

ANTI-LOCK BRAKE SYSTEM

1998 Mitsubishi Galant

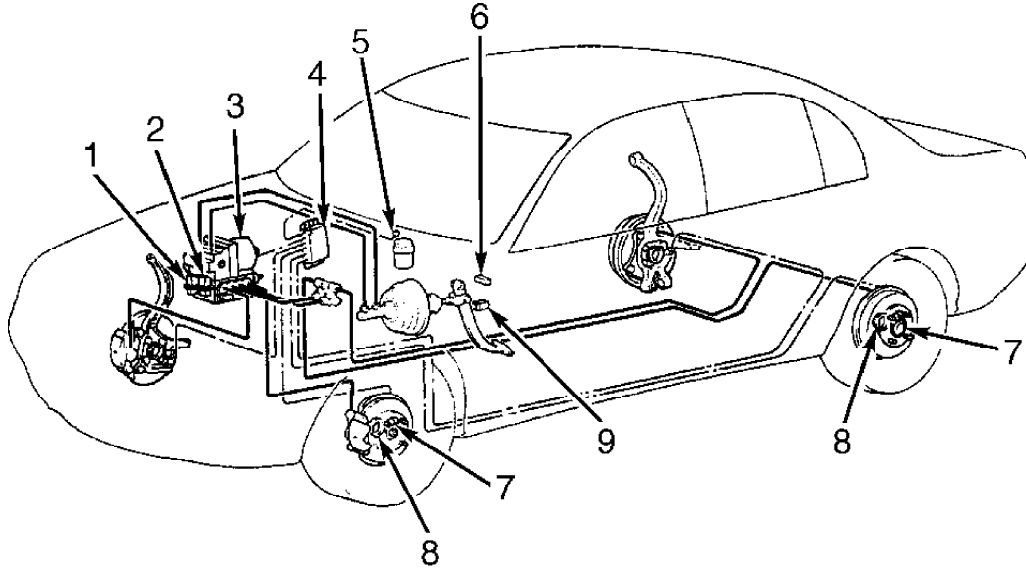
1997-98 BRAKES
Mitsubishi - Anti-Lock
Galant

DESCRIPTION

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS article in GENERAL INFORMATION.

NOTE: For more information on brake system, see BRAKE SYSTEM article.

The Anti-Lock Brake System (ABS) is designed to prevent wheel lock-up during heavy braking. This allows operator to maintain steering control while stopping vehicle in shortest distance possible. System consists of an ABS Electronic Control Unit (ECU), hydraulic unit, ABS valve relay, ABS motor relay, wheel speed sensors, ABS rotor, Data Link Connector (DLC), brakelight switch and ANTI-LOCK warning light. See Fig. 1. ABS has a self-diagnostic system to indicate a system malfunction by monitoring stored ABS ECU Diagnostic Trouble Codes (DTCs). See RETRIEVING DTCs under SELF-DIAGNOSTIC SYSTEM



- | | |
|----------------------------|------------------------|
| 1. ABS Motor Relay | 6. Data Link Connector |
| 2. ABS Valve Relay | 7. Wheel Speed Sensor |
| 3. Hydraulic Unit | 8. ABS Rotor |
| 4. ABS ECU | 9. Brakelight Switch |
| 5. ANTI-LOCK Warning Light | |

98H12440

Fig. 1: Locating ABS Components
Courtesy of Mitsubishi Motor Sales of America.

OPERATION

Each wheel sensor sends an AC electrical signal to ABS ECU. The ABS ECU translates this information as wheel speed. When any decelerating wheel speed rate is determined to be excessive in comparison to other monitored wheels, the hydraulic unit cycles hydraulic brake pressure to each wheel to equalize speed of all wheels. ABS turns itself off when vehicle speed drops to 4 MPH. Minor lock-up may occur at this point.

With engine running and vehicle speed more than 4 MPH, pump motor will operate for a short period of time and may be heard inside vehicle. During pump motor operation, ABS system is completing a self-check. During ABS system operation, a pulsing brake pedal and vibration in steering wheel and vehicle body may be experienced. These conditions are normal.

BLEEDING BRAKE SYSTEM

CAUTION: When adding brake fluid, ensure filter/strainer is properly fitted on reservoir tank.

ABS system is bled using conventional method. With engine running, manually bleed system using an assistant. For bleeding order, see BRAKE LINE BLEEDING SEQUENCE table. Ensure all air is removed from brake system. Refill brake fluid reservoir after bleeding procedure is complete.

BRAKE LINE BLEEDING SEQUENCE

Application	Sequence
Galant	RR, LF, LR, RF

ADJUSTMENTS

* PLEASE READ FIRST *

NOTE: For adjustment information on brake pedal height, free play, parking brake and brakelight switch, see BRAKE SYSTEM article.

WHEEL SPEED SENSOR

NOTE: Galant wheel speed sensor is not adjustable. Clearance between sensor mounting surface and rotor outside surface should be 1.11-1.12" (28.2-28.5 mm).

TROUBLE SHOOTING

* PLEASE READ FIRST *

NOTE: If system is not functioning properly after all testing procedures have been completed, substitute known-good ABS ECU and retest.

ANTI-LOCK WARNING LIGHT

1) Turn ignition on. ANTI-LOCK warning light should illuminate. Turn ignition switch to START position. Warning light should remain on and then go out after one second.

2) If warning light functions as specified, go step 3). If warning light does not function as specified, see appropriate trouble shooting test:

- * ANTI-LOCK WARNING LIGHT INOPERATIVE
- * ENGINE RUNNING, ANTI-LOCK WARNING LIGHT REMAINS ON
- * IGNITION SWITCH IN ON POSITION (ENGINE NOT RUNNING), ANTI-LOCK WARNING LIGHT STAYS ON FOR APPROXIMATELY ONE SECOND, THEN SWITCHES OFF
- * IGNITION SWITCH IN ON POSITION, ANTI-LOCK WARNING LIGHT FLASHES
- * IGNITION SWITCH TURNED TO START POSITION, WARNING LIGHT SWITCHES OFF IMMEDIATELY (DOES NOT REMAIN ON FOR ONE SECOND)

3) Test drive vehicle. If ABS light does not come on at low speed, go to next step. If ABS light comes on at low speed, motor relay, solenoid valve or wheel speed sensor malfunction is indicated. Go to step 6). If insufficient braking force or ABS malfunction exists, go to next step. If none of listed symptoms exist, go to step 6).

4) Check conventional brake system components for proper operation. Check for mechanical lock of hydraulic unit solenoid valve. Check for plugged hydraulic line in hydraulic unit. Repair or replace as necessary. If hydraulic unit is okay, go to next step.

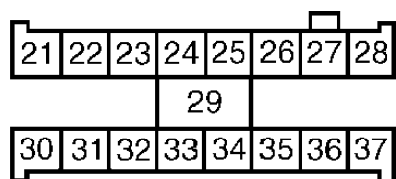
5) Check for faulty wheel speed sensor. See WHEEL SPEED SENSOR under COMPONENT TESTS. Replace sensor as necessary. See WHEEL SPEED SENSOR under REMOVAL & INSTALLATION. Inspect ABS ECU wiring. If testing indicates no mechanical or electrical failures, replace ABS ECU.

