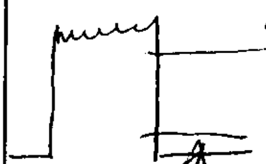
DC Signal How Much Noise is to Much

JENDHAM INC



Technical Training Manual

ADVANCED ENGINE DIAGNOSTICS

Asian Vehicle Applications

Dear Training Manual Owner:

In 1996, we founded JENDHAM, INC. (a San Diego-based company) to develop quality diagnostic information products and technical training programs to meet your needs as an automotive repair technician. To meet part of this goal, we continue to offer training programs that provide technical training on a variety of subjects. The Electrical Series includes hands-on training using our simulators.

The second part of this goal is to design new information products (i.e., our series of Handbooks and Training Manuals) to help you meet the challenge of rapid change occurring in the automobile repair business. At JENDHAM, we continue to create affordable repair information in a "technician-friendly" format in both print and electronic form.

This training manual on Advance Engine Diagnostics for Asian Vehicles is the eighth in our Engine Performance Series. While it was designed for use in our Advanced Engine Performance Class, this manual can be also be used as a self-study guide. To help you use this manual in this manner, we have included numerous case studies in the three OEM sections that allow you to compare how to test similar vehicles. You can even match their readings against the "known good" values we collected and published.

In keeping with the concept of linking our quick reference Handbook Series to our training manuals, we have included several examples of additional reference information in this manual from our Asian handbooks. This feature allows you to see an example of how to use handbook information as part of an overall diagnostic plan and shows how this information compliments the training manual.

While the handbooks and manuals can serve as excellent reference tools, they are not intended to substitute for the various service manuals that you currently use on the job. The range of service repair procedures and specifications between the vehicle manufacturers requires the use of other publications and electronic media during repair procedures for complete accuracy.

Thank you for purchasing our Advance Engine Diagnostics Training Manual, and for attending the AED course. We sincerely hope you find them to be a valuable source of information.

Yours truly,

John F. Astley
V.P. of Product Development

David C. Carlton
President and CEO

P.S. Thanks to the participants in the JENDHAM Technician Focus Group who contributed their time and ideas to help make the JI series of training manuals and handbooks a reality! A special thank you is in order to Dan Wilkins (Director of Training) and to the JI trainers (Dean Parsons, Tim Flannery and Vince Manship) who helped capture and edit our graphics.

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ADVANCED ENGINE DIAGNOSTICS

Introduction

About This Manual

This training manual was developed to provide you with information on how to find the cause of driveability problems using "advanced engine diagnostic" methods along with common shop test equipment. It includes in depth explanations of how to test Engine Control devices along with explanations of how you can expand your testing capability.

It is our hope that this manual will improve the thought process and test procedures you use whenever you test for vehicle problems. In this manner, you can progress to the next level of testing and repair. While this manual was developed for use with the AED Training Class, it can also be used as a stand-alone information and training resource.

<u>ASE Test Help</u>
The information in this manual can be invaluable to you as you prepare to take the ASE A-8 and L-1 tests. It can also expand on the repair knowledge required by most technicians who have already passed both of these tests.

<u>Main Features</u>
The main features of this manual are divided into four sections that include an Introduction to Advanced Engine Diagnostics (AED) as well as individual sections that explain how to use a DVOM, Lab Scope and Scan Tool to test vehicle controller (PCM and TCM) input and output signals used on Asian vehicle applications.

Overview of Sections

Section 1: Introduction Section - This section contains an overview of how to use the various sections of this AED Training Manual along with examples of how to test various Engine Controller sensors and switches that are common to all vehicle manufacturers. It also contains a list of common vehicle controller Terms and Acronyms.

Section 2: American Honda Motor Company, Inc. - This section contains examples of test procedures and recorded events for two specific vehicle applications for this vehicle manufacturer. The two vehicle examples are listed below:

- 1999 Accord Sedan
- 2000 Odyssey Van

Section 3: Nissan Motor Company, USA - This section contains examples of test procedures and recorded events for two specific vehicle applications for this vehicle manufacturer. The two vehicle examples are listed below:

- 1997 Maxima Sedan
- 1999 Sentra Sedan

Section 4: Toyota Motor Sales, USA Inc. - This section contains examples of test procedures and recorded events for two specific vehicle applications for this vehicle manufacturer. The two vehicle examples are listed below:

- 2000 Corolla Sedan
- 2000 4Runner Sport Utility Vehicle

<u>Warranty Information</u>
Examples of the California and Federal Emissions Warranties for three Asian vehicle manufacturers are included in this section.

<u>Diagnostic Help</u>
The OEM sections of this manual contain component test articles that include real world test examples and results for use with a BOB, DVOM, Scan Tool, and Lab Scope.

ADVANCED ENGINE DIAGNOSTICS

Warranty Information

California Emission Warranties

The California Air Resources Board (CARB) requires that new motor vehicles be designed, built and equipped to meet the State's stringent anti-smog standards.

California Emission Control Warranty Table (3/50, 7/70)

Emissions Performance	**3 Years or 50,000 Miles (whichever occurs first)** - The vehicle manufacturer warrants that if your vehicle fails to pass a California Smog Test, it will make the necessary repairs so that your vehicle will pass. This warranty if for 3 years or 50,000 miles (whichever occurs first). The warranty begins the date the vehicle is delivered to the first retail buyer or the date is it first put in service (whichever is earlier).
Long Term Defects	**7 Years or 70,000 Miles (whichever occurs first)** - Air Fuel Ratio Sensor (Toyota Highlander with 2AZ-FE and RAV4) - Air Manifold Gasket (Toyota MR2 Spyder) - Camshaft Position Sensor - Catalytic Converter - Charcoal Canister (Highlander, Land Cruiser & Sequoia - 2UZ-FE) - Distributor - Engine Control Module & Wiring Harness - Exhaust Center Pipe (Toyota Avalon & Highlander with 1MZ-FE) - Exhaust Center Pipe (Toyota Tacoma & Tundra) - Exhaust Front Pipe (Toyota 4Runner, Avalon, Camry, Camry Solara, Celica, Echo, Highlander with 1MZ-FE, Land Cruiser, MR2 Spyder, Sequoia, Tacoma & Tundra) - Exhaust Manifold(s) - Exhaust Manifold Gasket (Toyota Land Cruiser, Sequoia and Tundra with 2UZ-FE engine) - Flywheel with Integral Crankshaft Position Signal Plate - Front Exhaust Tube with Catalytic Converter - Fuel Pressure Regulator (Toyota Camry with 5S-FNE engine) - Fuel Pump (Toyota Highlander with 1MZ-FE engine, and Sienna) - Fuel Tank - Igniter (Toyota Sienna) - Knock Sensor - Intake Manifold, Intake Manifold Collector, Intake Surge Tank - Mass Airflow Sensor - Mass Airflow Sensor (Toyota Tacoma with 2RZ-FE and 3RZ-FE) - Right Exhaust Manifold Gasket (Avalon, Camry, Camry Solara and Highlander with 1MZ-FE engine, and on Sienna models) - Throttle Body - Torque Converter Drive Plate with Integral CKP Signal Plate - Transmission Control Module

ADVANCED ENGINE DIAGNOSTICS

Warranty Information

Federal Emission Control Warranties

The Federal Emission Control Warranty applies when both of the following occur:

- The vehicle fails to meet applicable emissions standards as judged by an emissions test by the Environmental Protection Agency (EPA).
- This failure results or will result in some penalty to the driver, such as a monetary fine or the denial of the right to use the vehicle, under local, state or federal law.

Federal Emission Control Warranty Table (2/24, 48/50, 96/80)

Emissions Related Parts	2 Years or 24,000 miles, 36 months or 36,000 miles (OEM specific) - The vehicle was designed, built and equipped to conform at the time of sale with all applicable federal emissions standards. - The vehicle is free from defects in materials and workmanship that may cause the vehicle to fail to meet these standards.
Emissions Defects	4 Years or 50,000 Miles, 4 years or 60,000 Miles (OEM specific) - Air/Fuel Feedback Control System - Airflow Sensor (Mass Airflow Sensor) - Camshaft Position Sensor - Cold Start Enrichment System (Toyota) - Crankshaft Position Sensor(s) - Deceleration Control System - Distributor Sensor (CMP Sensor) - Evaporative Emissions Control System (charcoal canister, fuel filler neck restrictor, check valve, fuel tank and fuel filler cap) - Exhaust Gas Recirculation System - Exhaust System (includes exhaust manifold) - Exhaust Pipe (manifold to catalyst and/or catalyst to catalyst) - Fuel Injection System - Idle Air Control System - Ignition System (spark plugs, igniter, ignition coils and wires) - Intake Air System (intake manifold, surge tank & throttle body) - Miscellaneous Parts (hoses, clamps, piping, etc.) - Oxygen Sensors - Positive Crankcase Ventilation System (oil filler cap, PCV valve) - Top Dead Center Position Sensor (Honda) - Transmission Control System - Vacuum or Temperature Sensitive Valves and Switches - Variable Timing Electronic Control System (Honda)
Long Term Defects	8 years or 80,000 Miles (Whichever Occurs first) - Catalytic Converter(s) - [illegible] Indicator Light & Bulb - [illegible] - Transmission Control Module

ADVANCED ENGINE DIAGNOSTICS

Technician Requirements

Basic Understanding

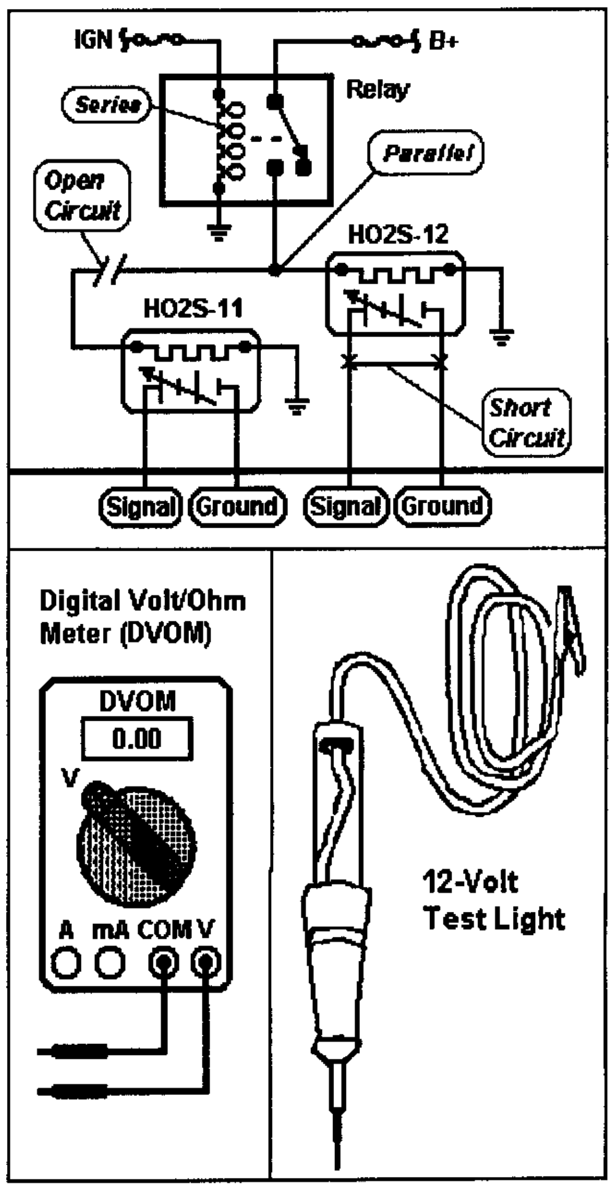
Introduction

As an automotive repair technician, you should have a basic understanding of how to use the hand tools and meters necessary to effectively use the information in this manual, or in other repair manuals or electronic media.

Note: ***Lack of basic knowledge of the Powertrain when performing test procedures could cause incorrect diagnosis or damage to Powertrain components. Do not attempt to diagnose a Powertrain problem without having this basic knowledge.***

Electricity and Electrical Circuits

You should understand basic electricity and know the meaning of voltage (volts), current (amps), and resistance (ohms). You should be able to identify a *Series* circuit as well as a *Parallel* circuit in an automotive diagram. Refer to the examples in the Graphic to the right.



You should understand what happens in an electrical circuit with an open circuit or a shorted wire, and you should be able to identify an open or shorted circuit condition using a DVOM. You should also be able to read and understand an automotive electrical wiring diagram.

Circuit Testing Tools

You should have (and know how to operate) a 12v Test Light, DVOM, Lab Scope and Scan Tool to diagnose vehicle computers and electrical circuits.

You should know not to use a 12v Test Light to diagnose the Engine Controller Electrical system unless specifically instructed to do so by test procedures.

You should have and know when to use an applicable aftermarket connector kit (to make a connection) whenever test procedures call for a connector to be probed in order to make a measurement.

Electrical Circuits

When you encounter a wiring problem during testing, and need to refer to electrical circuit information in electronic media or manuals, you should be comfortable with this type of information:

- Wiring schematics (including circuit numbers and colors)
- Electrical component connector, splice and ground locations
- Wiring repair procedures and wiring repair parts information

ADVANCED ENGINE DIAGNOSTICS

A New Diagnostic Approach

Where To Begin

Diagnosis of engine performance or driveability problems on a vehicle with onboard diagnostics requires that you have a well thought out plan on how to approach the problem. This plan can vary somewhat due to access to a particular computer and its components, but it should contain certain test steps that you repeat for each vehicle.

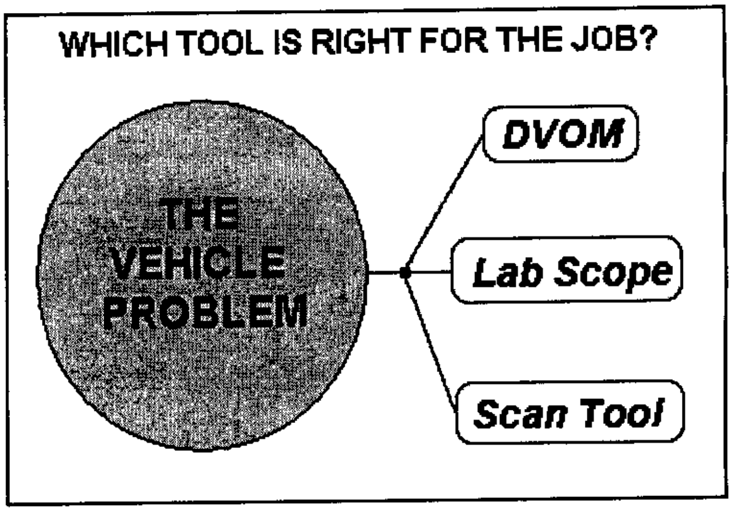
Test Procedures

If you are reasonably certain that a problem is related to the Powertrain Control Module (PCM), the first place to start is with the onboard diagnostics (use the applicable procedure to read and record all available trouble codes).

On vehicles with more than one on-board computer, if you are unsure whether the problem is Powertrain related, you may want to determine if there are any trouble codes related to another vehicle system. If you are certain which vehicle controller is at fault, you should start by checking for codes within that controller.

Choosing The Right Tool

An important decision that you make each time you begin a diagnosis or repair procedure is to decide *which tool is the right one to use for a particular component or test.*



While this decision sounds simple, there are a lot of tests that can be performed with more than one type of tool.

Throughout this manual we will focus on how and when to use the following shop tools:

- The Digital Volt/Ohm Meter
- The Lab Scope or Scope
- The Scan Tool or Scanner

For example, if you are testing a digital signal with a varying On/Off time, you may want to use a Lab Scope to make an accurate measurement of the device output. If you need to test the output of a TP sensor, the Scan Tool will give you this information very quickly and easily. However, neither of these tools is as efficient as a DVOM when you have to test the voltage on a power circuit or the voltage drop at a main ground circuit.

Repair Verification

Once a problem is repaired, you normally clear any trouble codes that were set and then verify proper operation of the vehicle system. To clear any codes in memory, refer to the information in other repair manuals or electronic media. To verify a repair, first duplicate the conditions present when the customer complaint occurred or when a code was set.

For OBD II systems, you must duplicate the actual code conditions (*enable criteria*) for a particular trouble code. The *enable criteria* for vehicles with OBD II can be found in the appropriate JENDHAM Asian Handbook on Trouble Codes and Diagnostics. Use this trouble code information to determine why a code resets. If an OBD II Main Monitor test runs and passes, the chances are good that the problem has been repaired correctly.

ADVANCED ENGINE DIAGNOSTICS

A New Diagnostic Approach

Tool Selection Table

The table below can be used as a guide to help you determine which of the listed tools should be used to test a particular component or circuit. It also contains a number that indicates a suggested order in which to use these tools (e.g., if you are testing a CMP sensor, the first choice is a Scan Tool (1), then a Lab Scope (2) and then a DVOM (3).

Honda Applications

Electronic Ignition	DVOM	Lab Scope	Scan Tool	Signal Type
CMP Sensor	3	2	1	Magnetic (AC volts)
CKP Sensor	3	2	1	Magnetic (AC volts)
TDC Sensor	3	2	1	Magnetic (AC volts)
Coil Primary (voltage/current)	2	1	-	Pulse signals
Fuel Controls	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
Fuel Injector	3	1	2	DC Volts - frequency
Oxygen Sensor	3	2	1	DC Volts - varies
Information Sensors	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
MAP Sensor	2	3	1	DC Volts (varies)
PCM Controlled Generator	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
Generator Control Signal	3	2	1	DC Volts (varies)

Nissan Applications

Electronic Ignition	DVOM	Lab Scope	Scan Tool	Signal Type
CMP Sensor	3	2	1	Optical (digital)
CKP Sensor	3	2	1	Optical (digital)
Coil Primary (voltage/current)	2	1	-	Pulse signals
Fuel Controls	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
Fuel Injector	3	1	2	DC Volts (frequency)
Oxygen Sensor	3	2	1	DC Volts (varies)
Information Sensors	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
MAF Sensor	2	3	1	DC Volts (varies)
MAP Sensor	2	3	1	DC Volts (varies)
PCM Controlled Generator	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
Generator Control Signal	---	---	---	---

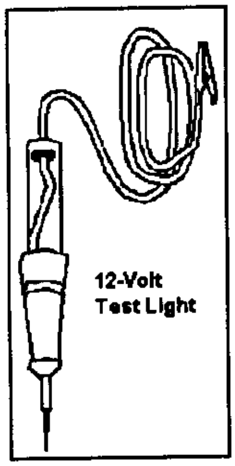
Toyota Applications

Electronic Ignition	DVOM	Lab Scope	Scan Tool	Signal Type
CMP Sensor	3	2	1	Magnetic (AC volts)
CKP Sensor	3	2	1	Magnetic (AC volts)
Coil Primary (voltage/current)	2	1	-	Pulse signals
Fuel Controls	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
Fuel Injector	3	1	2	DC Volts - frequency
Oxygen Sensor	3	2	1	DC Volts - varies
PCM Controlled Generator	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
Generator Signals	---	---	---	Not Applicable
Information Sensors	**DVOM**	**Lab Scope**	**Scan Tool**	**Signal Type**
MAF Sensor	2	3	1	DC Volts (frequency)
MAP Sensor	2	3	1	DC Volts (varies)

TOOLS & EQUIPMENT

12-Volt Test Lights

General Information



The 12-volt test light, whether it is a self-powered or stand-alone light, remains a useful tool for certain automotive electrical circuit tests. Most of us have used a 12-volt test light to check for source voltage and ground continuity in automotive electrical circuits for many years.

However, with the advent of computerized engine controls in 1978, the type of tool to use to test a vehicle controller (ABS, Engine or TCM) circuit has changed. In place of the 12-volt test light we now have the DVOM, Lab Scope and Scan Tool.

Circuits Okay to Test

The following circuits can be safely tested with a 12-volt test light:

- Battery Voltage (at the battery or other circuit connected to B+)
- Charging System (voltage at the alternator or its direct connection)
- Ignition System (voltage at the ignition switch circuit)
- Vehicle computer power ground circuits

Circuits Not Okay to Test

Don't test the following circuits with a 12v test light:

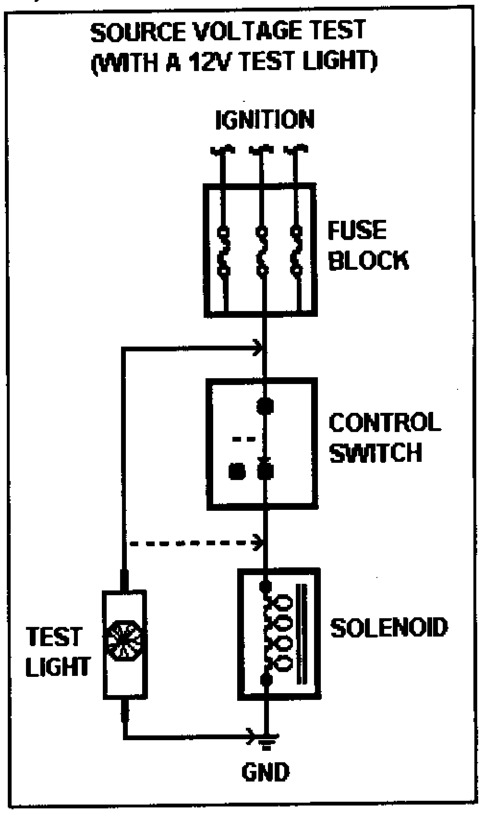
- Vehicle computer sensors or switch circuits
- Vehicle computer serial data circuits (these circuits include the vehicle Class 2 circuit)
- Vehicle computer sensor ground circuits

Source Voltage Test

An example of how to test for "source voltage" is shown in the Graphic to the right. This test can be used to check for available source voltage from the ignition switch to the control switch and solenoid.

Connect the 12-volt test light to battery ground and at a point in the circuit where you expect voltage.

In this case, you would expect the lamp to illuminate once the key is turned on, and the switch is closed to activate the solenoid circuit. The test lamp should illuminate with the probe connected to the solid line test point or to the dotted line test point and ground as shown in the Graphic.



Self-Powered Test Light

In automotive applications, the self-powered test light is designed for use during a continuity check. This tool includes a light bulb, a battery to supply power and two leads. To test the tool, be sure the switch is on and then touch the leads together. The bulb should light when the leads are touched together.

This type of tool is designed for use ONLY on an un-powered electrical circuit. Remove the fuse that supplies power to the circuit to be tested prior to testing. Select two specific points along the circuit through which there should be continuity and then connect one lead of the self-powered test light at each point. If continuity exists in that portion of the circuit, the test light should light up. **Do not use this test light on solid state circuits!**

TOOLS & EQUIPMENT

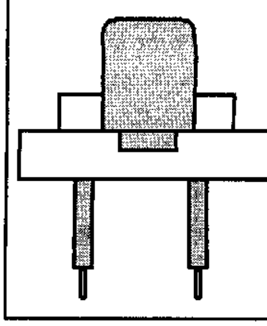
Injector "Noid" Light

General Information

The fuel injector "Noid" is a tool designed to help determine if the PCM is triggering one or more fuel injectors during cranking or engine running conditions. A set of these tools can be ordered from CTI at 1-800-742-5284 (website: www.concepttechnology.com).

The Noid light is designed to allow a low amount of current flow. The current flow does not match the current flow of any particular type of fuel injector circuit. A peak & hold injector circuit use fuel injectors with 1-2 ohms resistance while saturation switch injector circuits use injectors with 12-18 ohms of resistance. Due to these differences, this light should be used as described in this article.

"NOID" LIGHT



Several conditions related to the Noid light that could occur with a condition of "engine cranks, but does not run" are shown below:

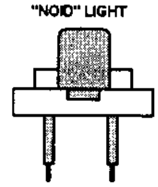
- The Noid light may blink in the Clear Flood mode, but no fuel will be delivered to the cylinders.
- If there is low voltage to the injector or a high resistance condition other than in the injector, the Noid light will blink, but the fuel injector may not operate properly.

Circuits To Test

The following injector circuits can be safely tested with an injector "Noid" light:

- Multiport fuel injector feed and control circuits
- Sequential fuel injector feed and control circuits
- Throttle body fuel injector feed and control circuits

No Start Condition Example

Step	Action	Value	Yes	No
1	Was the PCM read codes step done?	-	Go to Step 2.	Go to the PCM read codes step.
2	Inspect PCM ground connection at engine block. Is the connection clean and tight?	-	Go to Step 3.	Go to PCM power & ground checks.
3	Inspect the fuel pump/injector and ignition fuses. Are both fuses okay?	-	Go to Step 4.	Go to repair table for these devices.
4	Install a Scan Tool. Turn to key on, engine off. Does the TP sensor read less than the example value in the specification column?	**3.5v clear flood mode**	Go to Step 5.	Go to TP sensor high voltage code repair table.
5	Read the ECT and IAT sensor values. Are the sensor readings close to each other?	-	Go to Step 6.	Go to ECT or IAT sensor code repair table.
6	Check the MAP sensor while cranking the engine. Does the MAP sensor voltage change during cranking?	-	Go to Step 9.	Go to MAP sensor code repair table.
7	Remove all of the injector connectors. Install a **"Noid"** light at the Cylinder No. 1 connector. Crank the engine and observe the light. Repeat the same procedure for the rest of the cylinders. Did the **"Noid"** light flash "on" and "off" on all of the cylinders during cranking?	"NOID" LIGHT 	Go to Step 8.	Go to OEM repair chart for the cylinder that did not flash. If none of the injectors flash, check the RPM signal input.
8	Install a fuel pressure gage. Go to fuel pressure test installation chart. Turn key on for 2 seconds. Is the fuel pressure within specifications?	**TBI: 36 psi MFI: 33 psi SFI: 34 psi**	The Fuel system is okay.	Go to OEM repair chart to test the Fuel system.

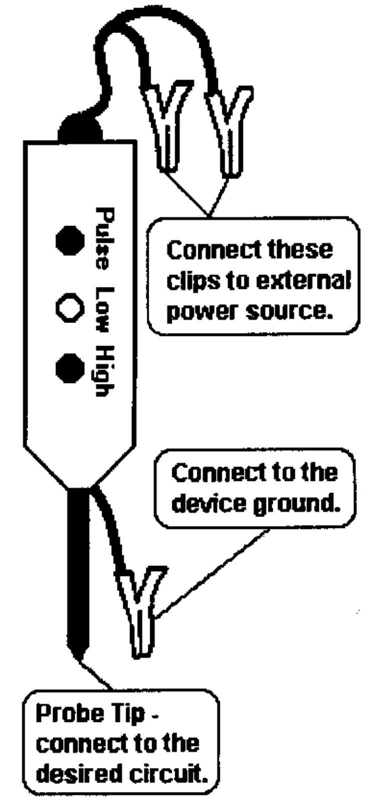
TOOLS & EQUIPMENT

Logic Probe

General Information

A logic probe is a self-powered solid-state device that can be used to test various digital circuits (e.g., Hall effect and Optical distributors). This tool is designed to test vehicle computer circuits that operate with a low voltage and low current. In effect, it will not affect the operation of the circuit under test due to its own high impedance (this is the opposite of a 12-volt test light that can load down and affect a vehicle computer circuit).

Logic Probe



Logic Probe Operation

The logic probe connects to an external power source (e.g., the vehicle battery or ignition power circuit) via the two clips shown at the top of the Graphic to the right.

The external ground at the other end of the Graphic can be connected to the ground circuit of the device to be tested so that the test probe will share the same ground.

Light Emitting Diodes

The probe contains three (3) light emitting diodes (LEDs) that are colored Red (High), Green (Low) and Yellow (Pulse). The LEDs are used to indicate the various voltage conditions that occur on the circuit connected at the probe tip.

The probe is designed to pulse one or more of the onboard LEDs whenever the digital circuit it is monitoring changes voltage (e.g., a change such as a digital signal).

Once the logic probe is powered up, the onboard circuits will quickly separate the voltage of the circuit under test into the possibilities shown by the three LEDs. The Low and High LED's will light up according to changes in the voltage level of a particular circuit.

Some logic probes are also equipped with a feature that provides an audible signal (sound) in addition to the LED functions.

Range Settings

The logic probe has a "range" switch that provides a pair of settings marked CMOS and TTL/LS. The CMOS position is used when checking signals in an electrical system with an operating range of 0 to 16 volts. The TTL/LS setting is used when checking signals in an electrical system with an operating range of 0 to 5 volts.

For example, if you were to use it to test the available voltage at the battery terminals (with an open circuit voltage of 12.4 volts), it could provide the following information. The RED (High) LED would come on and the other two LEDs would remain off with the range switch set to CMOS. If you were checking an IAC motor signal on a vehicle with the engine running, it could provide the following information with the range switch set to CMOS. The RED (high) LED would flash and so would the Yellow LED (Pulse).

Summary - The logic probe can be used to identify if a particular threshold voltage has been met (e.g., it can tell you if a coil or fuel injector is receiving a 12-volt feed voltage). It can also alert you to the fact that a digital signal is actually pulsing (e.g., a CMP sensor signal). However, it has only limited use as a diagnostic tool in automotive applications.

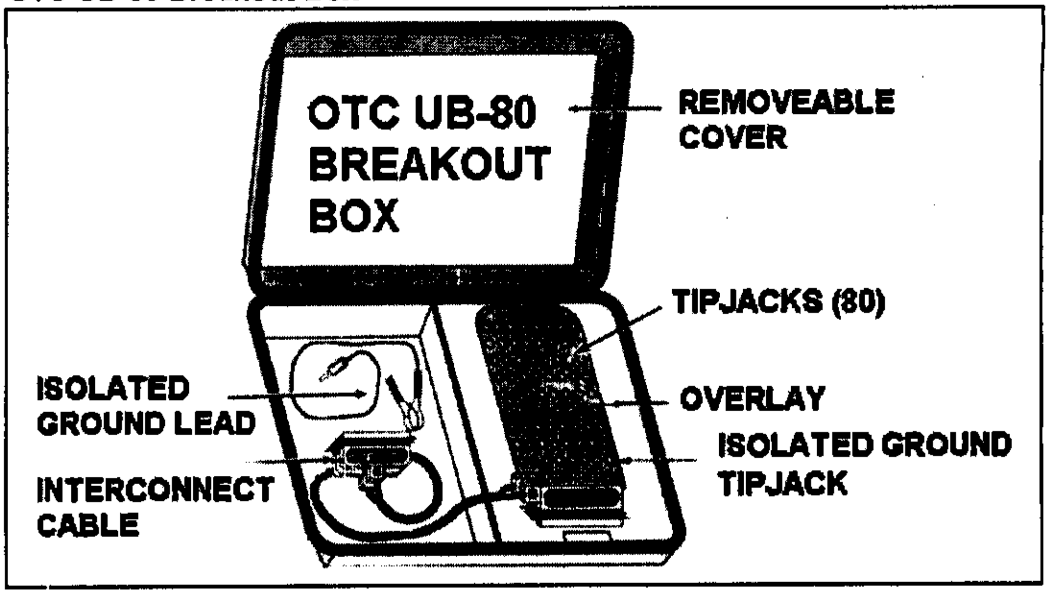
TOOLS & EQUIPMENT

Breakout Box

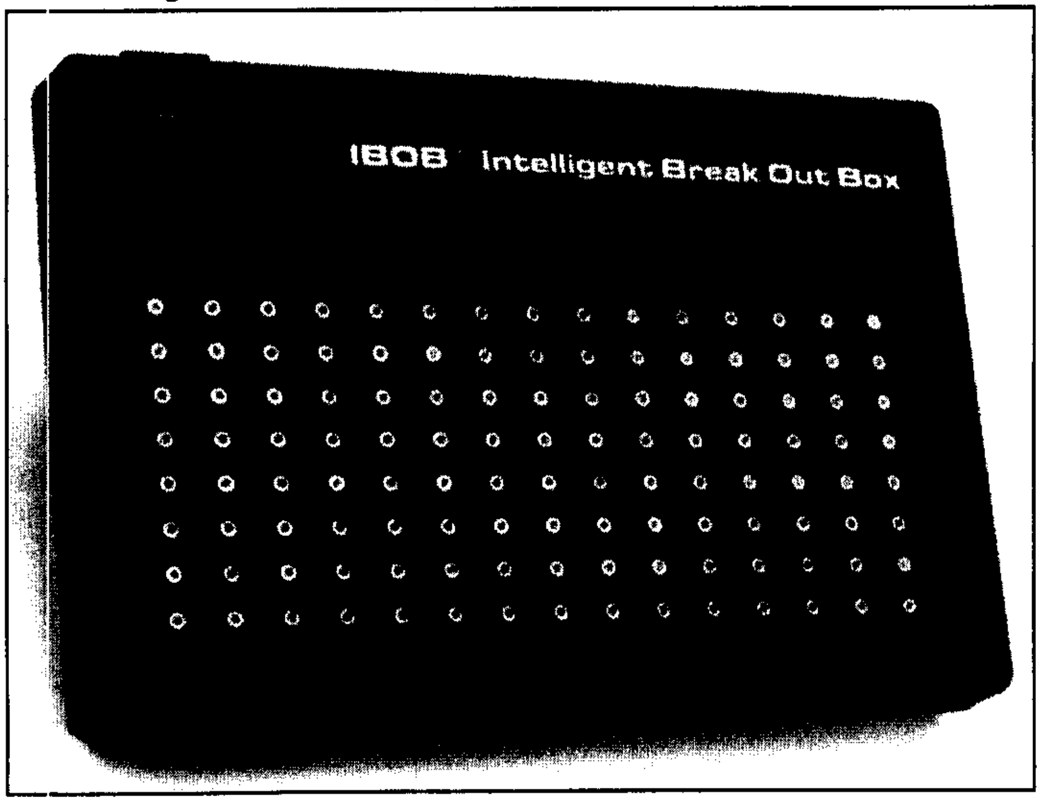
General Information

If a repair step requires that a frequency, voltage or resistance measurement be done at the PCM wiring harness, the recommended tool to use is a breakout box (BOB). The Honda Test Harness can also be used to do these measurements. An OTC UB-80 Breakout Box or MPSI Intelligent Breakout Box (with Asian adapters) can be obtained.

OTC UB-80 Breakout Box



MPSI Intelligent Breakout Box (IBOB)



TOOLS & EQUIPMENT

Digital Volt/Ohm Meter

General Information

The digital volt/ohm meter or DVOM is one of the most versatile and useful tools that you can own or have access to on a regular basis. It may be a toss up as to which tool you use more often - a DVOM or a Scan Tool.

The DVOM is used hand-in-hand whenever you use vehicle electrical wiring diagrams (these diagrams are the road maps for the electrical circuits that connect the vehicle electrical systems). While the DVOM has some limitation when compared to a digital storage oscilloscope (as discussed in this section), it still remains the most basic tool to use during diagnosis of electrical circuits.

<u>Basic Understanding</u>
Before you use the DVOM, there are some basic steps and selections that should be thoroughly understood about its operation.

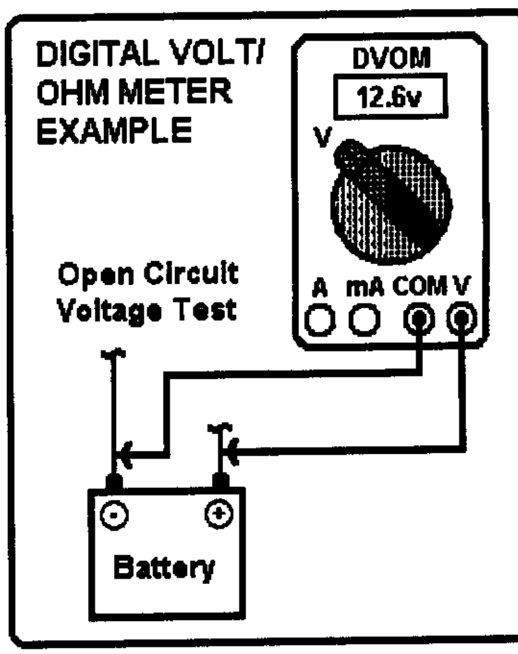
Read through the DVOM operator's manual prior to starting to use it. Perform a functional check before making any measurements.

<u>Functional Check</u>
A functional check includes these steps:

- Turn the DVOM "on" and check the condition (state of charge) of its battery.
- Inspect and test the DVOM leads for breaks in the insulation or open circuits.

Test the operation of the unit and its leads. A quick check of the DVOM is described below.

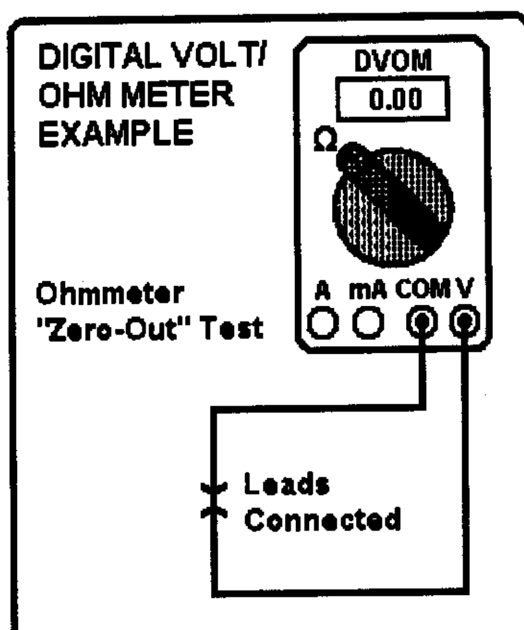
- Select the DC volts range. Connect the test probes across the battery terminals and read the battery open circuit voltage. If the DVOM does not read the battery voltage correctly, stop and repair the problem with the meter or its leads.



<u>Ohmmeter Calibration</u>
The ohmmeter needs to be calibrated prior to making low ohms tests. An example of how to calibrate the ohmmeter is described below:

First connect the DVOM lead probes together and then "zero" the meter. This calibration step may not be available on all digital volt/ohm meters.

- The meter reading should change from "infinity" or OL to "continuity" or near zero (0) ohms as the leads are touched together. Some meters have a quick "zero-out" method while in a low ohms range. Remember to perform this step before taking a low ohms reading.



TOOLS & EQUIPMENT

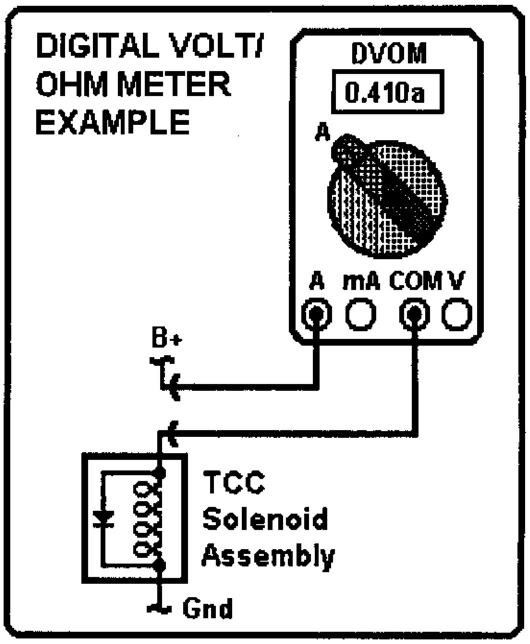
Digital Volt/Ohm Meter

General Information

Ammeter Measurements

Prior to making an ammeter measurement, there are important steps to follow to setup this type of current measurement with an ammeter. These steps are discussed below.

- First turn off the power to the circuit to be tested. If you don't know the exact amount of amperage flow in the circuit to be tested, start the test sequence in the highest amperage range. You can always change the test leads and selector to a lower position on the second test. This step can prevent overloading the internal amperage fuse in the DVOM and having to replace it once it is blown.
- If the DVOM reads 0.00 amps during an amperage test, the electrical circuit or the DVOM internal fuse may be open. Most digital volt/ohm meters include a simple test that can be used to test the internal amperage test fuse for an open condition. If the meter reads 0.00 amps, check the DVOM fuse prior to condemning a circuit.
- It is important to observe correct battery polarity when using an ammeter. Start the test by connecting the Red lead (B+) from the meter jack to the source voltage point and then connect the Black lead (B-) to ground. In some cases, the amperage reading will be different depending upon the polarity of the circuit. This can be an important point to remember for some kinds of amperage tests.



Proper Scale Selection

Selecting the proper DVOM scale to use for a particular function (amps, ohms or volts) is important whenever you make a test measurement. If you select the wrong scale, the test measurement will be invalid or missing, and can lead to replacement of good parts, or you could start down a series of test steps when there was really nothing wrong.

Most digital volt/ohm meters include both auto-ranging and manual range selection as an operating feature. During testing, pay particular attention to how you change between scales while in manual-ranging mode to prevent obtaining an incorrect or misleading reading on the DVOM display. The list below contains some tips for selecting a scale.

1) Start your test measurement on the highest scale and then work your way down the scale until you obtain the desired reading, or until the meter reading goes off-scale. On some digital volt/ohm meters an off-scale reading is displayed as O.L.
2) If the reading goes out of limits (O.L.), back up and then take another reading.
3) Once the reading is stable, use the scale indicator to convert the reading to the correct decimal point. Examples of how to convert readings are included below.
   - If the scale indicator is 'K' (for Kilo), move the decimal point 3 places to the right.
   - If the scale indicator is 'M' (for Meg), move the decimal point 6 places to the right.
   - If the scale indicator is 'm' (for milli), move the decimal point 3 places to the left.
   - If the scale indicator is 'u' (for micro), move the decimal point 6 places to the left.

TOOLS & EQUIPMENT

Digital Volt/Ohm Meter

General Information

The proper use of a DVOM on automotive applications requires that the user understand some basic arithmetic and how to properly use a calculator.

Scientific Notation

Your basic knowledge of shop tools should include how to use a calculator so that you can convert numbers using the "powers of ten" (called *Scientific Notation*). Once you master the use of Scientific Notation, you will be able to work with problems that have a small decimal value, or problems with very large decimal whole numbers.

In a calculator, a number can be entered (or a result is displayed) in terms of a power of ten. An example of this function might be as follows: 1234 might be entered as 1.234 x 10^3 and the number 0.001234 would appear as 1.234 x 10^{-3}. Refer to the table below.

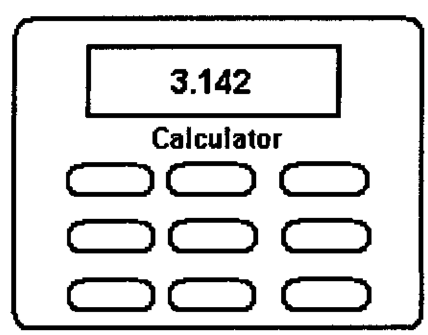
Scientific Notation Examples

10^0 = 1	10^0 = 1
10^1 = 10 deka (da) (D)	10^{-1} = 0.1 deci (d)
10^2 = 10 hecto (h)	10^{-2} = 0.01 centi (c)
10^3 = 1000 kilo (k)	10^{-3} = 0.001 milli (m)
10^4 = 10,000 myra (My)	10^{-4} = 0.0001
10^5 = 100,000	10^{-5} = 0.000,01
10^6 = 1,000,000 mega (M)	10^{-6} = 0.000,001 micro (u)
10^7 = 10,000,000	10^{-7} = 0.000,000,1
10^8 = 100,000,000	10^{-8} = 0.000,000,01
10^9 = 1,000,000,000 giga (G)	10^{-9} = 0.000,000,001 nano (n)
10^{10} = 10,000,000,000	10^{-10} = 0.000,000,000,1
10^{11} = 100,000,000,000	10^{-11} = 0.000,000,000,01
10^{12} = 1,000,000,000,000 tera (T)	10^{-12} = 0.000,000,000,001 pico (P)

"Power of Ten" Explanation

A decimal faction can be expressed using the Scientific Notation function (e.g., the number 10 times a negative power of ten). Multiples of ten can be expressed as ten to the proper positive power of ten in order to represent large decimal values. An example of this type of function appears in the Graphic.

The numbers to the left of the decimal point are limited to a one-digit number (a number between one and ten), and the remainder of the significant figures will be placed to the right side of the decimal point.



Scientific Notation Example:

3.142 x 10^{-1} = 0.3142

TOOLS & EQUIPMENT

Digital Volt/Ohm Meter

General Information

Terms & Explanations
There are a few terms that are used frequently with a digital volt/ohm meter that you should recognize and understand what they mean. These are terms that are used commonly during electrical circuit testing with a DVOM. A few of these terms are discussed in the article below.

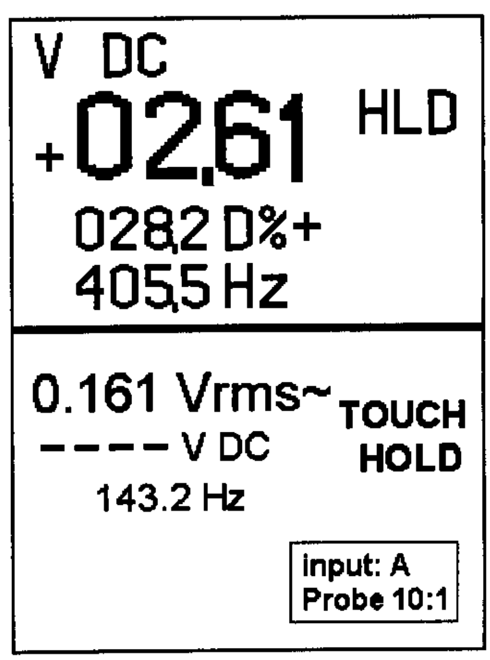
Digits or Counts
These terms are used to describe the number of digits that can be displayed on the face of the meter. Some digital volt/ohm meters have a limit of 3 1/2 digits, and can display up to a number (value) of 1999. Other meters can display up to 4 1/2 digits, and can display up to a number (value) of 19,999. It is worth noting that the more digits that can be displayed, the greater the resolution of the meter will appear.

