TESTS W/CODES

SELF-DIAGNOSTIC SYSTEM

NOTE: Fuel system self-diagnostics and ignition system diagnostics are covered separately in this article.

The fuel injection system and ignition system feature a built-in self-diagnostic function for fault tracing. A common diagnostic unit, located in the engine compartment behind the left strut assembly, interfaces directly with either ECU. The diagnostic unit has a push button, a Red Light-Emitting Diode (LED) and a selector (coding) cable. See Fig. 1.

Once the selector cable has been inserted in the correct slot, depressing the button once, twice or three times selects from one of three control (fault tracing) functions. Faults stored in ECU memory are read via a system of LED flashes. All fault codes have 3 digits, each capable of ranging from 1-to-4 digits. Since codes all have three numbers, each code requires three series of flashes. For easier reading, a 2.5-second interval separates each digit of the code.

Socket No. 2 in the diagnostic unit is used for fuel system testing. Socket 6 is used for ignition system testing.

FUEL SYSTEM (SELF-DIAGNOSTICS)

FUEL SYSTEM DIAGNOSTICS

The fuel system ECU carries out continuous checks. Faults in any of the following functions are stored in system memory.

* Fuel System ECU internal function
* Lambda-Sond (Oxygen Sensor)
* Coolant Temperature Sensor
* Mass Airflow Meter
* Battery Voltage
* Throttle Switch
* Ignition System ECU and RPM
* Speedometer
* Knock Sensor
* Idle (Speed) Valve
* Fuel Injectors

ENTERING SELF-DIAGNOSTICS (FUEL SYSTEM)

CONTROL FUNCTIONS

The system monitors the operation of components and switches. When the component or switch is operated according to a set procedure, the LED will display a 3-digit code. Failure to display a code indicates the control unit has failed to detect operation of the component/switch. In this case, the fault lies with the component/switch or associated connectors and wiring.

The functional check system can also test whether components/switches are correctly wired. As an example, it can be used to check whether the permanent/magnet generator (engine speed sensor) and wiring are intact if the engine fails to start.

Control Function No. 1 (Accessing Codes)

This function displays any of 17 different fuel system codes stored in ECU memory during engine operation.

Control Function No. 2 (Activating Breaker)

This function tests throttle switch. As it is activated, information is provided through LED in a flash code. This control function is generally used as a double-check after repairs.

Control Function 3 (Tests Fuel Injector & Idle Valve Circuits)

This function tests fuel injector and idle valve operation. It consists of a function cycle where the diagnostic system activates the components. You find out if the component is working by listening or putting a hand on it when it is activated.

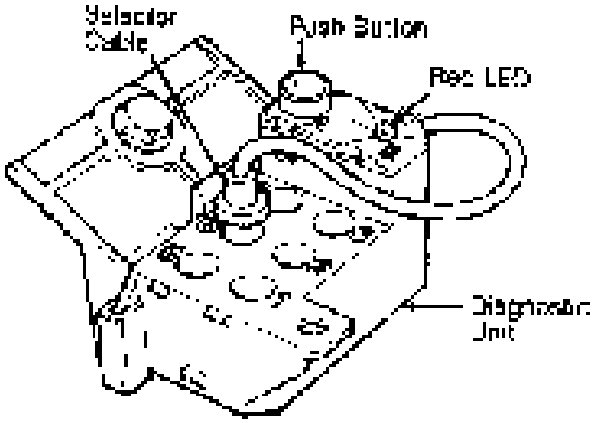

Fig. 1: Bosch & Rex-I Diagnostic Unit
Courtesy of Volvo Cars of North America.