6) Enter ABS self-diagnostics, and retrieve DTCs. See RETRIEVING DTCs under SELF-DIAGNOSTIC SYSTEM. If no DTCs are displayed, fault may be intermittent. Try to make malfunction reoccur. If no diagnostic output exists, check for faulty wiring harness between ABS ECU and self-diagnostic connector. Repair or replace as necessary.

ANTI-LOCK Warning Light Inoperative

1) If all other warning lights illuminate with ignition on, check for faulty warning light bulb. Replace bulb as necessary. If bulb is okay, go to step 3). If other warning lights do not illuminate, check fuse No. 8 in main fuse panel. If fuse is blown, correct cause of blown fuse, and replace fuse. If fuse is okay, go to next step.

2) Remove instrument cluster. Disconnect instrument cluster connector. Turn ignition on. Using a DVOM, measure voltage between ground and instrument cluster connector terminal No. 24 (Black/White wire). See Fig. 2. If battery voltage is present, go to next step. If battery voltage is not present, repair connectors or wiring between each junction block and instrument cluster. See WIRING DIAGRAMS.



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Fig. 2: Identifying Combination Meter Harness Connector Terminals
Courtesy of Mitsubishi Motor Sales of America.

3) Turn ignition off. Check for continuity between instrument cluster terminals No. 24 and 37. If no continuity is present, check

for faulty warning light bulb. Replace bulb as necessary. If bulb is okay, replace combination meter (instrument cluster). If continuity is present, go to next step.

4) Check and repair connectors and wiring harness between ABS valve relay and instrument cluster, and between instrument cluster and ABS ECU. See WIRING DIAGRAMS.

Engine Running, ANTI-LOCK Warning Light Remains On

1) Turn ignition off. Disconnect 22-pin ABS ECU connector. Restart engine. If light is no longer on, replace ABS ECU. If light remains on, go to next step.

2) Turn ignition off. Repair short inside instrument cluster or between instrument cluster and ABS ECU.

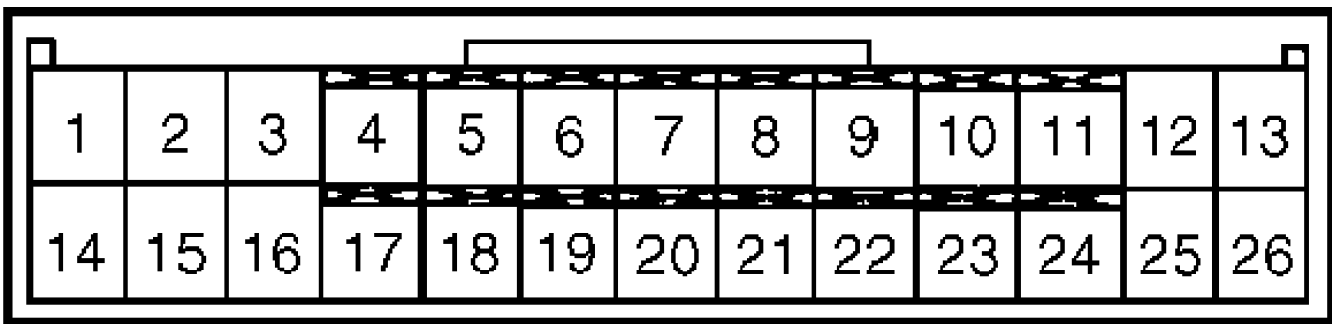
Ignition Switch In ON Position (Engine Not Running), ANTI-LOCK Warning Light Stays On For Approximately One Second, Then Switches Off

1) Turn ignition off. Disconnect ABS ECU 22-pin connector. Start and run engine. Using DVOM, check voltage between ABS ECU 22-pin connector terminal No. 38 and ground. See Figs. 3-4. If voltage is less than 7 volts, go to step 3). If voltage is more than 7 volts, go to next step.

2) Check and repair connectors and wiring harness between ignition switch and ABS ECU, and between generator and ABS ECU. See WIRING DIAGRAMS. If connectors and wiring harness are okay, go to next step.

3) Measure voltage between generator "L" terminal (White wire) and ground. If voltage is less than 7 volts, replace generator. If voltage is more than 7 volts, turn ignition off. Disconnect generator harness connector. Using DVOM, check continuity between generator "L" terminal (White wire) and ABS ECU 22-pin connector terminal No. 38.

4) If continuity does not exist, inspect and repair circuit as needed. If continuity exists, connect all components and retrieve DTCs. See RETRIEVING DTCs under SELF-DIAGNOSTIC SYSTEM.



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Fig. 3: Identifying ABS ECU Harness Connector Terminals 22-Pin Connector
 Courtesy of Mitsubishi Motor Sales of America.

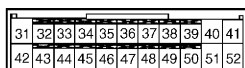


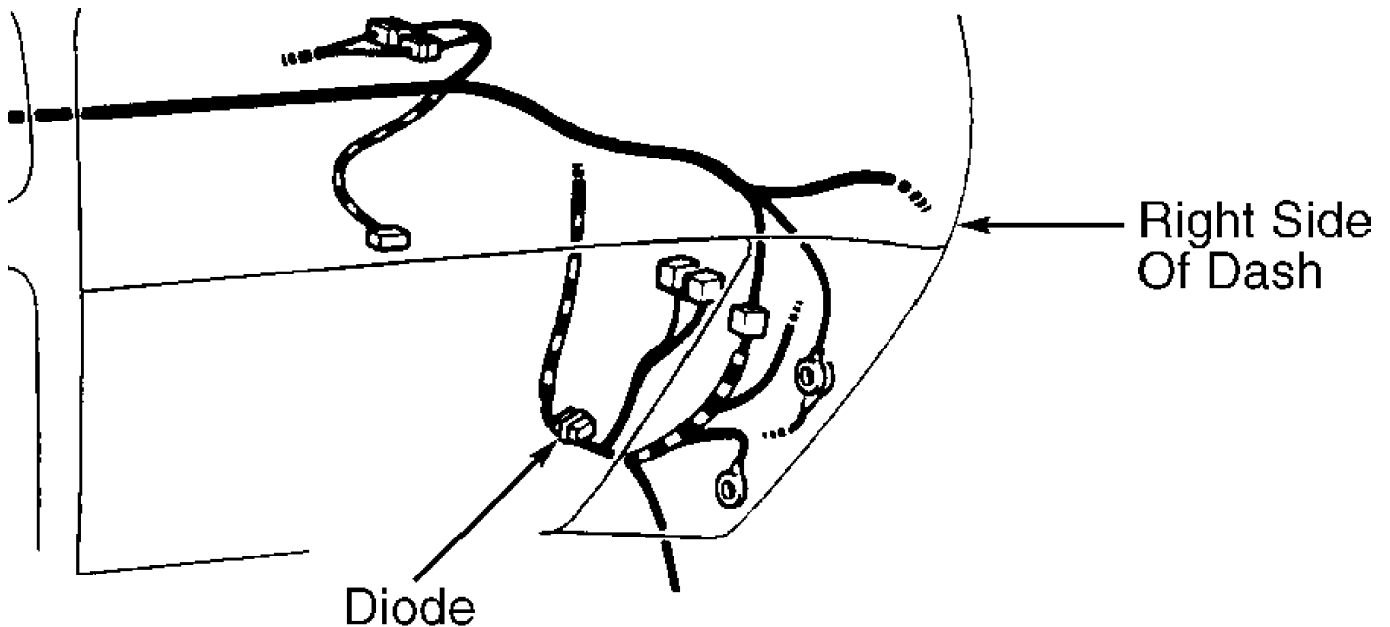
Fig. 4: Identifying ABS ECU Harness Connector Terminals 26-Pin Connector
 Courtesy of Mitsubishi Motor Sales of America.

