

Brake Assist System Description and Operation

System Component Description

The brake assist system consists of the following:

Brake Pedal

Multiplies the braking effort applied by the driver.

Brake Pedal Pushrod

Transfers multiplied input force received from the brake pedal to the vacuum brake booster.

Vacuum Brake Booster

Uses source vacuum to decrease effort required by the driver when applying the brakes.

Vacuum Source

The source vacuum for a spark ignition engine is normally derived from the Intake Manifold.

Vacuum Source Delivery System

Enables delivery and retention of source vacuum for vacuum brake booster.

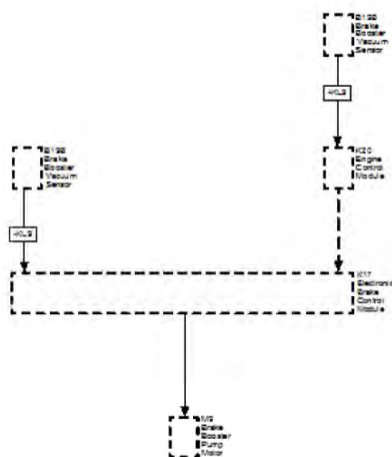
System Operation

Under normal driving conditions, without the brakes applied, vacuum is allowed to act on both sides of the diaphragm within the vacuum brake booster. When the brake pedal is applied, the effort by the driver is multiplied due to the relative length of the brake pedal in relationship to its pivot point and the point at which the push rod to the Vacuum Brake Booster is attached. Movement of the push rod causes a valve within the Vacuum Brake Booster to close between the two sides of the diaphragm, thus isolating each side. It also allows a valve to open that allows atmospheric pressure to act on the pedal side of the Vacuum Brake Booster whilst maintaining vacuum on the vacuum source side of the diaphragm. The movement of the Brake Pedal Pushrod is transferred to the Hydraulic Brake Master Cylinder via the Vacuum Brake Booster. The pressure differential within the Vacuum Brake Booster reduces the effort required by the driver in applying the brakes.

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System Component Description

Hydraulic Brakes Block Diagram



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Brake Booster Auxiliary Vacuum Pump

The Brake Booster Vacuum Pump is a secondary vacuum supply to the brake booster used to maintain sufficient vacuum for brake assist.

Brake Booster Vacuum Sensor Without KL9

The vacuum sensor is used to measure the level of vacuum available in the brake booster. The Electronic Brake Control Module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor is located in the brake booster or vacuum hose. The Brake Booster Vacuum Sensor supplies a voltage signal in relation to the pressure in the brake booster to the Electronic Brake Control Module.

Brake Booster Vacuum Sensor With KL9

The vacuum sensor is used to measure the level of vacuum available in the brake booster. The Engine Control Module supplies a 5V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor is located in the brake booster or vacuum hose. The Brake Booster Vacuum Sensor supplies a voltage signal in relation to the pressure in the brake booster to the Engine Control Module.

Electronic Brake Control Module

The Electronic Brake Control Module monitors the vacuum in the brake booster using the Brake Booster Vacuum Sensor. When the vacuum within the system drops, below 42 kPa (6 psi) the Electronic Brake Control Module turns ON the Brake Booster Auxiliary Vacuum Pump by providing a ground to the Brake Booster Pump Relay. The relay activates and supplies voltage to the Brake Booster Auxiliary Vacuum Pump. The Electronic Brake Control Module shuts the pump off when the vacuum pressure is above 55 kPa (8 psi) by removing the ground to the Brake Booster Pump Relay.

Vacuum Brake Booster

When brake system input force is applied, air at atmospheric pressure is admitted to the rear of both vacuum diaphragms, providing a decrease in brake pedal effort required. When input force is removed, vacuum replaces the atmospheric pressure within the booster. The booster uses source vacuum to decrease the effort required by driver when applying the brake.

Vacuum Source

Vacuum is supplied by the engine vacuum or by the Brake Booster Auxiliary Vacuum Pump.

System Operation

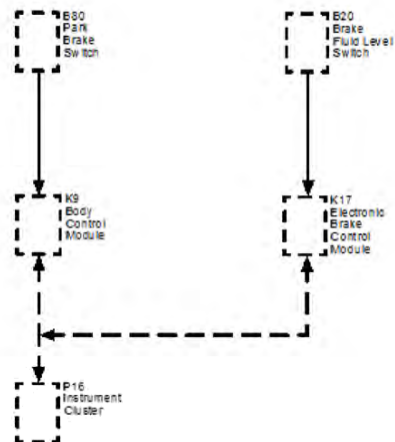
The pump can be switched on and off by the Electronic Brake Control Module based on the required vacuum. Pressure variations during braking can be measured, and the pump can be activated to generate additional vacuum if required to increase the braking force.

The pump runs for the first 5 seconds after engine running to perform a self test. Engine running, the pump may run another 30 seconds and then turns off, due to the timer relay. The pump has a maximum run time of 180 seconds per ignition cycle with engine running, when it reaches the maximum run time the pump shuts down to cool off and will not allow the pump to run again until the next engine run cycle.

Brake Warning System Description and Operation

Brake Warning Indicator

Hydraulic Brakes Block Diagram



The instrument cluster turns the brake warning indicator ON when the following occurs:

- The instrument cluster performs the bulb check. The brake warning indicator illuminates for 5 s.
- When the Electronic Brake Control Module (EBCM) detects low brake fluid level it sets DTCC0267 and sends a serial data message to the instrument cluster, which will illuminate the red brake indicator.
- The Body Control Module (BCM) detects that the parking brake is engaged. The instrument cluster receives a serial data message from the BCM requesting illumination.

Driver Information Center Messages

When the Electronic Brake Control Module (EBCM) detects low brake fluid level it sets DTC C0267 and sends a serial data message to the Driver Information Center, which will display Brake Fluid Low message.

Hydraulic Brake System Description and Operation

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Reservoir

Contains a supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder

Converts mechanical input force into hydraulic output pressure.

Hydraulic output pressure is distributed from the master cylinder through two hydraulic circuits to the Brake Modulator Assembly. Under normal braking the Brake Modulator Assembly allows fluid pressure to be distributed through out the hydraulic brake system.

Hydraulic Brake Pressure Balance Control System

Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force.

Pressure balance control is achieved through Electronic Brake Differential (EBD), which is a function of the ABS modulator. For specific information on the operation of Electronic Brake Differential (EBD) refer to [ABS Description and Operation](#).

Hydraulic Brake Pipes and Flexible Brake Hoses

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

Converts hydraulic input pressure into mechanical output force.

System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components then convert the hydraulic pressure back into mechanical force which presses brake linings against rotating brake system components.

DTC C0126

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 C0126

Brake Fluid Level Sensor Circuit

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	C0126 05	C0126 05	C0126 05	—
Ground	—	C0126 05	—	—

Circuit/System Description

The brake fluid level switch monitors the level of the brake fluid in the brake fluid reservoir. When the electronic brake control module sees the brake fluid level switch input closed, the DTC is set.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

- Low brake fluid level is detected for 5 s.
- An open is detected on the ground circuit.
- An open, short to ground, or short to voltage is detected on the signal circuit.

Action Taken When the DTC Sets

- The electronic brake control module disables the traction control and stability control for the duration of the ignition cycle.
- The traction control/stability control-active indicator turns ON.
- The brake warning indicator turns ON.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

[Hydraulic Brake Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Hydraulic Brake System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Verification

1. Verify that the brake fluid level is above the minimum level.

⇒ **If low**

Refer to [Brake Fluid Loss](#).

⇓ **If above minimum level**

2. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 2 and ground.

⇒ **If 10 Ω or greater**

2.1. Ignition OFF.

2.2. Test for less than 2 Ω in the ground circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω , repair the open/high resistance in the ground connection.

⇓ **If less than 10 Ω**

3. Ignition ON.

4. Verify the scan tool Brake Fluid Level Sensor parameter is OK.

⇒ **If the parameter is not OK**

4.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.

4.2. Test for infinite resistance between the signal circuit terminal 1 and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is OK**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.

6. Verify the scan tool Brake Fluid Level Sensor parameter is Low.

⇒ **If the parameter is not Low**

6.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

6.2. 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.

6.3. Test for less than 2 Ω in the signal circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω , replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is Low**

7. Test or replace the B20 Brake Fluid Level Switch.

Repair Instructions

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

- [Brake Fluid Level Sensor Replacement](#).
- [Control Module References](#) for electronic brake control module replacement, programming and setup.

DTC C027B

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 C027B

Brake Booster Electric Vacuum Pump

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Vacuum Pump Relay B+	2	2	—	—
Vacuum Pump Relay Ignition	2	2	—	—
Vacuum Pump Relay Control	C027B 02	C027B 05	C027B 05	—
Brake Booster Pump Motor Control	2	2	1	—
Brake Booster Pump Motor Ground	—	2	—	—
1. Brake Booster Pump Motor Always ON 2. Brake Booster Pump Motor Always OFF				

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module. When the vacuum within the system becomes weak, the electronic brake control module turns ON the brake booster pump motor by providing ground to the brake booster pump motor relay. The relay activates and supplies battery voltage to the brake booster pump motor.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

C027B 02

A short to ground is detected on the control circuit.

C027B 05

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A short to voltage or open/high resistance is detected on the control circuit.

Action Taken When the DTC Sets

The brake warning indicator turns ON.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

[Hydraulic Brake Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Brake Assist System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify the M9 Brake Booster Pump Motor turns ON and OFF when commanding the Brake Booster Electric Vacuum Pump On and Off with a scan tool.
 - ⇒ **If the M9 Brake Booster Pump Motor does not turn ON and OFF**
Refer to Circuit/System Testing.
 - ⇓ **If the M9 Brake Booster Pump Motor turn ON and OFF**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the KR14 Brake Booster Pump Motor Relay, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
 - 2.1. Ignition OFF, remove the test lamp.
 - 2.2. Test for less than 2 Ω in the B+ circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
 - 2.1. Ignition OFF, remove the test lamp.
 - 2.2. Test for infinite resistance between the B+ circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇓ If infinite resistance,

- 2.3. Disconnect the M9 Brake Booster Pump Motor.
- 2.4. Test for greater than $10\ \Omega$ between the control circuit terminal 87 and ground.
 - ⇒ If less than $10\ \Omega$, repair the short to ground on the circuit.
 - ⇒ If greater than $10\ \Omega$, test or replace the M9 Brake Booster Pump Motor.

↓ **If the test lamp illuminates**

3. Verify a test lamp illuminates between the ignition circuit terminal 85 and ground.

⇒ **If the test lamp does not illuminate**

- 3.1. Ignition OFF, remove the test lamp.
- 3.2. Test for less than $2\ \Omega$ in the ignition circuit end to end.
 - ⇒ If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than $2\ \Omega$, refer to [Power Mode Mismatch](#)

↓ **If the test lamp illuminates**

4. Connect a test lamp between the ignition circuit terminal 85 and the control circuit terminal 86.
5. Verify the test lamp turns ON and OFF when commanding the Brake Booster Pump Motor On and Off with a scan tool.

⇒ **If the test lamp is always OFF**

- 5.1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
- 5.2. Test for less than $1\ \text{V}$ between the control circuit and ground.
 - ⇒ If $1\ \text{V}$ or greater, repair the short to voltage on the circuit.
 - ↓ If less than $1\ \text{V}$
- 5.3. Ignition OFF.
- 5.4. Test for less than $2\ \Omega$ in the control circuit end to end.
 - ⇒ If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than $2\ \Omega$, replace the K17 Electronic Brake Control Module.

⇒ **If the test lamp is always ON**

- 5.1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K17 Electronic Brake Control Module.
- 5.2. Test for infinite resistance between the control circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇒ If infinite resistance, replace the K17 Electronic Brake Control Module.

↓ **If the test lamp turns ON and OFF**

6. Verify a test lamp does not illuminate between the control circuit terminal 87 and ground.

⇒ **If the test lamp illuminates**

Repair the short to voltage on the circuit.

↓ **If the test lamp does not illuminate**

7. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M9 Brake Booster Pump Motor. It may take up to 2 min for all vehicle systems to power down.
8. Test for less than $10\ \Omega$ between the M9 Brake Booster Pump Motor ground circuit terminal 2 and ground.

⇒ **If $10\ \Omega$ or greater**

- 8.1. Ignition OFF.
- 8.2. Test for less than $2\ \Omega$ in the ground circuit end to end.
 - ⇒ If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than $2\ \Omega$, repair the open/high resistance in the ground connection.

↓ **If less than $10\ \Omega$**

9. Connect the harness connector at the M9 Brake Booster Pump Motor.
10. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
11. Verify the M9 Brake Booster Pump Motor is activated.
 - ⇒ **If the M9 Brake Booster Pump Motor does not activate**
 - 11.1. Ignition OFF, remove the jumper wire.
 - 11.2. Test for less than 2 Ω in the control circuit terminal 87 end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , test or replace the M9 Brake Booster Pump Motor.
 - ⇓ **If the M9 Brake Booster Pump Motor activates**
12. Test or replace the KR14 Brake Booster Pump Motor Relay.

Component Testing

Relay Test

1. Ignition OFF, remove the KR14 Brake Booster Pump Motor Relay.
2. Test for 70-150 Ω between terminals 85 and 86.
 - ⇒ **If less than 70 Ω or greater than 150 Ω**
Replace the KR14 Brake Booster Pump Motor Relay.
 - ⇓ **If between 70-150 Ω**
3. Test for infinite resistance between the terminals listed below:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - ⇒ **If less than infinite resistance**
Replace the KR14 Brake Booster Pump Motor Relay.
 - ⇓ **If infinite resistance**
4. Install a 30 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 10 Ω between terminals 30 and 87.
 - ⇒ **If 10 Ω or greater**
Replace the KR14 Brake Booster Pump Motor Relay.
 - ⇓ **If less than 10 Ω**
6. All OK.

Repair Instructions

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

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

DTC C025E

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 C025E

Brake Pressure Vacuum Sensor Circuit

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	C025E 00	C025E 00	C025E 00	—
Signal	C025E 00	C025E 00	C025E 00	C025E 12, C025E 5A
Low Reference	—	C025E 00	—	—

Circuit/System Description

The brake booster vacuum sensor monitors the pressure in the brake booster. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

C025E 00

- A short to ground, short to voltage or open/high resistance is detected on the signal circuit.
- A short to ground, short to voltage or open/high resistance on the 5 V reference circuit.
- An open/high resistance is detected on the low reference circuit.

C025E 12

The electronic brake control module detects an erratic vacuum sensor signal.

C025E 5A

The vacuum sensor signal is not plausible.

C025E 71

The electronic brake control module receives an invalid serial data message from the engine control module.

Action Taken When the DTC Sets

The brake warning indicator turns ON.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The electronic control module will turn OFF the indicator in the next ignition cycle.

Reference Information

Schematic Reference

[Hydraulic Brake Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Brake Assist 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

C025E 71

1. Ignition ON.
2. Verify that DTCs P0556, P0557, or P0558 are not set.
⇒ **If any of the DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
- ↓ **If none of the DTCs are set**
3. Replace the K20 Engine Control Module.
4. Verify the DTC C025E 71 does not set while operating the vehicle under the conditions for Running the DTC.
⇒ **If the DTC sets**
Replace the K17 Electronic Brake Control Module.
- ↓ **If the DTC does not set**
5. All OK.

C025E 00, C025E 12, or C025E 5A

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B19B Brake Booster Vacuum Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
⇒ **If 10 Ω or greater**

2.1. Disconnect the harness connector at the K17 Electronic Brake Control Module.

2.2. Test for less than $2\ \Omega$ in the low reference circuit end to end.

⇒ If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.

⇒ If less than $2\ \Omega$, replace the K17 Electronic Brake Control Module.

↓ **If less than $10\ \Omega$**

3. Ignition ON.

4. Test for 4.8–5.2 V between the 5 V reference circuit terminal 3 and ground.

⇒ **If less than 4.8 V**

4.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.

4.2. Test for infinite resistance between the 5 V reference circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

↓ If infinite resistance

4.3. Test for less than $2\ \Omega$ in the 5 V reference circuit end to end.

⇒ If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.

⇒ If less than $2\ \Omega$, replace the K17 Electronic Brake Control Module.

⇒ **If greater than 5.2 V**

4.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

4.2. Test for less than 1 V between the 5 V reference circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K17 Electronic Brake Control Module.

↓ **If between 4.8–5.2 V**

5. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

6. Test for less than 1 V between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.

⇒ **If greater than 1 V**

Repair the short to voltage on the circuit.

↓ **If less than 1 V**

7. Ignition OFF.

8. Test for infinite resistance between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.

⇒ **If less than infinite resistance**

Repair the short to ground on the circuit.

↓ **If infinite resistance**

9. Test for less than $2\ \Omega$ between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and the K17 Electronic Brake Control Module signal circuit terminal 4.

⇒ **If $2\ \Omega$ or greater**

Repair the open/high resistance in the circuit.

↓ **If less than $2\ \Omega$**

10. Replace the B19B Brake Booster Vacuum Sensor.

11. Verify the DTC does not set while operating the vehicle under Conditions for Running the DTC.

⇒ **If the DTC sets**

Replace the K17 Electronic Brake Control Module.

↓ **If the DTC does not set**

12. All OK.

Repair Instructions

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

- [Power Vacuum Brake Booster Replacement](#) for power brake booster vacuum sensor replacement
- [Control Module References](#) for electronic brake control module replacement, programming and setup

DTC P0556, P0557, or P0558

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 P0556

Brake Booster Pressure Sensor Performance

DTC P0557

Brake Booster Pressure Sensor Circuit Low Voltage

DTC P0558

Brake Booster Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0557	P0557	—	P0556
Sensor Signal	P0557	P0557	P0558	P0556
Low Reference	—	P0557	—	P0556

Circuit/System Description

The brake booster vacuum sensor monitors the pressure in the brake booster. The engine control module supplies a 5V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the engine control module.

Conditions for Running the DTC

P0556

Engine Running.

P0557 or P0558

Ignition ON.

Conditions for Setting the DTC

P0556

The engine control module detects brake booster vacuum as being less than the intake manifold vacuum for more than 100 ms.

P0557

The engine control module detects less than 0.01 V on the brake booster sensor signal circuit for more than 12.5 ms.

P0558

The engine control module detects greater than 4.9 V on the brake booster sensor signal circuit for more than 12.5 ms.

Action Taken When the DTC Sets

DTCs P0556, P0557 or P0558 are Type B DTCs..

Conditions for Clearing the DTC

DTCs P0556, P0557 or P0558 are Type B DTCs.

Reference Information

Schematic Reference

[Hydraulic Brake Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Brake Booster Vacuum Assist Description and Operation](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B19B Brake Booster Vacuum Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
⇒ **If 10 Ω or greater**
 - 2.1. Disconnect the harness connector at the K20 Engine Control Module.
 - 2.2. Test for less than 2 Ω in the low reference circuit end to end.
⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
⇒ If less than 2 Ω , replace the K20 Engine Control Module.
- ⇓ **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8–5.2 V between the 5 V reference circuit terminal 3 and ground.
⇒ **If less than 4.8 V**
 - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

- 4.2. Test for infinite resistance between the 5 V reference circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇓ If infinite resistance
- 4.3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , replace the K20 Engine Control Module.
- ⇒ **If greater than 5.2 V**
- 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
- 4.2. Test for less than 1 V between the 5 V reference circuit and ground.
 - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
 - ⇒ If less than 1 V, replace the K20 Engine Control Module.
- ⇓ **If between 4.8–5.2 V**
- 5. Test for less than 1 V between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.
- ⇒ **If greater than 1 V**
- 5.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
- 5.2. 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 K20 Engine Control Module.
- ⇓ **If less than 1 V**
- 6. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 7. Test for infinite resistance between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.
- ⇒ **If less than infinite resistance**
Repair the short to ground on the circuit.
- ⇓ **If infinite resistance**
- 8. Test for less than 2 Ω in the B19B Brake Booster Vacuum Sensor signal circuit end to end.
- ⇒ **If 2 Ω or greater**
Repair the open/high resistance in the circuit.
- ⇓ **If less than 2 Ω**
- 9. Replace the B19B Brake Booster Vacuum Sensor.
- 10. Verify the DTC does not set while operating the vehicle under Conditions for Running the DTC.
- ⇒ **If the DTC sets**
Replace the K20 Engine Control Module.
- ⇓ **If the DTC does not set**
- 11. All OK.

Repair Instructions

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

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

Symptoms - Hydraulic Brakes

Important: The following steps must be completed before using the symptom tables.

1. Perform [Diagnostic System Check - Vehicle](#) before using the brake indicator symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control module(s) can communicate via the serial data link.
2. Perform the [Brake System Vehicle Road Test](#) before using the hydraulic brake symptom tables in order to duplicate the customer's concern.
3. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
 - [Brake Warning System Description and Operation](#)
 - [Hydraulic Brake System Description and Operation](#)
 - [Brake Assist System Description and Operation](#)
 - [Disc Brake System Description and Operation](#)

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the brake warning system. Refer to [Checking Aftermarket Accessories](#).
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to [Testing for Intermittent Conditions and Poor Connections](#).

Symptom List

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

- [Brake Warning Indicator Malfunction](#)
- [Brake Pulsation](#)
- [Brake System Noise](#)
- [Braking Action Uneven - Pulls to One Side](#)
- [Braking Action Uneven - Front to Rear](#)
- [Brake Pedal Excessive Travel](#)
- [Brake Pedal Excessive Effort](#)
- [Brakes Drag](#)
- [Brake System Slow Release](#)
- [Brake Fluid Loss](#)

Brake Booster Pump Motor 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
Vacuum Pump Relay B+	2	2	—	—
Vacuum Pump Relay Ignition	2	2	—	—
Vacuum Pump Relay Control	C027B 02	C027B 05	C027B 05	—
Brake Booster Pump Motor Control	2	2	1	—
Brake Booster Pump Motor Ground	—	2	—	—
1. Brake Booster Pump Motor Always ON 2. Brake Booster Pump Motor Always OFF				

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module. When the vacuum within the system becomes weak, the electronic brake control module turns ON the brake booster pump motor by providing ground to the brake booster pump motor relay. The relay activates and supplies battery voltage to the brake booster pump motor.

Reference Information

Schematic Reference

[Hydraulic Brake Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Brake Assist System Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)

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

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify the M9 Brake Booster Pump Motor turns ON and OFF when commanding the Brake Booster Electric Vacuum Pump On and Off with a scan tool.
 - ⇒ **If the M9 Brake Booster Pump Motor does not turn ON and OFF**
Refer to Circuit/System Testing.
 - ⇓ **If the M9 Brake Booster Pump Motor turn ON and OFF**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the KR14 Brake Booster Pump Motor Relay, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
 - 2.1. Ignition OFF, remove the test lamp.
 - 2.2. Test for less than 2 Ω in the B+ circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
 - 2.1. Ignition OFF, remove the test lamp.
 - 2.2. Test for infinite resistance between the B+ circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇓ If infinite resistance,
 - 2.3. Disconnect the M9 Brake Booster Pump Motor.
 - 2.4. Test for greater than 10 Ω between the control circuit terminal 87 and ground.
 - ⇒ If less than 10 Ω , repair the short to ground on the circuit.
 - ⇒ If greater than 10 Ω , test or replace the M9 Brake Booster Pump Motor.
 - ⇓ **If the test lamp illuminates**
3. Verify a test lamp illuminates between the ignition circuit terminal 85 and ground.
 - ⇒ **If the test lamp does not illuminate**
 - 3.1. Ignition OFF, remove the test lamp.
 - 3.2. Test for less than 2 Ω in the ignition circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 ohms, refer to [Power Mode Mismatch](#)
 - ⇓ **If the test lamp illuminates**
4. Connect a test lamp between the ignition circuit terminal 85 and the control circuit terminal 86.
5. Verify the test lamp turns ON and OFF when commanding the Brake Booster Pump Motor On and Off with a scan tool.
 - ⇒ **If the test lamp is always OFF**
 - 5.1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

5.2. Test for less than 1 V between the control circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V

5.3. Ignition OFF.

5.4. Test for less than 2 Ω in the control circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω , replace the K17 Electronic Brake Control Module.

⇒ **If the test lamp is always ON**

5.1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K17 Electronic Brake Control Module.

5.2. Test for infinite resistance between the control circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K17 Electronic Brake Control Module.

⇓ **If the test lamp turns ON and OFF**

6. Verify a test lamp does not illuminate between the control circuit terminal 87 and ground.

⇒ **If the test lamp illuminates**

Repair the short to voltage on the circuit.

⇓ **If the test lamp does not illuminate**

7. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M9 Brake Booster Pump Motor. It may take up to 2 min for all vehicle systems to power down.

8. Test for less than 10 Ω between the M9 Brake Booster Pump Motor ground circuit terminal 2 and ground.

⇒ **If 10 Ω or greater**

8.1. Ignition OFF.

8.2. Test for less than 2 Ω in the ground circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω , repair the open/high resistance in the ground connection.

⇓ **If less than 10 Ω**

9. Connect the harness connector at the M9 Brake Booster Pump Motor.

10. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.

11. Verify the M9 Brake Booster Pump Motor is activated.

⇒ **If the M9 Brake Booster Pump Motor does not activate**

11.1. Ignition OFF, remove the jumper wire.

11.2. Test for less than 2 Ω in the control circuit terminal 87 end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω , test or replace the M9 Brake Booster Pump Motor.

⇓ **If the M9 Brake Booster Pump Motor activates**

12. Test or replace the KR14 Brake Booster Pump Motor Relay.

Component Testing

Relay Test

1. Ignition OFF, remove the KR14 Brake Booster Pump Motor Relay.

2. Test for 70-150 Ω between terminals 85 and 86.

⇒ **If less than 70 Ω or greater than 150 Ω**

Replace the KR14 Brake Booster Pump Motor Relay.

↓ **If between 70-150 Ω**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

⇒ **If less than infinite resistance**

Replace the KR14 Brake Booster Pump Motor Relay.

↓ **If infinite resistance**

4. Install a 30 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 10 Ω between terminals 30 and 87.

⇒ **If 10 Ω or greater**

Replace the KR14 Brake Booster Pump Motor Relay.

↓ **If less than 10 Ω**

6. All OK.

Repair Instructions

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

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

Brake Warning 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
Brake Fluid Level Signal	C0126 05	C0126 05	C0126 05	—
Park Brake Signal	1	1	1	—
Brake Fluid Level Ground	—	C0126 05	—	—
1. Brake Warning Indicator Malfunction				

Circuit/System Description

The instrument cluster turns ON the brake warning indicator for 5 s after ignition ON. The body control module monitors the parking brake switch and will request the instrument cluster via serial data to turn the brake warning indicator ON when the parking brake is applied. The electronic brake control module monitors the brake fluid level switch and will request the instrument cluster via serial data to turn the brake warning indicator ON when low brake fluid is detected.

Reference Information

Schematic Reference

[Hydraulic Brake Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Hydraulic Brake System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Verification

1. Verify that the brake fluid is above minimum level.

⇒ **If low**Refer to [Brake Fluid Loss](#).⇓ **If above minimum level**

2. Ignition ON.

3. Verify the scan tool Brake Fluid Level Sensor is OK.

⇒ **If the parameter is Low**

Refer to Circuit/System Testing - Brake Fluid Level Switch Malfunction.

⇓ **If the parameter is OK**

4. Verify the scan tool Park Brake Switch parameter changes between Applied and Released while applying and releasing the parking brake.

⇒ **If the parameter does not change**

Refer to Circuit/System Testing - Park Brake Switch Malfunction.

⇓ **If the parameter changes**

5. Verify the brake warning indicator turns ON and OFF, when commanding the instrument cluster All Indicators On and Off with a scan tool.

⇒ **If the brake warning indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster.

⇓ **If the brake warning indicator turns ON and OFF**

6. All OK.

Circuit/System Testing**Note:** Circuit/System Verification must be performed before Circuit/System Testing.**Brake Fluid Level Switch Malfunction**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 10 Ω between the ground circuit terminal 2 and ground.⇒ **If 10 Ω or greater**

2.1. Ignition OFF.

2.2. Test for less than 2 Ω in the ground circuit end to end.⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.⇒ If less than 2 Ω , repair the open/high resistance in the ground connection.⇒ **If less than 10 Ω**

3. Ignition ON.

4. Verify the scan tool Brake Fluid Level Sensor parameter is Low.

⇒ **If the parameter is not Low**

4.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.