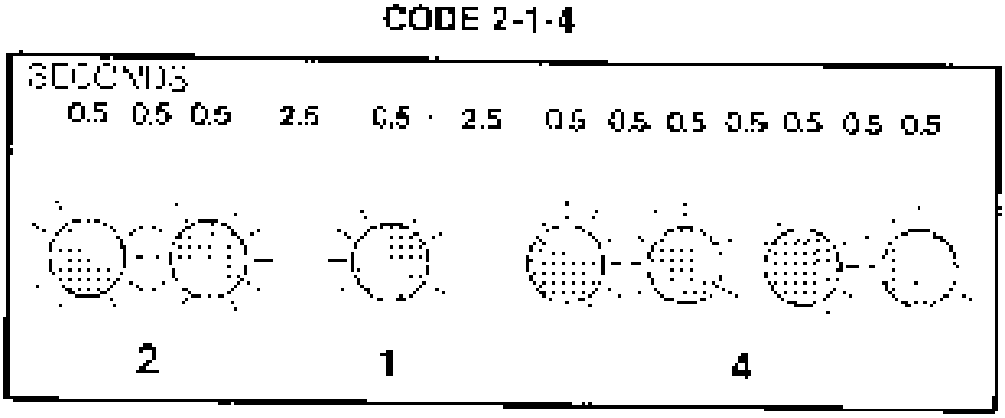

Fig. 2: Counting Red LED Code Flashes
Courtesy of Volvo Cars of North America.

RETRIEVING CODES (FUEL) CONTROL FUNCTION NO. 1

CAUTION: Never disconnect or connect ECU connector with ignition in "ON" position.

FUEL SYSTEM DIAGNOSTICS

1) Locate the diagnostic unit and remove its cover. Connect selector cable to No. 2 socket. Turn ignition to "ON" position. Enter control function No. 1 (access codes) by pressing push button one time for at least one second and no more than 3 seconds. To enter control function No. 2, press push button twice for at least one second and no more than 3 seconds. To enter control function No. 3, press push button three times for at least one second and no more than 3 seconds.

2) Watch the Red LED and count the number of flashes in the three-flash series. The flash series are separated by a three-second interval. See Fig. 2. Note all codes. Only three separate codes can be stored at once. If no codes are stored, the LED will flash a 1-1-1 to indicate the fuel system is operating properly.

3) If a fault code is received, refer to FUEL SYSTEM FAULT CODES table. Depress push button again and check for additional codes. Depress push button a third time, if necessary. If the first code repeats, there are no other codes.

4) The diagnostic system memory is full when three codes are present. Those three codes must be repaired before further codes can be retrieved.

NOTE: Not all codes listed in FUEL SYSTEM FAULT CODES table are used on every vehicle.

FUEL SYSTEM FAULT CODES TABLE

Code	Fault	Repair
1-1-1	No Faults	-----
1-1-2	ECU	Replace ECU
1-1-3	Fuel Injectors	Check Fuel Injectors Check Fuel Pressure
1-2-1	Mass Airflow Signal	(1) Check Airflow Meter & (1) O2 Heater Resistance
1-2-2	Air Temp. Sensor Signal	(1) Check Sensor
1-2-3	Cool. Temp. Sensor Signal	(1) Check Sensor
1-3-1	Ignition System RPM Signal	(2)
1-3-2	Batt. Voltage	Check Battery Check Charging System
1-3-3	Throttle Switch (Idle)	(1) Check Throttle Switch
1-5-4	EGR Flow Too High	EGR System
2-1-2	O2 Sensor Signal	Check Fuel Pump Relay (1) Check O2 Sensor Heater
2-1-3	Throttle Switch (Full Load)	(1) Check Throttle Switch
2-2-1	Lambda Operation	Check Intake Manifold (2) Check Fuel Pressure
2-2-2	Main Relay	Check Main Relay
2-2-3	Idle Valve Signal	(2)
2-3-1	Lambda Adjustment	Check Intake Manifold (2) Check Fuel Pressure
2-3-2	Lambda Adjustment	Check Intake Manifold (2) Check Fuel Pressure
2-3-3	Idle Valve (Air Leak)	Check Intake Manifold (1) Check Idle Valve
3-1-1	Speedometer Signal	(2)
3-1-2	Knock/Fuel Enrichment Signal Missing	(2)
3-2-1	Cold Start Valve	Check Cold Start Valve
3-2-2	Airflow Meter Hot Wire	(1) Check Airflow Meter

(1) - See I - SYSTEM/COMPONENT TESTS article.
(2) - See FUEL SYSTEM FAULT CODE TESTING in this article.

FUEL SYSTEM FAULT CODE TESTING

This section will cover fault codes dealing with fuel system ECU testing. The codes will be followed by an explanation of how to test and repair the affected circuit.

