5. Brakes

5.1. Brake Dust Warning

Warning:
Avoid taking the following actions when you service wheel brake parts: • Do not grind brake linings. • Do not sand brake linings. • Do not clean wheel brake parts with a dry brush or with compressed air. Some models or aftermarket brake parts may contain asbestos fibers which can become airborne in dust. Breathing dust with asbestos fibers may cause serious bodily harm. Use a water-dampened cloth in order to remove any dust on brake parts. Equipment is available commercially in order to perform this washing function. These wet methods prevent fibers from becoming airborne.

5.2. Antilock Brakes Systems

5.2.1. Description and Operation

5.2.1.1. ABS Description and Operation

This vehicle is equipped with a Bosch ABS 9.0 brake system. The electronic brake control module and the brake pressure modulator valve are serviced separately. The brake pressure modulator valve uses a four-circuit configuration to control hydraulic pressure to each wheel independently, the rear wheel is equipped with a redundant system of 2 sensors. Vehicles built with option RPO FX3 will feature stability enhancement.

The following vehicle performance enhancement systems are provided.

2020 Carmel Service Manual

Brakes

- ABS
- Brake Assist
- Electronic Brake Distribution
- Traction control system

The following components are involved in the operation of the above systems.

- Electronic Brake Control Module – The electronic brake control module controls the system functions and detects failures. It supplies voltage to the solenoid valves and pump motor.
- Brake pressure modulator valve – The brake pressure modulator valve contains the hydraulic valves and pump motor that are controlled electrically by the electronic brake control module. The brake pressure modulator uses a four circuit configuration with a diagonal split. The brake pressure modulator directs fluid from the reservoir of the master cylinder to the left front and rear wheels and fluid from the other reservoir to the right front wheel. The diagonal circuits are hydraulically isolated so that a leak or malfunction in one circuit will allow continued braking ability on the other.

  The brake pressure modulator contains the following components:

  - Brake pressure sensor
  - Four inlet valves (one per front wheel two for the rear wheel)
  - Four outlet valves (one per front wheel two for the rear wheel)
  - Two traction control supply valves
  - Two traction control isolation valves

- Body control module monitors the brake pedal position sensor signal when the brake pedal is applied and sends a high-speed serial data message to the electronic brake control module indicating the brake pedal position.
- Brake pressure sensor is used to sense the action of the driver application of the brake pedal. The sensor provides a voltage signal that will increase as the brake pedal is applied. The electronic brake control module monitors the brake pressure sensor which is integral to the brake pressure modulator.
- Instrument cluster - The instrument cluster displays the vehicle speed based on the information from the engine control module. The engine control module sends the vehicle speed information via a high-speed serial data to the body control module. The body control module then sends the vehicle speed information via a low speed serial data to the instrument cluster in order to display the vehicle speed, either in kilometers or miles, based on the vehicle configuration.
- Traction control switch - The traction control switch is a momentary switch. The body control module monitors the signal circuit from the traction control switch and sends a high-speed serial data message to the electronic brake control module indicating the switch position. The traction control is manually disabled or enabled by pressing the traction control switch.

- Steering angle sensor – The electronic brake control module receives serial data message inputs from the steering angle sensor. The steering angle sensor signal is used to calculate the desired yaw rate.
- Transmission control module - The electronic brake control module receives high speed serial data message inputs from the transmission control module indicating the gear position of the transmission for hill start assist functions.
- Wheel speed sensors – This vehicle is equipped with unique directional wheel speed sensors that can detect wheel direction as well as zero wheel speed. The wheel speed sensors are Active sensors that receive a 12 V power supply voltage from the electronic brake control module and provides an output signal to the module. As the wheel spins, the wheel speed sensor sends the electronic brake control module a DC square wave signal. The electronic brake control module uses the frequency of the square wave signal to calculate the wheel speed.

5.2.1.1.1. Power-Up-Self Test

The electronic brake control module is able to detect many malfunctions whenever the ignition is ON. However, certain failures cannot be detected unless active diagnostic tests are performed on the components. Shorted solenoid coil or motor windings, for example, cannot be detected until the components are commanded ON by the electronic brake control module. Therefore, a power-up self-test is performed to verify correct operation of system components. The electronic brake control module performs the first phase of the power-up self-test when the ignition is first turned ON. This phase consists of internal self-testing of the electronic brake control module along with electrical checks of system sensors and circuits.

5.2.1.1.2. Initialization Sequence

The initialization sequence cycles each solenoid valve and the pump motor, as well as the necessary relays, for approximately forty milliseconds to check component operation. The active test is initiated by the electronic brake control module at the start of the ignition cycle and the speed of the fastest wheel exceeds 16 km/h (10 MPH). If a fault condition is detected the electronic brake control module sets a DTC.

5.2.1.1.3. Antilock Brake System

When wheel slip is detected during a brake application, an ABS event occurs. During ABS braking, hydraulic pressure in the individual wheel circuits is controlled to prevent any wheel from slipping. A separate hydraulic line and specific solenoid valves are provided for each wheel. The ABS can decrease, hold, or increase hydraulic pressure to each wheel. The ABS does not, however, increase hydraulic pressure above the amount which is transmitted by the master cylinder during braking.

During ABS braking, a series of rapid pulsations is felt in the brake pedal. These pulsations are caused by the rapid changes in position of the individual solenoid valves as the electronic brake control module responds to wheel speed sensor inputs and attempts to prevent wheel slip. These pedal pulsations are present only during ABS braking and stop when normal braking is resumed or when the vehicle comes to a stop. A ticking or popping noise may also be heard as the solenoid valves cycle rapidly. During ABS braking on dry pavement, intermittent chirping noises may be heard as the tires approach slipping. These noises and pedal pulsations are considered normal during ABS operation.

Vehicles equipped with ABS may be stopped by applying normal force to the brake pedal. Brake pedal operation during normal braking is no different than that of previous non ABS systems. Maintaining a constant force on the brake pedal provides the shortest stopping distance while maintaining vehicle stability. The typical ABS activation sequence is as follows.

5.2.1.1.4. Pressure Hold

The electronic brake control module closes the inlet valve and keeps the outlet valve closed in order to isolate the system when wheel slip occurs. This holds the pressure steady on the brake so that the hydraulic pressure does not increase or decrease.

5.2.1.1.5. Pressure Decrease

The electronic brake control module decreases the pressure to individual wheels during a deceleration when wheel slip occurs. The inlet valve is closed and the outlet valve is opened. The excess fluid is stored in the accumulator until the return pump can return the fluid to the master cylinder.

5.2.1.1.6. Pressure Increase

The electronic brake control module increases the pressure to individual wheels during a deceleration in order to reduce the speed of the wheel. The inlet valve is opened and the outlet valve is closed. The increased pressure is delivered from the master cylinder.

5.2.1.1.7. Brake Assist

The brake assist function is designed to support the driver in emergency braking situations.
The electronic brake control module receives inputs from the brake pressure sensor.
When the electronic brake control module senses an emergency braking situation, the electronic brake control module will actively increase the brake pressure to a specific maximum.

5.2.1.1.8. Electronic Brake Distribution

The electronic brake distribution function is designed to support the driver in emergency braking situations.

The electronic brake distribution is a control system that enhances the hydraulic proportioning function of the mechanical proportioning valve in the base brake system. The electronic brake distribution control system is part of the operation software in the electronic brake control module. The electronic brake distribution uses active control with existing ABS in order to regulate the vehicle's rear brake pressure.

5.2.1.1.9. Traction Control System

When drive wheel slip is noted while the brake is not applied, the electronic brake control module will enter traction control mode. First, the electronic brake control module requests the engine control module to reduce the amount of torque to the drive wheels via the serial data. The engine control module reduces torque to the drive wheels by retarding spark timing and turning off fuel injectors. The engine control module reports the amount of torque delivered to the drive wheels via the serial data circuit.

- Pressure hold
- Pressure increase
- Pressure decrease

5.2.1.1.10. Driver Information Indicator

Brake Warning Indicator

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

- The instrument cluster performs the bulb check.
- The electronic brake control module detects some faults, such as more than two wheel speed sensors are defective or the failure relating to the basic brake system occurs and sends a serial data message to the instrument cluster requesting illumination.
- The park brake is engaged or the brake fluid level is low.

ABS Warning Indicator

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

- The instrument cluster performs the bulb check.
- The electronic brake control module detects a malfunction which disables the ABS and sends a serial data message to the instrument cluster requesting illumination.

Traction Control System Warning Indicator

The instrument cluster turns the traction control system/stability control system warning indicator ON when the following occurs:

- The instrument cluster performs the bulb check.
- The electronic brake control module detects a malfunction which disables the traction control and sends a serial data message to the instrument cluster requesting illumination.

Traction Control System OFF Indicator

The instrument cluster turns the Traction Control Off indicator ON when the following occurs:

- The instrument cluster performs the bulb check.
- The driver manually disables the traction control by pressing the traction control switch one time and releasing it. The body control module and electronic brake control module sends a serial data message to the instrument cluster requesting illumination.
- The electronic brake control module detects a malfunction which disables the traction control and sends a serial data message to the instrument cluster requesting illumination of the Traction Control Off indicator.

5.3. Hydraulic Brakes

5.3.1. Brake Assist System

Brake system input force from the driver is multiplied by the brake pedal and transferred by the pedal pushrod to the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the operation of the vacuum brake booster.

When brake system force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressure is admitted in its place. The vacuum acts to pull the diaphragm(s) forward, while the atmospheric pressure acts to push from behind. As a result, the amount of effort required by the driver is reduced. When input force is removed, vacuum again replaces atmospheric pressure within the vacuum power brake booster to help return the booster to rest. Return springs maintain the system in a rest position.

The brake assist system consists of the following:

5.3.1.1. Brake Pedal

Receives, multiplies and transfers brake system input force from driver.

5.3.1.2. Brake Pedal Pushrod

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

5.3.1.3. Vacuum Brake Booster

Uses source vacuum to decrease effort required by driver when applying brake system input force.

At rest, source vacuum is applied to both sides of the vacuum diaphragm for single boosters, or to both sides of each of the diaphragms for tandem boosters. Return springs maintain the booster in a rest position.

When brake system input force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressureis admitted in its place. This provides a decrease in brake pedal effort required. When input force is removed, vacuum againreplaces atmospheric pressure within the booster.

5.3.1.4. Vacuum Source

Supplies force used by vacuum brake booster to decrease brake pedal effort.

The primary source for vacuum is typically the vehicle's internal combustion engine. Some vehicles may use a vacuum pump toensure and adequate supply of vacuum under various operating conditions, such as during cold start-up, heavy throttle, andhigh altitude.

5.3.1.5. Vacuum Monitoring System

Provides a feedback voltage signal relative to the amount of vacuum available for the vacuum power brake booster.

This typically consists of a vacuum sensor mounted either into the power vacuum brake booster, integrated with the vacuum check valve, or in-line within the vacuum hose. The sensor feedback is typically monitored by the powertrain control module(s).

5.3.1.6. Vacuum Source Control

If equipped with a system to monitor available levels of vacuum for the brake assist system, the powertrain control module(s)typically perform the primary monitoring function.

The powertrain controller will typically monitor the feedback signal of a vacuum sensor, as it relates to available vacuum at the vacuum power brake booster. The powertrain controller uses the information to make sure available vacuum remains above predetermined levels. If additional vacuum is required, the powertrain controller may reactivate engine cylinders, if equipped and/or may alter the operation of various other engine controls and devices, as necessary.

5.3.1.7. Vacuum Source Delivery System

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

This typically consists of a vacuum check valve and a vacuum hose or pipe. If a vacuum pump is used, additional check valves may be used.

5.4. Disc Brakes

5.4.1. System Operation

5.4.1.1. Conventional Calipers

Mechanical output force is applied from the hydraulic brake caliper pistons to the inner brake pads. As the pistons press the inner brake pads outward, the caliper housings draw the outer brake pads inward. This allows the output force to be equally distributed. The brake pads apply the output force to the friction surfaces on both sides of the brake rotors, which slows the rotation of the tire and wheel assemblies. The correct function of both the brake pad and brake caliper hardware is essential for even distribution of braking force.

5.4.1.2. Sport Brembo Calipers

Mechanical output force is applied from the hydraulic brake caliper inboard and outboard pistons to the inner and outer brake pads. The brake calipers are a fixed, opposed-piston design, allowing the output force to be equally distributed through the distribution of the pressurized brake fluid within the caliper. The brake pads apply the output force to the friction surfaces on both sides of the brake rotors, which slows the rotation of the tire and wheel assemblies. The correct function of the brake pad hardware and of the brake caliper inboard and outboard pistons is essential for even distribution of braking force.

5.4.2. Disc Brakes system components

5.4.2.1. Disc Brake Pads

Applies mechanical output force from the hydraulic brake calipers to friction surfaces of brake rotors.

5.4.2.2. Disc Brake Rotors

Uses mechanical output force applied to friction surfaces from the disc brake pads to slow speed of tire and wheel assembly rotation.

5.4.2.3. Disc Brake Pad Hardware

Secures disc brake pads firmly in proper relationship to the hydraulic brake calipers. Enables a sliding motion of brake pads when mechanical output force is applied.

5.4.2.4. Disc Brake Caliper Hardware (Sport Brembo Brakes)

Provides mounting for hydraulic brake caliper and secures the caliper firmly in proper relationship to caliper bracket. Enables a sliding motion of the brake caliper to the brake pads when mechanical output force is applied.

5.5. Disc Brakes System Characteristics

5.5.1. Brakes Noise

Brake noise can occur and to a degree, some brake noise is normal. Variations in driving conditions such as the weather, environment, driving patterns, differences in vehicle loading, and type or style of driving, can affect brake wear. Any one of these variation scan cause brake noise to become apparent. Inspect and verify that all metal-to-metal contact areas of the brake pads, brake pad guides or springs, brake caliper housing, caliper bracket and/or suspension knuckle, as applicable, are clean and free of corrosion and scale.

Brake noise is a “slip-stick” vibration of disc brake components and, if it occurs intermittently, can be considered normal. Most brake noise may be eliminated or temporarily reduced by performing 3 or 4 aggressive brake applications. If the brake noise persists or consistently recurs, application of a damping compound to the brake pad mounting plate where it contacts the caliper can lessen the vibration as the components move relative to each other.

The following brake noises are characteristic of all brake systems. These noises cannot be avoided and may not indicate improper operation of the brake system.

5.5.2. Squeak/Squeal Noise

A squeak or squeal noise can occur on vehicles with front semi-metallic brake pads during light to medium brake pedal application at low to moderate vehicle speeds. Occasionally this noise may appear from the front or rear brakes after a period of non-use such as overnight, or cold brakes and/or in high humidity conditions.

5.5.3. Grinding Noise

Common occurrence for rear brakes and some front disc brakes during initial brake applications after the vehicle has been parked overnight. Caused by light corrosion forming on the metal brake component friction surfaces during vehicle non-use, typically disappears after the first few brake applications.

5.5.4. Groan Noise

Brakes

A groan type noise may be heard during a quick stop, or when slowly moving forward from a complete stop. On vehicles equipped with antilock brake systems (ABS), a groan or moan noise may occur during heavy brake application or on road surfaces with compromised traction such as loose gravel, or on wet or icy roads. This is a normal function of ABS activation.

5.6. Park Brake

5.6.1. Description and Operation

5.6.1.1. Park Brake System Description and Operation

System Component Description

The park brake system consists of the following:

Park Brake Lever Assembly

Receives, multiplies, and transfers park brake system apply input force from driver to park brake cable system.

Releases applied park brake system when lever release button is depressed and lever is returned to the at-rest position.

Park Brake Cable

Transfers input force received from park brake lever, to the park brake apply lever.

Park Brake Apply Lever

Multiplies and transfers input force to park brake actuator/adjuster.

Disc Brake Caliper Actuator

Uses multiplied input force from park brake lever assembly to apply disc brake caliper piston which compresses the brake pads against friction surface of brake rotor.

System Operation

Park brake apply input force is received by the park brake lever assembly being applied. The input force is multiplied by the lever assembly, transferred, through the park brake, to the rear caliper park brake apply lever. The park brake apply lever multiply and transfer the apply input force to in turn apply the disc brake caliper pistons which compress the brake pads against the friction surface of the brake rotor in order to prevent the rotation of the rear tire and wheel assembly. The park brake lever assembly releases an applied park brake system when it is released and returned to the at-rest position.

5.6.2. Diagnostic Information and Procedures

5.6.2.1. Symptoms Park Brake

Note: Review the system operation to familiarize yourself with the system functions. Refer to Park Brake System Description and Operation

Visual/Physical Inspection

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

Symptom List

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

- Park Brake Will Not Hold or Release
- Park Brake System Diagnosis

5.6.2.2. Park Brake Will Not Hold or Release

Park Brake Will Not Hold or Release

Step	Action	Yes	No
1	Were you sent here from a Park Brake Symptom table?	Go to Step 2	Go to Symptoms Park Brake
2	Inspect the park brake system for proper operation. Refer to Park Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	Inspect the disc brake system for proper operation. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	Inspect the hydraulic brake system for proper operation. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Symptoms Park Brake
5	Road test the vehicle to confirm correct operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

5.6.2.3. Park Brake System Diagnosis

Park Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the mechanical components of the PARK brake system in order to determine if the PARK brake 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 Hydraulic Brake Symptom table?	Go to Step 4	Go to Step 2
2	Were you sent here from a Park Brake Symptom table?	Go to Step 2	Go to Step 3
3	Is the symptom related to the ability of the park brake system to hold and/or release?	Go to Symptoms Park Brake	Go to Symptoms Hydraulic Brakes
4	1. Raise and support the vehicle with the rear axle supported by jack stands. Refer to Lifting and Jacking the Vehicle. 2. With the park brake RELEASED, attempt to rotate the rear wheel to check the rear brake for a significant amount of drag. Does the rear brake have a significant amount of drag?	Go to Step 8	Go to Step 5
5	1. Apply the park brake. 2. Attempt to rotate the rear wheel to check the rear brake for a significant amount of drag. Do the rear brakes have a significant amount of drag?	Go to Step 13	Go to Step 6
6	Visually inspect the park brake cable connections and the cable on the UNDERSIDE of the vehicle and swing arm for disconnections and/or damage. Was the park brake cable disconnected and/or damaged?	Go to Step 7	Go to Step 8
7	Reconnect or replace the park brake cable as necessary. Refer to Parking Brake Cable Replacement. Did you complete the repair and/or replacement?	Go to Step 13	-
8	1. Disconnect the rear park brake cable from the brake caliper piston apply levers. Refer to Parking Brake Cable Replacement. 2. Have an assistant apply and maintain the caliper piston apply lever to apply the caliper piston. 3. Attempt to rotate the rear wheels to check the rear brakes for a significant amount of drag. 4. Release the caliper piston apply lever. 5. Rotate the rear wheel to check the brake for a significant reduction of drag. Did the brake caliper apply and release properly?	Go to Step 10	Go to Step 9
9	Replace the rear brake caliper. Refer to Rear Brake Caliper	Go to Step	-

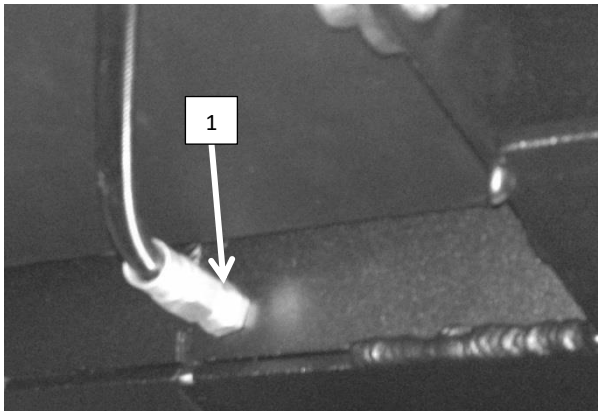
	Replacement. Did you complete the replacement?	13	
10	With the aid of an assistant, apply and release the parking brake while observing the cable for free movement. Did the park brake cables move freely?	Go to Step 12	Go to Step 11
11	Replace the park brake cable Refer to Parking Brake Cable Replacement. Did you complete the replacement?	Go to Step 11	-
12	Inspect the park brake lever assembly for proper operation and replace if necessary. Refer to Parking Brake Lever Replacement. Did you complete the replacement?	Go to Step 13	-
13	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Go to Step 13	-

5.6.3. Repair instructions

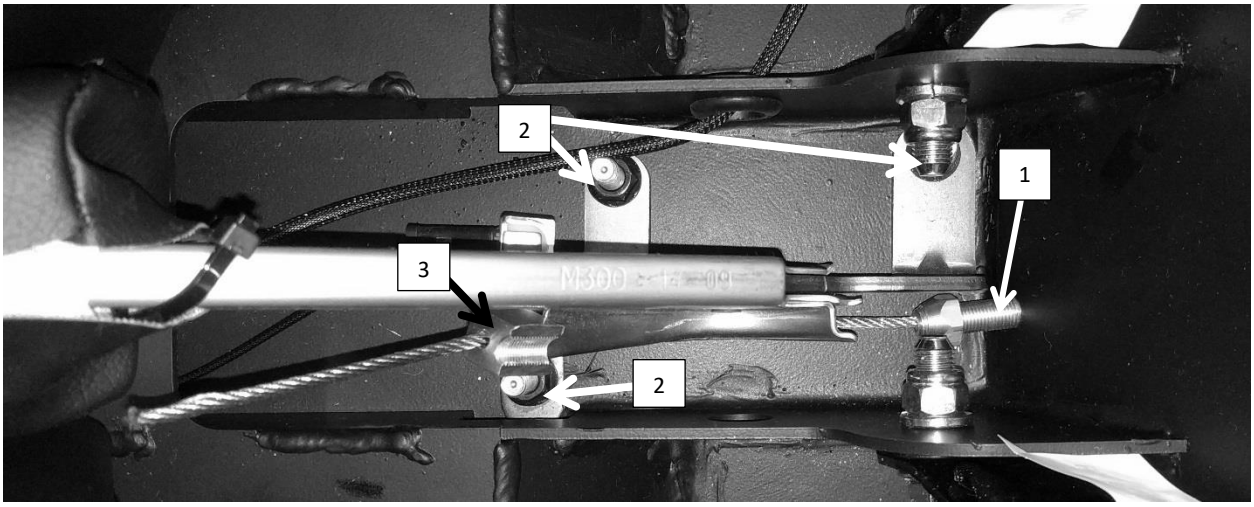
5.6.3.1. Parking Brake Lever Replacement

5.6.3.1.1. Removal Procedure

1. Remove both seats
2. Block the rear tire to prevent the vehicle from rolling
3. Ensure that the park brake lever is in the fully released position.
4. Disconnect the electrical connector from the park brake warning lamp switch.



5. Under the vehicle fully loosen the cable guide nut (1)

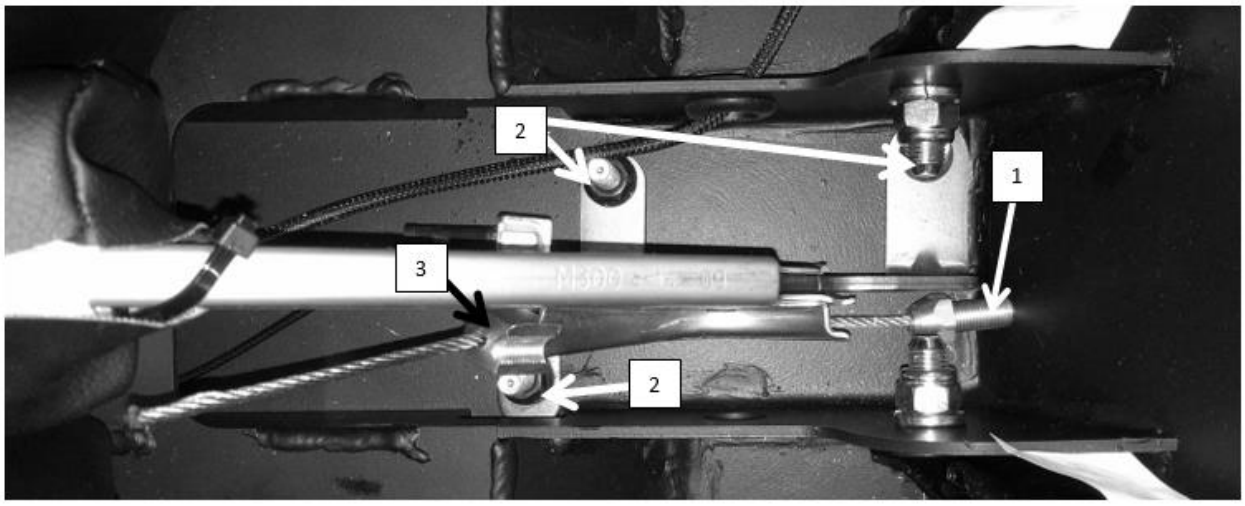


6. Using ONLY HAND TOOLS, loosen the adjusting nut (1) until the parking brake cable is slack
7. Remove the cable stop (3)
8. Remove the park brake lever mounting bolts (2).
9. remove the park brake lever assembly from the vehicle.

5.6.3.1.2. Installation Procedure

1. Install the park brake lever assembly to the vehicle.

Caution
Refer to Fastener Caution.

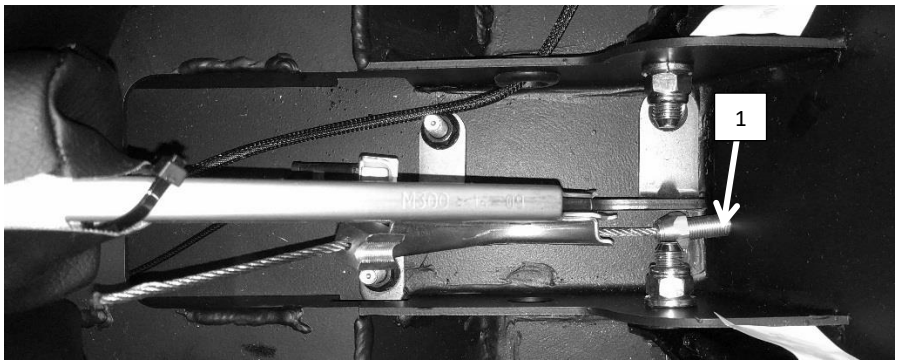


2. Install the park brake lever mounting bolts (2) and tighten to 22 Nm (16 lb ft).
3. Connect the electrical connector to the park brake warning lamp switch.
4. Adjust the park brake cable tension. Refer to Parking Brake Adjustment
5. Install both Seats

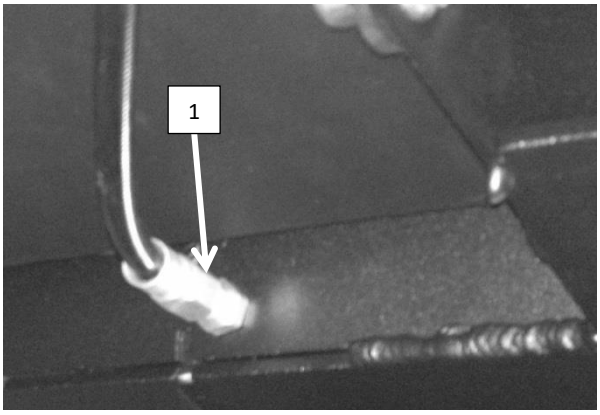
5.6.3.2. Parking Brake Cable Replacement

5.6.3.2.1. Removal Procedure

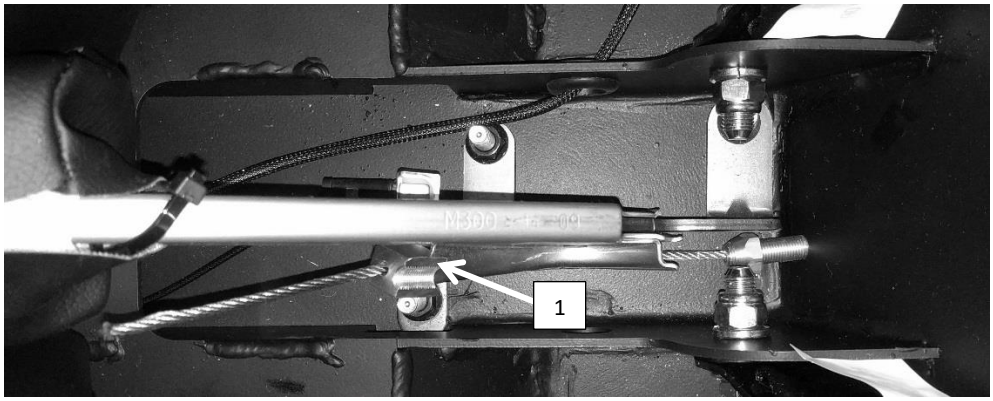
1. Remove Both Seats
2. Remove the Rear Hub Cover
3. Block the rear tire to prevent the vehicle from rolling
4. Ensure that the parking brake lever is in the fully released position.



5. Fully loosen the cable guide nut (1)



6. Using ONLY HAND TOOLS, loosen the adjusting nut (1) until the parking brake cable is slack



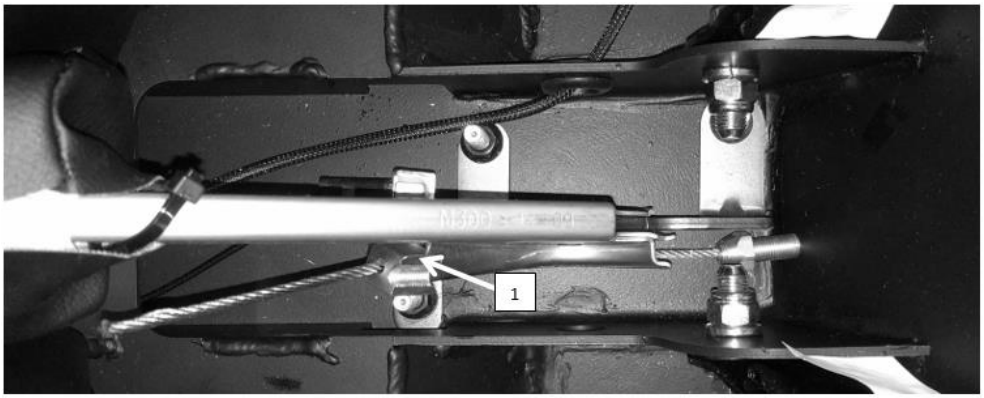
7. Remove the cable end stop (1)
8. Remove the parking brake cable ties from under the swing arm

9. Disconnect the parking brake cable (1) from the actuator lever and remove the parking brake cable from the cable bracket.
10. Feed the parking brake cable through the vehicle body.

