

- **Steering**
- **Power Steering**
- **Description and Operation**

The power steering system reduces the amount of effort needed to steer the vehicle. The system uses the powertrain control module, body control module, power steering control module, discrete battery voltage supply circuit, steering shaft torque sensor, steering wheel position sensor, power steering motor and the serial data circuit to perform the system functions. The power steering control module and the power steering motor are serviced with the steering column assembly. The steering shaft torque sensor and the steering wheel position sensor are not serviced separately from each other or from the steering column assembly

Steering Shaft Torque Sensor

The power steering control module uses the steering shaft torque sensor as it's main input for determining steering direction and the amount of assists needed. The steering column has an input shaft, from the steering wheel to the torque sensor, and an output shaft, from the torque sensor to the steering shaft coupler. The input and output shafts are separated by a section of torsion bar, where the torque sensor is located. The sensor is a 5volt dual analog inverse signal device with a valid signal voltage range of 0.25–4.75 volts. When applying torque to the steering column shaft during a right turn, the sensor's signal 1 voltage increases, while the signal 2 voltage decreases within the valid signal voltage range. When applying torque to the steering column shaft during a left turn, the signal 1 voltage decreases, while the signal 2 voltage increases within the valid signal voltage range. The power steering control module recognizes this change in signal voltage as steering direction and steering column shaft torque.

Steering Wheel Position Sensor

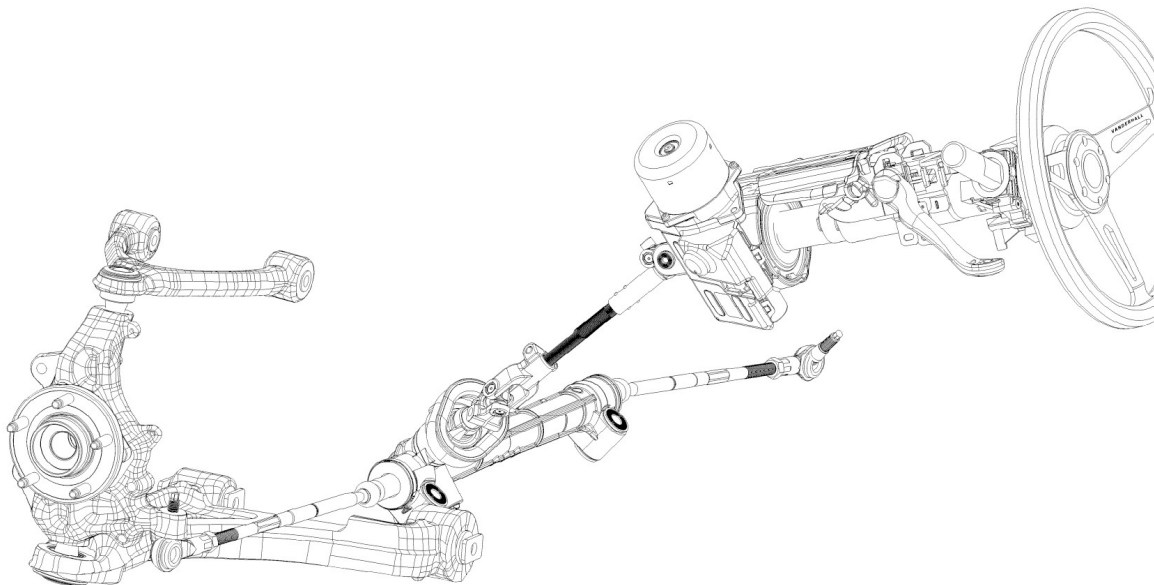
The power steering control module uses the steering position sensor to determine the steering system on center position. Since the power steering motor provides a slight amount of return to center assist, the power steering control module will command the power steering motor to the steering system center position and not beyond. The sensor is a 5volt dual analog triangle signal device with a valid signal voltage range of 0–5 volts. The sensors signal 1 and signal 2 voltage values will increase and decrease within the valid voltage range, and stay within 2.5–2.8 volts of each other as the steering wheel is turned.

Power Steering Motor

The power steering motor is a 12volt brushless DC reversible motor with a 65amp rating. The motor assists steering through a worm gear and reduction gear located in the steering column housing.

- **Power Steering Control Module**

The power steering control module uses a combination of steering shaft torque sensor input, vehicle speed, calculated system temperature and steering tuning to determine the amount of steering assist. When the steering wheel is turned, the power steering control module uses signal voltage from the steering shaft torque sensor to detect the amount of torque and steering direction being applied to the steering column shaft and then command the proper amount of current to the power steering motor. The power steering control module receives a vehicle speed message from the powertrain control module via the serial data circuit. At low speeds more assist is provided for easy turning during parking maneuvers. At high speeds, less assist is provided for improved road feel and directional stability. The power steering control module nor the power steering motor are designed to handle 65 amps continuously. If the power steering system is exposed to excessive amounts of static steering conditions, the power steering control module will go into a protection mode to avoid thermal damage to the power steering components. In this mode the power steering control module will limit the amount of current commanded to the power steering motor which reduces system temperature and steering assist levels. The power steering control module must also be setup with the correct steering tuning which are different in relation to the vehicles powertrain configuration, sedan, coupe, tire and wheel size etc. The power steering control module has the ability to detect malfunctions within the power steering system. Any malfunction detected will cause the driver information center (DIC) to turn ON a warning indicator.



