

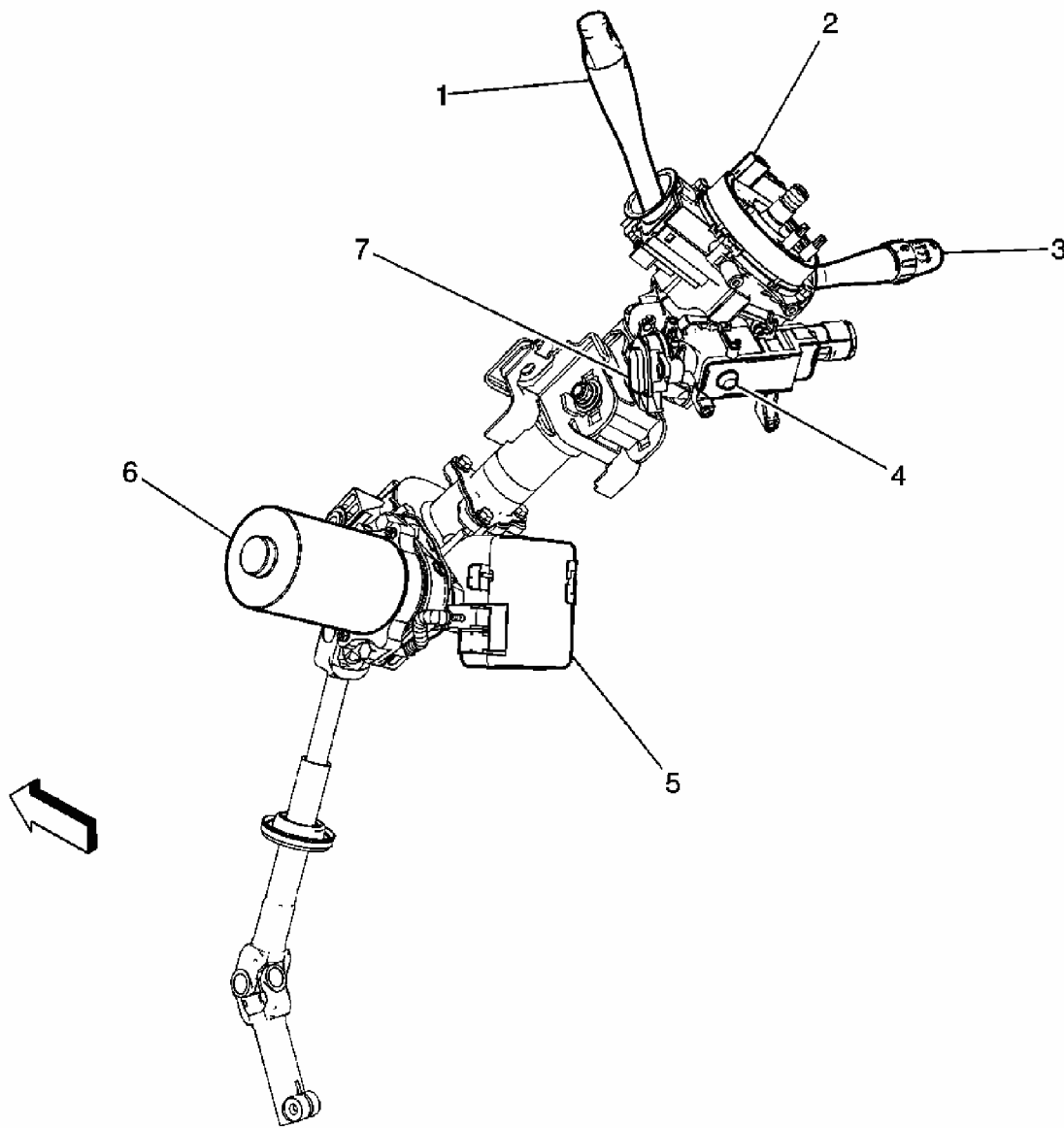
POWER STEERING SYSTEM COMPONENT VIEWS

Fig. 2: Steering Column Components
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 2

Callout	Component Name
1	Turn Signal / Multifunction Switch
2	Inflatable Restraint Steering Wheel Module Coil
3	Windshield Wiper / Washer Switch
4	Power Steering Control Module (PSCM)
5	Electronic Power Steering (EPS) Motor
6	Ignition Lock Cylinder Control Actuator (MN5)

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POWER STEERING SYSTEM CONNECTOR END VIEWS

Power Steering Control Module (PSCM) C1

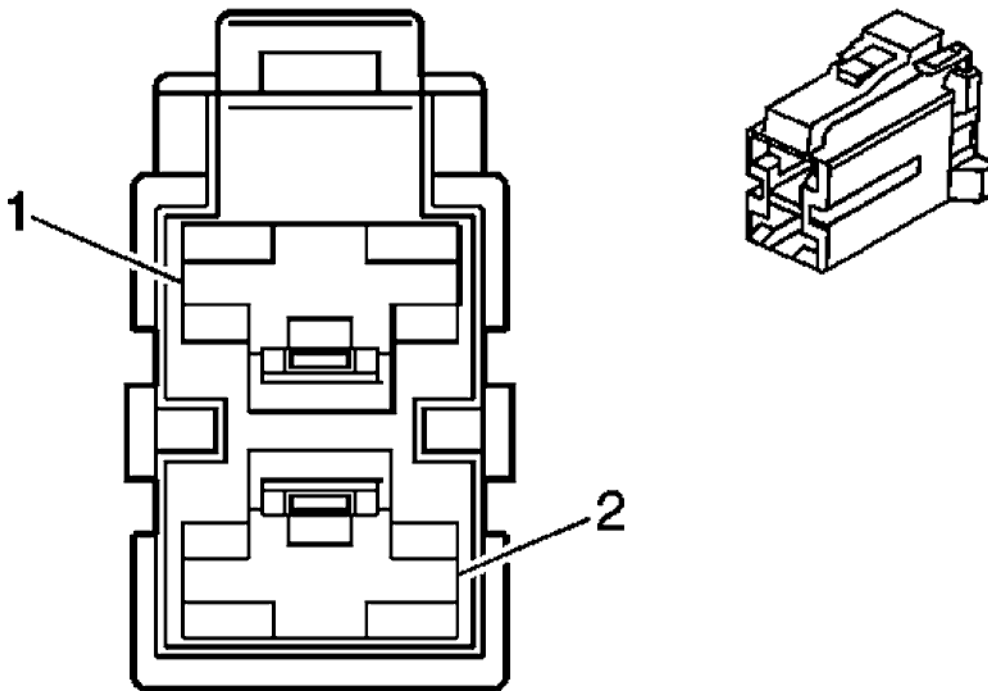


Fig. 3: Power Steering Control Module (PSCM) C1 Connector
Courtesy of GENERAL MOTORS CORP.

Power Steering System Connector End Views

Connector Part Information

- OEM: 7123-4123-30
- Service: 88953301
- Description: 2-Way F L Type (BK)

Terminal Part Information

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

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Power Steering Control Module (PSCM) C1

Pin	Wire Color	Circuit No.	Function
1	RD/BK	642	Battery Positive Voltage
2	BK	1150	Ground

Power Steering Control Module (PSCM) C2

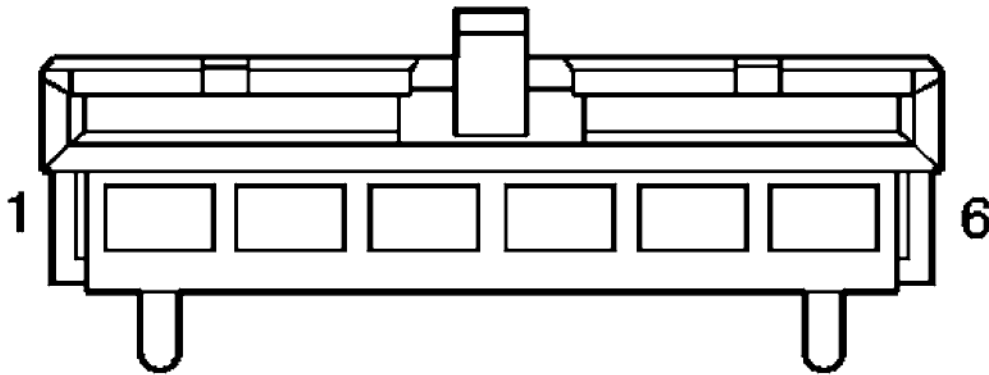


Fig. 4: Power Steering Control Module (PSCM) C2 Connector
Courtesy of GENERAL MOTORS CORP.

Power Steering System Connector End Views

Connector Part Information

- OEM: 776195-6
- Service: 88988409
- Description: 6-Way F040 (GY)

Terminal Part Information

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

Power Steering Control Module (PSCM) C2

Pin	Wire Color	Circuit No.	Function
1	TN/BK	2500	High Speed GMLAN Serial Data (+)

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2	TN	2501	High Speed GMLAN Serial Data (-)
3	-	-	Not Used
4	TN/BK	2500	High Speed GMLAN Serial Data (+)
5	TN	2501	High Speed GMLAN Serial Data (-)
6	PK	1539	Run/Crank Ignition 1 Voltage

Power Steering Control Module (PSCM) C3

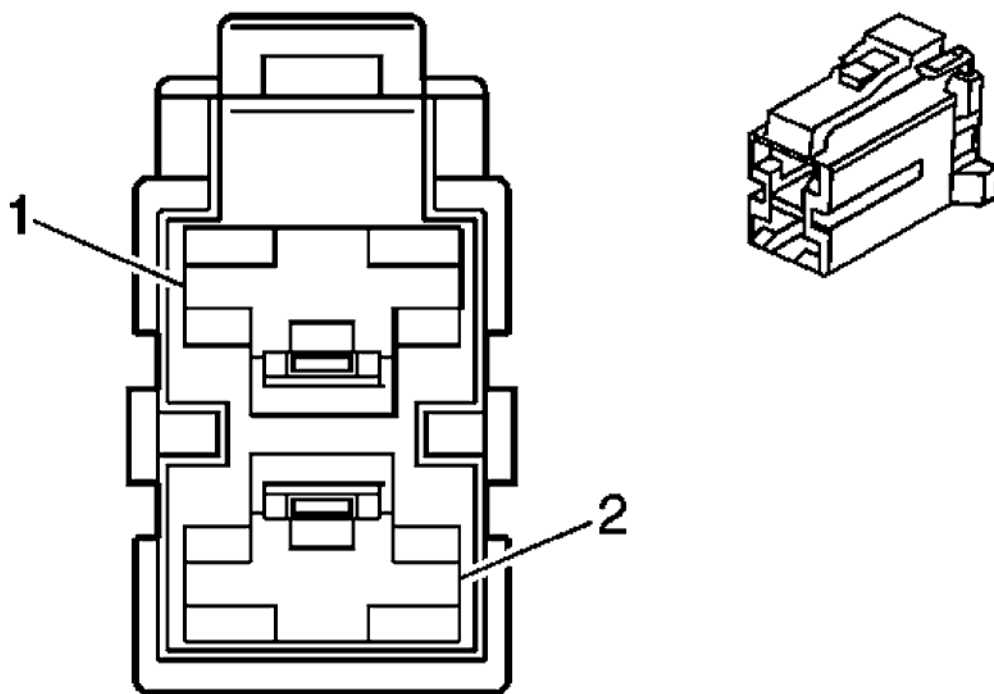


Fig. 5: Power Steering Control Module (PSCM) C3 Connector
Courtesy of GENERAL MOTORS CORP.