Resolution
This term is used to describe how fine a measurement the DVOM can perform. Some digital volt/ohm meters can only measure down to one millivolt (0.001v), while other meters can measure down to one microvolt (0.000001v). Refer to the article on Digits.

MIN/MAX Mode
The terms MIN/MAX Mode are used to indicate a feature found on many digital volt/ohm meters. Once you select this type of record mode, the DVOM (memory chip) samples, stores and remembers the lowest (MIN), the highest (MAX) and the average readings.

Each time a new MIN or MAX reading is detected by the DVOM, a beeper will sound to alert you that this action has occurred (if equipped). The beeper can be set to operate continuously in this mode (for up to 36 hours), or for as long as this function is applied. One common use for this function is to find an open or short circuit condition.

Hold Mode
The Hold Mode is a function found on most digital volt/ohm meters. Once this mode is selected (or Touch Hold is selected), the current reading can be stored for display at a later time. This allows the user to remove the DVOM from the work area (under the hood or under the dash), compare the stored reading to a specification or to just write it down. An example of these functions is shown in the Graphic to the right.



DVOM Limitations
As functional as a modern digital volt/ohm meter can be for test purposes, it does have its limitations due to the fact that is was designed to monitor circuit conditions, not the circuit activity. The reason that it cannot be used to monitor circuit activity is its slow update rate (typically about 4 times a second).

You may encounter a circuit that has electrical noise (EMI or RMI) or extraneous signals. In these cases, you may not be able to make a proper measurement or detect these other signals on the DVOM. In these cases, the Lab Scope is the "tool of choice".

TOOLS & EQUIPMENT

Digital Volt/Ohm Meter

General Information

Conversion Chart - Duty Cycle to Dwell

The information in the table below can be used to convert a duty cycle reading to a dwell reading, or a dwell reading to a duty cycle reading.

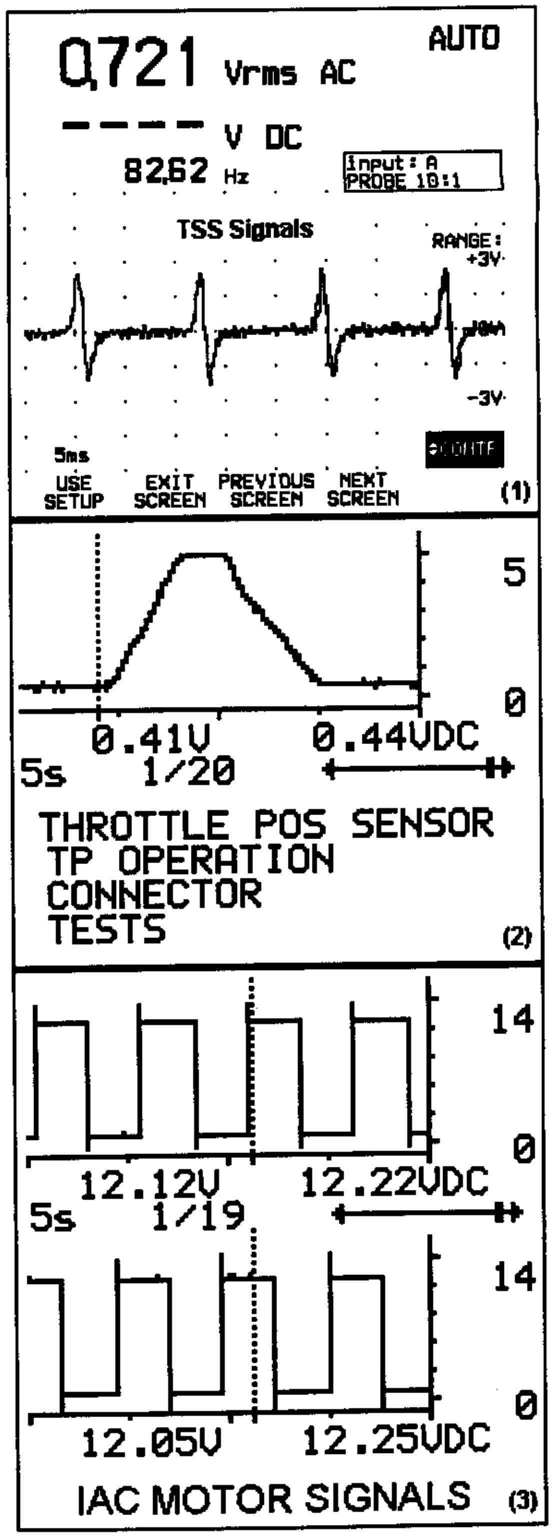
Duty Cycle Percentage (negative trigger)	Dwell Reading (by number of cylinders)				
	3	4	5	6	8
20%	24.0	18.0	14.4	12.0	9.0
22%	26.4	19.8	15.8	13.2	9.9
24%	28.8	21.6	17.3	14.4	10.8
26%	31.2	23.4	18.7	15.6	11.7
28%	33.6	25.2	20.2	16.8	12.6
30%	36.0	27.0	21.6	18.0	13.5
32%	38.4	28.8	23.0	19.2	14.4
34%	40.8	30.6	24.5	20.4	15.3
36%	43.2	32.4	25.9	21.6	16.2
38%	45.6	34.2	27.4	22.8	17.1
40%	48.0	36.0	28.8	24.0	18.0
42%	50.4	37.8	30.2	25.2	18.5
44%	52.8	39.6	31.7	26.4	19.8
46%	55.2	41.4	33.1	27.6	20.7
48%	57.6	43.2	34.6	28.8	21.6
50%	60.0	45.0	36.0	30.0	22.5
52%	62.4	46.8	37.4	31.2	23.4
54%	64.8	48.6	38.9	32.4	24.3
56%	67.2	50.4	40.3	33.6	25.2
58%	69.6	52.2	41.8	34.8	26.1
60%	72.0	54.0	43.2	36.0	27.0
62%	74.4	55.8	44.6	37.2	27.9
64%	76.8	57.6	46.1	38.4	28.2
66%	79.2	59.4	47.5	39.6	29.7
68%	81.6	61.2	49.0	40.8	30.6
70%	84.0	63.0	50.4	42.2	31.5
72%	86.4	64.8	51.8	43.2	32.4
74%	88.8	66.6	53.3	44.4	33.3
76%	91.2	68.4	54.7	45.6	34.2
78%	93.6	70.2	56.2	46.8	35.1
80%	96.0	72.0	57.6	48.0	36.0

TOOLS & EQUIPMENT

Digital Volt/Ohm Meter

General Information

Graphing Multimeter
An important advance in testing has occurred with the introduction of the "Graphing Multimeter". This tool has radically changed the approach to "glitch" failure diagnosis.



Plotting a Signal
The addition of the Graphing Multimeter allows you to plot the activity of an electrical signal (over time) and display the signal as a graph. Graphs that appear on a DVOM (or a Scan Tool) may look like a Lab Scope waveform, but they are different in design.

Measurement Capability
The Graphing Multimeter is designed to measure and display automotive signals in three common formats: frequency, pulsewidth and voltage. The method used to capture and display this type of information is different from that used with a Lab Scope.

The Graphing Multimeter has a very fast sampling rate. It is designed to continually monitor the minimum and maximum voltage levels that it detects on a circuit, and then store the readings into a buffer in the unit.

At this point, the CPU in the Multimeter does a calculation in order to plot the trace on the display to represent the activity of that circuit.

Fast Updates
As quickly as the meter display is updated, the internal buffer is cleared and the meter immediately starts over to sample and store the latest circuit activity. While the display update of the tool is fairly slow, it can be used quite successfully to capture any glitches on a circuit due to its fast sample update rate.

This is the key feature of this unit that allows it to easily capture and display voltage spikes.

Recording Capability (Glitch Capture)
Some Multimeters have the capability to record the activity on a particular circuit over an extended period of time. This feature can be invaluable when trying to find and isolate the cause of an intermittent circuit problem.

The three examples on this page show how different Multimeter functions can be used to capture various automotive electrical signals.

TOOLS & EQUIPMENT

DVOM Test Examples

MAP Sensor Test Example

Each OEM section of this manual contains examples of how to test engine control Information Sensors. An example of a DVOM test for a MAP sensor is shown below.

Honda Test Example

The manifold absolute pressure (MAP) sensor converts the value of the manifold absolute pressure into an analog signal that is used by the PCM to determine the amount of fuel delivery, idle speed and ignition timing.

<u>Circuit Descriptions</u>

The MAP sensor circuits can be checked with a DVOM as discussed next:

MAP Signal Circuit - This circuit should be checked for an open circuit condition and for a short-to-ground condition. Backprobe the RED/GRN wire at the 3-pin connector. The reading on this circuit with the key on should closely match the reading on a Scan Tool.

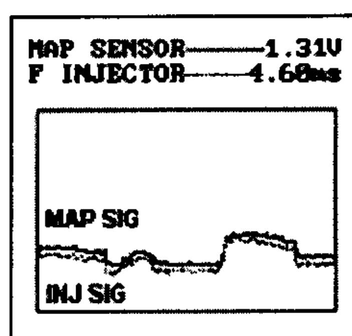
MAP Ground Circuit - Connect one lead to the MAP sensor ground circuit in the 3-P connector (BRN/BLK wire) and connect the other lead to battery negative. Then turn the key "on". The DVOM should read less than 50 millivolts if the ground circuit is okay.

MAP VREF Circuit - Disconnect the MAP sensor connector, turn the key on and backprobe the VREF circuit (YEL/RED wire). This circuit should read from 4.9-5.1v. If the VREF reading reads 0v, check the wire for a short to ground or an open circuit condition. Make repairs as needed. If the circuit is okay, substitute a known-good PCM and retest the circuit. Replace the original PCM if the VREF reading is now within range.

Graphic Meter Test (MAP Sensor)

<u>Dynamic Test</u>

Connect a Graphing Meter to the signal wire. Read the voltage in KOEO and KOER modes. Then compare the readings to the values in the Operating Range Charts. Note the close relationship between the MAP signal and injector control signal at idle rpm in the example.



Static Test - Connect a vacuum pump to the sensor and slowly apply vacuum to the sensor (sweep the sensor through its complete range). If the reading drops off or changes too quickly, replace the MAP sensor.

<u>MAP Sensor Calibration Test</u>

Connect the DVOM leads to the MAP signal and battery negative. Turn the key on, connect a vacuum pump to the sensor and slowly apply 10" Hg to the sensor. Record the reading at 10" Hg. At sea level, the reading should be 1.8-2.0v. At over 4000 feet, the reading should be under 1.8-2.0v (for each 1000 feet, the signal should drop 0.25v). If the voltage change is not as specified, replace the MAP sensor and repeat the test. If the sensor is okay, check the vacuum source to the MAP for leaks or a restriction.

<u>PCM Backup Strategy</u>

If the MAP sensor or its circuit fails, the PCM will shift to a backup strategy program that can allow the vehicle to limp-in for repair. To test this function, remove the MAP sensor 3-P connector and attempt to start the engine. The PCM will detect that the MAP signal is missing, set a code and switch to its backup strategy. The engine should start and run.

TOOLS & EQUIPMENT

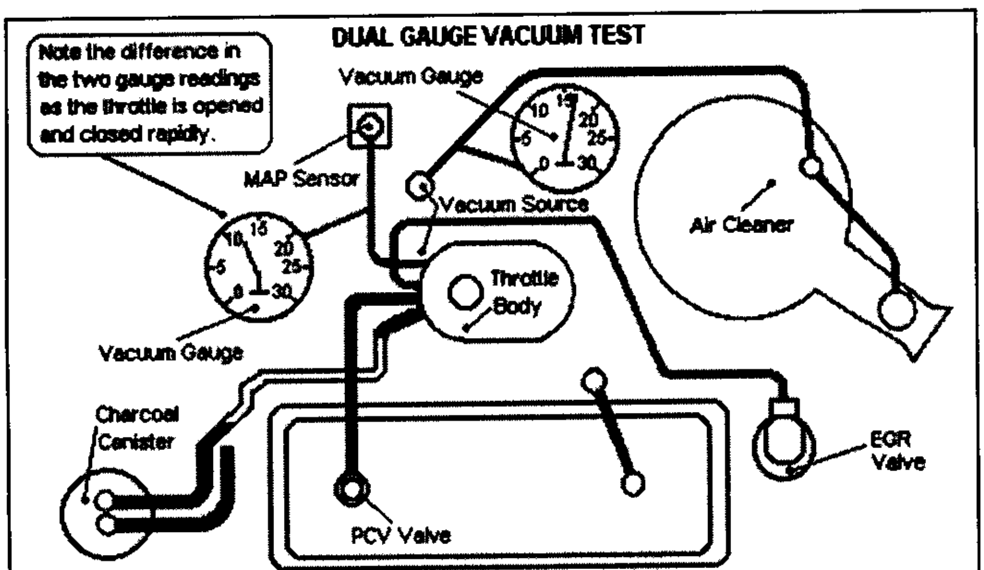
DVOM Test Examples

Dual Gauge Vacuum Test

Problems related to the source of the vacuum to the MAP sensor are difficult to diagnose. The vacuum connection at either the manifold or throttle body is vulnerable to restrictions or plugging due to contamination from the A/F mixture or PCV valve flow that can buildup and partially cover the vacuum port opening to the MAP sensor vacuum line. The dual gauge vacuum test was designed to determine if the MAP sensor source vacuum is correct.

To verify that the source vacuum is not restricted or delayed to the MAP sensor requires a pair of vacuum gauges (analog type), two 'T' type vacuum fittings, and two short pieces of vacuum hose. First, check the engine vacuum source line for any damaged areas or sharp bends that could cause leakage or a restriction resulting in a low vacuum reading.

Next, verify that the vacuum line is not restricted or full of moisture. If the driveability problem happens only when the engine is cold or in sub-zero temperatures, suspect that moisture may be in the vacuum line and collecting in a low area where it freezes. After the engine warms up, the ice melts and the problem goes away. Check for the presence of moisture. Remove both ends of the vacuum line and apply shop air to the vacuum line. If plastic vacuum lines are used, inspect them for melted or collapsed housings.



Engine Running Test

To test the source vacuum with the engine running, connect two vacuum gauges as shown in Graphic above. The gauges are connected at two separate vacuum sources. Place the transaxle in Park or Neutral and start the engine. Watch the operation of both gauges as the throttle is snapped open and closed rapidly (repeat this step several times). The gauges should track each other very closely. If the gauge on the MAP signal line lags behind the other gauge, clear the obstruction at the vacuum source. The problem may require throttle body removal to clean the MAP sensor vacuum opening.

Note: ***If a MAP vacuum signal is delayed, changes to fuel enrichment and timing will lag behind engine demands and result in tip-in hesitation or trailer hitching on Decel.***

TOOLS & EQUIPMENT

DVOM Test Examples

Main Relay Test Example

Each OEM section of this manual contains examples of how to test engine control devices. An example of a DVOM test for the Main Relay on a Honda is shown below.

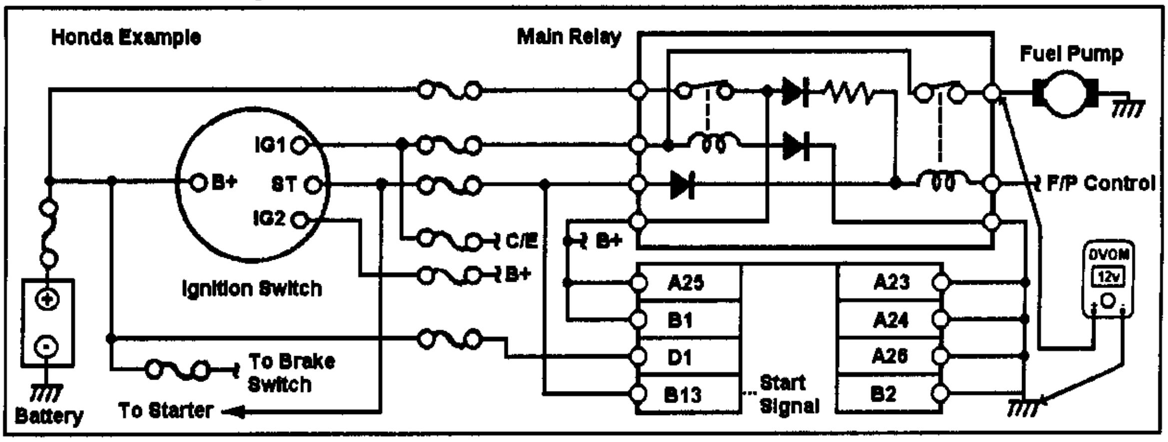
EFI Main Relay

Honda applications with fuel injection use a PGM-FI main relay that includes two relays inside one assembly. With the key on, one relay is energized and this action supplies battery voltage to the PCM and to the second relay. The second relay is energized by the PCM for two seconds whenever the ignition is turned to "on". It is also energized whenever the engine is running. It controls power to the fuel pump and to the injectors.

Circuit Description

With the key on, one relay is energized (IG1 circuit) and this action supplies voltage to the PCM and to the second relay. The second relay (fuel pump control) is energized by the PCM for two seconds whenever the key is turned on, and whenever the engine is running. It controls power to the fuel pump and fuel injectors. In this example, the DVOM should read near system voltage (12v) for two seconds after the key is turned to "on".

PGM-FI Main Relay Schematic



Diode Test with A DVOM

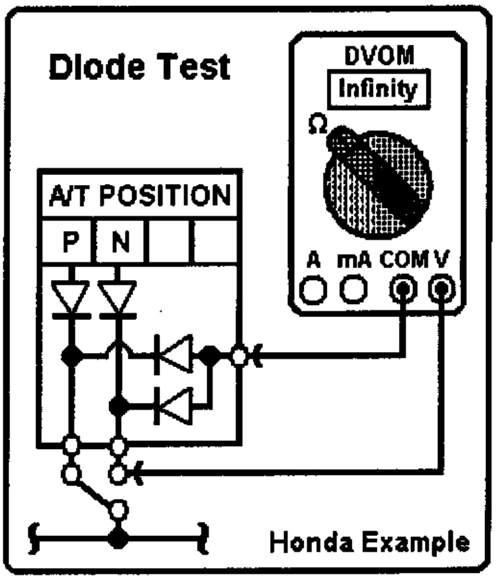
The A/T position indicator unit on Honda vehicles with an A/T includes diodes that allow current to flow in one direction to indicate the P/N position.

To test the 'N' diode, disconnect the wiring harness from the indicator. Measure the resistance of the LED. It should read high resistance in one direction and continuity in the other direction if the LED is functional.

Test Explanation

If the diode in this example reads Infinity in one direction and Continuity in the other direction, the diode is functional.

If the diode is shorted, the DVOM will read Continuity in both directions. If it is open, the DVOM will read Infinity in both directions.

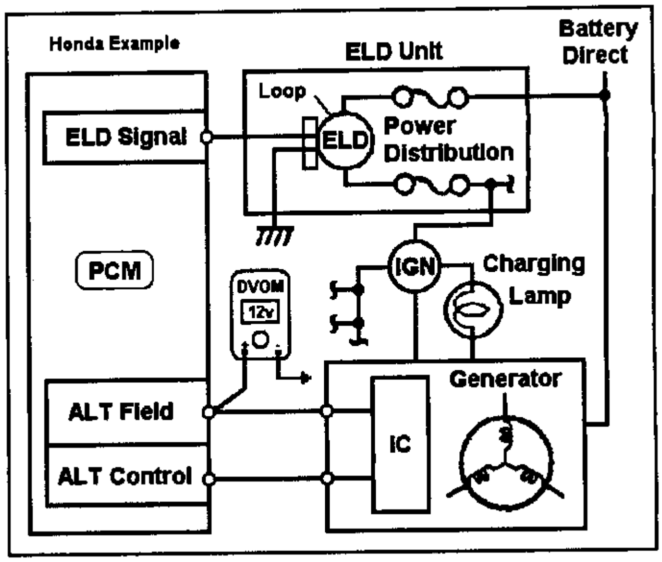


TOOLS & EQUIPMENT

DVOM Test Examples

PCM Generator Test Example

The Honda section of this manual includes an example of how to test a PCM Controlled Generator. An example of a DVOM test for the Honda Charging system is shown below.



PCM Controlled Charging System
Honda applications are equipped with a Charging system controlled and monitored by the PCM. The PCM commands the generator output to meet the driving conditions.

ELD Sensing Loop
The ELD Sensing Loop is mounted under the hood inside the main fuse box. Ignition voltage is provided after the dash fuse box on the circuit to the ignition switch. *Do not test this Charging system with a load tester!*

Generator 'FR' Signal
The PCM uses the generator 'FR' signal to detect when the generator is charging. This circuit is diagnosed as a symptom problem (there are not codes for it).

DVOM Test Example
Operate the engine at low or medium speed to set up the desired capture speed.

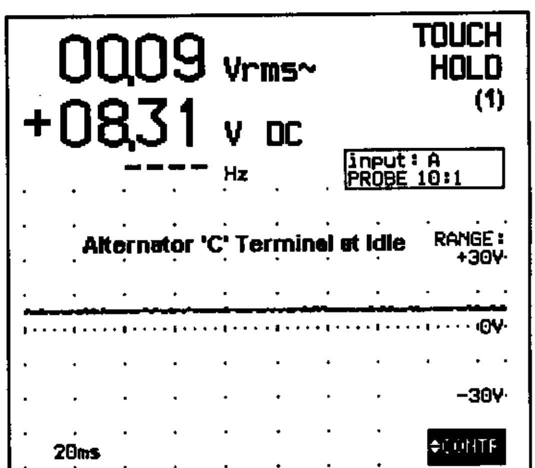
DVOM Connections (Generator Control)
Connect the DVOM positive probe to the generator control circuit at Pin C2 of the PCM 31-Pin connector (WHT/GRN wire). Connect the DVOM negative probe to the battery negative ground post.

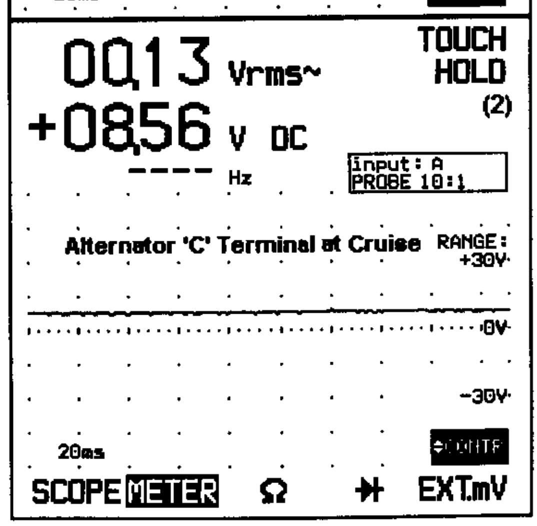
DVOM Connections (Generator Output)
To test the Generator output, zero the inductive amp probe from the Charging system tester. Then connect the probe clamp around the generator output circuit (the BLK wire).

DVOM Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

DVOM Explanation - Example (1)
In this example, the trace shows the voltage level of the generator control circuit with the lights, rear defroster and A/C on at idle speed.

DVOM Explanation - Example (2)
In this example, the trace shows the voltage level of the generator control circuit with the lights, rear defroster and A/C on at 2500 rpm.





TOOLS & EQUIPMENT

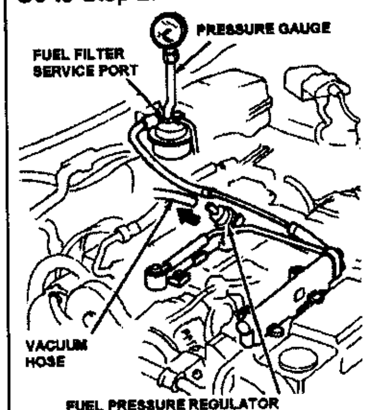
Honda Motor Company

Fuel Pressure Test Example

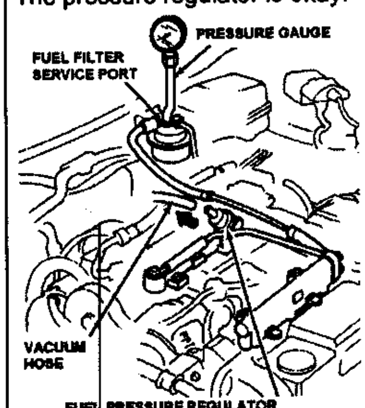
The Fuel system pressure test is part of a series of tests that can be used to determine the cause of a No Code problem. This test is used on a Fuel system with high pressure.

Fuel Pressure Release - Turn the ignition off and remove the fuel cap to relieve any fuel pressure in the fuel tank. Place a shop towel around the service bolt at the top of the fuel filter unit. Use the proper wrenches and slowly loosen the service bolt one complete turn.

Fuel Pressure Test Table

Step	Action	Value	Yes	No
1	**Caution: fuel system under pressure!** • Connect a fuel pressure gauge to the point where the service bolt connects. • Start the engine and then check for any signs of a fuel system leak. • Next, watch the fuel pressure with the engine at idle speed and the pressure regulator hose removed and plugged. The fuel pressure should read within the specified value with the vacuum hose to the regulator removed. • Does the fuel pressure read higher than the specified value to the right?	35-41 psi	Go to Step 2. 	Go to Step 3.
2	• Pressure too high - check for pinched fuel return hose or faulty fuel pressure regulator. Were any problems found?	---	Make repairs as required and then recheck the fuel system pressure starting at Step 1.	---
3	• Pressure too low - check for clogged fuel filter, a faulty pressure regulator, a fuel pump failure or leakage in the system. Were any problems found?	---	Make repairs as required and then recheck the fuel system pressure starting at Step 1.	---

Fuel Pressure Regulator Test Table

Step	Action	Value	Yes	No
1	**Caution: fuel system under pressure!** • Connect a fuel pressure gauge to the point where the service bolt connects. • Start the engine and then check for any signs of a fuel system leak. • Verify the pressure reading rises from 8-9 psi each time the vacuum hose is connected and removed from the regulator. The fuel pressure should be 35-41 psi with the vacuum hose off. • Does the pressure change normally?	8-9 psi	The pressure regulator is okay. 	Go to Step 2.
2	• If the pressure does not change normally, wrap a shop towel around the fuel return line and lightly pinch the return line. Did the pressure change?	---	Check for a restricted fuel filter and check the fuel pump output. Make repairs as needed and then retest the regulator.	Replace the fuel pressure regulator.

COMPONENT & SYSTEM TESTS

Nissan Motor Co.

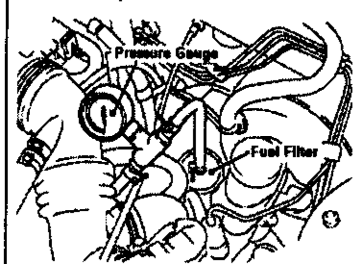
Fuel Pressure Test Example

The Fuel system pressure test is part of a series of tests that can be used to determine the cause of a No Code problem. This test is used on a Fuel system with high pressure.

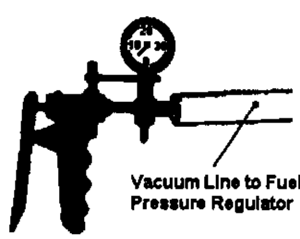
Fuel Pressure Release - Turn the ignition off and locate the fuse panel. Then remove the fuse to the fuel pump. Start the engine and after it stalls, crank it two to three times to release the fuel pressure. Turn the ignition off and replace the fuel pump fuse.

Caution: Keep open flames and sparks (including cigarettes) away from the work area.

Fuel Pressure Test Table (Sentra Example)

Step	Action	Value	Yes	No
1	**Caution: fuel system under pressure!** • Release the pressure in the system. • Disconnect the fuel hose between the fuel filter and fuel tube (place a shop towel around hose during removal to avoid any fuel spillage). • Install a fuel pressure gauge between the fuel filter and fuel tube. • Start the engine and check for leaks. • Read the fuel pressure at idle speed with the vacuum line connected. • Is the pressure within normal range?	28-36 psi	Go to Step 2. 	Test the fuel pressure regulator.
2	• With the engine at idle speed, read the pressure with the vacuum hose off. • Is the pressure within normal range?	39-43 psi	The Fuel system pressure is okay at this time.	Test the fuel pressure regulator.

Fuel Pressure Regulator Test Table (Sentra Example)

Step	Action	Value	Yes	No
1	**Caution: fuel system under pressure!** • Release the pressure in the system. • Disconnect the fuel hose between the fuel filter and fuel tube (place a shop towel around hose during removal to avoid any fuel spillage). • Install a fuel pressure gauge between the fuel filter and fuel tube. • Start the engine and check for leaks. • Stop the engine. • Remove the vacuum line to the regulator at intake manifold. • Connect a vacuum pump to this line. • Are these steps completed?	---	Go to Step 2. 	---
2	• Start the engine and read the change on the fuel pressure gauge as vacuum is slowly increased at the fuel pressure regulator vacuum line. • Did the fuel pressure decrease as the vacuum was increased with the hand vacuum pump?	---	The fuel pressure regulator is operating normally.	Replace the fuel pressure regulator and then retest the fuel pressure.

TOOLS & EQUIPMENT

Toyota Motor Company

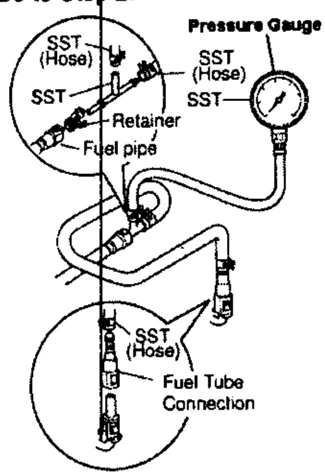
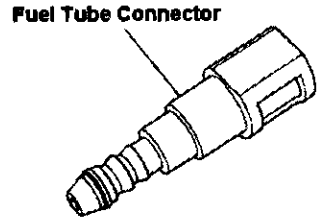
Fuel Pressure Test Example

The Fuel system pressure test is part of a series of tests that can be used to determine the cause of a No Code problem. This test is used on a Fuel system with high pressure.

Fuel Pressure Release - Turn the ignition off. Disconnect the fuel pump connector at the fuel pump. Start the engine and after it stalls, crank it two to three times to release any residual fuel pressure. Turn the ignition off and replace the fuel pump connector.

Caution: Keep open flames and sparks (including cigarettes) away from the work area.

Fuel Pressure Test Table (Corolla Example)

Step	Action	Value	Yes	No
1	**Caution: fuel system under pressure!** • Release the pressure in the system. • Disconnect the fuel pump connector. • Start the engine. Once it stalls, crank it two to three times to release residual fuel pressure. • Turn the ignition off and reconnect the fuel pump connector. • Are these steps completed?	---	Go to Step 2.  	---
2	• Purchase a new fuel tube and remove the fuel tube connector from its pipe. • Disconnect fuel tube connector at the fuel pipe (place a shop towel around the pipe during removal to avoid any fuel spillage). • Install a fuel pressure gauge at the fuel pipe (wipe up any gas spillage). • Start the engine and observe the fuel pressure reading on the fuel gauge. • Is fuel pressure value within range?	44-50 psi	Fuel system pressure is okay at this time. Inspect the fuel pressure regulator for signs of a fuel leak (at vacuum hose).  	Go to Step 3.
3	• Is the fuel pressure to high? • If yes, check for a faulty pressure regulator or pinched return line. • Were any problems found?	---	Make repairs as required and recheck the Fuel system pressure starting at Step 1. Remove pressure gauge and replace fuel tube connector.	Go to Step 4.
4	• Is the pressure too low? • If yes, check for a clogged fuel filter, a faulty pressure regulator, a failed fuel pump or fuel leakage in the system. • Were any problems found?	---	Make repairs as required and then recheck the Fuel system pressure starting at Step 1. Remove pressure gauge and replace fuel tube connector.	---

TOOLS & EQUIPMENT

Lab Scope

General Information

Oscilloscopes have been used in the automotive repair industry for a lot of years. They can provide a view into the heart of the vehicle's electrical system. Some of the common uses of the scope have been as an "ignition analyzer" or as part of an "engine analyzer".

With the advent of computerized engine controls on automobiles beginning in late 1978, the need for a more accurate method to view the engine controller input and output signals appeared. It was around 1987-88 that the automotive Oscilloscope or Lab Scope entered the shop work place in many areas. It quickly became the right tool at the right time in many repair shops that fixed difficult to diagnose engine control related problems.

Today, the automotive Oscilloscope is one of the most accurate and useful tools available to a host of repair technicians, and it has become the "tool of choice" to use to evaluate many common automotive signals.

<u>Vehicle Engine Controls</u>

The table below contains the names of many of the automotive electrical signals that a technician must be able to check in order to evaluate the vehicle Engine Controls. While it is not a complete list, it contains the names of the signals covered in this manual.

The Engine Control signals covered in the test examples in this manual include:

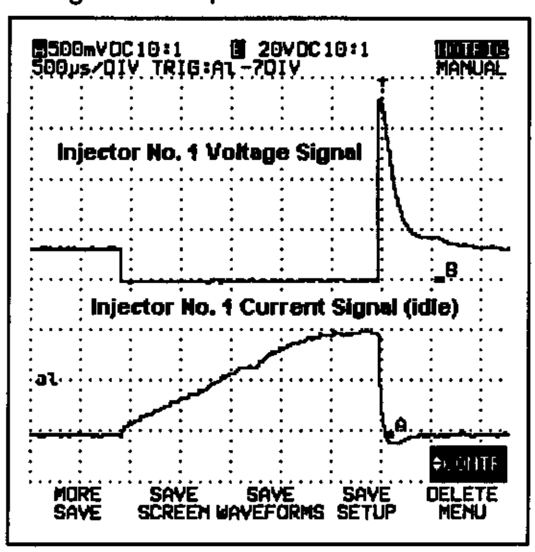
Input Signals	Output Signals
CKP, CMP & TDC Sensors	EGR Solenoid
MAF & MAP Sensors	EVAP Purge Solenoid
Air Fuel Sensor & Oxygen Sensor	Fuel Injectors
TP Sensor	Generator Control
Vehicle Speed Sensor	Idle Air Control Motor

Lab Scope Examples

Each Lab Scope Example in this manual includes a description of the test, the scope connections, the scope settings used during the capture, and an explanation of how the signals can be used during diagnosis. An example of a Lab Scope test is shown below.

<u>Lab Scope Test Example</u>

The Lab Scope can be used to test the fuel injector signals as it provides an accurate view of their waveforms and the current signal.



<u>Scope Connections</u>

Connect the Channel 'B' positive probe to the injector control signal. Connect the negative probe to the battery negative post.

Connect the Channel 'A' probe to a low amp probe current probe. Clamp the low amp probe around the battery feed circuit to the injector.

<u>Scope Settings</u>

To make the waveform as clear as possible, set the scope settings to match the examples.

<u>Lab Scope Example</u>

The top trace in this example shows the fuel injector voltage signal and the bottom trace shows the injector current signal at idle speed.

TOOLS & EQUIPMENT

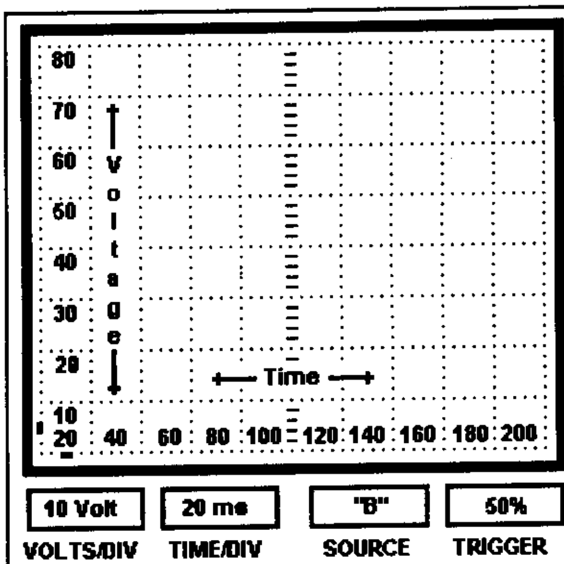
Lab Scope

General Information

Lab Scope Graticule

The Lab Scope display has horizontal and vertical lines referred to as graticules. These lines form a grid that fills the display area. These graticule lines can be turned "on" or "off" depending upon the brand of Lab Scope and its software capabilities.

Blocks created by the graticule lines form squares or boxes that represent the major divisions used with a Lab Scope. The grid lines are critical areas as they are used to determine the basis of all "time" and "voltage" measurements on the scope.



Note: The names in the boxes on this graphic represent examples of what can be found on a Lab Scope. They may not match your Lab Scope.

Time Measurement Explanation

The horizontal divisions in the scope display are used to measure the amount of time between events. The Lab Scope trace moves from the left side of the display to the right side of the display.

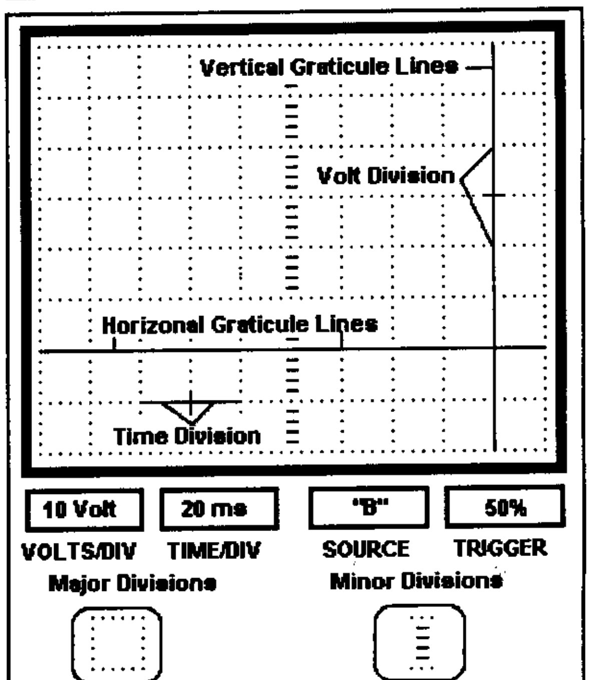
The actual amount of time for an event to occur is calculated by measuring the amount of time it takes for the trace to move from left to right.

Voltage Measurement Explanation

Vertical divisions in the scope display are used to measure the amount of voltage as the trace moves up and down the display.

When the trace moves up, this is a positive change in voltage (in relation to the ground level of the scope). When the trace moves down, this is a negative change in voltage (in relation to the ground level of the scope). In effect, an upward movement indicates more voltage and a downward movement indicates less voltage.

The amount of voltage is calculated by measuring the amount of voltage change against the vertical grid lines.



Major & Minor Divisions

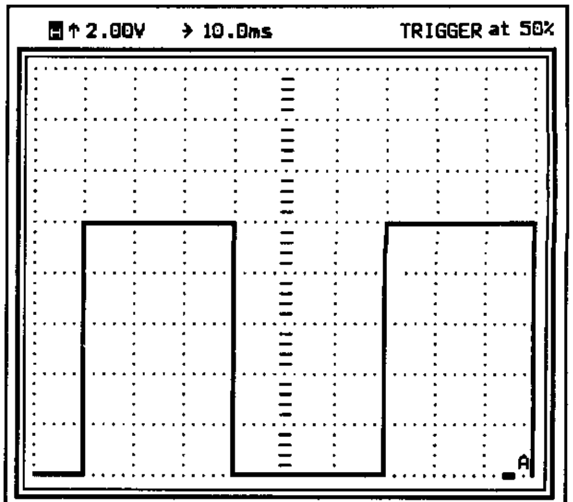
The graticule has a series of small lines from top to bottom (in the center vertical grid line) and from left to right (in the center horizontal grid line). These lines indicate minor divisions on the graticule. They can be used to calculate smaller divisions of time and/or voltage as needed. There are 5 minor divisions for each major division (time/voltage). Each voltage minor division equals 2.0v of its major division (10v per division divided by 5 subdivisions = 2.0v per subdivision).

TOOLS & EQUIPMENT

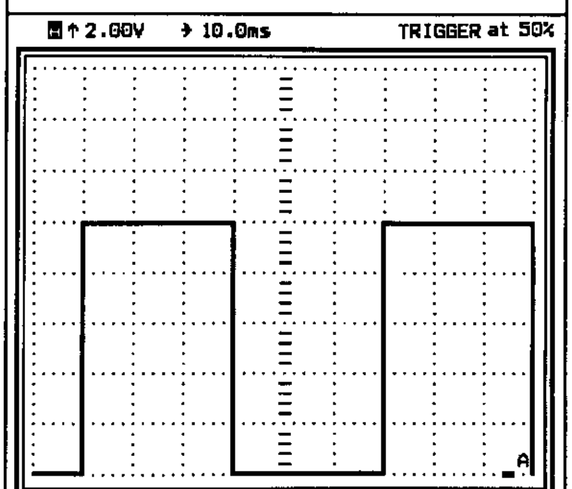
Lab Scope

Lab Scope Controls

The basic operational controls used on most Lab Scopes are similar. Some scopes have buttons that allow their software to provide more features (see the Operator's Manual).



In this example, the waveform (a squarewave) has a total on-time of 30 ms. A complete cycle (from "on" to "off" is 60 ms). The total on-time of each squarewave can be calculated by counting the number of horizontal grid lines inside each squarewave (in this case 3) and then multiplying that number by the setting for each (10 ms). The total on-time of 30 ms is derived from this value.



In this example, the waveform (a squarewave) has a total amplitude of 10 volts. This can been calculated by counting the number of vertical grid lines and then multiplying them by 2 (volts). The source for this pattern is Channel 'A'.

Note: The scope ground point is identified by the (–) symbol at the bottom right of the grid.

<u>Horizontal Controls</u>

The controls in the "horizontal area" are used to control the left and right movement of the scope trace. These controls include:

- Time/Division (used to determine the speed of a sweep horizontal movement)
- Sweep Variable (used for uncalibrated adjustments to the TIME/DIV setting)
- Position (used to adjust the waveform horizontally across the screen)
- X10 MAG (used to speed up the sweep speed to a rate of 10 times faster)
- The horizontal Channel 'A' sweep rate is set to 10 ms in this example.

<u>Vertical Controls</u>

The controls in the "vertical area" are used to control the upward and downward movement of the Lab Scope trace.

These controls include these functions:

- Volt/Division (used to determine the voltage value of each vertical division)
- Variable (used to make uncalibrated adjustments to the VOLT/DIV setting)
- Position (used to determine the vertical position of the waveform [the baseline])
- Input Coupling (used to determine the type of measurement (AC, DC or GND).
- Vertical Mode (used to select which channel ('A' or 'B') will be displayed)

<u>Lab Scope Example</u>

The vertical Channel 'A' volts division is set to 2.00v per division in this example. The total amplitude of this pattern is calculated by multiplying the number of vertical grid lines by the volts per division setting. In this case, there are five (5) vertical grid lines from ground to the top of the waveform. The total height of this pattern is 10 volts (e.g., 5 x 2.00 volts per division).

Note: ***The Lab Scope true ground position is identified by a ground symbol (—).***

TOOLS & EQUIPMENT

Lab Scope

Lab Scope Controls (Continued)

<u>Trigger Controls</u>

The Trigger controls are used to determine where the actual trigger point is found, and to allow the user to fine-tune the trigger adjustment to provide a stable display (the same trigger point starts the pattern sweep each time). They include the following examples:

- Source - Used to select the trigger signal source (INT, CHA, CHB, etc.).
- Delay or Mode - Used to adjust how the scope will respond to the trigger signal.
- Level - Used to adjust the voltage level the signal has to reach to trigger the sweep.
- Slope - Used to select the direction the voltage moves to reach the trigger point.

Note: The scope trigger for Channel 'A' is set to a value of 50% in the example below.

A trigger point is defined as a voltage level that is reached on the scope input leads, or it can be an internal setting within the scope. The setting is referred to as the INTERNAL or EXTERNAL trigger source. If INTERNAL is selected, the scope will trigger without an external trigger source.

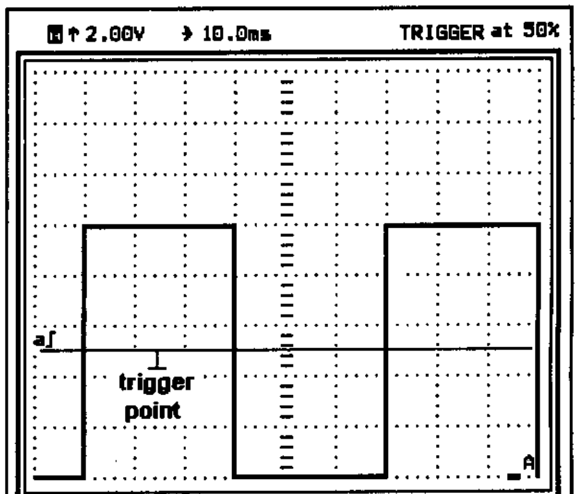
The scope logic is designed so that the "trigger" is a recognized "voltage level transition" from high to low state or from a low to high state.