4.2. Test for infinite resistance between the signal circuit terminal 1 and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is Low**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.

6. Verify the scan tool Brake Fluid Level Sensor parameter is OK.

⇒ **If the parameter is Low**

6.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

- 6.2. 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.
- 6.3. Test for less than 2 Ω in the signal circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , replace the K17 Electronic Brake Control Module.

⇓ **If the parameter is OK**

7. Test or replace the B20 Brake Fluid Level Switch.

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the B80 Park Brake Switch.
2. Verify that the B80 Park Brake Switch has no physical damage or incorrect installation.
 - ⇒ **If physical damage or incorrect installation is found**
Test or replace the B80 Park Brake Switch.
 - ⇓ **If the inspection is OK**
3. Ignition ON.
4. Verify the scan tool Park Brake Switch parameter is Released.
 - ⇒ **If the parameter is Applied**
 - 4.1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 - 4.2. Test for infinite resistance between the signal circuit terminal A 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 the parameter is Released**
5. Install a 3 A fused jumper wire between the signal circuit terminal A and ground.
6. Verify the scan tool Park Brake Switch parameter is Applied.
 - ⇒ **If the parameter is Released**
 - 6.1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 - 6.2. 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.
 - 6.3. Test for less than 2 Ω in the signal circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , replace the K9 Body Control Module.
 - ⇓ **If the parameter is Applied**
7. Test or replace the B80 Park Brake Switch.

Repair Instructions

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

- [Brake Fluid Level Sensor Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

Brake Pulsation

Brake Pulsation

Step	Action	Yes	No
DEFINITION: Fluctuation or pulsation is felt through the brake pedal, steering wheel, seat, floor, and/or in the vehicle ONLY when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	1. Inspect the disc brake system for the following conditions. ◦ Excessive thickness variation of rotor friction surfaces ◦ Excessive assembled lateral runout (LRO) of rotor friction surfaces ◦ Hard spots, heat checks, bluing discoloration of rotor friction surfaces; possibly due to brake drag ◦ Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation ◦ Loose, damaged or missing caliper or lining hardware ◦ Bent or damaged caliper or mounting component ◦ Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 3	Go to Symptoms - Hydraulic Brakes
3	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

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Brake System Noise

Brake System Noise

Step	Action	Yes	No
DEFINITION: Vehicle exhibits abnormal noise when braking; vehicle may exhibit abnormal noise during motion just after brake pedal release.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	1. Inspect the disc brake system for the following conditions. ◦ Lining wear indicator contact with rotor ◦ Debris trapped between rotor and splash shield or backing plate; and/or debris trapped between rotor and linings ◦ Contaminated linings ◦ Aftermarket linings ◦ Glazed linings ◦ Distorted, cracked or damaged linings ◦ Excessively worn linings ◦ Damaged or excessively worn caliper hardware and/or lining hardware ◦ Incorrectly installed, loose or missing caliper hardware and/or lining hardware ◦ Lack of lubrication or excessive corrosion on metal to metal contact surfaces ◦ Bent or damaged splash shield or backing plate ◦ Hard spots, heat checks, blueing discoloration of rotor friction surfaces ◦ Glazed rotor friction surfaces ◦ Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 9	Go to Step 3
3	1. Inspect the brake assist system for the following conditions.	Go to Step 9	Go to Step 4

Step	Action	Yes	No
	◦ Lack of lubrication or excessively worn pushrod or pedal pivots or pivot bushings ◦ Bent or damaged pedal pushrod, pedal, or pedal bracket ◦ Damaged or improperly operating vacuum booster and/or check valve, if equipped ◦ Low power steering fluid level, if equipped with hydraulic boost ◦ Improperly tensioned, excessively worn or damaged power steering belt, if equipped with hydraulic boost ◦ Restricted return hose from hydraulic booster, if equipped ◦ Improperly operating hydraulic booster, if equipped ◦ Improperly functioning power steering system, if equipped with a hydraulic booster assembly ◦ Contaminated power steering fluid, if equipped with hydraulic boost 2. Adjust, repair or replace components as necessary. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?		
4	1. Inspect the hydraulic brake system for the following conditions. ◦ Improper operation of caliper pistons ◦ Contaminated brake fluid 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 9	Go to Step 5
5	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 6	Go to Step 9
6	Ensure the park brake shoes are not adjusted too tightly, possibly causing a noise under certain conditions. Are the park brake shoes adjusted too tightly?	Go to Step 7	Go to Step 9
7	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots, and excessive radial runout.	Go to Step 9	Go to Step 8

Step	Action	Yes	No
	3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?		
8	Inspect the park brake system for proper operation. Refer to Park Brake System Diagnosis . Did you find and correct a condition?	Go to Step 9	Go to Symptoms - Hydraulic Brakes
9	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

Braking Action Uneven - Pulls to One Side

Test Description

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

4. [Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.](#)
5. [Steering components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.](#)

Braking Action Uneven - Pulls to One Side

Step	Action	Yes	No
DEFINITION: Vehicle pulls to one side only when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	1. Inspect the hydraulic brake system for the following conditions. ◦ Kinked, pinched or damaged brake pipe or flexible brake hose ◦ Sticking or improperly operating caliper piston ◦ Brake fluid leak 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	1. Inspect the disc brake system for the following conditions. ◦ Contaminated linings ◦ Glazed linings ◦ Distorted, cracked or damaged linings on one side ◦ Loose, damaged or missing caliper hardware and/or lining hardware ◦ Incorrect linings on one side ◦ Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag ◦ Glazed rotor friction surfaces ◦ Bent or damaged caliper or mounting component	Go to Step 6	Go to Step 4

Step	Action	Yes	No
	2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?		
4	1. Inspect the suspension system for the following conditions. ◦ Incorrect tire pressures ◦ Loose suspension component connections ◦ Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to Symptoms - Suspension General Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	1. Inspect the steering system for the following conditions. ◦ Loose steering component connections ◦ Excessively worn or damaged steering components 2. Adjust, repair or replace components as necessary. Did you find and correct a condition?	Go to Step 6	Go to Symptoms - Hydraulic Brakes
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

Braking Action Uneven - Front to Rear

Test Descriptions

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

4. [Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.](#)

Braking Action Uneven - Front to Rear

Step	Action	Yes	No
DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear axle. Sensitive or grabbing brakes: Excessive brake jump-in force relative to brake pedal input.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	1. Inspect the hydraulic brake system for the following conditions: ◦ Improper operation of caliper pistons ◦ Kinked, pinched or damaged brake pipe or flexible brake hose ◦ Brake fluid leak ◦ Improperly functioning proportion valve, if equipped ◦ Improper operation of dynamic rear proportion (DRP) system, if equipped 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	1. Inspect the disc brake system for the following conditions: ◦ Contaminated linings ◦ Glazed linings ◦ Distorted, cracked or damaged linings ◦ Excessively worn linings ◦ Aftermarket linings ◦ Damaged or excessively worn caliper hardware and/or lining hardware ◦ Hard spots, heat checks, blueing discoloration of rotor friction surfaces ◦ Glazed rotor friction surfaces	Go to Step 6	Go to Step 4

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Step	Action	Yes	No
	2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?		
4	1. Inspect the suspension system for the following conditions: ◦ Loose suspension component connections ◦ Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to Symptoms - Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	1. Inspect the brake assist system for the following conditions: ◦ Binding, bent or damaged pedal pushrod, pedal, or pedal bracket ◦ Damaged or improperly operating vacuum booster, if equipped ◦ Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Symptoms - Hydraulic Brakes
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Brake Pedal Excessive Travel

Brake Pedal Excessive Travel

Step	Action	Yes	No
DEFINITION: Brake pedal travels further than expected to obtain firm pedal and/or firm pedal cannot be obtained, pedal fades away, or pedal is spongy.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	Inspect the travel and feel of brake pedal applies. Perform the following: 1. Apply the brake pedal several times to fully deplete the power reserve. 2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. 3. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply. 4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply. Did you complete the brake pedal travel and feel inspections?	Go to Step 3	—
3	1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections: ◦ Pedal feel was spongy – Air in hydraulic system – External brake fluid leaks – Soft, weak or damaged hydraulic hoses; expanding under pressure ◦ Pedal fell away and/or traveled to or almost to floor – External brake fluid leaks – Poor brake fluid quality; low boiling point – Internal brake fluid leaks; improperly functioning master cylinder	Go to Step 8	Go to Step 4

Step	Action	Yes	No
	◦ Pedal was somewhat firm then dropped slightly, or pedal rose with successive applies, or pedal travel was different between slow and quick applies – Internal brake fluid leaks; improperly functioning master cylinder – Poor brake fluid quality; low boiling point ◦ Pedal returned to rest slowly after any of the applies – Internally damaged flexible brake hoses; hindering fluid return – Binding caliper pistons – Internal brake fluid leaks; improperly functioning master cylinder 2. Repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?		
4	1. Inspect the disc brake system for the following conditions: ◦ Cracked, excessively worn or damaged linings ◦ Cracked, excessively worn or damaged rotors ◦ Improperly operating, binding or damaged caliper hardware and/or lining hardware ◦ Loose or missing caliper hardware and/or lining hardware ◦ Excessive assembled lateral runout (LRO) of rotor friction surfaces ◦ Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?	Go to Step 8	Go to Step 5
5	Inspect for proper brake pedal travel. Refer to Brake Pedal Travel Measurement and Inspection. Is the brake pedal travel distance within the acceptable limits?	Go to Step 7	Go to Step 6
6	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components.	Go to Step 8	Go to Step 7

Step	Action	Yes	No
	◦ For the brake pedal pushrod component inspection, refer to Brake Pedal Pushrod Inspection. ◦ Inspect the brake pedal bushings for binding, excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?		
7	1. Inspect the brake assist system for the following conditions: ◦ Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist ◦ Power steering fluid leaks, if equipped with hydraulic power assist ◦ Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?	Go to Step 8	Go to Symptoms - Hydraulic Brakes
8	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Brake Pedal Excessive Effort

Brake Pedal Excessive Effort

Step	Action	Yes	No
DEFINITION: Brake pedal requires an increased amount of input from the driver to obtain good braking action and/or stopping distance is increased.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	1. Inspect the brake assist system for the following conditions: ◦ Vacuum leaks, if equipped with vacuum power assist ◦ Power steering fluid leaks, if equipped with hydraulic power assist ◦ Lack of lubrication, binding or excessively worn pushrod or pedal pivots or pivot bushings ◦ Bent or damaged pedal pushrod, pedal, or pedal bracket ◦ Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	1. Inspect the hydraulic brake system for the following conditions: ◦ Binding caliper pistons ◦ Internally damaged flexible brake hoses; hindering fluid flow ◦ External brake fluid leaks ◦ Kinked or damaged flexible brake hoses and/or pipes ◦ Internal brake fluid leaks; improperly operating master cylinder ◦ Poor brake fluid quality; low boiling point 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 4
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Step	Action	Yes	No
4	1. Inspect the disc brake system for the following conditions: ◦ Excessively worn linings ◦ Glazed linings ◦ Cracked, distorted or damaged linings ◦ Contaminated linings ◦ Binding, damaged or excessively worn caliper hardware and/or lining hardware ◦ Lack of lubrication or excessive corrosion on metal to metal contact surfaces ◦ Excessively worn or corroded rotor friction surfaces ◦ Glazed rotor friction surfaces ◦ Hard spots, heat checks, blueing discoloration of rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Symptoms - Hydraulic Brakes
5	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Brakes Drag

Brakes Drag

Step	Action	Yes	No
DEFINITION: Brake system does not fully release or has delayed release; vehicle motion may be hindered by brake system without applying brakes.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to Step 3	Go to Step 4
3	1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing. Did you find and correct a condition?	Go to Step 14	Go to Step 4
4	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 5	Go to Step 7
5	Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions. Are the park brake shoes adjusted too tightly?	Go to Step 6	Go to Step 7
6	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration and heat spots. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?	Go to Step 14	Go to Step 7
7	Inspect the park brake system for proper operation. Refer to Park Brake System Diagnosis . Did you find and correct a condition?	Go to Step 14	Go to Step 8
8		Go to Step 14	Go to Step 9

Step	Action	Yes	No
	1. Inspect the disc brake system for the following conditions: ◦ Binding, incorrectly installed or missing caliper hardware and/or lining hardware—Ensure free movement of linings and of caliper, if equipped with sliding type caliper ◦ Lack of lubrication or excessive corrosion on metal to metal contact surfaces ◦ Distorted or damaged linings ◦ Damaged or excessively worn caliper hardware and/or lining hardware ◦ Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?		
9	1. Separate the brake booster pushrod from the brake pedal. 2. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to Step 11	Go to Step 10
10	1. Inspect the pushrod for improper positioning and/or damage. Correctly position or replace the pushrod if necessary. 2. Inspect the brake pedal assembly for damage and replace if necessary. Did you complete the repair or replacement?	Go to Step 14	—
11	1. For vacuum boost systems, disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the brake booster. Do not disconnect any brake pipes. 3. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to Step 13	Go to Step 12
12	Replace the brake booster assembly. Did you complete the replacement?	Go to Step 14	—
13	1. Inspect the hydraulic brake system for the following conditions.	Go to Step 14	Go to Symptoms -

Step	Action	Yes	No
	◦ Improper operation of caliper pistons ◦ Contaminated brake fluid ◦ Internally damaged flexible brake hoses; hindering brake release ◦ Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?		Hydraulic Brakes
14	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Brake System Slow Release

Brake System Slow Release

Step	Action	Yes	No
DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system briefly after release of brake pedal.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	1. Inspect the hydraulic brake system for the following conditions: ◦ Improper operation of caliper pistons ◦ Internally damaged flexible brake hoses; hindering brake release ◦ Contaminated brake fluid ◦ Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	1. Inspect the brake assist system for the following conditions: ◦ Binding, bent or damaged pedal pushrod, pedal, or pedal bracket ◦ Damaged or improperly operating vacuum booster, if equipped ◦ Restricted return hose from hydraulic booster, if equipped ◦ Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	1. Inspect the disc brake system for the following conditions: ◦ Damaged or excessively worn caliper hardware and/or lining hardware ◦ Distorted or damaged linings	Go to Step 5	Go to Symptoms - Hydraulic Brakes

Step	Action	Yes	No
	◦ Lack of lubrication or excessive corrosion on metal to metal contact surfaces ◦ Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?		
5	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Brake Fluid Loss

Brake Fluid Loss

Step	Action	Yes	No
DEFINITION: Brake fluid level is low not related to lining wear.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	1. Inspect the following hydraulic brake system components for brake fluid leaks: ◦ Flexible brake hose connections; threaded and bolted ◦ Flexible brake hose crimp joints ◦ Brake pipe fittings ◦ Caliper piston seals ◦ Wheel cylinder piston seals, if equipped ◦ Master cylinder reservoir ◦ Master cylinder reservoir low pressure hose, if equipped ◦ Brake pressure modulator valve (BPMV) assembly, if equipped 2. Repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 8	Go to Step 3
3	Is the vehicle equipped with a vacuum brake booster?	Go to Step 4	Go to Step 6
4	1. Disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. 3. Inspect the rear of the master cylinder for a brake fluid leak. 4. Inspect for brake fluid in the vacuum brake booster. Did you find a brake fluid leak?	Go to Step 5	Go to Symptoms - Hydraulic Brakes
5	Replace the brake master cylinder and the vacuum brake booster. Did you complete the replacement?	Go to Step 8	—

Step	Action	Yes	No
6	1. Wipe clean the external surface of the master cylinder to hydraulic brake booster area, if equipped. 2. Separate the master cylinder from the hydraulic brake booster, if equipped. Do not disconnect any brake pipes. 3. Inspect the rear of the master cylinder for a brake fluid leak. Did you find a brake fluid leak?	Go to Step 7	Go to Symptoms - Hydraulic Brakes
7	Replace the brake master cylinder. Did you complete the replacement?	Go to Step 8	—
8	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Disc Brake System Diagnosis

Test Description

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

9. [Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.](#)
10. [Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.](#)
12. [Disc brake disc shields/backing plates that come in contact with disc brake discs may cause brake system noise.](#)
15. [Disc brake disc thickness variation that exceeds the maximum acceptable level can cause brake pulsation.](#)
19. [Disc brake disc thickness variation that exceeds the maximum acceptable level can cause brake pulsation.](#)
22. [Disc brake disc assembled lateral runout \(LRO\) that exceeds the maximum acceptable level can lead to thickness variation.](#)

Disc Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating correctly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	Visually inspect the brake pads for the following conditions: Refer to Brake Pad Inspection . - Lining thickness below specifications - Uneven and/or abnormal wear edge-to-edge and/or side-to-side - Looseness or damage including brake pad hardware - Evidence of contamination from an external substance Did you find any conditions to indicate a concern with any of the front and/or rear brake pad?	Go to Step 3	Go to Step 12
3	Are any of the front and/or rear brake pads contaminated?	Go to Step 8	Go to Step 4
4	Are any of the front and/or rear brake pads worn unevenly?	Go to Step 7	Go to Step 5

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Step	Action	Yes	No
5	Are any of the front and/or rear brake pads and/or brake pad hardware loose or damaged?	Go to Step 7	Go to Step 6
6	1. Remove and inspect the worn brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement. Did you complete the inspection and replacement?	Go to Step 12	—
7	Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. Note: Do NOT disconnect the hydraulic brake flex hoses from the brake calipers. 1. Remove the front and/or rear brake calipers, as appropriate, from the brake caliper anchor plates and support the brake calipers. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement. 2. Inspect the brake caliper anchor plate and the mounting/sliding hardware for the following conditions: ◦ Binding or seized brake caliper slides ◦ Worn, damaged or missing components ◦ Loose, bent, cracked, or damaged brake caliper anchor plate 3. Replace components as required. Refer to the following procedures as required: ◦ Front Brake Caliper Replacement. ◦ Rear Brake Caliper Replacement. 4. Replace the unevenly-worn, loose or damaged brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement. Did you complete the inspection and replacement?	Go to Step 12	—

Step	Action	Yes	No
8	1. Inspect the brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak. 2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required: ◦ Front Brake Caliper Overhaul or Front Brake Caliper Replacement. ◦ Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement. ◦ Front Brake Hose Replacement. ◦ Rear Brake Hose Replacement. ◦ Brake Pressure Modulator Valve Master Cylinder Reservoir Front Pipe Replacement. ◦ Brake Pressure Modulator Valve Master Cylinder Reservoir Rear Pipe Replacement. ◦ Front Brake Pipe Replacement - Right Side. ◦ Front Brake Pipe Replacement - Left Side. ◦ Rear Brake Front Pipe Replacement. ◦ Rear Brake Pipe Replacement. Did you find and correct the source of the leak causing contamination of the brake pads?	Go to Step 11	Go to Step 9
9	1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. 2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the brake pads. Refer to Rear Wheel Drive Shaft Outer Joint Boot Replacement. Did you find and correct the source of the leak causing contamination of the brake pads?	Go to Step 11	Go to Step 10
10	1. Clean the remaining disc brake system components to remove any traces of the contaminant. Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose	Go to Step 11	—

Step	Action	Yes	No
	and in turn may cause a brake fluid leak. Note: DO NOT disconnect the hydraulic brake flex hoses from the brake calipers. 2. Remove the front and/or rear brake calipers, as appropriate, from the brake caliper anchor plates and support the brake calipers. Refer to Front Brake Rotor Replacement and/or Rear Brake Rotor Replacement. 3. Inspect the brake caliper anchor plate/sliding hardware for the following conditions: ◦ Binding or seized hardware ◦ Distorted, worn, damaged or missing hardware components 4. Replace the brake calipers as required. Refer to Front Brake Caliper Replacement or Rear Brake Caliper Replacement. 5. Replace the contaminated brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement. Did you complete the cleaning, inspection and replacement?		
11	Visually inspect each of the rear disc brake disc shields/backing plates for evidence of contact with the brake discs. Are any of the brake disc shields/backing plates contacting the brake discs?	Go to Step 12	Go to Step 13
12	Repair or replace the disc brake disc shields/backing plates as required. Refer to Rear Brake Backing Plate Replacement. Did you complete the repair or replacement?	Go to Step 13	—
13	1. Inspect the thickness of each of the brake discs. Note: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH brake disc. 2. Make a determination for each brake disc if the brake disc can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to Brake Rotor Thickness Measurement. Does the brake disc meet the minimum requirements for REFINISHING?	Go to Step 14	Go to Step 17
14	Note: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH brake disc.	Go to Step 16	Go to Step 15

Step	Action	Yes	No
	Inspect each of the brake discs for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement. Does the brake disc exhibit thickness variation that exceeds the maximum acceptable level?		
15	1. Inspect each of the brake discs for the following surface and wear conditions: Refer to Brake Rotor Surface and Wear Inspection. ◦ Heavy rust and/or pitting ◦ Cracks and/or heat spots ◦ Too much blueing, discoloration ◦ Deep or greater than desired scoring beyond maximum acceptable level Note: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH brake disc. 2. Make a determination for each brake disc if the brake disc requires refinishing based upon the results of the inspection. If the brake disc exhibits any of the conditions listed previously, it requires refinishing. Does the brake disc require REFINISHING?	Go to Step 16	Go to Step 21
16	1. Refinish the brake disc. Refer to Brake Rotor Refinishing. 2. Inspect the brake disc thickness. Refer to Brake Rotor Thickness Measurement. Were you able to REFINISH the brake disc within the minimum requirements?	Go to Step 21	Go to Step 20
17	Is the brake disc at or below the DISCARD requirements?	Go to Step 20	Go to Step 18
18	Note: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH brake disc. Inspect each of the brake discs for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement. Does the brake disc exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 20	Go to Step 19
19	1. Inspect each of the brake discs for the following surface and wear conditions: Refer to Brake Rotor Surface and Wear Inspection.	Go to Step 20	Go to Step 21

Step	Action	Yes	No
	◦ Heavy rust and/or pitting ◦ Cracks and/or heat spots ◦ Too much blueing, discoloration ◦ Deep or greater than desired scoring beyond maximum acceptable level Note: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH brake disc. 2. Make a determination for each brake disc if the brake disc requires replacement based upon the results of the inspection. If the brake disc exhibits any of the conditions listed previously, it requires replacement. Does the brake disc require REPLACEMENT?		
20	Note: Whenever a brake disc is replaced, the assembled lateral runout (LRO) of the brake disc must be measured to make sure optimum performance of the disc brakes. Replace the brake disc. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement. Did you complete the replacement?	Go to Step 23	—
21	Note: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH brake disc. Inspect each of the brake discs for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to Brake Rotor Assembled Lateral Runout Measurement. Does the brake disc exhibit assembled LRO that exceeds the maximum acceptable level?	Go to Step 22	Go to Step 23
22	Correct the LRO for each brake disc that was determined to have LRO exceeding the maximum acceptable level. Refer to Brake Rotor Assembled Lateral Runout Correction. Did you complete the operation?	Go to Step 23	—
23	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK Return to Symptom Table	—

Hydraulic Brake System Diagnosis

Hydraulic Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the HYDRAULIC brake system in order to determine if the HYDRAULIC brake system is operating correctly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to Master Cylinder Reservoir Filling . Was the brake fluid level low?	Go to Step 3	Go to Step 4
3	1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination: ◦ Fluid separation, indicating two types of fluid are present - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance ◦ Fluid discoloration - Cloudy appearance - moisture - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to Step 5	Go to Step 6
4	1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination: ◦ Fluid separation, indicating two types of fluid are present - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance ◦ Fluid discoloration	Go to Step 5	Go to Step 12

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Step	Action	Yes	No
	- Cloudy appearance - moisture - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?		
5	1. Flush the hydraulic brake system. Refer to Hydraulic Brake System Flushing. 2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following steps. Refer to the procedures indicated. 2.1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2.2. Clean out the hydraulic brake pipes using denatured alcohol, or equivalent. 2.3. Dry the brake pipes using non-lubricated, filtered air. 2.4. Repair or replace ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. ▪ Replace the brake master cylinder reservoir cap diaphragm. ▪ Master Cylinder Replacement ▪ Brake master cylinder reservoir: Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air, or if necessary, replace the brake master cylinder reservoir. ▪ Front Brake Hose Replacement ▪ Rear Brake Hose Replacement ▪ Front Brake Caliper Overhaul or Front Brake Caliper Replacement ▪ Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement ▪ Brake Pressure Modulator Valve Replacement 3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated	Go to Step 9	—

Step	Action	Yes	No
	with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system. 4. Refill and bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding. Did you complete the operation and any required repairs and/or replacements?		
6	1. Inspect the following hydraulic brake system components for external fluid leaks. Repair or replace any of the components found to be leaking brake fluid. Refer to the appropriate procedures: ◦ Brake master cylinder reservoir cap diaphragm ◦ Master Cylinder Replacement ◦ Front Brake Hose Replacement ◦ Rear Brake Hose Replacement ◦ Brake Pressure Modulator Valve Master Cylinder Reservoir Front Pipe Replacement ◦ Brake Pressure Modulator Valve Master Cylinder Reservoir Rear Pipe Replacement ◦ Front Brake Pipe Replacement - Right Side ◦ Front Brake Pipe Replacement - Left Side ◦ Rear Brake Front Pipe Replacement ◦ Rear Brake Pipe Replacement ◦ Front Brake Caliper Overhaul or Front Brake Caliper Replacement ◦ Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement ◦ Brake Pressure Modulator Valve Replacement 2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding. While bleeding the hydraulic brake system, observe for the following conditions: ◦ The presence of air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced ◦ An unrestricted and even flow of brake fluid per axle during the bleeding procedure	Go to Step 7	Go to Step 12

Step	Action	Yes	No
	Did you find and correct a condition?		
7	Was there air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced?	Go to Step 19	Go to Step 8
8	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 9	Go to Step 10
9	Inspect the hydraulic function of the brake calipers for correct operation. Refer to Hydraulic Brake Component Operation Visual Inspection . Was the hydraulic function of the brake calipers operating correctly?	Go to Step 21	Go to Step 14
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 13	Go to Step 11
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to Step 17	—
12	Inspect the hydraulic function of the brake calipers/wheel cylinders for correct operation. Refer to Hydraulic Brake Component Operation Visual Inspection . Was the hydraulic function of the brake calipers/wheel cylinders operating correctly?	Go to Step 15	Go to Step 13
13	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating correctly: 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 2. Remove the tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation. 3. Open the suspected brake caliper bleeder valve. 4. Using a large G-clamp, compress the brake caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the brake caliper piston. 5. Close the brake caliper bleeder valve. Was the flow of brake fluid unrestricted and did the brake caliper piston move freely?	Go to Step 17	Go to Step 14
14	Repair or replace any brake caliper that was not operating correctly. Refer to the appropriate procedure. • Front Brake Caliper Overhaul or Front Brake Caliper Replacement	Go to Step 21	—

Step	Action	Yes	No
	• Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement Did you complete the repair and/or replacement?		
15	Bleed the hydraulic brake system to observe for the presence of air in the system and to observe for an unrestricted and even flow of brake fluid per axle during the bleeding procedure. Refer to Hydraulic Brake System Bleeding. Was there air in the system?	Go to Step 19	Go to Step 16
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 21	Go to Step 17
17	1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to Brake Pipe and Hose Inspection. 2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched, or damaged. Refer to the following procedures as necessary: ◦ Front Brake Hose Replacement ◦ Rear Brake Hose Replacement ◦ Brake Pressure Modulator Valve Master Cylinder Reservoir Front Pipe Replacement ◦ Brake Pressure Modulator Valve Master Cylinder Reservoir Rear Pipe Replacement ◦ Front Brake Pipe Replacement - Right Side ◦ Front Brake Pipe Replacement - Left Side ◦ Rear Brake Front Pipe Replacement ◦ Rear Brake Pipe Replacement 3. If none of the hydraulic brake pipes or flexible brake hoses were visibly bent, kinked, pinched, or damaged, replace the hydraulic brake flex hose at the restricted location. Did you find and correct a condition?	Go to Step 21	Go to Step 18
18	Replace the ABS brake modulator assembly, in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to Brake Pressure Modulator Valve Replacement. Did you complete the replacement?	Go to Step 21	—
19		Go to Step 21	Go to Step 20

Step	Action	Yes	No
	1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location, which may have drawn air into the system. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system. 3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid. Did you find and correct a condition?		
20	1. Inspect the brake master cylinder for internal fluid leaks. Refer to Brake System Internal Leak Test. 2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to Master Cylinder Replacement. Did you find and correct a condition?	Go to Step 21	Return to Symptom Table
21	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	—

