

Steering

Steering Wheel and Column - CTS Coupe & Wagon

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Intermediate Steering Shaft Bolt (at the upper and lower intermediate steering shafts)	33 N.m	24 lb ft
Lower Intermediate Steering Shaft Bolt (at the steering gear)	50 N.m	37 lb ft
Steering Column Bolt	27 N.m	20 lb ft
Steering Column Nut	27 N.m	20 lb ft
Steering Column Shroud Bolt	3 N.m	27 lb in
Steering Column Telescope Actuator Motor Adjustment Housing Bolt	8 N.m	71 lb in
Steering Column Telescope Actuator Motor Housing Bolt	8 N.m	71 lb in
Steering Column Tilt Wheel Actuator Motor Bolt	6 N.m	53 lb in
Steering Column Tilt Wheel Position Sensor Bolt	0.5 N.m	4 lb in
Steering Wheel Bolt	30 N.m	22 lb ft
Turn Signal Switch Bracket Bolt	11 N.m	97 lb in
Upper Intermediate Steering Shaft Bolt (at the steering column)	48 N.m	35 lb ft

SCHEMATIC AND ROUTING DIAGRAMS

STEERING WHEEL SCHEMATICS

Steering Wheel

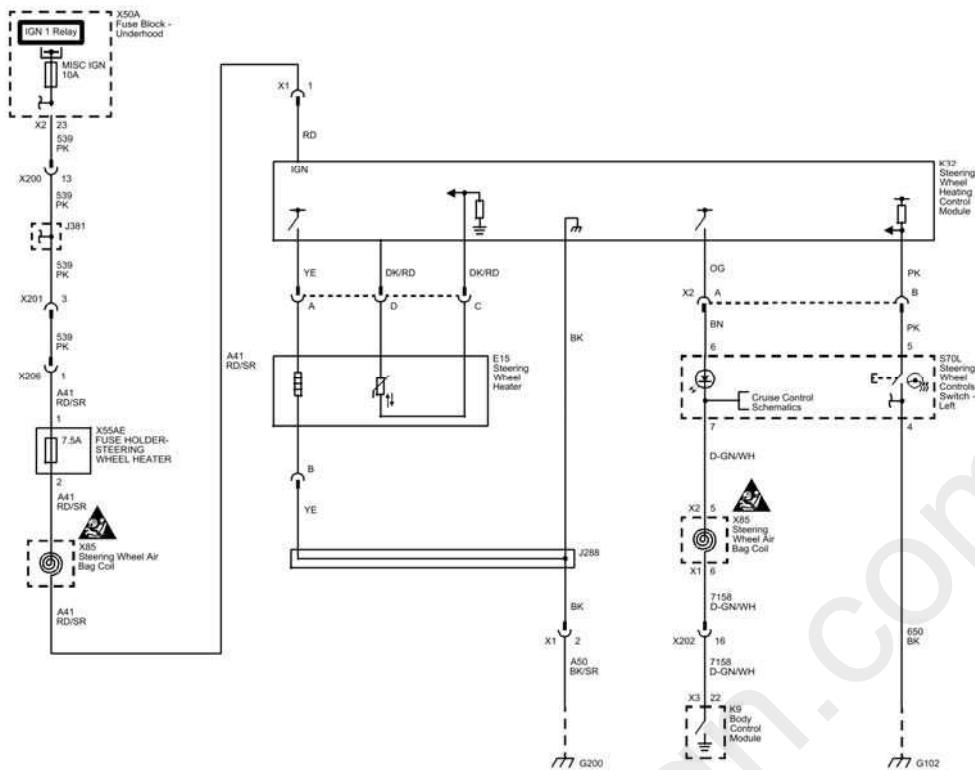


Fig. 1: Steering Wheel
Courtesy of GENERAL MOTORS COMPANY

COLUMN LOCK SCHEMATICS

Steering Column Lock

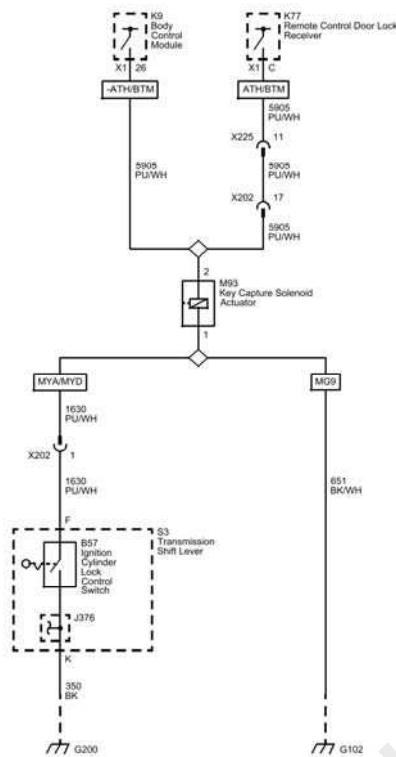


Fig. 2: Steering Column Lock

Courtesy of GENERAL MOTORS COMPANY

TILT/TELESCOPING STEERING COLUMN SCHEMATICS

A45 with N38 (Wagon)

A45 with N38 (Coupe)

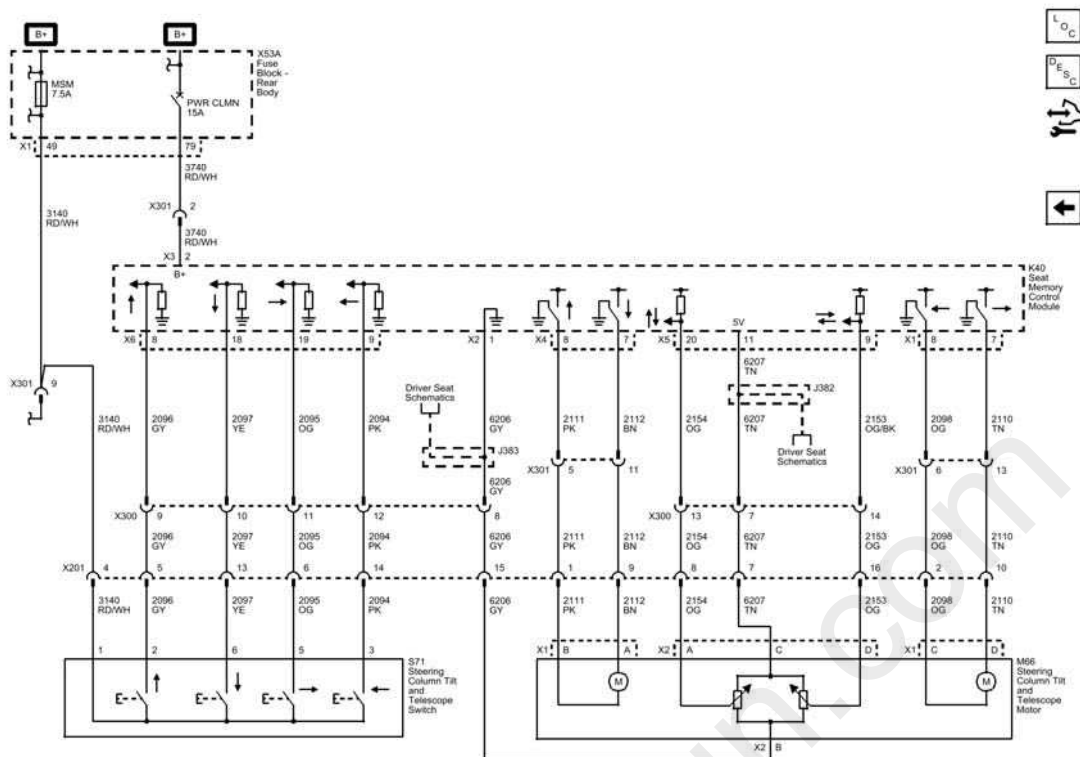


Fig. 4: Tilt/Telescoping Steering Column Schematics: A45 with N38 (Coupe)
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - STEERING WHEEL AND COLUMN

Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Steering Wheel and Column Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel and column.
- 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:

- **Noise in Steering Column**
- **Looseness in Steering Column**
- **Steering Column Tilt Function Inoperative**

- **Ignition Can/Cannot Be Turned Off with Transmission in Any Gear**

HEATED STEERING WHEEL INDICATOR MALFUNCTION

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Switch Signal	2	1	-	-
LED Control	3	3	4	-
Switch and LED Ground	-	1	-	-
Module Ground	-	1	-	-
1. Heated Steering Wheel System Inoperative 2. Heated Steering Wheel Always ON 3. LED Inoperative 4. LED Always ON				

Circuit/System Description

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module that steering wheel heat is requested. When the request is seen, the heated steering module supplies voltage to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel.

Reference Information

Schematic Reference

Steering Wheel Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - COUPE AND WAGON

Description and Operation

Steering Wheel and Column Description and Operation

Electrical Information Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify the S70L Steering Wheel Controls Switch - Left is OFF. The steering wheel heater indicator should not be illuminated and the left and right sides of the steering wheel should not be warm.
 - **The steering wheel is always warm**

Refer to **Heated Steering Wheel Malfunction**
 - **The steering wheel does not become warm and the heater indicator is illuminated**

Refer to Circuit/System Testing
 - **The steering wheel does not become warm and the heater indicator is not illuminated**
3. Press and release the S70L Steering Wheel Controls Switch - Left. The steering wheel heater indicator should illuminate and the left and right sides of the steering wheel should become warm.
 - **The steering wheel does not become warm**

Refer to **Heated Steering Wheel Malfunction**
 - **The steering wheel becomes warm and the heater indicator does not illuminate**

Refer to Circuit/System Testing
 - **The steering wheel becomes warm and the heater indicator illuminates**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X5 in-line harness connector at the K32 Steering Wheel Heating Control Module.
2. Test for less than 10 ohms between the ground terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify a test lamp illuminates between the B+ terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse. Refer to **Power Mode Mismatch**.
 - If 2 ohms or greater
 3. Verify the in-line fuse is OK and there is voltage at the fuse.
 - If the in-line fuse is blown, replace the K32 Steering Wheel Heating Control Module.
 - If the in-line fuse is OK, repair the open/high resistance in the circuit.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K32 Steering Wheel Heating Control Module.
 - **If the test lamp illuminates**
- 5. Ignition OFF, disconnect the harness connector at the S70L Steering Wheel Controls Switch - Left. Ignition ON.
- 6. Test for 80-90 kohms between the low reference circuit terminal 9 at the S70L Steering Wheel Controls Switch - Left and ground.
 - **If less than 80 kohms**
 1. Ignition OFF, disconnect the harness connector X3 at the K9 Body Control Module.
 2. Test for infinite resistance between the low reference terminal 9 at the S70L Steering Wheel Controls Switch - Left and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If 90 kohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If within the specified range**
- 7. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 5 and ground circuit terminal 4 at the S70L Steering Wheel Controls Switch - Left. Ignition ON.
- 8. Test for B+ between the control circuit terminal 6 and ground.
 - **If less than B+**

Replace the K32 Steering Wheel Heating Control Module.

○ **If B+**

9. Replace the S70L Steering Wheel Controls Switch - Left.

Repair Instructions

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

- **Steering Wheel Control Switch Assembly Replacement**
- **Control Module References** for steering wheel heating control module replacement, programming, and setup

HEATED STEERING WHEEL MALFUNCTION

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Switch Signal	2	1	-	-
Switch and LED Ground	-	1	-	-
Temperature Sensor Signal	3	3	3	-
Temperature Sensor Ground	-	3	-	-
Heater Element Control	3	3	2	-
Heater Element Ground	-	3	-	-
Module Ground	-	1	-	-
1. Heated Steering Wheel System Inoperative 2. Heated Steering Wheel Always ON 3. Heated Steering Wheel Inoperative				

Circuit/System Description

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module that steering wheel heat is requested. When the request is seen, the heated steering wheel control module supplies voltage to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel.

