ANTI-LOCK BRAKE SYSTEM

1998 Mitsubishi Montero

1997-98 BRAKES
Mitsubishi - Anti-Lock

Montero

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. Major components are a hydraulic unit, wheel speed sensors, "G" sensor, ABS Electronic Control Unit (ECU) and ANTI-LOCK warning light. ABS has a self-diagnostic system to indicate a system malfunction and for use in system trouble shooting.

OPERATION

Each wheel sensor sends an AC electrical signal to the ECU. The ECU reads 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 drops to 4 MPH. Minor lock-up may occur at this point.

With engine running and vehicle speed greater 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

BLEEDING PROCEDURES

CAUTION: When adding brake fluid, ensure filter 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 Load Sensing Proportioning Valve (LSPV) is bled in sequence. Remove all air from brake system. Refill brake fluid reservoir after bleeding procedure is complete.

BRAKE LINE BLEEDING SEQUENCE

Application	Sequence
Montero	RR, LR, LSPV, RF, LF

ADJUSTMENTS

* PLEASE READ FIRST *

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

WHEEL SPEED SENSOR (WSS)

NOTE: Rear WSS gap adjustment information is not available from manufacturer.

Front WSS-To-Rotor Gap Adjustment

1) Raise and support vehicle. Remove wheel(s). Inspect sensor pole piece for damage. Repair if necessary. If sensor pole piece is okay, check WSS-to-rotor gap.

2) Using a feeler gauge, check clearance between sensor pole and rotor tooth surface. See Fig. 1. Front WSS sensor clearance should be .008-.390" (0.2-1.0 mm). If clearance is not as specified, loosen sensor mounting bolt. Adjust sensor position until clearance is within specification. Tighten sensor mounting bolt to specification. See TORQUE SPECIFICATIONS.

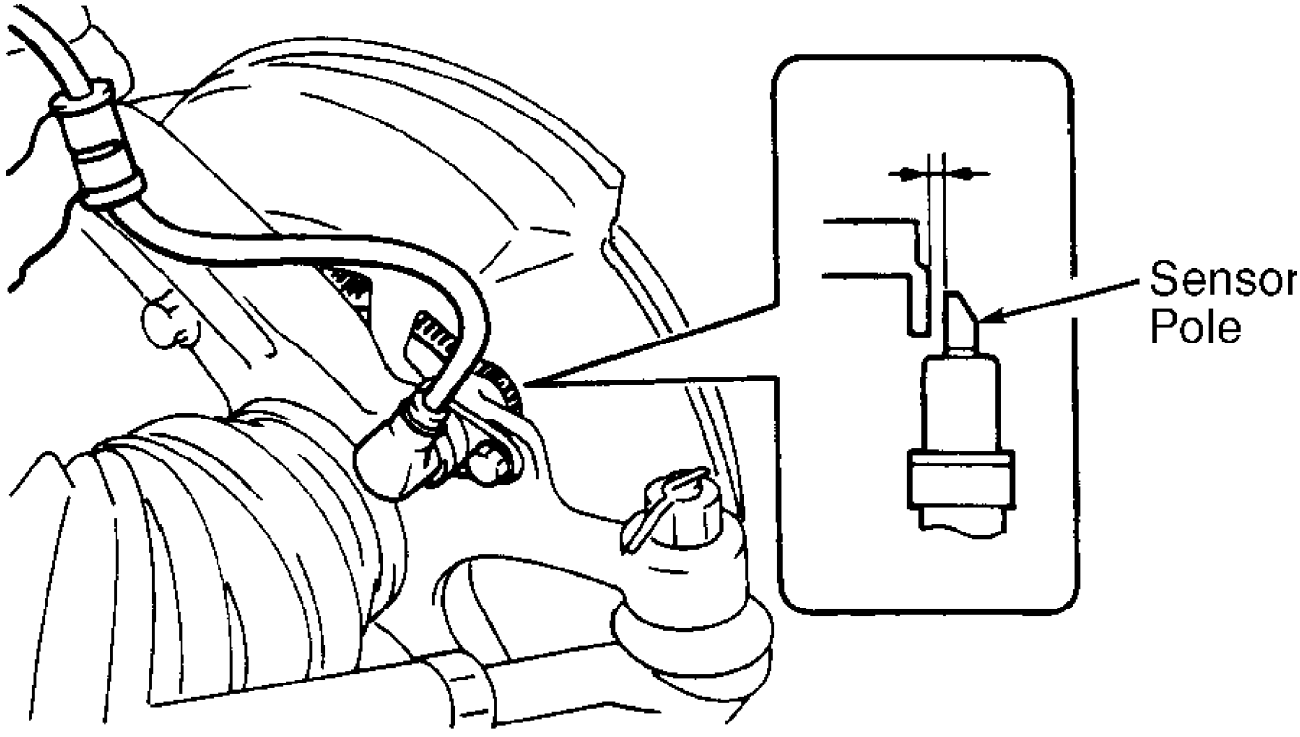

Fig. 1: Checking Front WSS-To-Rotor Gap
Courtesy of Mitsubishi Motor Sales of America.

TROUBLE SHOOTING

ANTI-LOCK WARNING LIGHT

1) Turn ignition on. ANTI-LOCK warning light should come on

for one second, and then go out. Turn ignition switch to START position. Warning light should come on and stay on.

2) When ignition switch is turned from START to ON position, warning light should come on for one second, and then go out. If warning light functions as specified, go to step 3). If warning light does not function as specified, see appropriate trouble shooting test:

* IGNITION SWITCH IN ON POSITION (ENGINE NOT RUNNING), ANTI-LOCK WARNING LIGHT INOPERATIVE
* AFTER ENGINE STARTS, ANTI-LOCK WARNING LIGHT REMAINS ON
* IGNITION SWITCH IN START POSITION, ANTI-LOCK WARNING LIGHT INOPERATIVE
* IGNITION SWITCH IN ON POSITION, ANTI-LOCK WARNING LIGHT BLINKS TWICE. IN START POSITION, LIGHT STAYS ON. WHEN IGNITION SWITCH IS CYCLED FROM START TO ON POSITION, LIGHT BLINKS ONCE, THEN TURNS OFF

3) Test drive vehicle. If ANTI-LOCK warning light does not come on at low speed, go to next step. If light comes on at low speed, motor relay, solenoid valve or Wheel Speed Sensor (WSS) 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) Ensure WSS rotor gap is correct. See WHEEL SPEED SENSOR (WSS) under ADJUSTMENTS. Check for faulty wheel speed sensor. See WHEEL SPEED SENSOR (WSS) under COMPONENT TESTS. Replace sensor as necessary. See WHEEL SPEED SENSOR (WSS) under REMOVAL & INSTALLATION. Inspect ECU connectors and related wiring harness. See WIRING DIAGRAMS . If testing indicates no mechanical or electrical failures, substitute ECU with known-good unit and retest.

6) Enter ABS self-diagnostics and retrieve Diagnostic Trouble Codes (DTCs). See RETRIEVING DTCs under SELF-DIAGNOSTIC SYSTEM. If no DTCs are displayed, fault may be intermittent. Attempt to make malfunction reoccur. If no diagnostic output exists, check and repair wiring harness between ECU and data link connector. See WIRING DIAGRAMS.

NOTE: Trouble shoot ANTI-LOCK warning light in following sequence: instrument cluster circuit, ECU and valve relay.

Ignition Switch In ON position (Engine Not Running), ANTI-LOCK Warning Light Inoperative

1) If all other warning lights come on with ignition on, go to step 3). If other warning lights do not come on, check fuse No. 11 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. Turn ignition on. Using DVOM, check voltage between vehicle ground and instrument cluster ANTI-LOCK warning light terminal No. 28. See Fig. 2. If light does not come on, go to next step. If light comes on, check and repair connectors and related wiring harness between instrument cluster, ABS valve relay and ECU. See WIRING DIAGRAMS.

3) Turn ignition off. Check for faulty warning light bulb. Replace bulb as necessary. If bulb is okay, check and repair connectors and related wiring harness between instrument cluster and ECU. See WIRING DIAGRAMS. If connectors and wiring are okay, replace instrument cluster.

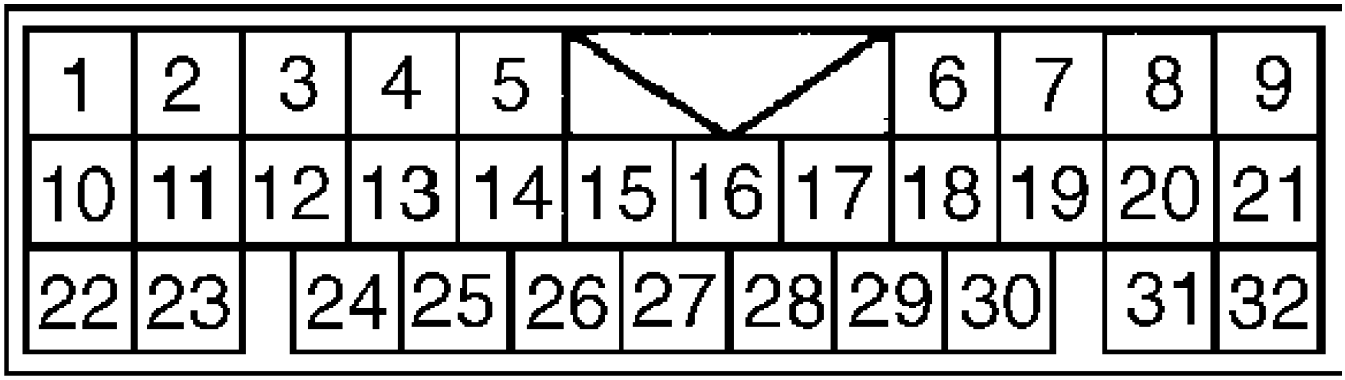

Fig. 2: Identifying Instrument Cluster Connector Terminals
Courtesy of Mitsubishi Motor Sales of America.

After Engine Starts, ANTI-LOCK Warning Light Remains On

1) With ignition on, disconnect instrument cluster connectors. If warning light remains on, replace instrument cluster. If warning light goes off, go to next step.