Brake Assist System Diagnosis

Brake Assist System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the brake ASSIST system in order to determine if the brake ASSIST system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 3	Go to Step 2
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?	Go to Step 5	Go to Diagnostic Starting Point - Vehicle
3	Inspect for proper brake pedal travel. Refer to Brake Pedal Travel Measurement and Inspection . Is the brake pedal travel distance within the acceptable limits?	Go to Step 5	Go to Step 4
4	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. - For the brake pedal pushrod component inspection, refer to Brake Pedal Pushrod Inspection. - Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 5	Go to Hydraulic Brake System Diagnosis to check for internal and external fluid leaks and air in the hydraulic brake system
5	Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to Brake System Vacuum Source Test . Is the vacuum reading within the acceptable limits?	Go to Step 6	Go to Engine Controls Diagnostics Information to check for vacuum issues, including vacuum pump operation, if equipped
6		Go to Step 7	Go to Step 8

Step	Action	Yes	No
	Does the condition occur during cold start-up conditions?		
7	Check engine vacuum, and vacuum pump operation, if equipped, under the same cold start-up conditions. Refer to Engine Controls Diagnostics. Did you find and correct a condition?	Go to Step 22	Go to Step 9
8	During the vacuum source test, did the vacuum booster check valve operate properly?	Go to Step 10	Go to Step 9
9	Replace the vacuum booster check valve. Refer to Power Brake Booster Pressure Sensor Replacement . Did you complete the replacement?	Go to Step 10	—
10	If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to Step 11	Go to Step 12
11	Replace the vacuum sensor grommet. Did you complete the replacement?	Go to Step 12	—
12	1. If the vehicle is equipped with a vacuum sensor, install a scan tool. 2. Using the Data Display function, determine if brake booster vacuum sensor data is available within either the chassis brake controls area or the powertrain engine controls area. Is vacuum sensor data available through the scan tool?	Go to Step 13	Go to Step 16
13	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2–3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. Note: Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level.	Go to Step 18	Go to Step 14

Step	Action	Yes	No
	6. Determine the rate of vacuum leak. Specification Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds Was the rate of vacuum leak within the specified allowable range?		
14	1. Deplete the vacuum reserve by pressing the brake pedal several times, or by removing the vacuum booster check valve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to Master Cylinder Replacement. 3. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Replace the vacuum seal as necessary. 4. Carefully reinstall the master cylinder to the brake booster. Refer to Master Cylinder Replacement. Did you complete the operation?	Go to Step 15	—
15	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2–3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. Note: Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level. 6. Determine the rate of vacuum leak. Specification Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds Was the rate of vacuum leak within the specified allowable range?	Go to Step 22	Go to Step 21
16	1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by	Go to Step 17	Go to Step 18

Step	Action	Yes	No
	removing the check valve or applying the brake pedal several times. Refer to Master Cylinder Replacement. 2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. 3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage. Does the vacuum seal exhibit any of the conditions listed?		
17	1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. Ensure the seal is positioned correctly during installation. 2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced. 3. Carefully reinstall the master cylinder to the brake booster. Refer to Master Cylinder Replacement. Did you complete the replacement?	Go to Step 18	—
18	Perform the vacuum boost functional test: 1. If still separated, reinstall the master cylinder to the booster. Refer to Master Cylinder Replacement. 2. If the engine was started after reinstalling the master cylinder to the booster, perform the following: With the engine OFF, depress the brake pedal several times to deplete the vacuum reserve. 3. Depress and maintain moderate foot pressure on the brake pedal. 4. Start the engine and observe pedal operation. 5. Observe for audible vacuum leaks. The brake pedal should fall slightly, then hold. Is there an audible vacuum leak coming from the brake pedal area?	Go to Step 21	Go to Step 19
19	Did the brake pedal fall slightly after the engine was started, then hold?	Go to Step 20	Go to Step 21
20	Perform the vacuum booster leak-down test: 1. Release the brake pedal.	Go to Step 22	Go to Step 21

Step	Action	Yes	No
	2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2–3 seconds and repeat once. 3. Turn the ignition OFF. 4. Wait 60 seconds. 5. Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. ◦ Both pedal applies should be assisted ◦ The amount of assist could diminish slightly with the second apply Were both pedal applies power assisted?		
21	Replace the vacuum brake booster. Refer to Power Vacuum Brake Booster Replacement. Did you complete the replacement?	Go to Step 22	—
22	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Brake Assist System OK Return to Symptom Table	—

Brake System Vehicle Road Test

Preliminary Inspections

1. Visually inspect easily accessible brake system components for obvious damage and/or leaks which may indicate that the vehicle should not be driven until further inspections have been completed.
2. Inspect the brake master cylinder reservoir fluid level and adjust only if necessary for brake system road testing. Refer to [Master Cylinder Reservoir Filling](#).
3. Inspect the tire inflation pressures and adjust as necessary.
4. Inspect the tire tread patterns to ensure that they are the same or very similar, especially per axle.
5. Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

Road Testing Procedure

Warning: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

1. Start the engine and allow it to idle.
2. Check to see if the brake system warning lamp remains illuminated.
3. If the brake system warning lamp remains illuminated, DO NOT proceed to test drive the vehicle until it is diagnosed and repaired. Refer to [Symptoms - Hydraulic Brakes](#).
4. Select a smooth, dry, clean and level road or large lot that is as free of traffic and obstacles as possible for brake system low speed road testing.
5. With the transmission in PARK, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
6. If the brake pedal apply felt spongy, or the pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
7. If the brake pedal apply did not feel spongy and the pedal travel was not excessive, proceed to step 8.
8. Release and apply the brakes.
9. While continuing to apply the brakes, shift the transmission into DRIVE, release the brakes and allow the engine to idle the vehicle away from the stopped position. Observe for a slow release of the brake system.
10. With the aid of an assistant to observe the vehicle's performance from outside of the vehicle, drive the vehicle at a low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to them, while you observe both the pedal effort and the pedal travel.
11. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
12. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 13.
13. Drive the vehicle in the opposite direction, at the same low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to him.
14. Drive the vehicle at a low speed and shift the transmission into NEUTRAL without applying the brakes. Observe for a rapid deceleration in vehicle speed, indicating possible brake drag.
15. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.

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16. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
17. While continuing to drive the vehicle at a moderate speed, perform several light applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
18. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
19. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 20.
20. While continuing to drive the vehicle at a moderate speed, perform several moderate applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action – either side to side, or front to rear.
A small amount of vehicle front end dip is expected during a moderate apply of the brakes.
21. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.

Brake Pedal Travel Measurement and Inspection

Special Tools

CH-28662 Brake Pedal Effort Gauge

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

1. With the ignition OFF and the brakes cool, apply the brakes 3–5 times, or until the brake pedal becomes firm, in order to deplete the brake booster power reserve.
2. Install the CH-28662 Brake Pedal Effort Gauge to the brake pedal.



3. Measure and record the distance (1) from the brake pedal to the rim of the steering wheel; note the points of measurement.
4. Apply and maintain the brakes with 445 N (100 lb) of force to the brake pedal, as indicated on the CH-28662 Brake Pedal Effort Gauge.
5. While maintaining 445 N (100 lb) of force to the brake pedal, measure and record the distance (2) from the same point on the brake pedal to the same point on the rim of the steering wheel.
6. Release the brakes and repeat steps 4 and 5 to obtain a second measurement. After obtaining a second measurement, proceed to step 7.
7. Average the first and second measurements recorded during the two applies of the brakes.
8. Subtract the initial measurement, unapplied (1), from the averaged, applied measurement (2) to obtain the brake pedal travel distance.
9. Compare the brake pedal travel distance obtained with the specification. Refer to [Brake System Specifications](#).

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Brake System Vacuum Source Test

Note:

- Engine temperature, accessory load, and elevation level will affect engine vacuum.
- Vacuum readings will decrease by approximately 2.7 kPa (0.8 in Hg) for every 305 m (1000 ft) of elevation above sea level.

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve.
2. Install a vacuum gauge to the engine vacuum hose.
3. Start the engine and allow the engine to idle until normal operating temperatures are reached.
4. With the vehicle in PARK, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is within the specified normal engine vacuum range.

Specification

47–68 kPa (14–20 in Hg)

5. Turn the ignition OFF.
6. If the engine vacuum reading was within the specified normal range, proceed to step 10.
7. If the engine vacuum reading was NOT within the specified normal range, inspect the engine vacuum hose for the following conditions:
 - Loose connection to the engine
 - Collapse, deformation or contamination
 - Cracks, cuts, dry-rot
8. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2–4.
9. If none of these conditions were found with the engine vacuum hose, then there is an engine vacuum source problem, check the engine vacuum system.
10. Remove the vacuum brake booster check valve from the booster.
11. Install the check valve to the engine vacuum hose.
12. Install the vacuum gauge to the check valve.
13. Start the engine and allow the engine to idle in PARK with the A/C system OFF, until normal operating temperatures are reached.
14. Turn the ignition OFF.
15. Check to see if the engine vacuum reading is maintained within the specified normal engine vacuum range.
Specification
47–68 kPa (14–20 in Hg)
16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.
17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the brake booster check valve, then repeat steps 11–15.
18. Inspect the brake booster check valve grommet for the following conditions:
 - Loose connection to the vacuum brake booster
 - Deformation or contamination
 - Cracks, cuts, dry-rot
19. If any of these conditions were found with the check valve grommet, replace the grommet.

Brake System External Leak Inspection

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. In order to inspect for external brake fluid leaks, first check the fluid level in the master cylinder.
While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.
2. If the fluid level is abnormally low, adjust the brake fluid level. Refer to [Master Cylinder Reservoir Filling](#).
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.
If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.
5. Turn OFF the ignition.
6. Visually inspect the following brake system components for brake fluid leaks, excessive corrosion, and damage. Give particular attention to all brake pipe and flexible hose connections to ensure that there are not any slight brake fluid leaks – even though the brake pedal may feel firm and hold steady:
 - Master cylinder brake pipe fittings
 - All brake pipe connections
 - Brake pipes
 - Brake hoses and connections
 - Brake calipers and/or wheel cylinders, if equipped
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, reinspect the hydraulic brake system to assure proper function.

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Brake System Internal Leak Test

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Start the engine and allow it to idle.
2. Apply light, steady pressure to the brake pedal. Observe both the brake pedal feel and travel.
3. Release the brakes and turn OFF the ignition.
4. If the brake pedal apply felt spongy, but the brake pedal travel was not excessive, perform the following steps:
 - 4.1. Inspect the brake system for external leaks. Refer to [Brake System External Leak Inspection](#).
 - 4.2. Pressure bleed the brake system in order to purge any air that may be trapped in the system. Refer to [Hydraulic Brake System Bleeding](#).



5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the following steps:
 - 5.1. Loosen the master cylinder-to-brake power booster mounting nuts.
 - 5.2. Carefully pull the master cylinder away from the brake power booster just enough to inspect the mounting surface of the master cylinder.
 - 5.3. Inspect the master cylinder mounting surface at the primary piston (2) for brake fluid leaks.
6. If the master cylinder exhibits any leakage around the primary piston (2), then the primary piston primary seal (4) and/or secondary seal (3) is leaking and the master cylinder requires overhaul or replacement.
7. If the master cylinder primary piston (2) does not exhibit any leakage, pressure bleed the brake system. Refer to [Hydraulic Brake System Bleeding](#).
8. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, but then gradually fell, then the master cylinder requires overhaul or replacement due to an internal leak past the secondary piston (1) from the secondary piston primary seal (6) or secondary seal (5).
9. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, then fell slightly, then became steady again, then the brake pressure modulator valve (BPMV) may be leaking internally, and may require replacement.

Hydraulic Brake Component Operation Visual Inspection



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Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the caliper piston (1) in relation to the caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
 - 4.1. Observe the caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
 - 4.2. Observe the caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the caliper piston (1) did not exhibit unrestricted and even movement during brake system apply and/or release, the piston square seal (3) may be worn or damaged and the caliper may require overhaul or replacement.

Brake Pipe and Hose Inspection

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Visually inspect all of the brake pipes for the following conditions:
 - Kinks, improper routing, missing or damaged retainers
 - Leaking fittings, excessive corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe, or pipes, require replacement.
3. Ensure that the vehicle axles are properly supported at ride height in order to maintain the proper relationship of the flexible brake hoses to the chassis.



4. Visually inspect all of the flexible brake hoses for the following conditions:
 - Kinks (1), improper routing, twists, chafing, missing or damaged retainers
 - Leaking connections, cracking, dry-rot, blisters, bulges
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose, or hoses require replacement.
6. Squeeze the flexible brake hoses with firm finger pressure to check for soft spots (2), indicating an internal restriction. Check the entire length of each flexible brake hose.
7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose, or hoses require replacement.

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Brake Pedal Pushrod Inspection



1. Disconnect the brake pedal pushrod (1) from the brake pedal.
2. Inspect the brake pedal pushrod eyelet bushing (2), if equipped, for cracks and/or excessive wear.
3. Reposition the pedal pushrod boot (3) toward the front of the vehicle to expose as much of the pedal pushrod (1) as possible.
4. Inspect the brake pedal pushrod (1) for straightness.
5. If the brake pedal pushrod eyelet bushing (2) exhibited cracks and/or excessive wear, then the bushing requires replacement.
6. If the brake pedal pushrod (1) is not straight, then the pushrod requires replacement.
7. Return the pedal pushrod boot (3) to its original position on the pedal pushrod (1).
8. Connect the brake pedal pushrod (1) to the brake pedal.

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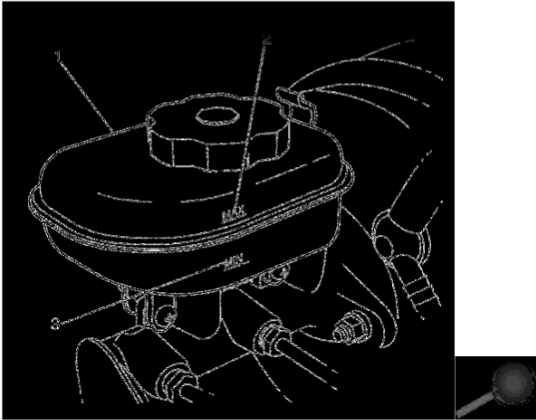
Master Cylinder Reservoir Filling

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Visually inspect the brake fluid level in the master cylinder reservoir (1).
2. If the brake fluid level is at or below the minimum allowable level (3) during routine fluid inspections, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the minimum allowable level (3) and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped up to the maximum fill level (2).

Note: If brake fluid is to be added to the master cylinder reservoir (1), clean the outside and around the reservoir cap prior to removal.

4. If a brake system service was just completed, the brake fluid may be topped up to the maximum fill level (2).
5. If the brake fluid level is above the minimum allowable level (3), adding brake fluid is not recommended under normal conditions.

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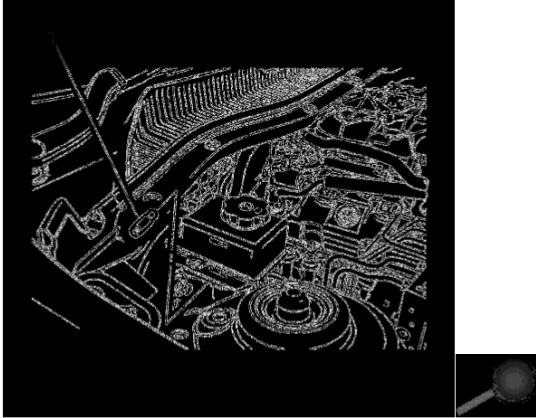
Master Cylinder Reservoir Replacement

Removal Procedure

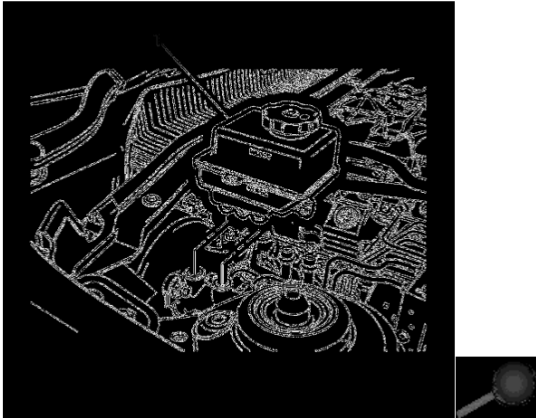
Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

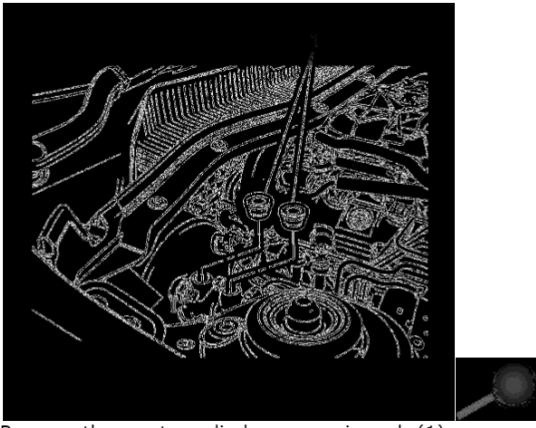
1. Remove and properly dispose of the brake fluid from the master cylinder reservoir.
2. Disconnect the brake fluid level sensor electrical connector.
3. If equipped with a manual transmission, disconnect the clutch master cylinder reservoir hose. Refer to [Clutch Master Cylinder Reservoir Hose Replacement](#).



4. Remove the master cylinder reservoir bolt (1).



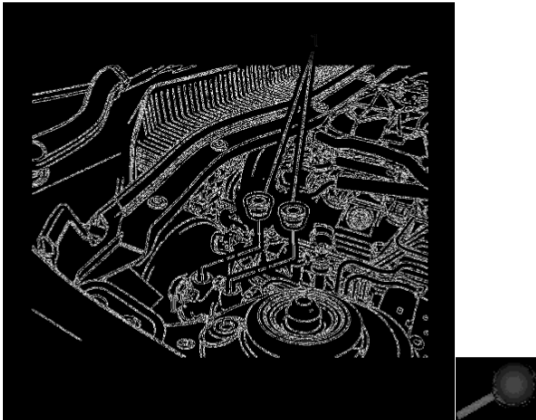
5. Remove the master cylinder reservoir (1).
6. Carefully pull the reservoir straight upward.



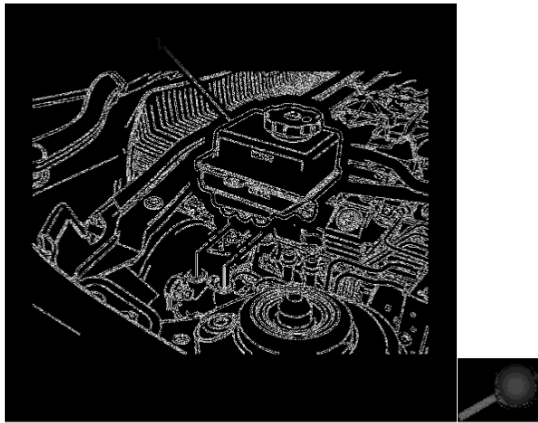
7. Remove the master cylinder reservoir seals (1).
8. Remove the brake fluid level sensor, if necessary. Refer to [Brake Fluid Level Sensor Replacement](#).

Installation Procedure

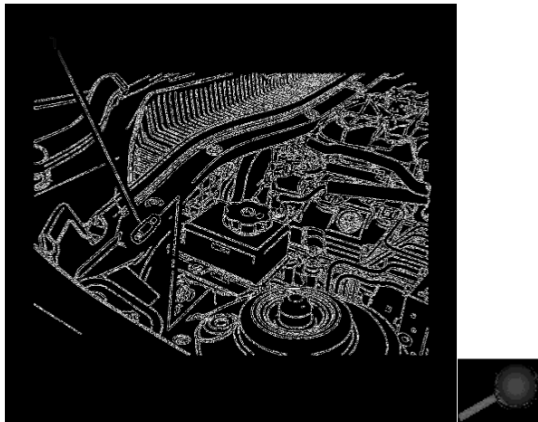
1. If installing the original master cylinder reservoir, clean the master cylinder reservoir with denatured alcohol and dry with filtered, non-lubricated compressed air.
2. Install the brake fluid level sensor, if removed. Refer to [Brake Fluid Level Sensor Replacement](#).



3. Install the master cylinder reservoir seals (1).
4. Lubricate the seals with GM approved or equivalent brake fluid from a clean, sealed brake fluid container. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).



5. Install the master cylinder reservoir (1).
6. Carefully press the reservoir straight downward.



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

7. Install the master cylinder reservoir bolt (1) and tighten to **8 N•m (71 lb in)**.
8. If equipped with a manual transmission, connect the clutch master cylinder reservoir hose. Refer to [Clutch Master Cylinder Reservoir Hose Replacement](#).
9. Connect the brake fluid level sensor electrical connector.
10. Fill the master cylinder reservoir. Refer to [Master Cylinder Reservoir Filling](#).

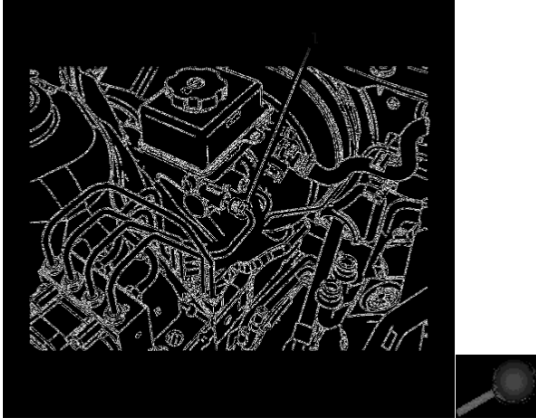
Master Cylinder Replacement

Removal Procedure

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. With the engine OFF, apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Disconnect the brake fluid level sensor electrical connector.
3. If equipped with a manual transmission, disconnect the clutch master cylinder reservoir hose. Refer to [Clutch Master Cylinder Reservoir Hose Replacement](#).

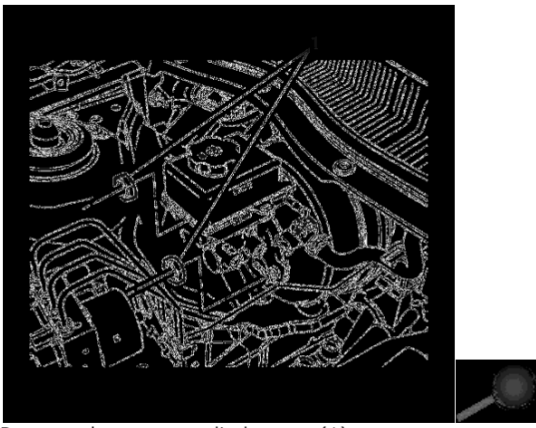


4. Disconnect the master cylinder secondary brake pipe fitting (1).
5. Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

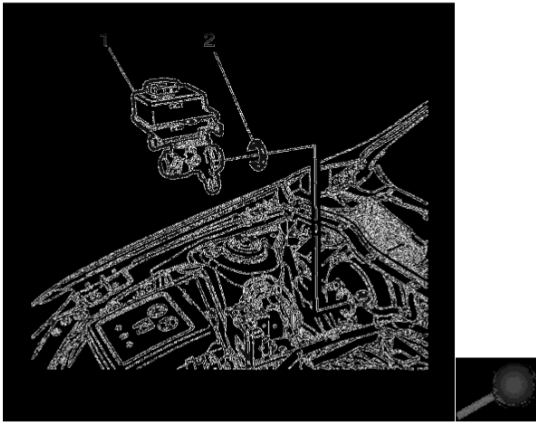


6. Disconnect the master cylinder primary brake pipe fitting (1).
7. Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

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8. Remove the master cylinder nuts (1).



9. Remove the master cylinder (1) from the power vacuum brake booster.

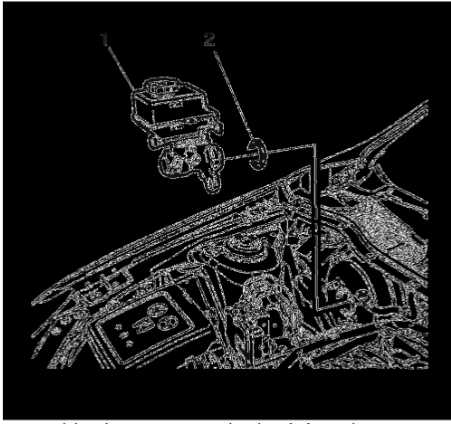
10. Inspect the O-ring seal (2) for damage and replace, if necessary.

11. Remove the brake fluid level sensor, if necessary. Refer to [Brake Fluid Level Sensor Replacement](#).

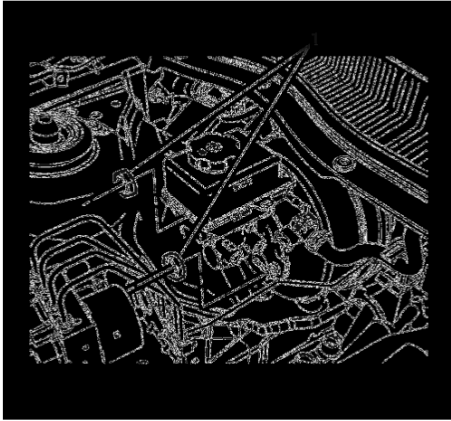
Installation Procedure

1. Install the brake fluid level sensor, if removed. Refer to [Brake Fluid Level Sensor Replacement](#).

2. If installing a new master cylinder, bench bleed the master cylinder. Refer to [Master Cylinder Bench Bleeding](#).



3. Assemble the master cylinder (1) to the O-ring seal (2).
4. Install the master cylinder to the power vacuum brake booster.

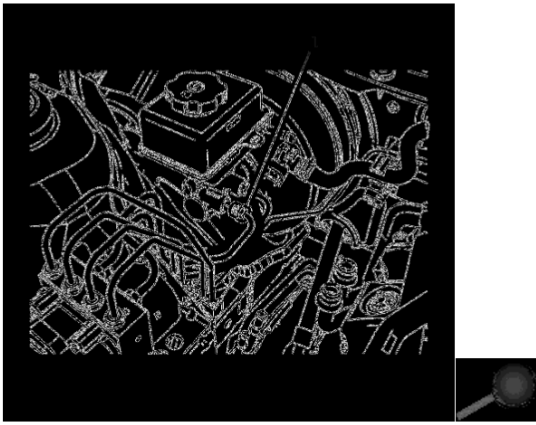


Caution: Refer to [Fastener Caution](#).

5. Install the master cylinder nuts (1) and tighten to **19 N·m (14 lb ft)**.



6. Connect the master cylinder primary brake pipe fitting (1) and tighten the fitting to **16 N•m (12 lb ft)**.



7. Connect the master cylinder secondary brake pipe fitting (1) and tighten the fitting to **16 N•m (12 lb ft)**.
8. If equipped with a manual transmission, connect the clutch master cylinder reservoir hose. Refer to [Clutch Master Cylinder Reservoir Hose Replacement](#).
9. Connect the brake fluid level sensor electrical connector.
10. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

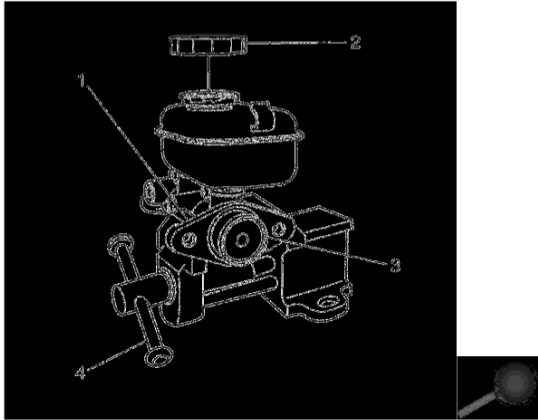
Master Cylinder Bench Bleeding

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

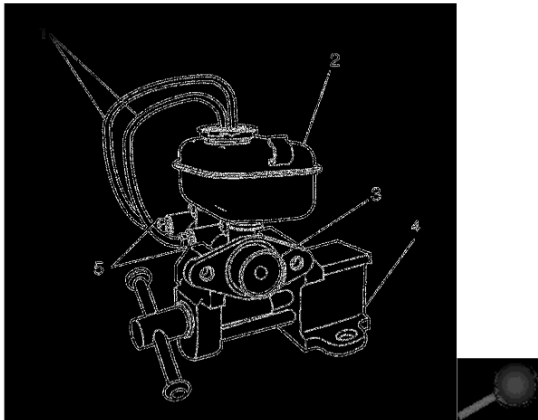
Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



Note: The rear of the primary piston (3) must be accessible.