CODE 1-3-1 (IGNITION SYSTEM RPM SIGNAL)

Turn ignition off. Disconnect fuel system ECU connector and remove protective sleeve. Connect a voltmeter between harness side of terminal No. 1 (Brown wire on 240 Series and Yellow/Green wire on 740 GL) and ground. Run starter motor. If reading is battery voltage, permanent/magnet generator (engine speed sensor) is okay. If the reading is not battery voltage, check wiring to sensor. If wiring is okay, test permanent/magnetic generator. For permanent/magnetic generator testing, see I - SYSTEM/COMPONENT TESTS article.

CODE 1-5-4 (EGR FLOW TOO HIGH)

1) Check engine idling. If engine idles unevenly, go to next step. If engine idles evenly, go to step 5).
2) Disconnect harness electrical connector from EGR vacuum controller. If idle is still uneven, go to next step. If engine idles evenly when connector is disconnected, check wiring between control module and EGR vacuum controller for short to ground. Repair as necessary. See L - WIRING DIAGRAMS article.
3) With engine idling, CAREFULLY remove yellow vacuum hose from EGR vacuum controller. If engine now idles evenly, install new EGR vacuum controller and retest. If engine still idles unevenly, go to next step.
4) With engine idling, CAREFULLY remove yellow hose at EGR valve. If engine now idles evenly, hose is obstructed. Replace hose and retest. If engine still idles unevenly, install new EGR valve and retest.
5) Check engine temperature. Verify that temperature rises to normal range smoothly, and that upper radiator hose is hot when temperature stabilizes. If the above conditions are not observed, install new thermostat and retest. If engine temperature control is normal, go to next step.
6) Turn ignition OFF. Clean EGR and ECT connectors and treat for corrosion, if necessary. Remove, clean, and reinstall ground wire at intake manifold

CODE 2-2-3 (IDLE VALVE SIGNAL)

Turn ignition off. Disconnect fuel system ECU connector and remove protective sleeve. Connect an ohmmeter between harness side of terminal No. 33 (Green/Red wire on 240 series and Red/Black wire on 740 GL) and terminal No. 9 (Orange wire on 240 Series and Blue/Yellow on 740 GL). Reading should be approximately 8 ohms. If reading is not approximately 8 ohms, check wiring and connectors. If wiring and connectors are okay, test idle valve. For idle valve testing, see procedures in I - SYSTEM/COMPONENT TESTS article.

CODE 3-1-1 (SPEEDOMETER SIGNAL)

Turn ignition off. Remove panel under instrument panel on driver's side. Disconnect 12-pin connector from speedometer. On 240 series, connect an ohmmeter between Blue wire of speedometer connector and terminal No. 34 (Blue wire) of fuel system ECU. On 740 GL, connect ohmmeter between Violet/White wire of speedometer connector and terminal No. 34 (Violet/White wire) of fuel system ECU. Resistance should be zero ohms. If resistance is present, check wiring and connectors. If problem persists, check speedometer operation and related wiring.

CODE 3-1-2 (KNOCK/FUEL ENRICHMENT)

Turn ignition on. Connect a voltmeter between terminal No. 28 (Brown wire on 240 series and Green/Red wire on 740 GL) of fuel system ECU connector and ground. Reading should be approximately 0.7 volt. If voltage is not specified, check resistance between appropriate ECU connector wire and knock sensor. For knock sensor testing, see procedures in I - SYSTEM/COMPONENT TESTS article.

ENTERING SELF-DIAGNOSTICS (FUEL) CONTROL FUNCTION NO. 2

ACTIVATE BREAKERS

1) Turn ignition on. Locate diagnostic unit and remove its cover. Connect selector cable to No. 2 socket. Turn throttle control at throttle body to full-load position. Depress push button twice. Each time the button is depressed, it should be held for more than 1 second and less than 3 seconds. The Red LED should flash.

2) Release throttle control. If flash series 3-3-3 comes up, the throttle switch works correctly in full-load position. If LED continues to flash rapidly, check throttle switch setting. See procedures in D - ADJUSTMENTS article in this section and proceed to next step.

3) Connect an ohmmeter between terminal No. 2 (Yellow/White wire on 240 series and Orange wire on 740 GL) of fuel system ECU and ground. Resistance should be zero ohms with throttle switch closed. Depress gas pedal slightly. Resistance should increase to 2000-3000 ohms. If resistance is not within specification, check wiring from ECU to throttle switch.

