

SERVICE MANUAL

SERVICE MANUAL SECTION

CF 500, CF 600 Brakes

Truck Model: CF 500

Truck Model: CF 600

Unit Code: 04GAX

Unit Code: 04JNH

Unit Code: 04NNH

Unit Code: 04086

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Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.

Follow all warnings, cautions, and notes.

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Safety Information

NOTE: Read the following before starting the service procedure.

The information contained in this International Service Manual Section was current at the time of printing and is subject to change without notice or liability.

You must follow your company safety procedures when you service or repair equipment. Be sure to understand all of the procedures and instructions before you begin work on the unit.

International uses the following types of notations to give warning of possible safety problems and to give information that will prevent damage to the equipment being serviced or repaired.



WARNING: A warning indicates procedures that must be followed exactly. Personal injury or possible death can occur if the procedure is not followed.

CAUTION: A caution indicates procedures that must be followed exactly. If the procedure is not followed, damage to equipment or components can occur.

NOTE: A note indicates an operation, procedure or instruction that is important for correct service.

Some procedures require the use of special tools for safe and correct service. Failure to use these special tools when required can cause injury to service personnel or damage to vehicle components.

This service manual section is intended for use by professional technicians, NOT a "do-it-yourselfer." It is written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the service section applies to your vehicle. See your International Truck Dealer for information on whether this service section applies to your vehicle.

Brake System — General Information

Specifications

Table 1 General Specifications

Item	Specification
Brake Pads	
Brake pad minimum thickness	3.0 mm (0.118 inch)
Brake pad maximum thickness variation (pad-to-pad)	2.0 mm (0.079 in.)
Brake pad maximum taper wear (in any direction)	3.0 mm (0.118 inch)
Brake Disc	
Front brake disc minimum thickness	36.0 mm (1.41 inch)
Rear brake disc minimum thickness	36.0 mm (1.41 inch)
Minimum thickness to machine front brake disc	36.6 mm (1.44 inch)
Minimum thickness to machine rear brake disc	36.6 mm (1.44 inch)

Table 2 Torque Specifications

Description	Nm	lbf-ft
Caliper bleeder screw	35	26
Master cylinder outlet tube fittings	25	18

Brake System Description and Operation

For brake booster information, refer to Power Brake Actuation(Power Brake Actuation, page 40).

The braking system is a front-to-rear split hydraulic system. For additional information, refer to Hydraulic Brake Actuation(Hydraulic Brake Actuation, page 36).

The front wheel brakes utilize a dual piston brake to caliper and disc brake system. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18).

The rear brakes utilize a dual piston brake caliper and disc brake system. For additional information, refer to Rear Disc Brake(Rear Disc Brake, page 25).

The vehicle is equipped with a cable-operated parking brake. For additional information, refer to Parking Brake and Actuation(Parking Brake and Actuation, page 29).

For anti-lock brake system information, refer to Antilock Control(Anti-Lock Control — 4-Wheel, page 42).

Brake System Diagnosis and Testing

Refer to the Wiring Diagrams for schematic and connector information.

Table 3 Special Tools

	EZ-Tech
 ST1137-A	Automotive Meter ZTSE4357 or equivalent

Inspection and Verification

! WARNING: Use of any brake fluid other than the approved DOT 3 will cause permanent damage to brake components and will render the brakes inoperative.

! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

CAUTION: Do not spill brake fluid onto painted surfaces. If spilled, wipe up immediately.

NOTE: Always check the fluid level in the brake master cylinder reservoir before carrying out the test procedures. If the fluid level is not at the correct level, clean the reservoir cap before removing, then add DOT 3 brake fluid.

NOTE: Prior to carrying out any diagnosis, make sure the red brake warning indicator is functional. For additional information, refer to Instrument Cluster in S08307.

The first indication that something may be wrong in the brake system is a change in the feeling through the brake pedal. The brake warning indicator in the instrument cluster and the brake fluid level in the brake master cylinder reservoir are also indicators of system concerns.

If a wheel is locked and the vehicle must be moved, open a bleeder screw at the locked wheel to let out enough fluid to relieve the pressure. Close the bleeder screw. This bleeding operation may release the brakes but will not correct the cause of the trouble. If this does not relieve the locked wheel condition, repair the locked components before proceeding.

Inspect all hoses and connections. All unused vacuum connectors should be capped. Make sure hoses and their connections are correctly secured and in good condition with no holes, soft or collapsed areas.

Road Test

The technician should have a thorough knowledge of the brake system operation and accepted general braking guidelines in order to detect any problems.

Select a road that is reasonably smooth and level. Gravel or bumpy roads are not suitable because the surface does not allow the tires to grip the road equally. Avoid crowned roads.

A key factor in evaluating brake concerns is the deceleration rate. This varies from vehicle to vehicle and with changes in operating conditions. It is evident how well the brakes are working after just a few applications.

Table 4 Visual Inspection Chart

Mechanical	Electrical
<ul style="list-style-type: none"> • Brake master cylinder • Brake caliper piston • Disc brake rotors • Brake pads • Power brake booster • Brake pedal linkage • Vacuum or hydraulic booster hose • Tires • Debris 	<ul style="list-style-type: none"> • Parking brake switch • Damaged or corroded wiring harness • Brake master cylinder fluid level switch

For low or spongy brake pedal concerns:

- check and, if necessary, refill the brake master cylinder reservoir.
- bleed the brake system and retest the brake pedal feel.
- if the brake pedal is still low or feels spongy, check the brake pedal mounting for looseness and correct installation. Check the brake booster and the brake master cylinder for loose mounting. Correct as necessary and retest the system for normal operation.

For a slow or incomplete brake pedal return concern:

- inspect for binding, damage, correct installation or interference at the brake pedal.
- check the brake booster for binding, damage and correct installation.

Brake Pads

NOTE: It is not required to install new brake pads if friction material properties are within guidelines. It is also not required to install new brake pads when the brake discs are machined.

- Remove the brake pads. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
- Inspect and measure the thickness of the brake pad friction material.
 - Install new brake pads if the thickness of the friction material is less than 3 mm (0.11 in). For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
 - Compare all 4 front or rear pads for uneven wear. Install new brake pads if the thickness of the friction material varies from pad to pad by more than 2 mm (0.07 in). For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
 - Install new brake pads if there are missing chunks or cracks in the lining through to the backing plate. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
 - If the friction material shows taper wear (the thickness varies by more than 3 mm (0.11 in) in any direction), verify the caliper guide pins are functioning correctly. For additional information, refer to Brake Caliper Guide Pins in this section.

Brake Discs

CAUTION: Using an impact tool without a torque socket will lead to unevenly tightened lug nuts. This causes brake disc on-vehicle lateral runout and brake roughness.

NOTE: It is generally not required to install new brake discs to address noise issues.

- Remove the brake disc. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
- Inspect the brake discs and measure the brake disc thickness in a minimum of 4 places around the circumference of the brake disc. Record the measurements.
 - Install new brake discs if any thickness measurement is less than the minimum specification. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
 - Install new brake discs if cracked. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
 - Machine the brake discs if the diagnosis has revealed vibration in the steering wheel, seat or pedal while braking. Heavily scored brake discs, similar to that caused by pads worn down to the backing plate, should also be installed new.

Brake Caliper

Inspect the brake calipers for the following:

- Brake fluid leaks. For additional information, refer to Brake System Leak Check in this section.
- Boots and seals for tears or cracks.
- Caliper piston for binding and corrosion.
- Guide pins for proper operation. For additional information, refer to Brake Caliper Guide Pins in this section.

Brake Caliper Guide Pins

CAUTION: Do not use power tools for caliper guide pin bore cleaning.

The guide pins should slide with a reasonable amount of hand force. If the brake pads show taper wear or the guide pins are difficult to move, then carry out the following steps.

NOTE: If a guide pin kit is not available, install a new caliper assembly.

- Disassemble the guide pins. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
- Use a wire brush, rolled-up sandpaper or emery cloth to remove all corrosion and foreign material from the caliper guide pin bores. Clean remaining debris from the bores with brake parts cleaner and compressed air.
- Install new brake pads if the lining is not within specifications. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18) for front disc brakes or Rear Disc Brake(Rear Disc Brake, page 25) for rear disc brakes.
- Assemble the caliper guide pins using new caliper seals, boots and guide pins. Use an ample amount of silicone brake caliper grease and dielectric compound to lubricate the bores and guide pins.

Brake Lines and Tubes

CAUTION: Never use copper tubing. It is subject to fatigue, cracking and corrosion, which could result in brake tube failure.

- Double-wall steel tubing is used throughout the brake hydraulic system. All brake tube fittings must be correctly double flared to provide strong, leakproof connections. When bending tubing to fit the underbody or rear axle contours, be careful not to kink or crack the tube.
- If a section of the brake tube is damaged, the entire section must be installed new with a tube of the same type, size, shape and length.

- When installing the hydraulic brake tubing, hoses or connectors, tighten all connections to specification. After installation, bleed the brake system. For additional information, refer to Brake System Bleeding in this section.
- The wet appearance on the outer cover of rubber brake hoses is called "sweating." This is a normal condition for neoprene rayon braid hose and is not a sign of leakage or cause to install a new hose.

Install a new flexible brake hose if the hose shows signs of softening, cracking or other damage.

When installing a new brake hose, position the hose to avoid contact with other vehicle components.

Non-Pressure Leaks

NOTE: The wet appearance on the outer cover of rubber brake hoses is called "sweating." This is a normal condition for neoprene rayon braid hose. The sweating condition is not evidence of a brake fluid leak and will not result in a loss of pressure in the system.

The only part of the brake system that could have a brake fluid loss that does not appear when the system is under pressure is the brake master cylinder reservoir under the following conditions:

- Missing or poorly-fitted brake master cylinder filler cap
- Punctured or otherwise damaged brake master cylinder reservoir
- Missing or damaged brake master cylinder filler cap gasket
- Missing, damaged or poorly-fitted sealing grommets between the brake master cylinder and the brake master cylinder reservoir

The brake master cylinder reservoir grommets are not separately repairable and must be installed new as part of a new brake master cylinder reservoir.

Brake Master Cylinder — Normal Conditions

The following conditions are considered normal and are not indications that the brake master cylinder is in need of service.

Condition 1: During normal operation of the brake master cylinder, the fluid level in the brake master cylinder reservoir will rise during brake application and fall during release. The net fluid level (such as after brake application and release) will remain unchanged.

Condition 2: A trace of brake fluid will exist on the booster shell below the master cylinder mounting flange. This results from the normal lubricating action of the master cylinder bore and seal.

Condition 3: Fluid level will decrease with pad wear.

Brake Master Cylinder — Abnormal Conditions

Changes in brake pedal feel or travel are indicators that something could be wrong in the brake system. GO to the Symptom Chart for abnormal condition diagnosis.

Brake Booster

Inspect the brake booster for the following:

- Excessive corrosion or damage
- Vacuum connections for leakage
- Vacuum hoses for kinks or leakage
- Brake booster check valve for correct operation

Changes in the brake pedal feel or travel are indicators that something could be wrong in the brake system. GO to the Symptom Chart for abnormal condition diagnosis.

Parking Brake

Raise and support the vehicle, and check the operation of the parking brake system with the vehicle on a hoist and the parking brake control fully released. Check for any damaged cables and install new components as necessary. Check the rear brake adjustment or carry out the brake system diagnosis. For additional information, refer to Parking Brake and Actuation(Parking Brake and Actuation, page 29).

Symptom Chart

Table 5 Symptom Chart

Condition	Possible Sources	Action
The red brake warning indicator is always on	A. Brake fluid level. B. Circuitry. Instrument cluster.	A. FILL the brake fluid reservoir to the MAX line. B. GO to Pinpoint Test A.
Red brake warning indicator inoperative	<ul style="list-style-type: none"> • Circuitry. • Bulb. 	<ul style="list-style-type: none"> • Refer to Instrument Cluster and Panel Illumination in S08307.
The brakes pull or drift	A. Tire air pressure. B. Brake pads. Brake components. C. Suspension component. Wheel alignment.	A. CHECK the tires for uneven or excessive wear, and correct inflation. B. CHECK the brake pads for uneven taper or excessive wear. REPAIR as necessary. CHECK the brake discs and the hubs for damage. REPAIR as necessary. C. CHECK wheel alignment. REFER to Suspension System in S03014.
Brake pedal goes down fast	A. Brake fluid level. B. Air in system. C. Brake master cylinder.	A. INSPECT the system for leaks. FILL the brake master cylinder reservoir. BLEED the system. REFER to Brake System Bleeding in this section. B. INSPECT the system for leaks. BLEED the system. REFER to Brake System Bleeding in this section. C. CARRY OUT the brake master cylinder component test in this section.
The brake pedal eases down slowly	A. Air in system. B. Brake master cylinder.	A. INSPECT the system for leaks. BLEED the system. REFER to Brake System Bleeding in this section. B. CARRY OUT the brake master cylinder component test in this section.

Table 5 Symptom Chart (cont.)

Condition	Possible Sources	Action
Brake lockup under light brake pedal force	<ul style="list-style-type: none"> A. Brake pads. B. Brake components. C. Parking brake component. D. Antilock brake control system. 	<ul style="list-style-type: none"> A. CHECK the brake pads for uneven taper or excessive wear. REPAIR as necessary. B. CHECK the brake components for correct operation. REPAIR as necessary. C. REPAIR or INSTALL new components as necessary. REFER to Parking Brake in this section. D. CHECK the anti-lock brake control system. REFER to Antilock Control(Anti-Lock Control — 4-Wheel, page 42).
Excessive/erratic brake pedal travel	<ul style="list-style-type: none"> A. Leak in hydraulic system. Air in system. Disc brake caliper. B. Brake master cylinder. C. Brake pads. D. Brake pedal. 	<ul style="list-style-type: none"> A. INSPECT the system for leaks. BLEED the system. REFER to Brake System Bleeding in this section. B. CARRY OUT the brake master cylinder component test in this section. C. CHECK the brake pads for excessive wear. D. CHECK the brake pedal for binding or obstructions. REPAIR as necessary.
Brakes drag	<ul style="list-style-type: none"> A. Parking brake component. B. Brake caliper guide pins. C. Disc brake caliper. D. Brake booster. E. Brake master cylinder. 	<ul style="list-style-type: none"> A. REPAIR or INSTALL new components as necessary. REFER to Parking Brake in this section. B. REPAIR or INSTALL new caliper guide pins, seals and boots. REFER to Brake Caliper Guide Pins in this section. C. REPAIR or INSTALL new brake calipers as necessary. REFER to Front Disc Brakes(Front Disc Brake, page 18) or Rear Disc Brakes(Rear Disc Brake, page 25). D. CARRY OUT the brake booster component test in this section.

Table 5 Symptom Chart (cont.)

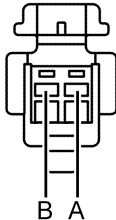
Condition	Possible Sources	Action
		E. CARRY OUT the brake master cylinder component test in this section.
Excessive brake pedal effort	A. Brake booster. B. Brake booster check valve. C. Brake booster manifold vacuum hose.	A. CARRY OUT the brake booster component test in this section. B. CARRY OUT the check valve component test in this section. C. REROUTE, REPAIR or INSTALL new components as necessary.
Hard or soft brake pedal feel	• Hydro-Boost®.	• CHECK the Hydro-Boost® system. REFER to the component test in this section.
Rattling noise	A. Caliper mounting bolts loose. B. Damaged or worn caliper guide pins or retainers. C. Missing or damaged anti-rattle clips or springs. D. Loose brake disc shield.	A. CHECK the caliper bolts. TIGHTEN to specifications. REFER to Front Disc Brakes(Front Disc Brake, page 18) or Rear Disc Brakes(Rear Disc Brake, page 25). B. CHECK the caliper guide pins and retainers for lubrication and correct operation. LUBRICATE or INSTALL new components as necessary. REFER to Brake Caliper Guide Pins in this section. C. CHECK the brake pads for missing clips or broken springs. INSTALL new components as necessary. REFER to Front Disc Brakes(Front Disc Brake, page 18) or Rear Disc Brakes(Rear Disc Brake, page 25). D. TIGHTEN the brake disc shield bolts to specification. REFER to Front Disc Brakes(Front Disc Brake, page 18) or Rear Disc Brakes(Rear Disc Brake, page 25).
Clicking noise — with brakes applied with anti-lock brake system (ABS)	• ABS hydraulic control unit.	• Acceptable condition.

Table 5 Symptom Chart (cont.)

Condition	Possible Sources	Action
Squealing noise — occurs on first (morning) brake application	<ul style="list-style-type: none"> • Brake pads. 	<ul style="list-style-type: none"> • Acceptable condition. Caused by humidity and low brake pad temperature.
Squealing noise — a continuous squeal	<ul style="list-style-type: none"> • Brake pads or linings worn below minimum thickness. 	<ul style="list-style-type: none"> • INSPECT brake pads for excessive wear, taper wear or uneven wear. VERIFY brake pads are within minimum specifications. REFER to Brake Pads in this section.
Squealing noise — an intermittent squeal brought on by cold, heat, water, mud or snow	<ul style="list-style-type: none"> • Brake pads. 	<ul style="list-style-type: none"> • Acceptable condition.
Groaning noise — occurs at low speeds with brake lightly applied (creeping)	<ul style="list-style-type: none"> • Brake pads. 	<ul style="list-style-type: none"> • Acceptable condition.
Grinding noise — continuous	<ul style="list-style-type: none"> • Brake pads or linings worn below minimum thickness. 	<ul style="list-style-type: none"> • INSPECT the brake pads, brake discs and attaching hardware for damage. VERIFY brake pads are within minimum specifications. REFER to Brake Pads in this section.
Moaning noise	<ul style="list-style-type: none"> • Brake linings contaminated with grease or oil. 	<ul style="list-style-type: none"> • INSPECT the brake pads for contamination. REPAIR or INSTALL new components as necessary. REFER to Front Disc Brakes(Front Disc Brake, page 18) or Rear Disc Brakes(Rear Disc Brake, page 25).
Vibration when the brakes are applied	<ul style="list-style-type: none"> • Uneven brake pad wear. • Brake disc pad transfer. • Brake disc. • Suspension components. 	<ul style="list-style-type: none"> • COMPLETE the brake system inspection described in Inspection and Verification in this section. • GO to Pinpoint Test B.
Brake vibration/shudder — occurs when the brake pedal is released	<ul style="list-style-type: none"> A. Brake caliper guide pins. B. Brake drag. 	<ul style="list-style-type: none"> A. INSPECT the brake caliper guide pins for correct operation. REFER to Brake Caliper Guide Pins in this section. B. INSPECT the brake pads for premature wear. REPAIR or INSTALL a new caliper as necessary. REFER to Front Disc Brakes(Front Disc Brake, page 18) or Rear Disc Brakes(Rear Disc Brake, page 25).

Connector Circuit Reference

Table 6 Parking Brake Switch C306

 <p>N0024196</p>		
Pin Number	Circuit Designation/ Description	Normal Condition/ Measurement
A	CKT 57B (BK) Parking brake switch ground	0 voltage and less than 5 ohms resistance to chassis ground.
B	CKT 162 (RD/LG) Power input circuit to parking brake indicator lamp	10 volts or greater to chassis ground with ignition ON and ACC.

Pinpoint Tests

Pinpoint Test A: The Red Brake Warning Indicator Is Always On

Normal Operation

The operating voltage required to supply the instrument cluster parking brake indicator is between 9 and 16 volts. Voltage is supplied by circuit 162 (RD/LG), ground is supplied by circuit 57B (BK).

Possible Causes

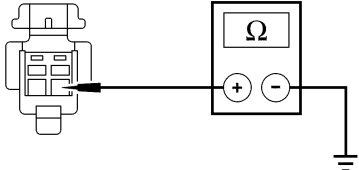
- Parking brake switch
- Circuit 162 (RD/LG)
- Daytime running light (DRL) module

- Instrument cluster

CAUTION: Use the Probe Kit for all test connections to prevent damage to the wiring terminals. Do not use standard multimeter probes.

NOTE: Prior to troubleshooting the vehicle for this concern, verify that the parking brake lever contacts the parking brake switch when the lever is in the fully released position.

