DYNAMIC DIGITAL FUEL INJECTION (DDFI) 4.2

MODEL YEAR CHANGE

The data link connector [91] has been relocated to the trunk on 2001 models.

INTRODUCTION

The Buell Dynamic Digital Fuel Injection (DDFI) System provides microprocessor-based electronic engine management for the 1203cc Buell Thunderstorm engine. The DDFI system has the following features:

- Independently mapped spark and fuel control.
- Engine and air temperature compensated fuel delivery.
- Engine load measurement through throttle position.
- Single point spark delivery (no waste spark).
- Sequential port indirect (manifold) fuel injection.
- Open/Closed-loop air/fuel control.
- Automatic enrichment at start.
- Engine speed and position determined using a single sensor (Cam Position Sensor).
- Full diagnostic capability compatible with the SCANALYZER (Part No. HD-41325).
- Returnless fuel system (excess pressure relieved in tank by Fuel Pressure Regulator Valve).

The DDFI system uses six sensors to monitor the operating conditions of the engine and make decisions as to spark and fuel delivery. These sensors are:

- Throttle position (TP) sensor.
- Camshaft position (CMP) sensor.
- Engine temperature (ET) sensor.
- Intake air temperature (IAT) sensor.
- Oxygen (O2) sensor.
- Bank Angle Sensor (BAS)

The DDFI system also analyzes how the engine performs during a ride. It then stores this information internally so it will be available for the next ride.

GENERAL

The Buell DDFI operates both as an open and closed loop system which allows it to adjust for all possible operating conditions. High lift cams make it necessary for an open loop system at idle and at wide open throttle. During open loop operation, the system utilizes programmed fuel and spark maps in the ECM which provide stable idle and ease of cold starting, and maximum power at wide open throttle (WOT).

During closed loop operation, the system relies on input from the O2 sensor to provide for the most efficient, stoichiometric air fuel mixture (14.6:1) which results in reduced emissions, good fuel economy and power. In order for the system to enter closed loop operation, the following conditions must be met:

- O2 Sensor at operating temperature (Engine at normal operating temperature).
- Operation above 2500 RPM with engine under load (approximately 40-60 mph in 4th or 5th gear).

By using both open and closed loop systems, engine performance is continuously tuned to compensate for changing conditions and provide maximum performance.

FOR MORE INFORMATION

To learn more about the Buell DDFI system, read the following topics in this section. A system diagram can be found on the next page in Figure 4-1.

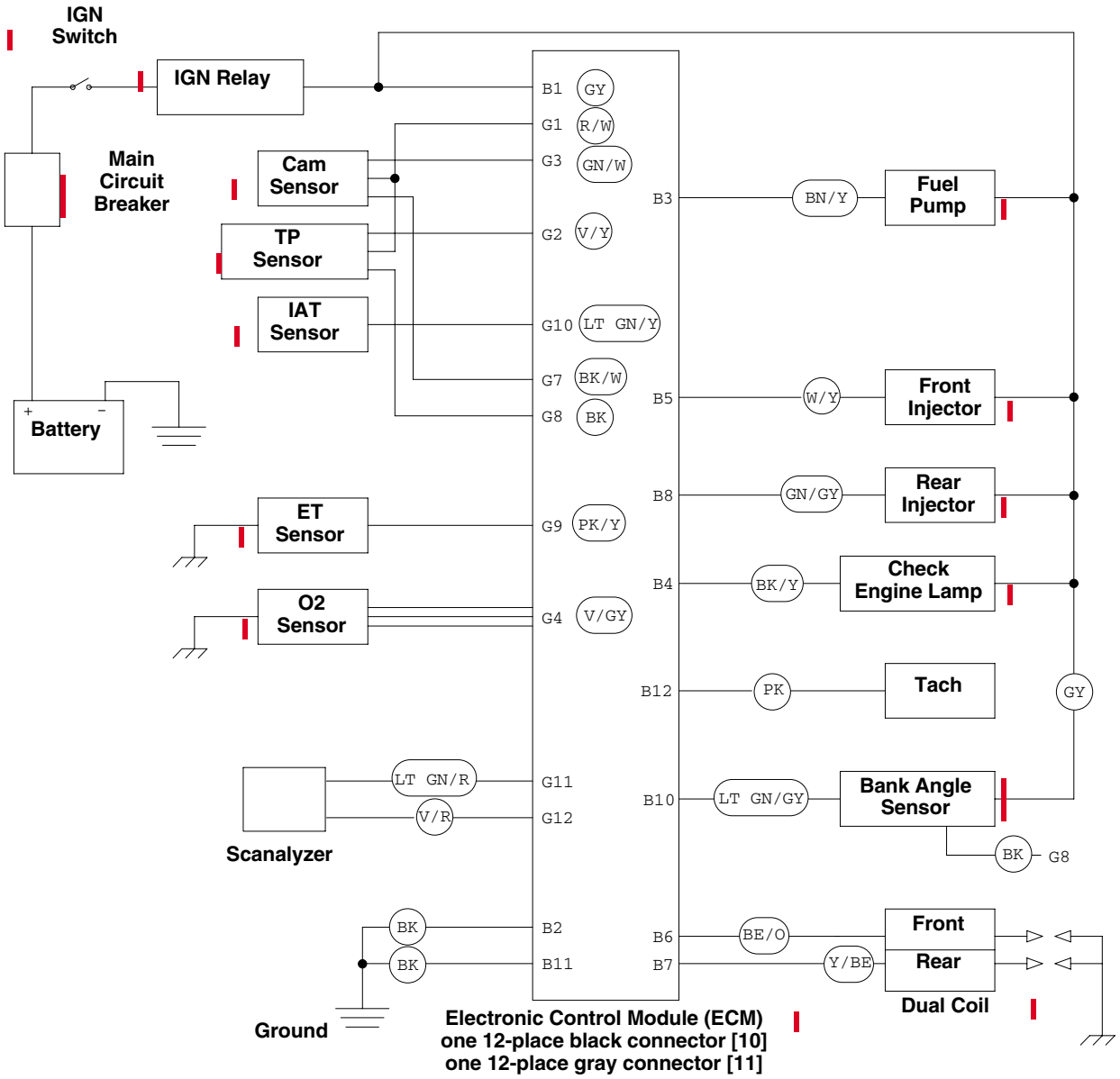
Troubleshooting

- 4.3 DIAGNOSTIC INTRODUCTION.
- 4.4 CHECKING FOR TROUBLE CODES .
- 4.6 CHECK ENGINE LAMP DIAGNOSTICS.
- 4.9 INITIAL DIAGNOSTIC CHECK.
- TABLE 4-5. TROUBLE CODES AND FAULT CONDITIONS.

Fuel Injection Components

- 4.29 ELECTRONIC CONTROL MODULE.
- 4.30 CAM POSITION SENSOR AND ROTOR
- 4.32 OXYGEN SENSOR.
- 4.33 ENGINE TEMPERATURE SENSOR.
- 4.34 BANK ANGLE SENSOR.
- 4.35 INTAKE AIR TEMPERATURE SENSOR.
- 4.36 THROTTLE POSITION SENSOR
- 4.40 FUEL PUMP.
- 4.41 THROTTLE BODY AND INTAKE MANIFOLD..

b0780x4x



WIRE COLOR CODES USED IN THIS DOCUMENT

LT	Light	**GY**	Gray	**V**	Violet
BK	Black	**O**	Orange	**W**	White
BE	Blue	**PK**	Pink	**Y**	Yellow
BN	Brown	**R**	Red		
GN	Green	**TN**	Tan		

Figure 4-1. Buell Dynamic Digital Fuel Injection

SYSTEM PROBLEMS

All system problems fall into at least one of three general categories.

No Start

The engine cranks over freely, but will not start. This does not include situations where the engine will not crank, such as a bad starter, dead battery, etc. This condition assumes that all obvious checks (fuel in tank, etc.) have been made.

Poor Performance

The engine starts but there are performance problems. These problems may include poor fuel economy, rough idle, engine misfire, engine hesitation, severe spark knock, etc.

Check Engine Lamp

See Figure 4-2. The check engine lamp indicates a fault condition exists. There may also be starting or performance problems.

RESOLVING PROBLEMS

To resolve system problems, five basic steps are involved. In order of occurrence, they are:

1. Check for trouble codes by observing check engine lamp. See 4.4 CHECKING FOR TROUBLE CODES.
2. Retrieve trouble codes using SCANALYZER (Part No. HD-41325) or check engine lamp diagnostics. See 4.5 SCANALYZER, 4.6 CHECK ENGINE LAMP DIAGNOSTICS and Figure 4-3.
3. Diagnose system problems. This involves using special tools and the diagnostic flow charts in this section.
4. Correct problems through the replacement and/or repair of the affected components.
5. After repairs are performed, the work must be validated. This involves clearing the trouble codes and confirming proper vehicle operation as indicated by the behavior of the check engine lamp.

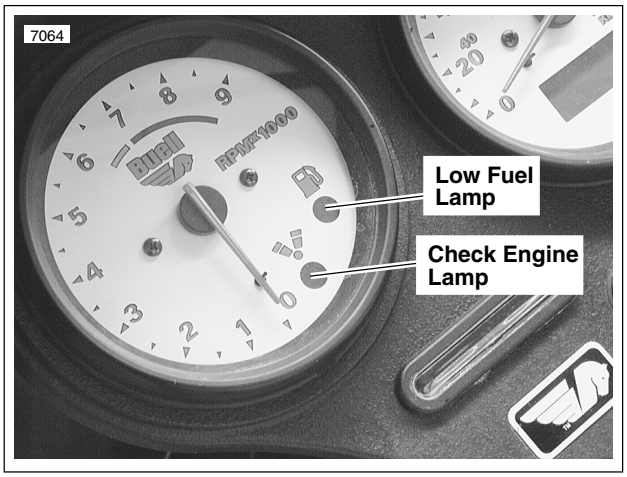


Figure 4-2. Check Engine Lamp

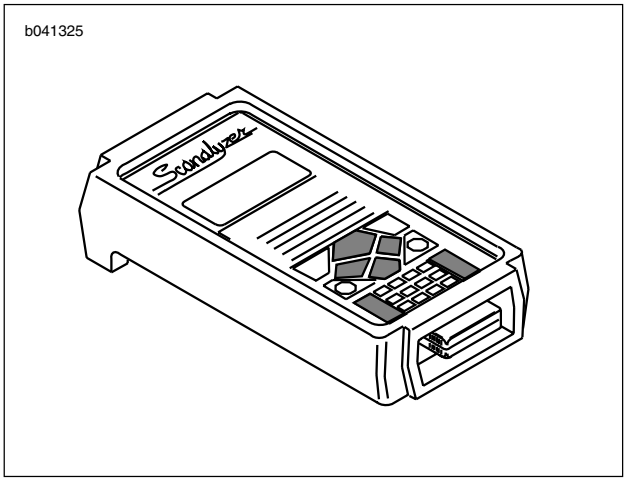


Figure 4-3. Scanalyzer (Part No. HD-41325)

CHECK ENGINE LAMP

To diagnose system problems, start by observing the behavior of the check engine lamp.

NOTE

- *See Figure 4-4. All references to "Key ON" or "Ignition Switch ON" require that the ignition key be in the IGN position and the engine stop switch be set to RUN.*
- *If the check engine lamp is not illuminated at Key ON or if it fails to turn OFF after the initial four second period, then a problem exists in the lamp circuit. See 4.10 CHECK ENGINE LAMP NOT ILLUMINATED AT KEY ON or 4.11 CHECK ENGINE LAMP ON CONTINUOUSLY for more information.*

1. When the ignition switch is turned ON after being OFF for 10 seconds or more, the check engine lamp will illuminate for approximately four seconds and then turn off.
2. See Figure 4-5. After lamp turns off after being illuminated for the first four second period, one of three situations may occur.
   a. The lamp remains off. This indicates there are no current fault conditions or stored functional trouble codes currently detected by the ECM.
   b. The lamp stays off for only four seconds and then comes back on for an eight second period. This indicates a functional error code is stored, but no current trouble code exists.
   c. If the lamp remains on beyond the eight second period, then a current trouble code exists.
3. See CODE TYPES for a complete description of trouble code formats.

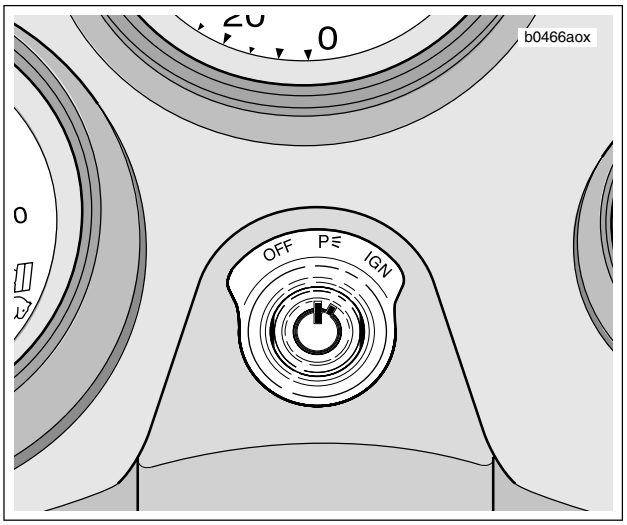


Figure 4-4. Ignition Key Switch

NOTE

Trouble codes relating to the fuel injectors or the ignition coil can only be fully diagnosed during actuation. For example, a problem with the ignition coil will be considered a current fault even after the problem is corrected, since the ECM will not know of its resolution until after the coil is exercised by vehicle start sequence. In this manner, there may sometimes be a false indication of the current trouble code.

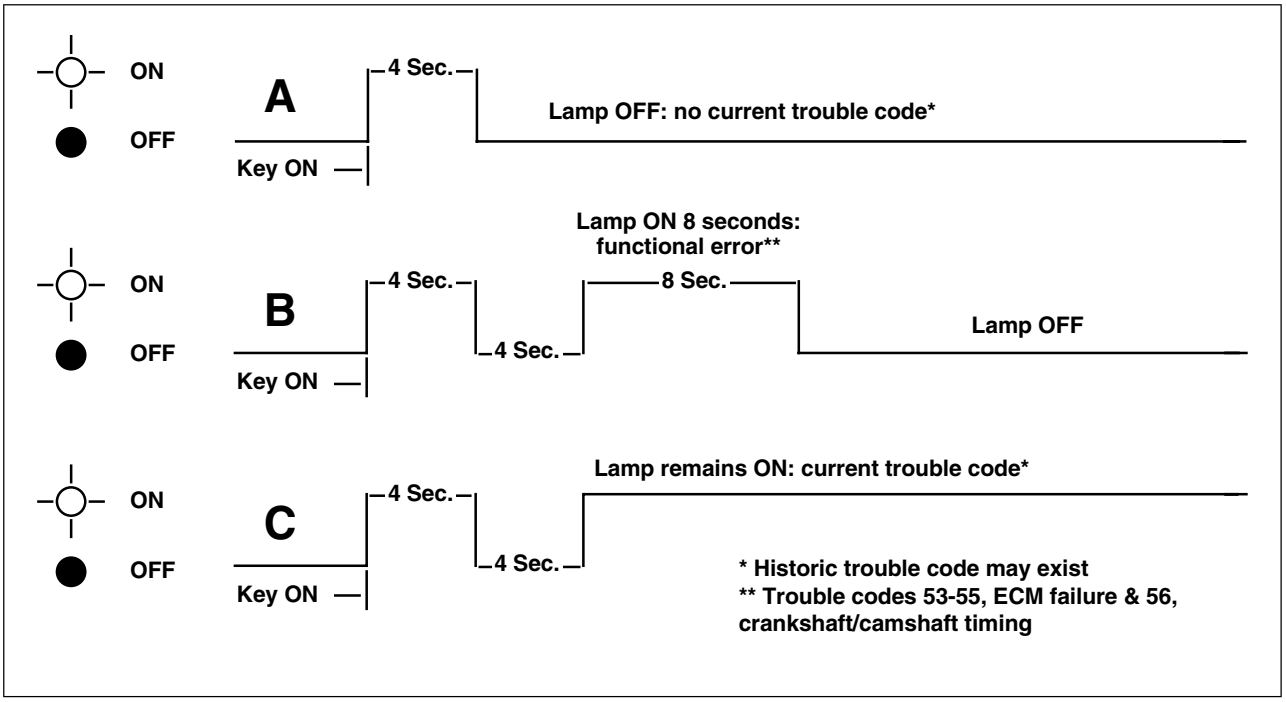


Figure 4-5. Check Engine Lamp Operation

CODE TYPES

There are three types of trouble codes: current, historic or functional. If a trouble code is stored, it can be read using either a Scanalyzer or check engine lamp diagnostics.

All trouble codes reside in the memory of the ECM until the code is cleared by use of the Scanalyzer or a total of 50 trips has elasped. A trip consists of a start and run cycle, the run cycle lasting at least 30 seconds. After the 50 trip retention period, the trouble code is automatically erased from memory providing that no subsequent faults of the same type are detected in that period.

Current

Current trouble codes are those which presently disrupt motorcycle operation. See the appropriate flow charts for solutions.

Historic

If a particular problem happens to resolve itself, the active status problem is dropped and it becomes a historic fault rather current fault.

Historic trouble codes are stored for a length of time to assist in the diagnosis of intermittent faults. The check engine lamp will not indicate the existence of only historic trouble codes.

It is important to note that historic trouble codes may also be present whenever the system indicates the existence of a current fault. See 4.4 CHECKING FOR TROUBLE CODES if multiple trouble codes are found.

Functional

A functional trouble code indicates an internal problem with the ECM (trouble codes 52 through 55) or with the camshaft sensor/timing (trouble code 56).

RET RIEVING TROUBLE CODES

The fuel injection system provides two levels of diagnostics.

