

# ANTI-LOCK BRAKE SYSTEM

1993 Mitsubishi Montero

1993 BRAKES  
Mitsubishi Anti-Lock Brakes

Montero

## DESCRIPTION

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 hydraulic unit, wheel speed sensors, "G" sensor, 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.

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

## OPERATION

Each wheel sensor sends an AC electrical signal to the Electronic Control Unit (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.

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS below.

## ANTI-LOCK BRAKE SAFETY PRECAUTIONS

- \* NEVER open a bleeder valve or loosen a hydraulic line while ABS is pressurized
- \* NEVER disconnect or reconnect any electrical connectors while ignition is on. Damage to ABS control unit may result.
- \* DO NOT attempt to bleed hydraulic system without first referring to the appropriate article.
- \* Only use specially designed brake hoses/lines on ABS-equipped vehicles.
- \* DO NOT tap on speed sensor components (sensor, sensor rings). Speed rings must be pressed, NOT hammered into hubs. Striking these components can cause demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.
- \* DO NOT mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable. Rolling diameter must be identical for all 4 tires. Some manufacturers recommend tires of the same brand, style and type. Failure to follow this precaution may cause inaccurate wheel speed readings.
- \* DO NOT contaminate speed sensor components with grease. Only use recommended anti-corrosion coating.

- \* When speed sensor components have been removed, ALWAYS check sensor-to-ring air gaps when applicable. These specifications can be found in each appropriate article.
- \* ONLY use recommended brake fluids. DO NOT use silicone brake fluids in an ABS-equipped vehicle.
- \* When installing transmitting devices (CB's, telephones, etc.) on ABS-equipped vehicles, DO NOT locate the antenna near the ABS control unit (or any control unit).
- \* Disconnect all on-board computers, when using electric welding equipment.
- \* DO NOT expose the ABS control unit to prolonged periods of high heat (185°F/85°C for 2 hours is generally considered a maximum limit).

## BLEEDING BRAKE SYSTEM

### BLEEDING PROCEDURES

When bleeding hydraulic system, follow normal manual or pressure bleeding procedures. Bleed brake system in following order: right rear, left rear, Load-Sensing Proportioning Valve (LSPV), right front and left front.

### ADJUSTMENTS

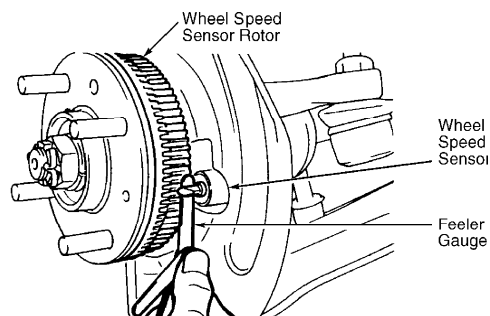
NOTE: For adjustment information for brake pedal height, free play, parking brake and stoplight switch, see BRAKE SYSTEM article in BRAKES section.

### WHEEL SPEED SENSOR

#### Sensor-To-Rotor Gap Adjustment

1) Raise and support vehicle. Remove wheel assembly. On rear axle, remove caliper assembly and support with wire. Remove rotor. Inspect sensor pole piece for damage. Repair if necessary. If sensor pole piece is okay, check wheel speed sensor-to-rotor gap.

2) Using a feeler gauge, check clearance between speed sensor pole and rotor tooth surface. See Fig. 1. Front sensor clearance should be .008-.390" (0.2-1.0 mm). Rear sensor clearance should be .012-.035" (0.3-0.9 mm). If clearance is not within specification, loosen sensor mounting bolt. Adjust sensor position until clearance is within specification. Tighten sensor mounting bolt to 84 INCH lbs. (120 N.m).



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Fig. 1: Checking Wheel Speed Sensor-To-Rotor Gap (Typical)  
Courtesy of Mitsubishi Motor Sales of America.

### TROUBLE SHOOTING

## ANTI-LOCK WARNING LIGHT

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

- \* ANTI-LOCK WARNING LIGHT INOPERATIVE.
- \* IGNITION SWITCH IN ON POSITION, WARNING LIGHT REMAINS ON.
- \* IGNITION SWITCH IN START POSITION, WARNING LIGHT INOPERATIVE.
- \* IGNITION SWITCH IN ON POSITION, WARNING LIGHT BLINKS TWICE. IN START POSITION, WARNING LIGHT STAYS ON. WHEN IGNITION SWITCH IS CYCLED FROM START TO ON POSITION, WARNING LIGHT BLINKS ONCE.

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 above 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 wheel speed sensor rotor gap is correct. See WHEEL SPEED SENSOR under ADJUSTMENTS. Check for faulty wheel speed sensor. See WHEEL SPEED SENSOR under COMPONENT TESTING. Replace sensor as necessary. See WHEEL SPEED SENSOR under REMOVAL & INSTALLATION. Inspect ECU wiring. If testing indicates no mechanical or electrical failures, substitute ECU with known good unit and retest.

6) Enter ABS self-diagnostics, and retrieve codes. See RETRIEVING CODES under DIAGNOSIS & TESTING. If no codes are displayed, fault may be intermittent. Attempt to make malfunction reoccur. If no diagnostic output exists, check for faulty wiring harness between ECU and self-diagnostic connector. Repair or replace as necessary.

NOTE: Trouble shoot warning light in following sequence:

- \* Instrument Cluster Circuit
- \* ECU and Valve Relay.

### ANTI-LOCK Warning Light Inoperative

1) If all other warning lights illuminate with ignition on, go to step 3). If other warning lights do not illuminate, 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.

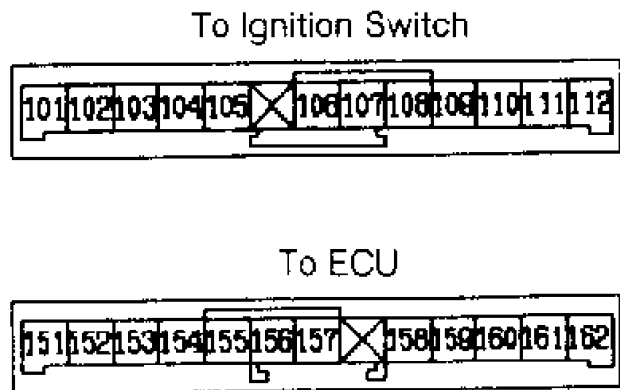
2) Remove instrument cluster. Turn ignition on. Using DVOM, measure voltage between vehicle ground and instrument cluster ABS warning light terminal No. 107. See Fig. 2. If battery voltage is present, repair or replace instrument cluster. If battery voltage is not present, repair wire harness between junction block and instrument cluster.

3) Turn ignition off. Check for faulty warning light bulb. Replace bulb as necessary. If bulb is okay, using an ohmmeter, check for continuity between instrument cluster connector terminals No. 107 and 158. See Fig. 2. If continuity exists, clean and/or repair connector terminals. If connector terminals are okay, check for open circuit to ECU and valve relay. Go to steps 4) and 5). If continuity does not exist, replace instrument cluster.

4) To check ECU, turn ignition off. Remove ECU connector. ECU is located on right rear wheelwell. See Fig. 17. Turn ignition on. Measure voltage between terminal No. 13 and vehicle ground. See Fig. 3. If battery voltage is not present, repair circuit between warning light and ECU. If battery voltage is present, substitute ECU with known good unit and retest.

5) To check valve relay, see HYDRAULIC UNIT RELAYS under COMPONENT TESTING. If relay is okay, remove hydraulic unit connector. Turn ignition on. Measure voltage between terminal No. 8 and vehicle ground. See Fig. 4. If battery voltage is present, go to next step. If battery voltage is not present, repair circuit between ABS warning light and hydraulic unit.

