

ANTI-LOCK BRAKE SYSTEM

1993 Mitsubishi Diamante

1993 BRAKES
Mitsubishi - Anti-Lock Brake System

Diamante

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, 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 the BRAKES section.

OPERATION

Each wheel sensor sends an AC electrical signal to the Electronic Control Unit (ECU). The 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 reaches 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

ABS system is bled using conventional method. Manually bleed system using foot method with 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 TABLE

Application	Sequence
Diamante	RR, LF, LR, RF

ADJUSTMENTS

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

WHEEL SPEED SENSOR

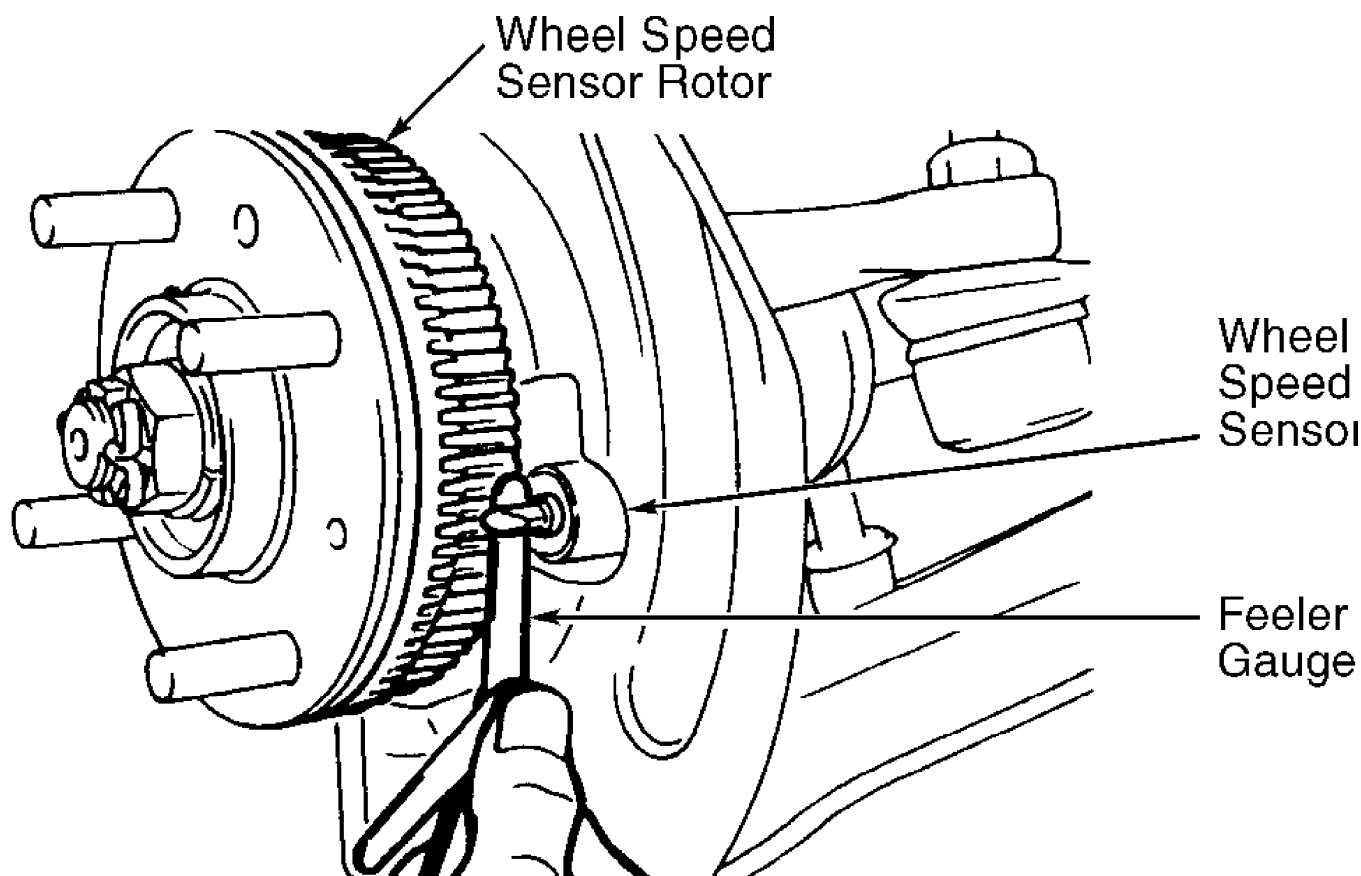
Sensor-To-Rotor Gap Adjustment

1) Raise and support vehicle. Remove tire and wheel assembly. 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. See WHEEL SPEED SENSOR-TO-ROTOR GAP SPECIFICATIONS table. If clearance is not within specification, loosen sensor mounting bolt. Adjust sensor position until clearance is within specification. Tighten sensor mounting bolt.

WHEEL SPEED SENSOR-TO-ROTOR GAP SPECIFICATIONS TABLE

Application	In. (mm)
Diamante	
Front	.012-.035 (.3-.9)
Rear	.008-.028 (.2-.7)



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

TROUBLE SHOOTING

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

ANTI-LOCK WARNING LIGHT

1) Turn ignition on. ANTI-LOCK warning light should blink twice, 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 blink twice, and then go out. 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.
- * 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 ONCE. IN START POSITION, WARNING LIGHT STAYS ON. WHEN IGNITION SWITCH IS CYCLED FROM START TO ON POSITION, WARNING LIGHT BLINKS ONCE.
- * IGNITION SWITCH IN ON POSITION, WARNING LIGHT BLINKS TWICE AND REMAINS OFF.

* WARNING LIGHT SWITCHES OFF ONE SECOND AFTER IGNITION SWITCH IS TURNED TO ON POSITION.

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, replace ECU.

6) Enter ABS self-diagnostics, and retrieve codes. See RETRIEVING CODES under DIAGNOSIS & TESTING. If no codes are displayed, fault may be intermittent. Try 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.

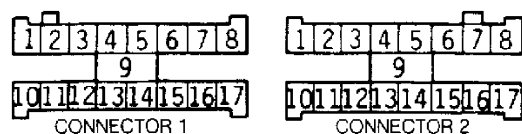
ANTI-LOCK Warning Light Inoperative

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 a DVOM, measure voltage between ground and instrument cluster ABS warning light terminal. See Fig. 2. See INSTRUMENT CLUSTER ABS WARNING LIGHT TERMINAL IDENTIFICATION table. If battery voltage is present, repair or replace instrument cluster. If battery voltage is not present, repair wiring between fuse and instrument cluster.

INSTRUMENT CLUSTER ABS WARNING LIGHT TERMINAL IDENTIFICATION TABLE

Application	Terminal No.
Diamante	(1) 115
(1) - See Fig. 2, connector 2.	