- The most sophisticated mode employs a portable diagnostic tool called a Scanalyzer. This device plugs into the motorcycle wiring harness. It facilitates the diagnosis of system problems through a direct interface with the ECM. See 4.5 SCANALYZER.
- The second mode requires using the check engine lamp. See 4.6 CHECK ENGINE LAMP DIAGNOSTICS for more information.

MULTIPLE TROUBLE CODES

The TP and CMP sensors are all connected to the same reference line (5v REF). If this line goes to ground or open, multiple trouble codes (codes 11 and 56) may be set.

Also, the ECM, fuel pump, fuel injectors, bank angle sensor and ignition coil all receive +12 volts from the ignition relay. If this line should go to ground the ignition fuse will open.

Always start with the trouble code having the lowest numerical value. See list of fault conditions on page 4-17 (Table 4-5.)

CHECK ENGINE LAMP BLINKS

In addition to alerting the rider to trouble codes, the check engine lamp will blink during operation to warn of potentially damaging engine operating temperatures. If the key is in the on position and the check engine lamp is blinking, the engine is at a potentially damaging temperature. While this condition is in effect, the ECM will reduce engine power to assist in cooling the engine down to a safe operating temperature. The check engine lamp will blink until the engine has cooled to a safe operating temperature.

SCANALYZER DIAGNOSTICS

Data Link Connector

See Figure 4-6. Using the Scanalyzer requires access to the data link connector located in the trunk.

Scanalyzer Cartridge

See Figure 4-7. Through a special programmable application cartridge, the Scanalyzer offers data displays and menu selections that allow for quick and easy retrieval of data. The device enables the user to perform a variety of diagnostic tests while monitoring inputs and outputs.

Sample Scanalyzer menu selections are shown in Figure 4-8.

INSTALLATION

The illumination of the check engine lamp usually indicates the presence of trouble codes. When trouble codes are present, and a SCANALYZER (Part No. HD-41325) and DIAGNOSTIC CARTRIDGE (Part No. B-41325-99) are available, proceed as follows:

1. Turn ignition/light key switch OFF.
2. Remove seat. See 2.40 SEAT.
3. See Figure 4-6. Locate the data link connector [91A] in the trunk.
4. Remove rubber protective plug from data link connector. Plug Scanalyzer into connector. If necessary, detach connector from frame.
5. Turn ignition/light key switch ON. Set engine stop switch to RUN, but do not start engine.
6. See Figure 4-7. Insert the diagnostic application cartridge (2) into the Scanalyzer (1). During the next few seconds, the Scanalyzer sequences through a series of screens that reflect a power-on self test, the system copyright, and then an attempt at communications with the ECM. Once communications is established with the ECM, the diagnostic menu appears. See Figure 4-8.
7. Continue with the instructions under USAGE.

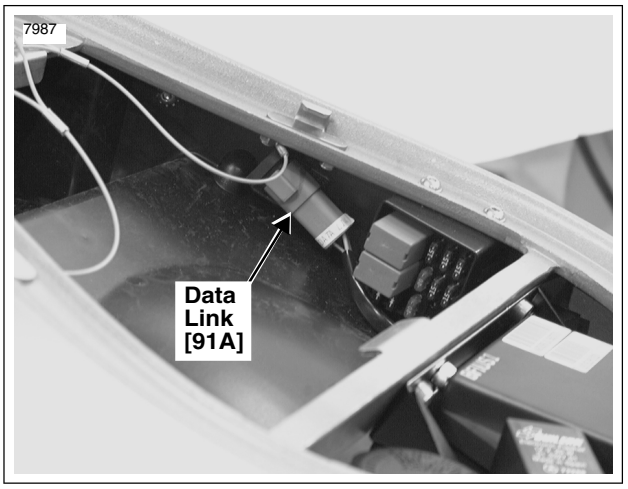
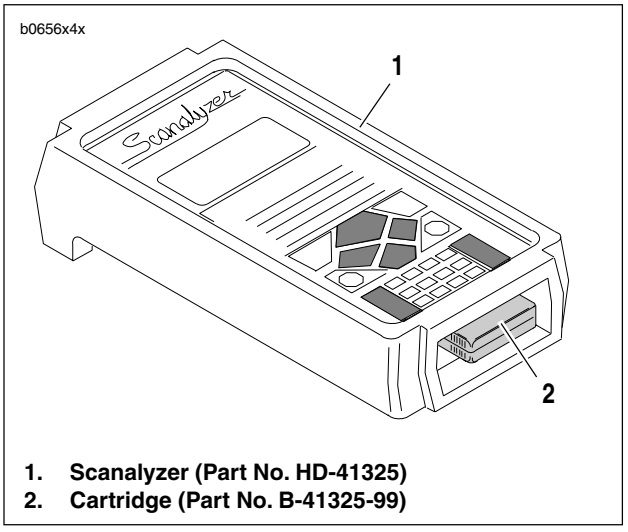


Figure 4-6. Data Link Connector [91A]



1. **Scanalyzer (Part No. HD-41325)**
2. **Cartridge (Part No. B-41325-99)**

Figure 4-7. Scanalyzer and Cartridge

Main Menu

DIAGNOSTIC MENU
1- System ID
2- Trouble Codes
3- Data Monitor
4- Active Diagnostic
5- Special Tests
6- Tool Setup
7- Calibrations

1 2 3 4 5 6 7

Secondary Menus

CALIBRATION MENU
1- TPS Zero Function
2- AFV Reset
MODE

TOOL SETUP MENU
1- General Setup
2- Save Setup
3- Restore Setup
MODE

SPECIAL TEST MENU
1- Wiggle Test
2- Data Capture
3- File Manager
MODE

ACTIVE TEST MENU
1- Fuel Pump
2- Front Injector
3- Rear Injector
4- Front Coil
5- Rear Coil
6- Tachometer
MODE

DATA MONITOR MENU

RPM = 0
ADVANCE F= 0.0 DEG
ADVANCE R= 0.0 DEG
ET = 14° F
ET = 4.98 V
IAT = 76° F
IAT = 3.75 V
O2 = 0.00 V
A/F RATIO= OPEN LOOP
AFV = 100.0%
TP = 6.0 DEG
TP = 7%
TP = 1.17 V
B+ = 11.60 V
BAS MODE= RUN MODE
BAS = 0.65 V
CHECK ENG= LAMP OFF
MODE

TROUBLE CODE MENU
1- Display Current
2- Display Historic
3- Clear Historic
MODE

SYSTEM ID
P/N 31652-99Y
CAL
BUEGC0B0
MODE

NOTE

The system ID part number varies depending upon market.

Figure 4-8. Scanalyzer Menus

USAGE

See Figure 4-8. The diagnostic menu is the primary system menu (main menu) through which all other secondary menus and displays are accessed. Since the screen may not be large enough to display all line items at any given time, use the up and down arrow keys to scroll through the list.

Checking Codes

1. See Figure 4-9. From the diagnostic menu, press number “2” to access the trouble codes menu. At this point, the unit allows the operator to:
   a. Press number “1” to display current trouble codes.
   b. Press number “2” to display historic trouble codes.
   c. Press number “3” to clear trouble codes. See Clearing Codes below.
2. When examining trouble codes, write down all codes on a piece of paper. If a current trouble code exists, place it at the top of the list.
   a. If trouble codes are present, see Table 4-5. Follow the applicable flow charts for each code.
   b. If trouble codes are NOT present, but starting or driveability problems are evident, see symptoms charts under 4.9 INITIAL DIAGNOSTIC CHECK.
   c. After reading current/historic trouble codes, simply press the mode key to return to the trouble codes menu.
3. Press the mode key again to return to the diagnostic menu. In this manner, regardless of where the operator is in the program, the mode key need only be pressed once or twice to return to the main menu.
4. After correcting system problems, clear trouble codes using the trouble codes menu of the scanalyzer.

Clearing Codes

Unlike the check engine lamp diagnostics, note that the Scanalyzer **does** allow the operator to clear trouble codes from memory as well as differentiate between current and historic codes.

Trouble codes cannot be cleared while the engine is running. Turn the engine off by setting handlebar stop switch to the OFF position, but leaving the ignition/light key switch ON. Return the handlebar engine stop switch to the RUN position and restart motorcycle.

NOTE

For more detailed instructions, refer to the literature provided with the Scanalyzer.

Figure 4-9. Scanalyzer Diagnostic Menu

REMOVAL

1. Turn ignition/light key switch OFF. Set engine stop switch to the OFF position.
2. Unplug Scanalyzer from data link connector. Install protective plug connector.

⚠WARNING

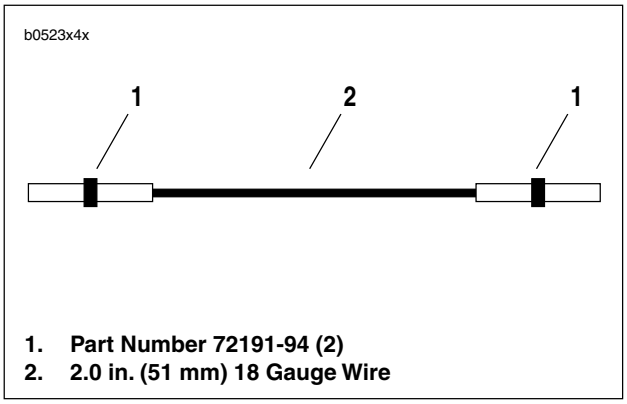
Always attach the data link connector to its mounting location on the frame. If data link connector is not secured to the frame it can get between fork and frame, limiting steering travel which may cause loss of control which could result in death or serious injury.

3. Attach data link connector to trunk.
4. Install seat. See 2.40 SEAT.
5. Road test vehicle and observe check engine lamp. Confirm proper operation without the reoccurrence of trouble codes. See 4.4 CHECKING FOR TROUBLE CODES.

RETRIEVING TROUBLE CODES

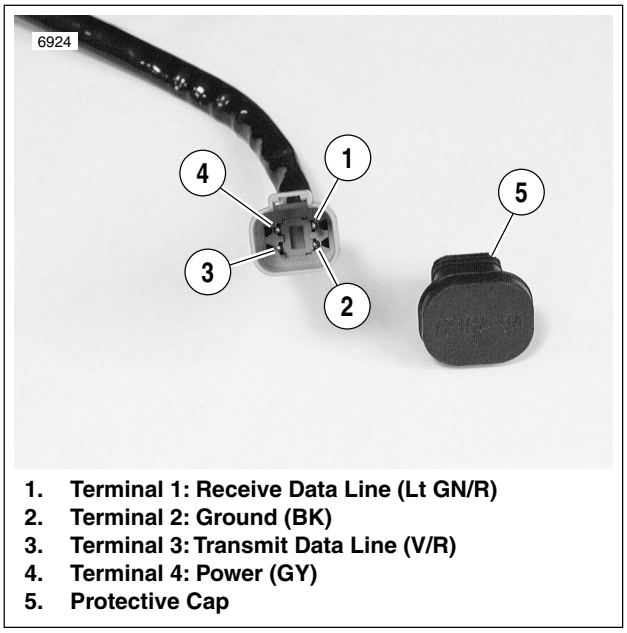
Trouble codes may be retrieved without the use of the SCANALYZER (Part No. HD-41325).

1. Remove seat. See 2.40 SEAT.
2. Detach data link connector [91A] from trunk. Remove protective cover.
3. To activate the diagnostic feature of the check engine lamp, proceed as follows:
   a. See Figure 4-10. Create diagnostic test wire from parts shown.
   b. See Figure 4-11. Install diagnostic test wire across Terminal 1 and Terminal 2 on the data link connector [91A].
   c. Turn the ignition/light key switch ON and wait approximately eight seconds for the check engine lamp to start flashing.
4. See Figure 4-12. All trouble codes are sent out as a series of flashes. To retrieve the first digit of the trouble code simply observe the number of times the lamp flashes.
   a. The transmission of a trouble code is always preceded by six rapid flashes (about 3 per second).
   b. This “intermission” is followed by a 2 second pause in which the lamp is off.
   c. The lamp will then flash one or more times to indicate the first digit of the trouble code. The length of time the lamp is illuminated and the length of time in which it is off are each about 1 second in duration.
5. The second digit follows:
   a. Following transmission of the first digit, there is another 2 second pause in which the lamp is off.
   b. The lamp will then flash one or more times to indicate the second digit of the trouble code. Count the number of times the lamp flashes to retrieve the second digit.
6. If more than one trouble code is sent:
   a. Following transmission of the second digit of the first code, there is a third 2 second pause in which the lamp is off.
   b. After the pause comes the intermission, which is followed by transmission of the next recorded trouble code.
   c. All subsequent codes are sent in the same manner, each separated from the next by the intermission.
7. Once all codes have been sent, the data string is repeated. When you have recorded the same trouble code twice, it is an indication that the transmission has been restarted and that all trouble codes have been retrieved.



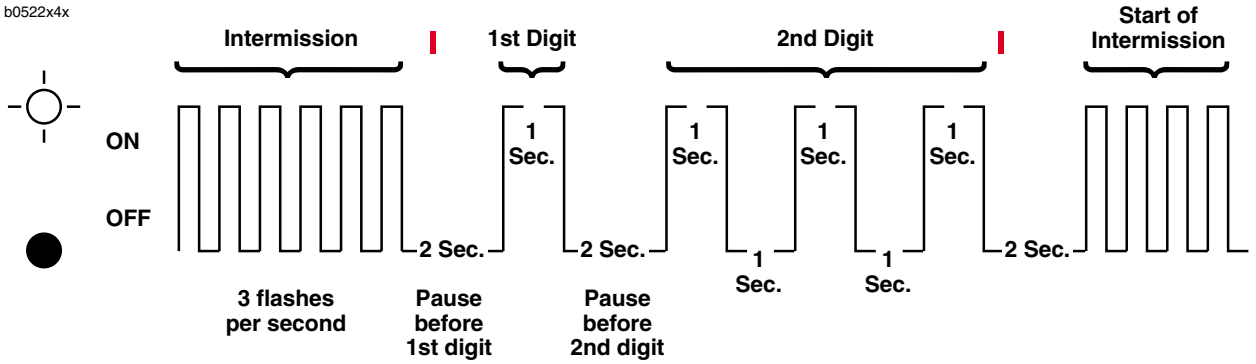
1. **Part Number 72191-94 (2)**
2. **2.0 in. (51 mm) 18 Gauge Wire**

Figure 4-10. Diagnostic Test Wire



1. **Terminal 1: Receive Data Line (Lt GN/R)**
2. **Terminal 2: Ground (BK)**
3. **Terminal 3: Transmit Data Line (V/R)**
4. **Terminal 4: Power (GY)**
5. **Protective Cap**

Figure 4-11. Installing Diagnostic Test Wire



NOTE

Looking at the above transmission, we can see that the trouble code is 13. The source of the fault condition is identified as the oxygen sensor according to Table 4-5.

Figure 4-12. Check Engine Lamp Diagnostics

NOTE

If the lamp flashes at a rate faster than normal, then you are observing the "Intermission" only, which means that no trouble codes are present.

8. When examining trouble codes, write down all codes on a piece of paper. If a current trouble code exists, place it at the top of the list.
   a. If trouble codes are present, see Table 4-5. Follow the applicable flow charts for each code.
   b. If trouble codes are NOT present, but starting or driveability problems are evident, see symptoms charts under 4.9 INITIAL DIAGNOSTIC CHECK.
9. Turn the ignition/light key switch OFF.
10. Install protective cover over data link connector. Attach connector to trunk.
11. Install seat. See 2.40 SEAT.

IMPORTANT NOTE

The engine may be started and run when the trouble codes are received using a jumper wire on Pins 1 and 2 of the data link connector. However, if the jumper wire is removed with the engine running, the check engine lamp will continue to flash trouble codes. To stop check engine lamp from flashing codes, turn engine stop switch OFF.

CLEARING CODES

After correcting system problems, clear trouble codes. If the Scanalyzer is not available, perform 50 start and run cycles. To execute one run cycle:

1. Start the vehicle.
2. Let it run for at least 30 seconds.
3. Turn the engine off.

GENERAL

The BREAKOUT BOX (Part No. HD-42682) splices into the main harness. Used in conjunction with a DVOM, it allows circuit diagnosis of wiring harness and connections without having to probe with sharp objects.

INSTALLATION

1. See Figure 4-13. Detach seat. Remove two screws and washers (3) to free ECM from ECM mounting bracket.
2. Depress latches on each side of connectors [10] (black) and [11] (gray).
3. See Figure 4-14. Attach Breakout Box (1) to black connector [10].
   a. Attach black connector from Breakout Box to corresponding black ECM connector.
   b. Attach black connector from the wiring harness to black connector on Breakout Box.
4. Attach Breakout Box to gray connector [11].
   a. Attach gray connector from Breakout Box to corresponding gray ECM connector.
   b. Attach gray connector from the wiring harness to gray connector on Breakout Box.

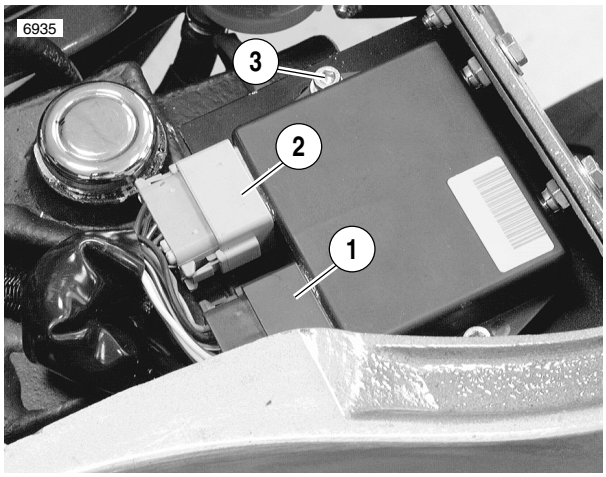
REMOVAL

1. See Figure 4-14. Depress latches on each side of connectors [10] (black) and [11] (gray).
2. Detach Breakout Box connectors from ECM connectors.
3. Detach Breakout Box connectors from wiring harness.
4. Reattach ECM connectors to wiring harness.

