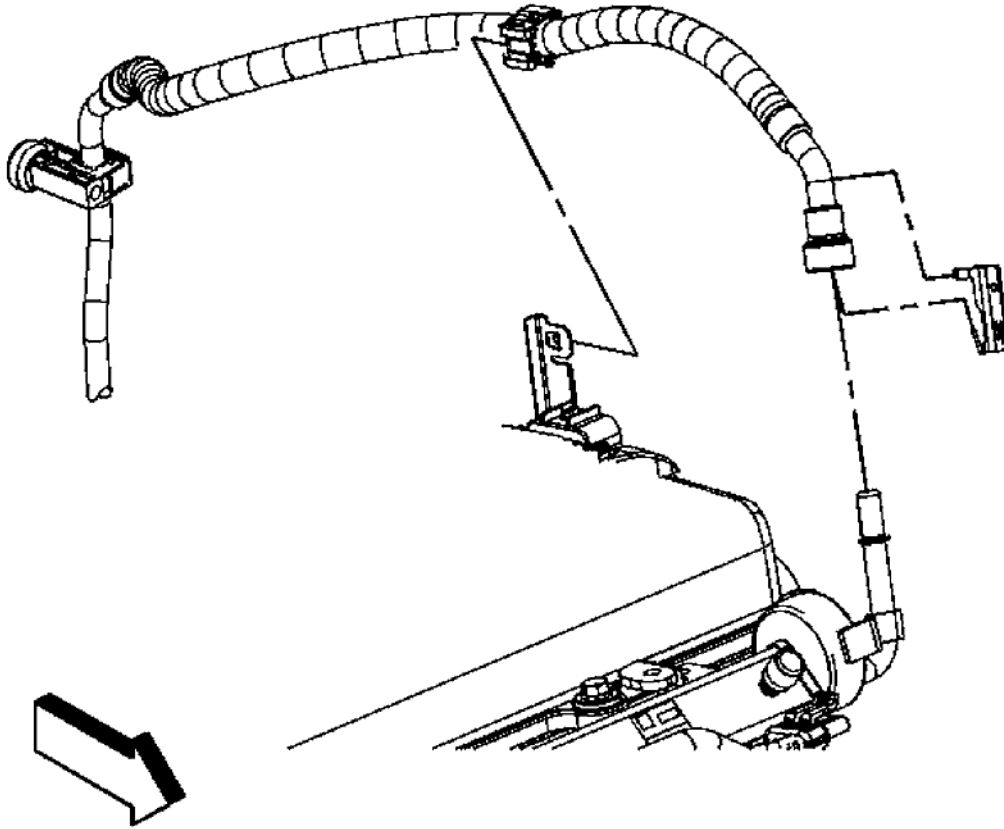


Fig. 146: Fuel Hose/Pipes
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the fuel feed pipe from the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
3. Cap or plug the fuel pipe and the engine fuel rail to prevent contamination.

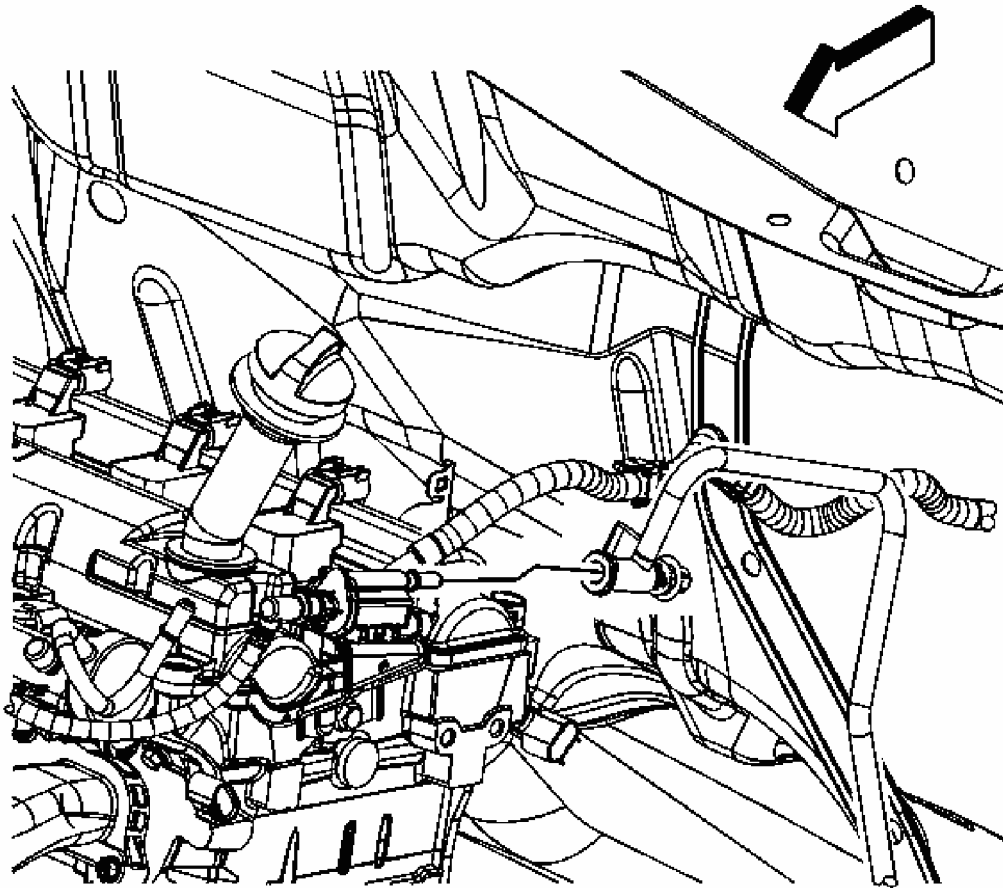


Fig. 147: EVAP Pipe From Purge Solenoid
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the evaporative emission (EVAP) pipe from the purge solenoid. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Cap or plug the EVAP pipe in order to prevent contamination.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
7. Remove the evaporative emission (EVAP) canister, if necessary. Refer to **Evaporative Emission (EVAP) Canister Replacement**.
8. Disconnect the fuel feed pipe quick connect fitting. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

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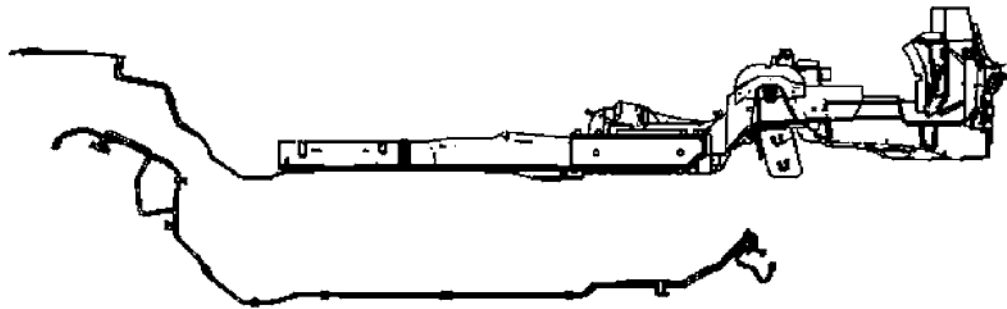


Fig. 148: Fuel/EVAP/brake Line Brackets
Courtesy of GENERAL MOTORS CORP.

9. Remove the brake lines from the fuel/EVAP/brake line brackets.
10. Remove the fuel/EVAP/brake line bracket nuts and remove the brackets from the body studs.
11. Remove the fuel and EVAP lines from the vehicle.
12. Open the brackets and remove the fuel feed pipe.

Installation Procedure

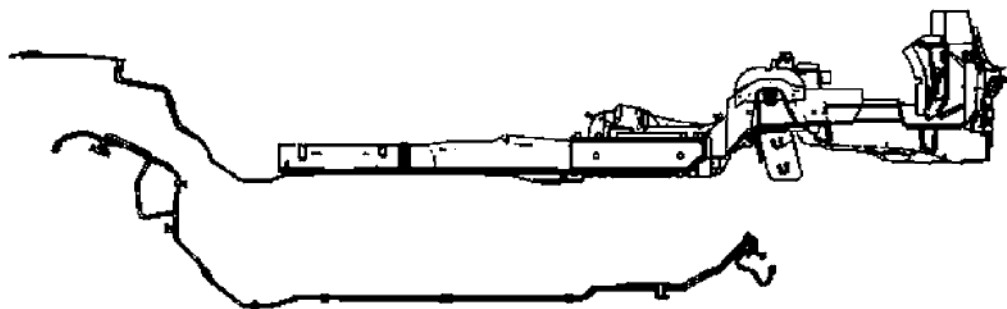


Fig. 149: Fuel/EVAP/brake Line Brackets
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel feed pipe to the brackets and close the covers.
2. Install the fuel and EVAP lines to the vehicle.

3. Install the fuel/EVAP/brake line bracket to the body studs.

NOTE: Refer to Fastener Notice .

4. Install the fuel/EVAP/brake line bracket nuts.

Tighten: Tighten the nuts to 10 N.m (89 lb in).

5. Install the brake lines to the fuel/EVAP/brake line brackets.

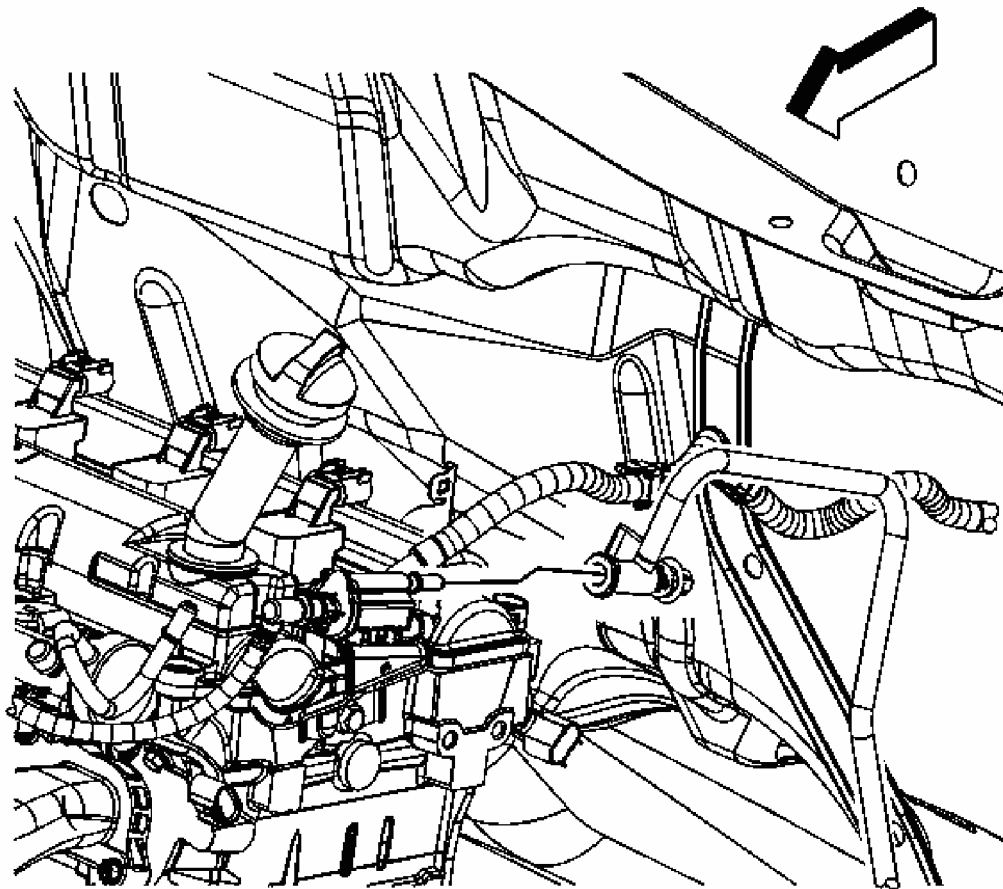


Fig. 150: Fuel Feed Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

6. Connect the fuel feed pipe quick connect fitting. Refer to Quick Connect Fitting(s) Service (Plastic Collar).

7. Install the canister, if necessary. Refer to **Evaporative Emission (EVAP) Canister Replacement**.
8. Lower the vehicle.
9. Remove the cap or plug from the EVAP pipe.
10. Connect the EVAP pipe to the purge solenoid. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

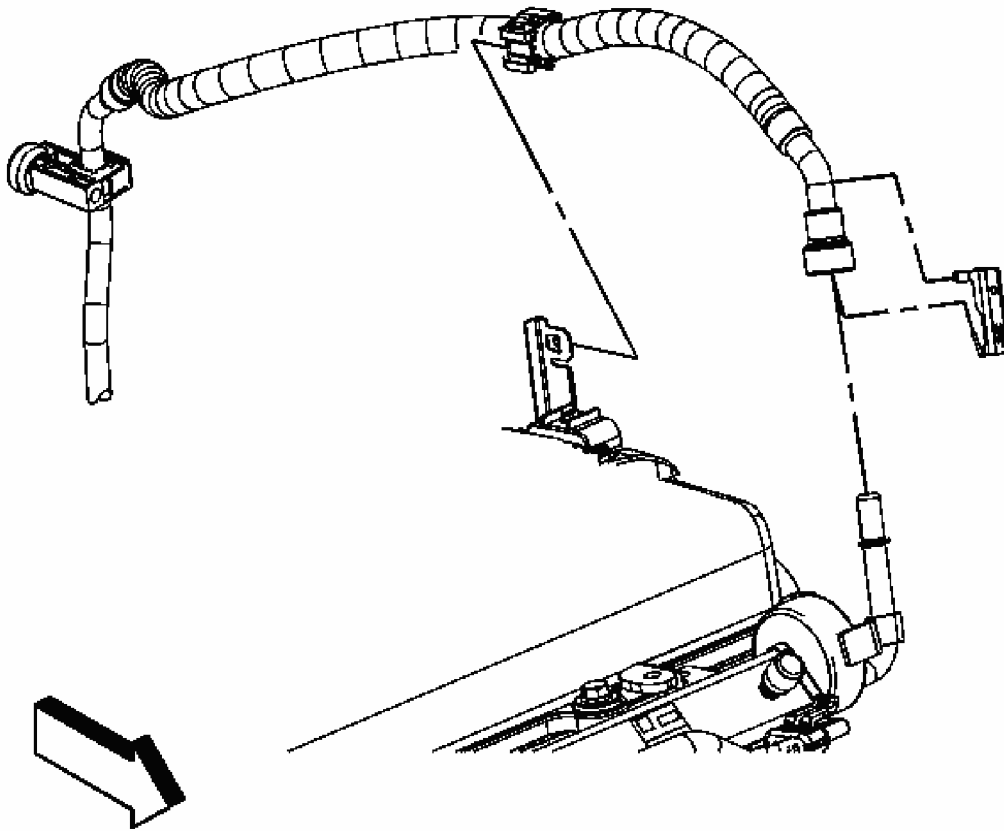


Fig. 151: Fuel Pipe & Engine Fuel Rail
Courtesy of GENERAL MOTORS CORP.

11. Remove the cap or plug from the fuel pipe and the engine fuel rail.
12. Connect the fuel feed pipe to the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
13. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
14. 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.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

Removal Procedure

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

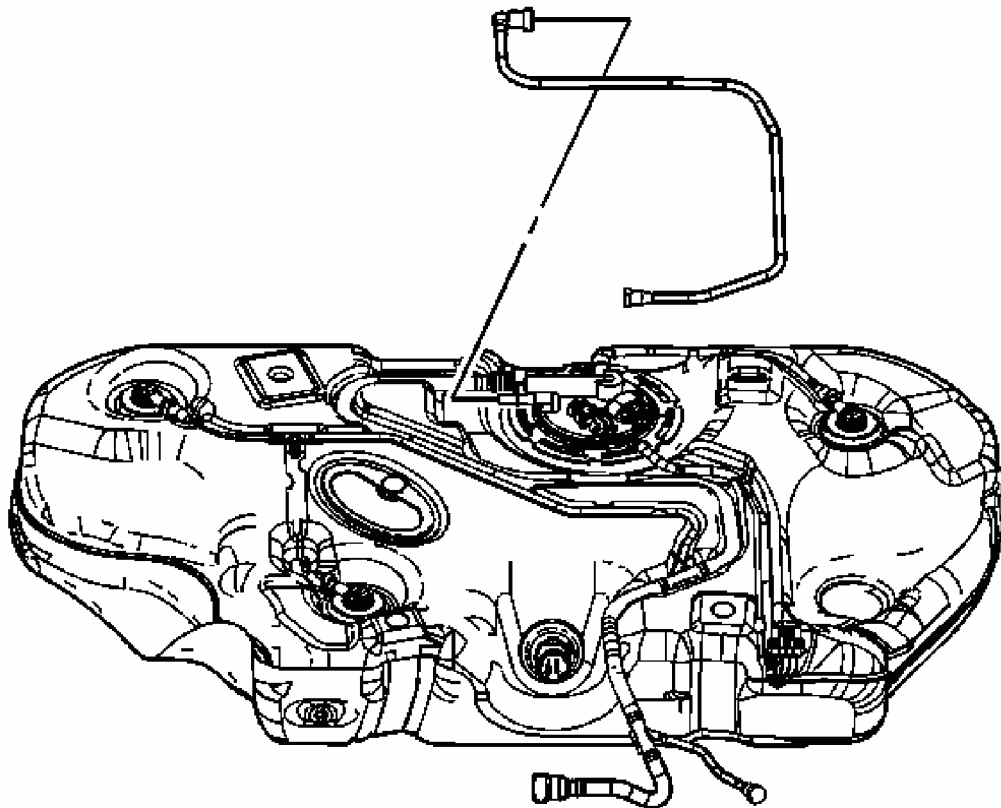


Fig. 152: Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the fuel feed intermediate pipe quick connect fitting from module. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Remove the fuel feed intermediate pipe from the fuel tank.

Installation Procedure

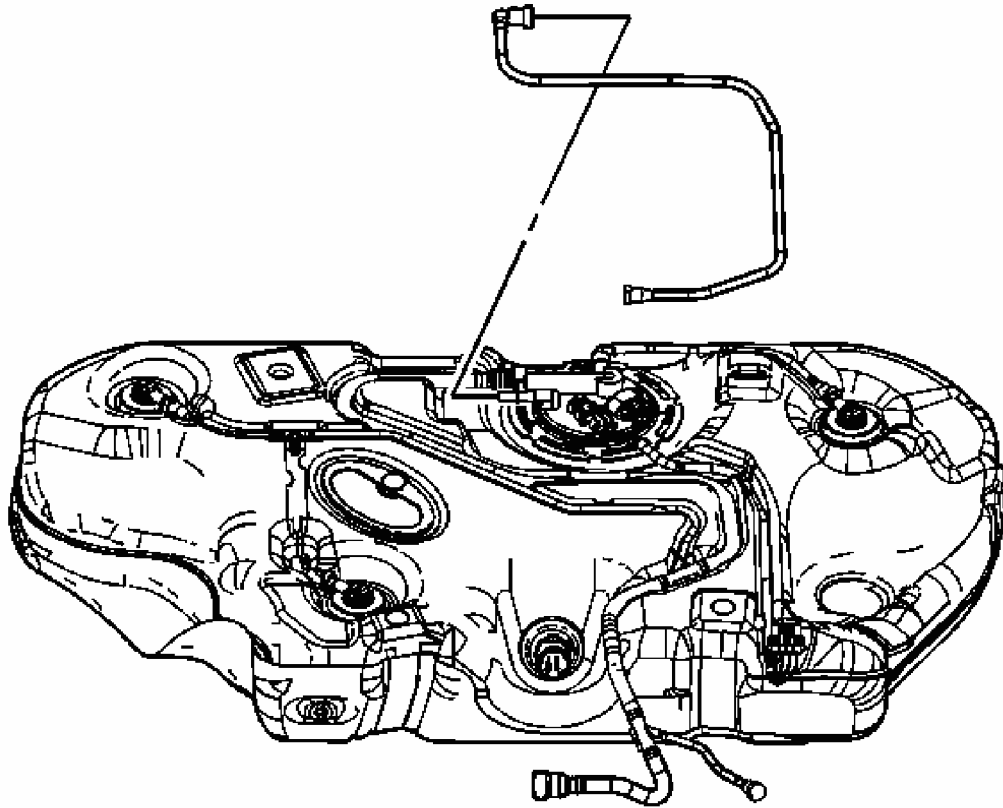


Fig. 153: Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

1. Connect the fuel feed intermediate pipe quick connect fitting to module. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
2. Install the fuel feed intermediate pipe to the fuel tank.
3. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK VENT PIPE REPLACEMENT

Removal Procedure

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

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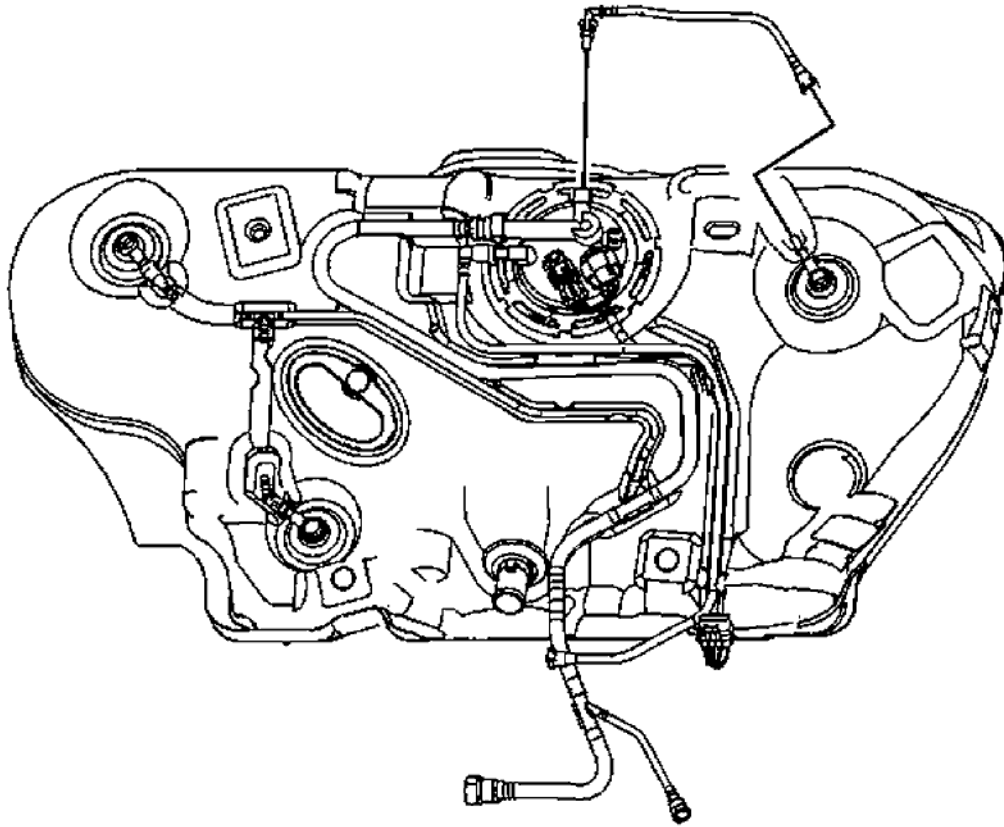


Fig. 154: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the fuel tank vent pipe quick connect fitting from the module and the valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Remove the fuel tank vent pipe from the fuel tank.

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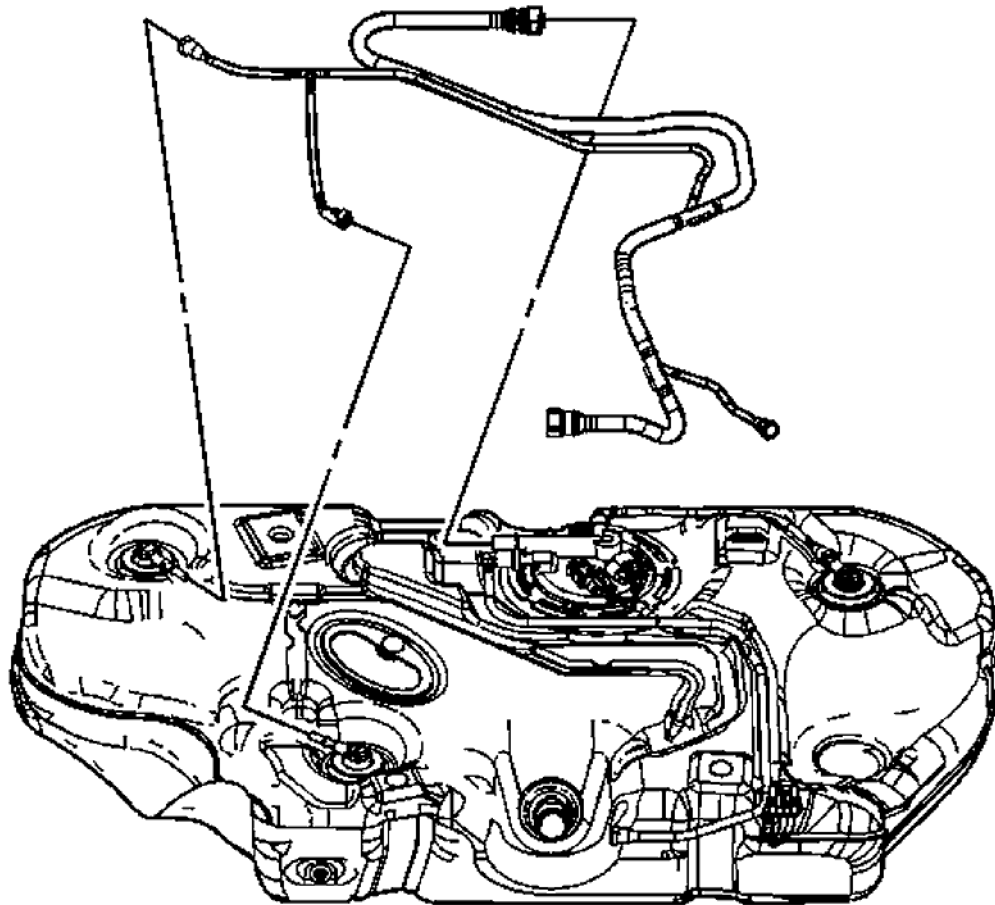


Fig. 155: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fuel tank vent pipe quick connect fittings from module and the valves. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Remove the fuel tank vent pipe from the fuel tank.

Installation Procedure

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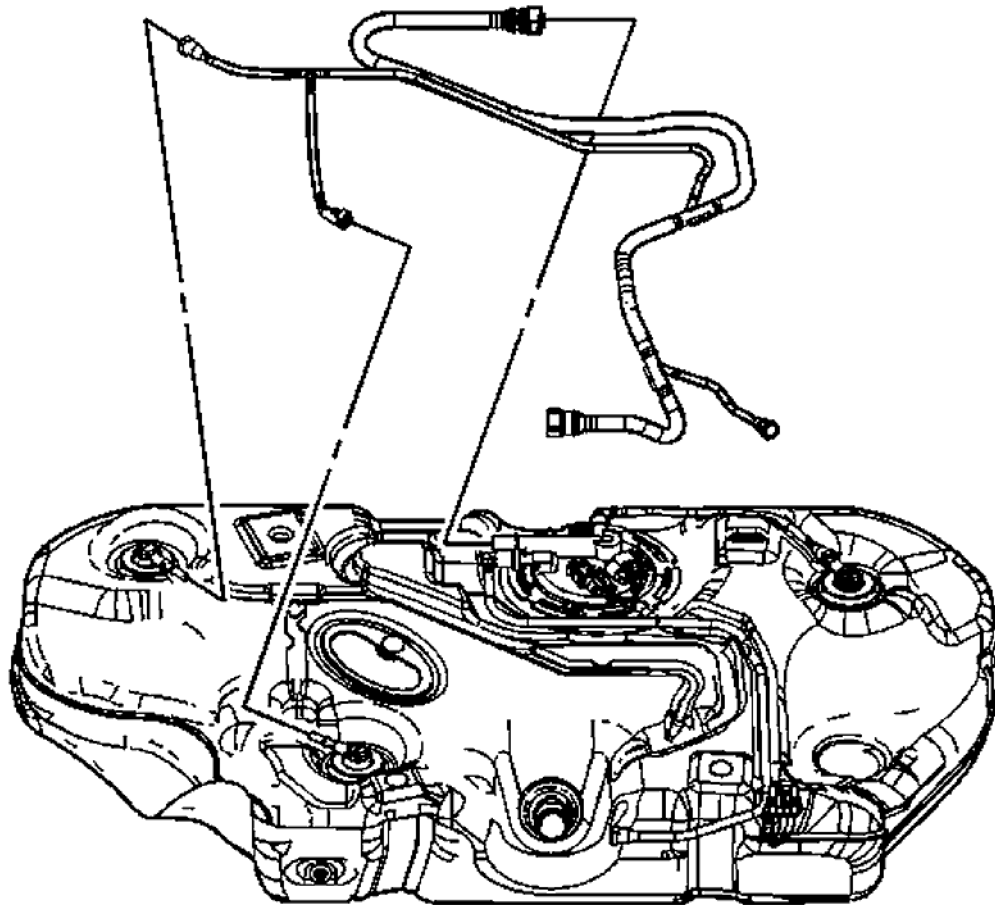


Fig. 156: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

1. Connect the fuel tank vent pipe quick connect fittings to the module and the valves. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
2. Install the fuel tank vent pipe to the fuel tank.

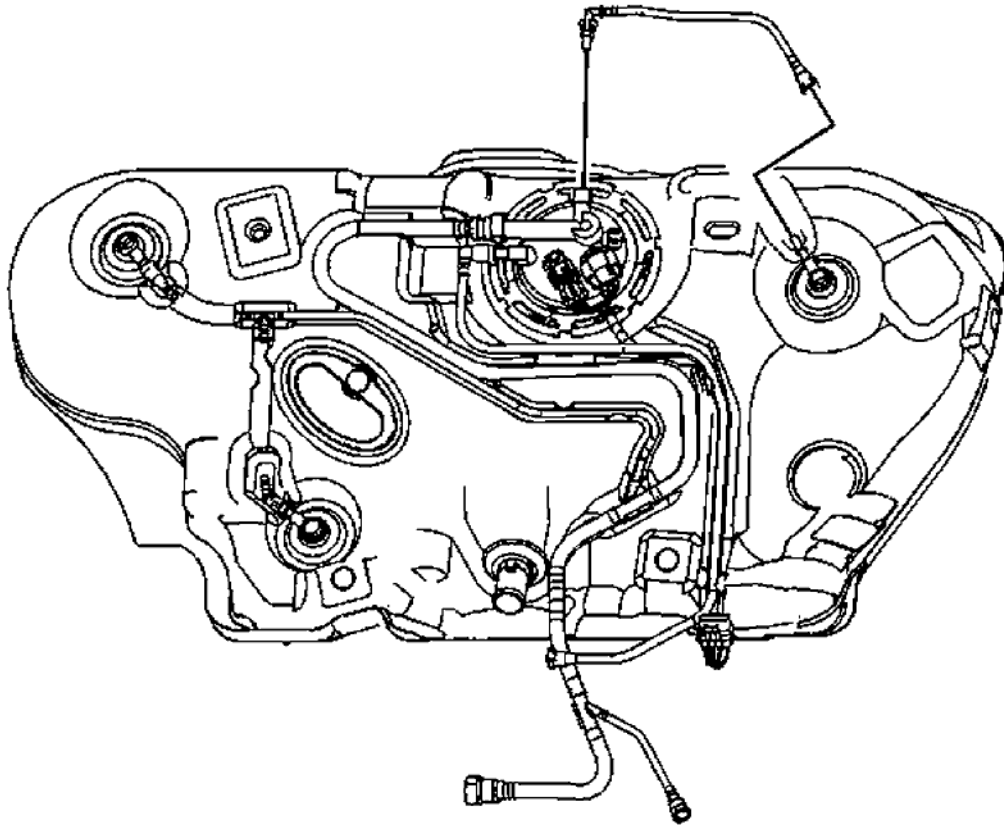


Fig. 157: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS CORP.

3. Connect the fuel tank vent pipe quick connect fitting to the module and the valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Install the fuel tank vent pipe to the fuel tank.
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL SYSTEM CLEANING

IMPORTANT: If the fuel filter is plugged, the fuel tank should be inspected internally and cleaned if necessary.

1. Remove the fuel pump module. Refer to **Fuel Pump Module Replacement**.
2. Inspect the fuel pump module strainer. Replace the pump module if the fuel strainer is contaminated.

IMPORTANT: 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.

3. Flush the fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to be sure that the removal of the water from the fuel tank is complete.
5. Allow the tank to dry completely before reassembly.
6. Disconnect the fuel feed pipe at the engine fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.

IMPORTANT: Only use oil-free compressed air to blow out the fuel pipes.

7. Clean the fuel pipes by applying air pressure in the opposite direction of the fuel flow.
8. Connect the fuel feed pipe to the engine fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
9. Install the fuel pump module. Refer to **Fuel Pump Module Replacement**.

FUEL RAIL ASSEMBLY REPLACEMENT

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief Procedure**.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.

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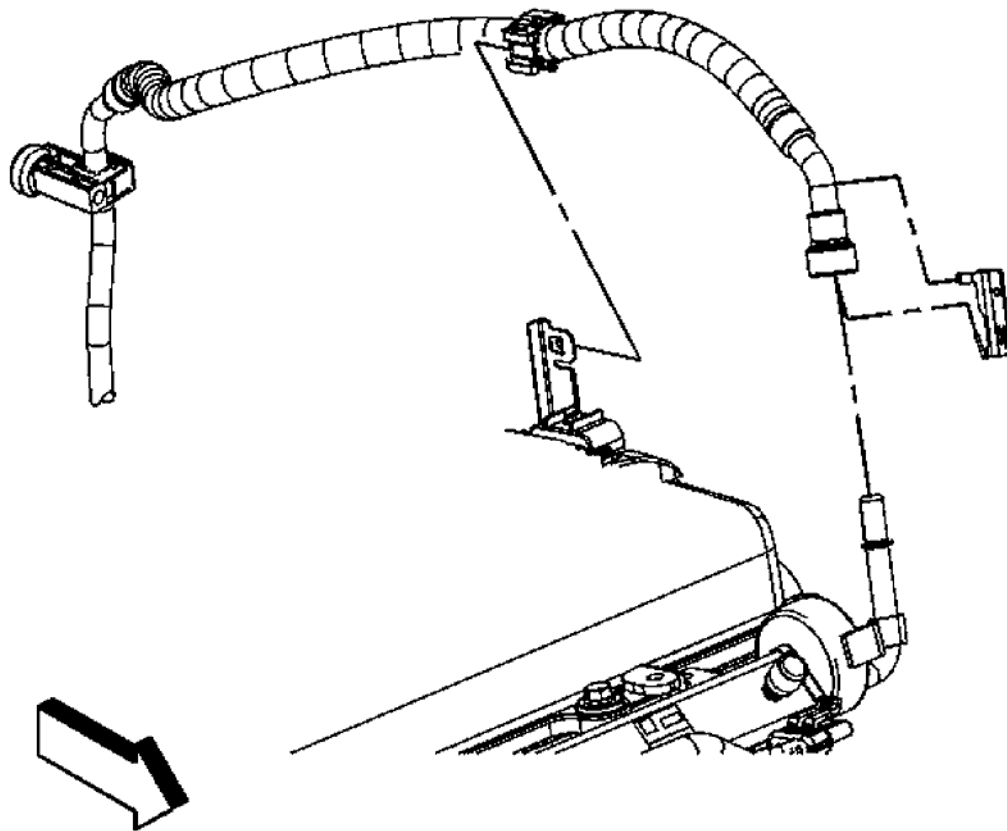


Fig. 158: Fuel Feed Line

Courtesy of GENERAL MOTORS CORP.

