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Brakes

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Hydraulic Brakes

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Booster Pump Rod Nut	68 N.m	50 lb ft
Brake Booster Mounting Nuts	36 N.m	27 lb ft
Master Cylinder Bracket Nut	45 N.m	33 lb ft

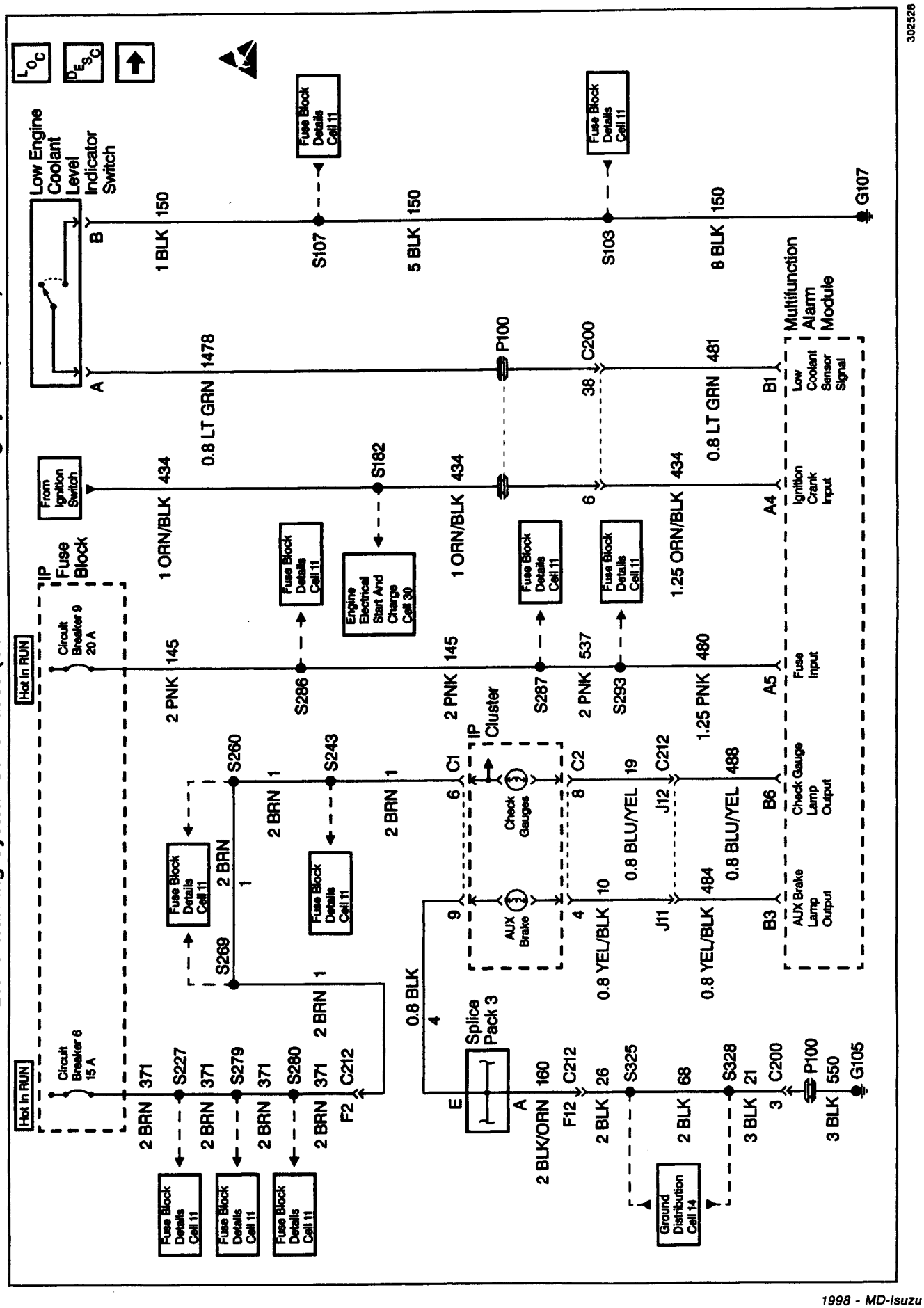
Schematic and Routing Diagrams

Hydraulic Brakes Schematic References

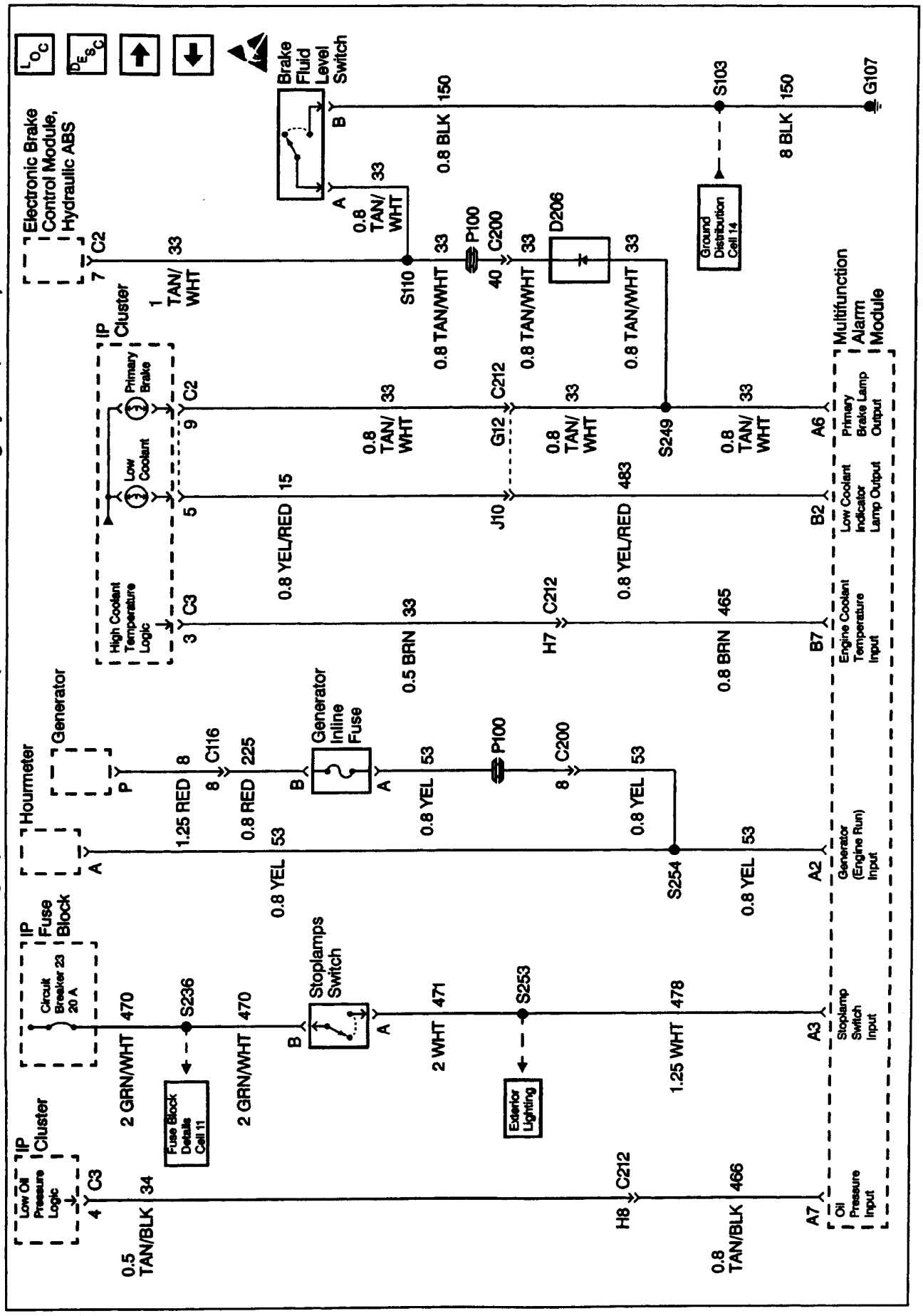
Reference on Schematic	Section Number - Subsection Name
Power Distribution Cell 10	8—Wiring Systems
Fuse Block Details Cell 11	8—Wiring Systems
Ground Distribution Cell 14	8—Wiring Systems

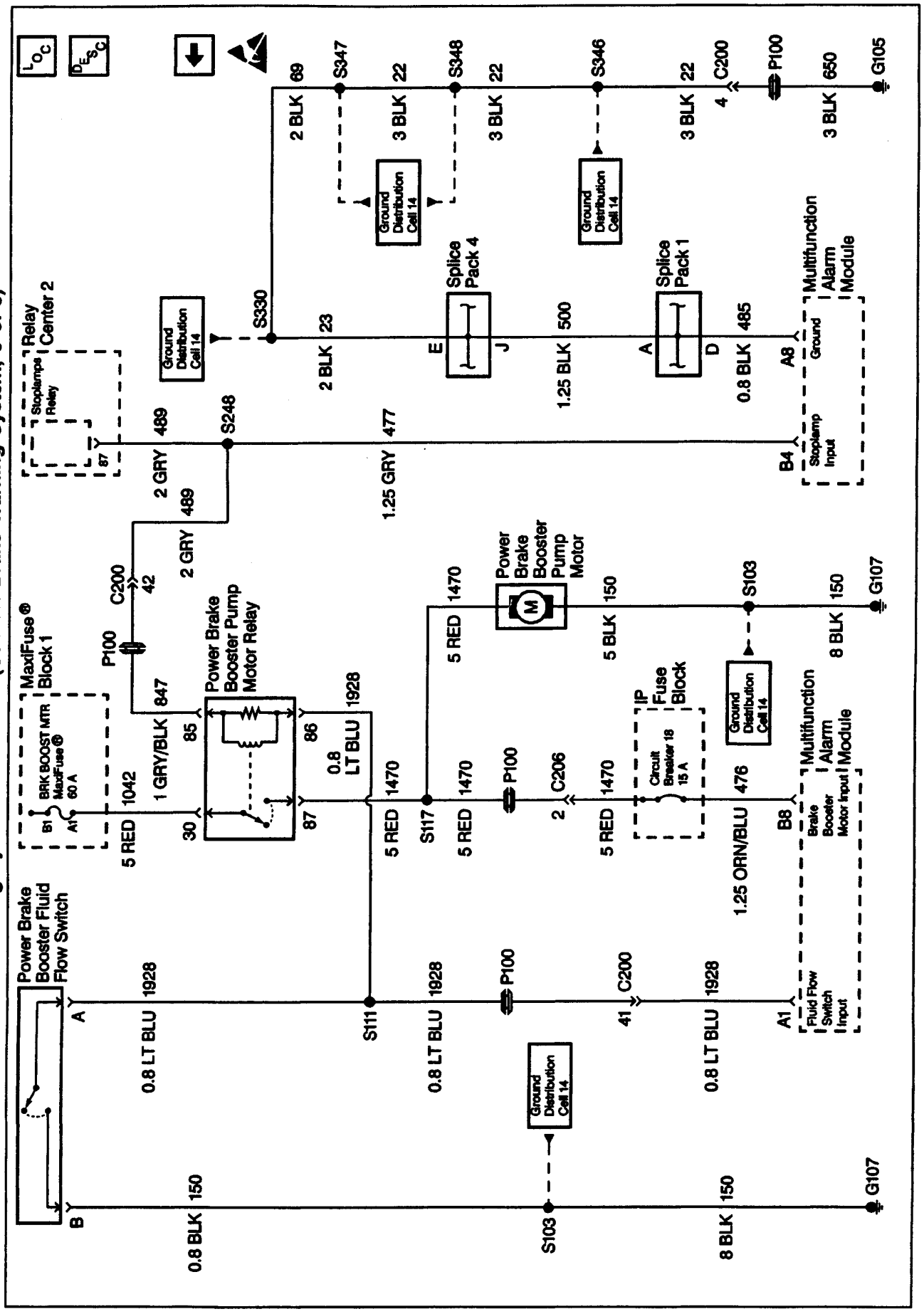
Hydraulic Brakes Schematic Icons

Icon	Icon Definition
19384	Refer to *ESD Notice* in Cautions and Notices.


Brake Warning System Schematics (Cell 41: Brake Warning System, 1 of 3)
302528
Low Engine Coolant Level Indicator Switch
Multifunction Alarm Module
Low Coolant Sensor Signal
Ignition Crank Input
Fuse Input
Check Gauge Lamp Output
AUX Brake Lamp Output
Splice Pack 3
Cluster
IP Fuse Block
From Ignition Switch
Circuit Breaker 9 20 A
Circuit Breaker 6 15 A
Hot In RUN
Fuse Block Details Cell 11
Engine Electrical Start And Charge Cell 30
Ground Distribution Cell 14
1 BLK 150
5 BLK 150
8 BLK 150
0.8 LT GRN 1478
1 ORN/BLK 434
1.25 ORN/BLK 434
2 PNK 145
2 PNK 537
1.25 PNK 480
2 BRN
0.8 BLK
0.8 YEL/BLK
0.8 BLU/YEL
2 BLK/ORN
2 BLK
3 BLK
S107
S103
S182
S286
S287
S293
S260
S243
S269
S227
S279
S280
P100
C200
C1
C2
C212
J12
J11
S325
S328
G107
G105
1998 - MD-Isuzu

Brake Warning System Schematics (Cell 41: Brake Warning System, 2 of 3)




Brake Warning System Schematics (Cell 41: Brake Warning System, 3 of 3)
Power Brake Booster Fluid Flow Switch
MaxiFuse® Block 1
BRK BOOST MTR MaxiFuse® 60 A
Power Brake Booster Pump Motor Relay
Power Brake Booster Pump Motor
IP Fuse Block
Circuit Breaker 18 15 A
Ground Distribution Cell 14
Relay Center 2
Stoplamps Relay
Splice Pack 4
Splice Pack 1
Multifunction Alarm Module
Fluid Flow Switch Input
Brake Booster Motor Input
Stoplamp Input
Ground
0.8 BLK 150
8 BLK 150
0.8 LT BLU 1928
5 RED 1042
1 GRY/BLK 847
0.8 LT BLU 1928
5 RED 1470
5 RED 1470
5 RED 1470
5 RED 1470
5 BLK 150
8 BLK 150
1.25 ORN/BLU 476
2 GRY 489
2 GRY 489
1.25 GRY 477
2 BLK 23
1.25 BLK 500
0.8 BLK 485
2 BLK 69
3 BLK 22
3 BLK 22
3 BLK 22
3 BLK 650
S103
S111
S117
S248
S330
S347
S348
S346
G107
G105
P100
C200
C206
302531

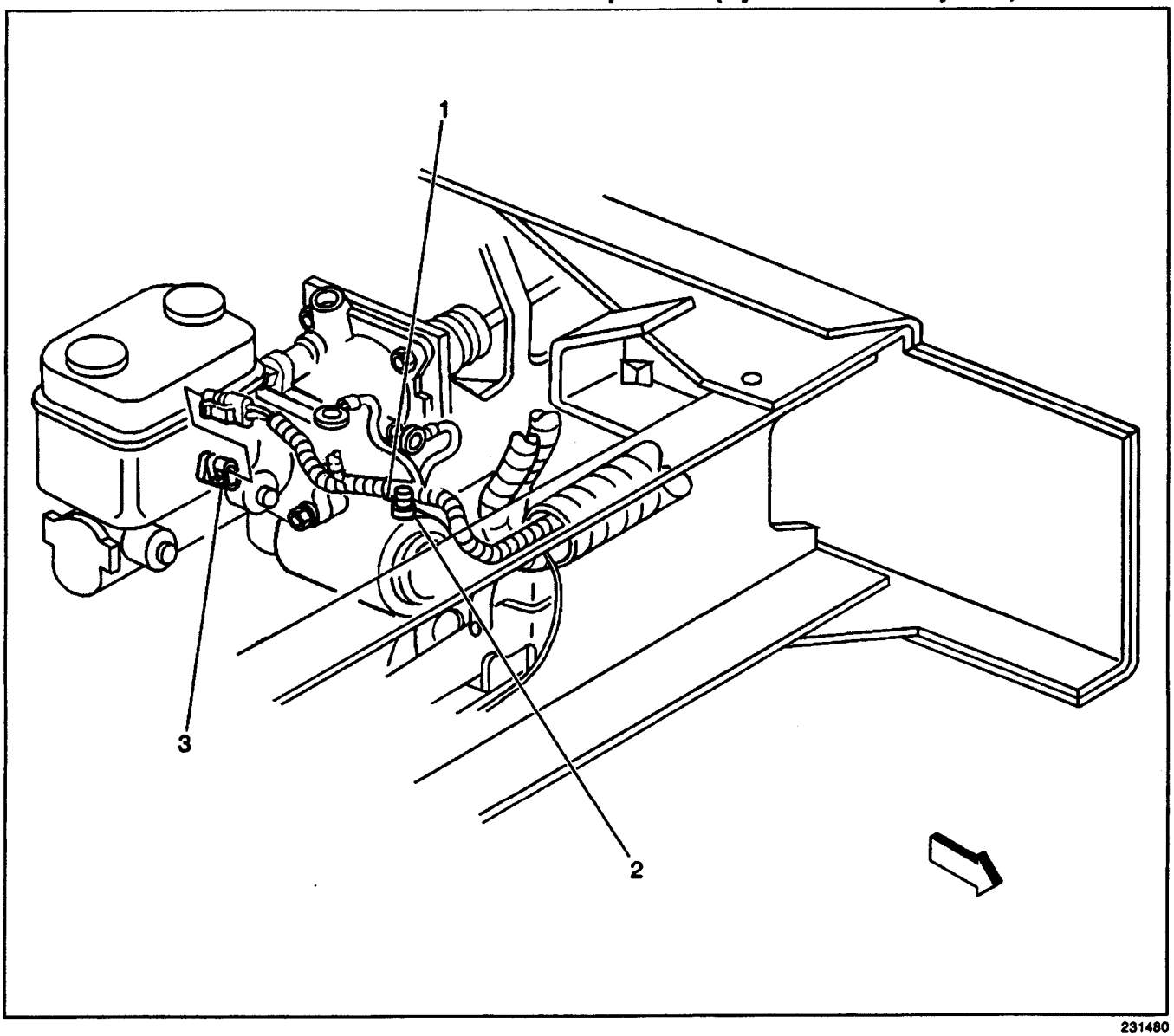
Component Locator

Hydraulic Brakes Components

Name	Location	Locator View	Connector End View
Brake Fluid Level Indicator Switch	Behind the left side of the front crossmember on the front of the brake master cylinder reservoir.	Refer to *Hydraulic Brakes Component Views*	Refer to *Hydraulic Brakes Connector End Views*
Power Brake (P/B) Booster Fluid Flow Switch (Hydraulic Brakes)	Right side of the power brake booster pump housing left of the brake master cylinder.	Refer to *Hydraulic Brakes Component Views*	Refer to *Hydraulic Brakes Connector End Views*
Power Brake (P/B) Booster Pump Motor (Hydraulic Brakes)	Left side front frame rail, behind the front crossmember at the brake master cylinder.	Refer to *Hydraulic Brakes Component Views*	Refer to *Hydraulic Brakes Connector End Views*
Power Brake (P/B) Booster Pump Motor Relay (Hydraulic Brakes)	Under the MaxiFuse.rtm block cover.	Refer to *Hydraulic Brakes Component Views*	Refer to *Hydraulic Brakes Connector End Views*

Hydraulic Brakes Component Views

Front Chassis Harness to Brake Components (Hydraulic Brake System)

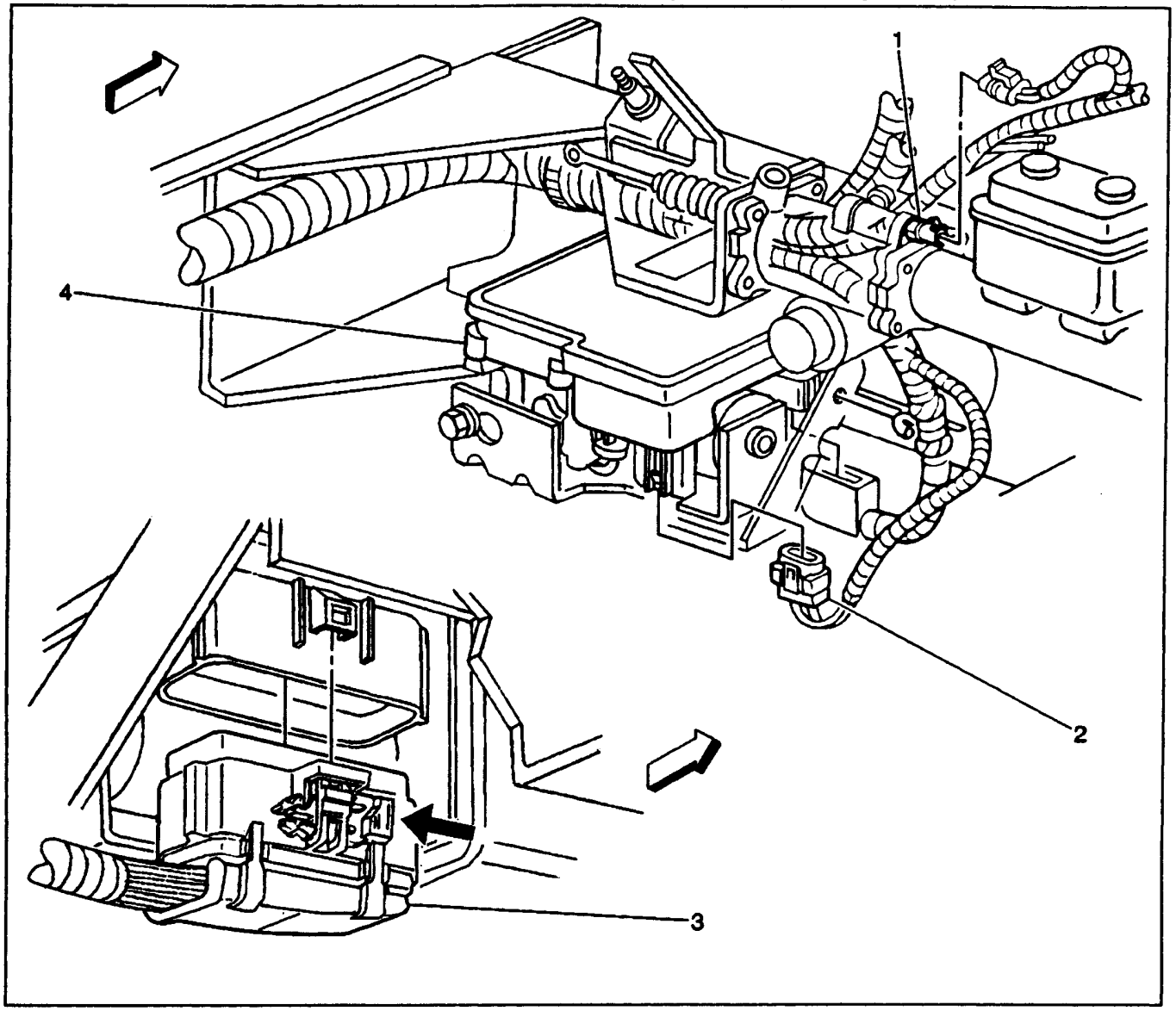


231480

Legend

(1) Power Brake Booster Pump
(2) Power Brake Booster Pump Motor
(3) Brake Fluid Level Indicator Switch

Front Chassis Harness to Brake Components (ABS-Hydraulic)

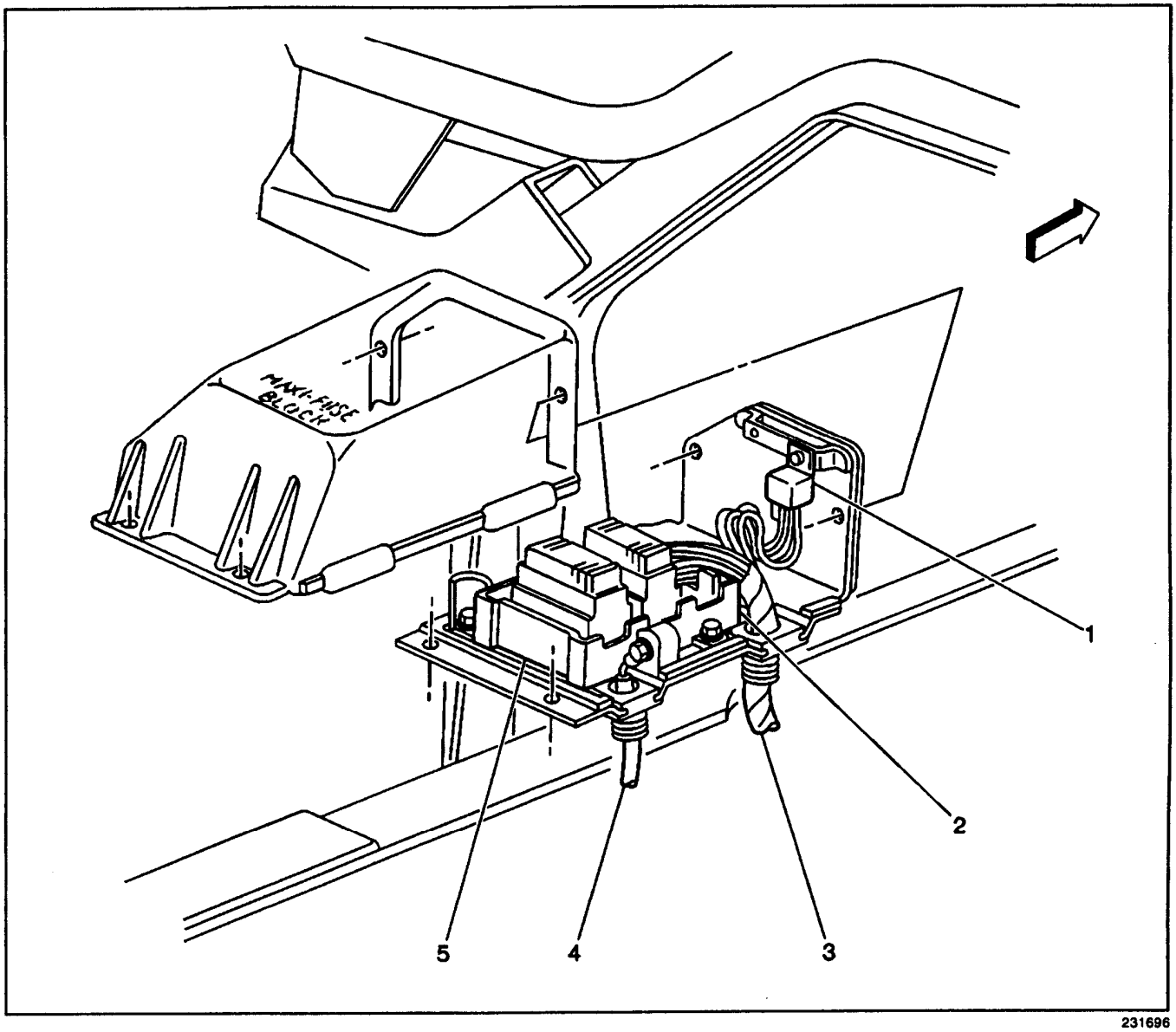


231487

Legend

(1) Brake Fluid Flow Switch
(2) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connecor C2 (2 cavities)
(3) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connector C1 (24 cavities)
(4) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connector C2 (2 cavities)

MaxiFuse® Blocks



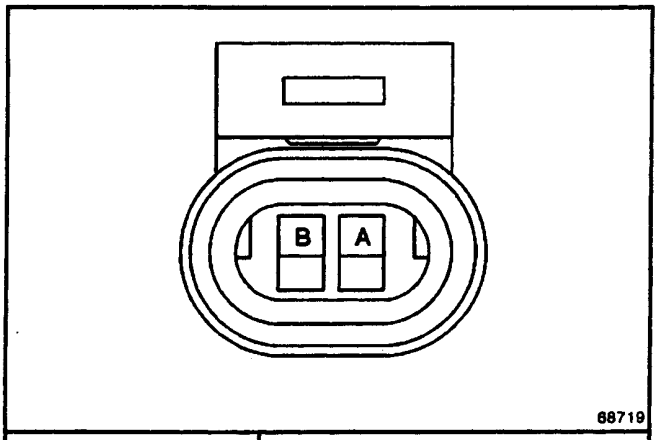
231696

Legend

(1) Power Brake Booster Pump Motor Relay
(2) MaxiFuse® Block 2
(3) Front Chassis Harness
(4) Positive Battery Cable Feed
(5) Maxifuse® Block 1

Hydraulic Brakes Connector End Views

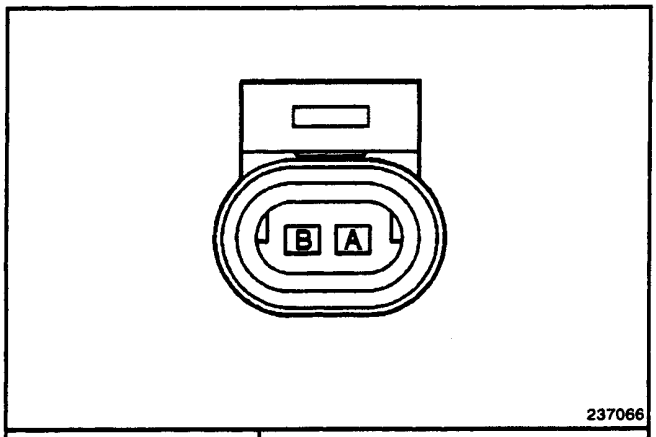
Power Brake Booster Brake Fluid Flow Switch



68719

Connector Part Information	• 12162198 • ASM 2F Metri Pack 150.2 Series Pull To Seat, Sealed (GRY)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	LT BLU	1928	Brake Booster Fluid Flow Switch Feed
B	BLK	150	Ground

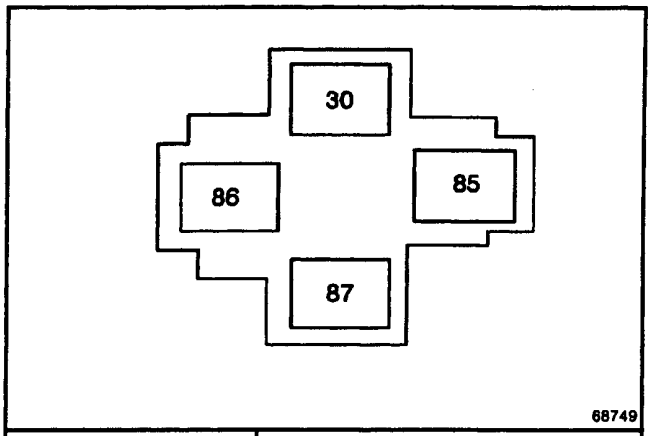
Brake Fluid Level Switch



237066

Connector Part Information	• 12162194 • ASM 2F Metri Pack 150.2 Series Pull To Seat, Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	TAN/WHT	33	Brake Warning Lindicator Lamp Output
B	BLK	150	Ground

Power Brake Booster Pump Motor Relay



68749

Connector Part Information	• 12124169 • ASM 4F Mixed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
30	RED	1042	Fuse Output Battery
85	GRY/BLK	847	Brake Pedal Switch Output ExtendedTravel
86	LT BLU	1928	Brake Booster Fluid Flow Switch Feed
87	RED	1470	Power Brake Booster Pump Motor Feed

Diagnostic Information and Procedures

Brake Warning Indicator Inoperative

Step	Action	Value(s)	Yes	No
1	1. Backprobe the multifunction alarm module with a *J 39200* Digital Multimeter (DMM) from terminal A8 to B+ 2. Measure the voltage. Is the voltage greater than the specified value?	10.0 volts	Go to *Step 2*	Go to *Step 3*
2	1. Turn the ignition switch to the RUN position. 2. Backprobe the multifunction alarm module with a *J 39200* (DMM) from terminal A5 to ground. 3. Measure the voltage. Is the voltage greater than the specified value?	10.0 volts	Go to *Step 4*	Go to *Step 5*
3	Repair the open in CKT 485 (BLK) between the multifunction alarm module and the lower ground buss 1. Is the repair complete?	—	System OK	—
4	1. Backprobe the multifunction alarm module with a *J 39200* (DMM) from terminal A4 to ground while cranking the engine. 2. Measure the voltage. Is the voltage greater than the specified value?	10.0 volts	Go to *Step 6*	Go to *Step 7*
5	Repair the open in CKT 145, 522 and 625 (PNK) between the instrument panel fuse block and the multifunction alarm module. Is the repair compete?	—	System OK	—
6	1. Turn the ignition switch to the LOCK position. 2. Disconnect the multifunction alarm module. 3. Start the engine. 4. Connect a test lamp from the multifunction alarm module connector terminal A2 to ground. Was the test lamp lit?	—	Go to *Step 8*	Go to *Step 9*
7	Repair the open in CKT 434 and 487 (ORN/BLK) between S182 and the multifunction alarm module. Is the repair complete?	—	System OK	—
8	Replace the multifunction alarm module. Refer to *Multifunction Alarm Module Replacement* in Instrument Panel, Gauges and Console. Is the repair complete?	—	System OK	—
9	Backprobe the inline fuse with a test lamp to ground. Was the test lamp lit?	—	Go to *Step 10*	Go to *Step 11*
10	Repair the open in CKT 53, 37 and 468 (YEL) between the inline fuse and the multifunction alarm module. Is the repair complete?	—	System OK	—
11	Inspect for an open in CKT 8 and 255 (RED) between the generator line and the inline fuse. Did you find an open?	—	—	Refer to Engine Electrical for Generator Diagnosis.
12	Repair the open. Is the repair complete?	—	System OK	—

AUX BRAKE Indicator and Alarm On w/Engine Running

Step	Action	Value(s)	Yes	No
1	1. Disconnect the multifunction alarm module connector. 2. Connect a test lamp from terminal A5 to terminal A1 at the multifunction alarm module. 3. Start the engine and run the engine for 30 seconds. Does the test lamp light?	—	Go to *Step 2*	Go to *Step 4*
2	1. Disconnect the brake fluid flow switch connector with the engine running. 2. Leave the test lamp connected as described in Step 1. Does the test lamp light?	—	Go to *Step 3*	Go to *Step 11*
3	Repair the short to ground in CKT 475 and CKT 1928 (LT BLU) between the following components: – The multifunction alarm module – The brake fluid flow switch – The hydraulic brake relay Is the repair complete?	—	System OK	—
4	1. Connect the test lamp between CKT 480 (PNK) and CKT 476 (ORN) at the multifunction alarm module. 2. Start the engine and run the engine. Does the test lamp light?	—	Go to *Step 9*	Go to *Step 5*
5	1. Turn the engine OFF. 2. Disconnect the power brake booster motor connector. 3. Install a fused jumper wire between CKT 150 (BLK) and CKT 1470 (RED) at the power brake booster motor connector. 4. Keep the test lamp connected at the multifunction alarm module connector. 5. Place the ignition switch in the RUN position. Does the test lamp light?	—	Go to *Step 6*	Go to *Step 7*
6	Replace the power brake booster pump motor. Refer to *Hydraulic Brake Booster Replacement.* Is the repair complete?	—	System OK	—
7	Connect a self-powered test lamp from CKT 150 (BLK) at the power brake booster pump motor to B+. Does the test lamp light?	—	Go to *Step 8*	Go to *Step 12*
8	Repair the open in CKT 476 (ORN/BLU) or CKT 474 and CKT 1470 (RED) between the power brake booster pump motor and the multifunction alarm module. Is the repair complete?	—	System OK	—
9	1. Connect a test lamp between CKT 150 (BLK) terminal A8 and CKT 847 (GRY) terminal B4 at the multifunction alarm module connector. 2. Apply the service brakes. Does the test lamp light?	—	Go to *Step 10*	Refer to *Stop Lamps Inoperative - All (Hydraulic Brakes)* in Lighting Systems
10	Replace the multifunction alarm module. Refer to *Multifunction Alarm Module Replacement* in Instrument Panels, Gauges and Console. Is the repair complete?	—	System OK	—

AUX BRAKE Indicator and Alarm On w/Engine Running (cont'd)

Step	Action	Value(s)	Yes	No
11	Replace the brake fluid flow switch. Refer to *Fluid Flow Switch Replacement.* Is the repair complete?	—	System OK	—
12	Repair the open in CKT 150 (BLK) between the power brake booster motor and ground. Is the repair correct?	—	System OK	—

AUX BRAKE Indicator Inoperative

Step	Action	Value(s)	Yes	No
1	1. Turn the ignition switch to the START position. 2. Observe the AUX BRK indicator lamp. Does the indicator lamp light for four seconds after the engine is cranked?	—	System OK	Go to *Step 2*
2	1. Remove the connector at the brake fluid flow switch. 2. Connect a self powered test lamp between the switch terminals. 3. Start the engine. 4. Observe the test lamp. Was the lamp lit?	—	Go to *Step 3*	Go to *Step 4*
3	Replace the flow switch. Refer to *Fluid Flow Switch Replacement.* Is the repair complete?	—	System OK	—
4	1. Connect a test lamp from CKT 1470 (RED) at the power brake booster pump motor relay to chassis ground. 2. Crank the engine. 3. Observe the test lamp. The test lamp will only light for four seconds. Was the lamp lit?	—	Go to *Step 5*	Go to *Step 6*
5	1. Backprobe the multifunction alarm module with a digital multimeter *J 39200* from terminal A3 to chassis ground. 2. Measure the voltage while applying the service brakes. Is the voltage more than the specification?	10.0 volts	Go to *Step 7*	Refer to *Stop Lamps Inoperative - All (Hydraulic Brakes)* in Lighting Systems
6	Replace the power brake booster pump motor relay. Refer to *Hydraulic Brake Booster Replacement.* Is the repair complete?	—	System OK	—
7	1. Remove the connector from the power brake booster pump motor. 2. Connect a self powered test lamp between the motor terminals. Was the lamp lit?	—	Go to *Step 8*	Go to *Step 11*
8	1. Remove the connectors at the multifunction alarm module and the 9 way instrument panel harness connector. 2. Connect a self powered test lamp from the instrument panel harness connector (terminal B4) to CKT 484 (YEL/BLK) at the multifunction alarm module (terminal B3). Was the lamp lit?	—	Go to *Step 9*	Go to *Step 10*

AUX BRAKE Indicator Inoperative (cont'd)

Step	Action	Value(s)	Yes	No
9	Replace the multifunction alarm module. Refer to *Multifunction Alarm Module Replacement* in Instrument Panels, Gauges and Console. Is the repair complete?	—	System OK	—
10	Repair the open in CKT 10 and CKT 484 (YEL/BLK) between the instrument panel harness connector and the multifunction alarm module. Is the repair complete?	—	System OK	—
11	Replace the power brake booster pump motor. Refer to *Hydraulic Brake Booster Replacement.* Is the repair complete?	—	System OK	—

External Conditions that Affect Brake Performance

- Tires — Tires with unequal contact and grip on the road cause unequal braking. The inflation and the tread pattern of the right and the left tires should be equal.
- Vehicle Loading — The most heavily loaded wheels on the vehicle require more braking force when the loading is unequal.
- Front Wheel Bearings — Loose front wheel bearings permit the rotor to tilt. Loose front wheel bearings also cause the rotor to have spotty contact with the linings. A tilted rotor that has spotty contact with the lining causes erratic braking.
- Front End Alignment — Misalignment of the following components will cause the brakes to pull to one side of the vehicle:
  - The front end
  - The camber
  - The caster

Brake System Diagnosis

Important: A vehicle that pulls to one side during braking may need a front end alignment. Do not assume that the reason the vehicle pulls to one side is a brake related condition. Ensure that the alignment is correct.

Test the brakes on a dry, clean, reasonably smooth and level roadway. The accuracy of the brake performance cannot be determined if the following road conditions exist:

- Wet roadway
- Greasy roadway
- Roadway covered with loose dirt

The road conditions prevent the tires from gripping the road equally. Crowned roadways affect brake testing by throwing the weight of the vehicle toward the wheels on one side of the vehicle. Rough roadways cause the wheels to bounce. Bouncing wheels affect the test accuracy.

Test the brakes at different vehicle speeds with light and heavy pressure. Do not lock the wheels and slide the tires on the roadway. Locked wheels and sliding tires do not indicate brake efficiency. Heavily braked, turning wheels will stop the vehicle in less distance than locked wheels. More tire-to-road friction is present with heavily braked, turning tires than with sliding tires.

Brake Pedal Excessive Effort with Engine Off (Brake Light On)

Problem	Action
DEFINITION: Excessive pedal pressure is required to stop with the engine OFF and BRAKE lamp ON.	
Low or no voltage exists at the Electrohydraulic (EH) pump motor connection of the wiring harness.	1. Inspect for an open circuit between the battery and the EH pump. 2. Repair the circuit as necessary.
A loose, dirty, or disconnected connection exists between the EH pump motor lead wire and the wiring harness.	Clean and secure the connection.
A poor ground exists between the EH pump and the booster.	Repair the circuit as necessary.
The EH pump is not functioning.	Replace the pump. Refer to *Electrohydraulic Pump Replacement.* Electrohydraulic Pump Replacement.

Brake Pedal Excessive Effort with Engine Off (Brake Light Off)

Problem	Action
DEFINITION: Excessive pedal pressure is required to stop with the engine OFF and BRAKE lamp OFF.	
The flow switch is malfunctioning.	Replace the flow switch. Refer to *Fluid Flow Switch Replacement* Fluid Flow Switch Replacement.
Little or no voltage exists to the following locations: • The ignition side of the coil relay • The battery connection to the relay • The electrohydraulic terminal on the relay	Clean the connections or replace the relay.
An open condition exists in the ignition diode.	Replace the diode.

Brake Pedal Excessive Effort to Stop

Problem	Action
DEFINITION: Excessive pedal pressure required to stop (Hard Pedal)	
The power steering pump is loose or broken.	1. Tighten the belt and the mounting hardware. 2. Replace the power steering pump. Refer to Power Steering Pump Replacement in Steering.
The brake power steering pump output pressure is low.	Install the gauge in the inlet line to the booster. The gauge should read at least 4137 kPa (600 psi) before the pedal becomes hard to push.
The drive belt on the power steering pump is loose.	Tighten the belt. Refer to Power Steering System in Power Steering.
The fluid level in the power steering pump is low.	Fill the power steering pump to the proper level with power steering fluid. Refer to Bleeding Power Steering System in Steering.
Air is present in the fluid.	Locate the air leak and correct the leak. Bleed the system. Refer to Bleeding Power Steering System in Steering.
An internal booster or power steering pump problem exists.	1. Test the internal booster and the power steering pump. 2. Repair or replace the faulty unit.

Brake Fluid Leaks

Apply and hold constant foot pressure on the brake pedal with the engine at idle position. Ensure that the transmission is in the NEUTRAL position. The brake hydraulic system may have the following conditions if the brake pedal gradually loses foot pressure:

- External leakage
- Internal leakage
- Incorrect component adjustment

Perform a visual inspection of the hydraulic system.

Inspect the master cylinder fluid level. A slightly low brake fluid level in either reservoir can result from normal lining wear. An abnormally low fluid level indicates a leak in the system. A full master cylinder does not always indicate that there is no leakage. Slight leakage can occur and not appear as a fluid level condition.

Internal leakage may be the cause if no external leaks are found. Internal leakage is related to an internal master cylinder condition. Disassemble the master cylinder in order to accurately diagnose internal leakage. Refer to the instructions included with the service repair kit. Contact the Bendix® Helpline at 1-800-AIR-BRAK (1-800-247-2725) for additional overhaul information.

Brake Hose and Pipe Inspection

Inspect the brake hoses and the pipes at least twice a year for the following conditions:

- Road damage
- Cracks
- Chafing of the outer cover

Inspect the brake hoses and the pipe connections for fluid leaks and damage. Replace the brake hoses and the pipe connections if fluid leaks or damages are detected. Ensure that all of the mounting hardware is in place and secure. Repair the hoses or the pipe connections as needed.

EH Pump and Booster Mating Surface Oil Leak

Problem	Action
DEFINITION: Oil leaks at the booster and the electrohydraulic pump mating surface.	
The pressure port and/or return port has missing or damaged O-rings.	Replace both O-rings.

EH Pump End Plate Oil Leak

Problem	Action
DEFINITION: Oil leaks from the electrohydraulic pump end plate.	
The plate seal has a missing end or is damaged.	Replace the electrohydraulic pump assembly. Refer to *Electrohydraulic Pump Replacement.* Electrohydraulic Pump Replacement.

EH Pump Motor Oil Leak

Problem	Action
DEFINITION: Oil leaks from the electrohydraulic pump motor.	
The shaft seal is damaged.	Replace the electrohydraulic pump assembly. Refer to *Electrohydraulic Pump Replacement* Electrohydraulic Pump Replacement.

EH Pump Noise

Problem	Action
DEFINITION: Excessive electrohydraulic pump noise (gurgle, chatter, etc) is present.	
Air is trapped in the electrohydraulic pump.	1. Depress the brake pedal lightly for 30 seconds with the engine OFF. 2. Repeat the brake pedal depression after 3 minutes if the problem continues. The noise diminishes with the brake use under normal driving conditions.

Master Cylinder Diagnosis

1. Inspect the master cylinder for the following conditions:
   - Cracked casting
   - Brake fluid leaks around the master cylinder

   Brake fluid leaks are indicated if there is one drop of fluid. A damp condition is not abnormal.
2. Inspect the master cylinder for the following conditions:
   - Binding pedal linkage
   - Incorrect pushrod length
3. Disassemble the master cylinder if the following conditions exist:
   - No brake pedal binding
   - Improper brake pedal travel

   Refer to the instructions enclosed with the service repair kit.
4. Inspect the master cylinder for swollen or elongated primary piston seal(s).

Hydraulic System Fluid Loss

Notice: Do not run the engine without fluid in the power steering pump reservoir. Doing so could damage the pump bearing and seals. The belt that drives the power steering pump also drives the coolant pump and other components. Do not disconnect the belt and run the engine. A malfunctioning power steering pump and/or system still serves as an idler pulley for the belt. If the pump is allowed to run without fluid in it, the bearings will seize up and cause the coolant pump to stop. This can cause damage to the engine.

Before starting the vehicle if the hydraulic brake booster system fails due to the loss of fluid, ensure that the necessary repairs are performed. Fill and bleed the hydraulic brake booster system.

Clean and flush the hydraulic booster system when the power steering pump is replaced. Metal shavings from a worn hydraulic pump will contaminate the system. Disassemble and clean the booster head. Replace the seals and the O-ring seals. Remove the pipes and the hoses. Blow clean the pipes and hoses of all metal shavings. Refer to *Hydraulic Brake Booster Description.*

Hydraulic Booster Noise Diagnosis

Noise caused by the relief valve is normal when the brakes are applied. Firmly pressing the brake pedal when the vehicle is parked also causes noise. Air temporarily gets into the fluid when the brakes are applied.

Hydraulic pump noise can be confused with transmission, rear axle or generator noise.

Air in the fluid causes noise. Fill and bleed the system when a hose has been disconnected.

Use the following steps in order to locate and correct the noise problems:

- Inspect the fluid level.
- Adjust the fluid level as needed.
- Inspect the hoses at the places where the hoses contact other vehicle parts.
- Reposition the hoses as needed.
- Inspect the fluid for air. The following conditions may exist if air is present:
  - Bubbles
  - Milky appearance
  - Extremely noisy operation
- Bleed the brake booster system if air is present.
- Inspect the hydraulic brake booster pump pressure.

Repair Instructions

Master Cylinder Reservoir Filling

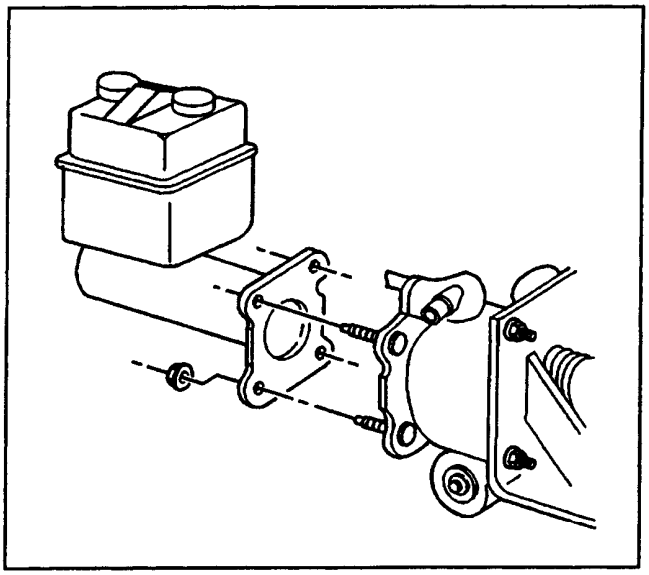
Keep the master cylinder reservoir filled in order to keep air out of the hydraulic system. Do not overfill the reservoir. The fluid expands due to heat from the brakes and the engine.

Clean the reservoir caps before opening the caps in order to keep out dirt. Add brake fluid to the reservoir until the brake fluid is even with the bottom of the filler neck or within 6 to 13 mm (1/4 to 1/2 in) of the top of the master cylinder reservoir.

Master Cylinder Replacement

Removal Procedure

1. Set the parking brake.
2. Block the drive wheels.
3. Place a suitable container under the master cylinder in order to catch the fluid.
4. Cap or plug the hydraulic pipes.
5. Remove the hydraulic pipes from the master cylinder.
6. Remove the low fluid level sensor connector.
7. Remove the mounting nuts.
8. Remove the master cylinder.



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Installation Procedure

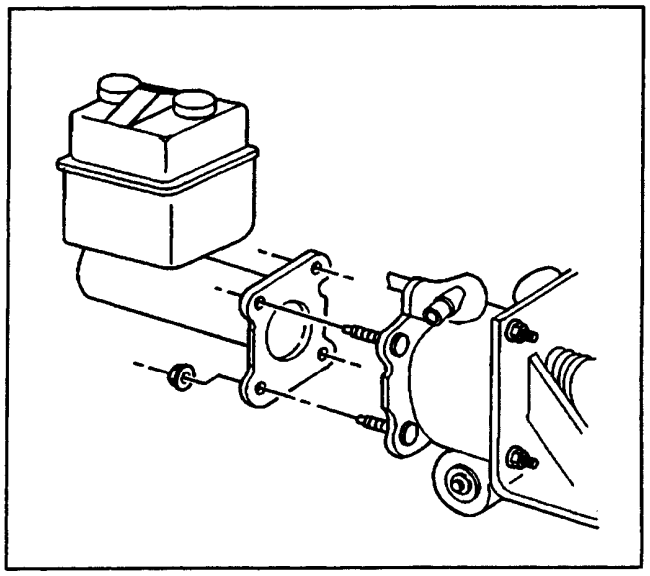
1. Install the master cylinder.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the mounting nuts.

   Tighten

   Tighten the mounting nuts to 36 N·m (27 lb ft).
3. Install the low fluid level sensor connector.
4. Install the hydraulic pipes to the master cylinder.
5. Bleed the brake system.

   Caution: After releasing the parking brake, be sure the vehicle will not roll forward or backwards when removing the wheel blocks. If the vehicle is not in gear, the vehicle may move possibly causing personal injury.
6. Remove the wheel blocks.
7. Release the parking brake.



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Master Cylinder Bench Bleeding

Bench bleeding removes the air from the master cylinder prior to the installation of the master cylinder. Bench bleeding reduces the amount of bleeding needed after the installation of the master cylinder onto the vehicle.

1. Plug the outlet ports.
2. Mount the master cylinder in a vise with the front end tilted slightly down.
3. Fill the reservoir with clean brake fluid.
4. Stroke the primary piston about 25 mm (1 in) several times using a smooth, rounded end tool. Resistance to the primary piston travel will not allow the full 25 mm (1 in) stroke when air is bled from the master cylinder.
5. Reposition the master cylinder in the vise with the front end tilted slightly up.
6. Repeat the stroke to the primary piston of about 25 mm (1 in) several times.
7. Reposition the master cylinder in the vise to the level position.
8. Loosen the plugs one at a time.
9. Push the piston into the bore in order to force the air from the cylinder.
10. Tighten the plug(s) before the piston returns to the original position in order to prevent air from being sucked into the cylinder.
11. Fill the reservoir.
12. Perform the normal bleeding procedure after the master cylinder is installed.

Master Cylinder Fluid Level Sensor Replacement

Removal Procedure

1. Remove the brake fluid from the master cylinder reservoir.
2. Remove the connector.
3. Remove the four bolts that hold the reservoir to the master cylinder.
4. Remove the reservoir.
5. Remove the fluid level switch from the reservoir. Use a pick or a thin tool in order to reach into the slot on the bottom of the reservoir. Compress the tabs while pulling out on the sensor.

Installation Procedure

1. Install the fluid level switch into the reservoir until the tabs click.
2. Install the reservoir.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Install the bolts.

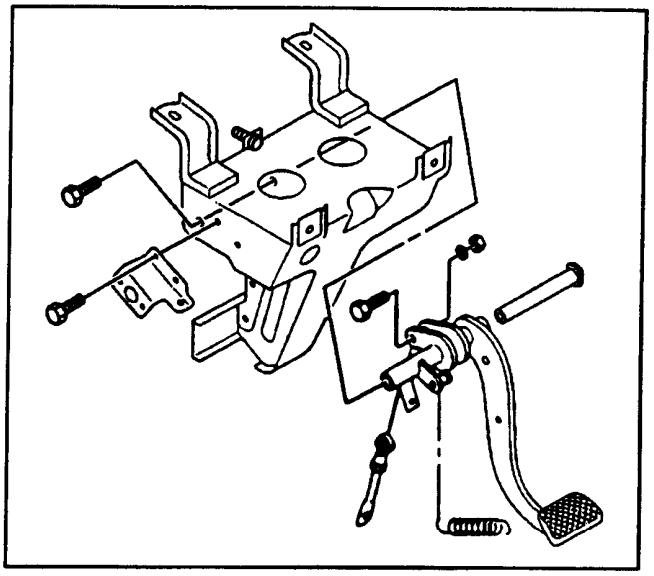
   Tighten

   Tighten the bolts to 22 N·m (16 lb ft).
4. Install the connector.
5. Fill the master cylinder with brake fluid.
6. Bleed the brake system.

Brake Pedal Replacement

Removal Procedure

1. Set the parking brake.
2. Remove the steering shaft assembly.
3. Remove the instrument panel trim as necessary.
4. Remove the pushrod.
5. Remove the bracket.
6. Remove the return spring.
7. Remove the pedal shaft.
8. Remove the brake pedal.
9. Inspect the bushings for wear or deterioration. Replace the bushings if necessary.



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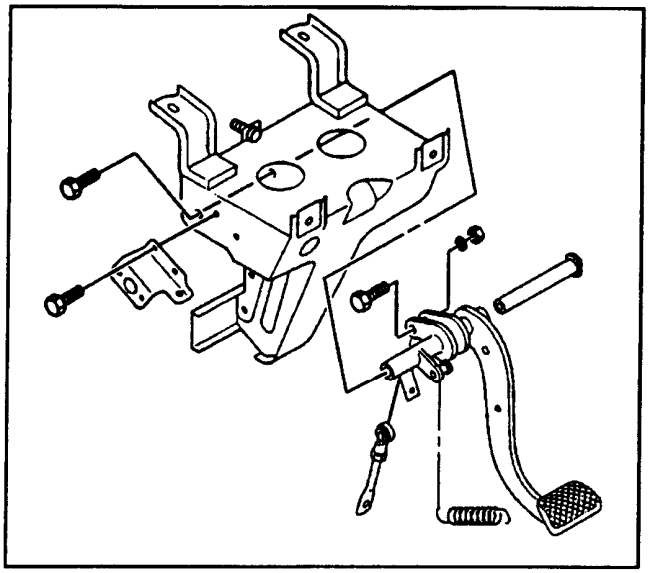
Installation Procedure

1. Install the brake pedal.
2. Install the pedal shaft.
3. Install the return spring.
4. Install the bracket.
5. Install the pushrod.
6. Install the instrument panel trim.
7. Install the steering shaft assembly.



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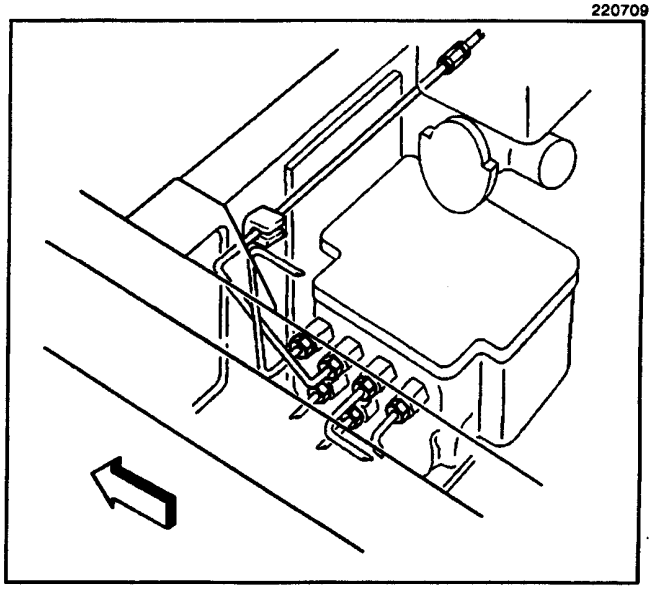
Pipe Replacement

Pipe Replacement

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

Brake pipes that run parallel to each other must maintain a 6 mm (1/4 in) clearance.



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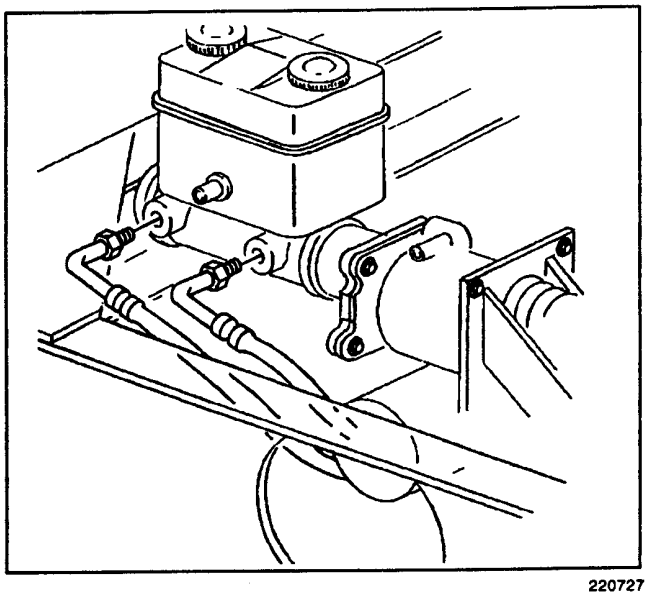

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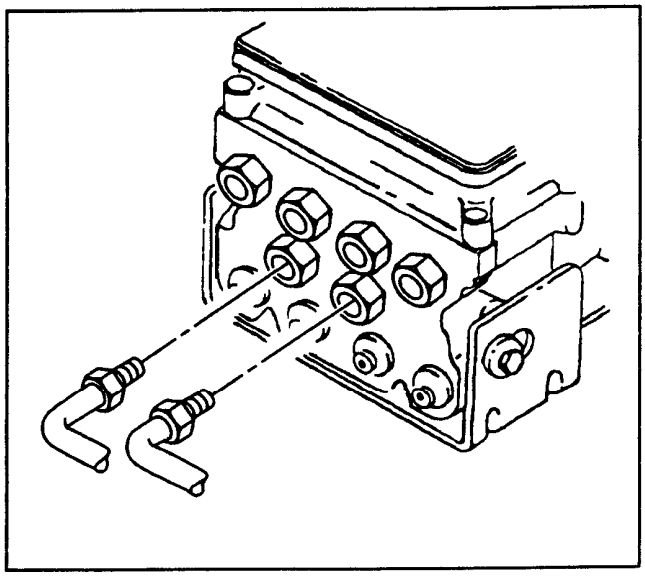

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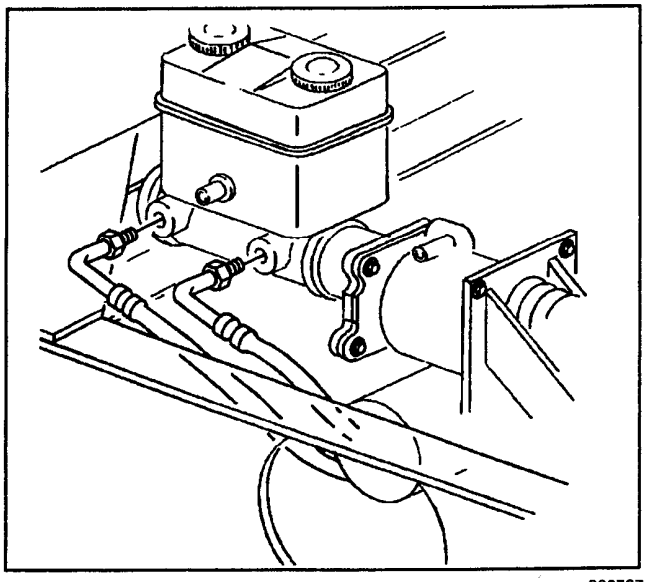

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Master Cylinder Hose Replacement (Front)

Removal Procedure

Important: Clean the dirt, the grease and the foreign particles from the hose fitting at both ends before removing the master cylinder hose.

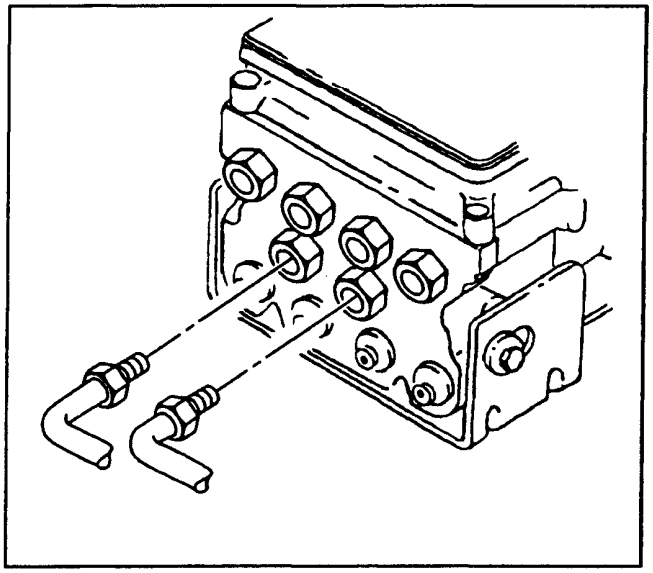
1. Remove the hose from the master cylinder.
2. Plug the front brake hose fitting.
3. Remove the hose from the electric hydraulic control unit.

Installation Procedure

1. Install the hose to the master cylinder.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the hose to the electric hydraulic control unit.
   Tighten
   Tighten the hose fittings to 19 N·m (14 lb ft).
3. Bleed the front brakes.



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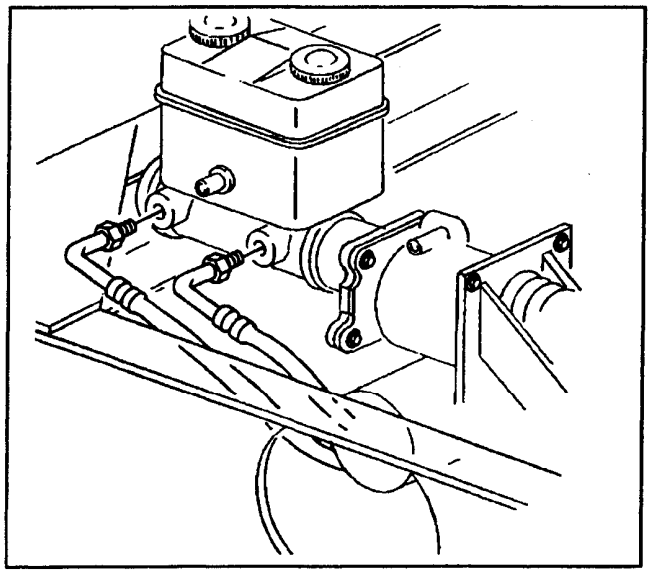
Master Cylinder Hose Replacement (Rear)

Removal Procedure

Important: Clean the dirt, the grease and the foreign particles from the hose fitting at both ends before removing the master cylinder hose.

1. Remove the hose from the master cylinder.



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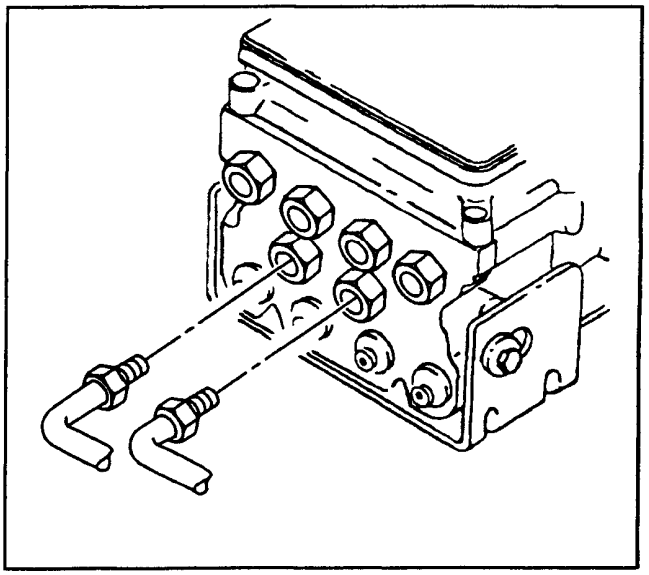
2. Remove the hose from the electric hydraulic control unit.



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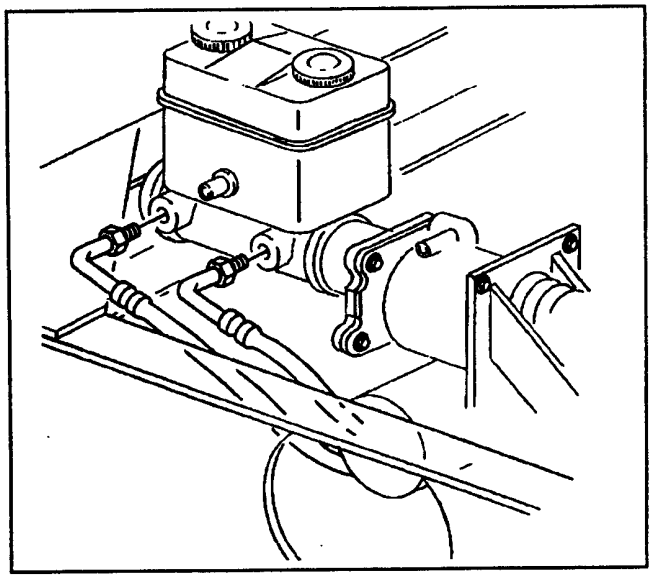

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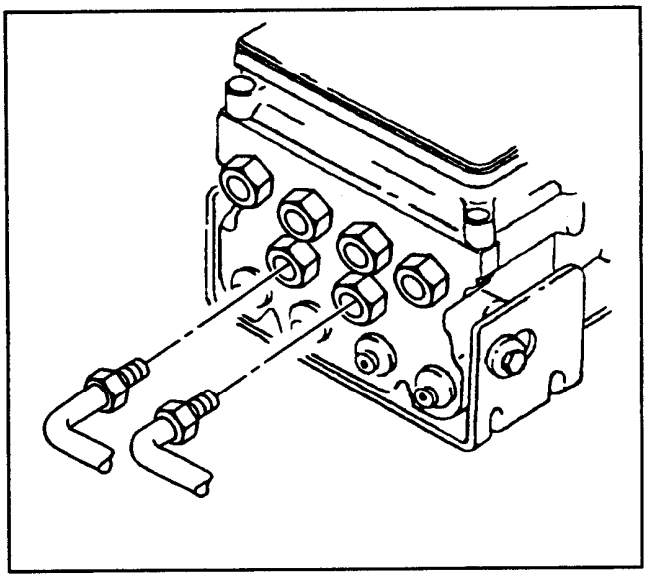

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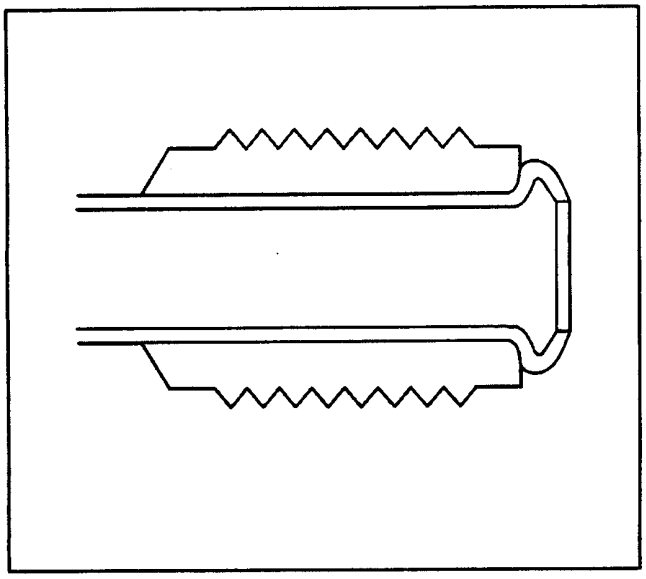


32140

Installation Procedure

1. Install the hose to the master cylinder.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

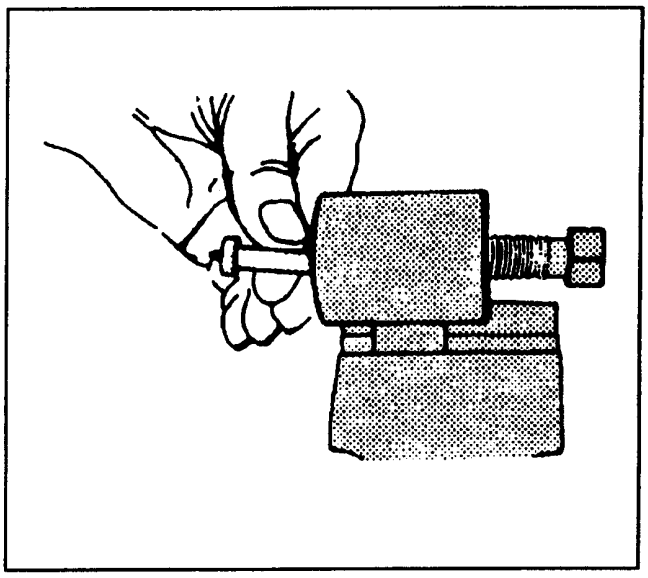
2. Install the hose to the electric hydraulic control unit.
   Tighten
   Tighten the hose fittings to 19 N.m (14 lb ft).
3. Bleed the rear brakes.

ISO Flares Replacement

Tools Required
J 29803-A Flaring Kit

1. Use the correct size steel pipe and fittings.
   The outside diameter of the pipe specifies the size.
2. Cut the steel pipe to length. Add 3 mm (1/8) to the length for each flare.
3. Install the fittings on the pipe before starting the flare.
4. Chamfer the inside and the outside diameter of the steel pipe with a deburring tool.
5. Remove all traces of the lubricant from the brake pipe and the flaring tool.
6. Clamp the flaring tool body in a vise.

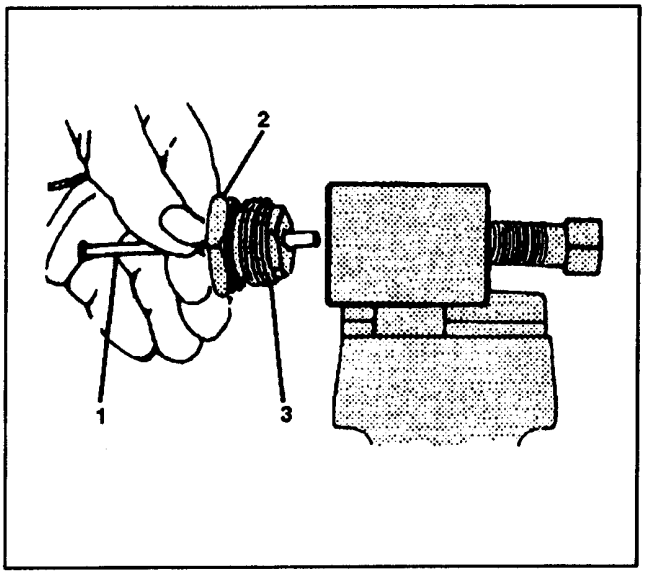
7. Select the correct size collet and the forming mandrel for the pipe size that is being used.
8. Insert the proper forming mandrel into the tool body.
9. Hold the mandrel in place with your finger. Thread the forcing screw in until the forcing screw makes contact and begins to move the forming mandrel.



32135

10. Slide the clamping nut over the brake pipe and into the correct collet. Leave about 19 mm (3/4 in) of the pipe extending out of the collet.
11. The brake pipe end must contact the face of the forming mandrel in order to insert the assembly into the tool body.
12. Tightly fasten the clamping nut into the tool body in order to prevent the pipe from pushing out.
13. Tighten the forcing screw with a wrench until the forcing screw bottoms. Do not over tighten the forcing screw. Over tightening the screw causes the flare to become oversized.
14. Take the clamping nut out of the tool body.
15. The flare is ready for use when the clamping nut and the collet assembly are disassembled.
16. Use a pipe bender in order to bend the pipe.

    Bending the pipe ensures a match to the old pipe.



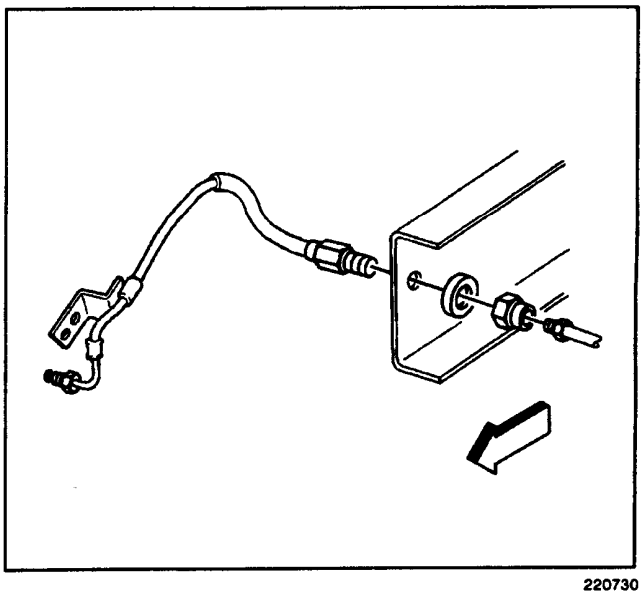
32136

Brake Hose Replacement - Front

Removal Procedure

Important: Clean the dirt, the grease and the foreign particles from the hose fittings at both ends before removing the master cylinder hose.

1. Remove the mounting bolts and the washers.
2. Remove the hose fittings from the caliper.
3. Remove the steel pipe(s) from the hose junction block.
4. Bend the steel pipe(s) in a backward position in order to clear the junction block.
5. Cap the steel pipes.
6. Remove the nut and the washer.
7. Remove the hose.



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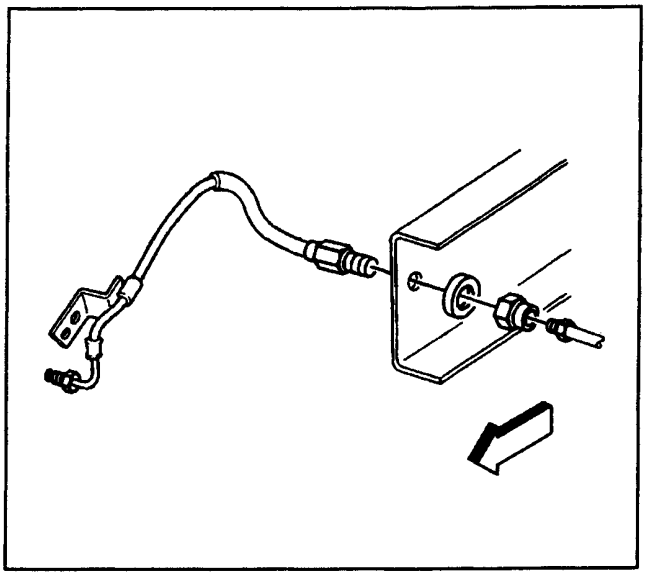


220730

Installation Procedure

1. Install the hose into the frame hole.
2. Install the washer.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Install the front brake hose nut.

   Tighten

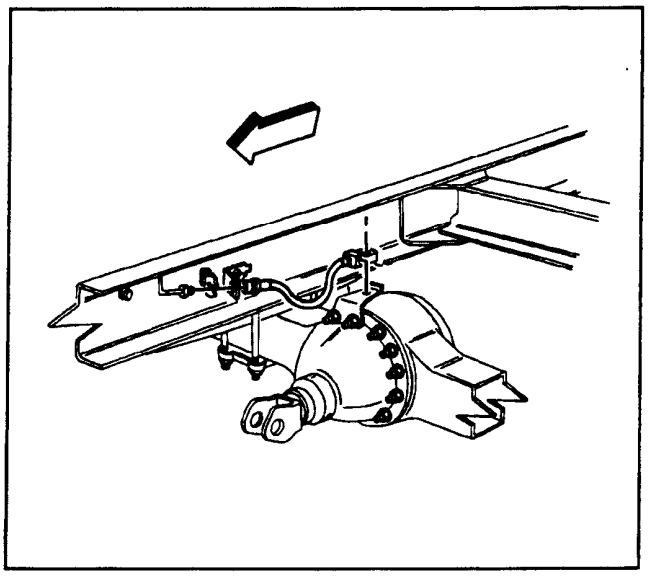
   Tighten the front brake hose nut to the 37 N.m (27 lb ft).
4. Install the steel pipe(s) to the junction block.

   Tighten

   Tighten the fitting(s) to 19 N.m (14 lb ft).
5. Ensure that the hose is not twisted in order to properly install the hose fitting to the caliper.
6. Install the bolts.

   Tighten

   - Tighten the fitting to 19 N.m (14 lb ft).
   - Tighten the bolts to 32 N.m (24 lb ft).
7. Install the washer.
8. Bleed the brakes.



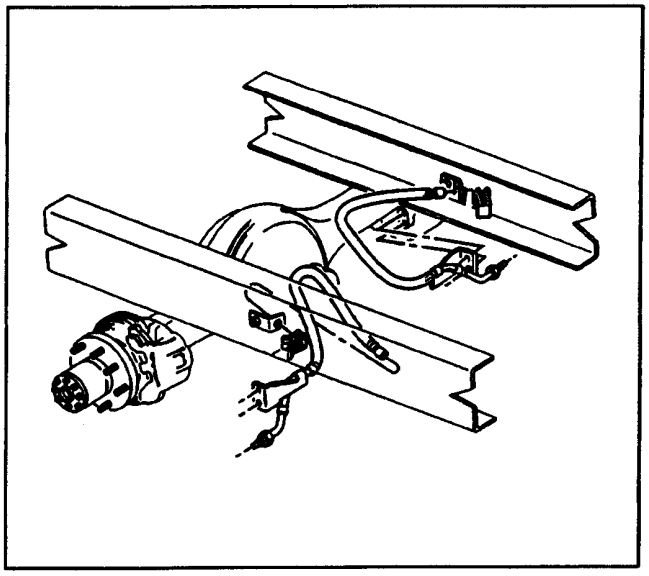
208913

Brake Hose Replacement - Rear

Removal Procedure

1. Remove the retainer.

2. Remove the brake hose from the chassis brake pipe.
3. Remove the brake pipes.
4. Plug the brake pipes.
5. Remove the mounting bolts.

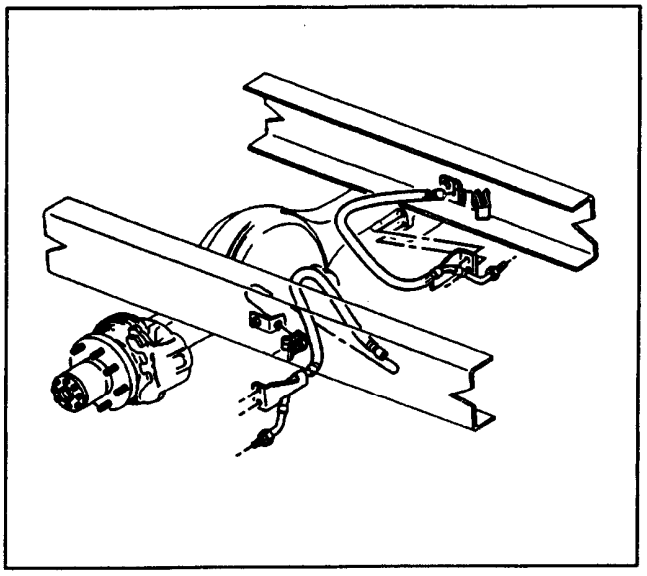


208909

Installation Procedure

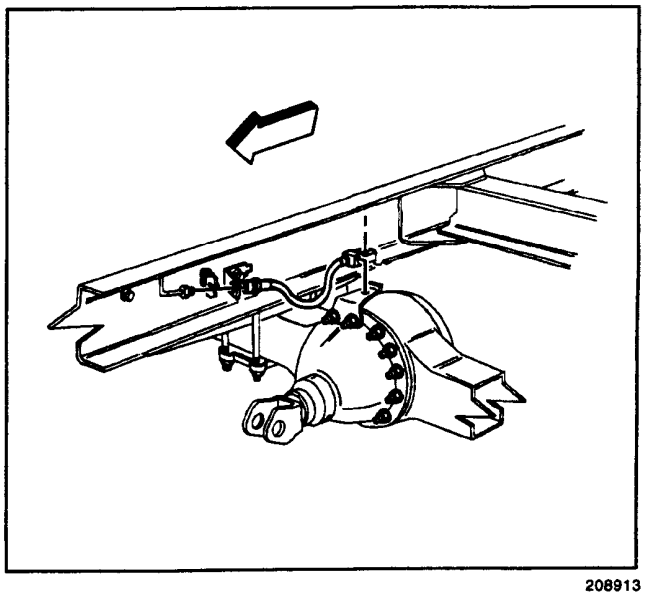
Notice: *Fastener Notice* in Cautions and Notices.

1. Install the mounting bolts.
   Tighten
   Tighten the mounting bolts to 32 N.m (24 lb ft).
2. Install the brake pipes.
   Tighten
   Tighten the brake pipe fittings to 19 N.m (14 lb ft).
3. Install the brake hose through the frame bracket.
4. connect the fitting to the brake hose.
   Tighten
   Tighten the fitting to 19 N.m (14 lb ft).



208909

5. Install the retainer.
6. Bleed the brakes.



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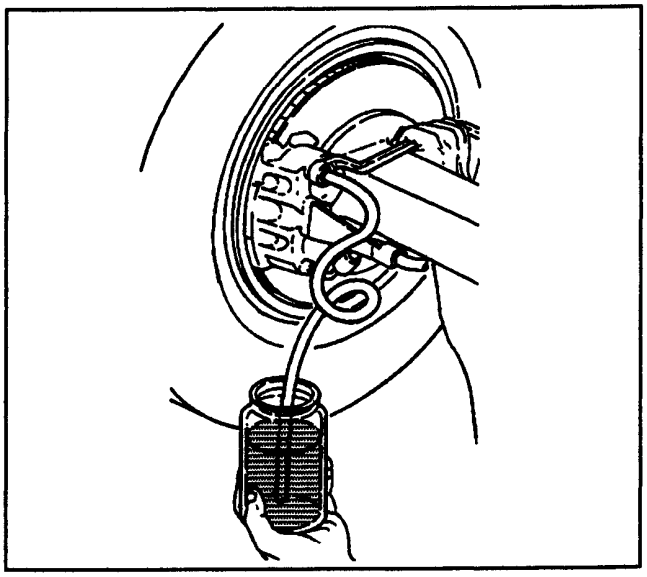


220731

Hydraulic Brake System Bleeding (Manual)

Bleeding the brake is necessary if air has entered the hydraulic brake system.

Bleed the system at all four wheels if a low fluid level has allowed air to enter the system or the brake pipes have been disconnected at the master cylinder. If a pipe is disconnected at one wheel, bleed only that wheel.

Bleed the master cylinder before you install the master cylinder into the vehicle. Bleeding the cylinder reduces the time required to bleed the hydraulic system when you remove the master cylinder.

Use the Hydraulic Brake System Bleeding procedure if the Electric Hydraulic Control Unit (EHCU) has not been replaced. If the EHCU has been replaced, refer to the ABS Bleeding Procedure in Antilock Brakes for the proper bleeding procedures.

Notice: Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

1. Fill the master cylinder reservoirs with DOT 3 motor vehicle brake fluid. Maintain the fluid level during the bleeding procedure.
2. Perform the following procedure if you suspect the master cylinder has air in the bore:
   - 2.1. Bleed the master cylinder before bleeding any wheel cylinder brake caliper.
   - 2.2. Disconnect the forward brake pipe connection at the master cylinder.
   - 2.3. Allow the brake fluid to flow from the connector port.
   - 2.4. Connect the brake pipe.

     Do not tighten the brake pipe.
   - 2.5. Apply the brake pedal slowly.

     Allow the air to bleed from the loose fitting.
   - 2.6. Tighten the fitting before releasing the pedal.
   - 2.7. Wait 15 seconds.
   - 2.8. Repeat this sequence, including the 15 second wait, until the air is plunged from the bore.
   - 2.9. Repeat the procedure for the rear pipe after all of the air is removed from the forward connection.
3. Bleed the brake system in the following sequence:
   - 3.1. The right rear
   - 3.2. The left rear
   - 3.3. The right front
   - 3.4. The left front

4. Attach a hose to the caliper bleeder valve. Immerse the opposite end of the hose into a container that is partially filled with clean brake fluid.
5. Slowly apply the brake pedal one time and hold the brake pedal.
6. Loosen the bleeder valve in order to purge the air from the caliper.
7. Tighten the bleeder valve and slowly release the pedal.
8. Wait 15 seconds.
9. Repeat the sequence, including the 15 second wait, until all of the air is purged from the caliper.
10. Continue steps 4 through 9 at each wheel until the brake system has been bled.
11. Inspect the brake pedal for sponginess. Repeat the bleeding procedure if the brake is spongy.

Hydraulic Brake System Bleeding (Pressure)

Bleeding is necessary if air has entered the hydraulic system.

Bleed the system at all four wheels if a low fluid level has allowed air to enter the system or the brake pipes has been disconnected at the master cylinder. If a pipe is disconnected at one wheel, then only bleed that wheel.

Bleed the master cylinder before you install the master cylinder into the vehicle.Bleeding the cylinder reduces the time required to bleed the hydraulic system when you remove the master cylinder.

Use the Hydraulic Brake System Bleeding procedure if the Electric Hydraulic Control Unit (EHCU) has not been replaced. If the EHCU has been replaced, refer to the ABS Bleed Procedure in Antilock Brakes for the proper bleeding procedures.

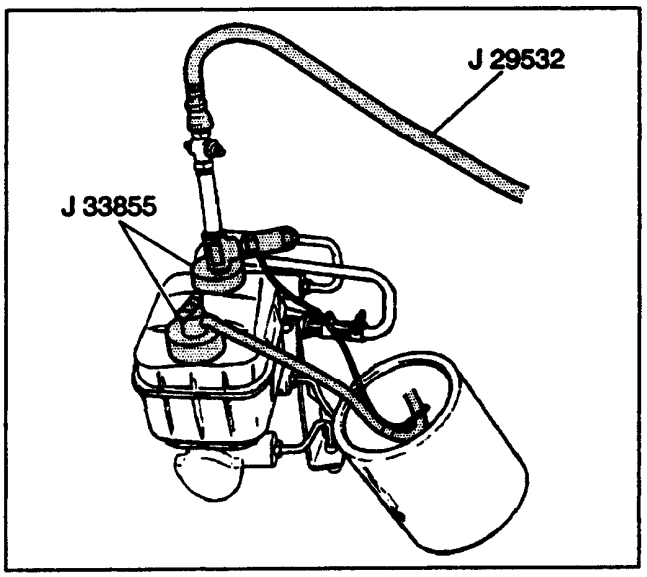
Tools Required

- *J 29532* Power Brake Bleeder
- *J 33855* Pressure Bleeder Adapter

Notice: Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

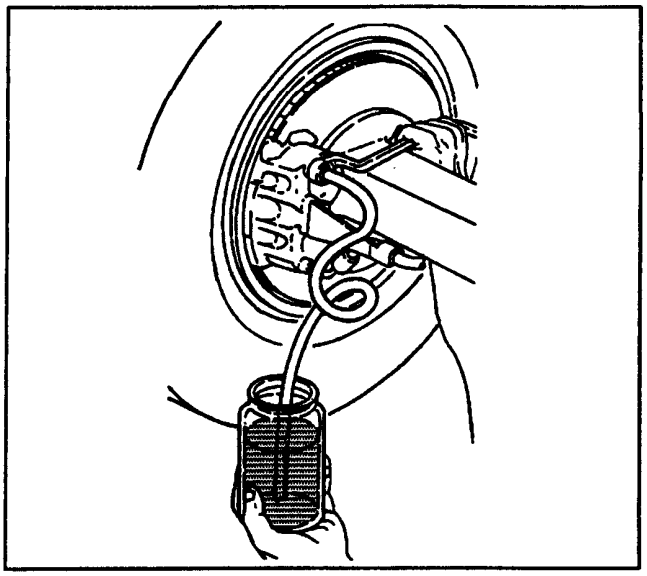
Use a diaphragm type pressure bleeder. The bleeder must have a rubber diaphragm between the air supply and the brake fluid in order to prevent the following from contaminating the hydraulic system:

- Air
- Moisture
- Oil
- Other contaminants



208940

1. Fill the pressure tank at least 2/3 full with the brake fluid. Bleed the bleeder each time the fluid is added.
2. Charge the bleeder to 140 to 170 kPa (20 to 25 psi).
3. Install the *J 33855* Pressure Bleeder Adapter on the master cylinder.
4. Connect the hose from the bleeder to the adapter.
5. Open the tank valve.
6. Bleed the brake system in the following sequence:
   - The right rear
   - The left rear
   - The right front
   - The left front
7. Attach the hose to the bleeder valve. Immerse the opposite end of the hose into a container that is partially filled with clean brake fluid.
8. Open the bleeder valve at lease 3/4 of a turn. Allow the fluid to flow until no air is found in the fluid.
9. Close the bleeder valve.
10. Repeat steps 7 through 9 at each wheel.
11. Inspect the brake pedal for sponginess. Repeat the entire bleeding procedure if the brake pedal is spongy.
12. Disconnect the line from the bleeder adapter.
13. Remove the bleeder adapter.
14. Fill the master cylinder to the proper fluid level. Refer to *Master Cylinder Reservoir Filling.*

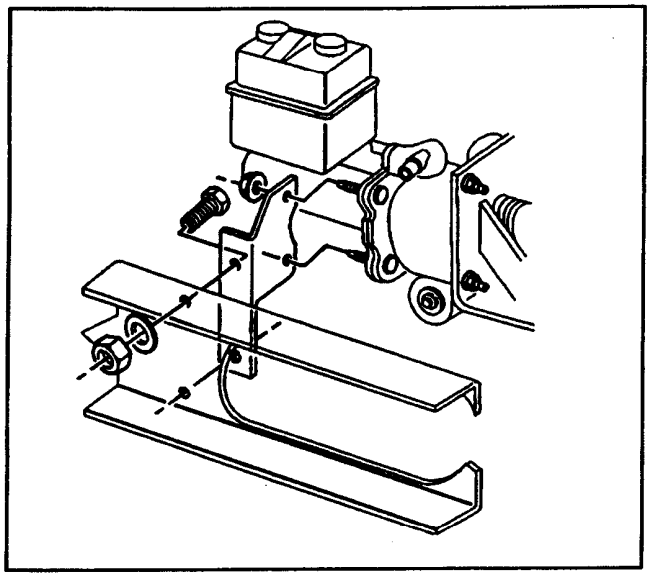


220731

Hydraulic Brake System Flushing

Notice: Do not use alcohol for flushing the system or cleaning assemblies where alcohol could be trapped and contaminate the brake fluid. The contaminated fluid can then cause the failure of the rubber components in the system.

(1) Flush at each bleeder valve. Flushing is similar to the bleeding procedure. The difference is that the bleeder valve is opened 1 1/2 turns. Fluid is forced through the lines and the bleeder valves until the fluid comes out clear in color. (2) Inspect the master cylinder fluid level after flushing each valve. (3) Refill the master cylinder fluid as required. Ensure that the master cylinder reservoir is filled to the proper level after flushing.



220749

Hydraulic Brake Booster Replacement

Removal Procedure

Flushing the system is required when dirt, sludge or water is found in the system. Flushing the system involves running clean fluid through the system until the draining fluid appears. Contaminated fluid in the booster system can cause the rubber parts to deteriorate.

Clean and flush the hydraulic booster system when the hydraulic pump is replaced. Metal shavings from a worn hydraulic pump contaminate the system.

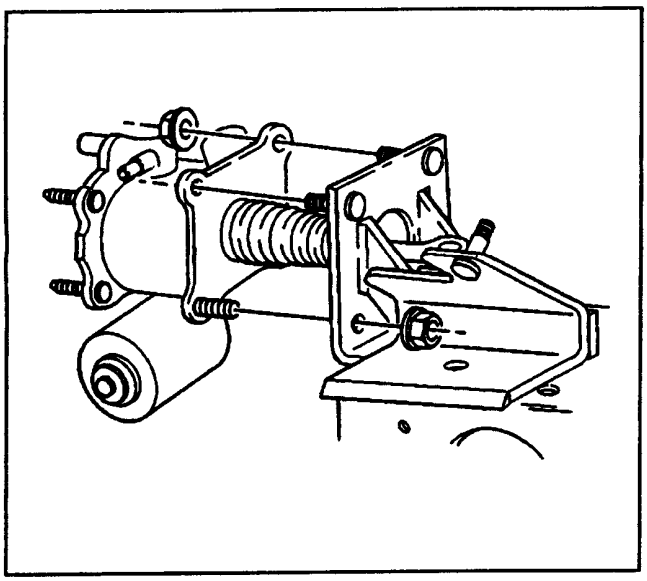
Disassemble the booster head. Clean the booster head. Replace all the seals and the o-ring seals.

Remove and blow clean the pipes and hoses of all metal shavings.

1. Block the vehicle wheels.

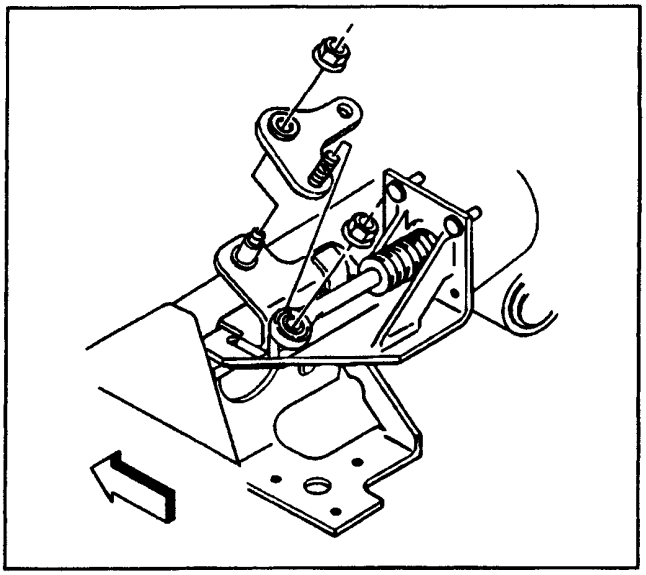
   Caution: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, also disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.

2. Disconnect the negative battery cable.
3. Tilt the cab. Refer to *Cab Tilting* in General Information.
4. Disconnect the electrical connectors from the electrohydraulic pump and the flow switch.
5. Remove the master cylinder bracket.
6. Remove the master cylinder. Position the master cylinder away from the booster head. Secure the master cylinder in an upright position.
7. Disconnect the hoses from the booster.



220742

8. Remove the booster pump rod nut from the lever.
9. Remove the nuts at the booster.
10. Remove the booster assembly.



220748

Installation Procedure

1. Install the booster assembly to the vehicle.

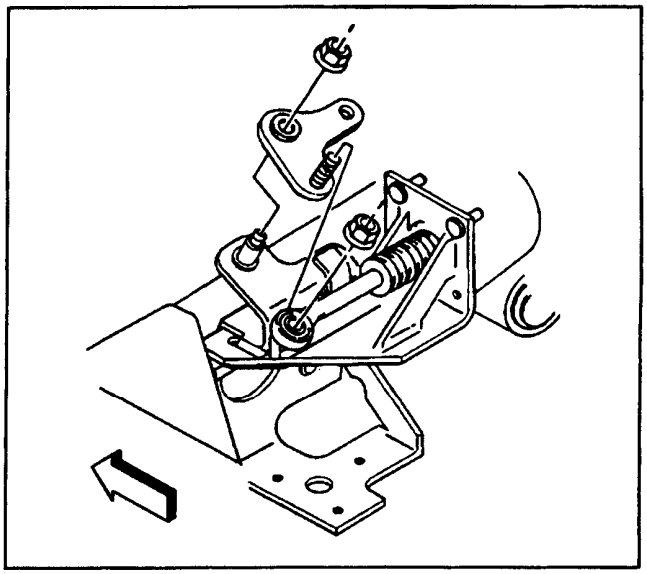
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the nuts at the booster.

   Tighten

   Tighten the nuts to 36 N·m (27 lb ft).
3. Install the booster pump rod to the lever.

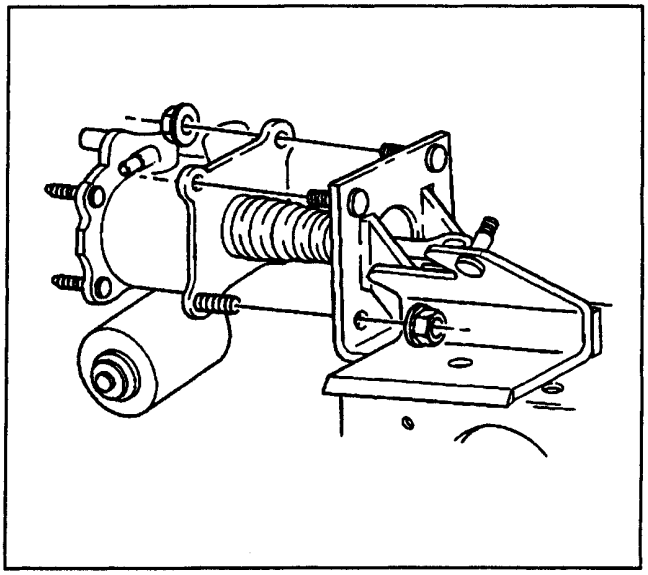
   Tighten

   Tighten the nuts to 68 N·m (50 lb ft).



220748

4. Install the hoses to the booster.



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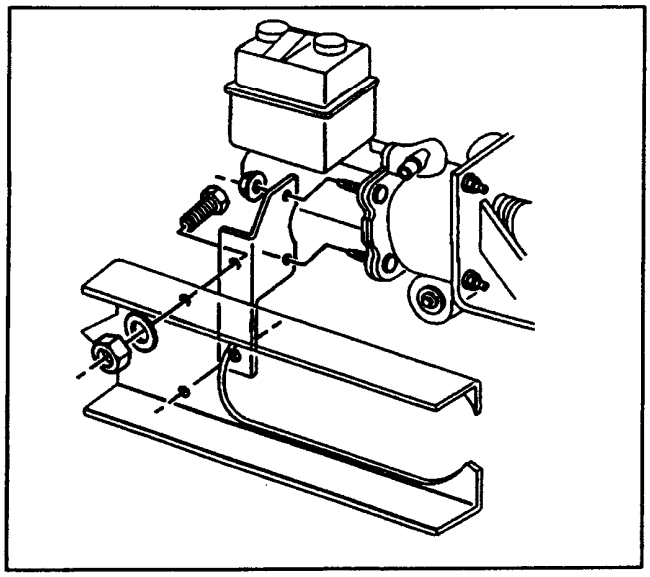


220749

5. Install the master cylinder.
6. Install the master cylinder bracket.
   Tighten
   Tighten the nuts to 45 N.m (33 lb ft).
7. Install the electrical connectors to the electrohydraulic pump and the flow switch.
8. Install the negative battery cable.
9. Fill the hydraulic pump reservoir.
10. Bleed the system.
11. Lower the cab. Refer to *Cab Tilting* in General Information.
12. Inspect the vehicle for the proper brake operation.
13. Remove the wheel blocks.

Electrohydraulic Pump Replacement

Removal Procedure

Notice: The EH pump operates on power steering fluid only. Do not service the EH pump in any brake servicing area. Be sure hands are clean of all brake fluid. Contamination can cause swelling and deterioration of rubber parts, brake damage, and the eventual loss of braking capability.

1. Block the vehicle wheels.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.
3. Remove the booster assembly. Refer to *Hydraulic Brake Booster Replacement.*
4. Remove the bolt and the spring washer.
5. Position a container in order to catch the leaking fluid.
6. Remove the bolts and the spring washers.
7. Remove the electrohydraulic pump.
8. Remove the o-ring seals.
9. Remove the relief valve and the spring.

Installation Procedure

1. Install the relief valve with the slotted end towards the center of the booster body.
2. Install the spring.
3. Install the new o-ring seals.
4. Install the electrohydraulic pump.
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
5. Install the bolts and the spring washers.
   Tighten
   Tighten the bolts to 31 N.m (23 lb ft).
6. Install the identification tag.
7. Install the spring washer and the bolt.
   Tighten
   Tighten the bolt to 13 N.m (116 lb in).

8. Install the booster assembly. Refer to *Hydraulic Brake Booster Replacement.*
9. Fill the hydraulic pump reservoir.
10. Bleed the system.
11. Inspect the vehicle for proper brake operation.
12. Remove the wheel blocks.
13. Lower the cab. Refer to *Cab Tilting* in General Information.

Fluid Flow Switch Replacement

Removal Procedure

1. Block the vehicle wheels.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.
3. Position a suitable container in order to catch the fluid from the flow switch and the hose. Do not re-use the old fluid.
4. Remove the electrical connector from the flow switch.

   Notice: Do not tighten the flow switch with a thick blade wrench. The flow switch may be damaged. Use a thin blade open end wrench.
5. Use an open wrench in order to remove the flow switch.
6. Remove the O-ring seal.

Installation Procedure

1. Install the new O-ring seal.

   Notice: Do not tighten the flow switch with a thick blade wrench. The flow switch may be damaged. Use a thin blade open end wrench.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Use an open end wrench in order to install the flow switch.

   Tighten

   Tighten the flow switch to 10 N.m (88 lb in).
3. Connect the electrical connector to the flow switch.
4. Fill the hydraulic pump reservoir.
5. Bleed the system.
6. Inspect the vehicle for proper brake operation.
7. Remove the wheel blocks.
8. Lower the cab. Refer to *Cab Tilting* in General Information.

Stoplamp Switch Replacement

Removal Procedure

Important: Refer to Lighting Systems in Body and Accessories for further information on the stoplamp switch electrical diagnosis.

1. Remove the electrical connectors.
2. Remove the retaining nut.
3. Remove the stoplamp switch.

Installation Procedure

1. Install the stoplamp switch.
2. Install the retaining nut.
3. Adjust the switch pin operating stroke to 2.4 mm.
4. Tighten the retaining nut.
5. Install the electrical connector.

Description and Operation

Hydraulic Brake Booster Description

Booster Assembly

The hydraulic booster applies force to the master cylinder when the brake pedal is applied. Brake pedal movement controls the fluid flowing through the booster head.

The fluid from the hydraulic brake booster pump enters the booster at the inlet port. The fluid flows through the control valve and the seat and exits through the outlet port and the flow switch before returning to the hydraulic brake booster pump.

The hydraulic booster cylinder rod attaches to a piston that contains the control valve seat. The assembly moves when pressure is applied to the brake pedal. As the control valve moves closer to the control valve seat in the piston, the fluid flow is restricted and the pressure builds on one side of the piston. The pressure overcomes the return spring and moves the piston to a balanced position. The piston is balanced when the pressure on each side of the return spring equals the pressure of the hydraulic fluid flowing through the control valve and the seat. The piston pushes the cylinder rod and applies pressure to the master cylinder as the piston moves.

A relief valve inside the booster head limits the pressure to 4826 kPa (700 psi). The limiting of the pressure in the booster head limits the brake line pressure at the master cylinder to 13455 kPa (1950 psi). The pressure level provides good braking without damaging the brake pipes or the hoses. The relief valve allows fluid to bypass the piston when actuated. Fluid constantly flows through the booster head when the engine is running.

Electrohydraulic Pump

The Electrohydraulic (EH) pump is used as a backup to the belt driven power steering pump. The EH pump turns on when the fluid stops flowing through the booster head. The EH pump is a small hydraulic pump that mounts to the bottom of the booster head.

The EH pump draws fluid from the low pressure side of the booster head piston. The EH pump delivers fluid to the high pressure side. The normal output of the EH pump is 2070–2415 kPa (300–500 psi) which is about half that of the power steering pump.

Flow Switch

A flow switch in the booster head outlet port senses the fluid flow. The flow switch controls a relay for the EH pump. A pedal switch also activates the EH pump when the brake pedal is applied and the engine is not running.

Pipes, Hoses, and Fittings

Stationary pipes and flexible hoses carry fluid throughout the hydraulic brake booster system. The stationary pipes and the flexible hoses connect the booster head to the hydraulic brake booster pump and the fluid reservoir.

Overhaul Information

Refer to the instructions enclosed with the service repair kit for overhaul information on the Bendix® brake booster. Contact the Bendix® Helpline at 1-800-AIR-BRAK (1-800-247-2725) for additional overhaul information.

Fluid and Fluid Handling

Notice: Hydraulic brake systems use two distinct and incompatible fluids. Power steering fluid is used in the hydraulic brake booster system. Brake fluid is used in the master cylinder and brake pipes. Use extreme care when selecting brake system fluids, or seal damage can result. Refer to General Information to select the correct fluid.

The hydraulic booster system uses no special fluids. However, ensure the use of the correct fluids. The master cylinder and the brake system use brake fluid. The hydraulic brake booster pump uses power steering fluid.

Substandard or Contaminated Brake Fluid

Contaminated fluid causes swelling and deterioration of the rubber parts. The swelling and deterioration leads to reduced brake performance and the loss of braking capability. Inspect the condition of the fluid at regular intervals and note any unusual consistency, color and signs of contaminants in the fluid.

Notice: Power steering fluid and brake fluid cannot be mixed. If brake seals contact power steering fluid or steering seals contact brake fluid, seal damage will result.

Do not reuse the brake system fluids Always discard the used fluid. Do not mix the power steering fluid with the hydraulic brake fluid. Flush the hydraulic booster system with clean power steering fluid if contamination occurs.

Do booster component bench servicing in a clean work area separate from the brake servicing area. Wash your hands before changing between the brake or the booster work area. Do not use the same containers for the fluids.

Brake Warning System Circuit Description (Primary Brake Lamp Description)

Primary Brake Lamp

The primary brake indicator lamp will light on vehicles equipped with hydraulic brakes and a continuous tone will sound if any of the following conditions occur:

- There is insufficient brake fluid in the reservoir.
- There is insufficient fluid flow in the hydro-boost system during braking.
- If the vehicle is equipped with antilock brakes, the Electronic Brake Control Module (EBCM) notices a fault.

The multifunction alarm module receives a ground signal from both the brake fluid level switch and the EBCM through CKT 33, 495 and 494 (TAN/WHT). The primary brake lamp is also connected through CKT 33, 495 and 494 (TAN/WHT) to the level switch, the EBCM and the alarm module. The brake fluid level switch is a float switch. The brake fluid level switch will close when the fluid in the reservoir drops below a minimum level. The EBCM will provide a ground path to the lamp and the alarm module if a diagnostic trouble code is set. The brake fluid flow switch is connected to the multifunction alarm module through CKT 475 and 1928 (LT BLU). If insufficient fluid flow is detected in the hydro-boost system the flow switch closes in order to provide a ground path to the alarm module.

Brake Warning System Circuit Description (Auxiliary Brake Lamp Descripti)

Auxiliary Brake Lamp

The AUX BRAKE indicator lamp will light on vehicles equipped with hydraulic brakes and a continuous tone will sound if any of the following conditions occur:

- There is fluid flow in the hydro-boost system within four seconds of the engine start.
- No input is received from the stoplamp relay during braking.

The brake fluid flow switch is connected to the multifunction alarm module through CKT 475 and 1928 (LT BLU). If insufficient fluid flow is detected in the hydro-boost system, the flow switch closes in order to provide a ground path to the alarm module. The switch should be open during the engine start. The multifunction alarm module receives the engine start voltage signal from the starter relay through CKT 434 and 487 (ORN/BLK). The multifunction alarm module receives the stoplamp relay voltage signal from the stoplamp relay through CKT 489 (GRY).

Special Tools and Equipment

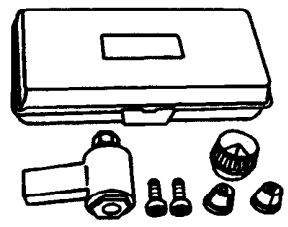
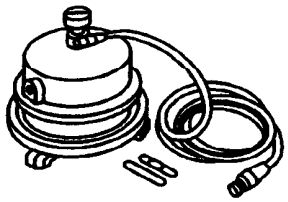
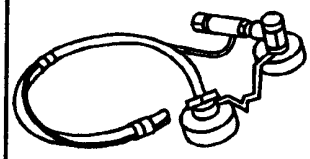
Illustration	Tool Number/ Description
 1089	J 29803-A Flaring Kit
 153125	J 29532 Power Brake Bleeder

Illustration	Tool Number/ Description
 218955	J 33855 Pressure Bleeder Adapter

Disc Brakes

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Bleeder Valve	17 N.m	13 lb ft
Brake Caliper Brake Hose Bracket Bolt	32 N.m	24 lb ft
Brake Caliper Brake Hose Nut	19 N.m	14 lb ft
Brake Caliper Mounting Plate Bolt	280 N.m	206 lb ft
Brake Caliper Retainer Screw	40 N.m	29 lb ft
Brake Shield Bolt	32 N.m	24 lb ft
Brake Rotor to Hub Bolt 9/16" OD (10 Bolt Pattern)	152 N.m	112 lb ft
Brake Rotor to Hub Bolt 5/8" OD (5 Bolt Pattern)	256 N.m	189 lb ft

Brake Lathe Specifications (Accuturn)

Data	Cut Information
Spindle Speed	150 RPM
Tool Cross Feed (per revolution)	0.076 mm (0.003 in)
Tool Bit Nose Radius	0.396 mm (0.003 in)
Vibration Dampener	Yes
Swirl Pattern 120 Grit	Yes

Brake Lathe Specifications (Ammco)

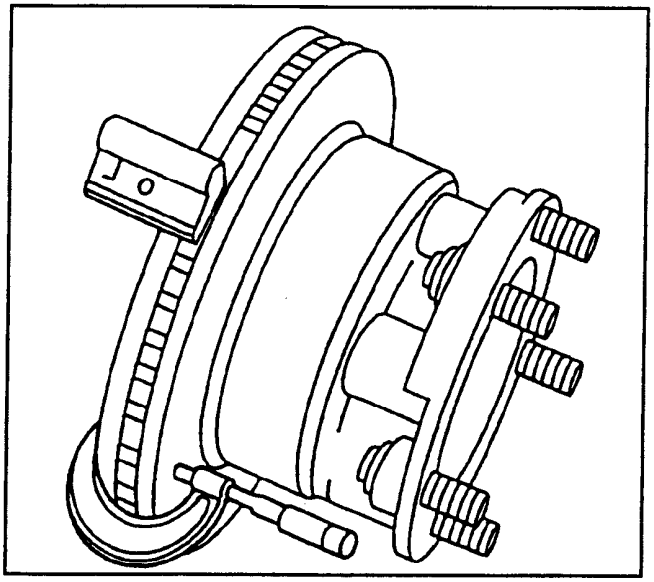
Data	Rough Cut	Finish Cut
Spindle Speed	150 RPM	150 RPM
Depth of Cut (per side)	0.127 mm (0.005 in)	0.051 mm (0.002 in)
Total Cross Feed (per revolution)	0.152–0.254 mm (0.006–0.01 in)	0.051 mm max. (0.002 in)
Vibration Dampener	Yes	Yes
Swirl Pattern 120 Grit	No	Yes

Component Specifications

Application	Specification	
	Metric	English
Brake Lining Replacement Thickness	1.60 mm	0.063 in
Brake Lining to Brake Rotor Maximum Clearance	0.13 mm	0.005 in
Brake Rotor OD Runout	0.76 mm	0.030 in
Brake Rotor Thickness Variation	0.05 mm	0.002 in
Brake Rotor Total Indicated Runout (TIR)	0.13 mm	0.005 in
Front Hub and Bearing Assembly Lateral Runout	0.040 mm	0.0016 in

Diagnostic Information and Procedures

Brake Rotor Thickness Variation Check



171512

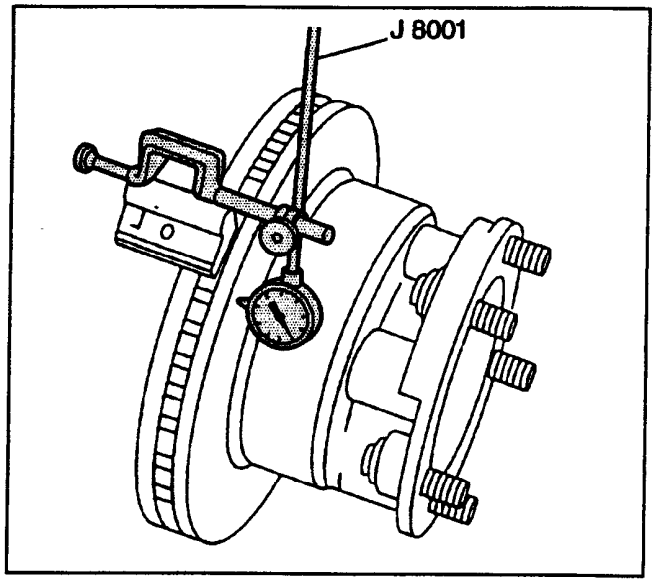
Check thickness variation by measuring the brake rotor thickness at four or more points around the circumference of the brake rotor. Use a micrometer calibrated in ten-thousands of an inch. Make all measurements about 25.4 mm (1 in) in from the edge of the brake rotor.

A brake rotor that varies in thickness by more than 0.05 mm (0.002 in) can cause brake pedal pulsation and/or front end vibration during brake applications. Refinish or replace a brake rotor that does not meet these specifications.

Brake Rotor Lateral Runout Check

Tools Required

J 8001 Dial Indicator Set



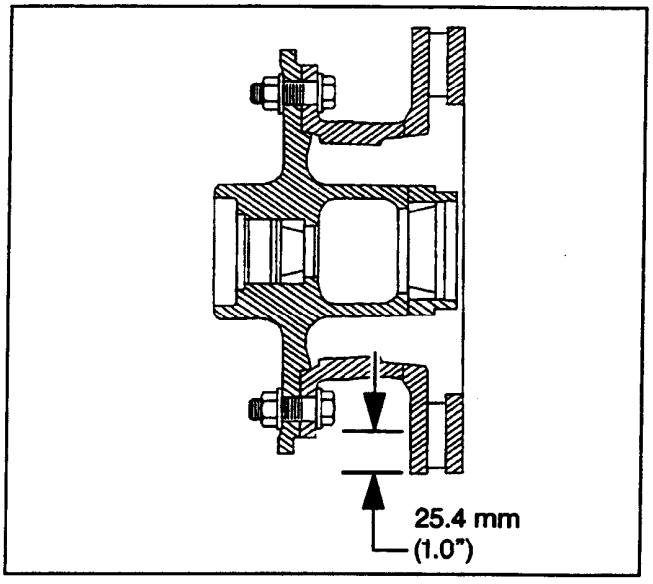
171514

Check the lateral runout with the wheels still installed on the vehicle. Keeping the wheels on the vehicle gives a much more accurate reading of the Total Indicated Runout (TIR) under real braking conditions. If the equipment is not available to perform the measurement with the wheels installed, measure with the wheels removed but with the brake caliper still installed.

In some cases, excessive lateral runout can be improved by indexing the brake rotor on the hub that is one or two bolt positions from the original position. If you cannot correct the lateral runout by indexing the brake rotor, check the hub and bearing assembly for excessive lateral runout or looseness. If the hub and bearing assembly lateral runout exceeds 0.040 mm (0.0016 in), replace the hub and/or bearing assembly as necessary. If the brake rotor's lateral runout is not within specifications, refinish or replace the rotor as necessary.

Measurement Procedure

1. Set the parking brake.
2. Block the vehicle wheels.
3. Raise the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
4. Support the vehicle with safety stands.
5. Remove the tires and wheels. Refer to *Wheel Bearing Adjustment*
6. Clean the brake rotor surface.
7. Tighten the wheel bearings to zero end play.



171510

8. Fasten a dial indicator to the steering knuckle so that the indicator button contacts the brake rotor surface about 25.4 mm (1 in) from the outer edge.
9. Set the dial indicator to zero.
10. Turn the wheel one complete revolution.
11. Observe the runout indicated on the dial.
12. The (TIR) must not exceed 0.13 mm (0.005 in).
13. Adjust the wheel bearings. Refer to *Wheel Bearing Adjustment* in Front Suspension.

Brake Rotor Tolerance

Rotor Tolerance And Surface Finish

Manufacturers closely hold brake rotor tolerances. These tolerances include flatness of the braking surfaces, parallelism, and lateral runout.

Maintaining the close tolerance on the shape of the braking surface prevents brake roughness or pulsation. The surface finish must be maintained at 60 Ra roughness or less.

Control the braking surface finish in order to avoid the following conditions:

- Hard pedal application
- Excessive brake fade
- Brake and steering pulls
- Erratic brake performance

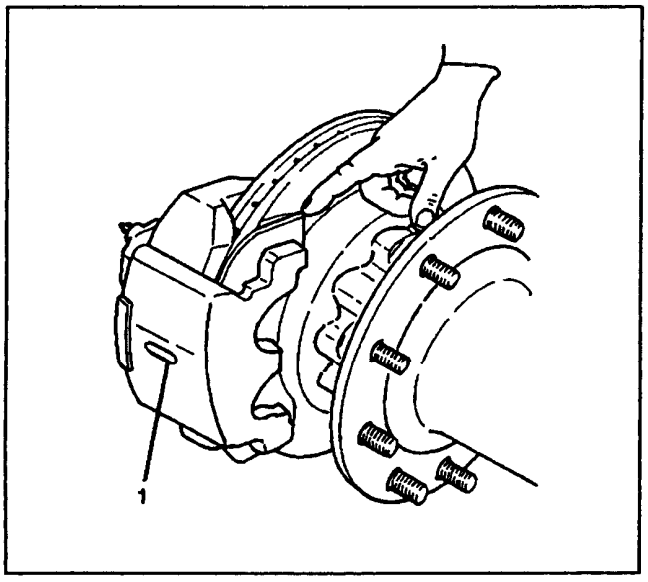
Controlled braking surface finish can prolong the life of the brake lining. Light scoring of the rotor braking surface not exceeding 1.5 mm (0.06 in) in depth is normal and will not damage the brake operation.

Repair Instructions

Brake Pad Inspection

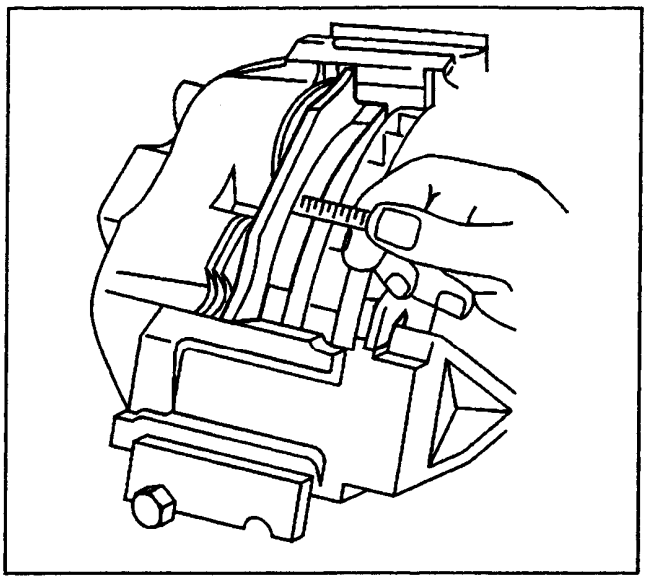
Lining Inspection

Inspect the brake linings every 9656 km (6,000 mi) and any time the wheels are removed (tire rotation, etc.). The preliminary inspection can be made with a mirror and flashlight. Remove the tire and wheel assembly in order to measure the linings.



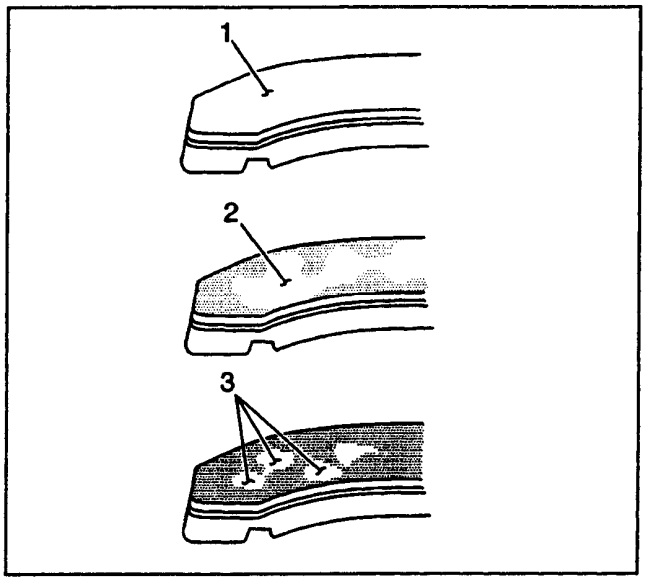
32117

Measure the linings with the brake caliper installed. The outer lining on brake calipers is exposed for easy inspection. The inner lining on Dayton-Walther brake calipers is also exposed. Inspect Bendix® inner linings through the inspection hole in the brake caliper housing. Replace the brake pad assemblies when the lining is worn to 1.6 mm (0.063 in). Measure the linings at their thinnest point.



200264

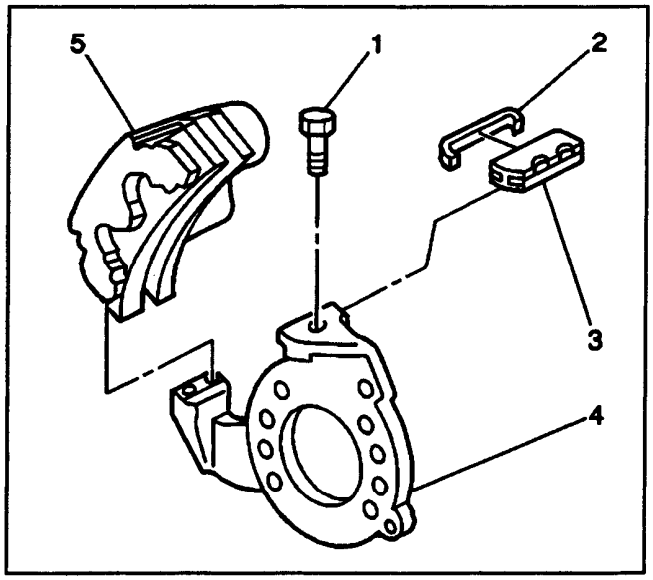
Brake linings should lightly contact the brake rotor or have no more than 0.13 mm (0.005 in) clearance. It is normal for the brakes to drag if the brakes were applied shortly before checking the brake clearance. If the brake linings are more than 0.13 mm (0.005 in) from the brake rotor, pump the brake pedal several times and recheck the lining clearance. If the lining clearance is still not within specifications, check for unevenly worn surfaces on the brake rotor, brake linings, or brake caliper pistons. New brake linings may have more clearance until they have worn to match the brake rotor. If the gap between either brake caliper piston face and the brake pad is more than 1.8 mm (0.071 in), overhaul the brake caliper.



171508

Remove the brake caliper in order to inspect the brake lining surface conditions. Refer to *Brake Caliper Replacement (Front, Bendix)* or *Brake Caliper Replacement (Front, Dayton-Walther)*. The brake linings must be free of grease and oil. The brake linings should show at least 70 percent wear (2) over the braking surface in order to indicate good lining contact.

Knock-back is a condition that occurs when a turning brake rotor pushes the brake linings and brake caliper pistons farther into the bores than normal. Excessive clearance results from the knock-back. The driver will notice increased pedal travel with the next brake application. Loose or worn suspension parts, especially the wheel bearings, can increase knock-back. Refer to Suspension Diagnosis.

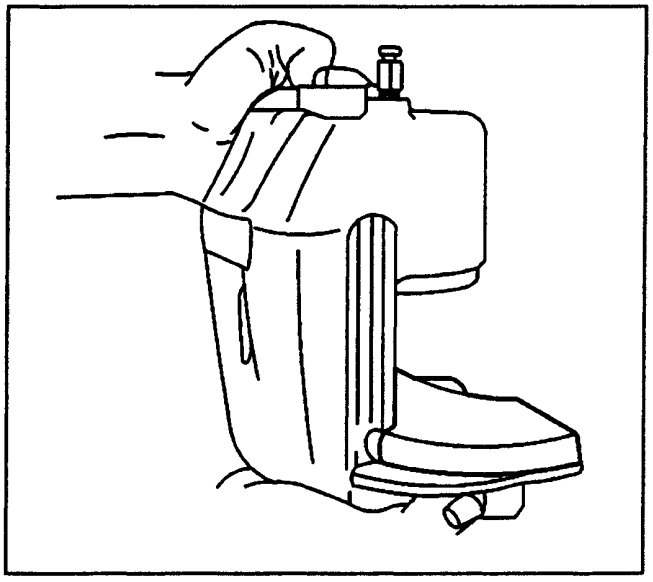


209267

Brake Pads Replacement (Front, Bendix)

Removal Procedure

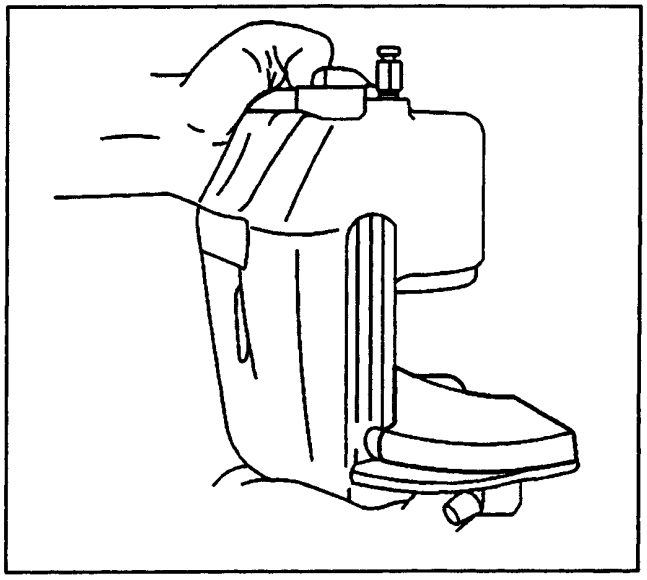
1. Remove the brake caliper (5). Refer to *Brake Caliper Replacement (Front, Bendix)* or *Brake Caliper Replacement (Front, Dayton-Walther).*
2. Remove the inner brake pad from the brake caliper mounting plate (4).


22104

3. Slide the outer brake pad along the rail in the brake caliper housing to the notches.
4. Remove the outer brake pad.
5. Inspect the brake caliper. Refer to *Brake Caliper Replacement (Front, Bendix).*

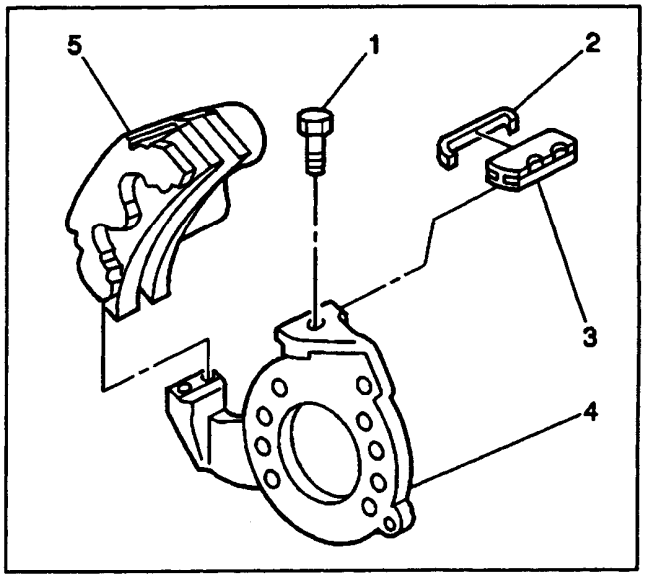
Installation Procedure

1. Install the outer brake pad into the brake caliper housing.
2. Install the inner brake pad onto the brake caliper mounting plate.



22104

3. Install the brake caliper (5). Refer to *Brake Caliper Replacement (Front, Bendix).*

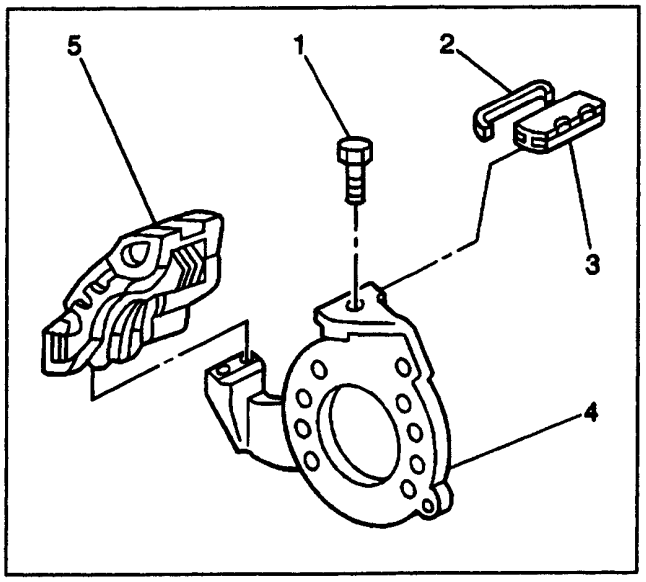


209267

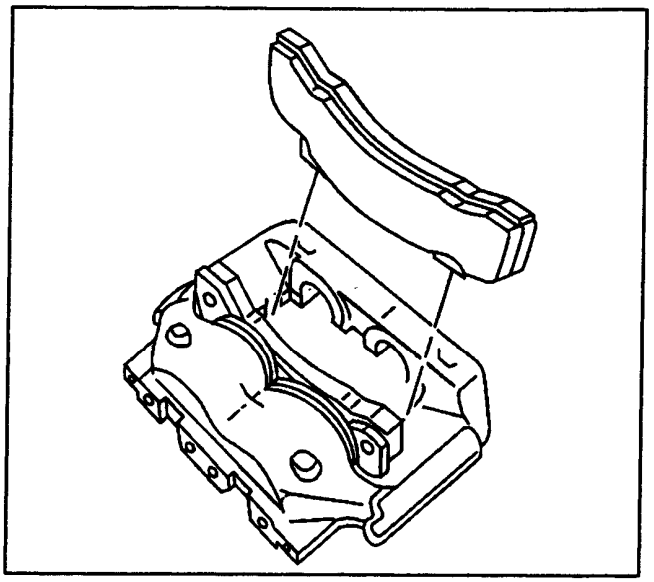
Brake Pads Replacement (Front, Dayton-Walther)

Removal Procedure

1. Remove the brake caliper (5). Refer to *Brake Caliper Replacement (Front, Bendix) Brake Caliper Replacement (Front, Dayton-Walther).*

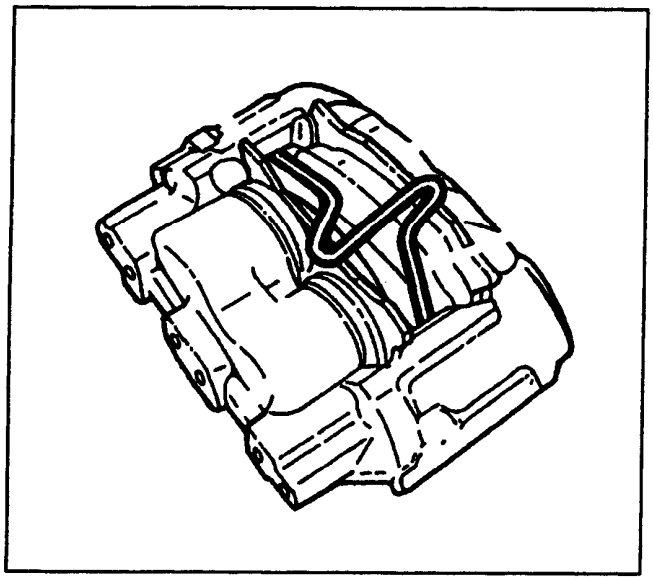


209264



200256

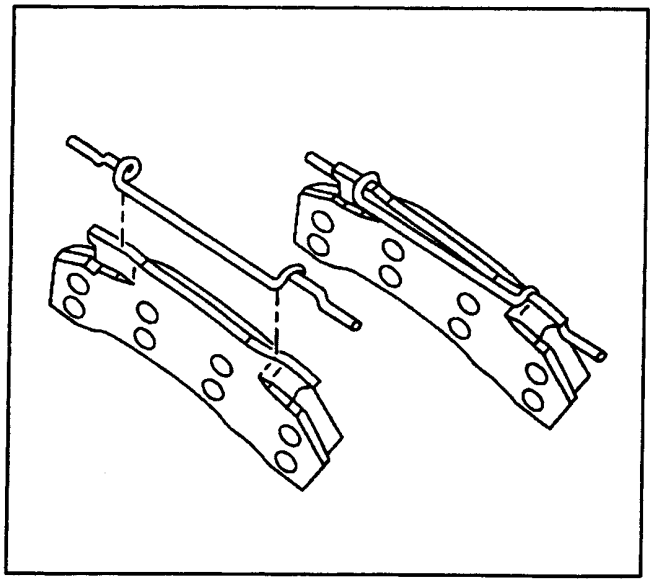
2. Slide the outer brake pad along the rail in the brake caliper housing to the notches.
3. Remove the outer brake pad.
4. Slide the inner brake pad along the rail in the brake caliper housing to the notches.
5. Remove the inner brake pad.



22102

Important: Either remove one factory installed Z spring from the brake caliper or remove two service kit springs from the brake pads, if equipped.

6. Remove the retainer spring(s).
7. Inspect the brake caliper. Refer to *Brake Caliper Replacement (Front, Bendix)* or *Brake Caliper Replacement (Front, Dayton-Walther)*.

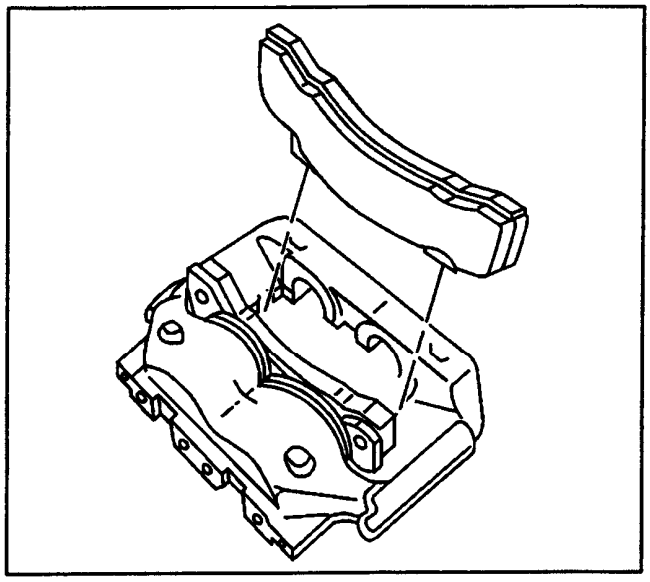


237231

Installation Procedure

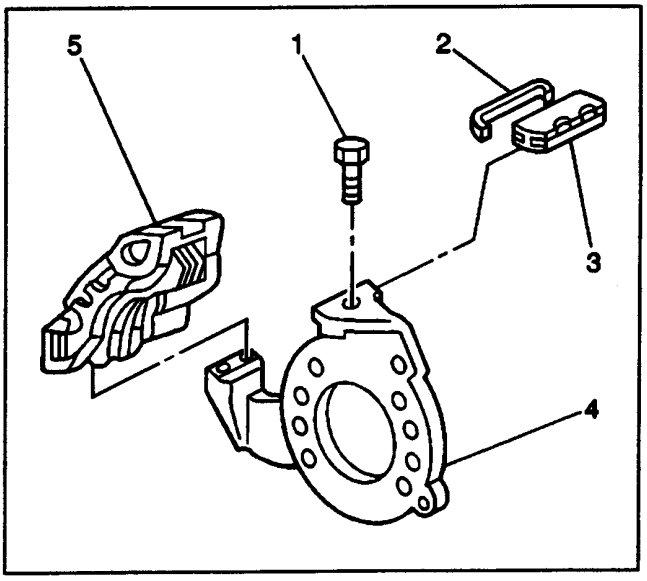
1. Install one service kit brake pad retainer spring on each brake pad.
2. Reuse the Z spring if the Z spring is undamaged. Descard the service springs if the Z spring is used.

3. Install the inner brake pad.
4. Install the outer brake pad.



200256

5. Install the brake caliper (5). Refer to *Brake Caliper Replacement (Front, Bendix) Brake Caliper Replacement (Front, Dayton-Walther).*

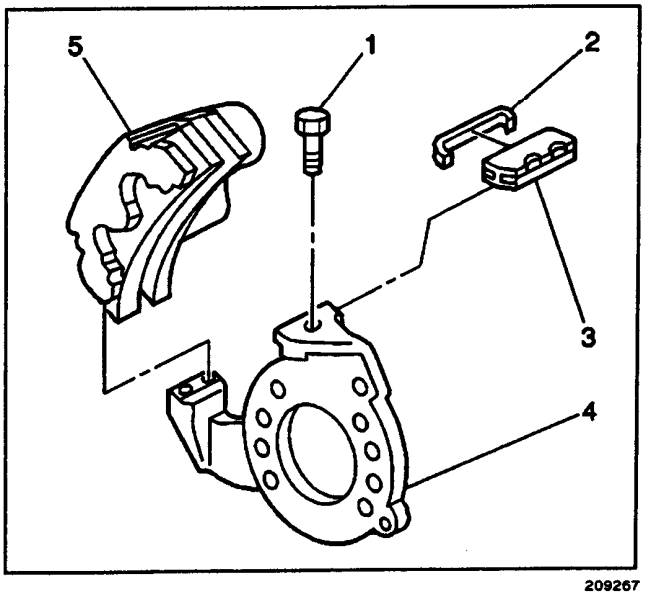


209264

Brake Pads Replacement (Rear, Bendix Rail Slider)

Removal Procedure

1. Remove the brake caliper (5). Refer to *Brake Caliper Replacement (Rear, Rail Slider).*
2. Remove the inner brake pad from the brake caliper mounting plate (4).



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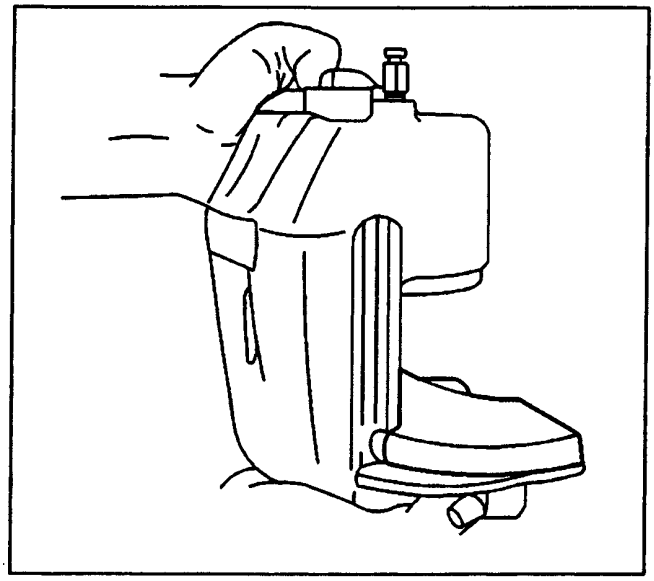
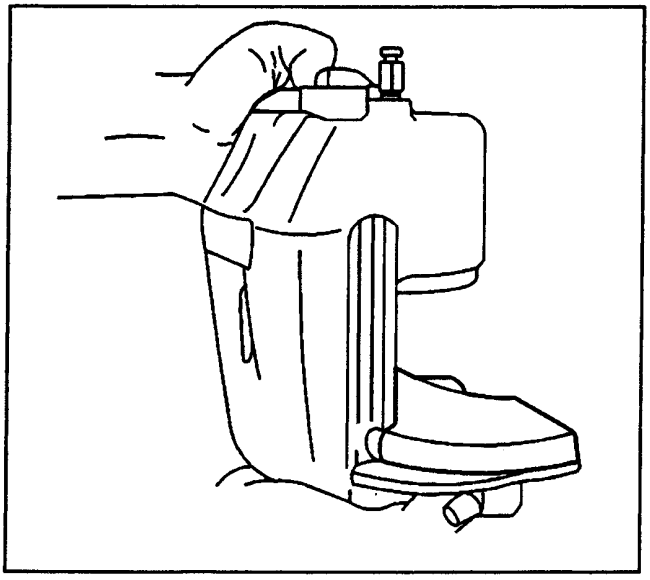


22104

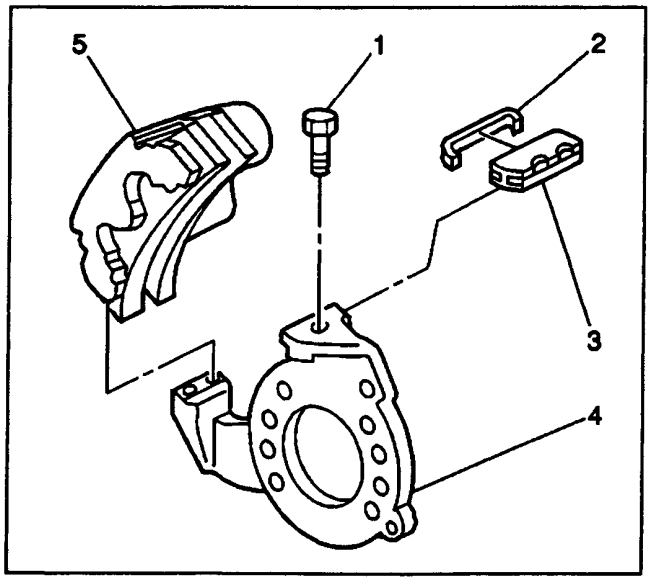
3. Slide the outer brake pad along the rail in the brake caliper housing to the notches.
4. Remove the outer brake pad.
5. Inspect the brake caliper. Refer to *Brake Caliper Replacement (Rear, Rail Slider)*



22104

Installation Procedure

1. Install the outer brake pad into the brake caliper housing.
2. Install the inner brake pad onto the brake caliper mounting plate.



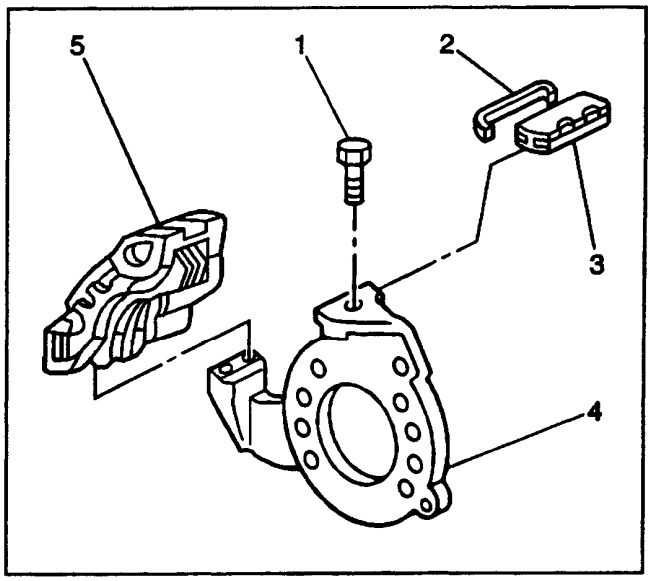
209267

3. Install the brake caliper (5). Refer to *Brake Caliper Replacement (Rear, Rail Slider).*

Brake Pads Replacement (Rear, Dayton-WaltherRailSlider)

Removal Procedure

1. Remove the brake caliper (5). Refer to *Brake Caliper Replacement (Rear, Rail Slider).*



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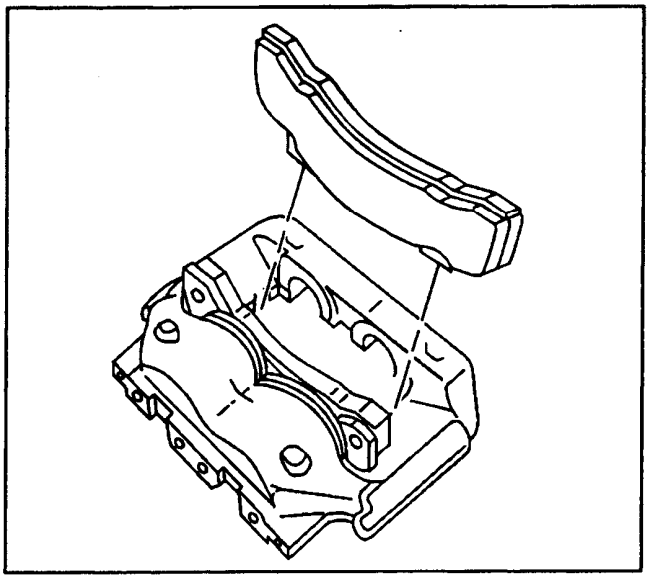
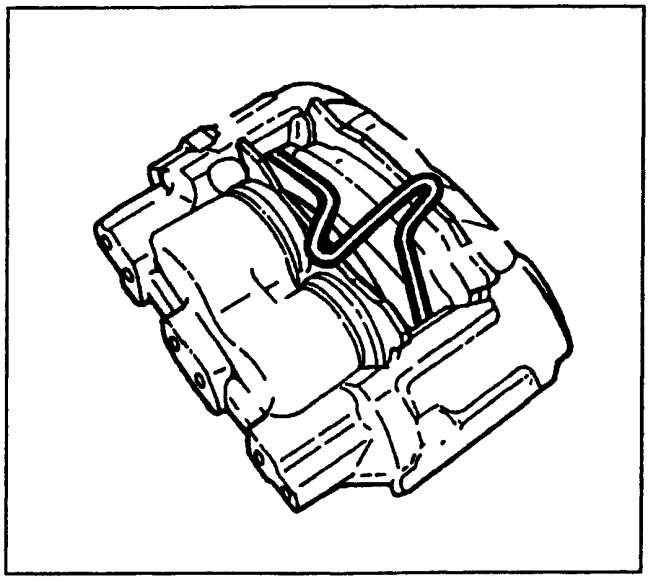
2. Slide the outer brake pad along the rail in the brake caliper housing to the notches.
3. Remove the outer brake pad.
4. Slide the inner brake pad along the rail in the brake caliper housing to the notches.
5. Remove the inner brake pad.


200256

Important: Either remove one factory installed Z spring from the brake caliper or remove two service kit springs from the brake pads, if equipped.

6. Remove the brake pad retainer spring.
7. Inspect the brake caliper. Refer to *Brake Caliper Replacement (Rear, Rail Slider).*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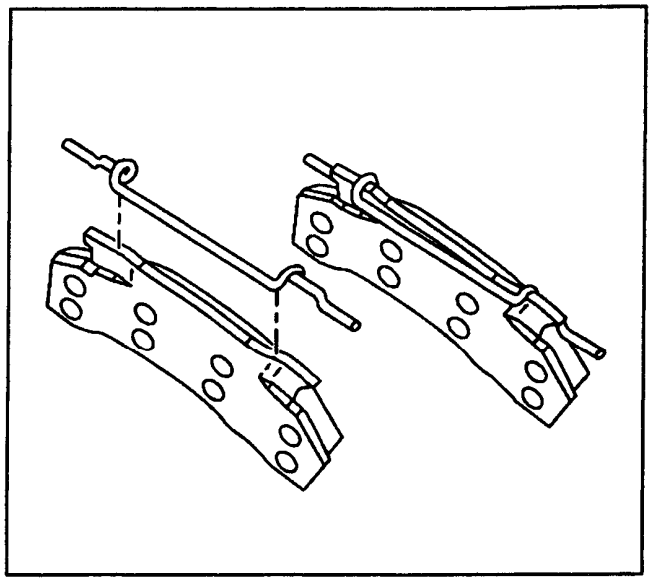

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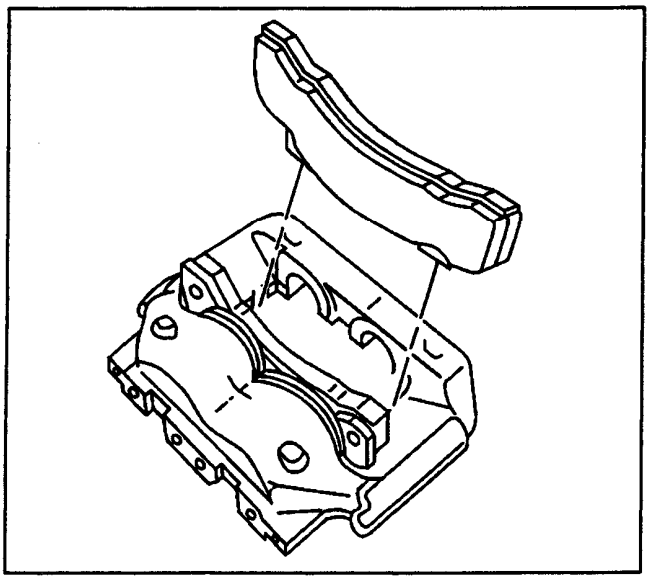

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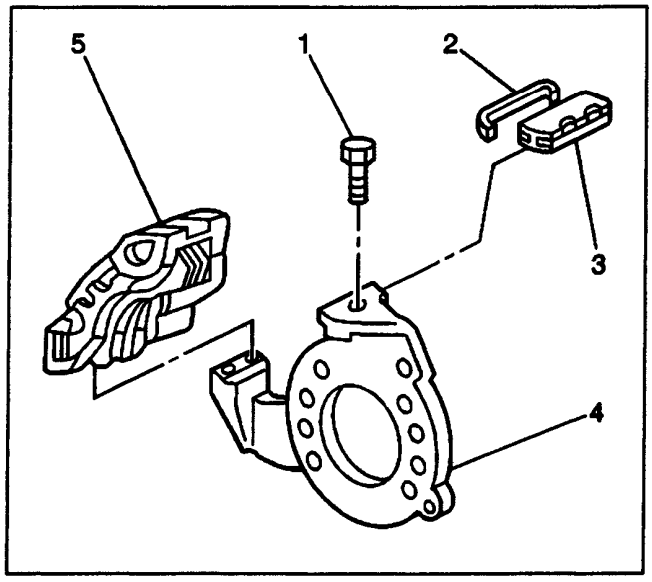


209264

Installation Procedure

1. Install one service kit brake pad retainer spring on each brake pad.
2. Reuse the Z spring if the Z spring is undamaged. Descard the service springs if the Z spring is used.
3. Install the inner brake pad.
4. Install the outer brake pad.
5. Install the brake caliper (5). Refer to *Brake Caliper Replacement (Rear, Rail Slider).*

Burnishing Pads and Rotors

Burnish the linings and rotors under the following conditions:

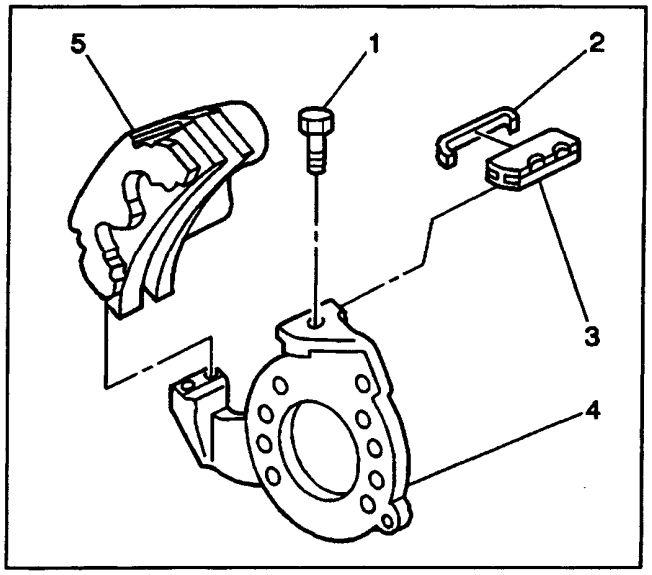
- You replaced the brake linings.
- You refinished the brake rotors.

Stop 20 times from 48 km/h (30 mph) using medium to firm brake pedal pressure. Do not overheat the brakes.

Brake Caliper Replacement (Front, Bendix)

Removal Procedure

1. Apply the parking brake.
2. Block the vehicle wheels.
3. Tilt the cab.
4. Remove about 2/3 of the brake fluid from the master cylinder reservoir.
   - Do not completely drain the master cylinder reservoir.
   - Drain the fluid from the brake caliper bleeder valve.
   - Drain the fluid into a suitable container. Discard the fluid.
5. Raise the vehicle. Support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle*
6. Remove the tires and wheels. Refer to *Wheel Removal (Front).*
7. Remove the brake caliper retainer screw (1).
8. Remove the brake caliper retainer (3) and the brake caliper spring (2) using a brass punch.
9. Compress the pistons, using one of the following methods:
10. Use a C-clamp between the inner brake caliper housing and the outer brake pad.



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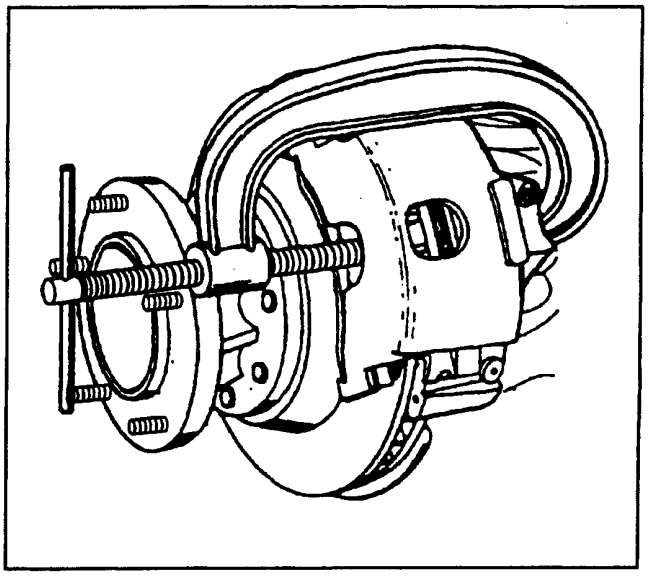
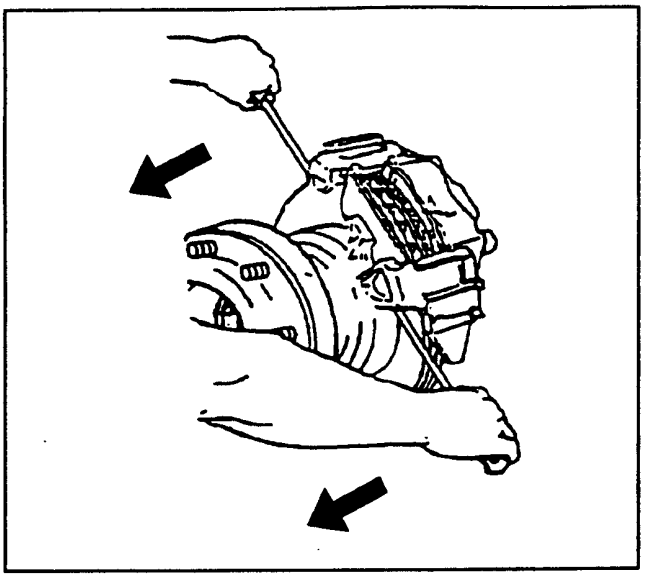

156331

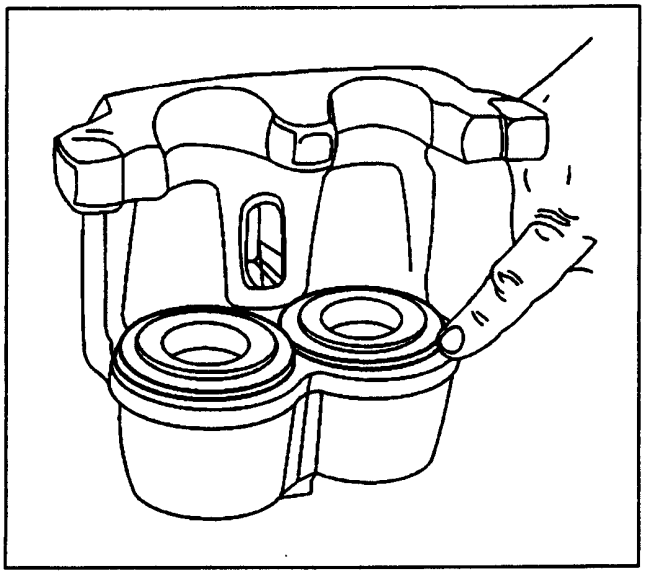


171517

11. Use screwdrivers in order to pry between the outer brake caliper housing and the outer brake pad.
12. While compressing the pistons, watch the reservoir for possible brake fluid overflow. The inner brake pad may stay on the brake caliper mounting plate (Bendix® caliper).
13. Remove the wheel speed sensor. Refer to in Wheel Speed Sensor Replacement in Antilock Brakes.
14. Disconnect the brake hose.
15. Cap or tape the brake hose fitting in order to prevent contamination.

    Notice: Do not allow calipers to hang from the flexible hoses. Doing so can damage the hoses.
16. Remove the front brake hose.

    Important:
    - Do not let the brake caliper hang from the brake hose. Suspend the brake caliper with a wire or cord.
    - It is not always necessary to remove the brake hose from the brake caliper when replacing the brake pad assemblies.
    - Clean the area around the brake hose on the brake caliper.
    - Cap or tape the fitting in order to prevent dirt from entering the brake hose.
17. Remove the brake caliper.



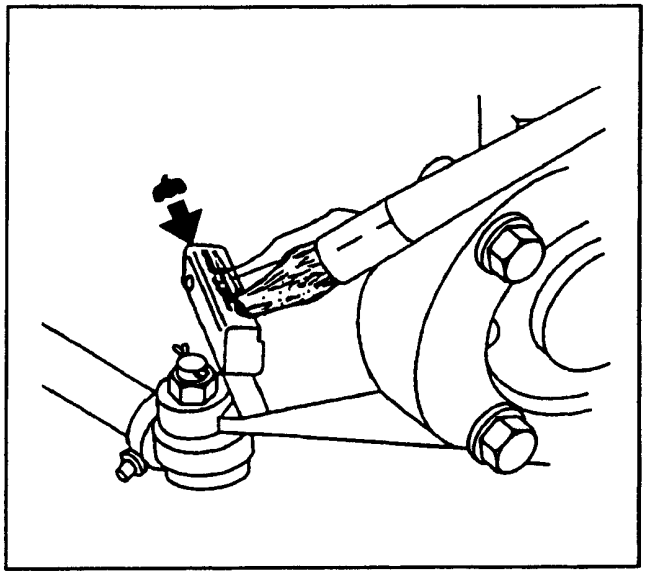
22105

Inspection Procedure

1. Inspect the inside of the brake caliper for brake fluid leaks. If you find a leak, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Bendix Rail Slider).*
2. Inspect the piston seal for leaks and brake fluid around the dust boot, the heat shield, and the inboard brake pad.
3. Inspect the dust boots for any damage. If you find damage, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Bendix Rail Slider)*
4. Inspect the support rail surfaces on the brake caliper.
5. Inspect the support rail surfaces on the brake caliper mounting plate.
6. Inspect the V-way surfaces on the brake caliper and the support rail surfaces on the brake caliper mounting plate.
7. Inspect the heat shields. If the heat shields are loose, replace the shields.
8. Inspect under the dust boots for leakage. If you find leakage, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Bendix Rail Slider).*

Installation Procedure

1. Clean the support rail surfaces of the brake caliper with a wire brush. File smooth any deep nicks or gouges.
2. Clean the support rail surfaces of the brake caliper mounting plate with a wire brush. File smooth any deep nicks or gouges.
3. Apply a thin coat of Brake Caliper Lubricant to the brake caliper mounting plate support rail surfaces.



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Important: Never drive the pistons into the bores with a mallet or metal tools.

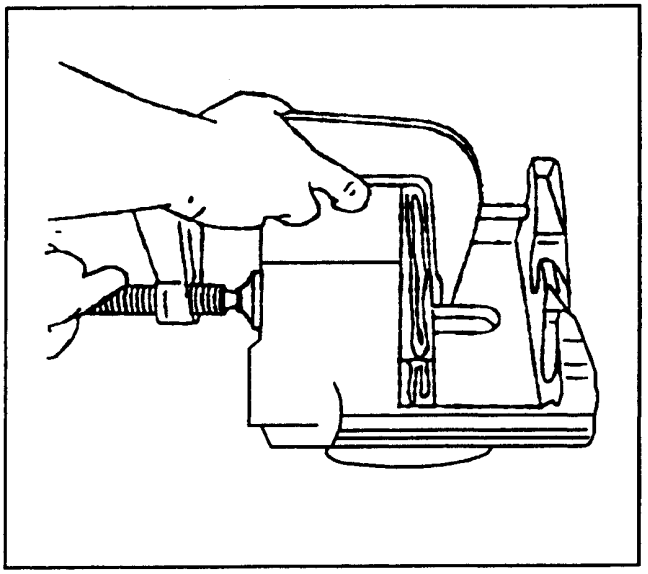
4. Install the brake caliper pistons to the bottom of the bores. If the piston cannot be pushed by hand, place a small block of wood over the pistons and the boots. Use a C-clamp around the wood block and brake caliper housing in order to push in the pistons.
5. Install the brake caliper.

   Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.
6. Loosely assemble the brake hose nut to the brake caliper.

   Notice: Refer to *Fastener Notice.*
7. Loosely assemble the brake hose bracket to the brake caliper.

   Tighten

   - Tighten the brake hose nut to 19 N.m (14 lb ft).
   - Tighten the brake hose bracket bolts to 32 N.m (24 lb ft).
8. Install the wheel speed sensor. Refer to in Wheel Speed Sensor Replacement in Antilock Brakes.
9. Select a shim. Refer to *Brake Caliper and Anchor Plate Wear Adjustment (Front, Bendix).*
10. Apply a thin coat of Brake Caliper Lubricant to the brake caliper retainer and the brake caliper spring.



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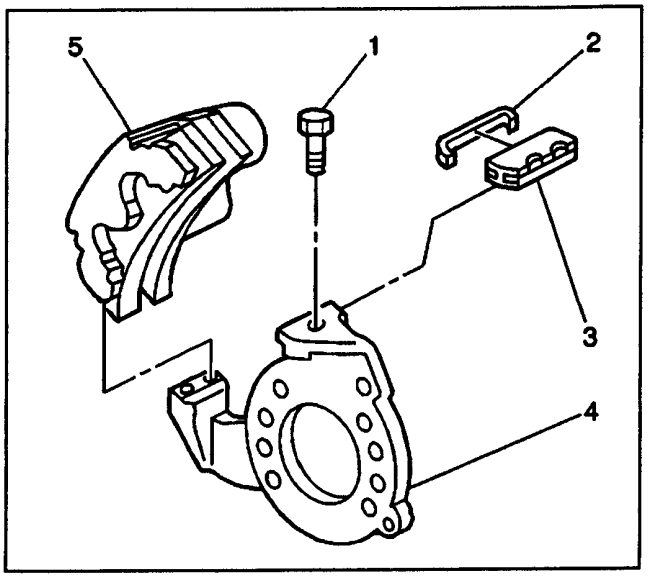


209267

11. Tap the brake caliper retainer and brake caliper spring into place using a brass punch and a light weight hammer. The hose in the brake caliper retainer should line up with the threaded hole in the brake caliper mounting plate.

    Important: The brake caliper retainer bolt boss must fit in the circular hole in the brake caliper retainer.

    Important: Do not reuse the brake caliper retainer bolt more than 4 times.

12. Install the brake caliper retainer bolt.

    Tighten

    Tighten the brake caliper retainer bolt to 40 N.m (29 lb ft).

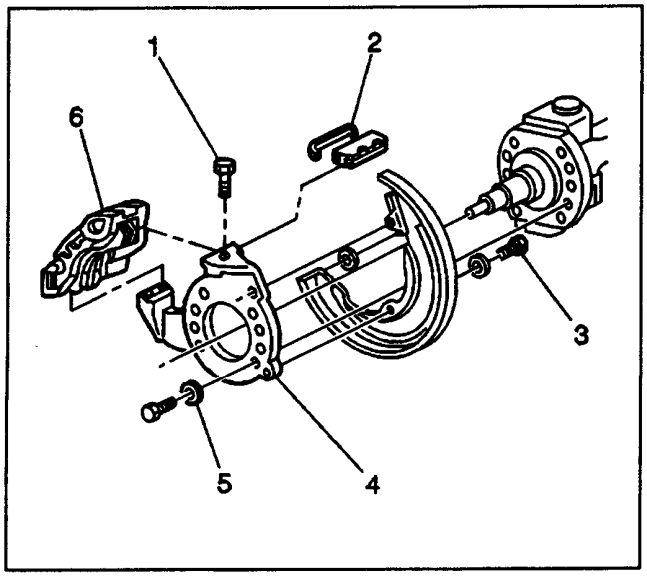
13. Fill the master cylinder reservoir with brake fluid. Refer to in Hydraulic Brakes.
14. Bleed the hydraulic brake system. Refer to Hydraulic Brakes.

    Important: Check the fluid level in the master cylinder reservoir after pumping the brake pedal.

15. Pump the brake pedal several times in order to ensure that the pedal is firm and the brake linings are adjusted.
16. Install the tires and wheels. Refer to *Wheel Removal (Front).*
17. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle.*

    Caution: Do not move the vehicle until a firm brake pedal is obtained. Air in the brake system can cause the loss of brakes with possible personal injury.

18. Remove the blocks.



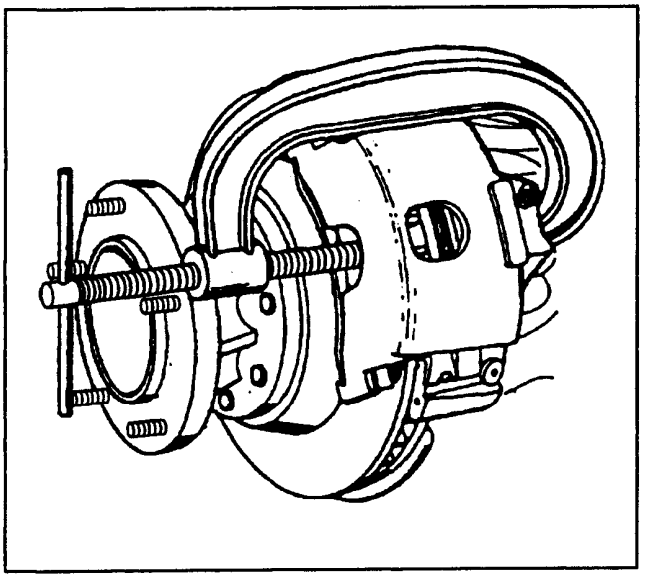
260919

Brake Caliper Replacement (Front, Dayton-Walther)

Removal Procedure

1. Apply the parking brake.
2. Block the vehicle wheels.
3. Remove about 2/3 of the brake fluid from the master cylinder reservoir.
   - Do not completely drain the master cylinder reservoir.
   - Drain the fluid from the brake caliper bleeder valve.
   - Drained the fluid into a suitable container. Discard the fluid.
4. Raise the vehicle. Support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle.*
5. Remove the tires and wheels. Refer to *Wheel Removal (Front).*

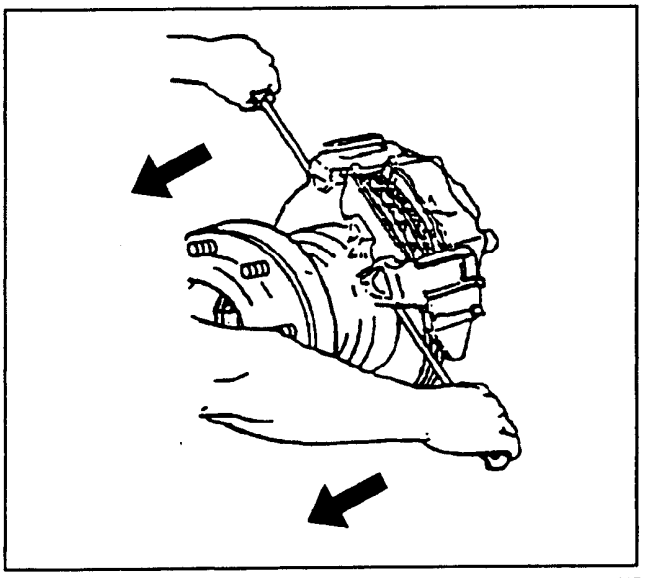
6. Remove the brake caliper retainer bolt (1).
7. Remove the brake caliper retainer (6) and brake caliper spring (2) using a brass punch.
8. Compress the pistons.
9. Use a C-clamp between the inner brake caliper housing and the outer brake pad.



156331

10. Use screwdrivers to pry between the outer brake caliper housing and the outer brake pad.
11. While compressing the pistons, watch the reservoir for possible brake fluid overflow.
12. Remove the wheel speed sensor. Refer to Wheel Speed Sensor Replacement in Antilock Brakes.
13. Disconnect the brake hose.
14. Cap or tape the brake hose fitting in order to prevent contamination.

    Notice: Do not allow calipers to hang from the flexible hoses. Doing so can damage the hoses.
15. Remove the brake caliper.



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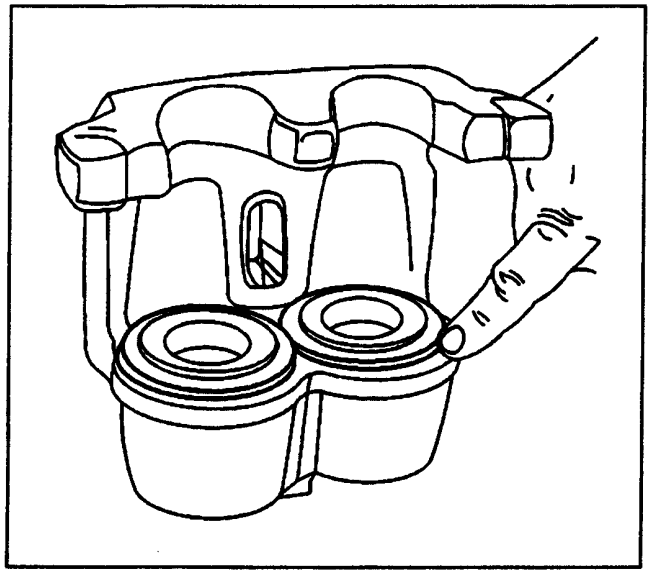

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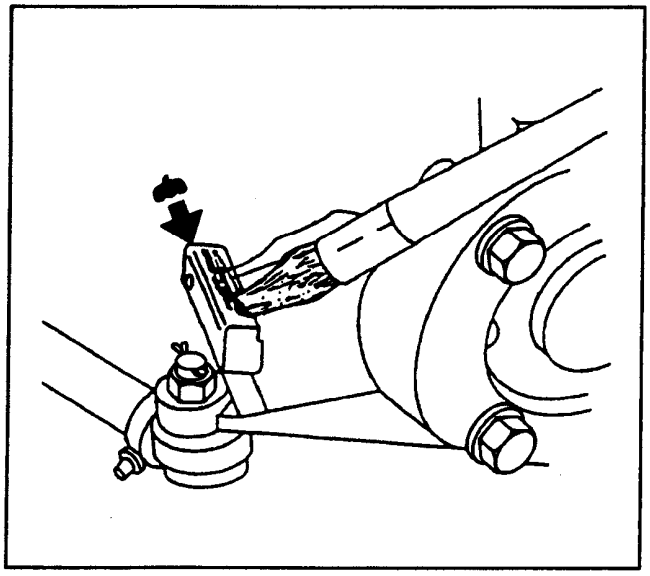


171530

Inspection Procedure

1. Clean the area around the brake hose on the brake caliper. Use Brake Parts cleaner.
2. Inspect the inside of the brake caliper for brake fluid leaks. If you find a leak, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Dayton-Walther Rail Slider).*
3. Inspect the piston seal for leaks and brake fluid around the dust boot, the heat shield, and the inboard brake pad.
4. Inspect the dust boots for any damage. If you find damage, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Dayton-Walther Rail Slider).*
5. Inspect the V-way surfaces on the brake caliper.
6. Inspect the V-way surfaces on the brake caliper mounting plate.
7. Inspect the heat shields. If the heat shields are loose, replace the shields.
8. Inspect under the dust boots for leakage. If you find leakage, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Dayton-Walther Rail Slider).*

Installation Procedure

1. Clean the V-way surfaces of the brake caliper with a wire brush. File smooth any deep nicks or gouges.
2. Clean the support rail surfaces of the brake caliper mounting plate with a wire brush. File smooth any deep nicks or gouges.
3. Apply a thin coat of Brake Caliper Lubricant to the brake caliper mounting plate support rail surfaces.

Important: Never drive the pistons into the bores with a mallet or metal tools.

4. Install the pistons into the bottom of the caliper bores.

   If you cannot push the completely pistons into the bores by hand, place a small block of wood over the pistons and dust boots. Use a C-clamp around the wooden block and brake caliper housing in order to push in the pistons.

5. Install the brake caliper.

   Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

6. Install the brake hose.
7. Loosely assemble the brake hose nut to the brake caliper.

   Notice: Refer to *Fastener Notice*

8. Loosely assemble the brake hose bracket to the brake caliper.

   Tighten

   - Tighten the brake hose nut to 19 N.m (14 lb ft).
   - Tighten the brake hose bracket bolts to 32 N.m (24 lb ft).

9. Install the wheel speed sensor. Refer to in Wheel Speed Sensor Replacement in Antilock Brakes.
10. Refer to *Brake Caliper and Anchor Plate Wear Adjustment (Front,Dayton-Walther).*
11. Apply a thin coat of Brake Caliper Lubricant to the brake caliper retainer and the brake caliper spring.
12. Tap the brake caliper retainer (6) and brake caliper spring (2) into place using a brass punch and a light weight hammer. The hose in the brake caliper retainer should line up with the threaded hole in the brake caliper mounting plate (4).

    Important: The brake caliper retainer bolt boss must fit in the circular hole in the brake caliper retainer.

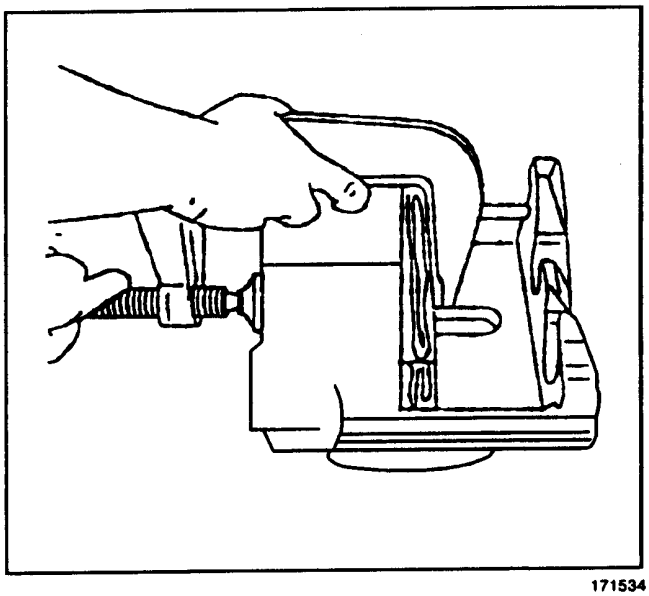
    Important: Do not reuse the brake caliper retainer bolt more than 4 times.

13. Install the brake caliper retainer bolt.

    Tighten

    Tighten the brake caliper retainer bolt to 40 N.m (29 lb ft).

14. Fill the master cylinder reservoir with brake fluid. Refer to Hydraulic Brakes.



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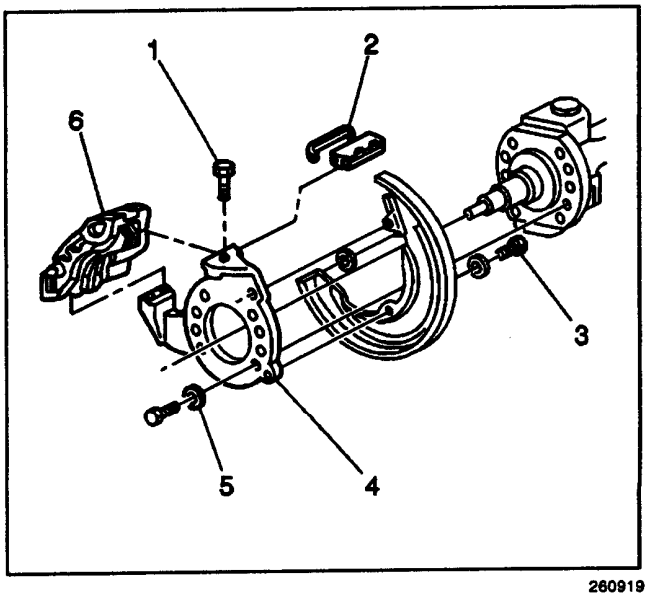
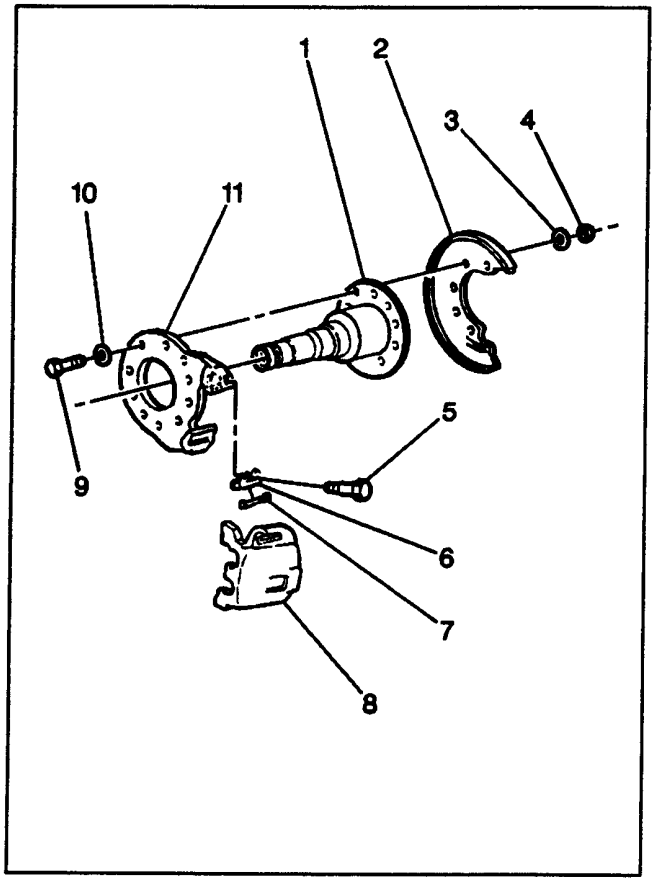


260919

15. Bleed the hydraulic brake system. Refer to Hydraulic Brakes.

    Important: Check the fluid level in the master cylinder reservoir after pumping the brake pedal.
16. Pump the brake pedal several times in order to ensure that the pedal is firm and the brake linings are adjusted.
17. Install the tires and wheels. Refer to *Wheel Removal (Front).*
18. Lower the vehicle. Refer to *Lifting and Jacking the Vehicle.*

    Caution: Do not move the vehicle until a firm brake pedal is obtained. Air in the brake system can cause the loss of brakes with possible personal injury.
19. Remove the blocks.
20. Release the parking brake.



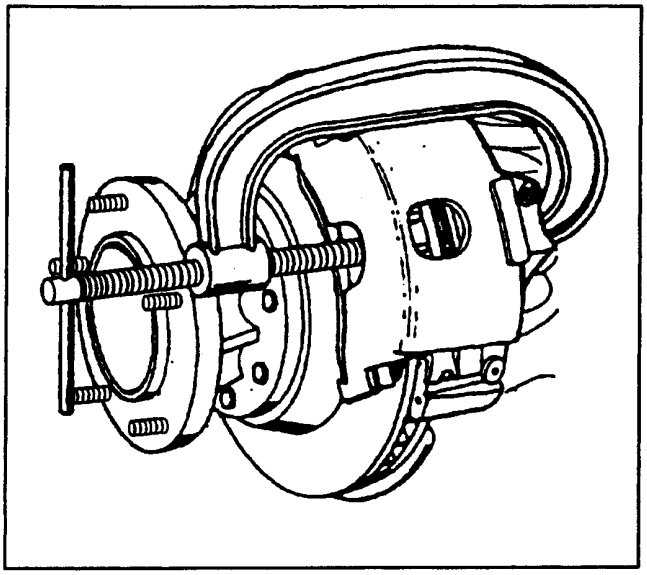
237274

Brake Caliper Replacement (Rear, Rail Slider)

Removal Procedure

1. Apply the parking brake.
2. Block the vehicle wheels.
3. Tilt the cab.
4. Remove about 2/3 of the brake fluid from the master cylinder reservoir.
   - Do not completely drain the master cylinder reservoir.
   - Drain the fluid from the brake caliper bleeder valve.
   - Drain the fluid into a suitable container. Discard the fluid.
5. Raise the vehicle. Support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle.*
6. Remove the tires and wheels. Refer to *Wheel Removal (Front).*
7. Remove the brake caliper retainer screw.
8. Remove the brake caliper retainer and the brake caliper spring (11) using a brass punch.
9. Compress the pistons.

10. Use a C-clamp between the inner brake caliper housing and the outer brake pad.

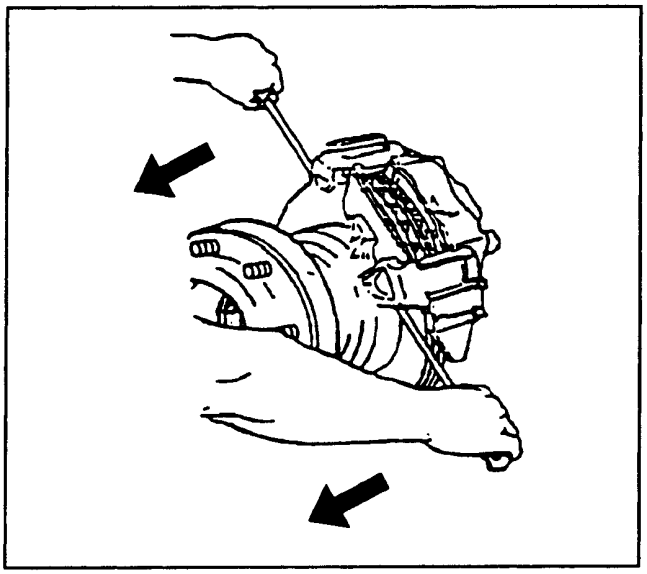


156331

11. Use screwdrivers in order to pry between the outer brake caliper housing and the outer brake pad.
12. While compressing the pistons, watch the reservoir for possible brake fluid overflow. The inner brake pad may stay on the brake caliper mounting plate (Bendix® caliper).
13. Remove the wheel speed sensor. Refer to in Wheel Speed Sensor Replacement in Antilock Brakes.
14. Disconnect the brake hose.

    Notice: Do not allow calipers to hang from the flexible hoses. Doing so can damage the hoses.
15. Remove the brake hose.

    Important:
    - Do not let the brake caliper hang from the brake hose. Suspend the brake caliper with a wire or cord.
    - Removing the brake hose from the brake caliper when replacing the brake pad assemblies is not always necessary.
    - Clean the area around the brake hose on the brake caliper.
    - Cap or tape the fitting in order to prevent dirt from entering the brake hose.
16. Remove the brake caliper.



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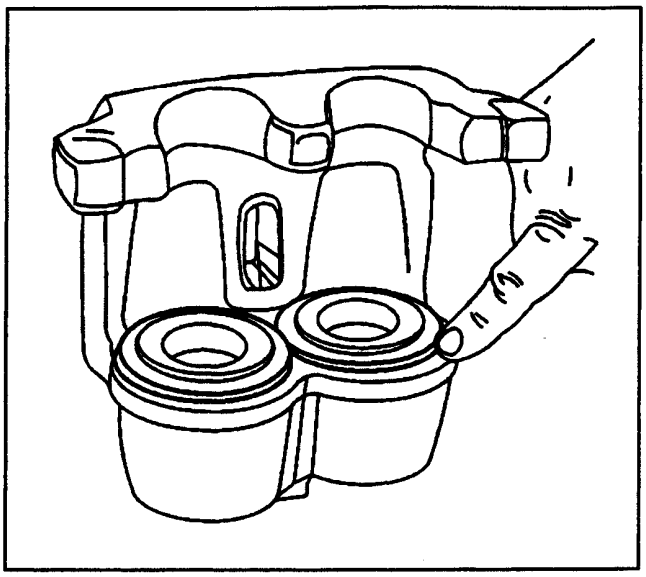

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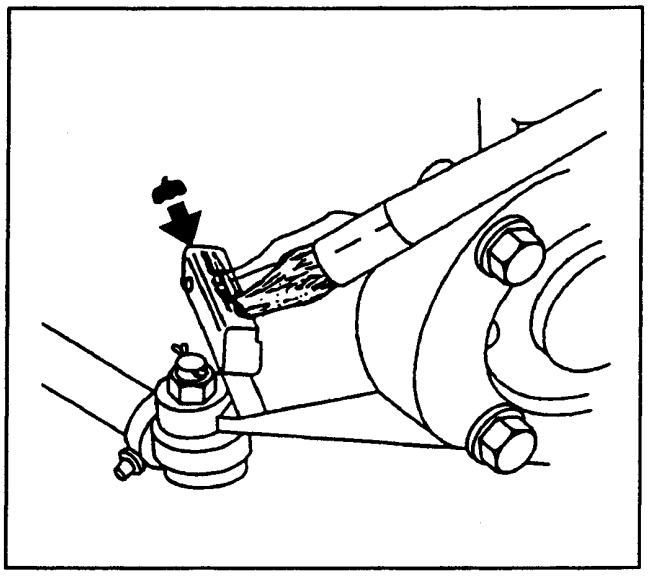


171530

Inspection Procedure

1. Inspect the inside of the brake caliper for brake fluid leaks. If you find a leak, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Dayton-Walther Rail Slider).*
2. Inspect the piston seal for leaks and brake fluid around the dust boot, the heat shield, and the inboard brake pad.
3. Inspect the dust boots for any damage. If you find damage, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Dayton-Walther Rail Slider).*
4. Inspect the V-way surfaces on the brake caliper.
5. Inspect the V-way surfaces on the brake caliper mounting plate.
6. Inspect the dust shields. If the dust shields are loose, replace the shields.
7. Inspect under the dust boots for leakage. If you find leakage, overhaul the brake caliper. Refer to *Brake Caliper Overhaul (Dayton-Walther Rail Slider).*

Installation Procedure

1. Clean the V-way surfaces of the brake caliper with a wire brush. File smooth any deep nicks or gouges.
2. Clean the V-way surfaces of the brake caliper mounting plate with a wire brush. File smooth any deep nicks or gouges.
3. Apply a thin coat of Brake Caliper Lubricant to the brake caliper mounting plate support rail surfaces.

Important: If the piston cannot be pushed by hand, place a small block of wood over the pistons and boots. Use a C-clamp around the wood block and brake caliper housing in order to push in the pistons.

Important: Never drive the pistons into the bores with a mallet or metal tools.

4. Install the brake caliper pistons to the bottom of the bores.
5. Install the brake caliper.

   Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.
6. Install the brake hose.
7. Loosely assemble the brake hose nut to the brake caliper.

   Notice: Refer to *Fastener Notice.*
8. Loosely assemble the brake hose bracket to the brake caliper.

   Tighten

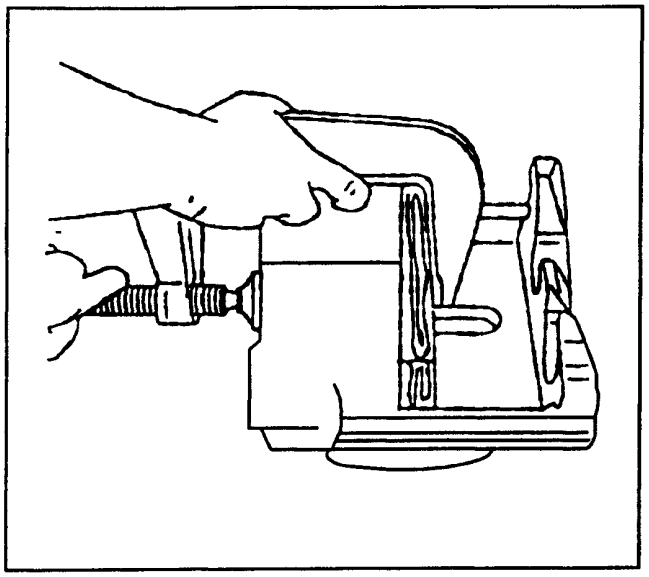
   - Tighten the brake hose nut to 19 N.m (14 lb ft).
   - Tighten the brake hose bracket bolts to 32 N.m (24 lb ft).
9. Install the wheel speed sensor. Refer to Wheel Speed Sensor Replacement in Antilock Brakes.
10. Install the brake caliper.
11. Install the brake caliper retainer spring in the support rail.
12. Select an appropriate shim. Refer to *Brake Caliper and Anchor Plate Wear Adjustment (Rear, Bendix).*
13. Apply a thin coat of Brake Caliper Lubricant to the brake caliper retainer and the brake caliper spring.
14. Tap the brake caliper retainer (3) and brake caliper spring (2) into place using a brass punch and a light weight hammer. The hose in the brake caliper retainer should line up with the threaded hole in the brake caliper mounting plate.
15. Install the brake caliper retainer screw.