⚠WARNING

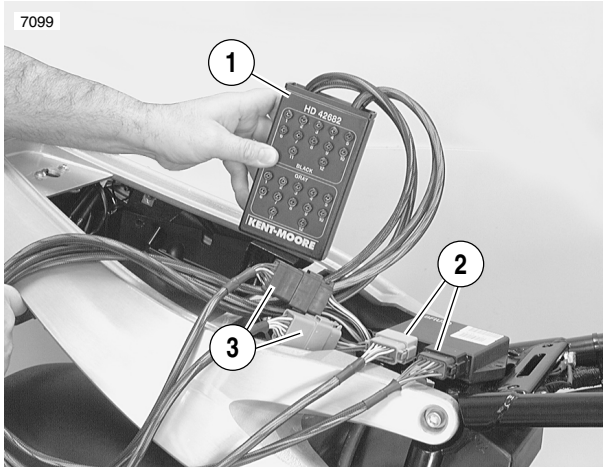
After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

5. Attach ECM to bracket with two screws. Reinstall seat.



1. **ECM Connector [10] (Black)**
2. **ECM Connector [11] (Gray)**
3. **Screw and Washer (2)**

Figure 4-13. ECM Connectors



1. **Breakout Box**
2. **ECM Connection**
3. **Wiring Harness Connection**

Figure 4-14. Installed Breakout Box

GENERAL

The wiggle test checks for the presence of intermittents in a wiring harness. Depending upon the availability of diagnostic tools, either version of this test may be used.

PROCEDURE

Using Scanalyzer (Part No. HD-41325)

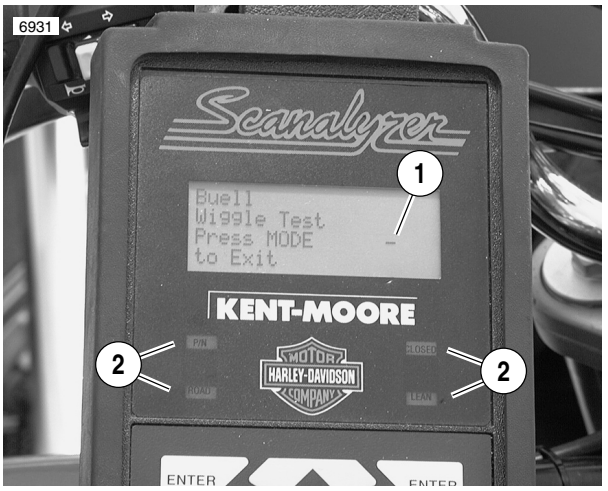
1. Connect Scanalyzer to vehicle. See 4.5 SCANALYZER.
2. Start motorcycle engine and run at idle.
3. Enter wiggle test mode.
   a. Press “5” from the DIAGNOSTIC MENU to enter the SPECIAL TESTS menu.
   b. Press “1” from the SPECIAL TESTS menu to enter the WIGGLE TEST.
4. Shake or wiggle harness to detect intermittents. If intermittents are present the Scanalyzer will beep, light the four corner LEDs and display a minus sign when a current trouble code is detected. See Figure 4-15.

NOTE

If a current trouble code is present when the wiggle test is entered, the Scanalyzer will respond as described immediately upon entering the wiggle test mode. With key ON and engine off, clear trouble codes and then perform wiggle test with vehicle running.

Using DVOM (Part No. HD-39978)

1. See Figure 4-16. Connect DVOM to wiring harness between the suspect connections. When diagnosing ECM connections, a BREAKOUT BOX (Part No. HD-42682) may be used to simplify the procedure. See 4.7 BREAKOUT BOX.
2. Set DVOM to read voltage changes.
3. Start motorcycle engine and run at idle.
4. Shake or wiggle harness to detect intermittents. If intermittents are present, radical voltage changes will register on the DVOM.



1. **Minus Sign**
2. **Corner LED (4)**

Figure 4-15. Wiggle Test Indicators

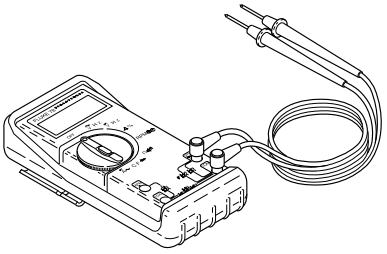


Figure 4-16. Fluke 78 Multimeter (DVOM) (Part No. HD-39978)

GENERAL

To locate faulty circuits or other system problems, follow the diagnostic flow charts in this section. For a systematic approach, always begin with INITIAL DIAGNOSTICS. Read the general information and then work your way through the flow chart box by box.

Diagnostic Notes

If a numbered circle appears adjacent to a flow chart box, then more information is offered in the diagnostic notes. Many diagnostic notes contain supplemental information, descriptions of various diagnostic tools or references to other parts of the manual where information on the location and removal of components may be obtained.

Scanalyzer Icon

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer may be used. If a number is printed next to the icon, then refer to the Scanalyzer notes, which are similar to the diagnostic notes, but are restricted to information on the use of the Scanalyzer. All Scanalyzer notes may be found at the end of the respective flow chart.

Circuit Diagram/Wire Harness Connector Table

When working through a flow chart, refer to the illustrations, the associated circuit diagram and the wire harness connector table as necessary. The wire harness connector table for each circuit diagram identifies the connector number, description, type and general location.

In order to perform most diagnostic routines, a Breakout Box and a DVOM are required. See 4.7 BREAKOUT BOX.

To perform the circuit checks with any degree of efficiency, a familiarity with the various wire connectors is also necessary.

Job/Time Code Values

Dealership technicians filing warranty claims should use the job/time code values printed in **bold text** underneath the appropriate repair.

INITIAL DIAGNOSTICS

General Information

The diagnostic check is an organized approach to identifying a problem caused by an electronic control system malfunction. If no problems are found after completion of the diagnostic check, a comparison of Scanalyzer parameters may be used to help locate intermittents and out-of-specification sensors. See Table 4-1.

Diagnostic Tips

- If the Scanalyzer is not working properly, check operation on another vehicle.
- If proper Scanalyzer function is verified, check data link connector [91A] for 12 volts (Terminal 4) and proper ground (Terminal 2). See Figure 4-17.
- See Figure 4-11. If Scanalyzer reads “No Response” with the ignition key switch turned ON (engine stop switch at RUN with the engine off), check serial receive data wire for an open or short to ground between data link Terminal 1 (Lt GN/R wire) and ECM.
- Check for an open diagnostic test terminal between data link Terminal 3 (V/R wire) and ECM. With ignition key switch turned ON, transmit data line (V/R wire) should have between 11-12 volts and receive data line (Lt GN/R wire) between 5-6 volts.

IMPORTANT NOTE

The engine may be started and run when the trouble codes are received using a jumper wire on Pins 1 and 2 of the data link connector. However, if the jumper wire is removed with the engine running, the check engine lamp will continue to flash trouble codes. To stop check engine lamp from flashing codes, turn engine stop switch OFF.

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the diagnostic check flow charts. See page 4-19.

1. Compare engine behavior to symptoms tables.
   a. Starts hard. See Table 4-2.
   b. Hesitates, stumbles, surges, misfires and/or sluggish performance. See Table 4-3.
   c. Engine exhaust emits black smoke or fouls plugs. See Table 4-4.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), black socket probes and patch cord.
3. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.7 BREAKOUT BOX.

All diagnostic codes are listed on page 4-17 in Table 4-5.

Table 4-1. Typical Scan Values

ITEM	MIN. VALUE	MAX. VALUE	HOT IDLE
RPM	500	6900	1000*
ET (temperature, °F)	3	558	varies
ET (voltage)	0.05	4.95	varies
IAT (temperature)	varies	varies	varies
IAT (voltage)	0.05	4.95	varies
TP (degrees)	0	85	6-6.5*
TP (voltage)	0.5	4.8	0.5-1.5*
INJ PW	varies	varies	varies
Advance (degrees)	0	45	3-30° (varies)
Battery (voltage)	8	16	13.5
Eng run	STOP	RUN	RUN
O2 (voltage)	0	1	0.4-0.6

*Depends on position of idle set screw

Table 4-2. Engine Starts Hard

SYMPTOM	SOLUTION
Engine temperature circuit	4.19 TROUBLE CODE 14.
Improper fuel pressure	4.14 FUEL PRESSURE TEST.
Spark plugs and/or wires	4.16 MISFIRE.
Battery discharged	See charging system trouble-shooting in Section 7.
CMP sensor	4.28 TROUBLE CODE 56.
Manifold leak	Spray water around induction module seals with engine idling. If RPM changes, change seals.
Ignition coil	4.16 MISFIRE.
Leaky injectors	Test fuel injectors. See 4.41 THROTTLE BODY AND INTAKE MANIFOLD.
Valve sticking	See Section 3

Table 4-3. Engine Performance Problems

SYMPTOM	SOLUTION
Engine temperature circuit	4.19 TROUBLE CODE 14.
CMP circuit	4.28 TROUBLE CODE 56.
Spark plugs and/or wires	4.16 MISFIRE.
Improper fuel pressure	4.14 FUEL PRESSURE TEST.
Improper TP sensor adjustment	Calibrate sensor. See 4.36 THROTTLE POSITION SENSOR.
Manifold leak	Spray water around induction module seals with engine idling. If RPM changes, change seals.
Throttle plates not opening fully	See Section 1.
EVAP hose disconnected from induction module (CA)	Connect.
Water or dirt in fuel system	Drain and refill with fresh fuel.

Table 4-4. Engine Exhaust Emits Black Smoke or Fouls Plugs

SYMPTOM	SOLUTION
Engine temperature circuit	4.19 TROUBLE CODE 14.
Clogged air filter	See Section 1.
Improper TP sensor adjustment	Calibrate sensor. See 4.36 THROTTLE POSITION SENSOR.
Leaky injectors	Test fuel injectors. See 4.41 THROTTLE BODY AND INTAKE MANIFOLD.
Improper fuel pressure	4.14 FUEL PRESSURE TEST.

Table 4-5. Trouble Codes and Fault Conditions

CODE NO.	FAULT CONDITION	RELEVANT TOPIC
11	Throttle position sensor	4.17 TROUBLE CODE 11
13	Oxygen sensor	4.18 TROUBLE CODE 13
14	Engine temperature sensor	4.19 TROUBLE CODE 14
15	Intake air temperature sensor	4.20 TROUBLE CODE 15
16	Battery voltage	4.21 TROUBLE CODE 16
23	Front fuel injector	4.22 TROUBLE CODES 23 AND 32
24	Front ignition coil	4.23 TROUBLE CODES 24 AND 25
25	Rear ignition coil	4.23 TROUBLE CODES 24 AND 25
32	Rear fuel injector	4.22 TROUBLE CODES 23 AND 32
33	Fuel pump	4.24 TROUBLE CODE 33
35	Tachometer	4.25 TROUBLE CODE 35
44	Bank angle sensor	4.26 TROUBLE CODE 44
52, 53, 54, 55	ECM failure	4.27 TROUBLE CODES 52, 53, 54 AND 55
56	Cam sync failure	4.28 TROUBLE CODE 56

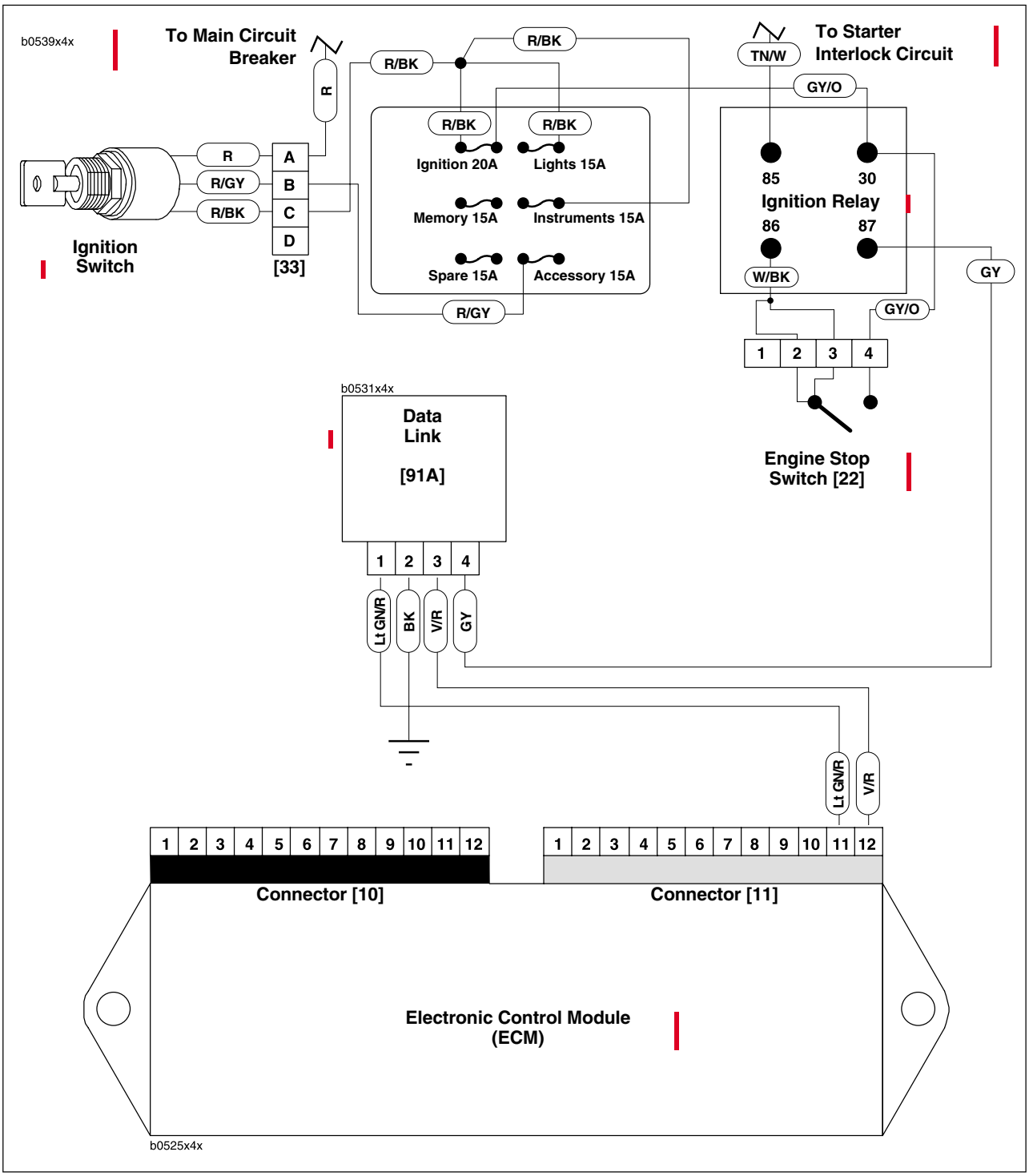
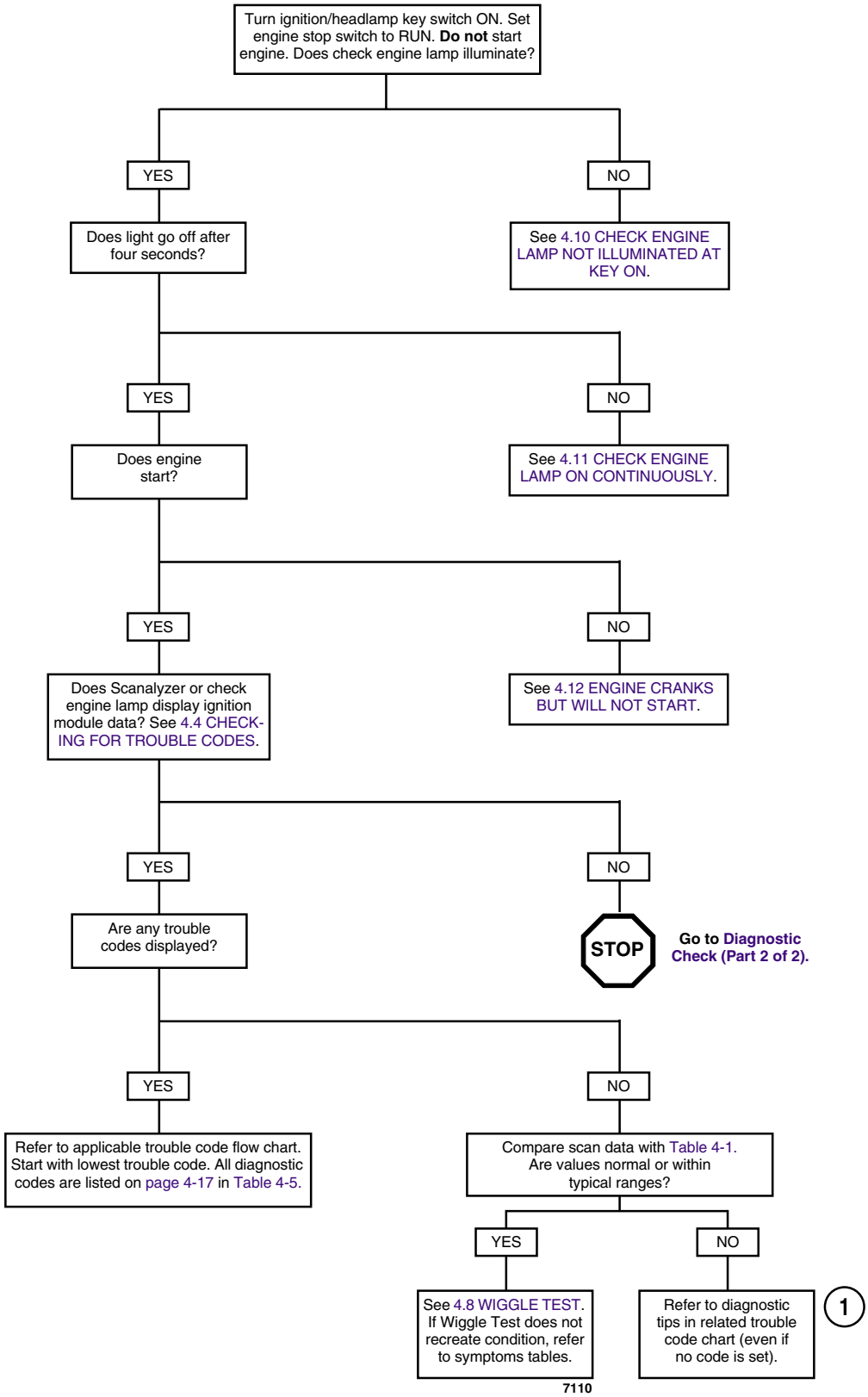