Table 7 PINPOINT TEST A: THE RED BRAKE WARNING INDICATOR IS ALWAYS ON

Test Step	Result / Action to Take
A1 CHECK PARKING BRAKE SWITCH <ul style="list-style-type: none"> Key in ON position. Disconnect: Parking Brake Switch C306. Does the red brake warning light go out? 	Yes INSTALL a new parking brake switch. TEST the system for normal operation. No GO to A2.
A2 CHECK CIRCUIT 162 (RD/LG) FOR SHORT TO GROUND <ul style="list-style-type: none"> Measure the resistance between parking brake switch C306-B, circuit 162 (RD/LG) harness side and ground.  <p>N0024190</p> <p>Is the resistance greater than 10,000 ohms?</p>	Yes GO to A3. No REPAIR circuit 162 (RD/LG). TEST the system for normal operation.
A3 CHECK THE DAYTIME RUNNING LIGHT (DRL) MODULE FOR FAULTS <ul style="list-style-type: none"> Connect the diagnostic tool. Carry out the DRL module on-demand self-test. Are DTCs retrieved?	Yes Diagnose the DRL module. REFER to Daytime Running Lamps. No Go to A4.
A4 CHECK INSTRUMENT CLUSTER <ul style="list-style-type: none"> Disconnect: Instrument Cluster C220a. Does the brake warning light go out?	Yes REPAIR or INSTALL a new instrument cluster. TEST the system for normal operation. No CHECK the instrument cluster for faults. REFER to Instrument Cluster in S08307.

Pinpoint Test B: Vibration When The Brakes Are Applied

Possible Causes

- Uneven brake pad wear

- Brake disc pad transfer
- Brake disc
- Suspension components

Table 8 PINPOINT TEST B: VIBRATION WHEN THE BRAKES ARE APPLIED

Test Step	Result / Action to Take
B1 CHECK ISIS AND TSIs <ul style="list-style-type: none"> Check ISIS and TSIs for applicable brake concerns. Is there applicable information available on ISIS or in a TSI?	Yes REFER to ISIS or the TSI. CARRY OUT any necessary repairs that are indicated by ISIS or the TSI. If the concern is still present, GO to B2. No GO to B2.
B2 ROAD TEST THE VEHICLE — LIGHT BRAKING <ul style="list-style-type: none"> Inspect the wheels and tires. Refer to Suspension System in S03014. Road test the vehicle. Warm the brakes by slowing the vehicle from 80 to 32 km/h (50 to 20 mph) using light brake force. At highway speeds of 89 to 97 km/h (55 to 60 mph), apply the brake using light pedal force. Is there a vibration/shudder felt in the steering wheel, seat or brake pedal?	Yes GO to B5. No GO to B3.
B3 ROAD TEST THE VEHICLE — MODERATE TO HEAVY BRAKING <ul style="list-style-type: none"> Road test the vehicle. At highway speeds of 89-97 km/h (55-60 mph), apply the brake using a moderate to heavy pedal force. Is there a vibration/shudder?	Yes Go to B4. No The concern is not present at this time.
B4 NORMAL ACTUATION OF THE ABS SYSTEM DIAGNOSIS <ul style="list-style-type: none"> During moderate to heavy braking, noise from the hydraulic control unit (HCU) and pulsation in the brake pedal can be observed. Pedal pulsation coupled with noise during heavy braking or on loose gravel, bumps, wet or snowy surfaces is acceptable and indicates correct functioning of the ABS. Pedal pulsation or steering wheel nibble (frequency is proportioned to the vehicle speed) indicates a concern with a brake or suspension component. Is the vibration/shudder vehicle speed sensitive?	Yes GO to B6. No The concern is not present at this time.
B5 APPLICATION OF THE PARKING BRAKE <ul style="list-style-type: none"> Apply the parking brake to identify if the problem is in the front or rear brake. At highway speeds of 89-97 km/h (55-60 mph), lightly apply the parking brake until the vehicle slows down. Release the parking brake immediately after the test. Is there a vibration/shudder?	Yes GO to B7. No GO to B6.

Table 8 PINPOINT TEST B: VIBRATION WHEN THE BRAKES ARE APPLIED (cont.)

Test Step	Result / Action to Take
B6 CHECK THE FRONT SUSPENSION <ul style="list-style-type: none"> Check the front suspension. Refer to Suspension System in S03014. Are all the suspension components in satisfactory condition?	Yes GO to B7. No REPAIR or INSTALL new components as necessary. TEST the system for normal operation.
B7 CHECK THE REAR SUSPENSION <ul style="list-style-type: none"> Check the rear suspension. Refer to Suspension System in S03014. Are all the suspension components in satisfactory condition?	Yes REFER to Noise, Vibration and Harshness in S10019 to continue diagnosis of the vibration. No REPAIR or INSTALL new components as necessary. TEST the system for normal operation.

Component Tests

! WARNING: Use of other than the approved DOT 3 brake fluid will cause permanent damage to the brake components and will render the brakes inoperative.

Always check brake fluid level and, if necessary, fill with DOT 3 Brake Fluid.

Brake Booster

- With the transmission in NEUTRAL and the engine stopped, apply the brakes several times to release the pressure in the system.
- Hold the brake pedal in the applied position.
- Start the engine.
- If the power brake system is functioning correctly, the brake pedal can be felt moving downward after the engine starts.

If power steering pump pressure is available to the Hydro-Boost® power brake booster and no power assist is felt, install a new Hydro-Boost® power brake booster and retest the system.

If power steering pump pressure is not available at the Hydro-Boost® power brake booster, check the power steering pump pressure and flow. For additional information, refer to Steering System in S05017.

Accumulator, Hydro-Boost®

- Start and run the engine.
- Stop the engine.
- Apply the brakes. The accumulator in the Hydro-Boost® power brake booster should retain enough pressure for at least 2 power assisted brake operations. If no power assist is felt, install a new Hydro-Boost® power brake booster and retest the system.

Brake Master Cylinder

- Disconnect the brake lines at the brake master cylinder.
- Plug the outlet ports of the brake master cylinder.
- Apply the brakes. If brake pedal height cannot be maintained, the brake master cylinder has an internal leak and must be installed new.

Compensator Port Check

The purpose of the compensator ports in the brake master cylinder is to supply any additional brake fluid


required by the system due to brake pad wear and to allow brake fluid returning from the brake lines to the brake master cylinder to enter the brake master cylinder reservoir.

The returning brake fluid will cause a slight turbulence in the brake master cylinder reservoir. Turbulence seen in the brake master cylinder reservoir upon release of the brake pedal is normal and shows that the compensating ports are not plugged.

General Procedures

Component Bleeding

Table 9 Special Tool

	EZ-Tech
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Master Cylinder Priming — In-Vehicle or Bench

! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

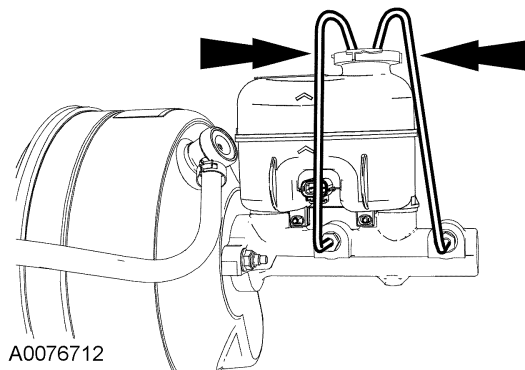
CAUTION: Do not allow the brake master cylinder reservoir to run dry during the bleeding operation. Keep the brake master cylinder reservoir filled with the specified brake fluid. Never reuse the brake fluid that has been drained from the hydraulic system.

CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.

NOTE: When any part of the hydraulic system has been disconnected for repair or replacement, air can enter the system and cause spongy brake pedal action. This requires bleeding of the hydraulic system after it has been properly connected. The hydraulic system can be bled manually or with pressure bleeding equipment.

NOTE: When the brake master cylinder has been replaced or the system has been emptied, or partially emptied, it should be primed to prevent air from entering the system.

1. For in-vehicle priming, disconnect the brake lines.
2. For bench priming, mount the brake master cylinder in a vise.
3. Install short brake tubes with the ends submerged in the brake master cylinder reservoir, and fill the brake master cylinder reservoir with DOT 3 brake fluid.



4. Have an assistant pump the brake pedal, or slowly depress the primary piston until clear fluid flows from both brake tubes, without air bubbles.
5. If the brake master cylinder is being primed at the bench, install it in the vehicle. For additional information, refer to Hydraulic Brake Actuation (Hydraulic Brake Actuation, page 36).

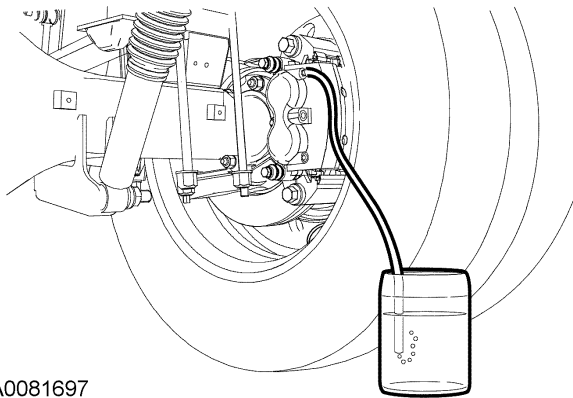
6. Remove the short brake tubes and install the brake outlet tubes.
 - Tighten the fittings to 25 Nm (18 lb-ft).
7. Bleed each brake tube at the brake master cylinder as follows:
 - a. Have an assistant pump the brake pedal and then hold firm pressure on the brake pedal.
 - b. Loosen the rearmost brake tube fittings until a stream of brake fluid comes out. While the assistant maintains pressure on the brake pedal, tighten the brake tube fitting.
 - c. Repeat this operation until clear, bubble-free fluid comes out.
 - d. Refill the brake master cylinder reservoir as necessary. Repeat the bleeding operation at the front brake tube.
3. With the RH rear bleeder screw open, cycle the brake pedal until no more air is seen in the waste line.
4. Tighten the RH rear bleeder screw, and disconnect the waste line.
5. Repeat Steps 2 through 4 for the LH rear bleeder screw, the RH front disc brake caliper bleeder screw and the LH front disc brake caliper bleeder screw, in that order.
6. Connect the diagnostic tool cable adapter into the vehicle data link connector (DLC) under the dash, and follow the diagnostic tool instructions.
7. Repeat the system bleed procedure as outlined in Steps 1 through 5.

Caliper

NOTE: It is not necessary to perform a complete brake system bleed if only the disc brake caliper was disconnected.

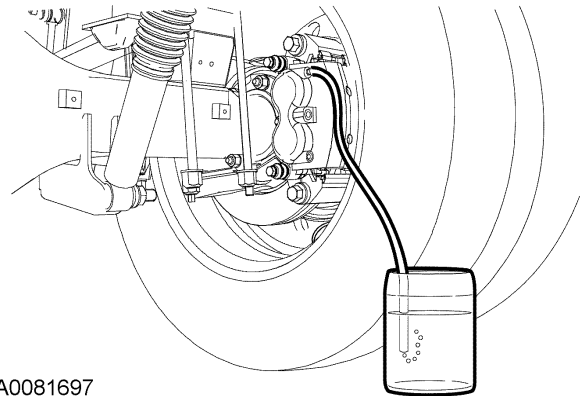
Four Wheel Anti-Lock Brake System (4WABS) Hydraulic Control Unit (HCU)

NOTE: This procedure only needs to be performed if the 4-wheel anti-lock brake (4WABS) hydraulic control unit (HCU) has been replaced or if air is suspected in the HCU.



A0081697

1. Clean all dirt from and remove the brake master cylinder filler cap, and fill the brake master cylinder reservoir with the specified brake fluid.
2. Connect a clear waste line to the RH rear bleeder screw and submerge the free end of the tube in a container partially filled with clean brake fluid.

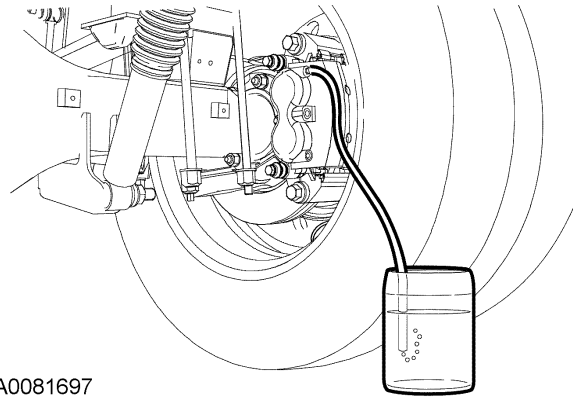


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1. Place a box-end wrench on the disc brake caliper bleeder screw. Attach a rubber drain tube to the disc brake caliper bleeder screw and submerge the free end of the tube in a container partially filled with clean brake fluid.
2. Have an assistant pump the brake pedal and then hold firm pressure on the brake pedal.

3. Loosen the disc brake caliper bleeder screw until a stream of brake fluid comes out. While the assistant maintains pressure on the brake pedal, tighten the disc brake caliper bleeder screw.
 - Repeat until clear, bubble-free fluid comes out.
 - Refill the brake master cylinder reservoir as necessary.
4. Tighten the disc brake caliper bleeder screw to 35 Nm (26 lb-ft).

NOTE: When any part of the hydraulic system has been disconnected for repair or replacement, air may get into the system and cause spongy brake pedal action. This requires bleeding of the hydraulic system after it has been properly connected. The hydraulic system can be bled manually or with pressure-bleeding equipment.



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Brake System Bleeding

Manual

! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

CAUTION: Do not allow the brake master cylinder reservoir to run dry during the bleeding operation. Keep the brake master cylinder reservoir filled with the specified brake fluid. Never reuse the brake fluid that has been drained from the hydraulic system.

CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.

1. Clean all dirt from and remove the brake master cylinder filler cap and fill the brake master cylinder reservoir with the DOT 3 motor vehicle brake fluid.
2. Place a box-end wrench on the RH rear bleeder screw. Attach a rubber drain tube to the RH rear bleeder screw and submerge the free end of the tube in a container partially filled with clean brake fluid.
3. Have an assistant pump the brake pedal and then hold firm pressure on the brake pedal.
4. Loosen the RH rear bleeder screw until a stream of brake fluid comes out. While the assistant maintains pressure on the brake pedal, tighten the RH rear bleeder screw.
 - Repeat until clear, bubble-free fluid comes out.
 - Refill the brake master cylinder reservoir as necessary.
5. Tighten the RH rear bleeder screw to 35 Nm (26 lb-ft).
6. Repeat Steps 2 through 5 for the LH rear bleeder screw.

7. Place a box-end wrench on the RH front disc brake caliper bleeder screw. Attach a rubber drain tube to the RH front disc brake caliper bleeder screw, and submerge the free end of the tube in a container partially filled with clean brake fluid.
8. Have an assistant pump the brake pedal and then hold firm pressure on the brake pedal.
9. Loosen the RH front disc brake caliper bleeder screw until a stream of brake fluid comes out. While the assistant maintains pressure on the brake pedal, tighten the RH front disc brake caliper bleeder screw.
 - Repeat until clear, bubble-free fluid comes out.
 - Refill the brake master cylinder reservoir as necessary.
10. Tighten the RH front disc brake caliper bleeder screw. For additional information, refer to Specifications in this section.
11. Repeat Steps 7 through 10 for the LH front disc brake caliper bleeder screw.

Pressure

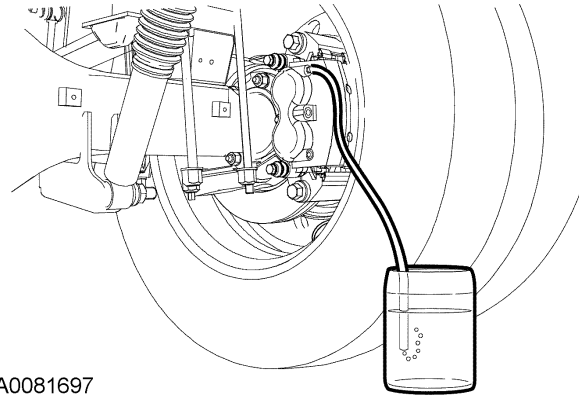
1. Clean all dirt from and remove the brake master cylinder filler cap and fill the brake master cylinder reservoir with the DOT 3 motor vehicle brake fluid.

NOTE: Master cylinder pressure bleeder adapter tools are available from various manufacturers of pressure-bleeding equipment. Follow the instructions of the manufacturer when installing the adapter.

2. Install the bleeder adapter to the brake master cylinder reservoir, and attach the bleeder tank hose to the fitting on the adapter.

NOTE: Bleed the longest line first. Make sure the bleeder tank contains enough specified brake fluid to complete the bleeding operation.

3. Place a box-end wrench on the RH rear bleeder screw. Attach a rubber drain tube to the RH rear bleeder screw and submerge the free end of the tube in a container partially filled with clean brake fluid.



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4. Open the valve on the bleeder tank.
5. Loosen the RH rear bleeder screw. Leave open until clear, bubble-free brake fluid flows, then tighten the RH rear bleeder screw to 35 Nm (26 lb-ft) and remove the rubber hose.
6. Continue bleeding the rear of the system, going in order from the LH rear bleeder screw to the RH front disc brake caliper bleeder screw, ending with the LH front disc brake caliper bleeder screw.
7. Close the bleeder tank valve. Remove the tank hose from the adapter and remove the adapter.

Brake System Leak Check

NOTE: Brake fluid is water soluble and it is possible that all evidence of fluid leakage has been washed off if the vehicle has been operated in rain or snow.

1. Make sure the brake master cylinder reservoir is full.
2. Apply the brakes several times and make sure the pedal feel is not spongy. If necessary, bleed the system. For additional information, refer to Brake System Bleeding in this section.
3. Verify that the reservoir level is dropping.
4. If the reservoir level is dropping, inspect the brake components, fittings and lines to locate the source of the leak.

Front Disc Brake

Specifications

Table 10 General Specifications

Item	Specification
Brake disc minimum thickness (Minimum safe thickness is stamped on each brake disc.)	—
Disc brake lining wear limit	1 mm (0.039 in.)

Table 11 Torque Specifications

Description	Nm	lbf-ft
Disc brake caliper pin bolt	56	41
Front brake hose bolt	35	26
Front disc brake caliper anchor plate bolt	400	296

Front Disc Brake Description and Operation

The front disc brake caliper:

- bolts to the front disc brake caliper anchor plate, which bolts to the front wheel spindle.
- is a dual piston, pin slider design.
- has a fluid inlet at the center of the caliper housing.

The front disc brake discs:

- are of a ventilated full-cast design, with non-directional cooling fins.
- are mounted to the front wheel spindle.
- are serviced with the disc brake caliper and front disc brake caliper anchor plate removed.

The front brake disc shield:

- is bolted to the brake caliper anchor plate.
- protects the front wheel bearings and inboard surface of the front disc brake rotor.

The brake pads:

- are housed in the front disc brake caliper anchor plate.
- are of a non-asbestos, semi-metallic composition.

Front Disc Brake Diagnosis and Testing

Refer to Brake System(Brake System — General Information, page 1).

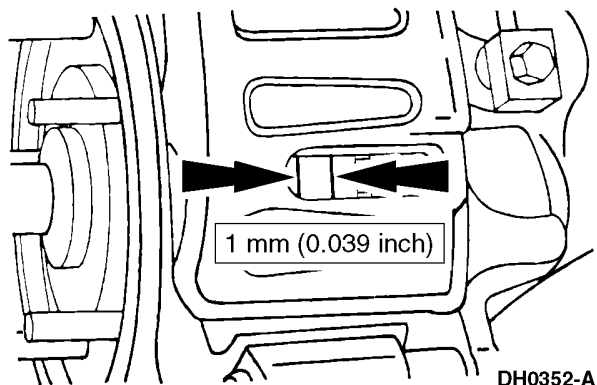
Removal and Installation

Brake Pads

1. Remove the brake master cylinder reservoir filler cap. Check brake fluid level in brake master cylinder reservoir. Remove fluid until brake master cylinder reservoir is half full.
2. Remove the wheel and tire assembly. For additional information, refer to Wheels and Tires in S17002.

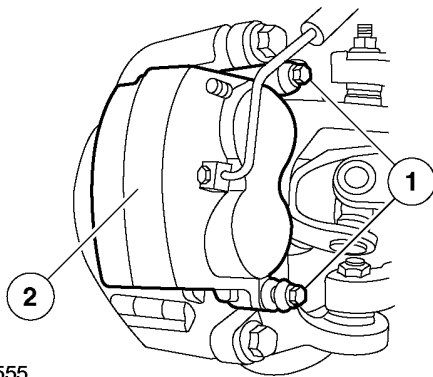
CAUTION: Install new pads if worn to or past the specified thickness above the metal backing plate or rivets. Only install pads in complete axle sets.

