

2018 STEERING

Power Steering - Traverse

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	10 N.m (89 lb in)
Steering Gear Housing Bolt	25 N.m (18 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 (Horizontal)	
• First Pass:	100 N.m (74 lb ft)
• Final Pass:	45 - 60 degrees
Steering Gear Bolt (Vertical)	
Steering Gear Heat Shield Bolt	
Steering Linkage Inner Tie Rod	
Steering Linkage Outer Tie Rod Nut	
• First Pass:	35 N.m (26 lb ft)
• Final Pass:	90 - 100 degrees

SCHEMATIC WIRING DIAGRAMS

POWER STEERING WIRING SCHEMATICS

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.
- Most instances of DTC C0176 setting are due to excessive steering inputs. Examples of excessive inputs:
 - Steering wheel turned to the end of the rack travel and held there for an extended period of time (30 seconds)
 - Steering turned from endstop to endstop repeatedly (10 times)

Reference Information

Schematic Reference

Power Steering Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation

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 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. Operate the vehicle within the conditions that the customer experienced, avoiding excessive inputs, and verify the DTC does not reset.
 - **If the DTC set outside of the conditions for running and setting**
 1. Ignition ON.
 2. 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.
 - Go to next step: If no steering components are mechanically binding
 3. Replace the K43 Power Steering Control Module.
 - **Go to next step: If the DTC did not set outside of the conditions for running and setting**
2. All OK. The power steering is operating as designed.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

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

DTC C0460

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 58

Steering Wheel Angle Sensor Hardware Fault

DTC C0460 5A

Steering Wheel Angle Sensor Signal Not Plausible

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 4B

Steering sensor not properly calibrated.

DTC C0460 58

Steering sensor encounters an internal hardware fault.

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.

Action Taken When the DTC Sets

- DTC C0460 is stored in memory.
- Active Return and Software Endstops not available.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

[Power Steering Wiring Schematics](#)

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation

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 C0460 4B

1. Ignition ON.
2. Verify that DTC C0460 4B is not set.
 - **If the DTC C0460 4B is set**

Calibrate the K43 Power Steering Control Module. Refer to [Power Steering Control Module Calibration](#)

1. Verify that DTC C0460 4B is not set.
 - **If the DTC C0460 4B is set**
Replace the steering gear.
 - **Go to next step: If the DTC C0460 4B did not set**
Go to next step: All OK.
 - **Go to next step: If the DTC C0460 4B is not set**
3. All OK.

DTC C0460 58

1. Verify that all harness connectors are installed properly at the K43 Power Steering Control Module.
 - **If a harness connector at the K43 Power Steering Control Module is not installed properly**
 1. Connect the appropriate harness connector properly at the K43 Power Steering Control Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the Steering Gear.
 - Go to next step: If the DTC does not set
 3. All OK.
 - **Go to next step: If all harness connectors at the K43 Power Steering Control Module are installed properly**
2. Ignition ON.
3. Verify the scan tool Steering Wheel Angle parameter changes when turning the steering wheel.
 - **If the parameter does not change**
Replace the Steering Gear.
 - **Go to next step: If the parameter changes**
4. All OK.

DTC C0460 5A

1. Ignition ON.
2. Verify that DTC C0460 5A is not set.
 - **If the DTC C0460 5A is set**
 1. Verify that the steering wheel angle alignment is correct. Refer to [Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment](#)
 2. Calibrate the K43 Power Steering Control Module. Refer to [Power Steering Control Module Calibration](#)
 3. Verify that DTC C0460 5A is not set.
 - **If the DTC C0460 5A is set**

Replace the steering gear.
 - **Go to next step: If the DTC C0460 5A did not set**

Go to next step: All OK.
 - **Go to next step: If the DTC C0460 5A 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 C0545

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 C0545 00

Steering Wheel Torque Sensor Malfunction

Circuit/System Description

The power steering control module continuously monitors the digital torque sensor's torque. 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.

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 torque sensor circuits.

Action Taken When the DTC Sets

- DTC C0545 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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation

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 C0545 00

1. Verify that all harness connectors are installed properly at the K43 Power Steering Control Module.
 - **If a harness connector at the K43 Power Steering Control Module is not installed properly**
 1. Connect the appropriate harness connector properly at the K43 Power Steering Control Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the Steering Gear.
 - Go to next step: If the DTC does not set
 3. All OK.
 - **Go to next step: If all harness connectors at the K43 Power Steering Control Module are installed properly**
2. Ignition ON.
3. Verify the scan tool Torque Sensor parameter changes when turning the steering wheel.
 - **If the parameter does not change**
Replace the Steering Gear.
 - **Go to next step: If the parameter changes**
4. 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 C056E

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: Diagnostic System Check - Vehicle

- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC C056E

Electronic Control Unit Software

Symptom Byte Information: [Symptom Byte List](#)

Circuit/System Description

For an overview of the component/system, refer to: [Power Steering System Description and Operation](#)

Conditions for Running the DTC

Ignition - On/Vehicle - In Service Mode

Conditions for Setting the DTC

- K43 Power Steering Control Module = Missing Calibration
- Power Steering Control Module SPS Calibration Status = Incomplete
- VIN Not Programmed
- Software Malfunction

Actions Taken When the DTC Sets

Power Steering Output Torque = Default

Conditions for Clearing the DTC

- K43 Power Steering Control Module = Programmed
- K43 Power Steering Control Module = Calibrated

Reference Information

Schematic Reference

[Power Steering Wiring Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Electrical Information Reference

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

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#)

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC C056E is not set.

- **If the DTC is set**
1. Perform all necessary programming and setup procedures for the control module: K43 Power Steering Control Module
 2. Verify the DTC does not set.
 - If the DTC sets - Replace the component: K43 Power Steering Control Module
 - Go to next step: If the DTC is not set
 3. All OK.
 - **Go to next step: If the DTC is not set**
3. All OK.

Repair Instructions

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

For control module replacement, programming, and setup refer to: [Control Module References](#)

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 Description and Operation](#).

Visual/Physical Inspection

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

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 Symptoms - Steering Wheel and Column
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. Is the power steering gear installation incorrect?	Go to Step 6	Go to Step 4
4	Inspect the intermediate steering shaft for proper installation and loose or missing fasteners. Is the intermediate steering shaft 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 Noise Diagnosis - Front Suspension . Are the front suspension components damaged or worn?	Go to Step 7	Go to Step 3

Step	Action	Yes	No
6	Install the power steering gear correctly. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement . 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	-
8	Install the intermediate steering shaft and/or fasteners correctly. Refer to Intermediate Steering Shaft Replacement . 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 8	Go to Step 3
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 9	-
7	Replace the power steering assist motor. Refer to Power Steering Assist Motor Replacement . Did you complete the repair?	Go to Step 9	-
8	Replace the power steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement . Did you complete the repair?	Go to Step 9	-

Step	Action	Yes	No
9	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
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

Step	Action	Yes	No
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 a worn or binding intermediate steering shaft. Is the intermediate shaft 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
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 Steering Linkage Outer Tie Rod Replacement . Did you complete the repair?	Go to Step 14	-

Step	Action	Yes	No
11	Replace the intermediate steering shaft. Refer to Intermediate Steering Shaft Replacement . Did you complete the repair?	Go to Step 14	-
12	Replace the power steering gear. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement . Did you complete the repair?	Go to Step 14	-
13	Replace the steering column. Refer to Steering Column Replacement (N37) . Steering Column Replacement (N38) . 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.
One or both of the steering column dash seals are binding.	Adjust or replace the steering column dash seal(s). • Steering Column Dash Inner Seal Replacement • Steering Column Dash Outer Seal Replacement
The intermediate steering shaft joints and/or fasteners are loose, worn or binding.	Tighten or replace the intermediate steering shaft joints and/or fasteners. Intermediate Steering Shaft Replacement
The electric belt drive rack and pinion steering gear is binding.	Replace the electric belt drive rack and pinion steering gear. Electric Belt Drive Rack and Pinion Steering Gear Replacement
The steering column shaft is bent.	Replace the steering column. Steering Column Replacement (N37) Steering Column Replacement (N38)
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 electric belt drive rack and pinion steering gear sensor wire is damaged.	Replace the electric belt drive rack and pinion steering gear. Electric Belt Drive Rack and Pinion Steering Gear Replacement
The power steering control module is malfunctioning.	Confirm the DTC and replace the power steering assist motor. Power Steering Assist Motor Replacement
The power steering assist motor shaft is binding.	Confirm the DTC and replace the power steering assist motor. Power Steering Assist Motor 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)

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.

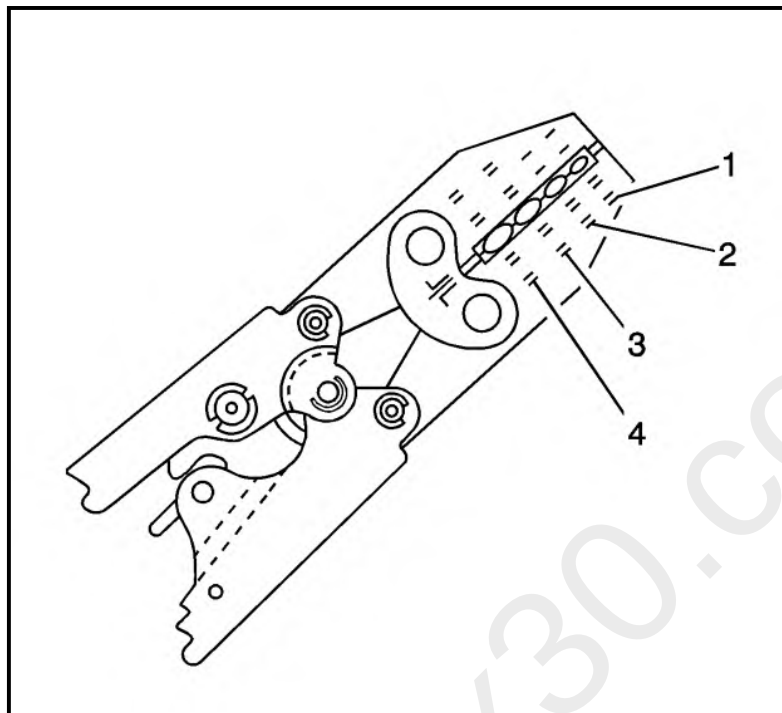
1. Open the harness by removing any tape:
 - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
 - Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
 - Do not use the crimp and DuraSeal 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:

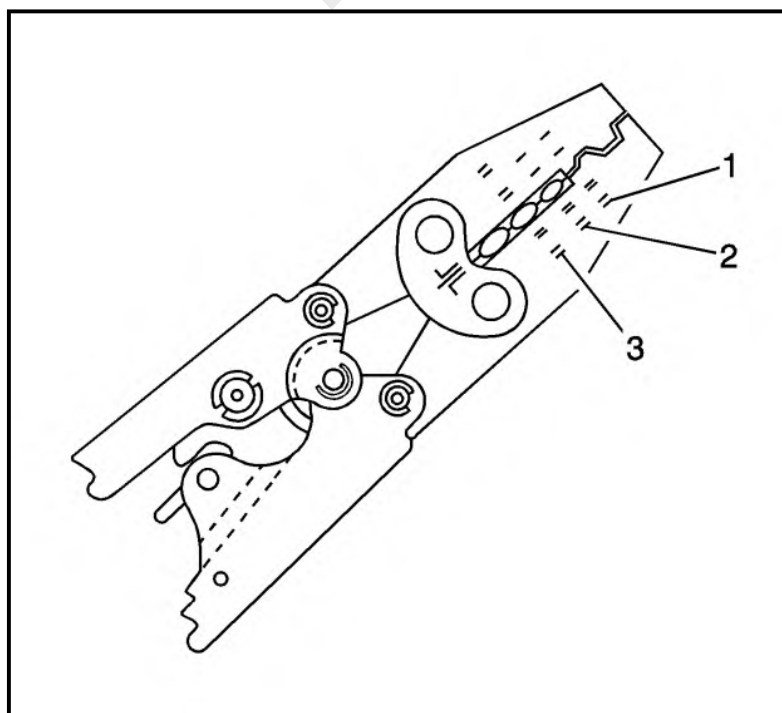
- When adding a length of wire to the existing harness, use the same size wire as the original wire.
 - Perform one of the following items in order to find the correct wire size:
 - Find the wire on the schematic and convert to regional wiring gauge size.
 - If you are unsure of the wire size, begin 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.



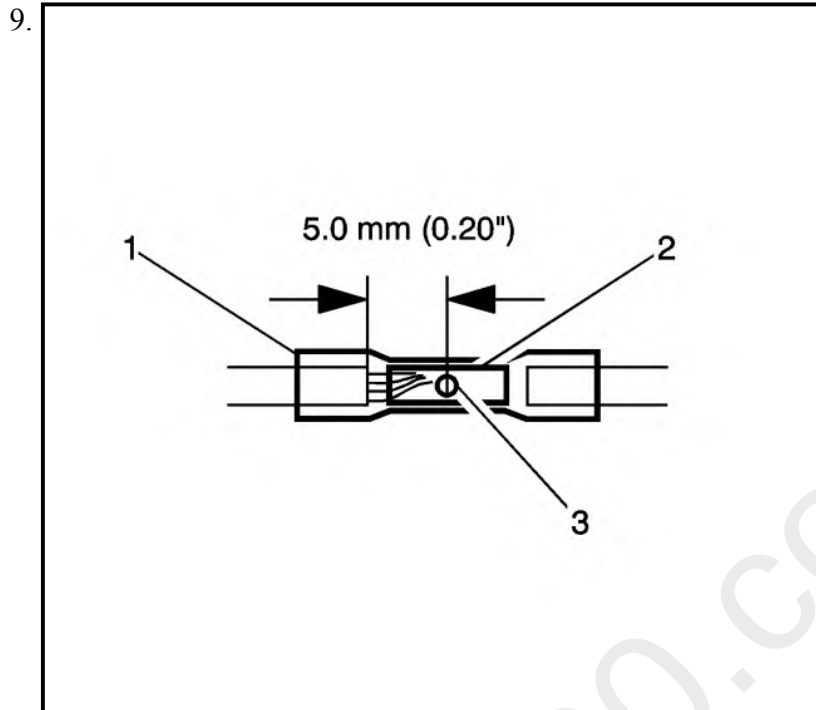
The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest 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.