• Steering Wheel • Steering Wheel Horn Cap • Steering Wheel Hub • Steering Column • Steering Coupler • Steering Rack & Pinion	• Upper Control Arm (Refer to Upper Control Arm in Suspension) • Lower Control Arm(Refer to Lower Control Arm in Suspension) • Steering Knuckle (Refer to Steering Knuckle in Suspension) • Wheel Hub (Refer to Wheel Bearing in Suspension)
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- **Fastener Specifications Steering Gear**

Application	Specification	
	Metric	English

Steering Gear Bolt (1)		
• First Pass	100 Nm	74 lb ft
• Final Pass	97 degrees	
Steering Linkage Inner Tie Rod	100 Nm	74 lb ft
Steering Linkage Outer Tie Rod Nut		
• First Pass	30 Nm	22 lb ft
• Final Pass	128 degrees	
1. Torque-to-yield fastener in use, requires NEW bolt.		

- **Fastener Specifications Steering Column**

Application	Specification	
	Metric	English
Intermediate Steering Shaft Lower Bolt	49 Nm	36 lb ft
Intermediate Steering Shaft Upper Bolt	49 Nm	36 lb ft
Steering Column Lower Support Bracket Bolt	22 Nm	16 lb ft
Steering Column Upper Support Bracket Nut	22 Nm	16 lb ft
Steering Wheel Bolt	45 Nm	33 lb ft

- **Adhesives, Fluids, Lubricants, and Sealers**

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material
Steering Linkage Inner Tie Rod	High Strength Threadlocker Red Loctite® 262

- **Diagnostic Information and Procedures**
- **Diagnostic**
- **DTC P0601, P0603, P0604, or P062F**
- **Diagnostic Instructions**
 - Perform the Diagnostic System Check Vehicle prior to using this diagnostic procedure.
 - Review Strategy Based Diagnosis for an overview of the diagnostic approach.
 - Diagnostic **Procedure** Instructions provides an overview of each diagnostic category.
- **DTC Descriptors**

DTC 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 V.
- Repetitive steering input applied.

- **Conditions for Setting the DTC**

The power steering control module detects a high system temperature.

- **Action Taken When the DTC Sets**

- DTC C0176 54 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.

- **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 downstream 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

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**

- 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

- Ignition ON.
- 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

- Verify that no steering components downstream 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 column assembly.

⇓ If the DTC is not set

- All OK.

⇓ If the DTC set outside of the conditions for running and setting

- All OK. The power steering is operating as designed.

- **Repair Instructions**

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

- Steering Column Replacement
- **Control Module References** for Power Steering Control Module replacement, programming and setup.

- **DTC C0475**

- **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

Electric Steering Motor Circuit Malfunction

DTC C0475 64

Electric Steering Motor Slip Detected

- **Circuit/System Description**

The power steering control module continuously monitors the voltage and current levels being commanded to the 3phase 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

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 Testing**

- Verify that DTC C0475 is not set.

⇒ If the DTC is set

Replace the K43 Power Steering Control Module.

⇓ If the DTC is not set

- All OK.

- **Repair Instructions**

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

- Steering Column Replacement
- **Control Module References** for power steering 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

DTC C0545 4B

Steering Wheel Torque Sensor Calibration Not Learned

- **Circuit/System Description**

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

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
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- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information.

- **Circuit/System Verification**

- Ignition ON.
 - Verify the scan tool Steering Input Torque parameter changes when turning the steering wheel.
- ⇒ If the parameter does not change
- Program the K43 Power Steering Control Module.
 - Verify the DTC does not set.
- ⇒ If the DTC sets, replace the Steering Column.
- ↓ If the DTC does not set
- All OK.
- ↓ If the parameter changes
- All OK.

- **Repair Instructions**

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

- Steering Column Replacement
- **Control Module References** for power steering 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 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
- Increase in Effort While Turning Steering Wheel
- Poor Return of Steering Wheel
- Steering Wheel Surges/Jerks While Turning
- Steering Wheel Kickback
- Steering Effort Hard or Too Easy in One or Both Directions

- **Rattle, Clunk, Pop or Shudder Noise from the Power Steering System**

Rattle, Clunk, or Shudder Noise from the Power Steering System			
Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Power Steering System Description and Operation
2	Verify that a rattle, clunk or shudder noise is present. Is a rattle, clunk or shudder noise present?	Go to Step 3	System OK
3	Inspect the power steering gear for the proper installation. Refer to Steering Gear Replacement. Is the power steering gear installation correct?	Go to Step 4	Go to Step 6
4	Inspect the intermediate shaft. Is the intermediate shaft worn?	Go to Step 7	Go to Step 5
5	5 Inspect the suspension. Is the suspension worn?	Go to Noise Diagnosis Front Suspension	Go to Step 2
6	Install the power steering gear correctly. Refer to Steering Gear Replacement. Did you complete the repair?	Go to Step 8	-
7	Replace the intermediate shaft. Refer to Intermediate Steering Shaft 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

- **Whine or Growl Noise from the Power Steering System**

Whine or Growl Noise from the Power Steering System			
Step	Action	Yes	No
Special Tools CH-39570 Chassis Ear			
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 for looseness and/or worn bushings. Is the steering gear loose or are the bushings worn?	Go to Step 6	Go to Step 4
4	Inspect the power steering motor for a whine or growl noise using the CH- 39570 ear . Is the noise present at the power steering 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 ear . Is the noise present at the power steering gear?	Go to Step 8	Go to Step 3
6	Tighten the power steering gear fasteners or replace the power steering gear due to worn bushings. Refer to Steering Gear Replacement . Did you complete the repair?	Go to Step 9	-
7	Replace the steering column, which includes the electronic power steering assist motor control unit. Refer to Steering Column Replacement . Did you complete the repair?	Go to Step 9	-
8	Replace the power steering gear. Refer to Steering Gear 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