Reference Information

Schematic Reference

Steering Wheel Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - COUPE AND WAGON

Description and Operation

Steering Wheel and Column Description and Operation

Electrical Information Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify the S70L Steering Wheel Controls Switch - Left is OFF. The steering wheel heater indicator should not be illuminated and the left and right sides of the steering wheel should not be warm.
 - **The steering wheel is always warm**

Refer to Circuit/System Testing
 - **The steering wheel does not become warm and the heater indicator is illuminated**

Refer to Heated Steering Wheel Indicator Malfunction
 - **The steering wheel does not become warm and the heater indicator is not illuminated**
3. Press and release the S70L Steering Wheel Controls Switch - Left. The steering wheel heater indicator should illuminate and the left and right sides of the steering wheel should become warm.
 - **The steering wheel does not become warm**

Refer to Circuit/System Testing
 - **The steering wheel becomes warm and the heater indicator does not illuminate**

Refer to Heated Steering Wheel Indicator Malfunction
 - **The steering wheel becomes warm and the heater indicator illuminates**

4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X5 in-line harness connector at the K32 Heated Steering Wheel Control Module.
2. Test for less than 10 ohms between the ground terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse. Refer to **Power Mode Mismatch**.
 - If 2 ohms or greater
 - 3. Verify the in-line fuse is OK and there is voltage at the fuse.
 - If the in-line fuse is blown, replace the K32 Steering Wheel Heating Control Module.
 - If the in-line fuse is OK, repair the open/high resistance in the circuit.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K32 Steering Wheel Heating Control Module.
 - **If the test lamp illuminates**
5. Ignition OFF, reconnect the in-line harness connector X5. Disconnect the harness connector at the S70L Steering Wheel Controls Switch - Left.
6. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**

7. Ignition ON.
8. Test for 4.5-5.5 V between the signal circuit terminal 5 and ground.
 - **If less than 4.5 V**
 1. Ignition OFF, disconnect the in-line connector at the S70L Steering Wheel Controls Switch - Left.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K32 Steering Wheel Heating Control Module.
 - **If 5.5 V or greater**
 1. Ignition OFF, disconnect the in-line connector at the S70L Steering Wheel Controls Switch - Left. Ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K32 Steering Wheel Heating Control Module.
 - **If with in 4.5-5.5 V**
9. Place the S70L Steering Wheel Controls Switch - Left in the OFF position.
10. Test for infinite resistance between terminal 5 and terminal 4 at the S70L Steering Wheel Controls Switch - Left.
 - **If less than infinite resistance**

Replace the S70L Steering Wheel Controls Switch - Left
 - **If infinite resistance**
11. Place the S70L Steering Wheel Controls Switch - Left in the ON position.
12. Test for less than 2 ohms between terminal 5 and terminal 4.
 - **If 2 ohms or greater**

Replace the S70L Steering Wheel Controls Switch - Left
 - **If less than 2 ohms**
13. Ignition OFF, disconnect the in-line harness connector at the E15 Steering Wheel Heater.
14. Test for less than 10 ohms between the ground circuit terminal B at the K32 Steering Wheel Heating Control Module and ground.
 - **If 10 ohms or greater**

Repair the open/high resistance in the circuit.
 - **If less than 10 ohms**
15. Test for 1.5-3.0 ohms between the control circuit terminal A and the ground circuit terminal B at the E15

Steering Wheel Heater.

- **If 10 ohms or greater**

Replace the E15 Steering Wheel Heater.

- **If less than 10 ohms**

16. Test for 6000-35000 ohms between the 12 V reference circuit terminal D and the low reference circuit terminal C at the E15 Steering Wheel Heater.

- **If not within the specified range**

Replace the E15 Steering Wheel Heater.

- **If within the specified range**

17. Replace the K32 Steering Wheel Heating Control Module.

Repair Instructions

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

- **Steering Wheel Control Switch Assembly Replacement**
- **Steering Wheel Replacement**
- **Control Module References** for steering wheel heating control module replacement, programming, and setup

STEERING COLUMN TILT FUNCTION INOPERATIVE

Steering Column Tilt Function Inoperative

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 <u>Symptoms - Steering Wheel and Column</u>
2	Verify that the steering column tilt function is inoperative. Does the steering column tilt function operate normally?	System OK	Go to Step 3
3	If equipped, verify that the following components are not seized or corroded: ● Tilt pivot pins ● Tilt head lock shoes Are the components seized or corroded?	Go to Step 7	Go to Step 4
4	Inspect the tilt pivot pins for binding. Are the tilt pivot pins binding?	Go to Step 8	Go to Step 5

5	Inspect for a weak or broken steering column tilt spring. Is the steering column tilt spring weak or broken?	Go to Step 9	Go to Step 6
6	Inspect the steering column wiring harness routing for tightness. Was the steering column wiring harness routed correctly?	Go to Step 11	Go to Step 10
7	Replace the steering column. Refer to <u>Steering Column Replacement</u> . Did you complete the repair?	Go to Step 11	-
8	If serviceable, replace the pivot pins. If not serviceable replace the steering column. Refer to <u>Steering Column Replacement</u> . Did you complete the repair?	Go to Step 11	-
9	If serviceable, replace the tilt spring. Did you complete the repair?	Go to Step 11	-
10	Route the steering column wiring harness to the correct location. Did you correctly route the wiring harness?	Go to Step 11	-
11	Operate the steering column tilt function in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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 <u>Symptoms - Steering Wheel and Column</u>
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?	Go to Step 9	Go to Step 4
4	Inspect the SIR/SRS coil for noise.		

	Is the SIR/SRS coil noisy?	Go to Step 10	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 11	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 12	Go to Step 7
7	Does the tilt joint need to be lubricated?	Go to Step 13	Go to Step 8
8	NOTE: Inspect the intermediate shaft for noise while driving the vehicle, turning the steering wheel, and applying the brakes. Inspect the intermediate shaft for noise. Is the intermediate shaft noisy?	Go to Step 14	Go to Step 15
9	NOTE: If the steering column mounting feature is damaged or sheared, replace the steering column. Refer to <u>Steering Column Replacement</u>. Tighten the steering column mounting fastener to specifications. Refer to <u>Fastener Tightening Specifications</u> . Did you complete the repair?	Go to Step 15	-
10	Replace the SIR/SRS coil. Refer to <u>Steering Wheel Airbag Coil Replacement</u> . Did you complete the repair?	Go to Step 15	-
11	Install the lock plate retaining ring correctly. Did you complete the repair?	Go to Step 15	-
12	NOTE: If the steering column upper and/or lower bearings are not serviceable, replace the steering column. Refer to <u>Steering Column Replacement</u>. Replace the upper and/or lower bearings, if serviceable. Did you complete the replacement?	Go to Step 15	-
13	Lubricate the tilt joint. Did you complete the repair?	Go to Step 15	-
	Replace the appropriate steering intermediate shaft		

14	component. Did you complete the repair?	Go to Step 15	-
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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 - Steering Wheel and Column
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?	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 feature is damaged or sheared, replace the steering column. Refer to <u>Steering Column Replacement</u>. Tighten the steering column mounting fastener to specifications. Refer to <u>Fastener Tightening Specifications</u> . 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 <u>Steering Column Replacement</u>. 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

TELESCOPING STEERING COLUMN CALIBRATION

Tilt/Telescoping Soft Stops

After replacement of the memory seat module (MSM), it is necessary to program the tilt/telescoping soft stops. Each soft stop is a programmable end of travel that is set approximately 1.3?cm (0.5?in) from the mechanical end of travel. The steering column has a soft stop set at each end of the telescoping in/out and tilt up/down movement. The system uses soft stops to prevent wear on the system by ensuring that the steering column movement stops before it reaches its mechanical end of travel in any direction. The soft stops are initially programmed at the factory. The stop positions may be reprogrammed, which is necessary any time the MSM, the tilt actuator or telescope actuators are replaced, as described in the following procedure.

Tilt/Telescoping Soft Stop Programming Procedure

1. Ignition ON, Engine OFF
2. Connect a scan tool to the vehicle
3. Select Memory Seat Module.
4. Select Special Functions.
5. Select Driver Seat.
6. Select Learn Column Soft Stops
7. Follow the scan tool on-screen instructions

UPPER INTERMEDIATE STEERING SHAFT REPLACEMENT

Removal Procedure

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.

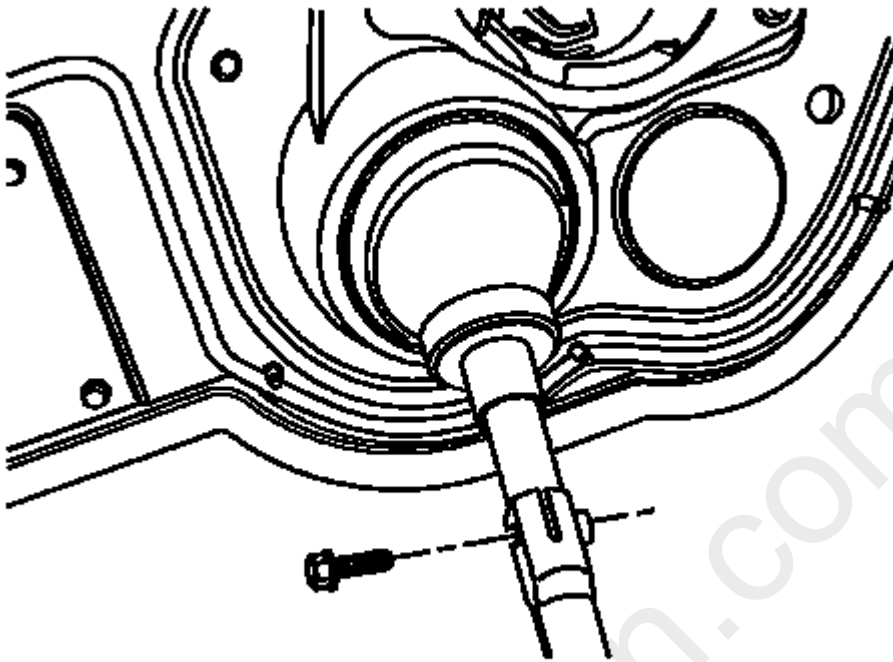


Fig. 5: View Of Upper-To-Center Intermediate Shaft Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Place scribe marks on the intermediate steering shaft and the upper intermediate steering shaft prior to removal. These marks will be used for the correct alignment during installation.

1. Remove the intermediate steering shaft bolt.
2. Disconnect the intermediate steering shaft from the upper intermediate steering shaft.
3. Remove the steering column. Refer to **Steering Column Replacement**.
4. Remove the upper intermediate steering shaft from the vehicle.

Installation Procedure

NOTE: If a new upper intermediate steering shaft is being installed then transfer the position of the alignment marks from the old component to the same locations on the new component. Failure to transfer the alignment marks may result in an off-center steering wheel after installation.