7.

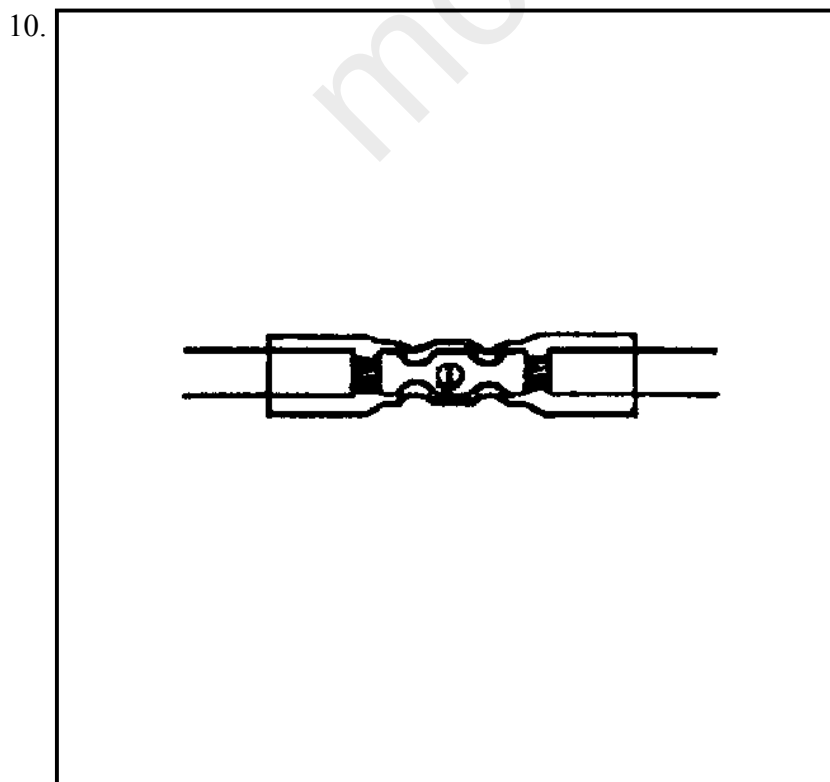


The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests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

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).



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.



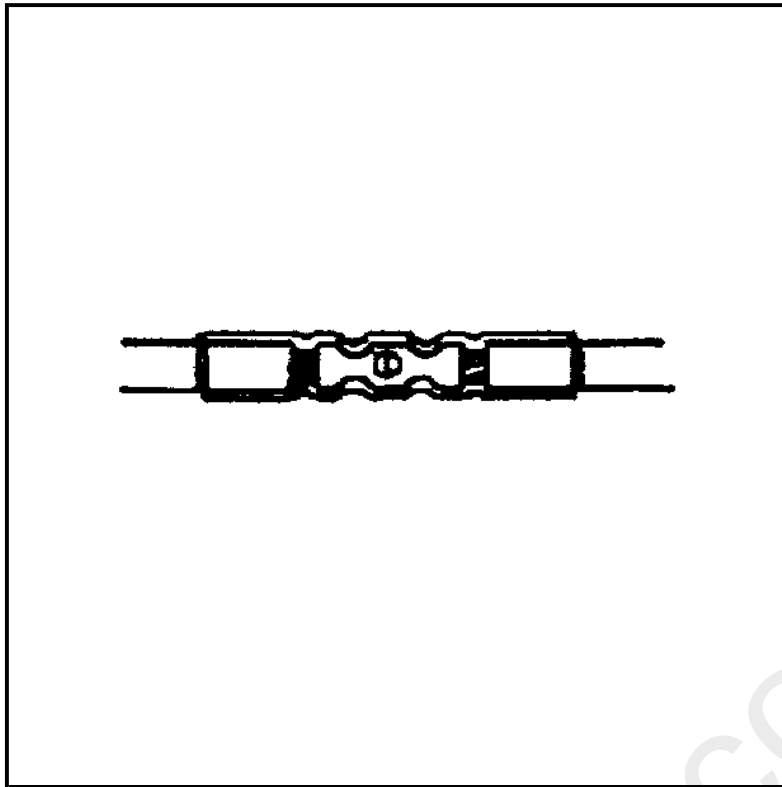
Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different

gauges.

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.

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.

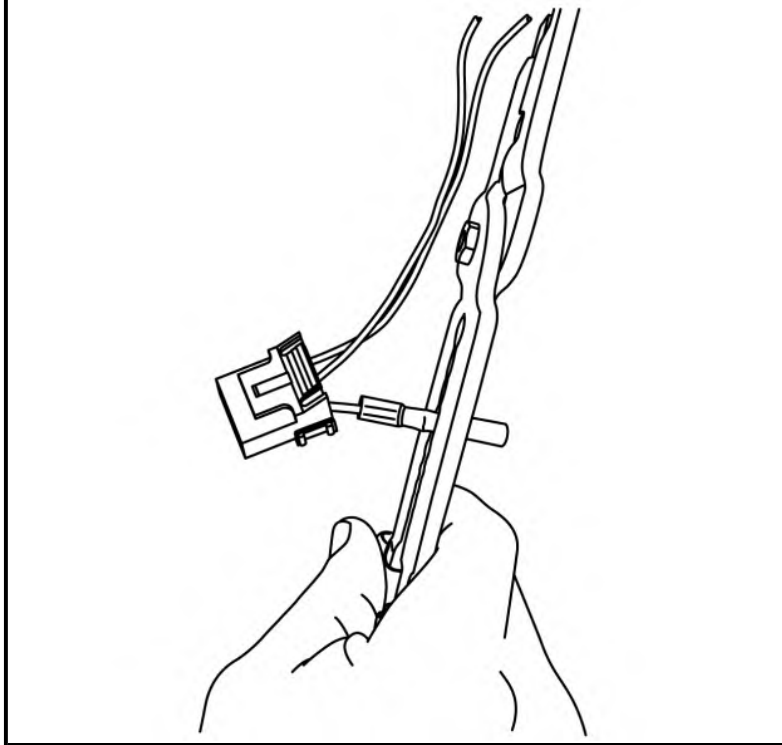
Weatherpack™ Wiring Repair

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.



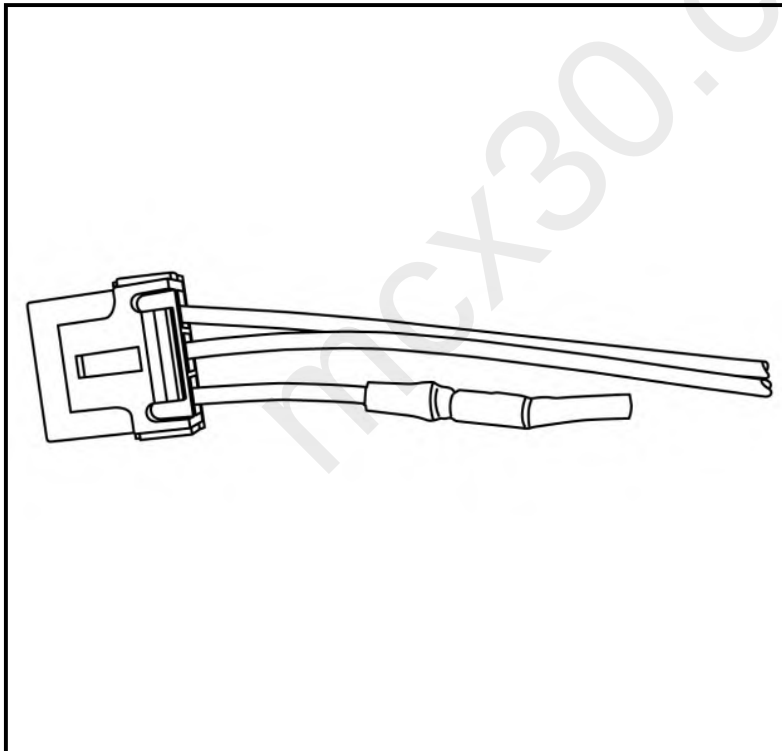


2. Tightly close the handles of the crimp tool until the crimper handles open when released.

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.

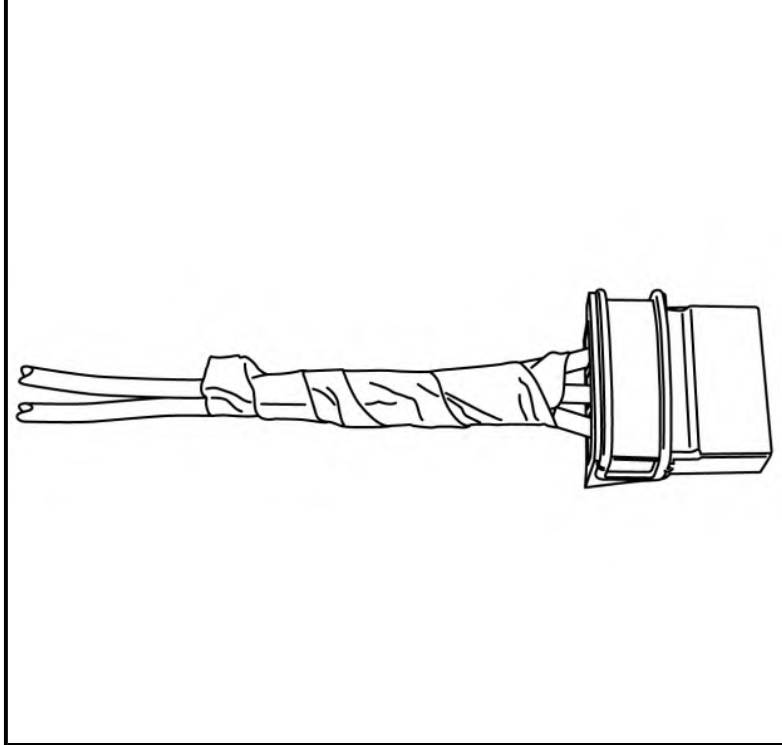


Start in the middle and gradually move the heat barrel to the open ends of the tubing:

- 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.

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 Wiring 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 Wiring 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.

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.**

- 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.