Ignition Switch In ON Position, ANTI-LOCK Warning Light Flashes

- 1) Turn ignition switch off and then on. Drive vehicle at more than 6 MPH. If light still flashes, go to next step.
- 2) Check and repair ABS ECU, ABS relay valve, ignition switch, and instrument cluster connectors and related wiring harness as needed. If connectors and wiring harness are okay, replace ABS ECU.

Ignition Switch Turned To START Position, ANTI-LOCK Warning Light Switches Off Immediately (Does Not Remain On For One Second)

- 1) Turn ignition off. Remove ABS valve relay. Inspect relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTS. Replace relay if needed. If relay is okay, DO NOT install relay and go to next step.
- 2) Disconnect ABS ECU 22-pin connector. Turn ignition on. Using DVOM, check voltage between relay connector terminal No. 3 (Green/Yellow wire) and ground. If battery voltage is present, inspect and repair ABS valve relay ground circuit (terminal No. 1, Black wire). See WIRING DIAGRAMS. If battery voltage is not present, go to next step.
- 3) Disconnect diode. See Fig. 5. Using DVOM, ensure continuity exists in one direction only. Replace diode if needed. If diode is okay, go to next step.
- 4) Check and repair ABS ECU, ABS relay valve, and diode connectors and related wiring harness as needed.



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Fig. 5: Locating ABS Diode
Courtesy of Mitsubishi Motor Sales of America.

SELF-DIAGNOSTIC SYSTEM

RETRIEVING DTCs

Using Scan Tool

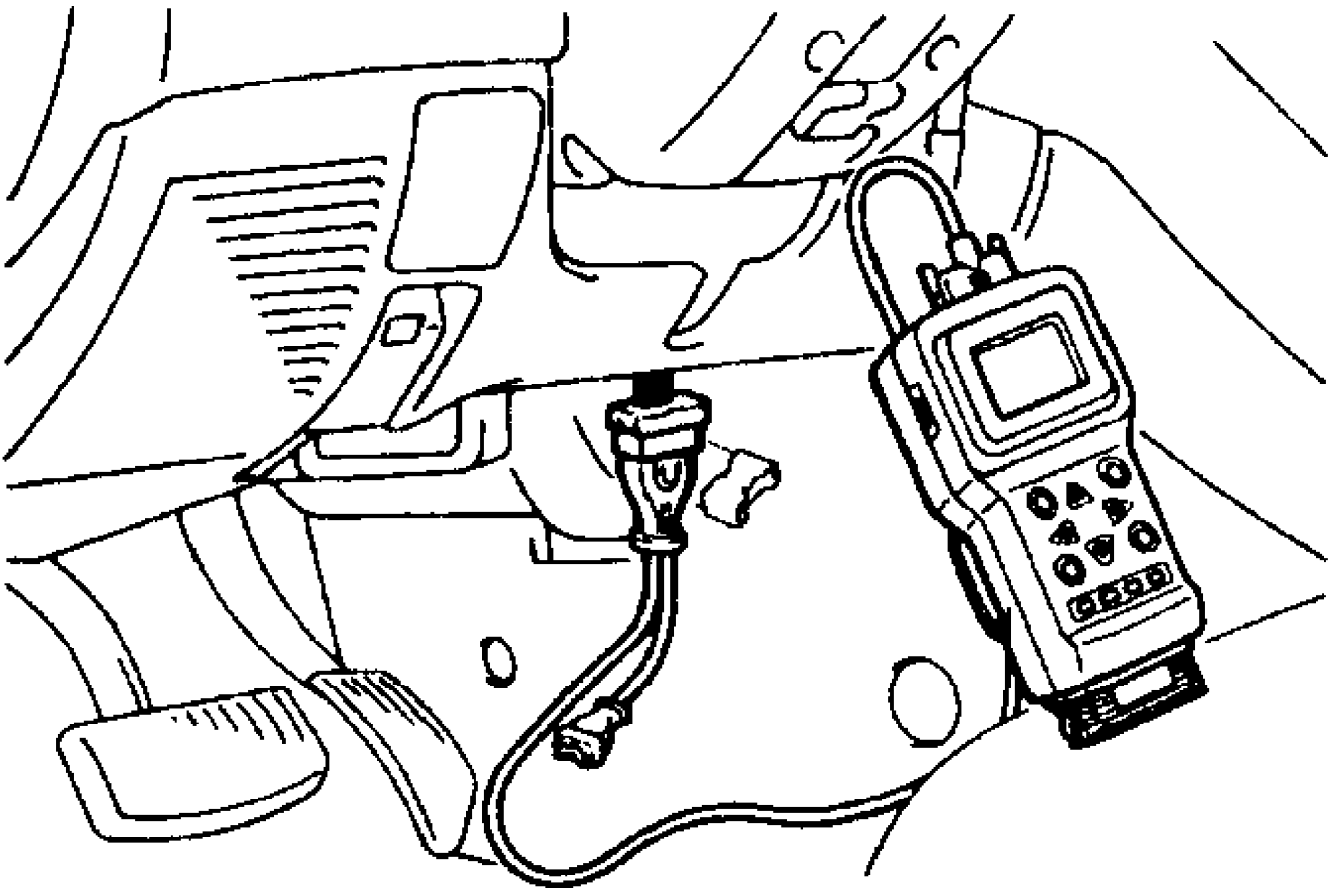
- 1) Refer to manufacturer's operation manual for instructions in use of scan tool. With ignition off, connect scan tool to 16-pin Data Link Connector (DLC), located under instrument panel, near

steering column. See Fig. 6.

2) Turn ignition on. ANTI-LOCK warning light should come on as ABS goes into self-diagnostic mode. Read and record all Diagnostic Trouble Codes (DTCs) from ABS ECU memory. Refer to scan tool manufacturer's instructions for specific DTC retrieval procedure.

3) After all DTCs have been retrieved and recorded, clear DTCs from ABS ECU memory. Refer to scan tool manufacturer's instructions for specific DTC clearing instructions. See DTC DEFINITION table and perform appropriate test(s) under DIAGNOSTIC TESTS.

4) If DTCs cannot be cleared, ABS ECU is currently detecting a malfunction. If DTCs can be cleared, problem is either intermittent or only appears while driving.



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Fig. 6: Locating Data Link Connector
Courtesy of Mitsubishi Motor Sales of America.

Using ANTI-LOCK Warning Light

1) Turn ignition on and depress brake pedal within 3 seconds and release. Continue to depress and release brake pedal once per second for 9 more cycles.

2) If DTCs are stored in ABS ECU memory, ANTI-LOCK light will begin to flash intermittently. Long flashes represent first digit of DTC; short flashes represent second digit. For example, 4 long flashes and 3 short flashes indicate DTC 43. If 2 or more DTCs are stored, lowest number will be displayed first.

3) After recording DTC(s), see DTC DEFINITION table and perform appropriate DTC test(s) under DIAGNOSTIC TESTS. If no DTCs are

stored, ANTI-LOCK warning light will flash constantly.