Power Steering System Connector End Views

Connector Part Information

- OEM: 7123-4123-30
- Service: 88953301
- Description: 2-Way F L Type (BK)

Terminal Part Information

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

Power Steering Control Module (PSCM) C3

Pin	Wire Color	Circuit No.	Function
1(+)	RD	5	Left Assist Motor Control
2(-)	BK	5	Right Assist Motor Control

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC C0000	Vehicle Speed Information Circuit
DTC C0176	System Thermal Error
DTC C0475	Electric Steering Motor Circuit
DTC C0545	Steering Wheel Torque Input Sensor
DTC C0845	Device Ignition 1 Circuit
DTC C0895	Device Voltage

DIAGNOSTIC STARTING POINT - POWER STEERING SYSTEM

System Familiarization

Review the electric power steering (EPS) system operation in order to familiarize yourself with the correct system functions and operations. Refer to **Power Steering System Description and Operation**.

Visual/Physical Inspection

- Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** in Wiring Systems.
- Inspect for aftermarket components such as tires, or wheels which could affect the operation and/or performance of the power steering system.
- Inspect the steering column for accident damage. Refer to **Steering Column Accident Damage Inspection** in Steering Wheel and Column.

System Diagnosis

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After incorrect system operation has been verified and that aftermarket devices, or intermittent conditions are not the cause, begin the system diagnosis with the Vehicle Diagnostic System Check. The Vehicle Diagnostic System Check will provide the following information:

1. The identification of the control modules that control the Power Steering System.
2. The ability of those control modules to communicate via the serial data circuit.
3. The presence of any stored diagnostic trouble codes (DTCs) in those control modules and there status.

The use of the Vehicle Diagnostic System Check will identify the correct procedure for diagnosing the malfunction and where the procedure is located. Refer to **Diagnostic System Check - Vehicle** in Vehicle DTC Information.

SCAN TOOL DATA LIST

Scan Tool Data List

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine ON/Steering wheel centered/No force applied to steering wheel			
Battery Voltage	PSCM	Volts	14
Ignition Voltage	PSCM	Volts	14
Motor Voltage +	PSCM	Volts	0.0
Motor Voltage -	PSCM	Volts	0.0
Steering Calibration	PSCM	Numeric 1-8	2
Steering Shaft Torque	PSCM	N.m or lb ft	0.00
Vehicle Speed	PSCM	km/h or mph	0

SCAN TOOL DATA DEFINITIONS

Battery Voltage

The scan tool displays 8-17 volts. The level of battery voltage available at the power steering control module (PSCM).

Ignition Voltage

The scan tool displays 0-17 volts. The level of ignition voltage available at the PSCM.

Motor Voltage +

The scan tool displays 7-14 volts. The amount of voltage being supplied to the EPS

motor while turning right.

Motor Voltage -

The scan tool displays 7-14 volts. The amount of voltage being supplied to the EPS motor while turning left.

Steering Calibration

The scan tool displays 1-8. The number of the steering calibration the PSCM has chosen based on the VIN. All 8 of the steering calibrations for EPS are stored in the body control module (BCM).

Steering Shaft Torque

The scan tool displays -20.70 N.m to +20.70 N.m (15.2 lb ft). The amount of torque being applied to the steering column shaft when turning the steering wheel. This signal voltage is from the detection coil of the torque sensor which is then converted to N.m by the PSCM. A - value indicates a left turn, a positive value indicates a right turn.

Vehicle Speed

The scan tool displays 0-255 km/h (0-156 mph). The actual speed of the vehicle.

DTC C0000

Circuit Description

The power steering control module (PSCM) receives a vehicle speed message from the powertrain control module (PCM) via the serial data circuit. The PSCM uses this vehicle speed message, and other inputs, to determine the desired amount of steering assist. At lower speeds, more assist is provided for easy turning during parking maneuvers. At higher speeds, less assist is provided for improved road feel and directional stability.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC C0000 Vehicle Speed Information Circuit

This vehicle has DTCs which include DTC symptoms. For more information on DTC symptoms, refer to **DTC Symptom Description** in Vehicle DTC Information.

DTC C0000

DTC Symptom	DTC Symptom Descriptor
71	Invalid Serial Data Received

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Conditions for Running the DTC

- The ignition is ON.
- DTCs U2100, U2105, 2107, or U2109 are not set.
- Power Steering System voltage is between 6-16 volts.

Conditions for Setting the DTC

The PSCM receives an invalid vehicle speed message from the PCM.

Action Taken When the DTC Sets

- DTC C0000 71 is stored in memory.
- The DIC displays the POWER STEERING warning message.
- Steering assist is set to a default level.
- Poor return to center.

Conditions for Clearing the DTC

- A current DTC will clear when the malfunction is no longer present.
- A history DTC will clear after 100 consecutive malfunction-free ignition cycles.
- Using a scan tool

Test Description

The number below refers to the step number on the diagnostic table.

2: This step tests for the presence of vehicle speed related DTCs in the control module where the vehicle speed message originates.

DTC C0000

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle in Vehicle DTC Information
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With the scan tool, select Powertrain Diagnostic Trouble Codes (DTC)	Go to Diagnostic Trouble Code	

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	function. Does the scan tool indicate the presence of any vehicle speed related DTCs?	(DTC) List - Vehicle in Vehicle DTC Information	Go to Step 3
3	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the conditions for running the DTC. Does the DTC reset?	Go to Step 2	System OK

DTC C0176

Circuit Description

The power steering control module (PSCM) monitors the temperature of the Power Steering System. The PSCM uses voltage, current levels and input from an internal temperature sensor to calculate an estimated system temperature. If the PSCM detects a high system temperature event is occurring, the amount of assist is reduced to lower system temperature to prevent thermal damage to the power steering components.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC C0176 System Thermal Error

This vehicle has DTCs which include DTC symptoms. For more information on DTC symptoms, refer to **DTC Symptom Description** in Vehicle DTC Information.

DTC C0176

DTC Symptom	DTC Symptom Descriptor
54	Temperature High

Condition for Running the DTC

- The ignition is ON, with the engine ON.
- Power Steering System voltage is 9-16 volts.
- Repetitive steering input is present.

Conditions for Setting the DTC

The PSCM detects a high system temperature.

Action Taken When the DTC Sets

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- DTC C0176 54 is stored in memory.
- Steering assist is reduced.

Conditions for Clearing the DTC

- A current DTC will clear when the Power Steering System temperature returns to normal.
- A history DTC will clear after 100 consecutive malfunction-free ignition cycles.
- Using a scan tool

Diagnostic Aids

- DTC C0176 54 does not indicate that a malfunction has occurred. Rather that the PSCM had to limit current to the power steering motor to avoid thermal damage to the Power Steering System components.
- Inspect the under dash area around the steering column assembly. Ensure that no other components have come in contact with the power steering motor and module assembly, such as under dash insulation, or other electrical components.
- Ensure that no steering components down stream of the power steering column assembly, such as ball joints, tie rod ends, universal joints, or the steering gear assembly, are mechanically binding.

Test Description

The number below refers to the step number on the diagnostic table.

2: This step tests if the high system temperature is driving condition related.

DTC C0176

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle in Vehicle DTC Information
2	Since most occurrences of the DTC are caused by excessive static steering, such as parking maneuvers and high ambient temperatures, review the Power Steering System with the customer to determine the conditions under which the DTC set. Did steering conditions and/or high ambient temperatures cause the DTC to set?	Go to Step 3	Go to Diagnostic Aids

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3	1. Use the scan tool in order to clear the DTCs.		
	2. Operate the vehicle within normal conditions.		
	Does the DTC reset?	Go to Step 2	System OK

DTC C0475

Circuit Description

The power steering control module (PSCM) continuously monitors the voltage and current levels being commanded to the power steering motor. The PSCM compares the commanded and feedback current levels to detect malfunctions in the power steering motor.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC C0475 Electric Steering Motor Circuit

This vehicle has DTCs which include DTC Symptoms. For more information on DTC Symptoms, refer to **DTC Symptom Description** .

DTC C0475

DTC Symptom	DTC Symptom Descriptor
00	No Additional DTC Information

Conditions for Running the DTC

- The ignition is ON, with the engine ON.
- Power Steering System voltage is 9-16 volts.
- Steering input is present.

Conditions for Setting the DTC

A short to ground, short to voltage, or an open in the power steering motor, or the circuits to the motor.

Action Taken When the DTC Sets

- A DTC C0475 00 is stored in memory.
- The driver information center (DIC) displays the POWER STEERING warning message.
- No steering assist is provided.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 100 consecutive malfunction-free ignition cycles.
- Using a scan tool

DTC C0475

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Turn ON the ignition, with the engine OFF. 2. With a scan tool, select Diagnostic Trouble Codes (DTC) function. Does the scan tool indicate that DTC C0475 00 is current?	Go to Step 3	Go to Step 4
3	Replace the steering column. Refer to Steering Column Replacement . Did you complete the repair?	Go to Step 3	-
4	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the Conditions for Running the DTC. Does DTC C0475 reset?	Go to Step 2	System OK

DTC C0545

Circuit Description

The power steering control module (PSCM) uses the steering shaft torque as its main input for determining steering direction and the amount of steering assist needed. The steering column has an input shaft from the steering wheel to the torque sensor and an output shaft from the torque sensor to the intermediate shaft coupler. The input and output shafts are separated by a section of torsion bar at the base of the steering column where the torque sensor is located. The torque sensor consists of a detecting coil, compensation coil and 3 detecting rings. Detecting ring 1 is fixed to the output shaft while detecting ring 2 is fixed to the input shaft. Both detecting rings have toothed edges that face each other. The detecting coil is positioned around the toothed edges of detecting rings 1 and 2. As torsional twist is applied to the steering column shaft's torsion bar when the steering wheel is turned, these

toothed edges change alignment with each other which effects the magnetic characteristics around the detecting coil, changing the coils impedance thus changing the sensor's signal voltage input to the PSCM. The PSCM recognizes this change in detecting coil signal voltage as steering column shaft torque. The compensation coil is positioned around detecting rings 2 and 3, which do not change alignment with each other as the steering wheel is turned. This coil is used to compensate for the rotation of the steering shaft and also conditions that can effect circuit impedance, such as voltage, current and ambient temperature, for accurate torque detection.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC C0545 Steering Wheel Torque Input Sensor

This vehicle has DTCs which include DTC Symptoms. For more information on DTC Symptoms, refer to **DTC Symptom Description** .

DTC C0545

DTC Symptom	DTC Symptom Descriptor
00	No Additional DTC Information

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The PSCM has not undergone the torque sensor calibration procedure.

Action Taken When the DTC Sets

- DTC C0545 00 is stored in memory.
- The driver information center (DIC) displays the POWER STEERING warning message.
- Slight steering effort imbalance

Conditions for Clearing the DTC

- A current DTC will clear on the next consecutive malfunction-free ignition cycle.
- A history DTC will clear after 100 consecutive malfunction-free ignition cycles.
- Using a scan tool

Diagnostic Aids

DTC C0545 4B will set upon the first ignition ON cycle after PSCM replacement.