5.6.3.2.2. Installation Procedure

1. Install the parking brake cable through the body

2. Connect the parking brake cable (1) to the actuator lever

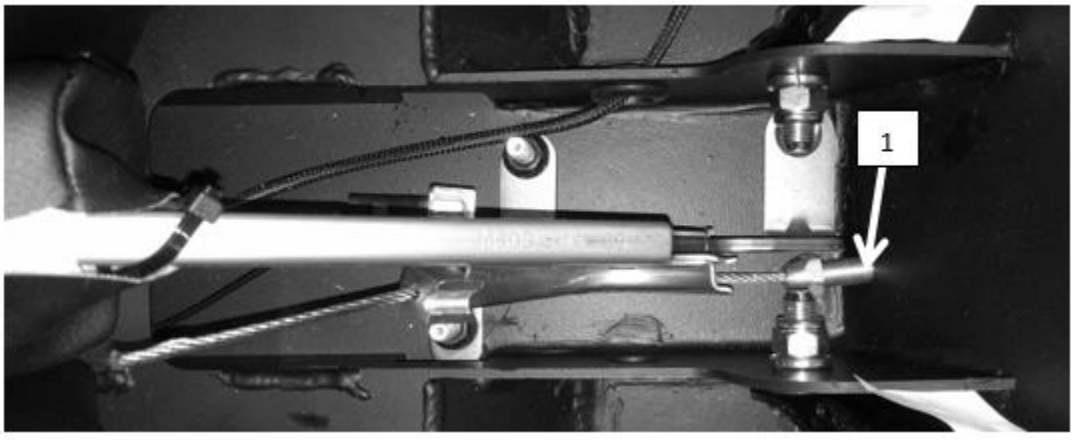


3. Install the cable stop against the brake handle and tighten both hex headed set screws
4. Adjust the parking brake. Refer to Parking Brake Adjustment.
5. Install the Rear Hub Cover
6. Install both Seats
7.

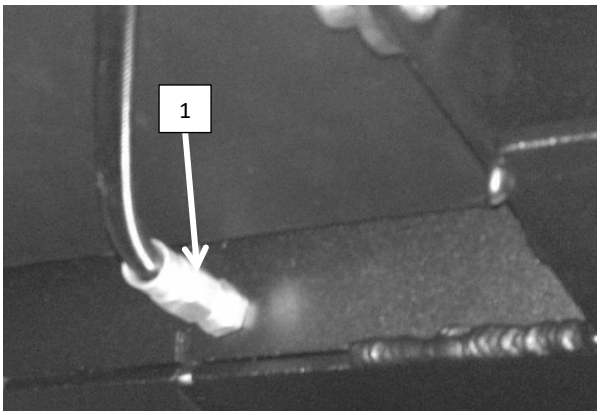
5.6.3.3. Parking Brake Adjustment

Note:
The park brake cable adjusting nut is a nylon lock type. Use ONLY HAND TOOLS whenever tightening or loosening the adjusting nut.

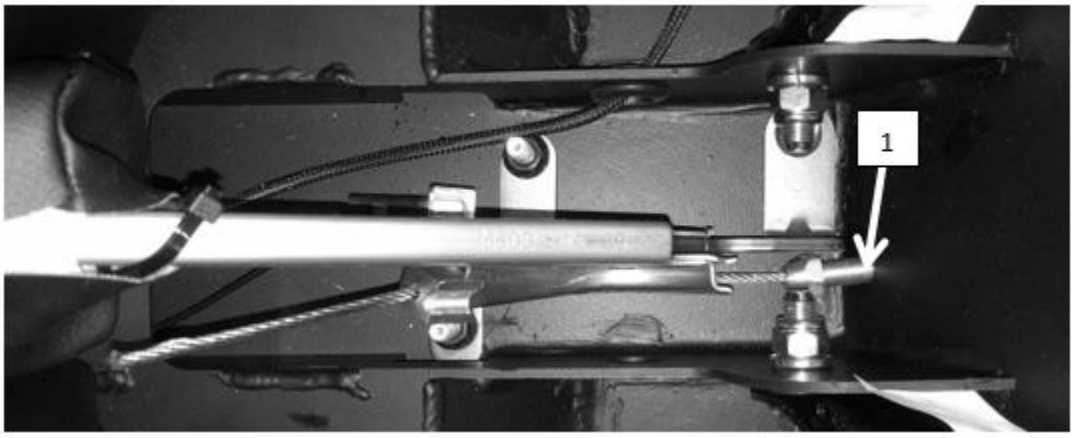
1. Apply and fully release the park brake several times. Verify that the park brake lever releases completely.
2. Turn ON the ignition. Verify the red BRAKE warning lamp is not illuminated.
3. If the red BRAKE warning lamp is illuminated, verify the following:
   - The park brake lever is in the fully released position and against the stop.
   - There is no slack in the park brake cables.
4. If the red BRAKE warning lamp remained illuminated and there were no other visible causes, refer to Symptoms Hydraulic Brakes.
5. Turn OFF the ignition.
6. Remove Both Seats



11. Fully loosen the cable guide nut (1)
7. Ensure the Parking brake handle is in the fully released position
8. Raise and support the vehicle. Raise the vehicle just enough to allow the rear tire and wheel to be rotated. Refer to Lifting and Jacking the Vehicle.
9. Ensure there is no brake drag by rotating the tire and wheel assemblies. If drag exists, verify the park brake apply levers are fully against the stops on the rear brake caliper.



10. Tighten the park brake cable adjusting nut (1) while an assistant turns the rear wheel until there is a slight drag on the wheel
11. Apply the park brake lever.
12. Attempt to rotate the rear tire and wheel assemblies. There should be no rotation forward or rearward.
13. Fully release the park brake lever.
14. Verify the park brake is released by rotating the rear tire and wheel assemblies. The tire and wheel assemblies should rotate freely and exhibit no drag.
15. If the tire and wheel assembly does not rotate freely, repeat the park brake cable adjustment procedure.
16. Raise the park brake lever 3 detent positions and attempt to rotate the rear tire and wheel assembly it assemblies should not rotate forward or rearward.
17. Raise the park brake lever one additional detent position and attempt to rotate the rear tire and wheel assembly.
18. Verify that it cannot be rotated.



19. Tighten the cable guide nut (1)
20. Lower the vehicle.
21. Install the Seats

5.7. Antilock Brake System Automated Bleed Procedure

5.7.1. Warnings and Cautions

Brake fluid may irritate eyes and skin. In case of contact, take the following actions:

- Eye contact—rinse thoroughly with water.
- Skin contact—wash with soap and water.
- If ingested—consult a physician immediately.

Use only DOT 3 Motor Vehicle Brake Fluid

Avoid spilling brake fluid onto plastic components, head lamps, painted surfaces, electrical connections, wiring, or cables as Brake fluid will damage plastics or painted surfaces and cause corrosion to electrical components. Protect any plastic components from exposure with an appropriate cover. If any brake fluid comes in contact with painted surfaces, immediately flush the area with water. If any brake fluid is spilled over electrical connections, wiring, or cables, use a clean shop cloth to wipe away the fluid.

The Auto Bleed Procedure may be terminated at any time during the process by pressing the EXIT button. No further Scan Tool prompts pertaining to the Auto Bleed procedure will be given. After exiting the bleed procedure, relieve bleed pressure and disconnect bleed equipment per manufacturer's instructions. Failure to properly relieve pressure may result in spilled brake fluid causing damage to components and painted surfaces.

5.7.2. Procedure Explanation

The ABS Automated Bleed Procedure uses a scan tool to cycle the system solenoid valves and run the pump to purge any air from the secondary circuits. These circuits are normally closed off and are only opened during system initialization at vehicle start up and during ABS operation. The automated bleed procedure opens these secondary circuits and allows any air trapped in these circuits to flow out toward the brake corners.

5.7.3. Performing the Automated Bleed Procedure

a. Raise and support the vehicle. (Follow the Lifting and Jacking the Vehicle Procedure)
b. Remove all three tire and wheel assemblies.
c. Inspect the brake system for leaks and visual damage. Repair or replace components as needed.
d. Inspect the battery state of charge. Battery Inspection/Test
e. Install an approved scan tool.
f. Turn the ignition ON, with the engine OFF.
g. With the scan tool, establish communications with the ABS system. Select Control Functions. Select Automated Bleed from the Control Functions menu.
h. Follow the scan tool directions until the desired brake pedal height is achieved.

i. If the bleed procedure is aborted, a malfunction exists. Perform the following steps before resuming the bleed procedure:
    i. If a DTC is detected, refer to Diagnostic Trouble Code (DTC) List - Vehicle, and diagnose the appropriate DTC.
    ii. If the brake pedal feels spongy, perform the pressure bleed procedure again. Hydraulic Brake System Bleeding

j. When the desired pedal height is achieved, press the brake pedal to inspect for firmness.

k. Lower the vehicle.

l. Remove the scan tool.

m. Install the tire and wheel assemblies. Tire and Wheel Removal and Installation.

n. Inspect the brake fluid level. Brake Master Cylinder Reservoir Filling.

o. Road test the vehicle while inspecting that the pedal remains high and firm.

5.8. Diagnostic Information and Procedures

5.8.1. DTC B0000, C0055, C0246, C1207-C1210, C1221-C1228, or C1232-C1235

5.8.1.1. 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.

5.8.1.1.1. DTC Descriptors

DTC B0000 71

Vehicle Speed Information Circuit Invalid Data

DTC C0055 00

Invalid Data Received From Electronic Brake Control Module Malfunction

DTC C0246 00

Invalid Data Received From Electronic Brake Control Module Malfunction

DTC C1207 00

Left Front Wheel Speed Sensor Circuit High Input Malfunction

DTC C1208 00

Right Front Wheel Speed Sensor Circuit High Input Malfunction

DTC C1209 00

Rear Wheel Speed Sensor 2 Circuit High Input Malfunction

DTC C1210 00

Rear Wheel Speed Sensor 1 Circuit High Input Malfunction

DTC C1221 00

Left Front Wheel Speed Sensor Circuit Malfunction

DTC C1222 00

Right Front Wheel Speed Sensor Circuit Malfunction

DTC C1223 00

Rear Wheel Speed Sensor 2 Circuit Malfunction

DTC C1224 00

Rear Wheel Speed Sensor 1 Circuit Malfunction

DTC C1225 00

Left Front Wheel Speed Sensor Circuit Performance Malfunction

DTC C1226 00
Right Front Wheel Speed Sensor Circuit Performance Malfunction
DTC C1227 00
Rear Wheel Speed Sensor 2 Circuit Performance Malfunction
DTC C1228 00
Rear Wheel Speed Sensor 1 Circuit Performance Malfunction
DTC C1232 00
Left Front Wheel Speed Sensor Circuit Low Input Malfunction
DTC C1233 00
Right Front Wheel Speed Sensor Circuit Low Input Malfunction
DTC C1234 00
Rear Wheel Speed Sensor 2 Circuit Low Input Malfunction
DTC C1235 00
Rear Wheel Speed Sensor 1 Circuit Low Input Malfunction

5.8.1.1.2. Circuit/System Description

The wheel speeds are detected by active wheel speed sensors. Each wheel speed sensor receives a 12 V reference voltage from the Electronic Brake Control Module and provides an alternating current square wave signal to the Electronic Brake Control Module. As the wheel spins, the Electronic Brake Control Module uses the frequency of the square wave signal to calculate the wheel speed. The Electronic Brake Control Module sends the wheel speed information as a serial data message.

5.8.1.1.3. Conditions for Running the DTC

Ignition ON

5.8.1.1.4. Conditions for Setting the DTC

A supervised periodic message that includes the wheel speed serial data has not been received.

5.8.1.1.5. Action Taken When the DTC Sets

Specific subsystems will not function or operate in degraded mode.

5.8.1.1.6. Conditions for Clearing the DTC

A current DTC clears when the diagnostic runs and passes.

5.8.1.1.7. Reference Information

Schematic Reference
Antilock Brake System Schematics
Connector End View Reference
Component Connector End Views
Description and Operation
ABS 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

5.8.1.1.8. Circuit/System Verification

1. Drive the vehicle in a straight line at a speed greater than 20 km/h (13 MPH).
2. Verify all scan tool Wheel Speed Sensor parameters are within 4 km/h (2.5 MPH) of each other.

⇒ If any parameter is not within 4 km/h (2.5 MPH) of each other
Refer to Circuit/System Testing.
⇓ If each parameter is within 4 km/h (2.5 MPH) of each other

3. 3. All OK.

5.8.1.1.9. Circuit/System Testing

1. Ignition ON.
2. Verify that DTC C0035, C0040, C0045, or C0050 is not set.

⇒ If any listed DTC are set
Refer to Diagnostic Trouble Code (DTC) List Vehicle.
⇓ If none of the listed DTCs are set

3. Replace the K17 Electronic Brake Control Module.
4. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

⇒ If the DTC sets
Replace the module that set the DTC.
⇓ If the DTC does not set

5. 5. All OK.

5.8.1.1.10. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for Control Module replacement, programming and setup

5.8.1.2. DTC B2745

5.8.1.2.1. 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.

5.8.1.2.2. DTC Descriptors

DTC B2745 02
Traction Control Switch Circuit Short to Ground
DTC B2745 71
Traction Control Switch Circuit Invalid Data

5.8.1.2.3. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B2745 02, B274571	1	1	B2745 71
Ground	-	1	-	-
1. Traction Control Switch inoperative				

5.8.1.2.4. Circuit/System Description

The Body Control Module monitors the signal circuit from the Traction Control Switch. When the Traction Control Switch is pressed once, the Body Control Module will request the Electronic Brake Control Module via serial data to disable the traction control. When the Traction Control Switch is pressed and held for five seconds, the Body Control Module will request the Electronic Brake Control Module to disable the electronic stability control. The Electronic Brake Control Module will request the Instrument Cluster via serial data to turn the Traction Control Off and the Stability Control Off indicator ON to notify the driver of the deactivation.

5.8.1.2.5. Conditions for Running the DTC

Ignition ON.
Ignition voltage is greater than 8 V.

5.8.1.2.6. Conditions for Setting the DTC

B2745 02
The Body Control Module detects a short to ground on the signal circuit.
B2745 71
The Body Control Module detects an erratic signal or invalid serial data from the Traction Control Switch.

5.8.1.2.7. Action Taken When the DTC Sets

- The Electronic Brake Control Module stores the DTC.
- The Electronic Brake Control Module disables the traction and the stability control for the duration of the ignition cycle.

5.8.1.2.8. Conditions for Clearing the DTC

- The conditions for setting the DTC are no longer present.
- The Electronic Brake Control Module clears the history DTC when a current DTC is not detected in 40 consecutive drive cycles.

5.8.1.2.9. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.2.10. Circuit/System Verification

1. Ignition ON
2. Verify the Instrument Cluster Traction Control indicator turns ON and OFF when commanding the Instrument Cluster All Indicators ON and OFF with a scan tool.

⇒ If the indicator does not turn ON and OFF
Replace the P16 Instrument Cluster
⇓ If the indicator turns ON and OFF

3. Verify the scan tool Traction Control Switch parameter changes between Active and Inactive while pressing and releasing the traction control switch.

⇒ If the parameter does not change
Refer to Circuit/System Testing.
⇓ If the parameter changes

4. All OK.

5.8.1.2.11. Circuit/System Testing

1. Ignition OFF, scan tool disconnected, and all vehicle systems OFF, disconnect the harness connector at the S48E Multifunction Switch-Center Console. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 9 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 Body Control Module Traction Control Switch parameter is Inactive.
⇒ If not Inactive
   4.1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module.
   4.2. Test for infinite resistance between the signal circuit terminal 5 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 Inactive
5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the ground circuit terminal 9.
6. Verify the scan tool Traction Control Switch parameter is Active.
⇒ If not Active
   6.1. Ignition OFF, disconnect the X2 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 Active
7. Test or replace the S48E Multifunction Switch-Center Console.

5.8.1.2.12. Component Testing

1. Ignition OFF, disconnect the harness connector at the S48E Multifunction Switch-Center Console.
2. Test for infinite resistance between the signal terminal 5 and the ground terminal 9 with the switch in the open position.
⇒ If less than infinite resistance
Replace the S48E Multifunction Switch-Center Console.
⇓ If infinite resistance
3. Test for less than 2 Ω between the signal terminal 5 and the ground terminal 9 with the switch in the closed position.
⇒ If 2 Ω or greater
Replace the S48E Multifunction Switch-Center Console.
⇓ If less than 2 Ω
4. All OK.

5.8.1.2.13. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Front Floor Console Multifunction Switch Replacement.
- Control Module References for Body Control Module, Electronic Brake Control Module, programming and setup

5.8.1.3. DTC C0035, C0040, C0045, or C0050

5.8.1.3.1. 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.

5.8.1.3.2. DTC Descriptors

DTC C0035 06
Left Front Wheel Speed Sensor Low Voltage/Open
DTC C0035 0F
Left Front Wheel Speed Sensor Circuit Signal Erratic
DTC C0035 18
Left Front Wheel Speed Sensor Circuit Signal Low Signal Amplitude
DTC C0035 5A
Left Front Wheel Speed Sensor Not Plausible
DTC C0040 06
Right Front Wheel Speed Sensor Low Voltage/Open
DTC C0040 0F
Right Front Wheel Speed Sensor Circuit Signal Erratic
DTC C0040 18
Right Front Wheel Speed Sensor Circuit Signal Low Signal Amplitude
DTC C0040 5A
Right Front Wheel Speed Sensor Not Plausible
DTC C0045 06
Rear -1 Wheel Speed Sensor Low Voltage/Open
DTC C0045 0F
Rear -1 Wheel Speed Sensor Circuit Signal Erratic
DTC C0045 18
Rear -1 Wheel Speed Sensor Circuit Signal Low Signal Amplitude
DTC C0045 5A
Rear -1 Wheel Speed Sensor Not Plausible
DTC C0050 06
Rear 2 Wheel Speed Sensor Low Voltage/Open
DTC C0050 0F
Rear 2 Wheel Speed Sensor Circuit Signal Erratic
DTC C0050 18
Rear 2 Wheel Speed Sensor Circuit Signal Low Signal Amplitude
DTC C0050 5A
Rear 2 Wheel Speed Sensor Not Plausible

5.8.1.3.3. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Sensor Ignition	C0035 06	C0035 06	-	C0035 0F, C0035 18, C0035 5A
Left Front Sensor Signal	C0035 06	C0035 06	C0035 06	C0035 0F, C0035 18, C0035 5A
Right Front Sensor Ignition	C0040 06	C0040 06	-	C0040 0F, C0040 18, C0040 5A
Right Front Sensor Signal	C0040 06	C0040 06	C0040 06	C0040 0F, C0040 18, C0040 5A
Rear -1 Sensor Ignition	C0045 06	C0045 06	-	C0045 0F, C0045 18, C0045 5A
Rear -1 Sensor Signal	C0045 06	C0045 06	C0045 06	C0045 0F, C0045 18, C0045 5A
Rear 2 Sensor Ignition	C0050 06	C0050 06	-	C0050 0F, C0050 18, C0050 5A
Rear 2 Sensor Signal	C0050 06	C0050 06	C0050 06	C0050 0F, C0050 18, C0050 5A

Component	Condition	DTC Symptom Bytes
Wheel Speed Sensor	• Physical damage • Debris on the wheel speed sensor or the encoder ring • Loose or worn wheel bearing • Loose or improperly mounted sensor • Air gap between the wheel speed sensor and the encoder ring too large • Water intrusion in the wiring harness	0F, 18, or 5A

5.8.1.3.4. Circuit/System Description

The wheel speeds are detected by active wheel speed sensors and encoder rings. The encoder ring consists of permanent magnets. Each wheel speed sensor receives ignition voltage from the electronic brake control module and provides an alternating current square wave signal to the electronic brake control module. As the wheel spins, the electronic brake control module uses the frequency of the square wave signal to calculate the wheel speed.

5.8.1.3.5. Conditions for Running the DTC

C0035 06, C0040 06, C0045 06, or C0050 06

- Ignition ON.
- Ignition voltage is greater than 8 V.

C0035 0F, C0040 0F, C0045 0F, or C0050 0F

- Ignition ON.
- Ignition voltage is greater than 8 V.
- Vehicle speed is greater than 20 km/h (12 MPH).

C0035 18, C0040 18, C0045 18, or C0050 18

- Ignition ON.
- Ignition voltage is greater than 8 V.
- No other wheel speed circuit DTCs are set.
- At least two other wheel speed circuits are not 0 km/h (0 MPH).

C0035 5A, C0040 5A, C0045 5A, or C0050 5A

- Ignition ON.
- Ignition voltage is greater than 8 V.
- The vehicle speed is greater than 20 km/h (12 MPH).
- Conditions for Setting the DTC

C0035 06, C0040 06, C0045 06, or C0050 06

- A short to voltage is detected on a wheel speed signal.
- A short to ground or an open/high resistance is detected on a wheel speed signal.
- A short to ground or an open/high resistance is detected on a wheel speed ignition circuit.

C0035 18, C0040 18, C0045 18, or C0050 18

- One wheel speed is less than 2 km/h (1.2 MPH).
- The remaining wheel speeds are greater than 10 km/h (6.2 MPH) for 0.154 seconds.
- The difference between the remaining wheel speeds are less than 4 km/h (2.5 MPH) from each other for more than 2 minutes.

C0035 0F, C0040 0F, C0045 0F, or C0050 0F

The electronic brake control module detected a rapid variation in the wheel speed. The wheel speed changes 20 km/h (12 MPH) or more in 0.7 seconds. The change must occur 56 times with no more than 0.7 seconds between occurrences.

C0035 5A, C0040 5A, C0045 5A, or C0050 5A

- The difference between fastest and slowest wheel speed is greater than 60% for more than 2 minutes.

5.8.1.3.6. Action Taken When the DTC Sets

- The ABS indicator turns ON.
- The traction/stability control indicator turns ON, if equipped with electronic stability control.
- The electronic brake distribution does not function optimally with multiple wheel speed sensor DTCs set.

- The electronic brake control module disables the ABS, the traction control and the stability control for the duration of the ignition cycle.

5.8.1.3.7. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.3.8. Diagnostic Aids

- Do not use a magnet to clean the encoder ring.
- Inspect the wheel hub bearing encoder ring for rust or corrosion.
- Inspect the wheel speed sensor for contamination, physical damage, and correct installation.
- If two or more wheel speed sensors are inoperative, diagnose each wheel speed sensor individually.
- If any of the symptom codes 0F, 18 or 5A are set, refer to the Diagnostic Fault Information table for possible mechanical faults or conditions.
- If the customer comments that the ABS indicator is ON only during moist environmental conditions (rain, snow, vehicle wash, etc.), inspect the wheel speed sensor wiring for signs of water intrusion.

5.8.1.3.9. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views
Description and Operation
ABS 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

5.8.1.3.10. Circuit/System Verification

1. Test drive the vehicle in a straight line at a speed greater than 40 km/h (25 MPH).
2. Verify all scan tool Wheel Speed Sensor parameters are within 4 km/h (2.5 MPH) of each other.

⇒ If any parameter is not within 4 km/h (2.5 MPH) of each other
Refer to Circuit/System Testing.
⇓ If each parameter is within 4 km/h (2.5 MPH) of each other

3. All OK.

5.8.1.3.11. Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate B5 Wheel Speed Sensor and the harness connector at the K17 Electronic Brake Control Module, ignition ON.

2. Test for less than 1 V between the appropriate K17 Electronic Brake Control Module harness connector terminals listed below and ground:
   - B5LF Wheel Speed Sensor – Left Front — terminal 34 and terminal 21
   - B5LR Wheel Speed Sensor – Rear -1 — terminal 33 and terminal 20
   - B5RF Wheel Speed Sensor – Right Front — terminal 18 and terminal 31
   - B5RR Wheel Speed Sensor – Rear 2 — terminal 19 and terminal 32

⇒ If 1 V or greater
Repair the short to voltage on the circuit.
⇓ If less than 1 V
3. Ignition OFF.
4. Test for infinite resistance between the K17 Electronic Brake Control Module harness connector terminals listed below and ground:
   - B5LF Wheel Speed Sensor – Left Front — terminal 34 and terminal 21
   - B5LR Wheel Speed Sensor – Rear -1 — terminal 33 and terminal 20
   - B5RF Wheel Speed Sensor – Right Front — terminal 18 and terminal 31
   - B5RR Wheel Speed Sensor – Rear 2 — terminal 19 and terminal 32

⇒ If less than infinite resistance
Repair the short to ground on the circuit.
⇓ If infinite resistance
5. Test for less than 2 Ω between the B5 Wheel Speed Sensor harness connector terminal 1 and the K17 Electronic Brake Control Module harness connector terminal listed below:
   - B5LF Wheel Speed Sensor – Left Front — terminal 34
   - B5LR Wheel Speed Sensor – Rear -1 — terminal 33
   - B5RF Wheel Speed Sensor – Right Front — terminal 18
   - B5RR Wheel Speed Sensor – Rear 2 — terminal 19

⇒ If 2 Ω or greater
Repair the open/high resistance in the circuit.
⇓ If less than 2 Ω
6. Test for less than 2 Ω between the B5 Wheel Speed Sensor harness connector terminal 2 and the K17 Electronic Brake Control Module harness connector terminal listed below:
   - B5LF Wheel Speed Sensor – Left Front — terminal 21
   - B5LR Wheel Speed Sensor – Rear -1 — terminal 20
   - B5RF Wheel Speed Sensor – Right Front — terminal 31
   - B5RR Wheel Speed Sensor – Rear 2 — terminal 32

⇒ If 2 Ω or greater
Repair the open/high resistance in the circuit.
⇓ If less than 2 Ω
7. Replace the B5 Wheel Speed Sensor.
8. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

⇒ If the DTC sets
Replace the K17 Electronic Brake Control Module.
⇓ If the DTC does not set
9. All OK.

5.8.1.3.12. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Front Wheel Speed Sensor Replacement

- Rear Wheel Speed Sensor Replacement
- Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.4. DTC C0110

5.8.1.4.1. 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.

5.8.1.4.2. DTC Descriptors

DTC C0110 04
Pump Motor Circuit Open
DTC C0110 06
Pump Motor Circuit Low Voltage/Open
DTC C0110 61
Pump Motor Stuck

5.8.1.4.3. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 1	C0201 00	C0201 00	-	-
Ground Terminal 13	-	C0110 04, C0110 06	-	-
Ground Terminal 38	-	U0121	-	-

Component	Condition	DTC Symptom Bytes
Pump Motor	• Wear • Damage • Lock	C0110 61

5.8.1.4.4. Circuit/System Description

The pump motor is an integral part of the brake pressure modulator, while the pump motor relay is integral to the electronic brake control module. The pump motor relay is not engaged during normal system operation. When ABS operation is required the electronic brake control module activates the pump motor relay and battery voltage is provided to the pump motor.

5.8.1.4.5. Conditions for Running the DTC

C0110 04 or C0110 06

Ignition ON.

C0110 61

- The vehicle speed is greater than 20 km/h (13 MPH), and brake is not applied.
- The test is initiated once per ignition cycle, when the vehicle speed is greater than 15 km/h (9 MPH), and a fault was set on the last ignition cycle.

Conditions for Setting the DTC
C0110 04 or C0110 06
The ground circuit is open, and the feedback voltage is greater than 5 V for 0.5 seconds, the pump is not activated. The electronic brake control module detects a low voltage in the pump motor supply circuit when the feedback voltage is less than 5 V for greater than 500 ms, and the pump motor is not activated.

C0110 61
The pump motor continues to rotate briefly after deactivation creating a feedback voltage. The electronic brake control module sets the DTC if the measured feedback voltage indicates a binding or stalled pump motor.

5.8.1.4.6. Action Taken When the DTC Sets

- The ABS indicator turns ON.
- The traction/stability control indicator turns ON, if equipped with electronic stability control.
- The electronic brake control module disables the ABS, the traction control and the electronic stability control for the duration of the ignition cycle.

5.8.1.4.7. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.4.8. Reference Information
Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.4.9. Circuit/System Verification
1. Ignition ON
2. Verify the ABS pump motor turns ON and OFF when commanding the ABS Pump Motor ON and OFF with a scan tool.
⇒ If the pump motor does not turn ON and OFF

Refer to Circuit/System Testing.
⇓ If the pump motor turns ON and OFF
3. All OK.

5.8.1.4.10. Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K17 Electronic Brake Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminals listed below and ground:
   - Terminal 13
   - Terminal 38

⇒ 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 a test lamp illuminates between the B+ circuit terminal 1 and ground.

⇒ If the test lamp does not illuminate and the circuit fuse is good
   4.1. Ignition OFF.
   4.2. 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
   4.1. Ignition OFF.
   4.2. Test for infinite resistance between the B+ circuit and ground.
⇒ If less than infinite resistance, repair the short to ground on the circuit.
⇒ If infinite resistance, replace the Q5 Brake Pressure Modulator.
⇓ If the test lamp illuminates
5. Replace the Q5 Brake Pressure Modulator.
6. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

⇒ If the DTC sets
Replace the K17 Electronic Brake Control Module.
⇓ If the DTC does not set
7. All OK.

5.8.1.4.11. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Brake Pressure Modulator Valve Replacement
- Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.5. DTC C0131

5.8.1.5.1. 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.

5.8.1.5.2. DTC Descriptors

DTC C0131 00
Traction Control System Pressure Circuit Malfunction
DTC C0131 5A
Traction Control System Pressure Circuit Not Plausible

5.8.1.5.3. Circuit/System Description

The electronic brake control module monitors the brake pressure sensor which is integral to the brake pressure modulator. The body control module monitors the brake pedal position sensor signal when the brake pedal is applied and sends a serial data message to the electronic brake control module indicating the brake pedal position. The electronic brake control module compares the brake pressure to the brake pedal position and uses this information for vehicle stability control.

5.8.1.5.4. Conditions for Running the DTC

Ignition ON.

5.8.1.5.5. Conditions for Setting the DTC

C0131 00
The electronic brake control module detects the brake pressure is out of specified range.
C0131 5A
The electronic brake control module does not detect that the master cylinder pressure changed after driving the vehicle at a speed greater than 40 km/h (25 MPH) and performing three brake stops.

5.8.1.5.6. Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- The electronic brake control module disables the traction/stability or the duration of the ignition cycle, and the ABS remains functional.

5.8.1.5.7. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.5.8. Diagnostic Aids

Diagnose all other stop lamp DTCs or Symptoms prior to performing this diagnostic procedure.

5.8.1.5.9. Reference Information

Schematic Reference

- Antilock Brake System Schematics
- Exterior Lights Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.5.10. Circuit/System Verification

1. Ignition ON.
2. Verify the stop lamps turn ON and OFF while applying and releasing the brake pedal.

⇒ If the stop lamps do not turn ON and OFF
Refer to Symptoms Lighting.
⇓ If the stop lamps turn ON and OFF

3. Verify the Brake Pedal Position Sensor or the brake pedal are not binding causing residual brake pressure to be detected, while the brake lights operate properly.

⇒ If a condition is found
Repair or replace the appropriate component.
⇓ If a condition is not found

4. Verify the scan tool Brake Pressure Sensor parameter changes from 0 V to 1 V when the brake pedal is applied.

⇒ If the Brake Pressure Sensor parameter does not change
4.1. Replace the Q5 Brake Pressure Modulator.
4.2. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
⇒ If the DTC sets, replace the K17 Electronic Brake Control Module.
⇓ If the DTC does not set.
4.3. All OK.
⇓ If the Brake Pressure Sensor parameter changes

5. All OK.

5.8.1.5.11. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
- Brake Pressure Modulator Valve Replacement
- Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.6. DTC C0161

5.8.1.6.1. 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.