3. Inspect the pads for wear or contamination.

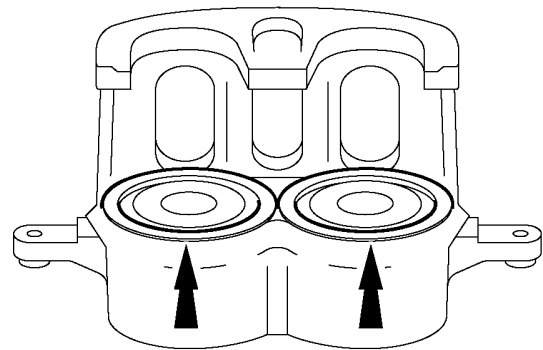


CAUTION: When removing the disc brake caliper, never allow it to hang from the brake hose. Provide a suitable support.

4. Remove the disc brake caliper.
 - To install, tighten to 56 Nm (41 lb-ft).



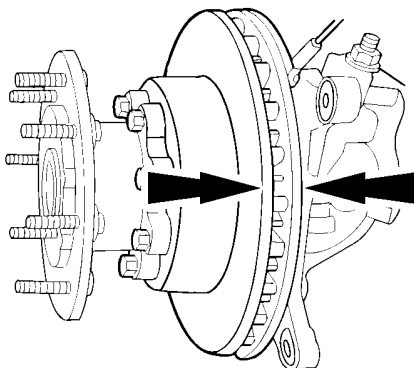
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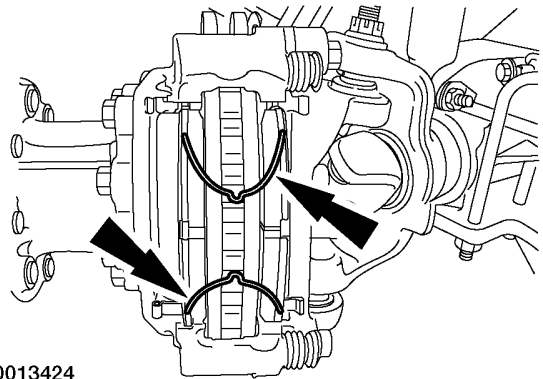
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Figure 7

1. Remove 2 disc brake caliper pin bolts.
2. Lift the disc brake caliper from the disc brake caliper anchor plate.
5. Measure the disc brake rotor thickness.
 - Install a new brake disc if not above the minimum thickness specification. Minimum safe thickness is stamped on the brake rotor.
7. If necessary, remove the V-springs.

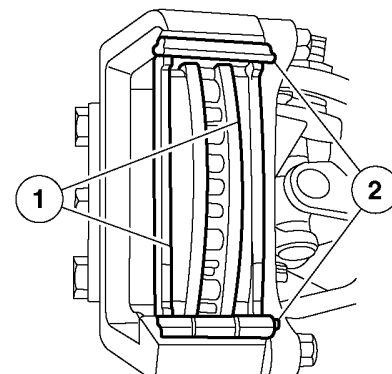


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6. Inspect the disc brake caliper for leaks.
 - If leaks are found, replacement is required.
8. Remove the brake pads and rail clips.



N0024554

Figure 11

1. Remove the pads.
2. Remove the front disc brake caliper anchor plate stainless steel rail clips.

9. To install, reverse the removal procedure.
 - Fill the brake master cylinder reservoir with clean brake fluid, then install the master cylinder reservoir filler cap.
 - Verify correct brake operation.

Brake Caliper

1. Remove the wheel and tire assembly. For additional information, refer to Wheels and Tires in S17002.

! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, wash it with water immediately.

2. Disconnect the brake hose.

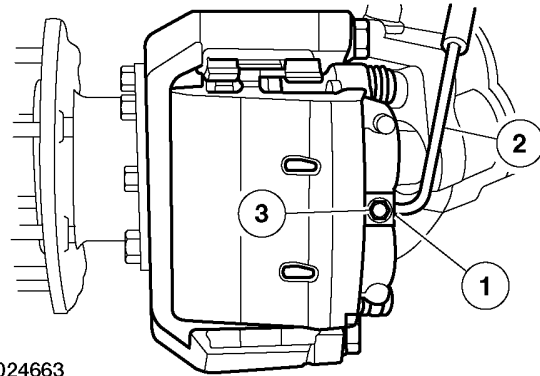


Figure 12

1. Remove the brake hose bolt.
2. Disconnect the brake hose.
 - a. To install, tighten to 35 Nm (26 lb-ft).
3. Remove and discard the copper washers. Plug the brake hose.
 - a. Use new copper washers.
3. Remove the disc brake caliper.
 - To install, tighten to 56 Nm (41 lb-ft).

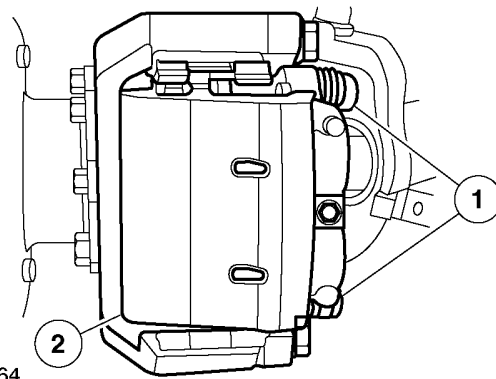
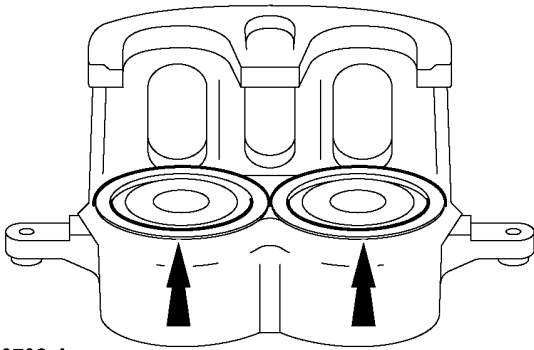


Figure 13

1. Remove the disc brake caliper pin bolts.
2. Lift the disc brake caliper from the disc brake caliper anchor plate.
4. Inspect the disc brake caliper for leaks.
 - If leaks are found, replacement is required.



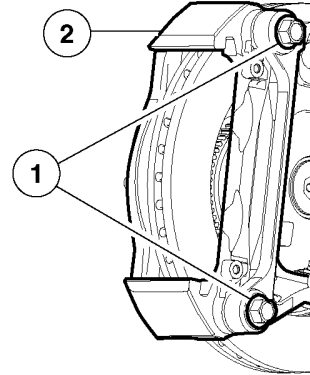
DH0703-A

5. To install, reverse the removal procedure.
 - Bleed the brake system. For additional information, refer to Brake System(Brake System — General Information, page 1).
 - Fill the brake master cylinder reservoir with clean brake fluid, then install the master cylinder reservoir filler cap.
6. Inspect the brake system operation.

Brake Caliper Anchor Plate

1. Remove the brake pads. For additional information, refer to Brake Pads in this section.

2. Remove the front disc brake caliper anchor plate.
 - To install, tighten to 400 Nm (296 lb-ft).

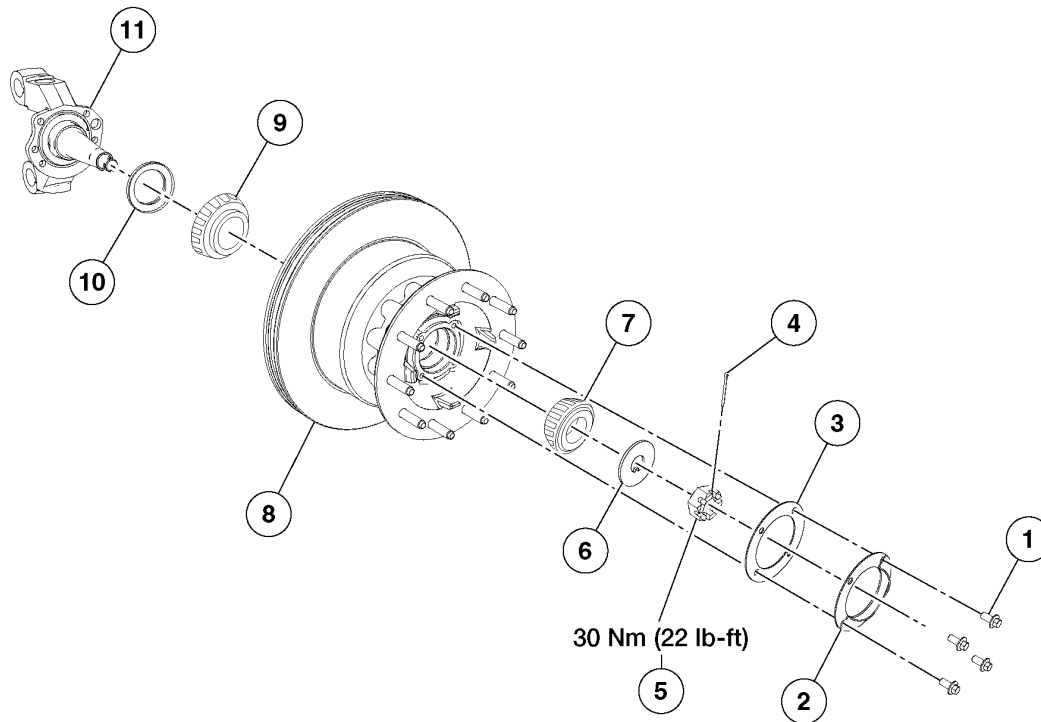


N0033331

Figure 15

1. Remove the 2 front disc brake caliper anchor plate bolts.
 2. Remove the front disc brake caliper anchor plate.
3. To install, reverse the removal procedure.

Brake Disc Removal



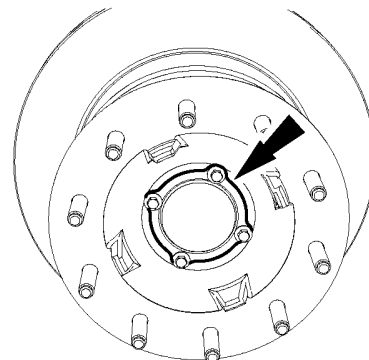
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Figure 16

- | | | |
|------------------------------|--------------------------------|-------------------|
| 1. Hub cap bolt (4 required) | 5. Castellated nut | 9. Inner bearing |
| 2. Hub cap | 6. Washer | 10. Grease seal |
| 3. Hub cap gasket | 7. Outer bearing | 11. Wheel spindle |
| 4. Cotter pin | 8. Hub and brake disc assembly | |

NOTE: The brake caliper and brake caliper anchor plate have been omitted from this illustration for clarity.

1. Remove the brake caliper anchor plate. For additional information, refer to Brake Caliper Anchor Plate in this section.
2. Remove the hub cap and gasket from the hub assembly.



N0020767

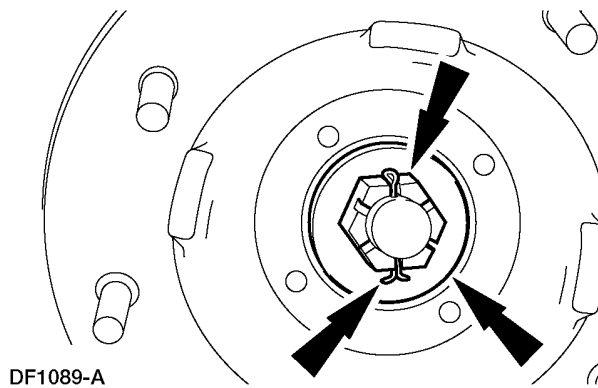
3. Remove and discard the cotter pin, castellated nut and washer.

S04049

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.

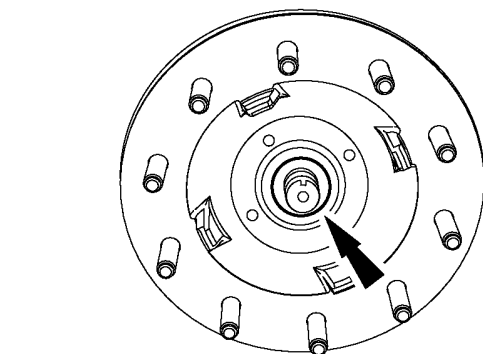
Follow all warnings, cautions, and notes.

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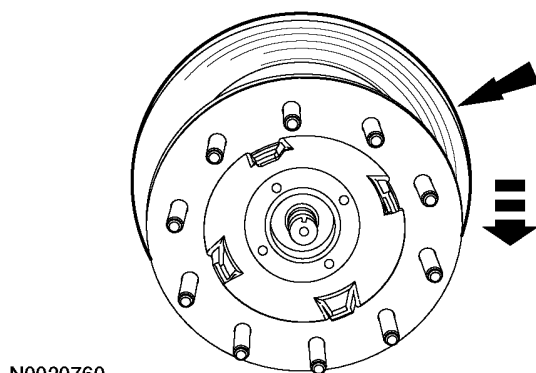


NOTE: Inspect the condition of the castellated nut threads to make sure of a free turning nut when reassembling.

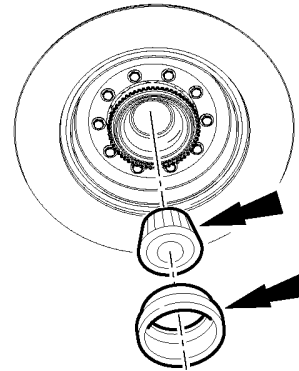
4. Remove the outer bearing cone and roller assembly.



5. Pull the hub assembly from the spindle.



6. Using care not to damage the bearing cage, use a suitable slide hammer and bearing seal remover to remove the inner bearing cone and bearing seal.

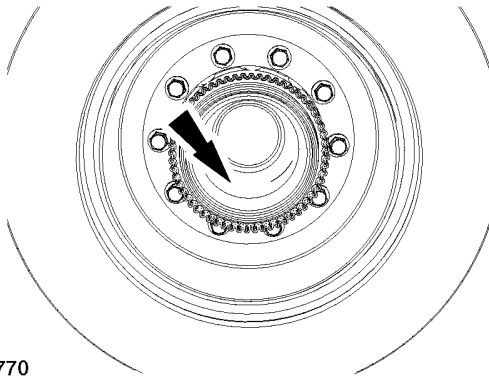


Brake Disc Installation

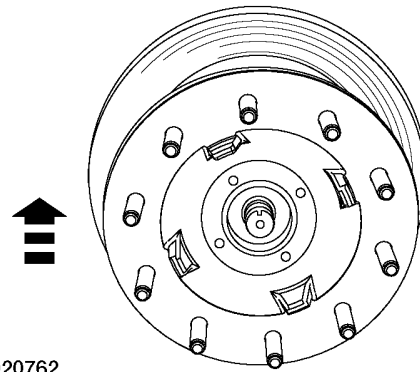
NOTE: Remove all traces of old lubricant from the bearings, hub and axle spindle. Inspect the bearings and bearing cups for pitting, spalling or unusual wear. If either bearings or bearing cups are worn or damaged, install new bearings and bearing cups.

NOTE: It is recommended that new bearings and bearing cups be installed in sets. If cups are worn or damaged, install the inner and outer bearing cups in the hub with an appropriate bearing cup driver tool. Check for correct seating of new bearing cups by trying to insert a 0.38-mm (0.0015-inch) feeler gauge between the bottom face of the cup and wheel hub seat. You should not be able to insert the feeler gauge.

1. Remove all burrs, nicks or scratches from the shoulder of the spindle and seal bore in the hub with emery cloth.
2. Pack the inside of the hub with grease. Fill the hub until the grease is flush with the inside diameters of both bearing cups.



N0020770

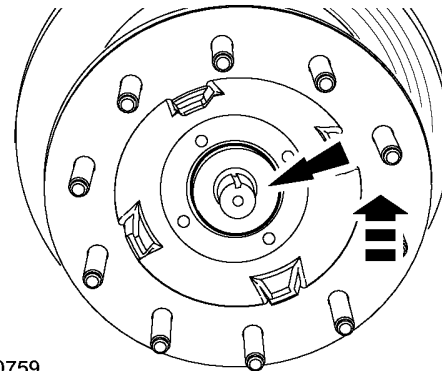


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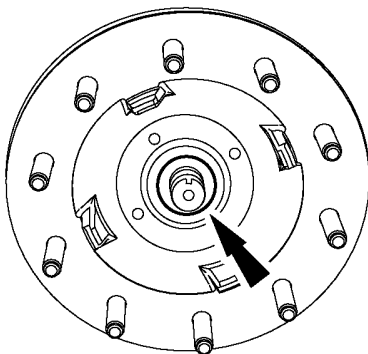
3. Pack the bearing cone and roller assemblies with grease. Use a bearing packer for this operation. If a packer is not available, work as much lubricant as possible between the rollers and cages.

CAUTION: Keep the hub centered on the spindle to prevent damage to the grease seal or spindle threads.

4. Place the inner bearing cone and roller assembly in the inner cup, then install the wheel bearing hub seal, using a suitable seal installer. Make sure seal is fully seated and lubricated.



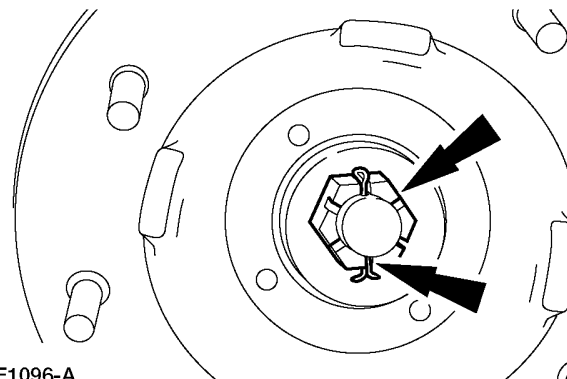
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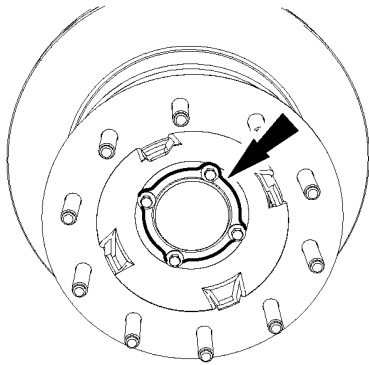
5. Install hub assembly.

6. Install the outer bearing cone and roller assembly and the washer on the spindle.
7. Install the castellated nut, then adjust the wheel bearing. For additional information, refer to Front Suspension in S03014.



DF1096-A

8. Install a new gasket and the hub cap.



N0020767

9. Install the brake caliper anchor plate. For additional information, refer to Brake Caliper Anchor Plate in this section.

Rear Disc Brake

Specifications

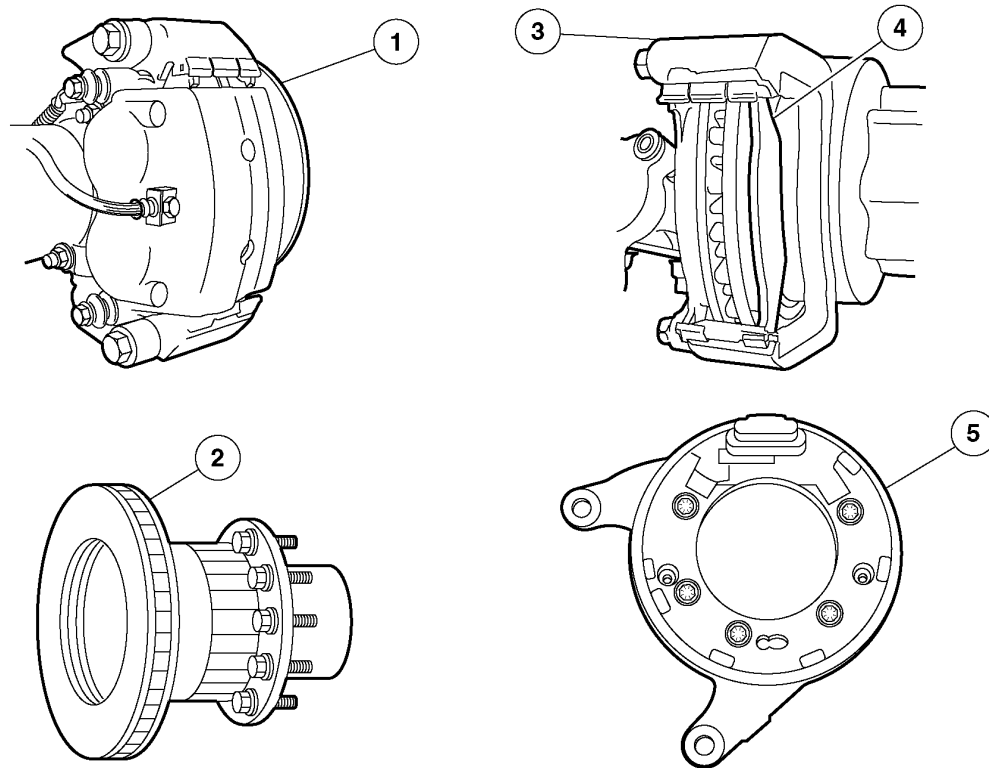
Table 12 General Specifications

Item	Specification
Disc brake lining wear limit	1 mm (0.039 in.)
Brake disc minimum thickness	36 mm (1.417 in)
Brake disc lateral runout	0.04 mm (0.0015 in)

Table 13 Torque Specifications

Description	Nm	lbf-ft
Disc brake caliper pin bolt	55	41
Brake caliper banjo bolt	50	37
Brake disc-to-wheel hub bolts	150 — 176	105 — 123
Brake caliper anchor bolts	400	295
Brake caliper support bracket	136	100

Rear Disc Brake Description and Operation



N0025078

Figure 28

- | | | |
|---|---|----------------------------------|
| 1. Rear disc brake caliper | 3. Rear disc brake caliper anchor plate | 5. Brake caliper support bracket |
| 2. Rear disc brake rotor and hub assembly | 4. Brake pads | |

The rear disc brake has the following characteristics:

- A 2-piston rear disc brake caliper
- A vented-cast, drum-in-hat type rear disc brake rotor
- A rear disc brake caliper anchor holds the brake pads
- A rear wheel drum-in-hat adapter holds the rear disc brake caliper anchor and the rear wheel disc brake shield

Rear Disc Brake Diagnosis and Testing

Refer to Brake System(Brake System — General Information, page 1).