2) Disconnect ECU 22-pin connector and ABS relay box 8-pin connector. See Fig. 3. If warning light goes off, replace ECU. If warning light stays on, check and repair connectors and related wiring harness between ECU, instrument cluster, and ABS valve relay. See WIRING DIAGRAMS.

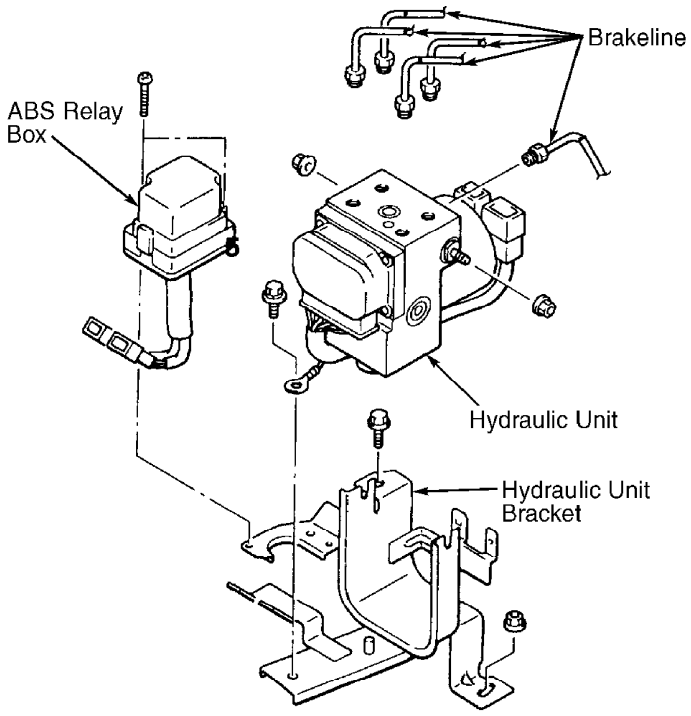

Fig. 3: Exploded View Of Hydraulic Unit & Components
Courtesy of Mitsubishi Motor Sales of America.

Ignition Switch In START Position, ANTI-LOCK Warning Light Inoperative

1) Inspect ABS relay box. See Fig. 3. Replace ABS relay box if needed. If ABS relay box is okay, go to next step.

2) Disconnect ECU 22-pin connector and ABS relay box 8-pin connector. Turn ignition on. Using a DVOM, check voltage between ABS relay box 8-pin harness connector terminal No. 5 and ground. See Fig. 4. If battery voltage does not exist, go to next step. If battery voltage exists, check and repair connectors and related wiring harness between ABS valve relay and ground. See WIRING DIAGRAMS.

3) Check and repair connectors and related wiring harness between instrument cluster and ABS valve relay. See WIRING DIAGRAMS.

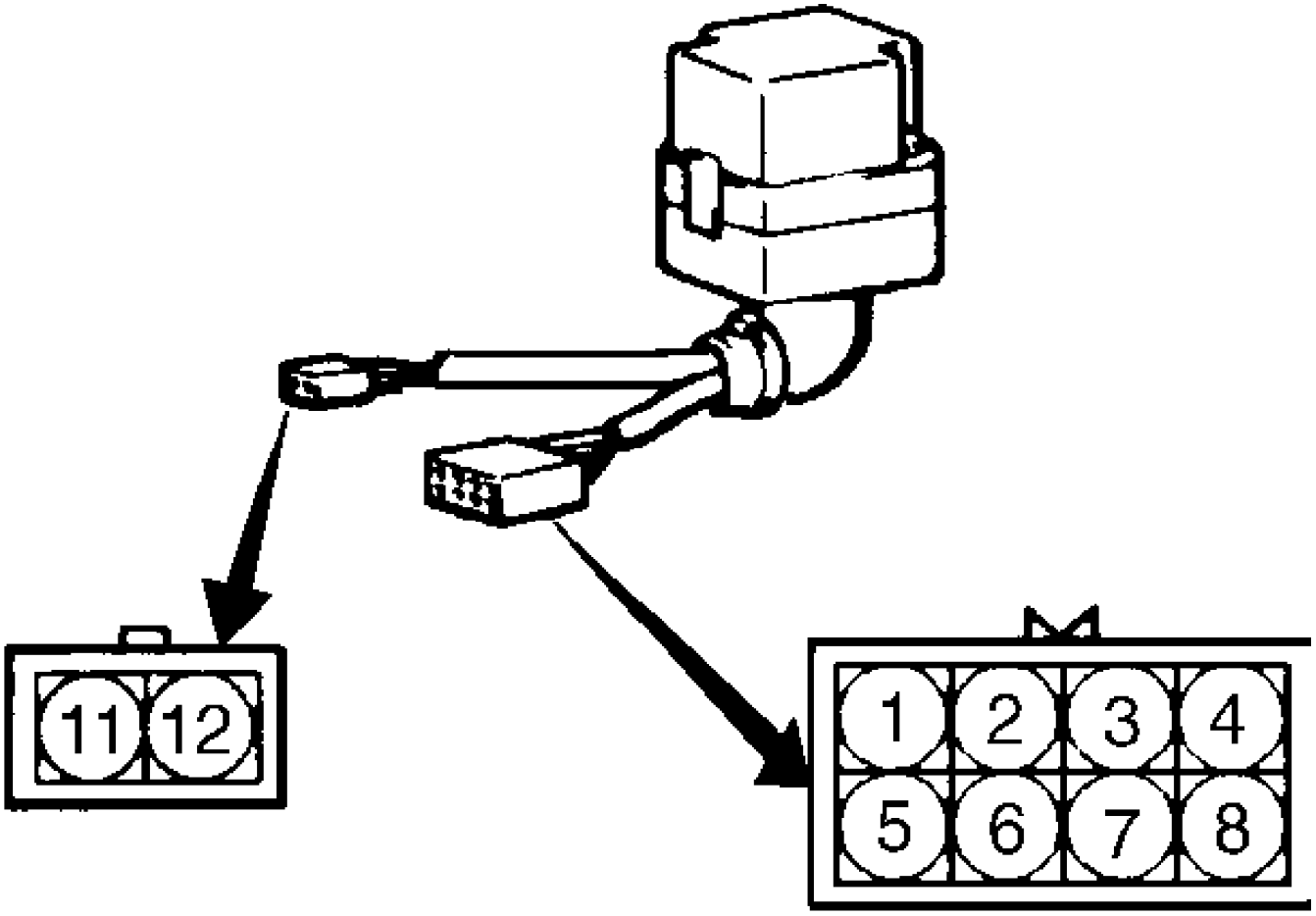

Fig. 4: Identifying ABS Relay Box Connector Terminals
Courtesy of Mitsubishi Motor Sales of America.

Ignition Switch In ON Position, ANTI-LOCK Warning Light Blinks Twice. In START Position, Light Stays On. When Ignition Switch Is Cycled From START To ON Position, Light Blinks Once

1) Disconnect ABS relay box connectors. See Fig. 3. Disconnect ECU 22-pin connector. Turn ignition on. Check voltage between ECU connector terminal No. 50 and ground. See Figs. 5-6. If battery voltage is not present, check and repair connectors and related wiring harness between instrument cluster and ECU. See WIRING DIAGRAMS. If battery voltage is present, go to next step.

2) Check and repair ECU 22-pin connector. If connector is okay, replace ECU.

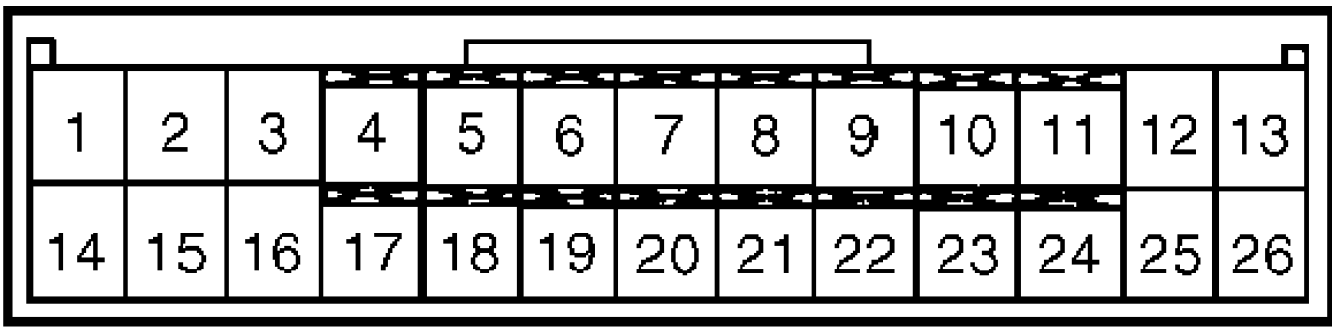

Fig. 5: Identifying ECU Harness Connector Terminals 22-Pin Connector
Courtesy of Mitsubishi Motor Sales of America.

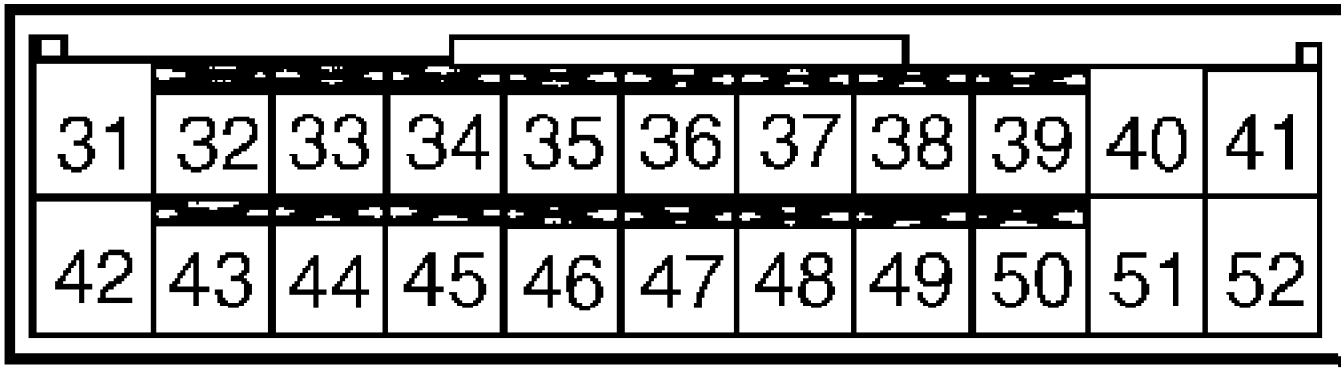

Fig. 6: Identifying ECU Harness Connector Terminals 26-Pin Connector
Courtesy of Mitsubishi Motor Sales of America.