The trigger voltage level can be set on a Lab Scope (either analog or digital design).

<u>Lab Scope Example</u>

The vertical Channel trigger level is set to 50% in the example to the right. If you take the total amplitude and divide it in half (50%), you can establish that the trigger level is close to 5 volts. In this case, the scope would begin to trigger once the trace exceeded a value near 5 volts.

Note: The note in this Graphic explains that a horizontal line was added to this example to indicate the trigger level point. It should be noted that a Lab Scope could be set to trigger from Channel 'A' or Channel 'B'. In this case, it is set to trigger off of Channel 'A' in the Graphic.



In this example, the waveform (a squarewave) has a total amplitude of 10 volts. This can been calculated by counting the number of vertical grid lines and then multiplying them by 2 (volts). The source for this pattern is Channel 'A'.

Note: The trigger point for this waveform is identified by the narrown horizontal line above.

<u>Input Coupling</u>

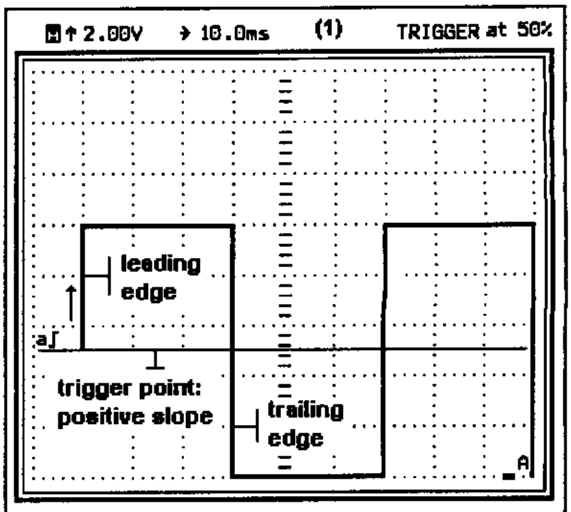
The Input Coupling setting is used to determine the type of measurement to be made:

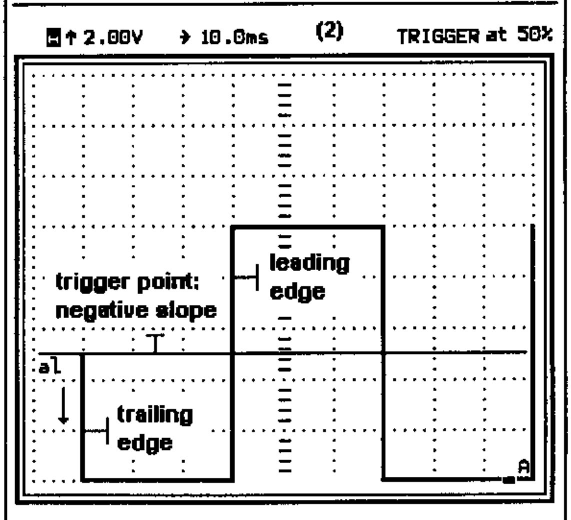
- AC Coupling - The AC selection allows only AC voltage to be displayed - any DC voltage is blocked out. This is a setting used when checking for a leaking diode.
- DC Coupling - The DC selection allows you to view both AC and DC voltages. It is used almost all of the time when you are testing automotive electrical signals.
- Ground Coupling - The Ground selection grounds the vertical amplifier on the scope, and is used to set the ground reference of the display area. You can use the vertical control to adjust the "grounded" display to a horizontal grid line.

TOOLS & EQUIPMENT

Lab Scope

Lab Scope Controls (Continued)





Slope Controls
The Slope control is used to set whether the voltage signal has to go "up" or "down" to reach the defined trigger level. In effect, if it has to go up it requires a higher voltage signal, and if it has to go "down", it requires a lower voltage signal.

Lab Scope Example (1)
In example (1), the Lab Scope trigger slope is set to a level that is in the middle of the squarewave (midpoint), and is set to a positive level (note the use of an up arrow in the Graphic). This setting causes the trace to initiate (start) on the first positive slope of the leading edge of waveform.

Lab Scope Example (2)
In example (2), the Lab Scope trigger slope is set to a level that is in the middle of the squarewave (midpoint), and is set to a negative level (note the use of a down arrow in the Graphic). This setting causes the trace to initiate (start) on the first negative slope of the trailing edge of the waveform.

Leading Edge Description
The leading edge of the waveform in Example (1) is described as the "positive going" slope of the waveform. The scope is set to trigger off of the positive slope in Example (1) in the Graphic.

Trailing Edge Description
The trailing edge of the waveform in Example (2) is described as the "negative going" slope of the waveform. The scope was set to trigger off of the negative slope in Example (2) in the Graphic.

TOOLS & EQUIPMENT

Lab Scope

Automotive Electrical Signals

Introduction

The various signals used with Engine Control devices on a modern automobile can be analog or digital in nature, and include a wide range in complexity and design.

In order to diagnose a problem in these devices, you need to know more about the types of devices (and their signals) that are included in the individual OEM sections of this manual. A list and description of the devices covered in this manual is provided next.

The analog sensors covered include:

- Engine Coolant Temperature (ECT)
- Intake Air Temperature (IAT)

The switch (on/off) signals covered include:

- Brake Pedal Position (on/off) Switch
  - Refer to the waveform in Example (1)
- Park Neutral Position Switch signal

The analog manifold air pressure and mass airflow measuring devices covered include:

- Manifold Air Pressure (MAP) Sensor
- Mass Airflow (MAF) Sensor

Electronic Ignition devices covered include:

- Ignition coil primary signals
  - Refer to the waveform in Example (2)
- Ignition Control Module (ICM) signals

Fuel Delivery system devices covered include:

- Camshaft position (CMP) sensor signals
- Crankshaft position (CKP) sensor signals
- Fuel injector signals
- Top Dead Center (TDC) sensor signals

The EGR and EVAP devices covered include:

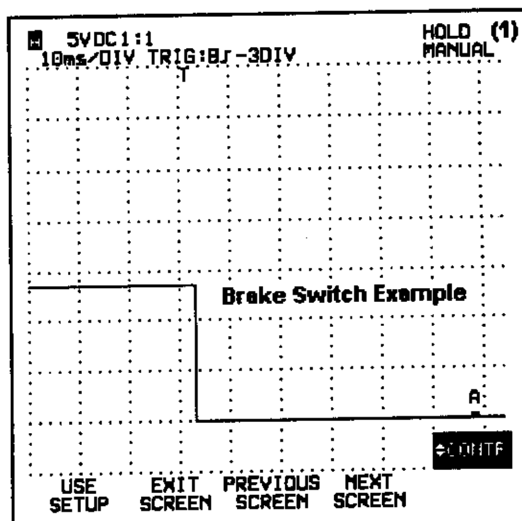
- EGR Solenoid signals
- EVAP Purge Valve signals

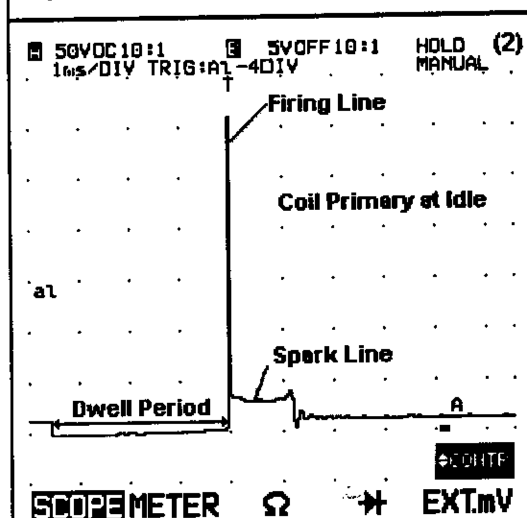
The Idle Air Control devices covered include:

- Idle Air Control (IAC) Motor signals

The TCM devices covered include:

- Counter Shaft speed sensor signals
- Main Shaft speed sensor signals
- PCM to TCM Serial Data signals





Common Terminology

Due to the proliferation of these automotive signals, Aftermarket and OEM repair technicians have adopted a series of terms (or terminology) to use to describe these signals as well as what is happening to them. These terms need to be thoroughly understood in order to connect to, measure and diagnose common automotive signals. A discussion of how this terminology relates to a Lab Scope begins on the next page.

TOOLS & EQUIPMENT

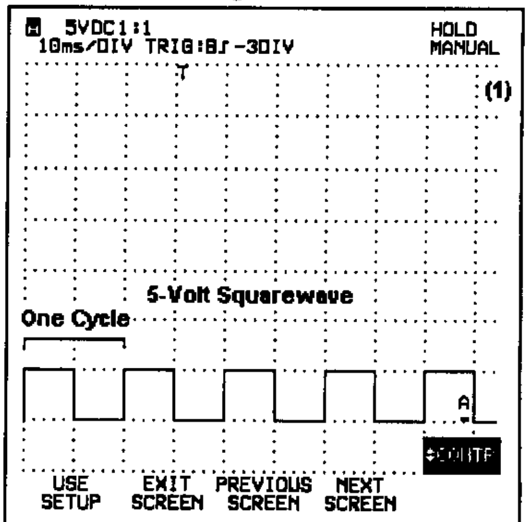
Lab Scope

Digital Signals - Terminology

Many of the signals used with the Engine or Transmission Controller in a modern automobile are digital in nature. These digital signals operate at various speeds (frequency) and pulsewidth (a variation in signal on-time). A description of the various terms used in this manual to describe these signals is provided on the next few pages.

Squarewave

Dictionary description of this term: *A square or rectangular shaped periodic wave (waveform) that alternately assumes two fixed values for equal lengths of time, with the transition time being negligible in comparison to the duration of each fixed value.*

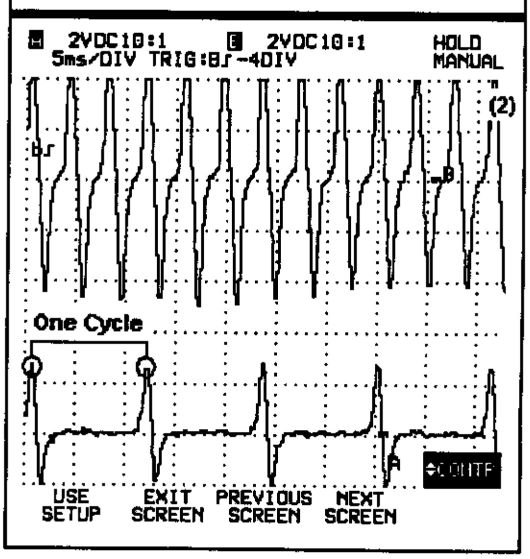


In automotive terms, the term squarewave has come to mean any signal that is 50% "on" and 50% "off". We also tend to use this term to describe automotive signals that have only two levels (i.e., a high wave and a low wave). The pattern in Example (1) shows the squarewave.

Cycle

Dictionary description of this term: *The change of an alternating wave from zero (0) to a positive peak and back to zero (0). The number of cycles per second (hertz) is referred to as the signal frequency.*

In Example (2), the cycle of the Channel 'A' signal starts at the peak amplitude to the left side and completes when it returns to the same point in the cycle as shown in the Graphic.



Channel 'A' Descriptions

The amount of time shown in this screen is 5 ms, and each cycle is 11 ms (each division has five subdivisions, and each subdivision equals 1 ms). The signal repeated itself 4 times on this screen in a 50 ms time frame (at 90.91 Hz).

Channel 'B' Descriptions

The total amount of time shown in this screen is 50 ms, and each cycle is 4 ms. The signal repeated itself 12 times on this screen (i.e., the Channel 'B' signal frequency is 250 Hz).

Frequency (*f*)

Dictionary description of this term: *The number of recurrences of a periodic phenomenon in a unit of time. Electrical frequency is specified as so many hertz, the number of alternations or repetitions per second in a recurring action.*

To calculate the frequency (*f*) of the Channel 'A' signal (Example 2), use this calculation: f = 1 cycle divided by 11 ms converted to 1 second, or f = 1 / .011 second = 90.91 Hz.

Hertz (Hz)

Dictionary description of this term: *A unit of frequency equal to one cycle per second.* The symbol used with this term is Hz.

TOOLS & EQUIPMENT

Lab Scope

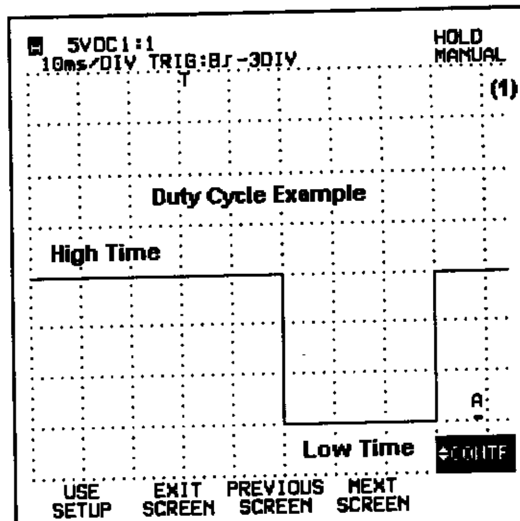
Digital Signals - Terminology

Duty Cycle

The dictionary description of this term is as follows: *The amount of time that a device operates, as opposed to the amount of time that it is idle.*

In automotive terms, we use the term duty cycle to indicate the percentage of time a digital signal is high versus the amount of time it is low. If you are measuring the duty cycle of a signal from a device, a complete cycle is considered 100% of a time period.

In most cases with automotive electrical devices, we consider the time period that the digital signal is low (Low Time) as the period we want to measure. This is because this is the period of time when most devices are enabled or energized (e.g., PWM solenoids).



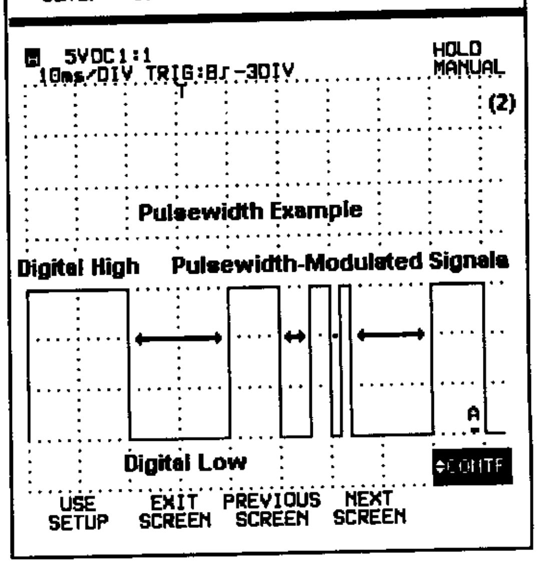
To calculate the duty cycle of the signal in Example (1), first count the number of divisions that make up a complete cycle (in this case, it is 8 divisions). This is 100% of the time period. Then do the math (divide 100 / 8 = 12.5%). The number of Low Time divisions is 3, and when we do the math (multiply 3 x 12.5 = 37.5%), we arrive at a duty cycle for this signal of 37.5%.

Pulsewidth (Pulse Duration or On-Time)

The dictionary description of this term is as follows: *The time interval between the points at which the instantaneous value on the leading and trailing edges bears a specified relationship to the peak pulse amplitude.*

In automotive terms, we use the term pulsewidth to express a measurement in time that a digital signal is active (or is low). In most of the devices that we diagnose we are looking at a pulsewidth signal that is in the digital low state (when the device is energized or "on").

In Example (2), the pulsewidth of the first digital low signal is 20 milliseconds long. The pulsewidth can be calculated by counting the number of horizontal divisions (2). Multiply that number by the time per division (2 x 10 ms).



Digital Pulsetrain (Pulsewidth-Modulated Signals)

This term is used to describe a digital automotive pulsewidth signal that has varying lengths of time from one signal to the next. The Pulsewidth Example above shows an example of a "Digital Pulsetrain" signal. This type of signal can be found on numerous output devices in which the PCM varies a pulsewidth-modulated signal to the device.

A "Digital Pulsetrain" signal is also used to provide signals between stand alone modules on the OBD II Class 2 circuit. In simple terms, a pulsewidth-modulated output is a digital signal in which the pulsewidth signal is varied.

TOOLS & EQUIPMENT

Lab Scope

Digital Signals - Terminology

<u>Electrical Waveform Sections</u>

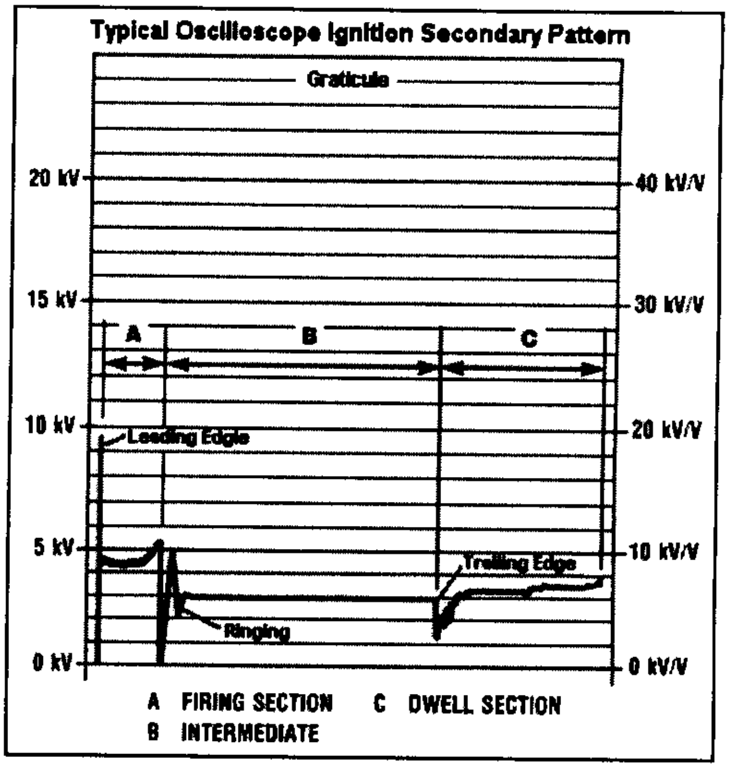
Each analog or digital waveform is made up of several distinct sections or components.

Once you learn to "slice up" a waveform by breaking it down into its individual components, you will find that it is not any more complicated to do than it was to analyze an automotive Ignition system pattern (with its firing, intermediate and dwell sections).

<u>Waveform Leading Edge</u>

The dictionary description of this term is as follows: *That transition of a pulse that occurs first (i.e., the low to high transition of a high clock pulse).*

The leading edge of a waveform can be described as that portion of the signal that is making the transition from the lower state to a higher state. It is also referred to as the "positive going slope" in automotive media.



<u>Waveform Trailing Edge</u>

The dictionary description of this term is as follows: *That transition of a pulse that occurs last (i.e., the high to low transition of a high clock pulse).* The trailing edge of a waveform can be described as that portion of the signal that is making the transition from a high state to a low state. It is also referred to as the "negative going slope" in automotive media.

<u>Waveform Ringing</u>

The dictionary description of this term is as follows: *A damped oscillation in an output signal of a system, as a result of a sudden change in the input signal, or a transient decaying oscillation about the high or low limit induced by unmatched impedance reflections.*

In automotive terms, a ringing (noise) appears in numerous PCM and TCM controlled signals. The normal discharge of an electrical coil in an electrical device can cause ringing to occur. In effect, as current flows through the coil, it absorbs some energy. Once current flow through the coil is stopped, the energy in the coil is released. The effects of this principal are apparent in the amount of energy discharged by the coil in the waveform on this page. Note the point at which the "ringing" occurs in the Graphic.

Depending upon the type of device and how it is connected in an automotive circuit, the effects of ringing may or may not cause problems. For example, on an air conditioning compressor clutch, a protective device (a diode or a resistor) is frequently used to control this unwanted "noise". The torque converter solenoid signal to the PCM is another circuit that is sensitive to the effects of ringing (from the coil in a TCC solenoid).

TOOLS & EQUIPMENT

Probes, Clips & Gadgets

Test Probes

The two most common types of test probes supplied with a Lab Scope are the 1:1 and 10.1 types. There are other test probes available with different types of connectors.

The function of three types of test probes used for automotive repair is described below:

- 1:1 test probe - used when there is no requirement to filter the signal to the scope.
- 10:1 test probe - attenuates the signal by a factor of 10 (10v signal = 1v output).
- 100:1 test probe - attenuates the signal by a factor of 100 (100v signal = 1v output).

Caution: ***Always route the test probes away from any moving objects under the hood.***

Test Probe Shielding
The test probe should have sufficient shielding built into it to protect it from any electrical noise in the test area that could be induced into the scope signal. This is a very critical point to understand during automotive testing due to the amount of electrical "noise" generated in the underhood area (e.g., the ignition and charging system).

Note: ***Some 1:1 probes are shielded and some are not built with any shielding.***

Changing the DSO Setup Screen
If you change the test probes, you need to change the setup screen on your DSO to reflect that change. In effect, you need to change the Lab Scope "probe menu" or physical setting to match the probe currently connected to the scope. If you don't make this change, you will receive an inaccurate waveform display on your scope screen.

Test Probe Identification
If you don't know the resistance of your test probe set (if they are not identified), you can use an ohmmeter to properly identify them. Disconnect the probe from the Lab Scope and connect the ohmmeter leads to both ends of the test probe (disconnected).

The test results should be similar to these examples:

- 1:1 test probe: The DVOM should read close to 000.0 ohms.
- 10:1 test probe: The DVOM should read close to 9,000,000 ohms (9M ohms).
- 100:1 test probe: The DVOM should read close to 99,000,000 ohms (99M ohms).

10:1 Test Probe - Key Points
The 10:1 test probe attenuates a signal by a factor of ten. A 10-volt signal at the probe tip will yield a 1-volt signal at the probe output to the scope. If you use a scope with 1 megohm of impedance with a 10:1 test probe, the input impedance will be 10 megohm.

Probe Adjustment
A good quality test probe will have a compensation adjustment (this is done periodically). The test probe may also have an attenuation adjustment that can be used to adjust the division factor of the scope using fine adjustments.

Analog Scopes & Test Probes
If you use an Analog Lab Scope and all three sets of test probes, pay particular attention to the test probe set you are using as there is no way to set the scope to match the type of probe. Compute the voltage settings to match the probes **before** viewing a waveform.

If you use a 1:1 test probe on an Analog scope, the volts per division setting you choose will match the scope graticule (e.g., if you select a voltage setting of 1 volt per division, this screen setting will equal 1v per division). If you select 1 volt per division and use a 10:1 probe, this voltage setting will equal 0.1 volts per division. If you select 1 volt per division and use a 100:1 test probe, this voltage setting will equal 0.01 volts per division.

TOOLS & EQUIPMENT

Probes, Clips & Gadgets

Inductive Amp Probe

General Information

The Low Current and High Current Inductive amp probe can be used with a DVOM, a graphing Multimeter or a Lab Scope. In many cases, a special adapter may be required to connect the current probe to a particular tool.

If your Lab Scope or Graphing Multimeter has BNC type plug input connections, an adapter is available from Automotive Electronics Services (AES). The part number is AES# 08-88-f. This adapter will allow you to connect an amp probe to your Lab Scope.

Amp Probe Settings

To use an low probe with a Lab Scope requires either adjusting the scope to a particular setting, or if there is no 10 mv setting available, the use of the reference chart.

Fluke Model 801-110

Probe Calibration	Scope Setting	Result
10a (at 100mv / div	Low Range	Low Current Test
100a (at 10mv / div	High Range	High Current Test

LS-2000 & ADL-7100 (High Amp)

Probe Calibration	Scope Setting	Result
10mv per amp	50mv per division	5a per div:>40a
10mv per amp	100mv / div (0.1v)	10a per div:>80a
10mv per amp	200mv / div (0.2v)	20a per div:>160a

LS-2000 & ADL-7100 (Low Amp)

Probe Calibration	Scope Setting	Result
100mv per amp	50mv per division	0.5a per div:>4a
100mv per amp	100mv / div (0.1v)	1a per div:>8a
100mv per amp	200mv / div (0.2v)	2a per div:>16a

Interro PDA, OTC Vision & MAC Insight (High Amp)

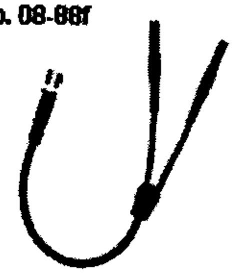
Probe Calibration	Scope Setting	Result
10mv per amp	0 to 0.5v with 4 div	12.5ma per div
10mv per amp	0 to 2v with 4 div	50 amps per div

Interro PDA, OTC Vision & MAC Insight (Low Amp)

Probe Calibration	Scope Setting	Result
100mv per amp	0 to 0.5v with 4 div	1.25ma per div
100mv per amp	0 to 2v with 4 div	5 amps per div

Low Current Amp Probe Example

No. 08-88f



Note: ***The three (3) most common probes used today are called: 1:1 probes, 10:1 probes and 100:1 probes. If you change a probe, be sure to identify the correct probe on the menu of your DSO (i.e., match the menu with the probe you installed). To check a probe with an ohmmeter, connect the DVOM leads to both ends of the probe (with the probe disconnected). A 1:1 probe will measure: 0.0 ohms, a 10:1 probe will measure: 9M ohms and a 100:1 probe will measure: 99M ohms.***

TOOLS & EQUIPMENT

Probes, Clips & Gadgets

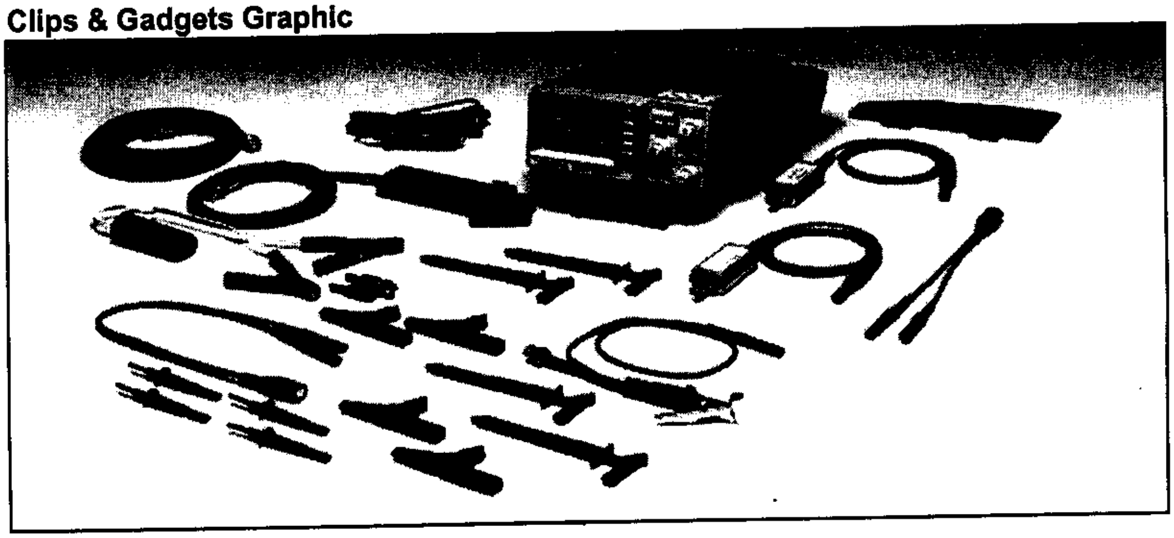
Clips & Gadgets

There are many factors to consider when connecting to a circuit from a vehicle computer or other device in order to make a measurement with a Lab Scope. However, none of these factors are more important than having the proper connectors, probes and leads.

Scope Leads
It all starts here as far as making a clean and accurate measurement. In some respects, the scope leads are what makes it suitable for use on a particular vehicle and test connection. The advancement in scope leads in the past few years has made the job of connecting and sustaining an accurate measurement far easier.

Test Probes
The type of measurement (e.g., backprobe or at the front of the connector, and the size of the terminal or sealed connector) lends itself to the use of a variety of test probes. Once again, changes in the test probes and how they are made has really improved.

Clips & Gadgets Graphic



Where To Look
While there are many sources for "clips & gadgets" (i.e., the local parts house, the tool wagon or parts catalog), one source that we can recommend highly in this area is a California company called Automotive Electronics Services or AES. They can be reached by telephone or on the WEB. Their number and URL address are shown below:

- Address: 3849 North Fine Avenue #102, Fresno, CA 93727
- Phone Numbers: 559-292-7851, Fax: 559-292-7851
- Email: support@aeswave.com or order@aeswave.com

TOOLS & EQUIPMENT

Lab Scope Software

AES Wave!

One of the most important uses of a Graphing Multimeter or Lab Scope is to save the values you capture to use with customer issues and to build a database of known good values. With that in mind, this article will explore one method to accomplish this task.

Note: Some of the information on this page was collected from the AES Wave website.

Automotive Electronics Services (AES)

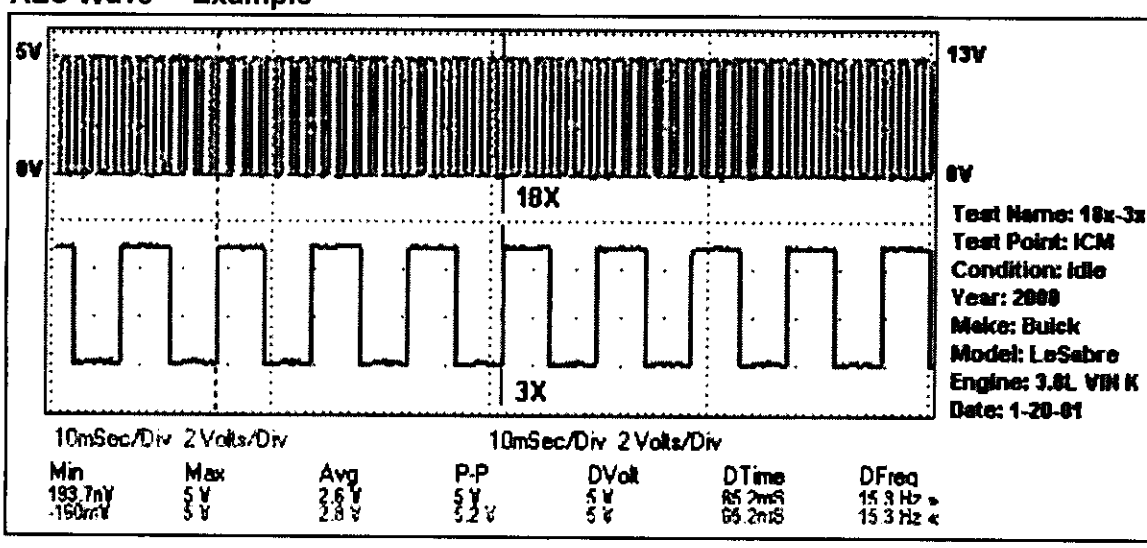
This company sells the ***AES Wave*** Information Management system to organize any valuable diagnostic information. It allows you to accomplish these important tasks:

- Capture screens and data points from test equipment (e.g., a Fluke Scopemeter)
- Acquire images from page scanners and digital cameras
- Save graphics and text files from any source

The software in this program utilizes a database to store and organize its data. The database eliminates the need to worry about filenames and makes it easy to retrieve data based on field entries. Each record includes several field entries and a note area.

This software also provides very powerful printing and image handling capabilities. It can be used to build customer reports or training manuals, and to create a job portfolio. The Graphic below contains an example from the AES Wave software on a late model Buick.

AES Wave™ Example



Equipment Compatibility

AES Wave software can be used to download screens from the following equipment:

ADL 7100 Sensor Scope	MAC Quick Scope
Counselor 2	MATCO Insight
Edge PAC Unit	Mastertech
ET-2020	OTC Vision, Vision II
Fluke 97 & 97a	Snap On / Edge PAC Unit
Fluke 98 & 98 Series 2	Snap On Vantage PGM
Interro PDA	Snap On Scanner
KAL 575, 575a & 565	TEK 565 & 575
LS-2000	TEK THS 710 & 720

TOOLS & EQUIPMENT

Lab Scope Examples

TP Sensor Example

The Throttle Position (TP) sensor is mounted to the throttle body where it detects the throttle valve angle.

TP Sensor Circuits

The three circuits that connect the TP sensor are:

- The VC circuit (the 5v reference voltage circuit)
- The VTA circuit (the TP sensor signal circuit)
- The E2 circuit (the TP sensor ground circuit)

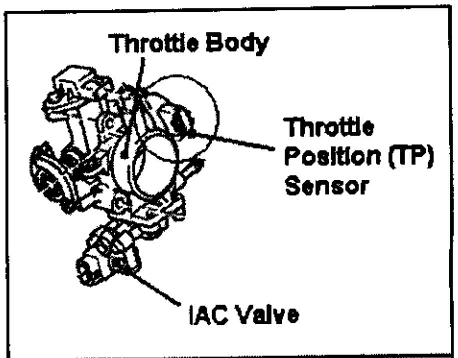
Circuit Operation

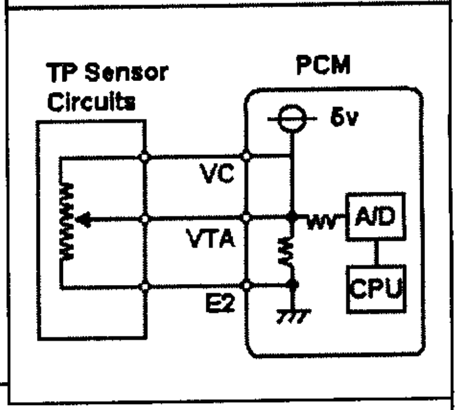
With the throttle valve fully closed, the TP sensor signal to the PCM is from 0.3-0.8v at terminal VTA.

The TP sensor voltage increases in proportion to the throttle valve-opening angle. The TP sensor signal is from 3.2-4.9v with the throttle valve fully open.

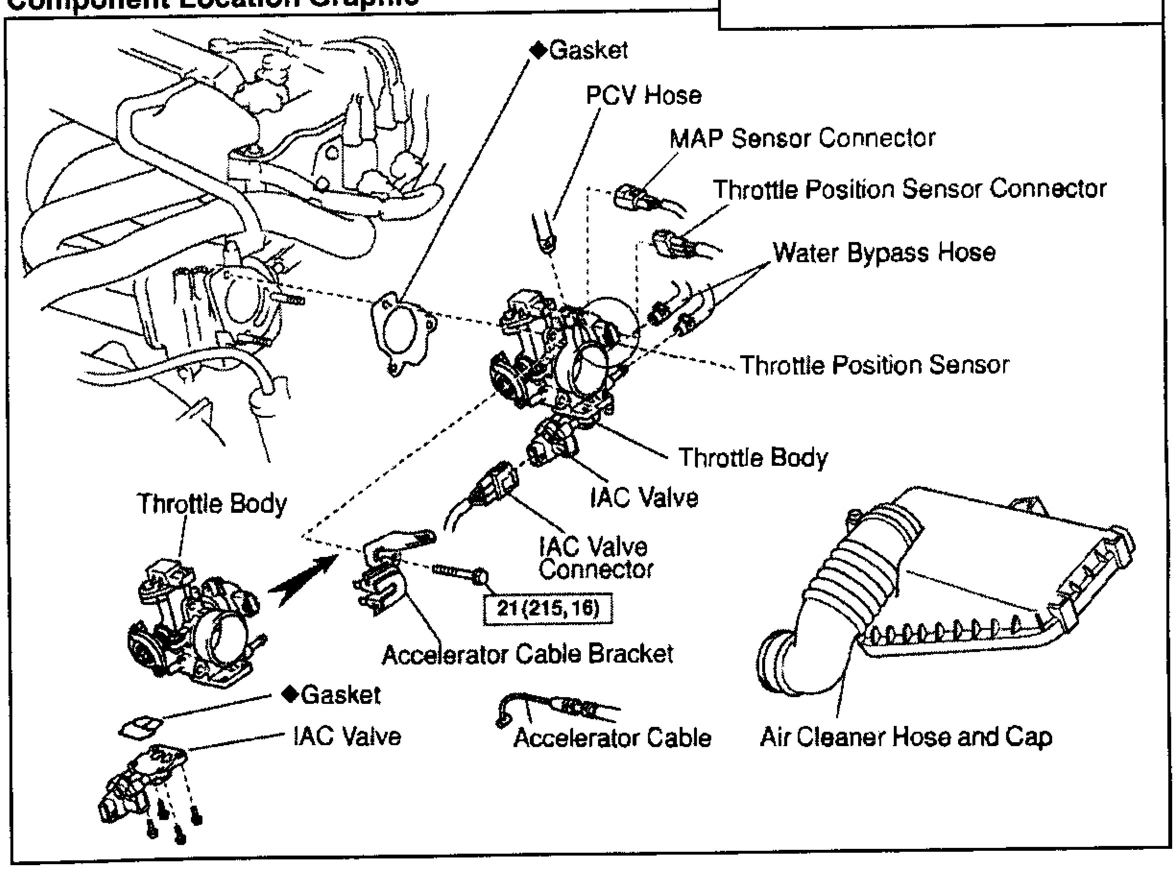
The PCM uses the signal (analog DC voltage) to detect the following vehicle driving conditions:

- Air Fuel (A/F) Ratio correction
- Fuel Cut Control
- Power Increase correction





Component Location Graphic

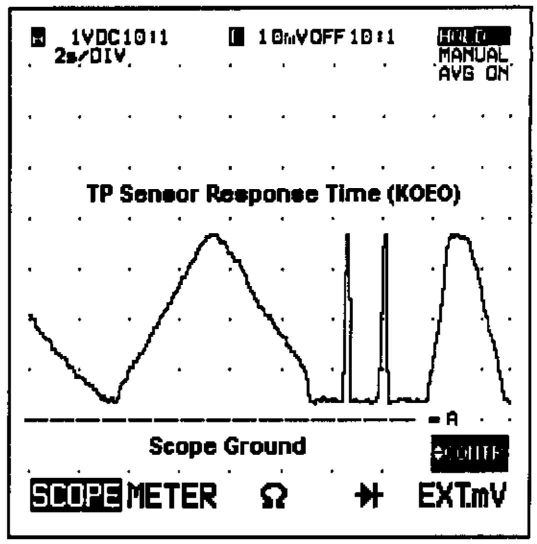


TOOLS & EQUIPMENT

Lab Scope Examples

Lab Scope Test (TP Sensor)

The Lab Scope can be used to test the operation of the TP sensor and its circuits, but is not the tool of choice for this device. The Scan Tool is a much easier tool to use to test the operation of this device. However, the Lab Scope will help find a circuit "glitch".



Scope Connections (Corolla M/T & 3SP A/T)

Connect the Channel 'A' positive probe to the TP sensor signal wire at Pin 11 of the PCM 16P connector (LT GRN wire). Then connect the Channel 'A' negative probe to the E2 sensor ground point at Pin 9 (BRN wire) of the PCM 16P connector.

Scope Connections (Corolla 4SP A/T)

Connect the Channel 'A' positive probe to the TP sensor signal wire at Pin 23 (LT GRN wire) of the PCM 24P connector. Then connect the Channel 'A' negative probe to the E1 GND at Pin 17 (BRN wire) of the PCM 24P connector.

Scope Settings

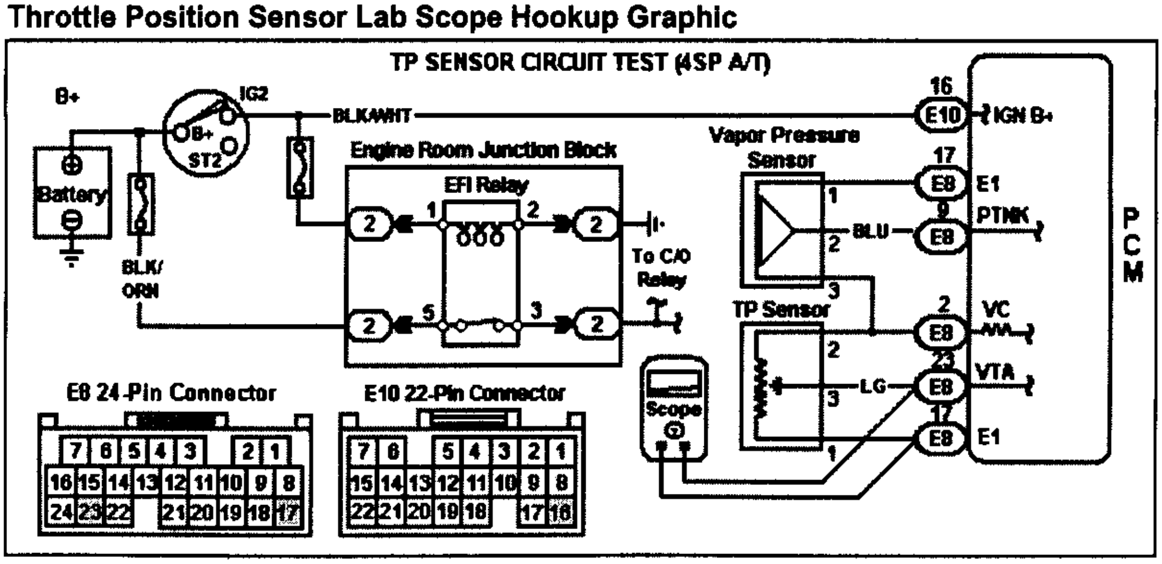
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example Explanation

In this example, the trace shows the TP sensor (analog signal) during a period when the throttle was opened and closed several times with the key on and engine off (KOEO).

The TP sensor signal should also be checked for breaks in the sensor resistor. One way to find this type of problem is to turn to key on, engine off and with the Lab Scope connected as shown in the Graphic below, slowly open and close the throttle while watching the TP sensor waveform for any sudden increase or decrease in the linear action of the pattern. A dropout (e.g., a sudden downward spike) in the TP sensor signal trace would indicate a short while a sudden upward spike would indicate an open circuit.

Throttle Position Sensor Lab Scope Hookup Graphic



TOOLS & EQUIPMENT

Lab Scope Examples

Ignition Coil Primary Test Example

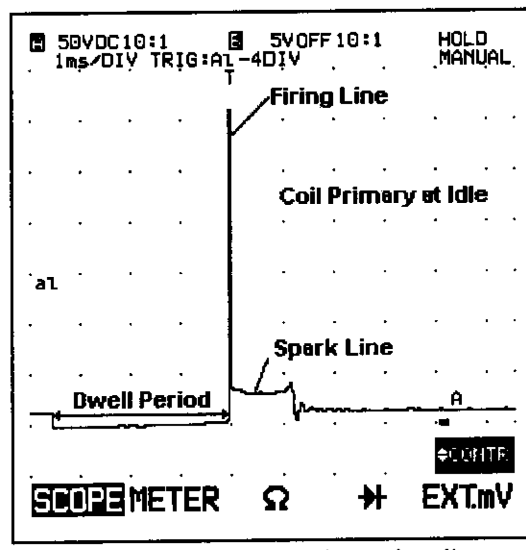
The Lab Scope can be used to view the ignition coil primary ground circuit as it provides an accurate view of its waveform and of any glitches. Prior to starting the test, place the gearshift selector in Park and block the drive wheels for safety.

Scope Connections

Connect the Channel 'A' positive probe to the IC ground wire for Coil No. 1 (BLK wire). Connect the Channel 'A' negative probe to chassis ground or the battery negative post.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples. The voltage setting for Channel 'A' was set to 200 mv in this example.



Lab Scope Tests

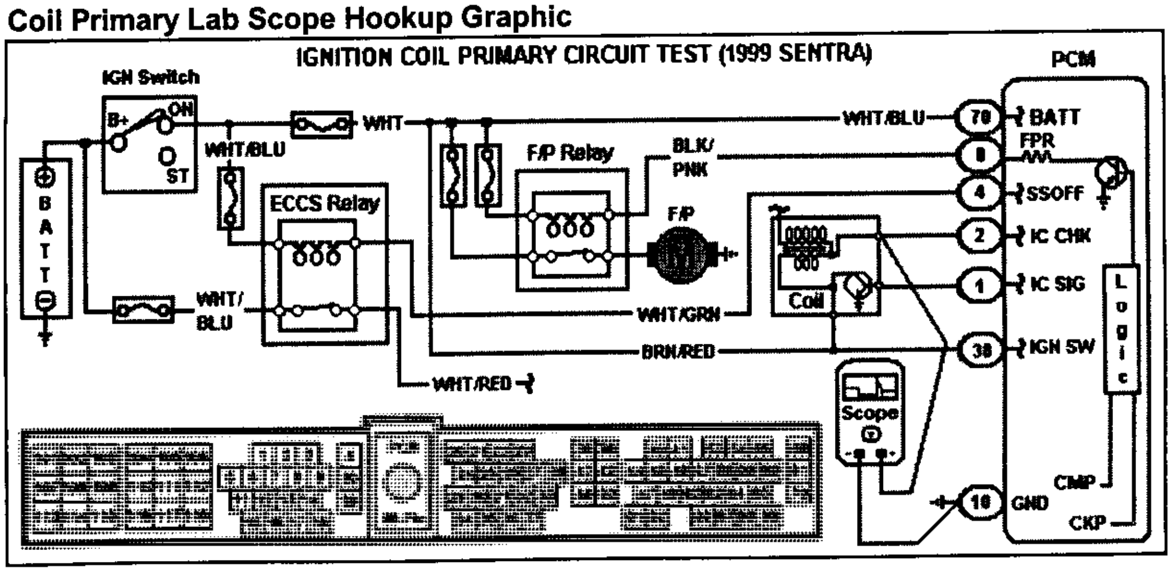
The igniter/coil ground circuit can be checked with the engine running at idle or cruise speeds with a cold or warm engine.