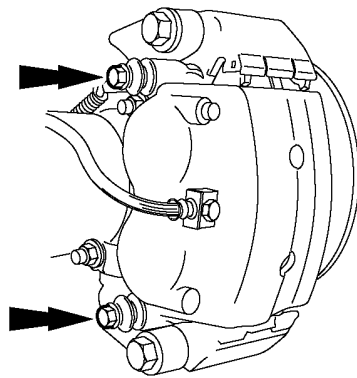
Removal and Installation

Brake Caliper

! WARNING: Brake fluid contains polyglycoethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

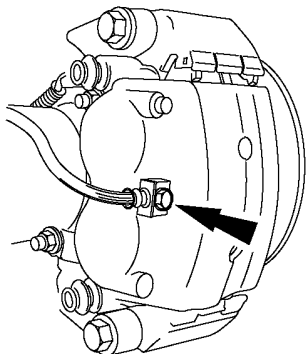
CAUTION: Brake fluid is harmful to painted or plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.

1. Remove the wheel and tire assembly. For additional information, refer to Wheels and Tires in S17002.
2. Remove the brake caliper pin bolts.
 - To install, tighten to 55 Nm (41 lb-ft).



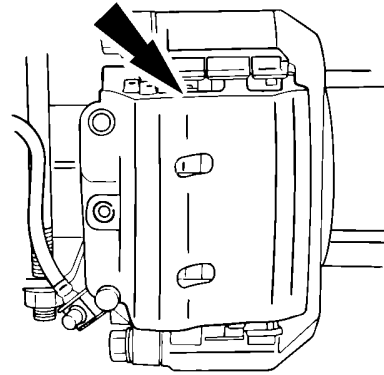
N0025024

3. Remove the brake caliper banjo bolt and discard the copper washers.
 - Before installing the brake caliper banjo bolt, install new copper washers.
 - To install, tighten to 50 Nm (37 lb-ft).



N0024715

4. Remove the rear brake caliper.

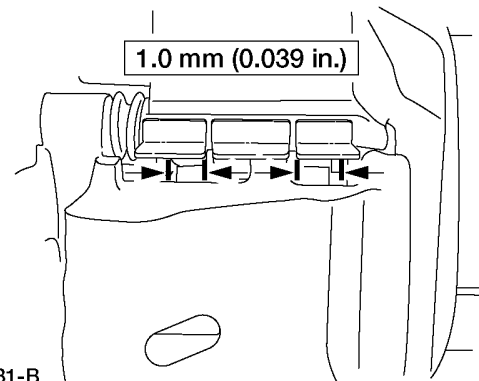


DH0578-A

5. To install, reverse the removal procedure.
 - Bleed the brake system. For additional information, refer to Brake System(Brake System — General Information, page 1).

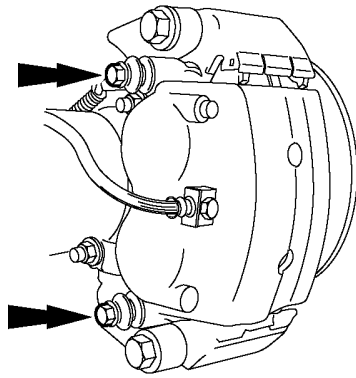
Brake Pads

1. Remove the brake master cylinder reservoir filler cap. Check brake fluid level in brake master cylinder reservoir. Remove fluid until brake master cylinder reservoir is half full.
2. Remove the wheel and tire assembly. For additional information, refer to Wheels and Tires in S17002.
3. Inspect the brake pads for wear or contamination. If worn, damaged, or past specification, install new brake pads.



DH0581-B

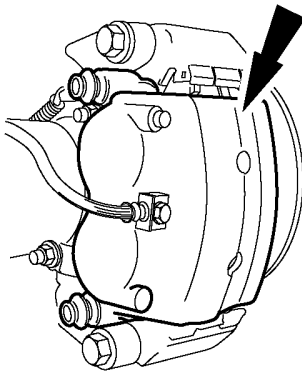
4. Remove the caliper pin bolts.
 - To install, tighten to 55 Nm (41 lb-ft).



N0025024

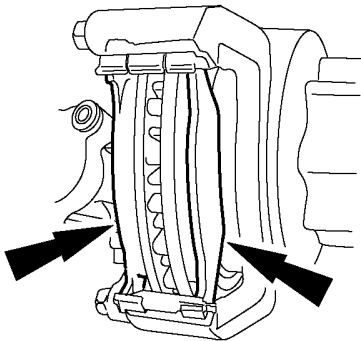
CAUTION: Never allow the rear disc brake caliper to hang from the brake hose. Provide a suitable support.

5. Remove the rear disc brake caliper.



DH0636-A

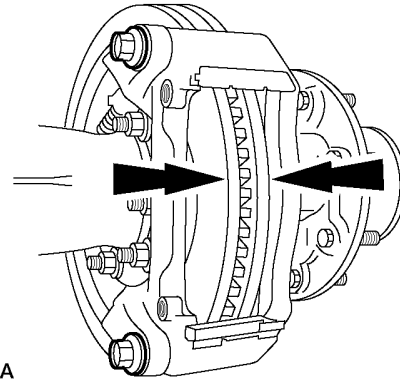
6. Remove the brake pads and rail clips.



DH0582-A

7. Measure the rear brake disc thickness.

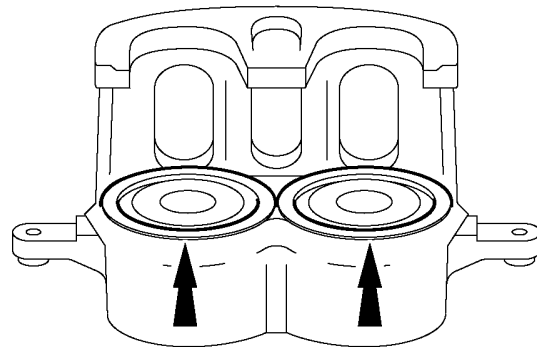
- Install a new rear brake disc if not within specification.



DH0969-A

8. Inspect the disc brake caliper for leaks.

- If leaks are found, replacement is required.



DH0703-A

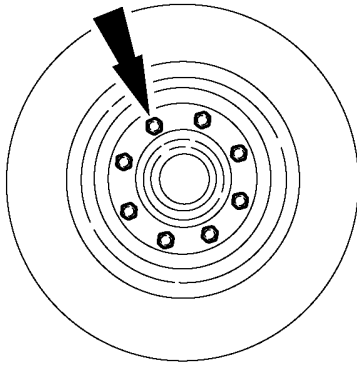
NOTE: Use an appropriate wood block or a used brake pad to protect the brake caliper pistons and boots.

9. Using a suitable tool, compress the brake caliper pistons into the caliper.
10. To install, reverse the removal procedure.

Brake Disc

1. Remove the rear wheel hub. For additional information, refer to Wheel Hubs and Bearings in S14020.

2. Remove the brake disc-to-hub bolts and separate the wheel hub and brake disc.

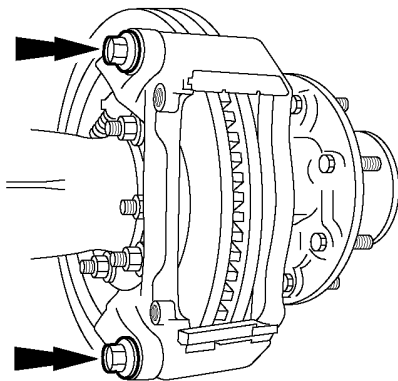


DH0705-A

3. Remove the brake disc.
4. To install, reverse the removal procedure.
 - To install, tighten to 150 — 176 Nm (105 — 123 lb-ft).

Brake Caliper Anchor Plate

1. Remove the brake pads. For additional information, refer to Brake Pads in this section.
2. Remove the upper and lower bolts and the rear disc brake caliper anchor plate.



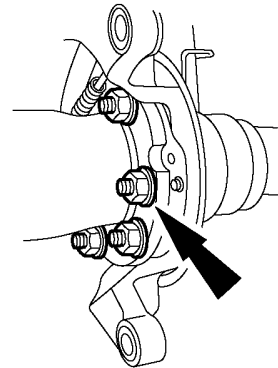
N0025061

3. To install, reverse the removal procedure.
 - Position the rear disc brake caliper anchor plate. Install the upper and lower bolts. Tighten the bolts in 3 stages.

- a. Stage 1: Tighten the upper bolt to 400 Nm (295 lb-ft).
- b. Stage 2: Using a suitable crow's foot socket, tighten the lower bolt to 136 Nm (100 lb-ft).
- c. Stage 3: Mark the rear disc brake caliper anchor plate and the lower bolt. Tighten the lower bolt an additional 1/8 to 1/4 turn.

Brake Caliper Support Bracket

1. Remove the brake caliper anchor plate (refer to Brake Caliper Anchor Plate Removal and Installation above).
2. Remove and discard the brake caliper support bracket nuts.
 - To install, tighten to 136 Nm (100 lb-ft).
 - Use new brake caliper support bracket nuts.



A0041386

3. To install, reverse the removal procedure.

Parking Brake and Actuation

Specifications

Table 14 Torque Specifications

Description	Nm	lbf-ft
Parking brake control retaining nuts	22	16
Parking brake cable tension adjuster locknut	24	18

Parking Brake Description and Operation**Parking Brake System**

The parking brake system is actuated when the parking brake control is applied. The parking brake control applies tension to the front parking brake cable and conduit, activating the parking brake assembly.

Parking Brake Warning System

The parking brake warning indicator:

- is located in the instrument cluster.
- illuminates to signal the driver that the parking brake is applied.

Parking Brake Diagnosis and Testing**Inspection and Verification**

1. Verify the customer's concern by operating the parking brake system to duplicate the condition.
2. Inspect to determine if one of the following mechanical or electrical concerns applies:

Table 15 Visual Inspection Chart

Mechanical	Electrical
<ul style="list-style-type: none">• Damaged parking brake control• Binding/damaged parking brake cables	<ul style="list-style-type: none">• Parking brake warning indicator switch. Refer to Instrument Cluster in S08307.

3. If inspection reveals obvious concern(s) that can be readily identified, repair as required.
4. If the concerns remain after the inspection, determine the symptoms. GO to the Symptom Chart.

Symptom Chart**Table 16**

Condition	Possible Sources	Action
The parking brake will not apply	<ul style="list-style-type: none">• Parking brake control.• Parking brake cables.• Parking brake assembly.	<ul style="list-style-type: none">• GO to Pinpoint Test A.
The parking brake will not release	<ul style="list-style-type: none">• Parking brake cables.• Parking brake control.• Parking brake release handle.• Parking brake assembly.	<ul style="list-style-type: none">• GO to Pinpoint Test B.

Pinpoint Tests

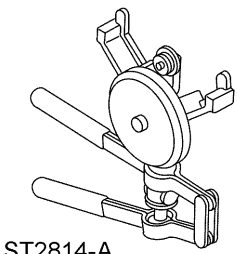
Table 17 PINPOINT TEST A: THE PARKING BRAKE WILL NOT APPLY

Test Step	Result / Action to Take
A1 CHECK THE PARKING BRAKE CABLES <ul style="list-style-type: none"> Raise and support the vehicle. Inspect for broken or binding parking brake cables. Is there a parking brake cable concern?	Yes INSTALL a new parking brake cable as necessary. TEST the system for normal operation. No GO to A2.
A2 CHECK THE PARKING BRAKE CONTROL <ul style="list-style-type: none"> Operate the parking brake control. Does the parking brake control operate smoothly?	Yes INSTALL a new parking brake assembly. TEST the system for normal operation. No REPAIR the binding condition in the parking brake control. TEST the system for normal operation.

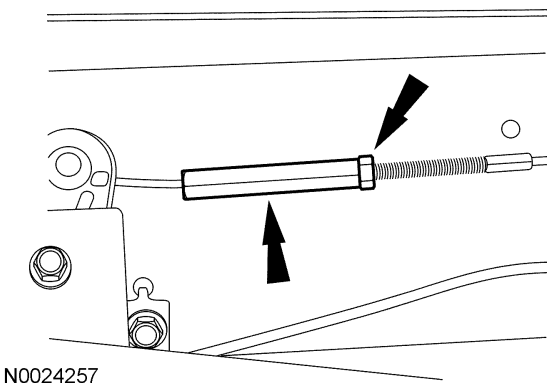
Table 18 PINPOINT TEST B: THE PARKING BRAKE WILL NOT RELEASE

Test Step	Result / Action to Take
B1 CHECK THE FRONT PARKING BRAKE CABLE <ul style="list-style-type: none"> Release the parking brake control. If the vehicle cannot be moved, raise and support it. Disconnect the parking brake cable at the parking brake lever. Does the parking brake release?	Yes INSPECT the front parking brake cable for binding. INSPECT the parking brake control for wear or damage. INSTALL new components as necessary. TEST the system for normal operation. No INSTALL a new parking brake assembly. TEST the system for normal operation.

General Procedures**Parking Brake Cable Adjustment****Table 19 Special Tool**

 <p>ST2814-A</p>	<p>Gauge, Parking Brake Cable Adjustment ZTSE4569</p>
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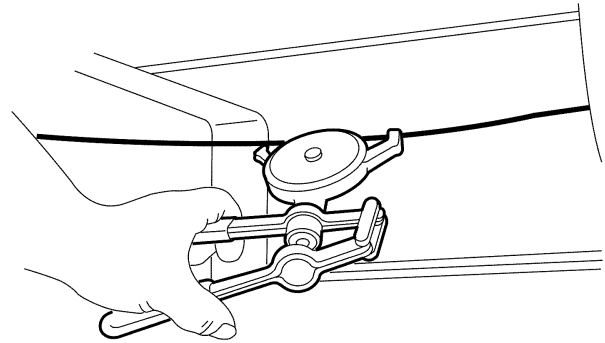
1. Set the parking brake.
2. Raise and support the vehicle. For additional information, refer to Jacking and Lifting in S10019.
3. Locate the parking brake cable adjuster along the RH side frame rail.
4. Hold the adjuster and loosen the adjuster locknut.



5. Using the special tool, check the parking brake cable tension. Depress the tool handle fully so that the wheel will engage the far side of the cable.

Release the handle quickly but smoothly and read the direct tension units on the dial face next to the indicating bar.

- Correct cable tension for adjustment of a new cable is 181 kg (400 lb).
- Correct cable tension for adjustment of an existing cable is 181 kg (400 lb).

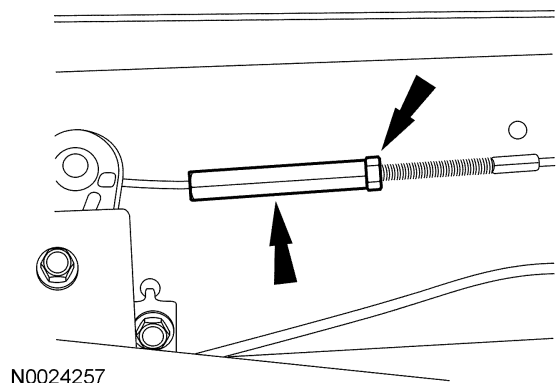


6. If tension is incorrect, remove the tool, release the park brake and readjust the tension by rotating the park brake cable adjuster. Recheck the cable tension. Repeat Steps 1-4 until tension is within specifications.
7. Tighten the adjuster locknut to 24 Nm (18 lb-ft).
8. Test the parking brake operation.

Parking Brake Cable Tension Release

NOTE: Make sure the parking brake control is fully released.

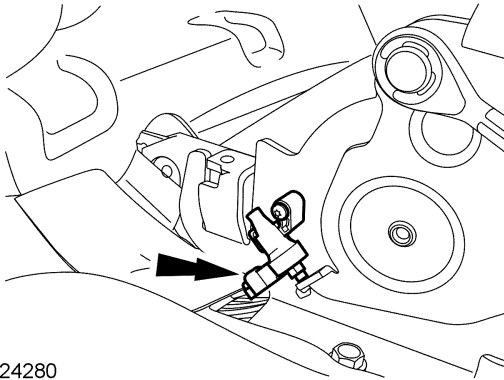
1. Locate the parking brake cable adjuster along the RH side frame rail.
2. Hold the adjuster and loosen the adjuster locknut.



Removal and Installation

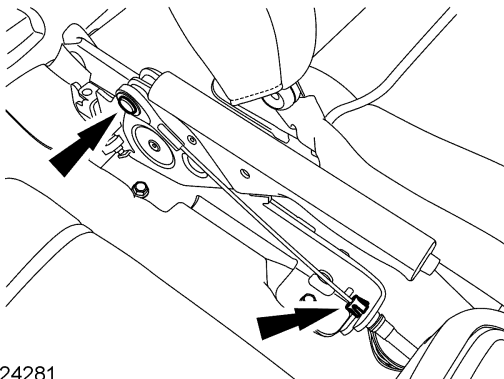
Parking Brake Control

1. Remove the parking brake control cover screws and remove the cover.
2. Disconnect the parking brake switch electrical connector.



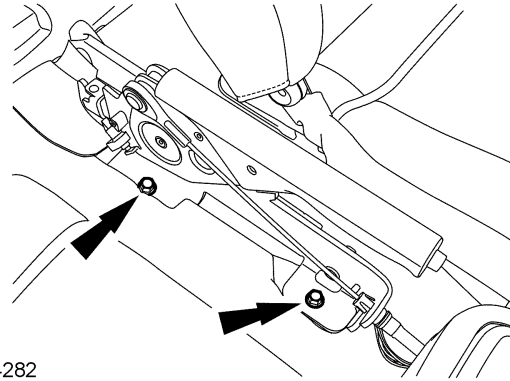
N0024280

3. Remove the parking brake cable from the parking brake control.
 - Remove the E-clip and slide the parking brake cable off of the stud.
 - Compress the parking brake cable retaining tabs and remove the parking brake cable from the parking brake control.



N0024281

4. Remove the bolts, then remove the parking brake control.
 - To install, tighten to 22 Nm (16 lb-ft).

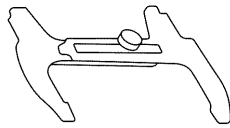


N0024282

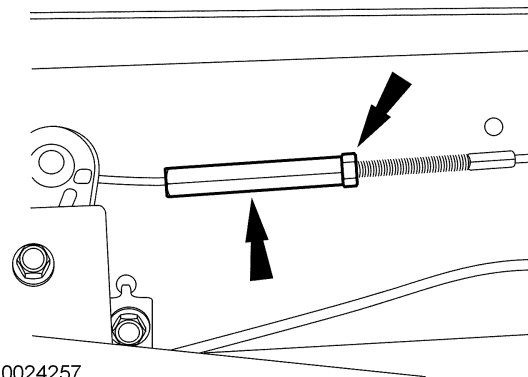
5. To install, reverse the removal procedure.