- **Increase in Effort While Turning Steering Wheel**

Increase in Effort While Turning Steering Wheel			
Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms Power Steering System
2	Verify that there is an increase in effort while turning is present. Does the system operate normally?	System OK	Go to Step 3
3	Check for the following tire related conditions: • Incorrect tire inflation • Improper tire size Did you find and correct the condition?	Go to Step 10	Go to Step 4
4	• Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. • Check for a binding or worn tie rod end. Is the tie rod binding or worn?	Go to Step 7	Go to Step 5
5	Check for a worn or binding intermediate shaft. Is the intermediate shaft worn or binding?	Go to Step 8	Go to Step 6
6	Check for a worn or binding steering gear. Is the steering gear worn or binding?	Go to Step 9	System OK
7	Replace the outer tie rod. Refer to Steering Linkage Outer Tie Rod Replacement. Did you complete the repair?	Go to Step 10	-
8	Replace the intermediate shaft. Refer to Intermediate Steering Shaft Replacement . Did you complete the repair?	Go to Step 10	-
9	Replace the steering gear. Refer to Steering Gear Replacement . Did you complete the repair?	Go to Step 10	-
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

- **Poor Return of Steering Wheel**

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	• Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. • Lubricate the tie rod ends and ball joints, if applicable. • Inspect the suspension system for worn or damaged components. • Repair as necessary. Did you find and correct the condition?	Go to Step 12	Go to Step 4
4	• Rotate the steering wheel ONE revolution in both directions. • 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
5	Note: Position the wheels straight ahead. Do NOT rotate the steering wheel more than one complete revolution from center. • Disconnect the intermediate shaft from the steering column. • Note the position of the steering wheel and rotate the steering wheel ONE revolution in both directions. • 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 shaft for stiff or loose joints. Repair or replace as necessary. Did you find and complete the repair?	Go to Step 12	Go to Step 7
7	• Remove the front tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation. • Disconnect both outer tie rod ends from the steering knuckles. • Use your hands in order to move the tie rod end studs. • If abnormally difficult to move, replace the tie rod end. Repair as necessary. Did you find and complete the repair?	Go to Step 12	Go to Step 8
8	• Use your hands to rotate the steering knuckle inboard and outboard in order to inspect for a binding strut bearings, ball joints, or axle. • 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	Inspect for binding in the steering gear. If a binding is present, repair or replace the 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	Inspect the steering column for a binding. If a 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**

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 or jerks while turning. Does the system operate normally?	System OK	Go to Step 3
3	Inspect the front suspension for worn or binding components. Did you find and correct the condition?	Go to Step 14	Go to Step 4
4	- Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. - Inspect the steering linkage outer tie rod for wear or a binding condition. Is the steering linkage outer tie rod worn or binding?	Go to Step 10	Go to Step 5
5	Inspect the intermediate steering shaft for wear or a binding condition. Is the intermediate steering shaft worn or binding?	Go to Step 11	Go to Step 6
6	Inspect the steering gear for wear or a binding condition. Is the steering gear worn or binding?	Go to Step 12	Go to Step 7
7	Inspect the steering column for wear or a binding condition. Is the steering column worn or binding?	Go to Step 13	Go to Step 8
8	Inspect the power steering assist motor for an indication of excessive heat. Does the power steering assist motor appear to be overheated?	Go to Step 9	Go to Step 13
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 13
10	Replace the steering linkage outer tie rod. Refer to Steering Linkage Outer Tie Rod Replacement . Did you complete the repair?	Go to Step 14	
11	Replace the intermediate steering shaft. Refer to Intermediate Steering Shaft Replacement. Did you complete the repair?	Go to Step 14	
12	Replace the steering gear. Refer to Steering Gear Replacement. Did you complete the repair?	Go to Step 14	
13	Replace the steering column. Refer to Steering Column Replacement. 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 Wheel Kickback**

Steering Wheel Kickback

Condition	Action
The steering column mounting bolts are loose	Tighten the pivot bolt and the mounting bolts to specification.
The steering gear is loosely mounted.	Tighten the steering gear mounting bolts to specification.

The steering linkage tie rods are loose or damaged.	Inspect the steering Linkage, Steering Rack, Steering Column. 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. Caution: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components: - The steering column - The intermediate shaft(s) - The steering gear After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to linkage tie rods. If necessary, replace the steering linkage tie rods. Refer to Steering Linkage Outer Tie Rod Replacement or to Steering Linkage Inner Tie Rod Replacement.
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- **Steering Effort Hard or Too Easy in One or Both Directions**

Steering Effort Hard or Too Easy in One or Both Directions	
Condition	Action
The battery power is low.	Confirm proper battery voltage.
The intermediate shaft dash seal is binding.	Adjust the dash seal, or replace the intermediate shaft assembly if necessary. Refer to Intermediate Steering Shaft Replacement .
The intermediate shaft joints are loose or worn.	Inspect the joints and the pinch bolts for damage, and replace the intermediate shaft if necessary. Refer to Intermediate Steering Shaft Replacement .
The steering gear is binding.	If necessary, inspect and replace the steering gear. Refer to Steering Gear Replacement .
The upper steering shaft is bent.	If necessary, replace the steering column. Refer to Steering Column Replacement .
The assist mechanism hub gear is misaligned or damaged.	Replace the steering column. Refer to Steering Column Replacement .
The sensor wire is damaged.	Replace the steering column. Refer to Steering Column Replacement .
The controller is malfunctioning.	Confirm the DTC. If necessary, replace the steering column, which includes the motor and module assembly. Refer to Steering Column Replacement .
The motor shaft is binding.	Confirm the DTC. If necessary, replace the steering column, which includes the motor and module assembly. Refer to Steering Column Replacement .