SELF-DIAGNOSTIC SYSTEM

RETRIEVING DTCs

Using Scan Tool

1) With ignition off, connect scan tool and ROM Pack to Data Link Connector (DLC) located under driver's side of dash, and to cigarette lighter socket. See Fig. 7.

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 ECU memory. Refer to scan tool manufacturer's instructions for specific DTC retrieval procedure.

3) After all of the DTCs have been retrieved and recorded, clear codes from ECU memory. Refer to scan tool manufacturer's instructions for specific DTC clearing instructions. Refer to DTC DEFINITION under SELF-DIAGNOSTIC SYSTEM. Refer to the appropriate DTC under DIAGNOSTIC TESTS.

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

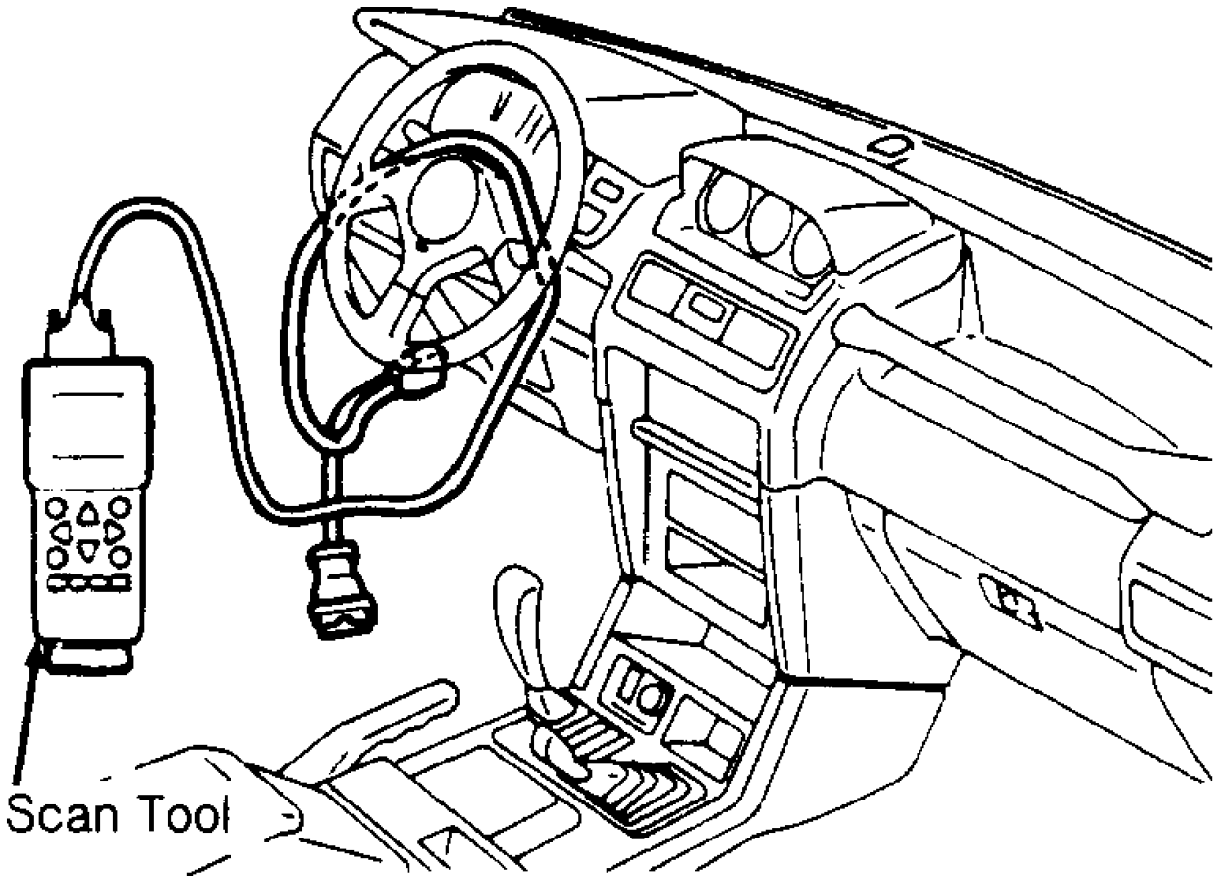

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Fig. 7: Connecting Scan Tool
Courtesy of Mitsubishi Motor Sales of America.

Using ANTI-LOCK Warning Light

1) To retrieve stored DTCs, locate Data Link Connector (DLC) under left side of dash. Turn ignition off. Ground DLC terminal No. 1. See Fig. 8.

2) If DTCs are stored in 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. DTC 51 will always be displayed if valve relay is removed.

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.

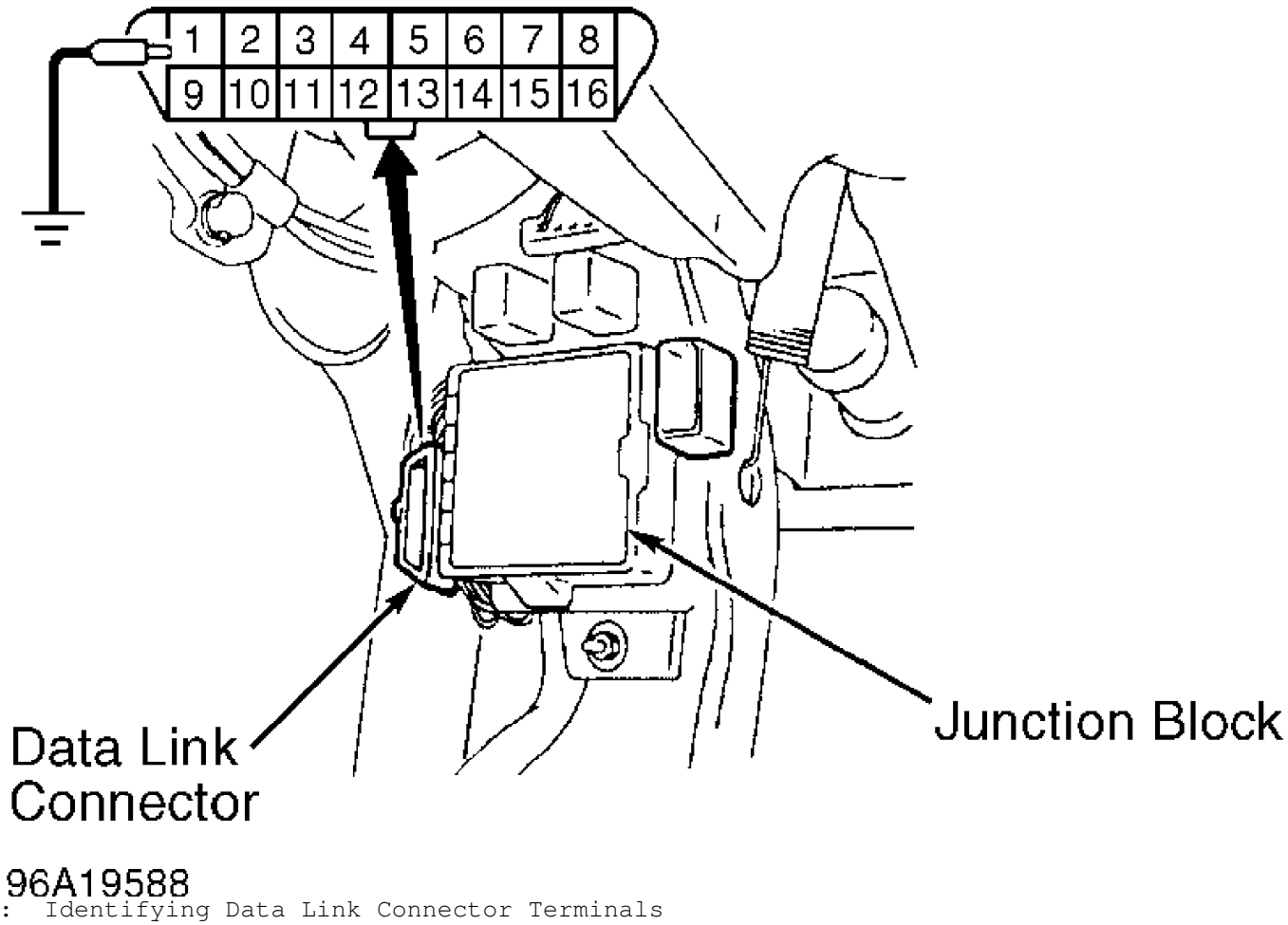

Fig. 8: Identifying Data Link Connector Terminals
Courtesy of Mitsubishi Motor Sales of America.

CLEARING DTCs

To clear DTCs using scan tool, follow scan tool manufacturer's instructions. To clear DTCs without scan tool, disconnect negative battery cable for at least 10 seconds. Reconnect battery cable and repeat RETRIEVING DTCs to confirm that malfunction has been corrected.

DTC DEFINITION

DTC	(1) System Affected
11	Right Front Wheel Speed Sensor (Open/Short)
12	Left Front Wheel Speed Sensor (Open/Short)
13	Right Rear Wheel Speed Sensor (Open/Short)
14	Left Rear Wheel Speed Sensor (Open/Short)
15	Wheel Speed Sensor Output Signal (Abnormal)
16	ECU Power Supply
21	Right Front Wheel Speed Sensor (Abnormal)
22	Left Front Wheel Sensor (Abnormal)
23	Right Rear Wheel Speed Sensor (Abnormal)
24	Left Rear Wheel Speed Sensor (Abnormal)
25	Free Wheel Engage Switch
26	Center Differential Lock Detection Switch
27	(2) Rear Differential Lock Detection Switch

27	(3) Rear Differential Lock Detection Switch
32	"G" Sensor System
33	Stoplight Switch System
41	RF Solenoid Valve Circuit
42	LF Solenoid Valve Circuit
43	Rear Solenoid Valve Circuit
51	Valve Relay
53	Motor Relay
63 Or 64	(4) Faulty ECU

(1) - See appropriate DTC under DIAGNOSTIC TESTS.
(2) - Vehicles with differential lock.
(3) - Vehicles without differential lock.
(4) - Replace ECU.

