

Figure 5 - ABS-VI Component Location View

### Hydraulic Modulator/Motor Pack Assembly

The hydraulic modulator/motor pack assembly controls hydraulic pressure to the front calipers and rear wheel cylinders or calipers by modulating hydraulic pressure to prevent wheel lock-up. The basic hydraulic modulator configuration consists of gear subassemblies, ball screws, nuts, pistons, and hydraulic check valves. The motor pack consists of three motors, three drive gears, and three ESBs. For more information, refer to "Base Braking Mode" and "Antilock Braking Mode" in this section.

### Electronic Brake Control Module (EBCM)

The controlling element of ABS VI is a microprocessor based Electronic Brake Control Module, or EBCM. Inputs to the system include three wheel speed sensors, the brake switch, ignition switch, and unswitched battery voltage. Outputs include three bidirectional motor controls, three lamp controls, two solenoid controls, and the system enable relay. A bidirectional serial data line, located in pin "M" of the Data Link Connector (DLC), is provided for service diagnostic tools and assembly plant testing.

The EBCM monitors the speed of each wheel. If any wheel begins to approach lock-up and the brake switch is "ON," the EBCM controls the motors and solenoids to reduce brake pressure to the wheel approaching lock-up. Once the wheel regains traction,

brake pressure is increased until the wheel again begins to approach lock-up. This cycle repeats until either the vehicle comes to a stop, the brake is released, or no wheels approach lock-up. Additionally, the EBCM monitors itself, each input (except the serial data link) and each output for proper operation. If any system malfunction is detected, the EBCM will store a DTC in nonvolatile memory (DTCs will not disappear if the battery is disconnected). Refer to "Self-Diagnostics" in this section for more detailed information.

**NOTICE:** There is no serviceable or removable PROM. The EBCM must be replaced as an assembly.

### Front Wheel Speed Sensors

The front wheel speed sensors consist of a variable reluctance sensor. The sensor and toothed ring are part of the hub and bearing assembly. As teeth pass by the sensor, an AC voltage with a frequency proportional to the speed of the wheel is generated. The magnitude of the voltage increases with increasing speed. The sensor is not repairable, nor is the air gap adjustable. The entire front bearing assembly must be replaced.

## Tech 1 Method

Select "F2: DTC(s)" for diagnostic trouble codes. After DTCs have been viewed completely, Tech 1 will ask, "CLEAR DTCs?"; answer "YES." Tech 1 will then read, "HISTORY DATA WILL BE LOST. CLEAR DTCs?" Answer "YES" and DTCs will be cleared.

## Ignition Cycle Default

If no diagnostic trouble codes occur for 100 drive cycles [a drive cycle occurs when the ignition is turned "ON" and the vehicle is driven faster than 16 km/h (10 mph)], any existing DTCs are automatically cleared from the EBCM memory.

## INTERMITTENTS AND POOR CONNECTIONS

As with most electronic systems, intermittent malfunctions may be difficult to accurately diagnose. The following is a method to try to isolate an intermittent malfunction, especially wheel speed circuitry.

If an ABS malfunction occurs, the ABS warning lamp will be "ON" during the ignition cycle in which the malfunction was detected. If it is an intermittent problem which seems to have corrected itself (ABS warning lamp "OFF"), a diagnostic trouble code will be stored. Also stored will be the history data of the DTC at the time the malfunction occurred. The Tech 1 must be used to read DTC history data.

Most intermittents are caused by faulty electrical connections or wiring. Refer to "Intermittents and Poor Connections" in SECTION 8A-4 for a very detailed explanation of how to locate and repair intermittent conditions.

## TECH 1 DIAGNOSTICS

The Tech 1, when plugged into the DLC, becomes part of the vehicle's electronic system. The Tech 1 can perform the following functions:

- Display ABS data.
- Display and clear ABS diagnostic trouble codes.
- Control ABS components.
- Perform extensive ABS diagnosis.
- Provide diagnostic testing for intermittent ABS conditions.

Each test mode has specific diagnosis capabilities which depend upon various keystrokes. In general, five keys control sequencing: "YES," "NO," "EXIT," up arrow and down arrow. The F0 through F9 keys select operating modes, perform functions within an operating mode, or enter DTC or model year designations.

