

2017 STEERING

Power Steering - CT6

SPECIFICATIONS

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

NOTE: <i>All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.</i>	
Application	
Power Steering Assist Motor Seal	
Steering Gear Belt	
Steering Gear Boot Inner Clamp	

Single Use Threaded Fastener/Component Tightening Specifications

NOTE: <i>All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.</i>	
Application	Specification
	Metric (English)
Power Steering Assist Motor Pivot Bolt	22 N.m (16 lb ft)
Steering Gear Bolt	
• First Pass:	58 N.m (43 lb ft)
• Final Pass:	30 degrees
Steering Gear Housing Cover Bolt - M6	10 N.m (89 lb in)
Steering Gear Housing Cover Bolt - M8	22 N.m (16 lb ft)

Reusable Threaded Fastener Tightening Specifications

NOTE: <i>All fasteners listed in this table can be reused after removal.</i>	
Application	Specification
	Metric (English)
Steering Gear Bolt	58 N.m (43 lb ft)
Steering Linkage Inner Tie Rod	105 N.m (77 lb ft)
Steering Linkage Outer Tie Rod Nut	
• First Pass:	35 N.m (26 lb ft)
• Final Pass:	85-95 degrees

SCHEMATIC WIRING DIAGRAMS

POWER STEERING WIRING SCHEMATICS

Power Steering

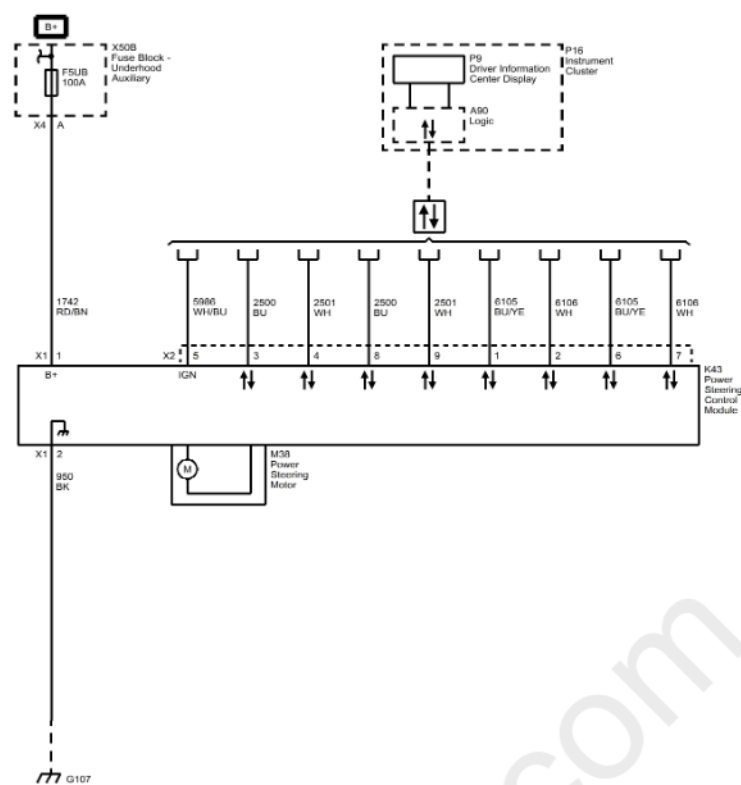


Fig. 1: Power Steering

Courtesy of GENERAL MOTORS COMPANY

Active Rear Steering (NYS)

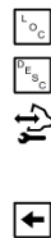
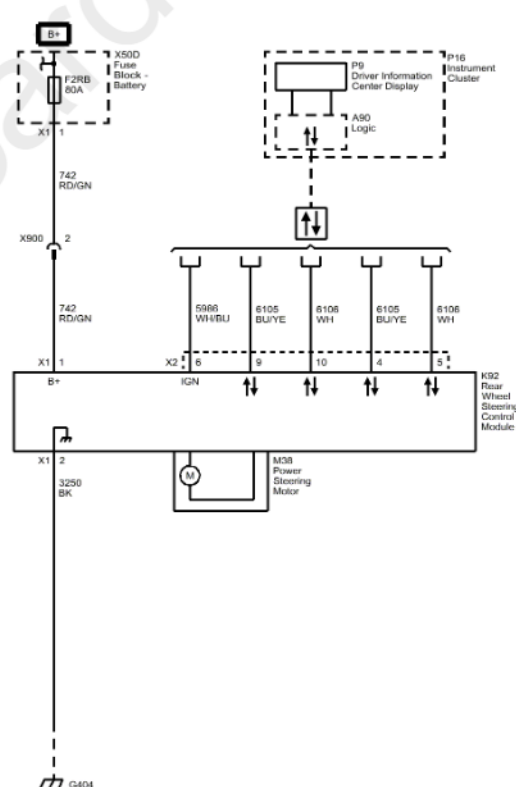


Fig. 2: Active Rear Steering (NYS)

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC C0176: CONTROL MODULE TEMPERATURE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC C0176 39

Control Module Temperature Sensor Internal Malfunction

DTC C0176 54

Control Module Temperature Sensor High Temperature

Circuit/System Description

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

Conditions for Running the DTC

- Ignition ON, engine running.
- Power steering system voltage is 9-16 volts.
- Repetitive steering input applied.

Conditions for Setting the DTC

DTC C0176 39

The power steering control module detects a failure of one of the two temperature sensors internal to the motor.

DTC C0176 54

The power steering control module detects a high system temperature.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Diagnostic Aids

- DTC C0176 54 does not indicate that a malfunction has occurred. Rather that the power steering control module had to limit current to the power steering motor to avoid thermal damage to the power steering system components. Discuss with the customer about driving conditions when the steering assist was reduced.
- 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.

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

DTC C0176 54

1. Verify that the DTC sets outside of the conditions for running and setting. Since most occurrences of this DTC are caused by excessive driver inputs, review with the customer the conditions under which the DTC set.
 - **If the DTC did not set outside of the conditions for running and setting**
 1. Ignition ON.
 2. Operate the vehicle within the conditions that the customer experienced, avoiding excessive inputs and verify the DTC does not reset.
 - If the DTC is set
 1. Verify that no steering components down stream of the power steering column assembly are mechanically binding. Refer to **Steering Effort Hard or Too Easy in One or Both Directions**
 - If steering components are mechanically binding, replace the mechanically binding steering components.
 - If no steering components are mechanically binding, replace the Steering Gear.
 - If the DTC is not set
 3. All OK.
 - **If the DTC set outside of the conditions for running and setting**
2. All OK. The power steering is operating as designed.

DTC C0176 39

1. Ignition ON.
2. Verify that DTC C0176 39 is not set.
 - **If the DTC is set**

Replace the K43 Power Steering Control Module.
 - **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for control module replacement, programming and setup.

DTC C0460: STEERING WHEEL ANGLE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC C0460 4B

Steering Wheel Angle Sensor Calibration Not Learned

DTC C0460 5A

Steering Wheel Angle Sensor Signal Not Plausible

DTC C0460 58

Steering Wheel Angle Sensor Performance

Circuit/System Description

The Electric Belt Drive Rack and Pinion Steering Gear contains the steering wheel angle sensor. The steering wheel angle sensor identifies the position and direction of the steering wheel rotation to calculate the driver intended driving direction. The power steering control module uses the signal to determine the proper amount of steering assist to provide.

Conditions for Running the DTC

The condition for running the DTC will not occur until the initialization phase has been completed. The initialization of the electronic brake control module occurs when the following conditions have been met:

- Ignition voltage is greater than 8 V.
- The initialization happens once each ignition cycle when the vehicle speed is greater than 20 km/h (12 MPH) and the vehicle is driven in a straight line without the brake pedal being applied.

Conditions for Setting the DTC

DTC C0460 5A

- Steering angle signal is not valid.
- Steering angle signal line is open.
- Angle signal cycle time is out of range.
- Angle signal duty is out of range.

DTC C0460 4B

Steering sensor zero position is not set.

DTC C0460 58

Steering sensor internal hardware failure detected.

Action Taken When the DTC Sets

- DTC C0460 is stored in memory.
- No steering assist.

Conditions for Clearing the DTC

A current DTC will clear on the next malfunction-free ignition cycle.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition ON.
2. Verify the DTC is not set.
 - **If the DTC is set**
 1. Calibrate the K43 Power Steering Control Module. Refer to Power Steering Control Module Programming and Setup
 2. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC
 - If the DTC sets, replace the Electric Belt Drive Rack and Pinion Steering Gear.
 1. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC
 - If the DTC sets, replace the K43 Power Steering Control Module.
 - If the DTC is not set
 2. All OK.
 - If the DTC is not set
 - 3. All OK.
3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Electric Belt Drive Rack and Pinion Steering Gear Replacement
- Control Module References for control module replacement, programming and setup.

DTC C0475: POWER STEERING MOTOR CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC C0475 00

Power Steering Motor Circuit Malfunction

Circuit/System Description

The power steering control module continuously monitors the voltage and current levels being commanded to the 3-phase steering assist motor. The power steering control module compares the desired and actual current levels to detect malfunctions in the internal power steering assist motor circuits.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The power steering control module detects a short to ground, short to voltage or an open/high resistance on any of the internal power steering assist motor circuits.

Action Taken When the DTC Sets

- The DTC is stored in memory.
- No steering assist.

Conditions for Clearing the DTC

A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the K43 Power Steering Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
3. Verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K43 Power Steering Control Module.
 - **If the test lamp illuminates**
4. Replace the K43 Power Steering Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

[Control Module References](#) for control module programming and setup.

DTC C0545: STEERING WHEEL TORQUE SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC C0545 00

Steering Wheel Torque Sensor

Circuit/System Description

The power steering control module continuously monitors the digital torque sensors torque and index current signals. As the steering wheel is turned and torsional twist is applied to the steering shaft, the steering input and output shafts are monitored via the torque signal circuit and then processed by the power steering control module to calculate the steering torque. The steering wheel torque sensor needs to be calibrated to be fully functional.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The power steering control module detects a short to ground, short to voltage or an open/high resistance on any of the torque sensor circuits.

Action Taken When the DTC Sets

- DTC C0545 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No Steering assist.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information.

Circuit/System Verification

1. Verify that DTC C0545 is not set.

- **If the DTC is set**

NOTE: Check the torque sensor terminal connections for signs of corrosion or damage.

Replace the steering gear.

- **If the DTC is not set**

2. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

DTC C055C: STEERING GEAR PERFORMANCE MALFUNCTION

Diagnostic Instructions

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

DTC Descriptor

DTC C055C 00

Steering Gear Performance Malfunction

Circuit/System Description

The power steering control module continuously verifies the mechanical friction of the steering gear. If the friction is too high the clutch between motor and rack slips and the internal angle is not longer valid.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The DTC is set when the mechanical friction of the steering gear is too high.

Action Taken When the DTC Sets

- DTC C055C is stored in memory.
- No steering assist.

Conditions for Clearing the DTC

A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Diagnostic Aids

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.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information.

Circuit/System Verification

1. Ignition ON.

2. Verify that DTC C055C is not set.

- **If the DTC is set**

1. Verify that no steering components down stream of the power steering column assembly are mechanically binding. Refer to [Steering Effort Hard or Too Easy in One or Both Directions](#)

- If steering components are mechanically binding, replace the mechanically binding steering components.
- If no steering components are mechanically binding, replace the steering gear.

- **If the DTC is not set**

3. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

DTC C0569: CALIBRATION/CONFIGURATION NOT PROGRAMMED

Diagnostic Instructions

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

DTC Descriptors

DTC C0569 31

Internal Check Sum Error

DTC C0569 42

Calibration Not Programmed

DTC C0569 46

Configuration Not Programmed

Circuit/System Description

The power steering control module continuously monitors the parameters of the steering gear. The power steering control module performs a self-test diagnostic during power-up. The configuration is not complete from supplier.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

Electronic power steering control module configuration is not complete.

Action Taken When the DTC Sets

- DTC C0569 is stored in memory.
- No steering assist.

Conditions for Clearing the DTC

A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information.

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C0569 is not set.
 - **If the DTC C0569 is set**
Replace the steering gear.
 - **If the DTC C0569 is not set**
3. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)
- [Control Module References](#) for power steering control module replacement, programming and setup.

DTC C056D: ELECTRONIC CONTROL UNIT MALFUNCTION (POWER STEERING CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptor

DTC C056D

Electronic Control Unit Malfunction

For symptom byte information, refer to [Symptom Byte List](#) .

Circuit/System Description

The internal fault detection is handled inside the power steering control module. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

The power steering control module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The power steering control module has detected an internal malfunction.

Action Taken When the DTC Sets

The power steering control module refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- This DTC may be stored as a history DTC without affecting the operation of the device.
- If stored only as a history DTC and not retrieved as a current DTC, do not replace the device.
- If this DTC is retrieved as both a current and history DTC, replace the device that set the DTC.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC C056D is not set.
 - **If DTC C056D is set**
 1. Program the K43 Power Steering Control Module.
 2. Verify the DTC does not set.

- If the DTC sets, replace the K43 Power Steering Control Module.
- If the DTC does not set

3. All OK.

- **If DTC C056D is not set**

3. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

[Control Module References](#) for control module replacement, programming and setup.

DTC C056E: ELECTRONIC CONTROL UNIT SOFTWARE

Diagnostic Instructions

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

DTC Descriptors

DTC C056E

Electronic Control Unit Software

For symptom byte information, refer to [Symptom Byte List](#).

Circuit/System Description

After replacement of the power steering control module, the power steering control module must be configured with the proper tuning profile using the service programming system (SPS).

After replacement of the power steering control module, power steering motor or steering gear, the steering position/torque sensor calibration procedure must be performed.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The device has detected an internal fault.

Actions Taken When DTC Sets

- DTC is stored in memory.
- Reduced or no steering assist.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

[Power Steering Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Power Steering System Description and Operation (Belt Drive Electronic Power Steering)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C056E is not set.
 - **If the DTC C056E is set**
 1. Program the K43 Power Steering Control Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K43 Power Steering Control Module.
 - If the DTC does not set
 - 3. All OK.
 - **If the DTC C056E is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup.

DTC C1436: STEERING WHEEL ANGLE SIGNAL

Diagnostic Instructions

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

DTC Descriptors

DTC C1436

Steering Wheel Angle Signal

For symptom byte information, refer to **Symptom Byte List**

Circuit/System Description

The steering wheel angle sensor is integrated into the steering gear assembly. The steering wheel angle sensor identifies the position and direction of the steering wheel rotation.

The electronic brake control module receives high speed serial data inputs from the steering angle sensor identifying the position and direction of the steering wheel rotation. The electronic brake control module utilizes this signal to calculate the driver intended driving direction.

Conditions for Running the DTC

The condition for running the DTC will not occur until the initialization phase has been completed. The initialization of the electronic brake control module occurs when the following conditions have been met:

- Ignition voltage is greater than 8 V
- The initialization happens once each ignition cycle when the vehicle speed is greater than 20 km/h (12 mph) and the vehicle is driven in a straight line without the brake pedal being applied.

Conditions for Setting the DTC

C1436 09

The steering wheel angle sensor signal gradient unplausible.

C1436 0A

The steering wheel angle sensor signal remains constant during turning maneuvers.

C1436 11

The steering wheel angle sensor signal is out of range.

Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- A Service StabiliTrak message may displayed on the driver information center.
- A Service Brake Assist message may displayed on the driver information center.
- A Service Power Steering Drive with Care message may displayed on the driver information center.
- The electronic brake control module disables the traction control and the electronic stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

- Check and adjust all tires to the stated cold air pressure as identified on the tire placard.
- The car should not pull in either direction causing the steering wheel to be off center while driving in a straight line on a level surface.
- Confirm that all tires are of the proper size and matching brands. If a mis-sized or non-matching brand tire is present, inform the customer that in order for the vehicle stability enhanced system to function normally, tires need to be a uniform size and rolling diameter.
- Inspect the serial data circuits and connections at the power steering control module and the electronic brake control module. They should be free from sources of electromagnetic interference and the connections should be clean and tight.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. With a scan tool check the Power Steering Control Module for any DTCs.
 - **If any DTCs are present in the Power Steering Control Module**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) in Power Steering Diagnostic Information and Procedures.
 - **If there are no DTCs present in the Power Steering Control Module**
 1. With a scan tool check to see if DTCs U0126, U0130 or U0130 are set.
 - **If DTCs U0126, U0130 or U0131 are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **If DTCs U0126, U0130 and U0130 are not set**
 2. With a scan tool check to see if DTCs C0035-C0050 are set in the Electronic Brake Control Module
 - **If DTCs C0035-C0050 are set in the Electronic Brake Control Module**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **If DTCs C0035-C0050 are not set in the Electronic Brake Control Module**
3. Perform the [Steering Wheel Angle Sensor Centering](#) procedure.
 - **If the Steering Angle Sensor Centering procedure corrected the DTC**

Proceed to step 6
 - **If the Steering Angle Sensor Centering procedure did not correct the DTC**
4. Replace the Steering Gear Assembly.
 - **If steering gear assembly replacement corrected the DTC**

Proceed to step 6
 - **If steering gear assembly replacement did not correct the DTC**
5. Replace the Electronic Brake Control module.
6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

SYMPTOMS - POWER STEERING SYSTEM

NOTE: Review the system description and operation in order to familiarize yourself with the system functions. Refer to [Power Steering System](#)

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.

Symptoms List

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

- **Rattle, Clunk, Pop or Shudder Noise from the Power Steering System**
- **Whine or Growl Noise from the Power Steering System**
- **Poor Return of Steering Wheel**
- **Steering Wheel Surges/Jerks While Turning**
- **Steering Effort Hard or Too Easy in One or Both Directions**

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

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>Symptoms - Steering Wheel and Column</u>
2	Road test the vehicle in order to verify the complaint. It may be necessary to compare to a like vehicle. Is a rattle, clunk, popping or shudder noise present?	Go to Step 3	System OK
3	Inspect the power steering gear for the proper installation. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement</u> . Is the power steering gear installation incorrect?	Go to Step 6	Go to Step 4
4	Inspect the intermediate steering shaft(s) for proper installation and loose or missing fasteners. Are the intermediate steering shaft(s) installed incorrectly or are any fasteners loose or missing?	Go to Step 8	Go to Step 5
5	Inspect the front suspension components for damage or wear. Refer to <u>Noise Diagnosis - Front Suspension</u> . Are the front suspension components damaged or worn?	Go to Step 7	Go to Step 3
6	Install the power steering gear correctly. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement</u> . Did you complete the repair?	Go to Step 9	-
7	Replace the damaged or worn front suspension components. Did you complete the repair?	Go to Step 9	-

Step	Action	Yes	No
8	Install the intermediate steering shaft(s) and/or fasteners correctly. Refer to: • Upper Intermediate Steering Shaft Replacement (LGW) Upper Intermediate Steering Shaft Replacement (LTG) Upper Intermediate Steering Shaft Replacement (LGX) • Mid Intermediate Steering Shaft Replacement (LTG) Mid Intermediate Steering Shaft Replacement (LGW) Mid Intermediate Steering Shaft Replacement (LGX) • Intermediate Steering Shaft Replacement (RWD) Intermediate Steering Shaft Replacement (AWD)		
	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

WHINE OR GROWL NOISE FROM THE POWER STEERING SYSTEM

Special Tools

CH-39570 Chassis Ear

Equivalent regional tools: [Special Tools](#)

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 Symptoms - Power Steering System
2	Verify that a whine or growl noise is present. Is a whine or growl noise present?	Go to Step 3	System OK
3	Inspect the power steering gear fasteners for looseness and inspect the power steering gear mounting surface for damage. Are the steering gear fasteners loose and/or the mounting surface damaged?	Go to Step 6	Go to Step 4
4	Inspect the power steering assist motor for a whine or growl noise using the CH-39570 chassis ear. Is the noise present at the power steering assist motor?	Go to Step 7	Go to Step 5
5	Inspect the power steering gear for a whine or growl noise using the CH-39570 chassis ear. Is the noise present at the power steering gear?	Go to Step 7	Go to Step 3

Step	Action	Yes	No
6	If the mounting surface on the power steering gear is NOT damaged then replace the power steering gear fasteners. If the mounting surface on the power steering gear IS damaged then replace the power steering gear AND power steering gear fasteners. Refer to: • Fastener Specifications • Electric Belt Drive Rack and Pinion Steering Gear Replacement Did you complete the repair?	Go to Step 8	-
7	Replace the power steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement. Did you complete the repair?	Go to Step 8	-
8	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

Step	Action	Yes	No
DEFINITION: After completing a turn, extra steering input is required for the steering wheel to return to center.			
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Power Steering System
2	Verify that poor return of the steering wheel is present. Does the system operate normally?	System OK	Go to Step 3
3	Perform the following steps: 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Lubricate the steering linkage outer tie rods and front suspension ball joints, if applicable. 3. Inspect the front suspension system for worn or damaged components. 4. Repair any worn or damaged front suspension components as necessary. Did you find and correct the condition?	Go to Step 12	Go to Step 4
4	Perform the following steps: 1. Rotate the steering wheel ONE revolution in both directions. 2. Rotate the steering wheel back to the original position. Was the steering wheel abnormally difficult to rotate in either direction?	Go to Step 5	Go to Step 10

Step	Action	Yes	No
	NOTE: • Once the intermediate steering shaft is disconnected, do NOT rotate the steering wheel more than one complete revolution from center. • Ensure the steering column is locked before connecting the intermediate steering shaft.		
5	Perform the following steps: 1. Position the front wheels straight ahead and lock the steering wheel to prevent rotation. 2. Disconnect the intermediate steering shaft from the steering column. 3. Note the position of the steering wheel and rotate the steering wheel ONE complete revolution in both directions. 4. Rotate the steering wheel back to the original position. Was the steering wheel abnormally difficult to rotate in either direction?	Go to Step 11	Go to Step 6
6	Inspect the intermediate steering shaft(s) for wear or a binding condition. Did you find and complete the repair?	Go to Step 12	Go to Step 7
7	Perform the following steps: 1. Remove the front tire and wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> . 2. Disconnect both steering linkage outer tie rods from the steering knuckles. 3. Use your hands in order to move the steering linkage outer tie rod studs. 4. If abnormally difficult to move, replace the steering linkage outer tie rod(s). Did you find and complete the repair?	Go to Step 12	Go to Step 8
8	Perform the following steps: 1. Turn each steering knuckle and strut assembly inboard and outboard to inspect for binding strut components, ball joints or drive axles. 2. Repair or replace any abnormally stiff or loose components. Did you find and complete the repair?	Go to Step 12	Go to Step 9

Step	Action	Yes	No
9	Perform the following steps: 1. Inspect for binding in the power steering gear. 2. If binding is present, repair or replace the power steering gear. Did you find and complete the repair?	Go to Step 12	Go to Step 10
10	Inspect the wheel alignment and adjust as necessary. Refer to Wheel Alignment Measurement . Did you find and complete the repair?	Go to Step 12	-
11	Perform the following steps: 1. Inspect the steering column for binding. 2. If binding is present, repair or replace the steering column as necessary. Did you find and complete the repair?	Go to Step 12	-
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

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 Symptoms - Power Steering System
2	Verify that the steering wheel surges/jerks while turning. Does the system operate normally?	System OK	Go to Step 3
3	Inspect for worn or binding front suspension components. Did you find and correct the condition?	Go to Step 14	Go to Step 4
4	Perform the following steps: 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Inspect the steering linkage outer tie rods for wear or a binding condition. Are the steering linkage outer tie rods worn or binding?	Go to Step 10	Go to Step 5
5	Inspect for worn or binding intermediate steering shaft(s). Are the intermediate steering shaft(s) worn or binding?	Go to Step 11	Go to Step 6
6	Inspect for a worn or binding power steering gear. Is the power steering gear worn or binding?	Go to Step 12	Go to Step 7
7	Check for a worn or binding steering column. Is the steering column worn or binding?	Go to Step 13	Go to Step 8

Step	Action	Yes	No
8	Check for excessive heat in the power steering assist motor. Does the power steering assist motor appear to be overheated?	Go to Step 09	Go to Step 12
9	NOTE: • Do NOT perform excessive parking lot maneuvers during testing. • Excessive parking lot maneuvers can cause the power steering assist motor to heat up. Allow the power steering assist motor to cool and retest the system. Did you correct the condition?	Go to Step 14	Go to Step 12
10	Replace the steering linkage outer tie rod(s). Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> . Did you complete the repair?	Go to Step 14	-
11	Replace the intermediate steering shaft(s). Refer to: • <u>Upper Intermediate Steering Shaft Replacement (LGW)</u> <u>Upper Intermediate Steering Shaft Replacement (LTG)</u> <u>Upper Intermediate Steering Shaft Replacement (LGX)</u> • <u>Mid Intermediate Steering Shaft Replacement (LTG)</u> <u>Mid Intermediate Steering Shaft Replacement (LGW)</u> <u>Mid Intermediate Steering Shaft Replacement (LGX)</u> • <u>Intermediate Steering Shaft Replacement (RWD)</u> <u>Intermediate Steering Shaft Replacement (AWD)</u> Did you complete the repair?	Go to Step 14	-
12	Replace the power steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement</u> . Did you complete the repair?	Go to Step 14	-
13	Replace the steering column. Refer to <u>Steering Column Replacement</u> . Did you complete the repair?	Go to Step 14	-
14	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

STEERING EFFORT HARD OR TOO EASY IN ONE OR BOTH DIRECTIONS

Condition	Action
The battery power is low.	Ensure proper battery voltage.

Condition	Action
One or more of the intermediate steering shaft boots is binding.	Adjust or replace the affected intermediate steering shaft boots. Refer to Intermediate Steering Shaft Boot Replacement (Inner) , Intermediate Steering Shaft Boot Replacement (Outer, LTG) , Intermediate Steering Shaft Boot Replacement (Outer, LGW) and/or Intermediate Steering Shaft Boot Replacement (Outer, LGX)
The intermediate steering shaft joints and/or fasteners are loose, worn or binding.	Tighten or replace the affected intermediate steering shaft joints and/or fasteners. Refer to: • Upper Intermediate Steering Shaft Replacement (LGW) Upper Intermediate Steering Shaft Replacement (LTG) Upper Intermediate Steering Shaft Replacement (LGX) • Mid Intermediate Steering Shaft Replacement (LTG) Mid Intermediate Steering Shaft Replacement (LGW) Mid Intermediate Steering Shaft Replacement (LGX) • Intermediate Steering Shaft Replacement (RWD) Intermediate Steering Shaft Replacement (AWD)
The power steering gear is binding.	Replace the power steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement .
The steering column shaft is bent.	Replace the steering column. Refer to Steering Column Replacement .
The connectors to the power steering assist motor are damaged or disconnected.	Perform the following steps: 1. Verify the connectors are properly connected. 2. Verify the connectors are not damaged. 3. If the connectors are damaged, replace the connectors.
The power steering gear sensor wire is damaged.	Replace the power steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement .
The power steering control module is malfunctioning.	Confirm the DTC and replace the power steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement .
The power steering assist motor shaft is binding.	Confirm the DTC and replace the power steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement .

REPAIR INSTRUCTIONS

WIRE TO WIRE REPAIR - STEERING

Special Tools

- EL-38125-10 Splice Sleeve Crimping Tool (non GMNA)

- **J-38125-5A** Ultra Torch Special Tool
- **J-38125-8** Splice Sleeve Crimping Tool (GMNA)

For equivalent regional tools, refer to [Special Tools](#).

WARNING: In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.

NOTE: If the wiring harness internal to the transmission is damaged, the wiring harness must be replaced. The use of splice sleeves in an attempt to repair the internal transmission wires, connectors or terminals could result in performance issues.

NOTE: Do not splice wires in Door Harness Grommets.

NOTE: The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.

Use only DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except high voltage and specialty cables. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Selection

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm ² / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19300089	Red (1) or Red/Green (1)	Red (2)	0.22-0.8/(18-26)
Blue 19168447	Blue (2)	Blue (3)	1.0-2.0/(14-16)
Yellow 19168448	Yellow (3)	Yellow (4)	3.0-5.0/(10-12)

1. Open the harness by removing any tape:

NOTE: You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

- Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
- Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
- Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.

2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches or connectors.

3. Strip the insulation:

- When adding a length of wire to the existing harness, use the same size wire as the original wire.
 - Perform one of the following items in order to find the correct wire size:
 - Find the wire on the schematic and convert to regional wiring gauge size.
 - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
 - Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.
 - Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
 - If the wire is damaged, repeat this procedure after removing the damaged section.
4. For high temperature wiring, slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.
5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.
6. The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest crimp nest (1) is used for crimping 22 to 26 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