- **Steering Wheel and Column Description and Operation**

The steering wheel and column have the following 4 primary functions:

- Vehicle steering
- Vehicle security
- Driver convenience
- Driver safety

Vehicle Steering

The steering wheel is the first link between the driver and the vehicle. The steering wheel is fastened to a steering shaft within the steering column. At the lower end of the steering column, the intermediate steering shaft connects the steering column to the steering gear.

Vehicle Security

The steering wheel and column may have theft deterrent components mounted and designed into the steering column.

Driver Convenience

The steering wheel and column may have driver controls attached for convenience and comfort.

Driver Safety

The steering column has safety features to protect the driver.

Energy-Absorbing Steering Column

The energy-absorbing steering column compresses in the event of a frontend collision, which reduces the chance of injury to the driver. The energy-absorbing feature, collapsible steering shaft, and break away mounting features help reduce the injury in the event of an accident.

- **Noise in Steering Column**

Noise in Steering Column			
Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms Steering Wheel and Column
2	Verify that noise is present in the steering column during operation. Is noise present in the steering column during operation?	Go to Step 3	System OK
3	Inspect the steering column mounting features for the following conditions: • The steering column mounting fasteners are loose. • The steering column mounting features are sheared. Are the steering column mounting features loose or sheared?	Go to Step 10	Go to Step 4
4	Inspect the SIR/SRS coil for noise. Is the SIR/SRS coil noisy?	Go to Step 11	Go to Step 5
5	If equipped, inspect the lock plate retaining ring for correct installation. Is the lock plate retaining ring installed incorrectly?	Go to Step 12	Go to Step 6
6	Inspect the steering column upper and lower bearings for the following conditions: • Damage • Lubrication • Wear • Proper seating Are the bearings in need of repair or replacement?	Go to Step 13	Go to Step 7
7	Does the steering column tilt joint need to be lubricated?	Go to Step 14	Go to Step 8
8	Note: Inspect the intermediate steering shaft for noise while driving the vehicle, turning the steering wheel, and applying the brakes. Inspect the intermediate steering shaft for noise. Is the intermediate steering shaft noisy?	Go to Step 15	Go to Step 9
9	Note: For vehicles equipped with a telescoping steering column, perform this step. If not equipped, go to next step. Inspect the steering column for noise while telescoping the column. Is the steering column noisy while telescoping?	Go to Step 16	Go to Step 17
10	Note: If the steering column mounting features are damaged or sheared, replace the steering column. Refer to Steering Column Replacement . Tighten the steering column mounting fasteners to specification. Refer to Fastener Tightening Specifications . Did you complete the repair?	Go to Step 17	-
11	Replace the SIR/SRS coil. Refer to Steering Wheel Airbag Coil Replacement. Did you complete the repair?	Go to Step 17	-
12	Install the lock plate retaining ring correctly. Did you complete the repair?	Go to Step 17	-

13	Note: If the steering column upper and/or lower bearings are not serviceable, replace the steering column. Refer to Steering Column Replacement. Replace the steering column upper and/or lower bearings, if serviceable. Did you complete the replacement?	Go to Step 17	-
14	Lubricate the steering column tilt joint. Did you complete the repair?	Go to Step 17	-
15	Replace the appropriate intermediate steering shaft component. Did you complete the repair?	Go to Step 17	-
16	Redistribute or add lubricant to the steering column lower jacket with the column telescoped to its end of outward travel. Did you complete the repair?	Go to Step 17	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

- **Looseness in Steering Column**

Looseness in Steering Column			
Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms Power Steering System
2	Verify that the steering column is loose. Is the steering column loose?	Go to Step 3	System OK
3	Inspect the steering column mounting features for the following conditions. • The steering column mounting fasteners are loose. • The steering column mounting features are sheared. Are the steering column mounting features loose or sheared?	Go to Step 5	Go to Step 4
4	Inspect the upper and/or lower bearings for looseness. Are any of the bearings worn or loose?	Go to Step 6	Go to Step 7
5	Note: If the steering column mounting features are damaged or sheared, replace the steering column. Refer to Steering Column Replacement . Tighten the steering column mounting fasteners to specification. Refer to Fastener Tightening Specifications. Did you complete the repair?	Go to Step 7	-
6	Note: If the steering column upper and/or lower bearings are not serviceable, replace the steering column. Refer to Steering Column Replacement . Replace the upper and/or lower bearings, if serviceable. Did you complete the repair?	Go to Step 7	-
7	Operate the steering column in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

- **Repair instructions**

- **Steering Angle Sensor Centering**

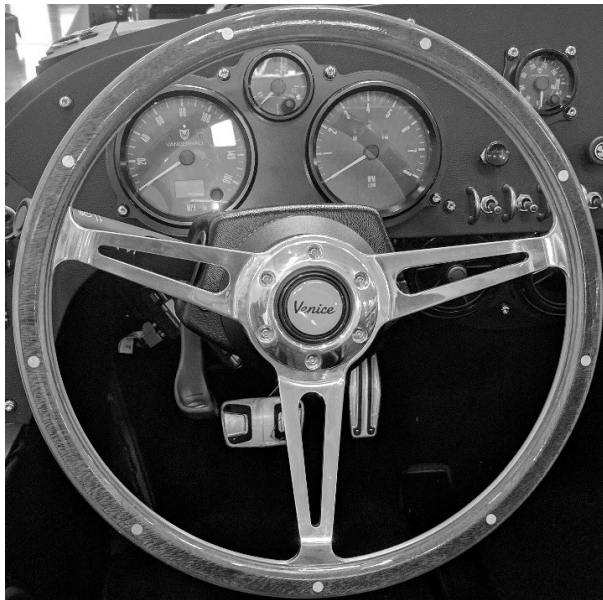
The steering angle sensor does not require centering often. Centering of the steering angle sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Wheel alignment
- Steering gear replacement
- Steering column replacement
- Collision or other physical damage
- Steering angle sensor replacement
- Electronic brake control module (EBCM) replacement