3. Disconnect the fuel feed line quick connect fitting from the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.

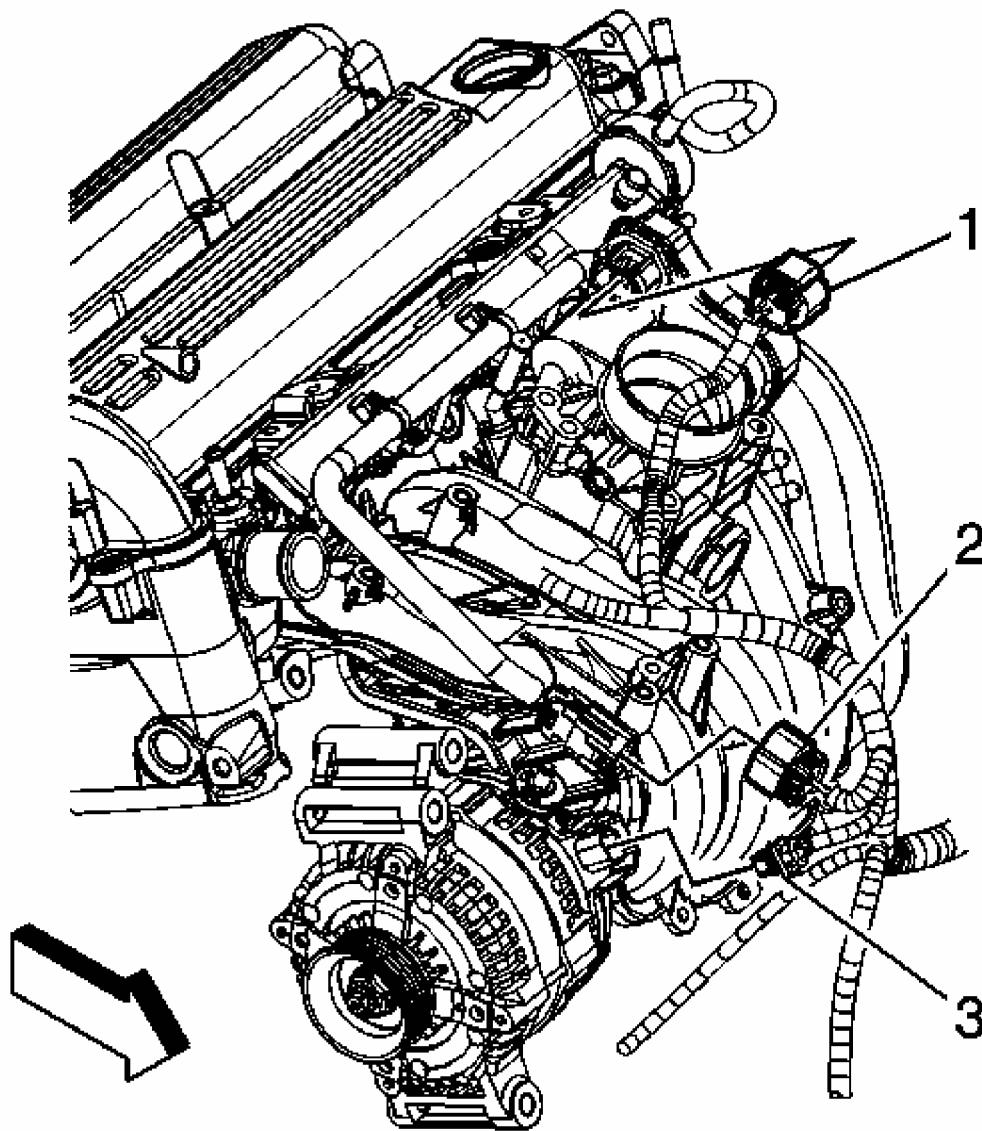


Fig. 159: Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fuel injector harness electrical connector (3).

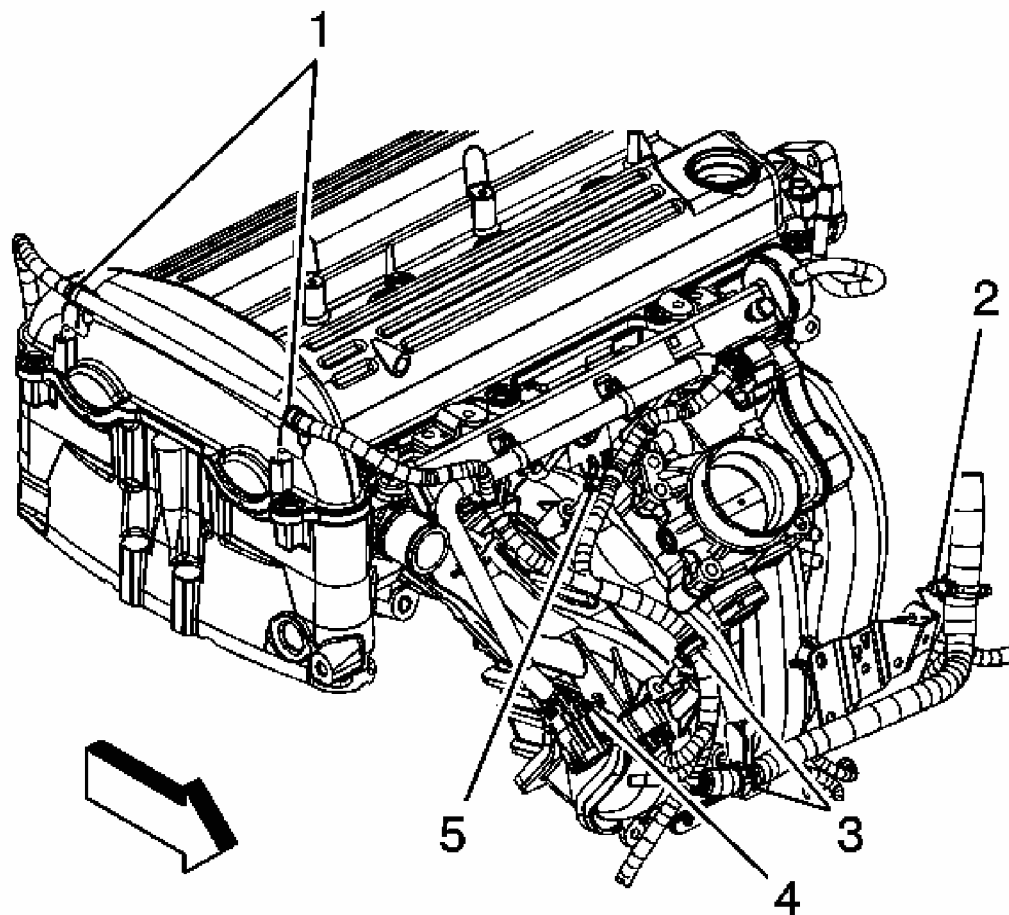


Fig. 160: Fuel Injector Harness Electrical Connector Clip
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel injector harness electrical connector clip (4) from the intake manifold.

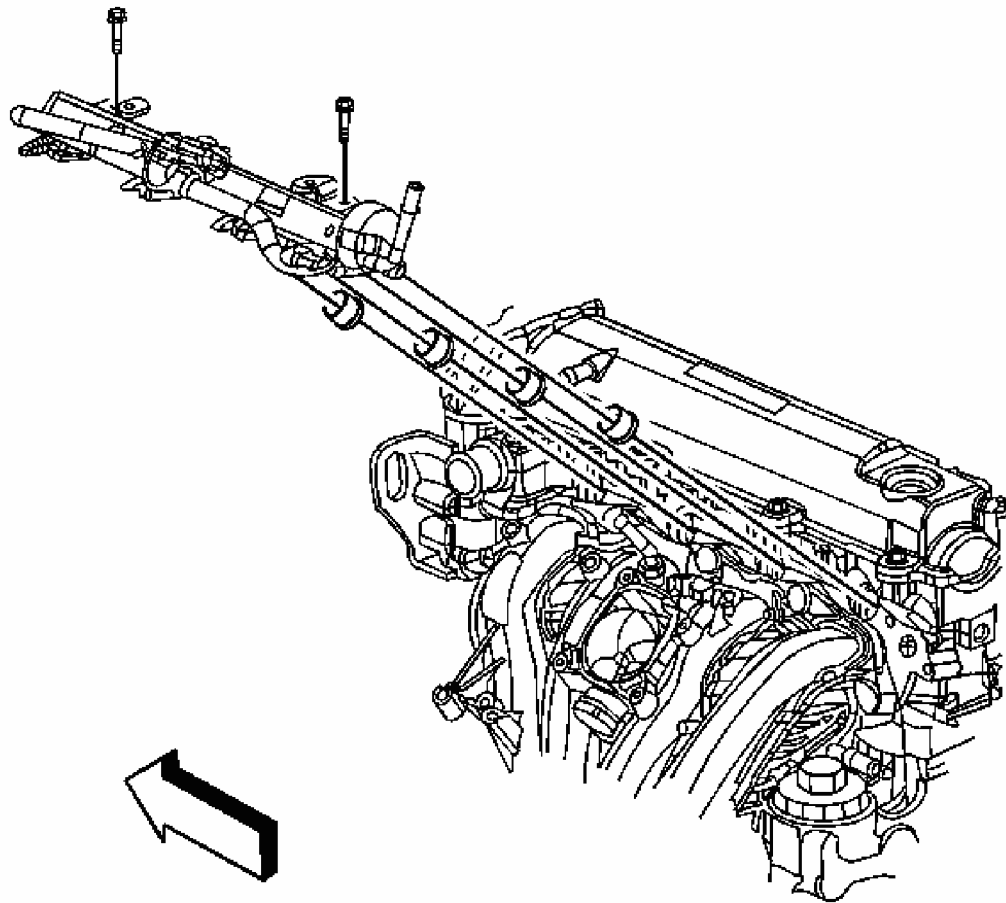


Fig. 161: Fuel Rail Studs
Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel rail studs.

IMPORTANT: Use care when removing the fuel rail assembly in order to prevent damage to the fuel injectors electrical connector terminals and spray tips.

7. Pull the fuel rail back and upward in order to release the fuel injectors from the cylinder head ports.
8. Remove the fuel rail.
9. Remove the fuel injectors, if necessary. Refer to **Fuel Injector Replacement**.

IMPORTANT: Install new lower O-rings when reusing fuel injectors. Lubricate the injector tip O-rings prior to installing the injectors into the intake manifold.

1. Install the fuel injectors, if necessary. Refer to **Fuel Injector Replacement**.
2. With the fuel injectors positioned downward, lower the fuel injectors into the cylinder head ports.
3. Carefully push the fuel injectors into the cylinder head ports.

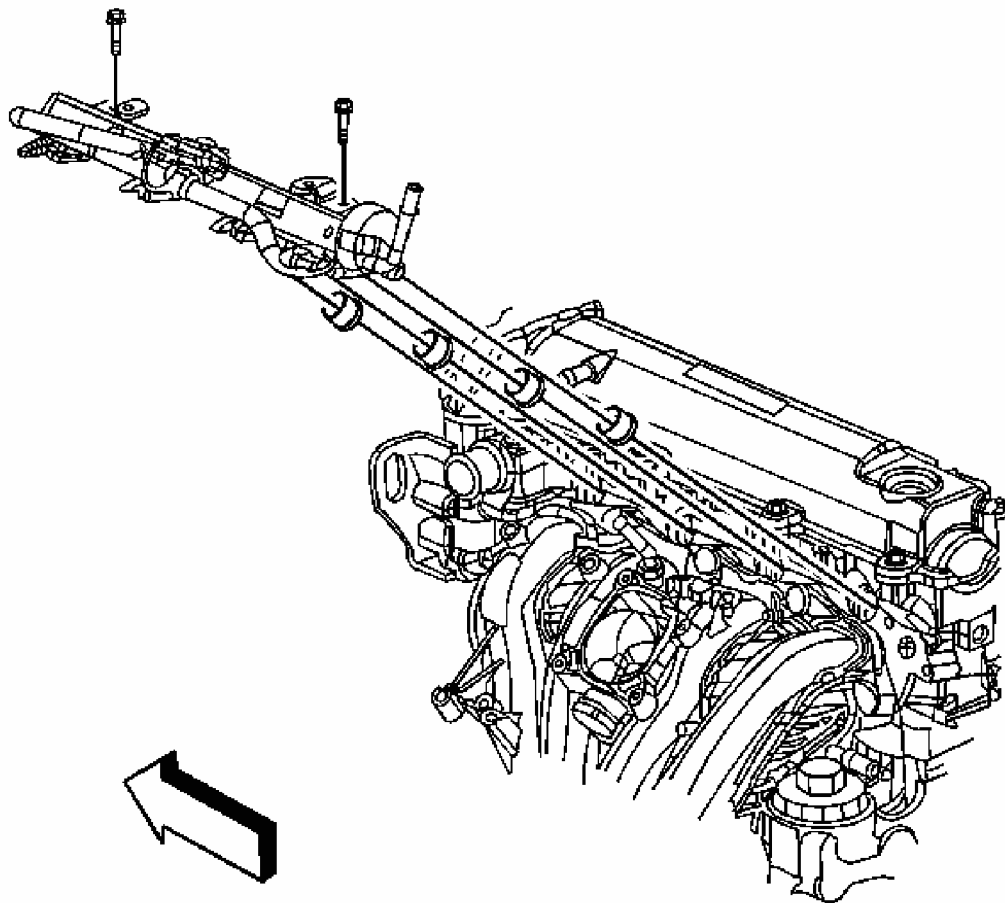


Fig. 162: Fuel Rail Studs
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **Fastener Notice**.

4. Install the fuel rail bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

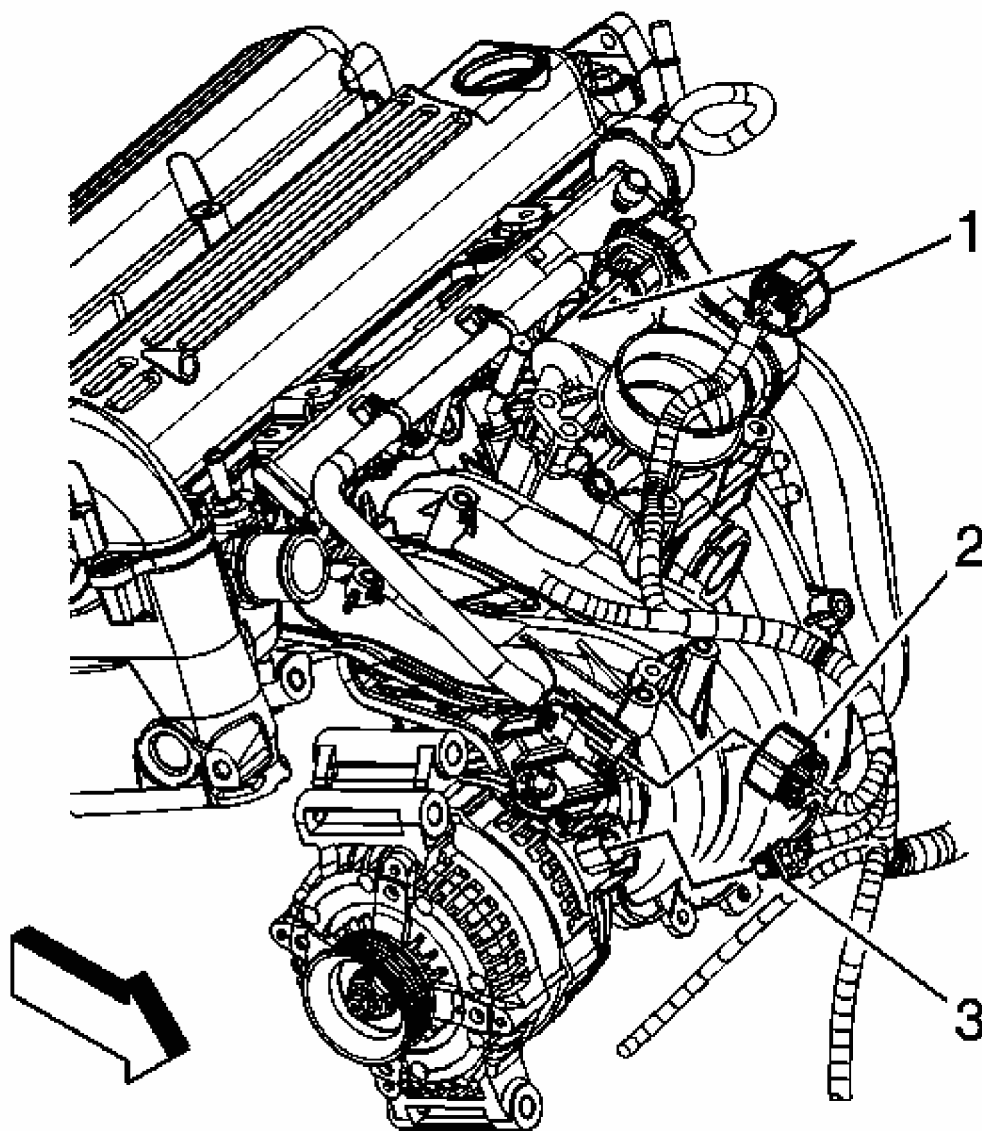


Fig. 163: Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Connect the fuel injector harness electrical connector (3).

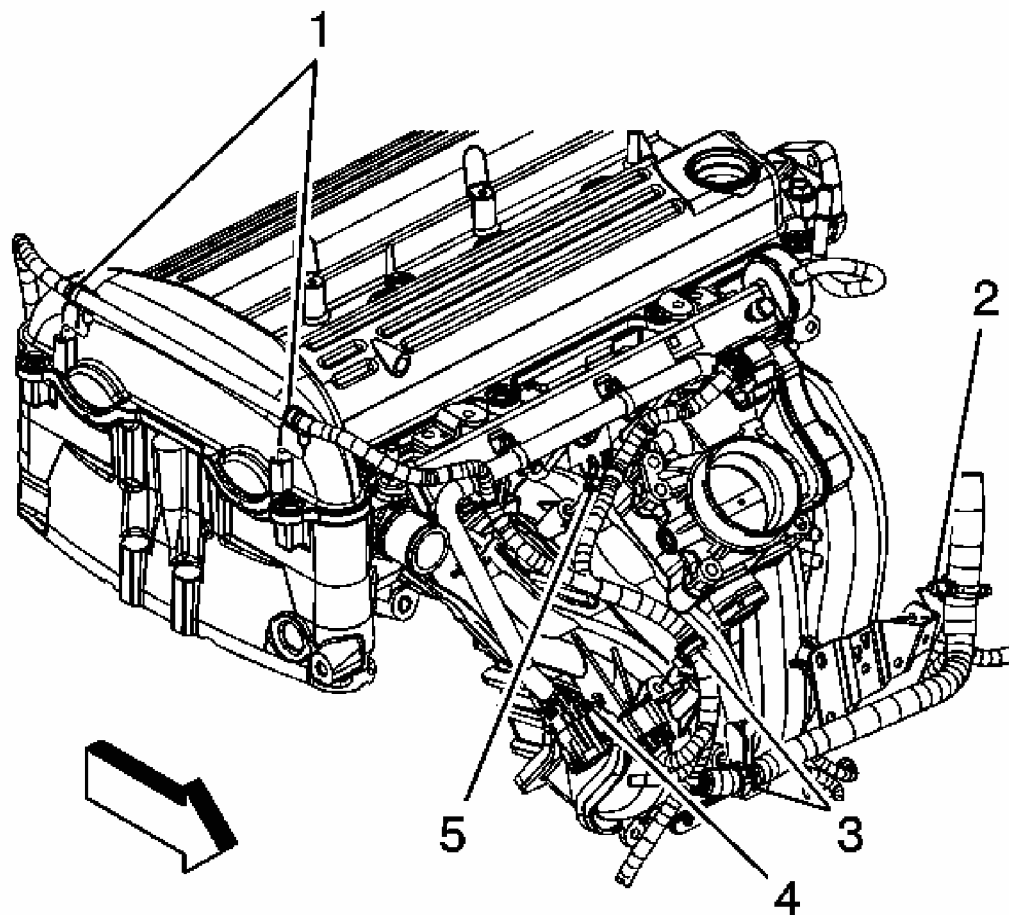


Fig. 164: Fuel Injector Harness Electrical Connector Clip
Courtesy of GENERAL MOTORS CORP.

6. Install the fuel injector harness electrical connector clip (4) to the intake manifold.

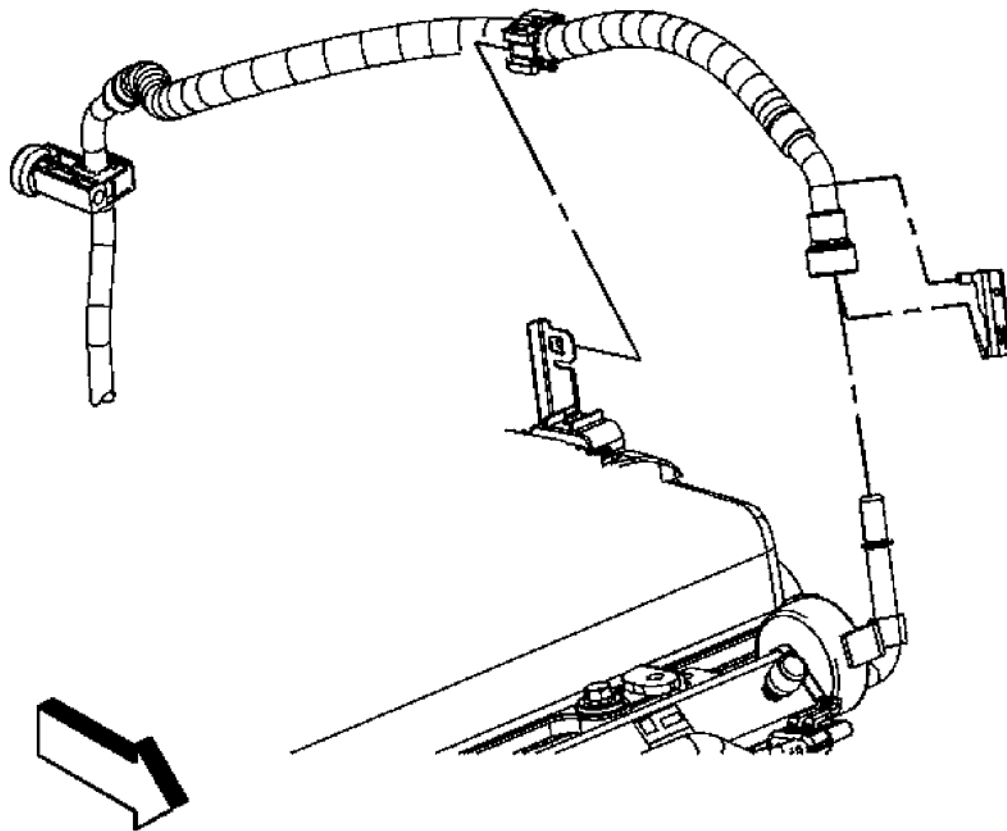


Fig. 165: Fuel Feed Line Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

7. Connect the fuel feed line quick connect fitting to the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
8. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
9. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
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.
 4. Inspect for fuel leaks.

FUEL INJECTOR REPLACEMENT

Removal Procedure

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NOTE: Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. 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.

IMPORTANT: If the fuel injectors are found to be leaking, the engine oil may be contaminated with fuel.

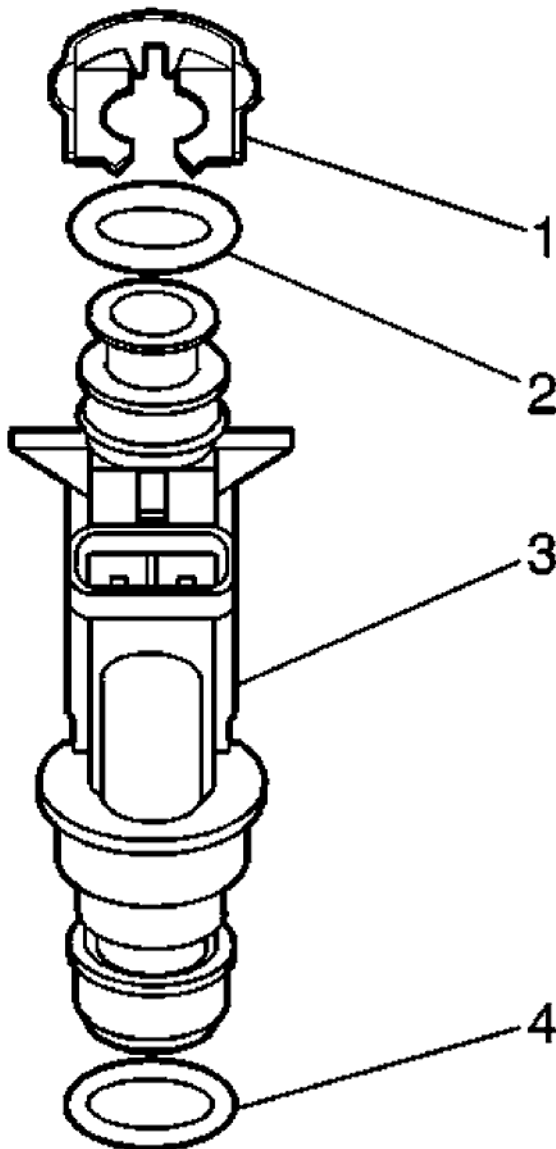


Fig. 166: Exploded View Of Fuel Injector & Components
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel rail. Refer to **Fuel Rail Assembly Replacement**.
2. Remove the fuel injector retaining clip (1).
3. Remove the fuel injector (3) from the fuel rail.
4. Remove and discard the fuel injector lower O-ring (4).
5. Remove and discard the fuel injector upper O-ring (2).

Installation Procedure

2006 Chevrolet HHR LT

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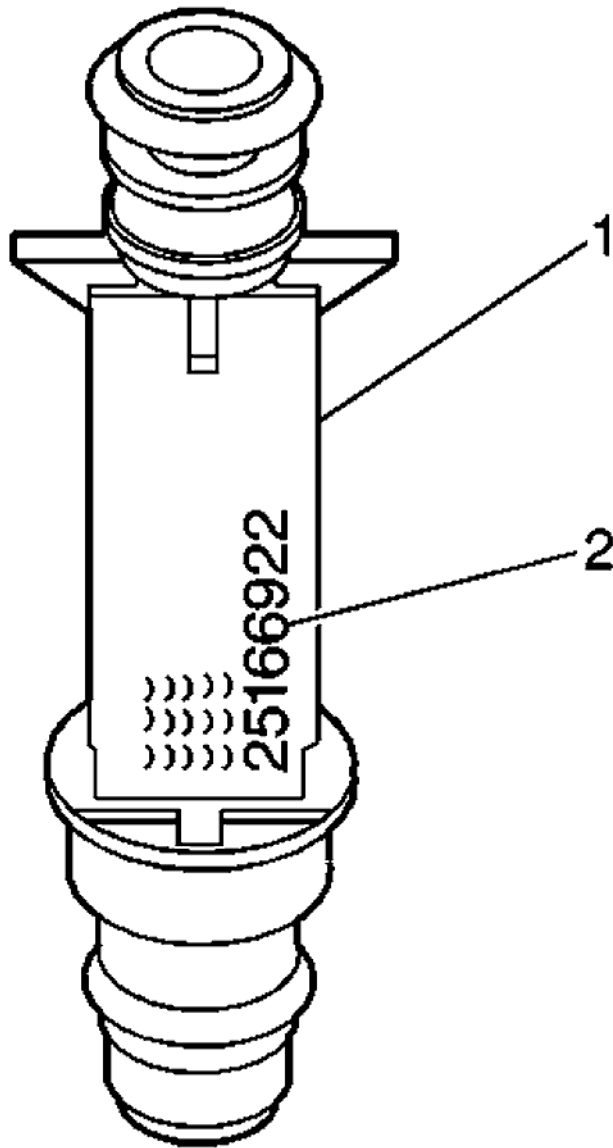


Fig. 167: Locating Fuel Injector Assembly Part Number
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Be sure to use the correct part number when ordering replacement fuel injectors.

1. The fuel injector assembly (1) is stamped with a part number identification (2).

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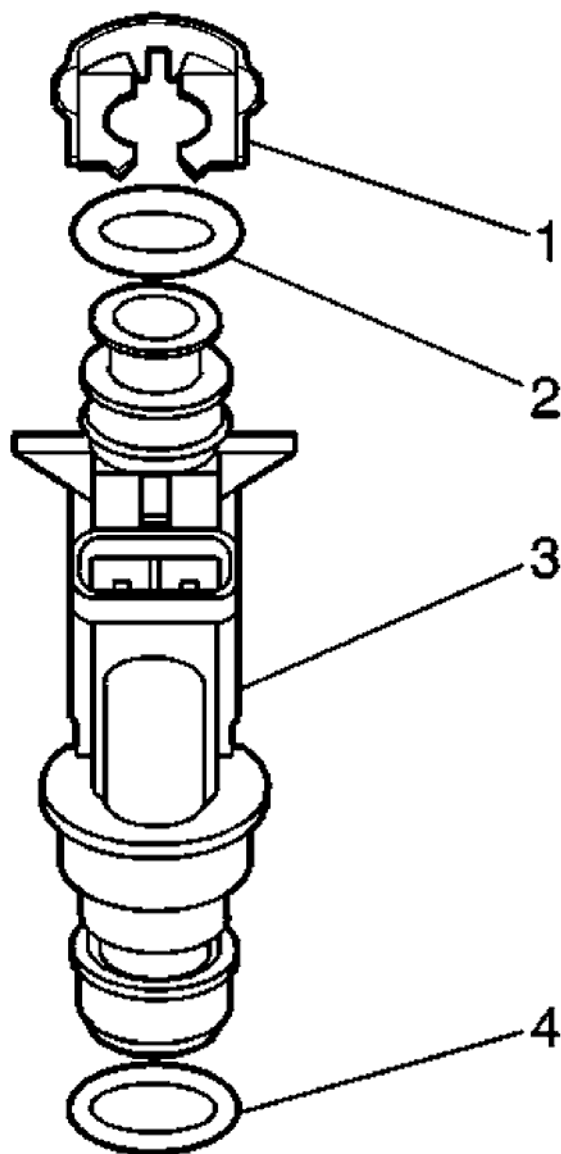


Fig. 168: Exploded View Of Fuel Injector & Components
Courtesy of GENERAL MOTORS CORP.

2. Lubricate the NEW injector O-rings with clean engine oil.
3. Install the fuel injector upper O-ring (2).
4. Install the fuel injector lower O-ring (4).
5. Install the fuel injector (3) to the fuel rail.
6. Install the fuel injector retaining clip (1).

7. Install the fuel rail. Refer to **Fuel Rail Assembly Replacement**.

EVAPORATIVE EMISSION (EVAP) CANISTER PURGE SOLENOID VALVE REPLACEMENT

Removal Procedure

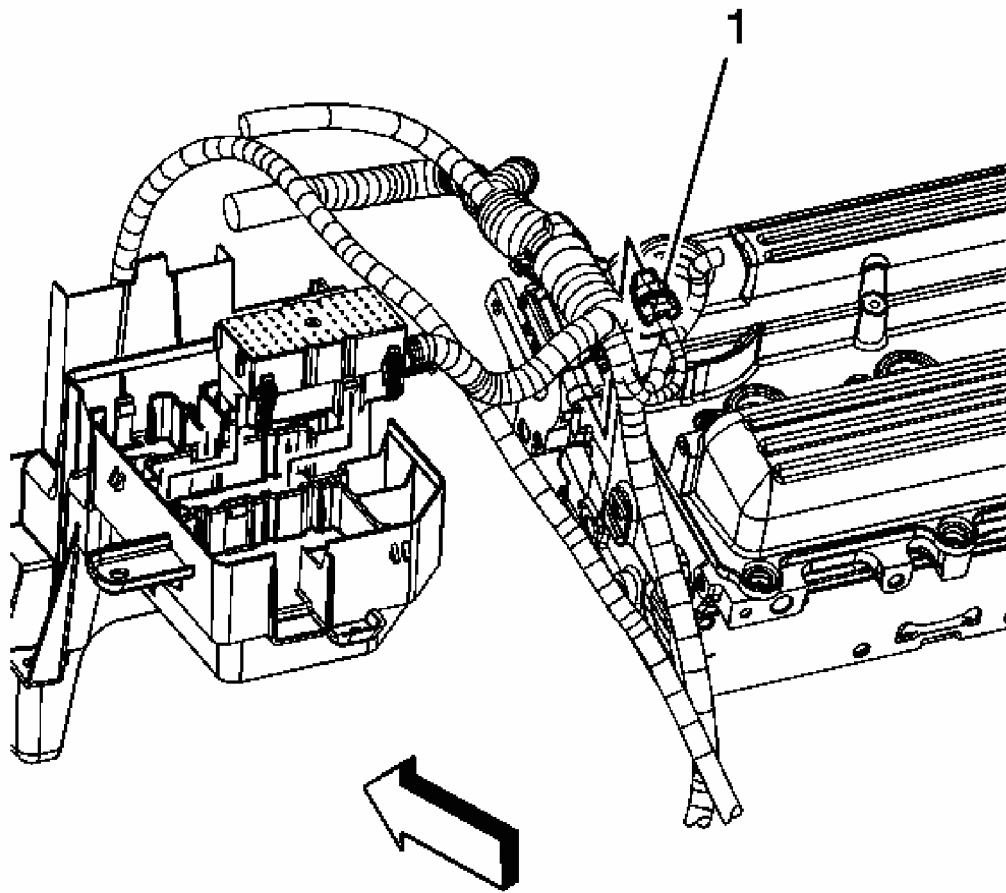


Fig. 169: EVAP Canister Purge Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the evaporative emission (EVAP) canister purge valve electrical connector (1).

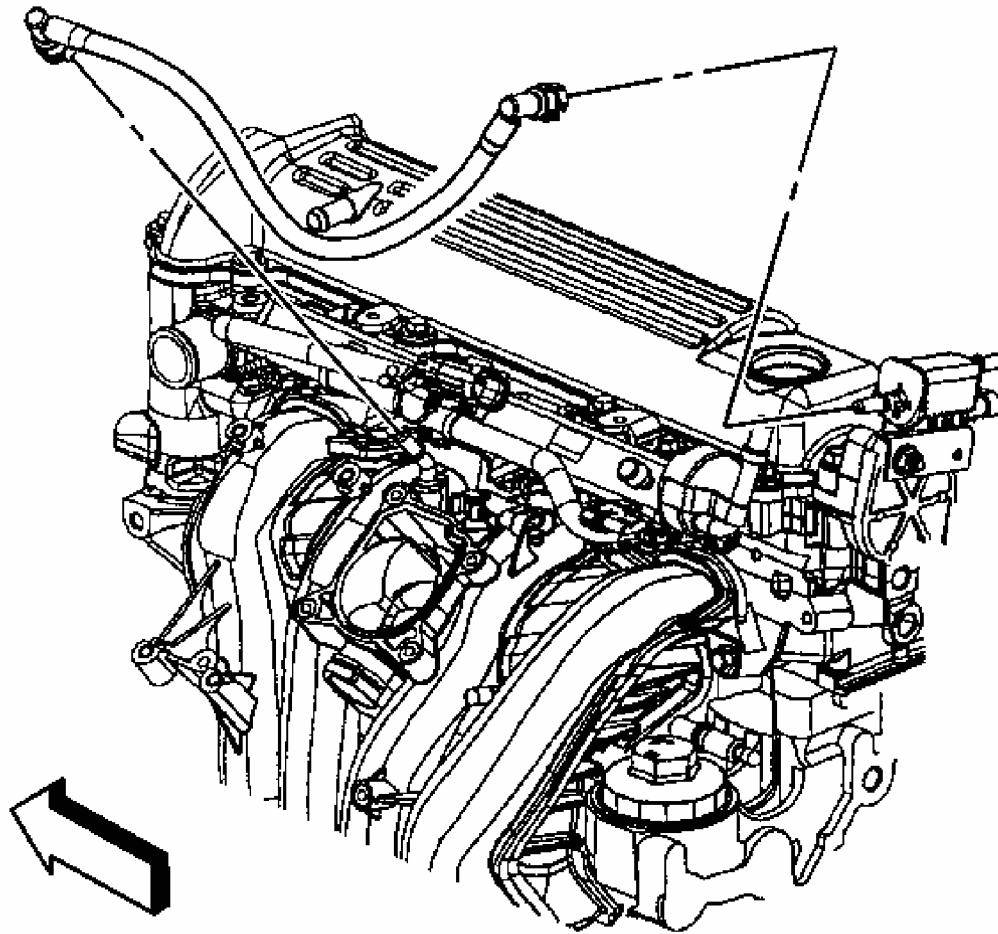


Fig. 170: EVAP Canister Purge Valve Tube
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the EVAP canister purge valve tube from the intake manifold. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Disconnect the chassis EVAP vapor line from the EVAP canister purge valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

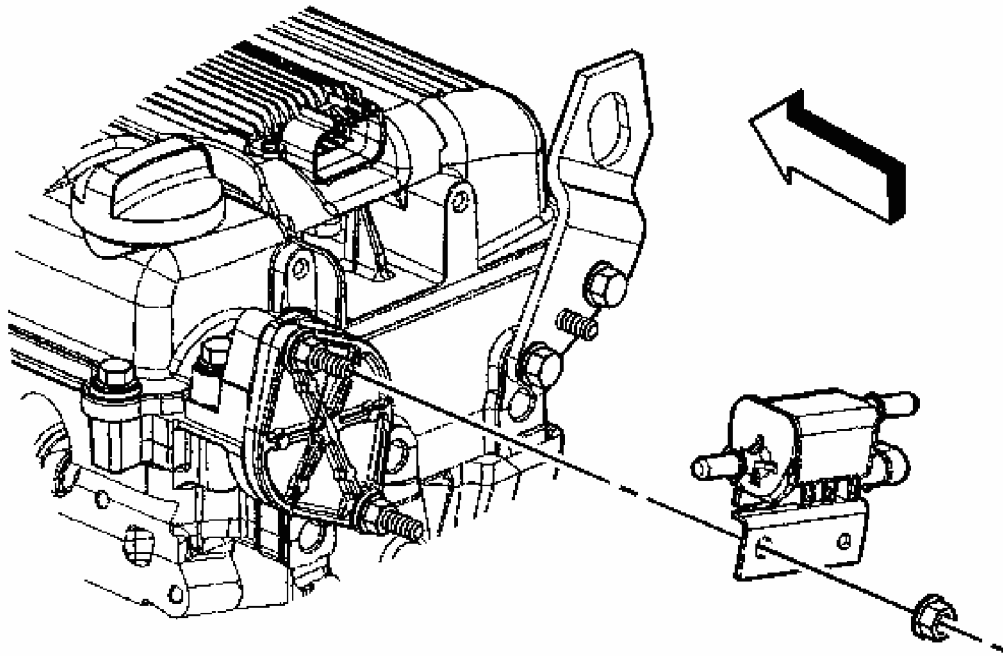


Fig. 171: EVAP Canister Purge Valve
Courtesy of GENERAL MOTORS CORP.