    Important: The brake caliper retainer bolt boss must fit in the circular hole in the brake caliper retainer.

    Important: Do not reuse the brake caliper retainer bolt more than 4 times.
16. Install the brake caliper retainer bolt.

    Tighten

    Tighten the brake caliper retainer bolt to 40 N.m (29 lb ft).
17. Fill the master cylinder reservoir with brake fluid. Refer to Hydraulic Brakes.



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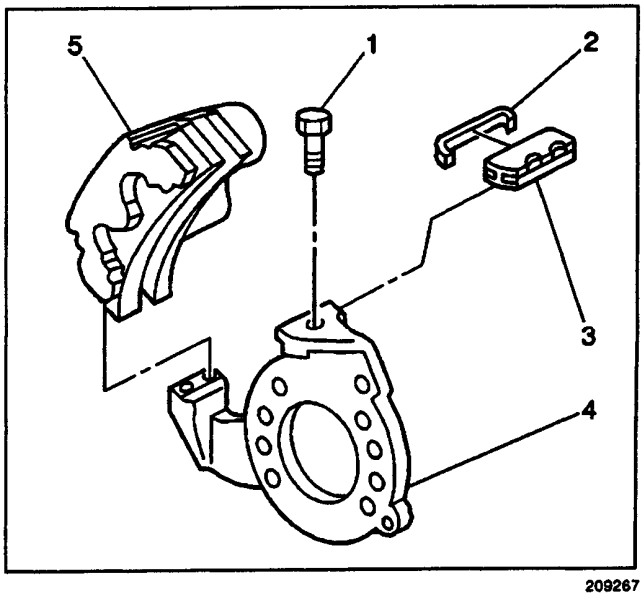


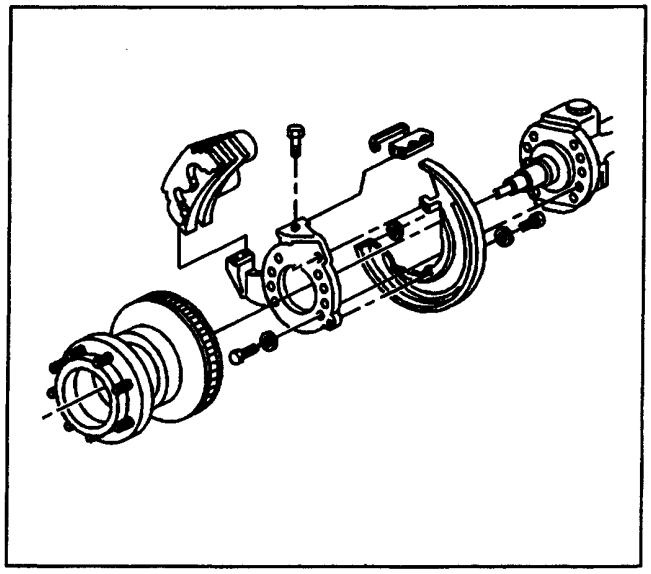
209267

18. Bleed the hydraulic brake system. Refer to Hydraulic Brakes.

    Important: Check the fluid level in the master cylinder reservoir after pumping the brake pedal.

    Pump the brake pedal several times in order to ensure that the pedal is firm and the brake linings are adjusted.
19. Install the tires and wheels. Refer to *Wheel Removal (Front).*
20. Lower the vehicle.

    Caution: Do not move the vehicle until a firm brake pedal is obtained. Air in the brake system can cause the loss of brakes with possible personal injury.
21. Remove the blocks.



237266

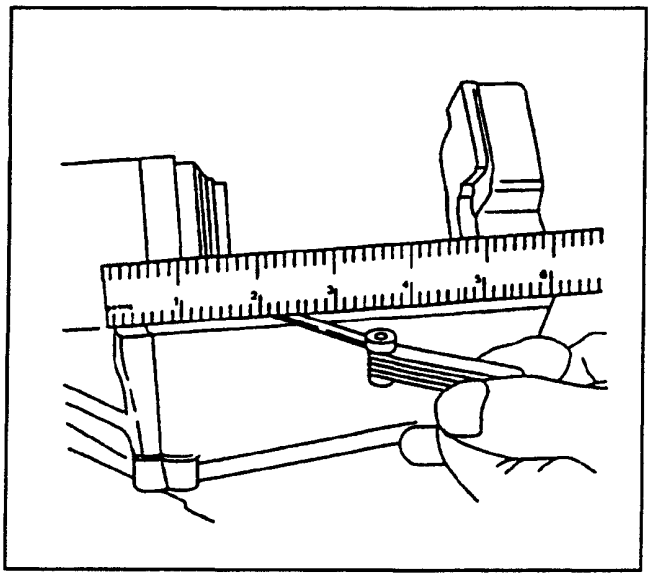
Brake Caliper and Anchor Plate Wear Adjustment (Front, Bendix)

Shim Selection

1. Remove the brake caliper retainer screw.
2. Tap out the brake caliper retainer and the brake caliper retainer spring.
3. Remove the brake caliper. Refer to *Brake Caliper Replacement (Front, Bendix).*
4. Clean the V-way surfaces of the brake caliper with a wire brush.

   File smooth any nicks and gouges.
5. Clean the support rail surfaces of the brake caliper mounting plate with a wire brush.

   File smooth any nicks and gouges.



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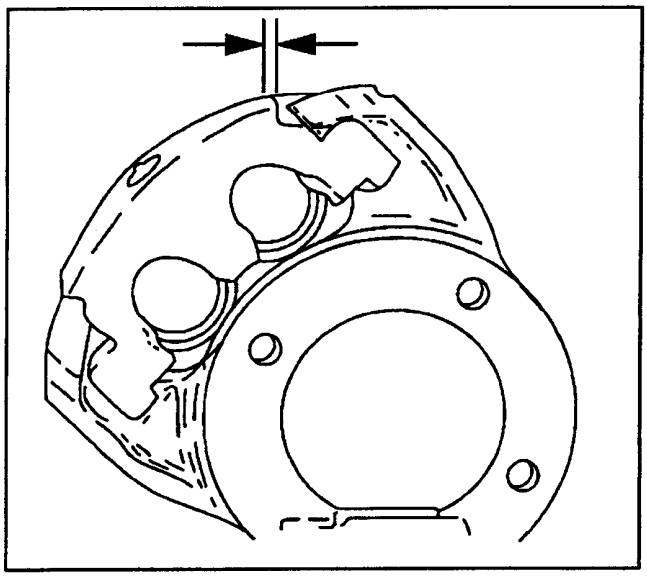
6. Lay a straight edge across the brake caliper V-way surfaces.
7. Measure the maximum depth of the brake caliper V-way surfaces.
8. If the brake caliper V-way surfaces are worn to a depth of 1.27 mm (0.050 in) or more, replace the brake caliper.
9. Temporarily mount the brake caliper on the brake caliper mounting plate.
10. Install a new brake caliper retainer.
11. Install the brake caliper retainer bolt.

    Important:
    - Do not install the spring at this time.
    - Make sure that the tool is equally distant from each edge of the brake caliper.
12. Insert a screwdriver between the brake caliper and the brake caliper retainer.
13. Pry firmly in order to ensure that the brake caliper is seated against all three slide surfaces.

14. Measure the bumper gap with the largest feeler gage (or stack of gages) that fit in the gap on either side of the screwdriver.
15. Select the correct size shim.
    - If the gap measurement is 0.0–1.47 mm (0.0–0.058 in), no shim is required.
    - If the gap measurement is 1.50–2.57 mm (0.059–0.101 in), use a shim thickness of 0.64 mm (0.025 in).
    - If the gap measurement is 2.59–3.68 mm (0.102–0.145 in), use a shim thickness of 1.14 mm (0.045 in).
16. If the gap exceeds 3.68 mm (0.145 in), replace with a new brake caliper.
17. Re-measure the gap.
18. If the bumper gap with the new brake caliper is 1.49–3.68 mm (0.059–0.145 in), Insert a screwdriver between the brake caliper and the brake caliper retainer, and pry firmly in order to ensure that the brake caliper is seated against all three slide surfaces.
19. If the bumper gap with the new brake caliper exceeds 3.68 mm (0.145 in), replace the brake caliper mounting plate.


237228

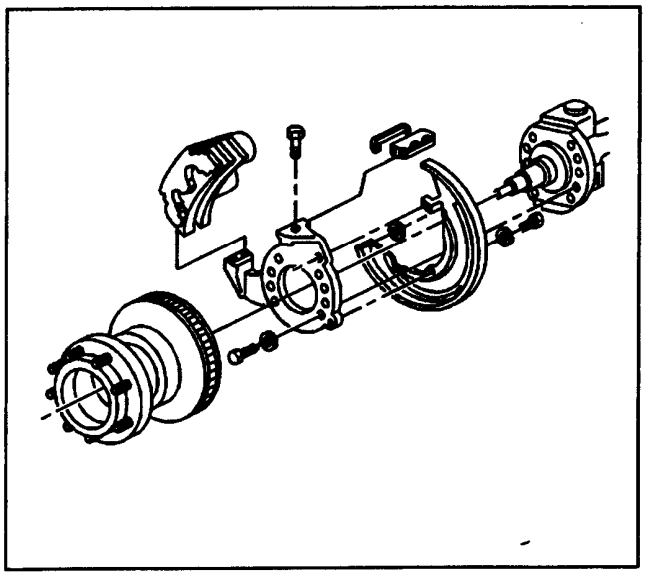
Important: Use a new brake caliper retainer and brake caliper retainer spring in order to assemble the new components.

20. Remove the brake caliper.
21. Install the selected shim on the brake caliper mounting plate support rail opposite to the brake caliper retainer and spring V-way.
22. Install the brake caliper.

    Notice: Refer to *Fastener Notice*
23. Install the brake caliper retainer screw.

    Tighten

    Tighten the screw to 40 N·m (29 lb ft).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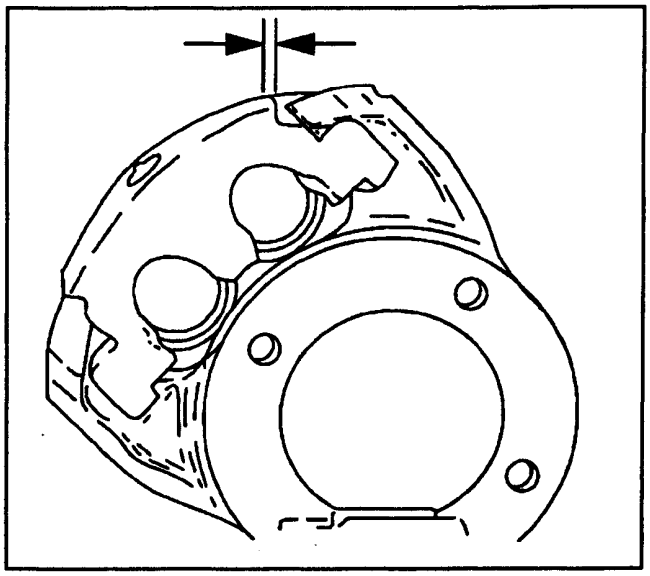

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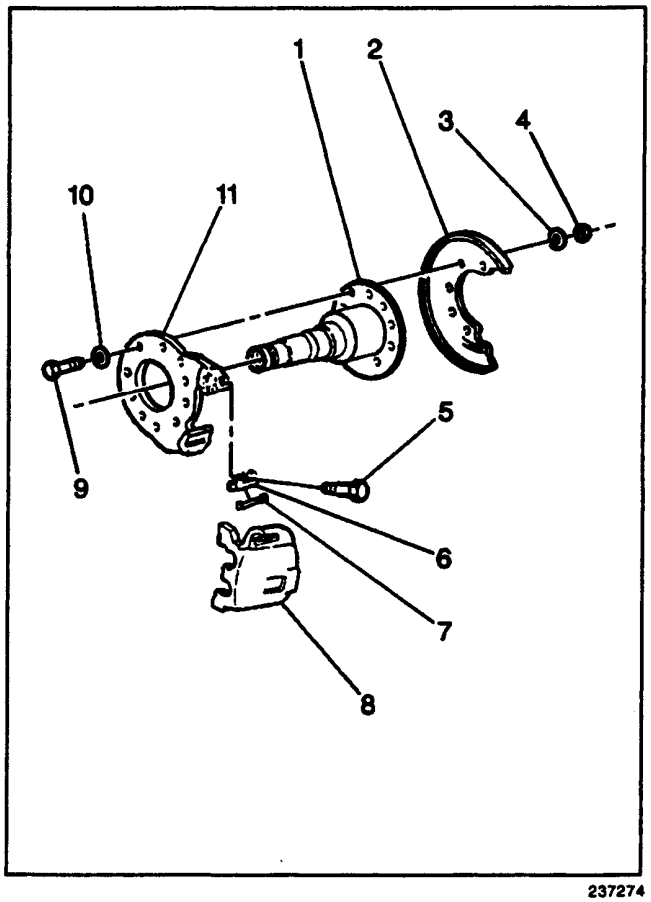
24. Marie the bumper gap.
25. If the gap exceeds 1.47 mm (0.058 in), install a thicker shim or replace the components as necessary.



237274

Brake Caliper and Anchor Plate Wear Adjustment (Rear, Bendix)

Shim Selection

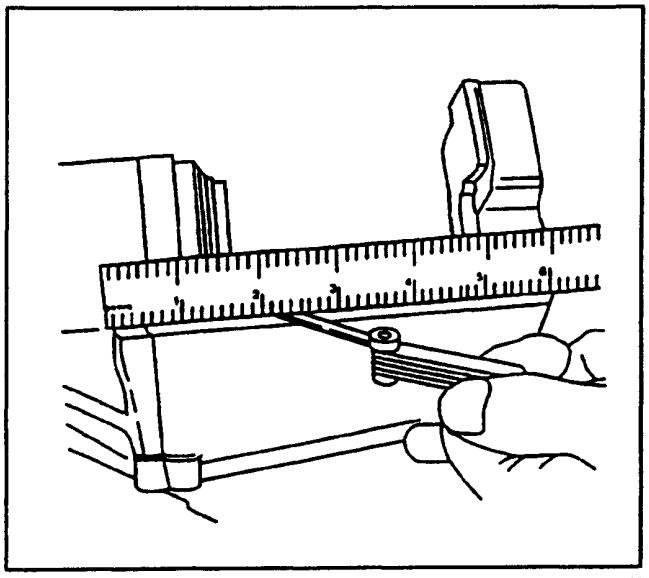
1. Remove the brake caliper retainer screw (5).
2. Tap out the brake caliper retainer (6) and the brake caliper retainer spring (7).
3. Remove the brake caliper. Refer to *Brake Caliper Replacement (Front, Bendix)*
4. Clean the V-way surfaces of the brake caliper with a wire brush.

   File smooth any nicks and gouges.
5. Clean the support rail surfaces of the brake caliper mounting plate with a wire brush.

   File smooth any nicks and gouges.

6. Lay a straight edge across the brake caliper V-way surfaces.
7. Measure the maximum depth of the brake caliper V-way surfaces.
8. If the brake caliper V-way surfaces are worn to a depth of 1.27 mm (0.050 in) or more, replace the brake caliper.
9. Temporarily mount the brake caliper on the brake caliper mounting plate.
10. Install a new brake caliper retainer.
11. Install the brake caliper retainer bolt.

    Important:
    - Do not install the spring at this time.
    - Make sure that the tool is equally distant from each edge of the brake caliper.
12. Insert a screwdriver between the brake caliper and the brake caliper retainer.
13. Pry firmly in order to ensure that the brake caliper is seated against all three slide surfaces.
14. Measure the bumper gap with the largest feeler gage (or stack of gages) that fit in the gap on either side of the screwdriver.
15. Select the correct size shim.
    - If the gap measurement is 0.0–1.47 mm (0.0–0.058 in), no shim is required.
    - If the gap measurement is 1.50–2.57 mm (0.059–0.101 in), use a shim thickness of 0.64 mm (0.025 in).
    - If the gap measurement is 2.59–3.68 mm (0.102–0.145 in), use a shim thickness of 1.14 mm (0.045 in).
16. If the gap exceeds 3.68 mm (0.145 in), replace with a new brake caliper.
17. Re-measure the gap.
18. If the bumper gap with the new brake caliper is 1.49–3.68 mm (0.059–0.145 in), Insert a screwdriver between the brake caliper and the brake caliper retainer, and pry firmly in order to ensure that the brake caliper is seated against all three slide surfaces.
19. If the bumper gap with the new brake caliper exceeds 3.68 mm (0.145 in), replace the brake caliper mounting plate.



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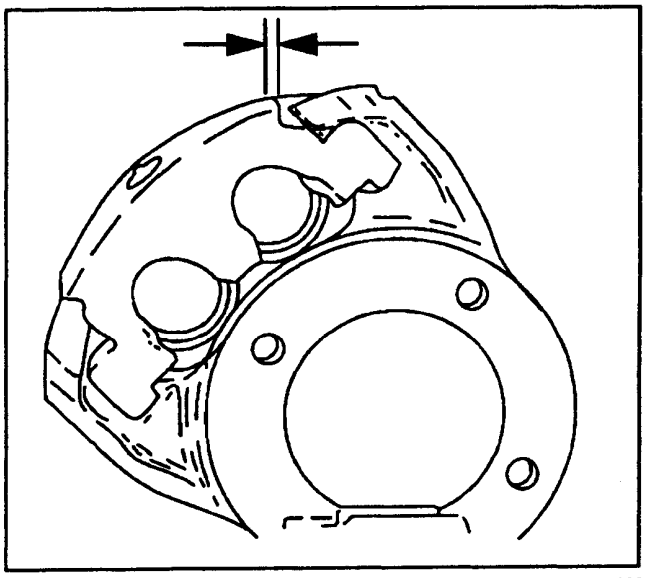

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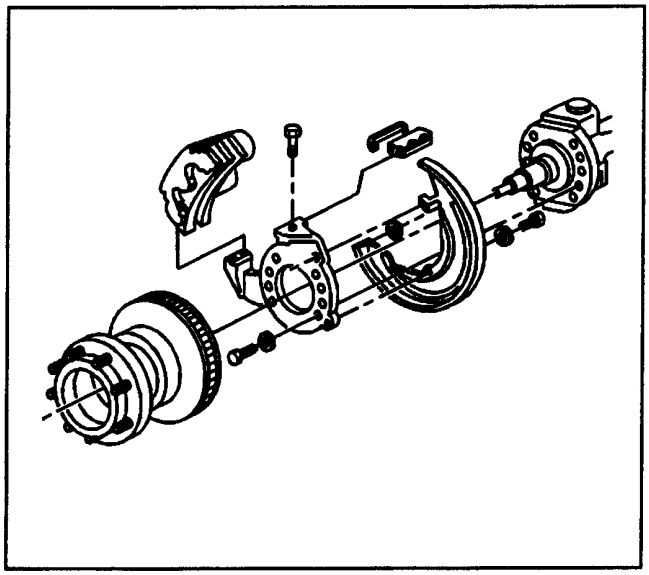


237266

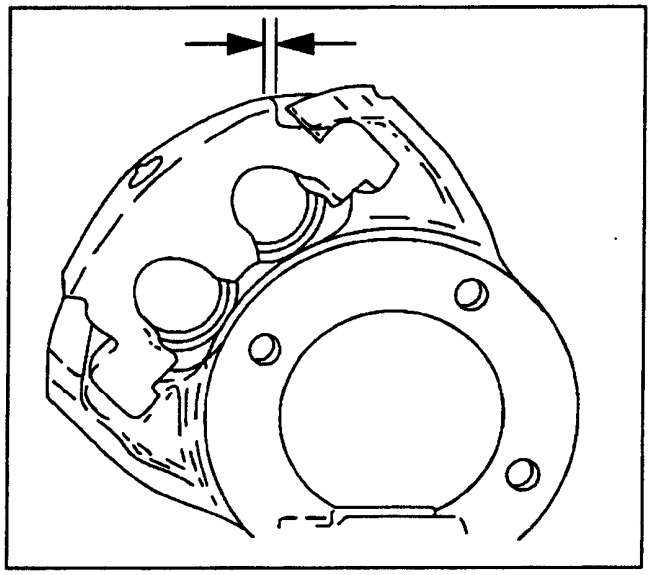
Important: Use a new brake caliper retainer and brake caliper retainer spring in order to assemble the new components.

20. Remove the brake caliper.
21. Install the selected shim on the brake caliper mounting plate support rail opposite to the brake caliper retainer and spring V-way.
22. Install the brake caliper.

    Notice: Refer to *Fastener Notice*
23. Install the brake caliper retainer screw.

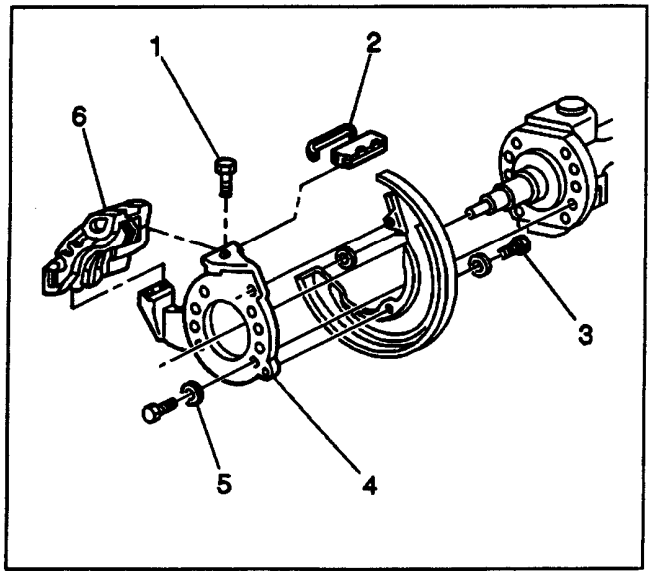
    Tighten

    Tighten the screw to 40 N·m (29 lb ft).



237228

24. Measure the bumper gap.
25. If the gap exceeds 1.47 mm (0.058 in), install a thicker shim or replace the components as necessary.



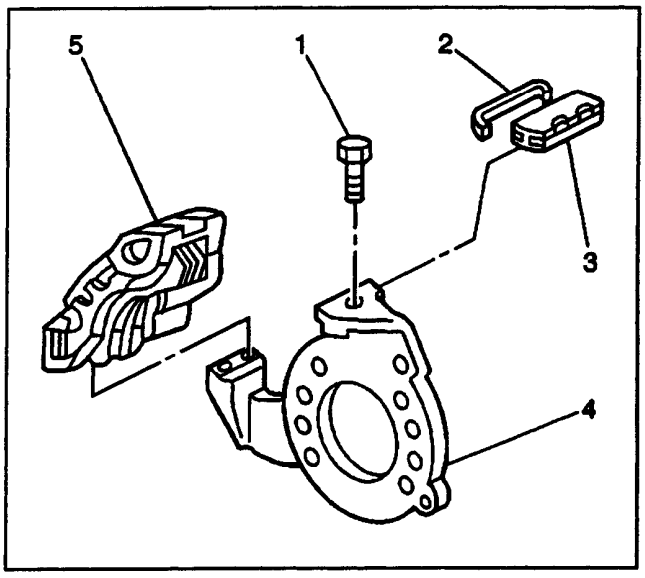
260919

Brake Caliper and Anchor Plate Wear Adjustment (Front, Dayton-Walther)

The brake caliper V-ways and brake caliper mounting plate support rails will wear and eventually cause the brake caliper to fit loosely. Dayton-Walther brakes use shims to adjust for this wear. Follow these steps when replacing the linings.

1. Remove the brake caliper retainer screw (1).
2. Tap out the brake caliper retainer (4) and the brake caliper retainer spring (2).
3. Remove the brake caliper (6). Refer to *Brake Caliper Replacement (Front, Dayton-Walther).*

4. Clean the V-way surfaces of the brake caliper (5) with a wire brush.
   File smooth any nicks and gouges.
5. Clean the support rail surfaces of the brake caliper mounting plate (4) with a wire brush.
   File smooth any nicks and gouges.
6. Temporarily mount the brake caliper on the brake caliper mounting plate.
7. Install a new brake caliper retainer (3).
8. Install the brake caliper retainer bolt (1).
9. Use a screwdriver in order to turn the vanes of the brake rotor in the forward direction. This will jam the brake caliper support rail in contact with the brake caliper mounting plate support rail.
10. Measure the brake caliper retainer gap with a feeler gauge laid full length in the gap.
    - If the gap is 0.89 mm (0.035 in), or less then no shim is needed.
    - If the gap is more than 0.89 mm (0.035 in), continue with step 10.
    - If the gap is greater than 2.92 mm (0.115 in), replace the brake caliper mounting plate. Refer to *Brake Caliper Replacement (Front, Dayton-Walther)*.
11. Select the correct size shim.
    - If the gap measurement is 0.91–1.40 mm (0.036–0.055 in), use a shim thickness of 0.51 mm (0.020 in).
    - If the gap measurement is 1.42–1.91 mm (0.056–0.075 in), use a shim thickness of 1.07 mm (0.042 in).
    - If the gap measurement is 1.93–2.41 mm (0.076–0.095 in), use a shim thickness of 1.47 mm (0.058 in).
    - If the gap measurement is 2.44–2.92 mm (0.096–0.115 in), use a shim thickness of 1.83 mm (0.072 in).
12. Remove the brake caliper retainer bolt.
13. Remove the brake caliper retainer.
14. Remove the brake caliper spring.



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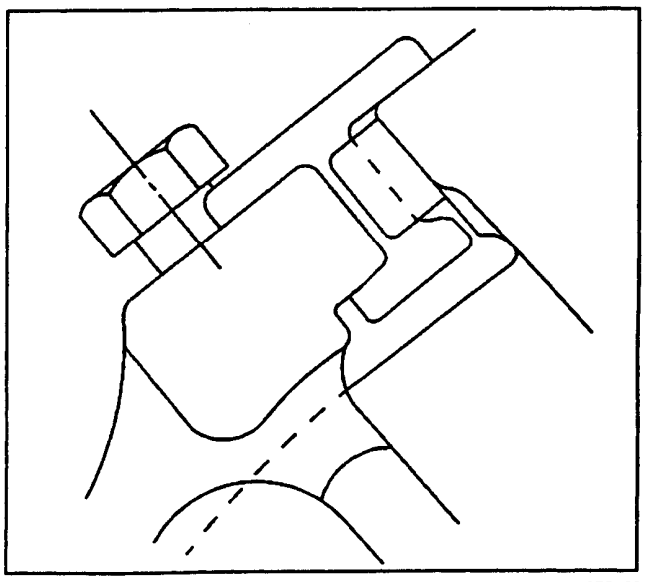
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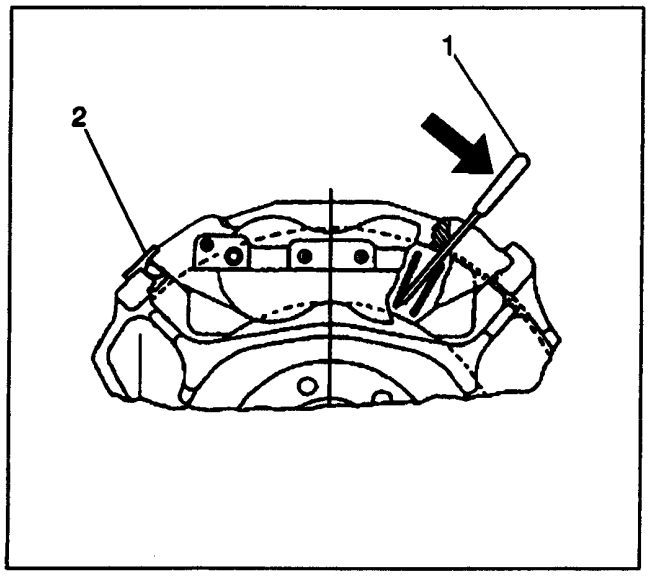
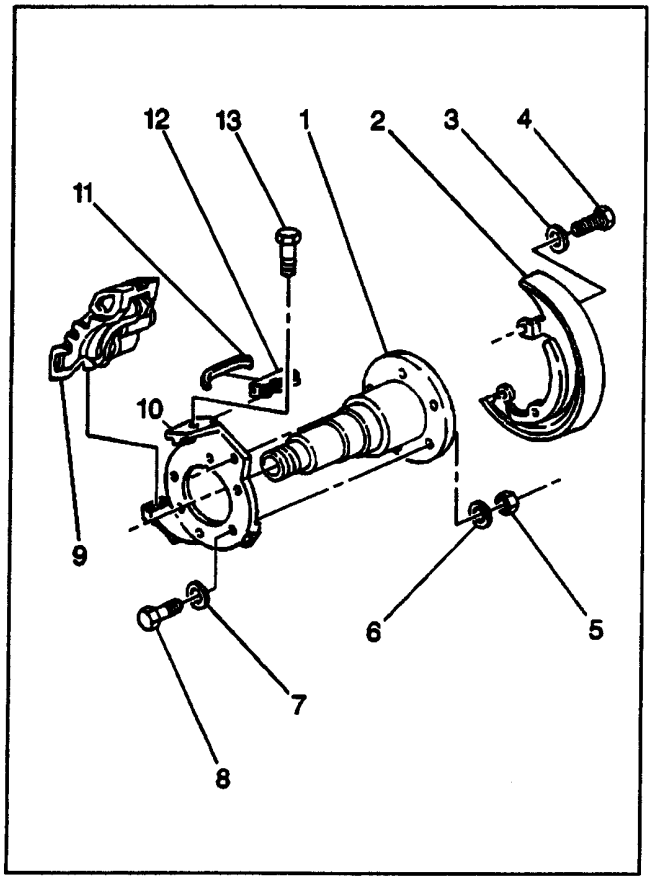


22098

15. Lift the forward (1) end of the brake caliper enough in order to provide clearance between the brake caliper and the brake caliper mounting plate support rail.

    This permits installation of the shim.

    Important: Place the shim with the widest side of the shim fitting against the widest surface of the brake caliper mounting plate.
16. Lower the brake caliper to the caliper's original position with the shim in place.
17. Install the brake caliper. Refer to *Brake Caliper Replacement (Front, Dayton-Walther).*



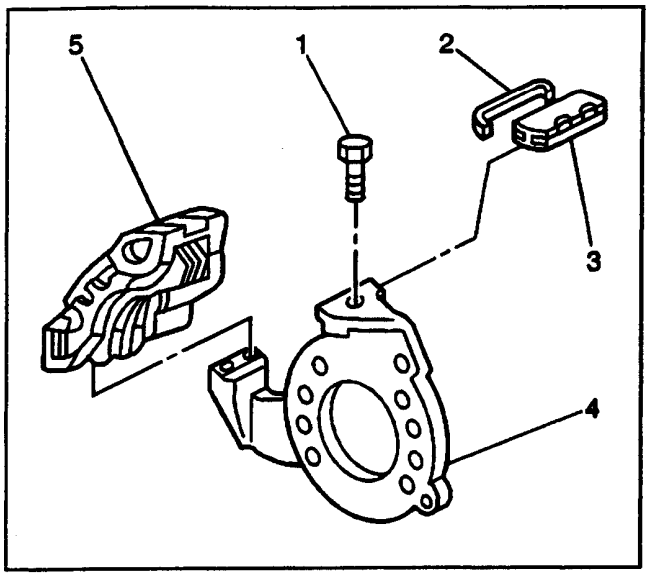
237280

Brake Caliper and Anchor Plate Wear Adjustment (Rear, Dayton-Walther)

The brake caliper V-ways and brake caliper mounting plate support rails will wear and eventually cause the brake caliper to fit loosely. Dayton-Walther brakes use shims to adjust for this wear. Follow these steps when replacing the linings.

1. Remove the brake caliper retainer screw (8).
2. Tap out the brake caliper retainer (12) and the brake caliper retainer spring (11).
3. Remove the brake caliper. Refer to *Brake Caliper Replacement (Rear, Rail Slider).*

4. Clean the V-way surfaces of the brake caliper (5) with a wire brush.
   File smooth any nicks and gouges.
5. Clean the support rail surfaces of the brake caliper mounting plate (4) with a wire brush.
   File smooth any nicks and gouges.
6. Temporarily mount the brake caliper on the brake caliper mounting plate.
7. Install a new brake caliper retainer (3).
8. Install the brake caliper retainer bolt (1).
9. Use a screwdriver in order to turn the vanes of the brake rotor in the forward direction. This will jam the brake caliper support rail in contact with the brake caliper mounting plate support rail.
10. Measure the brake caliper retainer gap with a feeler gauge laid full length in the gap.
    - If the gap is 0.89 mm (0.035 in), or less then no shim is needed.
    - If the gap is more than 0.89 mm (0.035 in), continue with step 10.
    - If the gap is greater than 2.92 mm (0.115 in), replace the brake caliper mounting plate. Refer to *Brake Caliper Replacement (Rear, Rail Slider).*
11. Select the correct size shim.
    - If the gap measurement is 0.91–1.40 mm (0.036–0.055 in), use a shim thickness of 0.51 mm (0.020 in).
    - If the gap measurement is 1.42–1.91 mm (0.056–0.075 in), use a shim thickness of 1.07 mm (0.042 in).
    - If the gap measurement is 1.93–2.41 mm (0.076–0.095 in), use a shim thickness of 1.47 mm (0.058 in).
    - If the gap measurement is 2.44–2.92 mm (0.096–0.115 in), use a shim thickness of 1.83 mm (0.072 in).
12. Remove the brake caliper retainer bolt.
13. Remove the brake caliper retainer.
14. Remove the brake caliper spring.



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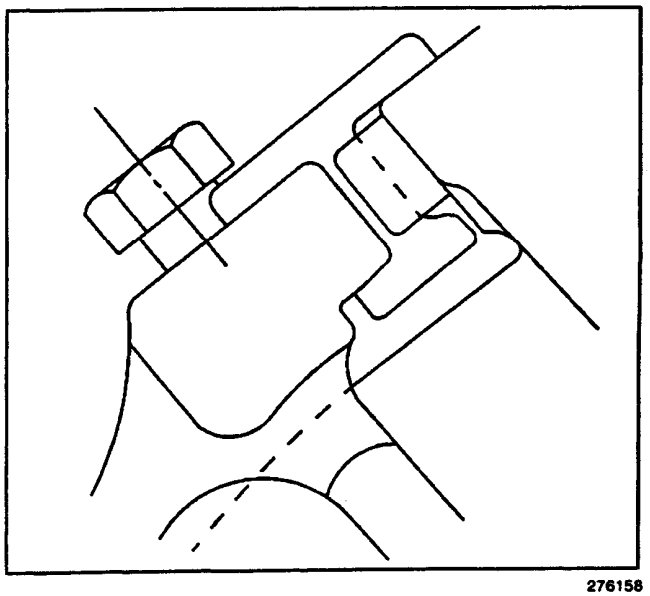
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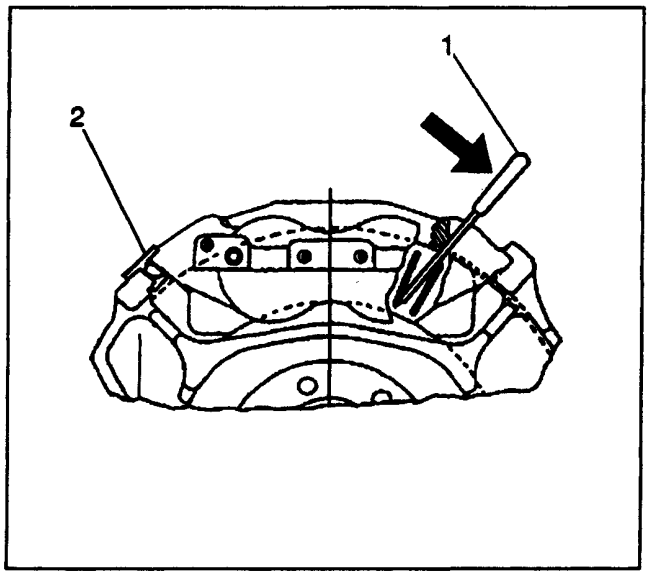
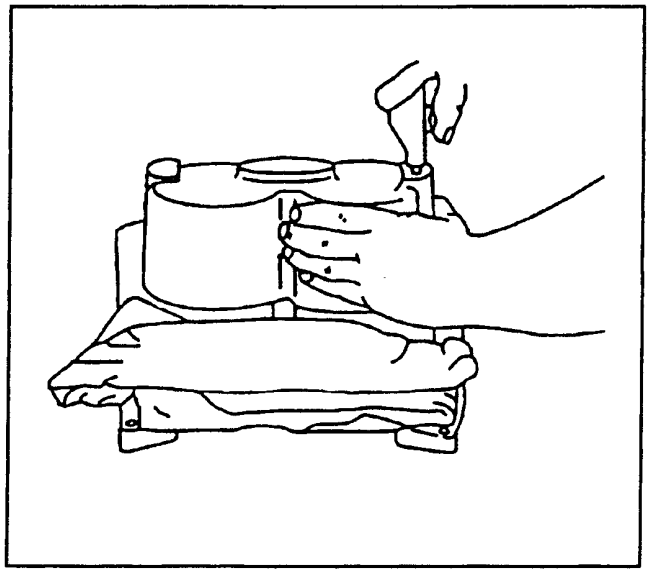


22098

15. Lift the forward end of the brake caliper enough in order to provide clearance between the brake caliper and the brake caliper mounting plate support rail.

    This permits installation of the shim.

    Important: Place the shim with the widest side of the shim fitting against the widest surface of the brake caliper mounting plate.
16. Lower the brake caliper to the caliper's original position with the shim in place.
17. Install the brake caliper. Refer to *Brake Caliper Replacement (Rear, Rail Slider).*



171564

Brake Caliper Overhaul (Bendix Rail Slider)

Disassembly Procedure

1. Remove the brake fluid from the brake caliper.
2. Clean the exterior of the brake caliper.

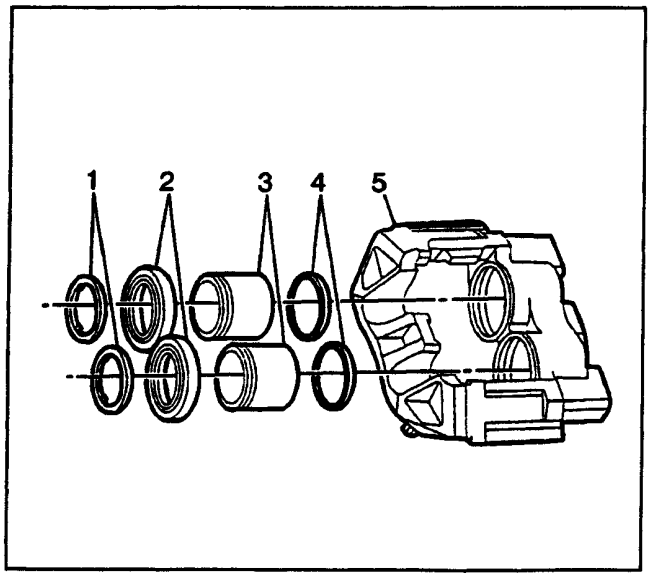
   Caution: Do not place your fingers in front of the piston in order to catch or protect the piston while applying compressed air. This could result in serious injury.

   Notice: Use only enough air to ease the piston out of the bore. If the piston is blown out, even with the padding, it can be damaged.
3. Remove the pistons from the bore by directing compressed air in to the caliper brake fluid inlet in order to remove the pistons from the caliper bore.
4. Pad the exterior of the brake caliper with a clean shop towel.

Important:

- Use just enough air pressure in order to ease the pistons out of the bore.
- If only one piston is blown loose, it may be necessary to reinsert the piston part way and block it in position.
- Apply air pressure in order to free the remaining piston.

5. Remove the heat shields (1).
6. Remove the dust boots (2).



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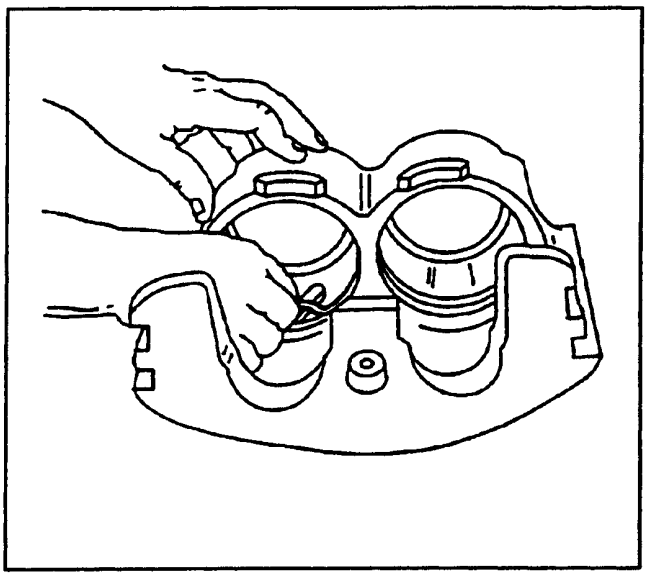
7. Remove the piston seals from the groove in the caliper bore using a pointed piece of wood or plastic.
8. Remove the brake caliper bleeder valve.



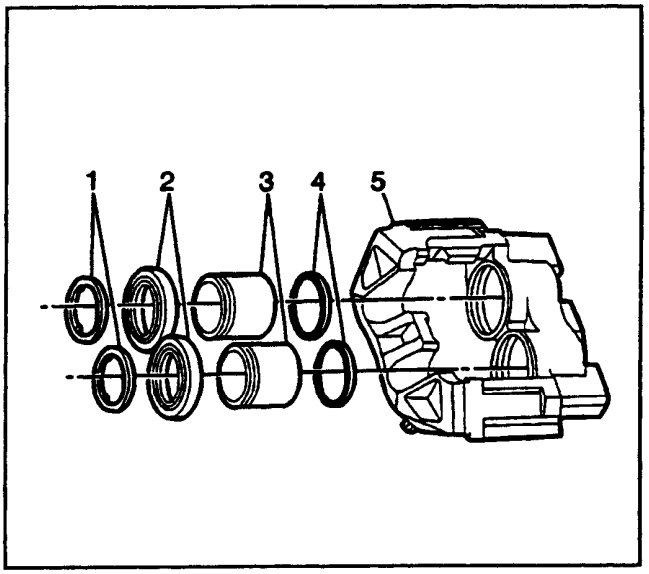
171569

Notice: Do not use mineral base cleaning solvents such as gasoline, kerosene, carbon tetrachloride, acetone, or paint thinner to clean the brake caliper. These solvents will cause rubber parts to become soft and swollen in an extremely short time.

9. Clean all of the parts in Brake Parts Cleaner.
10. Blow out all of the passages in the brake caliper housing (5) and the brake caliper bleeder valve.

    Use dry, filtered, unlubricated compressed air.
11. Clean the brake caliper support rail surfaces with a wire brush.
12. Inspect the support rail surfaces for rust or corrosion.
13. Inspect the brake caliper housing for cracks or other damage. Replace the caliper housing if necessary.
14. Inspect the outside diameter of the pistons for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

    Important: The outside diameter of the piston is the primary sealing surface of the brake caliper. The piston diameter is manufactured to very close tolerances. Do not refinish the piston diameter. Do not use abrasives on the piston diameter.
15. If you find any surface faults, replace the piston.



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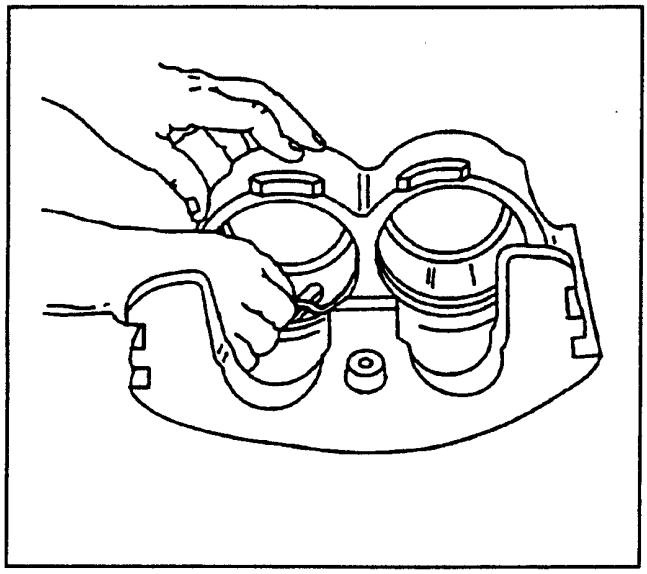
16. Inspect the caliper bore for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

    Important: Do not use any abrasive on the caliper bore, including emery cloth.
17. Polish out stains and minor corrosion from the caliper bore with crocus cloth.

    If you cannot remove the stains and corrosion with crocus cloth, replace the caliper.
18. Clean the caliper bore after using the crocus cloth.



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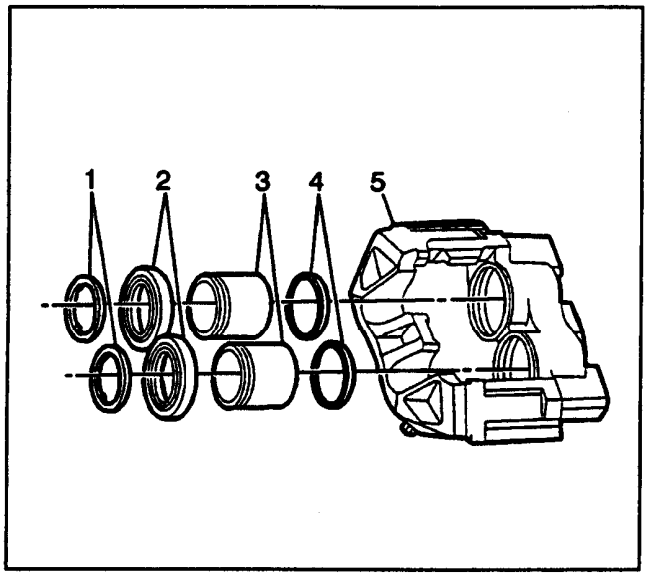
Assembly Procedure

1. Place the brake caliper housing on a clean work bench with the open ends of the caliper bores facing up.
2. Dip the new piston seal in Brake Fluid.
3. Gently work the piston seal around the caliper bore with a finger until the seal seats in the piston seal groove.
4. Ensure that the piston seal is not twisted or rolled in the groove.
5. Lubricate the piston and the caliper bore with Brake Fluid.
6. Gently push the piston into the caliper bore.
7. Rotate the piston slightly in order to prevent dislodging the piston seal.



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8. Press the dust boot (2) into the counterbore in the brake caliper housing (5).

   The dust boot fits in a counterbore in the brake caliper housing, and overlaps the stepped edge of the piston.
9. Install a new heat shield (1) on the piston (3). The shield's chamfer faces out.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
10. Install the brake caliper bleeder valve.

    Tighten

    Tighten the brake caliper bleeder valve to 17 N·m (13 lb ft).

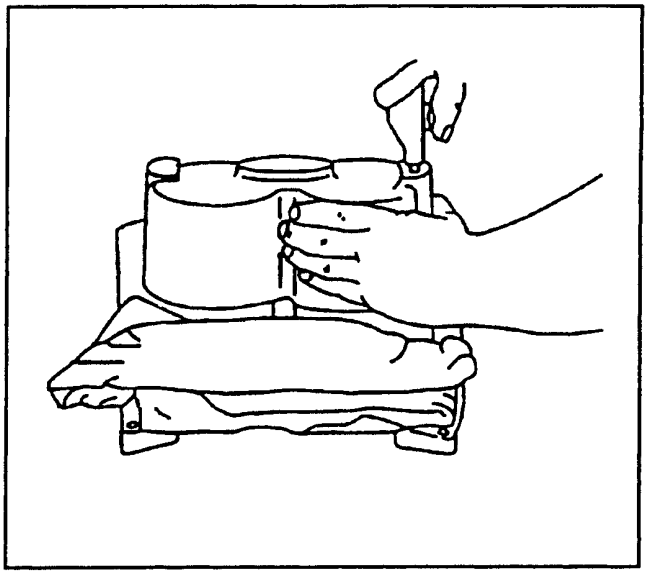
Brake Caliper Overhaul (Dayton-Walther Rail Slider)

Disassembly Procedure

1. Remove the brake fluid from the brake caliper.
2. Clean the exterior of the brake caliper.

   Caution: Do not place your fingers in front of the piston in order to catch or protect the piston while applying compressed air. This could result in serious injury.

   Notice: Use only enough air to ease the piston out of the bore. If the piston is blown out, even with the padding, it can be damaged.
3. Remove the pistons from the bore by directing compressed air in to the caliper brake fluid inlet in order to remove the pistons from the caliper bore.
4. Pad the exterior of the brake caliper with a clean shop towel.



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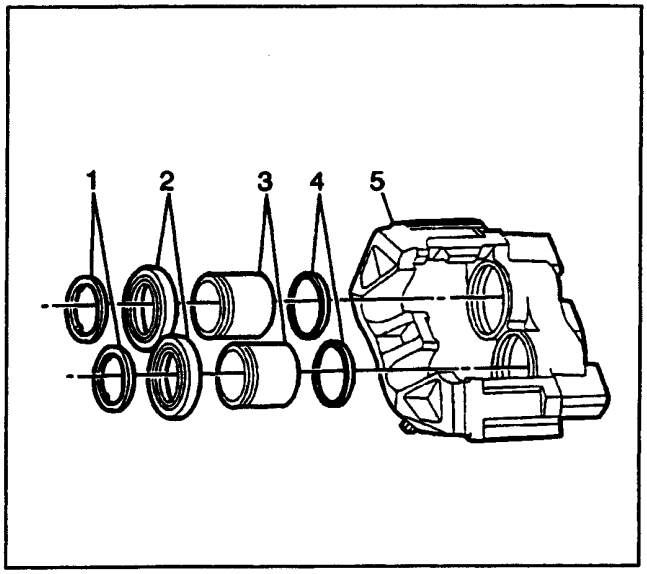
Important:

- Use just enough air pressure in order to ease the pistons out of the bore.
- If only one piston is blown loose, it may be necessary to reinsert the piston part way and block it in position.
- Apply air pressure in order to free the remaining piston.

5. Remove the heat shields (1).
6. Remove the dust boots (2).



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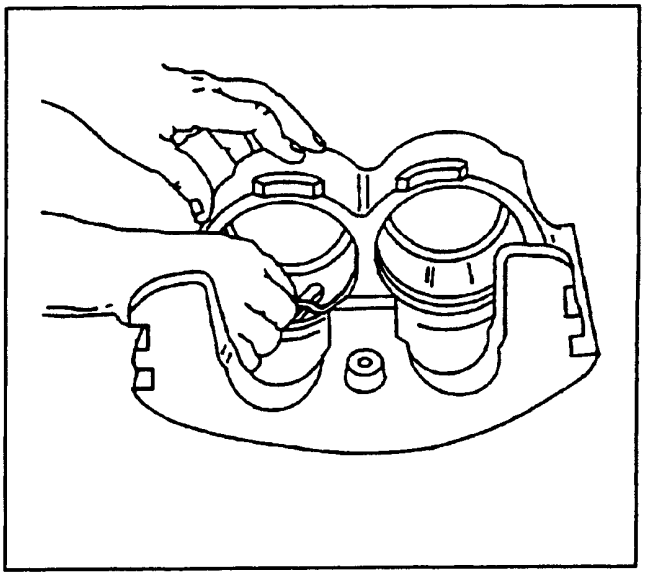
7. Remove the piston seals from the groove in the caliper bore using a pointed piece of wood or plastic.
8. Remove the brake caliper bleeder valve.



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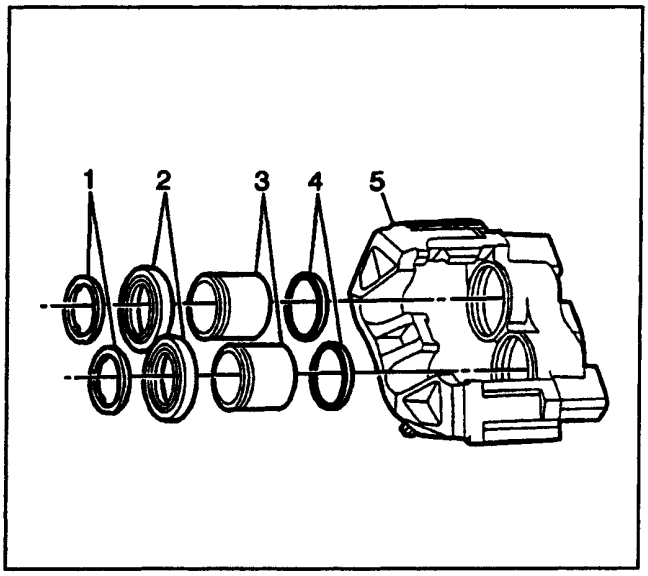

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Notice: Do not use mineral base cleaning solvents such as gasoline, kerosene, carbon tetrachloride, acetone, or paint thinner to clean the brake caliper. These solvents will cause rubber parts to become soft and swollen in an extremely short time.

9. Clean all of the parts in Brake Parts Cleaner.
10. Blow out all of the passages in the brake caliper housing (5) and the brake caliper bleeder valve.

    Use dry, filtered, unlubricated compressed air.
11. Clean the brake caliper support rail surfaces with a wire brush.
12. Inspect the support rail surfaces for rust or corrosion.
13. Inspect the brake caliper housing for cracks or other damage. Replace the caliper housing if necessary.
14. Inspect the outside diameter of the pistons for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

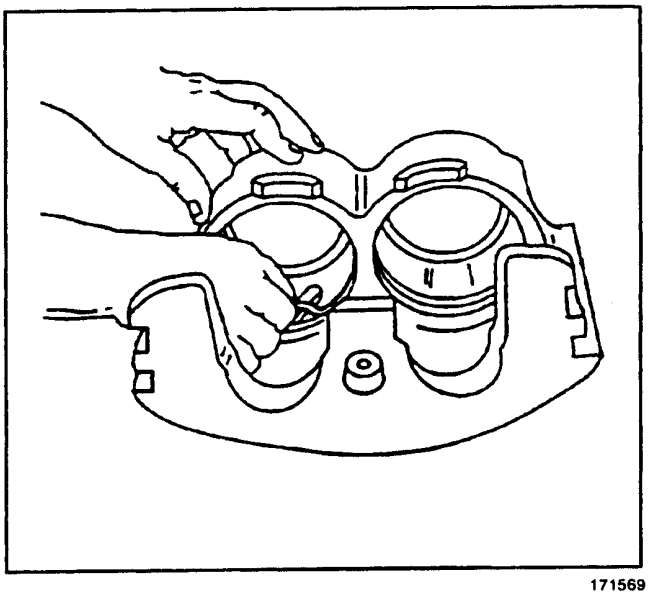
    Important: The outside diameter of the piston is the primary sealing surface of the brake caliper. The piston diameter is manufactured to very close tolerances. Do not refinish the piston diameter. Do not use abrasives on the piston diameter.
15. If you find any surface faults, replace the piston.
16. Inspect the caliper bore for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

    Important: Do not use any abrasive on the caliper bore, including emery cloth.
17. Polish out stains and minor corrosion from the caliper bore with crocus cloth.

    If you cannot remove the stains and corrosion with crocus cloth, replace the caliper.
18. Clean the caliper bore after using the crocus cloth.

Assembly Procedure

1. Place the brake caliper housing on a clean work bench with the open ends of the caliper bores facing up.
2. Dip the new piston seal in Brake Fluid.
3. Lubricate the caliper bore with Brake Fluid.
4. Gently work the piston seal (4) into the caliper bore piston seal groove until the seal seats properly.
5. Ensure that the piston seal is not twisted or rolled in the groove.



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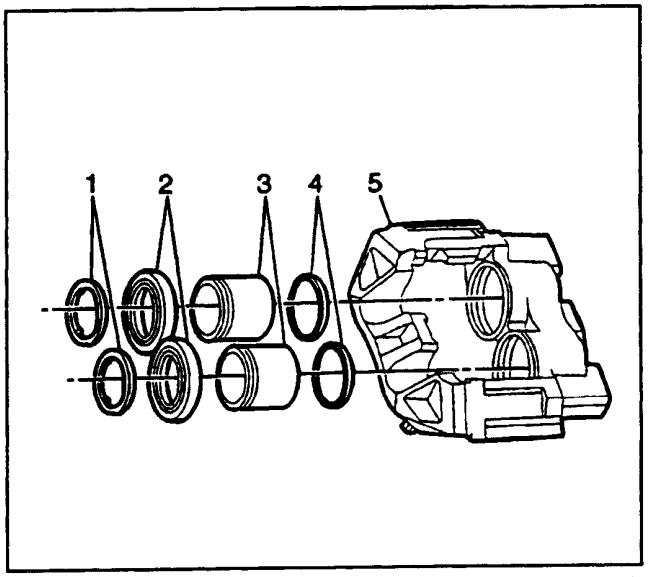
6. Install a new dust boot (2) into the caliper bore.

   Important:
   - Apply even force and slightly rotate the piston (3). This avoids cocking the piston in the caliper bore and dislodging the piston seal.
   - The dust boot will slide into the piston.
   - Ensure that the dust boot seats evenly into the piston groove.
7. Install the piston through boot and into the bore.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
8. Install the brake caliper bleeder valve.

   Tighten

   Tighten the brake caliper bleeder valve to 17 N.m (13 lb ft).



171587

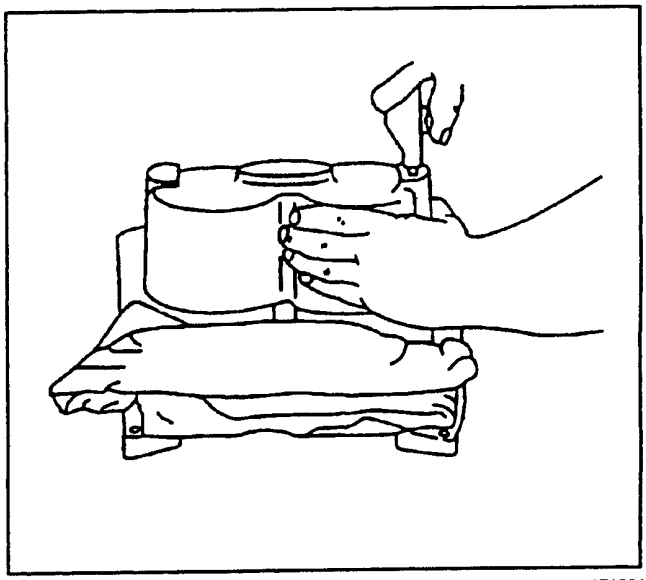
Brake Caliper Overhaul (Bendix)

Disassembly Procedure

1. Remove the brake fluid from the brake caliper.
2. Clean the exterior of the brake caliper.

   Caution: Do not place your fingers in front of the piston in an attempt to catch or protect it when applying compressed air. This could result in serious injury.

   Notice: Use only enough air to ease the piston out of the bore. If the piston is blown out, even with the padding, it can be damaged.
3. Remove the pistons from the bore by directing compressed air in to the caliper brake fluid inlet in order to remove the pistons from the caliper bore.
4. Pad the exterior of the brake caliper with a clean shop towel.



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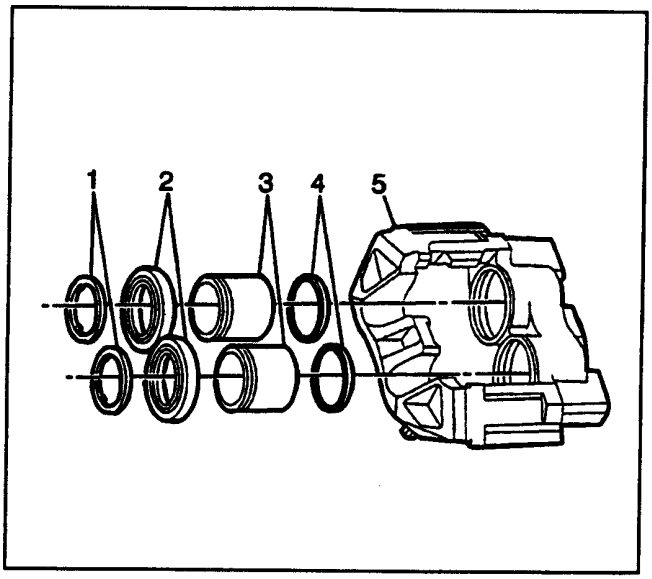
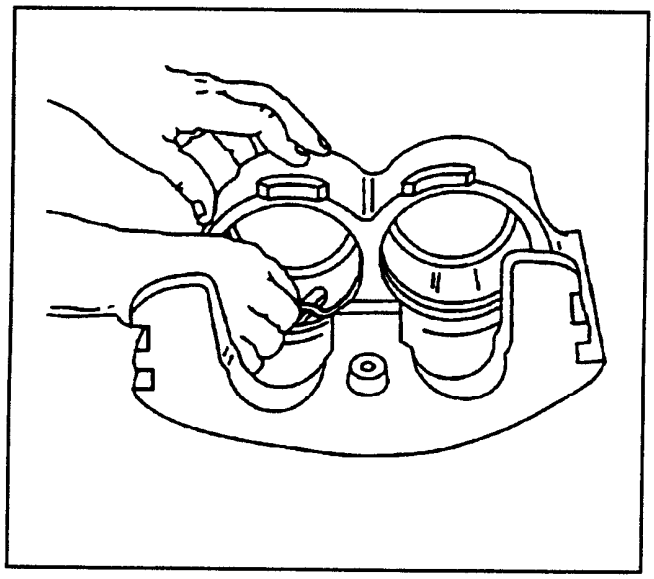


171587

Important:

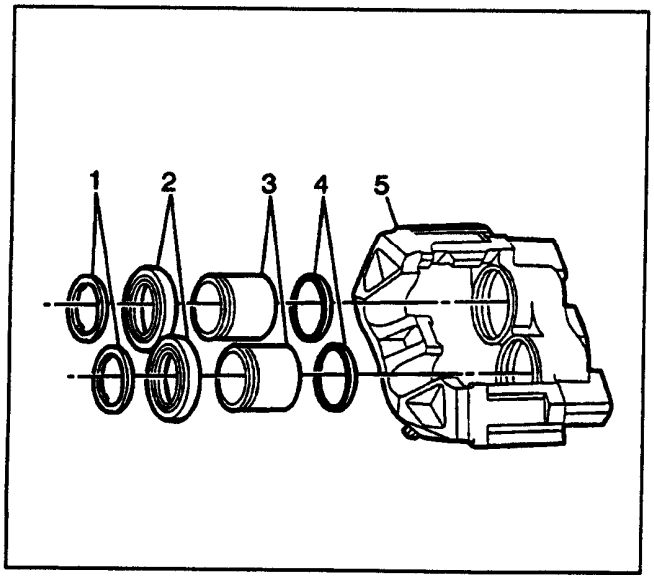
- Use just enough air pressure in order to ease the pistons out of the bore.
- If only one piston is blown loose, it may be necessary to reinsert the piston part way and block it in position.
- Apply air pressure in order to free the remaining piston.

5. Remove the heat shields (1).
6. Remove the dust boots (2).



171569

7. Remove the piston seals from the groove in the caliper bore using a pointed piece of wood or plastic.
8. Remove the brake caliper bleeder valve.



171587

Notice: Do not use mineral base cleaning solvents such as gasoline, kerosene, carbon tetrachloride, acetone, or paint thinner to clean the brake caliper. These solvents will cause rubber parts to become soft and swollen in an extremely short time.

9. Clean all of the parts in Brake Parts Cleaner.
10. Blow out all of the passages in the brake caliper housing (5) and the brake caliper bleeder valve.

    Use dry, filtered, unlubricated compressed air.
11. Clean the brake caliper support rail surfaces with a wire brush.
12. Inspect the support rail surfaces for rust or corrosion.
13. Inspect the brake caliper housing for cracks or other damage. Replace the caliper housing if necessary.

14. Inspect the outside diameter of the pistons for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

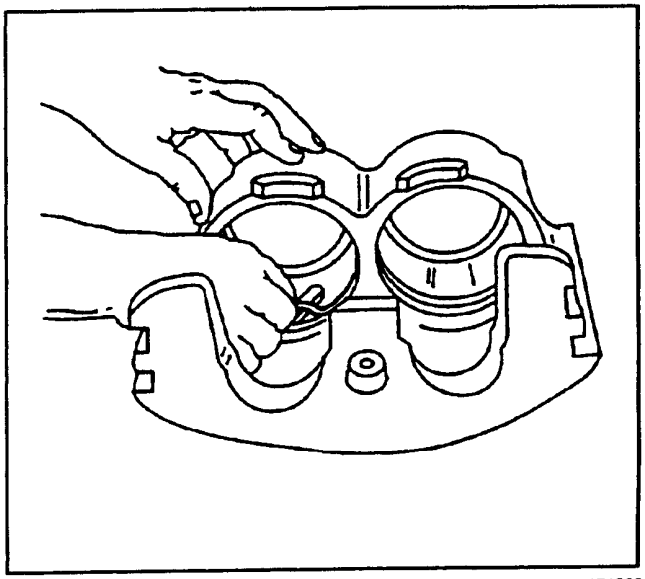
    Important: The outside diameter of the piston is the primary sealing surface of the brake caliper. The piston diameter is manufactured to very close tolerances. Do not refinish the piston diameter. Do not use abrasives on the piston diameter.
15. If you find any surface faults, replace the piston.
16. Inspect the caliper bore for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

    Important: Do not use any abrasive on the caliper bore, including emery cloth.
17. Polish out stains and minor corrosion from the caliper bore with crocus cloth.

    If you cannot remove the stains and corrosion with crocus cloth, replace the caliper.
18. Clean the caliper bore after using the crocus cloth.

Assembly Procedure

1. Place the brake caliper housing on a clean work bench with the open ends of the caliper bores facing up.
2. Dip the new piston seal in Brake Fluid.
3. Gently work the piston seal around the caliper bore with a finger until the seal seats in the piston seal groove.
4. Ensure that the piston seal is not twisted or rolled in the groove.
5. Lubricate the piston and the caliper bore with Brake Fluid.
6. Gently push the piston into the caliper bore.
7. Rotate the piston slightly in order to prevent dislodging the piston seal.



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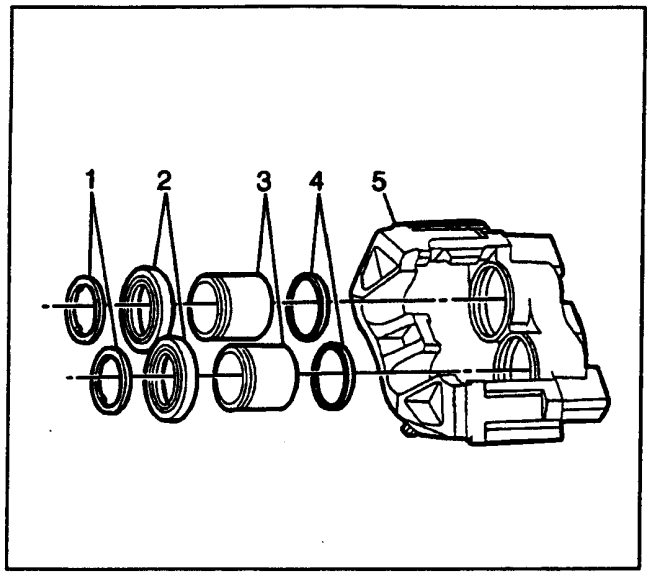


171587

8. Press the dust boot (2) into the counterbore in the brake caliper housing (5).

   The dust boot fits in a counterbore in the brake caliper housing, and overlaps the stepped edge of the piston.

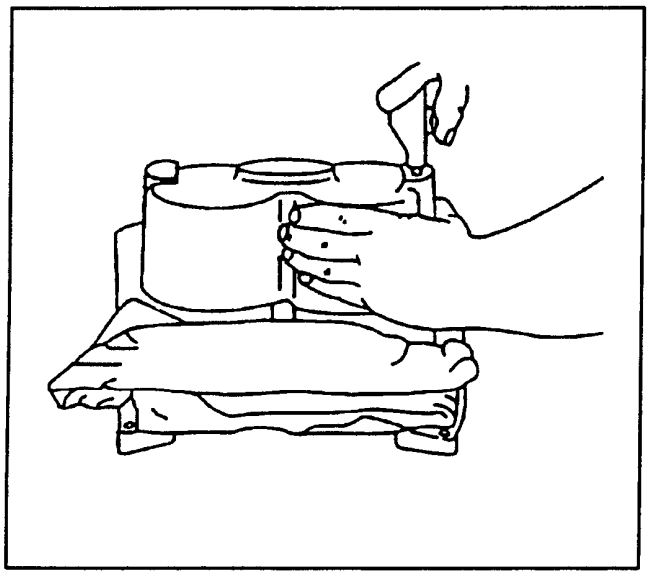
9. Install a new heat shield (1) on the piston (3). The shield's chamfer faces out.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.

10. Install the brake caliper bleeder valve.

    Tighten

    Tighten the brake caliper bleeder valve to 17 N.m (13 lb ft).



171564

Brake Caliper Overhaul (Dayton-Walther)

Disassembly Procedure

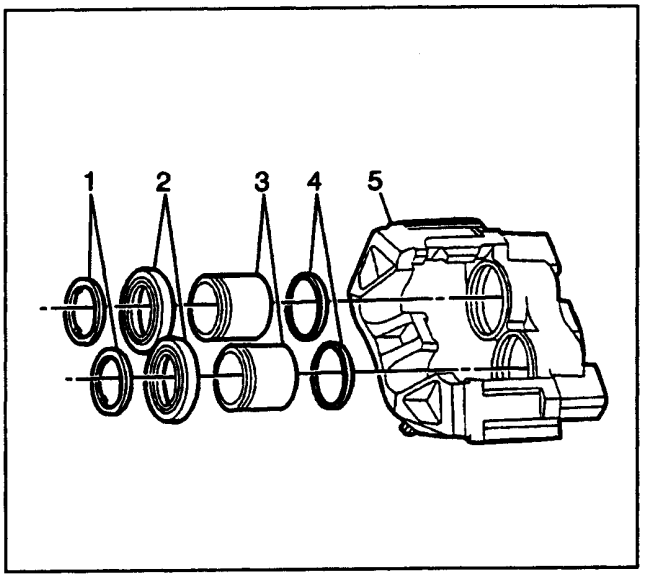
1. Remove the brake fluid from the brake caliper.
2. Clean the exterior of the brake caliper.
3. Pad the exterior of the brake caliper with a clean shop towel.

   Caution: Do not place your fingers in front of the piston in order to catch or protect the piston while applying compressed air. This could result in serious injury.

   Notice: Use only enough air to ease the piston out of the bore. If the piston is blown out, even with the padding, it can be damaged.

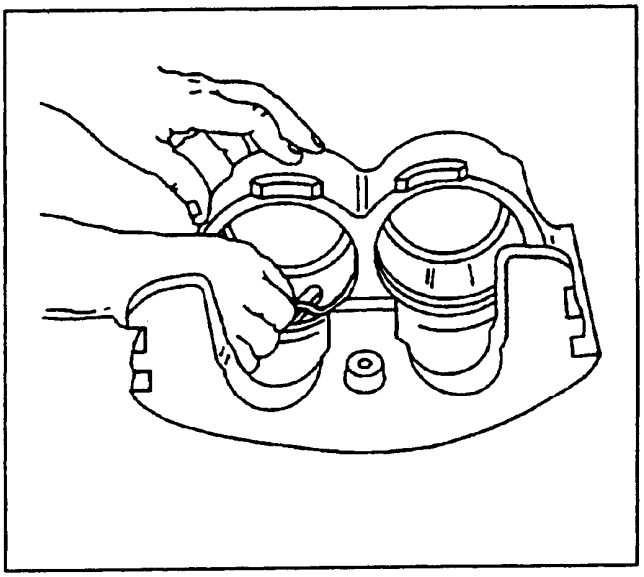
4. Direct compressed air in to the caliper brake fluid inlet in order to remove the pistons from the caliper bore.
   - 4.1. If only one piston leaves the bore, reinsert the piston part-way.
   - 4.2. Block the reinserted piston in place.
   - 4.3. Apply air pressure again. This should free the remaining piston.

5. Remove the heat shields (1).
6. Remove the dust boots (2).



171587

7. Remove the piston seals from the groove in the caliper bore using a pointed piece of wood or plastic.
8. Remove the brake caliper bleeder valve.

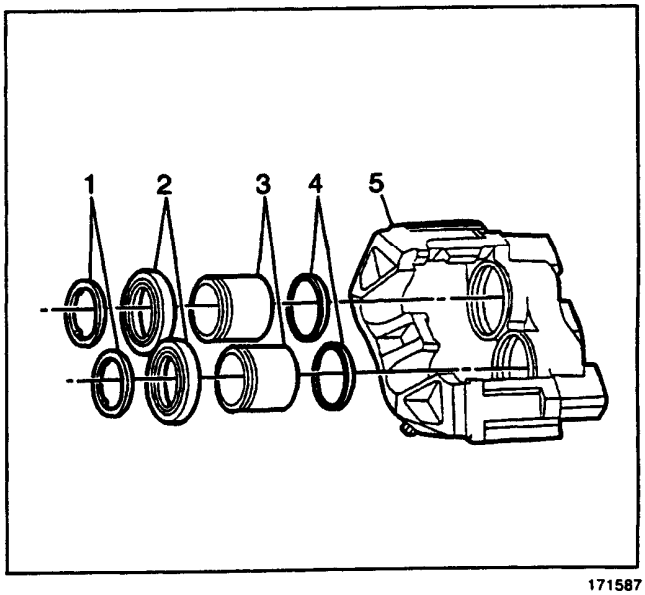


171569

Notice: Do not use mineral base cleaning solvents such as gasoline, kerosene, carbon tetrachloride, acetone, or paint thinner to clean the brake caliper. These solvents will cause rubber parts to become soft and swollen in an extremely short time.

9. Clean all of the parts in Brake Parts Cleaner.
10. Blow out all of the passages in the brake caliper housing (5) and the brake caliper bleeder valve.

    Use dry, filtered, unlubricated compressed air.
11. Clean the brake caliper support rail surfaces with a wire brush.
12. Inspect the support rail surfaces for rust or corrosion.
13. Inspect the brake caliper housing for cracks or other damage. Replace the caliper housing if necessary.



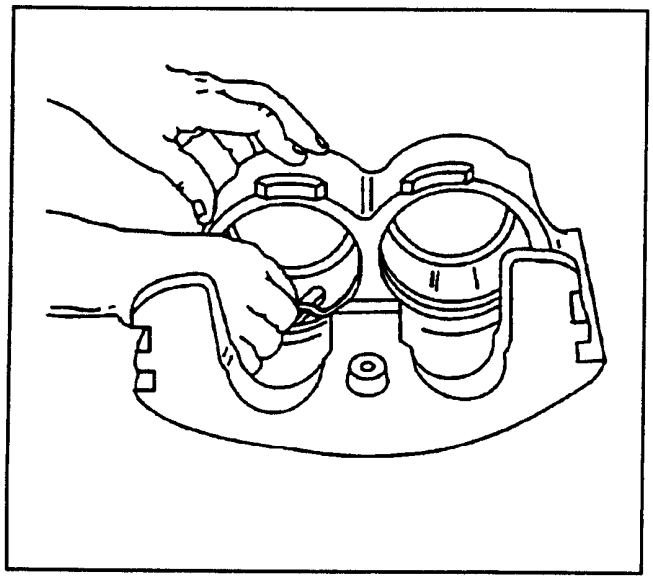
171587

14. Inspect the outside diameter of the pistons for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

    Important: The outside diameter of the piston is the primary sealing surface of the brake caliper. The piston diameter is manufactured to very close tolerances. Do not refinish the piston diameter. Do not use abrasives on the piston diameter.
15. If you find any surface faults, replace the piston.
16. Inspect the caliper bore for the following conditions:
    - Scoring
    - Nicks
    - Corrosion
    - Wear
    - Any other damage

    Important: Do not use any abrasive on the caliper bore, including emery cloth.
17. Polish out stains and minor corrosion from the caliper bore with crocus cloth.

    If you cannot remove the stains and corrosion with crocus cloth, replace the caliper.
18. Clean the caliper bore after using the crocus cloth.

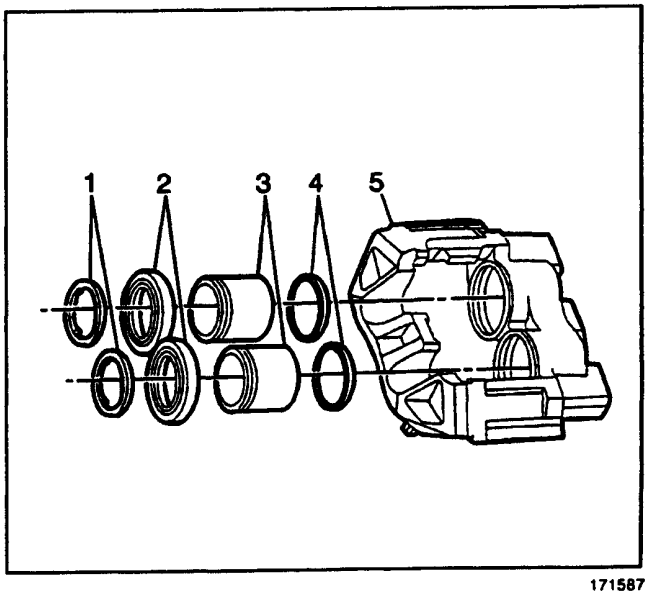


171569

Assembly Procedure

1. Place the brake caliper housing on a clean work bench with the open ends of the caliper bores facing up.
2. Dip the new piston seal in Brake Fluid.
3. Gently work the piston seal around the caliper bore with a finger until the seal seats in the piston seal groove.
4. Ensure that the piston seal is not twisted or rolled in the groove.
5. Lubricate the piston and the caliper bore.
6. Gently push the piston into the caliper bore.
7. Rotate the piston slightly in order to prevent dislodging the piston seal.

8. Press the dust boot (2) into the counterbore in the brake caliper housing (5).
   The dust boot overlaps the stepped edge of the piston.
9. Install a new heat shield (1) on the piston (3). The shield's chamfer faces out.
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
10. Install the brake caliper bleeder valve.
    Tighten
    Tighten the brake caliper bleeder valve to 17 N.m (13 lb ft).



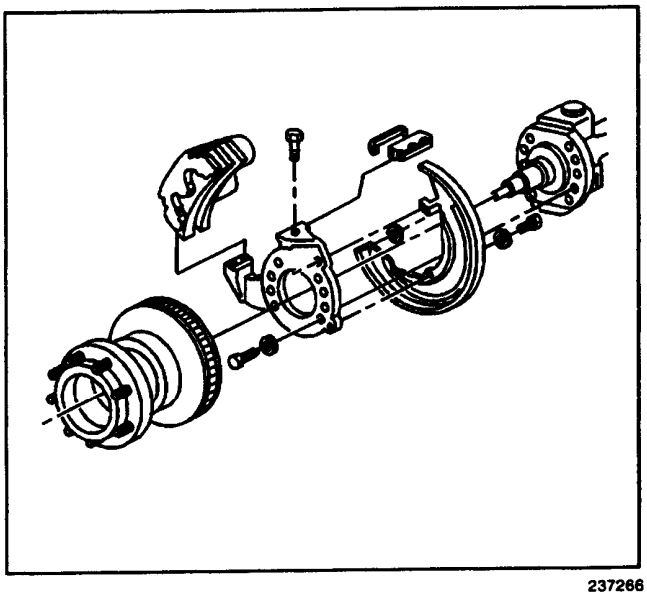
171587

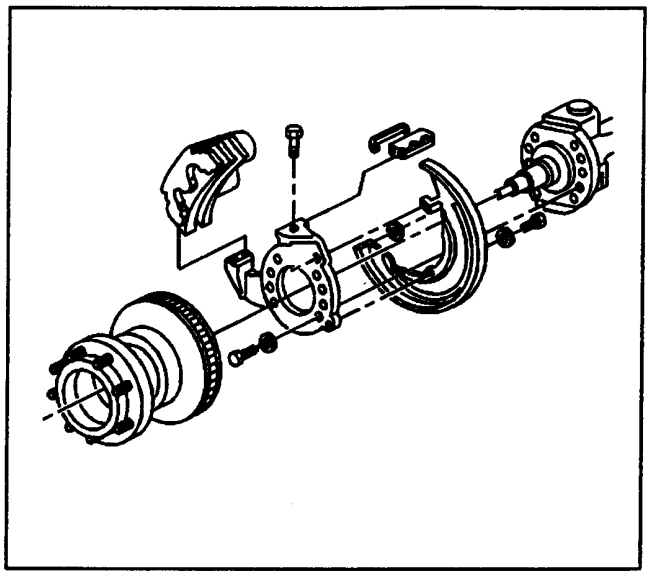
Brake Caliper Mounting Plate Replacement (Front, Bendix)

Use the brake caliper mounting plate in order to mount all of the stationary brake components. An L or R following the part number cast on the back of the plates indicates left or right side mounting. Some plates may also have an L or R painted on the front.

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Remove the brake caliper. Refer to *Brake Caliper Replacement (Front, Bendix).*
4. Remove the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Remove the bolts and washers.
6. Remove the brake caliper mounting plate .
7. Inspect the support rails for rust, corrosion, and wear.
8. Clean the support rails with a wire brush.
9. Inspect the brake caliper mounting plate for cracks or elongated bolt holes.
   Replace the mounting plate if necessary.


237266



237266

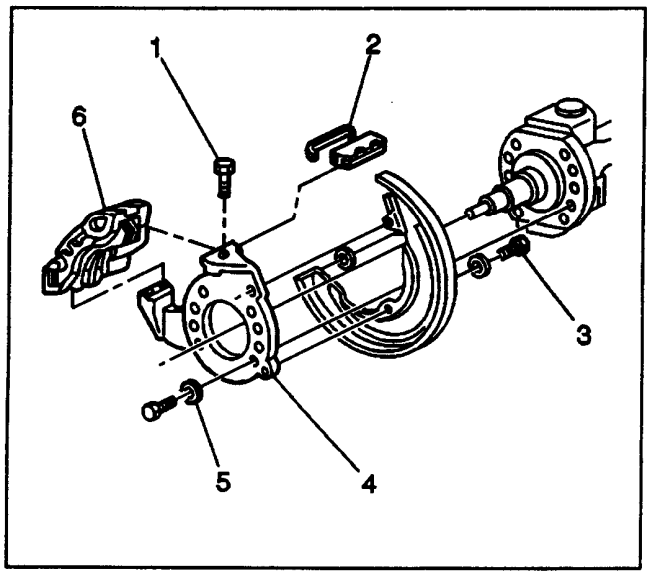
Installation Procedure

1. Install the brake caliper mounting plate to the steering knuckle.

   Important: Ensure that the threads are clean and greaseless before applying threadlocker.
2. Apply 272 Threadlocker to the threads of each brake caliper mounting plate bolt.

   Notice: Refer to *Fastener Notice.*
3. Install the bolts and washers.

   Tighten
   - Tighten the brake shield bolts to 32 N.m (24 lb ft).
   - Tighten the brake caliper mounting plate bolts to 280 N.m (206 lb ft).
4. Install the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Install the brake caliper. Refer to *Brake Caliper Replacement (Front, Bendix).*
6. Remove the blocks.



260919

Brake Caliper Mounting Plate Replacement (Front, Dayton-Walther)

Use the brake caliper mounting plate in order to mount all of the stationary brake components. An L or R following the part number cast on the back of the plates indicates left or right side mounting. Some plates may also have an L or R painted on the front.

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Remove the brake caliper (6). Refer to *Brake Caliper Replacement (Front, Dayton-Walther)*
4. Remove the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Remove the bolts and washers (3,5).
6. Remove the brake caliper mounting plate (4).
7. Inspect the support rails for rust, corrosion, and wear.
8. Clean the support rails with a wire brush.
9. Inspect the brake caliper mounting plate (4) for cracks or elongated bolt holes.

   Replace the mounting plate if necessary.

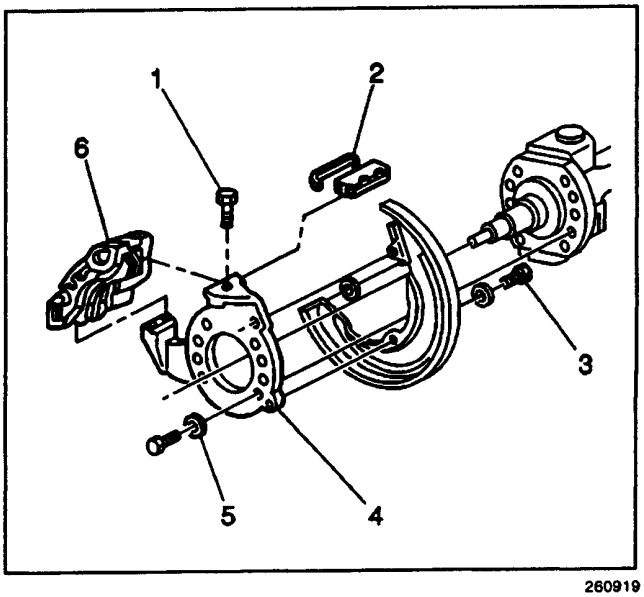
Installation Procedure

1. Install the brake caliper mounting plate (4) to the steering knuckle.

   Important: Ensure that the threads are clean and greaseless before applying threadlocker.
2. Apply 272 Threadlocker to the threads of each brake caliper mounting plate bolt.

   Notice: Refer to *Fastener Notice.*
3. Install the bolts and washers (3, 5).

   Tighten
   - Tighten the brake shield bolts to 32 N.m (24 lb ft).
   - Tighten the brake caliper mounting plate bolts to 280 N.m (206 lb ft).
4. Install the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Install the brake caliper (6). Refer to *Brake Caliper Replacement (Front, Dayton-Walther).*
6. Remove the blocks.



260919

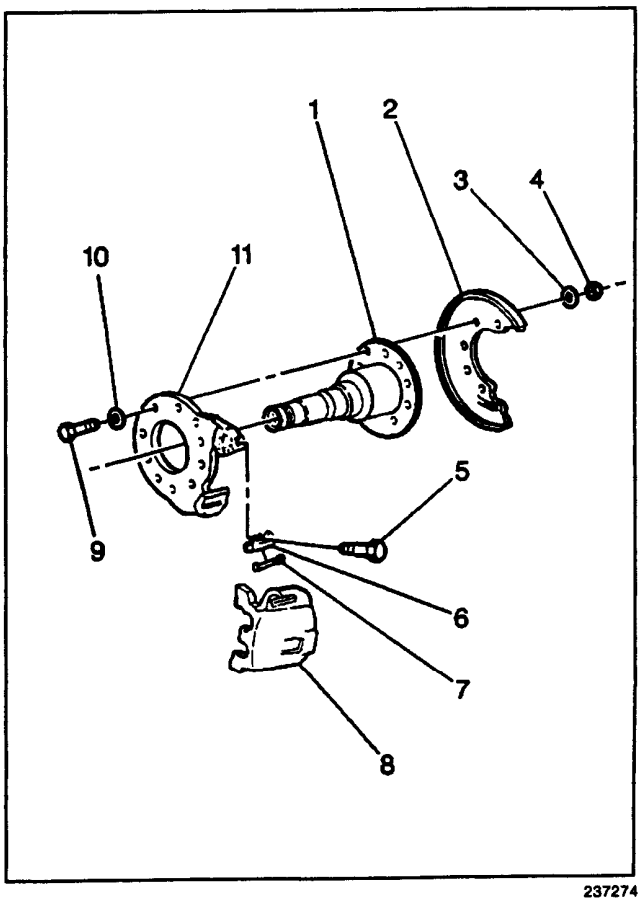
Brake Caliper Mounting Plate Replacement (Rear, Bendix Rail Slider)

Use the brake caliper mounting plate in order to mount all of the stationary brake components. An L or R following the part number cast on the back of the plates indicates left or right side mounting. Some plates may also have an L or R painted on the front.

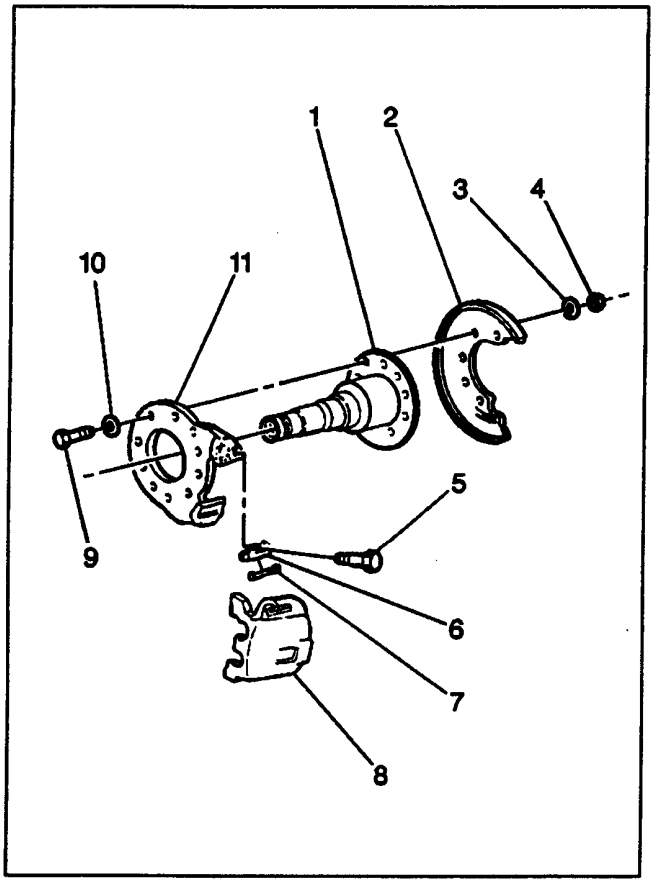
Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Remove the brake caliper (5). Refer to *Brake Caliper Replacement (Rear, Rail Slider).*
4. Remove the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Remove the bolts and washers.
6. Remove the brake caliper mounting plate (4).
7. Inspect the support rails for rust, corrosion, and wear.
8. Clean the support rails with a wire brush.
9. Inspect the brake caliper mounting plate for cracks or elongated bolt holes.

   Replace the mounting plate if necessary.



237274



237274

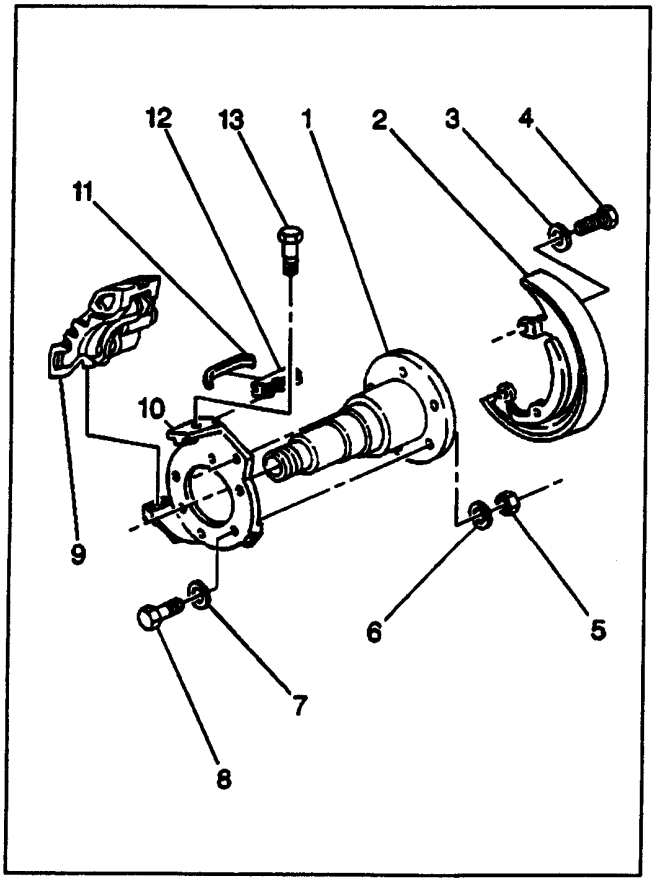
Installation Procedure

1. Install the brake caliper mounting plate (4) to the steering knuckle.

   Important: Ensure that the threads are clean and greaseless before applying threadlocker.
2. Apply 272 Threadlocker to the threads of each brake caliper mounting plate bolt.

   Notice: Refer to *Fastener Notice.*
3. Install the bolts and washers.

   Tighten
   - Tighten the brake shield bolts to 32 N·m (24 lb ft).
   - Tighten the brake caliper mounting plate bolts to 280 N·m (206 lb ft).
4. Install the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Install the brake caliper. Refer to *Brake Caliper Replacement (Rear, Rail Slider).*
6. Remove the blocks.



237280

Brake Caliper Mounting Plate Replacement (Rear, Dayton-Walther)

Use the brake caliper mounting plate in order to mount all of the stationary brake components. An L or R following the part number cast on the back of the plates indicates left or right side mounting. Some plates may also have an L or R painted on the front.

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Remove the brake caliper (5). Refer to *Brake Caliper Replacement (Rear, Rail Slider).*
4. Remove the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Remove the bolts and washers.
6. Remove the brake caliper mounting plate (4).
7. Inspect the support rails for rust, corrosion, and wear.
8. Clean the support rails with a wire brush.
9. Inspect the brake caliper mounting plate for cracks or elongated bolt holes.

   Replace the mounting plate if necessary.

Installation Procedure

1. Install the brake caliper mounting plate (4) to the steering knuckle.

   Important: Ensure that the threads are clean and greaseless before applying threadlocker.

2. Apply 272 Threadlocker to the threads of each brake caliper mounting plate bolt.

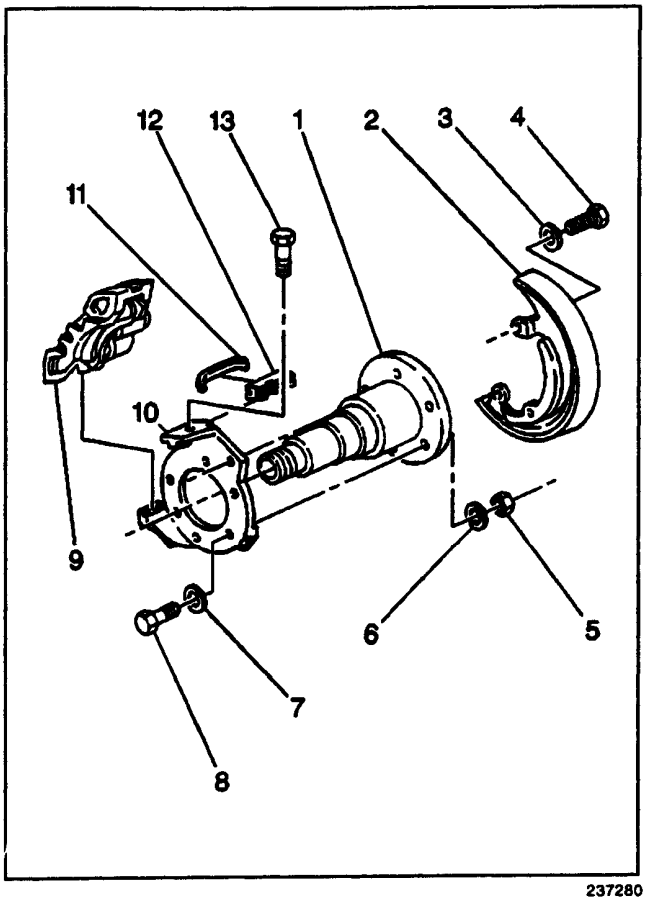
   Notice: Refer to *Fastener Notice.*

3. Install the bolts and washers.

   Tighten

   - Tighten the brake shield bolts to 32 N.m (24 lb ft).
   - Tighten the brake caliper mounting plate bolts to 280 N.m (206 lb ft).

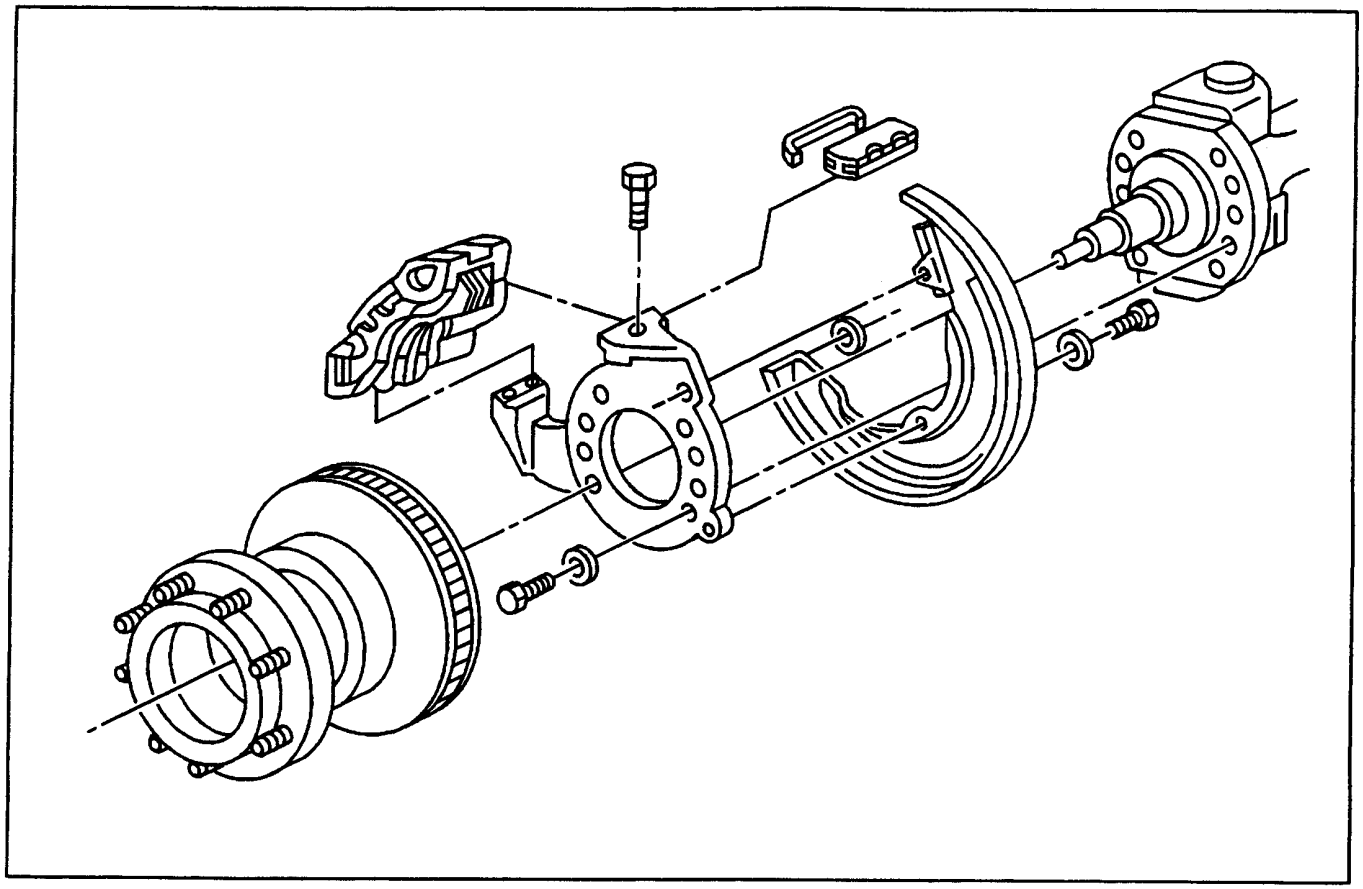
4. Install the hub and brake rotor assembly. Refer to the proper procedure in Front Suspension:
   - *Wheel Hub, Bearing, and Seal Replacement (Drum Brakes)*
   - *Wheel Hub, Bearing, and Seal Replacement (Disc Brakes)*
5. Install the brake caliper. Refer to *Brake Caliper Replacement (Rear, Rail Slider).*
6. Remove the blocks.



237280

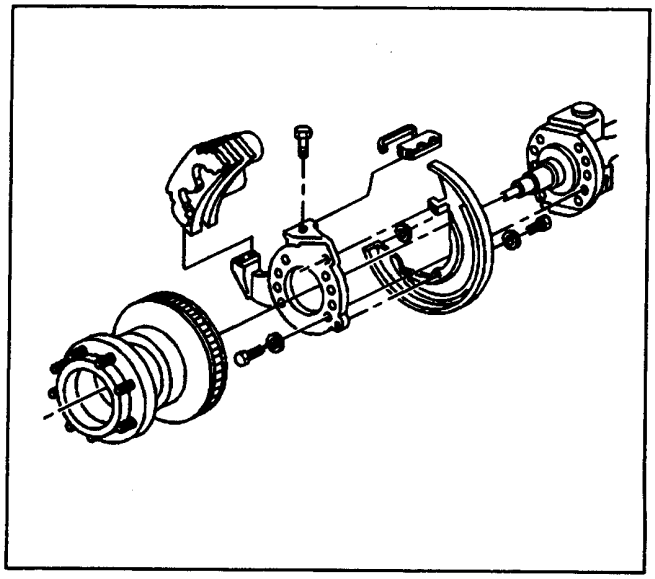
Description and Operation

Disc Brakes System Description (Front)



237270

All hydraulic foundation brakes are disc brake type. The Dayton-Walther rail slider type disc brake caliper is used on the 8,100 lb front axle. All other axles use the Bendix® rail slider type disc brake caliper.



237266

Disc Brakes System Description (Rear)

The front and rear disc brake assembly consists of the following components:

- The brake caliper
- The brake rotor (with a hub, or with a wheel)
- Brake pads
- The brake caliper mounting plate
- The brake shield

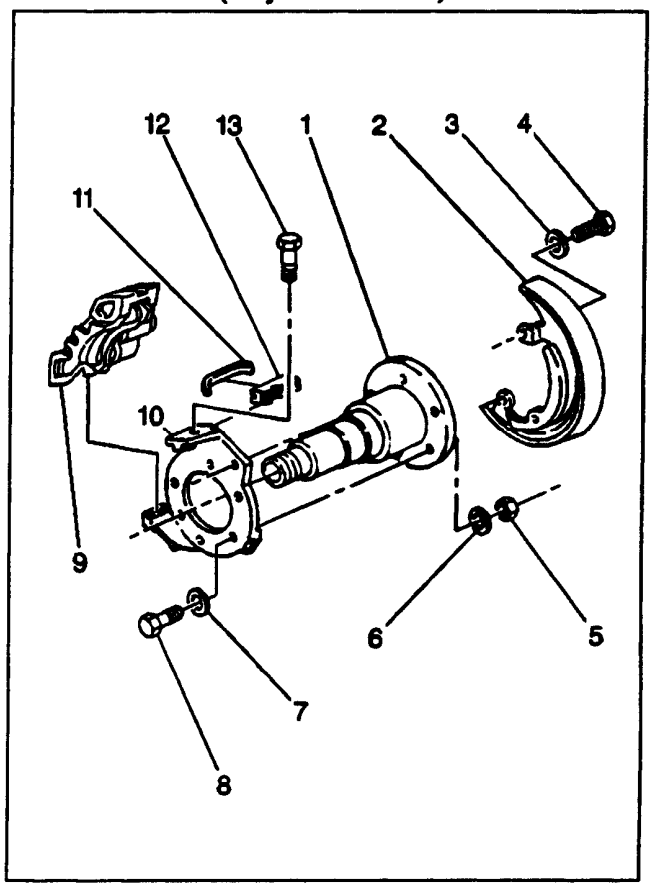
The brake rotor is bolted to the front hub or wheel. The rotor turns with the tire and wheel assembly. The brake caliper housing has machined bores and pistons. A seal in a groove of the wall in each bore provides a hydraulic seal and retracts the piston when fluid pressure is relieved. A dust boot keeps the piston bore clean. A metal heat shield protects the dust boot from the heat caused by braking friction. The brake caliper is mounted by a brake caliper retainer and the brake caliper retainer spring to the stationary brake caliper mounting plate. The brake caliper mounting plate and the brake shield is bolted to the steering knuckle.

The brake pad assemblies are held in place on each side of the brake rotor. The outer brake pad moves with the brake caliper housing. Depending on axle size, the inner brake pad is held in place by either the brake caliper mounting plate or the brake caliper housing. All original equipment brake pad linings are asbestos free.

Applying the brake pedal causes hydraulic pressure to move the brake caliper pistons. This causes the brake pads to clamp the brake rotor. The brake caliper adjusts its clamping position by sliding laterally in the support rails on the brake caliper mounting plate.

Releasing the brake pedal relieves the pressure applied to the brake caliper pistons. The pistons are pulled back in the bore by the action of the square cut piston seals returning to their original shape. This allows for a running clearance between the brake pad linings and the brake rotor.

Rear Disc Brake Components (Dayton-Walther)

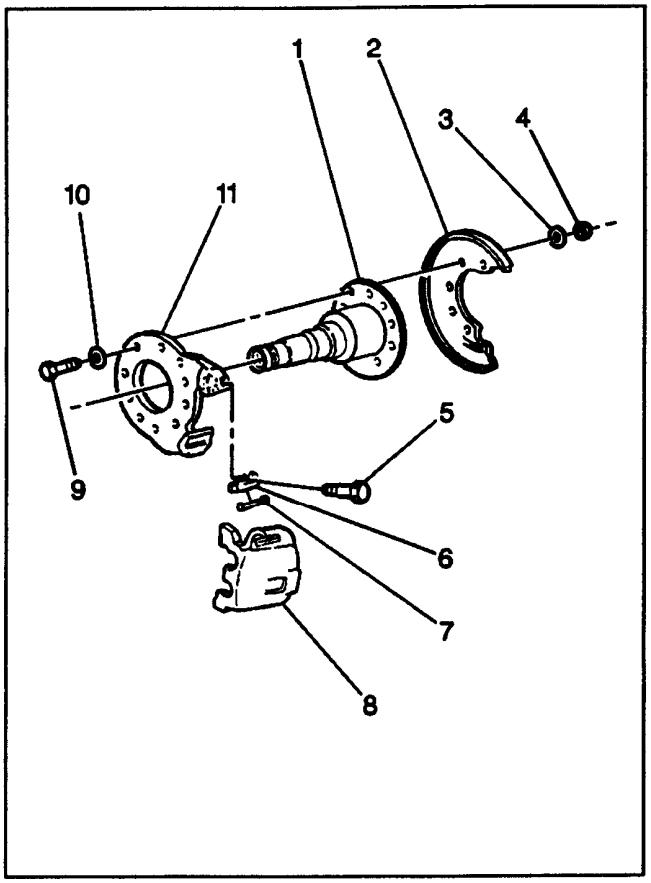


237280

Legend

(1) Rear Axle
(2) Brake Shield
(3) Washer
(4) Bolt
(5) Nut
(6) Washer
(7) Washer
(8) Brake Caliper Mounting Plate Bolt
(9) Brake Caliper
(10) Brake Caliper Mounting Plate
(11) Brake Caliper Retainer Spring
(12) Brake Caliper Retainer
(13) Brake Caliper Retainer Screw

Rear Disc Brake Components (Bendix®)



237274

Legend

(1) Rear Axle
(2) Brake Shield
(3) Washer
(4) Nut
(5) Brake Caliper Retainer Screw
(6) Brake Caliper Retainer
(7) Brake Caliper Retainer Spring
(8) Brake Caliper
(9) Brake Caliper Mounting Plate Bolt
(10) Washer
(11) Brake Caliper Mounting Plate

All hydraulic foundation brakes are disc brake type. The Dayton-Walther rail slider type disc brake caliper is used on the 15,000 lb rear axle. All other axles use the Bendix® rail slider type disc brake caliper.

The front and rear disc brake assembly consists of the following components:

- The brake caliper
- The brake rotor (with a hub, or with a wheel)
- Brake pads
- The brake caliper mounting plate
- The brake shield

The brake rotor is bolted to the front hub or wheel. The rotor turns with the tire and wheel assembly. The brake caliper housing has machined bores and pistons. A seal in a groove of the wall in each bore provides a hydraulic seal and retracts the piston when fluid pressure is relieved. A dust boot keeps the piston bore clean. A metal heat shield protects the dust boot from the heat caused by braking friction. The brake caliper is mounted by a brake caliper retainer and the brake caliper retainer spring to the stationary brake caliper mounting plate. The brake caliper mounting plate and the brake shield is bolted to the steering knuckle.

The brake pad assemblies are held in place on each side of the brake rotor. The outer brake pad moves with the brake caliper housing. Depending on axle size, the inner brake pad is held in place by either the brake caliper mounting plate or the brake caliper housing. All original equipment brake pad linings are asbestos free.

Applying the brake pedal causes hydraulic pressure to move the brake caliper pistons. This causes the brake pads to clamp the brake rotor. The brake caliper adjusts its clamping position by sliding laterally in the support rails on the brake caliper mounting plate.

Releasing the brake pedal relieves the pressure applied to the brake caliper pistons. The pistons are pulled back in the bore by the action of the square cut piston seals returning to their original shape. This allows for a running clearance between the brake pad linings and the brake rotor.

Park Brake

Specifications

Fastener Tightening Specifications (Electric/Hydraulic)

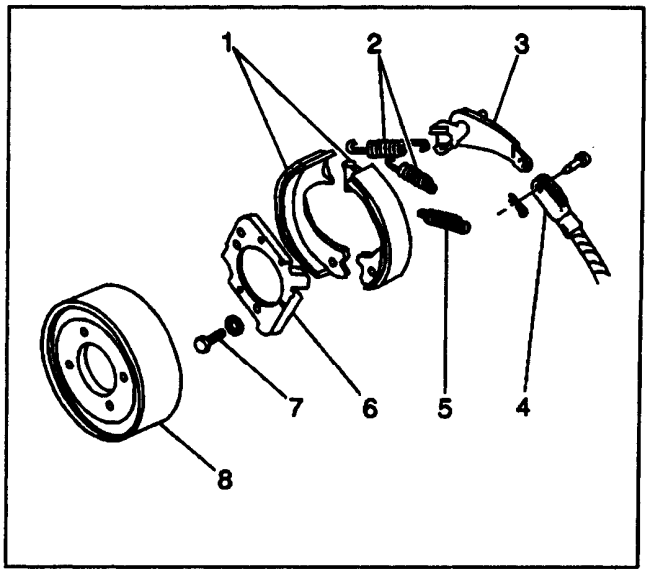
Application	Specification	
	Metric	English
Companion Flange Bolt (Bendix®)	140 N.m	103 lb ft
Propeller Shaft Nut	38 N.m	27 lb ft
Support Plate Bolt (Bendix®) Manual Transmission	86 N.m	63 lb ft
Support Plate Bolt (Bendix®) Automatic Transmission	46 N.m	34 lb ft
Bellcrank Pivot Nut (Bendix®) with Bellcrank Bracket	38 N.m	28 lb ft
Bellcrank Pivot Nut (Bendix®) on Transmission Boss	46 N.m	34 lb ft
Cover Bolt (ISUZU)	127 N.m	94 lb ft
Flange Nut (ISUZU)	784 N.m	579 lb ft

Repair Instructions

Park Brake Shoe Replacement (Bendix 229 mm - 9 in)

Removal Procedure

1. Remove the drum (6). Refer to *Brake Drum Replacement (Bendix 229 mm - 9 in).*
2. Remove the return springs (2).
3. Remove the anchor springs (5).
4. Remove the linings (1).
5. Spread the brake shoes apart.
6. Inspect the linings (1) for contamination.
7. Inspect the linings (1) for excessive wear.
   The minimum thickness (with bonded linings) is 1.52 mm (0.60 in).
   Replace the linings (1) as a set, if necessary.
8. Inspect the springs for distortion.
   Replace the springs, if necessary.
9. Inspect the springs for a loss of tension.
   Replace the springs, if necessary.
10. Inspect the cam lever (3) for grooves at the brake shoe contact points.
    Replace the cam lever (3), if necessary.



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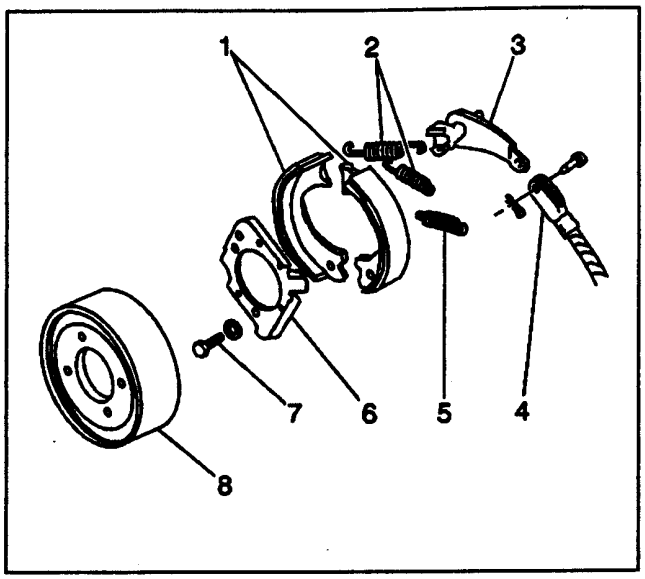

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Installation Procedure

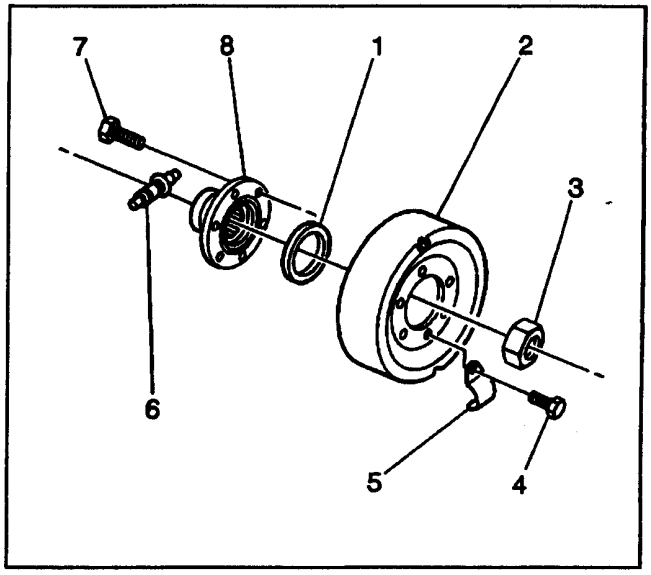
1. Install the linings (1).
   Place the cam lever (3) in position with the two fingers between the shoe webs.
2. Install the anchor spring (5).
   Lubricate the points where the brake shoes contact the support plate (6).
3. Install the return springs (2).
4. Install the drum (8). Refer to *Brake Drum Replacement (Bendix 229 mm - 9 in).*
5. Adjust the parking brake. Refer to Parking Brake Adjustment.

Park Brake Shoe Replacement (Bendix 254 mm - 10 in)

Removal Procedure

1. Block the wheels of the vehicle.
2. Release the parking brake.
3. Remove the propeller shaft. Refer to the appropriate replacement procedure in Propeller Shaft:
   - *One-Piece Propeller Shaft Replacement (Full Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Full Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/229)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/305)*
   - *Two-Piece Propeller Shaft Replacement (Inboard Slip Joint and Flange)*
   - *Three-Piece Propeller Shaft Replacement (Center Bearing, Full Yoke)*

4. Remove the flange nut (3).
5. Remove the drum (2) and flange (8).
6. Disconnect the O-ring seal (1) in the flange bore.



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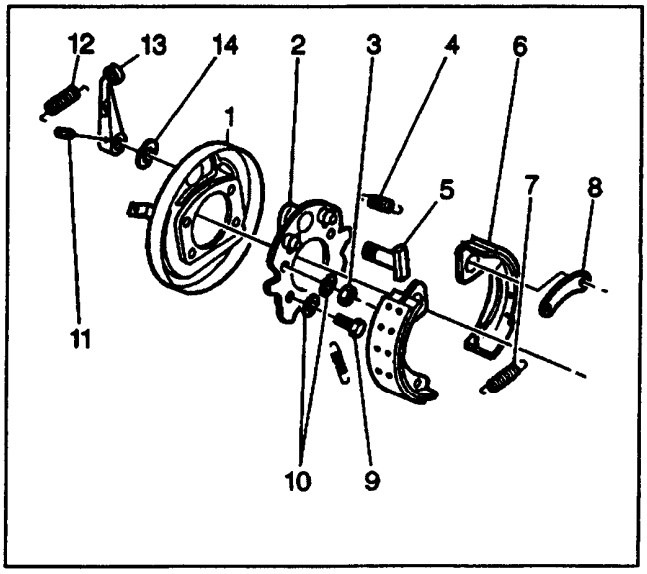
7. Remove the springs (4, 7).



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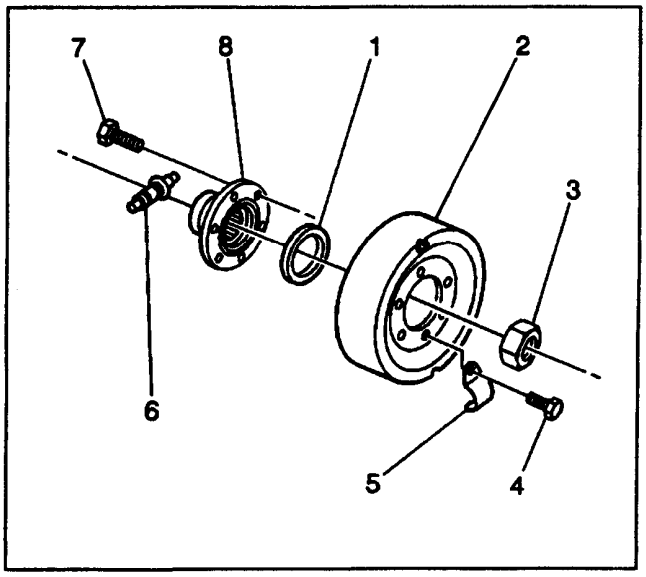
8. Remove the adjuster (6).



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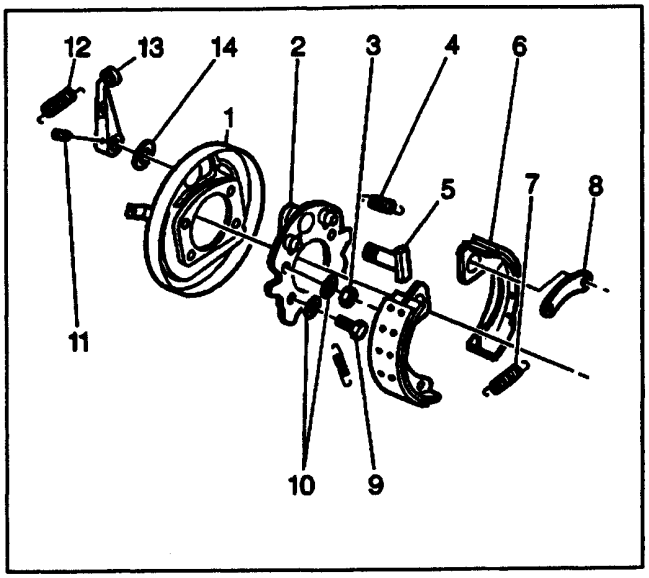

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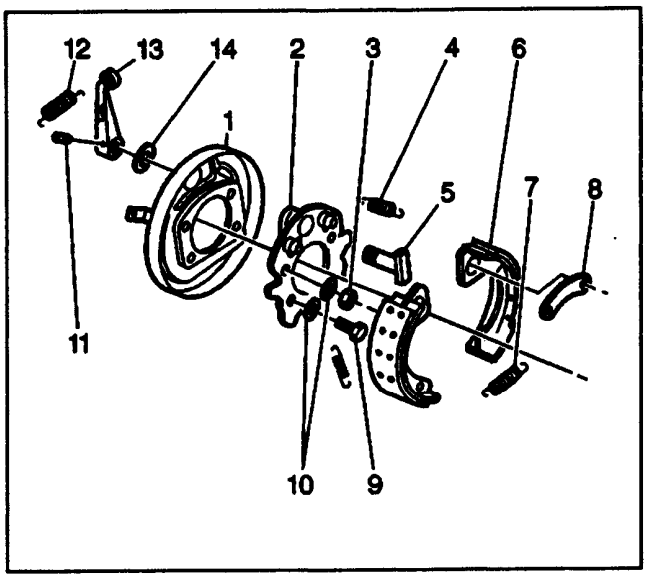
9. Remove the shoes (6).
10. Inspect the return spring. Ensure that the free length is 68 mm (2.68 in).
11. Inspect the shoes (6).
    - Replace the shoes if the web at the point of the cam contact is severely worn.
    - Replace the shoes if the riveted lining is 0.2 mm (0.008 in) from the rivet heads or on bonded shoes when worn to 2.0 mm (0.08 in).



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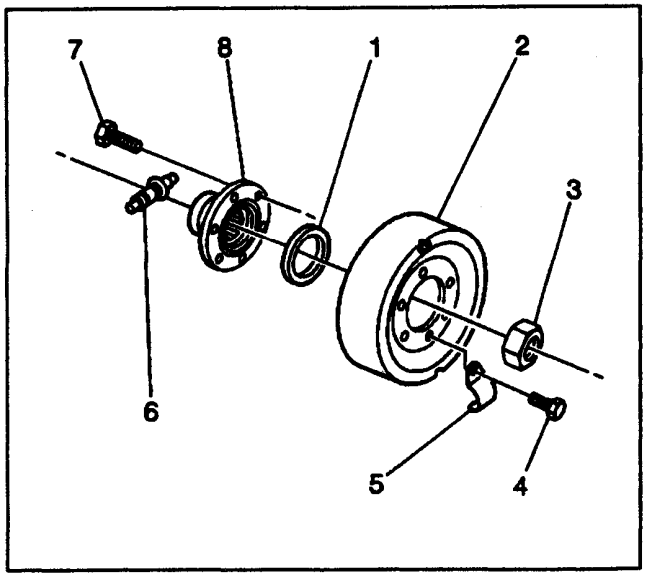
Installation Procedure

1. Install the shoes (6).



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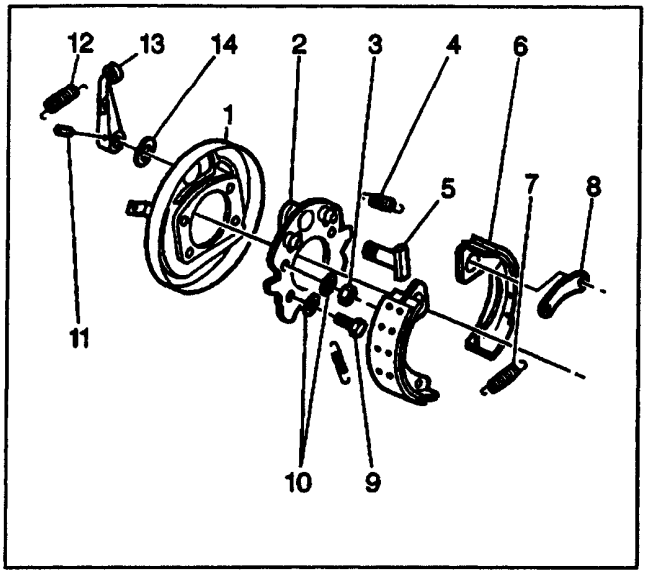
2. Install the adjuster (6).

3. Install the springs (4, 7).



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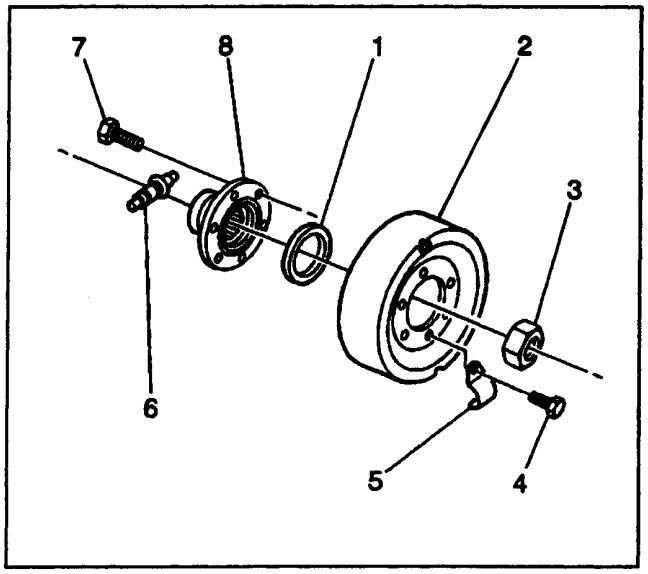
4. Install the drum (2) and the flange (8).
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
5. Install the flange nut (3).
   Tighten
   Tighten the flange nut to 784 N·m (579 lb ft).
6. Stake the nut in two places, 180 degrees apart.
7. Install the propeller shaft.
8. Adjust the brake shoes.
9. Verify that the brakes are functioning correctly.



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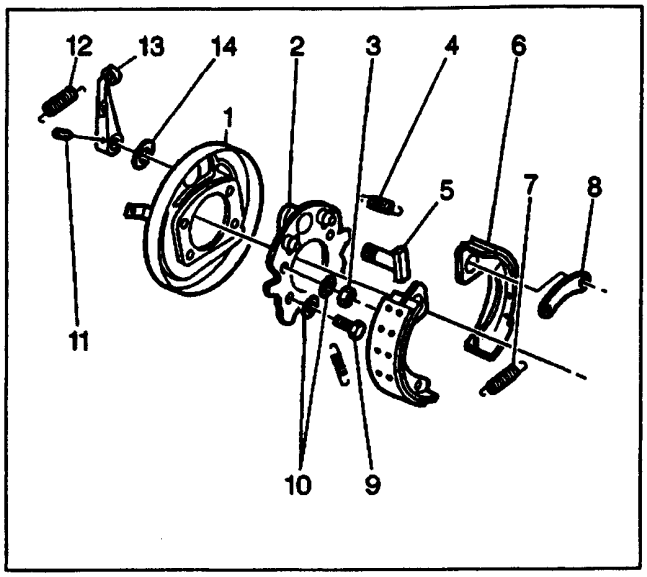
Park Brake Shoe Inspection

Replace the brake shoe and lining assemblies whenever the thickness of any lining is worn within 0.76 mm (0.030 inch) of the shoe.

Replace riveted shoe and lining assemblies when the lining is worn within 0.76 mm (0.030 inch) of any rivet head.



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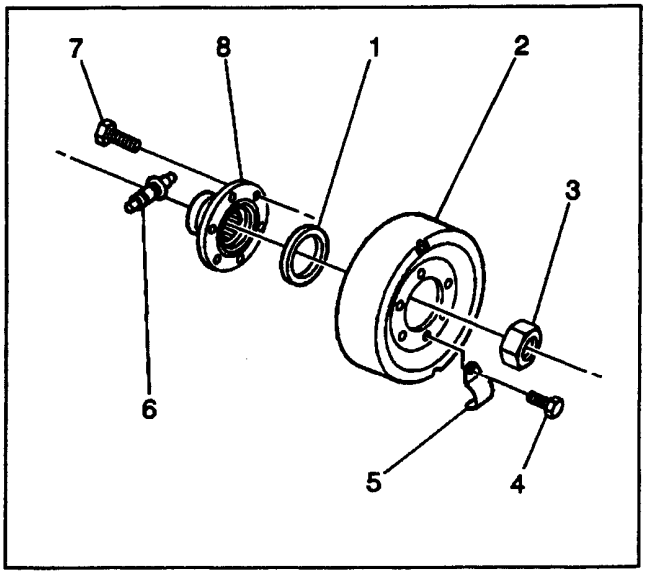
Park Brake Shoe Adjustment (Bendix 254 mm - 10 in)

Removal Procedure

Park the vehicle on a level surface before performing service on the parking brake.

1. Block the wheels of the vehicle.
2. Release the parking brake.
3. Raise the rear axle until the tires are off of the ground.
4. Remove the cable at the lever (13).



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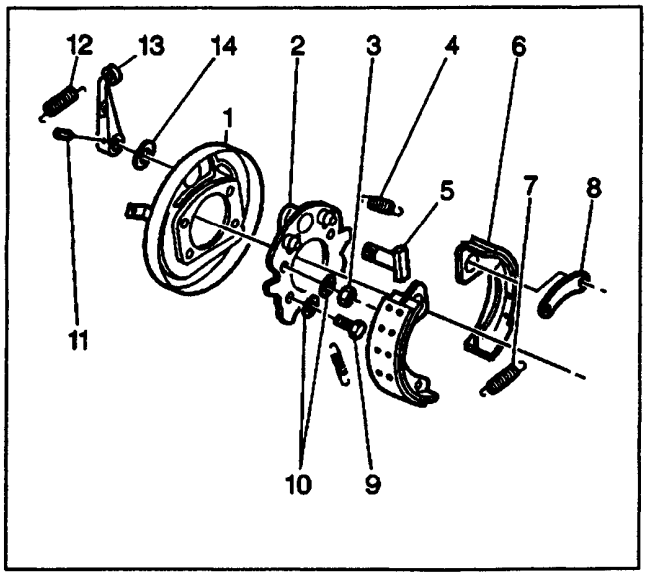
5. Rotate the drum (2) in order to align an access hole with the adjuster (6).
6. Remove the bolt (4).
7. Remove the cover (5).



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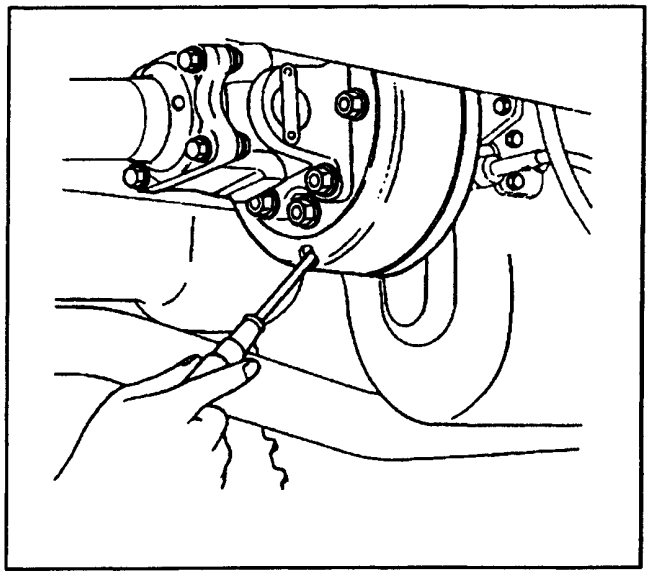
8. Move the lever (13) side to side several times in order to center the shoes (6).

9. Insert a screwdriver in the access hole and rotate the adjuster upward until the shoes drag on the drum.
10. Move the adjuster back 13 notches.
11. Measure the gap at the middle of the shoe lining in order to ensure that the gap has a 0.23 mm (0.009 in) measurement.



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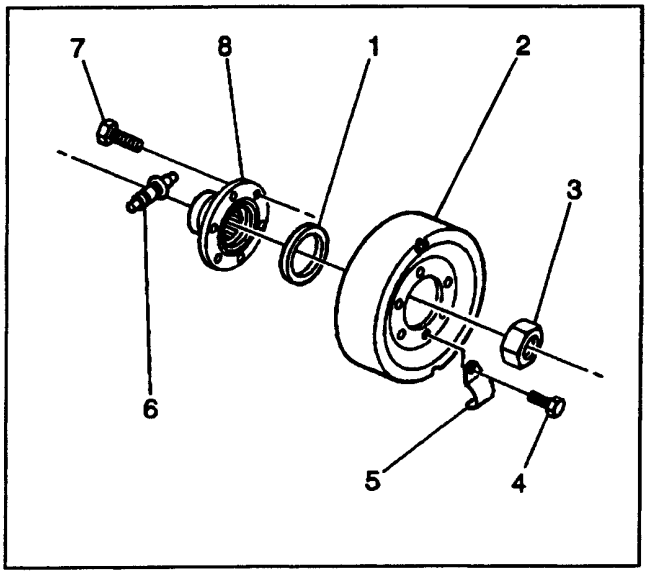
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the cover (5).
2. Install the bolt (4).



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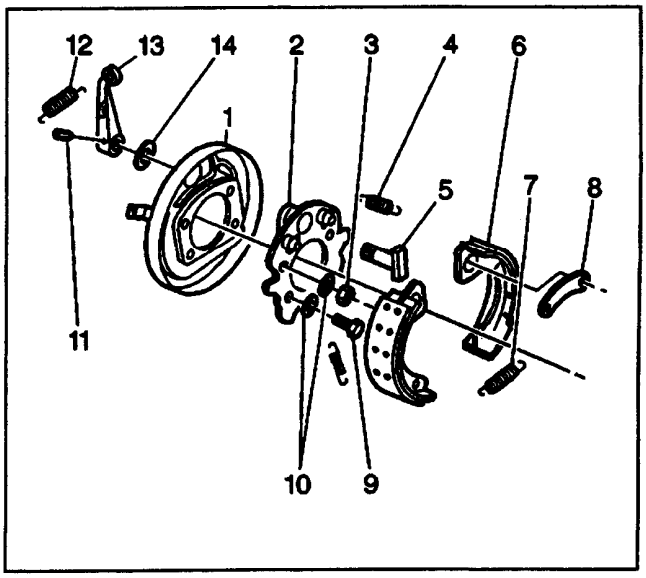
3. Connect the cable to the lever (13).
4. Verify the parking brake operation.



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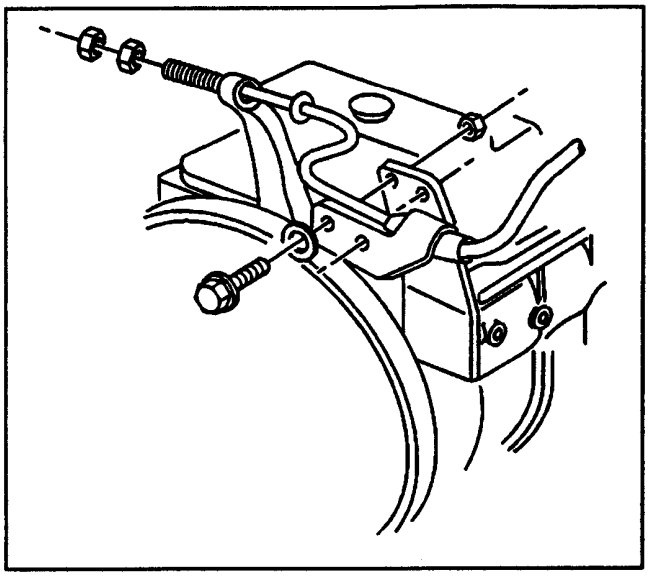

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Lever Adjustment

1. Block the wheels of the vehicle.
2. Release the parking brake.
3. Loosen the jamb nut.
4. Loosen the adjusting nut.
5. When connecting the cable with the cam lever, use the adjusting nut in order to remove any clearance between the cam and the shoe.
6. Lock the adjust nut with the locknut.
7. Remove the blocks from the wheels.

Park Brake Lubrication Procedure

Clean and lubricate the parking brake assembly and the cables. Do not allow the lubricant to contact the drum or the lining surfaces.

Notice: Frequent parking brake operation will require lubrication more often than once a month.

In order to reduce the amount of assembly wear, lubricate the following items monthly:

- The lever assembly pivot pin
- The slot clevis pin
- The slots
- The parking brake cable to the transmission clevis pin

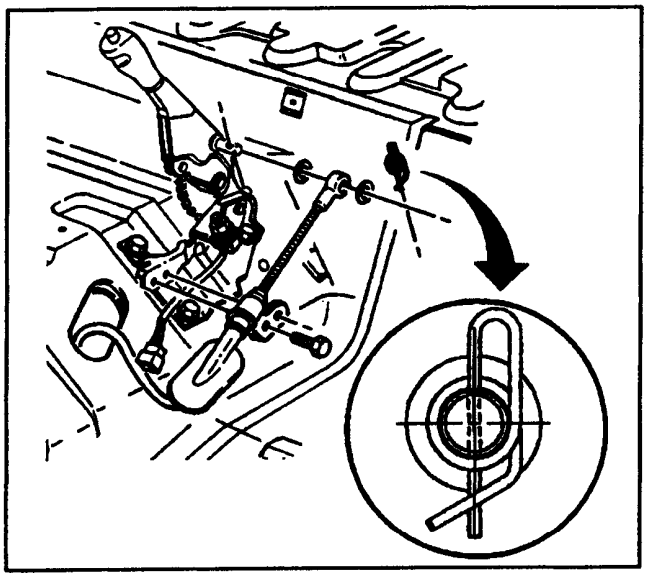
Use the following method in order to lubricate the parking brake assembly:

1. Apply a light coating of lubricant to the following areas:
   - The parking brake lever pivot pin
   - The right-hand side of the slot clevis
   - The left-hand side of the slot clevis
2. Apply a light coating of the same lubricant to the parking brake cable clevis pin which is located at the transmission brake.
3. Check the adjustment of the parking brake.
4. Adjust the parking brake if necessary.

Park Brake Lever Replacement (Mechanical)

Removal Procedure

1. Remove the console assembly.
2. Remove the mounting bolts.
3. Disconnect the cable from the lever.



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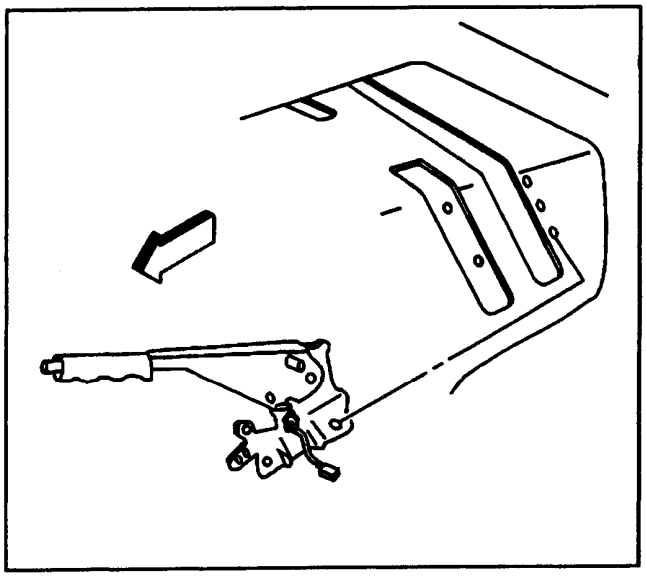
4. Remove the wiring harness.
5. Remove the parking brake lever.



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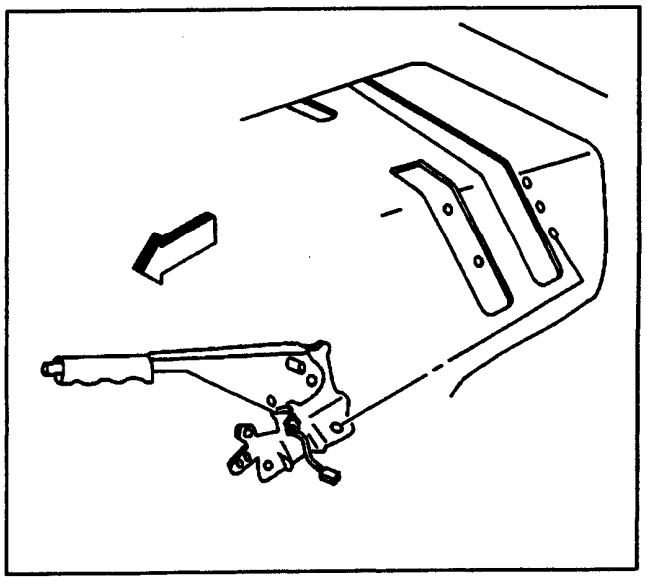
Installation Procedure

1. Connect the parking brake lever to the cab.
2. Install the wiring harness.



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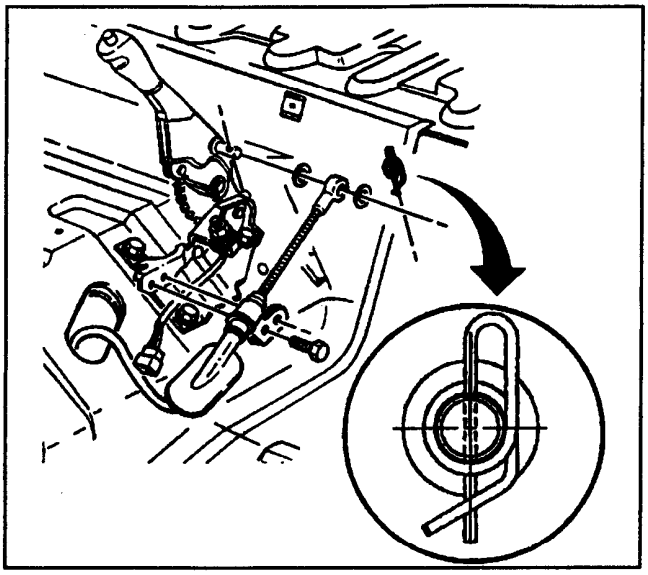

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3. Connect the cable to the lever.
4. Install the mounting bolts.
5. Install the console assembly.

Park Brake Lever Adjustment

1. Block the wheels of the vehicle.
2. Place the hand lever in the OFF position.
3. Perform the lining wear and linkage adjustments. Refer to the appropriate procedure:
   - *Park Brake Shoe Replacement (Bendix 229 mm - 9 in)*
   - *Park Brake Shoe Adjustment (Bendix 254 mm - 10 in)*
4. Place the hand lever in the ON position.
5. Inspect the parking brake's operating and holding ability.
6. Unblock the wheels.

Park Brake Warning Lamp Switch Replacement

Removal Procedure

1. Remove the parking brake lever. Refer to *Park Brake Lever Replacement (Mechanical)*.
2. Remove the mounting bolt.
3. Remove the wiring harness.
4. Remove the switch.

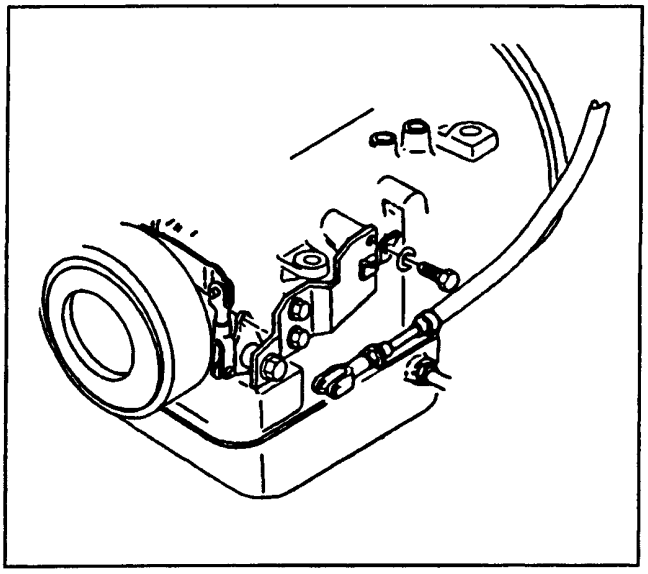
Installation Procedure

1. Install the switch.
2. Install the wiring harness.
3. Install the mounting bolt.
4. Install the parking brake lever. Refer to *Park Brake Lever Replacement (Mechanical)* in Cautions and Notices.

Park Brake Cable Replacement

Removal Procedure

1. Block the vehicle wheels.
2. Remove the lock nut on the actuator end of the cable at the 2 piece fitting.
3. Remove the end fitting.
4. Remove the cotter pin and the cable clevis pin.
5. Remove the fastener from the transmission bracket clip.
6. Remove the fastener from the transmission housing bracket.



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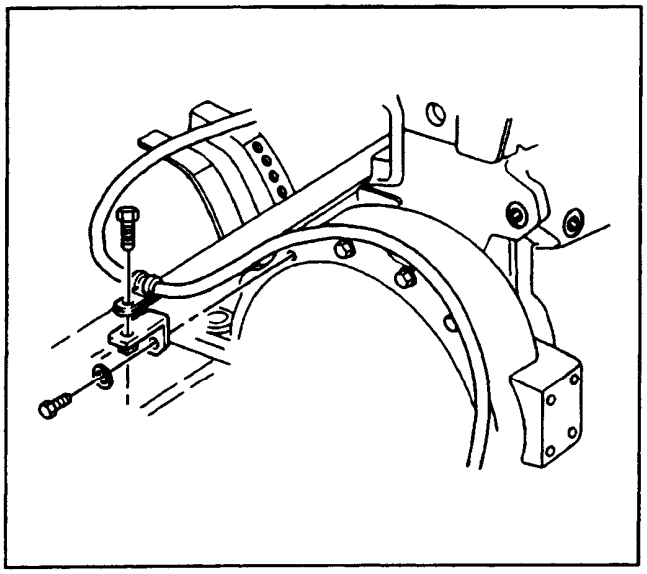
7. Remove the fastener from the frame bracket.
8. Remove the strap.



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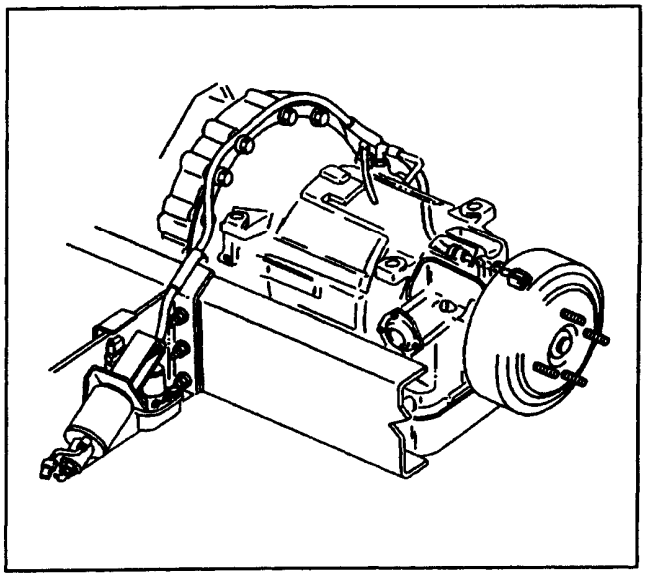
9. Remove the cable assembly.



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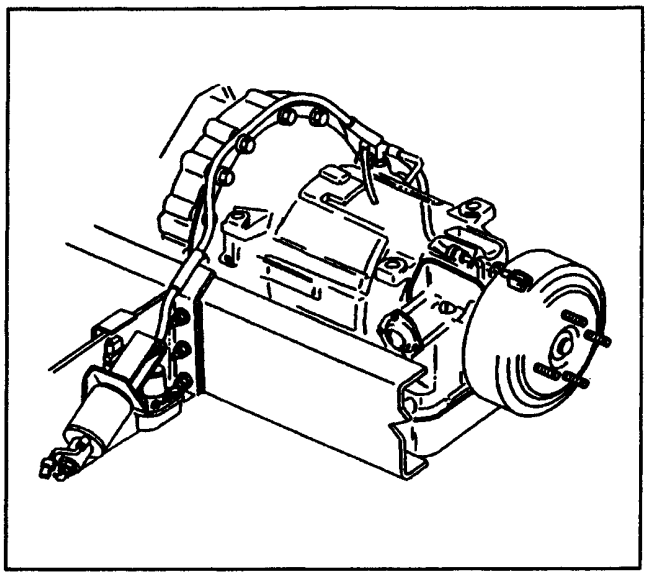

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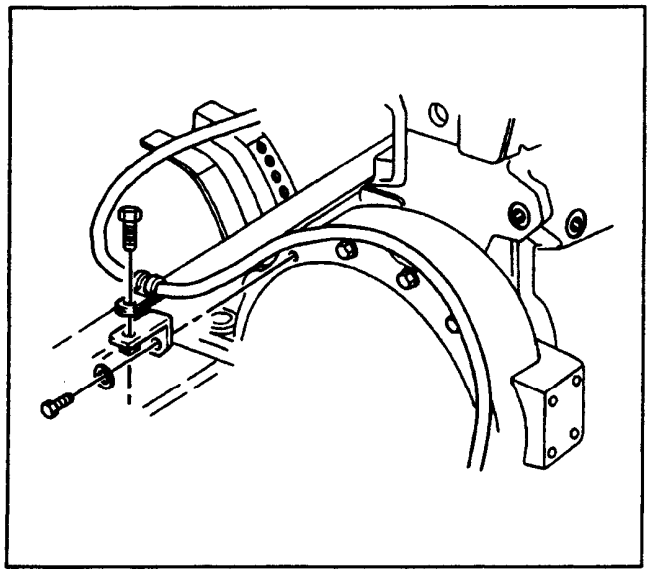
Installation Procedure

1. Install the new cable assembly.



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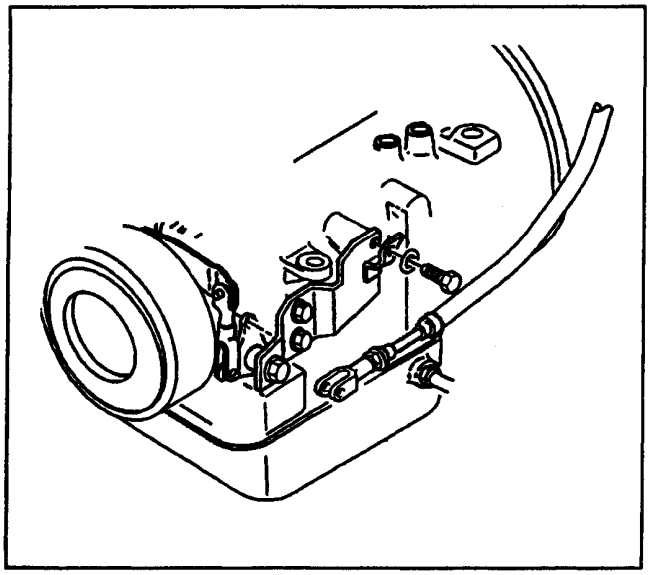
2. Install the strap.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the fastener from the frame bracket.

   Tighten

   Tighten the fastener from the frame bracket to 50 N·m (37 lb ft).



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4. Install the fastener from the transmission housing bracket.

   Tighten

   Tighten the fastener from the transmission housing bracket to 35 N·m (26 lb ft).

   Notice: Make sure that the clip has the bolt hole facing forward. If the clip is out of position, it may cause a binding condition in the parking brake released position.

5. Install the fastener from the transmission bracket clip.

   Tighten

   Tighten the fastener from the transmission bracket clip to 64 N·m (47 lb ft).

6. Install the small and the large ends of the two-piece cable fitting at the actuator. The small fitting should bottom on both the actuator and the large half of the 2 piece fitting.
   Tighten
   Tighten the 2 pieces of the fitting together to 54 N.m (40 lb ft).
7. Install the lock nut to the two-piece fitting.
   Tighten
   Tighten the lock nut to 45 N.m (33 lb ft).
8. Perform the drum adjustment. Refer to the following list for the appropriate brake:
   - *Brake Drum Replacement (Bendix 254 mm - 10 in)*
   - *Brake Drum Replacemen (Bendix 229 mm - 9 in)*

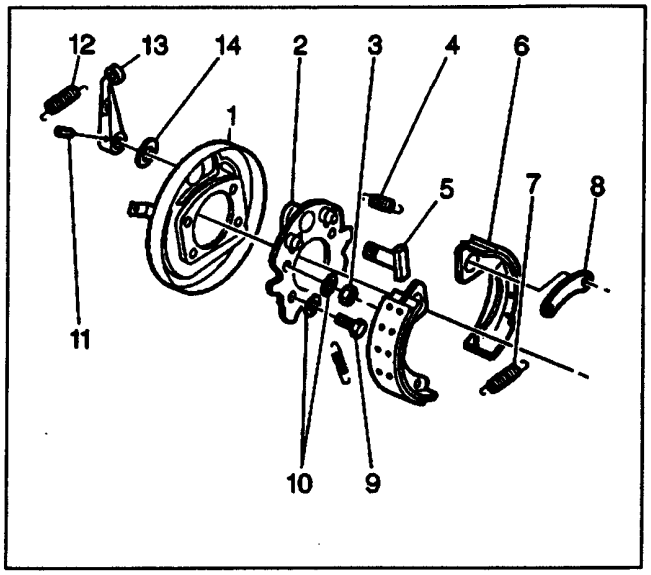
Park Brake Cable Inspection

Check the parking brake for free operation. The brake lever must return to the released position without sticking or binding. If a problem is present, check the cable routings for kinks or binding.

Brake Drum Replacement (Bendix 254 mm - 10 in)

Removal Procedure

1. Block the wheels of the vehicle.
2. Release the parking brake.
3. Remove the propeller shaft. Refer to the appropriate replacement procedure in Propeller Shaft:
   - *One-Piece Propeller Shaft Replacement (Full Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Full Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/229)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/305)*
   - *Two-Piece Propeller Shaft Replacement (Inboard Slip Joint and Flange)*
   - *Three-Piece Propeller Shaft Replacement (Center Bearing, Full Yoke)*



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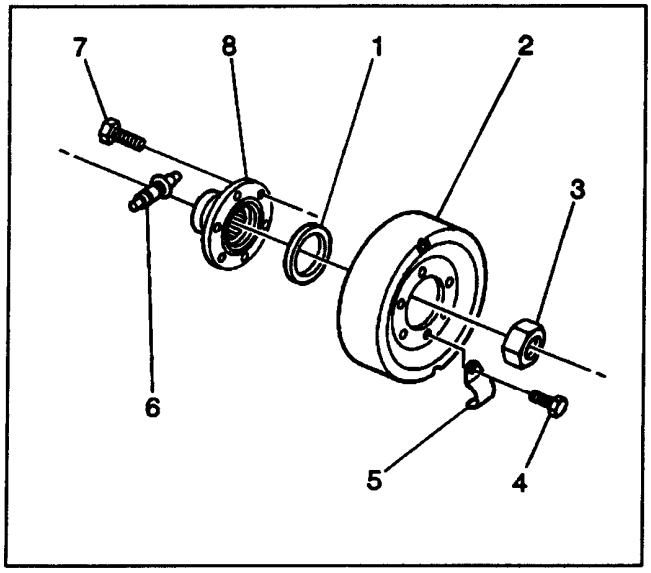
4. Remove the bolts (9).
5. Remove the washers (10).



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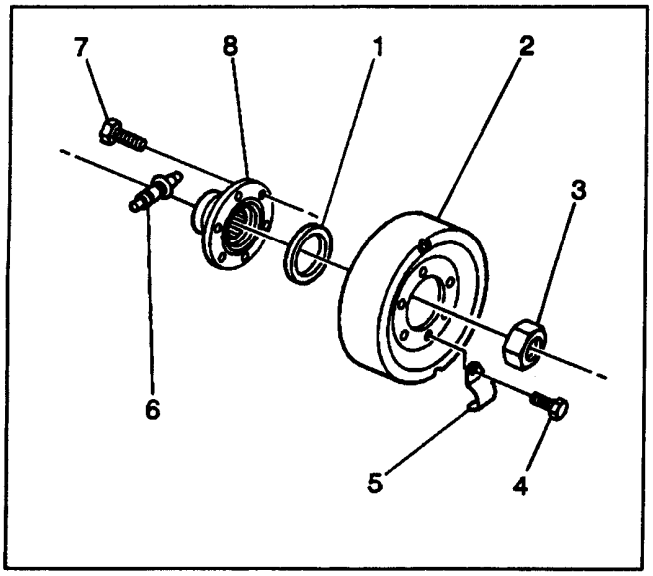
6. Remove the covers (5).
7. Remove the drum (2).
8. Measure the drum diameter.
9. Replace the drum if the ID is more than 256 mm (10.08 in).
10. Measure the drum run-out.
11. Replace the drum if the run-out varies by more than 0.05 mm (0.002 in).



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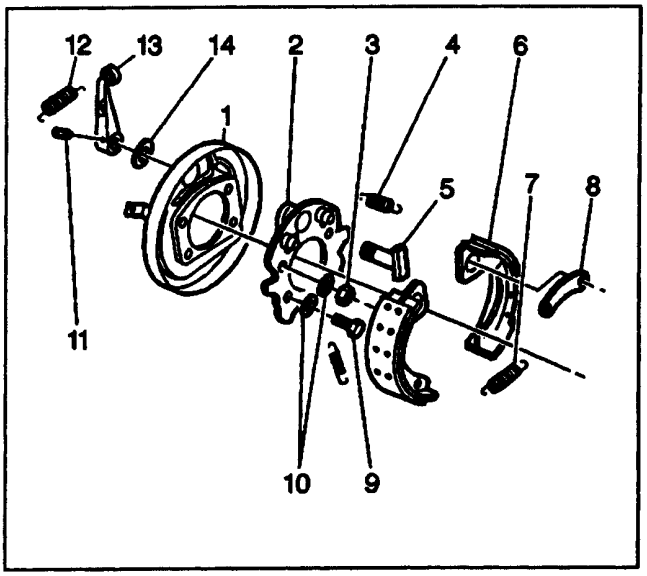
Installation Procedure

1. Install the drum (2).
2. Install the covers (5).

3. Install the bolts (9).
4. Install the washers (10).
5. Align the drum holes with the flange holes.
6. Install the propeller shaft. Refer to the appropriate replacement procedure in Propeller Shaft:
   - *One-Piece Propeller Shaft Replacement (Full Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Full Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/229)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/305)*
   - *Two-Piece Propeller Shaft Replacement (Inboard Slip Joint and Flange)*
   - *Three-Piece Propeller Shaft Replacement (Center Bearing, Full Yoke)*
7. Adjust the brake linings.
8. Verify the operation of the parking brake.



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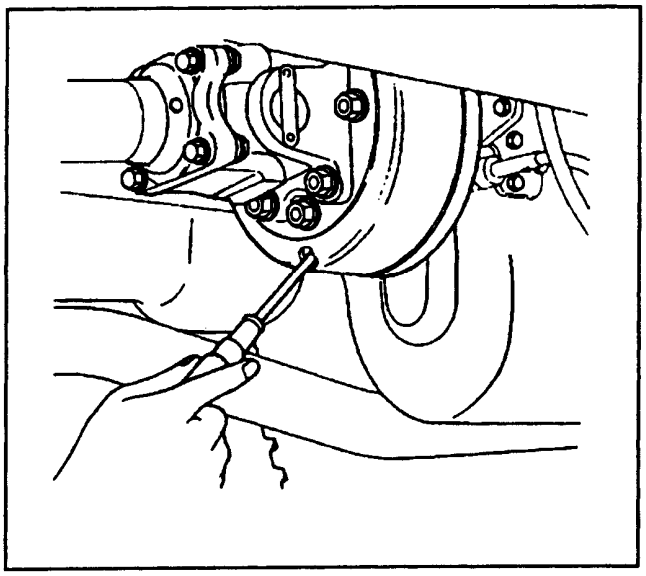
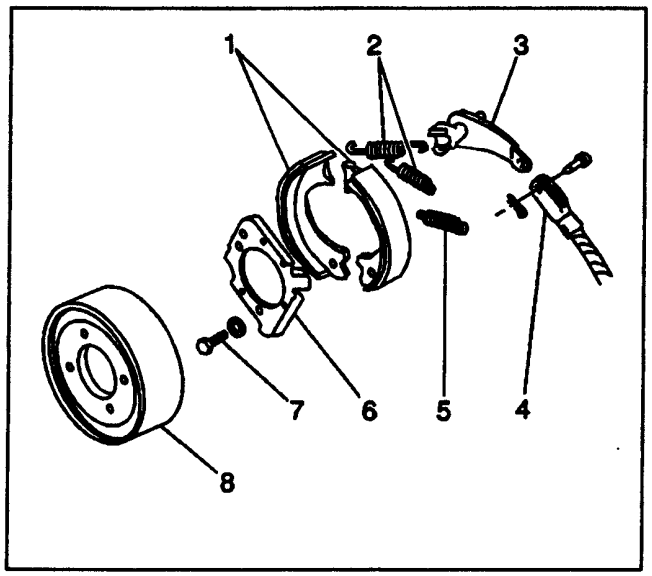

229428

Brake Drum Replacement (Bendix 229 mm - 9 in)

Removal Procedure

1. Block the vehicle wheels.
2. Remove the propeller shaft. Refer to the appropriate replacement procedure in Propeller Shaft:
   - *One-Piece Propeller Shaft Replacement (Full Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Full Yoke/305)*

- *One-Piece Propeller Shaft Replacement (Half Yoke/229)*
- *One-Piece Propeller Shaft Replacement (Half Yoke/305)*
- *One-Piece Propeller Shaft Replacement (Outboard Slip/229)*
- *One-Piece Propeller Shaft Replacement (Outboard Slip/305)*
- *Two-Piece Propeller Shaft Replacement (Inboard Slip Joint and Flange)*
- *Three-Piece Propeller Shaft Replacement (Center Bearing, Full Yoke)*



29070

3. Remove the following items from the center of the yoke:
   - The companion flange bolt
   - The washer
   - The retainer
4. Straighten the lock tab on the washer.
5. Remove the brake drum (8) and the yoke assembly from the transmission.
6. Remove the bolts that hold the drum (8) to the yoke.

   Important: Closely examine all mounting bolt holes in the drum for stress cracks.
7. Inspect the drum (8) for the following:
   - Cracks
   - Scoring
   - Pitting
   - Grooves
   - Overheating damage
8. Repair the drum as needed.
9. Inspect the linings (1) for contamination and excessive wear. The minimum lining thickness (with bonded linings) is 1.52 mm (0.060 in).
10. If replacement is necessary, replace the linings as a set.
11. Inspect the brake mechanism for proper operation.
12. Repair the brake mechanism as needed.

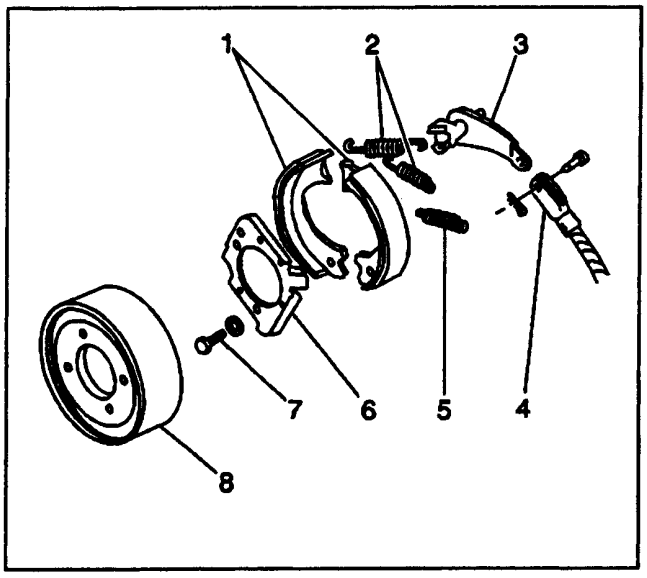
Installation Procedure

1. Install the bolts that hold the drum (8) to the yoke.
2. Install the drum and yoke assembly to the transmission.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Install the companion flange bolt and a new washer to the transmission mainshaft at the center of the yoke.

   Tighten

   Tighten the companion flange bolt to 140 N.m (103 lb ft).
4. Install the propeller shaft. Refer to the appropriate replacement procedure in Propeller Shaft:
   - *One-Piece Propeller Shaft Replacement (Full Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Full Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/229)*
   - *One-Piece Propeller Shaft Replacement (Half Yoke/305)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/229)*
   - *One-Piece Propeller Shaft Replacement (Outboard Slip/305)*
   - *Two-Piece Propeller Shaft Replacement (Inboard Slip Joint and Flange)*
   - *Three-Piece Propeller Shaft Replacement (Center Bearing, Full Yoke)*
5. Adjust the parking brake. Refer to *Park Brake Shoe Replacement (Bendix 229 mm - 9 in).*



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Brake Drum Inspection

When removing the parking brake drum, thoroughly clean and inspect the drum for the following conditions:

- Cracks
- Scores
- Deep grooves
- Out-of-round

Surface Finish

Clean slight scoring with a fine emery cloth. Heavy or extensive scoring causes excessive brake lining wear. The drum braking surface will need machining in order to remove these scores.

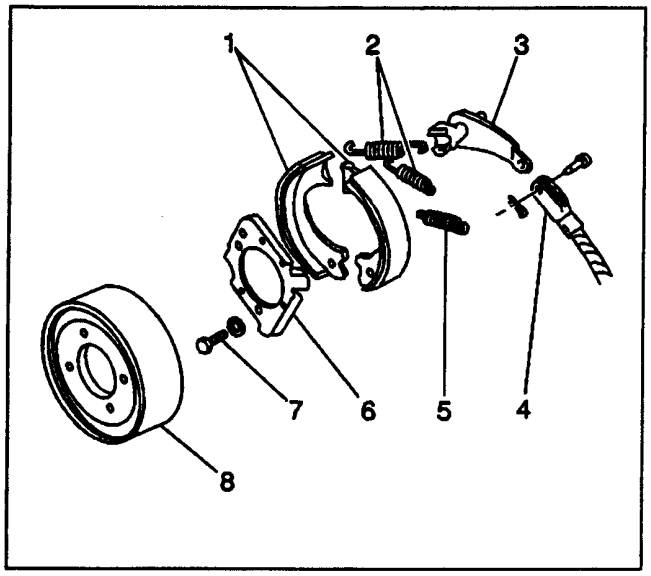
Do not machine the drum if the drum is grooved and the brake linings are slightly worn. Polish the drum braking surface with a fine emery cloth. Eliminating all of the drum grooves and ridges on the lining requires removing too much metal lining material. If the grooves and ridges match, leaving the drums alone is satisfactory service.

Inside Diameter Check

Measure the inside of the brake drum at two or more places around the circumference of the braking surface. Perform the measurements at the same distance in from the edge of the drum.

Taper Check

Measuring the drum for taper involves taking measurements at the inner and the outer edges of the machined surface at two or more places around the drum.



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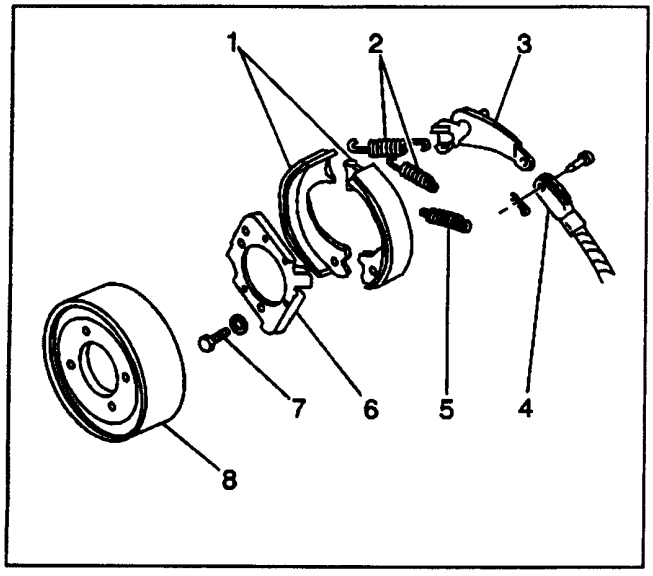
Park Brake Support Replacement

Removal Procedure

1. Remove the drum (8). Refer to *Brake Drum Replacement (Bendix 229 mm - 9 in).*
2. Remove the linings. Refer to *Park Brake Shoe Replacement (Bendix 229 mm - 9 in).*
3. Remove the bolts (7).
4. Remove the support plate (6).
5. Inspect the support plate for damage or distortion.
6. Replace the support plate, if necessary.
7. Inspect the support plate for corrosion.
8. Remove corrosion from the shoe contact surfaces with a fine emery cloth.



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Installation Procedure

1. Install the support plate (8).

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts (7).

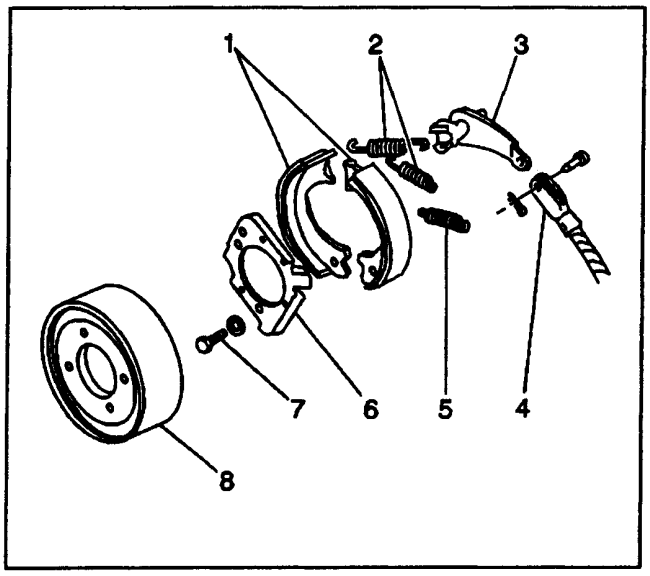
   Tighten

   - For vehicles with manual transmission, tighten the bolts to 86 N·m (63 lb ft).
   - For vehicles with automatic transmission, tighten the bolts to 46 N·m (34 lb ft).
3. Install the linings. Refer to *Park Brake Shoe Replacement (Bendix 229 mm - 9 in).*
4. Install the drum (6). Refer to *Brake Drum Replacement (Bendix 229 mm - 9 in).*

Park Brake Bellcrank and Cam Lever Replacement

Removal Procedure

1. Remove the drum (6). Refer to *Brake Drum Replacement (Bendix 254 mm - 10 in).*
2. Remove the linings (1). Refer to *Park Brake Shoe Replacement (Bendix 229 mm - 9 in).*



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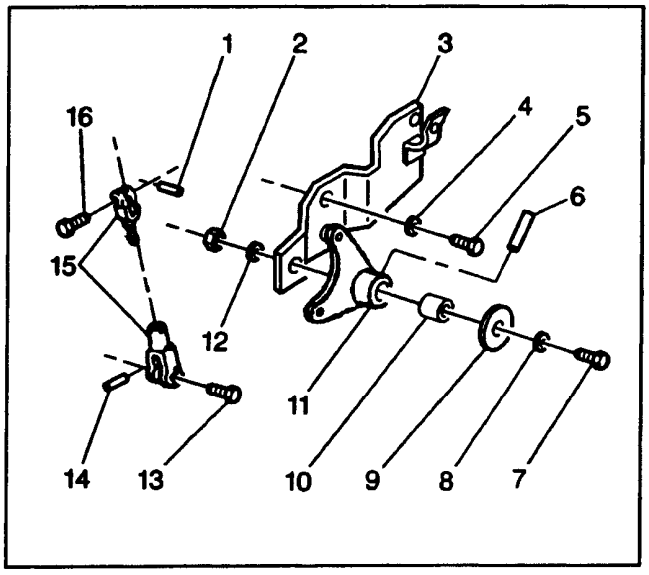
3. Remove the two cotter pins (1, 14).
4. Remove the two clevis pins (13, 16).



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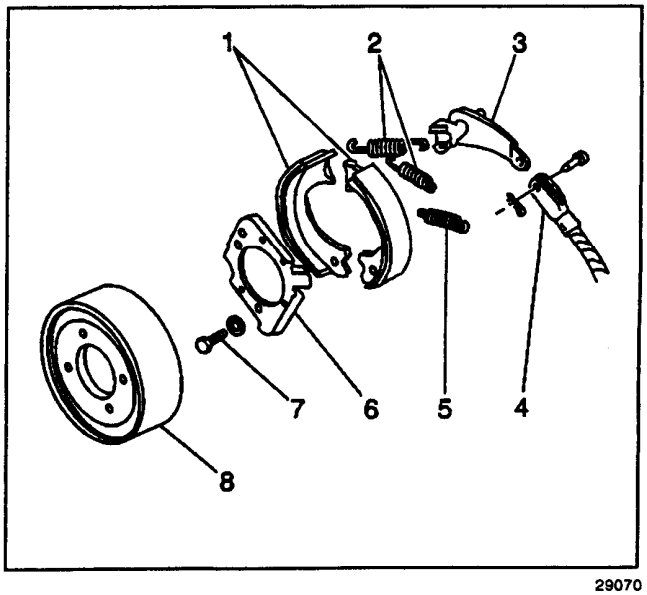
5. Remove the cam lever (3).
6. Loosening the support plate mounting bolts (7) may be necessary.



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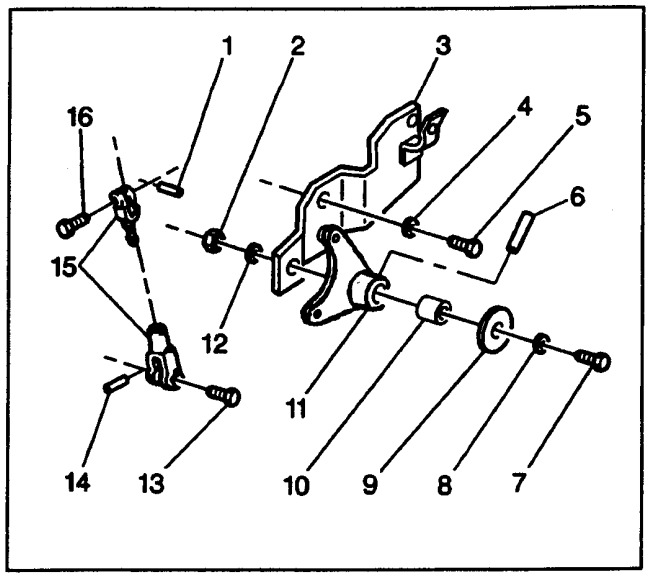

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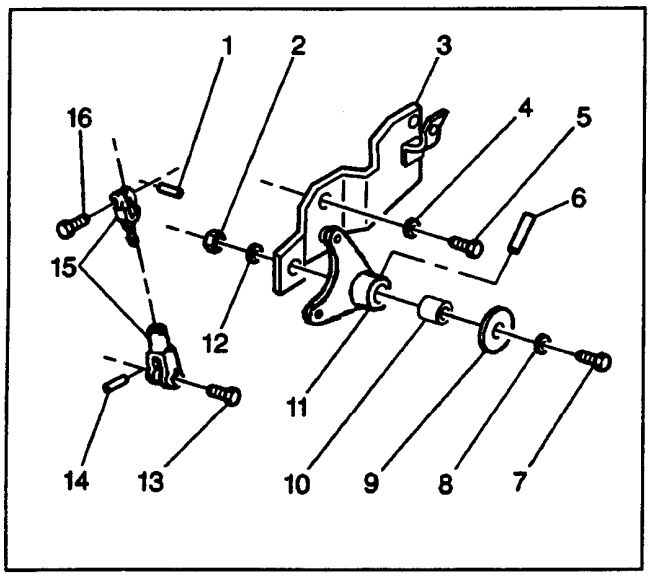
7. Remove the cotter pin and the clevis pin at the control cable arm of the bellcrank.
   Loosening the clevis jam nut (2) may be necessary in order to relieve binding of the pin in the clevis.
8. Remove the bellcrank bracket (3), if equipped.
9. Remove the following components:
   - Two bracket bolts (5)
   - The spring washers (4)
   - The bellcrank and bracket assembly (3)
10. Remove the bellcrank pivot nut (2) and the spring washer, if equipped.
11. Remove the bellcrank pivot bolt (5) and the two washers (4).
12. Remove the bellcrank (11).
13. Remove the bellcrank bushing (10).
14. Inspect the bellcrank bushing for wear.
    Replace the bellcrank bushing, if necessary.
15. Inspect the following components:
    - The washers
    - The levers
    - The clevises
16. Replace the components in the previous step if the following conditions exist:
    - Wear
    - Cracks
    - Damage
17. Inspect the bellcrank bracket (3) for damage, if equipped.
    Replace the bellcrank bracket, if necessary.



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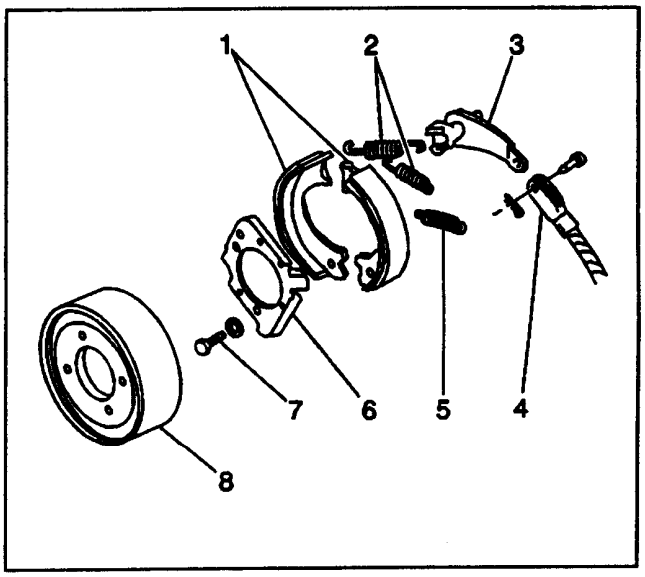
Installation Procedure

1. Install the bellcrank bushing (10).
2. Connect the bellcrank (11) to the bracket (3), if equipped, or directly to the transmission boss.
3. Install the bellcrank pivot bolt (7) and the two washers (8, 9).
   Tighten
   Tighten the bolt on assemblies mounted directly to the transmission boss to 98 N·m (72 lb ft).
4. Install the bellcrank pivot nut (2) and the spring washer (12), if equipped.
   Tighten
   Tighten the nut on assemblies with a bellcrank bracket to 38 N·m (28 lb ft).
5. Install the bellcrank bracket (3), if equipped, with the assembled bellcrank to the transmission housing.

6. Install the two bracket bolts (5) and the spring washers (4), if equipped.
   Tighten
   Tighten the bolts (5) to 30 N.m (22 lb ft).
7. Connect the control cable to the bellcrank (11).
8. Insert the bellcrank arm into the slot in the control cable clevis.
9. Insert the clevis pin.
10. Install a new cotter pin.
11. Tighten the control cable clevis lock nut, if the lock nut is loosened.
12. Install the cam lever (15).
13. Lubricate the socket in the transmission case boss.
14. Install the two clevis pins (13, 16).
15. Install the two new cotter pins (1, 14).
16. Install the linings (1). Refer to *Park Brake Shoe Replacement (Bendix 229 mm - 9 in).*
17. Install the drum (5). Refer to *Brake Drum Replacement (Bendix 254 mm - 10 in).*
18. Adjust the parking brake. Refer to *Park Brake Shoe Adjustment (Bendix 254 mm - 10 in).*



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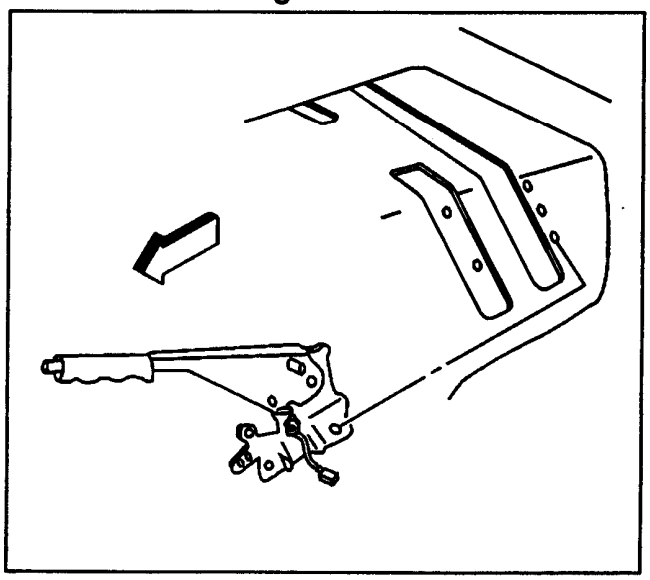
Description and Operation

Park Brake System Description

The parking brake is not designed for use in place of service brakes. Apply the parking brake only after the vehicle is brought to a complete stop, except in an emergency. Mechanically actuated parking brakes are internal-expanding drum-and-shoe type. The parking brakes are identified by their drum diameters and manufacturers. The transmission in the vehicle determines which parking brake is used.

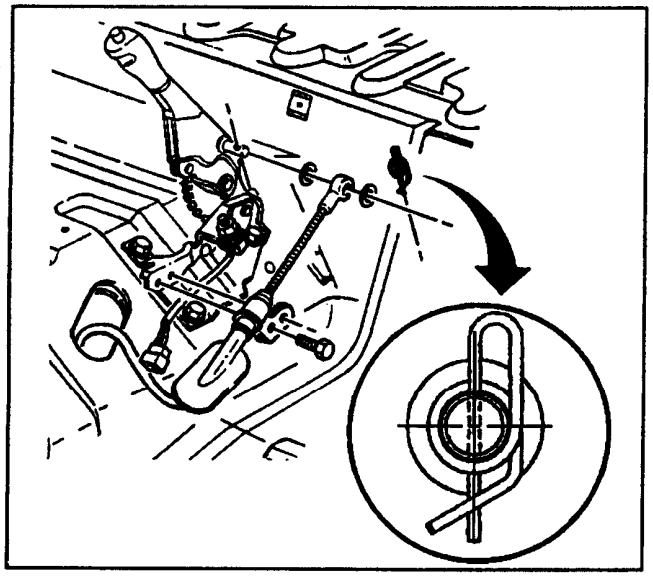
Lever

Parking Brake Lever



221273

Cable to Lever Attachment



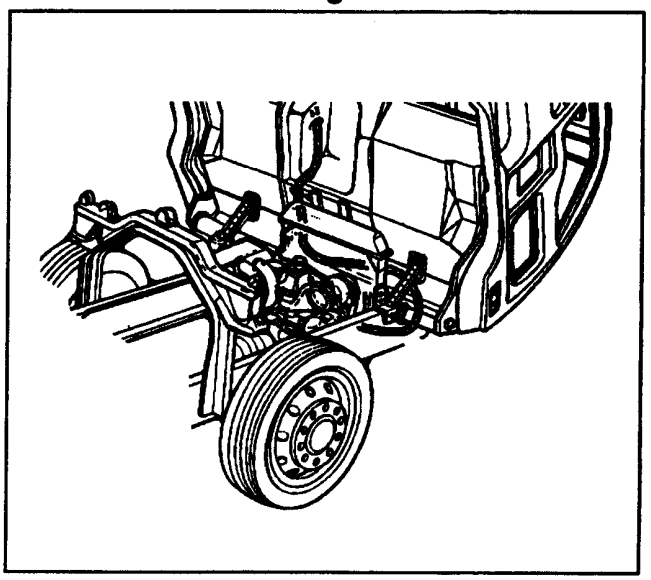
221274

The parking brake hand lever is mounted next to the driver's seat. The parking brake hand lever connects to the parking brake by a flexible cable. The cable end at the parking brake may have the following components in order to connect with the brake mechanism:

- A clevis
- A rod eye
- A pin

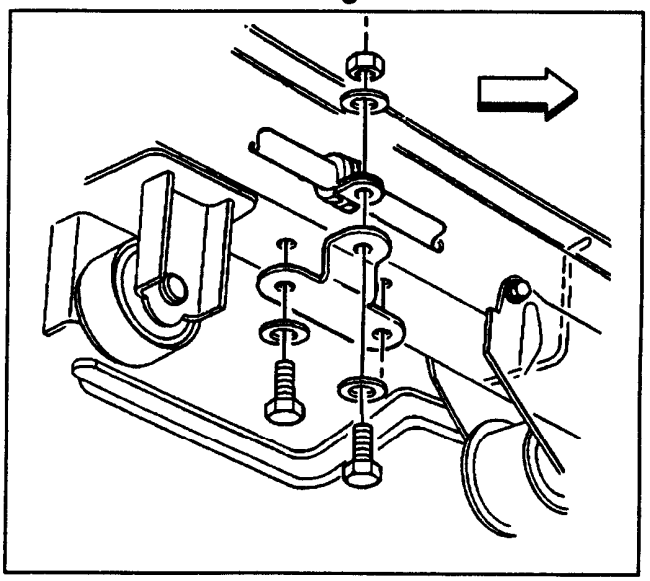
Cable System

Cable Routing on the Cab



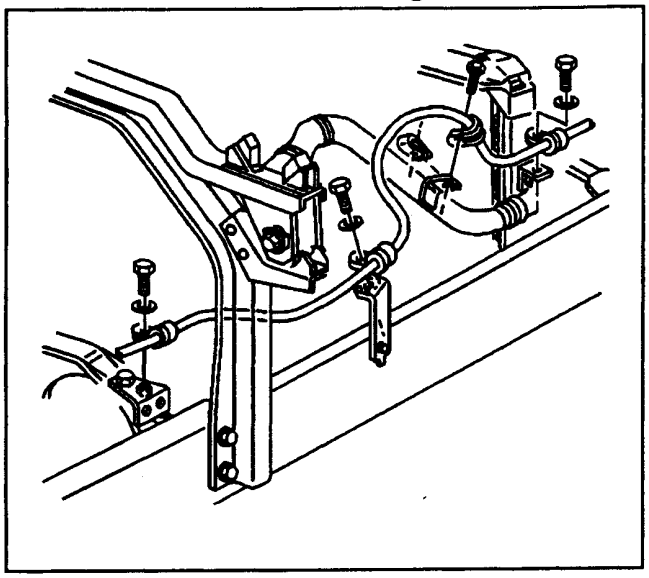
221276

Cable Mounting to the Cab



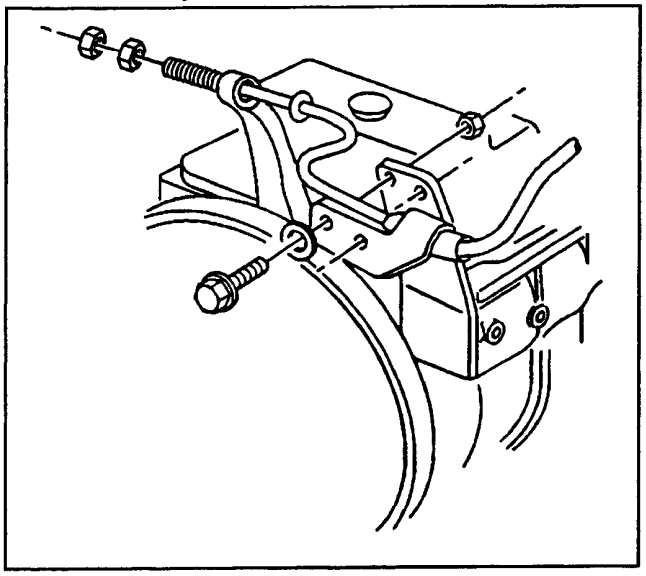
221277

Cable Routing



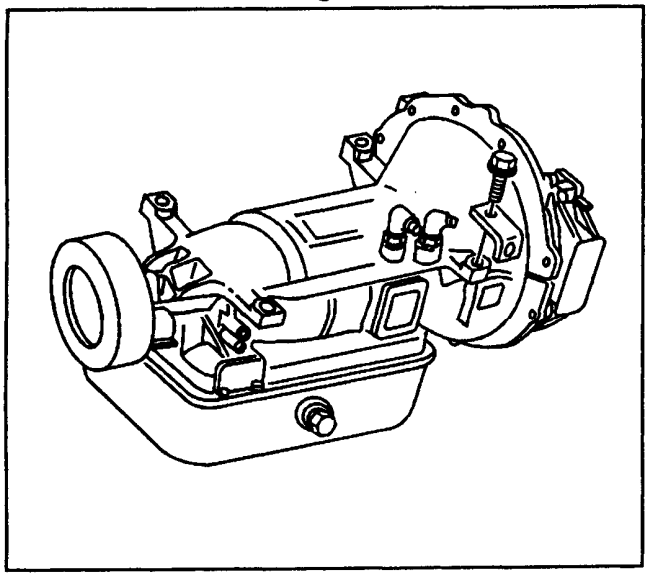
229417

Bracket Adjustment (Manual Transmission)



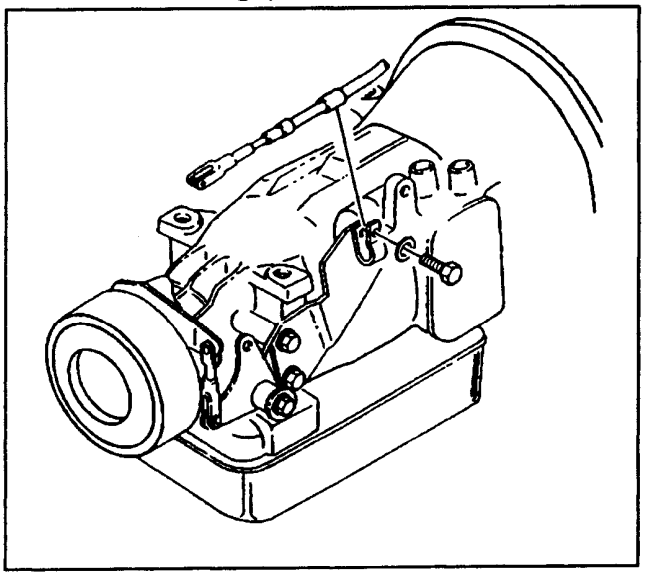
229422

Mounting Bracket



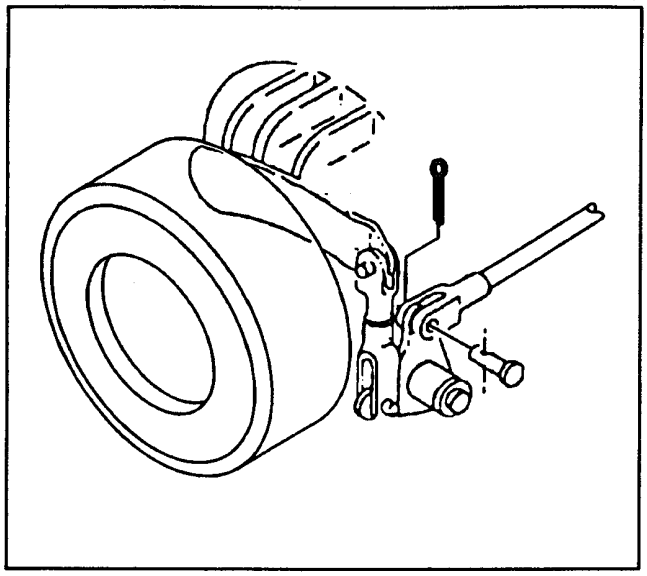
229421

Cable Mounting (Automatic Transmission)



221282

Bracket Adjustment (Automatic Transmission)



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A cable connects the lever to the propeller shaft-mounted parking brake. Coated parking brake cable assemblies are used on these vehicles. The wire strand is coated with a nylon material that slides through plastic seals inside the conduit end fittings. The nylon material protects the cable from corrosion and reduces parking brake effort.