The steering angle sensor centering procedure can be completed with a scan tool using the following steps:

- Using the steering wheel, align the front wheels forward.
- Apply the parking brake, or set the transmission in the Park.
- Install the scan tool to the data link connector.
- Turn the ignition ON, and the engine OFF.
- Select Steering Wheel Angle Sensor Reset in the Steering Wheel Angle Sensor Module Control Functions list.
- Follow the scan tool directions to complete the reset procedure.
- Select Steering Wheel Angle Sensor Learn in the Steering Wheel Angle Sensor Module Functions list.
- Follow the scan tool directions to complete the learn procedure.
- Clear any DTCs that may be set.

- **Steering Wheel Replacement**



- **Tools**

- T50 Torx wrench

- **Removal Procedures**

- Remove the Steering Wheel Horn Cap and Cover, Refer to [Steering Wheel Horn Cap and Cover Replacement](#)
- Remove the center steering column bolt using the T50 Torx wrench
- Pull on steering wheel carefully until freed from the steering column

- **Installation Procedures**

- Align the splines of the steering wheel to the steering column, Push steering wheel on to steering column,
- Install steering column bolt using T50 Torx wrench and torque to:
 - 61 Nm (45 Ft/lb.)
- Install steering wheel cover and horn cap, Refer to [Steering Wheel Horn Cap and Cover Replacement](#)

- **Steering Wheel Horn Cap & Cover**



- **Tools**

- 3 mm hex tool

- **Removal Procedures**

- Remove the 6 hex head screws from around the horn button
- Pull the Steering Wheel Horn cap forward and disconnect the wires
- Remove Steering wheel Horn Cap

- **Installation Procedures**

- Connect the wires to the Steering Wheel Horn Cap
- Install and tighten 6 hex head screws to 3.5 Nm (30 in lb.)

- **Steering Column Replacement**

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.

Caution:

With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR Coil Assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

Note

The steering column contains an electrically assisted power steering unit. This power steering unit must be reprogrammed if replaced

- **Tools**

- 10mm wrench
- 13mm wrench

- **Removal Procedures**

- With the steering wheel in the straight ahead position, LOCK the steering column.
- Disconnect battery
- Remove steering wheel, Refer to **Steering Wheel Replacement**
- Remove the steering column clam shell
- Disconnect all electrical connections
- Use paint in order to place match marks on the intermediate steering shaft and on the steering gear pinion shaft.
- Remove the intermediate steering shaft lower bolt (2).
- Disconnect the intermediate steering shaft from the steering gear pinion shaft.

Caution:

Do not support the steering column by only the lower or upper support bracket. Damage to the column lower bearing adapter could result.

- Support the steering column.
- Remove the 2 steering column lower support bracket bolts
- Remove the 2 steering column upper support bracket nuts

Caution:

Once the steering column is removed from the vehicle, the column is extremely susceptible to damage. Dropping the column assembly on the end could collapse the steering shaft or loosen the plastic injections, which maintain column rigidity. Leaning on the column assembly could cause the jacket to bend or deform. Any of the above damage could impair the columns collapsible design. Do NOT hammer on the end of the shaft, because hammering could loosen the plastic injections, which maintain column rigidity. If you need to remove the steering wheel, refer to the [Steering Wheel Replacement procedure](#) in this section.

- Remove the steering column assembly (1) from the vehicle.
- Transfer components as necessary.

- **Installation Procedures**

- If you are replacing the steering column or the intermediate steering shaft, copy the match marks from the old parts to the new parts.

Caution:
Do NOT allow the wiring harness to be pinched between the motor/module assembly and the steering column during installation. A pinched harness will cause diagnostic trouble codes to be set and may require replacement of the steering column.

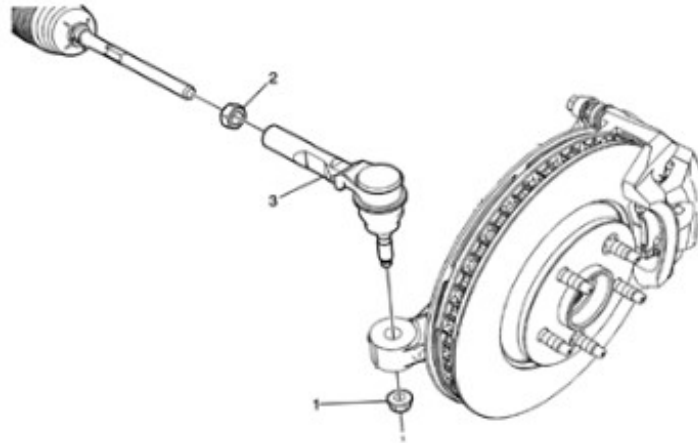
- Position the steering column assembly in the vehicle.
- Align the match marks and connect the intermediate steering shaft to the steering gear pinion shaft.

Warning
In order to ensure the intended function of the steering column in a vehicle during a crash and in order to avoid personal injury to the driver, perform the following: • Tighten the steering column lower fasteners before you tighten the steering column upper fasteners. Failure to do this can damage the steering column. • Tighten the steering column fasteners to the specified torque. Overtightening the upper steering column fasteners could affect the steering column collapse.

Caution:
Ensure all fasteners are securely seated before applying needed torque. Failure to do so may result in component damage or malfunctioning of steering column.