4. Remove the EVAP canister purge valve bracket bolt.
5. Remove the EVAP canister purge valve with bracket.
6. Remove the EVAP canister purge valve from the bracket.
7. Inspect for carbon release in the EVAP canister purge valve ports. If there is any loose carbon, replace the EVAP canister and any components necessary to remove the carbon particles.

Installation Procedure

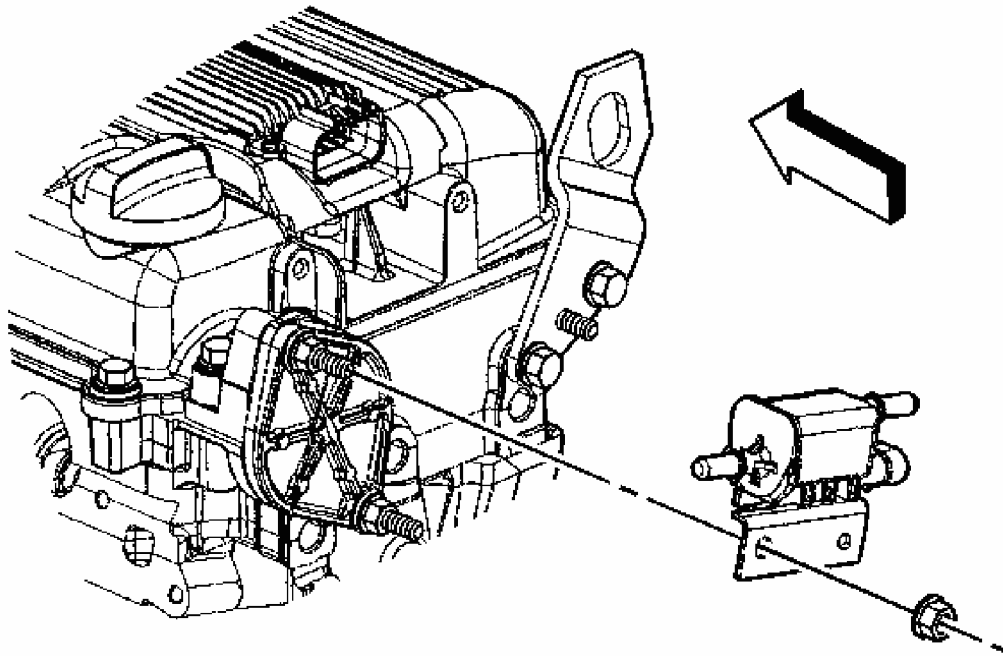


Fig. 172: EVAP Canister Purge Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the EVAP canister purge valve to the bracket.
2. Position the EVAP canister purge valve with bracket to the cylinder head.

NOTE: Refer to Fastener Notice .

3. Install the EVAP canister purge valve bracket bolt.

Tighten: Tighten the bolt to 18 N.m (13 lb ft).

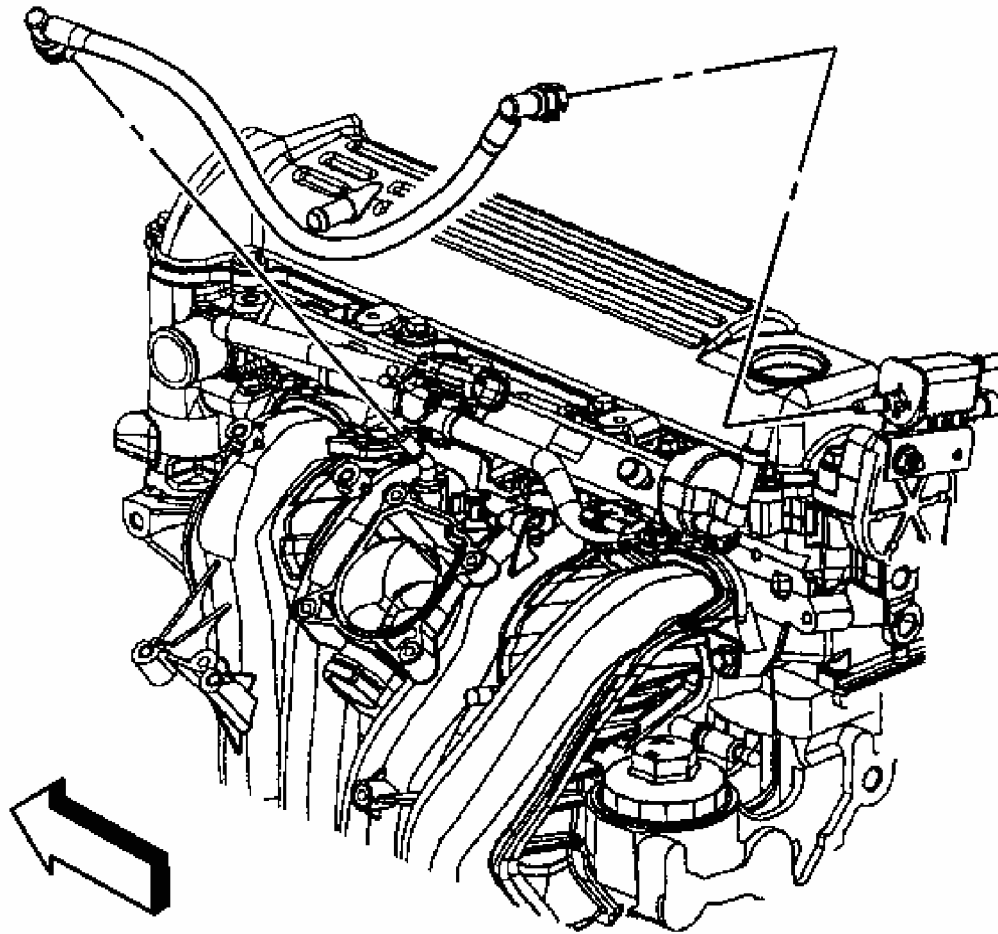


Fig. 173: EVAP Canister Purge Valve Tube
Courtesy of GENERAL MOTORS CORP.

4. Connect the EVAP canister purge valve tube to the intake manifold. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Connect the chassis EVAP vapor line to the EVAP canister purge valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

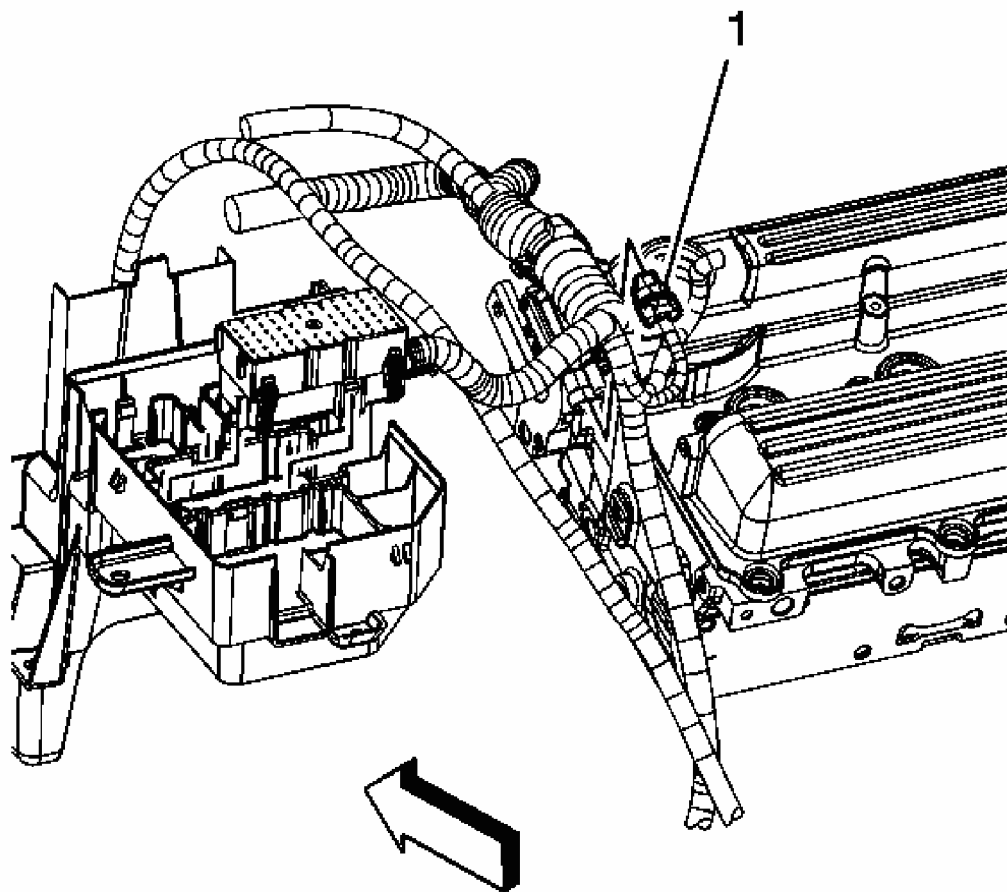


Fig. 174: EVAP Canister Purge Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the EVAP canister purge valve electrical connector (1).

EVAPORATIVE EMISSION (EVAP) CANISTER VENT SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

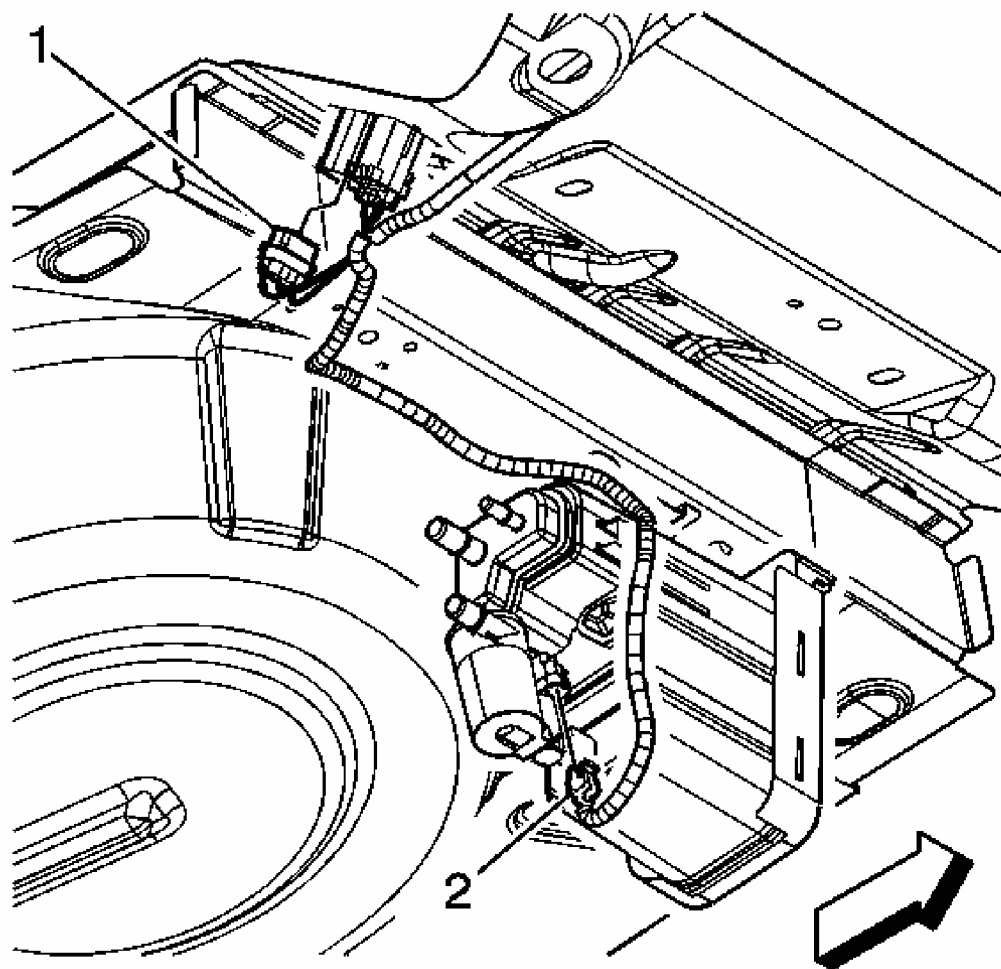


Fig. 175: EVAP Canister Vent Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the evaporative emission (EVAP) canister vent solenoid valve electrical connector (2).
3. Clean any dirt or debris that may be present around the EVAP canister vent valve.

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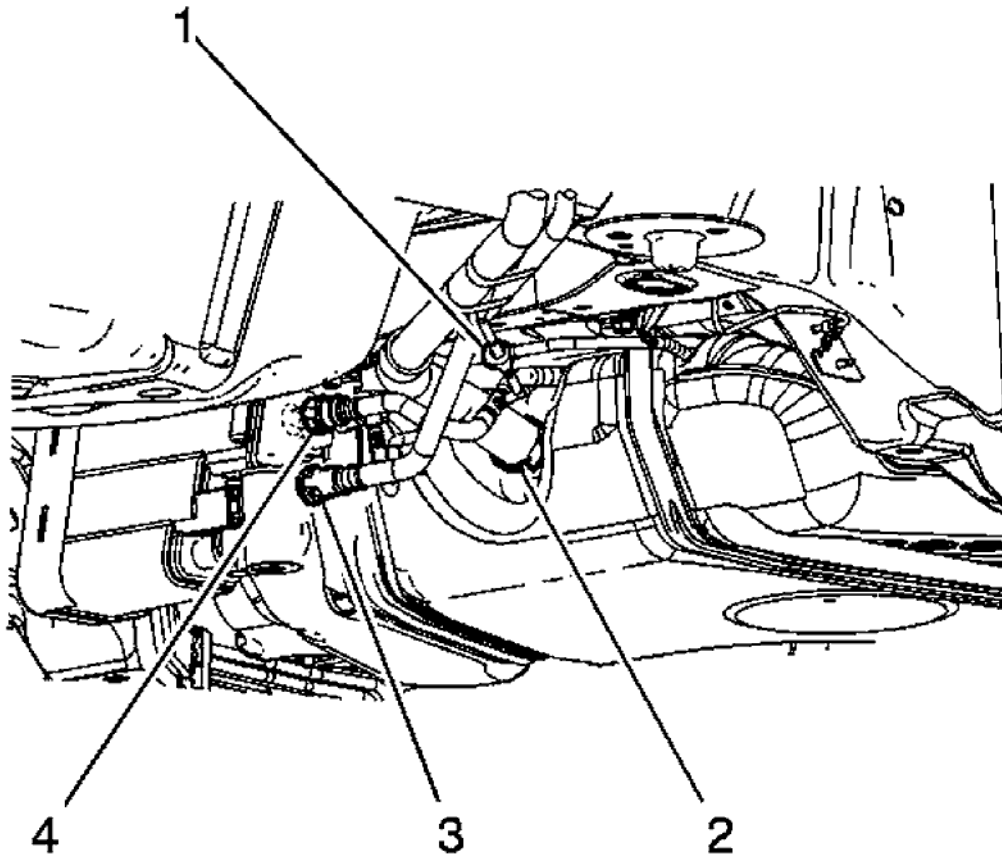


Fig. 176: Fresh Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fresh air tube quick connect fitting (3) from the EVAP vent solenoid valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

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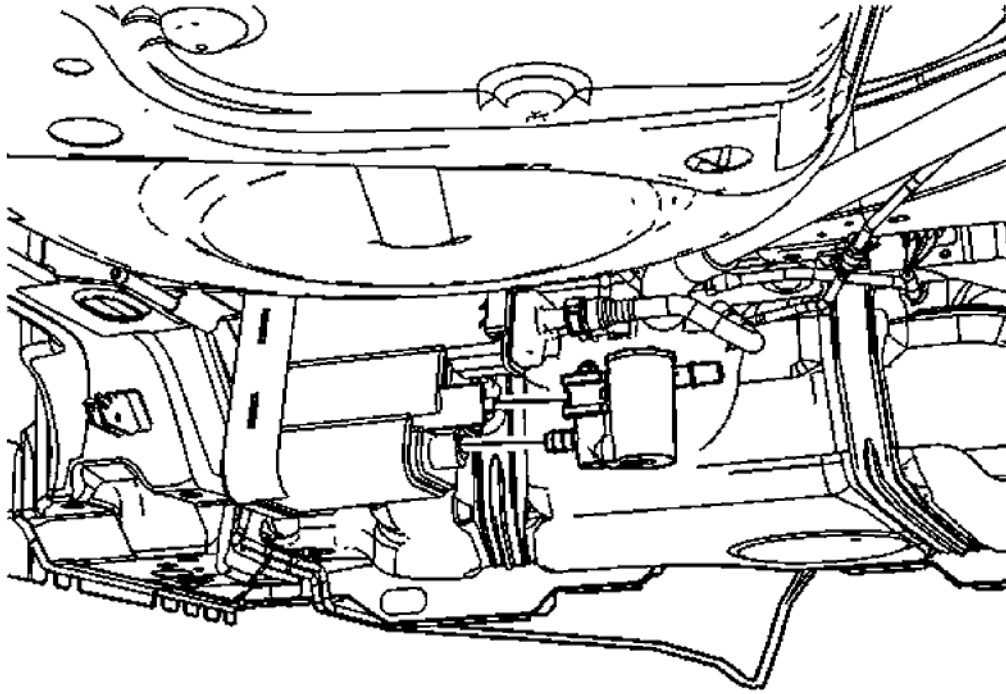


Fig. 177: EVAP Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

5. Disengage the retainer attaching the EVAP vent solenoid valve to the canister.
6. Remove the vent solenoid valve from the EVAP canister.

Installation Procedure

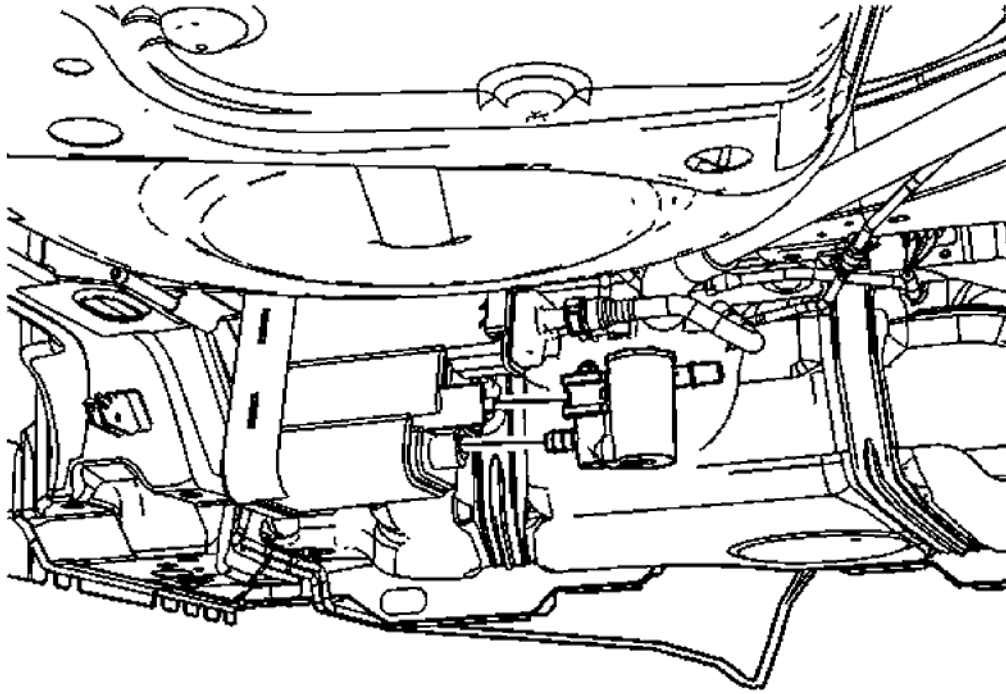


Fig. 178: EVAP Vent Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the vent solenoid valve to the EVAP canister.
2. Ensure that the retainer attaching the EVAP vent solenoid valve to the canister is engaged.

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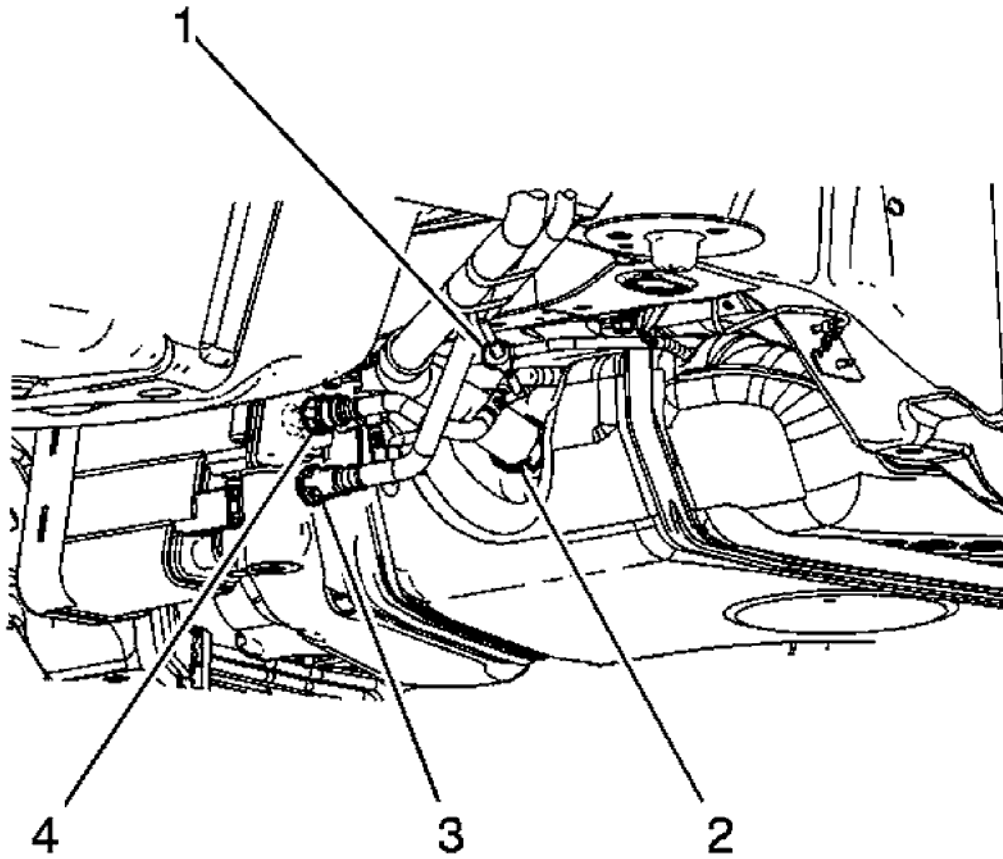


Fig. 179: Fresh Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

3. Connect the fresh air tube quick connect fitting (3) to the EVAP vent solenoid valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

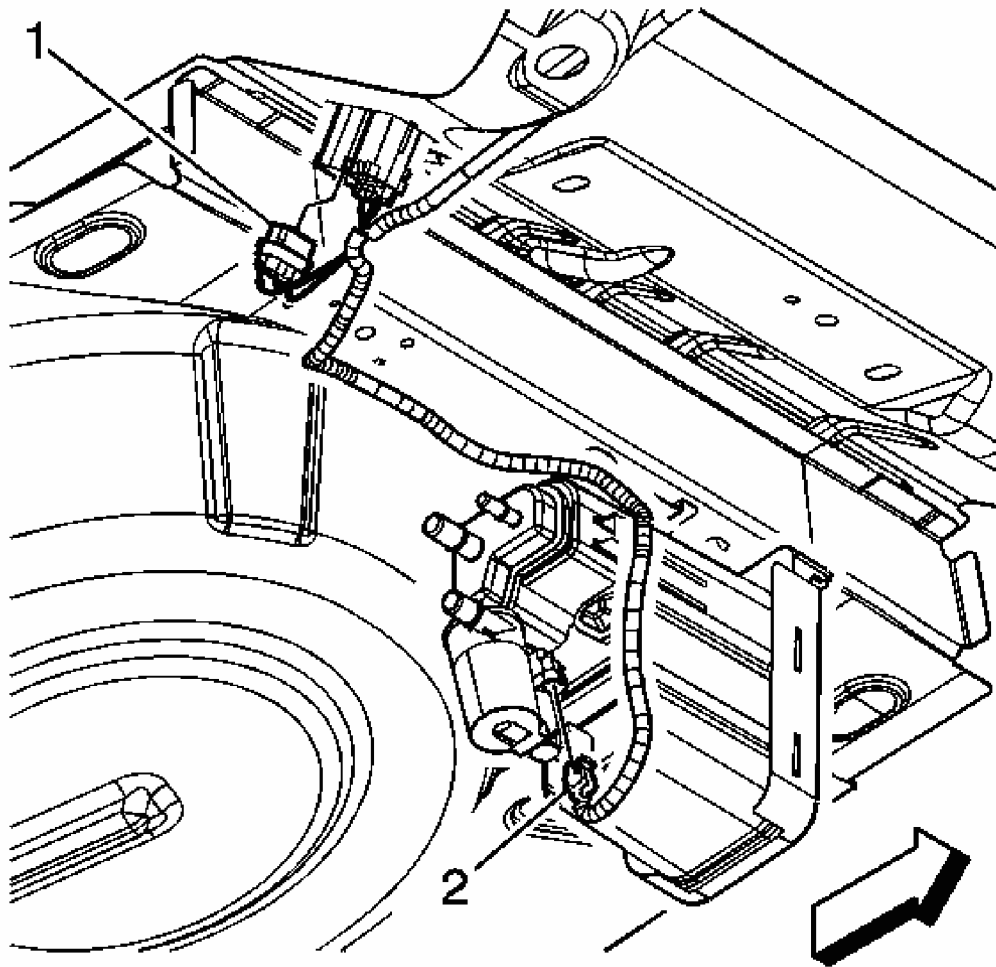


Fig. 180: EVAP Canister Vent Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the EVAP canister vent solenoid valve electrical connector (2).
5. Lower the vehicle.

EVAPORATIVE EMISSION (EVAP) HOSES/PIPES REPLACEMENT - ENGINE

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.

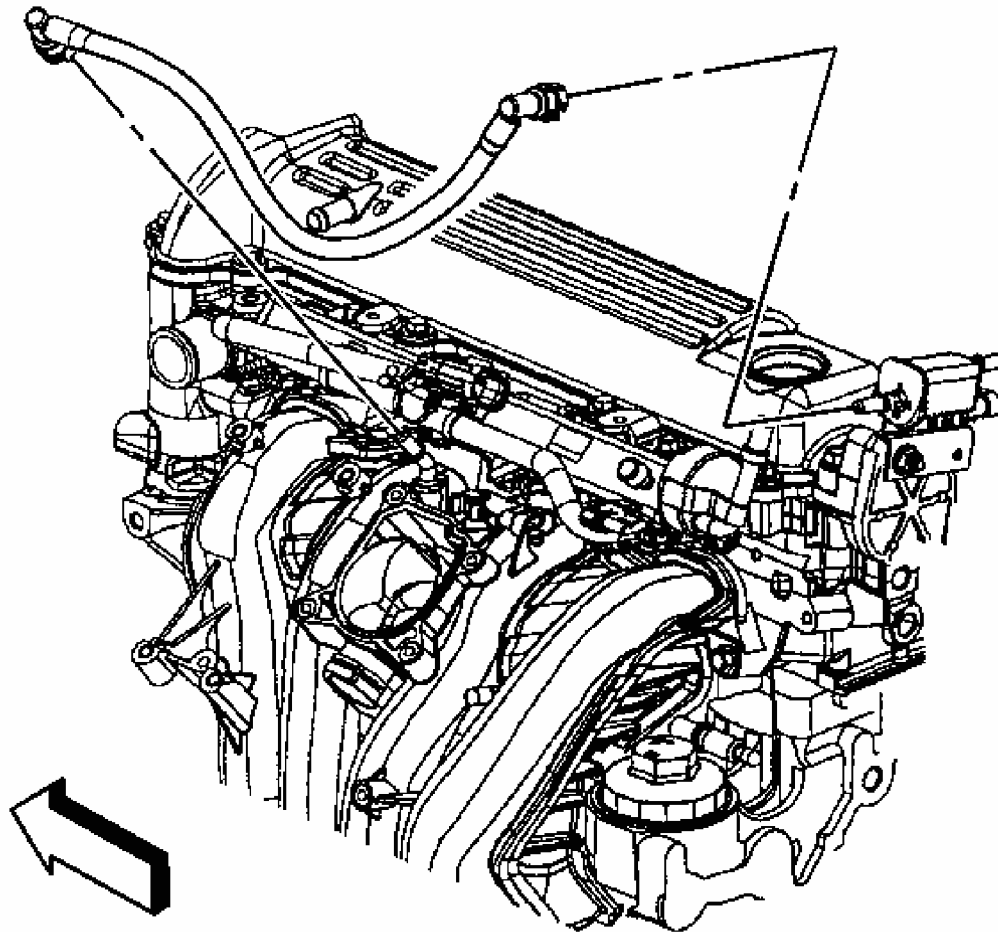


Fig. 181: EVAP Canister Purge Tube
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the evaporative emission (EVAP) canister purge tube from the purge valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Disconnect the EVAP purge tube from the intake manifold. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Remove the EVAP canister valve purge tube.

Installation Procedure

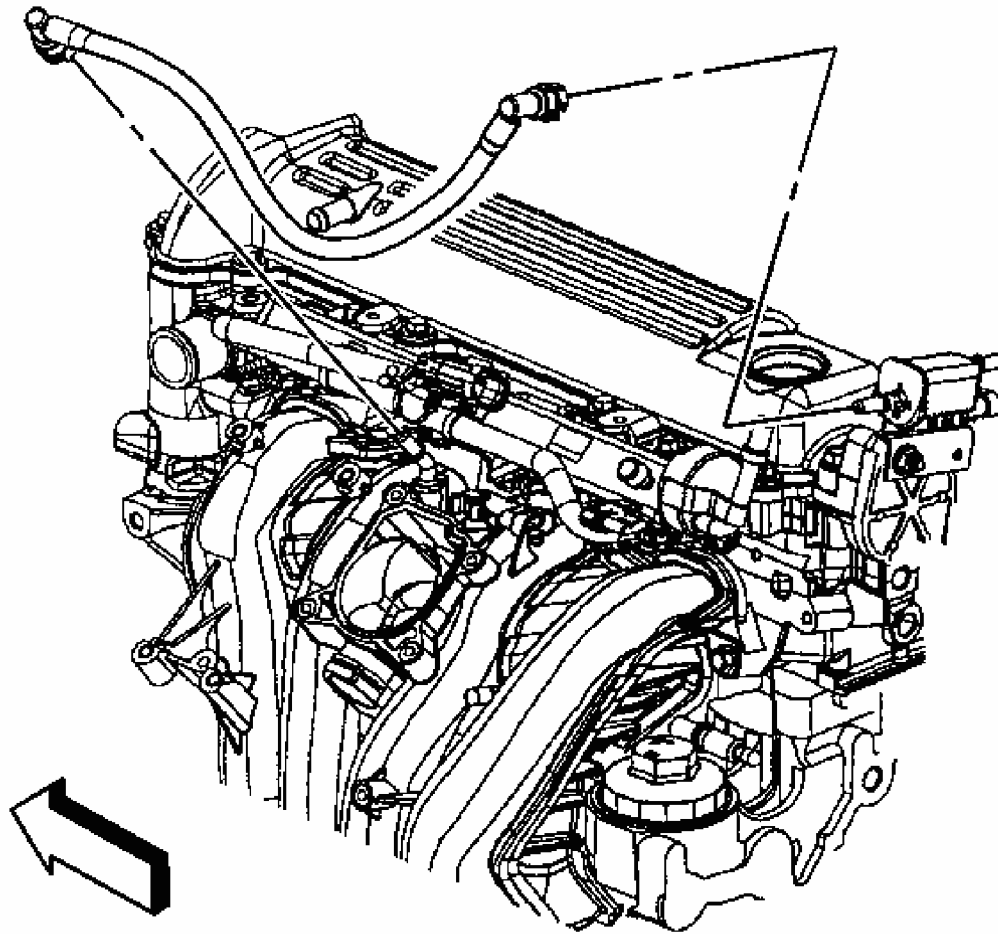


Fig. 182: EVAP Canister Valve Purge Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the EVAP canister valve purge tube.
2. Connect the EVAP purge tube to the intake manifold. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Connect the EVAP canister purge tube to the purge valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.

EVAPORATIVE EMISSION (EVAP) HOSES/PIPES REPLACEMENT - ENGINE/CHASSIS

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief Procedure**.

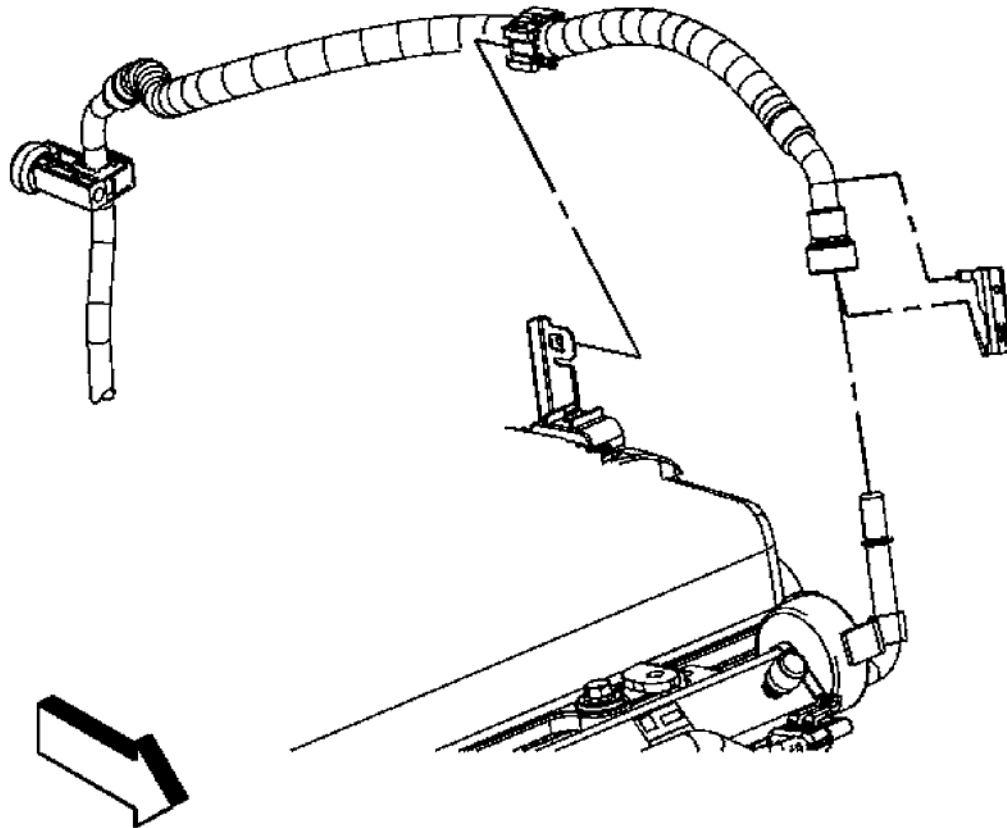


Fig. 183: Fuel Feed Pipe
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the fuel feed pipe from the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
3. Cap or plug the fuel pipe and the engine fuel rail to prevent contamination.