Notice: Handling of the parking brake cables during service requires extra care. Damage to the nylon coating reduces the corrosion protection. If the damaged area passes through the seal, increased parking brake effort could result. Avoid contacting the coating with sharp-edged tools, or the sharp surfaces of the vehicle underbody.

In order to prevent damage to the threaded parking brake adjusting rod when servicing the parking brake, complete the following steps:

- Before turning the adjusting yoke, clean the exposed threads on each side of the yoke.
- Lubricate the threads of the adjusting rod before turning the yoke.

Brake Lamp

The BRAKE warning lamp on the instrument cluster turns ON when you apply the parking brake. The BRAKE lamp can also be turned ON by the switch in the combination valve and the antilock brake system.

Parking Brake Switch

The parking brake switch is located on the lever assembly. The switch turns ON the BRAKE lamp when you apply the parking brake and turns OFF the BRAKE lamp when you release the parking brake.

Daytime Running Lamps

This vehicle uses a daytime running lamp (DRL) system. This system uses the parking brake switch in order to turn OFF the DRL when the ignition switch is ON and the parking brake is applied. Refer to *DRL Circuit Description* in Body and Accessories for more information on DRL.

Park Brake System Operation

Push in on the dash park brake switch in order to release the park brake. The Park Brake Control Module (PBCM) turns ON the park brake pump motor in order to supply hydraulic pressure to the park brake actuator. The park brake actuator has a large spring on the inside that applies the park brake. When running, the park brake pump motor supplies hydraulic pressure behind a piston in the actuator which overcomes opposing spring tension. The actuator moves when the spring compresses. This movement transfers over to the park brake through the park brake cable.

The pump shuts OFF after the park brake is released. The PBCM then monitors the system pressure. The PBCM turns ON the pump in order to maintain the system pressure if the pressure drops too low.

The park brake solenoid is de-energized when the dash park brake switch is pulled out. This allows the fluid to dump back into the hydraulic reservoir. The spring tension in the actuator moves against the piston as the pressure drops. The actuator applies the park brake through the movement of the park brake cable.

Vehicles with a steering column-mounted transmission shifter include a feature that applies the park brake when the shifter is placed in the PARK position. This feature operates in conjunction with the dash park brake switch to apply the park brake.

Air Brakes

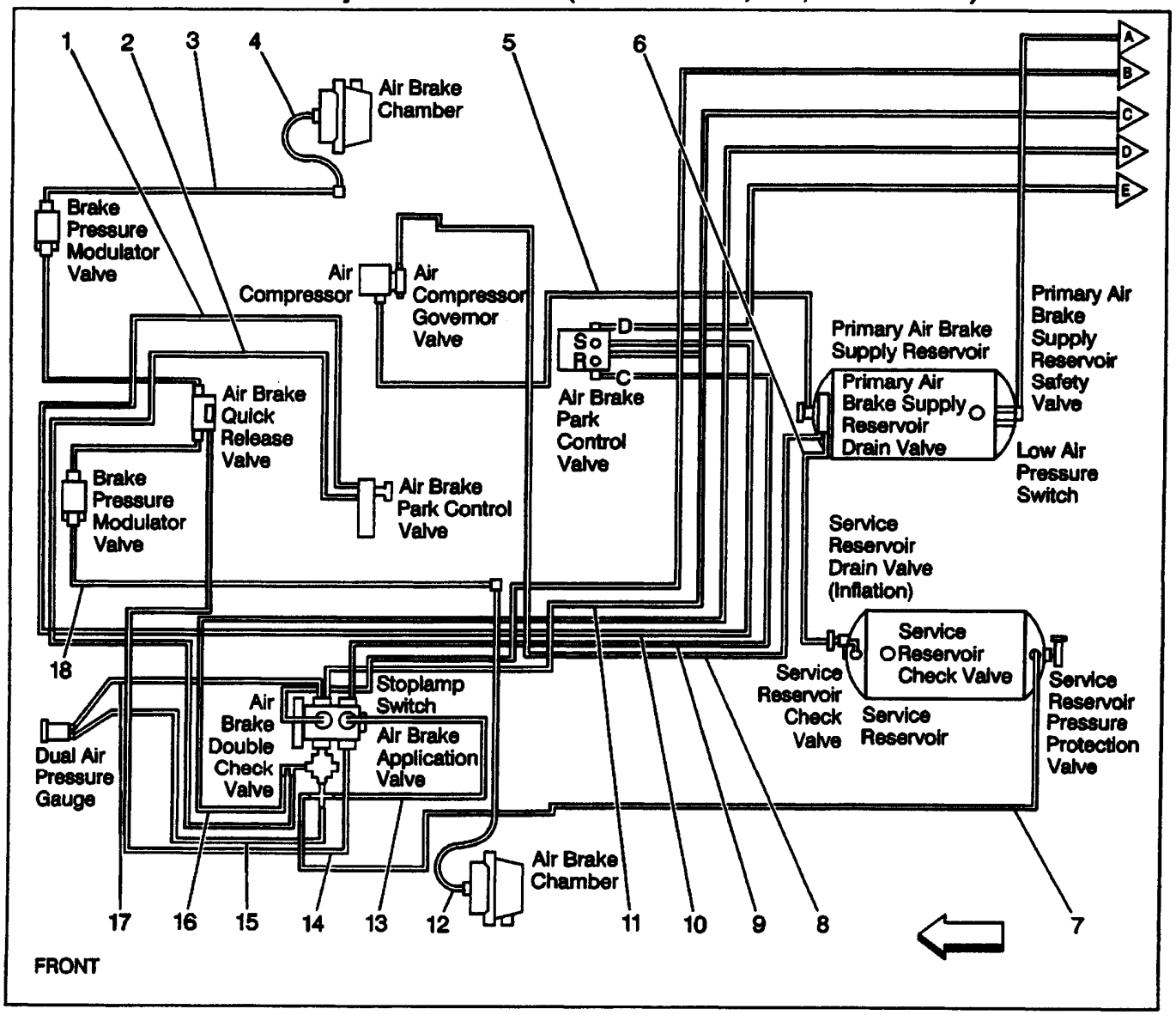
Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Air Dryer Delivery Port Elbow*	35 N.m	26 lb ft
Air Dryer Governor Port Elbow*	20 N.m	15 lb ft
Air Dryer Nut	45 N.m	33 lb ft
Air Dryer Supply Port Elbow*	35 N.m	26 lb ft
Air Reservoir Plug (All)	50 N.m	37 lb ft
Air Reservoir Support Bolt	53 N.m	39 lb ft
Brake Pedal Bracket Bolt (6 mm)	8 N.m	71 lb in
Brake Pedal Bracket Bolt (8 mm)	19 N.m	14 lb ft
Brake Pedal Joint Lock Nut	62 N.m	46 lb ft
Double Check Valve	28 N.m	21 lb ft
Dual Application Valve Mounting Bolt	40 N.m	29 lb ft
Elbow* (Air Brake Coupling Stud Nut)	20 N.m	15 lb ft
Inflation Valve	20 N.m	15 lb ft
Low Air Pressure Switch	12 N.m	106 lb in
Park Control Valve Nut (Cab Mounted)	6 N.m	53 lb in
Park Control Valve Nut (Chassis Mounted)	22 N.m	16 lb ft
Parking Control Valve Nut	6 N.m	53 lb in
Pressure Protection Valve	30 N.m	22 lb ft
Quick Release Valve (Double Check Type) Bolt	52 N.m	38 lb ft
Quick Release Valve Nut	22 N.m	16 lb ft
Relay Valve Bolt	52 N.m	38 lb ft
Relay Valve (Double Check Type) Bolt	52 N.m	38 lb ft
Reservoir Drain Valve	50 N.m	37 lb ft
Reservoir Drain Valve (Manual Type)	50 N.m	37 lb ft
Safety Valve	30 N.m	22 lb ft
Single Check Valve	50 N.m	37 lb ft
Stoplamp Switch	11 N.m	97 lb in
Strap Nut (All except Rear Axle)	28 N.m	21 lb ft
Strap Nut (Rear Axle)	23 N.m	17 lb ft
Stud Nut	45 N.m	33 lb ft
Towing Vehicle Protection Valve	22 N.m	16 lb ft
Trailer Air Brake Control Valve Bolt	40 N.m	29 lb ft
Trailer Air Brake Coupling	35 N.m	26 lb ft
Trailer Air Brake Dummy Coupling Nut	30 N.m	22 lb ft
Trailer Air Brake Stoplamp Switch	7 N.m	62 lb in
*Tighten the elbow to the specified torque, and then rotate a maximum of 360 degrees until the proper orientation is achieved.		

Schematic and Routing Diagrams

Air Brake System Schematics (F6/7B042 RQ2, JE4, JE5 w/o JYV)



Legend

(1) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(2) Air Brake Park Control Valve Supply Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Blue) O.D. 16 mm, 0.625 in

(3) Front Brake Pressure Modulator Valve to Front Air Brake Chamber supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

(4) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(5) Air Compressor to Primary Air Brake Supply Reservoir (Copper) O.D. 16 mm, 0.625 in

(6) Primary Air Brake Supply Reservoir to Front Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(7) Air Brake Double Check Valve to Front Axle Service Reservoir (Blue) O.D. 13 mm, 0.50 in

(8) Air Compressor Governor Valve to Primary Air Brake Supply Reservoir (Black) O.D. 10 mm, 0.375 in

(9) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Blue) O.D. 6 mm, 0.250 in

(10) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Park Control Valve (I/P Mounted) Delivery Tube Connector (Red) O.D. 10 mm, 0.375 in

(11) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Green) O.D. 13 mm, 0.50 in

(12) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(13) Air Brake Application Valve to Air Brake Double Check Valve (Blue) O.D. 13 mm, 0.50 in

(14) Air Brake Application Valve to Front Air Brake Quick Release Valve (Blue) O.D. 13 mm, 0.50 in

(15) Air Brake Double Check Valve to Dual Air Pressure Gauge (Blue) O.D. 6 mm, 0.250 in

(16) Air Brake Double Check Valve to Air Brake Park Control Valve (I/P Mounted) Supply Tube Connector (Brown) O.D. 10 mm, 0.375 in

(17) Air Brake Application Valve to Dual Air Pressure Gauge (Green) O.D. 6 mm, 0.250 in

(18) Front Brake Pressure Modulator Valve to Front Air Brake Chamber supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

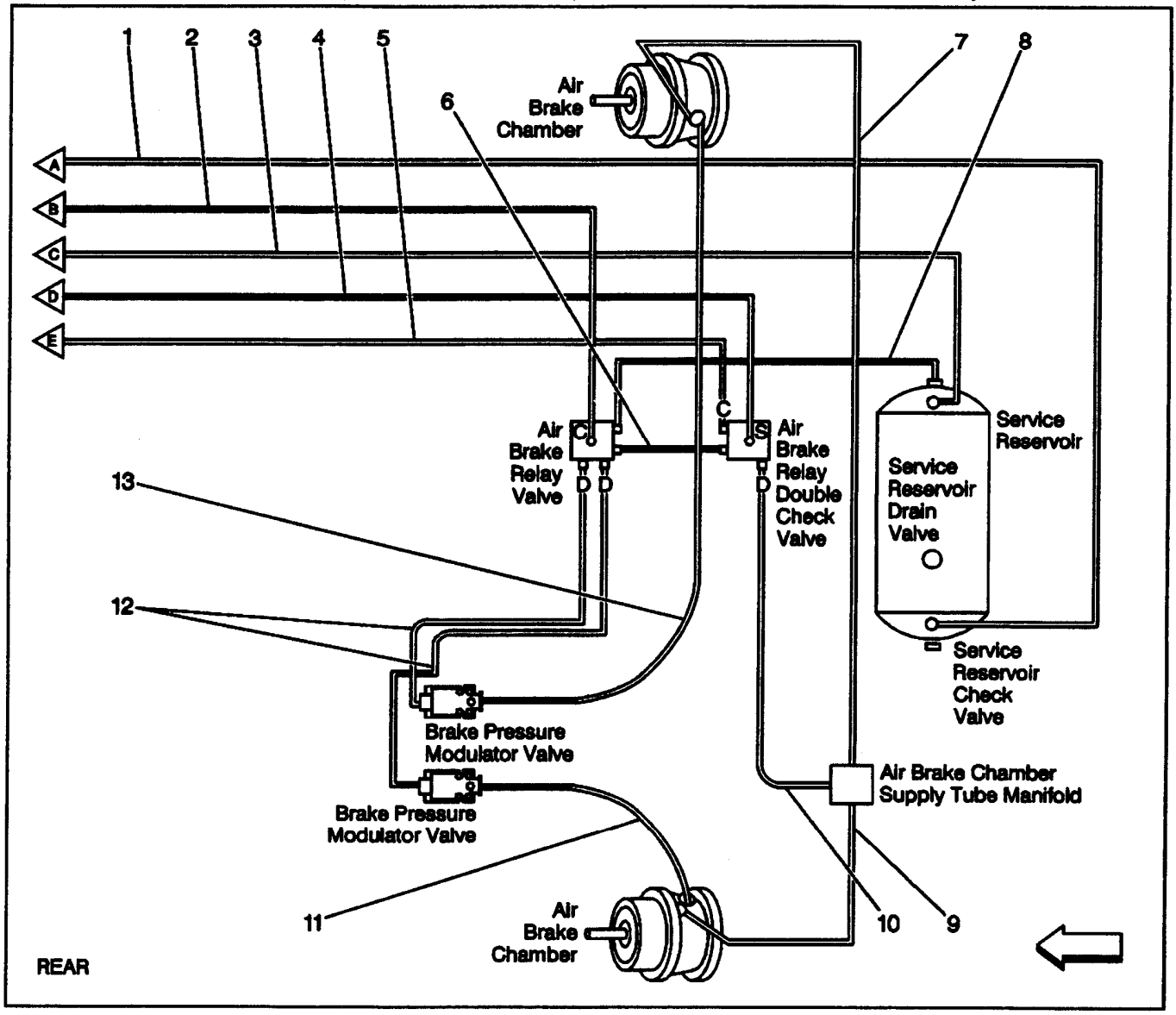
(c) Control Port

(d) Delivery Port

(r) Rear Reservoir Port

(s) Supply Port

Air Brake System Schematics (F6/7B042 RQ2, JE4, JE5 w/o JYV)



Legend

(1) Primary Air Brake Supply Reservoir to Rear Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(2) Air Brake Application Valve to Rear Air Brake Relay Valve (Green) O.D. 13 mm, 0.50 in

(3) Rear Axle Service Reservoir to Air Brake Park Control Valve (Chassis Mounted) (Green) O.D. 13 mm, 0.50 in

(5) Air Brake Double Check Valve to Rear Air Brake Relay Double Check Valve (Red) O.D. 13 mm, 0.50 in

(6) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Relay Double Check Valve (Black) O.D. 10 mm, 0.375 in

(7) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(8) Rear Air Brake Relay Valve to Rear Axle Service Reservoir (Green) O.D. 13 mm, 0.50 in

(9) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(10) Rear Air Brake Quick Release Double Check Valve to Rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(11) Rear Brake Pressure Modulator Valve to Rear Air Brake Chamber (Emergency Port) (Black) O.D. 27 mm, 1.06 in

(12) Rear Air Brake Relay Valve to Rear Brake Pressure Modulator Valve (Green) O.D. 19 mm, 0.750 in

(13) Rear Brake Pressure Modulator Valve to Rear Air Brake Chamber (Emergency Port) (Black) O.D. 27 mm, 1.06 in

(c) Control Port

(c1) Control Port

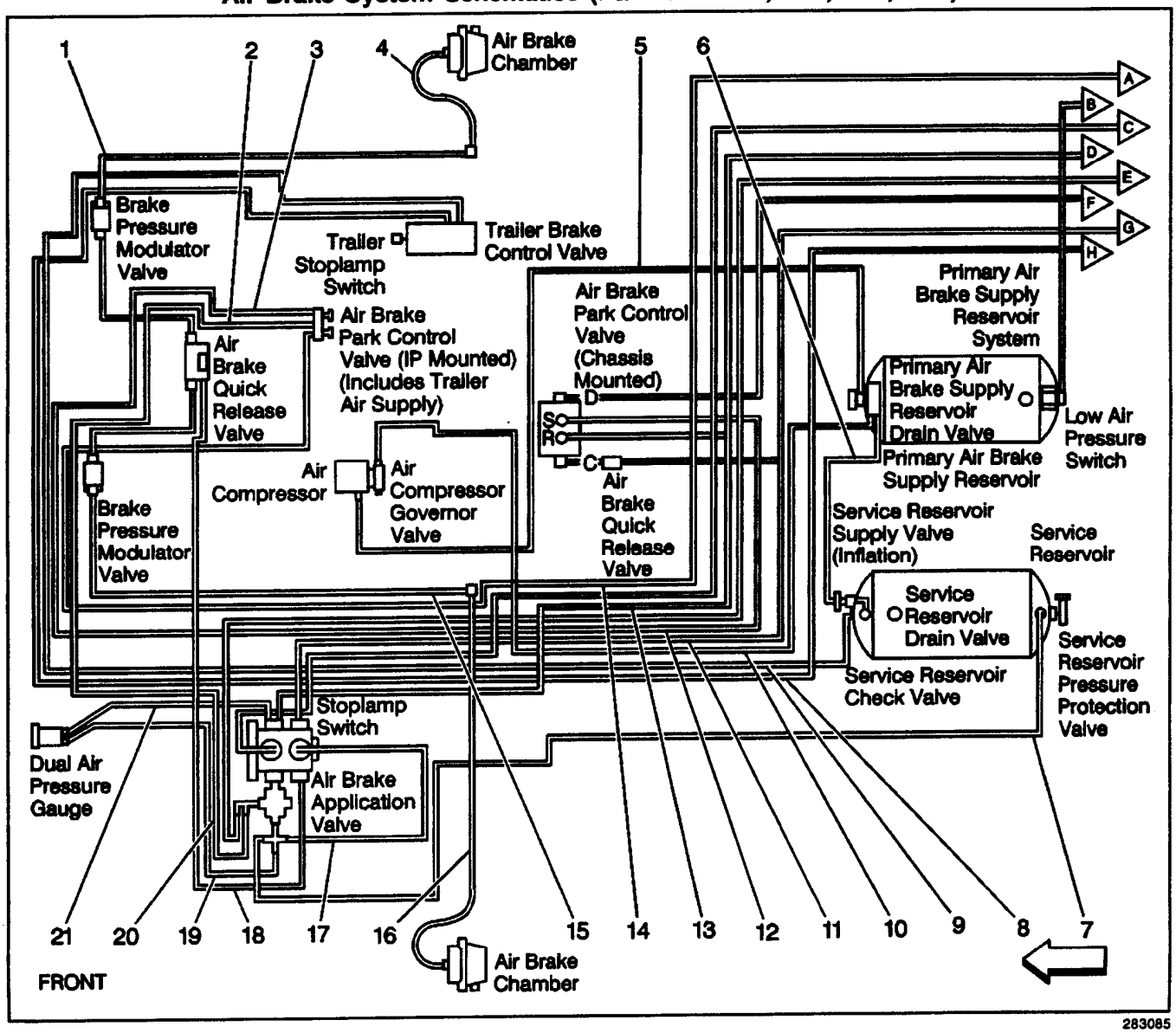
(d) Delivery Port

(d1) Delivery Port

(d2) Delivery Port

(s) Supply Port

Air Brake System Schematics (F6/7B042 RQ2, JE4, JE5, JYV)



283085

Legend

(1) Front Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

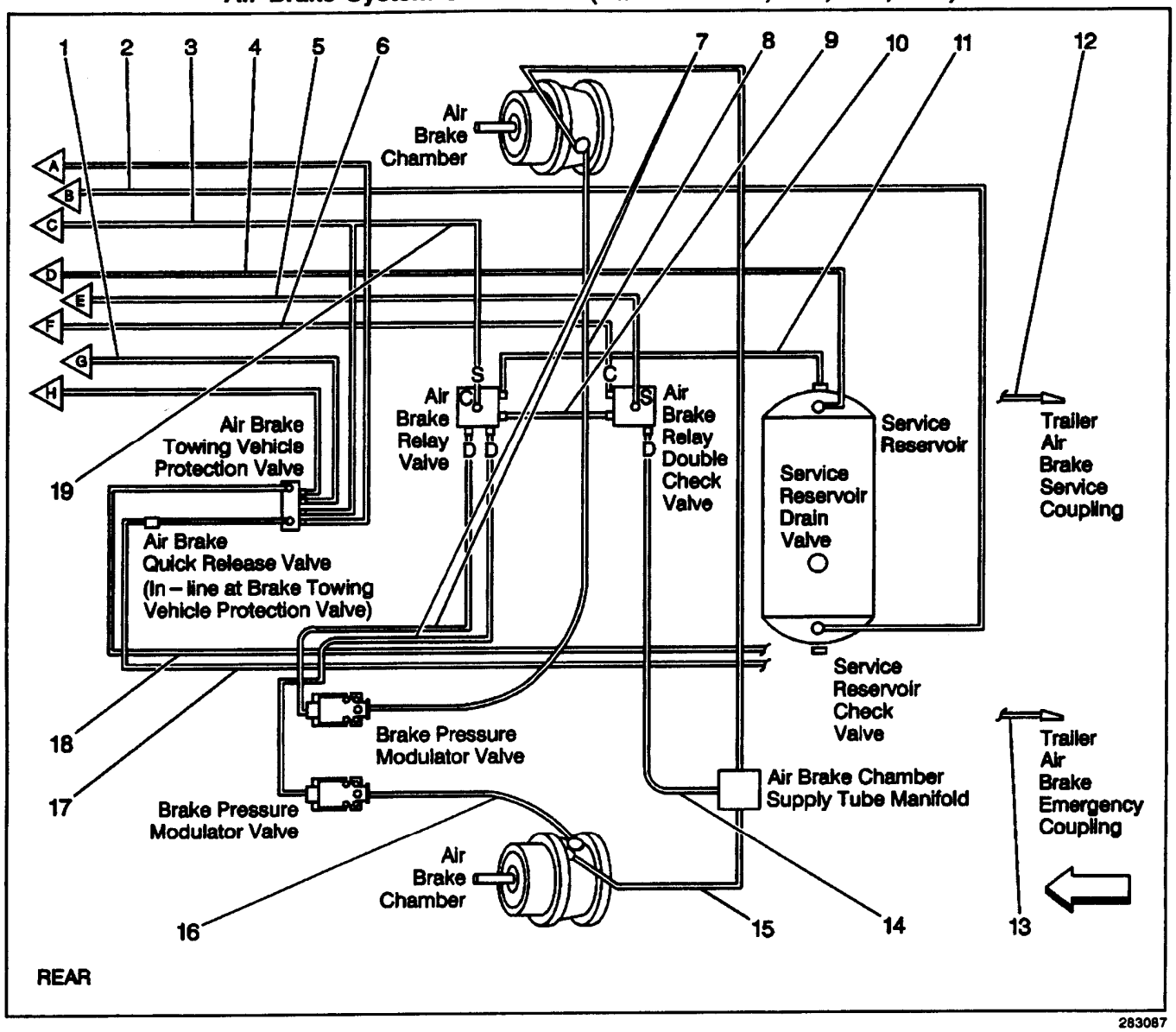
(2) Air Brake Park Control Valve Supply Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Blue) O.D. 16 mm, 0.625 in

(3) Air Brake Park Control Valve Delivery Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Orange) O.D 16 mm, 0.625 in

(4) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(5) Air Compressor to Primary Air Brake Supply Reservoir (Copper) O.D. 16 mm, 0.625 in
(6) Primary Air Brake Supply Reservoir to Front Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in
(7) Air Brake Double Check Valve to Front Axle Service Reservoir (Blue) O.D. 13 mm, 0.50 in
(8) Trailer Brake Control Valve Delivery Tube Connector to Air Brake Towing Vehicle Protection Valve (Yellow) O.D. 10 mm, 0.375 in
(9) Front Axle Service Reservoir to Trailer Brake Control Valve Supply Tube Connector (Blue) O.D 10 mm, 0.375 in
(10) Air Compressor Governor Valve to Primary Air Brake Supply Reservoir (Black) O.D. 10 mm, 0.375 in
(11) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Blue) O.D. 6 mm, 0.250 in
(12) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Park Control Valve (I/P Mounted) Delivery Tube Connector (Red) O.D. 10 mm, 0.375 in
(13) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Green) O.D. 13 mm, 0.50 in
(14) Trailer Air Supply Tube Connector to Air Brake Towing Vehicle Protection Valve (Yellow) O.D. 10 mm, 0.375 in
(15) Front Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 13 mm, 0.50 in
(16) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in
(17) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Blue) O.D. 6 mm, 0.250 in
(18) Air Brake Application Valve to Front Air Brake Quick Release Valve (Blue) O.D. 13 mm, 0.50 in
(19) Air Brake Double Check Valve to Dual Air Pressure Gauge (Blue) O.D. 6 mm, 0.250 in
(20) Air Brake Double Check Valve to Air Brake Park Control Valve (I/P Mounted) Supply Tube Connector (Brown) O.D. 10 mm, 0.375 in
(21) Air Brake Application Valve to Dual Air Pressure Gauge (Green) O.D. 6 mm, 0.250 in
(c) Control Port
(r) Rear Reservoir Port
(s) Supply Port

Air Brake System Schematics (F6/7B042 RQ2, JE4, JE5, JYV)



283087

Legend

(1) Park Brake Control Valve (Chassis Mounted) to Air Brake Towing Vehicle Protection Valve (Blue) O.D. 13 mm, 0.50 in

(2) Primary Air Brake Supply Reservoir to Rear Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(3) Air Brake Application Valve to Air Brake Towing Vehicle Protection Valve (Green) O.D. 13 mm, 0.50 in

(4) Rear Axle Service Reservoir to Rear Air Brake Park Control Valve (Chassis Mounted) (Green) O.D. 13 mm, 0.50 in

(5) Air Brake Double Check Valve to Rear Air Brake Relay Double Check Valve (Red) O.D. 13 mm, 0.50 in

(6) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Relay double Check Valve (Black) O.D. 10 mm, 0.375 in

(7) Rear Air Brake Relay Valve to Rear Brake Pressure Modulator Valve (Green) O.D. 19 mm, 0.750 in

(8) Rear Brake Pressure Modulator Valve to Rear Air Brake Chamber (Emergency Port) (Black) O.D. 27 mm, 1.06 in

(9) Rear Air Brake Relay Valve to Rear Air Brake Relay Double Check Valve (Green) O.D. 6 mm, 0.250 in

(10) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(11) Rear Air Brake Relay Valve to Rear Axle Service Reservoir (Green) O.D. 13 mm, 0.50 in

(12) Air Brake Towing Vehicle Protection Valve to Trailer Air Brake Service Coupling (Blue) O.D. 13 mm, 0.50 in

(13) Rear Air Brake Quick Release Valve (In-line at Air Brake Towing Vehicle Protection Valve) to Trailer Air Brake Emergency Coupling (Red) O.D. 13 mm, 0.50 in

(14) Rear Air Brake Relay Double Check Valve to Rear Air Brake Park Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(15) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(16) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(17) Rear Air Brake Quick Release Valve (In-line at Air Brake Towing Vehicle Protection Valve) to Trailer Air Brake Emergency Coupling (Red) O.D. 13 mm, 0.50 in

(18) Air Brake Towing Vehicle Protection Valve to Trailer Air Brake Service Coupling (Blue) O.D. 13 mm, 0.50 in

(19) Air Brake Application Valve to Air Brake Towing Vehicle Protection Valve (Green) O.D. 13 mm, 0.50 in

(c) Control Port

(c1) Control Port

(d) Delivery Port

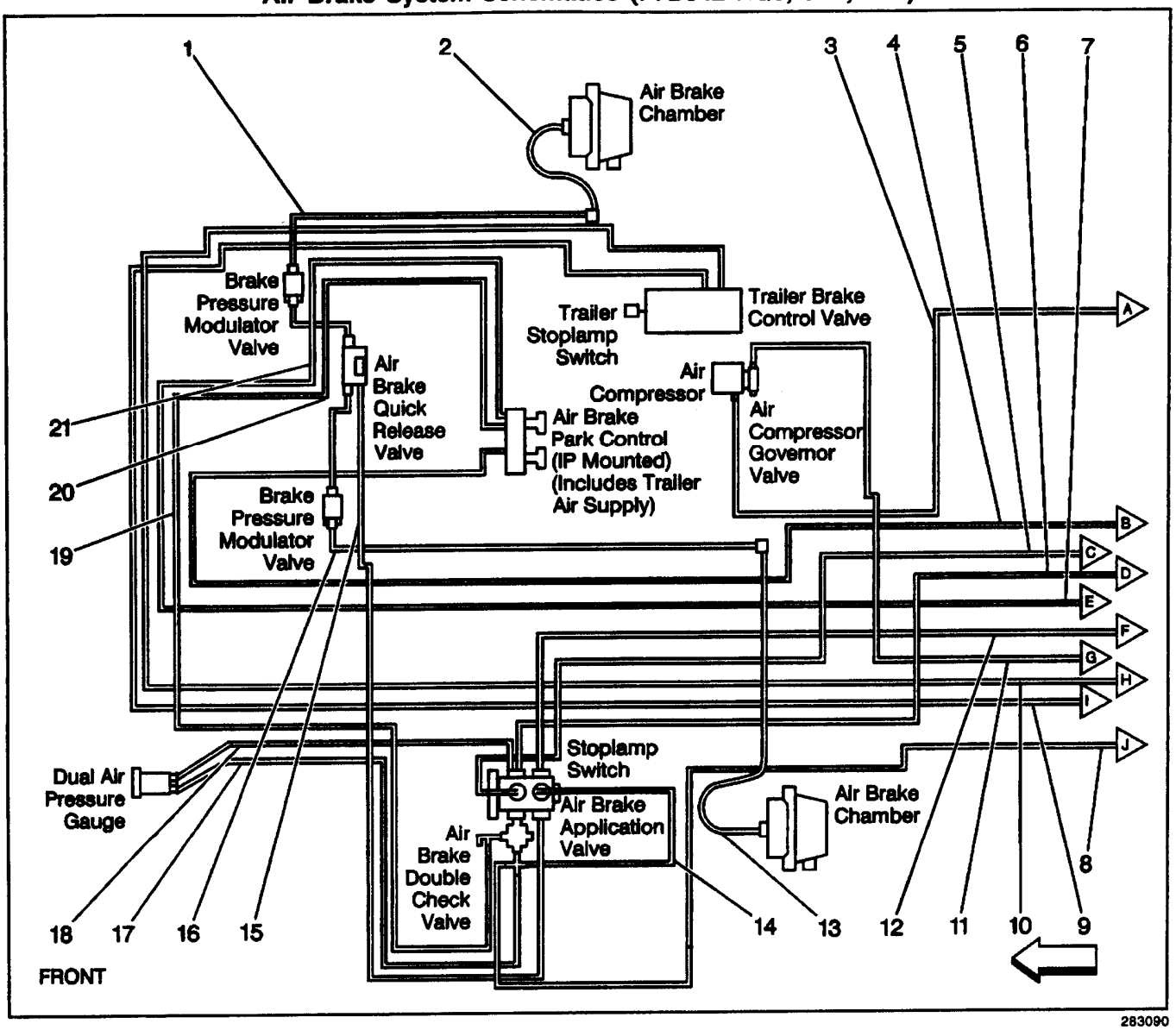
(d1) Delivery Port

(d2) Delivery Port

(s) Supply Port

(s1) Supply Port

Air Brake System Schematics (F7B042 RQ3, JE4, JE5)



Legend

(1) Front Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

(2) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(3) Air Compressor to Primary Air Brake Supply Reservoir (Copper) O.D. 16 mm, 0.625 in

(4) Trailer Air Supply Tube Connector to Air Brake Towing Vehicle Protection Valve (Yellow) O.D. 10 mm, 0.375 in

(5) Air Brake Application Valve to Air Brake Towing Vehicle Protection Valve (Green) O.D. 13 mm, 0.50 in

(6) Air Brake Application Valve to Rear Axle Service Reservoir (Green) O.D. 16 mm, 0.625 in

(7) Air Brake Park Control Valve Delivery Tube Connector to Rear Air Brake Quick Release Double Check Valve (Red) O.D. 10 mm, 0.375 in

(8) Air Brake Double Check Valve to Front Axle Service Reservoir (Blue) O.D. 13 mm, 0.50 in

(9) Trailer Brake Control Valve Delivery Tube Connector to Air Brake Towing Vehicle Protection Valve (Yellow) O.D. 13 mm, 0.50 in

(10) front Axle Service Reservoir to Trailer Brake Control Valve Supply Tube Connector (Blue) O.D. 10 mm, 0.375 in

(11) Air Compressor Governor Valve to Primary Air Brake Supply Reservoir (Black) O.D. 10 mm, 0.375 in

(12) Air Brake Application Valve to Air Brake Towing Vehicle Protection Valve (Blue) O.D. 13 mm, 0.50 in

(13) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(14) Air Brake Application Valve to Air Brake Double Check Valve (Blue) O.D. 13 mm, 0.50 in

(15) Air Brake Application Valve to Front Air Brake Quick Release Valve (Blue) O.D. 13 mm, 0.50 in

(16) Front Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

(17) Air Brake Double Check Valve to Dual Air Pressure Gauge (Blue) O.D. 6 mm, 0.250 in

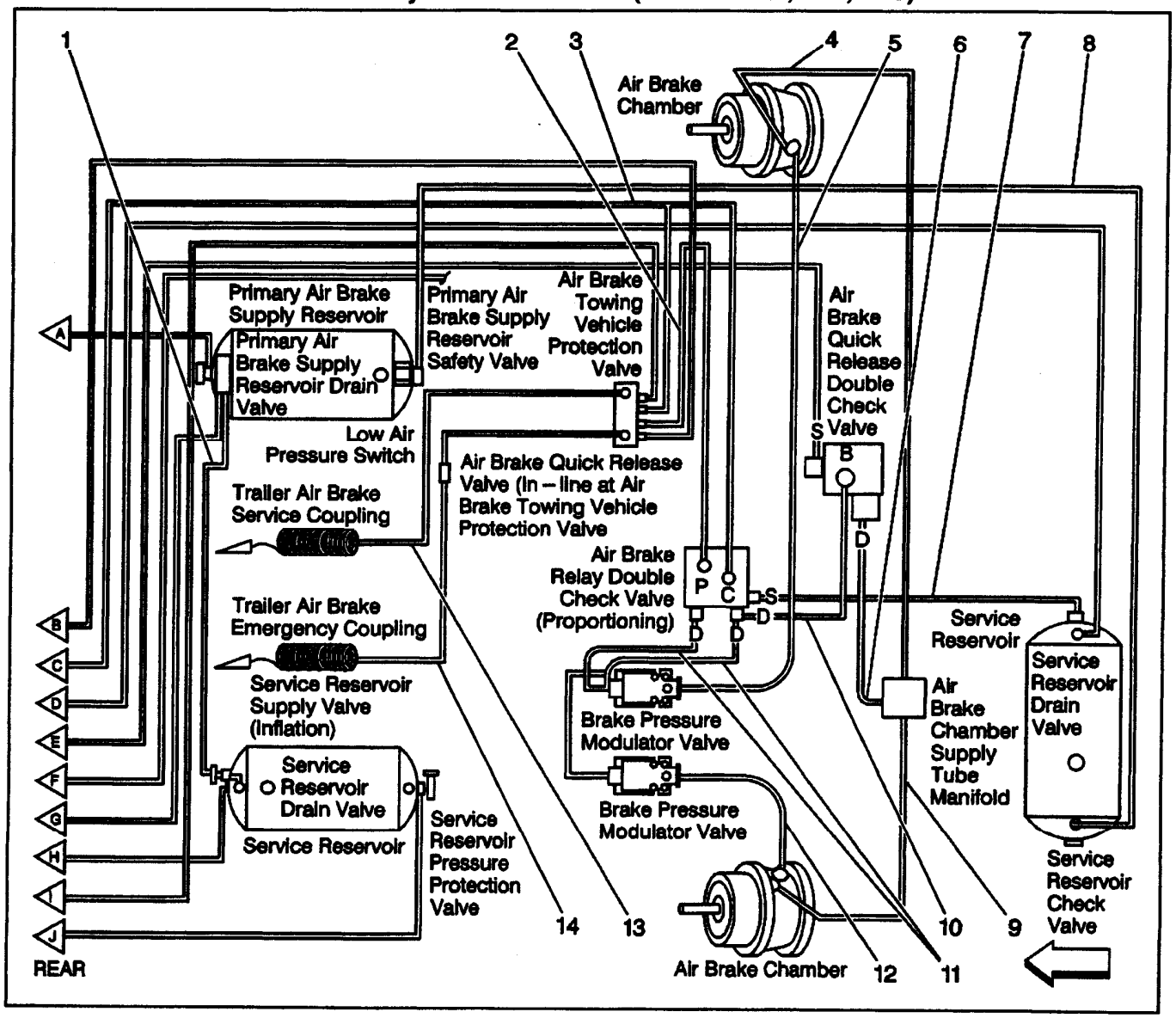
(18) Air Brake Application Valve to Dual Air Pressure Gauge (Green) O.D. 6 mm, 0.250 in

(19) Air Brake Double Check Valve to Air Brake Park Control Valve (I/P Mounted) Supply Tube Connector (Brown) O.D. 10 mm, 0.375 in

(20) Air Brake Park Control Valve Supply Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Blue) O.D. 16 mm, 0.625 in

(21) Air Brake Park Control Valve Delivery Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Copper) O.D. 16 mm, 0.625 in

Air Brake System Schematics (F7B042 RQ3, JE4, JE5)



Legend

(1) Primary Air Brake Supply Reservoir To Front Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(2) Air Brake Towing Vehicle Protection Valve to Rear Air Brake Relay Double Check Valve (Proportioning) (Yellow) O.D. 6 mm, 0.250 in

(3) Air Brake Towing vehicle Protection Valve to Rear Air Brake Relay Double Check Valve (Proportioning) (Green) O.D. 6 mm, 0.250 in

(4) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(5) Rear Brake Pressure Modulator Valve to Rear Air Brake Chamber (Emergency Port) (Black) O.D. 27 mm, 1.06 in

(6) Rear Air Brake Quick Release Double Check Valve to Rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(7) Rear Air Brake Quick Release Double Check Valve to Rear Axle Service Reservoir (Green) O.D. 13 mm, 0.50 in

(8) Primary Air Brake Supply Reservoir to Rear Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(9) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(10) Rear Air Brake Relay Double Check Valve (Proportioning) to Rear Air Brake quick Release Double Check Valve (Green) O.D. 13 mm, 0.50 in

(11) Rear Air Brake Relay Valve to Rear Brake Pressure Modulator Valve (Green) O. D. 13 mm, 0.50 in

(12) Rear Brake Pressure Modulator Valve to Rear Air Brake Chamber (Emergency Port) (Black) O.D. 27 mm, 1.06 in

(13) Air Brake Towing Vehicle Protection Valve to Trailer Air Brake Service Coupling (Blue) O.D. 13 mm, 0.50 in

(14) Rear Air Brake Quick Release Valve (In-line at Air Brake Towing Vehicle Protection Valve) to Trailer Air Brake Emergency Coupling (Red) O.D. 13 mm, 0.50 in

(b) Balance Port

(c) Control Port

(d) Delivery Port

(d1) Delivery Port

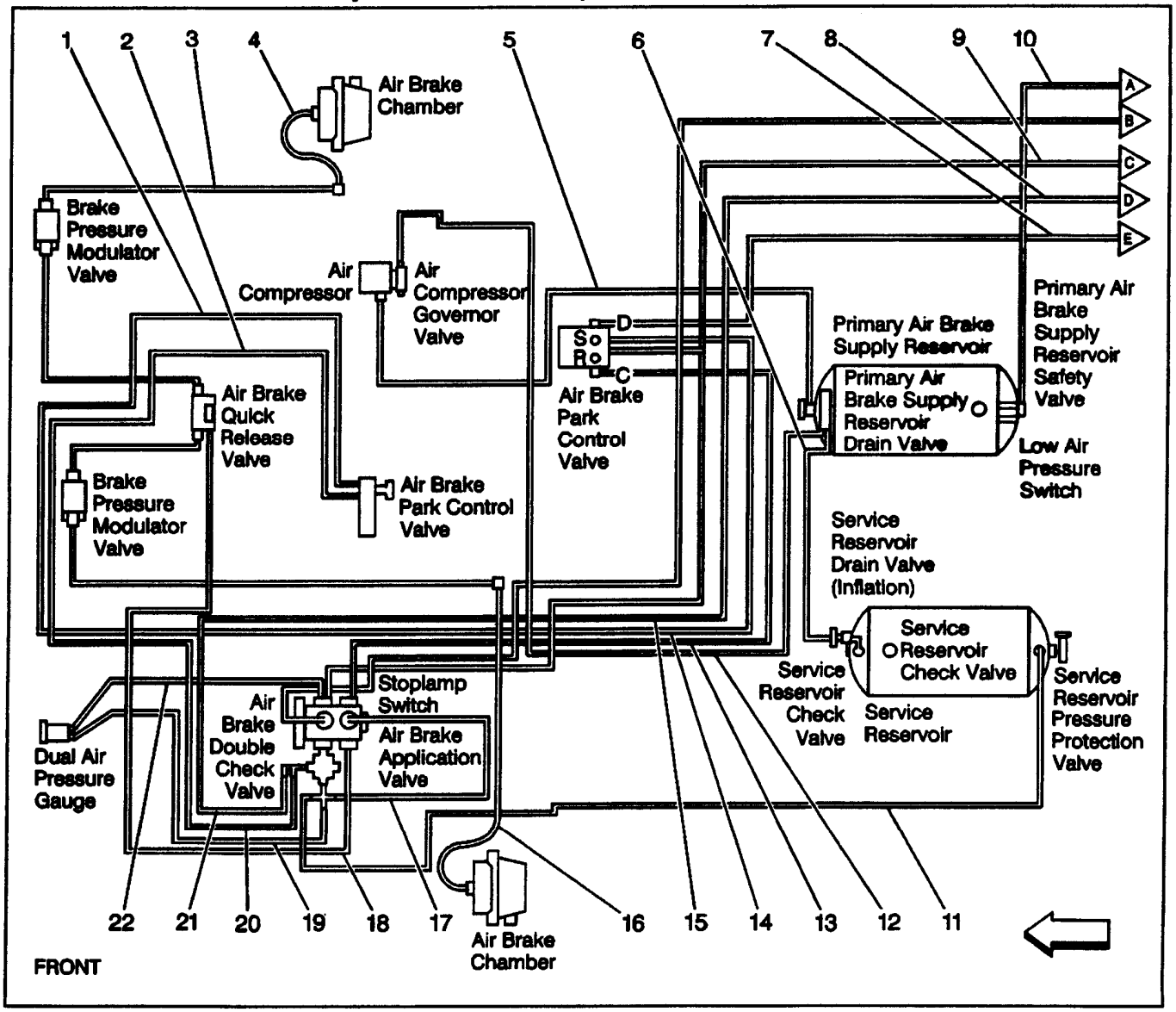
(d2) Delivery Port

(d3) Delivery Port

(s) Supply Port

(s1) Supply Port

Air Brake System Schematics (F7B064 RQ2, JE4, JE5 w/o JYV)



283082

Legend

(1) Air Brake Park Control Valve Delivery Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Orange) O.D 16 mm, 0.625 in

(2) Air Brake Park Control Valve Supply Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Blue) O.D. 16 mm, 0.625 in

(3) Front Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

(4) Front Air Brake Chamber to Front Air Brake Chamber supply Tube Elbow (Black) O.D. 19 mm, 0.750

(5) Air Compressor to Primary Air Brake Supply Reservoir (Copper) O.D. 16 mm, 0.625 in

(6) Primary Air Brake Supply Reservoir to Front Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(7) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Relay Double Check Valve (Black) O.D. 10 mm, 0.375 in

(8) Air Brake Double Check Valve to Rear Air Brake Relay Double Check Valve (Red) O.D. 13 mm, 0.50 in

(9) Air Brake Park Control Valve (Chassis Mounted) to Rear Axle Service Reservoir (Front Unit) (Green) O.D. 13 mm, 0.50 in

(10) Primary Air Brake Supply Reservoir to Rear Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(11) Air Brake Double Check Valve to Front Axle Service Reservoir (Blue) O.D. 13 mm, 0.50 in

(12) Air Compressor Governor Valve to Primary Air Brake Supply Reservoir (Black) O.D. 10 mm, 0.375 in

(13) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Blue) O.D. 6 mm, 0.250 in

(14) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Park Control Valve (I/P Mounted) Delivery Tube Connector (Red) O.D. 10 mm, 0.375 in

(15) Air Brake Double Check Valve to Rear Air Brake Relay Double Check Valve (Red) O.D. 13 mm, 0.50 in

(16) Front Air Brake Quick Release Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(17) Air Brake Application Valve to Air Brake Double Check Valve (Blue) O.D. 13 mm, 0.50 in

(18) Air Brake Application Valve to Front Air Brake Quick Release Valve (Blue) O.D. 13 mm, 0.50 in

(19) Air Brake Double Check Valve to Dual Air Pressure Gauge (Blue) O.D. 6 mm, 0.250 in

(20) Air Brake Double Check Valve to Air Brake Park Control Valve (I/P Mounted) Supply Tube Connector (Brown) O.D. 10 mm, 0.375 in

(21) Air Brake Double Check Valve to Rear Air Brake Relay Double Check Valve (Red) O.D. 13 mm, 0.50 in

(22) Air Brake Application Valve to Dual Air Pressure Gauge (Green) O.D. 6 mm, 0.250 in

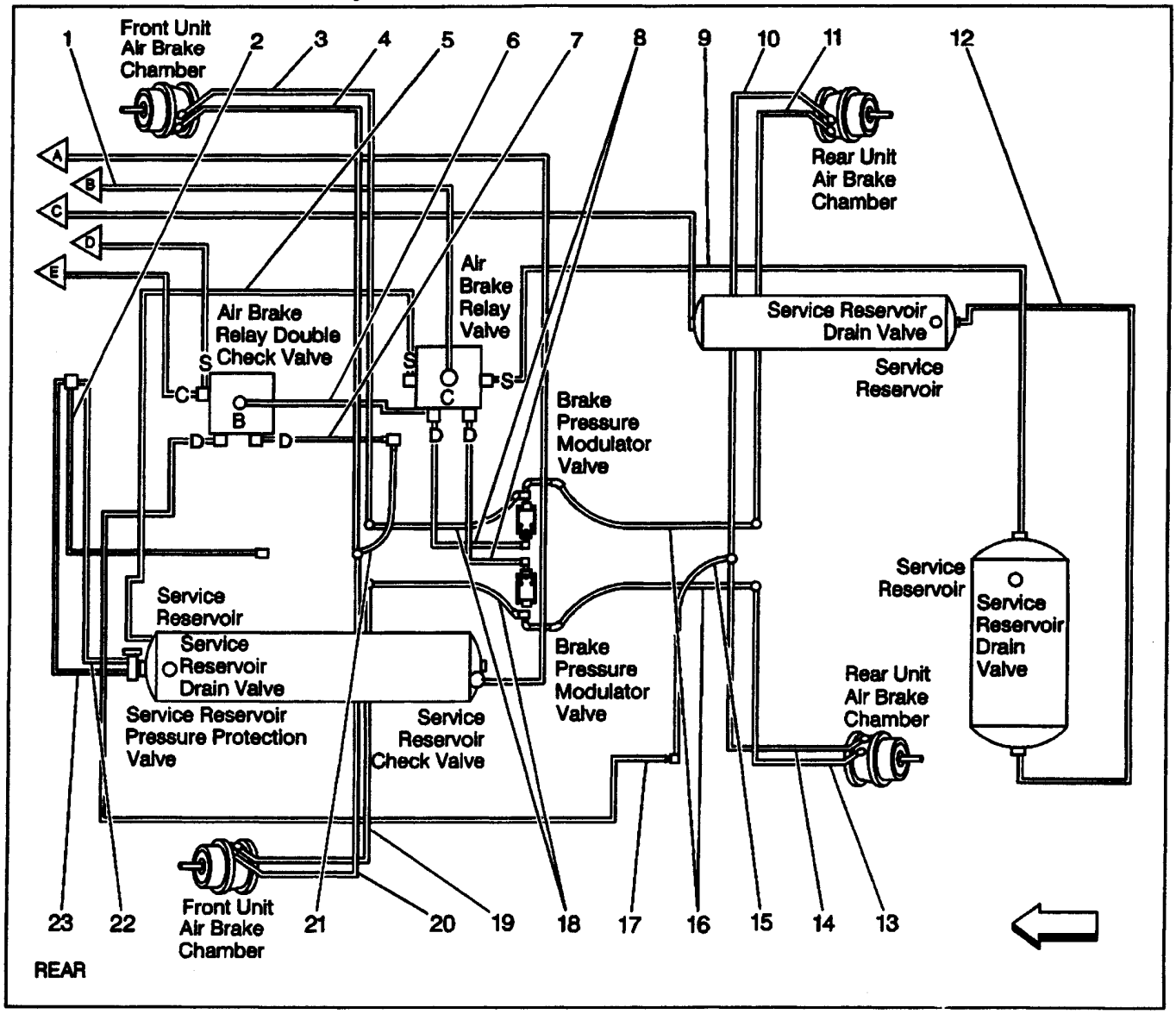
(c) Control Port

(d) Delivery Port

(r) Rear Reservoir Port

(s) Supply Port

Air Brake System Schematics (F7B064 RQ2, JE4, JE5 w/o JYV)



283083

Legend

(1) Air Brake Application Valve to Rear Air Brake Relay Valve (Green) O.D. 10 mm, 0.375 in

(2) Differential Lock Control Valve to Rear Axle Differential Lockout Air Shift Cylinder (Black) O.D. 6 mm, 0.250 in

(3) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(4) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(5) Rear Axle Service Reservoir (Front Unit) to rear Air Brake Relay Valve (Rear Axle Front Unit) (Green) O.D. 13 mm, 0.50 in

(6) Rear Air Brake Relay Double Check Valve to Rear Air Brake Relay Valve (Rear Axle Front Unit) (Green) O.D. 6 mm, 0.250 in

(7) Rear Air Brake Relay Double Check Valve to Rear Air Brake Park Supply Tube Manifold (Rear Axle Front Unit) (Red) O.D. 19 mm, 0.750 in

(8) Rear Air Brake Relay Valve to Rear Brake Pressure Modulator Valve (Green) O.D. 19 mm, 0.750 in

(9) Rear Air Brake Relay Valve to Rear Axle Service Reservoir (Green) O.D. 13 mm, 0.50 in

(10) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(11) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(12) Rear Axle Service Reservoir (Rear Unit) to Rear Axle Service Reservoir (Green) O.D. 13 mm, 0.50 in

(13) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(14) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(15) Rear Air Brake Park Supply Tube Manifold to Rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(16) Rear Brake Pressure Modulator Valve to Rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(17) Rear Air Brake Relay Double Check Valve to Rear Air Brake Park Supply Tube Manifold (Rear Axle Front Unit) (Red) O.D. 19 mm, 0.750 in

(18) Rear Brake Pressure Modulator Valve to Rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(19) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(20) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(21) Rear Air Brake Park Supply Tube Manifold to Rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(22) Differential Lock Control Valve to Rear Axle Service Reservoir (Front Unit) Pressure Protection Valve (Black) O.D. 6 mm, 0.250 in

(23) Rear Axle Service Reservoir (Front Unit) Pressure Protection Valve to Differential Lock Control Valve (Black) O.D. 6 mm, 0.250 in

(c) Control Port

(c1) Control Port

(d) Delivery Port

(d1) Delivery Port

(d2) Delivery Port

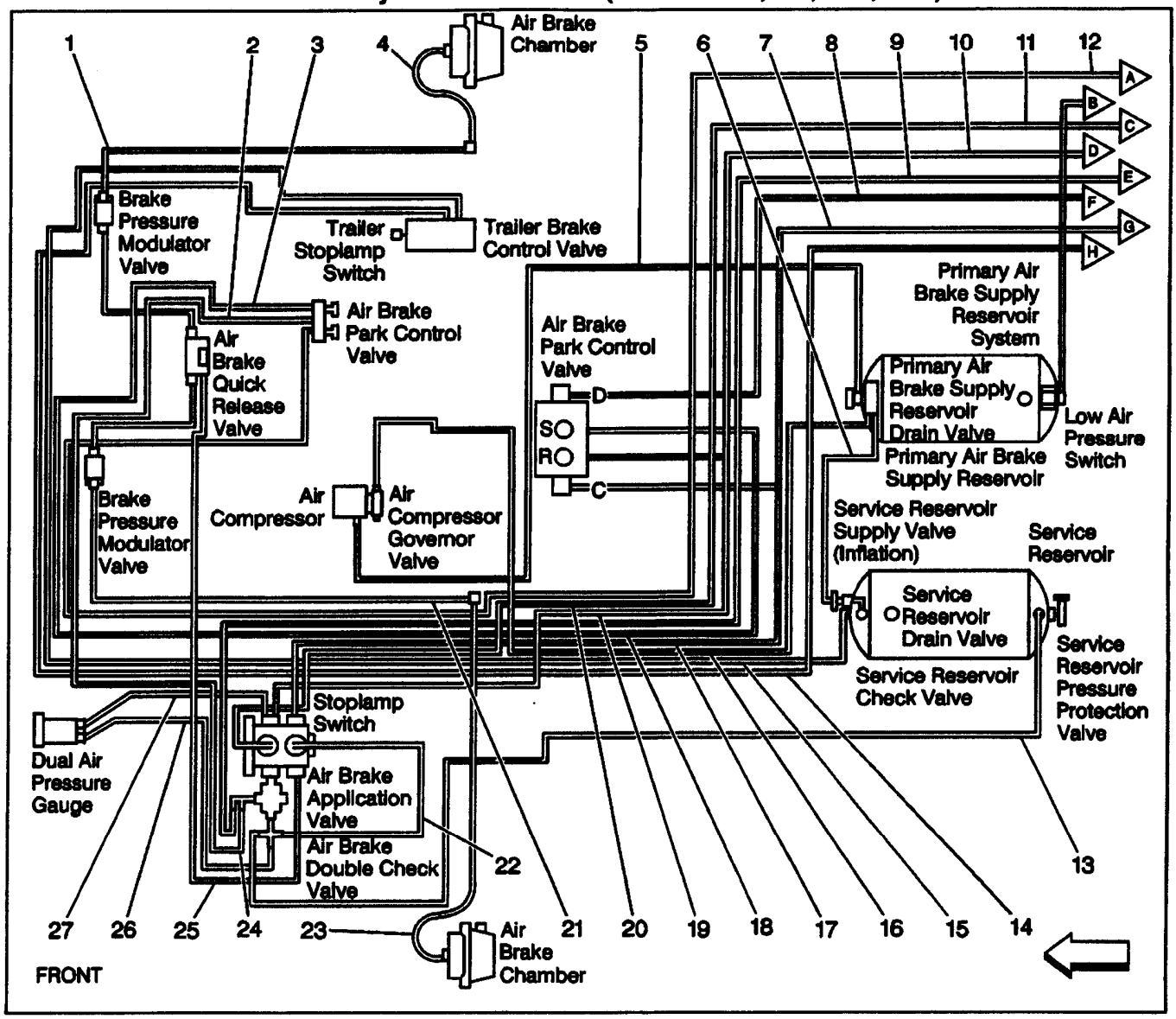
(d3) Delivery Port

(s) Supply Port

(s1) Supply Port

(s2) Supply Port

Air Brake System Schematics (F7B064 RQ2,JE4, JE5, JYV)



283088

Legend

(1) Front Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

(2) Air Brake Park Control Valve Supply Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Blue) O.D. 16 mm, 0.625 in

(3) Air Brake Park Control Valve Delivery Tube Connector to Air Brake Park Control Valve (I/P Mounted) (Orange) O.D 16 mm, 0.625 in

(4) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(5) Air Compressor to Primary Air Brake Supply Reservoir (Copper) O.D. 16 mm, 0.625 in

(6) Primary Air Brake Supply Reservoir to Front Axle Service Reservoir (Black) O.D. 13 mm, 0.50 in

(7) Park Brake Control Valve (Chassis Mounted) to Air Brake Towing Vehicle Protection Valve (Blue) O.D. 13 mm, 0.50 in

(8) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Relay Double Check Valve (Black) O.D. 10 mm, 0.375 in

(9) Air Brake Double Check Valve to Rear Air Brake Relay Double Check Valve (Red) O.D. 13 mm, 0.50 in

(10) Air Brake Park Control Valve (Chassis Mounted) to Rear Axle Service Reservoir (Front Unit) (Green) O.D. 13 mm, 0.50 in

(11) Air Brake Application Valve to Air Brake Towing Vehicle Protection Valve (Green) O.D. 13 mm, 0.50 in

(12) Trailer Air Supply Tube Connector to air Brake Towing Vehicle Protection Valve (Yellow) O.D. 10 mm, 0.375 in

(13) Air Brake Double Check Valve to Front Axle Service Reservoir (Blue) O.D. 13 mm, 0.50 in

(14) Trailer Brake Control Valve Delivery Tube Connector to Air Brake Towing Vehicle Protection Valve (Yellow) O.D. 10 mm, 0.375 in

(15) Front Axle Service Reservoir to Trailer Brake Control Valve Supply Tube Connector (Blue) O.D. 10 mm, 0.375 in

(16) Air Compressor Governor Valve to Primary Air Brake Supply Reservoir (Black) O.D. 10 mm, 0.375 in

(17) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Blue) O.D. 6 mm, 0.250 in

(18) Air Brake Park Control Valve (Chassis Mounted) to Air Brake Park Control Valve (I/P Mounted) Delivery Tube Connector (Red) O.D. 10 mm, 0.375 in

(19) Air Brake Application Valve to Air Brake Park Control Valve (Chassis Mounted) (Blue) O.D. 6 mm, 0.250 in

(20) Air Brake Application Valve to Air Brake Towing Vehicle Protection Valve (Green) O.D. 13 mm, 0.50 in

(21) Front Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 13 mm, 0.50 in

(22) Air Brake Application Valve to Air Brake Double Check Valve (Blue) O.D. 13 mm, 0.50 in

(23) Front Air Brake Chamber to Front Air Brake Chamber Supply Tube Elbow (Black) O.D. 19 mm, 0.750 in

(24) Air Brake Double Check Valve to Air Brake Park control Valve (I/P Mounted) Supply Tube Connector (Brown) O.D. 10 mm, 0.375 in

(25) Air Brake Application Valve to Front Air Brake Quick Release Valve (Blue) O.D. 13 mm, 0.50 in

(26) Air Brake Application Valve to Dual Air Pressure Gauge (Blue) O.D. 6 mm, 0.250 in

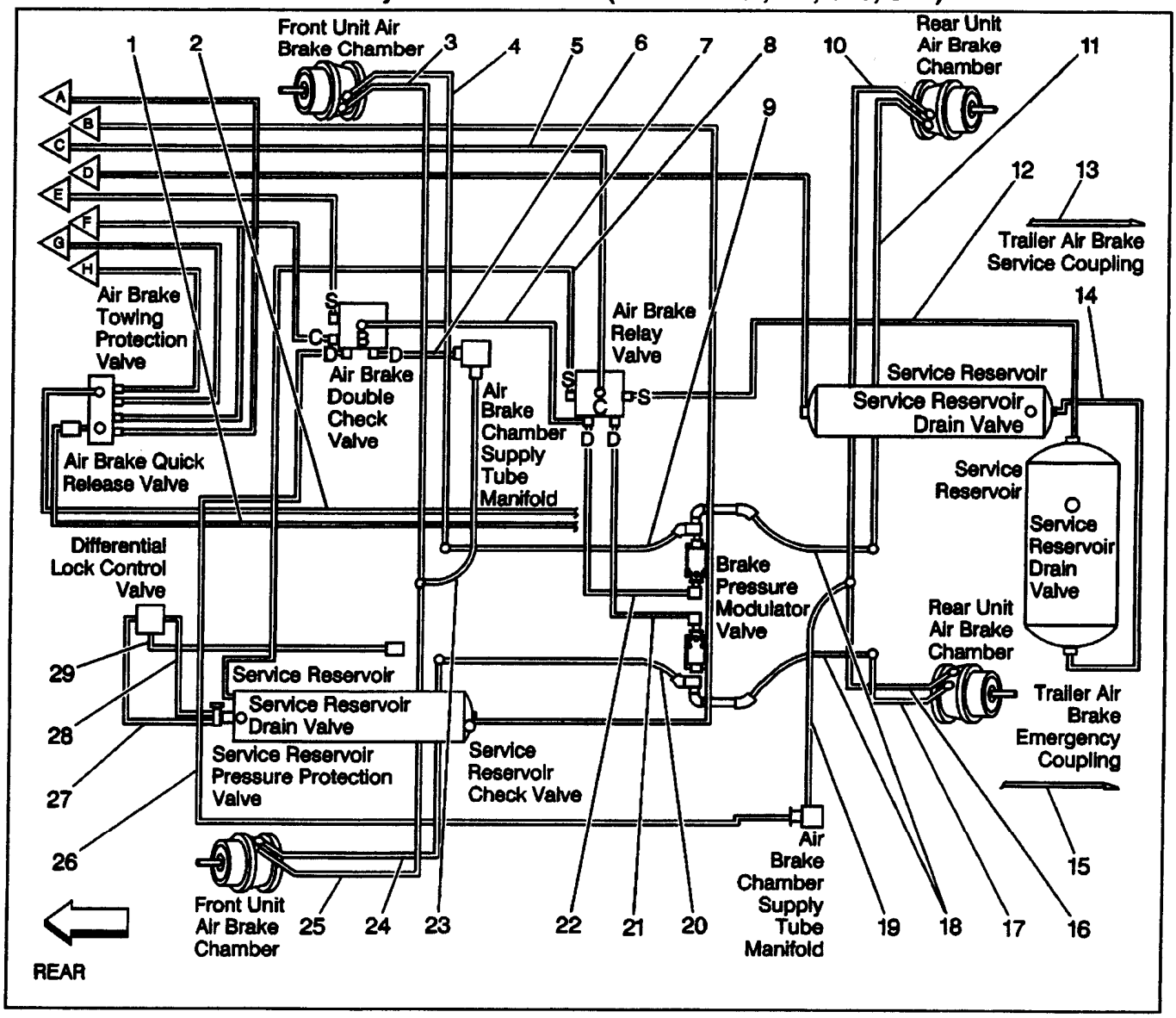
(27) Air Brake Application Valve to Dual Air Pressure Gauge (Green) O.D. 6 mm, 0.250 in

(c) Control Port

(r) Rear Reservoir Port

(s) Supply Port

Air Brake System Schematics (F7B064 RQ2,JE4, JE5, JYV)



283089

Legend

(1) Rear Air Brake Quick Release Valve (In-line at Air Brake Towing Vehicle Protection Valve) to Trailer Air Brake Emergency Coupling (Red) O.D. 13 mm, 0.50 in

(2) Air Brake Towing Vehicle Protection Valve to Trailer Air Brake Service Coupling (Blue) O.D. 13 mm, 0.50 in

(3) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(4) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(5) Air Brake Towing Vehicle Protection Valve to Rear Air Brake Relay Valve (Green) O.D. 13 mm, 0.50 in

(6) Rear Air Brake Relay Double Check Valve to rear Air Brake Park Supply Tube Manifold (Rear Axle Front Unit) (Red) O.D. 19 mm, 0.750 in

(8) Rear Axle Service Reservoir (Front Unit) to Rear Air Brake Relay Valve (Rear Axle Front Unit) (Green) O.D. 13 mm, 0.50 in

(9) Rear Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(10) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(11) Rear Air Brake Chamber Supply Tube Manifold To Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(12) Rear Air Brake Relay Valve to Rear Axle Service Reservoir (Green) O.D. 13 mm, 0.50 in

(13) Rear Brake Pressure Valve to Rear Air Brake Chamber (Emergency Port) (Black) O.D. 27 mm, 1.06 in

(14) Rear Axle service Reservoir (Rear Unit) to Rear Axle Service Reservoir (Green) O.D. 13 mm, 0.50 in

(15) Rear Air Brake Quick Release Valve (In-line at Air Brake Towing Vehicle Protection Valve) to Trailer Air Brake Emergency Coupling (Red) O.D. 13 mm, 0.50 in

(16) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(17) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(18) Rear Park Brake Pressure Modulator Valve to rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(19) Rear Air Brake Park Supply Tube Manifold to rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(20) Rear Brake Pressure Modulator Valve to Front Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(21) Rear Air Brake Relay Valve to Rear Brake Pressure Modulator Valve (Green) O.D. 19 mm, 0.750 in

(22) Rear Air Brake Relay Valve to Rear Brake Pressure Modulator Valve (Green) O.D. 19 mm, 0.750 in

(23) Rear Air Brake Park Supply Tube Manifold to rear Air Brake Chamber Supply Tube Manifold (Black) O.D. 27 mm, 1.06 in

(24) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Emergency Port) (Green) O.D. 13 mm, 0.50 in

(25) Rear Air Brake Chamber Supply Tube Manifold to Rear Air Brake Chamber (Service Port) (Red) O.D. 13 mm, 0.50 in

(26) Rear Air Brake Relay Double Check Valve to Rear Air Brake Park Supply Tube Manifold (Rear Axle Rear Unit) (Red) O.D. 19 mm, 0.750 in

(27) Rear Axle Service Reservoir (Front Unit) Pressure Protection Valve to Differential Lock Control Valve (Black) O.D. 6 mm, 0.250 in

(28) Differential Lock control Valve to Rear Axle Service Reservoir (Front Unit) Pressure Protection Valve (Black) O.D. 6 mm, 0.250 in

(29) Differential Lock Control Valve to Rear Axle Differential Lockout Air Shift cylinder (Black) O.D. 6 mm, 0.250 in

(b) Balance Port

(c) Control Port

(c1) Control Port

(d) Delivery Port

(d1) Delivery Port

(d2) Delivery Port

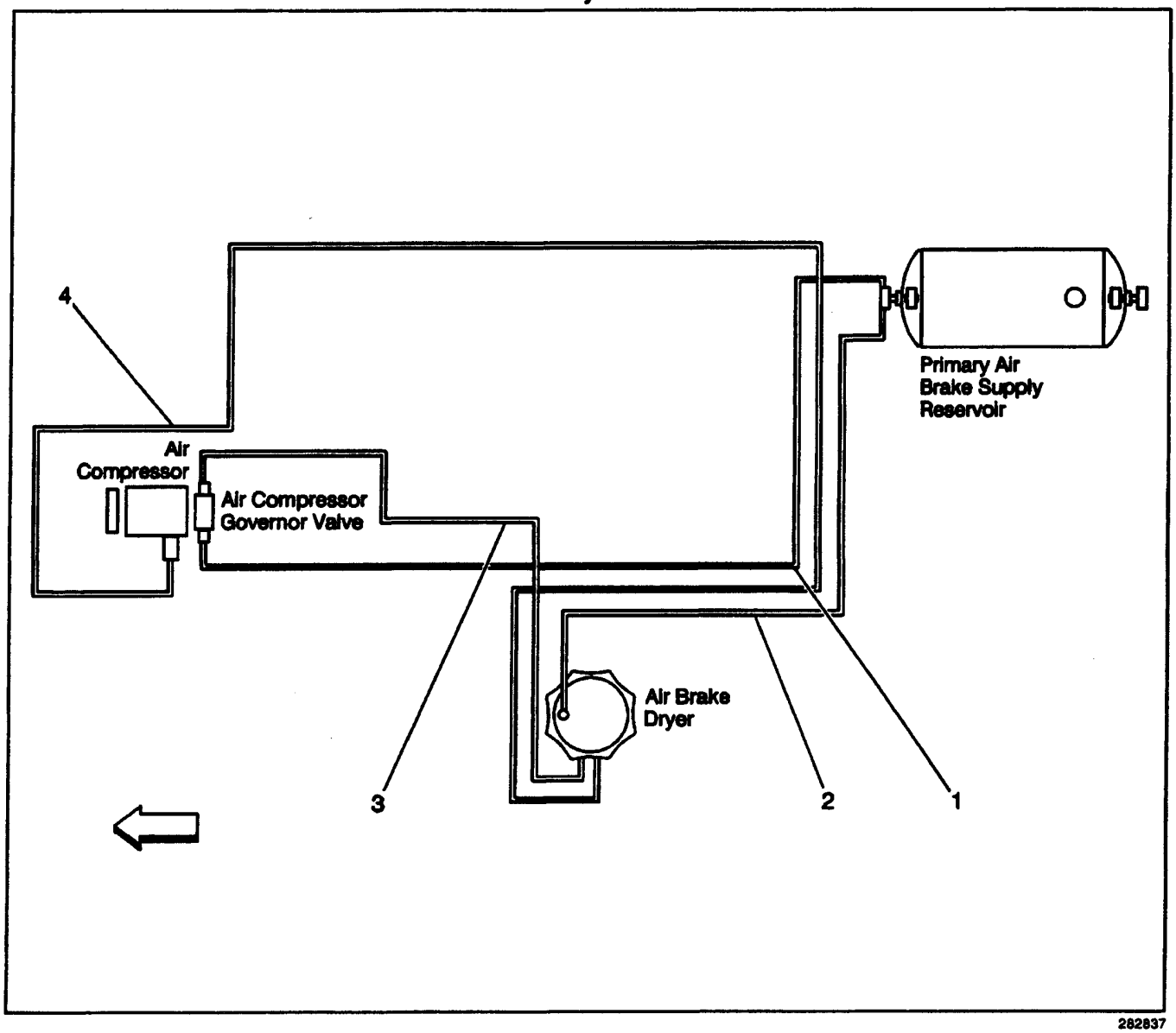
(d3) Delivery Port

(s) Supply Port

(s1) Supply Port

(s2) Supply Port

Air Brake Dryer Schematic



Legend

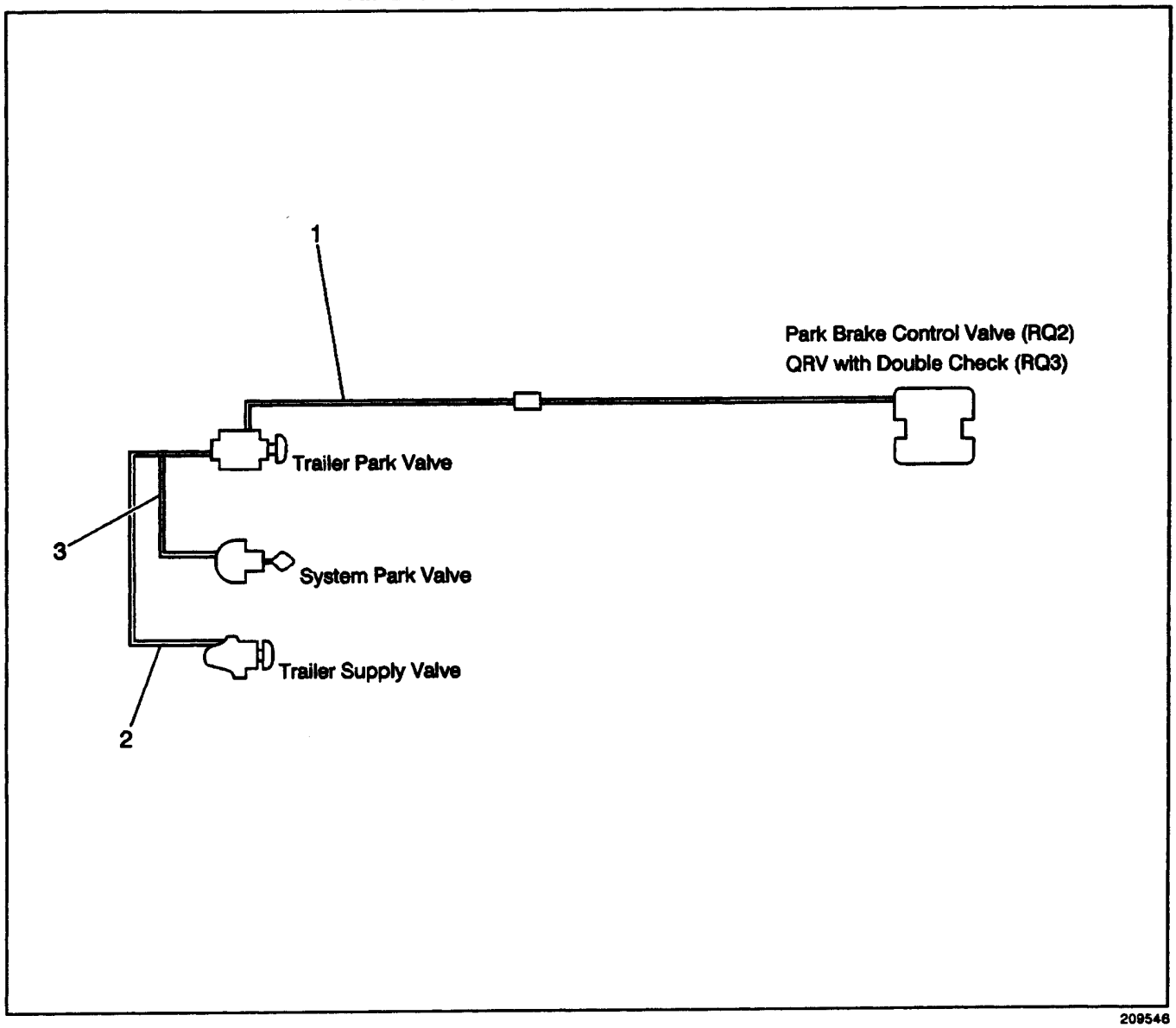
(1) Air Line (Air Compressor Governor Valve to Primary Air Brake Supply Reservoir)

(2) Air Line (Air Brake Dryer to Primary Air Brake Supply Reservoir)

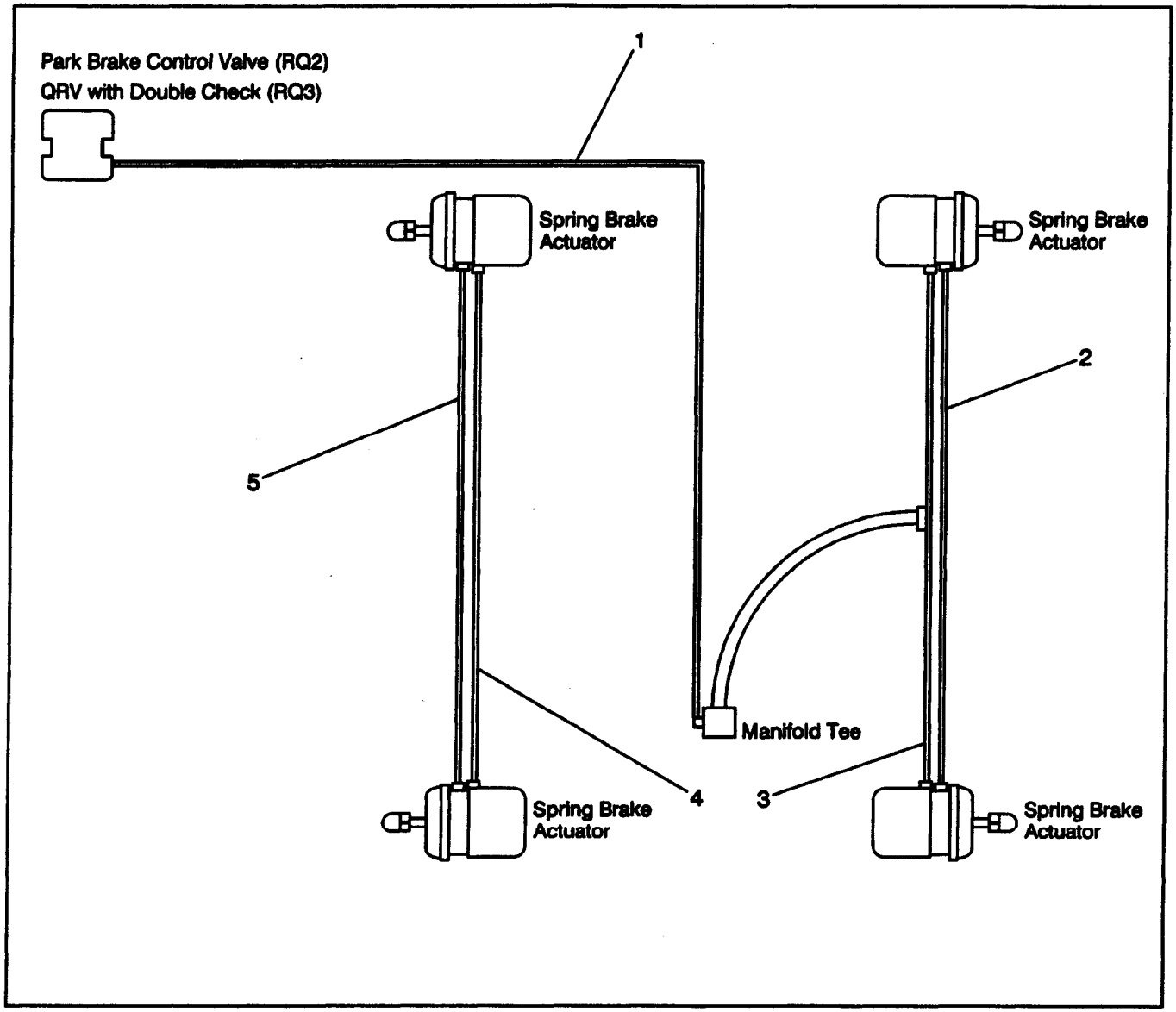
(3) Air Line (Air Compressor Governor Valve to Air Brake Dryer)

(4) Air Line (Air Compressor to Air Brake Dryer)

Air Brake Park Brake Control Schematic



Air Brake Park Brake Schematic



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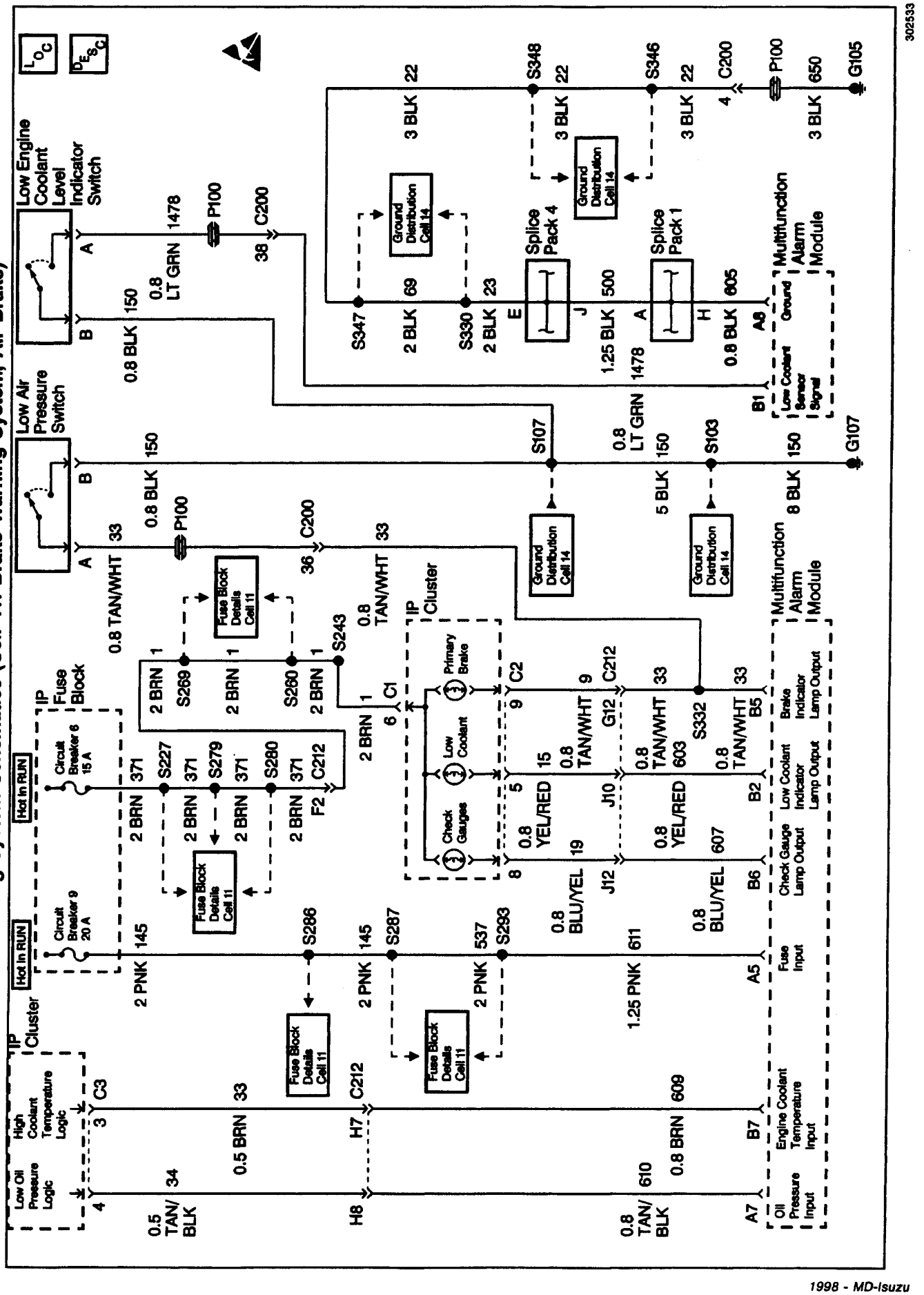
Air Brake System Schematic References

Reference on Schematic	Section Number - Subsection Name
Fuse Block Details Cell 11	8—Wiring Systems
Ground Distribution Cell 14	8—Wiring Systems

Air Brake System Schematic Icons

Icon	Icon Definition
19384	Refer to *ESD Notice* in Cautions and Notices.


Brake Warning System Schematics (Cell 41: Brake Warning System, Air Brake)
302533
Low Engine Coolant Level Indicator Switch
Low Air Pressure Switch
Hot In RUN
IP Fuse Block
Circuit Breaker 6 15 A
Circuit Breaker 9 20 A
IP Cluster
Low Oil Pressure Logic
High Coolant Temperature Logic
Fuse Block Details Cell 11
Ground Distribution Cell 14
Splice Pack 4
Splice Pack 1
Multifunction Alarm Module
Low Coolant Sensor Signal
Ground
Oil Pressure Input
Engine Coolant Temperature Input
Fuse Input
Check Gauge Lamp Output
Low Coolant Indicator Lamp Output
Brake Indicator Lamp Output
Check Gauges
Low Coolant
Primary Brake
0.8 TAN/WHT
0.8 BLK
0.8 LT GRN
2 BRN
2 PNK
0.8 YEL/RED
0.8 BLU/YEL
0.5 TAN/BLK
0.5 BRN
0.8 BRN
1.25 PNK
1.25 BLK
2 BLK
3 BLK
0.8 BLK
5 BLK
8 BLK
S347
S330
S348
S346
S107
S103
G105
G107
P100
C200
S243
S269
S260
S227
S279
S280
S286
S287
S293
S332
C1
C2
C3
C212
F2
H7
H8
A5
A7
A8
B1
B2
B5
B6
B7
G12
J10
J12
E
J
A
H
4
3
38
36
6
8
9
15
19
33
34
609
610
611
603
607
650
1478
150
500
605
22
69
23
1
33
371
145
537
5
9

Component Locator

Air Brake System Components

Name	Location	Locator View	Connector End View
Air Brake Dryer	On the left side of the frame in the component box	*Air Brake System Component Views* in Air Brakes	*Air Brake System Connector End Views* in Air Brakes
Engine Coolant Temperature (ECT) Switch (Cat® Diesel)	On the right side of the engine, on the upper rear of the coolant outlet	—	*Engine Controls Connector End Views* in Engine Controls-7.8L (Isuzu)
Engine Oil Pressure (EOP) Indicator Switch (Cat® Diesel and Engine Alarm)	On the left side of the engine block, on a tee fitting pointing up	—	*Engine Controls Connector End Views* in Engine Controls-7.8L (Isuzu)
Instrument Panel Cluster (IPC) C1 (15 cavities)	In the upper IP harness to the IPC	—	*Instrument Cluster Connector End Views* in Instrument Panel, Gauges and Console
Instrument Panel Cluster (IPC) C2 (9 cavities)	In the upper IP harness to the IPC	—	*Instrument Cluster Connector End Views* in Instrument Panel, Gauges and Console
IP Fuse Block	On the right top side of the IP, under the access panel	*Power and Grounding Component Views* in Wiring Systems	—
Low Air Pressure Switch (ABS-Air)	On the top rear of the primary air reservoir, at the right frame rail	*Air Antilock Brakes System Component Views* in Air Brakes	*Air Antilock Brakes System Connector End Views* in Air Brakes
Low Engine Coolant Level Indicator Switch (Isuzu Diesel w/ Automatic Engine Shutdown)	On the left cab bridge, on the bottom of the radiator surge tank	—	*Engine Controls Connector End Views* in Engine Controls-7.8L (Isuzu)
Moisture Ejector Heater (Air Brakes)	On the bottom if the primary air tank, between the frame rails	*Air Brake System Component Views* in Air Brakes	*Air Brake System Connector End Views* in Air Brakes
Multifunction Alarm Module (MFAM) (Air) C1 (16 cavities)	In the lower IP harness to the MFAM	*Air Brake System Component Views* in Air Brakes	*Air Brake System Connector End Views* in Air Brakes
C125 (38 cavities) (Isuzu Diesel)	On the front chassis harness to the engine harness at the left rear of the engine	—	*Inline Harness Connector End Views* in Wiring Systems
C200 (56 cavities) (Isuzu Diesel)	On the lower IP harness, to the front chassis harness, left center of the cab, in the cab interface connector.	—	*Inline Harness Connector End Views* in Wiring Systems
C212 (84 cavities)	On the lower IP harness to the upper IP harness, left center of the IP at the floor	—	*Inline Harness Connector End Views* in Wiring Systems
C404 (3 cavities)	On the front chassis harness, to the rear chassis and taillamps harness, inside the right frame rail, inboard of the batteries	—	*Inline Harness Connector End Views* in Wiring Systems

Air Brake System Components (cont'd)

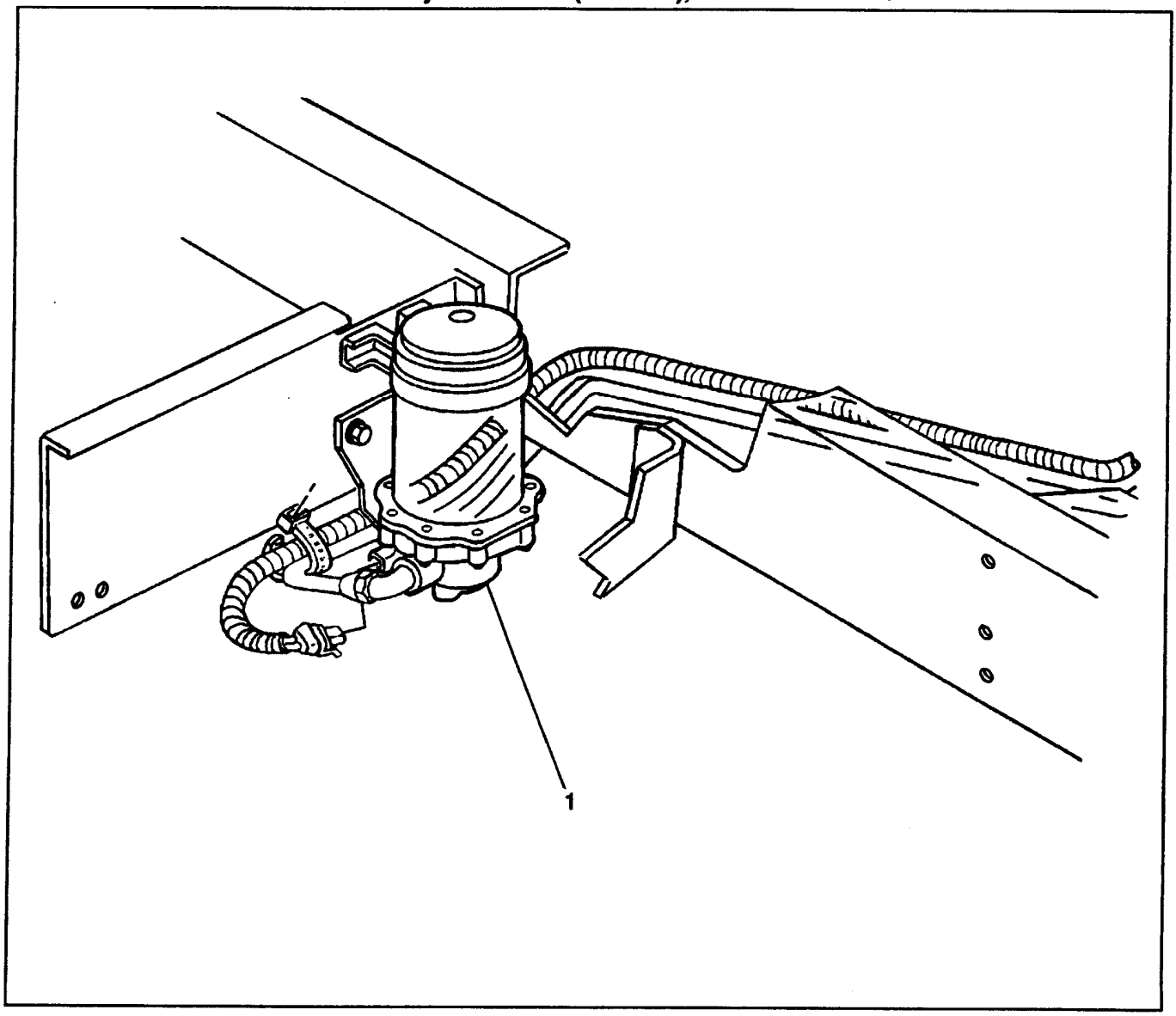
Name	Location	Locator View	Connector End View
C408 (2 cavities) (Long Wheelbase)	On the rear chassis and taillamps harness, to the air brake moisture ejector valve, approximately 15 cm from the ground connectors breakout	—	*Inline Harness Connector End Views* in Wiring Systems
G105	On the left front of the #1 crossmember	—	—
G107	On the front chassis harness, on the left frame rail, approximately 25 cm (9.9 in) rear of the front shock absorber	—	—
G404	On the rear chassis and taillamps harness, inboard the right frame rail, in the ground block (part of the negative battery cable)	—	—
P100	In the front chassis harness, underhood, center of the bulkhead, in the cab interface connector housing	—	—
Splice Pack 1	On the lower IP harness, below the left side of the IP, to the right of the steering column, joint connector 1, row 2, terminals 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2J and 2L	—	—
Splice Pack 4	In the upper IP harness, under the crash pad, on the top of the IP, joint connector 1, row 2, terminals 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2J and 2L	—	—
S103	In the front chassis harness, approximately 7 cm (2.8 in) rear of the main harness breakout	—	—
S107 (Cat® Diesel)	In the front chassis harness, approximately 10 cm (3.9 in) forward of the MaxiFuse® block breakout	—	—
S109	In the front chassis harness, approximately 4 cm (1.6 in) rear of the engine harness breakout	—	—
S183 (Cat® Diesel)	In the front chassis harness, approximately 16 cm (6.3 in) from the G107 ground breakout	—	—
S227	In the upper IP harness, under the IP, approximately 6 cm (2.4 in) left of the fuse block breakout	—	—
S243	In the upper IP harness, approximately 13 cm (5.1 in) from the IP connector toward the main harness	—	—
S260	In the upper IP harness, the main harness at the speedometer breakout	—	—
S269	In the upper IP harness, the main harness, approximately 21 cm (8.3 in) from the upper IP connector C212 (84 cavities)	—	—
S279	In the lower IP harnes, below the IP, approximately 5 cm (2.0 in) right of the relay center 1 harness breakout	—	—

Air Brake System Components (cont'd)

Name	Location	Locator View	Connector End View
S280	In the lower IP harness, in the main harness at the frame harness breakout	—	—
S286	In the lower IP harness, in the main harness at the fuse block harness breakout	—	—
S287	In the lower IP harness, in the main harness, approximately 22 cm (8.7 in) right of the fuse block harness breakout	—	—
S295	In the lower IP harness, in the main branch, at the C200 (56 cavities) and C202 (56 cavities) breakout	—	—
S330	In the lower IP harness	—	—
S332	In the lower IP harness	—	—
S346	In the lower IP harness	—	—
S347	In the lower IP harness	—	—
S348	In the lower IP harness	—	—
S363	In the lower IP harness	—	—
S400	In the rear chassis and taillamps harness, approximately 30 cm (11.8 in) from the engine harness connectors	—	—
S400 (Long Wheelbase)	In the rear chassis and taillamps harness, at the main branch, approximately 10 cm (3.9 in) from the ground connectors breakout	—	—
S400 (Low Profile)	In the rear chassis and taillamps harness, at the main branch, approximately 10 cm (3.9 in) from the ground connectors breakout	—	—
S401	In the rear chassis and taillamps harness, approximately 20 cm (7.9 in) from the engine harness connectors	—	—
S401 (Long Wheelbase)	In the rear chassis and taillamps harness, at the main branch, approximately 5 cm (2.0 in) from C410	—	—
S701	In the moisture ejector and air dryer harness, approximately 10 cm (3.9 in) after the air brake dryer breakout	—	—
S702	In the moisture ejector and air dryer harness, approximately 30 cm (11.8 in) after the air brake dryer breakout	—	—

Air Brake System Component Views

Air Brake Dryer Harness (ABS-Air), Left Forward View

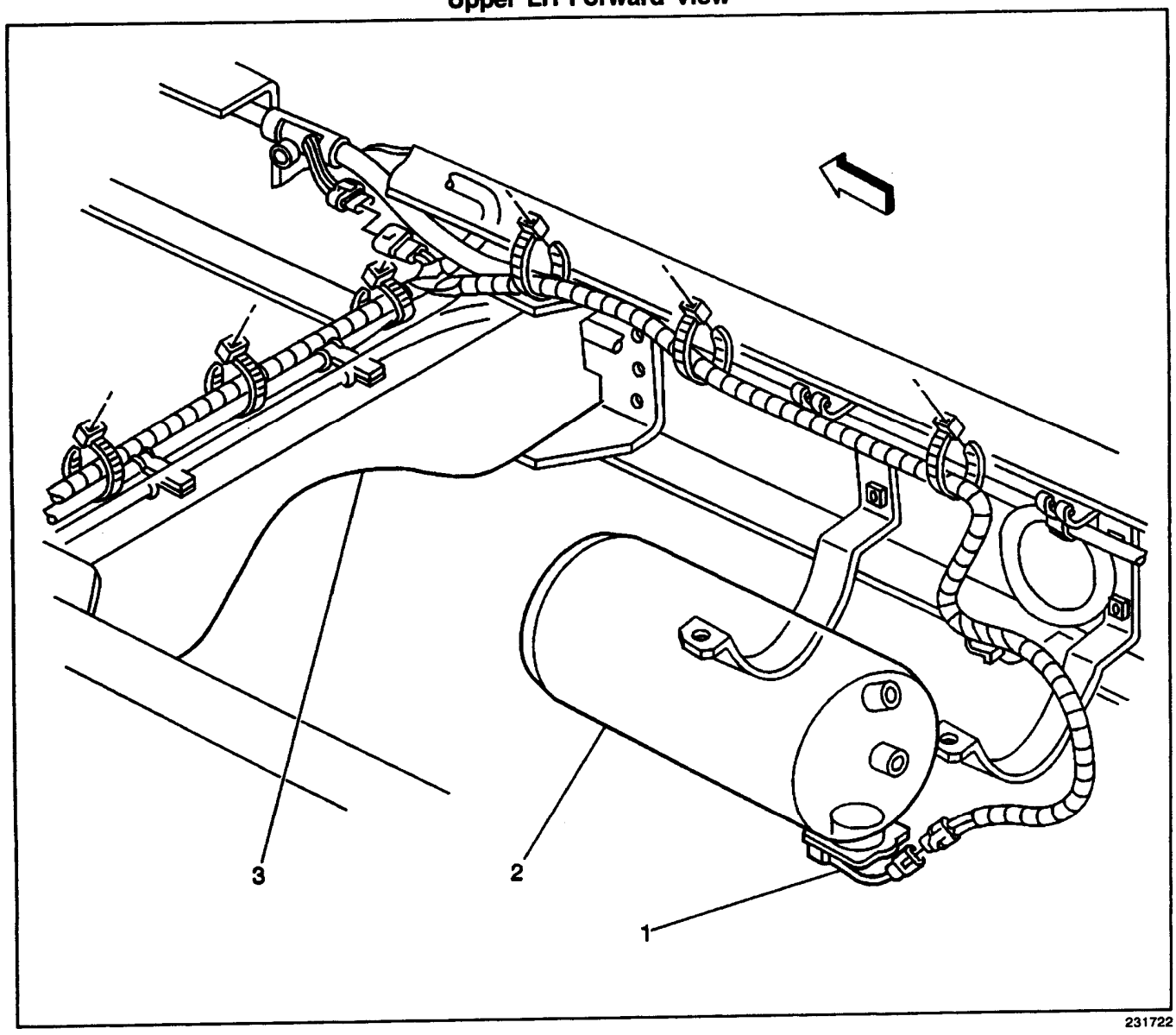


231721

Legend

(1) Air Brake Dryer

Air Dryer and Moisture Ejector Harness (ABS-Air) to Primary Air Reservoir; Upper LH Forward View

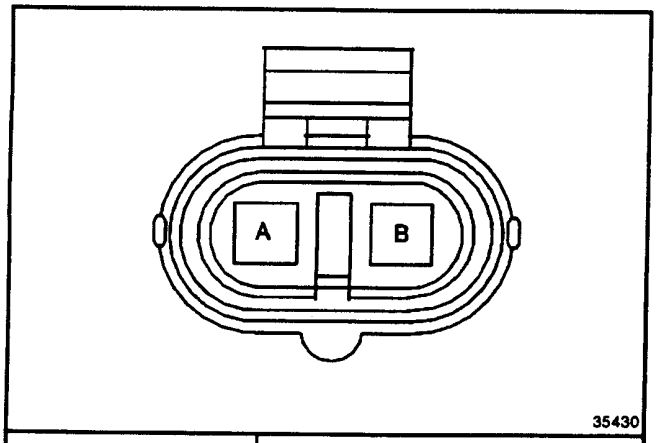


Legend

(1) Moisture Ejector Valve
(2) Primary Air Reservoir
(3) Back-of-Cab (BOC) Crossmember

Air Brake System Connector End Views

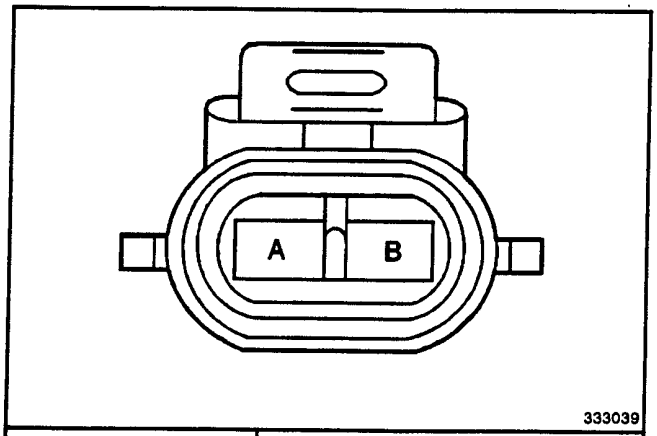
Air Brake Dryer



35430

Connector Part Information	• 12020599 • 2 Way F Metri-Pack 280 Series, Sealed (BLK)		
Pin	Wire Color	Circuit No.	Function
A	BRN	341	Fuse Output-Ignition
B	BLK	150	Ground

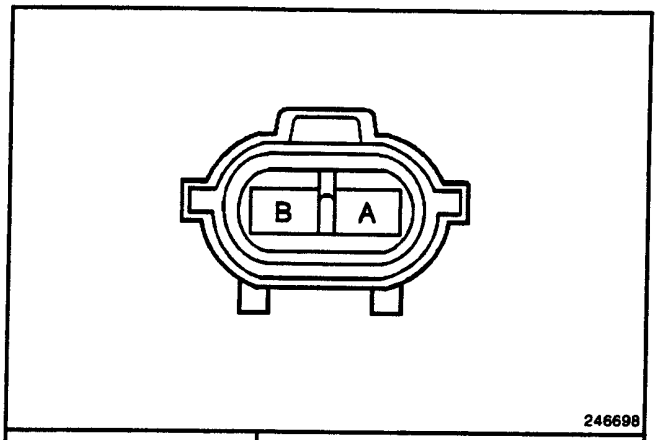
Moisture Ejector Heater



333039

Connector Part Information	• 12052644 • 2 Way F Metri-Pack 150 Series (LT GRY)		
Pin	Wire Color	Circuit No.	Function
A	BRN	341	Fuse Output-Ignition
B	BLK	150	Ground

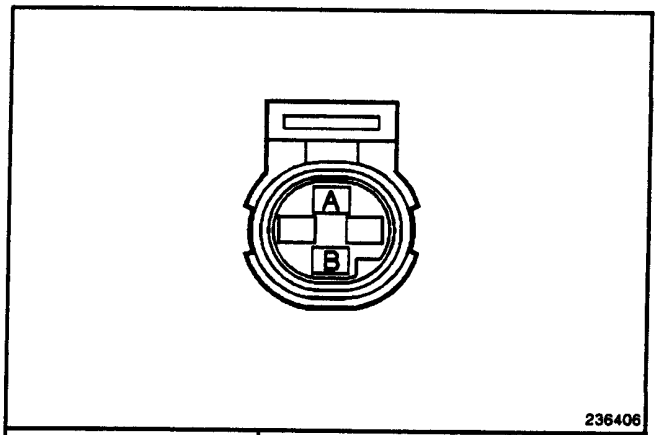
Park Brake Switch, Daytime Running Lamps (Air Brakes)



246698

Connector Part Information	• 2 Way M • (GRY)		
Pin	Wire Color	Circuit No.	Function
A	LT BLU	744	Daytime Running Lamps (DRL) Off Relay Air Brake
B	BLK	746	Park Brake Switch Air Brake

Low Air Pressure Switch



236406

Connector Part Information	• 12065400 • 2 Way F Metri-Pack 150 Series, Sealed (GRN)		
Pin	Wire Color	Circuit No.	Function
A	TAN/WHT	33	Brake Warning Indicator Lamp Output
B	BLK	150	Ground

Diagnostic Information and Procedures

Air Brakes Inoperative

Checks	Action
Check the air compressor for proper operation.	Refer to *Air Brake System Testing (Operational Check).*
Check the line or hose for restrictions.	Repair ir replace the line.
Check the air brake valve.	Refer to *Front Air Brake Limit Valve Test (Operational Check).*
Check for ice in the air system.	Refer to *Air Dryer/Moisture Ejector System Check.*
Check if the brakes are out of adjustment.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*

Air Brakes Not Operating Properly

Checks	Action
Check the line or hose for a restriction.	Replace or repair the line.
Check if the brakes are out of adjustment.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*
Check for air line leaks.	Refer to *Air Brake System Leak Test.*
Check for service chamber diaphragm leaks.	Refer to *Air Brake System Leak Test.*
Check if the governor cut-out adjustment is too low.	Refer to *Air Compressor Governor Valve Adjustment.*
Check for worn linings or drums.	Refer to *Air Drum Brake System Inspection.*
Check for a safety valve malfunction.	Refer to *Air Compressor Diagnosis (Air Compressor Not Unloading).*

Air Brakes Application Slow

Checks	Action
Check for a restricted line or hose.	Replace or repair the line.
Check for a faulty air brake valve.	Refer to *Air Brake Application Valve Test (Operational Check).*
Check if the brakes are out of adjustment.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*
Check for air line leaks.	Refer to *Low Air Pressure Switch Diagnosis.*
Check if the governor cut-out adjustment is too low.	Refer to *Air Compressor Governor Valve Adjustment.*
Check for worn linings or drums.	Refer to *Air Drum Brake System Inspection.*
Check for brake pedal linkage binding.	Refer to *Air Brake Pedal Replacement.*
Check for brake shoe binding.	Refer to *Brake Shoe Inspection.*
Check for camshaft bushing binding.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*
Check for a safety valve malfunction.	Refer to *Air Brake Dryer Safety Valve Exhausting Air.*

Pressure Loss w/Eng. Off - Brakes Released

Checks	Action
Check for a faulty air brake valve.	Refer to *Air Brake Application Valve Test (Operational Check).*
Check the air line for leaks.	Refer to *Air Brake System Leak Test.*
Check the compressor or the governor for leaking.	Refer to *Air Compressor and Governor Valve Diagnosis.*
Check the single check valve for leakage.	Refer to *Reservoir Check Valve Test (Operational Check).*
Check the spring brake chamber hose for leakage.	Refer to *Air Brake System Leak Test.*
Check the spring brake chamber diaphragm for leakage.	Refer to *Air Brake System Leak Test.*
Check if the reservoir drain valve is open or is leaking.	Refer to *Air Brake Reservoirs Contain Water.*

Pressure Loss w/Eng. Off - Brakes Applied

Checks	Action
Check for a faulty air brake valve.	Refer to *Air Brake Application Valve Test (Operational Check).*
Check if the air line leaks.	Refer to *Air Brake System Leak Test.*
Check the spring brake chamber hose for leaks.	Refer to *Air Brake System Leak Test.*
Check the compressor and the governor for leaks.	Refer to *Air Compressor Diagnosis (Air Compressor Not Unloading).*

Air Brake Safety Valve Blows Off

Checks	Action
Check for a safety valve malfunction.	Refer to *Air Brake Dryer Safety Valve Exhausting Air.*
Check if the governor cut-out adjustment is too high.	Refer to *Air Compressor Diagnosis (Air Compressor Not Unloading).*

Braking Uneven - Front to Rear

Checks	Action
Check for a restricted line or hose.	Replace or repair the line.
Check for a faulty air brake valve.	Refer to *Air Brake Application Valve Test (Operational Check).*
Check for ice in the air system.	Refer to *Air Dryer/Moisture Ejector System Check.*
Check if the brakes are out of adjustment.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*
Check for air line leaks.	Refer to *Air Brake System Leak Test.*
Check for service chamber diaphragm leaks.	Refer to *Air Brake System Leak Test.*
Check for worn linings or drums.	Refer to *Air Drum Brake System Inspection.*
Check for brake shoe binding.	Refer to *Brake Shoe Inspection.*
Check for camshaft bushing binding.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*

Braking Uneven - Side to Side

Checks	Action
Check for a restricted line or hose.	Replace or repair the line.
Check for a faulty air brake valve.	Refer to *Front Air Brake Limit Valve Test (Operational Check).*
Check if the brakes are out of adjustment.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*
Check for air line leaks.	Refer to *Air Brake System Leak Test.*
Check for brake shoe binding.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*
Check for camshaft bushing binding.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*

Air Brakes Make Grinding Sound When Applied

Checks	Action
Check for worn out brake shoe linings.	Refer to *Brake Shoe Replacement.*

Air Brakes Drag

Checks	Action
Check if the brakes are out of adjustment.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*
Check for brake pedal linkage binding.	Refer to *Air Brake Pedal Replacement.*
Check for brake shoe binding.	Refer to *Brake Shoe Inspection.*
Check for camshaft bushing binding.	Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*

Air Brake Dryer Constantly Cycling or Purging

Problem	Action
Excessive system leakage is evident.	Inspect for system leakage. Repair the system.
Excessive leakage is evident in one or more of the following components: • The fittings • The hoses • The tubing connected to the compressor • The air brake dryer • The main supply reservoir	1. Test the system for leakage at the following components: • The fittings • The reservoir drain valve (automatic type), if equipped • The safety valve in the supply reservoir 2. Repair or replace as needed.
The internal check valve is faulty.	1. Remove the check valve from the assembly from the end cover. 2. Apply air pressure to the delivery side of the valve. 3. Apply a soap solution at the opposite end. 4. Inspect for leakage. Permissible leakage is a 25 mm (1 in) bubble in five seconds. If the leakage is excessive, replace the check valve.
The governor is faulty.	1. Inspect the governor for proper cut-in and cut-out pressures. 2. Inspect the governor for excessive leakage in both positions. Refer to *Air Compressor and Governor Valve Diagnosis*

Air Brake Dryer Constantly Cycling or Purging (cont'd)

Problem	Action
The purge valve in the air brake dryer is leaking.	1. Open the supply port. 2. Apply 827 kPa (120 psi) at the control port. 3. Apply a soap solution to the supply port and the exhaust port (in the purge valve seat area). Permissible leakage is a 25 mm (1 in) bubble in five seconds. If the leakage is excessive, replace the purge valve.
The compressor unloader mechanism is leaking.	1. Remove the air inlet hose and the fitting from the air compressor inlet cavity. 2. Inspect for leakage in the unloader piston while the air compressor is unloaded. Slight leakage is permissible.

Air Brake Reservoirs Contain Water

Problem	Action
The air brake dryer desiccant cartridge requires replacement.	Replace the desiccant cartridge.
The air system was charged from an external air source. Air is not passing through the air brake dryer.	Decrease use of the inflation valve in order to charge the system.
The air brake dryer is not purging.	Refer to *Air Brake Dryer Testing.*
The purge (air exhaust) time is too short because of excessive system leakage.	Refer to *Air Brake Dryer Testing.*

Air Brake Dryer Safety Valve Exhausting Air

Problem	Action
The air brake desiccant cartridge is plugged or saturated with contaminants.	Replace the desiccant cartridge.
The internal check valve is faulty.	1. Remove the check vale from the assembly from the end cover. 2. Apply air pressure to the delivery side of the valve. 3. Apply a soap solution at the opposite end. 4. Inspect for leakage. A permissible leakage is a 25 mm (1 in) bubble in five seconds. If the leakage is excessive, replace the check valve.
The fittings or the tubing between the air brake dryer and the supply reservoir are faulty.	Determine if air is reaching the supply reservoir. Inspect the reservoir for kinked tubing or for restricted tube fittings.

Air Brake Dryer Purge Valve Exhausting Air

Problem	Action
Excessive air brake dryer purge valve leakage is evident.	Inspect for excessive leakage with the air compressor loaded. Apply a soap solution on the purge valve exhaust. If the leakage is excessive, overhaul or replace the air brake dryer.
The governor is faulty.	1. Inspect the governor for proper cut-in and cut-out pressures. 2. Inspect the governor for excessive leakage in both positions. Refer to *Air Compressor and Governor Valve Diagnosis.*
The purge control line is connected to one of the following components: • The reservoir • The exhaust port • The governor	Connect the control line to the unloader port of the governor.

Air Brake Dryer Purge Valve Exhausting Air (cont'd)

Problem	Action
The heater and thermostat or wiring are faulty. A fuse is blown.	Test the electrical circuit. *Air Brake Dryer Testing*
The inlet and the outlet air connections are reversed.	Connect the lines properly.
The check valve between the air brake dryer and the supply reservoir is faulty.	1. Test the check valve for proper operation. Remove the check valve from the assembly from the end cover. 2. Apply air pressure to the delivery side of the valve. 3. Apply a soap solution at the opposite end. 4. Inspect for leakage. Permissible leakage is 25 mm (1 in) bubble in five seconds. If leakage is excessive, replace the check valve.
The discharge line is kinked or blocked.	Clean or replace the line as needed.
Excessive bends in the discharge line cause the water to collect and freeze.	Correct the discharge line routing.
Excessive system leakage is evident.	Inspect for system leakage. Repair or replace parts as needed.

Air Brake Dryer Does Not Purge or Exhaust Air

Problem	Action
The purge control line exhibits one of following conditions: • Broken • Kinked • Frozen • Plugged • Disconnected	Determine if the air flows through the purge control line when the air compressor is unloaded.
The air brake dryer purge valve is faulty.	Replace the purge valve.

Desiccant Being Expelled From Purge Valve Exhaust

Problem	Action
The air brake dryer is not securely mounted, allowing too much vibration.	Tighten the air brake dryer mounting hardware.
The desiccant cartridge is faulty.	Replace the desiccant cartridge.
The air compressor piston ring is leaking.	Overhaul or replace the air compressor.
The air compressor is passing too much oil.	Overhaul or replace the air compressor.

Air Brake System Testing (Operational Check)

If the vehicle pulls to one side during braking, check the front wheels. Do not assume this is a brake related condition. Check the wheel alignment first.

Test the brakes on a dry, clean, reasonably smooth, and level roadway. Do not test the brake performance when the roadway is wet, greasy, or covered with loose dirt. These conditions prevent the tires from gripping the road equally. A crowned roadway also affects brake testing. This condition throws the weight of the vehicle toward the wheels on one side. Results are also affected when the roadway is rough enough to cause the wheels to bounce.

Test the brakes at different vehicle speeds with light and heavy pressure. Do not lock the wheels or slide the tires on the roadway. Heavily braked wheels will stop the vehicle in less distance than locked wheels. There is more friction present with a heavily braked tire than with a sliding tire.

External Conditions That Affect Brake Performance

- Uneven breaking is caused when tires have uneven contact and grip on the road. Check that the tires are equally inflated and that the tread pattern on the right and the left tires are approximately equal.
- Load the vehicle evenly. Uneven loading creates uneven braking. The most heavily loaded tires require the most braking force.
- Loose front wheel bearings allow the brake drum and the wheel to tilt. This causes inconsistent contact with the brake linings and erratic braking action.
- Misalignment of the front wheels, the camber and the caster settings, causes the brakes to pull to one side.

Air Brake System Testing (Leakage Test)

System Tests

1. Inspect the air lines and tubing for kinks, twists, or dents.
2. Inspect the hoses for wear, drying or overheating. The hoses should not rub against or touch anything with sharp edges.
3. Inspect the tubing clamps and the clips. The tubing should be firmly held in place and not sag or vibrate.
4. Inspect the nylon lines. Keep the nylon lines away from extreme heat sources.
5. Inspect the reservoir support bolts, the straps and the strap nuts. Tighten the components if necessary.
6. Inspect the air line connections. Tighten the connections if necessary.

Primary Brake Indicator or Alarm Inoperative

Step	Action	Value(s)	Yes	No
1	1. Backprobe the low air pressure switch with a DVM from terminal B to B+. 2. Measure the voltage. Is the voltage less than the specified value?	10.0 V	Go to *Step 2*	Go to *Step 3*
2	Repair the open in CKT 150 (BLK) between the low air pressure switch and G107. Is the primary brake indicator lamp or the continuous tone inoperative?	—	Go to *Step 3*	System OK
3	1. Disconnect the low air pressure switch. 2. Connect a fused jumper from low air pressure switch connector terminal A to B. 3. Turn the ignition switch to RUN. 4. Observe the lamp. Did the test lamp light?	—	Go to *Step 4*	Go to *Step 4*
4	Replace the low air pressure switch. Is the primary brake indicator lamp or the continuous tone inoperative?	—	Go to *Step 5*	System OK
5	1. Leave the jumper connected. 2. Backprobe the multifunction alarm module with a DVM from terminal B5 to B+. 3. Measure the voltage. Is the voltage less than the specified value?	10.0 V	Go to *Step 6*	Go to *Step 7*

Primary Brake Indicator or Alarm Inoperative (cont'd)

Step	Action	Value(s)	Yes	No
6	Repair the open in CKT 33 (TAN) and CKT 602 (WHT) between the low air pressure switch, the instrument cluster, and the multifunction alarm module. Is the primary brake indicator lamp or the continuous tone inoperative?	—	—	System OK
7	Replace the multifunction alarm module. Is the primary brake indicator lamp or the continuous tone inoperative?	—	—	System OK

Primary Brake Indicator or Alarm Always On

Step	Action	Value(s)	Yes	No
1	Disconnect the low air pressure switch. Do the lamp and tone remain on?	—	Go to *Step 2*	Go to *Step 3*
2	Inspect for a short to ground in CKT 33 (TAN) and CKT 602 (WHT) between the low air pressure switch, the instrument cluster, and the multifunction alarm module. Is there a short to ground?	—	Go to *Step 4*	Go to *Step 5*
3	Replace the low air pressure switch. Do the lamp and the tone remain on?	—	—	System OK
4	Repair the short to ground in CKT 33 (TAN) and CKT 602 (WHT) between the low air pressure switch, the instrument cluster, and the multifunction alarm module. Do the lamp and tone remain on?	—	—	System OK
5	Replace the low air pressure switch. Do the lamp and tone the remain on?	—	—	System OK

Low Air Pressure Switch Diagnosis

1. Apply the parking brake.
2. Drain all of the reservoirs. Refer to *Draining Reservoirs.*
3. Start the engine and run the engine at a fast idle.
4. Verify that the low pressure tone alarm is on.
   - If the tone alarm is not on when first charging the system, test the brake warning system.
   - For diagnosis of the brake warning system, refer to Brake Warning System Check.
5. The low pressure tone alarm should turn off when the dual air pressure gauge indicates 470–510 kPa (68–74 psi).
   - If the tone alarm does not turn off, test the brake warning system.
   - For diagnosis of the brake warning system, refer to Brake Warning System Check.

Stoplamp Switch Diagnosis

Stoplamp Switch Mechanical Test, Service and Trailer Air Brake

1. Connect the trailer air lines, if equipped, to a known operating trailer.
2. Block the vehicle wheels.
3. Start the engine.
4. Charge the air system to the governor cut-out point.
5. Apply the system park control, the trailer air supply, and the tractor park controls, if equipped.
6. Turn the engine to OFF.
7. Ensure the following:
   - The brake lamps should illuminate when either the foot brake or the trailer air brake control is applied.
   - The trailer air brake control and the foot brake should operate the trailer service brakes when applied individually.
   - If either of these switches does not function, replace the faulty stoplamp switch.

Trailer Stoplamp Switch Diagnosis

Trailer Stoplamp Switch Mechanical Test

1. Connect the trailer air lines, if equipped, to a known operating trailer.
2. Block the wheels.
3. Start the engine.
4. Charge the system air pressure to the governor cut-out point.
5. Apply the system park control, the trailer air supply, and the tractor park controls, if equipped.
6. Stop the engine.
7. Check that the brake lamps illuminate when you apply the foot brake or the trailer air brake control. If the switch does not function, replace the switch.
8. Check that the trailer air brake control and the foot brake operates the trailer service brakes when you apply the controls individually. If the switch does not function, replace the switch.
9. Remove the wheel blocks.

Air Brake Dryer Testing

1. Set the vehicle parking brake.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs*.
3. Start the engine.
4. Charge the air system to the governor cut-out point.
5. Verify that a discharge of air occurs at the air dryer exhaust port. This is the air dryer purge cycle.

   If the air dryer does not cycle properly, inspect the air dryer system for leaks. Refer to Air Brake System Schematics. Overhaul or replace the air dryer as necessary.

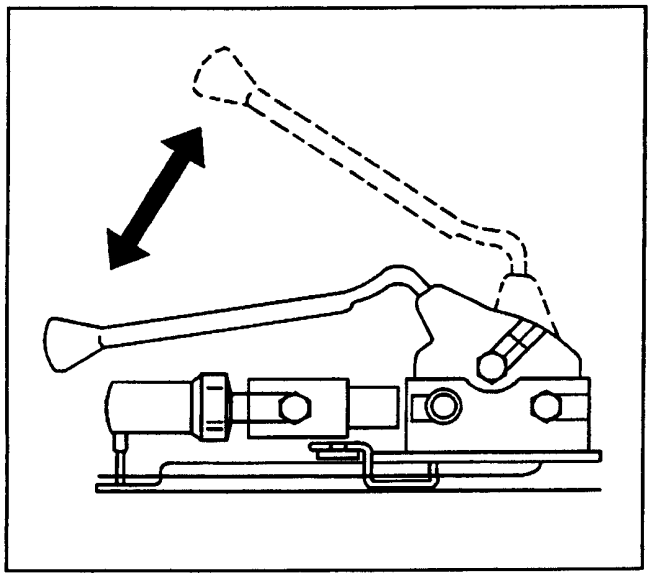
Air Brake System Leak Test

Air leakage is defined as measuring the size of a bubble formed over a specified period of time. A 25.4 mm (1 in) bubble formed over 5 seconds is equivalent to 100 standard cubic centimeters per minute (sccm). A 25.4 mm (1 in) bubble formed over 3 seconds is equivalent to 175 sccm.

Use a soap solution in order to perform all air leakage tests. This allows a bubble to form at the site of the air leak, giving a visual aid for diagnosing the air loss rate.

1. Inspect all tubing for kinks or dents.
2. Inspect all hoses for signs of wear, drying out, or overheating.
3. Inspect the suspension of all of the tubing. Support he tubing in order to eliminate vibration.
4. Inspect the suspension of all of the hoses. Position the hoses in a manner that will avoid the following conditions:
   - Abrasion
   - Overheating
5. Apply the parking brake.
6. Start the engine.
7. Charge the air system to the governor cut-out point.
8. Stop the engine.
9. Apply and release the service brakes.
10. Check the air leakage.
    - Check that the dual air pressure gauge on vehicles without trailer controls does not drop more than 28 kPa (4 psi) in 2 minutes.
    - Check that the dual air pressure gauge on vehicles with trailer controls does not drop more than 41 kPa (6 psi) in 2 minutes.
    - If the dual air pressure gauge reading drops more than specified, check for leaks at the following locations:
      - The air line connections
      - The application valve
      - The trailer control valve
      - The relay valve
      - The park brake control valve
      - The governor
      - Any other components on the supply side of the application valve
11. Start the engine.
12. Charge the system to the governor cut-out point.
13. Stop the engine.
14. Firmly apply the brakes and hold the brakes.
15. Check the air leakage.
    - If the air pressure drops 10% or more, check the air foundation brake adjustment at each wheel for excessive lining and brake drum wear. Refer to Air Foundation Brakes.
    - Check that the dual air pressure gauge on vehicles without trailer controls does not drop more than 41 kPa (6 psi) in 2 minutes.
    - Check that the dual air pressure gauge on vehicles with trailer controls does not drop more than 55 kPa (8 psi) in 2 minutes.
    - If the dual air gauge reading drops more than specified, test for leaks at the following locations. Double check the valves, the quick release valve, the relay valve and the other parts on the delivery side of the application valve.
      - The air line connections
      - The valves
      - The quick release valve
      - The relay valve
      - Any other components on the delivery side of the application valve

16. Start the engine.
17. Charge the air system to the governor cut-out point.
18. Stop the engine.



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19. On vehicles with trailer provisions, move the trailer air brake control valve handle up to the full ON position.
20. If air leakage is less than 41 kPa (6 psi), check for leakage at the following locations:air line fittings, trailer air brake control valve, towing vehicle protection valve, and any valves on the trailer.
    - The air line fitting
    - The trailer air brake control valve
    - The towing vehicle protection valve
    - Any valves on the trailer.

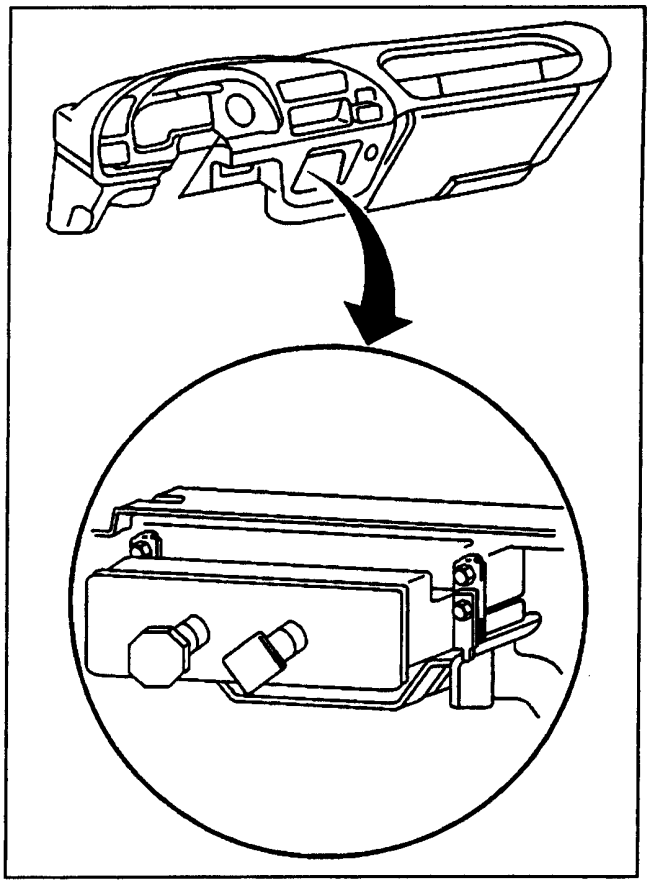
Reservoir Drain Valve

Test the reservoir drain valve periodically for leakage. Leakage is not permissible. Replace the reservoir drain valve if necessary.

1. Set the parking brake.
2. Start the engine.
3. Charge the air system to the governor cut-out point.
4. Apply a soap solution in order to cover the reservoir drain valve.
5. If bubbles appear indicating air leaks, replace the reservoir drain valve.

IP Mounted Air Brake Park Control Valve Test (Operational Check)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.



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5. Pull out the park control valve (cab mounted) knob and release the brake pedal.
6. Verify that the spring brake chamber assemblies are applied.
7. Push in the park control valve (cab mounted) knob.
8. Verify that the spring brake chamber assemblies are fully released.
9. Drain the front service air reservoir.
10. Observe the dual air pressure gauge while the rear air reservoir is draining.
11. Verify that the park control valve (cab mounted) pops out when the air pressure drops below 276 kPa (40 psi) on models without trailer provisions.

    For models with trailer provision, refer to *Parking Control Valve Test (Operational Check)*

    If the park control valve knob does not pop out, overhaul or replace the park control valve (cab mounted).
12. Remove the wheel blocks.

IP Mounted Air Brake Park Control Valve Test (Leakage Test)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Pull out the park control valve (cab mounted) knob and release the brake pedal.
6. Inspect the exhaust port for air leakage. The air leakage should not exceed 25.4 mm (1 in) bubble in 5 seconds.

   If air leakage is excessive, overhaul or replace the park control valve (cab mounted).
7. Inspect the plunger stem for air leakage. The air leakage should not exceed 25.4 mm (1 in) bubble in 5 seconds.

   If air leakage is excessive, overhaul or replace the park control valve (cab mounted).
8. Inspect the upper and lower valve body for air leakage.

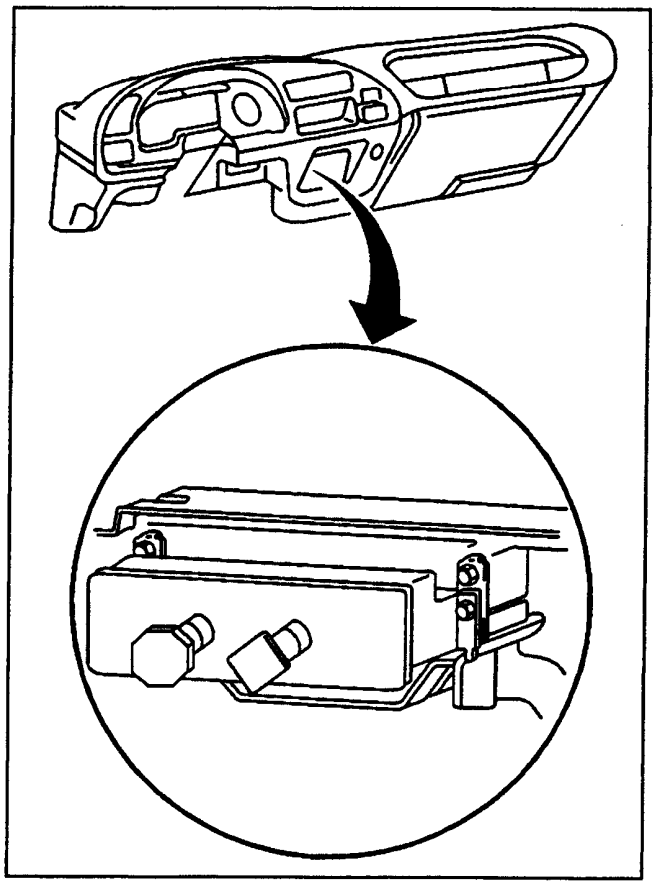
   No air leakage should occur between the upper and lower valve body. If air leakage occurs, overhaul or replace the park control valve (cab mounted).
9. Push in the system park knob.
10. Inspect the exhaust port for air leakage. Air leakage should not exceed a 25.4 mm (1 in) bubble in 3 seconds.

    If air leakage is excessive, overhaul or replace the park control valve (cab mounted).
11. Inspect the plunger stem for air leakage. Air leakage should not exceed a 25.4 mm (1 in) bubble in 3 seconds.

    If air leakage is excessive, overhaul or replace the park control valve (cab mounted).
12. Remove the wheel blocks.

Parking Control Valve Test (Operational Check)

1. Block the wheels.
2. Start the engine and charge the system to the air compressor governor cut-out point.
3. Stop the engine.



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4. Push in the trailer air supply knob.

   If the trailer air supply knob does not remain in, overhaul or replace the parking control valve.

   Important: The park control valve must not pop out before the trailer air supply knob. If the park control valve knob pops out first, overhaul or replace the parking control valve.
5. Slowly reduce the pressure in the air reservoirs.

   The trailer air supply knob must pop out when the air pressure is reduced to approximately 241-310 kPa (35-45 psi).
6. Hold in the trailer air supply knob and continue to reduce the pressure in all of the air reservoirs.

   Air must start to escape from the exhaust port when the trailer air supply line pressure reaches 138-241 kPa (20-35 psi).
7. Release the trailer air supply knob.
8. Start the engine.
9. Charge the system to the air compressor governor cut-out point.
10. Stop the engine.

11. Push in the control valve knob.
    If the park control valve does not remain in, overhaul or replace the parking control valve.
12. Pull out the trailer air supply knob.
13. Reduce the air pressure in all reservoirs. The park brake control knob must pop out at 138-209 kPa (20-30 psi). If the park control knob does not pop out at the specified pressure, overhaul or replace the parking control valve.
14. Start the engine.
15. Charge the system to the air compressor governor cut-out point.
16. Stop the engine.
17. Pull out the trailer air supply knob.
    If the park control knob does not remain in, overhaul or replace the parking control valve.
18. Push in the trailer supply knob.
19. Pull out the park control knob. The trailer air supply knob must pop out almost instantaneously. If the trailer air supply knob does not pop out as specified, overhaul or replace the parking control valve.
20. Remove the wheel blocks.

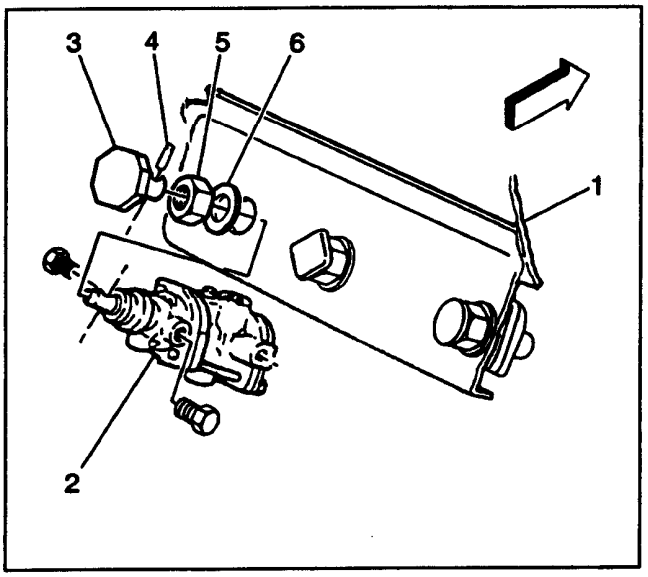
Parking Control Valve Test (Leakage Test)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Inspect for air leakage between the valve body and cover plate. Air leakage at the exhaust port must not exceed a 25.4 mm (1 in) bubble in 5 seconds.
   If air leakage is excessive, overhaul or replace the parking control valve.
6. Push in the trailer air supply knob.
7. Inspect the exhaust port for air leakage. Air leakage at the exhaust port must not exceed a 25.4 mm (1 in) bubble in 5 seconds.
   If air leakage is excessive, overhaul or replace the parking control valve.
8. Start the engine.
9. Charge the system to the air compressor governor cut-out point.
10. Stop the engine.
11. Push in the park control knob.
12. Inspect the exhaust port for air leakage. Air leakage at the exhaust port must not exceed a 25.4 mm (1 in) bubble in 5 seconds.
    If air leakage is excessive, overhaul or replace the parking control valve.
13. Remove the wheel blocks.

Trailer Brake Supply Valve Test (Operational Check)

Operational Check

1. Block the vehicle wheels.
2. Check the vehicle dual air pressure gauge for accuracy with the test gauge.
3. Install the test gauge and hose coupling on the trailer supply coupling (tractor emergency hose coupling) at the rear of the cab.
4. Start the engine.
5. Charge the system air pressure to the governor cut-out point.



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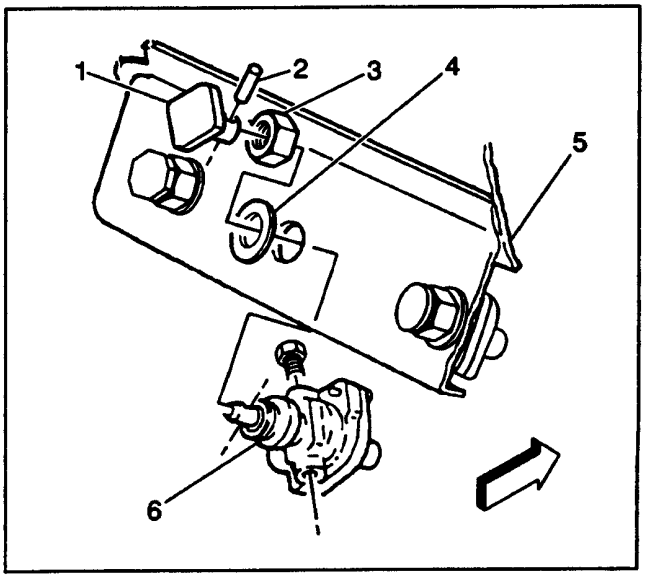
6. Pull out the trailer air supply (3).



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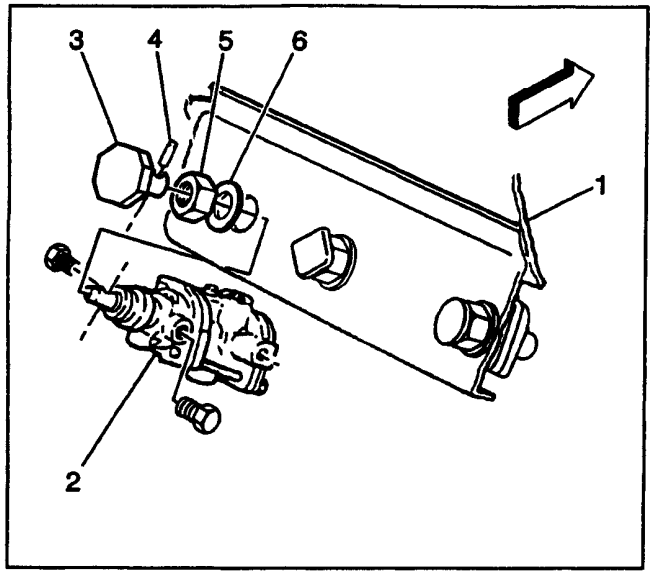
7. Pull out the system park knob (1).
8. Verify the test gauge reads zero.



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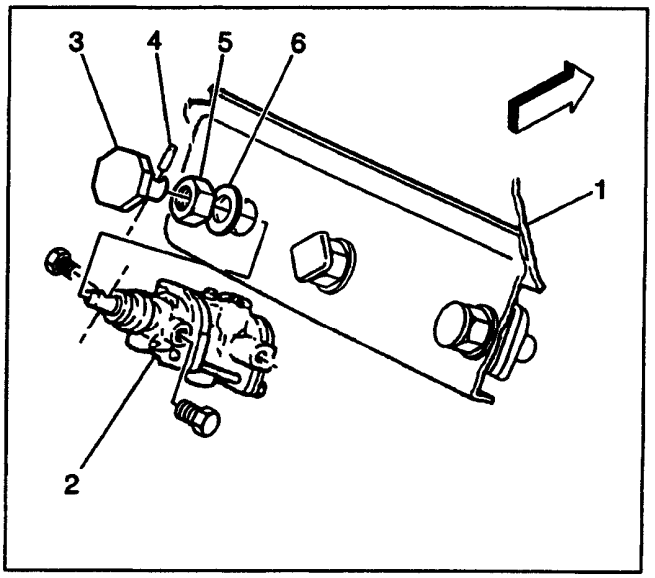
9. Push in the trailer air supply knob (3).
10. Verify that the test gauge reads zero. If the gauge shows air pressure, repair or replace the valve (2). For repair information, refer to Air Brake Valve Unit Repair.
11. Push in the system park knob.
12. Verify that the test gauge reads about the same as the dual air pressure gauge.
13. If not, check for leaks or blockages in the air lines. If the air lines are not blocked or leaking, repair or replace the valve (2). For repair information, refer to Air Brake Valve Unit Repair.
14. Turn off the engine with the system at the governor cut-out point.
15. Disconnect the test gauge and the hose coupling from the trailer supply line coupling.
16. Verify that the valve knob (3) pops out.
17. Check that the supply pressure remaining is 276–448 kPa (40–65 psi) as indicated on the dual air pressure gauge.
18. If the remaining pressure is not within these limits, replace the valve (2) or repair the pressure sensing ports on the valve. For repair information, refer to Air Brake Valve Unit Repair.
19. Set the parking brake.
20. Remove the wheel blocks.

Trailer Brake Supply Valve Test (Leakage Test)

1. Block the vehicle wheels.
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.



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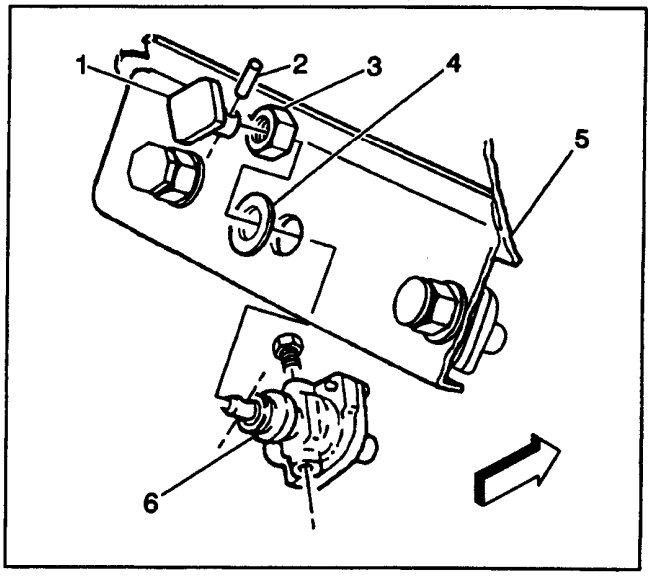
4. Pull out the trailer air supply knob (3)



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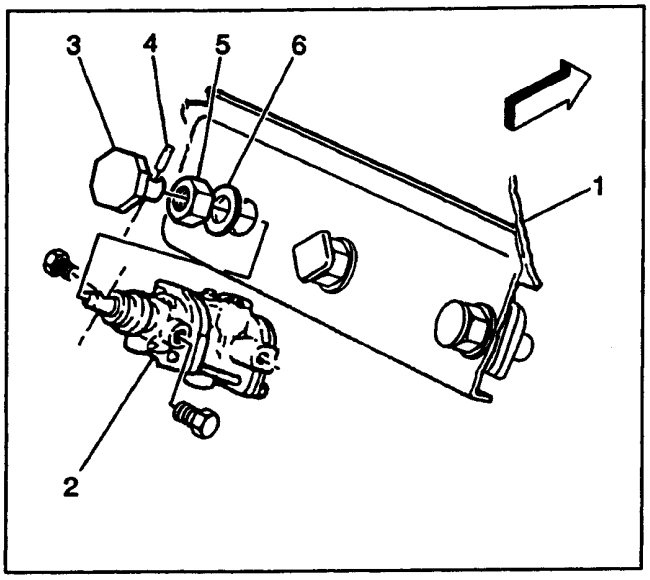
5. Pull out the system park knob (1).



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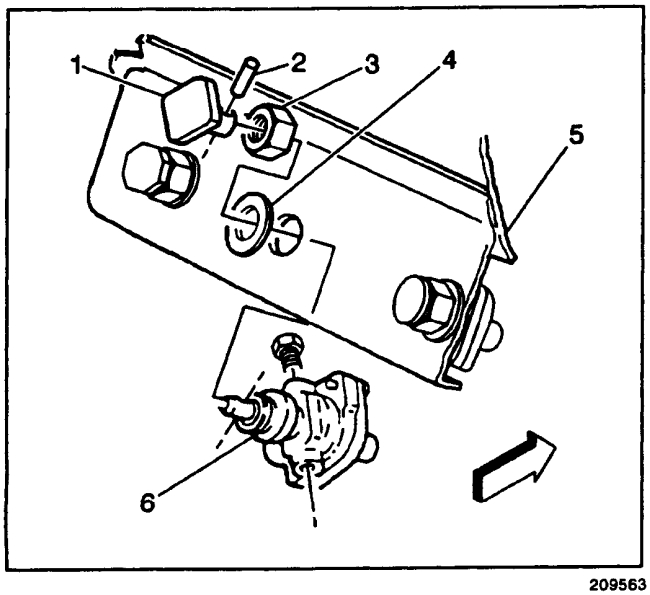
6. Apply a soap solution to the exhaust vent and around the base of the trailer air supply knob (3).
7. Verify that leakage is less than a 25 mm (1 in) bubble in 5 seconds. If not, repair or replace the valve. For repair information, refer to Air Brake Valve Unit Repair.
8. If the leakage exceeds these limitations, repair or replace the valve. For repair information, refer to Air Brake Valve Unit Repair.
9. Push in the trailer air supply knob (3).



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10. Apply a soap solution to the exhaust port.
11. Check that the leakage is less than a 25 mm (1 in) bubble in 5 seconds.
12. If the leakage exceeds these limitations, repair or replace the valve. For repair information, refer to Air Brake Valve Unit Repair.
13. Set the parking brake.
14. Remove the wheel blocks.

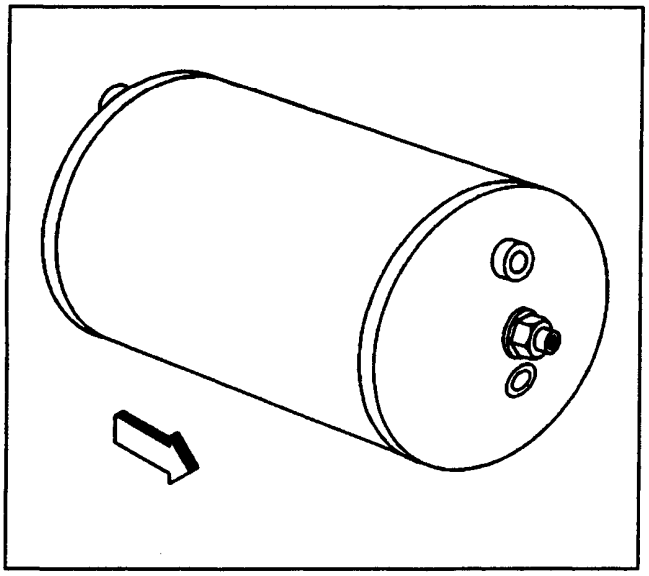
Reservoir Check Valve Test (Operational Check)

1. Apply the parking brake and block the vehicle wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Drain the air pressure from the supply air reservoir. Refer to *Draining Reservoirs.*

   Important: Applying and releasing the brakes repeatedly drains the supply air reservoir pressure. This can eventually cause the brakes to appear sluggish.
6. Ask an assistant to apply and release the brake pedal two times.
7. Verify that the front and rear slack adjusters move smoothly and promptly.
   - If the front brakes are sluggish or fail to move, overhaul or replace the single check valve at the front service air reservoir.
   - If the rear brakes are sluggish or fail to move, overhaul or replace the single check valve at the rear service air reservoir.
8. Start the engine.
9. Charge the system air pressure to the governor cut-out point.
10. Stop the engine.
11. Remove the wheel blocks.

Reservoir Check Valve Test (Leakage Test)

1. Apply the parking brake and block the vehicle wheels.
2. Start the engine.
3. Charge the system to the air compressor governor check-out point.
4. Stop the engine.
5. Drain the air pressure from the supply air reservoir. Refer to *Draining Reservoirs.*



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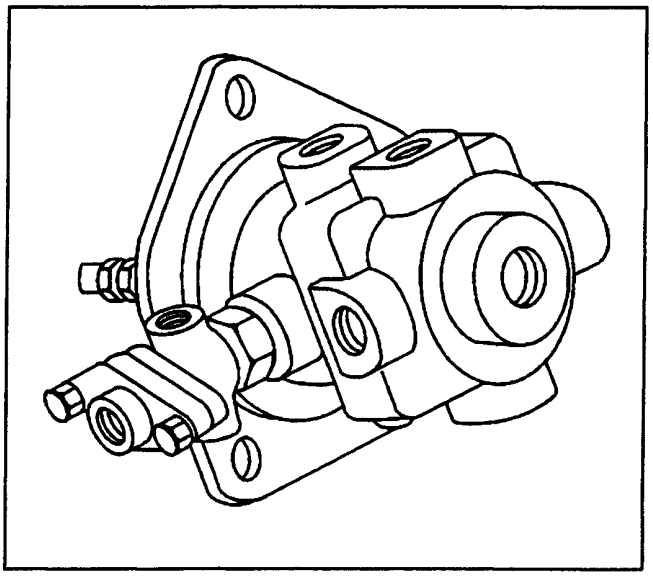
6. Disconnect the air line on the supply side of the single check valve.
7. Inspect the single check valve for air leakage. Air leakage must not exceed a 25.4 mm (1 in) bubble in 5 seconds.

   If leakage is excessive, overhaul or replace the single check valve.
8. Connect the supply port air line.
9. Start the engine.
10. Charge the air system to the governor cut-out point.
11. Stop the engine.
12. Test the brake for proper operation.
13. Remove the wheel blocks.

Air Brake Double Check Valve Test (Operational Check)

1. If the vehicle has trailer provisions, connect the vehicle to a known operating trailer.
2. Block the vehicle wheels.
3. Start the engine.
4. Charge the air system to the governor cut-out point.



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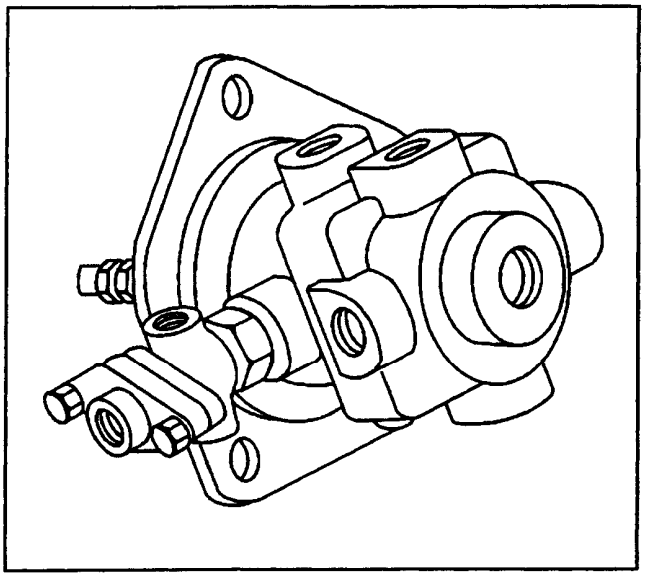
5. Push in the park control knob and push in the trailer air supply knob, if equipped.
6. Stop the engine.
7. Drain the rear service air reservoir.

8. Verify the following items:
   - The park control knob and the trailer air supply knob should remain in the applied position and not pop out.
   - The spring brake chamber assemblies must remain in the released position. If the assemblies are not in the same position, overhaul or replace the double check valve.
   - For models with trailer provisions, the brake pedal should apply the trailer service brakes. If the brake pedal does not apply the trailer service brakes, check the trailer air brake control valve. If the control valve is operational, overhaul or replace the double check valve.
9. Start the engine.
10. Charge the air system to the air compressor governor cut-out point.
11. Push in the park control knob and push in the trailer air supply knob.
12. Stop the engine.
13. Drain the front service air reservoir.
14. Verify the following items:
    - The park control knob and the trailer air supply knob should remain in the applied position and not pop out.
    - The spring brake chamber assemblies must remain in the released position. If the assemblies are not in the same position, overhaul or replace the double check valve.
    - For models with trailer provisions, the brake pedal should apply the trailer service brakes. If the brake pedal does not apply the trailer service brakes, check the trailer air brake control valve. If the control valve is operational, overhaul or replace the double check valve.
15. If any of the items does not function properly, overhaul or replace the double check valve.
16. Start the engine.
17. Charge the air system to the air compressor governor cut-out point.
18. Check for proper brake operation.
19. Stop the engine.
20. Set the parking brake.
21. Remove the wheel blocks.

Air Brake Double Check Valve Test (Leakage Test)

1. Block the vehicle wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*



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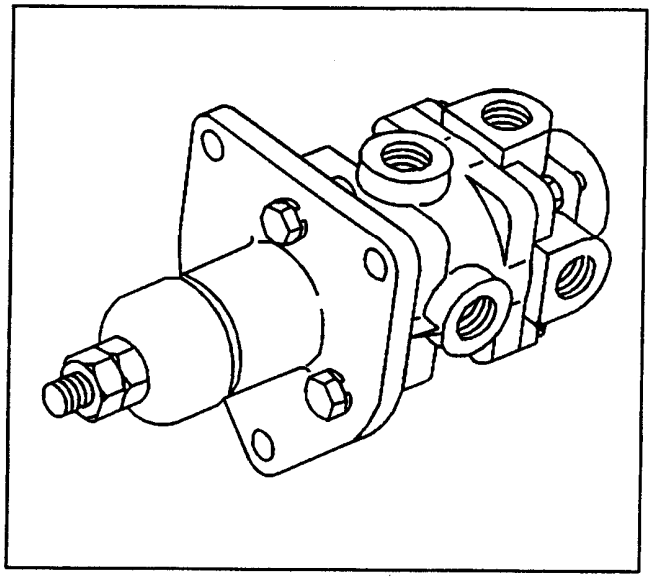
3. Remove the double check valve. Refer to *Air Brake Double Check Valve Replacement.*
4. Plug the delivery port.
5. Connect an air supply to one of the supply ports. Apply approximately 861 kPa (125 psi) of air pressure.
6. Apply a soap solution to the opposite supply port.
7. Check that the leakage is less than a 25.4 mm (1 inch) bubble in 5 seconds. If the leakage exceeds these specifications, repair or replace the double check valve.
8. Disconnect the air supply and repeat Steps 4–6 on the other supply port.
9. Shut off and disconnect the air supply.
10. Unplug the delivery port.
11. Install the double check valve.
12. Start the engine.
13. Charge the air supply system to the air compressor governor cut-out point.
14. Stop the engine.
15. Check for proper brake operation.
16. Remove the wheel blocks.

Air Brake Application Valve Test (Operational Check)

1. Block the wheels.
2. Install accurate test gauges into the front and rear dual application valve circuits.
3. Start the engine.
4. Charge the air system to the air compressor *governor cut-out* point.
5. Stop the engine.



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6. Test the delivery air pressure in both the front circuis and the rear circuits.
   - 6.1. Depress the brake pedal to several positions between fully released and fully applied.
   - 6.2. Check the delivered air pressure on the test gauges in order to see that the pressure varies equally and proportionality with the movement of the brake pedal.

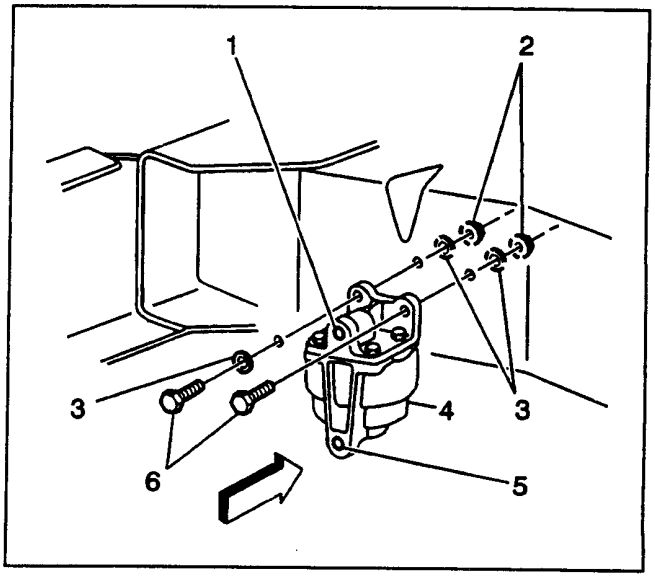
     After you release a full brake application, verify that the reading on the test gauges falls off to zero promptly. With both service air reservoirs at the same pressure, the rear brake circuit delivery air pressure will be about 14 kPa (2 psi) greater than the front brake delivery air pressure. This is a normal condition for this valve.
7. If the dual application valve does not operate as described, overhaul or replace the dual application valve.
8. Drain the air reservoirs.
9. Remove the test gauges.
10. Start the engine.
11. Charge the air system to the air compressor governor cut-out point.
12. Stop the engine.
13. Test the brake for proper operation.
14. Remove the wheel blocks.

Air Brake Application Valve Test (Leakage Test)

1. Block the wheels.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.
3. Remove the upper inner fender panel. Refer to Body Front End.
4. Lower the cab.
5. Start the engine.
6. Charge the air system to the air compressor governor cut-out point.
7. Stop the engine.
8. Tilt the cab.
9. Ask an assistant to apply the brake pedal.
10. Inspect the exhaust port and the body of the dual application valve for air leakage. Air leakage of a 25.4 mm (1 in) bubble in 3 seconds is permitted.

    If air leakage is excessive, overhaul or replace the dual application air valve.
11. Install the upper inner fender panel.
12. Lower the cab.
13. Test the brake for proper operation.
14. Remove the wheel blocks.

Front Air Brake Limit Valve Test (Operational Check)



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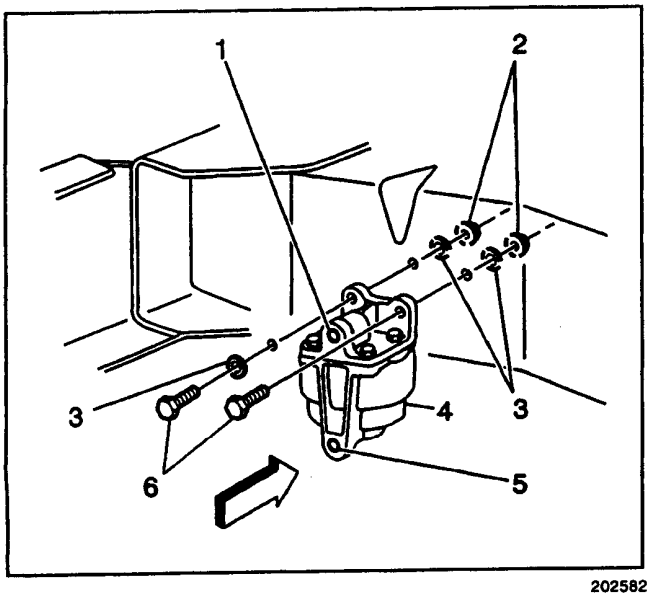
1. Install the test pressure gauges in the supply and the delivery lines of the limiting valve (4).
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Turn off the engine.
5. Apply the parking brake.
6. Apply the brake pedal slowly.

7. Check the pressure registered in the delivery line.

   The pressure should be approximately half of the supply line pressure. The 50 percent reduction should occur while the supply line pressure is below 275 kPa (40 psi). Repair or replace the valve (4) if this does not happen. Refer to Air Brake Valve Unit Repair.
8. Check that the delivery pressure catches up to the supply pressure when the supply line pressure exceeds 275 kPa (40 psi) but is less than 413 kPa (60 psi).
9. Check that the delivery line pressure is equal to the supply line pressure when the supply pressure exceeds 413 kPa (60 psi). Repair or replace the valve (4) if the pressure is not equal. Refer to Air Brake Valve Unit Repair.
10. Release the brakes.
11. Turn off the engine.
12. Remove the test air gauges.

Front Air Brake Limit Valve Test (Leakage Test)

1. Block the vehicle wheels.
2. Apply the parking brake.
3. Start the engine.
4. Charge the system air pressure to the governor cut-out point.
5. Have an assistant apply the brake pedal.
6. Apply a soap solution to the exhaust port and around the seam between the cover and the body.



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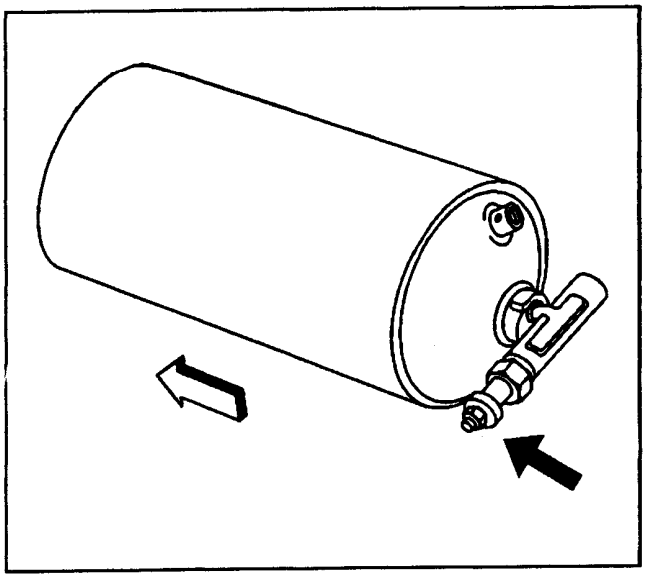
7. Check that no bubbles appear around the seam.
8. Repair or replace the valve (4) if bubbles appear. Refer to *Air Brake Application Valve Replacement.*
9. Check that the exhaust port leakage is less than a 25 mm (1 in) bubble in 5 seconds.
10. Repair or replace the valve (4) if the leakage exceeds this amount. Refer to *Air Brake Application Valve Replacement*
11. Remove the wheel blocks.

Front Axle Serv Rsvr Air Supply Valve Test (Operational Check)

1. Block the wheels.
2. Bleed the air pressure from the supply air reservoir. Refer to *Draining Reservoirs.*



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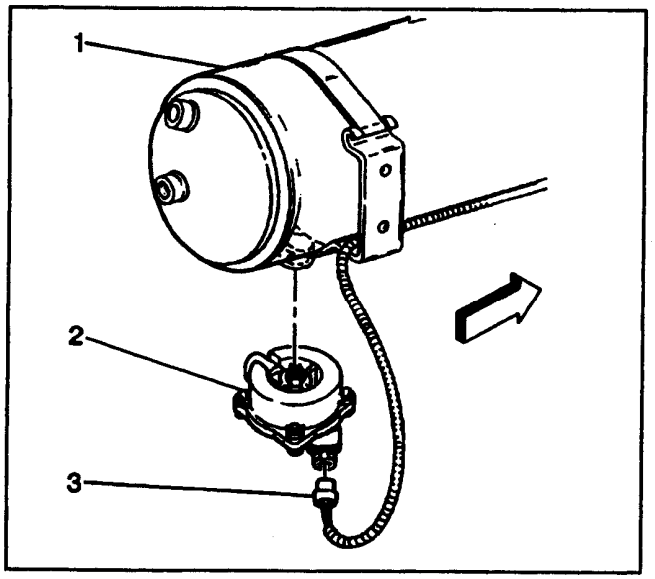
3. Connect a shop air hose to the inflation valve and fill the supply air reservoir.
4. Verify that the supply air reservoir fills.
5. Remove the wheel blocks.

Front Axle Serv Rsvr Air Supply Valve Test (Leakage Test)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Apply a soap solution in order to cover the inflation valve. Leakage is not permissible.
   - If bubbles appear, install the valve core finger tightly and inspect the valve for leaks.
   - If leakage is still present, replace the inflation valve.
6. Remove the wheel blocks.

Moisture Ejector Valve Test (Operational Check)

1. Start the engine.
2. Charge the system air pressure to the governor cut-out point.
3. Have an assistant apply and release the brake pedal several times.



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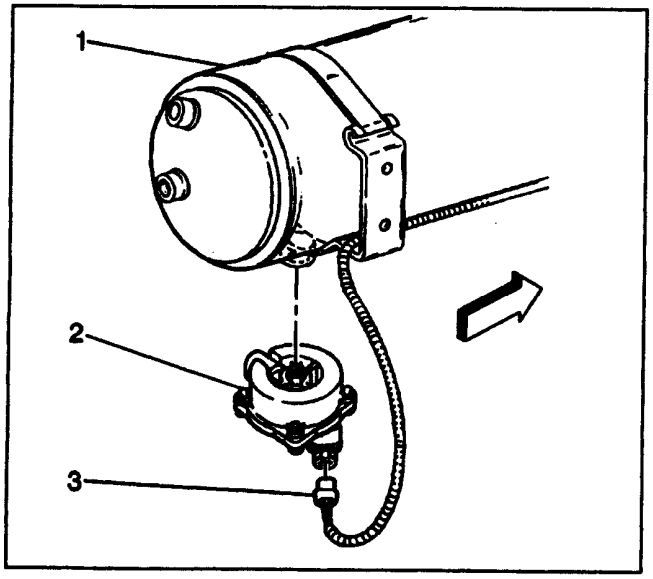
4. Check that a spurt of air occurs at the exhaust port.
5. Clean or replace the valve (2) if there is no air at the exhaust port. Refer to Air Brake Valve Unit Repair.

Moisture Ejector Valve Test (Leakage Test)

1. Release the brake pedal.
2. Cover the exhaust port and the seams with a soap solution.



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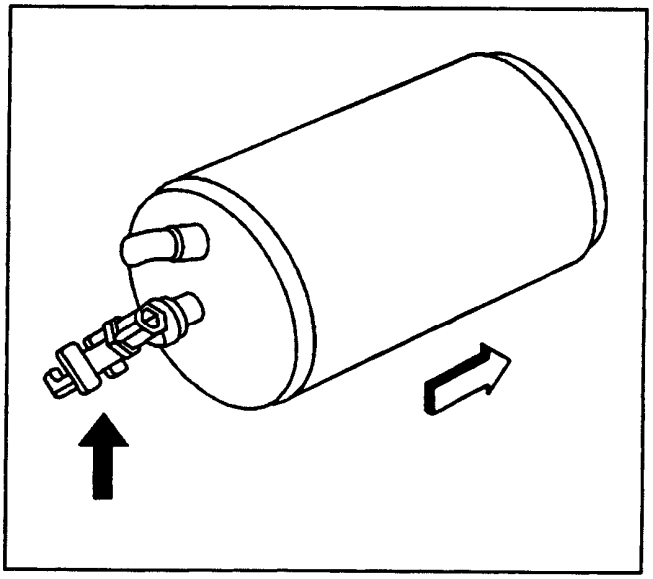
3. Repair or replace the valve (2) if excessive leakage appears.

Pressure Protection Valve Test (Operational Check)

1. Block the wheels.
2. Apply the parking brake.
3. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*



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4. Disconnect the air line from the pressure protection valve supply and the delivery ports.
5. Install test gauges and the drain valves onto the supply and delivery ports.
6. Start the engine.
7. Charge the system to the air compressor governor cut-out point.
8. Stop the engine.
9. While watching the test gauges, slowly exhaust pressure from the delivery side.
   - Both gauges will show a pressure loss until the pressure protection valve reaches its closing pressure.
   - The valve should close within 34 kPa (5 psi) of the rated pressure. If not replace the pressure protection valve.
10. Drain all of the air reservoirs.
11. Remove the drain valve and the test gauges.
12. Install the air lines.
13. Start the engine.
14. Charge the system to the air compressor governor cut-out point.
15. Stop the engine.
16. Inspect the system for air leakage.
17. Test the brakes for proper brake operation.
18. Remove the wheel blocks.

Pressure Protection Valve Test (Leakage Test)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Inspect the pressure protection valve for air leakage. A 25.4 mm (1 in) bubble in 3 seconds or longer is acceptable.

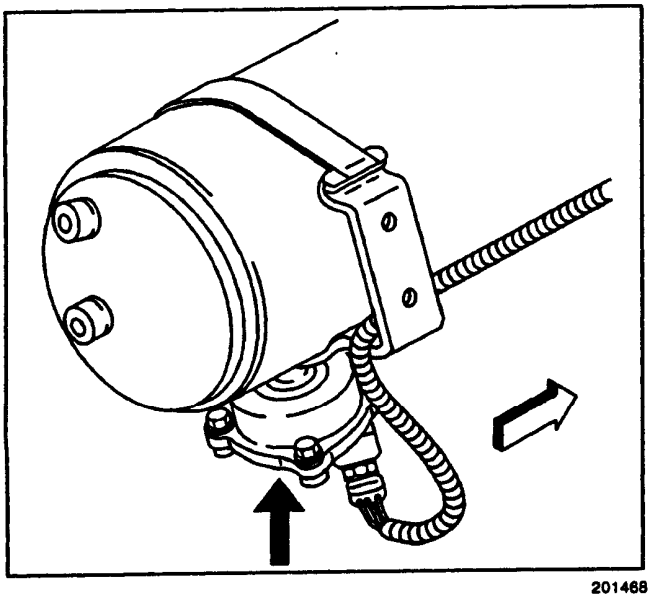
   If air leakage is excessive, replace the pressure protection valve.
6. Drain the air pressure from the delivery port and remove the air line connected to it.
7. Inspect the delivery port for leakage. A 25.4 mm (1 in) bubble in 5 seconds or longer is acceptable.

   If air leakage is excessive, replace the pressure protection valve.
8. Install the air line.
9. Remove the wheel blocks.

Reservoir Drain Valve Test

Operational Test

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Ask an assistant to apply and release the brake pedal several times.



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6. Verify that a discharge or air occurs at the reservoir drain valve (automatic type) exhaust port.

   If a discharge of air does not occur, clean, overhaul, or replace the reservoir drain valve (automatic type).
7. Remove the wheel blocks.

Air Leakage Test

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Cover the exhaust port and the seams with a soap solution. If air leakage appears, overhaul or replace the reservoir drain valve (automatic type).
6. Remove the wheel blocks.

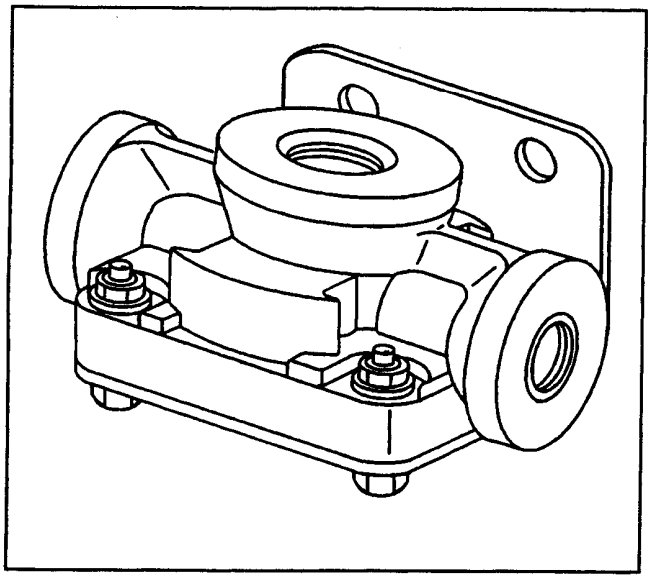
Air Brake Quick Release Valve Test (Operational Check)

1. Block the vehicle wheels.
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Stop the engine.
5. Ensure that the service brakes apply fully when you depress the brake pedal.
6. Verify that the brakes promptly release when you release the brake pedal.

   If the brakes are sluggish, check that air vents through the exhaust port when you release the brakes. If the brakes do not promptly release, repair or replace the quick release valve.
7. Remove the wheel blocks.

Air Brake Quick Release Valve Test (Leakage Test)

1. Block the vehicle wheels.
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Stop the engine.
5. Ask an assistant to apply the brake pedal.



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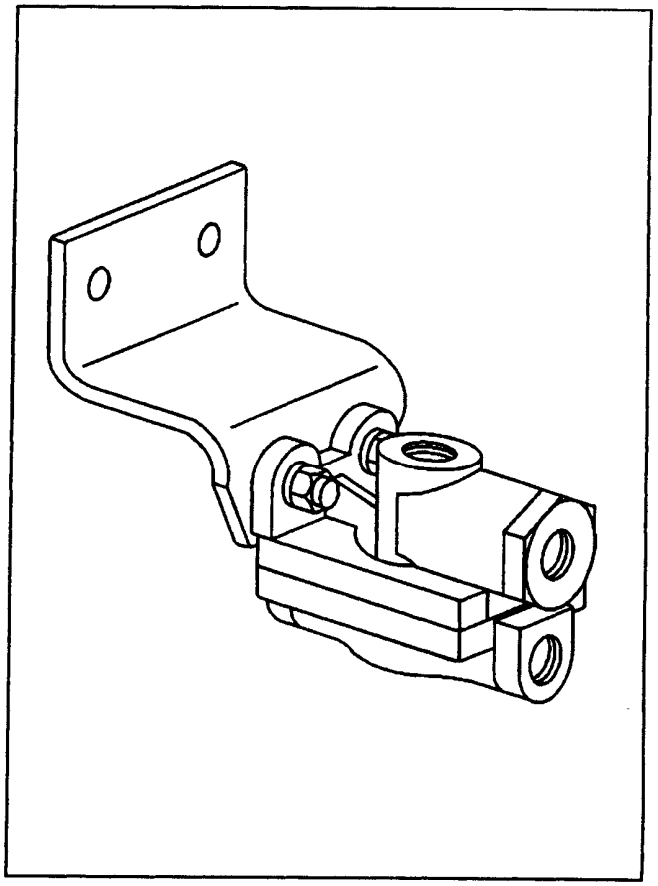
6. Inspect the exhaust port for air leakage. Air leakage of a 25.4 mm (1 inch) bubble in 3 seconds is acceptable. If the air leakage is excessive, overhaul or replace the quick release valve.
7. Inspect the upper and the lower valve body for air leakage. Air leakage is not permissable. If any bubbles appear, overhaul or replace the quick release valve.
8. Remove the wheel blocks.

Rear Air Brk Quick Release Double Check Valve Test (Operational Check)

1. Block the wheels.
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Stop the engine.
5. Release the brake pedal and push in the park control knob.
6. Verify that the spring brake chambers release promptly.
7. Pull out on the park control knob. Release the brake pedal.
8. Verify that a prompt exhaust of air occurs at the quick release valve (double check type) exhaust port.
9. Test the slack adjuster in order to verify that the spring brake is applied.
10. Remove the wheel blocks.

Rear Air Brk Quick Release Double Check Valve Test (Leakage Test)

1. Block the wheels.
2. Disconnect the air line from the balance port.
3. Start the engine.
4. Charge the air system to the air compressor governor cut-out point.
5. Stop the engine.
6. Push in the park control knob.



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7. Inspect the quick release valve (double check type) exhaust port and the balance port for air leakage. Air leakage less than 25.4 mm (1 in) bubble in 5 seconds is acceptable.

   If the air leakage is excessive, overhaul or replace the quick release valve (double check type).
8. Connect the air line to the balance port.
9. Pull out the park control knob.
10. Disconnect the air line from the supply port.
11. Ask an assistant to apply the brake pedal.
12. Inspect the supply port for air leakage. Air leakage less than 25.4 mm (1 in) bubble in 5 seconds is acceptable.

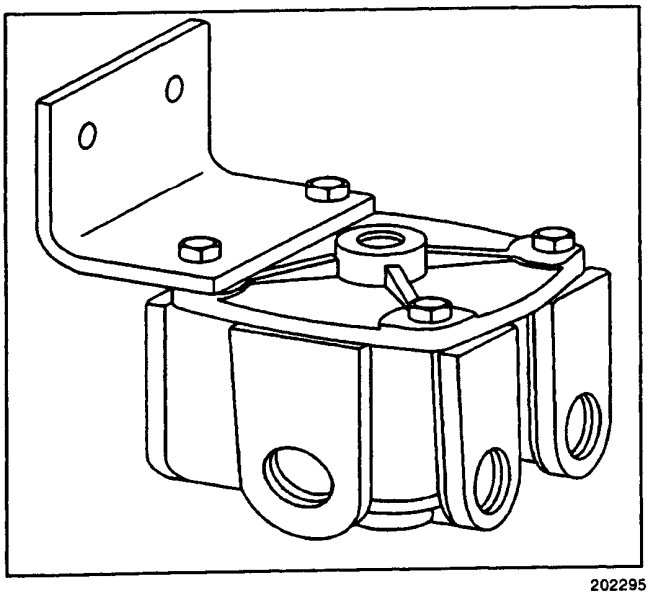
    If the air leakage is excessive, overhaul or replace the quick release valve (double check type).
13. Inspect the seam between the body and the cover for air leakage. Leakage is not permissable. If any bubbles appear, overhaul or replace the quick release valve (double check type).
14. Connect the air line at the supply port.
15. Inspect the air lines for leaks.
16. Remove the wheel blocks.

Rear Air Brake Relay Valve Test (Operational Check)

1. Block the wheels.
2. Start the engine.
3. Charge the air supply to the air compressor governor cut-out point.
4. Stop the engine.
5. While you check each wheel, ask an assistant to apply the brakes hard and then release the brakes several times.
   - Ensure that the brakes apply and release promptly at each wheel.
   - If the brakes do not apply and release promptly, overhaul or replace the relay valve.
6. Remove the wheel blocks.

Rear Air Brake Relay Valve Test (Leakage Test)

1. Block the wheels.
2. Start the engine.
3. Charge the air system to the air compressor governor cut-out point.
4. Stop the engine.
5. Release the brake pedal.



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6. Inspect the exhaust port and the area around the exhaust port retaining ring for air leakage. Air leakage less than a 25.4 mm (1 in) bubble in 3 seconds is acceptable.

   If air leakage is excessive, overhaul or replace the relay valve.
7. Ask an assistant to apply the brake pedal firmly.
8. Inspect the exhaust port for air leakage. Air leakage less than a 25.4 mm (1 in) bubble in 3 seconds is acceptable.

   If air leakage is excessive, overhaul or replace the relay valve.
9. Inspect the outside of the valve where the cover joins the valve body for air leakage. Air leakage is not pemissable.

   If any bubbles appear, overhaul or replace the relay valve.
10. Remove the wheel blocks.

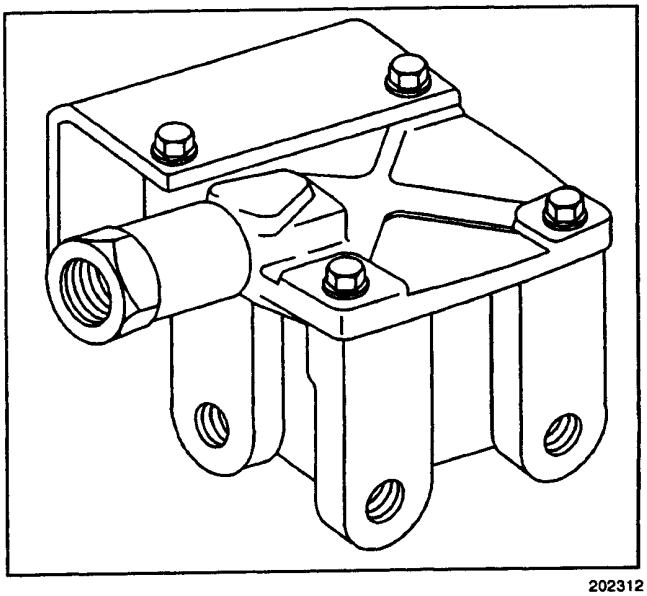
Rear Air Brake Relay Double Check Valve Test (Operational Check)

1. Block the wheels.
2. Start the engine.
3. Charge the air supply to the air compressor governor cut-out point.
4. Stop the engine.
5. While you check each wheel, ask an assistant to apply the brakes hard and then release the brakes several times.
6. Insure that the brakes apply and release promptly at each wheel.

   If the brakes do not apply and release promptly, overhaul or replace the relay valve (double check type).
7. Remove the wheel blocks.

Rear Air Brake Relay Double Check Valve Test (Leakage Test)

1. Start the engine.
2. Charge the air system to the air compressor governor cut-out point.
3. Stop the engine.
4. Release the brake pedal.
5. Pull out the park control knob.



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6. Inspect the exhaust port and inspect the area around the exhaust port retaining ring for air leakage. Air leakage less than a 25.4 mm (1 in) bubble in 3 seconds is acceptable.

   If air leakage is excessive, overhaul or replace the relay valve.

7. Push in the park control knob.
8. Inspect the exhaust port for air leakage. Air leakage less than a 25.4 mm (1 in) bubble in 3 seconds is acceptable.

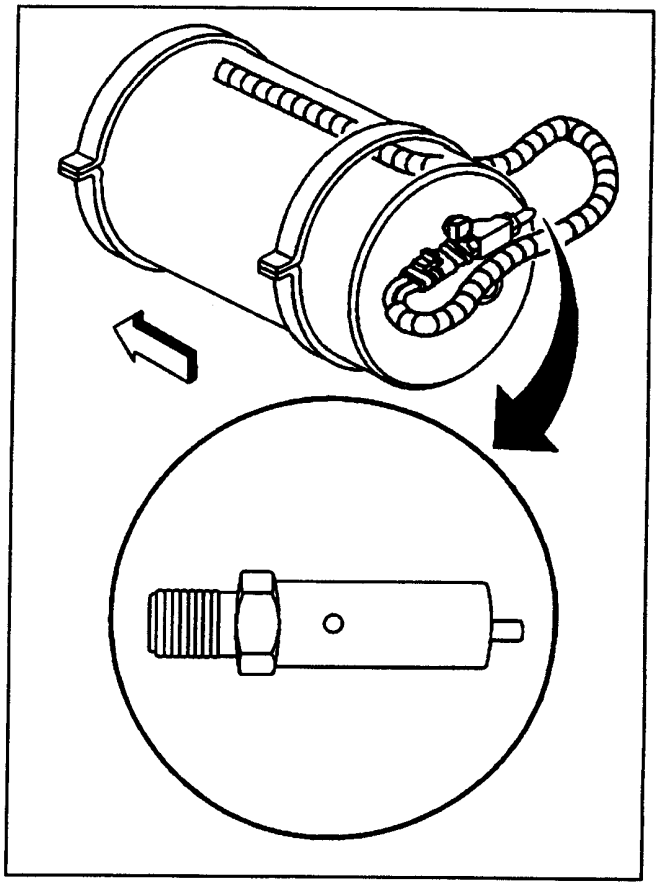
   If air leakage is excessive, overhaul or replace the relay valve (double check type).
9. Inspect the outside of the valve where the cover joins the valve body for air leakage. Air leakage is not permitted.

   If any bubbles appear, overhaul or replace the relay valve (double check type).
10. Disconnect the balance port air line.
11. Start the engine.
12. Charge the system to the air compressor governor cut-out point.
13. Stop the engine.
14. Inspect the balance port for air leakage. Air leakage less than a 25.4 mm (1 in) bubble in 3 seconds is acceptable.

    If air leakage is excessive, overhaul or replace the relay valve (double check type).
15. Connect the balance port air line.
16. Remove the wheel blocks.

Primary Air Brake Supply Rsvr Safety Valve Test (Operational Check)

1. Block the wheels.
2. Apply the parking brake.
3. Start the engine.
4. Charge the air system to the air compressor governor cut-out point.
5. Stop the engine.



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6. Pull out the exposed end of the valve stem. Air should exhaust from the safety valve exhaust port.

   If air does not exhaust from the safety valve exhaust port, replace the safety valve.
7. Release the valve stem. The air flow from the exhaust port should stop.

   If the air flow does not stop, replace the safety valve.
8. Remove the wheel blocks.

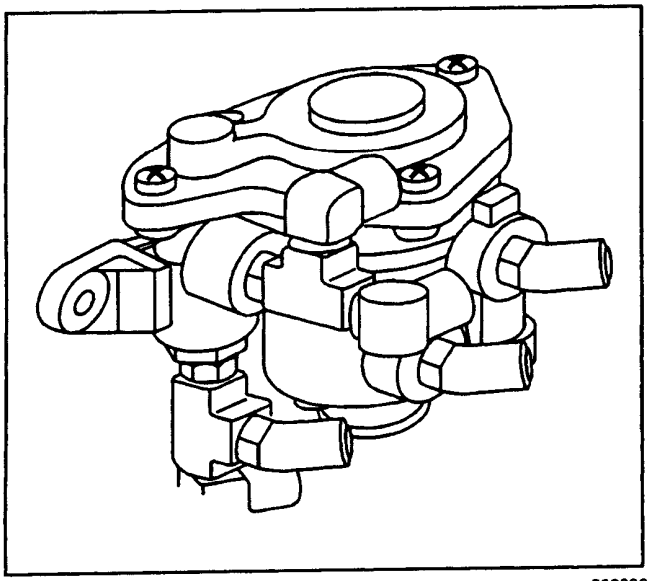
Primary Air Brake Supply Rsvr Safety Valve Test (Leakage Test)

1. Block the wheels.
2. Apply the parking brake.
3. Start the engine.
4. Charge the air system to the air compressor governor cut-out point.
5. Stop the engine.
6. Inspect the safety valve exhaust port for air leakage. Air leakage less than a 25.4 mm (1 in) bubble in 5 seconds is acceptable.

   If air leakage is excessive, replace the safety valve.
7. Remove the wheel blocks.

Chassis Mounted Air Brake Park Control Valve Test (Operational Check)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Pull out the park control knob.
6. Verify that the spring brake chamber assemblies apply promptly.



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7. Install an accurate test air pressure gauge in the delivery port air line.
8. Push in the park control knob.
9. Verify that the spring brake chamber assemblies release fully.
10. Verify that the test gauge pressure reading is approximately 379 kPa (55 psi) or more. This is the rated spring hold-off pressure.

    If the pressure reading is not correct, overhaul or replace the park control valve (chassis mounted).
11. Pull out the park control knob.
12. Verify that the test gauge reading promptly falls to zero. If the reading does not fall to zero, overhaul or replace the park control valve (chassis mounted).
13. Push in the park control knob.
14. Drain the air from the rear service air reservoir(s).
15. Ask an assistant to apply and release the brake pedal repeatedly.
16. Verify that the pressure reading decreases each time your assistant applys the brake pedal.

    After several applications of the brakes, the pressure on the gauge will drop to the point where release of the spring brake chamber assemblies will no longer occur.
17. Remove the test air pressure gauge from the delivery port air line.
18. Start the engine.
19. Charge the system to the air compressor governor cut-out point.
20. Stop the engine.
21. Check the brakes for proper operation.
22. Remove the wheel blocks.

Chassis Mounted Air Brake Park Control Valve Test (Leakage Test)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Push in the park control knob.
6. Inspect the exhaust port and around the valve cover for air leakage. Slight air leakage is permitted.

   If air leakage is excessive, overhaul or replace the park control valve (chassis mounted).
7. Remove the wheel blocks.

Towing Vehicle Protection Valve Test (Operational Check)

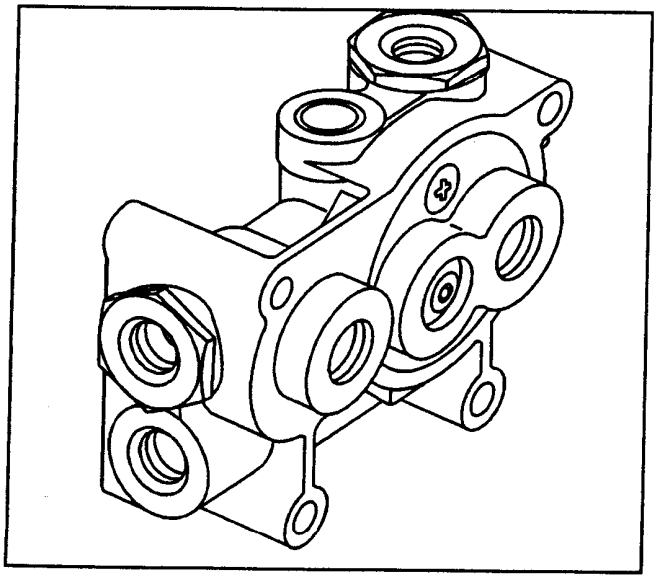
1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Connect an air pressure test gauge to the trailer air supply service coupling.
6. Pull up the trailer air brake control lever to the fully applied position.
7. Verify that pressure occurs at the trailer service air line coupling.
8. Push down the trailer air brake control lever to the full released position.
9. Ask an assistant to apply the brake pedal firmly.

10. Inspect for air leakage at the exhaust port of the trailer air brake control valve. Excessive leakage indicates a faulty double check valve shuttle within the towing vehicle protection valve.

    If the leakage is excessive, overhaul or replace the towing vehicle protection valve.
11. Release the brake pedal.
12. Disconnect the air pressure test gauge from the trailer air supply service coupling.
13. Start the engine.
14. Charge the system to the air compressor governor cut-out point.
15. Stop the engine.
16. Check the brakes for proper operation.
17. Remove the wheel blocks.

Towing Vehicle Protection Valve Test (Leakage Test)

1. Block the wheels
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.
5. Pull out the trailer air supply knob.
6. Disconnect the trailer air service air line.
7. Pull up the trailer air brake control valve lever in order to fully apply the trailer service brakes.



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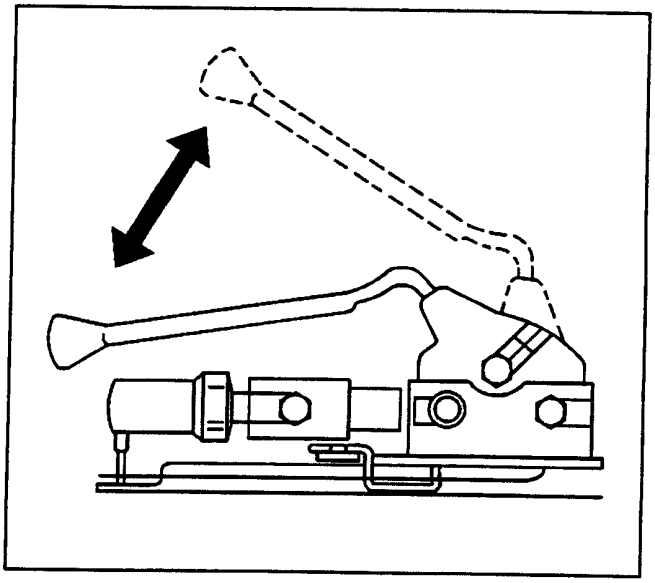
8. Hold a finger over the 1.6 mm (0.0625 in) vent hole in the valve.
9. Inspect the hose coupling and the exhaust port for leakage. If the air leakage is excessive, overhaul or replace the towing vehicle protection valve.
10. Release the trailer air brake hand control valve.
11. Connect an air pressure test gauge to the trailer air supply service coupling.
12. Pull up the trailer air brake control lever to the fully applied position.
13. Inspect for air leakage at the exhaust port. If the air leakage is excessive, overhaul or replace the towing vehicle protection valve.
14. Inspect the 1.6 mm (0.0625 in) vent hole in the valve for air leakage. Leakage is not permissible.

    If the air leakage is present, overhaul or replace the towing vehicle protection valve.
15. Push down the trailer air brake control lever.
16. Inspect the 1.6 mm (0.0625 in) vent hole in the valve for air leakage. Leakage is not permissible.

    If the air leakage is present, overhaul or replace the towing vehicle protection valve.
17. Drain all of the air from all of the lines and the air reservoirs.
18. Disconnect the air pressure test gauge from the trailer air supply service coupling.
19. Start the engine.
20. Charge the system to the air compressor governor cut-out point.
21. Stop the engine.
22. Check the brakes for proper operation.
23. Remove the wheel blocks.

Trailer Brake Control Valve Test (Operational Check)

1. Block the wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
3. Install a test air pressure gauge in the trailer air brake control valve delivery line.
4. Start the engine.
5. Charge the system to the air compressor governor cut-out point.
6. Stop the engine.



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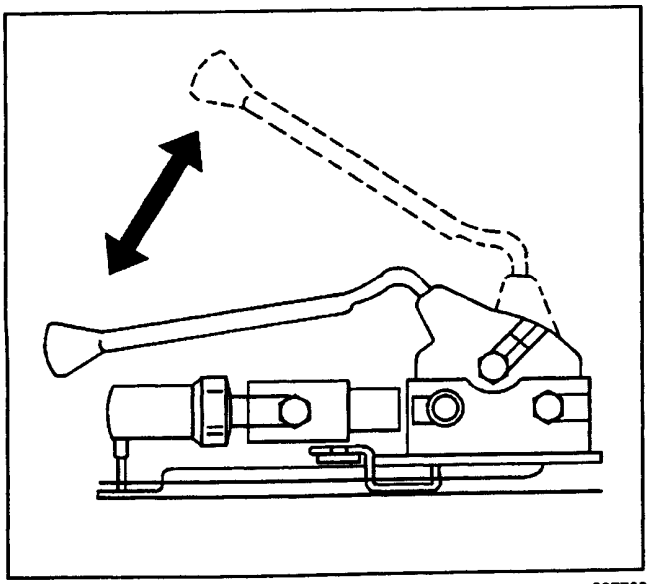
7. Push the trailer air brake control lever down to the full OFF position.
8. Verify that the test air pressure gauge indicates zero air pressure.

   If the gauge does not indicate zero air pressure, replace the trailer air brake control valve.
9. Pull up on the trailer air brake control lever to the full ON position.
10. Verify that the test air pressure gauge indicates the same air pressure as the the dual air pressure gauge.