5.8.1.6.2. DTC Descriptors

DTC C0161 5A

Antilock Brake System Brake Switch Not Plausible

DTC C0161 71

Antilock Brake System Brake Switch Invalid Data

5.8.1.6.3. Circuit/System Description

When the brake pedal is applied, the body control module sends a serial data message to the electronic brake control module in
reference to the brake pedal positions. The electronic brake control module compares the correlation between the brake pedal
position and the amount of brake pressure it senses from the brake pressure sensor, which is internal to the brake pressure
modulator. It uses this information to control the vehicle during an stability control event.

5.8.1.6.4. Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 8 V.

5.8.1.6.5. Conditions for Setting the DTC

- The electronic brake control module detects the brake pedal is not applied when the brake pressure is greater 15 bar (218 PSI) for 3 seconds.
- The electronic brake control module does not detect that the stop lamp switch signal changed after driving the vehicle at a speed greater than 40 km/h (25 MPH) and performing three brake stops.

5.8.1.6.6. Action Taken When the DTC Sets

- The traction/stability control indicator off turns ON, if equipped with electronic stability control. functional.

5.8.1.6.7. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.6.8. Diagnostic Aids

DTC C0161 may set if the brake pedal is applied while accelerating.
Diagnose all other stop lamp DTCs or Symptoms prior to performing this diagnostic procedure.

5.8.1.6.9. Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.6.10. Circuit/System Verification

1. Ignition ON.
2. Verify the stop lamps turn ON and OFF while applying and releasing the brake pedal.

⇒ If the stop lamps do not turn ON and OFF
Refer to Symptoms Lighting.
⇓ If the stop lamps turn ON and OFF

3. Verify the Brake Pedal Position Sensor or the brake pedal are not binding causing residual brake pressure to be detected, while the brake lights operate properly.

⇒ If a condition is found
Repair or replace the appropriate component.
⇓ If a condition is not found

4. All OK.

5.8.1.6.11. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

5.8.1.7. DTC C0201

5.8.1.7.1. 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.

5.8.1.7.2. DTC Descriptor

DTC C0201 00

Antilock Braking System Enable Relay Primary Circuit

5.8.1.7.3. Circuit/System Description

Battery positive voltage is supplied to the electronic brake control module at all times through a 40 A fuse located in the under-hood fuse block. The electronic brake control module uses this voltage to power the pump motor. The pump motor is an integral part of the brake pressure modulator, while the pump motor relay is integral to the electronic brake control module. The pump motor relay is not engaged during normal system operation. When the ABS, traction/stability operation is required the electronic brake control module activates the pump motor relay and turns the pump motor ON.

5.8.1.7.4. Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 8 V.

5.8.1.7.5. Conditions for Setting the DTC

The pump motor supply voltage is less than 4 V.

5.8.1.7.6. Action Taken When the DTC Sets

- The ABS indicator turns ON.
- The traction/stability control indicator turns ON, if equipped with electronic stability control.
- The electronic brake control module disables the ABS, the traction control and the stability control for the duration of the ignition cycle.

5.8.1.7.7. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.7.8. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.7.9. Circuit/System Testing

1. Ignition OFF all vehicle systems OFF, disconnect the harness connector at the K17 Electronic Brake Control Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal listed below and ground:
   - Terminal 13
   - Terminal 38

⇒ 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 a test lamp illuminates between the B+ circuit terminal 1 and ground.

⇒ If the test lamp does not illuminate and the circuit fuse is good
   4.1. Ignition OFF.
   4.2. 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
   4.1. Ignition OFF.
   4.2. Test for infinite resistance between the B+ circuit and ground.
⇒ If less than infinite resistance, repair the short to ground on the circuit.
⇒ If infinite resistance, replace the Q5 Brake Pressure Modulator.
⇓ If the test lamp illuminates
5. Replace the Q5 Brake Pressure Modulator.
6. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

⇒ If the DTC sets
Replace the K17 Electronic Brake Control Module.
⇓ If the DTC does not set
7. All OK.

5.8.1.7.10. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Brake Pressure Modulator Valve Replacement
- Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.8. DTC C0242 or P0856

5.8.1.8.1. 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.

5.8.1.8.2. DTC Descriptors

DTC C0242 00

Powertrain Control Module Indicated Traction Control

DTC P0856

Traction Control Torque Request Circuit

5.8.1.8.3. Circuit/System Description

When traction control is active, the Electronic Brake Control Module sends a serial data message to the Engine Control Module requesting torque reduction. When certain Engine Control Module DTCs are set, the Engine Control Module will not be able to perform the torque reduction for traction control. A serial data message is sent to the Electronic Brake Control Module indicating that traction control is not allowed.

5.8.1.8.4. Conditions for Running the DTC

Engine running.

5.8.1.8.5. Conditions for Setting the DTC

The Engine Control Module detects a fault that prevents it from performing a traction control function and sends a serial data message to the Electronic Brake Control Module indicating that torque reduction is not allowed.

5.8.1.8.6. Action Taken When the DTC Sets

- The Traction/stability Control Indicator Off turns ON, if equipped with electronic stability control.
- The Electronic Brake Control Module disables the Traction/stability Control for the duration of the ignition cycle.

5.8.1.8.7. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.8.8. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.8.9. Circuit/System Verification

1. Ignition ON.
2. Verify that no other DTCs are set except for C0242 or P0856.

⇒ If any other DTCs are set
Refer to the Diagnostic Trouble Code (DTC) List Vehicle.
⇓ If no other DTCs are set

3. Replace the K20 Engine Control Module.
4. Verify that DTC C0242 or P0856 does not set while operating the vehicle within the Conditions for Running the DTC.

⇒ If DTC C0242 or P0856 sets
Replace the K17 Electronic Brake Control Module.
⇓ If DTC C0242 or P0856 does not set

5. All OK.

5.8.1.8.10. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for Electronic Brake Control Module and Engine Control Module replacement, programming and setup

5.8.1.9. DTC C0277

5.8.1.9.1. 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.

5.8.1.9.2. DTC Descriptors

DTC C0277 4B

Brake Pedal Position Sensor Circuit Calibration Not Learned

5.8.1.9.3. Circuit/System Description

When the brake pedal is applied, the body control module sends a serial data message to the electronic brake control module in reference to the brake pedal positions. The electronic brake control module compares the correlation between the brake pedal position and the amount of brake pressure it senses from the brake pressure sensor, which is internal to the brake pressure modulator. It uses this information to control the vehicle during an stability control event.

5.8.1.9.4. Conditions for Running the DTC

- Brakes Applied.
- Battery voltage must be between 9–16 V.

5.8.1.9.5. Conditions for Setting the DTC

- The body control module sends invalid brake pedal position data to the electronic brake control module.
- The DTC may set in the body control module and/or electronic brake control module, when the brake pedal position sensor home position is not learned.

5.8.1.9.6. Actions Taken When the DTC Sets

- The ABS indicator is commanded ON.
- The red brake indicator is commanded ON.
- The stop lamps may not activate at the expected brake pedal positions.
- The traction/stability control indicator turns ON, if equipped with electronic stability control.

5.8.1.9.7. Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A DTC will not clear the current status until the next ignition cycle.
- A successful brake pedal position sensor calibration has been performed.
- A history DTC will clear once 40 malfunction-free ignition cycles have occurred.

5.8.1.9.8. Reference Information

Schematic Reference
Antilock Brake System Schematics
Exterior Lights Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS Description and Operation
Exterior Lighting Systems 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

5.8.1.9.9. Circuit/System Verification

1. Verify DTC C0277 is not set in the K9 Body Control Module.

⇒ If DTC is set
Refer to DTC C0277 or C0890.
⇓ If DTC is not set

2. Ignition ON
3. Verify the scan tool Body Control Module Brake Pedal Position Sensor Learned Released Position is YES.

⇒ If the released position is not YES
Perform the Brake Pedal Position Sensor Learn. Refer to Brake Pedal Position Sensor Calibration.
⇓ If the released position is YES

4. Verify the DTC does not set while operating the vehicle within 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.

5.8.1.9.10. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.10. DTC C027C

5.8.1.10.1. 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.

5.8.1.10.2. DTC Descriptor

DTC C027C

Front Brake Discs High Temperature
For symptom byte information refer to Symptom Byte List.

5.8.1.10.3. Circuit/System Description

The electronic brake control module monitors how often the traction control or the stability control system activates in order to
calculate an estimate of the front brake discs temperature. In most cases the high temperatures are caused by extended traction control activation. If the electronic brake control module calculates that the front brake components temperatures are too high, the electronic brake control module will temporarily suspend the traction control system function until the front brake discs cool down.

5.8.1.10.4. Conditions for Running the DTC

Ignition ON.

5.8.1.10.5. Conditions for Setting the DTC

The electronic brake control module detects the calculated temperature of the brake components is higher than 500°C (932°F).

5.8.1.10.6. Action Taken When the DTC Sets

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

5.8.1.10.7. Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.
The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.10.8. Diagnostic Aids

DTC C027C does not indicate a malfunction has occurred. This DTC indicates there was excessive traction control or stability control
activation that caused the high temperatures.

5.8.1.10.9. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.10.10. Circuit/System Verification

Note:
Since most occurrences of this DTC are caused by excessive brake usage, review with the customer the conditions under which the DTC set.

1. Allow the brakes to cool down before performing test.
2. Verify that no other DTCs are set.

⇒ If any other DTCs are set
Refer to Diagnostic Trouble Code (DTC) List Vehicle.
⇓ If no other DTCs are set

3. Verify DTC C027C does not set while driving the vehicle under normal braking conditions. Refer to Brake System Vehicle Road Test.

⇒ If the DTC sets
Replace the K17 Electronic Brake Control Module.
⇓ If the DTC does not set

4. 4. All OK.

5.8.1.10.11. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for electronic brake control module replacement, programming, and setup

5.8.1.11. DTC C0561

5.8.1.11.1. 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.

5.8.1.11.2. DTC Descriptor

DTC C0561 77

System Disabled Information Stored Engine Speed Out of Range

DTC C0561 78

System Disabled Information Stored Acceleration Pedal Position Out of Range

DTC C0561 79

System Disabled Information Stored Transmission Gear Invalid Data

5.8.1.11.3. Circuit/System Description

The electronic brake control module disables the traction and the stability control when other electronic control modules set DTCs for components that effect the operation of the brake system.

5.8.1.11.4. Conditions for Running the DTC

- Engine Running.
- Ignition voltage is greater than 8 V.

5.8.1.11.5. Conditions for Setting the DTC

The electronic brake control module receives an invalid serial data message from another module more than ten times.

5.8.1.11.6. Action Taken When the DTC Sets

- The ABS system remains functional.
- The electronic brake control module disables the stability control for the entire ignition cycle.

5.8.1.11.7. Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free drive cycles have occurred.

5.8.1.11.8. Diagnostic Aids

- This DTC indicates there are no problems in the brake system. The body control module, engine control module, and transmission control module should be checked for a possible fault first.
- Inspect the serial data circuits and connections at the engine control module and the electronic brake control module. They should be free from sources of electromagnetic interference and the connections should be clean and tight.

5.8.1.11.9. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation
ABS 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

5.8.1.11.10. Circuit/System Verification

5.8.1.11.10.1. C0561 77 or C0561 78

1. Ignition ON.
2. Verify there are no other DTCs set.

⇒ If any other DTCs are set
Refer to the Diagnostic Trouble Code (DTC) List Vehicle.
⇓ If no other DTCs are set

3. Replace the K20 Engine Control Module.
4. Verify the DTC does not set while operating the vehicle within 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.

5.8.1.11.10.2. C0561 79

1. Ignition ON.
2. Verify there are no other DTCs set.

⇒ If any other DTCs are set
Refer to the Diagnostic Trouble Code (DTC) List Vehicle.
⇓ If no other DTCs are set

3. Replace the K71 Transmission Control Module.
4. Verify the DTC does not set while operating the vehicle within 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.

5.8.1.11.11. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for Electronic Brake Control Module, Engine Control Module, or Transmission Control Module replacement, programming and setup

5.8.1.12. DTC C056D

5.8.1.12.1. 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.

5.8.1.12.2. DTC Descriptor

DTC C056D 00

Electronic Control Unit Hardware Malfunction

5.8.1.12.3. Circuit/System Description

The Electronic Brake Control Module detects an internal malfunction.

5.8.1.12.4. Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 8 V.

5.8.1.12.5. Conditions for Setting the DTC

The Electronic Brake Control Module detects an internal malfunction.

5.8.1.12.6. Action Taken When the DTC Sets

- The ABS Indicator turns ON.
- The red Brake Warning Indicator turns ON.
- The Traction/stability Control Indicator turns ON, if equipped with electronic stability control.
- The Electronic Brake Control Module disables the ABS, and the Traction/stability for the duration of the ignition cycle.

5.8.1.12.7. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.12.8. Reference Information

Schematic Reference
Antilock Brake System Schematics
Connector End View Reference
Component Connector End Views
Description and Operation
ABS 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

5.8.1.12.9. Circuit/System Verification

1. Verify that DTC C056D is not set.

⇒ If the DTC is set

Replace the K17 Electronic Brake Control Module.

⇓ If the DTC is not set
2. All OK.

5.8.1.12.10. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.13. DTC C056E

5.8.1.13.1. 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.

5.8.1.13.2. DTC Descriptors

DTC C056E 42

Electronic Control Unit Software Calibration Not Programmed

DTC C056E 47

Electronic Control Unit Software VIN Not Programmed

5.8.1.13.3. Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 8 V.

5.8.1.13.4. Conditions for Setting the DTC

A new service replacement Electronic Brake Control Module contains a unique manufacturing calibration. This DTC will be current whenever a new Electronic Brake Control Module is installed on a vehicle prior to the Service Programming System (SPS) event. The DTC will remain current until the Electronic Brake Control Module has undergone a successful program. Once the program event is completed, the DTC goes into history and can be cleared. After the DTC is cleared it can not return.

5.8.1.13.5. Action Taken When the DTC Sets

- The ABS Indicator turns ON.
- The red Brake Warning Indicator turns ON.
- The Traction/stability Control Indicator turns ON, if equipped with electronic stability control.
- The Electronic Brake Control Module disables the ABS, and the Traction/stability for the duration of the ignition cycle.

5.8.1.13.6. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.13.7. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.13.8. Circuit/System Verification

1. Verify that DTC C056E is not set.

⇒ If the DTC is set

1.1. Ignition ON
1.2. Program the K17 Electronic Brake Control Module.
1.3. Verify the DTC does not set after driving the vehicle above 40 km/h (25 MPH).

⇒ If the DTC sets, replace the K17 Electronic Brake Control Module.

⇓ If the DTC does not set.

1.4. All OK.

⇓ If the DTC is not set

2. All OK.

5.8.1.13.9. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.14. DTC C0710

5.8.1.14.1. 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.

5.8.1.14.2. DTC Descriptors

DTC C0710 4B

Steering Position Signal Calibration Not Learned

DTC C0710 5A

Steering Position Signal Not Plausible

DTC C0710 71

Steering Position Signal Invalid Data

5.8.1.14.3. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	U0126, C0710 71	U0126, C0710 71	-	C0710 5A
Ground	-	U0126, C0710 71	-	-

5.8.1.14.4. Circuit/System Description

The steering wheel angle sensor receives a 12 V reference from the electronic brake control module. The electronic brake control module receives serial data message inputs from the steering wheel angle sensor identifying the position and direction of the steering wheel rotation. The module utilizes this signal to calculate the driver intended driving direction.

5.8.1.14.5. Conditions for Running the DTC

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

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

5.8.1.14.6. Conditions for Setting the DTC

C0710 4B

The steering wheel angle sensor is not calibrated after installation.

C0710 5A

The steering wheel angle sensor is out of the specified range.

The steering wheel angle sensor offset is out of the specified range.

C0710 71

The steering wheel angle sensor signal is not plausible with the yaw rate signal and lateral acceleration signal.

5.8.1.14.7. Action Taken When the DTC Sets

- The ABS remains functional.
- The electronic brake control module disables the stability control for the duration of the ignition cycle.

5.8.1.14.8. Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

5.8.1.14.9. Diagnostic Aids

- Improperly mounted or loose steering wheel angle sensor.
- Inspect the vehicle for proper alignment. The car should not pull in either direction while driving straight on a level surface.
- Confirm that all tires are of the proper size and that all are matching brands. Check and adjust all tires to the stated cold air pressure as identified on the tire placard. If a mis-sized or non-matching brand tire is present, inform the customer that in order for the vehicle stability enhanced system to function normally, tires need to be a uniform size and rolling diameter.

5.8.1.14.10. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.14.11. Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Steering Wheel Position parameter corresponds to the actual steering wheel position as the steering wheel is turned through its entire range of motion.

⇒ If the parameter does not correspond with the steering wheel position or the reading is erratic
Refer to Circuit/System Testing.
⇓ If the parameter reading corresponds with the steering wheel position
3. All OK.

5.8.1.14.12. Circuit/System Testing

1. Ignition OFF all vehicle systems OFF, disconnect the harness connector at the B99 Steering Wheel Angle Sensor. 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 6 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 that a test lamp illuminates between the 12 reference circuit terminal 5 and ground.

⇒ If the test lamp does not illuminate

4.1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module
4.2. Test for infinite resistance between the 12 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 12 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 K17 Electronic Brake Control Module.
⇓ If the test lamp illuminates

5. Replace the B99 Steering Wheel Angle Sensor.
6. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

⇒ If the DTC sets
Replace the K17 Electronic Brake Control Module.
⇓ If the DTC does not set

7. All OK.

5.8.1.14.13. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Steering Angle Sensor Replacement
- Control Module References for Electronic Brake Control Module replacement, programming and setup

5.8.1.15. DTC P0501 or P1793

5.8.1.15.1. 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.

5.8.1.15.2. DTC Descriptors

DTC P0501

vehicle Speed Sensor Performance

DTC P1793

Wheel Speed Signal

For symptom byte information refer to Symptom Byte List.

5.8.1.15.3. Circuit/System Description

The wheel speeds are detected by active wheel speed sensors. Each wheel speed sensor receives a 12 V reference voltage from the electronic brake control module and provides an alternating current square wave signal to the electronic brake control module. As the wheel spins, the electronic brake control module uses the frequency of the square wave signal to calculate the wheel speed. The electronic brake control module sends the wheel speed information as a high speed controller area network (CAN) serial data message. Some modules connected to the high speed CAN bus monitor for the wheel speed information. The DTC is set when the wheel speed information has not been received.

5.8.1.15.4. Conditions for Running the DTC

Ignition ON.

5.8.1.15.5. Conditions for Setting the DTC

A supervised periodic message that includes the wheel speed serial data has not been received.

5.8.1.15.6. Action Taken When the DTC Sets

Specific subsystems will not function or operate in degraded mode.

5.8.1.15.7. Conditions for Clearing the DTC

A current DTC clears when the diagnostic runs and passes.

5.8.1.15.8. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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

5.8.1.15.9. Circuit/System Verification

1. Test drive the vehicle in a straight line at a speed greater than 40 km/h (25 MPH).
2. Verify all scan tool Wheel Speed Sensor parameters are within 4 km/h (2.5 MPH) of each other.

⇒ If any parameter is not within 4 km/h (2.5 MPH) of each other
Refer to Circuit/System Testing.
⇓ If each parameter is within 4 km/h (2.5 MPH) of each other
3. All OK.

5.8.1.15.10. Circuit/System Testing

1. Ignition ON.
2. Verify that DTC C0035, C0040, C0045, C0050, or C0055 is not set.

⇒ If any listed DTC is set
Refer to Diagnostic Trouble Code (DTC) List Vehicle diagnose that DTC prior to this diagnostic.
⇓ If none listed DTC is set
3. Ignition OFF, replace the K17 Electronic Brake Control Module, ignition ON.
4. Verify the DTC does not set.

⇒ If the DTC sets
Replace the module that set the DTC.
⇓ If the DTC does not set
5. All OK.

5.8.1.15.11. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Control Module References for Control Module replacement, programming and setup.

5.8.1.16. Symptoms Antilock Brake System

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

1. Perform the Diagnostic System Check Vehicle before using the symptom tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to ABS Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the ABS. 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:

- ABS Indicator Malfunction
- Traction Control/Stability Control Indicator Malfunction

5.8.1.17. ABS Indicator Malfunction

5.8.1.17.1. 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.

5.8.1.17.2. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B2745 02, B274571	1	1	B2745 71
Ground	-	1	-	-
1. Traction Control Switch inoperative				

5.8.1.17.3. Circuit/System Description

The Instrument Cluster illuminates the Traction/stability Control indicator, Traction Control Off indicator and Stability Control Off indicator for five seconds after the ignition is turned ON. When the Electronic Brake Control Module detects a fault it sends a serial data message to the Instrument Cluster commanding the Traction/stability Control indicator ON.

The Body Control Module monitors the signal circuit from the Traction Control Switch. When the Traction Control Switch is pressed once, the Body Control Module sends a serial data message to the Electronic Brake Control Module to disable the traction control system. When the Traction Control Switch is pressed and held for five seconds, the Body Control Module will request the Electronic Brake Control Module to disable the electronic stability control. The Electronic Brake Control Module will request the Instrument Cluster to turn the Traction Control Off and the Stability Control Off indicator ON to notify the driver of the deactivation.

5.8.1.17.4. Reference Information

Schematic Reference
Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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.

5.8.1.17.5. Circuit/System Verification

1. Ignition ON
2. Verify the Instrument Cluster Traction Control indicator turns ON and OFF when commanding the Instrument Cluster All Indicators ON and OFF with a scan tool.
⇒ If the indicator does not turn ON and OFF
Replace the P16 Instrument Cluster.
⇓ If the indicator turns ON and OFF
3. Verify the scan tool electronic brake control module Traction Control Switch parameter changes between Active and Inactive while pressing and releasing the traction control switch.
⇒ If the parameter does not change
Refer to Circuit/System Testing.
⇓ If the parameter changes
4. All OK.

5.8.1.17.6. Circuit/System Testing

1. Ignition OFF, scan tool disconnected, and all vehicle systems OFF, disconnect the harness connector at the S48E Multifunction Switch-Center Console. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 9 and ground.
⇒ If 5 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 5 Ω
3. Ignition ON.
4. Verify the scan tool Traction Control Switch parameter is Inactive.
⇒ If not Inactive
4.1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module.
4.2. Test for infinite resistance between the signal circuit terminal 5 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 Inactive
5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the ground circuit terminal 9.
6. Verify the scan tool Traction Control Switch parameter is Active.
⇒ If not Active
6.1. Ignition OFF, disconnect the X2 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 Active
7. Test or replace the S48E Multifunction Switch-Center Console.

5.8.1.17.7. Component Testing

1. Ignition OFF, disconnect the harness connector at the S48E Multifunction Switch-Center Console.
2. Test for infinite resistance between the signal terminal 5 and the ground terminal 9 with the switch in the open position.

⇒ If less than infinite resistance

Replace the S48E Multifunction Switch-Center Console.

⇓ If infinite resistance

3. Test for less than 2 Ω between the signal circuit terminal 5 and the ground terminal 9 with the switch in the closed position.

⇒ If 2 Ω or greater

Replace the S48E Multifunction Switch-Center Console.

⇓ If less than 2 Ω

4. All OK.

5.8.1.17.8. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Refer to Control Module References for Body Control Module, Electronic Brake Control Module or Instrument Cluster
replacement, programming and setup

5.8.1.18. Traction Control/Stability Control Indicator Malfunction

5.8.1.18.1. 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.

5.8.1.18.2. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B2745 02, B274571	1	1	B2745 71
Ground	-	1	-	-
1. Traction Control Switch inoperative				

5.8.1.18.3. Circuit/System Description

The Instrument Cluster illuminates the Traction/stability Control indicator, Traction Control Off indicator and Stability Control Off indicator for five seconds after the ignition is turned ON. When the Electronic Brake Control Module detects a fault it sends a serial data message to the Instrument Cluster commanding the Traction/stability Control indicator ON.

The Body Control Module monitors the signal circuit from the Traction Control Switch. When the Traction Control Switch is pressed once, the Body Control Module sends a serial data message to the Electronic Brake Control Module to disable the traction control system. When the Traction Control Switch is pressed and held for five seconds, the Body Control Module will request the Electronic Brake Control Module to disable the electronic stability control. The Electronic Brake Control Module will request the Instrument Cluster to turn the Traction Control Off and the Stability Control Off indicator ON to notify the driver of the deactivation.

5.8.1.18.4. Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
ABS 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.

5.8.1.18.5. Circuit/System Verification

1. Ignition ON
2. Verify the Instrument Cluster Traction Control indicator turns ON and OFF when commanding the Instrument Cluster All Indicators ON and OFF with a scan tool.

⇒ If the indicator does not turn ON and OFF

Replace the P16 Instrument Cluster.

⇓ If the indicator turns ON and OFF

3. Verify the scan tool electronic brake control module Traction Control Switch parameter changes between Active and Inactive while pressing and releasing the traction control switch.

⇒ If the parameter does not change

Refer to Circuit/System Testing.

⇓ If the parameter changes

4. All OK.

5.8.1.18.6. Circuit/System Testing

1. Ignition OFF, scan tool disconnected, and all vehicle systems OFF, disconnect the harness connector at the S48E Multifunction Switch-Center Console. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 9 and ground.

⇒ If 5 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 5 Ω

3. Ignition ON.
4. Verify the scan tool Traction Control Switch parameter is Inactive.

⇒ If not Inactive

4.1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module.

4.2. Test for infinite resistance between the signal circuit terminal 5 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 Inactive

5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the ground circuit terminal 9.
6. Verify the scan tool Traction Control Switch parameter is Active.

⇒ If not Active

6.1. Ignition OFF, disconnect the X2 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 Active

7. Test or replace the S48E Multifunction Switch-Center Console.

5.8.1.18.7. Component Testing

1. Ignition OFF, disconnect the harness connector at the S48E Multifunction Switch-Center Console.
2. Test for infinite resistance between the signal terminal 5 and the ground terminal 9 with the switch in the open position.

⇒ If less than infinite resistance
Replace the S48E Multifunction Switch-Center Console.
⇓ If infinite resistance
3. Test for less than 2 Ω between the signal circuit terminal 5 and the ground terminal 9 with the switch in the closed position.

⇒ If 2 Ω or greater
Replace the S48E Multifunction Switch-Center Console.
⇓ If less than 2 Ω
4. All OK.

5.8.1.18.8. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.
Refer to Control Module References for Body Control Module, Electronic Brake Control Module or Instrument Cluster replacement, programming and setup

5.8.1.18.9. Connector Reconnection Wheel Speed Sensor

Special Tools
EL-35616 Terminal Test Probe Kit

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

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

- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- A terminal did not seat all the way into the connector body
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to Inducing Intermittent Fault Conditions in order to duplicate the conditions required, in order to verify the customer concern.

- Refer to Testing for Electrical Intermittent for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to Scan Tool Snapshot **Procedure** for advanced intermittent diagnosis and Vehicle Data Recorder operation.

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

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

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

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

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

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

Follow the procedure below in order to test terminal contact:
1. Separate the connector halves.

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

Flat Wire Connectors
There are no serviceable parts for flat wire connectors on the harness side or the component side.
Follow the procedure below in order to test terminal contact:

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

Control Module/Component Voltage and Grounds
Poor voltage or ground connections can cause widely varying symptoms.

Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to Circuit Testing and Power Distribution Schematics.

Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to Circuit Testing and Ground Distribution Schematics.

Temperature Sensitivity

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

– High ambient temperatures

– Underhood/engine generated heat
– Circuit generated heat due to a poor connection, or high electrical load
– Higher than normal load conditions, towing, etc.

- If the intermittent is related to cold, review the data for the following:

– Low ambient temperatures In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
– The condition only occurs on a cold start.
– The condition goes away when the vehicle warms up.

- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to Inducing Intermittent Fault Conditions in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

- Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:
- A misrouted harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. — These components may induce electrical noise on a circuit that could interfere with normal circuit operation.

- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch — These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.

- Installation of non-factory or aftermarket add on accessories such as lights, 2way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. — These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to Checking Aftermarket Accessories.

- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:

– A new service control module is installed.
– A control module from another vehicle is installed.
– Revised software/calibration files have been released for this vehicle.

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

Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to Control Module References for replacement, setup, and programming.

5.8.2. Repair instructions

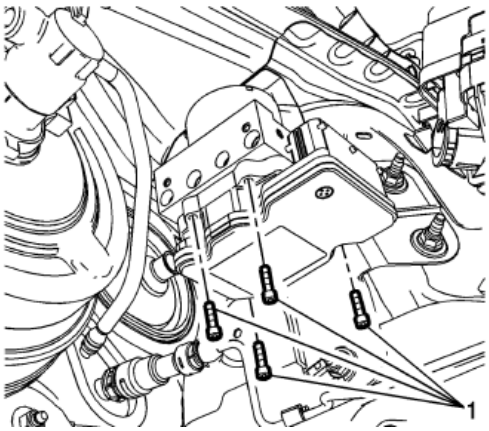
5.8.2.1. Electronic Brake Control Module Replacement

5.8.2.1.1. Removal Procedure

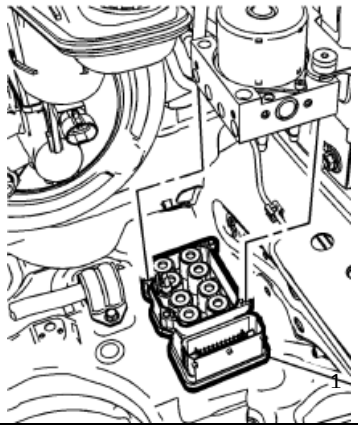
Warning:
Brake Fluid Irritant Warning

Caution:
Brake Fluid Effects on Paint and Electrical Components Caution

1. Remove the Air box
2. Disconnect the electronic brake control module (EBCM) electrical connector.



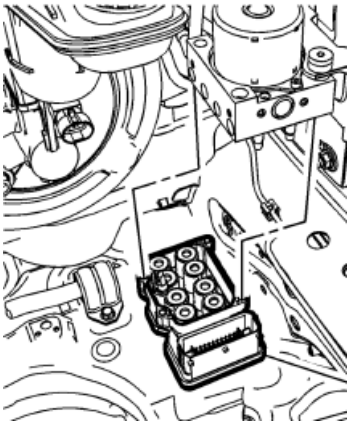
3. Remove the EBCM bolts (1),



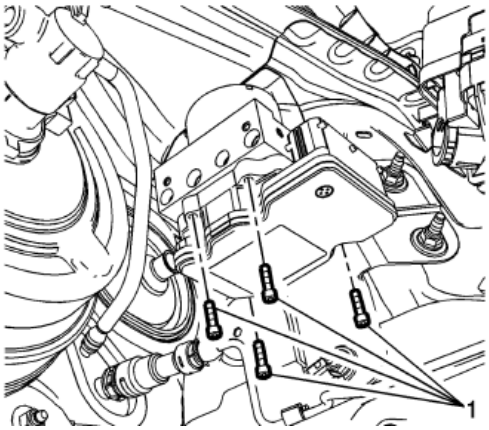
Note:
Do not pry the components apart.