In general, the Tech 1 has six test modes for diagnosing the ABS. The six test modes are as follows:

- **MODE F0: DATA LIST** - In this test mode, the Tech 1 continuously monitors wheel speed data, brake switch status and other inputs and outputs.
- **MODE F1: DTC HISTORY** - In this mode, DTC history data is displayed. This data includes how many ignition cycles since the DTC occurred, along with other information for the last DTC set. The first five and last DTC set are included in the DTC history data.
- **MODE F2: DIAGNOSTIC TROUBLE CODES** - In this test mode, diagnostic trouble codes stored by the EBCM, both current ignition cycle and history, may be displayed or cleared.
- **MODE F3: SNAPSHOT** - In this test mode, the Tech 1 captures data before and after a system malfunction (auto trigger) from a forced manual key press, or from a DTC setting.
- **MODE F4: MISC. TESTS** - In this test mode, the Tech 1 performs various ABS functional tests to assist in problem isolation during troubleshooting.
- **MODE F5: MOTOR REHOME** - In this mode, the Tech 1 commands the EBCM to rehome the motors on the hydraulic modulator/master cylinder assembly. This mode should **ALWAYS** be used prior to bleeding the brake system.

## Enhanced Diagnostics

Enhanced diagnostic information, found in the DTC HISTORY function of the Tech 1, is designed to provide the service technician with specific malfunction occurrence information. For each of the first five and the very last diagnostic trouble code stored, data is stored to identify the specific DTC, the number of occurrences, and the number of drive cycles since the malfunction first and last occurred [a drive cycle occurs when the ignition is turned "ON" and the vehicle is driven faster than 16 km/h (10 mph)]. However, if a malfunction is present, the drive cycle counter will increment by turning the ignition "ON" and "OFF." These first five diagnostic trouble codes are also stored in the order of occurrence. The order in which the first five DTCs occurred can be useful in determining if a previous malfunction is linked to the most recent malfunction, such as an intermittent wheel speed sensor which later becomes completely open.

During difficult diagnosis situations, this information can be used to identify malfunction occurrence trends. Did the malfunction only occur once over a large number of drive cycles, indicating an unusual condition present when it occurred?