STEERING LINKAGE INNER TIE ROD INSPECTION

Special Tools

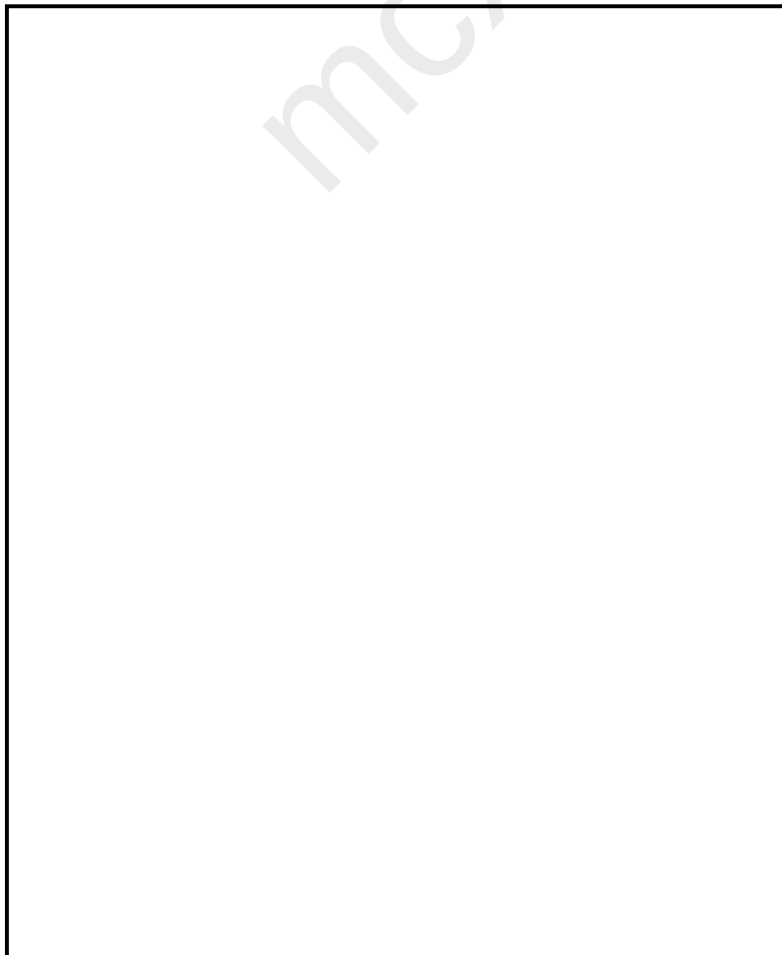
GE-8001 Dial Indicator Set

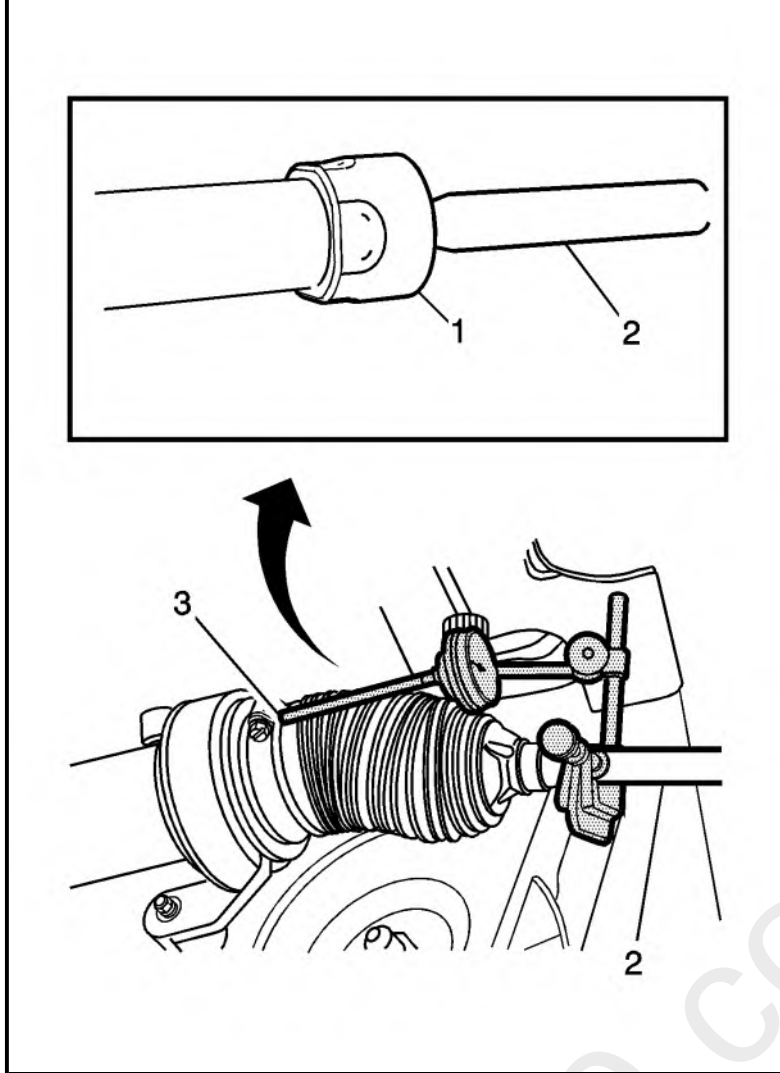
For equivalent regional tools, refer to [Special Tools](#).

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

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

2.



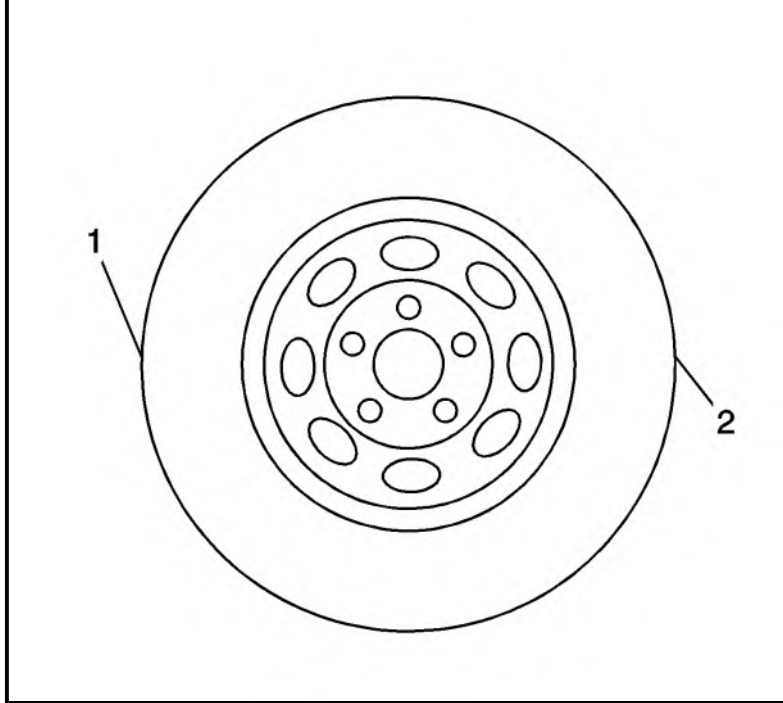


With the aid of an assistant, turn the steering wheel to the full stop position and hold the steering wheel in that position until the test is complete. Part of the steering linkage inner tie rod (2) being tested should be inside the steering gear housing. The inner tie rod housing (1) being tested should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

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.





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.

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.

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

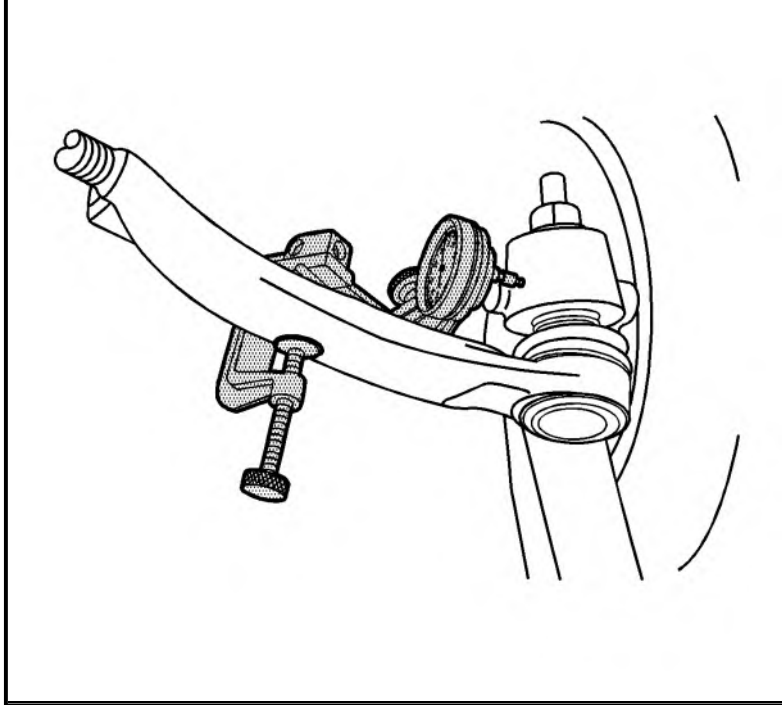
For equivalent regional tools, refer to [Special Tools](#).

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

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](#).
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](#).

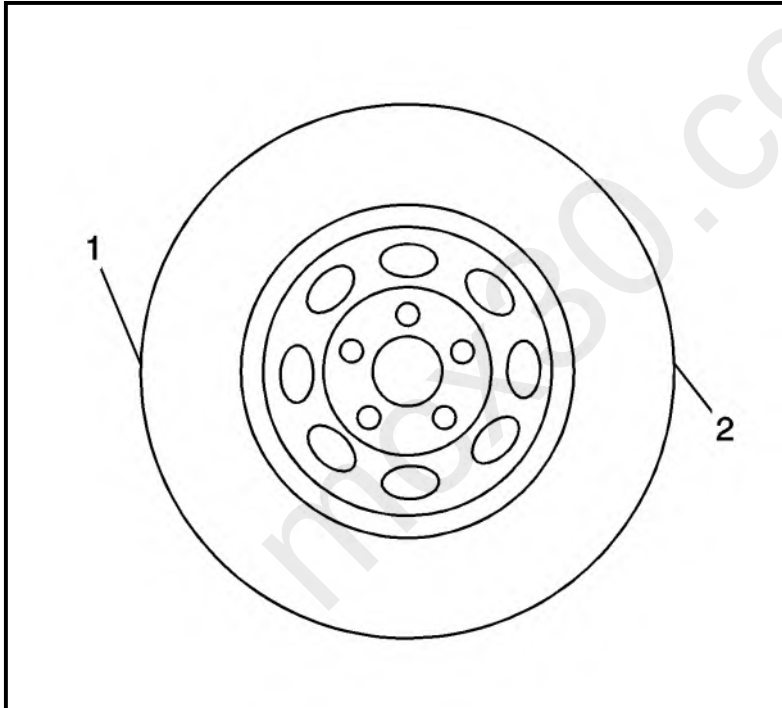
3.





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.

4.

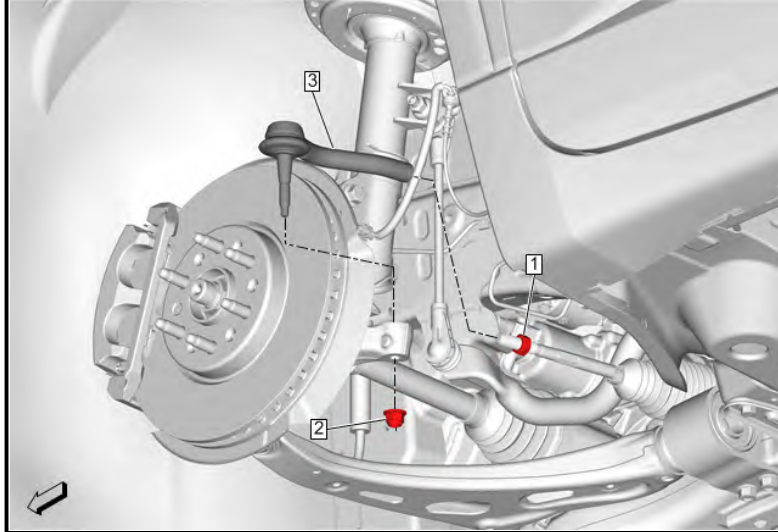


Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire to remove any lash.

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.

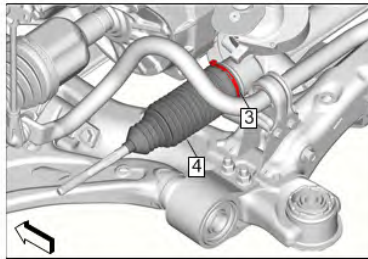
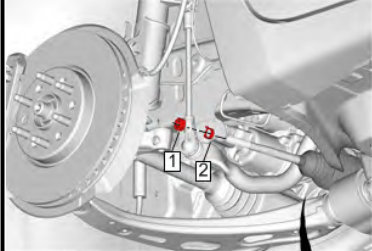
STEERING LINKAGE OUTER TIE ROD REPLACEMENT





Callout	Component Name
Preliminary Procedure Remove the front tire and wheel assembly. 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: (90 - 100 degrees)
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. 4. Install the front tire and wheel assembly. Tire and Wheel Removal and Installation 5. Measure and adjust the front toe. Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment Special Tools CH-161-B Bearing Puller Equivalent regional tools: Special Tools

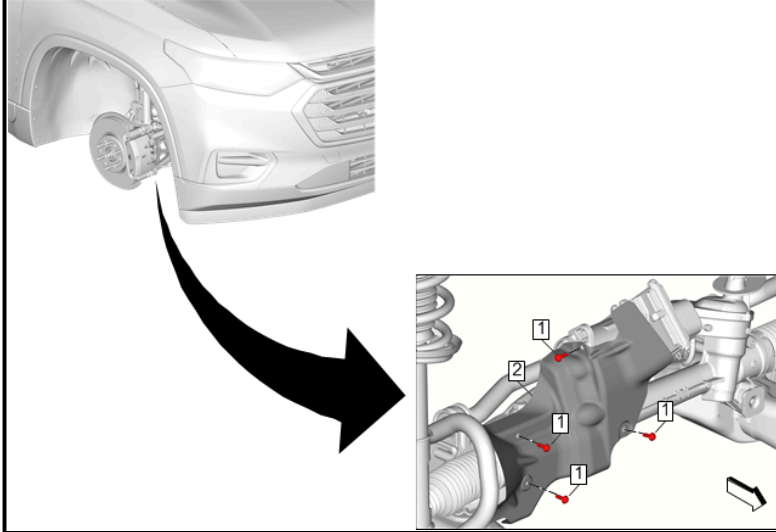
STEERING GEAR BOOT REPLACEMENT



Callout	Component Name
Preliminary Procedure Steering Linkage Outer Tie Rod Replacement	
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
3	Steering Gear Boot Inner Clamp Procedure - Cut the steering gear boot inner clamp. DISCARD the clamp. - 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. Special Tools DT-35910 Drive Axle Boot Clamp Pliers Equivalent regional tools: Special Tools
4	Steering Gear Boot Procedure - 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. Electric Belt Drive Rack and Pinion Steering Gear Replacement - 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.