4. Carefully separate the EBCM (1) from the BPMV.
5. Clean the sealing surfaces of the EBCM and the BPMV with denatured alcohol and allow to dry.

5.8.2.1.2. Installation Procedure



1. Install the EBCM (1) to the BPMV.



Caution:
Refer to Fastener Caution.

2. Install the EBCM bolts (1) and tighten to 3 Nm (26 lb in).
3. Connect the EBCM electrical connector.
4. Install the Air box
5. Program the EBCM. Refer to Control Module References.

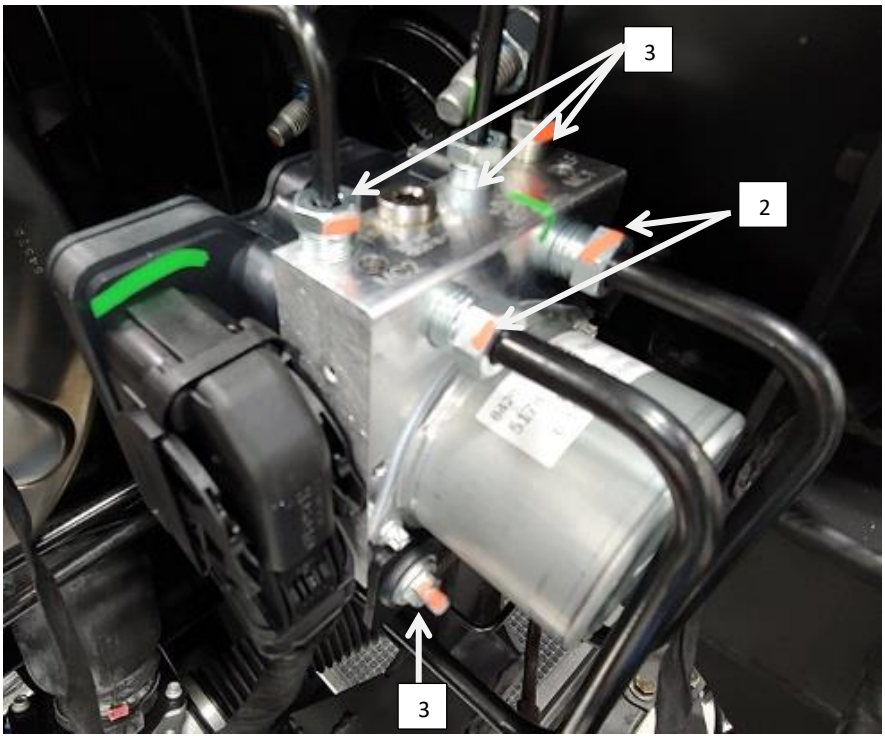
5.8.2.2. Brake Pressure Modulator Valve Replacement

5.8.2.2.1. Removal Procedure

Warning:
Brake Fluid Irritant Warning

Caution:
Brake Fluid Effects on Paint and Electrical Components Caution

Caution:
Always connect or disconnect the wiring harness connector from the EBCM/EBTCM with the ignition switch in the OFF position. Failure to observe this precaution could result in damage to the EBCM/EBTCM.



1. Place the ignition switch in the OFF position.
2. Remove the Air box

Note:
The area around the electronic brake control module (EBCM) and brake pressure modulator valve (BPMV) assembly must be free from loose dirt to prevent contamination of disassembled ABS components.

3. Clean the area surrounding the EBCM/BPMV of any accumulated dirt and debris.
4. Disconnect the EBCM electrical connector.
5. Disconnect the master cylinder secondary brake pipe fitting (1) from the BPMV.

6. Cap the brake pipe fitting and plug the BPMV inlet port to prevent brake fluid loss and contamination.
7. Disconnect the master cylinder primary brake pipe fitting (2) from the BPMV.
8. Cap the brake pipe fitting and plug the BPMV inlet port to prevent brake fluid loss and contamination.
9. Reference mark the BPMV outlet brake pipe fittings (3) and disconnect the fittings.
10. Cap the brake pipe fittings and plug the BPMV outlet ports to prevent brake fluid loss and contamination.
11. Remove the two bolts (3) from the BPMV.
12. Remove the EBCM from the vehicle.
13. If installing a new BPMV, remove the EBCM. Refer to Electronic Brake Control Module Replacement.

5.8.2.2.2. Installation Procedure

1. If installing a new BPMV, install the EBCM. Refer to Electronic Brake Control Module Replacement.
2. Install the BPMV and EBCM to the vehicle.

Caution:
Refer to Fastener Caution.

3. Install the BPMV bolts (4) and tighten to 11 Nm (97 lb in).
4. Install the BPMV outlet brake pipe fittings (3) to the BPMV outlet ports.

Note:
Install the brake pipes in the same locations referenced during removal.

5. Connect the brake pipe fittings and tighten to 18 Nm (13 lb ft).
6. Connect the master cylinder primary brake pipe fitting (1) to the BPMV and tighten to 18 Nm (13 lb ft).
7. Connect the master cylinder secondary brake pipe fitting (2) to the BPMV and tighten to 18 Nm (13 lb ft).
8. Connect the EBCM electrical connector.
9. Install the Air box
10. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding.
11. Perform the Diagnostic System Check Vehicle.
12. Observe the brake pedal feel after performing the diagnostic system check. If the pedal now feels spongy, air may have been in the secondary hydraulic circuit of the brake modulator which may have been introduced into the primary circuit. If the pedal feels spongy, bleed the antilock brake system. Refer to Antilock Brake System Automated Bleed.

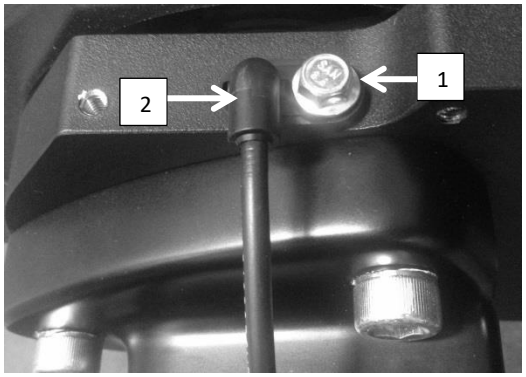
5.8.2.3. Rear Wheel Speed Sensor Replacement

5.8.2.3.1. Removal Procedure

Warning:
Refer to Brake Dust Warning.

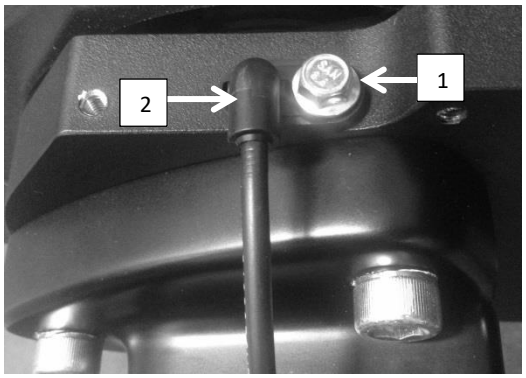
Note:
There are two wheel speed sensors on the rear wheel, one located on the top and one the bottom of the rear hub adaptor

1. Remove the Rear Hub Cover



2. Remove the rear wheel speed sensor(s) bolt(s) (1)
3. Remove the rear wheel speed sensor(s) (2)
4. Remove wire connectors along the underside of the swing-arm
5. Disconnect the rear wheel speed sensor electrical connection

5.8.2.3.2. Installation Procedure



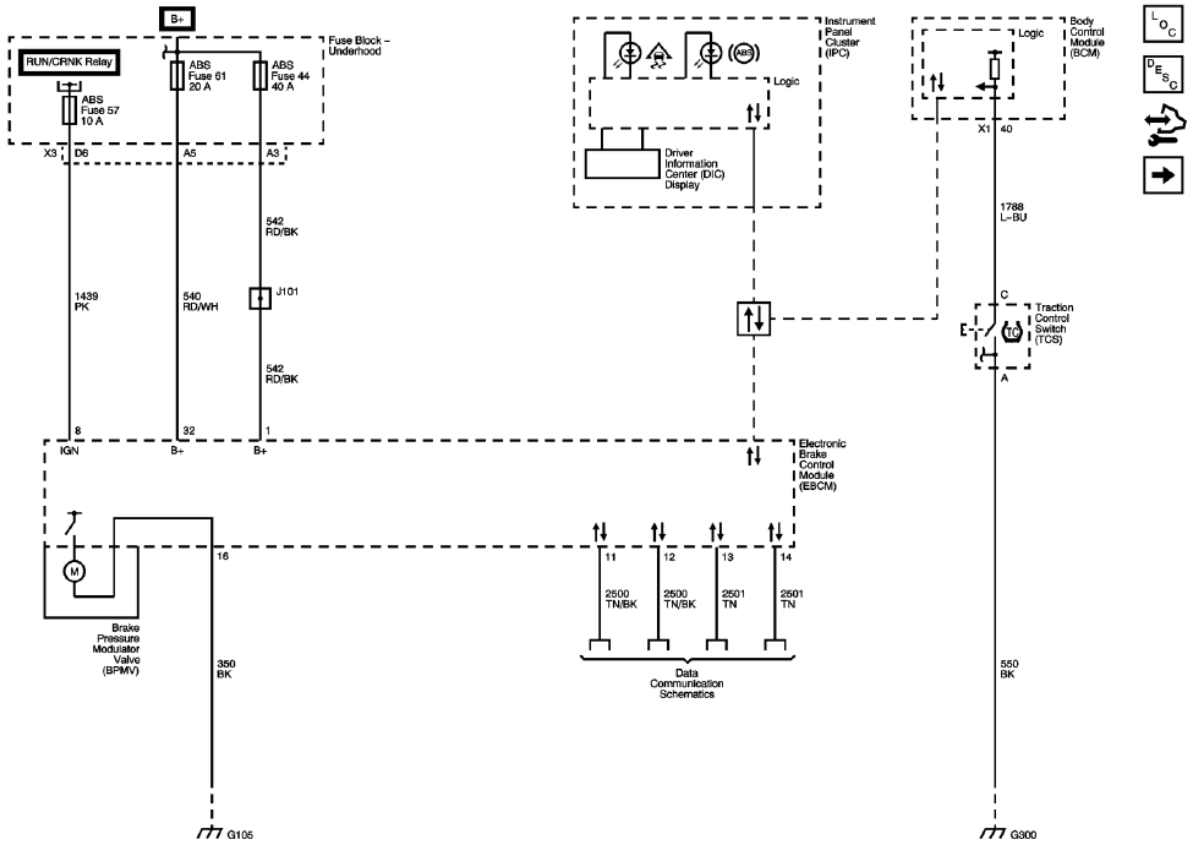
1. Insert the rear wheel speed sensor (2) in to the hub adaptor
2. Install the wheel speed sensor bolt (1) and tighten to 8 Nm (71 lb in)
3. Run wire under swing arm and install the wire holders
4. Install the rear hub cover

5.8.3. Specifications

Application	Specification	
	Metric	English
Brake Pipe Fitting	18 Nm	13 lb ft
Brake Pressure Modulator Valve Bolt	11 Nm	97 lb in
Brake Pressure Modulator Valve Bracket Nut	17 Nm	12 lb ft
Electronic Brake Control Module Bolt	3 Nm	26 lb in
Rear Wheel Speed Sensor Connector Cover Nut	2 Nm	18 lb in
Wheel Speed Sensor Bolt-Front and Rear	8 Nm	71 lb in

5.8.4. Schematic and Routing Diagrams

5.8.4.1. Power, Ground, Indicator, Traction Control Switch, and Brake Booster Vacuum Sensor



5.8.5. Special Tools and Equipment

5.9. Disc Brakes

5.9.1. Specifications

5.9.1.1. Disc Brake Component Specifications

Application	Specification	
	Metric	English
Front Brakes		
• Brake Pad Lining Minimum Thickness	1.0 mm	0.039 in
• Brake Pad Lining Thickness− New	12.0 mm	0.472 in
• Brake Rotor Diameter	280.00 mm	11.024 in
• Brake Rotor Discard Thickness*	22.0 mm	0.87 in
• Brake Rotor Maximum Allowable Assembled Lateral Runout	0.06 mm	0.002 in
• Brake Rotor Maximum Allowable Scoring	1.50 mm	0.059 in
• Brake Rotor Maximum Allowable Thickness Variation	0.025 mm	0.001 in
• Brake Rotor Minimum Allowable Thickness After Refinish	22.75 mm	0.896 in
• Brake Rotor Thickness− New	23.69 mm	0.933 in
Front Brakes (Sport Brembo)		
• Brake Rotor Diameter	315.5 mm	12.421 in
• Brake Rotor Discard Thickness*	24.0 mm	0.945 in
• Brake Rotor Maximum Allowable Assembled Lateral Runout	0.06 mm	0.002 in
• Brake Rotor Maximum Allowable Scoring	1.50 mm	0.059 in
• Brake Rotor Maximum Allowable Thickness Variation	0.025 mm	0.001 in
• Brake Rotor Minimum Allowable Thickness After Refinish	24.2 mm	0.952 in
• Brake Rotor Thickness− New	26.0 mm	1.023 in
Front Brakes (Without Sport Brembo)		
• Brake Rotor Diameter	296.00 mm	11.653 in
• Brake Rotor Discard Thickness*	22.8 mm	0.898 in
• Brake Rotor Maximum Allowable Assembled Lateral Runout	0.06 mm	0.002 in
• Brake Rotor Maximum Allowable Scoring	1.50 mm	0.059 in
• Brake Rotor Maximum Allowable Thickness Variation	0.025 mm	0.001 in
• Brake Rotor Minimum Allowable Thickness After Refinish	23.0 mm	0.906 in
• Brake Rotor Thickness− New	26.0 mm	1.023 in

* All brake rotors have a discard dimension cast into them. Replace any rotor that does not meet this specification. After refinishing the rotor, replace any rotor that does not meet the minimum thickness after refinish specification.

5.9.1.2. Fastener Specifications

Application	Specification	
	Metric	**English**
Brake Caliper Bleeder Valve– Front (Sport Brembo)	14 Nm	124 lb in
Brake Caliper Bleeder Valve– Front	11 Nm	97 lb in
Brake Caliper Bleeder Valve– Rear	11 Nm	97 lb in
Front Brake Caliper Bolts to Steering Knuckle (Sport Brembo)	130 Nm	96 lb ft
Rear Brake Caliper Bolts to Hub Adaptor	115 Nm	85 lb ft
Brake Caliper Bracket Bolt	115 Nm	85 lb ft
Rear Brake Caliper Guide Pin Bolt	34 Nm	25 lb ft
Brake Hose Fitting Bolt– Front (Sport Brembo)	40 Nm	30 lb ft
Brake Hose Fitting Bolt– Front and Rear	48 Nm	35 lb ft
Brake Rotor Screw– Front and Rear	10 Nm	89 lb in

5.9.2. Diagnostic Information and Procedures

5.9.2.1. Diagnostic Starting Point Disc Brakes

Begin the disc brake system diagnosis with Diagnostic Starting Point Hydraulic Brakes. The use of the Diagnostic Starting Point will lead to the identification of the correct procedure for diagnosing the system and where the procedure is located.

5.9.2.2. Diagnostic Starting Point Hydraulic Brakes

Begin the system diagnosis with Diagnostic System Check Vehicle. The Diagnostic System Check– Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check– Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

5.9.2.3. Brake Pad and Rotor Burnishing

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.

Burnishing the brake pads and brake rotors is necessary in order to ensure that the braking surfaces are properly prepared after service has been performed on the disc brake system.

This procedure should be performed whenever the disc brake rotors have been refinished or replaced, and/or whenever the disc brake pads have been replaced.

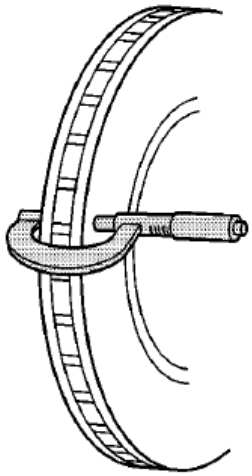
1. Select a smooth road with little or no traffic.
2. Accelerate the vehicle to 48 km/h (30 mph).

Note:
Use care to avoid overheating the brakes while performing this step.

3. Using moderate to firm pressure, apply the brakes to bring the vehicle to a stop. Do not allow the brakes to lock.
4. Repeat steps 2 and 3 until approximately 20 stops have been completed. Allow sufficient cooling periods between stops in order to properly burnish the brake pads and rotors.

5.9.2.4. Brake Rotor Thickness Measurement

Warning:
Refer to Brake Dust Warning.



1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement, if equipped.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the lowest thickness of the brake rotor at 4 or more points, equally spaced around the rotor.

   Ensure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outside edge of the rotor, about 13 mm (½ in), for each measurement.
4. Compare the lowest thickness measurement recorded to the following specifications:

Specification – Front

- Brake rotor minimum allowable thickness after refinishing: 23. mm (0.906 in)
- Brake rotor discard thickness: 22.8 mm (0.898 in)

Specification – Rear

- Brake rotor minimum allowable thickness after refinishing: 12 mm (0.472 in)
- Brake rotor discard thickness: 10.0 mm (0.394 in)

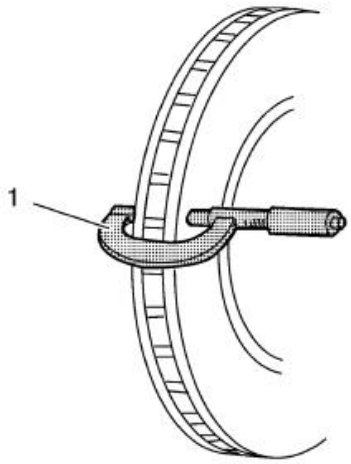
5. If the lowest thickness measurement of the brake rotor is above the minimum allowable thickness after refinishing specification, the rotor may be able to be refinished, depending upon surface and wear conditions which may be present.
6. If the lowest thickness measurement of the brake rotor is at or below the minimum allowable thickness after refinishing specification, the rotor may not be refinished.
7. 7. If the lowest thickness measurement of the brake rotor is at or below the discard thickness specification, the rotor requires replacement.

5.9.2.5. Brake Rotor Thickness Variation Measurement

Warning:
Refer to Brake Dust Warning.

Note:
Any disc brake rotor that exhibits thickness variation exceeding the maximum acceptable level must be refinished or replaced. Thickness variation exceeding the maximum acceptable level can cause brake pulsation.

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement.



2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Using a micrometer (1) calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the thickness of the brake rotor at 4 or more points, evenly spaced around the rotor.

   Ensure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the rotor, about 13 mm (½ in), for each measurement.
4. Calculate the difference between the highest and lowest thickness measurements recorded to obtain the amount of thickness variation.
5. Compare the thickness variation measurement to the following specification:

   Specification

   Brake rotor maximum allowable thickness variation: 0.025 mm (0.001 in)

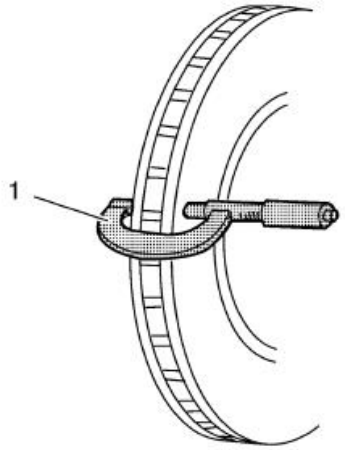
Note:
Whenever a brake rotor is refinished or replaced, the assembled lateral runout (LRO) of the rotor must be measured to ensure optimum performance of the disc brakes.

6. If the brake rotor thickness variation measurement exceeds the specification, the rotor requires refinishing or replacement.

5.9.2.6. Brake Rotor Surface and Wear Inspection

Warning:
Refer to Brake Dust Warning.

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Inspect the friction surfaces of the brake rotor for the following Braking Surface Conditions:
   - Heavy rust and/or pitting
     Light surface rust can be removed with an abrasive disc. Heavy surface rust and/or pitting must be removed by refinishing the rotor.
   - Cracks and/or heat spots
   - Excessive blueing discoloration



4. If the friction surfaces of the brake rotor exhibit one or more of the Braking Surface Conditions, the rotor requires refinishing or replacement.
5. Using a micrometer (1) calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the scoring depth of any grooves present on the rotor friction surfaces.
6. Compare the groove scoring depth recorded to the following specification:

Specification

Brake rotor maximum allowable scoring: 1.50 mm (0.059 in)

7. If the brake rotor scoring depth exceeds the specification, or if an excessive amount of scoring is present, the rotor requires refinishing or replacement.

5.9.2.7. Brake Rotor Assembled Lateral Runout Measurement

Special Tools
CH-41013 Rotor Resurfacing Kit
CH-42450A Wheel Hub Resurfacing Kit
CH-45101 Hub and Wheel Runout Gauge
CH-45101-100 Conical Brake Rotor Washers

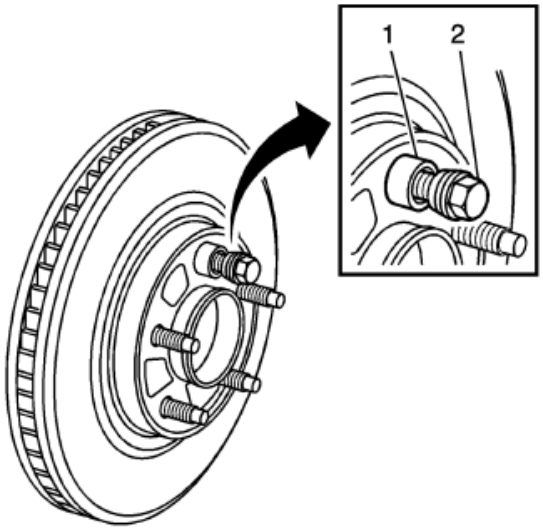
Warning:
Refer to Brake Dust Warning.

Note:
Brake rotor assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4,800–11,300 km (3,000–7,000 mi). Brake rotor thickness variation MUST be checked BEFORE checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.

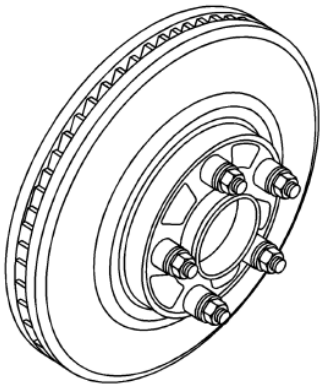
1. Match-mark the position of the brake rotor to the wheel studs if this has not been done already.

Note:
Whenever the brake rotor has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in excessive assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.

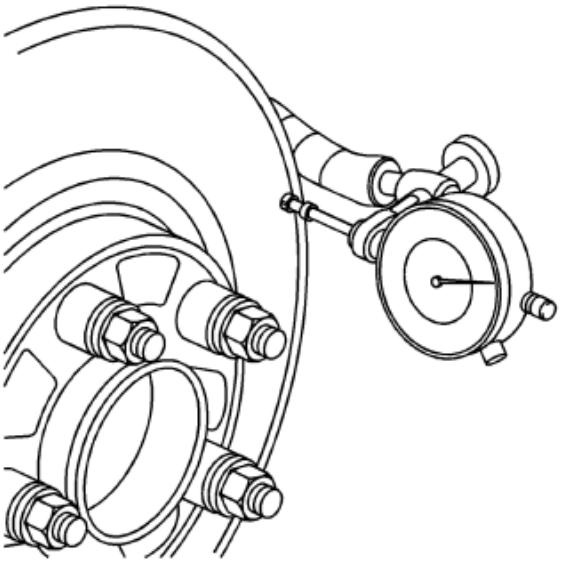
2. Inspect the mating surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles, corrosion, rust, or debris remaining. If the wheel hub/axle flange and/or if the brake rotor mating surfaces exhibit these conditions, perform the following steps:
   2.1. Remove the brake rotor from the vehicle. Refer to Front Brake Rotor Replacement and/or Rear Brake Rotor Replacement.
   2.2. Using the CH-42450A wheel hub resurfacing kit, thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
   2.3. Using the CH-41013 rotor resurfacing kit, thoroughly clean any rust or corrosion from the mating surface of the brake rotor.
   2.4. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Install the rotor to the hub/axle flange using the match-mark made prior to removal.



4. Hold the rotor firmly in place against the hub/axle flange and install one of the CH-45101-100 conical brake rotor washers (1), and one lug nut (2) onto the uppermost wheel stud.
5. Continue to hold the rotor secure and tighten the lug nut firmly by hand.



6. Install the remaining CH-45101-100 conical brake rotor washers and lug nuts onto the wheel studs and tighten the nuts firmly by hand in a star-pattern.
7. **Tighten** the lug nuts in a star-pattern to specification. Refer to Tire and Wheel Removal and Installation
8. If the brake rotor has been REFINISHED or REPLACED with a new rotor, proceed to step 14.
9. If the brake rotor meets the following criteria, proceed to step 10.
   - The rotor is within specifications and is being REUSED.
   - The rotor has NOT been refinished.
   - The rotor does NOT exhibit thickness variation exceeding the maximum allowable level.



10. Mount a dial indicator, CH-45101 hub and wheel runout gauge, or equivalent, to the steering knuckle and position the indicator button so it contacts the brake rotor friction surface at a 90 degree angle, approximately 13 mm (0.5 in) from the outer edge of the rotor.
11. 11. Measure and record the assembled LRO of the brake rotor.
    11.1. Rotate the rotor until the lowest reading is displayed on the indicator dial, then set the dial to zero.
    11.2. Rotate the rotor until the highest reading is displayed on the dial.
    11.3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
    11.4. Measure and record the amount of LRO.
12. Compare the brake rotor assembled LRO to the following specification:

Specification

Front brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)

Rear brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)

13. If the brake rotor assembled LRO is within specifications, proceed to step 18.

If the brake rotor assembled LRO exceeds the specification, refinish the rotor to ensure true parallelism. Refer to Brake Rotor Refinishing. After refinishing the rotor, proceed to step 14.

14. Mount a dial indicator, CH-45101 hub and wheel runout gauge, or equivalent, to the steering knuckle and position the indicator button so it contacts the brake rotor friction surface at a 90 degree angle, approximately 13 mm (0.5 in) from the outer edge of the rotor.
15. Measure and record the assembled LRO of the brake rotor.
    15.1. Rotate the rotor until the lowest reading is displayed on the indicator dial, then set the dial to zero.
    15.2. Rotate the rotor until the highest reading is displayed on the dial.
    15.3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
    15.4. Measure and record the amount of LRO.
16. Compare the brake rotor assembled LRO to the following specification:

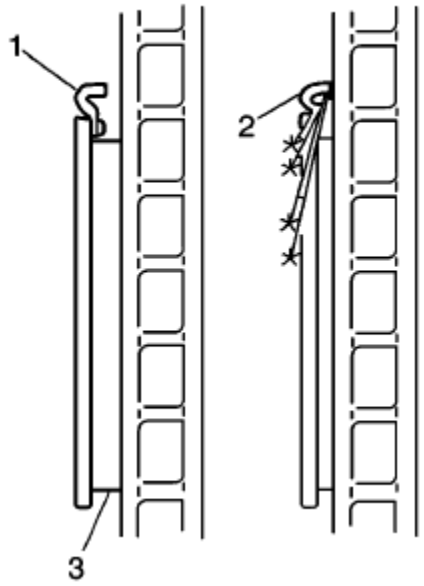
Specification

Front brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)

Rear brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)

17. If the brake rotor assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to Brake Rotor Assembled Lateral Runout Correction.
18. If the brake rotor assembled LRO measurement is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the CH-45101-100 conical brake rotor washers and the lug nuts.

5.9.2.8. Brake Pad Inspection



Warning:
Refer to Brake Dust Warning.

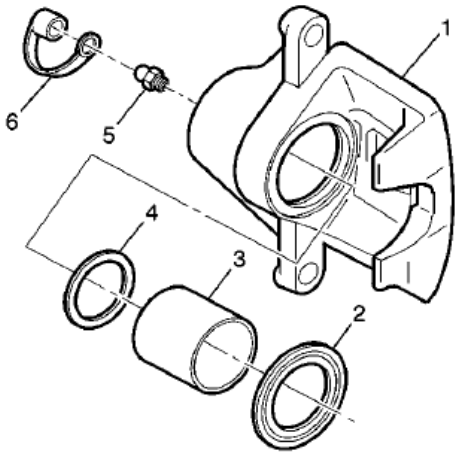
1. Inspect the disc brake pads at regular intervals, or whenever the tire and wheel assemblies are removed from the vehicle.
2. If replacement is necessary, always replace disc brake pads in axle sets.
3. Inspect both edges of the disc brake pad friction surfaces (3). The highest rate of wear normally occurs at the trailing edge of the disc brake pads.
4. Inspect the thickness of the disc brake pads (3) in order to ensure that they have not worn prematurely. The disc brake pad wear should be approximately even per axle set.

Note:
When replacing the disc brake pads, maintain the same disc brake pad wear sensor orientation.

5. Both front and rear disc brake pads have integral, audible wear sensors (1). When the disc brake pad wear reaches the minimum allowable thickness, the wear sensor contacts the disc brake rotor (2). The wear indicator will then produce an audible, high-pitched warning noise during wheel rotation.
6. Replace the disc brake pads when the friction surface (3) is worn to within 0.76 mm (0.030 in) of the mounting plates.
7. Remove the brake calipers and inspect the friction surfaces of the inner and outer disc brake pads to ensure that they are level. Place the disc brake pad friction surfaces together and measure the gap between the surfaces. If more than 0.13 mm (0.005 in) gap exists midway between the length of the disc brake pads, replace the disc brake pads.

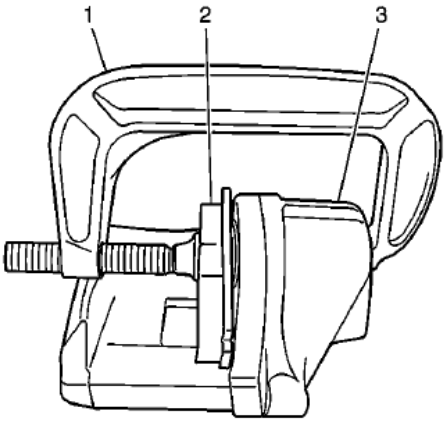
8. Verify that any disc brake pad shims that may be required are in place and not damaged or excessively corroded. Replace any missing or damaged shims in order to preserve proper disc brake performance.
9. Replace the disc brake pads if any have separated from the mounting plates.
10. Inspect the disc brake pads friction surfaces for cracks, fractures, or damage which may cause noise or otherwise impair disc brake performance

5.9.2.9. Brake Caliper Inspection



Warning:
Refer to Brake Dust Warning.

1. Inspect the brake caliper housing (1) for cracks, excess wear, and/or damage. If any of these conditions are present, the brake caliper requires replacement.
2. Inspect the caliper piston dust boot seal (2) for cracks, tears, cuts, deterioration and/or improper seating in the caliper body. If any of these conditions are present, the brake caliper requires overhaul or replacement.
3. Inspect for brake fluid leakage around the caliper piston dust boot seal (2) and on the disc brake pads. If there is any evidence of brake fluid leakage, the brake caliper requires overhaul or replacement.