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DTC C0545

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Turn ON the ignition, with the engine OFF. 2. With a scan tool, observe the DTC Information for DTC C0545 00. Does the scan tool indicate that DTC C0545 4B is current?	Go to Step 3	Go to Step 4
3	Calibrate the torque sensor. Refer to Control Module References . Did you complete the repair?	Go to Step 4	-
4	1. Clear the DTCs with the scan tool. 2. Operate the vehicle within the Conditions for Running the DTC. Does the DTC reset?	Go to Step 2	System OK

DTC C0845**Circuit Description**

The body control module (BCM) contains the 2-amp EPS fuse. This fuse and the ignition 1 voltage circuit supply ignition voltage to the power steering control module (PSCM). This ignition voltage is used to wake up the PSCM. The PSCM receives a class 2 power moding message from the BCM to determine the position of the ignition switch. When a power mode message is received, the PSCM monitors the ignition 1 voltage circuit to detect if a short to voltage, short to ground, or an open exists.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC C0845 Device Ignition 1 Circuit

This vehicle has DTCs which include DTC symptoms. For more information on DTC symptoms, refer to DTC Symptom Description.

DTC C0845

DTC Symptom	DTC Symptom Descriptor
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01	Short to Battery +
06	Short to Ground or Open

Conditions for Running the DTC

The PSCM has 9-16 volts.

Conditions for Setting the DTC

- The class 2 power mode message indicates OFF, and the ignition 1 voltage circuit is shorted to voltage.
- The class 2 power mode message indicates ON, and the ignition 1 voltage circuit is shorted to ground or open.
- DTCs U1300 and U1301 are not set.

Action Taken When the DTC Sets

- DTC C0847 is stored in memory.
- The instrument panel cluster (IPC) message center displays the PWR STR warning message.
- The EPS system is disabled.

Conditions for Clearing the DTC

- A current DTC will clear when the malfunction is no longer present.
- A history DTC will clear after 100 consecutive malfunction free ignition cycles.
- Using a scan tool

Diagnostic Aids

The ignition 1 voltage circuit supplies several other control modules with ignition voltage. Before preceding with the diagnostic table below, ensure no other control modules that use the ignition 1 circuit for their ignition voltage supply have any ignition voltage malfunctions present, such as the sensing and diagnostic module (SDM) or the cruise control module (CCM). Refer to **Power Distribution Schematics**. If an intermittent malfunction exists, refer to **Testing for Intermittent Conditions and Poor Connections** for further diagnosis.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

- 2:** This step tests if the malfunction is intermittent.
- 5:** This step tests if a short to ground exists in the ignition 1 voltage circuit, or in the PSCM.

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DTC C0845

Step	Action	Yes	No
Connector End Views Reference: Power Steering System Connector End Views			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, attempt to establish communication with the power steering control module (PSCM). Does the scan tool communicate with the PSCM?	Go to Step 6	Go to Step 3
3	1. Turn OFF the ignition. 2. Inspect the 2 A EPS fuse for an open. Is the fuse open?	Go to Step 4	Go to Step 7
4	1. Replace the 2 A EPS fuse. 2. Turn ON the ignition, with the engine OFF. Does the fuse open?	Go to Step 5	Go to Diagnostic Aids
5	Test the ignition 1 voltage circuit of the PSCM for a short to ground. Refer to Testing for Short to Ground and Wiring Repairs. Did you find and correct the condition?	Go to Step 11	Go to Step 10
6	Test the ignition 1 voltage circuit for a short to voltage. Refer to Testing for a Short to Voltage and Wiring Repairs. Did you find and correct the condition?	Go to Step 11	Go to Diagnostic Aids
7	Test the ignition 1 voltage circuit of the PSCM for an open. Refer to Circuit Testing and to Wiring Repairs. Did you find and correct the condition?	Go to Step 11	Go to Step 8
8	Inspect for poor connections at the harness connector of the body control module (BCM). Refer to Testing for Intermittent		

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	<u>Conditions and Poor Connections</u> and to <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 11	Go to Step 9
9	Inspect for poor connections at the harness connector of the PSCM. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and to <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 11	Go to Step 10
10	Replace the electronic power steering (EPS) assembly. Refer to <u>Steering Column Replacement</u> . Did you complete the replacement?	Go to Step 11	-
11	1. Use the scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC. Does DTC C0845 reset?	Go to Step 2	System OK

DTC C0895

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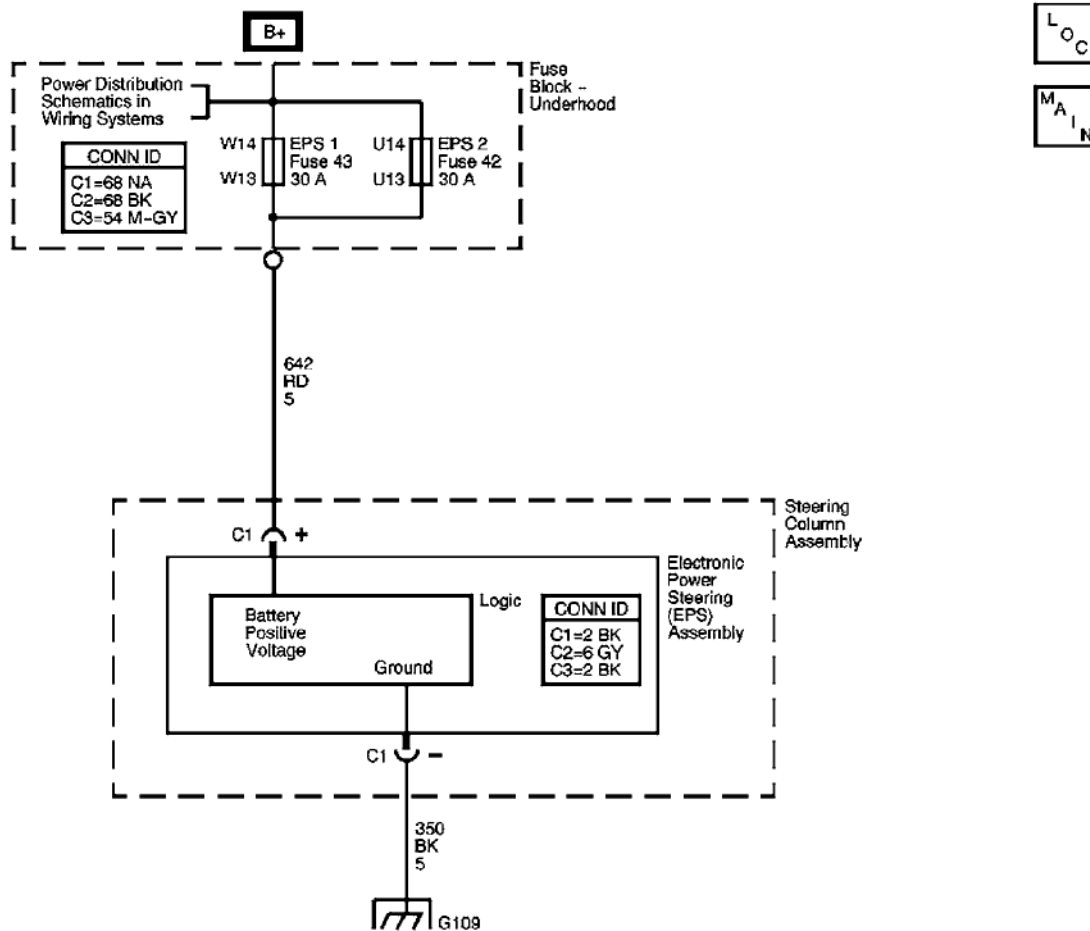


Fig. 6: DTC C0896 Circuit
Courtesy of GENERAL MOTORS CORP.

Circuit Description

The power steering control module (PSCM) has a discrete battery positive voltage supply circuit. The PSCM monitors the voltage level on this circuit to ensure the electric power steering (EPS) system has adequate voltage levels to perform the system functions.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC C0895 Device Voltage

This vehicle has DTCs which include DTC symptoms. For more information on DTC symptoms, refer to DTC Symptom Description.

DTC C0895

DTC Symptom	DTC Symptom Descriptor

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03	Voltage Below Threshold
11	Above Maximum Threshold
12	Below Minimum Threshold

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

EPS system battery voltage is less than 9.55 volts or greater than 17.5 volts.

Action Taken When the DTC Sets

- DTC C0896 is stored in memory.
- The instrument panel cluster (IPC) message center displays the PWR STR warning message.
- Steering assist is reduced.

Conditions for Clearing the DTC

- A current DTC will clear when EPS system voltage is 9.55-17.5 volts.
- A history DTC will clear after 100 consecutive ignition cycles with EPS system voltage between 9.55-17.5 volts.

Diagnostic Aids

The scan tool can be used to view the number of times a low battery voltage incident has occurred. If an intermittent malfunction exists, refer to **Testing for Intermittent Conditions and Poor Connections** for further diagnosis.

Test Description

The numbers below refer to the step number on the diagnostic table.

2: This step tests if the malfunction exists in the vehicles charging system.

3: This step tests if the malfunction is intermittent.

DTC C0895

Step	Action	Yes	No
Connector End Views Reference: Power Steering System Connector End Views			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle

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2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Battery Voltage parameter in the engine control module (ECM) Data List. Does the scan tool display 9.55-17.5 volts?	Go to Step 3	Go to Diagnostic System Check - Vehicle
3	With a scan tool, observe the Battery Voltage parameter in the electric power steering (EPS) Data List 1. Does the scan tool display 9.55-17.5 volts?	Go to Diagnostic Aids	Go to Step 4
4	Test the battery positive voltage circuit of the power steering control module (PSCM) for a high resistance. Refer to Circuit Testing and to Wiring Repairs. Did you find and correct the condition?	Go to Step 10	Go to Step 5
5	Test the ground circuit of the PSCM for a high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 10	Go to Step 6
6	Inspect for poor connections at the harness connector of the underhood fuse block stud terminal. Refer to Testing for Intermittent Conditions and Poor Connections and to Connector Repairs. Did you find and correct the condition?	Go to Step 10	Go to Step 7
7	Inspect for poor connections at the harness connector of the PSCM. Refer to Testing for Intermittent Conditions and Poor Connections and to Connector Repairs. Did you find and correct the condition?	Go to Step 10	Go to Step 8
8	Inspect for poor connections at the ground terminal G109. Refer to Testing for Intermittent Conditions and Poor Connections and to Connector Repairs. Did you find and correct the condition?	Go to Step 10	Go to Step 9
9	Replace the EPS assembly. Refer to Steering Column Replacement. Did you complete the replacement?	Go to Step 10	-
	1. Use the scan tool in order to clear the DTCs.		

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10	2. Operate the vehicle within the Conditions for Running the DTC.		
	Does DTC C0895 reset?	Go to Step 2	System OK

SYMPTOMS - POWER STEERING SYSTEM

IMPORTANT: Review the system description and operation in order to familiarize yourself with the system functions. Refer to Power Steering System Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power steering system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Rattle, Clunk, or Shudder Noise from the Power Steering System
- Increase in Effort While Turning Steering Wheel
- Poor Return of Steering Wheel
- Steering Wheel Surges/Jerks While Turning

RATTLE, CLUNK, OR SHUDDER NOISE FROM THE POWER STEERING SYSTEM

Rattle, Clunk, or Shudder Noise from the Power Steering System

Step	Action	Yes	No
1	Did you review the Power Steering System General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Steering Wheel and Column
2	Verify that a rattle, clunk or shudder noise is present. Is a rattle, clunk or shudder noise present?	Go to Step 3	System OK
3	Inspect the power steering gear for the proper installation. Refer to Power Steering Gear Replacement . Is the power steering gear installation incorrect?	Go to Step 6	Go to Step 4
	Inspect the intermediate shaft.		