1. Install the upper intermediate steering shaft to the vehicle.

2. Install the steering column. Refer to Steering Column Replacement.

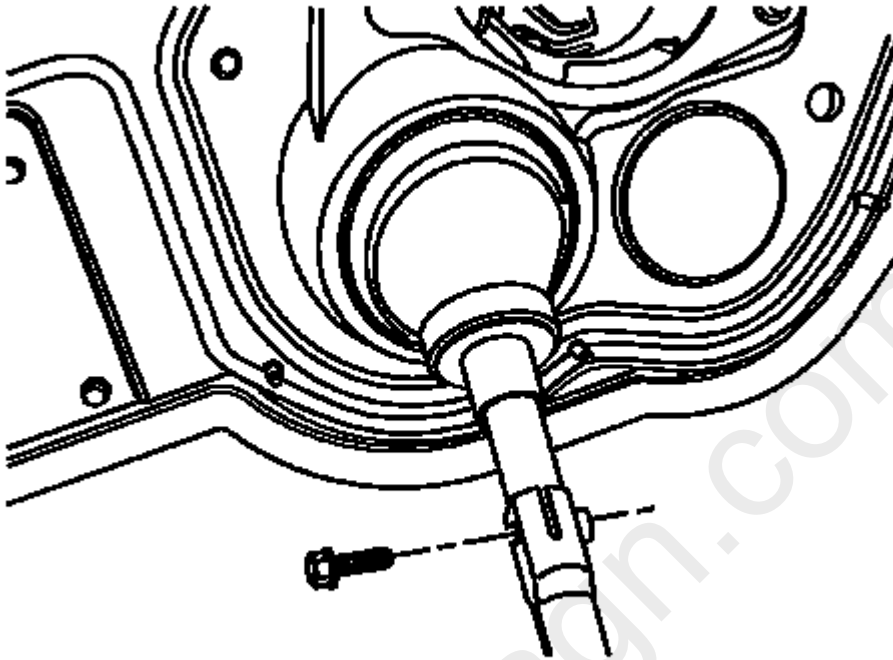


Fig. 6: View Of Upper-To-Center Intermediate Shaft Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Connect the intermediate steering shaft to the upper intermediate steering shaft.

CAUTION: Refer to Fastener Caution .

4. Install the intermediate steering shaft bolt.

Tighten

Tighten the bolt to 33 N.m (24 lb ft).

LOWER INTERMEDIATE STEERING SHAFT REPLACEMENT

Removal Procedure

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.

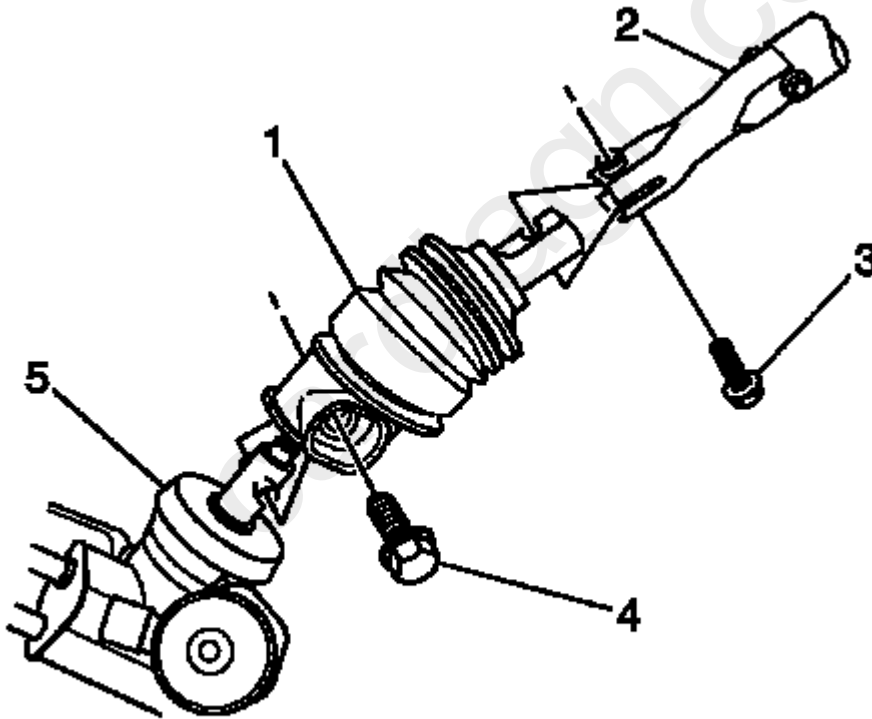


Fig. 7: View Of Steering Column Intermediate Shafts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Place scribe marks on the intermediate steering shaft and the lower intermediate steering shaft prior to removal. These marks will be used for

the correct alignment during installation.

1. Remove the intermediate steering shaft bolt (3).

NOTE: Place scribe marks on the lower intermediate steering shaft and the steering gear prior to removal. These marks will be used for the correct alignment during installation.

2. Remove the lower intermediate steering shaft bolt (4).
3. Disconnect the lower intermediate steering shaft (1) from the steering gear (5) and the intermediate steering shaft (2).
4. Remove the lower intermediate steering shaft from the vehicle.

Installation Procedure

NOTE: If a new lower intermediate steering shaft is being installed then transfer the position of the alignment marks from the old component to the same locations on the new component. Failure to transfer the alignment marks may result in an off-center steering wheel after installation.

1. Position the lower intermediate steering shaft to the vehicle.

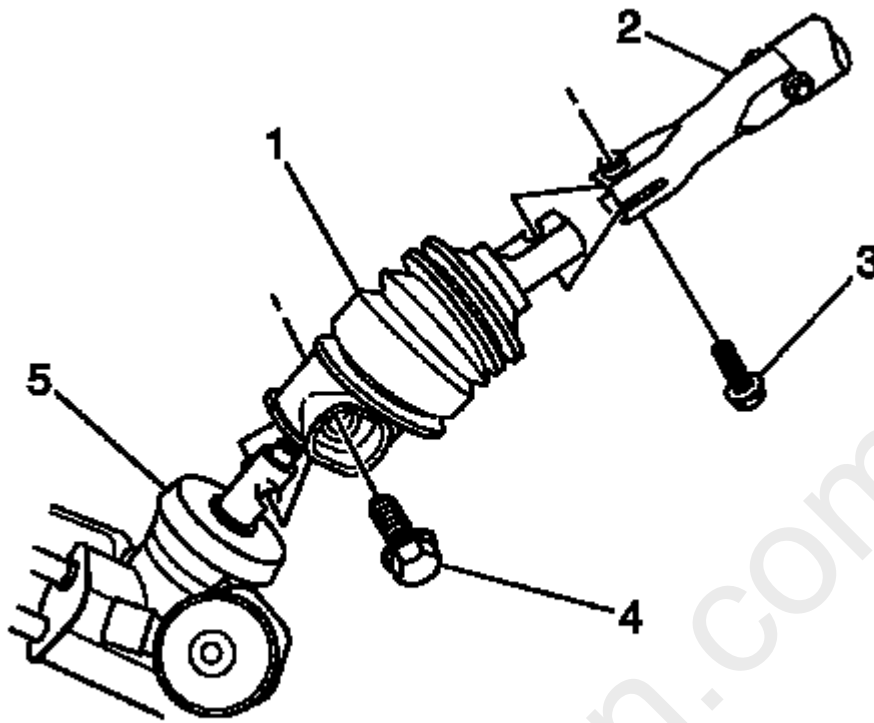


Fig. 8: View Of Steering Column Intermediate Shafts
Courtesy of GENERAL MOTORS COMPANY

2. Connect the lower intermediate steering shaft (1) to the steering gear (5) and the intermediate steering shaft (2).

CAUTION: Refer to Fastener Caution .

3. Install the lower intermediate steering shaft bolt (4).

Tighten

Tighten the bolt to 50 N.m (37 lb ft).

4. Install the intermediate steering shaft bolt (3).

Tighten

Tighten the bolt to 33 N.m (24 lb ft).

INTERMEDIATE STEERING SHAFT REPLACEMENT

Removal Procedure

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.

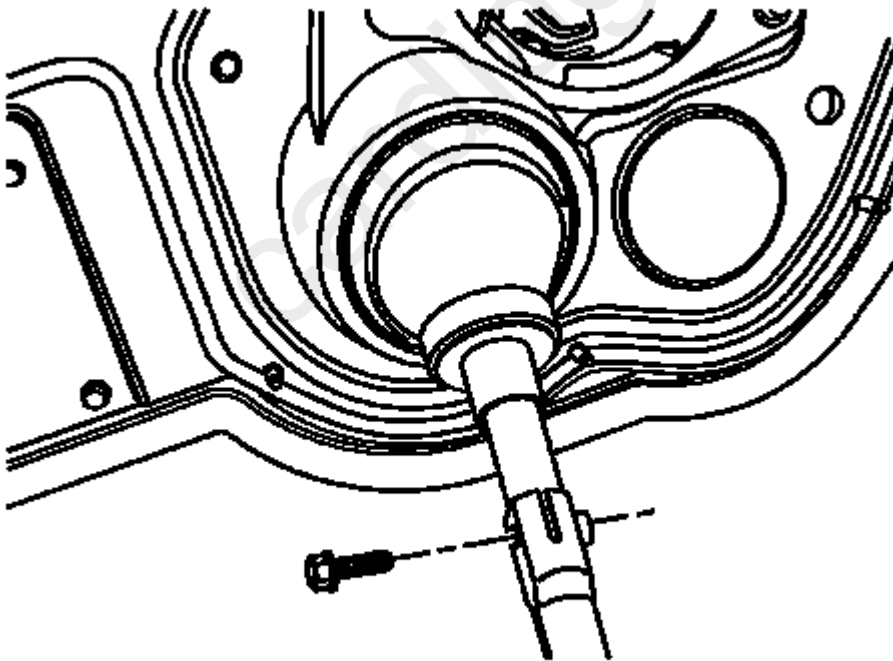


Fig. 9: View Of Upper-To-Center Intermediate Shaft Retaining Bolt

Courtesy of GENERAL MOTORS COMPANY

NOTE: Place scribe marks on the intermediate steering shaft and the upper intermediate steering shaft prior to removal. These marks will be used for the correct alignment during installation.

1. Remove the intermediate steering shaft bolt.

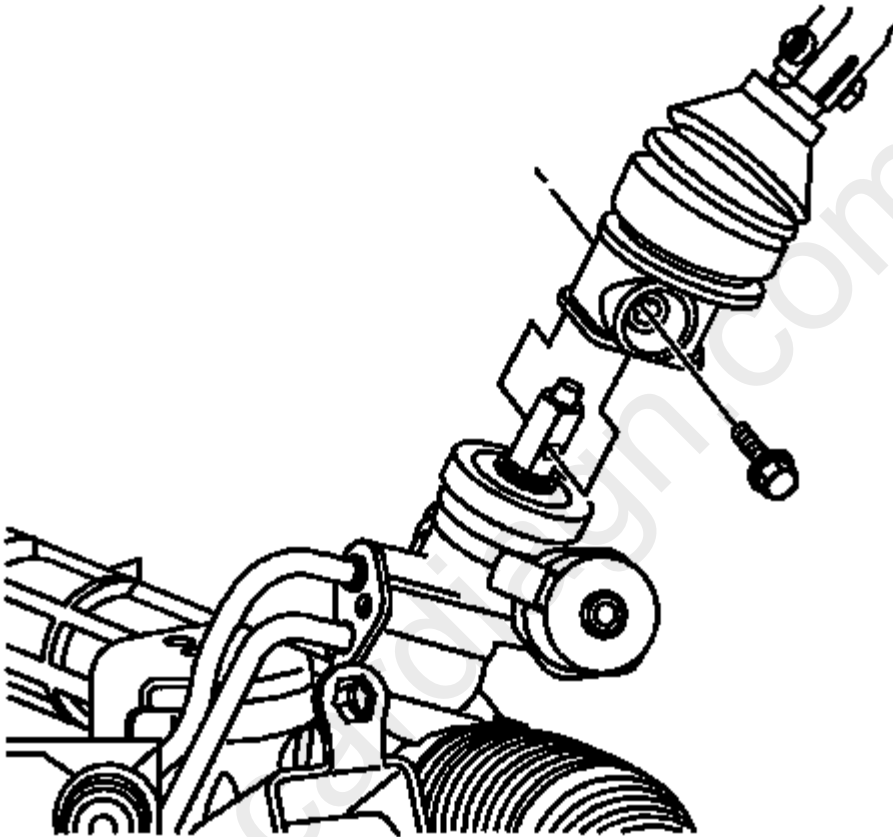


Fig. 10: View Of Intermediate Shaft Lower Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Place scribe marks on the lower intermediate steering shaft and the steering gear prior to removal. These marks will be used for the correct alignment during installation.