CLEARING DTCs

To erase DTC(s) with scan tool, follow scan tool manufacturer's instructions. To erase DTCs without scan tool, disconnect negative battery cable for at least 10 seconds.

DTC DEFINITION

DTC	(1) System Affected
11	Right Front Wheel Speed Sensor Circuit (Open)
12	Left Front Wheel Speed Sensor Circuit (Open)
13	Right Rear Wheel Speed Sensor Circuit (Open)
14	Left Rear Wheel Speed Sensor Circuit (Open)
16	Power Supply System
21	Right Front Wheel Speed Sensor Circuit (Short)
22	Left Front Wheel Speed Sensor Circuit (Short)
23	Right Rear Wheel Speed Sensor Circuit (Short)
24	Left Rear Wheel Speed Sensor Circuit (Short)
25	Right Front Wheel Speed Sensor (Excessive Gap)
26	Left Front Wheel Speed Sensor (Excessive Gap)
27	Right Rear Wheel Speed Sensor (Excessive Gap)
28	Left Rear Wheel Speed Sensor (Excessive Gap)
33	Brakelight Switch Circuit
35	Right Front Wheel Speed Sensor (High Speed Input)
36	Left Front Wheel Speed Sensor (High Speed Input)
37	Right Rear Wheel Speed Sensor (High Speed Input)
38	Left Rear Wheel Speed Sensor (High Speed Input)
41	Right Front Solenoid Valve Circuit (Input)
42	Left Front Solenoid Valve Circuit (Input)
43	Right Rear Solenoid Valve Circuit (Input)
44	Left Rear Solenoid Valve Circuit (Input)
45	Right Front Solenoid Valve Circuit (Output)
46	Left Front Solenoid Valve Circuit (Output)
47	Right Rear Solenoid Valve Circuit (Output)
48	Left Rear Solenoid Valve Circuit (Output)
51	Valve Relay Always Off
52	Valve Relay Always On
53	Motor Relay Always Off
54	Motor Relay Always On

(1) - See appropriate DTC under CIRCUIT TESTS.

DIAGNOSTIC TESTS

DTC 11, 12, 13 OR 14: WHEEL SPEED SENSOR CIRCUIT (OPEN)

NOTE: DTCs 11, 12, 13 and 14 are displayed when sensor with open circuit is identified. DTC 12 is also displayed if incorrect ABS ECU is installed.

1) Inspect condition of suspected speed sensor. Ensure tip of speed sensor is clean. If speed sensor is okay, go to next step.

2) Disconnect sensor connector. Using DVOM, check resistance between sensor terminals. If resistance is 1000-1200 ohms, go to next step. If resistance is not as specified, replace sensor.

3) Remove sensor. Check resistance between each sensor terminal and sensor body. If resistance is 100,000 ohms or more, go to next step. If resistance is not as specified, replace sensor.

4) Inspect condition of toothed rotor. Check for broken or deformed teeth. If toothed rotor is okay, go to next step.

5) Turn ignition off. Disconnect ABS ECU 22-pin and 26-pin connectors. Check resistance between specified ABS ECU connector terminals. See WHEEL SPEED SENSOR CIRCUIT IDENTIFICATION table. See Figs. 3-4. If resistance is 1000-1200 ohms, go to step 7). If resistance is not as specified, go to next step.

WHEEL SPEED SENSOR CIRCUIT IDENTIFICATION

Application	Terminals No.
Left Front	10 & 23
Right Front	34 & 45
Left Rear	35 & 46
Right Rear	9 & 22

6) Check connectors and wiring of each circuit between ABS ECU and sensor. See WIRING DIAGRAMS. Repair connectors and wiring as needed.

7) Check ABS ECU connectors. Repair connectors as needed. If connectors are okay, replace ABS ECU.

DTC 16: POWER SUPPLY SYSTEM

NOTE: DTC 16 is output when ABS ECU power supply voltage is not within standard value. If voltage returns to normal, DTC will be erased.

1) Ensure battery voltage is 10-17 volts. Turn ignition off. Disconnect ABS ECU 26-pin connector. Start engine. Using DVOM, check voltage between ABS ECU 26-pin connector terminal No. 12 and ground. See Figs. 3-4. If voltage is 10-17 volts, go to step 3). If voltage is not as specified, go to next step.

2) Check fuse No. 13. If fuse is okay, check continuity between fuse No. 13 connector (Black wire) and ignition switch, and fuse No. 13 connector (Blue wire) and ABS ECU 26-pin connector terminal No. 12. Repair wiring as needed. If circuit is okay, inspect charging system. Repair charging system as needed.

3) Check ABS ECU 26-pin connector. Repair connector as needed. If connector is okay, replace ABS ECU.

DTC 21, 22, 23 OR 24: WHEEL SPEED SENSOR CIRCUIT (SHORT)

NOTE: DTCs 21, 22, 23 and 24 are displayed when sensor with short circuit is identified.

1) Inspect condition of suspected speed sensor. Ensure tip of speed sensor is clean. If speed sensor is okay, go to next step.

2) Disconnect sensor connector. Using DVOM, check resistance between sensor terminals. If resistance is 1000-1200 ohms, go to next step. If resistance is not as specified, replace sensor.

3) Remove sensor. Check resistance between each sensor terminal and sensor body. If resistance is 100,000 ohms or more, go to next step. If resistance is not as specified, replace sensor.

4) Inspect condition of toothed rotor. Check for broken or deformed teeth. If toothed rotor is okay, go to next step.

5) Turn ignition off. Disconnect ABS ECU 22-pin and 26-pin connectors. Check for continuity between specified ABS ECU connector terminals and ground. See WHEEL SPEED SENSOR POWER CIRCUIT IDENTIFICATION table. See Figs. 3-4. If continuity does exist, repair circuit between ABS ECU and wheel

speed sensor as necessary. See WIRING DIAGRAMS. If continuity does not exist, replace ABS ECU.

WHEEL SPEED SENSOR POWER CIRCUIT IDENTIFICATION

Application	Terminals No.
Left Front	23
Right Front	45
Left Rear	46
Right Rear	22

DTC 25, 26, 27 OR 28: EXCESSIVE WHEEL SPEED SENSOR GAP

NOTE: DTCs 25, 26, 27 and 28 are displayed when detection speed of wheel speed sensor is less than standard value.

1) Inspect speed sensor installation. See WHEEL SPEED SENSOR under REMOVAL & INSTALLATION. Correct speed sensor installation as needed. If sensor is properly installed, go to next step.

2) Raise and support vehicle. Disconnect ABS ECU connectors. Using DVOM, backprobe specified ABS ECU connector terminals. See WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION table. See Figs. 3-4. Check voltage between each harness connector terminal while rotating wheel at 1/2 to one rotation per second. If pulse voltage is 70 mV or more, go to step 7). If voltage is not as specified, go to next step.

WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION

Application	Terminals No.
Left Front	26 & 39
Right Front	8 & 19
Left Rear	7 & 18
Right Front	27 & 40

3) Disconnect sensor connector. Using DVOM, check resistance between sensor terminals. If resistance is 1000-1200 ohms, go to next step. If resistance is not as specified, replace sensor.

4) Remove sensor. Check resistance between each sensor terminal and sensor body. If resistance is 100,000 ohms or more, go to next step. If resistance is not as specified, replace sensor.

5) Inspect condition of toothed rotor. Check for broken or deformed teeth. If toothed rotor is okay, go to next step.