Parking Brake Shoes

Table 20

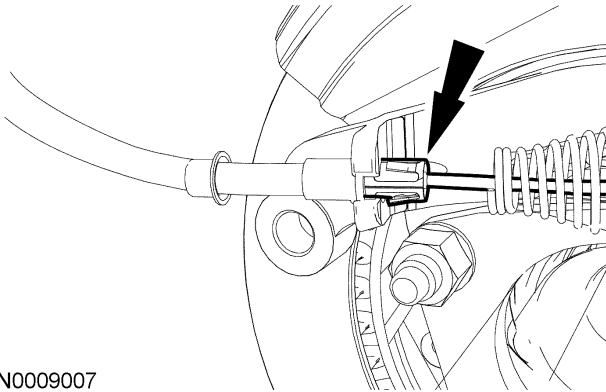
	Brake Adjusting Gauge
 <p>ST1468-A</p>	

1. Remove the rear brake disc. For additional information, refer to Rear Disc Brake(Rear Disc Brake, page 25).
2. Hold the adjuster and loosen the adjuster locknut.

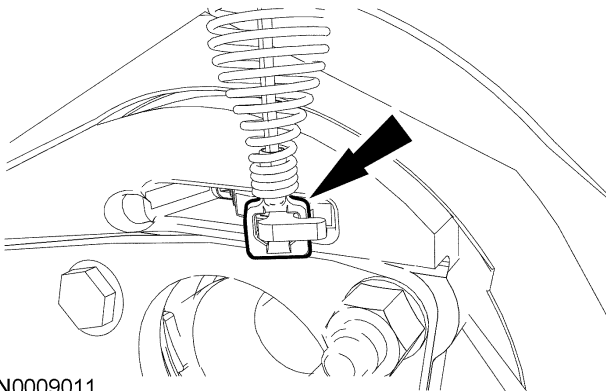


N0024257

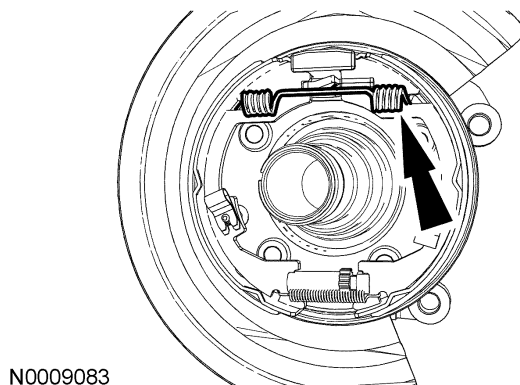
3. Remove the parking brake cable and conduit from the brake caliper anchor plate.



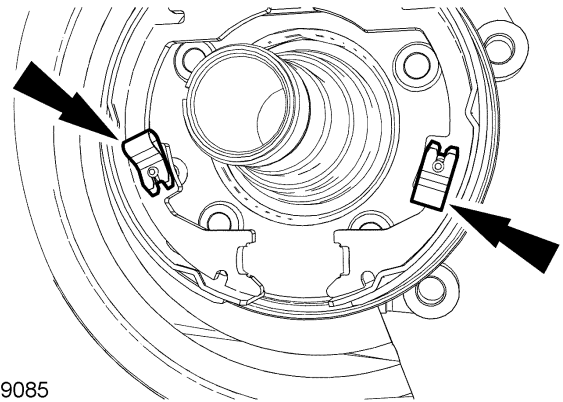
4. Disconnect the parking brake cable at the parking brake lever.



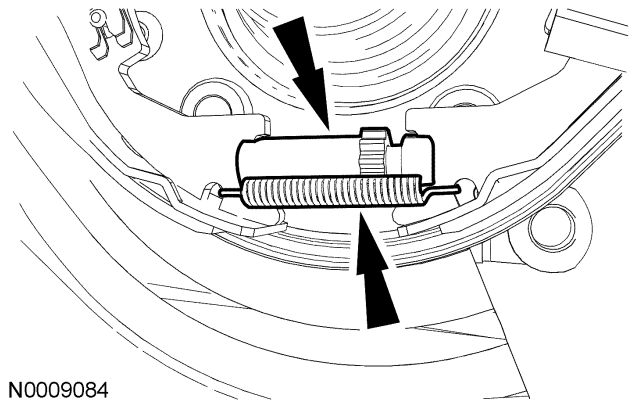
5. Remove the brake shoe retractor spring.



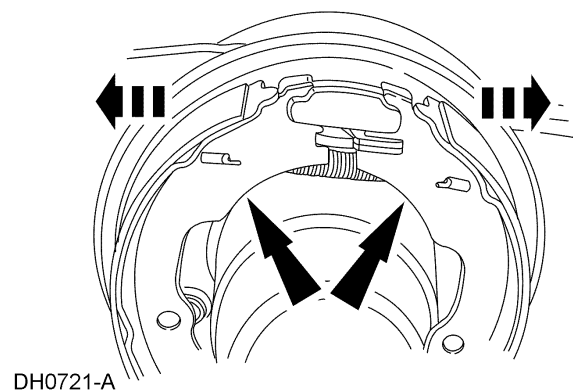
6. Remove the brake shoe hold-down clips.



7. Remove the brake adjuster screw and spring.



8. Remove the parking brake shoe and linings.



9. Inspect the components for excessive wear or damage and install new components as required.

S04049

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.

Follow all warnings, cautions, and notes.

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10. To install, reverse the removal procedure.
- Use the Brake Adjusting Gauge to set the rear brake shoe and lining diameter to 0.76 mm (0.030 in.) less than the inside diameter of the drum portion of the rear disc brake rotor.
 - Adjust the parking brake cable. For additional information, refer to Parking Brake Cable Adjustment in this section.
11. Burnish the parking brake shoe and linings.
- Accelerate the vehicle to 16 km/h (10 mph).
 - Shift the transmission to NEUTRAL.
 - Slowly apply the parking brake control to approximately 1/2 to 3/4 of its travel.
 - Allow the vehicle to come to a complete stop.
 - Release the parking brake.
 - Repeat the procedure 9 times.

Hydraulic Brake Actuation

Specifications

Table 21 Torque Specifications

Description	Nm	lbf-ft
Brake master cylinder nuts	40	30
Brake pedal bracket bolts	43	32
Brake pressure switch	17	13
Master cylinder reservoir bolts	25	18
Brake tubes	25	18

Hydraulic Brake Actuation Description and Operation


CAUTION: Blistering or swelling of rubber brake components may indicate contamination of the brake fluid by a petroleum-based substance. Contaminated rubber components in the hydraulic brake system must be installed new and the entire hydraulic brake system must be flushed with clean brake fluid to prevent recontamination.

This vehicle is equipped with a brake pedal-actuated dual brake system. The system consists of the following:

- Brake booster
 - Hydro-Boost®
- Brake master cylinder
- Front disc brake calipers
- Rear disc brake calipers
- Brake tubes and hoses
- Anti-lock brake system (ABS) components

The dual brake system is comprised of 2 separate circuits, the front wheel brakes and the rear wheel brakes.

Brake Fluid

 **WARNING:** Use of any brake fluid other than approved DOT 3 will cause permanent damage to brake components and will render the brakes inoperative.

! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

CAUTION: Brake fluid is harmful to painted or plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.

Use clean, fresh DOT 3 Motor Vehicle Brake Fluid.

- Do not reuse brake fluid drained or bled from the system.
- Do not use brake fluid that has been stored in an open container.
- Do not mix different types of brake fluid.

The brake pedal is connected to the power brake booster, which is connected to the brake master cylinder. When the brake pedal is depressed, brake fluid is pushed from the master cylinder through the metal tubing and flexible hoses to the rear disc brake calipers and the front disc brake calipers. The brake fluid enters the rear disc brake calipers, forcing the rear disc brake caliper pistons outward against the brake pads. The brake pads press against the braking surface on the brake discs. The front disc brake caliper pistons are forced outward against the brake pads and contact the braking surface of the brake discs and hub. When the brake pedal is released, the pressure is relieved, returning the brake caliper pistons and the brake shoes and linings to the unapplied position.

The ability of a brake system to stop the vehicle is dependent on the available traction.

Brake Master Cylinder

The brake master cylinder is a dual-piston type. The brake master cylinder operates as follows:

- When the brake pedal is depressed, pressure is applied by mechanical linkage to the primary and secondary piston.
- Brake master cylinder pistons apply hydraulic pressure to the 2 hydraulic circuits.

The brake master cylinder consists of:

- brake master cylinder reservoir.
- brake master cylinder body.

Brake Master Cylinder Reservoir

NOTE: Whenever the brake master cylinder reservoir is removed from the brake master cylinder, new grommets must be installed.

The brake master cylinder reservoir:

- is mounted to the brake master cylinder.
- holds fluid supply for each brake master cylinder hydraulic piston.
- provides visual fluid level markings.
- contains the brake master cylinder fluid level sensor.

Brake Tubes and Hoses

CAUTION: Never use copper tubing. It is subject to fatigue, cracking and corrosion which could result in brake tube failure.

Steel tubing is used throughout the brake hydraulic system. All brake tube fittings must be properly double flared to provide strong leakproof connections. When bending the tubing to fit the underbody or rear axle contours, be careful not to kink or crack the tube, allow the tube to contact any other component or come within 51 mm (2.0 in) of the exhaust system.

If a section of brake tube is damaged, the entire section must be replaced with a tube of the same type, size, shape and length.

When replacing hydraulic brake tubing, hoses or connectors, tighten all connections securely. After replacement, bleed the brake system. For additional information, refer to Brake System(Brake System — General Information, page 1).

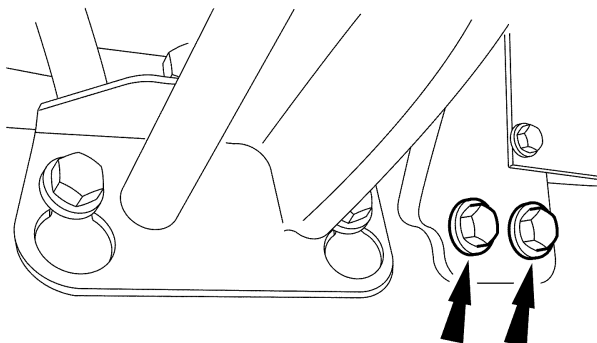
Hydraulic Brake Actuation Diagnosis and Testing

Refer to Brake System(Brake System — General Information, page 1).

Removal and Installation

Brake Pedal and Bracket

1. Remove the Hydro-Boost® assembly from the brake pedal bracket. For additional information, refer to Power Brake Actuation(Power Brake Actuation, page 40).
2. Disconnect the stoplight switch electrical connector and the brake pedal pushrod from the brake pedal pin.
3. Remove the upper brake pedal and bracket bolt.
 - To install, tighten to 43 Nm (32 lb-ft).
4. Remove the lower brake pedal and bracket bolts.
 - To install, tighten to 43 Nm (32 lb-ft).



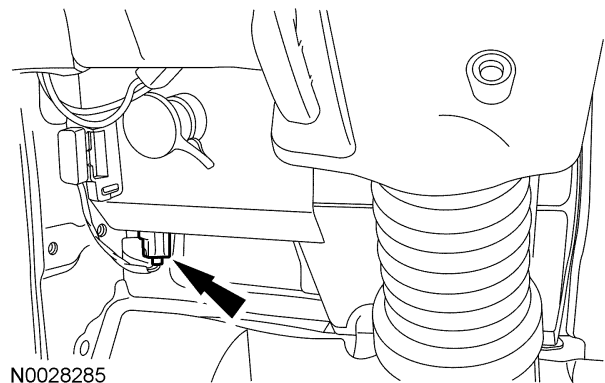
N0028458

5. To install, reverse the removal procedure.

Brake Master Cylinder

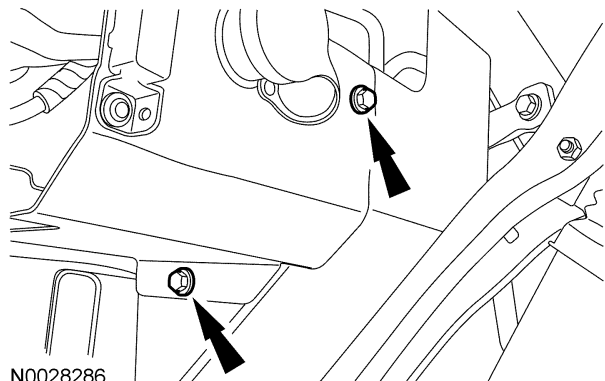
! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

1. Disconnect the brake pressure switch connector.



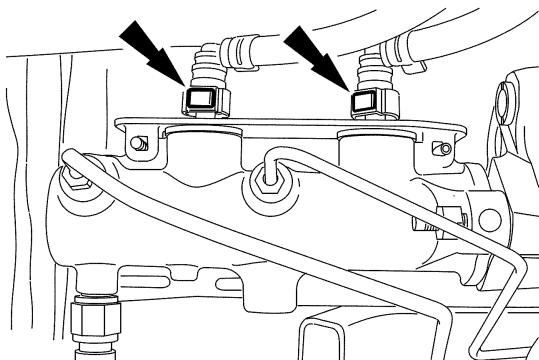
N0028285

2. Remove the LH lower access panel and position aside.



N0028286

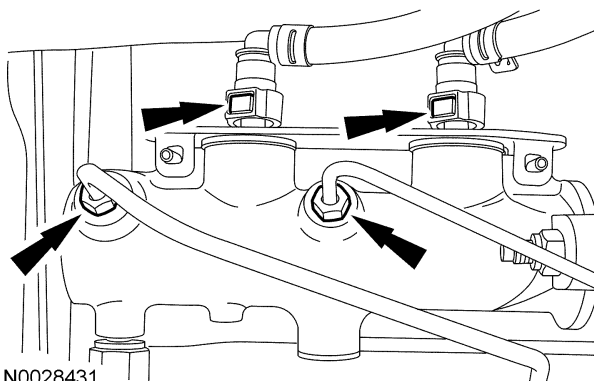
3. Place a drain pan under the master cylinder and disconnect the brake fluid reservoir hoses from the master cylinder ports.



N0028283

4. Disconnect the brake tubes.

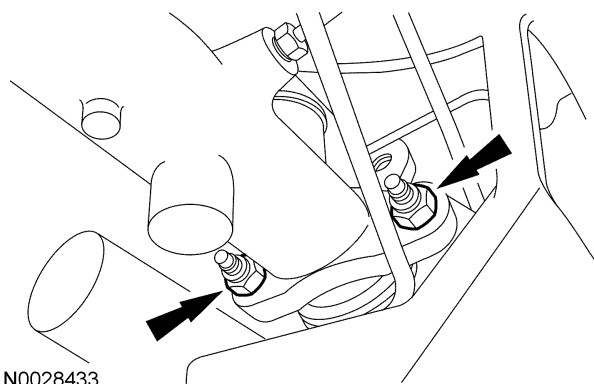
- To install, tighten to 25 Nm (18 lb-ft).



N0028431

5. Remove and discard the brake master cylinder nuts.

- To install, tighten to 40 Nm (30 lb-ft).



N0028433

6. Remove the brake master cylinder.

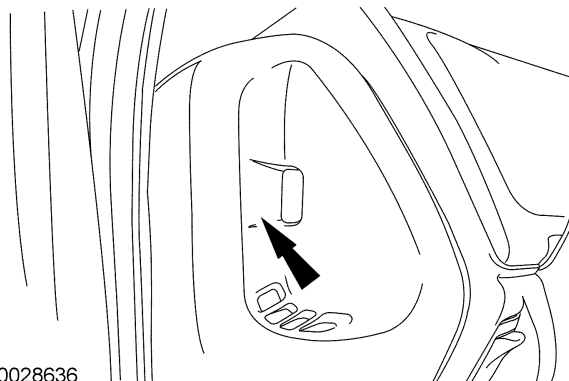
7. To install, reverse the removal procedure.

- Bleed the brake system. For additional information, refer to Brake System(Brake System — General Information, page 1).

Brake Fluid Reservoir

! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately.

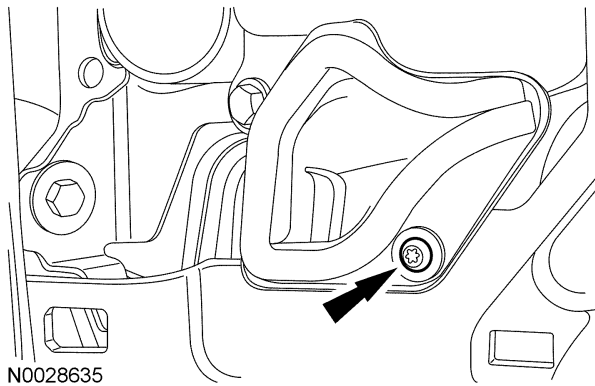
1. Remove the access panel.



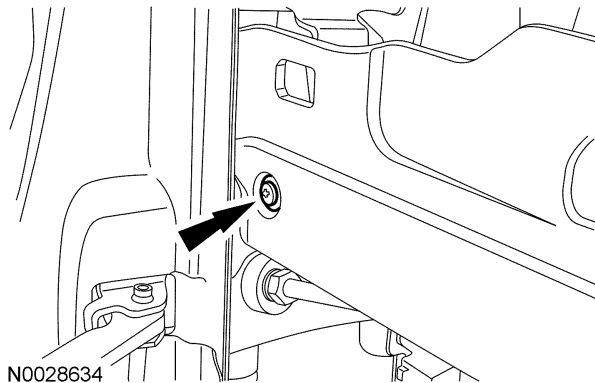
N0028636

2. Use a suitable suction device to drain the brake fluid reservoir.

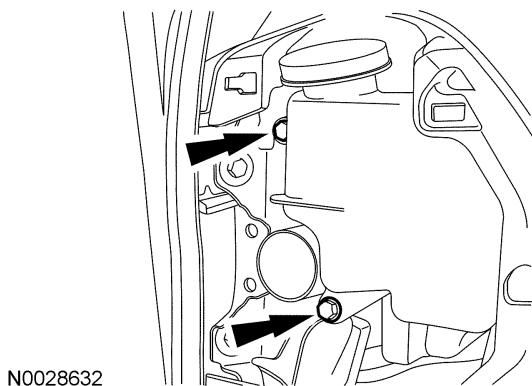
3. Remove the LH air duct.



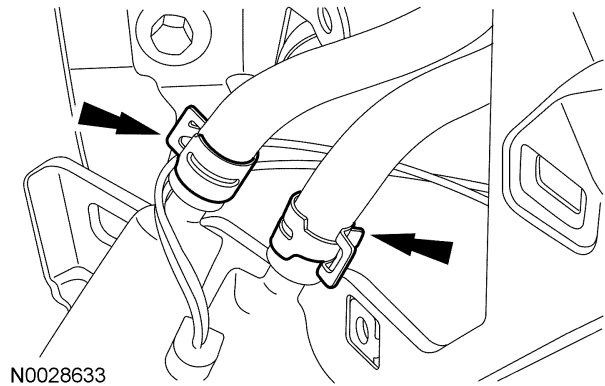
4. Remove the LH instrument cluster support screw for access.



5. Remove the master cylinder reservoir bolts.
- To install, tighten to 25 Nm (18 lb-ft).



6. Disconnect the brake fluid tubes from the brake fluid reservoir.



7. Disconnect the electrical connector (located near the master cylinder) and remove the brake fluid reservoir.
8. To install, reverse the removal procedure.
- Fill the brake master cylinder reservoir with brake fluid.
 - Verify brake correct brake system operation.

Power Brake Actuation

Specifications

Table 22 Torque Specifications

Description	Nm	lbf-ft
Hydro-boost® brake booster nut	55	41
Power steering fluid line fittings	28	21

Brake Booster Description and Operation

The Hydro-Boost® brake booster is a hydraulically operated brake booster powered by the power steering pump. The power steering pump provides the fluid pressure to operate both the power brake booster and the power steering gear.

The Hydro-Boost® accumulator stores sufficient fluid under pressure to provide at least 2 power-assisted brake applications in the event the power steering pump fluid flow is interrupted.

For low assist concerns on vehicles equipped with the Hydro-Boost® system, refer to Steering System in

S05017 to check the power steering pump pressure and flow.

Model identification is stamped into the power brake booster housing near the power steering pressure hose.

Power Brake System Diagnosis and Testing

Refer to Brake System(Brake System — General Information, page 1).

Hydro-Boost® Bleeding General Procedures

For additional information, refer to Steering System in S05017.