DIAGNOSTIC TESTS

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

NOTE: DTC will set if ECU detects a wheel speed sensor open or short circuit.

1) Ensure sensor is properly installed. See WHEEL SPEED SENSOR (WSS) under REMOVAL & INSTALLATION. Correct installation if needed. If installation is okay, go to next step.
2) Disconnect ECU 26-pin connector. Check resistance between specified ECU connector terminals. See WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION table. See Figs. 5-6. Resistance for front sensors should be 1170-1350 ohms. Resistance for rear sensors should be 1300-1500 ohms. If resistance is as specified, go to next step. If resistance is not as specified, check and repair connectors and related wiring between ECU and suspect sensor. See WIRING DIAGRAMS.

WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION

Application	Terminals No.
Left Front	7 & 20
Left Rear	9 & 22
Right Front	10 & 23
Right Rear	8 & 21

3) Raise and support vehicle. Disconnect ECU connectors. Using DVOM, backprobe specified ECU connector terminals. See WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION table. See Figs. 5-6. 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 8). If voltage is not as specified, go to next step.
4) Inspect condition of suspect speed sensor. Ensure tip of speed sensor is clean. If speed sensor is okay, go to next step.
5) Disconnect sensor connector. Using DVOM, check resistance across sensor terminals. Resistance for front sensors should be 1170-1350 ohms. Resistance for rear sensors should be 1300-1500 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace sensor.
6) 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.

7) Inspect condition of toothed rotor. Check for broken or deformed teeth. If toothed rotor is okay, go to next step.
8) Check ECU connectors. Repair connectors as needed. If connectors are okay, replace ECU.

DTC 15: WHEEL SPEED SENSOR OUTPUT SIGNAL (ABNORMAL)

NOTE: DTC will set if ECU detects a wheel speed sensor fault other than an open or short circuit.

1) Ensure sensor is properly installed. See WHEEL SPEED SENSOR (WSS) under REMOVAL & INSTALLATION. Correct installation if needed. If installation is okay, go to next step.
2) Raise and support vehicle. Disconnect ECU connectors. Using DVOM, backprobe specified ECU connector terminals. See WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION table. See Figs. 5-6. 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) Inspect condition of suspect speed sensor. Ensure tip of speed sensor is clean. If speed sensor is okay, go to next step.
4) Disconnect sensor connector. Using DVOM, check resistance across sensor terminals. Resistance for front sensors should be 1170-1350 ohms. Resistance for rear sensors should be 1300-1500 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace sensor.
5) 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.
6) Inspect condition of toothed rotor. Check for broken or deformed teeth. If toothed rotor is okay, go to next step.
7) Check ECU connectors. Repair connectors as needed. If connectors are okay, replace ECU.

DTC 16: ECU POWER SUPPLY

NOTE: DTC will set if ECU power supply voltage is not within standard value. If voltage returns to normal, DTC will be erased. Ensure battery is fully charged.

1) Ensure battery voltage is 10-17 volts. Turn ignition off. Disconnect ECU 26-pin connector. Start engine. Using DVOM, check voltage between ECU 26-pin connector terminal No. 13 and ground. See Figs. 5-6. If battery voltage exists, go to step 3). If battery voltage do es not exist, go to next step.
2) Check and repair connectors and related wiring between ignition switch and ECU. See WIRING DIAGRAMS. If connectors and wiring are okay, check and repair battery or charging system.
3) Check voltage between ECU 26-pin connector terminal No. 26 and ground. If battery voltage exists, go to next step. If battery voltage does not exist, check and repair connectors and wiring harness between fusible link and ECU. See WIRING DIAGRAMS.
4) Check and repair ECU connectors. If connectors are okay, replace ECU.

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

NOTE: DTC sets if wheel speed sensor does not output a signal when driving, and an open circuit cannot be found.

1) Ensure sensor is properly installed. See WHEEL SPEED SENSOR (WSS) under REMOVAL & INSTALLATION. Correct installation if needed. If installation is okay, go to next step.

2) Disconnect ECU 26-pin connector. Check resistance between specified ECU connector terminals. See WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION table. See Figs. 5-6. Resistance for front sensors should be 1170-1350 ohms. Resistance for rear sensors should be 1300-1500 ohms. If resistance is as specified, go to next step. If resistance is not as specified, check and repair connectors and related wiring between ECU and suspect sensor. See WIRING DIAGRAMS.

3) Raise and support vehicle. Disconnect ECU connectors. Using DVOM, backprobe specified ECU connector terminals. See WHEEL SPEED SENSOR OUTPUT CIRCUIT IDENTIFICATION table. See Figs. 5-6. 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 8). If voltage is not as specified, go to next step.

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

5) Disconnect sensor connector. Using DVOM, check resistance across sensor terminals. Resistance for front sensors should be 1170-1350 ohms. Resistance for rear sensors should be 1300-1500 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace sensor.

6) 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.

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

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

DTC 25: FREE WHEEL ENGAGE SWITCH

NOTE: DTC sets if ECU detects an open circuit in free wheel engage switch.

1) Start engine. Ensure 4WD indicator light operates correctly when transfer shift lever is moved to desired 4WD positions. If indicator light operates correctly, go to step 3). If indicator light does not operate correctly, go to next step.

2) Turn engine off. Check wiring harness between 4WD indicator control unit (located behind radio) and free wheel engage switch (located on right side of front differential housing, near carrier assembly). If circuit is okay, replace 4WD indicator control unit.

3) Disconnect ECU 22-pin connector. Turn ignition on. Using DVOM, check voltage between ECU 22-pin connector terminal No. 45 and ground. See Figs. 5-6. In 2WD, battery voltage should exist. Battery voltage should not exist in 4WD. If voltage is as specified, go to next step. If voltage is not as specified, check and repair connectors and wiring harness between free wheel engage switch and ECU. See WIRING DIAGRAMS.

4) Check and repair ECU 22-pin connector. If connector is okay, replace ECU.

DTC 26: CENTER DIFFERENTIAL LOCK DETECTION SWITCH

NOTE: DTC sets if ECU detects an open circuit in center differential lock detection switch system.

1) Start engine. Ensure 4WD indicator light operates correctly when transfer shift lever is moved to desired 4WD positions. If indicator light does not operate correctly, go to step 4). If indicator light operates correctly, go to next step.

2) Disconnect ECU 22-pin connector. Turn ignition on. Using

DVOM, check voltage between ECU 22-pin connector terminal No. 35 and ground. See Figs. 5-6. Battery voltage should exist in 4WD. Go to next step.

3) If voltage is not as specified, check and repair connectors and wiring harness between center differential lock detection switch and ECU. See WIRING DIAGRAMS. Center differential lock detection switch is located on side of transfer case. See Fig. 9. If voltage is as specified, check and repair ECU 22-pin connector. If connector is okay, replace ECU.

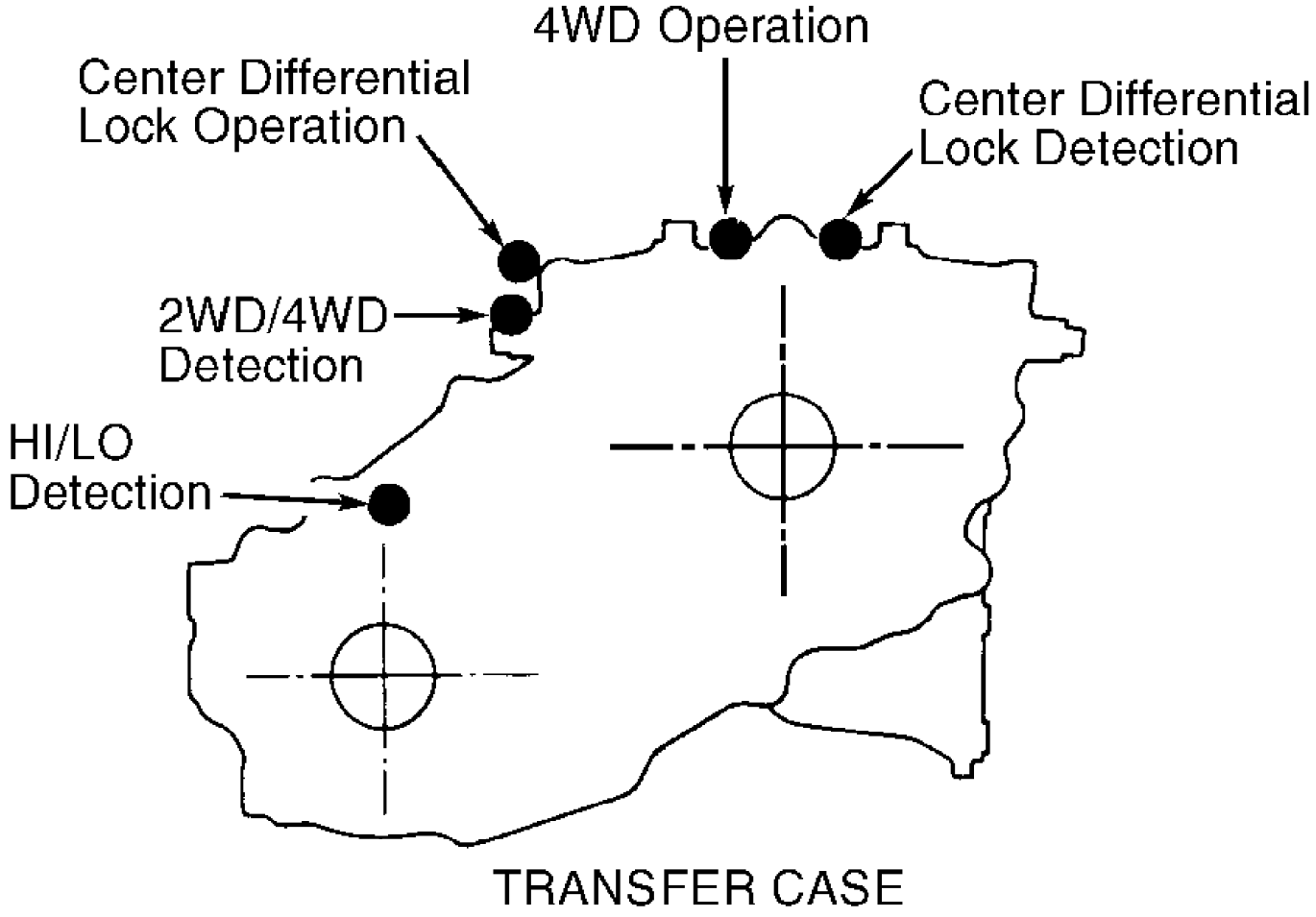

Fig. 9: Identifying 4WD Indicator Switch Location
Courtesy of Mitsubishi Motor Sales of America.