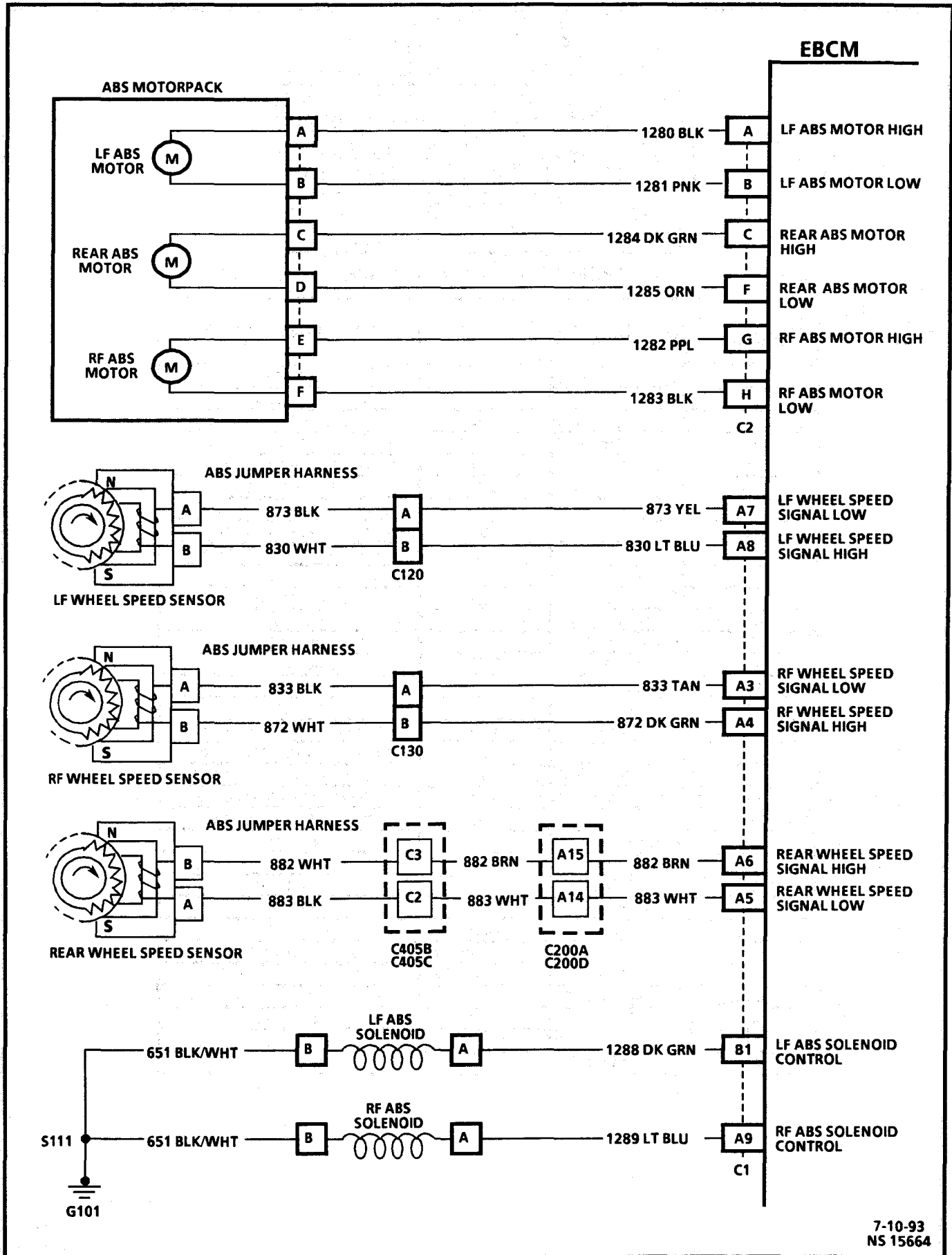
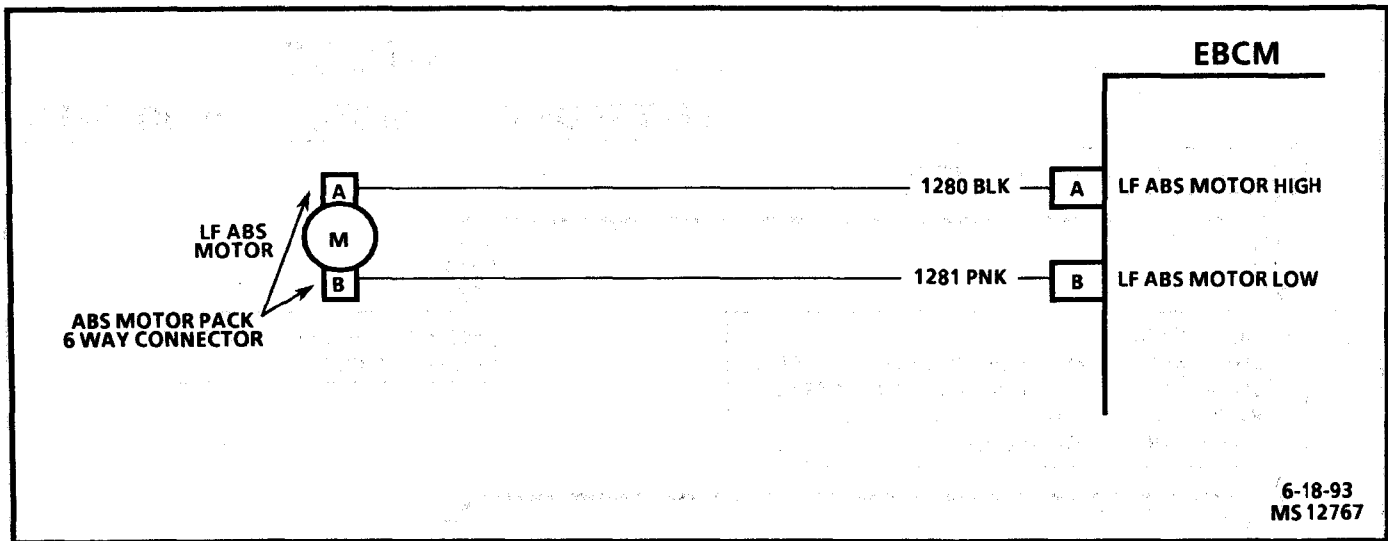


Figure 7 - Wiring Diagram (2 of 2)



## DTC 57

### LEFT FRONT ABS MOTOR CIRCUIT SHORTED TO GND

#### Circuit Description:

This DTC identifies an ABS motor circuit that is shorted to ground. This malfunction will not allow the ABS motor to be controlled at the commanded current rate or will cause the driver circuit to allow current directly to ground.