6) Turn ignition off. Check for continuity between terminal No. 9 and vehicle ground. If continuity does not exist, repair circuit between hydraulic unit and vehicle ground. If continuity exists, check for continuity between terminals No. 8 and 9. If continuity exists, check for defective connector. If continuity does not exist, replace hydraulic unit.



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

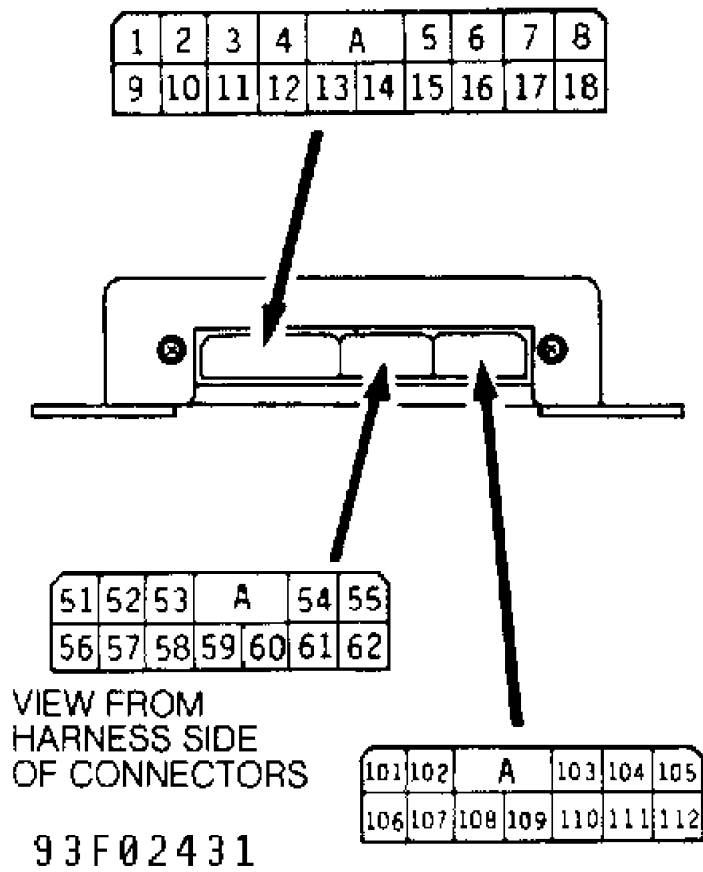
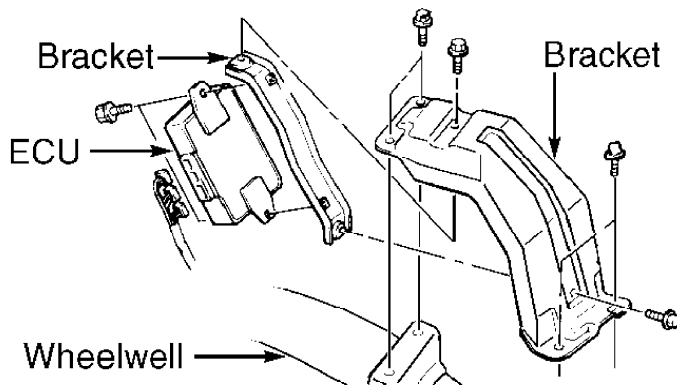


Fig. 3: Identifying ECU Connector Terminals  
Courtesy of Mitsubishi Motor Sales of America.



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Fig. 4: Identifying Hydraulic Unit 10-Pin Connector Terminals  
Courtesy of Mitsubishi Motor Sales of America.

Ignition Switch In ON Position, Warning Light Remains On  
(ECU Power Circuit)

1) Enter ABS self-diagnostics. See RETRIEVING CODES under DIAGNOSIS & TESTING. If diagnostic output exists, go to step 9). If no diagnostic output exists, connect Multi-Use Tester (MUT) to another electronic control system.

2) If MUT can communicate with another electronic control system, go to next step. If MUT cannot communicate with another electronic control system, tester is malfunctioning. Inspect diagnostic connector for damaged terminals and correct hook-up. Repair as necessary. If diagnostic connector is okay, replace MUT.

3) Check fuse No. 7 in main fuse panel. If fuse is okay, go to next step. If fuse is blown, correct cause of blown fuse, and replace fuse.

4) Turn ignition on. ABS power relay should energize. Listen if power relay makes a click noise. Power relay is located behind radio. If noise is not heard, go to next step. If noise is heard, go to step 6).

5) Remove ABS power relay. See ABS POWER RELAY under REMOVAL & INSTALLATION. Test ABS power relay. See ABS POWER RELAY under COMPONENT TESTING. Replace relay if faulty.

6) Disconnect ECU wiring harness connector. Turn ignition on. Measure voltage between terminal No. 6 and vehicle ground. See Fig. 3. If battery voltage is present, go to next step. If battery voltage is not present, repair open circuit between power relay and ECU.

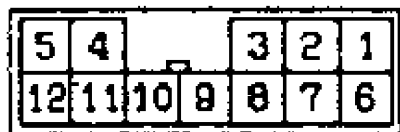
7) Check for continuity between vehicle ground and terminals No. 9, 10, 11 and 112. If continuity exists, go to next step. If continuity does not exist in any circuit, check for open in vehicle ground circuit. Repair or replace wiring harness as necessary.

8) Check for continuity between terminal No. 14 of ECU connector and terminal No. 4 of diagnostic connector. Also check for continuity between terminal No. 15 of ECU connector and terminal No. 10 of diagnostic connector. See Fig. 5. If continuity does not exist, check for open between ECU and diagnostic connector. Repair as necessary. If continuity exists, replace ECU and go to next step.

9) Check for trouble codes. See TROUBLE CODE DEFINITION under DIAGNOSIS & TESTING. If no trouble codes are present, go to next step. If any trouble codes are present, see appropriate CODE under DIAGNOSIS & TESTING.

10) Disconnect ECU connector. If warning light is no longer illuminated, substitute ECU with known good unit and retest. If warning light is still illuminated, disconnect hydraulic unit connector.

11) If warning light is still illuminated, repair wiring harness or replace instrument cluster. If warning light is no longer illuminated, test valve relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTING. Replace valve relay if defective. If valve relay is okay, replace hydraulic unit.



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Fig. 5: Identifying Diagnostic Connector Terminals  
Courtesy of Mitsubishi Motor Sales of America.

Ignition Switch In START Position, Warning Light Inoperative  
1) Remove ABS power relay fuse No. 7 from junction block.

Disconnect hydraulic unit 10-pin connector. Turn ignition on. Using DVOM, measure voltage between hydraulic unit harness connector terminal No. 8 and vehicle ground. See Fig. 4. If battery voltage is present, go to next step. If battery voltage is not present, repair circuit between ABS warning light and hydraulic unit.

2) Using ohmmeter, check for continuity between terminal No. 9 and vehicle ground. If continuity exists, go to next step. If continuity does not exist, repair hydraulic unit circuit.

3) Check continuity between hydraulic unit connector terminals No. 8 and 9. If continuity exists, go to next step. If continuity does not exist, replace valve relay.

4) Remove valve relay from hydraulic unit. Check for continuity between relay terminals No. 87a and 30. See Fig. 14. If continuity does not exist, replace valve relay. If continuity exists, hydraulic unit wiring harness is faulty. Replace hydraulic unit.

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

1) Disconnect hydraulic unit wiring harness connector.

Disconnect ECU wiring harness connector. Inspect connector terminals and repair as necessary.