Lab Scope Example

In this example, the Channel 'A' trace shows the EI Coil primary circuit at idle speed. The coil primary signal reached a peak of nearly 310 volts.

Each time that the EI coil fires the spark plug, the ignition primary circuit collapses in order to build up a suitable high voltage of from 3,000 to 8,000 volts in the secondary circuit. Note the ringing effect of the coil primary circuit just to the right of the spark firing line.

Coil Primary Lab Scope Hookup Graphic



TOOLS & EQUIPMENT

Lab Scope Examples

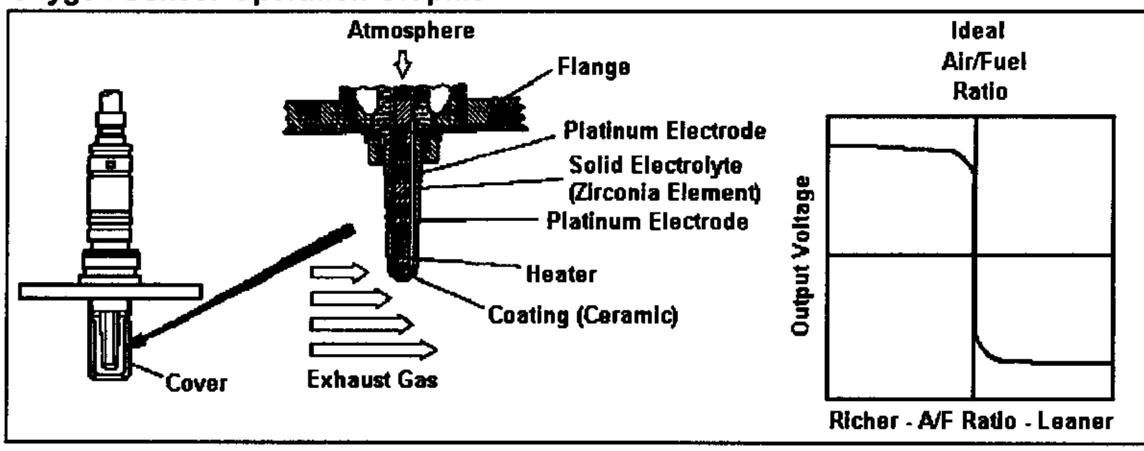
Oxygen Sensor Test Example

Each OEM section in the manual contains examples of how to test various Fuel Control devices. An example of a Lab Scope test for an Oxygen sensor is shown below.

The heated oxygen sensor (HO2S) is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust stream. The PCM determines the oxygen density of the exhaust gases through an input signal.

A heater is used along with the oxygen sensor in order to maintain stable oxygen detection performance. The PCM controls the operation of the heater in the oxygen sensor (it turns it "on" and "off").

Oxygen Sensor Operation Graphic

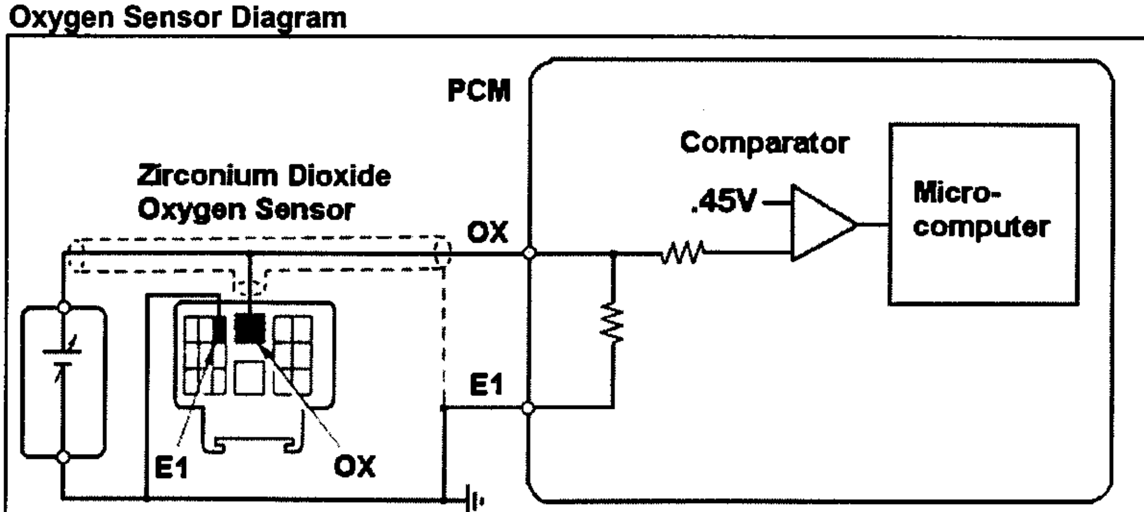


Conventional Oxygen Sensor Operation

In order to obtain a high purification rate for the CO, HC and NOx components of the exhaust gas, a three-way catalytic converter is used on this vehicle. This converter is very efficient when the A/F ratio is controlled at a rate close to stoichiometric A/F ratio.

The heated oxygen sensor has a characteristic whereby its output voltage changes suddenly when it is in the vicinity of the stoichiometric A/F ratio (near 14.7:1). This characteristic is used to detect the oxygen concentration in the exhaust gas and to provide feedback to the PCM for proper control of the A/F ratio.

Oxygen Sensor Diagram

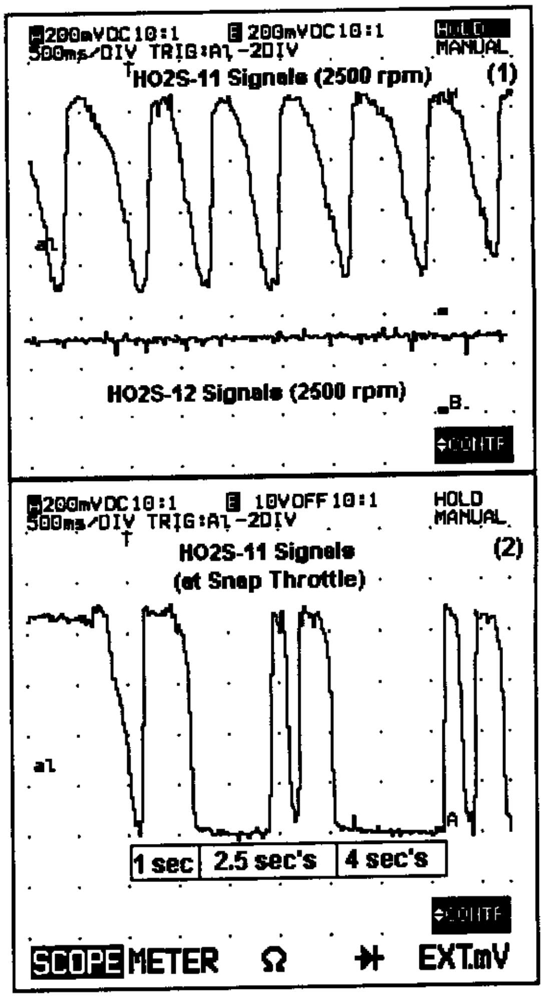


TOOLS & EQUIPMENT

Lab Scope Examples

Lab Scope Test (Oxygen Sensor)

The Lab Scope is the tool of choice to test the operation of the oxygen sensor and its circuits. Refer to the Oxygen Sensor Lab Scope Hookup Graphic below as needed.



Scope Connections (M/T or 3SP Automatic)
To view the OX1A signal, connect the Channel 'A' positive probe to the HO2S-11 circuit at PCM Pin 6 (WHT wire) of the E5 16P connector. To view the OX1B signal, connect the Channel 'B' positive probe to the HO2S-12 signal at PCM Pin 14 (RED wire) of the E5 16P connector. Connect the Channel 'A' negative probe to battery negative post.

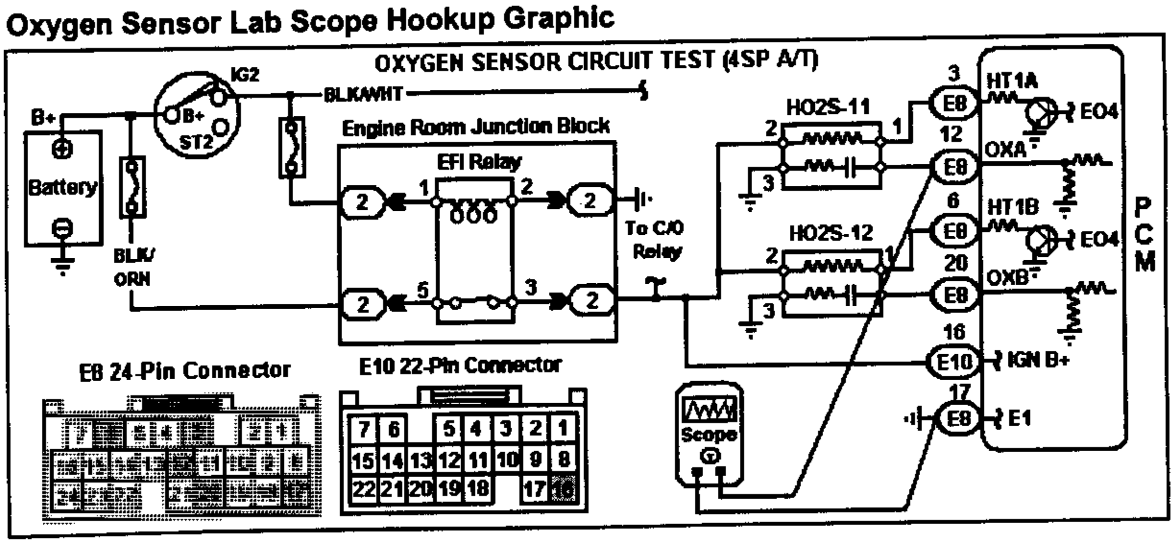
Scope Connections (4SP Automatic)
To view the OX1A signal, connect the Channel 'A' positive probe to the HO2S-11 circuit at PCM Pin 12 (WHT wire) of the E8 24P connector. To view the OX1B signal, connect the Channel 'B' positive probe to the HO2S-12 circuit at Pin 20 (RED wire) of the E8 24P connector. Connect the Channel 'A' negative probe to the battery negative post.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example (1) Explanation
In this example, the trace shows the front oxygen sensor (HO2S-11) signal at 2500 rpm.

Lab Scope Example (2) Explanation
In this example, the trace shows the HO2S-11 signal after three Snap Throttle events (after 1 second, 2.5 second and 4 second delays).

Oxygen Sensor Lab Scope Hookup Graphic



TOOLS & EQUIPMENT

Scan Tools

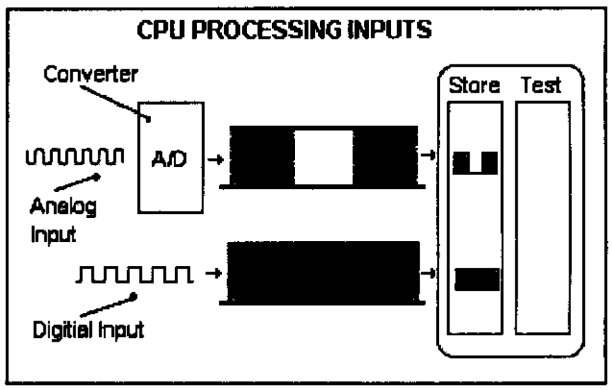
General Information

Scan Tools have been used in the automotive repair industry since the early 1980's to provide a view into the heart of the vehicle onboard computer. They help fill the need to access information contained in the vehicle controller (onboard diagnostics, serial data, etc.) The automotive Scan Tool entered the shop work place in serious numbers after 1980. It has become a true "essential" tool for any technician who performs diagnostic and repair work on any vehicle engine controller (i.e., ABS, Engine and Transmission).

Onboard Computer Functions

The Scan Tool is designed to talk to, receive information from, and interpret information from a vehicle on-board computer. To get the most benefit out of a Scan Tool, you should have at least a minimal understanding of how a vehicle computer operates.

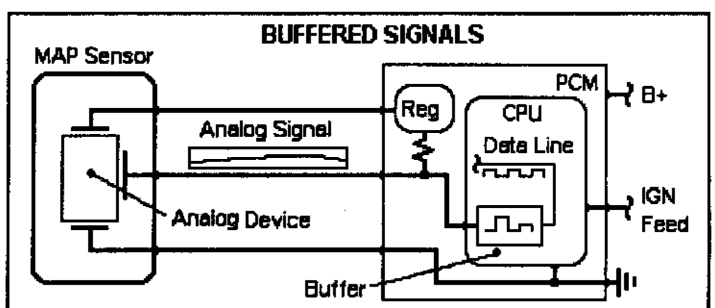
A computer is made up of several components to process and store information. Signals are evaluated based on the time periods established by a clock generator that measures the time of pulsed voltage signals. The main part of the computer is called a central processing unit (CPU). Different processing centers called chips store or process information. The CPU has three main functions that are described below:



- Receive input information from various devices (sensors and switches)
- Calculate input data, compare it to lookup tables and process the data
- Send commands to output devices

Data Stream

In order to understand how to repair a vehicle equipped with a computer, you should understand how a computer works and how it processes and calculates serial data. Microprocessors communicate with each other through serial data. Some of the serial data parameters identification (PID) items can be seen on the vehicle computer data stream.



For example, a MAP sensor monitors the manifold pressure and then provides an electrical signal to the CPU for processing. However, the CPU can only process certain types of voltage signals (the input voltage must be "prepared" or "conditioned"). In effect, some of the signals may be out of the operating range for the CPU. Input buffers convert voltage signals to a usable value by amplifying or converting an analog signal to a digital signal through an A/D converter. The CPU reads and processes the signal and calculates the desired output by sending the electrical signal through a buffer to filter the data. The data is processed and sent to the data line that feeds the data to computer programs that need the input. The CPU uses the value of the "buffered signal" to make its calculations. The Scan Tool reads these internal calculations via the serial data line.

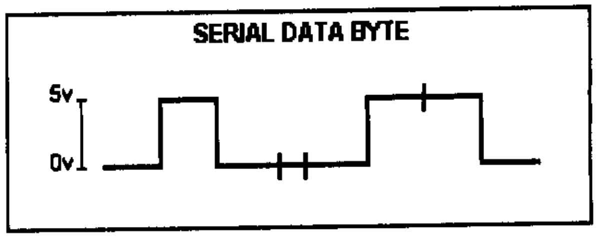
TOOLS & EQUIPMENT

Scan Tools

General Information

Data Bytes & Words

Serial data is a series of rapidly changing voltage signals pulsed from high to low or from low to high voltage. These voltage signals typically range in value from 5v, 7v or 12v (high) to 0v (low). They are transmitted along a circuit referred to as the serial data line.



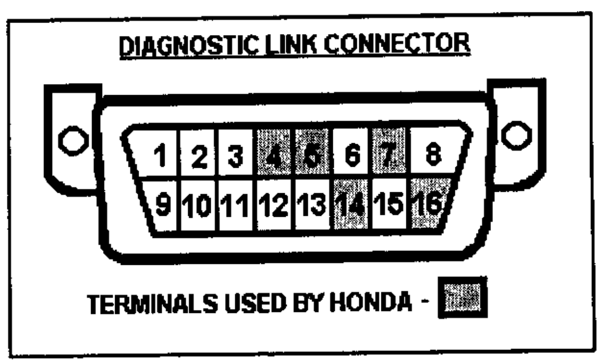
Each high and low signal is known as a digital signal because the high signal can be seen as "on" and the low signal can be seen as "off" by the CPU. This high to low relationship is called a "bit" of information. Sometimes this high/low combination is assigned numbers: with "1" assigned to the high signal and "0" assigned to the low signal. Translating digital signals into numbers also requires a "clock" that provides information on how long a signal is.

The vehicle controller (ABS, PCM, TCM, etc.) processes the information that represents the engine operating conditions, interprets the information, and then makes decisions on how to control its output devices. The CPU in the controller monitors the pulses of "bits" to make "words." Eight "bits" make a "byte" and this byte of data is combined and called a "word."

The meaning of the word "serial" in this context means "one after the other". Serial data words are read in a series, one at a time, in a specific order that can be accessed by an onboard or off-board computer (e.g., a Scan Tool). Early vehicle controllers transmitted a serial data stream that contained up to 20 words. The CPU interprets the digital signals into the information (data) needed to interpret and control engine operating conditions.

Diagnostic Link Connector

The Scan Tool interfaces with the controller serial data line via a Serial Data terminal in an interface cable or connector.



OBD I - The connectors used with vehicles with the first version of onboard diagnostics (OBD I) have many shapes and names. These were called the Data Link Connector (DLC), Assembly Line Data Link Connector (ALDL) or Self-Test terminal. A technician could access the trouble codes on these early systems, but could not read the serial data without an appropriate Scan Tool and connecting harness. The only other way to determine if the computer sensors and output controls were working properly was to monitor the computer terminal voltages one at a time in key on, or engine running mode.

OBD II - The connector used with vehicles with the second version of onboard diagnostics (OBD II) has one standard shape and is called the Diagnostic Test Connector. An example of this connector is shown in the Graphic on this page.

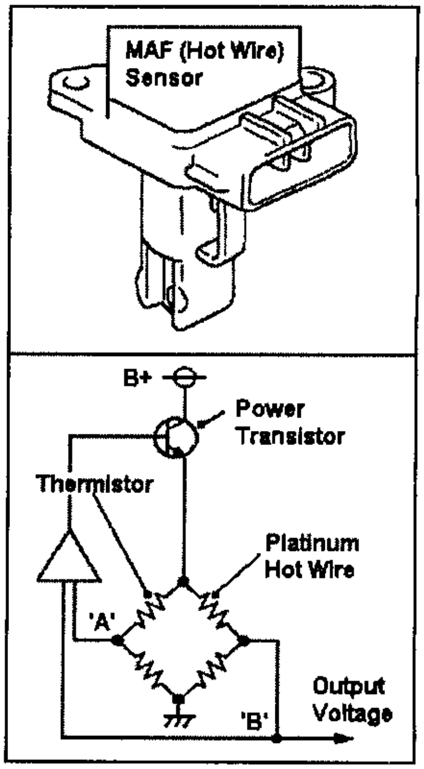
Summary - The Scan Tool is a convenient way to read serial data transmitted between controllers in order to view the status of the system or its current operating values. There are repair charts designed to guide you through checks of the computer serial data bus.

TOOLS & EQUIPMENT

Scan Tool Test Examples

MAF Sensor Test Example

Each OEM section of the manual contains examples of how to test various Information sensors. An example of a Scan Tool test for a MAF sensor is described next.



Toyota Test Example

The Mass Airflow (MAF) sensor is a Platinum hot-wire design. This MAF sensor works on the principle that the hot wire and the thermistor (which are positioned in the air intake bypass of the housing) detect any changes in the intake air temperature.

<u>System Components</u>

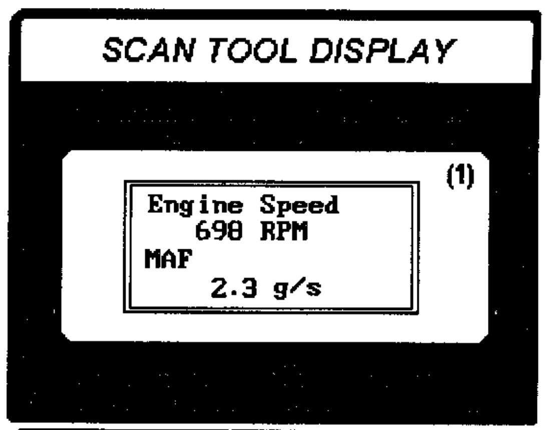
The hot wire airflow meter includes the following components:

- A Platinum hot wire
- A thermistor
- An airflow meter control circuit (inside the housing)

<u>Circuit Operation</u>

The airflow meter (control circuitry) maintains the hot wire at a set temperature by controlling the current flow through the hot wire. This amount of current flow is converted by the control unit into a MAF sensor output voltage signal, and is sent on to the PCM.

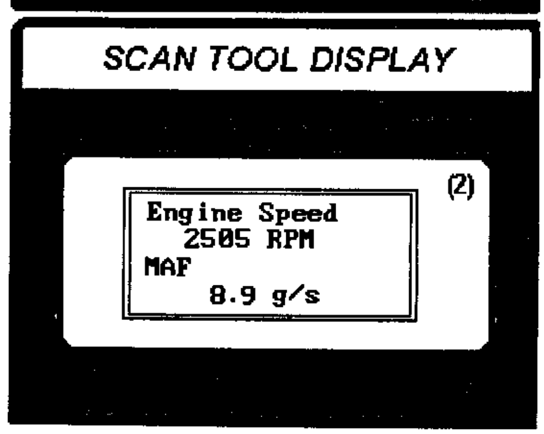
The hot wire circuit is constructed so that the Platinum hot wire and thermistor form a "bridge circuit". The internal power transistor is controlled so that the potential of circuit 'A' and circuit 'B' remains the same in order to maintain the correct hot wire temperature.



The Scan Tool is the tool of choice to use to test the operation of the MAF sensor and its circuits. MAF sensor information is provided in gms/sec (this allows you to compare to the values from a "known good" vehicle).

<u>Scan Tool Test (1) Example</u>

With the engine running at idle with the gear selector in Park or Neutral and the Parking Brake applied, record the MAF and RPM PID readings. Compare them to the example.



<u>Scan Tool Test (2) Example</u>

With the engine running at 2500 rpm with the gear selector in Park or Neutral and Parking Brake applied, record the MAF and RPM PID readings. Compare them to the example.

If the MAF PID readings do not match these examples, the MAF sensor may be dirty.

TOOLS & EQUIPMENT

Scan Tool Test Examples

MAP Sensor Test Example

Each OEM section of the manual contains examples of how to test Information Sensors. An example of a Scan Tool test for a MAP sensor is described on this page.

Circuit Description

The PCM supplies the MAP sensor with 5v power and ground circuits. The sensor ground circuit is connected to a common sensor ground connection that connects to the PCM and then to an eyelet connector on the engine.

No Start Condition

If the 5v VREF circuit is shorted to ground, these conditions will exist:

- The vehicle will not start
- The MIL (C/E lamp) could remain off
- A Scan Tool will read No Data

If the vehicle will not start, check the 5v supply to the MAP or TP sensor to quickly verify that the PCM is able to supply the 5v Reference to the circuits.

Scan Tool Test Example

The proper sequence to follow to obtain a Generic PID list from a Toyota vehicle is shown in the Graphic.

(1) Select F1: SCANTEST from the opening menu.
(2) Select Global OBD II from the Applications menu.
(3) Select F0: Powertrain from the Main menu.
(4) Initializing OBD II Communications screen appears.
(5) Select F0: DATALIST from the Select Mode menu. To view the I/M Readiness status of the OBD II Main Monitors, select F1: Readiness (or another choice).
(6) Select F0: Display Data from the Data List Menu.

Some of the Parameter ID (PID) items that are available in the Generic PID list for a Toyota are shown in this example.

To setup this test sequence, turn to key on and engine off. Then monitor the MAP sensor input on the Scan Tool display. Next, remove the MAP sensor source vacuum line. Then use a hand vacuum pump to supply vacuum to the MAP sensor vacuum port and apply vacuum to the sensor in increments of 5" of vacuum. Note the Scan Tool reading after each change in vacuum.

The transition in the vacuum readings should be within specifications and change smoothly as changes in vacuum are applied to the MAP sensor.

To test the MAP sensor input with the engine running, capture the MAP sensor PID data at idle and cruise speed. In the example on this page, the examples were captured with the vehicle in gear (at idle speed), then again at 30 and 55 mph. These are known good values. The MAP sensor input should increase and decrease smoothly through its complete range as shown in these examples.

IDLE SPEED

```
FT O2S B1 S1 ........ 0.0%
O2S B1 S2 ........ 0.035V
STORED DTCS .............. 0
MIL STATUS ............ OFF
OBD CERT. ......... OBD II
..........................
ENGINE SPEED ... 878RPM
ECT (°) ............. 180°F
VEHICLE SPEED ..... 0MPH
IGN. TIMING ....... 12.5°
ENGINE LOAD ....... 39.2%
MAP (P) ........ 11.6inHg
```

30 MPH

```
FT O2S B1 S1 ....... -2.3%
O2S B1 S2 ........ 0.035V
STORED DTCS .............. 0
MIL STATUS ............ OFF
OBD CERT. ......... OBD II
..........................
ENGINE SPEED . 1421RPM
ECT (°) ............. 199°F
VEHICLE SPEED ... 30MPH
IGN. TIMING ....... 10.0°
ENGINE LOAD ....... 26.2%
MAP (P) .......... 7.5inHg
```

55 MPH

```
FT O2S B1 S1 ........ 1.6%
O2S B1 S2 ........ 0.775V
STORED DTCS .............. 0
MIL STATUS ............ OFF
OBD CERT. ......... OBD II
..........................
ENGINE SPEED . 1969RPM
ECT (°) ............. 201°F
VEHICLE SPEED ... 55MPH
IGN. TIMING ....... 17.5°
ENGINE LOAD ....... 75.6%
MAP (P) ........ 21.8inHg
```

TOOLS & EQUIPMENT

Scan Tool Test Examples

Oxygen Sensor Test Example

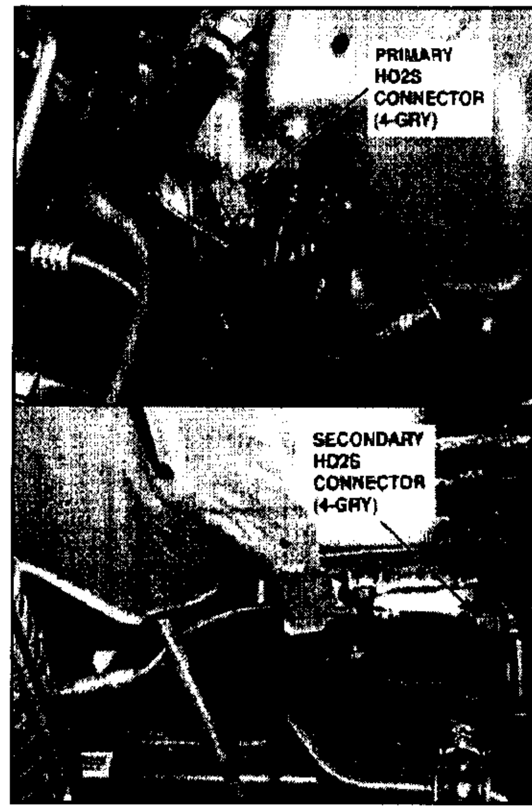
Each OEM section of the manual contains examples of how to test Fuel Control Devices. An example of a Scan Tool test for an Oxygen sensor is described next.

Honda Test Example

The heated oxygen sensor (HO2S) is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust stream and send a signal to the PCM. The PCM uses the HO2S signal to vary the duration of the fuel injection (the pulsewidth).

The PCM controls the A/F ratio by using the signals from both the primary (front) and secondary (rear) oxygen sensors. It can detect any deterioration in the primary sensor by evaluating the feedback period between the signals in the two sensors.

If the feedback period exceeds a certain value during "stable driving conditions", the PCM can determine if the front or rear oxygen sensor has deteriorated to a point that would adversely affect the tailpipe emissions. If this occurs, the PCM will set a trouble code.



Primary Oxygen Sensor Location

The primary (or front) oxygen sensor is mounted in the exhaust pipe in front of the three-way catalytic converter.

Secondary Oxygen Sensor Location

The secondary (rear) oxygen sensor is mounted in the three-way catalytic converter.

Oxygen Sensor Heaters

To stabilize their output signal, the oxygen sensors on this vehicle are equipped with an internal heater. The heater control circuits to the oxygen sensors are controlled by the PCM. They are activated a short time after engine startup.

Scan Tool Test Example

With the engine running at idle with the gear selector in Park or Neutral and the Parking Brake applied, record the Generic or OEM PID readings.

- Record the HO2S-11 reading at idle speed
- Record the HO2S-11 reading at acceleration
- Record the HO2S-11 reading at deceleration

Compare the hot idle reading to the example on this page.

```
ENGINE SPEED····868RPM
ECT (°)···············180°F
VEHICLE SPEED······0MPH
IGN. TIMING·········12.0°
ENGINE LOAD········40.0%
MAP (P)··········11.3inHg
TPS (%)···············10.5%
IAT (°)···············122°F
FUEL STAT 1·············OL
ST FT 1··················0.0%
LT FT 1················-5.4%
O2S B1 S1 ······ 0.045V
```

SYMPTOM DIAGNOSIS

General Test Examples

Introduction

This training manual contains numerous articles that describe how to use a specific piece of test equipment (i.e., a tool or piece of diagnostic equipment) during diagnosis of vehicle computer problems. Many of these problems are related to a trouble code. However, not all problems in the modern vehicle set a trouble code. Instead, they cause a condition or symptom to occur which may or may not be noticed by the driver.

General Test Examples

The articles included on the next few pages include information on how to test and repair known conditions or symptoms that occur on vehicle applications equipped with fuel injection and computer controls. Keep in mind that there are symptom repairs charts and tables available for other vehicle manufacturers that are similar to these examples.

Locate the symptom that matches the vehicle problem and refer to the Symptom Checks and Tests in the table below (these tests may not apply to all engines or systems).

Driveability Symptom List

Symptom Description	Symptom Checks & Tests
Test 1: Starting Concerns • Engine Does Not Crank • Hard Start, Long or Erratic Crank • Stall After Startup • No Start, Normal Crank • No Start due to a short to ground on VREF circuit (MIL is Off)	- Check battery, battery circuits to starter - Check for a damaged flywheel, engine compression, base timing and idle speed - Check for a failed fuel pump relay - Check for distributor rotor "punch-through" - Check for faulty ignition module or circuits - Check for short to ground on VREF circuit - Check for lack of starter signal to the PCM
Test 2: Idle Speed Concerns • Slow Return to Idle Speed • Rolling Idle Speed • Fast Idle Speed • Low or Slow Idle Speed	- Inspect for intake manifold vacuum leaks - Check the PCV valve, and for excessive carbon - Check for a restricted exhaust - Check base idle speed and fuel pressure - Check throttle body linkage for binding
Test 3: Stalls, Quits Running • At idle Speed • During Acceleration • During Cruise Speeds • During Deceleration	- Inspect for intake manifold vacuum leaks - Check PCV valve and for excessive carbon - Check for a restricted exhaust - Check base idle speed and fuel pressure - Check throttle body linkage for binding - Check for no A/C or electrical load signal
Test 4: Runs Rough • At idle Speed • During Acceleration • During Cruise Speeds	- Inspect for intake manifold vacuum leaks - "Scope" Ignition Secondary components - Check Base timing and idle speed setting - Check fuel pressure and fuel injectors
Test 5: Cuts Out, Misses • At idle Speed • During Acceleration • During Cruise Speeds	- Inspect for intake manifold vacuum leaks - "Scope" Ignition Secondary components - Check fuel pressure and fuel injectors - Check for restricted exhaust or converter
Test 6: Surges • During Acceleration • During Cruise Speeds • During Deceleration	- "Scope" Ignition Secondary components - Check fuel pressure and fuel injectors - Monitor LONGFT value with fault present - Remove/inspect O2S for contamination - Check for restricted exhaust or converter
Test 7: Hesitates, Poor Acceleration • During Acceleration • During Deceleration	- "Scope" Ignition Secondary components - Check the PCV Valve, related components - Check for sticking or broken engine parts
Test 8: Lack of Power, Sluggish • During Acceleration • During Cruise Speeds	- "Scope" Ignition Secondary components - Check fuel pressure and fuel injectors - Check for restricted exhaust or converter
Test 9: Emissions Compliance • Fails Tailpipe Inspection • Fails I/M Readiness Status	- Check Base engine idle speed and timing - Check PCM control of Fuel system (O2S) - OBD II: Do a PCM Reset and Drive Cycle

SYMPTOM DIAGNOSIS

General Test Examples

Test 1: Starting Concerns (Engine Cold or Hot)

Preliminary Checks

Prior to starting this symptom test, carefully perform these steps:

- Verify engine cranks (turns over), verify starter relay operation
- Verify that the EFI Main Relay energizes at Key on Engine Off
- Check Air Intake system for restrictions (air inlet tubes, dirty filter)
- For No Starts, use Scan Tool to check for a Starter Signal

Note: ***If the vehicle cranks and will not start, on DI systems, check the rotor for a "punch-through" condition. On EI systems, check the DIS coilpack for faults or leakage in the primary or secondary circuits for the cause of a fault.***

Test 1 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *No Start Only!* • Check battery cables, state of charge • Does the engine crank normally?	If yes, go to step 2	If no, make repairs to battery, starter or engine mechanical.
Step 2 Description: *Test Ignition Sec.* • Inspect ignition secondary components for damage or leakage (rotor shorted) • Check spark output with spark tester • Use engine analyzer to test secondary • Are Ignition system faults suspected?	If yes, make repairs as needed to the Ignition primary or secondary system. Then retest for the condition.	If no, go to step 3.
Step 3 Description: *Test Fuel System* • Test for leaks or low fuel pressure • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition.	If no, go to step 4.
Step 4 Description: *Exhaust restricted?* • Check for any leaking components • Test exhaust system for restriction • Is an exhaust restriction suspected?	If yes, locate the restriction and make the repair. Then retest for the condition.	If no, go to step 5.
Step 5 Description: *Is engine too hot?* • Check for signs of an overheating condition (related to a hard start fault) • Is the engine overheated?	If yes, make repairs to correct the overheating. Then retest the condition.	If no, go to step 6.
Step 6 Description: *Check PCV system* • Inspect PCV system components for broken parts or leaking connections • Test PCV valve operation • Are PCV system faults suspected?	If yes, make repairs as needed to the PCV system. Then retest for the condition.	If no, go to step 7.
Step 7 Description: *Test EVAP system* • Inspect for damaged or disconnected EVAP system components • Are EVAP system faults suspected?	If yes, make repairs as needed to the EVAP system. Then retest the condition.	If no, go to step 8.
Step 8 Description: *Test Base Engine* • Test engine compression • Check the timing chain & valve timing • Check for worn camshaft or valve train • Check for worn or jumped timing chain • Check for manifold gasket leaks • Are any Base Engine faults present?	If yes, make repairs as needed to the Base Engine. Then retest for the condition.	If no, something that caused the fault was missed. Repeat all of the test steps to locate and repair the starting concern.

SYMPTOM DIAGNOSIS

General Test Examples

Test 2: Idle Concerns

Preliminary Checks

Prior to starting this symptom test, inspect these underhood items:

- All engine related vacuum lines for proper routing and integrity
- All related electrical connectors and wiring harnesses for faults
- Check Air Intake system for restrictions (air inlet tubes, dirty filter)
- Check intake manifold and components for leaks (EGR, IAC, etc.)

Note: ***If a rough idle exists, check base timing and idle speed adjustments along with IAC operation. If okay, check the engine for dirty injectors or excessive carbon buildup.***

Test 2 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Is the Idle Speed Low?* • Does the warm engine have a low idle speed condition in Park or Neutral?	If yes (low idle or rough idle condition exists), go to step 2.	If no, condition is not present at time. Use Intermittent List
Step 2 Description: *Test IAC operation!* • Disconnect the IAC motor connector • Start the engine at part throttle in P/N • Does the engine start and run smoothly at part throttle in P or N?	If yes, refer to Idle Speed system tests and adjustments in other repair media to set the base idle.	If no, go to step 3.
Step 3 Description: *Compare PID Data* • Connect scan tool, turn off accessories • Start the engine and allow for warmup • Compare specific vehicle known-good Scan Tool readings to actual readings • Use a DVOM to test PCM pin voltages • Are PIDs or Pin voltages within range?	If yes, meaning all serial data items and pin chart readings match the known-good values, go to step 4. Look at the IAC readings.	If no (one or more readings are out of normal range), go to the Idle Speed tests in other manuals or repair media to make the repairs.
Step 4 Description: *Test Ignition Sec!* • Inspect ignition secondary components for damage or leakage (rotor shorted) • Check spark output with spark tester • Use engine analyzer to test secondary • Are Ignition system faults suspected?	If yes, make repairs as needed to the Ignition primary or secondary system. Then retest for the condition.	If no, go to step 5.
Step 5 Description: *Exhaust restricted?* • Check for any leaking components • Test exhaust system for restriction • Is an exhaust restriction suspected?	If yes, locate the restriction and make the repair. Then retest for the condition.	If no, go to step 6.
Step 6 Description: Test Fuel System! • Test for leaks or low fuel pressure • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition.	If no, go to step 7.
Step 7 Description: *Check PCV system* • Inspect PCV system components for broken parts or leaking connections • Test PCV valve operation • Are PCV system faults suspected?	If yes, make repairs as needed to the PCV system. Then retest for the condition.	If no, go to step 8.
Step 8 Description: *Test EVAP system* • Inspect for damaged or disconnected EVAP system components • Are EVAP system faults suspected?	If yes, make repairs as needed to the EVAP system. Then retest the condition.	If no, test Base engine compression and valve timing for reason for condition

SYMPTOM DIAGNOSIS

General Test Examples

Test 3: Stalls, Quits Running

Preliminary Checks

Prior to starting this symptom test, inspect these underhood items:

- All engine related vacuum lines for proper routing and integrity
- Check Air Intake system for restrictions (air inlet tubes, dirty filter)
- Check intake manifold and components for leaks (EGR, IAC, etc.)

Note: ***If the vehicle stalls or quits running and the base timing and idle adjustments are okay, also check the IAC Motor.***

Test 3 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Does the Engine Stall?* • Start warm engine in P/N (allow to idle) • Does the engine stall or almost stall?	If yes, read & repair any codes. With no codes, go to step 4.	If no (meaning the engine does not stall), go to step 2.
Step 2 Description: *Rough idle?* • Does the engine have a warm engine rough idle condition in P or N?	If yes (engine has a warm engine rough idle) go to step 4.	In no faults were detected, condition is not present now.
Step 3 Description: *Compare PID Data* • Connect scan tool, turn off accessories • Start the engine and allow for warmup • Compare the actual vehicle readings to *handbook vehicle specific readings.* • Use a DVOM to test PCM pin voltages • Are PIDs or Pin voltages within range?	If yes, meaning all serial data items and pin chart readings match the known-good values, go to step 5. Look at the IAC readings.	If no (one or more readings are out of normal range), go to the Idle Speed tests in other manuals or repair media to make the repairs.
Step 4 Description: *Recheck for Stall!* • Disconnect the IAC motor connector and recheck for stall or near stall • Start engine at part throttle in P/N. • Does engine stall with IAC removed?	If yes, refer to Idle Speed system tests and adjustments in other repair media to set base idle.	If no, go to step 6.
Step 5 Description: *Test IAC operation* • Start the engine at part throttle in P/N • Disconnect the IAC motor connector • Check for rpm drop on engine stall • Does the engine speed drop or does engine stall with IAC plug removed?	If yes, go to step 3 to read and record PIDs or Pin Chart values. Refer to examples of PID Data in handbook.	If no, refer to Idle Speed system tests and adjustments in other repair media to set the base idle.
Step 6 Description: *Test Ignition Sec!* • Inspect ignition secondary components for damage or leakage (rotor shorted) • Use engine analyzer to test secondary • Are Ignition system faults suspected?	If yes, make repairs to Ignition primary or secondary system. Then retest for the condition.	If no, go to step 7
Step 7 Description: *Test Fuel System* • Test for leaks or low fuel pressure • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition.	If no, go to step 8.
Step 8 Description: *Check PCV system* • Inspect PCV components for broken parts or leaks, test the valve operation • Are PCV system faults suspected?	If yes, make repairs to the PCV system. Then retest for the condition.	If no, go to step 9.
Step 9 Description: *Test EVAP system* • Inspect for damaged or disconnected EVAP system components • Are EVAP system faults suspected?	If yes, make repairs as needed to the EVAP system. Then retest the condition.	If no, test Base engine compression and valve timing for reason for condition

SYMPTOM DIAGNOSIS

General Test Examples

Test 4: Runs Rough

Preliminary Checks

Prior to starting this symptom test, inspect these underhood items:

- All engine related vacuum lines for proper routing and integrity
- Check intake manifold and components for leaks (EGR, IAC, etc.)

Note: ***If the engine runs rough and all engine subsystems are okay, check the engine for excessive carbon buildup.***

Test 4 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Does the engine run rough?* • Start warm engine in P/N (allow to idle) • Does the engine run rough?	If yes, read & repair any codes. With no codes, go to step 3.	If no (the engine does not run rough, go to step 2.
Step 2 Description: *Is it not running rough?* • Inspect various underhood items that could cause a rough running condition (IAC, Ignition system, throttle body). • Were any problems located?	If yes, correct the problem(s). Do a PCM Reset and Idle Relearn if it applies. Verify repair is done	If no obvious faults were detected and repaired during this step, problem is not present at this time.
Step 3 Description: Test IAC operation • Start the engine in P/N (allow it to idle) • Disconnect the IAC motor connector • Check for rough running condition • Next, reconnect the IAC connector • Did the engine run rough with IAC off?	If yes, go to step 4 to read and record PIDs or Pin Chart values. Refer to examples of PID Data in handbook.	If no, refer to Idle Speed system tests and adjustments in other repair media to set the base idle.
Step 4 Description: Compare PID Data • Connect scan tool, turn off accessories • Start the engine and allow for warmup • Compare the actual vehicle readings to *handbook vehicle specific readings.* • Use a DVOM to test PCM pin voltages • Are PIDs or Pin voltages within range?	If yes, meaning all serial data items and pin chart readings match the known-good values, go to step 5. Look at the IAC readings.	If no (one or more readings are out of normal range), go to engine system or component test related to the value that is out of range
Step 5 Description: Test Ignition Sec. • Inspect ignition secondary components for damage or leakage (rotor shorted) • Use engine analyzer to test secondary • Are Ignition system faults suspected?	If yes, make repairs to Ignition primary or secondary system. Then retest for the condition.	If no, go to step 6
Step 6 Description: Test Fuel System • Test for leaks or low fuel pressure • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition.	If no, go to step 7.
Step 7 Description: Exhaust restricted? • Check for any leaking components • Test exhaust system for restriction • Is an exhaust restriction suspected?	If yes, locate the restriction and make the repair. Then retest for the condition.	If no, go to step 8.
Step 8 Description: Check PCV system • Inspect PCV components for broken parts or leaks, test the valve operation • Are PCV system faults suspected?	If yes, make repairs to the PCV system. Then retest for the condition.	If no, go to step 9.
Step 9 Description: Test EVAP system • Inspect for damaged or disconnected EVAP system components • Are EVAP system faults suspected?	If yes, make repairs as needed to the EVAP system. Then retest the condition.	If no, test Base engine compression and valve timing for reason for condition

SYMPTOM DIAGNOSIS

General Test Examples

Test 5: Cuts-Out or Misses

Preliminary Checks

Prior to starting this symptom test, inspect these underhood items:

- All engine related vacuum lines for proper routing and integrity
- Check intake manifold and components for leaks (EGR, IAC, etc.)

Note: ***This condition may cause a steady pulsation or jerking that follows engine speed. It is usually more pronounced as the engine load increases.***

Test 5 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Does the engine miss at idle?* • Start warm engine in P/N (allow to idle) • Does the engine miss at idle speed?	If yes, read & repair any codes. With no codes, go to step 3.	If no (the engine does not miss at idle, go to step 2.
Step 2 Description: *No miss at idle!* • Inspect various underhood items that could cause a miss at idle condition (Ignition and Fuel system components) • Were any problems located?	If yes, correct the problem(s). Do a PCM Reset and Idle Relearn if it applies. Verify repair is done	In no obvious faults were detected and repaired during this step, problem is not present at this time.
Step 3 Description: *Compare PID Data* • Connect scan tool, turn off accessories • Start the engine and allow for warmup • Compare the actual vehicle readings to *handbook vehicle specific readings.* • Use a DVOM to test PCM pin voltages • Are PIDs or Pin voltages within range?	If yes, meaning all serial data items and pin chart readings match the known-good values, go to step 4. OBD II - see misfire history	If no (one or more readings are out of normal range), go to engine system or component test related to the value that is out of range
Step 4 Description: *Test Ignition Sec!* • Inspect ignition secondary components for damage or leakage (rotor shorted) • Use engine analyzer to test secondary • Are Ignition system faults suspected?	If yes, make repairs to Ignition primary or secondary system. Then retest for the condition.	If no, go to step 5
Step 5 Description: *Test Fuel system* • Test for leaks or low fuel pressure • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition.	If no, go to step 6.
Step 6 Description: *Exhaust restricted?* • Check for any leaking components • Test exhaust system for restriction • Is an exhaust restriction suspected?	If yes, locate the restriction and make the repair. Then retest for the condition.	If no, go to step 7.
Step 7 Description: *Test EVAP system* • Inspect for damaged or disconnected EVAP system components • Are EVAP system faults suspected?	If yes, make repairs as needed to the EVAP system. Then retest for the fault.	If no, go to step 8
Step 8 Description: *Check PCV system* • Inspect PCV components for broken parts or leaks, test the valve operation • Are PCV system faults suspected?	If yes, make repairs to the PCV system. Then retest for the condition.	If no, test Base engine compression and valve timing for possible causes of the condition. Also check Air Intake system components and the controls to the transaxle or transmission.