4. Inspect for smooth and complete travel of the caliper pistons into the caliper bores:

The movement of the caliper pistons into the caliper bores should be smooth and even. If the caliper piston is frozen or difficult to bottom, the caliper requires overhaul or replacement.

- For single piston caliper applications, insert a discarded inner brake pad (2) or block of wood in front of the piston. Using a large C-clamp (1) installed over the body of the caliper (3) and against the brake pad or block of wood, slowly bottom the piston in the bore.

- For dual piston caliper applications, insert a discarded inner brake pad (2) or block of wood in front of the pistons. Using 2 large C-clamps (1) installed over the body of the caliper (3) and against the brake pad or block of wood, slowly bottom the pistons evenly into the bores.

5.9.2.10. Front Disc Brake Mounting and Hardware Inspection

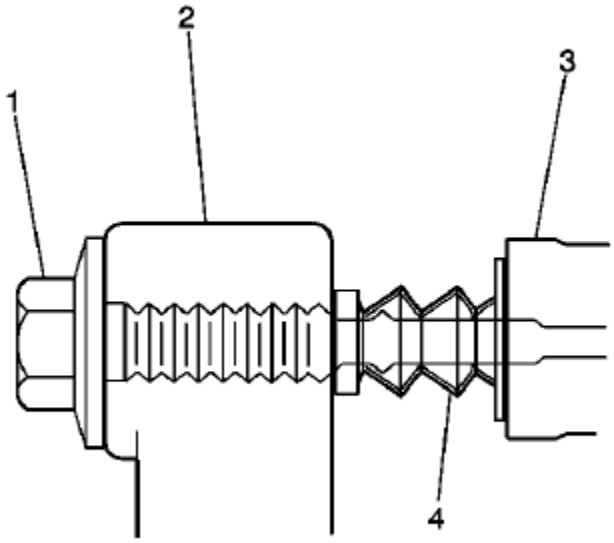
Warning:
Refer to Brake Dust Warning.

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum–full point and the minimum allowable level then no brake fluid needs to be removed from the reservoir before proceeding.
3. If the brake fluid level is higher than midway between the maximum–full point and the minimum allowable level then remove brake fluid to the midway point before proceeding.
4. Raise and support the vehicle. Refer Lifting and Jacking the Vehicle.
5. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.
6. Grasp the brake caliper housing and try to move the brake caliper housing up/down and forward/reverse in relation to the brake caliper mounting bracket. If excessive looseness is observed the brake caliper bracket bushings and/or the brake caliper mounting bolts may need to be replaced.
7. Compress the front caliper pistons.
   - Install a large C-clamp over the top of the caliper housing and against the back of the outboard pad.
   - Slowly tighten the C-clamp until the pistons are pushed completely into the caliper bores.
   - Remove the C-clamp from the caliper.
8. With the pistons compressed into the caliper bores, grasp the brake caliper housing and slide it back and forth on the brake caliper mounting bolts. Check for smooth operation. If the brake caliper housing slide force is high or the brake caliper housing does not slide smoothly, inspect the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings for wear or damage. If wear or damage conditions are found, replacement of the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings is necessary.
9. Remove the brake caliper mounting bolts from the brake caliper mounting bracket and support the brake caliper using heavy mechanics wire. Do Not remove the hydraulic brake hose from the caliper. Refer to Front Brake Caliper Replacement.

Note:
When replacing the disc brake pads, maintain the same disc brake pad wear sensor orientation.

10. Remove the disc brake pads from the brake caliper mounting bracket.
11. Inspect the disc brake pad mounting hardware for the following:
    - Missing mounting hardware
    - Excessive corrosion
    - Bent mounting tabs
    - Looseness at the brake caliper mounting bracket
    - Looseness at the disc brake pads
    - Excessive contaminants in the brake caliper mounting bracket surface and threads.
12. If any of the conditions listed are found, the disc brake pad mounting hardware requires replacement.

13. Ensure the disc brake pads are held firmly in place on the brake caliper mounting bracket, yet slide easily on the mounting hardware without binding.



14. Inspect the brake caliper guide pin bolt (1), brake caliper (2), caliper bracket (3), and the guide pin seal (4) for the following:
    - Binding
    - Seizing
    - Looseness in the brake caliper mounting bracket
    - Bent or damaged brake caliper mounting bolts
    - Cracked or torn boots
    - Missing boots
    - Bent or damaged brake caliper mounting bracket
15. If any of the conditions listed are found then the brake caliper mounting hardware requires replacement.
16. Install the disc brake pads to the brake caliper mounting bracket.
17. Install the disc brake caliper to the brake caliper mounting bracket. Refer to Front Brake Caliper Replacement.

5.9.2.11. Disc Brake System Description and Operation

5.9.2.11.1. System Component Description

The disc brake system consists of the following components:

Disc Brake Pads

Applies mechanical output force from the hydraulic brake calipers to friction surfaces of brake rotors.

Disc Brake Rotors

Uses mechanical output force applied to friction surfaces from the disc brake pads to slow speed of tire and wheel assembly rotation.

Disc Brake Pad Hardware

Secures disc brake pads firmly in proper relationship to the hydraulic brake calipers. Enables a sliding motion of brake pads when mechanical output force is applied.

Disc Brake Caliper Hardware

Provides mounting for hydraulic brake caliper and secures the caliper firmly in proper relationship to caliper bracket. Enables a sliding motion of the brake caliper to the brake pads when mechanical output force is applied.

5.9.2.11.2. System Operation (Floating Caliper)

Mechanical output force is applied from the hydraulic brake caliper pistons to the inner brake pads. As the pistons press the inner brake pads outward, the caliper housings draw the outer brake pads inward. This allows the output force to be equally distributed. The brake pads apply the output force to the friction surfaces on both sides of the brake rotors, which slows the rotation of the tire and wheel assemblies. The correct function of both the brake pad and brake caliper hardware is essential for even distribution of braking force.

5.9.2.11.3. System Characteristics

Brake Noise

Brake noise can occur and to a degree, some brake noise is normal. Variations in driving conditions such as the weather, environment, driving patterns, differences in vehicle loading, and type or style of driving, can affect brake wear. Any one of these variations can cause brake noise to become apparent. Inspect and verify that all metal-to-metal contact areas of the brake pads, brake pad guides or springs, brake caliper housing, caliper bracket and/or suspension knuckle, as applicable, are clean and free of corrosion and scale.

Brake noise is a “slip-stick” vibration of disc brake components and, if it occurs intermittently, can be considered normal. Most brake noise may be eliminated or temporarily reduced by performing 3 or 4 aggressive brake applications. If the brake noise persists or consistently recurs, application of a damping compound to the brake pad mounting plate where it contacts the caliper can lessen the vibration as the components move relative to each other. Refer to Adhesives, Fluids, Lubricants, and Sealers in this section for recommended compounds.

The following brake noises are characteristic of all brake systems. These noises cannot be avoided, and may not indicate improper operation of the brake system.

Squeak/Squeal Noise

A squeak or squeal noise can occur on vehicles with front semi-metallic brake pads during light to medium brake pedal application at low to moderate vehicle speeds. Occasionally this noise may appear from the front or rear brakes after a period of nonuse such as overnight, or cold brakes and/or in high humidity conditions.

Grinding Noise

Common occurrence for rear brakes and some front disc brakes during initial brake applications after the vehicle has been parked overnight. Caused by light corrosion forming on the metal brake component friction surfaces during vehicle nonuse.
Typically disappears after the first few brake applications.

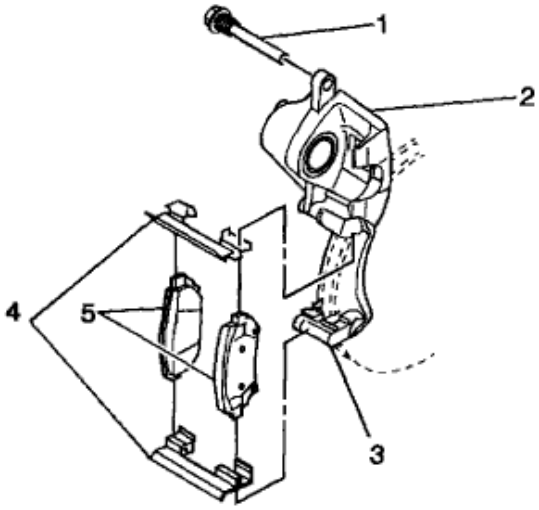
Groan Noise
A groan type noise may be heard during a quick stop, or when slowly moving forward from a complete stop. On vehicles equipped with antilock brake systems (ABS), a groan or moan noise may occur during heavy brake application or on road surfaces with compromised traction such as loose gravel, or on wet or icy roads. This is a normal function of ABS activation.

2020 Carmel Service Manual

Brakes

5.9.3. Repair instructions

5.9.3.1. Front Disc Brake Pads Replacement

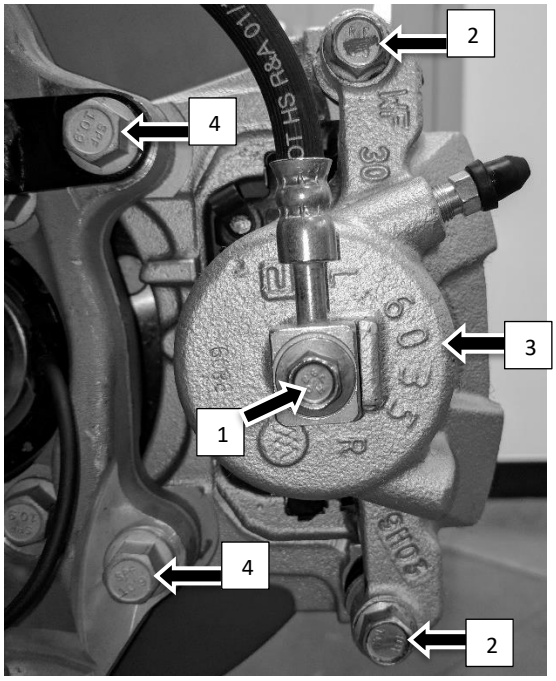


Front Disc Brake Pads Replacement

Callout	Component Name
Warning: Refer to Brake Dust Warning. **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. **Preliminary Procedure**s 1. Inspect the fluid level in the brake master cylinder reservoir. 2. If the brake fluid level is midway between the maximum full point and the minimum allowable level, no brake fluid needs to be removed from the reservoir before proceeding. 3. If the brake fluid level is higher than midway between the maximum full point and the minimum allowable level, remove brake fluid to the midway point before proceeding. 4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 5. Remove the tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation.	
1	Brake Cali[per Pin
2	Brake Caliper Assembly **Tip:** ○ Without disconnecting the brake hose, position the brake caliper out of the way and support with heavy mechanics wire or equivalent. ○ Place a block of wood or an old disc brake pad against the brake caliper piston. ○ Place a cloth pad and a block of wood on the outside of the caliper as to not mar the paint Using a large C-clamp, slowly and evenly compress the brake caliper piston squarely into the caliper bores.

3	Caliper Bracket
4	Brake Pad Anti-rattle springs (Qty: 2)
5	Brake Pads (Qty: 2)

5.9.3.2. Front Brake Caliper Replacement

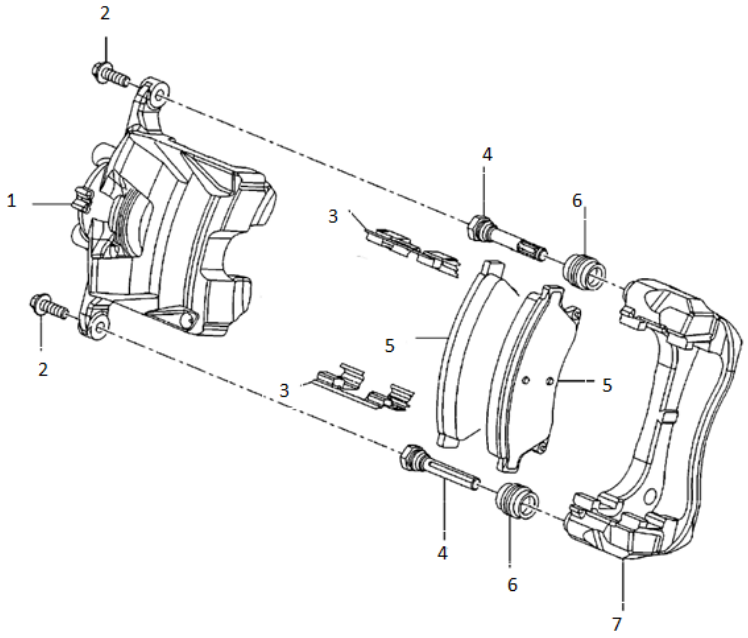


Front Brake Caliper Replacement

Callout	Component Name
Warning: Refer to Brake Fluid Irritant Warning. **Warning:** Refer to Brake Dust Warning. **Preliminary Procedure**s 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 2. Remove the tire and wheel. Refer to Tire and Wheel Removal and Installation.	
1	Brake Hose Fitting Bolt **Caution:** Refer to Fastener Caution. **Tighten** 40 Nm (30 lb ft)
	Brake Hose Fitting Gasket (Qty: 2) **Tip:** DO NOT reuse the brake hose fitting gaskets. Install NEW gaskets.
2	Brake Caliper Pins **Tighten:** 34Nm (25 lb ft)
3	Brake Caliper **Procedure** 1. If any of the disc brake caliper hardware is found to have excessive wear, replace the hardware. Refer to Front Brake Caliper Hardware Replacement. 2. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding. 3. After the installation is complete and with the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.

	4. Slowly release the brake pedal. 5. Wait 15 seconds, then repeat steps 3–4 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and the brake pads. 6. Fill the master cylinder to the proper level. Refer to Master Cylinder Reservoir Filling.
4	Brake Caliper bracket bolt **Tighten:** 115 Nm (85 ft.lb)

5.9.3.3. Rear Disc Brake Pad Replacement



Rear Disc Brake Pad Replacement

Callout	Component Name
Warning: Refer to Brake Dust Warning. **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. **Preliminary Procedure**s 1. Inspect the fluid level in the brake master cylinder reservoir. 2. If the brake fluid level is midway between the maximum full point and the minimum allowable level, no brake fluid needs to be removed from the reservoir before proceeding. 3. If the brake fluid level is higher than midway between the maximum full point and the minimum allowable level, remove brake fluid to the midway point before proceeding. 4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 5. Remove the Rear wheel assembly. Refer to Tire and Wheel Removal and Installation.	
1	Brake Caliper Assembly

	Tip: 1. Without disconnecting the brake hose, remove the upper Caliper bolt rotate the brake caliper down and support with heavy mechanics wire or equivalent. 2. Place a block of wood or an old disc brake pad against the brake caliper piston. 3. Using a Brake Caliper Compression tool, slowly and evenly compress the brake caliper piston squarely into the caliper bore.
2	Brake Caliper pin bolt **Tighten:** 115Nm (85 lb ft)
3	Brake Caliper Pin Tighten 27 Nm (20 lb in)
4	Brake pad Shim (Qty: 2)
5	Brake Pad (Qty: 2)
6	Brake Caliper Pin Boots (Qty:2)
7	Brake Caliper Housing

5.9.3.4. Rear Caliper Replacement

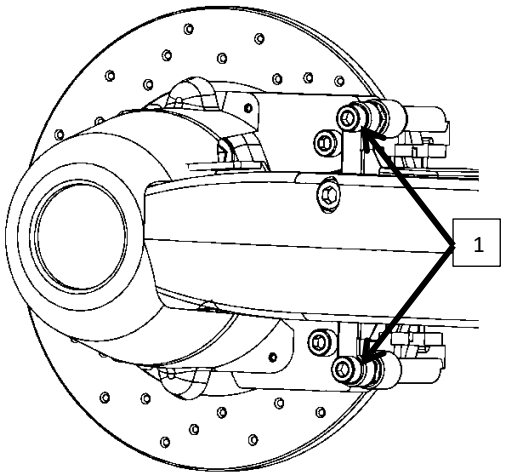
5.9.3.4.1. Removal procedures

1. Lift and support the vehicle, Refer to Lifting the Vehicle
2. Remove the Rear Hub Cover, Refer to Rear Hub Cover
3. Remove the Rear Wheel, Refer to Rear Wheel

Tip:
DO NOT reuse the brake hose fitting gaskets. Install NEW gaskets.

Tip:
Plug the brake hose fitting to prevent brake fluid loss and contamination.

4. Disconnect the Rear Brake Hose, Refer to Rear Brake Hose Replacement
5. Disconnect the Parking Brake Cable , Refer to Parking Brake Cable Replacement



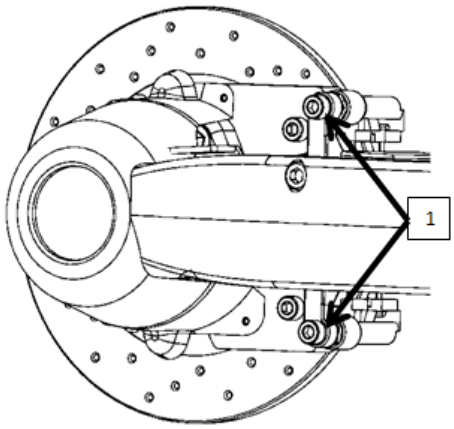
6. Remove Rear Brake Caliper bolts pins(1)

7. Remove Caliper

Note:
1. If any of the disc brake caliper hardware is found to have excessive wear, replace the hardware. Refer to Rear Brake Caliper Hardware Replacement.

5.9.3.4.2. Installation Procedures

1. Place the Brake Caliper around the Brake Rotor



2. Install the Brake Caliper Bolts and tighten to 27 Nm (20 lb in)
3. Connect the Parking Brake Cable , Refer to Parking Brake Cable Replacement
4. Connect the Rear Brake Hose, Refer to Rear Brake Hose Replacement
8. Install the Rear Hub Cover, Refer to Rear Hub Cover
5. Lower the vehicle
6. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding

Note:
1. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding. 2. After the installation is complete and with the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance. 3. Slowly release the brake pedal. 4. Wait 15 seconds, then repeat steps 3–4 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and the brake pads. 5. Fill the master cylinder to the proper level. Refer to Master Cylinder Reservoir Filling.

5.10. 5.3 Hydraulic Brakes

5.10.1. Description and Operation

5.10.1.1. Brake Assist System Description and Operation

5.10.1.1.1. System Component Description

The brake assist system consists of the following:

Brake Pedal
Receives, multiplies and transfers brake system input force from 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 driver when applying brake system input force. At rest, source vacuum is applied to both sides of the vacuum diaphragm for single booster. Return springs maintain the booster in a rest position. When brake system input force is applied, vacuum to the rear of the diaphragm is cut off, and air at atmospheric pressure is admitted in its place. This provides a decrease in brake pedal effort required. When input force is removed, vacuum again replaces atmospheric pressure within the booster.

Vacuum Source
Supplies force used by vacuum brake booster to decrease brake pedal effort. 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.

5.10.1.1.2. 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 while 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.

5.10.1.2. Brake Booster Vacuum Assist Description and Operation

In order to assure that vacuum is available to the vacuum brake booster, the motorcycle can contain a vacuum pump either in addition to the normal intake manifold vacuum source or as standalone. The pump provides negative pressure when the engine cannot properly accommodate the requirement, e.g. cold start, heavy throttle, high altitude and turbo pressure.

Electrical

Brakes

A low vacuum switch controls the 12 V to the relay coil in the brake vacuum assist pump. When more vacuum is needed the vacuum switch closes. The relay coil closes the relay contact and connects the electric motor to ground. The electric motor is fed with 12 V. When sufficient vacuum is reached the switch opens and the pump stops.

A venturi is connected between the intake manifold and the vacuum brake booster, amplifying the vacuum. This reduces the on-time for the pump. To prevent air flowing in the wrong direction check valves are used.

5.10.1.3. Brake Warning System Description and Operation

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 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.

5.10.1.3.1. 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 issue message.

5.10.1.4. Hydraulic Brake System Description and Operation

5.10.1.4.1. 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 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 on non-ABS equipped vehicles, is achieved through a proportioning valve assembly. Pressure balance control on ABS equipped vehicles, is achieved through electronic brake distribution (EBD), which is a function of the ABS modulator.

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.

5.10.1.4.2. 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.

5.10.1.5. Brake Fluid Irritant Warning

Warning:
Brake fluid may irritate eyes and skin. In case of contact, take the following actions: • Eye contact—rinse thoroughly with water.

- Skin contact—wash with soap and water.
- If ingested—consult a physician immediately.

5.10.1.6. Brake Fluid Effects on Paint and Electrical Components Caution

Caution
Avoid spilling brake fluid onto painted surfaces, electrical connections, wiring, or cables. Brake fluid will damage painted surfaces and cause corrosion to electrical components. If any brake fluid comes in contact with painted surfaces, immediately flush the area with water. If any brake fluid comes in contact with electrical connections, wiring, or cables, use a clean shop cloth to wipe away the fluid.

5.10.1.7. Diagnostic Starting Point Vehicle

Begin the system diagnosis with Diagnostic System Check Vehicle. The Diagnostic System Check Vehicle will provide a complete strategy to locate and repair a mechanical or electrical vehicle fault. Not following this strategy may cause additional diagnostic time and/or misdiagnosis.

The Diagnostic System Check Vehicle will provide the following strategy:

- When to verify the customer concern and identify related bulletins, recalls and preliminary information
- When to identify a control module that is not communicating, a control module that has set a DTC, and the DTC diagnostic priority
- When to address power mode concerns
- When to verify the engine cranks and runs
- When to diagnose symptom related concerns

5.10.2. Diagnostic Information and Procedures

5.10.2.1. DTC C0267

5.10.2.1.1. 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.

5.10.2.1.2. DTC Descriptor

DTC C0267

Low Brake Fluid Indicated

For symptom byte information refer to Symptom Byte List.

5.10.2.1.3. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	C0267 00	C0267 00	-	-
Ground	-	C0267 00	-	-

5.10.2.1.4. 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 low brake fluid level, the DTC is set.

5.10.2.1.5. Conditions for Running the DTC

Ignition ON.

5.10.2.1.6. Conditions for Setting the DTC

Low brake fluid level is detected for 8 s.

5.10.2.1.7. Action Taken When the DTC Sets

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

- The brake warning indicator turns ON.

5.10.2.1.8. Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

5.10.2.1.9. Reference Information

Schematic Reference
Hydraulic Brake Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
Brake Warning 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

5.10.2.1.10. Circuit/System Verification

1. Verify that the brake 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 parameter is Ok.
⇒ If the parameter is Low
Refer to Circuit/System Testing.
⇓ If the parameter is Ok
4. All OK.

5.10.2.1.11. 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 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 not Ok
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.

5.10.2.1.12. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Brake Fluid Level Indicator Switch Replacement
- Control Module References for electronic brake control module replacement, programming and setup

5.10.2.2. Symptoms - Hydraulic Brakes

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

1. Perform the Brake System Vehicle Road Test before using the hydraulic brake symptom tables in order to duplicate the customers concern.
2. 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 Booster Vacuum Assist Description and Operation
    - Brake Assist System Description and Operation
    - ABS Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the hydraulic brake 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 Booster Pump Motor Malfunction
- 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

5.10.2.3. Brake Booster Pump Motor Malfunction

5.10.2.3.1. 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.

5.10.2.3.2. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Booster Pump Motor B+	1	1		-
Brake Booster Vacuum Switch Ignition	-	1	1	-
Brake Booster Pump Motor Control	1	1	2	-
Brake Booster Pump Motor Ground	-	1	1	-
1. Brake Booster Pump Motor Always Off 2. Brake Booster Pump Motor Always On				

5.10.2.3.3. Circuit/System Description

The brake booster vacuum switch monitors the amount of vacuum available to the power brake booster. When the vacuum within the system drops, the switch within the brake booster vacuum switch closes allowing voltage to be supplied to the brake booster pump motor.

5.10.2.3.4. 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

Scan Tool Reference
Control Module References for scan tool information

5.10.2.3.5. Circuit/System Verification

1. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.
⇒ If damage, leakage or incorrect installation is found
Refer to Brake Assist System Diagnosis.
⇓ If the inspection is OK
2. Refer to Circuit/System Testing.

5.10.2.3.6. Circuit/System Testing

1. 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.
2. Test for less than 10 Ω between the ground circuit terminal 1 and ground.
⇒ If 10 Ω or greater
2.1. 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 that a test lamp illuminates between the B+ circuit terminal 5 and ground.
⇒ If the test lamp does not illuminate and the circuit fuse is good
4.1. Ignition OFF.
4.2. 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
4.1. Ignition OFF.
4.2. Test for infinite resistance between the B+ circuit and ground.
⇒ If less than infinite resistance, repair the short to ground on the circuit.
⇒ If infinite resistance, replace the M9 Brake Booster Pump Motor.
⇓ If the test lamp illuminates
5. Ignition OFF, connect the harness connector at the M9 Brake Booster Pump Motor and disconnect the harness connector at the B19C Brake Booster Vacuum Switch, ignition ON.
6. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
⇒ If the test lamp does not illuminate and the circuit fuse is good
6.1. Ignition OFF.
6.2. 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 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
6.1. Ignition OFF.
6.2. Test for infinite resistance between the ignition circuit and ground.
⇒ If less than infinite resistance, repair the short to ground on the circuit.
⇓ If infinite resistance
6.3. Disconnect the harness connector at the M9 Brake Booster Pump Motor.
6.4. 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 M9 Brake Booster Pump Motor.
⇓ If the test lamp illuminates

7. Verify that a test lamp does not illuminate between the control circuit terminal 2 and ground.
⇒ If the test lamp illuminates
Repair the short to voltage on the control circuit.
⇓ If the test lamp does not illuminate
8. Connect a 10 A fused jumper wire between the ignition circuit terminal 1 and the control circuit terminal 2.
9. Verify the M9 Brake Booster Pump Motor activates.
⇒ If the brake booster pump motor does not activate
9.1. Ignition OFF
9.2. 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 M9 Brake Booster Pump Motor.
⇓ If the brake booster pump motor activates
10. Test or replace the B19C Brake Booster Vacuum Switch.

5.10.2.3.7. Component Testing

1. Ignition OFF, disconnect the harness connector at the M9 Brake Booster Pump Motor. Install a 30 A fused jumper wire between the B+ circuit terminal 5 and B+. Install a 7.5 A fused jumper wire between the ignition circuit terminal 2 and B+. Install a jumper wire between the ground circuit terminal 1 and ground.
2. Verify the M9 Brake Booster Pump Motor activates.

⇒ If the brake booster pump motor does not activate
Replace the M9 Brake Booster Pump Motor.
⇓ If the brake booster pump motor activates
3. All OK.

5.10.2.3.8. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Power Brake Booster Pump Replacement

5.10.2.4. Brake Warning Indicator Malfunction

5.10.2.4.1. 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.

5.10.2.4.2. Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Fluid Level Signal	C0267 00	C0267 00	1	-
Park Brake Signal	1	1	1	-
Ground	-	C0267 00	-	-
1. Brake Warning Indicator Malfunction				

5.10.2.4.3. 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. When the electronic brake control module detects a fault, it sends a serial data message to the instrument cluster commanding the indicator ON.

5.10.2.4.4. Reference Information

Schematic Reference
Hydraulic Brake Schematics

Connector End View Reference
Component Connector End Views

Description and Operation
Brake Warning 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

5.10.2.4.5. 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 Electronic Brake Control Module 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 Body Control Module 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.

5.10.2.4.6. 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 minutes 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 Electronic Brake Control Module, 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 Electronic Brake Control Module, 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 1 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 1 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.

5.10.2.4.7. Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Brake Fluid Level Indicator Switch Replacement
- Parking Brake Indicator Switch Replacement
- Control Module References for body control module replacement, programming and setup.

5.10.2.5. 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, blueing discoloration of rotor fiction 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 of 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	-
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

5.10.2.6. 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 • 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: • 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 2. Adjust, repair or replace components as necessary. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Step 4
4	1. Inspect the hydraulic brake system for the following conditions.	Go to Step	Go to Step 5

	Improper operation of wheel cylinder pistons, if equipped 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?	7	
5	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. 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 7	Go to Step 6
6	Inspect the park brake system for proper operation. Refer to Park Brake System Diagnosis. Did you find and correct a condition?	Go to Step 7	Go to Symptoms - Hydraulic Brakes
7	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

5.10.2.7. Braking Action Uneven - Pulls to One Side

5.10.2.7.1. Test Description

The number below refer 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.