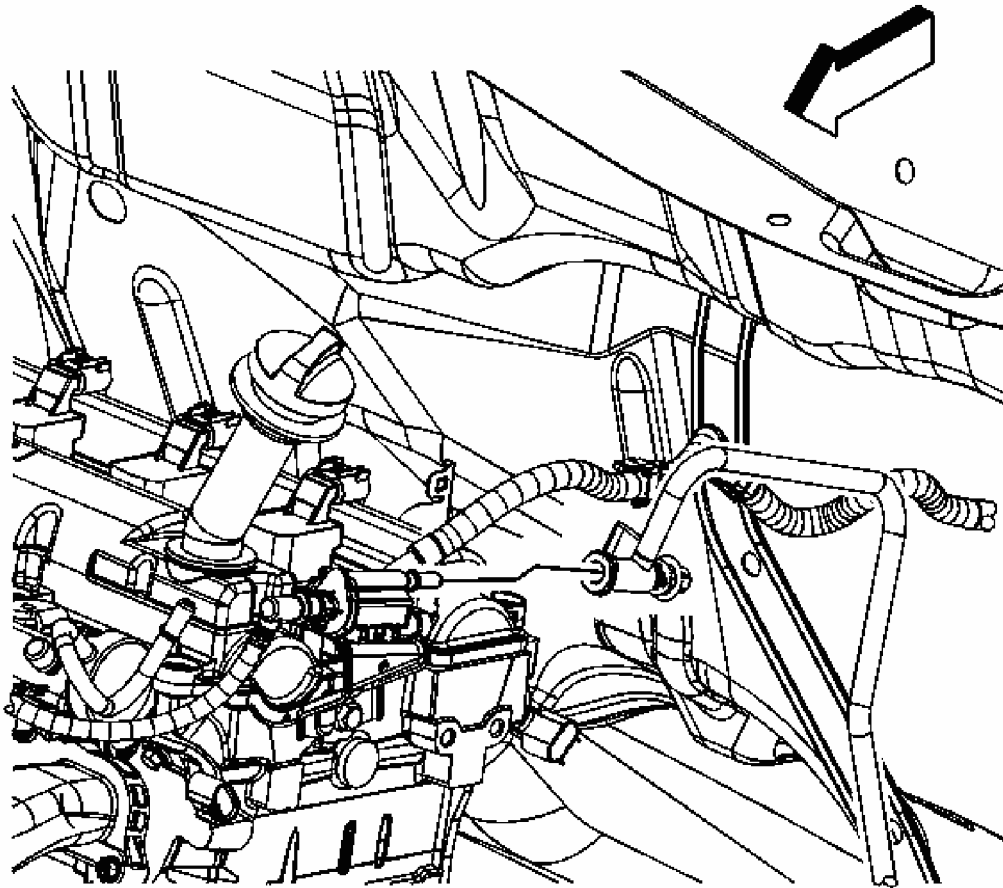


Fig. 184: EVAP Pipe From Purge Solenoid
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the evaporative emission (EVAP) pipe from the purge solenoid. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Cap or plug the EVAP pipe in order to prevent contamination.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
7. Remove the evaporative emission (EVAP) canister, if necessary. Refer to **Evaporative Emission (EVAP) Canister Replacement**.
8. Disconnect the fuel feed pipe quick connect fitting. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

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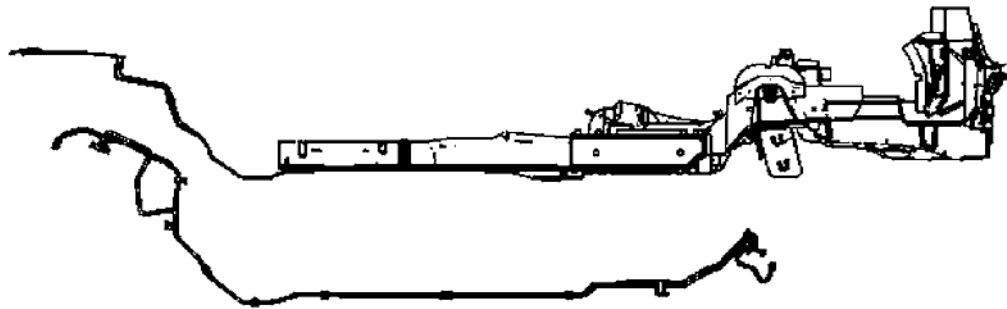


Fig. 185: Fuel/EVAP/brake Line Brackets
Courtesy of GENERAL MOTORS CORP.

9. Remove the brake lines from the fuel/EVAP/brake line brackets.
10. Remove the fuel/EVAP/brake line bracket nuts and remove the brackets from the body studs.
11. Remove the fuel and EVAP lines from the vehicle.
12. Open the brackets and remove the EVAP pipe.

Installation Procedure

1. Install the EVAP pipe to the brackets and close the covers.
2. Install the fuel and EVAP lines to the vehicle.

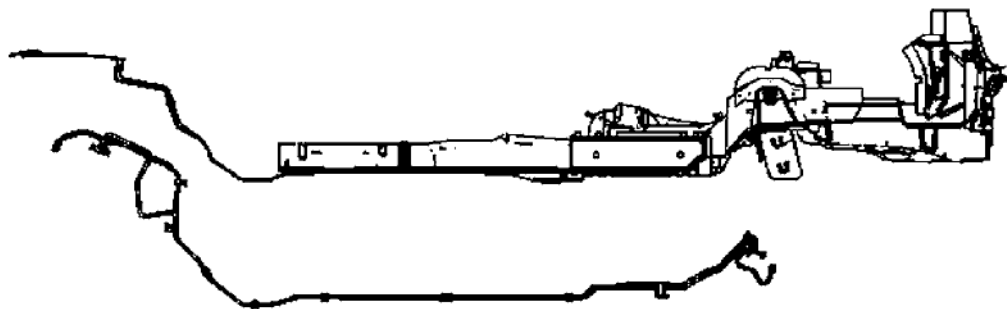


Fig. 186: Fuel/EVAP/brake Line Brackets
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel/EVAP/brake line bracket to the body studs.

NOTE: Refer to Fastener Notice .

4. Install the fuel/EVAP/brake line bracket nuts.

Tighten: Tighten the nuts to 10 N.m (89 lb in).

5. Install the brake lines to the fuel/EVAP/brake line brackets.

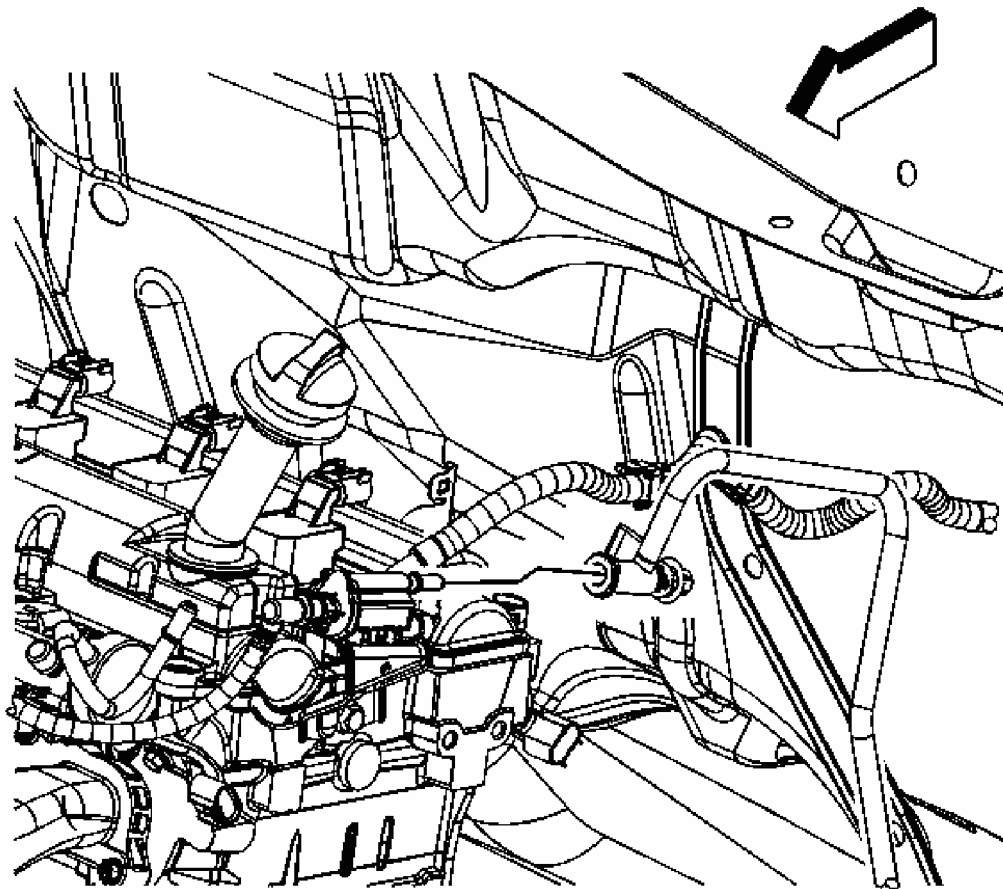


Fig. 187: Fuel Feed Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

6. Connect the fuel feed pipe quick connect fitting. Refer to Quick Connect Fitting(s) Service (Plastic Collar).

7. Install the canister, if necessary. Refer to **Evaporative Emission (EVAP) Canister Replacement**.
8. Lower the vehicle.
9. Remove the cap or plug from the EVAP pipe.
10. Connect the EVAP pipe to the purge solenoid. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

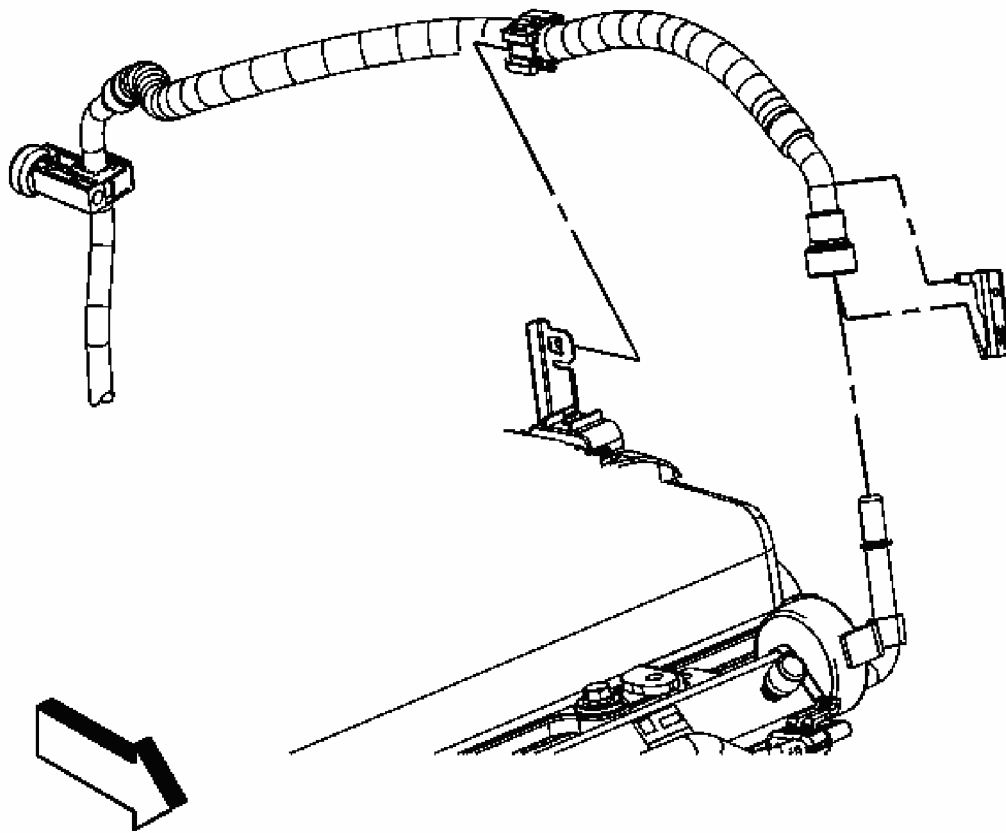


Fig. 188: Fuel Pipe
Courtesy of GENERAL MOTORS CORP.

11. Remove the cap or plug from the fuel pipe and the engine fuel rail.
12. Connect the fuel feed pipe to the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
13. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
14. 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.

EVAPORATIVE EMISSION (EVAP) CANISTER REPLACEMENT

Removal Procedure

NOTE: The EVAP canister may have released carbon particles which caused this part to fail and may cause damage to other components. Check the EVAP canister for loose carbon before returning the vehicle to service.

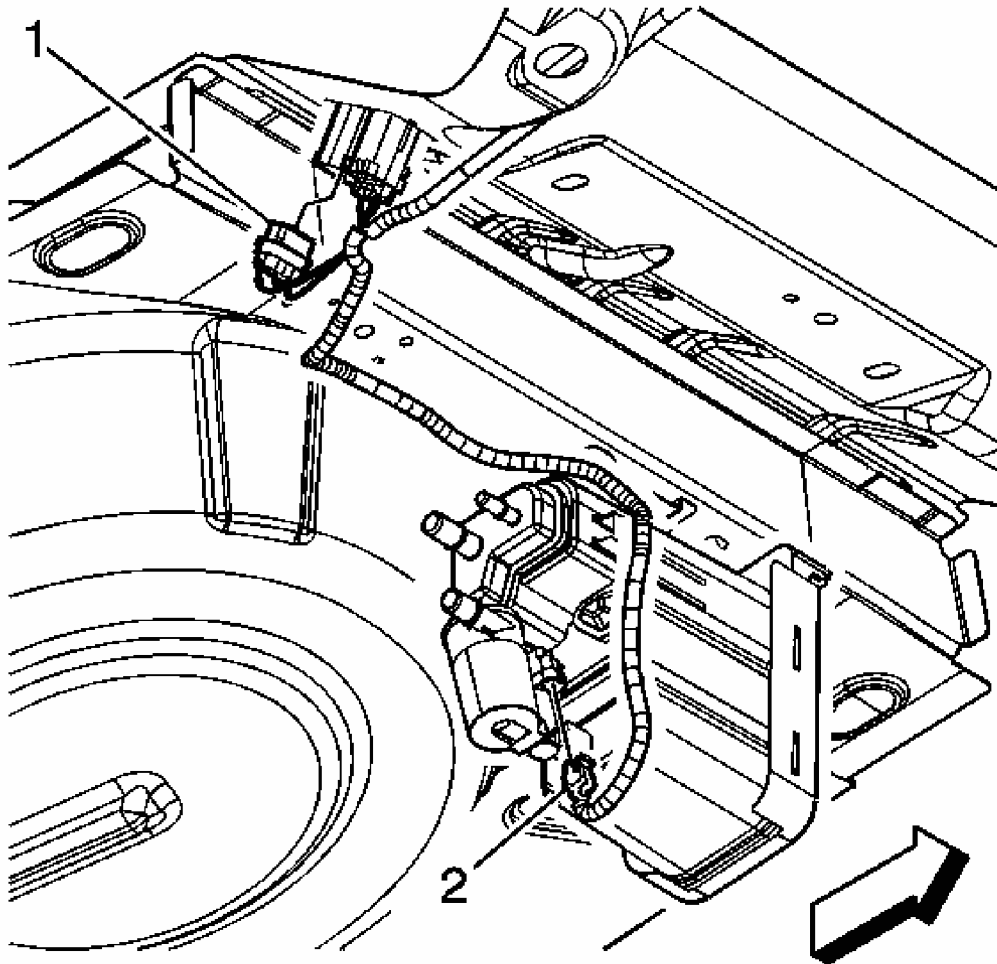


Fig. 189: EVAP Canister
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the evaporative emission (EVAP) canister vent solenoid valve electrical connector (2).
3. Clean any dirt or debris that may be present around the EVAP canister.

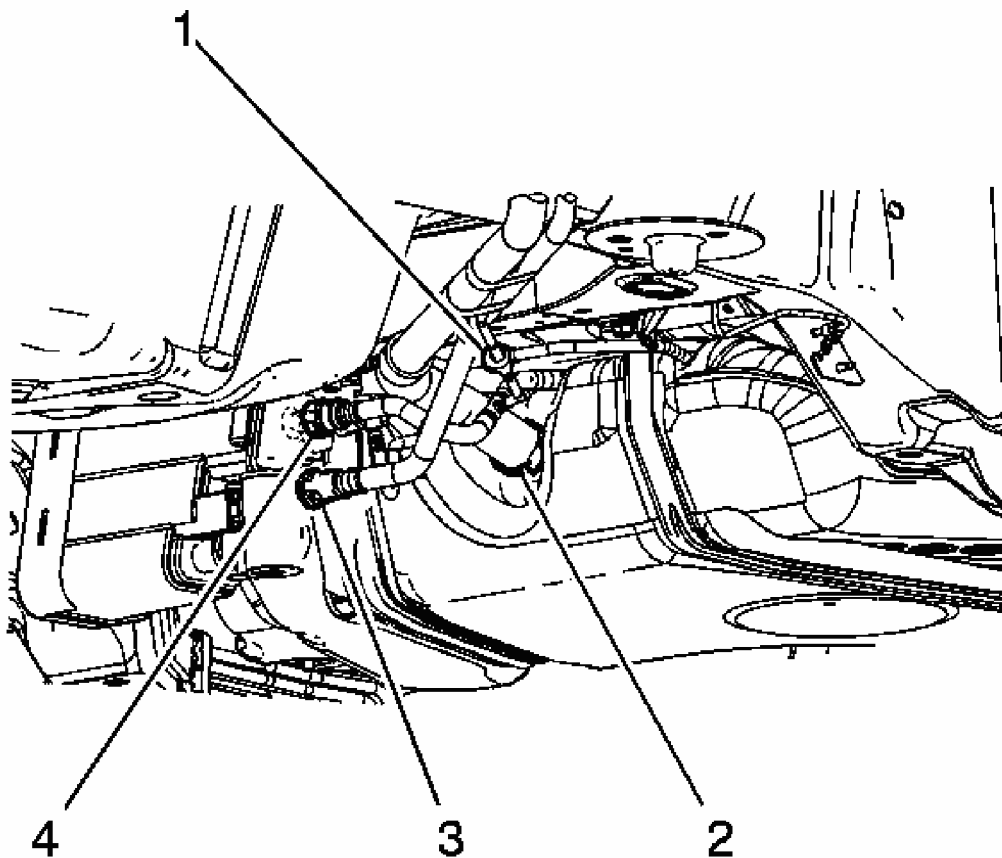


Fig. 190: Fresh Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fresh air tube quick connect fitting (3) from the vent solenoid valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Disconnect the fuel vent pipe quick connect fitting (4) from the canister. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

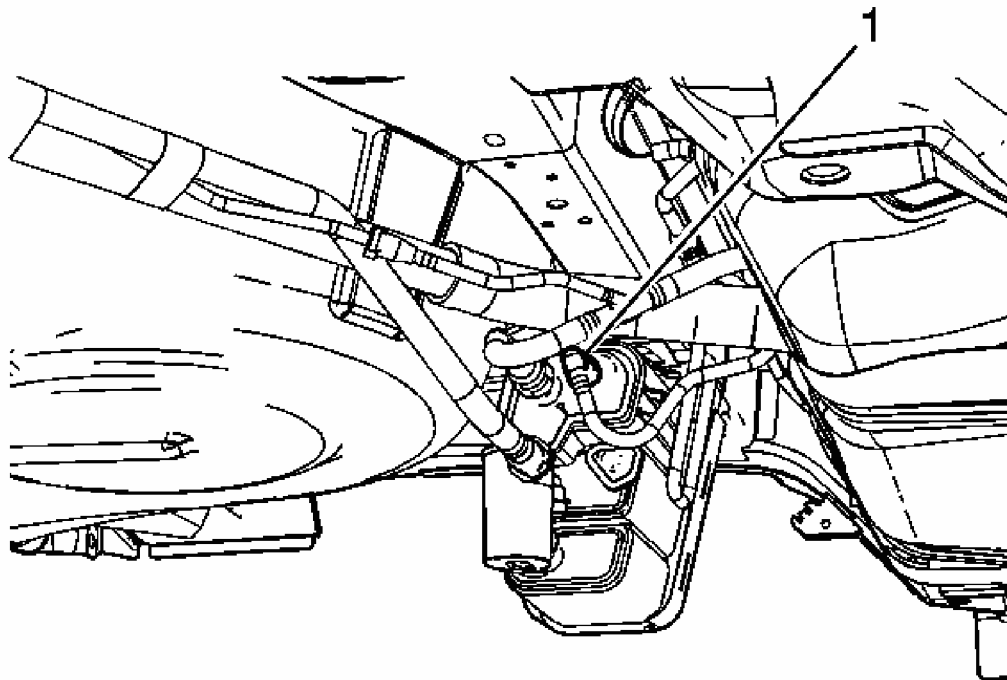


Fig. 191: EVAP Chassis Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the EVAP chassis pipe quick connect fitting (1) from the canister. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

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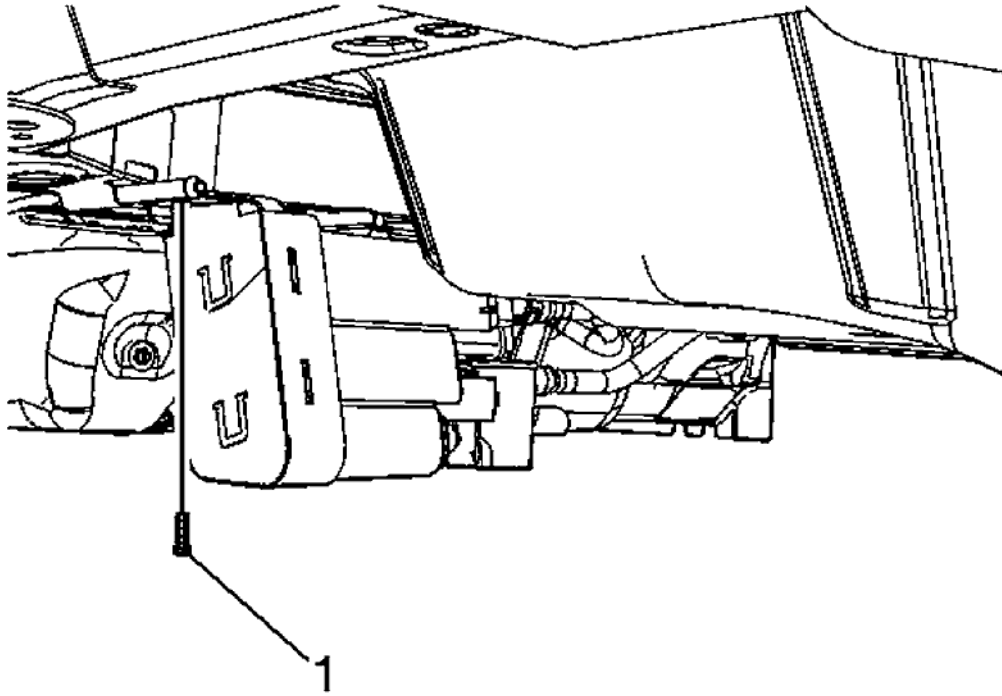


Fig. 192: EVAP Canister Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the EVAP canister bolt (1).

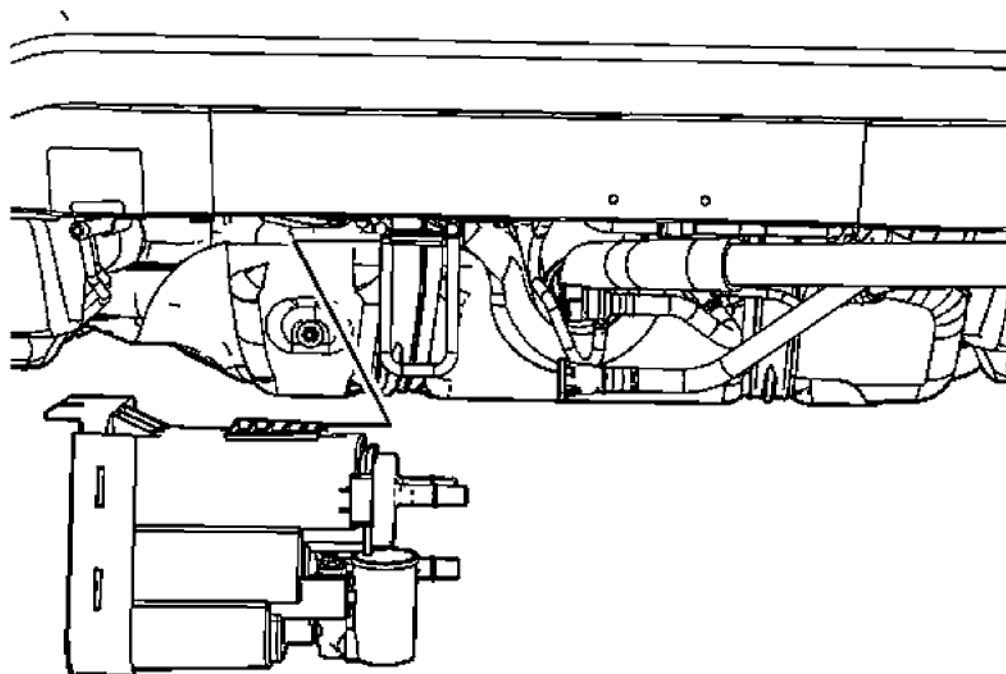


Fig. 193: EVAP Canister
Courtesy of GENERAL MOTORS CORP.

8. Remove the EVAP canister by sliding the canister towards the driver side of the vehicle.

Installation Procedure

1. Align the EVAP canister retaining feature to the canister bracket.

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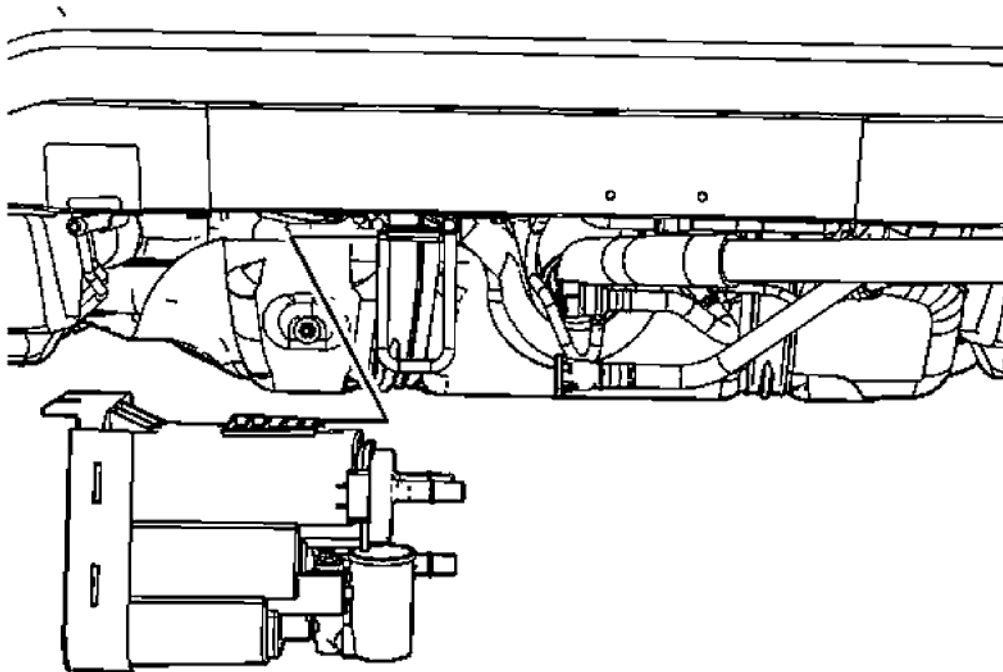


Fig. 194: EVAP Canister
Courtesy of GENERAL MOTORS CORP.

2. Install the EVAP canister by sliding the canister towards the passenger side of the vehicle.

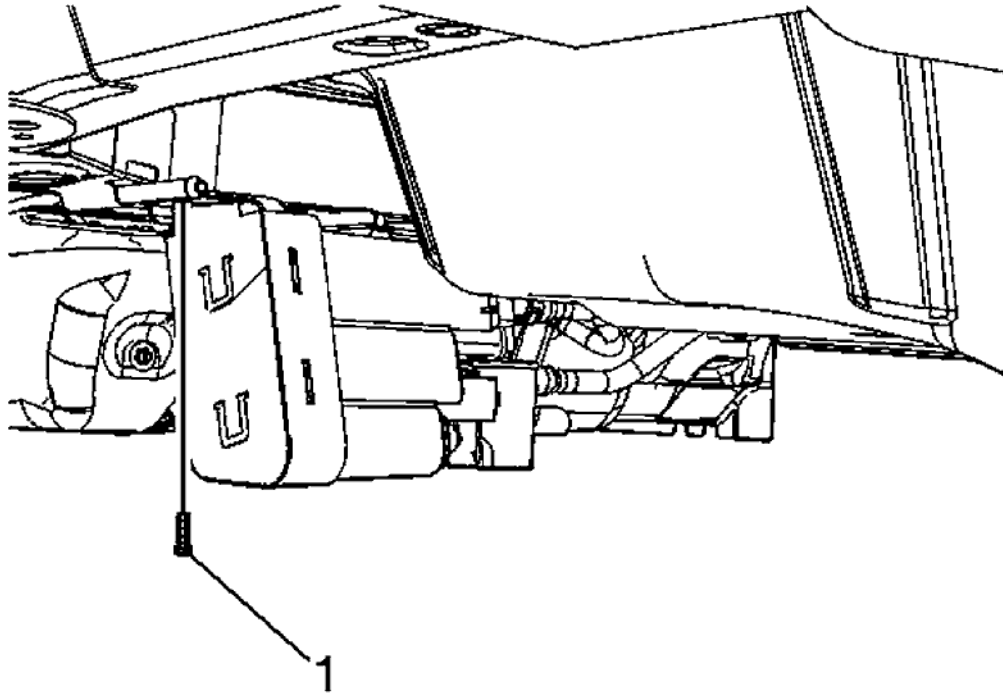


Fig. 195: EVAP Canister Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the EVAP canister bolt (1).

Tighten: Tighten the bolt to 10 N.m (89 lb in).

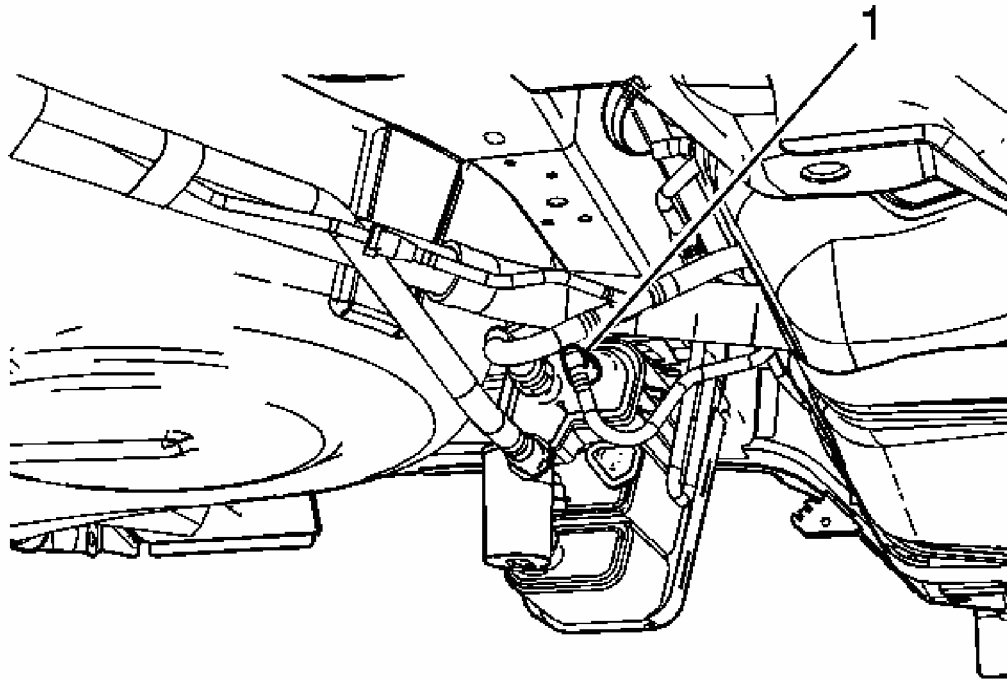


Fig. 196: EVAP Chassis Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

4. Connect the EVAP chassis pipe quick connect fitting (1) to the canister. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

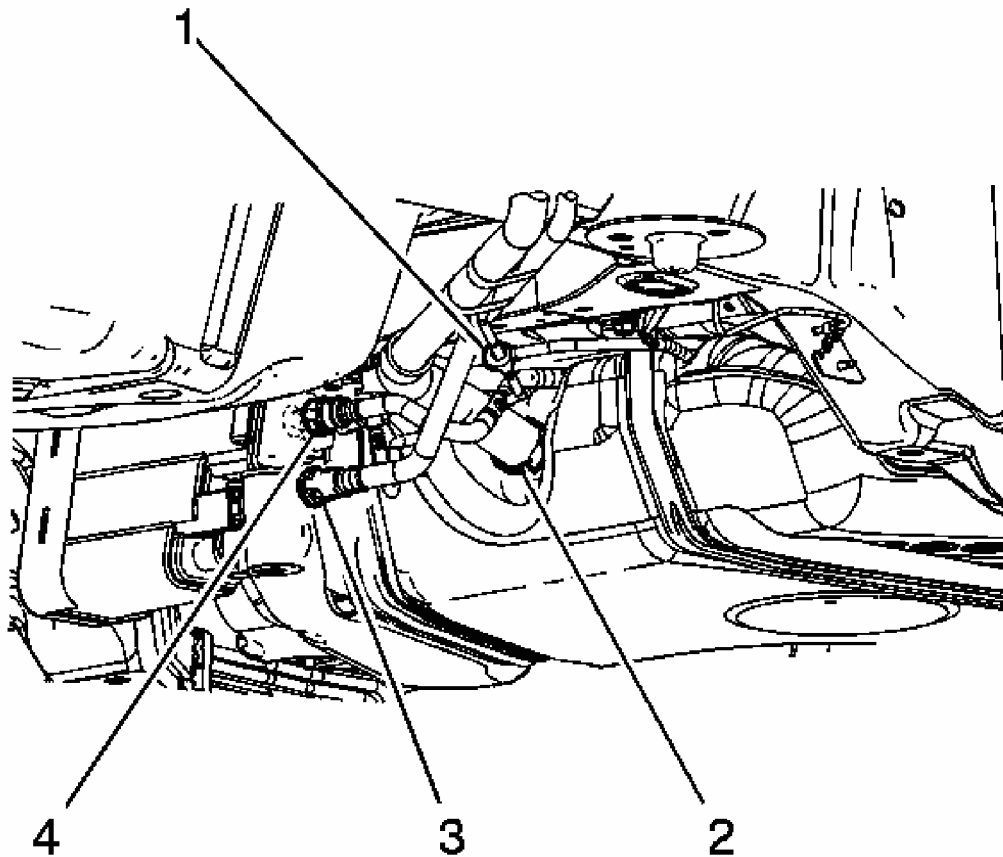


Fig. 197: Fuel Vent Pipe Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

5. Connect the fuel vent pipe quick connect fitting (4) to the canister. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
6. Connect the fresh air tube quick connect fitting (3) to the vent solenoid valve. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

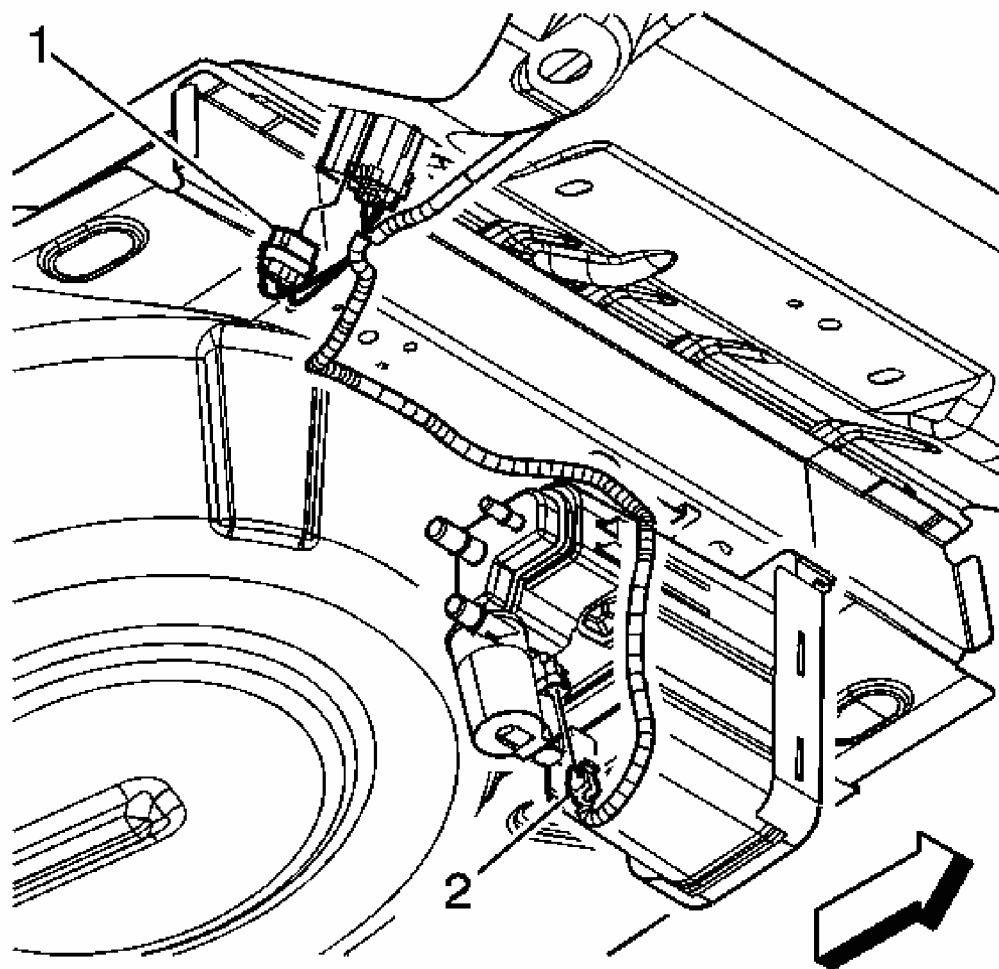


Fig. 198: EVAP Canister Vent Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Connect the EVAP canister vent solenoid valve electrical connector (2).
8. Lower the vehicle.