- Install, but do not tighten, the 2 steering column upper support bracket nuts
- Install, but do not tighten, the 2 steering column lower support bracket bolts
- Install the intermediate steering shaft lower bolt and tighten to 49 Nm (36 lb ft).
- **Tighten** the 2 steering column lower support bracket bolts to 22 Nm (16 lb ft).
- **Tighten** the 2 steering column upper support bracket nuts to 22 Nm (16 lb ft).
- Connect all electrical connections
- Install Ignition cylinder
- Install the windshield wiper and turn signal stocks
- Install the steering column clam shell
- Install the steering wheel, **Refer to Steering Wheel Replacement**
- Reconnect battery
- Setup the power steering control module. Refer to Power Steering Control Module Programming and Setup.
- Center the steering angle sensor. Refer to **Steering Angle Sensor Centering**.

- Steering Linkage Outer Tie Rod Replacement



Steering Linkage Outer Tie Rod Replacement

Callout	Component Name
Preliminary Procedures - Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 2. Remove the front tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.	
1	Steering Linkage Outer Tie Rod Nut Caution: Refer to Fastener Caution. Procedure Use the EN-45059 meter in order to tighten the outer tie rod nut to the specification. Tighten 30 Nm (22 lb ft) 128 degrees Special Tools EN-45059 Angle Meter
2	Steering Linkage Inner Tie Rod Nut Procedure - Use paint in order to place match marks on the steering linkage inner tie rod nut and on the steering linkage inner tie rod. - During installation, align the match marks. 3. Do not tighten the nut during installation. Tighten the nut after adjusting the front toe. Refer to Wheel Alignment Steering Wheel Angle and/or Front Toe Adjustment.

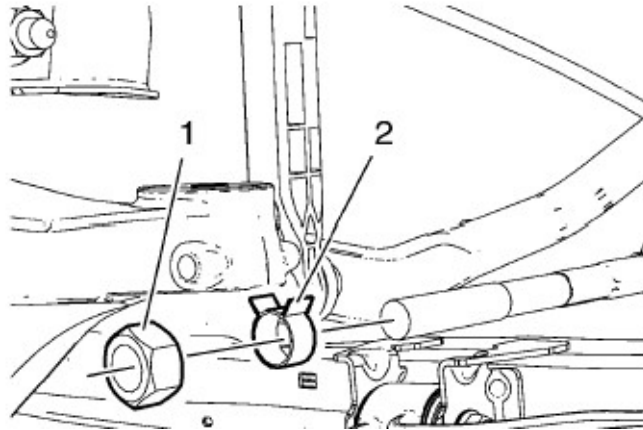
3	Steering Linkage Outer Tie Rod Caution: Do not free the ball stud by using a pickle fork or a wedge-type tool. Damage to the seal or bushing may result. Procedure • Use the CH-161-B puller in order to separate the steering linkage outer tie rod from the steering knuckle. • Inspect the steering linkage inner tie rod for bent or damaged threads. • Clean the tapered surface of the steering knuckle. • After the installation is complete, 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
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- **Steering Gear Boot Replacement**

Special Tools
CH-804 Tensioner

Removal Procedure

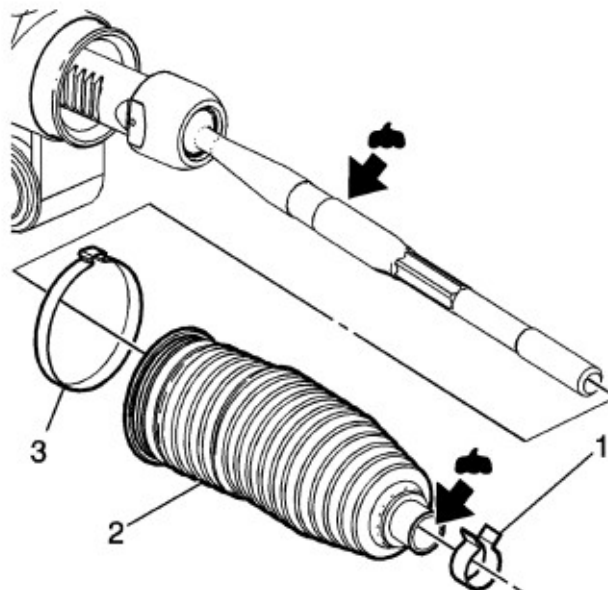
- Steering Linkage Outer Tie Rod » Remove — Steering Linkage Outer Tie Rod Replacement



Note:

Place match marks on the steering linkage inner tie rod nut and the steering linkage inner tie rod.

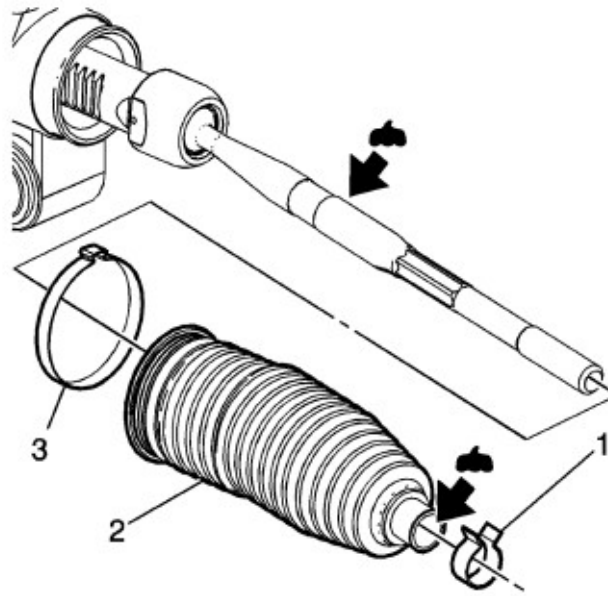
- Steering Linkage Inner Tie Rod Nut (1) » Remove
- Steering Gear Boot Outer Clamp (2) » Remove