    If the test air presssure gauge and the dual air pressure gauge do not have the same air pressure reading then replace the trailer air brake control valve.
11. Move the lever to several intermediate positions.
12. Verify that the test air pressure gauge indicates intermediate air pressures consistent with the handle position.
13. Drain all of the air reservoirs.
14. Remove the test air pressure gauge.
15. Start the engine.
16. Charge the system to the air compressor governor cut-out point.
17. Stop the engine.
18. Check for proper brake operation.
19. Remove the wheel blocks.

Trailer Brake Control Valve Test (Leakage Test)

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor cut-out point.
4. Stop the engine.



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5. Push down the trailer air brake control valve lever to the full OFF position.
6. Inspect the valve body and the exhaust port for air leakage. Air leakage is not permissible.

   If air leakage is present, replace the trailer air brake control valve.
7. Pull up the trailer air brake control lever to the full ON position.
8. Inspect the valve body and the exhaust port for air leakage. Air leakage is not permissible.

   If air leakage is present, replace the trailer air brake control valve.
9. Remove the wheel blocks.

Air Dryer/Moisture Ejector System Check

1. Check condition of circuit breaker #9. If circuit breaker is open, locate and repair cause of overload. Replace circuit breaker if necessary.

2. Check that G404 is clean and tight.

3. The air brake dryer and moisture ejector heater are both thermostatically controlled. The thermostat will activate the heating element when the valve body reaches a temperature of approximately 7°C (45°F). The heating elements will deactivate when the valve body is warmed to approximately 26°C (85°F).

4. If either the air brake dryer or the moisture ejector heater remain engaged above 26°C (85°F), replace the malfunctioning component.

5. Check for a broken or partially broken wire inside the insulation which could cause system malfunction but prove good in a continuity/voltage check with the system disconnected. These circuits may be interrmittent or resistive when loaded, and if possible, shoild be checked by monitoring for a voltage drop with the system operational (under load).

6. Check for proper installation of aftermarket electronic equipment which may affect the integrity of other systems. Refer to *Checking Aftermarket Accessories.*

Air Dryer and Moisture Ejector Do Not Work

Step	Action	Value(s)	Yes	No
1	1. Turn the ignition switch to RUN. 2. Backprobe the air dryer with a test lamp from terminal A to the chassis ground. Did the test lamp light?	—	Go to *Step 2*	Go to *Step 3*
2	Repair the open in CKT 150 (BLK) between the IP fuse block and S701. Do both the air dryer and the moisture ejector heater operate?	—	System OK	—
3	Repair the open in CKT 341, 139, and 145 (BRN) between the IP fuse block and G404. Do both the air dryer and the moisture ejector heater operate?	—	System OK	—

Air Dryer or Moisture Ejector Does Not Work

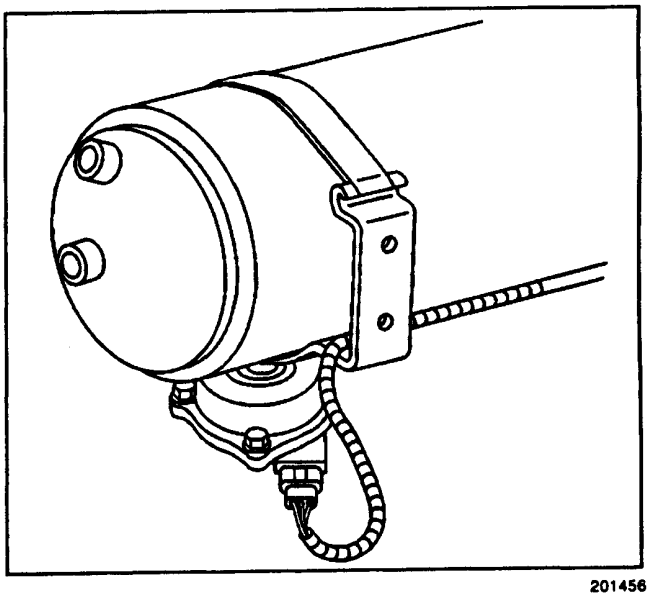
Step	Action	Value(s)	Yes	No
1	1. Turn the ignition switch to RUN. 2. Backprobe the inoperative component with a test lamp from terminal A to the chassis ground. Did the test lamp light?	—	Go to *Step 2*	Go to *Step 3*
2	Backprobe the inoperative component with a test lamp from terminal B to B+. Did the test lamp light?	—	Go to *Step 4*	Go to *Step 5*
3	Repair the open in CKT 341 (BRN) between S420 and the inoperative component. Does the air dryer or the moisture ejector heater operate?	—	System OK	—
4	Replace the inoperative component. Does the air dryer or the moisture ejector heater operate?	—	System OK	—
5	Repair the open in CKT 150 (BLK) between the inoperative component and G404. Does the air dryer or the moisture ejector heater operate?	—	System OK	—

Repair Instructions

Draining Reservoirs

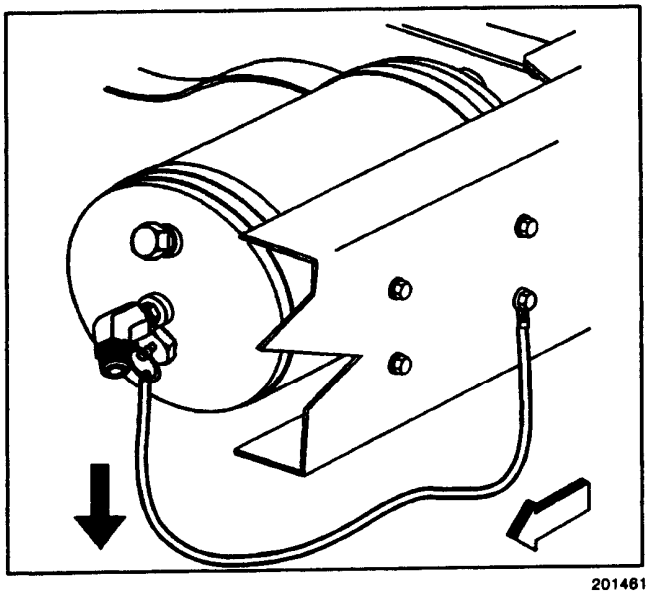
Daily Maintenance Draining

Water and contaminants should be drained from the primary air brake supply reservoir daily unless a reservoir drain valve (automatic type) is installed. Daily draining is not needed on reservoirs with the optional reservoir drain valve (automatic type). The reservoir drain valve (automatic type) automatically drains water and contaminants.



201456

1. Start the engine and charge the system with air.
2. Pull the cable attached to the reservoir drain valve (manual type) on the bottom of the supply reservoir.
3. After the water and contaminants stop draining, release the cable. The reservoir drain valve (manual type) will close.

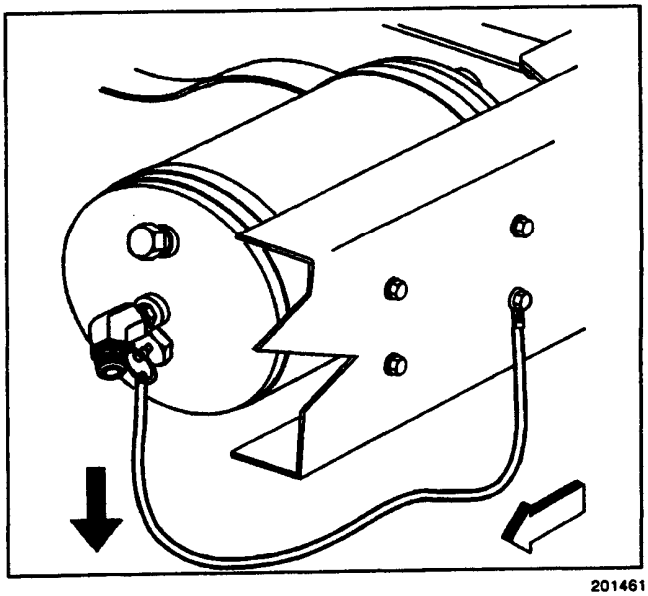


201461

Complete Service Draining

1. Block the vehicle wheels.
2. Apply the parking brake.
3. Drain the supply reservoir.

   On reservoirs with a reservoir drain valve (manual type), pull the reservoir drain valve cable until the reservoir drain valve opens. Hold the cable until all the air is drained.



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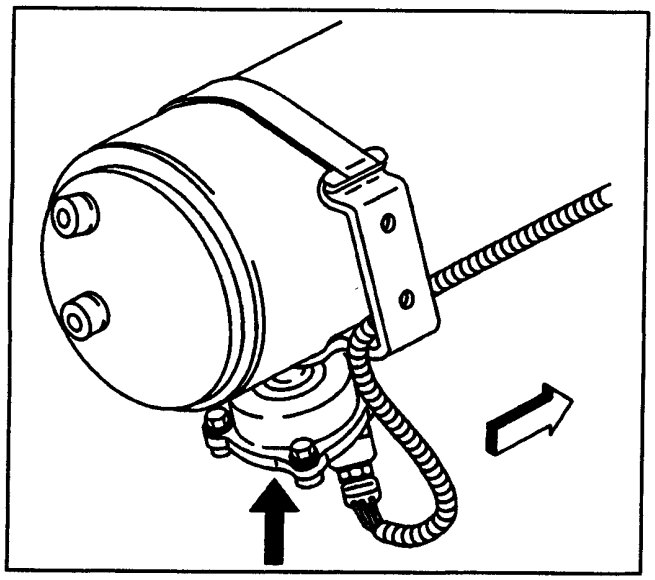

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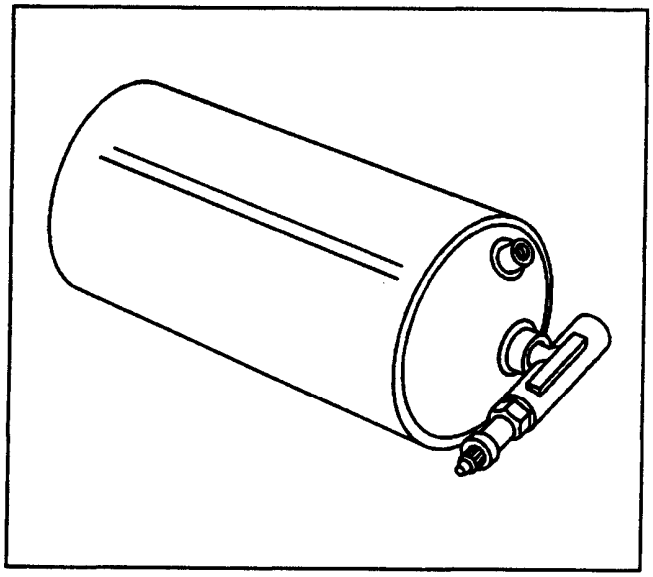
4. On reservoirs with a reservoir drain valve (automatic type), push upward on the wire in the exhaust port of the reservoir drain valve (automatic type) and hold until all the air is drained.
5. Open the reservoir drain valve (manual type) and drain the front service reservoir.
6. Open the reservoir drain valve (manual type) and drain the rear service reservoirs. Drain all of the rear service reservoirs.



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Filling Reservoirs

Standard Method

1. Charge the air system.

   Start the engine and allow the air compressor to fill the air system.
2. Remove the wheel blocks.

Optional Method

1. Connect a compressed air line to the inflation valve.
   - Ensure that the compressed air is free of moisture.
   - Do not fill the system with more than 861 kPa (125 psi) of air pressure.
2. Disconnect the compressed air line.
3. Remove the wheel blocks.

Applying Pipe Sealant

Apply pipe sealant, prior to the assembly procedure, to the following components:

- All male pipe threads not having pre-applied pipe sealant (burnt orange in color)
- Components with male pipe threads with pre-applied sealant that have been assembled and disassembled a maximum of five times must have pipe sealant applied before assembly

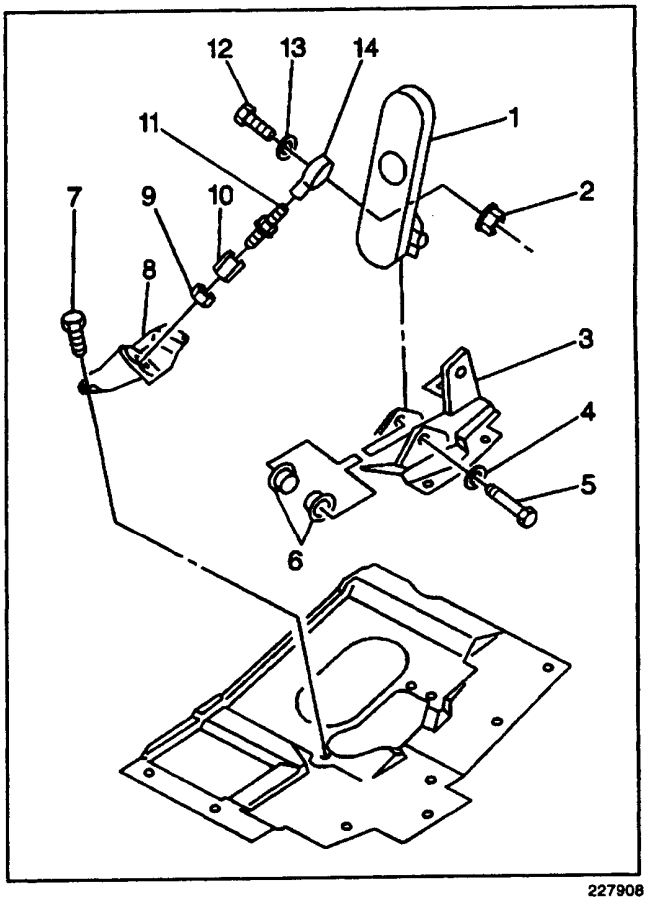
1. Clean the threads. Remove all grease and oil with a clean cloth.
2. Inspect the threads for damage. Replace any damaged threads.

   Important: Do not allow pipe thread sealant on any internal diameters.
3. Apply pipe sealant with Teflon® to the first few threads.

Air Brake Pedal Replacement

Removal Procedure

1. Block the wheels.
2. Remove the brake pedal bracket bolts (5) from the brake pedal bracket (3).
3. Tilt the cab. Refer to *Cab Tilting* in General Information.
4. Remove the left inner fender panel. Refer to Body Front End.
5. Loosen the brake pedal joint lock nut (9).
6. Turn the dual application valve push rod until it is free if the brake pedal joint nut (10).
7. Lower the cab.



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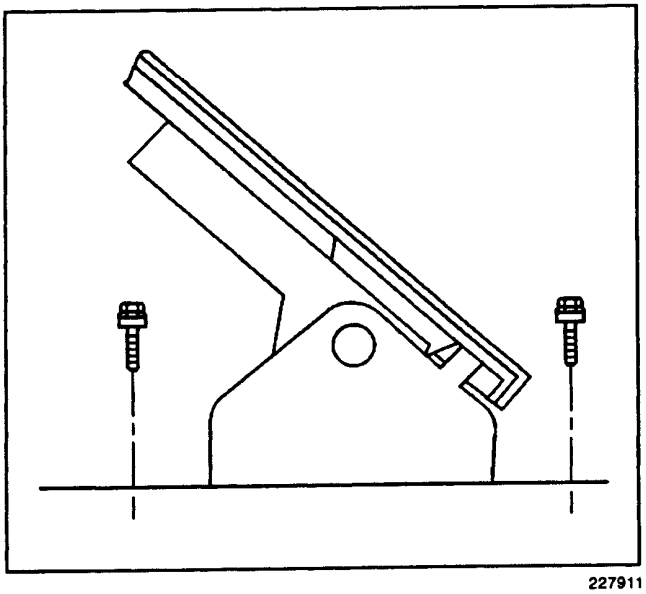
8. Remove the brake pedal.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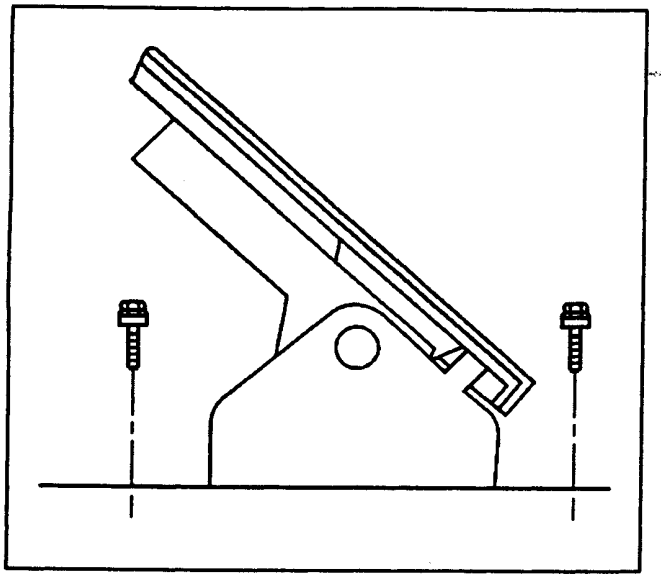

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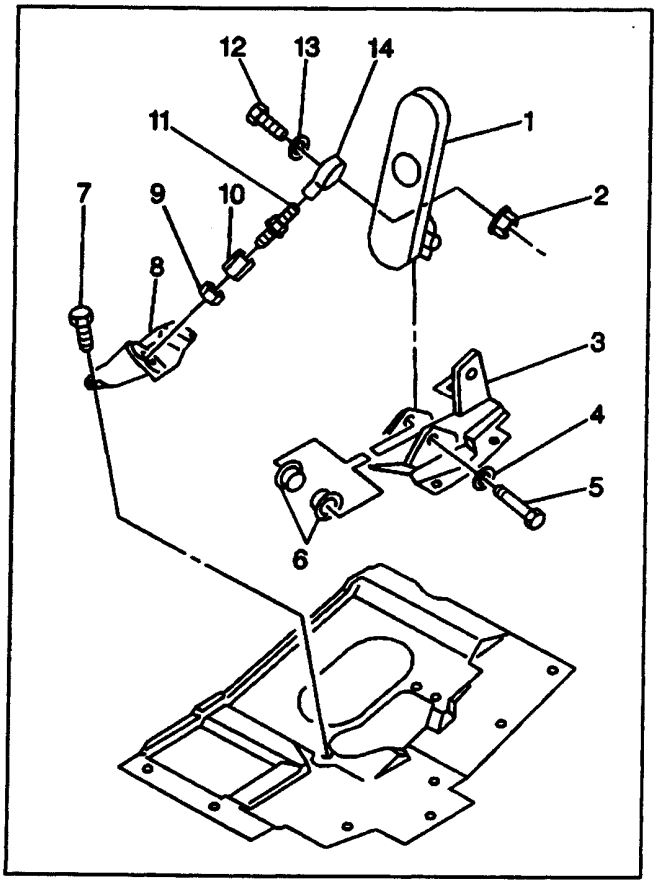


227908

Installation Procedure

1. Loosely fit the brake pedal into position.
2. Tilt the cab.
3. Loosely assemble the dual application valve push rod into the brake pedal joint nut (10).
4. Lower the cab.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
5. Install the brake pedal bracket bolts (5) to the brake pedal bracket (3).

   Tighten

   - Tighten the brake pedal bracket bolts (6 mm) to 8 N.m (71 lb in).
   - Tighten the brake pedal bracket bolts (8 mm) to 19 N.m (14 lb in).
6. Tilt the cab.
7. Pull up the top of the brake pedal until it is in contact with the stopper on the return side, while turning the brake pedal joint.

   Adjust the park pedal end play until 5.25– 5 mm (0.206 –0.182 in) end play is achieved.

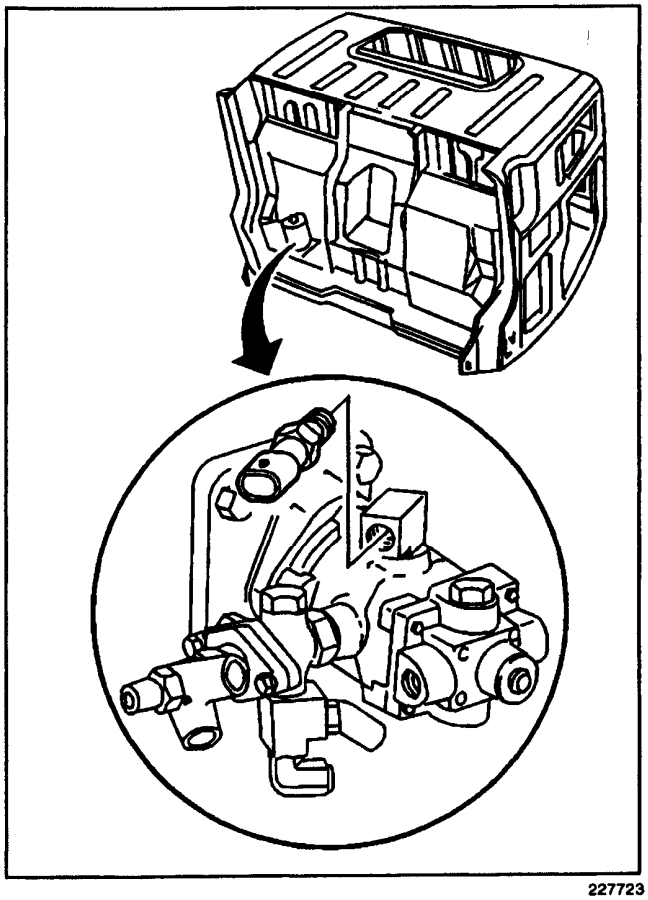
   Tighten

   Tighten the brake pedal joint lock nut to 62 N.m (46 lb ft).
8. Measure the end play 5.25–5 mm (0.206–0.182 in).
9. Install the left inner fender panel.
10. Lower the cab.
11. Perform the air leakage test. Refer to *Air Brake System Testing (Operational Check).*
12. Perform the operational test. Refer to *Air Brake System Testing (Operational Check).*

Stoplamp Switch Replacement

Removal Procedure

1. Block the vehicle wheels.
2. Set the parking brake.
3. Drain all of the air reservoirs. Refer to *Draining Reservoirs*.
4. Remove the wiring harness connector.
5. Remove the stoplamp switch.

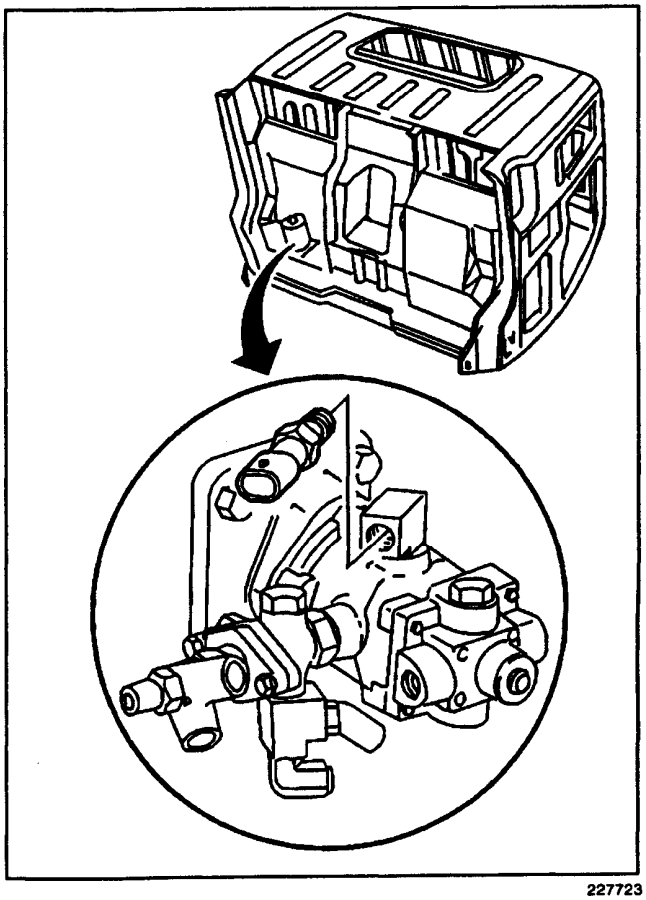


227723

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the stoplamp switch.
   Tighten
   Tighten the stoplamp switch to 11 N.m (97 lb in).
2. Install the wiring harness connector.
3. Start the engine and build up system air pressure.
4. Test the brakes for proper operation.
5. Remove the wheel blocks.



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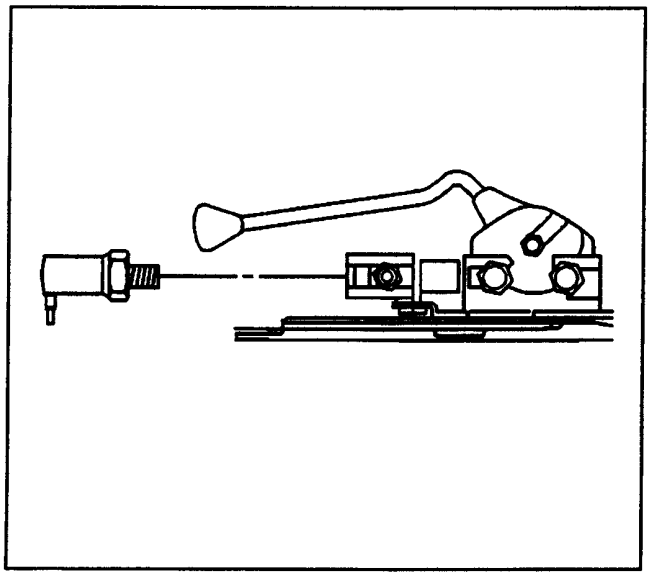

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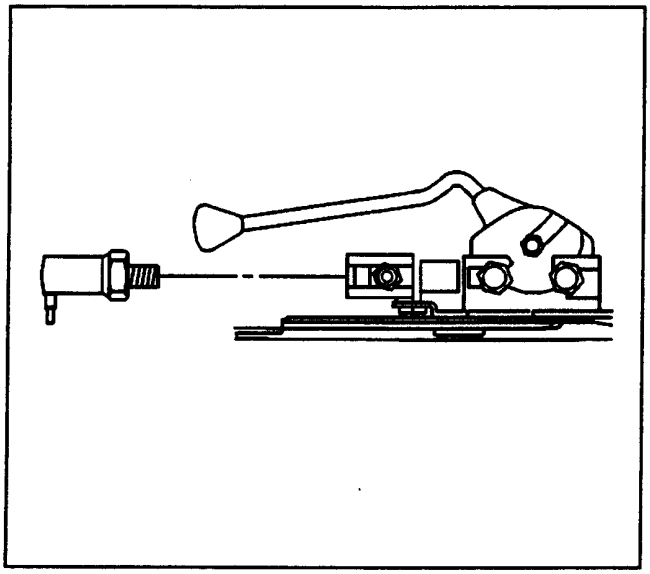
Trailer Stoplamp Switch Replacement

Removal Procedure

1. Set the parking brake.
2. Block the vehicle wheels.
3. Drain all of the air reservoirs. Refer to *Draining Reservoirs*.
4. Remove the wiring harness connector.
5. Remove the trailer air brake stoplamp switch.

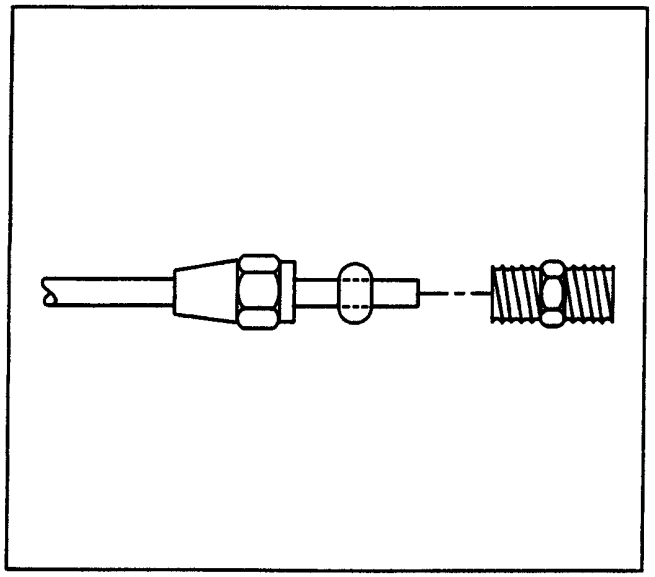


227732

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the trailer air brake stoplamp switch.
   Tighten
   Tighten the trailer air brake stoplamp switch to 7 N·m (62 lb in).
2. Install the wiring harness connector.
3. Start the engine and build up the system air pressure.
4. Test the brakes for proper operation.
5. Remove the wheel blocks.



201481

Hose and Line Replacement (Nylon and Metal - Compression)

Removal Procedure

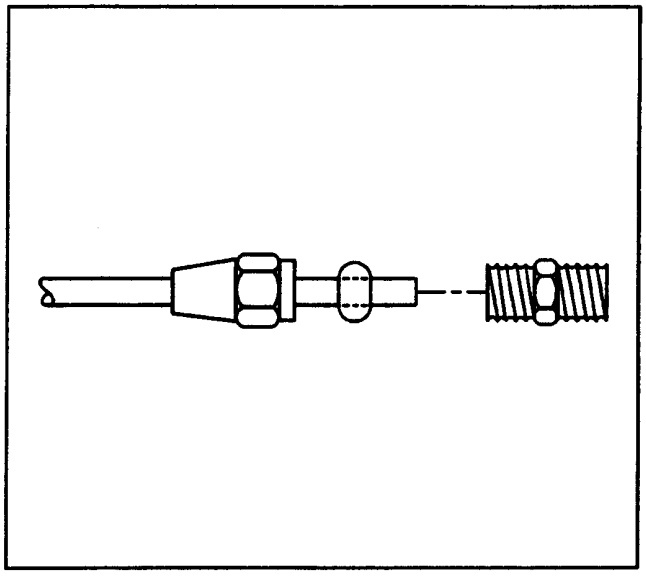
Notice: When replacing tubing, make sure that the tubing is free of burrs, cuttings, and dirt. While wearing safety glasses, use compressed air to blow out contaminants. Contaminants can destroy the air brake valve sealants.

Notice: Nylon air line should be used to replace existing nylon lines only. Do not route nylon air lines in areas where temperatures could exceed 93°C (200°F). Damage to the nylon lines could occur.

1. Apply the parking brake.
2. Block the wheels.
3. Remove the exhaust air from the lines. Refer to *Draining Reservoirs*.

Assembly and Disassembly Procedure

1. Remove the clips or the tubing clamps.
2. Remove the air line.
3. Remove the tube nuts from each fitting.
4. Remove the compression ring from the tube.
5. Clean the fittings and the tube nuts with a clean cloth.
6. Inspect the fittings and the tube nuts for the following conditions:
   - Nicks
   - Burrs
   - Wear Spots
7. Replace any damaged components.



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Important: Do not use the flared-type fittings in the air brake system. When replacing the air lines, use the end fitting kits to make new air line assemblies. Special tools are not required.

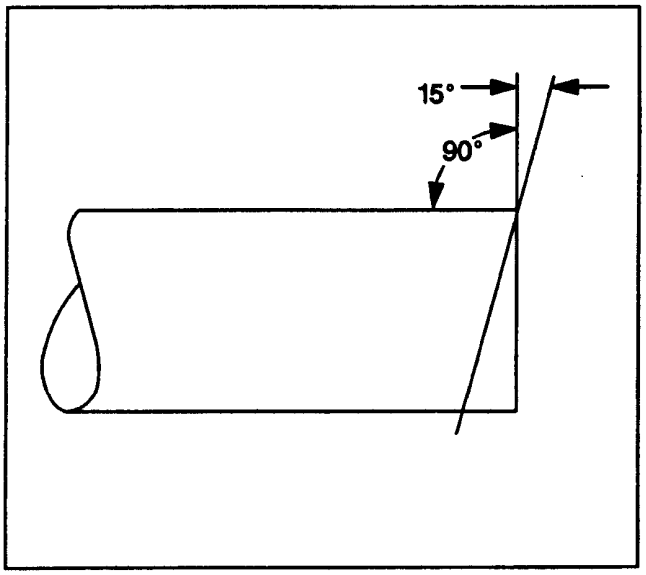
8. Cut the tube squarely at each end the same length as the old tube. Shape the metal tube to match the old tube.
9. Assemble the tube nut on the new tube.
10. Assemble the compression ring on the tube.

    Notice: Refer to *Fastener Notice* in Cautions and Notices.

    Important: Check that the tubing is completely inserted as far as it will go into the fitting.
11. Assemble the fitting and the tube.

    Tighten

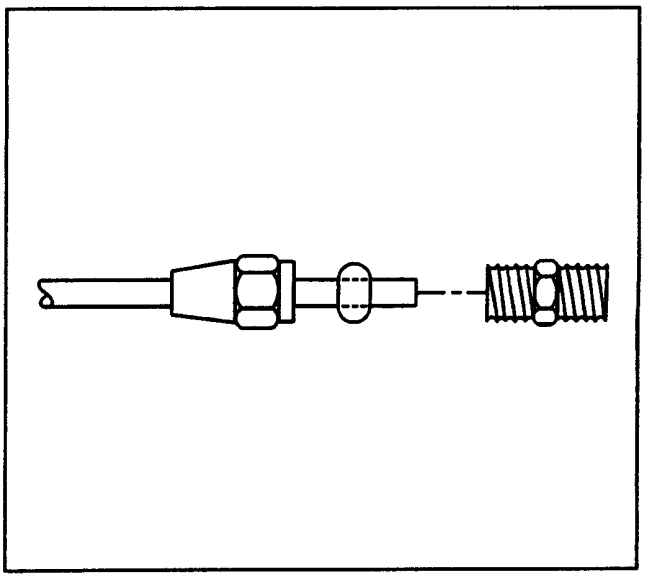
    Tighten the tube nut until 1 1/2 threads remain exposed between the tube nut and the fitting.



201499

Installation Procedure

1. Install the air line.
2. Install the clips or the tubing clamps.
3. Start the engine.
4. Charge the system air pressure to the governor cut-out point.
5. Check for leaks using a soap solution. Leaks are not permissible.
6. Check for the proper brake operation.
7. Remove the wheel blocks.



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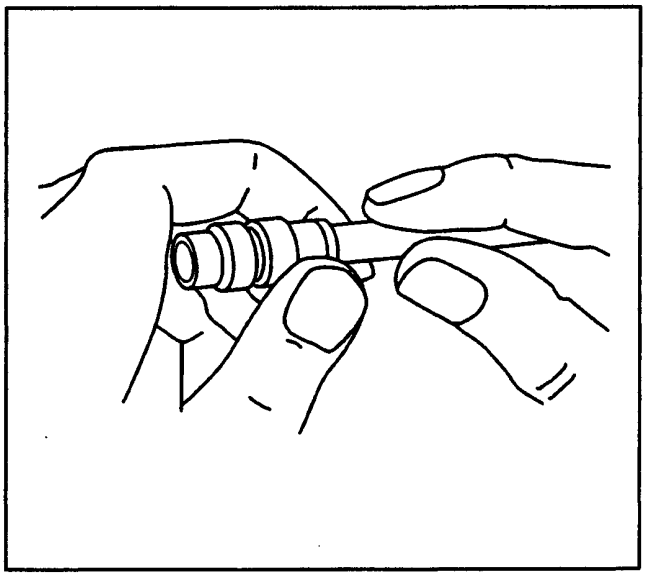


201509

Hose and Line Replacement (Nylon - Push-In)

Removal Procedure

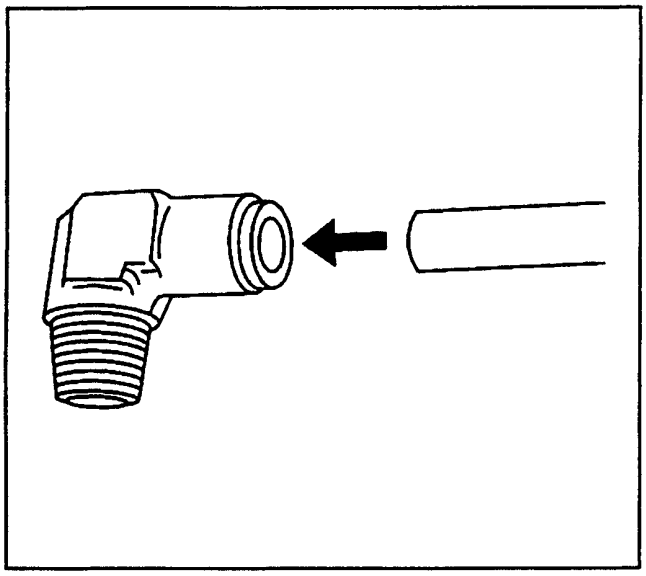
Notice: Nylon air line should be used to replace existing nylon lines only. Do not route nylon air lines in areas where temperatures could exceed 93°C (200°F). Damage to the nylon lines could occur.

Notice: When replacing air lines connected to the push-in type fittings, be certain that the nylon air line is pushed-in and seated in the fitting. Install the tube into the fitting until no tube color is visible between the gauge band and the fitting. The air line may blow out if the tube is not properly seated in the fitting.

1. Apply the parking brake.
2. Block the wheels.
3. Remove the exhaust air from the lines. Refer to *Draining Reservoirs.*
4. Remove the clips or the tubing clamps as needed.

   Important: Once removed, the nylon tube can be reinserted up to five times before it must be replaced.

5. Remove the nylon tube from the fitting using the following procedure:
   5.1. Push the nylon tube into the fitting until it bottoms on the tube stop.
   5.2. Depress the collet.
   5.3. Continue to depress the collet, while removing the tube from the fitting.
6. Inspect the fitting for the following conditions:
   - Nicks
   - Burrs
   - Wear spots
7. Replace the fitting if any of the aforementioned conditions exist.



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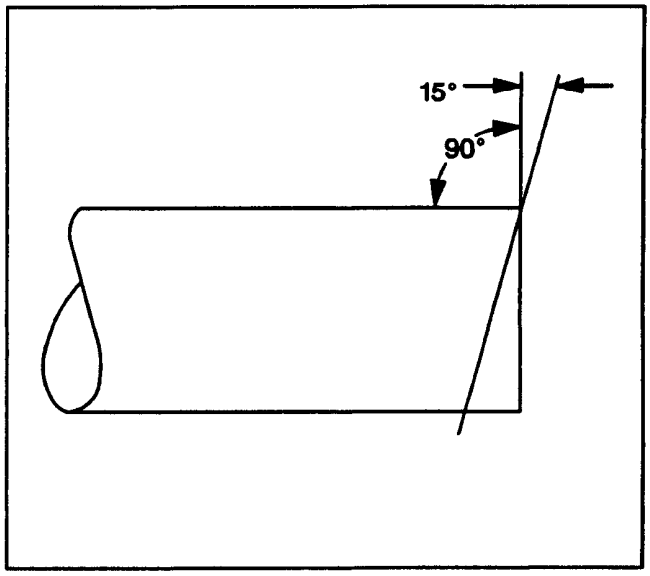
8. Cut the nylon tube with a sharp tube cutter.



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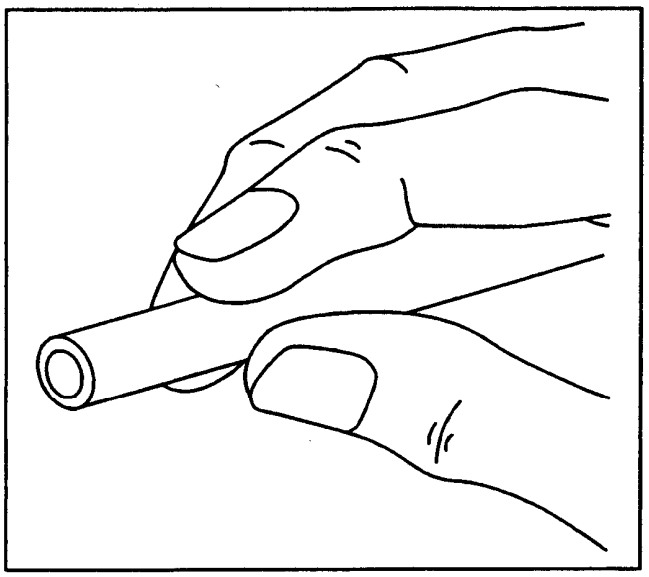
9. Check that the nylon tube is cut square and is free of burrs.
10. Assemble the nylon tube into the fitting. Push the tube firmly into the fitting until it bottoms on the tube stop.

Installation Procedure

1. Place tape around the air line to bundle it with the other air lines.
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Check for leaks with a soap solution around the fittings. Leakage is not permissible.
5. Check for proper brake operation.
6. Remove the wheel blocks.

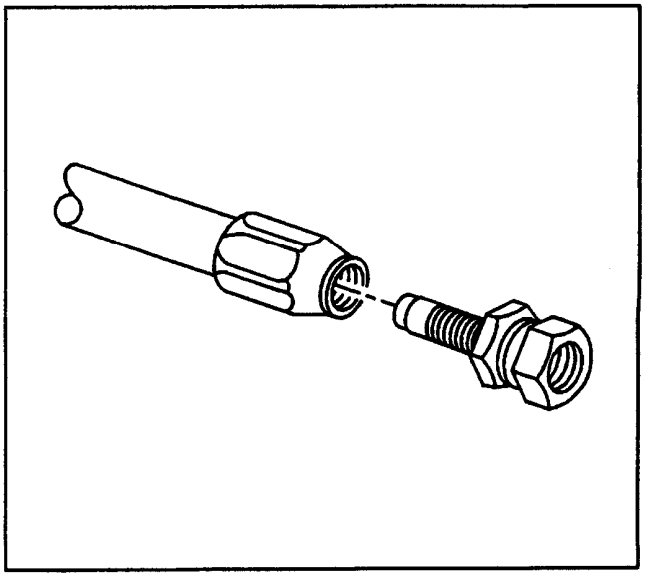


201515

Hose and Line Replacement (Flexible)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Exhaust the air from the lines. Refer to *Draining Reservoirs.*
4. Remove the air line.
5. Unscrew the nipple from the socket and the flexible hose.



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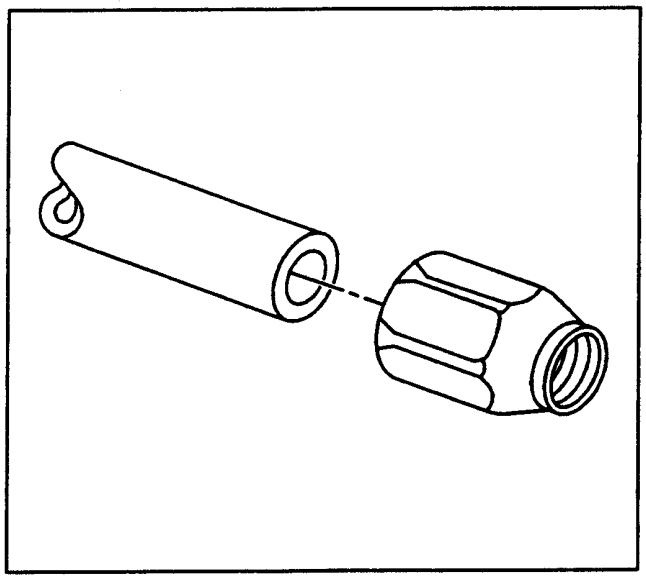

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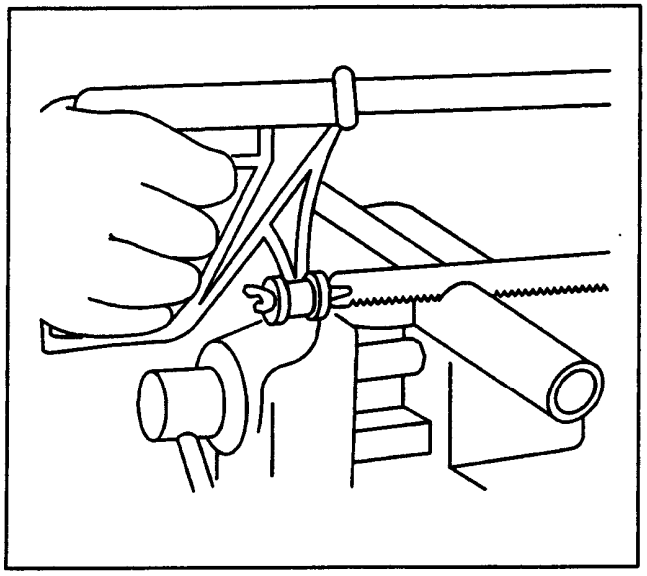
6. Disassemble the flexible hose. Turn the hose clockwise in order to unscrew the hose from the socket.
7. Clean the nipple and the socket with a clean cloth.
8. Inspect the nipple and the socket for the following conditions:
   - Nicks
   - Burrs
   - Wear Spots
9. Replace any damaged components.



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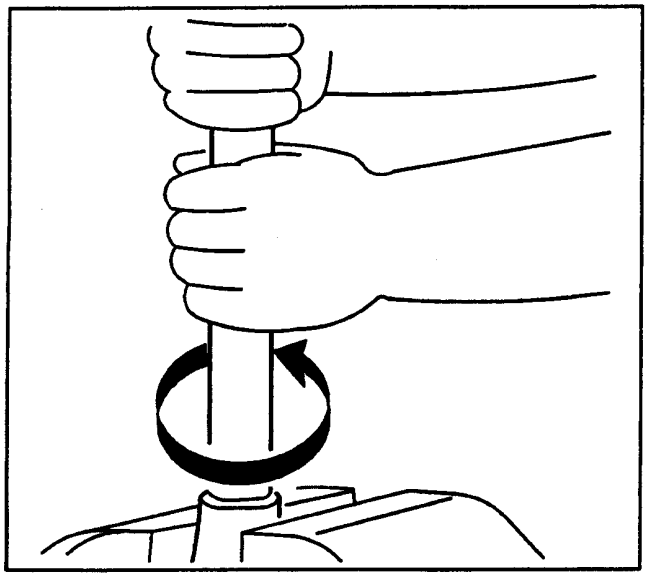
10. Use a fine tooth hacksaw or cutting wheel in order to cut the flexible hose squares the same length as the original part.



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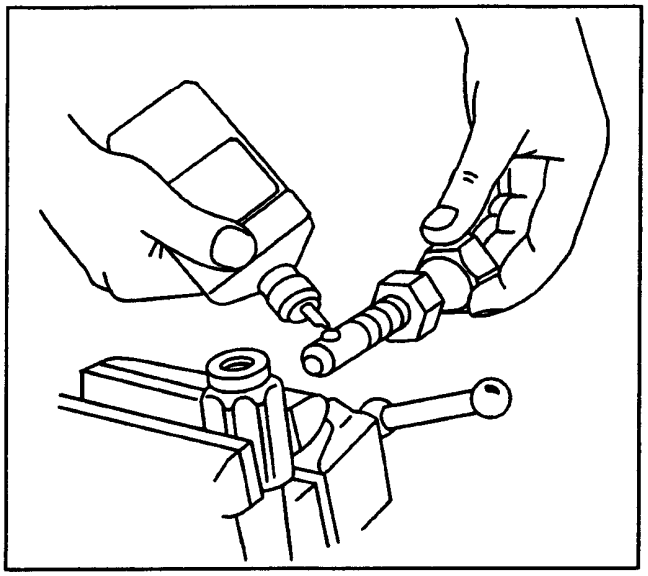
11. Assemble the flexible hose into the socket. Turn the hose counterclockwise in the socket until it bottoms; then back off the flexible hose 1/4 turn.

12. Lubricate the nipple threads with clean engine oil.



201548

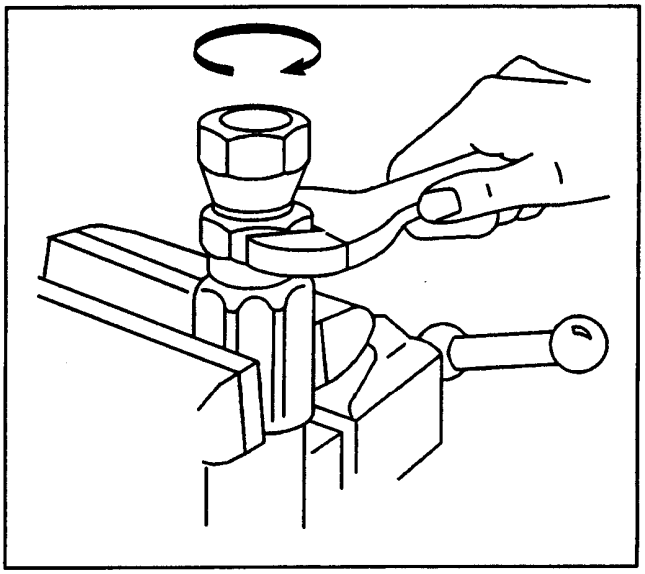
13. Assemble the nipple.

    Notice: Refer to *Fastener Notice* in Cautions and Notices.

14. Tighten the nipple.

    Tighten

    Tighten the nipple, leaving a 0.8 mm (0.03 in) clearance between the nipple hex and the socket.



201561

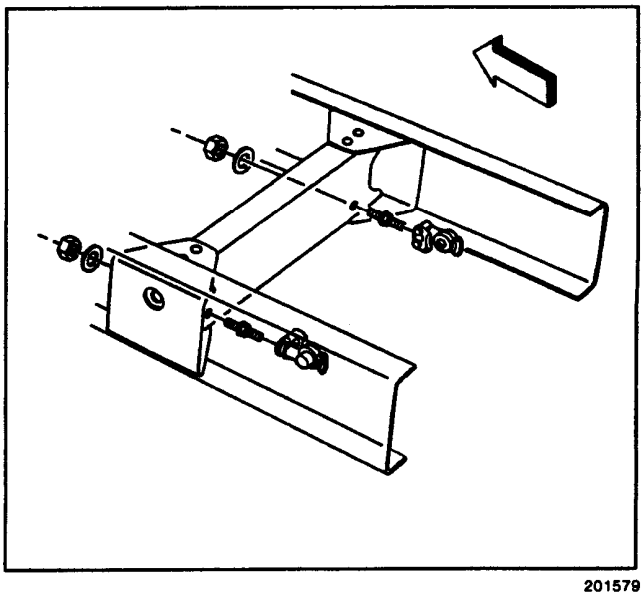
Installation Procedure

1. Install the air line.
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Check for leaks with a soap solution. No leakage is permissible.
5. Test the brakes for proper operation.
6. Remove the wheel blocks.

Hose and Line Replacement (Trailer Brake Coupling)

Removal Procedure

1. Set the parking brake.
2. Block the vehicle wheels.
3. Remove the trailer air brake coupling from the stud.



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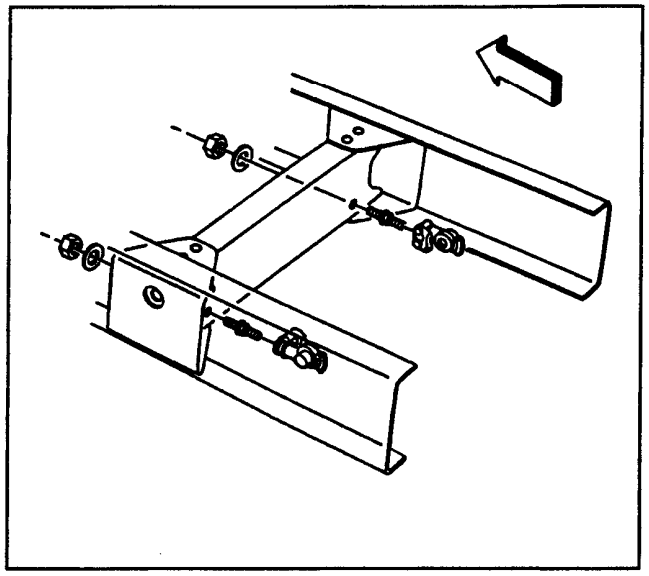

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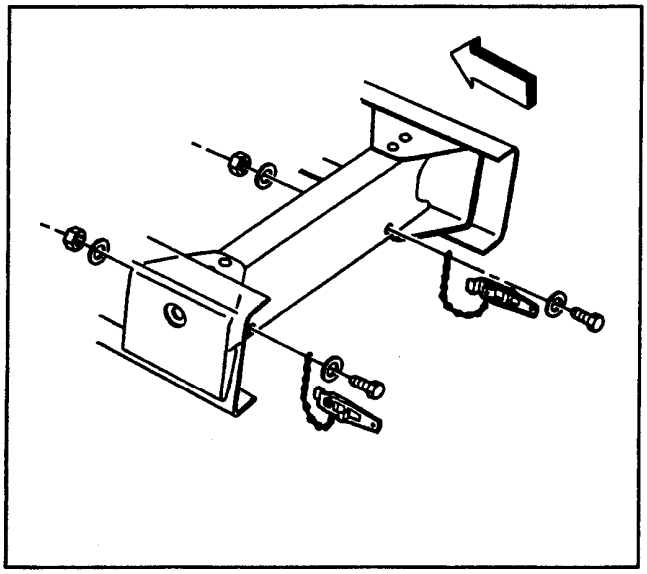
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the trailer air brake coupling to the stud.
   Tighten
   Tighten the trailer air brake coupling to 35 N.m (26 lb ft).
2. Remove the wheel blocks.

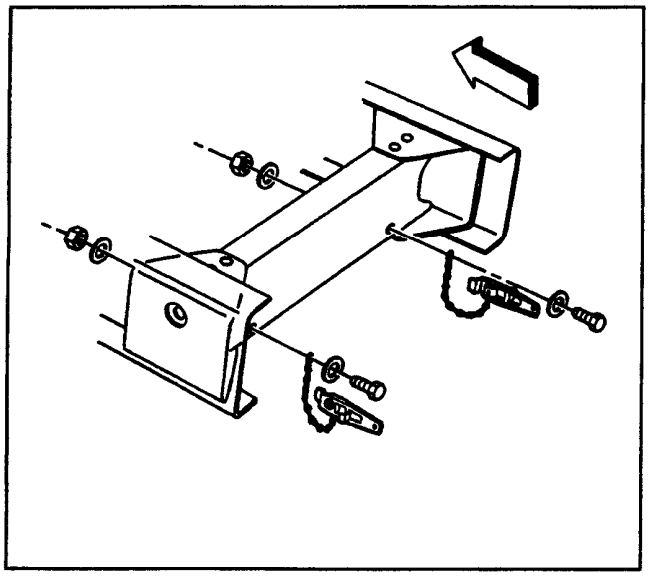


201619

Hose and Line Replacement (Trailer Brake Dummy Cap)

Removal Procedure

1. Block the vehicle wheels.
2. Apply the parking brake.
3. Remove the following components:
   3.1. The nut
   3.2. The washer
   3.3. The bolt
4. Remove the trailer air brake dummy coupling from the trailer air brake coupling.



201619

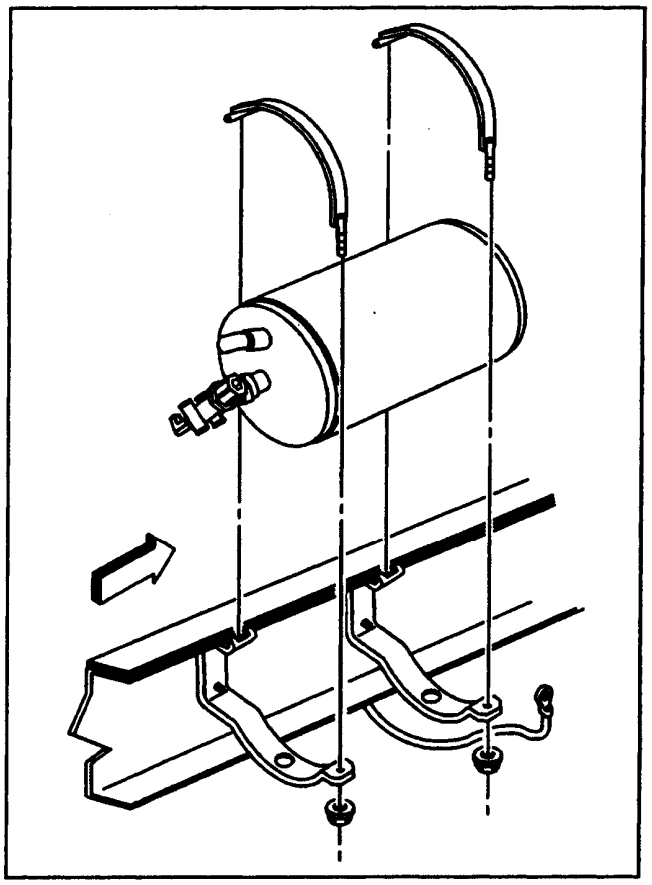
Installation Procedure

1. Install the trailer air brake dummy coupling to the trailer air brake coupling.
2. Install the following components:
   2.1. The bolt
   2.2. The washer
   Notice: Refer to *Fastener Notice.*
   2.3. The nut
   Tighten
   Tighten the nut to 30 N.m (22 lb ft).
3. Remove the wheel blocks.

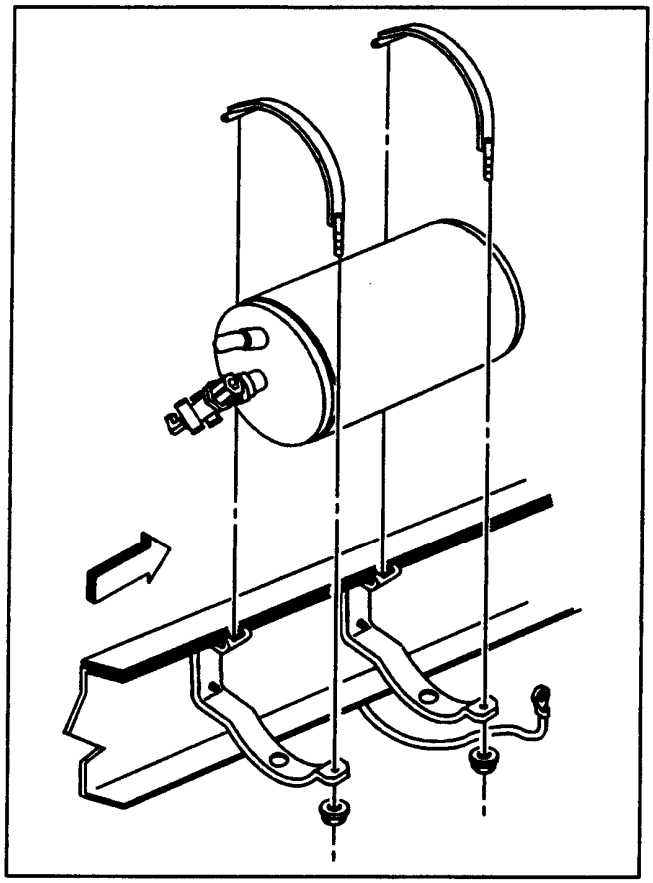
Reservoir Replacement (Supply)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all the reservoirs. Refer to *Draining Reservoirs.*
4. Remove the air lines. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
5. Remove the strap nuts.
6. Remove the straps from the air reservoir supports.
7. Remove the air reservoir.
8. Clean the air lines clean and the fittings with a dry cloth.
9. Clean the inside reservoir with steam or hot water.
10. Inspect the air lines for the following conditions:
    - Damage
    - Cracks
    - Bulges
    - Wear
11. Replace any damaged, cracked, bulged, or worn air lines.
12. Inspect the air reservoir for corrosion or damage. Replace the reservoir if weakened.
13. Inspect the air reservoir supports and inspect the straps for damage. Replace the supports and the straps as needed.



201630



201630

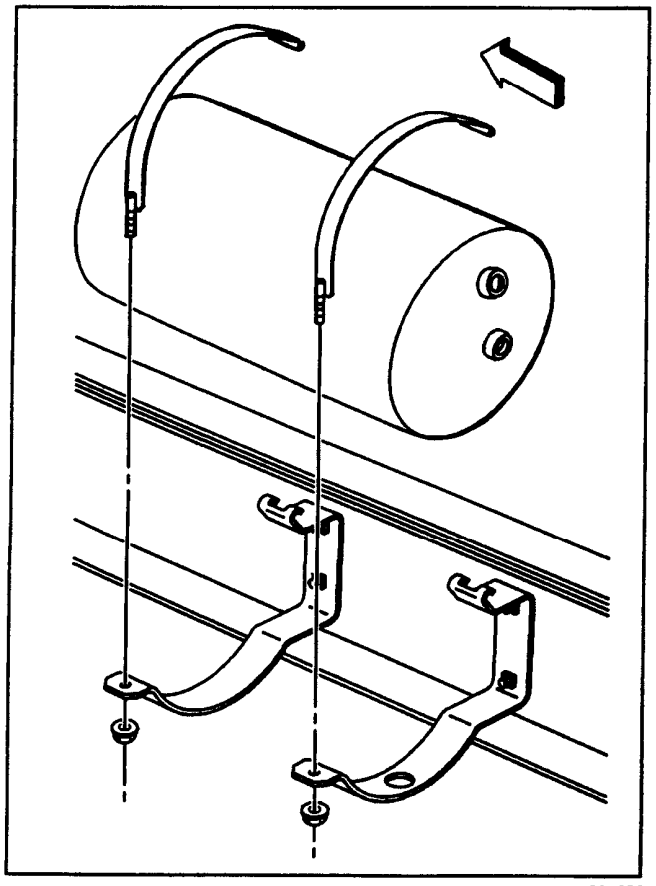
Installation Procedure

1. Install the air reservoir.
2. Install the straps to the air reservoir supports.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Install the strap nuts.

   Tighten

   Tighten the strap nuts to 23 N·m (17 lb ft).
4. Install the air lines.
5. Start the engine.
6. Charge the system air pressure to the governor cut-out point.
7. Check for leaks with a soap solution. Leakage is not permissible.
8. Test the brakes for proper operation.
9. Remove the wheel blocks.



201628

Reservoir Replacement (Front Service)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all the reservoirs. Refer to *Draining Reservoirs.*
4. Remove the air lines. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
5. Remove the strap nuts.
6. Remove the straps from the air reservoir supports.
7. Remove the air reservoir.
8. Clean the air lines clean and the fittings with a dry cloth.
9. Clean the inside reservoir with steam or hot water.

10. Inspect the air lines for the following conditions:
    - Damage
    - Cracks
    - Bulges
    - Wear
11. Replace any damaged, cracked, bulged, or worn air lines.
12. Inspect the air reservoir for corrosion or damage. Replace the reservoir if weakened.
13. Inspect the air reservoir supports and inspect the straps for damage. Replace as needed.

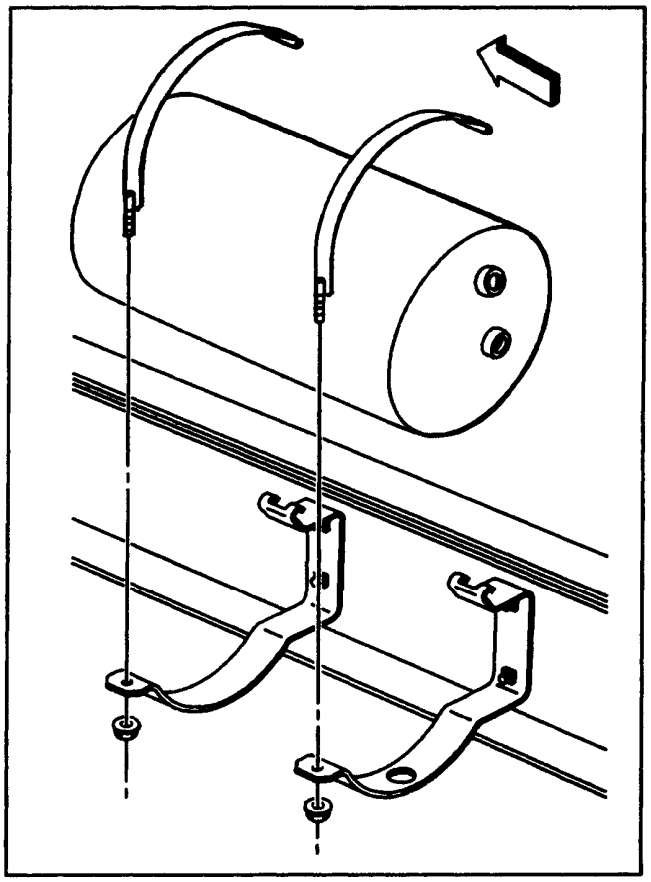
Installation Procedure

1. Install the air reservoir.
2. Install the straps to the air reservoir supports.

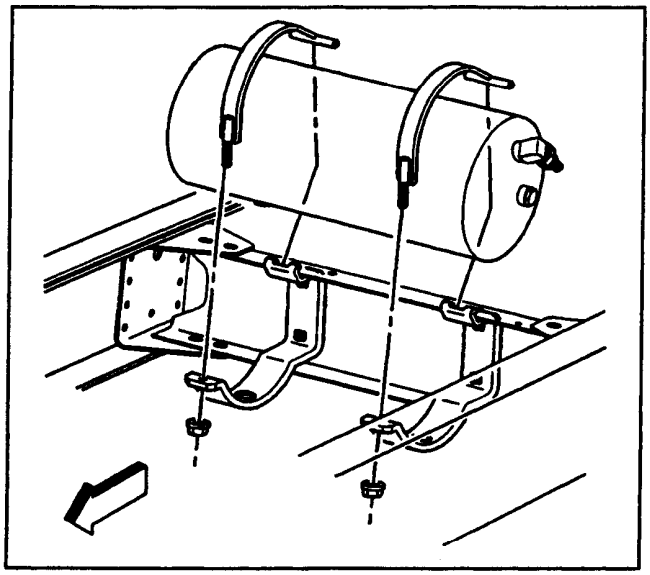
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Install the strap nuts.

   Tighten

   Tighten the strap nuts to 40 N·m (29 lb ft).
4. Install the air lines.
5. Start the engine.
6. Charge the system air pressure to the governor cut-out point.
7. Check for leaks with a soap solution. Leakage is not permissible.
8. Test the brakes for proper operation.
9. Remove the wheel blocks.



201628



201670

Reservoir Replacement (Truck Rear Service)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all the reservoirs. Refer to *Draining Reservoirs.*
4. Remove the air lines. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
5. Remove the strap nuts.
6. Remove the straps from the air reservoir supports.
7. Remove the air reservoir.
8. Clean the air lines clean and the fittings with a dry cloth.
9. Clean the inside reservoir with steam or hot water.
10. Inspect the air lines for the following conditions:
    - Damage
    - Cracks
    - Bulges
    - Wear
11. Replace any damaged, cracked, bulged, or worn air lines.
12. Inspect the air reservoir for corrosion or damage. Replace the reservoir if weakened.
13. Inspect the air reservoir supports and inspect the straps for damage. Replace the supports and the straps as needed.

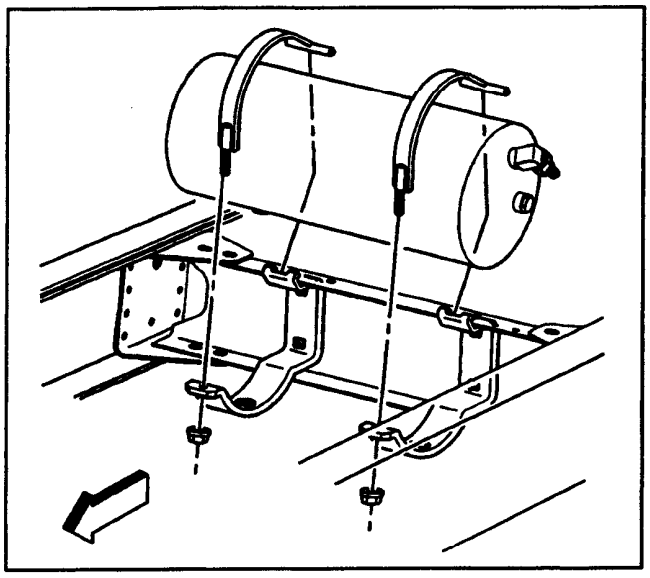
Installation Procedure

1. Install the air reservoir.
2. Install the straps to the air reservoir supports.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Install the strap nuts.

   Tighten

   Tighten the strap nuts to 23 N.m (17 lb ft).
4. Install the air lines.
5. Start the engine.
6. Charge the system air pressure to the governor cut-out point.
7. Check for leaks with a soap solution. Leakage is not permissible.
8. Test the brakes for proper operation.
9. Remove the wheel blocks.

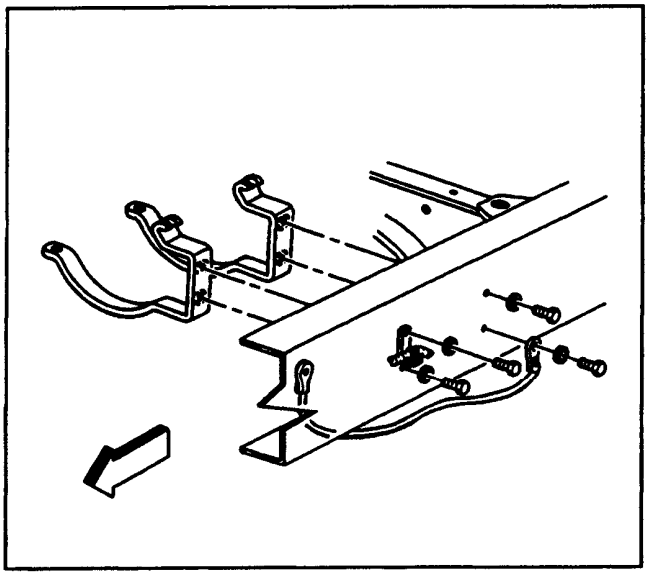


201670

Reservoir Support Replacement (Front Axle)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Remove the air reservoir. Refer to the following procedures:
   - *Reservoir Replacement (Supply)*
   - *Reservoir Replacement (Front Service)*
   - *Reservoir Replacement (Truck Rear Service)*
4. Remove the reservoir support bolts and the washers.
5. Remove the air reservoir supports.



201789

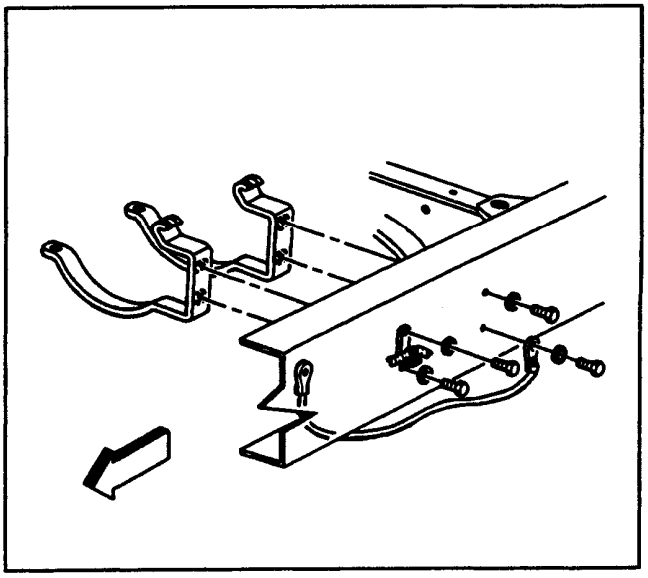
Installation Procedure

1. Install the air reservoir supports.

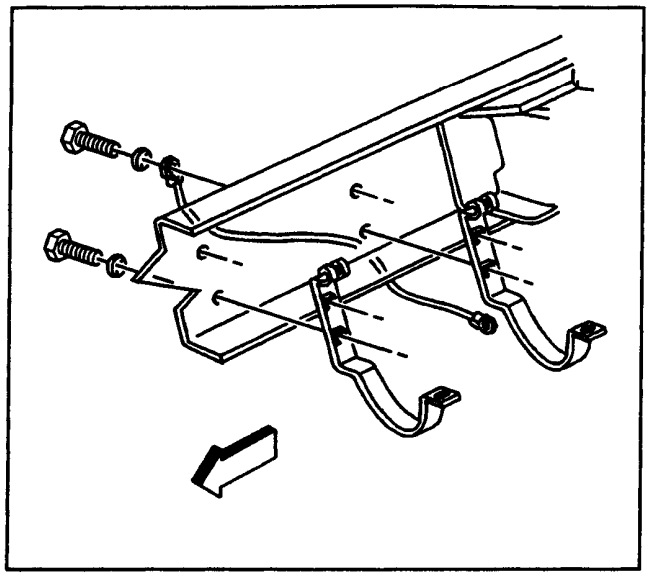
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the washers and bolts.

   Tighten

   Tighten the air reservoir support bolts to 53 N.m (39 lb ft).
3. Install the air reservoirs.



201789

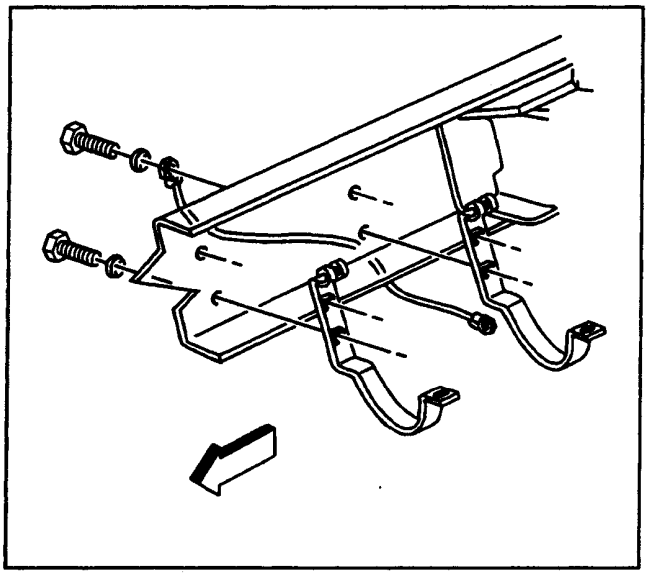


201794

Reservoir Support Replacement (Primary Air Brake)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Remove the air reservoir. Refer to the following procedures:
   - *Reservoir Replacement (Supply)*
   - *Reservoir Replacement (Front Service)*
   - *Reservoir Replacement (Truck Rear Service)*
4. Remove the reservoir support bolts and the washers.
5. Remove the air reservoir supports.



201794

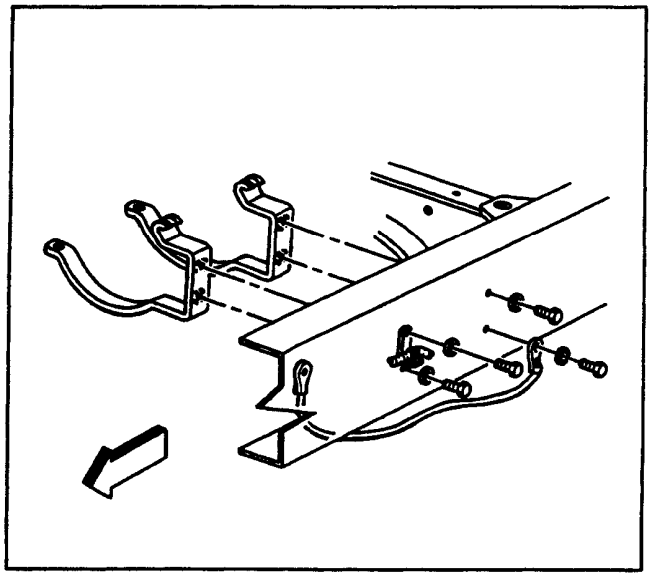
Installation Procedure

1. Install the air reservoir supports.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the washers and bolts.

   Tighten

   Tighten the air reservoir support bolts to 53 N·m (39 lb ft).
3. Install the air reservoirs.



201789

Reservoir Support Replacement (Rear Axle)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Remove the air reservoir. Refer to the following procedures:
   - *Reservoir Replacement (Supply)*
   - *Reservoir Replacement (Front Service)*
   - *Reservoir Replacement (Truck Rear Service)*
4. Remove the reservoir support bolts and the washers.
5. Remove the air reservoir supports.

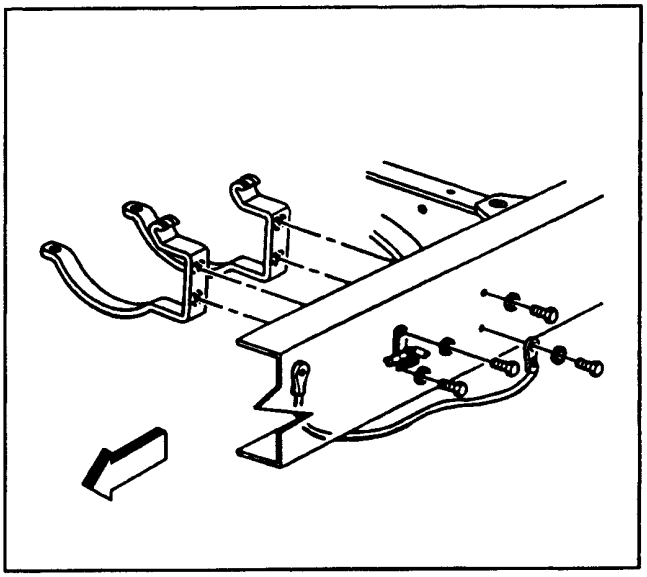
Installation Procedure

1. Install the air reservoir supports.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the washers and bolts.

   Tighten

   Tighten the air reservoir support bolts to 53 N.m (39 lb ft).
3. Install the air reservoirs.

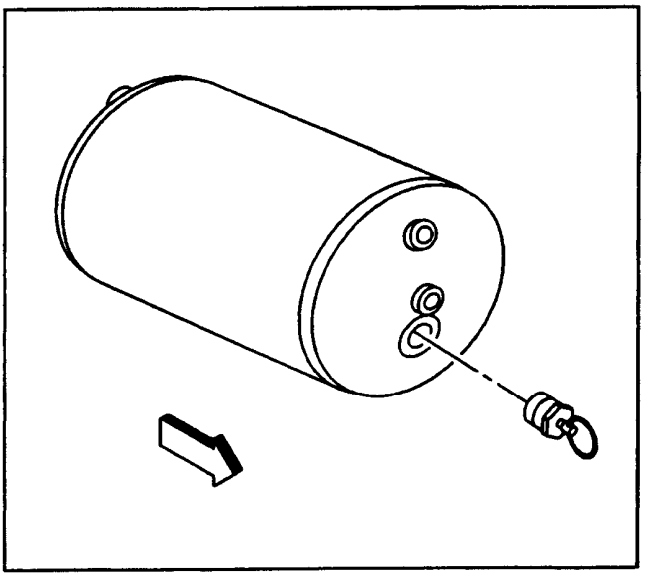


201789

Reservoir Drain Valve Replacement (Manual Type)

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all the reservoirs. Refer to *Draining Reservoirs.*
4. Remove the reservoir drain valve (manual type).



201690

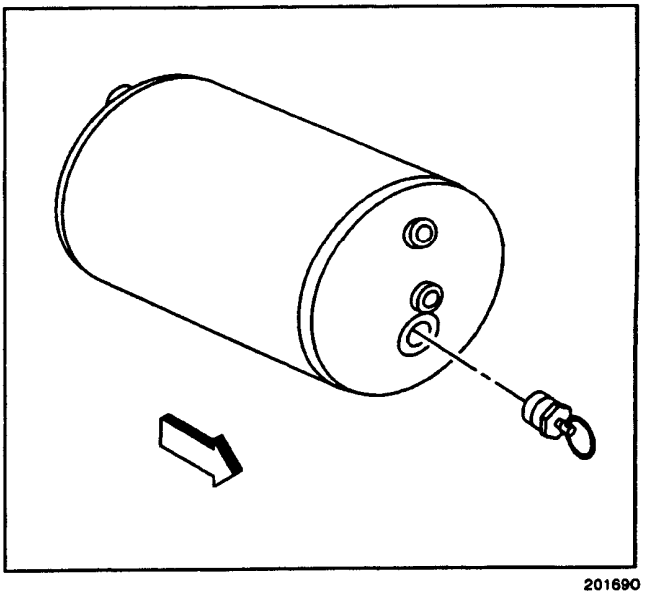
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

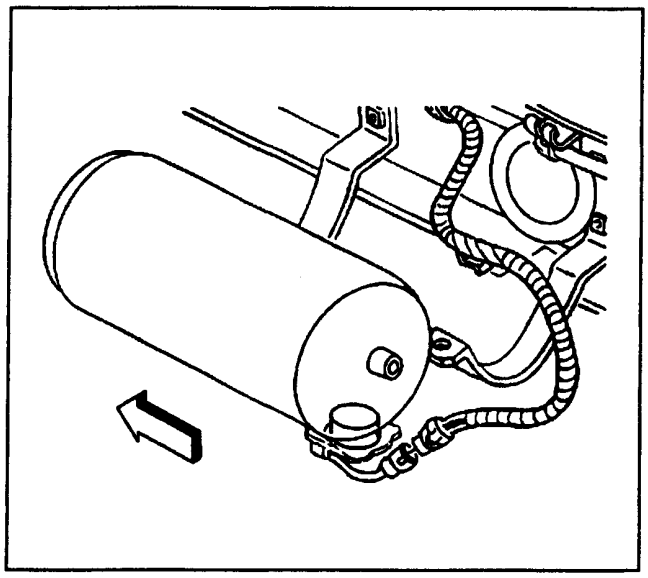
1. Install the reservoir drain valve (manual type).

   Tighten

   Tighten the primary air brake supply reservoir drain valve (manual type) to 50 N.m (37 lb ft).
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Check for leaks with a soap solution around the reservoir drain valve (manual type). Leakage is not permissible.
5. Remove the wheel blocks.



201690

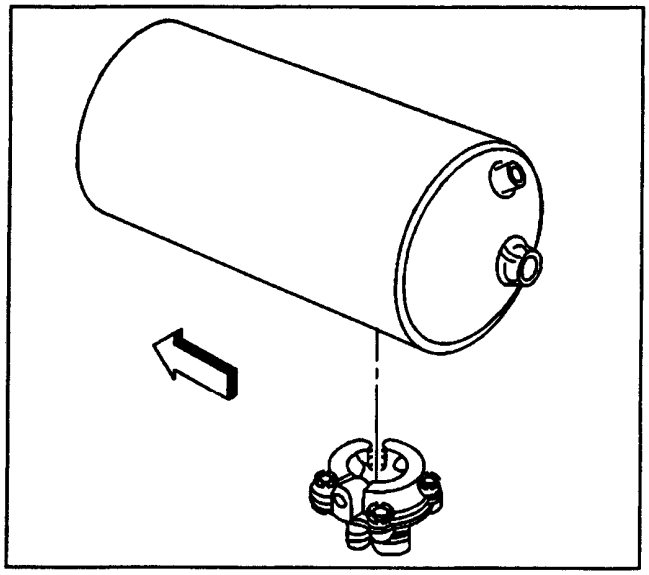


227919

Reservoir Drain Valve Replacement (Automatic Type)

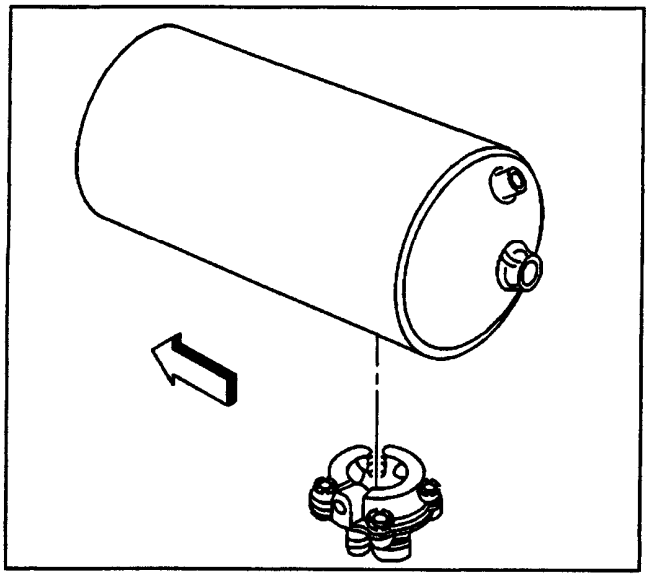
Removal Procedure

1. Block the wheels.
2. Drain all of the reservoirs. Refer to *Draining Reservoirs*.
3. Remove the reservoir drain valve (automatic type) wiring harness connector, if equipped.



227922

4. Remove the reservoir drain valve (automatic type).



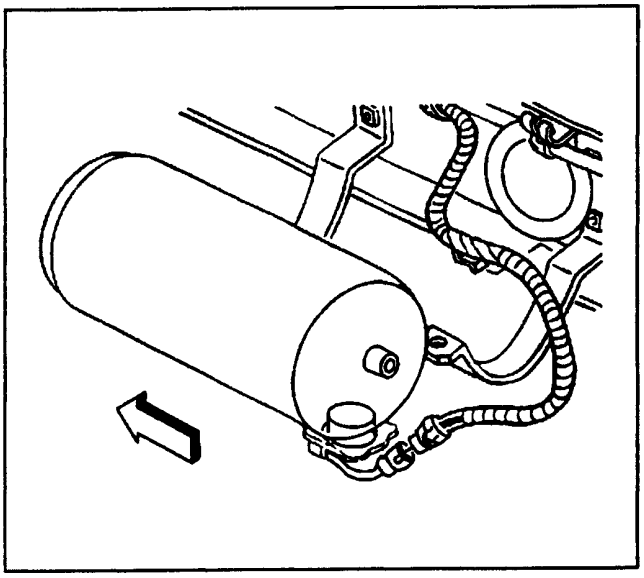
227922

Installation Procedure

Notice: Refer to *Fastener Notice* in Notices and Cautions.

1. Install the reservoir drain valve (automatic type).
   Tighten
   Tighten the reservoir drain valve (automatic type) to 50 N.m (37 lb ft).

2. Install the reservoir drain valve (automatic type) wiring harness connector, if equipped.
3. Perform the air leakage test. Refer to *Reservoir Drain Valve Test.*
4. Perform the operational test. Refer to *Reservoir Drain Valve Test.*

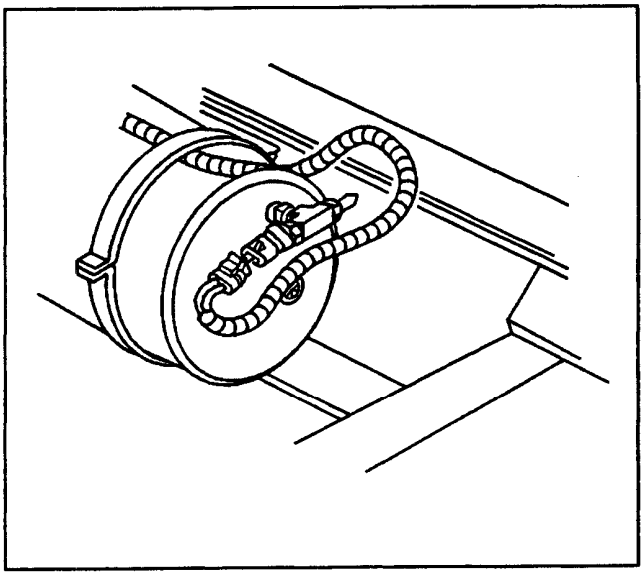


227919

Low Air Pressure Switch Replacement

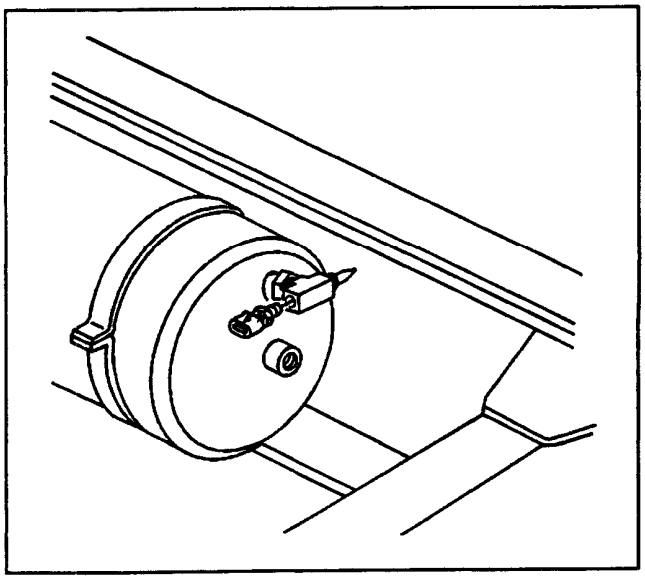
Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all the reservoirs. Refer to *Draining Reservoirs.*
4. Remove the wiring harness connector.

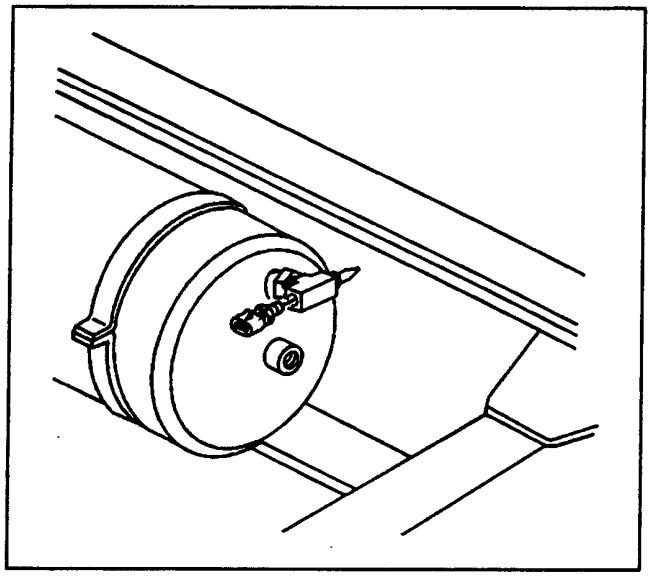


227835

5. Remove the low air pressure switch.



227841

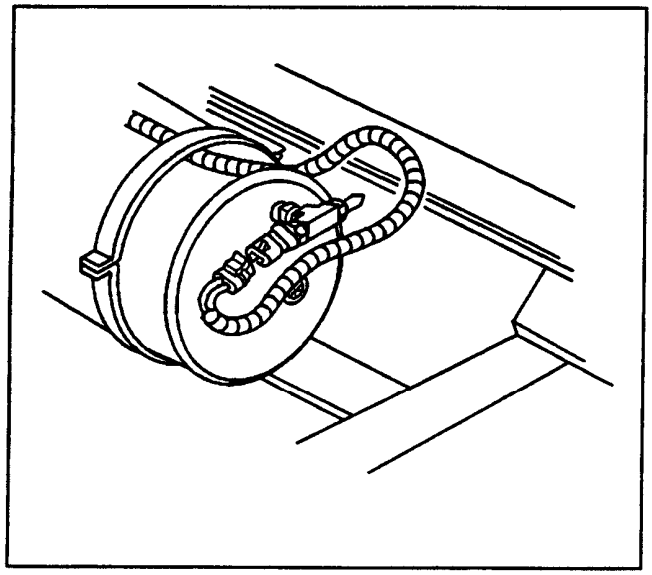


227841

Installation Procedure

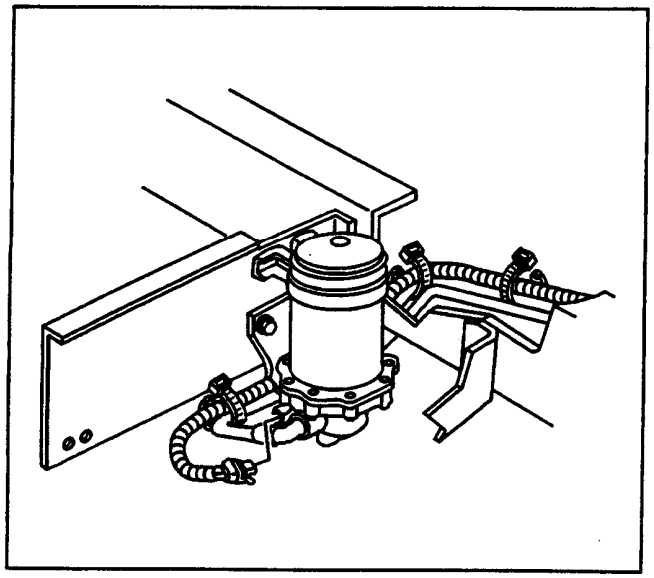
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the low air pressure switch.
   Tighten
   Tighten the low air pressure switch to 12 N·m (106 lb in).



227835

2. Install the wiring harness connector.
3. Start the engine.
4. Charge the system air pressure to the governor cut-out point.
5. Check for leaks with a soap solution around the low air pressure switch. Leakage is not permissible.
6. Check for proper operation. Refer to *Low Air Pressure Switch Diagnosis.*
7. Remove the wheel blocks.



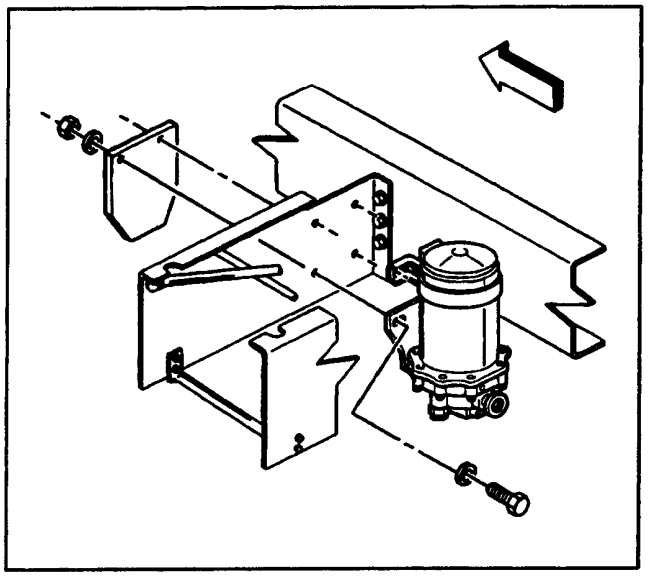
201587

Air Dryer Replacement

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain the reservoirs. Refer to *Draining Reservoirs.*
4. Remove the air lines.
5. Remove the wiring harness connector.

6. Remove the nuts, the washers, and the bolts.
7. Remove the air dryer.



201592

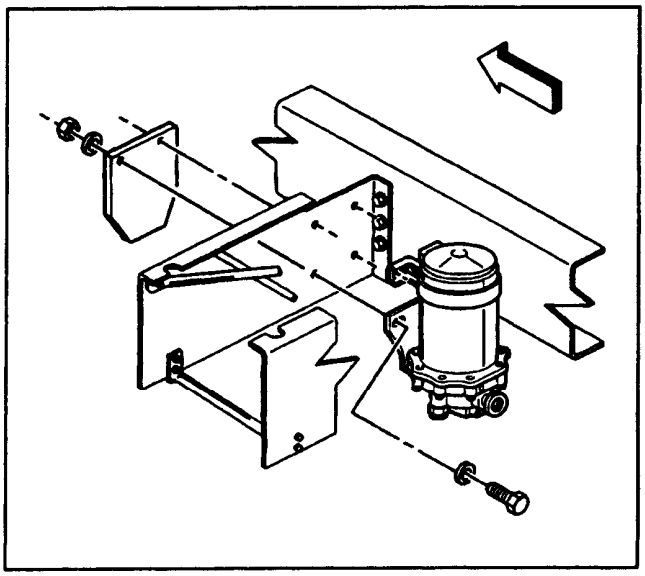
Installation Procedure

1. Install the air dryer.

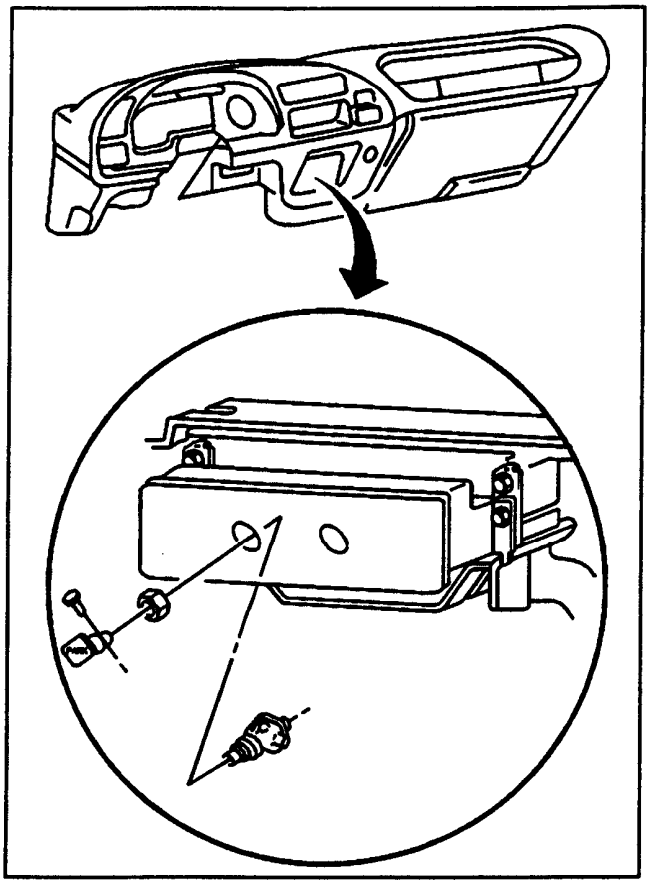
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers and the nuts.

   Tighten

   Tighten the air dryer nuts to 45 N.m (33 lb ft).
3. Install the air lines.
4. Start the engine.
5. Charge the system air pressure to the governor cut-out point.
6. Check for air leaks with a soap solution. Leakage is not permissible.
7. Check for the proper brake operation.
8. Remove the wheel blocks.



201592



227898

IP Mounted Air Brake Park Cont Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the air lines from the park control valve (cab mounted). Refer to the following procedures:

   Tag and label the air lines for later installation.
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
4. Remove the pin.
5. Remove the knob.
6. Remove the park control valve (cab mounted) nut.
7. Remove the park control valve (cab mounted).
8. Inspect the air lines for the following conditions. Repair or replace the lines as necessary.
   - Damage
   - Kinks
   - Wear

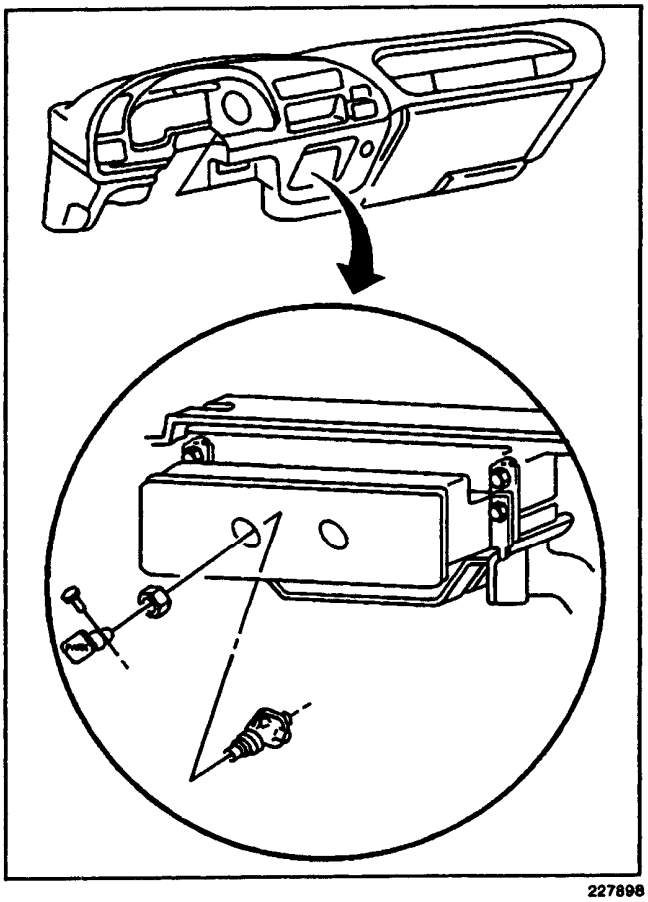
Installation Procedure

1. Install the park control valve (cab mounted).

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the park control valve (cab mounted) nut.

   Tighten

   Tighten the park control valve (cab mounted) nut to 6 N·m (53 lb in).
3. Install the knob.
4. Install the pin.
5. Install the air lines to the park control valve (cab mounted).
6. Perform the air leakage test. Refer to *IP Mounted Air Brake Park Control Valve Test (Leakage Test).*
7. Perform the operational test. Refer to *IP Mounted Air Brake Park Control Valve Test (Operational Check).*

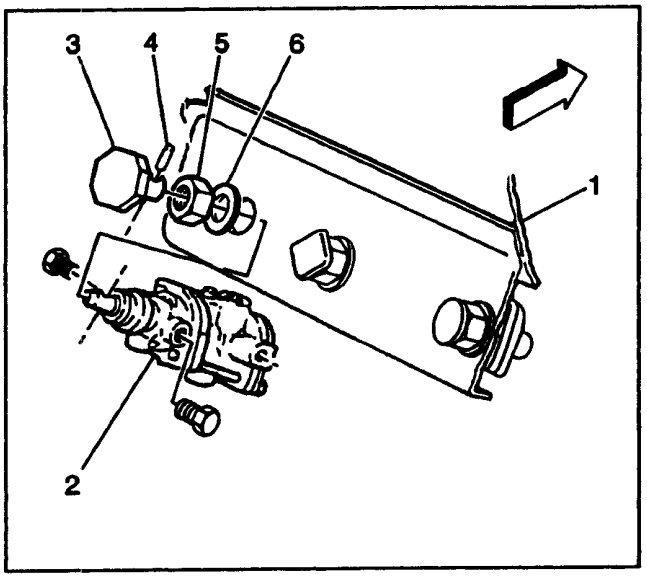


227898

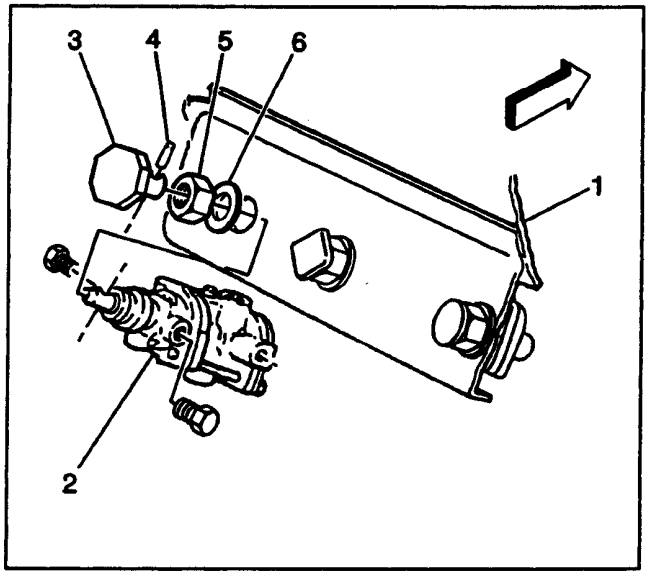
Trailer Brake Supply Valve Replacement

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all the reservoirs. Refer to *Draining Reservoirs.*
4. Disconnect the air lines from the valve.
5. Tag or label the air lines for later installation.
6. Remove the pin (4).
7. Remove the knob (3).
8. Remove the nut (5).
9. Remove the washer (6).
10. Remove the valve (2).
11. Inspect the air lines for damage or deterioration. Repair the air lines as needed.
12. Check the valve (2) for cracked, loose, or missing line clips or ties. Repair the line clips or the ties as needed.



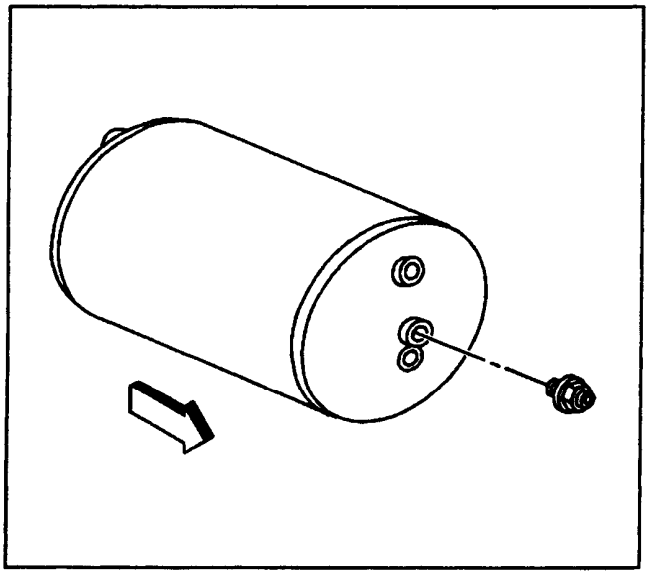
209561



209561

Installation Procedure

1. Install the valve (2).
2. Install the washer (6).
3. Install the nut (5).
4. Install the knob (3).
5. Install the pin (4).
6. Start the engine.
7. Charge the system air pressure to the governor cut-out point.
8. Stop the engine.
9. Check for air leaks using a soap solution.
10. Check for proper operation.
11. Remove the wheel blocks.

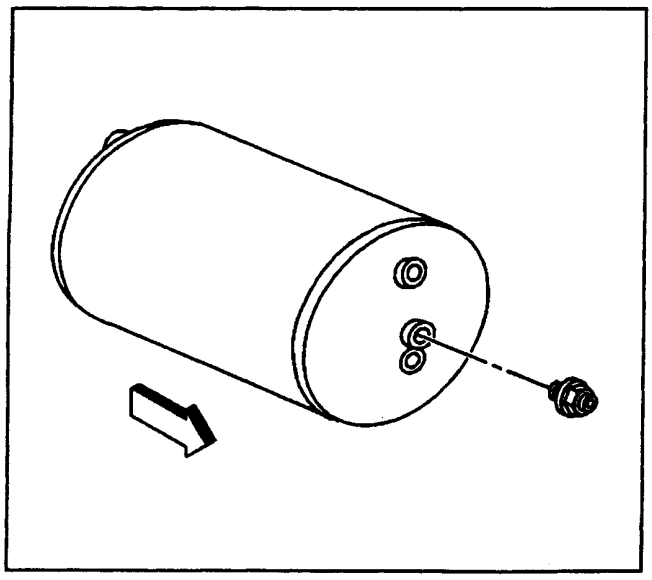


227901

Reservoir Check Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs*.
3. Remove the air line from the single check valve. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
4. Remove the single check valve.



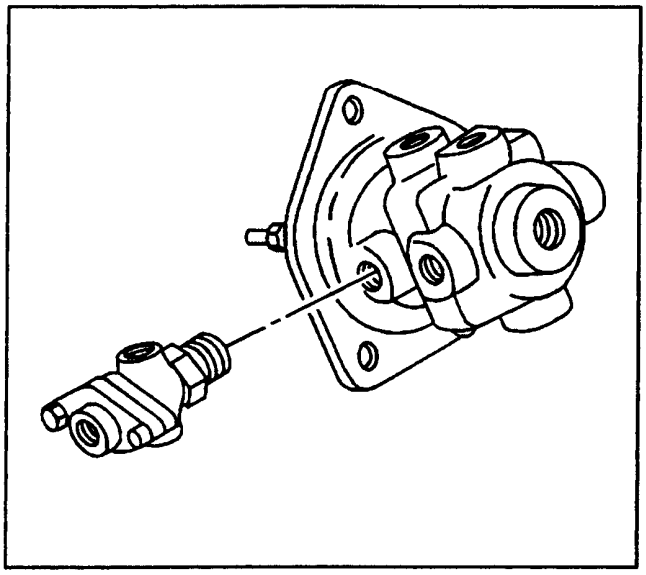
227901

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

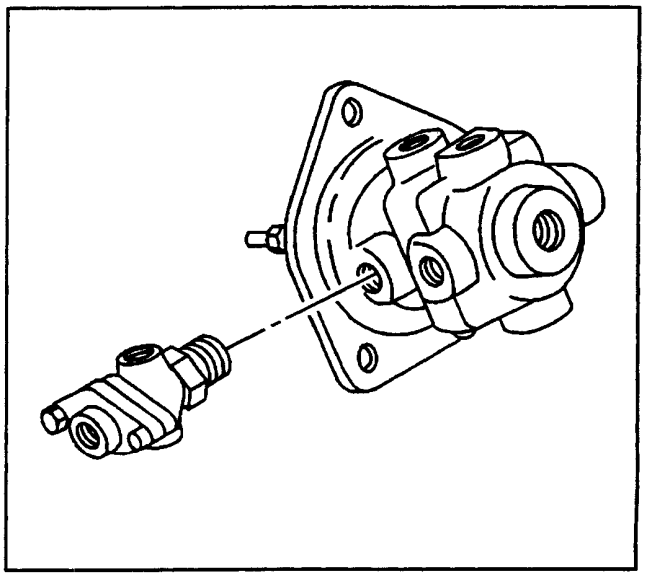
1. Install the single check valve.
   Tighten
   Tighten the single check valve to 50 N.m (37 lb ft).
2. Install the air line to the single check valve.
3. Perform the air leakage test. Refer to *Reservoir Check Valve Test (Leakage Test)*.
4. Perform the operational test. Refer to *Reservoir Check Valve Test (Operational Check)*.

Air Brake Double Check Valve Replacement


227905

Removal Procedure

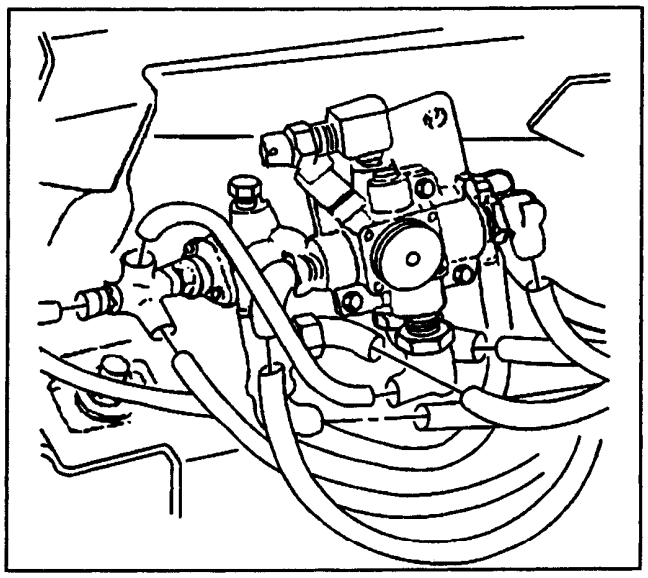
1. Block the wheels.
2. Tilt the cab. Refer to Cab Tilting in General Information.
3. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
4. Remove the upper inner fender panel. Refer to.
5. Remove the air lines from the double check valve. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
6. Remove the double check valve from the dual application valve.
7. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
8. Repair or replace the air lines as necessary.


227905

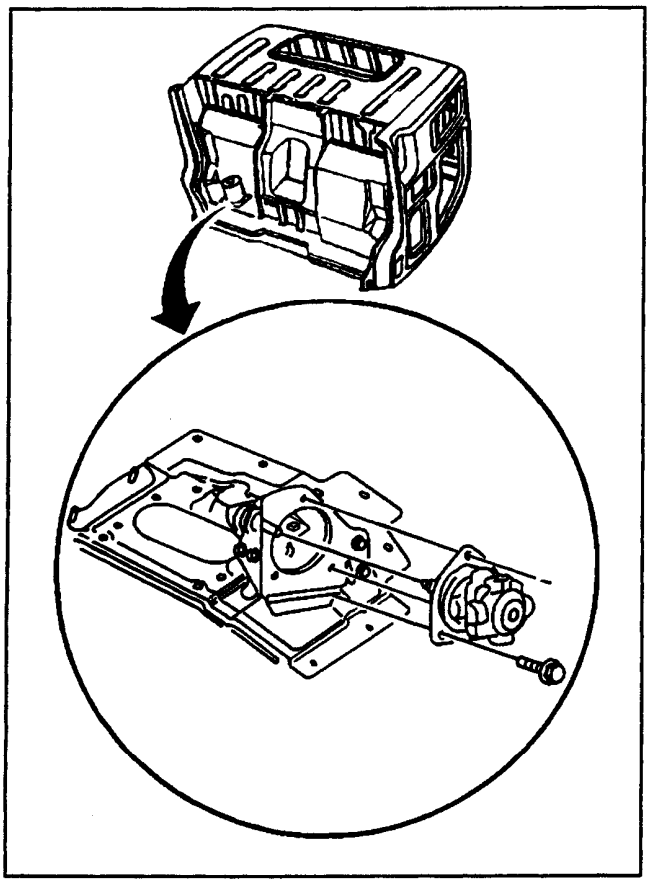
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the double check valve to the dual application valve.
   Tighten
   Tighten the double check valve to 28 N·m (21 lb ft).
2. Install the air lines to the double check valve.
3. Perform the air leakage test. Refer to *Air Brake Double Check Valve Test (Leakage Test).*
4. Perform the operational test. Refer to *Air Brake Double Check Valve Test (Operational Check).*
5. Install the upper inner fender panel.
6. Lower the cab.
7. Remove the wheel blocks.



227916



228756

Air Brake Application Valve Replacement

Removal Procedure

1. Block the wheels.
2. Tilt the cab. Refer to Cab Tilting in General Information.
3. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
4. Lift the inner fender panel.
5. Mark the air lines and connections in order to aid in installation.
6. Remove the wiring harness connector from the stoplamp switch.
7. Remove the air lines from the dual application valve.

   A double check valve and lines fittings are attached to the dual application valve. You can remove these fittings from the dual application valve or you can remove these fittings with the dual application valve as an assembly.
8. Remove the dual application valve mounting bolts.
9. Remove the dual application valve.
10. Inspect the air lines for the followings:
    - Damage
    - Kinks
    - Wear
11. Repair or replace the air lines as necessary.

Installation Procedure

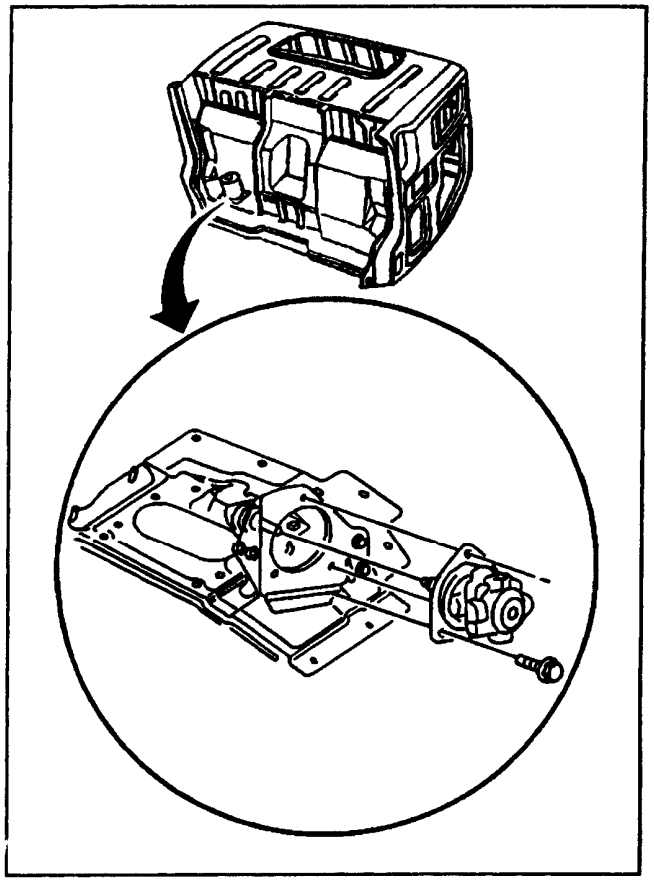
1. Install the dual application valve.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the dual application valve mounting bolts.

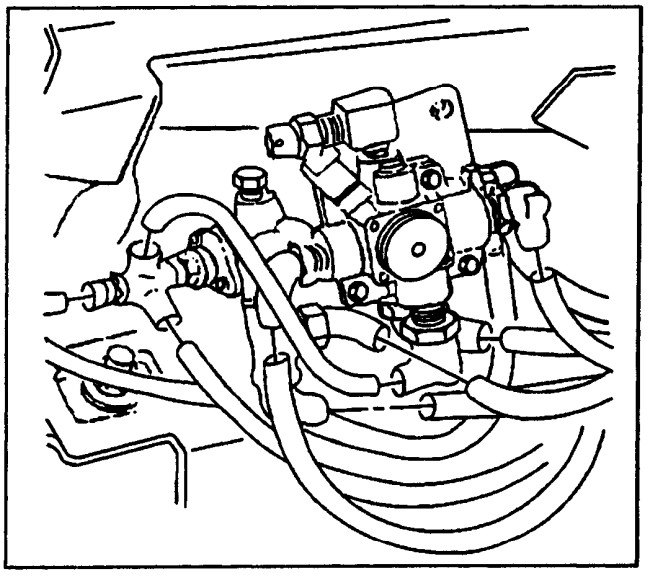
   Tighten

   Tighten the dual application mounting valves to 40 N·m (29 lb ft).

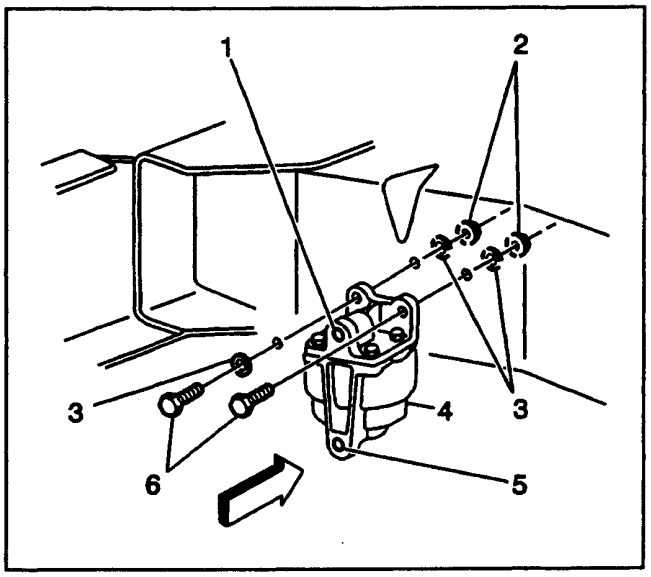


228756

3. Install the air lines to the dual application valve.
4. Check the brake pedal end play. Refer to Brake Pedal Replacement.
5. Perform the air leakage test. Refer to *Air Brake Application Valve Test (Leakage Test).*
6. Perform the operational test. Refer to *Air Brake Application Valve Test (Operational Check).*



227916

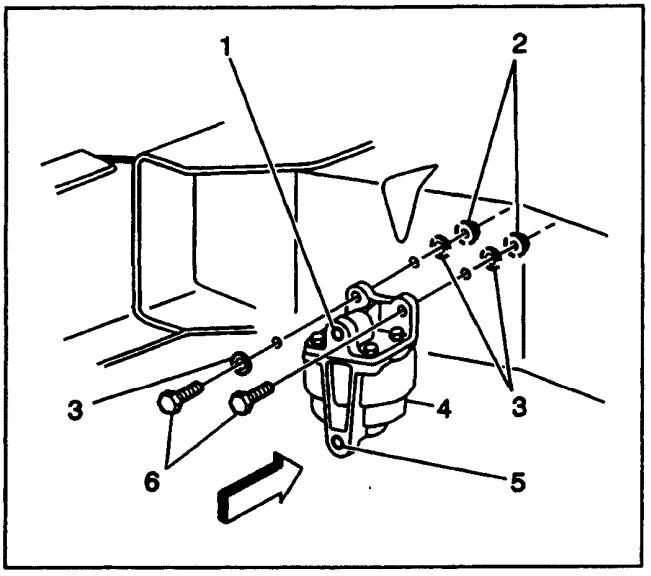


202582

Front Air Brake Limit Valve Replacement

Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all the reservoirs. Refer to *Draining Reservoirs*.
4. Disconnect the air lines at the valve (4).
5. Remove the mounting bolts (6).
6. Remove the washers (3).
7. Remove the nuts (2).
8. Remove the front axle limiting (ratio) valve (4).



202582

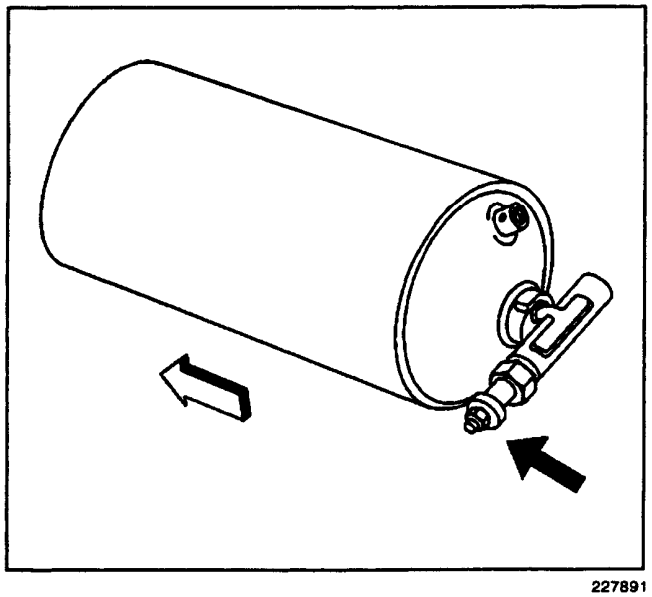
Installation Procedure

1. Install the front axle limiting (ratio) valve (4).
2. Install the bolts (6).
3. Install the washers (3).

   Notice: Refer to *Fastener Notice*
4. Install the nuts (2).

   Tighten

   Tighten the front axle limiting (ratio) valve nuts (2) to 22 N.m (16 lb ft).
5. Connect the air lines.
6. Start the engine.
7. Charge the system air pressure to the governor cut-out point.
8. Stop the engine.
9. Check for air leaks using a soap solution.
10. Check for proper operation.
11. Remove the wheel blocks.

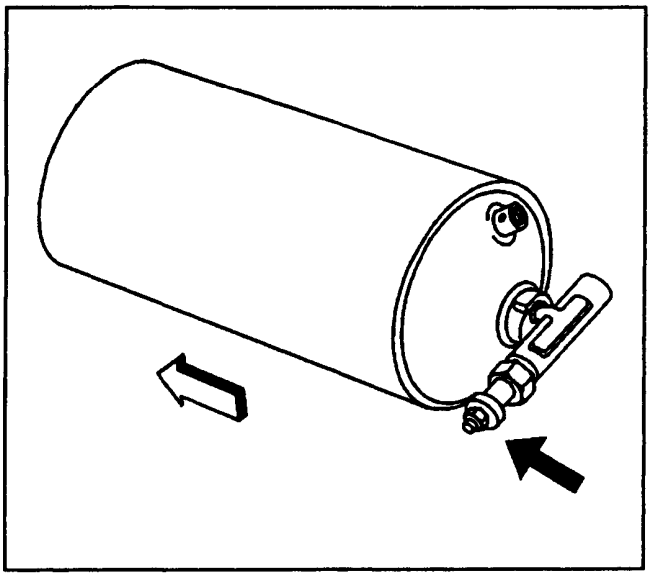


227891

Front Axle Serv Rsvr Air Supply Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs*.
3. Remove the inflation valve.



227891

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the inflation valve.
   Tighten
   Tighten the inflation valve to 20 N·m (15 lb ft). The exhaust port should point down and face the rear of the vehicle.
2. Perform the air leakage test. Refer to *Front Axle Serv Rsvr Air Supply Valve Test (Leakage Test).*
3. Perform the operational test. Refer to *Front Axle Serv Rsvr Air Supply Valve Test (Operational Check).*

Reservoir Drain Valve Replacement

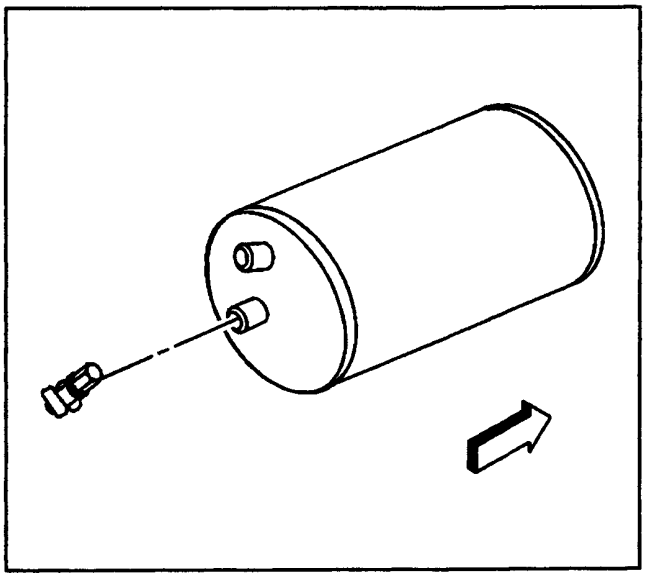
Removal Procedure

1. Apply the parking brake.
2. Block the wheels.
3. Drain all of the reservoirs. Refer to *Draining Reservoirs.*
4. Remove the reservoir drain valve (manual type).

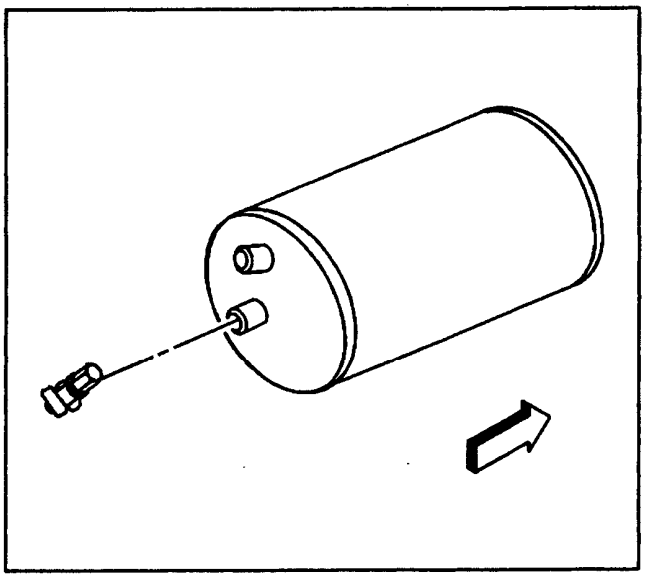
Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the reservoir drain valve (manual type).
   Tighten
   - Tighten the primary air brake supply reservoir drain valve (manual type) to 50 N·m (37 lb ft).
   - Tighten the front axle service reservoir drain valve (manual type) to 50 N·m (37 lb ft).
   - Tighten the rear axle service reservoir drain valve (manual type) to 50 N·m (37 lb ft).
2. Start the engine.
3. Charge the system air pressure to the governor cut-out point.
4. Inspect for leaks using a soap solution around the reservoir drain valve (manual type).
   No leakage is allowed.
5. Remove the wheel blocks.



227926



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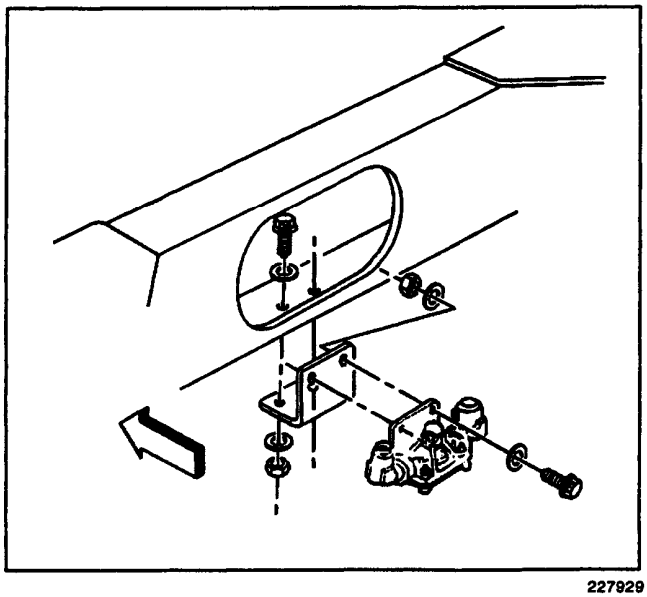


227929

Pressure Protection Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain all the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the air line from the pressure protection valve. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
4. Remove the pressure protection valve.

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the pressure protection valve.
   Tighten
   Tighten the pressure protection valve to 30 N.m (22 lb ft).
2. Install the air line to the pressure protection valve.
3. Perform the air leakage test. Refer to *Pressure Protection Valve Test (Leakage Test).*
4. Perform the operational test. Refer to *Pressure Protection Valve Test (Operational Check).*

Air Brake Quick Release Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
3. Tilt the cab. Refer to Cab Tilting in General Information.

4. Remove the air lines. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
5. Remove the nuts, the washers, and the bolts.
6. Remove the quick release valve from the bracket.
7. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
8. Repair or replace the air lines as necessary.

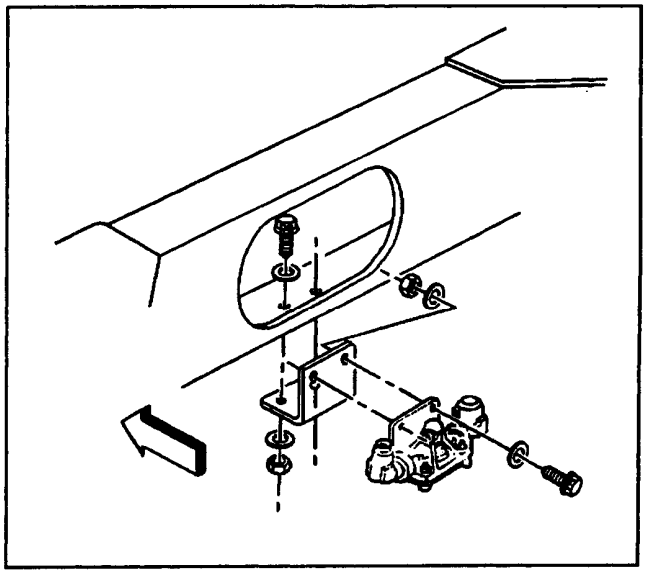
Installation Procedure

1. Install the quick release valve.

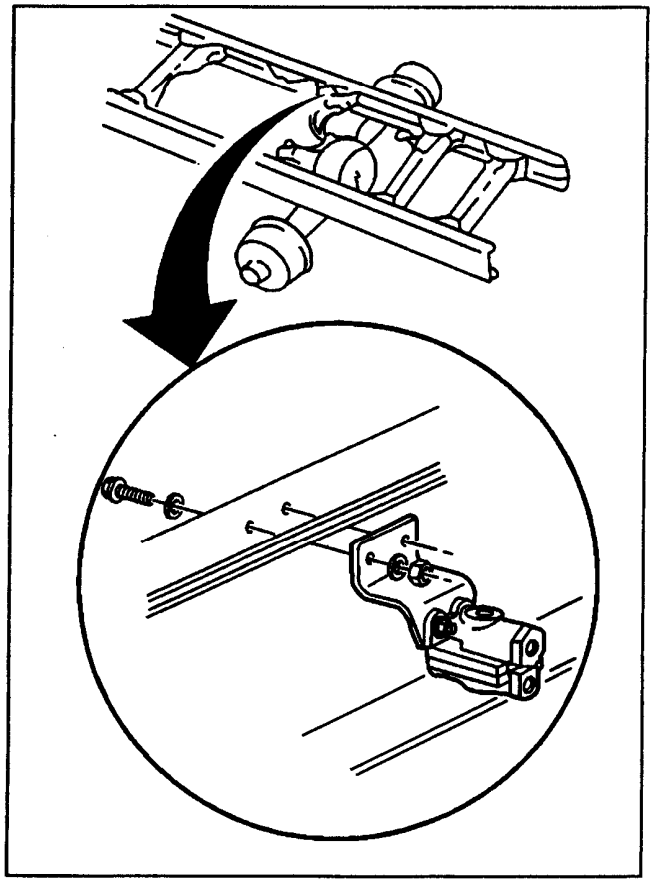
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers, and the nuts.

   Tighten

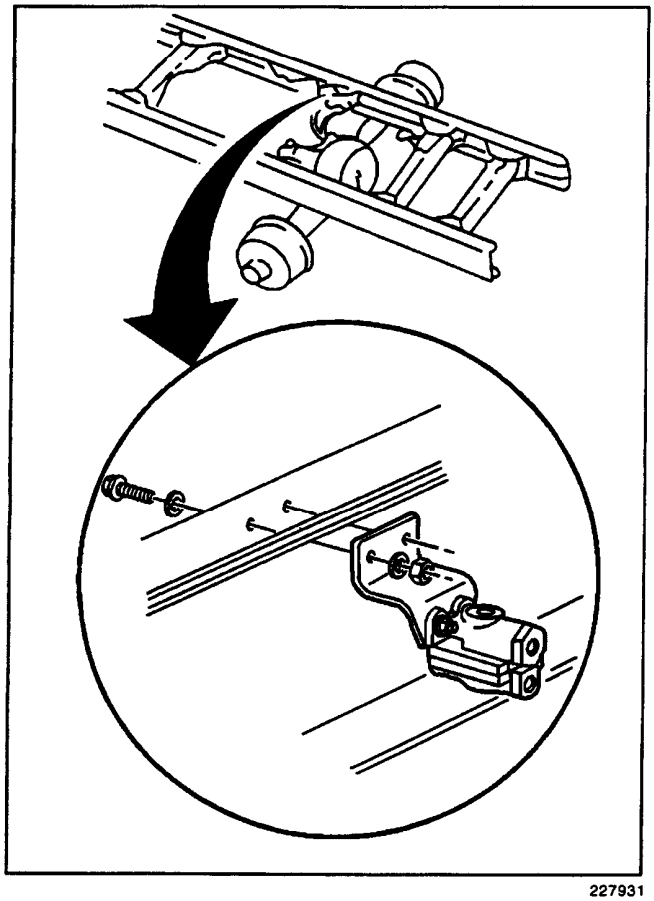
   Tighten the quick release valve nuts to 22 N.m (16 lb ft).
3. Install the air lines.
4. Perform the air leakage test. Refer to *Air Brake Quick Release Valve Test (Leakage Test).*
5. Perform the operational test. Refer to *Air Brake Quick Release Valve Test (Operational Check).*



227929



227931



227931

Air Brake Quick Rel Dbl Check Valve Replacement-RR

Removal Procedure

1. Block the vehicle wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the air lines from the quick release valve (double check type). Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
4. Remove the nuts, the washers, and the bolts.
5. Remove the quick release valve (double check type).
6. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
7. Repair or replace the air lines as necessary.

Installation Procedure

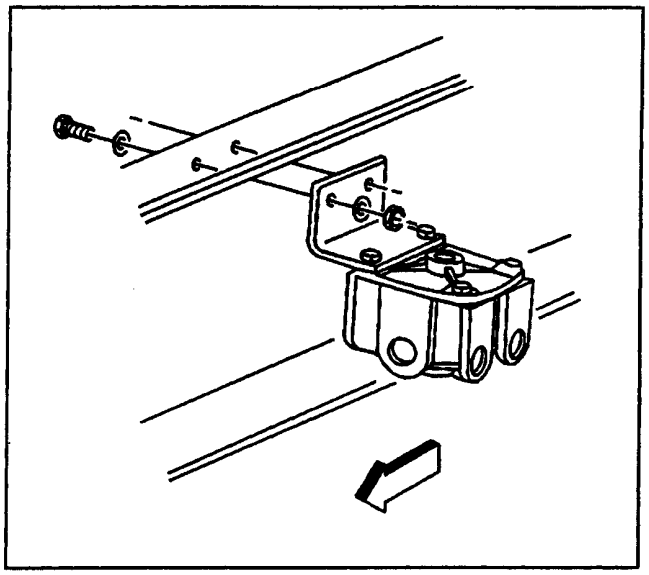
1. Install the quick release valve (double check type).

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers, and the nuts.

   Tighten

   Tighten the quick release valve (double check type) bolts to 52 N·m (38 lb ft).
3. Install the air lines to the quick release valve (double check type).
4. Perform the air leakage test. Refer to *Rear Air Brk Quick Release Double Check Valve Test (Leakage Test).*
5. Perform the operational test. Refer to *Rear Air Brk Quick Release Double Check Valve Test (Operational Check).*

Air Brake Relay Valve Replacement - Rear



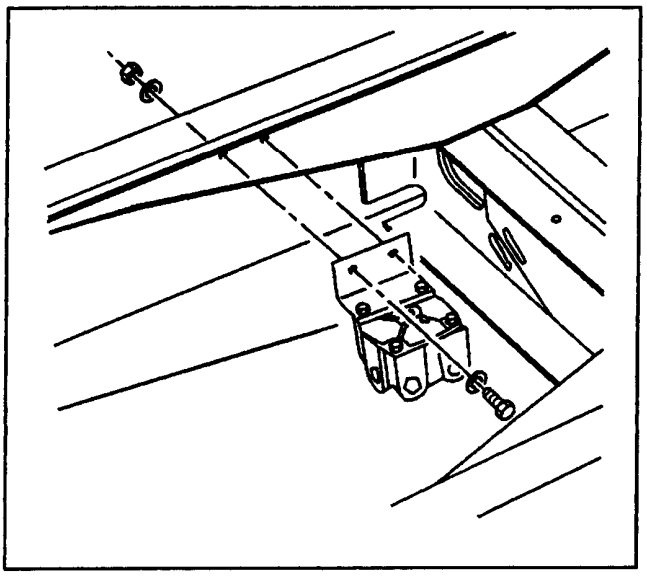
227932

Removal Procedure

1. Block the wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the air lines from the relay valve. Refer to the following procedures:

   Tag or label the air lines for installation.

   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
4. Remove the nuts, the washers, and the bolts.
5. Remove the relay valve.
6. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
7. Repair or replace the air lines as necessary.



227935

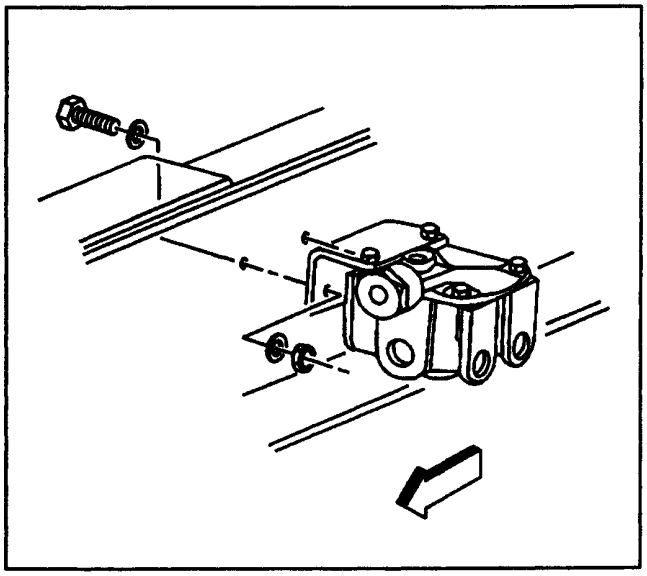
Installation Procedure

1. Install the relay valve to the bracket.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers, and the nuts.

   Tighten

   Tighten the relay valve bolts to 52 N.m (38 lb ft).
3. Install the air lines to the relay valve.
4. Perform the air leakage test. Refer to *Rear Air Brake Relay Valve Test (Leakage Test).*
5. Perform the operational test. Refer to *Rear Air Brake Relay Valve Test (Operational Check).*



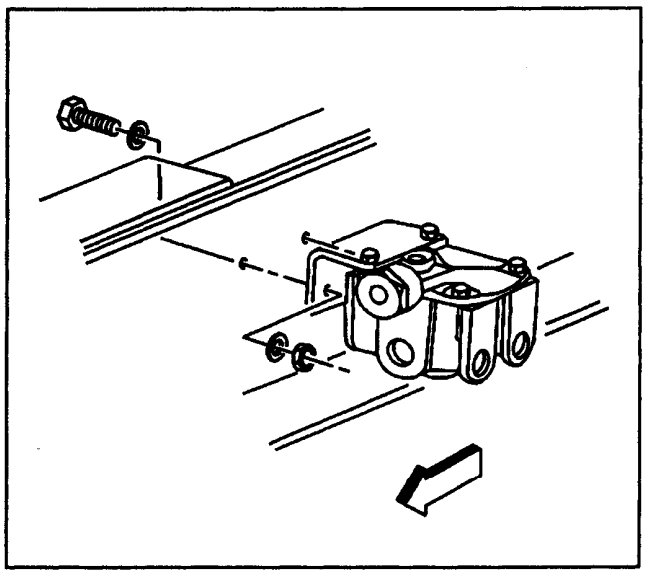
227936

Air Brake Relay Dbl Check Valve Replacement - Rear

Removal Procedure

1. Block the wheels.
2. Drain all of the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the air lines from the relay valve (double check type). Refer to the following procedures:

   Tag or label the lines for installation.
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacemen (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
4. Remove the nuts, the washers, and the bolts.
5. Remove the relay valve (double check type).
6. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
7. Repair or replace the air lines as necessary.



227936

Installation Procedure

1. Install the relay valve (double check type).

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers, and the nuts.

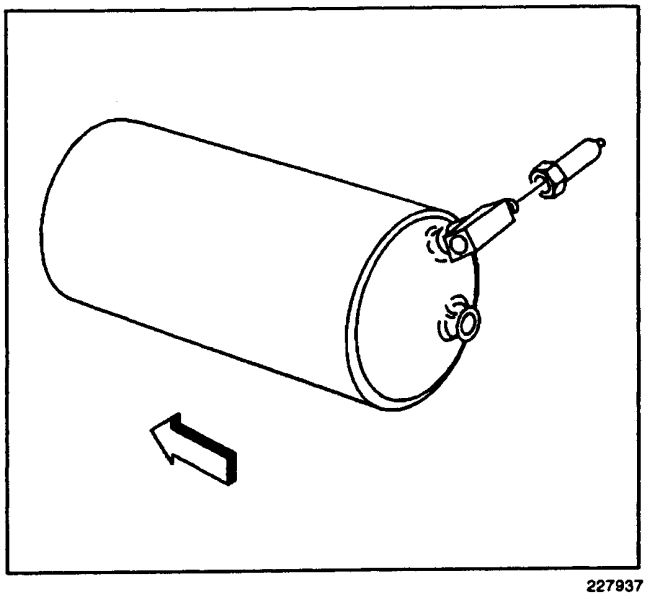
   Tighten

   Tighten the relay valve (double check type) bolts to 52 N.m (38 lb ft).
3. Install the air lines to the relay valve (double check type).
4. Perform the air leakage test. Refer to *Rear Air Brake Relay Double Check Valve Test (Leakage Test).*
5. Perform the operational test. Refer to *Rear Air Brake Relay Double Check Valve Test (Operational Check).*

Primary Air Brk Sply Rsvr Safety Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the safety valve.

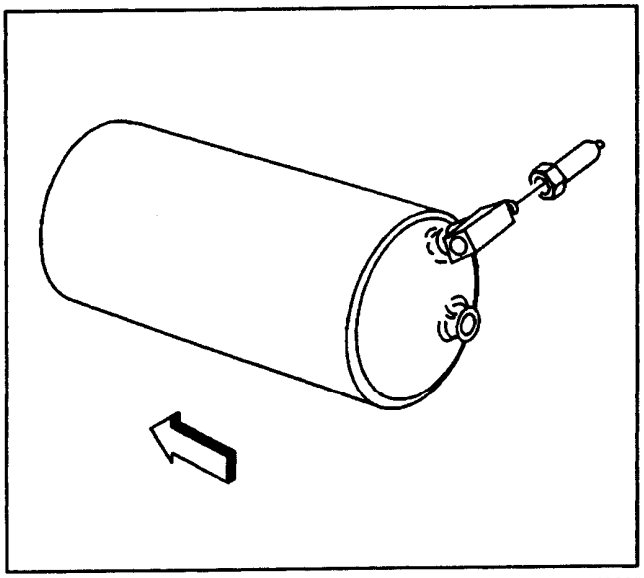


227937

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the safety valve.
   Tighten
   Tighten the safety valve to 30 N.m (22 lb ft).
2. Perform the air leakage test. Refer to *Primary Air Brake Supply Rsvr Safety Valve Test (Leakage Test).*
3. Perform the operational test. Refer to *Primary Air Brake Supply Rsvr Safety Valve Test (Operational Check).*

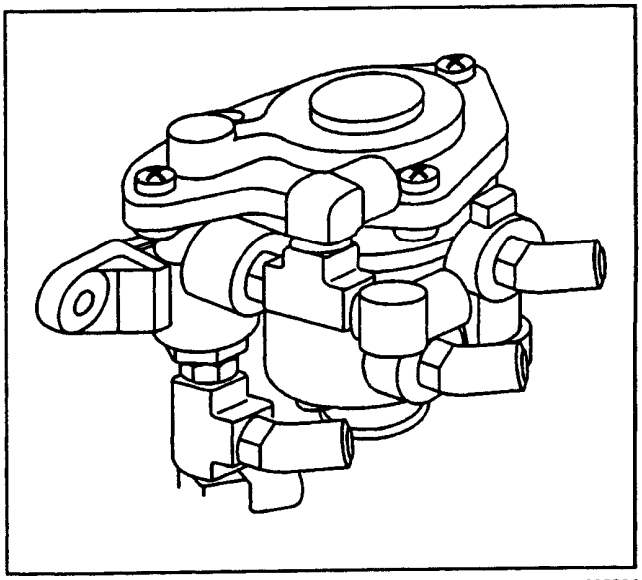


227937

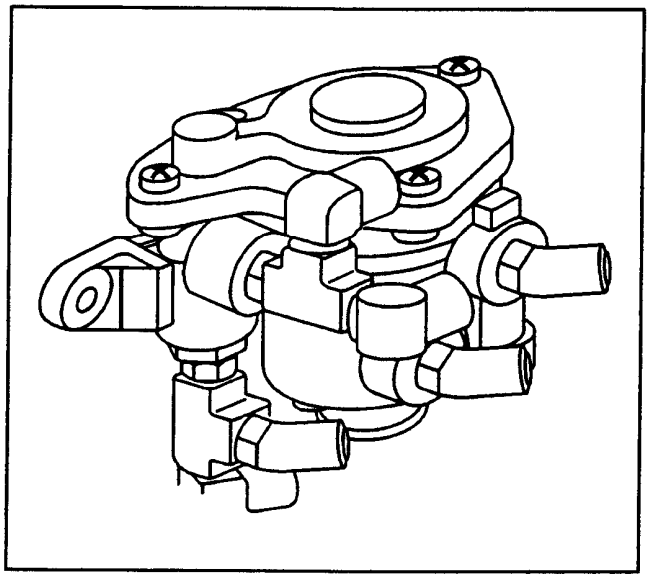
Chas Mount Air Brk Park Control Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the air lines from the valve. Refer to the following procedures:
   Tag or label the air lines for later installation.
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*



202326



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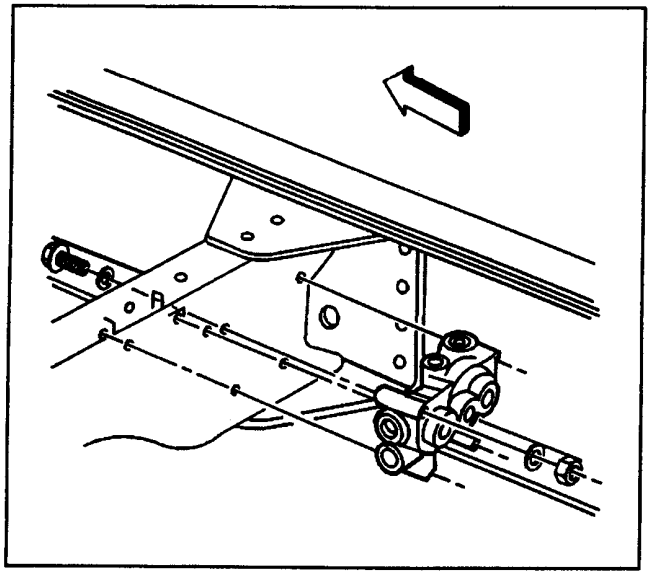


227940

4. Remove the nuts, the washers, and the bolts.
5. Remove the park control valve (chassis mounted) from the crossmember.
6. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
7. Replace or repair the air lines as necessary.

Installation Procedure

1. Install the park control valve (chassis mounted) to the crossmember.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers, and the nuts.
   Tighten

   Tighten the park control valve (chassis mounted) nuts to 22 N·m (16 lb ft).
3. Install the air lines to the park control valve (chassis mounted).
4. Perform the air leakage test. Refer to *Chassis Mounted Air Brake Park Control Valve Test (Leakage Test).*
5. Perform the operational test. Refer to *Chassis Mounted Air Brake Park Control Valve Test (Operational Check).*

Towing Vehicle Protection Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the air lines from the towing vehicle protection valve. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
4. Remove the nuts, the washers, and the bolts.
5. Remove the towing vehicle protection valve.
6. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
7. Replace or repair the air lines as necessary.

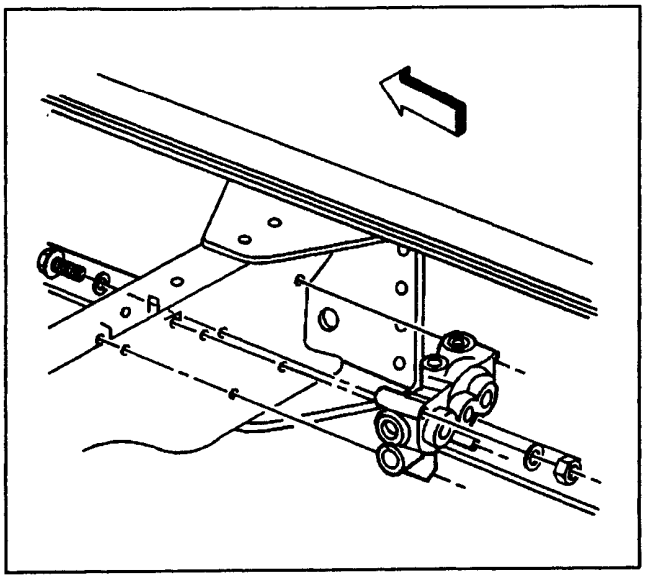
Installation Procedure

1. Install the towing vehicle protection valve.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers, and the nuts.

   Tighten

   Tighten the towing vehicle protection valve nuts to 22 N·m (16 lb ft).
3. Install the air lines to the towing vehicle protection valve.
4. Perform the air leakage test. Refer to *Towing Vehicle Protection Valve Test (Leakage Test).*
5. Perform the operational test. Refer to *Towing Vehicle Protection Valve Test (Operational Check).*



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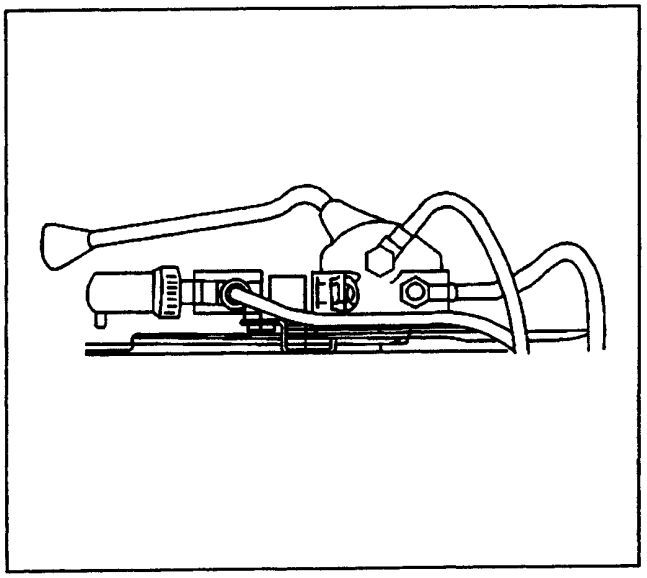
Trailer Brake Control Valve Replacement

Removal Procedure

1. Block the wheels.
2. Drain the air reservoirs. Refer to *Draining Reservoirs.*
3. Remove the console assembly.
4. Remove the air lines from the trailer air brake control valve. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
5. Remove the nuts, the washers, and the bolts.
6. Remove the trailer air brake control valve.
7. Inspect the air lines for the following:
   - Damage
   - Kinks
   - Wear
8. Replace or repair the air lines as necessary.



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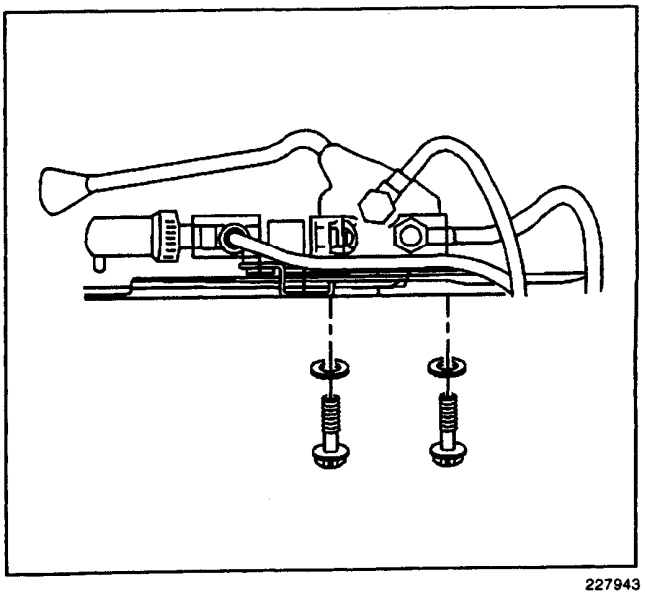

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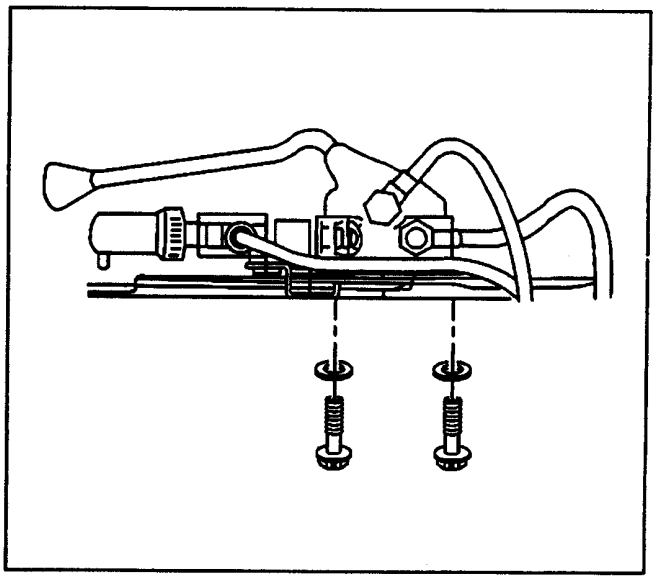

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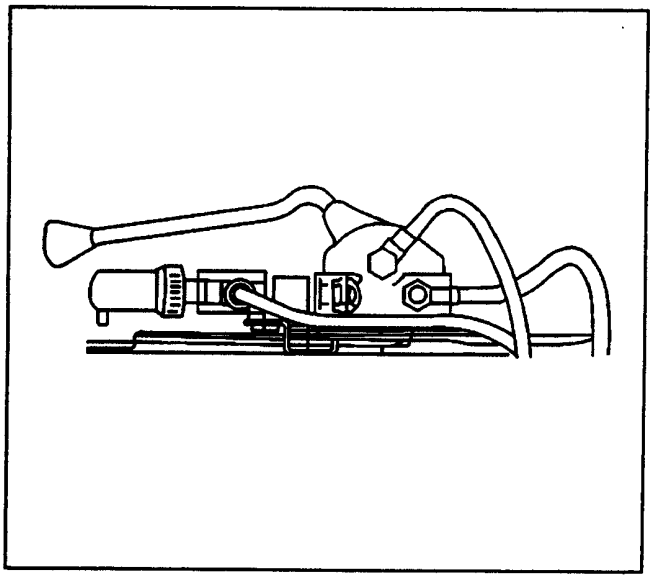

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Installation Procedure

1. Instal the trailer air brake control valve.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts, the washers, and the nuts.

   Tighten

   Tighten the trailer air brake control valve bolts to 40 N·m (29 lb ft).
3. Install the air lines to the trailer air brake control valve.
4. Perform the air leakage test. Refer to *Trailer Brake Control Valve Test (Leakage Test).*
5. Perform the operational test. Refer to *Trailer Brake Control Valve Test (Operational Check).*

Description and Operation

Air Brake System Description

The air brake valves include the following:

- Cab control valves
- Relay valves
- Automatic control valves
- Various safety valves

Air valves are pneumatic controls that route compressed air through hoses and lines to or from the air brake components. Air valves control the following:

- Service brake chambers
- Spring brake chamber assemblies
- Trailer supply
- Trailer service air lines

All air valves have air passages and internal moving parts. These moving parts direct the compressed air to the desired location. Each valve has the following components:

- At least one supply port to allow air to enter the valve
- One delivery port to allow air to exit the valve

Some valves have a control port that allows an air pressure source to control air flow through the valve. An exhaust port allows air to vent to the atmosphere. Some valves have special function control ports such as balance or reservoir ports. Refer to these valves for more discussion of the special ports.

Air brake valves operate either manually or automatically. Manual valves require the driver to move a knob, handle, or pedal in order to work the valve. Automatic valves use control ports or internal regulating parts in order to work.

Air Brake System Operation

The air brake system parts include the following:

- The air dryer
- The brake pedal
- The low air pressure switch
- The dual air pressure gauge
- Air lines
- Reservoirs
- Trailer air brake couplings
- A stoplamp switch
- The trailer air brake stoplamp switch

Air is supplied by a piston type air compressor. Refer to Air Compressor for on-vehicle service information of the air compressor equipment and controls.

Air flow is directed and controlled by air valves. Refer to specific portions of this section for on-vehicle service information of the air brake control valves.

The air foundation brakes are cam type. They are applied by the following:

- A camshaft
- A slack adjuster
- An air brake chamber

The parking brakes at the rear wheels are actuated by the spring brake chambers, which are controlled by the system park valve located in the cab. Refer to Air Compressor for on-vehicle service information of brake components located at the wheels.

Air Brake Component Description

Air Lines and Related Components

Notice: When replacing tubing, make sure that the tubing is free of burrs, cuttings, and dirt. While wearing safety glasses, use compressed air to blow out contaminants. Contaminants can destroy the air brake valve sealants.

The air lines deliver compressed air throughout the vehicle. The air lines are made from copper and nylon tubing.

Copper air lines consist of compression fittings with a diameter dimension of 19 mm (3/4 in).

Nylon air lines consist of push-in fittings in the following diameter dimensions:

- 4.8 mm (3/16 in)
- 6.4 mm (1/4 in)
- 9.5 mm (3/8 in)
- 12.7 mm (1/2 in)

The nylon air lines are color coded for system identification in the following ways:

Black: Accessory Equipment

Blue: Front System

Green: Rear System

Red: Parking Brake

Yellow: Trailer System

Blue: Trailer Supply

Nylon Air Lines

Notice: When replacing air lines connected to the push-in type fittings, be certain that the nylon air line is pushed-in and seated in the fitting. Install the tube into the fitting until no tube color is visible between the gauge band and the fitting. The air line may blow out if the tube is not properly seated in the fitting.

Notice: Nylon air line should be used to replace existing nylon lines only. Do not route nylon air lines in areas where temperatures could exceed 93°C (200°F). Damage to the nylon lines could occur.

All vehicles equipped with air brakes use a special push-in type fitting. These fittings are serviced as an assembly and should not be taken apart.

Flexible Hoses

Flexible hoses are used at the air brake chambers. These hoses connect the frame and axles with the trailer connections. Check the hoses for the following conditions:

- Chafed hoses
- Worn hoses
- Kinked flexible hoses

Replace the hoses as necessary.

Trailer and Brake Couplings
Vehicles equipped for trailer hauling have two flexible air lines that connect the truck or tractor and the trailer brake systems. One is the SERVICE air line and the other is the EMERGENCY air line. The EMERGENCY air line supplies constant air pressure to the trailer air system. The SERVICE air line delivers air to the trailer when braking is desired. Use either the foot brake pedal or the trailer brake control in order to apply the trailer brakes.

The flexible nylon air lines connect to the trailer through the couplings. When the couplings are connected, the pressure on two rubber gaskets makes an air-tight seal. Replace the rubber gaskets every 6 months. Uunder severe operating conditions, replace the gaskets more frequently.

The emergency coupling is located on the right side of the trailer air brake coupling hose bracket. This bracket is mounted on the cab and is tagged EMERGENCY. The service air line is located on the left side and is tagged SERVICE. When coupling the tractor and the trailer, connect the air lines properly. The corresponding couplings on the trailer are also tagged SERVICE and EMERGENCY.

Supporting Components
Maintain the following parts:

- Clips
- Ties
- Grommets
- Supporting brackets

Proper maintenance of these parts will prevent the following conditions:

- Unnecessary vibrations
- Loosening of the connections
- Separation of the connections

Check the air line routing and the support components regularly. Do not route the nylon lines near high heat sources such as the exhaust system.

Tabbed air line support brackets are used at some locations. A tab is positioned in a hole in the frame and retained with a single nut and bolt. The tab prevents the bracket from moving.

Use clamps on these brackets for holding bulky bundles of air lines and power cables. Verify that all clamps and brackets are be in place. Tighten all clamps and brackets securely.

The air line supports brace other components. Firmly mount the support in position. Do not allow the air lines to rub on the vehicle components.

The clamps and the band ties support and protect the air lines. Use the band ties in order to hold clusters of air lines and cables, when the use of clamps, brackets, or supports is not possible.

Heat Shields and Grommets
Grommets are used when air lines pass through frame members or sheet metal. The grommets prevent wear and cuts on the air lines. Check the grommets each time brake service is required. Components must be in good condition and must be mounted correctly. The grommets should not be torn or bent. Replace all missing or damaged grommets.

In order to protect the air lines from heat, reinstall any heat shields which you removed during service.

Notice: When replacing air lines connected to the push-in type fittings, be certain that the nylon air line is pushed-in and seated in the fitting. Install the tube into the fitting until no tube color is visible between the gauge band and the fitting. The air line may blow out if the tube is not properly seated in the fitting.

Notice: Nylon air line should be used to replace existing nylon lines only. Do not route nylon air lines in areas where temperatures could exceed 93°C (200°F). Damage to the nylon lines could occur.

All vehicles equipped with air brakes use a special push-in type fitting. These fittings are serviced as an assembly and should not be taken apart.

Air Brake Component Operation

Air Lines and Related Components
The air lines deliver the compressed air throughout the vehicle. The air lines are made from copper and nylon tubing. Fittings are 4.8 mm (3/16 in), 6.4 mm (1/4 in), 9.5 mm (3/8 in), 12.7 mm (1/3 in) diameter push-in type for all nylon air lines, and 19 mm (3/4 in) diameter compression fittings for copper air lines.

The nylon air lines are color coded for system identification in the following ways:

- Black — Accessory Equipment
- Blue — Front System
- Green — Rear System
- Red — Parking Brake
- Yellow — Trailer System
- Blue — Trailer Supply

Nylon Air Lines

Notice: Nylon air line should be used to replace existing nylon lines only. Do not route nylon air lines in areas where temperatures could exceed 93°C (200°F). Damage to the nylon lines could occur.

Notice: When replacing air lines connected to the push-in type fittings, be certain that the nylon air line is pushed-in and seated in the fitting. Install the tube into the fitting until no tube color is visible between the gauge band and the fitting. The air line may blow out if the tube is not properly seated in the fitting.

All vehicles equipped with air brakes use a special push-in type fitting. These fittings are serviced as an assembly and should not be taken apart.

Flexible Hoses
Flexible hoses are used at the air brake chambers, between the frame and axles, and the trailer connections. Any chafed, worn, or kinked flexible hoses must be replaced.

Supporting Components

Maintain all air line clips, ties, grommets and supporting brackets to prevent unnecessary vibrations, and the loosening or separation of connections. Check the air line routing and support the components regularly. Do not route the nylon lines near high heat sources such as the exhaust system.

Tabbed air line support brackets are used at some locations. A tab is positioned in a hole in the frame and retained with a single nut and bolt. The tab prevents the bracket from moving.

Use clamps on these brackets for holding the air line and power cable bundles. All clamps and brackets must be in place and tightened securely.

The air line supports support other components. Firmly mount the support in position. Do not allow the air lines to rub on the vehicle components.

The clamps and the band ties support and protect the air lines. Use the band ties to hold clusters of air lines and cables where it is not possible to use clamps, brackets or supports.

Heat Shields and Grommets

Grommets are used when air lines pass through frame members or sheet metal. The grommets prevent wear and cuts on the air lines. Check the grommets each time brake service is required. Components must be in good condition and mounted correctly. The grommets should not be torn or bent. Replace the grommets if they are missing or damaged.

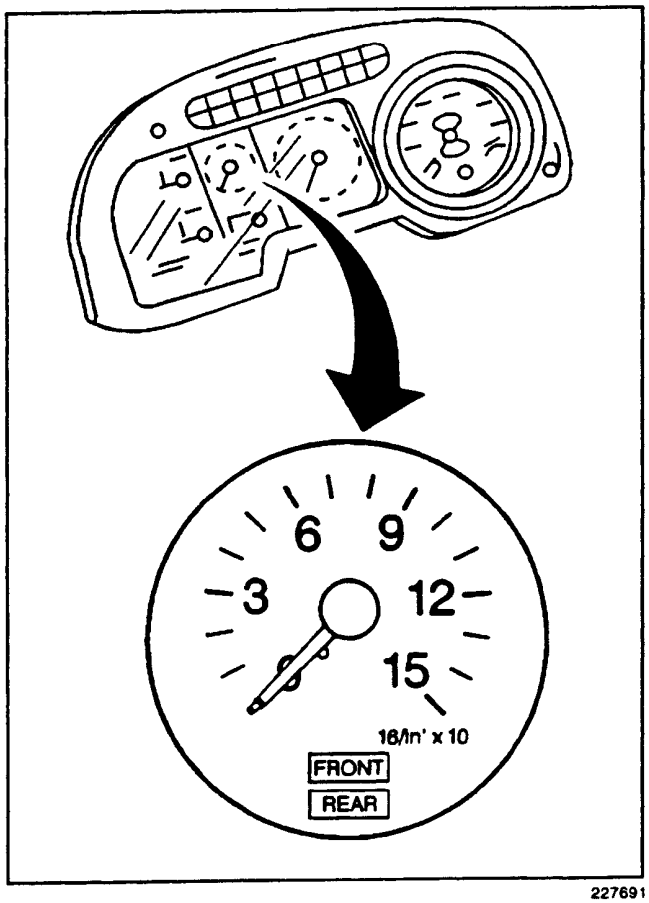
Any heat shields removed during service must be installed to protect the air lines from heat.

Reservoirs

Air reservoirs are the holding tanks for their respective systems. Each service system is a complete and separate air system. The service reservoirs isolate the front and the rear air brake systems. A front axle service reservoir stores compressed air for the front brakes. The rear service reservoirs store compressed air for the rear brakes. There is often more than 1 rear service reservoir. An in-line check valve at the inlet to each service reservoir prevents an air pressure loss from the service brakes if there is a leak in the supply air reservoir or the compressor discharge line. The service reservoirs are sometimes called dry tanks. The operator controls the air flow in both systems through a dual application valve.

The air supply reservoir holds heated air from the air compressor. As the air cools, water and contaminants collect in the supply reservoir. Drain this water at least once a day, unless the vehicle is equipped with an optional reservoir drain valve (automatic type).

Dual Air Pressure Gauge



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The dual air pressure gauge located in the instrument panel indicates the front and rear service system air pressures. Do not drive the vehicle when the front or rear gauge readings are below 450 kPa (65 psi). Check the dual air pressure gauge regularly with an accurate test gauge. Replace the dual air pressure gauge when the pressure reading varies by more than 27 kPa (4 psi), and there are no air leaks in the dual air pressure gauge circuit.

The dual air pressure gauge has 2 needles in contrasting colors. These needles show the front axle service and the rear axle service brake system air pressure. The dual air pressure gauge dial is marked from 0 to 15. Multiply the reading by 10 for the amount of psi.

The air pressure from the front and rear air brake systems is brought to the dual air pressure gauge through 2 nylon air lines. The 2 nylon air lines are routed from the instrument panel, through the floor, to the dual application valve. Inside the dual air pressure gauge, each nylon air line connects to a flattened, curved tube that straightens under internal pressure. The indicator needles are linked to the tubes and react to movement to indicate the air pressure.

Low Air Pressure Switch

The low air pressure switch is an air-controlled electrical switch that controls a cab tone alarm and warning light.

The low air pressure switch has a nominal pressure setting of 470 to 510 kPa (68 to 74 psi). If the low air pressure switch fails, replace the switch.

Air Brake Dryer System Description

The Bendix® AD-9 air brake dryer is a desiccant type (moisture absorbing) air dryer. The dryer consists of a die cast aluminum end cover secured to a cylindrical steel outer shell with eight cap screws and nuts. The end cover contains the following:

- A discharge check valve assembly
- A safety valve
- A purge valve housing assembly, which includes the following:
  - The heater
  - The thermostat assembly

The air brake dryer has three female pipe thread air connections. The ports and connections are identified as follows:

Air Brake Dryer System Description

Port Identification	Function/Connection
CON	Control Port (purge valve control and turbo cutoff)
SUP/11	Supply Port (air in)
DEL/2	Delivery Port (air out)

Air Brake Dryer System Operation

In the charge cycle, the compressed air flows into the air brake dryer through the supply port (SUP/11) where baffles change the direction of the air flow several times. This constant changing of air flow reduces the temperature and allows the contaminants to condense and drop to the bottom of the air brake dryer end cover. The air is then directed through a desiccant cartridge, where water, oil, and other contaminants first flow through an oil separator. The separator removes the water in liquid form as well as oil, oil vapor, and solid contaminates. Air then exits the oil separator and flows through the column of desiccant. The air becomes progressively dryer. The majority of the dry air exits through the internal check valve into the delivery port (DEL/2) and out to the supply reservoir.

In the purge cycle, the air compressor unloader port is connected to the air brake dryer control port (CON) which opens the purge valve in the bottom of the air brake dryer. This allows the water and contaminants to exit through the exhaust post in the bottom. Contaminants are blown out by air stored in the air brake dryer housing during the charge cycle. The complete purge cycle takes about 15–30 seconds.

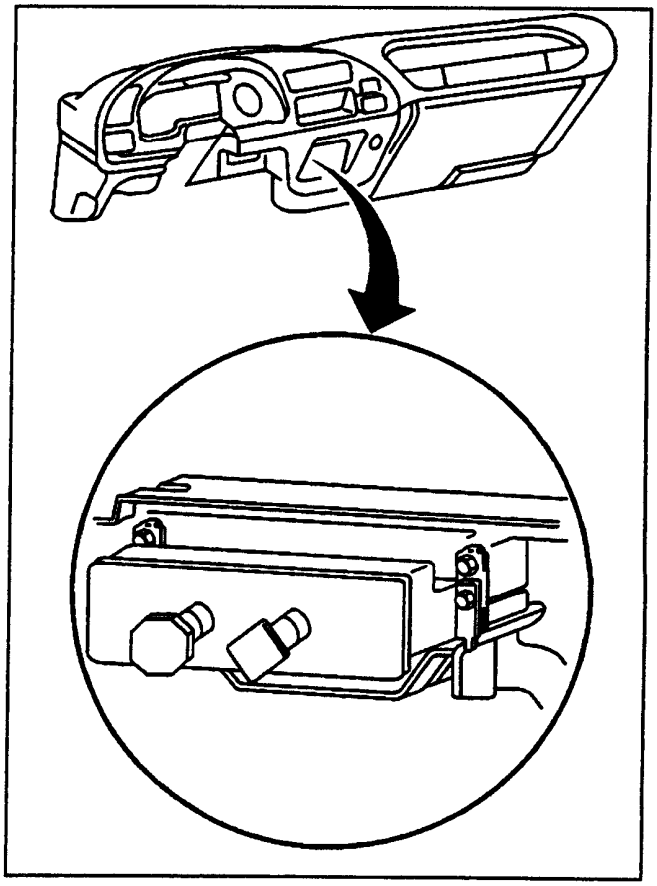
Air Brake Valves Description

The air brake valves include cab control valves, relay valves, automatic control valves, and various safety valves. Air valves are pneumatic controls that route compressed air through hoses and lines to or from the air brake components. They control service brake chambers, spring brake chamber assemblies, trailer supply, and trailer service air lines.

All air valves have air passages and internal moving parts. As the internal parts move, they direct the compressed air to the desired location. Each valve has at least one supply port to allow air to enter the valve and one delivery port to allow air to exit the valve. Some valves have a control port that allows an air pressure source to control when air can flow through the valve. An exhaust port allows air to vent to the atmosphere. Some valves have special function control ports such as balance or reservoir ports. The use of these special ports will be discussed on the valves that have them.

Air brake valves operate either manually or automatically. Manual valves require the driver to move a knob, handle, or pedal to work the valve. Automatic valves use control ports or internal regulating parts to work.

Park Control Valve, IP Mounted



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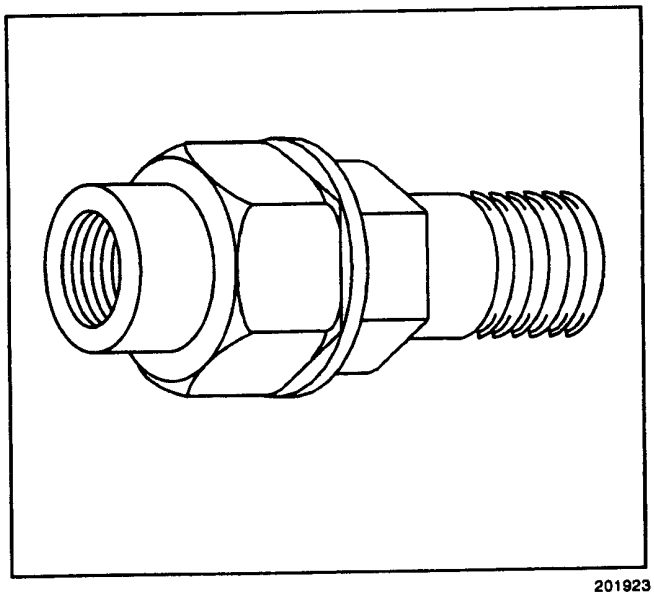
The Bendix® PP-1 park control valve (cab mounted) is used on air brakes models without trailer provisions. The park control valve (cab mounted) is mounted in the instrument panel and has a yellow diamond-shaped control knob. The vehicle spring brakes are applied when the knob is pulled out. Pulling the knob out (exhaust position) allows the spring brake chamber assemblies to be activated. This applies the parking brakes.

Pushing the knob in (applied position) releases the parking brakes as long as the supply pressure is above 276 kPa (40 psi). When the supply pressure drops to 276 kPa (40 psi) and below, the internal spring causes the knob to pop out. This then returns the valve to the exhaust position, applying the parking brakes.

The park control valve (cab mounted) has a supply port. a delivery port, and an exhaust port. When the knob is pulled out, the supply port is blocked and the delivery port vents to the exhaust port. When the knob is pushed in, the exhaust port is blocked and supply air flows out of the delivery port.

Single Check Valve



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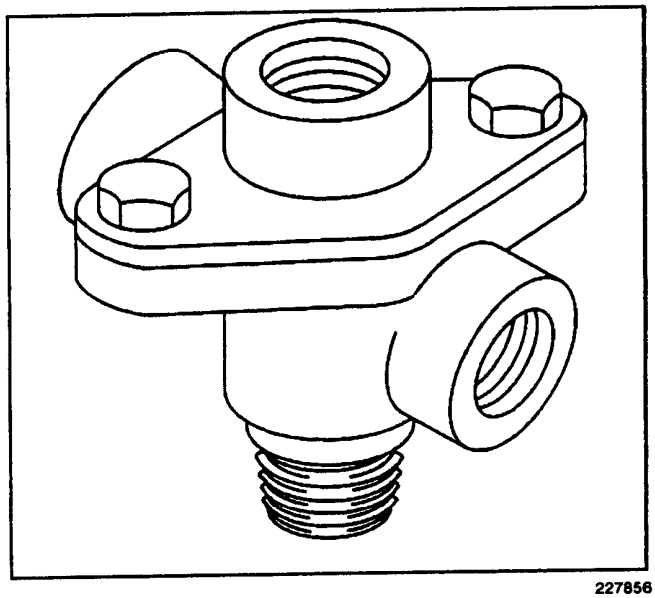
A Bendix® SC-1 single check valve is installed at the inlet of each service air reservoir that is fed by the supply air reservoir. This valve prevents the loss of service brake air pressure if a leak occurs in the supply portion of the system. The single check valve has a supply port and a delivery port. Air flow in the normal direction moves the check valve disc from its seat and the air flow is unobstructed. Air flow in the reverse direction is prevented by the seating of the single check disc, which is caused by a drop in up-stream air pressure and is assisted by the spring.

Double Check Valve



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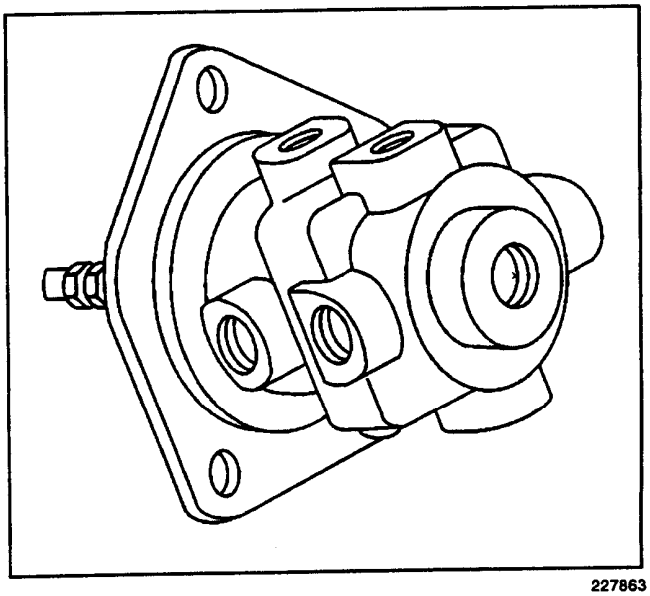
The Bendix® DC-4 double check valve directs air from two supply lines into a common delivery line. The supply line with the highest air pressure will feed air to the delivery port while the lower pressure supply line is blocked. The valve isolates the supply ports.

The double check valve uses the front and rear service reservoirs to supply air to the spring brake chamber assemblies and the trailer air supply line. The trailer air brake control vale ties into the double check valve on models with trailer provisions.

Dual Application Valve



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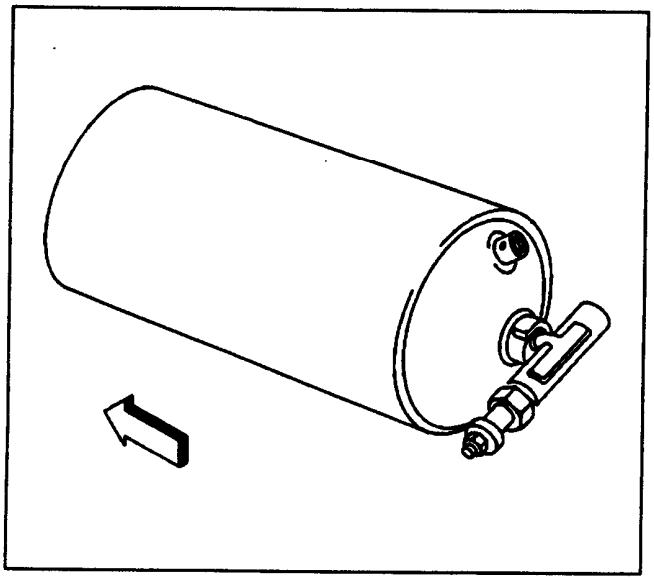
The Bendix® E-6 dual application valve is a manual valve activated by the brake pedal. The dual application valve has two separate supply and delivery circuits for the front and the rear service brakes. Separating the circuits allows the driver to gradually apply and release the brakes.

The supply, the delivery, and the exhaust ports are identified by letters cast into the dual application valve body next to the ports. The primary supply and delivery ports are located in the dual application valve upper body portion and the secondary supply and the delivery ports are located in the lower body portion of the dual application valve. Both of the circuits serve as flow control valves. The flow of air directly relates to the travel of the brake pedal. The primary and secondary circuits use a common exhaust port protected by an exhaust diaphragm.

Inflation Valve



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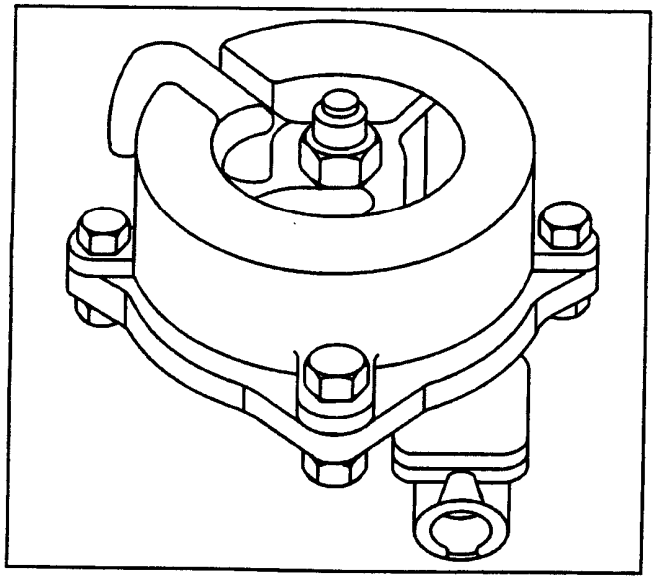
The inflation valve is located on the air compressor governor. The inflation valve is used to fill the air system from an external source.

The inflation valve is a check valve and fitting for an external air hose connection. A cap is located on the valve stem to keep out dirt and other contaminants.

Reservoir Drain Valve, Automatic Type



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The Bendix® DV-2 reservoir drain valve (automatic type) is available as an option. It is also available with an optional heater and a thermostat cast into the cover.

The reservoir drain valve (automatic type) automatically drains moisture and contaminants from the supply reservoir. It mounts to the supply air reservoir at the valve supply port with the reservoir drain valve (automatic type) exhaust port pointing down.

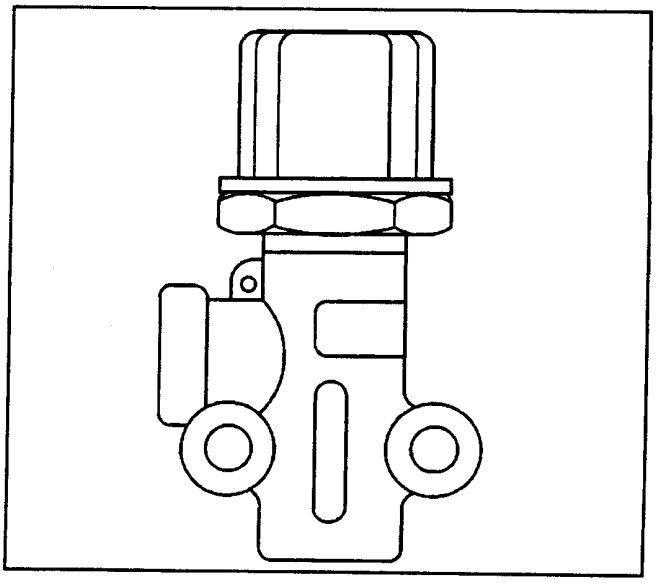
The supply and exhaust ports are normally closed. When the air compressor turns on to increase reservoir pressure, the supply port opens. This allows air and contaminants to collect in the sump of the reservoir drain valve (automatic type). The supply port remains open until the supply air reservoir pressure reaches the governor cut-out pressure. The valve spring then closes the supply port.

When the supply reservoir pressure drops about 14 kPa (2 psi), the sump cavity pressure opens the exhaust valve and allows the moisture and contaminants to be ejected from the sump cavity until the pressure in the sump cavity drops enough to close the exhaust valve. The length of time the exhaust valve remains open and the amount of moisture and contaminants ejected depends upon the sump pressure and the reservoir pressure drop that occurs each time air is used for the system.

The reservoir drain valve (automatic type) can be drained manually by moving the wire in the exhaust port upward, holding it in until the draining is complete.

The thermostat on the heated model will activate the heating element when the valve body reaches a temperature of approximately 7° C (45° F) and deactivates the heating element when the valve body is heated to approximately 29° C (85° F).

Pressure Protection Valve



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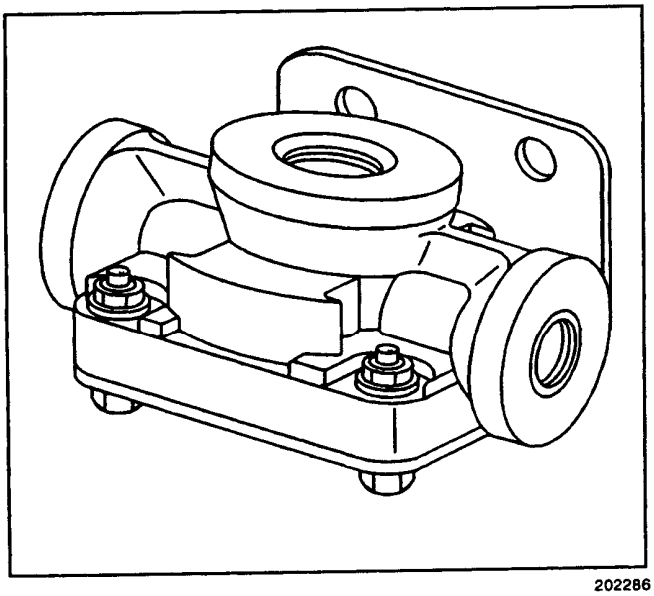
The Bendix® PR-2 pressure protection valve is used on vehicles with air accessories or provisions for air accessories. The pressure protection valve is located on the front service air reservoir and the rear service air reservoir.

The pressure protection valve protects the air supply to the brakes if a failure occurs in the accessory equipment. The pressure protection valve has a supply port and a delivery port.

The pressure protection valve allows air to flow from the supply port to the delivery port as long as sufficient air pressure is available. If air pressure decreases below the specified closing pressure, the internal regulating spring moves the piston, closing the inlet valve. The remaining air pressure at the supply side is retained. The closing pressure is noted on the label attached to the pressure protection valve. The opening pressure is 103–238 kPa (15–20 psi) higher than the closing pressure.

Quick Release Valve



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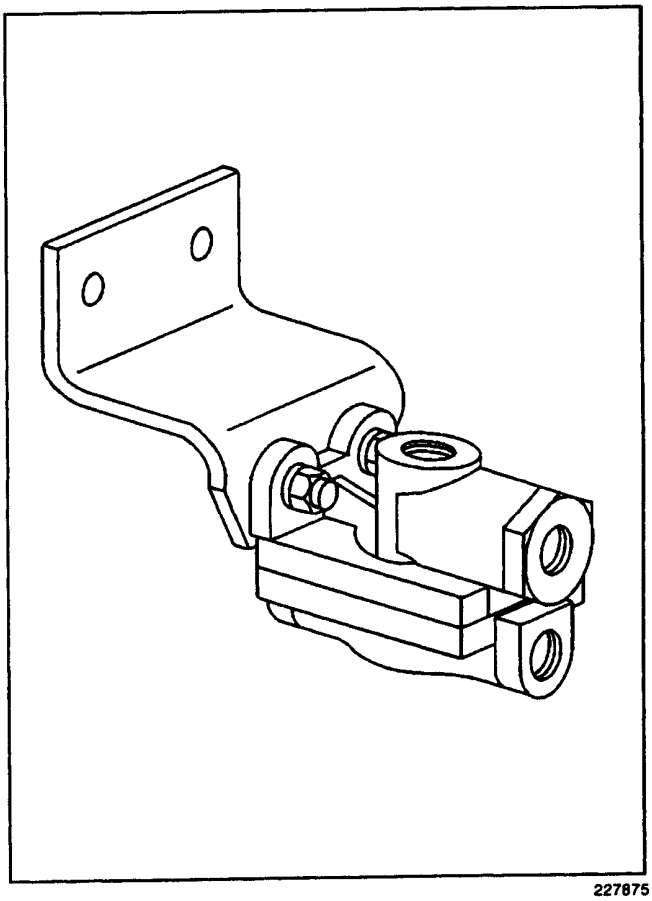
The Bendix® QR-N quick release valve is mounted to a bracket on the front chassis crossmember.

When the brakes are applied, supply air flows through the quick release valve and out two delivery ports connected to the service brake chamber assemblies at the front wheels. When the foot brake is released, service brake chamber assembly air at the delivery ports is immediately vented through the exhaust port rather than the dual application valve. The quick release valve reduces the time required to exhaust service brake chamber assembly air, as compared to the time required to exhaust air through the dual application valve.

The quick release valve has an internal diaphragm. Air entering the supply port of the quick release valve causes the center portion of the diaphragm to seal the exhaust ports. Simultaneously, the outer edge of the diaphragm moves away from the sealing lip of the upper valve body, allowing air to flow from the supply port out the two delivery ports. Air then flows through the quick release valve to the service brake chamber assemblies until they are full. When air flow stops, the lip of the diaphragm seals the supply port. This sealing action causes the delivered air pressure to be slightly less than the supply pressure. The maximum differential air pressure is typically (1 psi). Releasing the brake pedal causes air from the service brake chamber assemblies to raise the diaphragm. This seals the supply port and opens the exhaust port, venturing the service brake chamber air pressure.

Quick Release Valve, Double Check Type



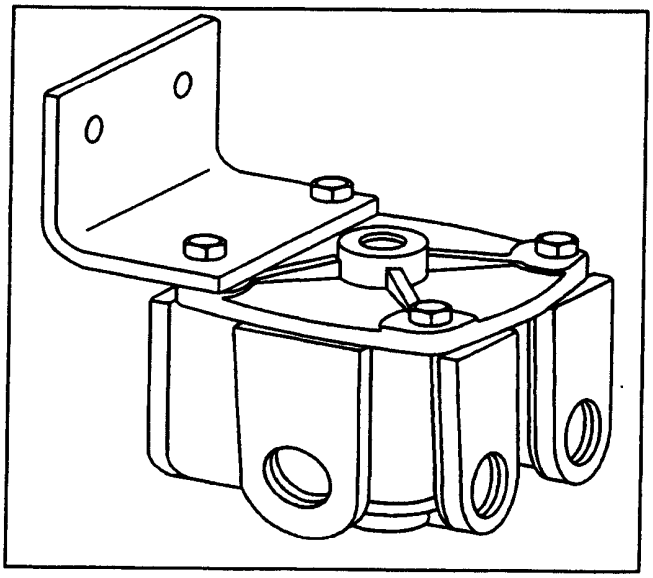
227875

The Bendix® QR-1C quick release valve (double check type) mounts to the right side frame rail near the rear axle assembly.