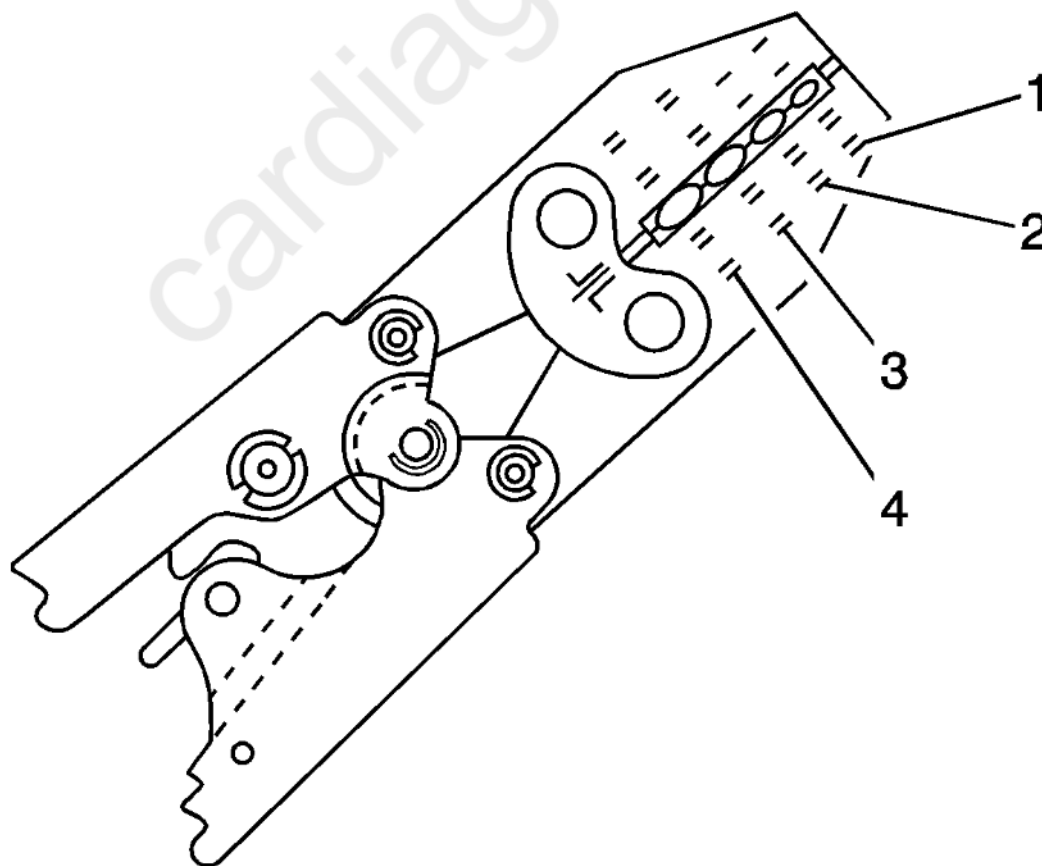


Fig. 3: Crimping Tool

Courtesy of GENERAL MOTORS COMPANY

7. The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

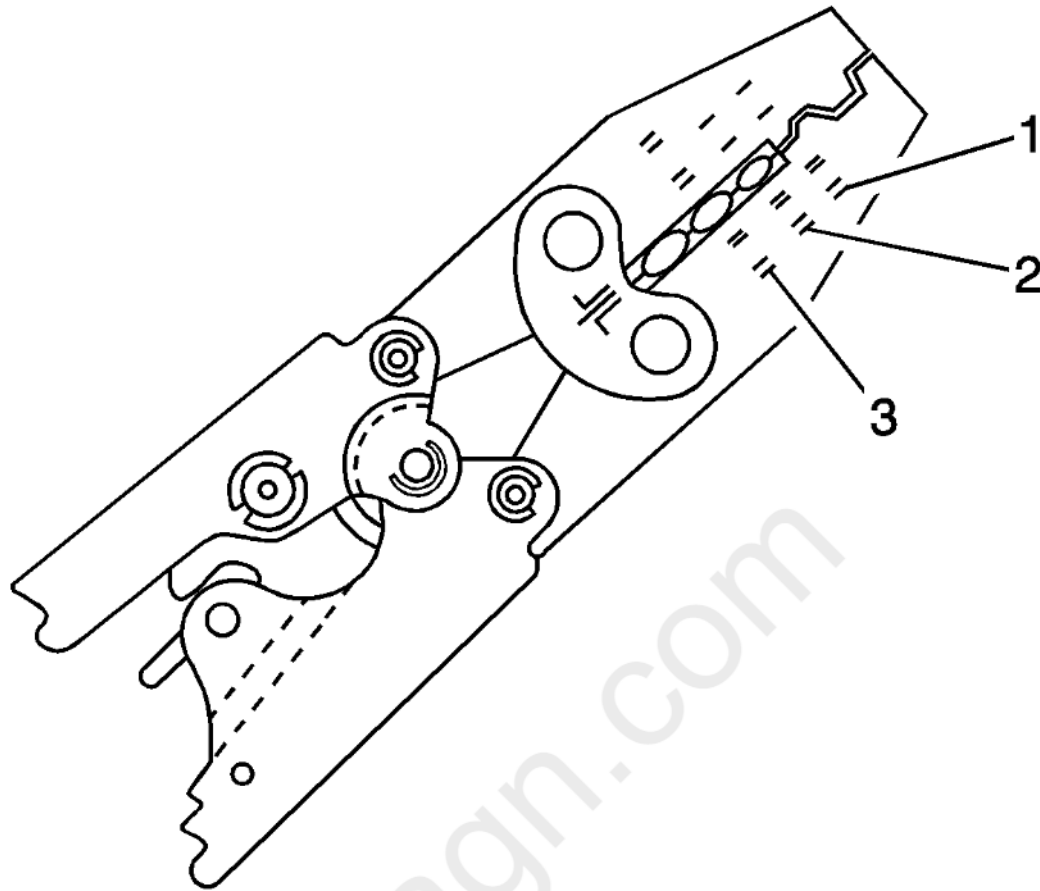


Fig. 4: Identifying Splice Crimp Tool Nests Terminal Identification
Courtesy of GENERAL MOTORS COMPANY

8. Use the splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. For the four crimp nest tool, use the three largest crimp nests to crimp the splice sleeves. For the three crimp nest tool, use all three crimp nests to crimp the splice sleeves. Use the four and three crimp tool diagrams (above) and the table (farther above) to match the splice sleeve with the correct crimp nest. The crimp tool diagram callout numbers match the numbers in the table (under crimp tool nest color).
9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.

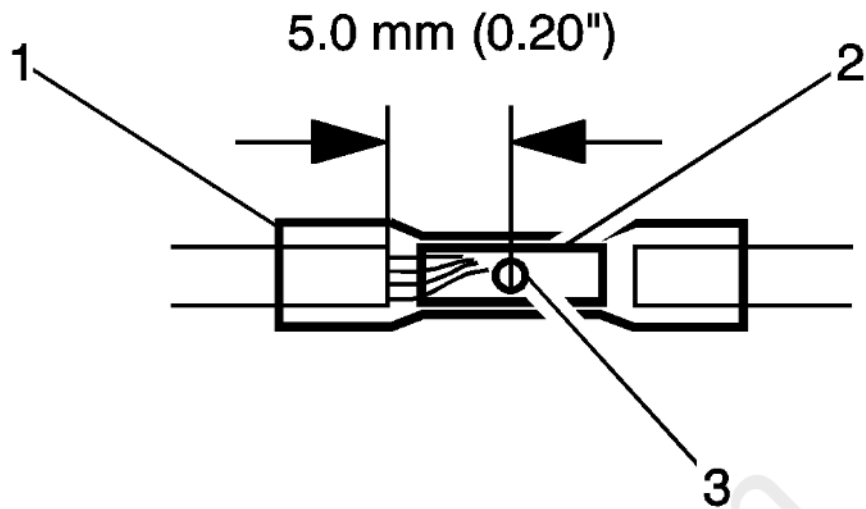


Fig. 5: Identifying Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.



Fig. 6: Crimped Duraseal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

11. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.

12. Using the heat torch, apply heat to the crimped area of the barrel.



Fig. 7: Crimped Duraseal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Weatherpack™ Wiring Repair

NOTE: Some replacement pigtail connectors may be delivered without the terminated leads installed into the connector. For Weatherpack™ connectors, all terminated leads included in the package should to be installed into the connector. If the connector end view shows that a terminal is not occupied, the extra terminated lead(s) need to be installed and the end(s) sealed using a DuraSeal splice sleeve and taped back into the harness.

1. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.

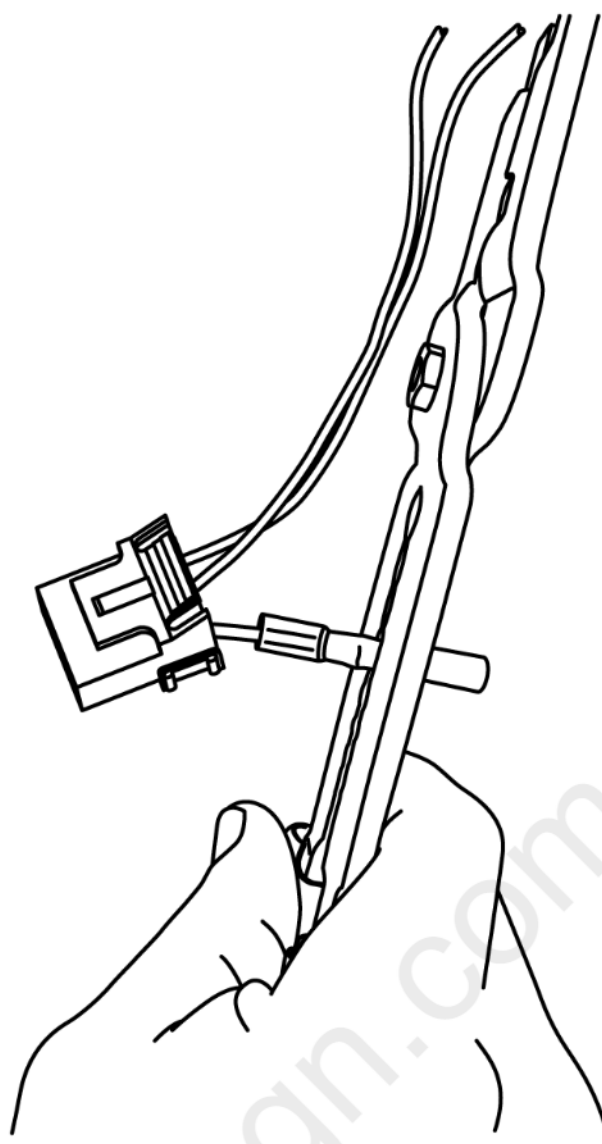


Fig. 8: Tightly Close Handles Of Crimp Tool

Courtesy of GENERAL MOTORS COMPANY

2. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Holding the DuraSEAL with one hand gently tug on the wire to ensure it is crimped in the DuraSeal.

3. Using the heat torch, apply heat to the crimped area of the barrel.
4. Start in the middle and gradually move the heat barrel to the open ends of the tubing:

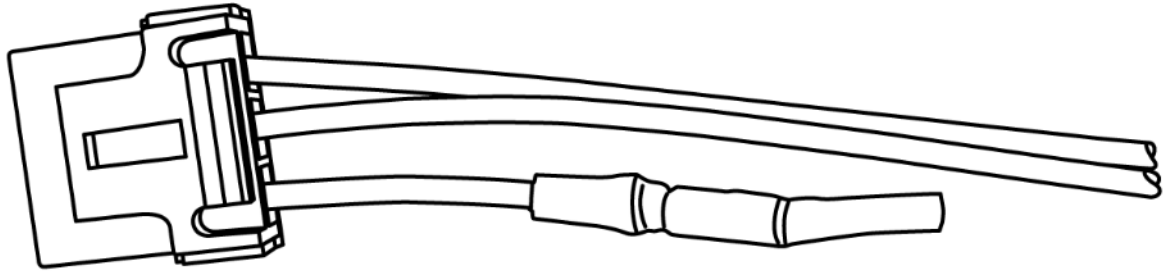


Fig. 9: Heat To Crimped Area Of Barrel

Courtesy of GENERAL MOTORS COMPANY

- The tubing will shrink completely as the heat is moved along the insulation.
- A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

5. Tape the extra terminated lead(s) back into the harness.



Fig. 10: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the heat torch, apply heat to the high temperature heat shrink tubing.
3. Gradually move the heat from the center to the open end of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
4. Replace any reflective tape and clips that may have been removed during the repair.

CONNECTOR RECONNECTION - STEERING

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to [Special Tools](#) .

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Loose, corroded or painted terminal stud/fastener
- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- A terminal not seated all the way into the connector body
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to [**Inducing Intermittent Fault Conditions**](#) in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to [**Testing for Electrical Intermittents**](#) for test procedures to detect intermittent open, high resistance, short to ground and short to voltage conditions.
- Refer to [**Scan Tool Snapshot Procedure**](#) for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease/lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use the **EL-35616** kit to test for proper terminal contact. Failure to use the **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter into the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) and [Power Distribution Schematics](#).
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point (screw or stud). Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) and [Ground Distribution Schematics](#).

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
 - High ambient temperatures
 - Underhood/engine generated heat
 - Circuit generated heat due to a poor connection or high electrical load

- Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
 - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
 - The condition only occurs on a cold start.
 - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to [Inducing Intermittent Fault Conditions](#) in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. - These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to [Checking Aftermarket Accessories](#).
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
 - A new service control module is installed.
 - A control module from another vehicle is installed.
 - Revised software/calibration files have been released for this vehicle.
- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to [Control Module References](#) for replacement, setup and programming.

NOTE: DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.

STEERING LINKAGE INNER TIE ROD INSPECTION

Special Tools

GE 8001 Dial Indicator Set

For equivalent regional tools, refer to [Special Tools](#).

1. Turn the ignition key to the ON position with the engine OFF.

NOTE: This inspection procedure does not supersede local government required inspections that have more stringent requirements.

2. With the aid of an assistant, turn the steering wheel to the full stop position and hold the steering wheel in that position until the test is complete. Part of the steering linkage inner tie rod (2) being tested should be inside the steering gear housing. The inner tie rod housing (1) being tested should be inside the steering gear housing and seated against the steering stop.

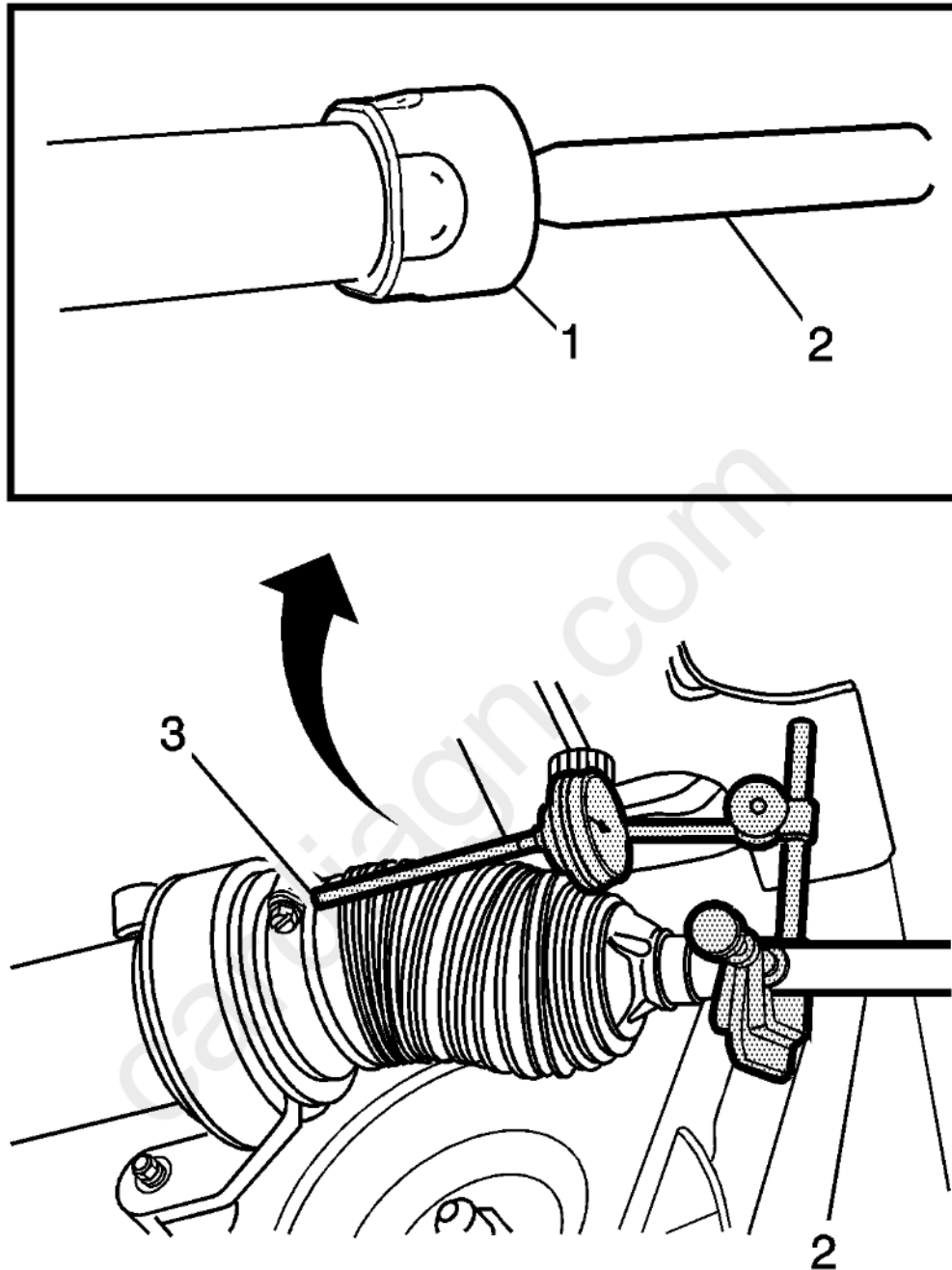


Fig. 11: Measuring Lash Between Inner Tie Rod & Steering Gear Housing
Courtesy of GENERAL MOTORS COMPANY

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
4. If there is not a good location for the **GE 8001** dial indicator pointer at the steering gear housing, install a large worm gear hose clamp (3) to the steering gear housing over the larger steering gear boot clamp and align the clamp so that the screw can be a location for the **GE 8001** dial indicator pointer.
5. Install the **GE 8001** dial indicator between the inner tie rod and the steering gear housing or the worm gear clamp in such a way as to measure the lash between the inner tie rod and the steering gear housing. The lash between the inner tie rod and the steering gear housing is equal to the lash

between the inner tie rod and the inner tie rod housing because the inner tie rod housing is inside the steering gear housing during this procedure.

6. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire in order to remove any lash.

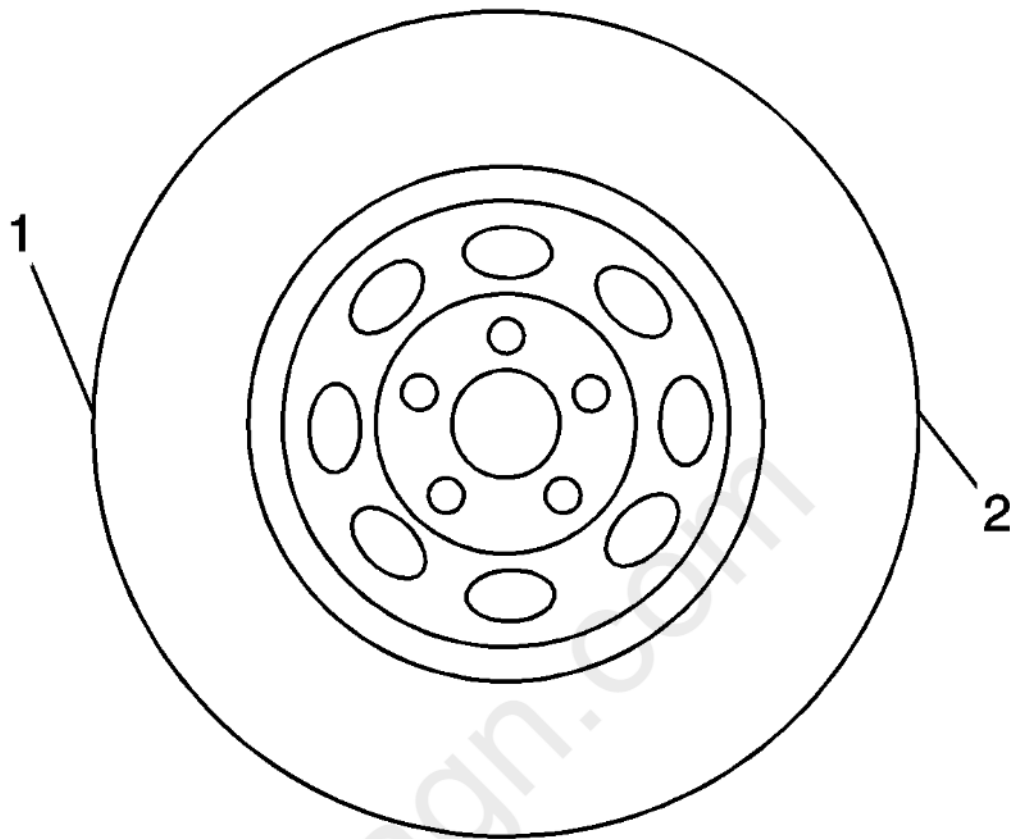


Fig. 12: Identifying Tire Grasping Positions

Courtesy of GENERAL MOTORS COMPANY

NOTE: Only move the tire enough to feel any lash between the inner tie rod and the inner tie rod housing without moving the steering gear rack.

7. Zero the **GE-8001** dial indicator.
8. On the same side of the tire previously pushed in, gently pull out and measure the lash.
9. Record the measurement shown on the **GE-8001** dial indicator.
10. If the measured value exceeds 0.5 mm (0.02 in), replace the inner tie rod. Refer to [Steering Linkage Inner Tie Rod Replacement](#).
11. Repeat the procedure for the other side.

STEERING LINKAGE OUTER TIE ROD INSPECTION

Special Tools

GE-8001 Dial Indicator Set

For equivalent regional tools, refer to [Special Tools](#).

1. Inspect the outer tie rod seal. If the outer tie rod seal is torn, replace the outer tie rod. Refer to [Steering Linkage Outer Tie Rod Replacement](#).

NOTE: This inspection procedure does not supersede local government

required inspections that have more stringent requirements.

2. Raise the side of the vehicle being inspected with a floor jack while maintaining contact between the opposite wheel and the shop floor. Support the lower control arm with a floor jack stand as far outboard as possible and remove the floor jack. Refer to [Lifting and Jacking the Vehicle](#) .
3. Install the **GE-8001** dial indicator between the outer tie rod and the steering knuckle as shown in the graphic. Note that the tire and wheel assembly is shown removed only for clarification of the **GE-8001** dial indicator position.

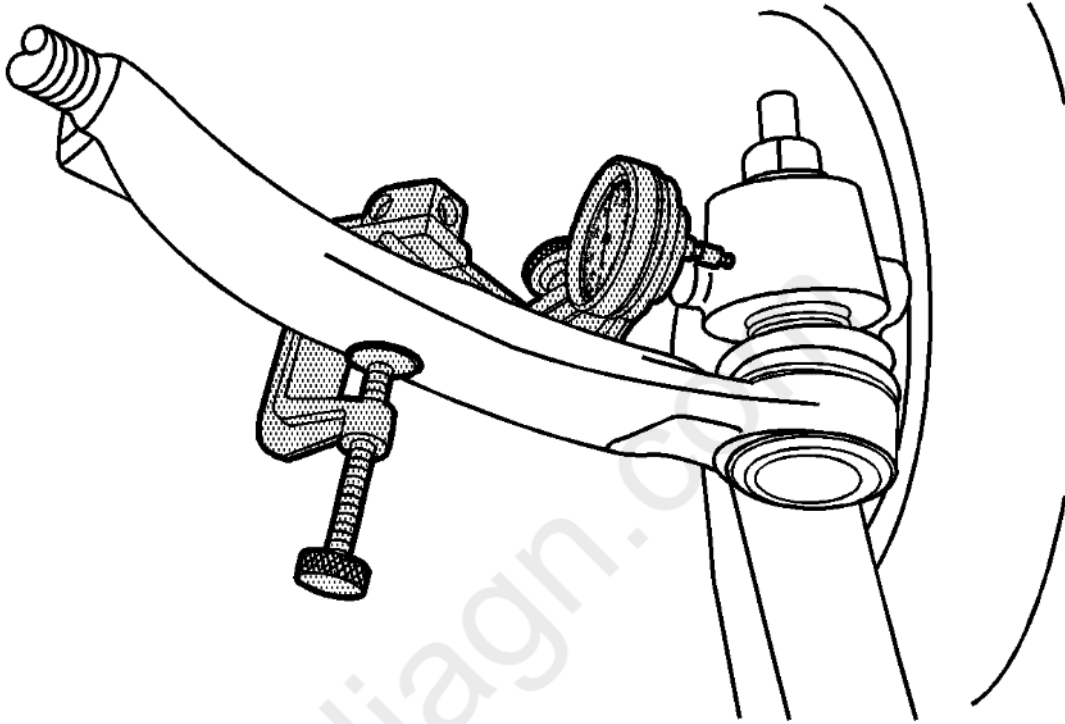


Fig. 13: Measuring Outer Tie Rod Lash

Courtesy of GENERAL MOTORS COMPANY

4. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire to remove any lash.

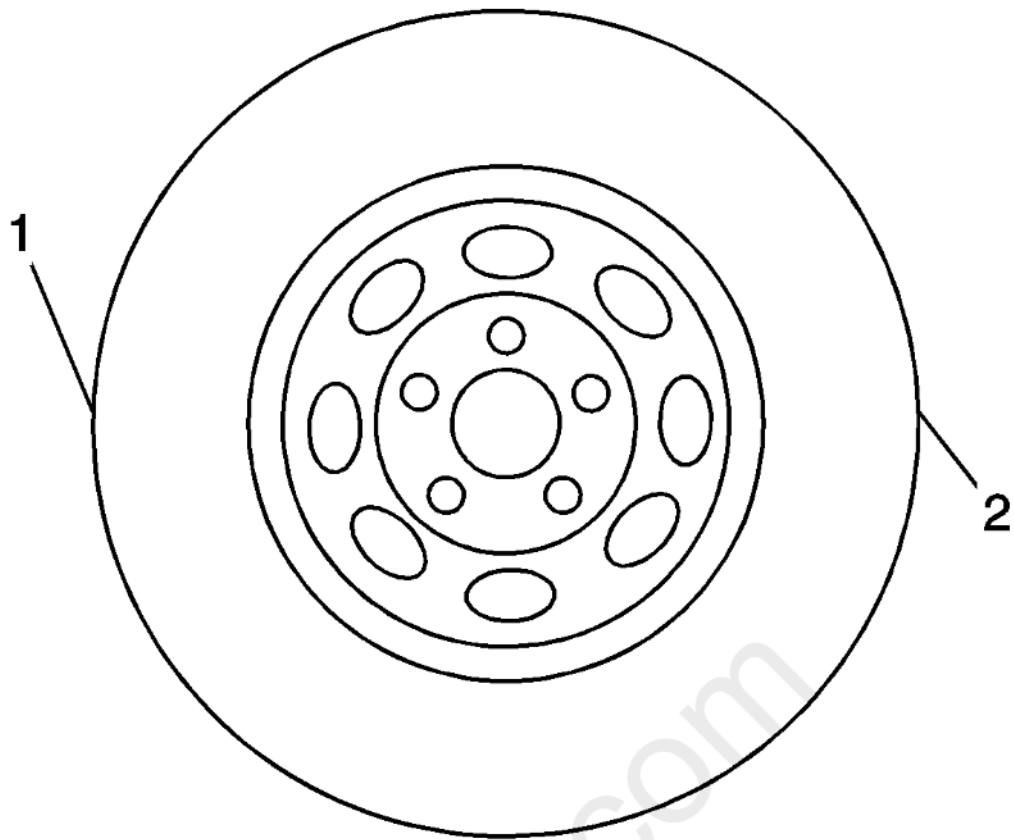


Fig. 14: Identifying Tire Grasping Positions

Courtesy of GENERAL MOTORS COMPANY

5. Zero the **GE-8001** dial indicator.
6. On the same side of the tire previously pushed inwards, gently pull outwards and measure the lash.
7. Record the measurement shown on the **GE-8001** dial indicator.
8. If the measured value exceeds 0.5 mm (0.02 in), replace the outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.
9. Repeat the procedure for the other side.

STEERING LINKAGE OUTER TIE ROD REPLACEMENT

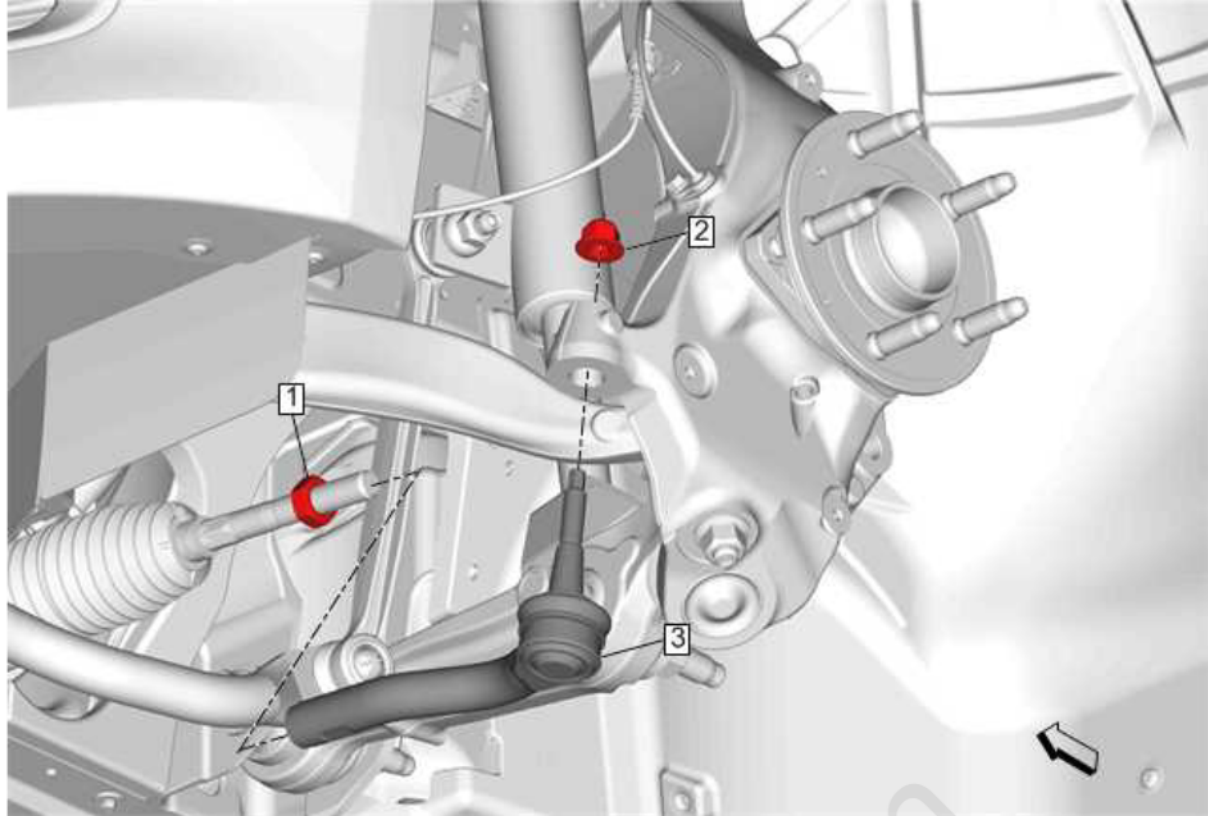


Fig. 15: Steering Linkage Outer Tie Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front tire and wheel assembly. Refer to Tire and Wheel Removal and Installation	
1	Steering Linkage Inner Tie Rod Nut Procedure Place match marks on the steering linkage inner tie rod nut and the steering linkage inner tie rod. NOTE: Do NOT tighten the steering linkage inner tie rod nut during installation. Tighten the nut after adjusting the front toe.
2	Steering Linkage Outer Tie Rod Nut CAUTION: Refer to Fastener Caution . Tighten First Pass: 35 N.m (26 lb ft) Final Pass: (85-95 degrees)

Callout	Component Name
3	Steering Linkage Outer Tie Rod CAUTION: Do not free the ball stud by using a pickle fork or a wedge-type tool. Damage to the seal or bushing may result. Procedure 1. Use the CH-161-B puller to separate the steering linkage outer tie rod from the steering knuckle. 2. Clean the tapered surface of the steering knuckle. 3. Inspect the steering linkage inner tie rod for bent or damaged threads. If necessary, replace the steering linkage inner tie rod. Refer to Steering Linkage Inner Tie Rod Replacement 4. Install the front tire and wheel assembly. Refer to Tire and Wheel Removal and Installation 5. Measure and adjust the front toe. Refer to Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment Special Tools CH-161-B Bearing Puller Equivalent regional tools: Special Tools