1. Secure the mounting flange of the brake master cylinder (1) in a suitable bench vise (4).
2. Remove the master cylinder reservoir cap (2).



Note: Install suitable fittings to the master cylinder ports (5) that match the type of flare seat required and also provide for hose attachment.

3. Install suitable fittings to the master cylinder ports (5).
4. Install transparent hoses (1) to the fittings installed to the master cylinder ports (5).
Route the hoses into the master cylinder reservoir (2).

Note: Brake fluid from a clean, sealed brake fluid container must be used when topping up the brake fluid level.

5. Fill the master cylinder reservoir (2) to the maximum fill level.

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Note: Make sure that the ends of the transparent hoses (1) running into the master cylinder reservoir (2) are fully submerged in the brake fluid.

Note: As air is bled from the primary and secondary pistons, the effort required to depress the primary piston (3) will increase and the amount of travel will decrease.

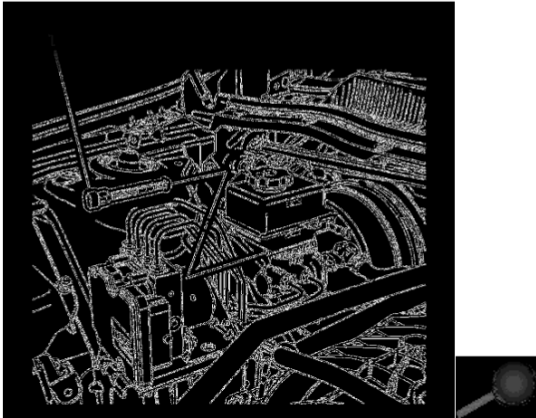
Note: Use a suitable smooth, round-ended tool to depress and release the primary piston (3) as far as it will travel. Observe the flow of fluid coming from the ports.

6. Depress and release the primary piston (3).
7. Continue to depress and release the primary piston (3) until fluid flows freely from the ports with no evidence of air bubbles.
8. Remove the fittings installed to the master cylinder ports (5) and transparent hoses (1).
Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.
9. Install the master cylinder reservoir cap.
10. Remove the master cylinder from the suitable bench vise (4).

Brake Fluid Level Sensor Replacement

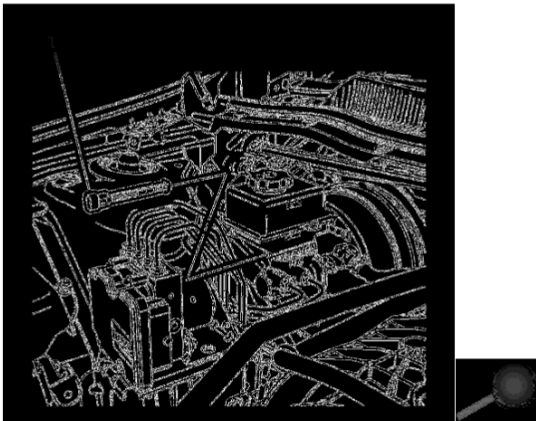
Removal Procedure

1. Disconnect the brake fluid level sensor electrical connector.



2. Compress the locking tabs and remove the brake fluid level sensor (1).

Installation Procedure



1. Install the brake fluid level sensor (1).
2. Ensure the locking tabs of the brake fluid level sensor are fully engaged in the master cylinder reservoir.
3. Connect the brake fluid level sensor electrical connector.

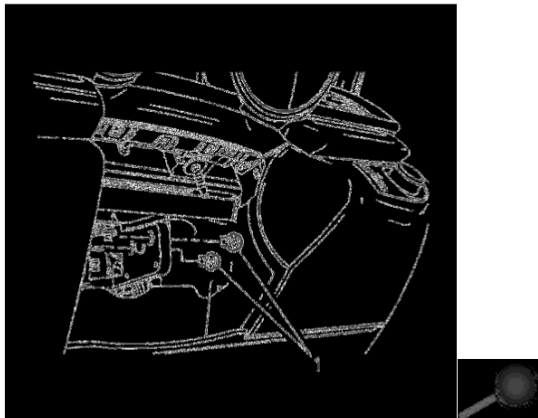
Brake, Accelerator, and Clutch Pedal Replacement

Removal Procedure

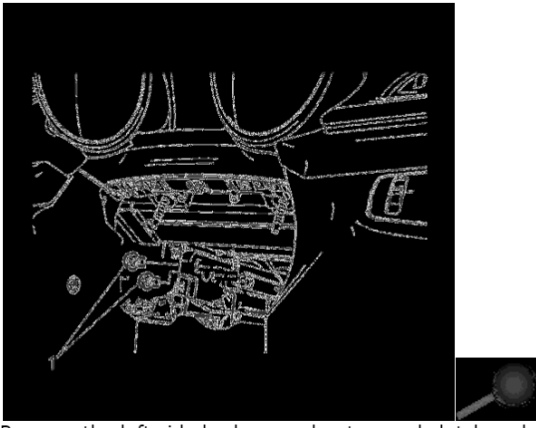
1. Remove the steering column. Refer to [Steering Column Replacement](#).
2. Remove the brake pedal position sensor. Refer to [Brake Pedal Position Sensor Replacement](#).
3. Remove the clutch pedal position switch. Refer to [Clutch Pedal Position Switch Replacement](#).
4. Disconnect the accelerator pedal position sensor electrical connector.
5. Remove the power vacuum brake booster. Refer to [Power Vacuum Brake Booster Replacement](#).
6. Disconnect the hydraulic clutch pipe from the clutch master cylinder. Refer to [Hydraulic Clutch Hose/Pipe Replacement](#).



7. Remove the brake, accelerator, and clutch pedal assembly nuts (1).



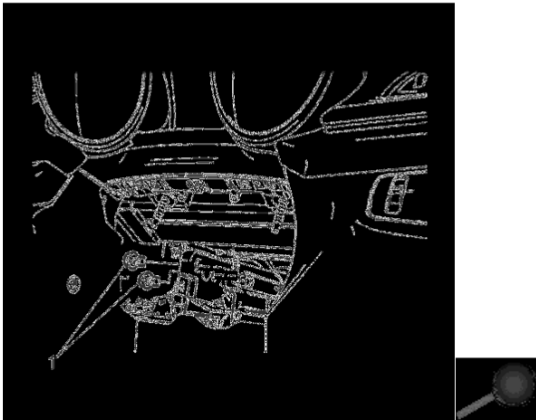
8. Remove the right side brake, accelerator, and clutch pedal assembly bolts (1).



9. Remove the left side brake, accelerator, and clutch pedal assembly bolts (1).
10. Remove the brake, accelerator, and clutch pedal assembly.
11. Remove the accelerator pedal position sensor. Refer to [Accelerator Pedal Position Sensor Replacement](#) or [Accelerator Pedal Position Sensor Replacement](#).
12. Remove the clutch master cylinder. Refer to [Clutch Master Cylinder Replacement](#).

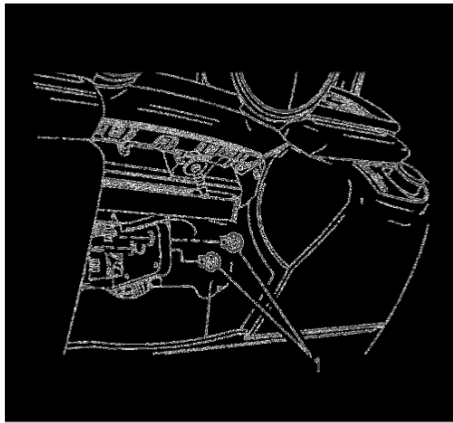
Installation Procedure

1. Install the clutch master cylinder. Refer to [Clutch Master Cylinder Replacement](#).
2. Install the brake, accelerator, and clutch pedal assembly to the dash panel.



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

3. Install the left side brake, accelerator, and clutch pedal assembly bolts (1) and tighten the bolts to **22 N·m (16 lb ft)**.



4. Install the right side brake, accelerator, and clutch pedal assembly bolts (1) and tighten the bolts to **22 N·m (16 lb ft)**.



5. Install the brake, accelerator, and clutch pedal assembly nuts (1) and tighten the nuts to **22 N·m (16 lb ft)**.
6. Connect the hydraulic clutch pipe to the clutch master cylinder. Refer to [Hydraulic Clutch Hose/Pipe Replacement](#).
7. Install the power vacuum brake booster. Refer to [Power Vacuum Brake Booster Replacement](#).
8. Install the clutch pedal position switch. Refer to [Clutch Pedal Position Switch Replacement](#).
9. Install the brake pedal position sensor. Refer to [Brake Pedal Position Sensor Replacement](#).
10. Install the accelerator pedal position sensor. Refer to [Accelerator Pedal Position Sensor Replacement](#) or [Accelerator Pedal Position Sensor Replacement](#).
11. Install the steering column. Refer to [Steering Column Replacement](#).

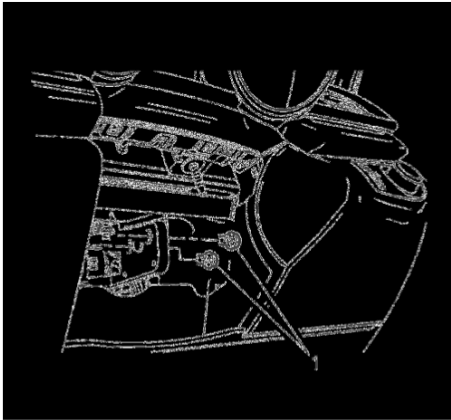
Brake and Accelerator Pedal Assembly Replacement

Removal Procedure

1. Remove the steering column. Refer to [Steering Column Replacement](#).
2. Remove the brake pedal position sensor. Refer to [Brake Pedal Position Sensor Replacement](#).
3. Disconnect the accelerator pedal position sensor electrical connector.
4. Remove the power vacuum brake booster. Refer to [Power Vacuum Brake Booster Replacement](#).

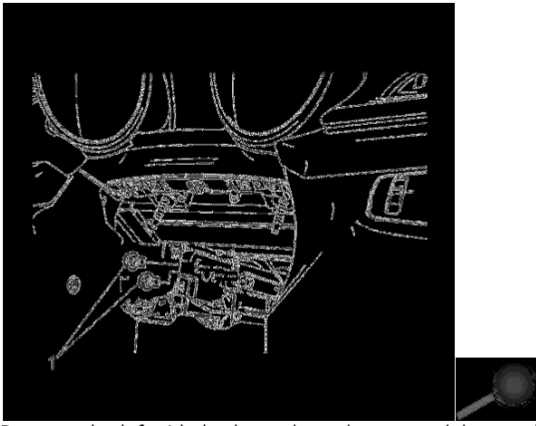


5. Remove the brake and accelerator pedal assembly nuts (1).



6. Remove the right side brake and accelerator pedal assembly bolts (1).

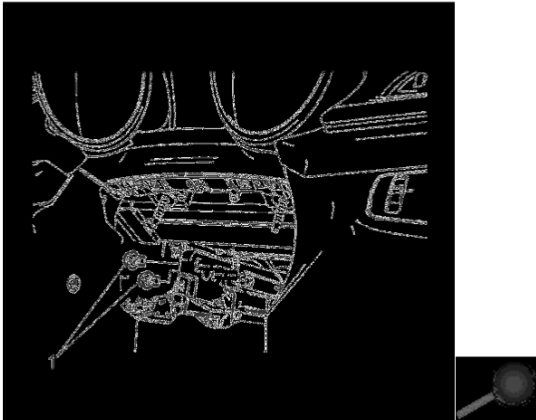
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7. Remove the left side brake and accelerator pedal assembly bolts (1).
8. Remove the brake and accelerator pedal assembly.
9. Remove the accelerator pedal position sensor. Refer to [Accelerator Pedal Position Sensor Replacement](#) or [Accelerator Pedal Position Sensor Replacement](#).

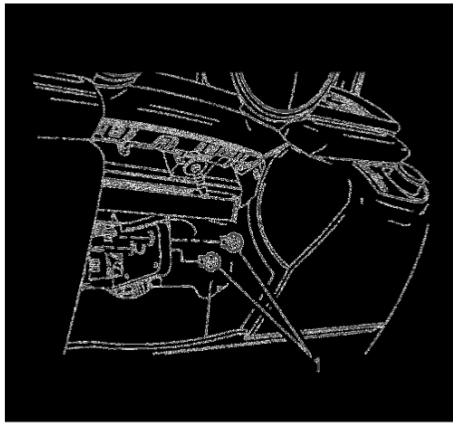
Installation Procedure

1. Install the brake and accelerator pedal assembly to the dash panel.



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

2. Install the left side brake and accelerator pedal assembly bolts (1) and tighten the bolts to **22 N·m (16 lb ft)**.



3. Install the right side brake and accelerator pedal assembly bolts (1) and tighten the bolts to **22 N•m (16 lb ft)**.



4. Install the brake and accelerator pedal assembly nuts (1) and tighten the nuts to **22 N•m (16 lb ft)**.
5. Install the power vacuum brake booster. Refer to [Power Vacuum Brake Booster Replacement](#).
6. Install the brake pedal position sensor. Refer to [Brake Pedal Position Sensor Replacement](#).
7. Install the accelerator pedal position sensor. Refer to [Accelerator Pedal Position Sensor Replacement](#) or [Accelerator Pedal Position Sensor Replacement](#).
8. Install the steering column. Refer to [Steering Column Replacement](#).

Brake Pressure Modulator Valve Master Cylinder Reservoir Front Pipe Replacement

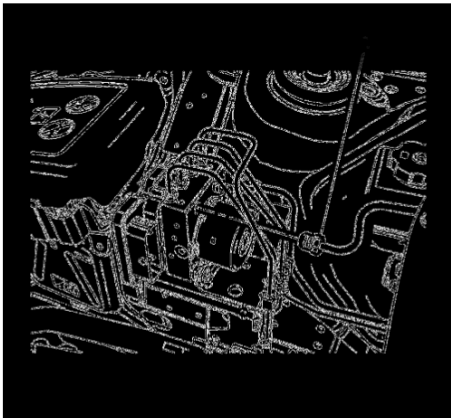
Removal Procedure

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Disconnect the master cylinder front brake pipe fitting (1) from the master cylinder.
2. Plug the master cylinder outlet port to prevent brake fluid loss and contamination.

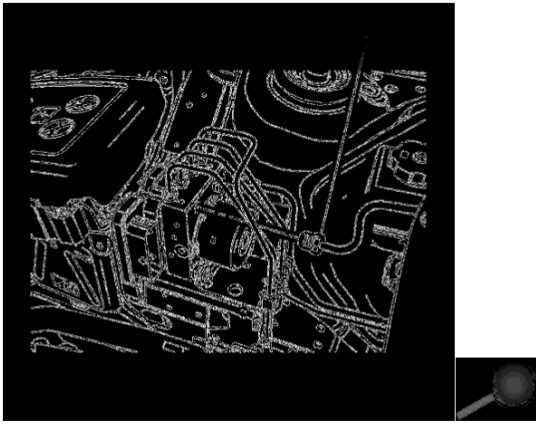


3. Disconnect the master cylinder front brake pipe fitting (1) from the brake pressure modulator valve (BPMV).
4. Plug the BPMV inlet port to prevent brake fluid loss and contamination.
5. Remove the BPMV master cylinder reservoir front pipe from the vehicle.

Installation Procedure

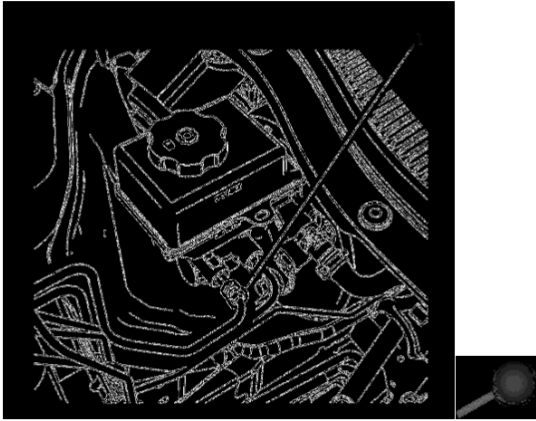
1. Install the BPMV master cylinder reservoir front pipe to the vehicle.

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

2. Connect the master cylinder front brake pipe fitting (1) to the BPMV and tighten the fitting to **16 N•m (12 lb ft)**.



3. Connect the master cylinder front brake pipe fitting (1) to the master cylinder and tighten the fitting to **16 N•m (12 lb ft)**.
4. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

Brake Pressure Modulator Valve Master Cylinder Reservoir Rear Pipe Replacement

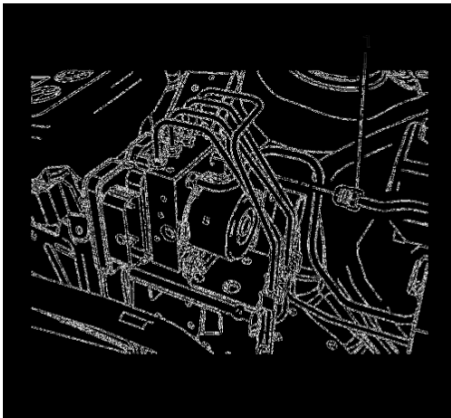
Removal Procedure

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Disconnect the master cylinder rear brake pipe fitting (1) from the master cylinder.
2. Plug the master cylinder outlet port to prevent brake fluid loss and contamination.

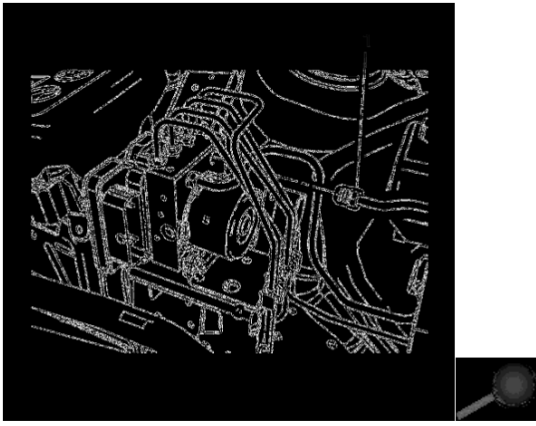


3. Disconnect the master cylinder rear brake pipe fitting (1) from the brake pressure modulator valve (BPMV).
4. Plug the BPMV inlet port to prevent brake fluid loss and contamination.
5. Remove the BPMV master cylinder reservoir rear pipe from the vehicle.

Installation Procedure

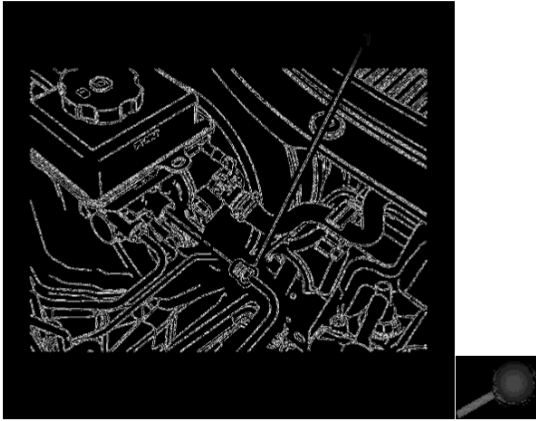
1. Install the BPMV master cylinder reservoir rear pipe to the vehicle.

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

2. Connect the master cylinder rear brake pipe fitting (1) to the BPMV and tighten the fitting to **16 N•m (12 lb ft)**.

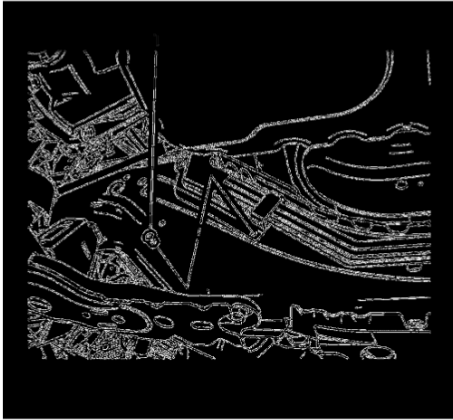


3. Connect the master cylinder rear brake pipe fitting (1) to the master cylinder and tighten the fitting to **16 N•m (12 lb ft)**.
4. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

Brake and Fuel Feed and Fuel Return and Evaporative Emission Pipe Protector Replacement

Removal Procedure

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



2. Remove and discard the brake and fuel pipe protector rivet (1).



3. Remove the brake and fuel pipe protector bolt (1).

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4. Remove the brake and fuel pipe protector (1) from the brake and fuel pipe underbody retainers.

Installation Procedure



1. Install the brake and fuel pipe protector (1) to the brake and fuel pipe underbody retainers.



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

2. Install the brake and fuel pipe protector bolt (1) and tighten to **22 N•m (16 lb ft)**.



3. Install a new brake and fuel pipe protector rivet (1).

Front Brake Pipe Replacement - Right Side

Special Tools

CH-23738-A Hand Vacuum Pump

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

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

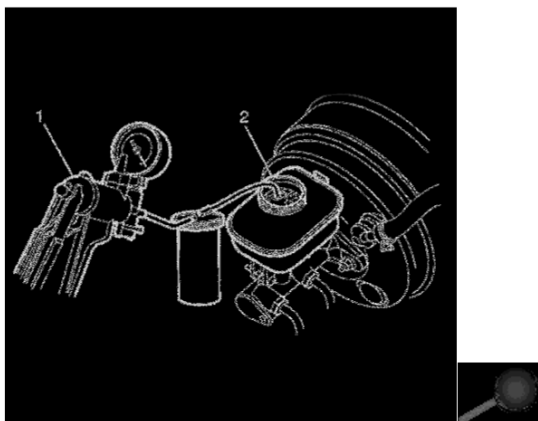
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

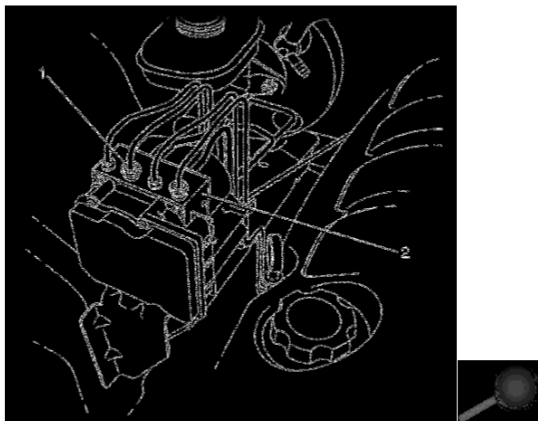
Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Clean the master cylinder, especially around the brake lines and reservoir cap.
2. Place a clean suitable container under the brake pressure modulator valve (BPMV).
3. Remove the master cylinder reservoir cap.



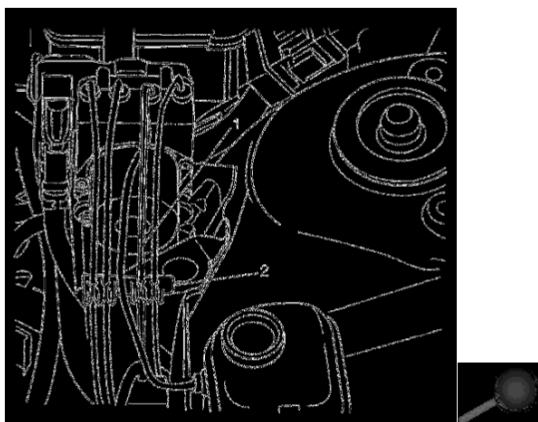
4. Siphon the brake fluid out of the master cylinder reservoir (2) using the CH-23738-A Hand Vacuum Pump (1).



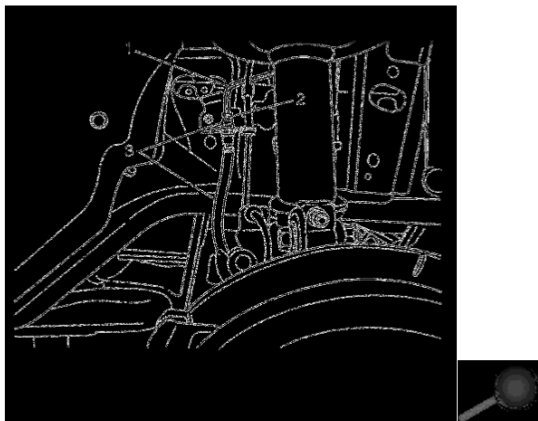
5. Disconnect the brake pipe (1) from the BPMV (2).

Note: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

6. Plug the BPMV (2).



7. Release the brake pipe (1) from the locating clip (2).
8. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
9. Remove the right front tyre and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
10. Remove the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).

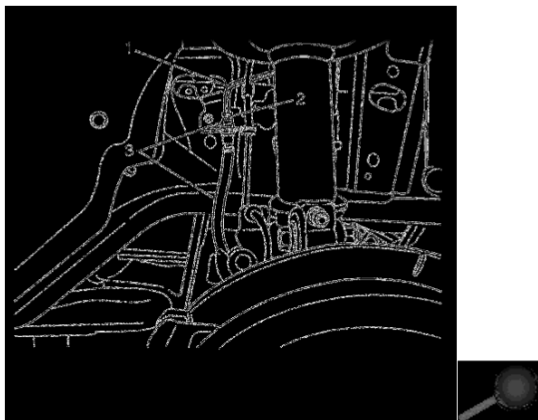


11. Clean all dirt and foreign material from the brake hose and the brake pipe fittings (2 and 3).

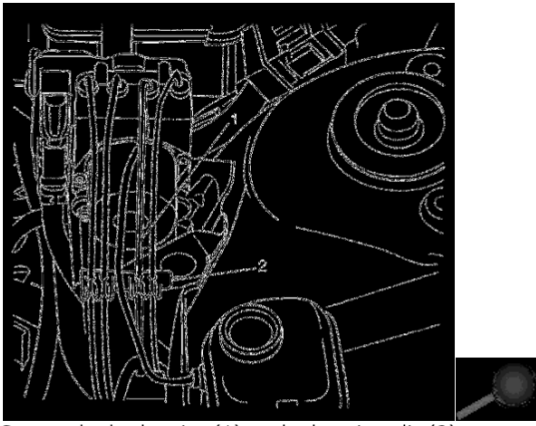
Note: Hold the brake hose (3) with a suitable tool whilst disconnecting the brake pipe fitting (2) to prevent damage to the brake pipe (1).

12. Disconnect the brake pipe fitting (2) from the brake hose (3).
13. Plug the brake hose to prevent brake fluid loss and contamination.
14. Remove the brake pipe (1).

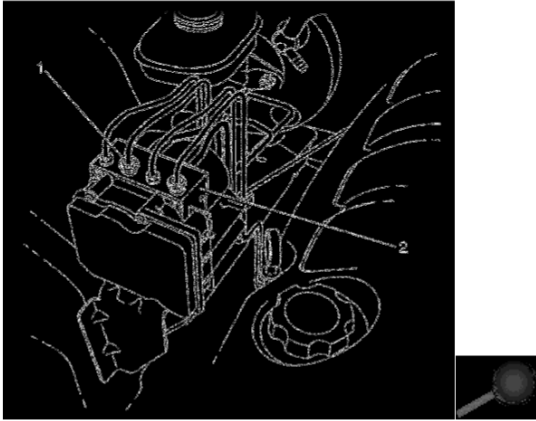
Installation Procedure



1. Install the brake pipe (1) to the vehicle.
2. Remove the rubber cap or plug from the brake hose (3).
- Note:** Do not tighten the brake pipe fitting until instructed.
3. Connect the brake pipe fitting (2) to the brake hose (3).
4. Lower the vehicle.



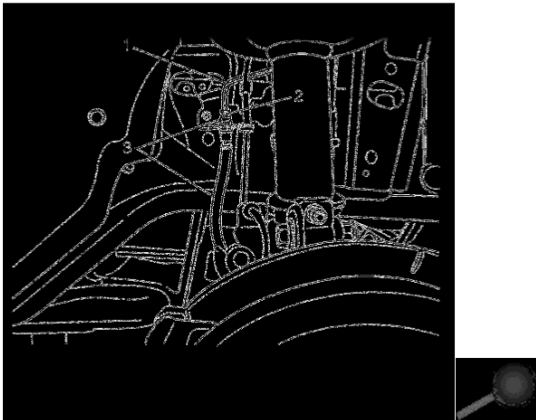
5. Secure the brake pipe (1) to the locating clip (2).