The quick release valve (double check type) is a dual function valve. The quick release valve's (double check type) primary function is to serve the emergency side of the spring brake chamber assemblies as a quick release valve. In addition, it functions as an anti-compound device. The quick release valve (double check type) prevents a service and emergency brake application from the occurring at the same time.

The quick release valve (double check type) has a supply port, a balance port, an exhaust port, and two delivery ports. Applying the park control valve (cab mounted) sends air into the supply port, out both delivery ports, and to the spring brake chamber assemblies. When the park control valve (cab mounted) pops out to apply the spring brake chamber assemblies, the supply and balance ports are sealed and the exhaust port opens. This vents the spring brake chamber assembly's air. Applying the brake pedal while the vehicle is parked causes service air to flow into the balance port, though the double check diaphragm, and out the delivery ports to the spring brake chamber assemblies.

Relay Valve



202295

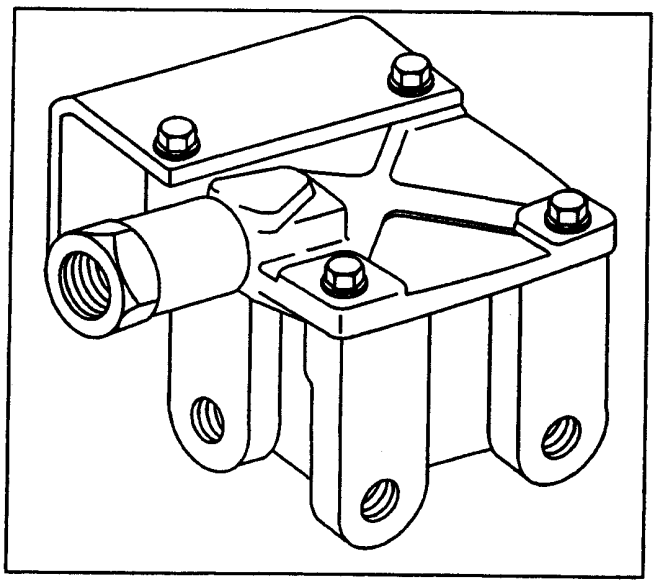
The Bendix® R-12 relay valve is mounted on a bracket to the frame side rail near the rear axle(s) to allow the shortest possible delivery lines to the rear service brake chamber assemblies.

The relay valve functions as a remote brake valve that delivers or releases air to the rear service brake chamber assemblies in response to control air from the dual application valve.

The relay valve has one control port, one supply port, two delivery ports, and one exhaust port. The control port connects to the rear service brake line from the dual application valve. The supply port connects to the rear axle service reservoir. The delivery ports connect to the rear service brake chamber assemblies.

As air pressure increases at the control port, an internal piston lowers to block the exhaust port and to gradually open the supply port in relation to piston travel. Supply air enters the cavity on the opposing face of the piston and flows out the delivery ports. With control and supply air on opposing faces, the piston balances to a position where the two pressures are equalized. Any change in control pressure then causes an equal change in delivery pressure. Releasing the brakes removes the control air. This causes the piston to rise, close the supply port, and open the exhaust port in the bottom of the relay valve. Service brake chamber assemblies air at the delivery ports then vent through the exhaust port.

Relay Valve, Double Check Type



202312

The Bendix® R-14 relay valve (double check type) is used on vehicles not built as tractors. It works with the parking brake control valve.

The relay vale (double check type) is mounted to the frame side rail near the rear axle(s) to allow the shortest possible delivery lines to the spring brake chamber assemblies.

The valve functions as a quick release valve that delivers or releases air to the spring brake chambers in response to the air pressure from the system park control valve (chassis mounted).

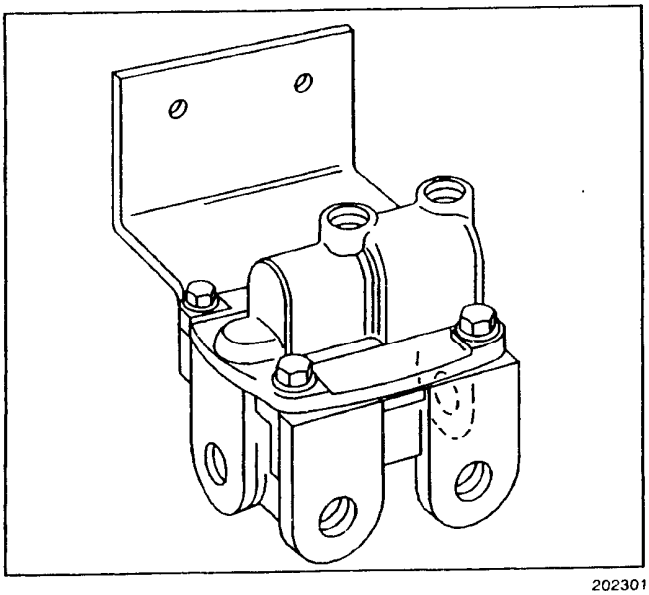
An internal double check diaphragm balances service brake line pressure and spring brake line pressure. This prevents the service brake chamber and the spring brake chamber from compounding their braking forces on the slack adjusters. When the service brake chambers and the spring brake chambers are applied at the same time, the double check diaphragm uses some air from the service brakes to partially release spring brake pressure from the slack adjuster. This balances the mechanical spring pressure with the service brake line pressure and keeps the slack adjusters from overloading.

The relay valve (double check type) has a control port, balance port, two supply ports, two delivery ports, and an exhaust port. The control port connects to the system park control valve (chassis mounted). The balance port connects to a relay valve delivery line. The control and balance lines are combined through an internal double check diaphragm to prevent brake compounding. One of the supply ports connects to the dual application valve, and the other is usually plugged. The delivery ports connect to the spring brake chamber assemblies.

When the dual application valve increases air pressure at the control port, an internal piston lowers to block the exhaust port and gradually open the supply port in relation to piston travel. Supply air enters the chamber on the opposing face of the piston and flows out the delivery ports. With control and supply air on the opposing faces, the piston balances to a position where the two pressures are equalized. Any change in control pressure then causes an equal change in delivery pressure.

When air pressure is released from the supply port and air pressure in the cavity above the relay piston is exhausted, air pressure under the piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chamber assemblies is then permitted to exhaust through the exhaust port, releasing the brakes.

Relay Valve, Proportioning Type



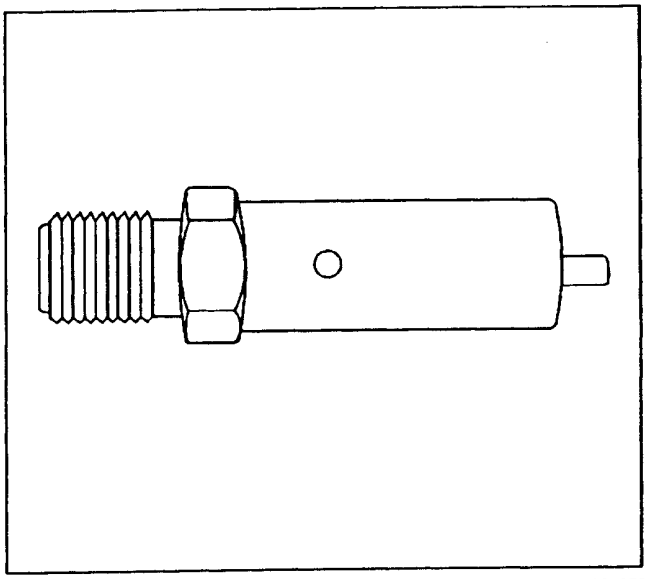
202301

The Bendix® BP-R1 relay valve (proportioning type) is only used on tractor applications. It is a combination of two individual valves in a single housing. The lower portion, or body, of the relay valve (proportioning type) contains a standard service brake relay valve. The upper portion, or cover, houses a brake proportioning valve to reduce normal service brake application pressure when the tractor is not towing a trailer.

The relay valve (proportional type) mounts to the right side frame rail. Air connections are identified by embossed letters. The relay valve (proportioning type) has a supply port connected to the rear service air reservoir, service port connected to the dual application valve, control port, and two delivery ports to allow air to flow to the service brake chamber assemblies.

When the tractor is pulling a trailer, it serves as a service brake relay valve to speed up apply and release time. When the tractor operates without a trailer, the relay valve (proportioning type) serves as service brake relay valve to speed up apply and release time. When the tractor operates without a trailer, the relay valve (proportioning type) reduces air pressure to the rear service brake chambers for improved control and reduced stopping distances.

Safety Valve

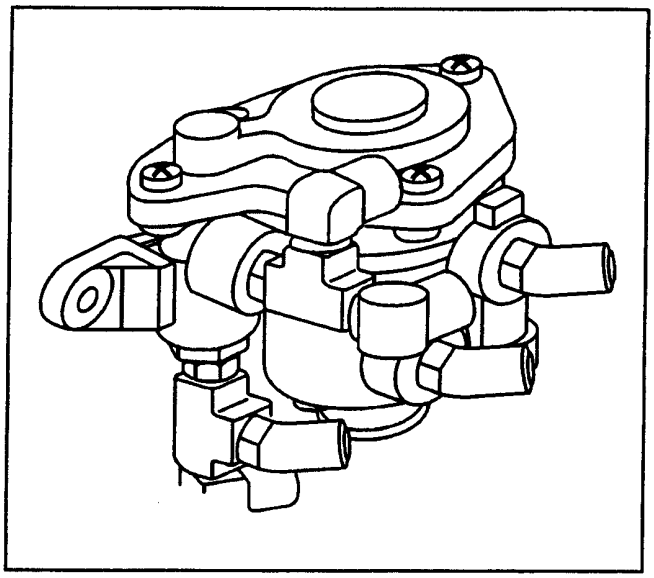


227879

A Bendix® ST-3 safety valve is installed in the air supply reservoir to stop air pressure buildup beyond a safe limit. The safety valve protects the reservoirs and lines in case of a governor malfunction. The safety valve is a spring-loaded type with a ball check valve and seat.

If the air pressure rises to approximately 1034 kPa (150 psi) it forces the ball check valve to unseat. This relieves air pressure through the exhaust vent in the spring cage. When the air pressure decreases sufficiently, the spring force seats the ball check valve, sealing off the supply air reservoir. This occurs at approximately 931 kPa (135 psi). The rated air pressure is attached to outside of the safety valve spring cage. The pressure setting on the safety valve is not adjustable.

Park Control Valve, Chassis Mounted



202326

The Bendix® SR-1 park control valve (chassis mounted) is used on all models that have spring brake chamber assemblies. The park control valve (chassis mounted) works with the relay valve. The park control valve (chassis mounted) allows the front brake service lines to modulate the spring brake chamber assemblies when the rear service air pressure fails.

The park control valve (chassis mounted) is mounted directly to the crossmember. The exhaust port always points down. The park control valve (chassis mounted) has a supply port connected to the park control valve (cab mounted), a delivery port connected to the front brake circuit on the dual application valve, a rear air reservoir port that senses rear service air reservoir pressure, and an exhaust port covered by a diaphragm. All of the ports are labeled with embossed letters.

The park control valve (chassis mounted) delivers a set air pressure to the delivery line as long as the supply and reservoir port pressures are 380 kPa (55 psi) or more. The air pressure is called the rated spring hold off pressure. The park control valve (chassis mounted) detects an air pressure loss in the rear service reservoir, through the reservoir port. When that happens, front brake service air at the control port of the park control valve modulates the spring brake chamber assemblies with the brake pedal as if they were service brakes. This allows the spring brake chamber assemblies to work in place of the service brakes during emergency situations.

When the park control valve (cab mounted) pulls out to the park position, supply port air is exhausted. This causes delivery port air to vent through the exhaust port.

Air Brake Valves Operation

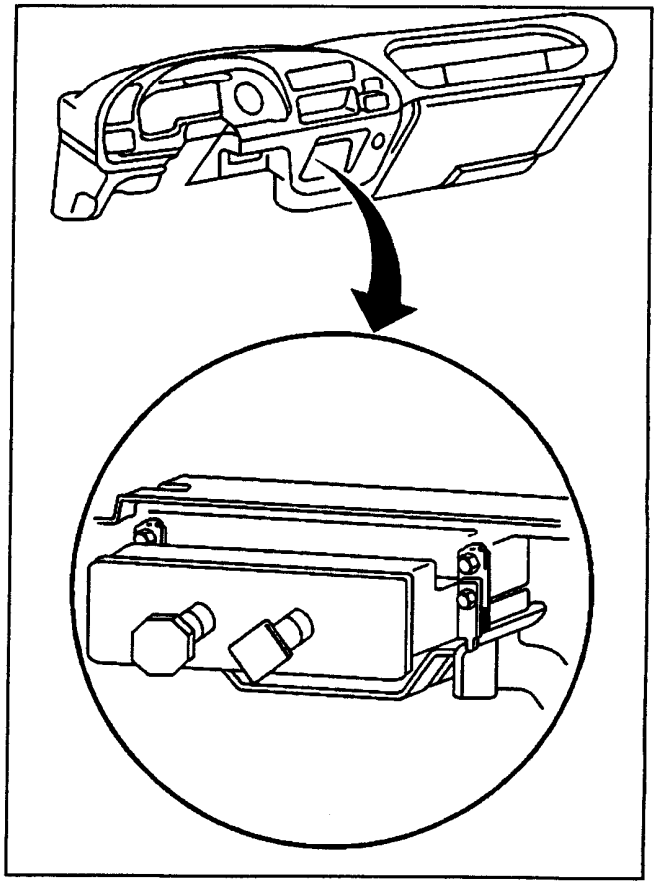
Air Brake Valves

The air brake valves include cab control valves, relay valves, automatic control valves, and various safety valves. Air valves are pneumatic controls that route compressed air through hoses and lines to or from the air brake components. They control service brake chambers, spring brake chamber assemblies, trailer supply, and trailer service air lines.

All air valves have air passages and internal moving parts. As the internal parts move, they direct the compressed air to the desired location. Each valve has at least one supply port to allow air to enter the valve and one delivery port to allow air to exit the valve. Some valves have a control port that allows an air pressure source to control when air can flow through the valve. An exhaust port allows air to vent to the atmosphere. Some valves have special function control ports such as balance or reservoir ports. The use of these special ports will be discussed on the valves that have them.

Air brake valves operate either manually or automatically. Manual valves require the driver to move a knob, handle, or pedal to work the valve. Automatic valves use control ports or internal regulating parts to work.

Park Control Valve, IP Mounted



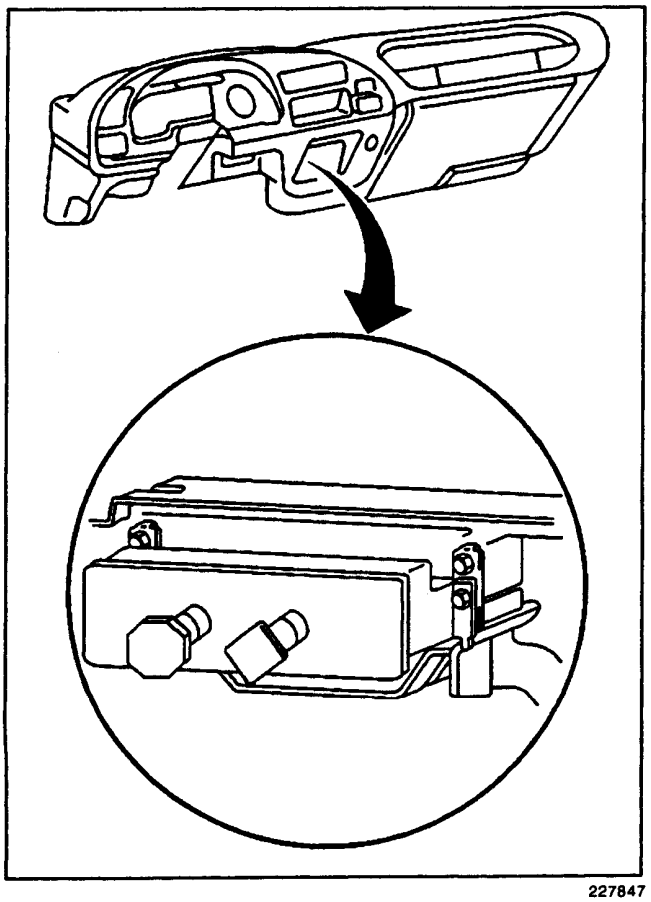
227847

The Bendix® PP-1 park control valve (cab mounted) is used on air brakes models without trailer provisions. The park control valve (cab mounted) is mounted in the instrument panel and has a yellow diamond-shaped control knob. The vehicle spring brakes are applied when the knob is pulled out. Pulling the knob out (exhaust position) allows the spring brake chamber assemblies to be activated. This applies the parking brakes.

Pushing the knob in (applied position) releases the parking brakes as long as the supply pressure is above 276 kPa (40 psi). When the supply pressure drops to 276 kPa (40 psi) and below, the internal spring causes the knob to pop out. This then returns the valve to the exhaust position, applying the parking brakes.

The park control valve (cab mounted) has a supply port. a delivery port, and an exhaust port. When the knob is pulled out, the supply port is blocked and the delivery port vents to the exhaust port. When the knob is pushed in, the exhaust port is blocked and supply air flows out of the delivery port.

Parking Control Valve



227847

The Bendix® MV-3 parking control valve is used on all models with trailer provisions. It is a two-knob control valve mounted in a single body, which includes a dual circuit supply valve and a check valve. The parking control is located in the instrument panel to the right of the driver. The parking control valve has a yellow diamond-shaped control knob for the park control, and a red octagon-shaped knob for the trailer air supply.

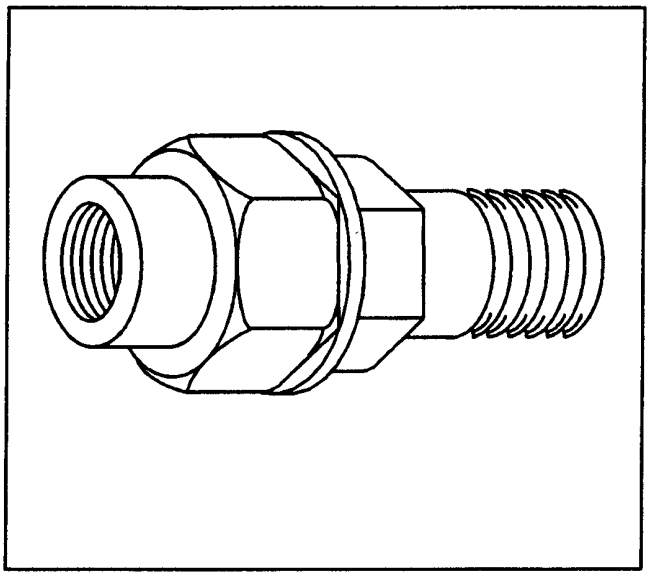
During the initial charge, with the system completely discharged, both knobs must be in the exhaust position (pulled out). When the air brake system pressure reaches 448 kPa (65 psi), the red knob (trailer air supply) may be pushed in, and should stay in, charging the trailer air brake system and releasing the trailer brakes. The yellow knob (park control) may now be pushed in, which will supply air to the spring brake chamber assemblies, releasing the parking brake.

In order to actuate the trailer parking brakes only, the red knob (trailer air supply) is pulled out, exhausting the trailer supply line. The trailer brakes are now applied either by the air emergency or the spring brake chamber assemblies, depending on the type of the trailer system. This mode is used while uncoupling the trailer. With both knobs pushed in for the normal run modes, the parking brakes on both the truck/tractor and trailer may be actuated by pulling the yellow knob (park control) out, which exhausts the air from the truck/tractor spring brake chamber assemblies, applying the parking brakes and simultaneously causes the the knob (trailer air supply) to pop out, applying the trailer brakes.

If both knobs are out when parking the combination vehicle and it is desired to recharge the trailer (leaving the truck/tractor parking brake applied), the red knob (trailer air supply) may be pushed in, re-pressurizing the trailer air supply line. This mode might also be used to park a combination vehicle with air actuated emergency brakes on the trailer to provide demonstrated parking capability with the truck/tractor spring brakes only.

With both knobs in (normal run configuration), if the air supply pressure to the parking control valve is reduced to approximately 241-310 kPa (35-45) psi), the red knob (trailer air supply) is held in manually and the pressure decreases to approximately 172 -241 kPa (25-35 psi), a tripper piston within the parking control valve will move upward, exhausting the trailer air supply, effecting the required non-override feature. The yellow knob (park control) will pop out at approximately 138 -210 kPa (20-30 psi).

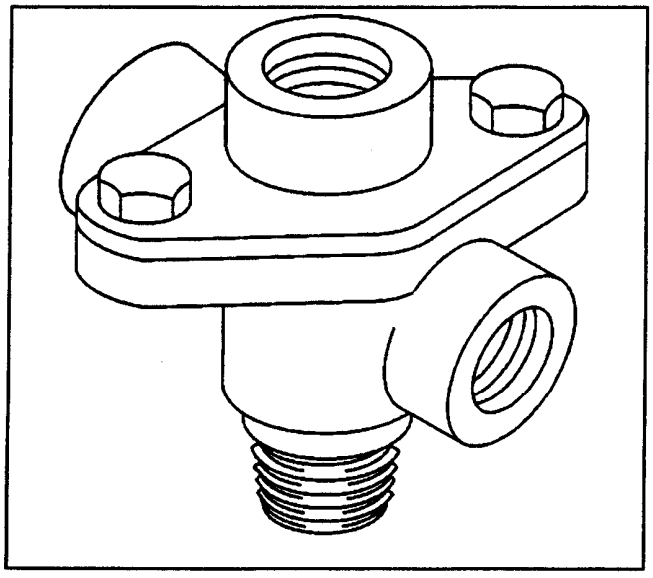
Single Check Valve



201923

A Bendix® SC-1 single check valve is installed at the inlet of each service air reservoir that is fed by the supply air reservoir. This valve prevents the loss of service brake air pressure if a leak occurs in the supply portion of the system. The single check valve has a supply port and a delivery port. Air flow in the normal direction moves the check valve disc from its seat and the air flow is unobstructed. Air flow in the reverse direction is prevented by the seating of the single check disc, which is caused by a drop in up-stream air pressure and is assisted by the spring.

Double Check Valve

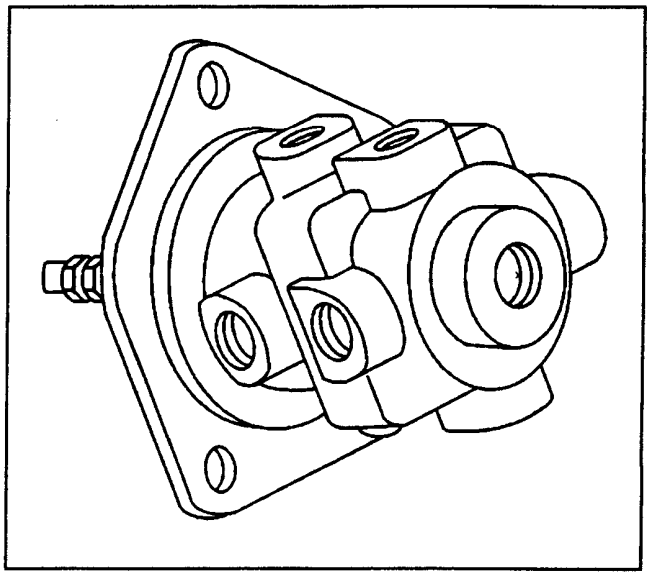


227856

The Bendix® DC-4 double check valve directs air from two supply lines into a common delivery line. The supply line with the highest air pressure will feed air to the delivery port while the lower pressure supply line is blocked. The valve isolates the supply ports.

The double check valve uses the front and rear service reservoirs to supply air to the spring brake chamber assemblies and the trailer air supply line. The trailer air brake control vale ties into the double check valve on models with trailer provisions.

Dual Application Valve

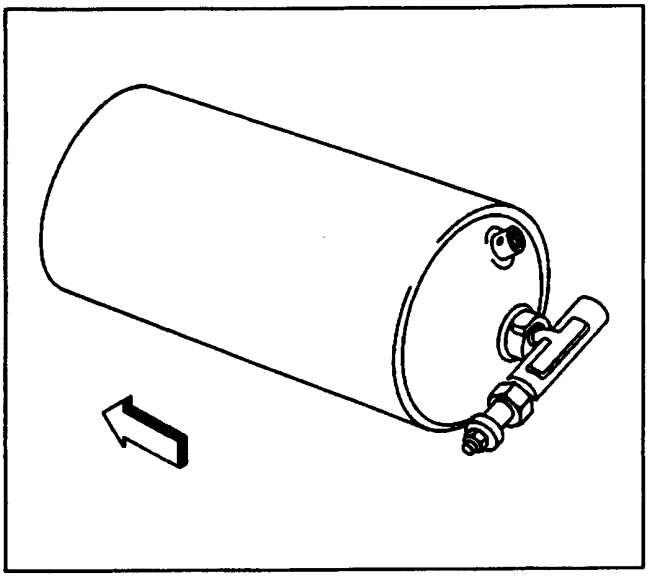


227863

The Bendix® E-6 dual application valve is a manual valve activated by the brake pedal. The dual application valve has two separate supply and delivery circuits for the front and the rear service brakes. Separating the circuits allows the driver to gradually apply and release the brakes.

The supply, the delivery, and the exhaust ports are identified by letters cast into the dual application valve body next to the ports. The primary supply and delivery ports are located in the dual application valve upper body portion and the secondary supply and the delivery ports are located in the lower body portion of the dual application valve. Both of the circuits serve as flow control valves. The flow of air directly relates to the travel of the brake pedal. The primary and secondary circuits use a common exhaust port protected by an exhaust diaphragm.

Inflation Valve

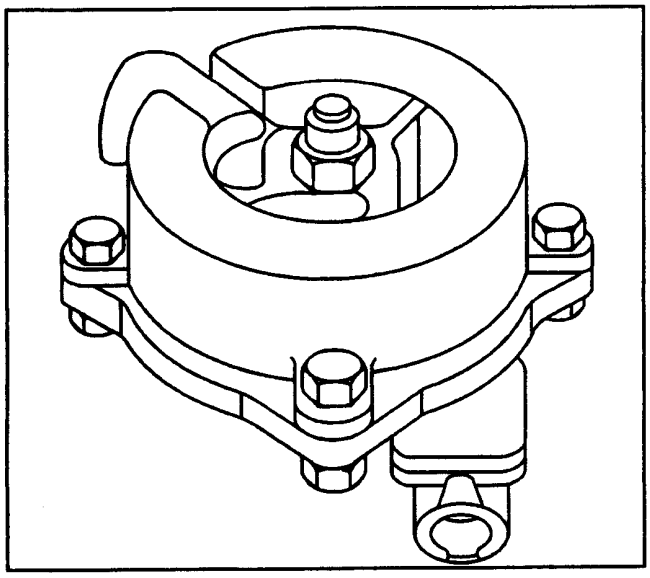


227870

The inflation valve is located on the air compressor governor. The inflation valve is used to fill the air system from an external source.

The inflation valve is a check valve and fitting for an external air hose connection. A cap is located on the valve stem to keep out dirt and other contaminants.

Reservoir Drain Valve, Automatic Type



202282

The Bendix® DV-2 reservoir drain valve (automatic type) is available as an option. It is also available with an optional heater and a thermostat cast into the cover.

The reservoir drain valve (automatic type) automatically drains moisture and contaminants from the supply reservoir. It mounts to the supply air reservoir at the valve supply port with the reservoir drain valve (automatic type) exhaust port pointing down.

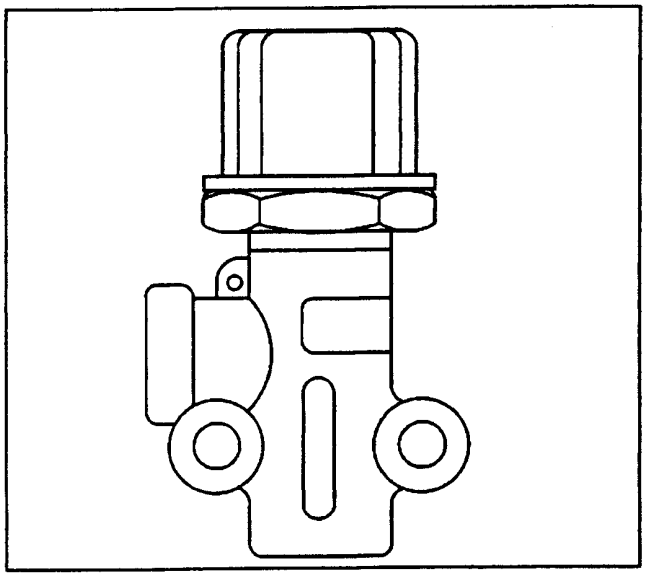
The supply and exhaust ports are normally closed. When the air compressor turns on to increase reservoir pressure, the supply port opens. This allows air and contaminants to collect in the sump of the reservoir drain valve (automatic type). The supply port remains open until the supply air reservoir pressure reaches the governor cut-out pressure. The valve spring then closes the supply port.

When the supply reservoir pressure drops about 14 kPa (2 psi), the sump cavity pressure opens the exhaust valve and allows the moisture and contaminants to be ejected from the sump cavity until the pressure in the sump cavity drops enough to close the exhaust valve. The length of time the exhaust valve remains open and the amount of moisture and contaminants ejected depends upon the sump pressure and the reservoir pressure drop that occurs each time air is used for the system.

The reservoir drain valve (automatic type) can be drained manually by moving the wire in the exhaust port upward, holding it in until the draining is complete.

The thermostat on the heated model will activate the heating element when the valve body reaches a temperature of approximately 7°C (45°F) and deactivates the heating element when the valve body is heated to approximately 29°C (85°F).

Pressure Protection Valve



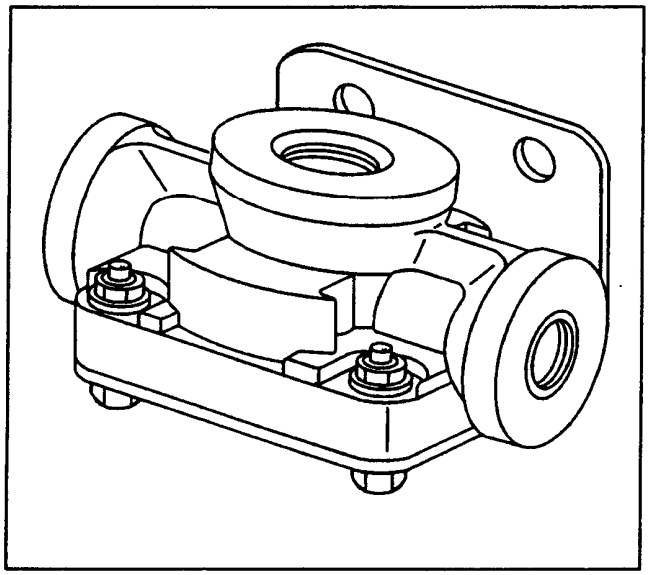
227873

The Bendix® PR-2 pressure protection valve is used on vehicles with air accessories or provisions for air accessories. The pressure protection valve is located on the front service air reservoir and the rear service air reservoir.

The pressure protection valve protects the air supply to the brakes if a failure occurs in the accessory equipment. The pressure protection valve has a supply port and a delivery port.

The pressure protection valve allows air to flow from the supply port to the delivery port as long as sufficient air pressure is available. If air pressure decreases below the specified closing pressure, the internal regulating spring moves the piston, closing the inlet valve. The remaining air pressure at the supply side is retained. The closing pressure is noted on the label attached to the pressure protection valve. The opening pressure is 103–238 kPa (15–20 psi) higher than the closing pressure.

Quick Release Valve



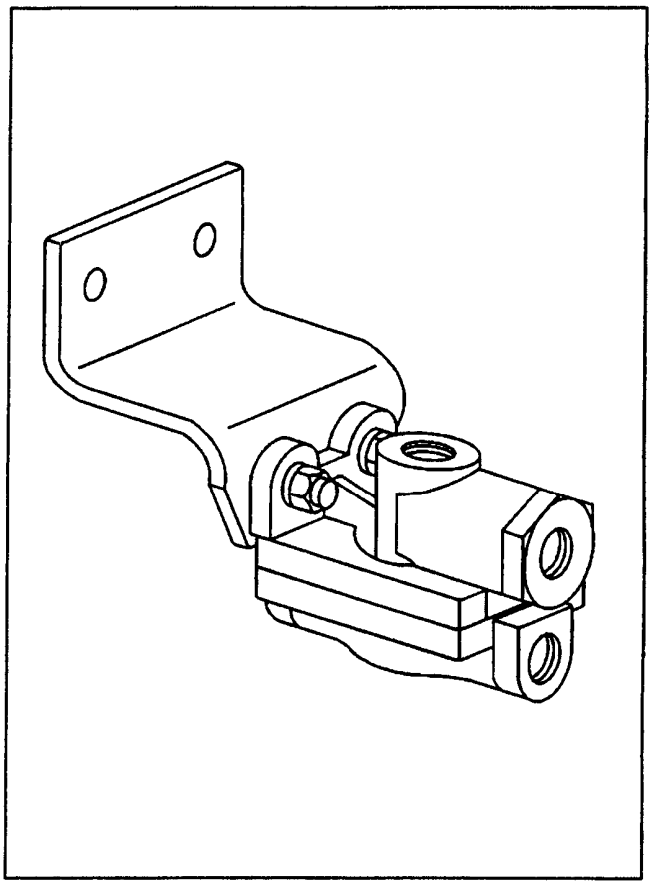
202286

The Bendix® QR-N quick release valve is mounted to a bracket on the front chassis crossmember.

When the brakes are applied, supply air flows through the quick release valve and out two delivery ports connected to the service brake chamber assemblies at the front wheels. When the foot brake is released, service brake chamber assembly air at the delivery ports is immediately vented through the exhaust port rather than the dual application valve. The quick release valve reduces the time required to exhaust service brake chamber assembly air, as compared to the time required to exhaust air through the dual application valve.

The quick release valve has an internal diaphragm. Air entering the supply port of the quick release valve causes the center portion of the diaphragm to seal the exhaust ports. Simultaneously, the outer edge of the diaphragm moves away from the sealing lip of the upper valve body, allowing air to flow from the supply port out the two delivery ports. Air then flows through the quick release valve to the service brake chamber assemblies until they are full. When air flow stops, the lip of the diaphragm seals the supply port. This sealing action causes the delivered air pressure to be slightly less than the supply pressure. The maximum differential air pressure is typically kPa (1 psi). Releasing the brake pedal causes air from the service brake chamber assemblies to raise the diaphragm. This seals the supply port and opens the exhaust port, venturing the service brake chamber air pressure.

Quick Release Valve, Double Check Type



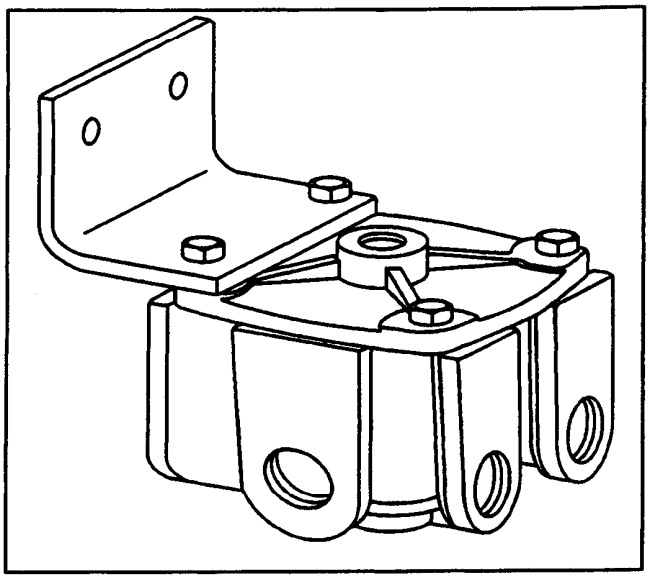
227875

The Bendix® QR-1C quick release valve (double check type) mounts to the right side frame rail near the rear axle assembly.

The quick release valve (double check type) is a dual function valve. The quick release valve's (double check type) primary function is to serve the emergency side of the spring brake chamber assemblies as a quick release valve. In addition, it functions as an anti-compound device. The quick release valve (double check type) prevents a service and emergency brake application from the occurring at the same time.

The quick release valve (double check type) has a supply port, a balance port, an exhaust port, and two delivery ports. Applying the park control valve (cab mounted) sends air into the supply port, out both delivery ports, and to the spring brake chamber assemblies. When the park control valve (cab mounted) pops out to apply the spring brake chamber assemblies, the supply and balance ports are sealed and the exhaust port opens. This vents the spring brake chamber assembly's air. Applying the brake pedal while the vehicle is parked causes service air to flow into the balance port, though the double check diaphragm, and out the delivery ports to the spring brake chamber assemblies.

Relay Valve



202295

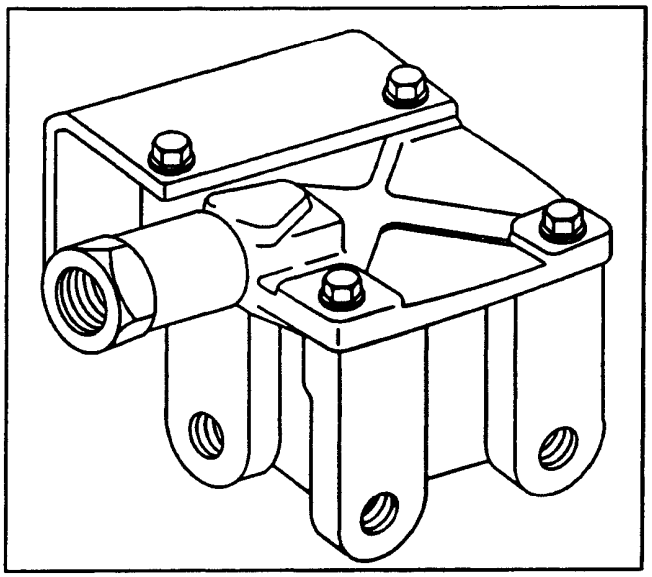
The Bendix® R-12 relay valve is mounted on a bracket to the frame side rail near the rear axle(s) to allow the shortest possible delivery lines to the rear service brake chamber assemblies.

The relay valve functions as a remote brake valve that delivers or releases air to the rear service brake chamber assemblies in response to control air from the dual application valve.

The relay valve has one control port, one supply port, two delivery ports, and one exhaust port. The control port connects to the rear service brake line from the dual application valve. The supply port connects to the rear axle service reservoir. The delivery ports connect to the rear service brake chamber assemblies.

As air pressure increases at the control port, an internal piston lowers to block the exhaust port and to gradually open the supply port in relation to piston travel. Supply air enters the cavity on the opposing face of the piston and flows out the delivery ports. With control and supply air on opposing faces, the piston balances to a position where the two pressures are equalized. Any change in control pressure then causes an equal change in delivery pressure. Releasing the brakes removes the control air. This causes the piston to rise, close the supply port, and open the exhaust port in the bottom of the relay valve. Service brake chamber assemblies air at the delivery ports then vent through the exhaust port.

Relay Valve, Double Check Type



202312

The Bendix® R-14 relay valve (double check type) is used on vehicles not built as tractors. It works with the parking brake control valve.

The relay vale (double check type) is mounted to the frame side rail near the rear axle(s) to allow the shortest possible delivery lines to the spring brake chamber assemblies.

The valve functions as a quick release valve that delivers or releases air to the spring brake chambers in response to the air pressure from the system park control valve (chassis mounted).

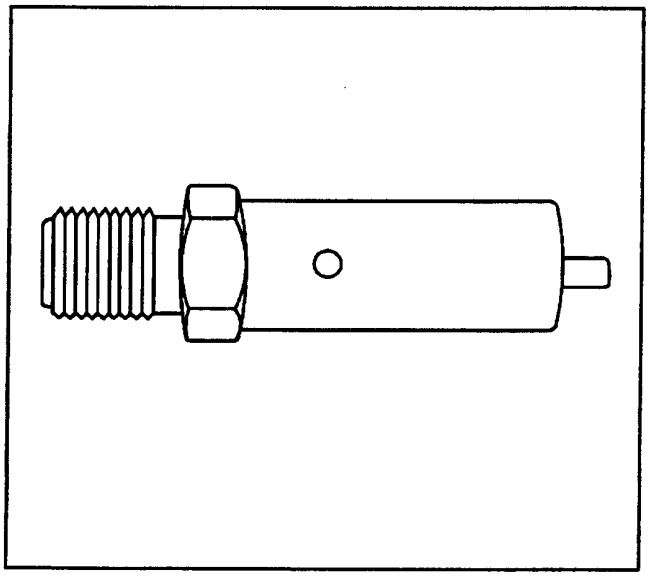
An internal double check diaphragm balances service brake line pressure and spring brake line pressure. This prevents the service brake chamber and the spring brake chamber from compounding their braking forces on the slack adjusters. When the service brake chambers and the spring brake chambers are applied at the same time, the double check diaphragm uses some air from the service brakes to partially release spring brake pressure from the slack adjuster. This balances the mechanical spring pressure with the service brake line pressure and keeps the slack adjusters from overloading.

The relay valve (double check type) has a control port, balance port, two supply ports, two delivery ports, and an exhaust port. The control port connects to the system park control valve (chassis mounted). The balance port connects to a relay valve delivery line. The control and balance lines are combined through an internal double check diaphragm to prevent brake compounding. One of the supply ports connects to the dual application valve, and the other is usually plugged. The delivery ports connect to the spring brake chamber assemblies.

When the dual application valve increases air pressure at the control port, an internal piston lowers to block the exhaust port and gradually open the supply port in relation to piston travel. Supply air enters the chamber on the opposing face of the piston and flows out the delivery ports. With control and supply air on the opposing faces, the piston balances to a position where the two pressures are equalized. Any change in control pressure then causes an equal change in delivery pressure.

When air pressure is released from the supply port and air pressure in the cavity above the relay piston is exhausted, air pressure under the piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chamber assemblies is then permitted to exhaust through the exhaust port, releasing the brakes.

Safety Valve

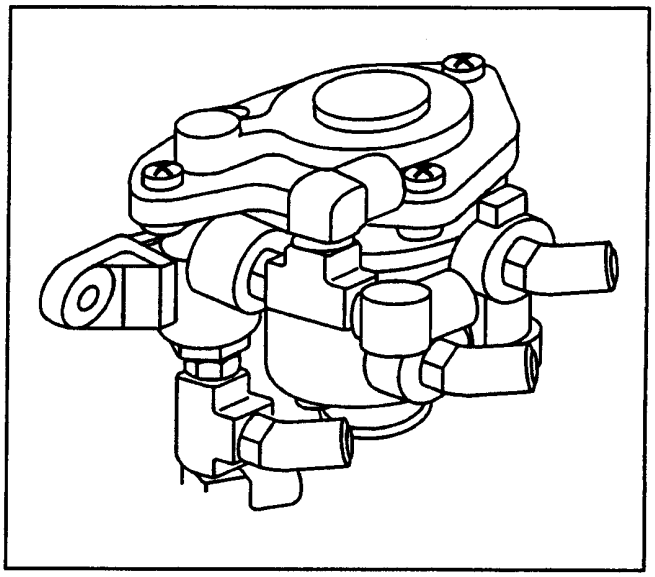


227879

A Bendix® ST-3 safety valve is installed in the air supply reservoir to stop air pressure buildup beyond a safe limit. The safety valve protects the reservoirs and lines in case of a governor malfunction. The safety valve is a spring-loaded type with a ball check valve and seat.

If the air pressure rises to approximately 1034 kPa (150 psi) it forces the ball check valve to unseat. This relieves air pressure through the exhaust vent in the spring cage. When the air pressure decreases sufficiently, the spring force seats the ball check valve, sealing off the supply air reservoir. This occurs at approximately 931 kPa (135 psi). The rated air pressure is attached to outside of the safety valve spring cage. The pressure setting on the safety valve is not adjustable.

Park Control Valve, Chassis Mounted



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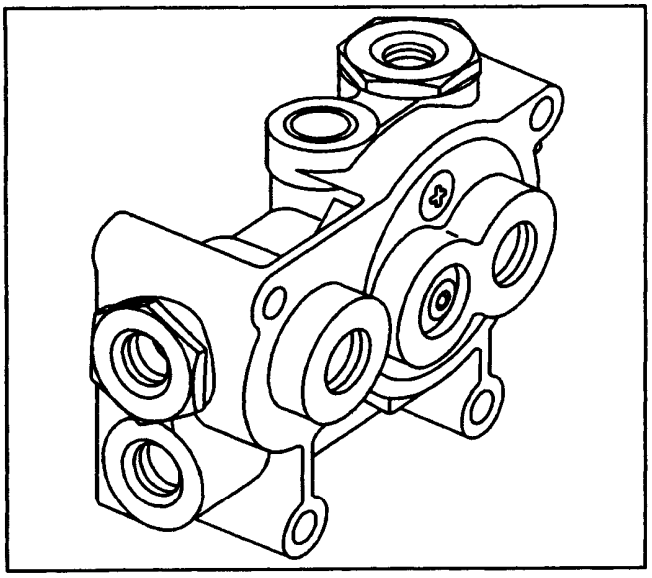
The Bendix® SR-1 park control valve (chassis mounted) is used on all models that have spring brake chamber assemblies. The park control valve (chassis mounted) works with the relay valve. The park control valve (chassis mounted) allows the front brake service lines to modulate the spring brake chamber assemblies when the rear service air pressure fails.

The park control valve (chassis mounted) is mounted directly to the crossmember. The exhaust port always points down. The park control valve (chassis mounted) has a supply port connected to the park control valve (cab mounted), a delivery port connected to the front brake circuit on the dual application valve, a rear air reservoir port that senses rear service air reservoir pressure, and an exhaust port covered by a diaphragm. All of the ports are labeled with embossed letters.

The park control valve (chassis mounted) delivers a set air pressure to the delivery line as long as the supply and reservoir port pressures are 380 kPa (55 psi) or more. The air pressure is called the rated spring hold off pressure. The park control valve (chassis mounted) detects an air pressure loss in the rear service reservoir, through the reservoir port. When that happens, front brake service air at the control port of the park control valve modulates the spring brake chamber assemblies with the brake pedal as if they were service brakes. This allows the spring brake chamber assemblies to work in place of the service brakes during emergency situations.

When the park control valve (cab mounted) pulls out to the park position, supply port air is exhausted. This causes delivery port air to vent through the exhaust port.

Towing Vehicle Protection Valve



202334

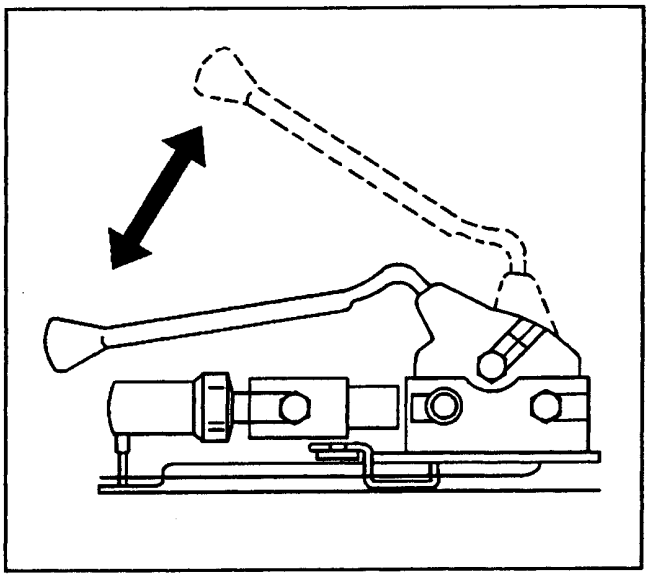
The Bendix® TP-5 towing vehicle protection valve is a combination quick release valve and a pressure sensing cutoff valve. The towing vehicle protection valve works with the trailer air supply valve in order to control trailer service brake lines in emergency situations.

The service brake and supply air lines are routed through this valve to the trailer. The towing vehicle protection valve protects the truck/tractor air brakes if there is a pressure loss in the trailer air system.

The towing vehicle protection valve is located on the crossmember. It has an internal service line shut off valve and a passage for the trailer supply air. The delivery line from the trailer air supply valve connects to the tractor emergency port. A delivery line from the dual application valve connects to the tractor service port. The trailer supply hose connects to the trailer emergency port. The trailer brake hose connects to the trailer service port.

When the supply pressure at the truck/tractor emergency port drops below 310 kPa (45psi), the towing vehicle protection valve closes the tractor service port.

Trailer Air Brake Control Valve



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The Bendix® TO-5 trailer air brake control valve is mounted on the floor, with the hand lever to the right of the driver's seat. It is used on models with trailer provisions.

Notice: The trailer air supply valve and trailer air system are not to be used as parking brakes at any time, under any circumstances. System air pressure could bleed off and release the brakes.

The trailer air brake control valve increases or decreases the delivered air pressure by the hand lever movement. The farther the handle is moved from the OFF toward the ON position, the greater the air pressure delivered to the trailer brakes. The hand lever stays in position until the lever is manually moved.

Air Dryer/Moisture Ejector Circuit Description

Voltage is applied to both the air dryer and the moisture ejector heater through circuit breaker 9 when the ignition switch is in RUN. Both the air dryer and the moisture ejector heater are equipped with thermal switches that will close whenever the outside temperature reaches 4°C (40°F) or lower. With these thermal switches closed, the air dryer and moisture ejector heater circuit will be complete. The heating elements will turn ON to warm the components and keep the air in the system from freezing. The air dryer and moisture heater will remain ON until the ambient temperature rises above 4°C (40°F), or the ignition switch is moved out of the RUN position.

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Air Drums

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Air Brake Chamber Clevis Jam Nut (Type 16 Service Air Brake Chamber)	45 N·m	33 lb ft
Front Air Brake Chamber Clevis Jam Nut (Types 20 and 24 Service Air Brake Chamber)	78 N·m	57 lb ft
Front Cam Brake Assembly Bolt	280 N·m	206 lb ft
Rear Air Brake Chamber Clevis Jam Nut	76 N·m	56 lb ft
Rear Cam Brake Assembly Bolt	220 N·m	162 lb ft
Release Stud Nut (Maximum Torque for Caging the Spring Brake Chamber Assembly)	47 N·m	35 lb ft
Release Stud Nut (Tool Storage)	7 N·m	62 lb in
Service Brake Chamber Assembly Mounting Nut (Type 16)	39 N·m	29 lb ft
Service Brake Chamber Assembly Mounting Nut (Types 20 and 24)	109 N·m	80 lb ft
Service Brake Chamber Clamp Ring Assembly Nut	34 N·m	25 lb ft
Slack Adjuster Control Arm Nut	17 N·m	13 lb ft
Spring Brake Chamber Assembly Mounting Nut	108 N·m	80 lb in
Spring Brake Chamber Clamp Ring Assembly Nut	34 N·m	25 lb ft

Air Drum Brake Component Specifications (Dimensional)

Application	Specification	
	Metric	English
Brake Drums		
Maximum Discard Diameter	Marked on Brake Drum	
Out-of-Round Maximum Dimension	0.38 mm	0.015"
Taper or Barrel Shape Maximum Dimension	0.25 mm	0.010"
Brake Linings		
Replacement Thickness	6.35 mm	0.25"
Pushrod Stroke Dimensions Maximum Allowable Stroke at 550–620 kPa (80–90 psi)		
Air Brake Chamber Type 16	44.4 mm	1.75"
Air Brake Chamber Type 20	44.4 mm	1.75"
Air Brake Chamber Type 24	44.4 mm	1.75"
Air Brake Chamber Type 30	50.8 mm	2.00"
Brake Shoe		
Brake Shoe Anchor Pin Hole Diameter (16.5" Brake Shoe Only)	25.62 mm	1.009"
Brake Shoe Anchor Pin to Brake Shoe Roller Hole Span Distance	325 mm	12.779"

Air Drum Brake Component Specifications (Front Brakes)

Information	Brake Shoe - 381 x 102 mm (15" x 4")	Brake Shoe - 419 x 127 mm (16.5" x 5")
Air Brake Automatic Slack Adjuster (Distance Between Pivot Points)	140 mm (5.5")	140 mm (5.5")
Air Brake Chamber Clevis Setup	72 mm (2.83")	72 mm (2.83")
Brake Lining Thickness	19.1 mm (0.75")	19.1 mm (0.75")
Brake Lining Width	102 mm (4")	127 mm (5")
Manufacturer	Rockwell	Rockwell
Type	Q Plus ™	Q Plus ™

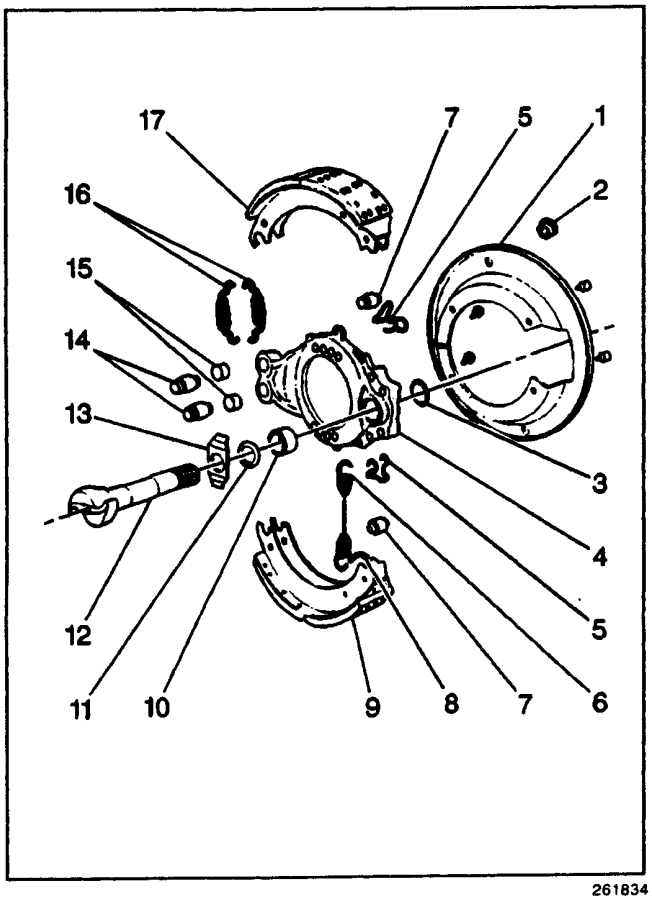
Air Drum Brake Component Specifications (Rear Brakes)

Information	Brake Shoe - 419 x 178 mm (16.5" x 7")	Brake Shoe - 419 x 178 mm (16.5" x 7")
Air Brake Automatic Slack Adjuster (Distance Between Pivot Points)	140 mm (5.5")	152 mm (6")
Air Brake Chamber Clevis Setup	68.5 mm (2.69")	68.5 mm (2.69")
Brake Lining Thickness	19.1 mm (0.75")	19.1 mm (0.75")
Brake Lining Width	178 mm (7")	178 mm (7")
Manufacturer	Rockwell	Rockwell
Type	Q Plus ™	Q Plus ™

Diagnostic Information and Procedures

Air Drum Brake System Diagnosis

1. Remove the brake drum.
2. Inspect the brake linings, the brake drums, and the camshaft. Refer to *Brake Drum Inspection*.



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3. Inspect the air brake anchor pins (14) for corrosion and wear.
   Replace the air brake anchor pins (14) if necessary.
4. Inspect the brake shoe rollers (7) for corrosion and wear.
   Replace the brake shoe rollers (7) if necessary.
5. Inspect the camshaft (12) for the following conditions:
   Replace the camshaft (12) as necessary.
   - Cracks
   - Wear
   - Corrosion
6. Inspect the brake chamber/camshaft support bracket (12) for the following conditions:
   Replace any damaged brackets.
   - Broken welds
   - Cracks
   - Misalignment

Repair Instructions

Air Drum Brake System Inspection

Front Air Brake Chamber

Front air brake chambers must be free to breathe through the pushrod opening and the four holes near the clamping flange.

Leakage Test

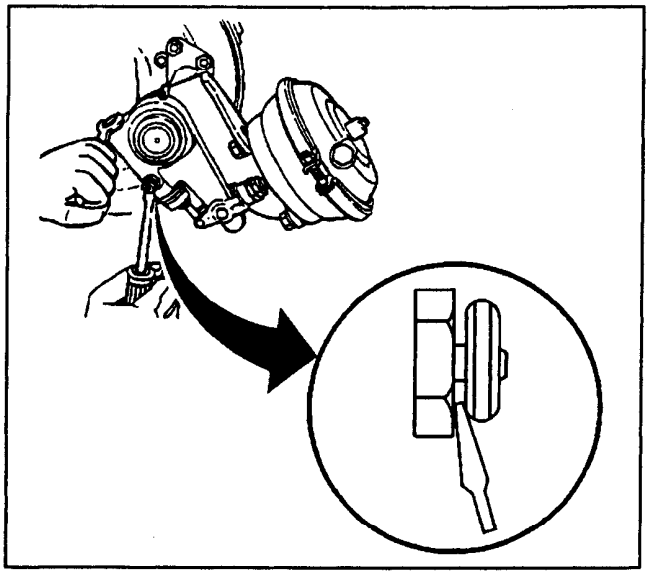
1. Block the wheels.
2. Start the engine.
3. Charge the air system to the air compressor governor valve cut-out point.
4. Stop the engine.
5. Have an assistant apply and hold the brake pedal.
6. Apply a soap solution around the front air brake chamber clamp and the breather holes.
7. Verify that no bubbles appear.
   - Lightly tap on the clamp and tighten the clamp bolts if bubbles appear.
   - Overhaul or replace the front air brake chamber if the bubbles continue. Refer to *Air Brake Chamber Overhaul (Service)*.
8. Set the parking brake.
9. Remove the wheel blocks.

Rear Air Brake Chamber

Rear air brake chambers must be free to breathe through the pushrod opening and four equally spaced holes near the clamping flange. Make sure these openings are clear.

Leakage Test

1. Block the wheels.
2. Start the engine.
3. Charge the air system to the air compressor governor valve cut-out point.
4. Stop the engine.
5. Have an assistant apply and hold the brake pedal.
6. Apply a soap solution around the air brake chamber clamp and the breather holes.
7. Verify that no bubbles appear.
   - Lightly tap on the clamp and tighten the clamp bolts if bubbles appear.
   - Overhaul or replace the rear air brake chamber if the bubbles continue. Refer to *Air Brake Chamber Overhaul (Spring)*.
8. Set the parking brake.
9. Remove the wheel blocks.



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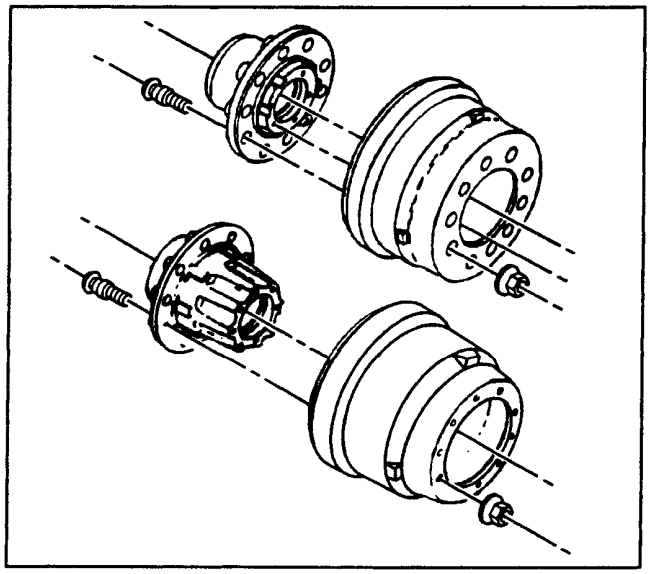

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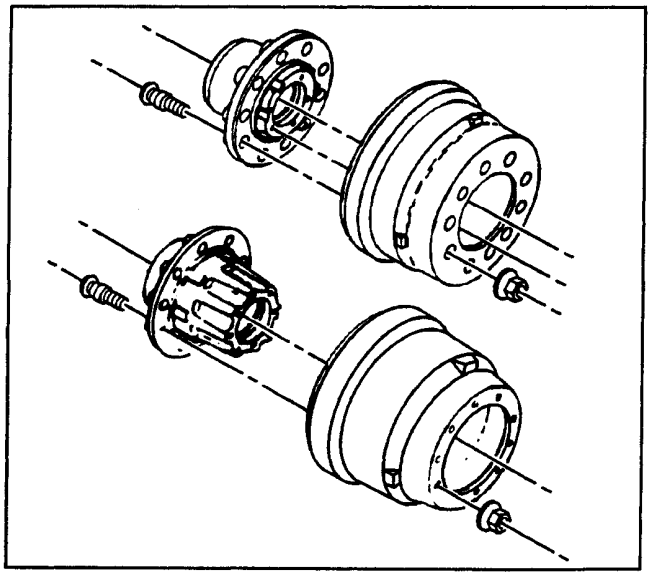

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Brake Drum Replacement

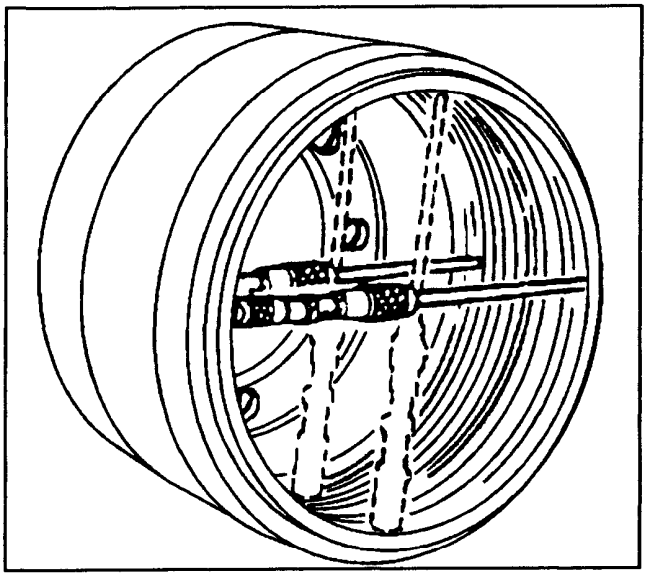
Removal Procedure

1. Refer to *Brake drum protective coating removal* and *Lifting and Jacking the Vehicle* in General Information.
2. Remove the tire and wheel assembly. Refer to *Wheel Removal (Front)* in Tires and Wheels.
3. Cage the rear air brake chamber. Refer to *Caging the Rear Air Brake Chamber.*
4. Release the air brake automatic slack adjuster fully in order to retract the shoes, then the brake drum will clear the brake linings.
   - 4.1. Disengage the pawl with a screwdriver.
   - 4.2. Turn the air brake automatic slack adjuster adjusting nut until the brakes shoes are fully retracted.
   - 4.3. Release the pawl in order to snap the pawl into engagement after the brake shoes have retracted.
5. Slide the brake drum from the hub.
6. Clean the brake drum using brake component cleaner.
7. Inspect the brake drum. Refer to *Brake Drum Inspection.*

Installation Procedure

1. Slide the brake drum onto the hub.
2. Adjust the wheel bearings if needed. Refer to *Wheel Bearing Adjustment.*
3. Install the tire and wheel assembly.
4. Adjust the brakes. Refer to *Air Drum Brake Adjustment (Pushrod Stroke Measurement)* or *Air Drum Brake Adjustment (Normal Wear Adjustment).*
5. Remove the supports.
6. Lower the vehicle.
7. Check the brakes for proper operation.

Brake Drum Inspection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Cracked, Scored or Grooved

A cracked brake drum is unsafe for further service. Replace a cracked brake drum. Do not attempt to weld a cracked brake drum. Smooth up any slight scores. Replace the brake drum if heavy or extensive scoring is present.

Polish the brake drum with a fine emery cloth. Do not refinish the brake drum if the brake linings are only slightly worn and the brake drum is only slightly grooved. Eliminating all grooves in the brake drum and smoothing the ridges on the brake lining would require removing too much metal and brake lining. If the components are left alone, the grooves and the ridges will match and should perform adequately.

Always replace a grooved brake drum when you are replacing the brake linings. Using a new brake lining with a grooved brake drum will cause brake lining wear and improper performance.

Out-of-Round or Tapered Brake Drum

An out-of-round or tapered brake drum can cause the following conditions:

- Inaccurate brake shoe adjustment
- Excessive wear of other brake parts
- Severe and irregular tire tread wear
- A pulsating brake pedal

Out-of-round and tapered brake drums may be accurately assessed with an inside micrometer and extension rods. Take the measurements at the open and closed edges of the machined surface, at right angles to one other. Replace the brake drum when the brake drum exceeds the specification limits for taper and/or out-of-round.

Inside Diameter Check

Perform the following checks prior to major vehicle servicing:

1. Measure the braking surface for maximum allowable diameter.

   Fading or overheating brakes can be caused by an oversized brake drum.

   1.1. Measure the brake drum diameters at four equally-spaced points near the middle of the braking surface.

   1.2. Replace the brake drum if any diameter is at, or more than, the maximum discard diameter stamped into the brake drum.

2. Measure the braking surface for out-of-round.

   Chatter at the wheels can be caused by out-of-round brake drums.

   2.1. Measure the brake drum diameters at four equally-spaced points near the middle of the braking surface.

   2.2. Replace the brake drum if any diameter readings are more than 0.38 mm (0.015 inch) apart.

Taper Check

1. A tapered or barrel-shaped brake lining will cause uneven brake drum wear.
2. Measure the brake drum diameters at four equally-spaced points near the top of the braking surface.
3. Average the four measurements in order to obtain an average diameter near the top of the braking surface.
4. Measure and average four diameters at the middle of the braking surface.
5. Measure and average four diameters at the bottom of the braking surface.
6. Compare the four average diameters in order to determine if the brake drum is tapered or barrel shaped.
7. Replace the brake drum if any of the average diameters are more than 0.25 mm (0.010 in) apart.

New Replacement Brake Drum Refinishing

Do not refinish the braking surface when installing new brake drums. These components are already at the correct level of surface finish.

Balance

Weights are used in order to balance the brake drums during manufacturing. Do not remove the weights. Replace the brake drum if the weights are missing.

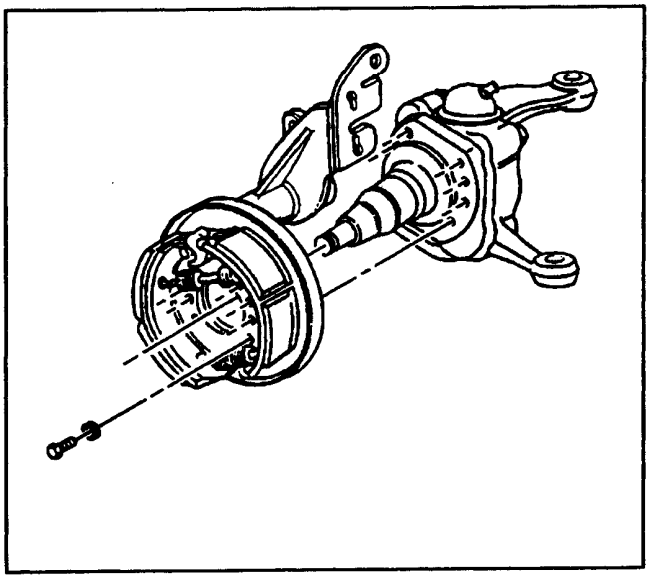
Brake Drum Refinishing

Do not rebore the brake face diameter. There is no way of knowing the number of heat cycles or severity of the cycles to which a brake drum has been subjected in actual usage.

Cam Brake Assembly Replacement (Front)

Removal Procedure

1. Block the rear wheels.
2. Drain the air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
3. Raise the front axle and support the front axle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
4. Remove the tire and wheel assembly. Refer to *Wheel Removal (Front)* in Tires and Wheels.
5. Remove the brake drum. Refer to *Brake Drum Replacement.*
6. Remove the air line from the front air brake chamber. Refer to the following procedures in Air Drums:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)* in Air Brakes.
7. Remove the wheel speed sensor (if equipped). Refer to Wheel Speed Sensor Replacement in Antilock Brakes.
8. Remove the bolts and the washers.
9. Remove the cam brake assembly from the knuckle.



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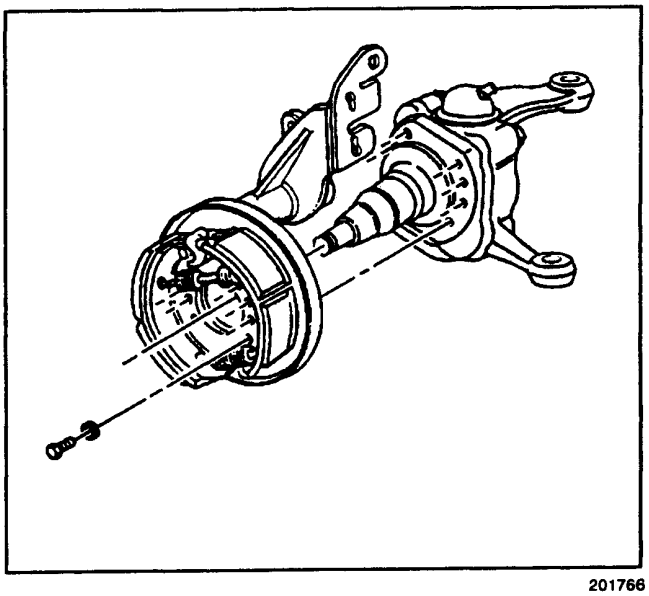
Installation Procedure

1. Install the cam brake assembly to the knuckle.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the washers and the bolts.

   Tighten

   Tighten the front brake assembly bolts to 280 N·m (206 lb ft).
3. Install the wheel speed sensor (if equipped). Refer to Wheel Speed Sensor Replacement in Antilock Brakes.
4. Install the air line to the front air brake chamber. Refer to the following procedures in Air Drums:
   - *Hose and Line Replacement (Nylon and Metal - Compression)* or
   - *Hose and Line Replacement (Nylon - Push-In)* or
   - *Hose and Line Replacement (Flexible)* in Air Brakes.
5. Install the brake drum. Refer to *Brake Drum Replacement.*
6. Adjust the front wheel bearings (if needed). Refer to *Wheel Bearing Adjustment.*
7. Install the tire and wheel assembly.
8. Remove the safety stands and lower the vehicle.
9. Start the engine.



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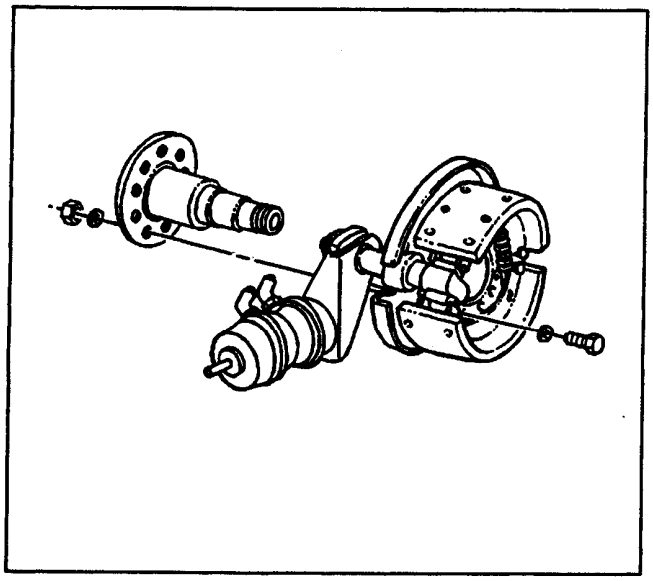

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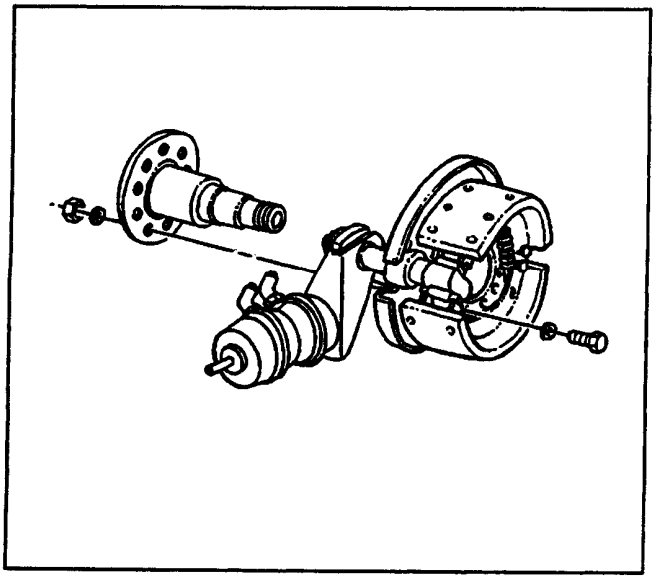
10. Charge the air system to the air compressor governor valve cut-out point.
11. Check for proper brake operation.
12. Stop the engine.
13. Set the parking brake.
14. Remove the wheel blocks.

Cam Brake Assembly Replacement (Rear)

Removal Procedure

1. Block the rear wheels.
2. Drain all air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
3. Cage the rear air brake chamber. Refer to *Caging the Rear Air Brake Chamber.*
4. Raise the rear axle and support the rear axle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
5. Remove the tire and wheel assembly. Refer to *Wheel Removal (Front)* in Tires and Wheels.
6. Remove the brake drum. Refer to *Brake Drum Replacement.*
7. Remove the air line from the rear air brake chamber. Refer to the following procedures in Air Drums:
   - *Hose and Line Replacement (Nylon and Metal - Compression)* or
   - *Hose and Line Replacement (Nylon - Push-In)* or
   - *Hose and Line Replacement (Flexible)* in Air Brakes.
8. Remove the wheel speed sensor (if equipped). Refer to Wheel Speed Sensor Replacement in Antilock Brakes.
9. Remove the bolts and the washers.
10. Remove the rear brake assembly from the rear axle.



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Installation Procedure

1. Install the rear cam brake assembly to the rear axle.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the bolts and the washers.

   Tighten

   Tighten the rear brake assembly bolts to 220 N·m (162 lb ft).
3. Install the wheel speed sensor (if equipped). Refer to Wheel Speed Sensor Replacement in Antilock Brakes.
4. Install the air line to the rear air brake chamber. Refer to the following procedures in Air Drums:
   - *Hose and Line Replacement (Nylon and Metal - Compression)* or
   - *Hose and Line Replacement (Nylon - Push-In)* or
   - *Hose and Line Replacement (Flexible)* in Air Brakes.

5. Install the brake drum. Refer to *Brake Drum Replacement.*
6. Adjust the rear wheel bearings (if needed). Refer to *Wheel Bearing Adjustment.*
7. Install the tire and wheel assembly.
8. Remove the safety stands and lower the vehicle.
9. Start the engine.
10. Charge the air system to the air compressor governor valve cut-out point.
11. Check for proper brake operation.
12. Stop the engine.
13. Set the parking brake.
14. Remove the wheel blocks.

Brake Shoe Inspection

Inspect the brake linings every 9656 km (6,000 miles) and any wheel removal, including tire rotation. Replace the brake linings before the rivet heads become exposed and score the brake drum. Replace the brake linings when the thickness of the brake lining is 6.3 mm (0.250 inches) at the thinnest point. Always replace the brake linings as a complete axle set.

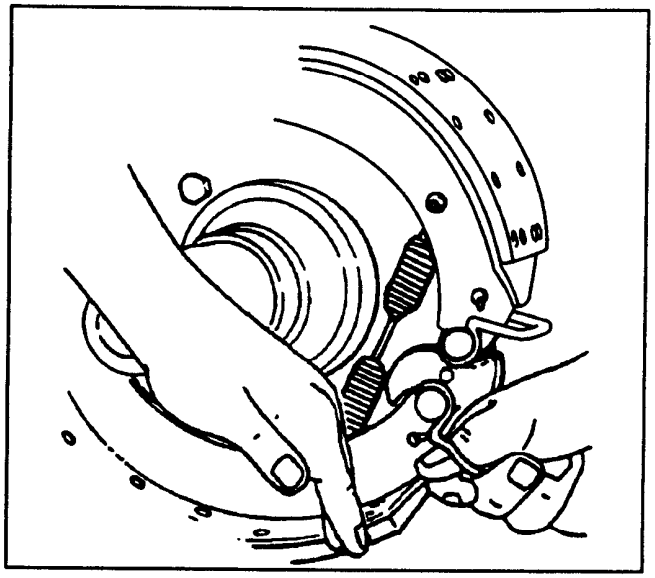
The brake linings should be free of grease and oil and show at least a 70 percent contact area over the braking surface, indicating satisfactory brake lining contact.

Caution: Avoid taking the following actions when you service wheel brake parts:

- ***Do not grind brake linings.***
- ***Do not sand brake linings.***
- ***Do not clean wheel brake parts with a dry brush or with compressed air.***

Some models or aftermarket brake parts may contain asbestos fibers which can become airborne in dust. Breathing dust with asbestos fibers may cause serious bodily harm. Use a water-dampened cloth in order to remove any dust on brake parts. Equipment is available commercially in order to perform this washing function. These wet methods prevent fibers from becoming airborne.

Remove any shiny glazed spots with an emery cloth while wearing a dust mask. Wipe the brake lining clean with a damp cloth.



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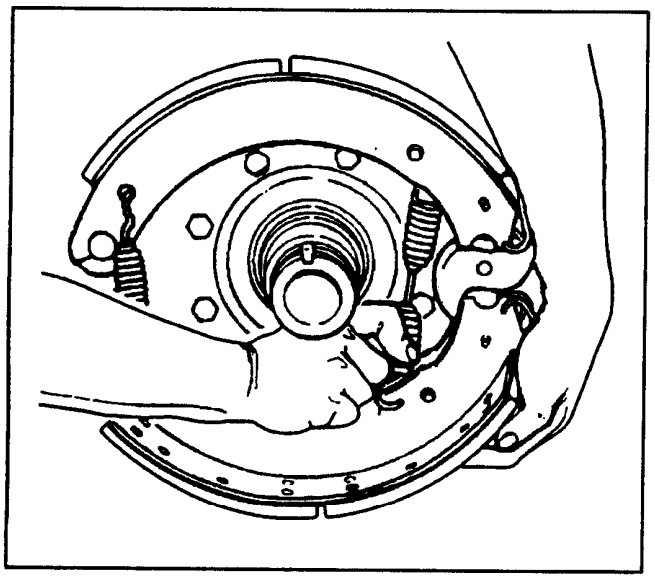
Brake Shoe Replacement

Removal Procedure

Replacement brake lining material is recommended for all vehicles in order to maintain the balance between the front and the rear brake performance. Replacement brake parts have been carefully selected in order to provide the proper brake balance in order to improve stopping distance and in order to provide brake control over the full range of the operating conditions. Installation of the front or the rear brake lining material with performance different from those of Replacement parts recommended for this vehicle can change the intended brake balance of this vehicle.

1. Block the wheels.
2. Drain all air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
3. Cage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
4. Raise the vehicle and support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
5. Remove the tire and wheel assembly. Refer to *Wheel Removal (Front)* in Tires and Wheels.
6. Remove the brake drums. Refer to *Brake Drum Replacement.*
7. Push down on the bottom brake shoe.
8. Pull on the brake shoe roll retainer in order to remove the bottom brake shoe roller.
9. Lift the bottom brake shoe in order to release the tension on the brake shoe return spring.
10. Remove the brake shoe return spring.



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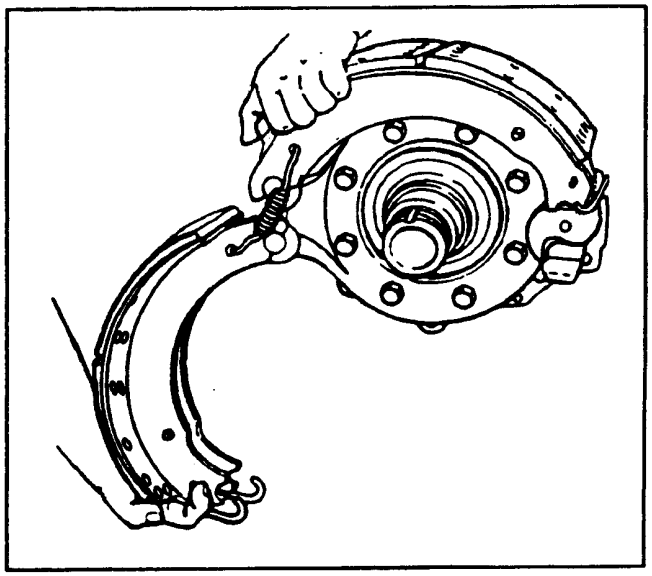
11. Rotate the bottom brake shoe in order to release the tension on the two retaining springs.



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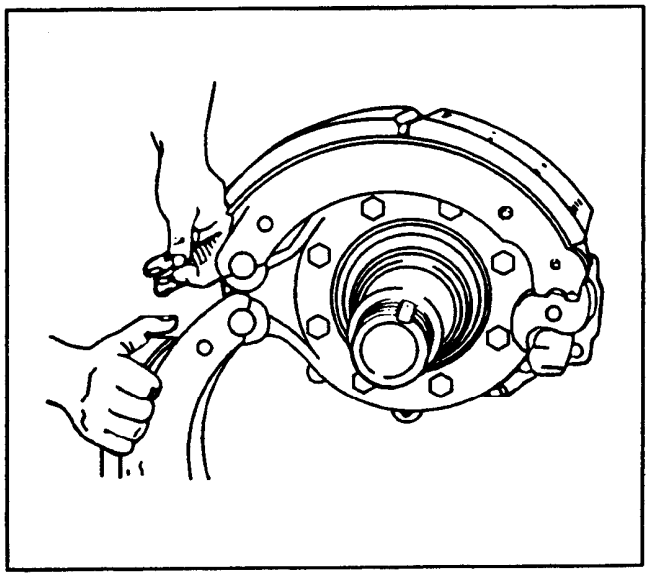
12. Remove the retaining springs.
13. Remove the brake shoes.



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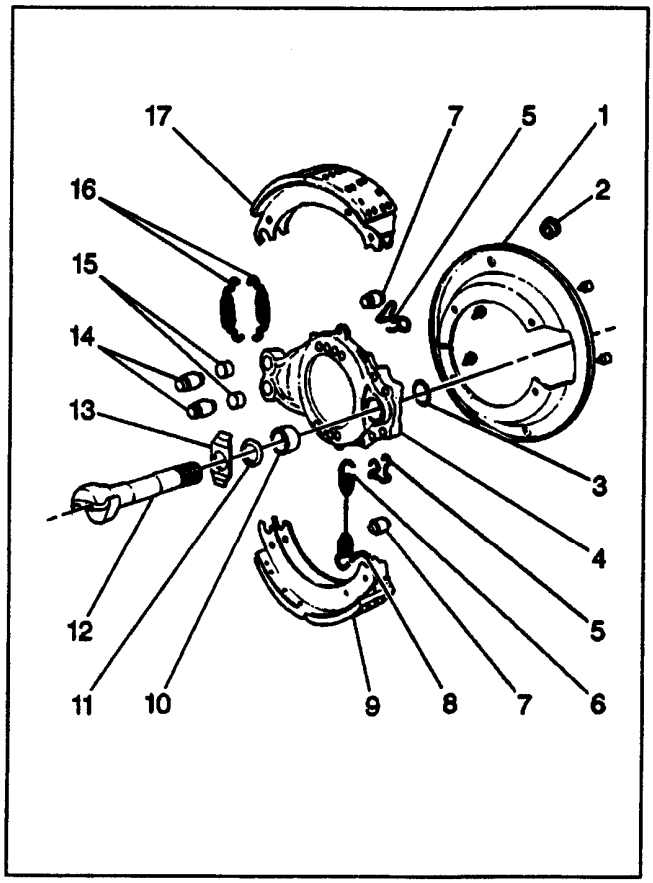

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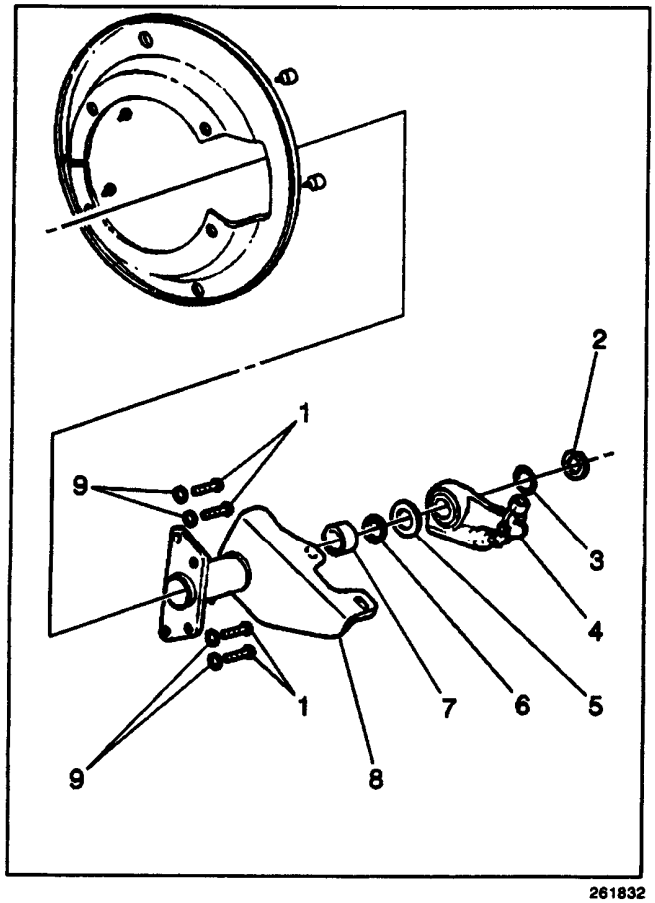
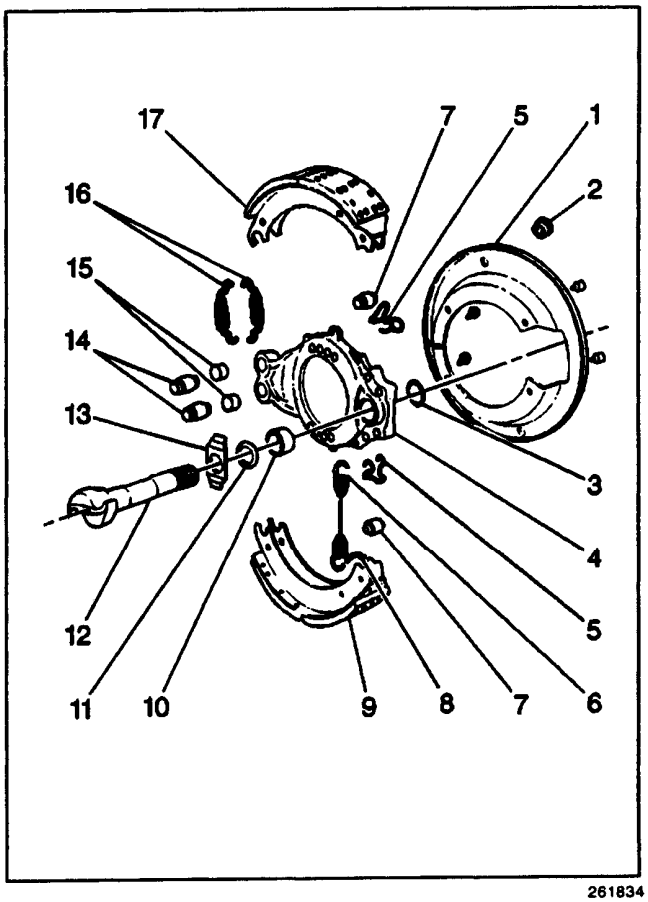
14. Inspect the brake spider (4) for expanded anchor pin holes and for cracks.
    Replace damaged brake spiders (4) and the anchor pin bushings (15).



261832

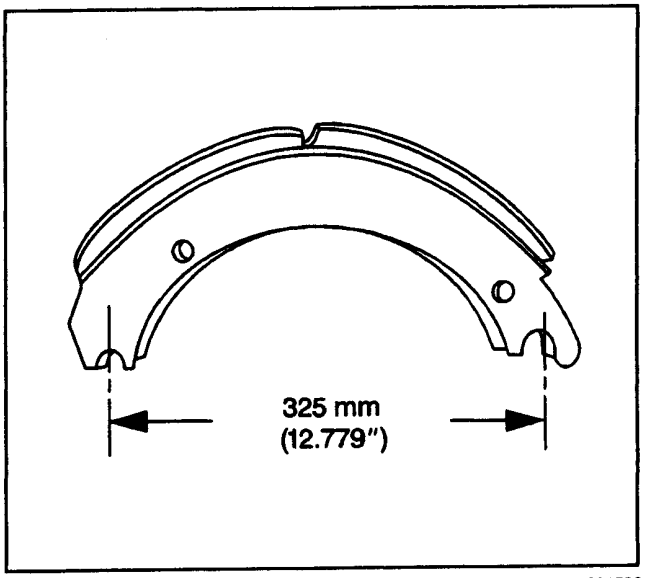
15. Inspect the brake chamber/camshaft support bracket (8) for the following conditions:
    Replace damaged brake chamber/camshaft support brackets (8).
    - Broken welds
    - Cracks
    - Misalignment

16. Inspect the anchor pins (14) for corrosion and wear.
    Replace damaged anchor pins (14).
17. Inspect the camshaft (12) for the following conditions:
    Replace damaged camshafts (12).
    - Cracks
    - Wear
    - Corrosion
18. Inspect the brake drums. Refer to *Brake Drum Inspection.*

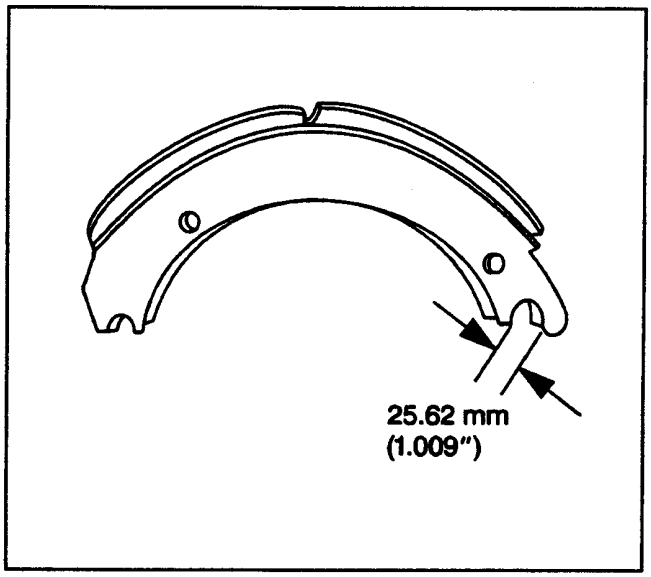


261834

19. Measure the brake shoe anchor pin to the brake shoe roller hole span distance on the 419 mm (16.5 in) diameter brake shoes.
20. Replace the brake shoe if the distance from the center of the brake shoe anchor pin slot to the center of the brake shoe roller slot is more than 325 mm (12.779 in).

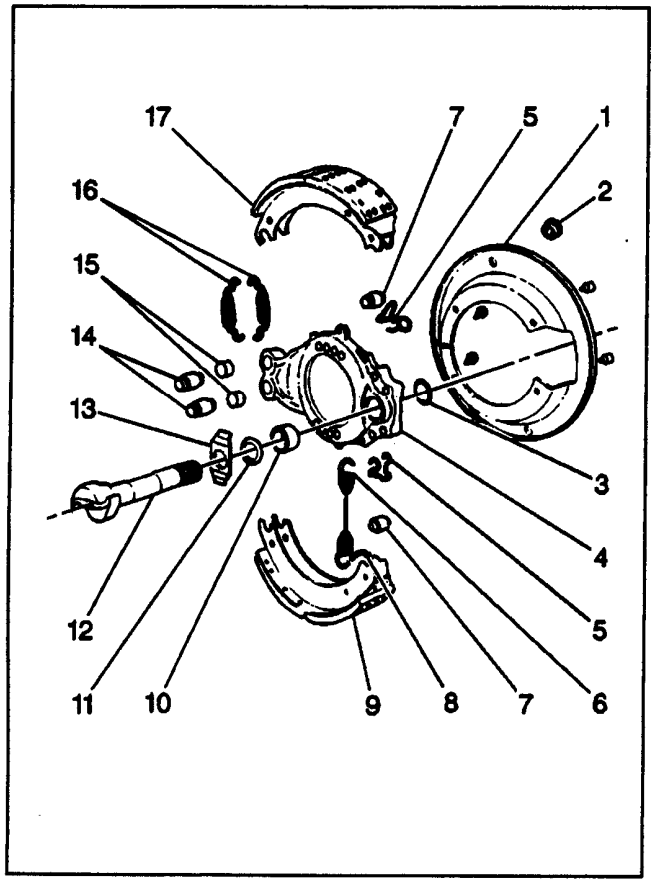


201783



201786

21. Measure the brake shoe anchor pin to the brake shoe roller hole span distance on the Rockwell 419 mm (16.5 in) diameter brake shoe.
22. Replace the brake shoe if the brake shoe anchor pin hole diameter is more than 25.62 mm (1.009 in).

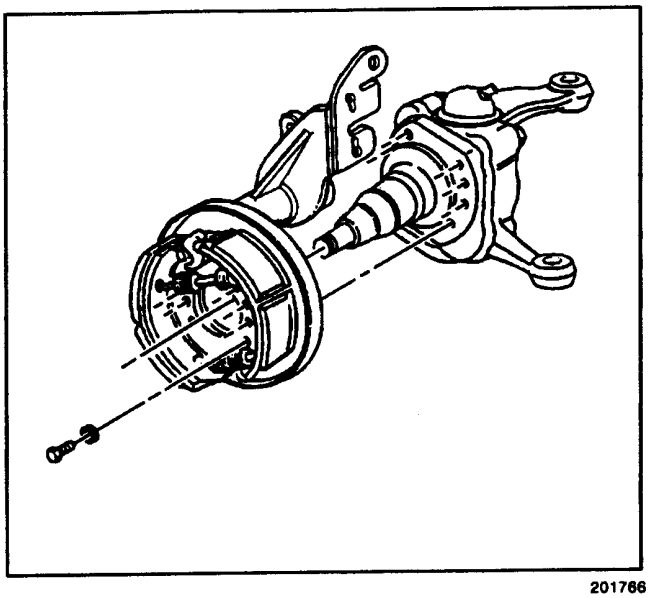


261834

23. Disassemble the brake lining (17) from the brake shoe.
24. Drill out the rivets.

Caution: Refer to Brake Dust Caution in Cautions and Notices.

25. Clean the burrs and the high spots from the brake shoe with a file.
26. Clean the brake shoe and the brake lining contact surfaces.



201766

Installation Procedure

1. Install the primary brake lining on the primary brake shoe.

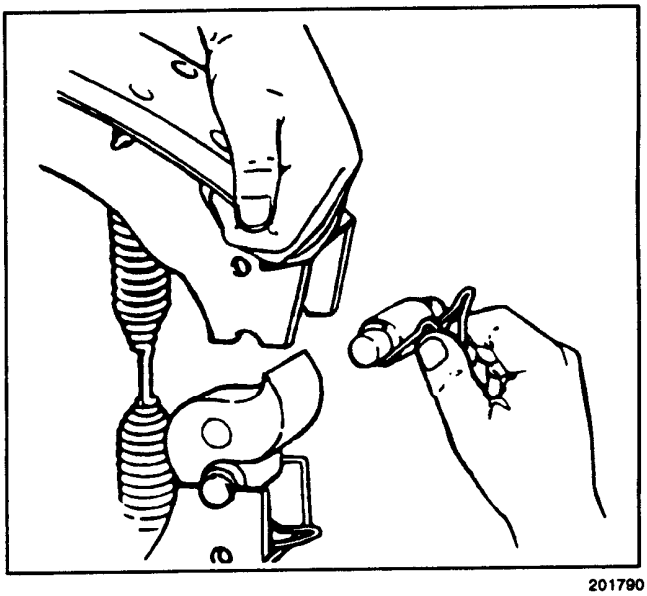
   The first brake shoe past the cam in the direction of the wheel rotation is the primary brake shoe. The primary and the secondary brake shoes may be in either position, depending on the location of the cam. If the cam is behind the axle, the top brake shoe is the primary brake shoe and the lower brake shoe is the secondary brake shoe. If the cam is in front of the axle, the lower brake shoe is the primary brake shoe.
2. Follow the rivet machine manufacturer's instructions.

   The brake lining to the brake shoe gap at both ends and both sides must not exceed 0.25 mm (0.010 in).

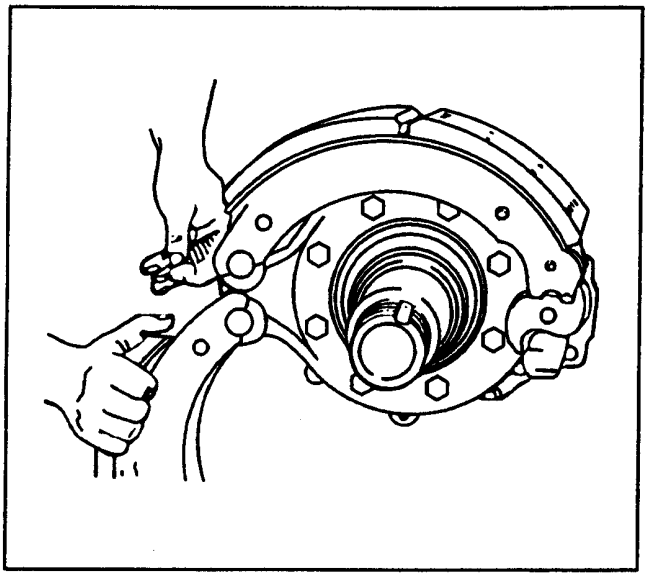
   The brake lining to the brake shoe gap between webs at both ends must not exceed 0.64 mm (0.025 in).
3. Assemble the new brake lining onto the brake shoe.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
4. Apply chassis to the anchor pins where the anchor pins touch the brake shoes.

   Important: Do not get grease on the part of the brake shoe roller that touches the camshaft.
5. Apply lubricant to the brake shoe rollers where the brake shoe rollers touch the brake shoes. Use a chassis lubricant.

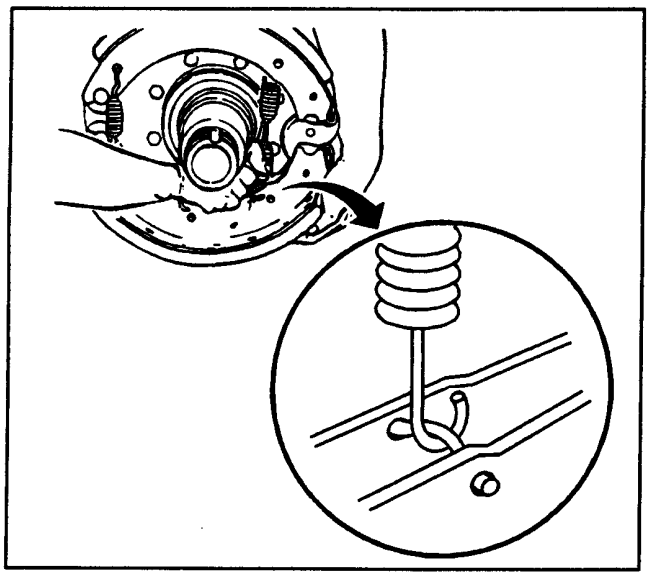


201790



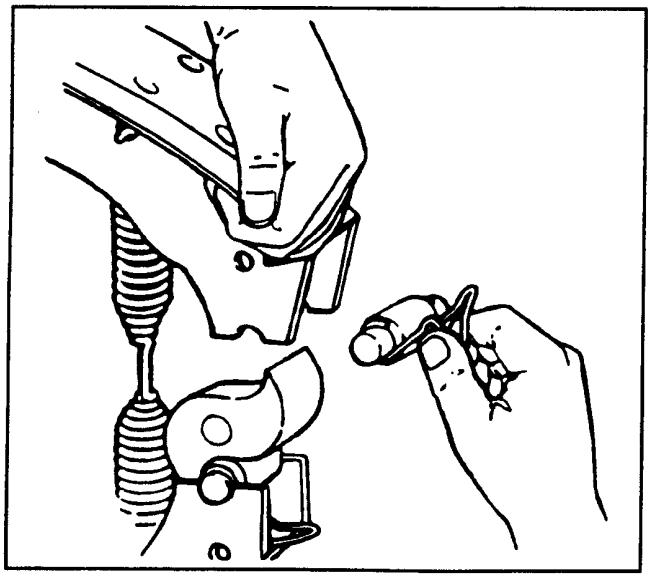
201781

6. Put the upper brake shoe in position on the top anchor pin.
7. Hold the lower brake shoe on the bottom anchor pin.
8. Install the two new brake shoe retaining springs.



201788

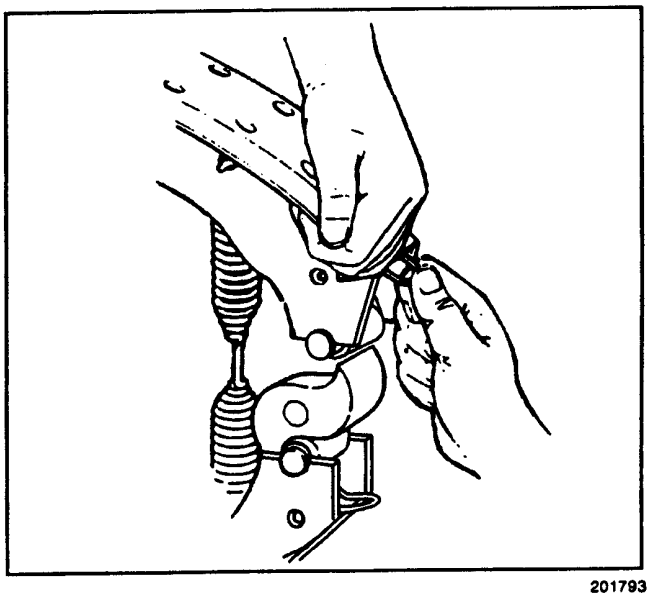
9. Rotate the lower brake shoe forward.
10. Install the new brake shoe return spring.
11. Install the open end of the return spring hooks toward the camshaft.



201790

12. Pull each brake shoe away from the camshaft in order to allow enough space for the brake shoe rollers and the brake shoe retainers.
13. Press the ears of the brake shoe retainer together in order to allow the brake shoe retainer to fit between the brake shoe webs.

14. Push the brake shoe retainer into the brake shoe web until the ears lock in the holes in the brake shoe webs.
15. Install the brake drums. Refer to *Brake Drum Replacement.*
16. Adjust the wheel bearings, if needed. Refer to *Wheel Bearing Adjustment.*
17. Install the tire and wheel assemblies. Refer to the following procedures in Tires and Wheels:
    - *Wheel Installation (Front)* in Tires and Wheels.
    - *Wheel Installation (Dual/Rear)* in Tires and Wheels.
18. Remove the safety stands and lower the vehicle.
19. Start the engine.
20. Charge the air system to the air compressor governor valve cut-out point.
21. Stop the engine.
22. Adjust the brakes. Refer to the following procedures:
    - *Air Drum Brake Adjustment (Pushrod Stroke Measurement).*
    - *Air Drum Brake Adjustment (Normal Wear Adjustment).*
23. Uncage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
24. Check for proper brake operation.
25. Set the parking brake.
26. Remove the wheel blocks.



201793

Brake Camshaft Replacement

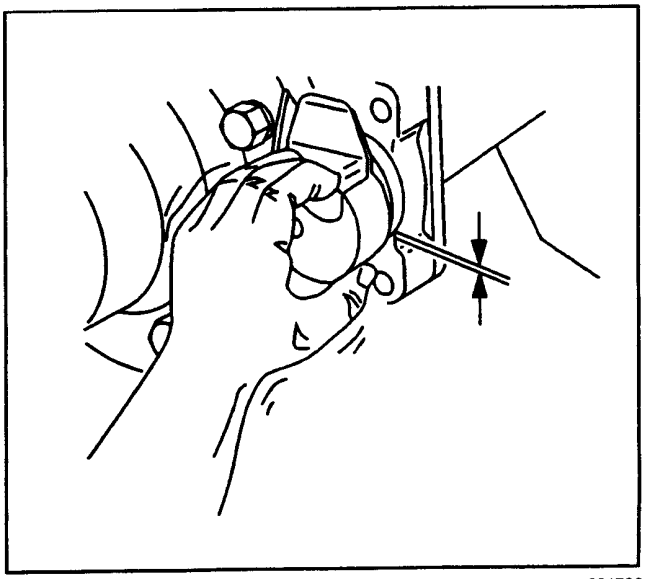
Removal Procedure

Lubricate the camshaft and check the camshaft for wear during brake realignment. The brake chamber/camshaft support bracket includes the following components:

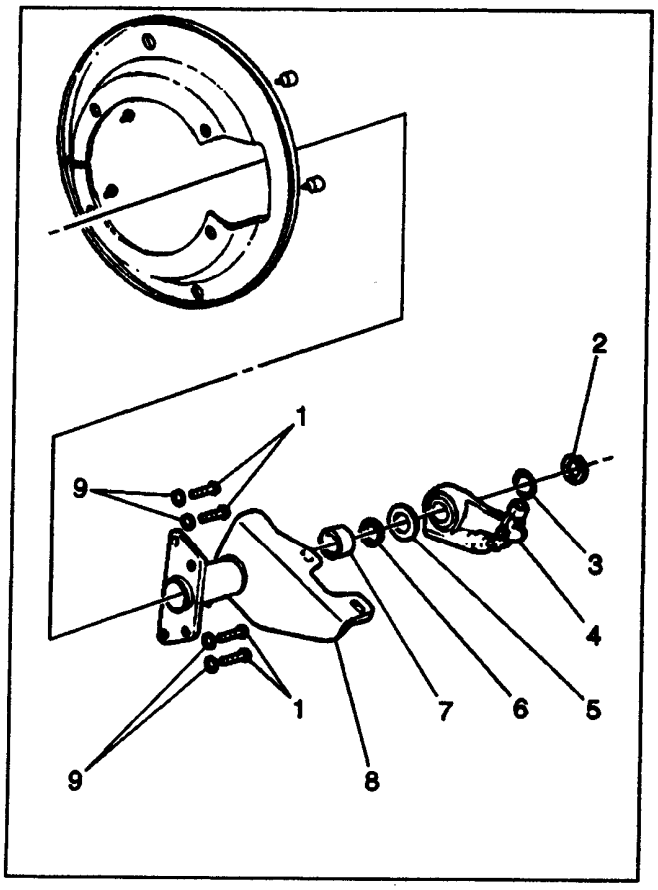
- Two bushings
- Two camshaft seals
- A lubrication fitting

The space between the bushings serves as the lubricant reservoir. Apply lubricant sparingly at the specified intervals. Refer to *Maintenance Schedule* in Maintenance and Lubrication.

1. Remove the brake linings. Refer to *Brake Shoe Replacement.*
2. Check the up-and-down and the side-to-side end play of the camshaft in order to determine if the camshaft bushings need replacement. Replace the camshaft bushings if the total movement is more than 0.76 mm (0.030 in).

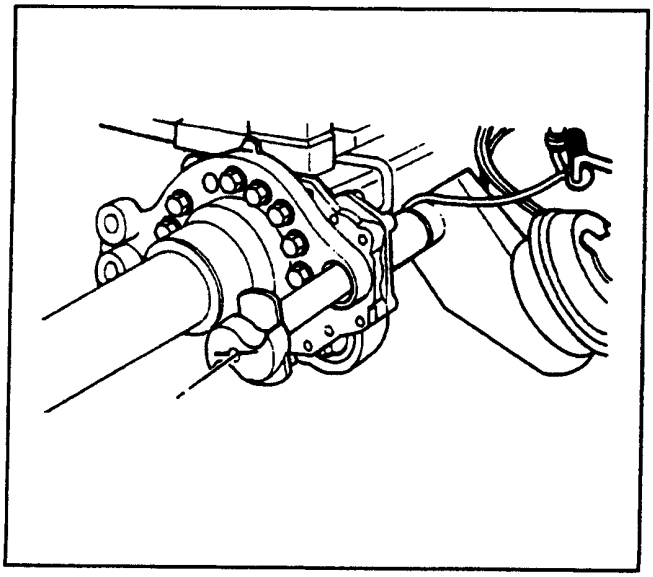


201796



261832

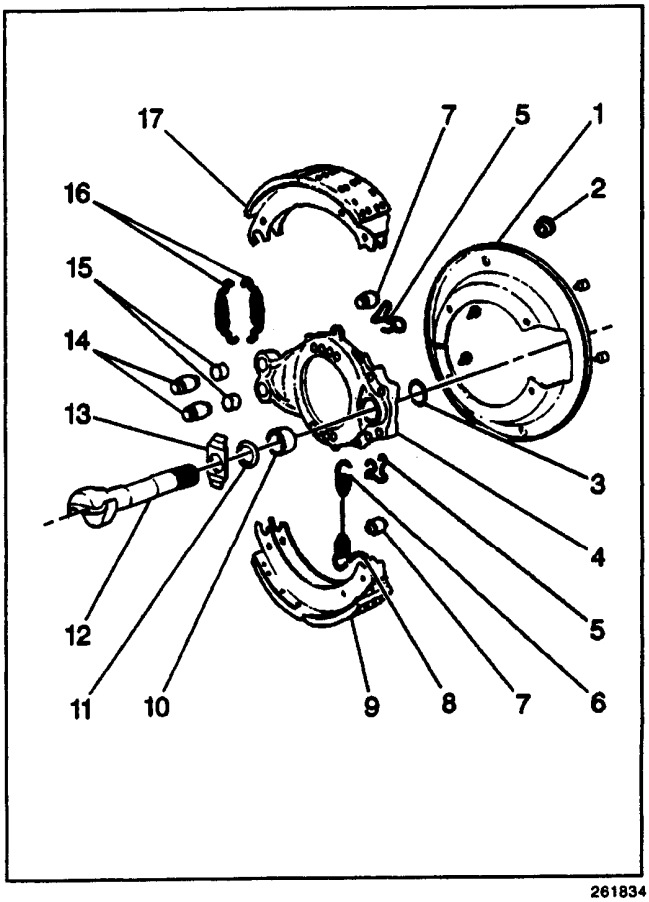
3. Remove the slack adjuster (4). Refer to *Air Brake Automatic Slack Adjuster Replacement (Rockwell)* or *Air Brake Automatic Slack Adjuster Replacement (Eaton)*.



201797

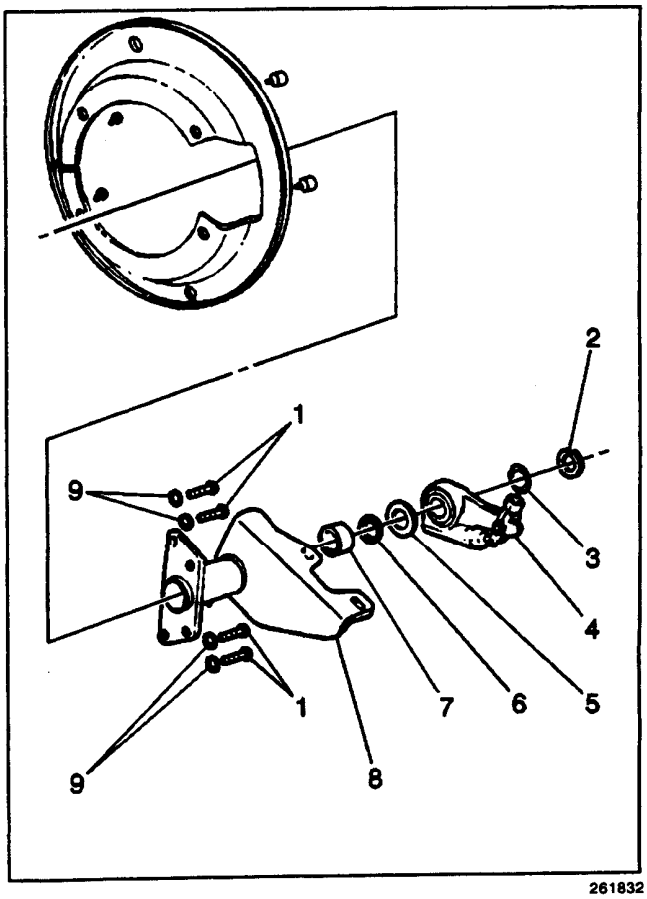
4. Pull the camshaft out from the brake chamber/camshaft support bracket.
5. Remove the camshaft.

6. Remove the camshaft seals (11).
7. Remove the camshaft bushings if needed (10).
8. Clean the old grease from the camshaft (12).



261834

9. Clean the old grease from the chamber/camshaft support bracket (8).



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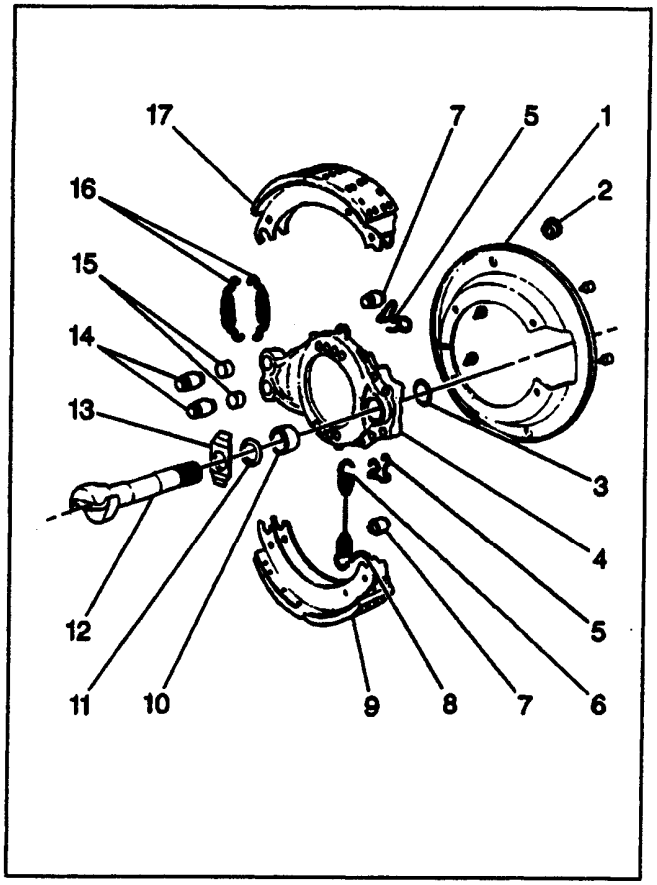


261834

10. Inspect the camshaft bearing surface areas for wear and corrosion.

    Replace the camshaft (12) if the camshaft bearing surfaces show signs of wear or roughness.

11. Inspect the cam head for wear or flat spots on the roller surfaces.

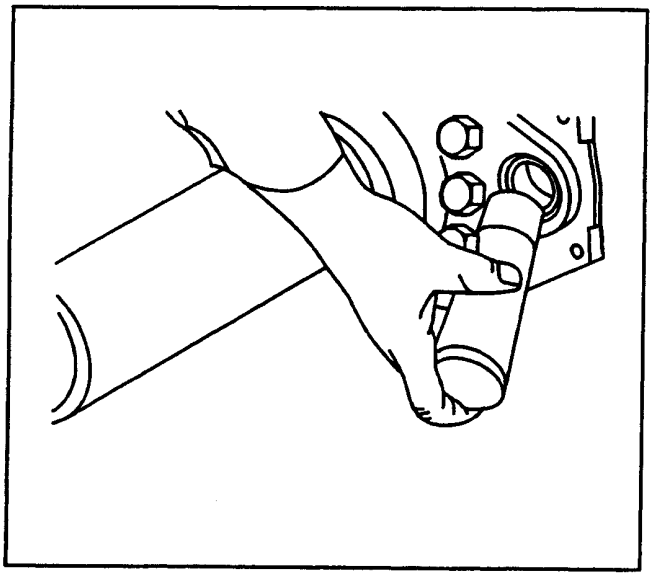
    Replace the camshaft (12) if any obvious wear or flat spots exist.

12. Inspect the camshaft splines for damage or wear.

    Replace the camshaft (12) if the camshaft splines are damaged.

13. Inspect the camshaft bushings (10) for deterioration.

    Replace the camshaft bushings (10) if needed.



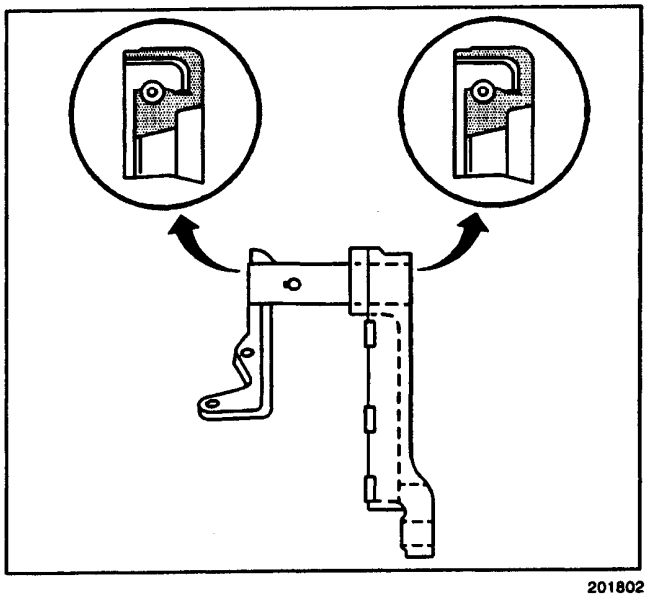
201800

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

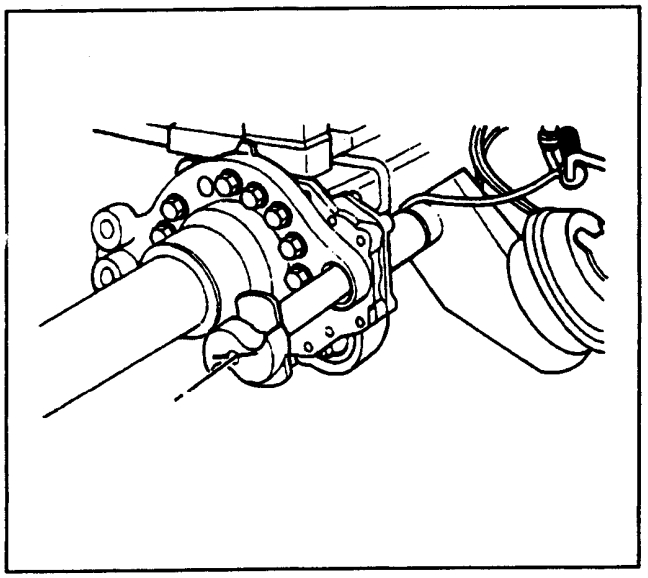
1. Install the camshaft bushings if needed.
2. Drive the camshaft bushings into the brake chamber/camshaft support bracket with a seal driver.

3. Install the new camshaft seals with the camshaft seal lips toward the slack adjuster.



201802

4. Apply a coat of grease to the camshaft bushings.
5. Install the camshaft.
6. Install the slack adjuster. Refer to the following procedures:
   - *Air Brake Automatic Slack Adjuster Replacement (Rockwell)* or
   - *Air Brake Automatic Slack Adjuster Replacement (Eaton).*
7. Install the brake linings. Refer to *Brake Shoe Replacement.*



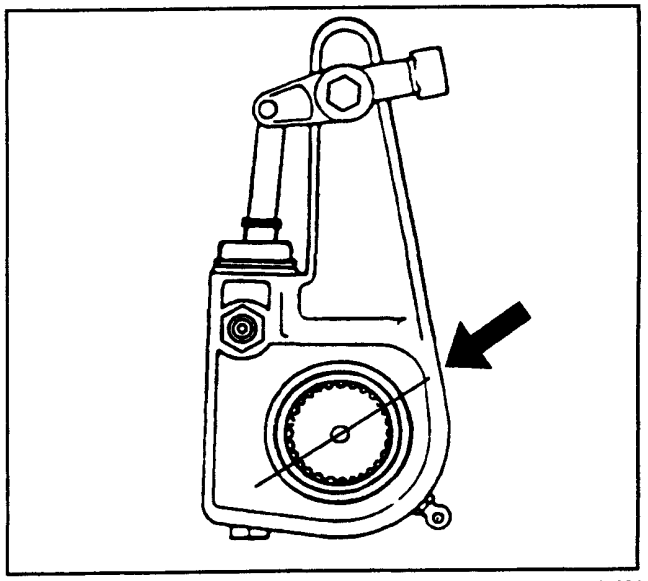
201797

Air Brake Automatic Slack Adjuster Replacement (Rockwell)

Removal Procedure

Important: For unit repair information on the Rockwell air brake automatic slack adjuster contact the Rockwell Field Support Center at 1–800–535–5560.

1. Block the wheels.
2. Cage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
3. Drain all of the air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
4. Raise the vehicle and support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
5. Mark the position of the slack adjuster to the camshaft by drawing a straight line on both components.



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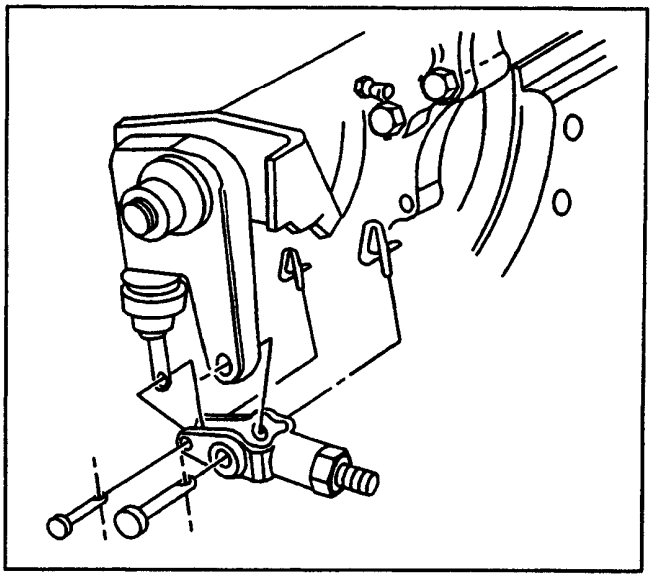
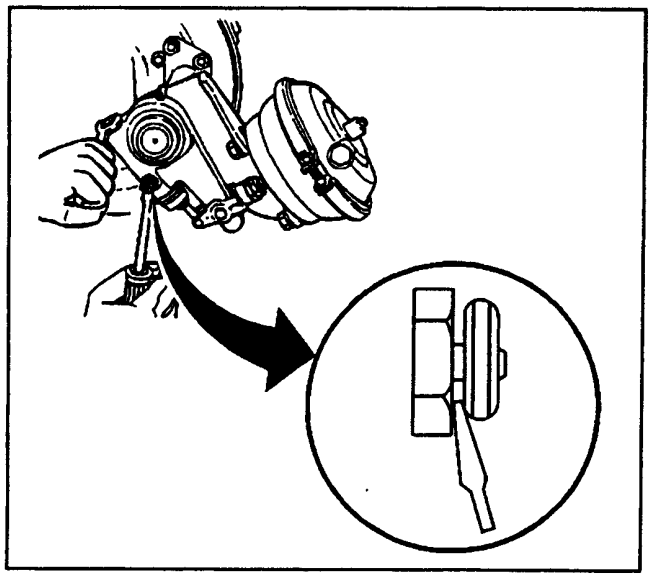


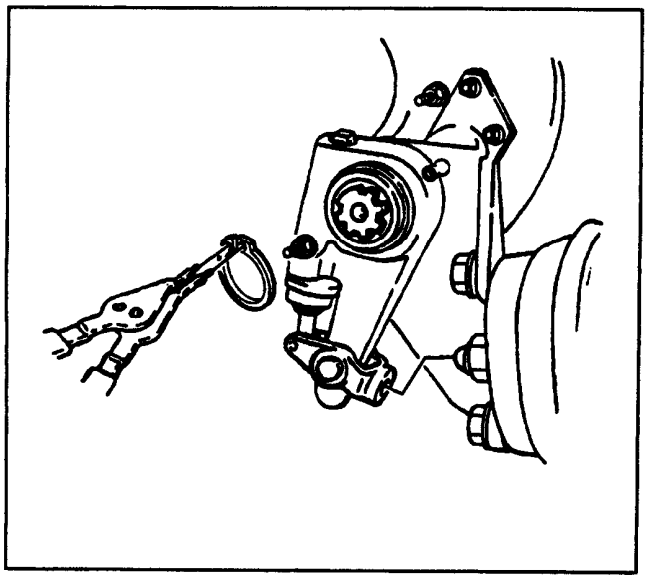
201809

6. Remove the retainers.
7. Remove the air brake chamber clevis pins.



201765

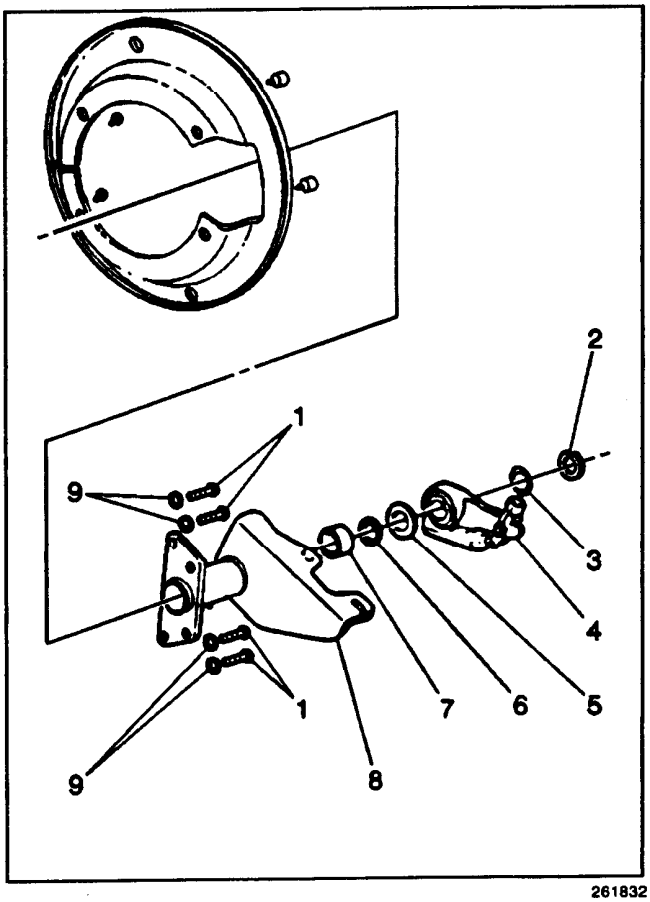
8. In order to fully release the air brake automatic slack adjuster, adhere to the following steps:
   - 8.1. Disengage the pawl with a screwdriver.
   - 8.2. Turn the slack adjuster adjusting nut until the air brake automatic slack adjuster is free from the air brake chamber clevis.
   - 8.3. Release the pawl so that the pawl snaps into engagement.



201813

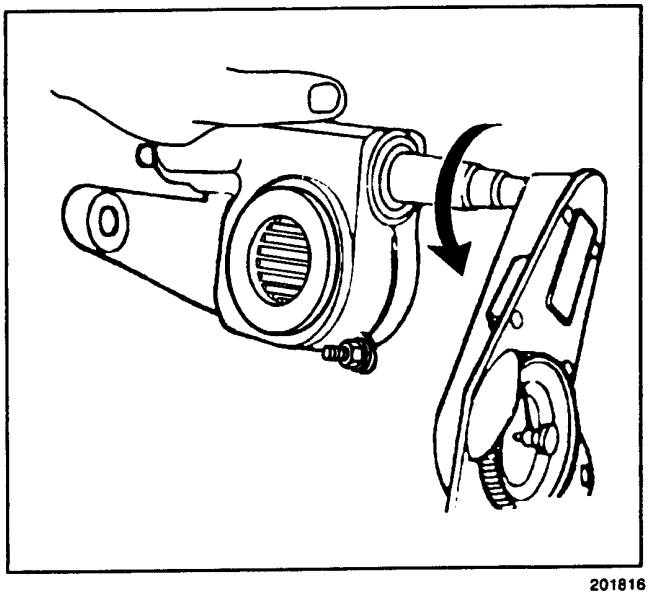
9. Remove the camshaft snap ring.

10. Remove the camshaft washer(s) (5).
11. Remove the slack adjuster (4).



261832

12. In order to check the slack adjuster adjusting nut torque, adhere to the following steps:
    12.1. Use a pound inch torque wrench in order to rotate the air brake automatic slack adjuster adjusting nut counterclockwise.
    12.2. Turn the air brake automatic slack adjuster gear 360 degrees (22 rotations of the air brake automatic slack adjuster adjusting nut). The torque must remain less than 4.51 N.m (40 lb in). Overhaul or replace the air brake automatic slack adjuster if the torque specification is exceeded.



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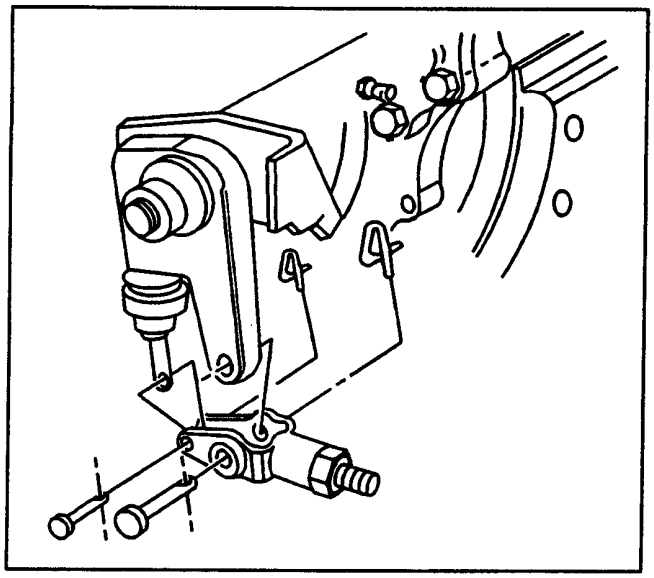
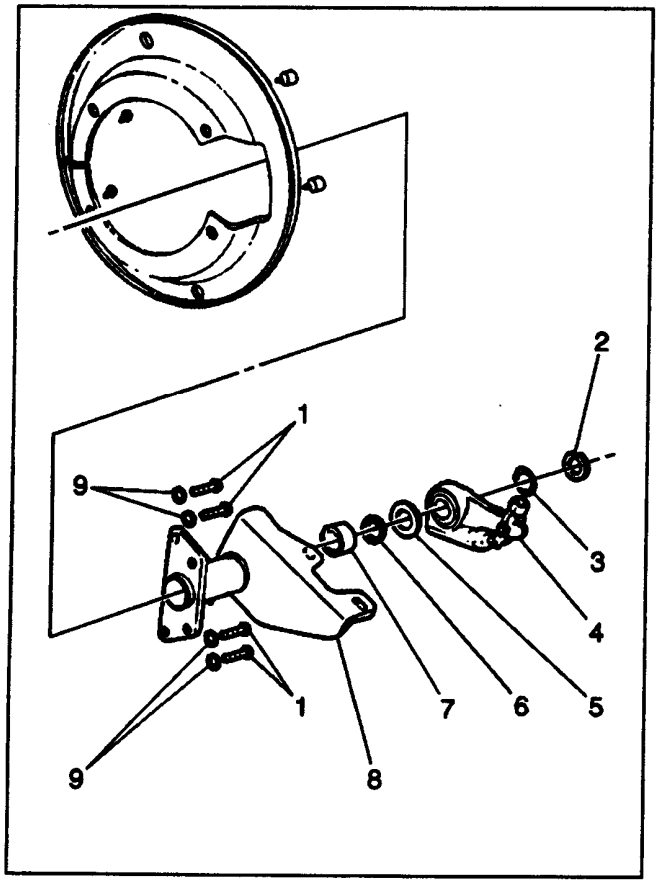


201809

13. Inspect the air brake chamber clevis pins for wear or damage.
    Replace the air brake chamber clevis pins if necessary.

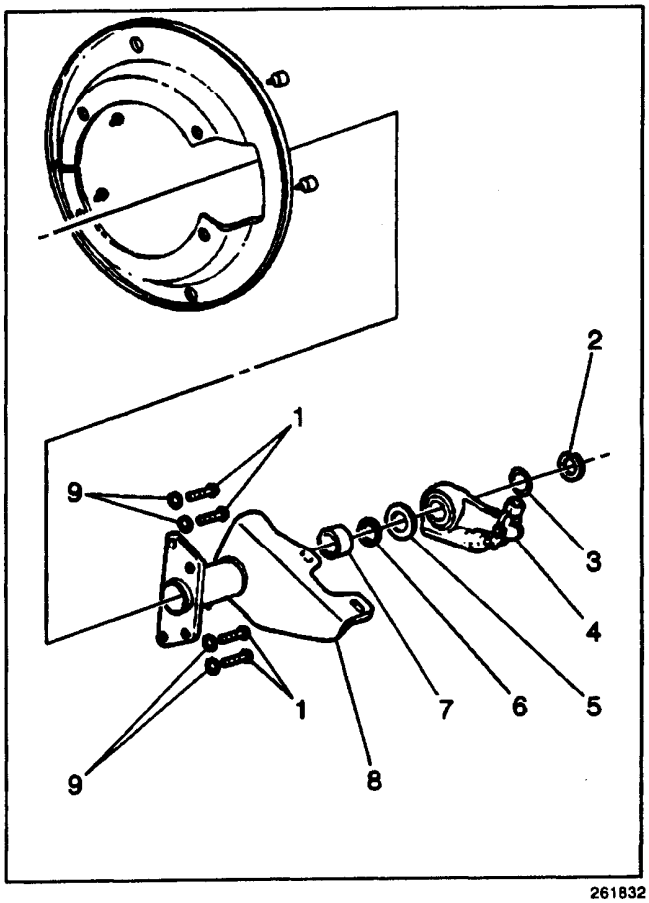


261832

14. Measure the bushing in the arm of the slack adjuster (4).
    Replace the bushings if the diameter exceeds 13.5 mm (0.531 in).

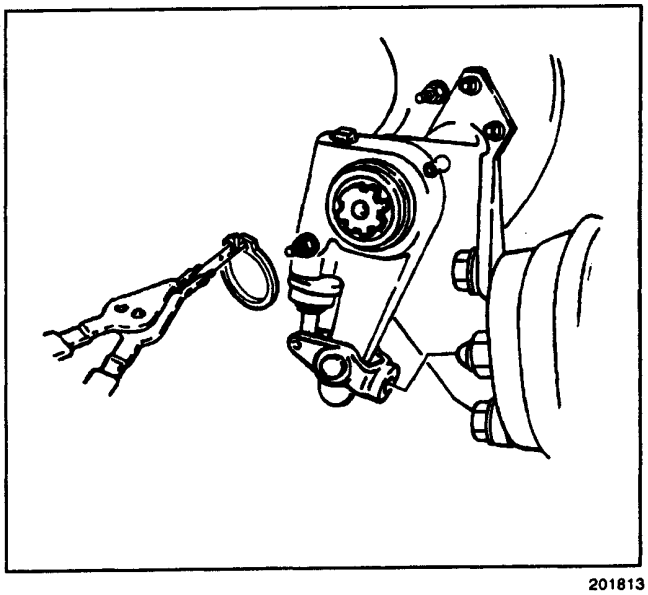
Installation Procedure

1. Install the slack adjuster (4) to the camshaft.
2. Install the camshaft washer(s) (5).



261832

3. Install the camshaft snap ring.



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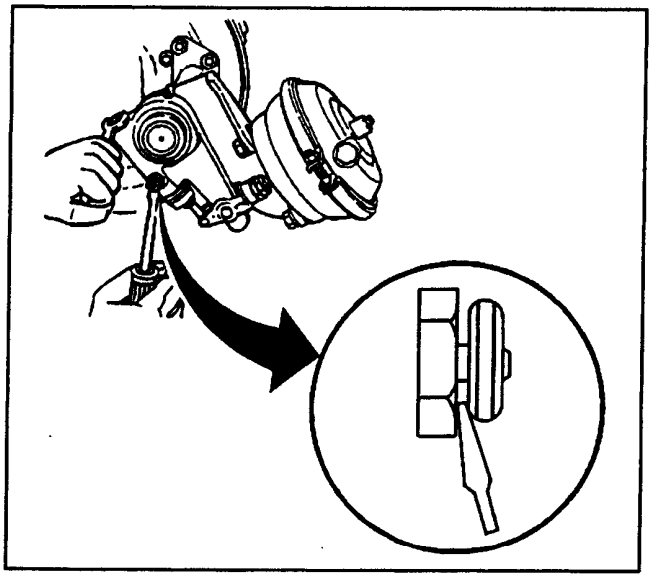
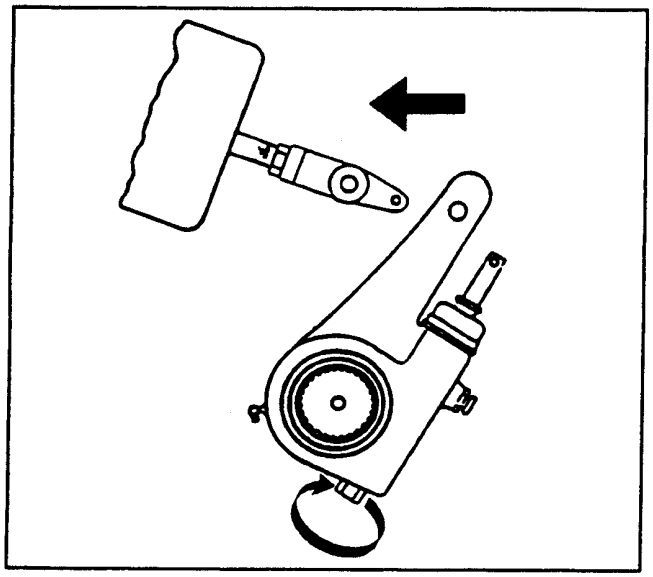


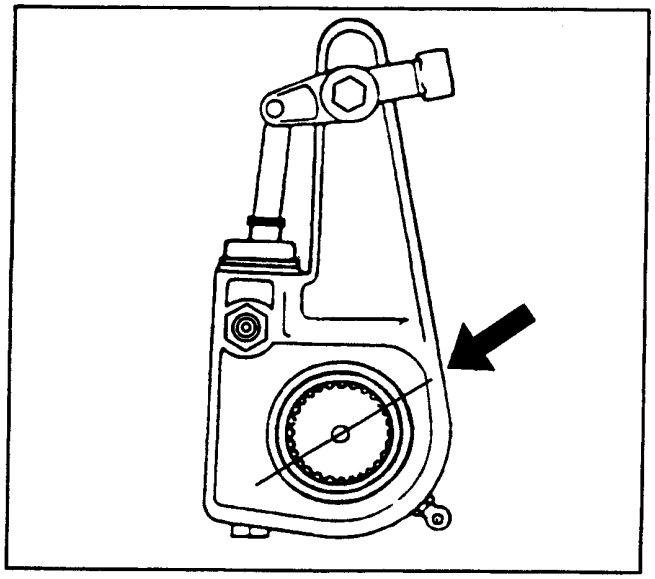
201765

4. Disengage the pawl assembly with a screwdriver.



201817

5. Turn the slack adjuster adjusting nut until the air brake automatic slack adjuster arm is properly aligned with the holes in the air brake chamber clevis.
6. Release the pawl so that the pawl snaps into engagement.

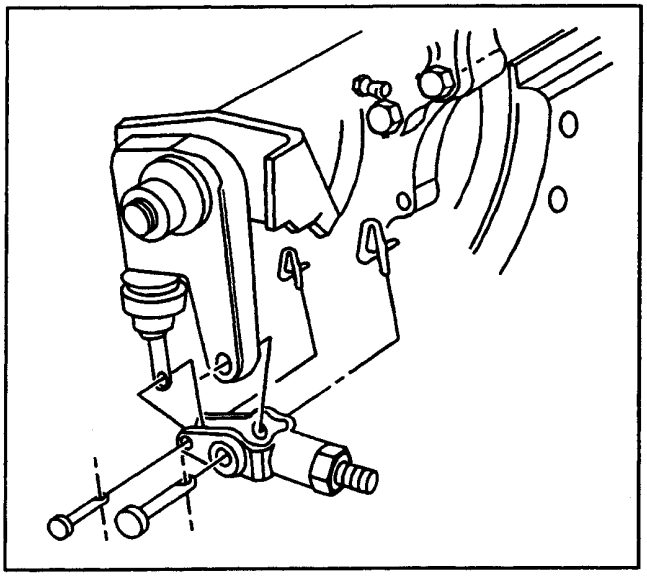


201804

7. Align the marks made on the slack adjuster and the camshaft.
8. Fully release the slack adjuster.

9. Install the air brake chamber clevis pins.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
10. Install the new retainers.
11. Adjust the brakes. Refer to the following procedures:
    - *Air Drum Brake Adjustment (Pushrod Stroke Measurement).*
    - *Air Drum Brake Adjustment (Normal Wear Adjustment).*
12. Remove the safety stands and lower the vehicle.
13. Uncage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
14. Check for proper brake operation.
15. Set the parking brake.
16. Remove the wheel blocks.



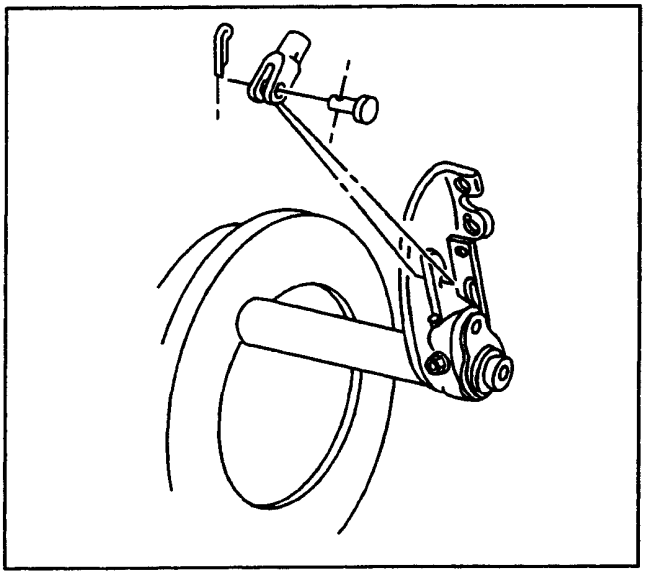
201809

Air Brake Automatic Slack Adjuster Replacement (Eaton)

Removal Procedure

Important: The Eaton® air brake automatic slack adjuster is not serviceable. Replace any damaged Eaton air brake automatic slack adjusters.

1. Block the wheels.
2. Cage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
3. Drain all air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
4. Remove the retainer.
5. Remove the air brake chamber clevis pin cotter pin.
6. Remove the air brake chamber clevis pin.
7. Fully release the slack adjuster by turning the slack adjuster counterclockwise until the slack adjuster arm is free from the air brake chamber clevis.
8. Remove the slack adjuster control arm nut and the washer.



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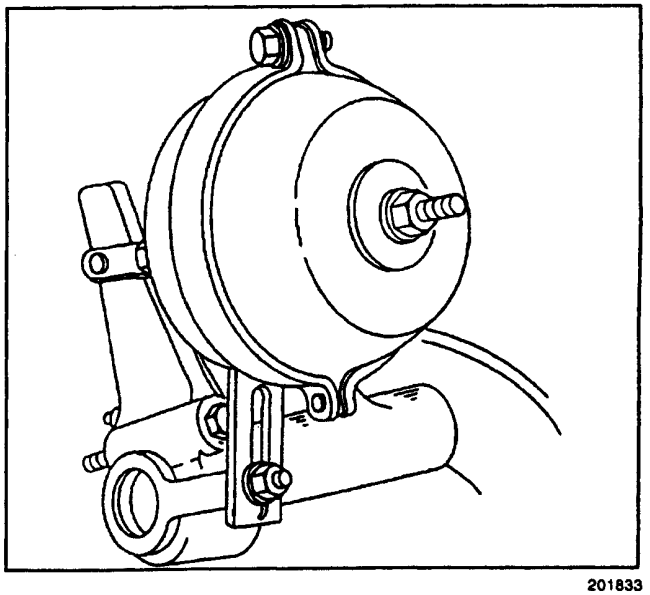
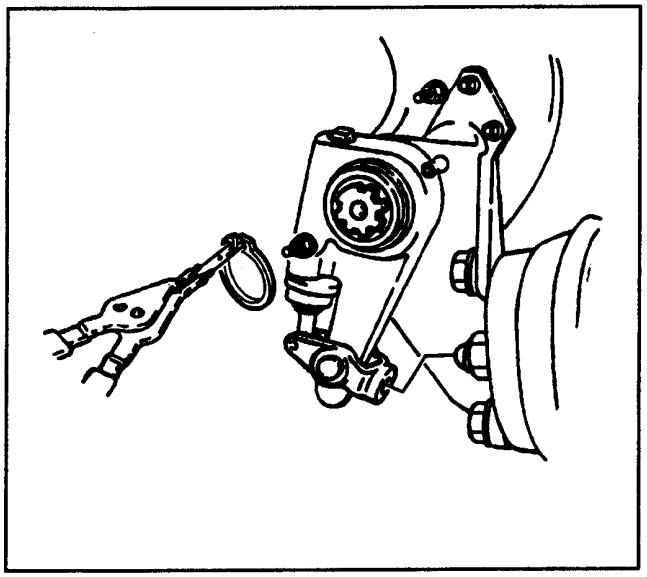
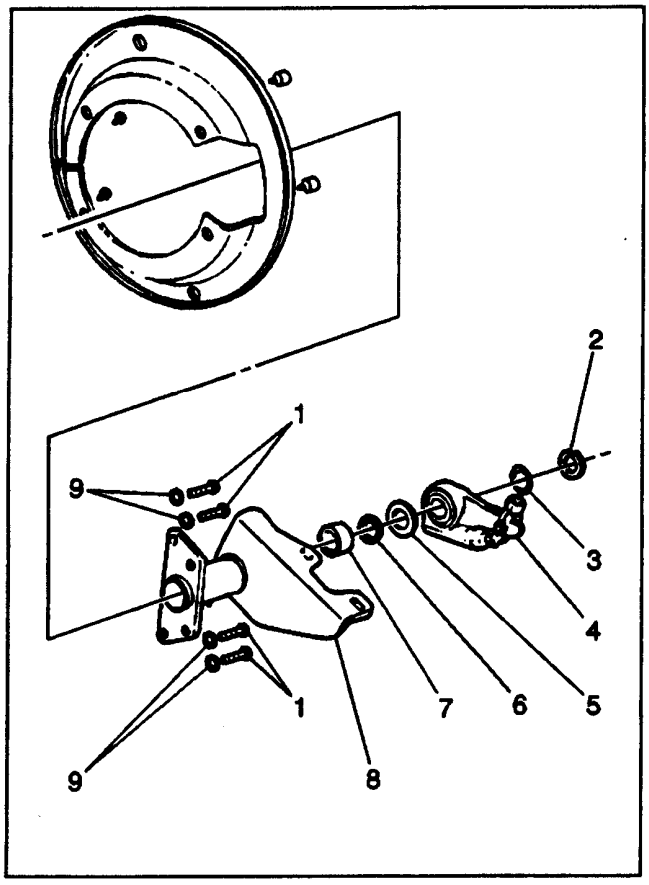


201833



201813

9. Remove the camshaft snap ring.



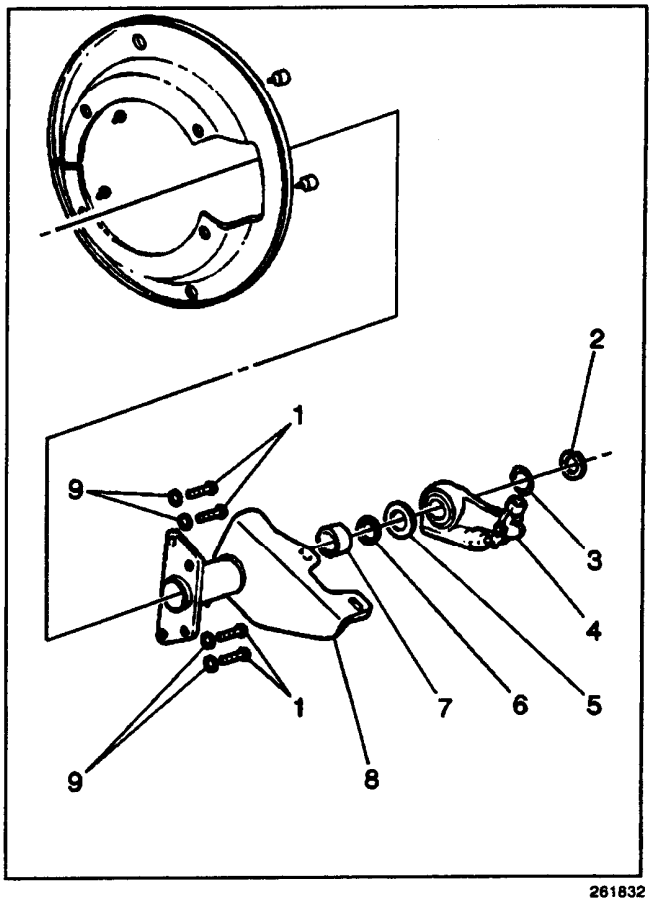
261832

10. Remove the camshaft washer(s) (5).
11. Remove the slack adjuster (4).
12. Inspect the slack adjuster (4) for damage or excessive wear.

    Replace the slack adjuster (4) if damage or excessive wear is present.

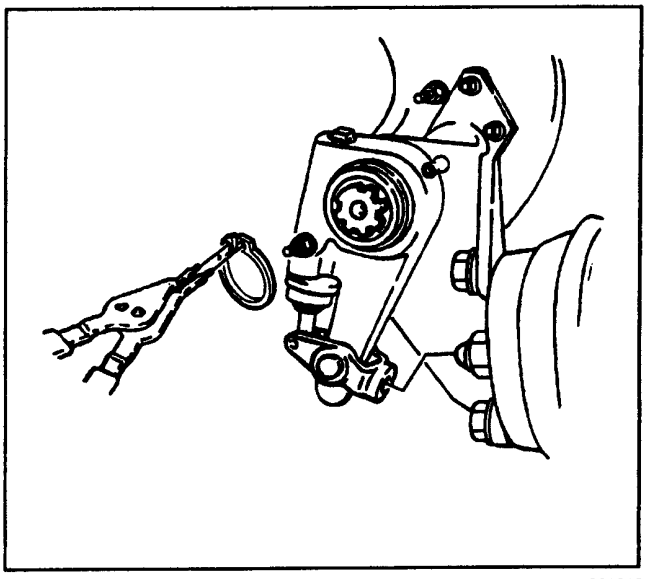
Installation Procedure

1. Lubricate the camshaft splines with anti-seize lubricant.
2. Install the slack adjuster (4) to the camshaft.
3. Install the camshaft washer(s) (5).

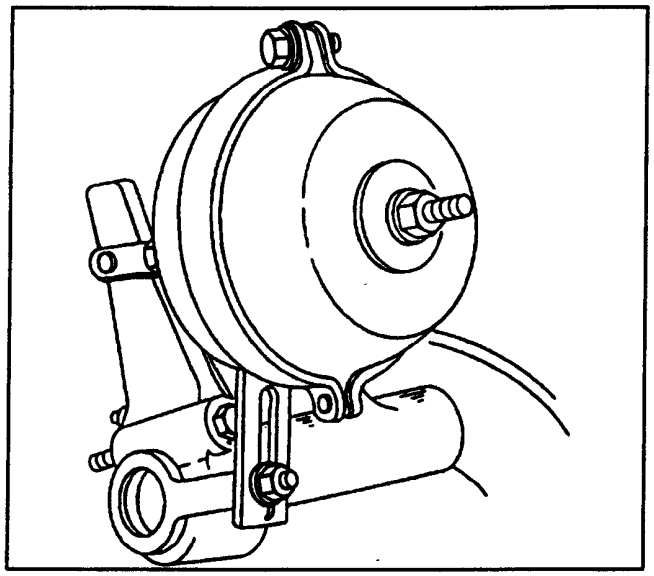


261832

4. Install the camshaft snap ring.

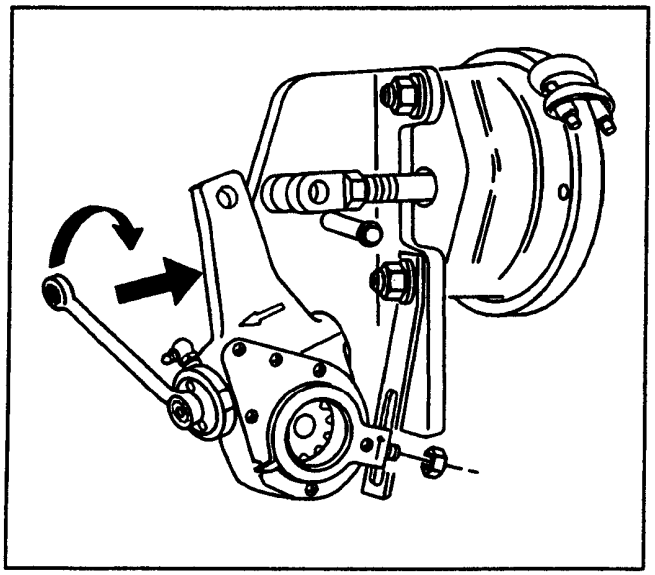


201813



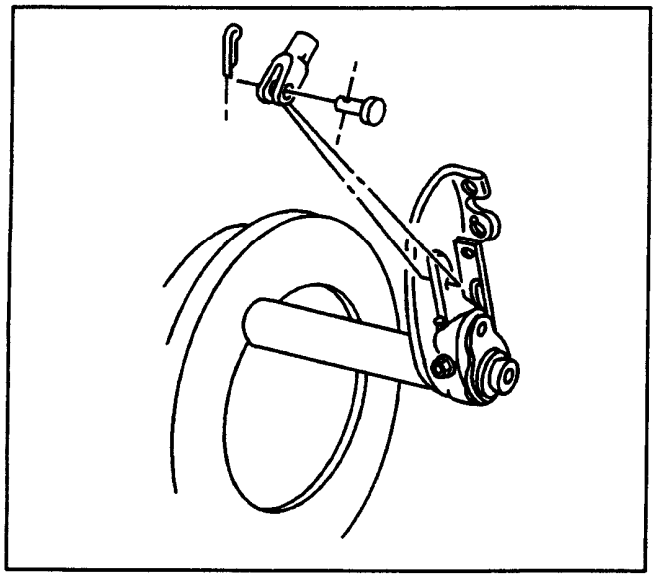
201833

5. Install the slack adjuster control arm washer.
6. Loosely install the slack adjuster control arm nut.



201826

7. Rotate the slack adjuster adjusting hex clockwise until the slack adjuster arm hole aligns with the air brake chamber clevis hole.



201820

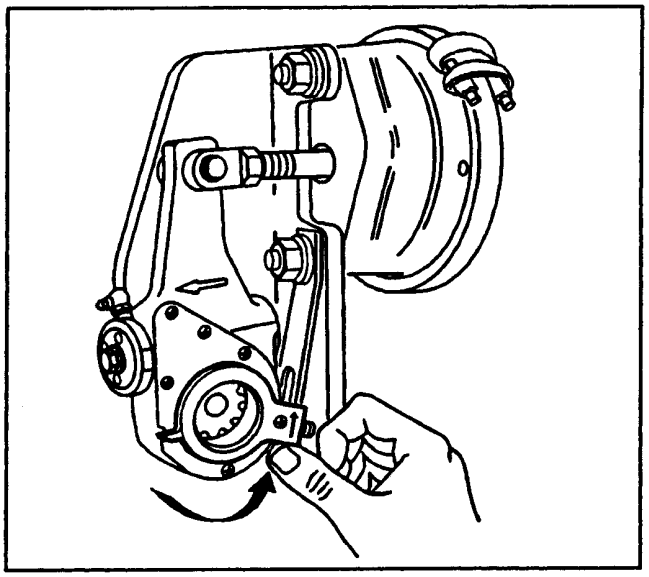
8. Install the air brake chamber clevis pin.
9. Do not install the retainer at this time.

   It may be necessary to remove the air brake chamber clevis pin later in order to check installation.

Notice: Excessive positioning force may damage the air brake automatic slack adjuster control arm. Most adjusters will be equipped with an installation indicator. The indicator must fall within the slot for proper installation. Incorrect air brake automatic slack adjuster control arm position can cause tight or dragging brakes.

10. Adjust the slack adjuster control arm. Rotate the control arm counterclockwise away from the slack adjuster adjusting hex. Continue the rotation towards the air brake chamber until the slack adjuster control arm comes to a definite internal stop.

    Use a plastic mallet in order to tap the slack adjuster control arm into position if necessary.
11. Install the slack adjuster control nut.



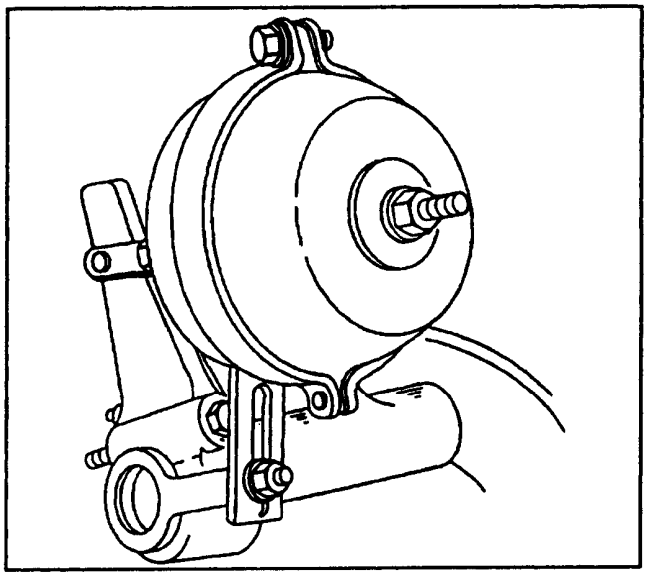
201829

Notice: Refer to *Fastener Notice* in Cautions and Notices.

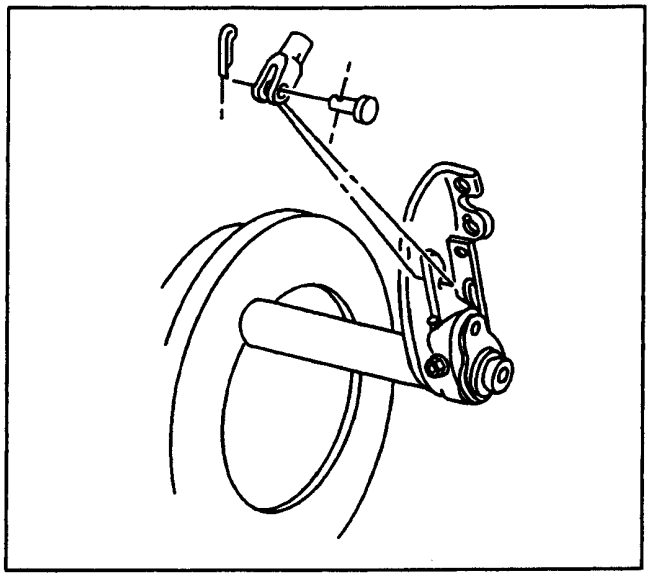
Important: Ensure that the slack adjuster control arm does not move from the correct position while tightening the slack adjuster control arm nut.

12. **Tighten**

    Tighten the slack adjuster control arm nut to 17 N·m (13 lb ft).
13. Adjust the brakes. Refer to the following procedures:
    - *Air Drum Brake Adjustment (Pushrod Stroke Measurement).*
    - *Air Drum Brake Adjustment (Normal Wear Adjustment).*
14. Start the engine.
15. Charge the system to the air compressor governor valve cut-out point.
16. Stop the engine.
17. Inspect the air brake automatic slack adjuster for proper installation.
18. Verify that the installation indicator is within the slot.

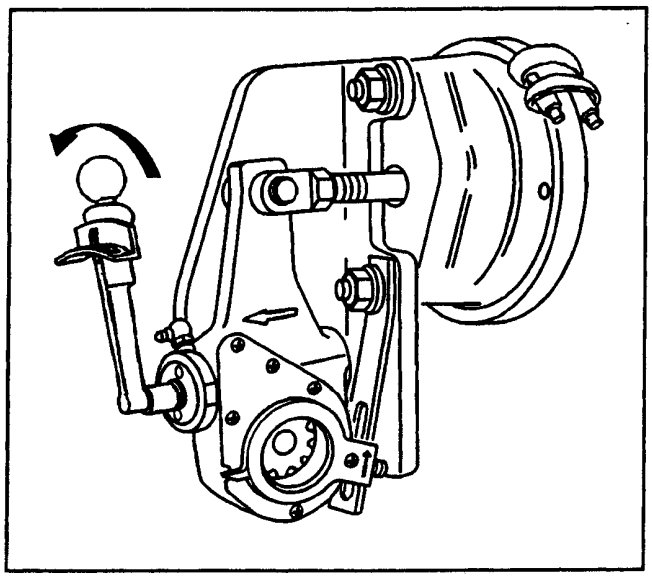


201833



201820

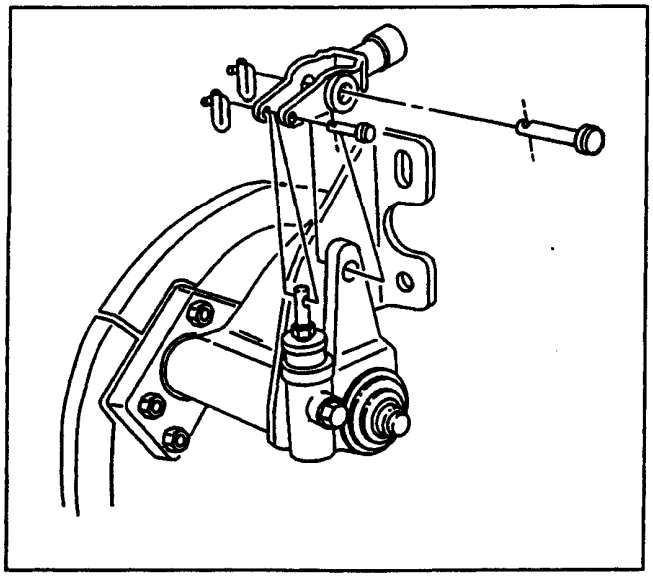
19. Remove the air brake chamber clevis pin.
20. Align the air brake chamber clevis hole and the slack adjuster arm hole.
21. Repeat steps 7–15 if the air brake chamber clevis retracts towards the air brake chamber when you remove the air brake chamber clevis pin.
22. Install the air brake chamber clevis pin.
23. Install the air brake chamber clevis pin cotter pin.



201843

24. Check the slack adjuster adjusting hex torque.
25. Use a pound inch torque wrench in order to rotate the slack adjuster adjusting hex counterclockwise.
26. The slack adjuster clutch should not slip at a torque less than 18 N.m (13 lb ft).

    A racheting sound occurs when the clutch slips. Replace the slack adjuster if the clutch slips at a lesser torque.
27. Start the engine.
28. Charge the system to the air compressor governor valve cut-out point.
29. Stop the engine.
30. Uncage the air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
31. Check for proper brake operation.
32. Set the parking brake.
33. Remove the wheel blocks.



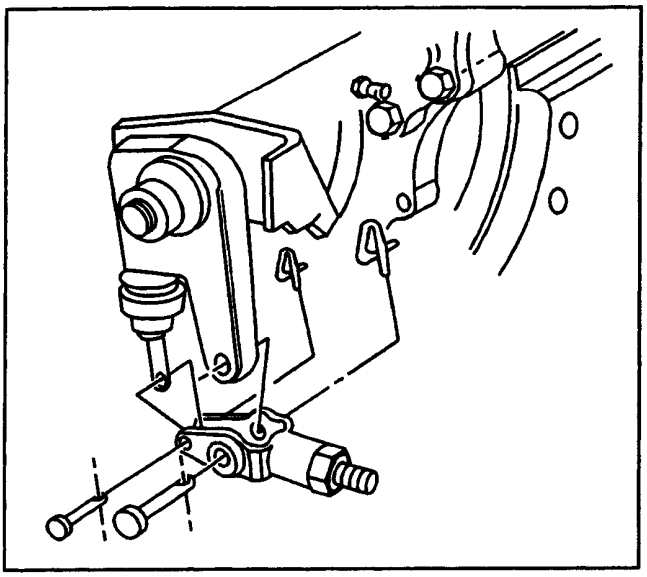
201846

Air Brake Chamber Clevis Replacement (Rockwell)

Removal Procedure

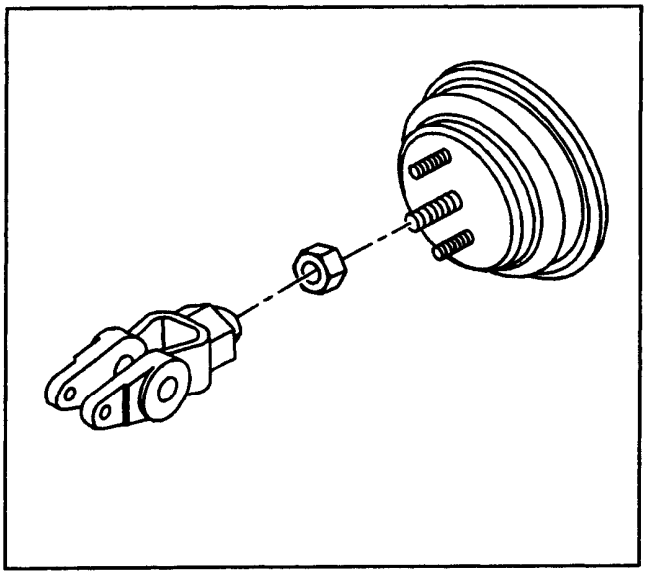
1. Block the wheels.
2. Cage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
3. Drain all air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
4. Mark the position of the slack adjuster to the camshaft by drawing a straight line on both parts.
5. Remove the front air brake chamber clevis pin retainers.
6. Remove the front air brake chamber clevis pins.

7. Remove the rear air brake chamber clevis pin retainers.
8. Remove the rear air brake chamber clevis pins.
9. Fully release the air brake automatic slack adjuster.
10. Disengage the pawl with a screwdriver.
11. Turn the slack adjuster adjusting nut until the slack adjuster is free from the air brake chamber clevis.
12. Release the pawl so that the pawl snaps into engagement.



201809

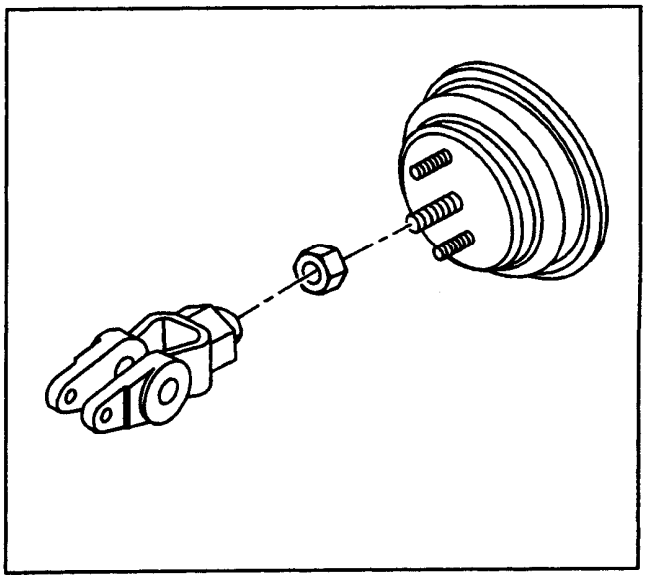
13. Loosen the jam nut.
14. Remove the air brake chamber clevis and the jam nut.
15. Inspect the service brake chamber pushrod for damage.
    Overhaul or replace the service brake chamber assembly if damaged.



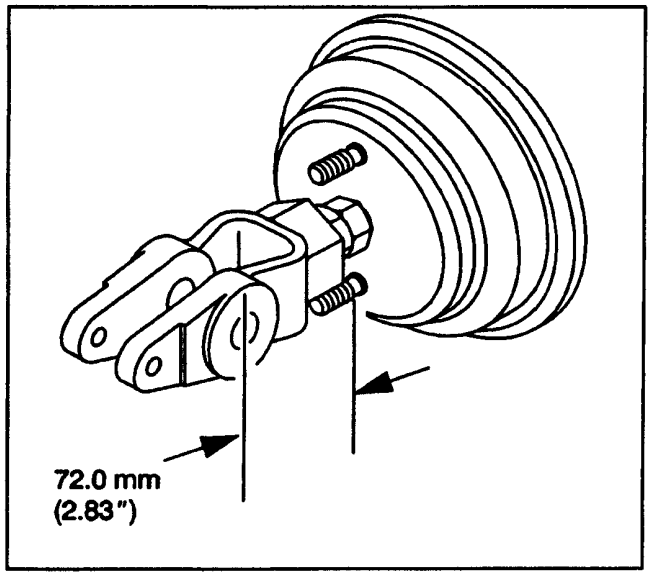
209228

Installation Procedure

1. Loosely assemble the jam nut and the air brake chamber clevis to the service brake chamber pushrod.
2. Adjust the air brake chamber clevis. Turn the air brake chamber clevis clockwise in order to decrease the distance. Turn the clevis counterclockwise in order to increase the distance.

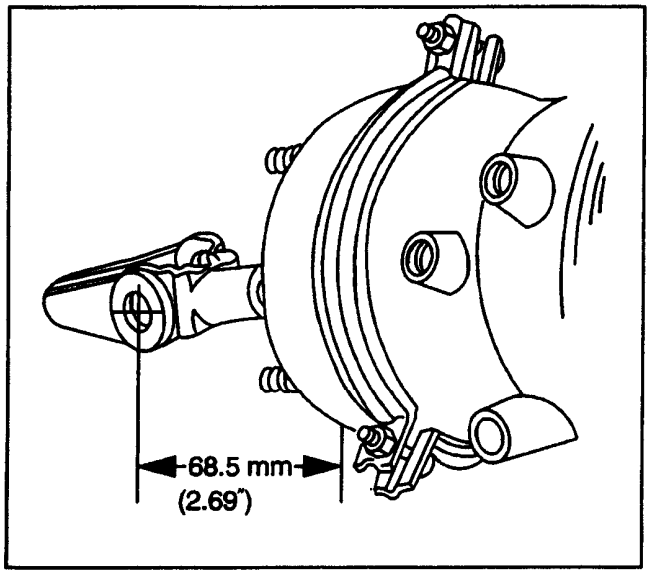


209228



201873

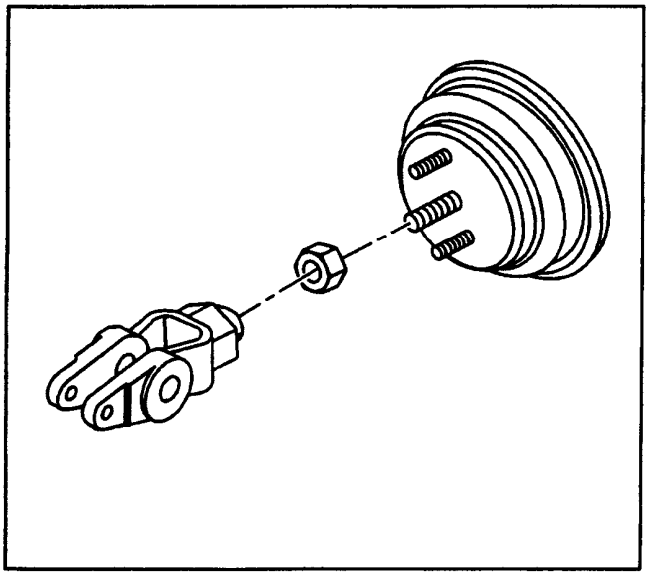
3. Adjust the front air brake chamber clevis to 72.0 mm (2.83 in) from the mounting surface of the service brake chamber to the center of the air brake chamber clevis pin mounting hole.



201877

Notice: Refer to *Fastener Notice* in Cautions and Notices.

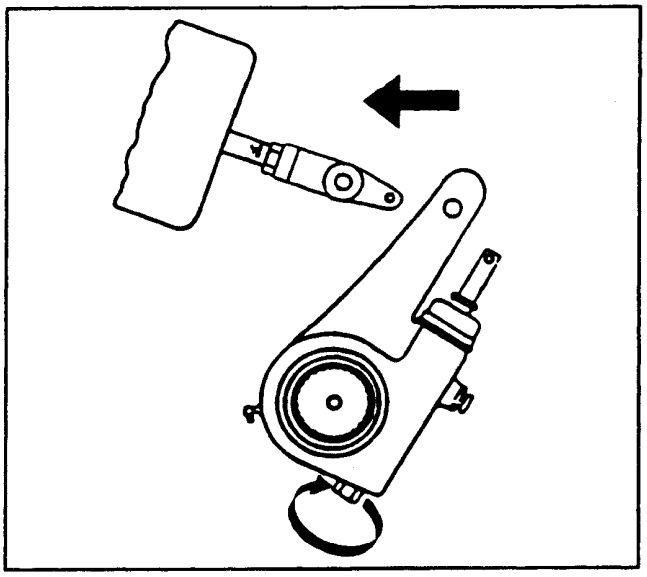
4. Adjust the rear air brake chamber clevis to 68.5 mm (2.69 in) from the mounting surface of the spring brake chamber to the center of the air brake chamber clevis pin mounting hole.
   Tighten
   - Tighten the front air brake chamber clevis jam nut (type 16 air brake chamber) to 45 N.m (33 lb ft).
   - Tighten the front air brake chamber clevis jam nut (types 20 and 24 air brake chamber) to 78 N.m (57 lb ft).
   - Tighten the rear air brake chamber clevis jam nut to 77 N.m (56 lb ft).



209228

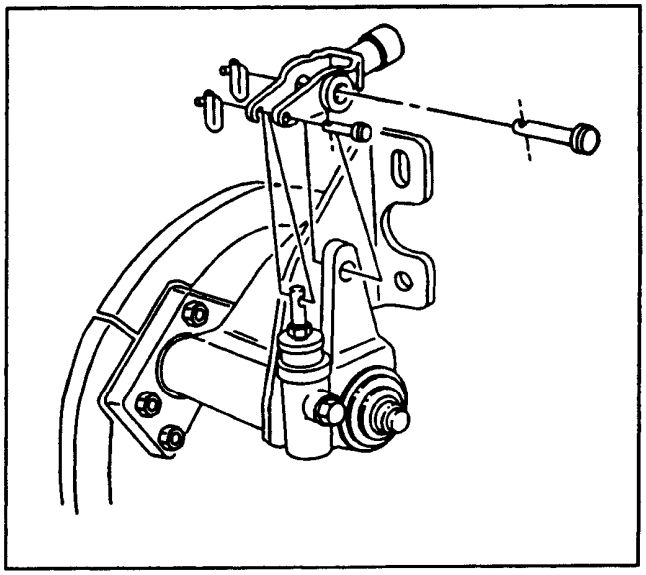
5. Fully release the slack adjuster.
6. Disengage the pawl with a screwdriver.

7. Turn the slack adjuster adjusting nut until the slack adjuster arm is properly aligned with the holes in the air brake chamber clevis.
8. Release the pawl so that the pawl snaps into engagement.



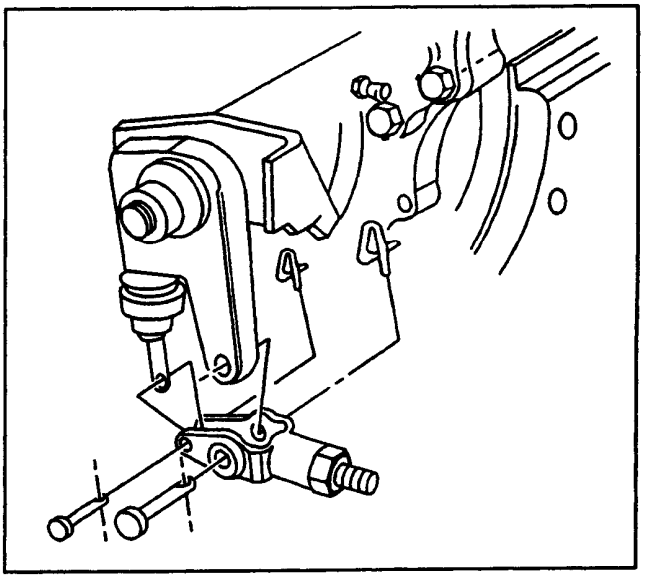
201817

9. Install the front air brake chamber clevis pins.
10. Install the new front air brake chamber clevis pin retainers.

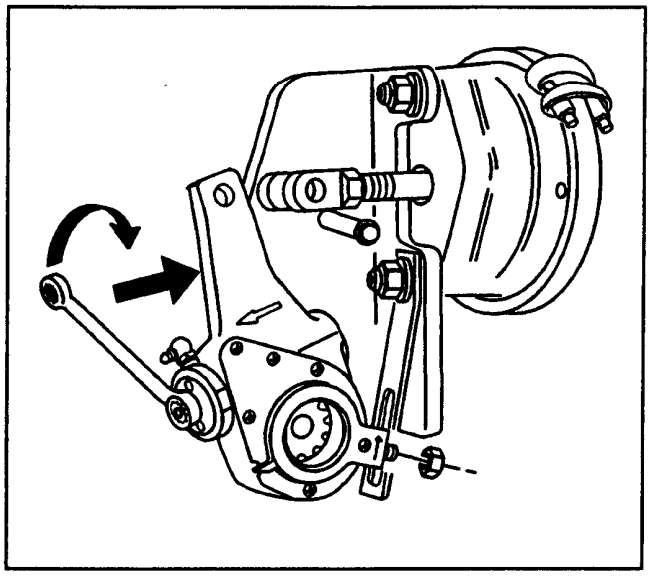


201846

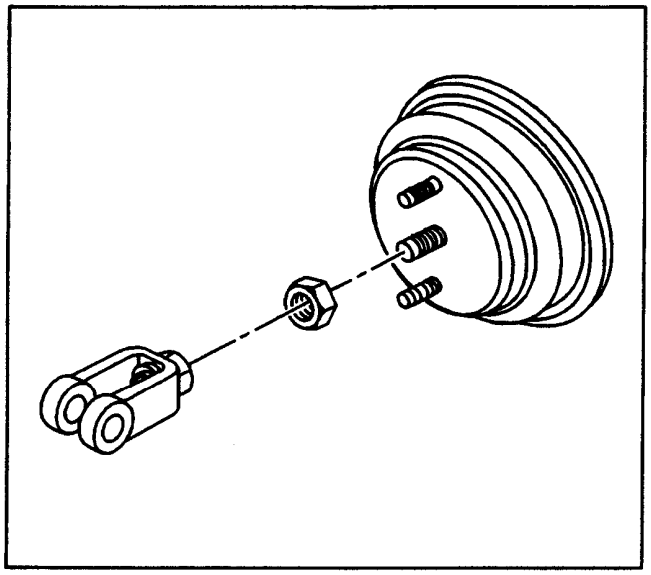
11. Install the rear air brake chamber clevis pins.
12. Install the new rear air brake chamber clevis pin retainers.
13. Adjust the brakes. Refer to the following procedures:
    - *Air Drum Brake Adjustment (Pushrod Stroke Measurement).*
    - *Air Drum Brake Adjustment (Normal Wear Adjustment).*
14. Start the engine.
15. Charge the system to the air compressor governor valve cut-out point.
16. Stop the engine.
17. Uncage the rear air brake chamber assemblies. Refer to *Caging the Rear Air Brake Chamber.*
18. Check for proper brake operation.
19. Set the parking brake.
20. Remove the wheel blocks.



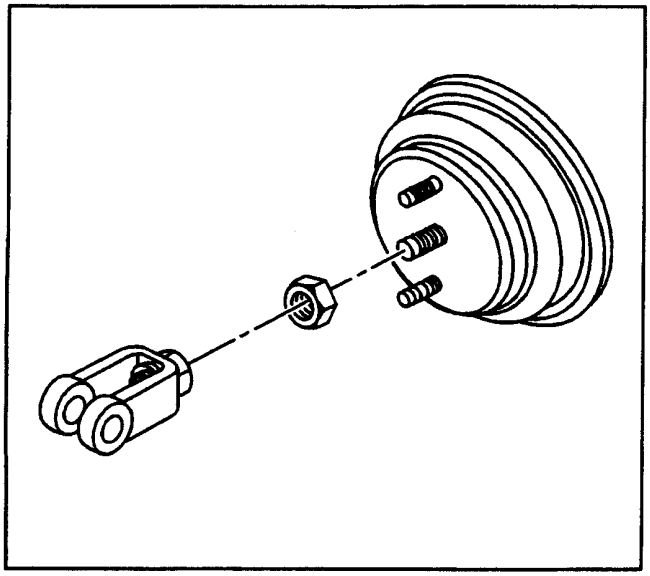
201809



201826



207511



207511

Air Brake Chamber Clevis Replacement (Eaton)

Removal Procedure

1. Block the wheels.
2. Cage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
3. Drain all air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
4. Remove the air brake chamber clevis pin cotter pin.
5. Remove the air brake chamber clevis pin.
6. Fully release the air brake automatic slack adjuster. Turn the air brake automatic slack adjuster counterclockwise until the slack adjuster arm is free from the air brake chamber clevis.
7. Loosen the jam nut.
8. Remove the air brake chamber clevis and the jam nut.
9. Inspect the service brake chamber pushrod for damage.

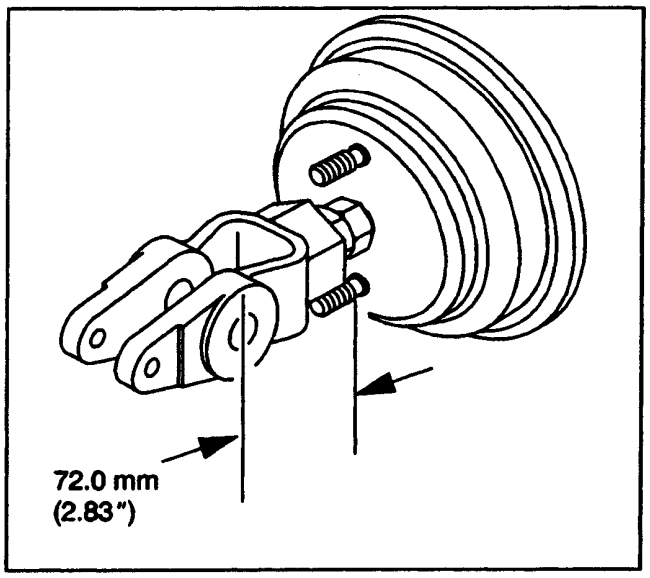
   Overhaul or replace the service brake chamber if damage exists.

Installation Procedure

1. Loosely assemble the jam nut and the air brake chamber clevis to the service brake chamber pushrod.
2. Adjust the air brake chamber clevis by turning the air brake chamber clevis clockwise in order to decrease the distance.

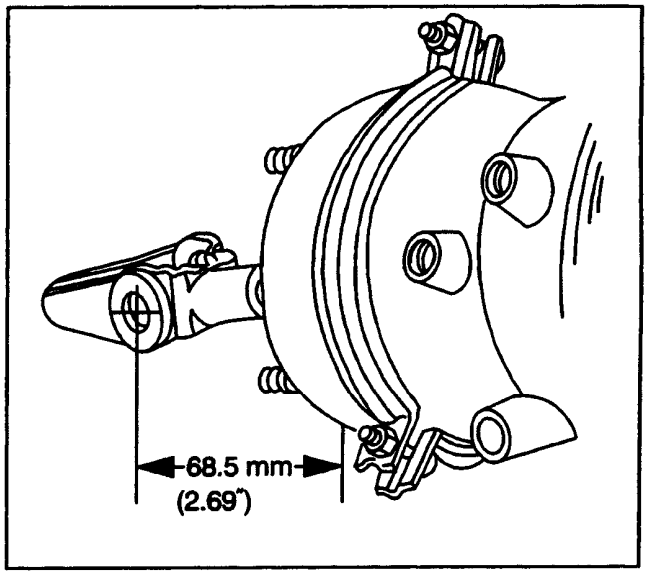
   Adjust the air brake chamber clevis. Turn the air brake chamber clevis counterclockwise.

3. Measure the front air brake chamber clevis to 72.0 mm (2.83 in) from the mounting surface of the service brake chamber to the center of the air brake chamber clevis pin mounting hole.



201873

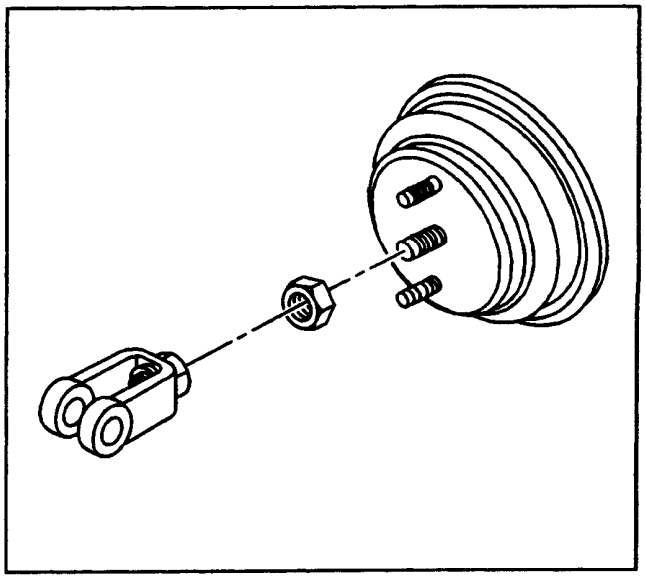
4. Measure the rear air brake chamber clevis to 68.5 mm (2.69 in) from the mounting surface of the spring brake chamber to the center of the air brake chamber clevis pin mounting hole.



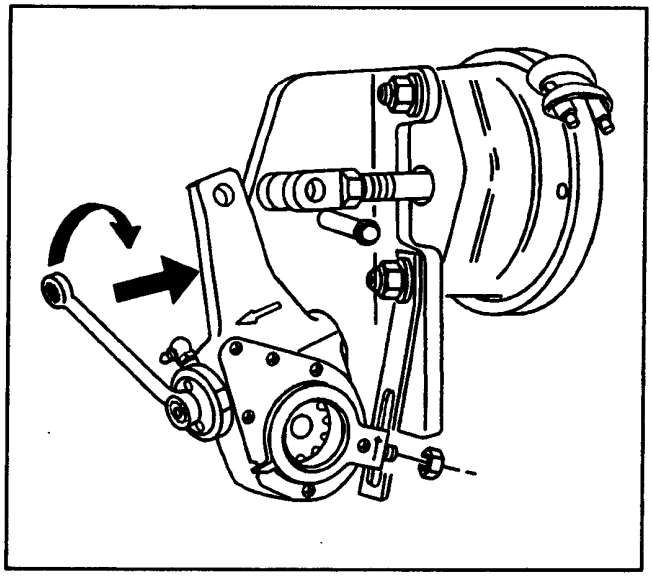
201877

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the front air brake chamber clevis jam nut.
   Tighten
   - Tighten the front air brake chamber clevis jam nut (type 16 air brake chamber) to 45 N.m (33 lb ft).
   - Tighten the front air brake chamber clevis jam nut (types 20 and 24 air brake chamber) to 78 N.m (57 lb ft).
   - Tighten the rear air brake chamber clevis jam nut to 77 N.m (56 lb ft).
6. Rotate the slack adjuster adjusting hex clockwise until the slack adjuster arm hole aligns with the air brake chamber clevis hole.



207511



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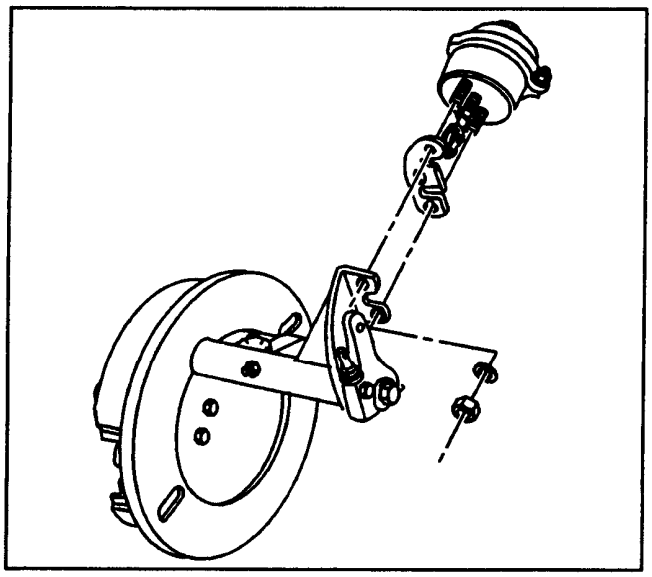
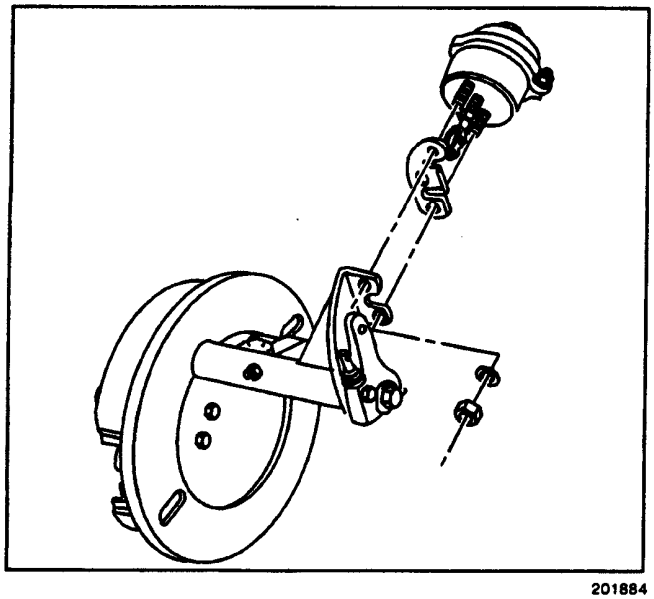


201884



201884

7. Install the air brake chamber clevis pin.
8. Install the air brake chamber clevis pin cotter pin.
9. Adjust the brakes. Refer to the following procedures:
   - *Air Drum Brake Adjustment (Pushrod Stroke Measurement).*
   - *Air Drum Brake Adjustment (Normal Wear Adjustment).*
10. Start the engine.
11. Charge the system to the air compressor governor valve cut-out point.
12. Stop the engine.
13. Uncage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
14. Check for proper brake operation.
15. Set the parking brake.
16. Remove the wheel blocks.