**DTC Will Set When:** DTC 57 can be set anytime. If the EBCM detects an out of range voltage on either of the left front ABS motor circuits indicating a circuit shorted to ground, a malfunction exists.

**Action Taken:** A malfunction DTC is stored, ABS is disabled and the "ABS INOP" lamp is turned "ON."

**DTC Chart Test Description:** Number(s) below refer to circled number(s) on the diagnostic chart.

1. Checks for a short to ground in the ABS motor "HIGH" circuitry.
2. Checks for a short to ground in the ABS motor "LOW" circuitry.
3. Checks for an ABS motor that is internally shorted to ground.
4. Ensures malfunction was not due to physical damage of the circuitry.

**Diagnostic Aids:** Using Tech 1, select manual control function, and exercise motor movement of affected channel in both directions while applying light pressure on the brake pedal.

If erratic or "jumpy" brake pedal movement is detected while performing an "apply" or "release" function of the motor, an intermittent malfunction may be indicated.

An "Intermittent" malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation.

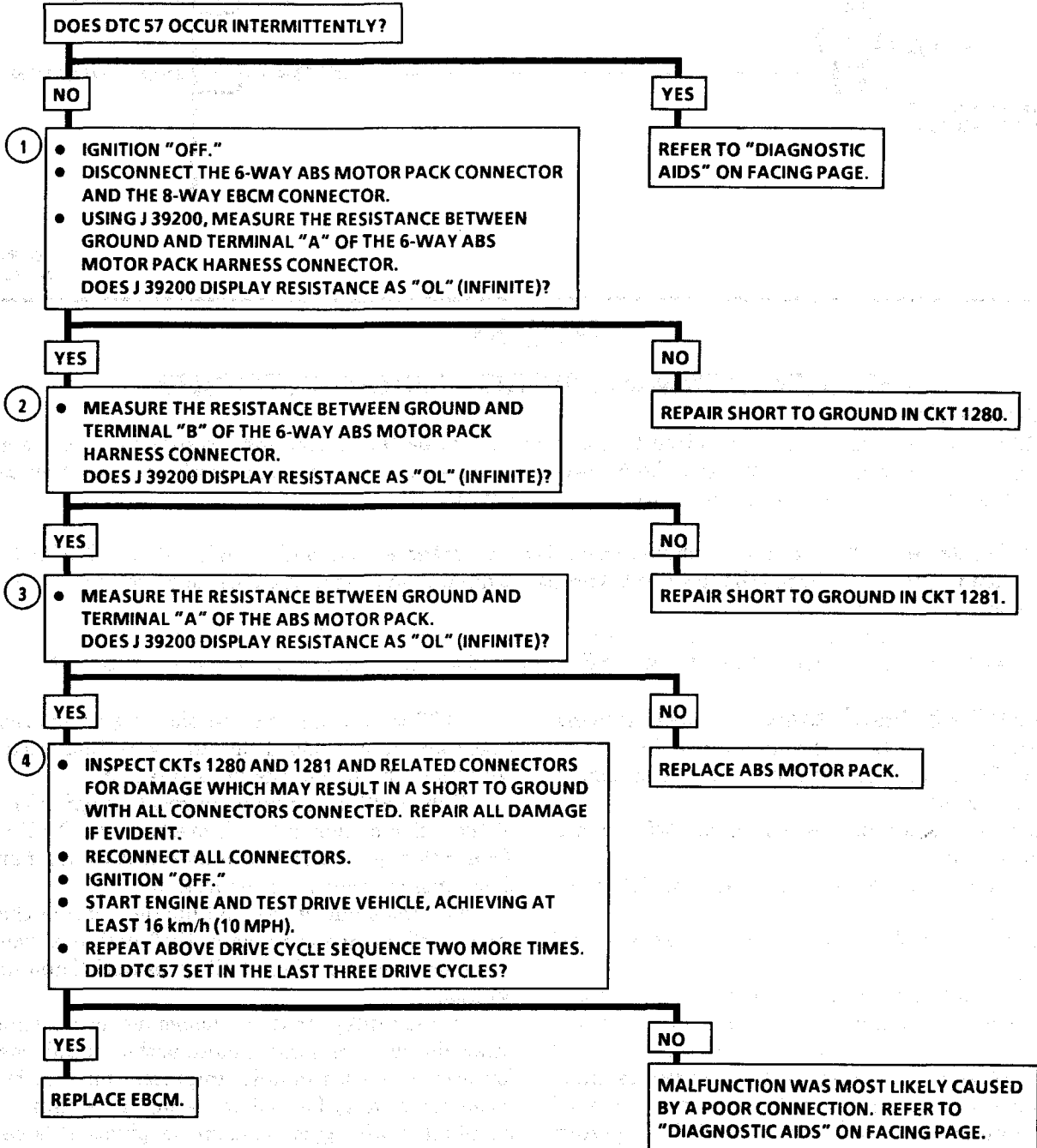
If the malfunction is not current, wiggle the wires of the affected channel and check if the DTC resets. This will help to pinpoint an intermittent malfunction in the motor circuitry or connections.