6. Remove the rubber cap or plug from the BPMV (2).

Note: Do not tighten the brake pipe fitting until instructed.

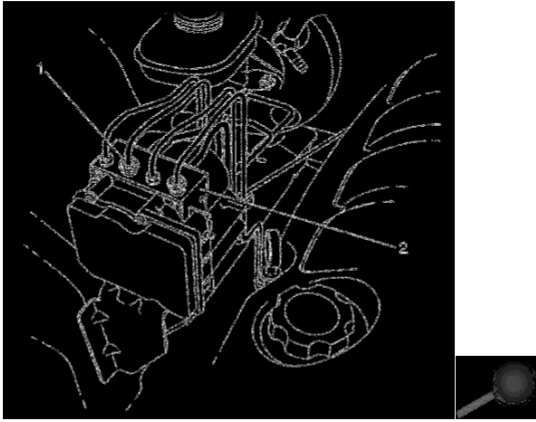
7. Install the brake pipe (1) to the BPMV (2).



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

Note: Hold the brake hose (3) with a suitable tool whilst connecting the brake pipe fitting (2) to prevent damage to the brake pipe (1).

8. Tighten the brake pipe fitting (2) to the brake hose (3) to **16 N·m (12 lb ft)**.



9. Tighten the brake pipe fitting (1) to the BPMV (2) to **16 N·m (12 lb ft)**.
10. Install the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).
11. Install the right front tyre and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
12. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

Front Brake Pipe Replacement - Left Side

Special Tools

CH-23738-A Hand Vacuum Pump

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

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

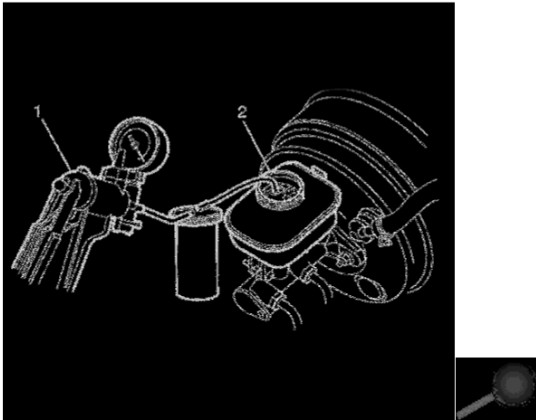
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

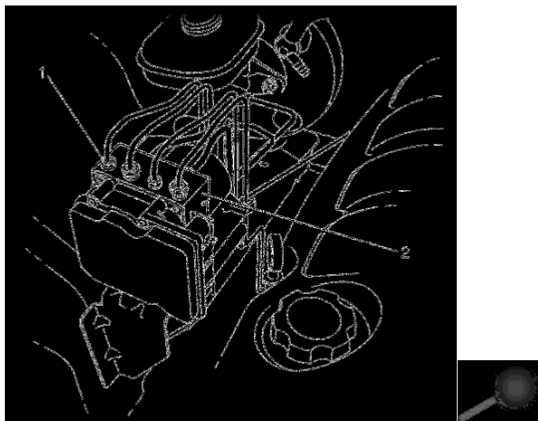
Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Clean the master cylinder, brake lines and reservoir cap.
2. Place a clean suitable container under the brake pressure modulator valve (BPMV).
3. Remove the master cylinder reservoir cap.



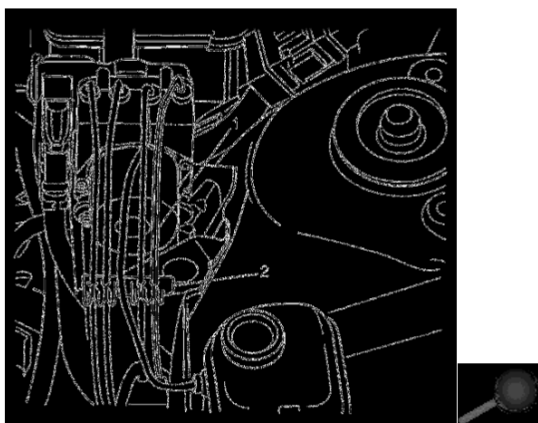
4. Siphon the brake fluid out of the master cylinder reservoir (2) using the CH-23738-A Hand Vacuum Pump (1).



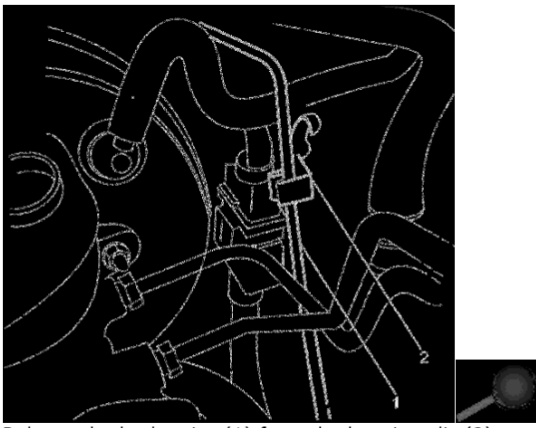
5. Disconnect the brake pipe (1) from the BPMV (2).

Note: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

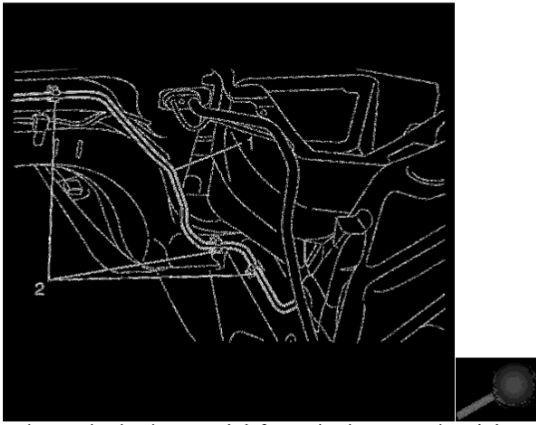
6. Plug the BPMV (2).
7. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
8. Remove the left front tyre and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
9. Remove the engine. Refer to [Engine Replacement](#) or [Engine Replacement](#).
10. Remove the heat shields in the engine bay.
11. Remove the sound proofing trim from the bulkhead.



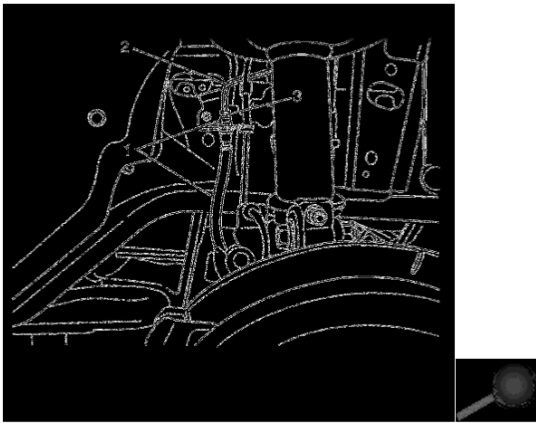
12. Release the brake pipe (1) from the locating clip (2).



13. Release the brake pipe (1) from the locating clip (2).



14. Release the brake pipe (1) from the locating clips (2).



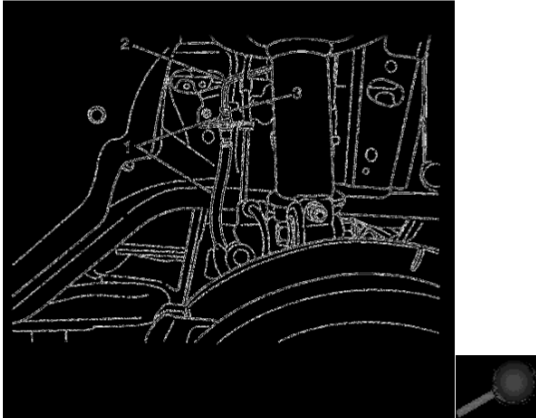
15. Clean all dirt and foreign material from the brake hose and the brake pipe fittings (1 and 3).

Note: Hold the brake hose (1) with a suitable tool whilst disconnecting the brake pipe fitting (3) to prevent damage to the brake pipe (2).

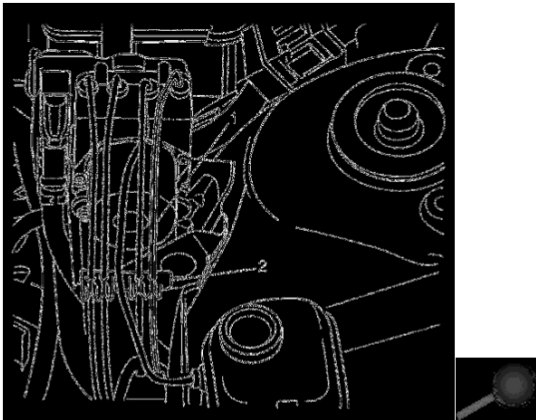
16. Disconnect the brake pipe fitting (3) from the brake hose (1).

17. Plug the brake hose (1).
18. Plug the brake hose to prevent brake fluid loss and contamination.
19. Remove the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).
20. Remove the brake pipe (2) from the vehicle.

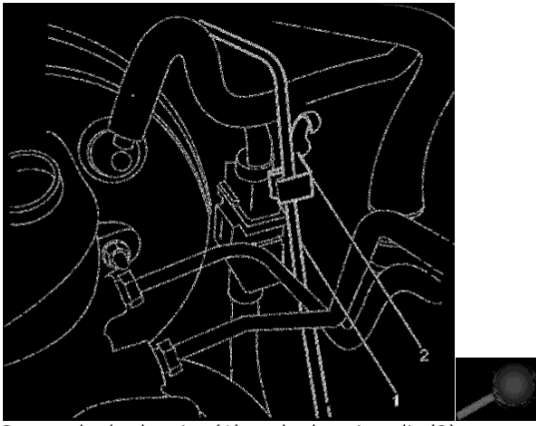
Installation Procedure



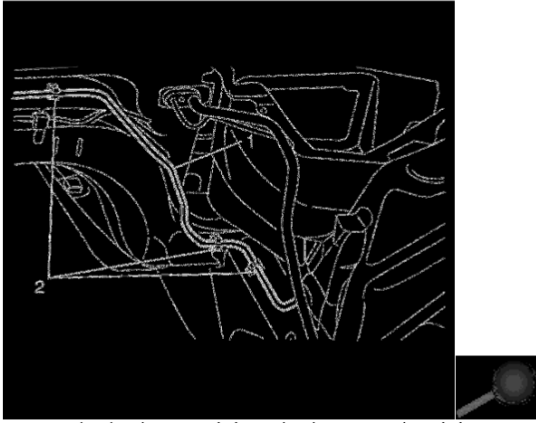
1. Install the brake pipe (2) to the vehicle.
2. Remove the rubber cap or plug from the brake hose (1).
3. Connect the brake pipe (2) to the brake hose (1).
4. Lower the vehicle.



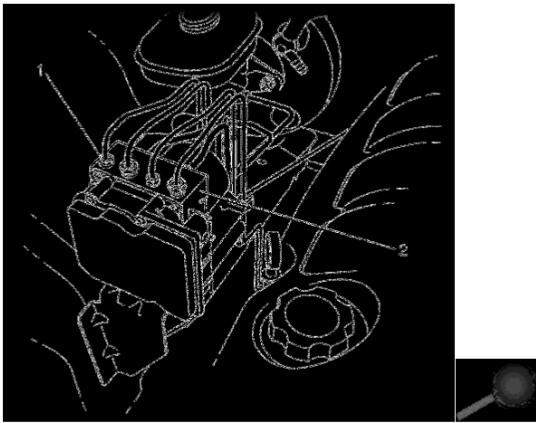
5. Secure the brake pipe (1) to the locating clip (2).



6. Secure the brake pipe (1) to the locating clip (2).



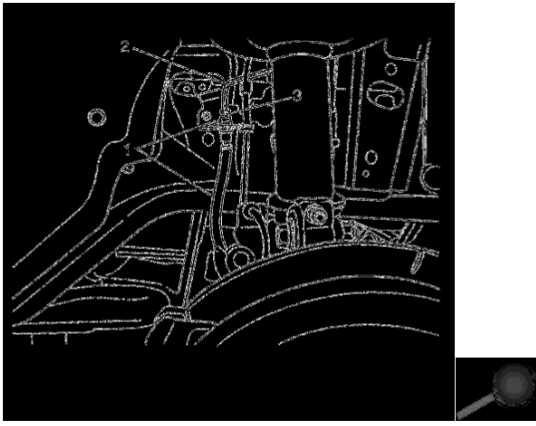
7. Secure the brake pipe (1) to the locating clips (2).



8. Remove the rubber cap or plug from the BPMV (2).

Note: Do not tighten the brake pipe fitting until instructed.

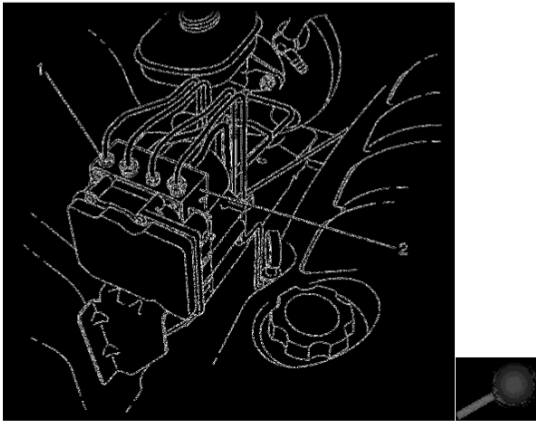
9. Install the brake pipe (1) to the BPMV (2).



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

Note: Hold the brake hose (1) with a suitable tool whilst connecting the brake pipe fitting (3) to prevent damage to the brake pipe (2).

10. Tighten the brake pipe fitting (3) to the brake hose (1) to **16 N•m (12 lb ft)**.



11. Tighten the brake pipe fitting (1) to the BPMV (2) to **16 N•m (12 lb ft)**.
12. Install the sound proofing trim to the bulkhead.
13. Install the heat shields to the engine bay.
14. Install the engine. Refer to [Engine Replacement](#) or [Engine Replacement](#).
15. Install the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).
16. Install the right front tyre and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
17. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

Front Brake Hose Replacement

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

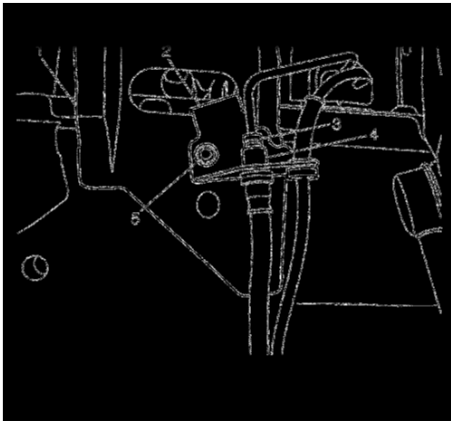
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

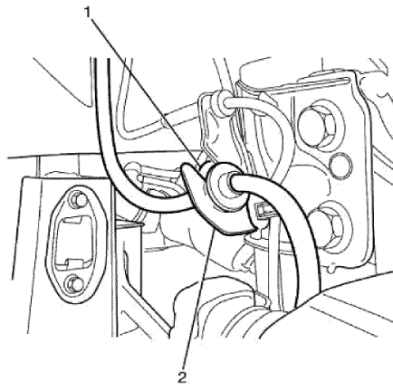
Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

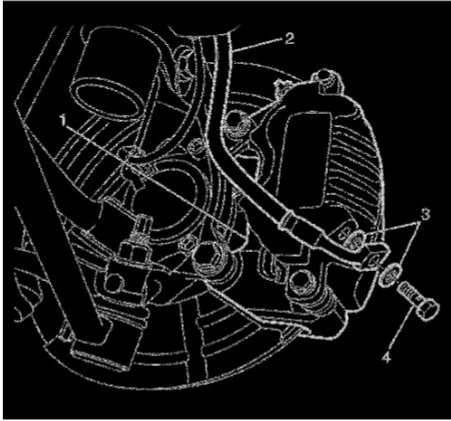
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.



4. Detach the ABS wheel speed sensor wiring harness (5) from the brake hose retaining bracket (2).
5. Place a clean suitable container under the brake pipe fitting (3).
Note: Hold the brake hose (4) with a suitable tool whilst disconnecting the brake pipe fitting (3) to prevent damage to the brake pipe fitting (3).
6. Disconnect the brake pipe fitting (3) from the brake hose (4).
Note: Install a rubber cap or plug to the brake pipe fitting (3) in order to prevent brake fluid loss and contamination.
7. Plug the brake pipe fitting (3).
8. Remove the brake hose retaining bracket to wheel house retaining nut (6).
9. Remove the brake hose retaining bracket (2) from the wheel house (1).



10. Detach the brake hose (1) from the strut mounted brake hose retaining bracket (2).



11. Remove the brake hose to brake caliper banjo retaining bolt (4).
12. Remove the brake hose (2) from the brake caliper (1).
- Note:** Install a rubber cap or plug to the brake caliper (1) in order to prevent brake fluid loss and/or contamination.
13. Plug the brake hose to brake caliper banjo retaining bolt hole in the brake caliper (1).
14. Place a shop towel on a hard surface.
- Note:** The copper brake hose sealing washers (3) may be stuck to the brake caliper (1) and/or the brake hose (2).
15. Tap the threaded end of the brake hose to brake caliper banjo retaining bolt (4) on the shop towel to remove the copper brake hose sealing washers (3) from the brake hose to brake caliper banjo retaining bolt (4).
- Note:** Copper brake hose sealing washers become work hardened due to the heat generated with brake applications and will not reseal. Install NEW copper brake hose sealing washers (4) whenever the brake hose to brake caliper banjo retaining bolt (3) is removed.
16. Remove the two copper brake hose sealing washers (3).
Discard the two copper brake hose sealing washers (3).

Installation Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a

hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

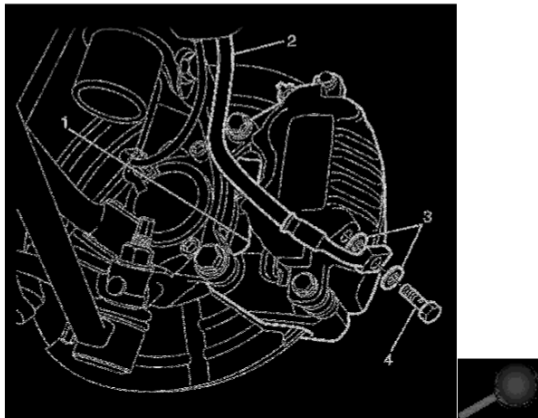
Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Note: Make sure the brake hose is not twisted or kinked after installation.

1. Remove the rubber plug from the brake hose to brake caliper banjo retaining bolt hole in the brake caliper.



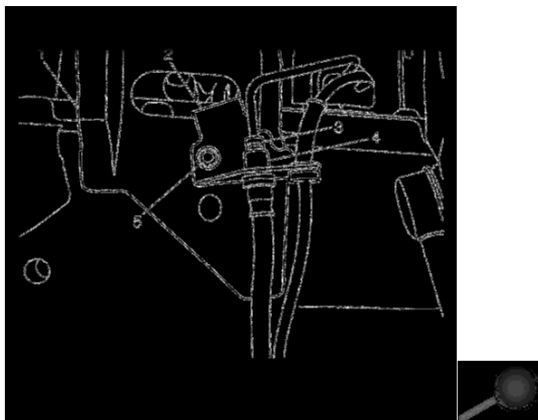
2. Assemble the NEW copper brake hose sealing washers (3), and the brake hose to brake caliper banjo retaining bolt (4) to the brake hose (2).

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

3. Install the brake hose (2) and brake hose to brake caliper banjo retaining bolt (4) to the brake caliper (1).

Tighten

Tighten the brake hose to brake caliper banjo retaining bolt to 35 N·m (26 lb ft).



4. Position the brake hose retaining bracket (2) to the inner skirt panel (1).
5. Install the brake hose retaining bracket to inner skirt panel retaining nut (5).

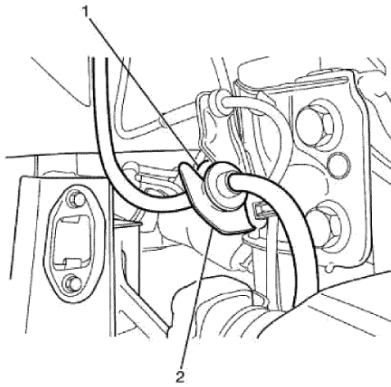
6. Remove the rubber cap or plug from the brake pipe fitting (3).

Note: Hold the brake hose (4) with a back up spanner whilst connecting the brake pipe fitting (3) to prevent damage to the brake pipe fitting (3).

7. Connect the brake pipe fitting (3) to the brake hose (4).

Tighten

Tighten the brake pipe fitting to 16 N·m (12 lb ft).



Note: Slightly twist the brake hose (1) to enable the slot in the brake hose retaining bracket (2) to line up with the flat in the brake hose (1). Slide the brake hose (1) down the brake hose retaining bracket (2) and allow the brake hose to return to its untwisted position for positive engagement in the brake hose retaining bracket (2).

8. Install the brake hose (1) to the strut mounted brake hose retaining bracket (2).
9. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).
10. Install the front wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
11. Lower the vehicle.

Rear Brake Pipe Replacement (Left)

Special Tools

J-23738-A Mityvac

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

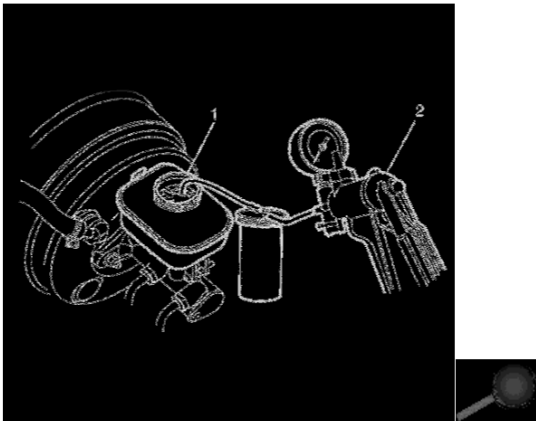
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

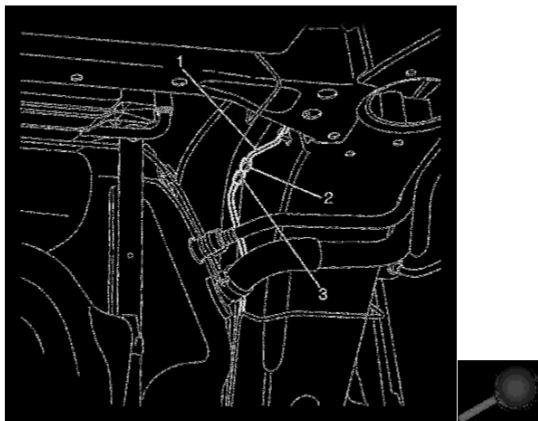
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Clean the master cylinder, brake lines and reservoir cap.
2. Remove the master cylinder reservoir cap.



3. Siphon the brake fluid out of the master cylinder reservoir (1) using a hand vacuum pump (2).
4. Remove the rear suspension sub frame assembly. Refer to [Rear Frame Replacement](#).

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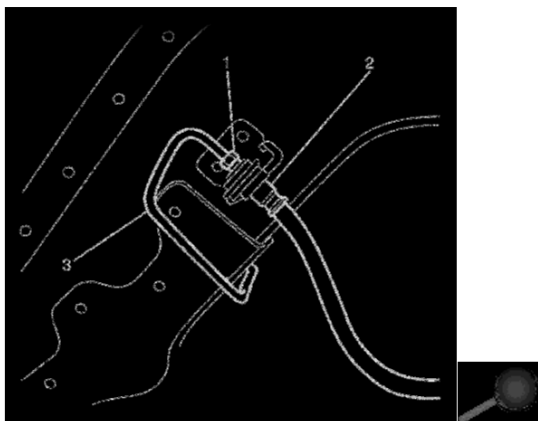


Note: Hold the brake pipe union (3) with a spanner whilst disconnecting the brake pipe fitting (2) to prevent damage to the brake pipe (1).

5. Disconnect the intermediate brake pipe (1) from the brake pipe union (3).

Note: Install a rubber cap or plug to the brake pipe union (3) in order to prevent brake fluid loss and/or contamination.

6. Plug the brake pipe union (3).

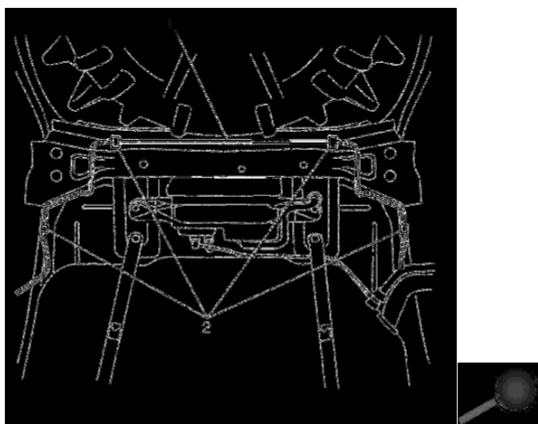


Note: Hold the brake hose (2) with a spanner whilst disconnecting the brake pipe fitting (1) to prevent damage to the brake pipe (3).

7. Disconnect the brake pipe fitting (1) from the brake hose (2).

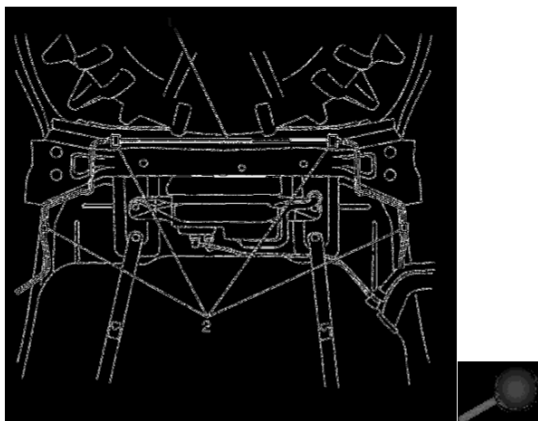
Note: Install a rubber cap or plug to the brake hose fitting end in order to prevent brake fluid loss and contamination.

8. Plug the brake hose (2).

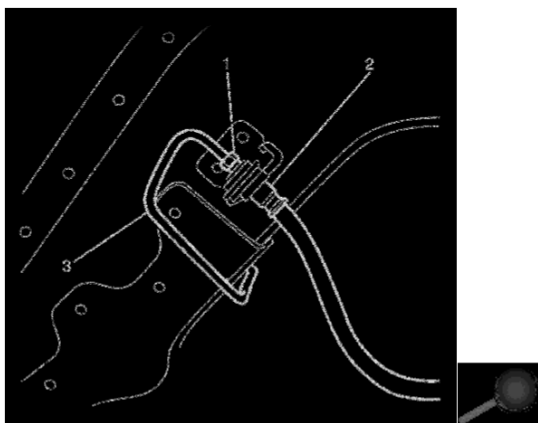


9. Remove the brake pipe (1) from the brake pipe retaining clips (2).

Installation Procedure



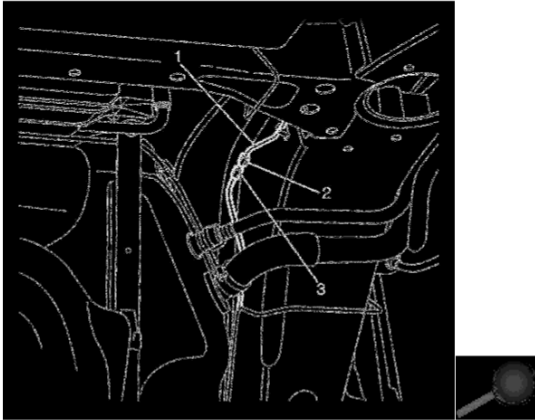
1. Install the brake pipe (1) to the brake pipe retaining clips (2).
2. Remove the rubber cap or plug from the brake hose.



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

Note: Hold the brake hose (2) with a spanner whilst connecting the brake pipe fitting (1) to prevent damage to the brake pipe (3).