EVAPORATIVE EMISSION (EVAP) SYSTEM CLEANING

Tools Required

J 41413 EVAP Pressure and Purge Station

Inspection Procedure

NOTE: Use the EVAP Pressure/Purge Diagnostic Station J 41413 in

order to provide a clean, dry, low pressure gas source. Do not substitute any other pressurized gas source. Damage may result to the EVAP system.

IMPORTANT: Proceed with the following procedure only if referenced by an evaporative emission (EVAP) diagnostic or repair procedure.

1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. Refer to **Evaporative Emission (EVAP) Canister Purge Solenoid Valve Replacement**.
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
 - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
 - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
 - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

Cleaning Procedure

1. Remove the EVAP canister. Refer to **Evaporative Emission (EVAP) Canister Replacement**.
2. Turn OFF the main valve on the **J 41413**.
3. Disconnect the hose from the diagnostic station pressure regulator.
4. Using a section of vacuum hose, connect one end onto the EVAP pressure/purge diagnostic station pressure regulator.
5. Connect the other end of the vacuum hose to the canister side of the purge pipe.
6. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
7. If the nitrogen does not clear the blockage, replace the purge pipe.
8. Return the EVAP pressure/purge diagnostic station to the stations original condition.
9. Install a NEW EVAP canister. Refer to **Evaporative Emission (EVAP) Canister Replacement**.
10. Lower the vehicle.
11. Install a new EVAP canister purge valve. Refer to **Evaporative Emission (EVAP) Canister Purge Solenoid Valve Replacement**.

12. Return to the diagnostic table that sent you here.

IGNITION COIL HOUSING REPLACEMENT

Removal Procedure

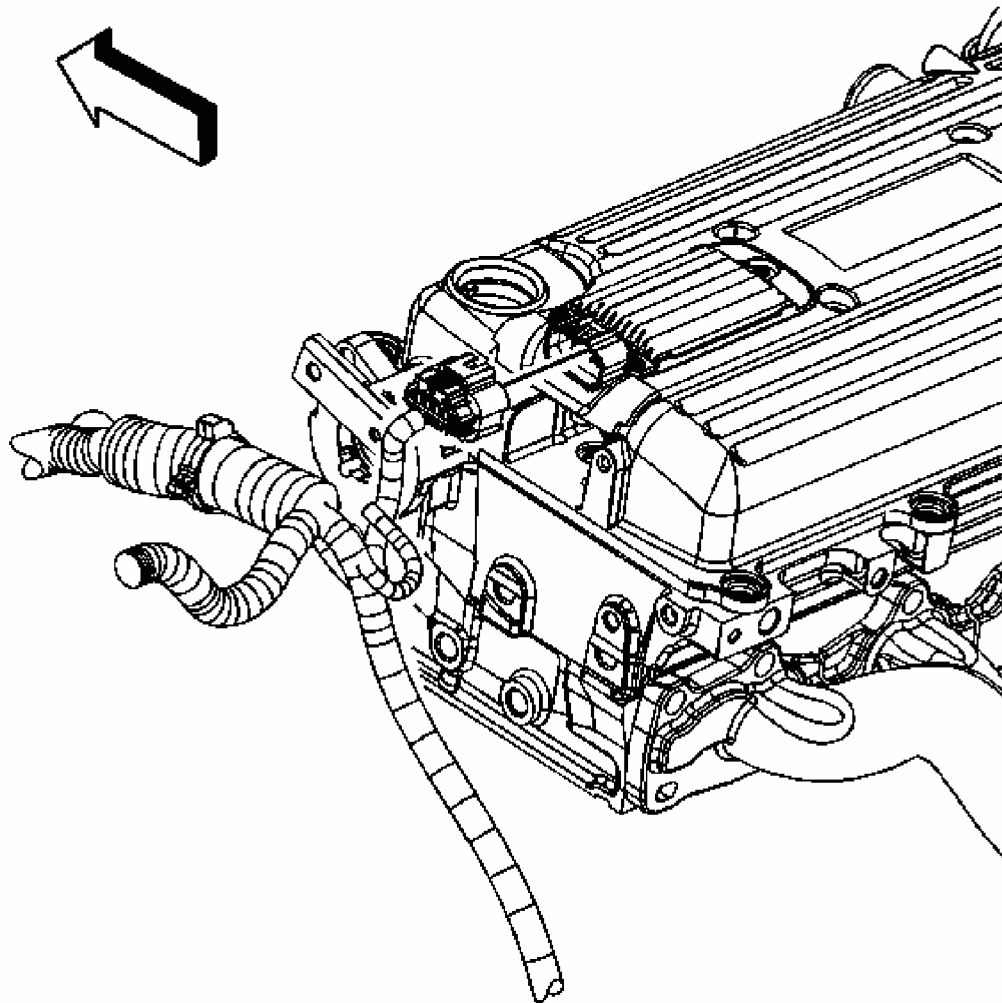


Fig. 199: Ignition Coil Housing
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the ignition control module electrical connector.

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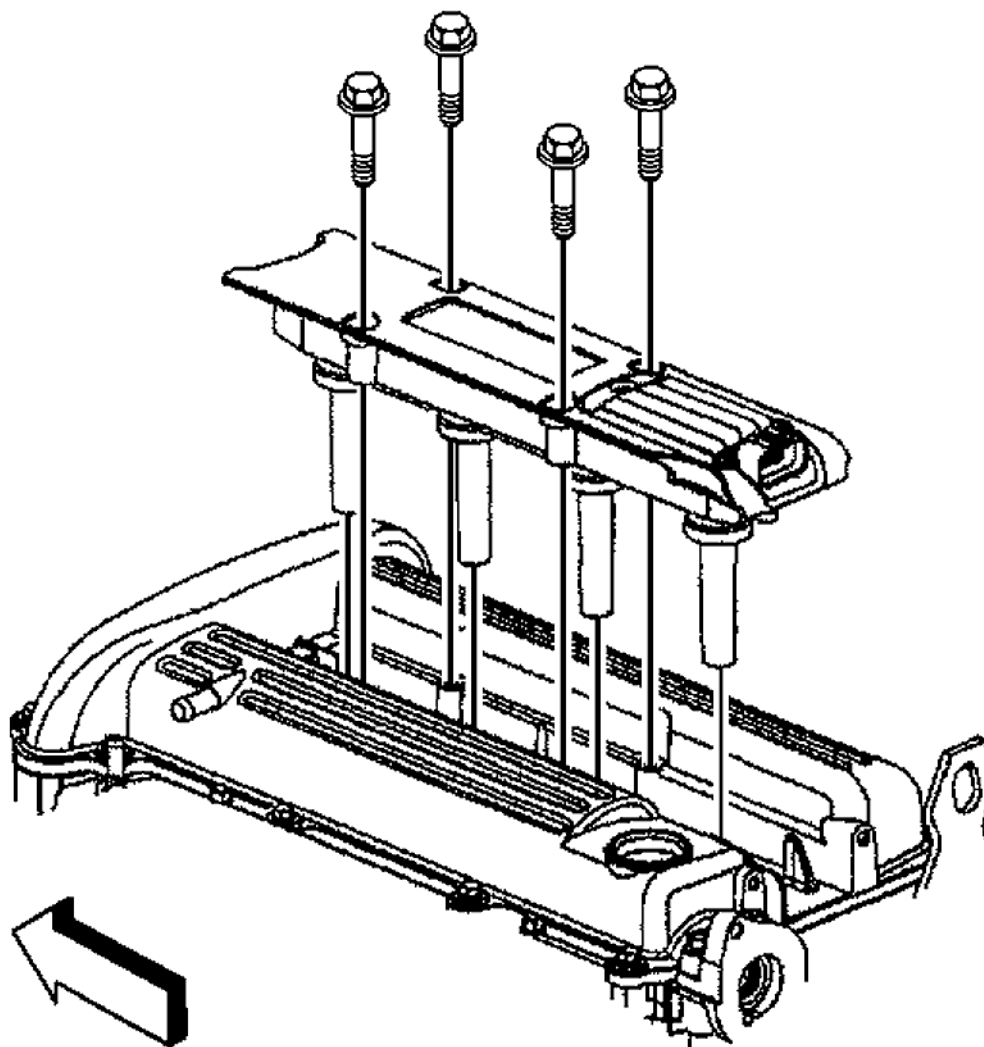


Fig. 200: Ignition Coil Housing Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the ignition coil housing bolts.
3. Remove the ignition coil housing from the camshaft cover.
4. Remove the ignition control module, if necessary. Refer to **Ignition Control Module Replacement**.

Installation Procedure

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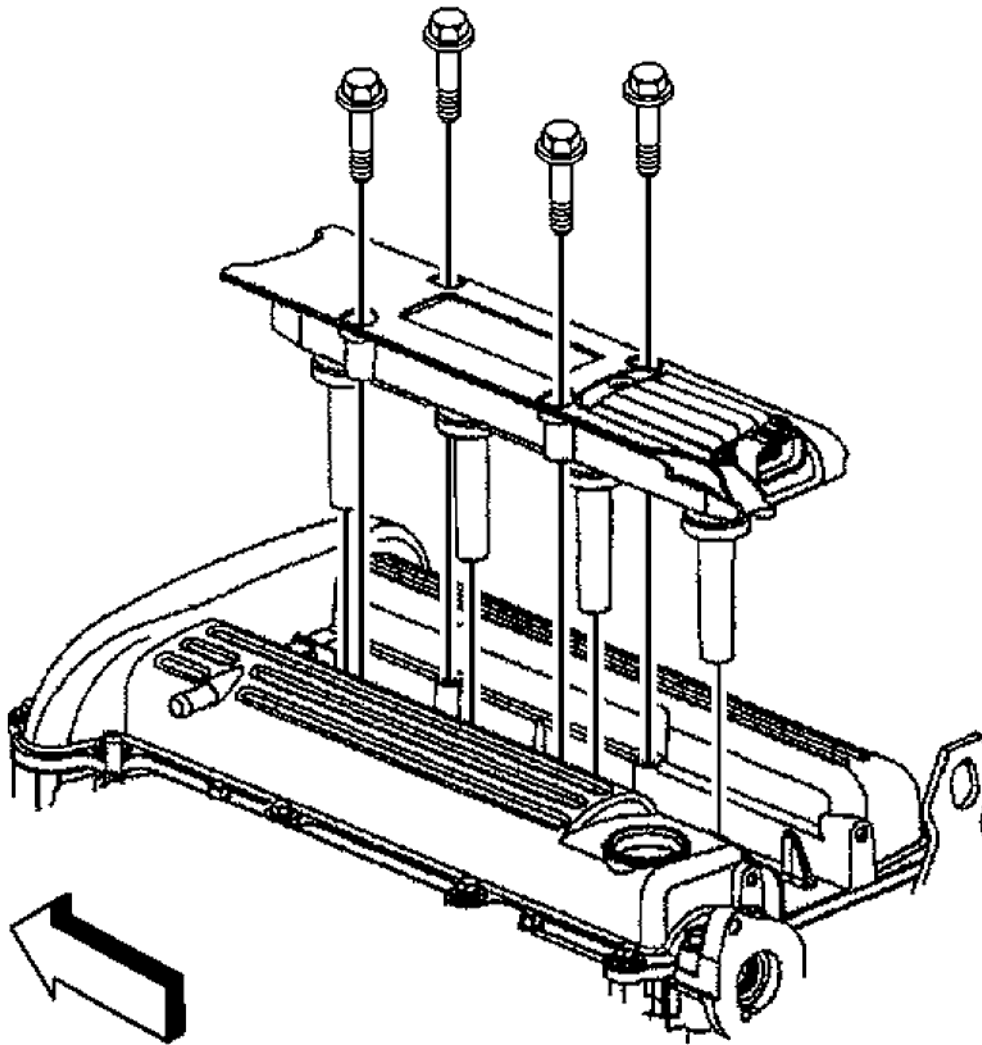


Fig. 201: Ignition Coil Housing Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition control module, if necessary. Refer to **Ignition Control Module Replacement**.
2. Install the ignition coil housing to the camshaft cover.

NOTE: Refer to **Fastener Notice** .

3. Install the ignition coil housing bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

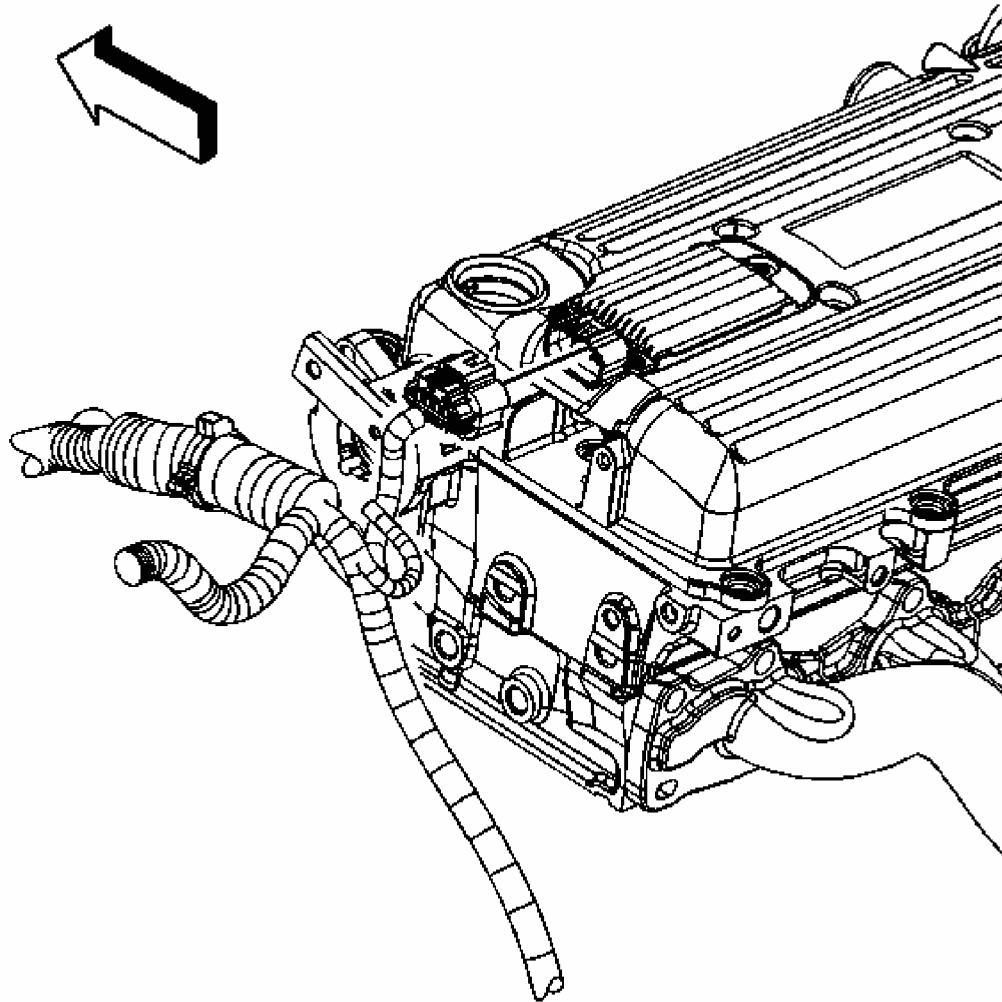


Fig. 202: Ignition Coil Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the ignition control module electrical connector.

IGNITION CONTROL MODULE REPLACEMENT

Removal Procedure

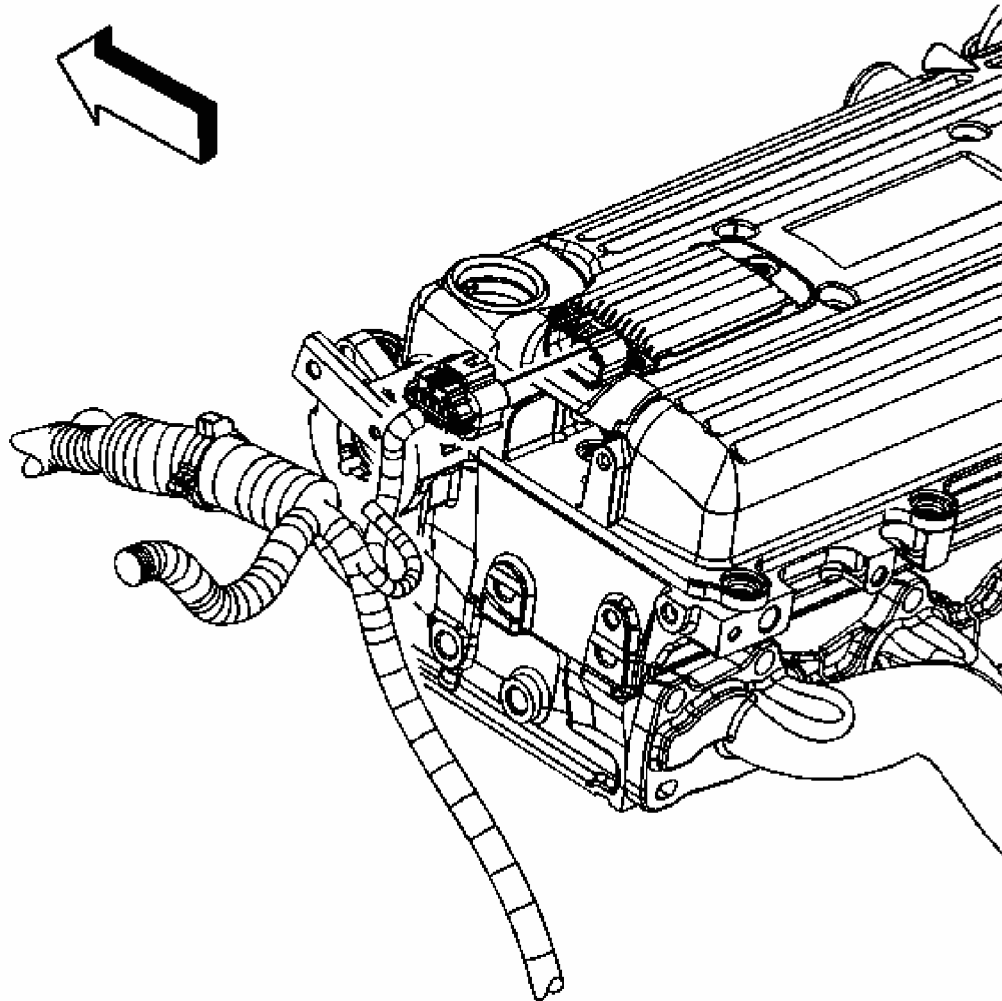


Fig. 203: Ignition Control Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the ignition control module electrical connector.

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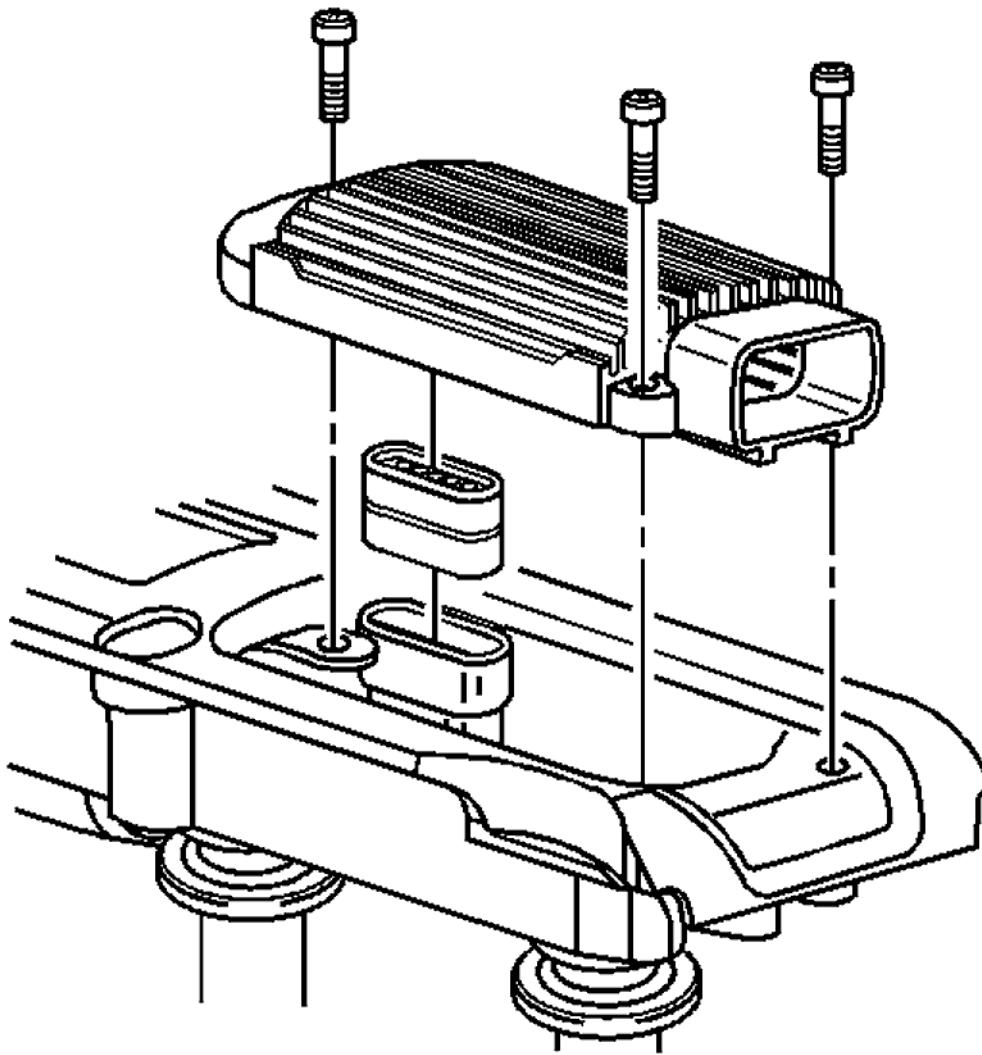


Fig. 204: View Of ICM

Courtesy of GENERAL MOTORS CORP.

2. Remove the ignition control module screws.
3. Remove the ignition control module from the ignition coil housing.

Installation Procedure

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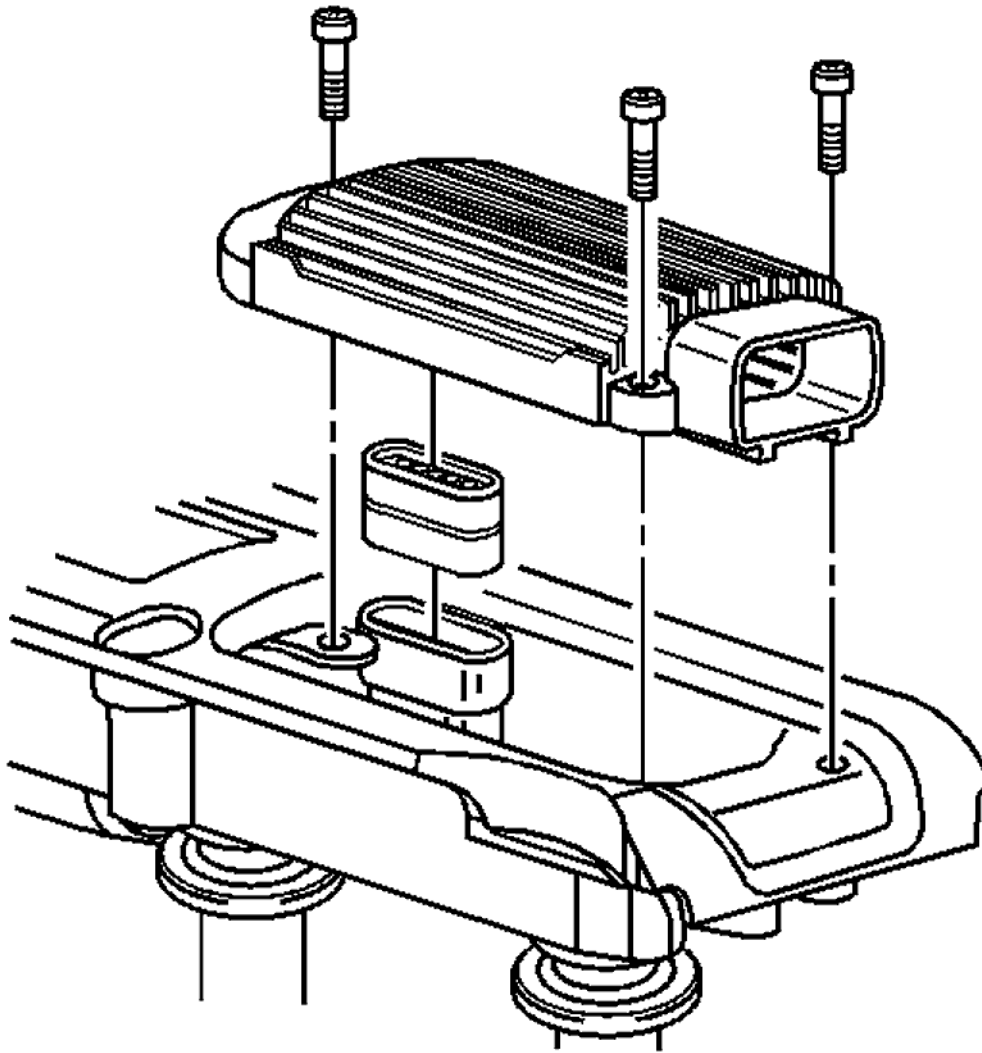


Fig. 205: View Of ICM

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure the interconnect and seal are lined up before module installation.

1. Install the ignition control module in the ignition coil housing.

NOTE: Refer to Fastener Notice .

2. Install the ignition control module screws.

Tighten: Tighten the screws to 1.5 N.m (13 lb in).

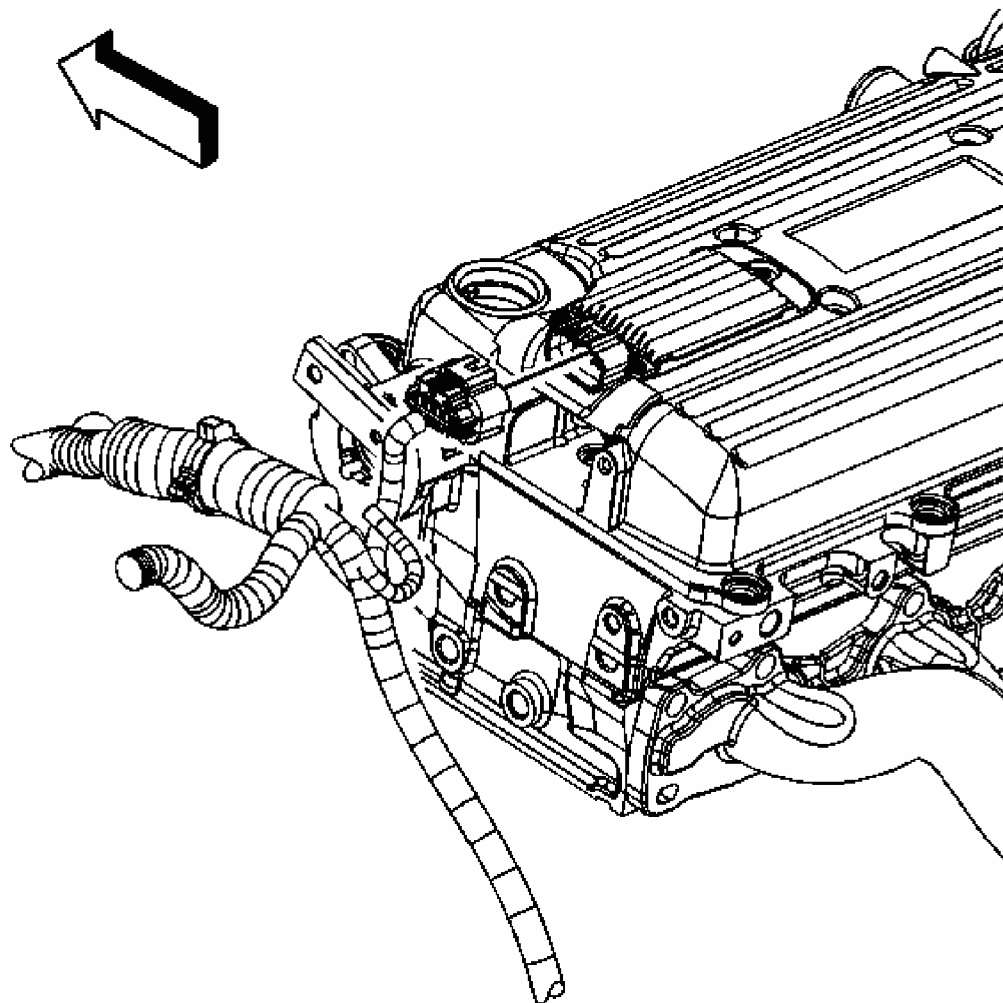


Fig. 206: Ignition Control Module Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the ignition control module electrical connector.

SPARK PLUG INSPECTION

Spark Plug Usage

- Ensure that the correct spark plug is installed. An incorrect spark plug causes

driveability conditions. Refer to **Ignition System Specifications** for the correct spark plug.

- Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - Spark plug fouling - colder plug
 - Pre-ignition causing spark plug and/or engine damage - hotter plug

Spark Plug Inspection

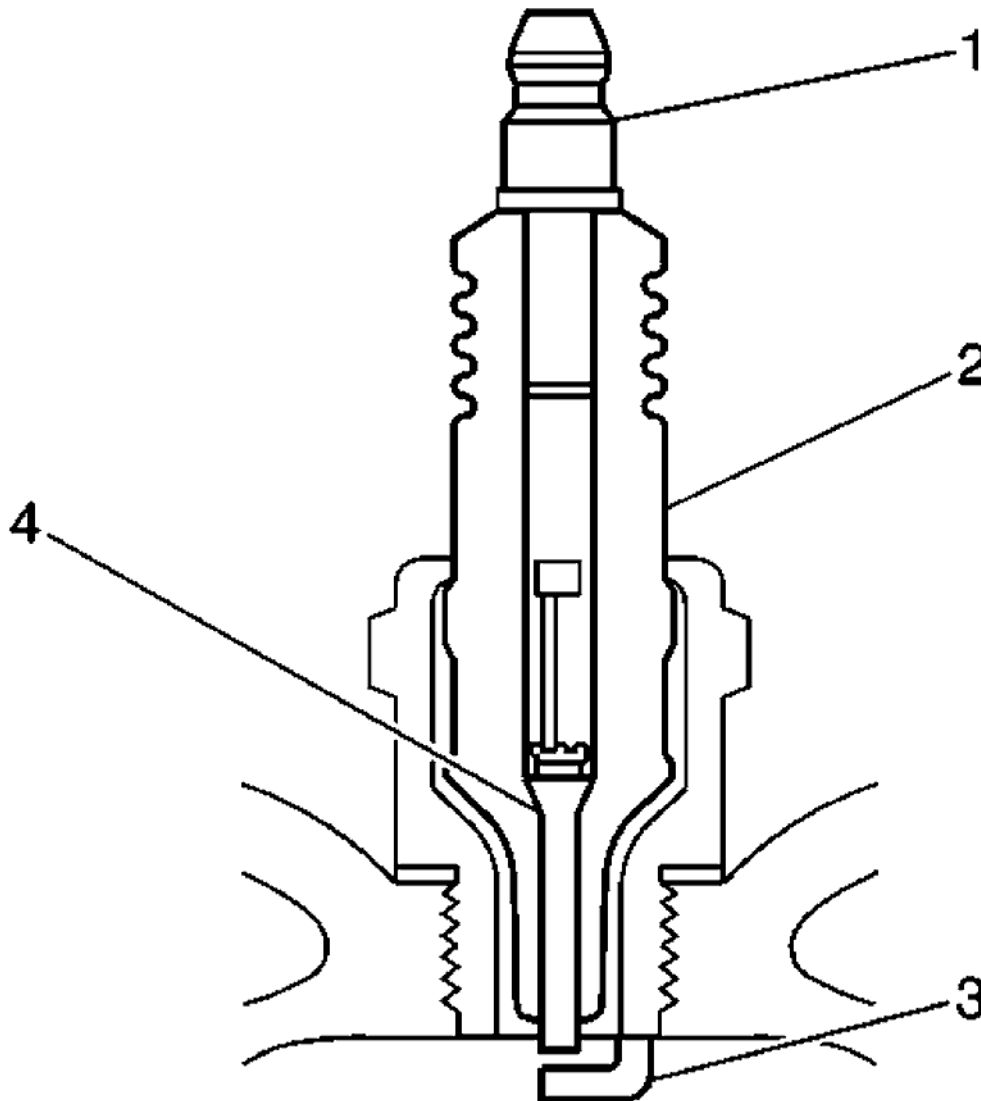


Fig. 207: Cross Sectional View Of Spark Plug

Courtesy of GENERAL MOTORS CORP.

- 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.