4) Turn throttle control slightly and observe Red LED. If LED turns off and then flashes 3-3-2 code, the throttle switch is working properly in idle position. If LED does not flash as described, repeat step 3).

5) Start engine and check RPM signal from ignition system ECU to fuel system ECU. If LED turns off and then flashes 3-3-1 code, RPM signal is correct. If engine won't start, run the starter until the LED turns off and proceed to next step. If the diode continues to flash, check ignition system and see LED DOES NOT FLASH in this article.

NOTE: Steps 6-8 are for A/C-equipped vehicles and steps 9-10 are for A/T-equipped vehicles.

6) Check on/off function of A/C compressor. Put A/C control in "ON" position. If LED turns off and then flashes 1-1-4 code, A/C switch is okay. Proceed to step 8). If LED continues to flash, proceed to next step.

7) Connect an ohmmeter between terminal No. 15 (Gray/Red wire on 240 series and Green/Yellow wire on 740 GL) of fuel system ECU and ground. On 240 series, resistance should be 1000 ohms with A/C off and 10 ohms with A/C on. On 740 GL, resistance should range from infinity with A/C off and 35 ohms with A/C on. If resistance is not within specification, check wiring and connections.

8) Turn ignition off. The LED will now return to rapid flashes prior to A/C compressor turning on. When the compressor turns on, the LED should turn off and then flash 1-3-4. If LED goes out, proceed to next step. Connect an ohmmeter between terminal No. 14 (Green wire on 240 series and Green/Red wire on 740 GL) of fuel system ECU and ground. Resistance should be 0-5 ohms. If resistance is not within specification, check wiring and connections.

9) This step will test idle speed compensation on A/T-equipped vehicles. Depress brake pedal and place gear selector in "DRIVE" position and then "NEUTRAL" position. Observe LED while shifting. A code 1-2-4 should flash and test is complete. If LED continues to flash rapidly, proceed to next step.

10) Put transmission gear selector in "NEUTRAL" position. Connect an ohmmeter between terminal No. 30 (Blue/Yellow wire on 240 series and Pink wire on 740 GL) of fuel system ECU and ground. Resistance should be zero ohm in "NEUTRAL" position and infinity in "DRIVE" position. If resistance is not within specification, check wiring, connections and gear selector switch.

ENTERING SELF-DIAGNOSTICS (FUEL) CONTROL FUNCTION NO. 3

SYSTEM ADJUSTMENT

1) Turn ignition on. Locate diagnostic unit and remove its cover. Connect selector cable to No. 2 socket. Depress push button three times. Each time the button is depressed, it should be held for more than 1 second and less than 3 seconds. While LED flashes, the fuel injectors and idle valve should operate. Check by listening or feeling component when it is activated. If injectors fail to operate and LED flashes, proceed to step 2). If idle valve fails to operate and LED flashes, proceed to step 3).

NOTE: Before testing fuel injector circuit on 740 GL, remove auxiliary relay and connect a jumper wire between Blue/Yellow wire terminal and Green/Red wire terminal of relay connector.

2) To test fuel injector circuit, connect an ohmmeter between harness side of terminals No. 9 (Orange wire on 240 series and Blue/Yellow wire on 740 GL) and No. 18 (Orange wire on 240 series and Gray wire on 740 GL) of fuel system ECU connector. Resistance should be 4 ohms. If reading is greater than 4 ohms, current cannot pass to injectors. See INJECTOR CIRCUIT RESISTANCE table. If resistance is incorrect, remove each injector connector. Each injector connector should have 16 ohms resistance. Repair as required.

INJECTOR CIRCUIT RESISTANCE TABLE

Resistance	No. of Faulty Injectors/Wires
5.3 Ohms	1 Injector/Wire
8 Ohms	2 Injectors/Wires
16 Ohms	3 Injectors/Wires

3) To test idle valve circuit, connect an ohmmeter between terminals No. 33 (Green/Red wire on 240 series and Red/Black wire on 740 GL) and No. 9 (Orange wire on 240 series and Blue/Yellow wire on 740 GL) of fuel system ECU connector. Resistance should be 8 ohms. If resistance is not within specification, check wiring and connections between idle valve and ECU. If wiring is okay, check idle valve. See IDLE VALVE in I - SYSTEM/COMPONENT TESTS article in this section.