Air Brake Chamber Replacement (Front)

Removal Procedure

1. Remove the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Rockwell).*
2. Remove the air line from the air brake chamber assembly. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)* or
   - *Hose and Line Replacement (Nylon - Push-In)* or
   - *Hose and Line Replacement (Flexible)* in Air Brakes.
3. Remove the mounting nuts and the washers from the air brake chamber assembly.
4. Remove the air brake chamber assembly from the brake chamber/camshaft support bracket.

Installation Procedure

1. Install the air brake chamber assembly to the brake chamber/camshaft support bracket.

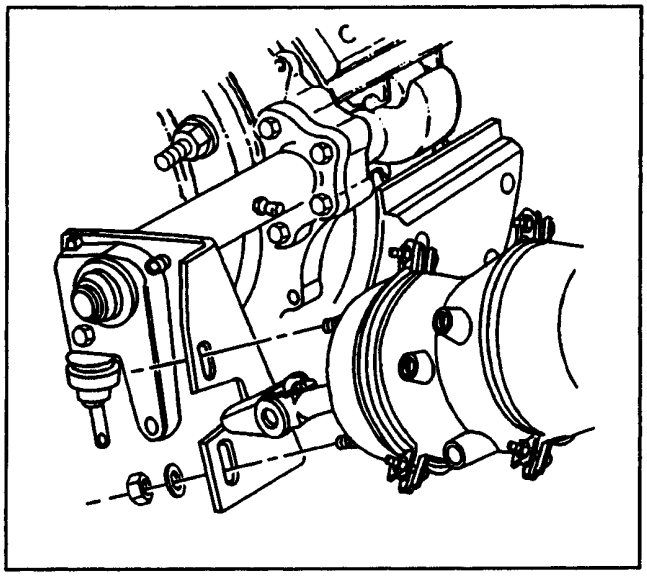
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the mounting washers and the nuts to the air brake chamber assembly.

   Tighten
   - Tighten the air brake chamber assembly (type 16) mounting nuts to 39 N.m (29 lb ft).
   - Tighten the air brake chamber assembly (type 20 and 24) mounting nuts to 74 N.m (55 lb ft).
3. Install the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Rockwell).*

Air Brake Chamber Replacement (Rear)

Removal Procedure

1. Remove the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Eaton).*
2. Remove the air line from the air brake chamber assembly. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)* or
   - *Hose and Line Replacement (Nylon - Push-In)* or
   - *Hose and Line Replacement (Flexible)* in Air Brakes.
3. Remove the mounting nuts and the washers from the air brake chamber assembly.
4. Remove the air brake chamber assembly from the brake chamber/camshaft support bracket.



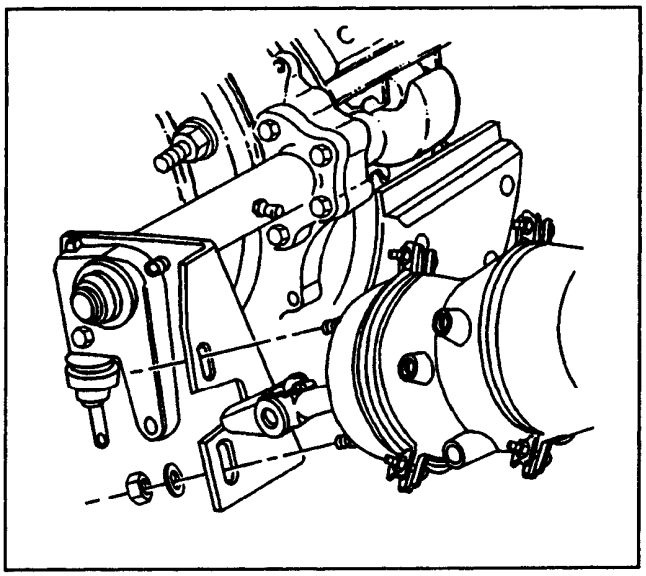
201891

Installation Procedure

1. Install the air brake chamber assembly to the brake chamber/camshaft support bracket.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the mounting washers and the nuts to the air brake chamber assembly.

   Tighten
   - Tighten the air brake chamber assembly (type 16) mounting nuts to 39 N·m (29 lb ft).
   - Tighten the air brake chamber assembly (type 20 and 24) mounting nuts to 74 N·m (55 lb ft).
3. Install the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Eaton).*

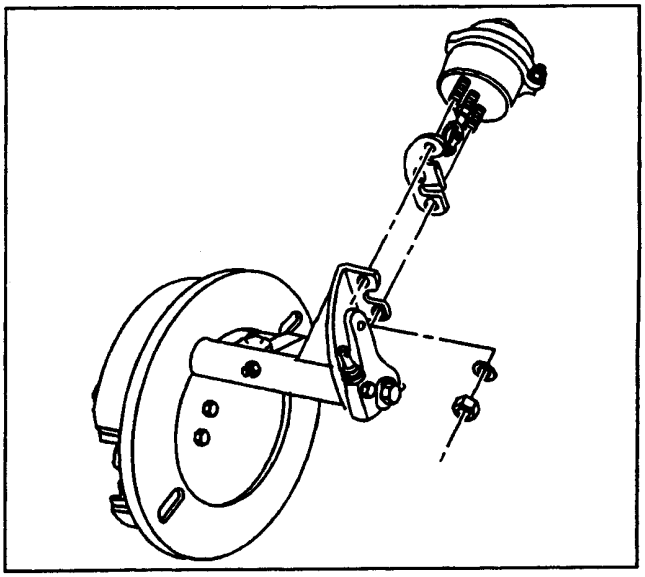


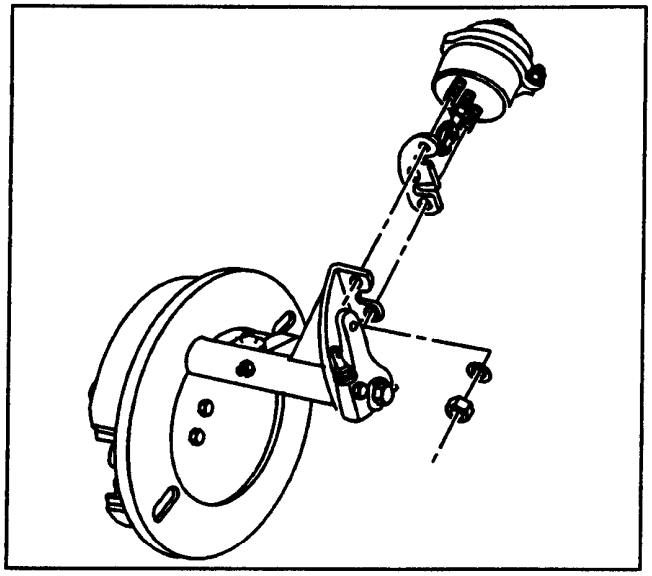
201891

Air Brake Chamber Replacement - Front (With Rockwell Slack Adjuster)

Removal Procedure

1. Remove the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Rockwell).*
2. Remove the air line from the air brake chamber assembly. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)* or
   - *Hose and Line Replacement (Nylon - Push-In)* or
   - *Hose and Line Replacement (Flexible)* in Air Brakes.
3. Remove the mounting nuts and the washers from the air brake chamber assembly.
4. Remove the air brake chamber assembly from the brake chamber/camshaft support bracket.


201884



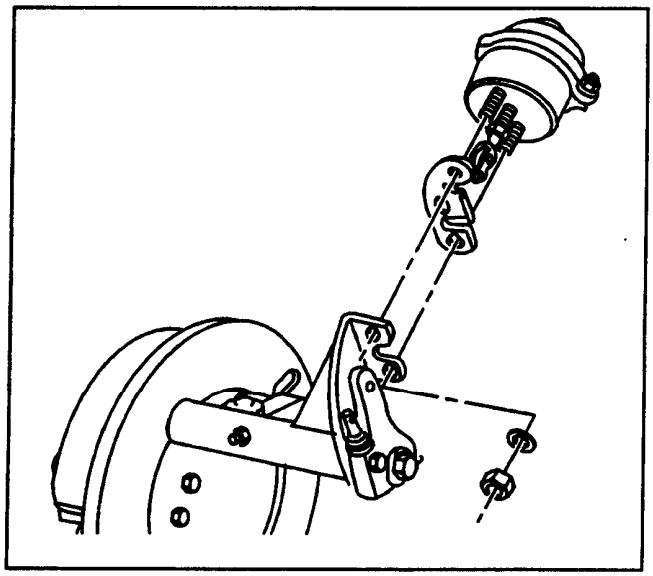
201884

Installation Procedure

1. Install the air brake chamber assembly to the brake chamber/camshaft support bracket.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the mounting washers and the nuts to the air brake chamber assembly.

   Tighten
   - Tighten the air brake chamber assembly (type 16) mounting nuts to 39 N.m (29 lb ft).
   - Tighten the air brake chamber assembly (type 20 and 24) mounting nuts to 74 N.m (55 lb ft).
3. Install the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Rockwell).*

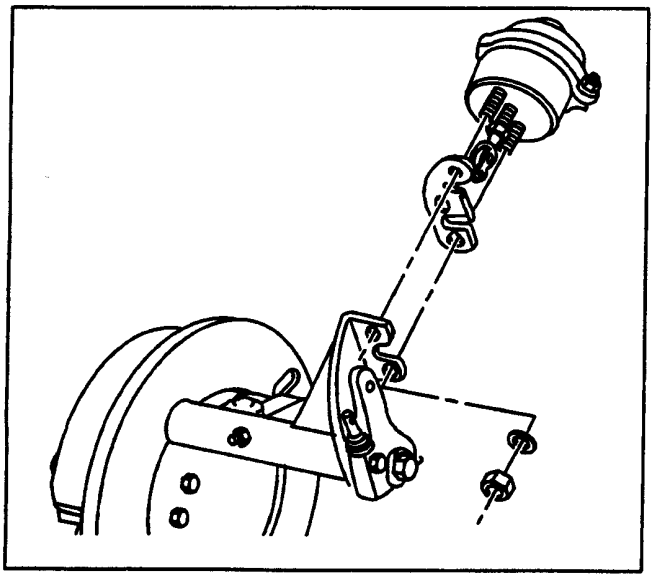


201888

Air Brake Chamber Replacement - Front (With Eaton Slack Adjuster)

Removal Procedure

1. Remove the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Eaton).*
2. Remove the air line from the air brake chamber assembly. Refer to the following procedures:
   - *Hose and Line Replacement (Nylon and Metal - Compression)* or
   - *Hose and Line Replacement (Nylon - Push-In)* or
   - *Hose and Line Replacement (Flexible)* in Air Brakes.
3. Remove the mounting nuts and the washers from the air brake chamber assembly.
4. Remove the air brake chamber assembly from the brake chamber/camshaft support bracket.



201886

Installation Procedure

1. Install the air brake chamber assembly to the brake chamber/camshaft support bracket.

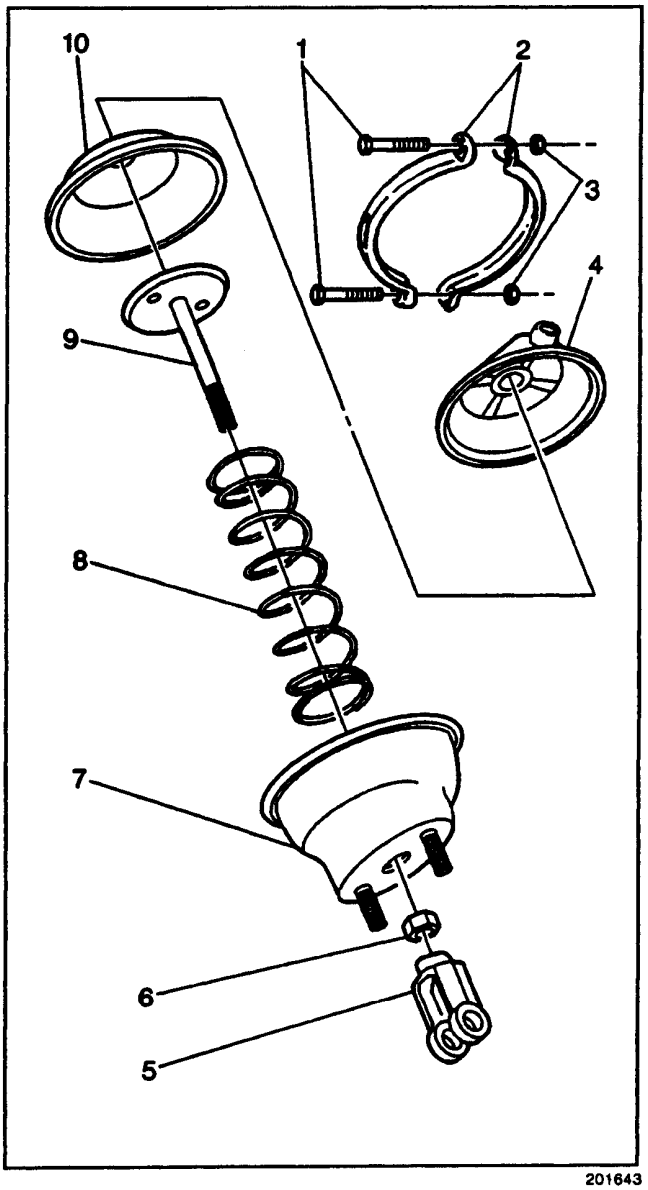
   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. Install the mounting washers and the nuts to the air brake chamber assembly.

   Tighten
   - Tighten the air brake chamber assembly (type 16) mounting nuts to 39 N.m (29 lb ft).
   - Tighten the air brake chamber assembly (type 20 and 24) mounting nuts to 74 N.m (55 lb ft).
3. Install the air brake chamber clevis. Refer to *Air Brake Chamber Clevis Replacement (Eaton).*

Air Brake Chamber Overhaul (Service)

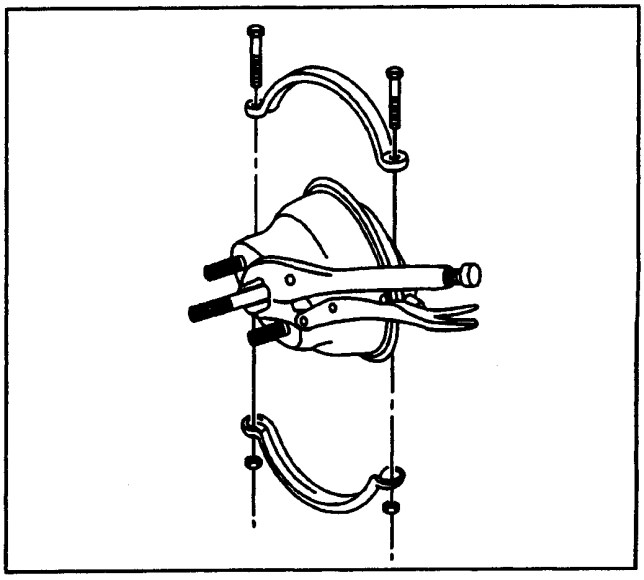
Disassembly Procedure

1. Mark the pressure cap (4) and the chamber assembly (7) in relation to the clamp ring assembly (2).
2. Remove the air brake chamber clevis (5) and the nut (6).
3. Pull out the pushrod (9).
4. Clamp the pushrod (9) using locking-type pliers.
5. Remove the nuts (3) and the bolts (1).



201643

6. Remove the clamp ring assembly.



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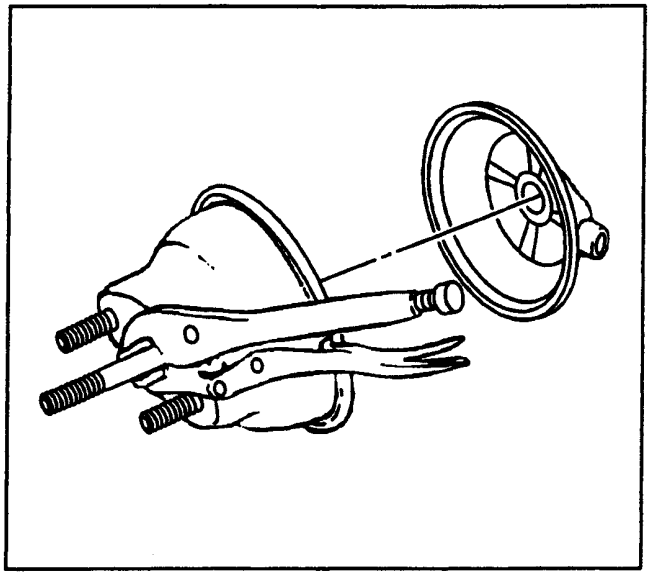
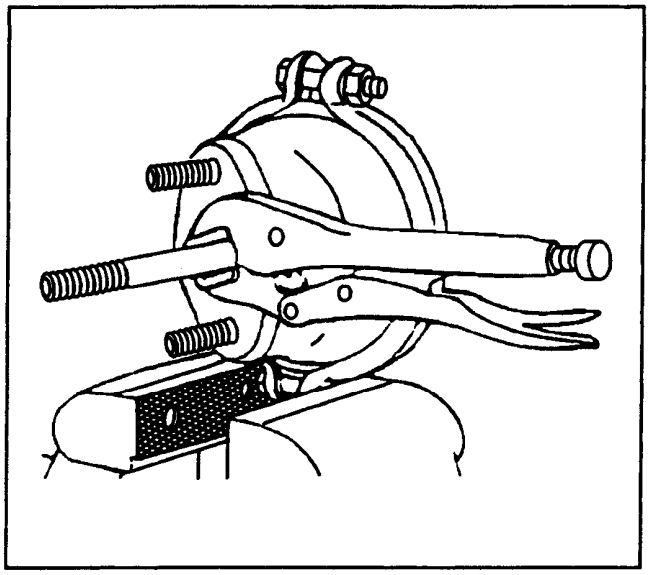


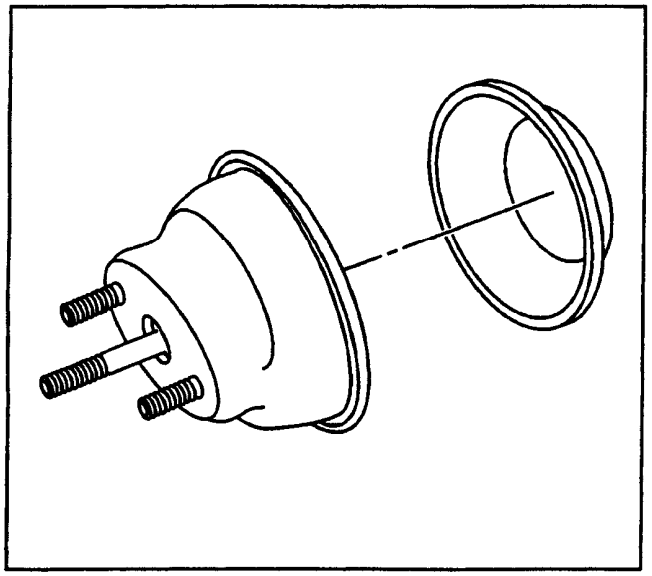
201671

7. Remove the pressure cap.



201669

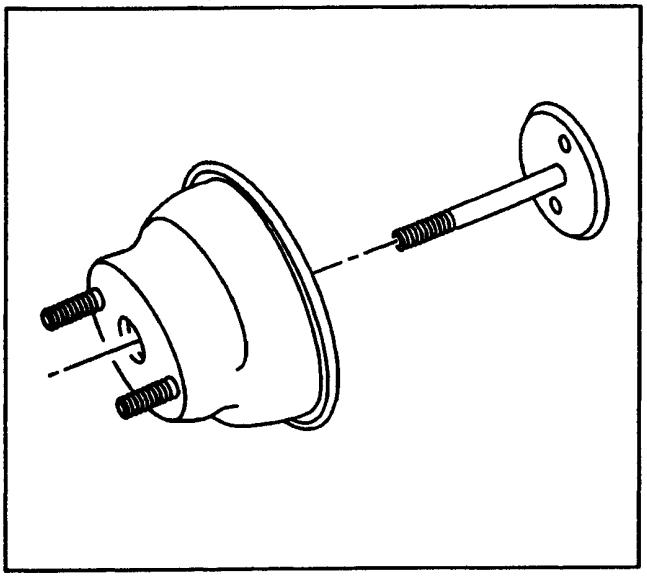
8. Release the locking-type pliers from the pushrod.



201673

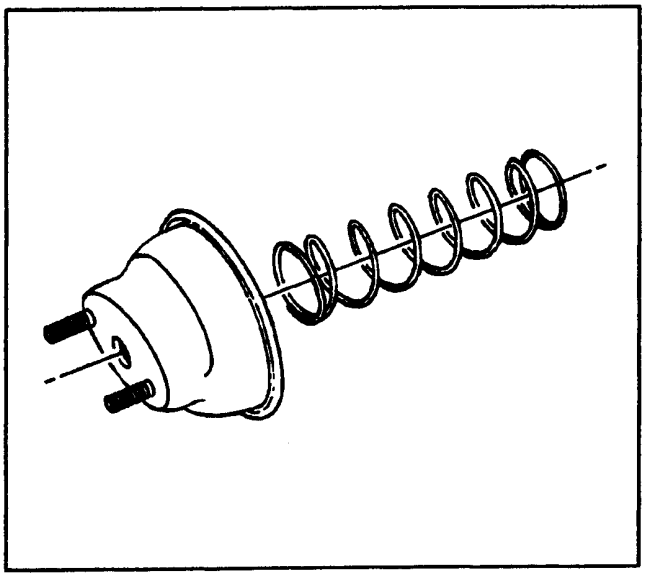
9. Remove the diaphragm.

10. Remove the pushrod.



201674

11. Remove the return spring.



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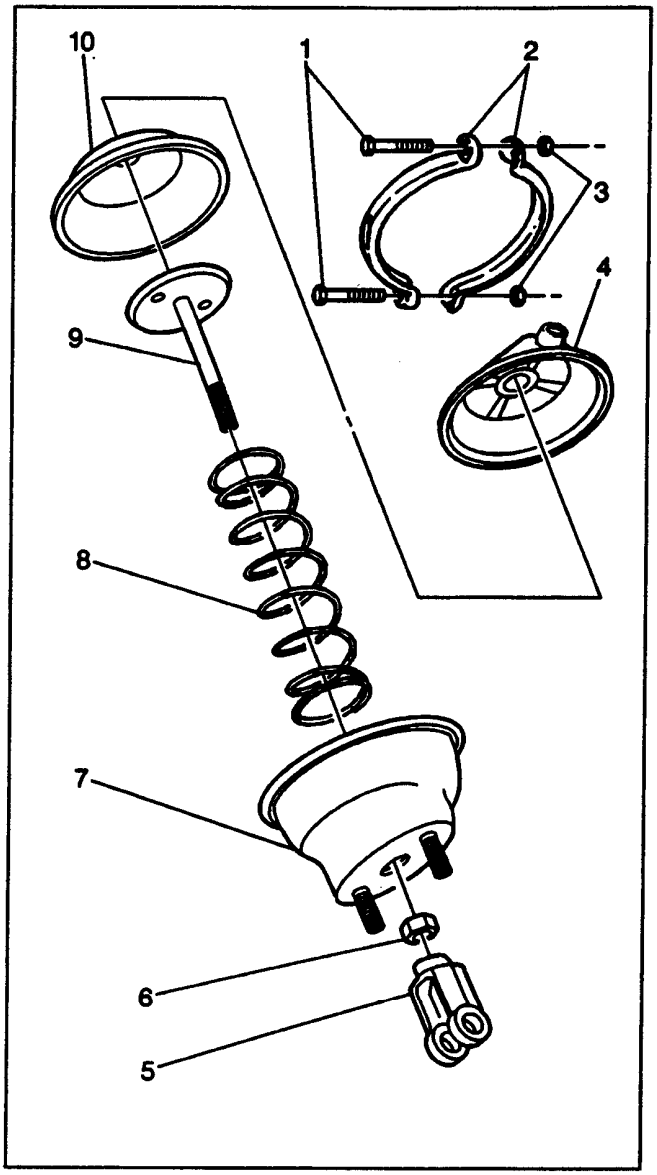
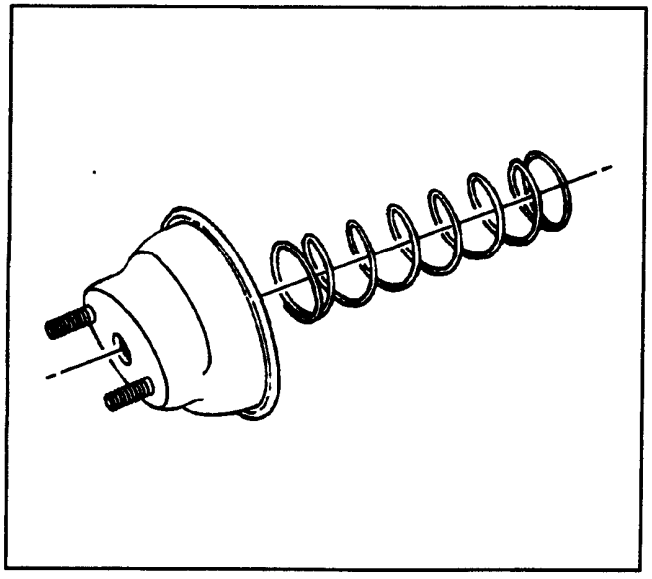


201643

12. Replace all worn and/or damaged parts.
13. Inspect the inside of the chamber assembly (7) for corrosion.
14. Replace the chamber assembly (7) if you find corrosion.
15. Inspect the following components:
    - The return spring (8)
    - The pushrod (9)
    - The clamp ring assembly (2)



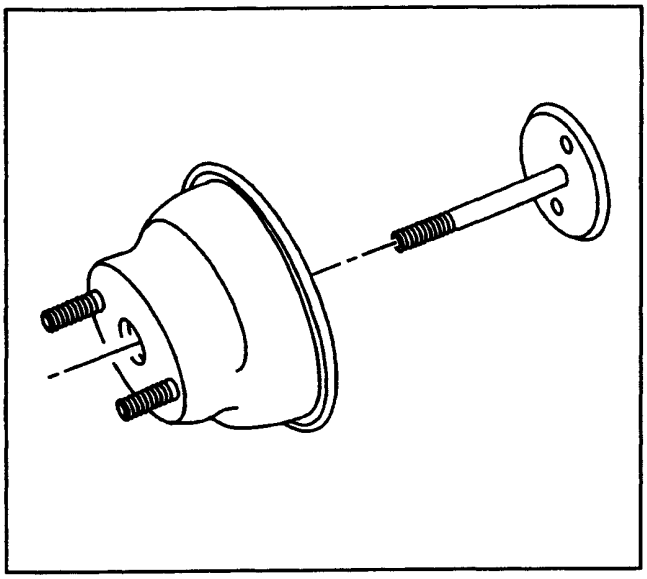
201676

Assembly Procedure

1. Install the return spring into the chamber assembly.

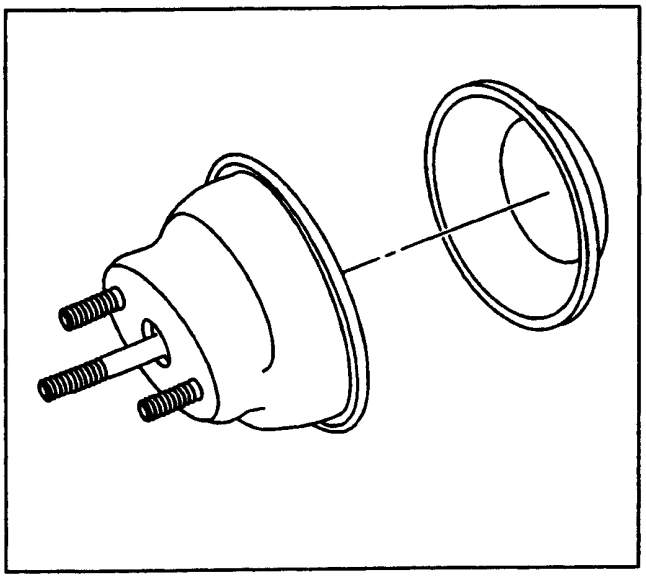
Important: Compress the return spring and clamp the pushrod in place with locking-type pliers.

2. Install the pushrod into the chamber assembly.



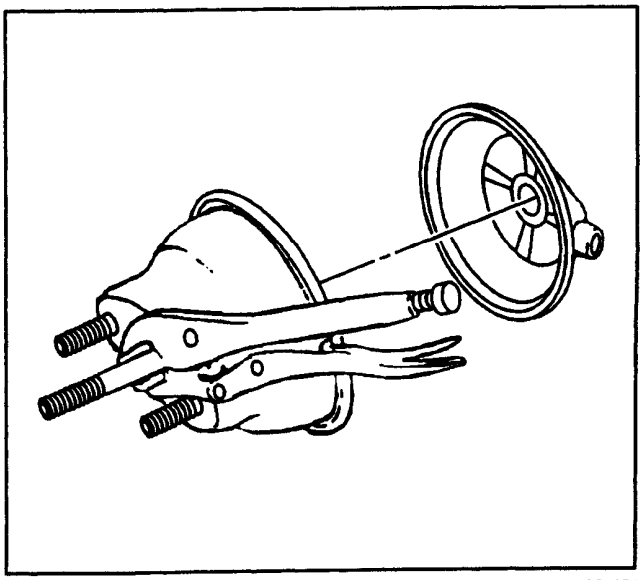
201674

3. Install the diaphragm into the chamber assembly.



201673

4. Install the pressure cap onto the chamber assembly.



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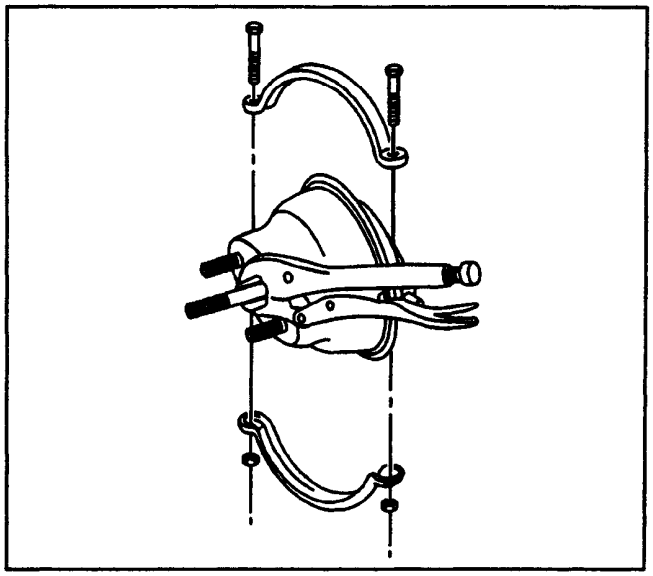
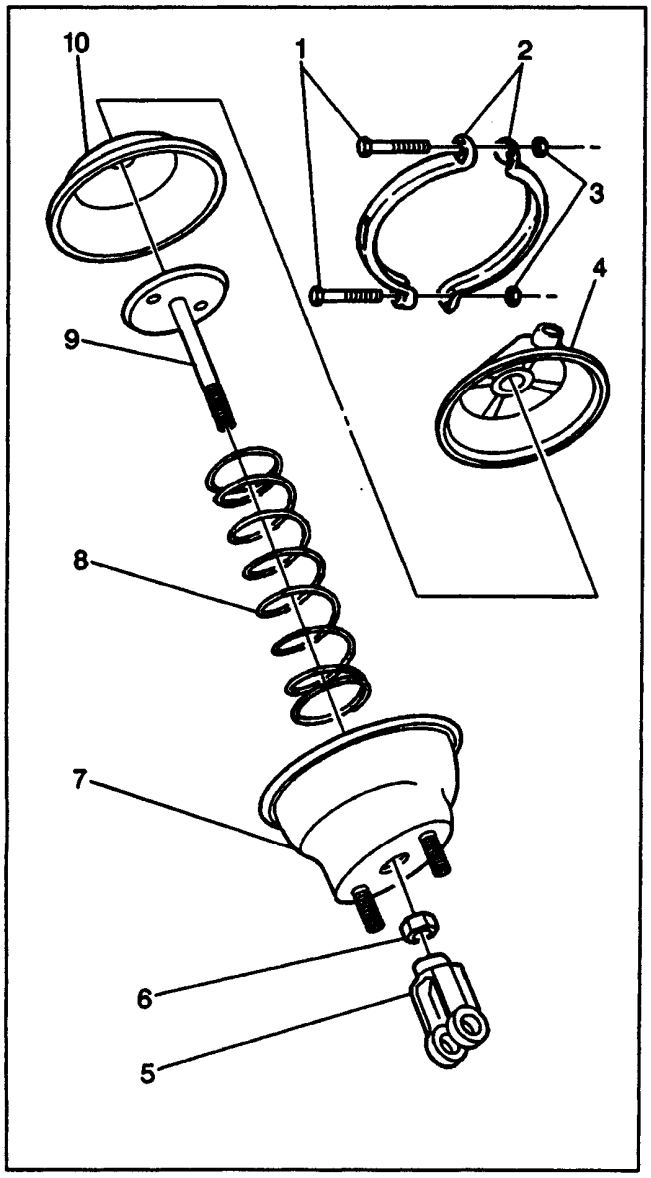


201666

5. Install the clamp ring assembly.

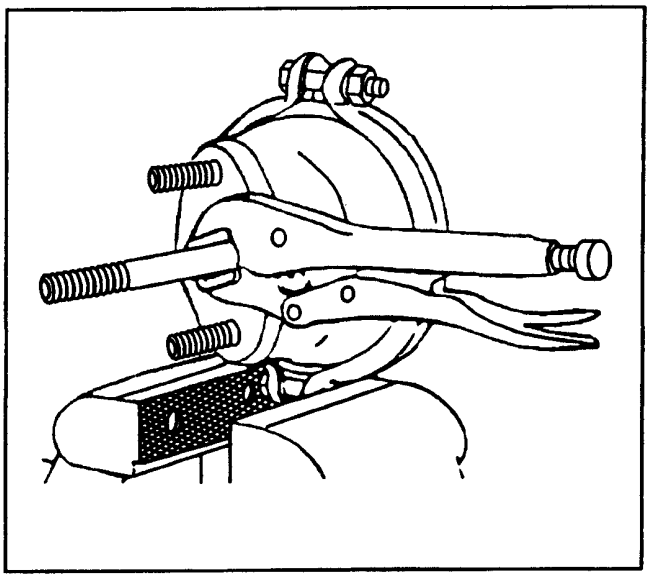


201643

Notice: Refer to *Fastener Notice* in Cautions and Notices.

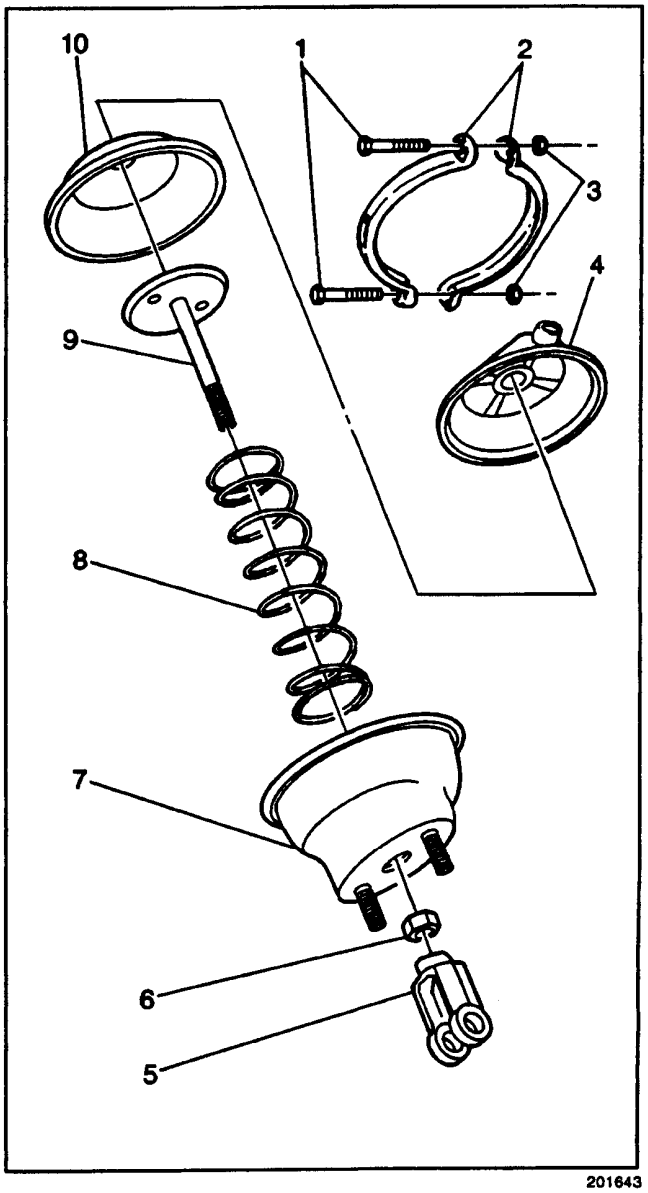
6. Align the marks made during the disassembly. Install the bolts (1) and the nuts (3).
   Tighten
   Tighten the nuts to 34 N·m (25 lb ft).

7. Release the locking-type pliers.



201669

8. Loosely fit the nut and the air brake chamber clevis to the pushrod. Refer to the following procedures:
   - *Air Brake Chamber Clevis Replacement (Rockwell)* or
   - *Air Brake Chamber Clevis Replacement (Eaton).*
9. Install the nut (6) and the air brake chamber clevis (5) to the pushrod (9).



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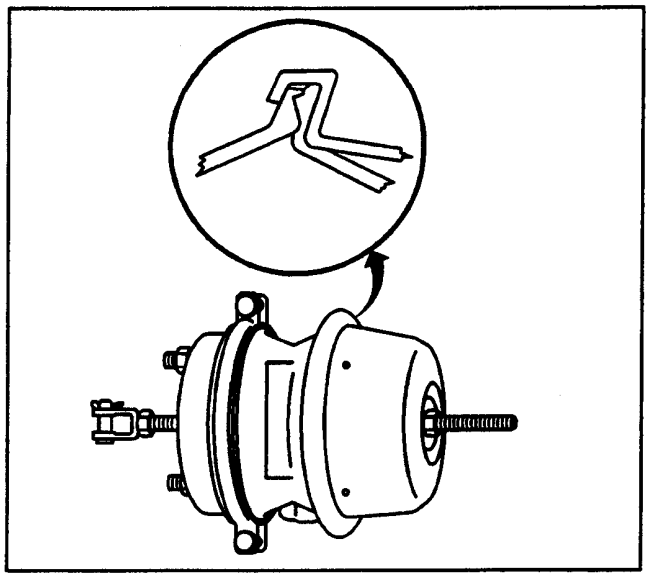
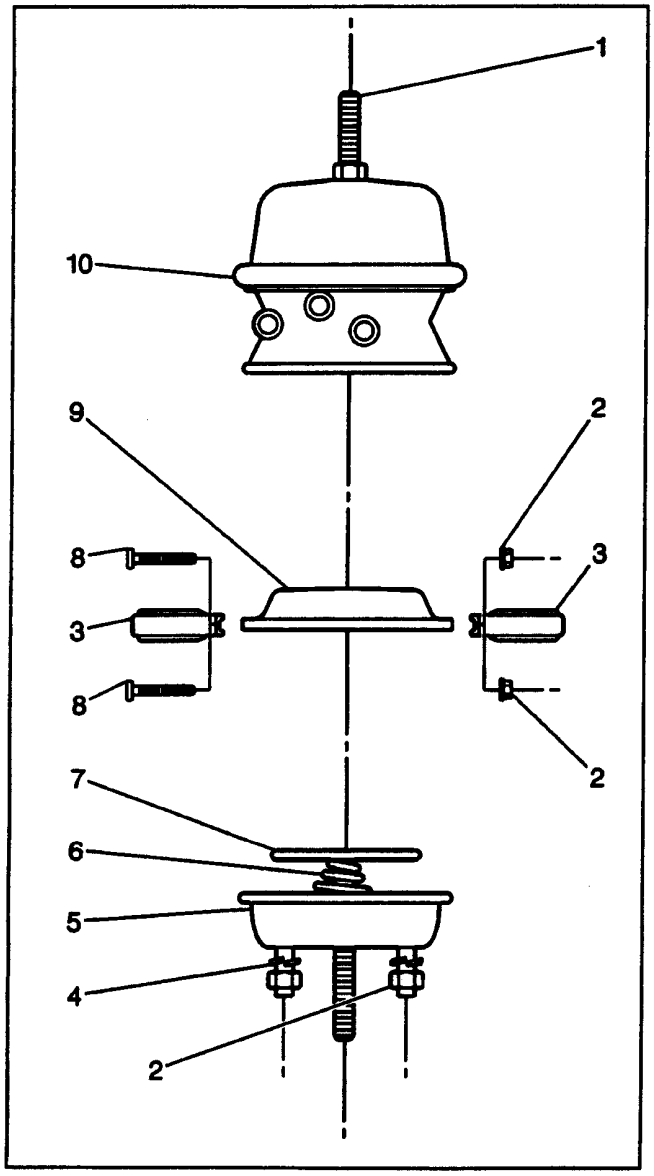


201678

Air Brake Chamber Overhaul (Spring)

Disassembly Procedure

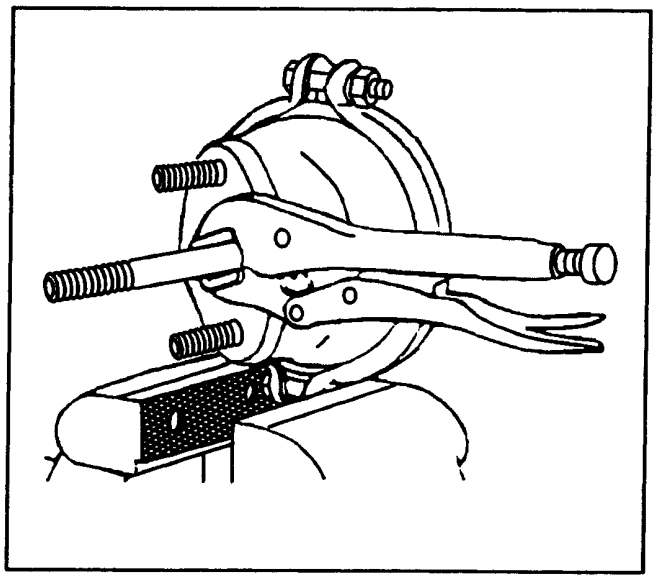
1. The spring brake chamber identification information is located on the adapter housing. The emergency side of the spring brake chamber uses a crimped safety seal and is not serviceable.



201679

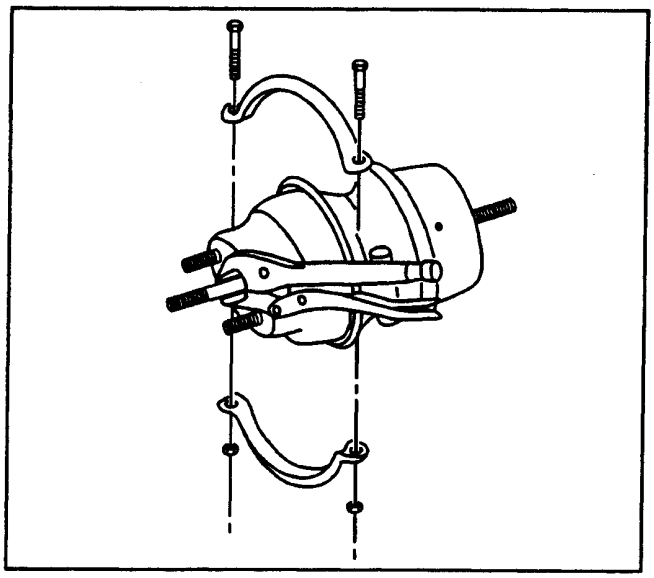
2. Mark the adapter (10) and the service housing (5) in relation to the clamp ring assembly (3).
3. Remove the air brake chamber clevis and the nut (2).

4. Pull out the pushrod and use locking-type pliers to clamp the pushrod.

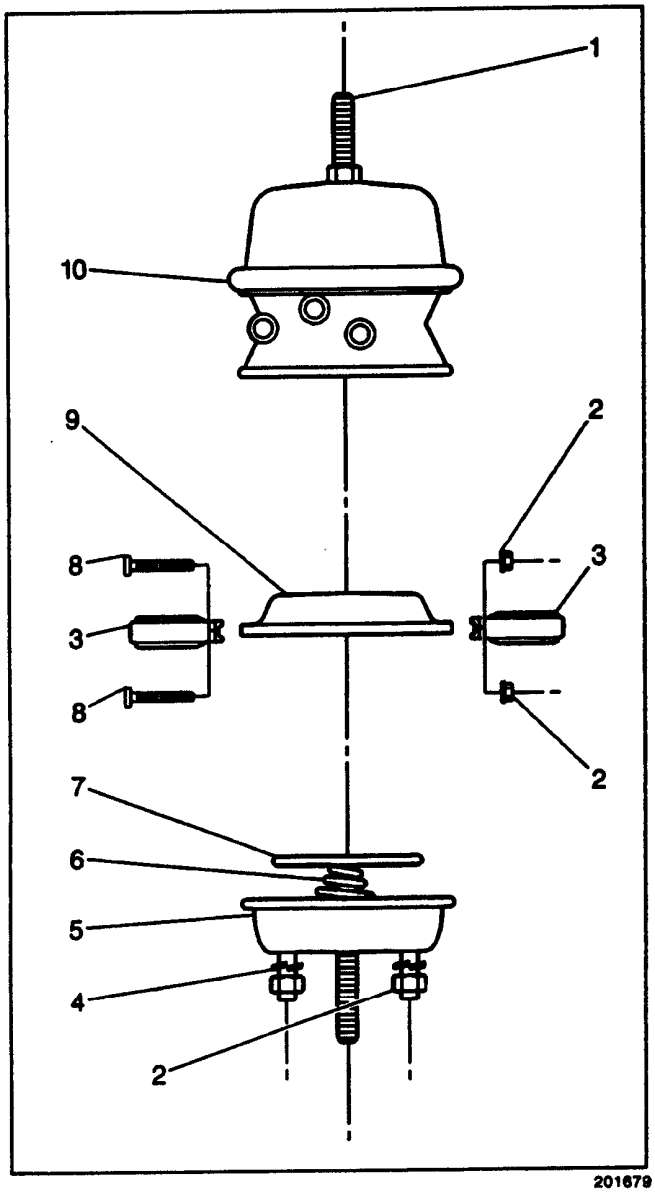


201669

5. Remove the nuts and the bolts.
6. Remove the clamp ring assembly.

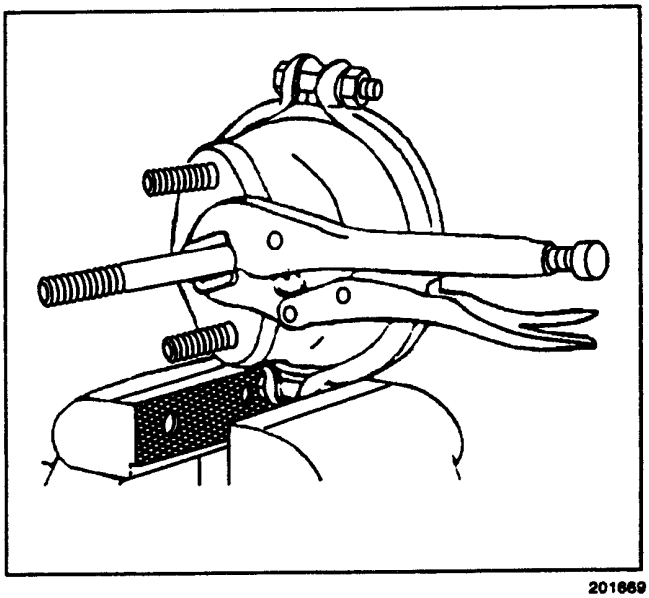


201682



201679

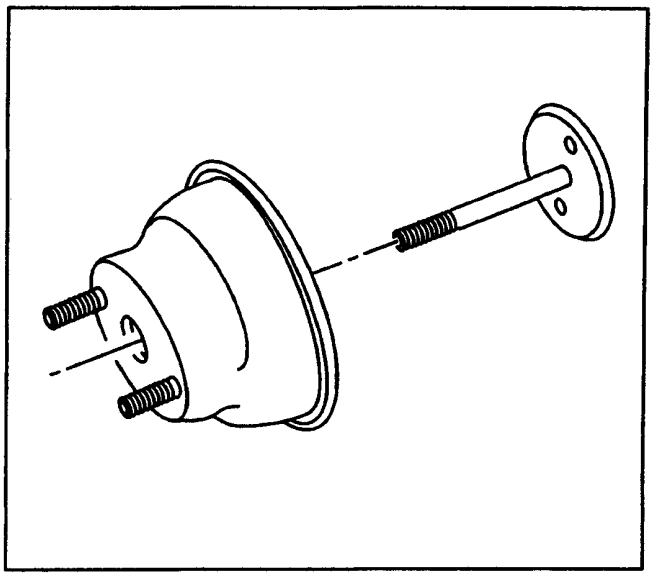
7. Remove the service housing (5) from the adapter (6).



201669

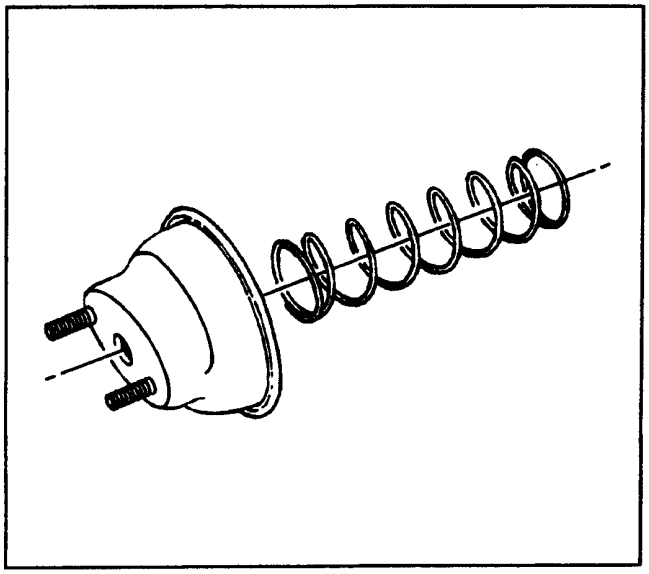
8. Release the locking-type pliers from the pushrod.

9. Remove the pushrod.



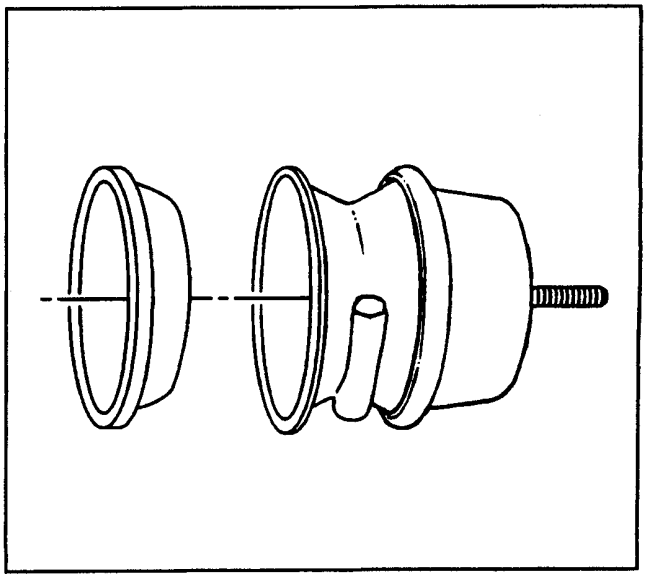
201674

10. Remove the return spring.

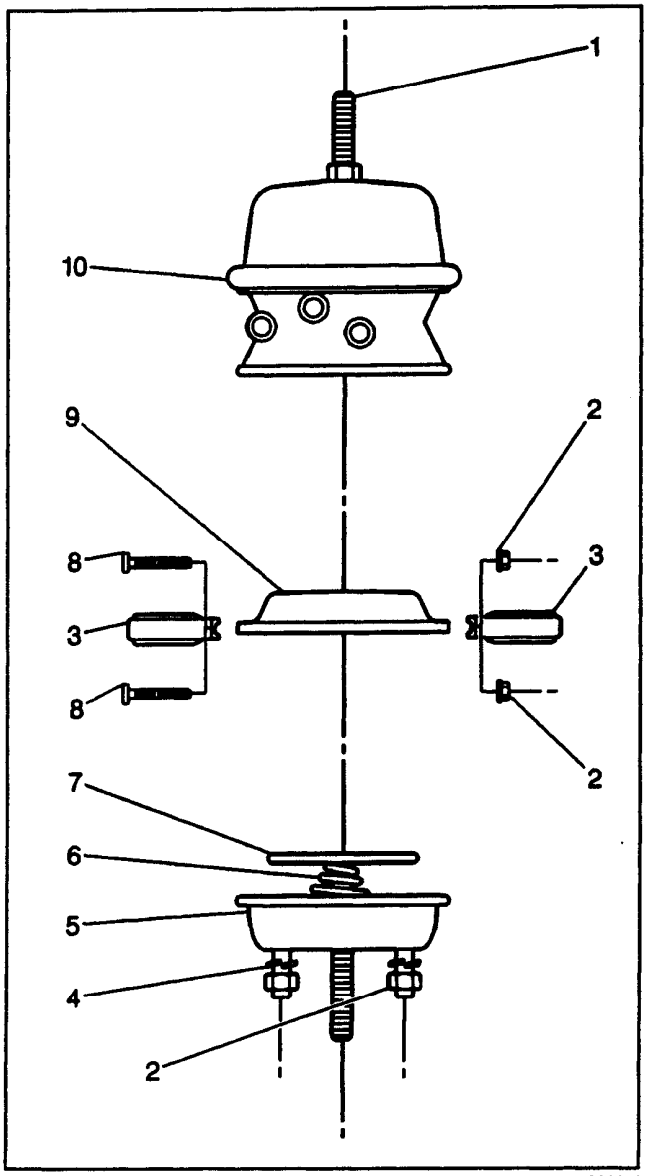


201676

11. Remove the diaphragm from the adapter.



201683



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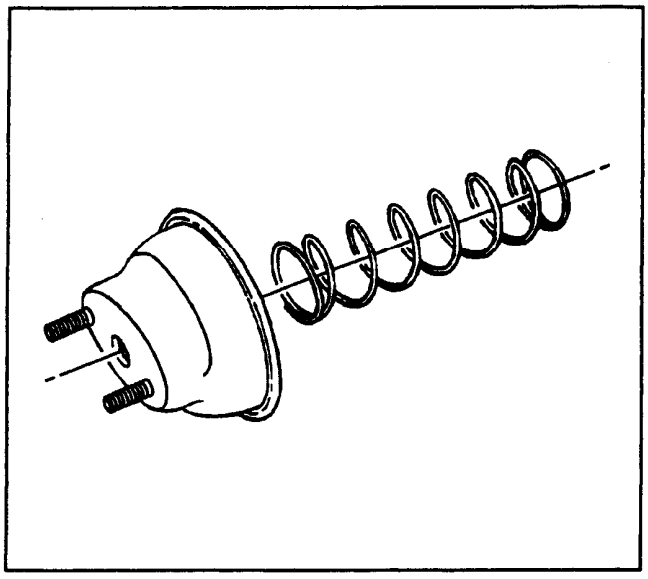


201676

Important: Replace all worn and/or damaged parts.

12. Inspect the inside of the service housing (5) for corrosion.

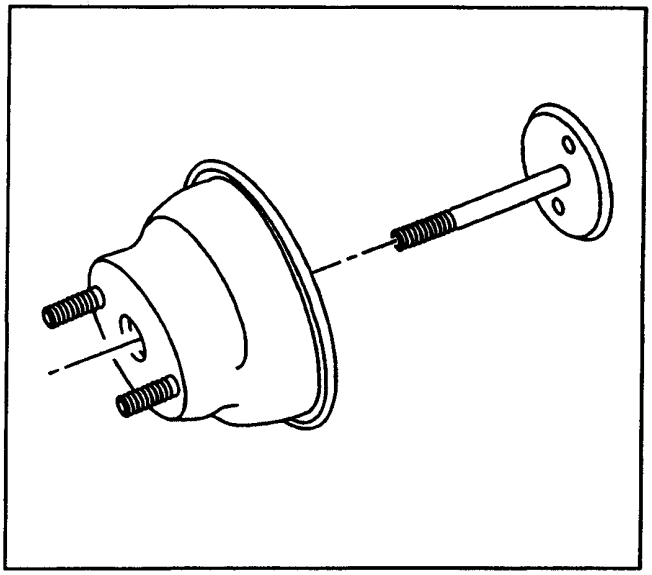
    Replace the service housing (5) if corrosion is found.
13. Inspect the adapter (10) wall and the lip.
14. Inspect the return spring (6).
15. Inspect the pushrod (7).
16. Inspect the clamp ring assembly (3).

Assembly Procedure

1. Install the return spring into the service housing.

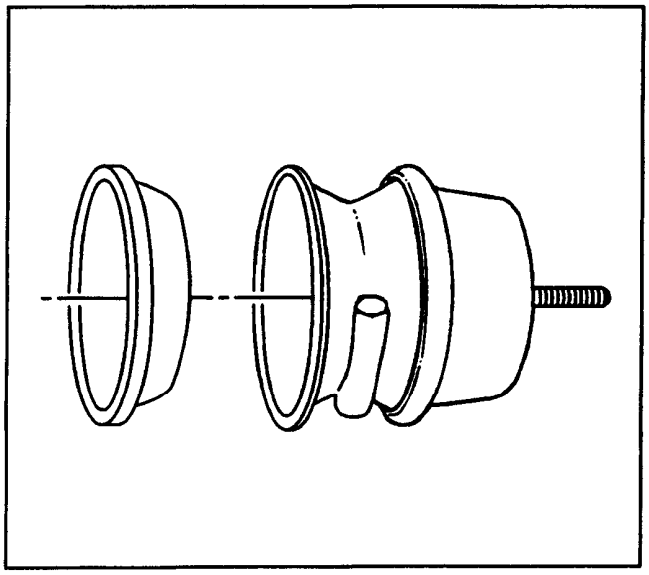
Important: Compress the return spring and clamp the pushrod in place with locking-type pliers.

2. Install the pushrod into the service housing.



201674

3. Install the diaphragm into the adapter.



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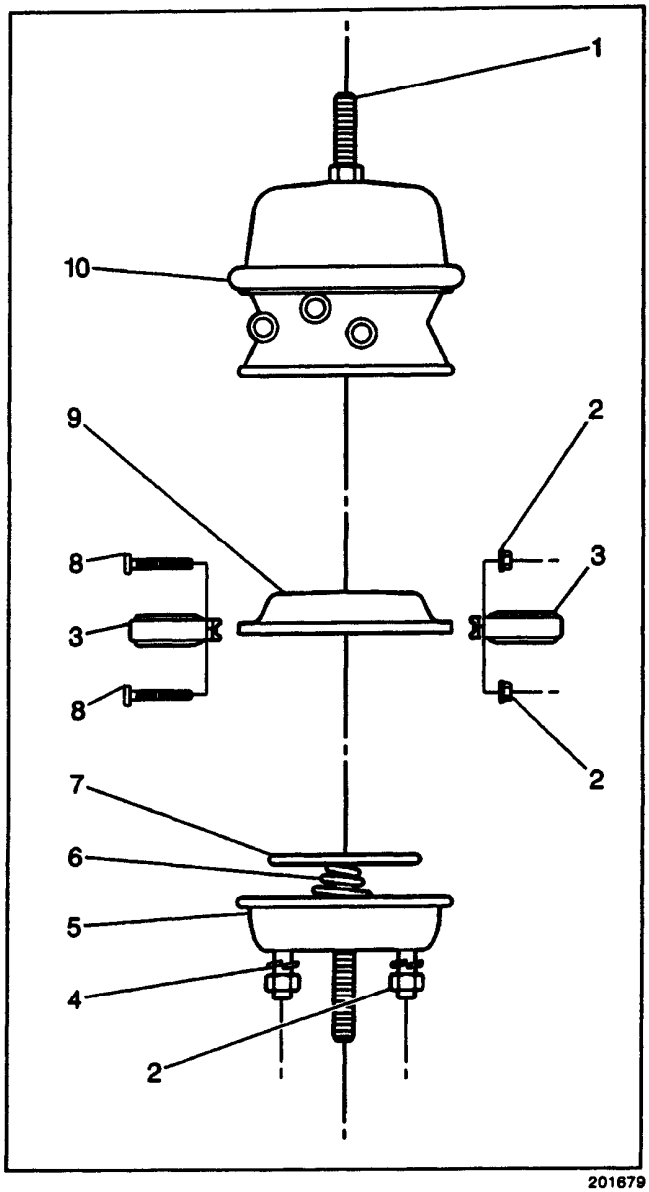
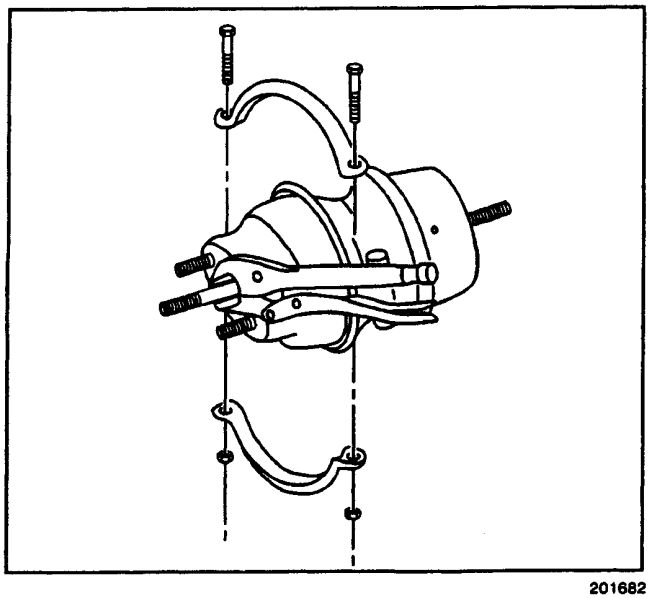


201679

4. Install the service housing (5) onto the adapter (10).



201682

Important: Align the marks made during disassembly.

5. Install the clamp ring assembly.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.

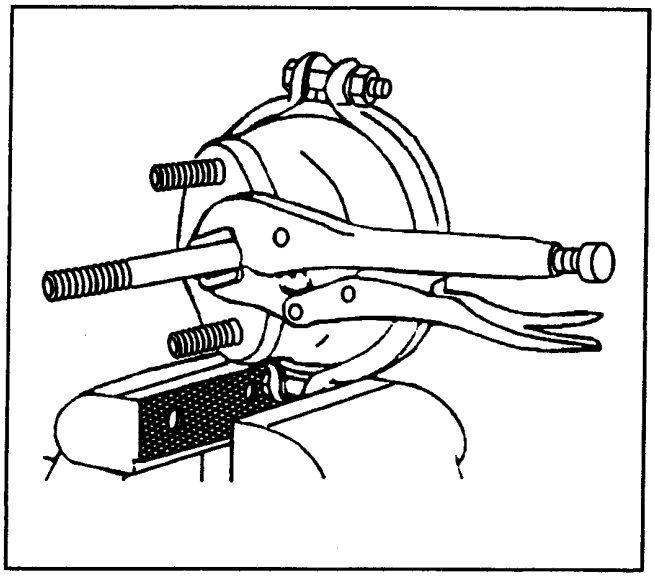
6. Install the bolts and the nuts.

   Tighten

   Tighten the nuts to 34 N.m (25 lb ft).

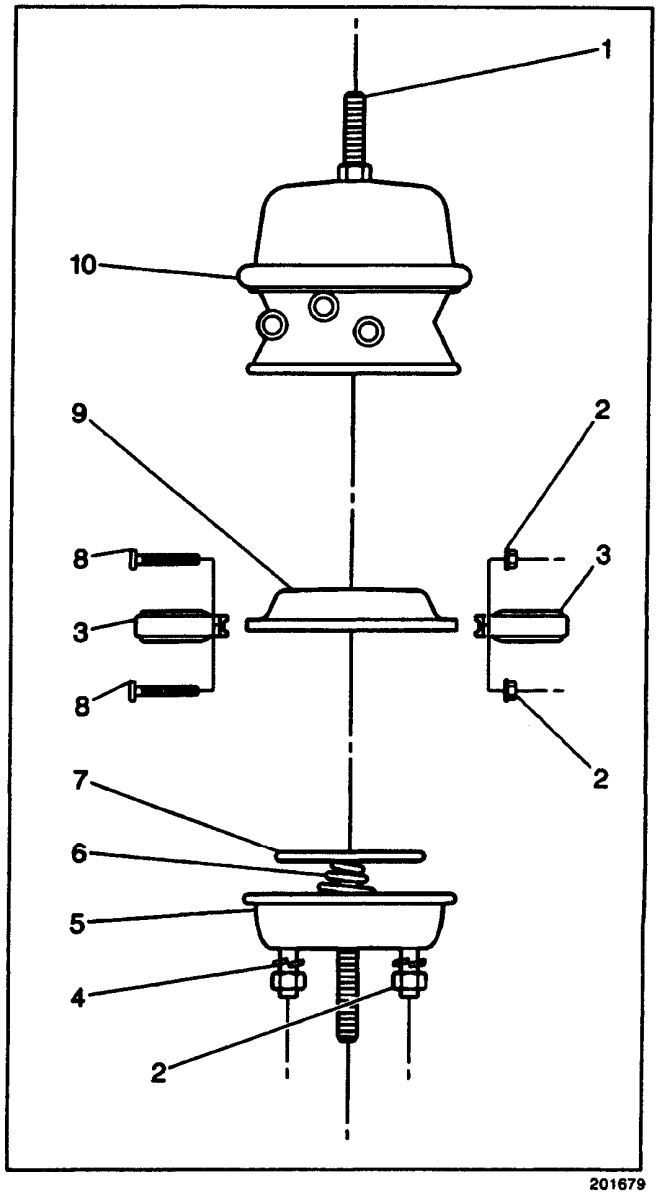
7. Inspect the clamp assembly for proper seating around the adapter and the service housing lip.

8. Release the locking-type pliers.



201669

9. Loosely fit the nut and the spring brake chamber clevis to the pushrod. Refer to the following procedures:
   - *Air Brake Chamber Clevis Replacement (Rockwell)* or
   - *Air Brake Chamber Clevis Replacement (Eaton).*
10. Install the nut (2) and the air brake chamber clevis to the pushrod (7).



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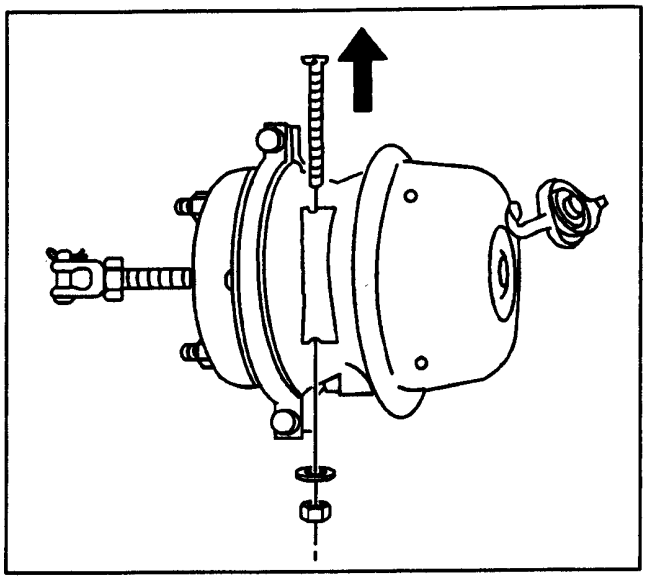


201893

Caging the Rear Air Brake Chamber

Caging Procedure

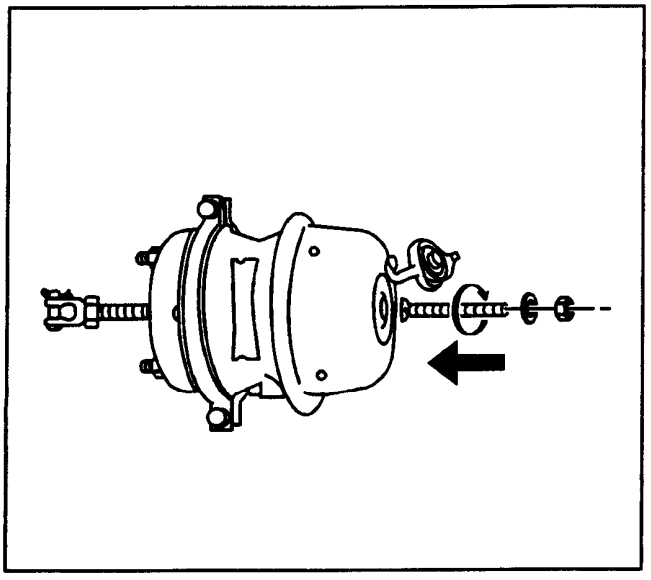
Caution: Do not attempt to cage the compression (power) spring when the rear air brake chamber shows structural damage. Caging the compression spring or disassembly of the spring brake chamber may result in the forceful release of the compression (power) spring and the chamber contents which may cause severe personal injury. Remove the entire rear air brake chamber if it has structural damage and replace with a new rear air brake chamber.

Caution: Do not drive the vehicle with the rear air brake chambers caged. Caging the rear air brake chambers disables the emergency and parking brakes. If a malfunction occurs with the service brakes, serious personal injury could result from not having any emergency brakes.

1. Block the wheels.
2. Start the engine.
3. Charge the system to the air compressor governor valve cut-out point.
4. Stop the engine.

   Important: Do not set the parking brake.
5. Inspect the rear air brake chamber for any structural damage.

   Do not try to cage the compression spring if there is any damage to the rear air brake chamber. Refer to the proper procedure:
6. Remove the dust plug from the release tool keyhole in the center of the rear air brake chamber.



201895

Caution: If air pressure is used to compress the compression spring, do not tighten the release nut more than finger tight. Torquing the release nut too tight may cause pressure plate damage resulting in the sudden release of the compression spring causing severe personal injury.

7. Remove the release tool assembly from the side pocket of the adapter.
8. Cage the rear air brake chambers.
   - 8.1. Insert the release stud through the keyhole in the rear air brake chamber (the spring brake chamber section) into the pressure plate.
   - 8.2. Turn the release stud 90 degrees (1/4 turn) clockwise.
   - 8.3. Pull on the release stud in order to ensure the release stud crosspin is properly seated in the pressure plate.

     Notice: Tighten the release stud nut no more than finger tight if air pressure is used to compress the compression (power) spring.
   - 8.4. Assemble the release stud washer and the nut on the release stud finger tight.

9. Measure the release stud length beyond the release stud nut.
10. Replace the rear air brake chamber if the stud length is less than 69.08 mm (2.72 in). Refer to the proper procedure:
    - Refer to *Air Brake Chamber Replacement (Front)* or
    - Refer to *Air Brake Chamber Replacement (Rear).*

    Caution: Do not torque the release stud more than the torque specified when caging the compression spring. If the specified release stud length cannot be obtained at the maximum allowed torque, there may be a broken compression spring. Do not attempt to disassemble any part of the spring brake chamber if the spring is broken. Replace the rear air brake chamber. Failure to observe this caution may result in sever personal injury.

    Notice: Do not use an impact wrench to tighten the release nut. Damage to the pressure plate and release stud can occur.

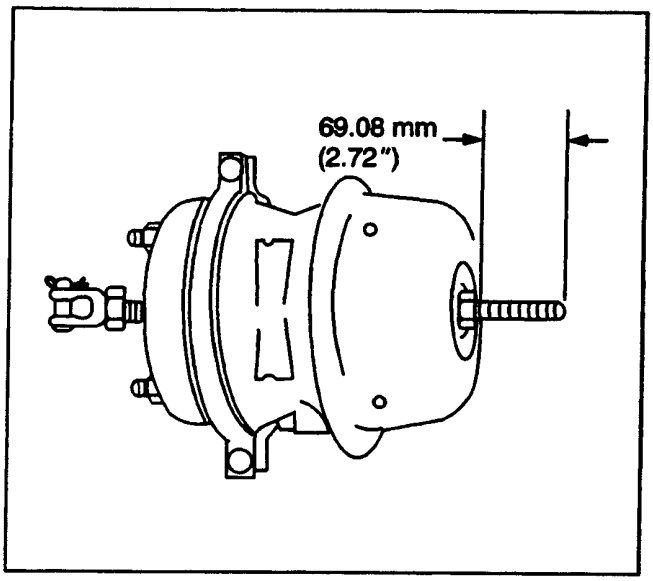
    Notice: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Fasteners requiring replacement or fasteners requiring the use of thread locking compound or sealant are identified in the service procedure. Do not use paints, lubricants, or corrosion inhibitors on fasteners or fastener joint surfaces unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems.

    Important: Tighten the release stud nut only if the rear air brake chamber (spring brake chamber section) is not pressurized.
11. Tighten the release stud nut.

    Use a hand wrench with the air pressure exhausted from the rear air brake chamber (spring brake chamber section).

    Tighten

    Tighten the release stud nut to a maximum of 47 N.m (35 lb ft).
12. Ensure that the pushrod is retracting.
13. Ensure that the compression spring is completely caged.
14. Measure the release stud length beyond the release stud nut.
15. Replace the rear air brake chamber if the stud length is less than 69.08 mm (2.72 in). Refer to the proper procedure:
    - Refer to *Air Brake Chamber Replacement (Front)* or
    - Refer to *Air Brake Chamber Replacement (Rear).*



201898

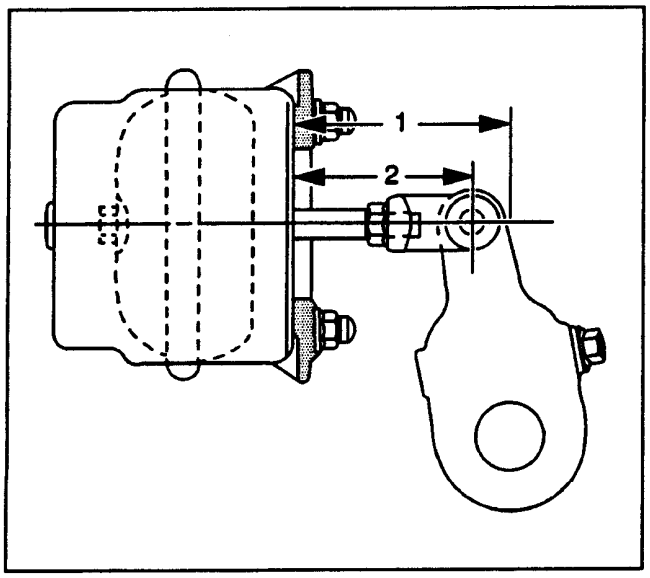
Uncaging Procedure

1. Unscrew the release stud nut and the washer from the release stud until the compression (power) spring pressure is completely relieved.
2. Turn the release stud 1/4 turn counterclockwise.
3. Remove the release stud from the keyhole in the rear air brake chamber.
4. Install the dust plug into the keyhole in the rear air brake chamber.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
5. Return the following components to the adapter storage pocket:
   - The release stud
   - The release stud nut
   - The washer

   Tighten

   Tighten the release stud nut to 7 N.m (62 lb in).
6. Start the engine.
7. Charge the system to the air compressor governor valve cut-out point.
8. Stop the engine.
9. Check for proper brake operation.
10. Set the parking brake.
11. Remove the wheel blocks.



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Air Drum Brake Adjustment (Pushrod Stroke Measurement)

Refer to *Maintenance Schedule* in Maintenance and Lubrication.

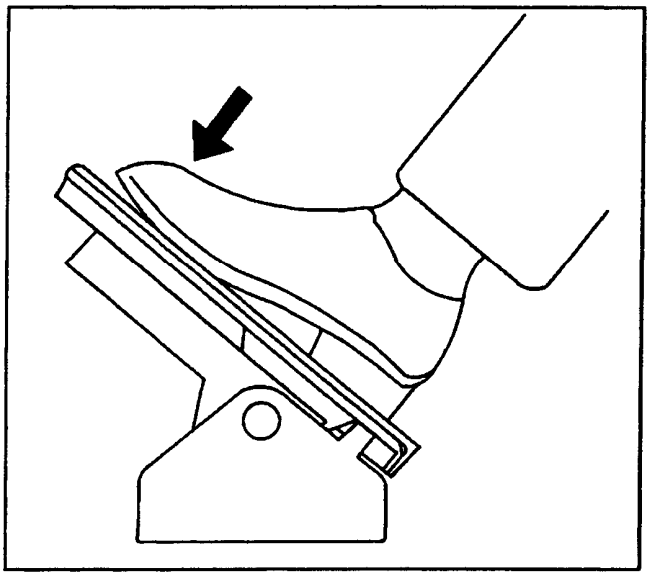
Measure the pushrod stroke in order to determine if the brakes are acceptably adjusted. The pushrod travel should be less than the maximum allowable stroke listed in the Dimensional Specifications Table. Refer to *Air Drum Brake Component Specifications (Dimensional).*

Pushrod Stroke Measurement

The stroke is the difference between the released air brake automatic slack adjuster position and the applied air brake automatic slack adjuster position. The applied position must be measured at 550–620 kPa (80–90 psi) air pressure in the brake chamber assemblies when the brakes are fully applied.

1. Start the engine to increase the air pressure to 690 kPa (100 psi) if necessary.
2. Stop the engine.
3. Apply and release the brakes to decrease the air pressure to 690 kPa (100 psi) if necessary.

4. Check the duel air pressure gauge in order to ensure that the air pressure in the air reservoirs is 690 kPa (100 psi) with the engine off and that the rear air brake chambers (spring brake chamber section) is released.
5. Measure the distance between the brake chamber assembly mounting surface and the center of the air brake chamber clevis pin on all of the brakes.
6. Have an assistant apply and hold one full brake application.
7. Measure the distance between the brake chamber assembly mounting surface and the center of the air brake chamber clevis pin on all of the brakes with the brakes applied at 550–620 kPa (80–90 psi).
8. Release the brakes.
9. Calculate the adjusted air brake chamber stroke at each brake.
   9.1. Subtract the dimension in measurement number 1 from the dimension in measurement number 2.
   9.2. The difference between the two dimensions is the adjusted air brake chamber stroke. The adjusted air brake chamber stroke must not be greater than the stroke length shown in the Dimensional Specifications Table. Refer to *Air Drum Brake Component Specifications (Dimensional).*
   9.3. Adjust the brakes if the pushrod stroke is greater than the specifications. Refer to *Air Drum Brake Adjustment (Normal Wear Adjustment).*



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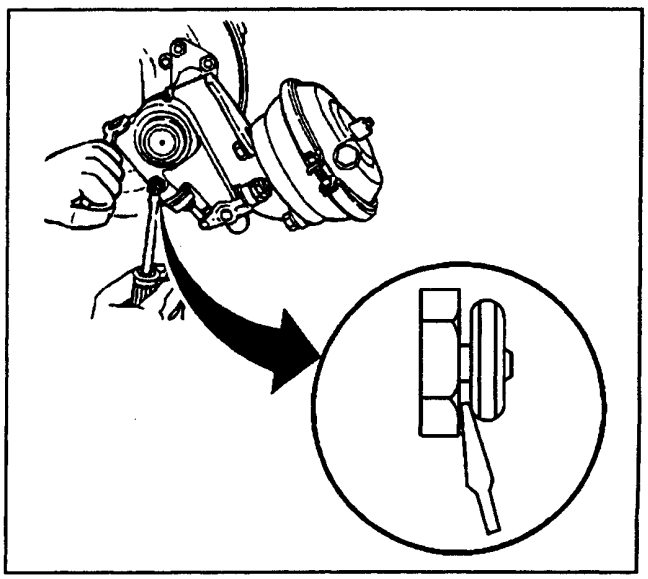
Air Drum Brake Adjustment (Normal Wear Adjustment)

Air Brake Automatic Slack Adjuster (Rockwell)

1. Block the wheels.
2. Cage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
3. Raise the vehicle and support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
4. Adjust the brakes.
   4.1. Disengage the pawl assembly with a screwdriver.
   4.2. Turn the slack adjuster adjusting nut until the brake linings contact the brake drum.
   4.3. Rotate the slack adjuster adjusting nut 180 degrees (1/2 turn).
5. Release the pawl.
6. Measure the air brake chamber pushrod stroke. Refer to *Air Drum Brake Adjustment (Pushrod Stroke Measurement).*
7. Repeat step 4 and step 5 on each wheel until all of the brakes have been adjusted.
8. Lower the vehicle.



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9. Uncage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
10. Check for proper brake operation.
11. Set the parking brake.
12. Remove the wheel blocks.

Air Brake Automatic Slack Adjuster (Eaton)

1. Block the wheels.
2. Cage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
3. Raise the vehicle and support the vehicle with safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.
4. Turn the slack adjuster adjusting hex clockwise until the brake linings contact the brake drum.
5. Rotate the slack adjuster adjusting hex counterclockwise 180 degrees (1/2 turn).

   A minimum of 17.62 N·m (13 lb ft) is necessary in order to overcome the clutch. You will hear a racheting sound.
6. Measure the air brake chamber pushrod stroke. Refer to *Air Drum Brake Adjustment (Pushrod Stroke Measurement).*
7. Repeat Steps 4–6 on each wheel until all of the brakes have been adjusted.
8. Lower the vehicle.
9. Uncage the rear air brake chambers. Refer to *Caging the Rear Air Brake Chamber.*
10. Check for proper brake operation.
11. Set the parking brake.
12. Remove the wheel blocks.

Description and Operation

Air Drum Brakes System Description

This section covers the brake parts located at the wheels. For information on other air brake system components refer to Air Brakes or Air Compressor Brakes.

The air foundation brake assembly consists of the following components:

- The service brake chamber assembly
- The spring brake chamber assembly
- The slack adjuster
- The camshaft brake assembly
- The brake drum

Air Compressor

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Air Inlet Pipe Bracket Nut	52 N.m	38 lb ft
Air Inlet Pipe Nut	63 N.m	46 lb ft
Air Compressor Mounting Bolt	73 N.m	54 lb ft
Air Compressor Mounting Nut	73 N.m	54 lb ft
Coolant Inlet Line Eye Bolt	41 N.m	30 lb ft
Coolant Outlet Line Eye Bolt	41 N.m	30 lb ft
Crankshaft Bearing Cover Bolt	8 N.m	71 lb in
Cylinder Body to Crankcase Bolt	29 N.m	21 lb ft
Cylinder Head to Cylinder Body Bolt	49 N.m	36 lb ft
Discharge Line Eye Bolt	63 N.m	46 lb ft
Governor Line Eye Bolt	41 N.m	30 lb ft
Governor Mounting Nut	22 N.m	16 lb ft
Oil Line Eye Bolt	30 N.m	22 lb ft

Air Compressor Mechanical Specifications

Application	Specification	
	Metric	English
Piston and Cylinder Bore	0.20 mm	0.008 in
Piston Pin and Piston Pin Hole	0.10 mm	0.004 in
Piston Ring Grooves and Piston Rings	0.15 mm	0.0059 in
Piston Ring Gap	1.00 mm	0.039 in
Piston Pin and Connecting Rod	0.10 mm	0.004 in
Crankshaft Journal and Connecting Rod	0.15 mm	0.0059 in

Air Compressor Gov Valve Adjustment Specifications

Application	Specification	
	Metric	English
Cut-in Pressure	725 kPa	105 psi
Cut-out Pressure	860 kPa	125 psi

Diagnostic Information and Procedures

Air Compressor Diagnosis (Air Compressor Not Unloading)

Problem	Action
The inlet valve plunger is damaged.	Replace any faulty parts.
There are intake cavity restrictions.	Remove the restrictions. Clean the cavity.
The governor is malfunctioning.	Overhaul or replace the governor. Refer to *Air Compressor Governor Valve Replacement.*
The unloader line or the cavity to the governor is restricted.	Remove the restriction.
The unloader mechanism is binding or sticking.	Overhaul or replace the cylinder head assembly. Refer to *Air Compressor Overhaul (Disassembly/Assembly).*

Air Compressor Diagnosis (Air Compressor Not Unloading)

Problem	Action
There is a restriction in the cylinder head or in the compressor.	Remove the restriction or clean the cylinder head and the discharge line.
The bearings are worn or burned out.	Replace the bearings.
The air compressor is not getting the proper lubrication.	Check the engine lubrication system and the oil supply hose. Repair or replace as necessary.
The air compressor is excessively worn.	Replace the air compressor. Refer to *Air Compressor Replacement.*

Air Compressor Diagnosis (Air Compressor Not Unloading)

Problem	Action
There is a restriction in the air compressor cylinder head intake cavities, the discharge cavities or in the discharge pipe.	Remove the restriction or clean the components.
There are leaking or broken discharge valves.	Replace the cylinder head assembly.
The air compressor is excessively worn.	Overhaul or replace the air compressor. Refer to *Air Compressor Overhaul (Disassembly/Assembly)* or *Air Compressor Replacement.*
The inlet valve is stuck open.	Replace the cylinder head assembly.
The inlet valves are worn.	Replace the cylinder head assembly.
There is excessive leakage in the system.	Check the system and repair as needed.

Air Compressor Diagnosis (Air Compressor Not Unloading)

Problem	Action
The governor is out of adjustment.	Adjust the governor. Refer to *Air Compressor Governor Valve Adjustment.*
The governor leaks.	Overhaul or replace the governor. Refer to *Air Compressor Governor Valve Replacement.*
The air compressor leaks.	Check the fittings, the bolts and the mating surfaces. Tighten or repair as needed.
The unloader is not functioning.	Overhaul the cylinder head assembly.
The governor is faulty.	Overhaul or replace the governor. Refer to *Air Compressor Governor Valve Replacement* or *Air Compressor Overhaul (Disassembly/Assembly).*

Air Compressor Diagnosis (Air Compressor Not Unloading)

Problem	Action
The air compressor is excessively worn.	Repair or replace the air compressor. Refer to *Air Compressor Replacement.*
The vacuum inlet is high.	Clean or repair the air compressor as necessary. Refer to *Air Compressor Replacement.*
The oil return line is small.	Install the proper size line.
There is excessive oil pressure.	Determine the cause of the condition and repair the condition.
The oil supply line to the air compressor is flooded.	Determine the cause of the condition. Repair the condition.
The oil seal rings in the crankcase cover are damaged.	Replace the seals.
The piston ring is not properly installed.	Install the piston ring properly.
There is back pressure from the engine crankcase.	Determine the cause of the pressure and repair the cause of the pressure.

Air Compressor and Governor Valve Diagnosis

Operation Test

1. Install a test gauge in the air compressor discharge line.
2. Start the engine and build up air pressure.
3. Check the reading on the test gauge when the air compressor cuts out.

   Compare the reading with the governor cut-out specification. Refer to *Air Compressor Gov Valve Adjustment Specifications.*
4. Slowly reduce the air pressure in the system.

   This is done by applying and releasing the brakes while the engine is running.
5. Check the reading on the test gauge when the air compressor cuts in.

   Compare the reading with the governor cut-in specification. Refer to *Air Compressor Gov Valve Adjustment Specifications.*
6. Adjust the governor if the cut-in or cut-out pressures are not within the specifications. Refer to *Air Compressor Gov Valve Adjustment Specifications.*

Leak Test

Run leakage tests on the Bendix® D-2 governor in both the cut-in and the cut-out positions.

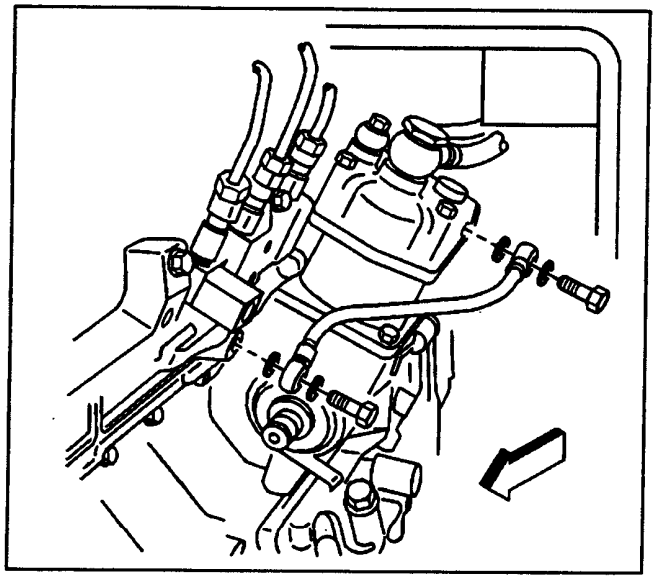
Cut-in Position

Apply a soap solution around the cover and the exhaust port. A slight bubble leakage is permitted. Excessive leakage indicates a faulty exhaust valve seat, exhaust stem O-ring, or O-ring at the top of the piston.

Cut-out Position

Apply a soap solution around the cover and to the exhaust port. A slight bubble leakage is permitted. Excessive leakage indicates a faulty exhaust valve seat, exhaust stem O-ring, or O-ring at the top of the piston.

If the governor does not function as described or if the leakage is excessive, overhaul or replace the governor. Refer to *Air Compressor Governor Valve Replacement.*



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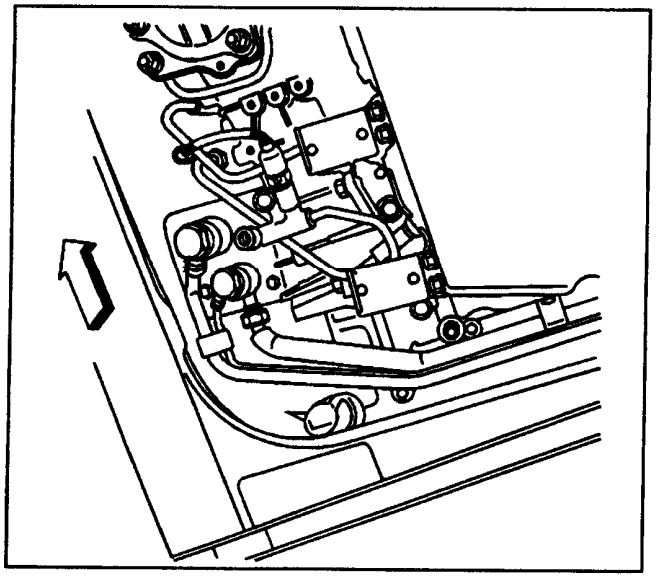

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Repair Instructions

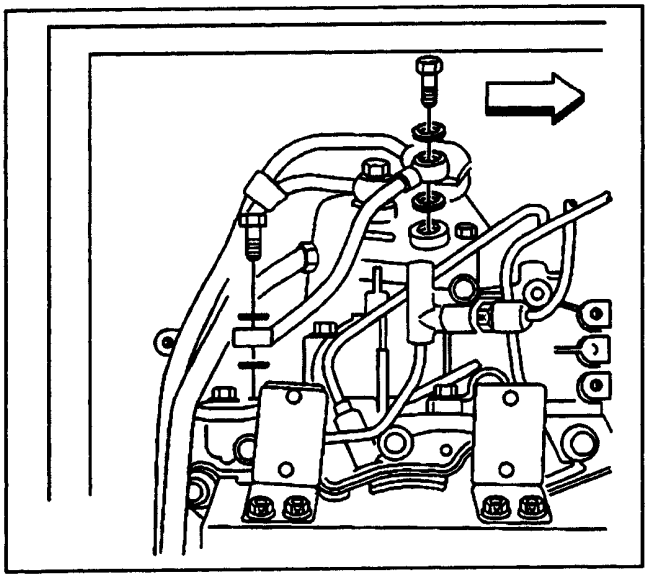
Air Compressor Replacement

Removal Procedure

1. Set the parking brake.
2. Block the vehicle wheels.
3. Tilt the cab. Refer to *Cab Tilting* in General Information.
4. Drain all of the air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.
5. Drain the coolant to below the level of the air compressor. Refer to *Draining and Filling Cooling System (Draining)* in Engine Cooling.

   Caution: Refer to Battery Disconnect Caution in Cautions and Notices.
6. Disconnect the negative battery cable.
7. Remove the fuel injector pump. Refer to the ISUZU service manual for this procedure.
8. Remove the coolant return pipe eye bolt, two gaskets connecting coolant return pipe to the air compressor. Discard all of the gaskets.
9. Disconnect the air inlet pipe at the air compressor.

10. Remove the two coolant inlet pipe eye bolts, four gaskets and the coolant inlet pipe from the air compressor and the engine. Discard all of the gaskets.



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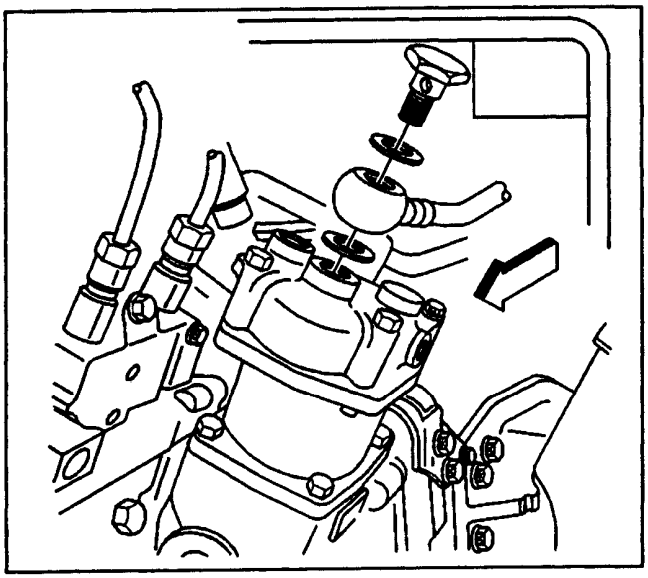
11. Remove the discharge pipe eye bolt, two gaskets connecting discharge pipe to the air compressor. Discard all of the gaskets.



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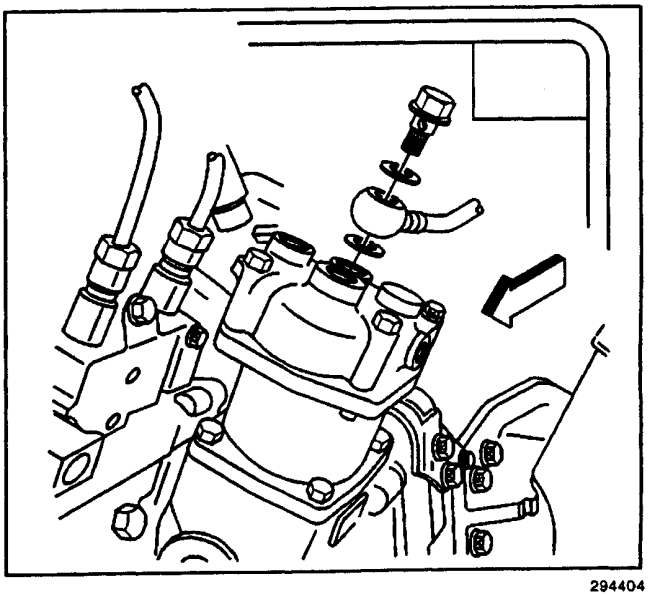
12. Remove the governor pipe eye bolt, two gaskets connecting the governor pipe to the air compressor. Discard all of the gaskets.



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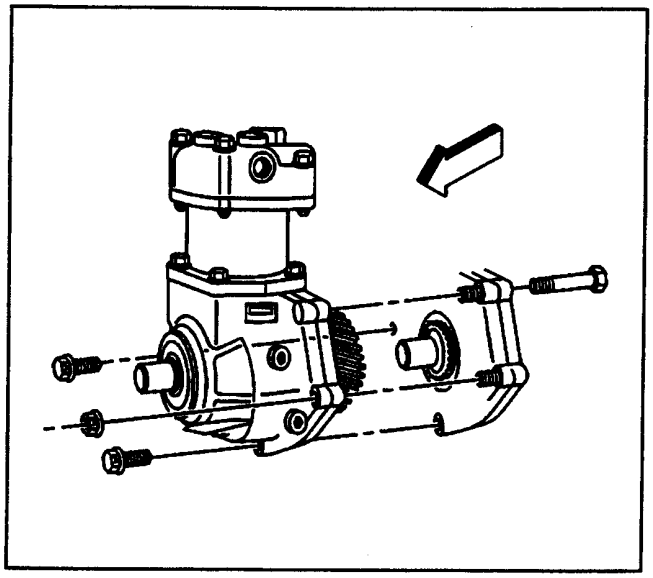

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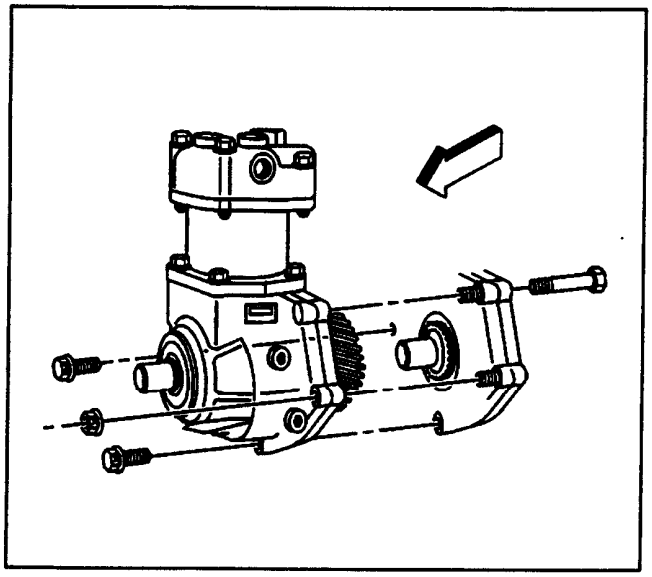
13. Remove the mounting bolts and the nut.
14. Remove the air compressor.
15. Remove the air compressor O-ring seal. Discard the O-ring.
16. Clean the exterior of the air compressor.
17. Clean any corroded lines.
18. Check for cracks on the following parts:
    - The air compressor crankcase
    - The mounting bosses
19. Ensure that the air compressor is in good condition and is not excessively worn.



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Installation Procedure

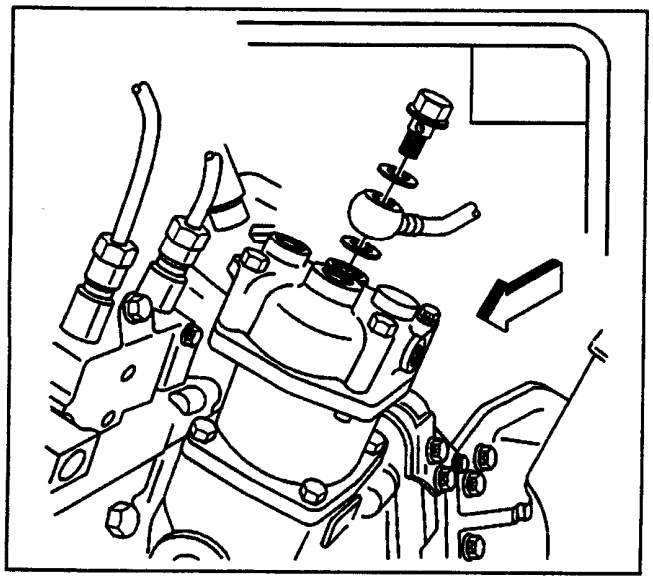
1. Install a new air compressor O-ring seal.
2. Install the air compressor.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Install the mounting bolts and the nut.

   Tighten

   3.1. Tighten the bolt to 57 N.m (42 lb ft).

   3.2. Tighten the nut to 71 N.m (52 lb ft).



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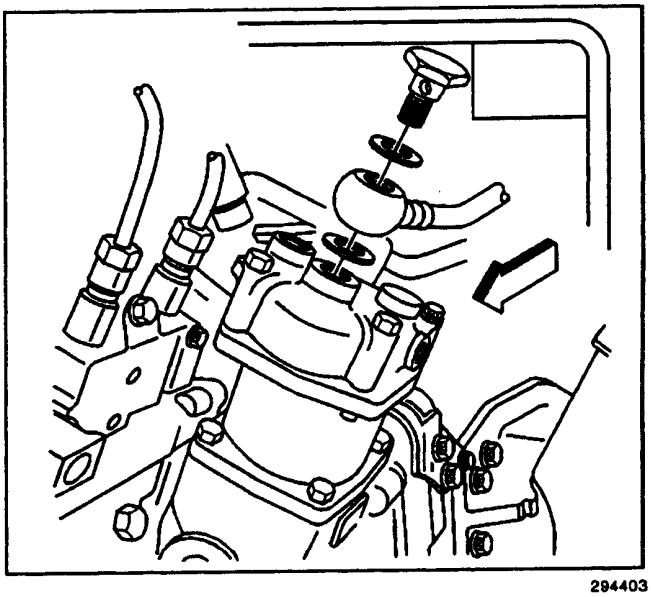
4. Install the governor pipe at the air compressor using the governor pipe eye bolt and two new gaskets.

   Tighten

   Tighten the governor pipe eye bolt to 41 N.m (30 lb ft).

5. Install the air discharge pipe at the air compressor using the air discharge pipe eye bolt and two new gaskets.
   Tighten
   Tighten the air discharge pipe eye bolt to 63 N.m (46 lb ft).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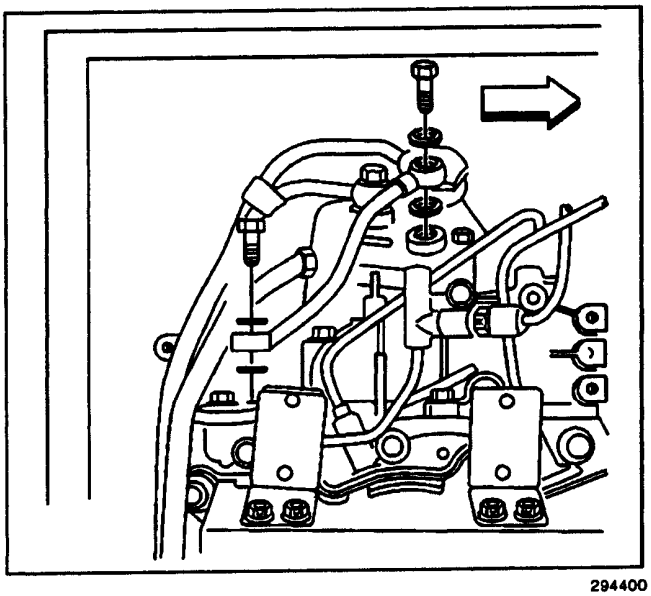
6. Install the coolant inlet pipe at the air compressor using the coolant inlet pipe eye bolt and two new gaskets.
   Tighten
   Tighten the coolant inlet pipe eye bolt to 41 N.m (30 lb ft).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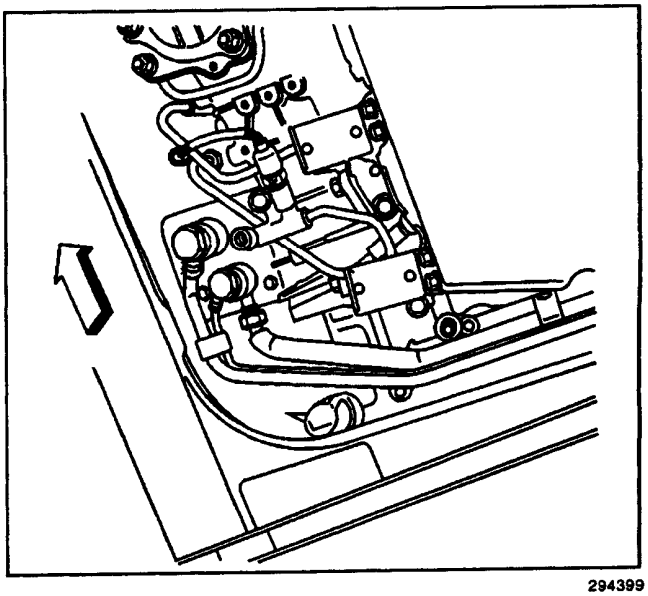
7. Install the air inlet pipe to the air compressor.
   Tighten
   Tighten the air inlet pipe to 63 N.m (46 lb ft).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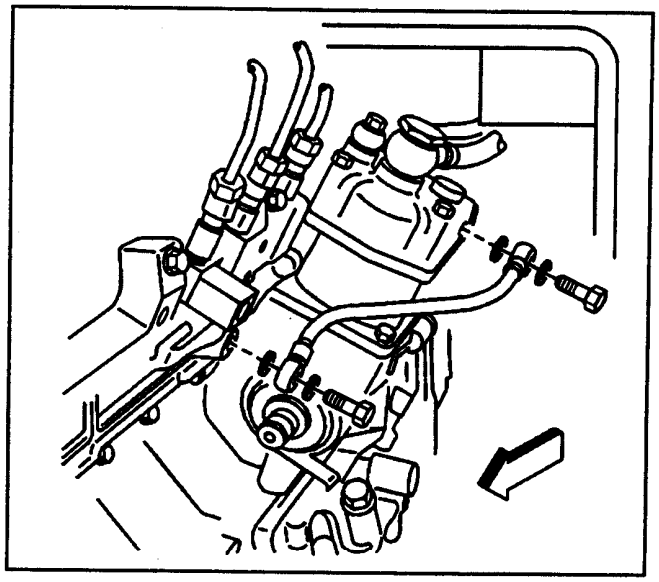

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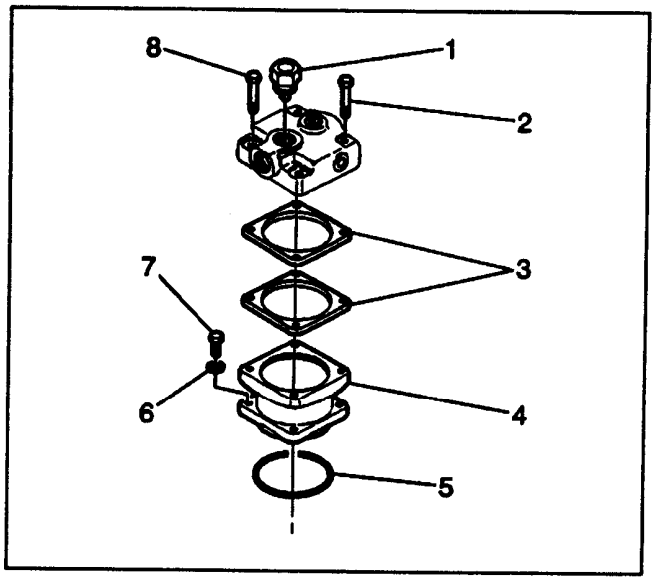

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8. Install the coolant return pipe using two coolant inlet pipe eye bolts and four new gaskets.
   Tighten
   Tighten the coolant return pipe eye bolt to 41 N.m (30 lb ft).
9. Install the fuel injector pump. Refer to the ISUZU service manual for this procedure.
10. Connect the negative battery cable.
11. Fill the cooling system. Refer to *Draining and Filling Cooling System (Filling)* in Engine Cooling.
12. Fill the engine with oil. Refer to *Fluid and Lubricant Recommendations* in Maintenance and Lubrication.
13. Lower the cab.

Air Compressor Overhaul (Disassembly/Assembly)

Disassembly Procedure

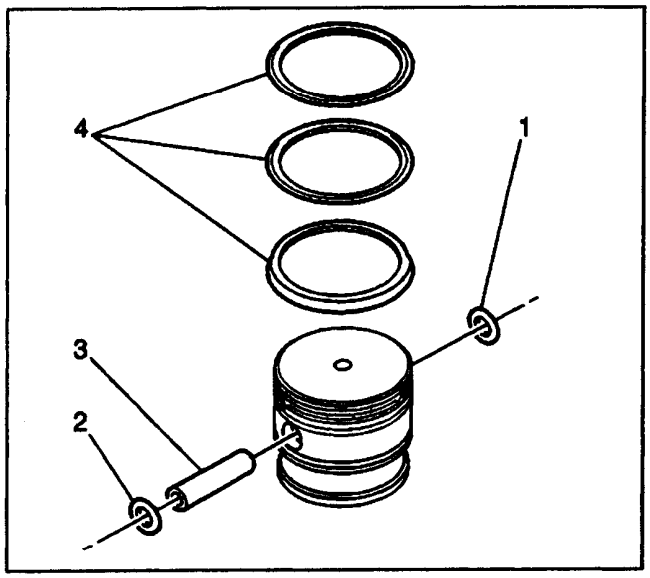
Important: Before you disassemble the compressor, mark the following components in order to show the relationships when you re-assemble the compressor:

- The cylinder head assembly to the cylinder body
- The cylinder body to the crankcase

1. Clean the compressor with engine degreaser.
2. Remove the cylinder head bolts (1, 2, 8).
   Tap the cylinder head with a soft faced mallet in order to break the gasket seal.
3. Remove the cylinder head gaskets (3).
4. Remove the air compressor cylinder body bolts (7).
   Use a wooden hammer in order to tap out the cylinder body from the crankcase.
5. Remove the air compressor cylinder body (4).
6. Remove the O-ring (5) from the cylinder body (4).

Important: Mark the relationship of the piston head to the connecting rod so that you can reassemble the parts later.

7. Remove the two piston pin snap rings (2).
8. Remove the piston pin (3).
9. Remove the piston.
10. Remove the piston ring assembly (4).
    Use piston rings pliers in order to remove the piston ring.



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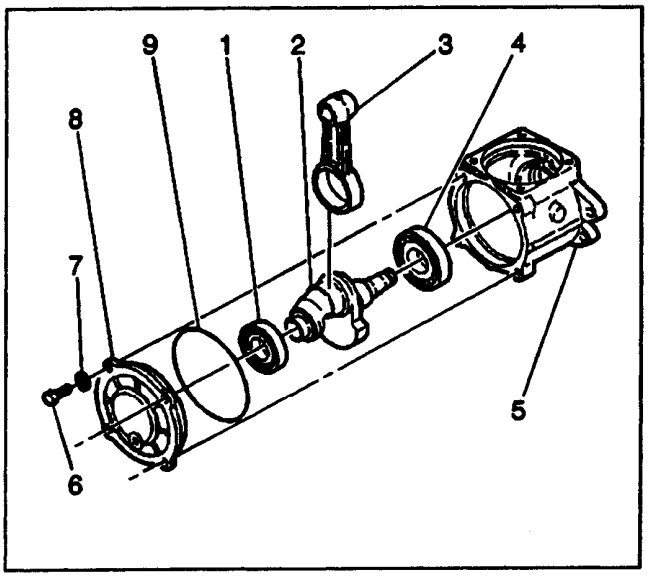
11. Remove the crankshaft bearing cover bolts (6).
12. Remove the O-ring (9) from the crankshaft bearing cover (3).
13. Remove the front crankshaft bearing (1).
    Use a suitable bearing remover in order to remove the crankshaft bearing.
14. Remove the connecting rod (3).
    Lower the connecting rod (3) by rotating the crankshaft (2).
15. Remove the connecting rod (3) from the crankshaft (2).
16. Remove the crankshaft (2) and the rear crankshaft bearing (4).
    Use a suitable press in order to remove the crankshaft bearing.



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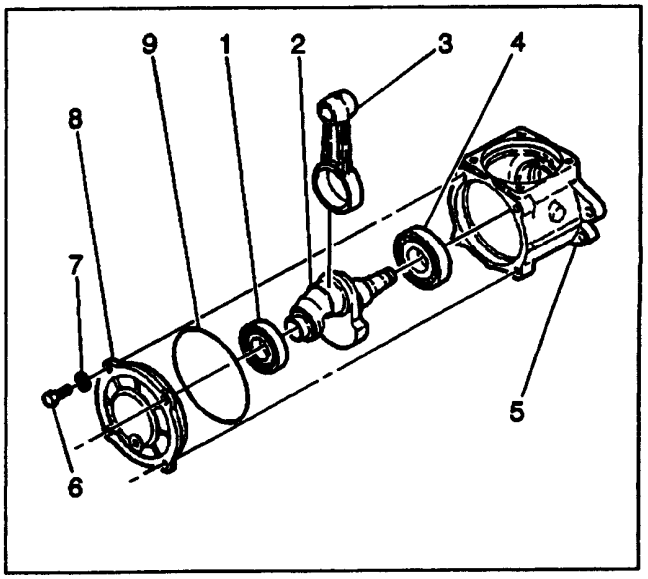
Assembly Procedure

Cleanliness during assembly is important. Dirt causes premature wear of the overhauled air compressor. Lightly lubricate all of the moving parts with clean engine oil during assembly. Engine oil provides an initial lubricant when you start the engine.

1. Install the crankshaft rear bearing (4) onto the crankshaft.
   Use a suitable press and a suitable support in order to assemble the crankshaft rear bearing.
2. Install the crankshaft with the bearing into the crankcase (5).
3. Install the connecting rod (3) onto the crankshaft (2).



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4. Install the crankshaft front bearing (1) onto the crankshaft (2).

   Use a suitable press and a suitable sleeve in order to assemble the crankshaft front bearing.

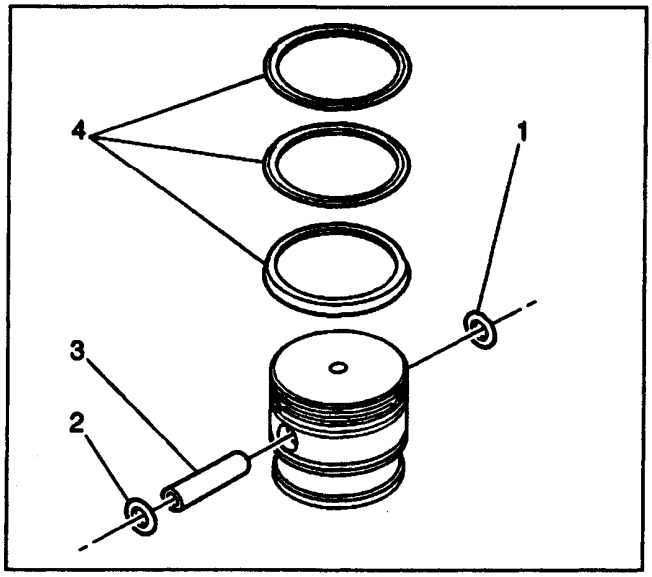
   Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the O-ring (9) and the crankshaft bearing cover (8).

   Tighten

   Tighten the crankshaft bearing cover bolts to 8 N.m (71 lb in).

6. Install the piston ring assembly (4).



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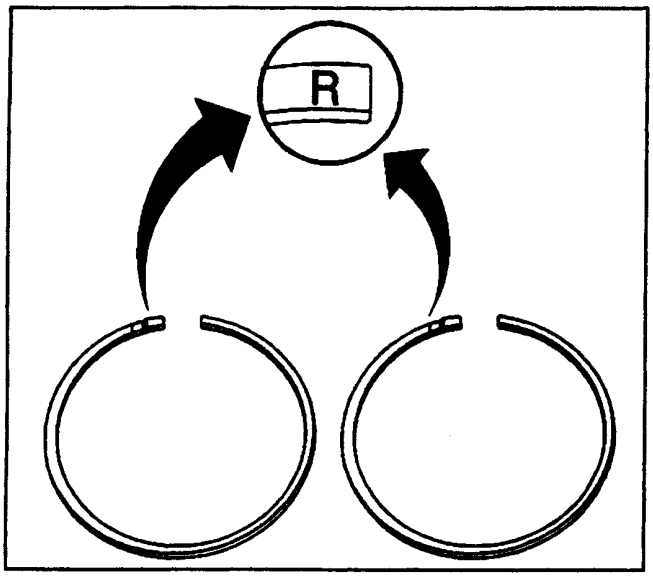

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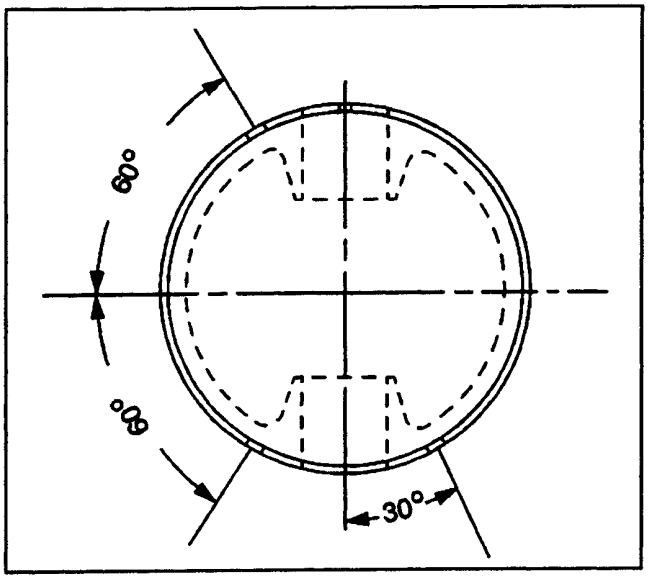
7. Install the first and the second rings with the R turned up.

8. Set the piston rings to the following recommended positions:
   8.1. Set the first compression ring at 30 degrees from the piston pin.
   8.2. Set the second compression ring at 60 degrees clockwise of the center line that is perpendicular to the piston pin center line.
   8.3. Set the expander ring at 60 degrees counter-clockwise of the center line that is perpendicular to the piston pin.



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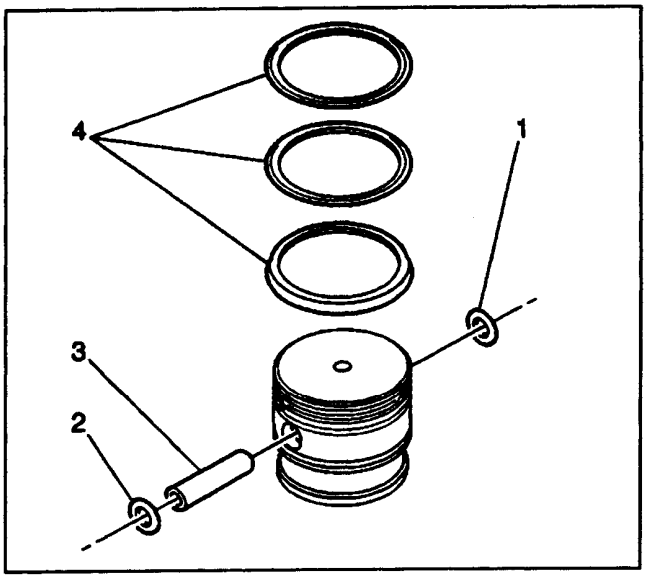
9. Install the piston pin (3) into the piston.
10. Install the piston snap rings (2) into the piston.



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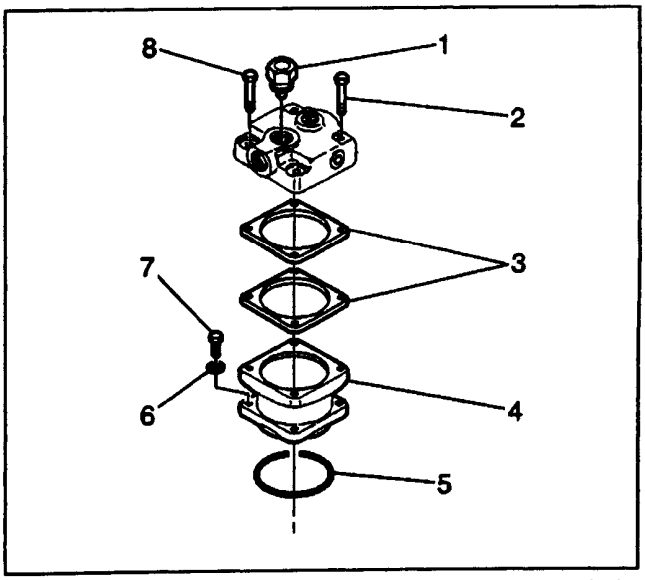
11. Install the cylinder body (4) and a new O-ring (5) into the crankcase.
    Tighten
    Tighten the bolts to 29 N·m (21 lb ft).
12. Install the new cylinder head gaskets (3) and a new cylinder head to the cylinder body.
    Tighten
    Tighten the bolts to 49 N·m (36 lb ft).



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Air Compressor Overhaul (Cleaning and Inspection)

Cleaning and Inspection

1. Clean all of the parts in parts cleaner.
   Dry the parts before you inspect the parts.
2. Remove the carbon deposits from the discharge cavities.
3. Remove the rust and the scale from the cooling cavities.
4. Scrape any foreign matter from the body surfaces.
   Use compressed air in order to remove dirt particles.
5. Clean the oil passages with a wire.
   Use compressed air in order to blow the loosened foreign matter out of the oil passages.
6. Inspect the crankcase surfaces for cracks and any other damage.
7. Inspect the tapered ends of the crankshaft and all of the machined parts for the following:
   - Wear
   - Scores
   - Damage
8. Inspect the cylinder bore for uneven wear.
9. Inspect the piston for the following conditions:
   - Scores
   - Cracks
   - Enlarged ring grooves

   Replace the piston if necessary.
10. Complete the following measurements:
    10.1. Measure the cylinder for uneven wear. The maximum limit is 0.1 mm (0.004 in).
    10.2. Measure the piston and the cylinder clearance. The maximum limit is 0.2 mm (0.008 in).
    10.3. Measure the piston ring groove and the piston ring clearance. The maximum limit is 0.15 mm (0.0059 in).
    10.4. Measure the piston ring gap. The maximum limit is 1.0 mm (0.039 in).
    10.5. Measure the piston pin and the piston hole clearance. The maximum limit is 0.1 mm (0.004 in).
    10.6. Measure the piston pin and the connecting rod small end clearance. The maximum limit is 0.1 mm (0.004 in).
    10.7. Measure the crankshaft journal and the connecting rod large end clearance. The maximum limit is 0.15 mm (0.0059 in).

Air Compressor Overhaul (Tests after Overhaul)

Important: Before you condemn or adjust the governor, check the dual air pressure gauge on the instrument panel. Use an accurate test gauge in order to verify the pressure that is shown on the dual air pressure gauge.

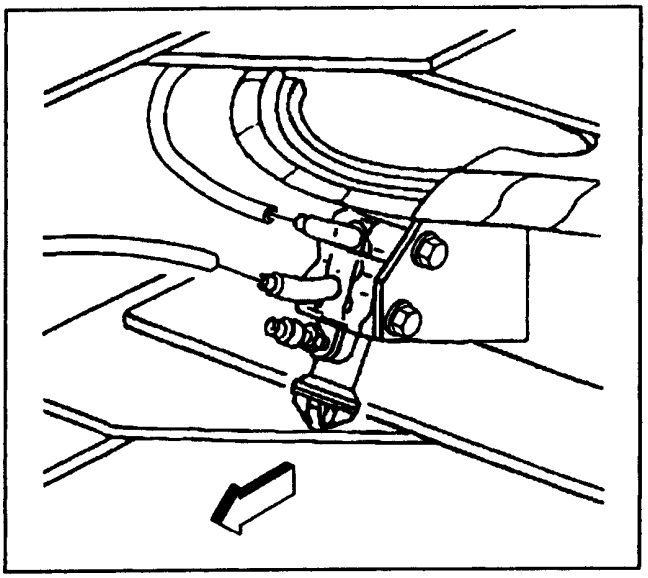
1. Start the engine.
2. Build up the air pressure.
3. Observe the reading on the dual air pressure gauge on the instrument panel when the governor cuts out. Refer to *Air Compressor Gov Valve Adjustment Specifications* for the cut-out pressure.
4. While the engine is still running, slowly reduce the air pressure. Apply and release the brakes in order to reduce the air pressure.
5. Observe the dual air pressure gauge when the governor cuts in. Refer to *Air Compressor Gov Valve Adjustment Specifications* for the cut-in pressure.
6. If you need to change the pressure settings, adjust the governor. Refer to *Air Compressor Governor Valve Adjustment.*

Air Compressor Governor Valve Replacement

Removal Procedure

1. Block the wheels.
2. Set the parking brake.
3. Drain all of the air reservoirs. Refer to *Draining Reservoirs* in Air Brakes.

   Important: Tag or label the air lines for later installation.
4. Remove the air lines. Refer to the following procedures in Air Brakes:
   - *Hose and Line Replacement (Nylon and Metal - Compression)*
   - *Hose and Line Replacement (Nylon - Push-In)*
   - *Hose and Line Replacement (Flexible)*
   - *Hose and Line Replacement (Trailer Brake Coupling)*
   - *Hose and Line Replacement (Trailer Brake Dummy Cap)*
5. Remove the nuts.
6. Remove the bolts.
7. Remove the washers.
8. Remove the governor.



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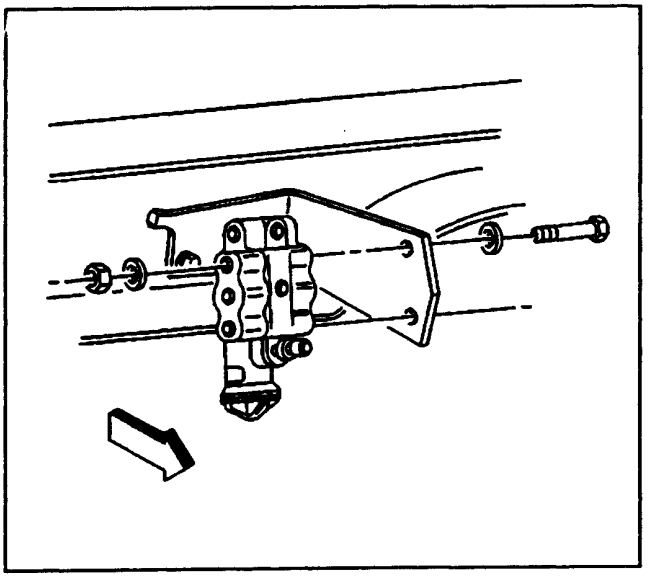

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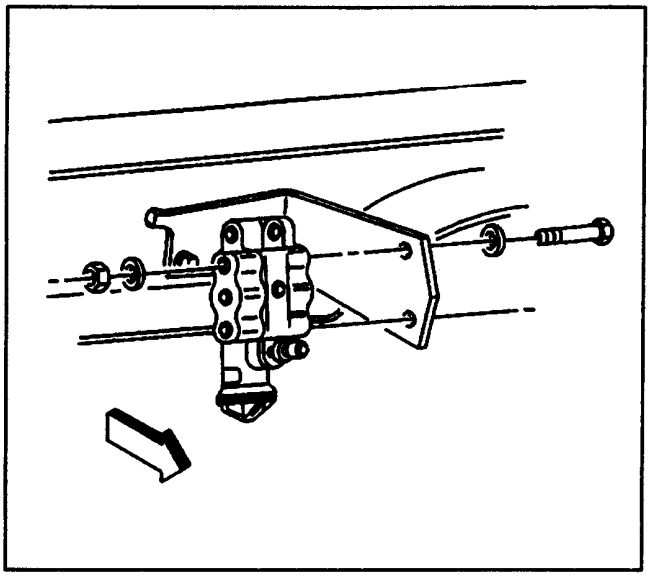

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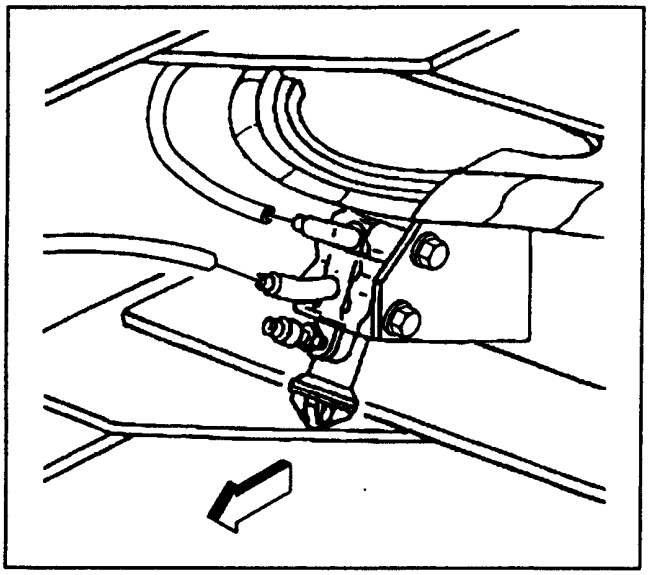

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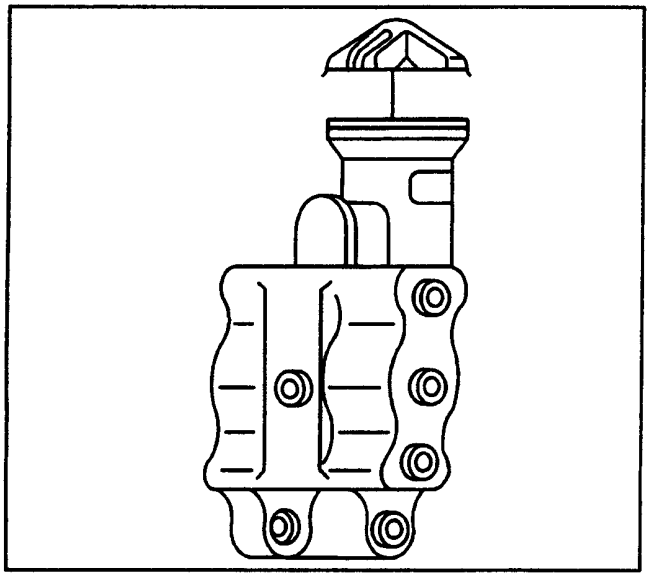

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Installation Procedure

1. Install the governor.
2. Install the bolts.
3. Install the washers.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
4. Install the nuts.

   Tighten

   Tighten the nuts to 33 N.m (16 lb ft).
5. Install the air lines.
6. Start the engine.
7. Adjust the chain cut-in and the cut-out pressures. Refer to *Air Compressor Governor Valve Adjustment.*
8. Check the system for leaks.
9. Ensure that the brakes operate properly.
10. Remove the wheel blocks.

Air Compressor Governor Valve Adjustment

You may need to adjust the governor under the following conditions:

- The range falls below 100 kPa (15 psi) of the recommended pressures
- The pressure settings are incorrect

Before you make any adjustments, check the engine air filter element and the governor air inlet hose for restrictions using the following procedure:

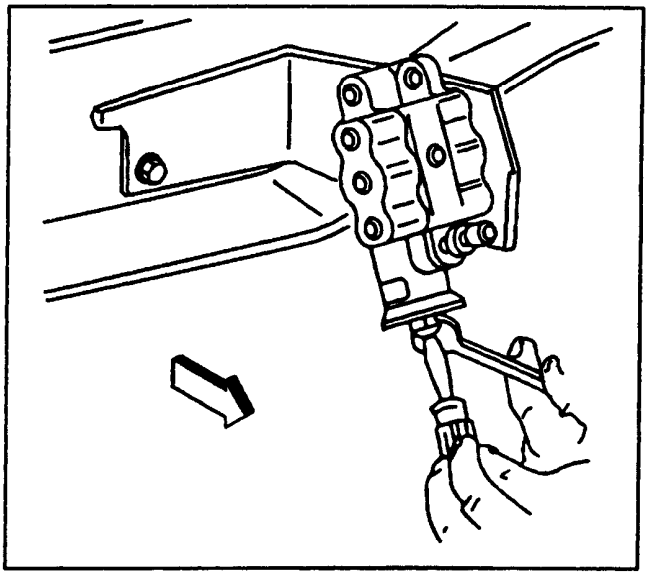
1. Remove the top cover from the governor.

2. Loosen the adjusting screw locknut.

   Important: Do not over adjust the adjusting screw. Each 1/4 turn of the adjusting screw locknut raises or lowers the pressure settings approximately 28 kPa (4 psi).

   - The pressure range between the cut-in and the cut-out setting is not adjustable.
   - In order to raise the pressure setting, turn the adjusting screw counter-clockwise. In order to lower the pressure setting, turn the adjusting screw clockwise.
   - After you make the adjustment, tighten the adjusting screw locknut.
   - Recheck the cut-in and the cut-out pressures.
   - Install the cover on the governor.

Refer to *Air Compressor Gov Valve Adjustment Specifications* for the correct governor settings.



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Description and Operation

Air Compressor Description

The air compressor is a one-cylinder, single-stage, reciprocating air compressor. The air compressor consists of three major subassemblies:

- The cylinder head
- The cylinder body
- The crankcase

The cylinder head houses the inlet and the discharge valving. The cylinder body contains the cylinder bore and the piston. The crankcase is a one-piece casting. The crankcase houses the crankshaft and the bearings.

Air Compressor Operation

The air compressor is flange mounted to the flywheel housing and is gear driven. The air compressor is lubricated from the engine oil lubrication system and is cooled through the engine cooling system. The model identification number is located on a plate that is attached to the air compressor crankcase.

A coolant inlet pipe provides coolant from the engine head to the air compressor. The coolant outlet pipe carries hot coolant back to the engine block.

An oil supply tube provides lubrication from the engine block to the air compressor. The oil is returned to the engine through the air compressor crankcase.

As the air compressor piston moves downward, air is drawn into the cylinder through the inlet valve of the cylinder head. This action is referred to as the intake stroke. As the piston begins to move upward, the inlet valve closes and the air above the piston is compressed. This action is referred to as the compression stroke. When the air pressure in the cylinder is greater than the air pressure in the air reservoir, the discharge valve raises off of the discharge valve seat. Air is then allowed to pass through the exhaust port and out of the discharge tube. As the intake stroke begins, the discharge valve seats again.

Air Compressor Governor Valve Description

The Bendix® D-2 governor operates in conjunction with the air compressor unloader mechanism. The governor automatically controls the air pressure in the air brake supply system between a maximum cut-out pressure and a minimum cut-in pressure. The air compressor runs continually while the engine runs. The governor actuates the air compressor unloader mechanism, controlling the actual compression of air. The mechanism stops or starts the compression of air when the maximum or the minimum air reservoir pressures are reached.

Air Compressor Governor Valve Operation

The air compressor runs continually while the engine is running. The actual compression of air is controlled by the governor actuating the air compressor unloader mechanism. The air compressor unloader mechanism stops or starts the compression of air under the following conditions:

- When the maximum reservoir pressure is reached
- When the minimum reservoir pressure is reached

The governor directs compressed air to the unloader assembly when the air pressure in the system reaches the governor cut-out pressure. The unloader pistons move and hold the inlet valves open. With the inlet valves open, the compression stroke can not occur. The governor exhausts air from the unloader assembly when the air pressure in the system drops to the governor cut-in pressure. The unloader springs move the pistons back to the normal positions and allow the inlet valves to function normally.

Antilock Brake System

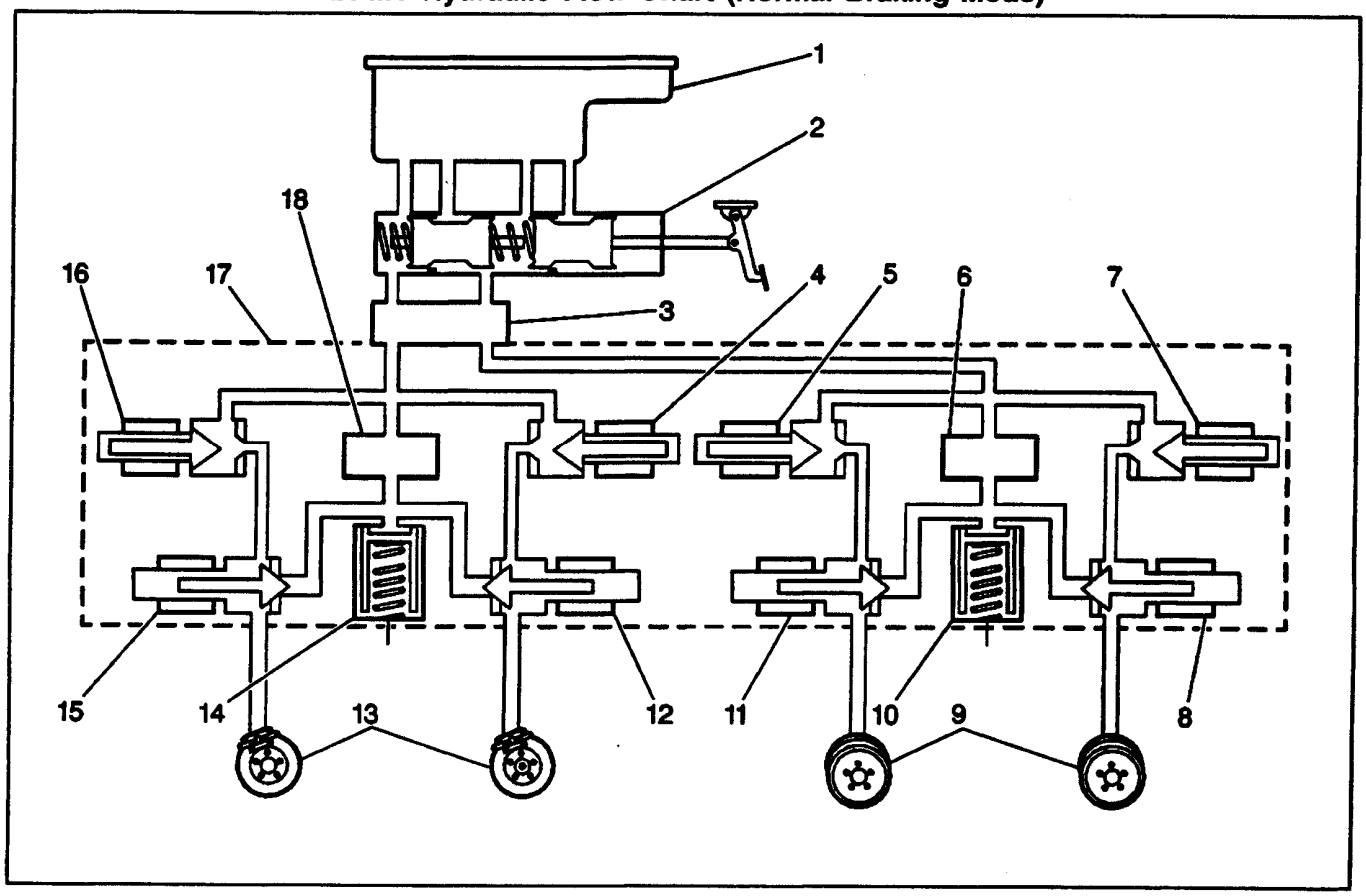
Specifications

Fastener Tightening Specifications

Application	N.m	Lb Ft	Lb In
EHCU Bracket Mounting Bolts	36	28	—
Combination Valve to BPMV	16	12	—
EBCM to BPMV	5	—	39
EHCU to Bracket	9	7	—
Front Brake Line to Combination Valve	24	18	—
Front Wheel Speed Sensor Mounting Bolts	26	19	—
Rear Brake Line to Combination Valve	24	18	—
Splash Shield Mounting Bolts	11	9	—
Tube Adapters to BPMV	31	23	—
Front Wheel Speed Sensor Harness Clip	11	9	—
EHCU Crossmember Nuts	36	28	—

Schematic and Routing Diagrams

BPMV Hydraulic Flow Chart (Normal Braking Mode)

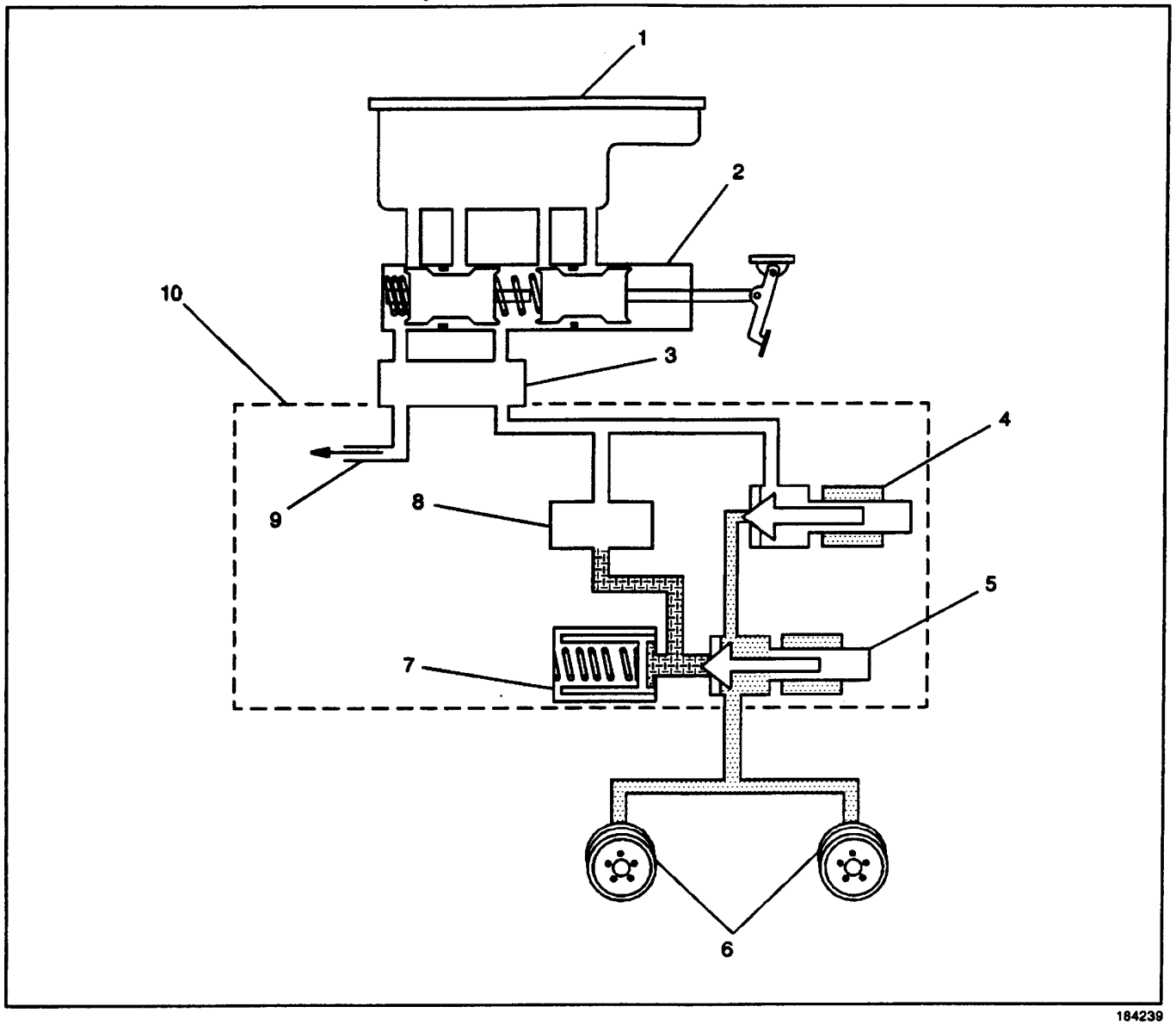


333254

Legend

(1) Master Cylinder Reservoir
(2) Master Cylinder
(3) Combination Valve
(4) Right Front Isolation Valve
(5) Left Rear Isolation Valve
(6) Rear Pump
(7) Right Rear Isolation Valve
(8) Right Rear Dump Valve
(9) Rear Drum Brakes
(10) Rear Accumulator
(11) Left Rear Dump Valve
(12) Right front Dump Valve
(13) Front Disc Brakes
(14) Front Accumulator
(15) Left Front Dump Valve
(16) Left Front Isolation Valve
(17) Brake Pressure Modulator Valve (BPMV)
(18) Front Pump

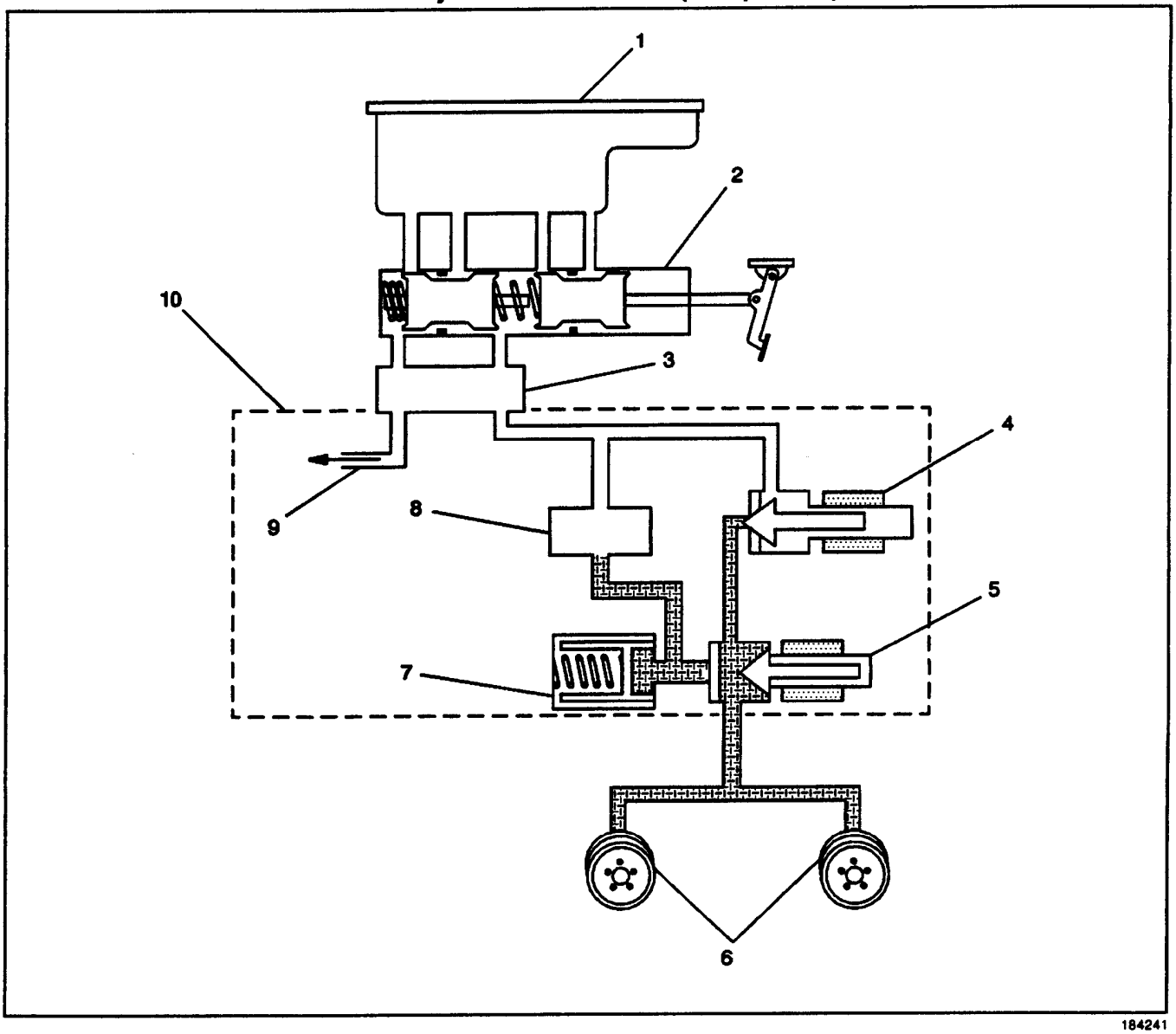
BPMV Hydraulic Flow Chart (Isolation Mode)



Legend

(1) Master Cylinder Reservoir
(2) Master Cylinder
(3) Combination valve
(4) Rear Isolation Valve
(5) Rear Dump Valve
(6) Rear Wheels
(7) Rear Accumulator
(8) Rear Pump
(9) To Front Channels
(10) Brake Pressure Modulator Valve (BPMV)

BPMV Hydraulic Flow Chart (Dump Mode)

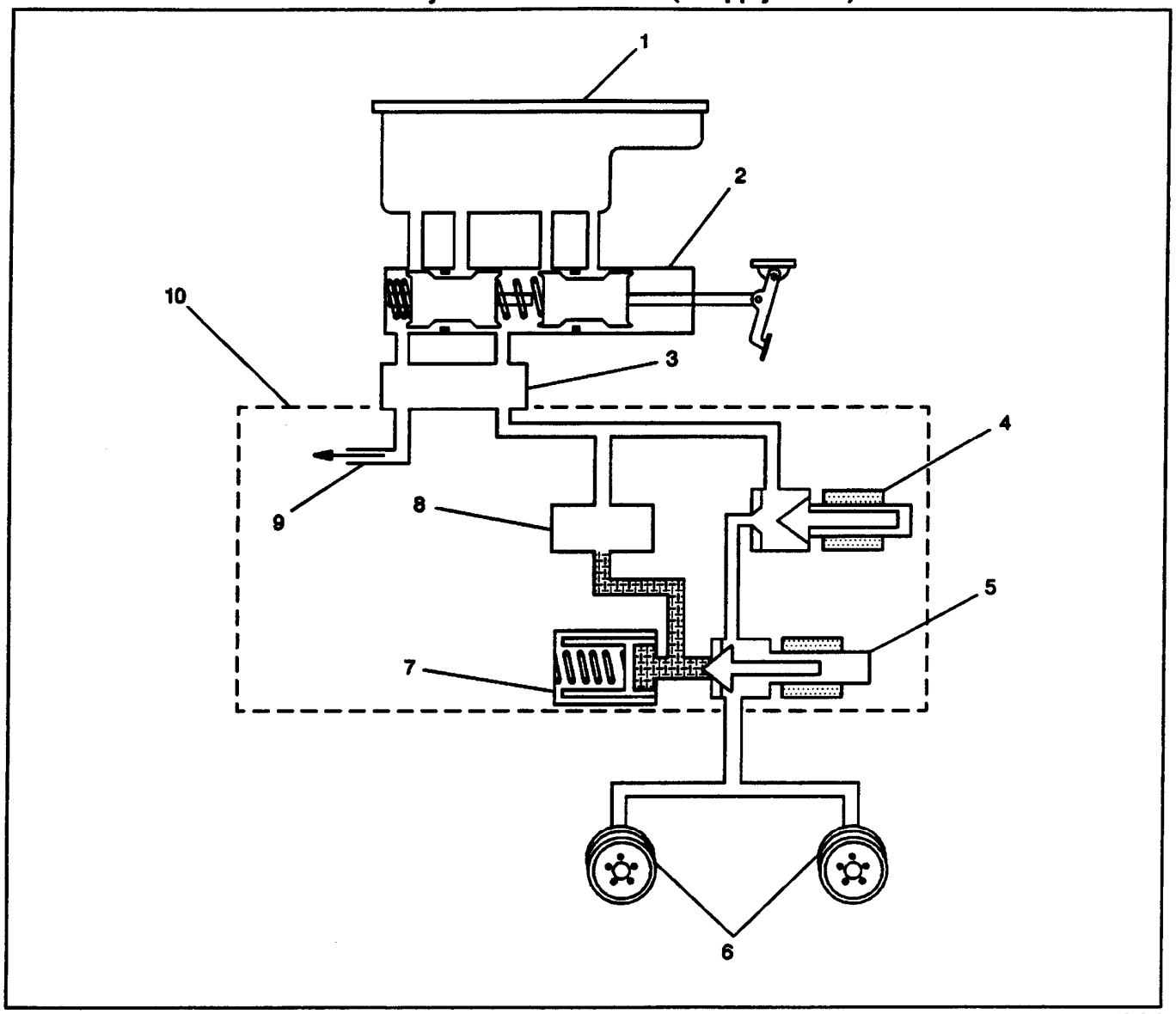


184241

Legend

(1) Master Cylinder Reservoir
(2) Master Cylinder
(3) Combination valve
(4) Rear Isolation Valve
(5) Rear Dump Valve
(6) Rear Wheels
(7) Rear Accumulator
(8) Rear Pump
(9) To Front Channels
(10) Brake Pressure Modulator Valve (BPMV)

BPMV Hydraulic Flow Chart (Reapply Mode)



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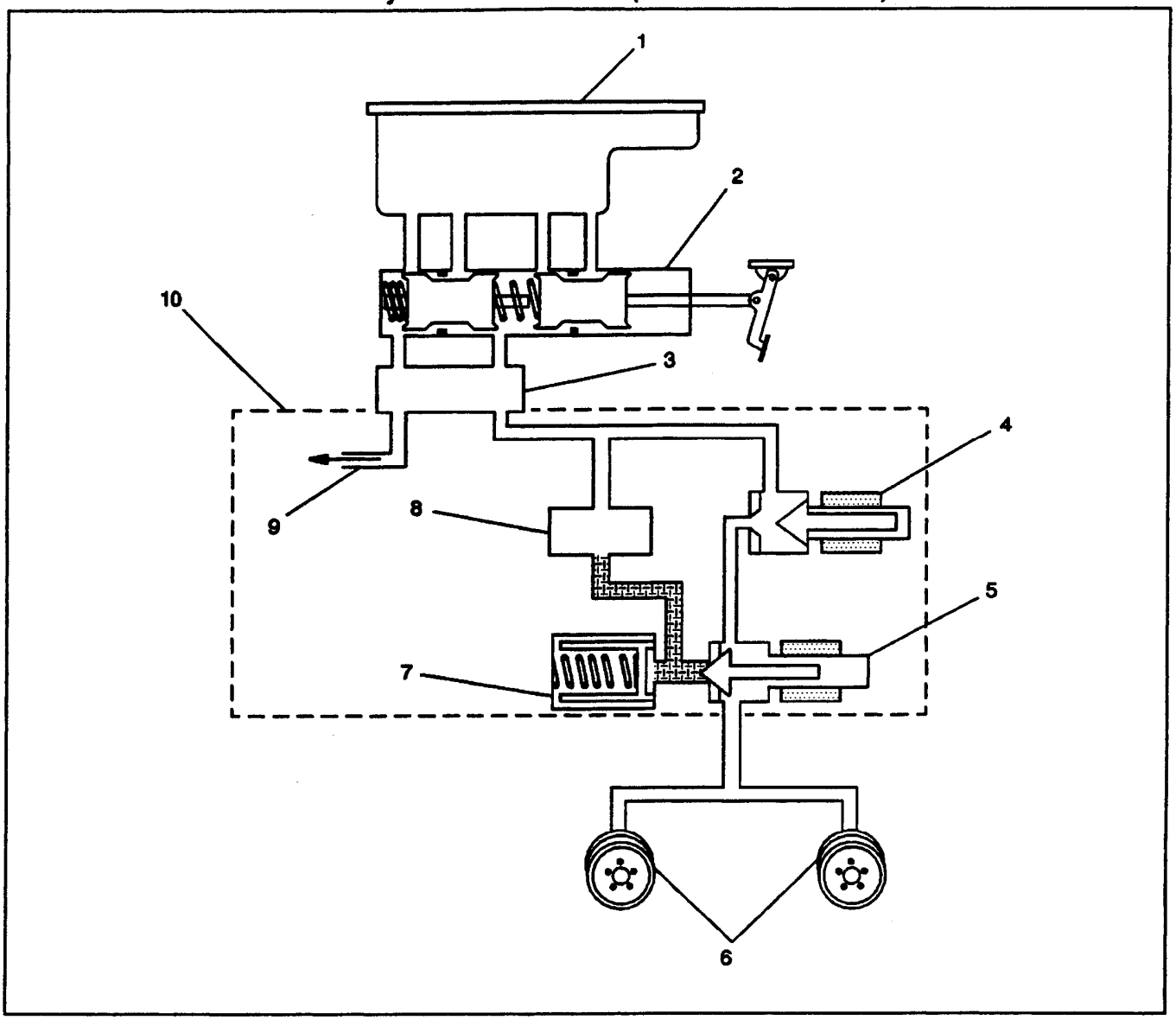
Legend

(1) Master Cylinder Reservoir
(2) Master Cylinder
(3) Combination valve
(4) Rear Isolation Valve
(5) Rear Dump Valve
(6) Rear Wheels
(7) Rear Accumulator
(8) Rear Pump
(9) To Front Channels
(10) Brake Pressure Modulator Valve (BPMV)

BPMV Hydraulic Flow Chart (Brake Release Mode)



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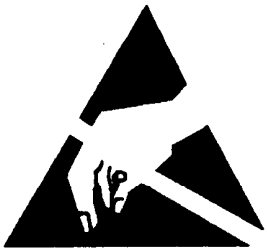
Legend

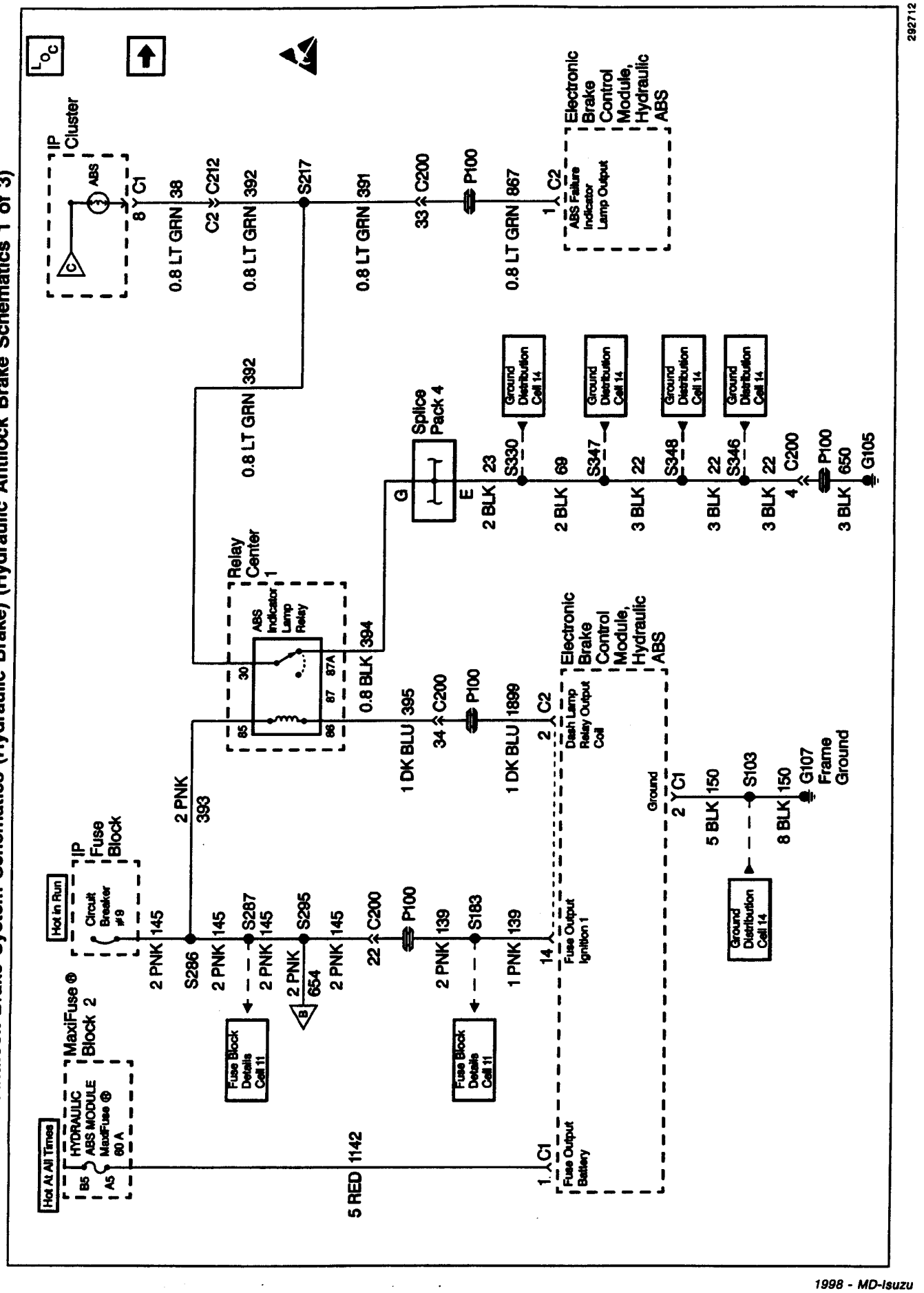
(1) Master Cylinder Reservoir
(2) Master Cylinder
(3) Combination valve
(4) Rear Isolation Valve
(5) Rear Dump Valve
(6) Rear Wheels
(7) Rear Accumulator
(8) Rear Pump
(9) To Front Channels
(10) Brake Pressure Modulator Valve (BPMV)

Antilock Brakes System Schematic References

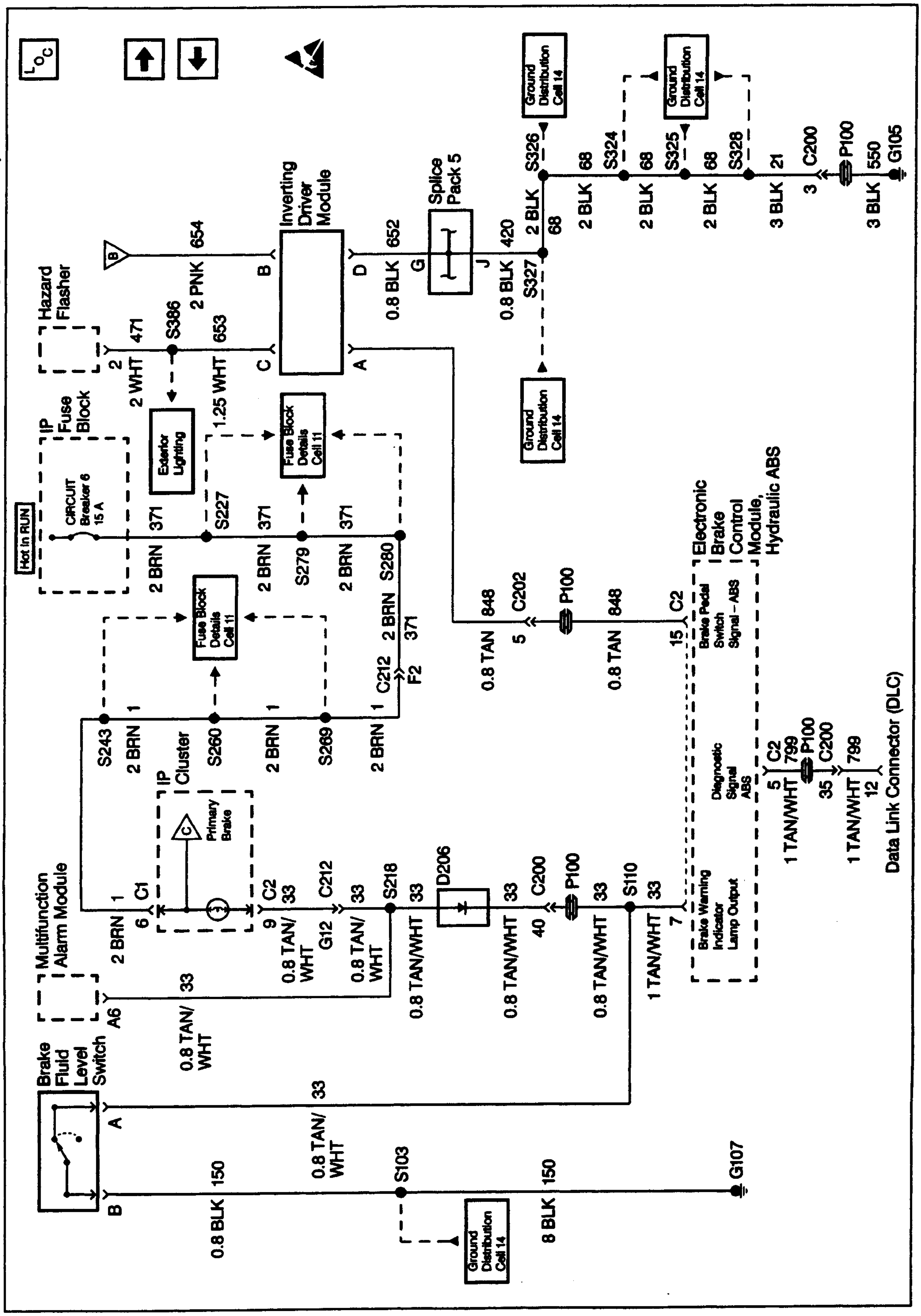
Reference on Schematic	Section Number - Subsection Name
Fuse Block Details Cell 11	8—Wiring Systems
Ground Distribution Cell 14	8—Wiring Systems

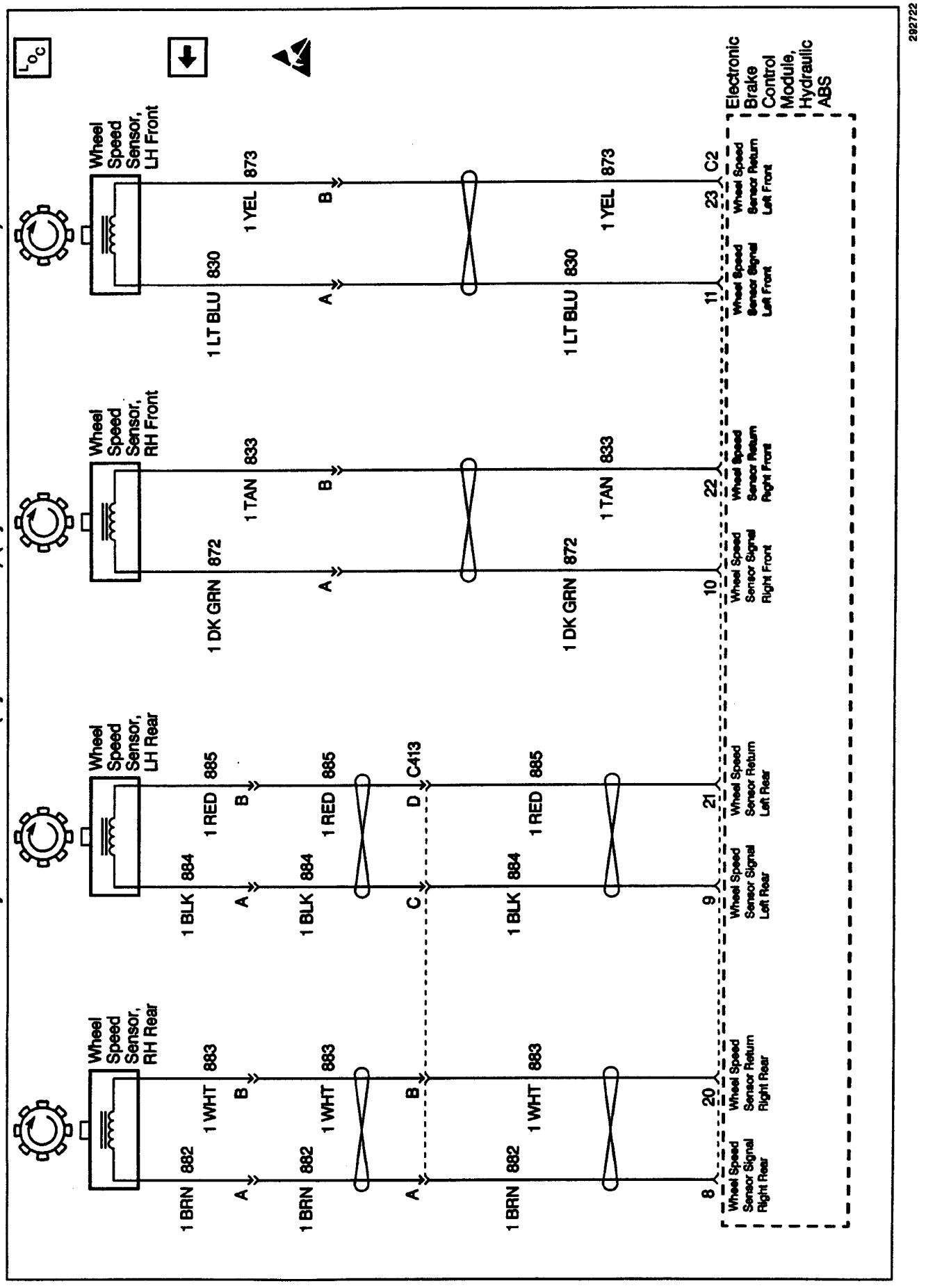
Antilock Brakes System Schematic Icons

Icon	Icon Definition
 19384	Refer to *ESD Notice.*


Antilock Brake System Schematics (Hydraulic Brake) (Hydraulic Antilock Brake Schematics 1 of 3)
292712
IP Cluster
ABS
C1
8
0.8 LT GRN 38
C2 C212
0.8 LT GRN 392
S217
0.8 LT GRN 391
33 C200
P100
0.8 LT GRN 867
1 C2
Electronic Brake Control Module, Hydraulic ABS
ABS Failure Indicator Lamp Output
Ground Distribution Cell 14
Splice Pack 4
G
E
2 BLK 23
S330
2 BLK 69
S347
3 BLK 22
S348
3 BLK 22
S346
3 BLK 22
C200
4
P100
650
3 BLK
G105
Relay Center 1
ABS Indicator Lamp Relay
30
85
86
87
87A
0.8 BLK 394
1 DK BLU 395
34 C200
P100
1 DK BLU 1899
2 C2
Dash Lamp Relay Output Coil
Electronic Brake Control Module, Hydraulic ABS
Ground
2 C1
5 BLK 150
S103
8 BLK 150
G107
Frame Ground
Ground Distribution Cell 14
2 PNK 393
IP Fuse Block
Hot in Run
Circuit Breaker #9
2 PNK 145
S286
2 PNK 145
S287
2 PNK 145
S295
2 PNK 145
C200
22
P100
2 PNK 139
S183
1 PNK 139
14
Fuse Output Ignition 1
Fuse Block Details Cell 11
B
2 PNK 654
MaxiFuse Block 2
Hot At All Times
B5
HYDRAULIC ABS MODULE MaxiFuse 60 A
A5
5 RED 1142
1 C1
Fuse Output Battery

Antilock Brake System Schematics (Hydraulic Brake) (Cell 44: Hydraulic Antilock Brake System 2 of 3)




Antilock Brake System Schematics (Hydraulic Brake) (Hydraulic ABS Schematics 3 of 3)
292722
Wheel Speed Sensor, LH Front
Wheel Speed Sensor, RH Front
Wheel Speed Sensor, LH Rear
Wheel Speed Sensor, RH Rear
Electronic Brake Control Module, Hydraulic ABS
1 LT BLU 830 A
1 YEL 873 B
1 DK GRN 872 A
1 TAN 833 B
1 BLK 884 A
1 RED 885 B
1 BRN 882 A
1 WHT 883 B
C413 C D
C2
11 Wheel Speed Sensor Signal Left Front
23 Wheel Speed Sensor Return Left Front
10 Wheel Speed Sensor Signal Right Front
22 Wheel Speed Sensor Return Right Front
9 Wheel Speed Sensor Signal Left Rear
21 Wheel Speed Sensor Return Left Rear
8 Wheel Speed Sensor Signal Right Rear
20 Wheel Speed Sensor Return Right Rear

Component Locator

Antilock Brakes System Components

Name	Location	Locator View	Connector End View
ABS Indicator Relay	On the right top of the IP, under the access panel, in relay center 1	Refer to *Antilock Brakes System Component Views*	Refer to *Antilock Brakes System Connector End Views*
Data Link Connector (DLC)	On the left side of the lower IP	Refer to *Data Link Connector Component Views*	Refer to *Data Link Connector End Views*
Electronic Brake Control Module (EBCM) (ABS-Hydraulic)	On the rear of the #1 crossmember	Refer to *Antilock Brakes System Component Views*	—
Electronic Brake Control Module (EBCM) (ABS-Hydraulic) C1 (2 cavities)	In the front chassis harness to the EBCM	Refer to *Antilock Brakes System Component Views*	Refer to *Antilock Brakes System Connector End Views*
Electronic Brake Control Module (EBCM) (ABS-Hydraulic) C2 (24 cavities)	In the front chassis harness to the EBCM	Refer to *Antilock Brakes System Component Views*	Refer to *Antilock Brakes System Connector End Views*
Instrument Panel Cluster (IPC)	On the left side of the IP	Refer to *Instrument Cluster Component Views*	—
Instrument Panel Cluster (IPC) C1 (15 cavities)	In the upper IP harness to the IPC	Refer to *Instrument Cluster Component Views*	Refer to *Instrument Cluster Connector End Views*
Instrument Panel Cluster (IPC) C2 (9 cavities)	In the upper IP harness to the IPC	Refer to *Instrument Cluster Component Views*	Refer to *Instrument Cluster Connector End Views*
IP Fuse Block	In the right top of the IP, under the access panel	Refer to *Power and Grounding Component Views*	—
MaxiFuse® Block 2	On the left rear of the cab, below the cab bridge	Refer to *Power and Grounding Component Views*	—
Multifunction Alarm Module (MFAM) (Hydraulic Brakes)	Under the right seat	Refer to *Audible Warnings Component Views*	—
Multifunction Alarm Module (MFAM) (Hydraulic Brakes) C1 (16 cavities)	In the lower IP harness to the MFAM	Refer to *Audible Warnings Component Views*	Refer to *Audible Warnings Connector End Views*
Multifunction Alarm Module (MFAM) (w/ Automatic Engine Shutdown) C2 (2 cavities)	In the lower IP harness to the MFAM	Refer to *Audible Warnings Component Views*	Refer to *Audible Warnings Connector End Views*
Splice Pack 5	Under the crash pad, in the top of the IP, joint connector 1, row 3, terminals A, B, C, D, E, F, G, H, J and L	—	—
Wheel Speed Sensor (WSS), Left Front (ABS-Hydraulic)	Mounted in the left front brake backing plate	Refer to *Antilock Brakes System Component Views*	Refer to *Antilock Brakes System Connector End Views*

Antilock Brakes System Components (cont'd)

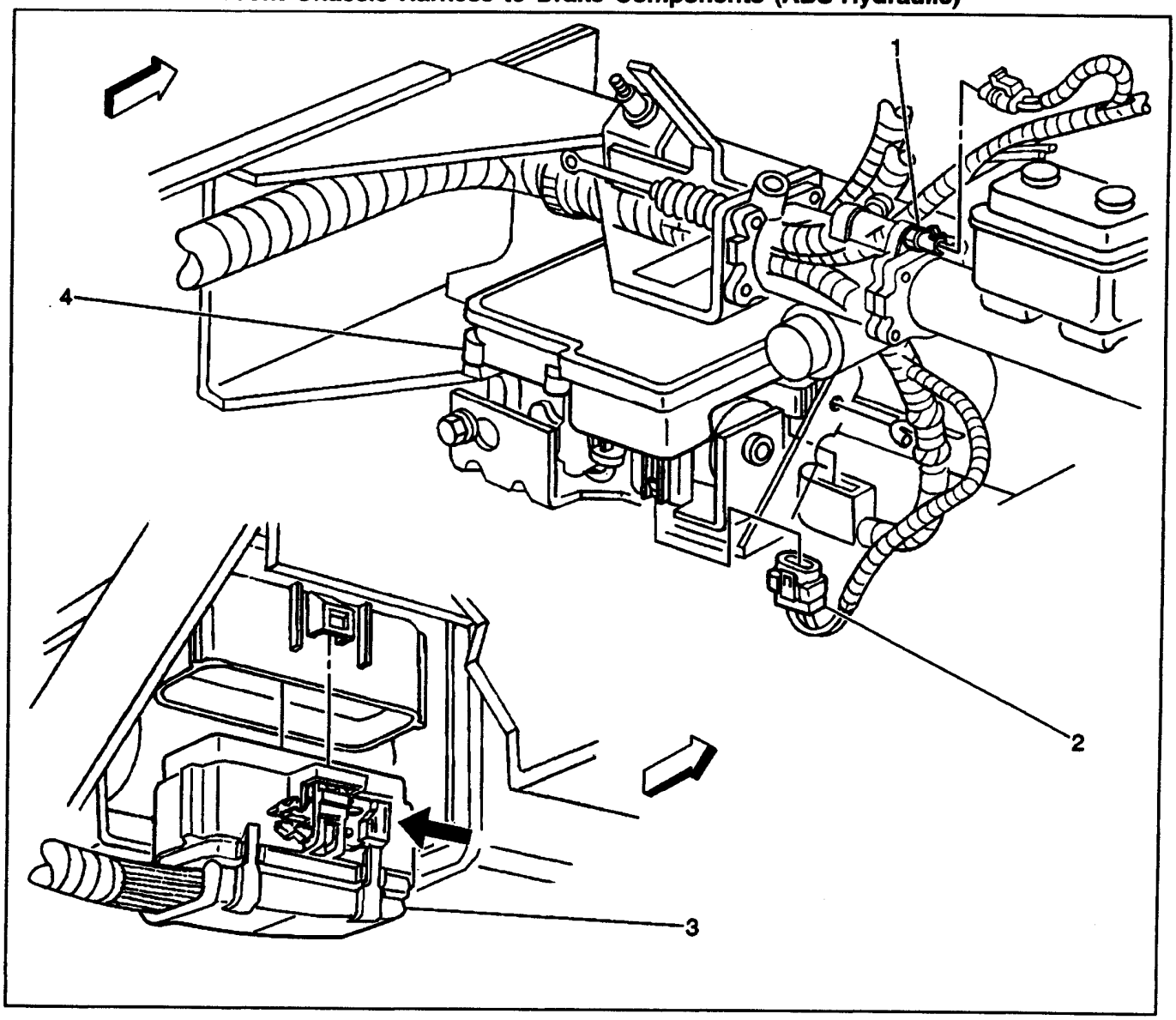
Name	Location	Locator View	Connector End View
Wheel Speed Sensor (WSS), Left Rear (ABS-Hydraulic)	Mounted in the left rear brake backing plate	Refer to *Antilock Brakes System Component Views*	Refer to *Antilock Brakes System Connector End Views*
Wheel Speed Sensor (WSS), Right Front (ABS-Hydraulic)	Mounted in the right front brake backing plate	Refer to *Antilock Brakes System Component Views*	Refer to *Antilock Brakes System Connector End Views*
Wheel Speed Sensor (WSS), Right Rear (ABS-Hydraulic)	Mounted in the right rear brake backing plate	Refer to *Antilock Brakes System Component Views*	Refer to *Antilock Brakes System Connector End Views*
C200 (56 cavities)	In the lower IP harness, to the front chassis harness, in the left center of the cab, in the cab interface connector housing	Refer to *Harness Routing Views*	Refer to *Inline Harness Connector End Views*
C202 (56 cavities)	In the lower IP harness, to the front chassis harness, in the left center of the cab, in the cab interface connector housing	Refer to *Harness Routing Views*	Refer to *Inline Harness Connector End Views*
C212 (84 cavities)	In the lower IP harness, to the upper IP harness, in the left center of the IP at the floor		
C413 (4 cavities)	In the front chassis harness, to the transmission harness, on inboard side of the left frame rail, to the left of the transmission		
D206	In the lower IP harness, plugged into the diode connector breakout	—	—
G105	On the left front of the #1 crossmember	Refer to *Power and Grounding Component Views*	—
G107	From the front chassis harness, on the left frame rail, approximately 25 cm (9.8 in) to the rear of the front shock absorber	Refer to *Power and Grounding Component Views*	—
P100	On the front chassis harness, under the hood, in the center of the bulkhead, in the cab interface connector housing	Refer to *Harness Routing Views*	—
S103	In the front chassis harness, approximately 7 cm (2.8 in) to the rear of the main harness breakout	—	—
S110	In the front chassis harness, approximately 7 cm (2.8 in) from the brake harness breakout toward the front turn signal harness	—	—
S183	In the front chassis harness, approximately 3 cm (1.2 in) forward of the engine oil pressure switch breakout	—	—
S217	In the lower IP harness, in the main branch, to the right of relay center 1	—	—
S218	In the upper IP harness	—	—
S227	In the upper IP harness, under the IP, approximately 6 cm (2.4 in) to the left of the fuse block breakout	—	—
S243	In the upper IP harness, approximately 13 cm (5.1 in) from the IP connector toward the main harness	—	—

Antilock Brakes System Components (cont'd)

Name	Location	Locator View	Connector End View
S260	In the upper IP harness, in the main harness at the speedometer breakout	—	—
S269	In the upper IP harness, in the main harness, approximately 21 cm (8.3 in) from the upper IP connector C212 (84 cavities)	—	—
S279	In the lower IP harness, below the IP, approximately 5 cm (2.0 in) to the right of the relay center 1 harness breakout	—	—
S280	In the lower IP harness, in the main harness, at the frame harness breakout	—	—
S286	In the lower IP harness, in the main harness, at the fuse block harness breakout	—	—
S287	In the lower IP harness, in the main harness, approximately 22 cm (8.7 in) to the right of the fuse block harness breakout	—	—
S295	In the lower IP harness, in the main branch, at the C200 (56 cavities) and C202 (56 cavities) breakout	—	—
S324	In the lower IP harness	—	—
S325	In the lower IP harness	—	—
S326	In the lower IP harness	—	—
S327	In the lower IP harness	—	—
S328	In the lower IP harness	—	—
S330	In the lower IP harness	—	—
S346	In the lower IP harness	—	—
S347	In the lower IP harness	—	—
S348	In the lower IP harness	—	—
S386	In the lower IP harness	—	—

Antilock Brakes System Component Views

Front Chassis Harness to Brake Components (ABS-Hydraulic)

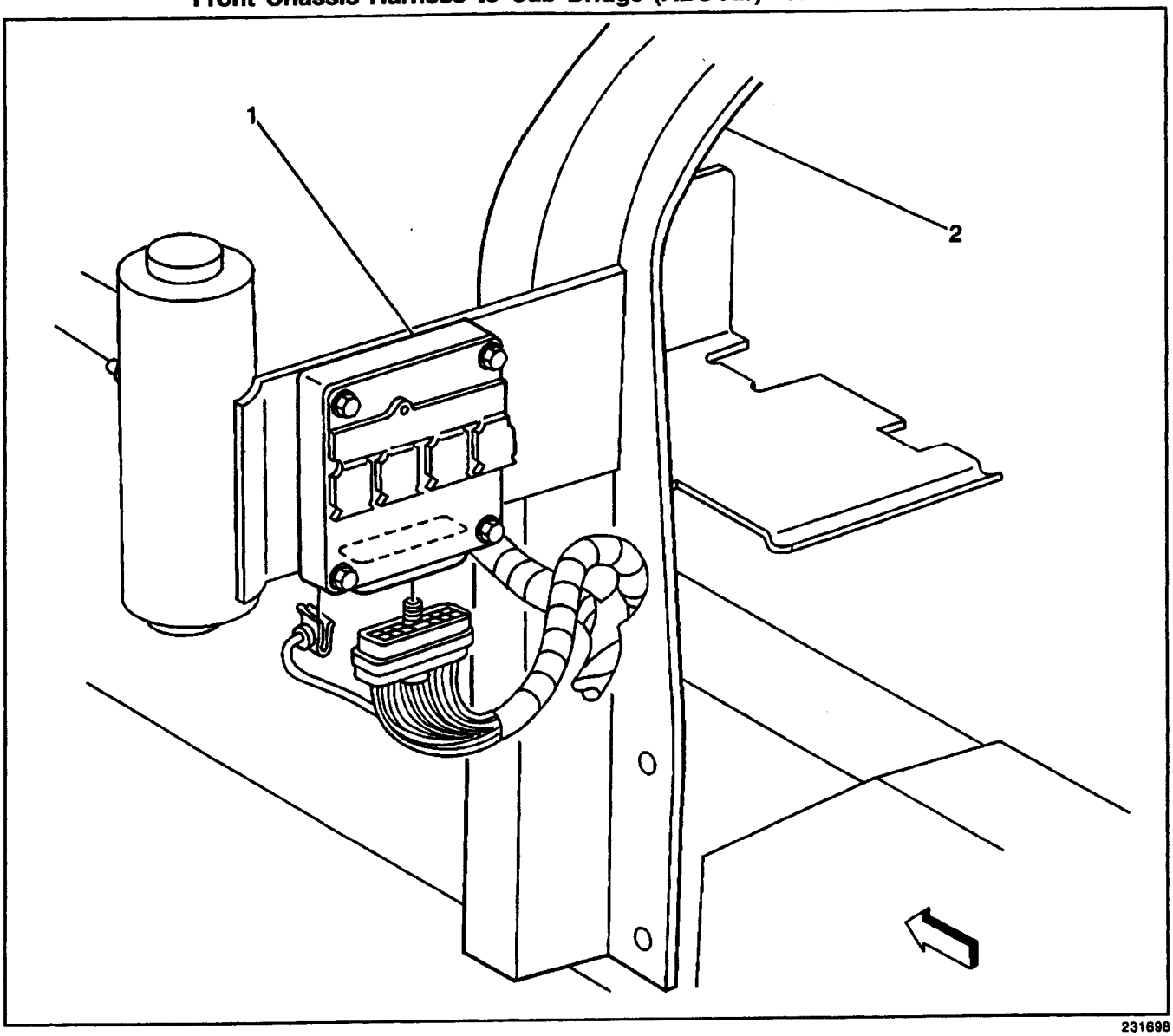


231487

Legend

(1) Brake Fluid Flow Switch
(2) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connecor C2 (2 cavities)
(3) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connector C1 (24 cavities)
(4) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connector C2 (2 cavities)

Front Chassis Harness to Cab Bridge (ABS-Air) LH Forward View

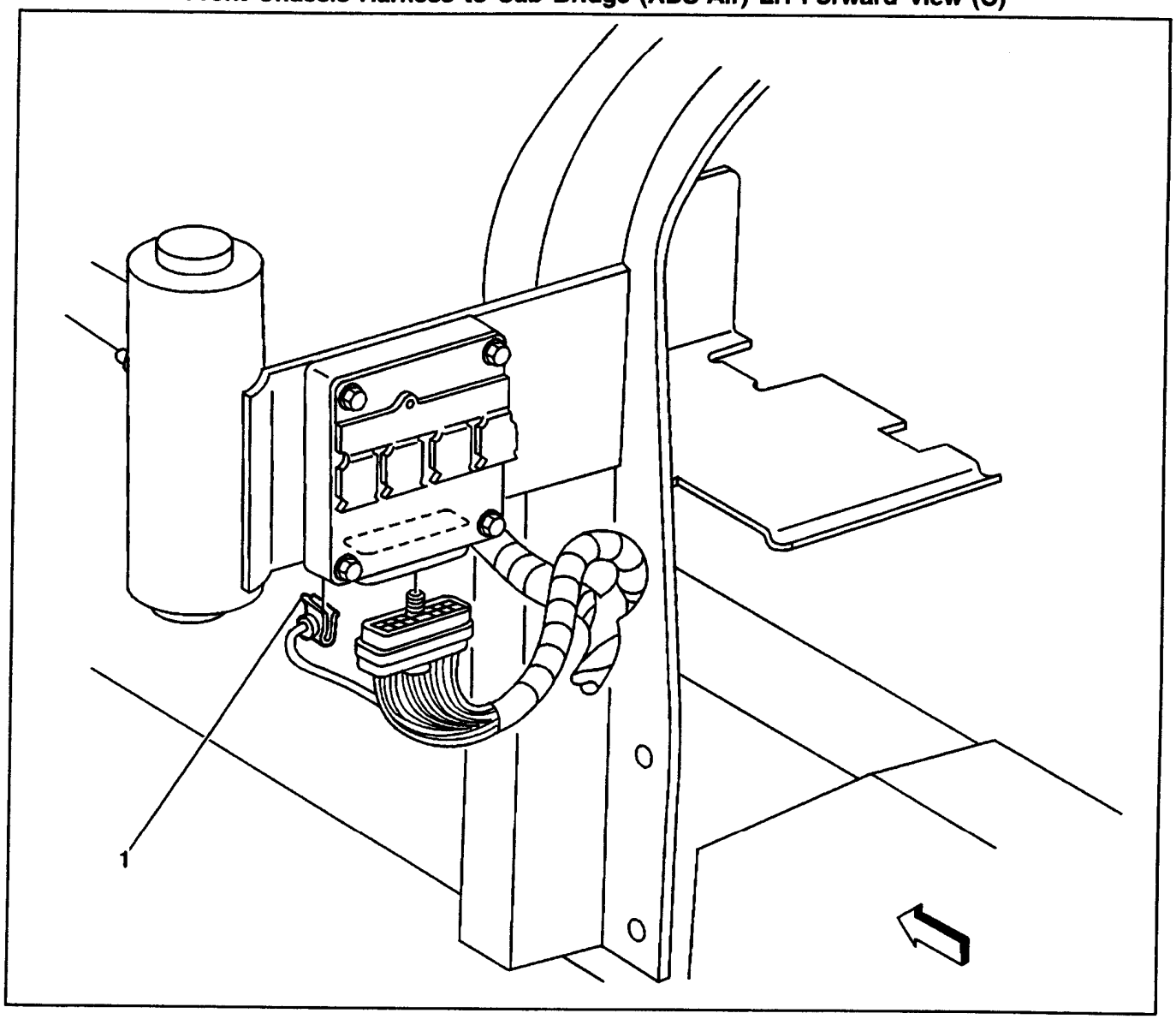


Legend

(1) Electronic Brake Control Module (EBCM) (ABS-Air)

(2) Cab Bridge

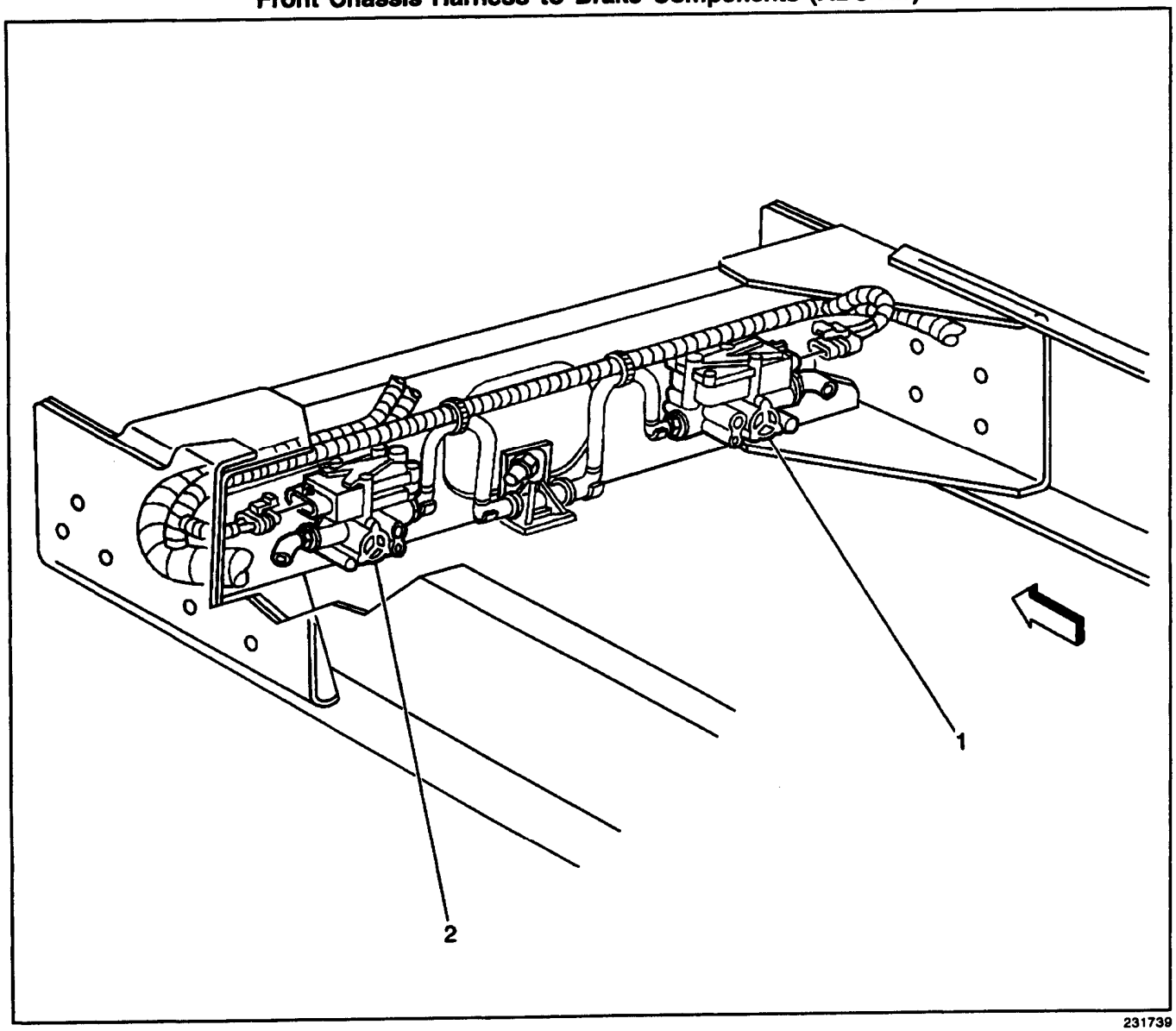
Front Chassis Harness to Cab Bridge (ABS-Air) LH Forward View (C)



Legend

(1) G104 (ABS-Air)

Front Chassis Harness to Brake Components (ABS-Air)



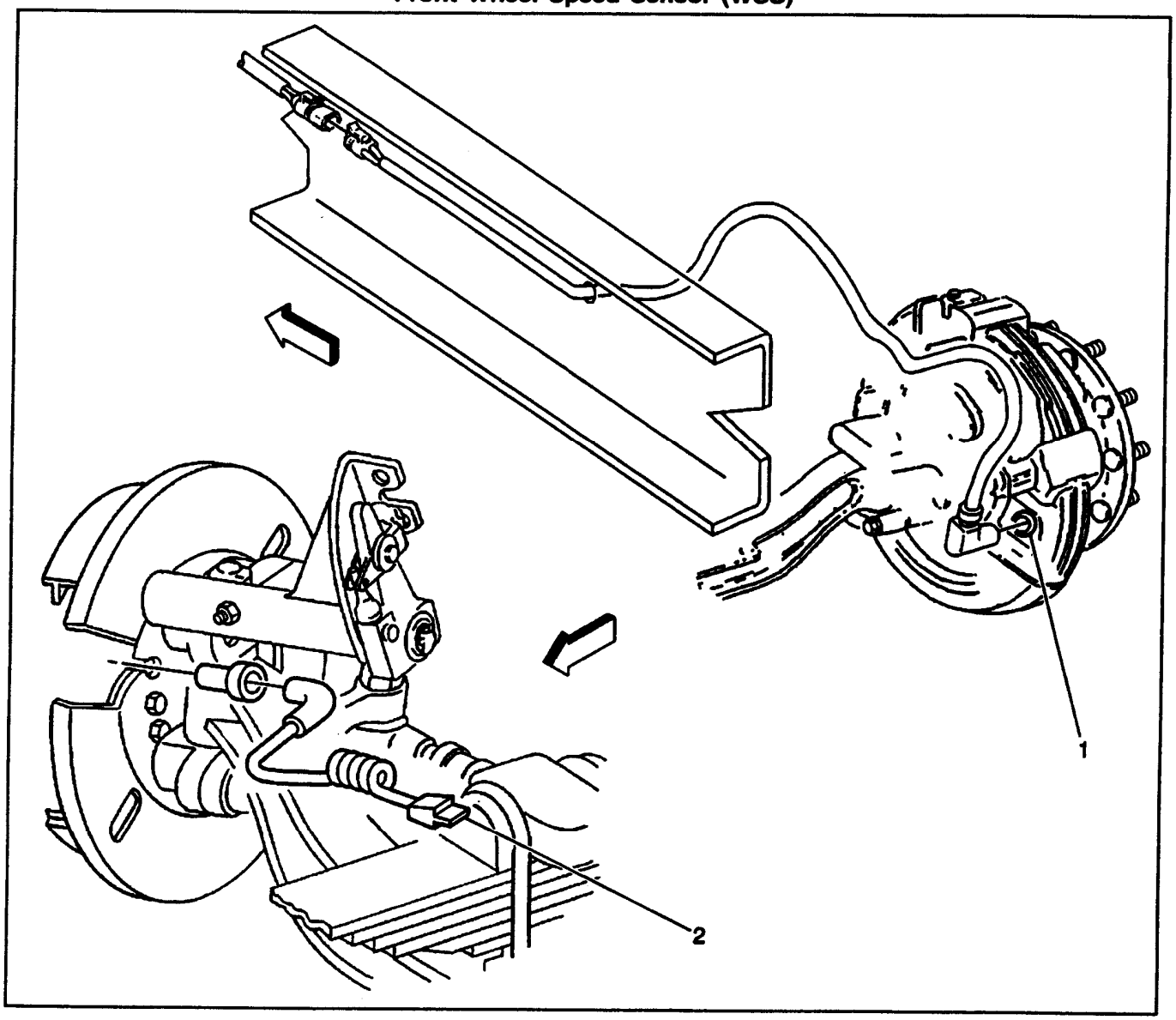
231739

Legend

(1) Brake Pressure Modulator Valve (BPMV), RH Front (ABS-Air)

(2) BPMV, LH Front (ABS-Air)

Front Wheel Speed Sensor (WSS)

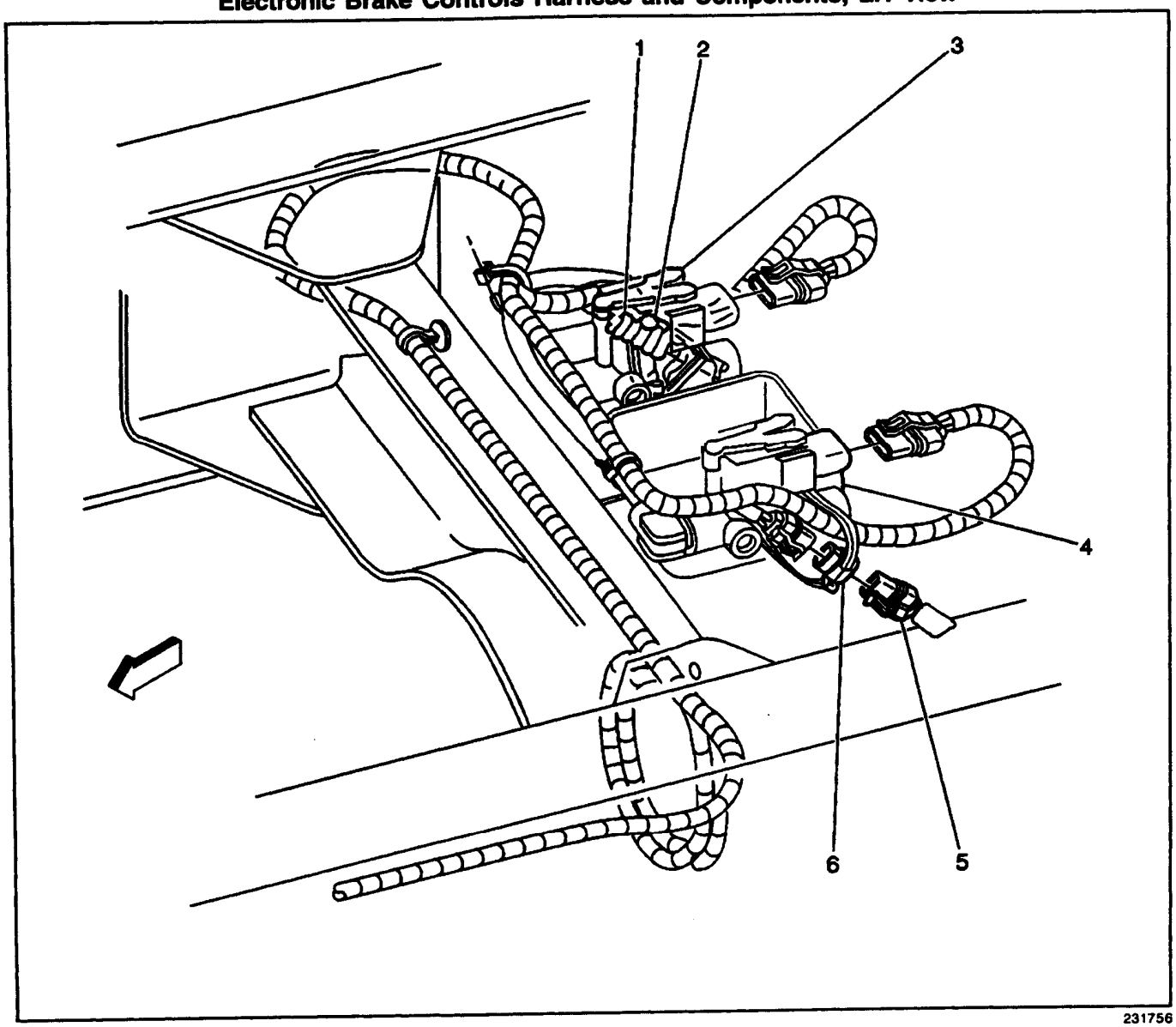


Legend

(1) RH Front Wheel Speed Sensor (WSS) (ABS-Hydraulic)

(2) RH Front WSS (ABS-Air)

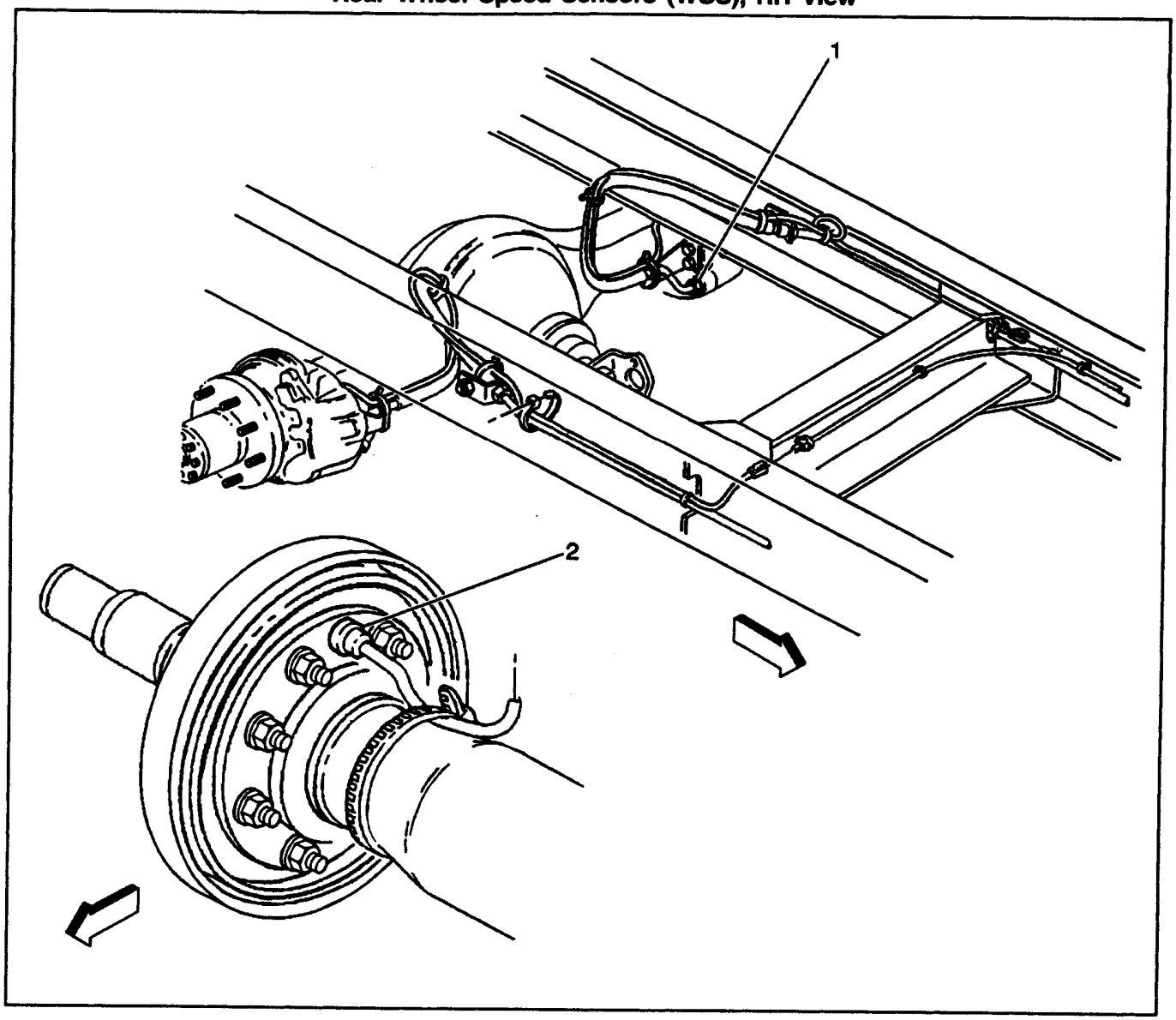
Electronic Brake Controls Harness and Components, LH View



Legend

(1) RH Rear Wheel Speed Sensor (WSS) (ABS-Air)
(2) RH R3ear Gender Adapter Connector (4 male-to-male cavities) (ABS-Air)
(3) RH Rear Brake Pressure Modulator Valve (BPMV) (ABS-Air)
(4) LH Rear BPMV (ABS-Air)
(5) LH Rear WSS (ABS-Air)
(6) LH Rear Gender Adapter Connector (4 male-to-male cavities) (ABS-Air)

Rear Wheel Speed Sensors (WSS), RH View



231761

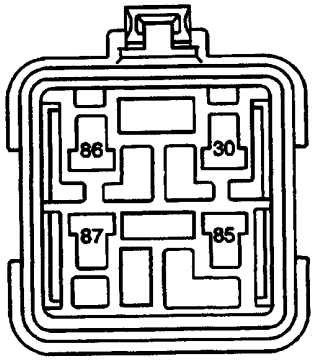
Legend

(1) LH Rear Wheel Speed Sensor (WSS) (ABS-Hydraulic)

(2) RH Rear WSS (ABS-Air)

Antilock Brakes System Connector End Views

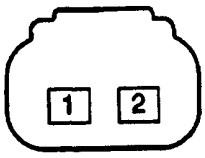
ABS Relay



39670

Connector Part Information	• 12129716 • 4 Way F Metri-Pack 280 Series, Flexlock, Sealed (GRY)		
Pin	**Wire Color**	**Circuit No.**	**Function**
30	RED	1442	Fuse Output-Battery
85	PNK	139	Fuse Output-Ignition
86	BLK	150	Ground
87	PNK	839	Fuse Output-Ignition

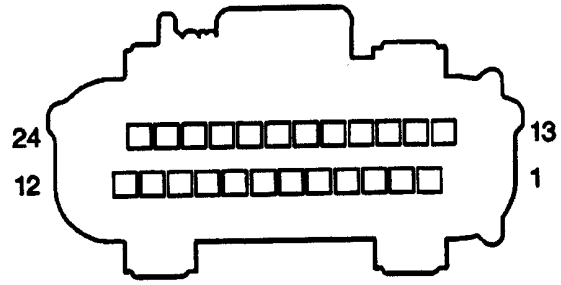
Electronic Brake Control Module C1 (Hydraulic)



239998

Connector Part Information	• 12162896 • 2 Way F Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
1	RED	1142	Fuse Output-Battery
2	BLK	150	Ground

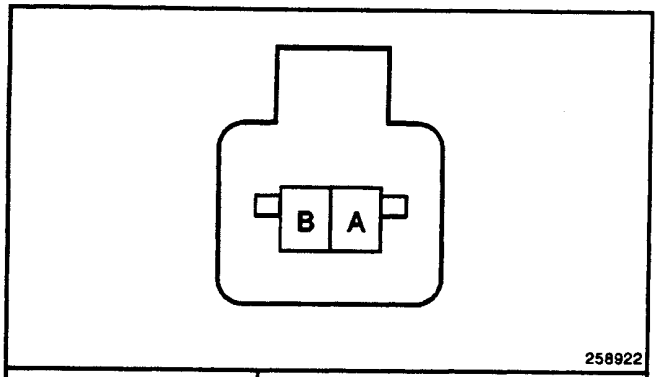
Electronic Brake Control Module C2 (Hydraulic)



309424

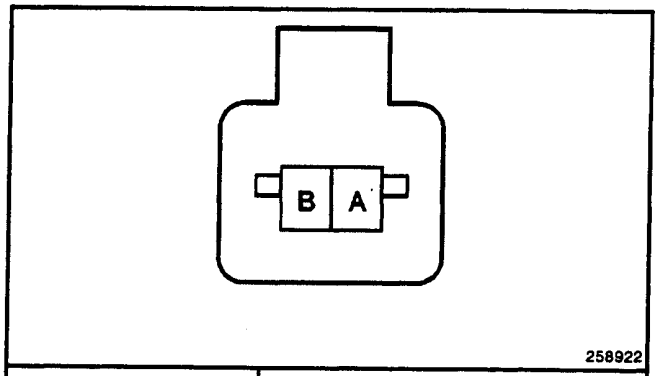
Connector Part Information	• 15324027 • 24 Way F (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
1	LT GRN	867	ABS Failure Indicator Lamp Output
2	DK BLU	1899	Dash Lamp Relay Output-Coil
3–4	—	—	Not Used
5	TAN/WHT	799	Diagnostic Signal-ABS
6	—	—	Not Used
7	TAN/WHT	33	Brake Warning Indicator Lamp Output
8	BRN	882	Wheel Speed Sensor Signal-Right Rear
9	BLK	884	Wheel Speed Sensor Signal-Left Rear
10	DK GRN	872	Wheel Speed Sensor Signal-Right Front
11	LT BLU	830	Wheel Speed Sensor Signal-Left Front
12–13	—	—	Not Used
14	PNK	139	Fuse Output-Ignition
15	TAN	848	Brake Pedal Switch Signal-ABS
16-19	—	—	Not Used
20	WHT	883	Wheel Speed Sensor Return-Right Rear
21	RED	885	Wheel Speed Sensor Return-Left Rear
22	TAN	833	Wheel Speed Sensor Return-Right Front
23	YEL	873	Wheel Speed Sensor Return-Left Front
24	—	—	Not Used

Wheel Speed Sensor, LH Front



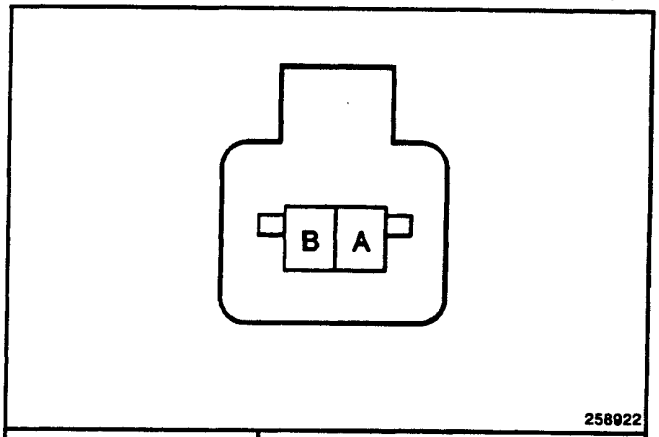
Connector Part Information	• 12162852 • 2Way F Metri-Pack 150.2 Series Pull To Seat (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	LT BLU	830	Wheel Speed Sensor Signal-Left Front
A	LT GRN	1903	AAS Wheel Speed Sensor Signal-Left Front
B	YEL	873	Wheel Speed Sensor Return-Left Front
B	ORN	1904	AAS Wheel Speed Sensor Return-Left Front

Wheel Speed Sensor, RH Front



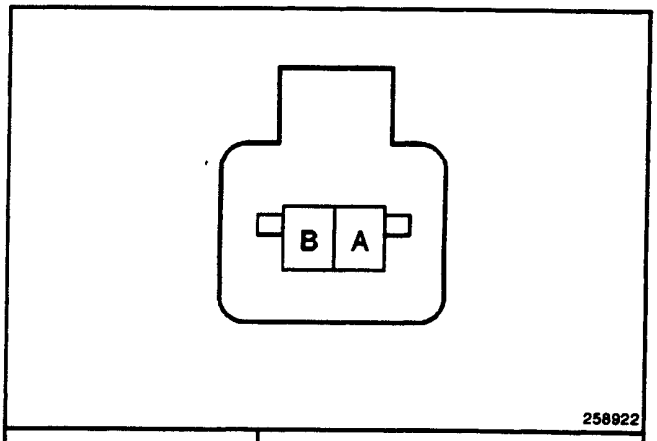
Connector Part Information	• 12162852 • 2Way F Metri-Pack 150.2 Series Pull To Seat (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	DK GRN	872	Wheel Speed Sensor Signal-Right Front
A	WHT	1909	AAS Wheel Speed Sensor Signal-Right Front
B	TAN	833	Wheel Speed Sensor Return-Right Front
B	BRN/WHT	1910	AAS Wheel Speed Sensor Return-Right Front

Wheel Speed Sensor, LH Rear (Hydraulic)



Connector Part Information	• 12162852 • 2Way F Metri-Pack 150.2 Series Pull To Seat (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	BLK	884	Wheel Speed Sensor Signal-Left Rear
B	RED	885	Wheel Speed Sensor Return-Left Rear

Wheel Speed Sensor, RH Rear (Hydraulic)



Connector Part Information	• 12162852 • 2Way F Metri-Pack 150.2 Series Pull To Seat (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	BRN	882	Wheel Speed Sensor Signal-Right Rear
B	WHT	883	Wheel Speed Sensor Return-Right Rear

Diagnostic Information and Procedures

Self-Diagnostics

The EBCM performs self-diagnostics of the ABS. The EBCM detects and isolates system failures. When a malfunction is detected, the EBCM sets a corresponding diagnostic trouble code (DTC).