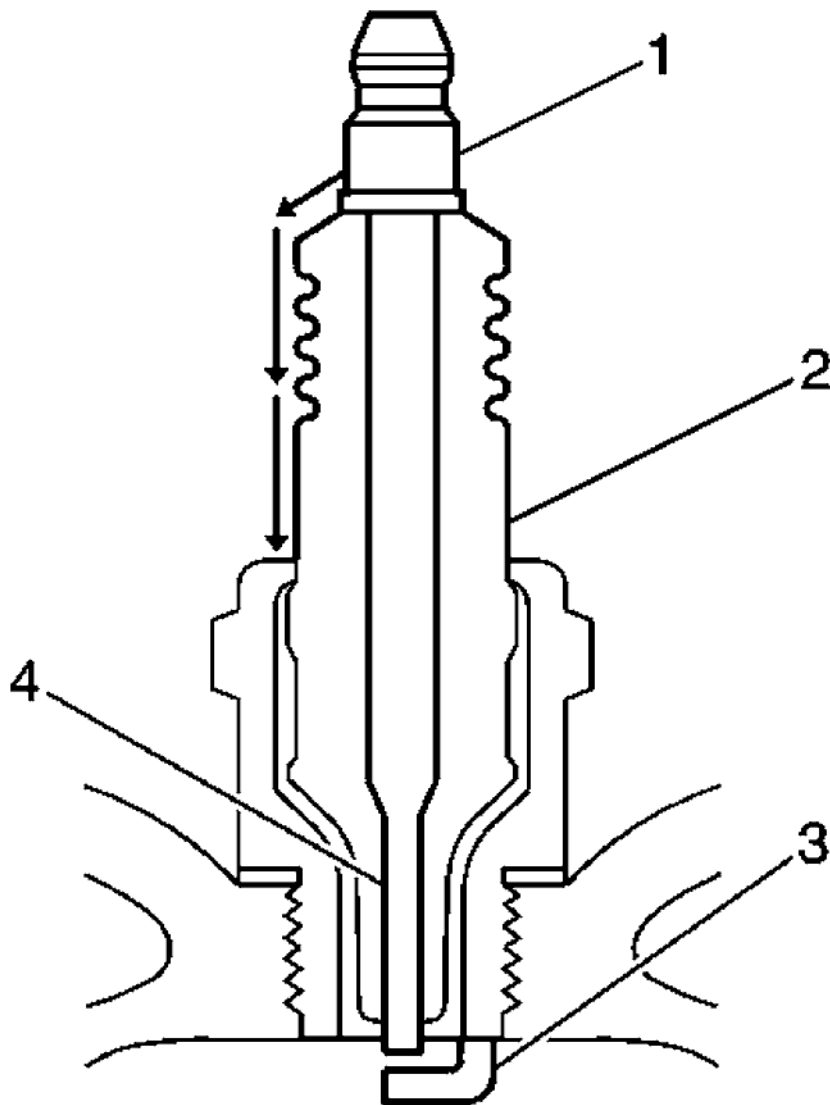


Fig. 208: Identifying Points For Inspecting Spark Plug For Flashover Or Carbon Tracking Soot

Courtesy of GENERAL MOTORS CORP.

- Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling 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, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.

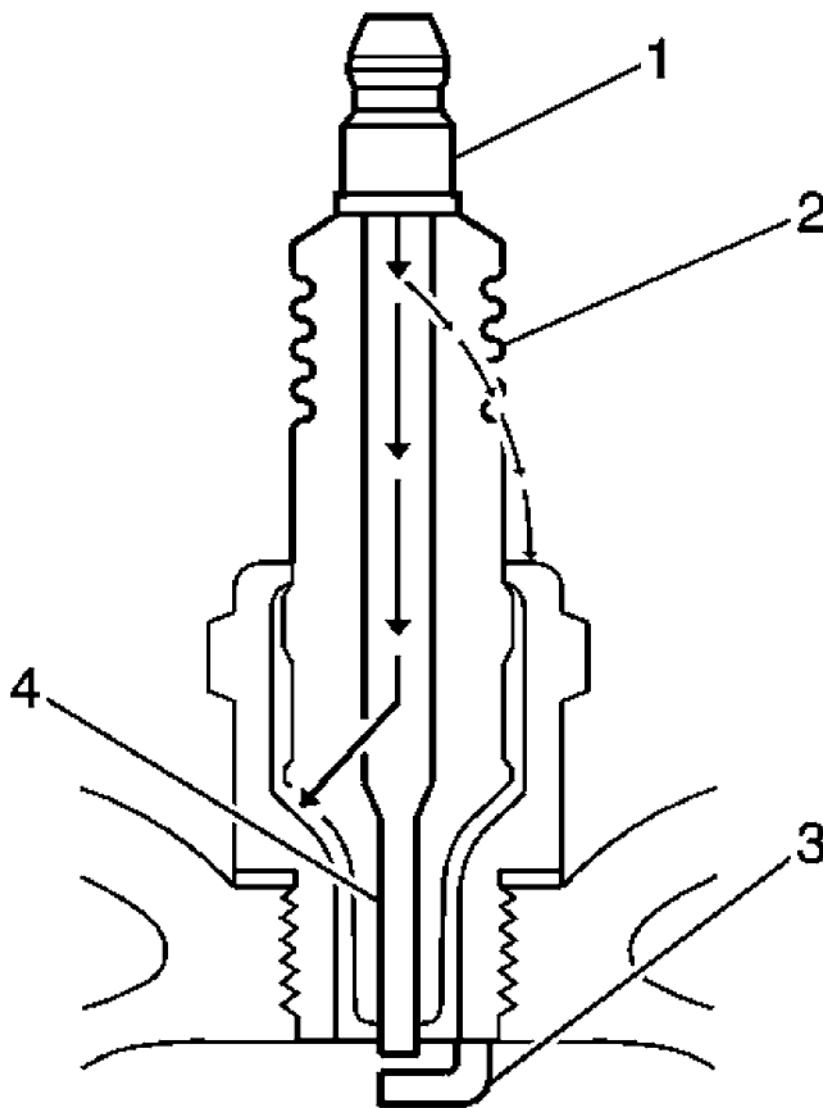


Fig. 209: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS CORP.

- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

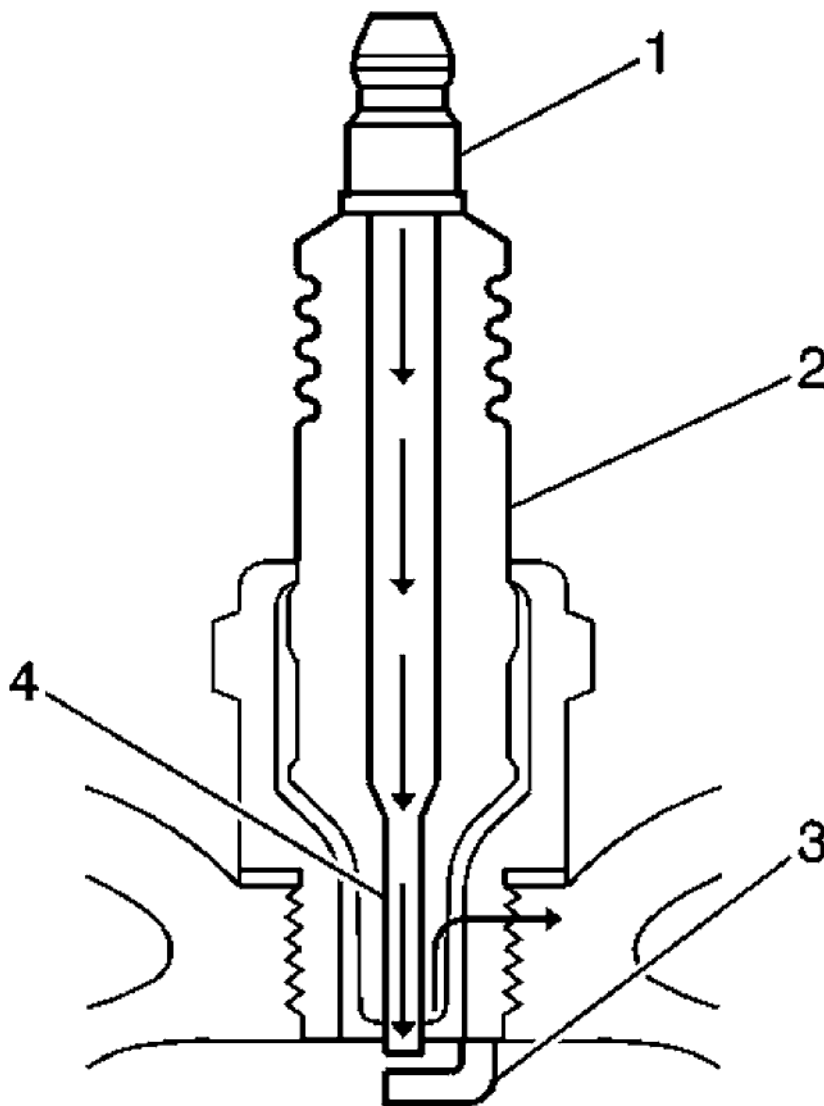


Fig. 210: Cutaway/Discription View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. Refer to **Ignition System Specifications**. An excessively wide electrode gap can prevent correct spark plug operation.

- 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 the center electrode (4).
- Inspect for a broken or worn side electrode (3).
- Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
 - A rattling sound indicates internal damage.
 - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 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 with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- Carbon Fouled-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
 - Weak coils
 - Worn ignition wires
 - Incorrect spark plug gap
 - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling-Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

Removal Procedure

NOTE: This engine has aluminum cylinder heads. Do not remove the spark plugs from a hot engine, allow it to cool first. Removing the spark plugs from a hot engine may cause spark plug thread damage or cylinder head damage.

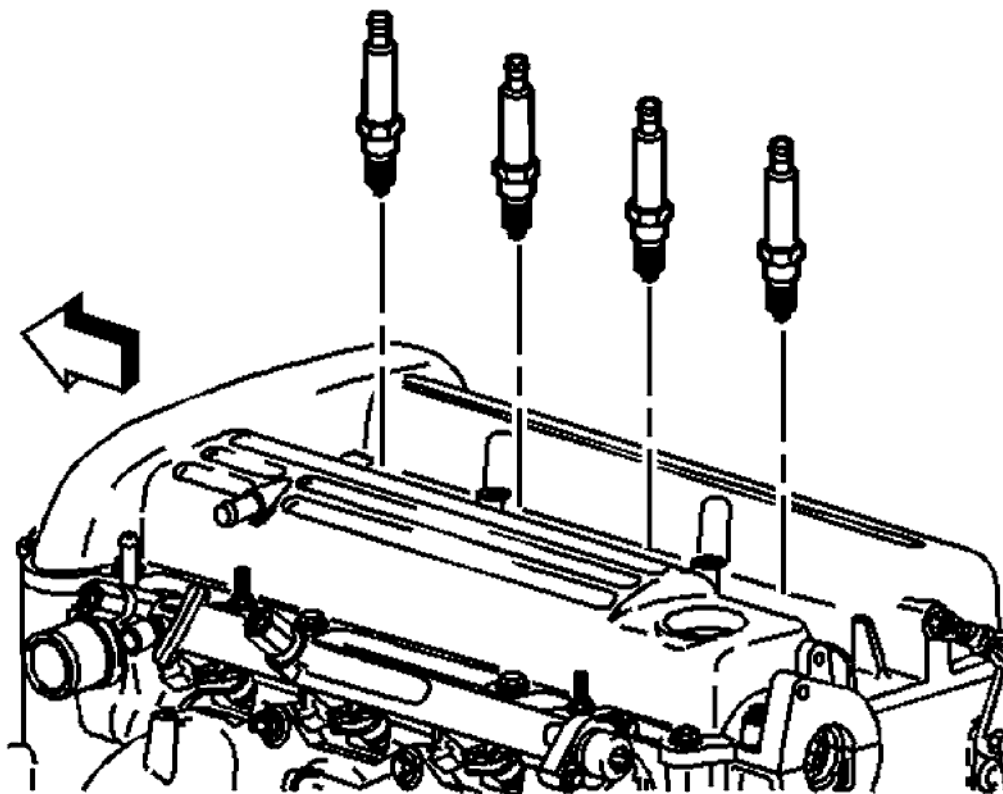


Fig. 211: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove any water and debris from the spark plug holes before spark plug removal with compressed air.

1. Remove the ignition coil housing. Refer to Ignition Coil Housing Replacement.
2. Remove the spark plugs.
3. Inspect the spark plugs. Refer to Spark Plug Inspection.

Installation Procedure

IMPORTANT: DO NOT coat the spark plugs with anti seize compound. Over

torquing could occur and damage to the cylinder head threads may result.

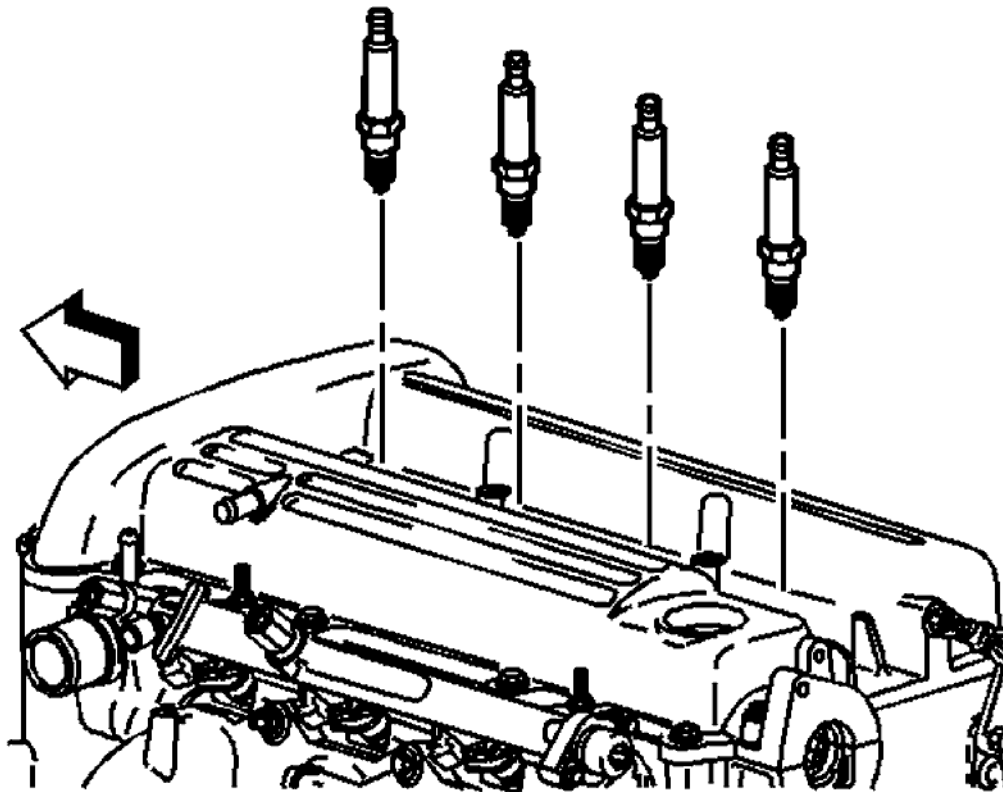


Fig. 212: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

1. Check the gap on the spark plug(s), using around wire type spark plug gap gage. Refer to **Ignition System Specifications**.
2. Install the spark plugs.

Tighten: Tighten the plugs to 20 N.m (15 lb ft).

3. Install the ignition coil housing. Refer to **Ignition Coil Housing Replacement**.

CRANKSHAFT POSITION (CKP) SENSOR REPLACEMENT

Removal Procedure

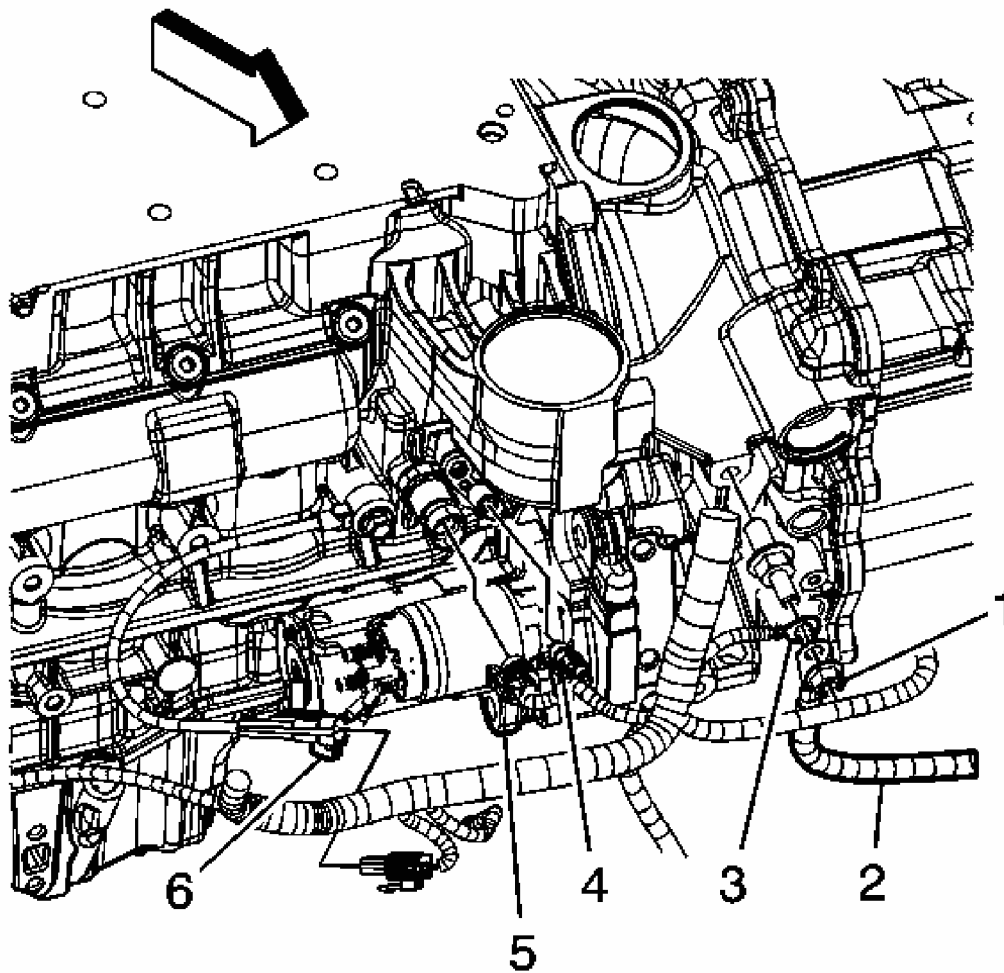


Fig. 213: CKP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the crankshaft position (CKP) sensor electrical connector.

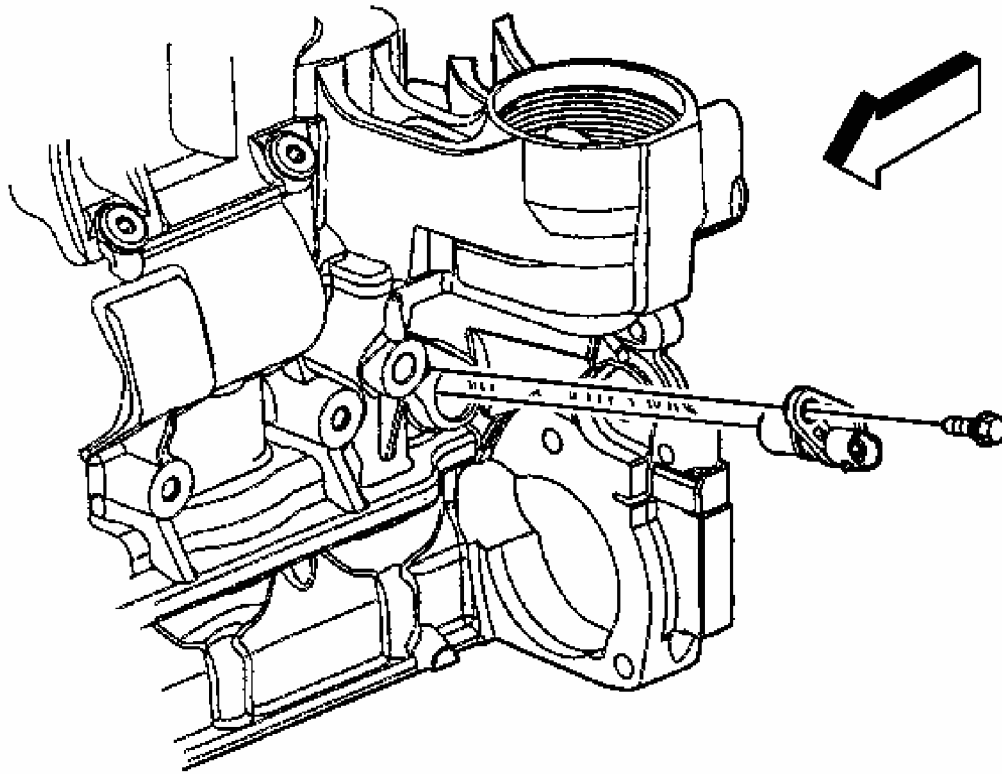


Fig. 214: CKP Sensor Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the CKP sensor bolt.
3. Remove the CKP sensor.

Installation Procedure

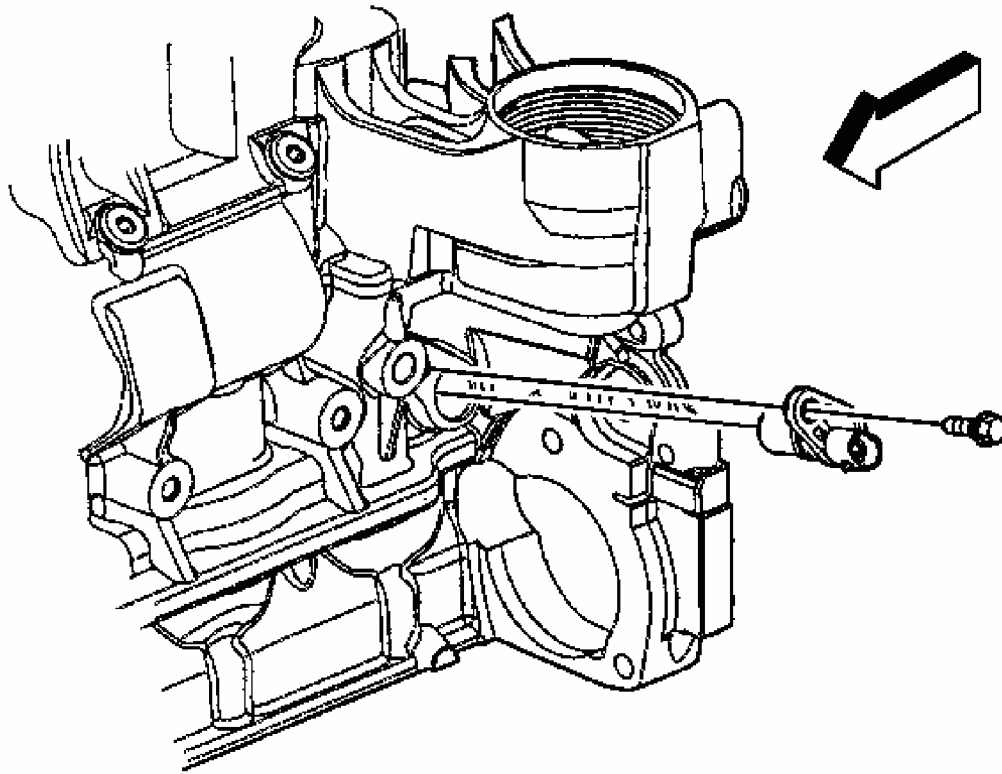


Fig. 215: CKP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Inspect the CKP sensor O-ring and lubricate with a mineral based grease.
2. Gently insert the CKP sensor into the block.

NOTE: **Refer to Fastener**
 Notice .

3. Install the CKP sensor bolt.

Tighten: Tighten the bolt to 10 N.m (89 lb in).

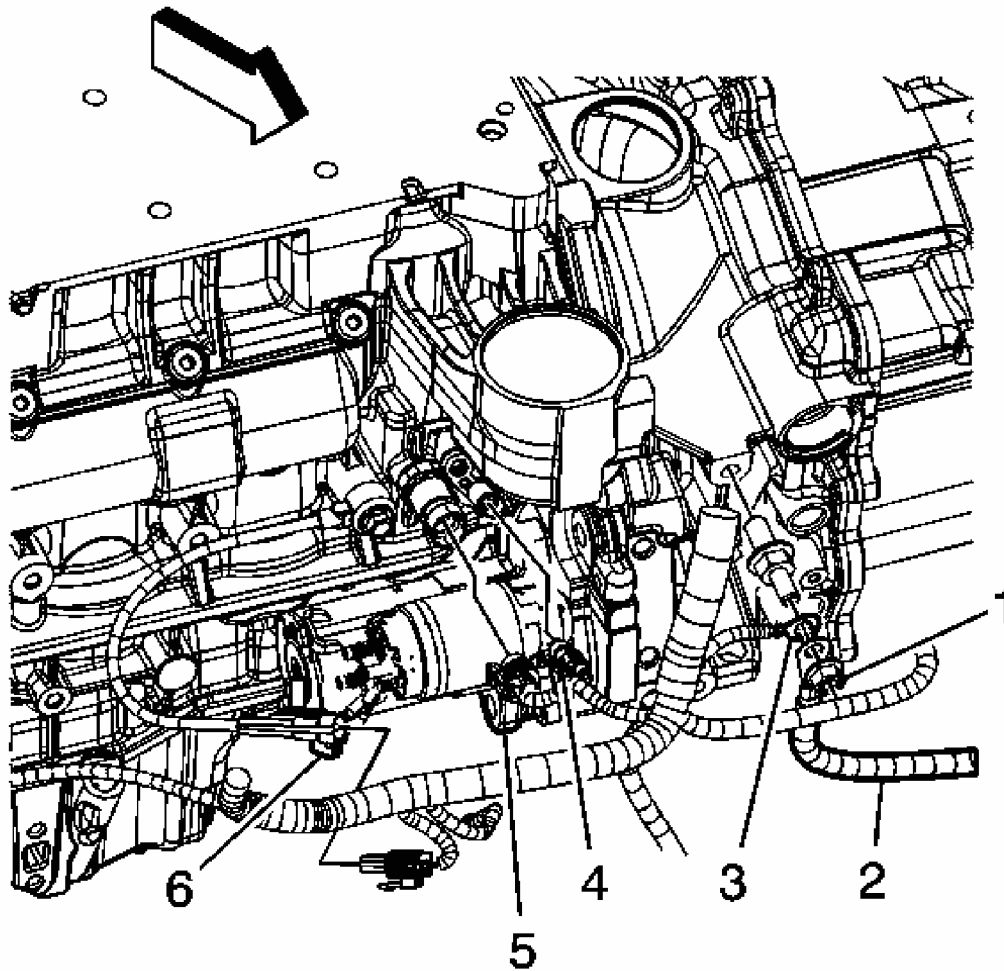


Fig. 216: CKP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the CKP sensor electrical connector.
5. Perform the CKP system variation learn procedure. Refer to **CKP System Variation Learn Procedure**.

KNOCK SENSOR (KS) REPLACEMENT

Removal Procedure

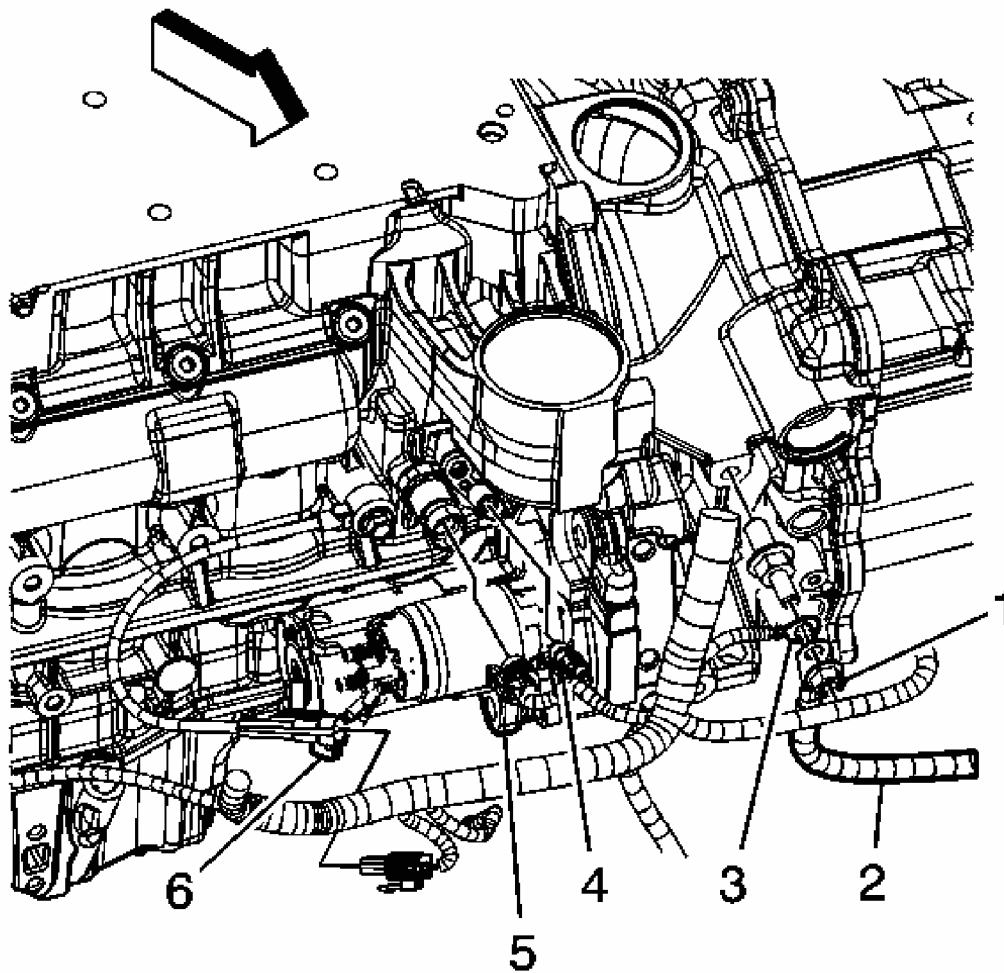


Fig. 217: KS Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the knock sensor (KS) harness electrical connector (6).

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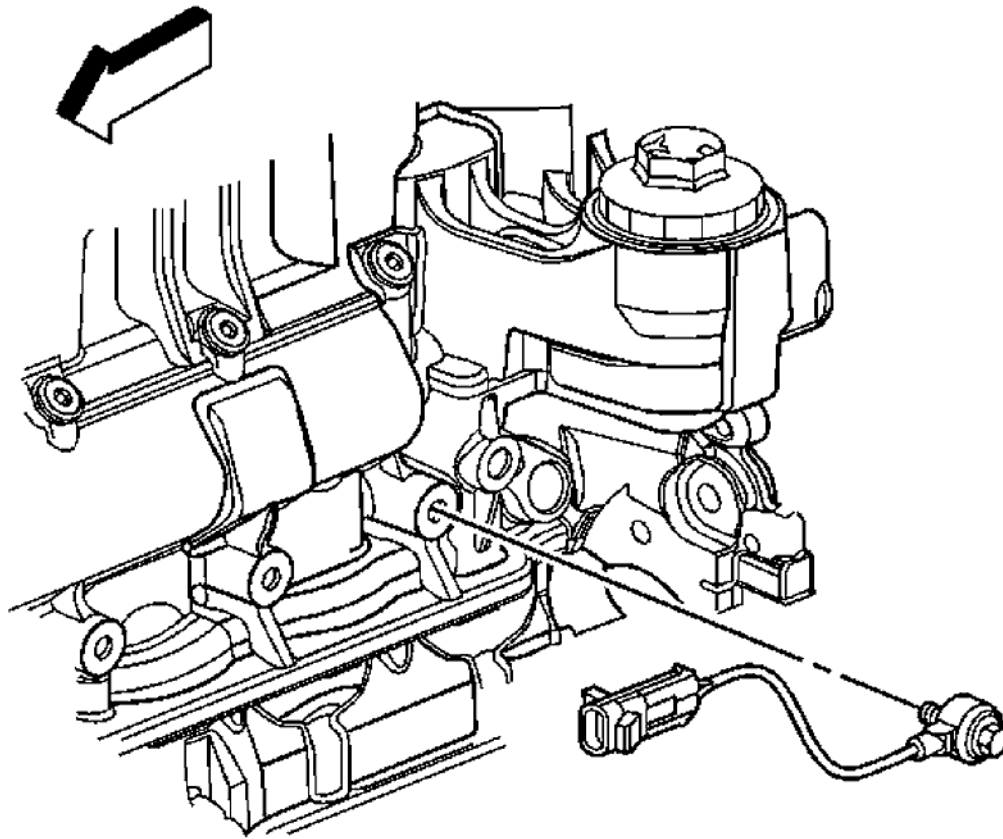


Fig. 218: KS Bolt

Courtesy of GENERAL MOTORS CORP.

2. Remove the KS bolt.
3. Remove the KS.

Installation Procedure

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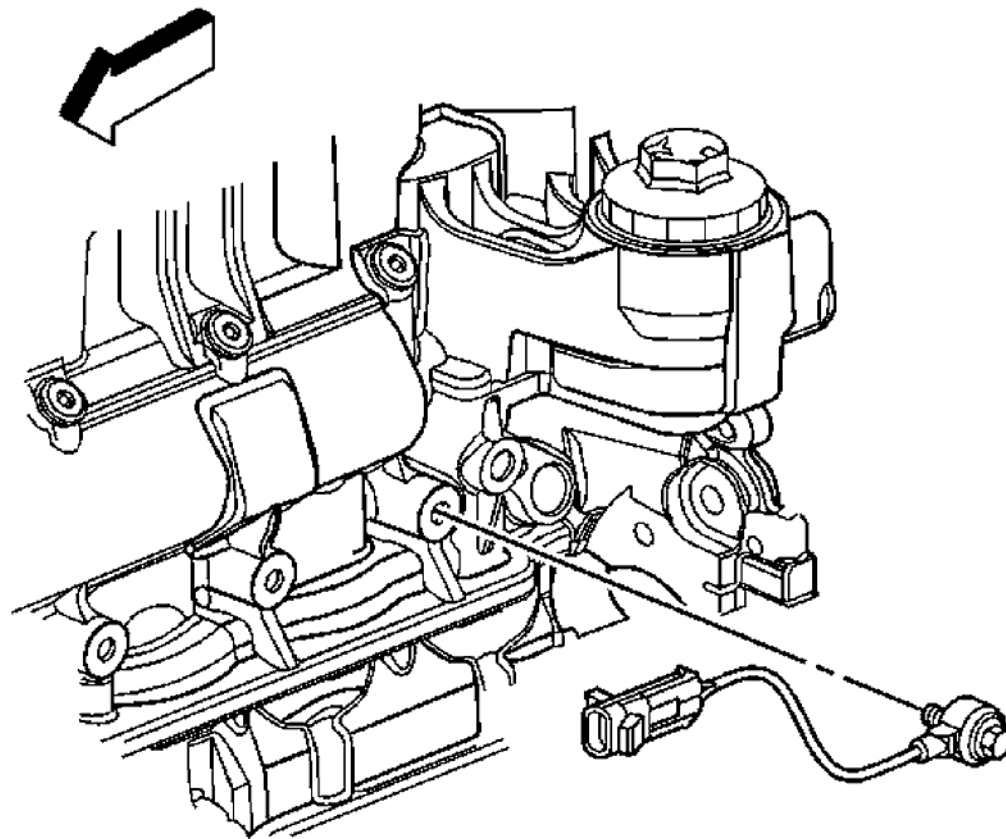


Fig. 219: KS Bolt

Courtesy of GENERAL MOTORS CORP.

1. Install the KS.

NOTE: Refer to Fastener Notice .