Figure 4-17. Diagnostic Check

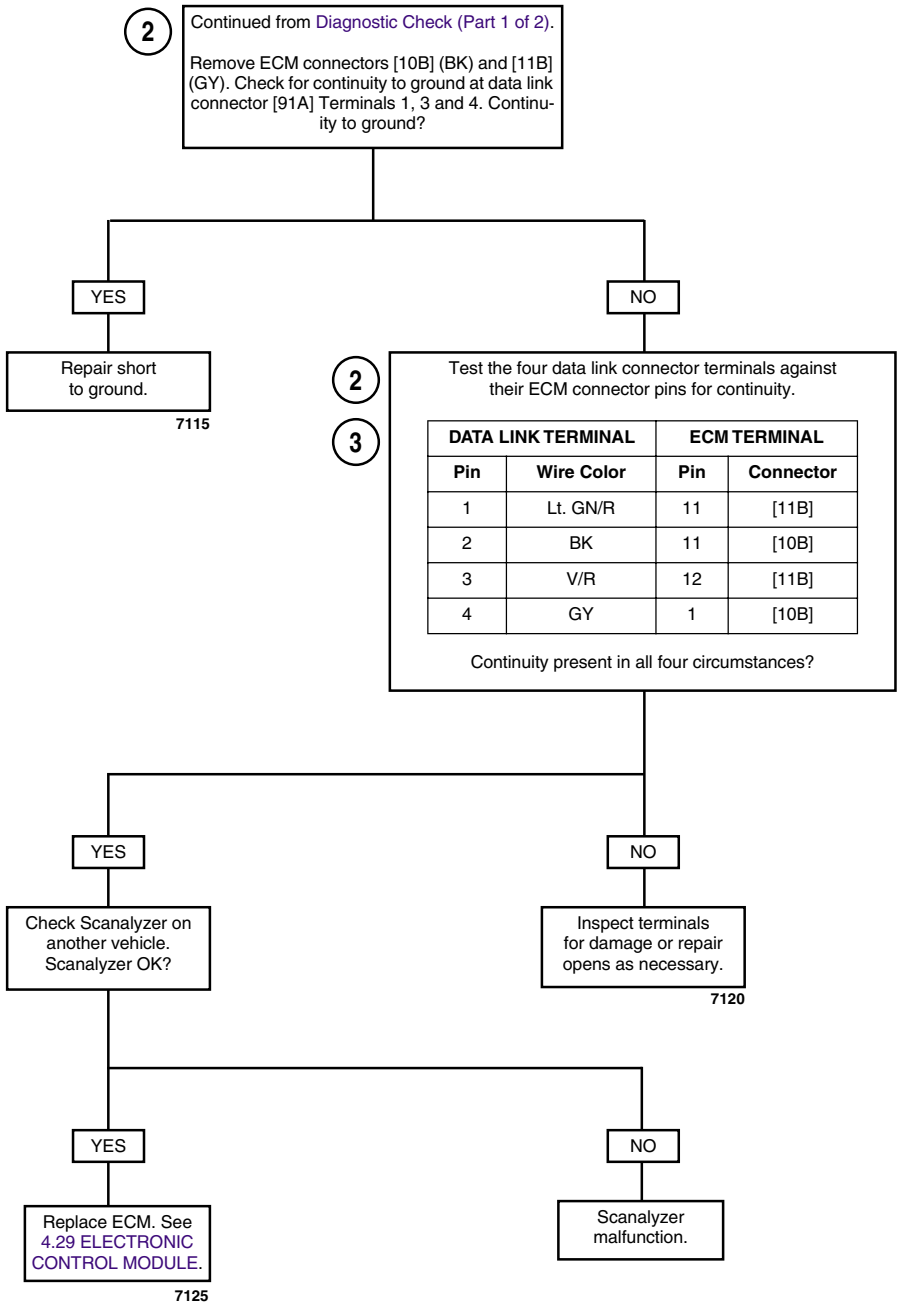
Table 4-6. Wire Harness Connectors in Figure 4-17.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[11]	ECM (gray)	12-place Deutsch	under seat
[91A]	Data link	4-place Deutsch	behind right side of steering head

Diagnostic Check (Part 1 of 2)



Diagnostic Check (Part 2 of 2)



CHECK ENGINE LAMP NOT ILLUMINATED AT KEY ON 4.10

GENERAL

If the engine stop switch is set to RUN with the engine off, and the ignition key switch is turned ON, the check engine lamp should illuminate for four seconds. See Figure 4-18.

Battery voltage is supplied to the lamp bulb. The lamp bulb is grounded by the ECM through the BK/Y wire. A lack of power to the ECM will cause the check engine lamp to be inoperative and also create a no start situation.

DIAGNOSTICS

Diagnostic Tips

Check for the following conditions:

- Check for open in BK/Y wire.
- Check for blown instrument fuse.

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.9 flow chart.

1. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), black pin probe and patch cord.
2. See Figure 4-19. Inspect connector [10] (black) for contamination or corrosion. If connection is good, replace ECM. See 4.29 ELECTRONIC CONTROL MODULE.
3. Check continuity between instrument connector [39] Pin 8 and ECM connector [10] (black), Pin 4.
   a. Gain access to tachometer cover by removing windscreen.
   b. Remove tachometer cover and pull check engine lamp from back of tachometer. See Figure 4-20. Remove check engine bulb from bulb socket.
   c. If continuity is present, check for short to battery on the BK/Y wire between connectors [39] and [10].
   d. If no continuity, check for damaged/open wires in the check engine lamp circuit.

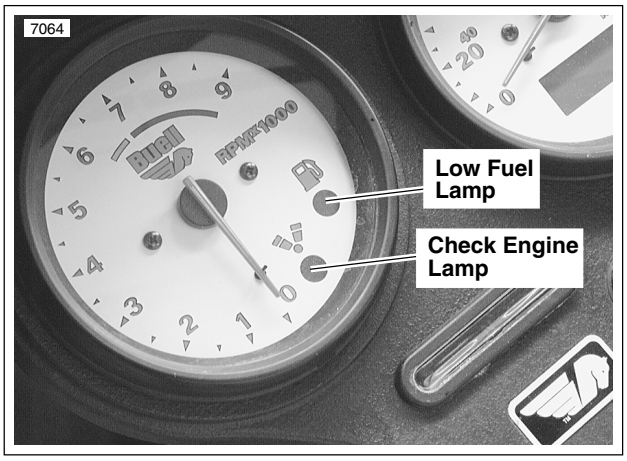


Figure 4-18. Check Engine Lamp

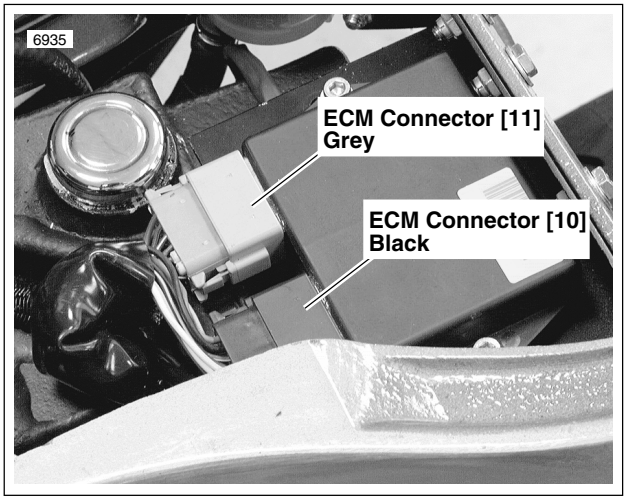


Figure 4-19. Electronic Control Module

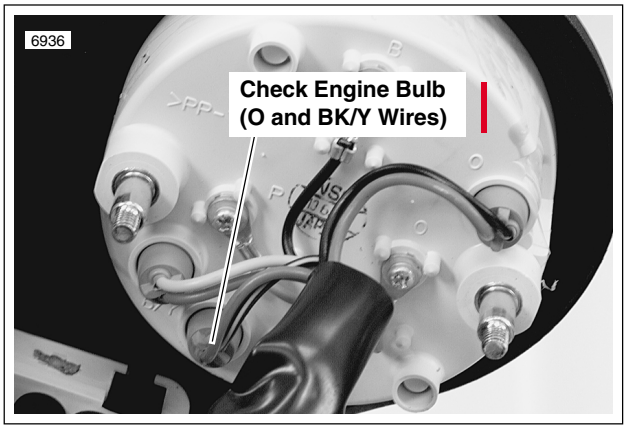


Figure 4-20. Check Engine Lamp Bulb

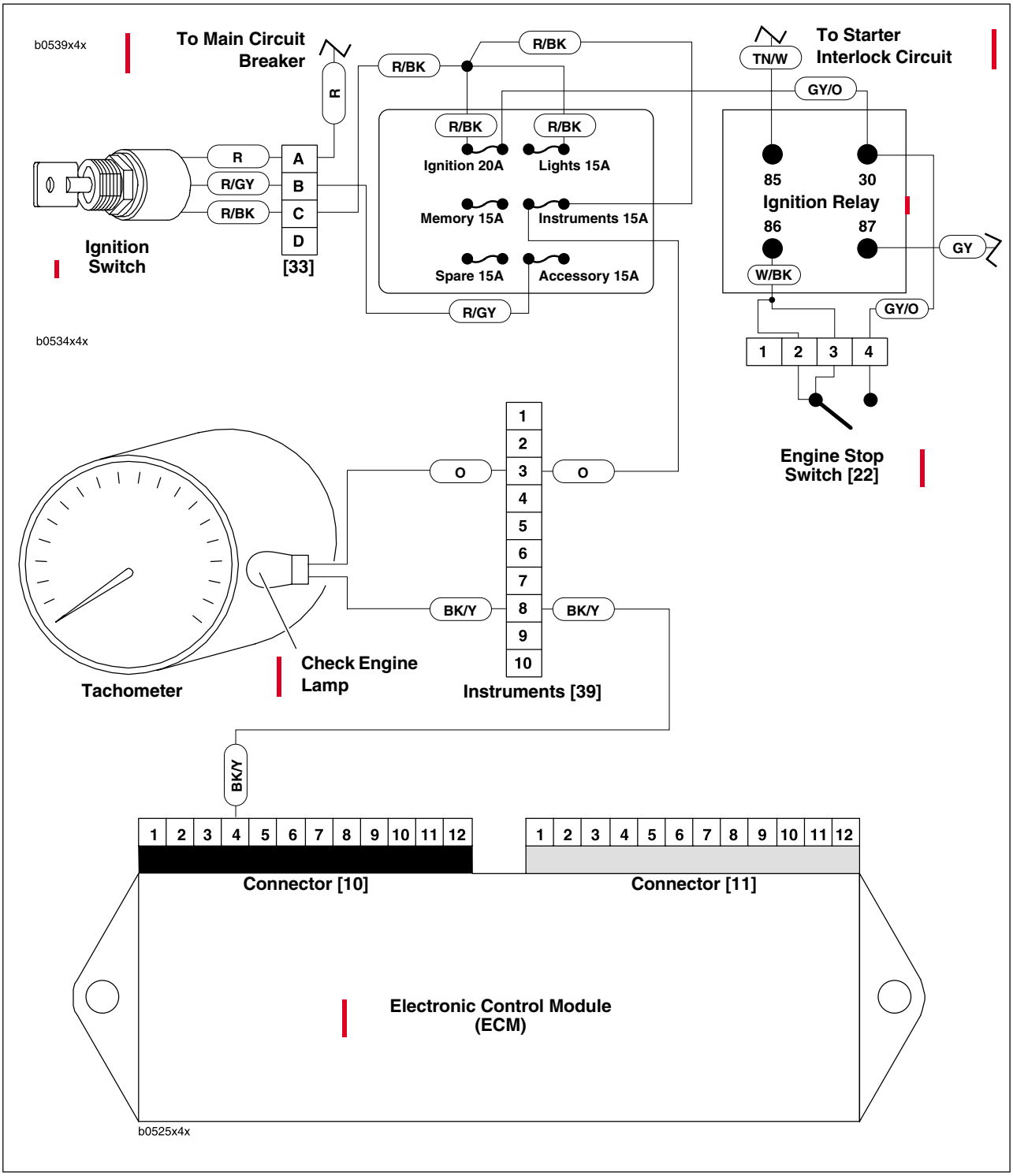
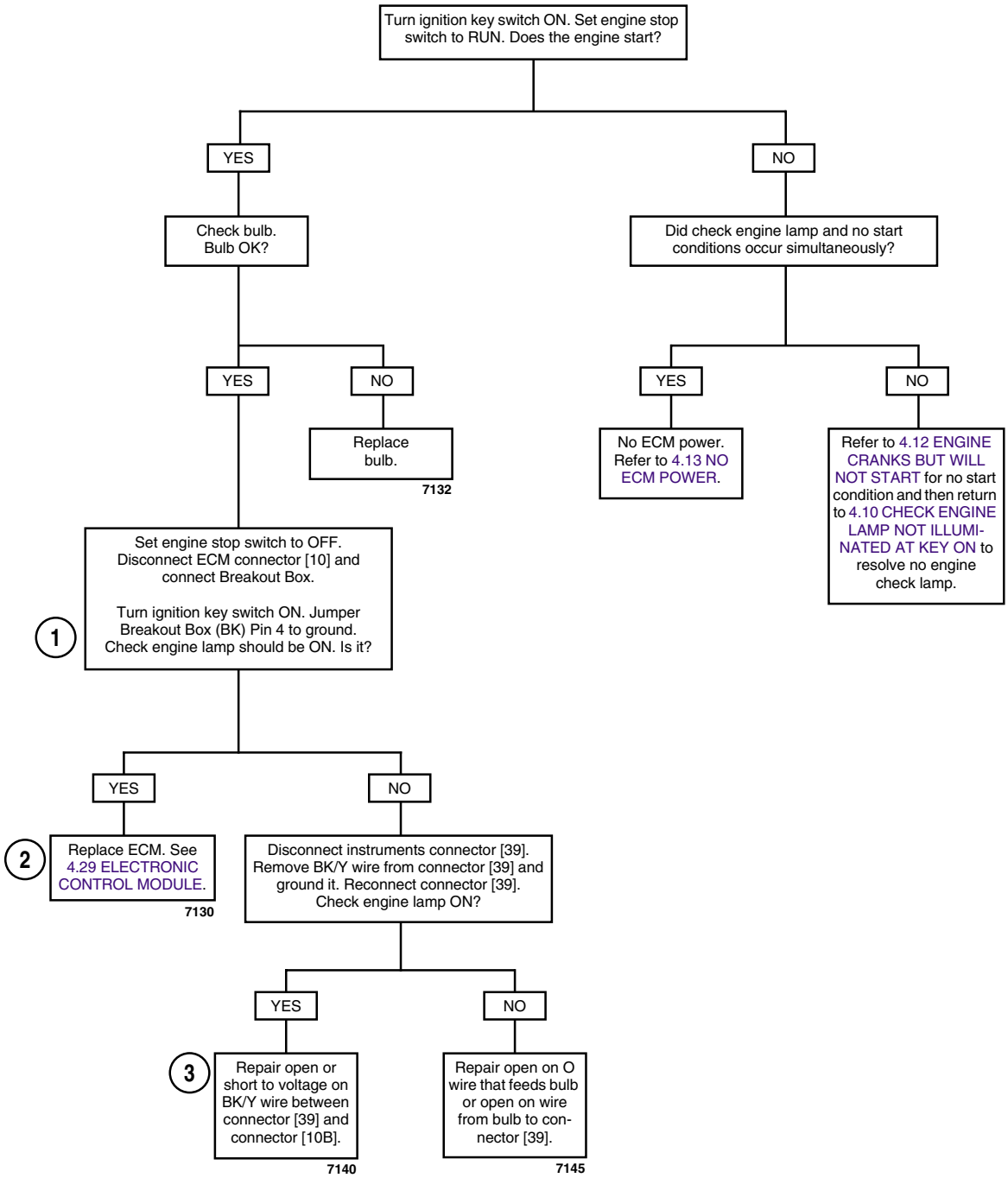


Figure 4-21. Check Engine Lamp Circuit

Table 4-7. Wire Harness Connectors in Figure 4-21.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Main harness to instruments	10-place Multilock	under fuel cell

Test 4.9


Turn ignition key switch ON. Set engine stop switch to RUN. Does the engine start?
YES
NO
Check bulb. Bulb OK?
Did check engine lamp and no start conditions occur simultaneously?
YES
NO
YES
NO
Replace bulb.
7132
No ECM power. Refer to 4.13 NO ECM POWER.
Refer to 4.12 ENGINE CRANKS BUT WILL NOT START for no start condition and then return to 4.10 CHECK ENGINE LAMP NOT ILLUMINATED AT KEY ON to resolve no engine check lamp.
Set engine stop switch to OFF. Disconnect ECM connector [10] and connect Breakout Box.
Turn ignition key switch ON. Jumper Breakout Box (BK) Pin 4 to ground. Check engine lamp should be ON. Is it?
1
YES
NO
2
Replace ECM. See 4.29 ELECTRONIC CONTROL MODULE.
7130
Disconnect instruments connector [39]. Remove BK/Y wire from connector [39] and ground it. Reconnect connector [39]. Check engine lamp ON?
YES
NO
3
Repair open or short to voltage on BK/Y wire between connector [39] and connector [10B].
7140
Repair open on O wire that feeds bulb or open on wire from bulb to connector [39].
7145

GENERAL

If the engine stop switch is set to RUN with the engine off, and the ignition key switch is turned ON, the check engine lamp should illuminate for four seconds. See Figure 4-22.