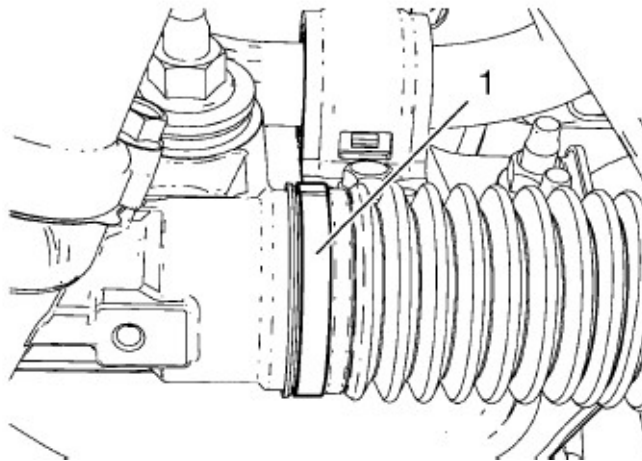
- Steering Gear Boot Inner Clamp (3) » Remove DISCARD the clamp.
- Steering Gear Boot (2) » Remove

- Clean the steering linkage inner tie rod and the steering gear boot contact area of any lubricant or debris.

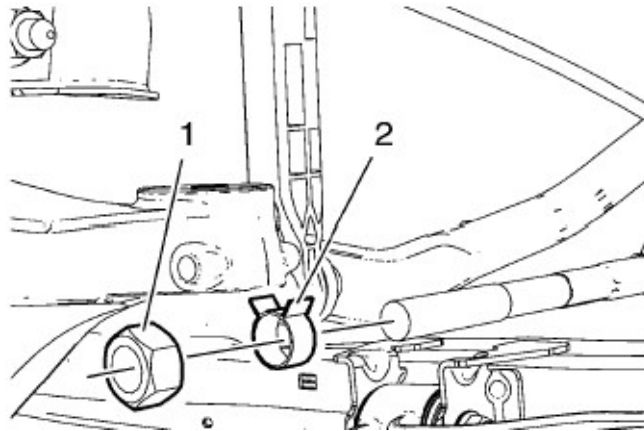
Installation **Procedure**



- Steering Gear Boot Inner Clamp (3) @ Steering Gear Boot (2) » Loosely install a NEW clamp.
- Apply the lubricant from the service kit to the steering linkage inner tie rod and to the steering gear boot.
- Steering Gear Boot (2) » Install



- Use the CH804 tensioner to tighten the steering gear boot inner clamp (1).



- Steering Gear Boot Outer Clamp (2) » Install
- Steering Linkage Inner Tie Rod Nut (1) » Install
- Steering Linkage Outer Tie Rod » Install — **Steering Linkage Outer Tie Rod Replacement**
- Measure and adjust the front toe. Wheel Alignment Steering Wheel Angle and/or Front Toe Adjustment

- **Steering Rack and Pinion**

- **Tools**

- 10mm wrench
- 18mm wrench

- **Removal**

Caution:
With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components: • The steering column • The intermediate shaft(s) • The steering gear After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

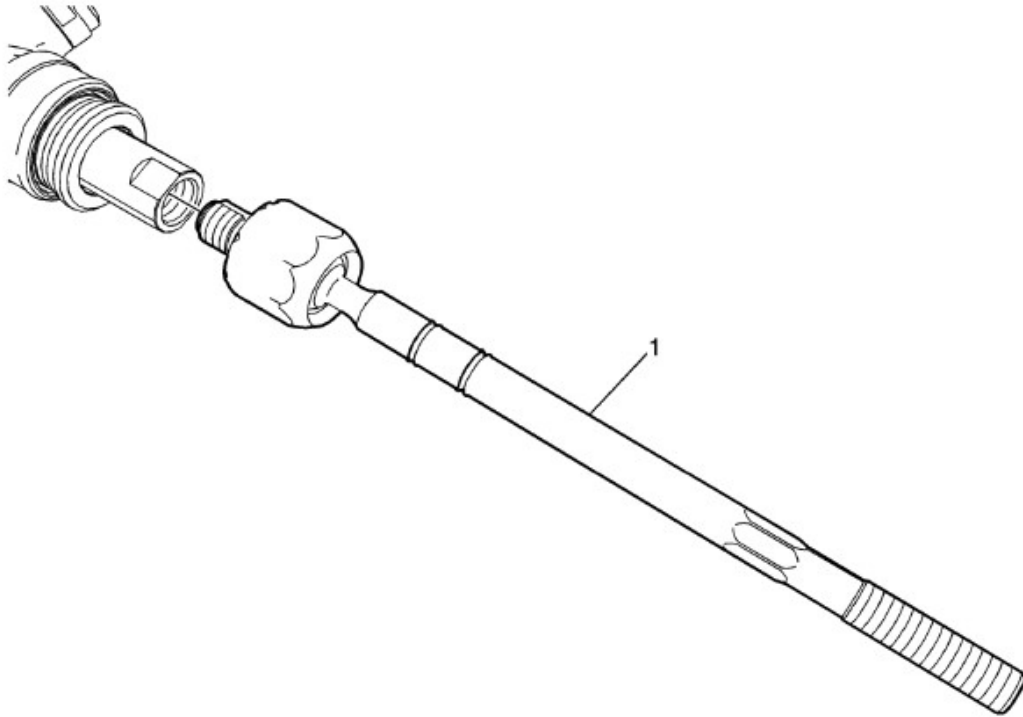
- Lift and support the vehicle
- Verify vehicle is safely secured
- Remove steering rack from both steering knuckles using an 18mm wrench
- Turn both steering knuckles fully forward and inward
- From underneath the vehicle, unbolt the two 18mm chassis bolts holding the steering rack in place
- Disconnect steering rack from the steering column using a 10mm wrench
- Maneuver the rack from side-to-side in order to remove

- **Installation**

Warning
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 fasteners could cause damage to the vehicle, component, or bodily injury.