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4	Is the intermediate shaft worn?	Go to Step 8	Go to Step 5
5	Inspect the suspension. Is the suspension worn?	Go to Step 7	Go to Noise Diagnosis - Front Suspension In Suspension General Diagnosis
6	Install the power steering gear correctly. Refer to Power Steering Gear Replacement . Did you complete the repair?	Go to Step 9	-
7	Replace the worn suspension components. Did you complete the repair?	Go to Step 9	-
8	Replace the intermediate shaft. Refer to Intermediate Steering Shaft Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

INCREASE IN EFFORT WHILE TURNING STEERING WHEEL

Increase in Effort While Turning Steering Wheel

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Power Steering System Description and Operation
2	Verify that there is an increase in effort while turning is present. Does the system operate normally?	System OK	Go to Step 3
3	Check for the following tire related conditions: • Incorrect tire inflation-Refer to Label - Vehicle Certification, Tire Place Card, Anti-Theft and Service Parts ID . • Improper tire size		

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	Did you find and correct the condition?	Go to Step 10	Go to Step 4
4	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Check for a binding or worn tie rod end. Is the tie rod binding or worn?	Go to Step 7	Go to Step 5
5	Check for a worn or binding intermediate shaft. Is the intermediate shaft worn or binding?	Go to Step 8	Go to Step 6
6	Check for a worn or binding steering gear. Is the steering worn or binding?	Go to Step 9	System OK
7	Replace the outer tie rod end. Refer to <u>Rack and Pinion Outer Tie Rod End Replacement</u> . Did you complete the repair?	Go to Step 10	-
8	Replace the intermediate shaft. Refer to <u>Intermediate Steering Shaft Replacement</u> . Did you complete the repair?	Go to Step 10	-
9	Replace the steering gear. Refer to <u>Power Steering Gear Replacement</u> . Did you complete the repair?	Go to Step 10	-
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

POOR RETURN OF STEERING WHEEL

Poor Return of Steering Wheel

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Power Steering System Description and Operation</u>
2	Verify a poor return of the steering wheel is present. Does the system operate normally?	System OK	Go to Step 3
3	Check for incorrect tire inflation. Refer to <u>Label - Vehicle Certification, Tire Place Card, Anti-Theft and Service Parts ID</u> . Did you find and correct the condition?	Go to Step 11	Go to Step 4

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4	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Check for a binding or worn tie rod end. Is the tie rod binding or worn?	Go to Step 8	Go to Step 5
5	Check for a worn or binding intermediate shaft. Is the intermediate shaft worn or binding?	Go to Step 9	Go to Step 6
6	Check for worn a or binding ball joint. Are the ball joints worn or binding?	Go to Step 10	Go to Step 7
7	Check for proper alignment of the front suspension. Refer to <u>Measuring Wheel Alignment</u> . Did you complete the wheel alignment?	Go to Step 11	-
8	Replace the outer tie rod end. Refer to <u>Rack and Pinion Outer Tie Rod End Replacement</u> . Did you complete the repair?	Go to Step 11	-
9	Replace the intermediate Shaft. Refer to <u>Intermediate Steering Shaft Replacement</u> . Did you complete the repair?	Go to Step 11	-
10	Replace the ball joint. Refer to <u>Lower Ball Joint Replacement</u> . Did you complete the repair?	Go to Step 11	-
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

STEERING WHEEL SURGES/JERKS WHILE TURNING

Steering Wheel Surges/Jerks While Turning

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Power Steering System Description and Operation
2	Verify that the steering wheel surges/jerks while turning. Does the system operate normally?	System OK	Go to Step 3
	Check for worn or binding front suspension		

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3	components. Did you find and correct the condition?	Go to Step 15	Go to Step 4
4	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> in General Information. 2. Check for a binding or worn tie rod end. Is the tie rod binding or worn?	Go to Step 11	Go to Step 5
5	Check for a worn or binding intermediate shaft. Is the intermediate shaft worn or binding?	Go to Step 12	Go to Step 6
6	Check for worn a binding steering gear. Is the steering gear worn or binding?	Go to Step 13	Go to Step 7
7	Check for a worn or binding steering column. Is the steering column worn or binding?	Go to Step 14	Go to Step 8
8	Check for excessive heat in the EPS motor. Does the EPS appear to be overheated?	Go to Step 09	Go to Step 10
9	IMPORTANT: • Do not perform excessive parking lot maneuvers during testing. • Excessive parking lot maneuvers can cause the EPS motor to heat up. Allow the EPS motor to cool and retest the system. Did you find and correct the condition?	Go to Step 15	Go to Step 10
10	Check for low battery voltage. Refer to <u>Diagnostic Starting Point - Engine Electrical</u> in Engine Electrical. Did you find and correct the condition?	Go to Step 15	System OK
11	Replace the outer tie rod end. Refer to <u>Rack and Pinion Outer Tie Rod End Replacement</u>. Did you complete the repair?	Go to Step 15	-
12	Replace the intermediate Shaft. Refer to <u>Intermediate Steering Shaft Replacement</u> in Steering Wheel and Column. Did you complete the repair?	Go to Step 15	-
13	Replace the steering gear. Refer to <u>Power Steering Gear Replacement</u>.		

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	Did you complete the repair?	Go to Step 15	-
14	Replace the steering column. Refer to Steering Column Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 15	-
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

REPAIR INSTRUCTIONS

RACK AND PINION OUTER TIE ROD END REPLACEMENT

Tools Required

J 24319-B Steering Linkage and Tie Rod Puller

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the front wheel. Refer to **Tire and Wheel Removal and Installation** .

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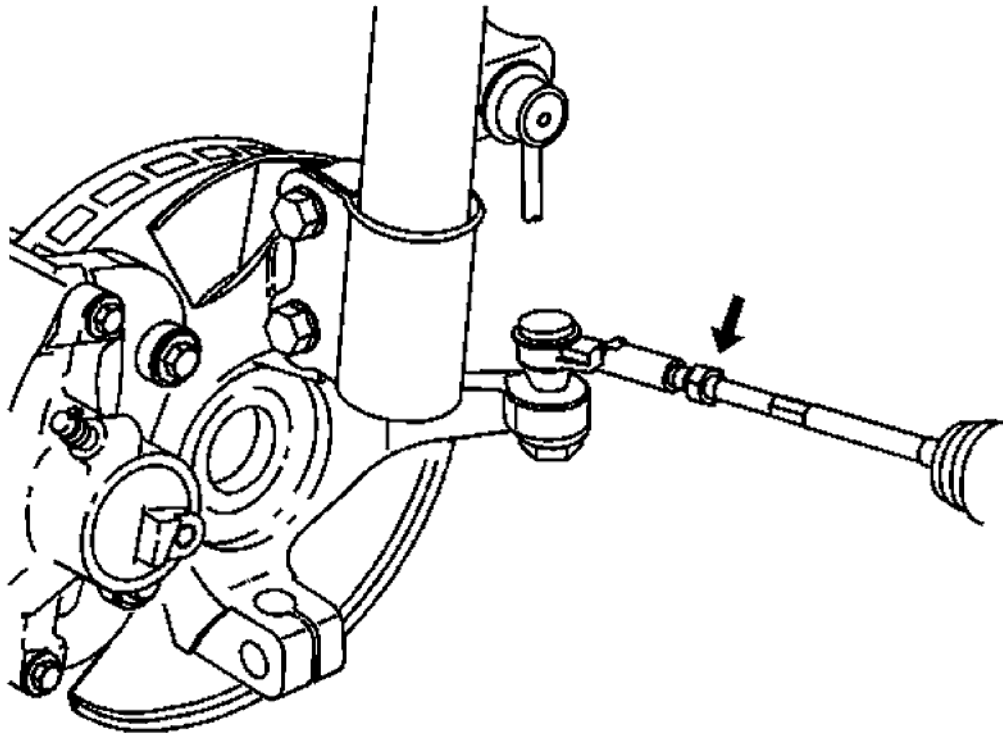


Fig. 7: Identifying Tie Rod Inner Jam Nut
Courtesy of GENERAL MOTORS CORP.

3. Loosen the outer tie rod to inner tie rod jam nut.

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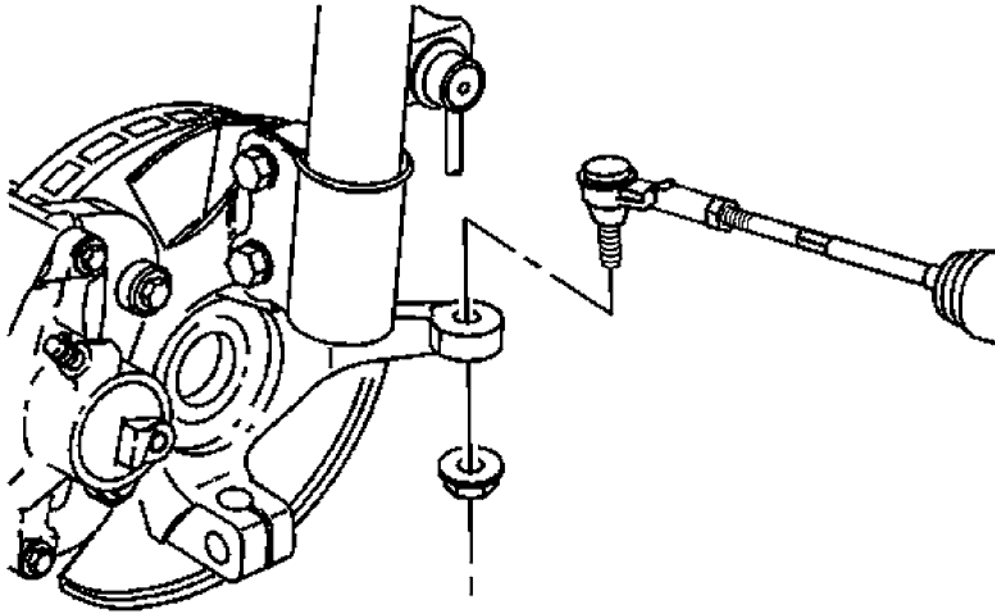