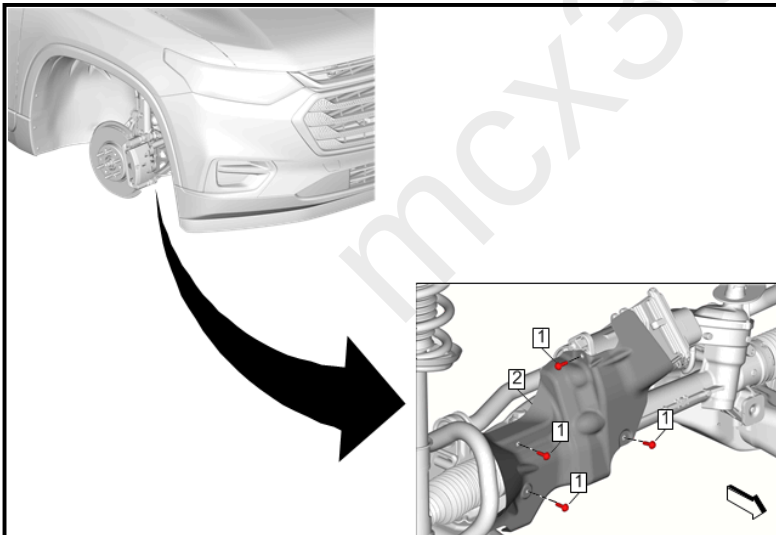
STEERING GEAR HEAT SHIELD REPLACEMENT (LFY)





Callout	Component Name
Preliminary Procedure <u>Warm Up Three-Way Catalytic Converter Replacement (LFY Bank 1 AWD) Warm Up Three-Way Catalytic Converter Replacement (LFY Bank 1 2WD) - Rear</u>	
1	Steering Gear Heat Shield Bolt [4x] CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Steering Gear Heat Shield

STEERING GEAR HEAT SHIELD REPLACEMENT (LTG)



Callout	Component Name
Preliminary Procedure <u>Exhaust Front Pipe Replacement (LTG)</u>	
1	Steering Gear Heat Shield Bolt [4x] CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Steering Gear Heat Shield

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:

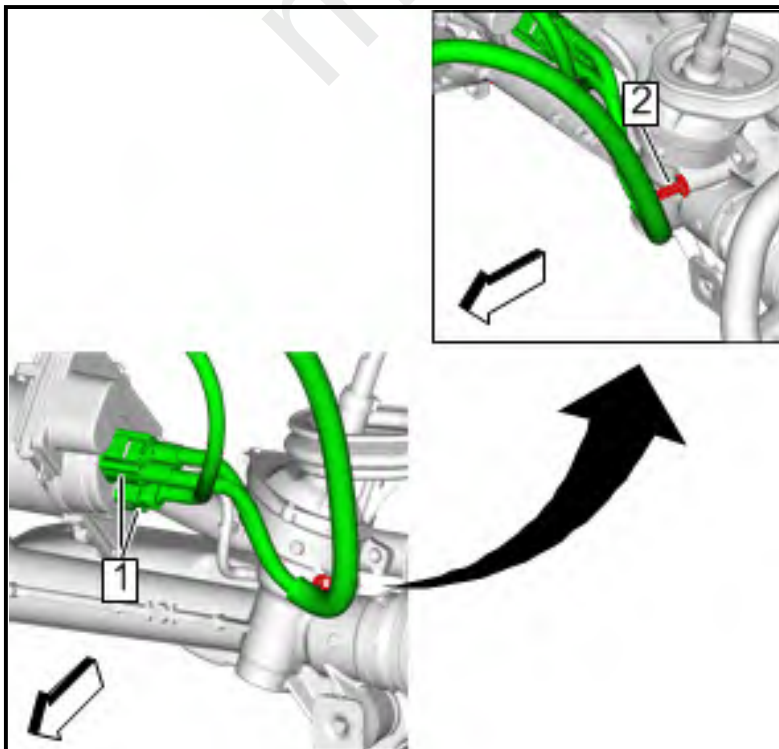
During removal and installation, all EPS components including mechanical and/or electrical is extremely susceptible to damage. Dropping or prying on any EPS component may cause internal damage. If damage occurs or a part is dropped, the EPS component must be replaced.

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.

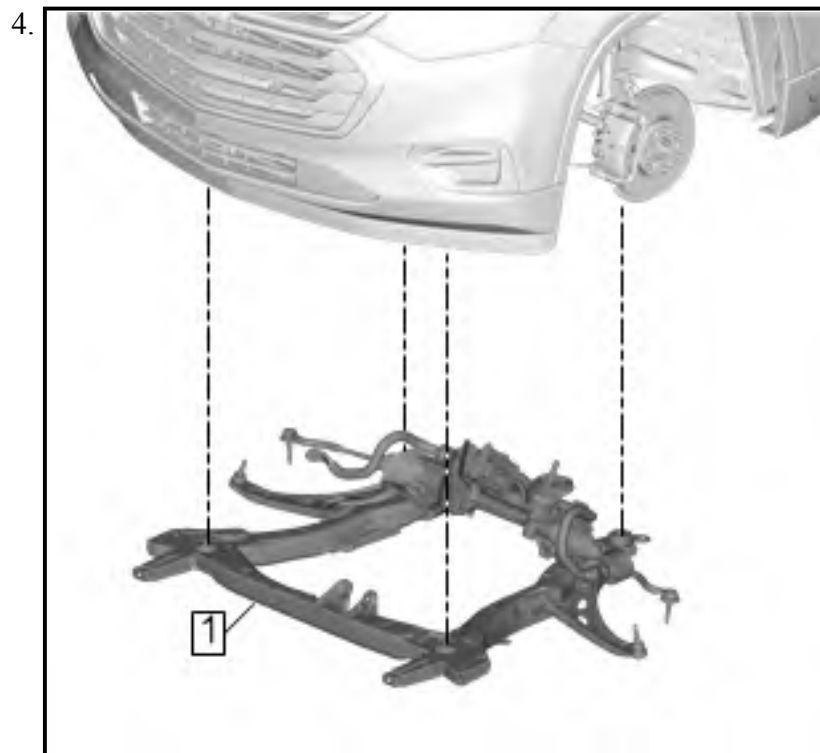
1. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

2.

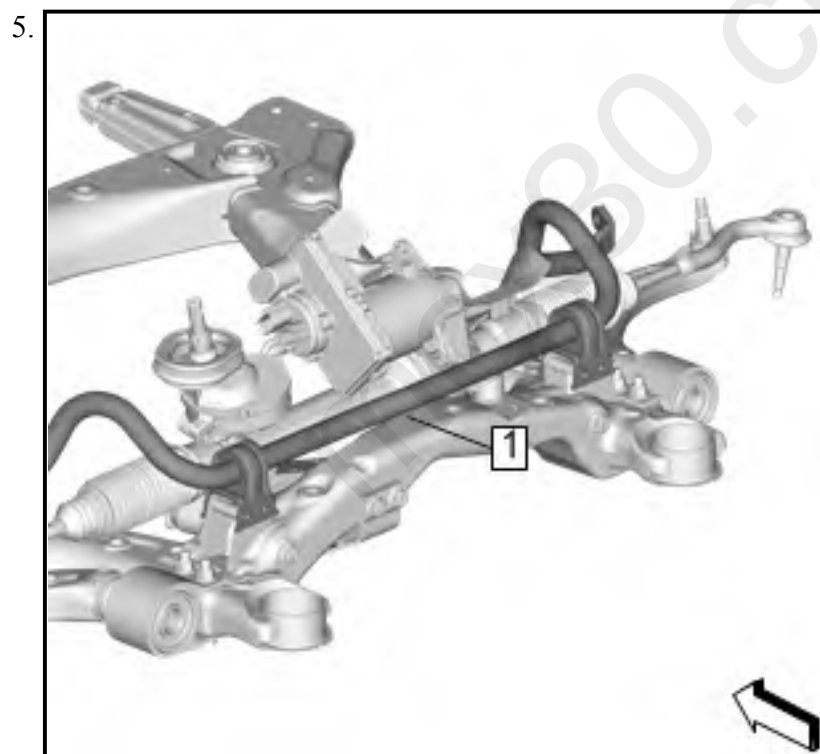


Disconnect the steering gear electrical connectors (1).

3. Remove the steering gear wiring harness clip (2) from the mounting point on the steering gear.

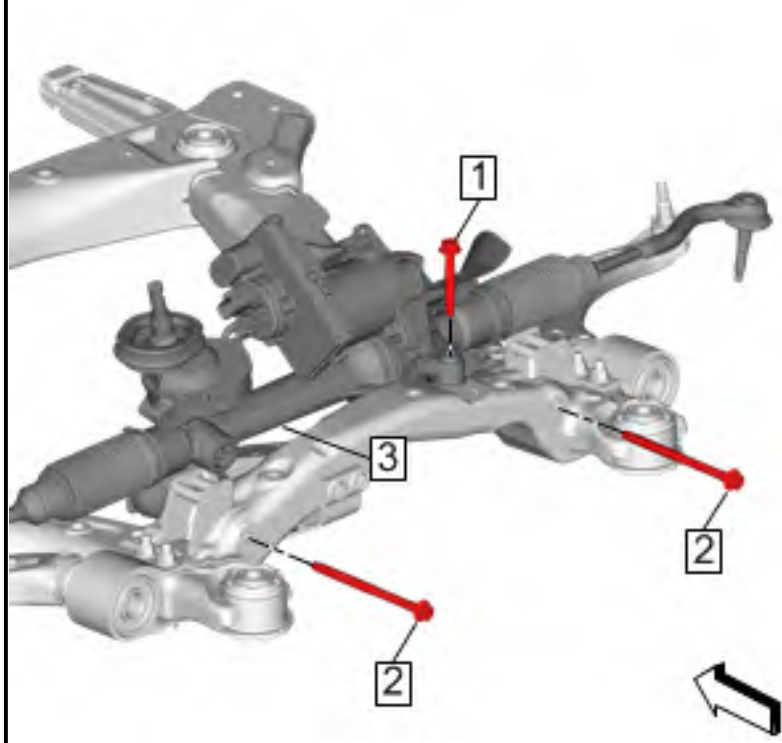


Drivetrain and Front Suspension Cradle (1) - Remove - [Drivetrain and Front Suspension Cradle Removal and Installation \(All Wheel Drive\)](#) [Drivetrain and Front Suspension Cradle Removal and Installation \(Front Wheel Drive\)](#)



Front Stabilizer Shaft (1) - Remove - [Stabilizer Shaft Replacement](#)

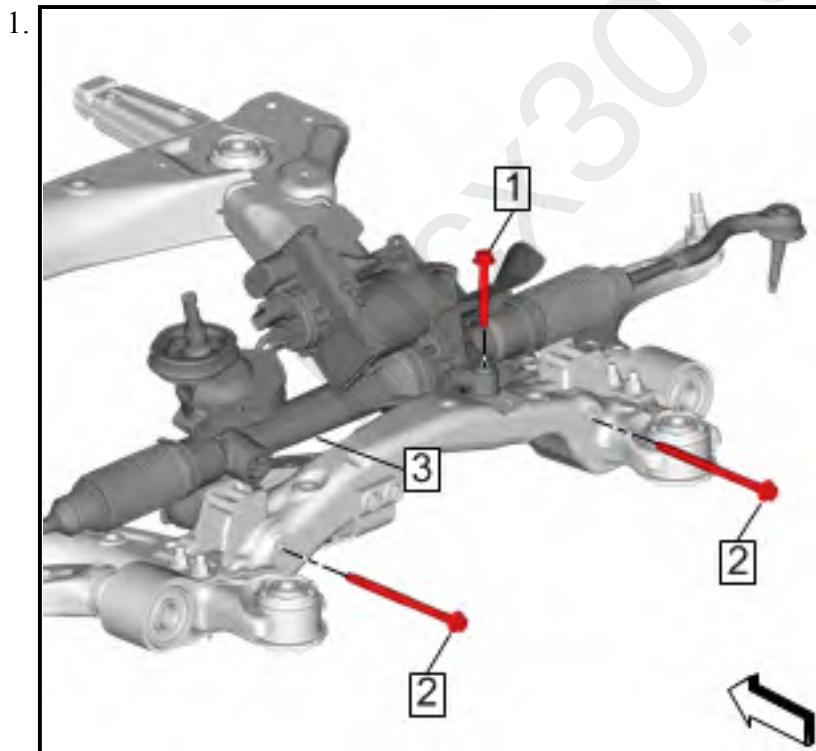




Steering Gear Bolt (1) - Remove

7. Steering Gear Bolt (2) - Remove [2x]
8. Remove the steering gear (3) from the drivetrain and front suspension cradle.
9. Transfer components as necessary.

Installation Procedure



Position the steering gear (3) on the drivetrain and front suspension cradle.

CAUTION: Refer to **Fastener Caution** .

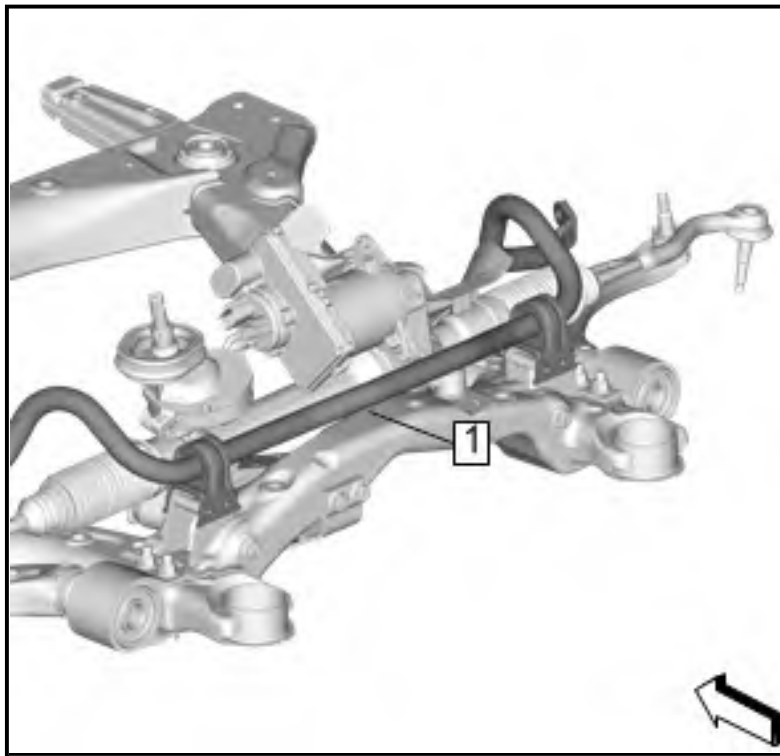
2. Steering Gear Bolt (2) - Install and tighten [2x]

Tighten

1. First Pass: 100 N.m (74 lb ft)
2. Final Pass: (45 - 60 degrees)

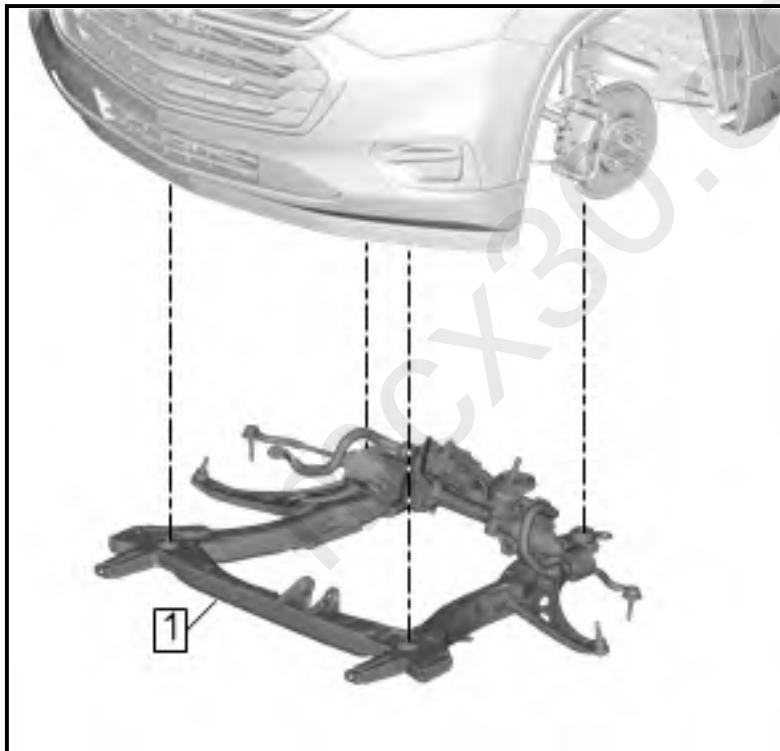
3. Steering Gear Bolt (1) - Install and tighten 100 N.m (74 lb ft)

4.