STEERING GEAR BOOT REPLACEMENT

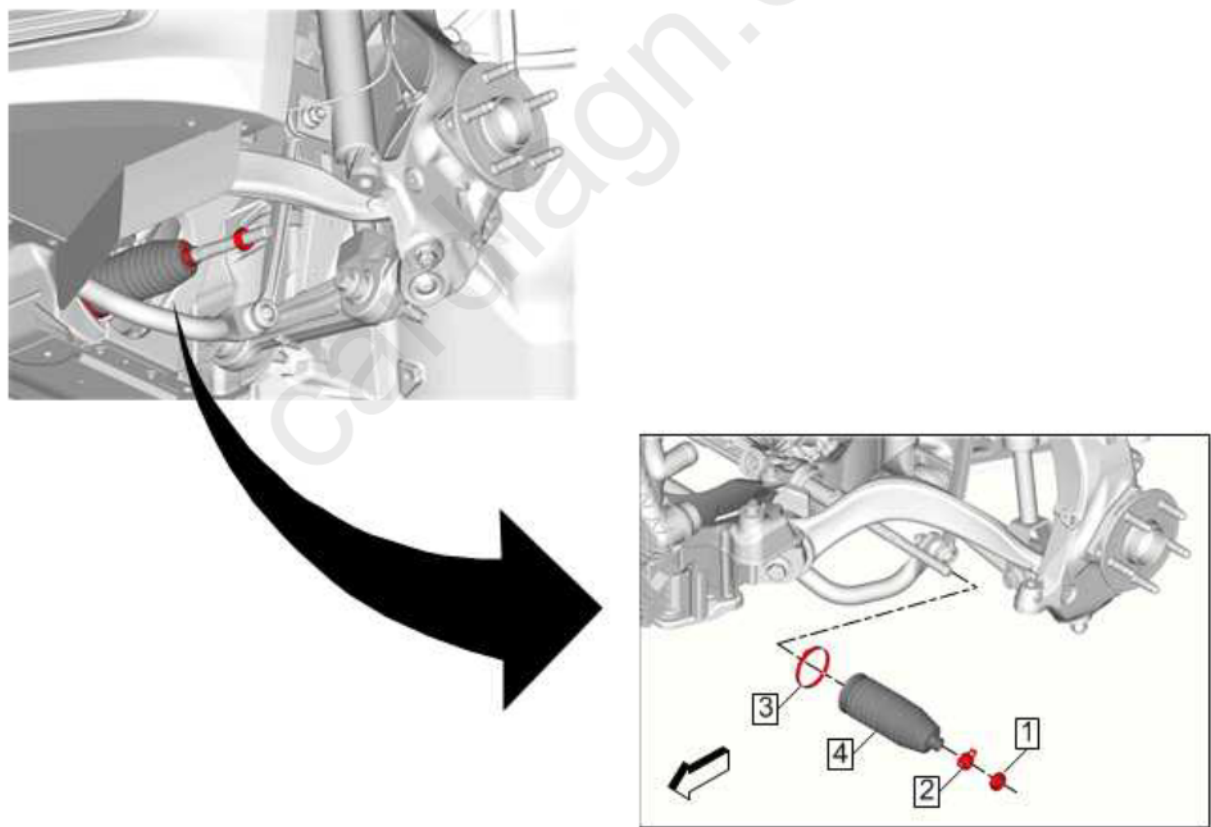


Fig. 16: Steering Gear Boot
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
Preliminary Procedure 1. <u>Steering Linkage Outer Tie Rod Replacement</u> 2. Remove the steering gear bolts and reposition the steering gear to gain access the steering gear boot inner clamp. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement</u>	
1	Steering Linkage Inner Tie Rod Nut Procedure Place match marks on the steering linkage inner tie rod nut and the steering linkage inner tie rod.
2	Steering Gear Boot Outer Clamp Steering Gear Boot Inner Clamp Procedure 1. Cut the steering gear boot inner clamp. DISCARD the clamp. 2. Use the DT-35910 pliers to install the NEW steering gear boot inner clamp. NOTE: • Position the NEW steering gear boot inner clamp on the steering gear boot before installing the boot on the steering gear. • The NEW steering gear boot inner clamp CANNOT be installed correctly with the steering gear bolted in place. The steering gear bolts MUST be removed and the steering gear repositioned in order to use the special tool correctly. Special Tools DT-35910 Drive Axle Boot Clamp Pliers Equivalent regional tools: <u>Special Tools</u>
4	Steering Gear Boot Procedure 1. After removing the steering gear boot, inspect the steering linkage inner tie rod for evidence of corrosion or contamination. If corrosion or contamination is evident, replace the steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement</u> 2. Install the steering gear boot and ensure the boot is seated in the assembly groove of the steering gear before installing the steering gear boot clamps.

ELECTRIC BELT DRIVE RACK AND PINION STEERING GEAR REPLACEMENT

Removal Procedure

- CAUTION:** Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:
- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.

- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
 - Jumpering or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches or on top of TVs, radios or other electrical devices.

CAUTION: During removal and installation, all EPS components including mechanical and/or electrical is extremely susceptible to damage. Dropping or prying on any EPS component may cause internal damage. If damage occurs or a part is dropped, the EPS component must be replaced.

CAUTION: Care must be taken during removal and installation of the Electronic Power Steering (EPS) components to not hit or break the EPS motor/controller module or module harness connectors. If the EPS motor/controller module or module connectors are damaged, the complete component must be replaced.

1. Drivetrain and Front Suspension Cradle (1) » Remove - [Drivetrain and Front Suspension Cradle Removal and Installation](#)

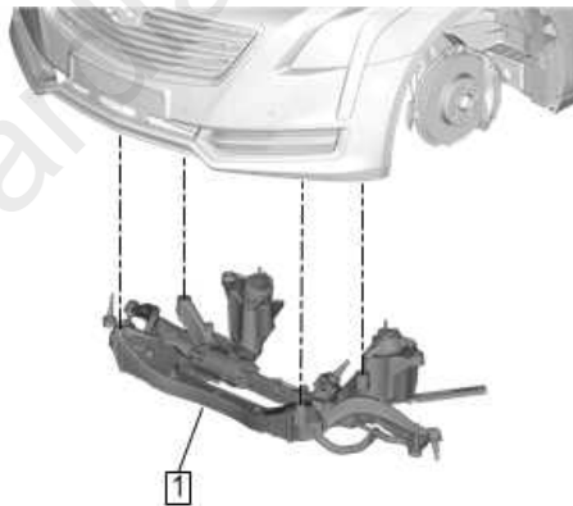


Fig. 17: Drivetrain And Front Suspension Frame
 Courtesy of GENERAL MOTORS COMPANY

2. Steering Gear Bolt (1) » Remove and DISCARD the bolts [4x]

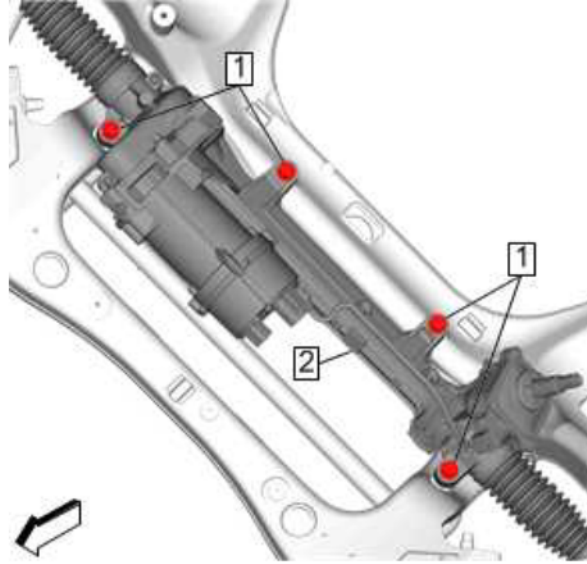


Fig. 18: Steering Gear Bolt

Courtesy of GENERAL MOTORS COMPANY

3. Remove the steering gear (2) from the drivetrain and front suspension frame.
4. Transfer components as necessary.

Installation Procedure

1. Position the steering gear (2) on the drivetrain and front suspension frame.

NOTE: Ensure steering gear bolts are tightened in the sequence shown in the illustration.

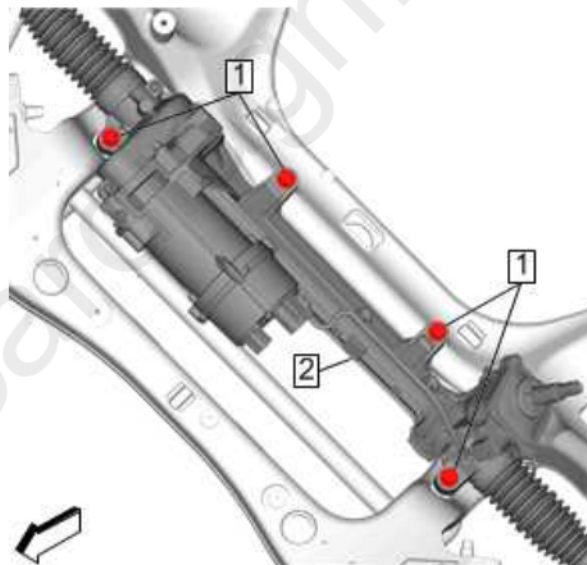


Fig. 19: Steering Gear Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Install NEW steering gear bolts.

CAUTION: Refer to [Fastener Caution](#) .

Steering Gear Bolt (1)» Install [4x] 58 N.m (43 lb ft)

Final Pass: (30 degrees)

3. Drivetrain and Front Suspension Cradle (1)» Install - [Drivetrain and Front Suspension Cradle Removal and Installation](#)

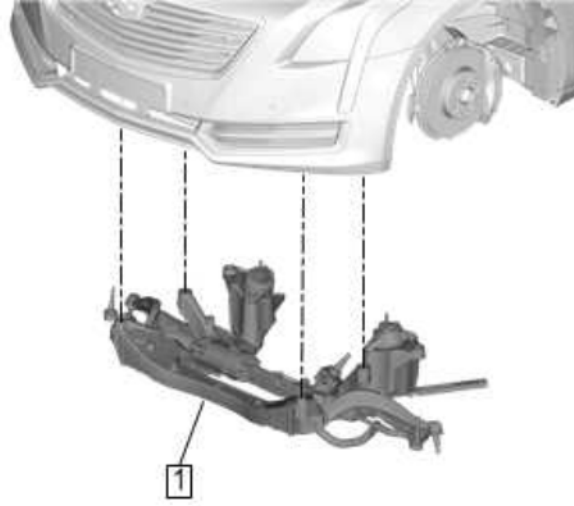


Fig. 20: Drivetrain And Front Suspension Frame
 Courtesy of GENERAL MOTORS COMPANY

4. Program the power steering control module. Refer to [Control Module References](#)
5. Measure and adjust the wheel alignment. Refer to [Wheel Alignment Measurement](#)

STEERING LINKAGE INNER TIE ROD REPLACEMENT

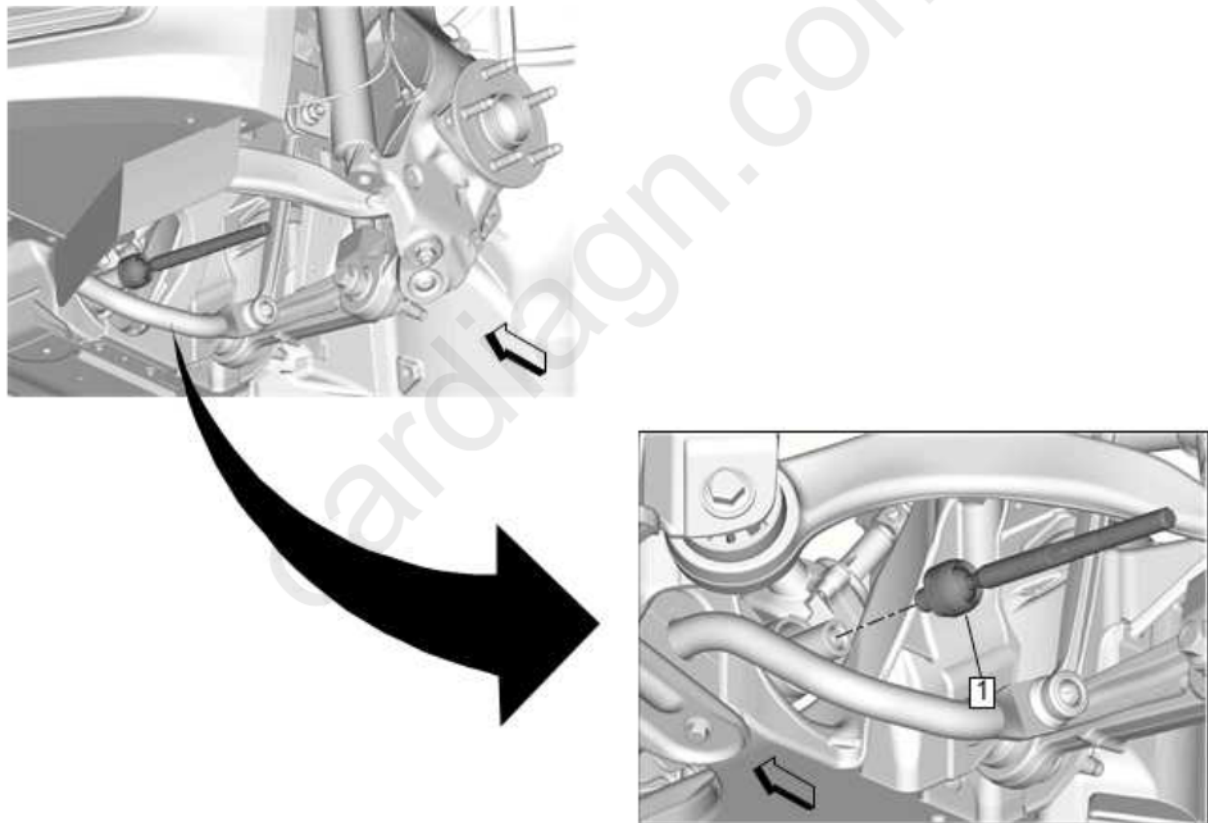


Fig. 21: Steering Linkage Inner Tie Rod
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	
1. Steering Gear Boot Replacement 2. After removing the steering gear boot, inspect the steering linkage inner tie rod for evidence of corrosion or contamination. If corrosion or contamination is evident, replace the steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement	

Callout	Component Name
1	Steering Linkage Inner Tie Rod CAUTION: Refer to Component Fastener Tightening Caution . Procedure 1. Place a wrench on the flats of the steering linkage inner tie rod housing. 2. Rotate the steering linkage inner tie rod housing counterclockwise to remove the steering linkage inner tie rod from the steering gear rack. 3. Rotate the steering linkage inner tie rod housing clockwise to install the steering linkage inner tie rod to the steering gear rack. Use the CH-6321 wrench and a torque wrench to tighten the steering linkage inner tie rod to specification. 4. Measure and adjust the front toe. Refer to Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment Tighten 105 N.m (77 lb ft) Special Tools CH-6321 Inner Tie Rod Wrench Equivalent regional tools: Special Tools

POWER STEERING ASSIST MOTOR REPLACEMENT

Special Tools

CH-6321 Inner Tie Rod Wrench

Equivalent regional tools: [Special Tools](#)

Removal Procedure

- CAUTION:** Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:
- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
 - Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
 - Do not allow tools to contact exposed terminals when servicing connectors.
 - Do not remove components from their protective packaging until required to do so.
 - Avoid the following actions unless required by the diagnostic procedure:
 - Jumpering or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
 - Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches or on top of TVs, radios or other electrical devices.

CAUTION: During removal and installation, all EPS components including mechanical and/or electrical is extremely susceptible to damage. Dropping or prying on any EPS component may cause internal damage. If damage occurs or a part is dropped, the EPS component must be replaced.

CAUTION: Care must be taken during removal and installation of the Electronic Power Steering (EPS) components to not hit or break the EPS motor/controller module or module harness connectors. If the EPS motor/controller module or module connectors are damaged, the complete component must be replaced.