NOTE: When checking for short in ECU circuit, remove ECU connector and ensure 4WD indicator light operates correctly. If 4WD indicator light operates correctly, replace faulty ECU. If 4WD indicator light does not operate correctly, replace faulty 4WD indicator control unit.

4) If no indicator lights come on, repair 4WD indicator power circuit, or check for faulty 4WD indicator control unit. See 4WD CONTROL UNIT under COMPONENT TESTS. If center differential light comes on, regardless of position of transfer shift lever, check the following:

* Check for short in center differential lock switch circuit.
* Check for faulty center differential lock switch.
* Check for short in ECU circuit or faulty ECU.
* Check for short in indicator control unit circuit or faulty 4WD indicator control unit.

Repair wiring harness or replace component as necessary. See WIRING DIAGRAMS.

5) If 4WD indicator light does not come on with transfer shift lever in "4H" position, repair wiring harness between 4WD indicator control unit and center differential lock switch. Check for faulty 4WD indicator control unit.

6) If 4WD indicator light does not come on with transfer shift lever in "4H" position, repair wiring harness between 4WD indicator control unit and free wheel engage switch. See WIRING DIAGRAMS. Check ground wire at engage switch. Check for faulty free wheel engage switch.

DTC 27: REAR DIFFERENTIAL LOCK DETECTION SWITCH (WITH DIFFERENTIAL LOCK)

NOTE: DTC is set if ECU detects an open circuit in rear differential lock detection switch system.

1) Start engine. Ensure rear differential indicator light comes on when top of rear differential lock switch (located below radio) is pushed. If indicator light comes on, go to step 3). If indicator light does not come on, go to next step.

2) Turn engine off. Check wiring harness between rear differential lock control unit and rear differential lock switch. See WIRING DIAGRAMS. Check rear differential lock control unit power circuit. See REAR DIFFERENTIAL CONTROL UNIT under COMPONENT TESTS. If circuit is okay, replace rear differential lock control unit.

3) Disconnect ECU 22-pin connector. Turn ignition on. Using DVOM, check voltage between terminal No. 46 and ground. See Figs. 5-6. When rear differential is locked, battery voltage should not be present. When rear differential is unlocked, battery voltage should be present. If voltage is as specified, go to next step. If voltage is not as specified, repair connectors and related wiring harness between ECU and rear differential lock switch. See WIRING DIAGRAMS.

4) Check and repair ECU 22-pin connector. If connector is okay, replace ECU.

DTC 27: REAR DIFFERENTIAL LOCK DETECTION SWITCH (WITHOUT DIFFERENTIAL LOCK)

NOTE: DTC is set if ECU detects an interruption of battery voltage at ECU terminal No. 46.

1) Check fuse No. 18 in main fuse block. If fuse is blown, correct cause of blown fuse, and replace fuse. If fuse is okay, go to next step.

2) Disconnect ECU 22-pin connector. Turn ignition on. Using DVOM, check voltage between terminal No. 46 and ground. See Figs. 5-6. If battery voltage is present, go to next step. If battery voltage is not present, check and repair connectors and related wiring harness between ECU and fuse No. 18. See WIRING DIAGRAMS.

3) Check and repair ECU 22-pin connector. If connector is okay, replace ECU.

DTC 32: "G" SENSOR SYSTEM

NOTE: DTC is set if ECU detects "G" sensor output voltage less

than 0.5 volt or more than 4.5 volts, or an open or short circuit in "G" sensor system.

1) Disconnect "G" sensor connector. Sensor is located on bracket under center console, next to shifter. See Fig. 10. Connect Special Tool (MB991348) between sensor and connector. Using a DVOM, check voltage between sensor connector terminals No. 2 (Blue/White wire) and No. 3 (Black/Red wire). Voltage should be 2.38-2.62 volts. If voltage is as specified, reconnect sensor connector and go to step 3). If voltage is not as specified, leave special tool and DVOM connected and go to next step.

2) Note top center position of sensor, and remove sensor. See "G" SENSOR under REMOVAL & INSTALLATION. Secure sensor so that arrow on sensor is facing straight down. Voltage should be 3.4-3.6 volts. If voltage is specified, reinstall sensor and go to next step. If voltage is not as specified, replace sensor.

3) Turn ignition off. Disconnect ECU 26-pin connector. Turn ignition on. Check voltage between ECU 26-pin connector terminals No. 4 and 17. See Figs. 5-6. Voltage should be 2.4-2.6 volts. If voltage is as specified, go to next step. If voltage is not as specified, check and repair connectors and related wiring harness between ECU and sensor. See WIRING DIAGRAMS.

4) Check and repair ECU 26-pin connector. If connector is okay, replace ECU.

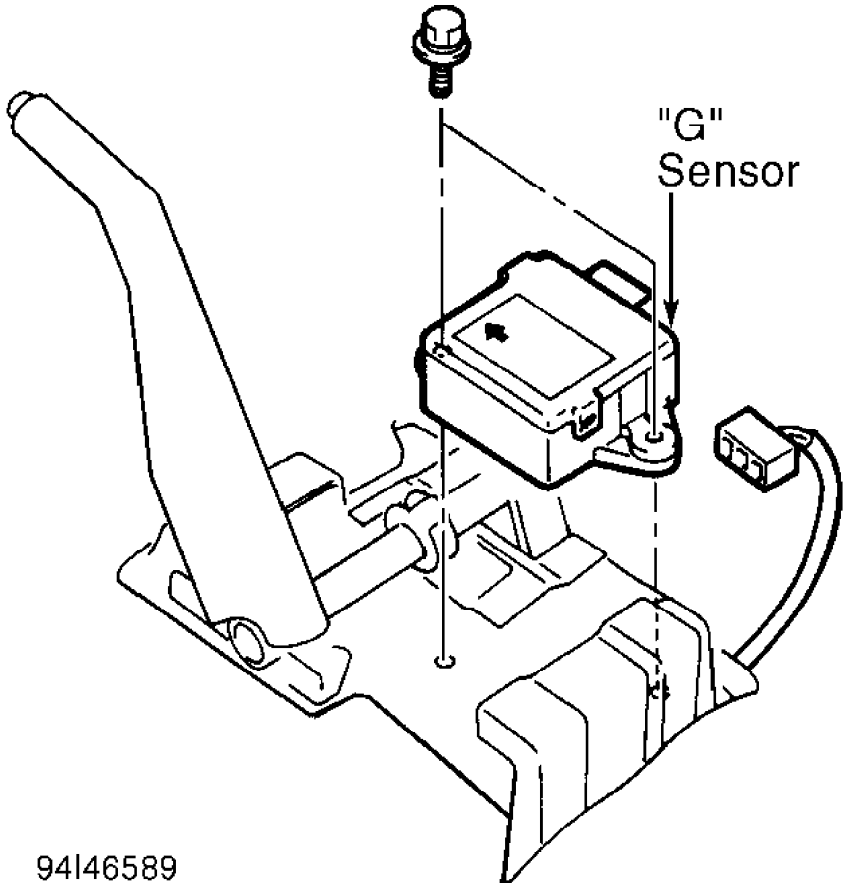

Fig. 10: Locating "G" Sensor
Courtesy of Mitsubishi Motor Sales of America.

DTC 33: STOPLIGHT SWITCH SYSTEM

NOTE: DTC is set if ECU detects stoplight switch stays on for 15 minutes or more, or an open circuit in stoplight switch system.

1) Check if stoplights are functioning correctly. If stoplights function correctly, go to next step. If stoplights do not function correctly, check and repair stoplight circuit. See WIRING DIAGRAMS.

2) Turn ignition off. Disconnect ECU 22-pin connector. Using DVOM, measure voltage between ECU 22-pin connector terminal No. 34 and ground while depressing brake pedal. See Figs. 5-6. If battery voltage is present, go to next step. If battery voltage is not present, check and repair connectors and related wiring harness between stoplight switch and ECU. See WIRING DIAGRAMS.

3) Check and repair ECU 22-pin connector. If connector is okay, replace ECU.

DTC 41, 42 OR 43: SOLENOID VALVE CIRCUIT

NOTE: DTC sets if ECU senses that solenoid is on with no power supplied, or off with power supplied.

1) Disconnect hydraulic unit connectors. Using ohmmeter, check resistance between hydraulic unit connectors terminals No. 4 and 12, 5 and 12, and 6 and 12. See Fig. 11. Resistance should be 4.04-4.54 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace faulty hydraulic unit. See HYDRAULIC UNIT under REMOVAL & INSTALLATION.

2) Check resistance between hydraulic unit connectors terminals No. 1 and 12, 2 and 12, and 3 and 12. Resistance should be 8.04-8.59 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace faulty hydraulic unit. See HYDRAULIC UNIT under REMOVAL & INSTALLATION.

3) Turn ignition off. Disconnect ECU connectors. Check continuity of each circuit between ECU connectors and hydraulic unit connectors. See WIRING DIAGRAMS. If continuity exists, go to next step. If continuity does not exist, check and repair connectors and related wiring harness between ECU and hydraulic unit. See WIRING DIAGRAMS.

4) Check continuity between hydraulic unit connector terminal No. 12 and ABS relay box terminal No. 1. See Figs. 4 and 11. If continuity exists, go to next step. If continuity does not exist, check and repair connectors and related wiring harness between hydraulic unit and ABS relay box. See WIRING DIAGRAMS.

5) Check and repair ECU connectors. If connectors are okay, replace ECU.