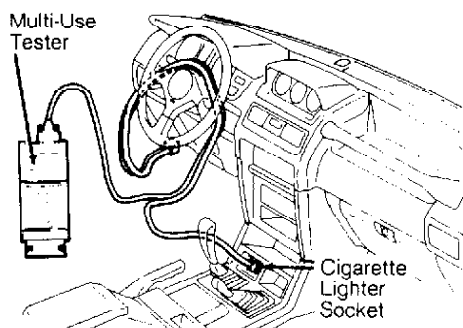
2) Turn ignition on. Measure voltage between ECU connector terminal No. 13 and vehicle ground. See Fig. 3. If battery voltage is not present, repair open or shorted circuit between ABS warning light and ECU. If battery voltage is present, substitute ECU with known good unit and retest.

## DIAGNOSIS & TESTING

### RETRIEVING CODES

Scan Tool

1) With ignition off, connect Multi-Use Tester (MB991341) and ROM Pack (MB991423) to diagnostic connector, located under driver's side of dash, and to cigarette lighter socket. See Fig. 6.



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Fig. 6: Connecting Multi-Use Tester  
Courtesy of Mitsubishi Motor Sales of America.

2) Turn ignition on. ABS warning light should come on as ABS goes into self-diagnostic mode. Read and record all diagnostic output

(trouble) codes from ECU memory. Refer to Multi-Use Tester (MUT) instructions for specific trouble code retrieval procedure.

3) After all trouble codes have been retrieved and recorded, clear codes from ECU memory. Refer to Multi-Use Tester (MUT) instructions for specific trouble code clearing instructions. See TROUBLE CODE DEFINITION and appropriate CODE under DIAGNOSIS & TESTING for servicing procedure.

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

#### Voltmeter

1) To retrieve stored trouble codes, locate diagnostic connector under left side of dash. Turn ignition off. Connect analog voltmeter between diagnostic terminal No. 4 and vehicle ground terminal No. 12 of diagnostic connector. See Fig. 5. Start engine.

2) Stored trouble codes will be indicated by sweeps of voltmeter needle. Long sweeps indicate first digit of code; short sweeps indicate second digit of code. If more than one fault is present, lowest number code will be given first. After trouble code has been retrieved, test indicated component and/or related circuit (if necessary). See TROUBLE CODE DEFINITION and appropriate CODE under DIAGNOSIS & TESTING for servicing procedure.

### CLEARING TROUBLE CODES

To clear trouble codes after repairs, disconnect negative battery cable for at least 10 seconds. Reconnect battery cable and repeat RETRIEVING CODES to confirm that failure has been corrected.

### TROUBLE CODE DEFINITION

#### TROUBLE CODES TABLE

Code	(1) System Affected
11	Right Front Wheel Sensor (Open)
12	Left Front Wheel Sensor (Open)
13	Right Rear Wheel Sensor (Open)
14	Left Rear Wheel Sensor (Open)
15	Sensor Output Signal Fault
16	ECU Power Voltage
21	Right Front Wheel Sensor (Short)
22	Left Front Wheel Sensor (Short)
23	Right Rear Wheel Sensor (Short)
24	Left Rear Wheel Sensor (Short)
25-27	4WD Power Circuit Fault
31	"G" Sensor Power Voltage
32	"G" Sensor Output Voltage
33	Stoplight Switch Circuit
41, 43, or 45	Solenoid Valve Circuit
51	Valve Relay
53	Motor Relay
63	Faulty ECU
64	Faulty ECU

(1) - See appropriate CODE under DIAGNOSIS & TESTING.

### CODE 11, 12, 13 OR 14

Faulty Wheel Speed Sensor Input

1) Trouble code will set if ECU detects wheel speed sensor



has no input signal. Trouble code will also set if wheel sensor voltage output is low while driving vehicle.

2) Inspect wheel sensor wiring harness for open or poor connection. Repair or replace if necessary. If no open circuit or poor connection is found, go to next step.

3) Test wheel speed sensor. See WHEEL SPEED SENSOR under COMPONENT TESTING. Replace speed sensor as necessary. Ensure wheel speed sensor-to-rotor gap is within specification. See WHEEL SPEED SENSOR under ADJUSTMENTS.

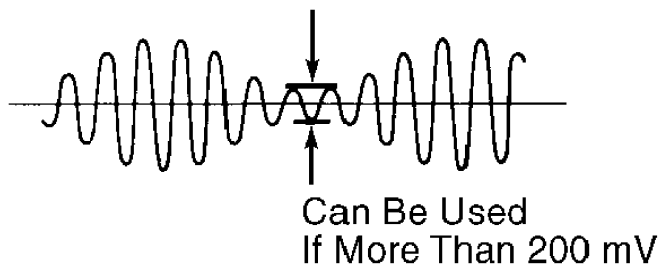
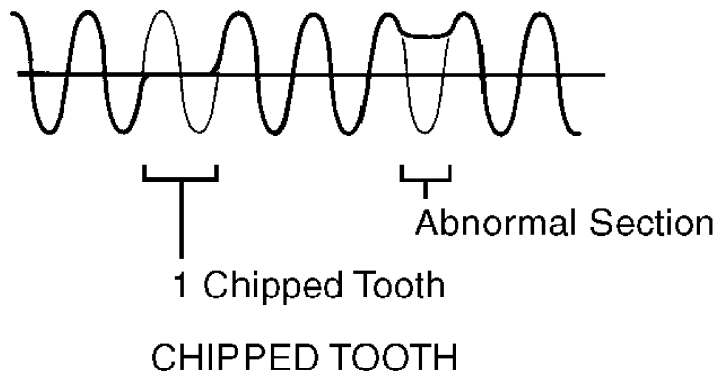
## CODE 15

### Faulty Wheel Speed Sensor Output

1) Test each sensor. See WHEEL SPEED SENSOR under COMPONENT TESTING. If all sensor voltages and resistances are within specification, go to next step. If any sensor is malfunctioning, replace speed sensor. See WHEEL SPEED SENSOR under REMOVAL & INSTALLATION.

2) Check each wheel speed sensor-to-rotor gap. See WHEEL SPEED SENSOR under ADJUSTMENTS. If all gaps are within specification, go to next step. If any gaps are not within specification, adjust sensor-to-rotor gap.

3) Inspect all wheel speed sensor rotors for damaged and missing teeth. Replace any damaged rotors. Using an oscilloscope, check wave-form patterns. See Fig. 7. If all rotors are okay, replace ECU. Ensure trouble code does not reset.



## ROTOR ECCENTRICITY

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Fig. 7: Identifying Abnormal ABS Rotor Wave-Form Patterns  
Courtesy of Mitsubishi Motor Sales of America.

## CODE 16

#### ECU Power Voltage

Start engine. Measure voltage between ECU terminal No. 6 and vehicle ground. See Fig. 3. If less than 10 volts is present, check fuse contacts and ECU connector. If 10 volts or more is present, measure voltage between ECU terminal No. 62 and vehicle ground. If less than 10 volts is present, check fuse contacts and ECU connector. If fuse contacts and ECU connector are okay, substitute ECU with known good unit and retest.

### CODE 21, 22, 23 OR 24

#### Faulty Wheel Speed Sensor Output

1) Test each sensor. See WHEEL SPEED SENSOR under COMPONENT TESTING. If all sensor voltages and resistances are within specification, go to next step. If any sensor is malfunctioning, replace sensor. See WHEEL SPEED SENSOR under REMOVAL & INSTALLATION.

2) Remove ECU connector. Check wheel speed circuit at ECU connector. See Fig. 3. See ECU CONNECTOR TERMINAL RESISTANCE SPECIFICATION table. If resistance values are not as specified, repair wiring harness. If resistance values are within specifications, go to next step.