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

3) Turn ignition off. Check for faulty warning light bulb. Replace bulb as necessary. If bulb is okay, check for continuity

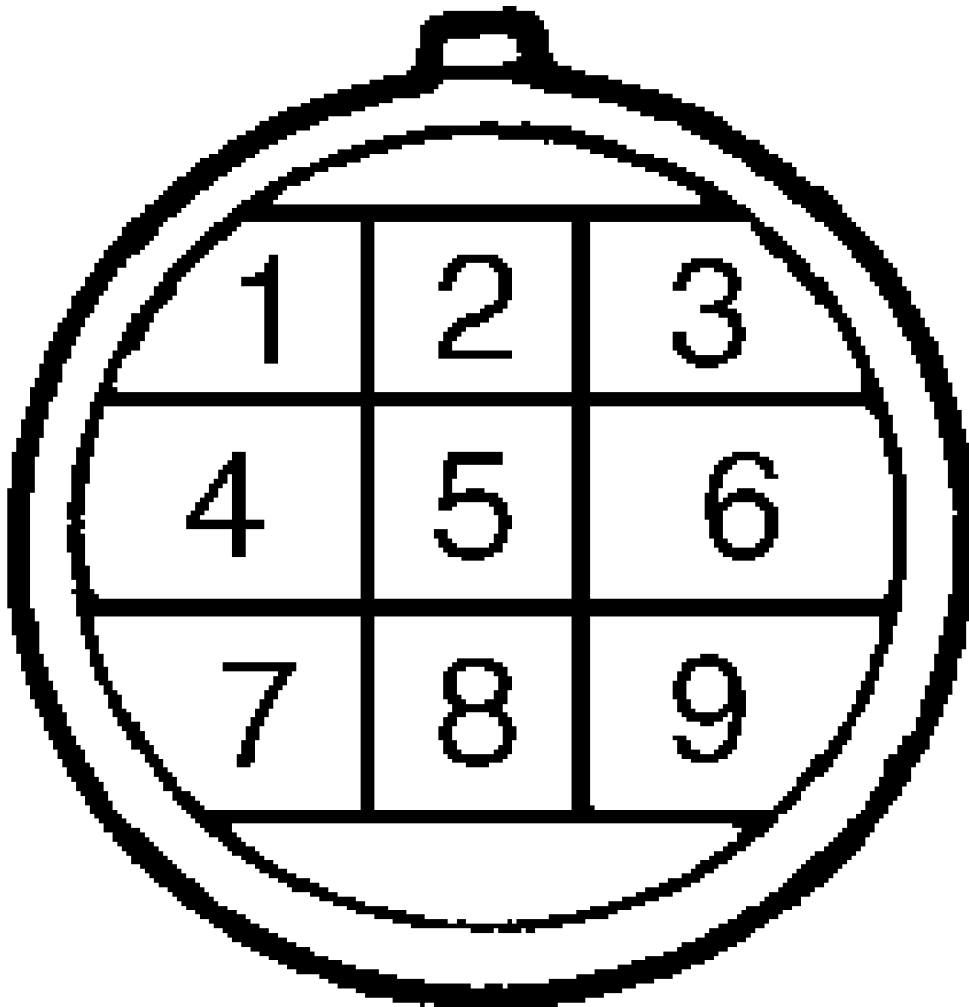
between appropriate instrument cluster connector terminals:

* Diamante: No. 101 and 115.

If continuity is present, clean and/or repair connector terminals. If continuity is not present, go to next step.

4) To check ECU, turn ignition off. Remove ECU connector. Turn ignition on. Measure voltage between terminal No. 21 and ground. See Fig. 4. If battery voltage is not present, repair circuit between warning light and ECU. If battery voltage is present, replace ECU.

5) To check valve relay, see HYDRAULIC UNIT RELAYS under COMPONENT TESTING. If relay is okay, remove connector. Turn ignition on. Measure voltage between terminal No. 101 (single wire connector) and ground. See Fig. 3.

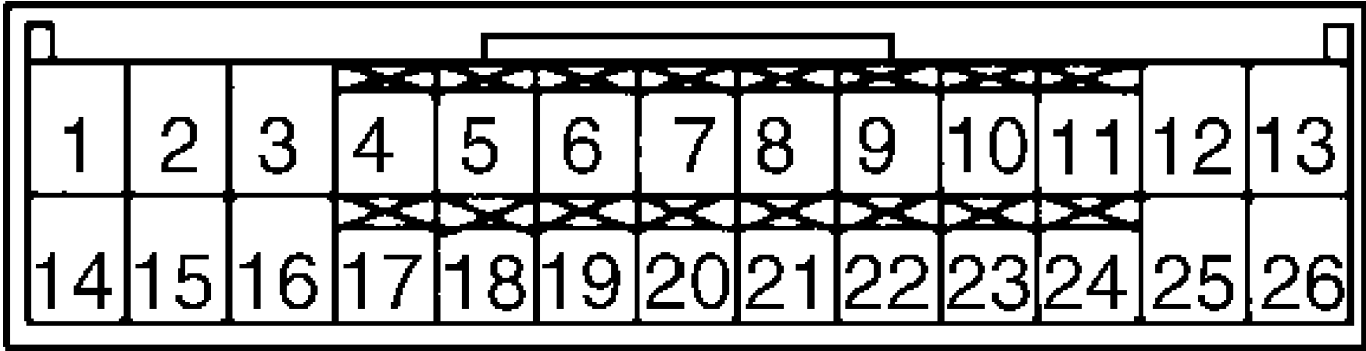
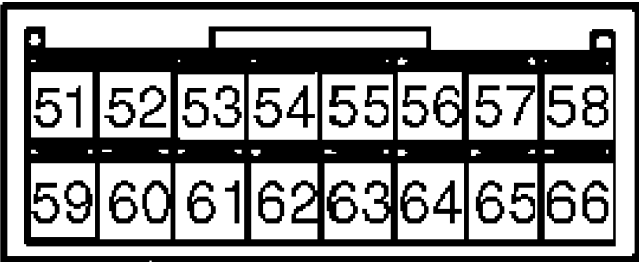


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Fig. 3: Hydraulic Unit 9-Pin Terminals
Courtesy of Mitsubishi Motor Sales of America.

6) Turn ignition off. Check for continuity between terminal No. 1 and ground. See Fig. 4. If continuity does not exist, repair

circuit between hydraulic unit and ground. If continuity exists, replace relay valve.



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Fig. 4: ECU Terminals
 Courtesy of Mitsubishi Motor Sales of America.

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

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. Refer to tester instruction manual.

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. 2 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) Remove and test ABS power relay. See ABS POWER RELAY under REMOVAL & INSTALLATION and COMPONENT TESTING. Replace relay if faulty. On all models, disconnect ECU wiring harness connector. Turn ignition on. Measure voltage between terminal No. 5 and ground. See Fig. 4. If battery voltage is present, go to next step. If battery voltage is not present, repair open circuit between power relay and ECU.

5) Check continuity between data link connector and ECU. See DATA LINK TO ECU TERMINAL IDENTIFICATION table. If no continuity exists check for open between ECU and diagnostic connector. Inspect and repair wiring as necessary.

Application	Data Link Terminal No.	Wire Color	(1) ECU Terminal No.
Diamante	4	BRN	22
	10	GRN/RED	9

(1) - See Fig. 4.

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

9) Disconnect ECU connector. If warning light is no longer illuminated, replace ECU. If warning light is still illuminated, disconnect hydraulic unit connector.