2. Remove the lower intermediate steering shaft bolt.
3. Disconnect the lower intermediate steering shaft from the steering gear.
4. Disconnect the intermediate steering shaft from the upper intermediate steering shaft.
5. Remove the lower intermediate steering shaft from the vehicle with the intermediate steering shaft still connected.

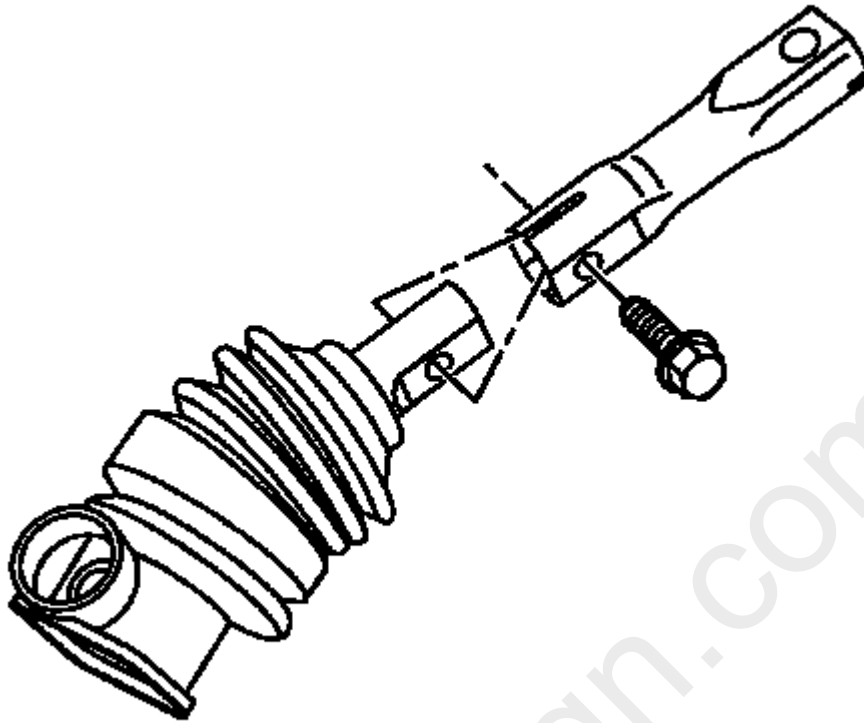


Fig. 11: View Of Lower-To-Center Intermediate Shaft Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Place scribe marks on the lower intermediate steering shaft and the intermediate steering shaft prior to removal. These marks will be used for the correct alignment during installation.

6. Remove the intermediate steering shaft bolt.
7. Disconnect the intermediate steering shaft from the lower intermediate steering shaft.

Installation Procedure

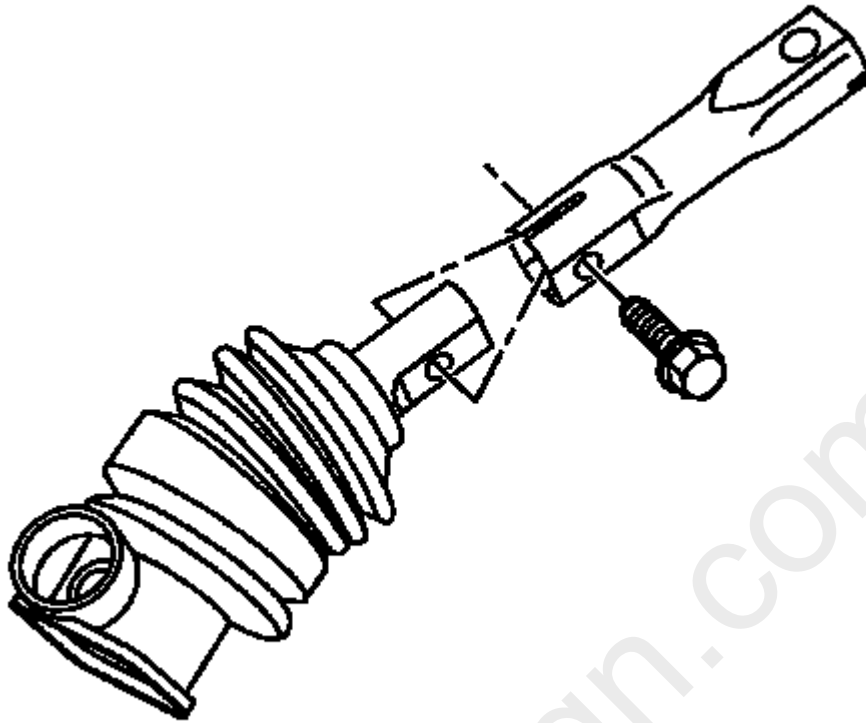


Fig. 12: View Of Lower-To-Center Intermediate Shaft Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: If a new intermediate steering shaft is being installed then transfer the position of the alignment marks from the old component to the same locations on the new component. Failure to transfer the alignment marks may result in an off-center steering wheel after installation.

CAUTION: Refer to Fastener Caution .

1. Connect the intermediate steering shaft to the lower intermediate steering shaft.
2. Install the intermediate steering shaft bolt at the lower intermediate steering shaft.

Tighten

Tighten the bolt to 33 N.m (24 lb ft).

3. Position the lower intermediate steering shaft to the vehicle with the intermediate steering shaft connected.

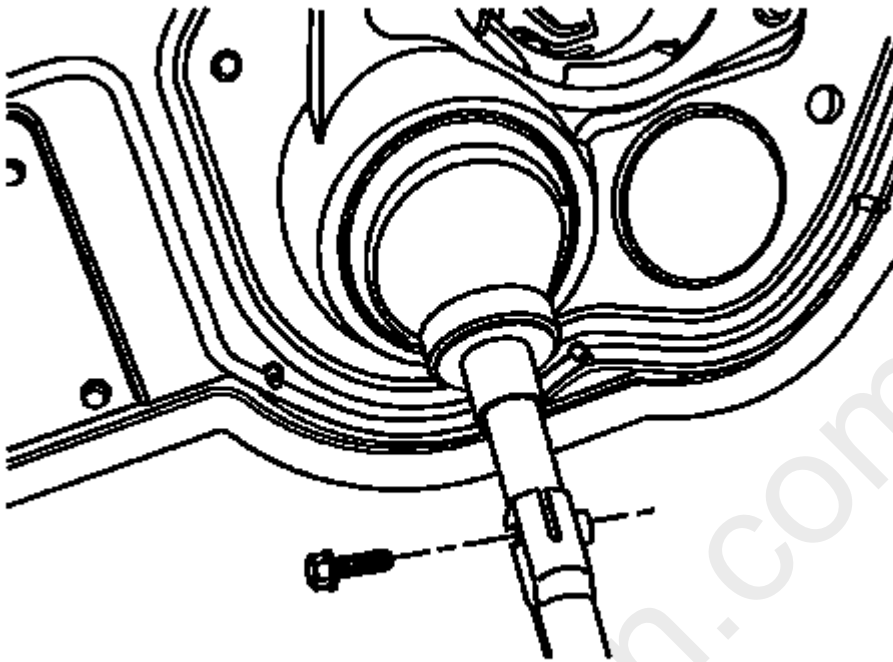


Fig. 13: View Of Upper-To-Center Intermediate Shaft Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Connect the intermediate steering shaft to the upper intermediate steering shaft.
5. Install the intermediate steering shaft bolt at the upper intermediate steering shaft.

Tighten

Tighten the bolt to 33 N.m (24 lb ft).

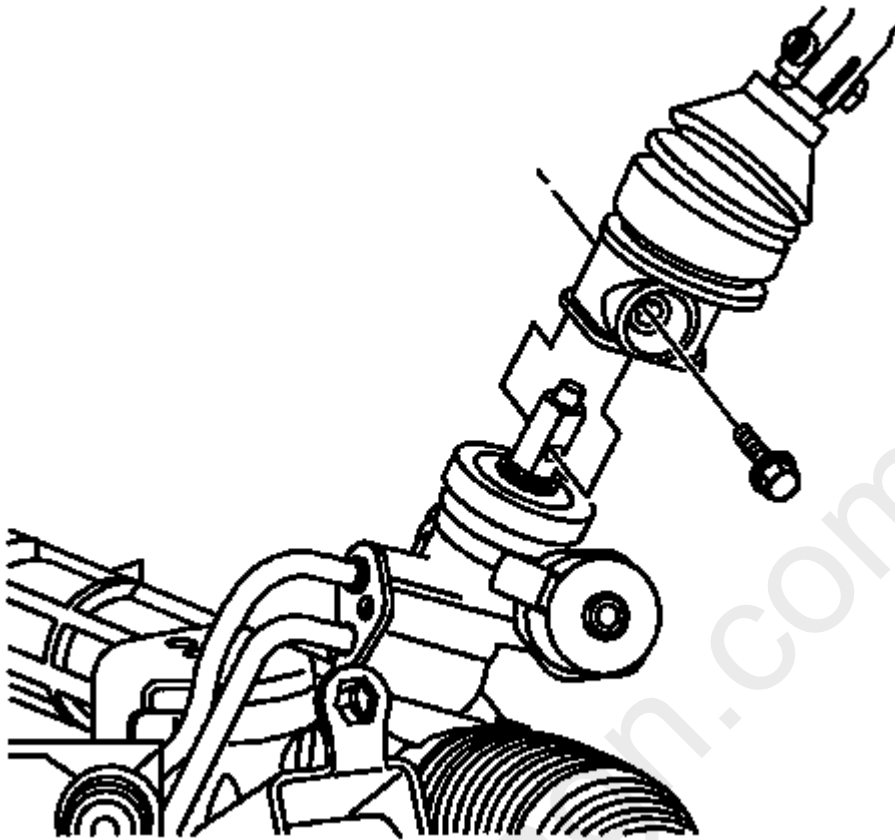


Fig. 14: View Of Intermediate Shaft Lower Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Connect the lower intermediate steering shaft to the steering gear.
7. Install the lower intermediate steering shaft bolt.

Tighten

Tighten the bolt to 50 N.m (37 lb ft).

STEERING COLUMN ACCIDENT DAMAGE INSPECTION

Inspection Procedure

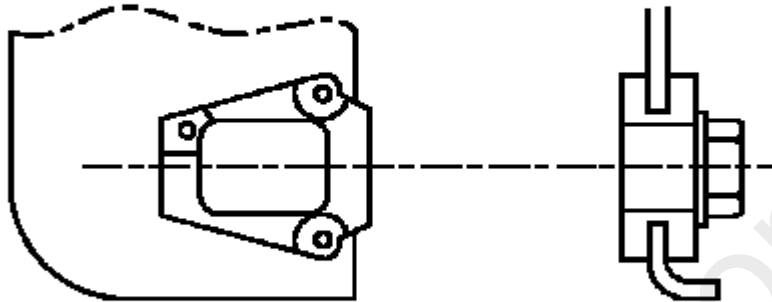


Fig. 15: Inspecting Capsules On Steering Column Bracket Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the capsules on the steering column bracket assembly. Verify that the capsules are seated securely in the bracket slots and inspect the capsules for any loose conditions when pushed or pulled by hand. If the capsules are not secure, perform one of the following procedures:
 - If the bracket is bolted to the jacket assembly, replace the bracket.
 - If the bracket is welded to the jacket assembly, replace the jacket assembly.