Front Stabilizer Shaft (1) - Install - [Stabilizer Shaft Replacement](#)

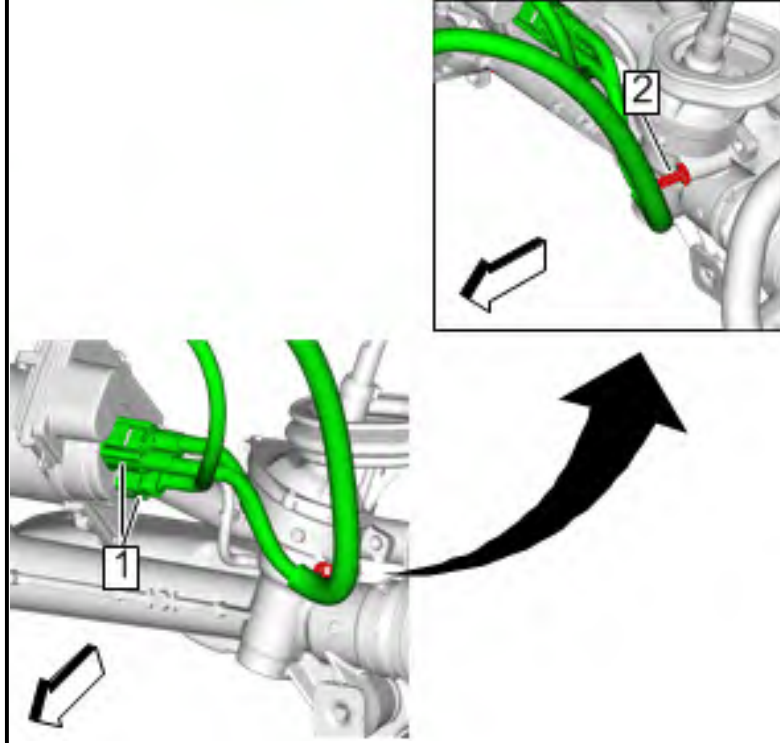
5.



Drivetrain and Front Suspension Cradle (1) - Install - [Drivetrain and Front Suspension Cradle Removal and Installation \(All Wheel Drive\)](#). [Drivetrain and Front Suspension Cradle Removal and Installation \(Front Wheel Drive\)](#)

6.

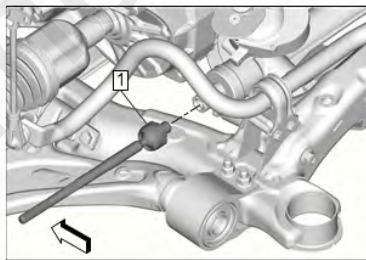
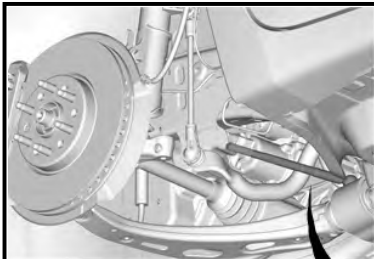




Connect the steering gear electrical connectors (1).

7. Install the steering gear wiring harness clip (2) in the mounting point on the steering gear.
8. Program the power steering control module. [Control Module References](#)
9. Measure and adjust the wheel alignment. [Wheel Alignment Measurement](#)

STEERING LINKAGE INNER TIE ROD REPLACEMENT



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. 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 . CAUTION: Holding the steering gear rack bar with anything other than a non-serrated adjustable wrench will cause damage to the steering gear Procedure 1. Cover the steering gear rack bar with a clean shop towel. 2. Hold the steering gear rack bar with a non-serrated adjustable wrench. 3. Rotate the steering linkage inner tie rod housing counterclockwise to remove the tie rod. 4. Rotate the steering linkage inner tie rod housing clockwise to install the tie rod. Use the CH-6321 wrench and a torque wrench to tighten the steering linkage inner tie rod to specification. 5. Measure and adjust the front toe. Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment Tighten 100 N.m (74 lb ft) Special Tools CH-6321 Inner Tie Rod Wrench Equivalent regional tools: Special Tools

POWER STEERING ASSIST MOTOR REPLACEMENT

Special Tools

GE-50576-A Acoustic Belt Tension Tester

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:

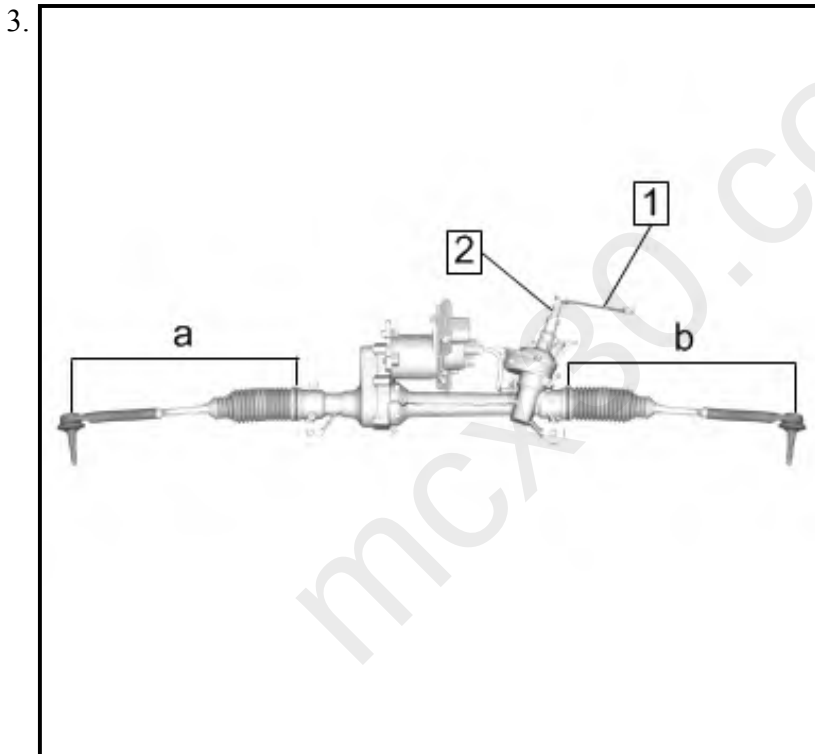
Care must be taken during removal and installation of the Electronic Power Steering (EPS) components to not hit or break the EPS motor/controller module or module harness connectors. If the EPS motor/controller module or module connectors are damaged, the complete component must be replaced.

1. Steering Gear - Remove - [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)

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.

2. Place the steering gear in a vise.

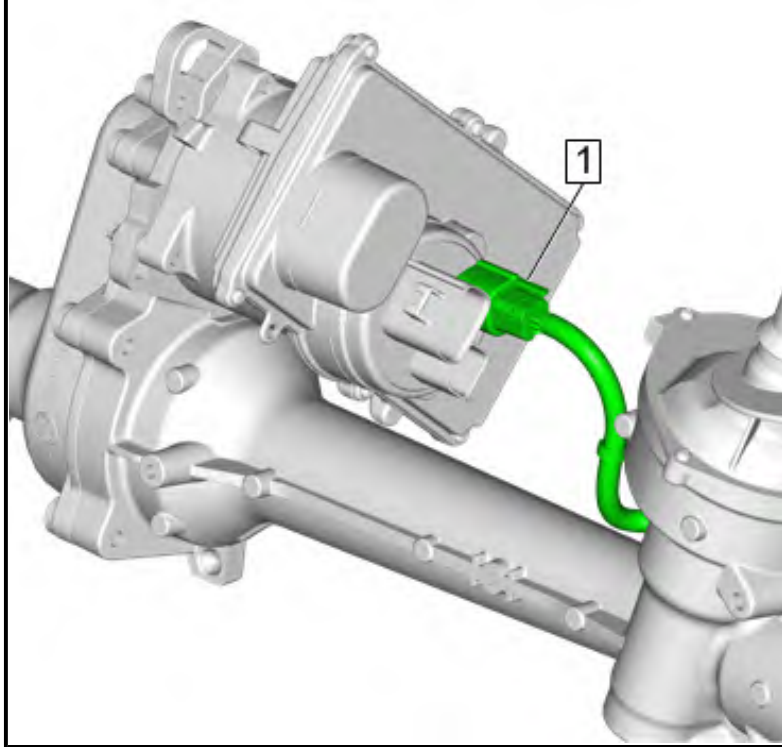
**NOTE:**

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

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

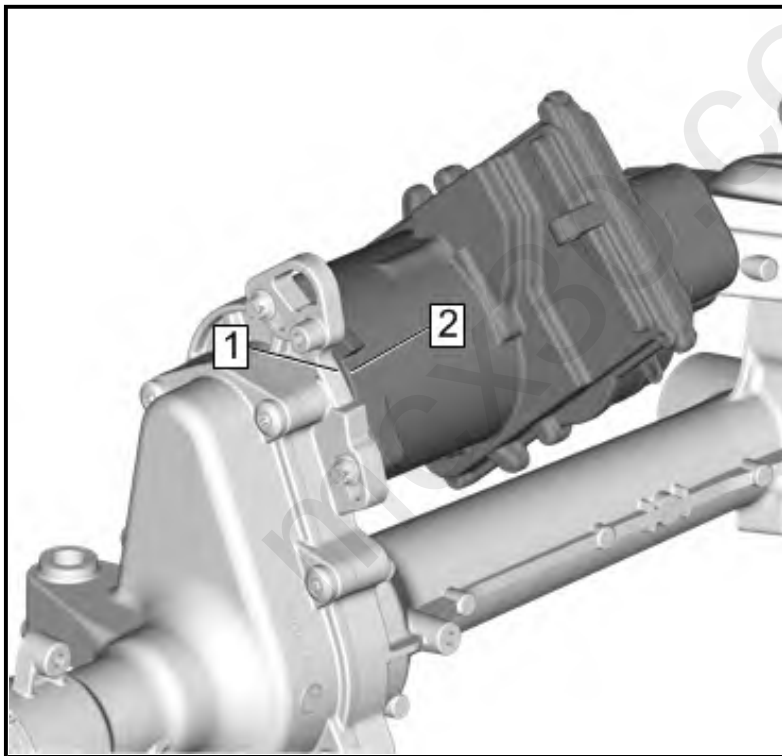
4. Use the following procedure to verify the steering gear rack is centered:
 1. Measure distance (a) from the top of the steering linkage outer tie rod to the steering gear boot inner clamp on either side of the steering gear rack.
 2. Measure distance (b) from the top of the steering linkage outer 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.





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.

6.

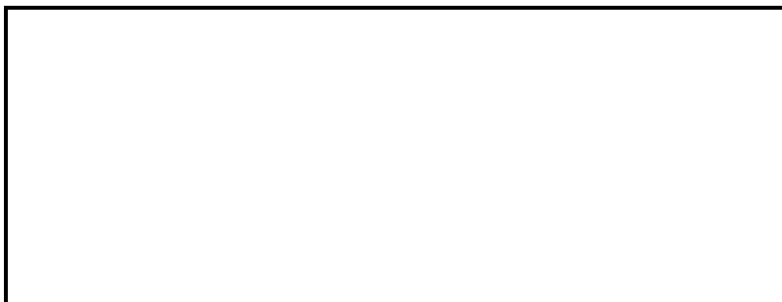


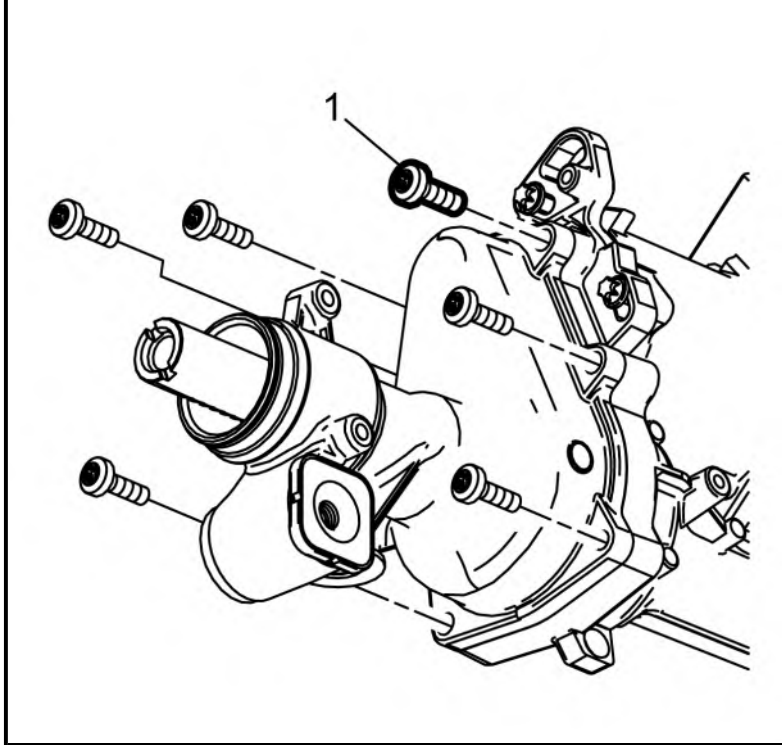
NOTE: Cleaning the entire area of dirt and debris will ensure no contaminants enter the steering gear.