- Lift and support the vehicle
- Verify vehicle is safely secured
- Turn both steering knuckles fully forward and inward
- From underneath the vehicle, maneuver the rack from the left to the right in order to place properly
- Install the two 18mm chassis bolts holding the steering rack in place
- Connect steering rack to the steering column using a 10mm wrench
- Bolt steering rack to both steering knuckles using an 18mm wrench
- Verify, by turning the steering wheel, that steering rack is installed correctly
- Install front wheel and torque lug nuts to:
 - **Tighten**
 - 1. 100 Nm (74 lb ft)
 - 2. 97 degrees
- Perform a vehicle alignment [Refer to Front End Alignment in Suspension](#)

- **Steering Linkage Inner Tie Rod Replacement**



Steering Linkage Inner Tie Rod Replacement

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 2. Remove the steering gear boot. Refer to Steering Gear Boot Replacement.	
1	Steering Linkage Inner Tie Rod Caution: Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear. Caution: Refer to Fastener Caution. Procedure 1. Place a pipe wrench on the flats of the steering gear rack. Position the pipe wrench between the steering gear housing and the steering linkage inner tie rod housing. 2. Place a wrench on the flats of the steering linkage inner tie rod housing. 3. Rotate the steering linkage inner tie rod housing counterclockwise in order to remove the steering linkage inner tie rod from the steering gear rack. 4. Apply thread locking adhesive to the steering linkage inner tie rod threads prior to installing it to the steering gear rack. Refer to Adhesives, Fluids, Lubricants, and Sealers. 5. Rotate the steering linkage inner tie rod housing clockwise in order to install the steering linkage inner tie rod to the steering gear rack. Tighten 100 Nm (74 lb ft)

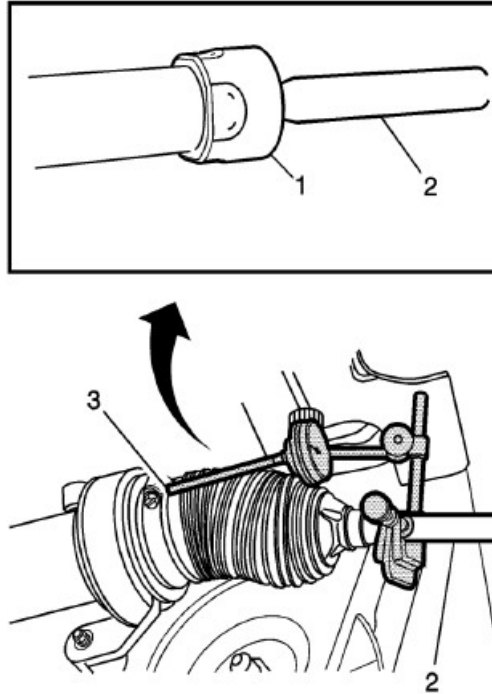
- **Steering Linkage Inner Tie Rod Inspection**

Special Tools

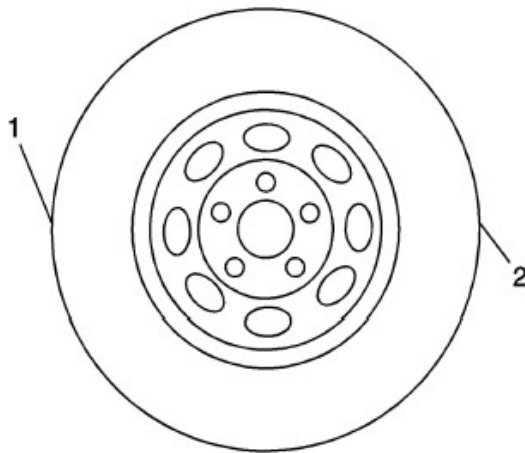
GE-8001 Dial Indicator Set

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

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



- 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.
- Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
- 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.
- 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.



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

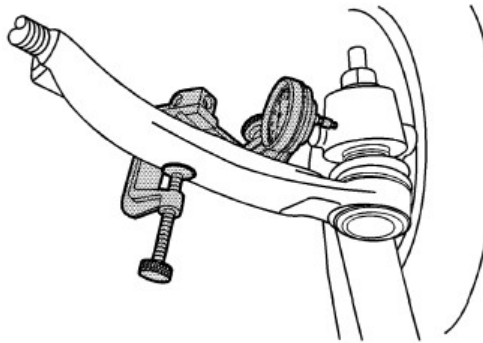
- **Steering Linkage Outer Tie Rod Inspection**

Special Tools

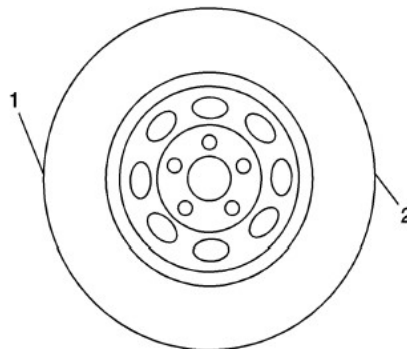
GE-8001 Dial Indicator Set

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

- 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](#).
- 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](#).



- 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.



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