The frequency of the malfunction can be checked by using the enhanced diagnostic function of the Tech 1, as described in "Tech 1 Diagnostics" found in this section.

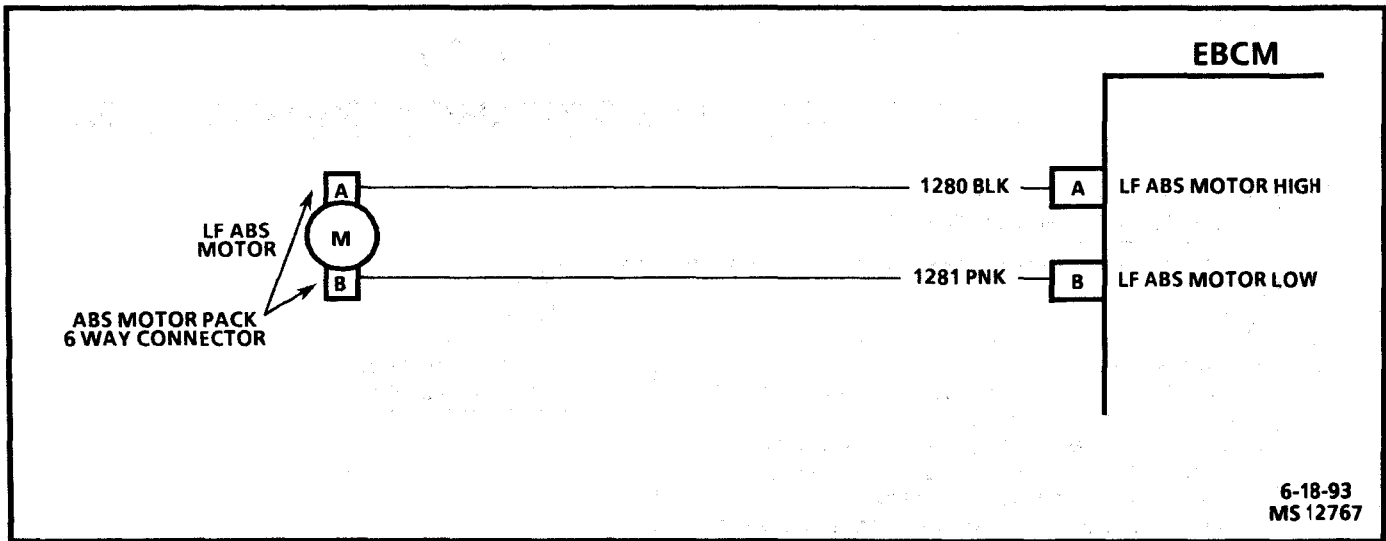
Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

## DTC 57

### LEFT FRONT ABS MOTOR CIRCUIT SHORTED TO GND



AFTER ALL DIAGNOSIS IS COMPLETE, CLEAR DTCs AND TEST DRIVE VEHICLE FOR THREE (3) DRIVE CYCLES TO VERIFY THAT DTC DOES NOT RESET. A DRIVE CYCLE CONSISTS OF STARTING THE VEHICLE, DRIVING OVER 16 km/h (10 MPH), AND THEN KEYING DOWN.