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.

7. Steering Linkage Inner Tie Rod @ Belt Side - Remove - [Steering Linkage Inner Tie Rod Replacement](#)

8.

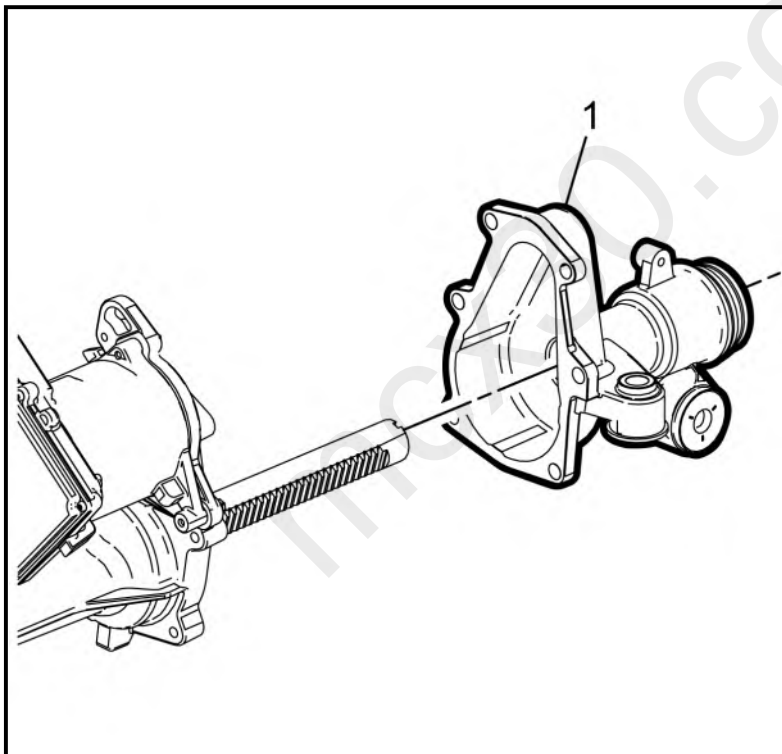




Remove the steering gear housing cover bolts (1).

DISCARD the bolts.

9.



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.

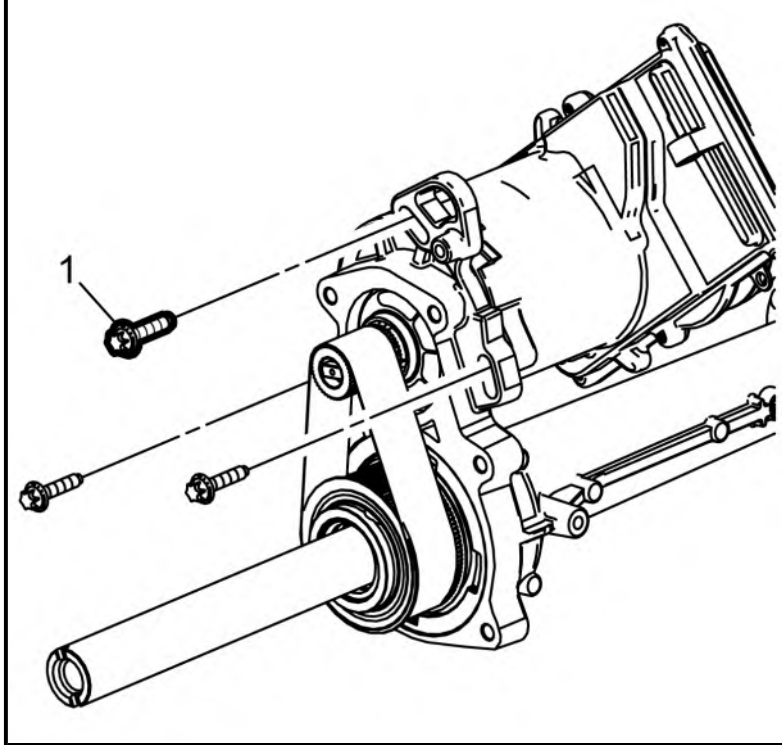
10. Inspect the inside of the steering gear housing for contamination and inspect the steering gear belt for any damage.

If there is any contamination in the steering gear housing or the belt is damaged, replace the steering gear.

[Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)

11.

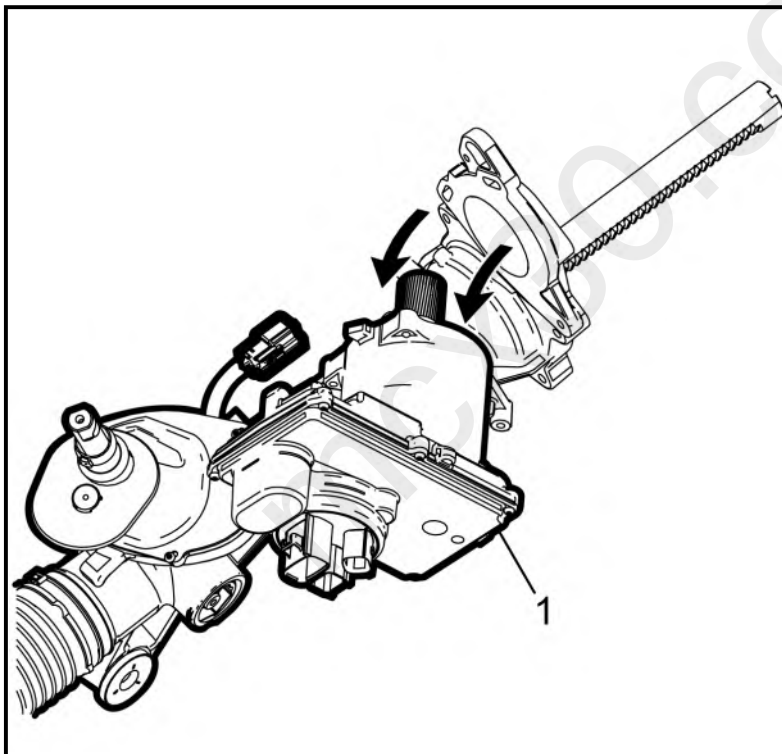




Remove the power steering assist motor pivot bolts (1).

DISCARD the bolts.

12.



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.

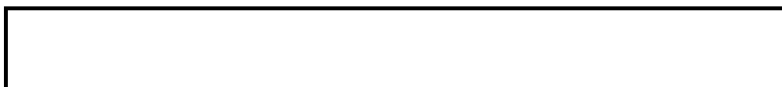
DISCARD the belt.

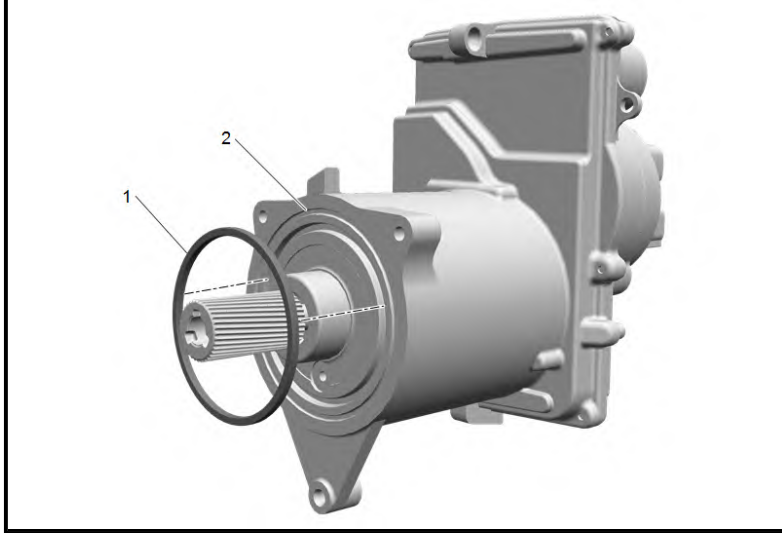
13. Install a clean shop rag over the large steering gear pulley to prevent any dirt and debris from entering the steering gear housing.

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).

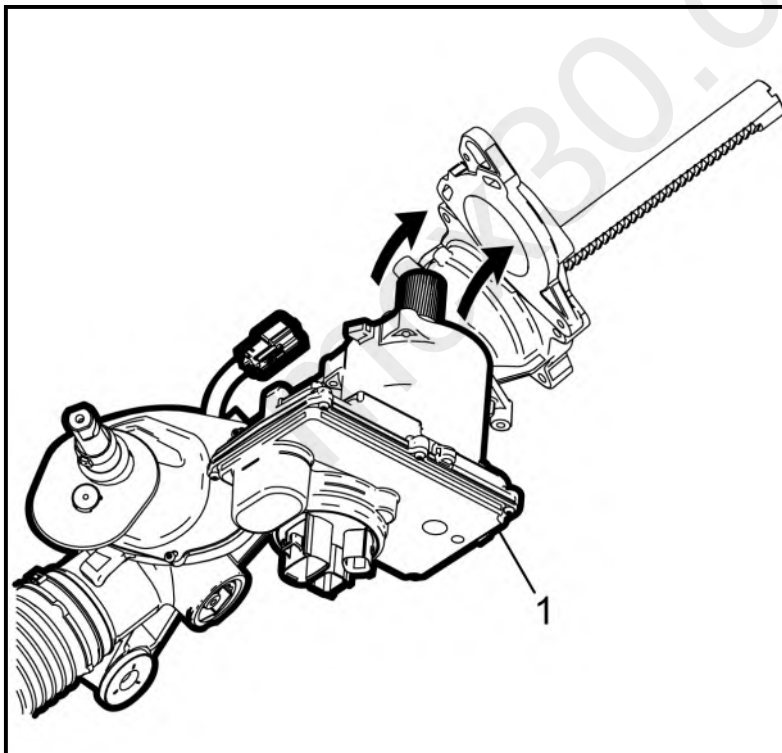
NOTE:

- Do NOT spray on the lithium grease or overspray may occur.
- The power steering assist motor gear teeth MUST remain grease free.

3. Add a light film of lithium grease to the nose (2) of the power steering assist motor.
4. Inspect the teeth 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.

5. Hang the NEW steering gear belt on the large steering gear pulley.
- 6.



NOTE:

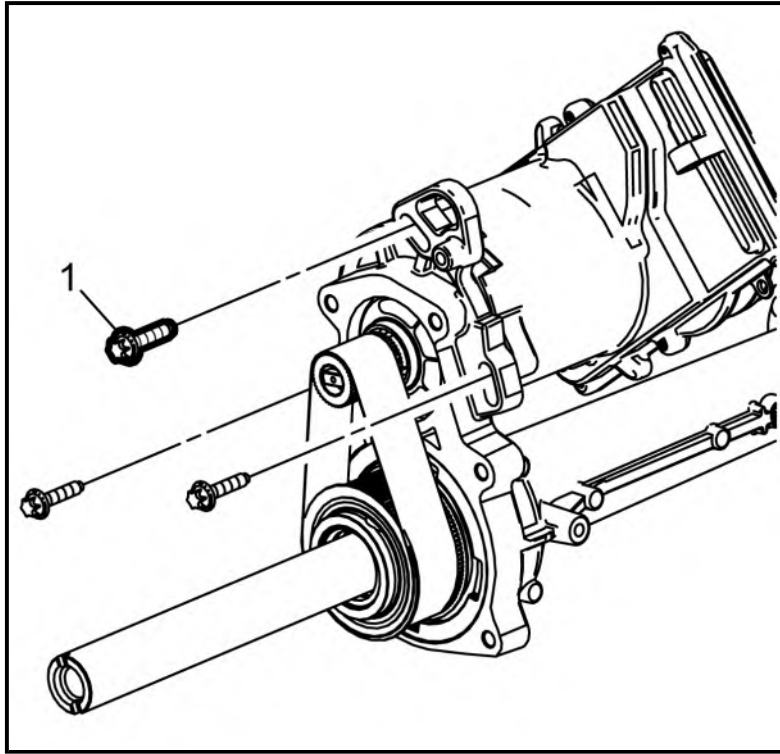
- Do NOT pinch or roll the power steering assist motor seal while installing the power steering assist motor into the steering gear housing.
- Before adding tension to the steering gear belt, ensure the belt is centered on the large steering gear pulley.

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.

Do NOT allow the belt to come into contact with any of the grease in the steering gear housing.

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.