3) Check each wheel speed sensor-to-rotor gap. See WHEEL SPEED SENSOR under ADJUSTMENTS. If all gaps are within specification, go to next step. If any gaps are not within specification, adjust sensor-to-rotor gap.

4) Inspect all wheel speed sensor rotors for damaged and missing teeth. Replace any damaged rotors. Using an oscilloscope, check wave-form patterns and output voltage. See Fig. 8. Output voltage should be 0.2 volt (200 mV). If all rotors and wheel speed sensors are okay, substitute ECU with known good unit and retest.

#### ECU CONNECTOR TERMINAL RESISTANCE SPECIFICATION TABLE

Application	ECU Terminals No.	Ohms
LF Wheel Speed Sensor	52 & 57	900-1100
RF Wheel Speed Sensor	51 & 56	900-1100
LR Wheel Speed Sensor	8 & 18	1300-2100
RR Wheel Speed Sensor	53 & 58	1300-2100

### CODE 25

#### Free-Wheel Engage Switch Circuit

1) Start engine. Ensure center differential 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 connector. Turn ignition on. Using DVOM, check voltage between terminal No. 55 and vehicle ground. See Fig. 3.

In 2WD battery voltage should exist. Battery voltage should not exist in 4WD. If voltage is as described, substitute ECU with known good unit and retest. See ELECTRONIC CONTROL UNIT (ECU) under REMOVAL & INSTALLATION. If voltage is not as described, repair harness between ECU and free-wheel engage switch.

## CODE 26

### Center Differential Lock Switch Circuit

1) Start engine. Ensure center differential indicator light operates correctly when transfer shift lever is moved to desired 4WD positions. If indicator light does not operate correctly, go to step 3). If indicator light operates correctly, disconnect ECU connector. Using DVOM, check voltage between terminal No. 107 and vehicle ground. See Fig. 3.

2) When center differential is locked, battery voltage should not be present. When center differential is unlocked, battery voltage should be present. If voltage is as described, substitute ECU with known good unit and retest. If voltage is not as described, repair wiring harness between ECU and center differential lock detection switch. See Fig. 8. Lock switch can be identified by Brown connector.

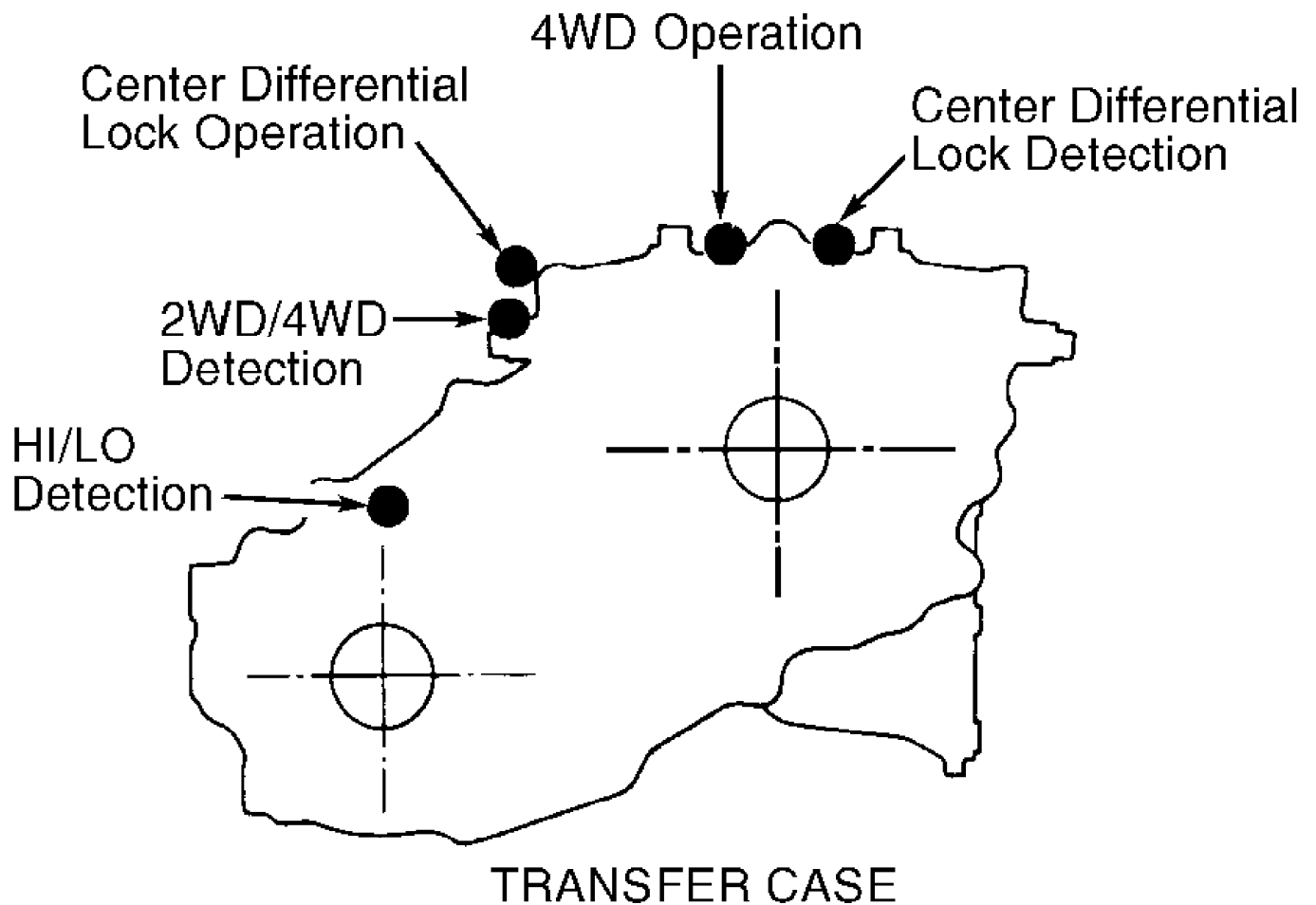
3) If no indicator lights illuminate, repair 4WD indicator power circuit, or check for faulty 4WD indicator control unit. See 4WD CONTROL UNIT under COMPONENT TESTING. If center differential light illuminates, regardless of position of transfer shift lever, check the following:

- \* 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.

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 center differential light does not illuminate 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.

5) If front wheel indicator light does not illuminate with transfer shift lever in "4H" position, repair wiring harness between 4WD indicator control unit and free-wheel engage switch. Check vehicle ground wire at engage switch. Check for faulty free-wheel engage switch.



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Fig. 8: Identifying 4WD Indicator Switch Location  
 Courtesy of Mitsubishi Motor Sales of America.

CODE 27

Rear Differential Lock Circuit (With Differential Lock)

1) Start engine. Ensure rear differential indicator light illuminates when top of rear differential lock switch, (located below radio) is pushed. If indicator light illuminates, go to next step. If indicator light does not illuminate, turn engine off. Check wiring harness between rear differential lock control unit and rear differential lock switch. Check rear differential lock control unit power circuit. See REAR DIFFERENTIAL CONTROL UNIT under COMPONENT TESTING. If circuit is okay, replace rear differential lock control unit.

2) Disconnect ECU connector. Turn ignition on. Using DVOM, check voltage between terminal No. 108 and vehicle ground. See Fig. 3. 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 described, substitute ECU with known good unit and retest. If voltage is not as described, repair wiring harness between ECU and rear differential lock switch.

Rear Differential Without Differential Lock

Check fuse No. 18 in main fuse block. Replace if necessary.