SYMPTOM DIAGNOSIS

General Test Examples

Test 6: Surges

Preliminary Checks

Prior to starting this symptom test, inspect these underhood items:

- Air leaks at the intake manifold mounting surface & throttle body
- All related vacuum lines for leaks, kinks, routing, splits & integrity
- Check charging voltage (13-15v), VSS reading at cruise speeds

Note: ***This condition may cause an engine power variation at steady throttle or cruise. It may feel like vehicle speeds up/slows down without throttle change.***

Test 6 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Does the vehicle surge?* • Drive vehicle - verify it bucks or jerks • Does the engine buck or jerk (cruise)?	If yes, read & repair any codes. With no codes, go to step 3.	If no (the engine does not buck or jerk, go to step 2.
Step 2 Description: *No Surge!* • Inspect various underhood items that could cause an intermittent condition (i.e., fuel, ignition system components) • Were any problems located?	If yes, correct the problem(s). Do a PCM Reset and Road Test to verify the repair is done.	In no obvious faults were detected and repaired during this step, problem is not present at this time.
Step 3 Description: *Compare PID Data* • Connect scan tool, turn off accessories • Drive the vehicle at cruise speeds and compare the actual vehicle readings to *handbook vehicle specific readings.* • Use a DVOM to test PCM pin voltages • Are PIDs or Pin voltages within range?	If yes, meaning all serial data items and pin chart readings match the known-good values, go to step 4. OBD II - see misfire history	If no (meaning one or more readings are out of range), go to engine system or component test related to the value that is out of range
Step 4 Description: *Check HO2S Input* • Perform a Snap-Accel Test of HO2S at Idle and Cruise speeds. As the throttle is snapped to open in P/N, the signal should quickly go to 0.5-1v. At Decel, the signal should move to 0.0-0.4v. • Did HO2S pass the Accel/Decel Test?	If yes, go to step 5. Note: The tool of choice to test the HO2S operation is the Lab Scope (so that waveforms can be observed).	If no, check for problems at sensor connector (loose or moisture tracking). Inspect sensor tip for white powder & for signs of coolant.
Step 5 Description: *Test Fuel system* • Test for leaks or low fuel pressure (a fuel gauge can be used to test fuel pressure at cruise and deceleration speeds). • Check for a restricted fuel filter. • Monitor LONGFT & SHRTFT at cruise. • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition. If SHRTFT reading is near 159, check the PCM ground at the engine grounds.	If no, go to step 6.
Step 6 Description: *Test Ignition Sec!* • Inspect ignition secondary components for damage or leakage (rotor shorted) • Test spark output with a spark tester. • Remove spark plugs, look for deposits • Use engine analyzer to test secondary • Are ignition system faults suspected?	If yes, make repairs to ignition primary or secondary system. Then retest for the original condition.	If no, go to step 7
Step 7 Description: *Exhaust restricted?* • Check for any leaking components • Test exhaust system for restriction • Is an exhaust restriction suspected?	If yes, locate the restriction and make the repair. Then retest for the condition.	In no faults were detected, problem is not present at this time.

SYMPTOM DIAGNOSIS

General Test Examples

Test 7: Hesitation, Sag or Stumble

Preliminary Checks

Prior to starting this symptom test, inspect these underhood items:

- Air leaks at the intake manifold mounting surface & throttle body
- Check charging voltage (13-15v), PCM main and sensor grounds
- Engine valve timing and compression, and for a worn camshaft

Note: ***This condition may feel like a momentary lack of response as the accelerator is pushed down. It may cause engine to stall if it is severe enough.***

Test 7 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Does the engine hesitate or Sag?* • Drive vehicle - verify lack of power. • Does the engine have lack of power?	If yes, read & repair any codes. With no codes, go to step 3.	If no, (engine does not have lack of power) go to step 2.
Step 2 Description: *No Hesitation!* • Inspect various underhood items that could cause an intermittent condition (i.e., fuel, ignition system components) • Were any problems located?	If yes, correct the problem(s). Do a PCM Reset and Road Test to verify the repair is done.	In no obvious faults were detected and repaired during this step, problem is not present at this time.
Step 3 Description: *Compare PID Data* • Connect scan tool, turn off accessories • Drive the vehicle at part throttle and compare the actual vehicle readings to *handbook vehicle specific readings.* • Use a DVOM to test PCM pin voltages • Are PIDs or Pin voltages within range?	If yes, meaning all serial data items and pin chart readings match the known-good values, go to step 4. Check the HO2S readings.	If no (meaning one or more readings were out of range), go to engine system or component test related to the value that is out of range
Step 4 Description: *Check HO2S Input* • Perform a Snap-Accel Test of HO2S at Idle and Cruise speeds. As the throttle is snapped to open in P/N, the signal should quickly go to 0.5-1v. At Decel, the signal should move to 0.0-0.4v. • Did HO2S pass the Accel/Decel Test?	If yes, go to step 5. Note: The tool of choice to test the HO2S operation is the Lab Scope (so that waveforms can be observed).	If no, check for problems at sensor connector (loose or moisture tracking). Inspect sensor tip for white powder & for signs of coolant.
Step 5 Description: *Test Fuel system* • Test for leaks or low fuel pressure (a fuel gauge can be used to test fuel pressure at cruise and deceleration speeds). • Check for a restricted fuel filter. • Monitor LONGFT & SHRTFT at cruise. • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition. If SHRTFT reading is near 159, check the PCM ground at ICM mounting point.	If no, go to step 6.
Step 6 Description: *Test Ignition Sec!* • Inspect ignition secondary components for damage or leakage (rotor shorted) • Test spark output with a spark tester. • Remove spark plugs, look for deposits • Use engine analyzer to test secondary • Are ignition system faults suspected?	If yes, make repairs to Ignition primary or secondary system. Then retest for the original condition.	If no, go to step 7
Step 7 Description: *Exhaust restricted?* • Check for any leaking components • Test exhaust system for restriction • Is an exhaust restriction suspected?	If yes, locate the restriction and make the repair. Then retest for the condition.	In no faults were detected, problem is not present at this time.

SYMPTOM DIAGNOSIS

General Test Examples

Test 8: Lack of Power, Sluggish or Spongy

Preliminary Checks

Prior to starting this symptom test, inspect these underhood items:

- Air leaks at the intake manifold mounting surface & throttle body
- Check charging voltage (13-15v), PCM main and sensor grounds
- Engine valve timing and compression, and for a worn camshaft

Note: ***This condition may cause the engine to deliver less than the expected power. There may be little increase in speed with accelerator pedal pushed part way.***

Test 8 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Is there a lack of power?* • Drive vehicle - verify lack of power. • Does the engine have lack of power?	If yes, read & repair any codes. With no codes, go to step 3.	If no, (engine does not have lack of power) go to step 2.
Step 2 Description: *No Lack of Power!* • Inspect various underhood items that could cause an intermittent condition (i.e., fuel, ignition system components) • Were any problems located?	If yes, correct the problem(s). Do a PCM Reset and Road Test to verify the repair is done.	In no obvious faults were detected and repaired during this step, problem is not present at this time.
Step 3 Description: *Compare PID Data* • Connect scan tool, turn off accessories • Drive the vehicle at part throttle and compare the actual vehicle readings to *handbook vehicle specific readings.* • Use a DVOM to test PCM pin voltages • Are PIDs or Pin voltages within range?	If yes, meaning all serial data items and pin chart readings match the known-good values, go to step 4. Check the HO2S readings.	If no (meaning one or more readings are out of range), go to engine system or component test related to the value that is out of range
Step 4 Description: *Check HO2S Input* • Perform a Snap-Accel Test of HO2S at Idle and Cruise speeds. As the throttle is snapped to open in P/N, the signal should quickly go to 0.5-1v. At Decel, the signal should move to 0.0-0.4v. • Did HO2S pass the Accel/Decel Test?	If yes, go to step 5. Note: The tool of choice to test the HO2S operation is the Lab Scope (so that waveforms can be observed).	If no, check for problems at sensor connector (loose or moisture tracking). Inspect sensor tip for white powder & for signs of coolant.
Step 5 Description: *Test Fuel system* • Test for leaks or low fuel pressure (a fuel gauge can be used to test fuel pressure at cruise and deceleration speeds). • Check for a restricted fuel filter. • Monitor LONGFT & SHRTFT at cruise. • Are any fuel system faults suspected?	If yes, make repairs to Fuel system and retest the condition. If SHRTFT reading is near 159, check the PCM ground at the engine grounds.	If no, go to step 6.
Step 6 Description: *Test Ignition Sec!* • Inspect ignition secondary components for damage or leakage (rotor shorted) • Test spark output with a spark tester. • Remove spark plugs, look for deposits • Use engine analyzer to test secondary • Are Ignition system faults suspected?	If yes, make repairs to Ignition primary or secondary system. Then retest for the original condition.	If no, go to step 7
Step 7 Description: *Exhaust restricted?* • Check for any leaking components • Test exhaust system for restriction • Is an exhaust restriction suspected?	If yes, locate the restriction and make the repair. Then retest for the condition.	In no faults were detected, problem is not present at this time.

SYMPTOM DIAGNOSIS

General Test Examples

Test 9: Emissions Compliance

<u>Preliminary Checks</u>

Prior to starting this symptom test, inspect these underhood items:

- Check that the Charging system voltage is within range (13-15v)
- Check the condition of the PCM main and sensor grounds

Note: ***This condition may cause the vehicle to fail a state tailpipe emissions test. A rotten egg smell may also accompany this condition (odors do not mean a test will fail).***

Test 9 Repair Chart

Step Number & Action to Take	Yes	No
Step 1 Description: *Analyze the I/M Report!* • Identify any High or Low Gas readings. • If a drive trace is included, identify the drive mode in which the gases failed (e.g., did the gases appear high early in the test and then decrease as the catalyst temperature increased?). • Has the I/M test report been analyzed?	Go to Step 2.	Carefully repeat all of steps listed under the description: *Analyze the report carefully!*
Step 2 Description: *EVAP Failure Only?* • Did the vehicle only fail the EVAP leak test or Purge Flow test (gases okay)?	Go to Step 22.	Go to Step 3.
Step 3 Description: *Develop Base Line* • Develop a base line of the current tailpipe emissions. Use a calibrated gas analyzer and record the current tailpipe readings. Repeat the test more than once to establish a true base line. • Watch for any related symptoms during the base line test (i.e., exhaust smoke or idle speed concerns). • Has the vehicle baseline been done?	Go to Step 4. Note: The vehicle base line report can be a useful tool as the readings can be compared against the final emission readings once all vehicle repairs are completed.	Repeat the base line test step until the vehicle baseline has been completed.
Step 4 Description: *Any other Symptoms Present?* Check for signs of these symptoms: • Rough, low or "hunting" engine idle. • Signs of exhaust smoke at tailpipe. • Cooling system (did engine warmup?). • Are any of these or any other high emission related symptoms present?	Go to the Symptom List in this repair manual and select the symptom that matches the vehicle condition. If it is not listed, refer to the information in other manuals or media.	Go to Step 5.
Step 5 Description: *Preliminary Checks Done?* Perform these inspections and checks: • Check vacuum lines for kinks or signs of moisture. • Check for loose or backed-out connections or terminals. • Check for the installation or use of aftermarket emission controls and components. • Were any faults or wrong parts found?	Make repairs to the fault or service the aftermarket component as needed. Go to Step 24 to verify the repairs.	Go to Step 6.
Step 6 Description: *Perform the Trouble Codes Check!* • Perform the correct OBD I check or OBD II diagnostic check to read and record any stored trouble codes. • Were any codes detected in this step?	Go to other repair manuals or electronic media and repair all codes	Go to Step 7.
Step 7 Description: *Check the CO Reading!* • Use a calibrated gas analyzer to check the vehicle CO reading. • Were the CO levels excessive?	Note: A high CO level indicates a rich A/F mixture. Go to Step 10.	Go to Step 8.
Step 8 Description: *Check the HC Reading!* • Use a calibrated gas analyzer to check the vehicle HC reading. • Were the HC levels excessive?	Note: A high HC level with normal to low CO level indicates a lean A/F mixture. Go to Step 16.	Go to Step 9.
Step 9 Description: *Check the NOx Reading!* • Use a calibrated gas analyzer to check the vehicle NOx reading. • Were the NOx levels excessive?	Go to Step 20.	Go to the Symptom List - look for other engine related symptoms (the gas levels are okay at this time).
Step 10 Description: *Rich Condition - Check HC Levels* • With high CO levels, check the HC levels with a calibrated gas analyzer. • Were the HC levels too high?	Go to Step 11 to check for a condition where the engine runs rich along with incomplete combustion.	Go to Step 15 to check for a rich running condition with the HC levels normal.

SYMPTOM DIAGNOSIS

General Test Examples

Test 9: Emissions Compliance

Test 9 Repair Chart - Continued

Step Number & Action to Take	Yes	No
Step 11 Description: *Test the Ignition System!* • Inspect ignition secondary components for damage or leakage (rotor leakage) • Test spark output with a spark tester. • COP system: Inspect coils and spark plugs for problems • Use engine analyzer to test the secondary ignition • Is the Ignition System okay?	Go to Step 12.	Make the needed repairs to Ignition primary or secondary system as needed. Go to Step 24 to verify the repairs.
Step 12 Description: *Check the PCV System!* • Inspect PCV components for broken parts or leaks, test the valve operation • Is the PCV system okay?	Go to Step 13.	Make the needed repairs to PCV system as needed. Go to Step 24 to verify the repairs.
Step 13 Description: *Check the Exhaust System!* • Check for any leaking components • Test exhaust system for restriction (the exhaust backpressure reading should be less than 1.5 psi at cruise speeds). • Is the Exhaust system okay?	Go to Step 14.	Make the needed repairs to the Exhaust system or related components. Go to Step 24 to verify the repairs.
Step 14 Description: *Test the Base Engine!* Check these Base Engine Components: • Check engine compression. • Check for wrong or worn camshaft. • Check valve train components. • Check condition of timing belt or chain. • Are the Base Engine components okay?	Recheck the results of the previous test steps. If they are all okay, the problem that caused the condition is not present at this time.	Make repairs to the Base Engine components as required. Go to Step 24 to verify the repairs.
Step 15 Description: *Rich A/F Mixture Condition!* • Test the Fuel system for problems that could cause a rich A/F mixture condition (leaking injectors, fuel pressure regulator, etc.). • Monitor the LONGFT & SHRTFT PID values at idle speed and at cruise speed. • Is the Fuel system okay?	Go to Step 18.	Make repairs to the Fuel system or required components as need to correct the "rich" condition. Go to Step 24 to verify the repairs.
Step 16 Description: High HC - Normal to Low CO Level • Test for leaks or low fuel pressure (a fuel gauge can be used to test fuel pressure at cruise and deceleration speeds). *Caution: Follow all safety precautions!* • Monitor the LONGFT and SHRTFT readings at engine idle and cruise for signs of a lean running condition. • Check for a weak pump, dirty fuel filter. • Is the Fuel system okay?	Go to Step 17.	Make repairs to the Fuel system as required to correct the "lean" condition. Go to Step 24 to verify the repairs.
Step 17 Description: *Test the Ignition System!* • Inspect ignition secondary components for damage or leakage (rotor leakage) • Test spark output with a spark tester. • COP system: Inspect coils and spark plugs for problems • Use engine analyzer to test the secondary ignition • Is the Ignition System okay?	Go to Step 18.	Make repairs to the Ignition primary or secondary system as required. Go to step 24 to verify repairs.
Step 18 Description: *Check the PCV System!* • Inspect PCV components for broken parts or leaks, test the valve operation • Is the PCV system okay?	Go to Step 19.	Make repairs to the PCV system as required. Go to Step 24 to verify the repairs.
Step 19 Description: *Test the Base Engine!* Check these Base Engine Components: • Check engine compression. • Check for wrong or worn camshaft. • Check valve train, timing chain or belt. • Are Base Engine components okay?	Recheck the test results from the previous test steps. If they are okay, the problem is not present at this time.	Make repairs to the Base Engine components as required. Go to Step 24 to verify the repairs.
Step 20 Description: *Check the EGR System!* • Perform the EGR Function Test as needed (check for a sticking EGR valve or leakage at the EGR valve). • Monitor EGR sensor Serial or PID data (compare actual readings to vehicle specific reading in this manual). • Is the EGR system okay?	Go to Step 21.	Make repairs to EGR system as required. Go to Step 24 to verify the repairs.

SYMPTOM DIAGNOSIS

General Test Examples

Test 9: Emissions Compliance

Test 9 Repair Chart - Continued

Step Number & Action to Take	Yes	No
Step 21 Description: *Additional Checks to Perform* Perform the following additional checks: • Analyze report for when the fault occurs (i.e., did it occur only at idle speed, at cruise speed or both?) • Check the Cooling system operation (have any add-on front facia or intake changes been made?) • Are all of these checks okay?	Recheck the test results from the previous test steps. If they are okay, the problem is not present at this time.	Make repairs to the systems or components as required. Go to Step 24 to verify the repairs.
Step 22 Description: *EVAP Problem Present!* • When does the EVAP fault occur? • Attempt to verify the EVAP failure. • Check for loose or damaged fuel cap. • Check condition of the carbon canister. • Inspect EVAP vacuum lines for damage or disconnects. • Are all of these checks okay?	Go to Step 23.	Make repairs to the systems or components as required. Go to Step 24 to verify the repairs.
Step 23 Description: *Test the EVAP System!* • Perform applicable EVAP system test and operation (refer to other repair manual or electronic media). • Check for a missing or loose gas cap. • Was the EVAP system okay?	Verify the test results. If they are all okay, the EVAP problem is not present at this time - the problem must have been intermittent!	Make repairs as needed to the EVAP system or its related components. Go to Step 24 to verify the repairs.
Step 24 Description: *Repair Verification Step!* • All vehicle repairs have been completed. • Key off, remove negative battery cable for over 15 minutes to reset the Fuel Tables in the PCM. • Reconnect the negative battery cable. • PCM Relearn Steps: run the engine at 2500 rpm in P/N for one minute, then idle in gear for two minutes. • Perform base line test of emissions (exhaust analyzer). • For I/M Emission Test areas where original gas concentrations are reported in grams per mile: refer to the paragraph that follows to verify GPM. • All other areas where original gas concentrations are reported in PPM: verify gas levels are within range. • Are all gas levels within the normal range?	Save any documentation required by the local or federal emission program laws or statutes.	If no, the gas levels are still too high or one of the gas levels is above the acceptable range. Return to step 1 of this test procedure and carefully repeat all of the test steps.

Excessive Grams Per Mile Verification Procedure

Follow this procedure to verify excessive grams per mile (GPM) indications using parts per million (PPM) readings. If the vehicle gas readings are excessive, compare the actual GPM readings to the gas cut-point levels needed to pass the required test. Determine how much the actual GPM reading exceeds the cut-point, as this data will provide an indication of how much the PPM reading is over the cut-point. It will also indicate how much the PPM reading needs to be reduced (e.g., if the actual reading is twice the cut-point reading, the baseline reading will have to be cut in half or more).

Example: If the actual HC produced by a vehicle were 1.6 GPM, the cut-point for HC would be 0.8 GPM (the actual reading is twice the cut-point). An HC reading from a test vehicle during the baseline test averages 440 PPM. Before this vehicle will pass an I/M test, the HC reading from the verification test must be 220 PPM (1/2 of baseline).

Summary: This method is meant to give a general idea of how much a PPM reading must be reduced for a vehicle to pass an I/M Test that calculates GPM. Your experience will determine if the emissions readings were reduced enough for the vehicle to pass.

AED GLOSSARY

Glossary of Acronyms & Terms

Acronyms - Old to New

1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
AC	Air Conditioning	A/C
A/C Cycling Switch	Air Conditioning Cycling Switch	A/C Cycling Switch
ACC Accelerator	Air Conditioning Clutch	A/C Clutch
ACCS	Air Conditioning Cycling Switch	A/C Cycling Switch
ACH	Air Cleaner Housing	ACL Housing
ACS	Air Conditioning System	A/C System
ACT	Intake Air Temperature	IAT
Adaptive Fuel Strategy	Fuel Trim	FT
AFC	Mass Air Flow	MAF
AFC	Volume Air Flow	VAF
After Cooler	Charge Air Cooler	CAC
Air Cleaner	Air Cleaner	ACL
Air Cleaner Element	Air Cleaner Element	ACL Element
Air Cleaner Housing	Air Cleaner Housing	ACL Housing
Air Cleaner Housing Cover	Air Cleaner Housing Cover	ACL Housing Cover
Air Conditioning	Air Conditioning	A/C
Air Conditioning Sensor	Air Conditioning Sensor	A/C Sensor
Air Control Valve	Secondary Air Injection Valve	AIR Control Valve
Air Flow Meter	Mass Air Flow Sensor	MAF Sensor
Air Flow Meter	Volume Air Flow Sensor	VAF Sensor
AI (Air Injection)	Secondary Air Injection	AIR
AIP (Air Injection Pump)	Secondary Air Injection Pump	AIR Pump
AIR (Air Injection Reactor)	Secondary Air Injection	AIR
AIR (Air Injection Reactor)	Pulsed Secondary Air Injection	PAIR
Air Temperature Sensor	Intake Air Temperature Sensor	IAT Sensor
Air Valve	Idle Air Control Valve	IAC Valve
AIRB	Secondary Air Injection Bypass	AIR Bypass
AIRD	Secondary Air Injection Diverter	AIR Diverter
Automatic Idle Speed Control	AIS Motor	AIS
AIV	Pulsed Secondary Air Injection	PAIR
Alcohol Concentration Sensor	Flexible Fuel Sensor	FF Sensor
ALCL	Assembly Line Communication Link	DLC
ALDL	Assembly Line Diagnostic Link	DLC
ALT (Alternator)	Generator	GEN
AM1 (Air Management 1)	Secondary Air Injection Bypass	AIR Bypass
AM2 (Air Management 2)	Secondary Air Injection Diverter	AIR Diverter
APS (Absolute Pressure Sensor)	Barometric Pressure Sensor	BARO Sensor
ATS (Air Temperature Sensor)	Intake Air Temperature Sensor	IAT Sensor
Automatic Transaxle	Automatic Transaxle	A/T
Automatic Transmission	Automatic Transmission	A/T
Backpressure Transducer	Exhaust Gas Recirculation Backpressure Transducer	EGR Backpressure Transducer

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1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
BARO	Barometric Pressure	BARO
Barometric Pressure Sensor	Barometric Pressure Sensor	BARO Sensor
Battery Positive Voltage	Battery Positive Voltage	B+
BLM (Block Learn Memory)	Long Term Fuel Trim	Long Term FT
BP Sensor	Barometric Pressure Sensor	BARO Sensor
C3I	Computer Controlled Coil Ignition	EI
CAC	Charge Air Cooler	CAC
Camshaft Position	Camshaft Position	CMP
Camshaft Position Sensor	Camshaft Position Sensor	CMP Sensor
Camshaft Sensor	Camshaft Position Sensor	CMP Sensor
Canister	Canister	Canister
Canister	Evaporative Emission Canister	EVAP Canister
Canister (Purge Vacuum Switching Valve)	Evaporative Emission Canister Purge Valve	EVAP Canister Purge Valve
Canister Purge Valve	EVAP Canister Purge Valve	EVAP Canister Purge Valve
Canister Purge VSV	EVAP Vacuum Switching Valve	EVAP Canister Purge Valve
CARB	Carburetor	CARB
CCC (Converter Clutch Control)	Torque Converter Clutch	TCC
CCO (Converter Clutch Override)	Torque Converter Clutch	TCC
CDI (capacitive discharge ignition)	Distributor Ignition	DI
CDROM (Compact Disc ROM)	Compact Disc Read Only Memory	CDROM
Central Multiport Fuel Injection	Central Multiport Fuel Injection	CMFI
CFI (Central Fuel Injection)	Throttle Body Fuel Injection	TBI
CFI (Continuous Fuel Injection)	Continuous Fuel Injection	CFI
Charcoal Canister	Evaporative Emission Canister	EVAP Canister
Check Engine	Malfunction Indicator Lamp	MIL
Check Engine	Service Reminder Indicator	SRI
CID (Cylinder ID) Sensor	Camshaft Position Sensor	CMP Sensor
CIS (continuous injection system)	Continuous Fuel Injection	CFI
CIS-E (Electronic CIS)	Continuous Fuel Injection	CFI
CKP (Crankshaft Position)	Crankshaft Position	CKP
CKP (Crankshaft Position) Sensor	Crankshaft Position Sensor	CKP Sensor
CL (Closed Loop)	Closed Loop	CL
Closed Bowl Distributor	Distributor Ignition	DI
Closed Throttle Position	Closed Throttle Position	CTP
CLS (Closed Loop System)	Closed Loop	CL
Clutch Pedal Position Switch	Clutch Pedal Position Switch	CPP Switch
Clutch Start Position Switch	Clutch Pedal Position Switch	CPP Switch
Clutch Start Switch	Clutch Pedal Position Switch	CPP Switch
Clutch Switch	Clutch Pedal Position Switch	CPP Switch
CMP (Camshaft Position)	Camshaft Position	CMP
CMP (Camshaft Position) Sensor	Camshaft Position Sensor	CMP Sensor
COC (Continuous Oxidation Catalyst Condenser)	Oxidation Catalytic Converter	OC

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1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
Condenser	Distributor Ignition Capacitor	DI Capacitor
Continuous Fuel Injection	Continuous Fuel Injection	CFI
Continuous Injection System	Continuous Fuel Injection System	CFI System
Continuous Injection System-E	Electronic Continuous Fuel Injection	Electronic CFI System
CP (Crankshaft Position)	Crankshaft Position	CKP
CPP (Clutch Pedal Position)	Clutch Pedal Position	CPP
CPS (Camshaft Position Sensor)	Camshaft Position Sensor	CMP Sensor
CPS (Crankshaft Position Sensor)	Crankshaft Position Sensor	CKP Sensor
Crank Angle Sensor	Crankshaft Position Sensor	CKP Sensor
Crankshaft Speed	Engine Speed	RPM
Crankshaft Speed Sensor	Engine Speed Sensor	RPM Sensor
CTO (Continuous Trap Oxidizer)	Continuous Trap Oxidizer	CTOX
CTS (Coolant Temperature Sensor)	Engine Coolant Temperature Sensor	ECT Sensor
CTS (Coolant Temperature Switch)	Engine Coolant Temperature Switch	ECT Switch
Cylinder ID (Identification) Sensor	Camshaft Position Sensor	CMP Sensor
D-Jetronic	Multiport Fuel Injection	MFI
Data Link Connector	Data Link Connector	DLC
Detonation Sensor	Knock Sensor	KS
DFI (Digital Fuel Injection)	Multiport Fuel Injection	MFI
DFI (Direct Fuel Injection)	Direct Fuel Injection	DFI
DI (Direct Injection)	Direct Fuel Injection	DFI
DI (Distributor Ignition)	Distributor Ignition	DI
DI (Distributor Ignition) Capacitor	Distributor Ignition Capacitor	DI Capacitor
Diagnostic Test Mode	Diagnostic Test Mode	DTM
Diagnostic Trouble Code	Diagnostic Trouble Code	DTC
DID (Direct Injection-Diesel)	Direct Fuel Injection	DFI
Digital EGR	Exhaust Gas Recirculation	EGR
Direct Fuel Injection	Direct Fuel Injection	DFI
Direct Ignition System	Electronic Ignition System	EI System
DIS (Distributorless Ignition System)	Electronic Ignition System	EI System
DIS Module (Distributorless Ignition System) Module	Ignition Control Module	ICM
Distance Sensor	Vehicle Speed Sensor	VSS
Distributor Ignition	Distributor Ignition	DI
DLC (Data Link Connector	Data Link Connector	DLC
DI (Distributorless Ignition)	Electronic Ignition	EI
DS (Detonation Sensor)	Knock Sensor	KS
DTC (Diagnostic Trouble Code)	Diagnostic Trouble Code	DTC
Dual Bed	Three- Way Oxidation Catalytic Converter	TWC+OC
Duty Solenoid for Purge Valve	Evaporative Emission Canister Purge Valve	EVAP Canister Purge Valve

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1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
E2PROOM (Electrically Erasable Programmable Read Only Memory)	Electrically Erasable Programmable Read Only Memory	EEPROM
Early Fuel Evaporation	Early Fuel Evaporation	EFE
EATX (Electronic Automatic Transmission/Transaxle)	Automatic Transmission	A/T
ECA (Electronic Control Assembly)	Powertrain Control Module	PCM
ECM (Engine Control Module)	Engine Control Module	ECM
ECT (Engine Coolant Temp.)	Engine Coolant Temperature	ECT
ECU4 (Electronic Control Unit 4)	Powertrain Control Module	PCM
EDF (Electro-Drive Fan) Control	Fan Control	FC
EDIS (Electronic Distributor Ignition System)	Distributor Ignition System	DI System
EDIS (Electronic Distributor Ignition System) Module	Distributor Ignition Control Module	Distributor ICM
EDIS - Electronic Distributorless Ignition System	Electronic Ignition System	EI System
EEC (Electronic Engine Control)	Engine Control	EC
EEC (Electronic Engine Control) Processor	Powertrain Control Module	PCM
EECS (Evaporative Emission Control System)	Evaporative Emission System	EVAP System
EEPROM	Electrically Erasable Programmable Read Only Memory	EEPROM
EFE (Early Fuel Evaporation)	Early Fuel Evaporation	EFE
EFI (Electronic Fuel Injection)	Multiport Fuel Injection	MFI
EFI (Electronic Fuel Injection)	Throttle Body Fuel Injection	TBI
EGO (Exhaust Gas Oxygen) Sensor	Oxygen Sensor	O2S
EGOS (Exhaust Gas Oxygen Sensor)	Oxygen Sensor	O2S
EGR (Exhaust Gas Recirculation)	Exhaust Gas Recirculation	EGR
EGR Diagnostic Valve	Exhaust Gas Recirculation Diagnostic Valve	EGR Diagnostic Valve
EGR System	Exhaust Gas Recirculation System	EGR System
EGR Valve	Exhaust Gas Recirculation Thermal Vacuum Valve	EGR TVV
EGR TVV	Exhaust Gads Recirculation Thermal Vacuum Valve	EGR TVV
EGRT (Exhaust Gas Recirculation Temperature)	Exhaust Gas Recirculation Temperature	EGRT
EGRT (Exhaust Gas Recirculation Temperature) Sensor	Exhaust Gas Recirculation Temperature Sensor	EGRT Sensor
EGRV (Exhaust Gas Recirculation Valve)	Exhaust Gas Recirculation Valve	EGR Valve
EGRVC (Exhaust Gas Recirculation Valve Control)	Exhaust Gas Recirculation Valve Control	EGR Valve Control

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Acronyms - Old to New

1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
EGS (Exhaust Gas Sensor)	Oxygen Sensor	O2S
EI (Electronic Ignition) (With Distributor)	Distributor Ignition	DI
EI (Electronic Ignition) (Without Distributor)	Electronic Ignition	EI
EM (Engine Modification)	Engine Modification	EM
EMR (Engine Maintenance Reminder)	Service Reminder Indicator	SRI
Engine Control	Engine Control	EC
Engine Coolant Fan Control	Fan Control	FC
Engine Coolant Level	Engine Coolant Level	ECL
Engine Coolant Level Indicator	Engine Coolant Level Indicator	ECL
Engine Coolant Temperature Sensor	Engine Coolant Temperature Sensor	ECT
Engine Coolant Temperature Switch	Engine Coolant Temperature Switch	ECTS
Engine Modification	Engine Modification	EM
Engine Speed	Engine Speed	RPM
EOS (Exhaust Oxygen Sensor)	Oxygen Sensor	O2S
Erasable Programmable Read Only Memory	Erasable Programmable Read Only Memory	EPROM
ESA (Electronic Spark Advance)	Ignition Control	IC
ESAC (Electronic Spark Advance Control)	Distributor Ignition	DI
EST (Electronic Spark Timing)	Ignition Control	IC
Evaporative Emission	Evaporative Emission	EVAP
Evaporative Emission Canister	Evaporative Emission Canister	EVAP Canister
EVAP (Evaporative Emission) Purge Valve	Evaporative Emission Canister Purge Valve	EVAP Canister Purge Valve
EVP (Exhaust Gas Recirculation Valve Position) Sensor	Exhaust Gas Recirculation Valve Position Sensor	EGR Valve Position Sensor
EVR (Exhaust Gas Recirculation Vacuum Regulator) Solenoid	Exhaust Gas Recirculation Vacuum Regulator Solenoid	EGR Vacuum Regulator Solenoid
EVRV (Exhaust Gas Recirculation Vacuum Regulator Valve)	Exhaust Gas Recirculation Vacuum Regulator Valve	EGR Vacuum Regulator Valve
Fan Control	Fan Control	FC
Fan Control Module	Fan Control Module	FC Module
Fan Control Relay	Fan Control Relay	FC Relay
Fan Motor Control Relay	Fan Control Relay	FC Relay
FBC (Feedback Carburetor)	Carburetor	CARB
FBC (Feedback Control)	Mixture Control	MC
FI (Fuel Injection)	Sequential Multiport Fuel Injection	SFI
FI (Fuel Injection)	Continuous Fuel Injection	CFI
FI (Fuel Injection	Central Multiport Fuel Injection	CMFI
FI (Fuel Injection)	Direct Fuel Injection	DFI

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1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
FI (Fuel Injection)	Indirect Fuel Injection	IFI
FI (Fuel Injection)	Multiport Fuel Injection	MFI
FI (Fuel Injection)	Throttle Body Fuel Injection	TBI
Flash EEPROM (Electrically Erasable Programmable Read Only Memory)	Flash Electrically Erasable Programmable Read Only Memory	FEEPROM
Flash EPROM (Flash Erasable Programmable Read Only Memory)	Flash Erasable Programmable Read Only Memory	FEPROM
Flexible Fuel	Flexible Fuel	FF
Flexible Fuel Sensor	Flexible Fuel Sensor	FF Sensor
Fourth Gear	Fourth Gear	4GR
Fuel Charging Station	Throttle Body	TB
Fuel Concentration Sensor	Flexible Fuel Sensor	FF Sensor
Fuel Level Sensor	Fuel Level Sensor	Fuel Level Sensor
Fuel Module	Fuel Level Sensor	Fuel Level Sensor
Fuel Module	Fuel Pump Module	FP Module
Fuel Pressure	Fuel Pressure	Fuel Pressure
FPRS	Fuel Pressure Regulator Sensor	Fuel Pressure Sensor
Fuel Regulator	Fuel Pressure Regulator	Fuel Pressure Regulator
Fuel Pump Relay	Fuel Pump Relay	FP Relay
Fuel Quality Sensor	Flexible Fuel Sensor	FF Sensor
Fuel Sender	Fuel Pump Module	FP Module
Fuel Sensor	Fuel Level Sensor	Fuel Level Sensor
Fuel Tank Unit	Fuel Pump Module	FP Module
Full Throttle	Wide Open Throttle	WOT
Generator	Generator	GEN
Governor	Governor	Governor
Governor Control Module	Governor Control Module	GCM
Governor Electronic Module	Governor Control Module	GCM
GRD (Ground)	Ground	GND
Heated Oxygen Sensor	Heated Oxygen Sensor	HO2S
HEDF (High Electro-Drive Fan) Control	Fan Control	FC
HEGO (Heated Exhaust Gas Oxygen) Sensor	Heated Oxygen Sensor	HO2S
HEI (High Energy Ignition)	Distributor Ignition	DI
High Speed Fan Control Switch	High Speed Fan Control Switch	High Speed FC Switch HO2S
HOS (Heated Oxygen Sensor)	Heated Oxygen Sensor	HO2S
Hot Wire Anemometer	Mass Air Flow Sensor	MAF Sensor
IACV (Idle Air Control Valve)	Idle Air Control Valve	IAC Valve
IATS (Intake Air Temperature Sensor)	Intake Air Temperature Sensor	IAT Sensor

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Acronyms - Old to New

1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
IC (Ignition Control)	Ignition Control	IC
ICM (Ignition Control Module)	Ignition Control Module	ICM
IDFI (Indirect Fuel Injection)	Indirect Fuel Injection	IFI
IDI (Indirect Diesel Injection)	Indirect Fuel Injection	IFI
IDI (Integrated Direct Ignition)	Electronic Ignition	EI
Idle Air Bypass Control	Idle Air Control	IAC
Idle Air Control	Idle Air Control	IAC
Idle Air Control Valve	Idle Air Control Valve	IAC Valve
Idle Speed Control	Idle Air Control	IAC
Idle Speed Control	Idle Speed Control	ISC
Idle Speed Control Actuator	Idle Speed Control Actuator	ISC Actuator
IFS (Inertia Fuel Shutoff)	Inertia Fuel Shutoff	IFS Ignition Control
Ignition Control	IC Ignition Control Module	Ignition Control Module
In Tank Module	Fuel Pump Module	FP Module
Inertia Fuel Shutoff Switch	Inertia Fuel Shutoff Switch	IFS Switch
INT (Integrator)	Short Term Fuel Trim	Short Term FT
Intake Air	Intake Air	IA
Intake Air Duct	Intake Air Duct	IA Duct
Intake Air Temperature	Intake Air Temperature	IAT
Intake Air Temperature Sensor	Intake Air Temperature Sensor	IAT Sensor
Intake Manifold Absolute Pressure Sensor	Manifold Absolute Pressure Sensor	MAP Sensor
Integrated Relay Module	Relay Module	RM
Inter Cooler	Charge Air Cooler	CAC
ISC (Idle Speed Control) Solenoid Vacuum Valve	Idle Speed Control Solenoid Vacuum Valve	ISC Solenoid Vacuum
ISC BPA (Idle Speed Control By Pass Air)	Idle Air Control	IAC
K-Jetronic	Continuous Fuel Injection	CFI
KAM (Keep Alive Memory)	Keep Alive (Random Access Memory)	Keep Alive RAM
KAM (Keep Alive Memory)	Non-Volatile Random Access Memory	NVRAM
KE-Jetronic	Continuous Fuel Injection	CFI
KE-Motronic	Continuous Fuel Injection	CFI
Knock Sensor	Knock Sensor	KS
L-Jetronic	Multiport Fuel Injection	MFI
Lambda	Oxygen Sensor	O2S
LH-Jetronic	Multiport Fuel Injection	MFI
Light Off Catalyst	Warm Up Three Way Catalytic Converter	WU-TWC
Light Off Catalyst	Warm Up Oxidation Converter	WU-TWC
Lock Up Relay	Torque Converter Clutch Relay	TCC Relay
Long Term Fuel Trim	Long Term Fuel Trim	Long Term FT

AED GLOSSARY

Glossary of Acronyms & Terms

Acronyms - Old to New

1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
Low Speed Fan Control Switch	Low Speed Fan Control Switch	Low Speed FC Switch
LUS (Lock Up Solenoid) Valve	Torque Converter Clutch Solenoid Valve	TCC Solenoid Valve
M/C (Mixture Control)	Mixture Control	MC
Malfunction Indicator Lamp	Malfunction Indicator Lamp	MIL
Manifold Absolute Pressure	Manifold Absolute Pressure	MAP
Manifold Absolute Pressure Sensor	Manifold Absolute Pressure Sensor	MAP
Sensor Manifold Differential Pressure	Manifold Differential Pressure	MDP
Manifold Surface Temperature	Manifold Surface Temperature	MST
Manifold Vacuum Zone	Manifold Vacuum Zone	MVZ
MAP (Manifold Absolute Pressure Sensor)	Manifold Absolute Pressure Sensor	MAP Sensor
Mass Air Flow	Mass Air Flow	MAF
Mass Air Flow Sensor	Mass Air Flow Sensor	MAF Sensor
MAT (Manifold Air Temperature)	Intake Air Temperature	IAT
MATS (Manifold Air Temperature Sensor)	Intake Air Temperature Sensor	IAT Sensor
MCS (Mixture Control Solenoid)	Mixture Control Solenoid	MC Solenoid
MCU (Microprocessor Control Unit)	Powertrain Control Module	PCM
MDP (Manifold Differential Pressure)	Manifold Differential Pressure	MDP
Mixture Control	Mixture Control	MC
Modes	Diagnostic Test Mode	DTM
Monotronic	Throttle Body Fuel Injection	TBI
Motronic	Multiport Fuel Injection	MFI
MPI (Multiport injection)	Multiport Fuel Injection	MFI
MPI (Multiport Injection)	Multiport Fuel Injection	MFI
MRPS (Manual Range Position Switch)	Transmission Range Switch	TR Switch
NDS (Neutral Drive Switch)	Park/Neutral Position Switch	PNP Switch
Neutral Safety Switch	Park/Neutral Position Switch	PNP Switch
NGS (Neutral Gear Switch)	Park/Neutral Switch	PNP Switch
NATS (Nissan Anti-Theft System)	NVIS (Nissan Vehicle Immobilizer System)	NVIS
NVRAM (Non-Volatile Random Access Memory)	Non-Volatile Random Access Memory	NVRAM
O2 (Oxygen Sensor)	Oxygen Sensor	O2S
OC (Oxidation Catalyst)	Oxidation Catalytic Converter	OC
Oil Pressure Sensor	Oil Pressure Sensor	Oil Pressure Sensor
Oil Pressure Switch	Oil Pressure Switch	Oil Pressure Switch
On-Board Diagnostic	On-Board Diagnostic	OBD
Open Loop	Open Loop	OL
OS (Oxygen Sensor)	Oxygen Sensor	O2S

AED GLOSSARY

Glossary of Acronyms & Terms

Acronyms - Old to New

1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
Oxidation Catalytic Converter	Oxidation Catalytic Converter	OC
OXS (Oxygen Sensor) Indicator	Service Reminder Indicator	SRI
P/N (Park/Neutral)	Park/Neutral Position	PNP
P/S (Power Steering) Pressure Switch	Power Steering Pressure Switch	PSP Switch
PAIR (Pulsed Secondary Air Injection)	Pulsed Secondary Air Injection	PAIR
Park/Neutral Position	Park/Neutral Position	PNP
Percent Alcohol Sensor	Flexible Fuel Sensor	FF Sensor
Periodic Trap Oxidizer	Periodic Trap Oxidizer	PTOX
PFE (Pressure Feedback Exhaust Gas Recirculation) Sensor	Pressure Feedback Exhaust Gas Recirculation Sensor	Pressure Feedback EGR Sensor
PFI (Port Fuel Injection)	Multiport Fuel Injection	MFI
PG (Pulse Generator	Vehicle Speed Sensor	VSS
PGM-FI (Programmed Fuel Injection)	Multiport Fuel Injection	MFI
PIP (Position Indicator Pulse)	Crankshaft Position	CKP
PNP (Park/Neutral Position)	Park/Neutral Position	PNP
Positive Crankcase Ventilation	Positive Crankcase Ventilation	PCV
Positive Crankcase Ventilation Valve	Positive Crankcase Ventilation Valve	PCV Valve
Power Steering Pressure	Power Steering Pressure	PSP
Power Steering Pressure Switch	Power Steering Pressure Switch	PSP Switch
Powertrain Control Module	Powertrain Control Module	PCM
Pressure Feedback EGR (Exhaust Gas Recirculation)	Pressure Feedback Exhaust Gas Recirculation	Pressure Feedback EGR
Pressure Sensor	Manifold Absolute Pressure Sensor	MAP Sensor
PRNDL (Park, Reverse, Neutral, Drive, Low)	Transmission Range	TR
Programmable Read Only Memory	Programmable Read Only Memory	PROM
Pulse Air	Pulsed Secondary Air Injection	PAIR
Pulsed Secondary Air Injection	Pulsed Secondary Air Injection	PAIR
Radiator Fan Control	Fan Control	FC
Random Access Memory	Random Access Memory	RAM
Read Only Memory	Read Only Memory	ROM
Recirculated Exhaust Gas Temperature Sensor	Exhaust Gas Recirculation Temperature Sensor	EGRT Sensor
Reed Valve	Pulsed Secondary Air Injection Valve	PAIR Valve
REGTS (Recirculated Exhaust Gas Temperature Sensor)	Exhaust Gas Recirculation Temperature Sensor	EGRT Sensor
Relay Module	Relay Module	RM
Remote Mounted TFI	Distributor Thick Film Ignition	DI
SABV (Secondary Air Bypass Valve)	Secondary Air Injection Bypass Valve	AIR Bypass Valve

AED GLOSSARY

Glossary of Acronyms & Terms

Acronyms - Old to New

1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
SACV (Secondary Air Check Valve)	Secondary Air Injection Control Valve	AIR Control Valve
SASV (Secondary Air Switching Valve)	Secondary Air Injection Switching Valve	AIR Switching Valve
SBEC (Single Board Engine Control)	Powertrain Control Module	PCM
SBS (Supercharger Bypass Solenoid)	Supercharger Bypass Solenoid	SCB Solenoid
Scan Tool	Scan Tool	ST
SEFI (Sequential Electronic Fuel Injection)	Sequential Multiport Fuel Injection	SFI
Self Test Codes	Diagnostic Trouble Code	DTC
Self-Test	On-Board Diagnostic	OBD
Self-Test Connector	Data Link Connector	DLC
Sequential Multiport Fuel Injection	Sequential Multiport Fuel Injection	SFI
Service Engine Soon	Malfunction Indicator Lamp	MIL
Service Engine Soon	Service Reminder Indicator	SRI
Service Reminder Indicator	Service Reminder Indicator	SRI
SFI (Sequential Fuel Injection)	Sequential Multiport Fuel Injection	SFI
Short Term Fuel Trim	Short Term Fuel Trim	Short Term FT
SLP (Selection Lever Position)	Transmission Range	TR
SMEC (Single Module Engine Control)	Powertrain Control Module	PCM
Smoke Puff Limiter	Smoke Puff Limiter	SPL
SPI (Single Point Injection)	Throttle Body Fuel Injection	TBI
Supercharger	Supercharger	SC
Supercharger Bypass	Supercharger Bypass	SCB
Sync Pickup	Camshaft Position	CMP
System Readiness Test	System Readiness Test	SRT
TAB (Thermactor Air Bypass)	Secondary Air Injection Bypass	AIR Bypass
TAD (Thermactor Air Diverter)	Secondary Air Injection Diverter	AIR Diverter
TBT (Throttle Body Temperature)	Intake Air Temperature	IAT
TFI (Thick Film Ignition)	Distributor Ignition	DI
TFI (Thick Film Ignition) Module	Ignition Control Module	ICM
Thermac	Secondary Air Injection	IAR
Thermac Air Cleaner	Air Cleaner	ACL
Thermactor	Secondary Air Injection	AIR
Thermactor II	Pulsed Secondary Air Injection	PAIR
Thermal Vacuum Switch	Thermal Vacuum Valve	TVV
Thermal Vacuum Valve	Thermal Vacuum Valve	TVV
Third Gear	Third Gear	3GR
Three Way + Oxidation Catalytic Converter	Three Way + Oxidation Catalytic Converter	TWC+OC
Three Way Catalytic Converter	Three Way Catalytic Converter	TWC

AED GLOSSARY

Glossary of Acronyms & Terms

Acronyms - Old to New

1980-92 Acronym/Term	Old Description	OBD II Acronym/Term
Throttle Body	Throttle Body	TB
Throttle Body Fuel Injection	Throttle Body Fuel Injection	TBI
Throttle Opener	Idle Speed Control	ISC
Throttle Opener Vacuum Switching Valve	Idle Speed Control Solenoid Vacuum Valve	ISC Solenoid Vacuum Valve
Throttle Opener VSV (Vacuum Switching Valve)	Idle Speed Control Solenoid Vacuum Valve	ISC Solenoid Vacuum Valve
Throttle Position	Throttle Position	TP
Throttle Position Sensor	Throttle Position Sensor	TP Sensor
Throttle Position Switch	Throttle Position Switch	TP Switch
Throttle Potentiometer	Throttle Position Sensor	TP Sensor
TOC (Trap Oxidizer-Continuous)	Continuous Trap Oxidizer	CTOX
TOP (Trap Oxidizer-Periodic)	Periodic Trap Oxidizer	PTOX
Torque Converter Clutch	Torque Converter Clutch	TCC
Torque Converter Clutch Relay	Torque Converter Clutch Relay	TCC Relay
TPI (Tuned Port Injection)	Multiport Fuel Injection	MFI
TPS (Throttle Position Sensor)	Throttle Position Sensor	TP Sensor
TPS (Throttle Position Switch)	Throttle Position Switch	TP Switch
TR (Transmission Range)	Transmission Range	TR
Transmission Control Module	Transmission Control Module	TCM
Transmission Position Switch	Transmission Range Switch	TR Switch
TRS (Transmission Range Select)	Transmission Range	TR
TRSS (Transmission Range Selection Switch)	Transmission Range Switch	TR Switch
Tuned Port Injection	Multiport Fuel Injection	MFI
Turbo (Turbocharger)	Turbocharger	TC
TWC & COC (Three Way + Oxidation Catalytic Converter)	Three Way + Oxidation Catalytic Converter	TWC+OC
Ultra Low Emission Vehicle	Ultra Low Emission Vehicle	ULEV
VAC (Vacuum) Sensor	Manifold Differential Pressure Sensor	MDP Sensor
Vacuum Switches	Manifold Vacuum Zone Switch	MVZ Switch
Vane Air Flow	Volume Air Flow	VAF
Variable Fuel Sensor	Flexible Fuel Sensor	FF Sensor
VAT (Vane Air Temperature)	Intake Air Temperature	IAT
VCC (Viscous Converter Clutch)	Torque Converter Clutch	TCC
Voltage Regulator	Voltage Regulator	VR
Volume Air Flow	Volume Air Flow	VAF
VSV (Vacuum Solenoid Valve) (Canister)	Evaporative Emission Canister Purge Valve	EVAP Canister Purge Valve
VSV (Vacuum Solenoid Valve) (Throttle)	Idle Speed Control Solenoid Vacuum Valve	ISC Solenoid Vacuum Valve
Warm Up Oxidation Catalytic Converter	Warm Up Oxidation Catalytic Converter	WU-OC
WOTS (Wide Open Throttle Switch)	Wide Open Throttle Switch	WOT Switch

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HONDA CONTENTS

HONDA CONTENTS

HONDA CONTENTS

ADVANCED ENGINE DIAGNOSTICS

Introduction

How To Use This Section

This section of the manual was developed to provide you with theory of operation and testing information for the Engine Control devices found on Honda Motor Co. vehicles.