1. Steering Gear Remove - [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)
2. Place the steering gear in a vise.

NOTE:

- The torque sensor wiring harness is NOT repairable. Do NOT attempt to repair the harness under any circumstances. If the harness is damaged then the steering gear MUST be replaced.
- When installing the steering gear in a vise and clamping on the barrel of the steering gear housing, do NOT pinch the torque sensor wiring harness. If available, use a soft jaw vise.

3. Use an open end wrench (1) to rotate the steering gear input shaft (2) to center the steering gear rack in its travel.

NOTE:

After the steering gear has been centered, do NOT allow the gear to move from the center position.

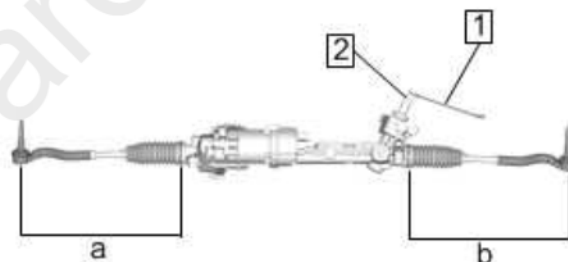


Fig. 22: Steering Gear Input Shaft
Courtesy of GENERAL MOTORS COMPANY

4. Use the following procedure to verify the steering gear rack is centered:
 1. Measure distance (a) from the top of the steering linkage outer tie rod to the steering gear boot inner clamp on either side of the steering gear rack.
 2. Measure distance (b) from the top of the steering linkage outer tie rod to the steering gear boot inner clamp on the opposite side of the steering gear rack.
 3. Verify both measurement (a) and measurement (b) are equal.
 4. If the measurements are not equal, turn the steering gear input shaft until the measurements are the same.

5. Remove any dirt and debris from the torque sensor wiring harness connector (1) and surrounding area and disconnect the connector from the power steering assist motor controller module.

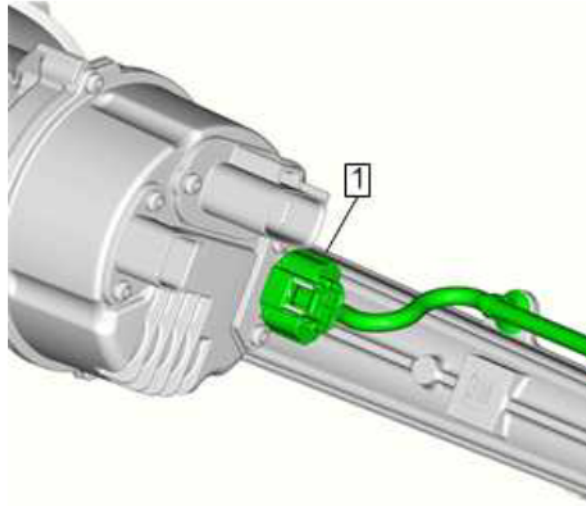


Fig. 23: Torque Sensor Wiring Harness Connector

Courtesy of GENERAL MOTORS COMPANY

6. Remove any dirt and debris from the steering gear where the steering gear housing (1) and the power steering assist motor (2) mate to the steering gear.

NOTE: **Cleaning the entire area of dirt and debris will ensure no contaminants enter the steering gear.**

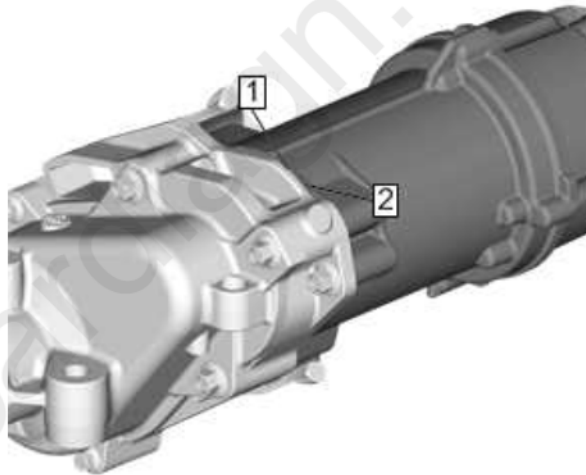


Fig. 24: Steering Gear Housing

Courtesy of GENERAL MOTORS COMPANY

7. Steering Linkage Inner Tie Rod @ Belt Side, » Remove - **Steering Linkage Inner Tie Rod Replacement**

CAUTION: **Before removing the steering gear housing cover bolts from the steering gear, the section of the threads that protrude past the steering gear MUST be cleaned with a wire brush. Failure to clean the threads may result in the bolts breaking during removal. If the bolts break, the complete steering gear must be replaced.**

8. Using a wire brush clean the threads of the steering gear housing cover bolts (1) that protrude past the steering gear.

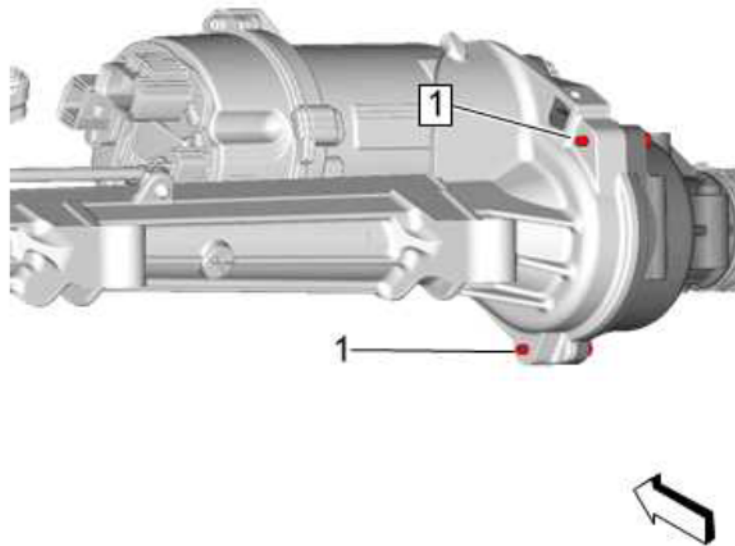


Fig. 25: Cleaning Threads Of Steering Gear Housing Cover Bolts
 Courtesy of GENERAL MOTORS COMPANY

9. Remove the steering gear housing cover bolts (1).

DISCARD the bolts.

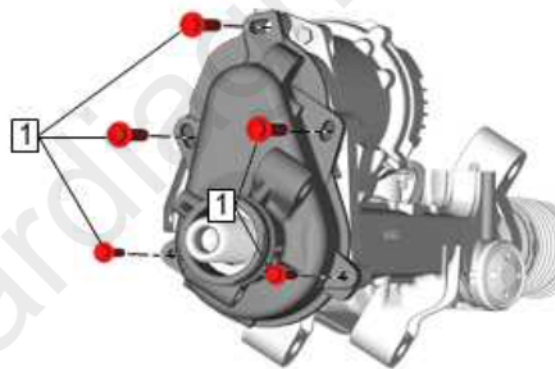


Fig. 26: Steering Gear Housing Cover Bolts
 Courtesy of GENERAL MOTORS COMPANY

10. Use a rubber mallet to tap on the steering gear housing cover (1) to release the dowel pins and remove the cover from the steering gear housing.

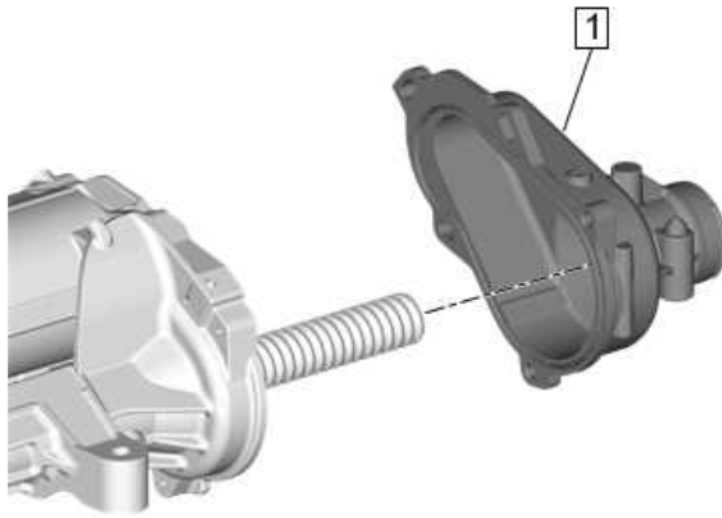


Fig. 27: Steering Gear Housing Cover

Courtesy of GENERAL MOTORS COMPANY

11. Inspect the inside of the steering gear housing for contamination and inspect the steering gear belt for any damage.

If there is any contamination in the steering gear housing or the belt is damaged, replace the steering gear. Refer to [**Electric Belt Drive Rack and Pinion Steering Gear Replacement**](#)

12. Remove the power steering assist motor pivot bolt (1).

Keep the OLD bolt for the installation process.

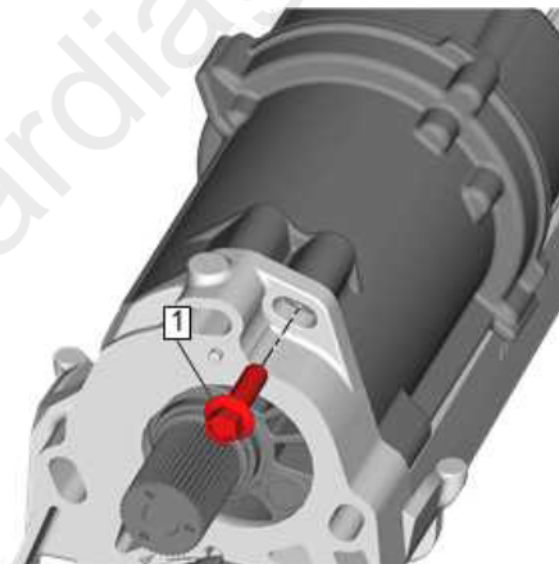


Fig. 28: Power Steering Assist Motor Pivot Bolt

Courtesy of GENERAL MOTORS COMPANY

13. Rotate the power steering assist motor (1) in the steering gear housing to remove the steering gear belt tension and then pull the motor toward the steering gear input shaft until the motor is released from the housing and belt.

DISCARD the belt.



Fig. 29: Power Steering Assist Motor
Courtesy of GENERAL MOTORS COMPANY

14. Install a clean shop rag (1) over the large steering gear pulley to prevent any dirt and debris from entering the steering gear housing.

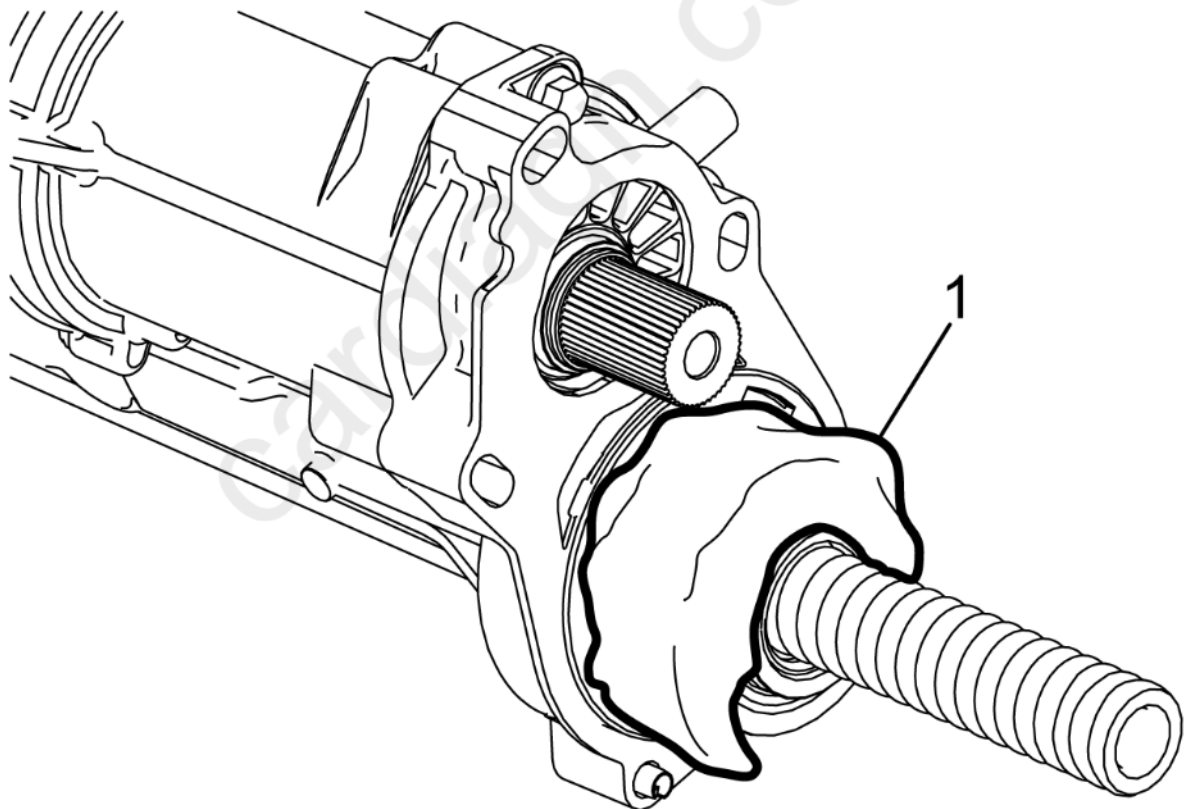


Fig. 30: Install Clean Shop Rag Over Large Steering Gear Pulley
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Use a clean shop rag to clean the power steering assist motor mating surface on the steering gear housing so it is free of old grease and loose particles.

2. Install a NEW power steering assist motor seal (1).

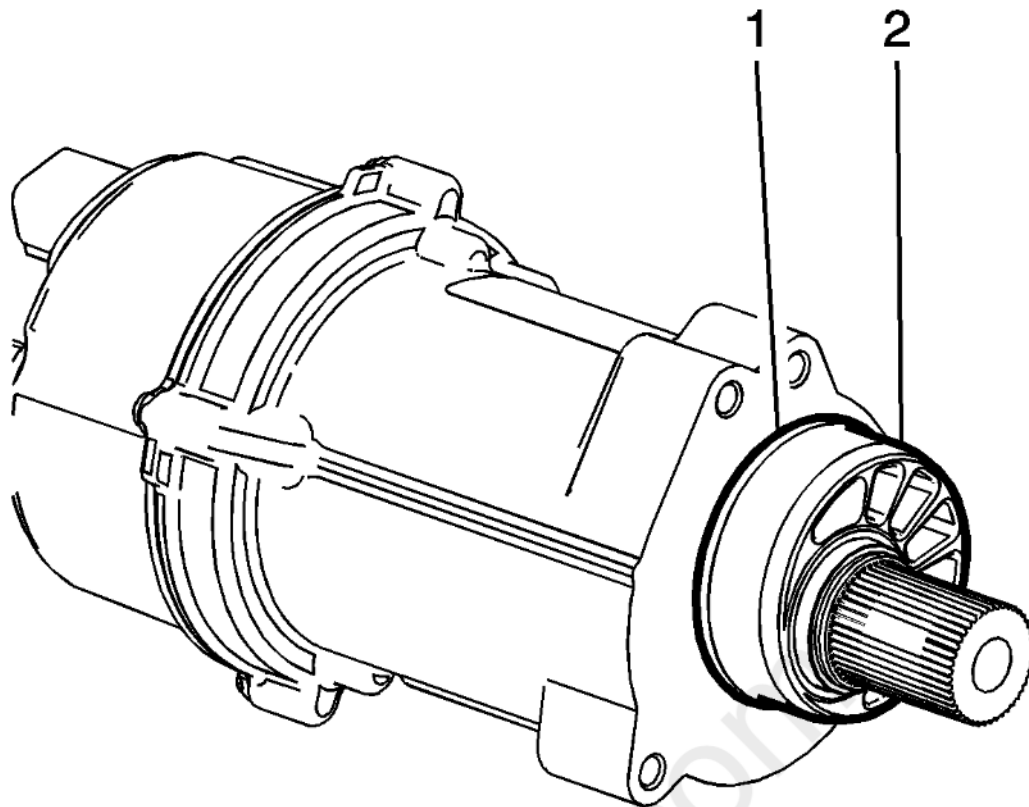


Fig. 31: Power Steering Assist Motor And O Ring
Courtesy of GENERAL MOTORS COMPANY

3. Add a light film of lithium grease to the nose (2) of the power steering assist motor.
4. Inspect the teeth (1) on the power steering assist motor gear and the large steering gear pulley.