3. Connect the brake pipe fitting (1) to the brake hose (3) and tighten to **16 N•m (12 lb ft)**.
4. Remove the rubber cap or plug from the brake pipe union.



Note: Hold the brake pipe union (2) with a spanner whilst connecting the brake pipe fitting (3) to prevent damage to the brake pipe (2).

5. Connect the brake pipe (1) to the brake pipe union (2) and tighten to **15 N•m (11 lb ft)**.
6. Install the rear suspension sub frame assembly. Refer to [Rear Frame Replacement](#).
7. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

Rear Brake Pipe Replacement (Right)

Special Tools

J-23738-A Mityvac

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

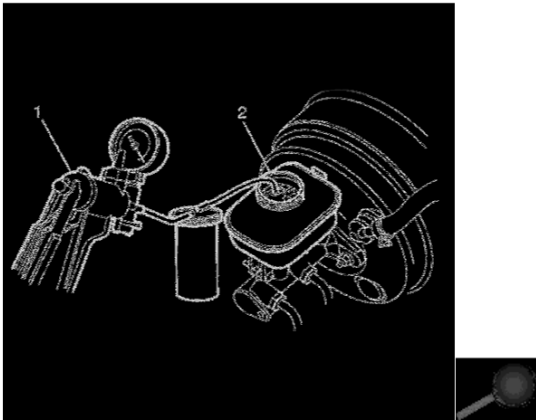
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

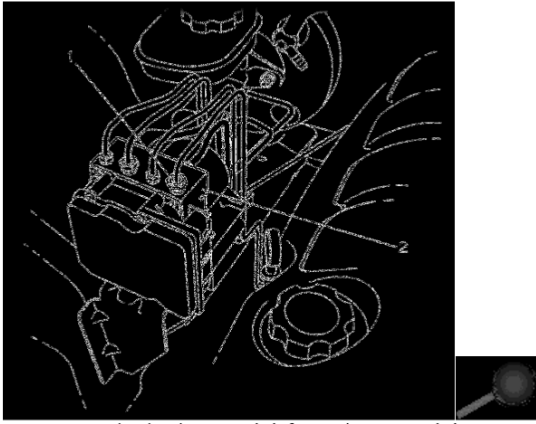
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Clean the master cylinder, brake lines and reservoir cap.
2. Place a clean suitable container under the brake pressure modulator valve (BPMV) assembly and master cylinder.
3. Remove the master cylinder reservoir cap.



4. Siphon the brake fluid out of the master cylinder reservoir (2) using the J-23738-A mityvac (1).

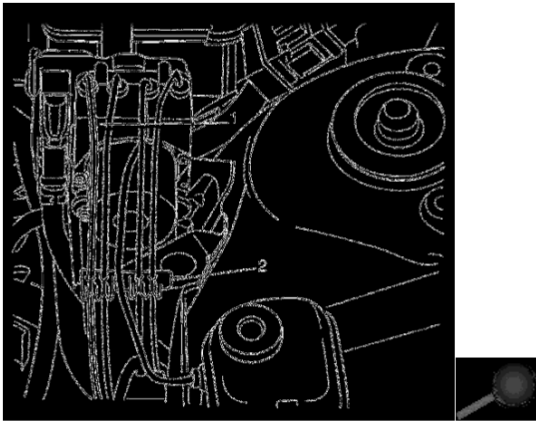
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5. Disconnect the brake pipe (1) from the BPMV (2).

Note: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

6. Plug the BPMV (2).

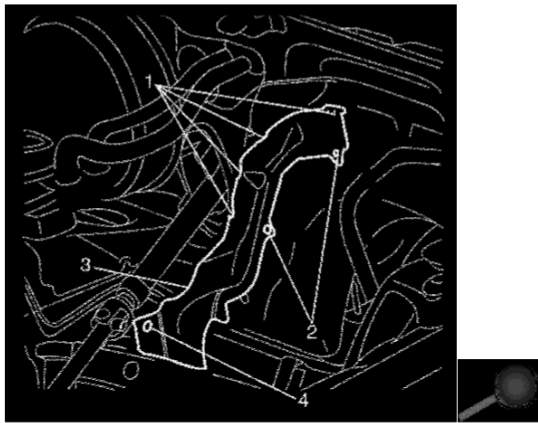


7. Detach the brake pipe (1) from the locating clip (2).

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

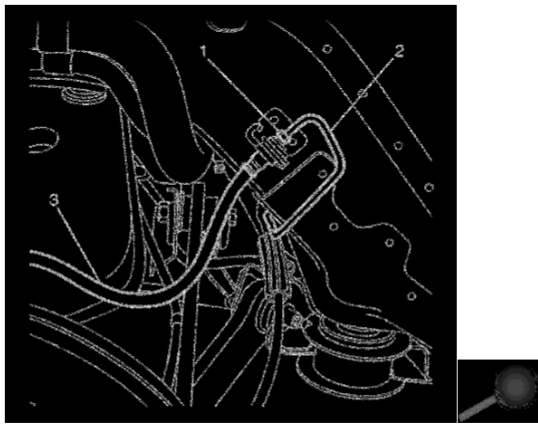


9. Remove the brake and fuel pipe splash shield to chassis retaining nuts (1).
10. Remove the brake and fuel pipe splash shield (2).
11. Remove the engine. Refer to [Engine Replacement](#) for the 3.0L and 3.6L engine or [Engine Replacement](#) for the 6.0L and 6.2L engine.



Note: The brake and fuel pipe heat shield (3) is retained by rivets (2). These rivets (2) must be drilled out during removal and replaced as per the installation procedure.

12. Remove the brake and fuel pipe heat shield to bulkhead retaining rivets (2).
13. Remove the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
14. Detach the brake and fuel pipe heat shield clips (1).
15. Remove the brake and fuel pipe heat shield (2).

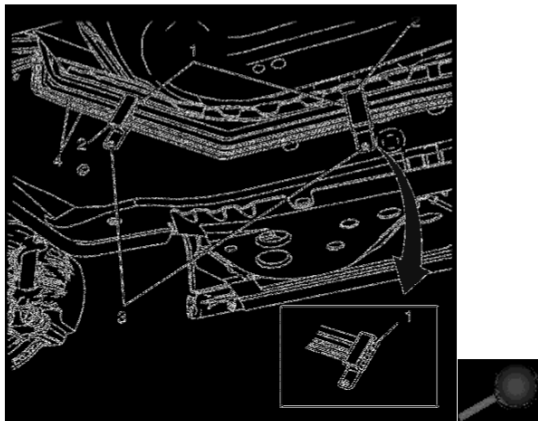


Note: Hold the brake hose (3) with a suitable whilst disconnecting the brake pipe fitting (1) to prevent damage to the brake pipe (2).

16. Disconnect the brake pipe fitting (1) from the brake hose (3).

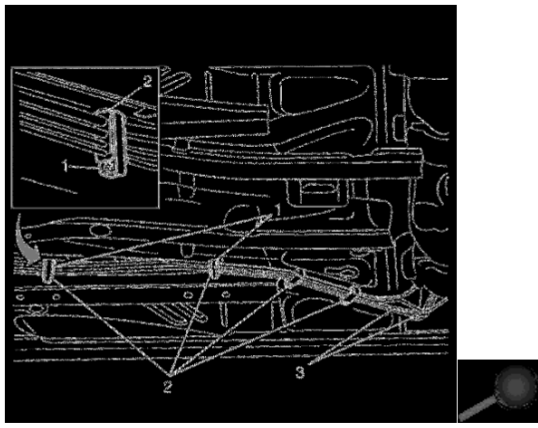
Note: Install a rubber cap or plug to the brake hose (3) in order to prevent brake fluid loss and contamination.

17. Plug the brake hose (3).



Note: The brake and fuel pipe retaining brackets (2) are retained by rivets (3). These rivets (3) must be drilled out during removal and replaced as per the installation procedure.

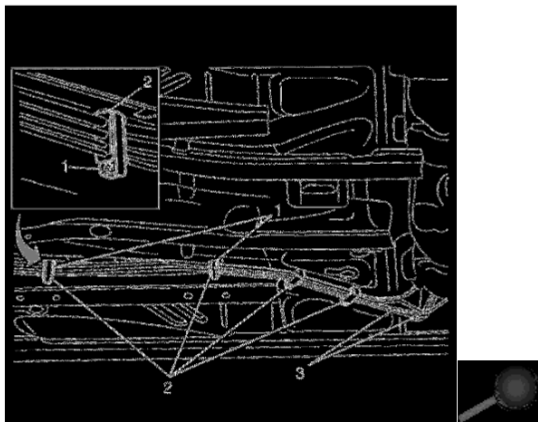
18. Remove the brake and fuel pipe retaining bracket to chassis retaining rivets (3).
19. Remove the brake and fuel pipe retaining brackets (2).
20. Remove the brake pipes (4) from the brake and fuel pipe retaining bracket rubber insulators (1).



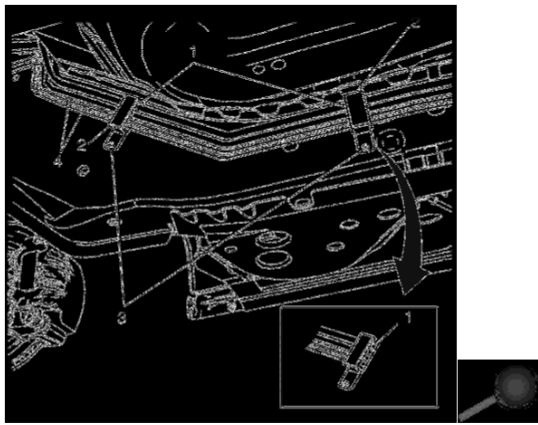
Note: Use a suitable tool to open the brake and fuel pipe retaining brackets (1) by detaching the brake and fuel pipe retaining bracket (1) clip.

21. Open the brake and fuel pipe retaining brackets (1).
22. Remove the brake pipes (3) from the brake and fuel pipe retaining bracket rubber insulators (2).
23. Remove the brake pipe from the vehicle.

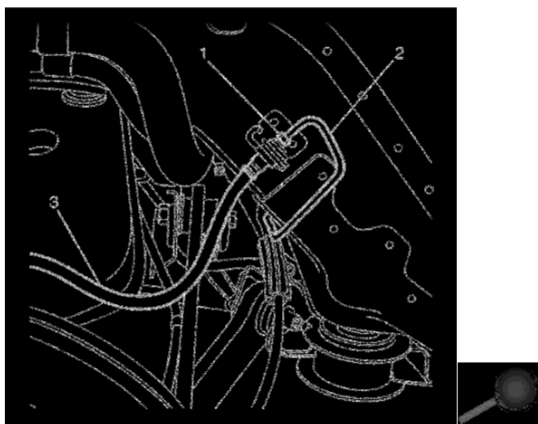
Installation Procedure



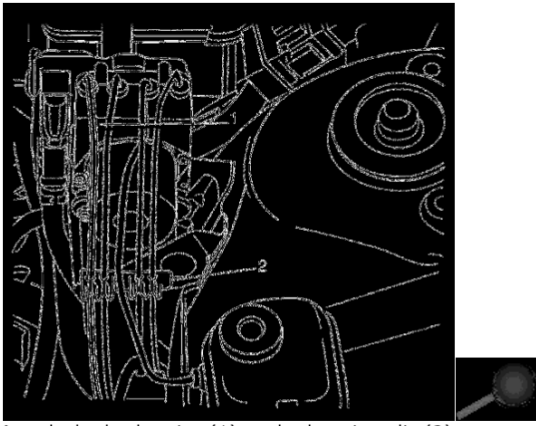
1. Install the brake pipes (3) to the brake and fuel pipe retaining bracket rubber insulators (2).
2. Close the brake and fuel pipe retaining brackets (1).



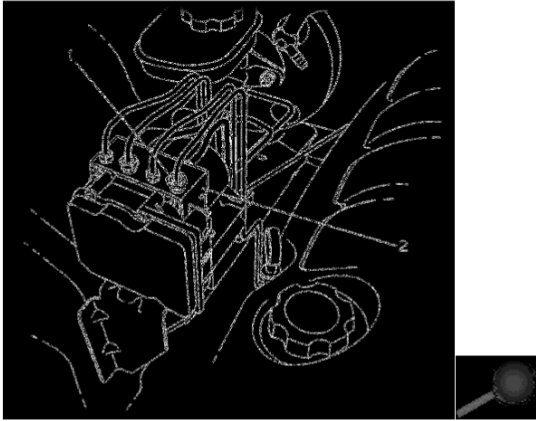
3. Install the brake pipes (4) to the two brake and fuel pipe retaining bracket rubber insulators (1).
4. Install the two brake and fuel pipe retaining brackets (2).
5. Install the NEW brake and fuel pipe retaining bracket to chassis retaining rivets (3).



6. Remove the rubber cap or plug from the brake hose (3).
7. Connect the brake pipe fitting (1) to the brake hose (3).
Do not fully tighten at this stage.
8. Lower the vehicle.

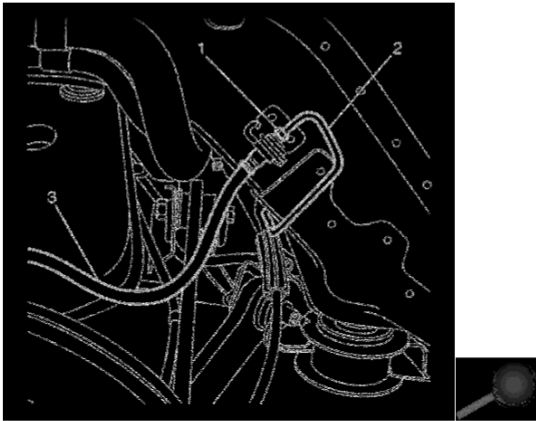


9. Attach the brake pipe (1) to the locating clip (2).



10. Remove the rubber cap or plug from the BPMV (2).

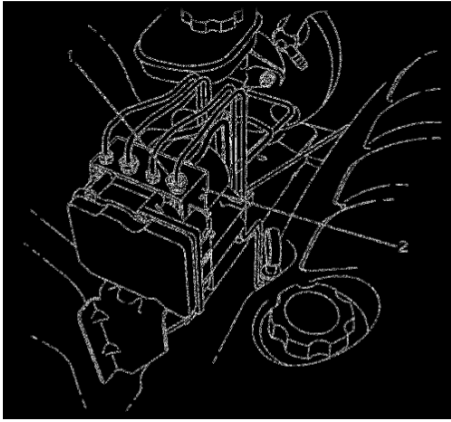
11. Install the brake pipe (1) to the BPMV (2).
Do not fully tighten at this stage.



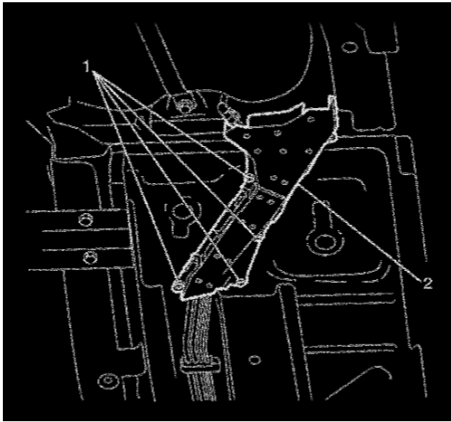
Caution: Refer to [Fastener Caution](#).

Note: Hold the brake hose (3) with a suitable tool whilst connecting the brake pipe fitting (1) to prevent damage to the brake pipe (2).

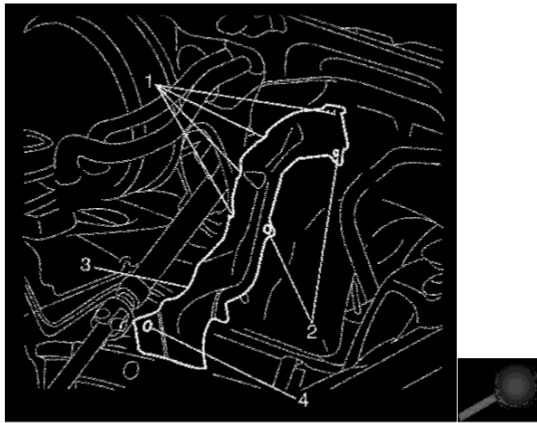
12. Tighten the brake pipe fitting (1) to the brake hose (3) to **16 N·m (12 lb ft)**.



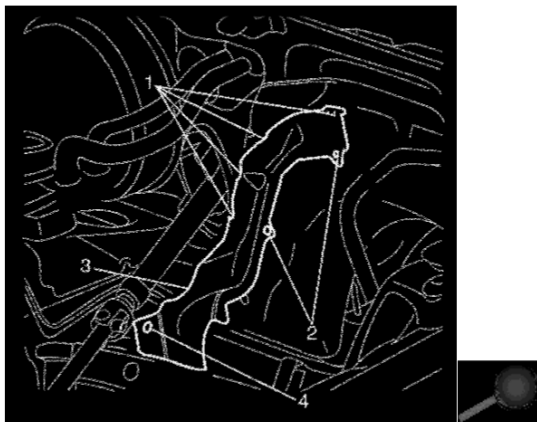
13. Tighten the brake pipe (1) to the BPMV (2) to **16 N·m (12 lb ft)**.
14. Raise the vehicle.



15. Install the brake and fuel pipe splash shield (2) to the underbody.
16. Install the brake and fuel pipe splash shield to chassis retaining nuts (1) and tighten to **5 N·m (43 lb in)**.



17. Install the brake and fuel pipe heat shield (3).
18. Attach the brake and fuel pipe heat shield clips (1).
19. Install NEW brake and fuel pipe heat shield to bulkhead retaining rivets (2).
20. Install the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
21. Install the engine. Refer to [Engine Replacement](#) for the 3.0L and 3.6L engine or [Engine Replacement](#) for the 6.0L and 6.2L engine.
22. Lower the vehicle.

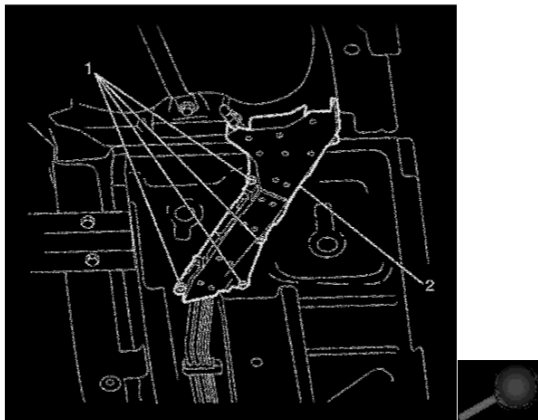


23. Install the brake and fuel pipe heat shield (3).
24. Attach the brake and fuel pipe heat shield clips (1).
25. Install NEW brake and fuel pipe heat shield to bulkhead retaining rivets (2).
26. Install the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
27. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

Rear Brake Pipe Protector Replacement

Removal Procedure

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the fasteners and the right side front underbody rear air deflector, if equipped.



3. Remove the rear brake pipe protector nuts (1).
4. Remove the rear brake pipe protector (2).

Installation Procedure

1. Install the rear brake pipe protector to the underbody studs.



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

2. Install the rear brake pipe protector nuts (1) to the rear brake pipe protector (2) and tighten the nuts to **4 N•m (35 lb in)**.
3. Install the right side front underbody rear air deflector, if equipped, and install the fasteners.

Rear Brake Front Pipe Replacement

Special Tools

J-23738-A Mityvac

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

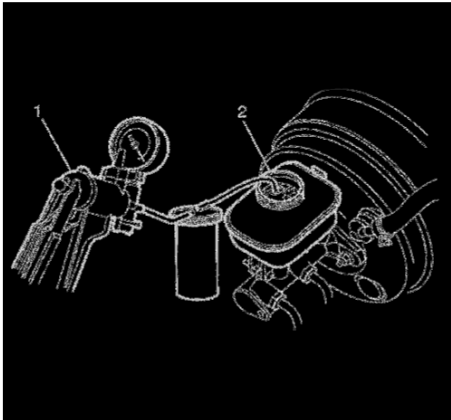
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

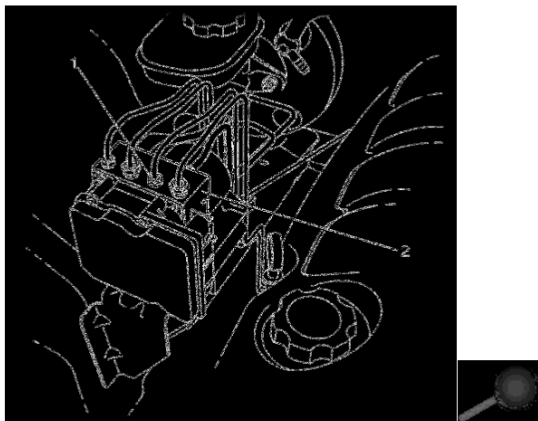
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Clean the master cylinder, brake lines and reservoir cap.
2. Place a clean suitable container under the brake pressure modulator valve (BPMV).
3. Remove the master cylinder reservoir cap.



4. Siphon the brake fluid out of the master cylinder reservoir (2) using the J-23738-A mityvac (1).

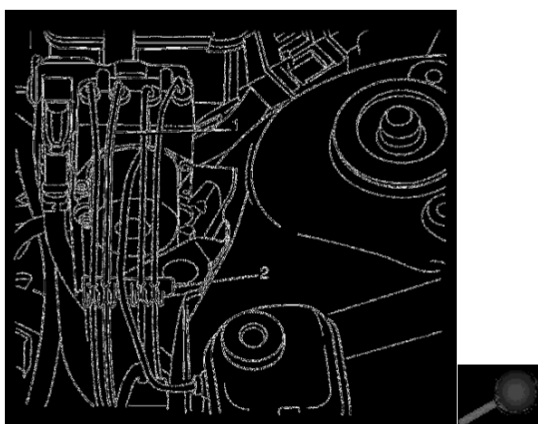
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5. Disconnect the brake pipe (1) from the BPMV (2).

Note: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

6. Plug the BPMV (2).

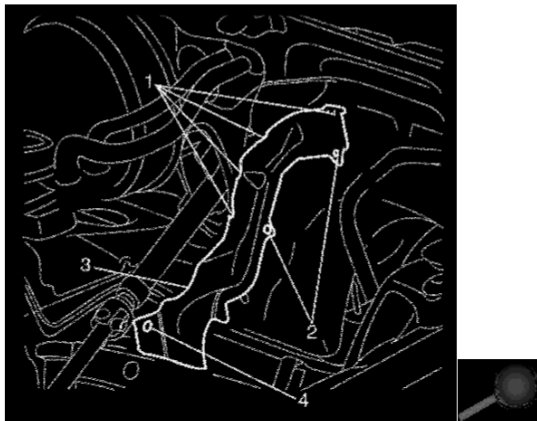


7. Detach the brake pipe (1) to the locating clip (2).

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

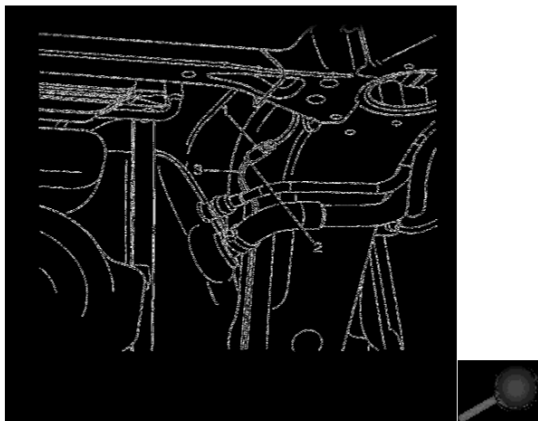


9. Remove the brake and fuel pipe splash shield to chassis retaining nuts (1).
10. Remove the brake and fuel pipe splash shield (2).
11. Remove the engine. Refer to [Engine Replacement](#) for the 3.0L and 3.6L engine or [Engine Replacement](#) for the 6.0L and 6.2L engine.



Note: The brake and fuel pipe protector shield (3) is retained by rivets (2). These rivets (2) must be drilled out during removal and replaced as per the installation procedure.

12. Remove the brake and fuel pipe heat shield to bulkhead retaining rivets (2).
13. Remove the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
14. Detach the brake and fuel pipe heat shield clips (1).
15. Remove the brake and fuel pipe protector shield (2).
16. Remove the rear subframe. Refer to [Rear Frame Replacement](#).

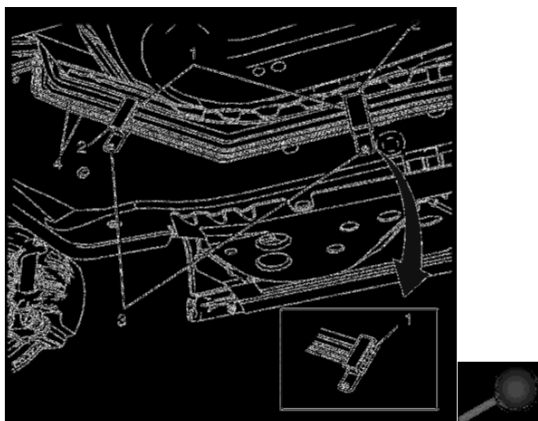


Note: Hold the brake pipe union (1) with a suitable tool whilst disconnecting the brake pipe fitting (2) to prevent damage to the intermediate brake pipe (3).

17. Disconnect the intermediate brake pipe (3) from the brake pipe union (1).

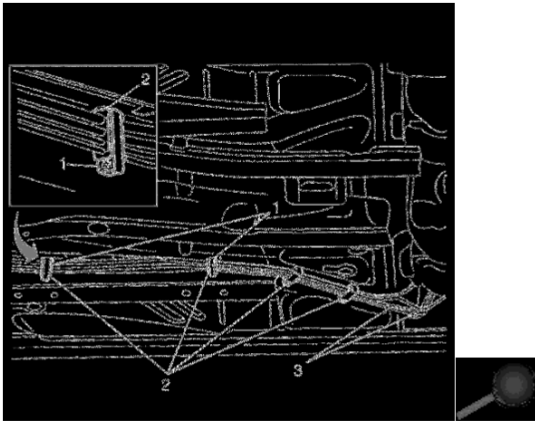
Note: Install a rubber cap or plug to the brake pipe union (1) in order to prevent brake fluid loss and/or contamination.

18. Plug the brake pipe union (1).



Note: The brake and fuel pipe retaining brackets (2) are retained by rivets (3). These rivets (3) must be drilled out during removal and replaced as per the installation procedure.

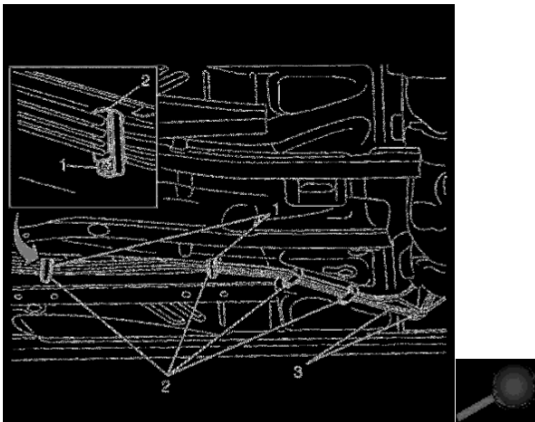
19. Remove the brake and fuel pipe retaining bracket to chassis retaining rivets (3).
20. Remove the brake and fuel pipe retaining brackets (2).
21. Remove the brake pipes (4) from the brake and fuel pipe retaining bracket rubber insulators (1).



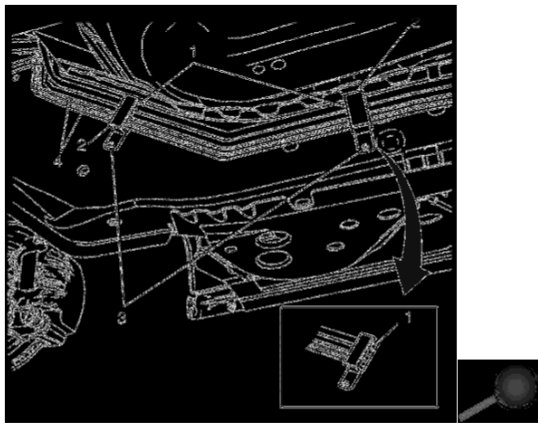
Note: Use a suitable tool to open the brake and fuel pipe retaining brackets (2) by detaching the brake and fuel pipe retaining bracket (2) clip.