This information was written in a manner that will allow you to easily compare how to connect up to a similar vehicle component and make a test measurement. In many cases we have recommended which piece of diagnostic or test equipment to use first (depending upon the trouble code or related symptom) for a particular component.

This information includes various articles for the following vehicles:

1) 1999 Accord (2.3L I4 VIN CG6 Engine)

2) 2000 Odyssey (3.5L V6 VIN RD1 Engine)

Key Subject Areas

A description of the Engine Control devices included in this section is provided below:

Information Sensors

- ECT Sensor
- IAT Sensor
- MAP Sensor
- VSS Sensor

Crankshaft Position Sensors

- CKP Sensor
- TDC Sensor

Cylinder Position Sensor

- CYP Sensor

EGR Control Solenoid

EVAP Control Solenoid

Fuel Injectors

Idle Air Control Motor

Oxygen Sensors

TP Sensor

Reference Information

This section includes important reference information in the following categories:

- PCM Computer Locations (1990-2001)
- Parameter Identification (PID) examples for the Powertrain Control Module (PCM)
- Pin Voltage Table examples for the Powertrain Control Module (PCM)
- Wiring Diagram examples for the Powertrain Control Module (PCM)

Diagnostic Help

All of the articles in this section contain separate component tests along with "real world" test examples and results that you can use to compare to a similar vehicle and engine application. All of this information was captured using conventional automotive repair tools and software (i.e., a DVOM, a Lab Scope and a Scan Tool).

ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

Vehicle Identification Number

The vehicle identification number (VIN) is a seventeen (17) digit legal identifier of the vehicle. It is located on a plate that is attached to the upper left corner of the instrument panel. It can be seen through the windshield from outside the vehicle.

The VIN information includes the country of origin, the make, the vehicle type, the passenger safety equipment, the car line, the body style, the engine, a check digit, the model year, the assembly plant and vehicle build sequence.

Honda Vehicle Identification Number (VIN) Code Example

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	H	G	C	G	6	6	7	4	X	A	1	5	8	8	8	9

VIN Code Decoding Table (1999 Accord Example)

Position	Interpretation	Code = Description		
1, 2 & 3	Manufacturer, Make & Type	1HG = Honda of America Mfg., Inc., U.S.A Honda, Passenger Vehicle		
4, 5 & 6	Line, Body & Engine Type (Underhood)	CF8 = Accord I4/F23A5 (2.3L I4 SOHC SMFI) CG5 = Accord I4/F23A1 (2.3L I4 SOHC SMFI VTEC) CG6 = Accord I4/F23A4 (2.3L I4 SOHC SMFI VTEC) *Note: These are the three engines that were used in this particular vehicle application in model year 1999.*		
7	Body Type & Transmission	4-Door Sedan/4-Speed Automatic		
8	Vehicle Grade (Series)	7 = EX-ULEV		
9	Check Digit	---		
10	Model Year (Driver's Door)	L = 1990 M = 1991 N = 1992 P = 1993	1994 = R 1995 = S 1996 = T 1997 = V	1998 = W 1999 = X 2000 = Y 2001 = 1
11	Factory Code	A = Marysville, Ohio Factory in U.S.A. C = Saitama Factory in Japan (Sayama) H = Allison Plant, Ontario, Canada L = East Liberty, Ohio Plant, U.S.A S = Suzuka Plant, Mie Prefecture, Japan		
12 through 17	Vehicle Build Sequence	-----		

ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

<u>Vehicle Emission Control Information</u>

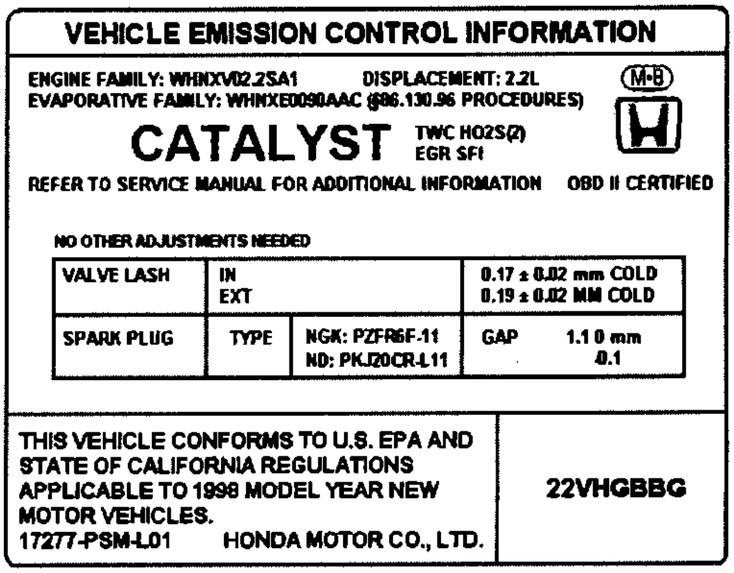
The Vehicle Emission Control Information Label (sticker) is located under the hood. This example is for 1998 Prelude 2.2L I4 Engine with an automatic transmission.

TWC HO2S (2), EGR SFI

The items in this designation indicate this vehicle has a three-way catalyst (TWC), two heated oxygen sensors, an EGR system and sequential fuel injection.

OBD II Certified

This designator on the VECI label indicates this vehicle has been certified for OBD II use.



50ST (50 States)

If this designator is used, the vehicle conforms to U.S. EPA & State of California regulations applicable to 1998 model year new motor vehicles (50 States).

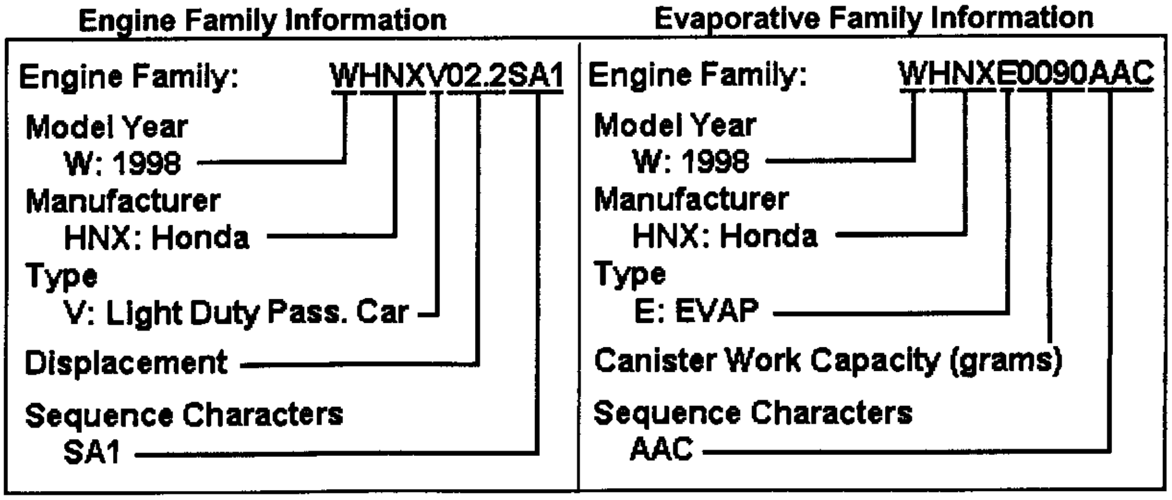
49ST (49 States/Federal)

If this designator is used, the vehicle conforms to U.S. EPA regulations applicable to 1998 model year new motor vehicles (49 States).

CAL (California)

If this designator is used, the vehicle conforms to U.S. EPA and State of California regulations applicable to 1998 model year new passenger cars provided that the vehicle is only introduced into commerce in the State of California.

Engine Family Information **Evaporative Family Information**



ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

<u>Vehicle Group Identification</u>

An example of one page of the Vehicle Identification information from a 1999 Honda Civic Factory Repair Manual is shown in the Graphic below.

1999 Honda Civic VIN Graphic (D16Y7 Engine)

U.S. 1999 Model (4-door Sedan)

Vehicle Identification Number

JHM EJ6 5 2 * X S 000001

Manufacturer, Make and Type of Vehicle
- 1HG: HONDA OF AMERICA MFG., INC. HONDA Passenger vehicle
- 2HG: HONDA OF CANADA MFG., INC. HONDA Passenger vehicle

Line, Body and Engine Type
- EJ6: CIVIC 4-door/D16Y7
- EJ8: CIVIC 4-door/D16Y8

Body Type and Transmission Type
- 5: Sedan/5-speed Manual
- 6: Sedan/4-speed Automatic

Vehicle Grade
- 1: DX-V
- 2: DX
- 3: DX with A/C
- 4: EX
- 7: LX
- 9: LX with ABS and A/C

Check Digit

Model Year
- X: 1999

Factory Code
- L: East Liberty, Ohio Plant, U.S.A.
- H: Alliston Plant, Ontario, Canada

Serial Number
- 000001: JAPAN, U.S.A.
- 500001: CANADA

Engine Number

D16Y7 - 4300001

Engine Type
- D16Y7: 1600 SOHC 16-valves Sequential Multiport Fuel-injected Engine
- D16Y8: 1600 SOHC VTEC 16-valves Sequential Multiport Fuel-injected Engine

Serial Number
- U.S.A : D16Y7, D16Y8 – 4500001–

Transmission Number

B4RA - 8000001

Transmission Type
- B4RA : 4-speed Automatic Transmission
- S40 : 5-speed Manual Transmission

Serial Number
- B4RA (U.S.A.) : 8000001–
- M4RA (JAPAN): 4000001–
- S40 (JAPAN) : 1000001–

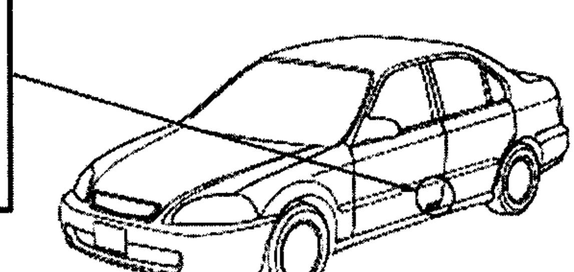
Paint Code

Paint Code	Color
BG-41P	Iced Teal Pearl
G-95P	Clover Green Pearl
NH-578	Taffeta White
NH-592P	Flamenco Black Pearl
NH-583M	New Vogue Silver Metallic
R-96P	Inza Red Pearl

Paint Code

COLOR NH-578

Vehicle Identification Number and Federal Motor Vehicle Safety Standard Certification



ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

Engine Code Definitions - Accord

Code	Definition
CD5	Accord I4/F22B2 (2.2L I4 SOHC SMFI)
CD5	Accord I4/F22B1 (2.2L I4 SOHC SMFI VTEC)
CD7	Accord I4/F22B2 (2.2L I4 SOHC SMFI)
CD7	Accord I4/F22B1 (2.2L I4 SOHC VTEC)
CE1	Accord I4/F22B2 (2.2L I4 SOHC SMFI)
CE1	Accord I4/F22B1 (2.2L I4 SOHC SMFI VTEC)
CF8	Accord I4/F23A5 (2.3L I4 SOHC SMFI)
CG1	Accord V6/J30A1 (3.0L V6 SOHC SMFI)
CG3	Accord I4/F23A1 (2.3L I4 SOHC SMFI)
CG3	Accord I4/F23A4 (2.3L I4 SOHC SMFI VTEC)
CG5	Accord I4/F23A1 (2.3L I4 SOHC SMFI VTEC)
CG6	Accord I4/F23A4 (2.3L I4 SOHC SMFI VTEC)
CG7	Accord I4/F22B1 (2.2L I4 SOHC SMFI)
CG7	Accord I4/F22B1 (2.2L I4 SOHC SMFI VTEC)
CF8	Accord I4/F23A5 (2.3L I4 SOHC SMFI)

Engine Code Definitions - Civic

Code	Definition
EJ6	Civic 1.6L/D16Y7 (1.6L I4 SOHC SMFI)
EJ7	Civic 1.6L/D16Y5 (1.6L I4 SOHC SMFI VTEC-E)
EJ8	Civic 1.6L/D16Y8 (1.6L I4 SOHC SMFI VTEC)

Engine Code Definitions - Del Sol Convertible

Code	Definition
EG2	Del Sol 1.6L/B16A2 (1.6L I4 SOHC SMFI)
EH6	Del Sol 1.6L/D16Y7 (1.6L I4 SOHC SMFI)
EH6	Del Sol 1.6L/D16Y7 (1.6L I4 SOHC SMFI VTEC)

Engine Code Definitions - Prelude

Code	Definition
BA8	Prelude 2.2L/F22A1 (2.2L I4 SOHC SMFI)
BB1	Prelude 2.2L/H22A1 (2.2L I4 DOHC SMFI VTEC)
BB2	Prelude 2.2L/H23A1 (2.2L I4 DOHC SMFI)
BB6	Prelude 2.2L/H22A4 (2.2L I4 DOHC SMFI VTEC)

Engine Code Definitions - CR-V

Code	Definition
RD1	CR-V 2.0L/B20Z2 (2.0L I4 DOHC SMFI)
RD2	CR-V 2.0L/B20Z2 (2.0L I4 DOHC SMFI)

Engine Code Definitions - Odyssey

Code	Definition
CF8	Odyssey 2.3L/F23A5 (2.3L I4 SOHC SMFI)
RA1	Odyssey 2.2L/F22B6 (2.2L I4 SOHC SMFI)
RL1	Odyssey 3.5L/J35A1 (3.5L V6 SOHC SMFI)

ADVANCED ENGINE DIAGNOSTICS

PCM Location Tables

Car Applications

This table can be used to identify the location of the Powertrain Control Module (PCM) for 1990-2001 Honda Motor Company vehicles.

PCM Location Table - Cars

Year	Accord	Civic & CRX	Prelude & Del Sol
1990	**Accord Models** • Located under driver's seat	**Civic Models** • Located at the bottom of passenger floor pan **CRX Models** • Located under driver's seat	**Prelude Models** • Located behind right hand side of instrument panel
1991	**Accord Models** • Located under driver's seat	**Civic Models** • Located at the bottom of passenger floor pan **CRX Models** • Located under driver's seat	**Prelude Models** • Located behind right hand side of instrument panel
1992	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude Models** • Located behind right hand side of instrument panel
1993	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude & Del Sol Models** • Located behind right hand side of instrument panel
1994	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude & Del Sol Models** • Located behind right hand side of instrument panel
1995	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude & Del Sol Models** • Located behind right hand side of instrument panel
1996	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude & Del Sol Models** • Located at the bottom of passenger floor pan
1997	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude & Del Sol Models** • Located at the bottom of passenger floor pan
1998	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude Models** • Located at the bottom of passenger floor pan
1999	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude Models** • Located at the bottom of passenger floor pan
2000	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude Models** • Located at the bottom of passenger floor pan
2001	**Accord Models** • Located at the bottom of passenger floor pan	**Civic Models** • Located behind the right hand kick panel	**Prelude Models** • Located at the bottom of passenger floor pan

ADVANCED ENGINE DIAGNOSTICS

PCM Location Tables

Sport Utility Vehicle & Truck Applications

This table can be used to identify the location of the Powertrain Control Module (PCM) for 1990-2001 Honda Motor Company sport utility vehicle and van applications.

PCM Location Table - Sport Utility Vehicles & Vans

Year	SUV (CR-V)	SUV (Passport)	Van (Odyssey)
1993		**Passport Models** • Located behind the driver's side kick panel	
1994		**Passport Models** • Located behind the driver's side kick panel	
1995		**Passport Models** • Located behind center console	**Odyssey Models** • 2.2L - Located at bottom of passenger floor pan
1996		**Passport Models** • Located behind center console	**Odyssey Models** • 2.2L - Located at bottom of passenger floor pan
1997	**CR-V Models** • Located behind the right side kick panel	**Passport Models** • Located behind center console	**Odyssey Models** • 2.2L - Located at bottom of passenger floor pan
1998	**CR-V Models** • Located behind the right side kick panel	**Passport Models** • Located behind center console	**Odyssey Models** • 2.3L - Located at bottom of passenger floor pan
1999	**CR-V Models** • Located behind the right side kick panel	**Passport Models** • Located behind center console	**Odyssey Models** • 3.5L - Located behind lower center of dash area
2000	**CR-V Models** • Located behind the right side kick panel	**Passport Models** • Located behind center console	**Odyssey Models** • 3.5L - Located behind lower center of dash area
2001	**CR-V Models** • Located behind the right side kick panel	**Passport Models** • Located behind center console	**Odyssey Models** • 3.5L - Located behind lower center of dash area

DLC Location Table - Acura & Honda

Year	Model	Location
1996-97	Accord	Behind the Ash Tray
1999-2001	Accord	Below Dash to the left of the Center Console
1997-1999	Acura CL	Above the Shifter (1999) or behind right side of console
1996-1999	Acura NSX	Behind a removable cover under the Glove Box
1996-1998	Acura RL	Behind the right side of Center Console
1999-2001	Acura RL	Behind the Ash Tray (in front of the shifter)
1996-2001	Acura TL	Behind the Ash Tray (1996-98) or behind the Radio
1997-2001	Civic	Near the left side Kick Panel
1997-2001	Civic Del Sol	To the right side of the Center Console (under a cover)
1997-2001	CRV	Below the right side of the Center Console
1996-2001	Odyssey	Below the right side of the Center Console
1996	Prelude	Under Cup Holder (behind the shifter)
1997-2001	Prelude	Behind the right side of Center Console

ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

Introduction

The Honda Programmed Fuel Injection (PGM-FI) system is a computerized emission and fuel control system that provides optimum control of the engine and transmission on models with an Automatic Transaxle.

At the heart of the PGM-FI system is a Powertrain Control Module (PCM). It includes a central processor unit and digital control system used to control various engine systems. The PCM can accept multiple sensor and switch inputs and perform fast calculations so that it can quickly decide how to control the various engine system output devices.

OBD System Diagnostics

In 1988, in order to meet government regulations, the OBD I system was added to the PGM-FI system. This first version of emission control diagnostics incorporates a set of strategies controlled by software inside the PCM. These strategies include control of the Check Engine light, code setting and clearing.

The 1992-95 Civic (I4 engines), 1994-95 Accord (I4 engines) and 1995 Accord V6 models include bi-directional communication with a Scan Tool. This feature allows the user to read trouble codes and a series of serial data items (i.e., ECT, IAT, HO2S, MAP, TP, RPM and VSS signals).

Backup and Failsafe Functions

The PGM-FI system includes a *backup function* that is used to provide minimal engine operation should the CPU portion of the PCM fail. This system also includes a *failsafe function* that is used if one of the main sensor inputs to the PCM is lost (i.e., the ECT, MAP or TP sensor signal).

System Hardware & Software

The Powertrain in the PGM-FI system is divided into system hardware and software.

The hardware components include:

- All related actuators, relays, and solenoids
- All related sensors, switches, interconnecting wires, connectors and terminals
- The PGM-FI Main Relay and Powertrain Control Module or PCM

Operating Strategies

The software components include the programs that contain the strategies used by the PCM to control system outputs based on related inputs.

The PCM contains operating strategies in memory for the following systems:

- A/T Lockup Converter Control
- Fuel Delivery Control
- Idle Speed Control
- Ignition Spark Timing Control
- Powertrain Diagnostics

ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

Sensor Inputs

The PCM in the PGM-FI system receives signals from these sensors:

- Air Temperature (TA) sensor and Atmospheric (PA) or Pressure sensor
- Engine Coolant Temperature sensor (indicates engine temperature)
- Crank, CYP and TDC sensors (located in the distributor or near the crankshaft)
- EGR Valve Lift sensor (indicates the amount of EGR sensor opening)
- Electronic Load Detector sensor (indicates the amount of electronic load to the PCM)
- MAP sensor (indicates the amount of engine load)
- Oxygen sensor and Throttle Angle (Position) sensor (indicates the throttle opening)
- Vehicle Speed sensor (indicates the vehicle speed)

Switch Inputs

The PCM in the PGM-FI system receives signals from these switches:

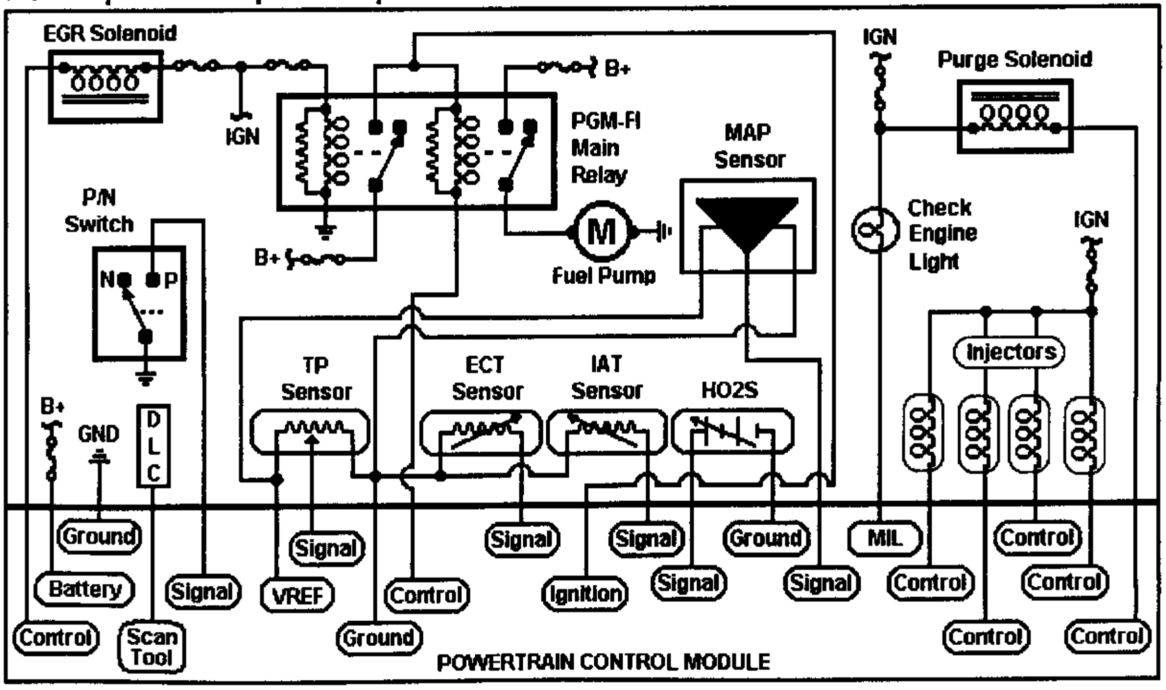
- Air Conditioning and Transaxle Shift Position switch (indicated the switch position)
- Generator 'FR' (indicates the charging command) and Starter signals to the PCM
- Battery Voltage signal (indicates the battery voltage at Ignition 1 (IGN1) terminal
- Brake Switch and Heater Fan Switch (indicates the switch function - On or Off)

Output Device Signals

The PCM in the PGM-FI system controls the operation of these devices:

- A/C Compressor Clutch operation (control the clutch On/Off function)
- Air Induction Tandem Valve (controls the valve On/Off function)
- A/T Lockup (clutch) solenoid operation (controls the solenoid On/Off function)
- EGR Control and Purge Cut-Off solenoid operation (turns the solenoid On/Off)
- Fast Idle Control solenoid operation (turns the solenoid On/Off)
- Fuel injector operation and Ignition Igniter Unit (controls the coil primary On/Off)
- MFI Main Relay On/Off operation (turns the fuel pump On/Off)

PCM Inputs & Outputs Graphic



ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

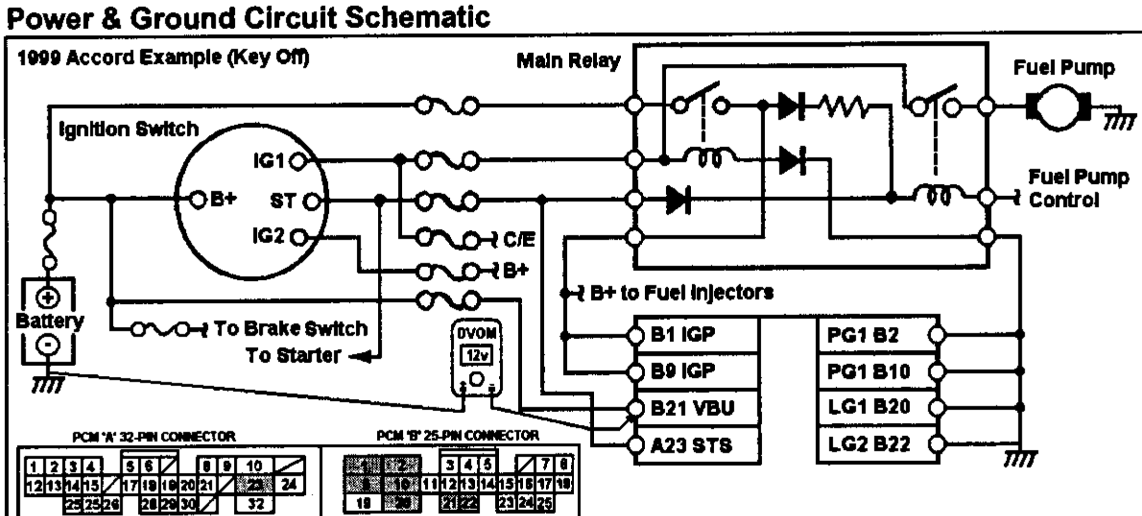
Power & Ground Circuit Tests

The tests in this article should be performed whenever the PCM, an actuator or sensor is suspected of being the cause of a trouble code (Code) or symptom (No Code) problem.

Power & Ground Circuit Repair Table (1996 Accord 2.3L I4 Example)

Step	Action	Value	Yes	No
1	Turn the key off. Connect a breakout box (BOB) to the PCM (if available). Is this step complete?	-	Go to Step 2.	Connect the Breakout Box.
2	Turn the key on. Then connect the voltmeter positive probe to each power ground (B2, B10) circuit and then the sensor (Logic) ground circuits (B20, B22). Connect the negative probe to the battery negative post. If a BOB is not available, carefully backprobe each individual connector. Does the meter read less than specified value?	<0.1v	Go to Step 3.	Repair the cause of the high resistance ground reading. Then retest for the condition.
3	Connect the DVOM (voltmeter) positive probe to each PCM ignition feed terminal (B1, B9). Connect the negative probe to the battery negative post. Does the meter read within the specified value with the key turned to on?	Within ± 0.3v of the battery voltage	Go to Step 4.	Repair cause of low ignition feed circuit reading. Then retest for the condition.
4	Turn the key off. Connect the DVOM (voltmeter) positive probe to the Keep Alive Battery (Voltage backup) circuit at Pin B21 of the PCM. Connect the negative probe to the battery negative post. Does the meter read within the specified value?	Within ± 0.3v of the battery voltage	The power and ground circuits are okay at this time. The test is completed.	Repair cause of low Keep Alive power reading. Then retest for the condition.

Power & Ground Circuit Schematic



Battery Ignition Off Draw

A vehicle without a current drain problem will still have a small amount of current drain on the battery with the ignition key off. This "key off" draw can be from 4-10 milliamps once the vehicle control modules shut down (10-20 seconds after the key is removed).

Electrostatic Discharge Sensitive Devices

Electrostatic discharge sensitive (EDS) devices are solid-state components that should be handled very carefully. Always touch a known good engine ground before handling these parts. This step should be repeated while handling the part or after sliding across the seat. Avoid touching the terminals on the part except with a meter probe as directed.

ADVANCED ENGINE DIAGNOSTICS

Data Bus Communication

Introduction

The 1992-95 Civic (I4 engines), 1994-95 Accord (I4 engines) and 1995 Accord V6 models use two connectors to read codes, enable diagnostics and communicate PID data to a Scan Tool. Vehicles equipped with OBD II also use more than one test connector, but OBD II information is available at the DLC on these applications.

Serial Data

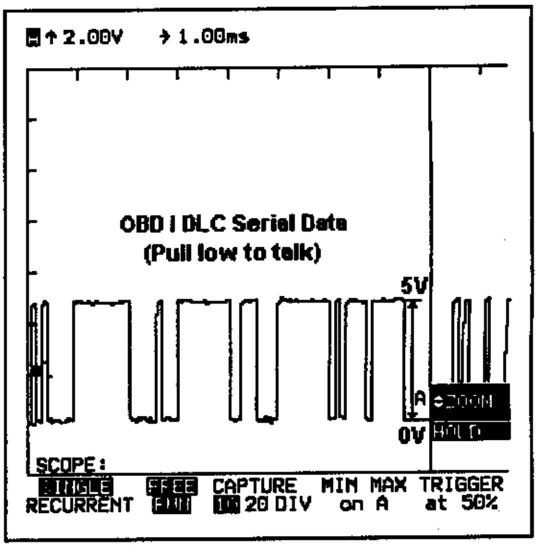
Serial data refers to information transferred in a linear fashion over a single line, one bit at a time. During actual communication, serial data captured from the DLC transmit and receive circuits will appear similar to the examples in the Graphics on this page.

Service Check System Connector (OBD I)

The Service Check System (SCS) connector is used to read trouble codes. If the PGM-FI light remains on with the engine running, and the SCS connector is jumped, the PCM will flash any stored codes via the C/E light.

Data Link Connector (OBD I)

The DLC circuit on an OBD I system is used to transmit and receive data from an Aftermarket or OEM Scan Tool (i.e., the PCM uses this circuit to communicate with the Scan Tool).



Lab Scope Test (Serial Data)

To read the serial data on an OBD I system, connect the Channel 'A' positive probe to the DLC pin of the connector and the Channel 'A' negative probe to the battery negative post.

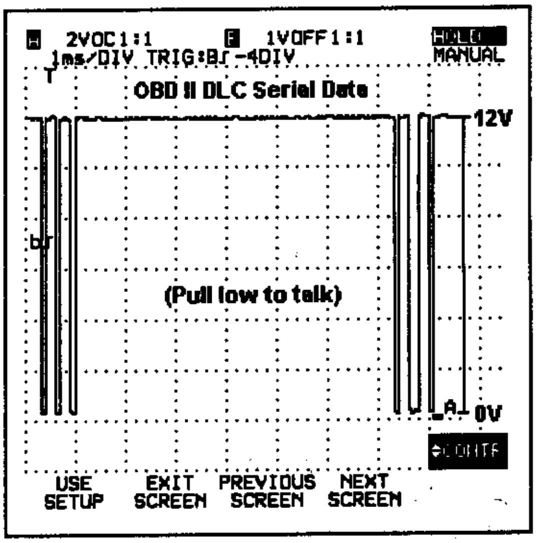
Scope Settings

To make the picture as clear as possible, set the lab scope settings to match the examples.

K-Line Data Link Connector (OBD II)

The PCM exchanges information (i.e., MIL condition, trouble codes, I/M Readiness Status and PID data) with an OBD II certified Scan Tool through the ISO 9141 protocol.

Once the Scan Tool is powered up, 12 volts is provided to the K-Line pin of the DLC on these systems. When the ignition is turned "on", the controller and Scan Tool toggle this voltage to generate serial data between these devices.



Scope Connections (OBD II Example)

Connect the Channel 'A' positive probe to the K-Line circuit (WHT wire) of the correct PCM connector. Connect the Channel 'A' negative probe to the battery negative post.

Scope Settings

To make the picture as clear as possible, set the scope settings to match the examples.

Lab Scope Example Explanation

The PCM receives commands and transmits data between itself and the Scan Tool by toggling the K-Line circuit high and low. Note that the 12v signal is pulled "low" to talk.

ADVANCED ENGINE DIAGNOSTICS

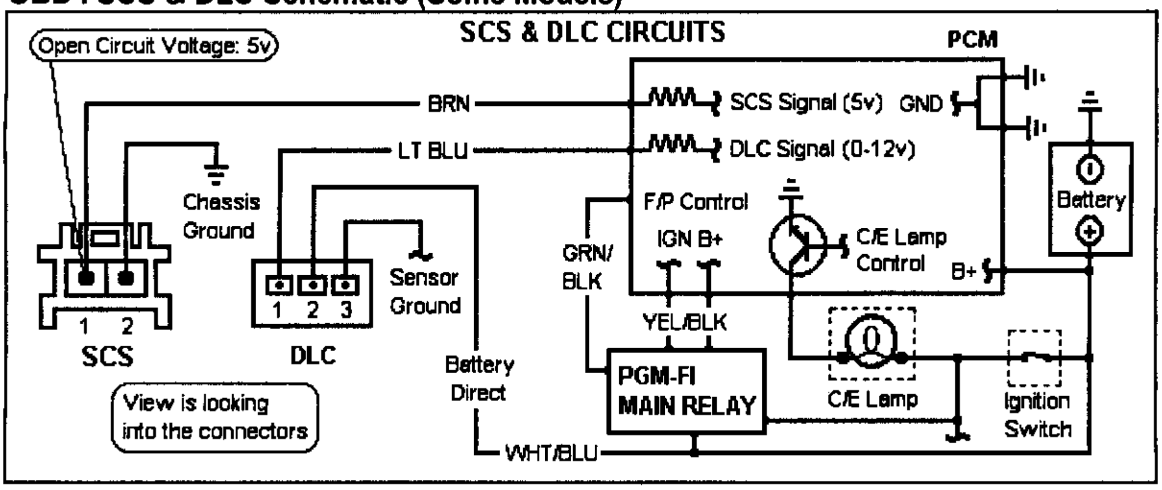
Data Bus Communication

Scan Tool Communication

A Scan Tool can be used to connect to (and communicate with) the PCM controller.

OBD I System - Connect the Scan Tool to the underdash test connector labeled DLC. The first time the PCM detects an electrical circuit fault, a hard code is stored in memory and the PGM-FI is illuminated. To read trouble codes manually, turn the key "on" and ground the SCS connector. A Scan Tool can be used to read any stored codes and data stream information stored in the PCM on some 1992-95 models. The LED's on the PCM are used to read any trouble codes stored in the PCM on early OBD I models.

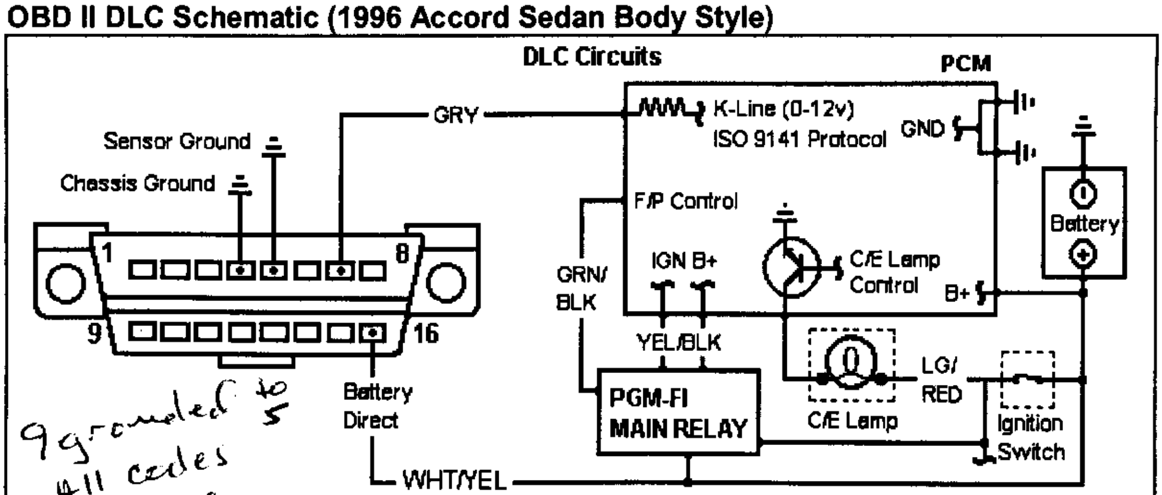
OBD I SCS & DLC Schematic (Some Models)



OBD II Systems - Connect the Scan Tool to the test connector located inside the vehicle labeled DLC. The first time the PCM detects an emissions-related fault, a pending code is set. The second time it fails, the MIL is illuminated and a hard code is set. OBD II Certified Scan Tools are used to communicate with the PCM to read codes and PIDs.

The Scan Tool communicates with the Generic and OEM data streams on the K-Line (ISO 9141) interface circuit. This circuit is used to transfer data between the PCM and an OBD II certified Scan Tool (a digital 0-12v circuit). The DLC is connected to direct battery at Pin 16 and also connected to a "clean" chassis ground on Pin 4. It is connected to sensor ground on Pin 5 on most applications. Refer to the OBD II DLC Schematic.

OBD II DLC Schematic (1996 Accord Sedan Body Style)



9 grounded to 5 All codes Become One Trip

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Electronic Ignition

Introduction

The PCM controls the Electronic Ignition (EI) system on this vehicle by sending signals to the ignition control (IC) unit or igniter. The ignition coil is supplied battery voltage from Fuse 11 in the Driver's Underdash Fuse/Relay Box (refer to the EI schematic below).

The PCM, located under the passenger side front floor mat, contains memory tables that it uses to calculate the IC signals sent to the IC module mounted inside the distributor.

The PCM sends a command signal to the Coil/Igniter unit that indicates when to switch the coil primary "on" and "off" to control the amount of spark advance during all engine-operating conditions. The PCM adjusts the dwell period (e.g., Idle: 8°, Cruise: 40°).

System Components

The EI system on this vehicle application includes the following components:

- The CYP sensor (mounted inside the distributor at the top side of the engine)
- The CKP and TDC sensors (mounted behind the bottom of the timing cover)
- The internal high energy coil and igniter (mounted inside the distributor assembly)
- The engine can lose any one of the three engine position inputs and still start!

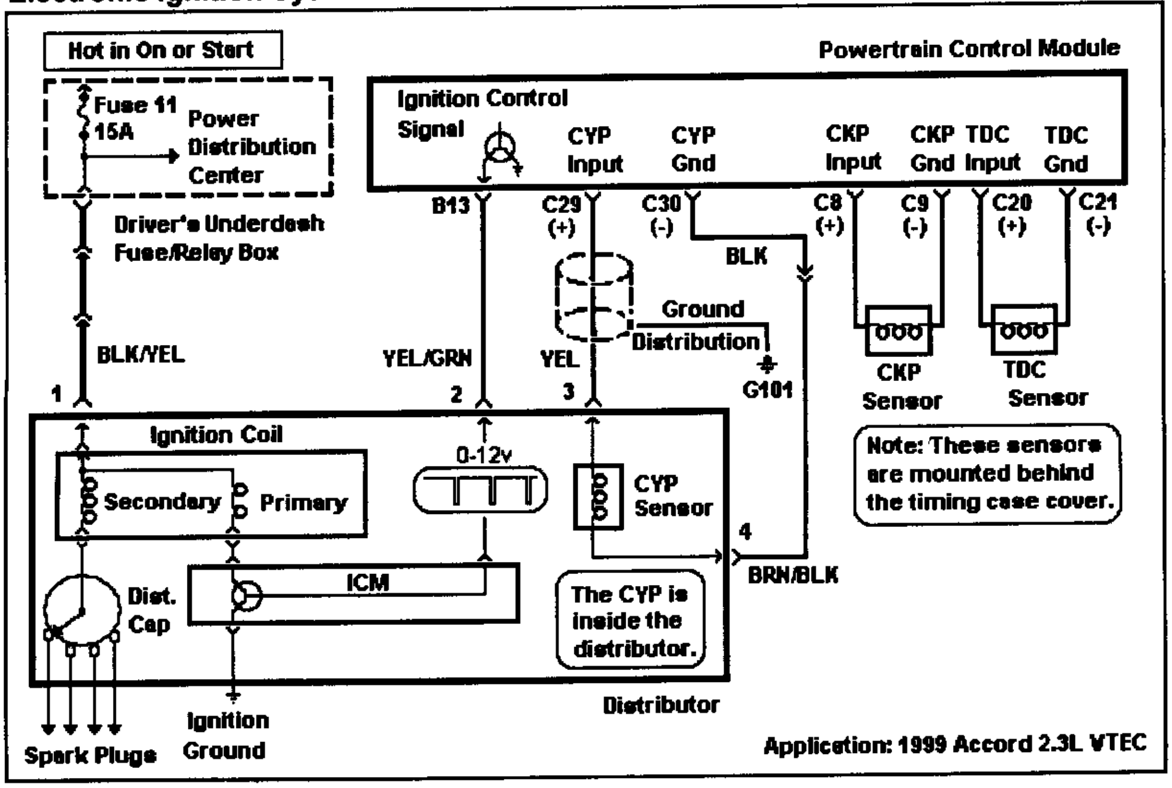
Ignition Spark Timing

The PCM contains lookup tables that contain the base ignition timing at various engine speeds and manifold airflow rates. It adjusts the amount of ignition spark advance according to these tables and through information from several other sensor inputs.