10) If warning light is still illuminated, repair 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.

Ignition Switch In START Position, Warning Light Inoperative

1) Remove valve relay from hydraulic unit. Inspect connector terminals, and repair if necessary. Test valve relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTING. Replace as needed.

2) Turn ignition on. Measure voltage between valve relay wiring harness connector terminal No. 3 and ground. See Fig. 12. If battery voltage is present, go to next step. If battery voltage is not present, repair circuit or diode between ABS warning light and valve relay.

3) Using an ohmmeter, check for continuity between valve relay terminal No. 1 and ground. If continuity exists, replace valve relay. If no continuity exists, repair circuit between valve relay and ground.

Ignition Switch In ON Position, Warning Light Blinks Twice And Remains Off

1) Remove hydraulic unit wiring harness connector. Disconnect ECU wiring harness connector. Inspect connector terminals and repair as necessary.

2) Turn ignition on. Measure voltage between terminal No. 21 and ground. See Fig. 4. If battery voltage is not present, repair open or shorted circuit between ABS warning light and ECU. If battery voltage is present, replace faulty ECU.

Warning Light Switches Off One Second After Ignition Switch Is Turned To ON Position

Disconnect ECU wiring harness connector. Inspect connector terminals and repair as necessary. Turn ignition on. Measure voltage between ECU connector terminal No. 61 and ground. See Fig. 4. If battery voltage is not present, repair open or shorted circuit between alternator "L" terminal and ECU. If battery voltage is present, replace faulty ECU.

DIAGNOSIS & TESTING

RETRIEVING CODES

Scan Tool

1) With ignition off, connect Multi-Use Tester (MB991341) and ROM pack (MB991423) to self-diagnostic connector, located under driver

side of dash, and to cigarette lighter socket. See Fig. 5.

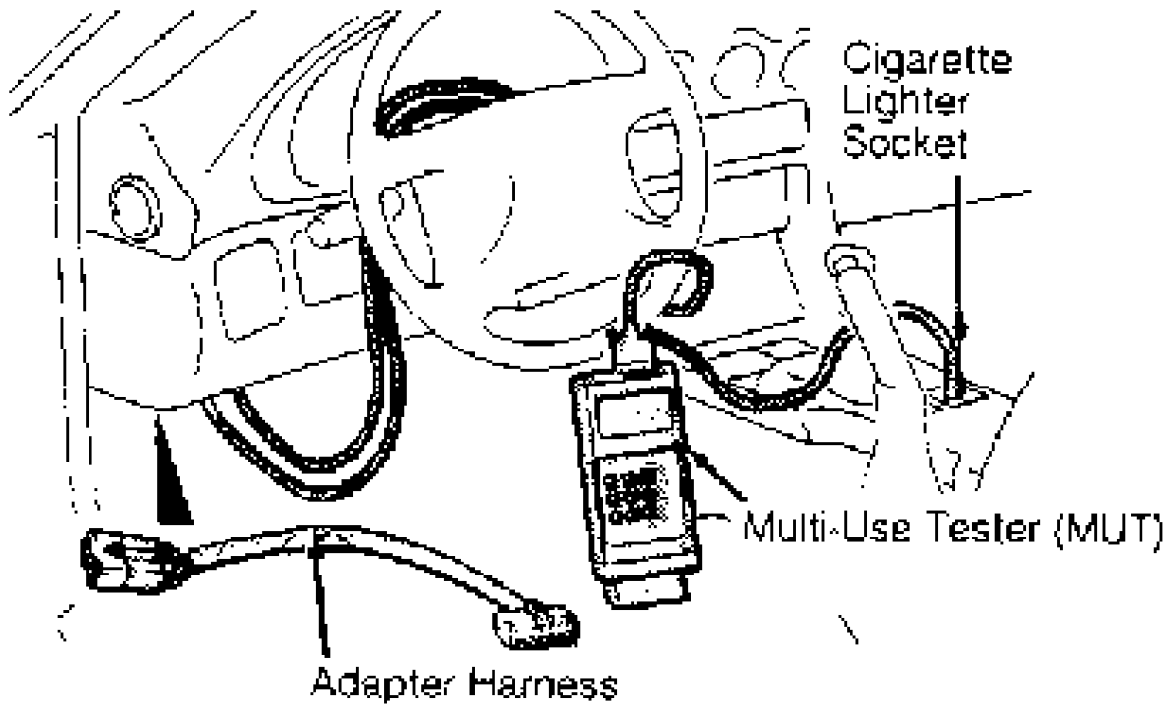


Fig. 5: Connecting Multi-Use Tester (Typical)
Courtesy of Mitsubishi Motor Sales of America.

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.

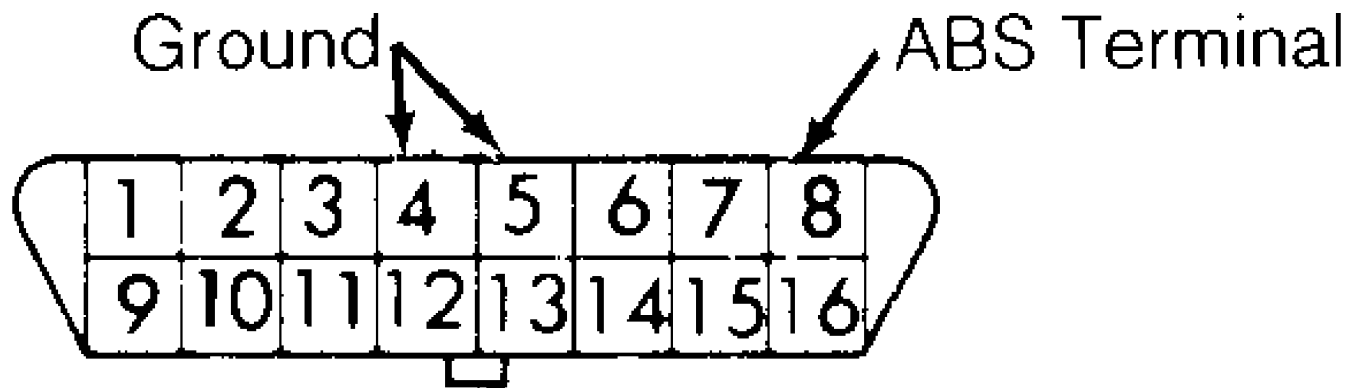
3) After all trouble codes have been retrieved and recorded, clear codes from ECU memory. Refer to Multi-Use Tester (MUT) instructions for specific trouble code clearing instructions. See TROUBLE CODE DEFINITION and appropriate CODE under DIAGNOSIS & TESTING for servicing procedure.

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 and ground terminal of diagnostic connector. See Fig. 6. 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).