Removal and Installation

Brake Booster

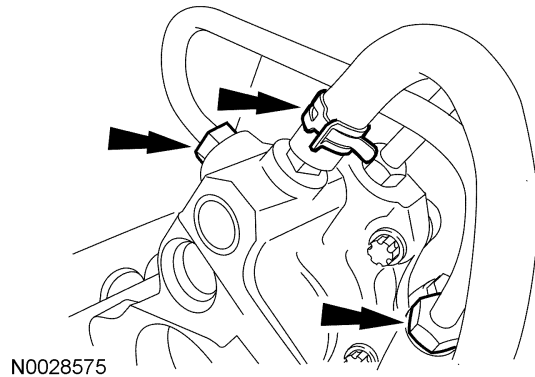
! WARNING: The power brake booster should not be carried by the accumulator, nor should it ever be dropped on the accumulator. Check the snap ring on the accumulator for correct seating before the power brake booster is used. The accumulator contains high-pressure nitrogen gas and can be dangerous if mishandled.

! WARNING: If the accumulator is to be disposed of, it must not be exposed to excessive heat. Before discarding the accumulator, drill a 1.6 mm (1/16 inch) diameter hole in the end of the accumulator can to relieve the gas pressure. Always wear safety glasses when performing this operation.

1. With the engine off, depress the brake pedal several times to discharge the accumulator.
2. Remove the brake master cylinder from the brake booster. For additional information, refer to Hydraulic Brake Actuation(Hydraulic Brake Actuation, page 36).

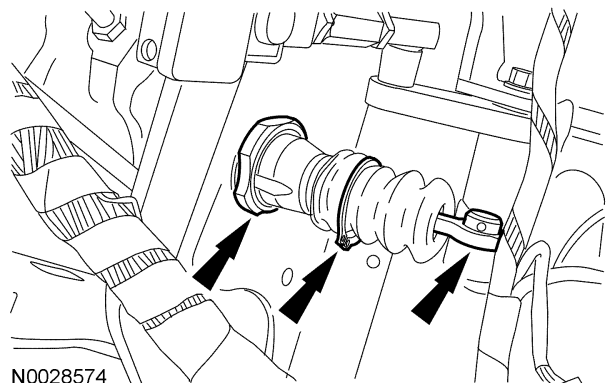
3. Place a suitable drain pan under the brake booster and disconnect the power steering fluid line fittings.

- To install, tighten to 28 Nm (21 lb-ft).



4. Remove the brake booster from the brake pedal assembly.

- Remove and discard the input rod cotter pin, then separate the input rod from the brake pedal arm.
 - Use a new cotter pin.
- Remove the snap ring.
- Remove the nut.
 - To install, tighten to 55 Nm (41 lb-ft).



5. To install, reverse the removal procedure.

- Install new O-ring seals on the power steering pressure fittings.

- Bleed the Hydro-Boost® system. For additional information, refer to Steering System in S05017.

Anti-Lock Control — 4-Wheel

Specifications

Table 23 Torque Specifications

Description	Nm	lb-ft	lb-in
Anti-lock brake control module screws	3	—	27
Hydraulic control unit (HCU) bracket-to-frame nuts	30	22	—
HCU-to-bracket bolt	11	8	—
Front anti-lock brake sensor bolt	18	13	—
Hydraulic brake tube—1/2-20	25	18	—
Hydraulic brake tube—7/16-24	17	13	—
Rear wheel speed sensor bolt	20	15	—

Anti-Lock Control Description and Operation

The vehicle is equipped with a 3-channel anti-lock brake system (ABS) that prevents wheel lockup by automatically modulating the brake pressure during an emergency stop.

The ABS controls the front and rear brakes separately. The brake pedal force required to engage the ABS function may vary with the road surface condition. A dry surface requires greater force than a slippery surface.

During ABS operation, the driver may feel a pulsation in the brake pedal, accompanied by a slight up and down movement in the pedal height. In addition, a mechanical noise from the engine compartment may be heard. The pedal effort and pedal feel during

normal braking are similar to that of a conventional power brake system.

When the brakes are applied, brake fluid is forced from the brake master cylinder outlet ports to the hydraulic control unit (HCU) inlet ports. The fluid pressure is transmitted through 3 normally open solenoid valves inside the HCU, through the outlet ports of the HCU to the brakes. One circuit of the brake master cylinder feeds the front brakes, while the other circuit feeds the rear brakes. If the anti-lock brake control module senses that a wheel is about to lock, based on wheel speed sensor data, the solenoid valve will pulse closed, preventing more fluid from entering that circuit. The anti-lock brake control module then reads the sensor signal from the affected wheel again. If the wheel is still decelerating, the normally closed solenoid valve for that circuit is opened. A controlled amount of hydraulic pressure between the normally open valve and the brake is relieved into the HCU accumulator. Once the affected wheel returns to vehicle speed, the anti-lock brake control module returns the solenoid valves to their normal condition, allowing fluid flow to the affected brake.

The anti-lock brake control module monitors the electromechanical components of the system. Malfunction of the anti-lock brake system will cause the anti-lock brake control module to shut off or inhibit the system, however, normal power-assisted braking remains. Malfunctions are indicated by the yellow ABS warning indicator in the instrument cluster.

The ABS system is self-monitoring. When the ignition switch is placed in the RUN position, the anti-lock brake control module performs a preliminary self-check on the anti-lock electrical system indicated by a 3-second illumination of the yellow ABS warning indicator in the instrument cluster.

A self-test of the solenoid valve coils and the pump motor is carried out when the vehicle is started. During start up, the brake pedal must be released to run the self-test. If the brake pedal is depressed or a failed brake switch occurs, the self-test is run at 6 km/h (4 mph) regardless of brake pedal position.

The anti-lock brake control module and the hydraulic control unit can be serviced separately.

Diagnostic Trouble Code Index

Table 24 Anti-Lock Brake System (ABS) Diagnostic Trouble Code (DTC) Index

DTC	Description	Source	Action
B1317	Battery Voltage High	ABS Module	GO to Pinpoint Test B.
B1318	Battery Voltage Low	ABS Module	GO to Pinpoint Test B.
B1342	ECU is faulted	ABS Module	REPAIR all other DTCs. CLEAR the DTCs. TEST the system for normal operation. If the DTC is retrieved, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section.
B2477	Module Configuration Failure	ABS Module	CONFIGURE the ABS module. REFER to Module Configuration in S08307. CLEAR the DTCs. REPEAT the self-test. If DTC B2477 is retrieved again, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module. REPEAT the self-test.
C110A	ABS Active Circuit Short to Battery	ABS Module	If any other DTCs are present, diagnose those DTCs first. CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1095	ABS Hydraulic Pump Motor Circuit Failure	ABS Module	GO to Pinpoint Test C.
C1096	ABS Hydraulic Pump Motor Circuit Open	ABS Module	GO to Pinpoint Test C.
C1115	ABS Power Relay Output Short Circuit to Battery	ABS Module	CLEAR all DTCs. DRIVE the vehicle. If DTC C1115 is retrieved again, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1145	Wheel Speed RF Sensor Input Circuit Failure	ABS Module	GO to Pinpoint Test D.
C1155	Speed Wheel Sensor LF Input Circuit Failure	ABS Module	GO to Pinpoint Test D.
C1175	Speed Wheel Sensor Rear Input Circuit Failure	ABS Module	GO to Pinpoint Test D.
C1185	ABS Power Relay Output Circuit Failure	ABS Module	CLEAR all DTCs. If DTC C1185 is retrieved again, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1194	ABS Outlet Valve Coil LF Circuit Failure	ABS Module	CLEAR all DTCs. If DTC C1194 is retrieved again, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.

Table 24 Anti-Lock Brake System (ABS) Diagnostic Trouble Code (DTC) Index (cont.)

DTC	Description	Source	Action
C1198	ABS Inlet Valve Coil LF Circuit Failure	ABS Module	CLEAR all DTCs. If DTC C1198 is retrieved again, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1210	ABS Outlet Valve Coil RF Circuit Failure	ABS Module	CLEAR all DTCs. If DTC C1210 is retrieved again, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1214	ABS Inlet Valve Coil RF Circuit Failure	ABS Module	CLEAR all DTCs. If DTC C1214 is retrieved again, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1222	Wheel Speed Mismatch	ABS Module	GO to Pinpoint Test E.
C1233	Speed Wheel LF Input Signal Missing	ABS Module	GO to Pinpoint Test E.
C1234	Speed Wheel RF Input Signal Missing	ABS Module	GO to Pinpoint Test E.
C1236	Speed Wheel Rear Input Signal Missing	ABS Module	GO to Pinpoint Test E.
C1242	ABS Outlet Valve Coil LR Circuit Failure	ABS Module	CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1246	ABS Outlet Valve Coil RR Circuit Failure	ABS Module	CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1250	ABS Inlet Valve Coil LR Circuit Failure	ABS Module	CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1254	ABS Inlet Valve Coil RR Circuit Failure	ABS Module	CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
C1329	ABS Valve Outlet Coil Over RF Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1329 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.
C1330	ABS Outlet Valve Coil Over LR Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1330 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.

Table 24 Anti-Lock Brake System (ABS) Diagnostic Trouble Code (DTC) Index (cont.)

DTC	Description	Source	Action
C1331	ABS Outlet Valve Coil Over RR Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1331 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.
C1332	ABS Outlet Valve Coil Over LF Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1332 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.
C1333	ABS Inlet Valve Coil Over RF Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1333 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.
C1334	ABS Inlet Valve Coil Over LR Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1334 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.
C1335	ABS Inlet Valve Coil Over RR Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1335 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.
C1336	ABS Inlet Valve Coil Over LF Temperature	ABS	CLEAR all DTCs. DRIVE the vehicle. If DTC C1336 is retrieved again, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CARRY OUT the self-test without the brake pedal applied.
C1446	Brake Switch Circuit Failure	ABS Module	GO to Pinpoint F.
C1730	Reference Voltage Out of Range (+5V)	ABS Module	If any other DTCs are present, diagnose those DTCs first. CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
U0073	CAN Bus Off-Transmit Error	ABS Module	If any other DTCs are present, diagnose those DTCs first. CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
U1900	CAN Communication Bus Fault-Receive Error	ABS Module	Refer to Module Communications Network in S08307.


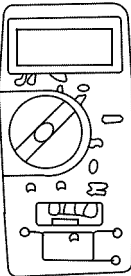
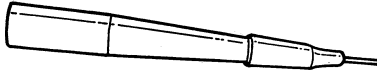
Table 24 Anti-Lock Brake System (ABS) Diagnostic Trouble Code (DTC) Index (cont.)

DTC	Description	Source	Action
U2050	No Application Present	ABS Module	If any other DTCs are present, diagnose those DTCs first. CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.
U2051	One or More Calibration Files Missing/Corrupt	ABS Module	If any other DTCs are present, diagnose those DTCs first. CLEAR all DTCs. DRIVE the vehicle. If the DTC is still present, INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CARRY OUT the self-test without the brake pedal applied.

Anti-Lock Control Diagnosis and Testing

Refer to the Wiring Diagrams for schematic and connector information.

Table 25 Special Tools

	EZ-Tech
 ST1137-A	Digital Multimeter ZTSE4357
	Probe Kit ZTSE4435B

Inspection and Verification

1. Verify the customer concern by operating the vehicle and applying the brakes under different conditions to duplicate the condition.
2. Inspect to determine if one of the following mechanical or electrical concerns apply:

Table 26 Visual Inspection Chart

Mechanical	Electrical
<ul style="list-style-type: none"> • Parking brake cable • Tire pressure • Tire size or mismatched tires 	<ul style="list-style-type: none"> • Power Distribution Center (PDC) fuses 20 (60A) and 29 (60A) • Connectors • Grounds • Circuitry open/shorted

3. If the inspection reveals an obvious concern(s) that can be readily identified, repair as required.
4. If the concern remains after the inspection, connect the diagnostic tool to the data link connector (DLC) located beneath the instrument panel and select the vehicle to be tested from the diagnostic tool menu. If the diagnostic tool does not communicate with the vehicle:
 - check that the program card is correctly installed.
 - check the connections to the vehicle.
 - check the ignition switch position.

- verify that the battery voltage is between 10 and 16 volts. For additional information, refer to Charging System in S08307.
5. If the diagnostic tool still does not communicate with the vehicle, refer to the diagnostic tool manual.
 6. Carry out the DATA LINK DIAGNOSTIC TEST. If the diagnostic tool responds with:
 - CKT914, CKT915 or CKT70 = ALL ECUS NO RESP/NOT EQUIP, refer to Module Communications Network in S08307.
 - NO RESP/NOT EQUIP for anti-lock brake control module, GO to Pinpoint Test L.
 - SYSTEM PASSED, retrieve and record the continuous diagnostic trouble codes (DTCs), erase the continuous DTCs and carry out self-test diagnostics for the anti-lock brake system module.
 7. If the DTCs retrieved are related to the concern, refer to Anti-Lock Brake System (ABS) Module Diagnostic Trouble Code (DTC) Index to continue diagnostics.
 8. If no DTCs related to the concern are retrieved, to continue diagnostics.

Symptom Chart

Failure of a mechanical brake component may not cause the yellow ABS warning indicator to illuminate or a DTC to be stored. The Symptom Chart is a starting point to begin diagnosis of these concerns.

Table 27

Condition	Possible Sources	Action
No communication with the ABS module	<ul style="list-style-type: none"> • PDC fuse 20 (60A). • PDC fuse 29 (60A). • Circuitry. • ABS module. • Diagnostic tool. 	<ul style="list-style-type: none"> • GO to Pinpoint Test A.
ABS misfire, ABS too sensitive, ABS fires on normal stop	<ul style="list-style-type: none"> A. Rear wheel speed sensor ring is damaged. B. Front wheel speed sensor ring is damaged. C. Sensor output is out of sync. D. Chafed wire insulation or pinched wire due to incorrect routing causing intermittent short. E. Parking brake adjustment too tight. Brake linings are grabby. F. Loose wheel speed sensor(s). 	<ul style="list-style-type: none"> A. REMOVE rear wheel speed sensor from the differential housing; INSPECT the rear wheel speed sensor. B. INSPECT for damaged teeth. INSPECT both front wheel speed sensor rings. C. GO to Pinpoint Test E. D. INSPECT wiring harness from front wheel knuckle-to-frame and from the rear axle-to-frame for worn or chafed wire insulation. E. ELIMINATE base brake system as cause of problem. F. TIGHTEN wheel speed sensor bolt to specifications. REFER to Specifications.
Wheels lock up	<ul style="list-style-type: none"> A. ABS outlet (dump) valve. B. Leaky ABS inlet (isolation) valve during ABS (soft). Damp or contaminated rear brake linings, or stuck/leaking rear disc brake caliper. Binding parking brake. Leaking rear axle seal. 	<ul style="list-style-type: none"> A. GO to Pinpoint Test H. B. ELIMINATE base brake system as cause of problem. REFER to Brake System(Brake System — General Information, page 1).
Yellow ABS warning indicator does not illuminate at prove out	<ul style="list-style-type: none"> • Circuitry. • Instrument cluster. 	<ul style="list-style-type: none"> • Refer to Instrument Cluster in S08307.

Hard or soft brake pedal	<p>A. Stuck ABS inlet (isolation) valve (hard brake pedal) or leaky ABS outlet (dump) valve (soft brake pedal).</p> <p>B. Hydraulic leak in brake line or hose, fitting, master cylinder or caliper (soft brake pedal).</p> <p>Air in brake system (soft brake pedal).</p> <p>Little or no power assist (hard brake pedal).</p> <p>Stuck or inoperative caliper (hard brake pedal).</p> <p>Pinched or crimped brake line or hose (hard brake pedal).</p>	<p>A. GO to Pinpoint Test H.</p> <p>B. ELIMINATE base brake system as cause of problem. REFER to Brake System(Brake System — General Information, page 1).</p>
Lack of deceleration during medium/hard brake application	<p>A. Stuck shut ABS inlet (isolation) valve or leaky ABS outlet (dump) valve (rear axle only).</p> <p>B. Hydraulic leak in brake line or hose, fitting, master cylinder or caliper.</p> <p>Air in brake system.</p> <p>Little or no power assist.</p> <p>Stuck or inoperative caliper.</p>	<p>A. GO to Pinpoint Test H.</p> <p>B. ELIMINATE base brake system as cause of problem. REFER to Brake System(Brake System — General Information, page 1).</p>
Vehicle pulls during braking	<p>A. Frozen or binding brake caliper (one side of vehicle).</p> <p>Uneven brake pad wear.</p> <p>Pinched or crimped brake line or hose.</p> <p>B. Fully or partially blocked front ABS inlet (isolation) valve.</p>	<p>A. ELIMINATE base brake system as cause of problem. REFER to Brake System(Brake System — General Information, page 1).</p> <p>B. INSTALL a new hydraulic control unit (HCU). REFER to Hydraulic Control Unit in this section.</p>
Soft or excessive pedal travel	<ul style="list-style-type: none"> Hydraulic control unit (HCU). 	<ul style="list-style-type: none"> GO to Pinpoint Test H.

Pinpoint Tests

Pinpoint Test A: No Communication with the ABS Module

CAUTION: Use the Probe Kit for all test connections to prevent damage to the wiring terminals. Do not use standard multimeter probes.

Table 28 PINPOINT TEST A: NO COMMUNICATION WITH THE ABS MODULE

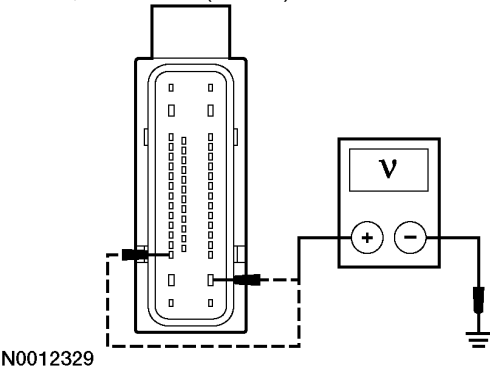
Test Step	Result / Action to Take
A1 VERIFY DIAGNOSTIC TOOL COMMUNICATION WITH THE VEHICLE <ul style="list-style-type: none"> Connect the diagnostic tool to data link connector (DLC) C251. Verify diagnostic tool communication with the vehicle. Does the network test pass for the engine control module (ECM)?	Yes GO to A2. No REFER to the diagnostic tool manual for further diagnosis.
A2 CHECK PDC FUSE 20 (60A) AND FUSE 29 (60A) <ul style="list-style-type: none"> Check PDC fuse 20 (60A) and fuse 29 (60A). Are the fuses okay?	Yes GO to A3. No CHECK and REPAIR PDC input side of the suspect fuse cavity. TEST the system for normal operation.
A3 CHECK FOR VOLTAGE INPUT TO THE ANTI-LOCK BRAKE SYSTEM (ABS) MODULE <ul style="list-style-type: none"> Disconnect: ABS Module C135. Key in ON position. Measure the voltage between ABS module C135-2, circuit 601 (LB/PK), harness side and ground and between ABS module C135-32, circuit 489 (PK/BK).  <p>N0012329</p> Is the voltage greater than 10 volts?	Yes GO to A4. No REPAIR circuit 601 (LB/PK) or circuit 534 (YE/LG). TEST the system for normal operation.
A4 CHECK THE ABS MODULE GROUNDS <ul style="list-style-type: none"> Key in OFF position. Disconnect the battery negative cable. Measure the resistance between ABS module C135-16 circuit 530 (LG/YE), harness side and ground and between C135-45 circuit 57 (BK), harness side and ground. 	Yes Refer to Module Communications Network in S08307. No

Table 28 PINPOINT TEST A: NO COMMUNICATION WITH THE ABS MODULE (cont.)

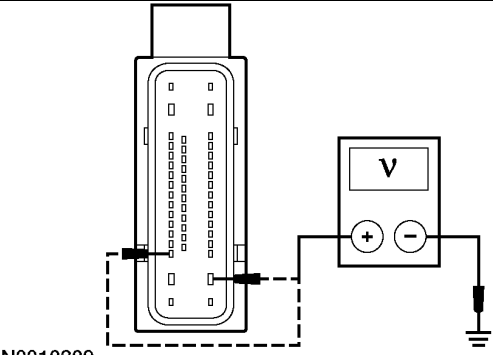
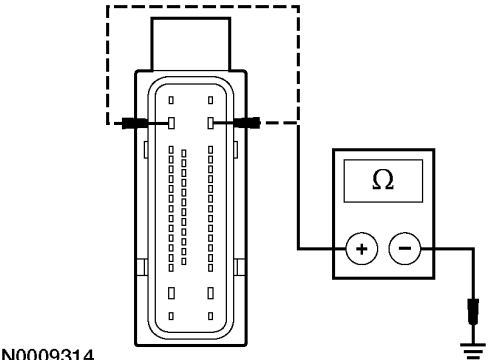
Test Step	Result / Action to Take
<p>N0009314</p> <p>Is the resistance less than 5 ohms?</p>	<p>REPAIR circuit 534 (YE/LG) or circuit 57 (BK). TEST the system for normal operation.</p>

CAUTION: Use the Probe Kit for all test connections to prevent damage to the wiring terminals. Do not use standard multimeter probes.