The teeth are directional and the NEW steering gear belt MUST be installed in the proper direction.

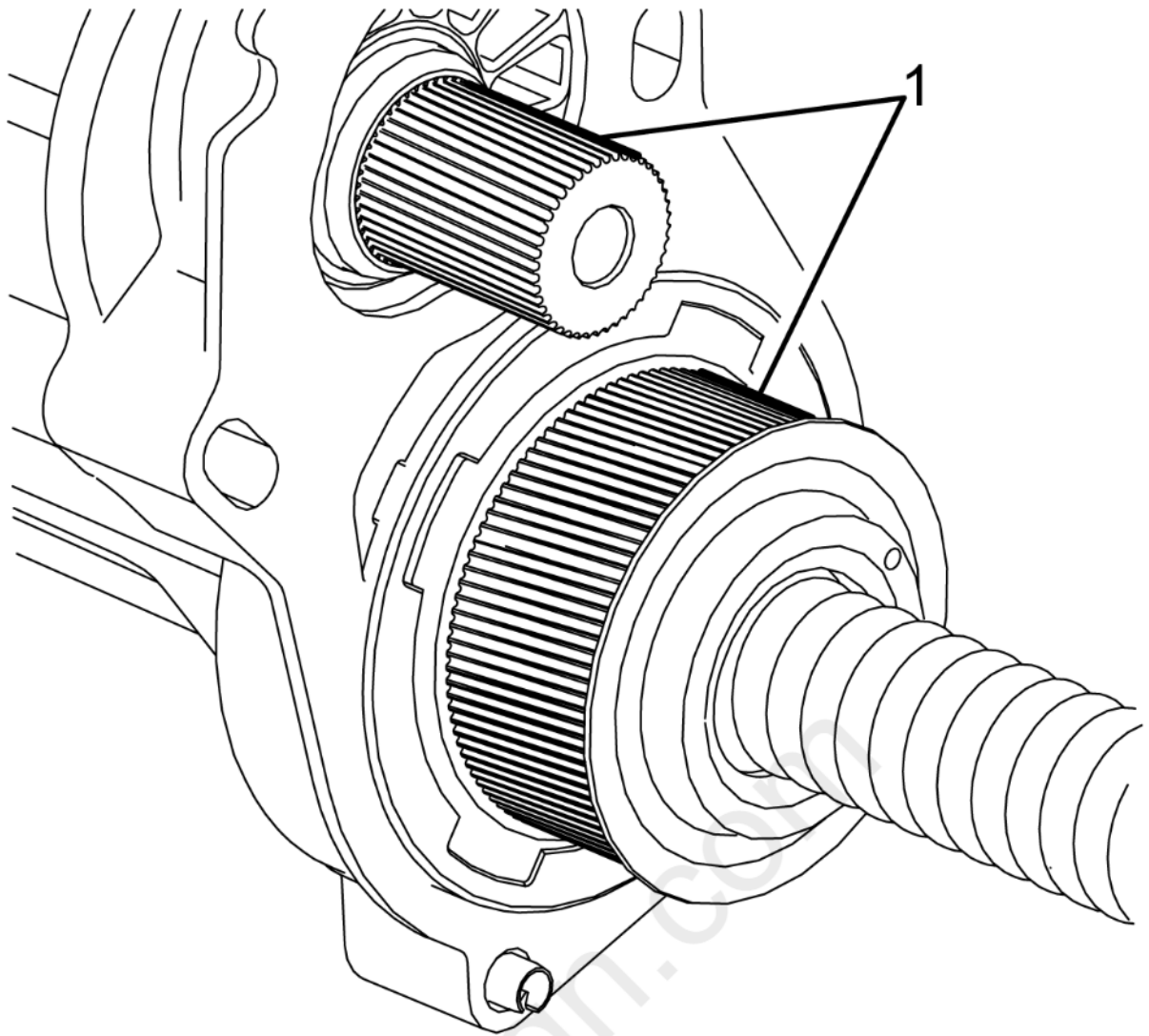


Fig. 32: Power Steering Assist Motor Gear And Large Steering Gear Pulley.
 Courtesy of GENERAL MOTORS COMPANY

5. Hang the NEW steering gear belt on the large steering gear pulley.
6. Install the nose of the power steering assist motor (1) into the steering gear housing and slide the steering gear belt onto the nose of the motor.



Fig. 33: Power Steering Assist Motor
 Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Do NOT pinch or roll the power steering assist motor seal while installing the power steering assist motor into the

steering gear housing.

- Before adding tension to the steering gear belt, ensure the belt is centered on the large steering gear pulley.

7. After the power steering assist motor (1) is installed in the steering gear housing and steering gear belt, rotate the motor clockwise, while making sure the screw holes in the motor and slotted holes in steering gear housing are aligned properly.
8. Install 5 space washers (1) and the OLD power steering assist motor pivot bolt (2).

Tighten the OLD pivot bolt by hand.

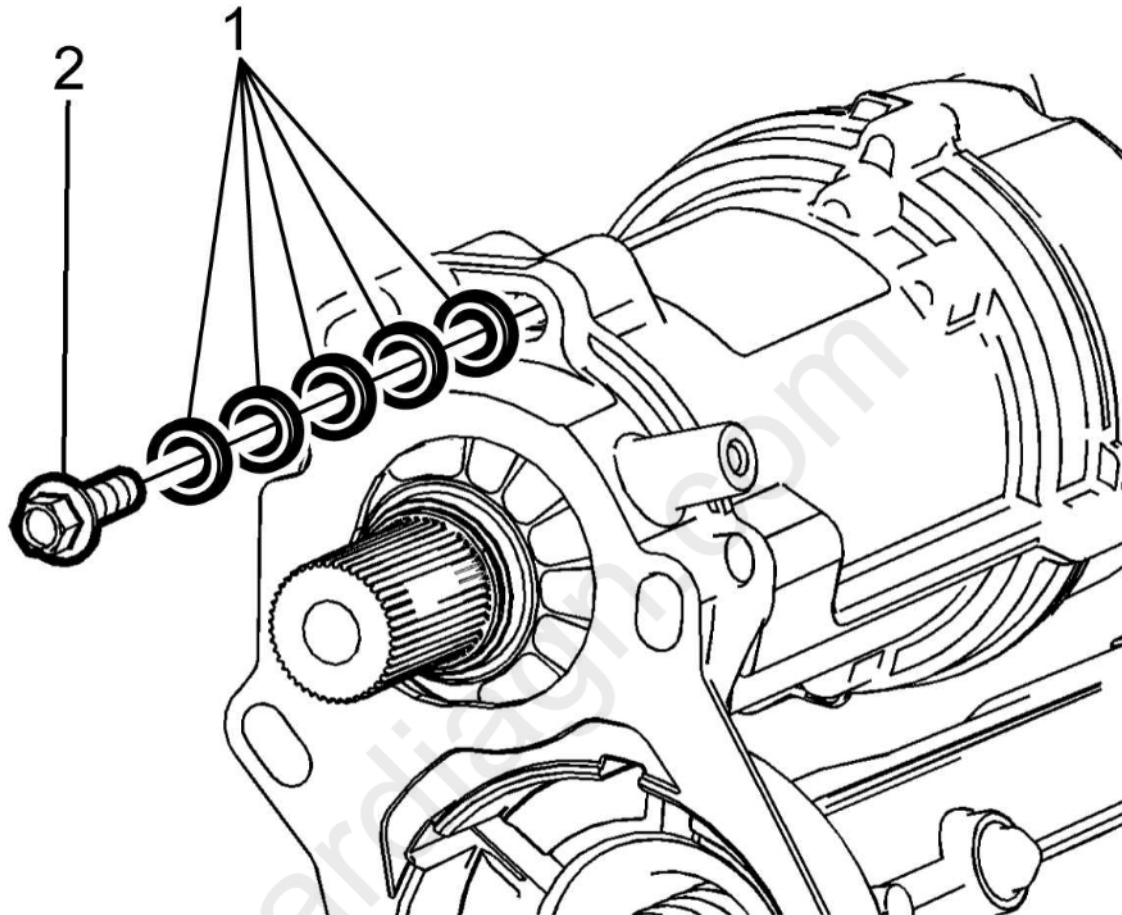


Fig. 34: Space Washers And Old Power Steering Assist Motor Pivot Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The space washers will ensure the power steering assist motor is flush with the steering gear housing.
- After hand tightening the OLD power steering assist motor pivot bolt, ensure the motor can still rotate.

9. Use an open end wrench (1) to rotate the steering gear input shaft (2) 90 degrees in both directions and back to the center position to seat the steering gear belt.

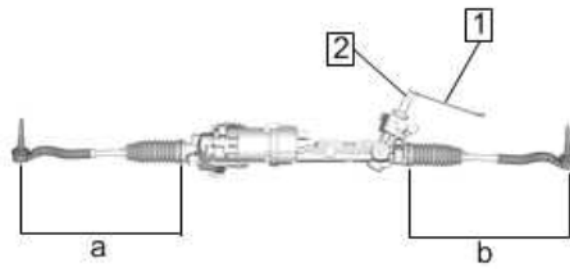


Fig. 35: Steering Gear Input Shaft

Courtesy of GENERAL MOTORS COMPANY

10. Use the following procedure to verify the steering gear rack is centered:
 1. Measure distance (a) from the top of the steering linkage outer tie rod to the steering gear boot inner clamp on either side of the steering gear rack.
 2. Measure distance (b) from the top of the steering linkage outer tie rod to the steering gear boot inner clamp on the opposite side of the steering gear rack.
 3. Verify both measurement (a) and measurement (b) are equal.
 4. If the measurements are not equal, turn the steering gear input shaft until the measurements are the same.
11. Place the body of the GE-50576-A tester (1) on a flat surface or secure it to the steering gear housing and position the microphone of the tester 6 mm (0.25 in) from the steering gear belt. NEVER hold the tester by hand while taking measurements or the reading will be inaccurate.

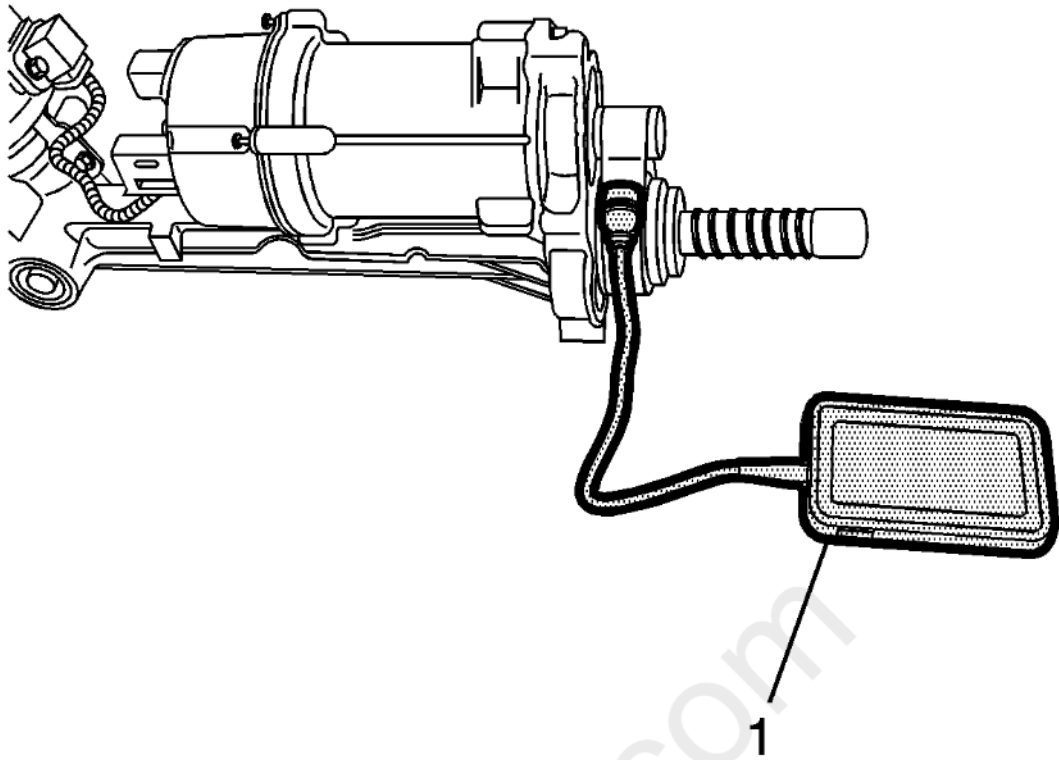


Fig. 36: Belt Tension Sonic Gauge

Courtesy of GENERAL MOTORS COMPANY

12. Use a finger to strum the steering gear belt (1) at the center location between the pulleys 3 times to get an average belt tension measurement.

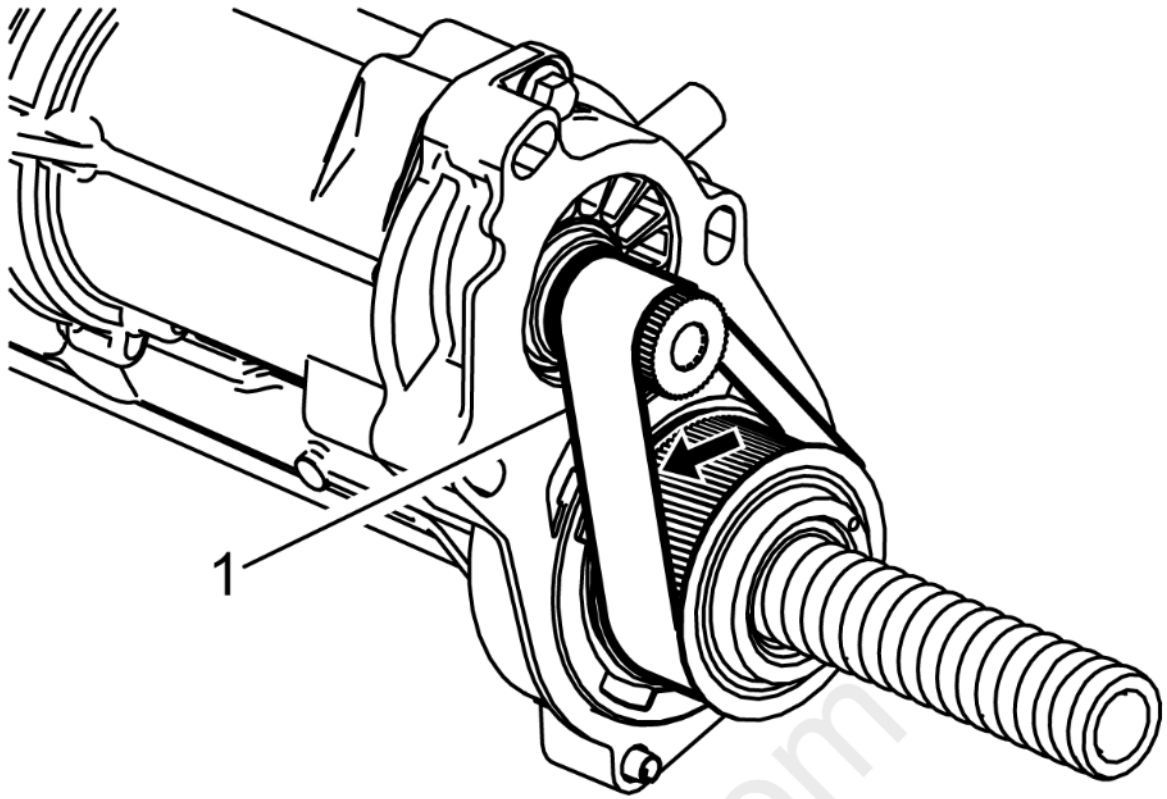


Fig. 37: Steering Gear Belt

Courtesy of GENERAL MOTORS COMPANY

1. If the average steering gear belt tension measurement is between 350-380 Hz then continue to the next step. If the average of the measurements is lower or higher than the specification, then rotate the power steering assist motor clockwise to tighten the belt or counterclockwise to loosen the belt, and take the average of another set of 3 measurements. Repeat this step until the average of the measurements is within the range specified and then tighten the power steering assist motor pivot bolt to 22 N.m (16 lb ft).
 2. Recheck the steering gear belt tension using the GE-50576-A tester. If the reading is not between 350-380 Hz then loosen the power steering assist motor pivot bolt and readjust the belt tension. If the measurement is still within the specified range then continue to the next step.
13. Remove the OLD power steering assist motor pivot bolt and space washers.
 14. Install the NEW power steering assist motor pivot bolt (1) and tighten to 22 N.m (16 lb ft).