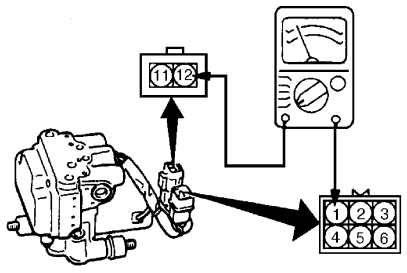

Fig. 11: Identifying Hydraulic Unit Connector Terminals
Courtesy of Mitsubishi Motor Sales of America.

DTC 51: VALVE RELAY

NOTE: DTC is set if valve relay is removed or if no power is supplied to relay.

1) Inspect ABS relay box. See Fig. 3. Replace ABS relay box if needed. If ABS relay box is okay, go to next step.
2) Disconnect ABS relay box 8-pin connector. Turn ignition on. Using a DVOM, check voltage between ABS relay box 8-pin harness connector terminal No. 6 and ground. See Fig. 4. If battery voltage exists, go to next step. If battery voltage does not exist, check and repair wiring harness between ABS valve relay and fusible link No. 1. See WIRING DIAGRAMS.
3) Disconnect ECU connectors. Check resistance between ECU 22-pin connector terminal No. 37 and ECU 26-pin connector terminal No. 26. Resistance should be 60-120 ohms. If resistance is as specified, go to next step. If resistance is not as specified, check and repair connectors and related wiring harness between ABS valve relay and ECU. See WIRING DIAGRAMS.
4) Check continuity between ECU 22-pin connector terminal No. 48 and ground. If continuity exists, go to next step. If continuity does not exist, check and repair wiring harness between ABS valve relay and ECU. See WIRING DIAGRAMS.
5) Check and repair ECU 22-pin connector. If connector is okay, replace ECU.

DTC 53: MOTOR RELAY

NOTE: DTC is set when ECU detects motor relay on but motor does not run, motor relay off but motor does not stop, or when motor relay is faulty.

1) Using scan tool, perform hydraulic unit actuator test. If motor is not operating, go to next step. If motor is still operating, repair wiring harness between hydraulic unit and ECU. See WIRING DIAGRAMS.
2) Inspect ABS relay box. See Fig. 3. Replace ABS relay box if needed. If ABS relay box is okay, go to next step.
3) Disconnect ABS relay box 2-pin connector. Using DVOM, check voltage between 2-pin connector terminal No. 11 and ground. See Fig. 4. If battery voltage is present, go to next step. If battery volt age is not present, check and repair wiring harness between ABS motor relay and fusible link No. 1. See WIRING DIAGRAMS.
4) Turn ignition off. Disconnect ECU connectors. Check resistance between ECU 22-pin connector terminal No. 38 and 26-pin connector terminal No. 26. Resistance should be 26-38 ohms. If resistance is as specified, go to next step. If resistance is not as specified, check and repair connectors and related wiring harness between ABS motor and ECU. See WIRING DIAGRAMS.
5) Check resistance between ECU 22-pin connector terminal No. 49 and ground. Resistance should be 0.1-0.3 ohm. If resistance is as specified, go to next step. If resistance is not as specified, check and repair hydraulic unit motor ground connection or wiring harness between ECU and hydraulic unit. See WIRING DIAGRAMS.
6) Check motor operation. Momentarily apply battery voltage to hydraulic unit connector terminal No. 11. See Fig. 11. If motor operates, go to next step. If motor does not operate, replace hydraulic unit.
7) Check and repair ECU 22-pin connector. If connector is okay, replace ECU.

COMPONENT TESTS

4WD CONTROL UNIT

Remove radio and remove 4WD control unit. Disconnect control unit harness connector. Backprobe harness connector. Check voltage between each individual terminal and ground terminal No. 8 (Black wire). See Figs. 12 and 13. If after all tests have been completed system is not operating properly, substitute 4WD control unit with known-good unit and retest.

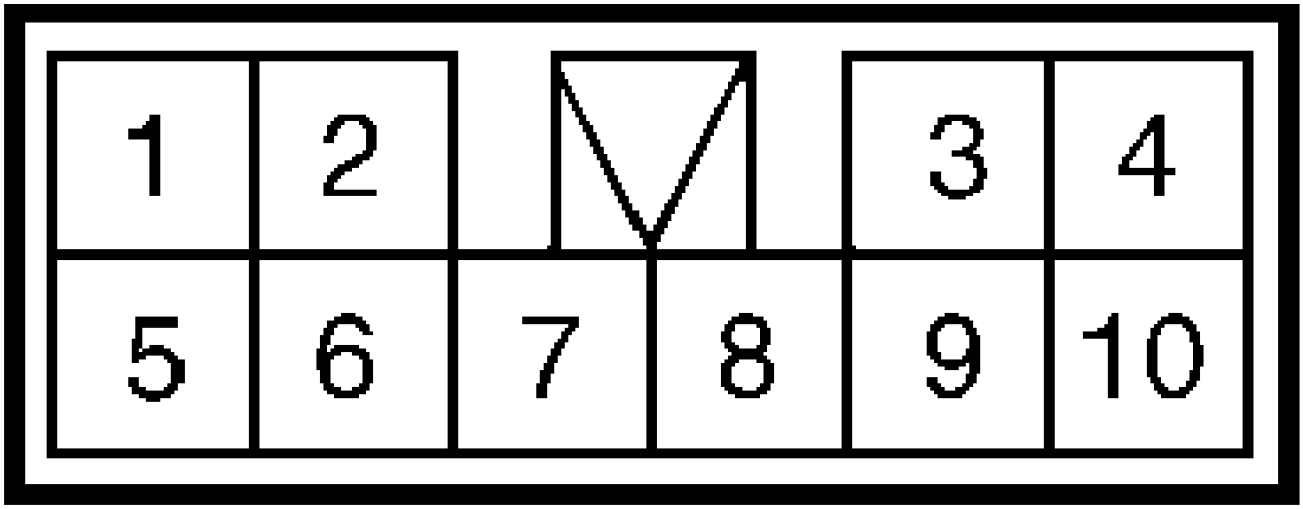

Fig. 12: Identifying 4WD Control Unit Connector
Courtesy of Mitsubishi Motor Sales of America.

	Terminal ID.	Function/Description	Voltage Value (DC Volts Unless Otherwise Specified)
Yellow/Blue	1	HI/LO Detection Switch	KOEO – 9-11 Volts With Transfer In "N" KOEO – 0 Volt In "4HLc" Or "4LLc"
Blue/Orange	2	4WD Operation Detection Switch	KOEO – 9-11 Volts In "2H" KOEO – 0 Volt "4H"
Blue/Yellow	3	Ignition Switch (IG2)	Ignition Off – 0 Volt Ignition On – Battery Voltage
Blue/Green	4	Center Differential Lock Indicator Light	KOEO – Battery Voltage With Transfer In "4H" KOEO – 0-1.5 Volts With Transfer In "4HLc"
Blue/White	5	Center Differential Lock Detection Switch	KOEO – 9-11 Volts With Transfer In "4H" KOEO – 0 Volt With Transfer In "4HLc"
Yellow/Green	6	Free Wheel Engage Switch	KOEO – 9-11 Volts With Vehicle in 2WD KOEO – 0 Volt With Vehicle in 4WD
Yellow/Blue	7	Center Differential Lock Operation Detection Switch	KOEO – 9-11 Volts With Transfer In "4H" KOEO – 0 Volt With Transfer In "4HLc"
Yellow/Black	9	Rear Wheel Indicator Light	KOEO – 0 Volt With Transfer In "N" KOEO – 9-11 Volts In "4HLc" Or "4LLc"
Yellow/Red	10	Front Wheel Indicator Light	KOEO – 0 Volt With Vehicle In 2WD KOEO – 9-11 Volts With Vehicle In 4WD

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Fig. 13: 4WD Control Unit Pin Voltage Chart
Courtesy of Mitsubishi Motor Sales of America.

4WD INDICATOR SWITCHES

All switches are mounted to transfer case. See Fig. 9. Switches use single harness lead and ground to transfer case. See 4WD INDICATOR SWITCH CONTINUITY CHECK table. Ensure all appropriate grounding straps are connected to vehicle body or frame.

4WD INDICATOR SWITCH CONTINUITY CHECK

Switch	Transfer Control Lever Position	Specification
Center Differential Lock Detection Switch	4H	No Continuity
Detection Switch	4HLc	Continuity
Center Differential Lock Operation Detection Switch	4H	No Continuity
"	4HLc	Continuity
4WD Operation Detection Switch	2H	No Continuity
Detection Switch	4H	Continuity
HI/LO Detection Switch	4HLc	Continuity
"	N	No Continuity
"	4LLc	Continuity
2WD/4WD Detection Switch	2H	Continuity
"	4H	No Continuity

REAR DIFFERENTIAL CONTROL UNIT

Remove rear seat and remove rear differential control unit. Do not disconnect control unit harness connector. Backprobe harness connector. Check voltage between each individual terminal and ground terminal No. 6 (Black wire). See Figs. 14 and 15. If after all tests have been completed system is not operating properly, substitute rear differential control unit with known good-unit and retest.

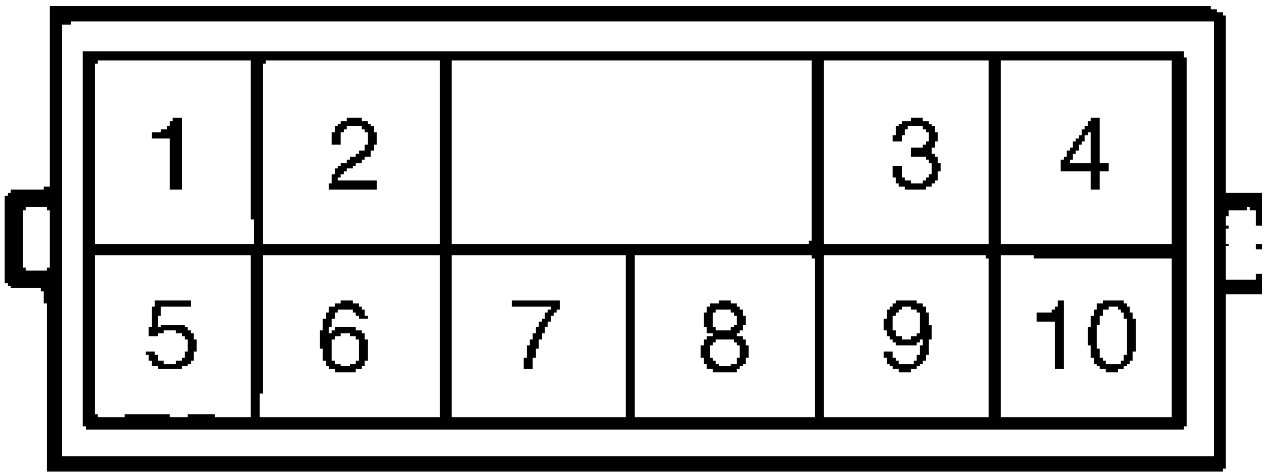
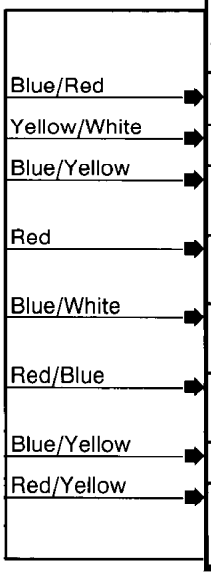


Fig. 14: Identifying Rear Differential Control Unit Connector
Courtesy of Mitsubishi Motor Sales of America.