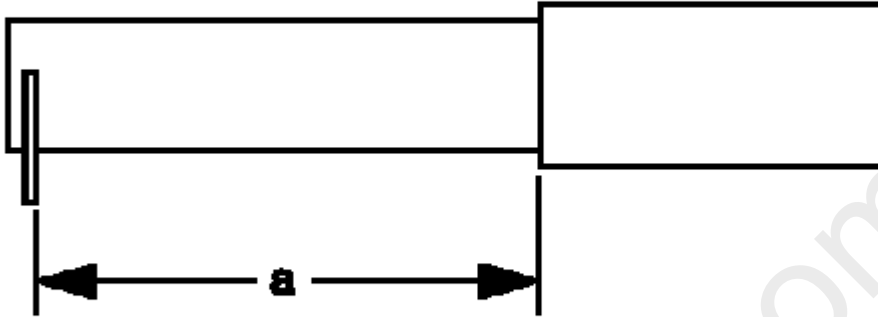


Fig. 16: Inspecting Jacket Assembly Dimensions
Courtesy of GENERAL MOTORS COMPANY

NOTE: Measurement procedure only for manually adjusted steering columns.

2. Inspect the jacket assembly for collapse by measuring the distance from the lower edge of the upper jacket to a defined point on the lower jacket. If measured dimensions (A), are not within specifications (100 mm), install a steering column.

STEERING COLUMN SHROUD REPLACEMENT (WITHOUT KEY RELEASE LEVER KNOB)

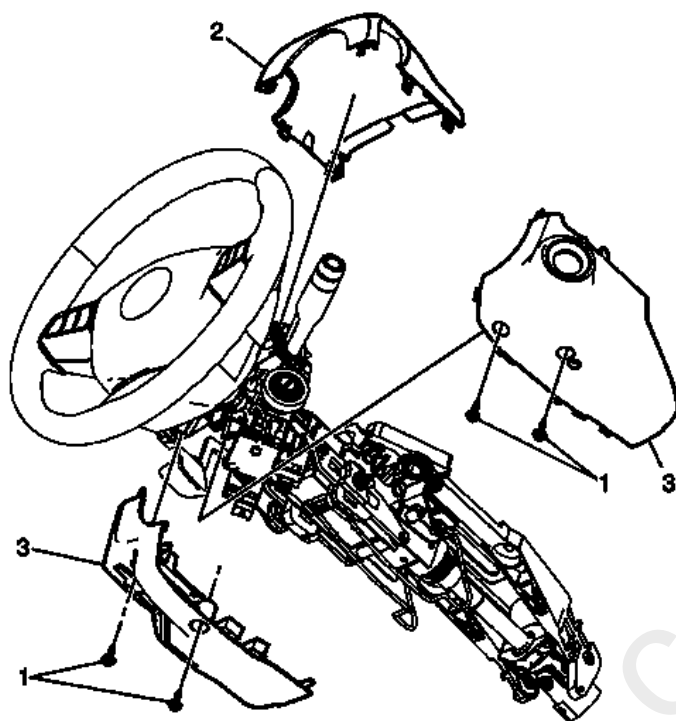


Fig. 17: Steering Column Shroud (Without Key Release Lever Knob)

Courtesy of GENERAL MOTORS COMPANY

Steering Column Shroud Replacement (Without Key Release Lever Knob)

Callout	Component Name
1	Steering Column Shroud Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . TIP: When removing or replacing one side of the steering column shroud, remove all four steering column shroud bolts to allow for the slack needed to separate the pieces. Tighten 3 N.m (27 lb in)
2	Steering Column Upper Shroud TIP: Detach the steering column housing cover from the steering column upper shroud before attempting removal.
3	Steering Column Shroud (Qty: 2) TIP: Replace each piece of the steering column shroud as needed.

STEERING COLUMN SHROUD REPLACEMENT (WITH KEY RELEASE LEVER KNOB)

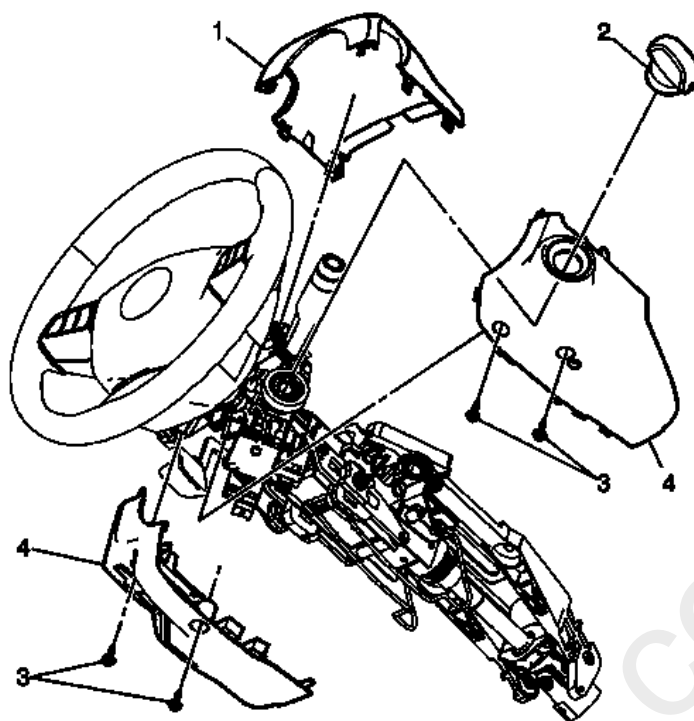


Fig. 18: Identifying Steering Column Shroud (With Key Release Lever Knob)
 Courtesy of GENERAL MOTORS COMPANY

Steering Column Shroud Replacement (With Key Release Lever Knob)

Callout	Component Name
1	Steering Column Upper Shroud TIP: Detach the steering column housing cover from the steering column upper shroud before attempting removal.
2	Steering Column Key Release Lever Knob Procedure In order to release the knob, push a pick type tool into the access hole on the bottom of the knob while pulling on the knob. Refer to <u>Steering Column Key Release Lever Knob Replacement</u> .
3	Steering Column Shroud Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . TIP: When removing or replacing one side of the steering column shroud, remove all 4 steering column shroud bolts in order to allow for the slack necessary to separate the pieces. Tighten 3 N.m (27 lb in)
4	Steering Column Shroud (Qty: 2) TIP: Replace each piece of the steering column shroud as necessary.

TURN SIGNAL SWITCH BRACKET REPLACEMENT

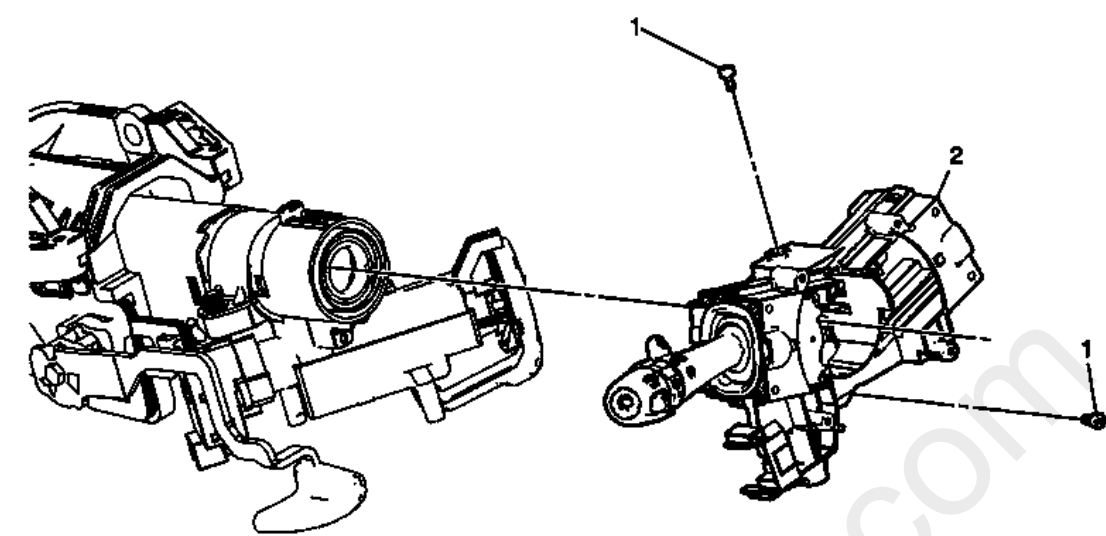


Fig. 19: Identifying Turn Signal Switch Bracket
Courtesy of GENERAL MOTORS COMPANY

Turn Signal Switch Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the inflatable restraint steering wheel module coil. Refer to <u>Steering Wheel Airbag Coil Replacement</u> .	
1	Turn Signal Switch Bracket Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 11 N.m (97 lb in)
2	Turn Signal Switch Bracket Procedure 1. Disconnect any electrical connectors as needed. 2. Release the plastic retaining tabs to release the turn signal switch bracket from the steering column.

3. Transfer any parts as needed.

TURN SIGNAL MULTIFUNCTION SWITCH REPLACEMENT

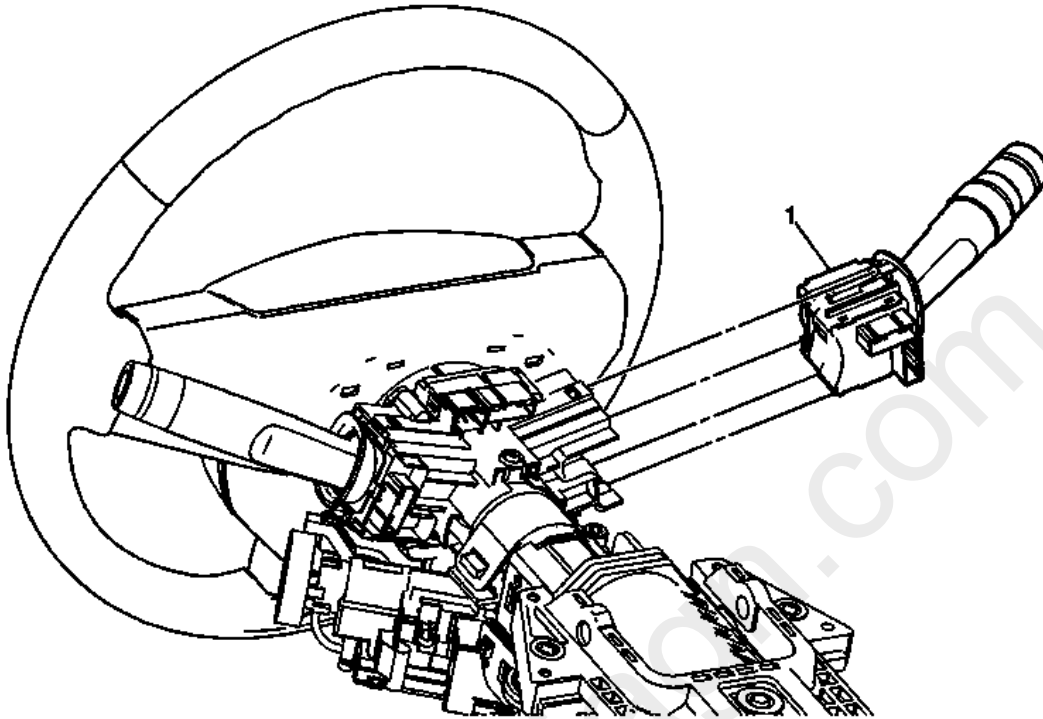


Fig. 20: Turn Signal Multifunction Switch
Courtesy of GENERAL MOTORS COMPANY

Turn Signal Multifunction Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the steering column shroud. Refer to <u>Steering Column Shroud Replacement (Without Key Release Lever Knob)</u> , <u>Steering Column Shroud Replacement (With Key Release Lever Knob)</u> .	
1	Turn Signal Multifunction Switch Procedure 1. Disconnect any electrical connectors as needed. 2. Release the plastic retaining tabs and remove the turn signal multifunction switch from the turn signal switch bracket.