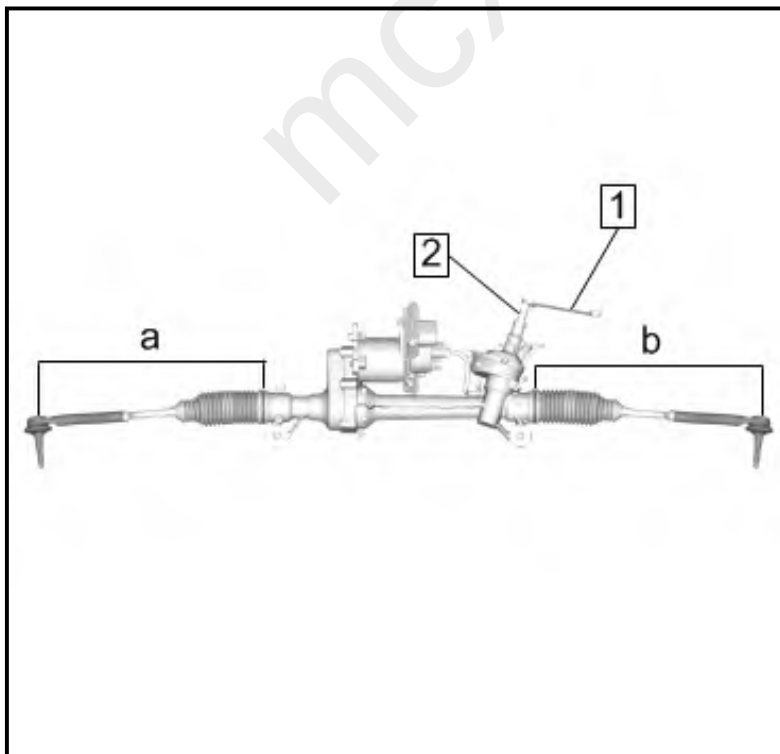


CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE: After hand tightening the **NEW** power steering assist motor pivot bolts, ensure the motor can still rotate.

Install and tighten the **NEW** power steering assist motor pivot bolts (1) by hand.

9.

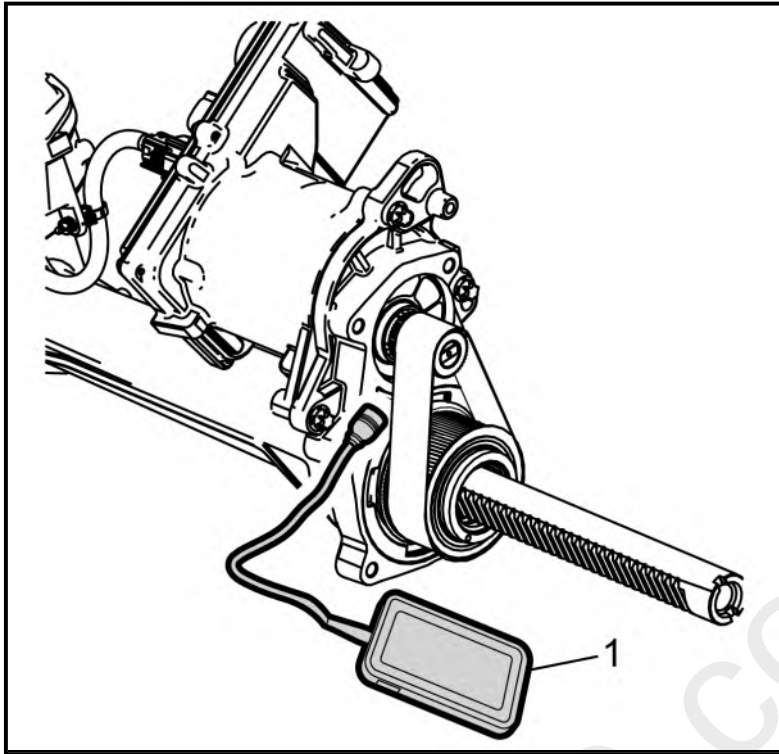


Use an open end wrench (1) to rotate the steering gear input shaft (2) 90 degrees in both directions and back to the center position to seat the steering gear belt.

10. Use the following procedure to verify the steering gear rack is centered:

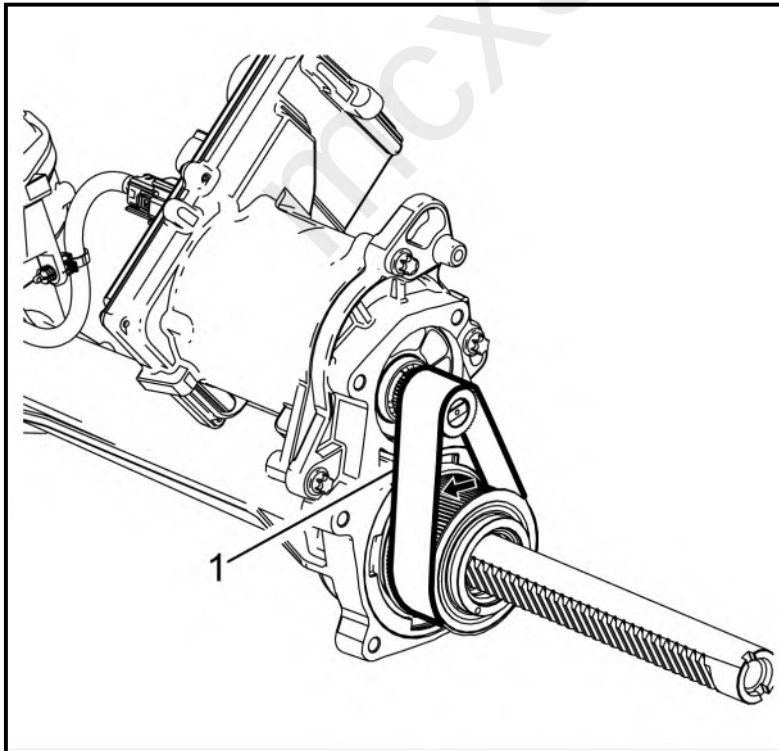
1. Measure distance (a) from the top of the steering linkage outer tie rod to the steering gear boot inner clamp on either side of the steering gear rack.
2. Measure distance (b) from the top of the steering linkage outer tie rod to the steering gear boot inner clamp on the opposite side of the steering 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.

12.



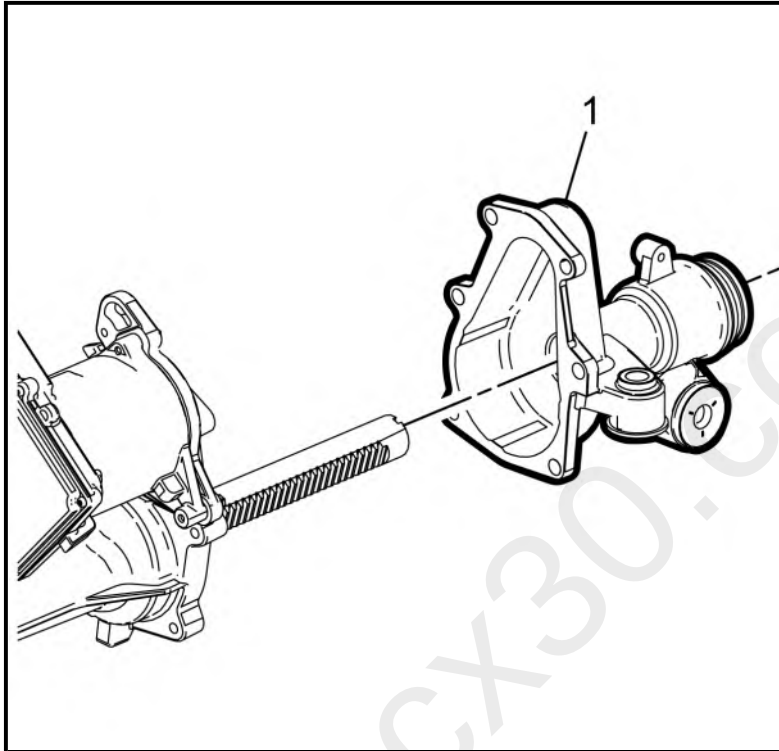
CAUTION: Refer to **Fastener Caution** .

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.

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 bolts to 10 N.m (89 lb in).
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. 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.
14. Inspect the steering gear housing cover seal and ensure the seal is seated correctly and that both dowel pins are seated.

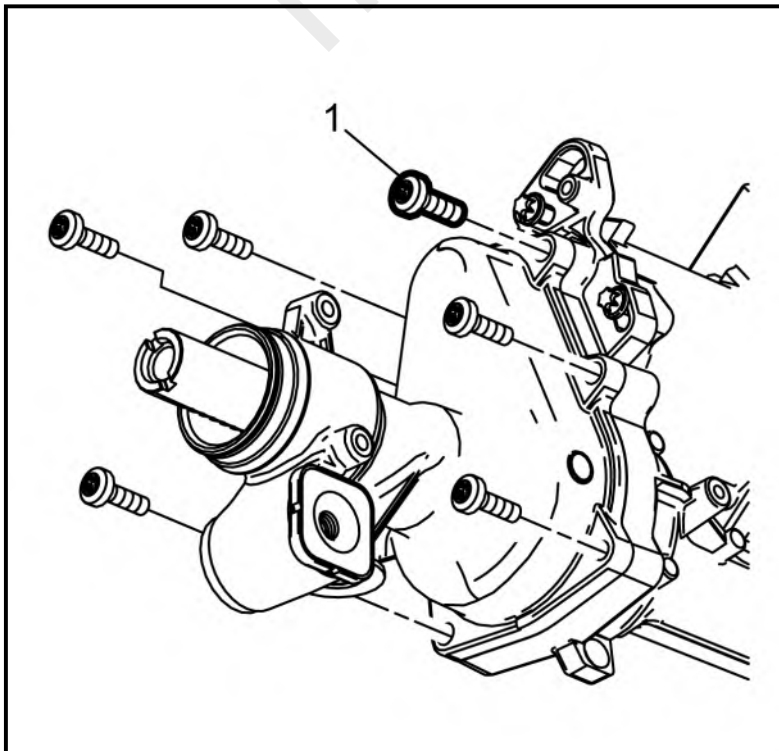
If the seal is damaged, install a NEW seal.

15.



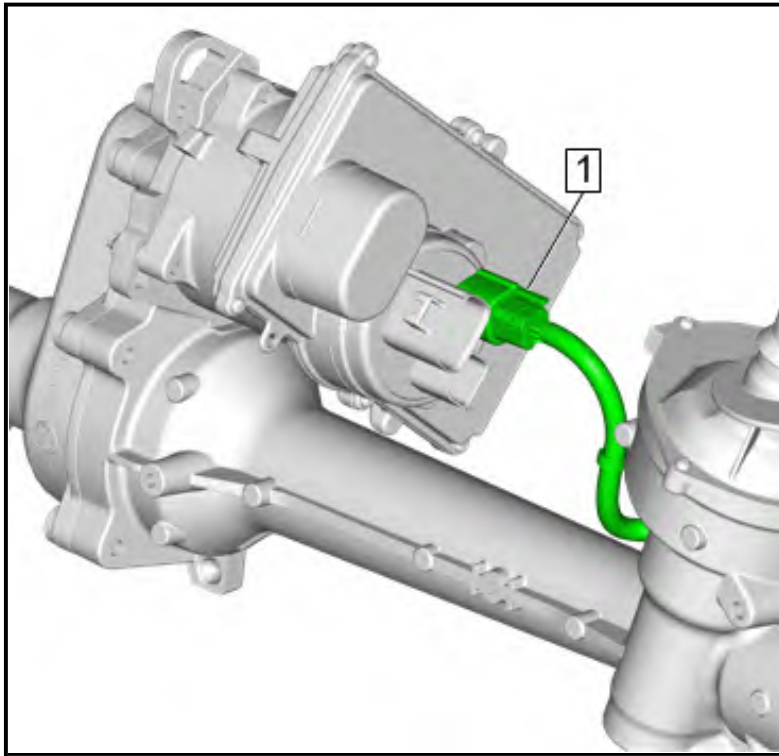
Install the steering gear housing cover (1).

16.



Install the NEW steering gear housing cover bolts (1) and tighten to 25 N.m (18 lb ft).

17.



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.

Connect the torque sensor wiring harness connector (1) to the power steering assist motor controller module.

Ensure the connector lock is engaged.

18. Steering Linkage Inner Tie Rod @ Belt Side - Install - [Steering Linkage Inner Tie Rod Replacement](#)

19. Remove the steering gear from the vise.

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.

20. Steering Gear - Install - [Electric Belt Drive Rack and Pinion Steering Gear Replacement](#)

21. Program the power steering control module. [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

NOTE: Ensure the front wheels are facing straight ahead before turning the engine off.

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

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

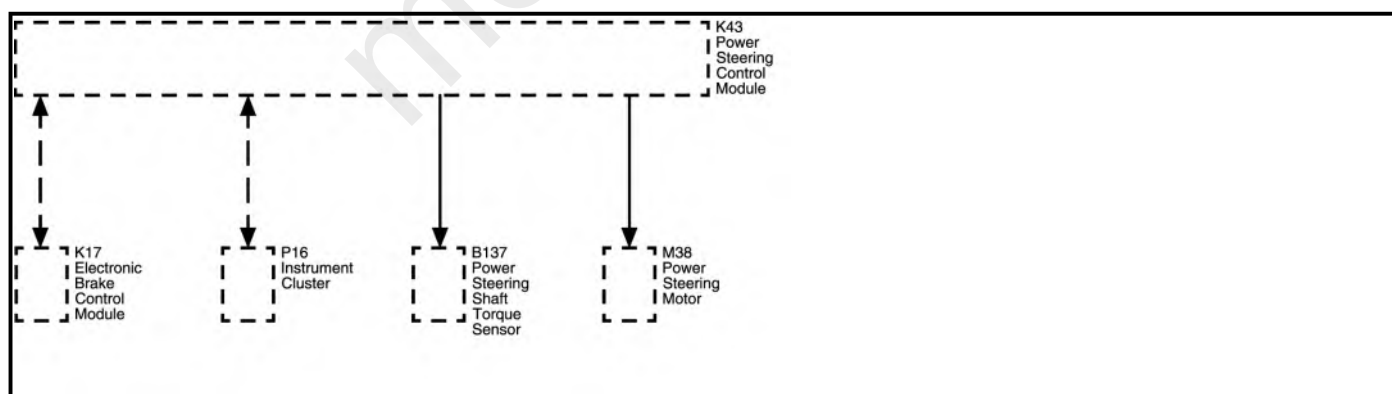
1. Using the steering wheel, align the front wheels in the center forward position.
2. Using a scan tool, perform the Configuration/Reset Functions, Steering Wheel Angle Sensor Centering procedure.
3. Steer from the center position slowly 90° to the left.
4. Steer slowly back to the center position and 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 endstops are learned automatically and do not require any additional procedures.