Fig. 8: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

4. Remove the tie rod to steering knuckle nut and discard.

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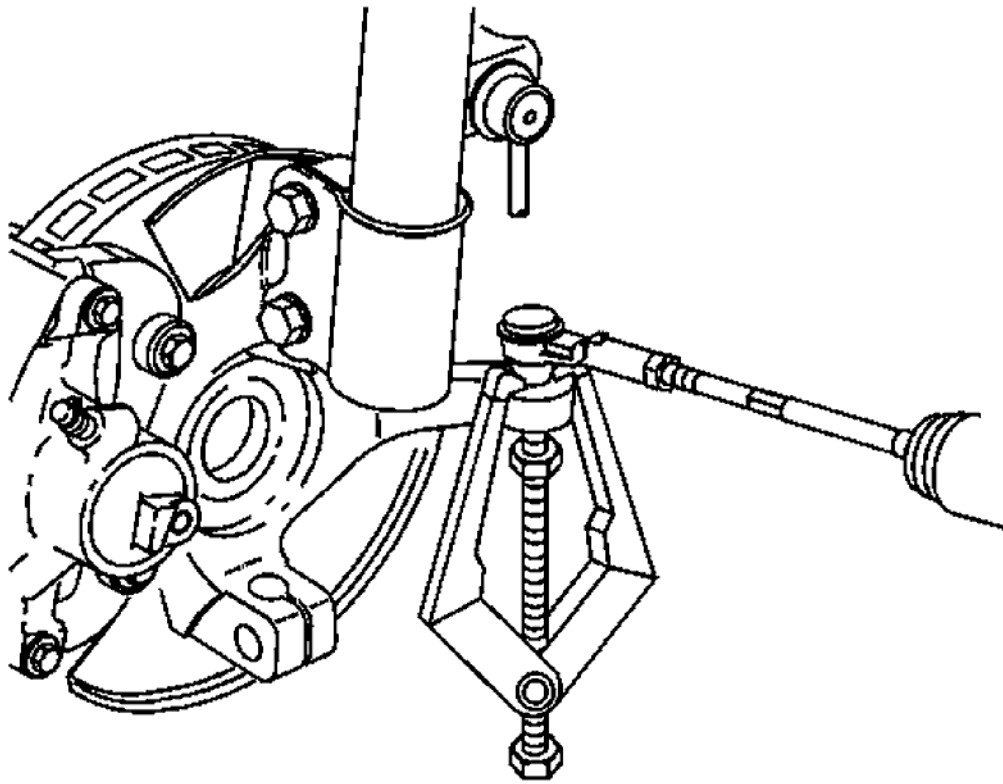


Fig. 9: Separating Outer Tie Rod End From Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

5. Use the **J 24319-B** to separate the outer tie rod from the steering knuckle.

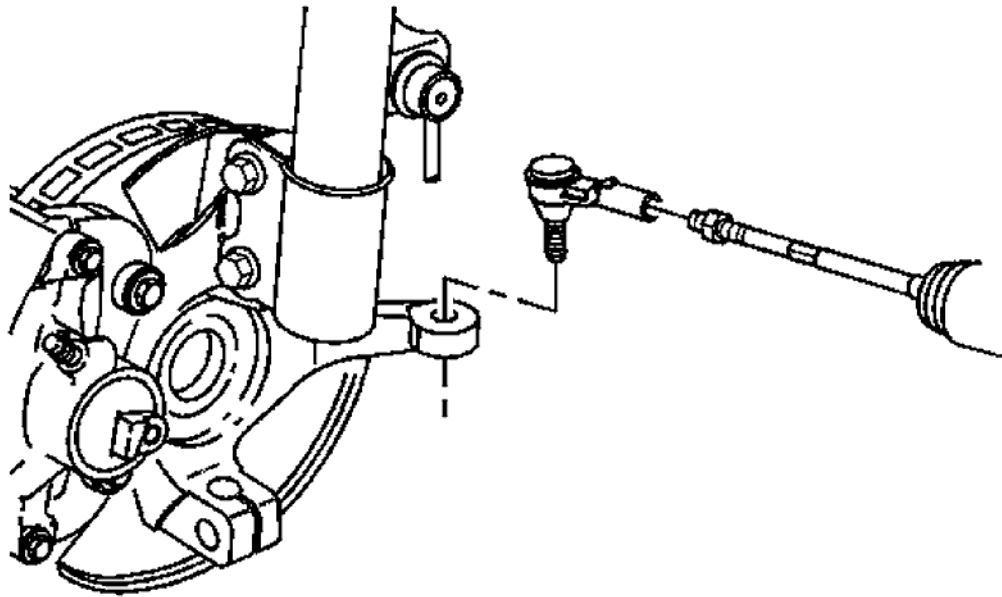


Fig. 10: View Of Outer & Inner Tie Rods
Courtesy of GENERAL MOTORS CORP.

6. Remove the outer tie rod from the inner tie rod. Record the number of turns used in removal to aid in the installation.
7. Remove the outer to inner tie rod jam nut and discard.

Installation Procedure

1. Thoroughly clean the inner tie rod threads.

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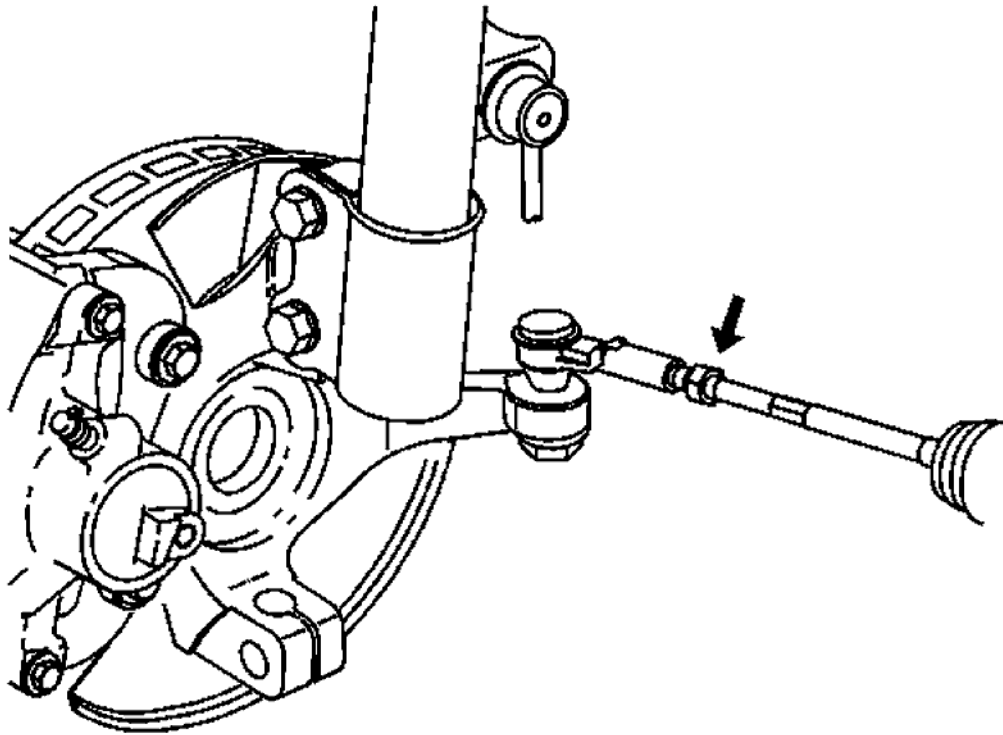


Fig. 11: Identifying Tie Rod Inner Jam Nut
Courtesy of GENERAL MOTORS CORP.

2. Install a new outer to inner tie rod jam nut.

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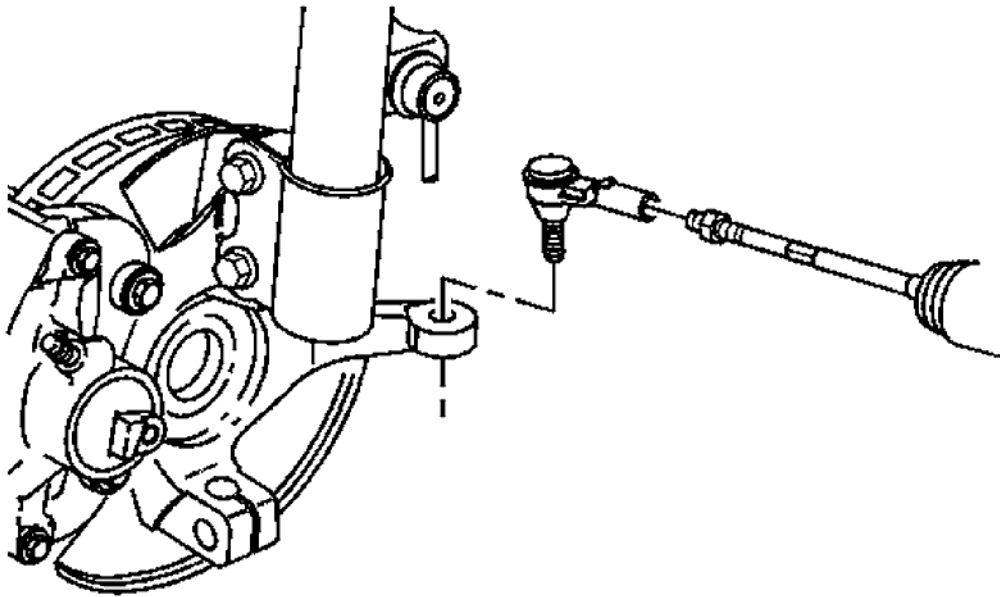


Fig. 12: View Of Outer & Inner Tie Rods
Courtesy of GENERAL MOTORS CORP.

3. Thread the outer tie rod onto the inner tie rod using the previously recorded thread count.

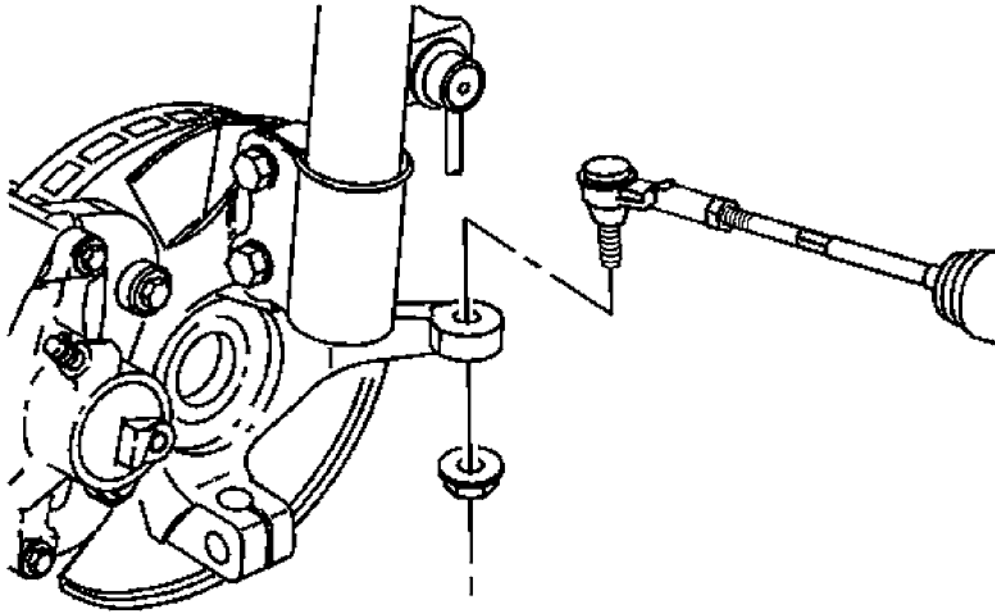


Fig. 13: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

4. Install the outer tie rod to the steering knuckle.

NOTE: Refer to Fastener Notice .

5. Install a new outer tie rod nut.

Tighten: Tighten the nut to 60 N.m (44 lb ft).

6. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
7. Set the toe. Refer to Front Toe Adjustment .

RACK AND PINION BOOT REPLACEMENT - ON VEHICLE

Tools Required

J 22610 Keystone Clamp Pliers. See Special Tools.

Removal Procedure

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

Information.