STEERING WHEEL HEAT CONTROL MODULE REPLACEMENT

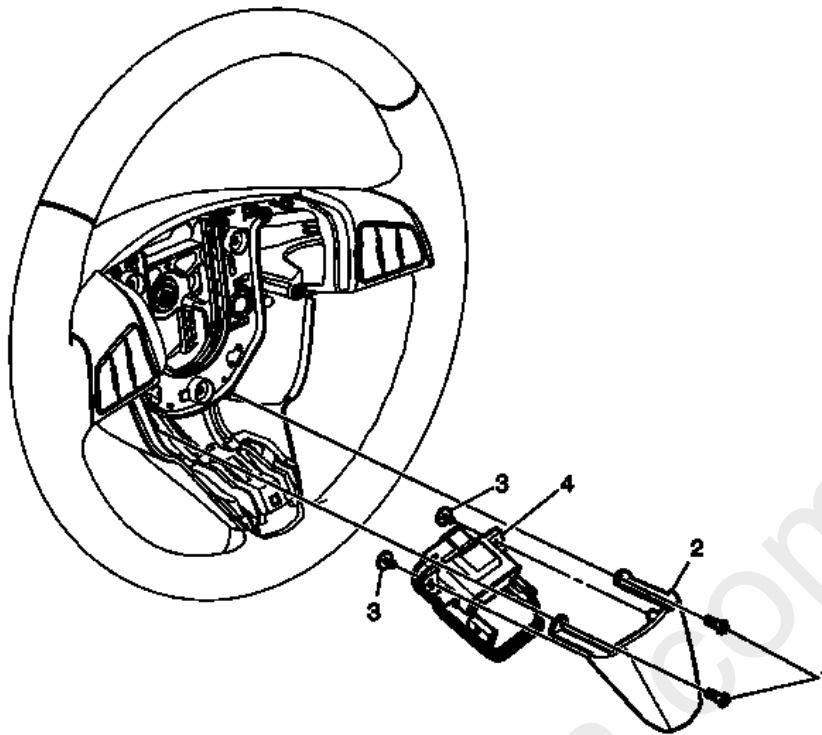


Fig. 21: Steering Wheel Heat Control Module, Steering Wheel Bezel & Screws
 Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Heat Control Module Replacement

Callout	Component Name
Preliminary Procedure	
Remove the steering wheel airbag. Refer to .	
1	Steering Wheel Bezel Screws (Qty 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Steering Wheel Bezel
3	Steering Wheel Heat Control Module Screws (Qty 2) CAUTION: Refer to <u>Fastener Caution</u> .
4	Steering Wheel Heat Control Module Procedure Disconnect the steering harness from the steering wheel heat control module.

STEERING WHEEL REPLACEMENT

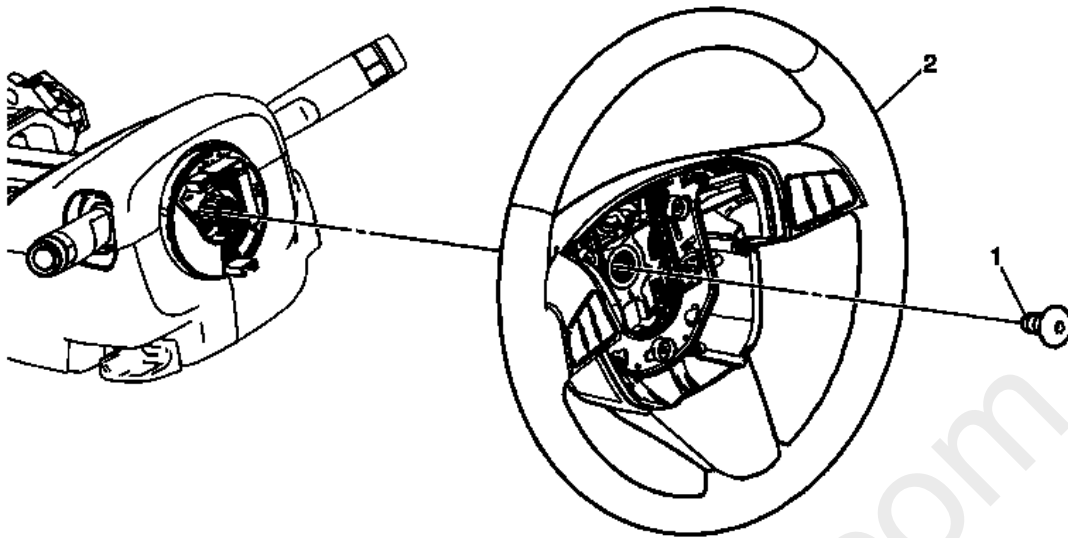


Fig. 22: Steering Wheel

Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Replacement

Callout	Component Name
Preliminary Procedure Remove the inflatable restraint steering wheel module. Refer to Airbag Steering Wheel Module Replacement .	
1	Steering Wheel Bolt CAUTION: Refer to Fastener Caution . Tighten 30 N.m (22 lb ft)
2	Steering Wheel Procedure 1. Disconnect all electrical connectors as needed. 2. Remove the steering wheel . 3. Transfer any parts as needed.

STEERING COLUMN TILT WHEEL AND TELESCOPE SWITCH REPLACEMENT

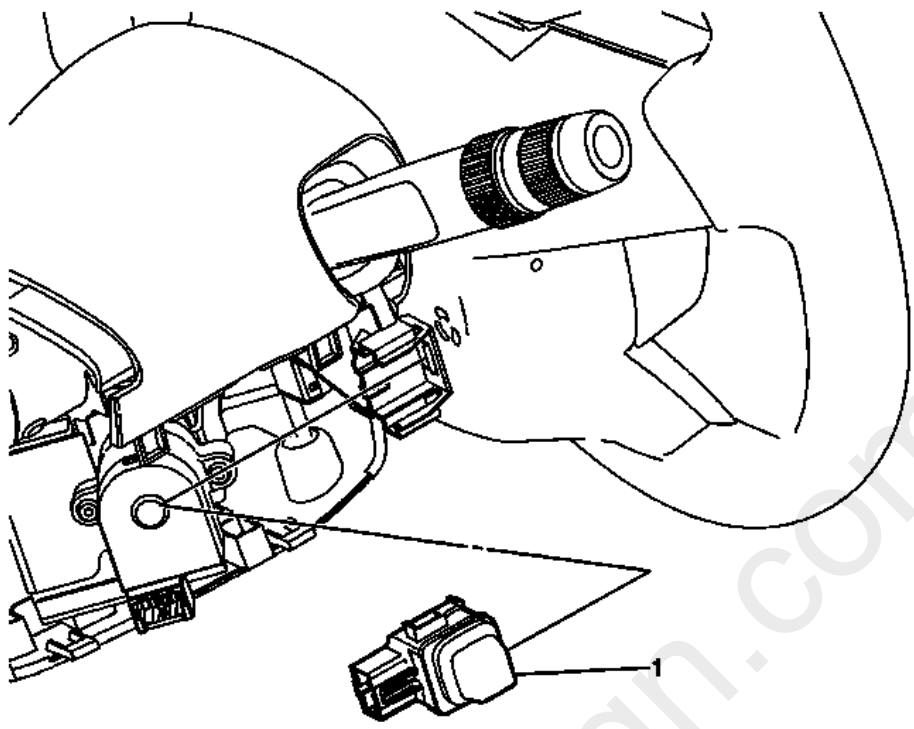


Fig. 23: Identifying Steering Column Tilt Wheel & Telescope Switch
Courtesy of GENERAL MOTORS COMPANY

Steering Column Tilt Wheel and Telescope Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the lower left steering column shroud. Refer to <u>Steering Column Shroud Replacement (Without Key Release Lever Knob)</u> , <u>Steering Column Shroud Replacement (With Key Release Lever Knob)</u> .	
1	Steering Column Tilt Wheel and Telescope Switch Procedure 1. Disconnect any electrical connectors as needed. 2. Release the plastic retaining tabs to release the switch from the turn signal switch bracket.

STEERING COLUMN TILT WHEEL POSITION SENSOR REPLACEMENT

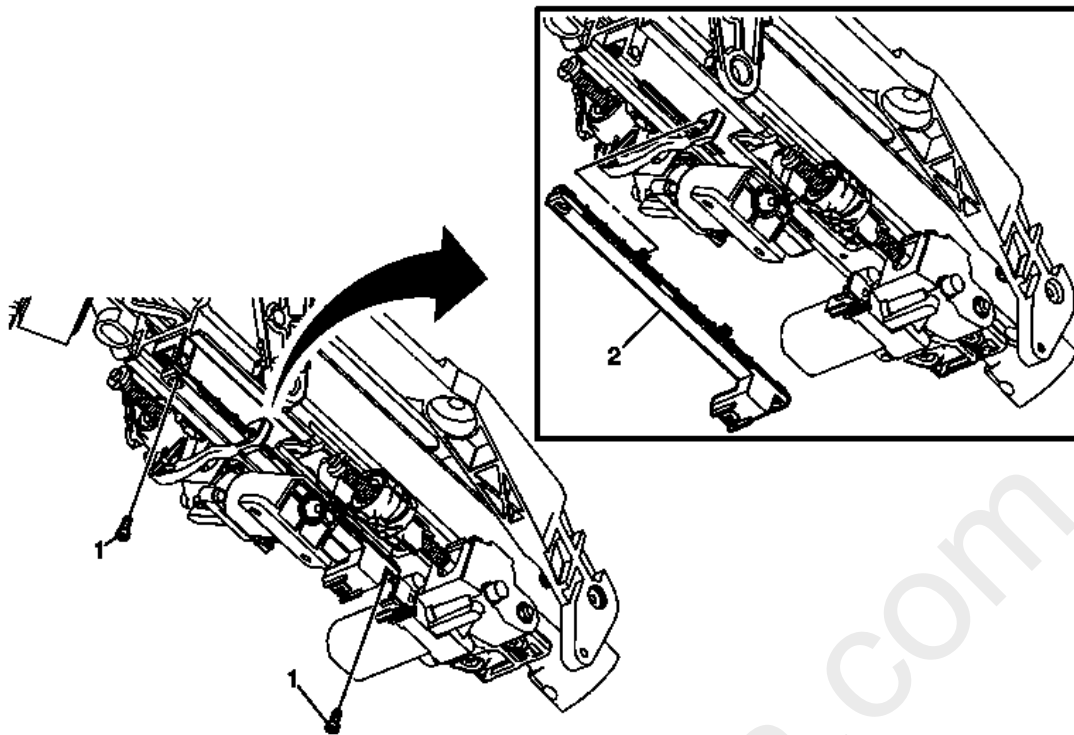


Fig. 24: Identifying Steering Column Tilt Wheel Position Sensor
 Courtesy of GENERAL MOTORS COMPANY

Steering Column Tilt Wheel Position Sensor Replacement

Callout	Component Name
Preliminary Procedure	
Remove the steering column. Refer to <u>Steering Column Replacement</u> .	
1	Steering Column Tilt Wheel Position Sensor Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 0.5 N.m (4 lb in)
	Steering Column Tilt Wheel Position Sensor CAUTION: Cover any openings on the steering column while servicing the motor. Do not allow anything to drop into the openings on the steering column. Objects or contaminants in the openings on the steering column could damage the steering column. This damage could impair the collapsible design of the steering column. Procedure

2

1. Disconnect any electrical connectors as necessary.
2. If necessary, reposition the steering column tilt wheel actuator motor.
3. If necessary, reposition the steering column telescope actuator motor.
4. During the installation, align the position sensor arms with both actuator motors.
5. After the installation is complete, perform the telescoping steering column calibration. Refer to .