2. Install the KS bolt.

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

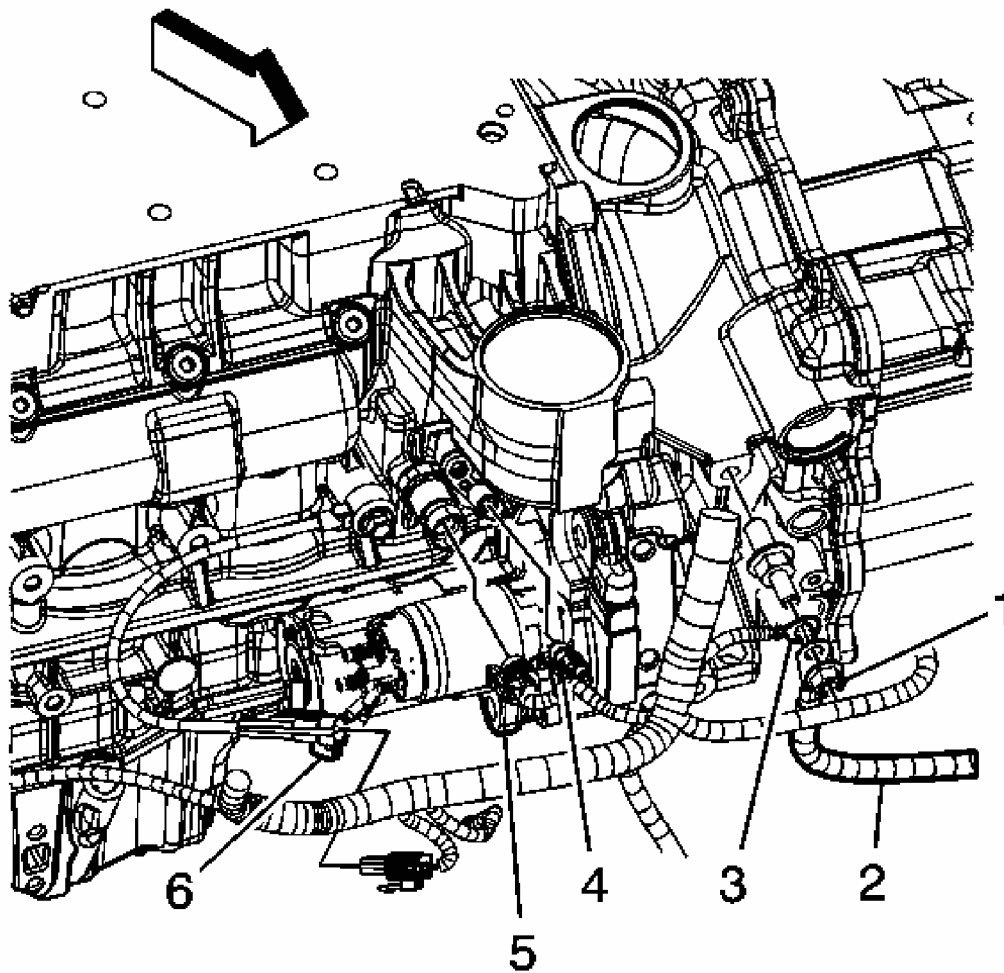


Fig. 220: KS Harness Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the KS harness electrical connector (6).

AIR CLEANER ELEMENT REPLACEMENT

Removal Procedure

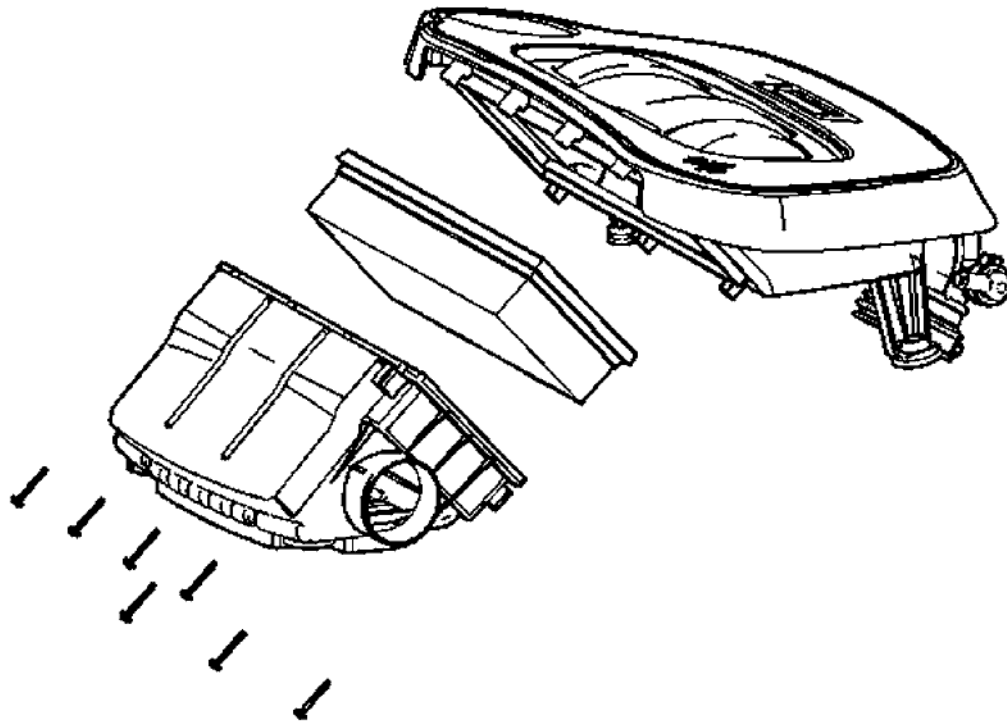


Fig. 221: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
2. Loosen the air cleaner screws.
3. Separate the upper and lower portions of the air cleaner assembly.
4. Remove the air cleaner filter from the lower air cleaner housing.
5. Inspect the air cleaner filter for dust, dirt, and water contamination.

Installation Procedure

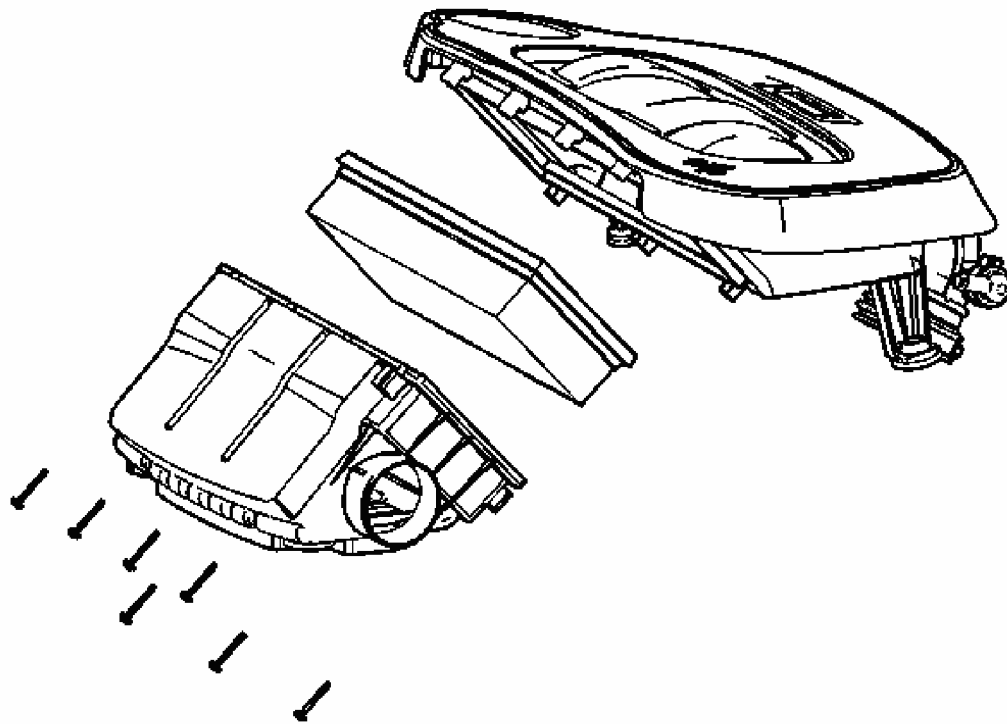


Fig. 222: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the air cleaner filter into the lower air cleaner housing.
2. Install the upper air cleaner cover to the lower air cleaner housing.

NOTE: Refer to Fastener Notice .

3. Tighten the air cleaner screws.

Tighten: Tighten the screws to 4 N.m (35 lb in).

4. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.

AIR CLEANER ASSEMBLY REPLACEMENT

Removal Procedure

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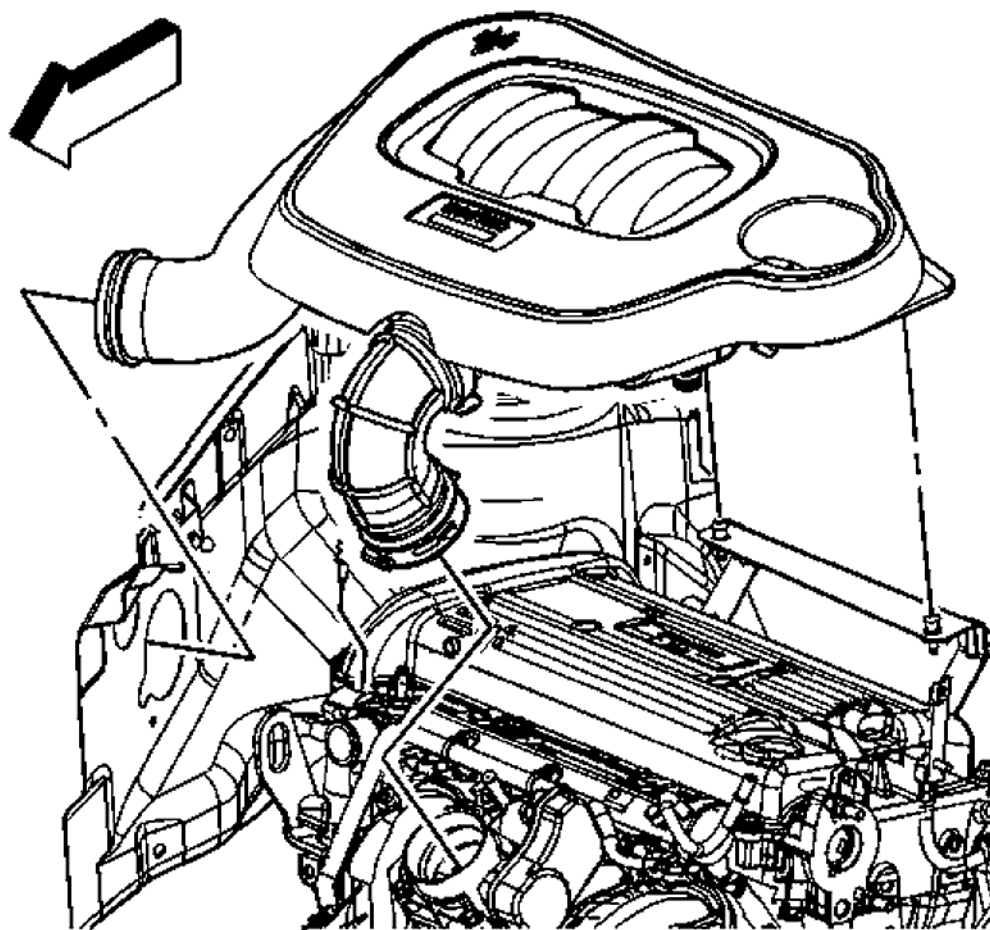


Fig. 223: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

1. Loosen the air cleaner outlet duct clamp at the throttle body.
2. Gently pull up in order to remove the air cleaner assembly.

Installation Procedure

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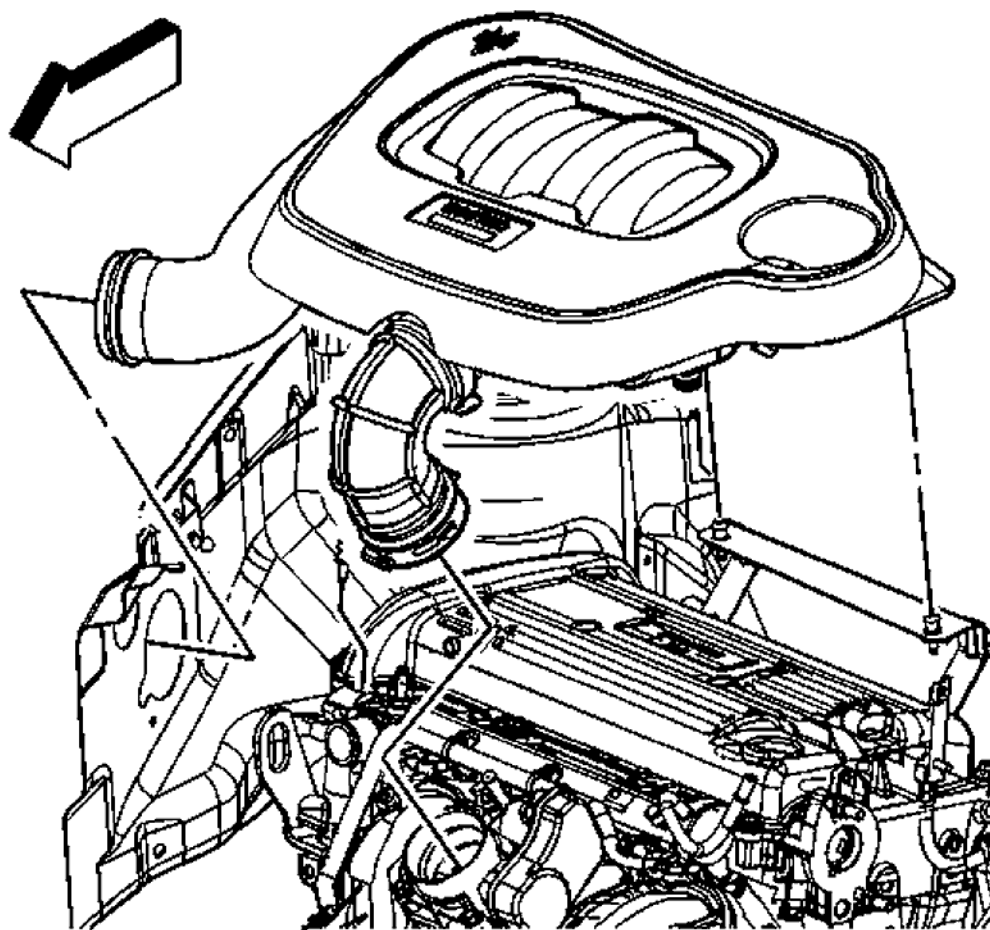


Fig. 224: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

1. Gently push down until the air cleaner assembly engages the studs.
2. Connect the air cleaner outlet duct to the throttle body.

Tighten: Tighten the clamp to 5 N.m (44 lb in).

AIR CLEANER OUTLET DUCT REPLACEMENT

Removal Procedure

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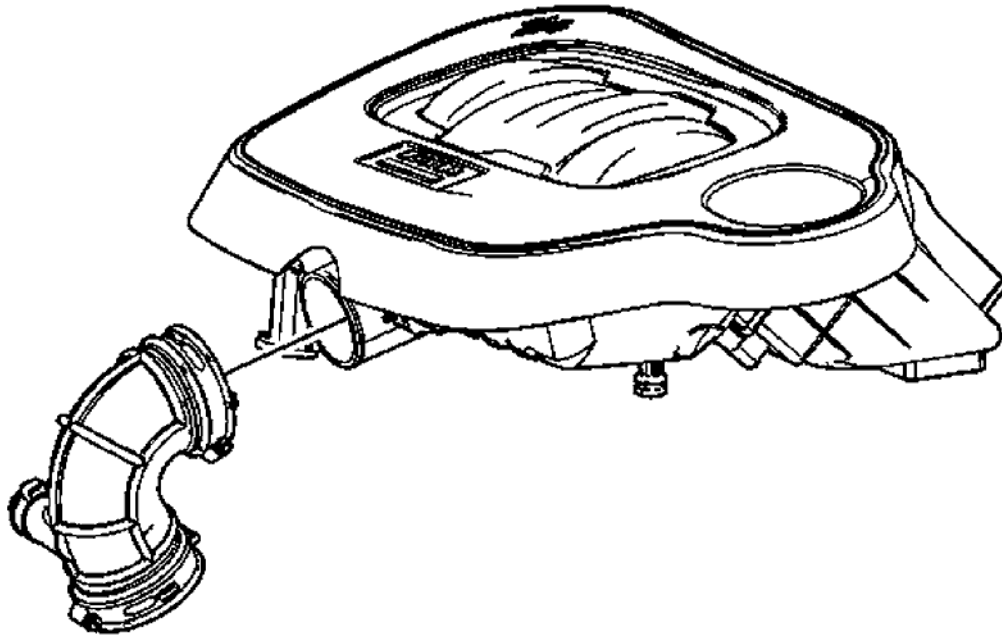


Fig. 225: Air Cleaner Assembly Outlet Duct
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
2. Loosen the clamp at the air cleaner housing.
3. Remove the air cleaner outlet duct.

Installation Procedure

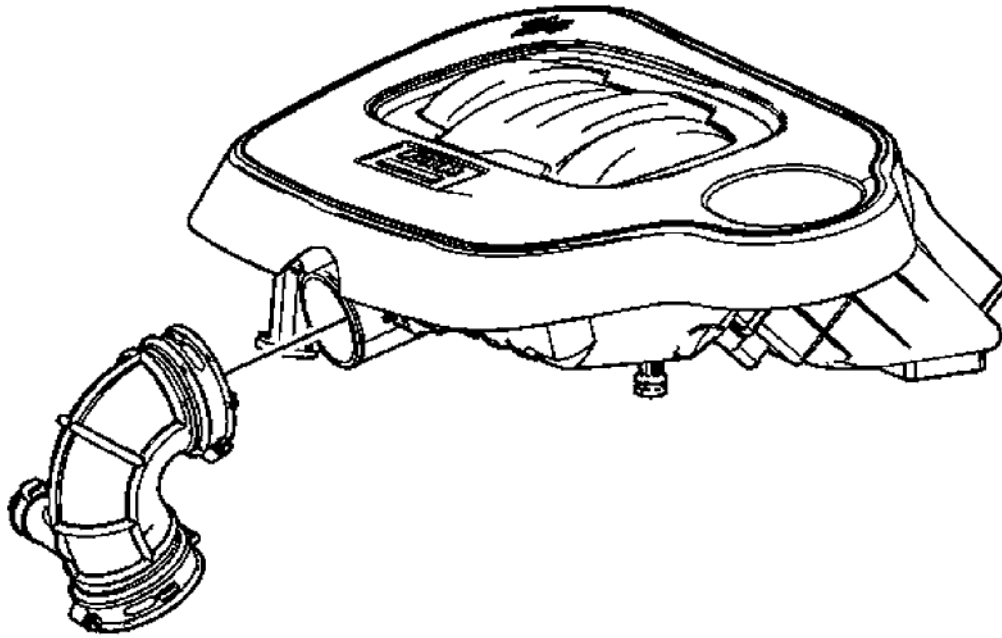


Fig. 226: Air Cleaner Assembly Outlet Duct
Courtesy of GENERAL MOTORS CORP.

1. Install the air cleaner outlet duct.

NOTE: Refer to Fastener Notice .

2. Tighten the clamp at the air cleaner housing.

Tighten: Tighten the clamp to 5 N.m (44 lb in).

3. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.

DESCRIPTION AND OPERATION

ENGINE CONTROL MODULE (ECM) DESCRIPTION

Powertrain

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 looks at the information from various sensors and other inputs, and controls the systems that affect vehicle performance and emissions. The ECM also performs the diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver with 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. Review the components and wiring diagrams in order to determine which systems are controlled by the ECM.

The following are some of the functions that the ECM controls:

- The engine fueling
- The ignition control (IC)
- The knock sensor (KS) system
- The evaporative emissions (EVAP) system
- The generator
- The A/C clutch control
- The cooling fan control

Engine Control Module Function

The ECM constantly looks at the information from various sensors and other inputs and controls 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 with 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 input and output devices in the ECM include analog-to-digital converters, signal buffers, counters, and output drivers. The output drivers are electronic switches that complete a ground or voltage circuit when turned on. Most ECM controlled components are operated by output drivers. The ECM monitors these driver circuits for proper operation and, in most cases, can set a DTC corresponding to the controlled device if a problem is detected.

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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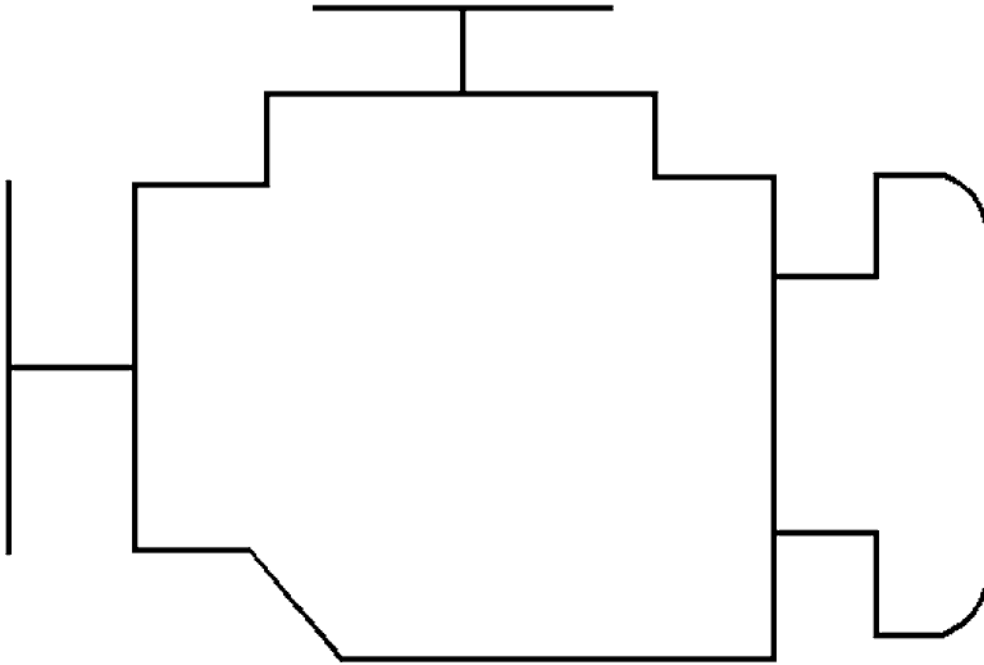


Fig. 227: MIL Symbol On Instrument Cluster
Courtesy of GENERAL MOTORS CORP.

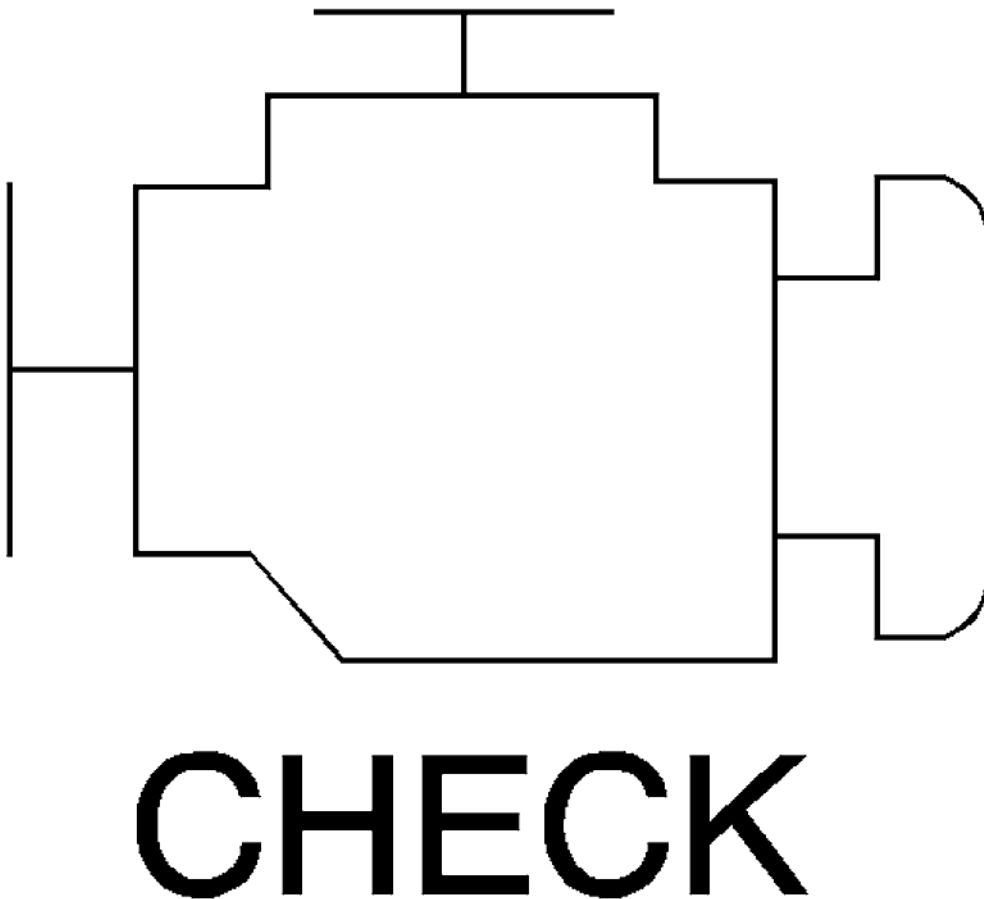


Fig. 228: Check Engine Light Symbol
Courtesy of GENERAL MOTORS CORP.

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.

- 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.

Warm-up Cycle

The ECM uses warm-up cycles to run some diagnostics and to clear any diagnostic trouble codes (DTCs). A warm-up cycle occurs when the engine coolant temperature increases 22°C (40°F) from the start-up temperature. The engine coolant must also achieve a minimum temperature of 71°C (160°F). The ECM counts the number of warm-up cycles in order to clear the malfunction indicator lamp (MIL). The ECM will clear the DTCs when 40 consecutive warm-up cycles occur without a malfunction.

Diagnostic Trouble Codes (DTCs)

The ECM is programmed with test routines that test the operation of the various systems the ECM controls. Some tests monitor internal ECM functions. Many tests are run continuously. Other tests run only under specific conditions, referred to as Conditions for Running the DTC. When the vehicle is operating within the conditions for running a particular test, the ECM monitors certain parameters and determines if the values are within an expected range. The parameters and values considered outside the range of normal operation are listed as Conditions for Setting the DTC. When the Conditions for Setting the DTC occur, the ECM executes the Action Taken When the DTC Sets. Some DTCs alert the driver via the MIL or a message. Other DTCs do not trigger a driver warning, but are stored in memory. The ECM also saves data and input parameters when most DTCs are set. This data is stored in the Freeze Frame and/or Failure Records.

The DTCs are categorized by type. The DTC type is determined by the MIL operation and the manner in which the fault data is stored when a particular DTC fails. In some cases there may be exceptions to this structure. Therefore, when diagnosing the system it is important to read the Action Taken When the DTC Sets and the Conditions for Clearing the DTC in the supporting text.

There are different types of DTCs and different actions taken when the DTCs set. Refer to Diagnostic Trouble Code (DTC) Type Definitions for a description of the general characteristics of each DTC type.

FUEL SYSTEM DESCRIPTION

Fuel System Overview

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.

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 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 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 the fuel feed pipe and the fuel rail in order to prevent long cranking times.

Fuel Tank

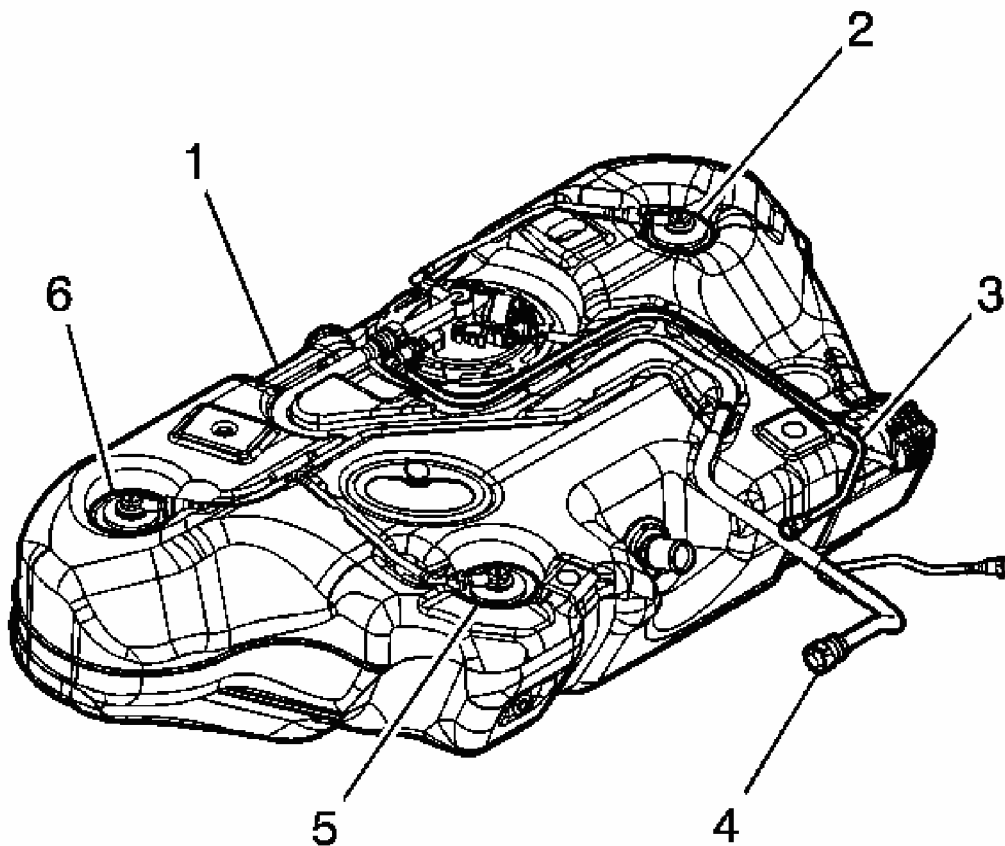


Fig. 229: Fuel Tank

Courtesy of GENERAL MOTORS CORP.

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The fuel tank (1) 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.

Fuel Fill Pipe

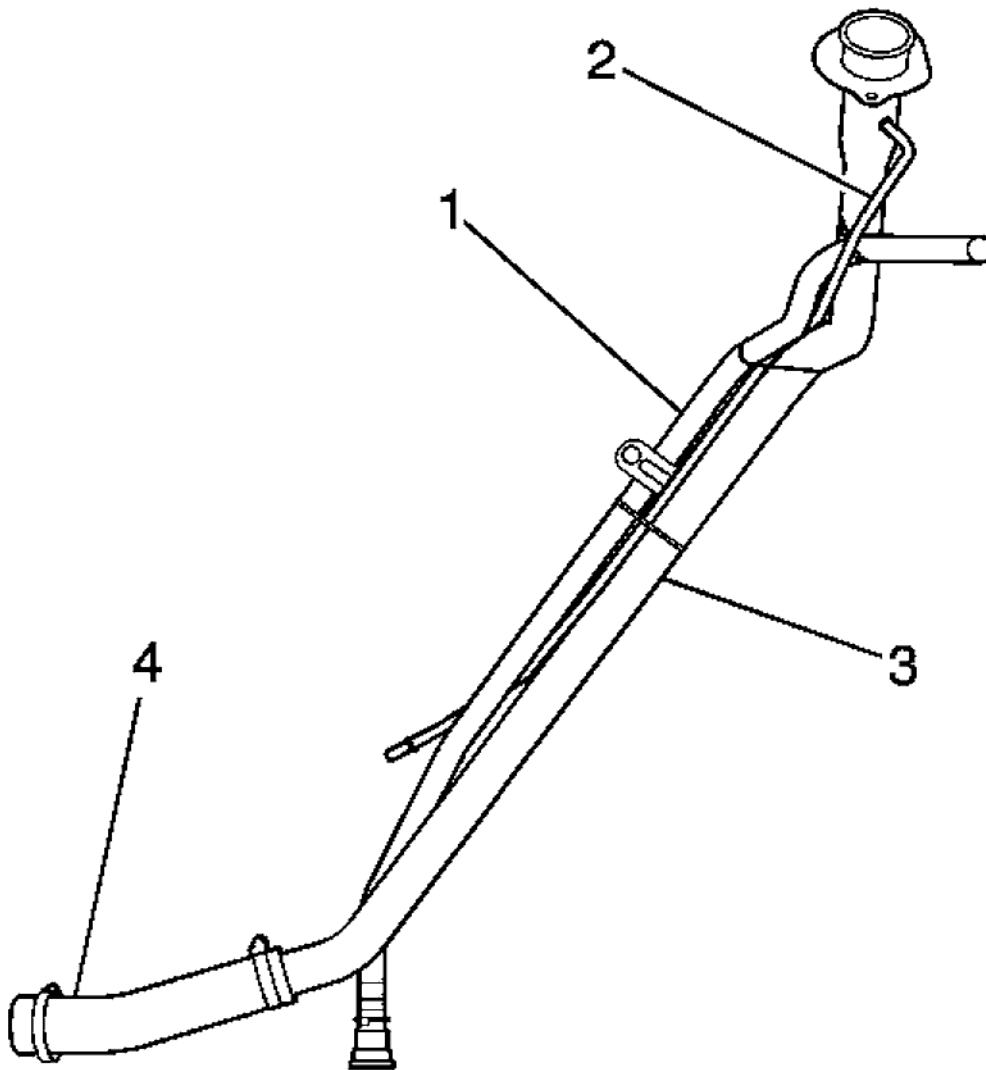


Fig. 230: Fuel Fill Pipe
Courtesy of GENERAL MOTORS CORP.

The fuel fill pipe (3) has a built-in restrictor in order to prevent refueling with leaded fuel.

Fuel Filler Cap

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NOTE: If a fuel tank filler cap requires replacement, use only a fuel tank filler cap with the same features. Failure to use the correct fuel tank filler cap can result in a serious malfunction of the fuel and EVAP system.

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. A fuel filler cap that is not fully seated may cause a malfunction in the emission system.

Fuel Pump Module

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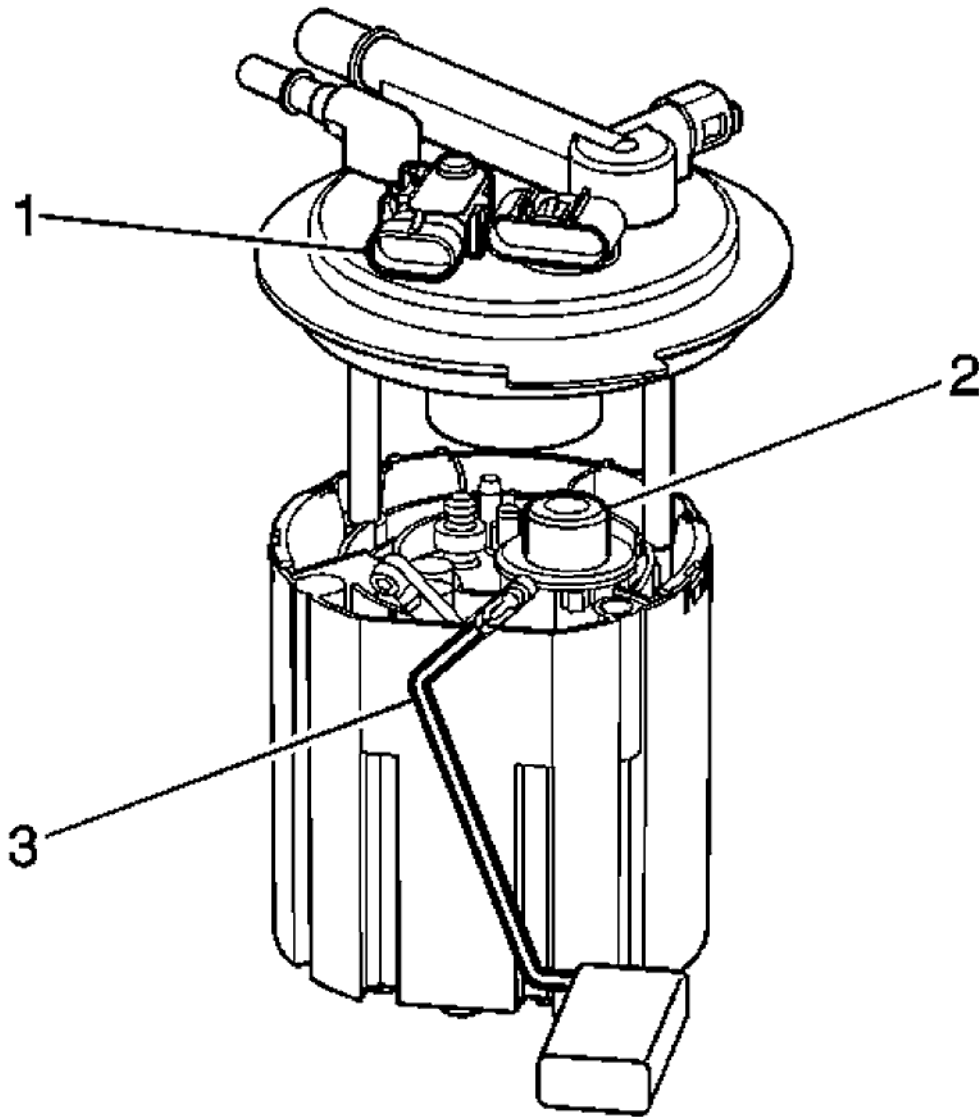


Fig. 231: Fuel Pump Module

Courtesy of GENERAL MOTORS CORP.