2. Remove the front wheel. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.

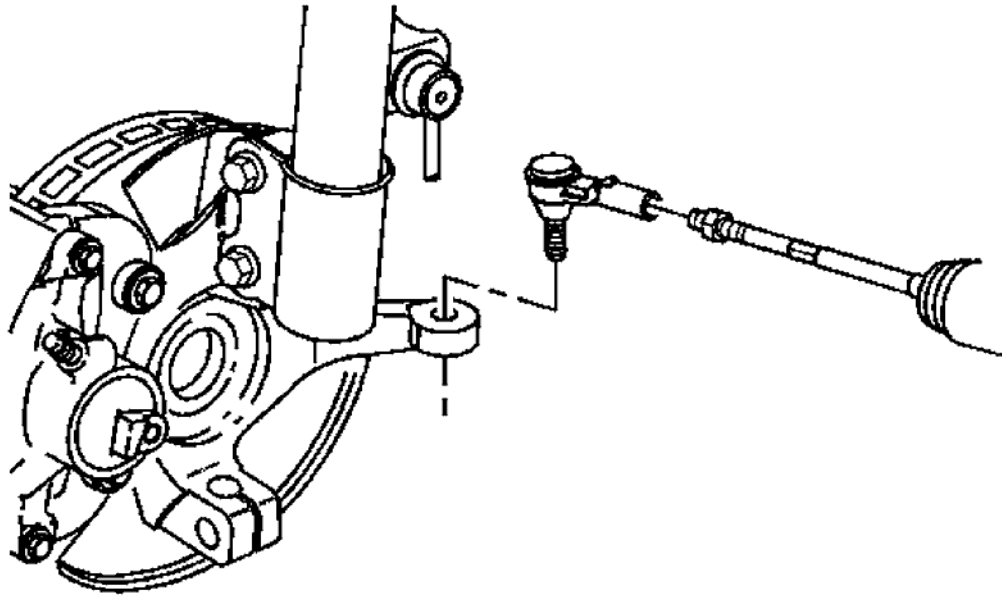


Fig. 14: View Of Outer & Inner Tie Rods
Courtesy of GENERAL MOTORS CORP.

3. Remove the outer tie rod end. Refer to **Rack and Pinion Outer Tie Rod End Replacement**.
4. Remove the outer to inner tie rod jam nut and discard.
5. Remove the outer steering gear boot spring clamp.
6. Using cutters, cut the inner steering gear boot clamp, remove and discard.

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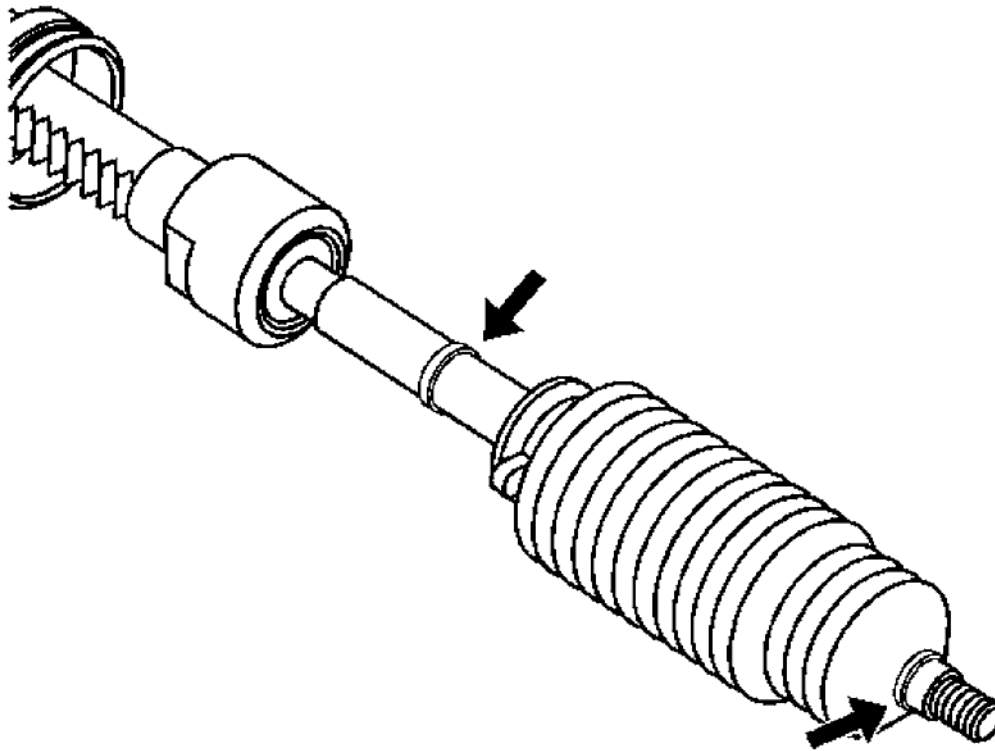


Fig. 15: View Of Steering Gear Boot
Courtesy of GENERAL MOTORS CORP.

7. Disengage the steering gear boot from the steering gear and remove over the inner tie rod.
8. Inspect the sealing surfaces and threaded shaft portion of the steering gear and inner tie rod. The surfaces must be clean and free of debris.

Installation Procedure

1. Install a new clamp on the inner portion of the steering gear boot.

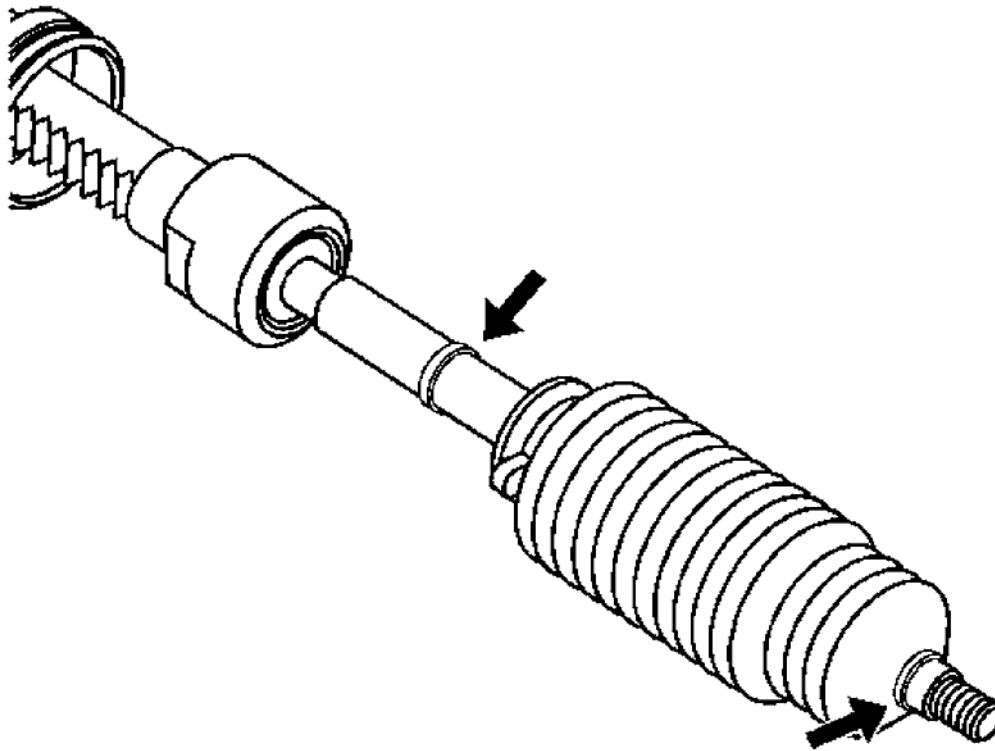


Fig. 16: View Of Steering Gear Boot
Courtesy of GENERAL MOTORS CORP.

2. Apply grease from the service kit to the indicated locations.

IMPORTANT: The boot must seat in the groove in the steering gear.

3. Install the boot over the inner tie rod onto the steering gear.
4. Using the **J 22610** , crimp the inner boot clamp on the steering gear housing. See **Special Tools**.
5. Install the small spring clamp on the outer portion of the inner tie rod end.
6. Install a new outer to inner tie rod jam nut.

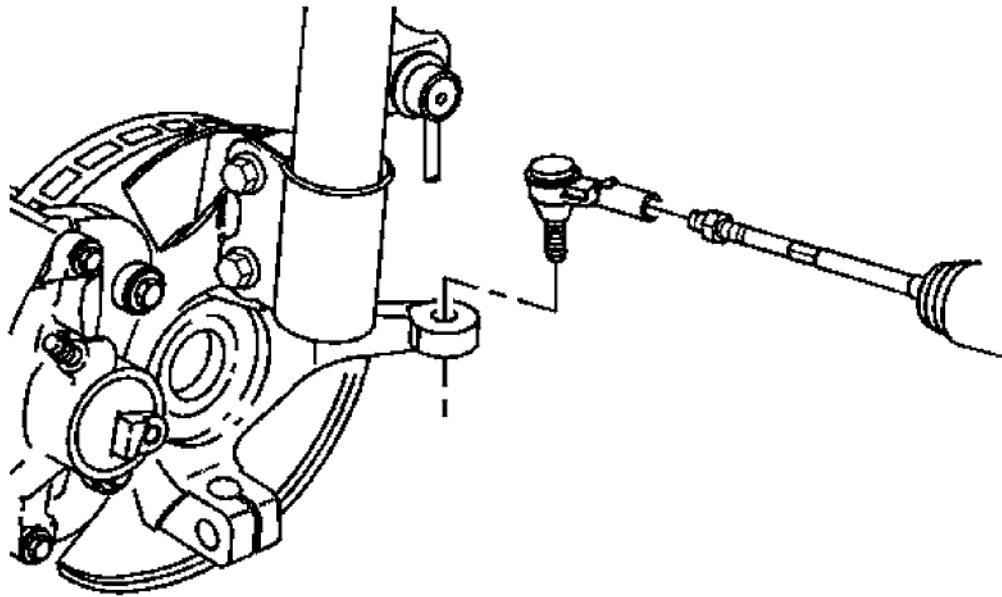


Fig. 17: View Of Outer & Inner Tie Rods
Courtesy of GENERAL MOTORS CORP.

7. Install the outer tie rod end. Refer to **Rack and Pinion Outer Tie Rod End Replacement**.
8. Install the wheel. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.
9. Set the toe. Refer to **Front Toe Adjustment** in Wheel Alignment.

POWER STEERING GEAR REPLACEMENT

Tools Required

J 24319-B Steering Linkage and Tie Rod Puller

Removal Procedure

1. Turn the steering wheel to the straight ahead position and remove the key from the ignition.
2. Turn the wheel counterclockwise in order to lock the steering column in place.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
4. Remove the front wheels. Refer to **Tire and Wheel Removal and Installation**.