Disconnect ECU connector. Turn ignition on. Using DVOM, check voltage at terminal No. 108 and vehicle ground. See Fig. 3. If battery voltage is present, substitute ECU with known good unit and retest. If battery voltage is not present, check for open circuit between ECU and fuse block. Repair wiring harness as necessary.

## CODE 31

### "G" Sensor Power Voltage

1) If Code 31 is present, and Code 32 is not present, substitute ECU with known good unit and retest. If Code 31 and Code 32 are both present, disconnect "G" sensor wiring harness connector. "G" sensor is located under center console. See Fig. 18. Turn ignition to ACC switch position. Using ohmmeter, check continuity between "G" sensor harness connector terminal No. 1 (Blue wire) and vehicle ground. If continuity does not exist, replace "G" sensor. If continuity exists, disconnect ECU connector.

2) Check continuity between terminal No. 1 and vehicle ground. If continuity exists, repair wiring harness between ECU and "G" sensor. If continuity does not exist, replace faulty ECU.

## CODE 32

### "G" Sensor Output Signal

1) Park vehicle on level surface. Using Multi-Use Tester, check "G" sensor voltage. Refer to Multi-Use Tester (MUT) instructions for specific test procedure. Voltage should be 2 - 3 volts. If voltage is not as described, go to step 3). If voltage is as described, note top center position of "G" sensor, and remove "G" sensor, located under center console next to shifter. See "G" SENSOR under REMOVAL & INSTALLATION.

2) Check voltage when sensor is tilted 50 degrees to the left of center. Voltage should be 0.3-0.7 volt. Tilt sensor 50 degrees to right of center and check voltage. Voltage should be 4.3-4.7 volts. If voltage is as described, substitute ECU with known good unit and retest. If voltage is not as described, replace "G" sensor.

3) If "G" sensor voltage is less than 0.2 volt, go to next step. If "G" sensor voltage is more than 4.8 volts, go to step 9). If "G" sensor voltage is 0.3-4.7 volts, check for poor vehicle ground connection (loose mounting bolt) at sensor. Repair as necessary. If connection is okay, replace "G" sensor.

4) Turn ignition on. Using DVOM, check for 7.0-7.5 volts at ECU connector terminal No. 103. See Fig. 3. If voltage is as described, go to next step. If voltage is not as described, turn ignition off. Disconnect ECU and "G" sensor connectors. Using ohmmeter, check continuity between ECU connector terminal No. 103 and vehicle ground. If continuity exists, repair wiring harness between ECU and "G" sensor. If continuity does not exist, substitute ECU with known good unit and retest. See ELECTRONIC CONTROL UNIT (ECU) under REMOVAL & INSTALLATION. See Fig. 17.

5) Disconnect "G" sensor connector. Turn ignition on. Check for 7.0-7.5 volts between terminal No. 1 (Blue wire) and vehicle ground. If voltage is as described, go to next step. If voltage is not as described, repair wiring harness between ECU and "G" sensor.

6) Connect "G" sensor connector. Check voltage at terminal No. 3 (Blue/White wire) and vehicle ground. Voltage should be 2-3 volts. If voltage is as described, go to step 8). If voltage is not as described, turn ignition to switch ACC position. Disconnect "G" sensor connector. Using ohmmeter, check resistance between terminal No. 3 (Blue/White) and vehicle ground. Resistance should be 500 ohms or more. If resistance is as described, replace "G" sensor.

7) If resistance is not 500 ohms or more, turn ignition off. Disconnect "G" sensor and ECU connectors. Check continuity between

terminal No. 3 and vehicle ground. If continuity does not exist, substitute ECU with known good unit and retest. If continuity exists, repair wiring harness between ECU and "G" sensor.

8) Turn ignition on. Using DVOM, check voltage at ECU terminal No. 110 and vehicle ground. See Fig. 3. Voltage should be 2-3 volts. If voltage is as described, substitute ECU with known good unit and retest. If voltage is not as described, repair wiring harness between ECU and "G" sensor.

9) Disconnect "G" sensor connector. Using ohmmeter, check continuity between terminal No. 2 (Black/Red) and vehicle ground. If continuity exists, replace "G" sensor. If continuity does not exist, check continuity between ECU terminal No. 111 and vehicle ground. If continuity exists, repair wiring harness between ECU and "G" sensor. If continuity does not exist, substitute ECU with known good unit and retest.

## CODE 33

### Stoplight Switch Circuit

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

2) Disconnect ECU connector. Using DVOM, measure voltage between terminal No. 109 and vehicle ground while depressing brake pedal. See Fig. 3. If battery voltage is not present, repair or replace wiring harness between stoplight switch and ECU. See appropriate wiring diagram. If battery voltage is present, stoplight switch circuit is okay. Replace ECU.

## CODE 41, 43 OR 45

### Solenoid Valve Circuit

1) Disconnect hydraulic unit 10-pin connector. Using ohmmeter, measure resistance between hydraulic unit terminal No. 7 and terminals No. 3, 5 and 6. See Fig. 4.

2) Resistance should be 1000-1300 ohms. If resistance is within specification, go to next step. If resistance is not within specification, replace faulty hydraulic unit. See HYDRAULIC UNIT under REMOVAL & INSTALLATION.

3) Connect hydraulic unit 10-pin connector. Disconnect ECU wiring harness connector. Measure resistance between ECU terminal No. 62 and terminals No. 1, 2 and 3. See Fig. 3.

4) Resistance should be 1000-1300 ohms. If resistance is not within specification, repair or replace wiring harness. If all resistance tests are within specification, solenoid valve circuit is okay. Replace ECU.

## CODE 51

### Valve Relay Circuit

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

2) Check pump motor, and repair if necessary. Turn ignition on. Disconnect hydraulic unit 2-pin connector. Measure voltage between terminal No. 52 and vehicle ground. See Fig. 9.

3) If battery voltage is not present, repair wiring harness between fusible link and hydraulic unit 2-pin connector. If battery voltage is present, turn ignition off. Using ohmmeter, check for continuity between hydraulic unit 10-pin connector terminals No. 7 and 8. See Fig. 4. If continuity exists, go to next step. If continuity does not exist, repair or replace hydraulic unit.

4) Connect hydraulic unit connector. Disconnect ECU

connector. Using ohmmeter, measure resistance between ECU connector terminals No. 4 and 5. See Fig. 3. Resistance should be 60-120 ohms. If resistance is within specification, go to next step. If resistance is not within specification, repair wiring harness between hydraulic unit and ECU.

5) Turn ignition on. Measure voltage between ECU connector terminal No. 62 and vehicle ground. If battery voltage is not present, repair or replace faulty wiring harness between hydraulic unit and ECU. If battery voltage is present, replace faulty ECU.



93C00267

Fig. 9: Identifying Hydraulic Unit 2-Pin Connector  
Courtesy of Mitsubishi Motor Sales of America.

### CODE 53

#### Motor Relay Circuit

1) Using MUT, perform hydraulic unit actuator test. If motor is not operating, go to next step. If motor is still operating, repair or replace wiring harness between hydraulic unit and ECU.

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

3) Check pump motor vehicle ground connection. Ensure vehicle ground wire has a clean, tight connection. Repair ground connection if necessary. If vehicle ground connection is okay, go to next step.

4) Install motor relay. Turn ignition on. Disconnect hydraulic unit 2-pin connector. Measure voltage between terminal No. 51 and vehicle ground. See Fig. 9. If battery voltage is present, go to next step. If battery voltage is not present, repair harness between fusible link and hydraulic unit 2-pin connector.