6) Turn ignition off. Disconnect ABS ECU connectors. Check and repair wiring harness between ABS ECU and wheel speed sensor as necessary. See WIRING DIAGRAMS.

7) Inspect sensor twisted-pair wires. Check for damage to cables and flex cables to check for open circuits. Repair twisted-pair wires as needed. If twisted-pair wires are okay, replace ABS ECU.

DTC 33: BRAKELIGHT SWITCH CIRCUIT

NOTE: DTC 33 is output if an open circuit is detected when brakelights switch is on for 15 minutes or more. DTC will also be output if a short circuit is detected.

1) Check if brakelights are functioning correctly. If brakelights function correctly, go to next step. If brakelights do not function correctly, check brakelight circuit and repair as needed.

2) Turn ignition off. Disconnect ABS ECU 26-pin connector.

Using DVOM, check voltage between ABS ECU 26-pin connector terminal No. 4 (Green wire) and ground while depressing brake pedal. If battery voltage is not present, repair or replace wiring harness between brakelight switch and ABS ECU. If battery voltage is present, go to next step.

3) Check ABS ECU 26-pin connector. Repair connector as needed. If connector is okay, replace ABS ECU.

DTC 35, 36, 37 & 38: WHEEL SPEED SENSOR (HIGH SPEED INPUT)

NOTE: DTCs 35, 36, 37 and 38 are output if a sensor pulse equal to a vehicle speed of 186 MPH or more is input to ABS ECU due to ignition noise or excessive axle vibration.

1) Inspect speed sensor installation. See WHEEL SPEED SENSOR under REMOVAL & INSTALLATION. Correct speed sensor installation as needed. If sensor is properly installed, go to next step.

2) Raise and support vehicle. Disconnect ABS ECU connectors. Using DVOM, backprobe specified ABS ECU connector terminals. See WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION table. See Figs. 3-4. Check voltage between each harness connector terminal while rotating wheel at 1/2 to one rotation per second. If pulse voltage is 70 mV or more, go to step 7). If voltage is not as specified, go to next step.

3) Disconnect sensor connector. Using DVOM, check resistance between sensor terminals. If resistance is 1000-1200 ohms, go to next step. If resistance is not as specified, replace sensor.

4) Remove sensor. Check resistance between each sensor terminal and sensor body. If resistance is 100,000 ohms or more, go to next step. If resistance is not as specified, replace sensor.

5) Inspect condition of toothed rotor. Check for broken or deformed teeth. If toothed rotor is okay, go to next step.

6) Ensure all wheel bearings do not have any perceptible lateral movement. See BRAKE SYSTEM article for inspection procedures. If bearings are okay, inspect sensor harness for damage. Repair harness as needed.

7) Inspect sensor twisted-pair wires. Check for damage to cables and flex cables to check for open circuits. Repair twisted-pair wires as needed. If twisted-pair wires are okay, replace ABS ECU.

DTC 41- 48: SOLENOID VALVE CIRCUIT

NOTE: DTCs 41- 48 will be output if the ABS ECU detects a short or open in solenoid valve harness or solenoid coil.

1) Ensure battery voltage is 10-17 volts. Turn ignition off. Disconnect hydraulic unit 2-pin and 10-pin connectors. Using DVOM, check resistance between 2-pin connector terminal No. 31 or 32 (Green Yellow wires) and each 10-pin connector terminal (except terminals No. 5 and 10). See Fig. 7. Go to next step.

2) Resistance on input circuits should be 5.5-6.5 ohms, and 2.95-3.95 ohms on output circuits. See HYDRAULIC UNIT CONNECTOR CIRCUIT IDENTIFICATION table. If resistance is not as specified on each circuit, replace hydraulic unit. If resistance is as specified, go to next step.

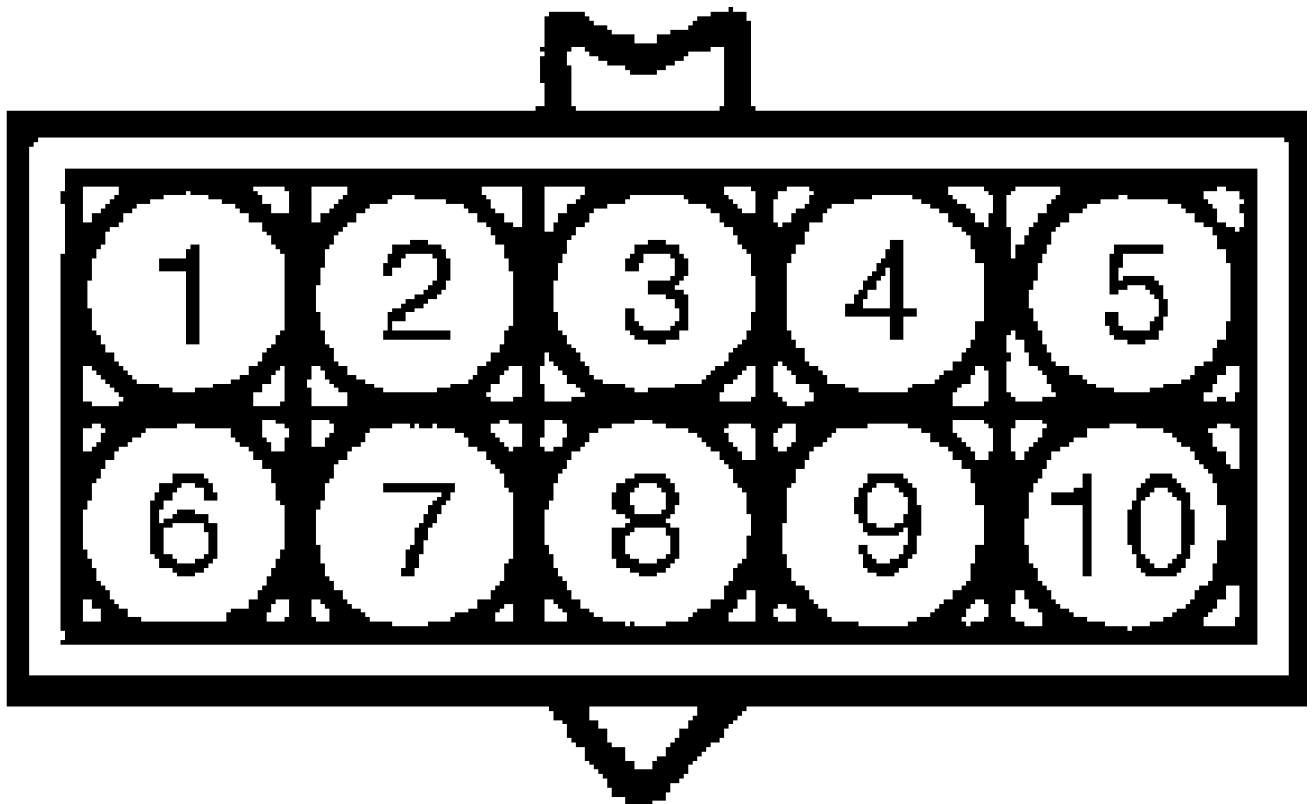
HYDRAULIC UNIT CONNECTOR CIRCUIT IDENTIFICATION

Application	Terminals No.
Input Circuits	1, 2, 3, & 4
Output Circuits	6, 7, 8 & 9

3) Disconnect ABS ECU connectors. Check continuity of circuits between ABS ECU connectors and hydraulic unit 10-pin connector. See WIRING DIAGRAMS. If continuity does not exist in any circuit, inspect and repair suspected circuit(s) as needed. If continuity exists in all circuits, go to next step.