The fuel pump module consists of the following major components:

- The fill limit vent valve
- The fuel level sensor (3)
- The fuel tank pressure (FTP) sensor (1)
- The fuel pump

- The fuel strainer
- The fuel pressure regulator (2)

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 control module sends the fuel level information via the GMLAN serial data circuit to the instrument panel cluster (IPC). This information is used for the IPC fuel gage and the low fuel warning indicator, if applicable. The control module also monitors the fuel level input for various diagnostics.

Fuel Pump

The fuel pump is mounted in the fuel pump module reservoir. The fuel pump is an electric high-pressure pump. Fuel is pumped to the fuel injection system at a specified flow and pressure. The fuel pump delivers a constant flow of fuel to the engine even during low fuel conditions and aggressive vehicle maneuvers. The control module controls the electric fuel pump operation through a fuel pump relay. The fuel pump flex pipe acts to dampen the fuel pulses and noise generated by the fuel pump.

Fuel Strainer

The fuel strainer attaches to the lower end of the 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.

Fuel Pressure Regulator

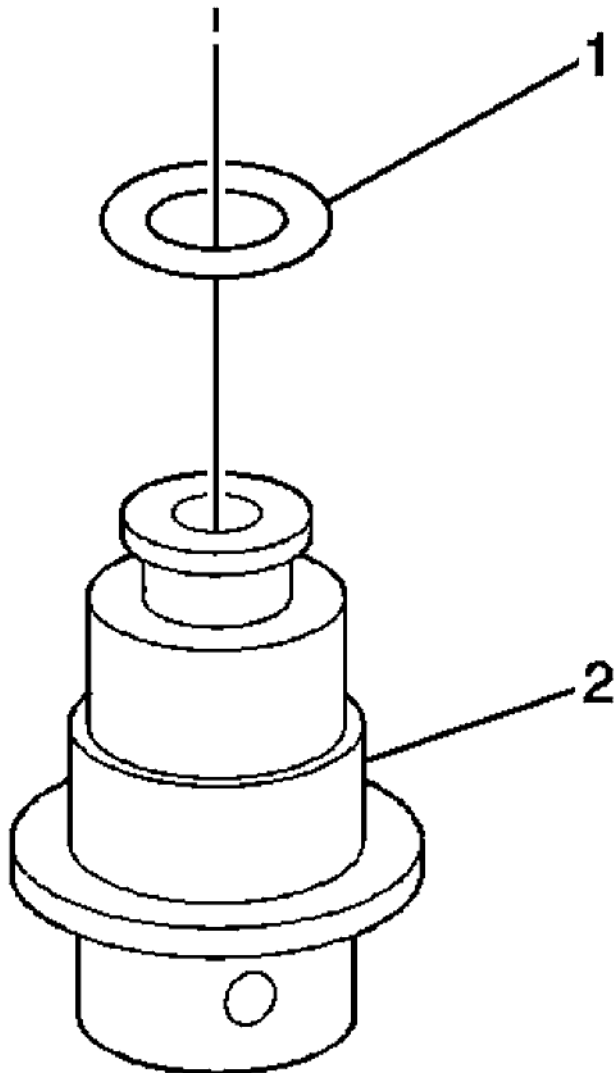


Fig. 232: View Of Fuel Pressure Regulator
Courtesy of GENERAL MOTORS CORP.

The fuel pressure regulator (2) is contained in the fuel pump module near the fuel pump outlet. The fuel pressure regulator is a diaphragm relief valve. The diaphragm has fuel pressure on one side and regulator spring pressure on the other side. The fuel pressure regulator is not vacuum biased. Fuel pressure is controlled by a pressure balance across the regulator. The fuel system pressure is constant.

The fuel feed pipe carries fuel from the fuel tank to the fuel injection system. The fuel pipe consists of 2 sections:

- The rear fuel pipe is located from the top of the fuel tank to the chassis fuel pipe. The rear fuel pipe is constructed of nylon.
- The chassis fuel pipe is located under the vehicle and connects the rear fuel pipe to the fuel rail. The chassis fuel pipe is constructed of galvanized aluminum with a section of flexible hose protected by a braided covering.

Nylon Fuel Pipes

CAUTION: 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 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.

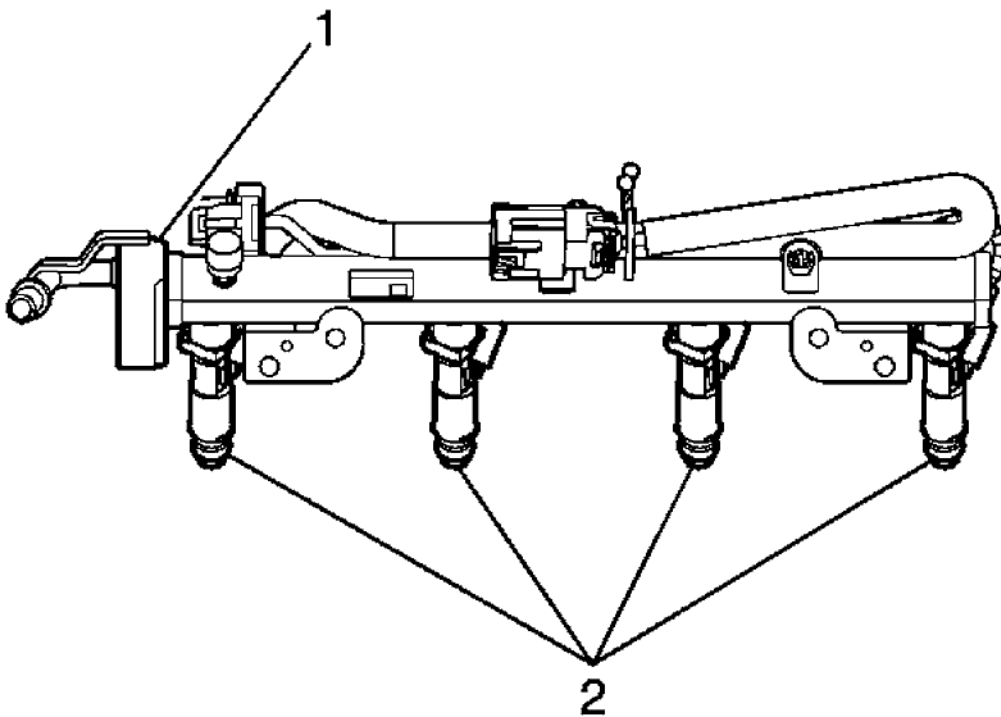
Fuel Rail Assembly

Fig. 233: Fuel Rail Assembly
Courtesy of GENERAL MOTORS CORP.

The fuel rail assembly attaches to the cylinder head. The fuel rail assembly performs the following functions:

- Positions the injectors (2) in the intake ports of the cylinder head
- Distributes fuel evenly to the injectors
- Integrates the fuel pulse dampener (1) into the fuel metering system

Fuel Injectors

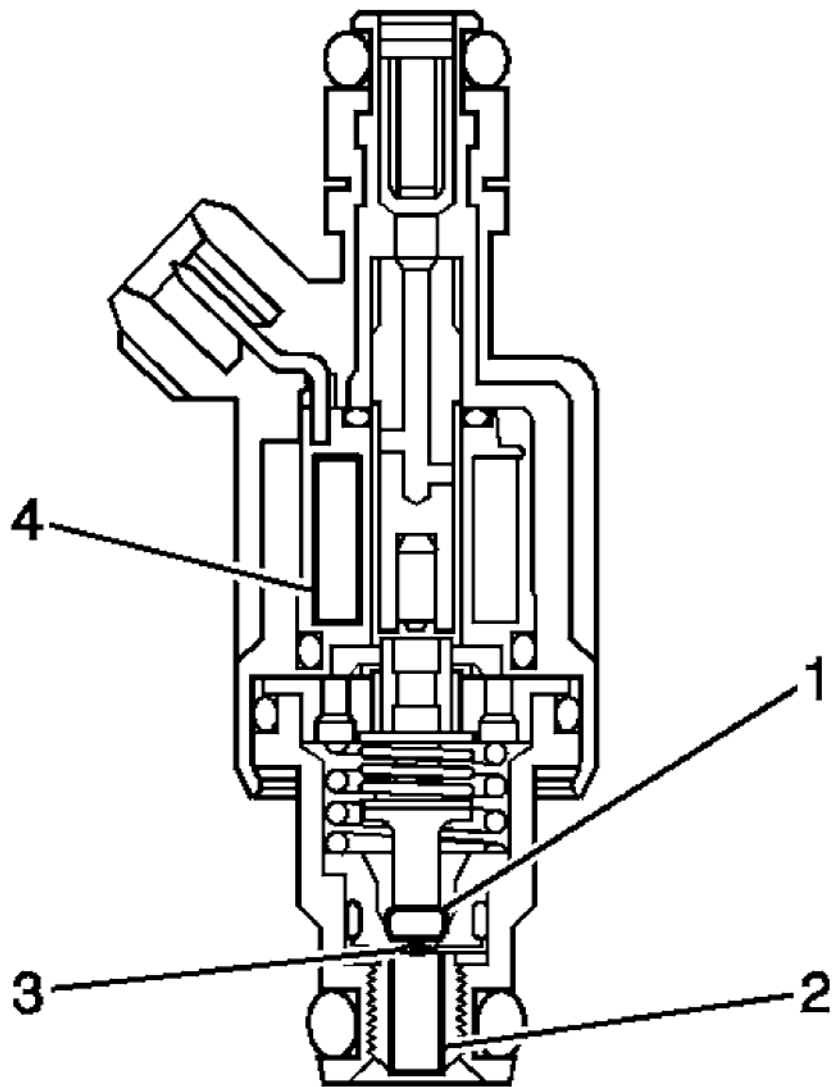


Fig. 234: Fuel Injector Assembly Cross Sectional View
Courtesy of GENERAL MOTORS CORP.

The fuel injector assembly is a solenoid device controlled by the control module that meters pressurized fuel to a single engine cylinder. The control module energizes the high-impedance, 12 ohms, injector solenoid (4) to open a normally closed ball valve (1). This allows fuel to flow into the top of the injector, past the ball valve, and through a director plate (3) 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 (2). 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. The fuel pressure regulator compensates for engine load by increasing fuel pressure as the engine vacuum drops.

Fuel Pulse Dampener

The fuel pulse dampener attaches inside a housing on the fuel rail 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.

Fuel Metering Modes of Operation

The control module monitors voltages from several sensors in order to determine how much fuel to give the engine. The control module controls the amount of fuel delivered to the engine by changing the fuel injector pulse width. The fuel is delivered under one of several modes.

Starting Mode

When the ignition is first turned ON, the control module energizes the fuel pump relay for 2 seconds. This allows the fuel pump to build pressure in the fuel system. The control module calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), manifold absolute pressure (MAP), mass air flow (MAF), and throttle position (TP) sensors. The system stays in starting mode until the engine speed reaches a predetermined RPM.

Clear Flood Mode

If the engine floods, clear the engine by pressing the accelerator pedal down to the floor and then crank the engine. When the throttle position (TP) sensor is at wide open throttle (WOT), the control module reduces the fuel injector pulse width in order to increase the air to fuel ratio. The control module holds this injector rate as long as the throttle stays wide open and the engine speed is below a predetermined RPM. If the throttle is not held wide open, the control module returns to the starting mode.

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 a predetermined RPM, the system begins Open Loop operation. The control module ignores the signal from the heated oxygen sensor (HO2S). The control module calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), manifold absolute pressure (MAP), mass air flow (MAF), and throttle position (TP) sensors. The system stays in Open Loop until meeting the following conditions:

- The HO2S has varying voltage output, showing that the HO2S is hot enough to operate properly.

- The ECT sensor is above a specified temperature.
- A specific amount of time has elapsed after starting the engine.

Specific values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM). The system begins Closed Loop operation after reaching these values. In Closed Loop, the control module calculates the air/fuel ratio, injector ON time, based upon the signal from various sensors, but mainly from the HO2S. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

When the driver pushes on the accelerator pedal, air flow into the cylinders increases rapidly. To prevent possible hesitation, the control module increases the pulse width to the injectors to provide extra fuel during acceleration. This is also known as power enrichment. The control module determines the amount of fuel required based upon the throttle position (TP), the engine coolant temperature (ECT), the manifold absolute pressure (MAP), the mass air flow (MAF), and the engine speed.

Deceleration Mode

When the driver releases the accelerator pedal, air flow into the engine is reduced. The control module monitors the corresponding changes in the throttle position (TP), the mass air flow (MAF), and the manifold absolute pressure (MAP). The control module shuts OFF fuel completely if the deceleration is very rapid, or for long periods, such as long, closed-throttle coast-down. The fuel shuts OFF in order to prevent damage to the catalytic converters.

Battery Voltage Correction Mode

When the battery voltage is low, the control module compensates for the weak spark delivered by the ignition system in the following ways:

- Increasing the amount of fuel delivered
- Increasing the idle RPM
- Increasing the ignition dwell time

Fuel Cutoff Mode

The control module cuts OFF fuel from the fuel injectors when the following conditions are met in order to protect the powertrain from damage and improve driveability:

- The ignition is OFF. This prevents engine run-on.
- The ignition is ON but there is no ignition reference signal. This prevents flooding or backfiring.
- The engine speed is too high, above red line.

- The vehicle speed is too high, above rated tire speed.
- During an extended, high speed, closed throttle coast down-This reduces emissions and increases engine braking.
- During extended deceleration, in order to prevent damage to the catalytic converters

Fuel Trim

The control module controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The control module monitors the heated oxygen sensor (HO2S) signal voltage while in Closed Loop and regulates the fuel delivery by adjusting the pulse width of the injectors based on this signal. The ideal fuel trim values are around 0 percent for both short and long term fuel trim. A positive fuel trim value indicates the control module is adding fuel in order to compensate for a lean condition by increasing the pulse width. A negative fuel trim value indicates that the control module is reducing the amount of fuel in order to compensate for a rich condition by decreasing the pulse width. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltage. These changes fine tune the engine fueling. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. A scan tool can be used to monitor the short and long term fuel trim values. The long term fuel trim diagnostic is based on an average of several of the long term speed load learn cells. The control module selects the cells based on the engine speed and engine load. If the control module detects an excessively lean or rich condition, the control module will set a fuel trim diagnostic trouble code (DTC).

EVAPORATIVE EMISSION (EVAP) CONTROL SYSTEM DESCRIPTION

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 vapor pipe, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent line and EVAP 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 control module will command the EVAP purge solenoid valve ON, allowing engine vacuum to be applied to the EVAP canister. With the EVAP vent solenoid valve OFF, fresh air is drawn through the vent solenoid and the vent line 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 pipe 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.

Large Leak Test

This tests for large leaks and blockages in the evaporative emission (EVAP) system. The

control module commands the EVAP vent solenoid valve ON and commands the EVAP purge solenoid valve ON, with the engine running, allowing engine vacuum into the EVAP system. The control module monitors the fuel tank pressure (FTP) sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time. The control module then commands the EVAP purge solenoid valve OFF, sealing the system, and monitors the vacuum level for decay. If the control module does not detect that the predetermined vacuum level was achieved, or the vacuum decay rate is more than a calibrated level on 2 consecutive tests, DTC P0455 will set.

Small Leak Test

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

The EONV diagnostic utilizes the temperature changes in the fuel tank immediately following a drive cycle to use the naturally occurring vacuum or pressure in the fuel tank. When the vehicle is driven, the temperature rises in the tank. After the vehicle is parked, the temperature in the tank continues to rise for a period of time, then start to drop. The EONV diagnostic relies on this temperature change and its corresponding pressure change to determine if an EVAP system leak is present.

The EONV diagnostic is designed to detect leaks as small as 0.51 mm (0.02 in). The diagnostic can determine if a small leak is present based on vacuum or pressure readings in the EVAP system. When the system is sealed, a finite amount of pressure or vacuum will be observed. When a 0.51 mm (0.02 in) leak is present, often little or no pressure or vacuum is observed. If the test reports a failing value, DTC P0442 will set.

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, commanding the EVAP vent solenoid valve OFF, and monitoring the fuel tank pressure (FTP) sensor for an increase in vacuum. If the vacuum increases more than a calibrated value, DTC P0446 will set.

Purge Solenoid 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 control module tests for this by commanding the EVAP purge solenoid valve OFF and the vent solenoid valve ON, sealing the system, and monitors the fuel tank pressure (FTP) for an

increase in vacuum. If the control module detects that the EVAP system vacuum increases above a calibrated value, DTC P0496 will set.

Check Gas Cap Message

If equipped, the powertrain control module (PCM) sends a class 2 message to the driver information center (DIC) illuminating the Check Gas Cap message when any of the following occur:

- A malfunction in the evaporative emission (EVAP) system and a large leak test fails
- A malfunction in the EVAP system and a small leak test fails

EVAP System Components

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

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.

EVAP Purge Solenoid Valve

The evaporative emission (EVAP) purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. The 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, allowing engine vacuum to enter the EVAP system.

EVAP Vent Solenoid Valve

The evaporative emission (EVAP) vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The control module commands the valve ON, closing the valve during some EVAP tests, allowing the system to be tested for leaks.

Fuel Tank Pressure Sensor

The fuel tank pressure (FTP) sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. The control module provides a 5-volt reference and a ground to the FTP sensor. The FTP sensor provides a signal voltage back to the control module that can vary between 0.1-4.9 volts. A high FTP sensor voltage indicates a low fuel tank pressure or vacuum. A low FTP sensor voltage indicates a high fuel tank pressure.

EVAP Service Port

The evaporative emission (EVAP) service port is located in the EVAP purge pipe between the EVAP purge solenoid valve and the EVAP canister. The service port is identified by a green colored cap.

ELECTRONIC IGNITION (EI) 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 one coil for each pair of cylinders. Each pair of cylinders that are at top dead center (TDC) at the same time are known as companion cylinders. The cylinder that is at TDC of its compression stroke is called the event cylinder. The cylinder that is at TDC of its exhaust stroke is called the waste cylinder. When the ignition coil is triggered, both companion cylinder spark plugs fire at the same time, completing a series circuit. Because the lower pressure inside the waste cylinder offers very little resistance, the event cylinder uses most of the available voltage to produce a very high energy spark. This is known as waste spark ignition. The ignition coils and ignition control module (ICM) are contained within one assembly. The ignition coil/ICM assembly is mounted in the center of the engine camshaft cover, with short boots connecting the ignition coils to the spark plugs. The ignition coil driver modules within the ICM are commanded ON/OFF by the engine control module (ECM). The EI system consists of the following components:

Crankshaft Reluctor Wheel

The crankshaft reluctor wheel is part of the crankshaft. The reluctor wheel has 7 machined notches, 6 of which are equally spaced 60 degrees apart. The 7th notch is spaced 10 degrees after one of the 60-degree notches. The 10-degree notch is used to synchronize the engine position, while the other notches are used to provide cylinder location during a revolution.

Crankshaft Position (CKP) Sensor

The crankshaft position (CKP) sensor is a permanent magnet generator, known as a variable reluctance sensor. The CKP sensor produces an AC voltage of different amplitude and frequency. The frequency depends on the velocity of the crankshaft. The AC voltage output depends on the crankshaft position and the battery voltage. The CKP sensor works in conjunction with a 7X reluctor wheel attached to the crankshaft. The CKP sensor produces 7 pulses for each revolution of the crankshaft. The pulse from the 10-degree notch is known as the sync pulse. The sync pulse is used to synchronize the coil firing sequence with the CKP. The CKP sensor is used for ignition timing, the fuel injector timing, misfire diagnostics and tachometer display. The CKP sensor is connected to the engine control module (ECM) by a signal circuit and a low reference circuit.

Ignition Control Module (ICM) and Ignition Coils

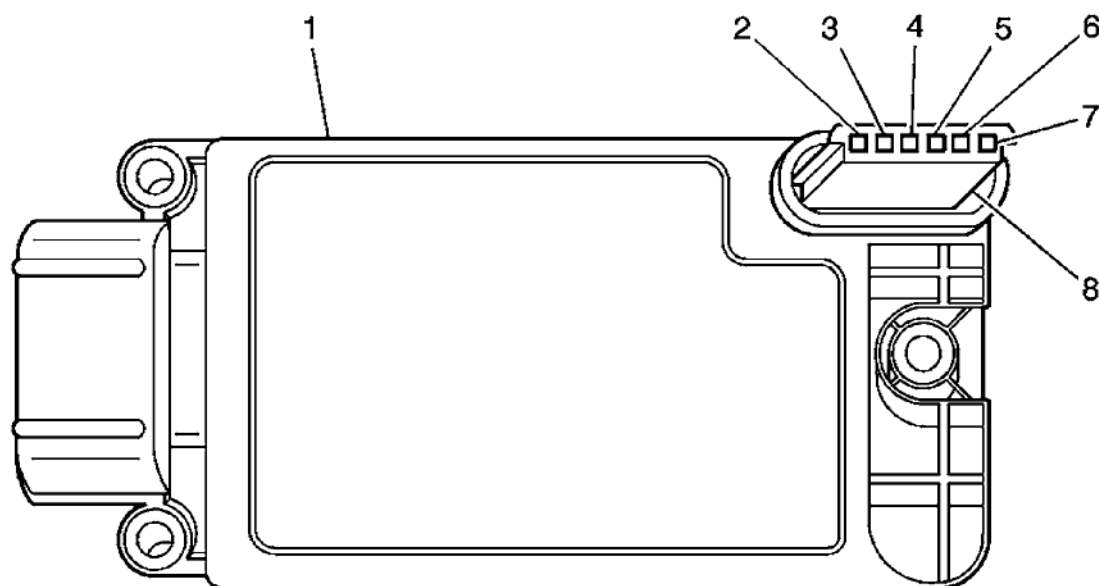


Fig. 235: Ignition Control Module (ICM) & Ignition Coils
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 235

Callout	Component Name
1	Ignition Control Module (ICM)
2	Compression Sense Ignition (CSI) Pickup
3	Not Used
4	2-3 Coil Control
5	Ignition Voltage
6	1-4 Coil Control
7	Not Used
8	Interconnect

The engine control module (ECM) supplies a signal on each of the ignition control (IC) timing control circuits to the ignition control module (ICM). The ICM fires the correct ignition coil at the correct time based on the signals. The ICM detects if cylinder 1 or cylinder 3 is on the compression stroke by sensing the secondary voltage and polarity of each side of the ignition coil. The ICM detects this voltage with sensing circuitry integrated into each ignition coil. The higher voltage is on the compressing cylinder. This is called compression sense ignition. The ICM provides a synthesized cam signal to the ECM based on these inputs. The ECM uses the cam signal to synchronize fuel injection.

This system consists of the following circuits:

- An ignition voltage circuit
- A ground circuit

- A camshaft position (CMP) sensor signal circuit
- An IC timing control circuit for cylinders #1 and #4
- An IC timing control B circuit for cylinders #2 and #3

Engine Control Module (ECM)

The ECM controls all ignition system functions, and constantly corrects the spark timing. The ECM monitors information from various sensor inputs that include the following:

- The throttle position (TP) sensor
- The engine coolant temperature (ECT) sensor
- The intake air temperature (IAT) sensor
- The vehicle speed sensor (VSS)
- The transmission gear position or range information sensors
- The engine knock sensors (KS)

Modes of Operation

There is one normal mode of operation during which the engine control module (ECM) controls spark. If the crankshaft position (CKP) pulses are lost the engine will not run. The loss of a camshaft position (CMP) signal may result in a longer crank time since the ECM cannot determine which stroke the pistons are ON. DTCs are available to accurately diagnose the ignition system with a scan tool.

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION**Purpose**

The throttle actuator control (TAC) system delivers improved throttle response and greater reliability and eliminates the need for mechanical cable. The TAC system performs the following functions:

- Accelerator pedal position sensing
- Throttle positioning to meet driver and engine demands
- Throttle position sensing
- Internal diagnostics
- Cruise control functions
- Manage TAC electrical power consumption

The TAC system includes the following components:

- The accelerator pedal position (APP) sensors
- The throttle body assembly

- The engine control module (ECM)

Accelerator Pedal Position (APP) Sensor

The accelerator pedal contains 2 individual accelerator pedal position (APP) sensors within the assembly. The APP sensors 1 and 2 are potentiometer type sensors each with 3 circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

The APP sensors are used to determine the pedal angle. The engine control module (ECM) provides each APP sensor a 5-volt reference circuit and a low reference circuit. The APP sensors provide the ECM with signal voltage proportional to the pedal movement. The APP sensor 1 signal voltage at rest position is near the low reference and increases as the pedal is actuated. The APP sensor 2 signal voltage at rest position is also near the low reference and increases as the pedal is actuated.

Throttle Body Assembly

The throttle assembly contains the following components:

- The throttle blade
- The throttle actuator motor
- The throttle position (TP) sensor 1 and 2

The throttle body functions similar to a conventional throttle body with the following exceptions:

- An electric motor opens and closes the throttle valve.
- The throttle blade is spring loaded in both directions and the default position is slightly open.
- There are 2 individual TP sensors within the throttle body assembly.

The TP sensors are used to determine the throttle plate angle. The TP sensors provide the engine control module (ECM) with a signal voltage proportional to throttle plate movement. The TP sensor 1 signal voltage at closed throttle is near the 5-volt reference and decreases as the throttle plate is opened. The TP sensor 2 signal voltage at closed throttle is near the low reference and increases as the throttle plate is opened.

Engine Control Module

The engine control module (ECM) is the control center for the throttle actuator control (TAC) system. The ECM determines the drivers intent and then calculates the appropriate

throttle response. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the TAC motor.

Modes of Operation

Normal Mode

During the operation of the throttle actuator control (TAC) system, several modes or functions are considered normal. The following modes may be entered during normal operation:

- Minimum pedal value-At key-up the engine control module (ECM) updates the learned minimum pedal value.
- Minimum throttle position (TP) values-At key-up the ECM updates the learned minimum TP value. In order to learn the minimum TP value, the throttle blade is moved to the closed position.
- Ice break mode - If the throttle 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.
- 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 by 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.

KNOCK SENSOR (KS) SYSTEM DESCRIPTION

Purpose

The knock sensor (KS) 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. The ECM uses the KS system to test for abnormal engine noise that may indicate detonation, also known as spark knock.

Sensor Description

The knock sensor (KS) system uses a flat response 2-wire sensor. 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 dependent upon the level of knock that the KS detects. The engine control module (ECM) receives the KS signal through a signal circuit. The KS ground is supplied by the ECM through a low reference circuit.

The ECM learns a minimum noise level, or background noise, at idle from the KS and uses calibrated values for the rest of the RPM range. The ECM uses the minimum noise level to calculate a noise channel. A normal KS 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 KS signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the ECM only uses KS 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 ECM has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The ECM will always try to work back to a zero compensation level, or no spark retard. An abnormal KS signal will stay outside of the noise channel or will not be present. KS diagnostics are calibrated to detect faults with the KS circuitry inside the ECM, the KS wiring, the KS voltage output, or constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

AIR INTAKE SYSTEM DESCRIPTION

The primary function of the Air Intake System is to provide filtered air to the engine. The system uses a cleaner element mounted in a housing. The cleaner housing is remotely mounted and uses intake ducts to route the incoming air into the throttle body. The secondary function of the Air Intake System is to muffle air induction noise. This is achieved through the use of resonators attached to the air intake ducts. The resonators are tuned to the specific powertrain. The mass air flow (MAF)/intake air temperature (IAT) sensor is used to measure the temperature and the volume of the air entering the engine.

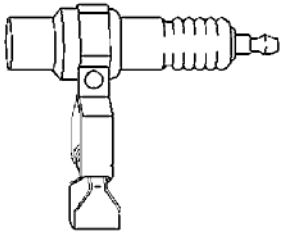
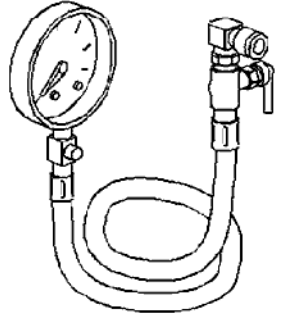
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SPECIAL TOOLS AND EQUIPMENT

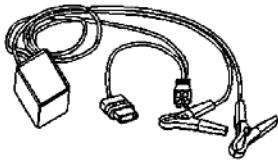
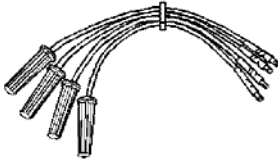
SPECIAL TOOLS

Special Tools

Illustration	Tool Number/ Description
	GE 41415-50 Fuel Tank Cap Adapter
	J 26792 Spark Tester
	J 34730-1A Fuel Pressure Gage
	J 35616-A GM Terminal Test Kit
	J 36012-A Ignition System Diagnostic Harness

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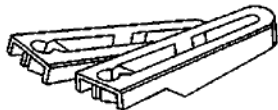


J 37027-1A

IAC Motor Driver

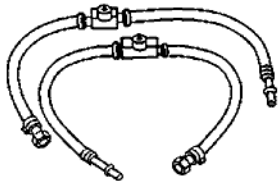
You may also use an IAC Motor Driver from one of the approved manufacturers listed below:

- OTC
- Thexton
- CTI
- Snap On
- MAC Tools
- NAPA/Balkamp



J 37088-A

Fuel Line Disconnect Tool Set



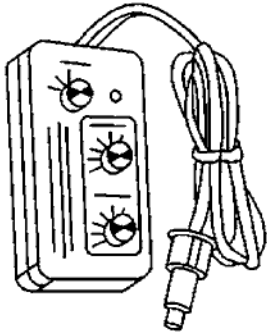
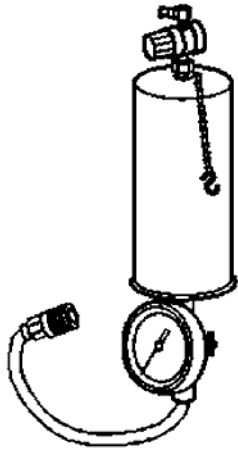
J 37287

Fuel Pipe Shut-Off Adapter

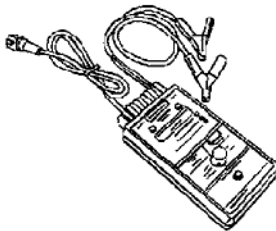
J 38500-A
Fuel Injector Cleaner

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J 38522
Variable Signal Generator

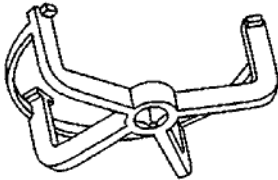
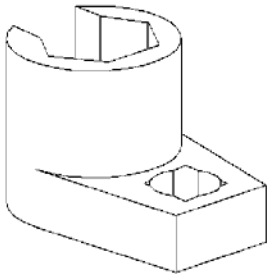


J 39021
Fuel Injector Tester

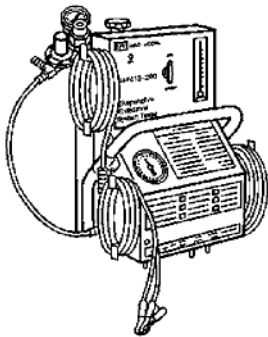
J 39194-C
Oxygen Sensor Wrench

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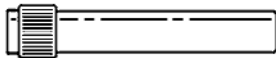
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J 39765
Fuel Sender Lock Nut Wrench



J 41413-200
Evaporative Emissions System Tester
(EEST)

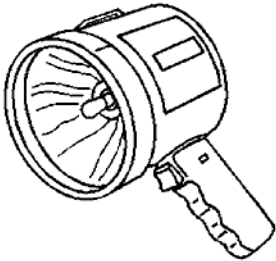


J 41413-VLV
EVAP Service Port Vent Fitting

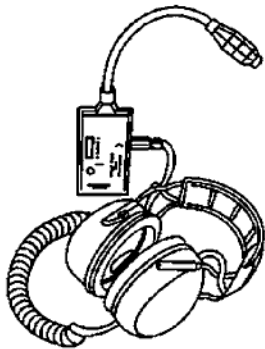
J 41413-SPT
High Intensity White Light

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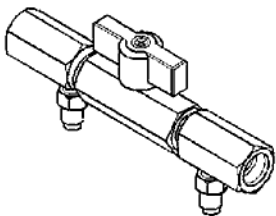
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J 41415-40
Fuel Tank Cap Adapter



J 41416
Ultrasonic Leak Detector

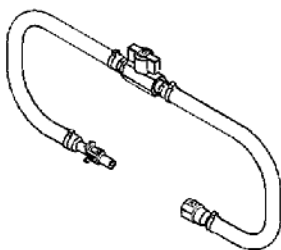
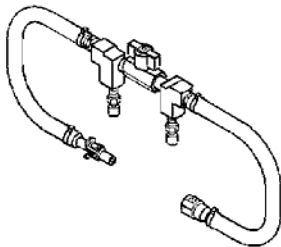
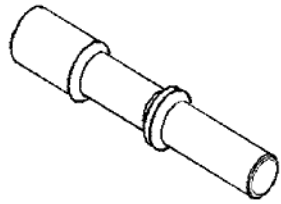
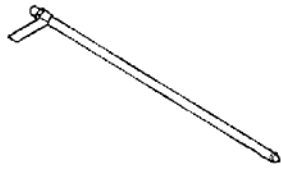
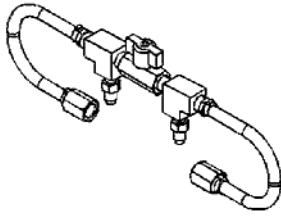


J 42873-1
Fuel Line Shut-Off Adapter

J 42873-2
Fuel Line Shut-Off Adapter

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J 42960-1
Fuel Drain Hose

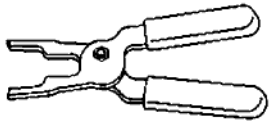
J 42960-2
Fuel Flapper Door Holder

J 42964-1
Fuel Line Shut-Off Adapter

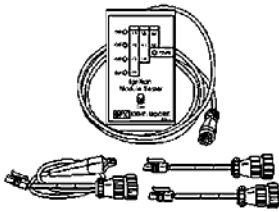
J 42964-2
Fuel Line Shut-Off Adapter

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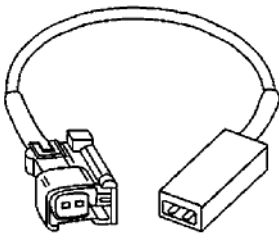
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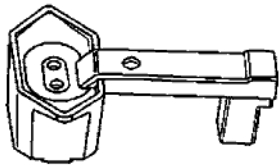
J 43244
Relay Puller Pliers



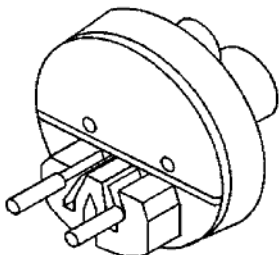
J 43298
Ignition Module Tester



J 44062
Injector Test Adapter



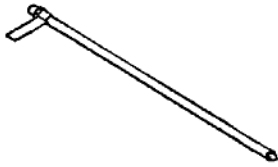
J 44175
Fuel Composition Tester



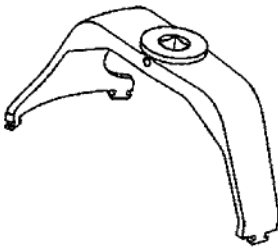
J 44603
Injector Test Lamp

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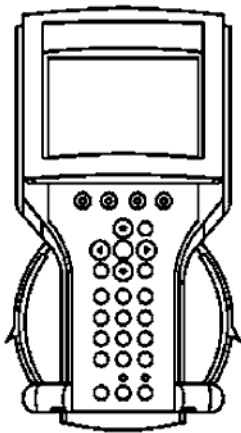
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J 45004
Fuel Tank Drain Hose



J 45722
Fuel Sender Lock Ring Wrench



7000061
Tech II Diagnostic Scan Tool