TIP: The connectors on the harness are for a single use only. If you disconnect either connector or both connectors, replace the harness.

STEERING COLUMN REPLACEMENT

Removal Procedure

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.

1. LOCK the steering column and verify the front wheels are in the straight ahead position.

WARNING: This vehicle is equipped with a Supplemental Inflatable Restraint (SIR) System. Failure to follow the correct procedure could cause the following conditions:

- Air bag deployment
- Personal injury
- Unnecessary SIR system repairs

In order to avoid the above conditions, observe the following

guidelines:

- Refer to SIR Component Views in order to determine if you are performing service on or near the SIR components or the SIR wiring.
 - If you are performing service on or near the SIR components or the SIR wiring, disable the SIR system. Refer to Disabling the SIR System.
2. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling** .
 3. Remove the steering column shroud. Refer to **Steering Column Shroud Replacement (Without Key Release Lever Knob)**, **Steering Column Shroud Replacement (With Key Release Lever Knob)**.
 4. Remove the driver knee bolster bracket. Refer to **Driver Knee Bolster Bracket Replacement (Right Hand Drive)** , **Driver Knee Bolster Bracket Replacement (Left Hand Drive)** .
 5. Disconnect any electrical connectors as necessary.

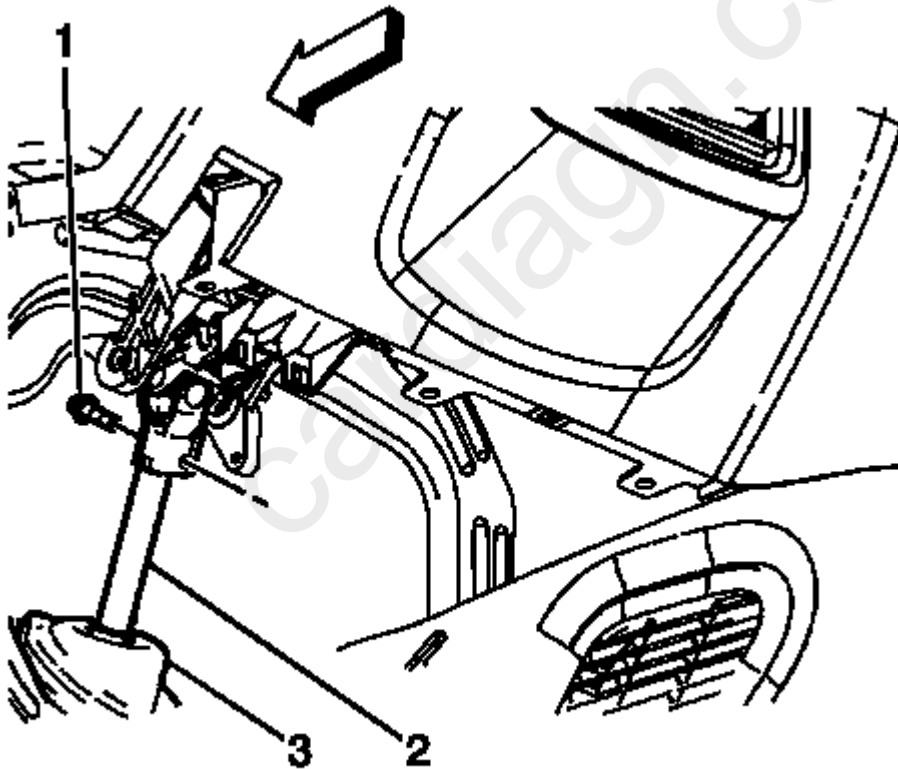


Fig. 25: Identifying Intermediate Steering Shaft Components
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper intermediate steering shaft bolt (1).

7. Disconnect the upper intermediate steering shaft (2) from the steering column. Do not pull the intermediate steering shaft lower seal (3) away from the body panel.

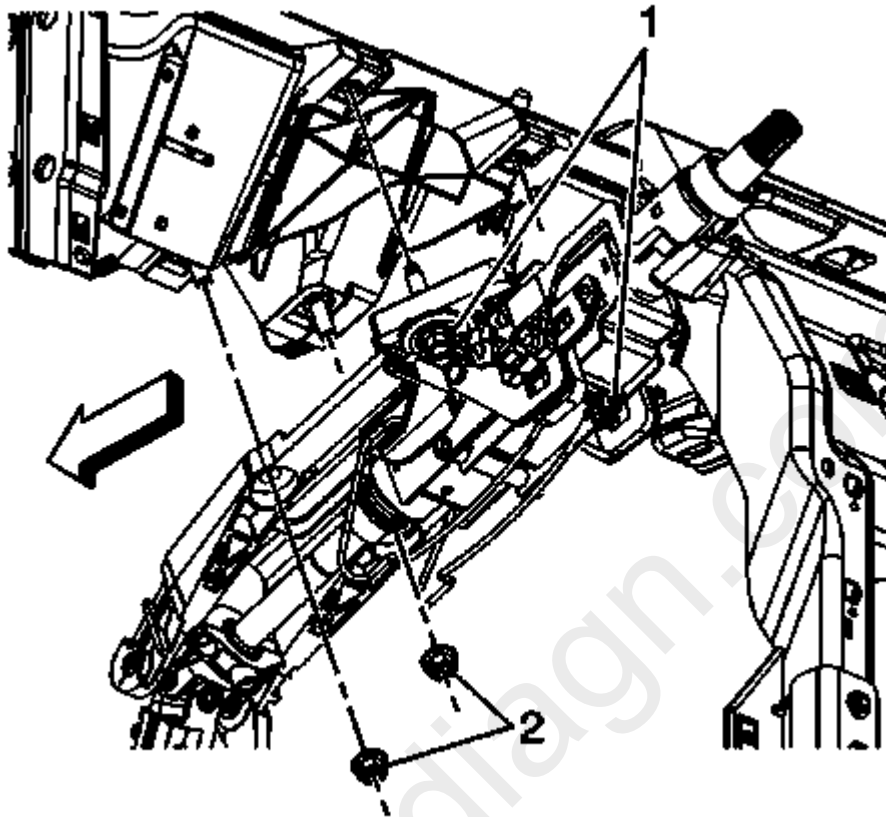


Fig. 26: Identifying Steering Column Nuts & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the steering column nuts (2) and the steering column bolts (1).

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.

9. Remove the steering column from the vehicle.
10. Transfer any parts as necessary.

Installation Procedure

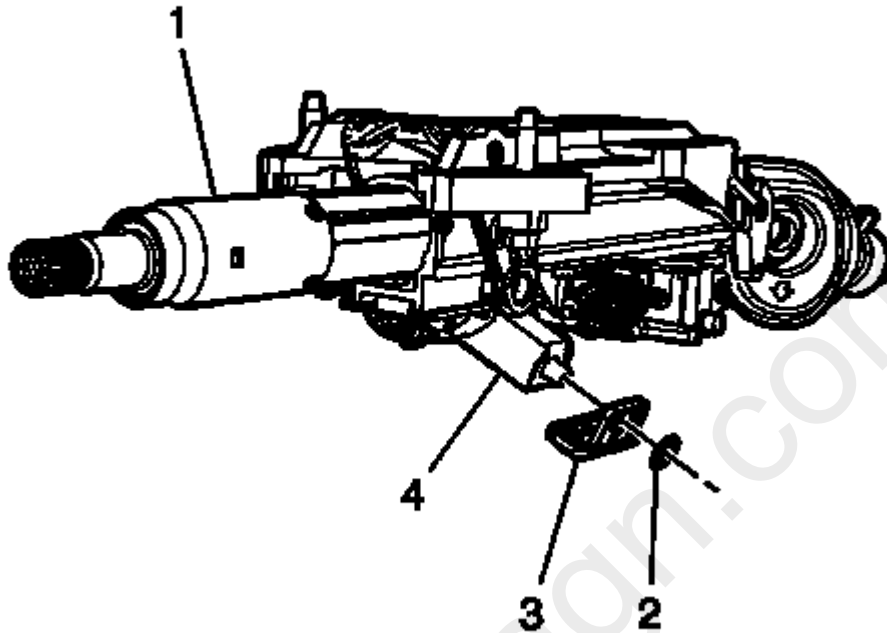


Fig. 27: Identifying Steering Column Assembly, Steering Column Tilt Wheel Actuator Motor, Star Washer And Plastic Bracket

Courtesy of GENERAL MOTORS COMPANY

1. If you are installing a NEW steering column assembly (1) or a steering column with a NEW steering column tilt wheel actuator motor (4), use a flat blade pry tool in order to GENTLY remove the star washer (2) and the plastic bracket (3) from the tilt wheel actuator motor.

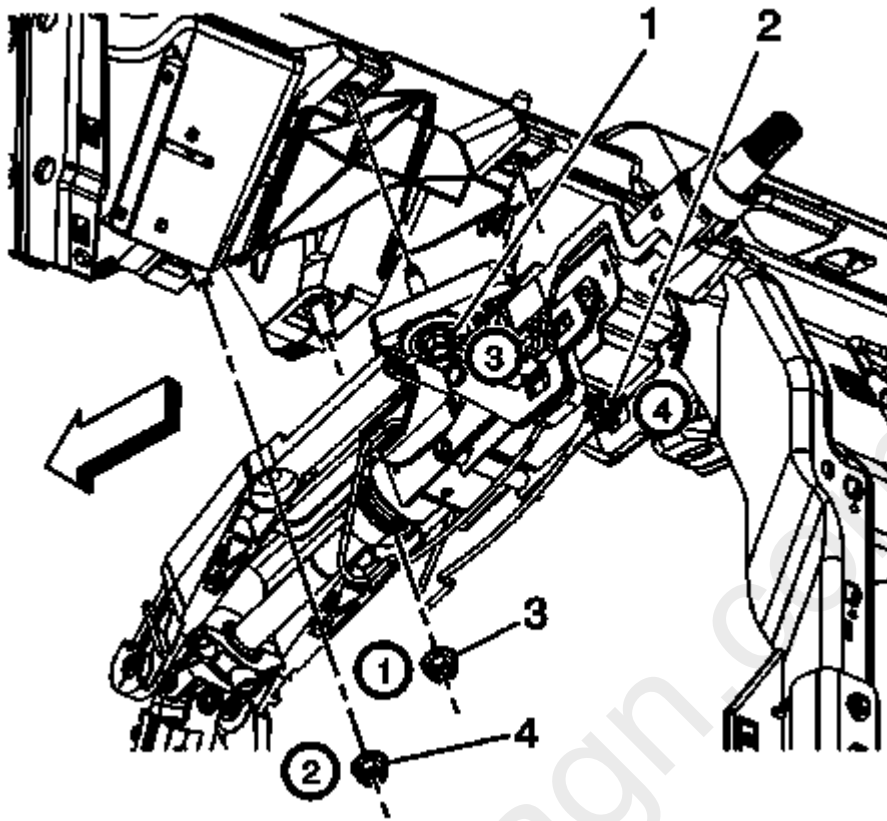


Fig. 28: Identifying Steering Column Nuts & Bolts
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Hand tighten the nuts and the bolts in sequence. DO NOT apply any clamping force.