DESCRIPTION AND OPERATION

POWER STEERING SYSTEM DESCRIPTION AND OPERATION



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:

- A belt drive and a ball nut mechanism
- A power pack; containing the power steering control module, its sensors, the power steering motor

- A torque sensor
- The steering gear (rack and pinion)

The belt driven electric power steering system reduces the amount of effort needed to steer the vehicle by utilizing the power steering control module to control the power steering motor to maneuver the steering rack. The power steering control module uses input from the torque sensor, motor rotational sensor, battery voltage circuit and GMLAN serial data circuit to determine the level of motor assist. Vehicle speed and engine speed from the GMLAN serial data circuit is also used to adjust 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 torque sensor is attached to the steering gear housing near the input shaft, and is critical to proper operation of the electronic power steering system. As the steering wheel is turned and torque is applied to the steering shaft, the torque sensor monitors the amount of input torque.

The power steering control module responds to the torque sensor and motor rotational sensor by commanding current to the power steering motor.

The power steering control module and motor are attached to the base of the steering gear housing, and applies power assist through the belt drive and ball nut mechanism to the steering rack. The ball nut mechanism translates the rotational movement of the belt drive system to lateral movement of the steering rack. 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. Additionally, the power steering control module calculates an internal system temperature which is used to protect the power steering system from damage caused by high temperature. When the calculated temperature exceeds a pre-determined level the amount of current commanded to the power steering motor is reduced. This will result in a temporary reduced level of assist. Full assist will return once the calculated temperature drops below the pre-determined level.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	CH-24319-01 CH-24319-B J-24319-B SA91100C 7503 Universal Steering Linkage and Tie Rod Puller

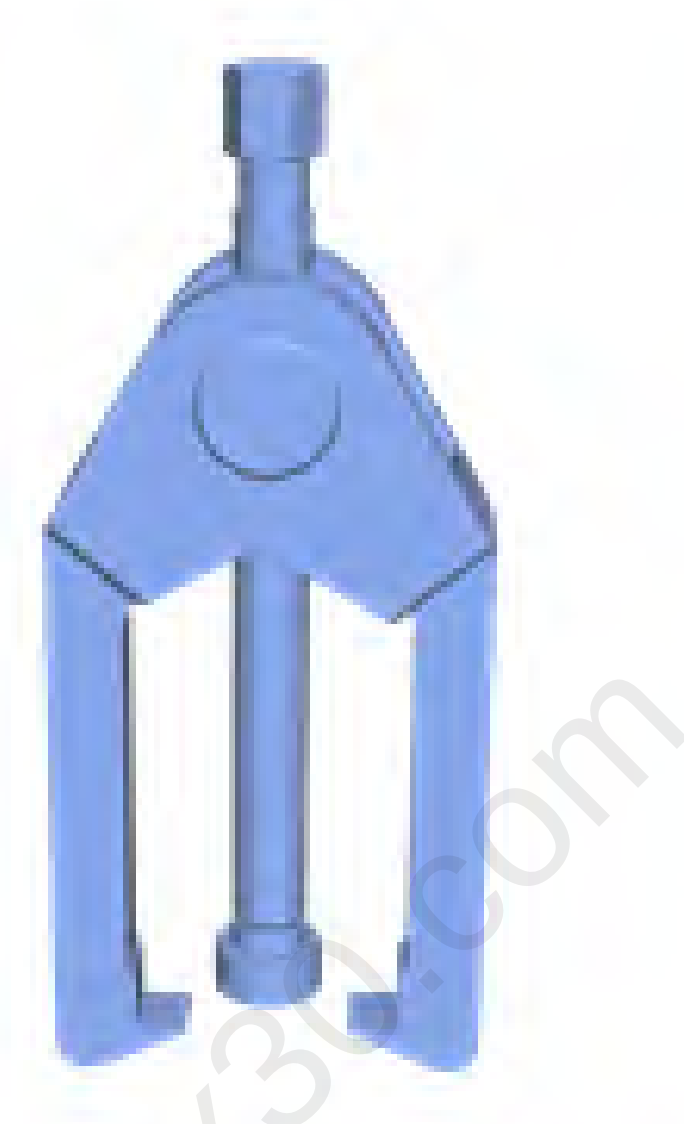
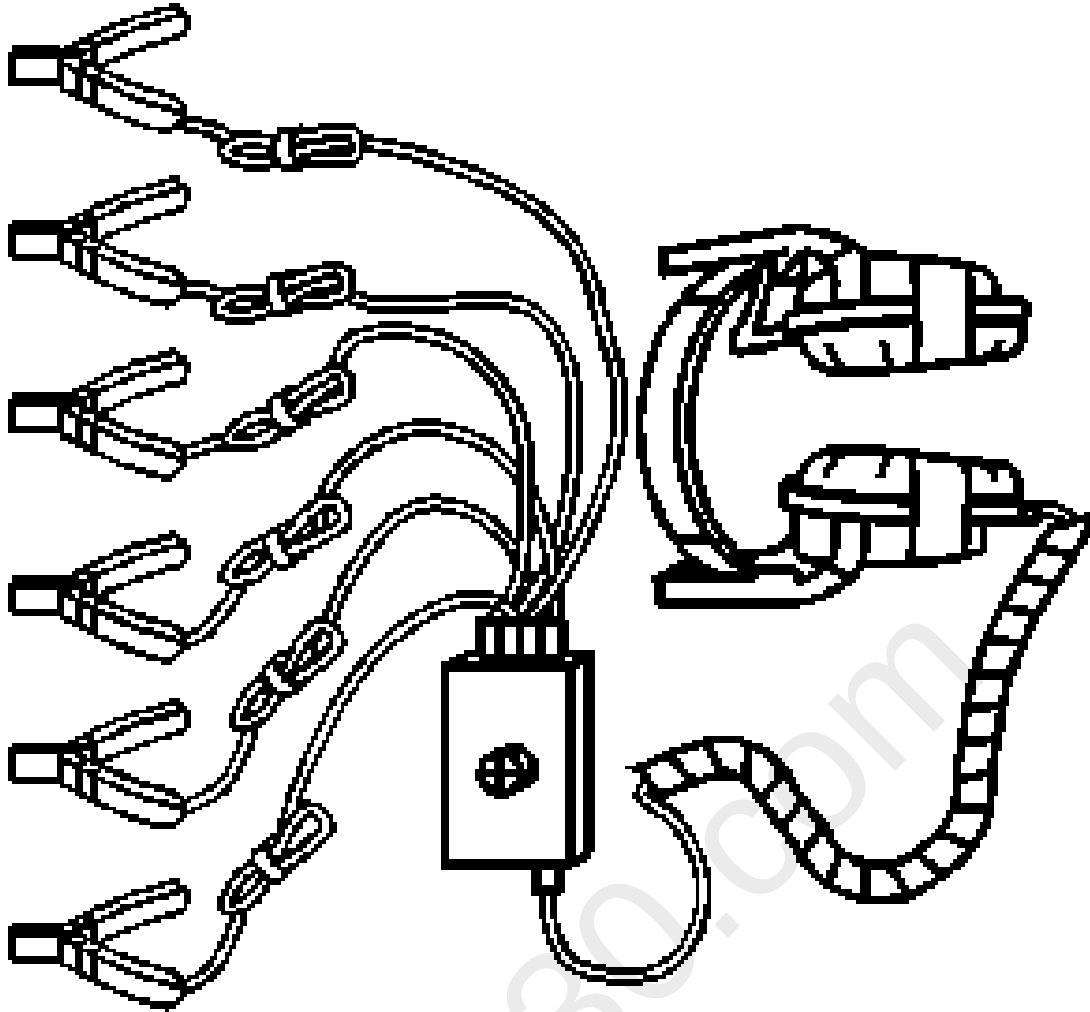
Illustration	Tool Number/Description
	

Illustration	Tool Number/Description
	CH-6321 J-34028 KM-6321 8997009 Inner Tie Rod Wrench

Illustration	Tool Number/Description
	CH-39570 J-39570 Chassis Ear

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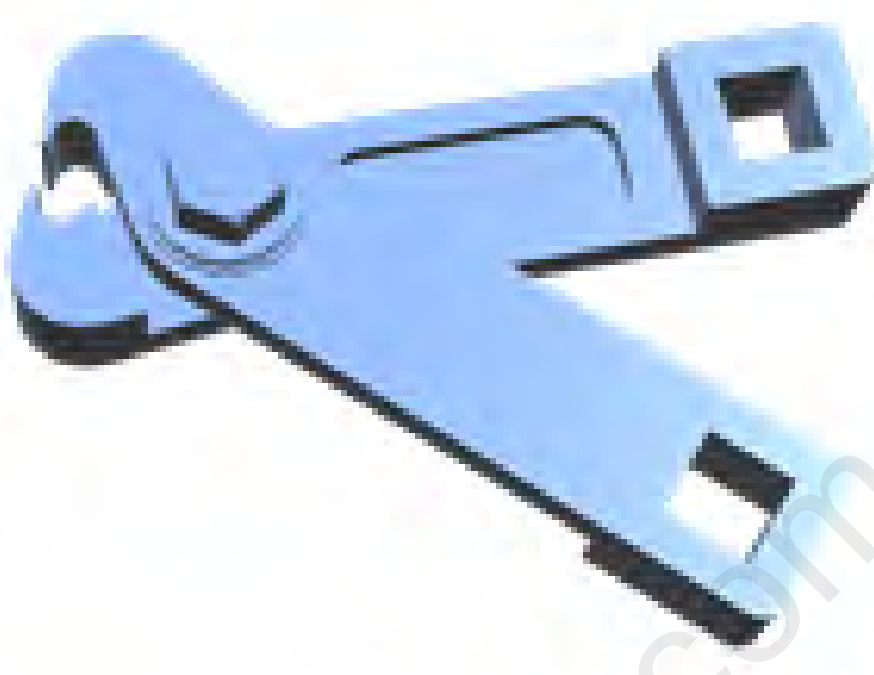
Illustration	Tool Number/Description
	DT-35910 J-35910 Drive Axle Boot Clamp Pliers

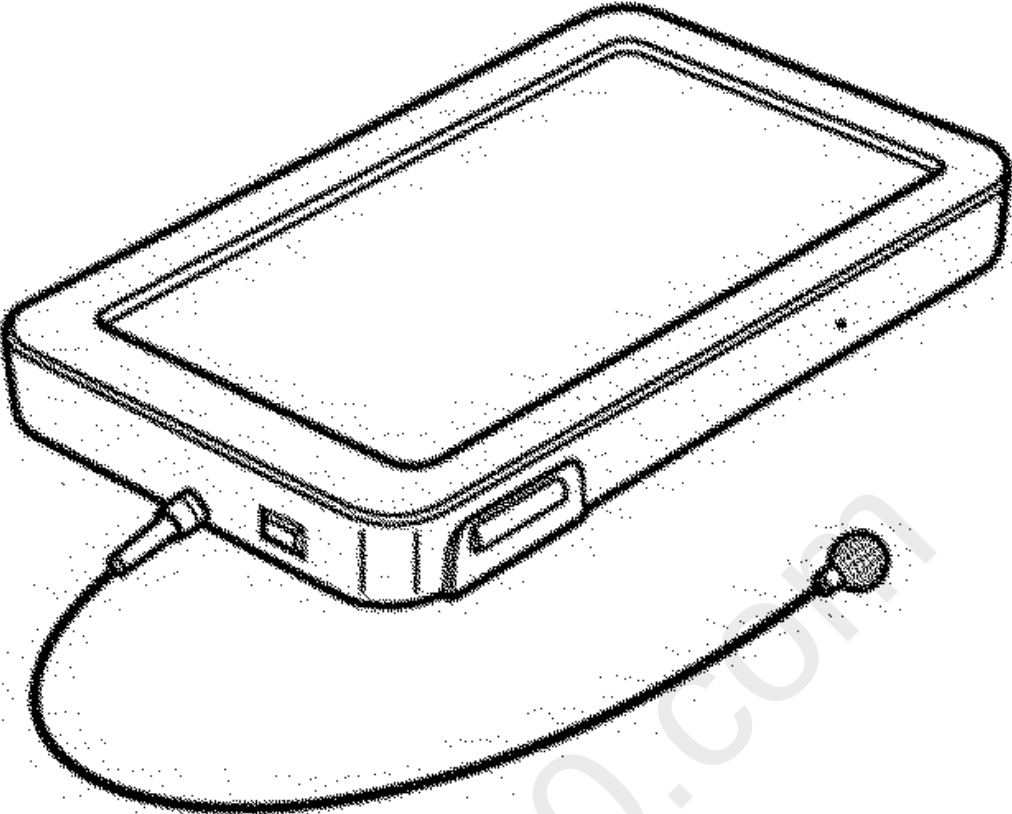
Illustration	Tool Number/Description
 The illustration shows a rectangular, box-like device with a flat top surface. A cable is connected to the bottom left corner, and a probe with a circular head is attached to the bottom right corner. The device has a small rectangular slot on the bottom edge. A large, faint watermark 'mcx30.com' is visible across the bottom half of the page.	GE-50576-A Acoustic Belt Tension Tool

Illustration	Tool Number/Description
	GE-8001 J-8001 Dial Indicator Set