22. Open the brake and fuel pipe retaining brackets (2).
23. Remove the brake pipe (1) from the brake and fuel pipe retaining bracket rubber insulators (3).

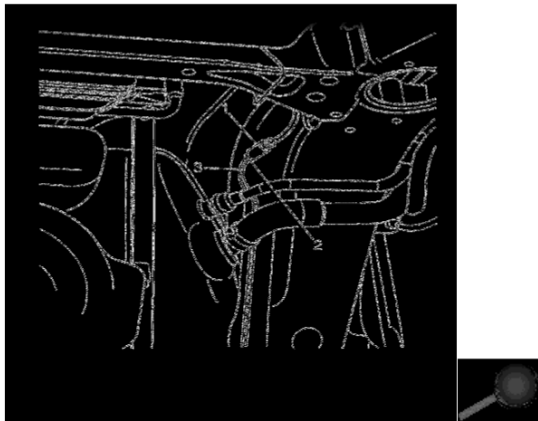
Installation Procedure



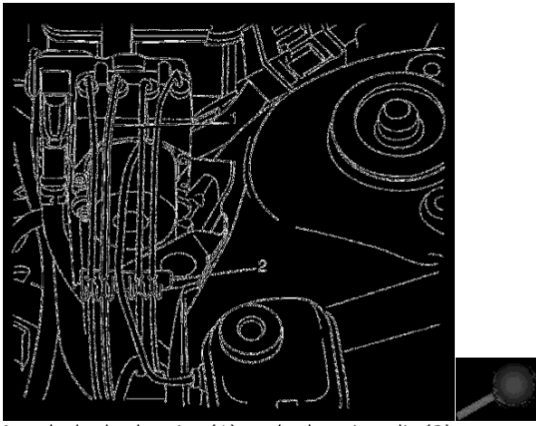
1. Install the brake pipes (3) to the brake and fuel pipe retaining bracket rubber insulators (2).
2. Close the brake and fuel pipe retaining brackets (1).



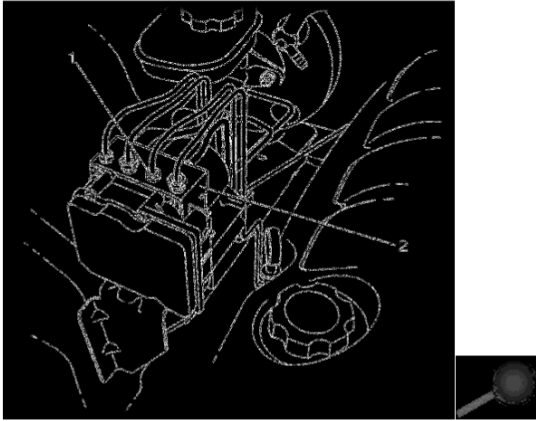
3. Install the brake pipes (4) to the two brake and fuel pipe retaining bracket rubber insulators (1).
4. Install the two brake and fuel pipe retaining brackets (2).
5. Install the NEW brake and fuel pipe retaining bracket to chassis retaining rivets (3).
6. Remove the rubber cap or plug from the brake pipe union.



- Note:** Hold the brake pipe union (1) with a spanner whilst connecting the brake pipe fitting (2) to prevent damage to the brake pipe (3).
7. Connect the brake pipe (1) to the brake pipe union (2).

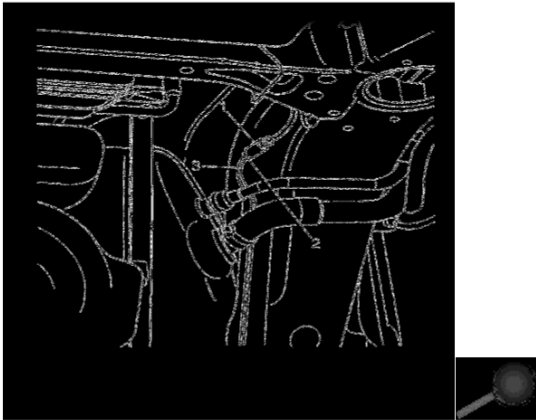


8. Attach the brake pipe (1) to the locating clip (2).



9. Remove the rubber cap or plug from the BPMV (2).

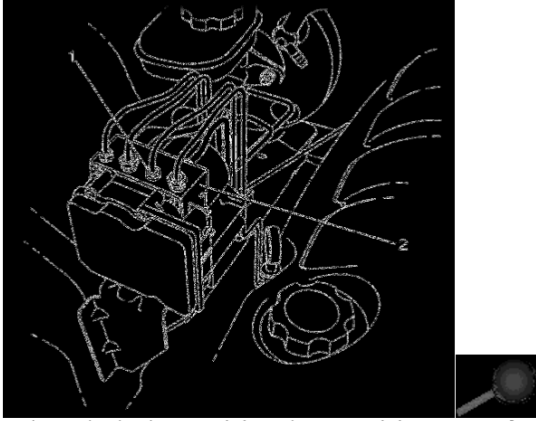
10. Install the brake pipe (1) to the BPMV (2).



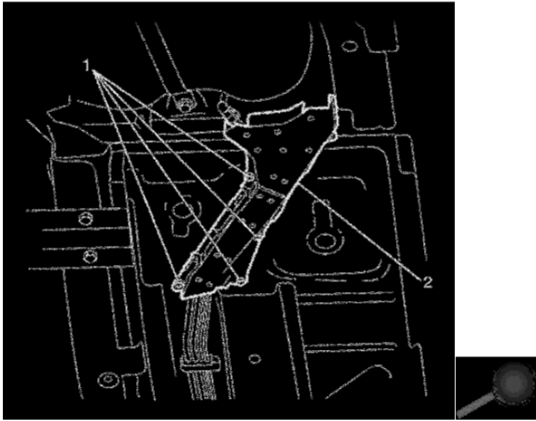
Caution: Refer to [Fastener Caution](#).

Note: Hold the brake pipe union (1) with a suitable tool whilst connecting the brake pipe fitting (2) to prevent damage to the brake pipe (3).

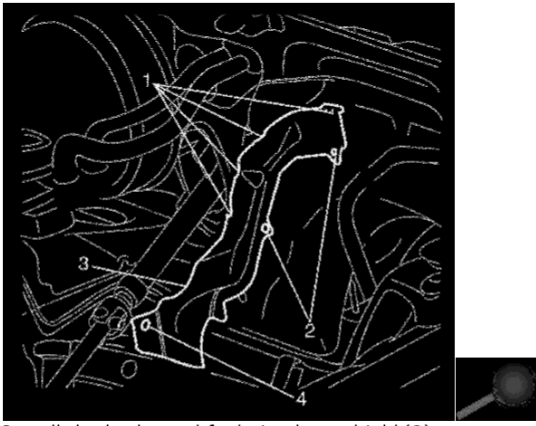
11. Tighten the brake pipe (1) to the brake pipe union (2) to **15 N•m (11 lb ft)**.



12. Tighten the brake pipe (1) to the BPMV (2) to **16 N•m (12 lb ft)**.
13. Install the rear subframe. Refer to [Rear Frame Replacement](#).



14. Install the brake and fuel pipe splash shield (2) to the underbody.
15. Install the brake and fuel pipe splash shield to chassis retaining nuts (1) and tighten to **5 N•m (43 lb in)**.
16. Lower the vehicle.



17. Install the brake and fuel pipe heat shield (3).
18. Attach the brake and fuel pipe heat shield clips (1).
19. Install NEW brake and fuel pipe protector shield to bulkhead retaining rivets (2).
20. Install the brake and fuel pipe protector shield to bulkhead retaining bolt (4).
21. Install the engine. Refer to [Engine Replacement](#) for the 3.0L and 3.6L engine or [Engine Replacement](#) for the 6.0L and 6.2L engine.
22. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

Rear Brake Hose Replacement

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

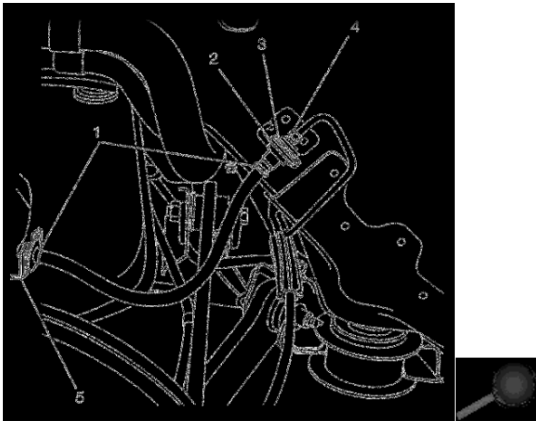
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.



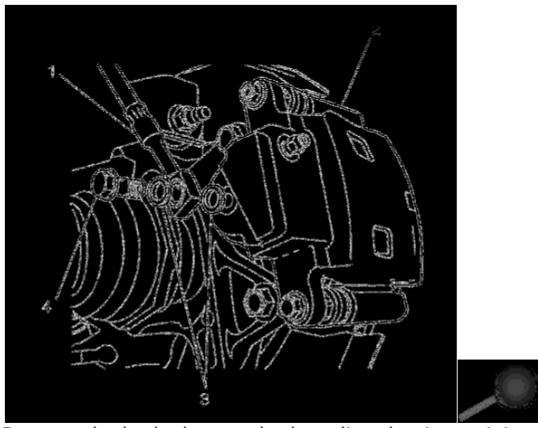
4. Place a clean suitable container under the brake pipe fitting (4).

Note: Hold the brake hose (1) with a suitable tool whilst disconnecting the brake pipe fitting (4) to prevent damage to the brake pipe fitting (4).

5. Disconnect the brake pipe fitting (4) from the brake hose (1).

Note: Install a rubber cap or plug to the brake pipe fitting (4) in order to prevent brake fluid loss and contamination.

6. Plug the brake pipe fitting (4).
7. Remove the brake hose retaining clip (2) from brake hose (1) and remove from the brake hose retaining bracket (3).
8. Detach the brake hose (1) from the upper control arm mounted brake hose retaining bracket (5).



9. Remove the brake hose to brake caliper banjo retaining bolt (4) from the brake caliper (2).
10. Remove the brake hose (1) from the brake caliper (2).

Note: Install a rubber cap or plug to the exposed brake caliper (2) in order to prevent brake fluid loss and/or contamination.

11. Plug the brake hose to brake caliper banjo retaining bolt hole in the brake caliper (2).
12. Place a shop towel on a hard surface.

Note: The copper brake hose sealing washers (3) may be stuck to the brake caliper (2) and/or the brake hose (1).

13. Tap the threaded end of the brake hose to brake caliper banjo retaining bolt (4) on the shop towel to remove the copper brake hose sealing washers (3) from the brake hose to brake caliper banjo retaining bolt (4).

Note: Copper brake hose sealing washers (3) become work hardened due to the heat generated with brake applications and will not reseal. Install NEW copper brake hose sealing washers (3) whenever the brake hose to brake caliper banjo retaining bolt (4) is removed.

14. Remove the two copper brake hose sealing washers (3).
Discard the two copper brake hose sealing washers (3).

Installation Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

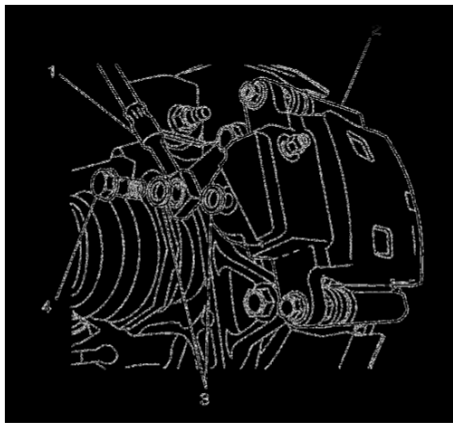
Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Note: Make sure the brake hose is not twisted or kinked after installation.

1. Remove the rubber cap or plug from the brake hose to brake caliper banjo retaining bolt hole in the brake caliper.



2. Assemble the NEW copper brake hose sealing washers (3), and the brake hose to brake caliper banjo retaining bolt (4) to the brake hose (1).

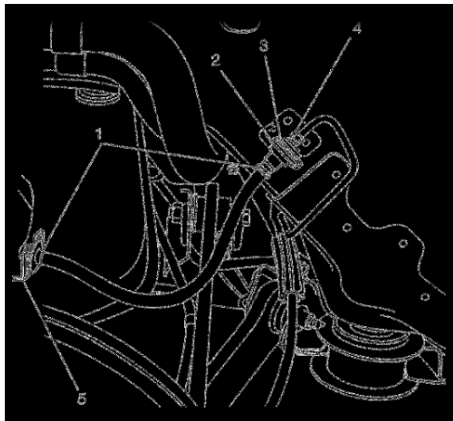
Caution: Refer to [Fastener Caution](#).

3. Install the brake hose to brake caliper banjo retaining bolt (4) to the brake caliper (2).

Tighten

Tighten the brake hose to brake caliper banjo retaining bolt to 35 N•m (26 lb ft).

4. Remove the rubber cap or plug from the brake pipe fitting end.



5. Install the brake pipe fitting (3) to the brake hose (1) through brake hose retaining bracket (4).

Tighten

Tighten the brake pipe fitting to 16 N•m (12 lb ft).

6. Install the bracket retainer clip (2).

Note: Slightly twist the brake hose (1) to enable the slot in the brake hose retaining bracket (5) to line up with the flat in the brake hose (1). Slide the brake hose (1) down the brake hose retaining bracket (5) and allow the brake hose to return to its untwisted position for positive engagement in the brake hose retaining bracket (5).

7. Attach the brake hose (1) to the upper control arm mounted brake hose retaining bracket (5).

8. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).

9. Install the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).

10. Lower the vehicle.

Hydraulic Brake System Bleeding (Pressure)

Special Tools

- J 29532 Diaphragm Pressure Bleeder
- J 35589-A Brake Pressure Bleeder Adapter

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

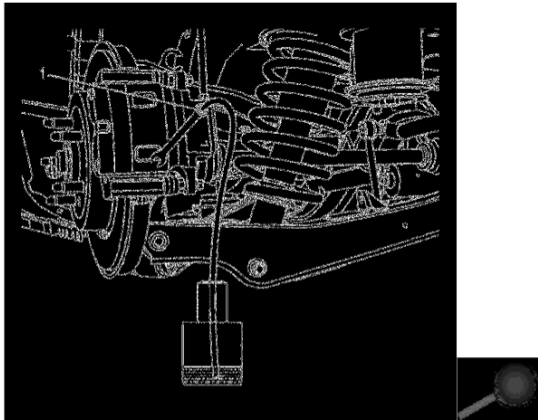
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Place a clean suitable container beneath the brake master cylinder to catch brake fluid spills.
Note: With the ignition OFF and the brakes cool, apply the brakes 3–5 times, or until the brake pedal becomes firm, in order to deplete the vacuum brake booster power reserve.
2. Deplete the vacuum brake booster power reserve.
3. If you have performed a brake master cylinder bench bleed, disconnected the brake pipes from the master cylinder or the Brake Pressure Modulator Valve (BPMV), you MUST perform the following steps to bleed air at the ports of the hydraulic component:
 - 3.1. Clean the outside of the reservoir on and around the reservoir cap prior to removal.
 - 3.2. With the brake pipes installed securely to the master cylinder or BPMV, loosen and separate one of the brake pipes from the port of the component:
For the BPMV, perform these steps in the sequence of system flow; begin with the fluid feed pipes from the master cylinder.
 - 3.3. Allow a small amount of brake fluid to gravity bleed from the open port of the component.
 - 3.4. Reconnect the brake pipe to the component and tighten securely.
 - 3.5. With the aid of an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
 - 3.6. Loosen the same brake pipe to purge air from the open port of the component.
 - 3.7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
 - 3.8. Wait 15 seconds, then repeat steps 3.3–3.7 until all air is purged from the same port of each component.
 - 3.9. With the brake pipe installed securely to the master cylinder or BPMV, and after all air has been purged from the first port of the component that was bled, loosen and separate the next brake pipe from the component, then repeat steps 3.3–3.8 until each of the ports on the component has been bled.
 - 3.10. After completing the final component port bleeding procedure, make sure that each of the brake pipe to component fittings is correctly tightened.
4. Clean the outside of the reservoir on and around the reservoir cap.
5. Remove the master cylinder reservoir cap and diaphragm.
6. Fill the brake master cylinder reservoir to the maximum-fill level with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.
7. Set up the brake pressure bleeder following the manufacturer's instructions.

8. Open the brake pressure bleeder fluid valve to allow pressurised brake fluid to enter the brake system.

Note: Any brake fluid leaks identified require repair prior to completing this procedure.

9. Wait approximately 30 seconds, then inspect the entire hydraulic brake system in order to make sure that there are no existing external brake fluid leaks.
10. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
11. Remove the wheels. Refer to [Tire and Wheel Removal and Installation](#).



Note: Make sure the brake master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to maintain the correct level.

12. Fit a suitable tool onto the LEFT REAR wheel hydraulic circuit bleeder valve (1).
13. Install a transparent hose over the end of the LEFT REAR wheel hydraulic circuit bleeder valve (1).
14. Submerge the open end of the transparent hose into a container partially filled with brake fluid (3) conforming to specification, from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.
15. Loosen the bleeder valve to purge air from the wheel hydraulic circuit. Allow fluid to flow until air bubbles stop flowing from the bleeder, then tighten the bleeder valve.
16. Tighten the wheel circuit bleeder valve securely.
17. Fit a suitable tool onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
18. Repeat steps 13–15.
19. Tighten the wheel circuit bleeder valve securely.
20. Fit a suitable tool onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
21. Repeat steps 13–15.
22. Tighten the wheel circuit bleeder valve securely.
23. Fit a suitable tool onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
24. Repeat steps 13–15.
25. After completing the final wheel hydraulic circuit bleeding procedure, make sure that each wheel hydraulic circuit bleeder valve is correctly tightened.
26. Close the brake pressure bleeder fluid valve.
27. Install the wheels. Refer to [Tire and Wheel Removal and Installation](#).
28. Lower the vehicle.
29. Remove the brake pressure bleeder from the brake master cylinder reservoir.

30. Fill the brake master cylinder reservoir to the maximum-fill level with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.
31. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
Note: If it is determined that air was induced into the system upstream of the BPMV prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed.
Refer to [Antilock Brake System Automated Bleed](#).
32. If the brake pedal feels spongy, repeat the bleeding procedure again. If the brake pedal still feels spongy after repeating the bleeding procedure, perform the following step:
Inspect the brake system for external leaks. Refer to [Brake System External Leak Inspection](#).
33. Turn the ignition ON, engine OFF. Check to see if the brake system warning lamp is illuminated.
Note: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.
34. If the brake system warning lamp is illuminated, refer to [Symptoms - Hydraulic Brakes](#).

Hydraulic Brake System Bleeding (Manual)

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

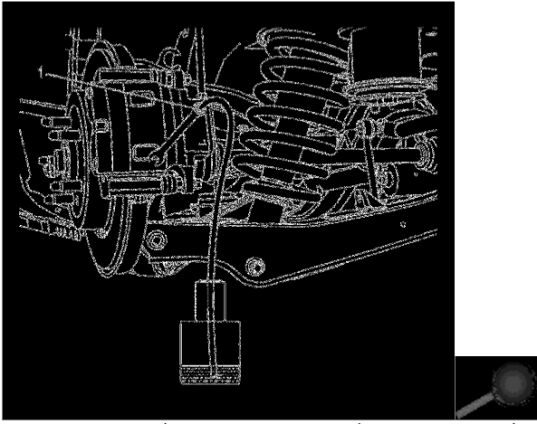
Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Place a clean suitable container beneath the brake master cylinder to catch brake fluid spills.
Note: With the ignition OFF and the brakes cool, apply the brakes 3–5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleed, disconnected the brake pipes from the master cylinder or the hydraulic modulator assembly, you MUST perform the following steps to bleed air at the ports of the hydraulic component:
 - 3.1. Clean the outside of the reservoir on and around the reservoir cap prior to removal.
 - 3.2. With the brake pipes installed securely to the master cylinder or hydraulic modulator assembly, loosen and separate one of the brake pipes from the port of the component:
For the hydraulic modulator assembly, perform these steps in the sequence of system flow; begin with the fluid feed pipes from the master cylinder.
 - 3.3. Allow a small amount of brake fluid to gravity bleed from the open port of the component.
 - 3.4. Reconnect the brake pipe to the component and tighten securely.
 - 3.5. With the aid of an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
 - 3.6. Loosen the same brake pipe to purge air from the open port of the component.
 - 3.7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
 - 3.8. Wait 15 seconds, then repeat steps 3.3–3.7 until all air is purged from the same port of each component.
 - 3.9. With the brake pipe installed securely to the master cylinder or hydraulic modulator assembly, and after all air has been purged from the first port of the component that was bled, loosen and separate the next brake pipe from the component, then repeat steps 3.3–3.8 until each of the ports on the component has been bled.
 - 3.10. After completing the final component port bleeding procedure, make sure that each of the brake pipe to component fittings is correctly tightened.
4. Clean the outside of the brake master cylinder reservoir on and around the reservoir cap.
Note: Make sure the brake master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to maintain the correct level.
5. Remove the master cylinder reservoir cap.
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
7. Remove the wheels. Refer to [Tire and Wheel Removal and Installation](#).

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8. Fit a correct sized ring spanner onto the LEFT REAR wheel hydraulic circuit bleeder valve (1).
9. Install a transparent hose over the end of the LEFT REAR wheel hydraulic circuit bleeder valve (1).
10. Submerge the open end of the transparent hose into a container partially filled with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.
11. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
12. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
13. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
14. Wait 15 seconds, then repeat steps 11–13 until all air is purged from the wheel hydraulic circuit.
15. Tighten the wheel circuit bleeder valve securely.
16. Fit a correct sized ring spanner onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
17. Repeat steps 9–15.
18. Fit a correct sized ring spanner onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
19. Repeat steps 9–15.
20. Fit a correct sized ring spanner onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
21. Repeat steps 9–15.
22. After completing the final wheel hydraulic circuit bleeding procedure, make sure that each of the 4 wheel hydraulic circuit bleeder valves is correctly tightened.
23. Install the wheels. Refer to [Tire and Wheel Removal and Installation](#).
24. Lower the vehicle.
25. Fill the brake master cylinder reservoir to the maximum-fill level with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.
26. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

Note: If it is determined that air was induced into the system upstream of the hydraulic modulator assembly prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed. Refer to [Antilock Brake System Automated Bleed](#).
27. If the brake pedal feels spongy, repeat the bleeding procedure again. If the brake pedal still feels spongy after repeating the bleeding procedure, perform the following steps:
 - 27.1. Inspect the brake system for external leaks. Refer to [Brake System External Leak Inspection](#).
 - 27.2. Pressure bleed the hydraulic brake system in order to purge any air that may still be trapped in the system.

28. Turn the ignition ON, engine OFF. Check to see if the brake system warning lamp is illuminated.

Note: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

29. If the brake system warning lamp is illuminated, refer to [Symptoms - Hydraulic Brakes](#).

Hydraulic Brake System Flushing

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

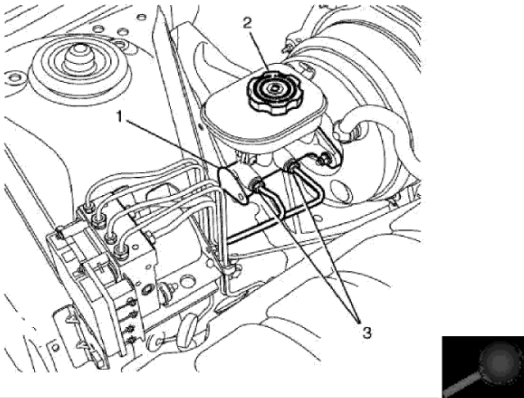
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

1. Clean the brake master cylinder brake master cylinder reservoir, brake line connections and reservoir cap.
2. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:
 - Fluid separation indicates two types of fluid are present. A substance other than the recommended brake fluid has been introduced into the brake hydraulic system.
 - Swirled appearance = oil-based substance.
 - Layered appearance = silicone-based substance.
 - Fluid discolouration, indicating the presence of moisture or particles that have been introduced into the brake hydraulic system.
 - Cloudy appearance = moisture.
 - Dark appearance/suspended particles in fluid = dirt, rust, corrosion and/or brake dust.
3. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
4. If the brake fluid IS contaminated with an oil-based or a silicone-based substance, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir to master cylinder grommets, perform the following:
 - 4.1. Remove ALL of the following components listed from the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.
Refer to the following procedures:
 - [Master Cylinder Replacement](#)
 - [Front Brake Hose Replacement](#)
 - [Rear Brake Hose Replacement](#)
 - [Front Brake Caliper Replacement](#)
 - [Rear Brake Caliper Replacement](#)
 - [Brake Pressure Modulator Valve Replacement](#)
 - 4.2. Clean out all the hydraulic brake pipes using denatured alcohol, or equivalent.
 - 4.3. Dry the brake pipes using non-lubricated, filtered air.
 - 4.4. Replace ALL of the following components listed and install them to the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.
Refer to the following procedures:
 - [Master Cylinder Replacement](#)
 - [Front Brake Hose Replacement](#)
 - [Rear Brake Hose Replacement](#)

- [Front Brake Caliper Replacement](#)
- [Rear Brake Caliper Replacement](#)
- [Brake Pressure Modulator Valve Replacement](#)
- Replace the brake master cylinder reservoir cap.

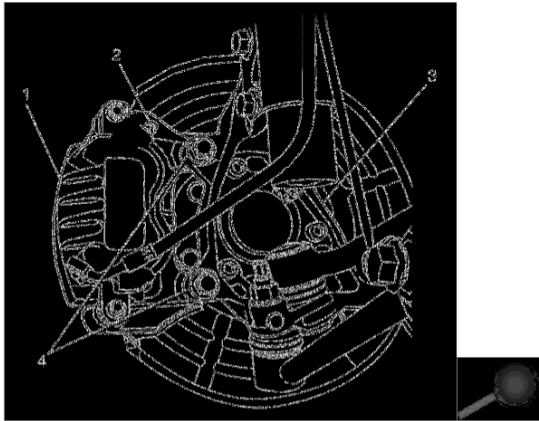
5. If the brake fluid IS NOT contaminated with an oil-based or a silicone-based substance, but was contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap.
6. Place a clean suitable container under the master cylinder.



7. Disconnect brake lines (3) from the master cylinder (1).
8. Remove master cylinder reservoir cap (2).
9. Allow the master cylinder (1) to drain into the container until empty.

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

10. Install the brake lines (3) to master cylinder (1) and tighten to **16 N·m (12 lb ft)**.
11. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
12. Remove the tyre and wheel assemblies. Refer to [Tire and Wheel Removal and Installation](#).



13. Loosen the brake caliper bleed screw (2).

Note: Bolts with micro-encapsulated thread sealant must be replaced after removal.

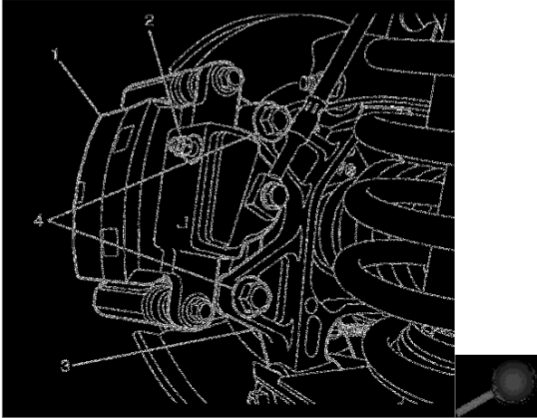
14. Remove the brake caliper anchor plate to steering knuckle retaining bolts (4). Discard the bolts.

Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

15. Detach the brake caliper (1) from the steering knuckle (3).
16. Suspend the brake caliper (1) upside down with heavy mechanics wire or equivalent.
17. Remove the bleed screw (2) to drain contents of the brake caliper (1) into suitable container.
18. Tighten the bleed screw (2).
19. Reinstall the brake caliper (1) to the steering knuckle (3).

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

20. Install the NEW brake caliper anchor plate to steering knuckle retaining bolts (4) and tighten to **60N•m +120 degrees (44 lb ft +120 degrees)**.
21. Repeat steps 13-20 for the right side front brake caliper.



22. Loosen the brake caliper bleed screw (2).

Note: Bolts with micro-encapsulated thread sealant must be replaced after removal.