4) Check continuity between hydraulic unit 2-pin connector terminals No. 31 and 32, and ABS valve relay connector terminal No. 3. See WIRING DIAGRAMS. If continuity does not exist on either circuit, inspect and repair suspected circuit as needed. If continuity exists on both circuits, go to next step.

5) Check hydraulic unit 2-pin connector. Repair connector as needed. If connector is okay, replace ABS ECU.



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Fig. 7: Identifying Hydraulic Unit 10-Pin Harness Connector
Courtesy of Mitsubishi Motor Sales of America.

DTC 51: VALVE RELAY ALWAYS OFF

NOTE: DTC is output if ABS ECU detects relay is removed or if power is supplied to relay but relay does not energize.

1) Ensure battery voltage is 10-17 volts. Remove and test valve relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTS. Replace relay if needed. If relay is okay, go to next step.

2) Using DVOM, check voltage between valve relay connector terminal No. 6 (White/Yellow wire) and ground. See Fig. 8. If battery voltage is present, go to step 4). If battery voltage is not present, go to next step.

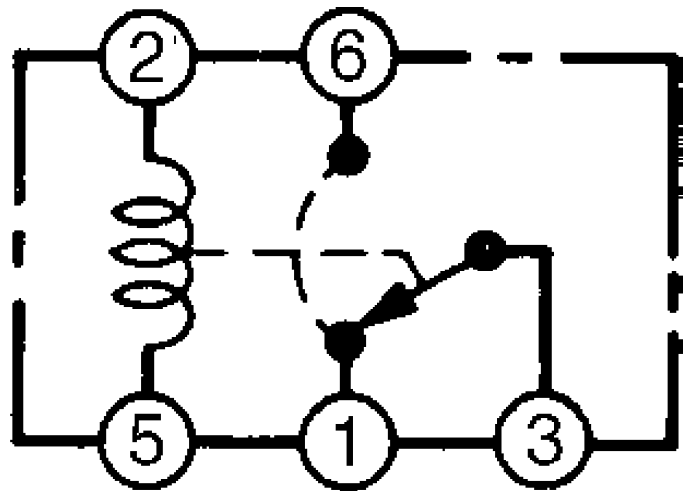
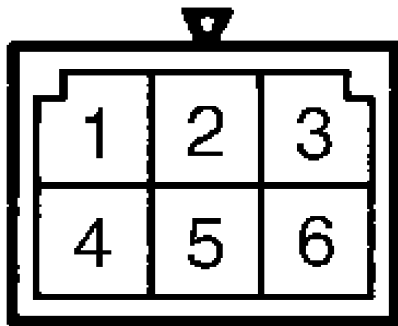
3) Check condition of fuse No. 1. Replace fuse if needed. If fuse is okay, inspect and repair circuit between fuse No. 1 and relay connector terminal No. 6.

4) Install valve relay. Turn ignition off. Disconnect ABS ECU 26-pin connector. Turn ignition on. Check voltage between ABS ECU 26-pin connector terminal No. 13 and ground. See Figs. 3-4. If battery voltage is present, go to step 6). If battery voltage is not present, go to next step.

5) Check and repair connectors and related wiring harness between ignition switch and ABS relay valve as needed. If connectors and wiring harness are okay, check and repair wiring harness between fusible link No. 13 and ABS ECU.

6) Check voltage between ABS valve relay connector terminal No. 3 (Green/Yellow wire) and ABS ECU 22-pin connector terminal No. 43 (Green/Yellow wire). If battery voltage is present, go to next step. If battery voltage is not present, inspect and repair circuit between ABS ECU terminal No. 43 and relay connector terminal No. 3.

7) Check ABS ECU 22-pin connector. Repair connector as needed. If connector is okay, replace ABS ECU.



93H00270

Fig. 8: Identifying Valve Relay Harness Connector
Courtesy of Mitsubishi Motor Sales of America.

DTC 52: VALVE RELAY ALWAYS ON

NOTE: DTC is output if ABS ECU detects relay is removed or if no power is supplied to relay and relay remains energized.

1) Remove and test valve relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTS. Replace relay if needed. If relay is okay, go to next step.

2) Turn ignition off. Disconnect ABS ECU 26-pin connector. Turn ignition on. Check voltage between ABS ECU 26-pin connector terminal No. 13 and ground. See Figs. 3-4. If battery voltage is present, replace ABS ECU. If battery voltage is not present, inspect and repair circuit between ABS ECU terminal No. 13 and relay connector.

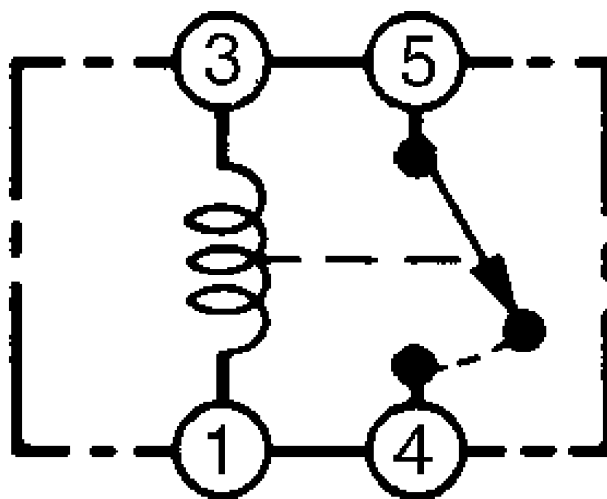
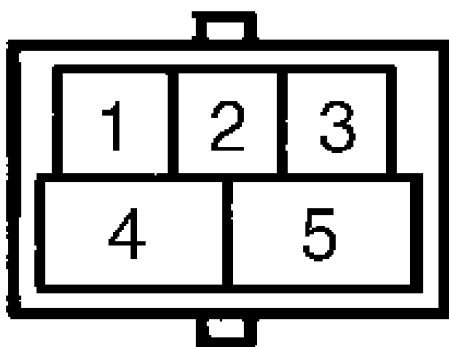
DTC 53: MOTOR RELAY ALWAYS OFF

NOTE: DTC is output if ABS ECU detects relay is removed or if power is supplied to relay but relay does not energize.

1) Using scan tool, perform actuator tests No. 1-5. Refer to scan tool manufacturer's instructions for actuator test procedure. If hydraulic unit motor can be heard operating during each actuator test, go to step 6). If motor cannot be heard during specific actuator test(s), go to next step.

2) Remove and test motor relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTS. Replace relay if needed. If relay is okay, go to next step.

3) Check voltage between relay connector terminal No. 5 and ground. See Fig. 9. If battery voltage is present, go to next step. If battery voltage is not present, inspect and repair wiring harness between fusible link No. 4 and ABS motor relay.



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Fig. 9: Identifying Motor Relay Harness Connector
Courtesy of Mitsubishi Motor Sales of America.

4) Turn ignition off. Disconnect ABS ECU 22-pin connector. Check voltage between ABS ECU 22-pin connector terminal No. 31 and ground. See Figs. 3-4. If battery voltage is present, go to next step. If voltage is not present, inspect and repair circuit between ABS ECU terminal No. 31 and relay connector terminal No. 1.