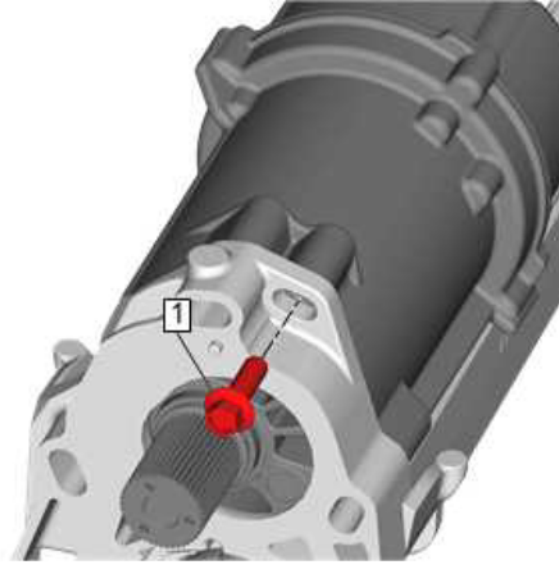


Fig. 38: Power Steering Assist Motor Pivot Bolt
Courtesy of GENERAL MOTORS COMPANY

15. Use a clean shop rag to clean the steering gear housing cover mating surface on the steering gear housing so it is free of old grease and loose particles.
16. Inspect the steering gear housing cover seal (1) and ensure the seal is seated correctly and that both dowel pins (2) are seated.

If the seal is damaged, install a NEW seal.



Fig. 39: Steering Gear Housing Cover Seal
Courtesy of GENERAL MOTORS COMPANY

17. Install the steering gear housing cover (1).

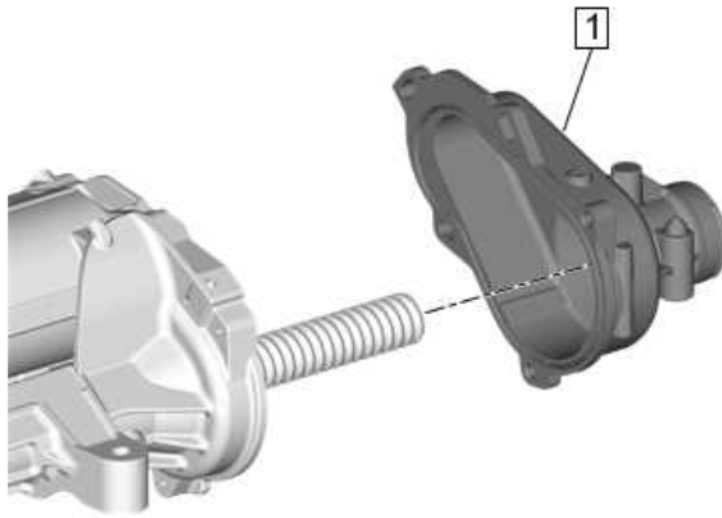


Fig. 40: Steering Gear Housing Cover

Courtesy of GENERAL MOTORS COMPANY

18. Install the NEW steering gear housing cover bolts (1) and tighten by hand.

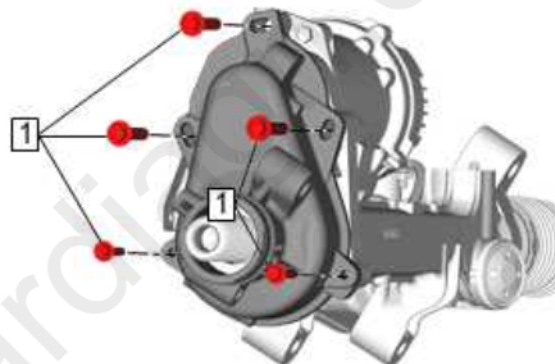


Fig. 41: Steering Gear Housing Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

19. Tighten the steering gear housing cover bolts in the following sequence:

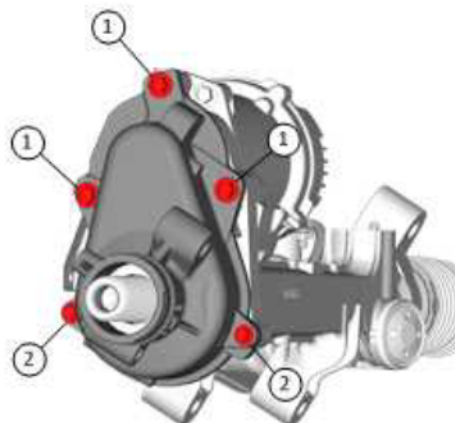


Fig. 42: Steering Gear Housing Cover Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

1. M8 Bolts (1): 22 N.m (16 lb ft)
 2. M6 Bolts (2): 10 N.m (89 lb in)
20. Connect the torque sensor wiring harness connector (1) to the power steering assist motor controller module.

CAUTION: Ensure the torque sensor wiring harness is fully connected and seated to the electric power steering motor controller module. If the harness connector is not fully engaged, damage to the module will occur when the key is turned on and replacement of the module will be necessary.

NOTE: The torque sensor wiring harness is NOT repairable. Do NOT attempt to repair the harness under any circumstances. If the harness is damaged then the steering gear MUST be replaced.

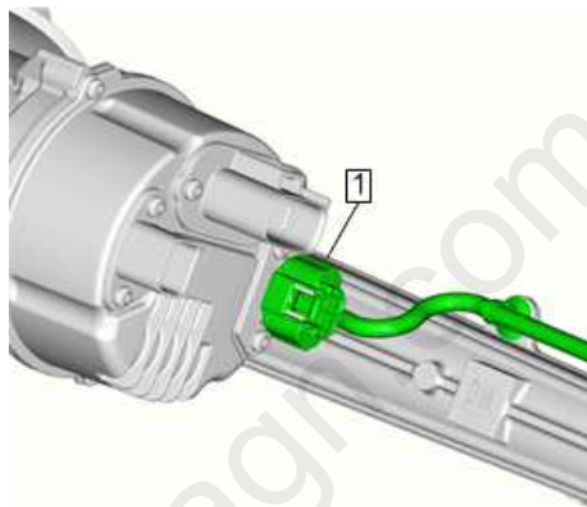


Fig. 43: Torque Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS COMPANY

21. Steering Linkage Inner Tie Rod @ Belt Side, » Install - [Steering Linkage Inner Tie Rod Replacement](#)
22. Remove the steering gear from the vise.
23. Steering Gear, » Install - [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)

CAUTION: During removal and installation, all EPS components including mechanical and/or electrical is extremely susceptible to damage. Dropping or prying on any EPS component may cause internal damage. If damage occurs or a part is dropped, the EPS component must be replaced.

CAUTION: Care must be taken during removal and installation of the Electronic Power Steering (EPS) components to not hit or break the EPS motor/controller module or module harness connectors. If the EPS motor/ controller module or module connectors are damaged, the complete component must be replaced.

24. Program the power steering control module. Refer to [Control Module References](#)

POWER STEERING CONTROL MODULE CALIBRATION

Steering Angle Sensor Centering and Software Endstop Learning

WARNING: An inaccurate or not centered steering angle sensor could limit the operation of the electric power steering and may result in personal injury.

Centering of the steering angle sensor and software endstop learning might be required after certain service procedures are performed. Some of these procedures are as follows:

- Steering angle sensor replacement
- Steering gear replacement
- Power steering assist motor replacement
- Steering column replacement
- Steering linkage inner tie rod replacement
- Steering linkage outer tie rod replacement

NOTE: It is necessary to perform the steering angle sensor centering BEFORE the software endstop learning.

Internal Steering Angle Sensor Centering

The centering procedure of the internal steering angle sensor can be completed with the following steps:

Conditions: Front axle measured and set, engine running, vehicle speed 0 km/h (0 MPH), internal steering angle sensor is activated.

1. Using the steering wheel, align the front wheels in the center forward position.
2. Using a scan tool, perform the Configuration/Reset Functions, Steering Wheel Angle Sensor Centering procedure.
3. Steer from the center position slowly 90°, to the left.
4. Steer slowly back to the center position and then slowly 90°, to the right.
5. Steer slowly back to the center position.
6. Perform the steering movements again.
7. Centering procedure is completed.

Software Endstop Learning

The software endstop learning procedure can be completed with the following steps:

Conditions: Front axle measured and set, vehicle speed 0 km/h (0 MPH), internal steering angle sensor is calibrated or external steering angle sensor sends a valid CAN signal.

1. Using a scan tool, perform the Configuration/Reset Functions, Power Steering Softstops Reset procedure and follow the on-screen instructions.
2. Using a scan tool, perform the Configuration/Reset Functions, Power Steering Softstops Learn procedure and follow the on-screen instructions.
3. Software endstop learning procedure is completed.

DESCRIPTION AND OPERATION

POWER STEERING SYSTEM DESCRIPTION AND OPERATION (BELT DRIVE ELECTRONIC POWER STEERING)

Electric Power Steering Block Diagram

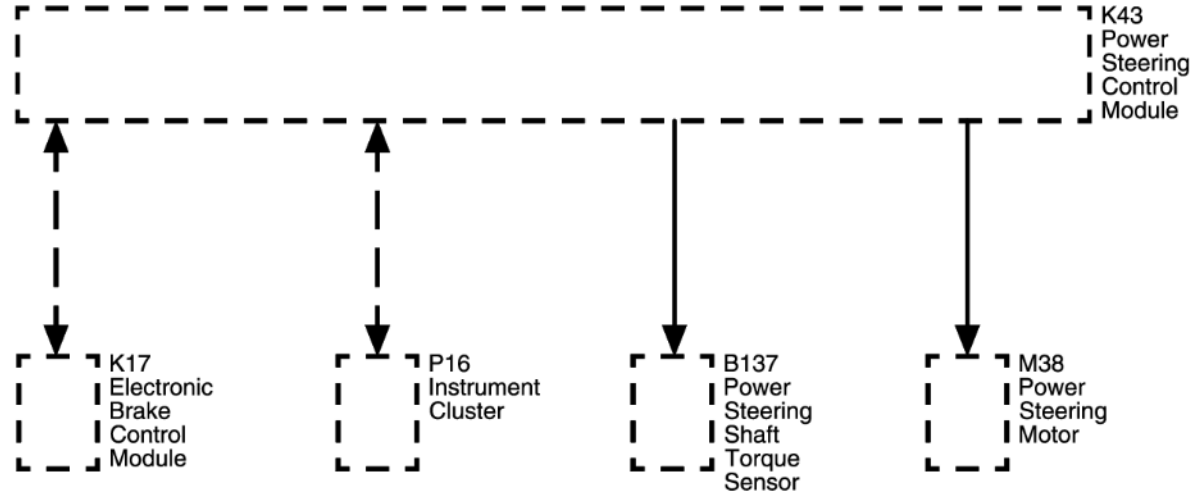


Fig. 44: Electric Power Steering Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
K43	K43 Power Steering Control Module
K17	K17 Electronic Brake Control Module
P16	P16 Instrument Cluster
B137	B137 Power Steering Shaft Torque Sensor
M38	M38 Power Steering Motor

The belt driven electronic power steering system consists of the following components:

- The integrated electromechanical power steering unit, containing the power steering control module, its sensors, the power steering motor, a belt drive and a ball nut mechanism
- The Electric Belt Drive Rack and Pinion Steering Gear containing the steering angle sensor and power steering shaft torque sensor

The belt driven electric power steering system reduces the amount of effort needed to steer the vehicle utilizing the power steering control module to control the power steering motor to maneuver the steering gear. The power steering control module also uses a combination of the torque sensor, motor rotational sensor, battery voltage circuit and GMLAN serial data circuit to perform the system functions. The power steering control module monitors vehicle speed and engine speed from the engine control module via the GMLAN serial data circuit to determine the amount of steering assist needed to steer the vehicle. At low 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.

The power steering control module uses a combination of the torque sensor, motor rotational sensor, vehicle speed and calculated system temperature inputs to determine the amount of assist needed. The power steering control module continuously monitors the digital torque sensor's torque and index current signals. As the steering wheel is turned and torsional twist is applied to the steering shaft, the steering input and output shafts are monitored via the torque signal circuit and then processed by the power steering control module to calculate the steering torque. The voltage signals of the motor position sensor and the digital torque sensor's index current signal are both processed by the power steering control module to detect and calculate the steering wheel angle.

The power steering control module responds to the change in the digital torque sensor signals as well as the motor rotational sensor's voltage signals by commanding current to the power steering motor. The power steering control module controls the motor drive circuit to drive the alternating current motor. The power steering control module & motor assembly is attached to the base of the steering gear housing and applies power assist directly to the rack with a belt drive and a ball nut mechanism to maneuver the rack laterally depending on the direction the steering wheel is turned.

The power steering control module has the ability to calculate an internal system temperature to protect the power steering system from damage caused by high temperature. To reduce a high system

temperature, the power steering control module will reduce the amount of current commanded to the power steering motor, which reduces the amount of steering assist. The power steering control module has the ability to detect malfunctions within the electric power steering system. Any malfunction detected that disables steering assist will cause the SERVICE POWER STEERING message to be displayed on the driver information center.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

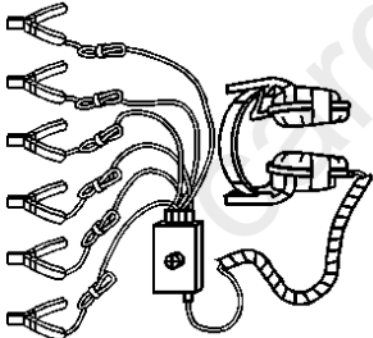
Illustration	Tool Number/Description
	CH-161-B J-22888-20A KM-161-B Bearing Puller
	CH-6321 J-34028 KM-6321 8997009 Inner Tie Rod Wrench
	CH-39570 J-39570 Chassis Ear
	DT-35910 J-35910 Drive Axle Boot Clamp Pliers

Illustration	Tool Number/Description
	GE-50576-A Acoustic Belt Tension Tool
	GE-8001 J-8001 Dial Indicator Set