Displaying DTCs

Read DTCs using a *Scan Tool*. No provisions are made for Flash Code DTCs.

Clearing DTCs

Use a *Scan Tool* in order to erase the DTCs in the EBCM memory. Verify proper system operation and absence of DTCs when the clearing procedure completes. The EBCM will not permit DTC clearing until all DTCs have been displayed. Also, DTCs cannot be cleared by unplugging the EBCM, by disconnecting the battery cables, or by turning the ignition OFF.

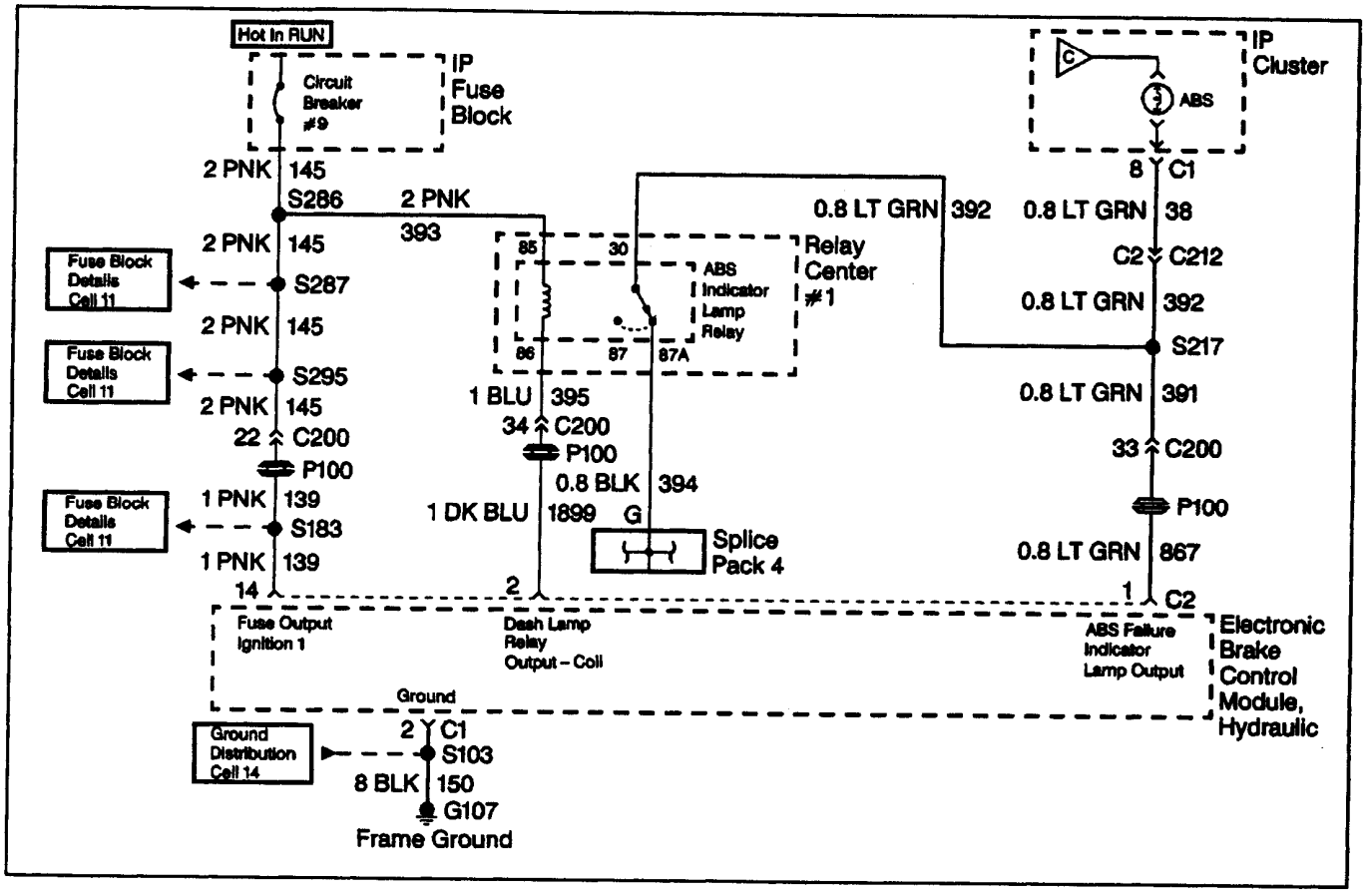
Intermittents and Poor Connections

Most intermittent faults are caused by a faulty electrical connection or faulty wiring. Occasionally a damaged EBCM can be the cause of an intermittent fault. Refer to Intermittents and Poor Connections in Electrical Diagnosis for a detailed explanation of how to locate and repair intermittent conditions.

Scan Tool Diagnosis

Refer to the Scan Tool Owner's Manual for information about the Scan Tool and the various modes.

Diagnostic System Check



324876

System Description

The diagnostic system check is an organized approach to identifying an Antilock Brake System (ABS) malfunction. The diagnostic system check must be the starting point for any ABS complaint diagnosis. The diagnostic system check directs the service technician to the next logical step in diagnosing the complaint. Refer to the appropriate table (below) for Gas, or Diesel engines.

Diagnostic serial data is transmitted/received by the EBCM through connector C2, terminal 5. The EBCM is supplied switched ignition voltage through connector C2, terminal 14, and ground is provided through connector C1, terminal 2.

Diagnostic Aids

Excessive resistance in the ground or power supply circuits will not allow communication with the EBCM. If communication with the EBCM is not possible, ensure that the ABS ground connection is good and that there is no excessive resistance in any of the power supply circuits.

Test Description

The numbers below refer to the steps in the diagnostic table:

3. This step checks for normal ABS indicator lamp operation.
4. This step checks for ignition voltage at the EBCM.
5. This step checks for high resistance in the ground circuit.
9. This step checks for high resistance in the ignition voltage circuit.
10. This step checks for a short to ground in the ignition voltage circuit.
11. This step checks for a short to ground in the EBCM.

Diagnostic System Check

Step	Action	Value(s)	Yes	No
1	1. Verify that all of the EBCM connectors are connected properly. 2. Install the *Scan Tool*. 3. Turn the ignition to RUN. 4. Attempt to communicate with the EBCM using the *Scan Tool*. Is data being received from the EBCM?	—	Go to Step *2*	Go to Step *4*
2	Using the *Scan Tool*, check for any DTCs. Are any current or history DTCs displayed?	—	Refer to the Appropriate DTC Table	Go to Step *3*
3	1. Turn the ignition to OFF for 10 seconds. 2. Turn the ignition to RUN and observe the ABS indicator lamp. Did the ABS indicator lamp turn ON for three seconds and then turn OFF?	—	System is operating normally. Refer to Diagnostic Aids.	Go to Step *12*
4	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector. 3. Turn the ignition to RUN. 4. Using the *J 39200*, measure the voltage between the 24-way EBCM harness connector terminal 14 and ground. Is the voltage measured within the specified range?	10–15V	*Go to Step 5*	*Go to Step 9*
5	1. Turn the ignition to OFF. 2. Disconnect the negative battery cable. Refer to *Battery Disconnect Caution* in Cautions and Notices. 3. Using the *J 39200*, measure the resistance between the 2-way EBCM harness connector terminal 2 and the negative battery terminal. Is the resistance measured within the specified range?	0–2Ω	Go to Step *6*	Go to Step *13*
6	1. Inspect the EBCM terminals and the EBCM harness connector terminals for poor terminal contact. 2. Inspect the battery terminals and the battery cable terminals for poor connection. Refer to Checking Terminal Contact in Electrical Diagnosis. Is the terminal contact or the connection poor?	—	Go to Step *7*	Go to Step *8*
7	Replace the terminals or repair the poor connection. Is the repair complete?	—	Go to Step *1*	—
8	Reconnect the EBCM connectors and the battery cables. Are the EBCM connectors and the battery cables reconnected?	—	Refer to Wiring Systems (Cell 50) for serial data circuit diagnosis	—

Diagnostic System Check (cont'd)

Step	Action	Value(s)	Yes	No
9	1. Disconnect the positive battery cable. 2. Turn the ignition to RUN. (This is to provide circuit continuity.) 3. Using the *J 39200*, measure the resistance between the 24-way EBCM connector terminal 14 and the positive battery cable. Is the resistance measured within the specified range?	0–2Ω	Go to Step *10*	Go to Step *14*
10	1. Turn the ignition to OFF. 2. Remove Circuit Breaker 9. 3. Using the *J 39200*, measure the resistance between the 24-way EBCM connector terminal 14 and ground. Is the resistance measurement equal to the specified value?	OL	Go to Step *11*	Go to Step *15*
11	1. Reconnect the EBCM. 2. Using the *J 39200*, measure the resistance between the ABS indicator relay terminal 85 and ground. Is the resistance measurement within the specified range?	OL	Problem is intermittent. Refer to Diagnostic Aids.	Go to Step *16*
12	Observe the ABS indicator lamp. Does the ABS indicator lamp stay on?	—	Go to *ABS Indicator On No DTC Set*	Go to *ABS Indicator Off No DTC Set*
13	Repair open or high resistance in CKT 150. Is the repair complete?	—	Go to Step *1*	—
14	1. Repair open or high resistance in CKT 139. 2. Check Circuit Breaker 9 for proper operation. Is the repair complete?	—	Go to Step *1*	—
15	1. Repair short to ground in CKT 139. 2. Check for an open in Circuit Breaker 9. Is the repair complete?	—	Go to Step *1*	—
16	Inspect CKT 139 and the 24-way EBCM harness connector for physical damage which may result in a short to ground with the 24-way EBCM harness connector connected to the EBCM. Is there evidence of damage?	—	Go to Step *16*	Go to Step *17*
17	Repair the terminals which are damaged. Is the repair complete?	—	Go to Step *1*	—
18	1. Replace the EBCM. 2. Check for an open in Circuit Breaker 9. Is the repair complete?	—	Go to Step *1*	—

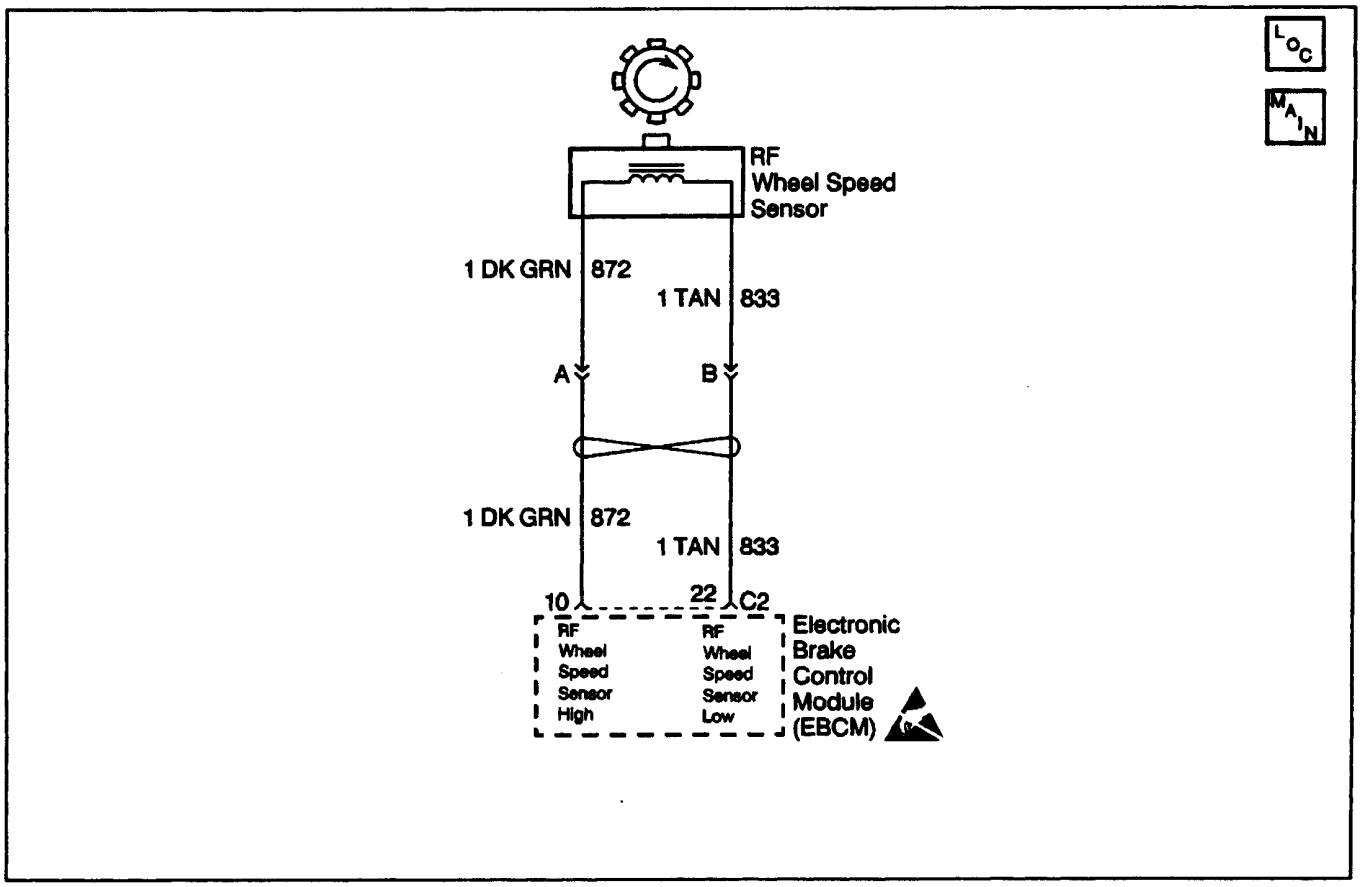
DTC List

DTC	Definition
DTC C0221	*DTC C0221 RF Wheel Speed Sensor Circuit Open*
DTC C0222	*DTC C0222 RF Wheel Speed Signal Missing*
DTC C0223	*DTC C0223 RF Wheel Speed Signal Erratic*
DTC C0225	*DTC C0225 LF Wheel Speed Sensor Circuit Open*
DTC C0226	*DTC C0226 LF Wheel Speed Signal Missing*
DTC C0227	*DTC C0227 LF Wheel Speed Signal Erratic*
DTC C0231	*DTC C0231 RR Wheel Speed Signal Circuit Open*
DTC C0232	*DTC C0232 RR Wheel Speed Signal Missing*
DTC C0233	*DTC C0233 RR Wheel Speed Signal Erratic*
DTC C0235	*DTC C0235 LR Wheel Speed Signal Circuit Open*
DTC C0236	*DTC C0236 LR Wheel Speed Signal Circuit Missing*
DTC C0237	*DTC C0237 LR Wheel Speed Signal Erratic*
DTC C0238	*DTC C0238 Wheel Speed Mismatch*
DTC C0241	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0242	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0243	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0244	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0245	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0246	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0247	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0248	*DTC C0241-C0258 EBCM Control Valve Circuit*

DTC List (cont'd)

DTC	Definition
DTC C0251	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0252	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0253	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0254	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0255	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0256	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0257	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0258	*DTC C0241-C0258 EBCM Control Valve Circuit*
DTC C0265	*DTC C0265 or C0266 EBCM Relay Circuit*
DTC C0266	*DTC C0265 or C0266 EBCM Relay Circuit*
DTC C0267	*DTC C0267 or C0268 Pump Motor Circuit Open/Shorted*
DTC C0268	*DTC C0267 or C0268 Pump Motor Circuit Open/Shorted*
DTC C0269	*DTC C0269 or C0274 Excessive Dump/ Isolation Time*
DTC C0271	*DTC C0271-C0273 EBCM Malfunction*
DTC C0272	*DTC C0271-C0273 EBCM Malfunction*
DTC C0273	*DTC C0271-C0273 EBCM Malfunction*
DTC C0274	*DTC C0269 or C0274 Excessive Dump/ Isolation Time*
DTC C0279	*DTC C0279 Trim Level Not Selected*
DTC C0281	*DTC C0281 Brake Switch Circuit*
DTC C0286	*DTC C0286 ABS Indicator Lamp Circuit Shorted to B+*

DTC C0221 RF Wheel Speed Sensor Circuit Open



324880

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- No output from the right front wheel speed sensor for 1.0 second.
- Excessive right front wheel speed sensor resistance for 1.0 second.

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0221 is a Condition Latched DTC, which indicates that the above actions remain true only as long as the condition persists.

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion.

Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The numbers below refer to the steps in the diagnostic table:

2. This step checks the resistance of the right front wheel speed sensor circuit.
3. This step checks the resistance of the right front wheel speed sensor wiring.
4. This step checks the resistance of the right front wheel speed sensor.

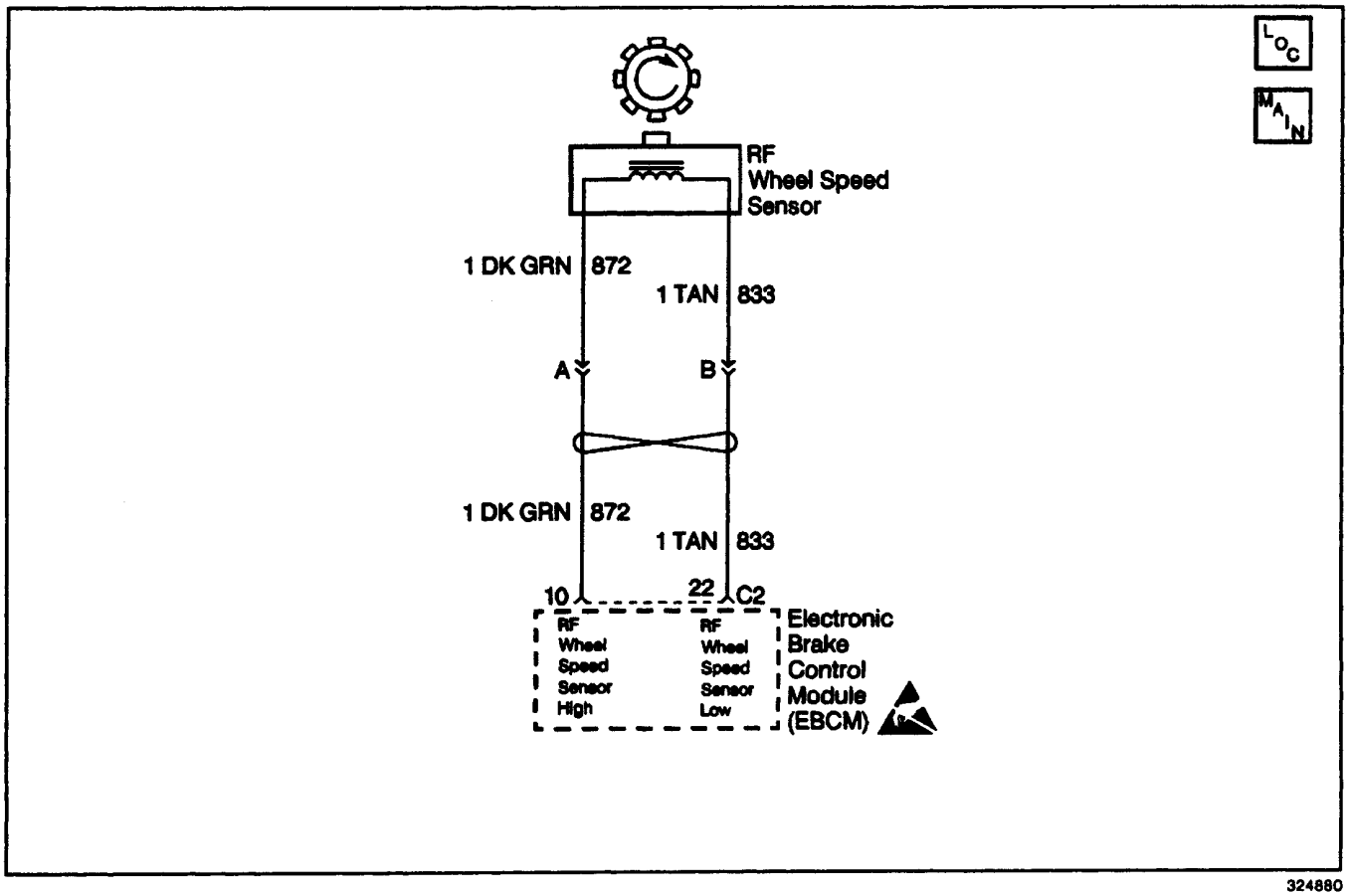
DTC C0221 RF Wheel Speed Sensor Circuit Open

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn ignition to OFF. 2. Disconnect the 24-way EBCM harness connector. 3. Using a *J 39200*, Measure the resistance between terminals 10 and 22 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *3*
3	1. Disconnect the right front wheel speed sensor harness connector from the wheel speed sensor pigtail. 2. Using a *J 36169-A* connect terminal A and terminal B of the 2-way wheel speed sensor harness connector (chassis harness side). 3. Using a *J 39200* measure the resistance between terminals 10 and 22 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	0–2 Ω	Go to Step *4*	Go to Step *7*
4	Using a *J 39200*, measure the resistance between terminal A and terminal B of the right front wheel speed sensor pigtail. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step*8*
5	1. Inspect the 24-way EBCM harness connector terminals 10 and 22 for poor terminal contact or corrosion. 2. Inspect CKT 833 and CKT 872 for damage that could result in an open circuit. Repair damage if evident. 3. Replace the terminals if poor contact or corrosion exists. 4. Reconnect all the connectors. 5. Using the *Scan Tool*, clear all DTCs. 6. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0221 set as a current DTC?	—	Go to Step *6*	Malfunction is intermittent. Refer to Diagnostic Aids

DTC C0221 RF Wheel Speed Sensor Circuit Open (cont'd)

Step	Action	Value(s)	Yes	No
6	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or high resistance in CKT 833 or CKT 872. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0222 RF Wheel Speed Signal Missing



324880

Circuit Description

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Conditions for Setting the DTC

- The right front wheel speed is less than 6 km/h (4 mph)
- All other wheel speeds are greater than 13 km/h (8 mph)
- No unexpected wheel acceleration/deceleration. Anything that keeps the right front wheel speed sensor low while the vehicle is moving above 13 km/h (8 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0222 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The numbers below refer to the steps in the diagnostic table:

3. This step checks the resistance of the right front wheel speed sensor.
4. This step checks the voltage output of the right front wheel speed sensor.
5. This step checks for a short in the wiring between the wheel speed sensor circuits.
6. This step checks for a short to ground in the right front wheel speed sensor circuits.

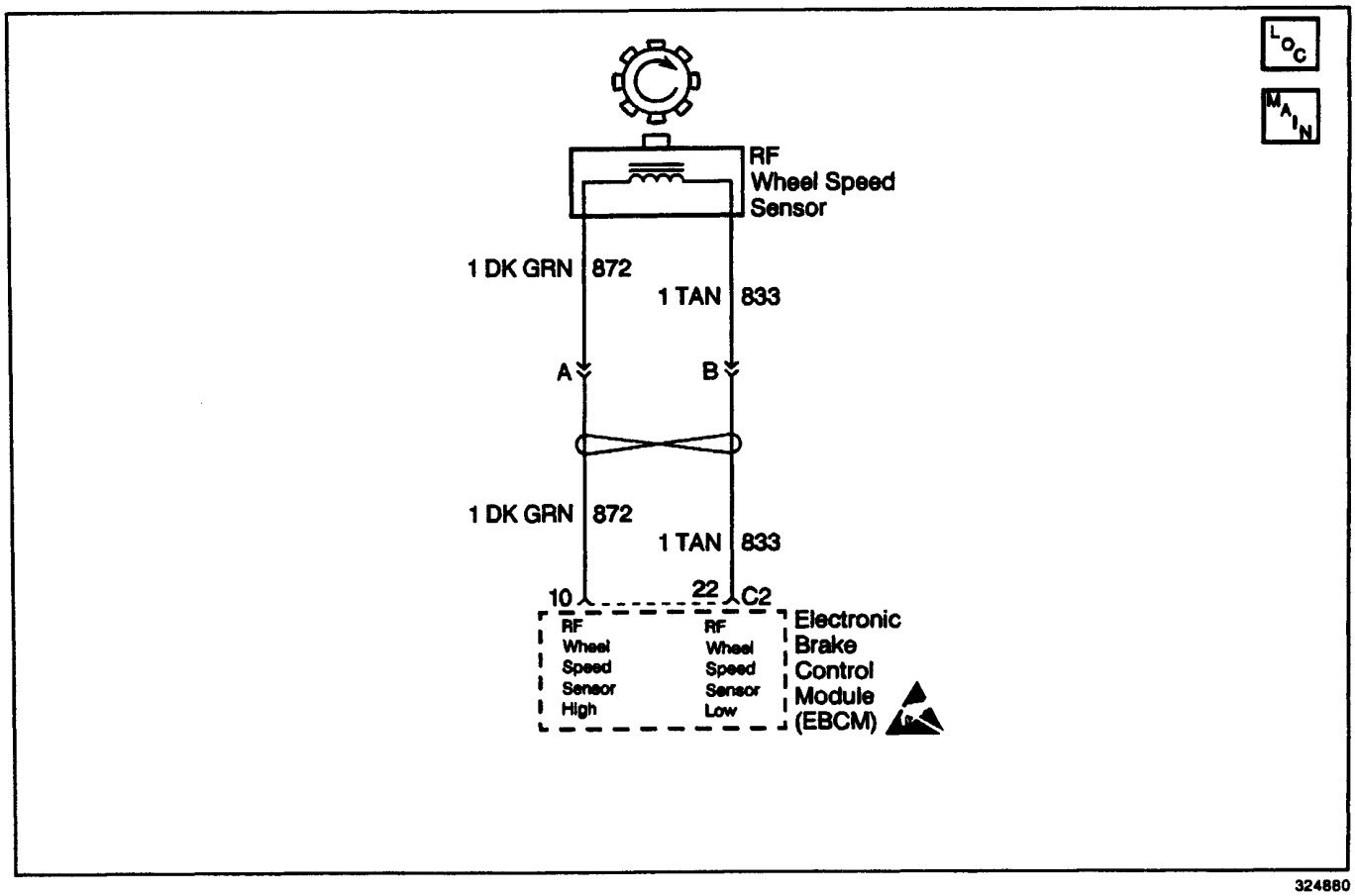
DTC C0222 RF Wheel Speed Signal Missing

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn ignition to OFF. 2. Inspect the right front wheel speed sensor, sensor wire and the connectors for signs of damage or corrosion. 3. Inspect the wheel speed sensor and the toothed ring for looseness, paying particular attention to the toothed ring. Any deviation will affect the wheel speed sensor output signal. 4. Inspect the 24-way EBCM harness connector and harness for signs of damage or corrosion. Is there evidence of physical damage?	—	Go to Step *8*	Go to Step *3*
3	1. Disconnect the right front wheel speed sensor harness connector from the wheel speed sensor. 2. Using a *J 39200*, measure the resistance between terminal A and terminal B of the right front wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *4*	Go to Step *9*
4	1. With the *J 39200* still connected, select the A/C voltage scale. 2. Spin the wheel by hand while observing the voltage reading. Is the voltage measured equal to or greater than the specified value?	100 mV	Go to Step *5*	Go to Step *9*

DTC C0222 RF Wheel Speed Signal Missing (cont'd)

Step	Action	Value(s)	Yes	No
5	1. Disconnect the 24-way EBCM harness connector from the EBCM. 2. Using a *J 39200*, measure the resistance between terminals 10 and 22 of the 24-way EBCM harness connector. Is the resistance measurement equal to the specified value?	OL	Go to Step *6*	Go to Step *11*
6	1. Reconnect the right front wheel speed sensor. 2. Using a *J 39200*, measure the resistance between terminal 10 of the 24-way EBCM harness connector and ground. Is the resistance measurement equal to the specified value?	OL	Go to Step *7*	Go to Step *12*
7	1. Inspect the 24-way EBCM harness connector terminals 10 and 22 for poor terminal contact or corrosion. Inspect CKT 833 and CKT 872 for damage that could result in a shorted circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool* clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0222 set as a current DTC?	—	*Go to Step 10*	Malfunction is intermittent. Refer to Diagnostic Aids
8	Make the necessary repairs. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Replace the right front wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the short between CKT 833 or CKT 872. Is the repair complete?	—	Go to *Diagnostic System Check*	—
12	Repair the short to ground in CKT 833 or CKT 872. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0223 RF Wheel Speed Signal Erratic



324880

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- The average wheel speed for all wheel speed signals is greater than 40 km/h (25 mph).
- The average left front wheel speed is greater than 40 km/h (25 mph).
- No speed signal input to the EBCM from the right front wheel speed sensor for 15ms. Anything which suddenly prevents (intermittent) the right front wheel speed signal from toggling while the vehicle is moving greater than 40 km/h (25 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0223 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The numbers below refer to the steps in the diagnostic table:

3. This step checks the resistance of the right front wheel speed sensor
4. This step checks the voltage output of the right front wheel speed sensor.
5. This step checks for a short in the wiring between the wheel speed sensor circuits.
6. This step checks for a short to ground in the wheel speed sensor circuits.

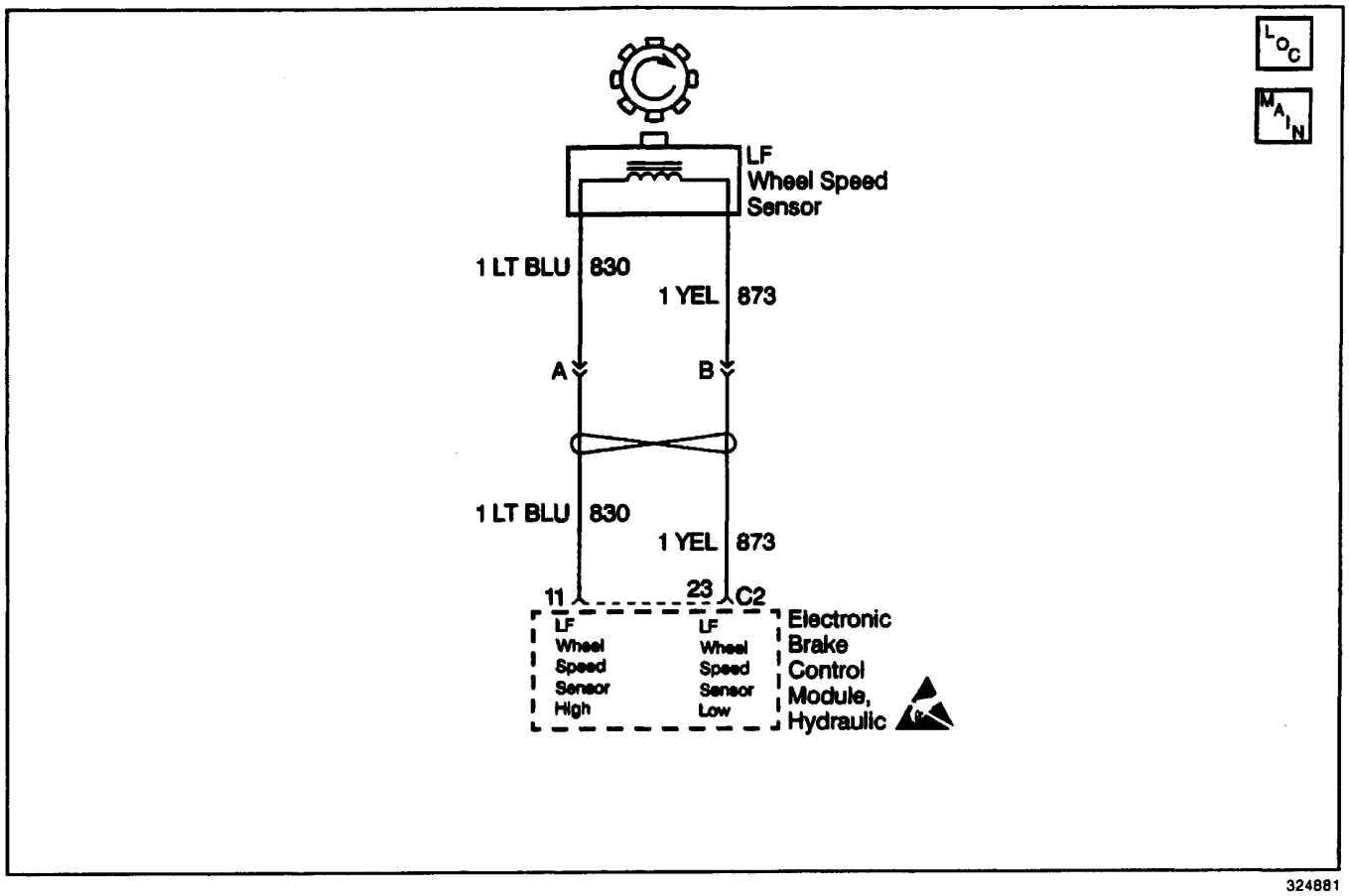
DTC C0223 RF Wheel Speed Signal Erratic

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector from the EBCM. Inspect the EBCM harness connector for signs of damage or corrosion. 3. Inspect the wheel speed sensor harness and the sensor harness connector for signs of damage or corrosion. Are all the connections clean and tight?	—	Go to Step *3*	Go to Step *6*
3	Using a *J 39200*, measure the resistance between terminals 10 and 22 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *4*
4	1. Disconnect the wheel speed sensor from the wheel speed sensor harness pigtail connector. 2. Using a *J 39200*, measure the resistance between terminal A and terminal B of the right front wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *7*	Go to Step *8*
5	1. Reconnect all the connectors. 2. Verify that the right front wheel speed sensor is securely mounted and that the tone wheel is in good condition. Are the wheel speed sensor and the tone wheel in good condition?	—	Malfunction is intermittent. Refer to Diagnostic Aids	—

DTC C0223 RF Wheel Speed Signal Erratic (cont'd)

Step	Action	Value(s)	Yes	No
6	Make the necessary repairs to the 24-way EBCM harness connector. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or high resistance in CKT 833 or CKT 872. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0225 LF Wheel Speed Sensor Circuit Open



324881

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- No output from the left front wheel speed sensor for 1.0 second.
- Excessive left front wheel speed sensor resistance for 1.0 second.

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0225 is a Condition Latched DTC, which indicates that the above actions remain true only as long as the condition persists.

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion.

Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The numbers below refer to the steps in the diagnostic table:

2. This step checks the resistance of the left front wheel speed sensor circuit.
3. This step checks the resistance of the left front wheel speed sensor wiring.
4. This step checks the resistance of the left front wheel speed sensor.

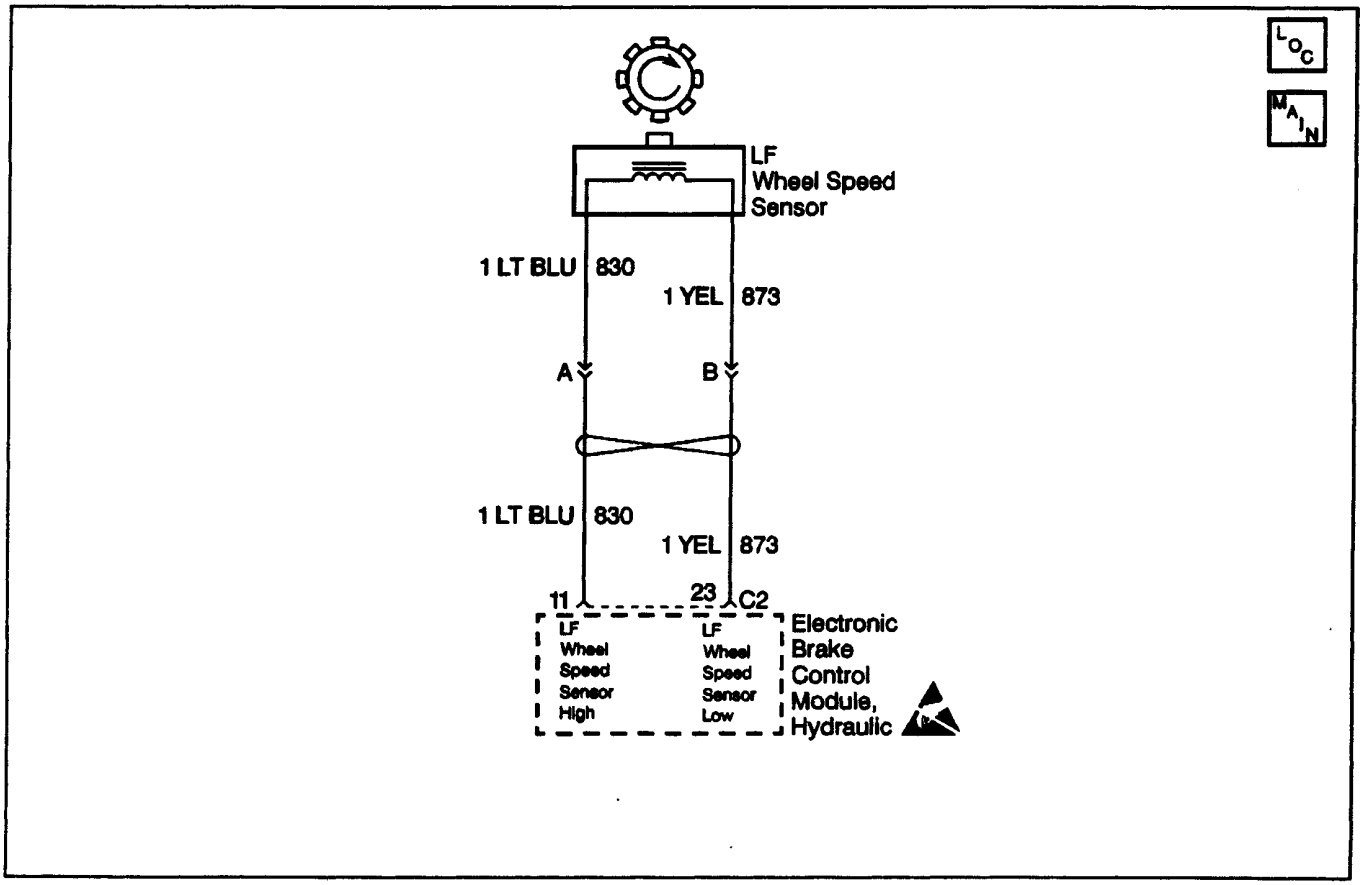
DTC C0225 LF Wheel Speed Sensor Circuit Open

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector. 3. Use the *J 39200*, measure the resistance between terminal 11 and terminal 23 of the 24-way EBCM harness connector. Is the resistance measurement with the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *3*
3	1. Disconnect the left front wheel speed sensor harness connector from the wheel speed sensor pigtail. 2. Using a *J 36169-A* jumper terminal A and terminal B of the 2-way wheel speed sensor harness connector (chassis harness side). 3. Using a *J 39200*, measure the resistance between terminal 11 and terminal 23 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	0–2 Ω	Go to Step *4*	Go to Step *7*
4	Using a *J 39200*, measure the resistance between terminal A and terminal B of the left front wheel speed sensor pigtail. Is the resistance measured within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *8*
5	1. Inspect the 24-way EBCM harness connector terminals 11 23 for poor terminal contact or corrosion. Inspect CKT 830 and CKT 873 for damage that could result in an open circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool* clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0225 set as a current DTC?	—	Go to Step *6*	Malfunction is intermittent. Refer to Diagnostic Aids

DTC C0225 LF Wheel Speed Sensor Circuit Open (cont'd)

Step	Action	Value(s)	Yes	No
6	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or the high resistance in CKT 830 or CKT 873. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0226 LF Wheel Speed Signal Missing



324881

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- The left front wheel speed is less than 6 km/h (4 mph)
- All other wheel speeds are greater than 13 km/h (8 mph)
- No unexpected wheel acceleration/deceleration. Anything that keeps the left front wheel speed sensor low while the vehicle is moving above 13 km/h (8 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0226 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The numbers below refer to the steps in the diagnostic table:

3. This step checks the resistance of the left front wheel speed sensor.
4. This step checks the voltage output of the left front wheel speed sensor.
5. This step checks for a short in the wiring between the left front wheel speed sensor circuits.
6. This step checks for a short to ground in the left front wheel speed sensor circuits.

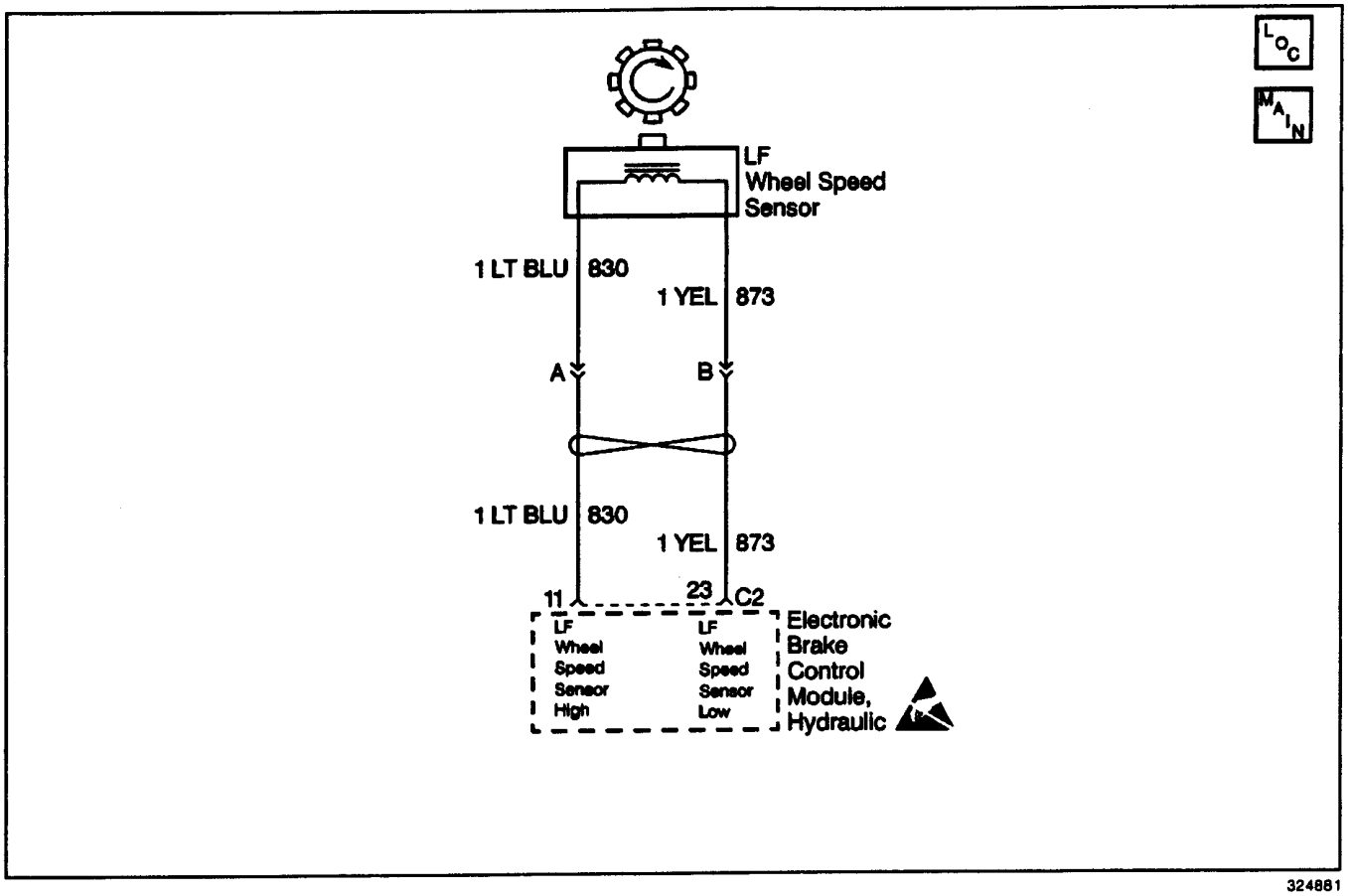
DTC C0226 LF Wheel Speed Signal Missing

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Inspect the left front wheel speed sensor, sensor wire and the connectors for signs of damage or corrosion. 3. Inspect the wheel speed sensor and the toothed ring for looseness paying particular attention to the toothed ring. Any deviation will affect the wheel speed sensor output signal. 4. Inspect the 24-way EBCM harness connector and harness for signs of damage or corrosion. Is there evidence of physical damage?	—	Go to Step *8*	Go to Step *3*
3	1. Disconnect the left front wheel speed sensor harness connector from the wheel speed sensor. 2. Using a *J 39200,* Measure the resistance between terminal A and terminal B of the left front wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *4*	Go to Step *9*
4	1. With the *J 39200* still connected, select the A/C voltage scale. 2. Spin the wheel by hand while observing the voltage reading. Is the voltage measured equal to or greater than the specified value?	100 mV	Go to Step *5*	Go to Step *9*
5	1. Disconnect the 24-way EBCM harness connector from the EBCM. 2. Using a *J 39200* Measure the resistance between terminal 11 and terminal 23 of the 24-way EBCM harness connector. Is the resistance measurement equal to the specified value?	OL	Go to Step *6*	Go to Step *11*

DTC C0226 LF Wheel Speed Signal Missing (cont'd)

Step	Action	Value(s)	Yes	No
6	1. Reconnect the left front wheel speed sensor. 2. Using a *J 39200*, measure the resistance between terminal 11 of the 24-way EBCM harness connector and ground. Is the resistance measurement equal to the specified value?	OL	Go to Step *7*	Go to Step *12*
7	1. Inspect the 24-way EBCM harness connector terminals 11 and 23 for poor terminal contact or corrosion. Inspect CKT 830 and CKT 873 for damage that could result in a shorted circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool*, clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0226 set as a current DTC?	—	Go to Step *10*	Malfunction is intermittent. Refer to Diagnostic Aids
8	Make necessary repairs. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Replace the left front wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the short between CKT 830 and CKT 873. Is the repair complete?	—	Go to *Diagnostic System Check*	—
12	Repair the short to ground in CKT 830 or CKT 873. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0227 LF Wheel Speed Signal Erratic



324881

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- The average wheel speed for all wheel speed signals is greater than 40 km/h (25 mph).
- The average left front wheel speed is greater than 40 km/h (25 mph).
- No speed signal input to the EBCM from the left front wheel speed sensor for 15ms. Anything which suddenly prevents (intermittent) the left front wheel speed signal from toggling while the vehicle is moving greater than 40 km/h (25 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0227 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

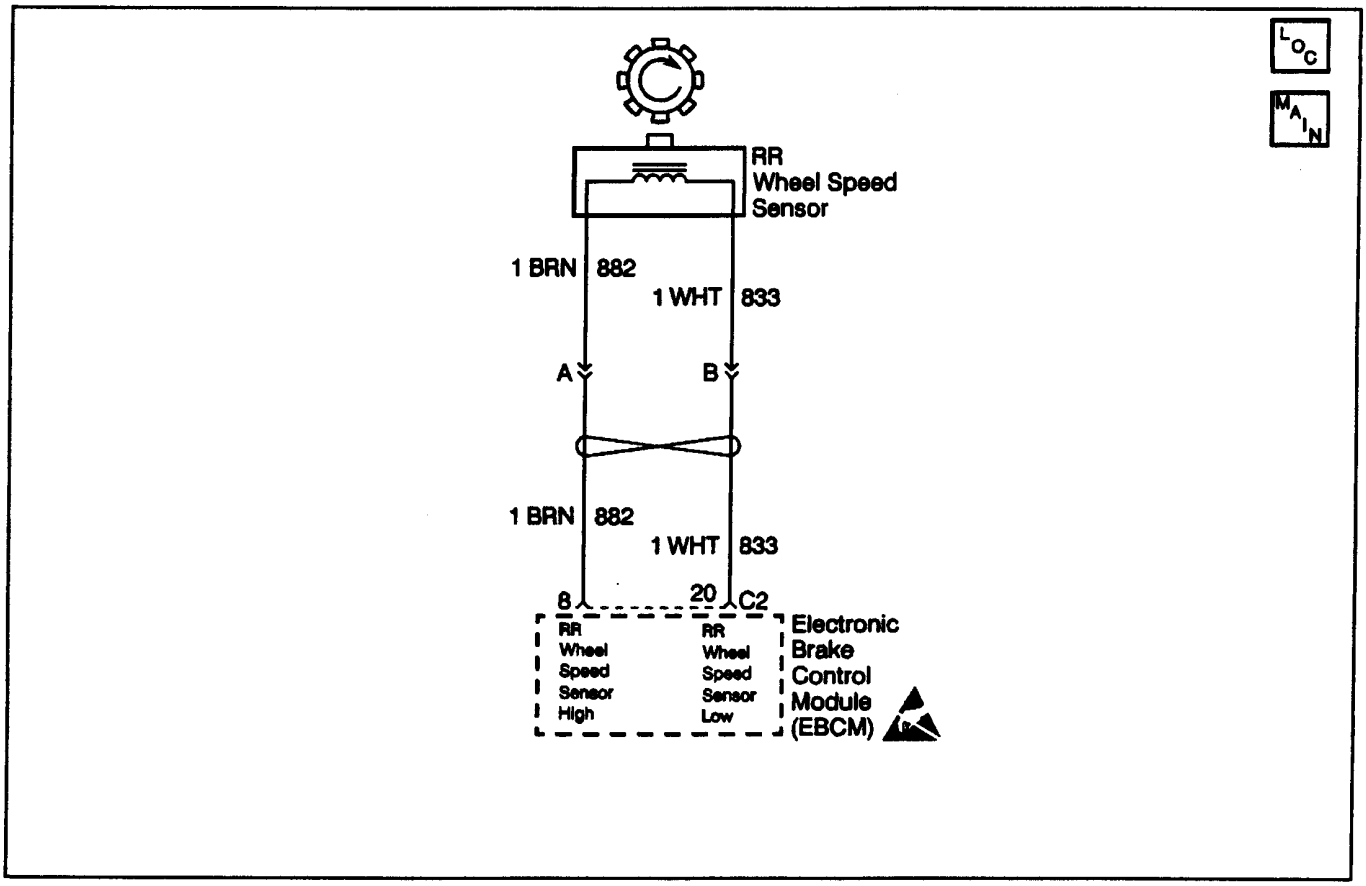
The numbers below refer to the steps in the diagnostic table:

2. This step checks the EBCM 24-way connector for looseness, corrosion, etc.
3. This step measures the resistance of the EBCM 24-way connector terminals 11 and 23.
4. This step measures the resistance at the left front wheel speed sensor connector.
6. This step inspects the left front WSS and the tone wheel for physical damage or excessive clearance.

DTC C0227 LF Wheel Speed Signal Erratic

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector from the EBCM. 3. Inspect the harness connector for signs of damage or corrosion. 4. Inspect the wheel speed sensor harness and the sensor harness connector for signs of damage or corrosion. Are all the connections clean and tight?	—	Go to Step *3*	Go to Step *6*
3	Using a *J 39200*, measure the resistance between terminals 11 and 23 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *4*
4	1. Disconnect the wheel speed sensor from the wheel speed sensor harness connector. 2. Using a *J 39200*, measure the resistance between terminal A and terminal B of the left front wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *7*	Go to Step *8*
5	1. Reconnect all the connectors. 2. Verify that the left front wheel speed sensor is securely mounted and that the tone wheel is in good condition. Are the wheel speed sensor and the tone wheel in good condition?	—	Malfunction is intermittent. Refer to Diagnostic Aids	—
6	Repair the 24-way EBCM harness connector if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or the high resistance in CKTs 830 or 873. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0231 RR Wheel Speed Signal Circuit Open



324883

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- No output from the right rear wheel speed sensor for 1.0 second.
- Excessive right rear wheel speed sensor resistance for 1.0 second.

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0231 is a Condition Latched DTC, which indicates that the above actions remain true only as long as the condition persists.

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion.

Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

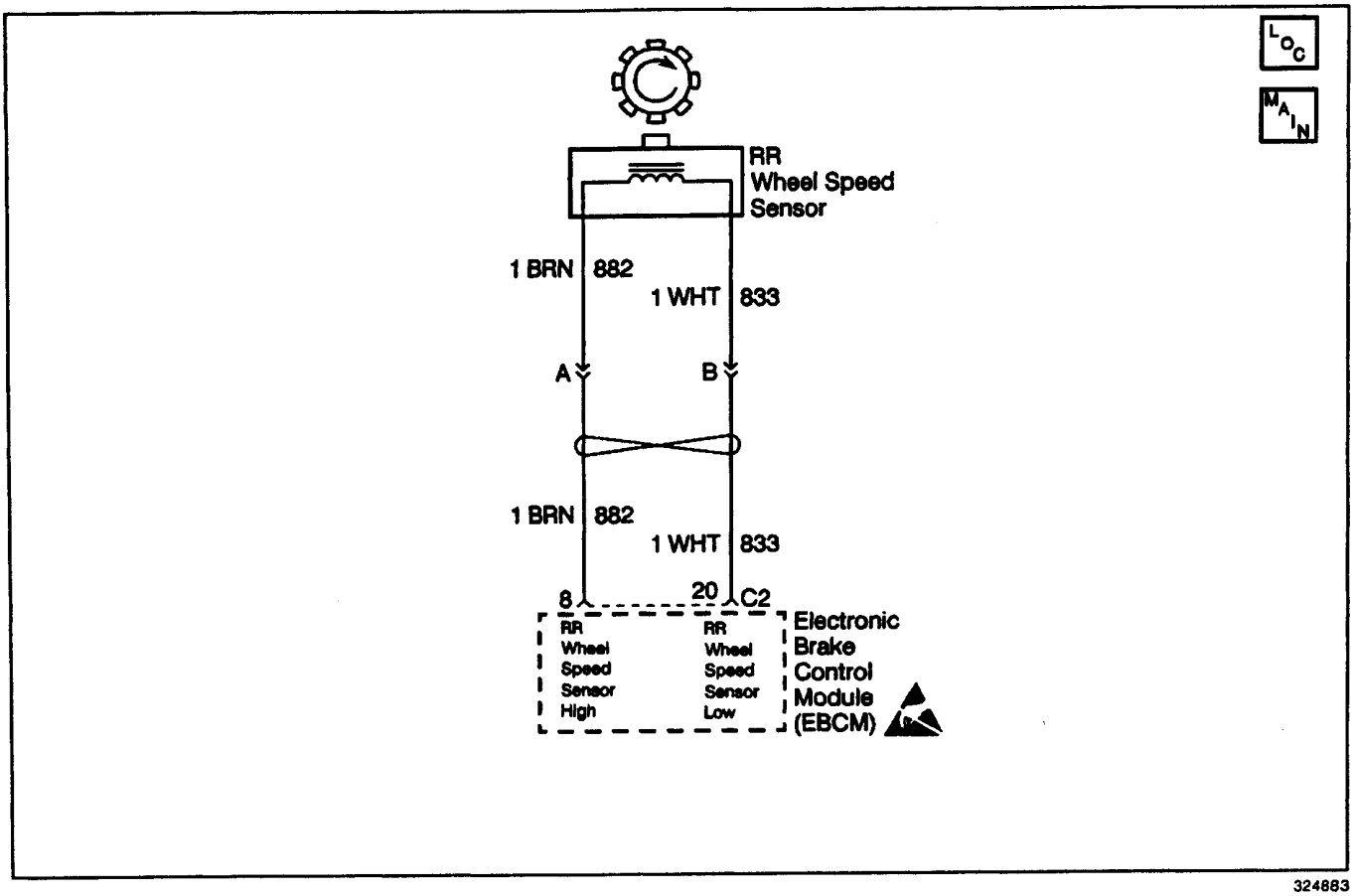
The numbers below refer to the steps in the diagnostic table:

2. This step checks the resistance of the right rear wheel speed sensor circuit.
3. This step checks the resistance of the right rear wheel speed sensor wiring.
4. This step checks resistance of the right rear wheel speed sensor.

DTC C0231 RR Wheel Speed Signal Circuit Open

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step 2	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector. 3. Using a *J 39200*, measure the resistance between terminals 8 and 20 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step 5	Go to Step 3
3	1. Disconnect the right rear wheel speed sensor harness connector from the wheel speed sensor pigtail. 2. Using a *J 36169-A* jumper terminal A and terminal B of the 2-way wheel speed sensor harness connector (chassis harness side). 3. Using a *J 39200*, measure the resistance between terminal 8 and terminal 20 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	0–2 Ω	Go to Step 4	Go to Step 7
4	Using a *J 39200*, measure the resistance between terminal A and terminal B of the right rear wheel speed sensor pigtail. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step 5	Go to Step 8
5	1. Inspect the 24-way EBCM harness connector terminal 8 and terminal 20 for poor terminal contact or corrosion. Inspect CKT 882 and CKT 883 for damage that could result in an open circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool* clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0231 set as a current DTC?	—	Go to Step 6	Malfunction is intermittent. Refer to Diagnostic Aids
6	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or the high resistance in CKT 882 or CKT 883. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0232 RR Wheel Speed Signal Missing



324883

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- The right rear wheel speed is less than 6 km/h (4 mph)
- All other wheel speeds are greater than 13 km/h (8 mph)
- No unexpected wheel acceleration/deceleration. Anything that keeps the right rear wheel speed sensor low while the vehicle is moving above 13 km/h (8 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0232 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The numbers below refer to the steps in the diagnostic table:

3. This step checks for the resistance of the right rear wheel speed sensor.
4. This step checks the voltage output of the right rear wheel speed sensor.
5. This step checks for a short in the wiring between the wheel speed sensor circuits.
6. This step checks for a short to ground in the right rear wheel speed sensor circuits.

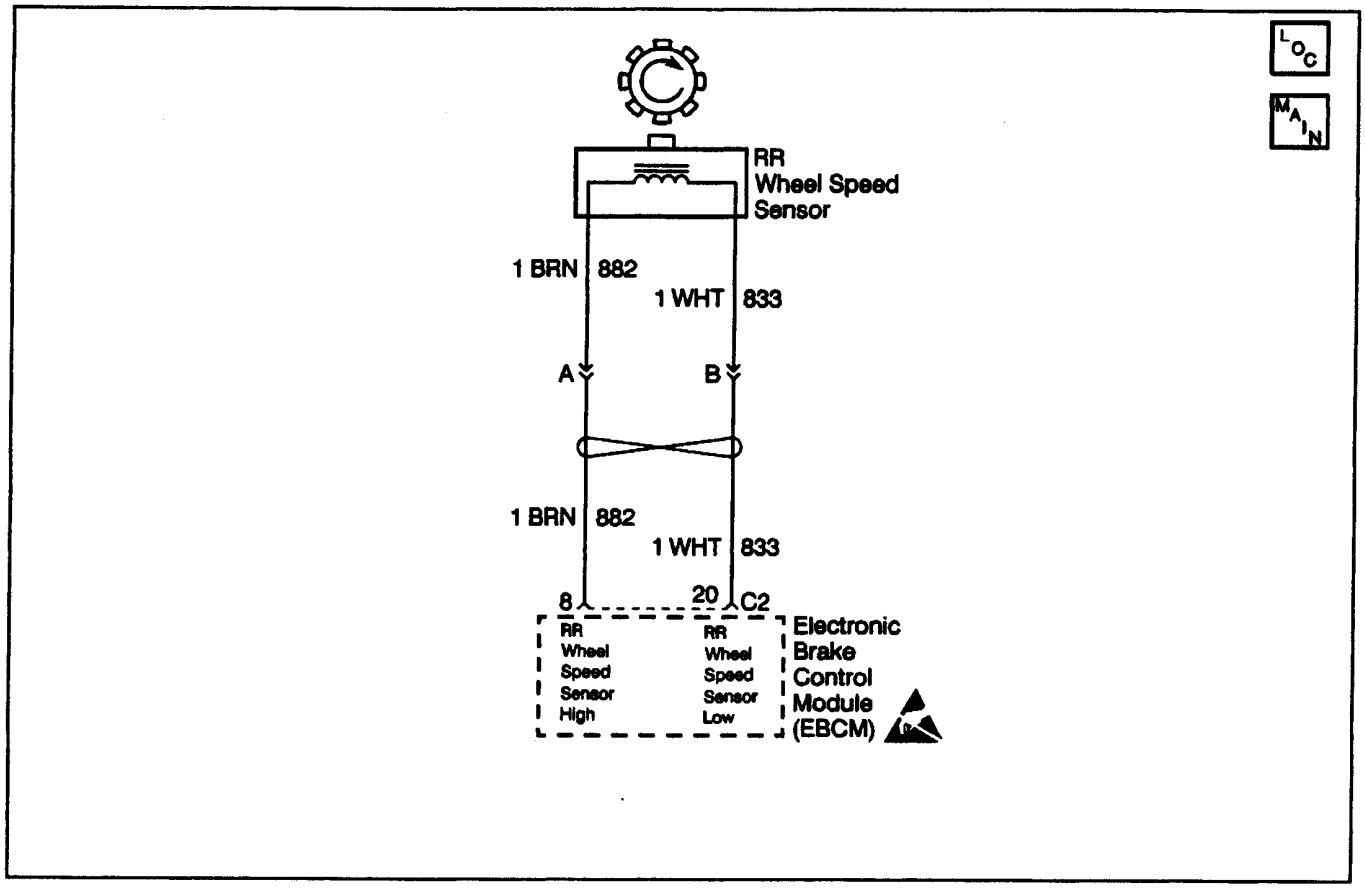
DTC C0232 RR Wheel Speed Signal Missing

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Inspect the right rear wheel speed sensor, sensor wire and the connectors for signs of damage or corrosion. 3. Inspect the wheel speed sensor and the toothed ring for looseness paying special attention to the toothed ring. Any deviation will affect the wheel speed sensor output signal. 4. Inspect the 24-way EBCM harness connector and harness for signs of damage or corrosion. Is there evidence of physical damage?	—	Go to Step *8*	Go to Step *3*
3	1. Disconnect the right rear wheel speed sensor harness connector from the wheel speed sensor. 2. Using a *J 39200*, measure the resistance between terminal A and terminal B of the right rear wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *4*	Go to Step *9*
4	1. With the *J 39200* still connected, select the A/C voltage scale. 2. Spin the wheel by hand while observing the voltage reading. Is the voltage measured equal to or greater than the specified value?	100 mV	Go to Step *5*	Go to Step *9*
5	1. Disconnect the 24-way EBCM harness connector from the EBCM. 2. Using a *J 39200*, measure the resistance between terminal 8 and terminal 20 of the 24-way EBCM harness connector. Is the resistance measurement equal to the specified value?	OL	Go to Step *6*	Go to Step *11*

DTC C0232 RR Wheel Speed Signal Missing (cont'd)

Step	Action	Value(s)	Yes	No
6	1. Reconnect the right rear wheel speed sensor. 2. Using a *J 39200*, measure the resistance between terminal 8 of the 24-way EBCM harness connector and ground. Is the resistance measurement equal to the specified value?	OL	Go to Step *7*	Go to Step *12*
7	1. Inspect the 24-way EBCM harness connector terminals 8 and 20 for poor terminal contact or corrosion. Inspect CKTs 882 and 883 for damage that could result in a shorted circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Clear all DTCs using the scan tool. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0232 set as a current DTC?	—	Go to Step *10*	Malfunction is intermittent. Refer to Diagnostic Aids
8	Repair as necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Replace the right rear wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the short between CKT 882 and CKT 883. Is the repair complete?	—	Go to *Diagnostic System Check*	—
12	Repair the short to ground in CKT 882 or CKT 883. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0233 RR Wheel Speed Signal Erratic



324883

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- The average wheel speed for all wheel speed signals is greater than 40 km/h (25 mph).
- The average left rear wheel speed is greater than 40 km/h (25 mph).
- No speed signal input to the EBCM from the right rear wheel speed sensor for 15ms. Anything which suddenly prevents (intermittent) the right rear wheel speed signal from toggling while the vehicle is moving greater than 40 km/h (25 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0233 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

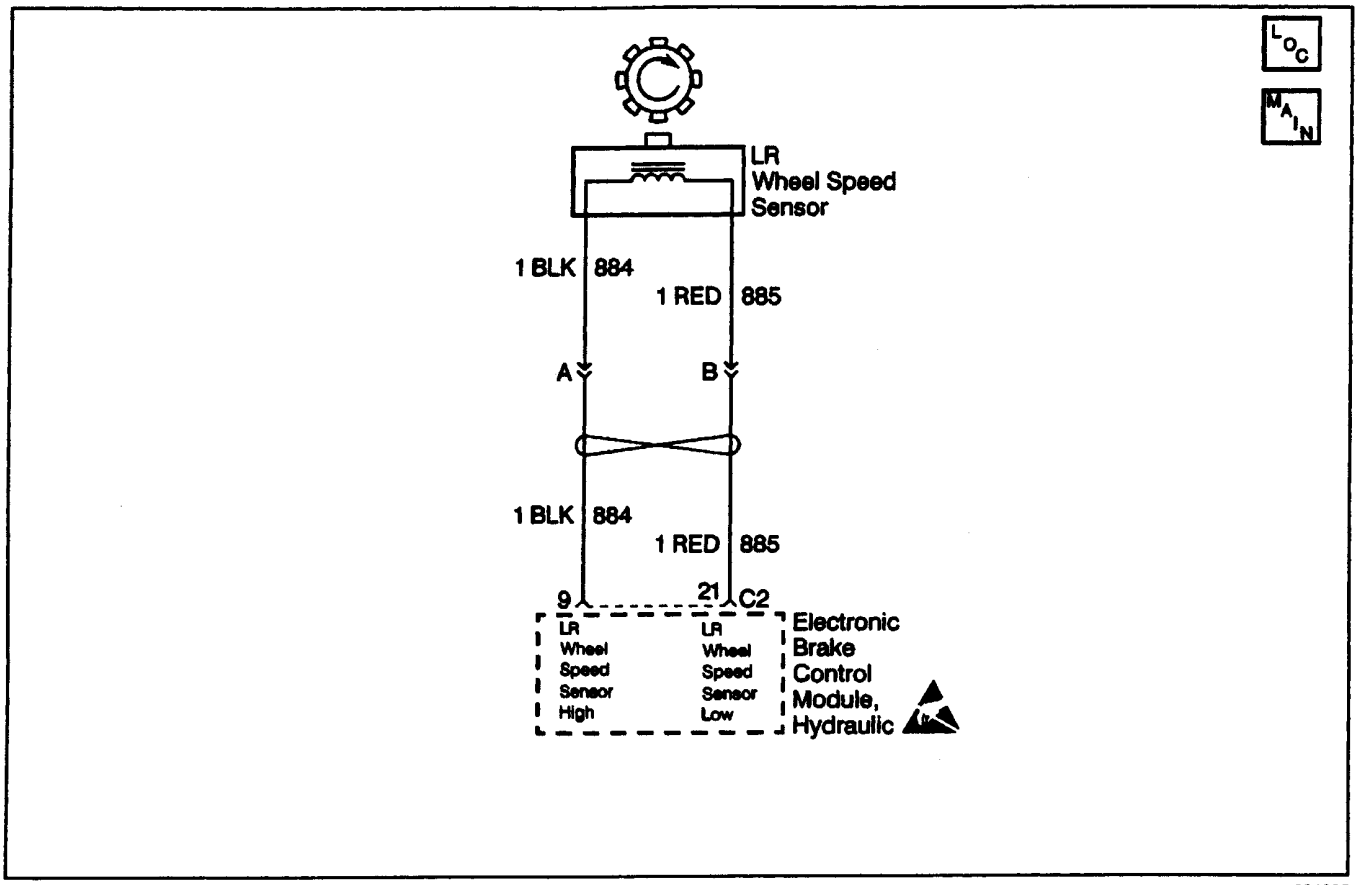
The numbers below refer to the steps in the diagnostic table:

2. This step checks the EBCM 24-way connector for looseness, corrosion, etc.
3. This step measures the resistance of the wheel speed sensor at the EBCM 24-way connector terminal 8 and terminal 20.
4. This step measures the resistance at the right rear wheel speed sensor connector.
6. This step inspects the right rear wheel speed sensor and the tone wheel for physical damage or excessive clearance.

DTC C0233 RR Wheel Speed Signal Erratic

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector from the EBCM. 3. Inspect the EBCM harness connector for signs of damage or corrosion. 4. Inspect the wheel speed sensor harness and the sensor harness connector for signs of damage or corrosion. Are all connections clean and tight?	—	Go to Step *3*	Go to Step *6*
3	Using a *J 39200*, measure the resistance between terminal 8 and terminal 20 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *4*
4	1. Disconnect the wheel speed sensor from the wheel speed sensor harness connector. 2. Using a *J 39200*, measure the resistance between terminal A and terminal B of the right rear wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *7*	Go to Step *8*
5	1. Reconnect all the connectors. 2. Verify that the right rear wheel speed sensor is securely mounted and that the tone wheel is in good condition. Are the wheel speed sensor and the tone wheel in good condition?	—	Malfunction is intermittent. Refer to Diagnostic Aids	—
6	Repair the 24-way EBCM harness connector if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or the high resistance in CKTs 882 or 883. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0235 LR Wheel Speed Signal Circuit Open



324885

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- No output from the left rear wheel speed sensor for 1.0 second.
- Excessive left rear wheel speed sensor resistance for 1.0 second.

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0235 is a Condition Latched DTC, which indicates that the above actions remain true only as long as the condition persists.

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion.

Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

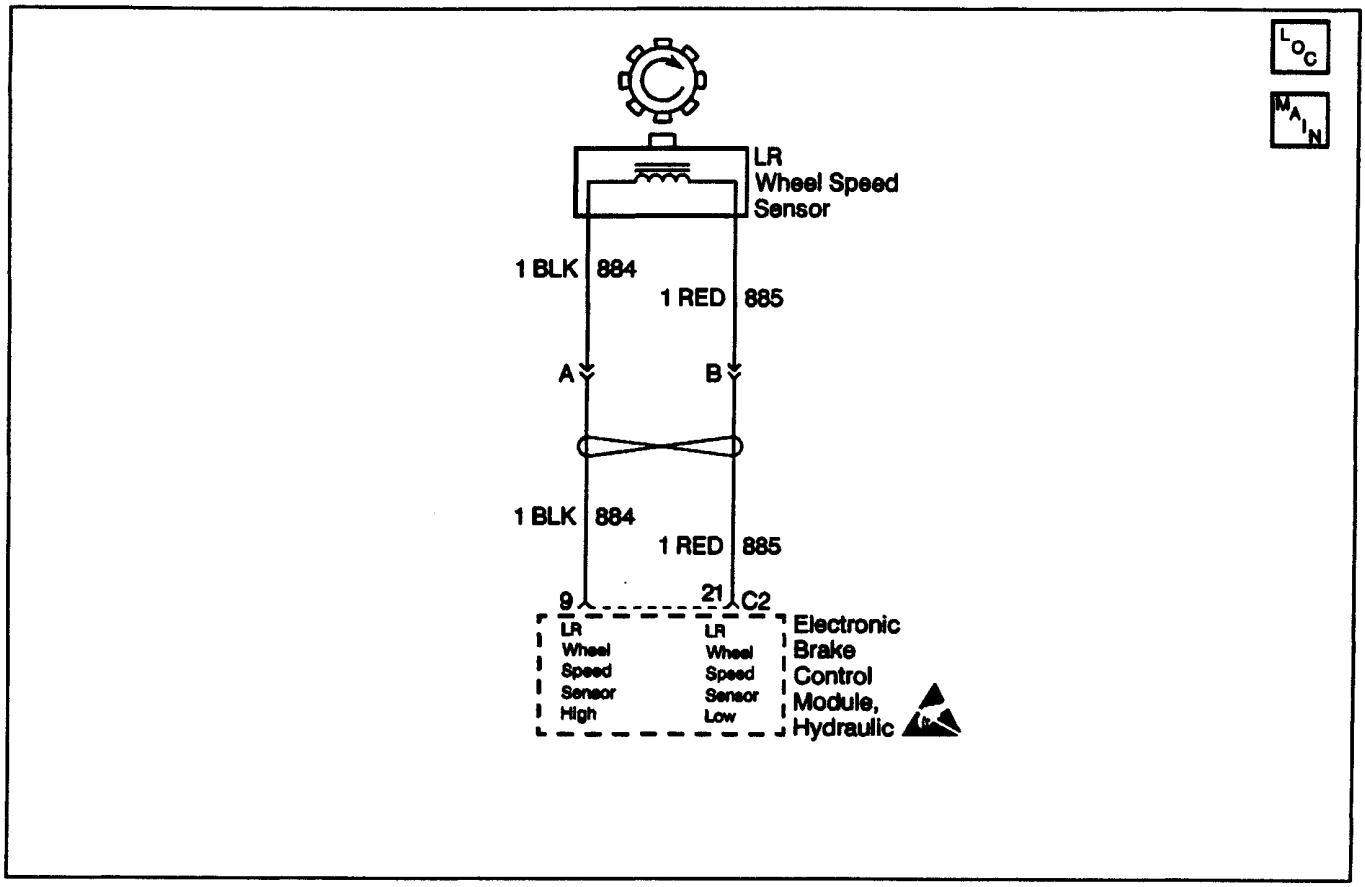
The numbers below refer to the steps in the diagnostic table:

2. This step checks the resistance of the left rear wheel speed sensor circuit.
3. This step checks the resistance of the left rear wheel speed sensor wiring.
4. This step checks the resistance of the left rear wheel speed sensor.

DTC C0235 LR Wheel Speed Signal Circuit Open

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector. 3. Using a the *J 39200*, measure the resistance between terminal 9 and terminal 21 of the 24-way EBCM harness connector. Is the resistance within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *3*
3	1. Disconnect the left rear wheel speed sensor harness connector from the wheel speed sensor pigtail. 2. Using a *J 36169-A*, jumper terminal A and terminal B of the 2-way wheel speed sensor harness connector (chassis harness side). 3. Using a *J 39200*, measure the resistance between terminal 9 and terminal 21 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	0–2 Ω	Go to Step *4*	Go to Step *7*
4	Using a *J 39200*, measure the resistance between terminal A and terminal B of the left rear wheel speed sensor pigtail. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *8*
5	1. Inspect the 24-way EBCM harness connector terminal 9 and terminal 21 for poor terminal contact or corrosion. Inspect CKT 884 and CKT 885 for damage that could result in an open circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all connectors. 3. Using the *Scan Tool*, clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0235 set as a current DTC?	—	Go to Step *6*	Malfunction is intermittent. Refer to Diagnostic Aids
6	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or the high resistance in CKT 884 or CKT 885. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0236 LR Wheel Speed Signal Circuit Missing



324885

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- The left rear wheel speed is less than 6 km/h (4 mph)
- All other wheel speeds are greater than 13 km/h (8 mph)
- No unexpected wheel acceleration/deceleration. Anything that keeps the left rear wheel speed sensor low while the vehicle is moving above 13 km/h (8 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0236 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The numbers below refer to the steps in the diagnostic table:

3. This step checks for the resistance of the left rear wheel speed sensor.
4. This step checks the voltage output of the left rear wheel speed sensor.
5. This step checks for a short in the wiring between the wheel speed sensor circuits.
6. This step checks for a short to ground in the left rear wheel speed sensor circuits.

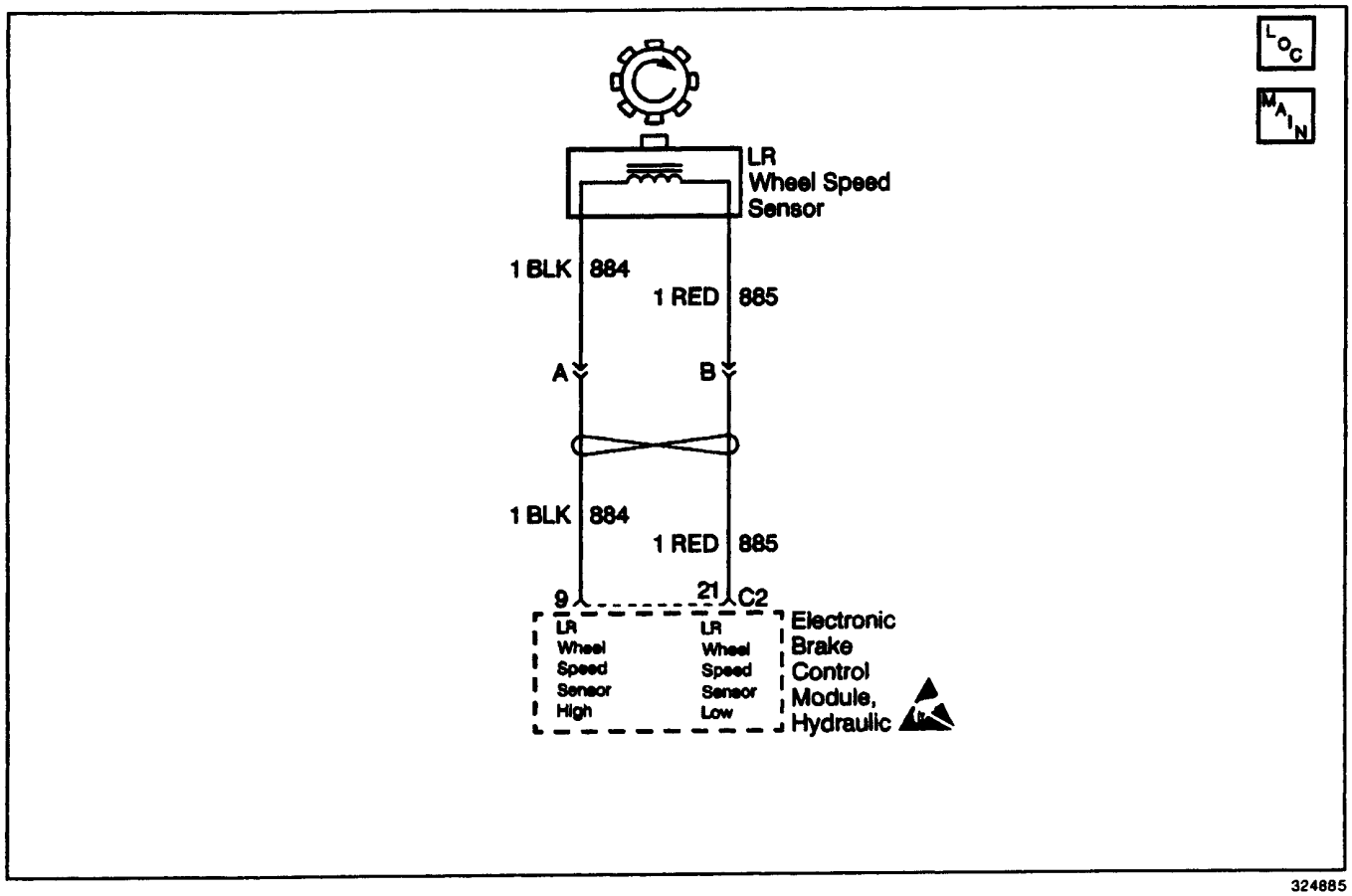
DTC C0236 LR Wheel Speed Signal Circuit Missing

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Inspect the left rear wheel speed sensor, sensor wire and connectors for signs of damage. 3. Inspect the wheel speed sensor and the toothed ring for looseness paying particular attention to the toothed ring. Any deviation will affect the wheel speed sensor output signal. 4. Inspect the 24-way EBCM harness connector and harness for signs of damage or corrosion. Is there evidence of physical damage?	—	Go to Step *8*	Go to Step *3*
3	1. Disconnect the left rear wheel speed sensor harness connector from the wheel speed sensor. 2. Using a *J 39200*, measure the resistance between terminal A and terminal B of the left rear wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *4*	Go to Step *9*
4	1. With the *J 39200* still connected, select the A/C voltage scale. 2. Spin the wheel by hand while observing the voltage reading. Is the voltage measured equal to or greater than the specified value?	100 mV	Go to Step *5*	Go to Step *9*
5	1. Disconnect the 24-way EBCM harness connector from the EBCM. 2. Using a *J 39200* measure the resistance between terminal 9 and terminal 21 of the 24-way EBCM harness connector. Is the resistance measurement equal to the specified value?	OL	Go to Step *6*	Go to Step *11*

DTC C0236 LR Wheel Speed Signal Circuit Missing (cont'd)

Step	Action	Value(s)	Yes	No
6	1. Reconnect the left rear wheel speed sensor. 2. Using a *J 39200*, measure the resistance between terminal 9 of the 24-way EBCM harness connector and ground. Is the resistance measurement equal to the specified value?	OL	Go to Step *7*	Go to Step *12*
7	1. Inspect the 24-way EBCM harness connector terminal 9 and terminal 21 for poor terminal contact or corrosion. Inspect CKT 884 and CKT 885 for damage that could result in a shorted circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool*, clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0236 set as a current DTC?	—	Go to Step *10*	Malfunction is intermittent. Refer to Diagnostic Aids
8	Make the necessary repairs. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Replace the left rear wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the short between CKTs 884 and 885. Is the repair complete?	—	Go to *Diagnostic System Check*	—
12	Repair short to ground in CKTs 884 or 885. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0237 LR Wheel Speed Signal Erratic



324885

Circuit Description

The wheel speed sensor coil emits an electromagnetic field. A toothed ring on the wheel passes by the wheel speed sensor and disrupts this electromagnetic field. The disruption in the field causes the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the speed of the wheel. The amplitude of the wheel speed signal is also directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap.

Conditions for Setting the DTC

- The average wheel speed for all wheel speed signals is greater than 40 km/h (25 mph).
- The average left rear wheel speed is greater than 40 km/h (25 mph).
- No speed signal input to the EBCM from the left rear wheel speed sensor for 15ms. Anything which suddenly prevents (intermittent) the left rear wheel speed signal from toggling while the vehicle is moving greater than 40 km/h (25 mph).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0237 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

Any of the following conditions may cause an intermittent malfunction:

- A poor connection
- Wire insulation that is rubbed through
- A wire breaks inside the insulation

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

If the customer says that the ABS indicator lamp is on only during humid conditions such as rain, snow, or vehicle wash, then thoroughly inspect all wheel speed sensor circuits for signs of water intrusion. Use the following procedure:

1. Spray the suspected area with a 5% salt water solution (two teaspoons of salt to 12 oz. of water)
2. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds

If the DTC returns, replace the suspected harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and the harness connector for corrosion. If evidence of corrosion exists, then replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear.*

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

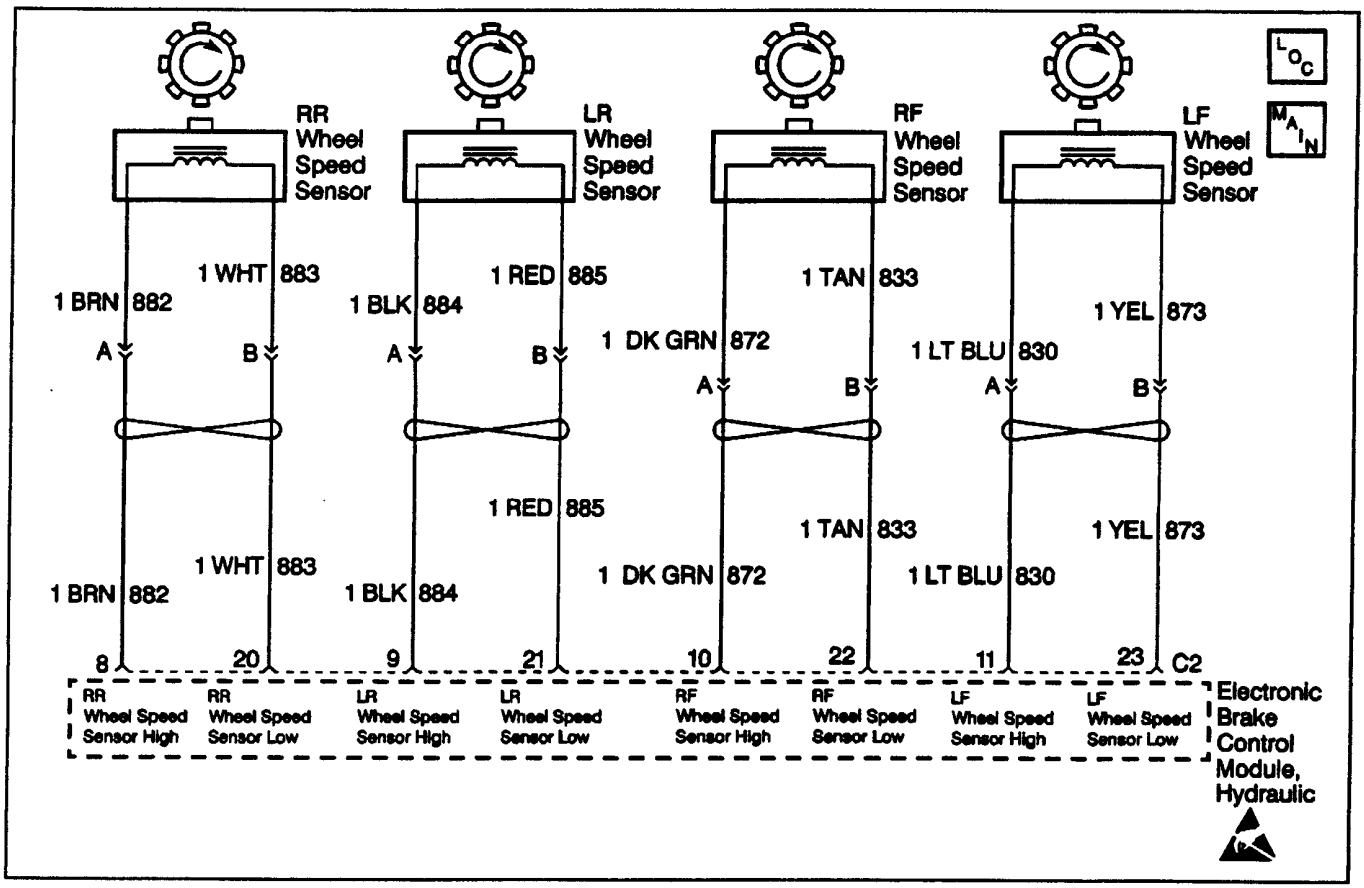
The numbers below refer to the steps in the diagnostic table:

2. This step checks the EBCM 24-way connector for looseness, corrosion, etc.
3. This step measures the resistance of the wheel speed sensor at the EBCM 24-way connector terminals 9 and 21.
4. This step measures the resistance at the left rear wheel speed sensor connector.
6. This step inspects the left rear wheel speed sensor and the tone wheel for physical damage or excessive clearance.

DTC C0237 LR Wheel Speed Signal Erratic

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector from the EBCM. 3. Inspect the EBCM harness connector for signs of damage or corrosion. 4. Inspect the wheel speed sensor harness and the sensor harness connector for signs of damage or corrosion. Are all the connections clean and tight?	—	Go to Step *3*	Go to Step *6*
3	Using a *J 39200*, measure the resistance between terminals 9 and 21 of the 24-way EBCM harness connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *5*	Go to Step *4*
4	1. Disconnect the wheel speed sensor from the wheel speed sensor harness connector. 2. Using a *J 39200*, measure the resistance between terminal A and terminal B of the left rear wheel speed sensor pigtail connector. Is the resistance measurement within the specified range?	1500–2500 Ω	Go to Step *7*	Go to Step *8*
5	1. Reconnect all the connectors. 2. Verify that the left rear wheel speed sensor is securely mounted and that the tone wheel is in good condition. Are the wheel speed sensor and the tone wheel in good condition?	—	Malfunction is intermittent. Refer to Diagnostic Aids	—
6	Repair the 24-way EBCM harness connector if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair the open or the high resistance in CKT 884 or CKT 885. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0238 Wheel Speed Mismatch



324888

Circuit Description

As a toothed ring passes by the wheel speed sensor, changes in the electromagnetic field cause the wheel speed sensor to produce a sinusoidal (AC) voltage signal. The frequency and amplitude of the sinusoidal (AC) voltage signal are proportional to the wheel speed. The amplitude of the wheel speed signal is directly related to the distance between the wheel speed sensor coil and the toothed ring. This distance is referred to as the air gap. The EBCM can detect wheel speed signal malfunctions as they happen. An error in reported wheel speed can be compensated for by the EBCM up to a point. The error compensation will allow the EBCM to continue to function normally instead of setting a DTC. If the wheel speed mismatch increases beyond that point, the EBCM will set DTC C0238.

Conditions for Setting the DTC

- One mismatched wheel speed is more than double or less than half the other three.
- The vehicle speed is greater than 19 km/h (12 mph)
- No unexpected wheel acceleration: anything that generates consistent differences between the wheel speed signals

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTC C0238 is an Ignition Latched DTC, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

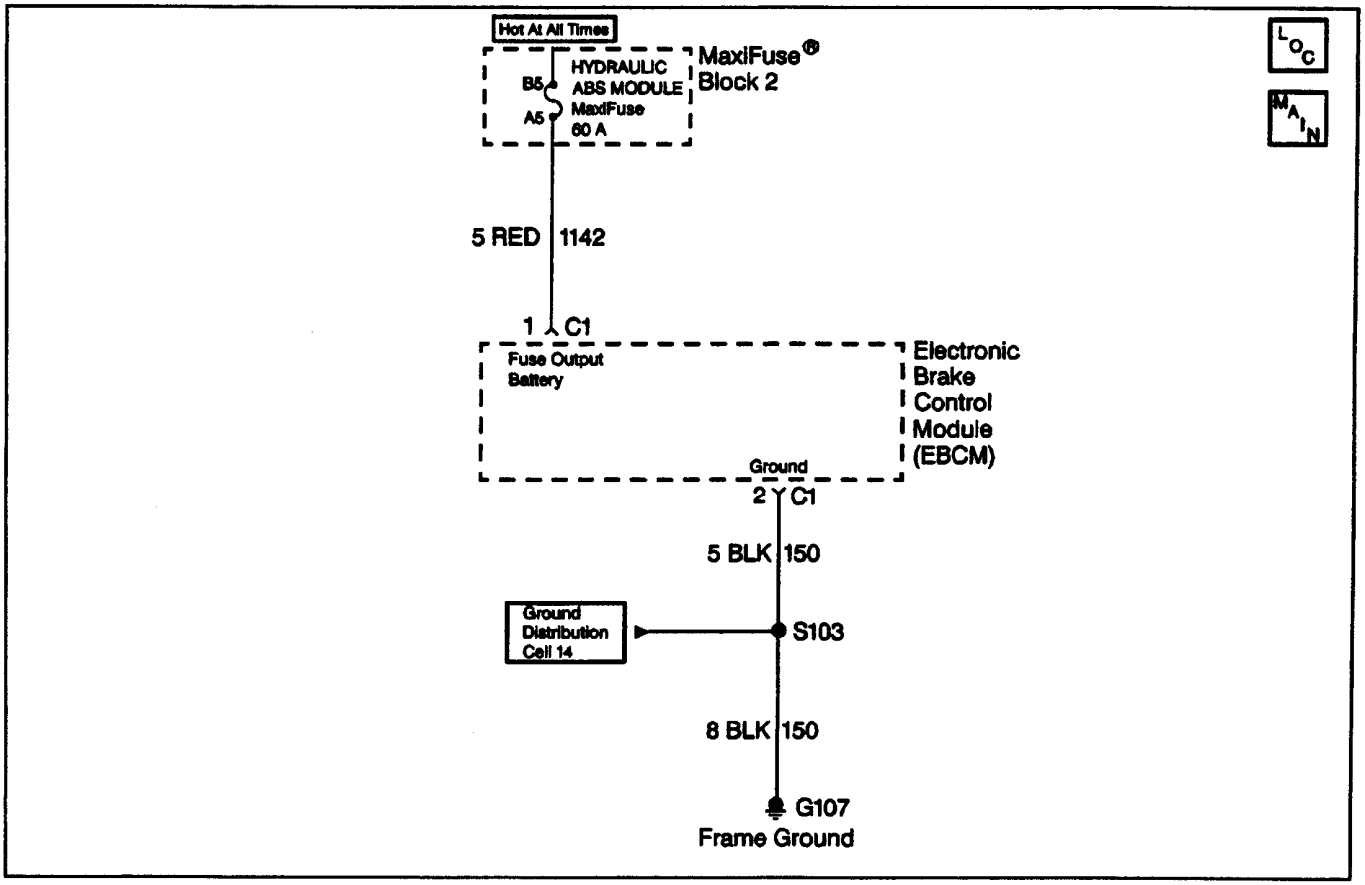
Diagnostic Aids

Installing significantly different tires on the vehicle usually sets a DTC C0238.

DTC C0238 Wheel Speed Mismatch

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	Inspect the vehicle tires for a variation in tire size. Are all four tire sizes the same?	—	Go to Step *3*	Refer to Diagnostic Aids
3	1. Using the *Scan Tool*, clear all DTCs. 2. While driving the vehicle, monitor and compare all the wheel speeds. Does the Scan Tool indicate a mismatch in wheel speeds?	—	Go to Step *4*	Malfunction is intermittent. Refer to Diagnostic Aids
4	Does the scan tool indicate a mismatch with the right front wheel speed?	—	Go to *DTC C0223 RF Wheel Speed Signal Erratic*	Go to Step *5*
5	Does the scan tool indicate a mismatch with the left front wheel speed?	—	Go to *DTC C0227 LF Wheel Speed Signal Erratic*	Go to Step *6*
6	Does the scan tool indicate a mismatch with the right rear wheel speed?	—	Go to *DTC C0233 RR Wheel Speed Signal Erratic*	Go to Step *7*
7	Does the scan tool indicate a mismatch with the left rear wheel speed?	—	Go to *DTC C0237 LR Wheel Speed Signal Erratic*	—

DTC C0241-C0258 EBCM Control Valve Circuit



324892

Circuit Description

The EBCM microprocessor will ground the indicated solenoid coil (RF dump/isolation, LF dump/isolation, RR dump/isolation, or LR dump/isolation) circuit to energize the solenoid coil whenever the solenoid valve is needed. Refer to ABS Braking Mode in *ABS System Operation*. The magnetic force created by the solenoid coil will close the isolation valve.

Conditions for Setting the DTC

Open Circuit

- The ABS bulb check is complete
- Low voltage exists on the EBCM solenoid driver circuit when high voltage is expected (the solenoid is not energized)

Shorted Circuit

- The ABS bulb check is complete
- High voltage is present on the EBCM solenoid driver circuit when the voltage is expected to be low (solenoid energized).

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTCs C0241–C0258 are Ignition Latched DTCs, which indicates the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

This DTC usually sets because of an open/shorted solenoid coil within the EBCM. The solenoid coil is located within the BPMV and is not serviceable. If the test does not repair the DTC, then replace the EBCM.

If this DTC sets with other DTCs, check for the following conditions:

- A poor EBCM power or signal ground
- A poor EBCM power or ignition feed

Test Description

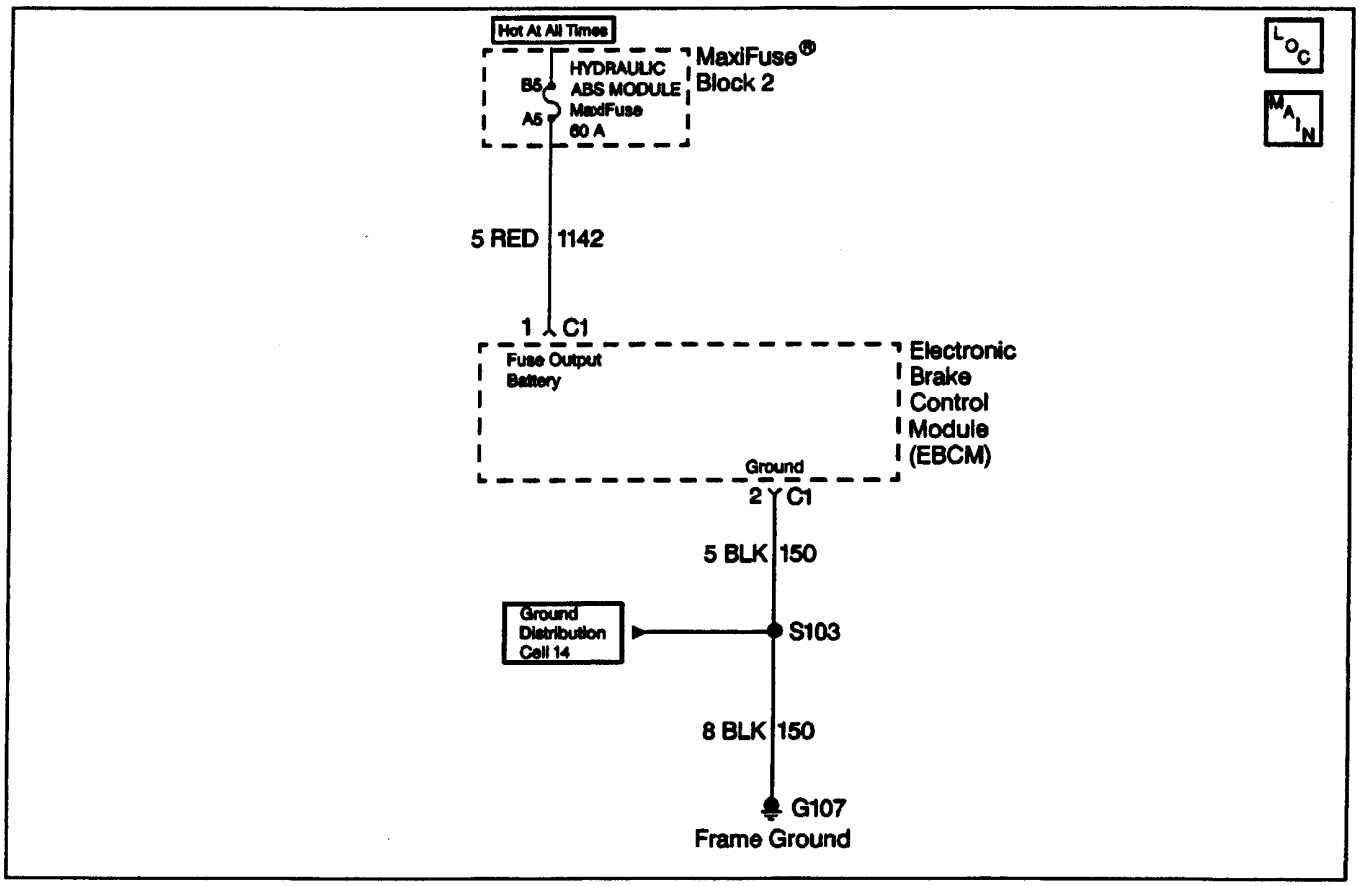
The numbers below refer to the steps in the diagnostic table:

3. This step checks the resistance of the ground circuit.
4. This step checks the ignition voltage available to the EBCM.

DTC C0241-C0258 EBCM Control Valve Circuit

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 2-way EBCM harness connector from the EBCM. 3. Inspect the connector for damage or corrosion that could cause a loss of power to the EBCM. Is the connector in good condition?	—	Go to Step *3*	Go to Step *7*
3	Using a *J 39200*, measure the resistance between terminal 2 of the 2-way EBCM harness connector and ground. Is the resistance measurement within the specified range?	0–2 Ω	Go to Step *4*	Go to Step *8*
4	1. Turn the ignition to RUN. 2. Using a *J 39200*, measure the resistance between terminal 1 of the 2-way EBCM harness connector and ground. Is the voltage measured equal to or greater than the specified value?	10 V	Go to Step *6*	Go to Step *5*
5	Inspect the 60 amp ABS maxi-fuse. Is the fuse open?	—	Go to Step *10*	Go to Step *11*
6	1. Inspect the 2-way EBCM harness connector for poor terminal contact or corrosion. Inspect CKT 1142 and CKT 150 for damage which may result in an open circuit. Repair damage if evdent. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool* clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does the DTC set as a current DTC?	—	Go to Step *9*	Malfunction is intermittent. Refer to Diagnostic Aids
7	Repair the 2-way EBCM harness connector if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Repair the open or the high resistance in CKT 150. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Repair the short to ground in CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the open or the high resistance in CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0265 or C0266 EBCM Relay Circuit



324892

Circuit Description (DTC C0065/C0266)

The pump motor relay supplies power to all eight solenoid coils (four isolation solenoid coils and four dump solenoid coils) and the pump motor when the ABS is required. The relay and the eight solenoid coils are located within the EBCM.

Conditions for Setting the DTC (DTC C0265)

- The EBCM microprocessor commands the relay on
- Low voltage exists on all eight solenoid driver circuits when high voltage is expected (the solenoid is not energized)

Conditions for Setting the DTC (DTC C0266)

- The ABS bulb check is complete
- High voltage exists on the pump motor driver circuit when all are expected to be low (the relay is not commanded on)

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTCs C0265–C0266 are Ignition Latched DTCs, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids (DTC C0265)

DTC C0265 usually sets because of an open relay coil or non-closable relay contacts. The relay is located within the EBCM. The relay is not serviceable. If the test does not repair the DTC, then replace the EBCM.

If DTC C0265 appears with other DTCs repair the other DTCs first. Clear all DTCs. Then run three function tests with the *Scan Tool*. Refer to this diagnostic chart if DTC C0265 resets.

Diagnostic Aids (DTC C0266)

DTC C0266 usually sets when the relay contacts are stuck closed. The relay is located within the EBCM. The relay is not serviceable. If the test does not repair the DTC, then replace the EBCM.

Test Description

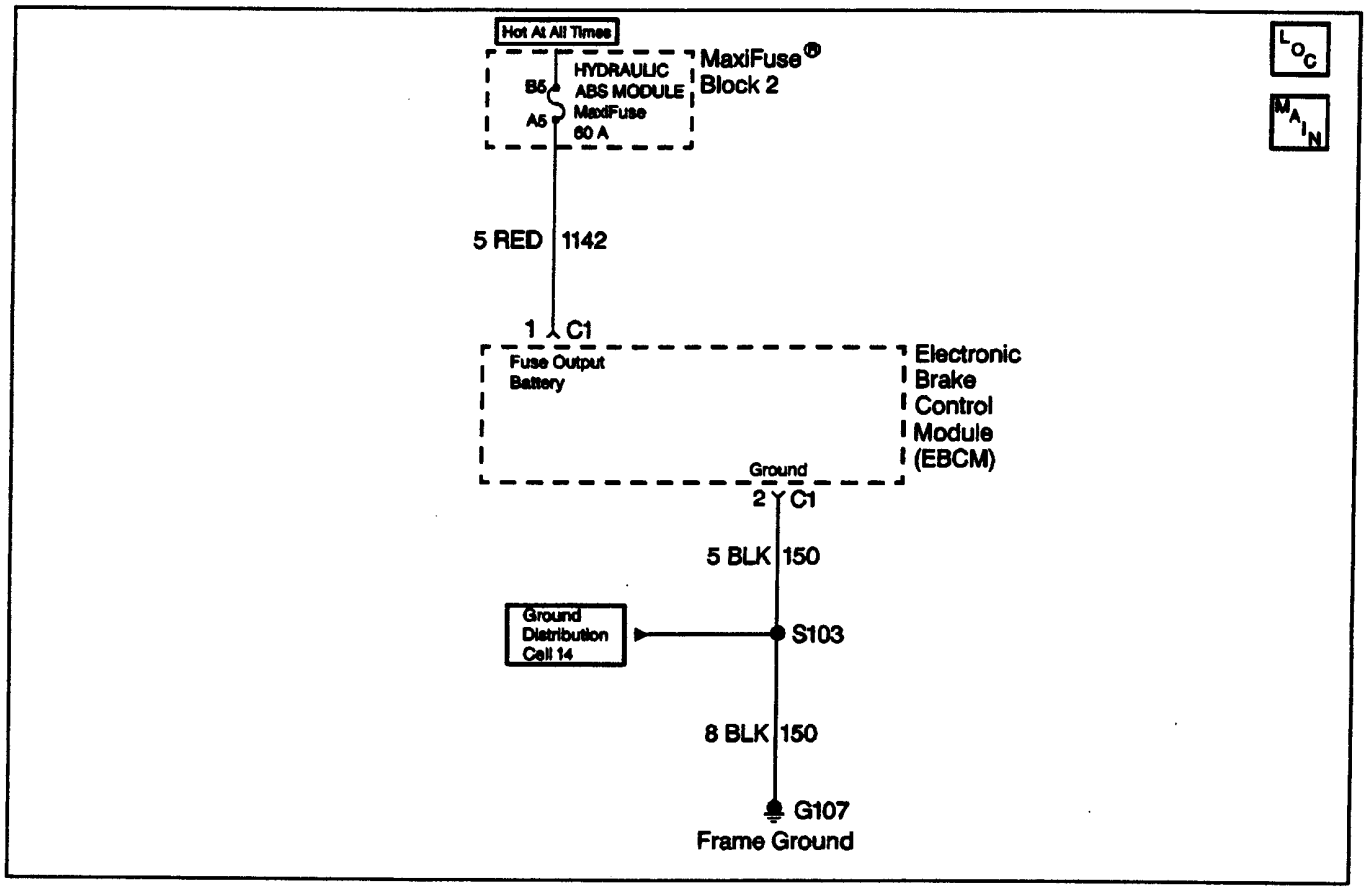
The numbers below refer to the steps in the diagnostic table:

3. This step checks the resistance of the ground circuit.
4. This step checks the ignition voltage available to the EBCM.

DTC C0265 or C0266 EBCM Relay Circuit

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 2-way EBCM harness connector from the EBCM. 3. Inspect the connector for damage or corrosion that could cause a loss of power to the EBCM. Is the connector in good condition?	—	Go to Step *3*	Go to Step *7*
3	Using the *J 39200*, measure the resistance between terminal 2 of the 2-way EBCM harness connector and ground. Is the resistance measurement within the specified range?	0-2 Ω	Go to Step *4*	Go to Step *8*
4	1. Turn the ignition switch to RUN. 2. Using a *J 39200*, measure the voltage between terminal 1 of the 2-way EBCM harness connector and ground. Is the voltage measured equal to or greater than the specified value?	10 V	Go to Step *6*	Go to Step *5*
5	Inspect the 60–amp ABS maxi-fuse. Is the fuse open?	—	Go to Step *10*	Go to Step *11*
6	1. Inspect the 2-way EBCM harness connector for poor terminal contact or corrosion. Inspect CKT 1142 and CKT 150 for damage that may result in an open circuit. Repair damage if evident. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool* clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does the DTC set as a current DTC?	—	Go to Step *9*	Malfunction is intermittant. refer to Diagnostic Aids
7	Repair the 2-way EBCM harness connector if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Repair the open or the high resistance in CKT 150. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Repair the short to ground in CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the open or high resistance in CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0267 or C0268 Pump Motor Circuit Open/Shorted



324892

Circuit Description

The pump motor circuit is integral to the BPMV. The EBCM microprocessor energizes the relay within the EBCM in order to supply the battery voltage to the high side of the pump motor. The EBCM microprocessor grounds the low side of the pump motor when activation of the pump motor is required.

Conditions for Setting the DTC (C0267)

- The EBCM internal relay is on
- The pump motor is off
- Low voltage is present from the low side of the pump motor when high voltage is expected

Conditions for Setting the DTC (C0268)

- Vehicle speed is 13 km/h (8 mph)
- The EBCM internal relay is on
- The pump motor is commanded ON and then OFF
- High voltage exists from the low side of the pump motor for 100 ms when the voltage is expected to be low

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTCs C0267/C0268 are ignition latched DTCs, which indicates that the above actions remain true until the ignition switch is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

The pump motor is integral with the BPMV. Do not service the pump motor separately. A poor power/ground connection at the 2-way EBCM connector or the 2-way pump motor harness from the EBCM to the pump motor can cause a DTC C0267. A seized pump motor, shorted pump motor windings or a poor power/ground at the 2-way EBCM connector can cause a DTC C0268. Replace the EBCM or the BPMV if the following tests show that the pump motor EBCM internal circuits have failed.

Important: Reset the J 39200 test leads to zero prior to making any resistance measurements. Refer to the J 39200 in the user's manual.

Test Description

The numbers below refer to the steps in the diagnostic table:

3. This step checks for an open pump motor circuit. The pump motor circuit resistance should not be above the 0.3 ohms. Reset the *J 39200* test leads to zero prior to making this low resistance measurement.
5. This step determines the resistance of the EBCM ground circuit.
7. This step determines the ignition voltage available to the EBCM.

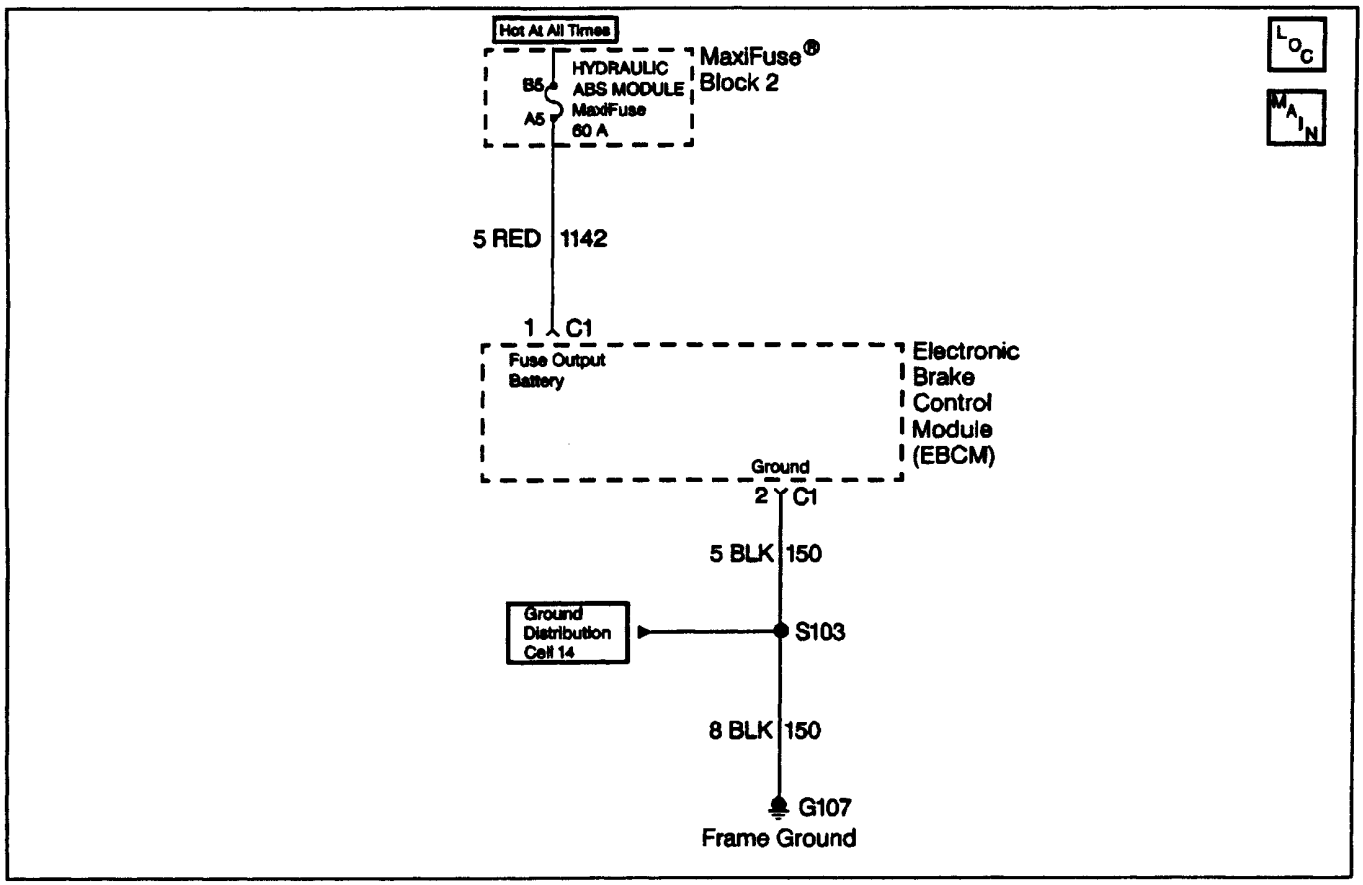
DTC C0267 or C0268 Pump Motor Circuit Open/Shorted

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 2-way pump motor pigtail connector from the EBCM. 3. Inspect the connector and the wiring for damage or corrosion that could result in an open circuit between the pump motor and the EBCM. Is the connector and the wiring in good condition?	—	Go to Step *3*	Go to Step *10*
3	Using a *J 39200*, measure the resistance between terminals 1 and 2 of the 2-way pump motor pigtail connector. Is the resistance within the specified range?	0.1–0.3 Ω	Go to Step *15*	Go to Step *4*
4	1. Turn the ignition to OFF. 2. Disconnect the 2-way EBCM harness connector from the EBCM. 3. Inspect the connector for damage or corrosion that could cause a loss of power to the EBCM. Is the connector in good condition?	—	Go to Step *5*	Go to Step *9*
5	Using a *J 39200*, measure the resistance between terminal 2 of the 2-way EBCM harness connector and the ground. Is the resistance within the specified range?	0–2 Ω	Go to Step *6*	Go to Step *11*
6	• Turn the ignition to RUN. • Using a *J 39200*, measure the voltage between terminal 1 of the 2-way EBCM harness connector and the ground. Is the voltage equal to or greater than the specified value?	10.0 V	Go to Step *8*	Go to Step *7*
7	Inspect the 60–amp ABS maxi-fuse. Is this fuse open?	—	Go to Step *13*	Go to Step *14*
8	• Inspect the 2-way EBCM harness connector for poor terminal contact or corrosion. Inspect CKT 1142 and CKT 150 for damage that could result in an open circuit. Repair any evident damage. Replace the terminals if poor contact or corrosion exists. • Reconnect all the connectors. • Using the *Scan Tool*, clear all the DTCs. • Test drive vehicle above 16 km/h (10 mph). Does the DTC set as a current DTC?	—	Go to Step *12*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the 2-way EBCM harness connector if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0267 or C0268 Pump Motor Circuit Open/Shorted (cont'd)

Step	Action	Value(s)	Yes	No
10	Repair the 2-way pump motor pigtail connector or wiring if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the open or the high resistance in the CKT 150. Is the repair complete?	—	Go to *Diagnostic System Check*	—
12	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
13	Repair short to ground in CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—
14	Repair the open or the high resistance in CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—
15	Replace the BPMV assembly. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0269 or C0274 Excessive Dump/Isolation Time



324892

Circuit Description (DTC C0269)

The EBCM microprocessor grounds the dump valve coil(s) to energize and open the dump valve, allowing fluid to be dumped into the LPA. This is done with very short activation pulses opening and closing the dump valve passageway. Brake pressure is lowered at the wheel and allows the affected wheel to begin rolling again. Each dump valve is opened independently to control the deceleration of the wheel.

Circuit Description (DTC C0274)

The EBCM microprocessor grounds the isolation coil to energize and close the isolation valve. This will prevent any additional brake pressure applied by the driver from reaching the wheel. Further increases in brake pressure will be prohibited. Each isolation valve is closed independently to isolate each wheel. The EBCM microprocessor also uses a software subroutine to monitor for any ABS event which would initiate an isolation command. This subroutine is performed every 1.0 second.

Conditions for Setting the DTC (DTC C0269)

Dump time (pressure reduction) exceeds 9 seconds, which can be caused from:

- Locked rotors
- Excessively low road surface friction.

Conditions for Setting the DTC (DTC C0274)

Isolation time (pressure hold) exceeding 120 consecutive 1.0 second checks.

Action Taken When the DTC Sets

- The ABS indicator lamp turns on
- The ABS disables

DTCs C0269–C0274 are Ignition Latched DTCs, which indicates that the above actions remain true until the ignition is turned to OFF (even if the cause of the DTC is intermittent).

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids (DTC C0269/C0274)

If any other DTCs are set, repair those DTCs first. If there are no DTCs set, ensure the ABS is operating properly by performing using the Scan Tool "Function Test."

Test Description

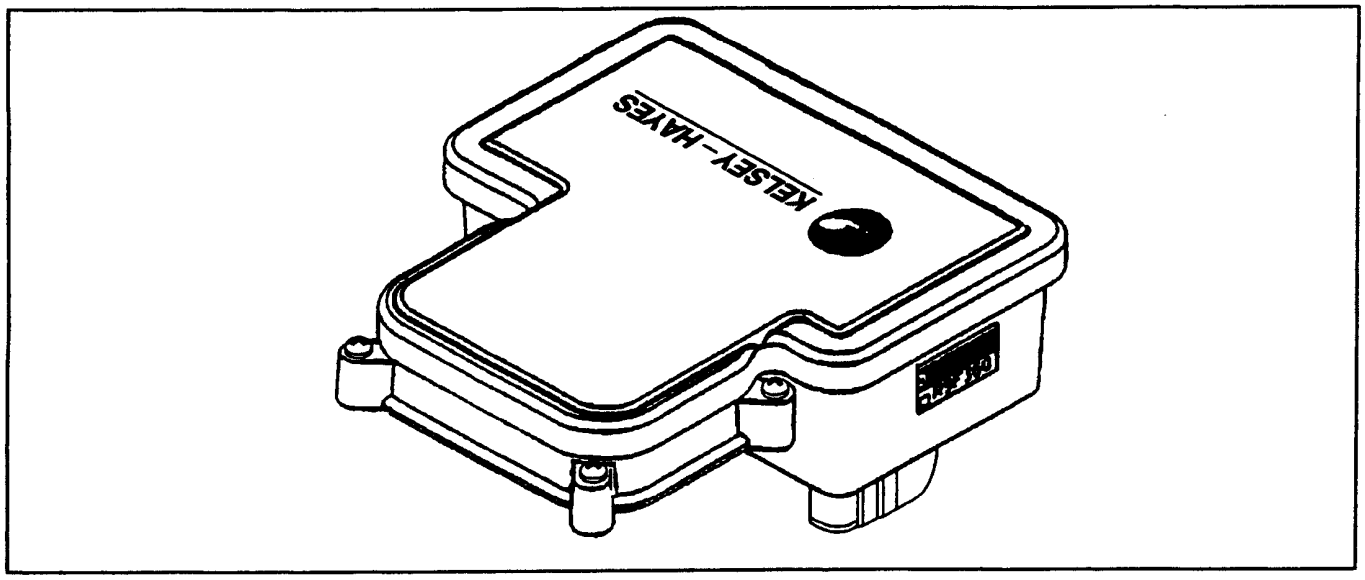
The numbers below refer to the steps in the diagnostic table:

3. This step determines the resistance of the ground circuit.
4. This step determines the ignition voltage available to the EBCM.

DTC C0269 or C0274 Excessive Dump/Isolation Time

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	1. Turn the ignition switch to OFF. 2. Disconnect the 2-way EBCM harness connector from the EBCM. 3. Inspect the connector for damage or corrosion that could cause a loss of power to the EBCM. Is the connector in good condition?	—	Go to Step *3*	Go to Step *7*
3	Using a *J 39200*, measure the resistance between terminal 2 of the 2-way EBCM harness connector and ground. Is the resistance measurement within the specified range?	0–2 Ω	Go to Step *4*	Go to Step *8*
4	1. Turn the ignition switch to RUN. 2. Using a *J 39200*, measure the voltage between terminal 1 of the 2-way EBCM harness connector and the ground. Is the voltage equal to or greater than the specified value?	10.0 V	Go to Step *6*	Go to Step *5*
5	Inspect the 60–amp ABS maxi-fuse. Is the fuse open?	—	Go to Step *10*	Go to Step *11*
6	1. Inspect the 2-way EBCM harness connector for poor terminal contact or corrosion. Inspect CKT 1142 and CKT 150 for damage that could result in an open circuit. Repair damage if evident. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Using the *Scan Tool* clear all DTCs. 4. Test drive vehicle above the 16 km/h (10 mph) Does the DTC set as a current DTC?	—	Go to Step *9*	Malfunction is intermittent. Refer to Diagnostic Aids
7	Repair the 2-way EBCM harness connector if necessary. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Repair the open or the high resistance in the CKT 150. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Repair the short to ground in the CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—
11	Repair the open or the high resistance in the CKT 1142. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0271-C0273 EBCM Malfunction



175132

Circuit Description

The EBCM initializes a self-test when the ignition is turned to the RUN position. This internal self-test verifies that all ABS circuitry is operating correctly.

Conditions for Setting the DTC

Any condition within the EBCM which causes a memory error will set this DTC.

Action Taken When the DTC Sets

- The ABS indicator lamp is turned on
- The ABS is disabled

These DTCs are Permanent Latched DTCs, which indicates that the above actions remain true until the DTC is cleared using a *Scan Tool.*

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

DTCs C0271–C0273 are EBCM internal diagnosis trouble codes. Replace the EBCM if these tests show that the EBCM circuitry has failed.

Test Description

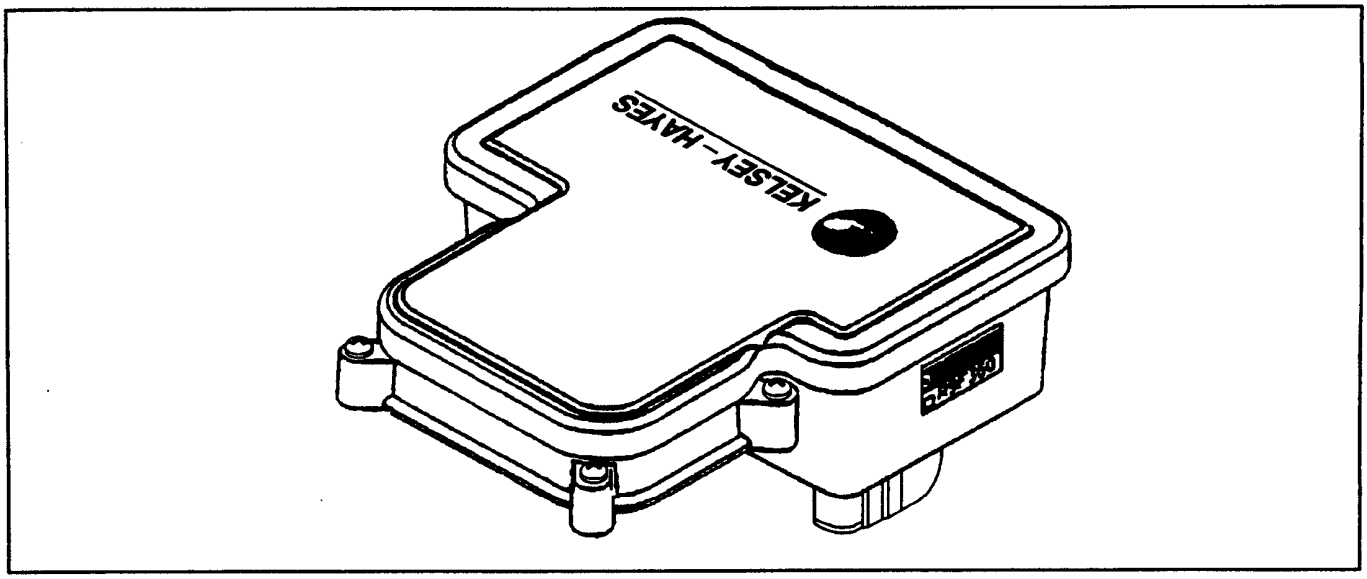
The numbers below refer to the steps in the diagnostic table:

2. This step checks if the EBCM will "Clear DTCs".
3. This step checks if the DTC has been set previously.

DTC C0271-C0273 EBCM Malfunction

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	Install the *Scan Tool* and attempt to clear the DTCs. Did the DTCs clear?	—	Go to Step *3*	Go to Step *4*
3	Check the history DTCs and the data. Was this the first time the DTC has set?	—	Go to *Diagnostic System Check*	Go to Step *4*
4	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0279 Trim Level Not Selected



175132

Circuit Description

The ABS is capable of operating with different brake types and different wheel bases from several different vehicle configurations. All vehicles are preprogrammed from the factory with the proper trim level calibration. The trim level calibration corresponds to the different wheel bases and brake types available on each vehicle. Whenever the EBCM is replaced and/or the wheel base is increased or decreased, it is necessary to set the trim level calibration in the EBCM. It will be necessary to obtain the wheel base and type of brakes (using RPO codes) to select the correct trim level on the Scan Tool. Once programmed, this calibration will remain even if the battery is disconnected or the EBCM is removed from the vehicle. Refer to "Trim Level Calibration", in *ABS System Description.*

Conditions for Setting the DTC

EBCM installed on vehicle without trim level calibration.

Action Taken When the DTC Sets

- The ABS indicator lamp is turned on
- The ABS is disabled

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

If any other DTCs are set, Repair those DTCs first. If no other DTCs are set, ensure that the correct trim level is set using the Scan Tool. Refer to "Trim Level Calibration", in *ABS System Description.*

Test Description

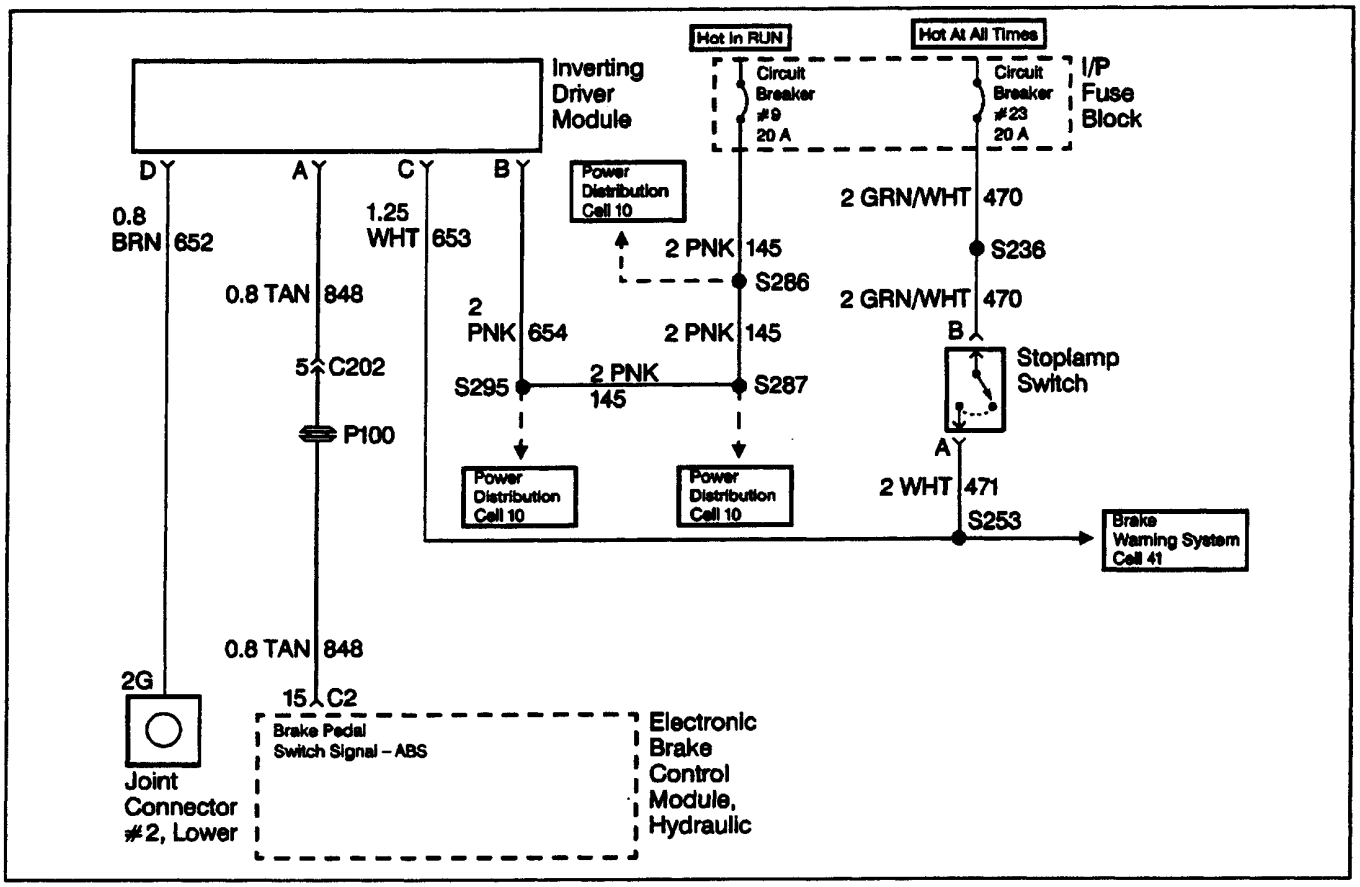
The numbers below refer to the steps in the diagnostic table:

2. This step checks for an EBCM trim level calibration.
3. This step checks for the correct EBCM trim level calibration.

DTC C0279 Trim Level Not Selected

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	Go to Step *2*	Go to *Diagnostic System Check*
2	Using the *Scan Tool*, read the current trim calibration level within the EBCM. Refer to Trim Level Calibration in *ABS System Description*. Is the trim level calibration correct for the vehicle?	—	Go to Step *3*	Go to Step *5*
3	1. Using the *Scan Tool*, clear all DTCs. 2. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0279 set as a current DTC?	—	Go to Step *4*	Malfunction is intermittent. Refer to Diagnostic Aids on the facing page.
4	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—
5	Using the *Scan Tool*, calibrate the EBCM with the correct trim level. Refer to Trim level Calibration in *ABS System Description*. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0281 Brake Switch Circuit



324893

Circuit Description

The Stop Lamp Switch is normally closed. With the ignition in the RUN position and the brake pedal not depressed, the EBCM will have ignition voltage present at terminal 15 of the 24–way connector. When the brakes are applied, the voltage present at terminal 15 of the EBCM will be zero.

Conditions for Setting the DTC

- Vehicle above 56 km/h (35 mph) for 10 seconds, followed by vehicle at rest for 1 second.
- Stop lamp never switching during the above condition

Action Taken When the DTC Sets

- The ABS indicator lamp will not be illuminated
- The ABS will not be disabled

DTC C0281 is advisory code only. The DTC is stored in memory, but the ABS indicator lamp will not light, and ABS will not be disabled.

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

DTC C0281 can be set by a faulty Stop Lamp Switch, misadjusted Stop Lamp Switch or damage in CKT 848 or CKT 451. Also, a driver who rides the brake at power-up through 24 km/h (15 mph can set this DTC.

Thoroughly check any circuitry that is suspected of causing the intermittent complaint for the following conditions:

- Backed out terminals
- Improper mating
- Broken locks
- Improperly formed or damaged terminals
- Poor terminal to wiring connections
- Physical damage to the wiring harness

Test Description

The numbers below refer to the steps in the diagnostic table:

2. This step checks the functionality of the Stop Lamp Switch circuit using the *Scan Tool.*
3. This step checks the functionality of the Stop Lamp Switch circuit (including the Inverter Driving Module) using a *J 39200.*
4. This step checks the functionality of the Stop Lamp Switch circuit up to the Inverting Driving Module.
8. This step checks for a short to ground in the Stop Lamp Switch circuit between the Inverting Driver Module and the EBCM.
9. This step checks the resistance in the ground circuit to the Inverting Driver Module.
10. This step checks the ignition voltage at the Inverting Driver Module.

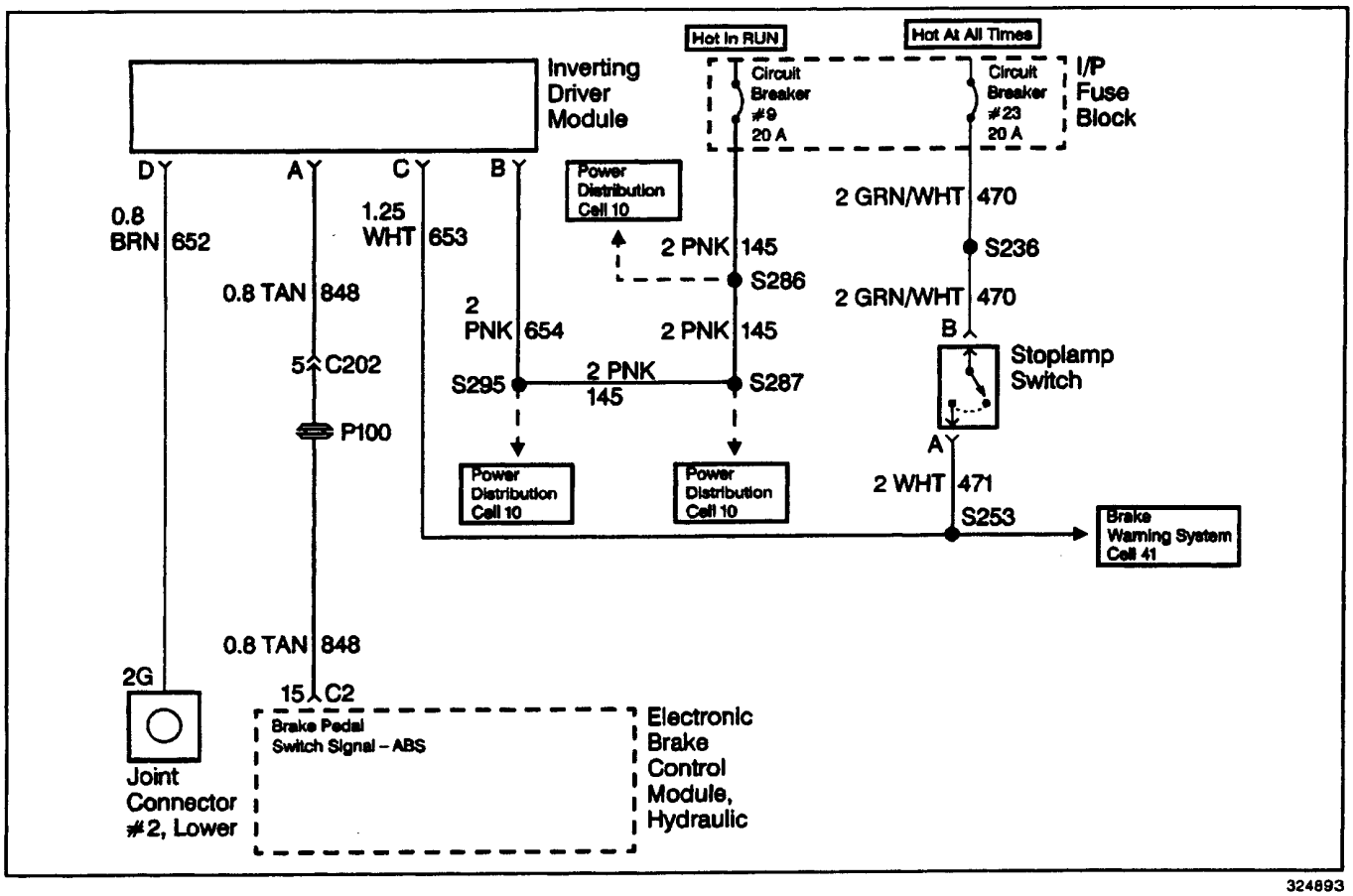
DTC C0281 Brake Switch Circuit

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	*Go to Step 2*	Go to *Diagnostic System Check*
2	1. Install the *Scan Tool.* 2. Turn the ignition to RUN. 3. Using the Data List function of the scan tool, check the operation of the Stop Lamp Switch while applying and releasing the brake pedal. Does the scan tool indicate that the Stop Lamp Switch is opening and closing?	—	*Go to Step 11*	*Go to Step 3*
3	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector. 3. Using a *J 39200,* measure the voltage between terminal 15 of the 24-way connector and ground while applying and releasing the brake pedal. Is the voltage measured switching between the specified range?	0–12 V	*Go to Step 11*	*Go to Step 4*
4	1. Turn the ignition to OFF. Disconnect the Inverting Driver Module harness connector. 2. Using a *J 39200,* measure the voltage between terminal C of the Inverting Driver Module harness connector connector and ground while depressing the brake pedal. Is the voltage equal to or greater than the specified range?	10 V	*Go to Step 7*	*Go to Step 5*
5	1. Disconnect the brake switch harness connector from the brake switch. 2. Using a *J 39200,* measure the voltage between terminal B of the brake switch harness connector and ground. Is the voltage equal to or greater than the specified range?	10 V	*Go to Step 6*	*Go to Step 12*
6	Using a *J 39200,* measure the resistance between terminal A of the brake switch harness connector and terminal C of the Inverting Driver Module harness connector. Is the Stop Lamp Switch adjustment correct?	0–2 Ω	Malfunction is intermittent. Refer to Diagnostic Aids	*Go to Step 13*
7	Using a *J 39200,* measure the resistance between terminal A of the Inverting Driver Module harness connector and terminal 15 of the 24-way EBCM harness connector. Is the resistance measured within the specified range?	0–2 Ω	*Go to Step 8*	*Go to Step 15*

DTC C0281 Brake Switch Circuit (cont'd)

Step	Action	Value(s)	Yes	No
8	Using a *J 39200*, measure the resistance between terminal A of the Inverting Driver Module harness connector and ground. Is the resistance measured within the specified range?	OL	*Go to Step 13*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Using a *J 39200*, measure the resistance between terminal D of the Inverting Driver Module harness connector and ground. Is the resistance measured within the specified range?	OL	*Go to Step 10*	*Go to Step 16*
10	Using a *J 39200*, measure the voltage between terminal B of the Inverting Driver Module harness connector and ground. Is the voltage equal to or greater than the specified range?	10 V	Malfunction is intermittent. Refer to Diagnostic Aids	*Go to Step 17*
11	1. Inspect the 24-way EBCM harness connector for poor terminal contact or corrosion. Inspect CKT 848 for damage which may result in an open or shorted circuit. Repair damage if evident. Replace terminals if poor contact or corrosion exists. 2. Reconnect all connectors. 3. Using the *Scan Tool*, clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0281 set as a current code?	—	*Go to Step 19*	Malfunction is intermittent. Refer to Diagnostic Aids
12	Repair open in CKT 470. Is the repair complete?	—	Go to *Diagnostic System Check*	—
13	Repair open in CKT 653. Is the repair complete?	—	Go to *Diagnostic System Check*	—
14	Repair misadjusted or faulty brake switch. Is the repair complete?	—	Go to *Diagnostic System Check*	—
15	Repair open in CKT 848. Is the repair complete?	—	Go to *Diagnostic System Check*	—
16	Repair open in CKT 652. Is the repair complete?	—	Go to *Diagnostic System Check*	—
17	Repair open in CKT 654 or CKT 145. Is the repair complete?	—	Go to *Diagnostic System Check*	—
18	Repair short to ground in CKT 848. Is the repair complete?	—	Go to *Diagnostic System Check*	—
19	Replace the EBCM. Is the repair complete?	—	Go to *Diagnostic System Check*	—

DTC C0286 ABS Indicator Lamp Circuit Shorted to B+



324893

Circuit Description

The amber ABS indicator lamp operates in two modes; normal and backup. In the normal mode, ignition voltage is supplied to the ABS indicator light bulb in the instrument cluster through the IGN SW fuse. The indicator is normally on unless the EBCM switches the indicator off, by energizing the ABS indicator lamp relay and opening the circuit. If the EBCM senses that a fault has occurred, it will set a DTC and light the ABS indicator lamp by grounding the ABS indicator lamp circuit. In the backup mode, the ABS indicator lamp relay circuit (normally closed) will ensure that the ABS indicator lamp is illuminated if the 24-way connector is disconnected or poorly seated, or if the EBCM has failed during normal operation. If either of these fault conditions occur, the ABS indicator lamp will be illuminated.

Conditions for Setting the DTC

- High voltage is present on the ABS indicator lamp control circuit when low voltage is expected (lamp is turned on)
- Anything that keeps the ABS indicator lamp circuit high when the lamp is expected to be on

Action Taken When the DTC Sets

The ABS is not disabled.

Conditions for Clearing the DTC

- Repair the conditions responsible for setting the DTC
- Use the *Scan Tool* Clear DTCs function

Diagnostic Aids

DTC C0286 typically sets because of a shorted ABS indicator lamp. Yet DTC C0286 can also set because of a short to voltage in the wiring between the ABS indicator lamp and the EBCM.

Test Description

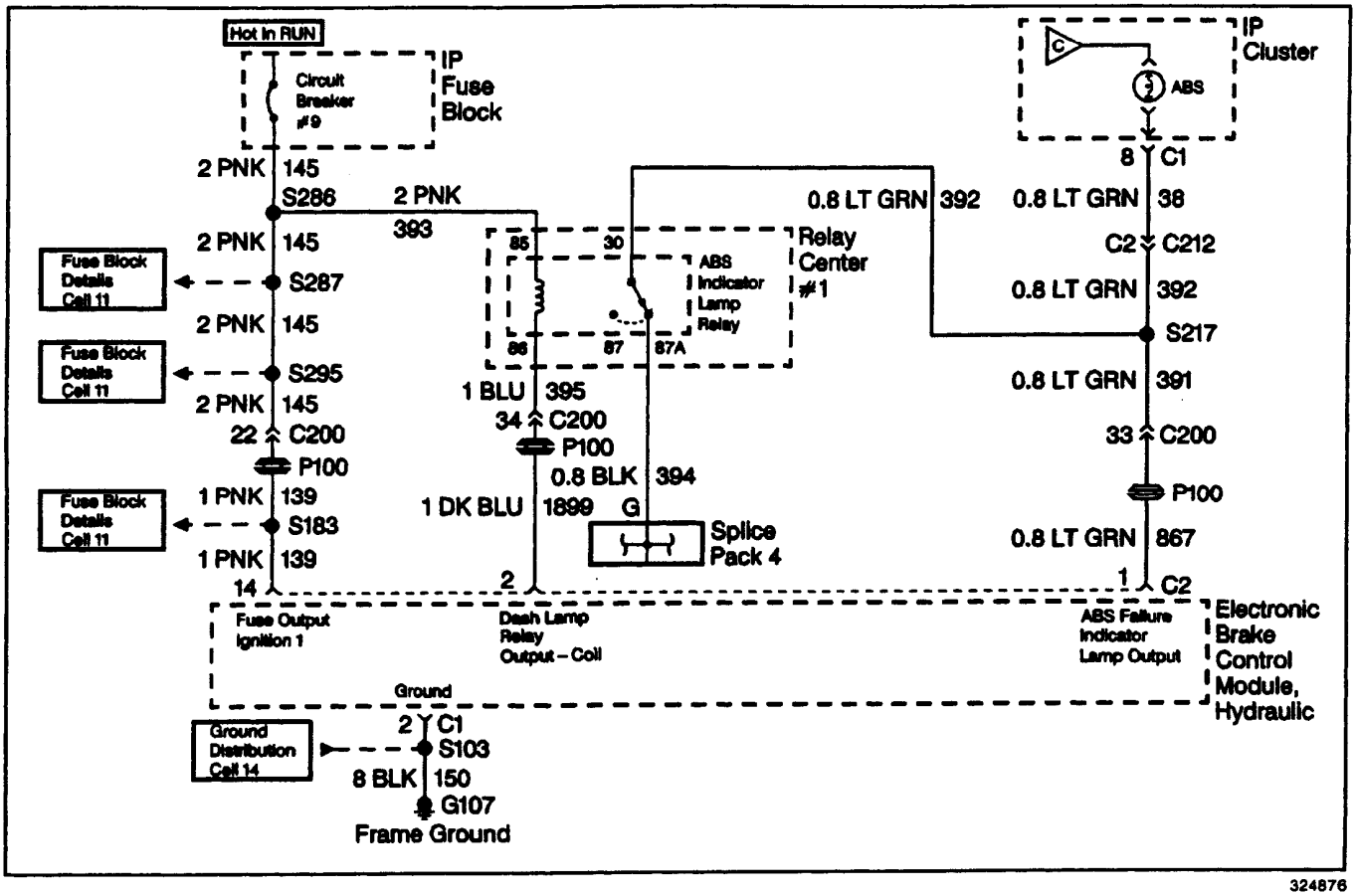
The numbers below refer to the steps in the diagnostic table:

2. This step checks for normal operation of the ABS indicator lamp.
3. This step turns off the ABS indicator lamp with a *J 36169-A*.

DTC C0286 ABS Indicator Lamp Circuit Shorted to B+

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	*Go to Step 2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to RUN. 2. Observe the amber ABS indicator lamp operation. 3. Did the ABS indicator lamp turn on and then turn off after 3 seconds?	—	Malfunction is intermittent. Refer to Diagnostic Aids.	*Go to Step 3*
3	1. Turn the ignition to OFF. 2. Disconnect the 24–way EBCM harness connector from the EBCM. 3. Using a *J 36169-A* with a 10 amp fuse, connect terminal 2 of the 24–way EBCM harness connector to ground. 4. Turn ignition to RUN. Does the ABS indicator lamp turn off?	—	*Go to Step 5*	*Go to Step 4*
4	Inspect the jumper wire fuse. Is the fuse open?	10 V	*Go to Step 7*	*Go to Step 5*
5	1. Inspect the 24-way EBCM harness connector for poor terminal contact or corrosion. Inspect CKT 1899 or CKT 395 for damage which may result in a shorted circuit. Repair damage if evident. Replace the terminal if poor contact or corrosion exists. 2. Reconnect all connectors. 3. Using the *Scan Tool*, clear all DTCs. 4. Test drive the vehicle above 16 km/h (10 mph). Does DTC C0286 set as a current DTC?	—	*Go to Step 6*	Malfunction is intermittent. Refer to Diagnostic Aids
6	Replace the EBCM. Is repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair a short to voltage in CKT 1899 or CKT 395. Is the repair complete?	—	Go to *Diagnostic System Check*	—

ABS Indicator Off No DTC Set



324876

Circuit Description

The amber ABS indicator lamp operates in two modes; normal and backup. In the normal mode, ignition voltage is supplied to the ABS indicator light bulb in the instrument cluster through the IGN SW fuse. The indicator is normally on unless the EBCM switches the indicator off, by energizing the ABS indicator lamp relay and opening the circuit. If the EBCM senses that a fault has occurred, it will set a DTC and light the ABS indicator lamp by grounding the ABS indicator lamp circuit. In the backup mode, the ABS indicator lamp relay circuit (normally closed) will ensure that the ABS indicator lamp is illuminated if the 24-way connector is disconnected or poorly seated, or if the EBCM has failed during normal operation. If either of these fault conditions occur, the ABS indicator lamp will be illuminated. if the following conditions exist:

- Open or high resistance in CKT 867
- The EBCM is faulty

Diagnostic Aids

If the ABS indicator lamp is off always with no DTCs set (never turns on at bulb check, with the vehicle started or with the ignition switch in the RUN position), an open or high resistance in the lamp circuit is present between the instrument panel and the EBCM. Also check for an open instrument panel fuse or an open bulb.

Test Description

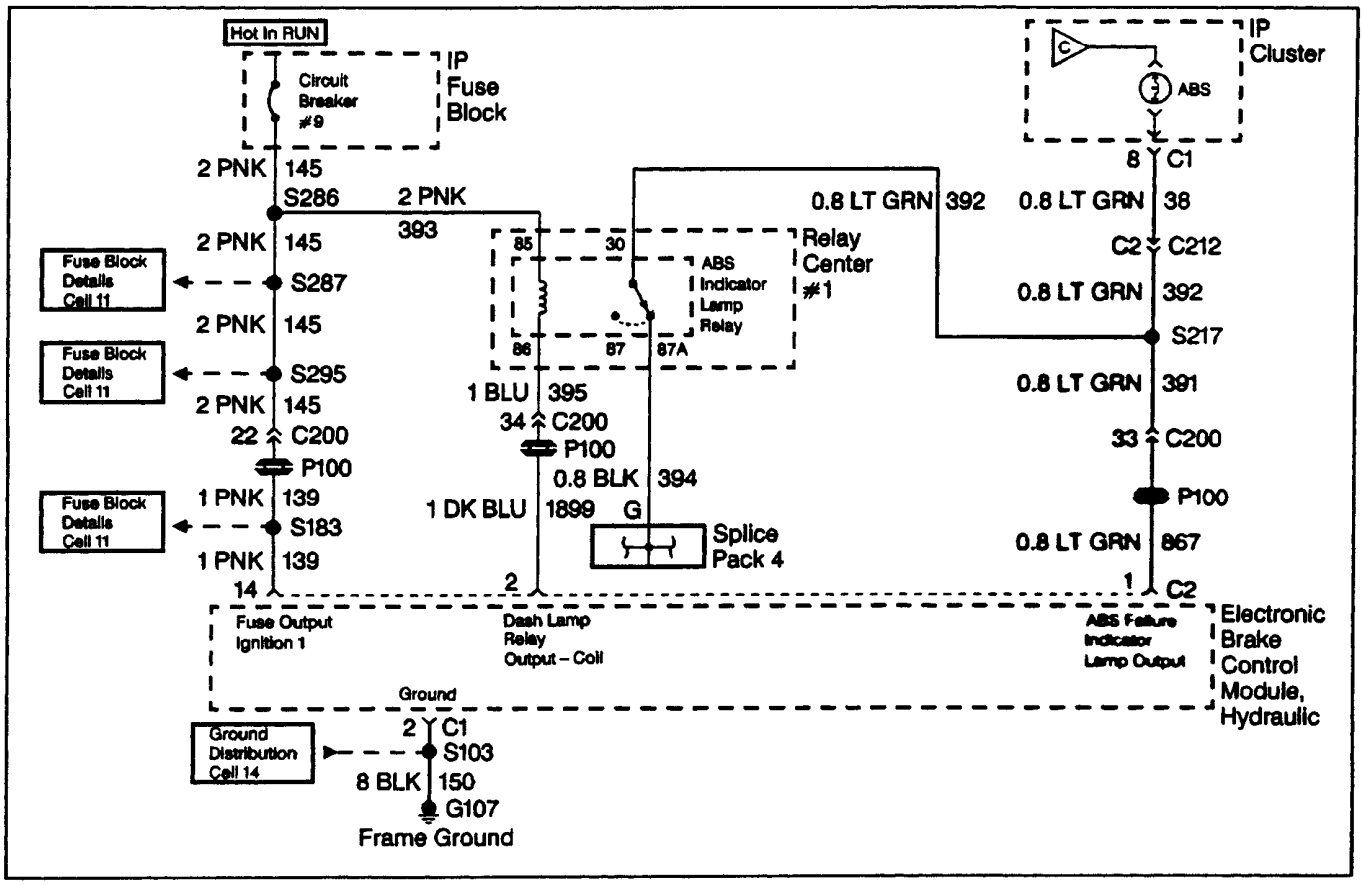
The numbers below refer to the steps in the diagnostic table:

2. This step checks for normal operation of the ABS indicator lamp.
3. This step manually (with fused jumper) turns on the ABS indicator lamp by bypassing the ABS indicator relay.
5. This step checks for a short to ground in CKT 1899.

ABS Indicator Off No DTC Set

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	*Go to Step 2*	Go to *Diagnostic System Check*
2	1. Disconnect the ABS indicator lamp relay. 2. Using a *J 36169-A*, connect terminal 30 of the ABS indicator lamp relay to ground. 3. Turn the ignition to RUN. Does the ABS indicator lamp turn on?	—	*Go to Step 3*	*Go to Step 4*
3	Using a *J 39200*, measure the resistance between the relay center harness connector terminal 87A and ground. Is the resistance within the specified range?	0–2 Ω	*Go to Step 9*	*Go to Step 7*
4	Inspect the jumper fuse wire. Is the fuse open?	—	*Go to Step 6*	*Go to Step 5*
5	1. Disconnect the 15-way instrument panel connector. 2. Using a *J 39200*, measure the resistance between the ABS indicator lamp relay harness connector terminal 30 and the 15-way instrument panel harness connector terminal 8. Is the resistance within the specified range?	0–2 Ω	Refer to Instrument Panel for ABS indicator light repair.	*Go to Step 8*
6	Repair a short to voltage in CKT 392, CKT 38, CKT 391 or CKT 867. Is the repair complete?	—	Go to *Diagnostic System Check*	—
7	Repair an open in CKT 394. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Repair an open in CKT 392 or CKT 38. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Repair the open or the high resistance in CKT 867. Is the repair complete?	—	Go to *Diagnostic System Check*	—

ABS Indicator On No DTC Set



324876

Circuit Description

The amber ABS indicator lamp operates in two modes; normal and backup. In the normal mode, ignition voltage is supplied to the ABS indicator light bulb in the instrument cluster through the IGN SW fuse. The indicator is normally on unless the EBCM switches the indicator off, by energizing the ABS indicator lamp relay and opening the circuit. If the EBCM senses that a fault has occurred, it will set a DTC and light the ABS indicator lamp by grounding the ABS indicator lamp circuit. In the backup mode, the ABS indicator lamp relay circuit (normally closed) will ensure that the ABS indicator lamp is illuminated if the 24-way connector is disconnected or poorly seated, or if the EBCM has failed during normal operation. If either of these fault conditions occur, the ABS indicator lamp will be illuminated. if the following conditions exist:

- Short to ground in CKT 867
- Open or high resistance in CKT 1899
- Open or high resistance in CKT 39
- The ABS indicator lamp relay is faulty
- The EBCM is faulty

Diagnostic Aids

If the ABS indicator lamp is on always with no DTCs set (never turns off with the vehicle started or with the ignition switch in the RUN position), there is a short to ground in CKT 867 between the instrument cluster and the EBCM, or there is a fault in the ABS indicator lamp relay circuit.

Test Description

The numbers below refer to the steps in the diagnostic table:

2. This step checks for normal operation of the ABS indicator lamp.
3. This step manually (with fused jumper) turns off the ABS indicator lamp.

ABS Indicator On No DTC Set

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	*Go to Step 2*	Go to *Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect the 24-way EBCM harness connector. 3. Using a *J 36169-A*, connect terminal 2 of the 24-way EBCM harness connector to ground. 4. Turn the ignition to RUN. Does the ABS indicator lamp turn off?	—	*Go to Step 5*	*Go to Step 3*
3	1. Turn the ignition to OFF. 2. Remove the ABS indicator relay. 3. Turn the ignition to RUN. Does the ABS indicator lamp turn off?	—	*Go to Step 4*	*Go to Step 6*
4	Using a *J 39200*, measure the voltage between the ABS indicator relay harness connector terminal 85 and ground. Is the voltage measured equal to or greater than the specified value?	10 V	*Go to Step 4*	*Go to Step 7*
5	Using a *J 39200*, measure the resistance between the relay center harness connector terminal 86 and the EBCM harness connector terminal 2. Is the resistance within the specified range?	0–2 Ω	*Go to Step 9*	*Go to Step 8*
6	1. Inspect the 24-way EBCM harness connector terminal 2 for poor terminal contact or corrosion. Inspect CKT 1899 or CKT 395 for damage that could result in an open circuit. Repair damage if evident. Replace the terminals if poor contact or corrosion exists. 2. Reconnect all the connectors. 3. Turn the ignition to RUN. Is the ABS indicator lamp on constantly?	—	*Go to Step 7*	Malfunction is intermittent. Refer to Diagnostic Aids
7	Repair the short to ground in CKT 392 or CKT 38. Is the repair complete?	—	Go to *Diagnostic System Check*	—
8	Repair the open or the high resistance in CKT 393, CKT 145 or a damaged circuit breaker #9. Is the repair complete?	—	Go to *Diagnostic System Check*	—
9	Repair an open in CKT 395 or CKT 1899. Is the repair complete?	—	Go to *Diagnostic System Check*	—
10	Replace the ABS indicator relay. Is the repair complete?	—	Go to *Diagnostic System Check*	—

Repair Instructions

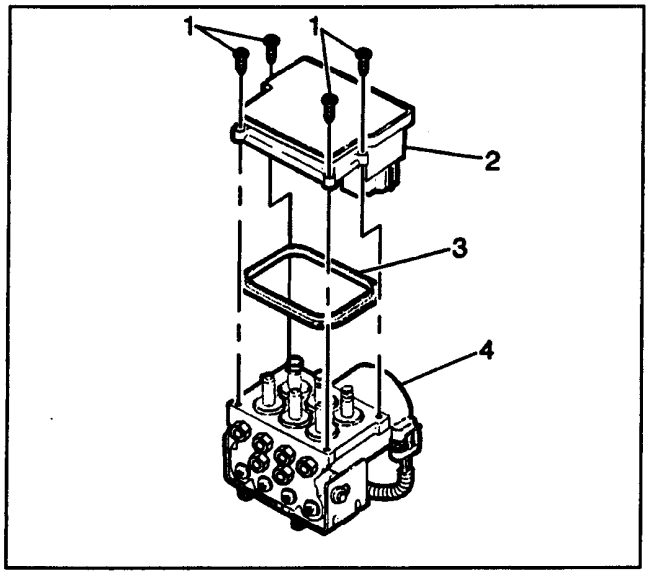
ABS Bleed Procedure

Important:

- Use the two-person bleed procedure under the following conditions:
  - Installing a new Electro-Hydraulic Control Unit (EHCU) or Brake Pressure Modulator Valve (BPMV)
  - Air is trapped in the valve body
- Do not drive the vehicle until the brake pedal feels firm.
- Do not reuse brake fluid that is used during bleeding.
- Use the vacuum, the pressure and the gravity bleeding procedures only for base brake bleeding.

Two Person Procedure

1. Raise the vehicle in order to access the system bleed screws.
2. Bleed the system at the right rear wheel first.
3. Install a clear hose on the bleed screw.
4. Immerse the opposite end of the hose into a container partially filled with clean DOT 3 brake fluid.
5. Open the bleed screw 1/2 to one full turn.
6. Slowly depress the brake pedal. While the pedal is depressed to its full extent, tighten the bleed screw.
7. Release the brake pedal and wait 10–15 seconds for the master cylinder pistons to return to the home position.
8. Repeat the previous steps for the remaining wheels. The brake fluid which is present at each bleed screw should be clean and free of air.
9. This procedure may use more than a pint of fluid per wheel. Check the master cylinder fluid level every four to six strokes of the brake pedal in order to avoid running the system dry.
10. Press the brake pedal firmly and run the *Scan Tool* Function Test four times. Release the brake pedal between each test.
11. Bleed all four wheels again using Steps 3–9. This will remove the remaining air from the brake system.
12. Evaluate the feel of the brake pedal before attempting to drive the vehicle.
13. Bleed the system as many times as necessary in order to obtain the appropriate feel of the pedal.



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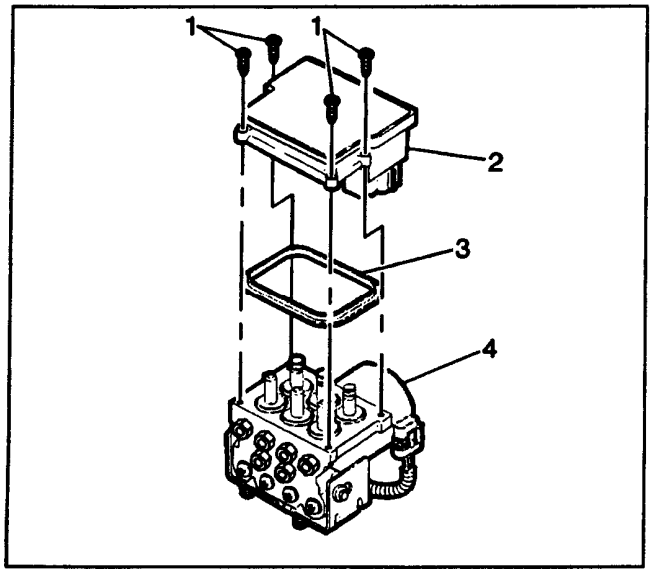


156566

Electronic Brake Control Module Replacement

Removal Procedure

Important: After installation, calibrate the new EBCM to the tire size that is appropriate to the vehicle. Refer to Tire Size Calibration and to Trim Level Calibration in *ABS System Description.*

1. Remove the negative battery cable. Refer to *Battery Disconnect Caution* in Cautions and Notices.
2. Remove the three EBCM wiring harness connectors.
3. Remove the four T-25 Torx® bolts (1) that fasten the EBCM to the BPMV.
4. Remove the EBCM (2) from the BPMV (4) Removal may require a light amount of force.

   Important: Do not use a tool to pry the EBCM from the BPMV. Excessive force will damage the EBCM.
5. Clean the BPMV with a clean, dry cloth.

Installation Procedure

Important: If the EBCM mounting bolts are corroded or damaged, do not reuse the old mounting bolts. Install new EBCM mounting bolts with the new EBCM.

Important: Do not use RTV or any other type of sealant on the EBCM to BPMV mating surface.

1. Install EBCM (2) to BPMV (4).
2. Install the four EBCM bolts (1).

   Tighten

   Tighten the four bolts to 5 N·m (39 lb in) in an X-pattern.

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
3. Connect the four electrical connectors to the EBCM.
4. Connect the negative battery cable. Refer to *Battery Disconnect Caution* in Cautions and Notices.
5. Revise the tire calibration using the *Scan Tool.*
6. Return to Diagnostic System Check. Refer to *Diagnostic System Check.*

Brake Pressure Modulator Valve Replacement

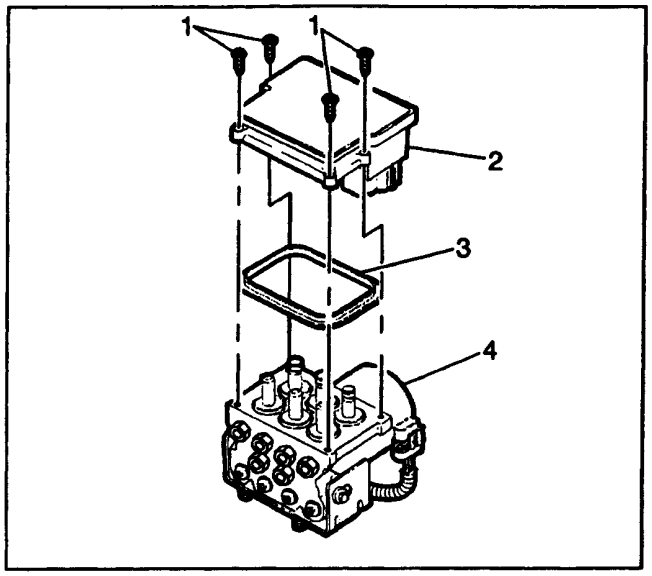
Removal Procedure

1. Disconnect the negative battery cable. Refer to *Battery Disconnect Caution* in Cautions and Notices.
2. Remove the three EBCM electrical connectors.
3. Remove the combination valve electrical connector.
4. Remove the six brake lines from the BPMV.
5. Remove the BPMV pump motor electrical connector from the EBCM.

6. Remove the four T-25 Torx® bolts (1) that fasten the EBCM to the BPMV.
7. Remove the EBCM (2) from the BPMV (4) Removal may require a light amount of force.

   Important: Do not use a tool to pry the EBCM from the BPMV. Excessive force will damage the EBCM.
8. Remove the three allen bolts (11) which fasten the combination valve to the BPMV.
9. Remove the combination valve from the BPMV.
10. Remove the two transfer tubes (13).

    Important: Do not reuse the transfer tubes. Always install new transfer tubes when replacing the BPMV.
11. Remove the three tube adapters (6).
12. Remove the three BPMV mounting bracket bolts (9).
13. Remove the BPMV (4) from the EHCU mounting bracket (7).
14. Clean the BPMV (4) with a clean, dry cloth.



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Installation Procedure

Important: Do not reuse the EBCM mounting bolts. Always install new EBCM mounting bolts with the new EBCM.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the BPMV (4) onto the EHCU (7) mounting bracket.

   Tighten

   Tighten the three BPMV mounting mounting bolts (9) to 9 N·m (7l lb ft).
2. Install the three tube adapters (6).

   Tighten

   Tighten the tube adapters to 31 N·m (23 lb ft).

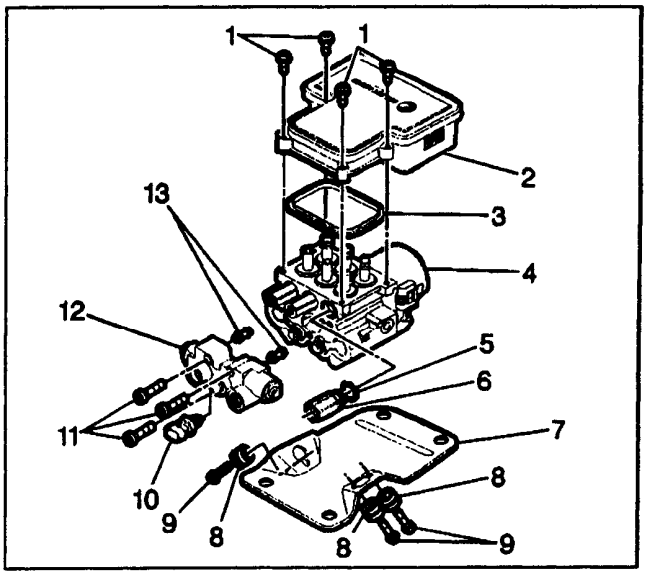
   Important: Do not reuse the transfer tubes (13). Always install new transfer tubes when removing the combination valve (12).
3. Install two new transfer tubes (13) into the combination valve (12).
4. Install the combination valve (12) onto the BPMV (4).
5. Install the three combination valve fastening bolts (11).

   Tighten

   Tighten the three allen bolts first to 8 N·m (6 lb ft) and then to 12 N·m (12 lb ft).
6. Install EBCM (2) to BPMV (4).
7. Install the four new EBCM bolts (1).

   Tighten

   Tighten the four bolts to 5 N·m (39 lb in) in an X-pattern.
8. Install the BPMV pump motor electrical connector to the EBCM.
9. Install the EHCU to vehicle.