5) Check ABS ECU 22-pin connector. Repair connector as needed. If connector is okay, replace ABS ECU.

6) Disconnect hydraulic unit 10-pin connector. Check resistance between 10-pin connector (component side) terminals No. 5 and 10. See Fig. 7. If resistance is 10-13 ohms, go to next step. If resistance is not within specification, replace hydraulic unit.

7) Turn ignition off. Disconnect ABS ECU 22-pin connector. Check resistance between ABS ECU 22-pin connector terminals No. 33 and 44. If resistance is 10-13 ohms, go to step 9). If resistance is not as specified, go to next step.

8) Inspect connectors and related wiring harness between ABS ECU and hydraulic unit. Repair connectors and wiring harness as needed. If connectors and wiring harness are okay, replace hydraulic unit.

9) Check ABS ECU 22-pin connector. Repair connector as needed. If connector is okay, replace ABS ECU.

DTC 54: MOTOR RELAY ALWAYS ON

NOTE: DTC 54 may output if hydraulic motor sensor is registering motor revolutions due to noise interference, even though motor relay is off .

1) Turn ignition switch to ON position. Monitor operation of hydraulic unit motor. Turn ignition off. If motor stops, replace ABS ECU. If motor continues to operate, go to next step.

2) Remove and inspect motor relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTS. Replace relay if needed. If relay is okay, go to next step.

3) Inspect and repair connectors and wiring harness between hydraulic unit and ABS ECU 22-pin connector terminal No. 44 (Black/Blue wire). See WIRING DIAGRAMS. If connectors and wiring harness are okay, go to next step.

4) Check and repair connectors and wiring harness between ABS motor relay and ABS ECU 22-pin connector terminal No. 31. See WIRING DIAGRAMS. If connectors and wiring harness are okay, replace ABS ECU.

COMPONENT TESTS

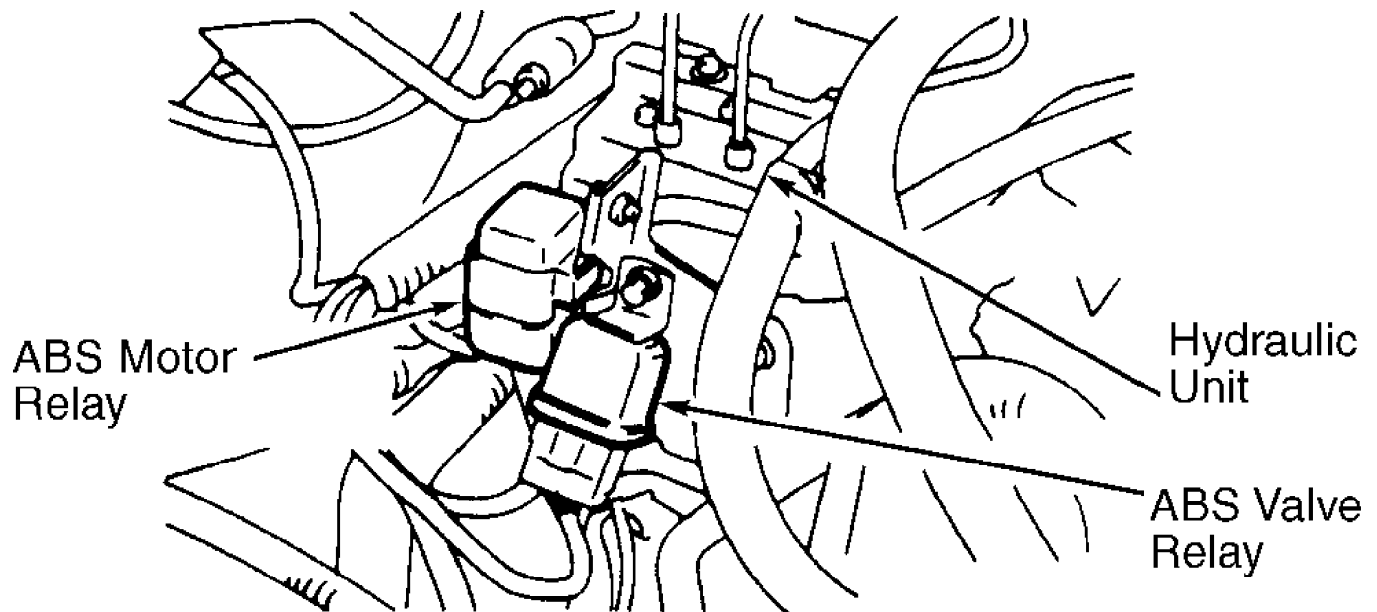
HYDRAULIC UNIT RELAYS

NOTE: Relays are mounted next to hydraulic unit.

Motor Relay

1) Remove relay. See Fig. 10. Using a DVOM, check resistance between relay terminals No. 1 and 3. See Fig. 9. Resistance should be 49-99 ohms. Check for continuity between terminals No. 4 and 5. Continuity should not exist.

2) Apply battery voltage and ground between relay terminals No. 1 and 3. Check for continuity between terminals No. 4 and 5. Continuity should be zero ohms. If relay does not test as specified, replace relay.



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Fig. 10: Locating Hydraulic Unit Relays
Courtesy of Mitsubishi Motor Sales of America.

Valve Relay

1) Remove relay. Using a DVOM, check resistance between relay terminals No. 2 and 5. See Fig. 8. Resistance should be 55-105 ohms.

Check resistance between terminals No. 1 and 3. Resistance should be zero ohms.

2) Check for continuity between relay terminals No. 3 and 6. Continuity should not exist. Apply battery voltage and ground between terminals No. 2 and 5. Check for continuity between terminals No. 1 and 3. Continuity should not exist.

3) Check for resistance between terminals No. 3 and 6. Resistance should be zero ohms. If relay does not test as specified, replace relay.

WHEEL SPEED SENSOR

Sensor Resistance Test

1) Before testing sensor resistance, ensure pole piece-to-wheel speed sensor tip is clean. Check wheel sensor pole piece for damage. Replace pole piece if damaged.

2) Disconnect sensor connector. Inspect sensor wiring harness for broken and pinched wires. Repair or replace harness as necessary. Using a DVOM, check sensor resistance across wiring connector terminals. Resistance should be 1000-2000 ohms. If resistance is not as specified, replace sensor. If resistance is as specified, go to GROUND CIRCUIT TEST.

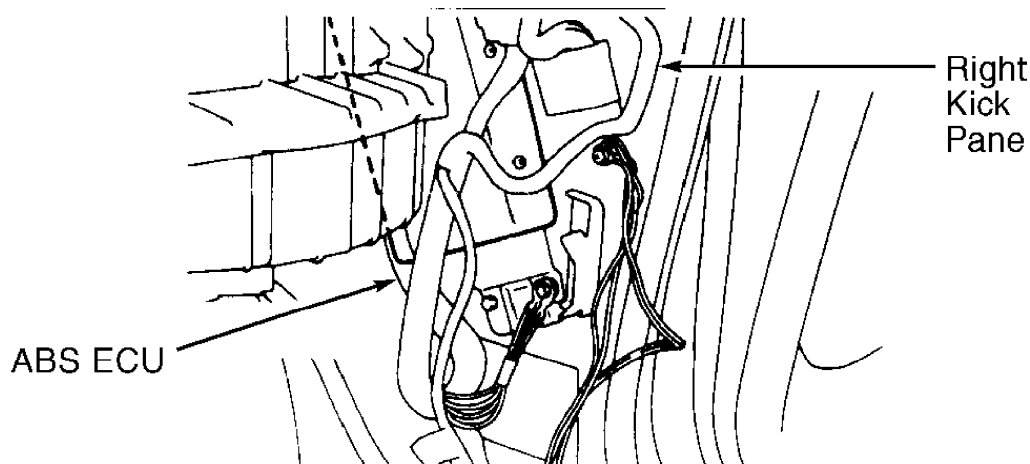
Ground Circuit Test

Disconnect wheel speed sensor connector. Check resistance between each wheel speed sensor terminal and sensor housing. Resistance should be more than 100,000 ohms. If resistance is less than specified, replace wheel speed sensor.