Following the initial period of illumination, the lamp should go off for four seconds. It may then come back on for an eight second period (for a stored error) or remain on continuously (current error).

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.10 flow chart.

1. See Figure 4-23. If the lamp goes off when the black ECM connector [10] is unplugged, the BK/Y wire is **not** shorted to ground.

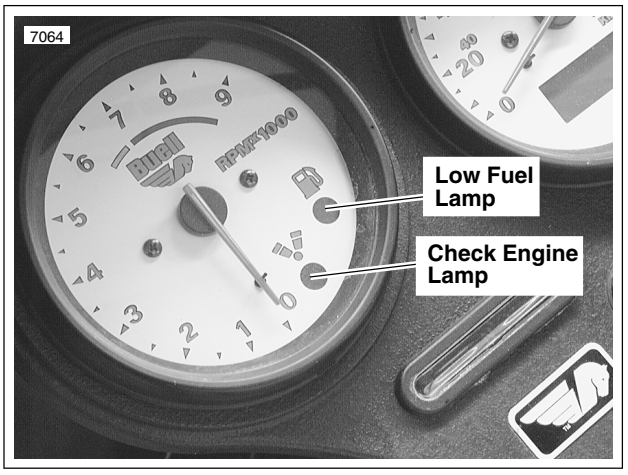


Figure 4-22. Check Engine Lamp

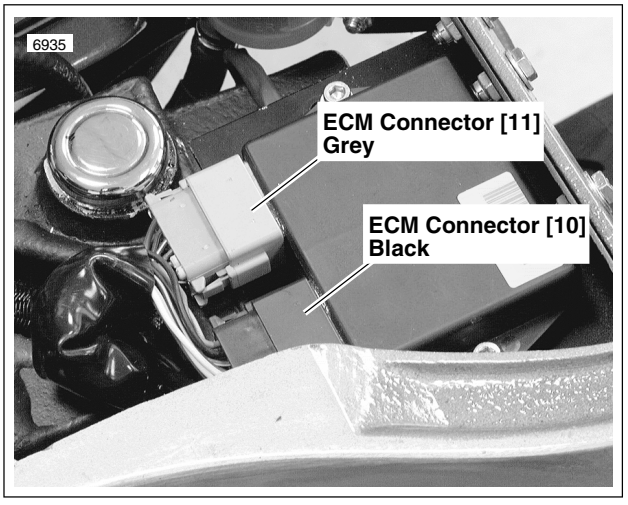


Figure 4-23. Electronic Control Module

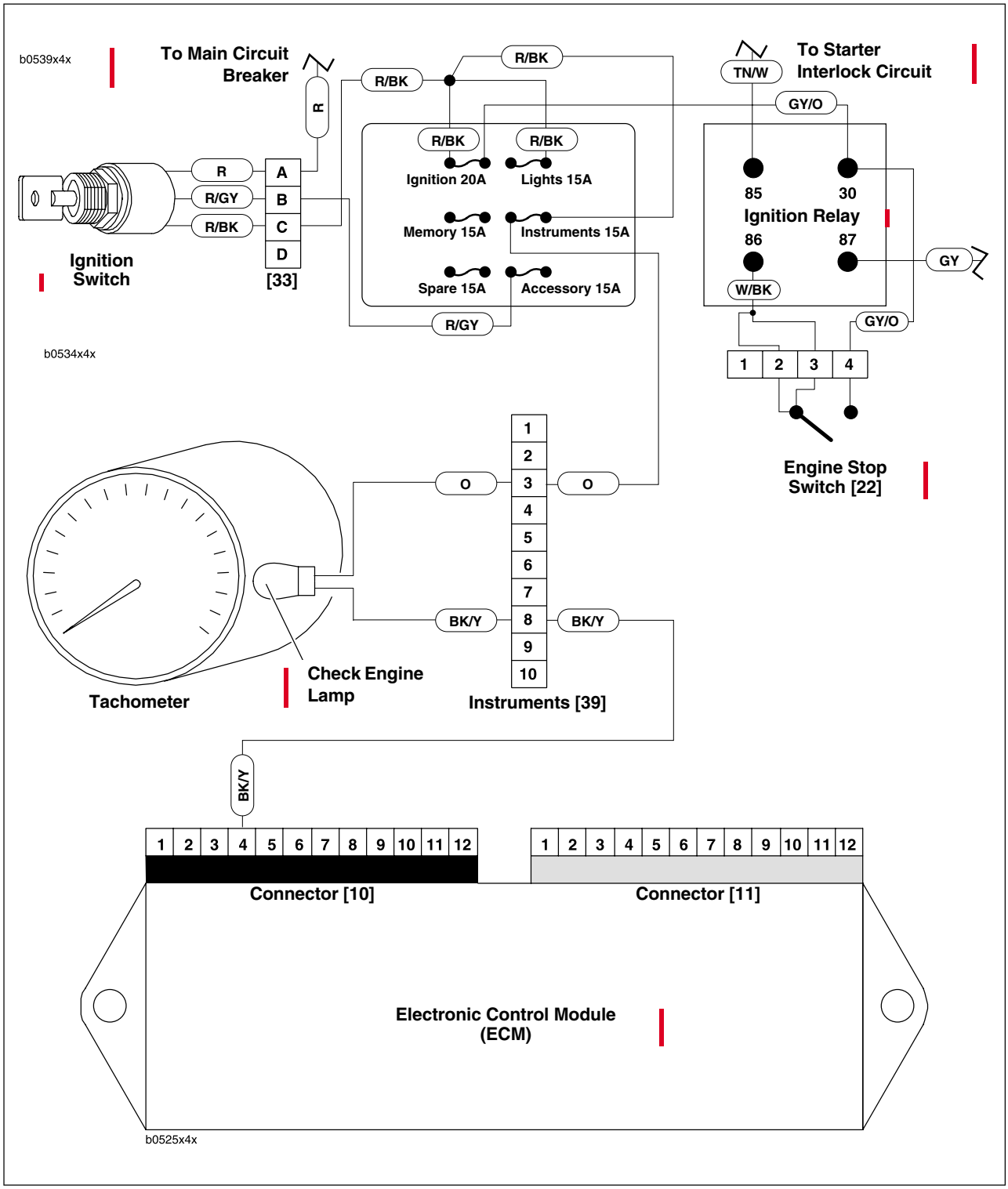
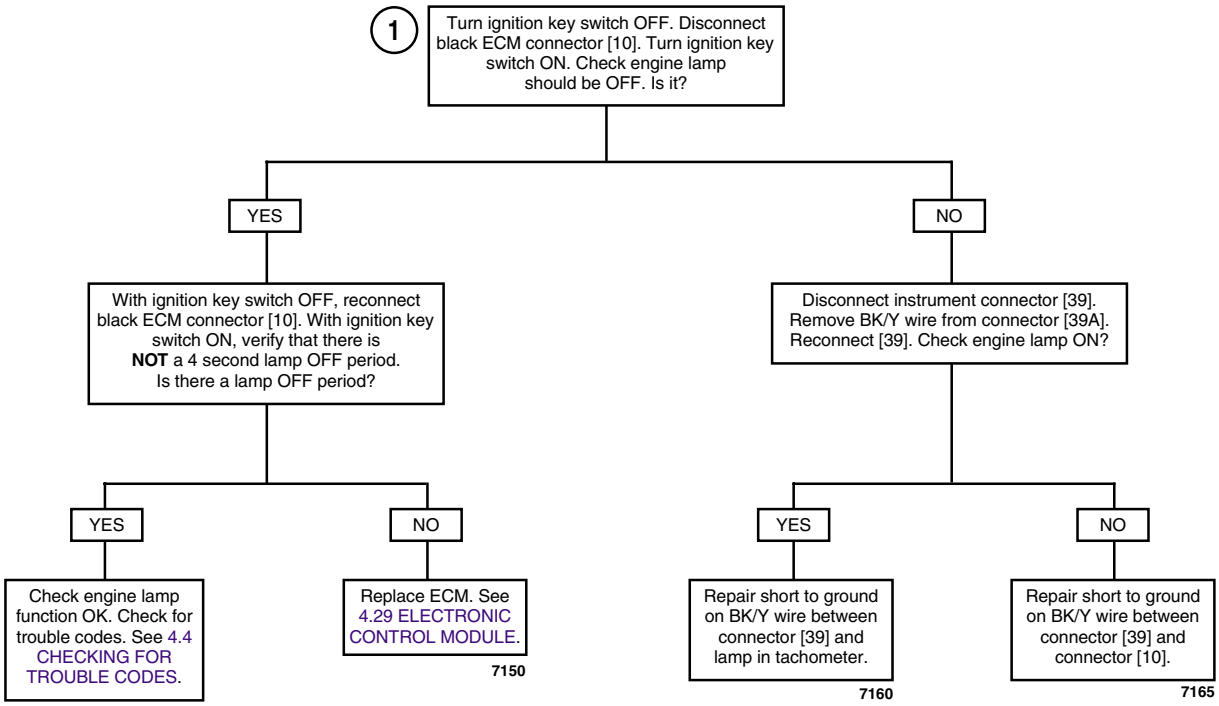


Figure 4-24. Check Engine Lamp Circuit

Table 4-8. Wire Harness Connectors in Figure 4-24.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Main harness to instruments	10-place Multilock	under fuel cell

Test 4.10


1
Turn ignition key switch OFF. Disconnect black ECM connector [10]. Turn ignition key switch ON. Check engine lamp should be OFF. Is it?
YES
NO
With ignition key switch OFF, reconnect black ECM connector [10]. With ignition key switch ON, verify that there is **NOT** a 4 second lamp OFF period. Is there a lamp OFF period?
Disconnect instrument connector [39]. Remove BK/Y wire from connector [39A]. Reconnect [39]. Check engine lamp ON?
YES
NO
YES
NO
Check engine lamp function OK. Check for trouble codes. See 4.4 CHECKING FOR TROUBLE CODES.
Replace ECM. See 4.29 ELECTRONIC CONTROL MODULE.
7150
Repair short to ground on BK/Y wire between connector [39] and lamp in tachometer.
7160
Repair short to ground on BK/Y wire between connector [39] and connector [10].
7165

GENERAL

If the starter will not crank engine, the problem is not ignition related. See Section 5-Electric Starter.

IMPORTANT NOTE

The engine may be started and run when the trouble codes are received using a jumper wire on Pins 1 and 2 of the data link connector. However, if the jumper wire is removed with the engine running, the check engine lamp will continue to flash trouble codes. To stop check engine lamp from flashing codes, turn engine stop switch OFF.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.12 flow charts.

1. Check battery condition. Perform a voltage test and recharge if below 12.80 volts. Check battery connections and perform load test. Replace the battery if necessary.
2. Remove spark plug cable from spark plug.
   a. Visually check condition of plug.
   b. See Figure 4-25. Attach cable to SPARK PLUG TESTER (Part No. HD-26792). Clip tester to cylinder head bolt.
   c. While cranking starter, look for spark. Repeat procedure on other spark plug cable.

⚠WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

3. Purge fuel line and remove fuel tank to access fuel injectors. See 4.37 FUEL TANK. Use test lamp as shown in Figure 4-26.
4. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404) gray pin probe and patch cord.

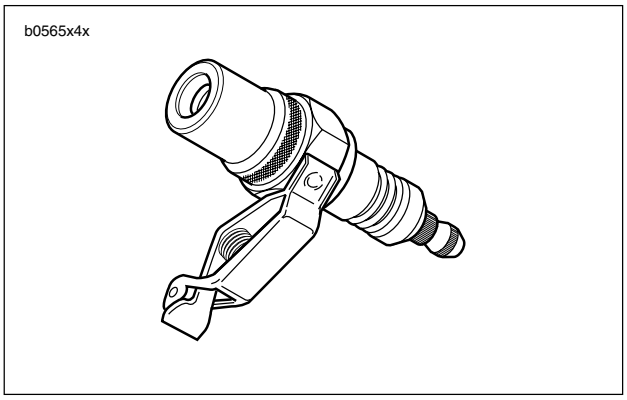


Figure 4-25. Spark Plug Tester (Part No. HD-26792)

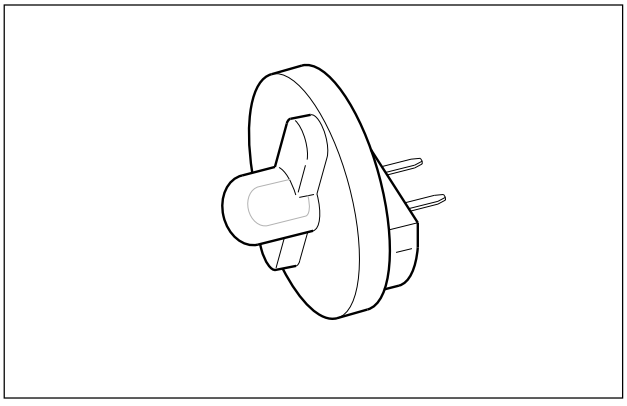


Figure 4-26. Test Lamp

5. Connect BREAKOUT BOX (Part No. HD-42682) between harness and ECM. See 4.7 BREAKOUT BOX.
6. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404) gray pin probe and patch cord.
7. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404) black pin probe and patch cord.

Table 4-9. Wire Harness Connectors in Figure 4-27.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[11]	ECM (gray)	12-place Deutsch	under seat
[14]	CMP sensor	3-place Deutsch	next to starter
[18]	Ignition coil	3-place Packard	under fuel cell, left side