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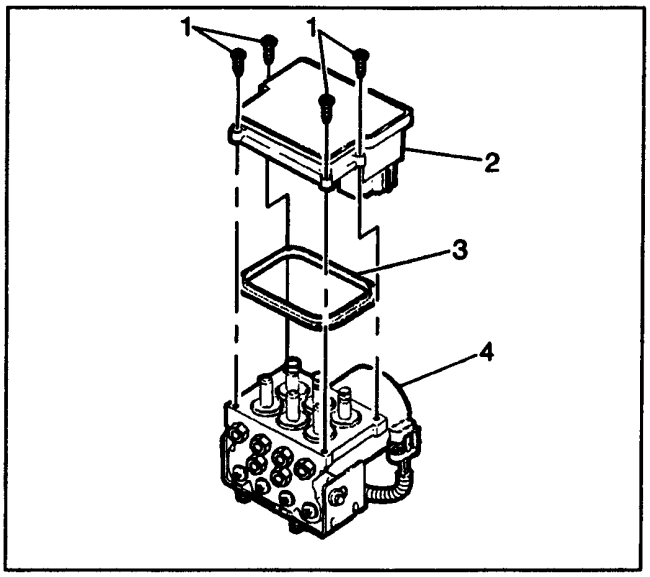
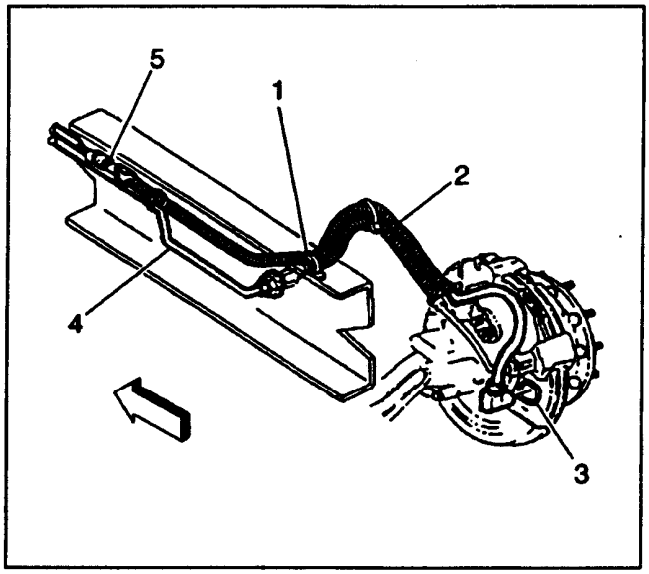


156566

10. Connect the three electrical connectors to the EBCM.
11. Connect the five brake lines to the combination valve.
    Tighten
    Tighten the five brake lines to 30 N.m (22 lb ft).
12. Connect the negative battery cable.
13. Bleed the brake system. Refer to *ABS Bleed Procedure.*
14. Return to *Diagnostic System Check.*

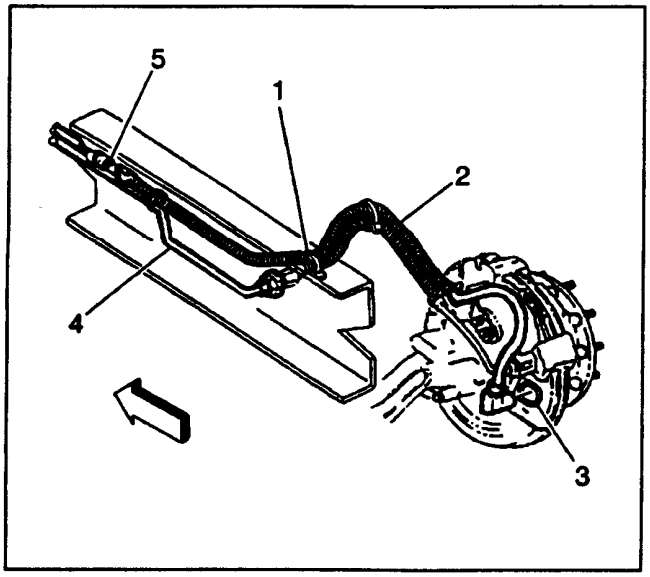


156568

Wheel Speed Sensor Replacement - Front

Removal Procedure

1. Disconnect the electrical connector (5).
2. Remove the nylon straps (1) retaining the sensor wire to the brake line. Note the location of the straps.
3. Remove the wheel speed sensor from the bore.
4. Remove the speed sensor retaining clip (3). The clip may come out with the wheel speed sensor or stay in the bore. If the sensor retaining clip (3) is still functioning correctly, save it for reinstallation. If the sensor retaining clip (3) is not functioning correctly, replace the sensor retaining clip (3).



156568

Installation Procedure

Important: You may have to use the wire retainers from the old wheel speed sensor wire on the new sensor. Do not damage the new wire when installing the retainers.

Important: When the wheel speed sensor is fully installed in the block bore, it contacts the tone ring which is attached to the wheel hub. Normal bearing play between the sensor tip and tone ring in the wheel hub will move the sensor tip away from the tone ring. This automatically establishes the proper air gap.

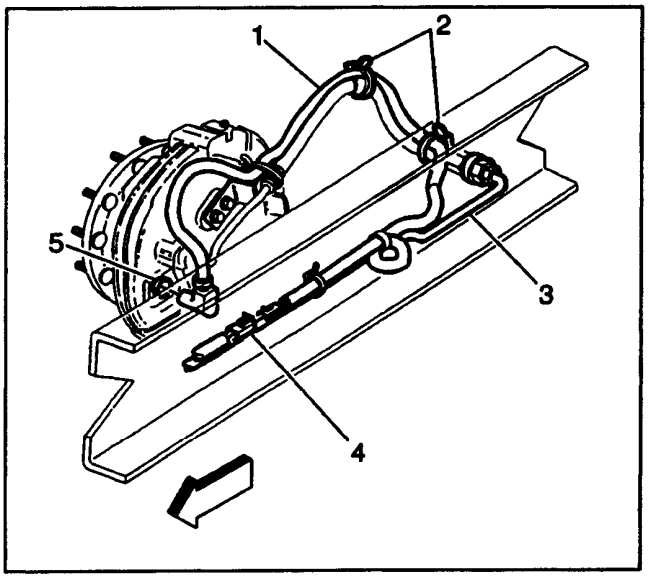
1. Install the wheel speed sensor retaining clip (3). completely into the bore. The clip should stop at the retaining tabs. Insert the wheel speed sensor into the clip. The wheel speed sensor should contact the tone ring.

2. Secure the sensor wire to the brake line with a wire tie(1) in the location noted during removal.
3. Connect the electrical connector (5).

Wheel Speed Sensor Replacement - Rear

Removal Procedure

1. Disconnect the electrical connector.
2. Remove the nylon straps retaining the sensor wire to the brake line. Note the location of the straps.
3. Remove the wheel speed sensor (1) from the bore.
4. Remove the speed sensor retaining clip (2). The clip may come out with the wheel speed sensor or stay in the bore. If the sensor retaining clip is still functioning correctly, save it for reinstallation. If the sensor retaining clip is not functioning correctly, replace the sensor retaining clip.



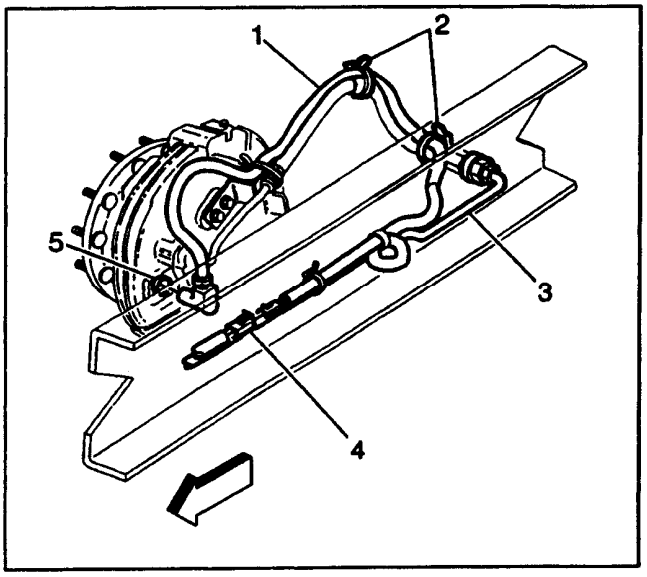
156570

Installation Procedure

Important: You may have to use the wire retainers from the old wheel speed sensor wire on the new sensor. Do not damage the new wire when installing the retainers.

Important: When the wheel speed sensor is fully installed in the block bore, it contacts the tone ring which is attached to the wheel hub. Normal bearing play between the sensor tip and tone ring in the wheel hub will move the sensor tip away from the tone ring. This automatically establishes the proper air gap.

1. Install the wheel speed sensor retaining clip (2) completely into the bore. The clip should stop at the retaining tabs. Insert the wheel speed sensor (1) into the clip. The wheel speed sensor should contact the tone ring.
2. Secure the sensor wire to the brake line with a wire tie in the location noted during removal.
3. Connect the electrical connector.



156570

Tube Adapter Replacement

Removal Procedure

Important: If you must remove more than one tube adapter at one time, stamp the BPMV with a number (1, 2 or 3) in order to indicate the number of grooves cut into the tube adapters. This procedure will aid proper reassembly.

1. Remove the appropriate brake line from the tube adapter.
2. Remove the tube adapter.

Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the new tube adapter.
   Tighten
   Tighten the tube adapter to 31 N.m (23 lb ft).
2. Install the brake line.
   Tighten
   Tighten the brake line to 30 N.m (22 lb ft).
3. Bleed the system. Refer to *ABS Bleed Procedure.*

Description and Operation

Service Precautions

When working on this system, observe the following precautions:

- Before welding on the vehicle with an electric welding unit, complete the following steps:
  - Turn the ignition switch OFF.
  - Disconnect the EBCM connectors.
- Do not use a fast charger for starting the engine.
- Disconnect the negative battery cable when fast charging. Refer to *Battery Disconnect Caution* in Cautions and Notices.
- Never disconnect the battery from the vehicle electrical system while the engine is running.
- Connect all wiring harness connectors securely.
- Proper speed sensor wiring, routing and retaining are necessary in order to prevent false signals due to electrical noise. You can achieve proper system operation only by restoring the system to its original condition.

  When servicing the ABS, note the routing, position, mounting and locations of the following items:
  - All components
  - The wiring
  - The connectors
  - The clips
  - The brackets
  - The brake pipes

Follow the above mentioned precautions when working on ABS. Familiarize yourself with ABS and it relationships with other components on the vehicle.

General System Description

This section covers diagnostic and service procedures for the four wheel antilock brake system (ABS). These models use the three sensor ABS. Speed information is obtained using a wheel speed sensor (WSS) at each front wheel and the vehicle speed sensor (VSS) for rear wheel speed information. ABS reduces the occurrence of wheel lockup during severe brake applications. The system regulates hydraulic pressure to all four wheels. The pressure is regulated by the brake pressure modulator valve (BPMV).

ABS is designed to provide the average driver with the following:

- Optimal steering control and stability when braking
- Optimal braking performance with available traction

Wheel Slip

The ability of a vehicle to stop is related to the friction of the road surface. At 0% slip, the tires rotate freely; at 100% slip, the tire and wheel are locked. Stopping distance increases and steering control is diminished.

With a 10%-20% slip, vehicle stopping distance will be as short as possible and steering control will be at its optimum. Some slip is necessary to stop the wheel and achieve maximum braking.

When ABS operation occurs, the driver of the vehicle should always continue to push hard on the brake pedal. Never pump the brakes. The ABS system will automatically modulate the brakes.

Steering Control

Steering control, like braking, also depends on tire traction. A locked tire in a 100% slip condition delivers less than optimum braking and directional control. Thus, some tire rotation is desirable for steering control. The tires must regain traction before steering control is restored to the vehicle.

Abbreviations and Definitions

BPMV: Brake Pressure Modulator Valve

CKT: Circuit

DLC: Data Link Connector

DMM: Digital Multimeter

DTC: Diagnostic Trouble Code

EBCM: Electronic Brake Control Module

EHCU: Electro-Hydraulic Control Unit

Infinite: Open Circuit/Unmeasurably High Resistance

LPA: Low Pressure Accumulator

OL: Open Circuit/Unmeasurably High Resistance

WSS: Wheel Speed Sensor

The EHCU is the entire ABS unit, including the BPMV and the EBCM. The BPMV is defined as the hydraulic control portion of the EHCU. The BPMV includes the internal control valves, the electric motor and the pumps. The BPMV does not include the EBCM. The EBCM is the electronic control portion of the EHCU. The EBCM mounts to the top of the BPMV. The EBCM is housed in aluminum with a black plastic top.

Basic Knowledge Required

You must have a basic knowledge of the following items before using this section. Without this basic knowledge, you will have difficulties using the diagnostic procedures contained in this section.

If you need a review of basic electrical troubleshooting, see the introduction to Electrical Diagnosis. Electrical Diagnosis also contains information on the basic use of circuit testing tools.

Basic Electrical Circuits

You should understand the basic electrical theory. You should also know the meaning of basic electrical concepts and measurement: voltage (volts), current (amperes) and resistance (ohms). You should understand what happens in a circuit with an open or shorted wire. You should be able to read and understand a wiring diagram.

Use of Circuit Testing Tools

You should be familiar with the high impedance Digital Multimeter (DMM) *J 39200*. You should be familiar with the meter controls and how to use them correctly. You should be able to measure voltage, resistance and current. You should also know how to use jumper wires to bypass components in order to test circuits.

ABS System Description

Electro-Hydraulic Control Unit

The Electro-Hydraulic Control Unit (EHCU) is located on the left frame rail behind the cab. The EHCU assembly includes the Electronic Brake Control module (EBCM) and the Brake Pressure Modulator Valve (BPMV). The EHCU regulates hydraulic pressure in the brake system during an antilock stop.

Electronic Brake Control Module

The Electronic Brake Control Module (EBCM) is part of the EHCU. The EBCM is the electronic portion of the EHCU. The major function of the EBCM is to control the BPMV. Inputs to the EBCM include the following items:

- Four wheel speed signals
- Stop Lamp Switch
- Differential pressure switch
- Ignition switch voltage
- Un-switched battery voltage

Outputs of the EBCM include the following items:

- Four isolation solenoids (internal to the EBCM)
- Four dump solenoids (internal to the EBCM)
- The amber ABS indicator lamp
- The red BRAKE warning lamp
- The pump motor

A diagnostic serial data link (UART, ABS only) is also used for diagnostic service tools and assembly plant testing. A serial data circuit (Class 2) is used for transmitting a "rough road" signal to the PCM.

The EBCM monitors the speed of each wheel. If any wheel approaches lockup, the EBCM controls the solenoids (isolation solenoid and dump solenoid) in order to reduce brake pressure to the wheel approaching lockup. Once the wheel regains traction, brake pressure is increased until the wheel again approaches lockup. This cycle repeats until either the vehicle comes to a stop, the brake is released, or the wheel is no longer approaching lockup. The EBCM also runs self diagnostics in order to check for any system malfunctions. Refer to *Self-Diagnostics*. If the EBCM detects a malfunction with the system, the ECBM will illuminate the amber ABS indicator in order to alert the driver of a malfunction.

Brake Pressure Modulator Valve

The Brake Pressure Modulator Valve (BPMV) is part of the EHCU. The BPMV is the hydraulic portion of the EHCU. The EBCM controls the BPMV. The BPMV is split into the following four hydraulic channels:

- Left front
- Right front
- Left rear
- Right rear

Each channel has an isolation valve and a dump valve.

Wheel Speed Sensors

The Wheel Speed Sensors (WSS) are a magnetic coil/pickup type. Each WSS produces an AC voltage signal which is transmitted to the EBCM in order to indicate how fast the wheel is turning. The speed of the wheel is directly proportional to the frequency and amplitude of the wheel speed signal.

Wheel Speed Sensor Tone Wheels

Each Wheel Speed Sensor (WSS) uses a tone wheel in order to produce an alternating current (AC) voltage signal. Tone wheels are metal rings with teeth on the outside diameter. The AC voltage is produced as the teeth pass through the magnetic field of the WSS pole piece. The tone wheels are attached to the rotor or the drum. Any imperfections in the tone rings, such as a broken tooth or a missing tooth, can cause an inaccurate wheel speed signal.

Tire Size Calibration

The EBCM accepts wheel speed signals from several different sizes of tire and wheel combinations. All vehicles are preprogrammed from the factory with the proper tire size calibration. Whenever you replace the EBCM or change the tire size, you must reset the tire size calibration in the EBCM using *Scan Tool.*

Trim Level Calibration

The ABS can operate with different brake types and different wheel bases from several different vehicle configurations. All vehicles are pre-programmed from the factory with the proper trim level calibration. This trim level calibration corresponds to the different wheel bases and axles/brake types available on each vehicle. Whenever you replace the EBCM or change the wheel base of the vehicle, you must recalibrate the trim level within the EBCM.

Use the *Scan Tool.* You must first obtain the wheel base and axle type using RPO codes (refer to General Information) in order to select the correct trim level on the *Scan Tool.* Once programmed, this calibration will remain, even if the battery is disconnected or if the EBCM is removed from the vehicle. Refer to the following table for trim level calibration selection.

ABS System Description

Wheel Base	Front Axle RPO Code	Software Version
Less than or equal to 423 cm (170 in)	FL1	A
Less than or equal to 432 cm (200 in)	FL2/F43/FM6/ FS7	B
Greater than 423 cm (170 in)	FL1	C
Greater than 432 cm (200 in)	FL2/F43/FM6/ FS7	D

ABS System Operation

ABS Indicator Lamp Operation

The system uses an amber ABS indicator lamp in the instrument cluster in order to show system operation and malfunctions.

Normal Lamp Operation

A bulb check occurs each time the ignition switch is turned to the RUN position. The ANTILOCK and BRAKE lamps should turn on, remain on for about two seconds, then turn off. The ABS indicator lamp also indicates system malfunctions. When the EBCM detects a malfunction in the system, the EBCM turns the ANTILOCK and sometimes the BRAKE lamp on. The lamp may remain on or turn off depending on the malfunction. In order to determine the specific cause of the malfunction, refer to the ABS Diagnostic System Check.

Tires and ABS

Correct tire size, proper inflation, accurate alignment and even wear are needed for good brake performance. These items are essential for proper ABS performance.

Spare Tire

Use of the spare tire supplied with the vehicle will not affect the performance of the system.

Replacement Tires

If the replacement tires are not the same size as the original tires, you must change the tire size calibration within the EBCM using a *Scan Tool.* Refer to Tire Size Calibration portion of ABS System Description. Failure to change the tire calibration when replacing the original tires with a different size tire can affect the performance of the ABS.

Self-Tests

The ABS performs the following two system self-tests:

- The first self-test is performed when the ignition is turned to RUN. Both the ABS indicator lamp and the BRAKE warning lamp will turn on for 3 seconds, then they will turn off. This test confirms correct operation of the EBCM and the lamps. If one of the lamps remains on, either the ABS or the base brake system will require service.
- The second self-test is performed when the vehicle reaches a speed of greater than 3 mph. At this time the internal EBCM relay, six solenoid coils and BPMV pump motor are cycled and checked for shorts/opens. The BPMV pump will make a slight sound when this function occurs.

Normal Braking Mode

Refer to Normal Braking Mode in *BPMV Hydraulic Flow Chart.*

During normal braking, pressure is applied through the brake pedal. Fluid travels from the master cylinder, through the combination valve and into the BPMV. Once in the BPMV, the fluid travels through the normally-open isolation valves, through the normally-closed dump valves and out into the brakes.

During normal braking, the pumps are not turned on. The low pressure accumulators and attenuators are empty. Only residual pressure is stored in these accumulators and attenuators.

The EBCM constantly monitors wheel speed sensor inputs for rapid deceleration. If the ABS becomes disabled for any reason, the driver will always have base brakes. The normally-open isolation valves and normally-closed dump valves will remain in these positions in order to allow normal fluid pressure to the wheels.

ABS will not operate without wheel slip. The vehicle must be going at least 13 km/h (8 mph) in order to begin ABS operation.

ABS Braking Mode

The ABS will monitor the three-wheel speed sensors and control the hydraulic pressure changes at each wheel until the vehicle has come to a complete stop or until the driver has released the brake pedal. The system operates through the following process:

1. Pressure isolation/maintain
2. Pressure decrease
3. Pressure increase
4. Brake release (fluid return)

Sequence Of Events

1. With the vehicle at 13 km/h (8 mph) or greater, the driver depresses the brake pedal.
2. The wheel speed begins to decrease as the master cylinder pressure and brake pressure increase.
3. As the wheel speed continues to decrease from vehicle speed, the normally-open isolation valve for the affected channel closes to stop additional pressure to the wheel. The master cylinder pressure continues to increase as the driver depresses the pedal, but the wheel brake pressure is now limited to the ABS system pressure.
4. When the EBCM determines that the wheel is about to lock-up, the normally-closed dump valve opens. This bleeds off some of the pressure at the wheel cylinder (or caliper) in order to allow the wheel to return to a speed closer to the speed of the vehicle.
5. The dump valve is again closed and the isolation valve remains closed in order to allow the wheel speed to completely recover from the lock-up.
6. Once the vehicle has recovered from the lock-up tendency, the isolation valve is momentarily pulsed open in order to allow the master cylinder pressure and pump pressure to reach the brakes. This controlled pressure rise continues until the wheel is at optimum brake output or until the brake pressure is brought up to master cylinder output pressure. The ABS allows the brake fluid to flow to the wheel, build pressure and try to force another departure, repeating Step 3 through Step 6. The following paragraphs describe the various modes in detail.

Isolation Mode (Pressure Maintain)

Refer to Isolation Mode in *BPMV Hydraulic Flow Chart.*

Isolation will occur when the driver applies excessive braking for the given road conditions, causing the wheels to decelerate at a rate which exceeds the vehicle's capability.

If the information from the wheel speed sensors indicate excessive wheel deceleration (imminent lock-up), the first step in the antilock sequence is to isolate the brake pressure being applied by the driver.

The EBCM applies a voltage to the isolation coil in order to close the rear isolation valve. This will prevent any additional brake pressure applied by the driver from reaching the wheel. With the isolation valve closed, further increases in brake pressure from the driver will be prohibited.

Dump Mode (Pressure Decrease)

Refer to Dump Mode in *BPMV Hydraulic Flow Chart.*

Once the pressure is isolated, it must be reduced in order to get the wheels rolling once again. Reducing pressure is accomplished by dumping a portion of the brake fluid pressure into the rear low pressure accumulator (LPA).

The EBCM energizes the dump valve coil(s) in order to open the rear dump valve, allowing fluid from the wheels to be dumped into the LPA. Very short activation pulses open and close the dump valve passageway in order to control this action. Brake pressure is lowered at the wheel and allows the affected wheel to begin rolling again.

The fluid taken from the wheels forces a spring back. The fluid is stored in the LPA at approximately 1034 kPa (150 psi). A portion of the fluid also primes the pump so it can begin building reapply pressure. The dump valves are opened independently in order to control the deceleration of the wheel.

Reapply Mode (Pressure Increase)

Refer to Reapply Mode in *BPMV Hydraulic Flow Chart.*

The reapply sequence is initiated in order to obtain optimum braking at each wheel. The rear isolation valve is momentarily pulsed open in order to allow the master cylinder and rear pump pressure to reach the brakes. This controlled pressure rise continues until the wheel is at optimum brake output or until the brake pressure is brought up to the master cylinder output pressure.

If more pressure is required, more fluid is drawn from the master cylinder and applied to the brakes. The driver will feel pedal pulsations or pedal drop. This is normal and expected when in the antilock mode.

As fluid is reapplied, the wheels begin to slow down at the optimum rate. If the wheels approach imminent lock-up again, the module will isolate, dump and reapply. These control cycles (isolation, dump and reapply) occur in millisecond intervals, allowing several cycles to occur each second.

Brake Release

At the end of the antilock stop, when the driver releases the brake pedal, the motor will remain on for a short time in order to help drain any fluid left in the LPA. As the fluid drains back into the system, the spring force in the LPA pushes the piston to the home position. The isolation valve is turned off and fluid returns through the isolation orifice.

Special Tools and Equipment

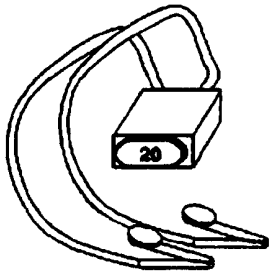
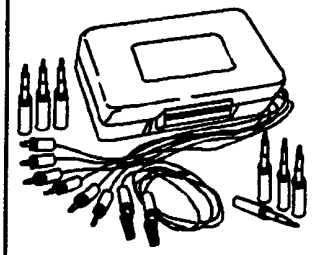
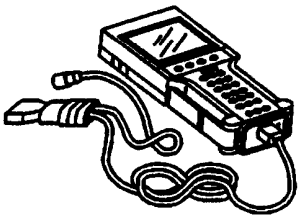
Illustration	Tool Number/ Description
3430	J 39200 Digital Multi-Meter
 1025	J 36169 Fused Jumper Wire

Illustration	Tool Number/ Description
 11799	J 35616 Connector Adapter Test Kit
 39438	Tech 2 Scan Tool

Air Antilock Brake System

Specifications

Fastener Tightening Specifications

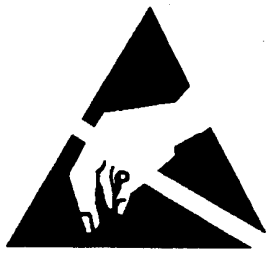
Application	N.m	Lb Ft	Lb In
Front Modulator Valve Fitting Supply Connector	22	16	—
Front Modulator Valve Fitting Supply Elbow	22	16	—
Front Modulator Valve Fitting Delivery Elbow	35	26	39
Rear Modulator Valve Fitting Supply Connector (single axle)	37	27	—
Rear Modulator Valve Fitting Delivery Connector (single axle)	37	27	—
Rear Modulator Valve Fitting Delivery Connector (tandem axle)	35	26	—
Rear Modulator Valve Fitting Supply Elbow (tandem axle)	35	26	—
Rear Modulator Valve Fitting Supply Tee (tandem axle)	35	26	—
Rear Modulator Valve Fitting Supply Nipple (tandem axle)	35	26	—
Front Modulator Valve to Crossmember	23	17	—
Rear Modulator Valve to Bracket (single axle)	30	22	—
Rear Modulator Valve Bracket to Frame (single axle)	70	52	—
Rear Modulator Valve to Bracket (tandem axle)	23	17	—
Rear Modulator Valve to Crossmember (tandem axle)	45	33	—
Front Wheel Speed Sensor Wire Retention Bracket	13	—	115
Rear Wheel Speed Sensor Wire Retention Bracket	33	24	—
EBCM to Bracket	8	—	71
EBCM Bracket to Cowl	29	21	—
EBCM Harness Connector	2	—	18

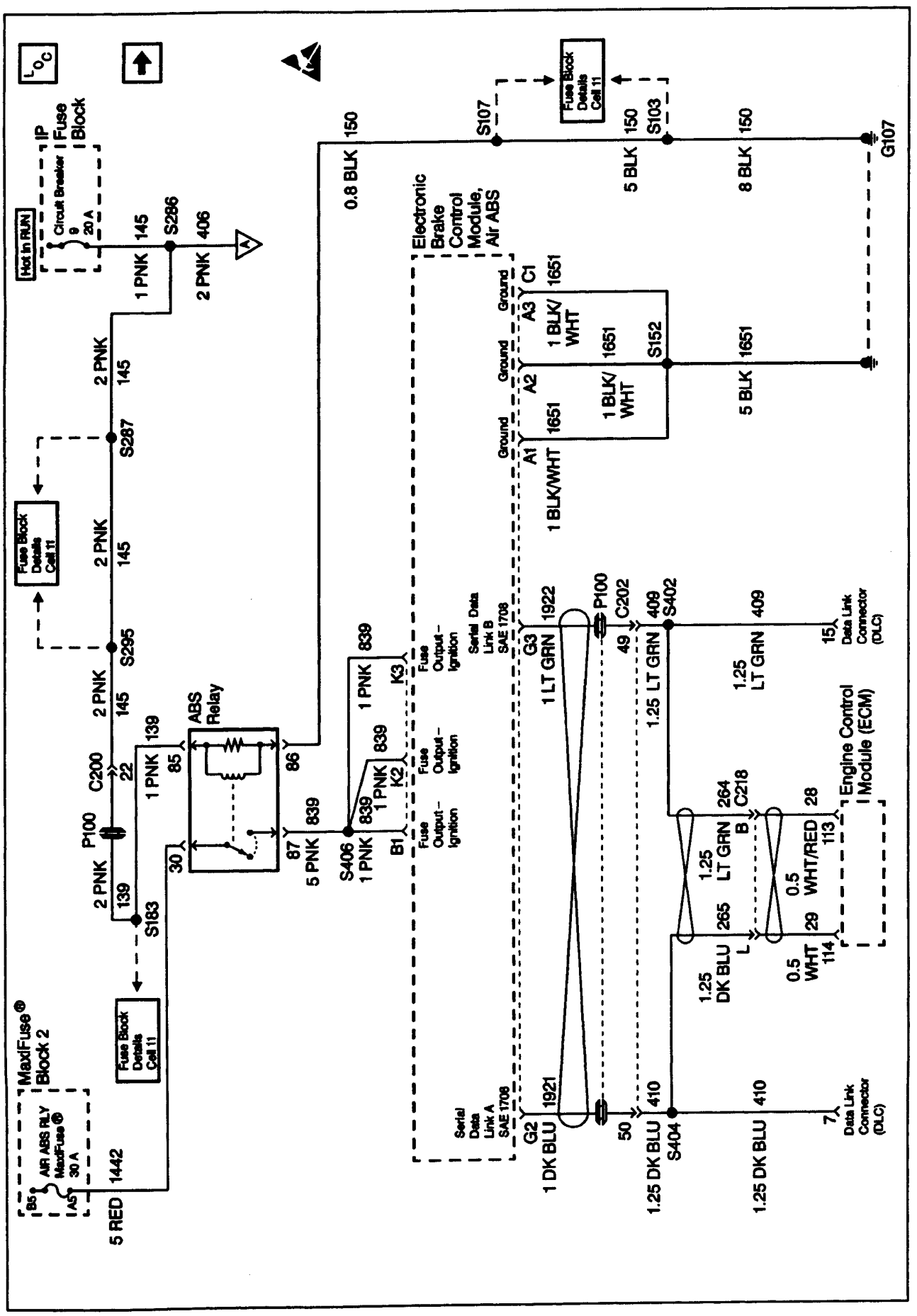
Schematic and Routing Diagrams

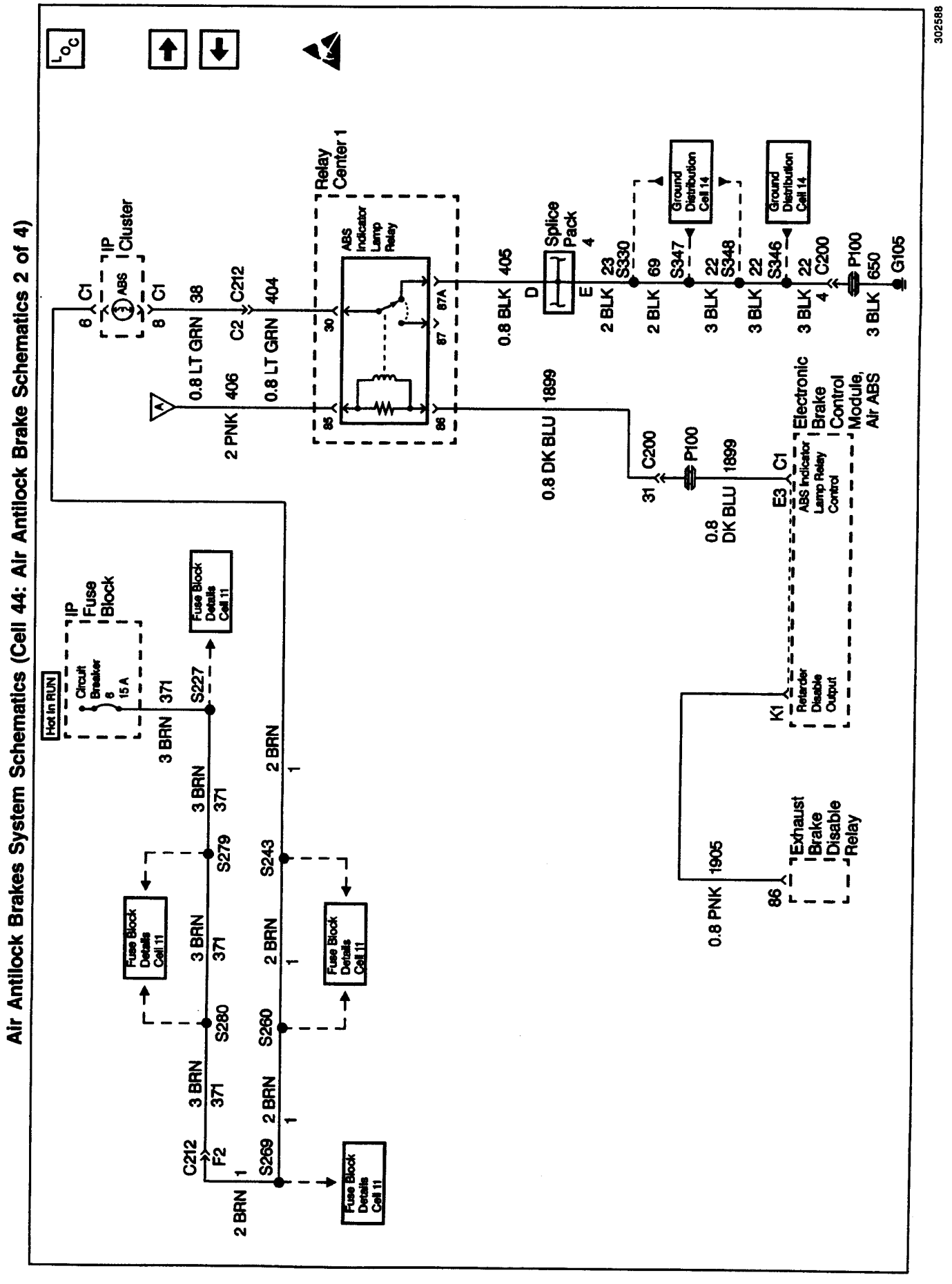
Air Antilock Brakes System Schematic References

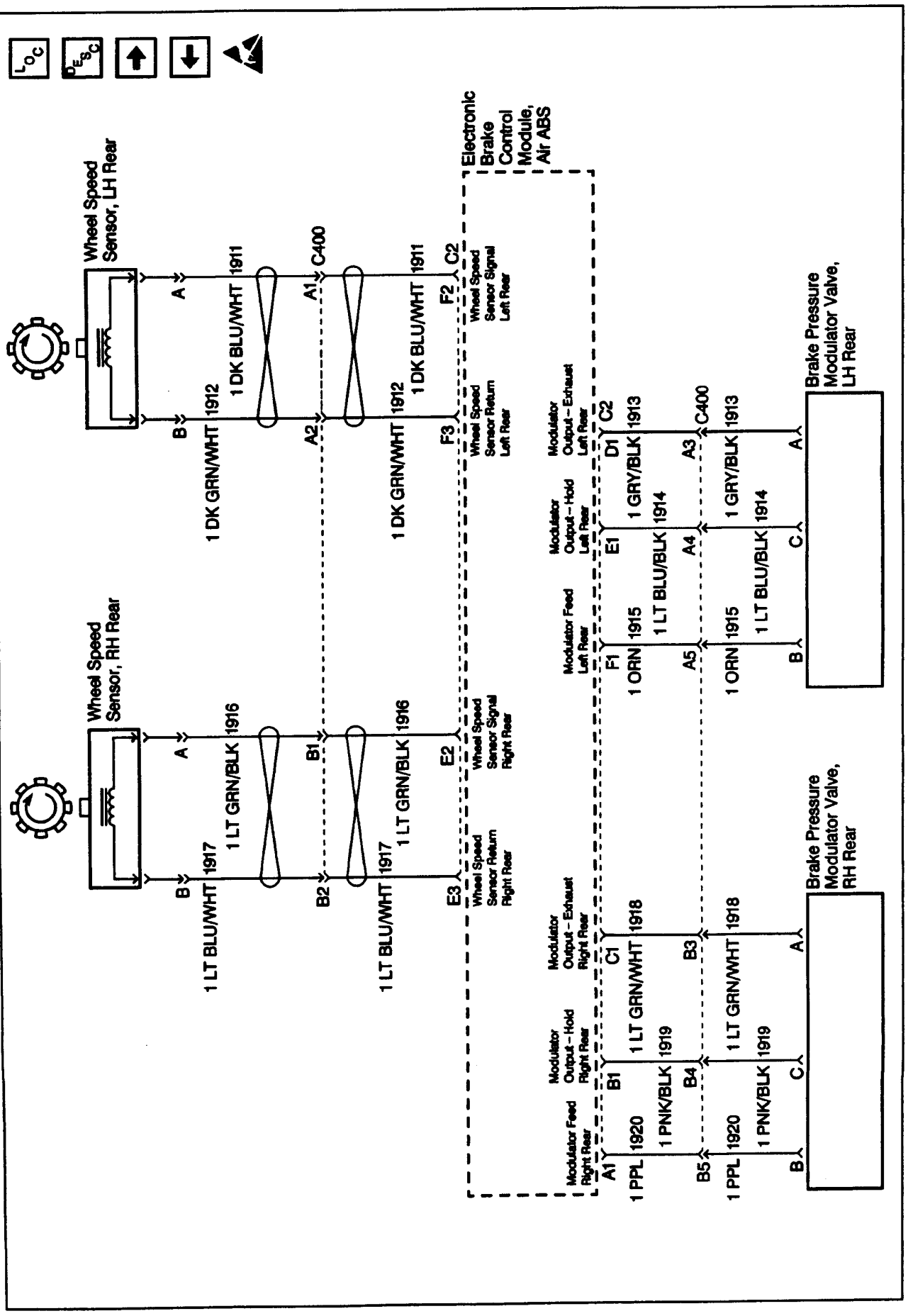
Reference on Schematic	Section Number - Subsection Name
Fuse Block Details Cell 11	8—Wiring Systems
Ground Distribution Cell 14	8—Wiring Systems

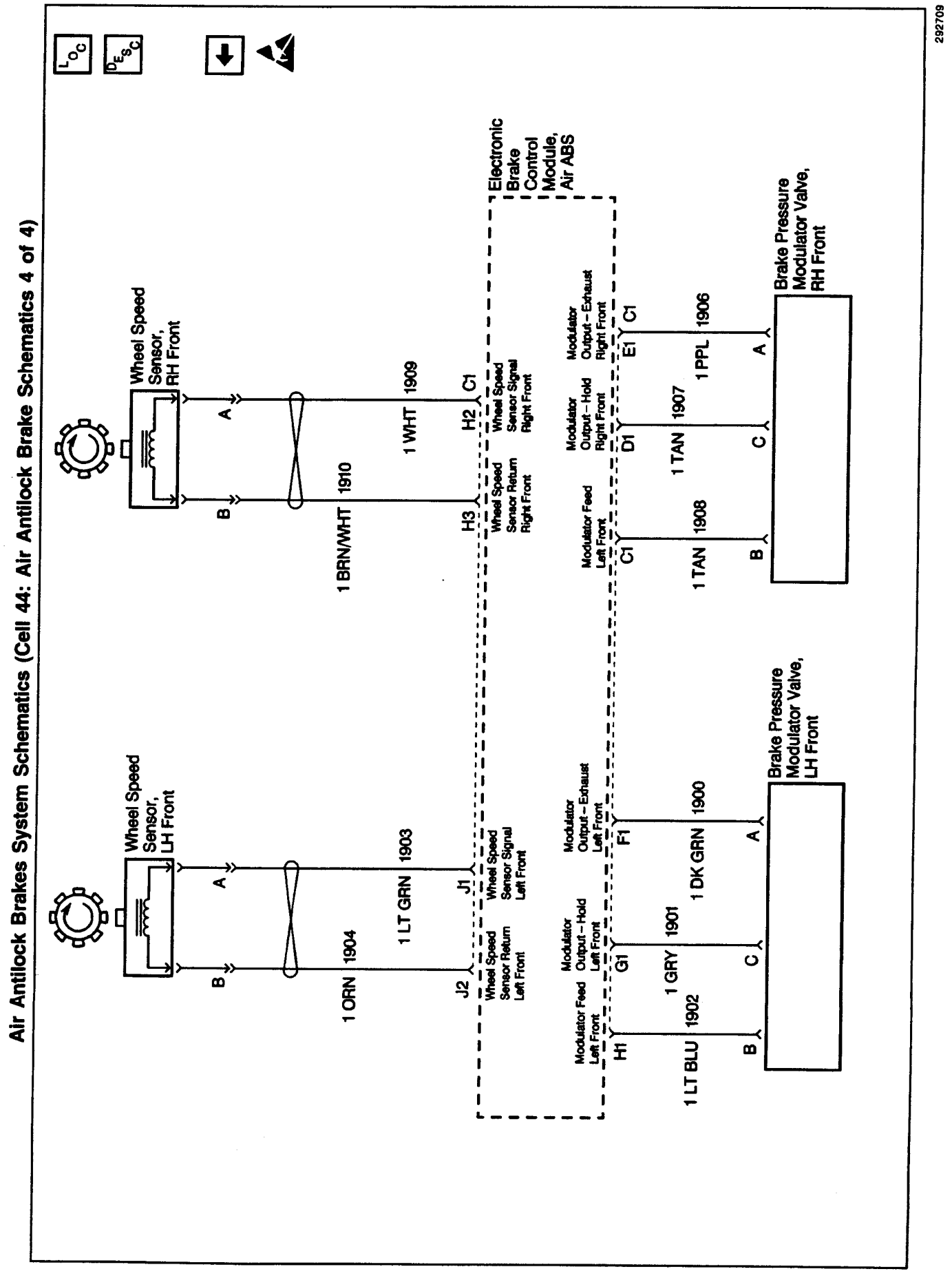
Air Antilock Brakes System Schematic Icons

Icon	Icon Definition
 19384	Refer to *ESD Notice* in Cautions and Notices.


Air Antilock Brakes System Schematics (Cell 44: Air Antilock Brake Schematic 1 of 4)
302586
MaxiFuse® Block 2
AIR ABS RLY MaxiFuse® 30 A
B5
A5
1442
5 RED
Fuse Block Details Cell 11
S163
2 PNK
139
P100
C200
22
1 PNK
139
85
30
ABS Relay
86
87
5 PNK
839
S406
1 PNK
839
1 PNK
839
K2
B1
K3
Fuse Output - Ignition
Fuse Block Details Cell 11
2 PNK
145
S295
2 PNK
145
S287
2 PNK
145
1 PNK
145
S286
2 PNK
406
A
Hot in RUN
Circuit Breaker 9 20 A
IP Fuse Block
0.8 BLK
150
S107
Fuse Block Details Cell 11
Electronic Brake Control Module, Air ABS
Ground
A1
1651
1 BLK/WHT
Ground
A2
1651
1 BLK/WHT
Ground
A3
1651
1 BLK/WHT
C1
S152
1651
5 BLK
5 BLK
150
S103
8 BLK
150
G107
Serial Data Link B SAE 1708
G3
1922
1 LT GRN
P100
C202
49
1.25 LT GRN
409
S402
1.25 LT GRN
409
15
Data Link Connector (DLC)
Serial Data Link A SAE 1708
G2
1921
1 DK BLU
50
1.25 DK BLU
410
S404
1.25 DK BLU
410
7
Data Link Connector (DLC)
1.25 DK BLU
265
L
1.25 LT GRN
264
C218
B
0.5 WHT
114
0.5 WHT/RED
29
113
28
Engine Control Module (ECM)


Air Antilock Brakes System Schematics (Cell 44: Air Antilock Brake Schematics 2 of 4)
302588
Hot In RUN
IP Fuse Block
Circuit Breaker 6 15 A
371
S227
3 BRN
Fuse Block Details Cell 11
S279
S243
S280
S260
S269
C212
F2
2 BRN
IP Cluster
ABS
C1
6
8
38
C212
C2
404
0.8 LT GRN
406
2 PNK
Relay Center 1
ABS Indicator Lamp Relay
85
86
30
87
87A
405
0.8 BLK
D
Splice Pack 4
E
23
S330
69
S347
22
S348
S346
C200
P100
650
G105
Ground Distribution Cell 14
1899
0.8 DK BLU
31
0.8 DK BLU
E3
Electronic Brake Control Module, Air ABS
ABS Indicator Lamp Relay Control
K1
Retarder Disable Output
Exhaust Brake Disable Relay
1905
0.8 PNK
86


Air Antilock Brakes System Schematics (Cell 44 Air Antilock Brake Schematics 3 of 4)
292705
Wheel Speed Sensor, LH Rear
Wheel Speed Sensor, RH Rear
Electronic Brake Control Module, Air ABS
Brake Pressure Modulator Valve, LH Rear
Brake Pressure Modulator Valve, RH Rear
1 DK GRN/WHT 1912
1 DK BLU/WHT 1911
1 LT BLU/WHT 1917
1 LT GRN/BLK 1916
1 LT GRN/WHT 1918
1 PNK/BLK 1919
1 PPL 1920
1 ORN 1915
1 LT BLU/BLK 1914
1 GRY/BLK 1913
Wheel Speed Sensor Return Left Rear
Wheel Speed Sensor Signal Left Rear
Wheel Speed Sensor Return Right Rear
Wheel Speed Sensor Signal Right Rear
Modulator Output - Hold Right Rear
Modulator Output - Exhaust Right Rear
Modulator Feed Left Rear
Modulator Output - Hold Left Rear
Modulator Output - Exhaust Left Rear
Modulator Feed Right Rear


Air Antilock Brakes System Schematics (Cell 44: Air Antilock Brake Schematics 4 of 4)
292709
Wheel Speed Sensor, LH Front
Wheel Speed Sensor, RH Front
Electronic Brake Control Module, Air ABS
Brake Pressure Modulator Valve, LH Front
Brake Pressure Modulator Valve, RH Front
A
B
1 ORN 1904
1 LT GRN 1903
1 BRN/WHT 1910
1 WHT 1909
J2
J1
H3
H2
C1
Wheel Speed Sensor Return Left Front
Wheel Speed Sensor Signal Left Front
Wheel Speed Sensor Return Right Front
Wheel Speed Sensor Signal Right Front
Modulator Feed Left Front
Modulator Output – Hold Left Front
Modulator Output – Exhaust Left Front
Modulator Output – Hold Right Front
Modulator Output – Exhaust Right Front
H1
G1
F1
D1
E1
C1
1 LT BLU 1902
1 GRY 1901
1 DK GRN 1900
1 TAN 1908
1 TAN 1907
1 PPL 1906
C
A
1998 - MD-Isuzu

Component Locator

Air Antilock Brakes System Components

Name	Location	Locator View	Connector End View
ABS Relay (ABS-Air)	On the left side of the cab bridge, on the relay bracket on the front of the electronic brake control module (EBCM)	*Air Antilock Brakes System Component Views* in Antilock Brake System	*Air Antilock Brakes System Connector End Views* Views in Antilock Brake System
Brake Pressure Modulator Valve (BPMV), LH Rear (ABS-Air)	On the left crossmember, forward of the rear axle	*Air Antilock Brakes System Component Views* in Air Brakes-ABS	*Air Antilock Brakes System Connector End Views* in Air Brakes-ABS
Brake Pressure Modulator Valve (BPMV), RH Rear (ABS-Air)	On the right crossmember, forward of the rear axle	*Air Antilock Brakes System Component Views* in Air Brakes-ABS	*Air Antilock Brakes System Connector End Views* in Air Brakes-ABS
Brake Pressure Modulator Valve (BPMV), LH Front (Cat® Diesel)	On the left rear of the front crossmember	*Air Antilock Brakes System Component Views* in Air Brakes-ABS	*Air Antilock Brakes System Connector End Views* in Air Brakes-ABS
Brake Pressure Modulator Valve (BPMV), RH Front (Cat® Diesel)	On the right rear of the front crossmember	*Air Antilock Brakes System Component Views* in Air Brakes-ABS	*Air Antilock Brakes System Connector End Views* in Air Brakes-ABS
Data Link Connector (DLC)	On the left side of the lower IP	*Data Link Connector Component Views* in Wiring Systems	*Data Link Connector End Views* in Wiring Systems
Electronic Brake Control Module-C1 (EBCM) (ABS-Air)	On the left side of the cab bridge, on the power steering reservoir mounting bracket	*Air Antilock Brakes System Component Views* in Antilock Brake System-Air	*Air Antilock Brakes System Connector End Views* in Antilock Brake System-Air
Electronic Brake Control Module-C2 (EBCM) (ABS-Air)	On the inboard side of the left frame rail, to the rear of #1 crossmember, on the bracket	*Air Antilock Brakes System Component Views* in Antilock Brake System-Air	*Air Antilock Brakes System Connector End Views* in Antilock Brake System-Air
Instrument Panel Cluster (IPC) *C1 (15 cavities)	In the upper IP harness to the IPC	—	*Instrument Cluster Connector End Views* in Instrument Panel, Gauges and Console
IP Fuse Block	On the right top side of the IP, under the access panel	*Power and Grounding Component Views* in Wiring Systems	—
MaxiFuse® Block 2	On the left rear of the cab, below cab bridge	*Power and Grounding Component Views* in Wiring Systems	—
Relay Center 1	In the right top of the IP, under the access cover	*Power and Grounding Component Views* in Wiring Systems	—
Wheel Speed Sensor (WSS) Left Front (ABS-Air)	Mounted in the left front brake backing plate	—	*Air Antilock Brakes System Connector End Views* in Antilock Brake System-Air
Wheel Speed Sensor (WSS) Right Front (ABS-Air)	Mounted in the right front brake backing plate	—	*Air Antilock Brakes System Connector End Views* in Antilock Brake System-Air
Wheel Speed Sensor (WSS) Left Rear (ABS-Air)	Mounted in the left rear brake backing plate	—	*Air Antilock Brakes System Connector End Views* in Antilock Brake System-Air

Air Antilock Brakes System Components (cont'd)

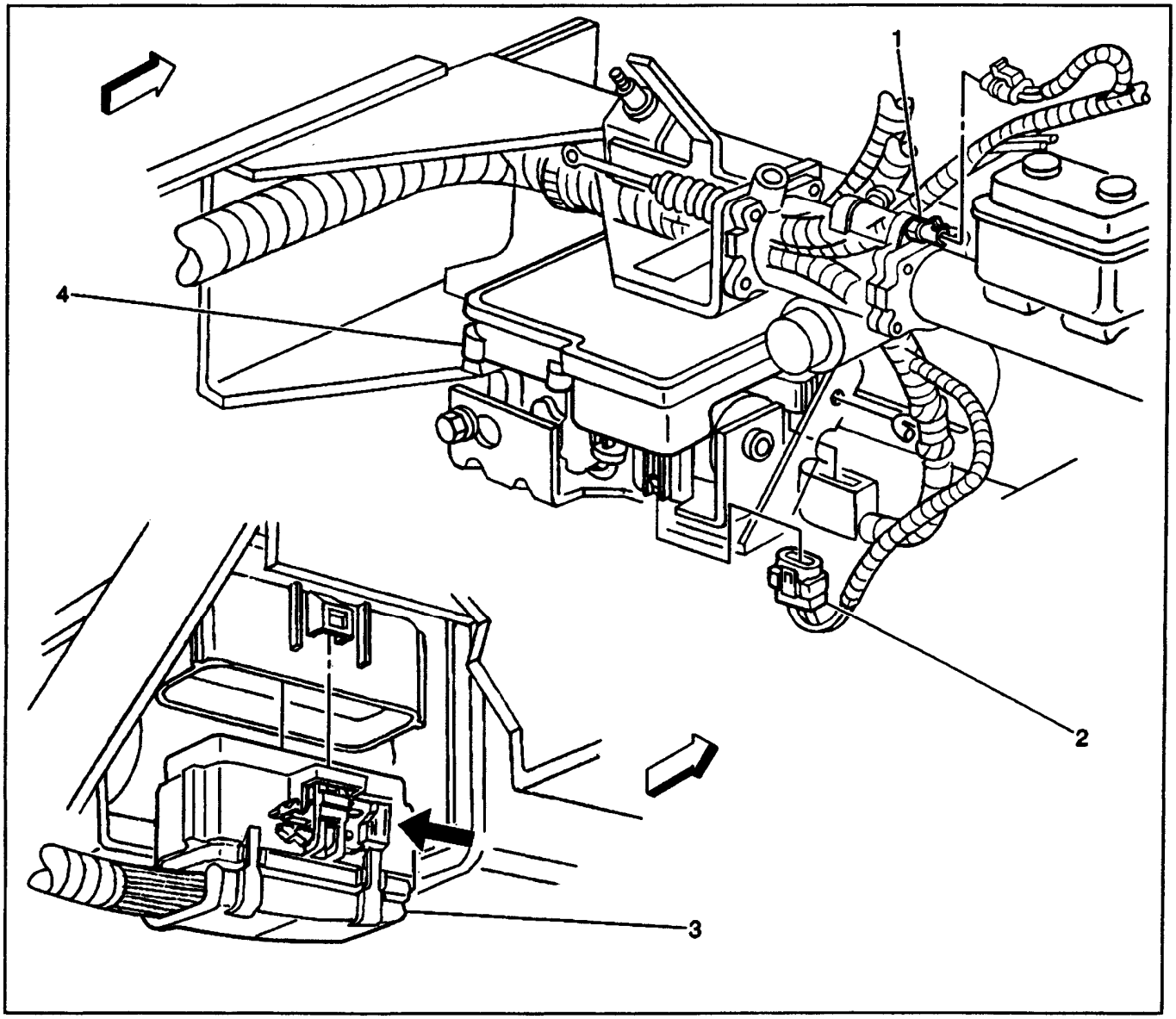
Name	Location	Locator View	Connector End View
Wheel Speed Sensor (WSS) Right Rear (ABS-Air)	Mounted in the right rear brake backing plate	—	*Air Antilock Brakes System Connector End Views* in Antilock Brake System-Air
C200 (56 cavities)	On the lower IP harness, to the front chassis harness, left center of the cab, in the cab interface connector.	—	*Inline Harness Connector End Views* in Wiring Systems
C202 (56 cavities)	On the lower IP harness, to the front chassis harness, left center of the cab, in the cab interface connector.	—	*Inline Harness Connector End Views* in Wiring Systems
C212 (84 cavities)	On the lower IP harness to the upper IP harness, left center of the IP at the floor	—	*Inline Harness Connector End Views* in Wiring Systems
C400 (15 cavities) (ABS-Air)	On the front chassis harness, to the ABS-air brake harness, inboard of the left frame rail left of the transmission	—	*Inline Harness Connector End Views* in Wiring Systems
C406 (7 cavities) (Cat® Diesel)	Inside the right frame rail inboard of the batteries	—	*Inline Harness Connector End Views* in Wiring Systems
G107	On the front chassis harness, on the left frame rail, approximately 25 cm (9.9 in) rear of the front shock absorber	—	—
G111		—	—
P100	In the front chassis harness, underhood, center of the bulkhead, in the cab interface connector housing	—	—
Splice Pack 4	In the upper IP harness, under the crash pad, on the top of the IP, joint connector 1, row 2, terminals 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2J and 2L	—	—
S103	In the front chassis harness, approximately 7 cm (2.8 in) rear of the main harness breakout	—	—
S107 (Cat® Diesel)	In the front chassis harness, approximately 10 cm (3.9 in) forward of the MaxiFuse® block breakout	—	—
S109	In the front chassis harness, approximately 4 cm (1.6 in) rear of the engine harness breakout	—	—
S152	In the front chassis harness, approximately 9 cm (3.5 in) from the G107 ground breakout	—	—
S183 (Cat® Diesel)	In the front chassis harness, approximately 16 cm (6.3 in) from the G107 ground breakout	—	—
S227	In the upper IP harness, under the IP, approximately 6 cm (2.4 in) left of the fuse block breakout	—	—
S243	In the upper IP harness, approximately 13 cm (5.1 in) from the IP connector toward the main harness	—	—
S260	In the upper IP harness, the main harness at the speedometer breakout	—	—

Air Antilock Brakes System Components (cont'd)

Name	Location	Locator View	Connector End View
S269	In the upper IP harness, the main harness, approximately 21 cm (8.3 in) from the upper IP connector C212 (84 cavities)	—	—
S279	In the lower IP harnes, below the IP, approximately 5 cm (2.0 in) right of the relay center 1 harness breakout	—	—
S280	In the lower IP harness, in the main harness at the frame harness breakout	—	—
S286	In the lower IP harness, in the main harness at the fuse block harness breakout	—	—
S287	In the lower IP harness, in the main harness, approximately 22 cm (8.7 in) right of the fuse block harness breakout	—	—
S295	In the lower IP harness, in the main branch, at the C200 (56 cavities) and C202 (56 cavities) breakout	—	—
S402	In the front chassis harness, 10 cm (3.9 in) to the front of the ABS harness breakout in the main harness	—	—
S404	In the front chassis harness, 17 cm (6.7 in) to the front of the ABS harness breakout in the main harness	—	—
S406	In the front chassis harness, approximately 7 cm (2.8 in) to the ABS harness breakout	—	—

Air Antilock Brakes System Component Views

Front Chassis Harness to Brake Components (ABS-Hydraulic)

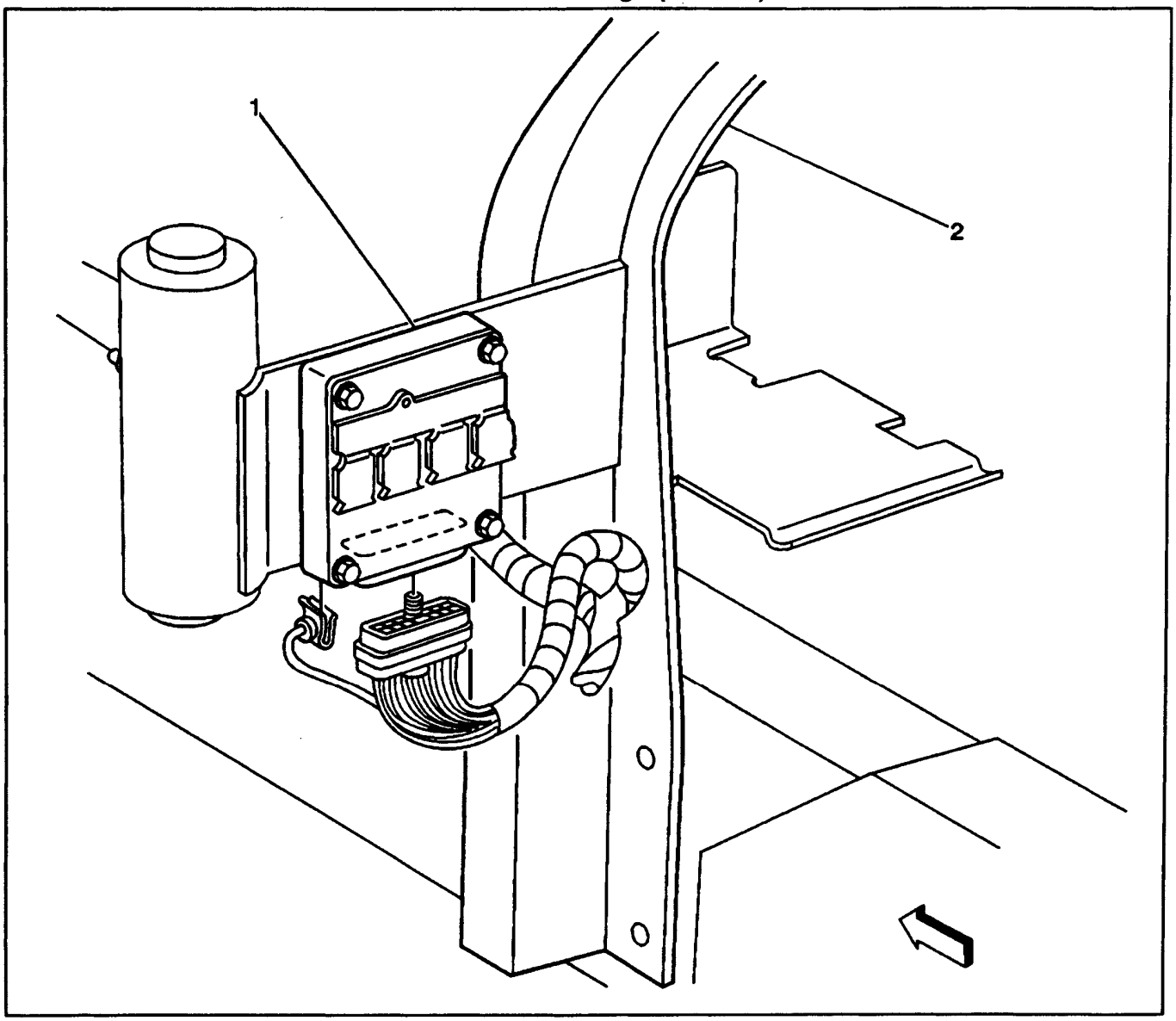


231487

Legend

(1) Brake Fluid Flow Switch
(2) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connecor C2 (2 cavities)
(3) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connector C1 (24 cavities)
(4) Electronic Brake Control Module (EBCM) (ABS-Hydraulic) Connector C2 (2 cavities)

Front Chassis Harness to Cab Bridge (ABS-Air) LH Forward View



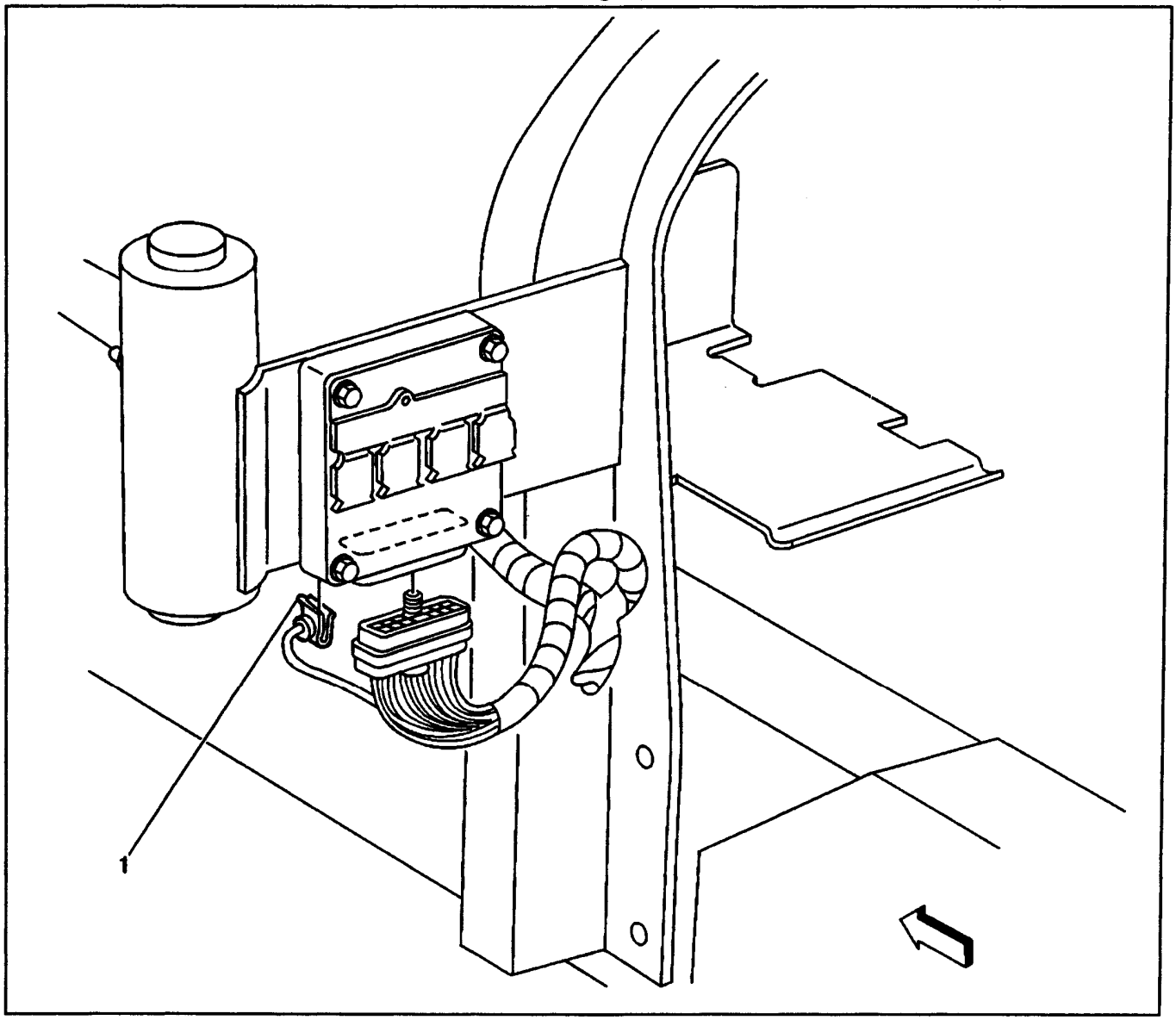
231698

Legend

(1) Electronic Brake Control Module (EBCM) (ABS-Air)

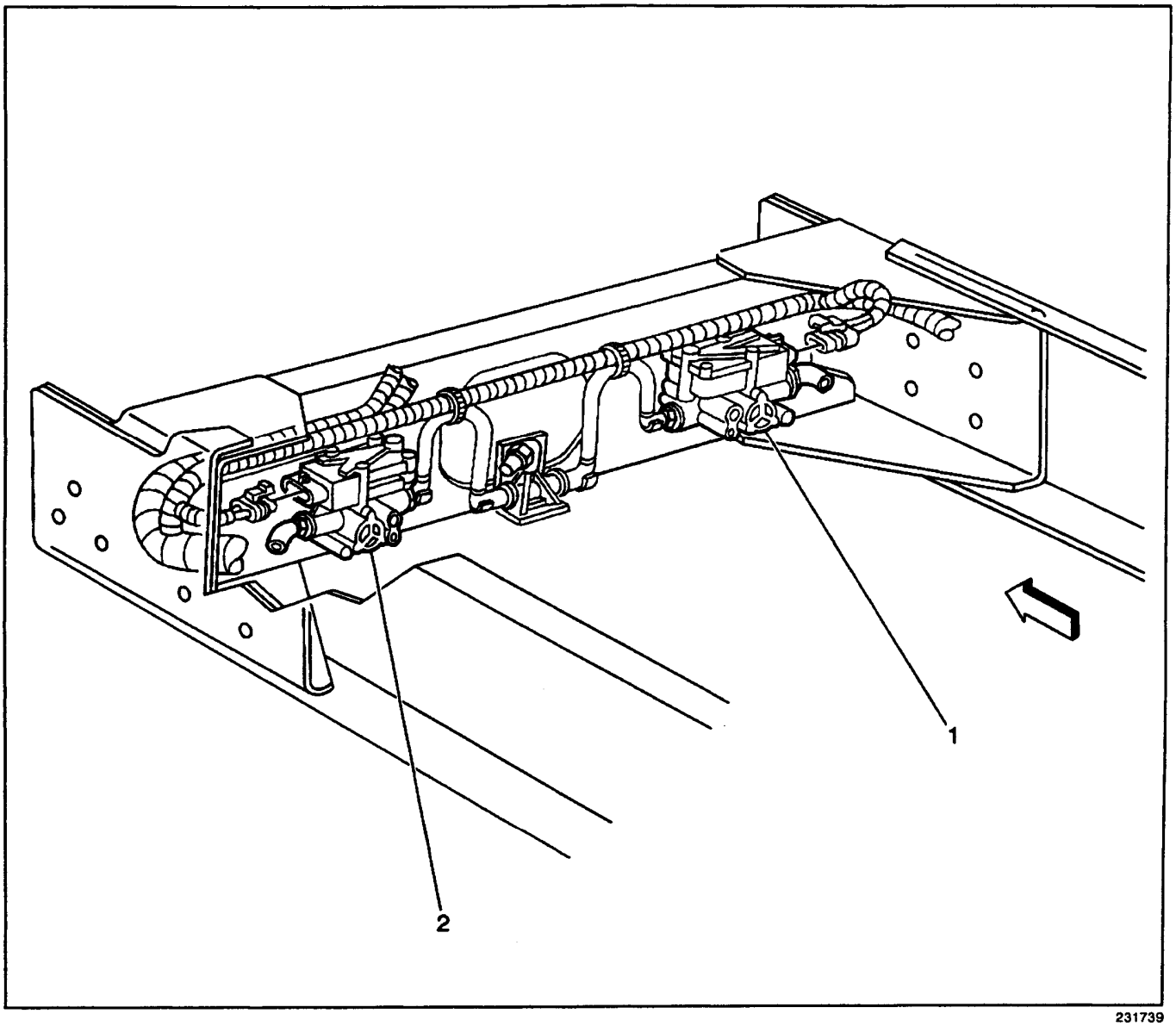
(2) Cab Bridge

Front Chassis Harness to Cab Bridge (ABS-Air) LH Forward View (C)



Legend
(1) G104 (ABS-Air)

Front Chassis Harness to Brake Components (ABS-Air)



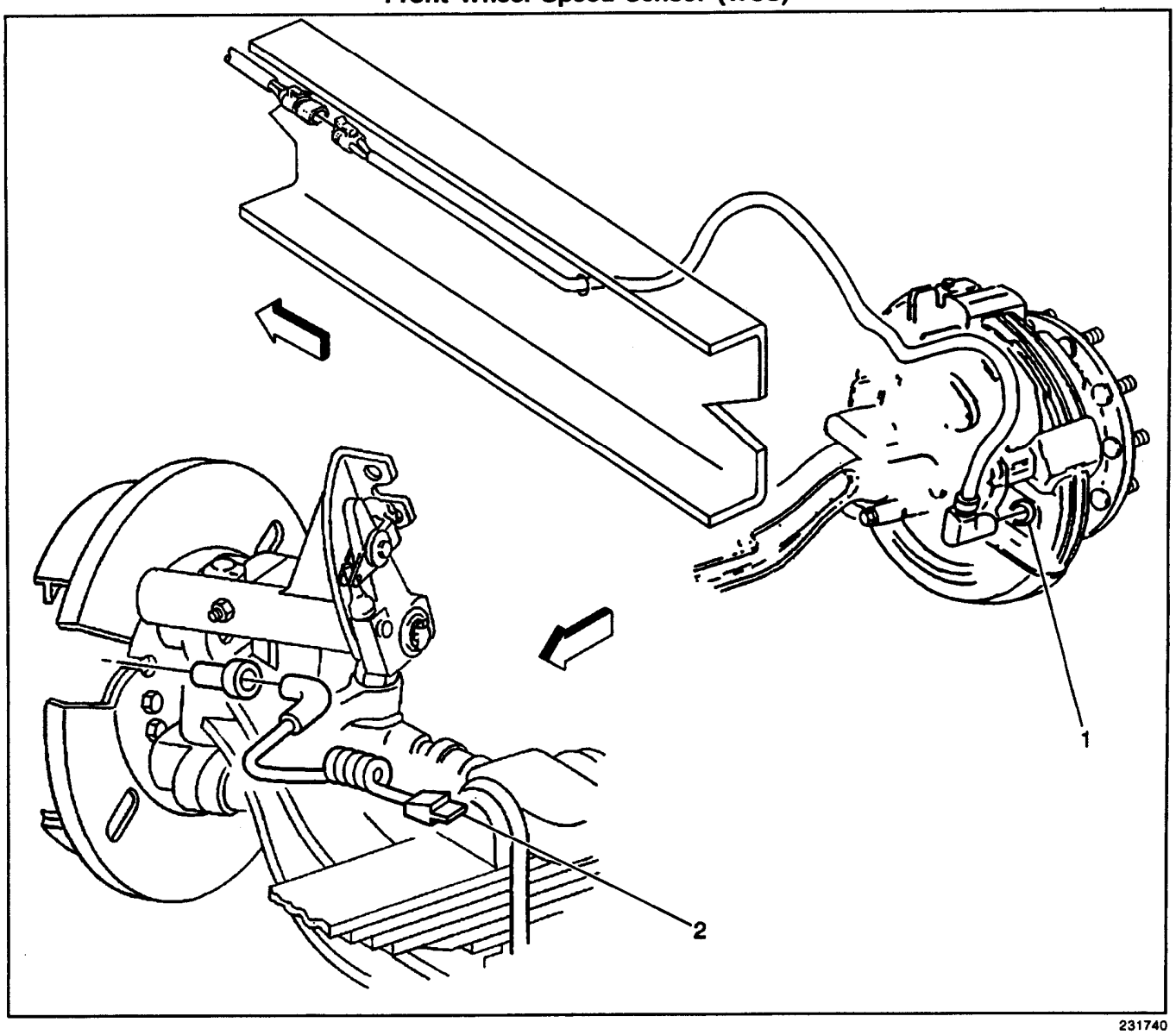
231739

Legend

(1) Brake Pressure Modulator Valve (BPMV), RH Front (ABS-Air)

(2) BPMV, LH Front (ABS-Air)

Front Wheel Speed Sensor (WSS)



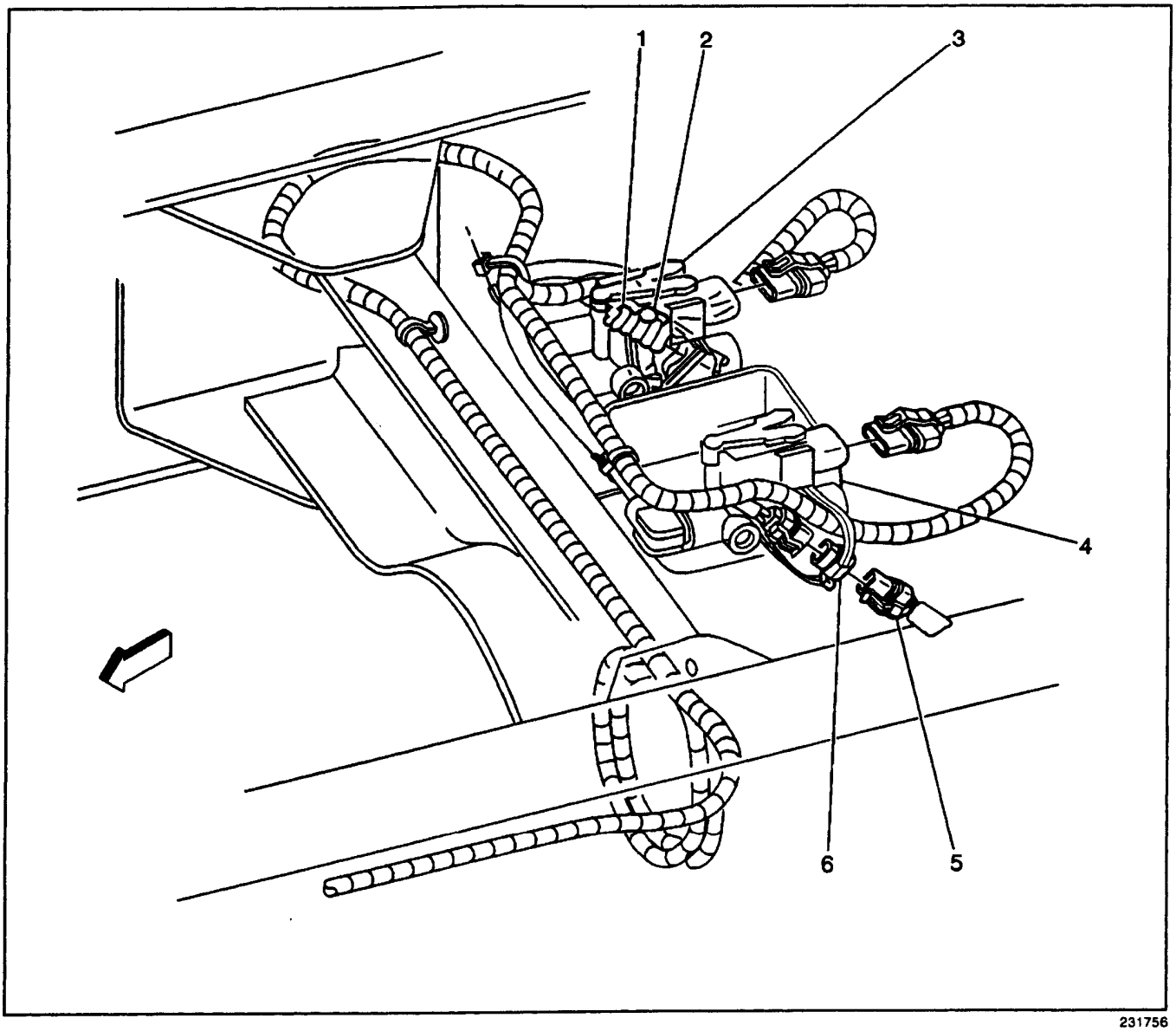
231740

Legend

(1) RH Front Wheel Speed Sensor (WSS) (ABS-Hydraulic)

(2) RH Front WSS (ABS-Air)

Electronic Brake Controls Harness and Components, LH View

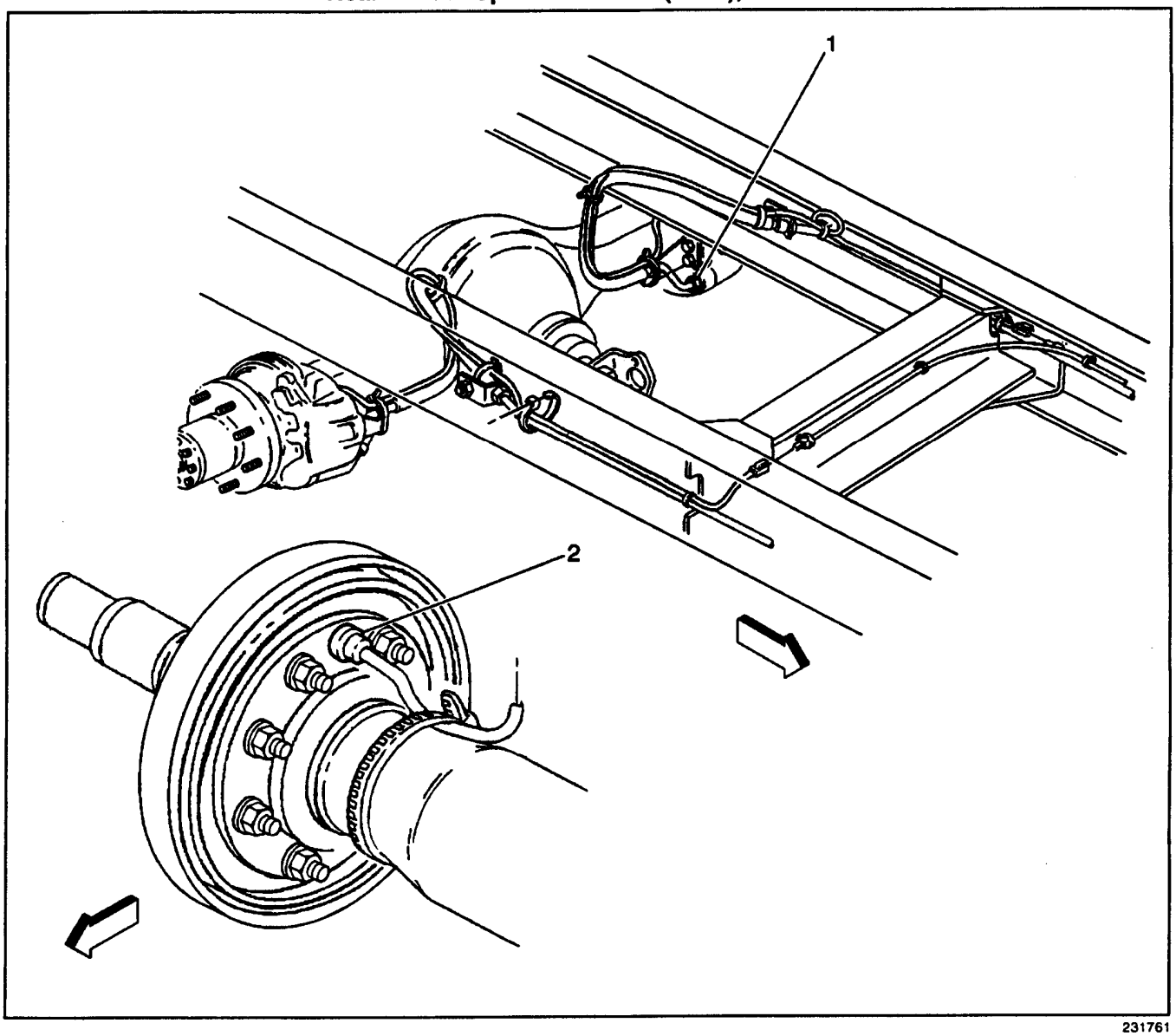


231756

Legend

(1) RH Rear Wheel Speed Sensor (WSS) (ABS-Air)
(2) RH R3ear Gender Adapter Connector (4 male-to-male cavities) (ABS-Air)
(3) RH Rear Brake Pressure Modulator Valve (BPMV) (ABS-Air)
(4) LH Rear BPMV (ABS-Air)
(5) LH Rear WSS (ABS-Air)
(6) LH Rear Gender Adapter Connector (4 male-to-male cavities) (ABS-Air)

Rear Wheel Speed Sensors (WSS), RH View



231761

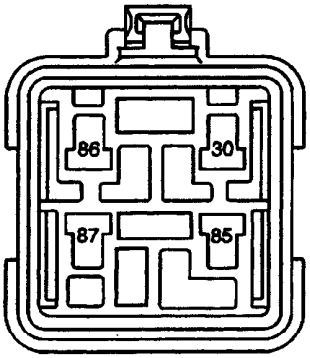
Legend

(1) LH Rear Wheel Speed Sensor (WSS) (ABS-Hydraulic)
(2) RH Rear WSS (ABS-Air)

Visual Identification

Air Antilock Brakes System Connector End Views

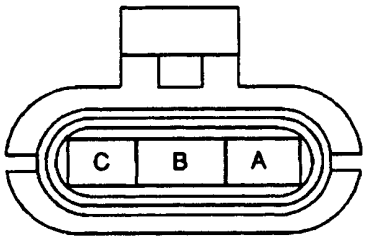
ABS Relay



39670

Connector Part Information	• 12129716 • 4 Way F Metri-Pack 280 Series, Flexlock, Sealed (GRY)		
Pin	**Wire Color**	**Circuit No.**	**Function**
30	RED	1442	Fuse Output-Battery
85	PNK	139	Fuse Output-Ignition
86	BLK	150	Ground
87	PNK	839	Fuse Output-Ignition

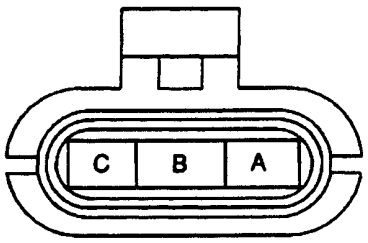
Brake Pressure Modulator Valve, LH Front



38598

Connector Part Information	• 12040977 • 3 Way F Metri-Pack 280 Series Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	DK GRN	1900	AAS Modulator Output-Exhaust-Left Front
B	LT BLU	1902	AAS Modulator Feed-Left Front

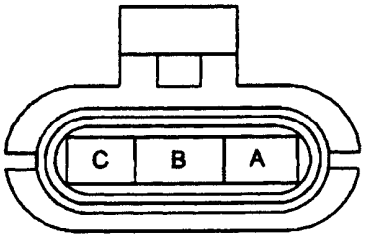
Brake Pressure Modulator Valve, LH Front (cont'd)



38598

Connector Part Information	• 12040977 • 3 Way F Metri-Pack 280 Series Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
C	GRA	1901	AAS Modulator Output-Hold- Left Front

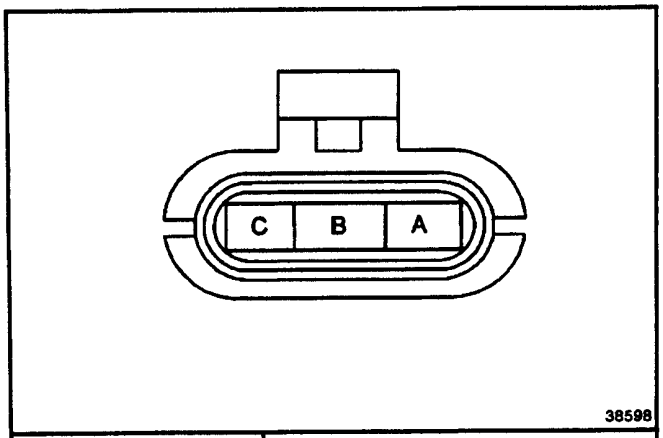
Brake Pressure Modulator Valve, RH Front



38598

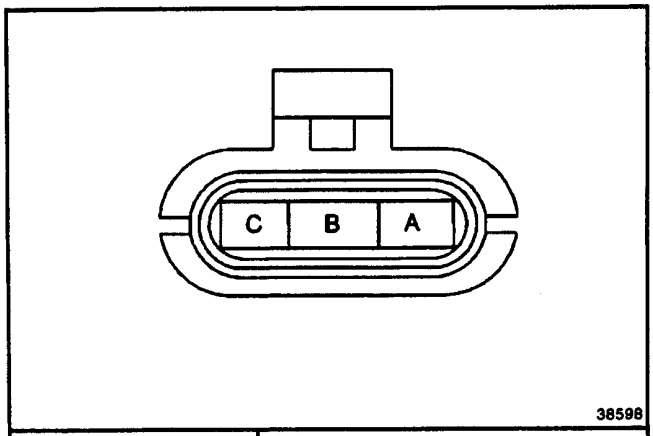
Connector Part Information	• 12040977 • 3 Way F Metri-Pack 280 Series Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PPL	1906	AAS Modulator Output-Exhaust-Right Front
B	TAN	1908	AAS Modulator Feed-Right Front
C	YEL	1907	AAS Modulator Output-Hold-Right Front

Brake Pressure Modulator Valve, LH Rear (Air)



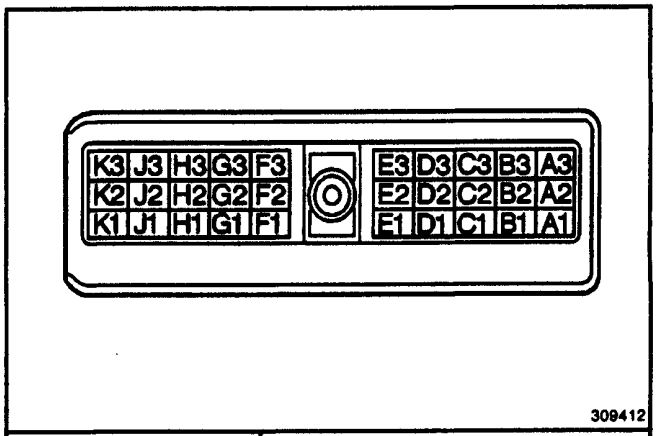
Connector Part Information	• 12040977 • 3 Way F Metri-Pack 280 Series Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	GRA/BLK	1913	AAS Modulator Output -Exhaust-Left Rear
B	ORN	1915	AAS Modulator Feed-Left Rear
C	LT BLU/BLK	1914	AAS Modulator Output-Hold-Left Rear

Brake Pressure Modulator Valve, RH Rear (Air)



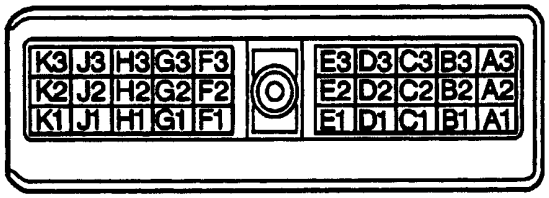
Connector Part Information	• 12040977 • 3 Way F Metri-Pack 280 Series Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	LT GRN/WHT	1918	AAS Modulator Output-Exhaust-Right Rear
B	PPL	1920	AAS Modulator Feed-Right Rear
C	PNK/BLK	1919	AAS Modulator Output-Hold- Right Rear

Electronic Brake Control Module C1 (Air)



Connector Part Information	• 12034398 • 30 Way F Metri-Pack 150 Series Pull To Seat, Sealed (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A1	BLK/WHT	1651	Air Anti Skid System Ground
A2	BLK/WHT	1651	Air Anti Skid System Ground
A3	BLK/WHT	1651	Air Anti Skid System Ground
B1	PNK	839	Fuse Output-Ignition
B2–B3	—	—	Not Used
C1	TAN	1908	AAS Modulator Feed-Right Front
C2–C3	—	—	Not Used
D1	YEL	1907	AAS Modulator Output-Hold-Right Front
D2–D3	—	—	Not Used
E1	PPL	1906	AAS Modulator Output-Exhaust-Right Front
E2	—	—	Not Used
E3	DK BLU	1899	Dash Lamp Relay Output-Coil
F1	DK GRN	1900	AAS Modulator Output-Exhaust-Left Front
F2–F3	—	—	Not Used
G1	GRA	1901	AAS Modulator Output-Hold-Left Front
G2	TAN/BLK	1921	Serial Data Link-A-SAE 1707

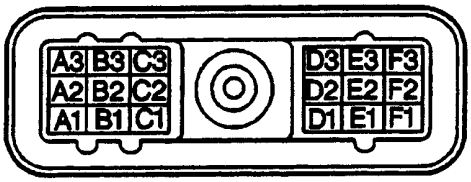
Electronic Brake Control Module C1 (Air) (cont'd)



309412

Connector Part Information		• 12034398 • 30 Way F Metri-Pack 150 Series Pull To Seat, Sealed (BLK)	
Pin	**Wire Color**	**Circuit No.**	**Function**
G3	WHT/BLK	1922	Serial Data Link-B-SAE 1707
H1	LT BLU	1902	AAS Modulator Feed-Left Front
H2	WHT	1909	AAS Wheel Speed Sensor Signal-Right Front
H3	BRN/WHT	1910	AAS Wheel Speed Sensor Return-Right Front
J1	LT GRN	1903	AAS Wheel Speed Sensor Signal-Left Front
J2	ORN	1904	AAS Wheel Speed Sensor Return-Left Front
J3	—	—	Not Used
K1	PNK	1905	Retarder Disable Output
K2	PNK	839	Fuse Output-Ignition
K3	PNK	839	Fuse Output-Ignition

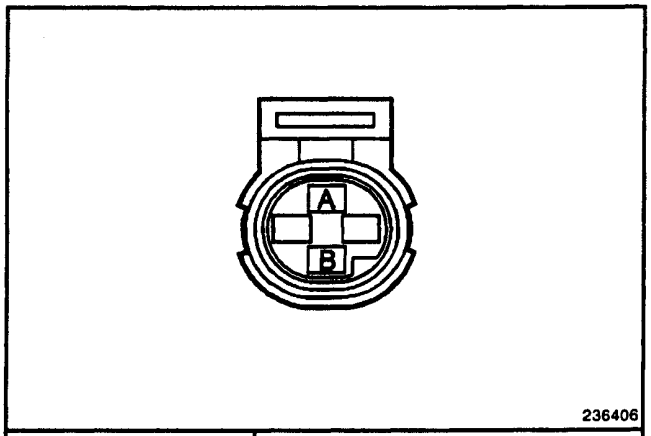
Electronic Brake Control Module C2 (Air)



230155

Connector Part Information		• 12040921 • 18 Way F Metri-Pack 150 Series Pull To Seat, Sealed (BLK)	
Pin	**Wire Color**	**Circuit No.**	**Function**
A1	PPL	1920	AAS Modulator Feed-Right Rear
A2–A3	—	—	Not Used
B1	PNK/BLK	1919	AAS Modulator Output-Hold-Right Rear
B2–B3	—	—	Not Used
C1	LT GRN/WHT	1918	AAS Modulator Output-Exhaust-Right Rear
C2–C3	—	—	Not Used
D1	GRA/BLK	1913	AAS Modulator Output-Exhaust-Left Rear
D2–D3	—	—	Not Used
E1	LT BLU/BLK	1914	AAS Modulator Output-Hold-Left Rear
E2	LT GRN/BLK	1916	AAS Wheel Speed Sensor Signal-Right Rear
E3	LT BLU/WHT	1917	AAS Wheel Speed Sensor Return-Right Rear
F1	ORN	1915	AAS Modulator Feed-Left Rear
F2	DK BLU/WHT	1911	AAS Wheel Speed Sensor Signal-Left Rear
F3	DK GRN/WHT	1912	AAS Wheel Speed Sensor Return-Left Rear

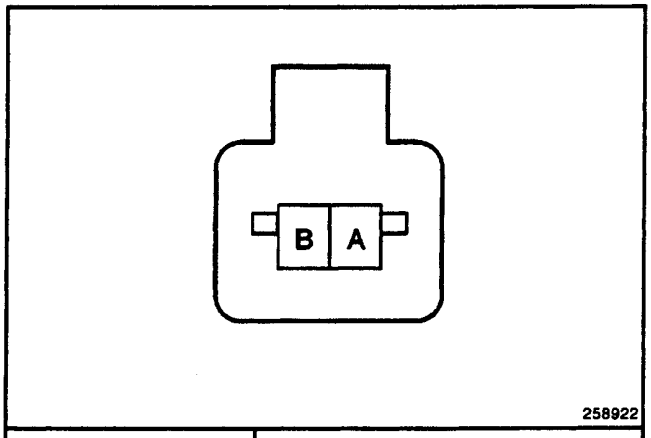
Low Air Pressure Switch



236406

Connector Part Information	• 12065400 • 2 Way F Metri-Pack 150 Series, Sealed (GRN)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	TAN/WHT	33	Brake Warning Indicator Lamp Output
B	BLK	150	Ground

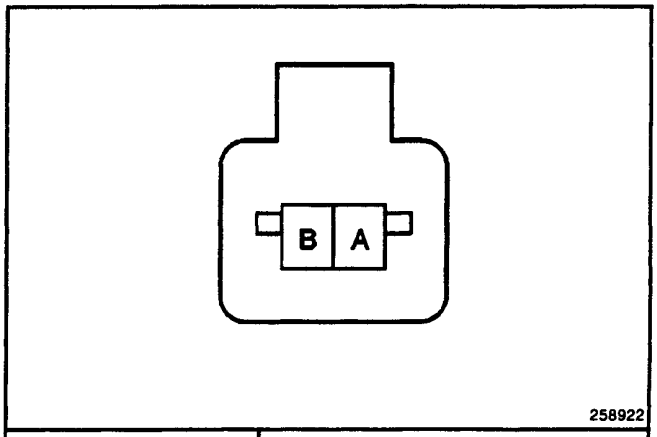
Wheel Speed Sensor, LH Front



258922

Connector Part Information	• 12162852 • 2Way F Metri-Pack 150.2 Pull To Seat (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	LT BLU	830	Wheel Speed Sensor Signal-Left Front
A	LT GRN	1903	AAS Wheel Speed Sensor Signal-Left Front
B	YEL	873	Wheel Speed Sensor Return-Left Front
B	ORN	1904	AAS Wheel Speed Sensor Return-Left Front

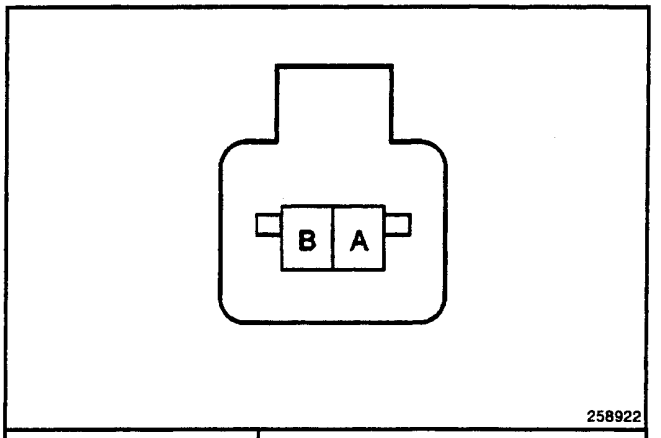
Wheel Speed Sensor, RH Front



258922

Connector Part Information	• 12162852 • 2Way F Metri-Pack 150.2 Pull To Seat (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	DK GRN	872	Wheel Speed Sensor Signal-Right Front
A	WHT	1909	AAS Wheel Speed Sensor Signal-Right Front
B	TAN	833	Wheel Speed Sensor Return-Right Front
B	BRN/WHT	1910	AAS Wheel Speed Sensor Return-Right Front

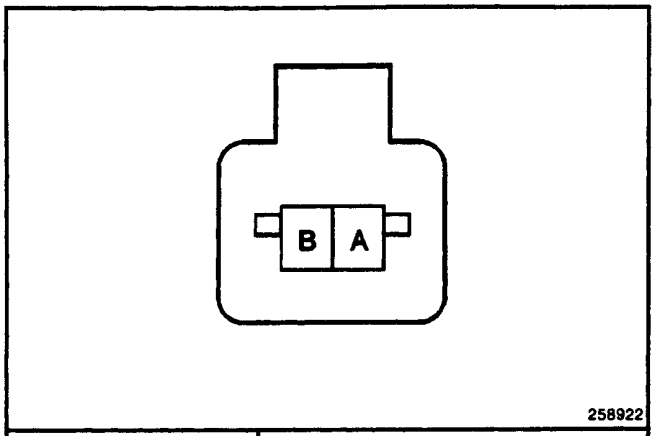
Wheel Speed Sensor, LH Rear (Air)



258922

Connector Part Information	• 12162852 • 2Way F Metri-Pack 150.2 Pull To Seat (BLK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	DK BLU/WHT	1911	AAS Wheel Speed Sensor Signal-Left Rear
B	DK GRN/WHT	1912	AAS Wheel Speed Sensor Return-Left Rear

Wheel Speed Sensor, RH Rear (Air)



258922

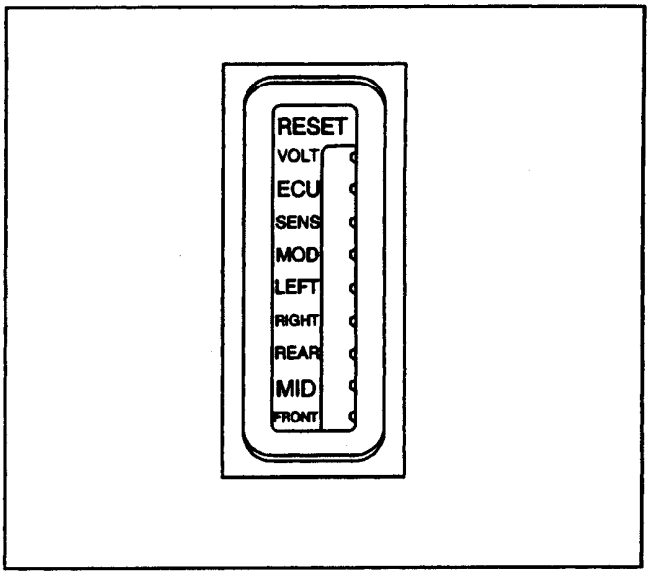
Connector Part Information		• 12162852 • 2Way F Metri-Pack 150.2 Pull To Seat (BLK)	
Pin	**Wire Color**	**Circuit No.**	**Function**
A	LT GRN/BLK	1916	AAS Wheel Speed Sensor Signal-Right Rear
B	LT BLU/WHT	1917	AAS Wheel Speed Sensor Return-Right Rear

Diagnostic Information and Procedures

Self-Diagnostics

EBCM Self Test

The EBCM performs a self test which continuously checks for proper operation of the entire ABS. The ABS indicator lamp (controlled by the (EBCM) located in the instrument panel) alerts the driver of a malfunction with the ABS. The diagnostic status lamps (located on the side of the EBCM housing) assist the technician to locate a malfunction with a specific ABS component. Special tools or equipment are not needed in order to read the EBCM diagnostic status lamps.



156583

- When the EBCM detects a malfunction with the ABS, the following actions occur:
  - The ABS indicator lamp is illuminated
  - The associated diagnostic status lamps are illuminated
  - All or a portion of the ABS is disabled (standard braking is available)
  - The portion of the ABS disabled is dependent upon the type of malfunction present
- If the air modulator at the right front wheel has an open circuit, the EBCM disables the ABS for BOTH the right front and left rear wheels (the EBCM divides and separates the brakes diagonally).

  The ABS will continue to function for the left front wheel and right rear wheel. A low voltage problem or EBCM malfunction will result in complete disabling of the ABS.

  Two or more failures will also result in the disabling of the entire system. With the failed component approach described above, the vehicle will retain improved braking stability after a single failure.
- The failed condition is stored and not cleared by the loss of power to the EBCM. The diagnostic status lamps will illuminate when the power is restored and remain illuminated until the failure is corrected.

  After the problem is corrected, the technician can clear or reset the EBCM diagnostics by passing a small magnet over the RESET point in the diagnostics window.

EBCM DIAGNOSTIC STATUS LAMPS
There are nine diagnostic status lamps located on the side of the EBCM. There is also a mechanically actuated reset switch. The first five diagnostic status lamps locate a problem to a specific component on the vehicle. The remaining four diagnostic status lamps indicate the location of the component. For normal operation, the only diagnostic status lamp illuminated will be the green VOLT diagnostic status lamp. If a malfunction exists with a component or component wiring, three diagnostic status lamps will be illuminated. For example, a malfunction with a right front wheel speed circuit would illuminate the RIGHT, FRONT and SENS diagnostic status lamps. The diagnostic status lamps are controlled by the EBCM and are either on or off depending upon their monitor function.

RESET
The EBCM contains a magnetically sensitive switch that is used to reset the EBCM. The reset switch is located directly beneath the RESET label on the EBCM. The device will respond to a magnet which has strength sufficient to lift a three (3) ounce weight. Holding a magnet against the RESET will cause all diagnostic status lamps to initially illuminate and erase all malfunctions (turning off any illuminated diagnostic status lamps).

VOLT Diagnostic Status Lamp
The VOLT diagnostic status lamp is green and will be illuminated during vehicle operation in order to indicate that vehicle voltage is present at the EBCM. If vehicle voltage is below 11.0 V or above 17.0 V, the VOLT status lamp will flash.

ECU Diagnostic Status Lamp
The ECU diagnostic status lamp is red and will illuminate in order to indicate an EBCM malfunction. The ECU diagnostic status lamp is illuminated for all EBCM failures except low voltage. For voltages less than 9.0 V, the ECU diagnostic status lamp illuminates to indicate an inoperative controller. When the voltage exceeds 9.0 V, the ECU status lamp will no longer be illuminated.

SENS Diagnostic Status Lamp
The SENS diagnostic status lamp is red and will illuminate in order to indicate a malfunction with one of the four wheel speed sensor circuits. The SENS diagnostic status lamp will illuminate with the RIGHT or LEFT diagnostic status lamp and the FRONT or REAR diagnostic status lamp.

MOD Diagnostic Status Lamp
The MOD diagnostic status lamp is red and will illuminate in order to indicate a malfunction with one of the four modulator solenoid circuits. The MOD diagnostic status lamp will illuminate with the RIGHT or LEFT diagnostic status lamp and the FRONT or REAR diagnostic status lamp.

LEFT Diagnostic Status Lamp
The LEFT diagnostic status lamp is red and will illuminate in order to indicate the location of a malfunction. The LEFT diagnostic status lamp will illuminate with the FRONT or REAR diagnostic status lamp and the MOD or SENS diagnostic status lamp.

RIGHT Diagnostic Status Lamp
The RIGHT diagnostic status lamp is red and will illuminate in order to indicate the location of a malfunction. The RIGHT diagnostic status lamp will illuminate with the FRONT or RIGHT lamps and the MOD or SENS diagnostic status lamp.

REAR Diagnostic Status Lamp
The REAR diagnostic status lamp is red and will illuminate in order to indicate the location of a malfunction. The REAR diagnostic status lamp will illuminate with the RIGHT or LEFT diagnostic status lamp and the MOD or SENS diagnostic status lamp.

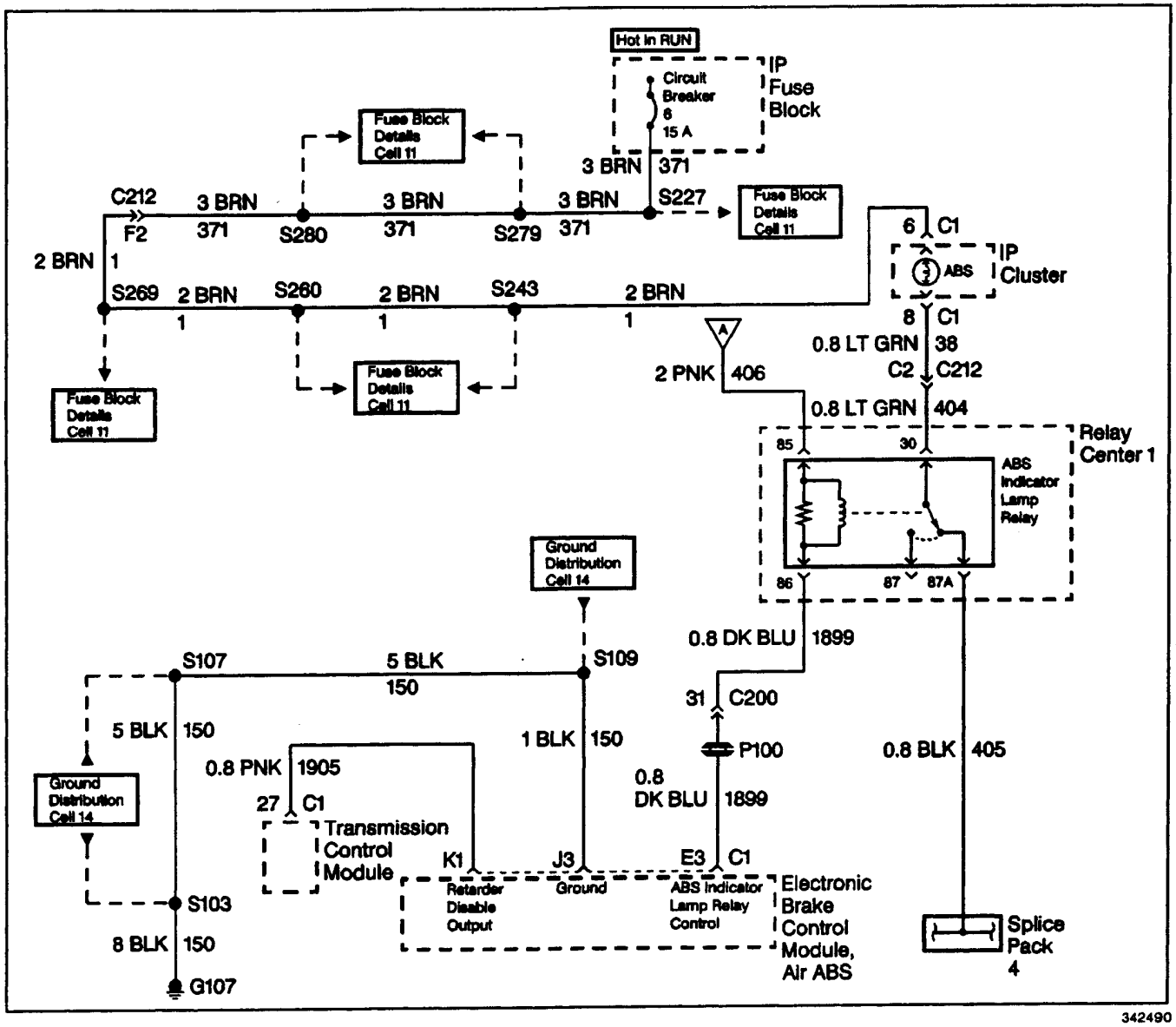
MID Diagnostic Status Lamp
The MID diagnostic status lamp is not used in troubleshooting the ABS and should illuminate only when a magnet is held on the RESET switch.

FRONT Diagnostic Status Lamp
The FRONT diagnostic status lamp is red and will illuminate in order to indicate the location of a malfunction. The FRONT diagnostic status lamp will illuminate with the RIGHT or LEFT diagnostic status lamp and the MOD or SENS diagnostic status lamp.

Intermittents and Poor Connections

Most intermittent faults are caused by a faulty electrical connection or faulty wiring. Occasionally a damaged EBCM can be the cause of an intermittent fault. Refer to Intermittents and Poor Connections in Electrical Diagnosis for a detailed explanation of how to locate and repair intermittent conditions.

Air ABS Diagnostic System Check



342490

System Description

The diagnostic system check is an organized approach to identifying an Antilock Brake System (ABS) malfunction. The diagnostic system check must be the starting point for any ABS complaint diagnosis because it directs the service technician to the next logical step in diagnosing the complaint. Failure to perform the Diagnostic System Check will result in extended diagnostic time, incorrect diagnosis and parts replacement.

The EBCM is supplied battery voltage (through the ABS relay) to terminals K1 and K2. Ground is provided through terminals A1, A2 and the ground clip on the EBCM chassis.

Diagnostic Aids

Excessive resistance in the signal ground or ignition power circuit will not allow communication with the EBCM. If communication with the EBCM is not possible, ensure that the ABS signal ground connection is good and that there is no excessive resistance in the ignition power circuit.

Test Description

An example test description follows:

5. This test will by-pass the ABS indicator relay in order to help isolate the malfunction.
15. This test checks the ABS indicator lamp and the wiring in order to help isolate the malfunction.

18. This test isolates the malfunction to either a shorted ABS indicator lamp relay coil or a wire shorted to voltage.
20. This test measures the voltage present at the EBCM.
23. This test measures the voltage present at the ABS relay contacts.
28. This test checks for a malfunctioning EBCM. If the red diagnostic status lamp is on, the voltage available to the EBCM is either below 9 V or above 9 V.
41. If the 30 amp ABS fuse is open, a short to ground in CKT 142, CKT 1941 or an internal short in the ABS relay is indicated.

Air ABS Diagnostic System Check

Step	Action	Value(s)	Yes	No
1	Turn the ignition to RUN and observe the ABS indicator lamp. Does the ABS indicator lamp turn on, flash twice, then remain on?	—	*Go to Step 3*	*Go to Step 2*
2	Does the ABS indicator lamp turn on, and remain on without flashing.	—	*Go to Step 11*	*Go to Step 4*
3	Drive the vehicle at speeds above 16 km/H (10 mph) while observing the ABS indicator lamp. Does the ABS indicator lamp remain on?	—	*Go to Step 11*	System OK. Refer to Diagnostic Aids on the facing page.
4	1. Turn the ignition to OFF. 2. Remove the ABS indicator lamp relay from the relay center #1. 3. Using a fused jumper wire such as *J 36169-A*, jumper terminal 30 of relay center #1 to ground. 4. Turn the ignition to RUN. Observe the ABS indicator lamp, is the ABS lamp on?	—	*Go to Step 6*	*Go to Step 5*
5	1. Turn the ignition to OFF. 2. Remove and inspect the ABS indicator lamp (refer to Instrument Panel and Gauges). Is the ABS indicator lamp open?	—	*Go to Step 30*	*Go to Step 31*
6	1. Remove the jumper wire. 2. Using a *J 39200*, measure the voltage between terminal 85 of the relay center #1 and ground. Is the voltage measured within the specified range?	11-16 V	*Go to Step 7*	*Go to Step 8*
7	1. Turn the ignition to OFF. 2. Using a *J 39200*, measure the resistance between terminal 87A of the relay center #1 and ground. Is the resistance measured within the specified range?	0-2 Ω	*Go to Step 9*	*Go to Step 35*
8	Inspect the circuit breaker #9. Is the circuit breaker closed?	—	*Go to Step 32*	*Go to Step 33*
9	1. Install the ABS indicator lamp relay. 2. Disconnect the EBCM harness connector from the EBCM. 3. Turn the ignition to RUN. Is the ABS indicator lamp on?	—	*Go to Step 34*	*Go to Step 10*
10	1. Turn the ignition to OFF. 2. Using a *J 39200*, measure the resistance between terminal 86 of the relay center #1 and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 36*	*Go to Step 37*
11	Observe the diagnostic status lamp window on the side of the EBCM. Is the green VOLT status lamp on?	—	*Go to Step 12*	*Go to Step 13*

Air ABS Diagnostic System Check (cont'd)

Step	Action	Value(s)	Yes	No
12	Is the green VOLT status lamp flashing?	—	*Go to Step 20*	*Go to Step 14*
13	1. Turn the ignition to RUN. 2. Observe the diagnostic status lamp window on the side of the EBCM. Are any red diagnostic status lamps on?	—	*Go to Step 34*	*Go to Step 20*
14	Observe the diagnostic status lamp window on the side of the EBCM. Are any red diagnostic status lamps on?	—	*Go to Step 28*	*Go to Step 15*
15	1. Turn the ignition to OFF. 2. Disconnect the EBCM harness connector from the EBCM. 3. Using a fused jumper wire such as *J 36169-A*, jumper terminal E3 of the EBCM harness connector to ground. 4. Turn the ignition to RUN. Is the ABS indicator lamp off?	—	*Go to Step 34*	*Go to Step 16*
16	Remove and inspect the jumper wire fuse. Is the fuse open?	—	*Go to Step 18*	*Go to Step 17*
17	Remove the ABS indicator lamp relay from the relay center. Is the ABS indicator lamp on?	—	*Go to Step 39*	*Go to Step 19*
18	1. Remove the ABS indicator lamp relay from the relay center #1. 2. Using a *J 39200*, measure the resistance between terminal E3 of the EBCM harness connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 38*	*Go to Step 36*
19	Using a *J 39200*, measure the voltage between terminal 85 of the relay center #1 and ground. Is the voltage measured within the specified range?	11–14 V	*Go to Step 36*	*Go to Step 32*
20	1. Turn the ignition to OFF. 2. Disconnect the EBCM harness connector from the EBCM. 3. Turn the ignition to RUN. 4. Using a *J 39200*, measure the voltage between terminal K2 and terminal A1 of the EBCM harness connector. Is the voltage measured within the specified range?	11–14 V	*Go to Step 34*	*Go to Step 21*
21	1. Turn the ignition to OFF. 2. Using a *J 39200*, measure the resistance between terminal A1 of the EBCM harness connector and ground. 3. Using a *J 39200*, measure the resistance between terminal A2 of the EBCM harness connector and ground. 4. Make sure that the ground clip on the EBCM chassis is clean and tight. Are both resistance measurements within the specified range?	0–2 Ω	*Go to Step 22*	*Go to Step 40*
22	Using a *J 39200*, measure the voltage of the vehicle battery. Refer to the Battery section. Is the voltage measured within the specified range?	11.5–14 V	*Go to Step 23*	Refer to Battery section

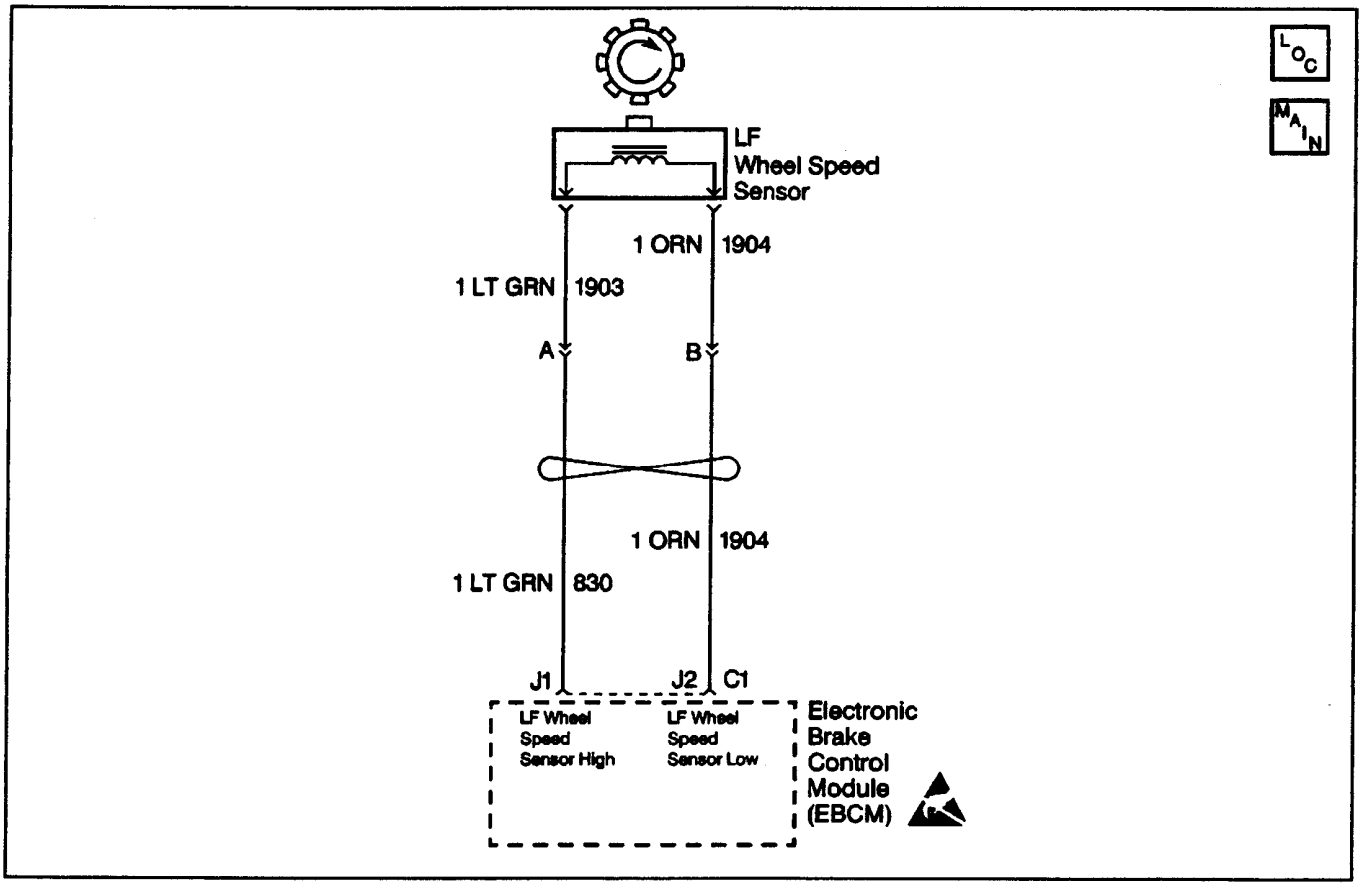
Air ABS Diagnostic System Check (cont'd)

Step	Action	Value(s)	Yes	No
23	1. Remove the ABS relay. 2. Turn the ignition to RUN. 3. Using a *J 39200*, measure the voltage between terminal 30 of the ABS relay harness connector and ground. Is the voltage measured within the specified range?	11–14 V	*Go to Step 25*	*Go to Step 24*
24	1. Turn the ignition to OFF. 2. Remove and inspect the 30 amp ABS fuse. Is the fuse open?	—	*Go to Step 41*	*Go to Step 42*
25	1. Turn the ignition to OFF. 2. Using a *J 39200*, measure the resistance between terminal 87 of ABS relay harness connector and terminals B1, K2 and K3 of the EBCM harness connector. Is the resistance measured within the specified range?	0–2 Ω	*Go to Step 26*	*Go to Step 43*
26	1. Turn the ignition to RUN. 2. Using the *J 39200*, measure the voltage between terminal 85 of the ABS relay harness connector and ground. Is the voltage measured within the specified range?	11–14 V	*Go to Step 27*	*Go to Step 44*
27	1. Turn the ignition to OFF. 2. Using a *J 39200*, measure the resistance between terminal 86 of the ABS relay harness connector and ground. Is the resistance measured within the specified range?	0–2 Ω	*Go to Step 45*	*Go to Step 35*
28	Observe the diagnostic status lamps on the side of the EBCM. Is the red ECU lamp on?	—	*Go to Step 20*	*Go to Step 29*
29	Observe the diagnostic status lamps on the side of the EBCM. There should be a minimum of three diagnostic status lamps on: • One LEFT or RIGHT • One FRONT or REAR • One MOD or SENS Are there three diagnostic status lamps on?	—	Go to the EBCM Diagnostic Status Lamps Table	*Go to Step 34*
30	Replace the ABS indicator lamp. Refer to Body and Chassis in Instrument Panel and Gauges.	—	*Go to Step 1*	—
31	Repair the open or high resistance in CKT 38 or CKT 404. Is the the broken wire or high resistance condition repaired?	—	*Go to Step 1*	—
32	Repair the open or high resistance in CKT 145 or CKT 406. Is the the broken wire or high resistance condition repaired?	—	*Go to Step 1*	—
33	1. Check for a short to ground in CKT 145 or CKT 406. 2. Replace the circuit breaker. Is the short corrected or the circuit breaker replaced?	—	*Go to Step 1*	—

Air ABS Diagnostic System Check (cont'd)

Step	Action	Value(s)	Yes	No
34	1. Inspect the EBCM harness connector for physical damage that may cause a malfunction with the EBCM connector connected to the EBCM. 2. Reconnect all of the connectors. 3. Drive the vehicle above 24 km/h (15 mph) for at least 30 seconds. Is the malfunction still present?	—	*Go to Step 46*	The malfunction is intermittant. Go to Diagnostic Aids
35	Repair the open or high resistance in CKT 150. Is the broken wire or high resistance repaired?	—	*Go to Step 1*	—
36	Replace the ABS indicator lamp relay. Is the malfunction corrected?	—	*Go to Step 1*	—
37	Repair the short to ground in CKT 1899. Is the short corrected?	—	*Go to Step 1*	—
38	Repair the short to voltage in CKT 1899. Is the short corrected?	—	*Go to Step 1*	—
39	Repair the short to ground in CKT 38 or CKT 404. Is the short corrected?	—	*Go to Step 1*	—
40	Repair the open or high resistance in CKT 1651. Is the broken wire or high resistance repaired?	—	*Go to Step 1*	—
41	Check for a short to ground in CKT 1442 or a shorted ABS relay. Is the shorted wire or shorted ABS relay repaired?	—	*Go to Step 1*	—
42	Repair the open or high resistance in CKT 1442. Is the broken wire or high resistance repaired?	—	*Go to Step 1*	—
43	Repair the open or high resistance in CKT 839. Is the broken wire or high resistance repaired?	—	*Go to Step 1*	—
44	Repair the open or high resistance in CKT 139 or CKT 145. Is the broken wire or high resistance repaired?	—	*Go to Step 1*	—
45	Replace the ABS relay. Is the malfunction corrected?	—	*Go to Step 1*	—
46	Replace the EBCM. Is the malfunction corrected?	—	System OK	—

Status Lamps Illuminated - Left, Front, and Sens



325396

Circuit Description

As the toothed ring passes by the wheel speed sensor, changes in the electromagnetic field cause the wheel speed sensor to produce a sinusoidal (AC) voltage signal whose frequency and amplitude is proportional to wheel speed. The magnitude of this signal is directly related to wheel speed and the proximity of the wheel speed sensor to the toothed ring, often referred to as the air gap.

Conditions for Illuminating Diagnostic Status Lamps

- Open wheel speed sensor or wheel speed sensor wiring
- Shorted wheel speed sensor or wheel speed sensor wiring
- Wheel speed signal not present or does not conform to design criteria

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the LEFT, FRONT and SENS diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all wheel speed sensor circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front* in this section.

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

3. This test checks for the correct resistance of the wheel speed sensor circuit (including wiring).
4. This test checks for the correct resistance of the wheel speed sensor.
5. This step checks for a short to ground in the wheel speed sensor circuit.

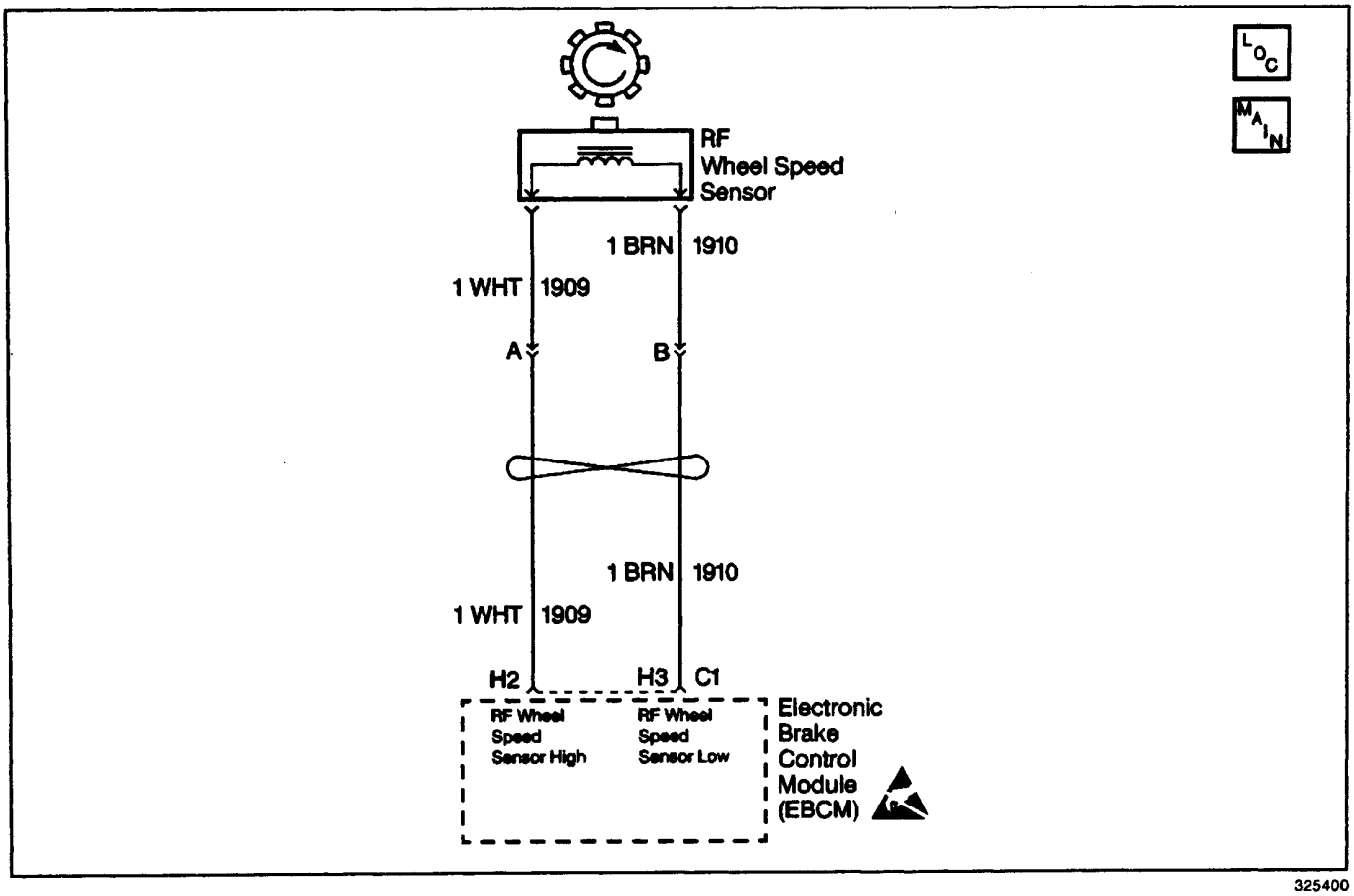
Status Lamps Illuminated - Left, Front, and Sens

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C1. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals J1 and J2 of the EBCM connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 5*	*Go to Step 4*
4	Using a *J 39200*, measure the resistance between terminals A and B of the LF wheel speed sensor connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 13*	*Go to Step 12*
5	Using a *J 39200*, measure the resistance between terminal J1 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 6*	*Go to Step 15*
6	Inspect the wheel bearings for looseness or excessive wear and verify that the bearing free play is within specific Refer to "Front Suspension" for bearing information. Are the wheel bearings OK?	—	*Go to Step 7*	*Go to Step 10*
7	Inspect the wheel speed sensor for proper installation. Is the wheel speed sensor properly installed?	—	*Go to Step 8*	*Go to Step 11*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
10	Repair excessive bearing play. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Left, Front, and Sens (cont'd)

Step	Action	Value(s)	Yes	No
12	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair open or high resistance in CKT 1903 or 1904. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
15	Repair short to ground in CKT 1903 or 1904. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Right, Front and Sens



325400

Circuit Description

As the toothed ring passes by the wheel speed sensor, changes in the electromagnetic field cause the wheel speed sensor to produce a sinusoidal (AC) voltage signal whose frequency and amplitude is proportional to wheel speed. The magnitude of this signal is directly related to wheel speed and the proximity of the wheel speed sensor to the toothed ring, often referred to as the air gap

Conditions for Illuminating Diagnostic Status Lamps

- Open wheel speed sensor or wheel speed sensor wiring
- Shorted wheel speed sensor or wheel speed sensor wiring
- Wheel speed signal not present or does not conform to design criteria

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the RIGHT, FRONT and SENS diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all wheel speed sensor circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thorough checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Front* in this section.

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

3. This test checks for the correct resistance of the wheel speed sensor circuit (including wiring).
4. This test checks for the correct resistance of the wheel speed sensor.
5. This step checks for a short to ground in the wheel speed sensor circuit.

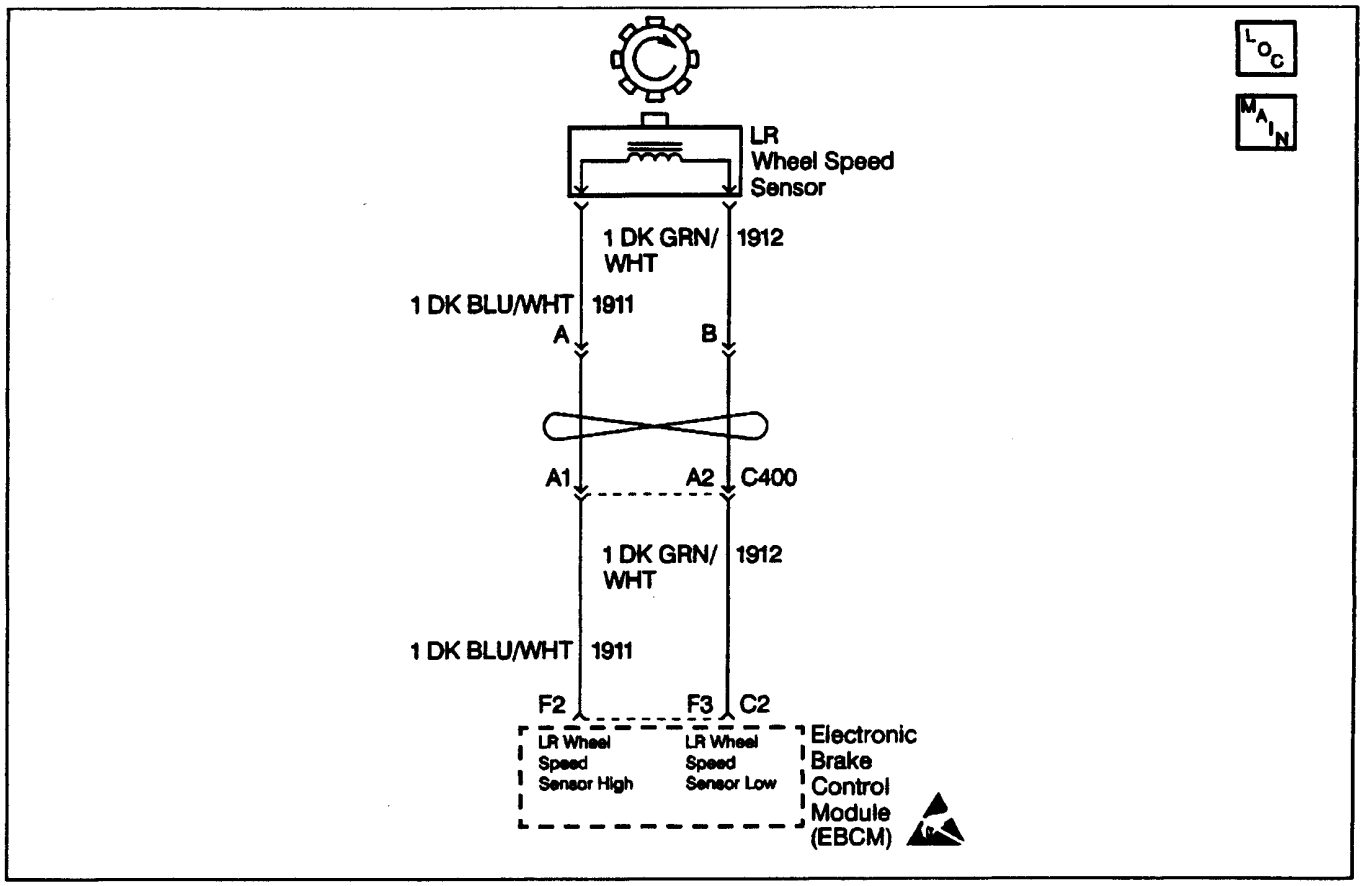
Status Lamps Illuminated - Right, Front and Sens

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C1. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals H3 and H2 of the EBCM harness connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 5*	*Go to Step 4*
4	Disconnect the wheel speed sensor wiring harness from the wheel speed sensor pigtail connector. Using a *J 39200*, measure the resistance between terminals A and B of the RF wheel speed sensor connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 13*	*Go to Step 12*
5	Using a *J 39200*, measure the resistance between terminal H3 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 6*	*Go to Step 15*
6	Inspect the wheel bearings for looseness or excessive wear and verify that the bearing free play is within specification. Refer to "Front Suspension" for bearing information. Are the wheel bearings OK?	—	*Go to Step 7*	*Go to Step 10*
7	Inspect the wheel speed sensor for proper installation. Is the wheel speed sensor properly installed?	—	*Go to Step 8*	*Go to Step 11*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Right, Front and Sens (cont'd)

Step	Action	Value(s)	Yes	No
10	Repair excessive bearing play. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
12	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair open or high resistance in CKT 1909 or 1910. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
15	Repair short to ground in CKT 1909 or 1910. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Left, Rear, and Sens



341059

Circuit Description

As the toothed ring passes by the wheel speed sensor, changes in the electromagnetic field cause the wheel speed sensor to produce a sinusoidal (AC) voltage signal whose frequency and amplitude is proportional to wheel speed. The magnitude of this signal is directly related to wheel speed and the proximity of the wheel speed sensor to the toothed ring, often referred to as the air gap.

Conditions for Illuminating Diagnostic Status Lamps

- Open wheel speed sensor or wheel speed sensor wiring
- Shorted wheel speed sensor or wheel speed sensor wiring
- Wheel speed signal not present or does not conform to design criteria

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the LEFT, REAR and SENS diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all wheel speed sensor circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear* in this section.

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

3. This test checks for the correct resistance of the wheel speed sensor circuit (including wiring).
4. This test checks for the correct resistance of the wheel speed sensor.
5. This step checks for a short to ground in the wheel speed sensor circuit.

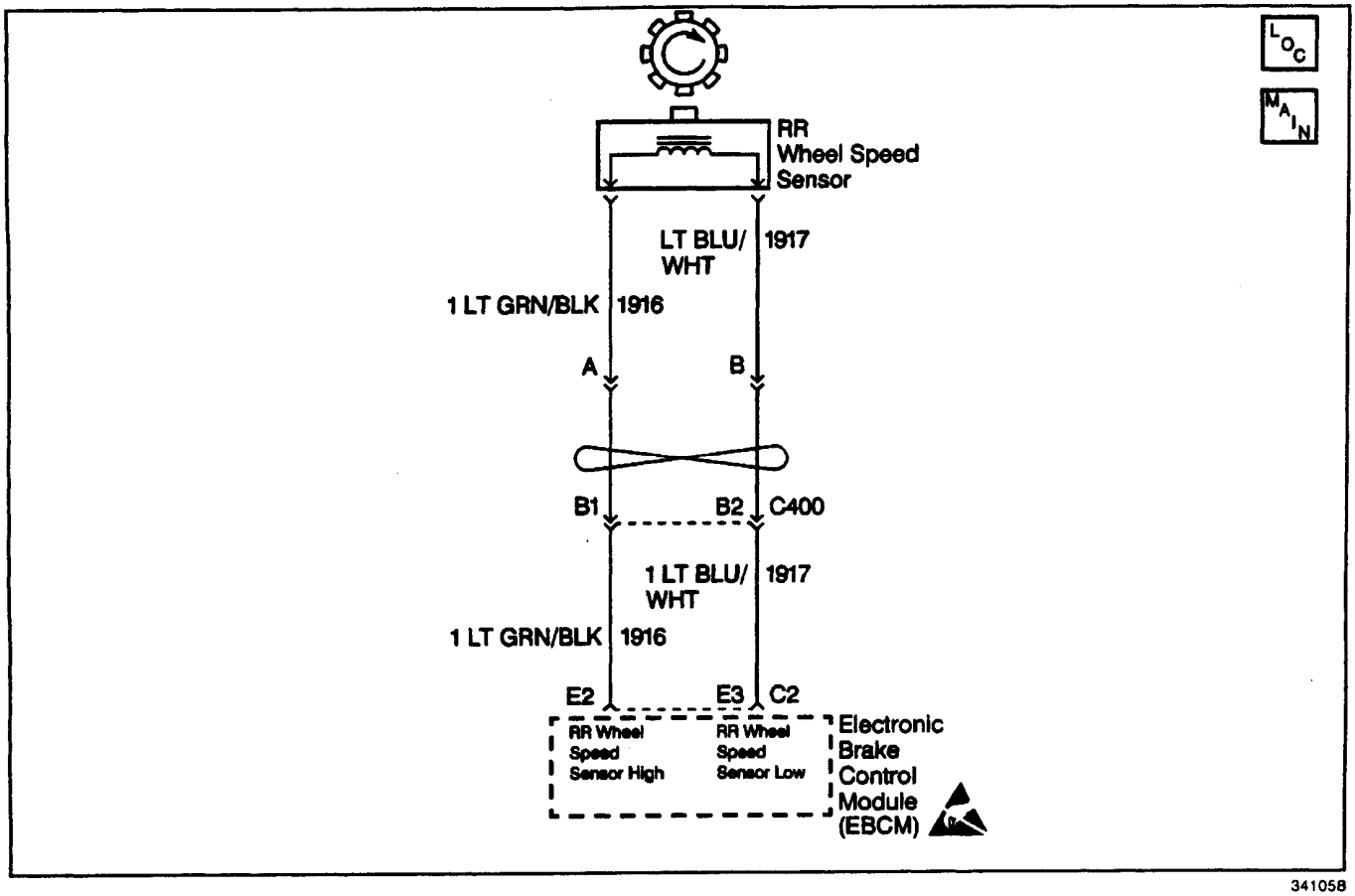
Status Lamps Illuminated - Left, Rear, and Sens

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C2. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals F2 and F3 of the EBCM harness connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 5*	*Go to Step 4*
4	Disconnect the wheel speed sensor wiring harness from the wheel speed sensor pigtail connector. Using a *J 39200*, measure the resistance between terminals A and B of the LR wheel speed sensor connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 13*	*Go to Step 12*
5	Using a *J 39200*, measure the resistance between terminal F2 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 6*	*Go to Step 12*
6	Inspect the wheel bearings for looseness or excessive wear and verify that the bearing free play is within specification. Refer to "Rear Axle" for bearing information. Are the wheel bearings OK?	—	*Go to Step 7*	*Go to Step 10*
7	Inspect the wheel speed sensor for proper installation. Is the wheel speed sensor properly installed?	—	*Go to Step 8*	*Go to Step 11*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
10	Repair excessive bearing play. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Left, Rear, and Sens (cont'd)

Step	Action	Value(s)	Yes	No
12	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair open or high resistance in CKT 1911 or 1912. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
15	Repair short to ground in CKT 1911 or 1912. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Right, Rear and Sens



341058

Circuit Description

As the toothed ring passes by the wheel speed sensor, changes in the electromagnetic field cause the wheel speed sensor to produce a sinusoidal (AC) voltage signal whose frequency and amplitude is proportional to wheel speed. The magnitude of this signal is directly related to wheel speed and the proximity of the wheel speed sensor to the toothed ring, often referred to as the air gap.

Conditions for Illuminating Diagnostic Status Lamps

- Open wheel speed sensor or wheel speed sensor wiring
- Shorted wheel speed sensor or wheel speed sensor wiring
- Wheel speed signal not present or does not conform to design criteria

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the RIGHT, REAR and SENS diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all wheel speed sensor circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting a wheel speed sensor, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the wheel speed sensor. Refer to *Wheel Speed Sensor Replacement - Rear* in this section.

Resistance of the wheel speed sensor will increase with an increase in sensor temperature. Refer to the following table for temperature/resistance values.

WSS Temperature vs. Sensor Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
-40 to 4	-40 to 40	1500 to 2500
5 to 43	41 to 110	1500 to 2500
44 to 93	111 to 200	1500 to 2500
94 to 150	201 to 302	1500 to 2500

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

3. This test checks for the correct resistance of the wheel speed sensor circuit (including wiring).
4. This test checks for the correct resistance of the wheel speed sensor.
5. This step checks for a short to ground in the wheel speed sensor circuit.

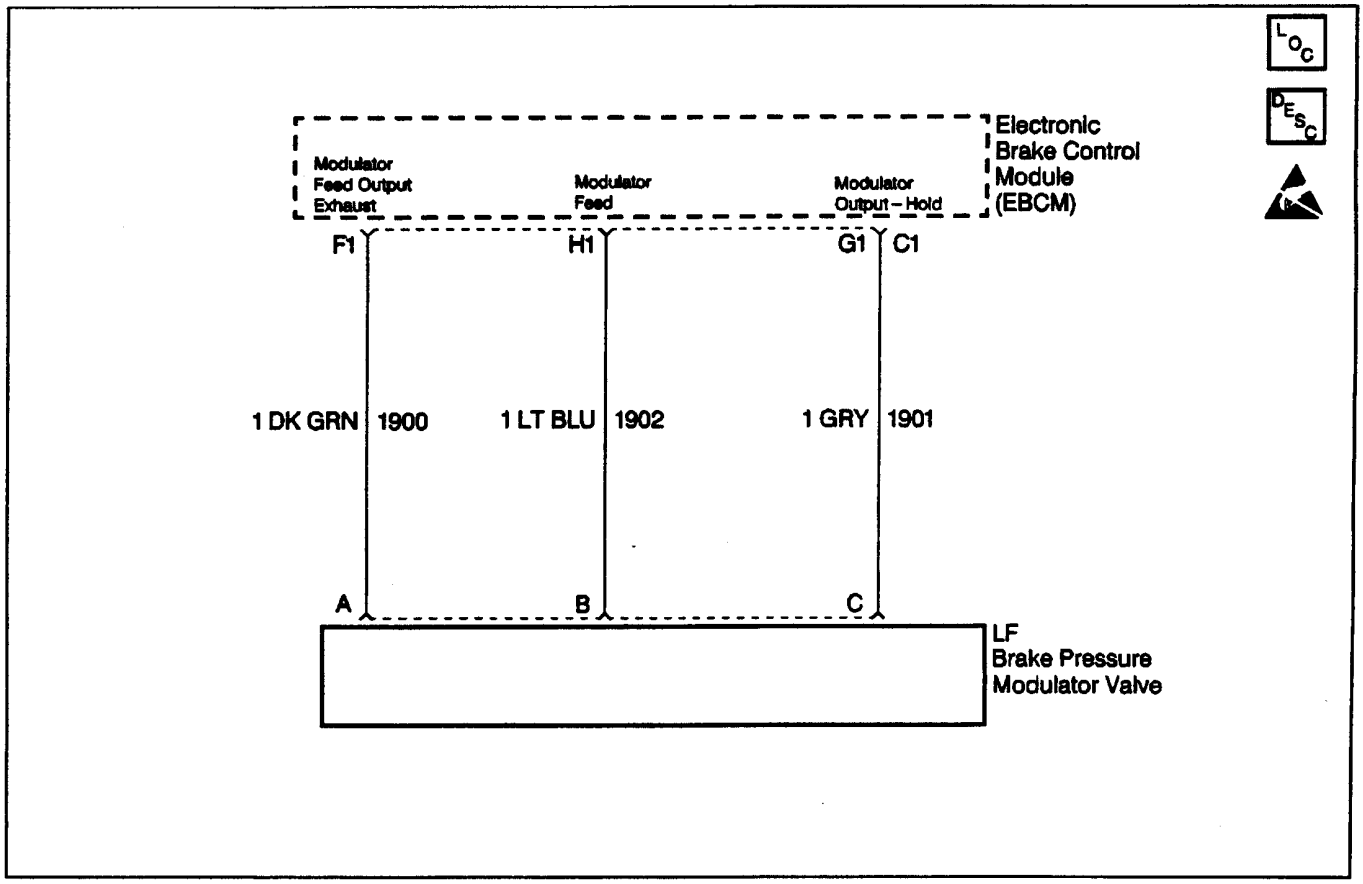
Status Lamps Illuminated - Right, Rear and Sens

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C2. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals E2 and E3 of the EBCM harness connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 5*	*Go to Step 4*
4	Disconnect the wheel speed sensor wiring harness from the wheel speed sensor pigtail connector. Using a *J 39200*, measure the resistance between terminals A and B of the RR wheel speed sensor connector. Is the resistance measured within the specified range?	1500–2500Ω	*Go to Step 13*	*Go to Step 12*
5	Using a *J 39200*, measure the resistance between terminal E2 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 6*	*Go to Step 15*
6	Inspect the wheel bearings for looseness or excessive wear and verify that the bearing free play is within specification. Refer to "Rear Axle" for bearing information. Are the wheel bearings OK?	—	*Go to Step 7*	*Go to Step 10*
7	Inspect the wheel speed sensor for proper installation. Is the wheel speed sensor properly installed?	—	*Go to Step 8*	*Go to Step 11*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Right, Rear and Sens (cont'd)

Step	Action	Value(s)	Yes	No
10	Repair excessive bearing play. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
12	Replace the wheel speed sensor. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair open or high resistance in CKT 1916 or 1917. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
15	Repair short to ground in CKT 1916 or 1917. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Left, Front, and Mod



325410

Circuit Description

The red diagnostic status lamps latches on to indicate a permanent or intermittent open or short circuit in the solenoids of one of the four modulators or the wiring connecting it to the system.

Conditions for Illuminating Diagnostic Status Lamps

- Open in modulator valve solenoid or modulator valve wiring
- Short in modulator valve solenoid or modulator valve wiring

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the LEFT, FRONT and MOD diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all modulator valve circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting a modulator valve, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the modulator valve. Refer to *Modulator Valve Replacement - Front* in this section.

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

3. This test checks for the correct resistance of the modulator valve exhaust solenoid circuit (including wiring). This test also checks for a short to ground in the modulator valve circuitry.
4. This test checks for the correct resistance of the modulator valve hold solenoid circuit (including wiring).

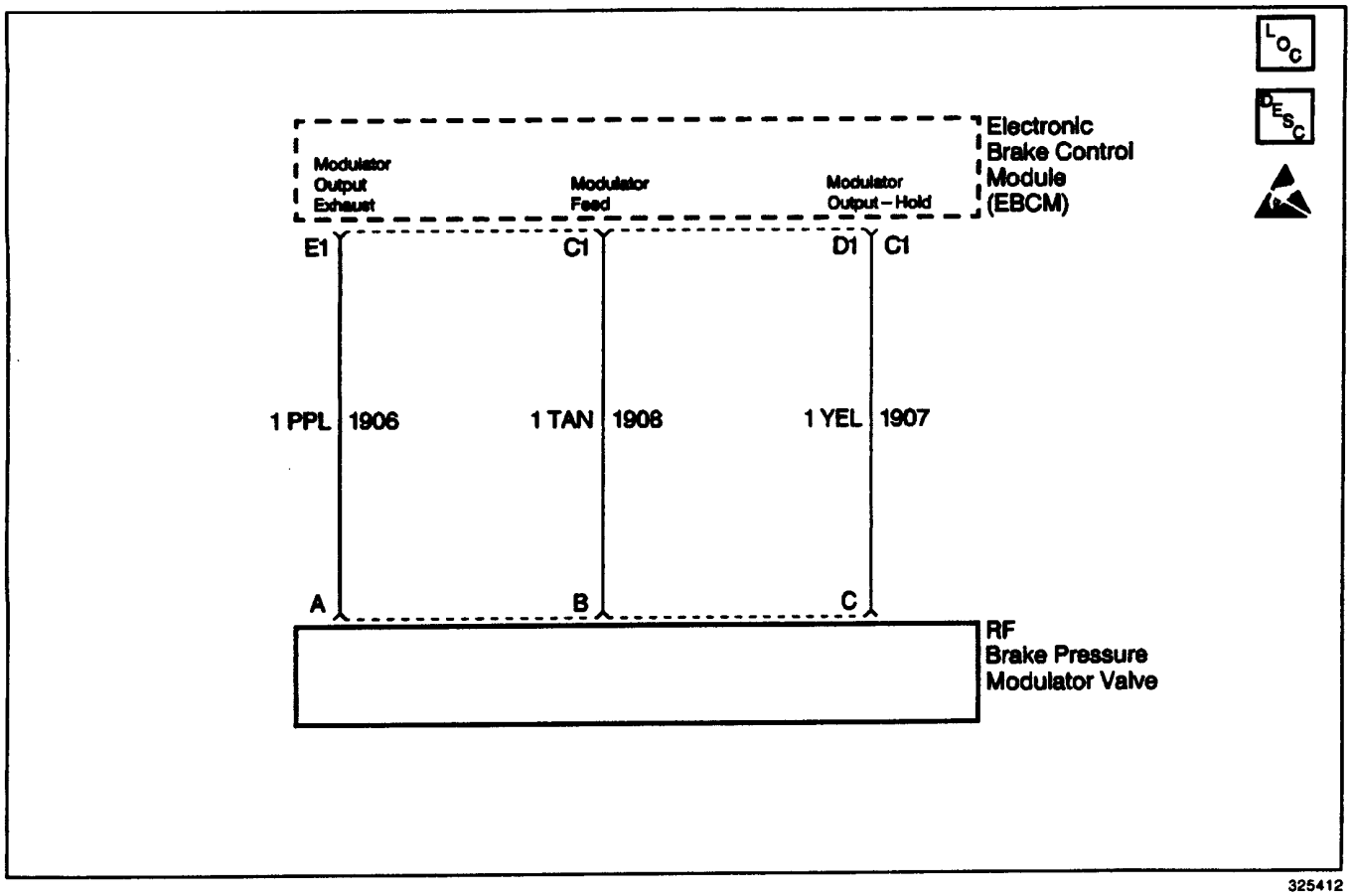
Status Lamps Illuminated - Left, Front, and Mod

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C1. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals H1 and F1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 4*	*Go to Step 6*
4	Using a *J 39200*, measure the resistance between terminals H1 and G1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 5*	*Go to Step 7*
5	Using a *J 39200*, measure the resistance between terminal H1 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 8*	*Go to Step 13*
6	1. Disconnect the left front modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals A and B of the LF modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 11*	*Go to Step 10*
7	1. Disconnect the left front modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals B and C of the LF modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 12*	*Go to Step 10*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
10	Replace the left front modulator valve. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair open or high resistance in CKT 1900 or 1902. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Left, Front, and Mod (cont'd)

Step	Action	Value(s)	Yes	No
12	Repair open or high resistance in CKT 1902 or 1901. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair short to ground in CKT 1900, 1901 or 1902. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Right, Front and Mod



325412

Circuit Description

The red diagnostic status lamps latches on to indicate a permanent or intermittent open or short circuit in the solenoids of one of the four modulators or the wiring connecting it to the system.

Conditions for Illuminating Diagnostic Status Lamps

- Open in modulator valve solenoid or modulator valve wiring
- Short in modulator valve solenoid or modulator valve wiring

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the RIGHT, FRONT and MOD diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all modulator valve circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting a modulator valve, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the modulator valve. Refer to *Modulator Valve Replacement - Front* in this section.

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

3. This test checks for the correct resistance of the modulator valve exhaust solenoid circuit (including wiring). This test also checks for a short to ground in the modulator valve circuitry.
4. This test checks for the correct resistance of the modulator valve hold solenoid circuit (including wiring).

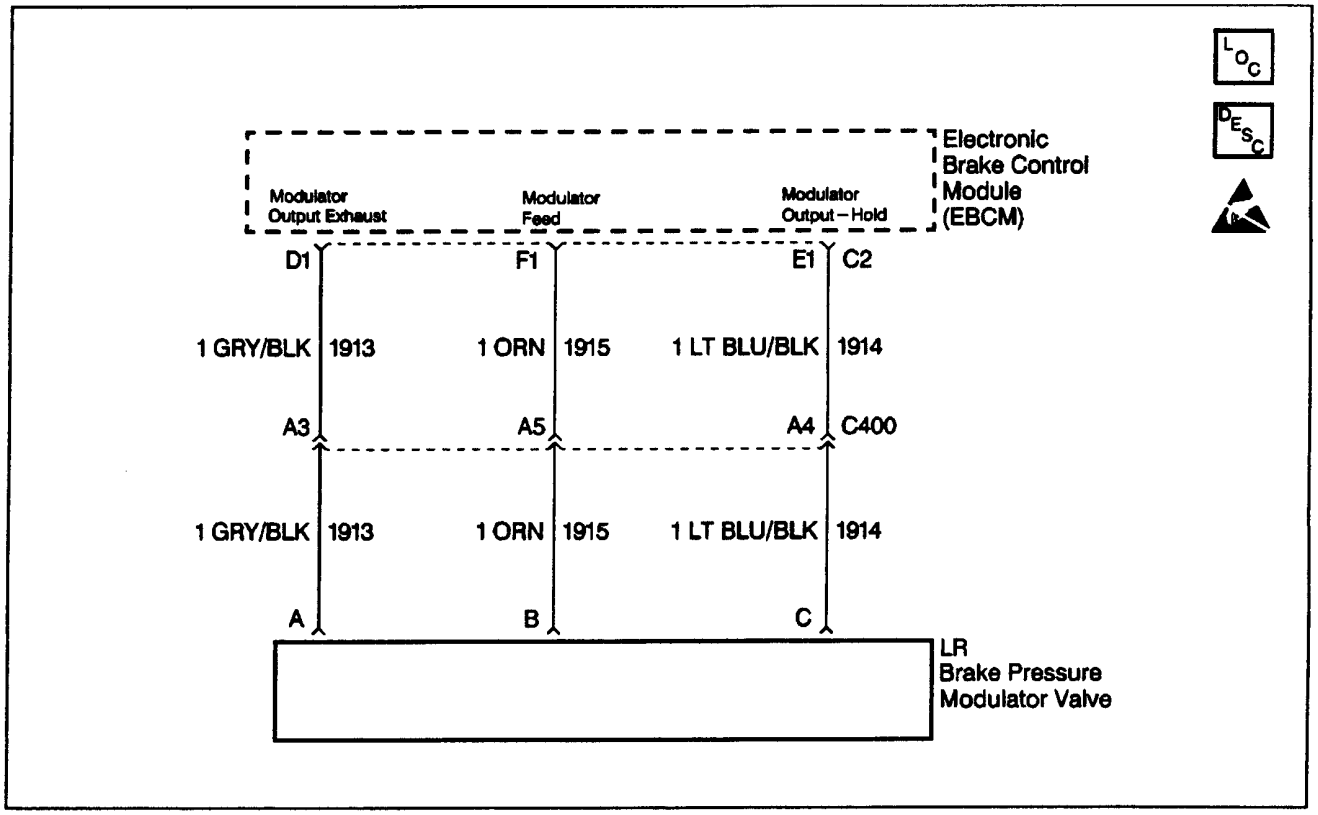
Status Lamps Illuminated - Right, Front and Mod

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C1. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals C1 and E1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 4*	*Go to Step 6*
4	Using a *J 39200*, measure the resistance between terminals C1 and D1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5	*Go to Step 5*	*Go to Step 7*
5	Using a *J 39200*, measure the resistance between terminal C1 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 8*	*Go to Step 13*
6	1. Disconnect the right front modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals A and B of the RF modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 11*	*Go to Step 10*
7	1. Disconnect the right front modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals B and C of the RF modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 12*	*Go to Step 10*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
10	Replace the right front modulator valve. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair open or high resistance in CKT 1906 or 1908. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Right, Front and Mod (cont'd)

Step	Action	Value(s)	Yes	No
12	Repair open or high resistance in CKT 1907 or 1908. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair short to ground in CKT 1906, 1907 or 1908. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Left, Rear, and Mod



341608

Circuit Description

The red diagnostic status lamps latches on to indicate a permanent or intermittent open or short circuit in the solenoids of one of the four modulators or the wiring connecting it to the system.

Conditions for Illuminating Diagnostic Status Lamps

- Open in modulator valve solenoid or modulator valve wiring
- Short in modulator valve solenoid or modulator valve wiring

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the LEFT, REAR and MOD diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all modulator valve circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting a modulator valve, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the modulator valve. Refer to *Modulator Valve Replacement - Rear* in this section.

Test Description

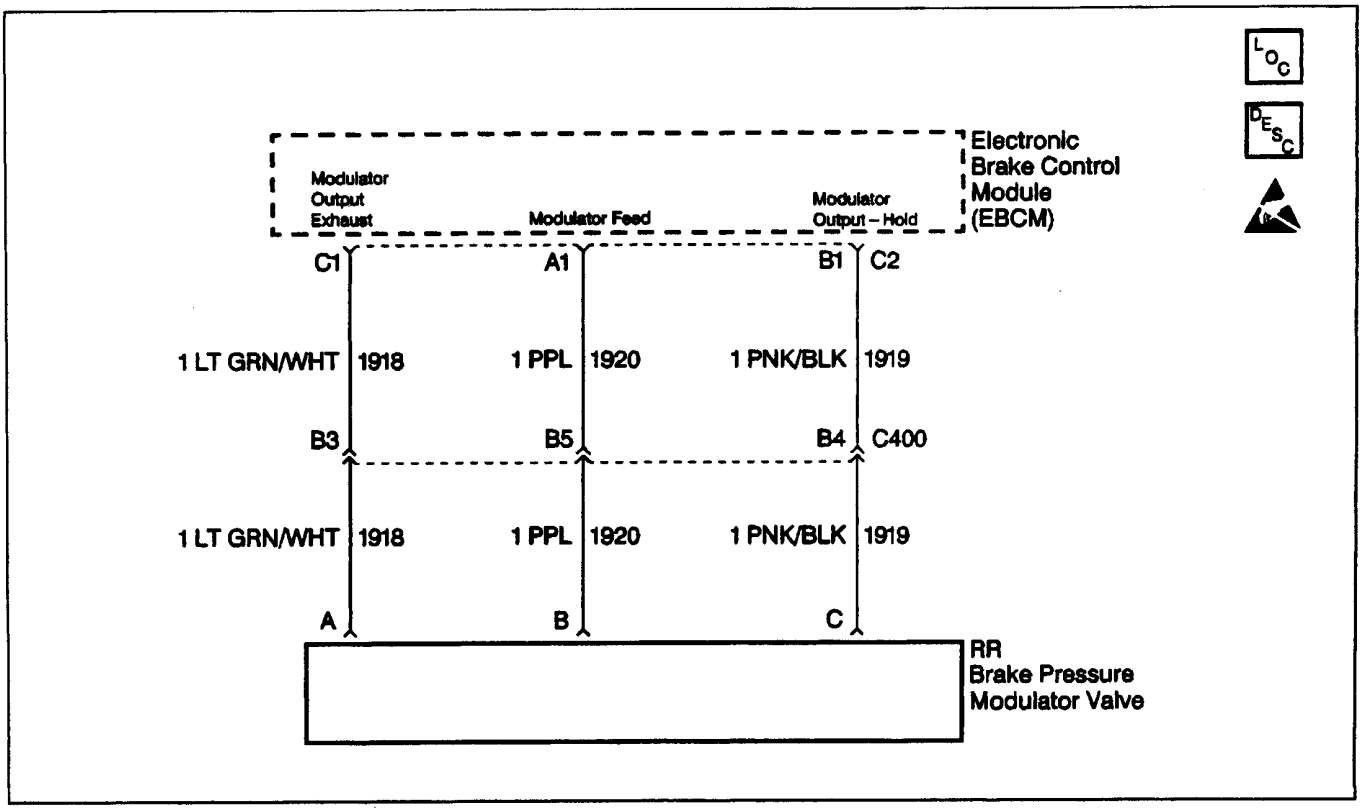
The number(s) below refer to the step number(s) on the diagnostic table.

3. This test checks for the correct resistance of the modulator valve exhaust solenoid circuit (including wiring). This test also checks for a short to ground in the modulator valve circuitry.
4. This test checks for the correct resistance of the modulator valve hold solenoid circuit (including wiring).

Status Lamps Illuminated - Left, Rear, and Mod

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C2. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals F1 and D1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 4*	*Go to Step 6*
4	Using a *J 39200*, measure the resistance between terminals F1 and E1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 5*	*Go to Step 7*
5	Using a *J 39200*, measure the resistance between terminal F1 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 8*	*Go to Step 13*
6	1. Disconnect the left rear modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals A and B of the LR modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 11*	*Go to Step 10*
7	1. Disconnect the left rear modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals B and C of the LR modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 12*	*Go to Step 10*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
10	Replace the left rear modulator valve. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair open or high resistance in CKT 1913 or 1915. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
12	Repair open or high resistance in CKT 1915 or 1914. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair short to ground in CKT 1913, 1914 or 1915. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—

Status Lamps Illuminated - Right, Rear and Mod



341609

Circuit Description

The red diagnostic status lamps latches on to indicate a permanent or intermittent open or short circuit in the solenoids of one of the four modulators or the wiring connecting it to the system.

Conditions for Illuminating Diagnostic Status Lamps

- Open in modulator valve solenoid or modulator valve wiring
- Short in modulator valve solenoid or modulator valve wiring

Action Taken When Diagnostic Status Lamps Illuminate

- The ABS indicator lamp is illuminated
- The ABS is disabled

Conditions for Clearing Diagnostic Status Lamps

- Repair the condition responsible for illuminating status lamps
- Reset the EBCM (see Diagnostic Status Lamps)

Diagnostic Aids

An intermittent malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation. If the RIGHT, REAR and MOD diagnostic status lamps are on only during moist environmental changes (rain, snow, vehicle wash), all circuitry should be thoroughly inspected for signs of water intrusion. Use the following procedure. Spray the suspected are with a 5% salt water solution (two teaspoons of salt to 12 oz. of water). Test drive the vehicle over various road surfaces (bumps, turns, etc.) above 24 km/H (15 mph) for at least 30 seconds. If condition returns, replace suspected harness.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

When inspecting the modulator valve, inspect the sensor terminals and harness connector for corrosion and/or water intrusion. If evidence of corrosion or water intrusion exists, replace the modulator valve. Refer to *Modulator Valve Replacement - Rear* in this section.

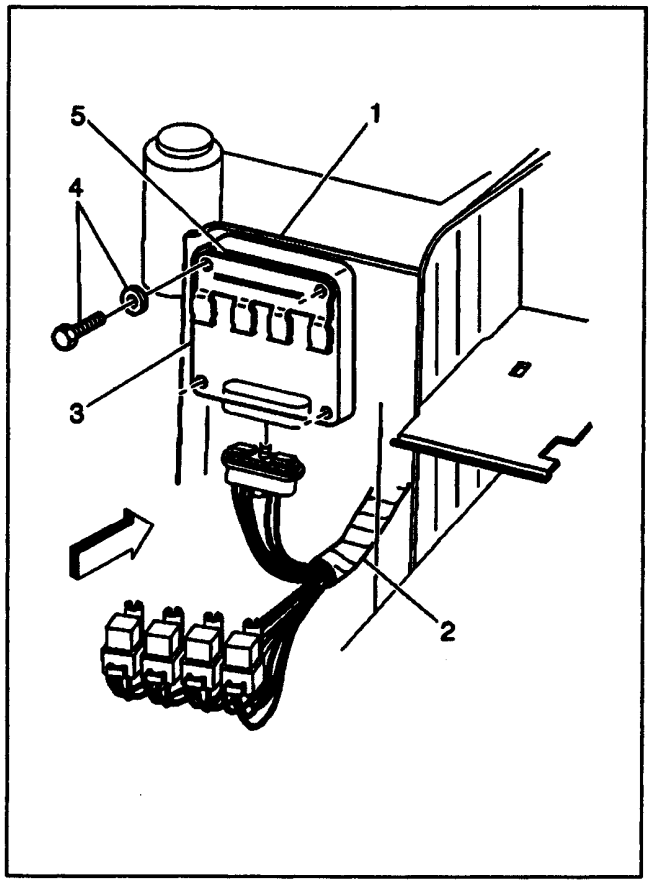
Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

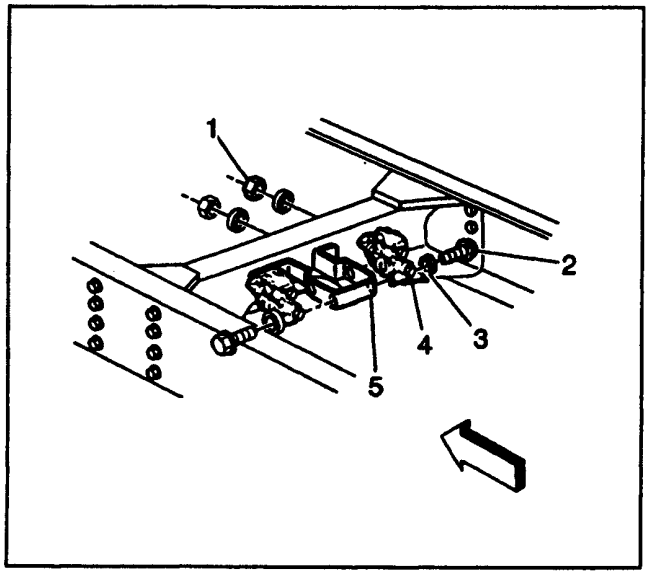
3. This test checks for the correct resistance of the modulator valve exhaust solenoid circuit (including wiring). This test also checks for a short to ground in the modulator valve circuitry.
4. This test checks for the correct resistance of the modulator valve hold solenoid circuit (including wiring).

Status Lamps Illuminated - Right, Rear and Mod

Step	Action	Value(s)	Yes	No
1	Were you sent here from the Diagnostic System Check?	—	*Go to Step 2*	Go to *Air ABS Diagnostic System Check*
2	1. Turn the ignition to OFF. 2. Disconnect EBCM connector C2. 3. Inspect the connector for signs of damage or corrosion. Is the connector OK?	—	*Go to Step 3*	*Go to Step 9*
3	Using a *J 39200*, measure the resistance between terminals A1 and C1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 4*	*Go to Step 6*
4	Using a *J 39200*, measure the resistance between terminals A1 and B1 of the EBCM connector. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 5*	*Go to Step 7*
5	Using a *J 39200*, measure the resistance between terminal A1 of the EBCM connector and ground. Is the resistance measured equal to the specified value?	OL	*Go to Step 8*	*Go to Step 13*
6	1. Disconnect the right rear modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals A and B of the RR modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 11*	*Go to Step 10*
7	1. Disconnect the right rear modulator harness connector. 2. Using a *J 39200*, measure the resistance between terminals B and C of the RR modulator valve. Is the resistance measured within the specified range?	3.5–5Ω	*Go to Step 12*	*Go to Step 10*
8	1. Reconnect all connectors. 2. Perform magnetic reset. 3. Test drive the vehicle above 16 km/H (10 mph). Did the ABS indicator lamp turn on and stay on?	—	*Go to Step 14*	Malfunction is intermittent. Refer to Diagnostic Aids
9	Repair the EBCM connector. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
10	Replace the right rear modulator valve. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
11	Repair open or high resistance in CKT 1918 or 1920. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
12	Repair open or high resistance in CKT 1920 or 1919. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
13	Repair short to ground in CKT 1918, 1919 or 1920. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—
14	Replace the EBCM. Is the repair complete?	—	Go to *Air ABS Diagnostic System Check*	—



341642



156601

Repair Instructions

Electronic Brake Control Module Replacement

Removal Procedure

1. Negative Battery Cable. Refer to *Battery Disconnect Caution.*
2. Remove the electrical connector bolt from EBCM.
3. Remove the electrical connector from EBCM.

Installation Procedure

1. Install EBCM to bracket.
2. Install the EBCM electrical connector.
3. Install the EBCM electrical connector bolt.
   Tighten
   Tighten the EBCM electrical connector bolt to 2 N.m (18 lb in)
   Notice: Refer to *Fastener Notice* in General Information.
4. Connect the negative battery cable. Refer to *Battery Disconnect Caution.*
5. Return to *Air ABS Diagnostic System Check.*

Modulator Valve Replacement - Rear

Removal Procedure

1. Disconnect the negative battery cable.
   Caution: Refer to Battery Disconnect Caution in Cautions and Notices.
2. Remove tie straps.
3. Disconnect electrical connector.
4. Remove the air lines.
   Refer to *Hose and Line Replacement* in Air Brakes.
5. Remove the two mounting bolts (2), four washers (3) and two nuts (5).
6. Remove the modulator (4).

Installation Procedure

Important: It may be necessary to transfer the fittings from the old modulator to the replacement part.

1. Install the modulator to vehicle using two mounting bolts (2), four washers (3) and two nuts (5).

   Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. **Tighten**

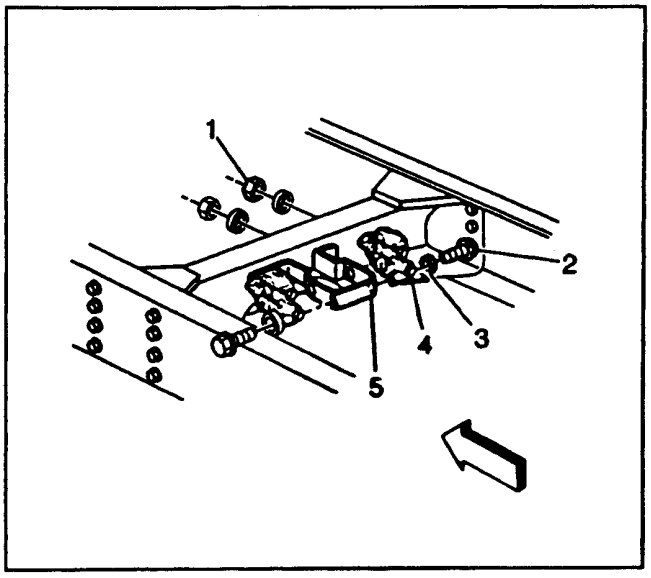
   Tighten the modulator nuts (5) to 70 N.m (52 lb ft).

3. Connect air lines to modulator valve.

   Refer to *Hose and Line Replacement* in Air Brakes.

4. Install the modulator electrical connector.
5. Install new tie straps.
6. Reconnect the negative battery cable.

   Caution: Refer to Battery Disconnect Caution in Cautions and Notices.



156601

Modulator Valve Replacement - Front

Removal Procedure

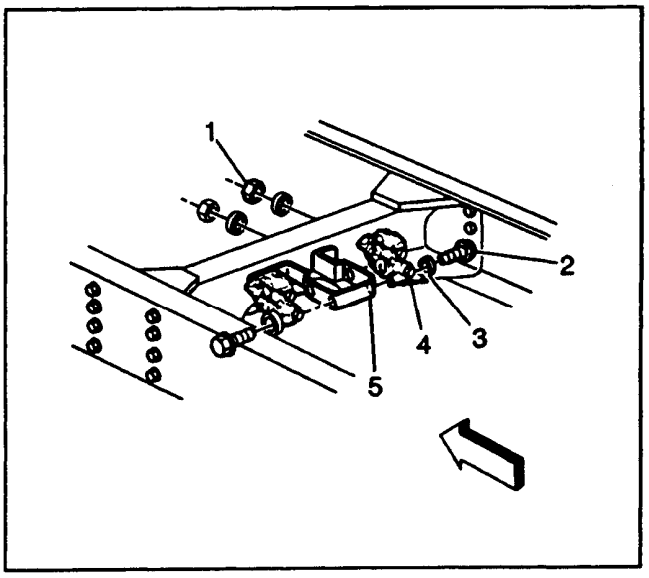
1. Disconnect the negative battery cable.

   Caution: Refer to Battery Disconnect Caution in Cautions and Notices.

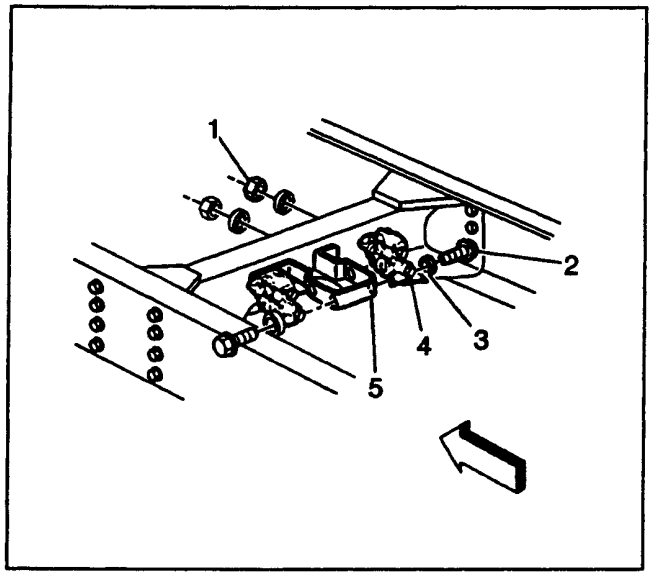
2. Remove tie straps.
3. Disconnect electrical connector.
4. Remove the air lines.

   Refer to *Hose and Line Replacement* in Air Brakes.

5. Remove the two mounting bolts (2), four washers (3) and two nuts (5).
6. Remove the modulator (4).



156601



156601

Installation Procedure

Important: It may be necessary to transfer the fittings from the old modulator to the replacement part.

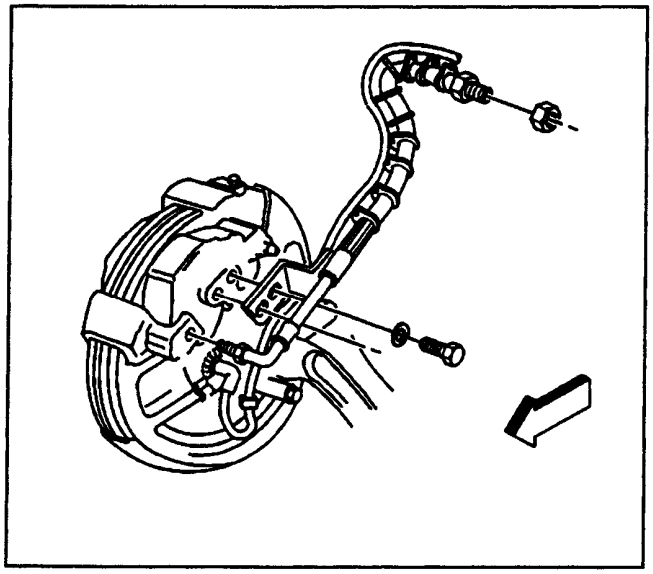
1. Install the modulator to vehicle using two mounting bolts (2), four washers (3) and two nuts (5).

   Notice: Refer to *Fastener Notice* in Cautions and Notices.
2. **Tighten**

   Tighten the modulator nuts (5) to 70 N·m (52 lb ft).
3. Connect air lines to modulator valve.

   Refer to *Hose and Line Replacement* in Air Brakes.
4. Install the modulator electrical connector.
5. Install new tie straps.
6. Reconnect the negative battery cable.

   Caution: Refer to Battery Disconnect Caution in Cautions and Notices.



305635

Wheel Speed Sensor Replacement - Front

Removal Procedure

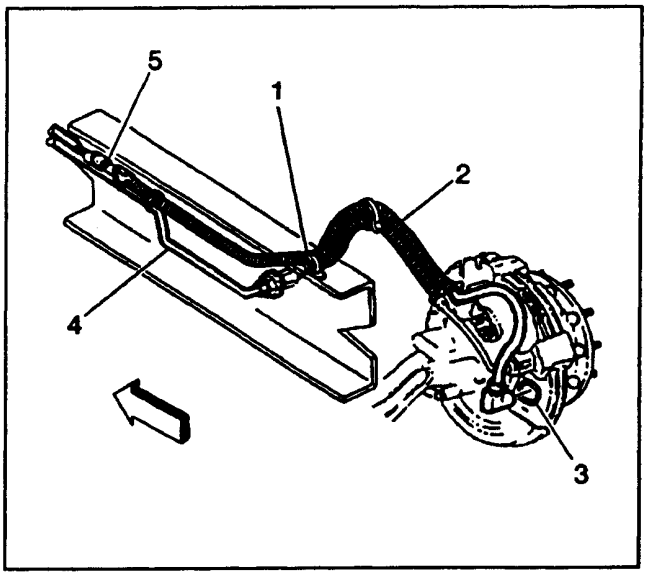
1. Disconnect the electrical connector.
2. Remove the nylon straps retaining the sensor wire to the brake line. Note the location of the straps.
3. Remove the wheel speed sensor from the bore.
4. Remove the speed sensor retaining clip. The clip may come out with the wheel speed sensor or stay in the bore. If the sensor retaining clip is still functioning correctly, save it for reinstallation. If the sensor retaining clip is not functioning correctly, replace the sensor retaining clip.

Installation Procedure

Important: You may have to use the wire retainers from the old wheel speed sensor wire on the new sensor. Do not damage the new wire when installing the retainers.

Important: When the wheel speed sensor is fully installed in the block bore, it contacts the tone ring which is attached to the wheel hub. Normal bearing play between the sensor tip and tone ring in the wheel hub will move the sensor tip away from the tone ring. This automatically establishes the proper air gap.

1. Install the wheel speed sensor retaining clip (3) completely into the bore. The clip should stop at the retaining tabs. Insert the wheel speed sensor into the clip. The wheel speed sensor should contact the tone ring.
2. Secure the sensor wire (2) to the brake line (4) with a wire tie (1) in the location noted during removal.
3. Connect the electrical connector (5).



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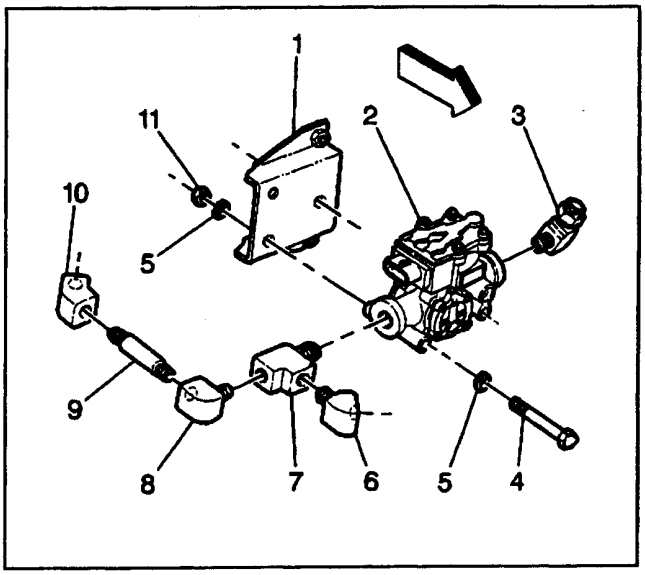
Wheel Speed Sensor Replacement - Rear

Removal Procedure

1. Disconnect the electrical connector.
2. Remove the nylon straps retaining the sensor wire to the brake line. Note the location of the straps.
3. Remove the wheel speed sensor (1) from the bore.
4. Remove the speed sensor retaining clip (2). The clip may come out with the wheel speed sensor or stay in the bore. If the sensor retaining clip is still functioning correctly, save it for reinstallation. If the sensor retaining clip is not functioning correctly, replace the sensor retaining clip.



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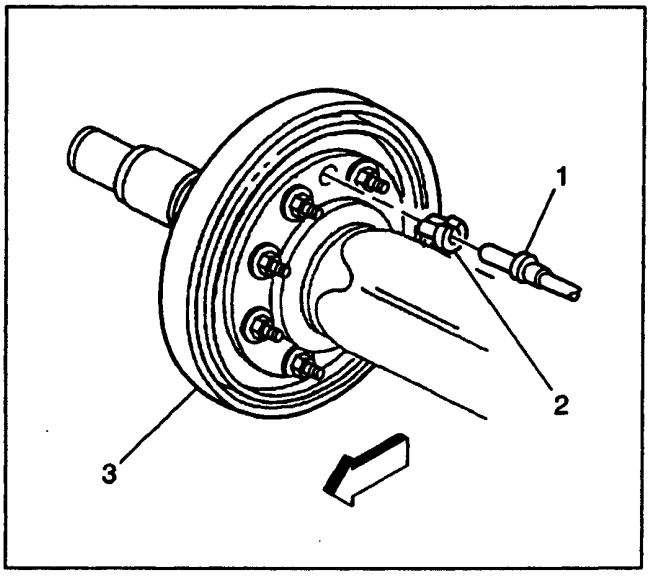

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Installation Procedure

Important: You may have to use the wire retainers from the old wheel speed sensor wire on the new sensor. Do not damage the new wire when installing the retainers.

Important: When the wheel speed sensor is fully installed in the block bore, it contacts the tone ring which is attached to the wheel hub. Normal bearing play between the sensor tip and tone ring in the wheel hub will move the sensor tip away from the tone ring. This automatically establishes the proper air gap.

1. Install the wheel speed sensor retaining clip (2) completely into the bore. The clip should stop at the retaining tabs. Insert the wheel speed sensor (1) into the clip. The wheel speed sensor should contact the tone ring.
2. Secure the sensor wire to the brake line with a wire tie in the location noted during removal.
3. Connect the electrical connector.

Description and Operation

Service Precautions

When working on this system, observe the following precautions:

- Before welding on the vehicle with an electric welding unit, complete the following steps:
  - Turn the ignition switch OFF.
  - Disconnect the EBCM connectors.
- Do not use a fast charger for starting the engine.
- Disconnect the negative battery cable when fast charging. Refer to *Battery Disconnect Caution* in Cautions and Notices.
- Never disconnect the battery from the vehicle electrical system while the engine is running.
- Connect all wiring harness connectors securely.
- Proper speed sensor wiring, routing and retaining are necessary in order to prevent false signals due to electrical noise. You can achieve proper system operation only by restoring the system to its original condition.

  When servicing the ABS, note the routing, position, mounting and locations of the following items:
  - All components
  - The wiring
  - The connectors
  - The clips
  - The brackets
  - The brake pipes

Follow the above mentioned precautions when working on ABS. Familiarize yourself with ABS and it relationships with other components on the vehicle.

General System Description

ABS Indicator Lamp Relay

The ABS indicator Lamp Relay is a normally closed relay. The ABS indicator is always on unless the EBCM energizes the relay coil and the relay contacts are opened.This logic ensures that the ABS indicator lamp will always be illuminated if there is a malfunction with the EBCM.

The Air ABS provides individual wheel braking control by using an Electronic Brake Control Module (EBCM), four wheel speed sensors and four air brake modulators. The EBCM monitors the rate of deceleration during braking and subsequently adjusts the brake application pressure at each wheel. The ABS will provide improved steerability and vehicle stability.

The rear axle brakes are controlled completely independent of each other. The brake application pressure at each individual wheel is adjusted solely on the basis of its behavior on the road surface on which it is traveling.

While each steering axle brake is under the control of an individual modulator, the EBCM does not treat these brakes totally independent of each other. The EBCM will control the braking force differences between the two brakes in order to minimize steering wheel pull, in the event each wheel is traveling on a different road surface.

In the case of vehicles equipped with tandem rear axles (6x2 or 6x4), the wheel speed sensors are installed at the wheels on the axle that is most likely to lose traction first. A single modulator controls both curb side brakes on the tandem, and another modulator controls both brakes on the drivers side of the tandem.

Since the brakes will likely be on the same road surface, both brakes on one side of the tandem are treated as one with this arrangement.

Base Braking Application

During normal braking, air pressure from the brake valve enters the control port of the service relay valve (either an antilock or standard service relay valve). The service relay valve delivers air through the ABS modulator located near the brake wheel and into the brake actuator.

ANTILOCK Braking Mode

If a service brake application is made and the wheel speed sensors detect an impending lockup, the EBCM will immediately begin modification of the brake application using the antilock modulator(s) at the affected wheel(s).

Solenoid valves contained in the modulator are energized and de-energized by the EBCM in order to modify the brake application. When a solenoid coil is energized, the solenoid valve will either open or close, causing exhaust or re-application of air pressure to the brake actuator. The solenoids in each modulator are controlled independently by the EBCM.

System Self Test

The EBCM will perform a self test which continuously checks for proper operation of the entire ABS. In order to alert the driver of a malfunction with the ABS, the EBCM will illuminate the ABS indicator lamp (located in the instrument panel).

In order to assist the technician locate a malfunction with a specific ABS component, the EBCM will illuminate any diagnostic status lamps associated with the malfunction (located on the side of the EBCM housing).

Wheel Speed Sensors

The front Wheel Speed Sensors (WSS) are a magnetic coil/pickup type. Each WSS produces an AC voltage signal which is transmitted to the EBCM in order to indicate how fast the wheel is turning. The speed of the wheel is directly proportional to the frequency and amplitude of the wheel speed signal.

Wheel Speed Sensor Tone Wheels

Each Wheel Speed Sensor uses a tone wheel in order to produce an AC voltage signal. Tone wheels are metal rings with teeth on the outside diameter. The AC voltage is produced as the teeth pass through the magnetic field of the WSS pole piece. The tone wheels are attached to the rotor or the drum. Any imperfections in the tone rings, such as a broken tooth or a missing tooth, can cause an inaccurate wheel speed signal.

Abbreviations and Definitions

MOD: Modulator Valve

CKT: Circuit

DLC: Data Link Connector

DMM: Digital Multimeter

DTC: Diagnostic Trouble Code

EBCM: Electronic Brake Control Module

EHCU: Electro-Hydraulic Control Unit

Infinite: Open Circuit/Unmeasurably High Resistance

LPA: Low Pressure Accumulator

OL: Open Circuit/Unmeasurably High Resistance

WSS: Wheel Speed Sensor

The EHCU is the entire ABS unit, including the BPMV and the EBCM. The BPMV is defined as the hydraulic control portion of the EHCU. The BPMV includes the internal control valves, the electric motor and the pumps. The BPMV does not include the EBCM. The EBCM is the electronic control portion of the EHCU. The EBCM mounts to the top of the BPMV. The EBCM is housed in aluminum with a black plastic top.

Basic Knowledge Required

You must have a basic knowledge of the following items before using this section. Without this basic knowledge, you will have difficulties using the diagnostic procedures contained in this section.

If you need a review of basic electrical troubleshooting, see the introduction to Electrical Diagnosis. Electrical Diagnosis also contains information on the basic use of circuit testing tools.

Additionally, General Motors Service Training offers courses in electrical and electronic service.

Basic Electrical Circuits
You should understand the basic electrical theory. You should also know the meaning of basic electrical concepts and measurement: voltage (volts), current (amperes) and resistance (ohms). You should understand what happens in a circuit with an open or shorted wire. You should be able to read and understand a wiring diagram.

Use of Circuit Testing Tools
You should be familiar with the high impedance Digital Multimeter (DMM) *J 39200*. You should be familiar with the meter controls and how to use them correctly. You should be able to measure voltage, resistance and current. You should also know how to use jumper wires to bypass components in order to test circuits.

Air ABS System Description

Electronic Brake Control Module
The controlling element of ABS is the Electronic Brake Control Module. Inputs to the system include four wheel speed sensors, brake switch, ignition switch, and unswitched battery power. Outputs include four air modulators and the ABS indicator lamp. The EBCM monitors the speed of each wheel. If any wheel begins to approach lock-up, the EBCM controls the air modulators to reduce brake pressure to the wheel approaching lock-up. Once the wheel regains traction, brake pressure is increased until the wheel again begins to approach lock-up. This cycle repeats until either the vehicle comes to a stop, the brake is released, or no wheels approach lock-up. Additionally, the EBCM monitors itself, each input and output for proper operation. If any system malfunction is detected, the EBCM will illuminate a light emitting diode (s) located in a window on the side of the EBCM housing. These diagnostic LED's are referred to as the diagnostic status lamps.

Wheel Speed Sensors
Wheel speed information is provided to the EBCM via a wiring harness from individual wheel speed sensors located at the wheels. Working in conjunction with a tone ring, wheel speed sensors provide information to the EBCM in the form of an AC voltage signal which varies in voltage and frequency as the speed of the wheel increases or decreases.The wheel speed sensor is installed in a mounting block on the axle housing. A spring loaded retaining clip is used to secure the wheel speed sensor into the mounting bore. This spring retainer is designed in a way that allows the wheel speed sensor to slide back and forth under force, but will retain it's position when force is removed. This allows the wheel speed sensor to self adjust after it is installed in the mounting bore and allows for an air gap between the wheel speed sensor and tone ring.

Wheel Speed Sensor Tone Wheels
Each Wheel Speed Sensor uses a tone wheel in order to produce an AC voltage signal. Tone wheels are metal rings with teeth on the outside diameter. The AC voltage is produced as the teeth pass through the magnetic field of the WSS pole piece. The tone wheels are attached to the rotor or the drum. Any imperfections in the tone rings, such as a broken tooth or a missing tooth, can cause an inaccurate wheel speed signal.

Tire Size Calibration
The EBCM accepts wheel speed signals from several different sizes of tire and wheel combinations. All vehicles are preprogrammed from the factory with the proper tire size calibration. Whenever tires of a different size are installed on the vehicle, the EBCM will automatically recalibrate itself to compensate.

Air ABS System Operation

ABS Indicator Lamp Operation
The system uses an amber ABS indicator lamp in the instrument cluster in order to show system operation and malfunctions.

Normal ABS Indicator Lamp Operation
The amber ABS indicator lamp is located in the instrument panel and alerts the driver of a malfunction in the ABS system. At vehicle start up, the EBCM illuminates the the amber ABS indicator light in the instrument cluster. The indicator will flash two times on start up and remain on until the vehicle reaches 11 to 16 km/H (7 to 10 mph), and then turn off. If a malfunction is present, the ABS indicator will remain on after the vehicle reaches 11 to 16 km/H (7 to 10 mph).

Tires and ABS
Correct tire size, proper inflation, accurate alignment and even wear are needed for good brake performance. These items are essential for proper ABS performance.

Spare Tire
Use of the spare tire supplied with the vehicle will not affect the performance of the system.

Replacement Tires
If the replacement tires are not the same size as the original tires, the EBCM will automatically recalibrate itself to compensate for the mismatch in wheel speeds.

Self-Tests
The EBCM performs a self test which continously checks for proper operation of the ABS system. The ABS indicator lamp alerts the driver of a malfunction in the ABS system. In the event that the EBCM detects a malfunction in the ABS system it will illuminate the amber ABS lamp located in the instrument panel. The associated diagnostic status lamps will also be illuminated.

Special Tools and Equipment

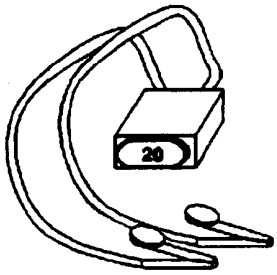
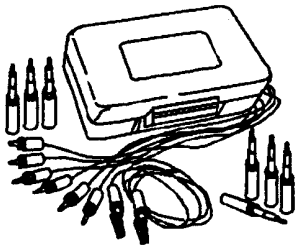
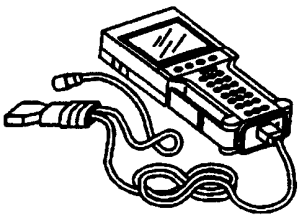
Illustration	Tool Number/ Description
3430	J 39200 Digital Multi-Meter
 1025	J 36169 Fused Jumper Wire

Illustration	Tool Number/ Description
 11799	J 35616 Connector Adapter Test Kit
 39438	Tech 2 Scan Tool

BLANK

A

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