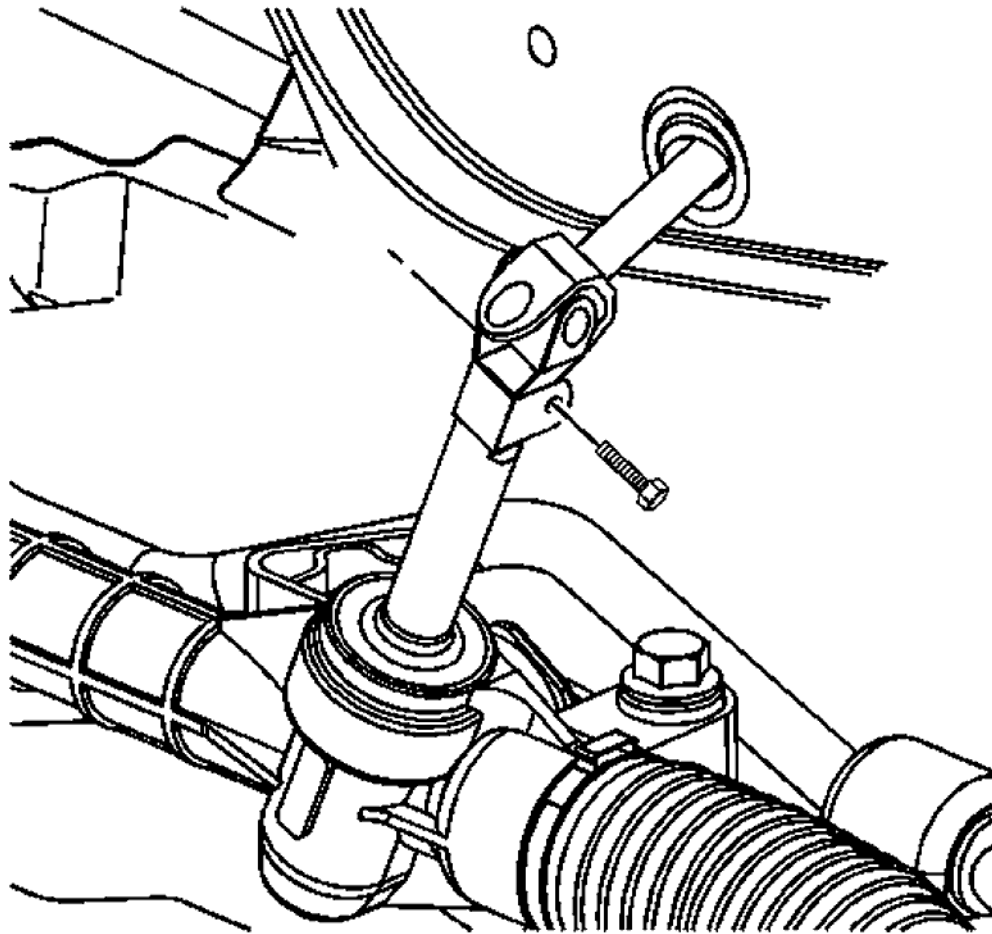


Fig. 18: View Of Intermediate Shaft-To-Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not rotate the intermediate shaft once separated from the gear. Possible damage or a malfunction could occur.

5. Remove the steering gear to intermediate shaft pinch bolt and discard.
6. Disconnect the intermediate shaft from the steering gear.

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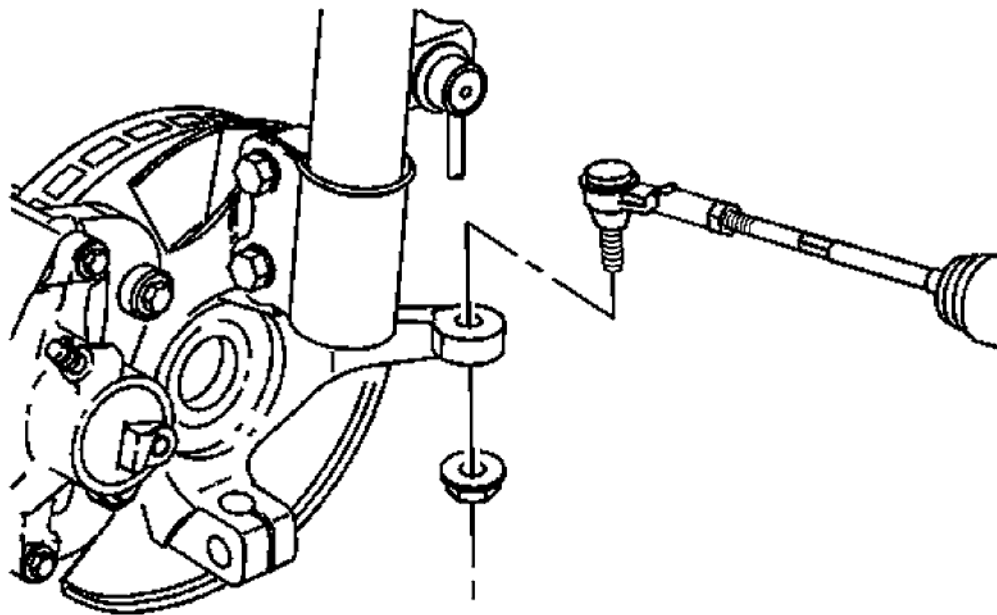


Fig. 19: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

7. Remove both steering gear outer tie rod to knuckle nuts and discard the nuts.

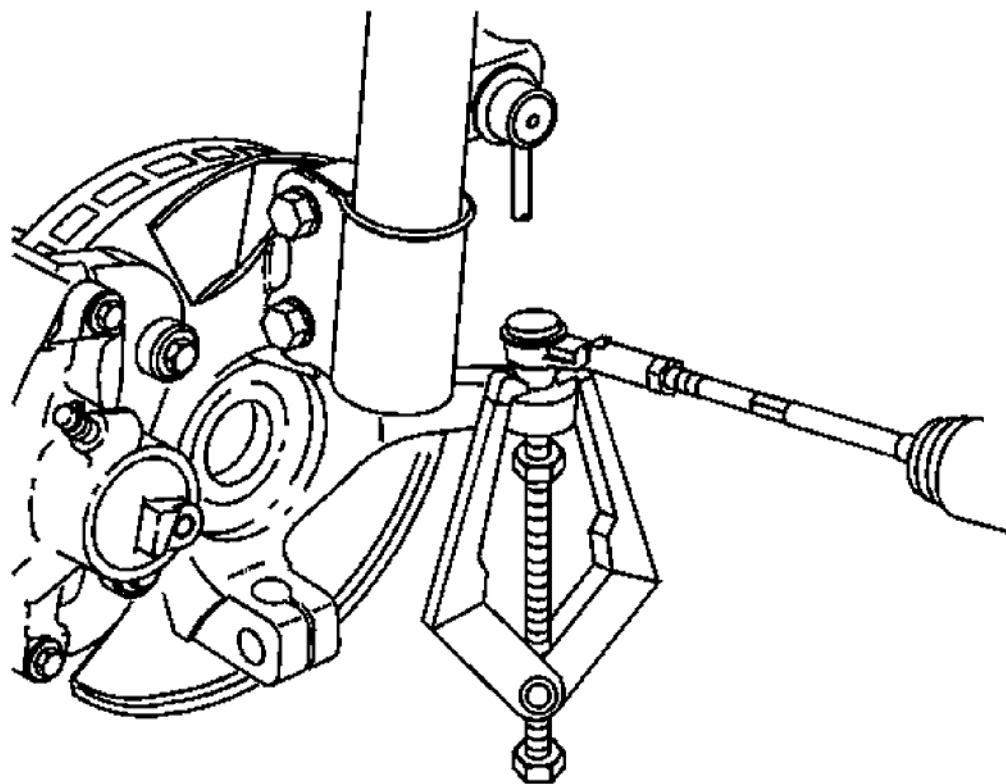


Fig. 20: Separating Outer Tie Rod End From Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not attempt to separate the joint using a wedge type tool.

8. Use the **J 24319-B** to separate the outer tie rods from the steering knuckles.

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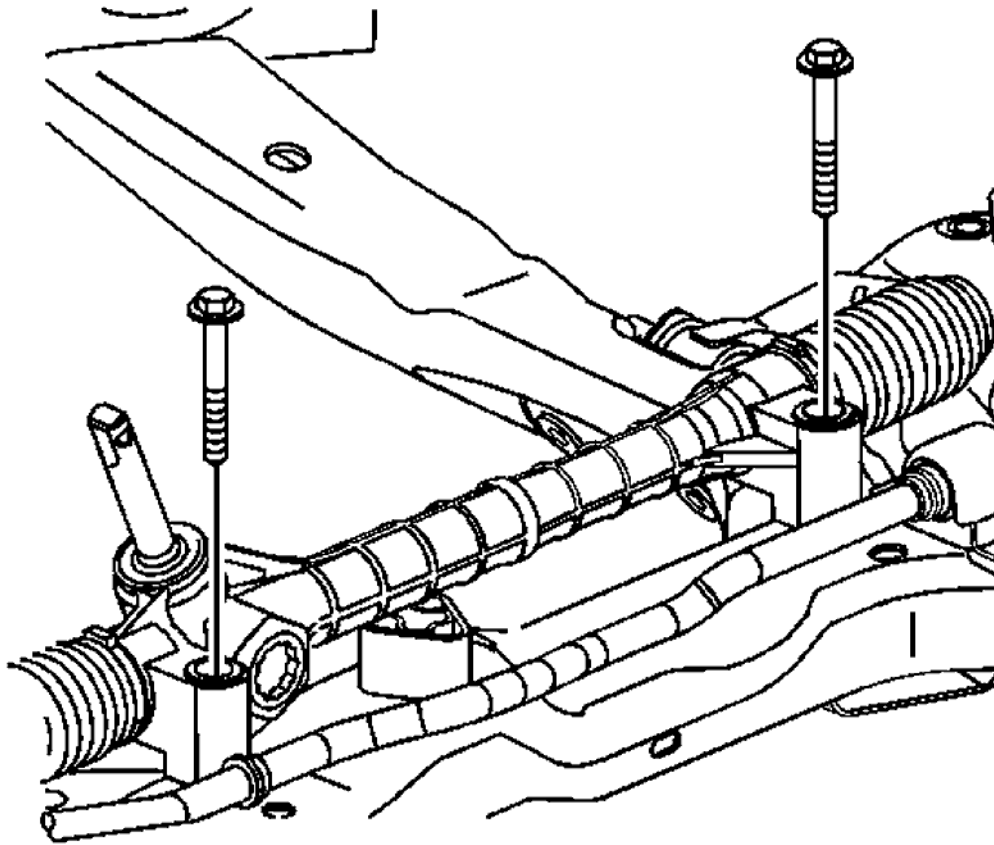


Fig. 21: View Of Steering Gear Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the steering gear bolts.
10. Remove the rear transmission mount. Refer to **Transmission Mount Replacement - Rear** for the 4T40-E/4T45-E automatic transaxle.
11. Carefully remove the steering gear from the frame and the vehicle through the LH wheel opening.