## DTC 58

### LEFT FRONT ABS MOTOR CIRCUIT SHORTED TO BATT

#### Circuit Description:

This DTC identifies an ABS motor circuit that is shorted to battery or an ABS motor that has low or no resistance. This malfunction will not allow the ABS motor to be controlled at the commanded current rate or will cause the ABS motor to turn in the opposite direction, or not at all.

**DTC Will Set When:** DTC 58 can be set only when the ABS motor is commanded "OFF." If the EBCM detects an out of range voltage on either of the left front ABS motor circuits indicating a circuit shorted to battery or an ABS motor shorted, a malfunction exists.

**Action Taken:** A malfunction DTC is stored, ABS is disabled and the "ABS INOP" lamp is turned "ON."

**DTC Chart Test Description:** Number(s) below refer to circled number(s) on the diagnostic chart.

1. Checks for a short to voltage in the ABS motor "HIGH" circuitry.
2. Checks for a short to voltage in the ABS motor "LOW" circuitry.
3. Checks for a short between the "HIGH" and "LOW" motor circuits.
4. Checks for an ABS motor that is internally shorted.
5. Ensures malfunction was not due to physical damage of the circuitry.

**Diagnostic Aids:** Using Tech 1, select manual control function, and exercise ABS motor movement of affected channel in both directions while applying light pressure on the brake pedal.

If erratic or "jumpy" brake pedal movement is detected while performing an "apply" or "release" function of the ABS motor, an intermittent malfunction may be indicated.

An "Intermittent" malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation.

If the malfunction is not current, wiggle the wires of the affected channel and check if the DTC resets. This will help to pinpoint an intermittent malfunction in the motor circuitry or connections.

The frequency of the malfunction can be checked by using the enhanced diagnostic function of the Tech 1, as described in "Tech 1 Diagnostics" found in this section.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.

**NOTICE:** J 39200 TEST LEADS MUST BE "ZEROED" PRIOR TO MAKING ANY RESISTANCE MEASUREMENTS. REFER TO J 39200 USER'S MANUAL.

## DTC 58 LEFT FRONT ABS MOTOR CIRCUIT SHORTED TO BATT

DOES DTC 58 OCCUR INTERMITTENTLY?

NO

1

- IGNITION "OFF."
- DISCONNECT THE 6-WAY ABS MOTOR PACK CONNECTOR AND THE 8-WAY EBCM CONNECTOR.
- IGNITION "ON."
- USING J 39200, MEASURE THE VOLTAGE BETWEEN GROUND AND TERMINAL "A" OF THE 6-WAY ABS MOTOR PACK HARNESS CONNECTOR. IS VOLTAGE 1 VOLT OR LESS?

YES

2

- MEASURE THE VOLTAGE BETWEEN GROUND AND TERMINAL "B" OF THE 6-WAY ABS MOTOR PACK HARNESS CONNECTOR. IS VOLTAGE 1 VOLT OR LESS?

YES

3

- IGNITION "OFF."
- USING J 39200, MEASURE THE RESISTANCE BETWEEN TERMINAL "A" AND TERMINAL "B" OF THE 6-WAY ABS MOTOR PACK HARNESS CONNECTOR. DOES J 39200 DISPLAY RESISTANCE AS "OL" (INFINITE)?

YES

4

- USING J 39200, MEASURE THE RESISTANCE BETWEEN TERMINAL "A" AND TERMINAL "B" OF THE ABS MOTOR PACK. IS RESISTANCE GREATER THAN  $0.4\Omega$ ?

YES

5

- INSPECT CKTs 1280 AND 1281 AND RELATED CONNECTORS FOR DAMAGE WHICH MAY RESULT IN A SHORT TO VOLTAGE WITH ALL CONNECTORS CONNECTED. REPAIR ALL DAMAGE IF EVIDENT.
- RECONNECT ALL CONNECTORS.
- IGNITION "OFF."
- START ENGINE AND TEST DRIVE VEHICLE, ACHIEVING AT LEAST 16 km/h (10 MPH).
- REPEAT ABOVE DRIVE CYCLE SEQUENCE TWO MORE TIMES. DID DTC 58 SET IN THE LAST THREE DRIVE CYCLES?