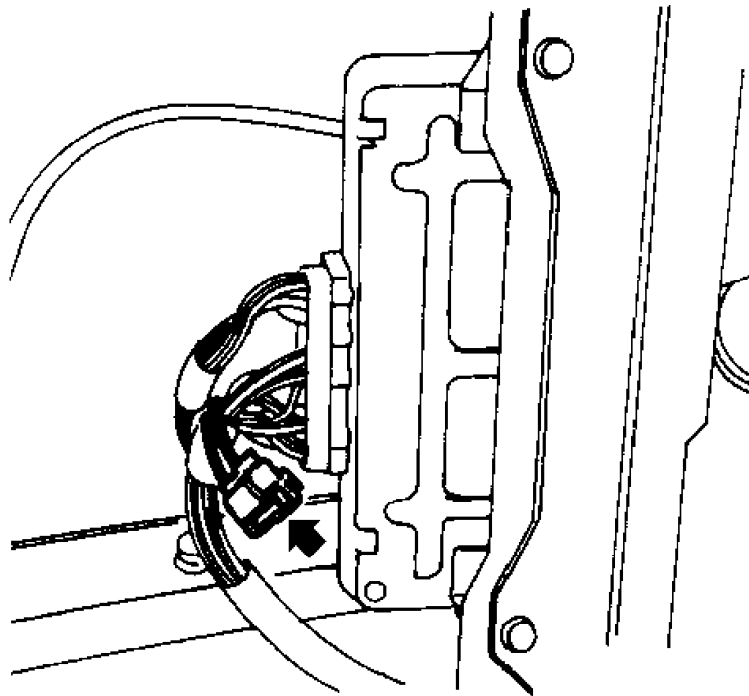


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Fig. 6: Identifying Diagnostic Check Connector Terminals
Courtesy of Mitsubishi Motor Sales of America.

CLEARING CODES

To erase one code, locate diagnostic code erasure connector. See Fig. 7. Using jumper wire, connect code erasure connector terminals. Turn ignition on. ABS warning light should come on. After 3 seconds, turn ignition off. Disconnect jumper wire. Turn ignition on. To erase more than one code, repeat procedure.



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Fig. 7: Locating Diagnostic Code Erasure Connector
Courtesy of Mitsubishi Motor Sales of America.

TROUBLE CODE DEFINITION

TROUBLE CODES TABLE

Code	(1) System Affected
11	Right Front Wheel Speed Sensor (Open)
12	Left Front Wheel Speed Sensor (Open)
13	Right Rear Wheel Speed Sensor (Open)
14	Left Rear Wheel Speed Sensor (Open)
15	Speed Sensor Output Signal Fault
16	Low/High Battery Voltage
21	Right Front Wheel Speed Sensor (Short)
22	Left Front Wheel Speed Sensor (Short)
23	Right Rear Wheel Speed Sensor (Short)
24	Left Rear Wheel Speed Sensor (Short)
25	Failure Of Both Rear Wheel Sensors
31, 32	Wheel Speed Sensor Rotor
35	Low Alternator "L" Terminal Voltage
37	Low Pressure Warning Switch Voltage
41-46	Solenoid Valve Circuit
51	Valve Relay Failure Or Short
52	Valve Relay Failure
53	Low Voltage To Motor Relay
54	Motor Relay Failure Or Short
61	Hydraulic Unit
62	Miscellaneous Failures
63	Faulty ECU

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

CODE 11, 12, 13 OR 14

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

Faulty Wheel Speed Sensor Input

Trouble code will set if ECU detects wheel speed sensor has open circuit. Check continuity of circuit between ECU and sensor. See WIRING DIAGRAM. Repair as needed. Inspect condition of speed sensors. See WHEEL SPEED SENSOR under COMPONENT TESTING.

CODE 15

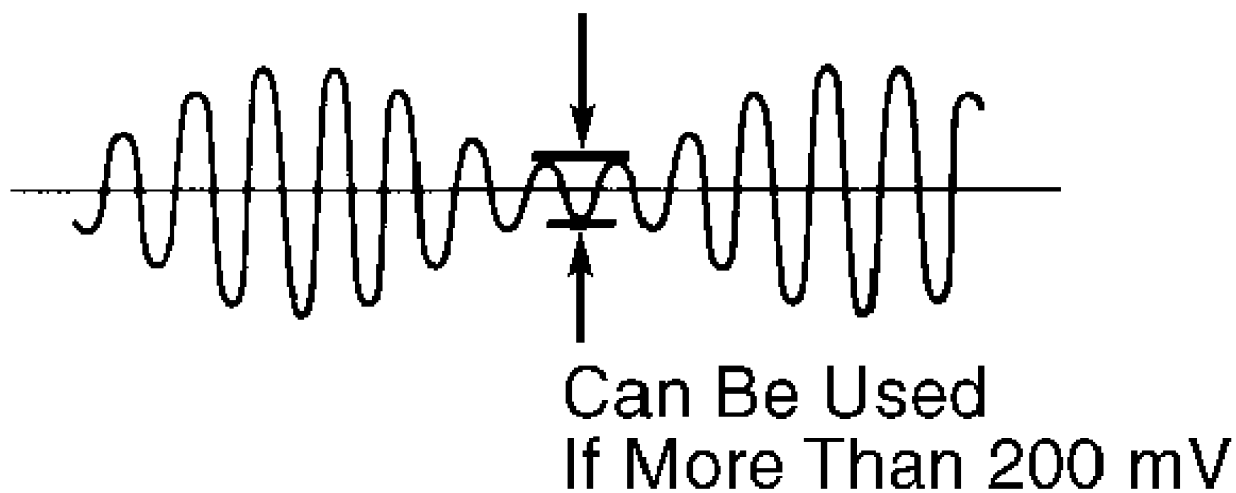
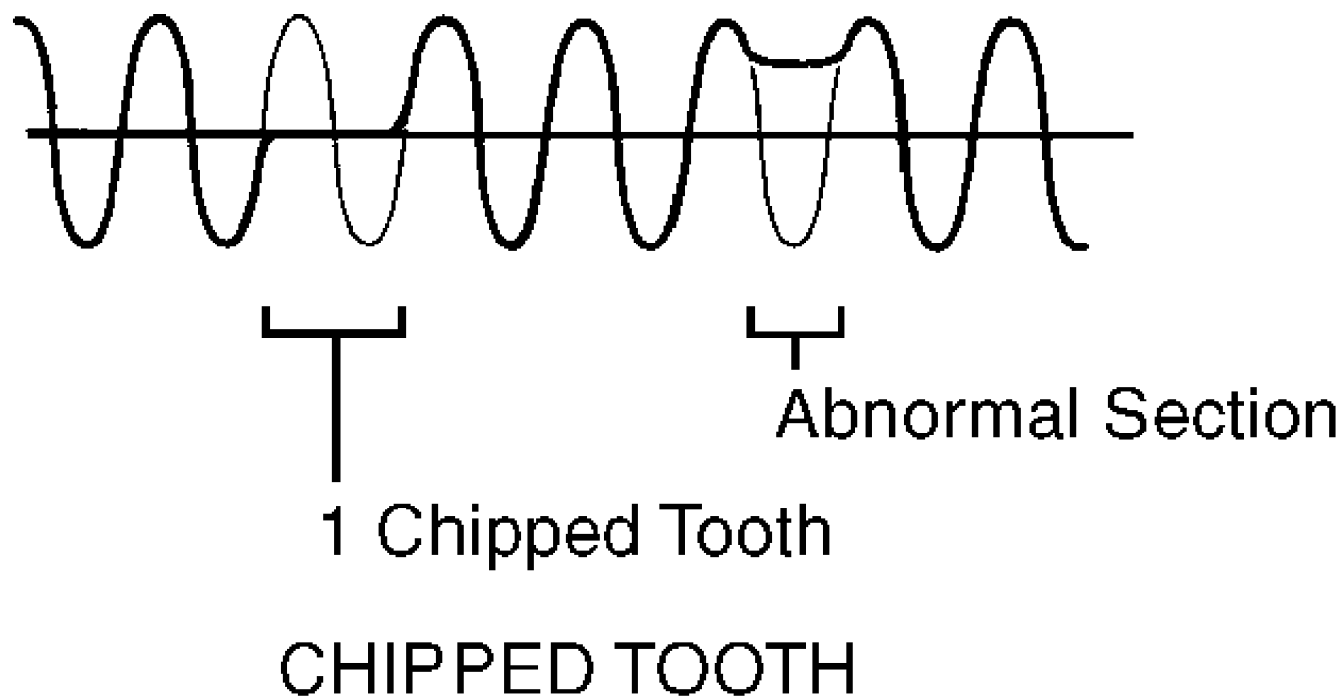
NOTE: If after all testing procedures have been completed system is not functioning properly, substitute ABS ECU with known good unit and retest.