Table 29 PINPOINT TEST B: DTCs B1317 AND B1318 — BATTERY VOLTAGE HIGH/LOW

Test Step	Result / Action to Take
<p>B1 CHECK THE BATTERY VOLTAGE</p> <ul style="list-style-type: none"> Measure the battery voltage between the positive and negative battery posts with the key ON engine OFF (KOEO) and with the engine running. <p>Is the battery voltage between 10 and 13 volts with KOEO and between 11 and 16 volts with the engine running?</p>	<p>Yes</p> <p>GO to B2.</p> <p>No</p> <p>CHECK the charging system. REFER to Charging System in S08307. CLEAR the DTCs. REPEAT the self-test.</p>
<p>B2 CHECK THE VOLTAGE TO THE ANTI-LOCK BRAKE SYSTEM (ABS) MODULE</p> <ul style="list-style-type: none"> Key in OFF position. Disconnect: ABS Module C135. Key in ON position. Measure the voltage between ABS module C135-2, circuit 601 (LB/PK), harness side and ground; and between ABS module C135-32, circuit 489 (PK/BK) harness side and ground. 	<p>Yes</p> <p>GO to B3.</p> <p>No</p> <p>REPAIR the circuit(s) in question. CLEAR the DTCs. REPEAT the self-test.</p>

Table 29 PINPOINT TEST B: DTCs B1317 AND B1318 — BATTERY VOLTAGE HIGH/LOW (cont.)

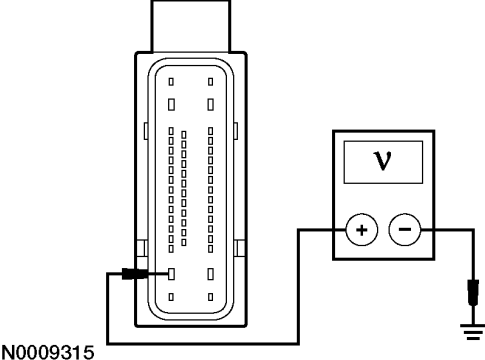
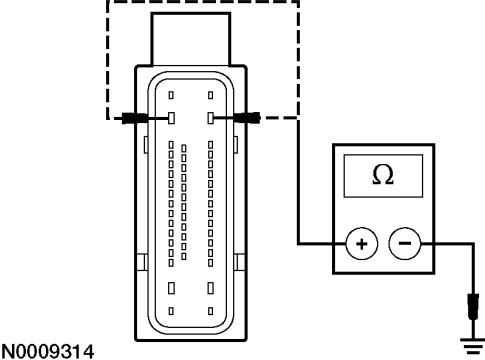
Test Step	Result / Action to Take
 <p>N0012329</p> <p>Are the voltages greater than 10 volts?</p>	
<p>B3 CHECK THE ABS MODULE GROUNDS</p> <ul style="list-style-type: none"> • Key in OFF position. • Measure the resistance between ABS module C135-16 circuit 530 (LG/YE), harness side and ground; and between ABS module C135-45 circuit 57 (BK), harness side and ground.  <p>N0009314</p> <p>Is the resistance less than 5 ohms?</p>	<p>Yes</p> <p>GO to B4.</p> <p>No</p> <p>REPAIR the circuit(s) in question. CLEAR the DTCs. REPEAT the self-test.</p>
<p>B4 CHECK FOR CORRECT ABS MODULE OPERATION</p> <ul style="list-style-type: none"> • Disconnect the ABS connector. • Check for: <ul style="list-style-type: none"> — corrosion. — pushed-out pins. • Connect the ABS connector and make sure that it is seated correctly. • Operate the system and verify the concern is still present. <p>Is the concern still present?</p>	<p>Yes</p> <p>INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CLEAR the DTCs. REPEAT the self-test.</p> <p>No</p> <p>The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the DTCs. REPEAT the self-test.</p>

CAUTION: Use the Probe Kit for all test connections to prevent damage to the wiring terminals. Do not use standard multimeter probes.

Table 30 PINPOINT TEST C: DTCs C1095 AND C1096 — ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE/OPEN

Test Step	Result / Action to Take
C1 CHECK THE ANTI-LOCK BRAKE SYSTEM (ABS) PUMP MOTOR <ul style="list-style-type: none"> Key in ON position. Does the ABS pump motor run continuously?	Yes GO to C5. No GO to C2.
C2 CHECK PUMP MOTOR OPERATION <ul style="list-style-type: none"> Key in ON position. Enter the following diagnostic mode on the diagnostic tool: ABS Module Active Command. Trigger the ABS module pump motor ON active command. Does the ABS pump motor run for approximately 2 seconds?	Yes CLEAR the DTCs. CHECK the yellow ABS warning indicator while driving the vehicle (brakes must not be applied) above 32 km/h (20 mph). If the yellow ABS warning indicator illuminates, RETRIEVE the DTCs. If DTC C1096 is retrieved, GO to C5. If DTC C1095 is retrieved, INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CLEAR the DTCs. REPEAT the self-test. No TRIGGER the ABS module pump motor OFF active command. GO to C3.
C3 CHECK CIRCUIT 534 (YE/LG) <ul style="list-style-type: none"> Key in OFF position. Disconnect: ABS Module C135. Measure the voltage between ABS module C135-31, circuit 534 (YE/LG), harness side and ground. 	Yes GO to C4. No

Table 30 PINPOINT TEST C: DTCs C1095 AND C1096 — ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE/OPEN (cont.)

Test Step	Result / Action to Take
 <p>N0009315</p> <ul style="list-style-type: none"> Key in ON position. <p>Is the voltage greater than 10 volts?</p>	<p>REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.</p>
<p>C4 CHECK THE ABS MODULE GROUNDS</p> <ul style="list-style-type: none"> Key in OFF position. Measure the resistance between ABS module C135-16 circuit 534 (YE/LG), harness side and ground; and between ABS module C135-45 circuit 57 (BK), harness side and ground.  <p>N0009314</p> <p>Are the resistances less than 5 ohms?</p>	<p>Yes</p> <p>INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. CLEAR the DTCs. REPEAT the self-test.</p> <p>No</p> <p>REPAIR the circuit. CLEAR the DTCs. REPEAT the self-test.</p>
<p>C5 CHECK FOR CORRECT ABS MODULE OPERATION</p> <ul style="list-style-type: none"> Disconnect the ABS connector. Check for: <ul style="list-style-type: none"> corrosion. pushed-out pins. Connect the ABS connector and make sure that it is seated correctly. Operate the system and verify the concern is still present. <p>Is the concern still present?</p>	<p>Yes</p> <p>INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. TEST the system for normal operation.</p> <p>No</p> <p>The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the DTCs. REPEAT the self-test.</p>

CAUTION: Use the Probe Kit for all test connections to prevent damage to the wiring terminals. Do not use standard multimeter probes.

Table 31 PINPOINT TEST D: DTC C1145 (RF), C1155 (LF) OR C1175 (REAR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE

Test Step	Result / Action to Take																					
D1 CHECK FOR FAULT REPEATABILITY NOTE: Both circuits must be checked for each DTC. <ul style="list-style-type: none">Connect the diagnostic tool.Enter the following diagnostic mode on the diagnostic tool: Clear the Continuous DTCsDrive the vehicle with at least 16 km/h (10 mph).Retrieve and document continuous DTCs. Is DTC C1145, C1155 or C1175 retrieved?	Yes GO to D2. No If any other DTCs are retrieved, GO to the Anti-Lock Brake System (ABS) Module Diagnostic Trouble Code (DTC) Index.																					
D2 CHECK FOR A SHORT TO VOLTAGE NOTE: Both circuits must be checked for each DTC. <ul style="list-style-type: none">Key in OFF position.Disconnect: ABS Module C135.Disconnect: Suspect Wheel Speed Sensor.Key in ON position.Measure the voltage between ABS module C135, harness side and ground, as follows:<table border="1"><thead><tr><th>DTC</th><th>ABS Module C135 Pin</th><th>Circuit</th></tr></thead><tbody><tr><td>C1145 (RF)</td><td>26</td><td>497 (WH)</td></tr><tr><td>C1145 (RF)</td><td>27</td><td>510 (TN/RD)</td></tr><tr><td>C1155 (LF)</td><td>12</td><td>498 (PK)</td></tr><tr><td>C1155 (LF)</td><td>13</td><td>495 (TN)</td></tr><tr><td>C1175 (rear)</td><td>42</td><td>492 (BN)</td></tr><tr><td>C1175 (rear)</td><td>41</td><td>494 (TN/LG)</td></tr></tbody></table> Is voltage present?	DTC	ABS Module C135 Pin	Circuit	C1145 (RF)	26	497 (WH)	C1145 (RF)	27	510 (TN/RD)	C1155 (LF)	12	498 (PK)	C1155 (LF)	13	495 (TN)	C1175 (rear)	42	492 (BN)	C1175 (rear)	41	494 (TN/LG)	Yes REPAIR the circuit(s) in question. CLEAR the DTCs. REPEAT the self-test. No GO to D3.
DTC	ABS Module C135 Pin	Circuit																				
C1145 (RF)	26	497 (WH)																				
C1145 (RF)	27	510 (TN/RD)																				
C1155 (LF)	12	498 (PK)																				
C1155 (LF)	13	495 (TN)																				
C1175 (rear)	42	492 (BN)																				
C1175 (rear)	41	494 (TN/LG)																				

Table 31 PINPOINT TEST D: DTC C1145 (RF), C1155 (LF) OR C1175 (REAR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (cont.)

Test Step	Result / Action to Take																												
D3 CHECK FOR A SHORT TO GROUND NOTE: Both circuits must be checked for each DTC. <ul style="list-style-type: none">Key in OFF position.Measure the voltage between ABS module C135, harness side and ground as follows: <table><tr><th>DTC</th><th>ABS Module C135 Pin</th><th>Circuit</th></tr><tr><td>C1145 (RF)</td><td>26</td><td>497 (WH)</td></tr><tr><td>C1145 (RF)</td><td>27</td><td>510 (TN/RD)</td></tr><tr><td>C1155 (LF)</td><td>12</td><td>498 (PK)</td></tr><tr><td>C1155 (LF)</td><td>13</td><td>495 (TN)</td></tr><tr><td>C1175 (rear)</td><td>42</td><td>492 (BN)</td></tr><tr><td>C1175 (rear)</td><td>41</td><td>494 (TN/LG)</td></tr></table> Are the resistances greater than 10,000 ohms?	DTC	ABS Module C135 Pin	Circuit	C1145 (RF)	26	497 (WH)	C1145 (RF)	27	510 (TN/RD)	C1155 (LF)	12	498 (PK)	C1155 (LF)	13	495 (TN)	C1175 (rear)	42	492 (BN)	C1175 (rear)	41	494 (TN/LG)	Yes GO to D4. No REPAIR the circuit in question. CLEAR the DTCs. TEST the system for normal operation.							
DTC	ABS Module C135 Pin	Circuit																											
C1145 (RF)	26	497 (WH)																											
C1145 (RF)	27	510 (TN/RD)																											
C1155 (LF)	12	498 (PK)																											
C1155 (LF)	13	495 (TN)																											
C1175 (rear)	42	492 (BN)																											
C1175 (rear)	41	494 (TN/LG)																											
D4 CHECK FOR AN OPEN NOTE: Both circuits must be checked for each DTC. <ul style="list-style-type: none">Measure the resistance between ABS module C135, harness side and the suspected wheel speed sensor connector, harness side, as follows: <table><tr><th>DTC</th><th>Circuit</th><th>ABS Module C135 Pin</th><th>Wheel Speed Sensor Connector Pin</th></tr><tr><td>C1145 (RF)</td><td>510 (TN/RD)</td><td>27</td><td>C160-2</td></tr><tr><td>C1145 (RF)</td><td>497 (WH)</td><td>26</td><td>C160-1</td></tr><tr><td>C1155 (LF)</td><td>495 (TN)</td><td>13</td><td>C150-2</td></tr><tr><td>C1155 (LF)</td><td>498 (PK)</td><td>12</td><td>C150-1</td></tr><tr><td>C1175 (rear)</td><td>492 (BN)</td><td>42</td><td>C455-1</td></tr><tr><td>C1175 (rear)</td><td>494 (TN/LG)</td><td>41</td><td>C455-2</td></tr></table> Are the resistances less than 5 ohms?	DTC	Circuit	ABS Module C135 Pin	Wheel Speed Sensor Connector Pin	C1145 (RF)	510 (TN/RD)	27	C160-2	C1145 (RF)	497 (WH)	26	C160-1	C1155 (LF)	495 (TN)	13	C150-2	C1155 (LF)	498 (PK)	12	C150-1	C1175 (rear)	492 (BN)	42	C455-1	C1175 (rear)	494 (TN/LG)	41	C455-2	Yes GO to D5. No REPAIR the circuit(s) in question. CLEAR the DTCs. REPEAT the self-test.
DTC	Circuit	ABS Module C135 Pin	Wheel Speed Sensor Connector Pin																										
C1145 (RF)	510 (TN/RD)	27	C160-2																										
C1145 (RF)	497 (WH)	26	C160-1																										
C1155 (LF)	495 (TN)	13	C150-2																										
C1155 (LF)	498 (PK)	12	C150-1																										
C1175 (rear)	492 (BN)	42	C455-1																										
C1175 (rear)	494 (TN/LG)	41	C455-2																										

Table 31 PINPOINT TEST D: DTC C1145 (RF), C1155 (LF) OR C1175 (REAR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (cont.)

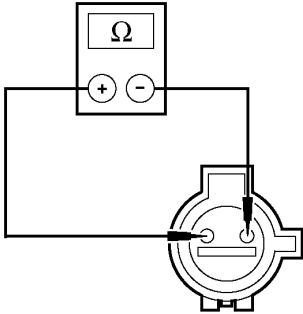
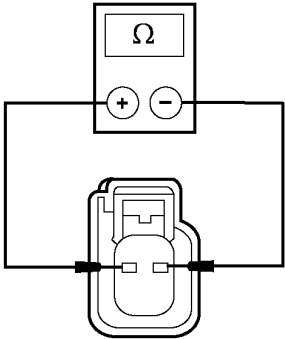
Test Step	Result / Action to Take
<p>D5 CHECK FOR SHORTED WHEEL SPEED SENSOR CIRCUITS</p> <ul style="list-style-type: none"> Measure the resistance between the suspect front wheel speed sensor pins, harness side with the meter in the 10 megaohm range.  <p>A0057968</p> <ul style="list-style-type: none"> Measure the resistance between the rear wheel speed sensor pins, harness side with the meter in the 10 megaohm range.  <p>A0075883</p> <p>Is there any continuity?</p>	<p>Yes</p> <p>REPAIR the circuit(s) in question. CLEAR the DTCs. REPEAT the self-test.</p> <p>No</p> <p>GO to D6.</p>
<p>D6 CHECK THE ABS MODULE OUTPUT</p> <ul style="list-style-type: none"> Connect: ABS Module C135. Key in ON position. Measure the voltage between the suspect front wheel speed sensor pins, harness side. 	<p>Yes</p> <p>INSTALL a new wheel speed sensor. For the front wheel speed sensor, REFER to Front Wheel Speed Sensor in this section. CLEAR the DTCs. REPEAT the self-test. For the rear wheel speed sensor, REFER to Rear Wheel Speed Sensor in</p>

Table 31 PINPOINT TEST D: DTC C1145 (RF), C1155 (LF) OR C1175 (REAR) — WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (cont.)

Test Step	Result / Action to Take
<div data-bbox="423 401 594 695"> </div> <p data-bbox="233 705 324 726">A0057374</p> <ul data-bbox="155 762 831 821" style="list-style-type: none"> • Measure the voltage between the rear wheel speed sensor pins, harness side. <div data-bbox="370 831 651 1167"> </div> <p data-bbox="224 1161 318 1182">A0075884</p> <p data-bbox="155 1209 599 1236">Are the voltages greater than 10 volts?</p>	<p data-bbox="889 369 1422 428">this section. CLEAR the DTCs. TEST the system for normal operation.</p> <p data-bbox="889 495 927 522">No</p> <p data-bbox="889 543 1003 571">GO to D7.</p>
<p data-bbox="155 1260 776 1287">D7 CHECK FOR CORRECT ABS MODULE OPERATION</p> <ul data-bbox="155 1308 837 1604" style="list-style-type: none"> • Disconnect the ABS connector. • Check for: <ul data-bbox="201 1402 428 1478" style="list-style-type: none"> — corrosion. — pushed-out pins. • Connect the ABS connector and make sure that it is seated correctly. • Operate the system and verify the concern is still present. <p data-bbox="155 1625 477 1652">Is the concern still present?</p>	<p data-bbox="889 1260 935 1287">Yes</p> <p data-bbox="889 1308 1422 1398">INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CLEAR the DTCs. REPEAT the self-test.</p> <p data-bbox="889 1465 927 1493">No</p> <p data-bbox="889 1514 1422 1635">The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the DTCs. REPEAT the self-test.</p>

CAUTION: Use the Probe Kit for all test connections to prevent damage to the wiring terminals. Do not use standard multimeter probes.

Table 32 PINPOINT TEST E: DTC C1222 — WHEEL SPEED MISMATCH/ DTC C1233 (LF), C1234 (RF) OR C1236 (REAR) — WHEEL SPEED SENSOR SIGNAL FAULT

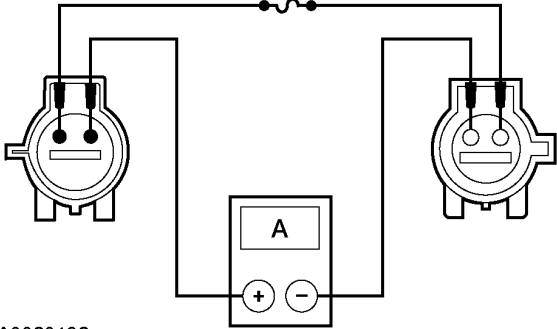
Test Step	Result / Action to Take
<p>E1 CHECK FOR DTCs</p> <ul style="list-style-type: none"> Connect the diagnostic tool. Key in ON position. Retrieve the ABS module DTCs. <p>Are DTCs C1145, C1155 or C1175 present?</p>	<p>Yes</p> <p>GO to Pinpoint Test D.</p> <p>No</p> <p>If DTC C1222 is present, GO to E4. If DTC C1233 or C1234 is present, GO to E2. If DTC C1236 is present, GO to E3. If no DTCs are present, GO to E5.</p>
<p>E2 CHECK THE FRONT WHEEL SPEED SENSOR OUTPUT</p> <ul style="list-style-type: none"> Key in OFF position. Disconnect: Wheel Speed Sensor C150 (LF) or C160 (RF). If DTC C1233 is present, connect a fused (5A) jumper wire between LF wheel speed sensor C150-1 , circuit 498 (PK), harness side and LF wheel speed sensor C150-1 , component side. Connect the automotive meter between LF wheel speed sensor C150-2, circuit 495 (TN), harness side and LF wheel speed sensor C150-2, component side.  <p>A0080198</p> <ul style="list-style-type: none"> If DTC C1234 is present, connect a fused (5A) jumper wire between RF wheel speed sensor C160-1 , circuit 497 (WH), harness side and RF wheel speed C160-1, component side. Connect the automotive meter between RF wheel speed sensor C160-2 , circuit 510 (TN/RD), harness side and RF wheel speed sensor C160-2, component side. Key in ON position. Measure the amperage while slowly spinning the wheel. <p>Does the amperage vary between approximately 6 mA and 14 mA?</p>	<p>Yes</p> <p>GO to E6.</p> <p>No</p> <p>INSTALL a new wheel speed sensor, REFER to Front Wheel Speed Sensor in this section. CLEAR the DTC. REPEAT the self-test.</p>

Table 32 PINPOINT TEST E: DTC C1222 — WHEEL SPEED MISMATCH/ DTC C1233 (LF), C1234 (RF) OR C1236 (REAR) — WHEEL SPEED SENSOR SIGNAL FAULT (cont.)