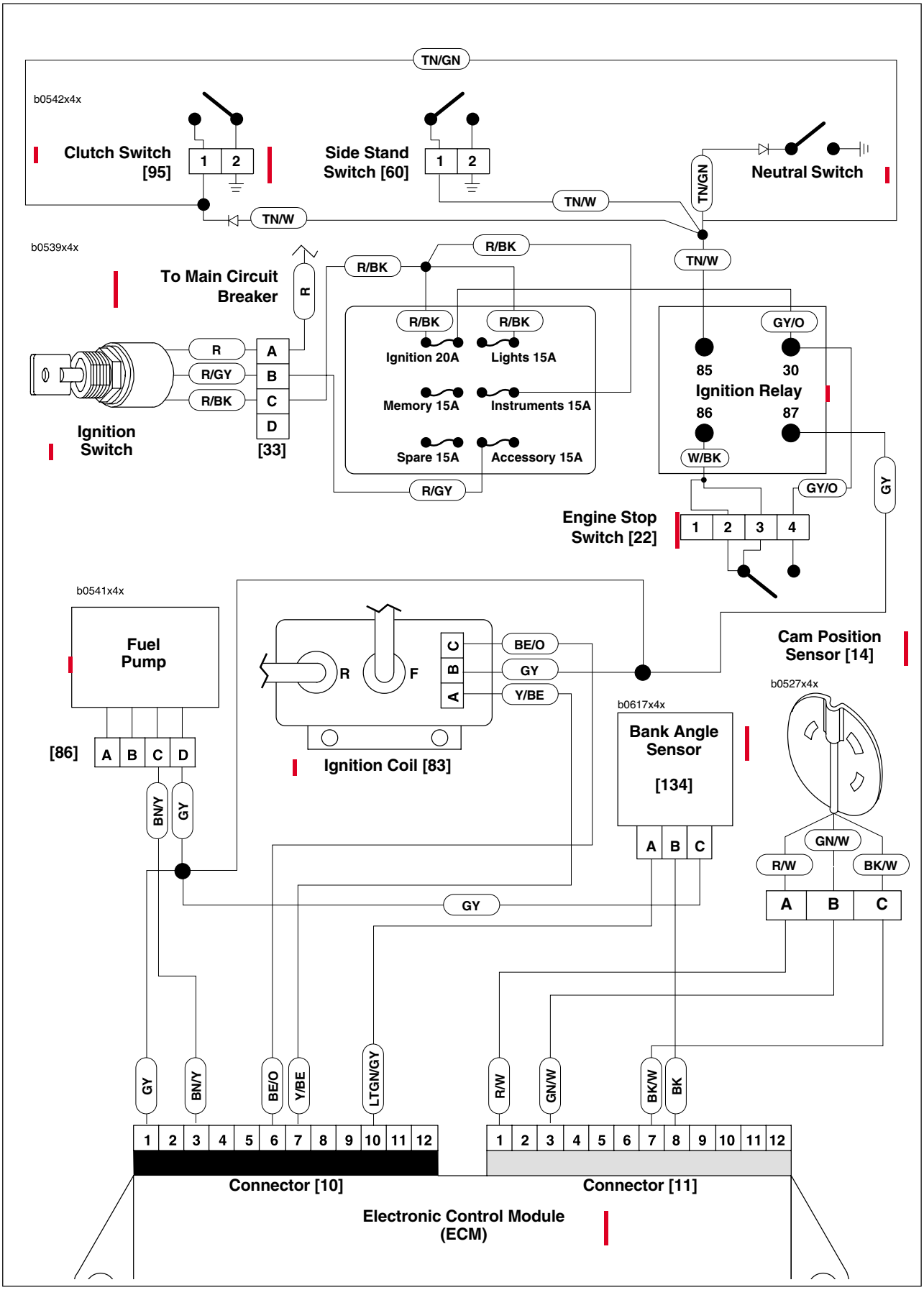
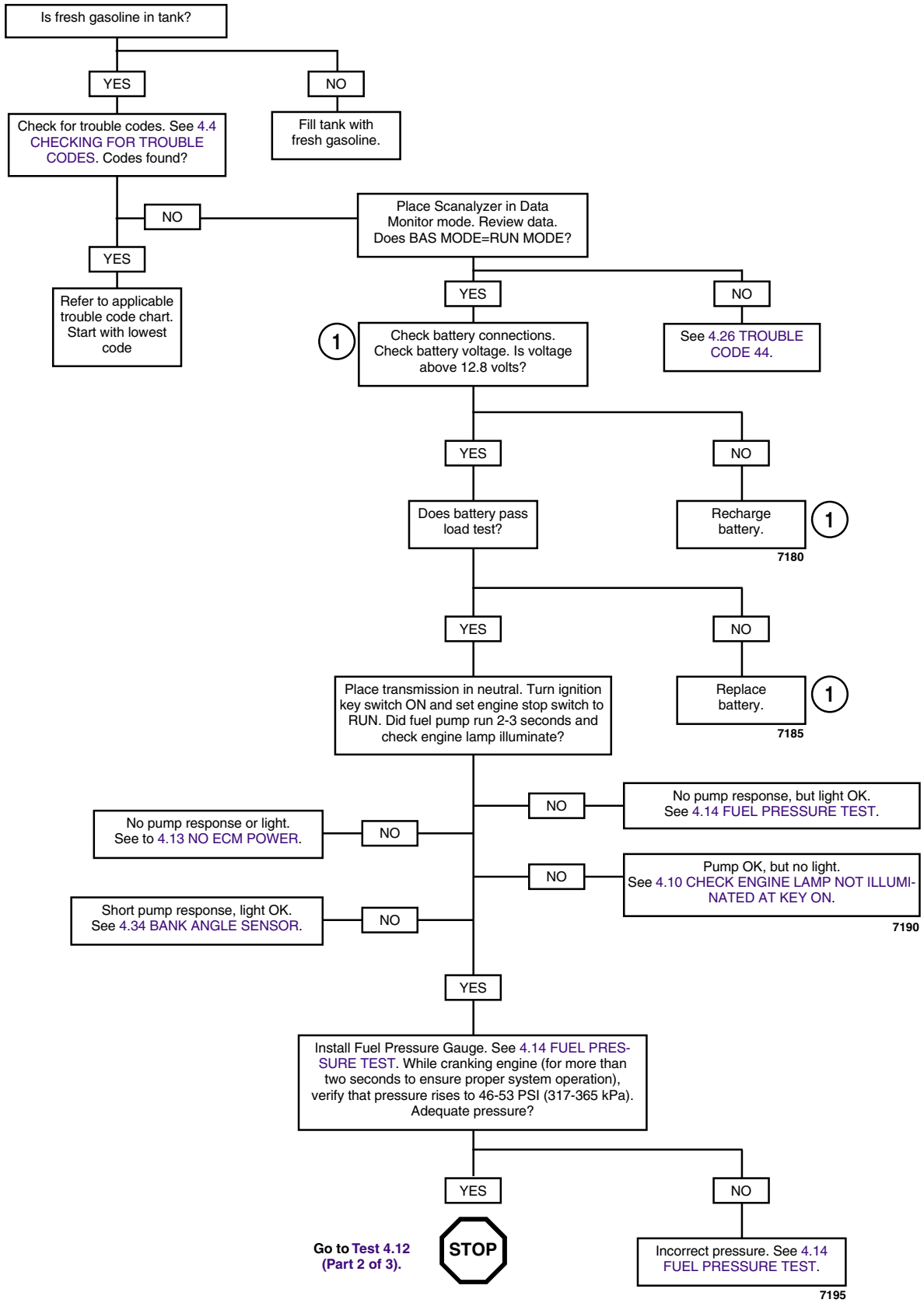
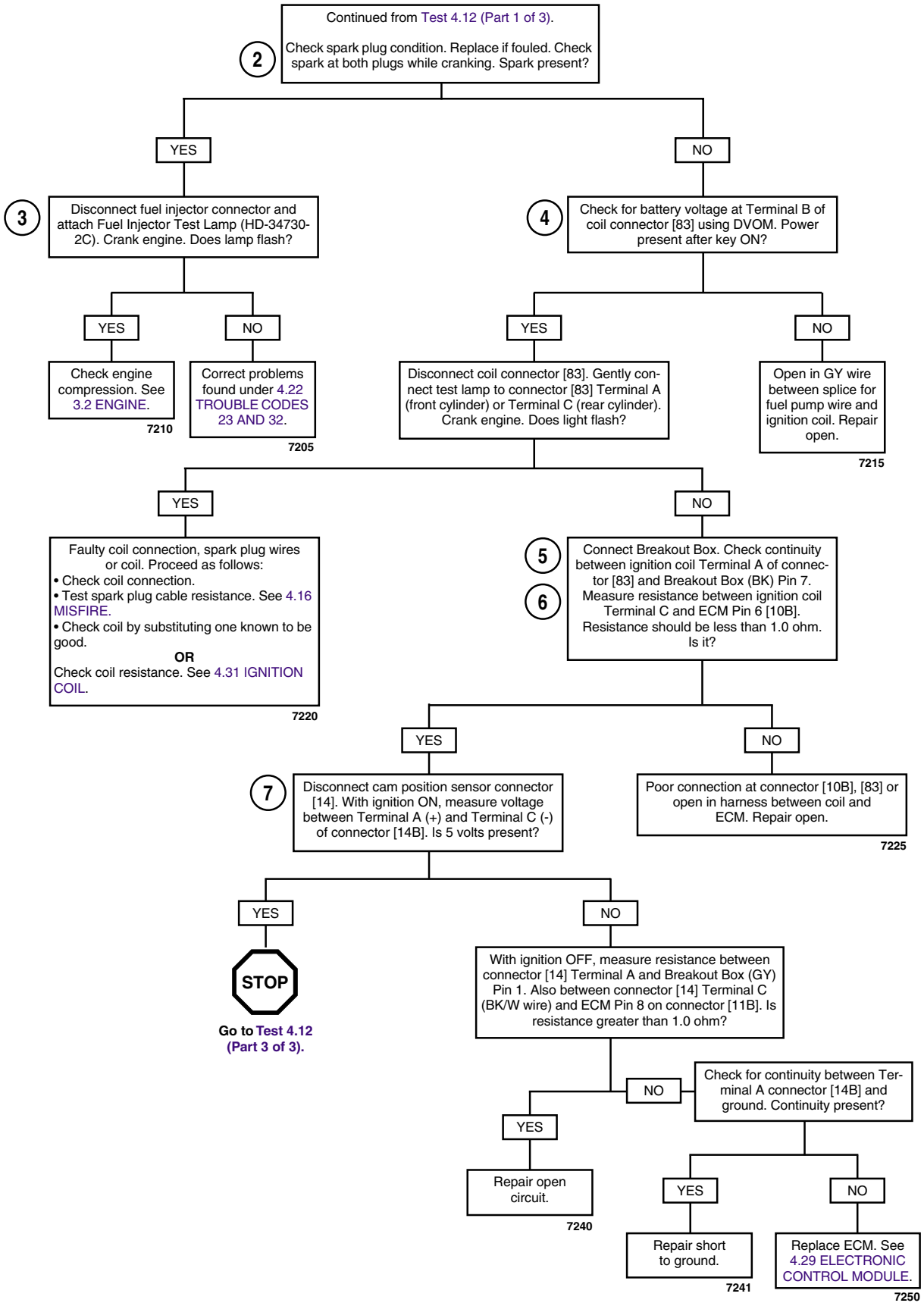


Figure 4-27. Ignition Circuit

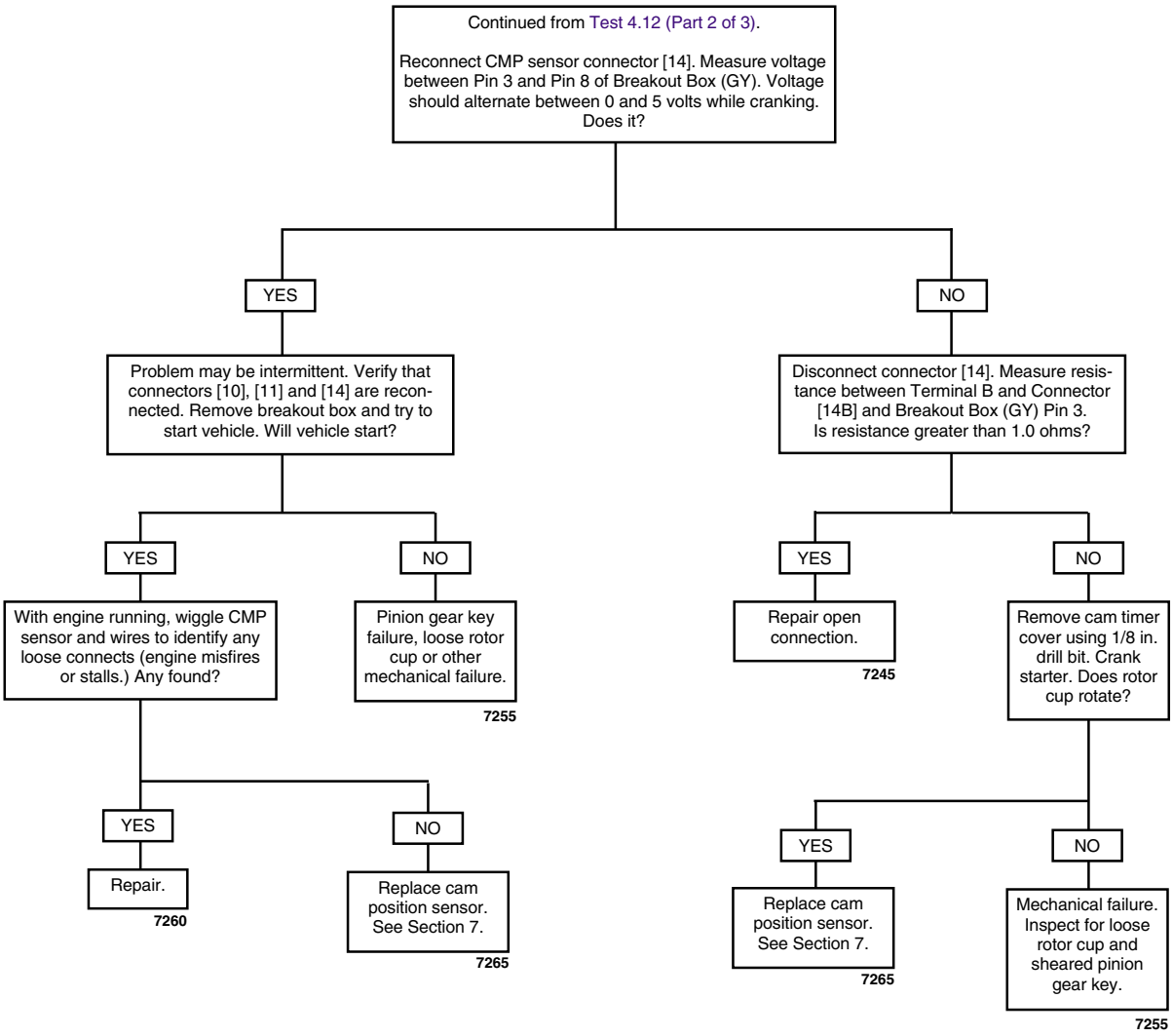
Test 4.12 (Part 1 of 3)



Test 4.12 (Part 2 of 3)



Test 4.12 (Part 3 of 3)



GENERAL

A relay controlled by the engine stop switch supplies power to the ECM. The relay requires a ground to operate. If the ground is not established, the ECM will not receive power. Grounds may be established three ways.

- By placing the motorcycle in neutral and grounding the relay through the neutral switch. See Figure 4-28.
- By retracting the side stand and grounding the relay through the side stand switch. See Figure 4-29.
- By disengaging the clutch and grounding the relay through the clutch switch. See Figure 4-30.

If the ECM does not appear to be receiving power, check the ground sources. A blown ignition fuse can also disable the ECM.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.13 flow chart.

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.7 BREAKOUT BOX.

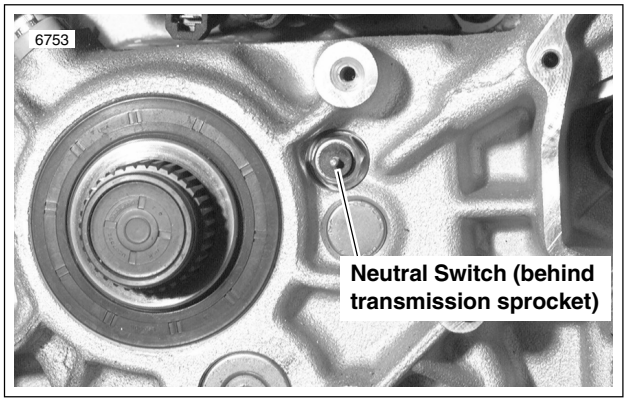


Figure 4-28. Neutral Switch

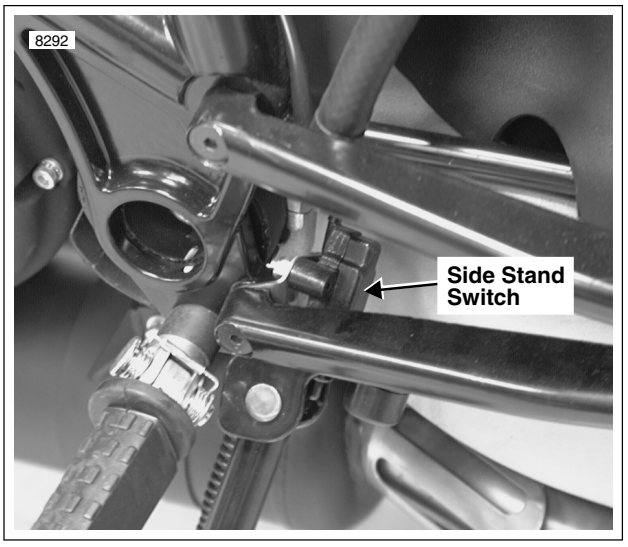
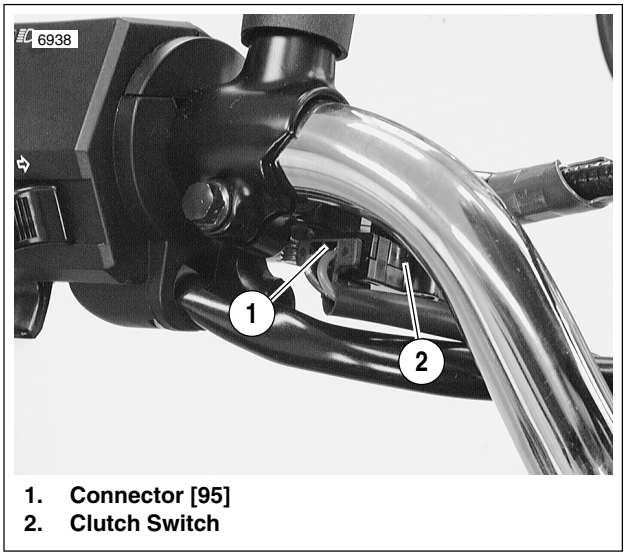