Faulty Wheel Speed Sensor Output

1) This code normally is set when Codes 11-14 are set. 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) 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 waveform patterns. See Fig. 8. If all rotors are okay, replace ECU and road test vehicle. Ensure trouble code does not reset.



ROTOR ECCENTRICITY

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Fig. 8: Identifying Abnormal ABS Rotor Waveform Patterns
Courtesy of Mitsubishi Motor Sales of America.

ECU Power Voltage

Start engine. Using DVOM, measure voltage between ECU terminal No. 5 (backprobe) and ground. If 10 volts or more are present, replace ECU. If less than 10 volts are present, check fuse (No. 2) contacts and ECU connector. Repair as necessary. If fuse contacts and ECU connector are okay, replace faulty ECU.

CODE 21, 22, 23 OR 24

Faulty Wheel Speed Sensor Output

1) Trouble code will set if ECU detects wheel speed sensor has no output signal. Trouble code will also set if wheel sensor voltage output is low while driving vehicle.

2) Inspect condition of sensor rotor. Damage of rotor teeth can set code. Inspect wheel sensor wiring harness for poor connection. See WIRING DIAGRAM. Repair or replace if necessary. If no short circuit or poor connection is found, go to next step.

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

CODE 25

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

Malfunction Of Both Rear Wheel Sensors

Code is set when no signal is output from both rear wheel sensors. Code can also set if vehicle has rear wheels prevented from turning (stuck situation) when front wheels are turning. Conduct testing procedures from CODE 11, 12, 13 OR 14.

CODE 31, 32, 33 OR 34

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

Damaged Wheel Speed Sensor Rotor

Inspect condition of wheel speed sensor and rotor. Damaged components or incorrect sensor-to-rotor gap can set code. See WHEEL SPEED SENSOR in ADJUSTMENTS. Check for excessive hub runout or defective bearing.

CODE 35

Low Alternator "L" Terminal Voltage

Remove ECU connector. Inspect for damage and repair as necessary. Turn ignition on. Using DVOM, measure voltage between terminal No. 61 and vehicle ground. See Fig. 4. If 7 volts or more are present, replace ECU. If less than 7 volts are present, inspect and repair wiring harness between ECU connector and alternator. If wiring harness is okay, inspect alternator. Replace as needed.

CODE 37

Low Hydraulic Pressure

This code will set if hydraulic unit pressure is less than correct operating pressure. If pressure increases to correct operating pressure, code will be erased. If pressure does not increase to

correct operating pressure within 35 seconds, Code 37 will be erased and Code 61 will be set. See CODE 61.

CODE 41, 42, 43, 44, 45 OR 46

Solenoid Valve Circuit

1) Disconnect hydraulic unit 1-pin connector and 9-pin connector. Using ohmmeter, measure resistance between 1-pin component connector and hydraulic unit terminals No. 2, 3, 5, 6, 8 and 9. See Fig. 3.

2) Resistance of each circuit should be 2800–3400 ohms. If resistance is correct, go to next step. If resistance is not correct, replace faulty hydraulic unit. See HYDRAULIC UNIT under REMOVAL & INSTALLATION.

3) Connect hydraulic unit 9-pin connector. Disconnect ECU wiring harness connector. Measure resistance between hydraulic unit 1-pin connector and specified ECU connector terminals. See Fig. 4. See HYDRAULIC UNIT-TO-ECU CIRCUIT IDENTIFICATION table.

4) Resistance should be 2800–3400 ohms. If resistance is not within specification, repair circuit not within specification. If all resistance tests are within specification, solenoid valve circuit is okay. Replace faulty ECU.

HYDRAULIC UNIT-TO-ECU CIRCUIT IDENTIFICATION TABLE

Hydraulic Unit	ECU Terminal No. (Wire Color)
1-Pin Terminal	1 (Blue/White)
1-Pin Terminal	2 (Red/Black)
1-Pin Terminal	3 (Red/White)
1-Pin Terminal	14 (Blue/Black)
1-Pin Terminal	15 (Yellow/Black)
1-Pin Terminal	16 (Yellow/Red)

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.