5. Steering components that are not operating correctly 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 • Sticking or improperly operating wheel cylinder pistons • 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 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	1. Inspect the suspension system for the following conditions: • Incorrect tire pressure	Go to Step 6	Go to Step 5

	• 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?		
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. Refer to Symptoms Power Steering System. 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

5.10.2.8. Braking Action Uneven - Front to Rear

Test Description

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

5. 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 wheel. 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 wheel cylinder pistons, if equipped • Improper operation of caliper pistons • Kinked, pinched or damaged brake pipe or flexible brake hose • Brake fluid leak • Improperly functioning proportioning valve, 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 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 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 4
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:	Go to Step	Go to

	• Binding, bent or damaged pedal pushrod, pedal • Damaged or improperly operating vacuum booster, if equipped 2. Adjust, repair or replace components as necessary. Refer to Brake Assist System Diagnosis. Did you find and correct a condition?	6	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

5.10.2.9. Brake Pedal Excessive Travel

Brake Pedal Excessive Travel

Step	Action	Yes	No
DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear wheel. 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	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 • 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 – Binding wheel cylinder pistons, if equipped	Go to Step 8	Go to Step 4

	• Pedal returned to rest slowly after any of the applies. – Internally damaged flexible brake hoses; hindering fluid return – Binding caliper pistons – Binding wheel cylinder pistons, if equipped – 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. • 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. 3. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. 4. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 8	Go to Step 7
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	Go to Step 6	Go to Symptoms - Hydraulic Brakes

	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?		
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

5.10.2.10. 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 • 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
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.	Go to Step 5	Go to Symptoms - Hydraulic Brakes

	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

5.10.2.11. Brakes Drag

Brakes Drag

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	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 Step 3
3	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?	Go to Step 9	Go to Step 4
4	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 6	Go to Step 5
5	1. Inspect the pushrod for improper position 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 9	-
6	1. 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.	Go to Step 8	Go to Step 7

	Do the brake corners still exhibit the brake drag condition?		
7	Replace the brake booster assembly. Did you complete the replacement?	Go to Step 9	-
8	1. Inspect the hydraulic brake system for the following conditions: • 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?	Go to Step 3	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

5.10.2.12. Brake System Slow Release

Brake System Slow Release

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 hydraulic brake system for the following conditions: • Improper operation of wheel cylinder pistons, if equipped • 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 • 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?	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

5.10.2.13. Brake Fluid Loss

Brake Fluid Loss

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 following hydraulic brake system components for brake fluid leaks: • Flexible brake hose connections; threaded and bolted • Flexible brake hose crimping joints • Brake pipe fittings • Caliper piston seals • Master cylinder reservoir • Master cylinder reservoir low pressure hose, 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 5	Go to Step 3
3	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 the brake fluid leak?	Go to Step 4	Go to Symptoms - Hydraulic Brakes
4	Replace the brake master cylinder and the vacuum brake booster. Did you complete the replacement?	Go to Step 5	-
5	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

5.10.2.14. 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 rotor shields/backing plates that come in contact with disc brake rotors may cause brake system noise.
15. Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.
19. Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.
22. Disc brake rotor 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 the Hydraulic Brake Symptom table?	Go to Step 2	Go to Symptoms - Hydraulic Brakes
2	Visually inspect the disc 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 disc brake pads?	Go to Step 3	Go to Step 12
3	Are any of the front disc brake pads contaminated?	Go to Step 8	Go to Step 4
4	Are any of the front disc brake pads worn unevenly?	Go to Step 7	Go to Step 5
5	Are any of the front disc 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 disc brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn disc brake pads as a complete axle set. Refer to Front 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 calipers. 1. Remove the front brake caliper, as appropriate, from the mounting bracket and support the brake caliper. Refer to Front Brake Caliper Replacement. 2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions: • Binding or seized hardware • Worn, damaged or missing hardware components • Loose, bent, cracked, or damaged brake caliper mounting bracket 3. Replace components as required. Refer to Front Brake Caliper Bracket Replacement 4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement. Did you complete the inspection and replacement?	Go to Step 12	
8	1. Inspect the disc 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 • Front Brake Caliper Replacement • Front Brake Hose Replacement • 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 Front Wheel Drive Shaft Outer Joint and Boot Replacement. Did you find and correct the source of the leak causing	Go to Step 11	Go to Step 10

	contamination of the brake pads?		
10	1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 2. Replace any components found to be leaking which may be the source of the contamination to the pads. Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	
11	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 and in turn may cause a brake fluid leak. **Note:** Do NOT disconnect the hydraulic brake flex hoses from the calipers. 2. Remove the front disc brake caliper from the brake caliper mounting bracket and support the brake caliper. Refer to Front Brake Caliper Replacement. 3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions: Refer to Front Disc Brake Mounting and Hardware Inspection. • Binding or seized hardware • Distorted, worn, damaged or missing hardware components 4. Replace the brake mounting/sliding hardware components as required. Refer to Front Disc Brake Mounting and Hardware Inspection. 5. Replace the contaminated brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement. Did you complete the cleaning, inspection and replacement?	Go to Step 12	
12	6. Check the thickness of each of the disc brake rotors. **Note:** Make the following determination and answer the question individually for EACH rotor.	Go to Step 13	Go to Step 16

	7. Make a determination for each brake rotor if the brake rotor can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to Brake Rotor Thickness Measurement. Does the brake rotor meet the minimum requirements for REFINISHING?		
13	**Note:** Make the following determination and answer the question individually for EACH rotor. Inspect each of the brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement. Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 15	Go to Step 14
14	1. Inspect each of the brake rotors for the following surface and wear conditions: Refer to Brake Rotor Surface and Wear Inspection. 1. Heavy rust and/or pitting 2. Cracks and/or heat spots 3. Excessive blueing discoloration 4. Deep or excessive scoring beyond maximum acceptable level **Note:** Make the following determination and answer the question individually for EACH rotor. 2. Make a determination for each brake rotor if the brake rotor requires refinishing based upon the results of the inspection. 3. If the brake rotor exhibits any of the conditions listed previously, it requires refinishing. Does the brake rotor require REFINISHING?	Go to Step 15	Go to Step 20
15	1. Refinish the brake rotor. Refer to Brake Rotor Refinishing. 2. Inspect the brake rotor thickness. Refer to Brake Rotor Thickness Measurement. Were you able to REFINISH the brake rotor within the minimum requirements?	Go to Step 20	Go to Step 19
16	Is the brake disc at or below the DISCARD requirements?	Go to Step 19	Go to Step 17
17	**Note:** Make the following determination and answer the question individually for EACH rotor. Inspect each of the brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness	Go to Step 19	Go to Step 18

	Variation Measurement. Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?		
18	1. Inspect each of the brake rotors for the following surface and wear conditions: Refer to Brake Rotor Surface and Wear Inspection. 1. Heavy rust and/or pitting 2. Cracks and/or heat spots 3. Excessive blueing discoloration 4. Deep or excessive scoring beyond maximum acceptable level **Note:** Make the following determination and answer the question individually for EACH rotor. 2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires replacement. Does the brake rotor require REPLACEMENT?	Go to Step 19	Go to Step 20
19	**Note:** Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the brake rotor must be measured to ensure optimum performance of the disc brakes. Replace the brake rotor. Refer to Front Brake Rotor Replacement. Did you complete the replacement?	Go to Step 22	
20	**Note:** Make the following determination and answer the question individually for EACH rotor. Inspect each of the brake rotors for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to Brake Rotor Assembled Lateral Runout Measurement. Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?	Go to Step 21	Go to Step 22
21	Correct the LRO for each brake rotor 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 22	
22	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK	

		Return to Symptom Table	

5.10.2.15. Hydraulic Brake System Diagnosis Test Description

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 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 the Hydraulic 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: 1. Fluid separation, indicating two types of fluid are present – Swirled appearance – oil-based substance – Layered appearance – silicone-based substance 2. 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 4	Go to Step 5
4	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.	Go to Step 8	-

	• 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 • Front Brake Caliper Replacement 3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated 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?		
5	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 Pipe Replacement • Front Brake Caliper Overhaul • Front Brake Caliper 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, and/or the proportioning valve assembly, was replaced • An unrestricted and even flow of brake fluid per axle during the bleeding procedure Did you find and correct a condition?	Go to Step 6	Go to Step 11

6	Was there air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder, and/or the proportioning valve assembly, was replaced?	Go to Step 18	Go to Step 7
7	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 8	Go to Step 9
8	Inspect the hydraulic function of the brake calipers and/or wheel cylinders, if equipped for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection. Was the hydraulic function of the brake calipers/wheel cylinders operating properly?	Go to Step 20	Go to Step 13
9	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 12	Go to Step 10
10	Was the flow of brake fluid restricted at the rear wheel hydraulic components during the bleeding procedure?	Go to Step 16	
11	Inspect the hydraulic function of the brake calipers/wheel cylinders for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection. Was the hydraulic function of the brake calipers/wheel cylinders operating properly?	Go to Step 14	Go to Step 12
12	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly: 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 C-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 caliper bleeder valve. Was the flow of brake fluid unrestricted and did the caliper piston move freely?	Go to Step 16	Go to Step 13
13	Repair or replace any brake caliper/wheel cylinder that was not operating properly. Refer to the appropriate procedure. • Front Brake Caliper Overhaul • Front Brake Caliper Replacement Did you complete the repair and/or replacement?	Go to Step 20	-
14	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 18	Go to Step 15

15	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 20	Go to Step 16
16	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 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 20	Go to Step 17
17	Replace the 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 16	-
18	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?	Go to Step 20	Go to Step 19
19	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 19	Return to Symptom Table
20	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	-

5.10.2.16. 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 the Hydraulic Brake Symptom table?	Go to Step 3	Go to Step 2
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 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. Inspect the brake pedal for a misaligned, bent and/or damaged condition. Inspect the brake pedal bushings for excessive wear and/or damage. 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	Does the condition occur during cold startup conditions?	Go to Step 7	Go to Step 8
7	Check engine vacuum, and vacuum pump operation, if equipped, under the same cold startup conditions. Refer to Engine Controls	Go to Step 22	Go to Step 9

	Diagnostics. Did you find and correct a condition?		
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. 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. 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 18	Go to Step 14
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	Go to Step 22	Go to Step 21

	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?		
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 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?	Go to Step 17	Go to Step 18
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	-

5.10.2.17. Brake System Vehicle Road Test

5.10.2.17.1. 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
5. Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

5.10.2.17.2. 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. Visually inspect if the brake warning indicator 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 or Neutral, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
   - If the brake pedal apply felt spongy, or the pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
   - If the brake pedal apply did not feel spongy and the pedal travel was excessive, proceed to step 6.
6. Release and apply the brakes.
7. 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.
8. 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.
   - 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.
   - If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 9.
9. 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 the assistant.
10. 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.

11. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
12. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
13. 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.
    - 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.
    - If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 14.
14. 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.
15. 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.

5.10.2.18. 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. Install a scan tool to the vehicle.
4. Start the engine and allow the engine to idle until normal operating temperatures are reached.

Note:
To obtain the gauge pressure from the manifold absolute pressure (MAP) sensor, subtract the absolute pressure of the MAP sensor from atmospheric pressure.

5. With the vehicle in PARK or NEUTRAL with the park brake on, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is the gauge pressure calculated from the pressure of the MAP sensor indicated on the scan tool.
6. Turn the ignition OFF.
7. If the engine vacuum reading is within the specified normal range, proceed to step 11.
8. If the engine vacuum reading is 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, or brittleness
9. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2–5.
10. 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.
11. Remove the vacuum brake booster check valve from the booster.
12. Install the check valve to the engine vacuum hose.
13. Install the vacuum gauge to the check valve.
14. Start the engine and allow the engine to idle in park or neutral with the park brake on and with the A/C system OFF, until normal operating temperatures are reached.
15. Turn the ignition OFF.

Note:
To obtain the gauge pressure from the manifold absolute pressure (MAP) sensor, subtract the absolute pressure of the MAP sensor from atmospheric pressure.

16. Visually inspect the engine vacuum reading is maintained at the same gauge pressure as the pressure obtained from the MAP sensor as indicated on the scan tool.
17. If the engine vacuum reading is maintained within the specified normal range, proceed to step 19.
18. If the engine vacuum reading is NOT maintained within the specified normal range, replace the vacuum brake booster check valve, then repeat steps 12–16.

19. Inspect the vacuum brake booster check valve grommet for the following conditions:
    - Loose connection to the vacuum brake booster
    - Deformation or contamination
    - Cracks, cuts or brittleness
20. If any of these conditions were found with the check valve grommet, replace the grommet.

5.10.2.19. Brake System External Leak Inspection

Warning:
Refer to Brake Fluid Irritant Warning.

Caution:
Refer to Brake Fluid Effects on Paint and Electrical Components Caution.

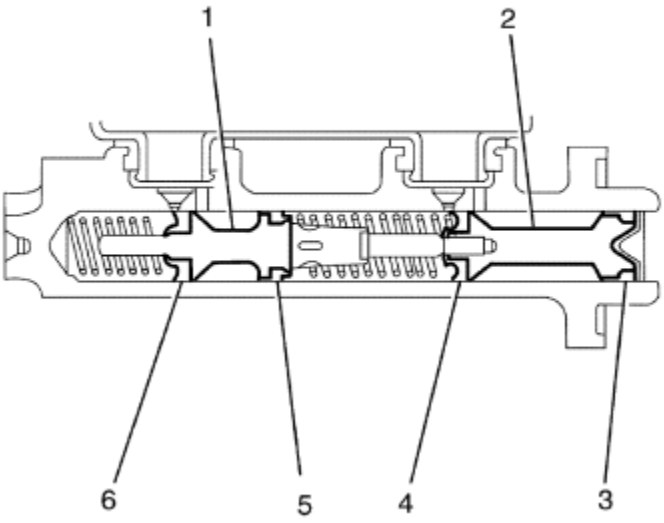
1. In order to inspect for external brake fluid leaks, first inspect the fluid level in the master cylinder.
   While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.
2. If the fluid 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 the ignition OFF.
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
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, re-inspect the hydraulic brake system to assure proper function.

5.10.2.20. 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 the ignition OFF.
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.



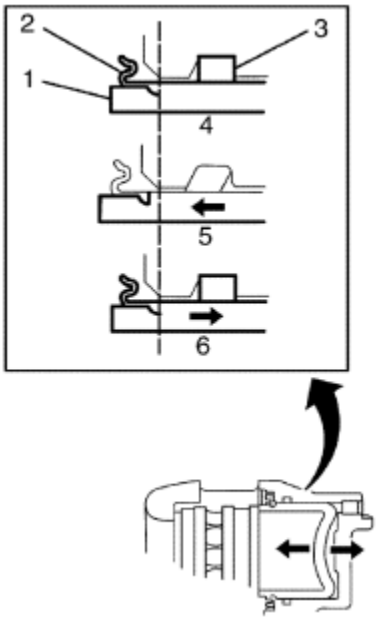
5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the following steps:
   5.1. Loosen the master cylinder-to-vacuum brake booster retaining nuts.
   5.2. Carefully pull the master cylinder away from the vacuum brake booster just enough to inspect the mounting 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.

5.10.2.21. Hydraulic Brake Component Operation Visual Inspection

Disc Brake



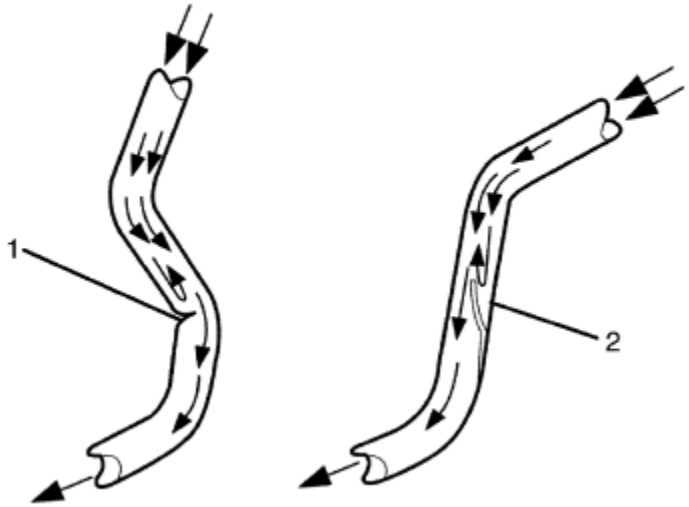
1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the brake caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the brake caliper piston (1) in relation to the brake 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 brake caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
   4.2. Observe the brake caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the brake 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 brake caliper may require overhaul or replacement.

5.10.2.22. Brake Pipe and Hose Inspection

Warning:
Refer to Brake Fluid Irritant Warning.

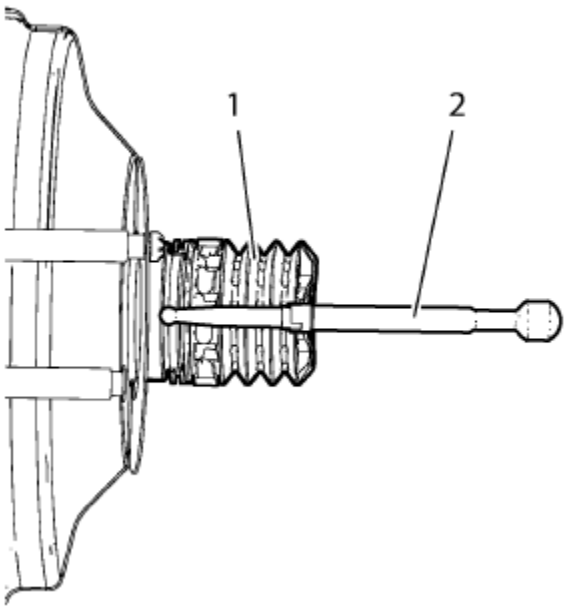
Caution:
Refer to Brake Fluid Effects on Paint and Electrical Components Caution.

1. Visually inspect all of the brake pipes for the following conditions:
   - Kinks, incorrect 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 correctly 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, perished, cracked, blistered, brittle or bulging hoses
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 inspect for soft spots (2), indicating an internal restriction. Inspect 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.

5.10.2.23. Brake Pedal Pushrod Inspection



1. Disconnect the brake pedal pushrod (2) from the brake pedal.
2. Reposition the pedal pushrod boot (1) toward the front of the vehicle to expose as much of the pedal pushrod (2) as possible.
3. Inspect the brake pedal pushrod (2) for straightness.
4. If the brake pedal pushrod (2) is not straight, then the pushrod requires replacement.
5. Return the pedal pushrod boot (1) to its original position on the pedal pushrod (2).
6. Connect the brake pedal pushrod (2) to the brake pedal.

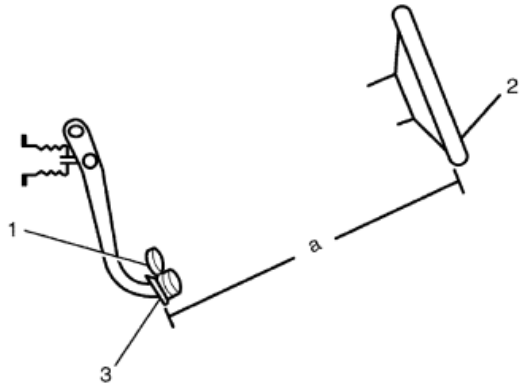
5.10.2.24. Brake Pedal Travel Measurement and Inspection

Special Tools

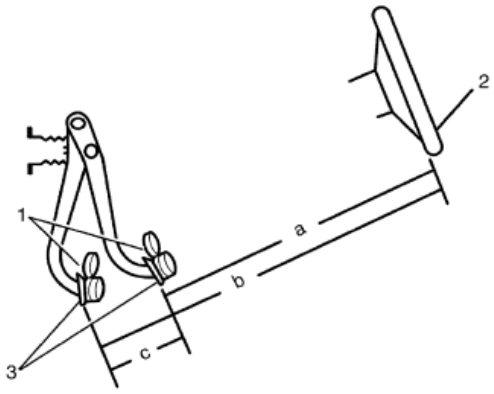
CH28662 Brake Pedal Effort Gauge

For equivalent regional tools, 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 CH28662 gauge (1), or equivalent, to the brake pedal (3).
3. Measure and record the distance (a) from the brake pedal (3) to the rim of the steering wheel (2). Note the points of measurement.



4. Apply and maintain a force of 445 N (100 lb) to the brake pedal, as indicated on the CH28662 gauge (1), or equivalent.
5. While maintaining 445 N (100 lb) of force to the brake pedal (3), measure and record the distance (b) from the same point on the brake pedal (3) to the same point on the rim of the steering wheel (2).
6. Release the brake pedal (3) 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 for the 2 applies of the brakes.

8. Subtract the initial unapplied distance (a), from the average applied distance (b) to obtain the brake pedal travel measurement (c).

Specification
Maximum brake pedal travel – measured with the ignition OFF, brake booster power assist depleted, and the brakes cool.

5.10.3. Repair instructions

5.10.3.1. Hydraulic Brake Fluid Replacement

Warning:
Brake Fluid Irritant Warning

Caution:
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 effort becomes firm to deplete the brake booster power reserve.
2. Clean the outer surface of the master cylinder brake fluid reservoir, on and around the reservoir cap, prior to removing the cap and diaphragm. Master Cylinder Reservoir Filling
3. Fill the master cylinder brake fluid reservoir to the maximum-fill level with approved brake fluid from a clean, sealed brake fluid container. Adhesives, Fluids, Lubricants, and Sealers
4. Maintain the brake fluid level in the master cylinder brake fluid reservoir to between the minimum and maximum-fill
   level during the brake fluid replacement procedure.
5. Following the hydraulic brake system bleeding procedure, bleed each of the hydraulic brake wheel circuits until clean, clear brake fluid is observed coming from each bleeder valve. Hydraulic Brake System Bleeding
6. Fill the master cylinder brake fluid reservoir to the maximum-fill level with approved brake fluid from a clean, sealed brake fluid container. Master Cylinder Reservoir Filling
7. Securely install the master cylinder brake fluid reservoir diaphragm and cap.
8. Slowly apply and release the brake pedal, observing the brake pedal feel.
9. If the brake pedal feels spongy, perform the following:
   9.1. Visually inspect the hydraulic brake system for external leaks. Brake System External Leak Inspection
   9.2. Bleed the brake system. See Hydraulic Brake System Bleeding (Pressure) or Hydraulic Brake System Bleeding (Manual)

5.10.3.2. Master Cylinder Reservoir Filling

Warning:
Brake Fluid Irritant Warning

Caution:
Brake Fluid Effects on Paint and Electrical Components Caution

1. Visually inspect the brake fluid level through the brake master cylinder reservoir.
2. If the brake fluid level is at or below the half-full point during routine fluid checks, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the half-full point during routine fluid checks, and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped-off up to the maximum-fill level.
4. If brake system service was just completed, the brake fluid may be topped-off up to the maximum-fill level.
5. If the brake fluid level is above the half-full point, adding brake fluid is not recommended under normal conditions.
6. If brake fluid is to be added to the master cylinder reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm. Use only approved brake fluid from a clean, sealed brake fluid container.

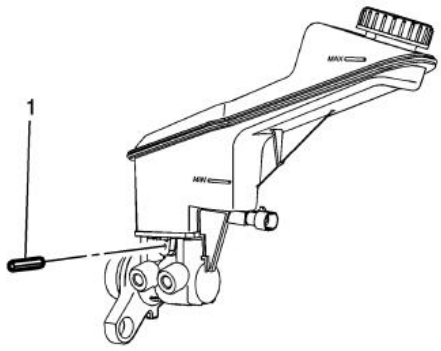
5.10.3.3. Master Cylinder Reservoir Replacement

5.10.3.3.1. Removal Procedure

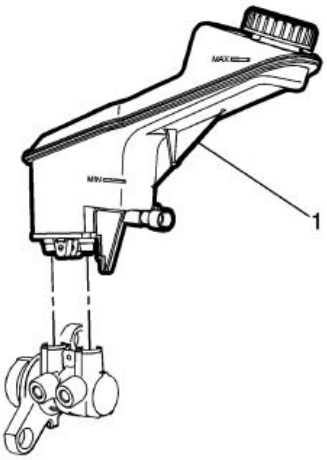
Warning:
Brake Fluid Irritant Warning

Caution
Brake Fluid Effects on Paint and Electrical Components Caution

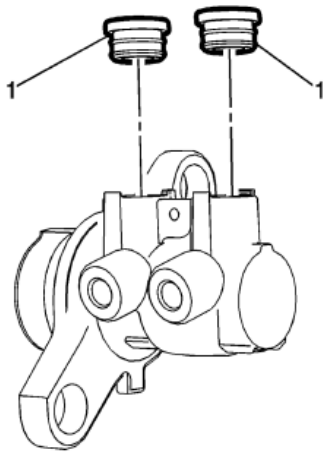
1. Remove and properly dispose of the brake fluid from the master cylinder reservoir.
2. Remove the brake master cylinder. Refer to Master Cylinder Replacement.



3. Remove and discard the brake master cylinder reservoir roll pin (1).

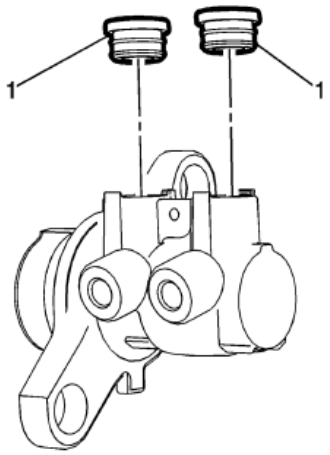


4. Remove the master cylinder reservoir (1) by carefully pulling straight upward.
5. Remove the brake fluid level indicator switch, if necessary. Refer to Brake Fluid Level Indicator Switch Replacement.

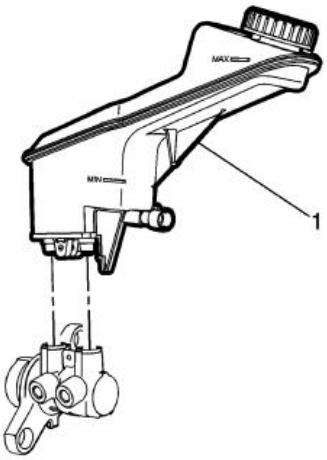


6. Remove the brake master cylinder reservoir seals (1).
7. If replacing the master cylinder reservoir, discard the reservoir seals.

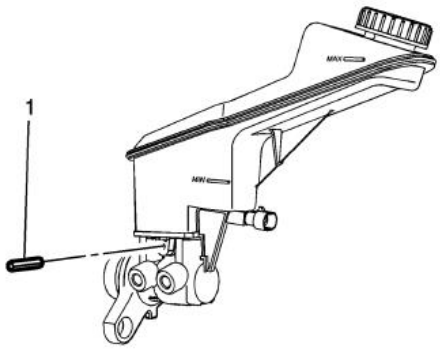
5.10.3.3.2. Installation Procedure



1. Lightly lubricate the brake master cylinder reservoir seals (1) with approved brake fluid from a clean, sealed, brake fluid container.
2. Install the lubricated brake master cylinder reservoir seals to the brake master cylinder.



3. Install the master cylinder reservoir (1) by firmly pressing straight downward.
4. Install the brake fluid level indicator switch, if removed. Refer to Brake Fluid Level Indicator Switch Replacement.



5. Install a new brake master cylinder reservoir roll pin (1).
6. Install the brake master cylinder. Refer to Master Cylinder Replacement.

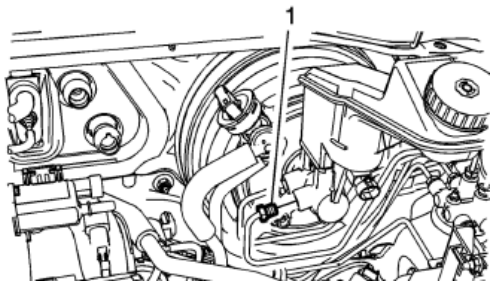
5.10.3.4. Master Cylinder Replacement

5.10.3.4.1. Removal Procedure

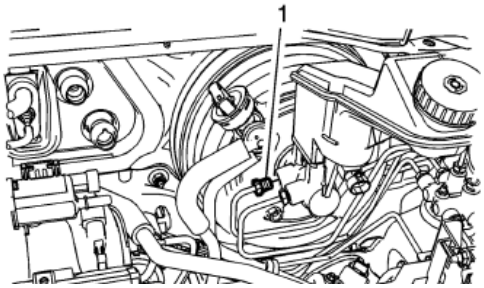
Warning:
Brake Fluid Irritant Warning

Caution:
Brake Fluid Effects on Paint and Electrical Components Caution

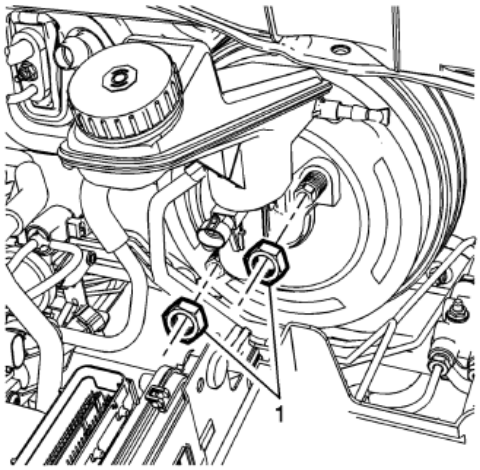
1. Place the ignition switch in the OFF position.
2. Remove the Air Box
3. Remove the Electronic Brake Control Module
4. Disconnect the brake fluid level indicator switch electrical connector.
5. Using a suitable suction device, remove and properly discard the brake fluid from the brake master cylinder reservoir.



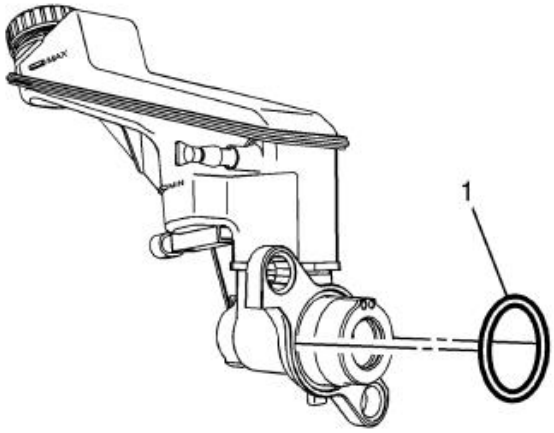
6. Disconnect the master cylinder secondary brake pipe fitting (1).
7. Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.



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



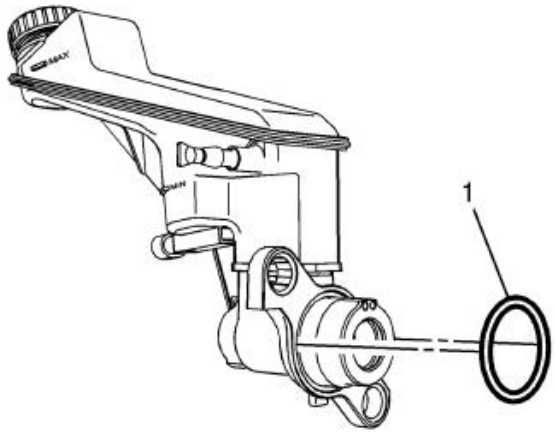
10. Remove the master cylinder nuts (1).
11. Remove the brake master cylinder.



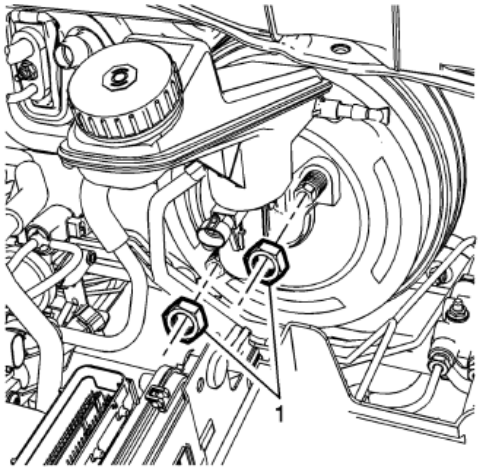
12. Remove the master cylinder seal (1).
13. Inspect the master cylinder seal for damage or deterioration and replace, if necessary.
14. Remove the brake fluid level indicator switch, if necessary. Refer to Brake Fluid Level Indicator Switch Replacement.
15. Remove the master cylinder reservoir, if necessary. Refer to Master Cylinder Reservoir Replacement.

5.10.3.4.2. Installation Procedure

1. Install the master cylinder reservoir, if removed. Refer to Master Cylinder Reservoir Replacement.
2. Bench bleed the master cylinder. Refer to Master Cylinder Bench Bleeding.
3. Install the brake fluid level indicator switch, if removed. Refer to Brake Fluid Level Indicator Switch Replacement.

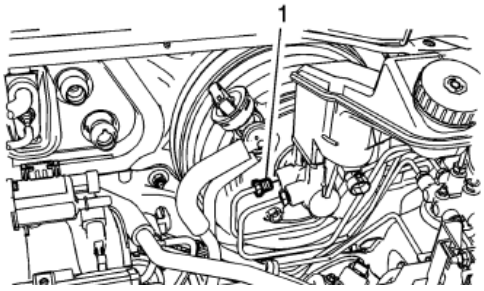


4. Install the master cylinder seal (1).
5. Install the master cylinder to the power vacuum brake booster.

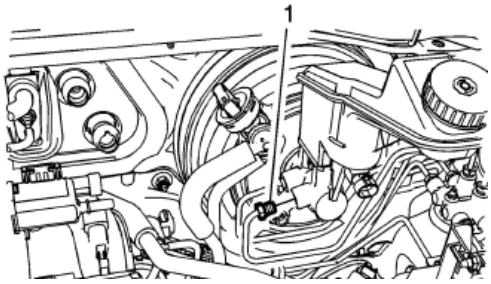


Caution
Refer to Fastener Caution.