23. Remove and discard the brake caliper anchor plate to steering knuckle retaining bolts (4).

Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

24. Detach the brake caliper (1) from the knuckle (3).
25. Suspend the brake caliper (1) upside down with heavy mechanics wire or equivalent.
26. Remove the bleed screw (2) to drain contents of the brake caliper (1) into suitable container.
27. Tighten the bleed screw (2).
28. Reinstall the brake caliper (1) to the knuckle (3).
29. Install the NEW brake caliper to knuckle retaining bolts (4) and tighten to **110N•m (81 lb ft)**.
30. Repeat steps 22-29 for the right side rear brake caliper.
31. Bleed brake system. Refer to [Hydraulic Brake System Bleeding](#).
32. Install the tyre and wheel assemblies. Refer to [Tire and Wheel Removal and Installation](#).

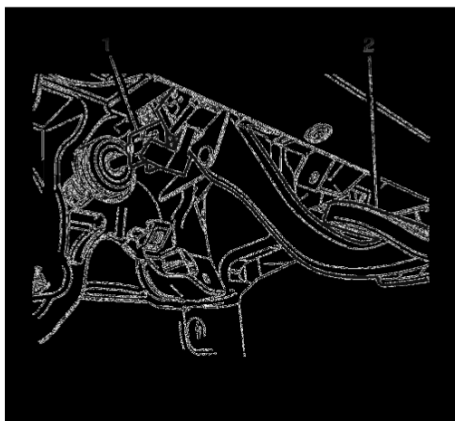
Power Vacuum Brake Booster Replacement

Removal Procedure

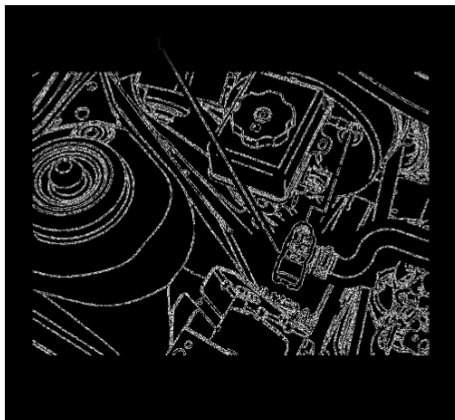
Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. With the engine OFF, apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the brake pedal position sensor. Refer to [Brake Pedal Position Sensor Replacement](#).

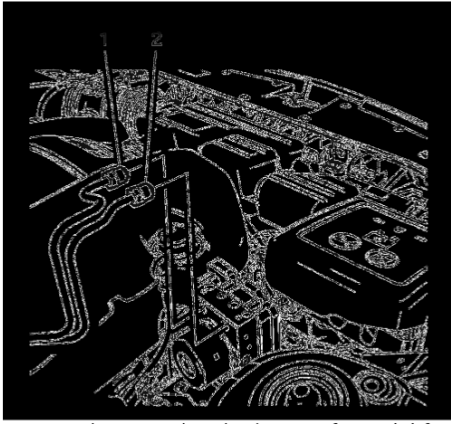


3. Compress the locking tabs on the power vacuum brake booster pushrod retainer (1) and pull the brake pedal (2) rearward to release the brake pedal from the power vacuum brake booster pushrod.



4. Disconnect the power brake booster pressure sensor electrical connector.
5. Remove the power brake booster pressure sensor and hose assembly (1) from the power vacuum brake booster and position aside.
6. Remove the master cylinder assembly. Refer to [Master Cylinder Replacement](#).

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7. Remove the secondary brake pipe fitting (1) from the brake pressure modulator valve (BPMV) assembly.
8. Plug the BPMV inlet port to prevent brake fluid loss and contamination.
9. Remove the primary brake pipe fitting (2) from the BPMV assembly.
10. Plug the BPMV inlet port to prevent brake fluid loss and contamination.



11. Completely loosen the power vacuum brake booster bolts (1).
12. Remove the power vacuum brake booster from the vehicle.

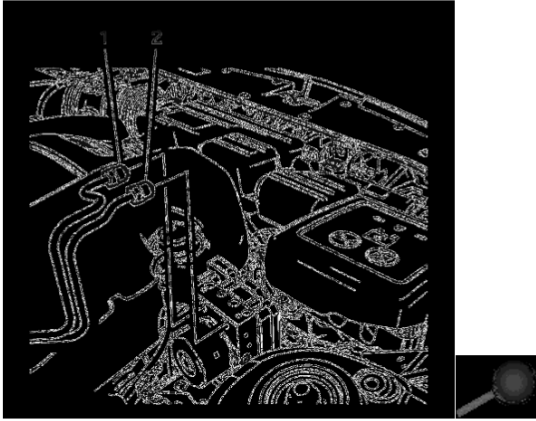
Installation Procedure

1. Install the power vacuum brake booster to the vehicle.

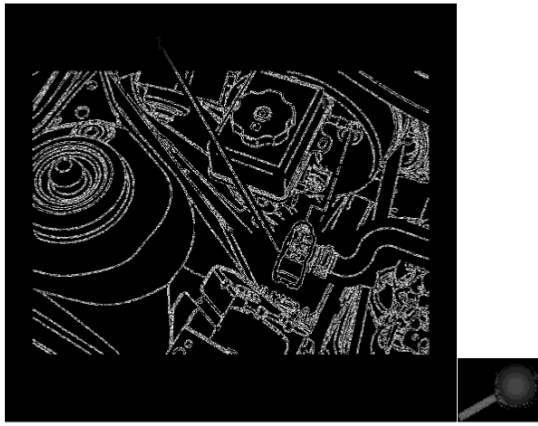


Caution: Refer to [Fastener Caution](#).

2. Tighten the power vacuum brake booster bolts (1) to **19 N•m (14 lb ft)**.

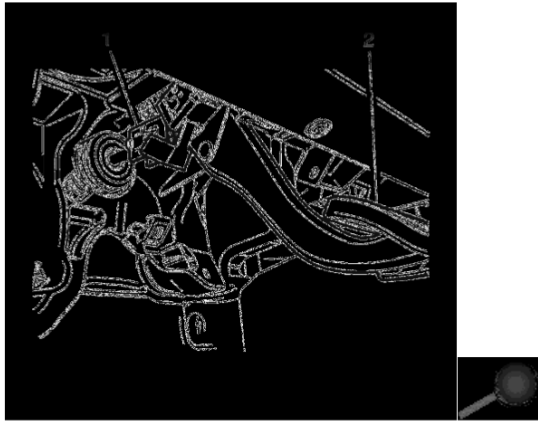


3. Install the secondary brake pipe fitting (1) to the BPMV assembly and tighten to **23 N•m (17 lb ft)**.
4. Install the primary brake pipe fitting (2) to the BPMV assembly and tighten to **23 N•m (17 lb ft)**.
5. Install the master cylinder assembly. Refer to [Master Cylinder Replacement](#).



Note: A small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

6. Install the power brake booster pressure sensor and hose assembly (1) to the power vacuum brake booster.
7. Connect the power brake booster pressure sensor electrical connector.



8. Install the power vacuum brake booster pushrod retainer (1) to the power vacuum brake booster pushrod.
9. Install the brake pedal (2) to the power vacuum brake booster pushrod retainer.
10. Ensure the power vacuum brake booster pushrod retainer locking tabs are fully engaged in the brake pedal assembly.
11. Install the brake pedal position sensor. Refer to [Brake Pedal Position Sensor Replacement](#).

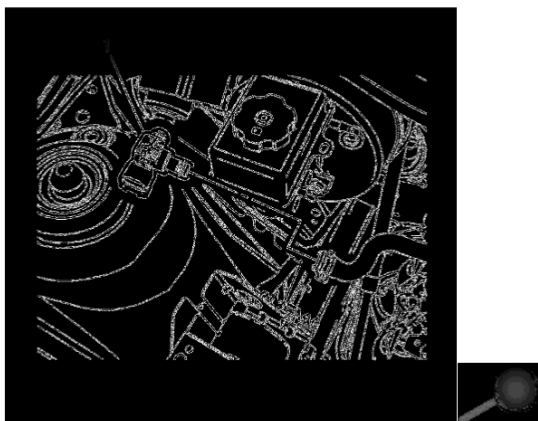
Power Brake Booster Pressure Sensor Replacement

Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Disconnect the power brake booster pressure sensor electrical connector.

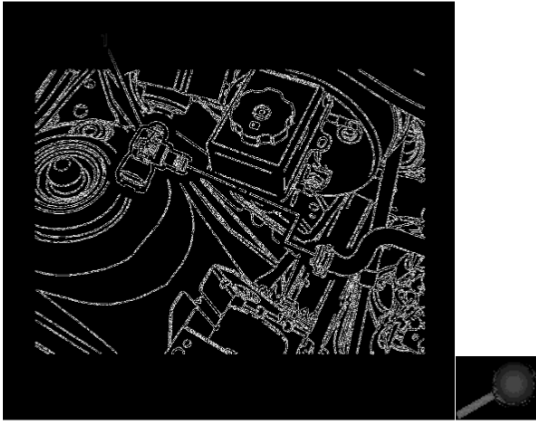


3. Remove the power brake booster pressure sensor (1) and hose assembly from the power vacuum brake booster.



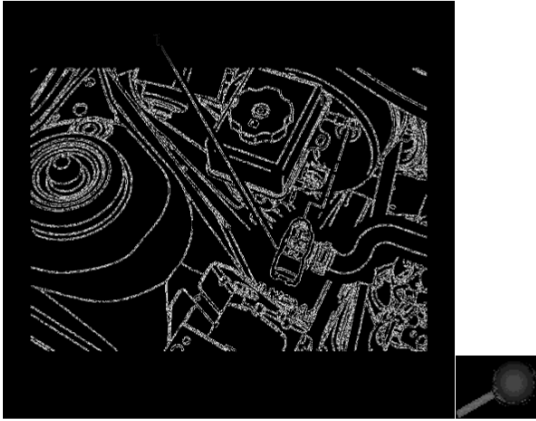
4. Compress the power brake booster vacuum hose clamp and remove the power brake booster pressure sensor (1).

Installation Procedure



Note: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

1. Compress the power brake booster vacuum hose clamp and install the power brake booster pressure sensor (1).



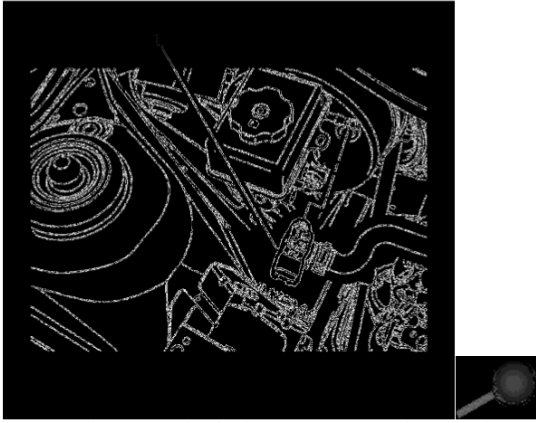
Note: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

2. Install the power brake booster pressure sensor (1) and hose assembly to the power vacuum brake booster.
3. Connect the power brake booster pressure sensor electrical connector.

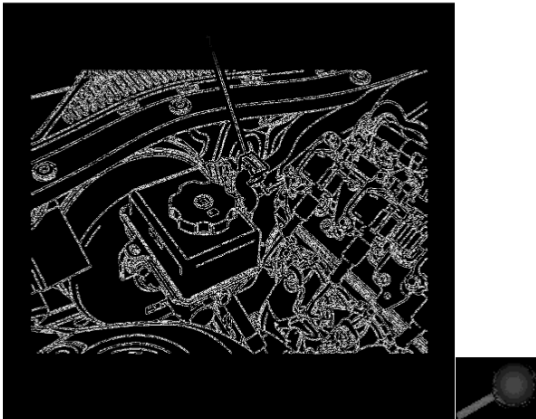
Power Brake Booster Vacuum Hose Replacement (L77, LS3, LSA)

Removal Procedure

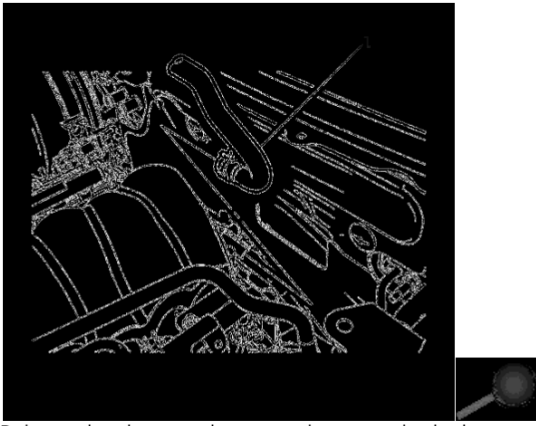
1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the engine cover. Refer to [Engine Cover Replacement](#).
3. Remove the lower air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).
4. Disconnect the power brake booster pressure sensor electrical connector.



5. Remove the power brake booster vacuum hose and pressure sensor assembly (1) from the power vacuum brake booster.



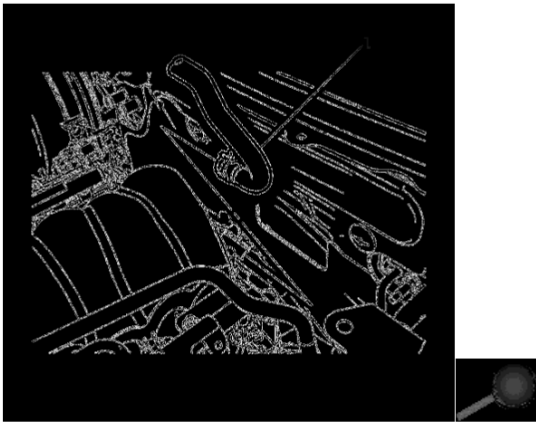
6. Release the power brake booster vacuum hose from the dash panel clip (1).



7. Release the clamp and remove the power brake booster vacuum hose (1) from the intake manifold vacuum port.
8. Remove the power brake booster vacuum hose and pressure sensor assembly from the vehicle.
9. Remove the power brake booster pressure sensor. Refer to [Power Brake Booster Pressure Sensor Replacement](#).

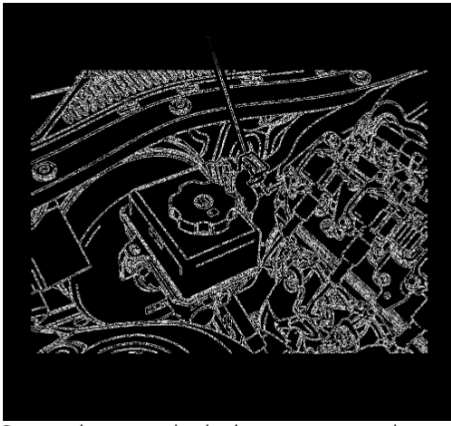
Installation Procedure

1. Install the power brake booster pressure sensor to the power brake booster vacuum hose. Refer to [Power Brake Booster Pressure Sensor Replacement](#).
2. Install the power brake booster vacuum hose and pressure sensor assembly to the vehicle.



Note: A small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

3. Install the power brake booster vacuum hose (1) to the intake manifold vacuum port and secure the clamp.



4. Secure the power brake booster vacuum hose to the dash panel clip (1).



Note: A small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

5. Install the power vacuum brake booster vacuum hose and pressure sensor assembly (1) to the power vacuum brake booster.
6. Connect the power brake booster pressure sensor electrical connector.
7. Install the lower air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).
8. Install the engine cover. Refer to [Engine Cover Replacement](#).

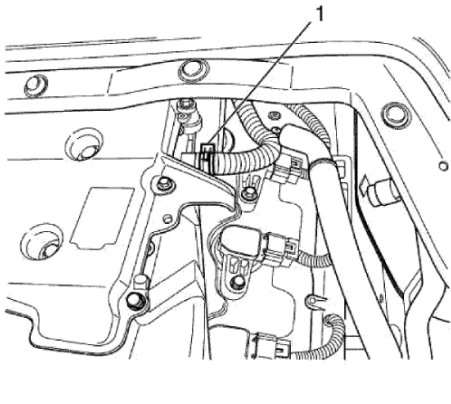
Power Brake Booster Vacuum Hose Replacement (LFW, LFX, LWR)

Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
3. Disconnect the power brake booster pressure sensor electrical connector.



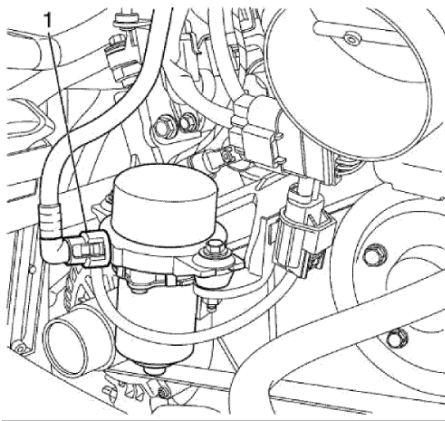
4. Remove the power brake booster pressure sensor (1) and hose assembly from the power vacuum brake booster.



5. Compress the vacuum hose clamp (1) and remove the power brake booster vacuum hose from the intake manifold vacuum port.

Note: Do not reuse the vacuum hose clamp.

6. Discard the clamp.



7. Release the power brake booster vacuum hose quick connect (1) from the power brake booster pump.

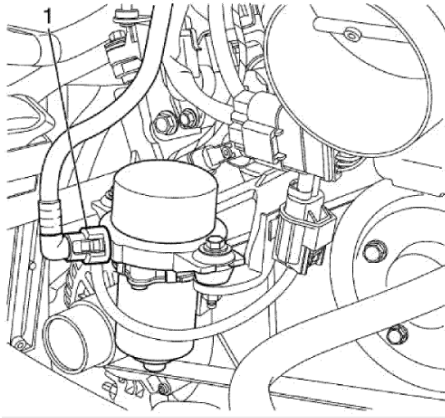


8. Remove the power brake booster pressure sensor (1) from the power brake booster vacuum hose, if necessary. Refer to [Power Brake Booster Pressure Sensor Replacement](#).

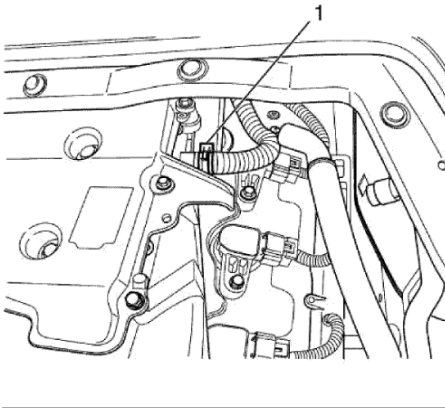
Installation Procedure



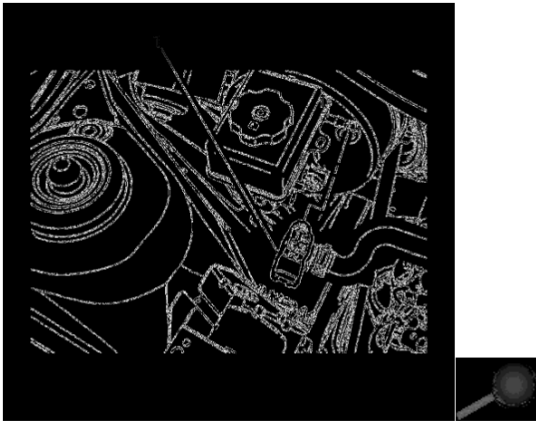
1. Install the power brake booster pressure sensor (1) to the power brake booster vacuum hose, if removed. Refer to [Power Brake Booster Pressure Sensor Replacement](#).



2. Install the power brake booster vacuum hose quick connect (1) to the power brake booster pump.



3. Install a new clamp (1) to the power brake booster vacuum hose.
Note: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.
4. Compress the vacuum hose clamp (1) and install the power brake booster vacuum hose to the intake manifold vacuum port.
5. Secure the clamp.



Note: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

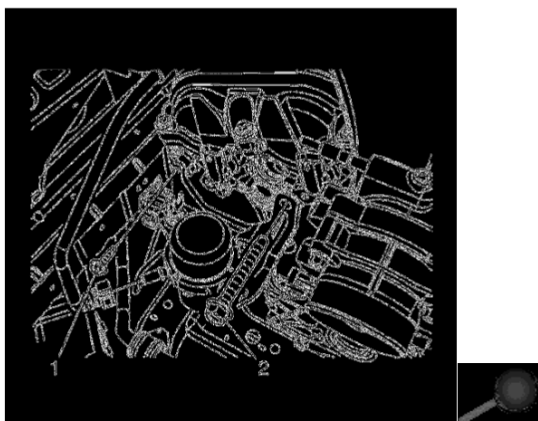
6. Install the power brake booster pressure sensor and vacuum hose assembly (1) to the power vacuum brake booster.
7. Connect the power brake booster vacuum sensor electrical connector.
8. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).

Power Brake Booster Pump Replacement

Removal Procedure



1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
3. Disconnect the power brake booster pump hose quick connect (1).
4. Disconnect the power brake booster pump hose from the pump.
5. Disconnect the power brake booster pump electrical connector.

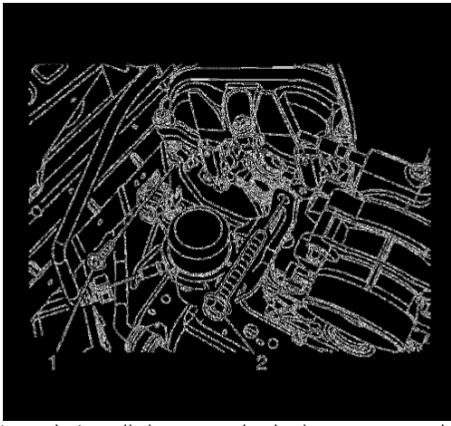


6. Remove the power brake booster pump bracket M6 bolt (1).
7. Remove the power brake booster pump bracket M12 bolt (2).
- Note:** Do not disassemble the power brake booster pump and bracket.
8. Remove the power brake booster pump and bracket assembly from the engine.

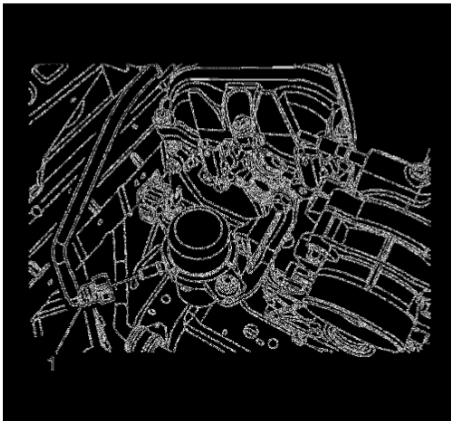
Installation Procedure

1. Position the power brake booster pump to the vehicle.

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2. Loosely install the power brake booster pump bracket M6 bolt (1).
3. Loosely install the power brake booster pump bracket M12 bolt (2).
- Caution:** Refer to [Fastener Caution](#).
4. Tighten the power brake booster pump bracket M6 bolt to **9 N·m (80 lb in)**.
5. Tighten the power brake booster pump bracket M12 bolt to **58 N·m (43 lb ft)**.



6. Install the power brake booster pump hose to the pump.
7. Connect the power brake booster pump hose quick connect (1).
8. Connect the power brake booster pump electrical connector.
9. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

Fastener Tightening Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Hose Fitting Bolt - Front and Rear	35 N•m	26 lb ft
Brake Pedal Assembly Bolt	22 N•m	16 lb ft
Brake Pedal Assembly Nut	22 N•m	16 lb ft
Brake Pipe Fitting	16 N•m	12 lb ft
Brake Pipe Fitting - Brake Pressure Modulator Valve	23 N•m	17 lb ft
Brake Pipe Protector Bolt	22 N•m	16 lb ft
Master Cylinder Nut	19 N•m	14 lb ft
Master Cylinder Reservoir Bolt	8 N•m	71 lb in
Power Brake Booster Pump Bracket M6 Bolt	9 N•m	80 lb in
Power Brake Booster Pump Bracket M12 Bolt	58 N•m	43 lb ft
Power Vacuum Brake Booster Bolt	19 N•m	14 lb ft
Rear Brake Pipe Protector Nut	5 N•m	44 lb in

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Brake Component Specifications

Brake Component Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve (Except HSV)	12 N•m	106 lb in
Brake Caliper Bleeder Valve (HSV)	17 N•m	13 lb ft

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Brake System Specifications

Brake System Specifications

Component	Application	Specification
Brake Fluid	Type	DOT 4 Hydraulic Brake Fluid Conforming to Specification Number GMW3356 or HN2456
	Capacity	0.9 Litres (0.791 quarts)
Brake Booster	Make	Mando Corporation
	Type	Tandem Vacuum Suspended
	Size	203 mm (8 in) or 229 mm (9 in)
Master Cylinder	Type	Fore/aft split
	Bore Size	25.4 mm (1.016 in)
	Nominal Stroke	37 mm (1.456 in)
Brake Pedal Travel	Maximum Specification with 445 N·m (100 lbs) of force applied to the pedal with the ignition OFF and the booster power reserve depleted.	90 mm (3.54 in)

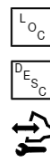
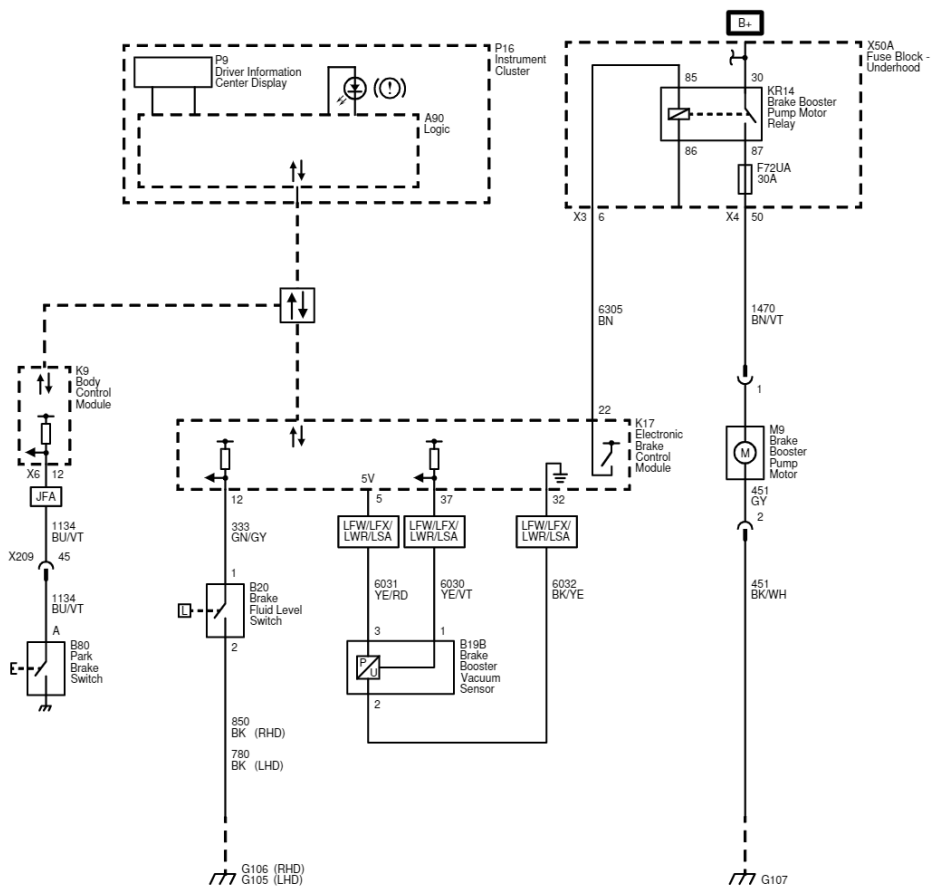
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Adhesives, Fluids, Lubricants, and Sealers

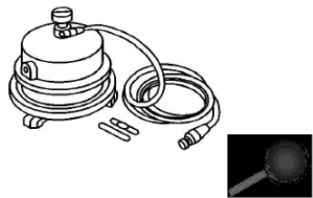
Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material
Hydraulic Brake System	DOT 4 Hydraulic Brake Fluid Conforming to Specification Number GMW3356 or HN2456

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Special Tools

Illustration	Tool Number / Description
	J 28662 Brake Pedal Effort Gauge
	J 23728-A Hand Vacuum Pump
	J 29532 Diaphragm Pressure Bleeder
	J 35589-A Brake Pressure Bleeder Adapter
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.