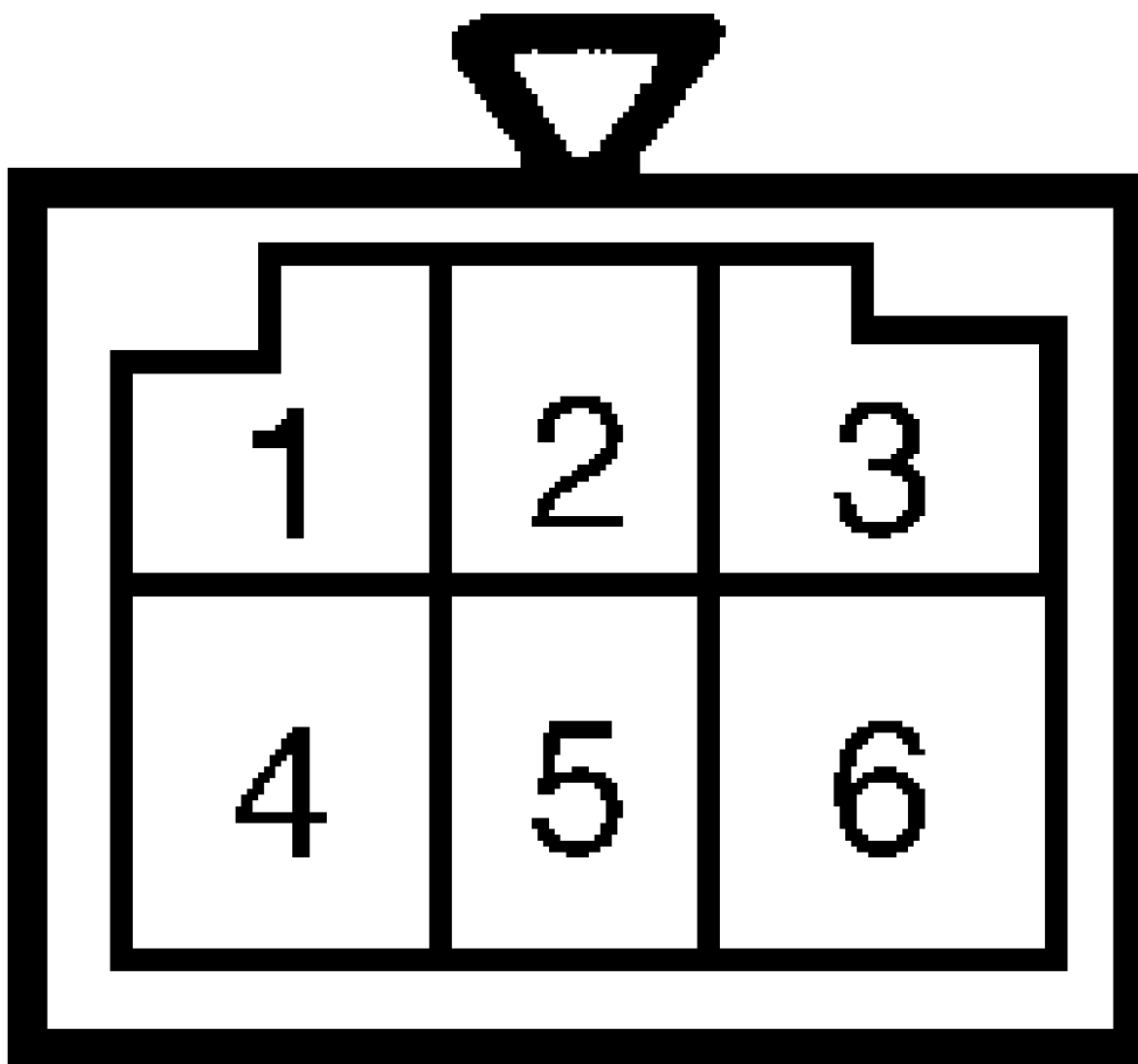
2) Remove ECU 26-pin connector. Using an ohmmeter, measure resistance between ECU connector terminal No. 8 and ground. See Fig. 4. If resistance is infinite, replace ECU. If resistance is not infinite, repair short between ECU connector and valve relay.

CODE 52 OR 53

Motor Relay Circuit

1) Check Yellow 60-amp fusible link No. 6, located in fuse block next to battery. If fusible link is blown, repair short circuit and replace fuse. If fuse is okay, remove connectors from solenoid valve, motor relay and valve relay. Inspect connectors for damage and repair if necessary. If connectors are okay, go to next step.

2) Measure voltage between valve relay wiring harness connector terminal No. 6 and ground. See Fig. 9. If battery voltage is not present, repair circuit between 60-amp fusible link and valve relay. If battery voltage is present, go to next step.



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

3) Turn ignition on. Measure voltage between valve relay wiring harness connector terminal No. 2 and ground. If battery voltage is not present, repair circuit between fuse No. 2, and valve relay. If battery voltage is present, go to next step.

4) 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.

5) Disconnect ECU connector. Turn ignition on. Measure voltage between ECU connector terminal No. 8 and ground. See Fig. 4. If battery voltage is present, go to next step. If battery voltage is not present, repair harness between valve relay and ECU connector.

6) Turn ignition off. Locate diode in valve relay White/Black wire. See Fig. 10. Using an ohmmeter, ensure diode resistance is

infinite in one direction only. Replace diode if necessary. If diode is okay, go to next step.

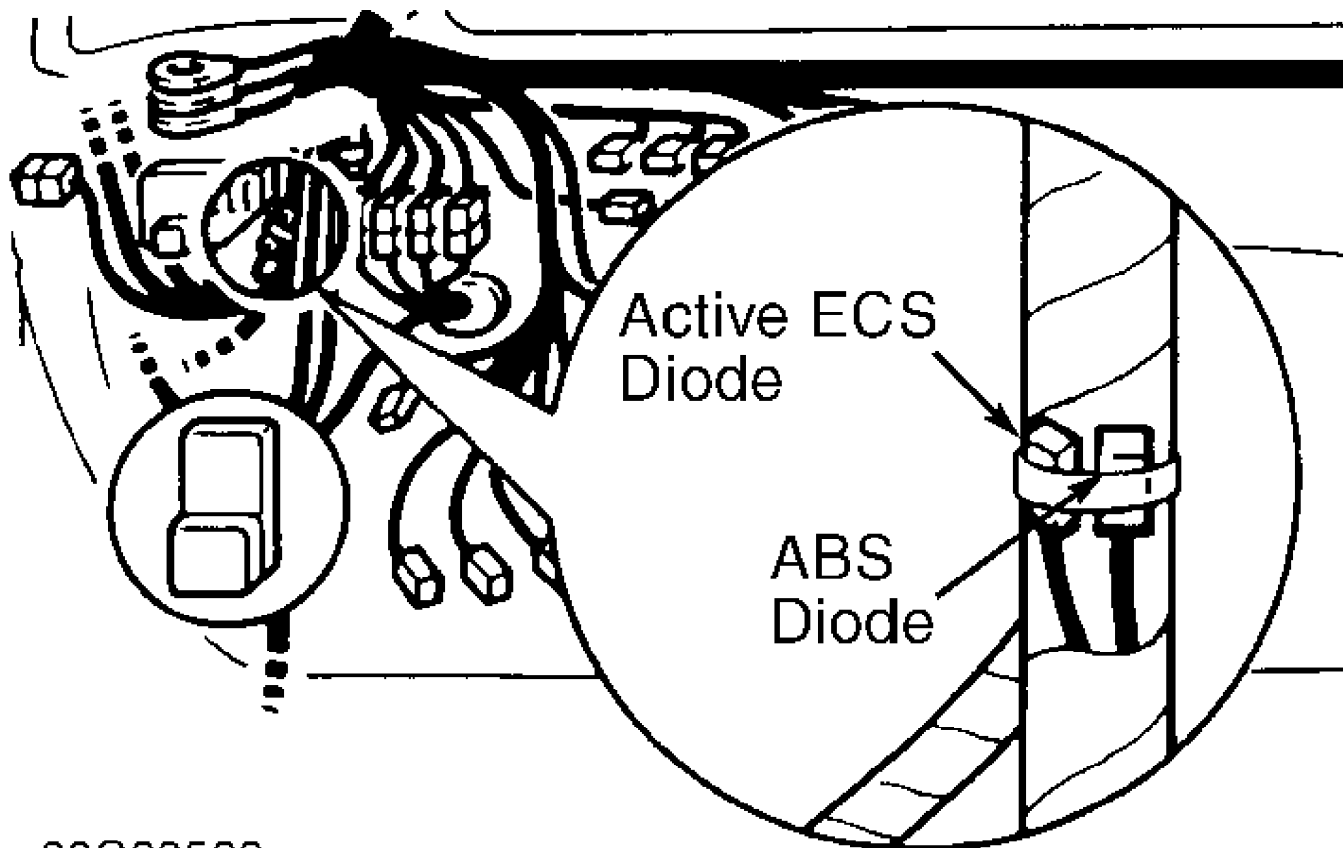
7) Remove motor relay. Inspect terminals and repair if necessary. If terminals are okay, turn ignition on. Measure voltage between motor relay wiring harness connector terminal No. 5 (White/Yellow wire) and ground. If battery voltage is present, go to next step. If battery voltage is not present, repair wiring harness between 60-amp fusible link and motor relay.