6. Install the master cylinder nuts (1) and tighten to 50 Nm (37 lb ft).

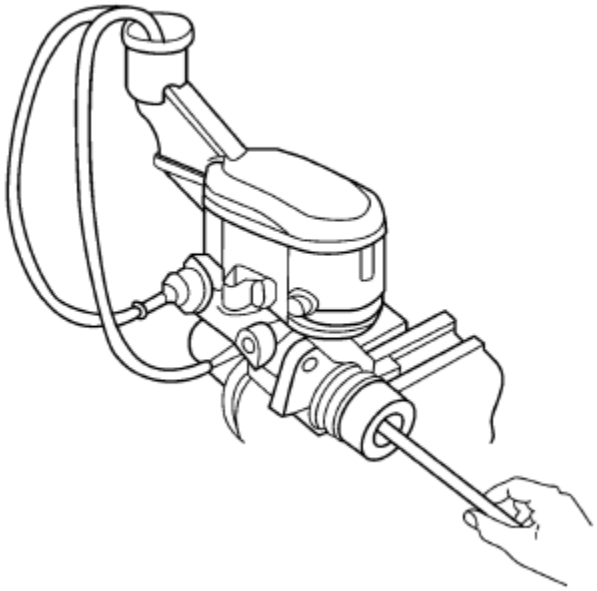


7. Connect the master cylinder primary brake pipe fitting (1) and tighten to 18 Nm (13 lb ft).



8. Connect the master cylinder secondary brake pipe fitting (1) and tighten to 18 Nm (13 lb ft).
9. Connect the brake fluid level indicator switch electrical connector.
10. Install the Electronic Brake Control Module
11. Install the Air Box
12. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding.

5.10.3.5. Master Cylinder Bench Bleeding



Warning:
Brake Fluid Irritant Warning

Caution:
Brake Fluid Effects on Paint and Electrical Components Caution

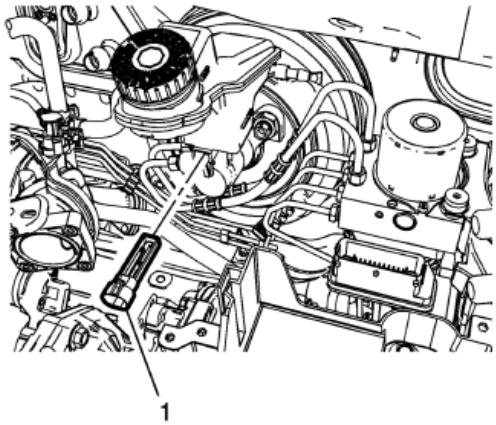
1. Secure the mounting flange of the brake master cylinder in a bench vice so that the rear of the primary piston is accessible.
2. Remove the master cylinder reservoir cap and diaphragm.
3. Install suitable fittings to the master cylinder ports that match the type of flare seat required and also provide for hose attachment.
4. Install transparent hoses to the fittings installed to the master cylinder ports, then route the hoses into the master cylinder reservoir.
5. Fill the master cylinder reservoir to the maximum fill level with brake fluid from a clean, sealed brake fluid container. Refer to Master Cylinder Reservoir Filling.
6. Ensure that the ends of the transparent hoses running into the master cylinder reservoir are fully submerged in the brake fluid.
7. Using a smooth, round-ended tool, depress and release the primary piston as far as it will travel, a depth of about 25 mm (1 in), several times. Observe the flow of fluid coming from the ports.
   As air is bled from the primary and secondary pistons, the effort required to depress the primary piston will increase and the amount of travel will decrease.
8. Continue to depress and release the primary piston until fluid flows freely from the ports with no evidence of air bubbles.
9. Remove the transparent hoses from the master cylinder reservoir.
10. Install the master cylinder reservoir cap and diaphragm.
11. Remove the fittings with the transparent hoses from the master cylinder ports. Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.

12. Remove the master cylinder from the vice.

5.10.3.6. Brake Fluid Level Indicator Switch Replacement

5.10.3.6.1. Removal Procedure

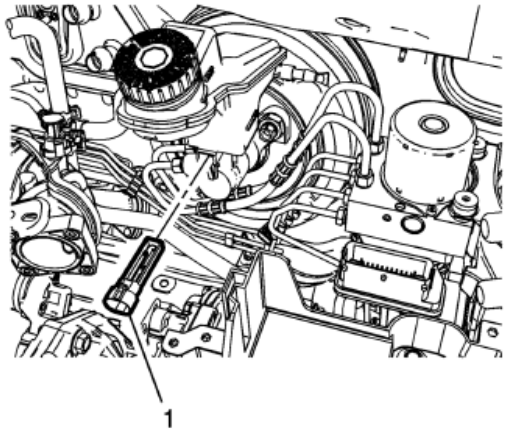
1. Disconnect the brake fluid level indicator switch electrical connector.



2. Using a small, flat-bladed tool, lift the locking tab on the underside of the brake fluid level indicator switch (1) and remove the switch.
3. Inspect the master cylinder reservoir for damage and replace, if necessary. Refer to Master Cylinder Reservoir Replacement.

5.10.3.6.2. Installation Procedure

1. Install the master cylinder reservoir, if removed. Refer to Master Cylinder Reservoir Replacement.



2. Install the brake fluid level indicator switch (1) by pressing the switch firmly into the brake master cylinder reservoir.
3. Connect the brake fluid level indicator switch electrical connector.

5.10.3.7. Hydraulic Brake System Bleeding (Pressure)

Special Tools
CH29532 Diaphragm Type Brake Pressure Bleeder
CH35589A Brake Pressure Bleeder Adapter

Warning:
Brake Fluid Irritant Warning

Caution
Brake Fluid Effects on Paint and Electrical Components Caution

1. Place a clean shop cloth around the brake master cylinder reservoir to catch brake fluid spills.
2. With the ignition OFF and the brakes cool, apply the brakes 3–5 times, or until the brake pedal effort increases significantly, to deplete the brake booster power reservoir.
3. If you have performed a master cylinder bench bleeding on this vehicle, or if you have disconnected the brake pipes from the proportioning valve assembly or the brake modulator assembly, you must perform the following steps to bleed air at the ports of the hydraulic components.
   3.1. Remove the Air box
   3.2. Fill the master cylinder reservoir to the maximum-full level with the approved brake fluid from a clean, sealed brake fluid container.
   If removal of the reservoir cap and diaphragm is necessary, clean the outside of the reservoir on and around the cap prior to removal.
   3.3. With the brake pipes installed securely to the master cylinder, proportioning valve assembly, or the brake pressure modulator valve assembly, loosen and separate one of the brake pipes from the port of the component.

Note:
For the proportioning valve assembly or the brake pressure modulator valve assembly, perform these steps in the sequence of system flow; begin with the fluid feed pipes on the master cylinder.

   3.4. Allow a small amount of brake fluid to gravity bleed from the open port of the component.
   3.5. Connect the brake pipe fitting to the component and tighten securely.
   3.6. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
   3.7. Loosen the same brake pipe fitting to purge air from the open port of the component.
   3.8. **Tighten** the brake pipe fitting, then have the assistant slowly release the brake pedal.
   3.9. Wait 15 seconds, then repeat steps 3.3–3.7 until all air is purged from the same port of each component.
   3.10. With the brake pipe fitting installed securely to the master cylinder, proportioning valve assembly, or brake pressure modulator assembly 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 and repeat steps 3.3–3.8 until each of the ports on the component has been bled.
   3.11. After completing the final component port bleeding procedure, ensure that each of the brake pipe fittings is properly tightened.

4. Fill the brake master cylinder reservoir to the maximum-fill level with the approved brake fluid from a clean, sealed brake fluid container. Ensure the master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to remain the proper level. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
5. Set up the brake pressure bleeder following the manufacturer's instructions.
6. Open the brake pressure bleeder fluid valve to allow pressurized brake fluid to enter the brake system.
7. Wait approximately 30 seconds, and then inspect the entire hydraulic brake system in order to ensure that there are no existing external brake fluid leaks. Any brake fluid leaks identified require repair prior to completing this procedure.
8. Install a proper box-end wrench onto the REAR wheel hydraulic circuit bleeder valve
9. Install a transparent hose over the end of the wheel hydraulic circuit bleeder valve
10. Submerge the open end of the transparent hose into a transparent container partially filled with the approved brake fluid from a clean, sealed brake fluid container.
11. 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.
12. **Tighten** the wheel circuit bleeder valve securely.
13. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
14. Install a transparent hose over the end of the wheel hydraulic circuit bleeder valve, then repeat steps 10–12.
15. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
16. Install a transparent hose over the end of the wheel hydraulic circuit bleeder valve, then repeat steps 10–12.
17. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 3 wheel hydraulic circuit bleeder valves is properly tightened.
18. Close the brake pressure bleeder fluid valve.
19. Remove the brake pressure bleeder from the brake master cylinder reservoir.
20. Fill the brake master cylinder reservoir to the maximum-full level with the approved brake fluid from a clean, sealed brake fluid container.
21. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
22. 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:
    22.1. Inspect the brake system for external leaks. Refer to Brake System External Leak Inspection.
    22.2. If equipped with antilock brakes, using a scan toll, perform the antilock brake system automated bleeding procedure to remove any air that may have been trapped in the brake pressure modulator valve (BPMV). Refer to Antilock Brake System Automated Bleed
23. Turn the ignition ON, with the 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.

24. If the brake system warning lamp remains illuminated, refer to Symptoms Hydraulic Brakes.

5.10.3.8. Hydraulic Brake System Bleeding (Manual)

Warning:
Brake Fluid Irritant Warning

Caution
Brake Fluid Effects on Paint and Electrical Components Caution

1. 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. Place a clean shop cloth around the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to Fluid and Lubricant Recommendations.
5. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
6. Install a transparent hose over the end of the bleeder valve.
7. Submerge the open end of the transparent hose into a transparent container partially filled with brake fluid from a clean, sealed brake fluid container.
8. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
9. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
10. **Tighten** the bleeder valve, then have the assistant slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 8-10 until all air is purged from the wheel hydraulic circuit.
12. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.
13. Fill the brake master cylinder reservoir to the maximum-fill level with brake fluid from a clean, sealed brake fluid container.
14. Slowly press and release the brake pedal. Observe the brake pedal feel.
15. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:
16. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

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

17. If the brake system warning lamp remains illuminated, refer to Diagnostic Starting Point Vehicle.

5.10.3.8.1. Bleeding the Complete Brake Hydraulic System

1. 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. Place a clean shop cloth around the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to Fluid and Lubricant Recommendations.
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to Master Cylinder Bench Bleeding.
6. If the brake pipes have been removed from the master cylinder, the following steps must be performed.
   - 6.1. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe fitting from the front port of the brake master cylinder.
   - 6.2. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder. Capture and properly dispose of the brake fluid in an approved container.
   - 6.3. Install the front brake pipe fitting to the front port of the brake master cylinder and tighten the fitting. Refer to Fastener **Tighten**ing Specifications.
   - 6.4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
   - 6.5. Loosen the front brake pipe fitting from the front port of the brake master cylinder to purge air from the master cylinder port.
   - 6.6. **Tighten** the front brake pipe fitting, then have the assistant slowly release the brake pedal.
   - 6.7. Wait 15 seconds, then repeat steps 6.4-6.6 until all air is purged from the front brake pipe fitting of the front port of the master cylinder.
   - 6.8. After all air is purged from the front port of the brake master cylinder, tighten the front master cylinder brake pipe fitting. Refer to Fastener **Tighten**ing Specifications.
   - 6.9. With the front brake pipe fitting installed securely to the front port of the brake master cylinder, loosen and separate the rear brake pipe fitting from the rear port of the brake master cylinder.
   - 6.10. Repeat steps 6.2-6.7 for the rear port of the brake master cylinder.
   - 6.11. After all air is purged from the rear port of the brake master cylinder, tighten the rear master cylinder brake pipe fitting. Refer to Fastener **Tighten**ing Specifications.
   - 6.12. Slowly press and release the brake pedal. Observe the brake pedal feel.
   - 6.13. If the brake pedal feels spongy, proceed to step 7.
   - 6.14. If the brake pedal feels firm, proceed to step 24.
7. If the brake pipes have been removed from the brake pressure modulator valve (BPMV) assembly, air must be purged from each port of the respective assembly beginning with the feed pipes from the master cylinder.
   - 7.1. Loosen and separate one of the master cylinder brake pipe fittings from the inlet port of the assembly to be bled.
   - 7.2. Allow a small amount of brake fluid to gravity bleed from the open port of the assembly. Capture and properly dispose of the brake fluid in an approved container.
   - 7.3. Install the brake pipe fitting and to the inlet port of the assembly and tighten securely.

7.4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
7.5. Loosen the same brake pipe fitting to purge air from the open port of the assembly.
7.6. **Tighten** the brake pipe fitting, and then have the assistant slowly release the brake pedal.
7.7. Wait 15 seconds, then repeat steps 7.4-7.6 until all air is purged from the brake pipe fitting of the assembly.
7.8. Repeat steps 7.1-7.7 for all of the remaining ports of the assembly.
7.9. After bleeding each port of the assembly, tighten all of the brake pipe fittings on the assembly. Refer to Fastener **Tighten**ing Specifications.
7.10. Fill the master cylinder reservoir to the maximum-full level with brake fluid from a clean, sealed brake fluid container.
7.11. Slowly press and release the brake pedal. Observe the brake pedal feel.
7.12. If the brake pedal feels spongy, proceed to step 8.
7.13. If the brake pedal feels firm, proceed to step 24.

8. Install a proper box-end wrench onto the REAR wheel hydraulic circuit bleeder valve.
9. Install a transparent hose over the end of the bleeder valve.
10. Submerge the open end of the transparent hose into a transparent container partially filled with approved brake fluid from a clean, sealed brake fluid container.
11. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the brake 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. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
16. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
17. After completing the final wheel hydraulic circuit bleeding procedure, tighten all the wheel hydraulic circuit bleeder valves and install the bleeder valve dust caps.
18. Fill the master cylinder reservoir to the maximum-full level with brake fluid from a clean, sealed brake fluid container.
19. Slowly press and release the brake pedal. Observe the brake pedal feel.
20. If the brake pedal feels spongy, perform the following procedure.
    20.1. If equipped with antilock brakes, install a scan tool and perform the Antilock Brake System Automated Bleed to remove air which may be trapped in the BPMV.
    20.2. Inspect the hydraulic brake system for external leaks. Refer to Brake System External Leak Inspection.
    20.3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
21. If the brake pedal still feels spongy, pressure bleeds the hydraulic brake system. Refer to Hydraulic Brake System Bleeding
22. Turn the ignition switch ON with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

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

23. If the brake system warning lamp remains illuminated, refer to Diagnostic Starting Point Vehicle

2020 Carmel Service Manual

Brakes

Hydraulic Brake System Flushing

Warning:
Brake Fluid Irritant Warning

Caution
Brake Fluid Effects on Paint and Electrical Components Caution

1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:
   - Fluid separation, indicating 2 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 discoloration, 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
2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
3. If the brake fluid WAS 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:

   3.1. 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 procedures indicated:

   - Master Cylinder Replacement
   - Front Brake Hose Replacement
   - Rear Brake Hose Replacement
   - Front Brake Caliper Replacement
   - Brake Pressure Modulator Valve Replacement

   3.2. Clean out all the hydraulic brake pipes using denatured alcohol, or equivalent.

   3.3. Dry the brake pipes using non-lubricated, filtered air.

   3.4. Repair or 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 procedures indicated:

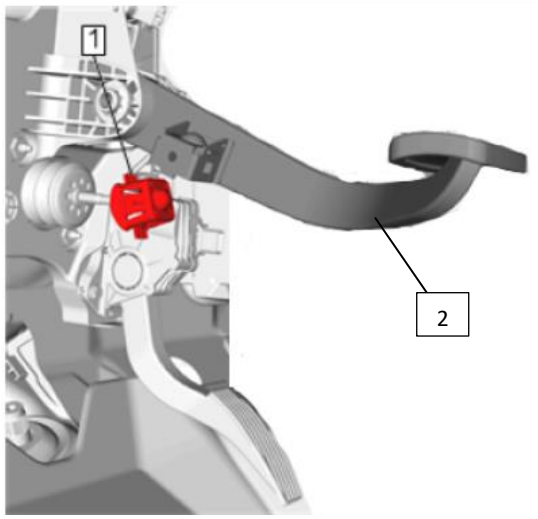
- Master Cylinder Replacement; also perform the following:
- Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to Master Cylinder Reservoir Replacement.
- Front Brake Hose Replacement
- Rear Brake Hose Replacement
- Front Brake Caliper Replacement
- Brake Pressure Modulator Valve Replacement

4. If the brake fluid WAS 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 diaphragm which may have allowed the moisture or particles to enter the hydraulic system.
5. Fill the brake master cylinder reservoir to the maximum-fill level with the approved brake fluid from a clean, sealed brake fluid container.
6. Pressure bleed the hydraulic brake system. Begin the procedure with the pressure bleeder reservoir filled to the maximum-fill level with the correct brake fluid as indicated. Refer to Hydraulic Brake System Bleeding.

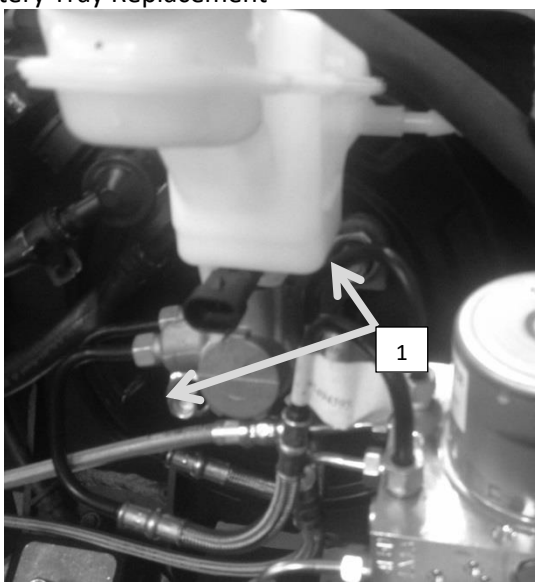
5.10.3.9. Brake and Accelerator Pedal Assembly Replacement

5.10.3.9.1. Removal Procedure

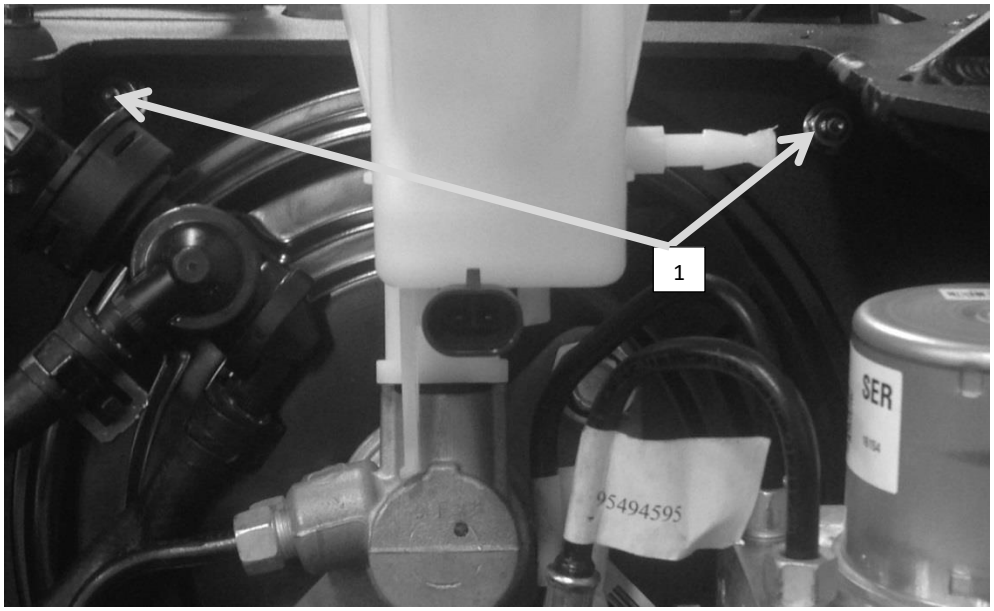
1. Remove the Air Box
2. Brake Pedal Position Sensor Electrical Connector » Disconnect
3. Accelerator Pedal Position Sensor Electrical Connector » Disconnect



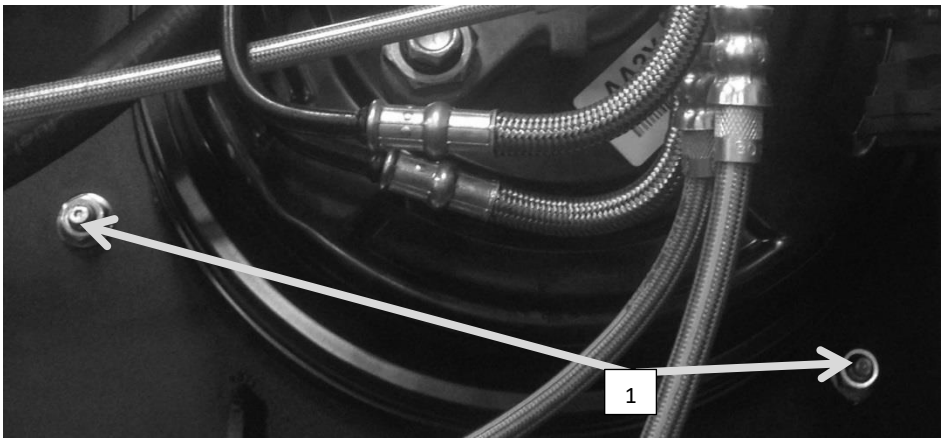
4. Compress the locking tabs on the brake pedal retainer (1).
5. Release the brake pedal (2) from the brake pedal retainer.
6. Battery Tray » Remove — Battery Tray Replacement



7. Power Vacuum Brake Booster Bolt (1) » Remove [2x]



8. Brake Pedal Assembly Nut (1) » Remove [2x]



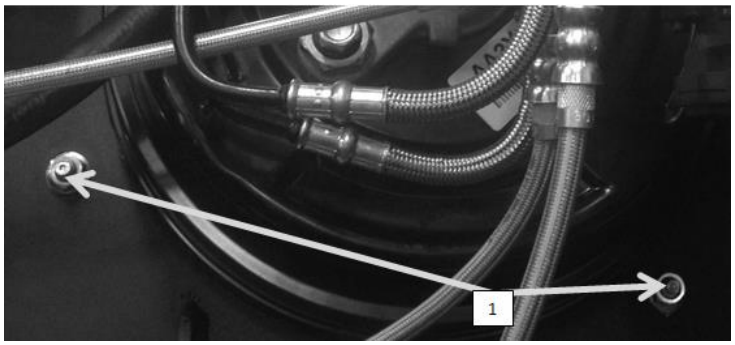
9. Brake Pedal Assembly Nut (1) » Remove [2x]
10. Brake Pedal Assembly » Remove
11. Pedal Box Mounting Bracket Nut (1) » Remove
12. Brake Pedal Position Sensor » Remove — Brake Pedal Position Sensor Replacement
13. Accelerator Pedal Position Sensor » Remove — Accelerator Pedal Position Sensor Replacement

5.10.3.9.2. Installation Procedure

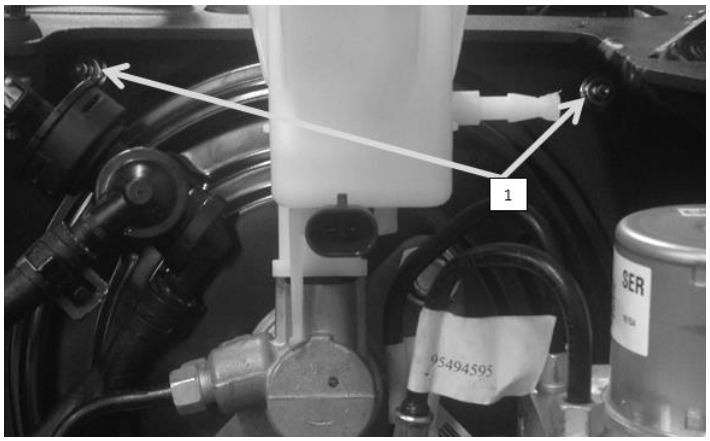
1. Accelerator Pedal Position Sensor » Install — Accelerator Pedal Position Sensor Replacement
2. Brake Pedal Position Sensor » Install — Brake Pedal Position Sensor Replacement

Caution
Refer to Fastener Caution

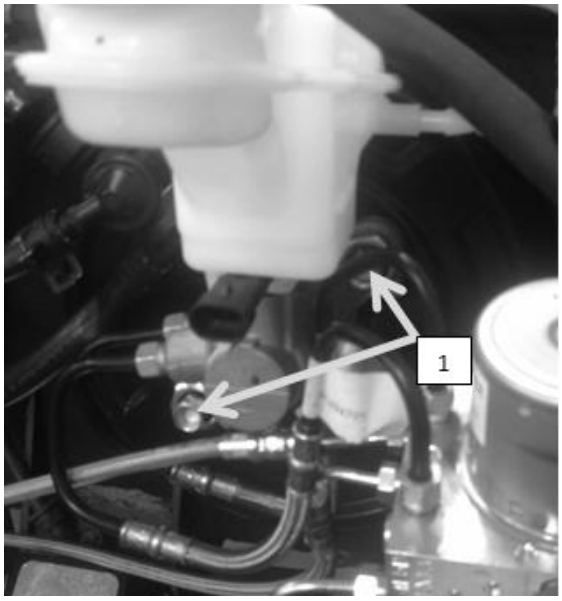
3. Brake Pedal Assembly » Install



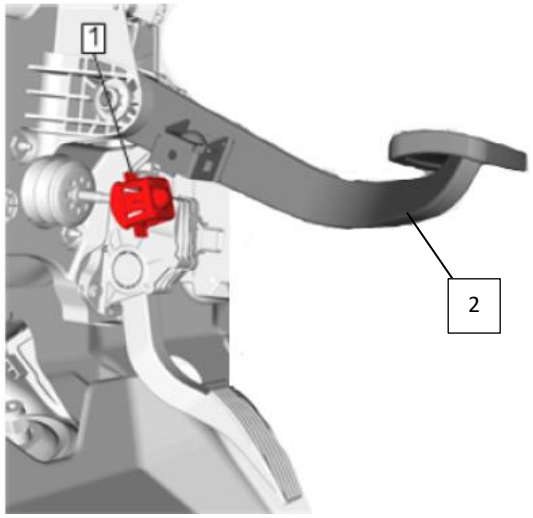
4. Brake Pedal Assembly Nut (1) » Install and tighten 22 Nm (16 lb ft)[2x]



5. Brake Pedal Assembly Nut (1) » Install and tighten 22 Nm (16 lb ft)[2x]



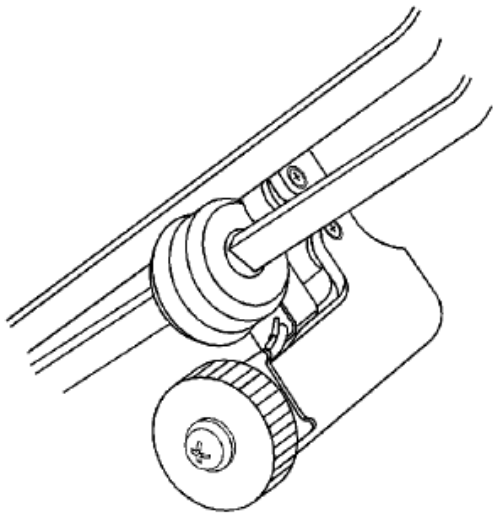
6. Power Vacuum Brake Booster Bolt (1) » Install and tighten 22 Nm (16 lb ft)[2x]



7. Install the brake pedal retainer (1) to the power vacuum brake booster pushrod.
8. Install the brake pedal (2) to the brake pedal retainer.
9. Accelerator Pedal Position Sensor Electrical Connector » Connect
10. Brake Pedal Position Sensor Electrical Connector » Connect
11. Install the Air box

5.10.3.10. Brake Pipe Replacement

Special Tools
CH-45405 Brake Pipe Flaring Kit



Warning:
Refer to Brake Fluid Irritant Warning.

Warning:
Always use double walled steel brake pipe when replacing brake pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and cause brake system failure.

Caution:
Refer to Brake Fluid Effects on Paint and Electrical Components Caution.

Note:
When servicing the brake pipes, note the following: • If sectioning the brake pipe, use replacement pipe of the same type and outside diameter. • Use fittings of the appropriate size and type. • Only create flares of the same type or design as originally equipped on the vehicle.

1. Inspect the area of brake pipe to be repaired or replaced.
2. Release the brake pipe to be replaced from the retainers, as required.
3. Select an appropriate location to section the brake pipe, if necessary.
   - Allow adequate clearance in order to maneuver the CH-45405 Brake Pipe Flaring Kit.
   - Avoid sectioning the brake pipe at bends or mounting points.

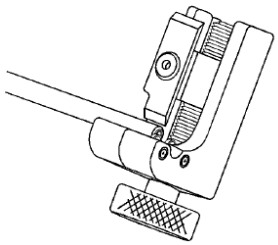
4. Using a string or wire, measure the length of the pipe to be replaced including all pipe bends.
5. Add to the measurement taken the appropriate additional length required for each flare to be created.

Specification

6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe
9.50 mm (0.374 in) for 6.35 mm (1/4 in) diameter pipe
12.67 mm (0.499 in) for 7.94 mm (5/16 in) diameter pipe

Note:
Ensure that the brake pipe end to be flared is cut at a square, 90 degree angle to the pipe length.

6. Using the pipe cutter included in the CH-45405 Brake Pipe Flaring Kit , carefully cut the brake pipe squarely to the measured length.
7. Remove the sectioned brake pipe from the vehicle.
8. Select the appropriate size of brake pipe and tube nuts, as necessary. The brake pipe outside diameter determines brake pipe size.



9. Strip the nylon coating from the brake pipe end to be flared, if necessary.
   9.1. Select the appropriate blade on the coating stripping tool included in the CH-45405 Brake Pipe Flaring Kit , by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers.

Specification

   9.2. 6.35 mm (0.250 in) blade for 4.76 mm (3/16 in) diameter pipe
   9.3. 9.50 mm (0.374 in) blade for 6.35 mm (1/4 in) and 7.94 mm (5/16 in) diameter pipe
   9.4. Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
   9.5. While holding the brake pipe firmly against the stripping tool roller ledges, rotate the thumbwheel of the tool until the blade contacts the brake pipe coated surface.

Note:
Do not gouge the metal surface of the brake pipe.

   9.6. Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
   9.7. After each successive revolution of the stripping tool, carefully rotate the thumbwheel of the tool clockwise, in order to continue stripping the coating from the brake pipe until the metal pipe surface is exposed.
   9.8. Loosen the thumbwheel of the tool and remove the brake pipe.