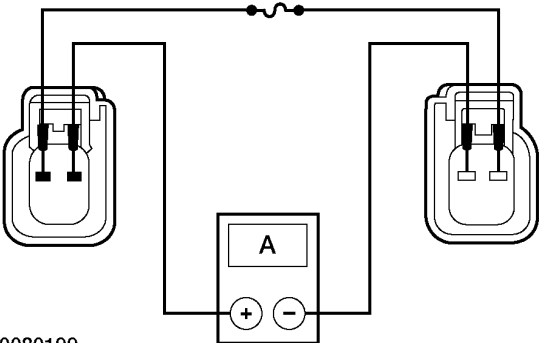
Test Step	Result / Action to Take
<p>E3 CHECK THE REAR WHEEL SPEED SENSOR OUTPUT</p> <ul style="list-style-type: none"> Key in OFF position. Disconnect: Rear Wheel Speed Sensor C455. Connect a fused (5A) jumper wire between rear wheel speed sensor, C455-1, circuit 492 (BN), harness side and rear wheel speed sensor C455-1, component side. Connect the automotive meter between rear wheel speed sensor C455-2, circuit 494 (TN/LG), harness side and rear wheel speed sensor C455-2, component side.  <p>A0080199</p> <ul style="list-style-type: none"> Key in ON position. Measure the amperage while slowly spinning the wheel. <p>Does the amperage vary between approximately 6 mA and 14 mA?</p>	<p>Yes</p> <p>GO to E6.</p> <p>No</p> <p>INSTALL a new wheel speed sensor. REFER to Rear Wheel Speed Sensor in this section. CLEAR the DTC. REPEAT the self-test.</p>
<p>E4 CHECK FOR CORRECT ABS MODULE CONFIGURATION</p> <p>NOTE: DTC C1222 indicates that there is a problem with the axle configuration in the ABS module.</p> <ul style="list-style-type: none"> Carry out the ABS module configuration. Verify that the vehicle data matches the vehicle options. Clear the DTC and carry out the self-test. <p>Is DTC 1222 still present?</p>	<p>Yes</p> <p>GO to E6.</p> <p>No</p> <p>The system is operating correctly at this time. CLEAR the DTC. REPEAT the self-test.</p>

Table 32 PINPOINT TEST E: DTC C1222 — WHEEL SPEED MISMATCH/ DTC C1233 (LF), C1234 (RF) OR C1236 (REAR) — WHEEL SPEED SENSOR SIGNAL FAULT (cont.)

Test Step	Result / Action to Take
E5 MONITOR THE WHEEL SPEED SENSOR PID <ul style="list-style-type: none"> Enter the following diagnostic mode on the diagnostic tool: ABS Module Wheel Speed Sensor PIDs Drive the vehicle at various speeds above 10 km/h (6 mph) while monitoring the PIDs. Do all of the PIDs match?	<p>Yes</p> <p>GO to E6.</p> <p>No</p> <p>INSTALL a new wheel speed sensor. REFER to Front Wheel Speed Sensor in this section. CLEAR the DTCs. REPEAT the self-test.</p>
E6 CHECK FOR CORRECT ABS MODULE OPERATION <ul style="list-style-type: none"> Disconnect the ABS connector. Check for: <ul style="list-style-type: none"> — corrosion. — pushed-out pins. Connect the ABS connector and make sure that it is seated correctly. Operate the system and verify the concern is still present. Is the concern still present?	<p>Yes</p> <p>INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. CLEAR the DTCs. REPEAT the self-test.</p> <p>No</p> <p>The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the DTCs. REPEAT the self-test.</p>

Table 33 PINPOINT TEST F: DTC C1446 — BRAKE SWITCH CIRCUIT FAILURE

Test Step	Result / Action to Take
F1 MONITOR THE ENGINE CONTROL MODULE (ECM) PIDs <ul style="list-style-type: none"> Enter the following diagnostic mode on the diagnostic tool: ECM PID. Press and release the brake pedal while monitoring the ECM stoplamp switch PID. Does the PID agree with the brake pedal position?	Yes GO to F2. No REFER to Exterior Lighting in S08307 to continue diagnosis of the stoplamps.
F2 MONITOR THE ANTI-LOCK BRAKE SYSTEM (ABS) MODULE STOPLAMP SWITCH PID <ul style="list-style-type: none"> Enter the following diagnostic mode on the diagnostic tool: ABS Module PID. Press and release the brake pedal while monitoring the stoplamp switch PID. Does the PID agree with the brake pedal position?	Yes INSTALL a ABS module. REFER to Anti-lock Brake System Module in this section. CLEAR the DTCs. REPEAT the self-test. No GO to F3.
F3 CHECK FOR CORRECT ABS MODULE OPERATION <ul style="list-style-type: none"> Disconnect the ABS connector. Check for: <ul style="list-style-type: none"> corrosion. pushed-out pins. Connect the ABS connector and make sure that it is seated correctly. Operate the system and verify the concern is still present. Is the concern still present?	Yes INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. TEST the system for normal operation. No The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the DTCs. REPEAT the self-test.

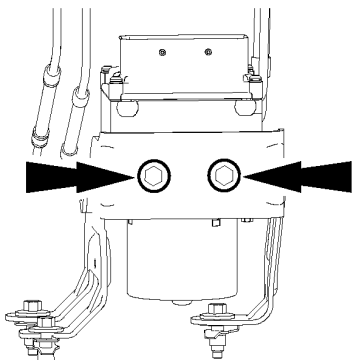
Table 34 PINPOINT TEST G: THE YELLOW ANTI-LOCK BRAKE SYSTEM (ABS) MODULE WARNING INDICATOR IS ALWAYS ON

Test Step	Result / Action to Take
G1 CHECK FOR DTCs <ul style="list-style-type: none"> Connect the diagnostic tool. Key in ON position. Retrieve the ABS module DTCs. Are any DTCs present?	Yes If the DTCs retrieved are related to the concern, GO to the Anti-Lock Brake System (ABS) Module Diagnostic Trouble Code (DTC) Index to continue diagnosis. No GO to G2.

Table 34 PINPOINT TEST G: THE YELLOW ANTI-LOCK BRAKE SYSTEM (ABS) MODULE WARNING INDICATOR IS ALWAYS ON (cont.)

Test Step	Result / Action to Take
G2 CARRY OUT THE INSTRUMENT CLUSTER ABS WARNING INDICATOR ACTIVE COMMAND <ul style="list-style-type: none"> Enter the following diagnostic mode on the diagnostic tool: Instrument Cluster Active Command. Select the instrument cluster INDICATOR LAMP CONTROL active command. Command all warning lamps ON then OFF. Does the yellow ABS warning indicator continue to illuminate?	Yes GO to G3. No GO to G4.
G3 CHECK FOR CORRECT INSTRUMENT CLUSTER OPERATION <ul style="list-style-type: none"> Disconnect all the instrument cluster connectors. Check for: <ul style="list-style-type: none"> corrosion. pushed-out pins. Connect all the instrument cluster connectors and make sure they seat correctly. Operate the system and verify the concern is still present. Is the concern still present?	Yes INSTALL a new instrument cluster. REFER to Instrument Cluster. TEST the system for normal operation. No The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the DTCs. REPEAT the self-test.
G4 CHECK FOR CORRECT ABS MODULE OPERATION <ul style="list-style-type: none"> Disconnect the ABS connector. Check for: <ul style="list-style-type: none"> corrosion. pushed-out pins. Connect the ABS connector and make sure that it is seated correctly. Operate the system and verify the concern is still present. Is the concern still present?	Yes INSTALL a new ABS module. REFER to Anti-Lock Brake System Module in this section. TEST the system for normal operation. No The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector. CLEAR the DTCs. REPEAT the self-test.

Table 35 PINPOINT TEST H: SOFT OR EXCESSIVE PEDAL TRAVEL

Test Step	Result / Action to Take
H1 CHECK THE BASE BRAKE COMPONENTS <ul style="list-style-type: none"> Visually inspect the brake lines from the hydraulic control unit (HCU) to the brake calipers. Visually inspect the calipers and brake components. Are any of these components damaged?	Yes REPAIR or INSTALL new components as necessary. TEST the system for normal operation. No GO to H2.
H2 CHECK FOR A LEAKING DUMP VALVE <ul style="list-style-type: none"> Key in OFF position. Remove the rubber boots from the 2 HCU low pressure accumulators (LPA).  <p>N0009374</p> <ul style="list-style-type: none"> Insert a clean steel implement, (such as a paper clip or small screwdriver) into each LPA. Key in START position. NOTE: A leaking dump valve is similar to the master cylinder bypass condition. It is important that the pedal be quickly and forcefully applied to rule out master cylinder bypass as a cause. Typically, master cylinder bypass occurs only at low pedal pressure rates. <p>Have an assistant press hard on the brake pedal while observing the steel implements.</p> Do any of the implements move out 6.35 mm (0.25 in) or more?	Yes INSTALL a new HCU. REFER to Hydraulic Control Unit in this section. No REMOVE the steel implements. INSTALL the rubber boots on each LPA. REFER to Brake System(Brake System — General Information, page 1) for diagnosis of the base brake system.

Removal and Installation

Hydraulic Control Unit

! WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with eyes. Wash hands thoroughly after handling. If brake fluid contacts eyes, flush eyes with running water for 15 minutes. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

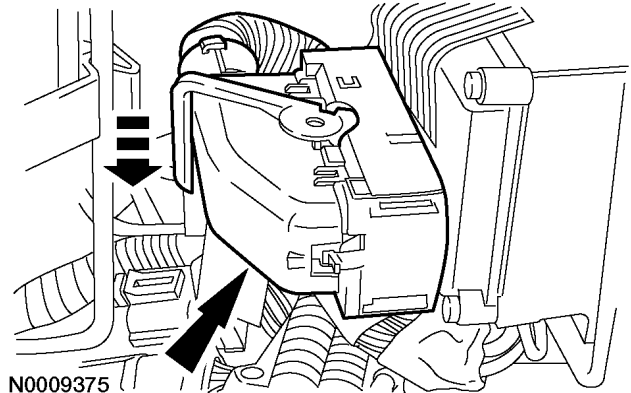
CAUTION: Electronic modules are sensitive to static electrical charges. If exposed to these charges, damage may result.

CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.

CAUTION: Only authorized inlet hydraulic brake tubes should be used. These tubes are of specific design and only authorized parts should be used when installing new inlet brake tubes.

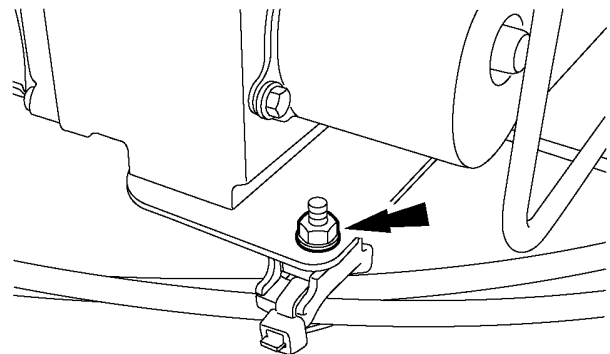
CAUTION: When installing either the HCU or the anti-lock brake system (ABS) module individually, make sure that the number of coils (metal cans) in the ABS module equals the number of valves in the HCU. This is an additional method of verifying that the correct replacement part number has been selected.

1. Disconnect the battery. For additional information, refer to Battery, Mounting and Cables in S08307.
2. Push the lock forward and release the ABS electrical connector.

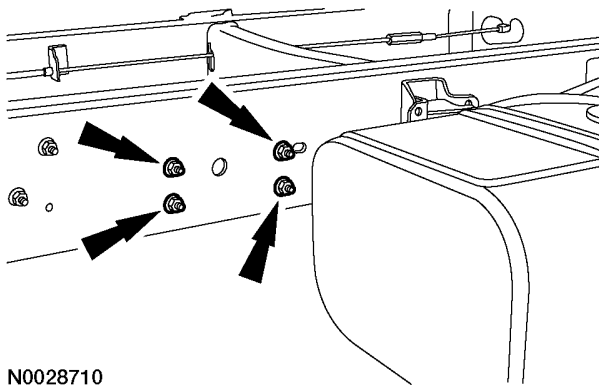


NOTE: Plug each open port to prevent brake fluid from spilling.

3. Disconnect the hydraulic brake line fittings.
 - To install, tighten the 1/2-20 fittings to 25 Nm (18 lb-ft).
 - To install, tighten the 7/16-24 fittings to 17 Nm (13 lb-ft).
4. Loosen the nut and remove the fuel lines from bracket.



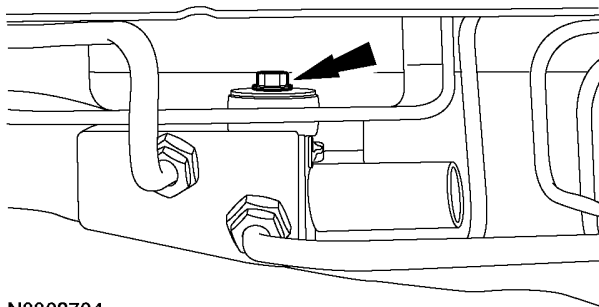
5. Remove the nuts and the HCU and bracket assembly.
 - To install, tighten to 30 Nm (22 lb-ft).



N0028710

6. Remove the bolt and remove the HCU from the bracket.

- To install, tighten to 11 Nm (8 lb-ft).



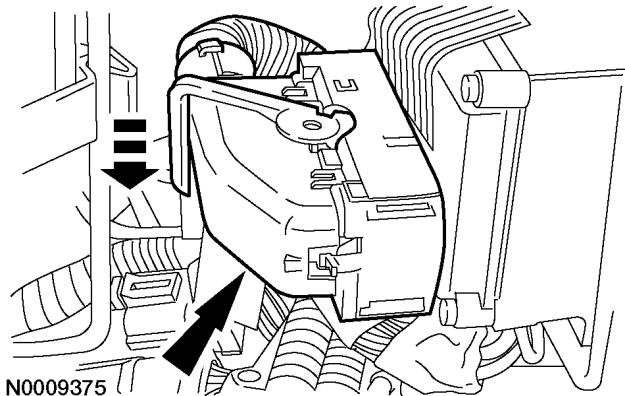
N0028724

7. To install, reverse the removal procedure. Bleed the brake system. For additional information, refer to Brake System(Brake System — General Information, page 1).

Anti-Lock Brake System (ABS) Module

CAUTION: When installing a new HCU or anti-lock brake system (ABS) module individually, make sure that the number of coils (metal cans) in the ABS module equals the number of valves in the HCU. This is an additional method of verifying that the correct replacement part number has been selected.

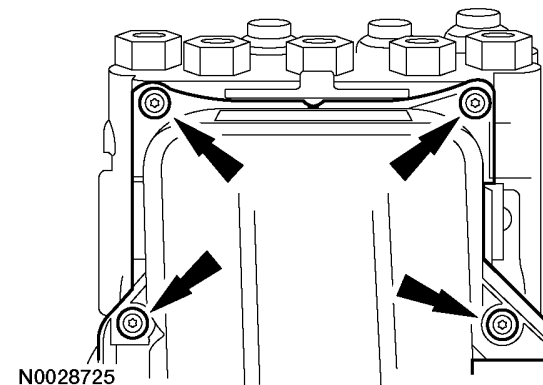
1. Disconnect the battery. For additional information, refer to Battery, Mounting and Cables in S08307.
2. Push the lock forward and release the ABS electrical connector.



N0009375

3. Remove the screws and the ABS module.

- To install, tighten to 3 Nm (27 lb-in).



N0028725

4. To install, reverse the removal procedure.
- Verify correct ABS operation.

Rear Wheel Speed Sensor

1. Disconnect the battery. For additional information, refer to Battery, Cables and Mounting in S08307.
2. Raise and support the vehicle. For additional information, refer to Jacking and Lifting in S10019.
3. Disconnect the electrical connector.

4. Remove the rear wheel speed sensor.
 - Remove the bolt.
 - To install, tighten to 20 Nm (15 lb-ft).
 - Remove the rear wheel speed sensor.



CAUTION: Use care not to get dirt in the rear axle housing.

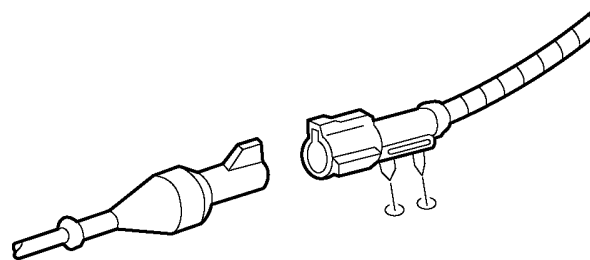
5. To install, reverse the removal procedure.

Clean and inspect the rear anti-lock brake sensor.

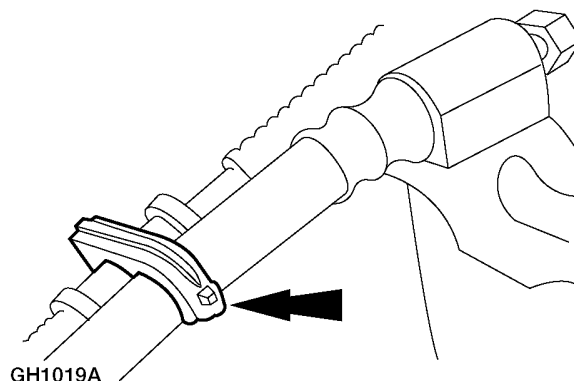
 - a. Clean the axle mounting surface.
 - b. Inspect and clean the magnetized rear anti-lock brake sensor pole piece.
 - c. Inspect the rear anti-lock brake sensor O-ring for damage. Install a new O-ring if necessary.
 - d. Lightly lubricate the rear anti-lock brake sensor O-ring rear axle lubricant.

Front Wheel Speed Sensor

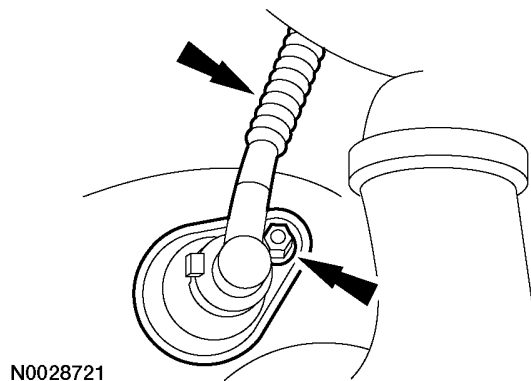
1. Disconnect the front anti-lock brake sensor electrical connector.



2. Separate the sensor cable from the brake hose clips.



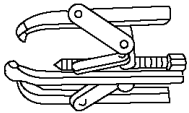
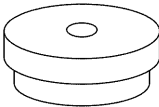
3. Remove the front anti-lock brake sensor bolt and the front anti-lock brake sensor.
 - To install, tighten to 18 Nm (13 lb-ft).



4. To install, reverse the removal procedure.

Front Wheel Speed Sensor Ring Removal

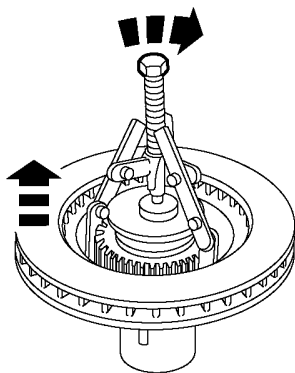
Table 36 Special Tools

 <p>ST1184-A</p>	<p>2- or 3-Jaw Puller</p>
 <p>ST1369-A</p>	<p>Hub Step Plate ZTSE4727</p>

1. Remove the front disc brake rotor. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18).

CAUTION: Discard the front brake anti-lock sensor ring.

2. Use the special tools to remove the front brake anti-lock sensor ring.

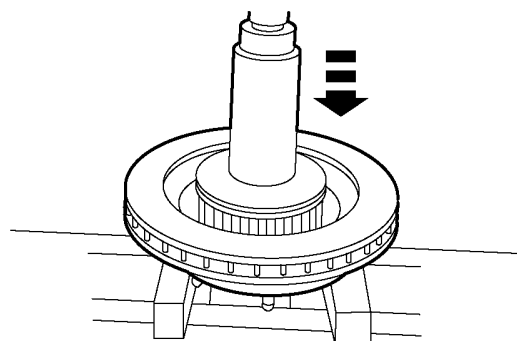


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Front Wheel Speed Sensor Ring Installation

CAUTION: The front brake anti-lock sensor ring must be pressed on straight.

1. Use an appropriate size cylinder and press to install the front brake anti-lock sensor ring.



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2. Install the front disc brake rotor. For additional information, refer to Front Disc Brake(Front Disc Brake, page 18).

Rear Wheel Speed Sensor Ring

NOTE: The rear anti-lock brake sensor indicator is attached to the differential case. It is necessary to remove the ring gear in order to remove the rear anti-lock brake sensor indicator.

Refer to the appropriate section, i.e., Driveline System, Driveshaft, Rear Drive Axle, or Wheel Hubs and Bearings for the procedure.