8) Remove motor relay and valve relay. Check for continuity between motor relay wiring harness terminal No. 3 (White/Black) and valve relay wiring harness terminal No. 3 (White/Black wire). If continuity is present, go to step 10). If continuity is not present, repair White/Black wire between motor relay and valve relay.

9) Remove and test motor relay. See HYDRAULIC UNIT RELAYS under COMPONENT TESTING. Replace motor relay as needed. Install motor relay. Disconnect ECU connector. Turn ignition on. Measure voltage between ECU wiring harness connector terminal No. 7 and ground. See Fig. 4.

10) If battery voltage is not present, repair wiring harness between motor relay connector terminal No. 1 (Blue/White wire) and ECU connector terminal No. 7.

12) If battery voltage is present, check for short circuit between motor relay connector terminal No. 4 (White/Black wire), and ECU connector terminal No. 13. If circuit is okay, replace faulty ECU.



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Fig. 10: Locating ABS Diode

Courtesy of Mitsubishi Motor Sales of America.

1) Turn ignition off. Remove motor relay connector. Inspect connector terminals for damage and repair if necessary. If connector terminals are okay, measure resistance between terminal No. 4 (White/Black wire), and ground. If resistance is .5-1.5 ohms, go to next step. If resistance is not .5-1.5 ohms, repair open or shorted short circuit between motor relay connector and hydraulic unit. If circuit is okay, replace hydraulic unit.

2) Remove ECU connector. Using an ohmmeter, measure resistance between ECU connector terminal No. 7 and ground. If zero ohms is present, replace ECU. If resistance is not zero ohms, repair short circuit in wiring harness between motor relay and ECU connector.

CODE 61

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

1) Start engine and allow to idle for 2 minutes. Stop engine. Repeat procedure 10 times. Bleed BRAKE SYSTEM. See BLEEDING BRAKE SYSTEM. If Code 61 is no longer present, system is okay and testing is complete. If Code 61 is still present, go to next step.

2) Remove hydraulic unit 9-pin connector. See Fig. 3. Inspect connector terminals and repair if necessary. Remove ECU connector. See Fig. 4. Check for continuity between ECU connector terminal No. 52 and hydraulic unit connector terminal No. 7. Check for continuity between ECU connector terminal No. 53 and hydraulic unit connector terminal No. 4. If continuity is not present, repair circuit. If continuity is present, replace hydraulic unit.

CODE 62

1) Code 62 indicates a problem with wheel speed sensor(s) or a faulty hydraulic unit. A false Code 62 may be set, however, if vehicle is driven for long periods on snow or ice, left and right tires are different sizes, or brakes are dragging.

2) Test each wheel speed 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.

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 waveform patterns and output voltage. See Fig. 8. Output voltage should be 0.2 volts (200 mV). If all rotors and wheel speed sensors are okay, go to next step.

5) If after all testing procedures have been completed system is not functioning properly, substitute ABS ECU with known good unit and retest. If Code 62 does not reset, replace original ECU. If Code 62 does reset, replace hydraulic unit.

CODE 63

If Code 63 is present, replace faulty ECU.

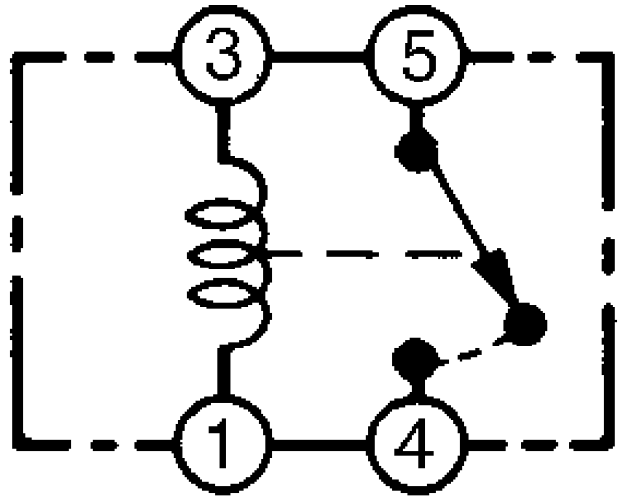
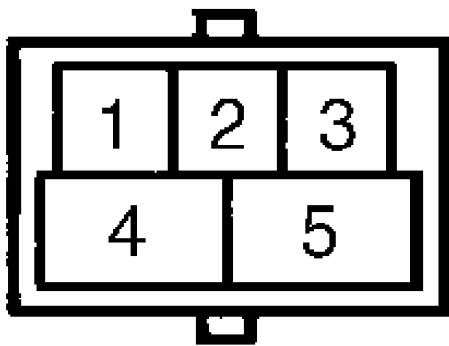
COMPONENT TESTING

HYDRAULIC UNIT RELAYS

Motor Relay

1) Remove motor relay. Using an ohmmeter, measure resistance between relay terminals No. 1 and 3. See Fig. 11. Resistance should be 49-99 ohms. Check for continuity between relay terminals No. 4 and 5. Continuity should not exist.

2) Apply battery voltage between relay terminal No. 1 and terminal No. 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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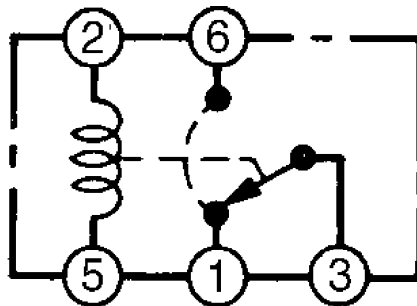
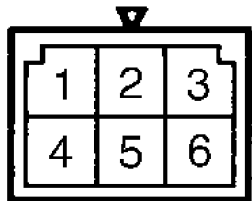
Fig. 11: Identifying Motor Relay Terminals
Courtesy of Mitsubishi Motor Sales of America.

Valve Relay

1) Remove valve relay. Using an ohmmeter, measure resistance between relay terminals No. 2 and 5. See Fig. 12. Resistance should be 55-105 ohms. Measure resistance between relay 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 between terminal No. 2 and terminal No. 5. Check for continuity between terminals No. 1 and 3. Continuity should not exist.

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



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Fig. 12: Identifying Valve Relay Terminals
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 as necessary. Using an ohmmeter, measure sensor resistance at wiring connector. See WHEEL SPEED SENSOR RESISTANCE SPECIFICATIONS table. If resistance is not within specification, replace sensor. If resistance is within specification, go to GROUND CIRCUIT TEST.

WHEEL SPEED SENSOR RESISTANCE SPECIFICATIONS TABLE

Application	Ohms
Front	1400-2200
Rear	1300-2100

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.