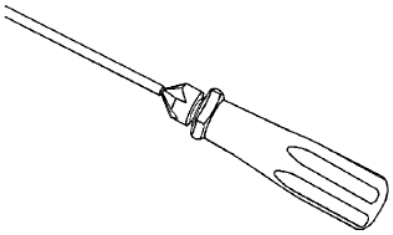
Note: Ensure that all loose remnants of the nylon coating have been removed from the brake pipe.

9.9. Inspect the stripped end of the brake pipe to ensure that the proper amount of coating has been removed.

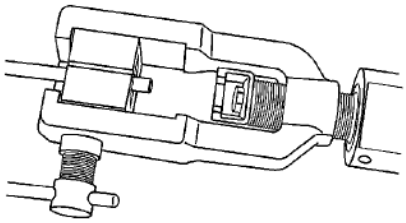
Specification

9.10. 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe

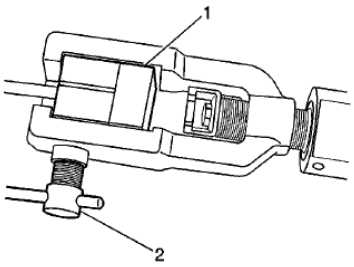
9.11. 9.50 mm (0.374 in) for 6.35 mm (1/4 in) and 7.94 mm (5/16 in) diameter pipe



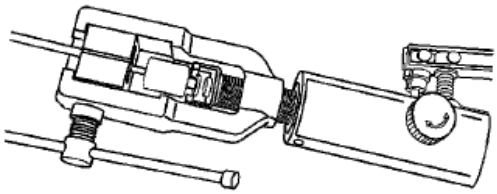
10. Chamfer the inside and outside diameter of the pipe with the deburring tool included in the CH-45405 Brake Pipe Flaring Kit .
11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the CH-45405 Brake Pipe Flaring Kit of lubricant, contaminants, and debris.



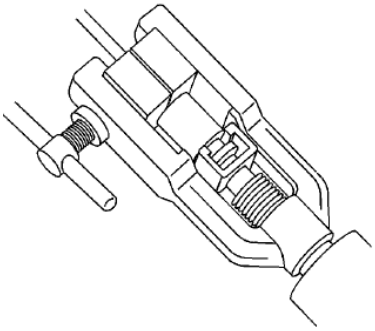
13. Loosen the die clamping screw of the CH-45405 Brake Pipe Flaring Kit .
14. Select the corresponding die set and install the die halves into the die cage with the full, flat face of one die facing the clamping screw, and the counter-bores of both dies facing the forming ram.



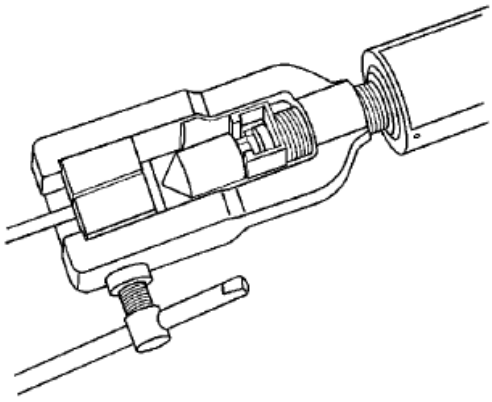
15. Place the flat face of an unused die (1) against the die halves in the clamping cage and hold firmly against the counter-bored face of the dies.
16. Insert the prepared end of the pipe to be flared through the back of the dies until the pipe is seated against the flat surface of the unused die (1).
17. Remove the unused die (1).
18. Ensure that the rear of both dies are seated firmly against the enclosed end of the die cage.
19. Firmly hand tighten the clamping screw (2) against the dies.



20. Select the appropriate forming mandrel and place into the forming ram.
21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the CH-45405 Brake Pipe Flaring Kit until it bottoms against the die cage.
23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the CH-45405 Brake Pipe Flaring Kit until the forming mandrel bottoms against the clamping dies.



24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.

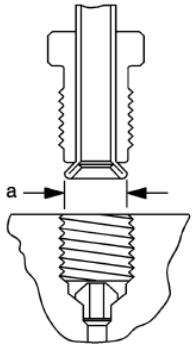


25. Insert the finishing cone into the forming ram.
26. Rotate the hydraulic fluid control valve clockwise to the closed position.
27. Rotate the body of the CH-45405 Brake Pipe Flaring Kit until it bottoms against the die cage.
28. While guiding the finishing cone into the exposed end of pipe to be flared, operate the lever of the CH4-5405

Brake Pipe Flaring Kit until the finishing cone bottoms against the dies.

29. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.

30. Loosen the die clamping screw and remove the dies and pipe.
31. If necessary, lightly tap the dies until the die halves separate.



32. Inspect the brake pipe flare for correct shape and diameter (a).

Specification

- 6.74–7.10 mm (0.265–0.279 in) flare diameter for 4.76 mm (3/16 in) diameter pipe
- 8.57–9.27 mm (0.344–0.358 in) flare diameter for 6.35 mm (1/4 in) diameter pipe
- 10.42–10.79 mm (0.410–0.425 in) flare diameter for 7.94 mm (5/16 in) diameter pipe

33. If necessary, using the removed section of brake pipe as a template, shape the new pipe with a suitable brake pipe bending tool.

Note:
When installing the pipe, maintain a clearance of 19 mm (3/4 in) from all moving or vibrating components.

33. Install the pipe to the vehicle with the appropriate brake pipe unions, as required.
34. If previously released, secure the brake pipe to the retainers.
35. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding.
36. With the aid of an assistant, inspect the brake pipe flares for leaks by starting the engine and applying the brakes.

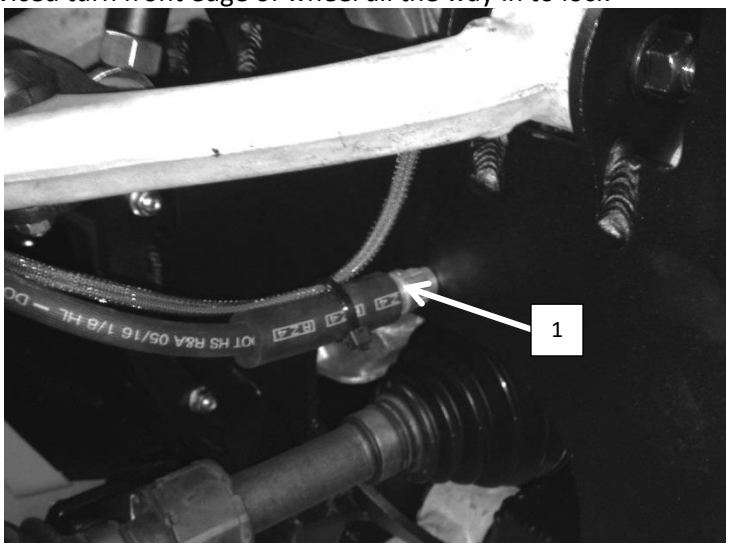
5.10.3.11. Front Brake Hose Replacement

5.10.3.11.1. Removal Procedure

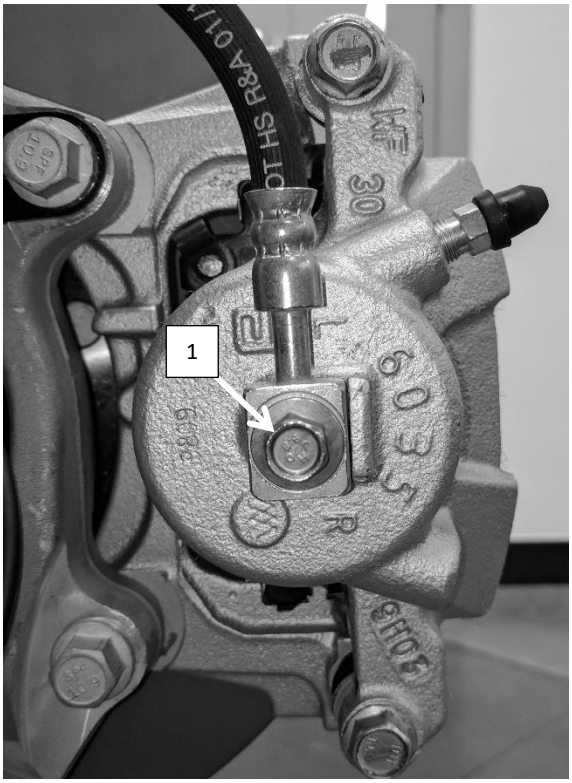
Warning:
Refer to Brake Dust Warning.

Warning:
Refer to Brake Fluid Irritant Warning.

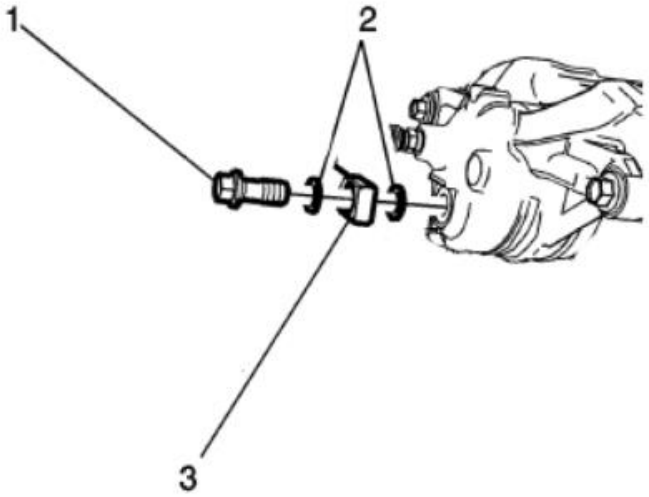
1. For the side being serviced turn front edge of wheel all the way in to lock



2. Remove the brake pipe fitting (1) from the front brake hose.
3. Cap the brake pipe fitting to prevent brake fluid loss and contamination.
4. Release the brake hose grommet from the Wheel Fender Mount

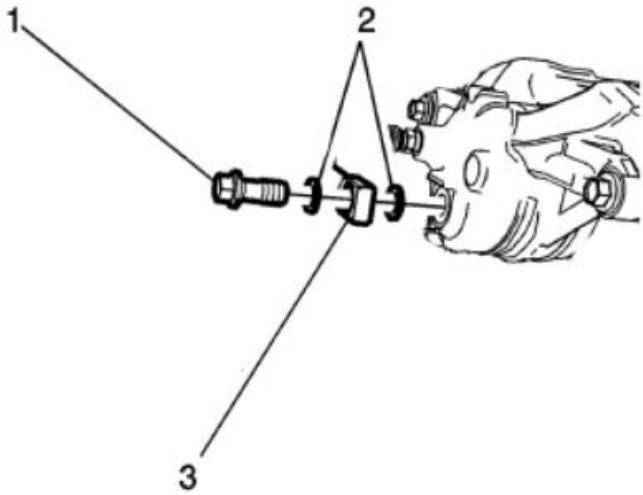


5. Remove the brake hose fitting bolt (1).



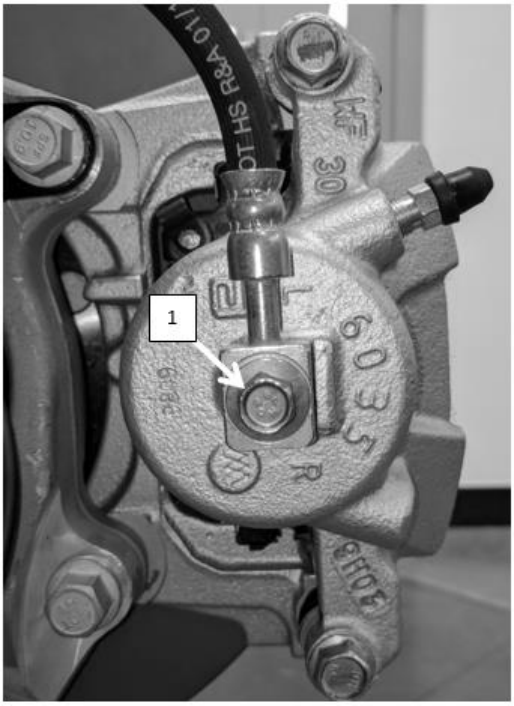
6. Remove and discard the brake hose fitting gaskets (2) from the brake hose fitting (3).
7. Remove the brake hose.

5.10.3.11.2. Installation Procedure



1. Assemble the brake hose fitting bolt (1) and the new brake hose fitting gaskets (2) to the brake hose fitting (3).

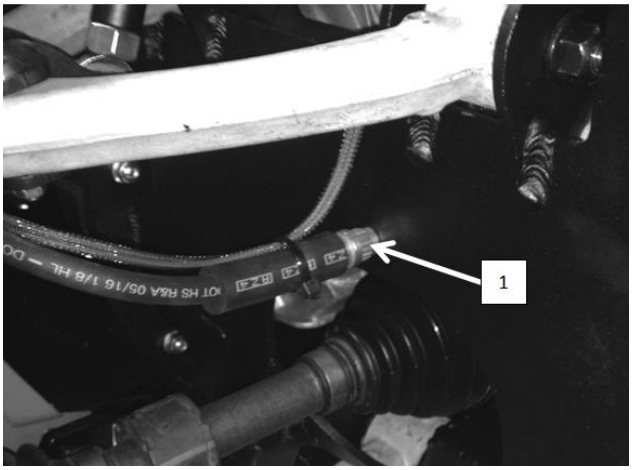
Caution:
Refer to Fastener Caution.



2. Install the brake hose assembly to the brake caliper and tighten the fitting bolt to 40 Nm (30 lb ft).
3. Install the brake hose to the Wheel Fender bracket and install the retainer.

2020 Carmel Service Manual

Brakes



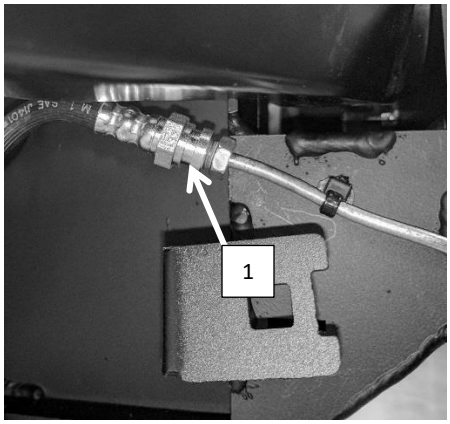
5.10.3.12. Rear Brake Hose Replacement

5.10.3.12.1. Removal Procedure

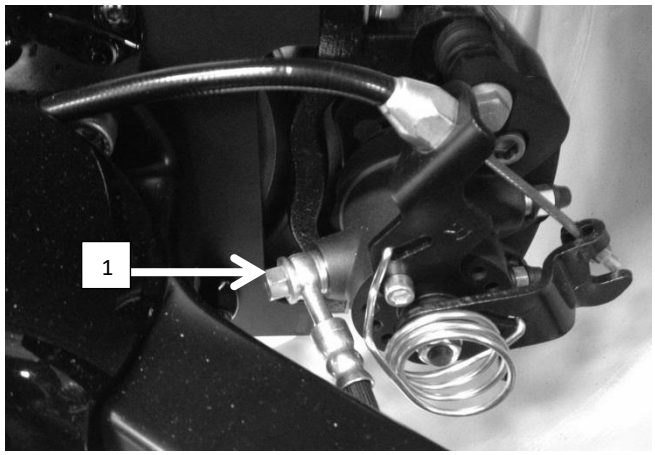
Warning:
Refer to Brake Dust Warning.

Warning
Refer to Brake Fluid Irritant Warning.

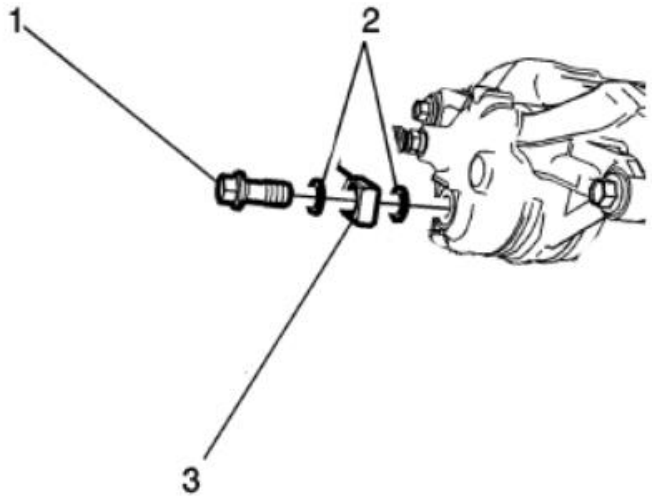
1. Remove the Rear Rocker Panel, See Rocker Body Panel



2. Remove the brake pipe fitting (1) from the rear brake hose.
3. Cap the brake pipe fitting to prevent brake fluid loss and contamination.
4. Pull the brake hose out of the chassis
5. Remove wire connectors supporting the brake hose along the underside of the swing-arm
6.
7. Place a clean rag in the rear wheel, under the brake line to catch any drips

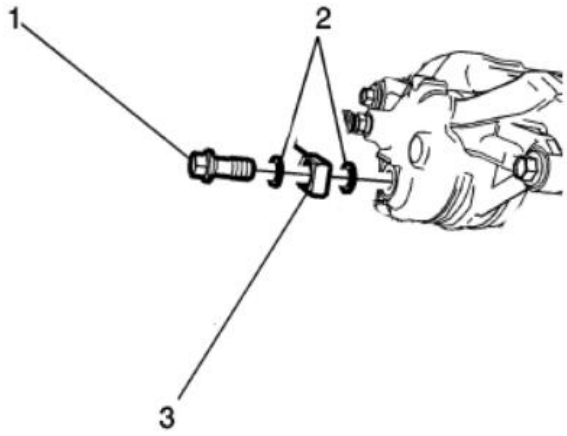


8. Remove the brake hose from the Rear Caliper (1)
9. Remove the brake hose fitting bolt (1).



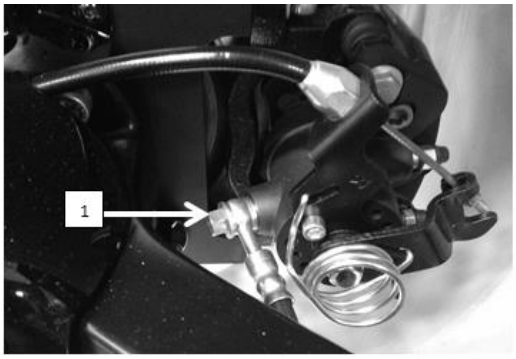
10. Remove and discard the brake hose fitting gaskets (2) from the brake hose fitting (3).
11. Remove the brake hose.

5.10.3.12.2. Installation Procedure

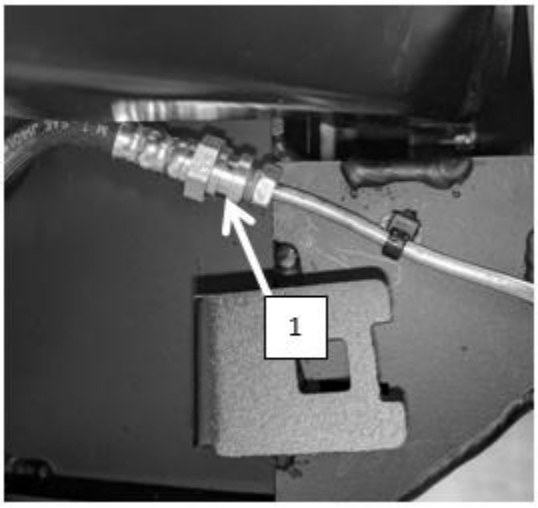


1. Assemble the brake hose fitting bolt (1) and the new brake hose fitting gaskets (2) to the brake hose fitting (3).

Caution:
Refer to Fastener Caution.



2. Install the brake hose assembly to the brake caliper and tighten the fitting bolt to 40 Nm (30 lb ft).



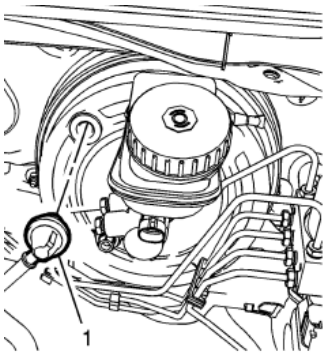
3. Install the brake pipe fitting (1) to the front brake hose and tighten the fitting to 18 Nm (13 lb ft).

4. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding.
5. Inspect the hydraulic line fittings for leaks
6. Install the Body Rocker Panel, Refer to Body Rocker Panel.

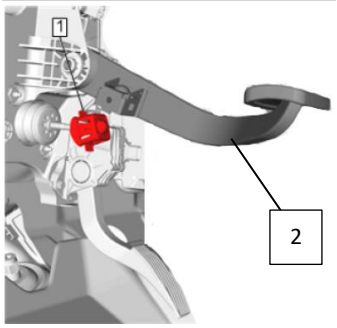
5.10.3.13. Power Vacuum Brake Booster Replacement

5.10.3.13.1. Removal Procedure

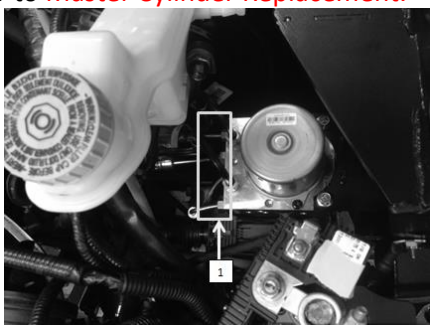
1. With the engine OFF, apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Disconnect the power vacuum brake booster vacuum sensor electrical connector



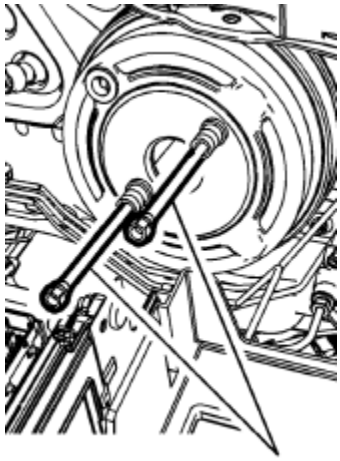
3. Remove the power brake booster vacuum check valve (1) from the power vacuum brake booster.



4. Compress the tabs on the top and bottom of the brake booster pushrod retainer (1) and lift the brake pedal (2) rearward to disconnect the brake pedal from the power brake booster pushrod.
5. Inspect the brake booster pushrod retainer for damage and replace, if necessary.
6. Remove the master cylinder. Refer to Master Cylinder Replacement.



7. Disconnect the front and rear brake pipe fittings (1) from the brake pressure modulator valve (BPMV). Refer to Brake Pressure Modulator Valve Replacement.



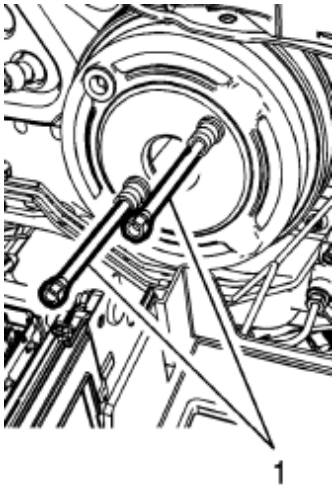
8. Completely loosen the power vacuum brake booster bolts (1).
9. Remove the power vacuum brake booster.
10. Inspect the power vacuum brake booster gasket for damage and replace, if necessary.

5.10.3.13.2. Installation Procedure

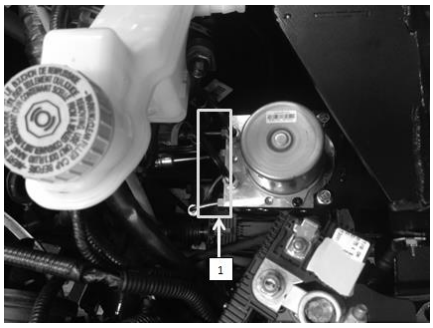
1. Install the power vacuum brake booster gasket, if removed.
2. Install the power vacuum brake booster and bolts.

Caution:
Refer to Fastener Caution.

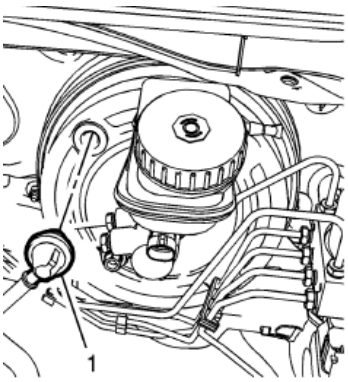
Note:
Do not over tighten the power vacuum brake booster bolts. If the power vacuum brake booster bolts are over tightened, the brake pedal may remain applied after a high pressure brake pedal application.



3. Install the power vacuum brake booster bolts (1) and tighten to 22 Nm (16 lb ft).

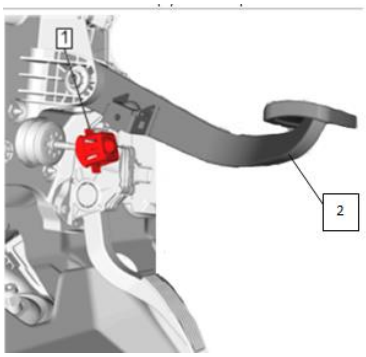


4. Connect the front and rear brake pipe fittings (1) to the brake pressure modulator valve (BPMV).
5. Refer to Brake Pressure Modulator Valve Replacement.
6. Install the master cylinder. Refer to Master Cylinder Replacement.



7. Install the power brake booster vacuum check valve (1) to the power vacuum brake booster.
8. Connect the power vacuum brake booster vacuum sensor electrical connector, if equipped.
9. Install the power brake booster pushrod retainer (1) to the power brake booster pushrod, if removed.

Note:
Ensure the power vacuum brake booster pushrod retainer is fully seated in the brake pedal arm.

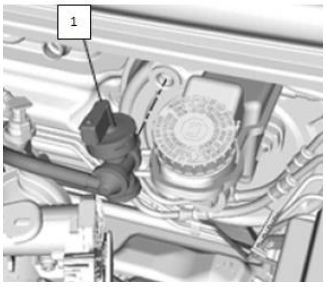


10. Position the brake pedal (2) to the power brake booster pushrod retainer and firmly seat the brake pedal to the retainer.

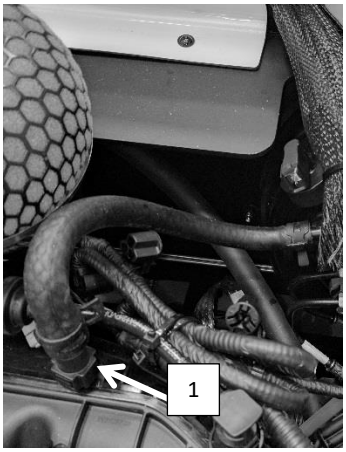
5.10.3.14. Power Brake Booster Vacuum Check Valve and Hose Replacement

5.10.3.14.1. 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 brake booster vacuum reserve.



2. Power Brake Booster Vacuum Sensor (1) pull to remove

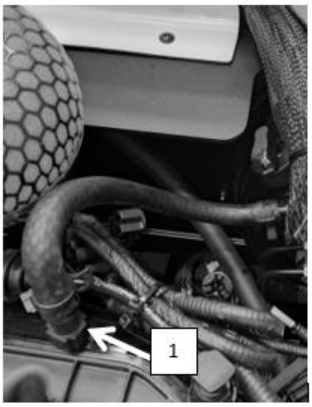


3. Disconnect the Quick Connect Fitting (1) at the Intake Manifold

4. Remove the Power Brake Booster Vacuum Hose Assembly

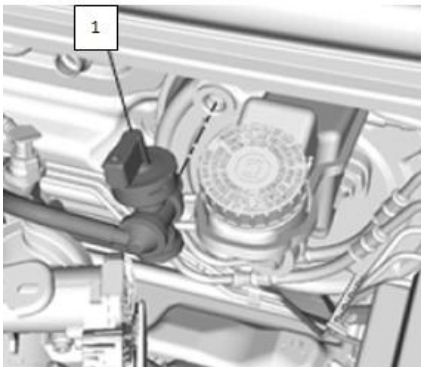
5.10.3.14.2. Installation Procedure

1. Install the Power Brake Booster Vacuum Hose Assembly



2. Connect the Quick Connect Fitting (1) at the Intake Manifold

Note:
A small amount of denatured alcohol may be used as a lubricant for assembly.

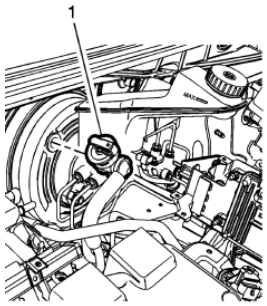


3. Install the Power Brake Booster Vacuum Sensor (1)

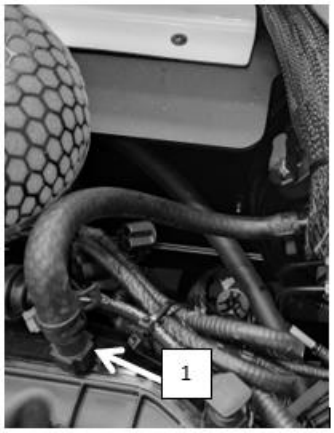
5.10.3.15. Power Brake Booster Vacuum Sensor Replacement

5.10.3.15.1. Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times to deplete the power vacuum brake booster vacuum reserve.



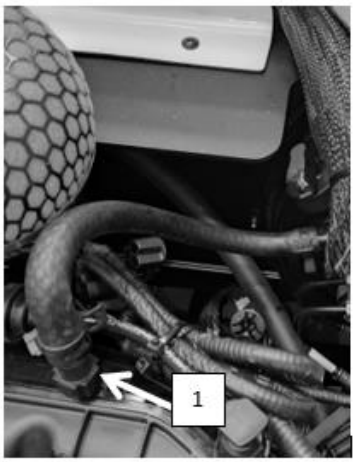
2. Disconnect the power brake booster vacuum pipe quick connect (1) from the power brake booster pump.



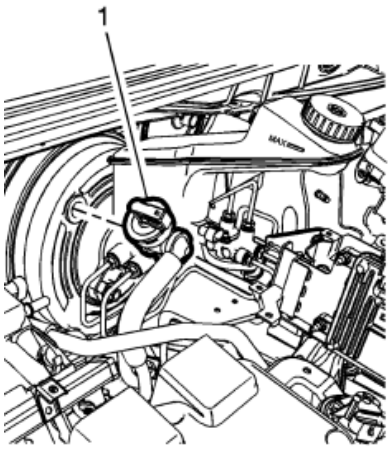
3. Disconnect the power brake booster vacuum pipe quick connect (1) from the intake manifold fitting.
4. Remove the power brake booster vacuum pipe and vacuum sensor assembly.

5.10.3.15.2. Installation Procedure

1. Install the power brake booster vacuum pipe and vacuum sensor assembly.



2. Connect the power brake booster vacuum pipe quick connect (1) to the intake manifold fitting.



Note:
A small amount of denatured alcohol may be used as a lubricant for assembly.

3. Connect the power brake booster vacuum sensor (1) to the power vacuum brake booster grommet.

2020 Carmel Service Manual

Brakes

DRAFT – 1.0
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