DIAGNOSTIC UNIT LED DOES NOT FLASH

If Red LED light does not flash when push button is depressed, or no code is flashed, perform the following steps and repair as required:

1) Check ECU ground connection on intake manifold.
2) Check fuel pump relay and primary pump fuses.
3) Ensure ECU connector and ground connection are tight.
4) Turn ignition off. Locate fuel system ECU behind glove box. Disconnect connector and remove protective sleeve. Connect a voltmeter between harness side of terminal No. 4 (Red wire on 240 series and White wire on 740 GL) and ground. If reading is battery voltage, proceed to step 5). If reading is less than battery voltage, check for shorts. If there is no voltage, check wire between control unit connector and fuse No. 1 in distribution unit.

5) Turn ignition on. Connect a voltmeter between harness side of terminal No. 12 (Green/Black wire on 240 series and Green/White wire on 740 GL) and ground. Reading should be battery voltage. Depress push button on diagnostic unit. Reading should be zero volt. If there is no voltage at the ECU, take voltage reading at diagnostic unit connector. If 12 volts are present when the push button is depressed, proceed to next step.

6) Connect voltmeter between ground and Red/Black wire on 240 series and Blue wire on 740 GL of diagnostic unit connector. Reading should be 12 volts. If reading is not 12 volts, proceed to next step.

7) Connect voltmeter between harness side of terminal No. 9 (Orange wire on 240 series and Black/Yellow wire on 740 GL) and ground on ECU connector. Also connect a jumper wire between terminal No. 21 (Yellow/Black wire on 240 series and Red wire on 740 GL) and ground. The main relay should activate and voltage reading should be battery voltage. Check wiring to relay. If wiring is okay, replace relay. (The main relay on 240 series is next to fuel system ECU. On 740, main relay is located in fuse/relay box.)

IGNITION SYSTEM (SELF-DIAGNOSTICS)

IGNITION SYSTEM DIAGNOSTICS

The ignition system ECU carries out continuous checks. Faults in these areas are stored in memory:

* Ignition System ECU
* Knock Sensor
* Fuel System ECU
* Permanent/Magnet Generator (Engine Speed Sensor)
* Coolant Temperature Sensor
* Throttle Switch

ENTERING SELF-DIAGNOSTICS (IGNITION SYSTEM) CONTROL FUNCTIONS

The system monitors the operation of certain components by operating the item(s) in question. When the component or switch is operated according to a set procedure, the LED will display a 3-digit code. Failure to display a code indicates the control unit has failed to detect operation of the component/switch. In this case, the fault lies with the component/switch, connectors and/or wiring.

The functional check system can also test whether components/switches are correctly wired. As an example, it can be used to check whether the permanent/magnet generator (engine speed sensor) and wiring are intact if the engine fails to start.

CONTROL FUNCTION NO. 1 (ACCESSING CODES)

This function displays any codes stored in ignition system ECU memory during engine operation. The system can store 7 different ignition system faults.

CONTROL FUNCTION 2 (ACTIVATING BREAKERS)

This function allows a specific component to be tested for operation and connection. As each is activated, information is provided through LED in a flash code. This control function is generally used as a double-check after repairs.

CONTROL FUNCTION 3 (TESTING EGR CONVERTER - CALIFORNIA ONLY)

In this function, the diagnostic unit activates EGR converter. You find out if the component is working by listening or putting a hand on it when it is activated.

RETRIEVING CODES (IGNITION SYSTEM) CONTROL FUNCTION NO. 1

CAUTION: Never connect or disconnect ECU connector with ignition in "ON" position.

IGNITION SYSTEM DIAGNOSTICS

1) Locate the diagnostic unit and remove its cover. Connect selector cable to No. 6 socket. Turn ignition to "ON" position. Enter control function No. 1 (access codes) by pressing push button one time for at least one second and no more than 3 seconds. To enter control function No. 2, press push button twice for at least one second and no more than 3 seconds. To enter control function No. 3, press push button three times for at least one second and no more than 3 seconds.