YES

REPLACE EBCM.

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

REPAIR SHORT TO VOLTAGE IN CKT 1280.

NO

REPAIR SHORT TO VOLTAGE IN CKT 1281.

NO

REPAIR SHORT BETWEEN CKTs 1280 AND 1281.

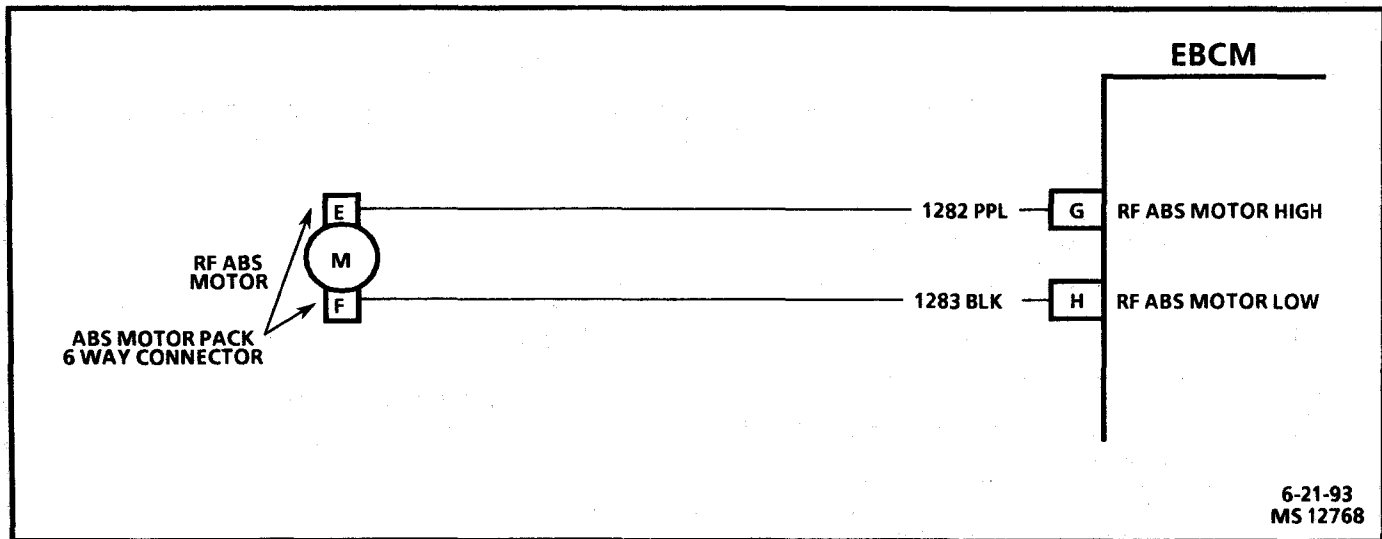
NO

REPLACE ABS MOTOR PACK.

NO

MALFUNCTION WAS MOST LIKELY CAUSED BY A POOR CONNECTION. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

AFTER DIAGNOSIS IS COMPLETE, CLEAR DTCs AND TEST DRIVE VEHICLE FOR THREE (3) DRIVE CYCLES TO VERIFY THAT DTC DOES NOT RESET. A DRIVE CYCLE CONSISTS OF STARTING THE VEHICLE, DRIVING OVER 16 KM/H (10 MPH), AND THEN KEYING DOWN.



## DTC 63

### RIGHT FRONT ABS MOTOR CIRCUIT SHORTED TO BATT

#### Circuit Description:

This DTC identifies an ABS motor circuit that is shorted to battery or an ABS motor that has low or no resistance. This malfunction will not allow the ABS motor to be controlled at the commanded current rate or will cause the ABS motor to turn in the opposite direction or not at all.

**DTC Will Set When:** DTC 63 can be set only when the ABS motor is commanded "OFF." If the EBCM detects an out of range voltage on either of the right front ABS motor circuits indicating a circuit shorted to battery or an ABS motor shorted, a malfunction exists.