5) Connect hydraulic unit wiring harness. Disconnect ECU

wiring harness connector. Using ohmmeter, measure resistance between ECU harness connector terminals No. 5 and 12. See Fig. 3. Resistance should be 30-60 ohms. If resistance is not within specification, repair or replace wiring harness between hydraulic unit and ECU. If resistance is within specification, go to next step.

6) Using ohmmeter, measure resistance between ECU connector terminal No. 106 and vehicle ground. Resistance should be .1-.3 ohm. If resistance is not within specification, repair or replace wiring harness between hydraulic unit and ECU. If resistance is within specification, replace faulty ECU.

## CODE 63 OR 64

If Code 63 or Code 64 is present, replace faulty ECU.

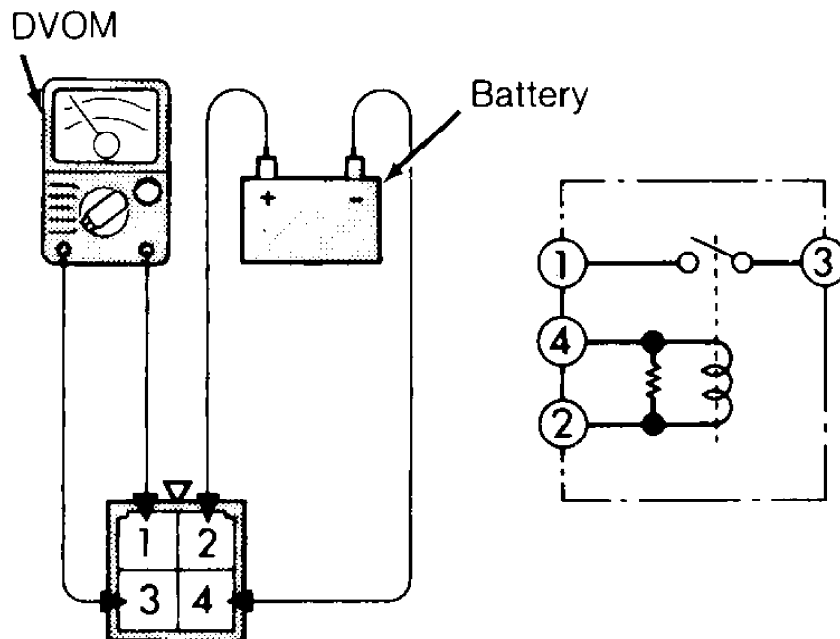
## COMPONENT TESTING

### ABS POWER RELAY

1) Remove ABS power relay. Relay is located behind radio. Disconnect relay connector. Using ohmmeter, check for continuity between terminals No. 1 and 3. See Fig. 10. If continuity exists, replace relay.

2) If continuity does not exist, check for continuity between terminals No. 2 and 4. If continuity exists, go to next step. If continuity does not exist, replace relay.

3) Apply battery voltage to terminal No. 2, and vehicle ground terminal No. 4. Check for continuity between terminals No. 1 and 3. If continuity exists, relay is okay. If continuity does not exist, replace relay.



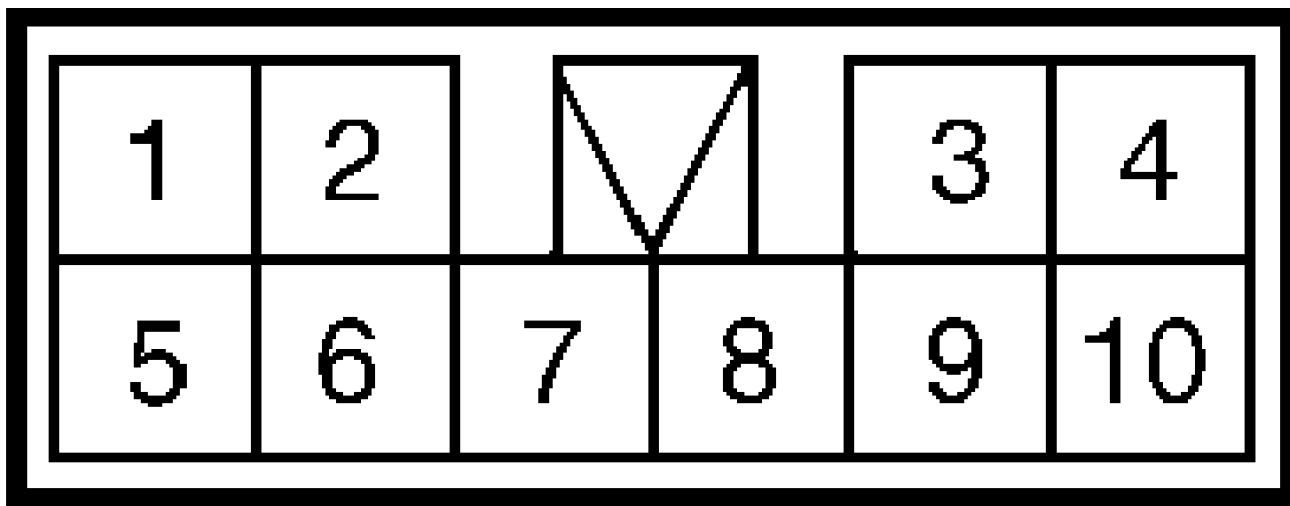
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Fig. 10: Testing ABS Power Relay  
Courtesy of Mitsubishi Motor Sales of America.

## 4WD CONTROL UNIT



Remove radio and remove 4WD control unit. Disconnect control unit harness connector. Backprobe harness connector. Measure voltage between each individual terminal and ground terminal No. 8 (Black wire). See Figs. 11 and 12. If after all tests have been completed system is not operating properly, substitute 4WD control unit with known good unit and retest.



# 93B82421

Fig. 11: 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

93C82422  
 Fig. 12: 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. 8. 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 (1)	Transfer Control Lever Position	Specification
Center Differential Lock Detection Switch	4H ..... 4HLc .....	No Continuity Continuity
Center Differential Lock Operation Detection Switch	4H .....	No Continuity
Operation Detection Switch	4HLc .....	Continuity
4WD Operation Detection Switch	2H ..... 4H .....	No Continuity Continuity
HI/LO Detection Switch	4HLc ..... N ..... 4LLc .....	Continuity No Continuity Continuity
2WD/4WD Detection Switch	2H ..... 4H .....	Continuity No Continuity

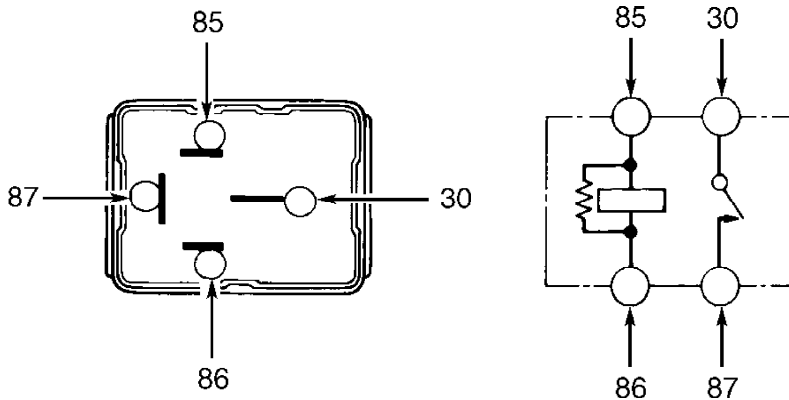
(1) - See Fig. 8 for switch location.

HYDRAULIC UNIT RELAYS

Motor Relay

1) Remove motor relay. Using ohmmeter, measure resistance between relay terminals No. 85 and 86. See Fig. 13. Resistance should be 30-60 ohms. Check for continuity between relay terminals No. 30 and 87. Continuity should not exist.