Figure 4-29. Side Stand Switch



1. **Connector [95]**
2. **Clutch Switch**

Figure 4-30. Clutch Switch

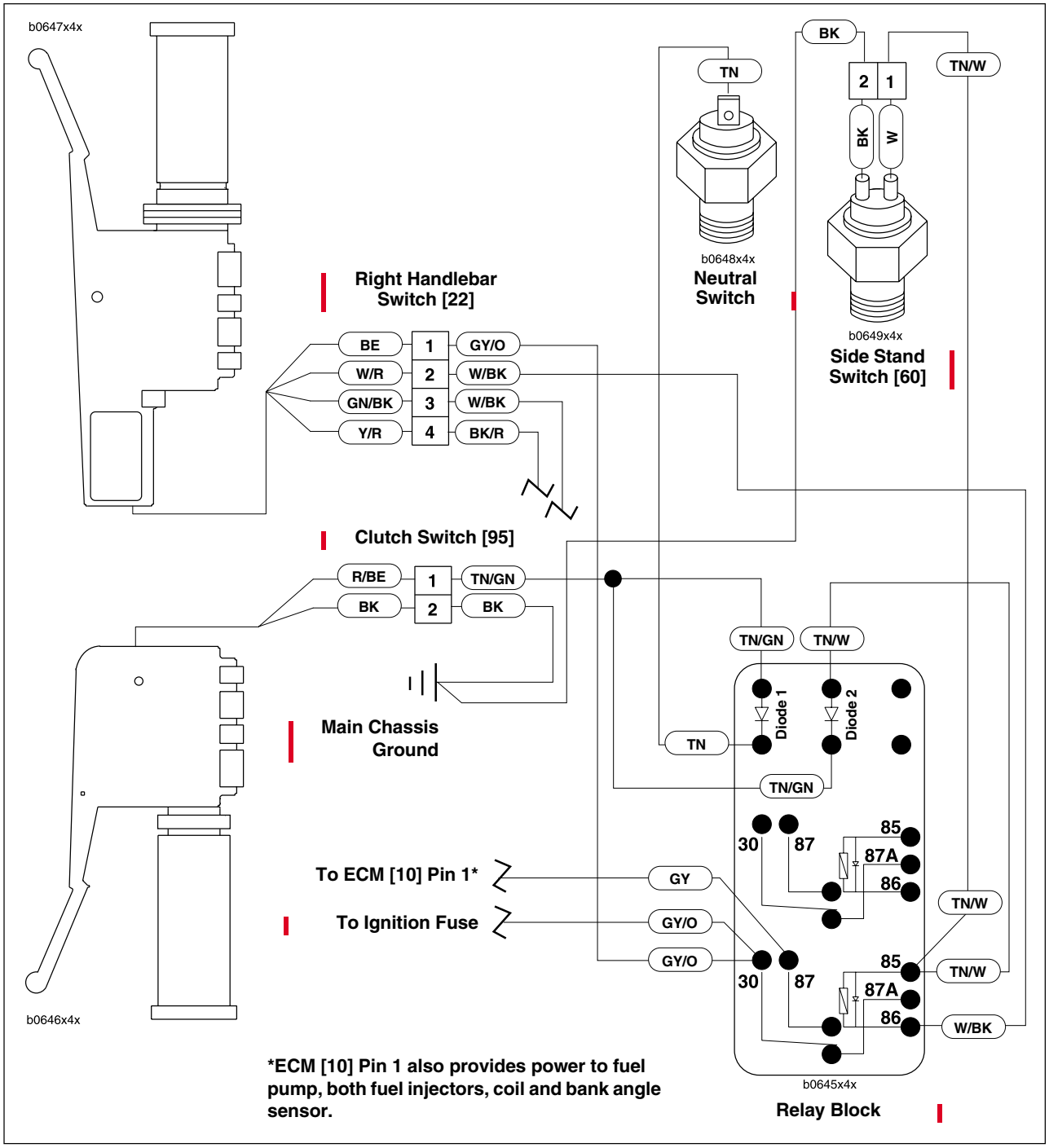


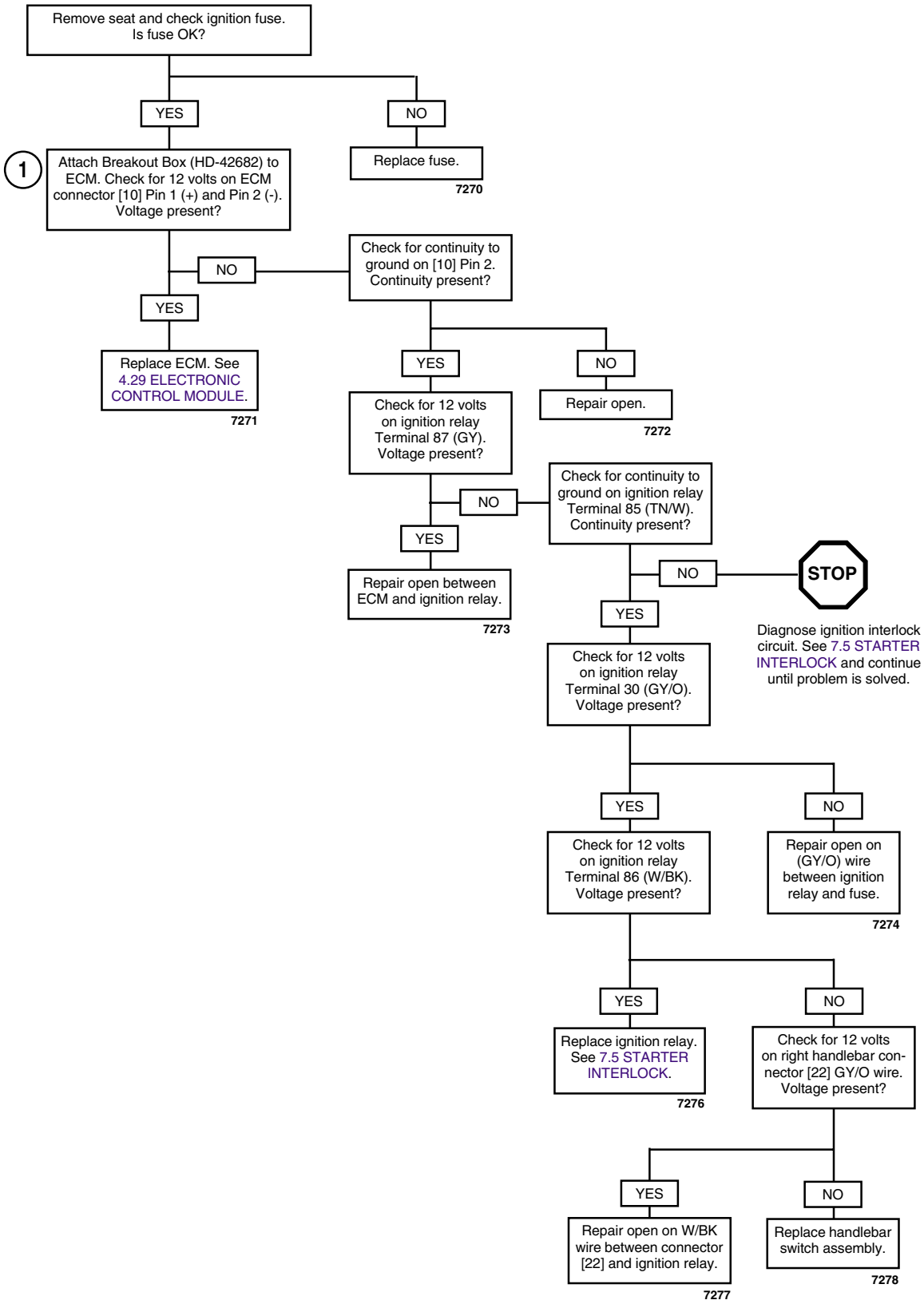
Figure 4-31. ECM Power Circuit

Table 4-10. Wire Harness Connectors in Figure 4-31.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[22]	Right handlebar switch	4-place	under fuel cell, right side
[95]	Clutch switch	2-place	clutch lever bracket

No ECM Power

CONDITION: Sidestand up, key ON and transmission in neutral



INSPECTION

⚠WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

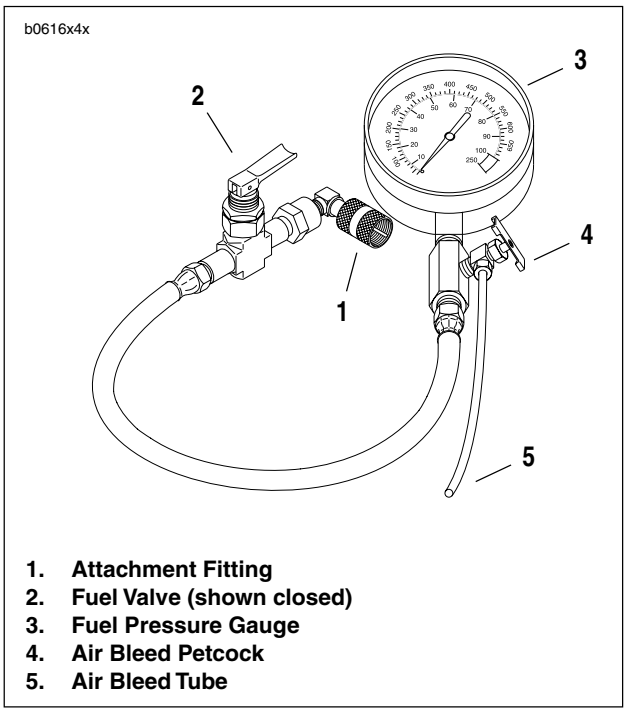
1. Purge the fuel supply line of high pressure gasoline.
   a. See Figure 4-32. Disconnect the 4-place fuel pump connector [86]. Connector is on the left side, above the rear cylinder spark plug.
   b. With the motorcycle in neutral, start the engine and allow vehicle to run.
   c. When the engine stalls, press the starter button for 3 seconds to remove any remaining fuel from fuel line.
2. Wrap a shop towel around the fuel supply fitting.

⚠WARNING

A small amount of gasoline will drain from the valve when the gauge is installed. Thoroughly wipe up any spilt fuel immediately. Dispose of rags in a suitable manner. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

3. See Figure 4-33. Attach FUEL PRESSURE GAUGE (Part No. HD-41182) to Schraeder valve on fuel supply fitting.
   a. Verify that fuel valve (2) and air bleed petcock (4) on the gauge are closed.
   b. See Figure 4-34. Remove protective cap (3) from Schraeder valve (2).
   c. Thread gauge into Schraeder valve.
4. See Figure 4-32. Attach fuel pump connector to main wiring harness.
5. See Figure 4-33. Pressurize the fuel system.
   a. Start and idle engine to pressurize the fuel system.
   b. Open fuel valve (2) on fuel pressure gauge to allow fuel to flow down the gauge hose.
   c. Position the air bleed tube (5) in the beaker.
   d. Open and close the air bleed petcock (4) to purge the fuel pressure gauge and hose of air. Repeat this step several times until only solid fuel (without bubbles) flows from the air bleed tube (5).
   e. Close the air bleed petcock (4).

Figure 4-32. Fuel Pump Connector [86]



1. **Attachment Fitting**
2. **Fuel Valve (shown closed)**
3. **Fuel Pressure Gauge**
4. **Air Bleed Petcock**
5. **Air Bleed Tube**

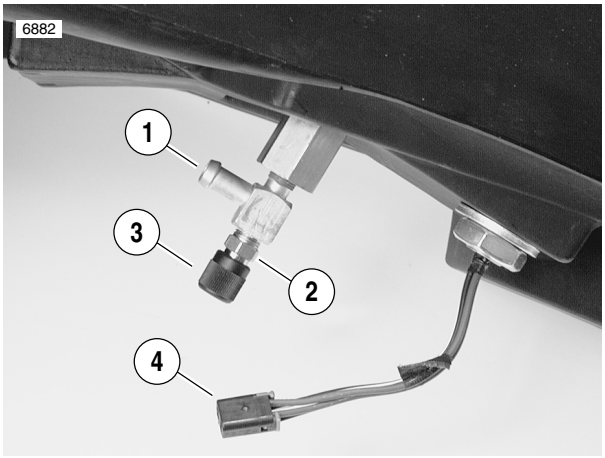
Figure 4-33. Fuel Pressure Gauge (Part No. HD-41182)

6. Open throttle and increase engine speed to 2500-3000 RPM. Note the reading on the pressure gauge.
   a. If pressure is 46-53 psi (317-365 kPa) then system is operating within limits.
   b. If pressure is not within limits, see Test 4.14 (Part 1 of 2) flow chart after disconnecting pressure gauge.

⚠WARNING

A small amount of gasoline will drain from the valve when the valve is removed. Thoroughly wipe up any spilt fuel immediately. Dispose of rags in a suitable manner. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

7. See Figure 4-34. Turn engine off. Detach pressure gauge from Schraeder valve.
   a. Open the air bleed petcock to relieve fuel system pressure and purge the pressure gauge of gasoline.
   b. Remove pressure gauge from valve.
   c. Install protective cap on valve.



1. **Fuel Outlet**
2. **Schraeder Valve**
3. **Protective Cap**
4. **Fuel Pump Connector**

Figure 4-34. Schraeder Valve and Cap (Fuel Tank Removed From Chassis)

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.14 flow charts.

1. See Figure 4-35. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray socket probe and patch cord.
2. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.7 BREAKOUT BOX.

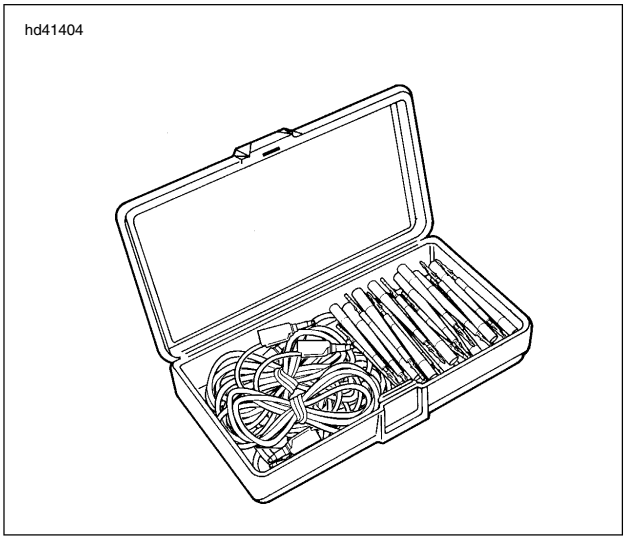


Figure 4-35. Harness Connector Kit

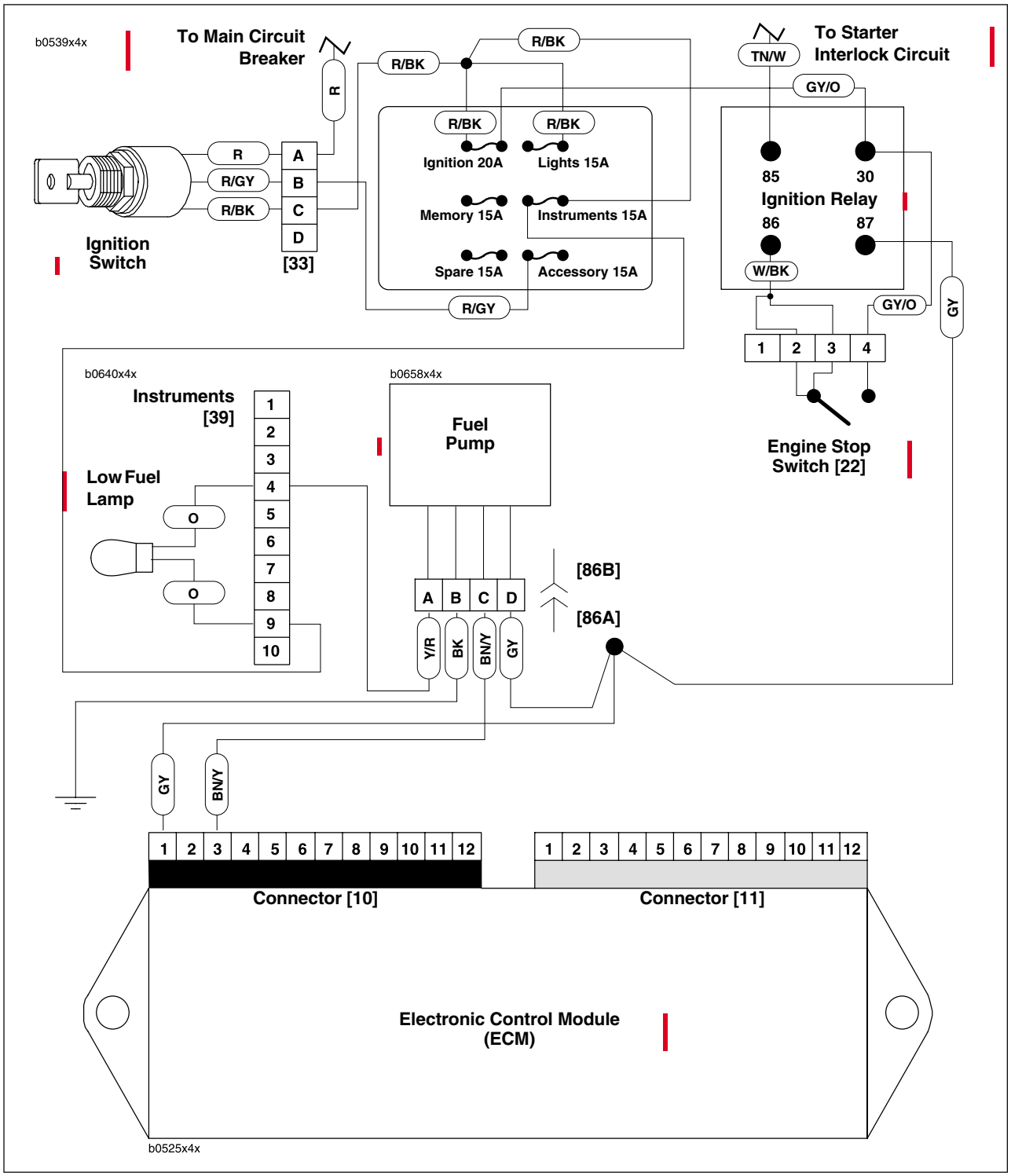
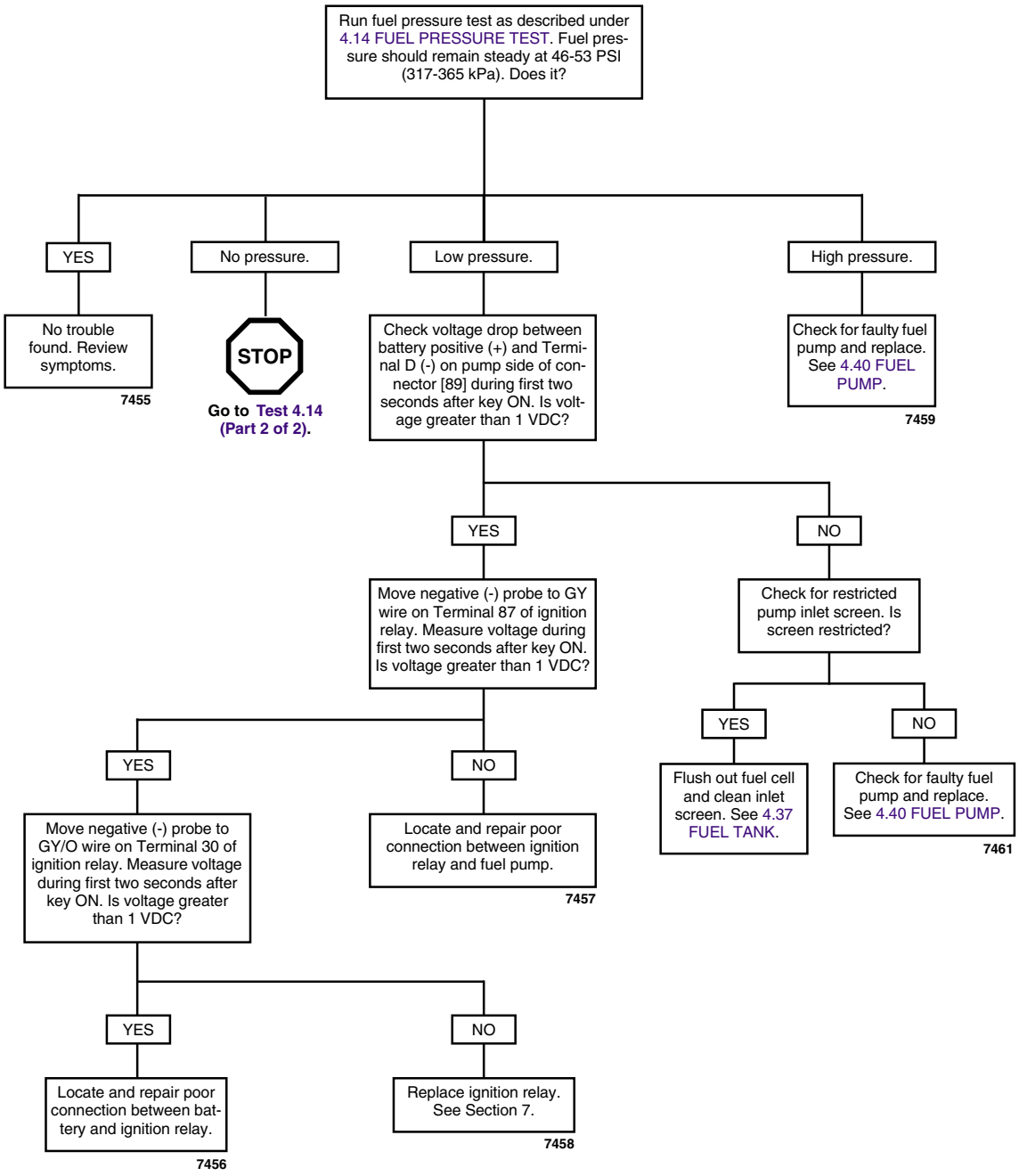