Ignition Coil Operation

The ignition coil assembly consists of a single coil (less than 1 ohm resistance) mounted inside the distributor. Spark plug cables rout to each cylinder from the ignition coil.

Electronic Ignition System Schematic

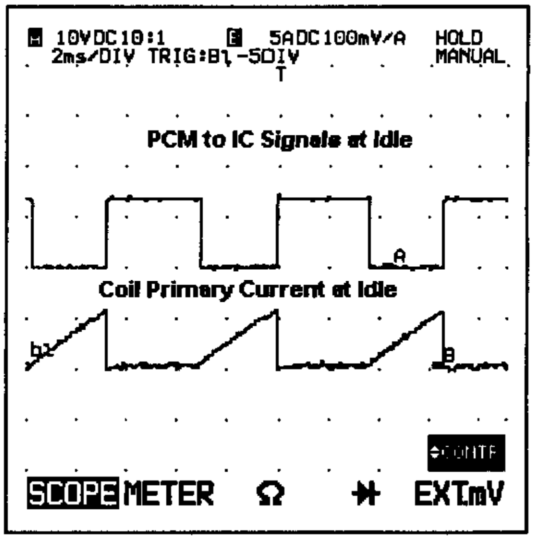


1999 ACCORD (2.3L I4 VTEC VIN CG6)

Electronic Ignition

Lab Scope Test (IC Signals)

The Lab Scope can be used to test the signals from the PCM to the igniter inside the distributor. The IC circuit from the PCM to the igniter can be monitored for any glitches. Prior to starting the test, place the gearshift selector in Park (A/T) and block the wheels.



Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (IC Signal)

Connect the Channel 'A' positive probe to the IC signal at Pin B13 (YEL/GRN wire) of the PCM 25-Pin connector. Connect the negative probe to the battery negative ground post.

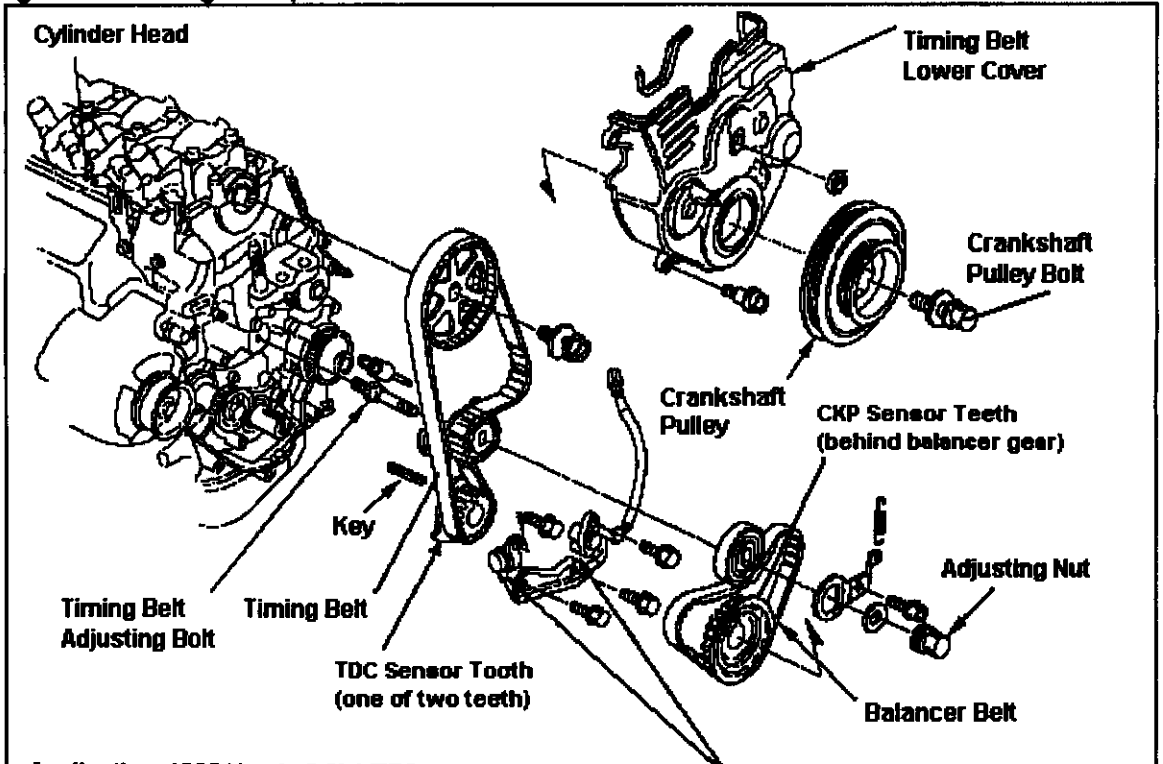
Scope Connections (Coil Primary)

Connect a low amp probe to the Channel 'B' and zero the probe. Clamp the probe around the B+ feed circuit to the coil (BLK/YEL wire).

Lab Scope Example

In this example, the top trace shows the IC module signals (0-12v). The bottom trace shows the coil primary current signals (about 6 amps) at idle speed. The PCM controls the ignition timing on this engine (8-10° BTDC). Note the lack of a current limiting effect on the coil primary circuit with the engine running at idle speed under these conditions.

Ignition Timing Components



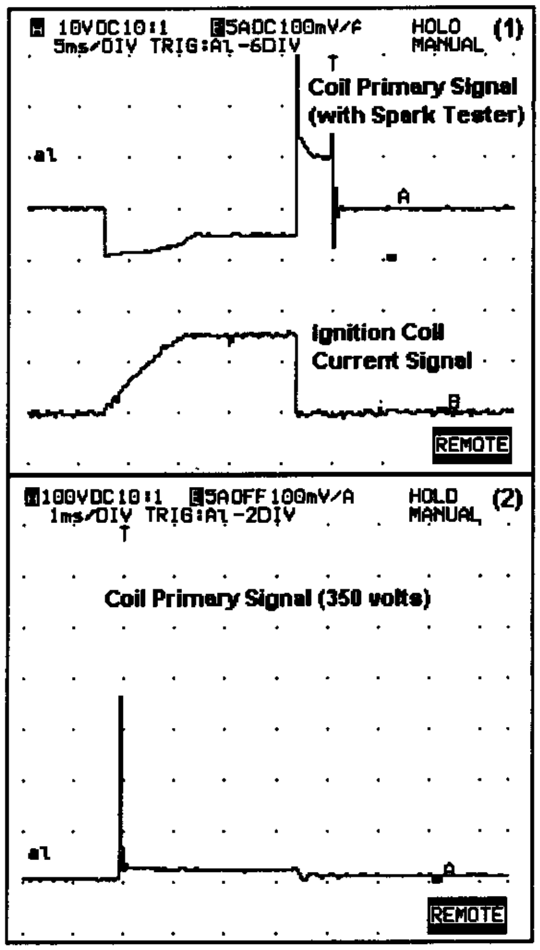
Application: 1999 Honda 2.3L VTEC

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Electronic Ignition

Lab Scope Test (Coil Primary)

The Lab Scope (or an engine analyzer) can be used to view the coil secondary signals on this vehicle as it can be easily connected to the secondary wires. However, it is very difficult to connect a Lab Scope to the coil primary circuit (it is inside the distributor with no visible access to the coil primary wiring).



Scope Connections

To perform the capture shown here, remove the distributor cap. Connect the coil secondary tower safely to a spark tester and to ground.

Connect the Channel 'A' positive probe to the coil primary circuit to the WHT/BLU wire inside the distributor. Connect the Channel 'A' negative probe to the battery ground post.

Connect a low amp probe to Channel 'B' and zero the amp probe. Clamp the probe around the B+ feed circuit to the coil (BLK/YEL wire).

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

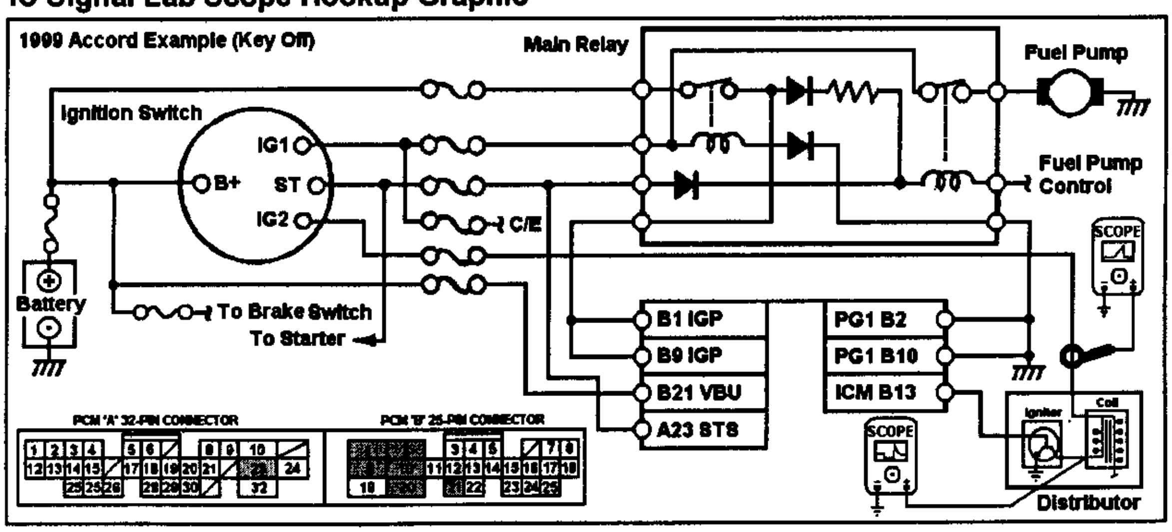
Lab Scope Tests

Crank the engine to capture these examples.

Lab Scope Explanations - Examples (1) & (2)

In example (1), the top trace shows the coil primary signal while the bottom trace shows the coil primary current during cranking. Note that the coil primary current reached 7 amps due to the coil current limiting effect with the spark tester connected. This test can be used to test the coil and igniter (No Start Test). In example (2), the coil primary reached 350v.

IC Signal Lab Scope Hookup Graphic

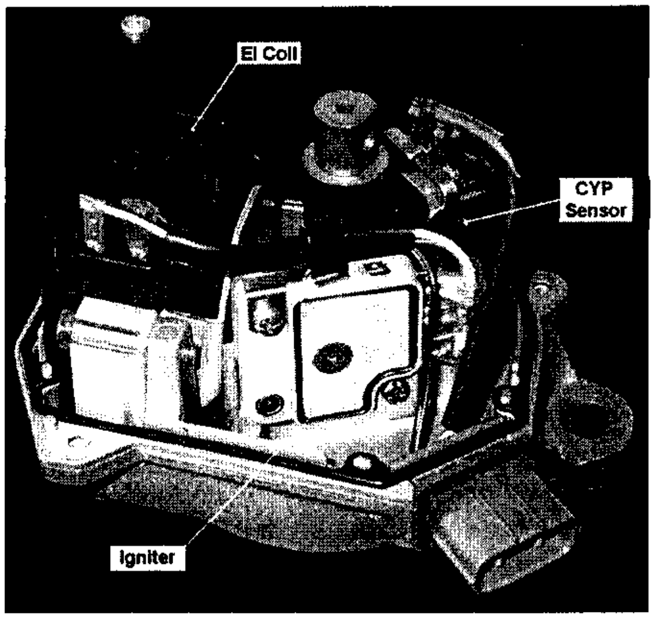


1999 ACCORD (2.3L I4 VTEC VIN CG6)

Electronic Ignition

CYP Sensor Overview

The cylinder position (CYP) sensor is a magnetic pickup mounted inside the distributor housing adjacent to a pulse wheel or rotor located on the distributor shaft.



The CYP sensor is connected to the PCM by two circuits that supply an AC voltage signal as the distributor rotates. As the single rotor notch passes the CYP sensor, it generates an AC signal that changes in frequency with the engine speed.

There is (1) CYP signal and (4) TDC signals for each camshaft revolution.

The PCM uses the CYP signal as a reference point to detect the position of Cylinder No. 1 for sequential fuel injection. The CYP signal occurs at a crankshaft position that is 450° ahead of the TDC signal for Cylinder No. 1.

Key Point: *The engine will start and run fine without CYP signals present.*

DVOM Test (CYP Sensor)

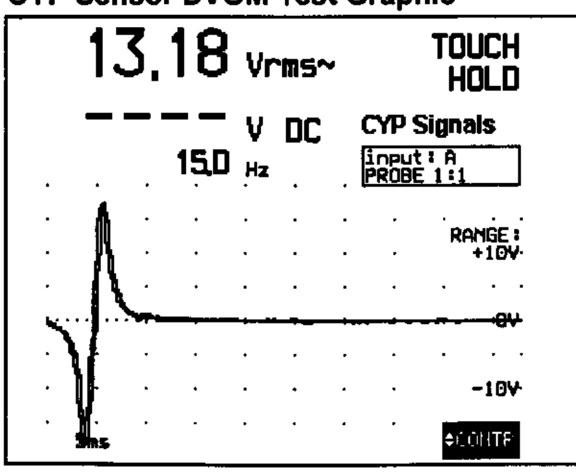
A DVOM can be used to test the AC output signal from the CYP sensor to the PCM. This test method can be used to determine if there is any sensor output. The example on this page was captured with a Fluke 99-B with Meter or DVOM selected using a 1:1 probe.

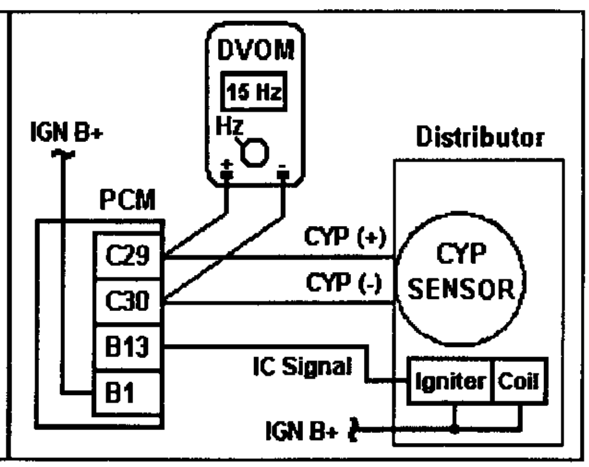
DVOM Connections (CYP Sensor)

Connect the DVOM positive probe to the CYP (+) signal at PCM pin C29 (YEL wire) and the negative probe to the CYP (-) signal at PCM pin C30 (BLK wire) or at the wire harness connector at the side of the distributor assembly.

The DVOM should show a voltage near 13v and 15 hertz at idle speed. The time base setting was 5 ms and the voltage setting was 10v AC during the event for this capture.

CYP Sensor DVOM Test Graphic



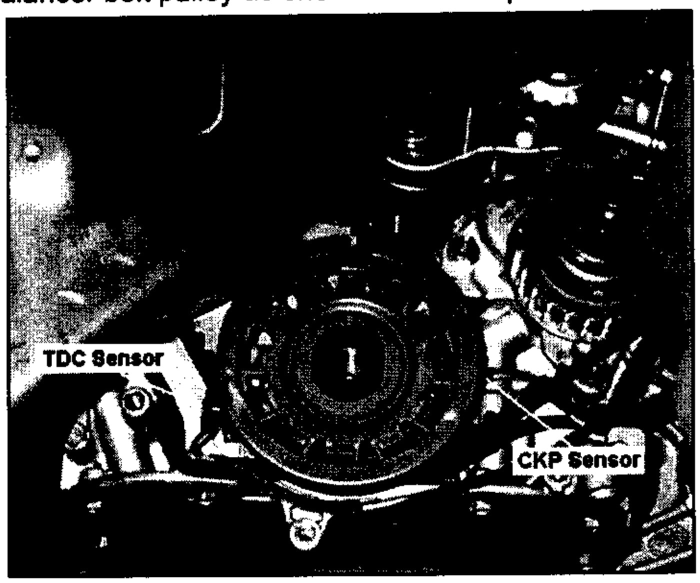


1999 ACCORD (2.3L I4 VTEC VIN CG6)

Electronic Ignition

CKP & TDC Sensor Overview

The crankshaft position (CKP) and top dead center (TDC) sensors are located behind the balancer belt pulley at the bottom of the engine. The combination CKP and TDC sensor unit is mounted behind the balancer belt pulley as shown in the Graphic below.



The CKP sensor is positioned to detect the 12x slots on the pulley.

The TDC sensor is positioned to detect a pair of tabs at the back of the timing belt gear.

The PCM uses the CKP sensor signals to calculate the fuel injection timing and the ignition timing for each cylinder.

The PCM uses the TDC sensor signals to determine the ignition timing at startup and when the CKP sensor signal is abnormal.

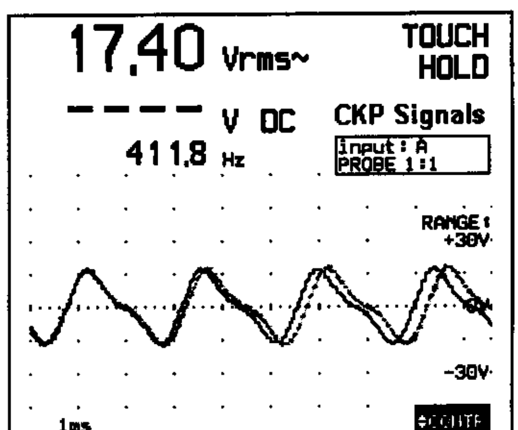
Key Point - The engine will start and run with one sensor missing.

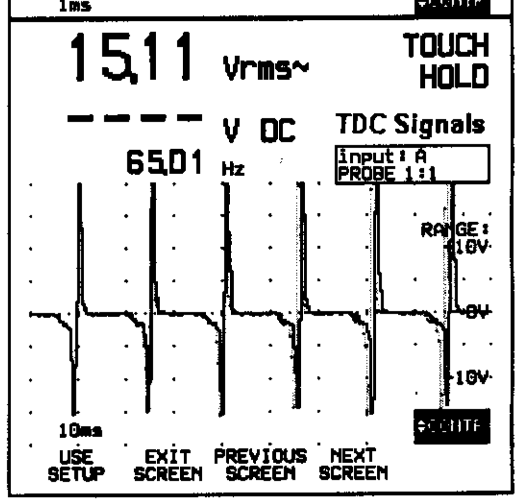
Misfire Detection

The PCM uses the CKP sensor inputs to monitor fluctuations in engine speed to detect when a misfire is present (as part of OBD II diagnostics).

DVOM Test (CKP & TDC Sensors)

A DVOM can be used to test the AC output signals from the CKP and TDC sensors. This test method can be used to quickly determine if these sensors are working. The examples to the right are from a Fluke 99B with Meter selected and a 1:1 probe connected to scope Input 'A'.





DVOM Connections (CKP Sensor)

Connect the DVOM leads to the CKP (+) signal at Pin C8 (BLU wire) and the CKP (-) signal at Pin C9 (WHT wire) at the PCM or at the wire harness connector near the top of the engine. The DVOM should show a voltage near 17v at 411 hertz at idle speed. The time base setting was set at 1 ms with the engine at idle speed.

DVOM Connections (TDC Sensor)

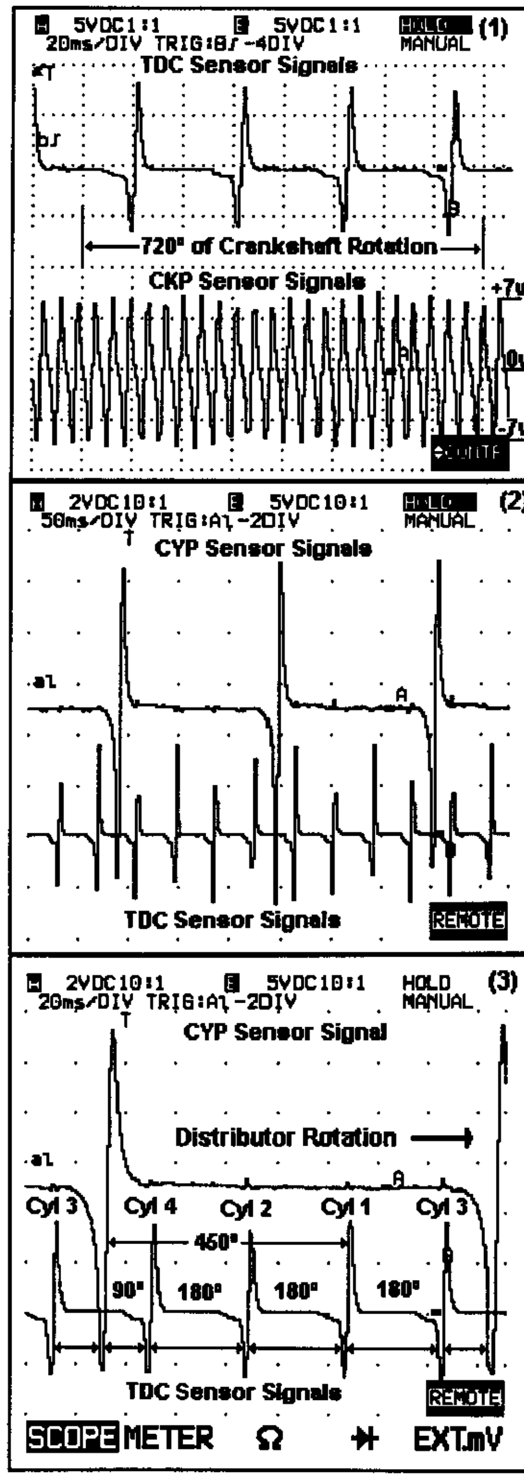
Connect the DVOM leads to the TDC (+) signal at Pin C20 (GRN wire) and the TDC (-) signal at Pin C21 (RED wire) at the PCM or at the wire harness connector near the top of the engine. The DVOM should show a voltage near 15v at 65 hertz with engine running at idle speed.

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Electronic Ignition

Lab Scope Test (CKP, CYP & TDC Sensor)

The Lab Scope can be used to test the signals from the CKP, CYP and TDC sensors as it provides an excellent view of the various sensor waveforms and of any possible glitches. Prior to starting the test, place the gearshift selector in Park (A/T).



Lab Scope Tests

The signals from these three (3) sensors can be checked at both Idle and Cruise speeds with the engine cold or warm.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (CKP Sensor)

Connect the Channel 'A' positive probe to the CKP (+) signal at Pin C8 (BLU wire) and the negative probe to the CKP (-) signal at Pin C9 (the WHT wire) of the PCM 31-Pin connector.

Scope Connections (CYP Sensor)

Connect the Channel 'A' positive probe to the CYP (+) signal at Pin C29 (YEL wire) and the negative probe to the CYP (-) signal at Pin C30 (BLK wire) of the PCM 31-Pin connector.

Scope Connections (TDC Sensor)

Connect the Channel 'B' positive probe to the TDC (+) signal at Pin C20 (GRN wire). Connect the Channel 'B' negative probe to the TDC (-) signal at Pin C21 (the RED wire).

Lab Scope Explanation - Example (1)

In this example, the top trace shows the 2x TDC signal and the bottom trace shows the 12x CKP sensor signals at idle speed. Both of these traces show signals that are 15v peak to peak. Note that 24 CKP sensor signals appear during 720 degrees of crankshaft rotation.

Lab Scope Explanation - Example (2)

In this example, the top trace shows the CYP 1/2x signal and the bottom trace shows the TDC 2x signals at idle speed. Note that the TDC sensor signal is higher in amplitude. Note the relationship of the CYP 1/2x signal to the TDC 2x signal. The CYP sensor signal occurs every 720 degrees of crankshaft rotation

Lab Scope Explanation - Example (3)

In this example, the top trace shows the CYP sensor signal and the bottom trace shows the TDC sensor signal. Note that the CYP sensor signal occurs 450° before Cyl No. 1 is at TDC.

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Fuel System

Introduction

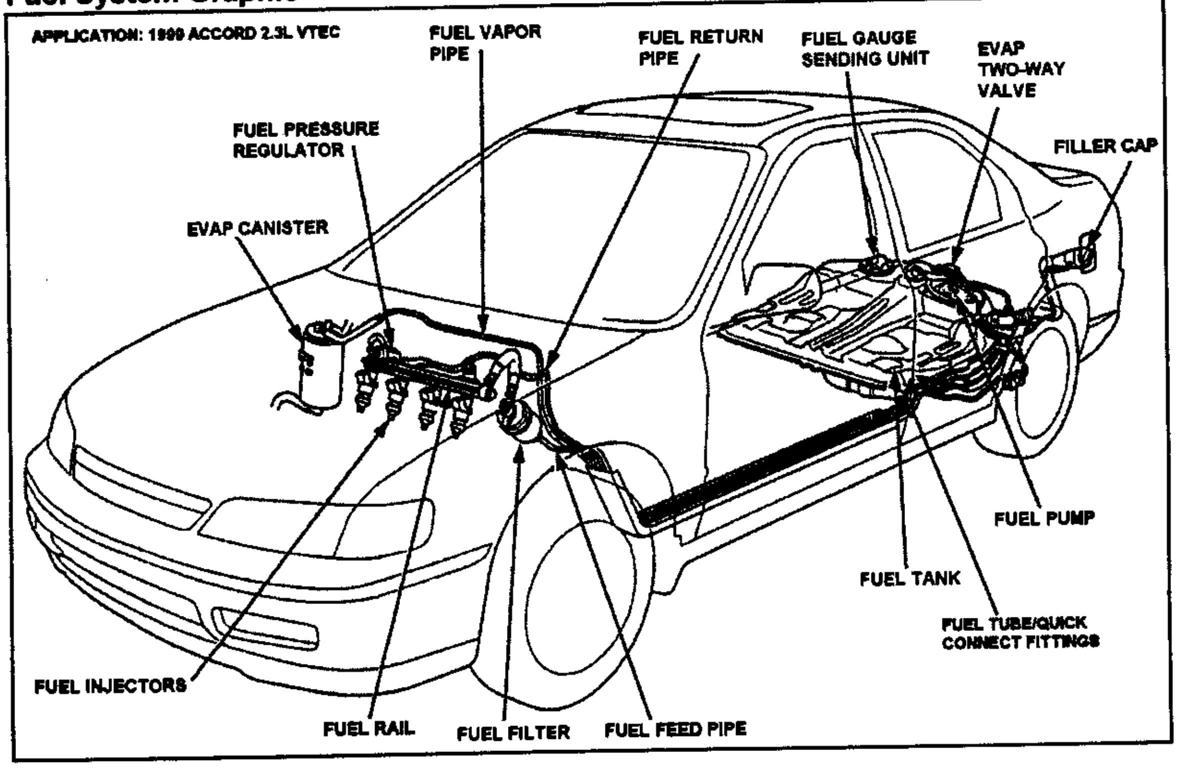
The Fuel Delivery system on this vehicle application is designed to deliver fuel at a regulated high pressure to the fuel rail and injectors. Additionally, this Fuel system is also designed to cutoff fuel pressure if the engine stops running.

System Components

The Fuel system on this application includes the fuel tank, fuel pump, fuel filter, pressure regulator, fuel injectors, fuel tube/quick connect fittings, fuel lines and hoses and fuel rail.

The electrical portion of the Fuel system consists of the main relay, in-tank fuel pump, fuel injectors, the battery feed and fuel control circuits from the PCM to the injectors.

Fuel System Graphic



1999 ACCORD (2.3L I4 VTEC VIN CG6)

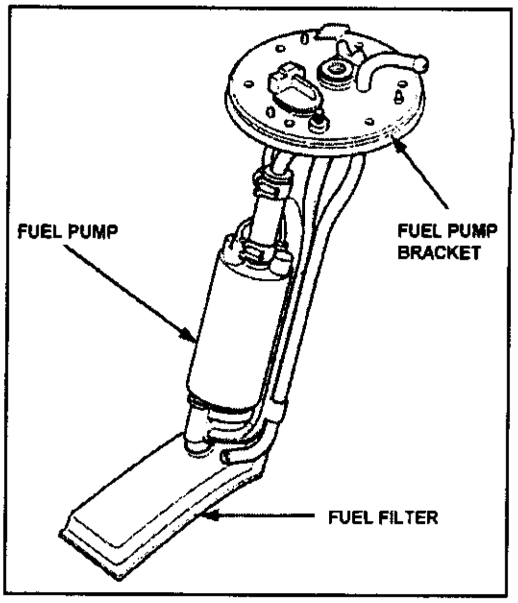
Electric Fuel Pump

General Description

This vehicle application uses an in-line, impeller-type electric fuel pump. Fuel is drawn from the fuel tank through a one-way check valve and delivered to the fuel rail in the engine compartment. A baffle is provided to prevent fuel pulsation on the direct drive fuel pump.

An external fuel filter (sock) is used on the impeller type pump, while an internal fuel filter is used on the direct drive pump. A check valve is used to maintain fuel pressure in the fuel line for a short time after shutdown to ease restarting on all models.

The fuel pump has an internal relief valve to prevent excessive pressure in the fuel delivery system. This valve opens if there is a blockage in the discharge side. If the relief valve opens, fuel flows from the high-pressure side to the low-pressure side of the fuel pump.

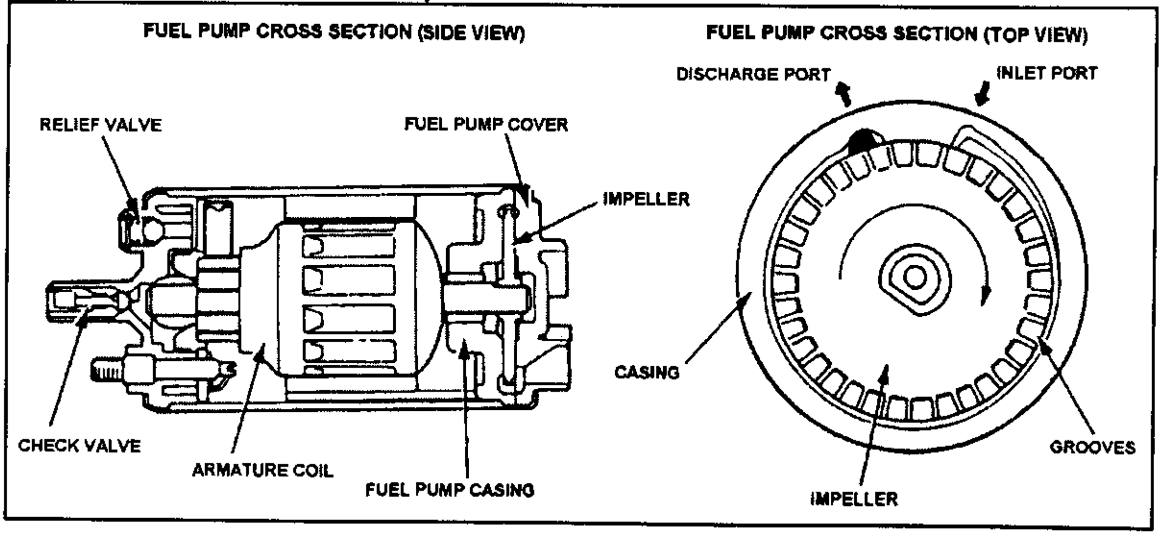


System Operation

The fuel pump is energized for two seconds when the key is first turned on to pressurize the fuel delivery system. Once the engine starts, the main relay supplies voltage to the fuel pump motor and the motor turns along with the impeller. Pressure changes are created by the numerous grooves around the impeller. Refer to the Graphic below.

Fuel enters the inlet port and flows inside the motor from the pumping chamber and is forced through the discharge port via the check valve. If fuel flow is obstructed at the discharge side of the fuel line, the relief valve will open to bypass fuel to the inlet port to prevent high fuel pressure. Once the engine stops, the PCM turns off the fuel pump through the main relay due to the loss of ignition reference (rpm) signals. An internal check valve closes by spring action to retain residual pressure for quick restarts.

Fuel Pump Cross-Section Graphic



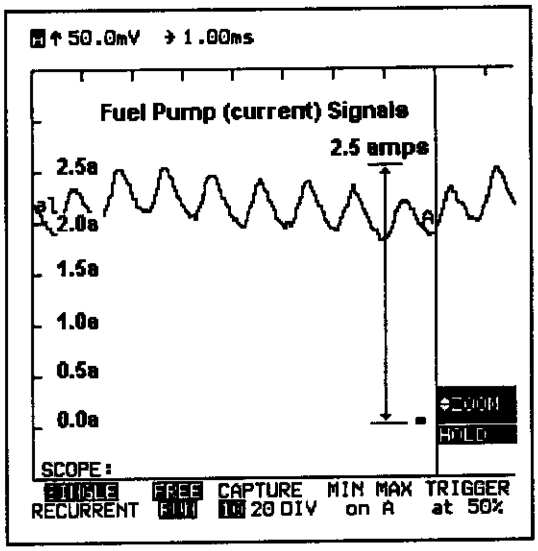
1999 ACCORD (2.3L I4 VTEC VIN CG6)

Electric Fuel Pump

Lab Scope Test (Fuel Pump)

If you suspect that the fuel pump is faulty, you can use a low amp probe with an inductive pickup to monitor the operation of the fuel pump and its related circuits.

An example of a known good fuel pump motor waveform from this vehicle application is shown in the Graphic to the right.



If the fuel pump is in good condition and operating normally, the current draw will be less than 4 amps on this vehicle.

Lab Scope Settings

Set the Lab Scope to these initial settings:

- Volts per division: 50 mv
- Time per division: 1 ms
- Trigger setting: 50% with a positive slope

Scope Connections Settings (Amp Probe)

Set the amp probe to 100 mv. Zero the amp probe prior to starting the test. Locate the main relay and install the amp probe around the wire between the relay and fuel pump. Start the engine and allow the reading to stabilize.

Lab Scope Example Explanation

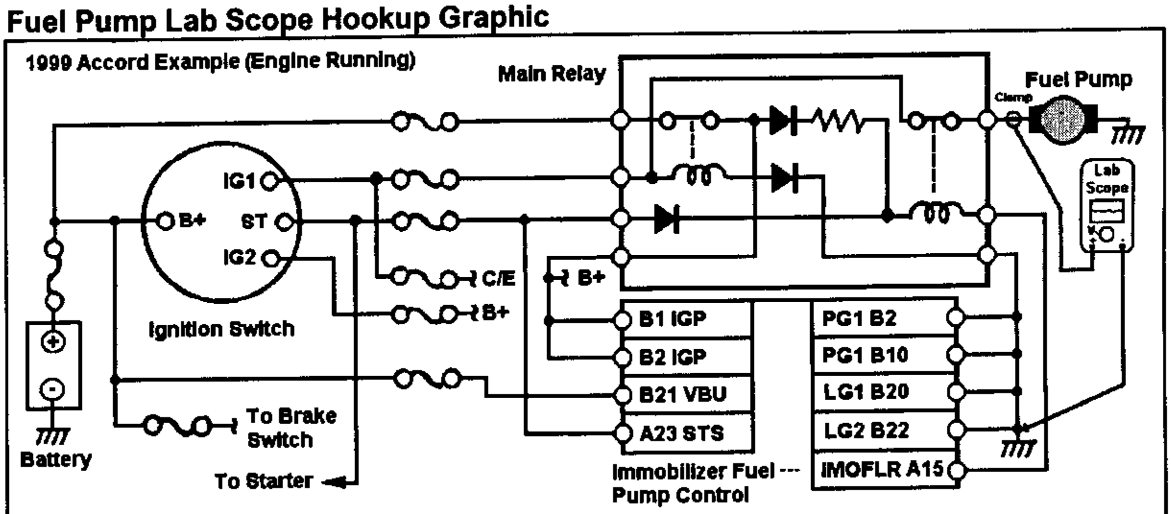
In this example, the trace shows the fuel pump current with the engine at idle speed. Note the even pattern from this known good fuel pump. Note how the fuel pump portion of the main relay is energized by the PCM by controlling the Immobilizer Fuel Pump Control circuit (Pin A15) to provide power to the fuel pump.

Symptom Diagnosis

Depending upon the type of problem, you may want to let the engine run for a period of time until it occurs - this allows you to monitor the amount of change in the fuel pump current trace (this period of time gives the fuel pump motor time to ramp up).

In some cases, you may need to let the engine run until the engine stalls or begins to stall and then capture the waveform at that particular moment.

Fuel Pump Lab Scope Hookup Graphic



1999 ACCORD (2.3L I4 VTEC VIN CG6)

Fuel Injectors

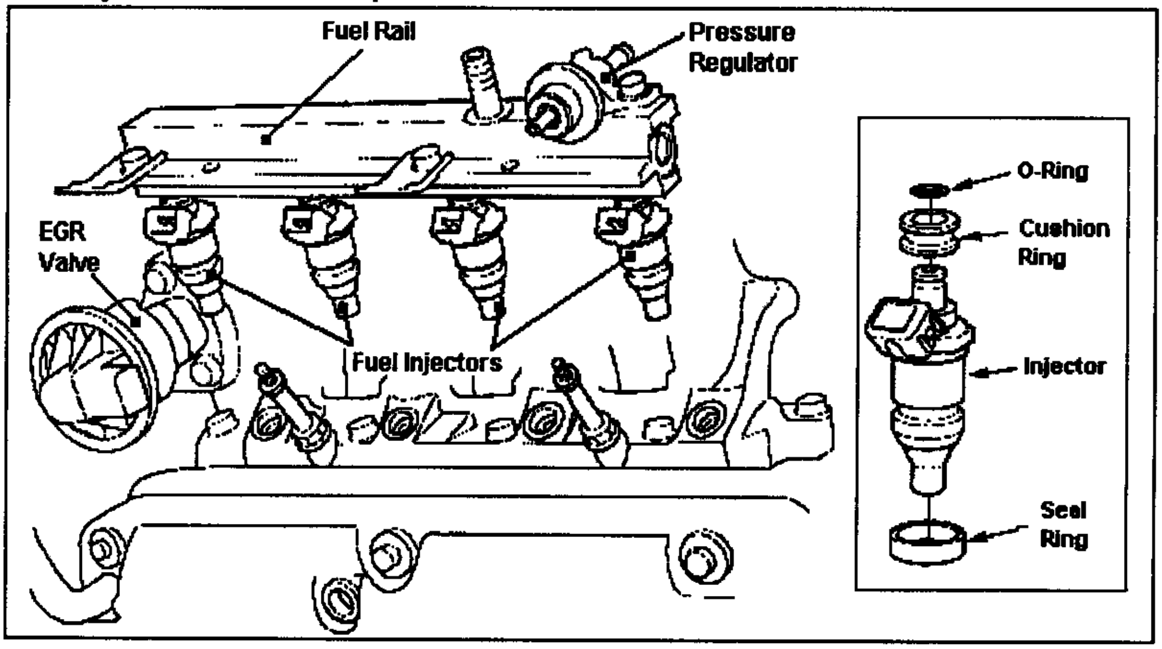
General Description

The fuel injectors on this engine application are solenoid-operated (N.C.) valves that are designed to meter the fuel flow to each combustion chamber. Each injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel delivered is controlled by the length of time the injector is held open (injector pulsewidth).

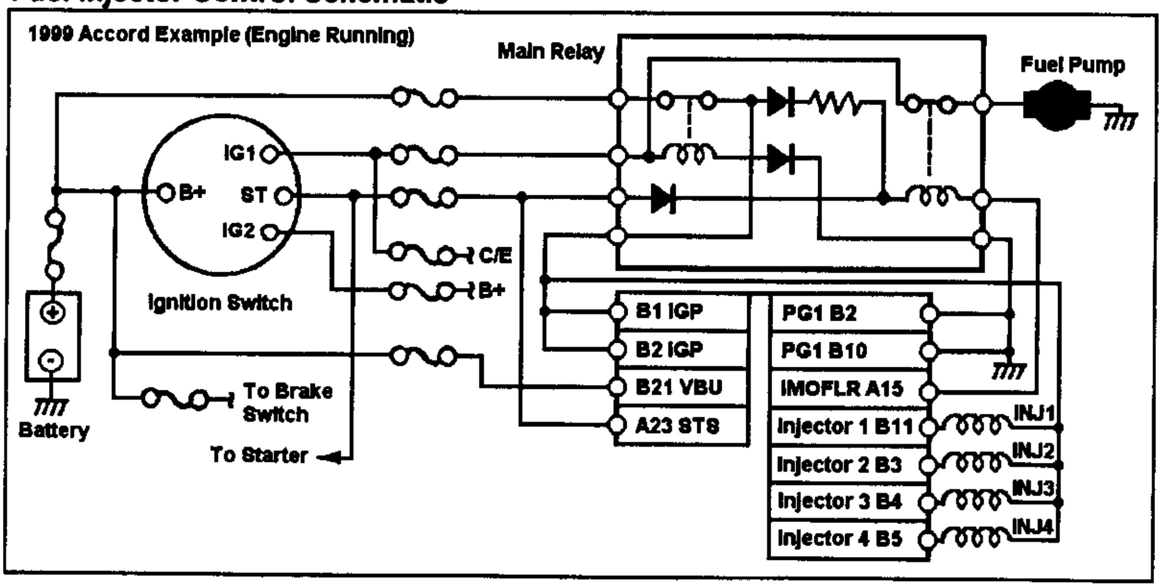
Each injector is connected to a battery feed circuit at the PGM-FI main relay. The PCM controls an injector driver circuit that connects the injector to ground at the correct time.

These injectors are referred as "saturated switch" injectors. The injector ontime is the time between the downward vertical line and upward vertical spike on a Lab Scope.

Fuel Injector Location Graphic



Fuel Injector Control Schematic



1999 ACCORD (2.3L I4 VTEC VIN CG6)

Fuel Injectors

DVOM Test (Fuel Injector)

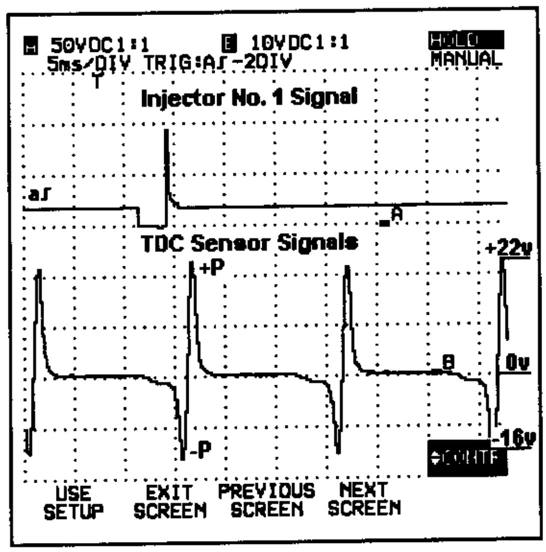
Connect the DVOM positive probe to the injector control wire and the negative probe to the battery negative post (refer to the Lab Scope hookup shown in the Graphic below).

Start the engine and allow it to idle. Monitor the amount of injector "on-time" on the DVOM. Then raise the engine speed to 2500 rpm and monitor injector "on-time" again.

Specification: The fuel injector "on-time" for this vehicle application is from 2.0 to 3.3 ms.

Lab Scope Test (Fuel Injector)

The Lab Scope is the "tool of choice" to test operation of the fuel injector and its circuits.



Scope Connections

Connect the Channel 'A' positive probe to one of the injector control wires and the negative probe to battery negative ground post.

To view the TDC sensor signals along with the injector control signal, connect the Channel 'B' positive probe to the TDC sensor (+) circuit at Pin C20 (GRN wire) of the 31-Pin connector.

Scope Settings

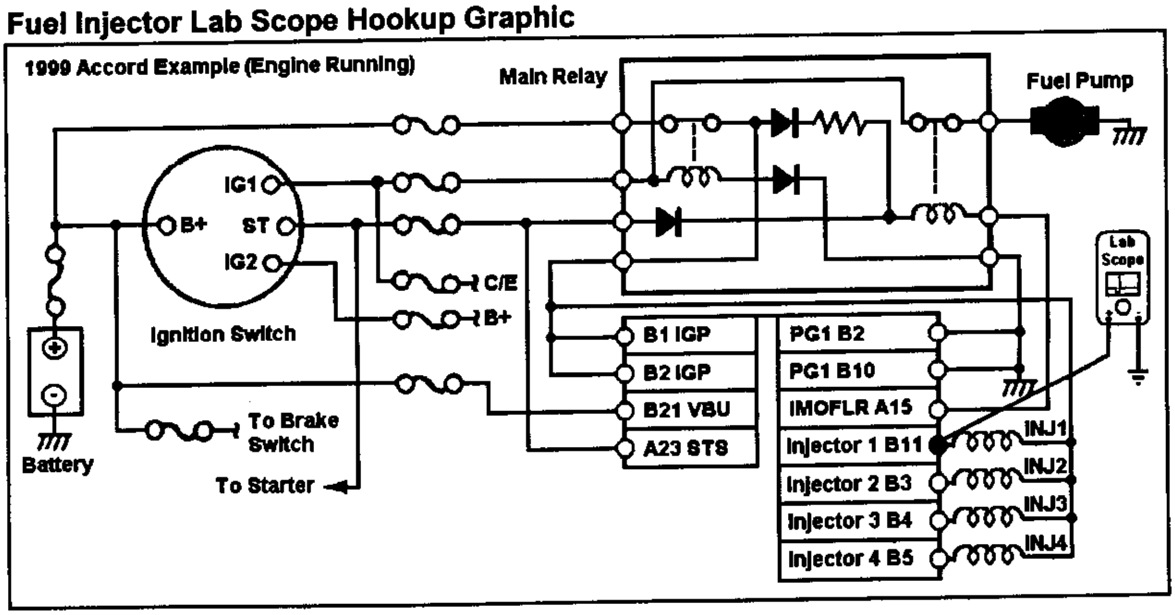
To make the wavefoms as clear as possible, set the scope settings to match the examples.