**Action Taken:** A malfunction DTC is stored, ABS is disabled and the "ABS INOP" lamp is turned "ON."

**DTC Chart Test Description:** Number(s) below refer to circled number(s) on the diagnostic chart.

1. Checks for a short to voltage in the ABS motor "HIGH" circuitry.
2. Checks for a short to voltage in the ABS motor "LOW" circuitry.
3. Checks for short circuit between ABS motor "HIGH" and motor "LOW".
4. Checks for proper resistance of the ABS motor.
5. Ensures malfunction was not due to physical damage of the circuitry.

**Diagnostic Aids:** Using Tech 1, select manual control function, and exercise motor movement of affected channel in both directions while applying light pressure on the brake pedal.

If erratic or "jumpy" brake pedal movement is detected while performing an "apply" or "release" function of the motor, an intermittent malfunction may be indicated.

An "Intermittent" malfunction may be caused by a poor connection, rubbed through wire insulation, or a wire that is broken inside the insulation.

If the malfunction is not current, wiggle the wires of the affected channel and check if the DTC resets. This will help to pinpoint an intermittent malfunction in the motor circuitry or connections.

The frequency of the malfunction can be checked by using the enhanced diagnostic function of the Tech 1, as described in "Tech 1 Diagnostics" found in this section.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections or physical damage to the wiring harness.



**NOTICE:** J 39200 TEST LEADS MUST BE "ZEROED" PRIOR TO MAKING ANY RESISTANCE MEASUREMENTS. REFER TO J 39200 USER'S MANUAL.

## DTC 63 RIGHT FRONT MOTOR CIRCUIT SHORTED TO BATT

DOES DTC 63 OCCUR INTERMITTENTLY?

NO

1

- IGNITION "OFF."
- DISCONNECT THE 6-WAY ABS MOTOR PACK CONNECTOR AND THE 8-WAY EBCM CONNECTOR.
- IGNITION "ON."
- USING J 39200, MEASURE THE VOLTAGE BETWEEN GROUND AND TERMINAL "E" OF THE 6-WAY ABS MOTOR PACK HARNESS CONNECTOR. IS VOLTAGE 1 VOLT OR LESS?

YES

2

- MEASURE THE VOLTAGE BETWEEN GROUND AND TERMINAL "F" OF THE 6-WAY ABS MOTOR PACK HARNESS CONNECTOR. IS VOLTAGE 1 VOLT OR LESS?

YES

3

- IGNITION "OFF."
- USING J 39200, MEASURE THE RESISTANCE BETWEEN TERMINAL "E" AND TERMINAL "F" OF THE 6-WAY ABS MOTOR PACK HARNESS CONNECTOR. DOES J 39200 DISPLAY RESISTANCE AS "OL" (INFINITE)?

YES

4

- USING J 39200, MEASURE THE RESISTANCE BETWEEN TERMINAL "E" AND TERMINAL "F" OF THE ABS MOTOR PACK. IS RESISTANCE GREATER THAN 0.4Ω?

YES

5

- INSPECT CKTs 1282 AND 1283 AND RELATED CONNECTORS FOR DAMAGE WHICH MAY RESULT IN A SHORT TO VOLTAGE WITH ALL CONNECTORS CONNECTED. REPAIR ALL DAMAGE IF EVIDENT.
- RECONNECT ALL CONNECTORS.
- IGNITION "OFF."
- START ENGINE AND TEST DRIVE VEHICLE, ACHIEVING AT LEAST 16 km/h (10 MPH).
- REPEAT ABOVE DRIVE CYCLE SEQUENCE TWO MORE TIMES. DID DTC 63 SET IN THE LAST THREE DRIVE CYCLES?

YES

REPLACE EBCM.

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

REPAIR SHORT TO VOLTAGE IN CKT 1282.

NO

REPAIR SHORT TO VOLTAGE IN CKT 1283.

NO

REPAIR SHORT BETWEEN CKTs 1282 AND 1283.

NO

REPLACE ABS MOTOR PACK.

NO

MALFUNCTION WAS MOST LIKELY CAUSED BY A POOR CONNECTION. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

AFTER DIAGNOSIS IS COMPLETE, CLEAR DTCs AND TEST DRIVE VEHICLE FOR THREE (3) DRIVE CYCLES TO VERIFY THAT DTC DOES 6-24-93 NOT RESET. A DRIVE CYCLE CONSISTS OF STARTING THE VEHICLE, DRIVING OVER 16 KM/H (10 MPH), AND THEN KEYING DOWN. MS 12777