Installation Procedure

1. Install the steering gear to the frame through the LH wheel opening.

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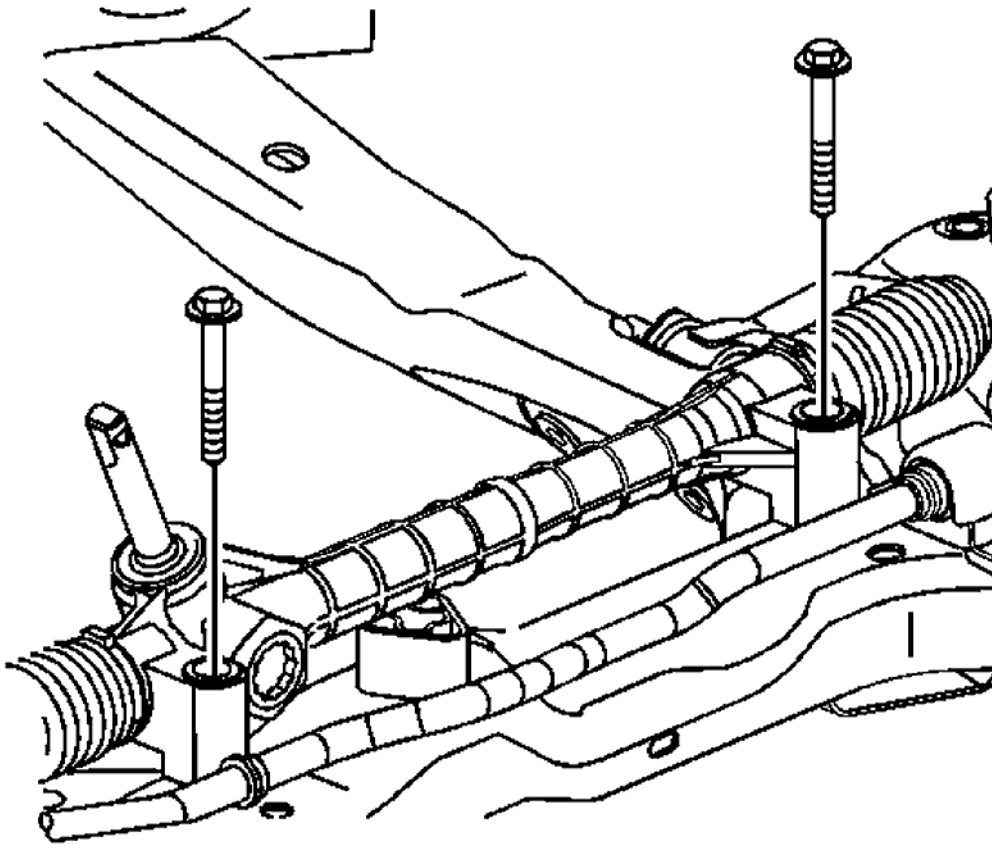


Fig. 22: View Of Steering Gear Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the steering gear bolts.

Tighten: Tighten the bolts to 110 N.m (81 lb ft).

3. Install the rear transmission mount. Refer to Transmission Mount Replacement - Rear for the 4T40-E/4T45-E automatic transaxle.

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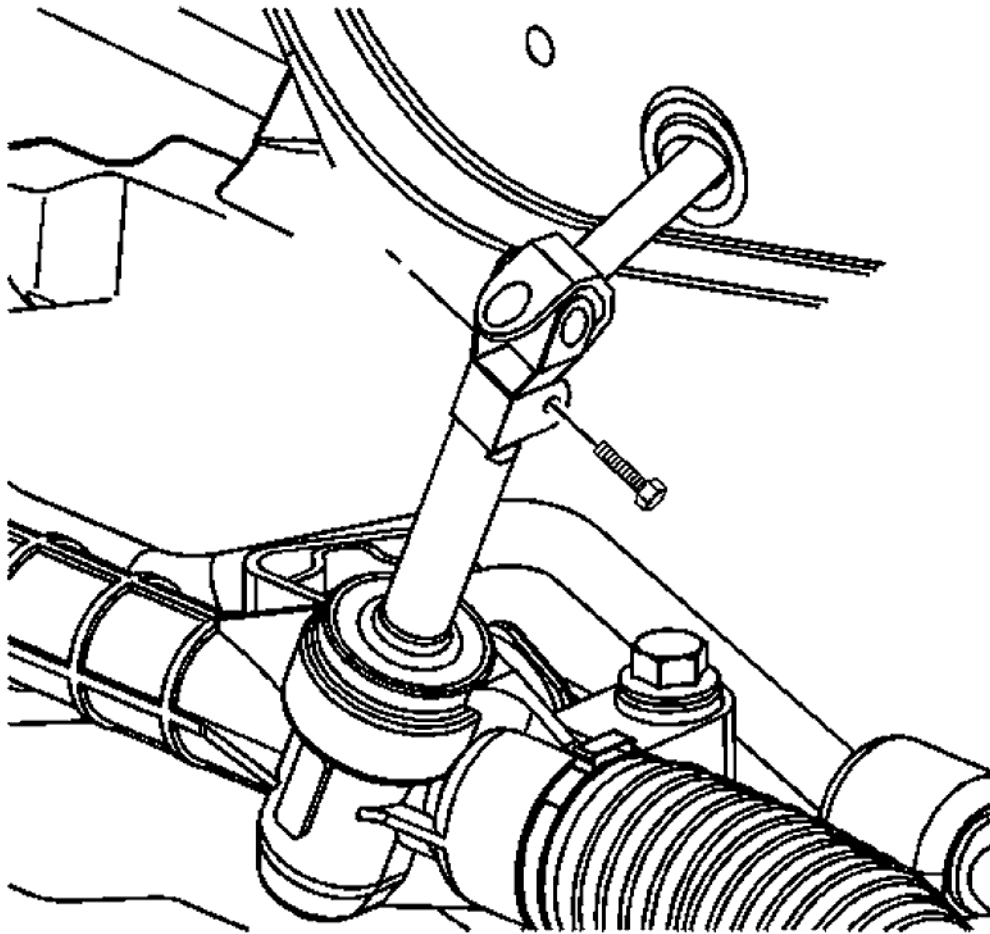


Fig. 23: View Of Intermediate Shaft-To-Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS CORP.

4. Connect the intermediate shaft to the steering gear.
5. Install a new intermediate shaft pinch bolt.

Tighten: Tighten the bolts to 34 N.m (25 lb ft).

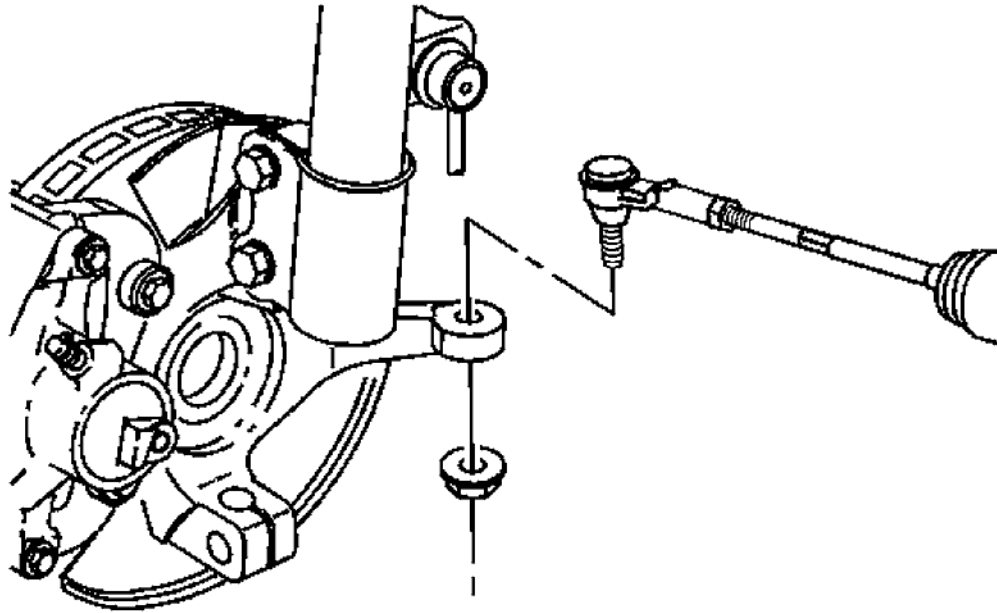


Fig. 24: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

6. Install the outer tie rods to the steering knuckles.
7. Install new outer tie rod nuts.

Tighten: Tighten the bolts to 60 N.m (44 lb ft).

8. Install the front wheels. Refer to **Tire and Wheel Removal and Installation** .
9. Lower the vehicle.
10. Adjust the toe if necessary. Refer to **Front Toe Adjustment** .

DESCRIPTION AND OPERATION

POWER STEERING SYSTEM DESCRIPTION AND OPERATION

The electric power steering (EPS) system reduces the amount of effort needed to steer the vehicle. The system uses the body control module (BCM), power steering control module (PSCM), torque sensor, discrete battery voltage supply circuit, EPS motor, serial data bus, and the instrument panel cluster (IPC) message center to perform the system functions. The PSCM, torque sensor, not the EPS motor are serviced separately from each other or from the steering column. Any EPS components diagnosed to be malfunctioning requires replacement of the steering column assembly, also known as the EPS assembly.

Torque Sensor

The PSCM uses a torque sensor as its main input for determining the amount of steering assist. The steering column has an input shaft, from the steering wheel to the torque sensor, and an output shaft, from the torque sensor to the steering shaft coupler. The input and output shafts are separated by a torsion bar, where the torque sensor is located. The sensor consists of a compensation coil, detecting coil and 3 detecting rings. These detecting rings have toothed edges that face each other. Detecting ring 1 is fixed to the output shaft, detecting rings 2 and 3 are fixed to the input shaft. The detecting coil is positioned around the toothed edges of detecting rings 1 and 2. As torque is applied to the steering column shaft the alignment of the teeth between detecting rings 1 and 2 changes, which causes the detecting coil signal voltage to change. The PSCM recognizes this change in signal voltage as steering column shaft torque. The compensation coil is used to compensate for changes in electrical circuit impedance due to circuit temperature changes from the electrical current and voltage levels as well as ambient temperatures for accurate torque detection.

EPS Motor

The EPS motor is a 12-volt brushed DC reversible motor with a 61-amp rating. The motor assists steering through a worm shaft and reduction gear located in the steering column housing.

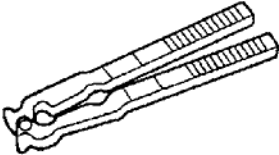
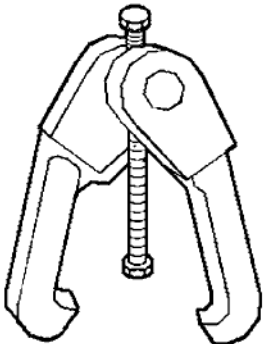
Power Steering Control Module (PSCM)

The PSCM uses a combination of torque sensor inputs, vehicle speed, calculated system temperature and the steering calibration to determine the amount of steering assist. When the steering wheel is turned, the PSCM uses signal voltage from the torque sensor to detect the amount of torque being applied to the steering column shaft and the amount of current to command to the EPS motor. The PSCM receives serial data from the engine control module (ECM) to determine vehicle speed. At low speeds more assist is provided for easy turning during parking maneuvers. At high speeds, less assist is provided for improved road feel and directional stability. The PSCM nor the EPS motor are designed to handle 61 amps continuously. The PSCM will go into overload protection mode to avoid system thermal damage. In this mode the PSCM will limit the amount of current commanded to the EPS motor which reduces steering assist levels. The PSCM also chooses which steering calibration to use when the ignition is turned ON, based on the production map number stored in the BCM. The PSCM contains all 8 of the steering calibrations which are different in relation to the vehicle's RPO's. The PSCM has the ability to detect malfunctions within the EPS system. Any malfunction detected will cause the IPC message center to display PWR STR (or Power Steering) warning message.

SPECIAL TOOLS AND EQUIPMENT**SPECIAL TOOLS****Special Tools**

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Illustration	Tool Number/Description
	J-22610 Keystone Clamp Pliers
	J-24319-B Steering Linkage and Tie Rod Puller