REMOVAL & INSTALLATION

ABS ECU

Remove dash panel under glove box. Remove passenger scuff plate. Remove right kick panel. Ensure ignition is off. Disconnect ABS ECU harness connectors. Remove ABS ECU. See Fig. 11. To install, reverse removal procedure.



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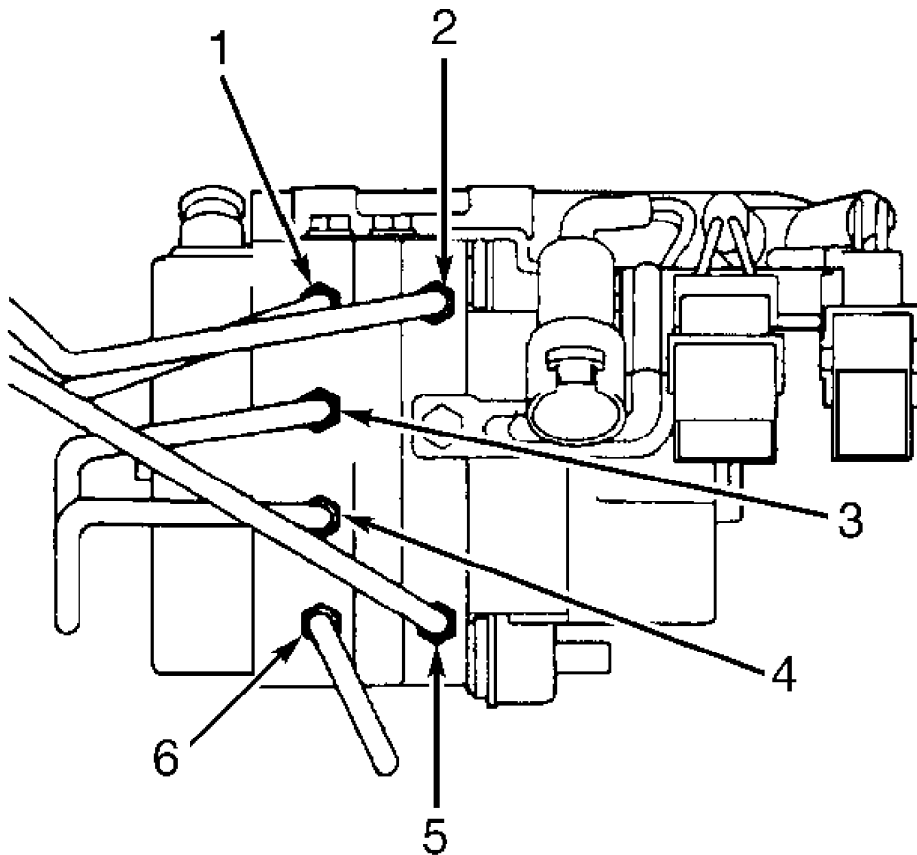
Fig. 11: Locating ABS ECU
Courtesy of Mitsubishi Motor Sales of America.

HYDRAULIC UNIT

CAUTION: DO NOT turn hydraulic unit upside down or lay unit on its side. DO NOT drop hydraulic unit. DO NOT disassemble unit. Replace hydraulic unit as an assembly. If unit is replaced, slowly release safety plug to release internal gas.

Removal & Installation

Remove air intake hose. Remove mounting bracket and relays. Disconnect brakelines and harness connectors. Remove hydraulic unit. To install, reverse removal procedure. Ensure brakelines are correctly installed. See Fig. 12.



1. Hydraulic Unit-To-Right Rear Brake
2. From Master Cylinder (For Right Front & Left Rear)
3. Hydraulic Unit-To-Right Front Brake
4. Hydraulic Unit-To-Left Rear Brake
5. From Master Cylinder (For Left Front & Right Rear)
6. Hydraulic Unit-To-Left Front Brake

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Fig. 12: Identifying Hydraulic Unit Brakeline Connections
Courtesy of Mitsubishi Motor Sales of America.

NOTE: Before removing wheel speed sensor, note sensor wiring harness routing for installation reference.

Removal (Front)

Raise and support vehicle. Remove front wheel. Remove splash shield. Remove retaining clips from speed sensor wiring harness. Disconnect speed sensor connector. Remove sensor mounting bolt. Note sensor wiring harness routing, and remove sensor.

Installation

1) Install speed sensor bracket if removed. Sensor mounting brackets are not interchangeable from side-to-side. Each bracket is stamped with an "FR" indicating front bracket, and an "R" or "L" to indicate right or left.

2) Temporarily install speed sensor. Route speed sensor wiring harness in its original location, and ensure no twists exist in harness. To complete installation, reverse removal procedure.

Removal (Rear)

Raise and support vehicle. Remove rear wheel. Remove retaining clips and band from speed sensor wiring harness. Disconnect speed sensor connector. Remove sensor mounting bolt. Note sensor wiring harness routing, and remove sensor.

Installation

1) Install sensor bracket if removed. Sensor mounting brackets are not interchangeable from side-to-side. Each bracket is stamped with an "R" or "L" to indicate right or left.

2) Temporarily install speed sensor. Route speed sensor wiring harness in its original location, and ensure no twists exist in harness. Ensure sensor harness is not in contact with trailing arm. Reverse removal procedure to complete installation.

WHEEL SENSOR ROTOR

NOTE: For more information on front or rear brake assembly, see BRAKE SYSTEM article.

Removal & Installation (Front)

Raise and support vehicle. remove front wheel. Remove brake disc. Remove disc assembly. Remove wheel bearings. Remove axle hub. Remove bolts attaching sensor rotor to hub assembly. To install, reverse removal procedure.

Removal & Installation (Rear)

Raise and support vehicle. Remove rear wheel. Remove rear brake drum and shoes. Disconnect parking brake cable. Remove rear hub assembly. Remove sensor rotor. To install, reverse removal procedure.

OVERHAUL

HYDRAULIC UNIT

DO NOT attempt to overhaul or disassemble hydraulic unit. If hydraulic unit is defective, replace unit as an assembly. See HYDRAULIC UNIT under REMOVAL & INSTALLATION.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Hydraulic Unit Mounting Bolts	13-18 (18-24)
Wheel Lug Nuts	65-80 (88-108)
	INCH Lbs. (N.m)
Bleed Screw	60-84 (7-9)
Flared Brake Line Nuts	120-144 (14-16)
Front Sensor Rotor Mounting Bolts	84-120 (9-14)
Wheel Speed Sensor Bolt	84-120 (9-14)

WIRING DIAGRAMS