2) Watch the Red LED and count the number of flashes in the three-flash series. The flash series are separated by a three-second interval. See Fig. 2. Note all codes. Only three separate codes can be stored at once. If no codes are stored, the LED will flash a 1-1-1 to indicate the ignition system is operating properly.

3) If a fault code is received, refer to IGNITION SYSTEM FAULT CODES table in this article. Depress push button again and check for additional codes. Depress push button a third time, if necessary. If the first code repeats, there are no other codes.

4) The diagnostic system memory is full when three codes are present. Those three codes must be repaired before further codes can be retrieved.

IGNITION SYSTEM FAULT CODES TABLE

Code	Fault	Repair
1-1-1	No Faults	-----
1-4-2	ECU	Replace ECU
1-4-3	Knock Sensor Signal	(1)
1-4-4	Fuel System Load Signal	(1)
2-1-4	Perm./Magnet Generator	(1)
2-2-4	Cool. Temp. Sensor	Check Temp. Sensor (2)
2-3-4	Throttle Switch Signal	(1)

(1) - See IGNITION SYSTEM FAULT CODE TESTING in this article.
(2) - See I - SYS/COMP TEST article in this section.

IGNITION SYSTEM FAULT CODE TESTING

This section will cover fault codes dealing with ignition system ECU testing. The codes will be followed by an explanation of how to test and repair the affected circuit.

IGNITION SYSTEM ECU LOCATION TABLE

Application	Location
240 Series	Behind Glove Box
740 GL	Under Instrument Panel, Next to Gas Pedal

CODE 1-4-3 (KNOCK SENSOR SIGNAL)

Turn ignition off. Remove ignition system ECU. Disconnect ECU connector and remove protective sleeve. Disconnect knock sensor connector and jumper terminals. Measure resistance between terminals No. 12 (Black wire) and No. 13 (Green wire). Resistance should be zero ohms. If resistance is okay, replace knock sensor. If resistance is too high, wiring is faulty.

CODE 1-4-4 (FUEL SYSTEM ECU LOAD SIGNAL)

Turn ignition off. Disconnect ECU connector and remove protective sleeve. Connect an voltmeter between harness side of terminal No. 8 (Yellow/Brown wire on 240 series and Yellow wire on 740 GL) and ground. Turn ignition on. Reading should be approximately 0.1 volt. If reading is not 0.1 volt, check for break in wiring between ECUs or fault in fuel system ECU.

CODE 2-1-4 (PERMANENT/MAGNET GENERATOR OR ENGINE SPEED SENSOR SIGNAL)

Turn ignition off. Disconnect ECU connector and remove protective sleeve. Connect an ohmmeter between terminals No. 10 (Blue/Yellow wire on 240 series and Red wire on 740 GL) and No. 23 (Yellow/Red wire on 240 series and Blue wire on 740 GL). Resistance should be 215-265. If resistance is not within specification, check wiring. If wiring is okay, check sensor. See PERMANENT/MAGNET GENERATOR under SYSTEM & COMPONENT TESTING article in this section.

CODE 2-3-4 (THROTTLE SWITCH SIGNAL)

Turn ignition off. Disconnect ECU connector and remove protective sleeve. Connect an ohmmeter between terminal No. 7 (Yellow/White wire on 240 series and Orange wire on 740 GL) and ground. Reading should be zero ohms. If resistance is not within specification, check resistance at throttle switch. For throttle switch testing, see SYSTEM & COMPONENT TESTING article.

ERASING DIAGNOSTIC SYSTEM MEMORY

1) After all fault codes have been read and the faults corrected, the diagnostic system memory can be erased. Turn ignition switch to "ON" position. Read fault codes again. Depress push button for more than 5 seconds. After 3 seconds, the LED should light. While the LED is lit, depress push button again for more than 5 seconds. Release button. LED should be out. Disconnect battery cable to erase codes.

2) To ensure memory is erased, depress push button for more than 1 second and less than 3 seconds. A flash code 1-1-1 denotes erased memory.

SUMMARY

If no hard fault codes (or only pass codes) are present, proceed to H - TESTS W/O CODES article for diagnosis by symptom (i.e. ROUGH IDLE, NO START, etc.), or intermittent diagnostic procedures.