2) Apply battery voltage to relay terminal No. 85, and vehicle ground terminal No. 86. Check for continuity between terminals No. 30 and 87. Continuity should exist. If relay does not test as specified, replace relay.



91108043

Fig. 13: Identifying Motor Relay Terminals  
Courtesy of Mitsubishi Motor Sales of America.

Valve Relay

1) Remove valve relay. Using ohmmeter, measure resistance

between relay terminals No. 85 and 86. See Fig. 14. Resistance should be 60-120 ohms.

2) Check for continuity between relay terminals No. 30 and 87a. Continuity should exist. Check for continuity between relay terminals No. 30 and 87. Continuity should not exist.

3) Apply battery voltage to relay terminal No. 85, and vehicle ground terminal No. 86. Check for continuity between terminals No. 30 and 87. Continuity should exist. Check for continuity between terminals No. 30 and 87a. Continuity should not exist. If relay does not test as specified, replace relay.

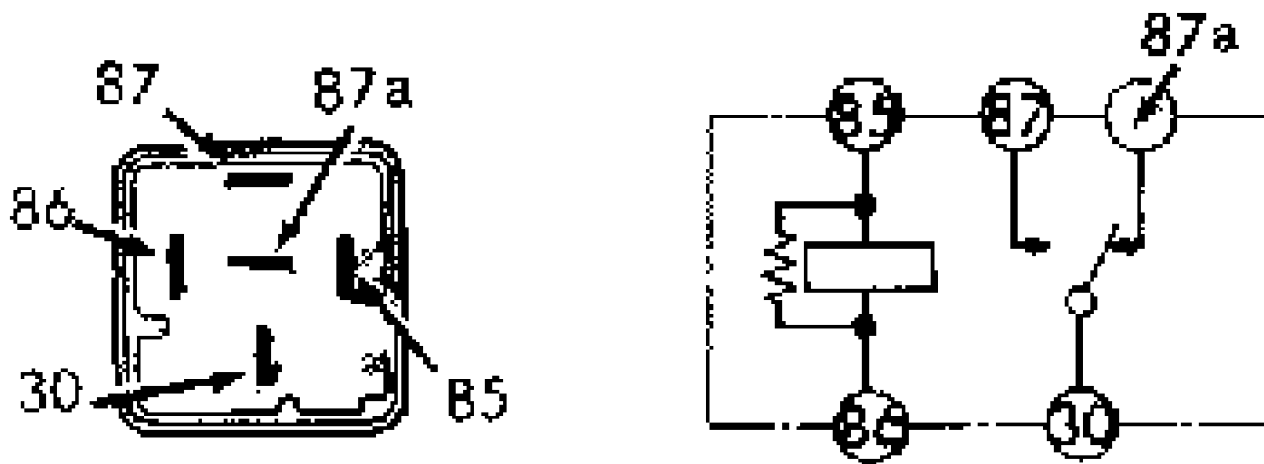
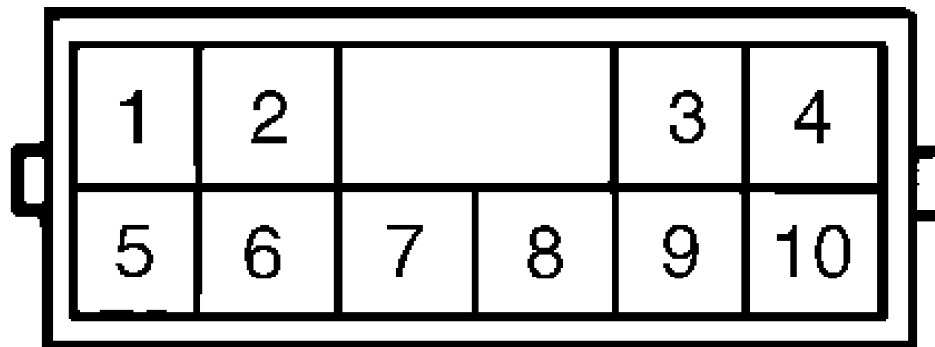


Fig. 14: Identifying Valve Relay Terminals  
Courtesy of Mitsubishi Motor Sales of America.

### REAR DIFFERENTIAL CONTROL UNIT

Remove rear seat and remove rear differential control unit. Do not disconnect control unit harness connector. Backprobe harness connector. Measure voltage between each individual terminal and ground terminal No. 6 (Black wire). See Figs. 15 and 16. If after all tests have been completed system is not operating properly, substitute rear differential control unit with known good unit and retest.



### 93D82423

Fig. 15: Identifying Rear Differential Control Unit Connector  
Courtesy of Mitsubishi Motor Sales of America.

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

93E82424

Fig. 16: Rear Differential Control Unit Pin Voltage Chart  
Courtesy of Mitsubishi Motor Sales of America.

## 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. If pole piece is damaged, replace sensor.

2) Disconnect sensor connector. Inspect sensor wiring harness for broken and pinched wires. Repair or replace harness as necessary. Using ohmmeter, measure sensor resistance at wiring connector. Front sensor resistance should be 900-1100 ohms. Rear resistance should be 1300-2100 ohms. If resistance is not within specification, replace sensor. If resistance is within specification, go to GROUND CIRCUIT TEST.

### Ground Circuit Test

Disconnect wheel speed sensor wiring harness connector. Measure resistance between wheel speed sensor terminals and sensor housing. Resistance should be more than 100,000 ohms. If resistance is less than specification, replace wheel speed sensor.

## REMOVAL & INSTALLATION

### ABS POWER RELAY

#### Removal & Installation

ABS power relay is located behind radio. Disconnect negative battery cable. Remove front center console, located in front of shift lever. Remove radio. Disconnect relay connector, and remove relay. To install, reverse removal procedure.

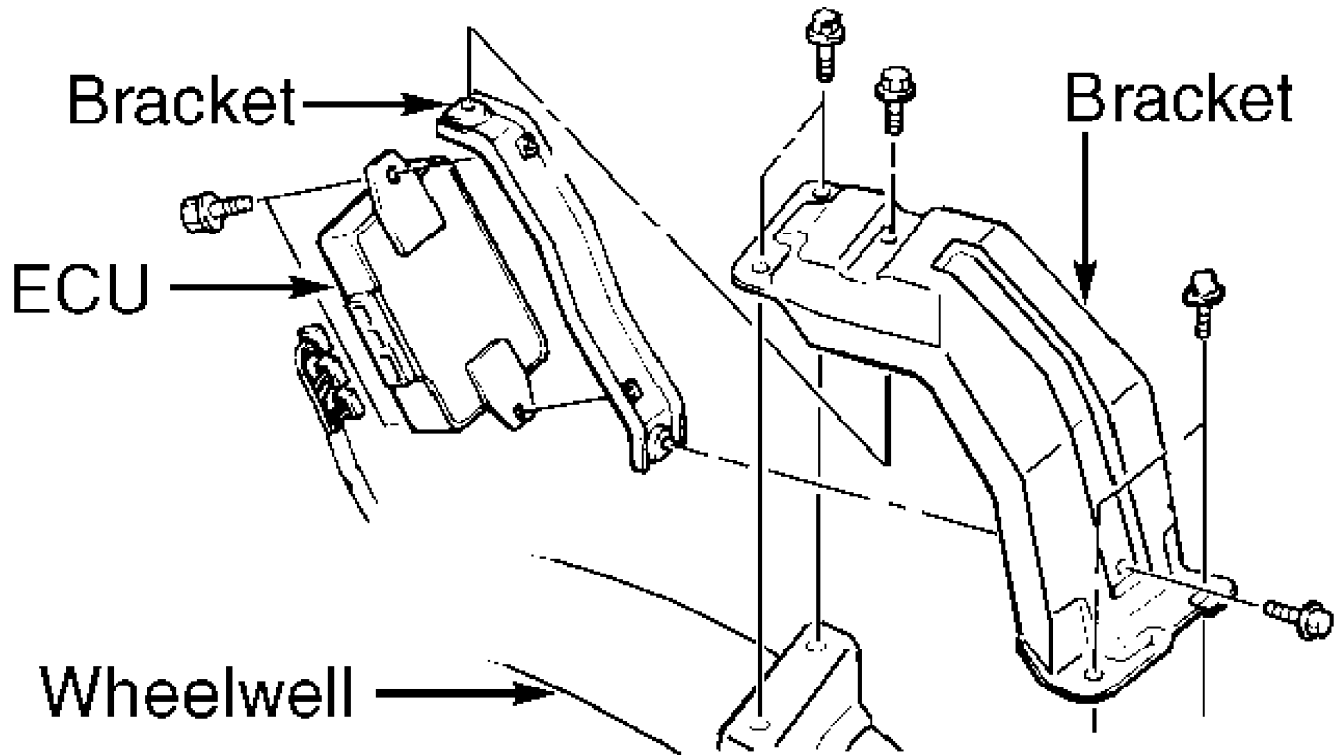
### ELECTRONIC CONTROL UNIT (ECU)