Terminal ID.	Function/Description	Voltage Value (DC Volts Unless Otherwise Specified)
1	Rear Differential Lock Switch (OFF)	KOEO - Battery Voltage With Transfer In "N"
2	Vehicle Speed Sensor	KOER - 5 Volts With Wheels Rotating
3	Ignition Switch (IG1)	Ignition Off - 0 Volt Ignition On - Battery Voltage
4	Rear Differential Lock Air Pump	KOEO - Battery Voltage When Pumping Air KOEO - 0 Volt When Releasing Air
5	Center Differential Lock Switch	KOEO - Battery Voltage With Transfer Unlocked KOEO - 0 Volt With Transfer Locked
8	Rear Differential Lock Detection Switch	KOEO - Bat. Voltage/Differential Unlocked KOEO - 0 Volt With Differential Locked
9	Rear Differential Lock Switch (ON)	KOEO - 0 Volt
10	Rear Differential Lock Indicator Light	KOEO - 0 Volt With Differential Locked KOEO - Battery Voltage With Differential Locked

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Fig. 15: Rear Differential Control Unit Pin Voltage Chart
Courtesy of Mitsubishi Motor Sales of America.

WHEEL SPEED SENSOR (WSS)

WSS Resistance Test

1) Before testing WSS resistance, ensure pole piece-to-WSS tip is clean. Check WSS pole piece for damage. If pole piece is damaged, replace WSS.

2) Disconnect WSS connector. Inspect WSS wiring harness for broken and pinched wires. See WIRING DIAGRAMS. Repair harness as necessary. If harness is okay, go to next step.

3) Using ohmmeter, check resistance across WSS terminals. Resistance for front WSS should be 1170-1350 ohms. Resistance for rear WSS should be 1300-1500 ohms. If resistance is as specified, go to GROUND CIRCUIT TEST. If resistance is not as specified, replace WSS.

Ground Circuit Test

Disconnect WSS wiring harness connector. Check resistance between each WSS terminal and WSS housing. Resistance should be more than 100,000 ohms. If resistance is not as specified, replace WSS.

REMOVAL & INSTALLATION

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation

1) ECU is located behind right rear quarter panel trim. See Fig. 16. Disconnect negative battery cable. Remove quarter panel mounti ng screws and trim clip.

2) Carefully remove quarter panel trim. Disconnect ECU wiring harness connector. Remove ECU mounting bolts/nuts and ECU. To install, reverse removal procedure.

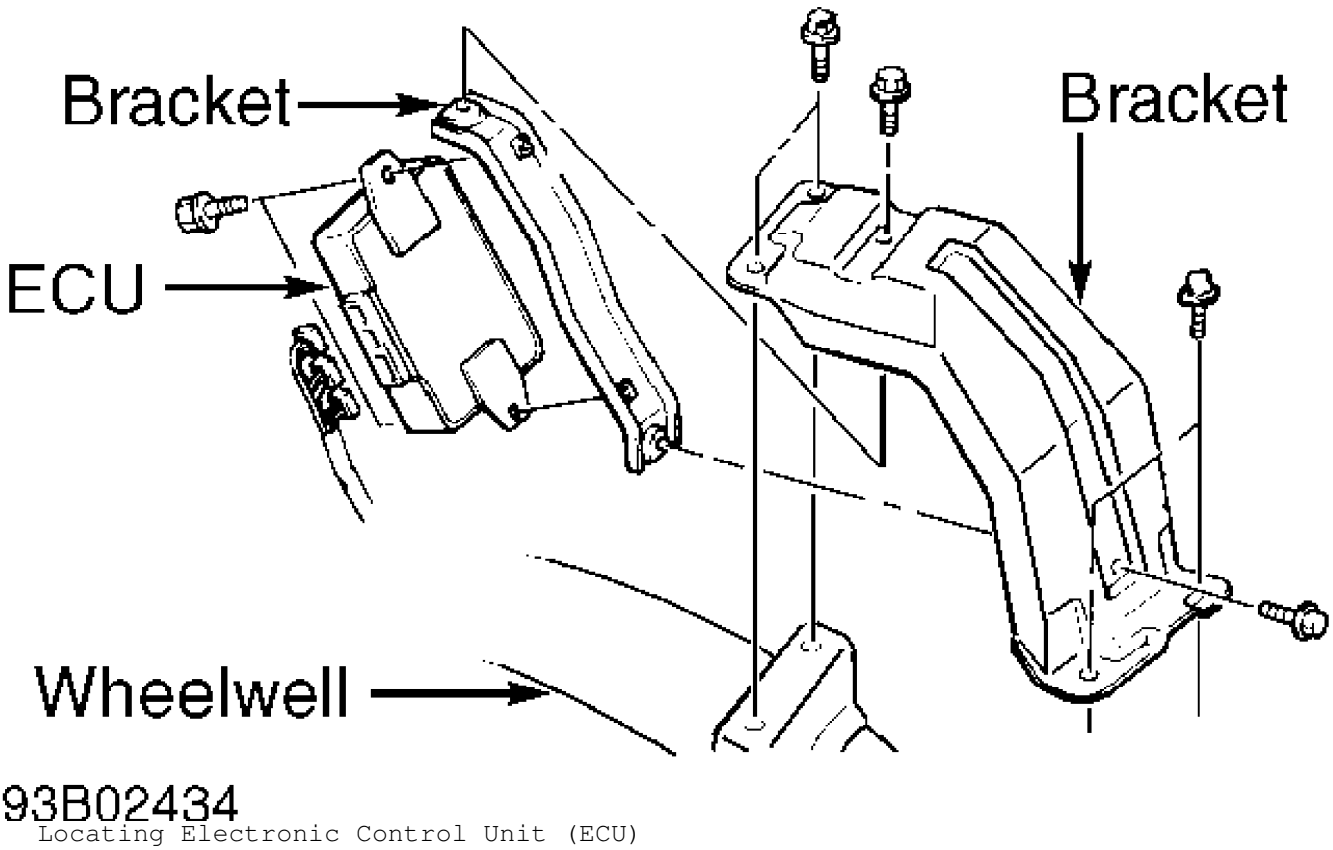


Fig. 16: Locating Electronic Control Unit (ECU)
Courtesy of Mitsubishi Motor Sales of America.

"G" SENSOR

CAUTION: DO NOT turn "G" sensor upside-down or lay unit on its side. DO NOT drop "G" sensor. DO NOT disassemble unit. Replace "G" sensor as an assembly.

Removal & Installation

Sensor is located under center console, near shifter. See Fig. 10. Remove center console assembly. Disconnect sensor wiring harnes s connector. Remove sensor. To install, reverse removal procedure. Tighten bolts to specification. See TORQUE SPECIFICATIONS.

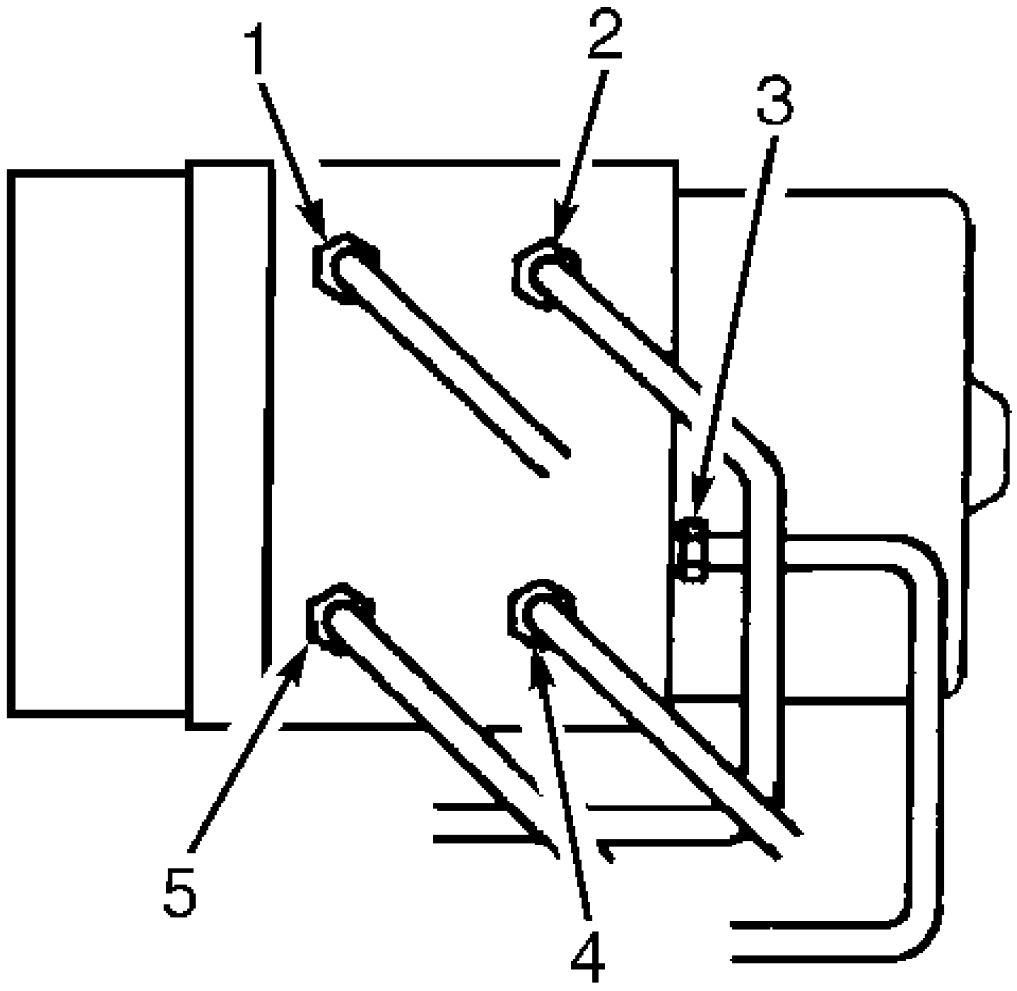
HYDRAULIC UNIT

Removal

Remove brakelines from hydraulic unit. Remove ABS relay box cover. See Fig. 3. Disconnect ground wire and wiring harness connectors from hydraulic unit. Remove hydraulic unit retaining nuts. Carefully remove hydraulic unit.