2. Install the steering column to the vehicle and start the steering column nuts (3, 4) and bolts (1, 2) by hand using the following sequence:
 1. Position the steering column in the vehicle.
 2. Hand start the steering column nuts (3, 4).
 3. Hand start the steering column bolts (1, 2).
 4. Hold the steering column flush against the instrument panel carrier.
 5. Hand tighten steering column nut (3).
 6. Hand tighten steering column nut (4).
 7. Hand tighten steering column bolt (1).
 8. Hand tighten steering column bolt (2).

CAUTION: Refer to Fastener Caution .

NOTE: Tighten the nuts and the bolts in sequence to the specification.

3. Tighten the steering column nuts (3, 4) and bolts (1, 2) in the following sequence:
 1. Tighten the steering column nut (3) to 27 N.m (20 lb ft).
 2. Tighten the steering column nut (4) to 27 N.m (20 lb ft).
 3. Tighten the steering column bolt (1) to 27 N.m (20 lb ft).
 4. Tighten the steering column bolt (2) to 27 N.m (20 lb ft).

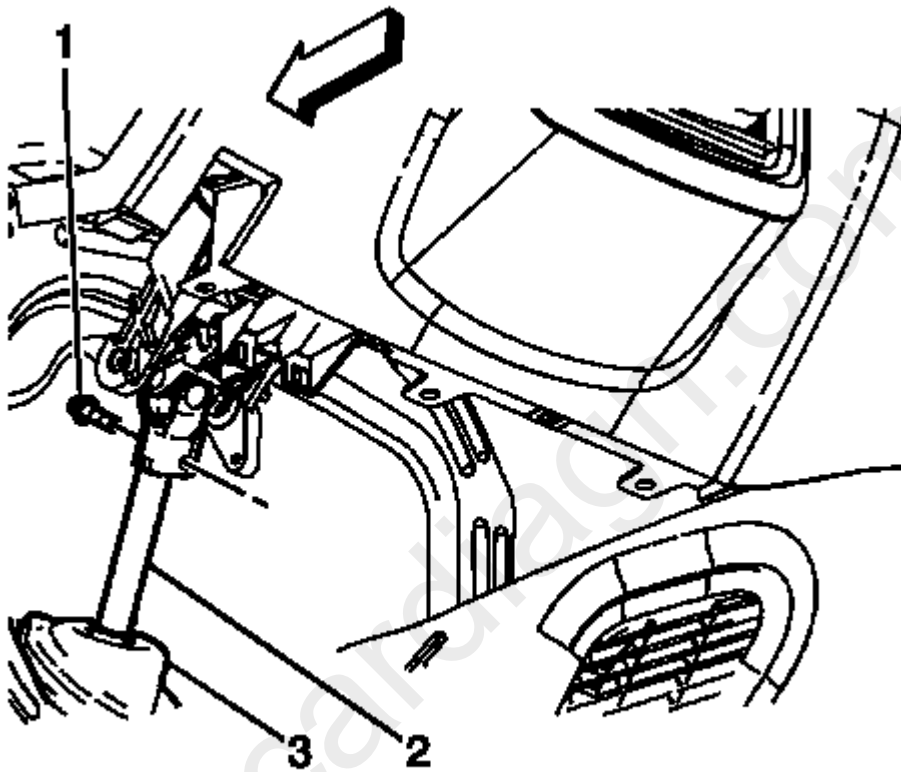


Fig. 29: Identifying Intermediate Steering Shaft Components
Courtesy of GENERAL MOTORS COMPANY

4. Connect the intermediate steering shaft (2) to the steering column shaft.
5. Install the intermediate steering shaft bolt (1) and tighten the bolt to 33 N.m (24 lb ft).
6. Ensure the intermediate steering shaft upper seal (3) is seated correctly.
7. Connect all electrical connectors as necessary.
8. Install the driver knee bolster bracket. Refer to **Driver Knee Bolster Bracket Replacement (Right Hand Drive)** , **Driver Knee Bolster Bracket Replacement (Left Hand Drive)** .
9. Install the steering column shroud. Refer to **Steering Column Shroud Replacement (Without Key Release Lever Knob)**, **Steering Column Shroud Replacement (With Key Release Lever Knob)**.

10. Enable the SIR. Refer to **SIR Disabling and Enabling** .
11. If equipped with a power tilting and telescoping steering column, calibrate the telescoping steering column. Refer to **Telescoping Steering Column Calibration**.

STEERING ANGLE SENSOR REPLACEMENT

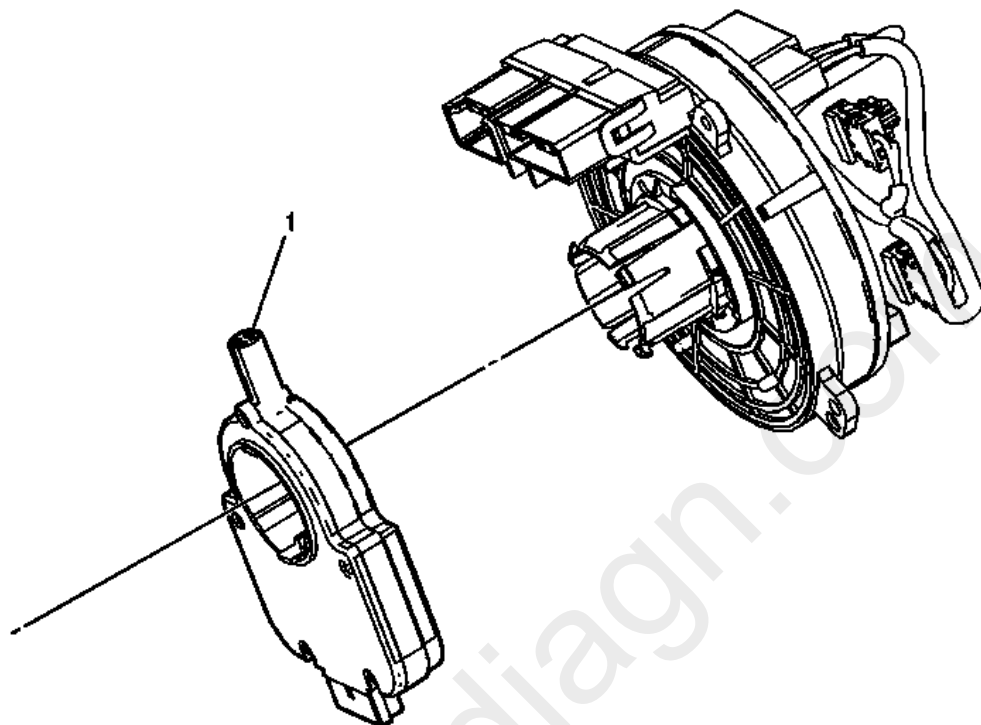


Fig. 30: Identifying Steering Angle Sensor
 Courtesy of GENERAL MOTORS COMPANY

Steering Angle Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the steering wheel airbag coil. Refer to <u>Steering Wheel Airbag Coil Replacement</u> .	
1	Steering Angle Sensor Procedure 1. Disconnect any electrical connectors as necessary. 2. Squeeze the plastic retaining tabs on the steering wheel airbag coil in order to remove the steering angle sensor. 3. After the installation is complete, center the steering angle sensor. Refer to <u>Steering Angle Sensor Centering</u> .

DESCRIPTION AND OPERATION

STEERING WHEEL AND COLUMN DESCRIPTION AND OPERATION

The steering wheel and column has 4 primary functions:

- Heated Steering Wheel
- Vehicle steering
- Vehicle security
- Driver convenience
- Driver safety

Heated Steering Wheel

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module that steering wheel heat is requested. When the request is seen, the heated steering wheel control module supplies ground to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel. The heated steering wheel temperature is monitored through an internal temperature sensor. When the steering wheel reaches operating temperature the module will cycle the voltage on and off to maintain the operating temperature.

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 column. At the lower end of the column, the intermediate shaft connects the column to the steering gear.

Vehicle Security, Found on Some Vehicle Models

Theft deterrent components are mounted and designed into the steering column. The following components allow the column to be locked in order to minimize theft:

- The ignition switch-location varies
- The steering column lock-content varies
- The ignition cylinder-location varies
- The theft deterrent module-location varies

Driver Convenience

The steering wheel and column may also have driver controls attached for convenience and comfort. The following controls may be mounted on or near the steering wheel or column.

- The turn signal switch
- The hazard switch
- The headlamp dimmer switch

- The wiper/washer switch
- The horn pad/cruise control switch
- The redundant radio/entertainment system controls
- The manual/power tilt or tilt/telescoping functions
- The power pedal adjustment control switch
- The navigation/OnStar® features
- The HVAC controls

Driver Safety

The steering wheel and column has safety features to protect the driver. The following components may be mounted on or near the steering column:

Energy-Absorbing Steering Column

The energy-absorbing steering column compresses in the event of a front-end 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. In addition to these features, the following driver safety features may be on the steering column. To inspect the steering column for damage, refer to **Steering Column Accident Damage Inspection**.

Electronic Park Lock (EPL)/Ignition Lock Cylinder Control Actuator

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an ignition lock cylinder control actuator system in the steering column. The ignition lock cylinder control actuator purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The column ignition lock system consists of an ignition lock cylinder control actuator, and a park position switch that is located in the automatic transmission shift lock control switch. The ignition lock cylinder control actuator contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Linear Shift Assembly

If the vehicle is equipped with a column mounted gear shift, it has a linear shift assembly on the steering column. The linear shift assembly has a cable that runs from the linear shift assembly to the ignition lock cylinder case. The purpose of this cable is to prevent the ignition key from being turned to the OFF position when the transmission is in gear and the vehicle may still be moving. The linear shift assembly cable contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

SIR Coil and Module

For additional information on the operation of the SIR coil and module, refer to **Supplemental Inflatable Restraint System Description and Operation** .

Automatic Transmission Shift Lock Actuator

The automatic transmission shift lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consists of the following components: the automatic transmission shift lock control solenoid, the automatic transmission shift lock control switch, the body control module (BCM), the powertrain control module (PCM)/engine control module (ECM). With the ignition in the ON position, voltage is supplied to automatic transmission shift lock control switch. Voltage flows through the normally closed contacts of the automatic transmission shift lock control switch to the automatic transmission shift lock control solenoid. When the BCM receives a class 2 message from the PCM/ECM indicating the transmission is in the park position the BCM then grounds the automatic transmission shift lock solenoid control circuit . This energizes the automatic transmission shift lock control solenoid causing the transmission shift lever to be physically locked in the PARK position. When the brake pedal is pressed the contacts in the automatic transmission shift lock control switch open, de-energizing the automatic transmission shift lock control solenoid. This allows the shift lever to be move out of the PARK position.

Steering Wheel Angle Sensor or Steering Wheel Position Sensor

The steering wheel position sensor is located somewhere along the steering shaft assembly. The sensor measures the position of the steering wheel and the speed at which it is rotated. A signal representing this measurement is provided to the vehicle stability enhancement system (VSES) module. The VSES module uses this signal, along with several others representing different vehicle conditions, to monitor the driving behavior of the vehicle and ensure that it stays in control. If the VSES module determines that the vehicle is out of control it provides signals to the powertrain control module (PCM) and the ABS module. These output signals are used to modulate the transmission torque and brake pressure of each of the vehicles wheels in order to regain control of the vehicle.