Figure 4-36. Fuel Pump Circuit

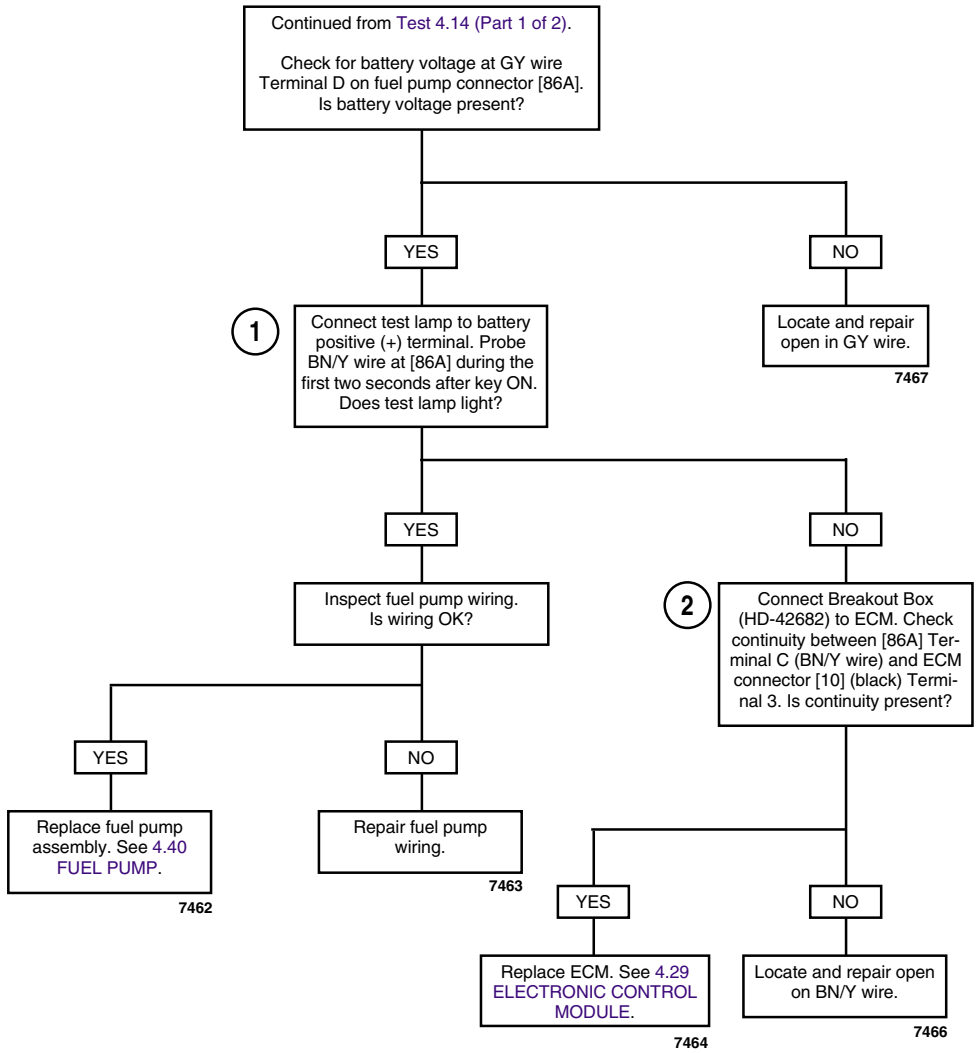
Table 4-11. Wire Harness Connectors in Figure 4-36.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Instruments	10-place Multilock	under fuel cell
[86]	Fuel pump	4-place Packard	above rear cylinder head, left side

Test 4.14 (Part 1 of 2)

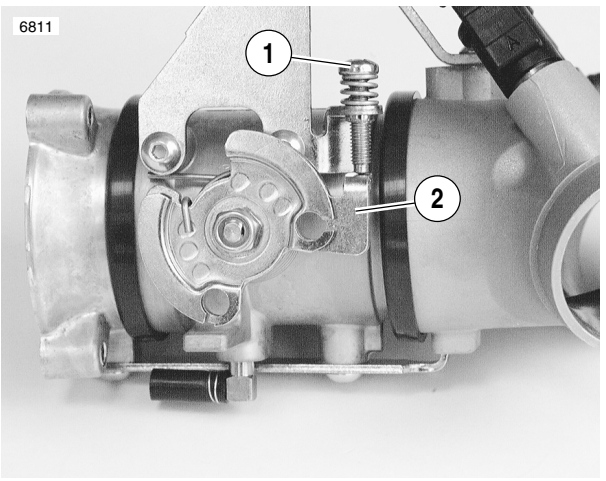


Test 4.14 (Part 2 of 2)



ADJUSTMENTS

See Figure 4-37. Use the adjuster attached to the throttle body to make idle speed adjustments. Normal idle speed 850-1050 RPM.



1. Idle Adjustment Screw (Cable not Shown)
2. Stop Plate

Figure 4-37. Idle Adjustment Screw

GENERAL

Misfire At Idle or Under Load

Misfire conditions may be caused by:

- Battery condition and connections.
- Fuel system problems. See tables under 4.9 INITIAL DIAGNOSTIC CHECK.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.16 flow charts.

⚠WARNING

Thoroughly wipe up any spilled fuel and dispose of rags in a suitable manner. Any open spark around gasoline or other combustibles could result in fire or explosion causing death or serious injury.

1. See Figure 4-38. A SPARK TESTER (Part No. HD-26792) must be used to verify adequate secondary voltage (25,000 volts) at the spark plug.
   a. Turn ignition switch OFF.
   b. Remove spark plug cable from spark plug. Visually check plug condition.
   c. Attach cable to SPARK TESTER. Clip tester to cylinder head bolt.
   d. While cranking engine, watch for spark to jump tester gap on leads.
   e. Reinstall and repeat procedure on other spark plug cable.
2. Perform spark plug cable resistance test.
   a. Remove spark plug cable from spark plug and ignition coil. For best results, use a needle nose pliers for removal/installation on coil. Gently grasp cable as close to terminals as possible.
   b. Using an ohmmeter, touch probes to terminals on each end plug wire.
   c. Compare resistance values to Table 4-12. Replace cables not meeting specifications. Reinstall and repeat procedure on other spark plug cable.

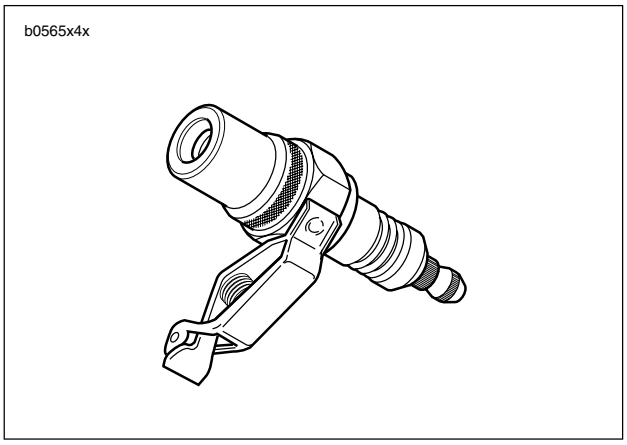


Figure 4-38. Spark Tester (Part No, HD-26792)

Table 4-12. Spark Plug Cables

SPECIFICATION	REAR	FRONT
Length-in. (mm)	19.0-19.25 (482.6-489.0)	7.25-7.50 (184.2-190.5)
Resistance -ohms	4750-11,230	1812-4375

3. If carbon tracking is evident, replace ignition coil and inspect spark plug wires. Wires must be clean and tight. Excessive wire resistance or faulty connections can cause coil damage. See 4.31 IGNITION COIL.
4. This test can also be performed by substituting a known good coil for one causing the no spark condition. The coil does not require full installation to be functional. Verify faulty coil by performing resistance test. See 4.31 IGNITION COIL.
5. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray pin probe and patch cord to the coil connector [18].
6. Inspect for corrosion at battery terminals, main circuit breakers, ignition fuse terminals (GY/O and R/BK), right handlebar connector [1] and coil connector.

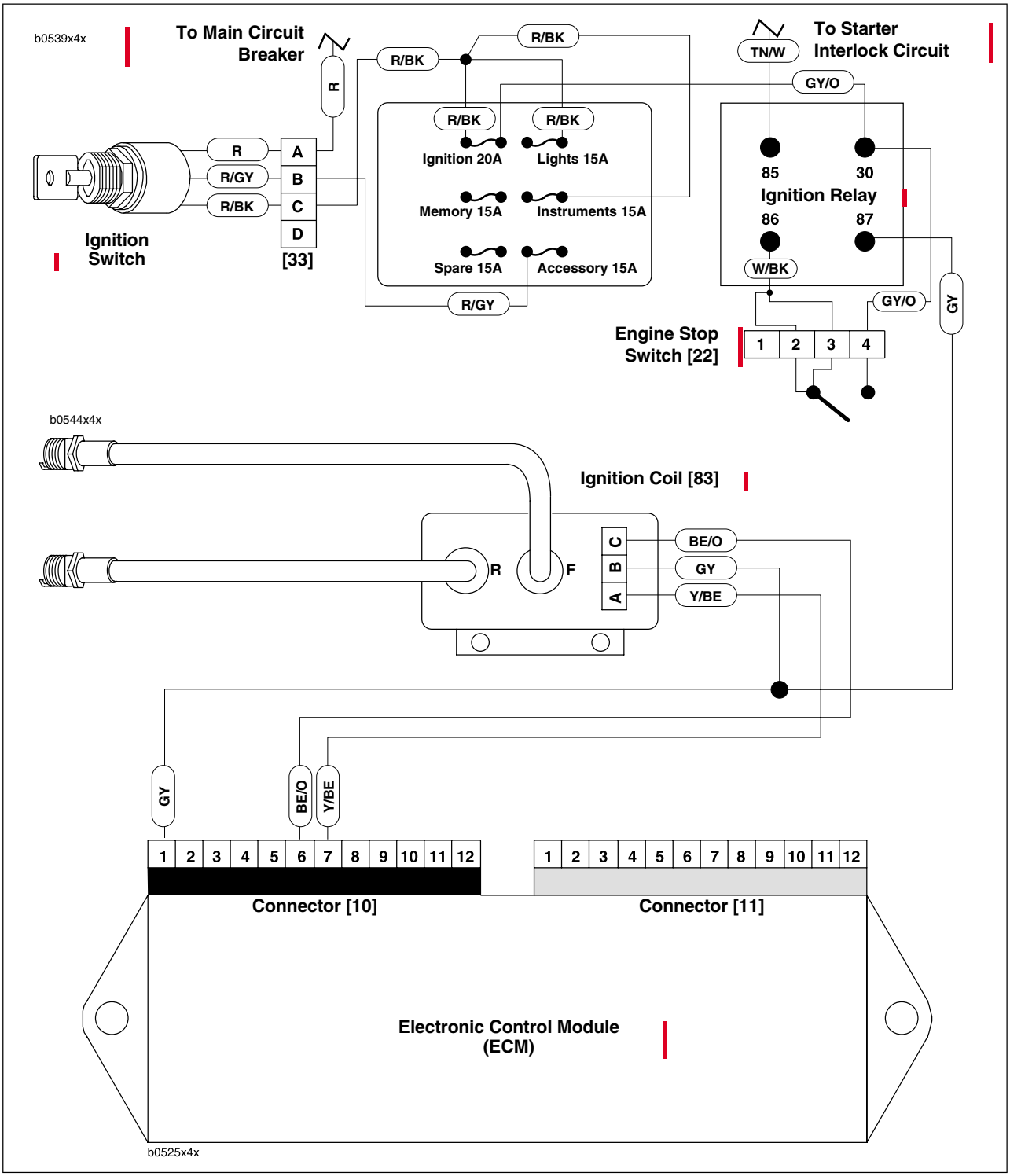
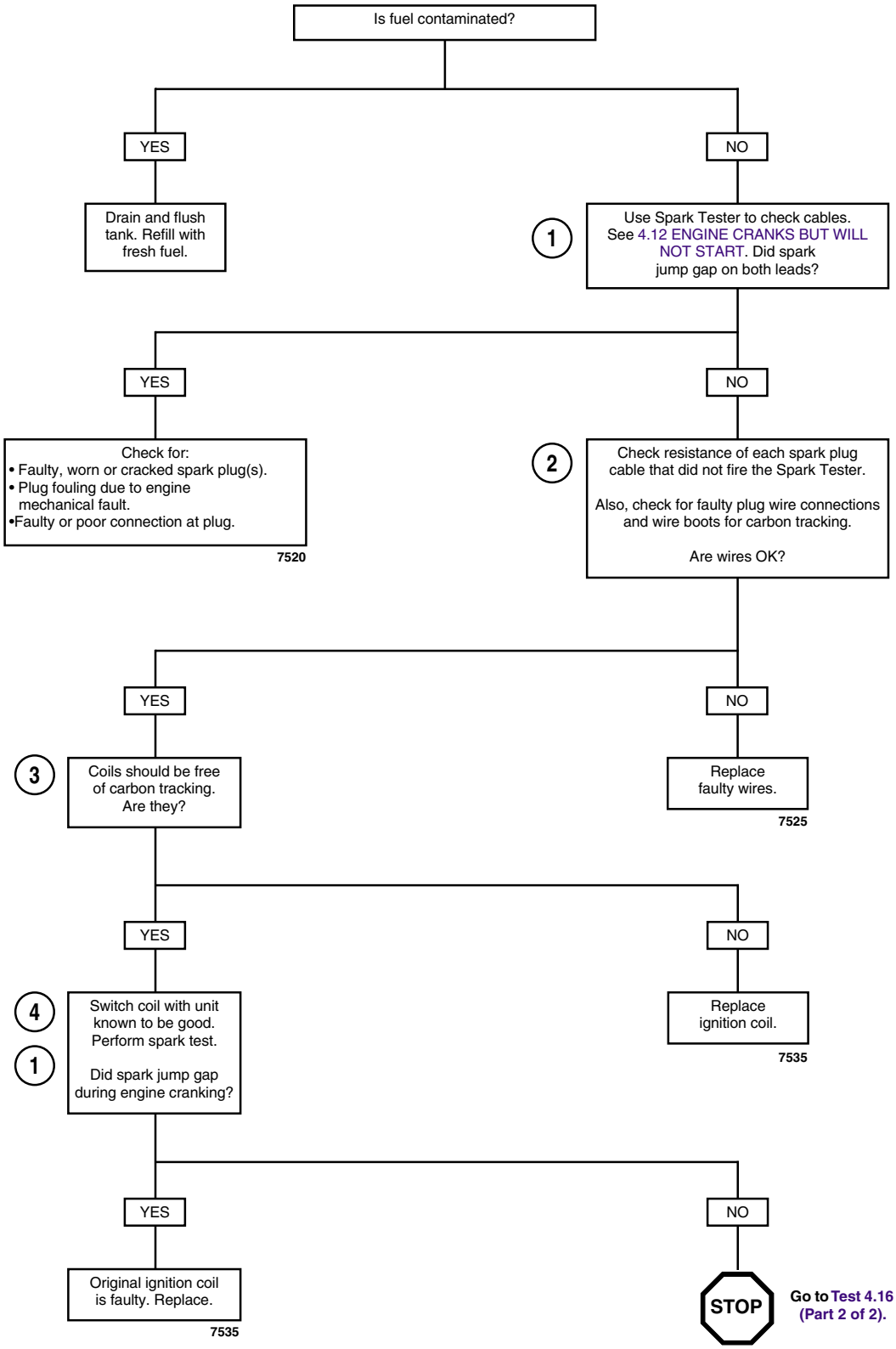


Figure 4-39. Ignition Coil Circuit

Table 4-13. Wire Harness Connectors in Figure 4-39.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[22]	Right handlebar switch	4-place	under fuel cell
[83]	Coil	3-place Packard	under fuel cell, left side

Test 4.16 (Part 1 of 2)



Test 4.16 (Part 2 of 2)