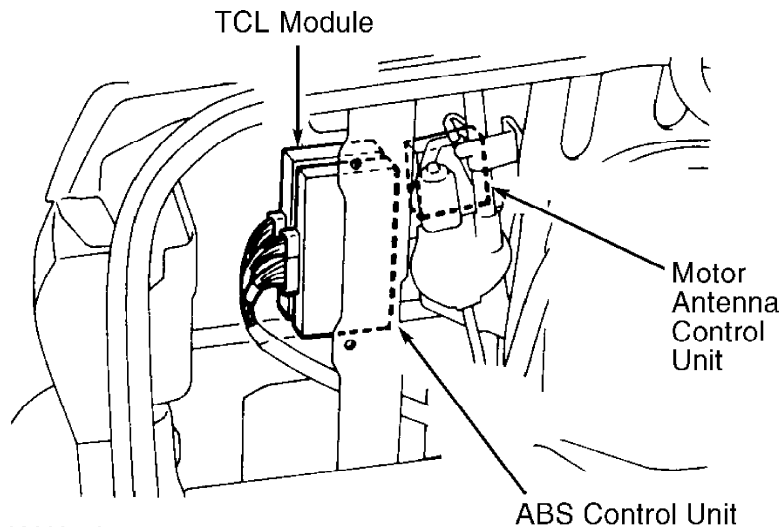
REMOVAL & INSTALLATION

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation

1) ECU is located behind left rear quarter panel trim in trunk. See Fig. 13. 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. 13: Locating ABS Electronic Control Unit
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.

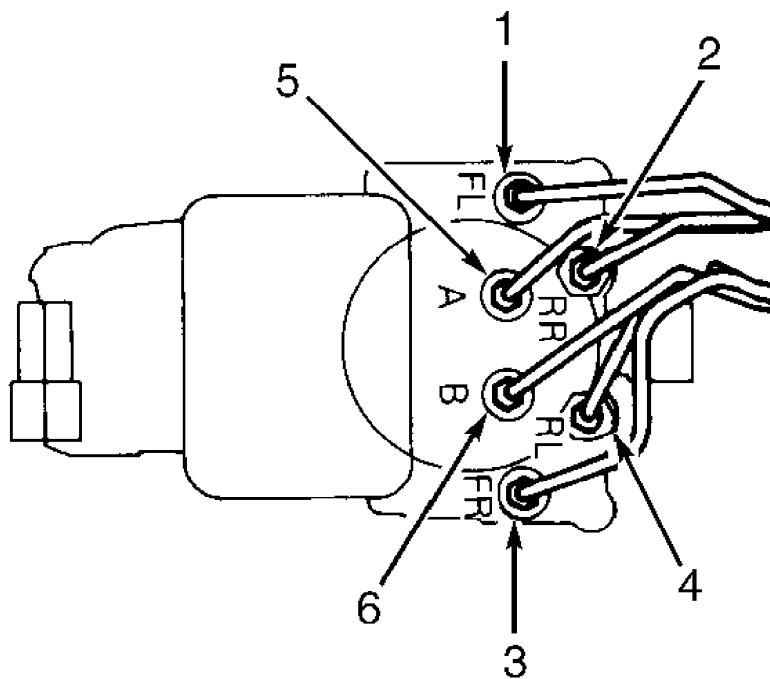
Removal

1) Remove hydraulic unit connectors, connector bracket and clip. Disconnect hydraulic lines. Remove A/C pressure clamp bolt.

2) Remove condenser tank and bracket. Disconnect 4-wheel steering connector. Push hydraulic unit backward until clear of A/C lines. Remove hydraulic unit and bracket.

Installation

To install, reverse removal procedure. Install hydraulic unit brakelines. Ensure brakelines are installed in correct location. See Fig. 14. Bleed BRAKE SYSTEM. See BLEEDING BRAKE SYSTEM.



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

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Fig. 14: Identifying Brakeline Connections To Hydraulic Unit
Courtesy of Mitsubishi Motor Sales of America.

WHEEL SPEED SENSOR

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

Removal & Installation

Unplug wheel sensor connector. Remove bolts attaching sensor. Remove wheel 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

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

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	Ft. Lbs. (N.m)
Front Bearing Nut	144-188 (195-255)
Front Brake Caliper Bolts	58-72 (78-97)
Hydraulic Unit Mounting Bolts	13-18 (18-24)
Rear Bearing Nut (FWD Disc)	(1) 144-188 (195-255)
Rear Bearing Nut (FWD Drum)	(2)
Rear Brake Caliper Bolts	36-43 (48-58)
Wheel Lug Nuts	65-80 (88-108)
	INCH Lbs. (N.m)
Bleeder Screw	60-84 (7-9)
Flared Brakeline Nuts	120-144 (14-16)
Front Sensor Rotor Mounting Bolts	84-120 (9-14)
Wheel Speed Sensor Bolt	84-120 (9-14)
(1) - Install a new nut.	
(2) - Tighten bearing to 14 ft. lbs (19 N.m). Back off bearing nut, and tighten to 84 INCH lbs. (9 N.m).	

WIRING DIAGRAMS

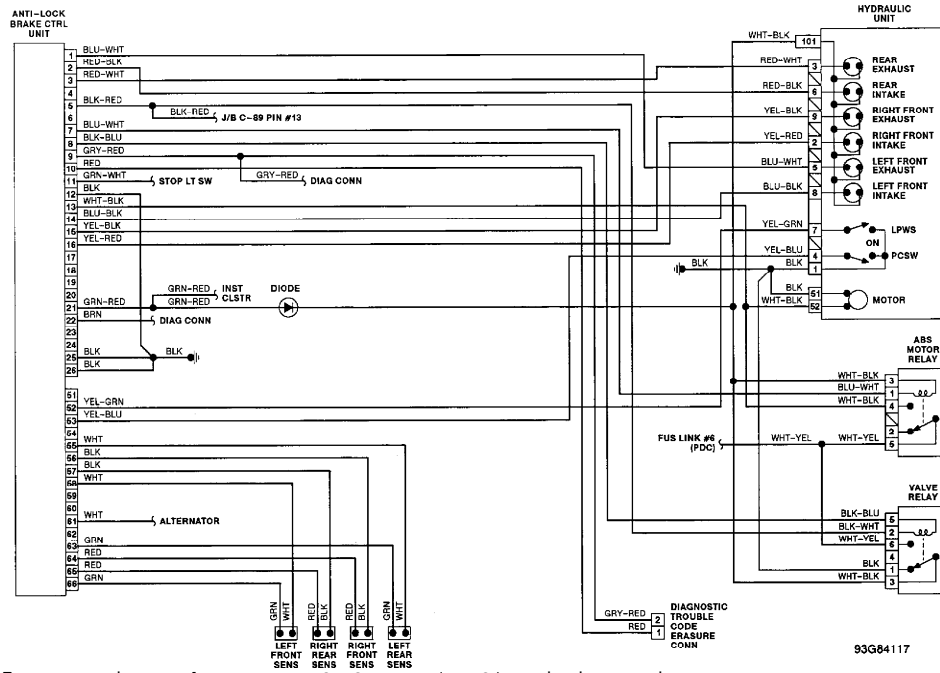


Fig. 15: Anti-Lock BRAKE SYSTEM (ABS) Wiring Diagram