Installation

To install, reverse removal procedure. Install hydraulic unit brakelines. Ensure brakelines are installed in correct location. See Fig. 17. Bleed brake system. See BLEEDING BRAKE SYSTEM.



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

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Fig. 17: Identifying Hydraulic Unit Brakeline Connections
Courtesy of Mitsubishi Motor Sales of America.

WHEEL SPEED SENSOR (WSS)

Removal & Installation

Disconnect WSS connector. Remove WSS bolts. Remove WSS from vehicle. To install, reverse removal procedure. Sensors are not interchangeable. Adjust wheel WSS-to-rotor gap. See WHEEL SPEED SENSOR (WSS) under ADJUSTMENTS. To complete installation, reverse removal procedure. Tighten WSS bolts to specification. See TORQUE SPECIFICATIONS.

WHEEL SENSOR ROTOR

Removal & Installation

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.

OVERHAUL

HYDRAULIC UNIT

DO NOT attempt to overhaul or disassemble hydraulic unit. If hydraulic unit is defective, replace entire assembly.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	INCH Lbs. (N.m)
"G" Sensor Mounting Bolt	80 (9.0)
Wheel Speed Sensor (WSS) Bolt	84-120 (9.5-14.6)

WIRING DIAGRAMS

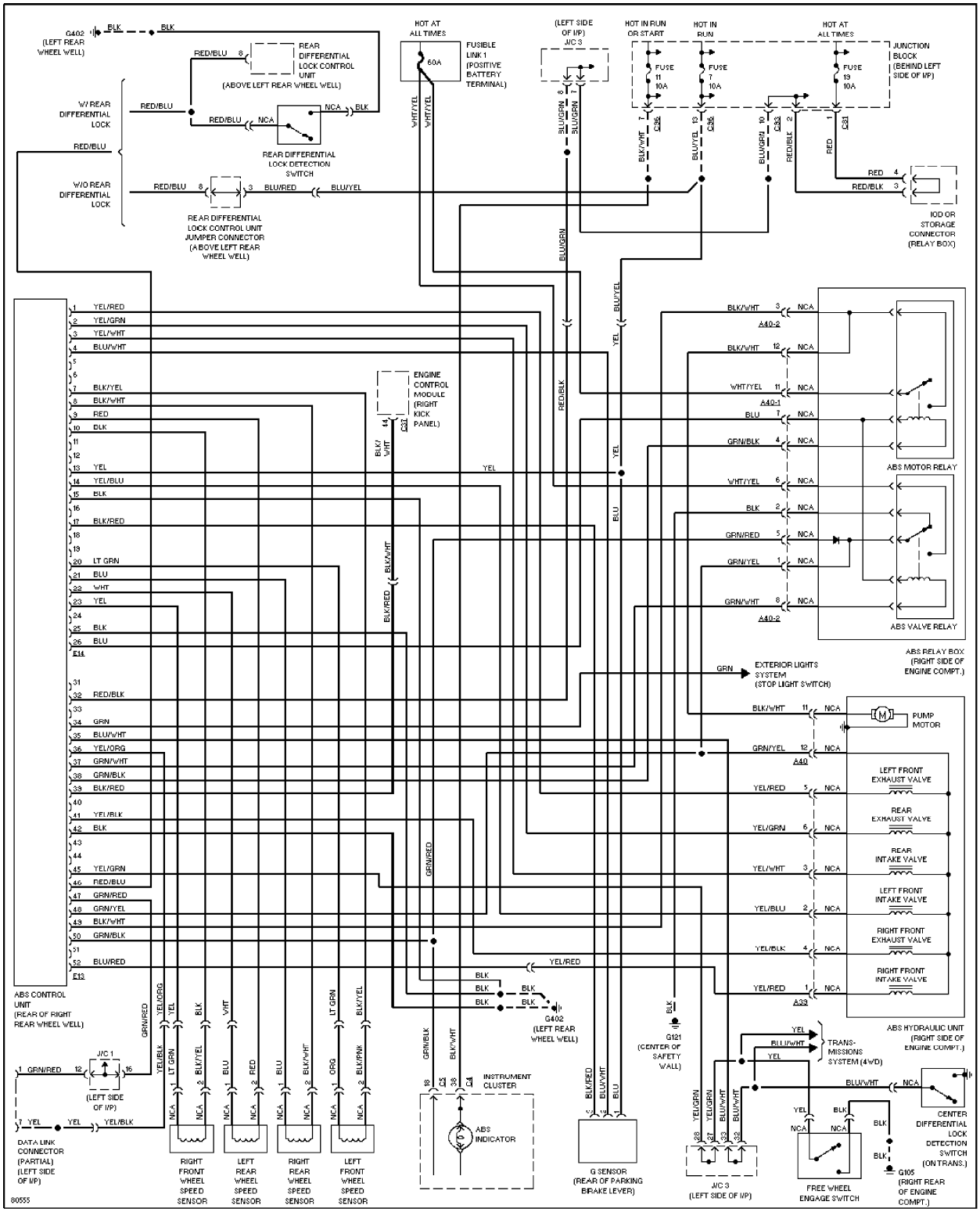

Fig. 18: Anti-Lock Brake System (ABS) Wiring Diagram (1997 Montero)

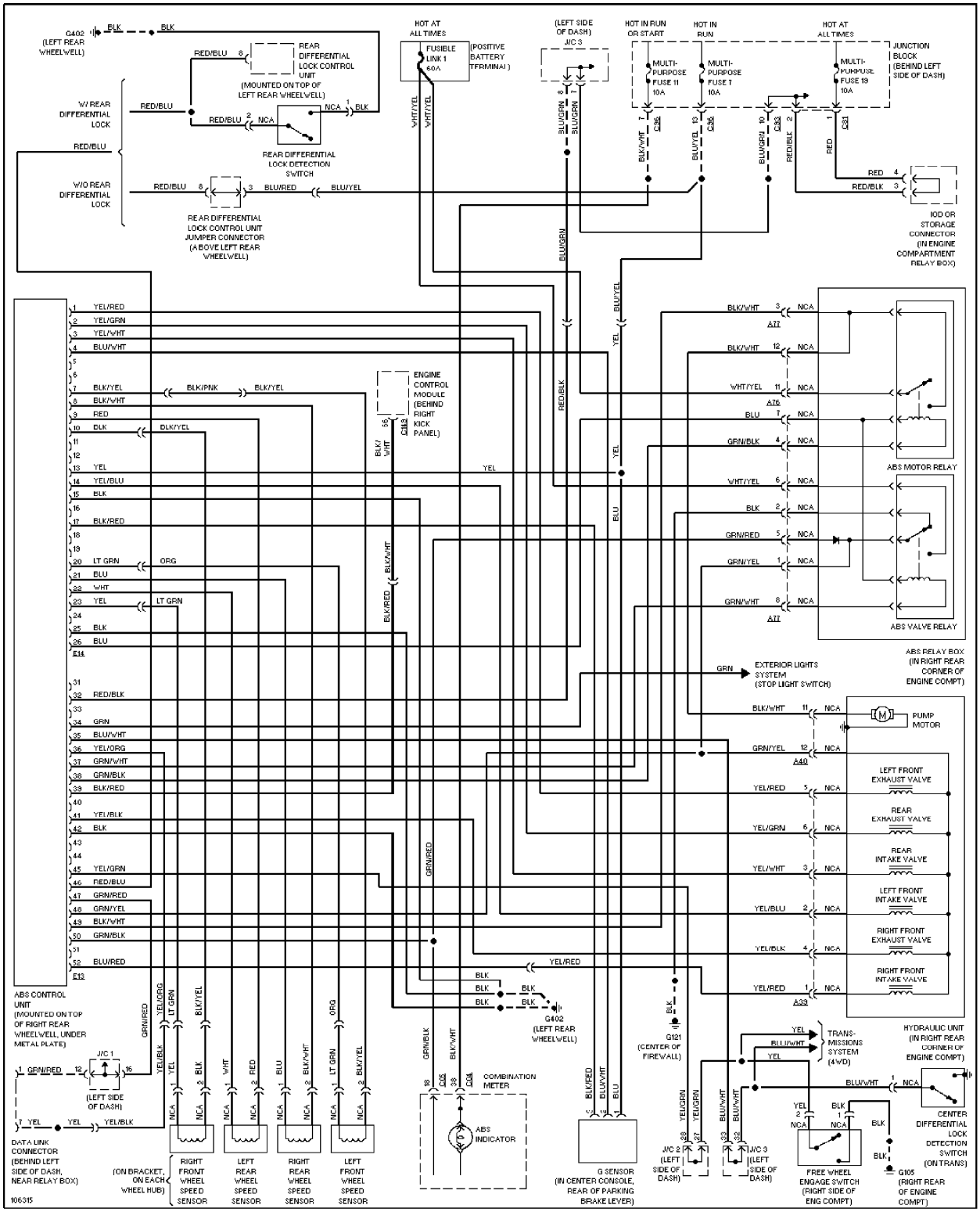

Fig. 19: Anti-Lock Brake System (ABS) Wiring Diagram (1998 Montero)