#### Removal & Installation

1) ECU is located behind right rear quarter panel trim. See Fig. 17. Disconnect negative battery cable. Remove quarter panel

mounting 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.



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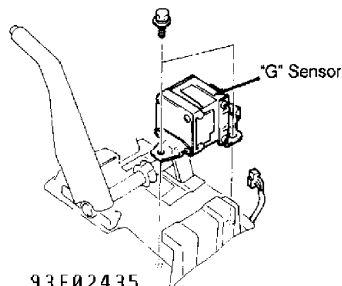
Fig. 17: Locating Electronic Control Unit (ECU)  
Courtesy of Mitsubishi Motor Sales of America.

### "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. 18. Remove center console assembly. Disconnect sensor wiring harness connector. Remove sensor. To install, reverse removal procedure. Tighten bolts to 80 INCH lbs. (12 N.m).



93E02435

Fig. 18: Locating "G" Sensor  
Courtesy of Mitsubishi Motor Sales of America.

## HYDRAULIC UNIT

### Removal

Remove brakelines from hydraulic unit. Remove relay box cover. See Fig. 19. Disconnect vehicle 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. Bleed brake system. See BLEEDING BRAKE SYSTEM.

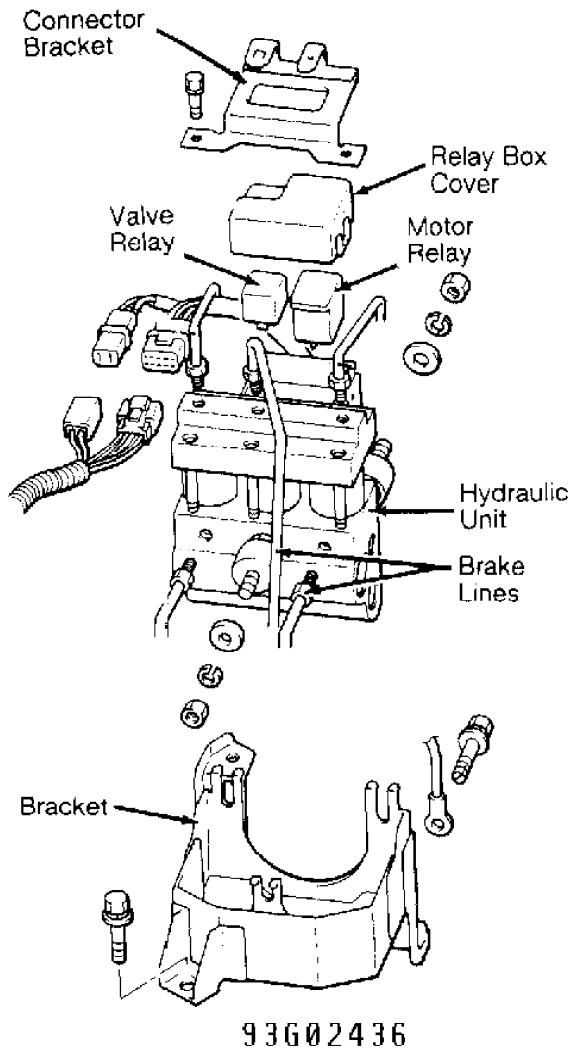


Fig. 19: Exploded View Of Hydraulic Unit & Components  
Courtesy of Mitsubishi Motor Sales of America.

## WHEEL SPEED SENSOR

Removal & Installation

Unplug wheel sensor connector. Remove sensor bolts. Remove speed sensor from vehicle. To install, reverse removal procedure. Sensors are not interchangeable. Adjust wheel speed sensor-to-rotor gap. See WHEEL SPEED SENSOR under ADJUSTMENTS. To complete installation, reverse removal procedure.

**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 TABLE

Application	INCH Lbs. (N.m)
"G" Sensor Mounting Bolt .....	80 (12)
Wheel Speed Sensor Bolt .....	84-120 (9-14)

**WIRING DIAGRAM**

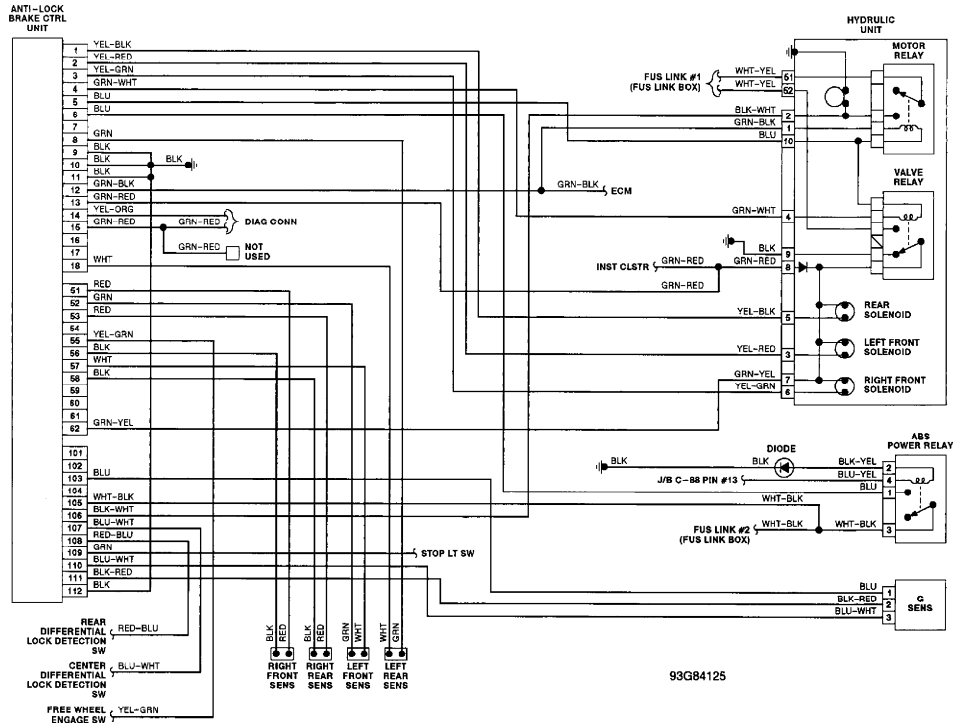


Fig. 20: Anti-Lock Brake System (ABS) Wiring Diagram