Lab Scope Example Explanation

In this example, the two traces show the fuel injector control signal and TDC sensor (38v peak to peak) signal at off-idle speed.

Note the height of the injector spike (near 95v) in the example and the relationship of the injector On/Off signal as it relates to the point where the TDC sensor signal starts its downward path in the negative (-P) direction.

Fuel Injector Lab Scope Hookup Graphic



1999 ACCORD (2.3L I4 VTEC VIN CG6)

Intake Air System

Introduction

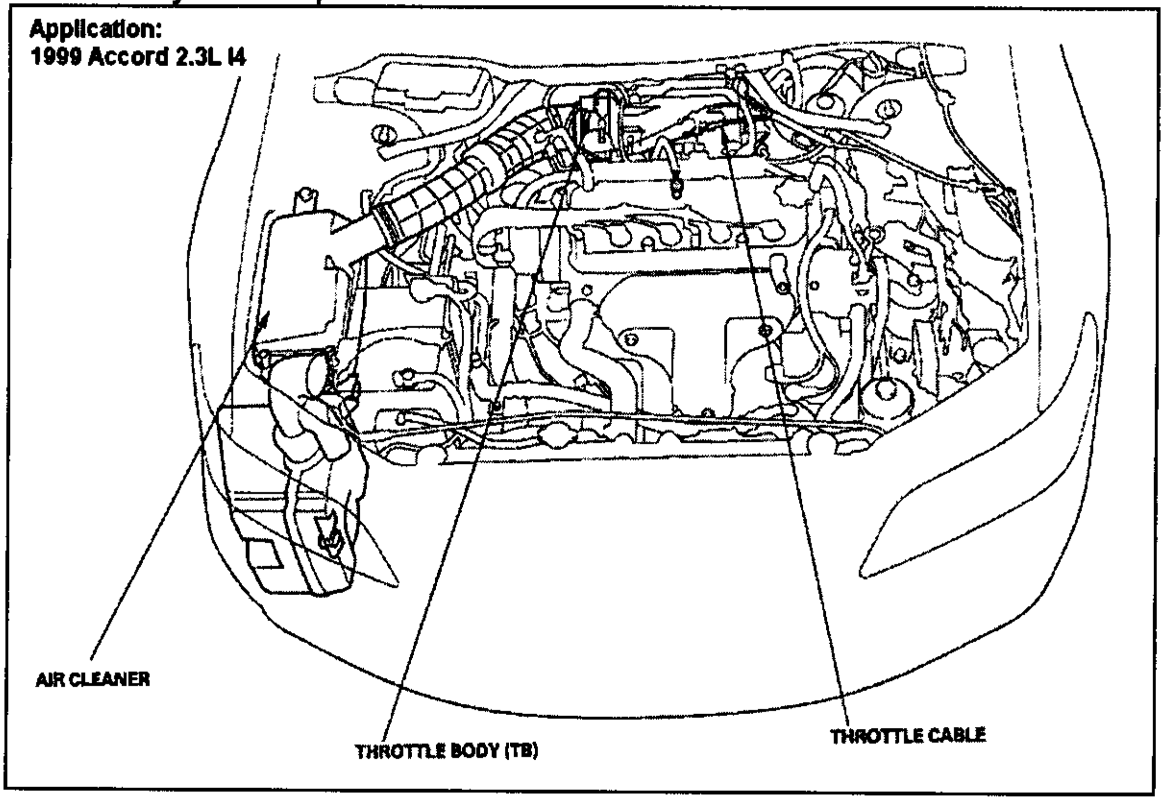
The Air Intake system supplies air for all of the engine needs. A resonator in the intake pipe provides additional silencing as air is drawn into the engine. An idle air control (IAC) solenoid is used to control the engine idle speed under all engine-operating conditions.

System Components

The Intake Air system on this vehicle application includes these components:

- Air Cleaner
- Air Cleaner Housing
- Fuel Injection Idle Air Control (IAC) Valve or Solenoid
- Throttle Cable
- Throttle Body

Intake Air System Graphic



1999 ACCORD (2.3L I4 VTEC VIN CG6)

Idle Air Control Solenoid

General Description

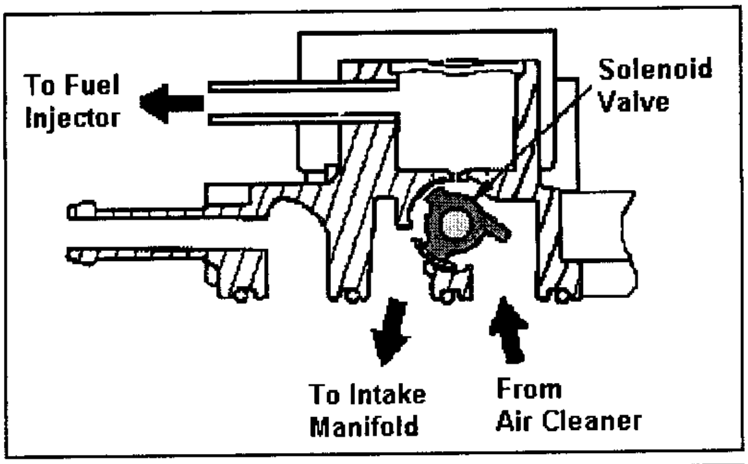
The PCM controls the engine idle speed by adjusting the position of the IAC solenoid valve under all engine-operating conditions. The PCM contains information for the desired idle speed under various conditions in its memory tables.

Note: The IAC solenoid (valve) was introduced in 1993 on all engines with fuel injection.

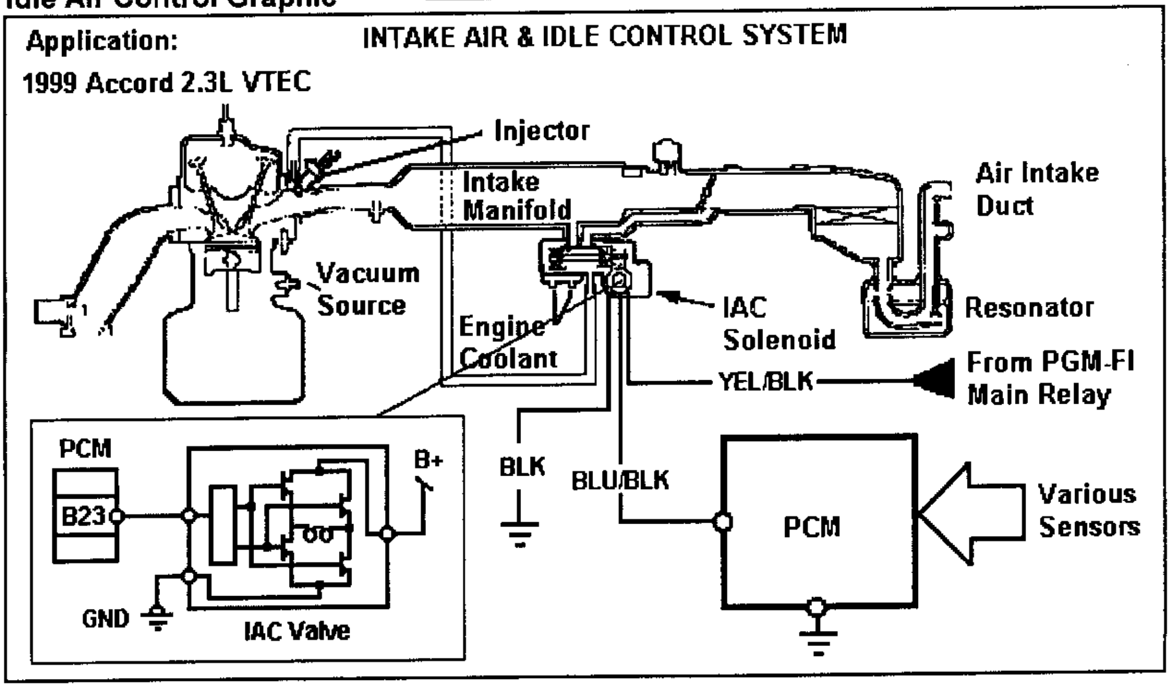
System Operation

The PCM accomplishes the task of controlling the idle speed by sending electric current pulses to the IAC solenoid to change the amount of air that bypasses the throttle body into the intake manifold.

This action energizes the solenoid valve (opens it) in order to maintain the correct idle speed for all conditions.



Idle Air Control Graphic



Technical Service Bulletin

Honda TSB 99064 (12/99) describes a "Hesitation during Acceleration" condition on this vehicle. The "fix" is to adjust the base idle speed setting (monitor idle speed on a Scan Tool). The adjusting screw should be lightly seated and then backed out 3 1/2 turns.

1999 ACCORD (2.3L I4 VTEC VIN CG6)

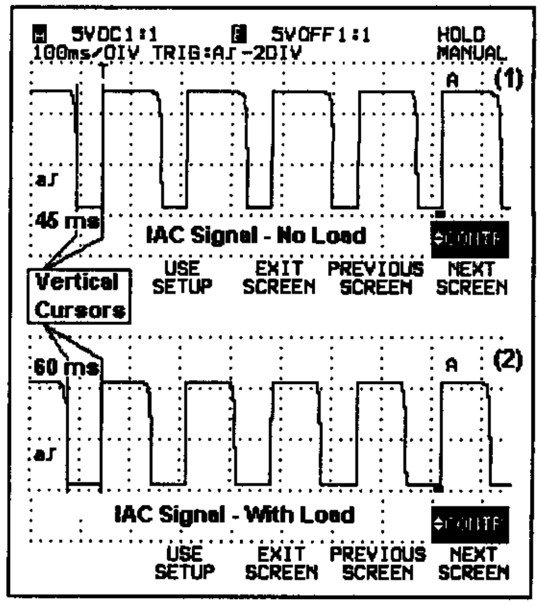
Idle Air Control Solenoid

Lab Scope Test (IAC Solenoid)

The Lab Scope can be used to test the operation of the IAC solenoid and its circuits. The two examples on this page represent two separate captures of the IAC solenoid signals.

Scope Connections (Examples 1 & 2)

Connect the Channel 'A' positive probe to the IAC solenoid control circuit (BLK/BLU wire) at PCM Pin B23 and the Channel 'A' negative probe to the battery negative post.



Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the example.

IAC Solenoid Lab Scope Test

Start the engine and allow it to fully warm up. Then capture the IAC solenoid waveform with the gear selector in Park or Neutral. Then with the gear selector still in P/N, turn on the air conditioning and select the high blower position. Also turn on the lights and radio. These loads should cause the PCM to adjust the IAC solenoid valve position (under load).

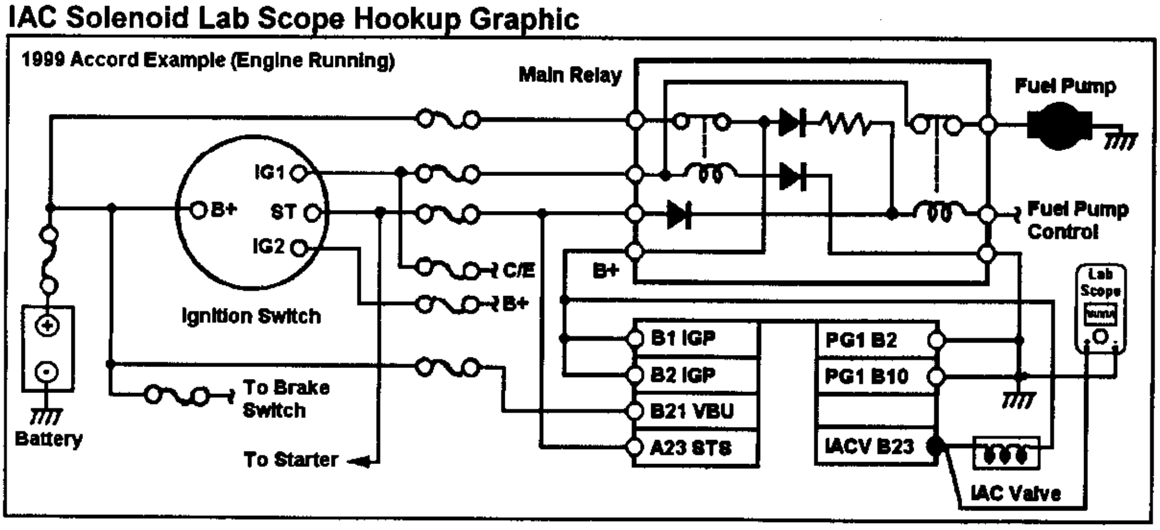
Lab Scope Explanation - Example (1)

This trace shows a known good IAC solenoid waveform without any load applied with the vehicle in Park. The average IAC signal ontime without any load applied is 45 ms.

Lab Scope Explanation - Example (2)

This trace shows a known good IAC solenoid waveform with some engine load applied (A/C, blower motor and lights "on"). The average IAC signal ontime is about 60 ms under a condition with a load applied. You can compare the amount of difference in ontime by reading the amount of time between the cursors (the low point of the waveform) for both captures. The amount of time with no load applied (45 ms) versus with a load (60 ms) amounts yields a difference of about 15 ms (the result is a higher engine idle speed).

IAC Solenoid Lab Scope Hookup Graphic



1999 ACCORD (2.3L I4 VTEC VIN CG6)

Manifold Absolute Pressure Sensor

General Description

The manifold absolute pressure (MAP) sensor converts the value of the manifold absolute pressure into an analog signal that is used by the PCM to determine the amount of fuel delivery, idle speed and ignition timing.

<u>MAP Sensor Circuits</u>

The MAP sensor circuits can be checked with a DVOM as discussed next:

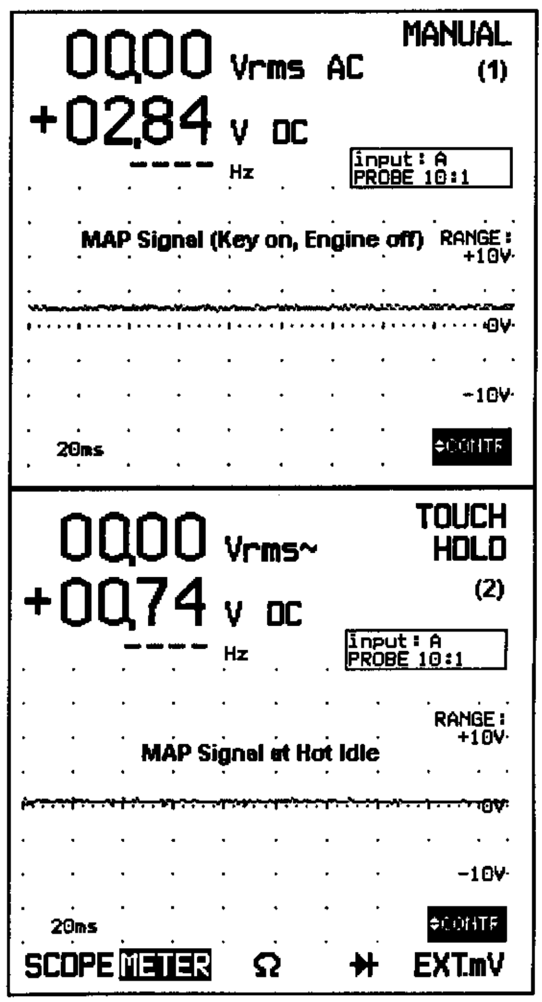
MAP VREF Circuit - Disconnect the MAP sensor connector, turn the key on and backprobe the VREF circuit (YEL/RED wire). This circuit should read from 4.9-5.1v.

MAP Ground Circuit - Connect one lead to the MAP sensor ground circuit in the 3-P connector and the other lead to battery negative. Then turn the key "on". The DVOM should read less than 50 millivolts if the ground circuit is okay.

MAP Signal Circuit - This circuit should be checked for an open circuit condition and for a short-to-ground condition. Backprobe the RED/GRN wire at the 3-pin connector. The reading on this circuit with the key on should closely match the reading on a Scan Tool.

DVOM Test (MAP Sensor)

The DVOM can be used to test the MAP sensor signal. Connect the positive probe to the signal (RED/GRN wire) at Pin C17 of the 31-Pin 'C' connector. Connect the negative probe to the battery negative post. Turn the key on or start the engine and compare the readings to the values in the Pin Voltage tables at the end of this vehicle section.



Sweep Test - Remove the sensor and connect a vacuum pump to it. Slowly apply vacuum to the sensor (sweep the sensor through its complete range). If the reading drops off or changes too quickly, replace the MAP sensor.

<u>MAP Sensor Calibration Test</u>

Connect one DVOM lead to the MAP sensor signal and the other lead to battery ground. Turn the key on, connect a vacuum pump to the sensor and slowly apply 10" Hg to the sensor. Record the reading at 10" Hg. The reading should be 1.8-2.0v at sea level. The value should be under 1.8-2.0v at over 4,000 ft. (it should drop 0.25v for each 1,000 ft.).

If the voltage change is not as specified, replace the sensor and repeat the test. If the sensor is okay, check the vacuum source to the MAP for leaks or a restriction.

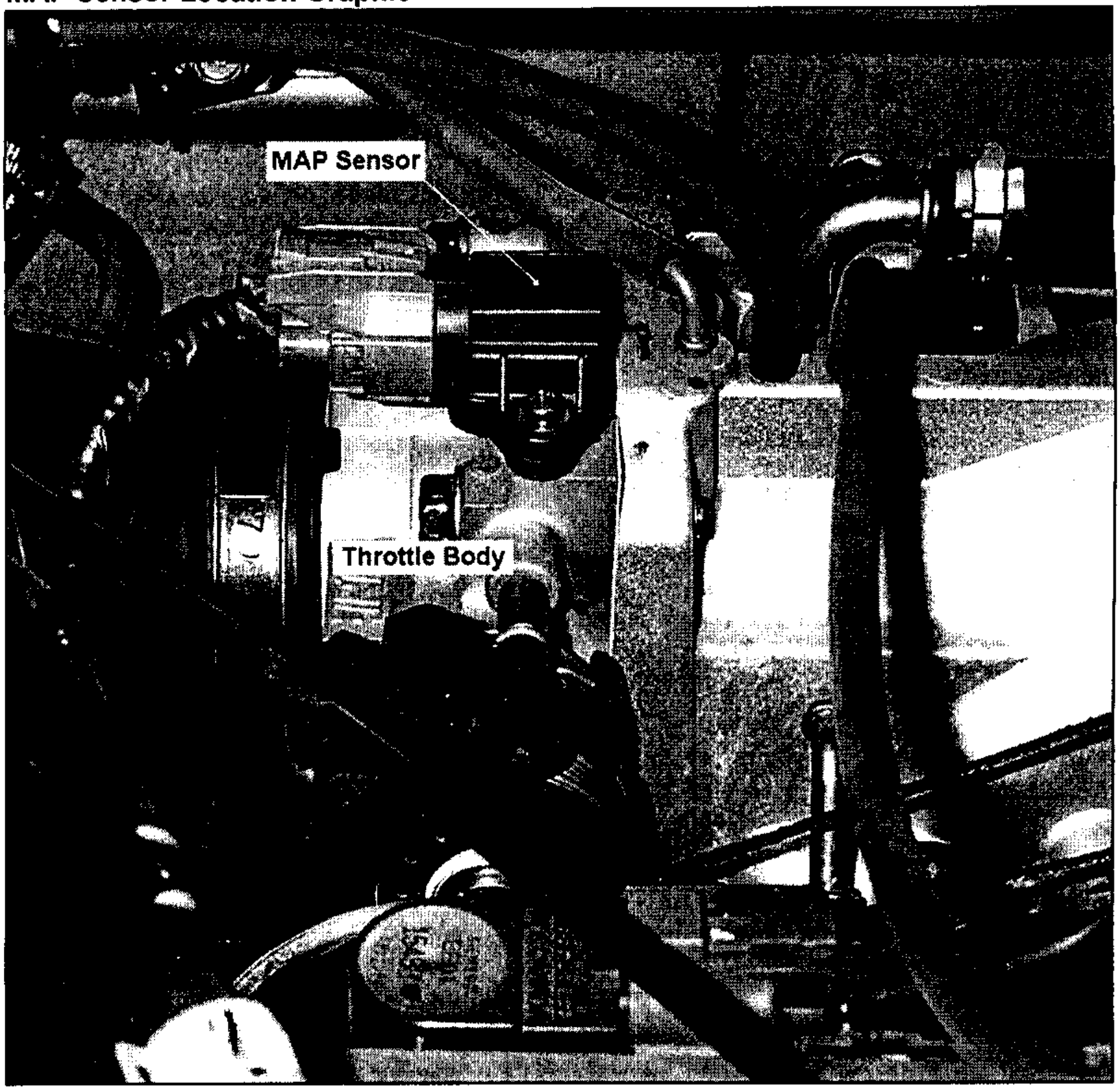
Summary - Problems with the MAP sensor or its vacuum source can cause the engine to run extremely rich. If engine vacuum is low due to a mechanical problem, the MAP signal will be over 1.1v at idle speed (normal is from 0.75-0.85v at hot idle) and the engine will run rich.

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Manifold Absolute Pressure Sensor

Component Location

MAP Sensor Location Graphic



1999 ACCORD (2.3L I4 VTEC VIN CG6)

Manifold Absolute Pressure Sensor

Lab Scope Test (MAP Sensor)

The Lab Scope can be used to test the MAP sensor as it provides a very accurate view of sensor response and any glitches. The Scan Tool is the tool of choice for this sensor. Prior to starting the test, place the shift selector in Park (A/T) and block the drive wheels.

<u>Scope Connections</u>

Connect the Channel 'A' positive probe to the MAP sensor signal at Pin C17 (RED/GRN wire) of the PCM 31-Pin connector and the negative probe to the battery ground post.

<u>Scope Settings</u>

To make the waveform as clear as possible, set the scope settings to match the examples. The MAP sensor waveform may have slight differences from one Lab Scope to another depending upon the scope capabilities and settings.

<u>Lab Scope Tests</u>

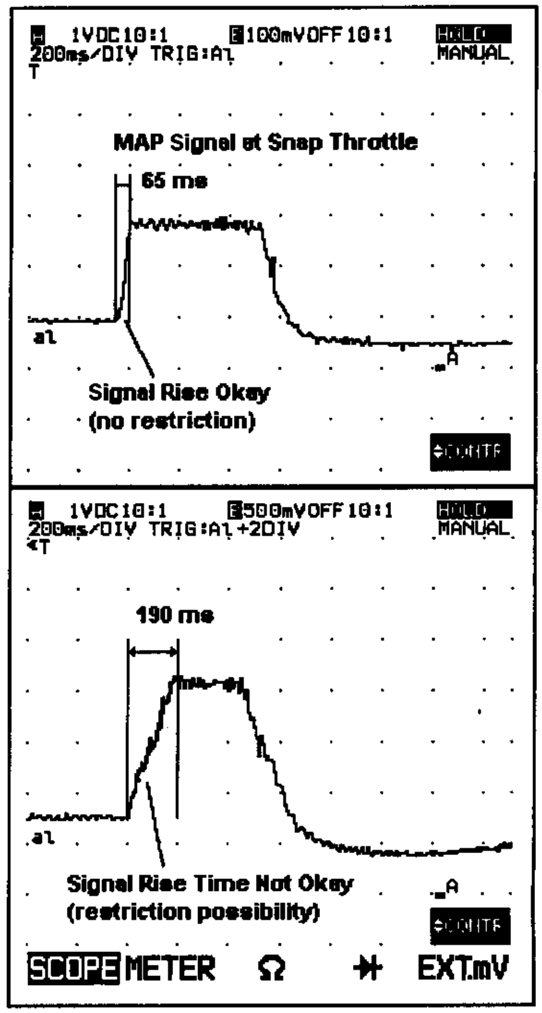
Start the engine and raise the engine speed to 2500 rpm for 2 minutes to allow it to warmup. With the engine at hot idle (in Park), perform a snap throttle test of the MAP sensor signal by quickly opening and closing the throttle while monitoring the waveform for any problems.

<u>Lab Scope Example (1)</u>

There is one third of a division between the vertical cursors in this example. Each division equals 200 ms. This is an example of a good MAP sensor signal during a Snap Test. Note the signal rise time occurred in 65 ms.

<u>Lab Scope Example (2)</u>

There is one division between the vertical cursors in example (2). Each division equals 200 ms.



To calculate the rise time of the MAP sensor signal, push the Hold or Record button on your scope to capture the pattern on your scope. Turn on the vertical cursors. Position one cursor at the point where the signal starts to rise and position the second cursor at the point where the signal stops rising. The actual rise time of the signal can now be calculated.

In example (2), note the "delayed response" in the MAP sensor signal indicated by the fact that it took almost 200 ms for the signal to reach its peak.

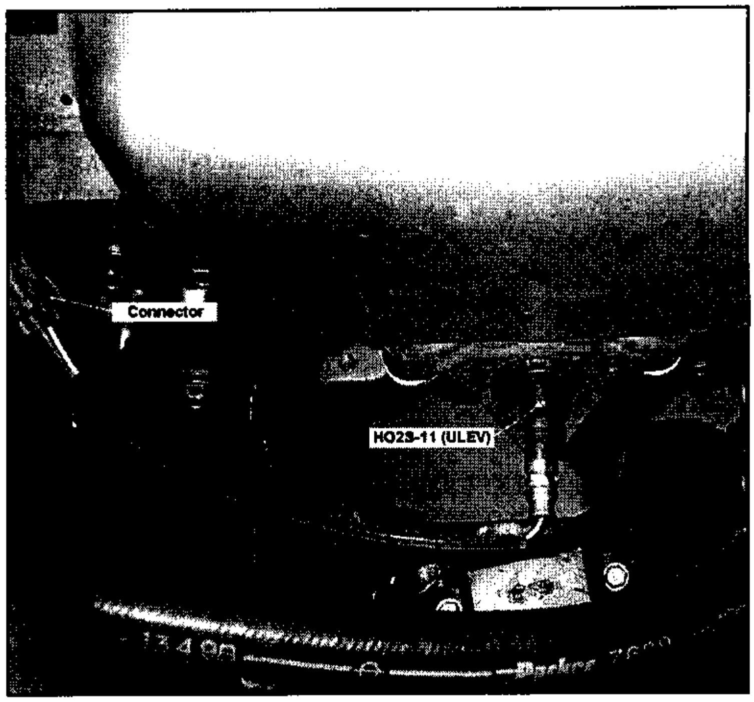
If the engine operation is sluggish, the exhaust system may be restricted or the timing chain may have "jumped" out of phase. Perform the test outlined in the two examples above to determine if the MAP sensor has failed.

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Oxygen Sensor

General Description

The heated oxygen sensor (HO2S) is mounted in the exhaust where it can monitor the oxygen content of the exhaust stream and send signals to the PCM. The PCM uses the HO2S signal to calculate the amount of injector pulsewidth and changes to long and Short Term fuel trim values.



The PCM controls the A/F ratio by using the signals from the front and rear oxygen sensors.

The PCM detects deterioration in the front (primary) sensor by evaluating the feedback period between signals from the front and rear sensors.

If it exceeds a certain value during "stable driving conditions", the PCM will calculate whether the front or rear oxygen sensor has deteriorated to a point that could adversely affect tailpipe emissions. If this occurs, the PCM will set a trouble code.

Oxygen Sensor Locations

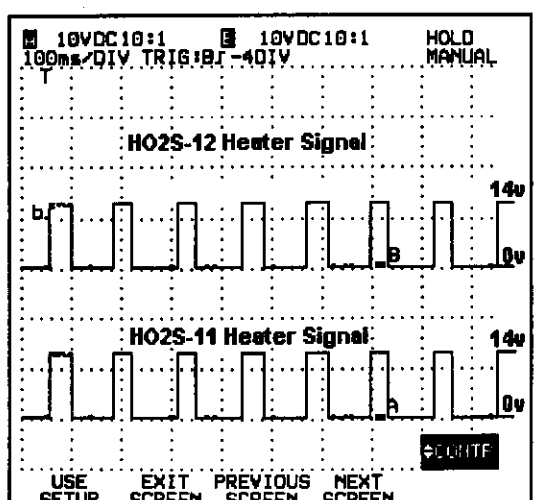
The front oxygen sensor is mounted in the exhaust pipe (in front of the converter). The rear oxygen sensor is mounted in the three-way catalyst (TWC) in the converter housing.

Oxygen Sensor Heaters

The oxygen sensors on this vehicle are equipped with an internal heater to stabilize their output signal. The heater control circuits are controlled by the PCM after engine startup.

Lab Scope Test (HO2S Heater)

The Lab Scope is the tool of choice to monitor the signals to the HO2S heater control circuits.



Scope Connections (4-Speed A/T)

Connect the Channel 'A' positive probe to front heater control circuit at Pin C13 (WHT wire) of the 31-Pin 'C' connector and negative probe to the battery ground post. Connect the Channel 'B' positive probe to Pin CA8 (BLK/WHT wire) at the PCM 32-Pin 'A' connector.

Lab Scope Example Explanation

The traces in this example show known good HO2S-11 and HO2S-12 heater control signals with the engine at normal temperature. Note that the control signals are system voltage.

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Oxygen Sensor

Lab Scope Test (HO2S Signal)

The Lab Scope is the tool of choice to monitor the operation of the secondary (rear) and front (primary) oxygen sensor circuits.

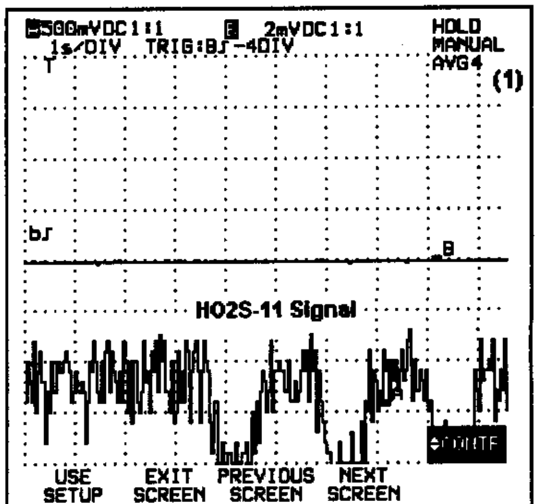
<u>Scope Connections (Example 1)</u>
Connect the Channel 'A' positive probe to the Pin C14 (RED wire) of the PCM 31-Pin connector (the primary oxygen sensor signal circuit). Connect the Channel 'A' negative probe to the battery negative ground post.

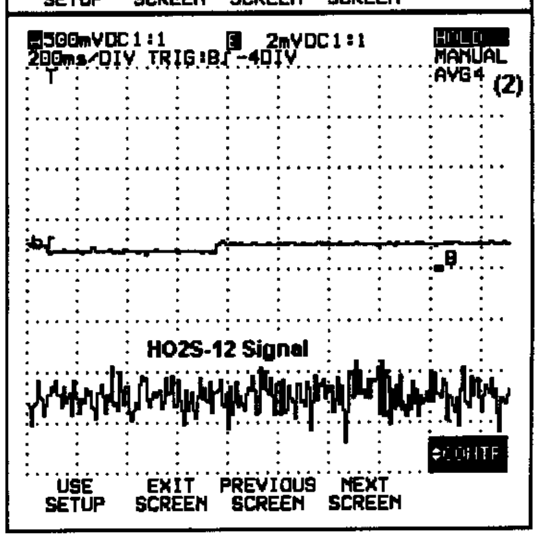
<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Scope Connections (Example 2)</u>
Connect the Channel 'A' positive probe to the Pin A23 (WHT/RED wire) of the PCM 32-Pin connector (secondary oxygen sensor signal circuit). Connect the Channel 'A' negative probe to the battery negative ground post.

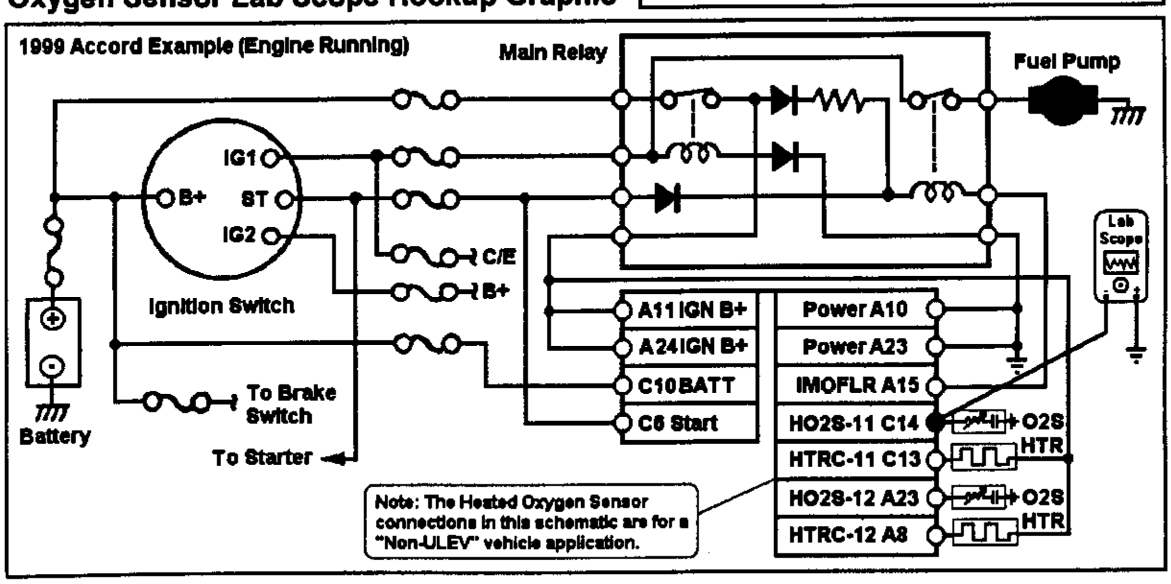
<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Lab Scope Example (1) Explanation</u>
The traces in these examples show a normal front and rear oxygen sensor waveform with the engine at hot idle speed.
Note: When monitoring an oxygen sensor waveform, use a 10:1 probe if available.





Oxygen Sensor Lab Scope Hookup Graphic

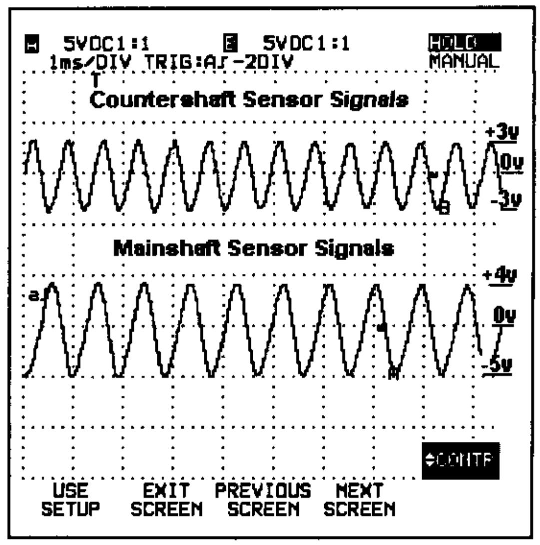


1999 ACCORD (2.3L I4 VTEC VIN CG6)

Main Shaft & Countershaft Speed Sensors

General Description

The Main Shaft and Countershaft Speed sensors are magnetic pickup design sensors that output an AC signal during periods of time when these different shafts are moving. The Lab Scope is the "tool of choice" to test the operation of this design of sensor.



Scope Connections (Countershaft Sensor)
Connect the Channel 'B' positive probe to the Countershaft Speed sensor signal circuit at Pin D10 (BLU wire). Connect the negative probe at Pin D16 (GRN wire). This is the Countershaft Speed sensor ground.

Scope Connections (Main Shaft Sensor)
Connect the Channel 'A' positive probe to the Main Speed sensor signal circuit at Pin D11 (RED wire). The Main Shaft speed sensor ground is on Pin D12 (WHT wire).

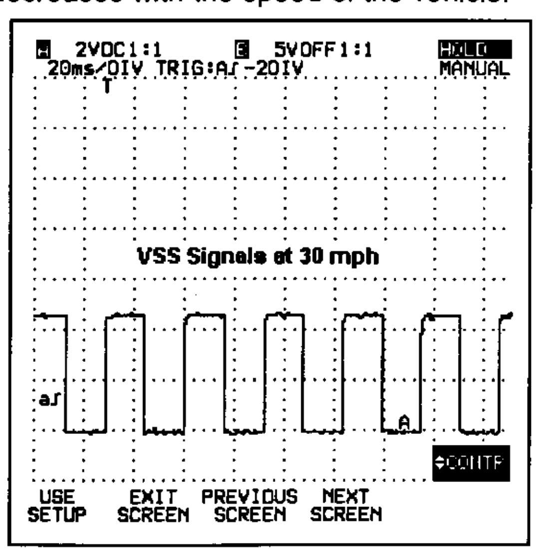
Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Test Example
Connect the Lab Scope to the correct terminals at the PCM (inside the vehicle) and then drive the vehicle at low or medium speed to set up the desired capture speed. The top trace in this example shows a known good Main Shaft speed sensor waveform while the bottom trace shows the Countershaft Speed sensor waveform at 30 mph.

Vehicle Speed Sensor (A/T)

Lab Scope Test (VSS)

The vehicle speed sensor is driven by the differential. It is designed to generate a pulsed DC voltage signal of 0v to 5v (from an input voltage of 5 volts) with the vehicle moving. The number of cycles per second increases or decreases with the speed of the vehicle.



Scope Connections (Vehicle Speed Sensor)
Connect the Channel 'A' positive probe to the VSS signal at Pin A9 (BLU/WHT wire) and the negative probe to the battery ground post.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Vehicle Speed Sensor Test
Connect the Lab Scope to the correct terminals at the PCM (inside the vehicle). Then start the engine and drive the vehicle at 30 mph to set up the VSS capture.

Lab Scope Example
The trace in this example shows a known good Vehicle Speed sensor waveform.

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Reference Information

How To Access & Use Generic PID Information

The Scan Tool Parameter Identification (PID) Mode allows access to certain data values, analog and digital input and output signals, calculated values and system status information.

The Generic OBD II PID list is an example of the PIDs that all OBD II compatible Scan Tools must be able to access and display.

Scan Tool PID Menus

An example of how to navigate through the Vetronix Scan Tool menus to locate the Generic PID information is shown in the Graphic to the right.

This Graphic contains an example of how to read the engine related parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column of the example represent known good values for this engine application.

If all of these PID values are within normal range, refer to the Symptom Diagnosis information in Section 1.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete Generic PID list for this vehicle is shown in the Graphic.

1) Select F1: SCANTEST from the opening menu.
2) Select Global OBD II from the Applications menu.
3) Select F0: Powertrain from the Main menu.
4) Initializing OBD II Communications screen appears.
5) Select F0: DATALIST from the Select Mode menu. To view the I/M Readiness status of the OBD II Main Monitors, select F1: Readiness (or another choice).
6) Select F0: Display Data from the Data List Menu.

Some of the sixteen PID items available in the Generic PID list for this vehicle are shown in the last frame.

Diagnostic Tip

The Typical Values in the example on this page should be used after the following conditions are met:

- The Honda PGM-FI Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

(1)
```
FUNCTION MENU
F1: SCANTEST
F2: DIGITAL METER
F3: OSCILLOCOPE
F4: EMISSION TESTS
F8: TECH TOOLBOX
F9: SETUP
```

(2)
```
APPLICATIONS ↑↓
-> GLOBAL OBD II
   GM P/T
   GM CHASSIS
```

(3)
```
MAIN MENU
F0:Powertrain
F1:Replay Data
F9:OBDII Toolpak
```

(4)
```
Initializing
OBD II
Communications
```

(5)
```
SELECT MODE ↑↓
F0:Datalist
F1:Readiness
F2:DTCs
```

```
SELECT MODE ↑↓
F3:Snapshot
F4:OBD Controls
F5:System Tests
```

```
SELECT MODE ↑↓
F8:Information
F9:OBDII Toolpak
```

(6)
```
DATA LIST MENU
F0:Display Data
F1:Data Setup
```

```
ENGINE SPD........766RPM
VSS.....................0MPH
ECT SENSOR...........86°C
IAT SENSOR...........66°C
MAP SENSOR.........28kPa
CLV........................28%
BARO S.................88kPa
TP SENSOR........... 0.2°
HO2S S1...............0.88V
ST FUEL TRIM.......0.98
LT FUEL TRIM.......0.92
O2 FB COND.......CLOSED
```

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Reference Information

How To Access & Use OEM PID Information

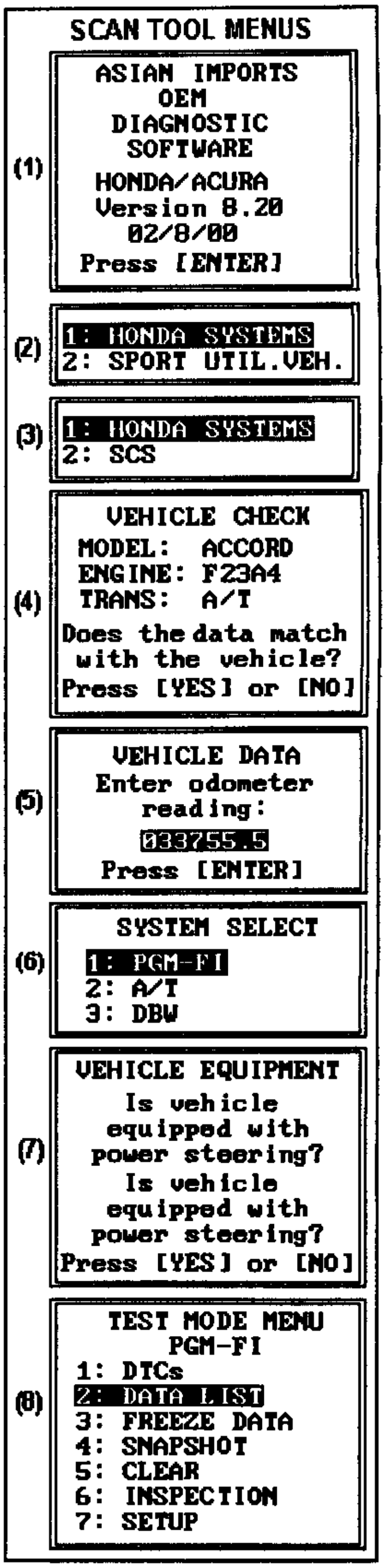
The OEM PID List on the next page contains the engine related parameters available on the Scan Tool. The list is arranged in alphabetical order. The items under "Typical Value" represent known good readings for this engine.

If all of the PID values are within normal range, refer to the Symptom Diagnosis information in Section 1.

<u>Scan Tool PID Menus</u>

An example of how to navigate through Vetronix Scan Tool menus to locate PID data is shown in the Graphic.

1) Insert the Honda OEM cartridge and press ENTER.
2) Select HONDA SYSTEMS from the Program Menu.
3) Select HONDA SYSTEMS from the Program Menu.
4) Verify the correct vehicle during the Vehicle Check.
5) Enter the correct VIN code as well as the odometer reading and then verify both entries.
6) Answer YES or NO to the Power Steering question.
7) Answer YES or NO to the factory A/C question.
8) Select 2: Data List from the Test Mode Menu.



<u>Parameter ID (PID) Information</u>

The parameters in the PCM PID Tables in this manual are listed in alphabetical order. The Data List selection in the Scan Tool is used to view all of the PID items for this particular vehicle.

The other Test Menu choices available while using the OEM side of the Scan Tool include DTC's, Freeze Data, Snapshot, Clear, Inspection and Setup Modes.

This vehicle application has a total of forty-seven (47) parameter identification (PID) items that can be viewed with the OEM side of the Scan Tool.

You can find more detailed information on "known good" PID data examples for this vehicle application on the next page.

<u>Diagnostic Tip</u>

The Typical Values in this article should be used after the following conditions are met:

- The Honda PGM-FI Self-Check has been completed.
- The engine is at idle (unless otherwise specified).
- The throttle is closed (unless otherwise specified).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

1999 ACCORD (2.3L I4 VTEC VIN CG6)

Reference Information

PCM PID Tables

Note: ***The following readings were obtained with the engine at idle speed, radiator hose hot, throttle closed, gear selector in Park and all accessories turned off.***

Serial Data Name	Range or Value	Hot Idle	30 MPH	55 MPH
A/C Switch	ON or OFF	OFF	OFF	OFF
A/C Clutch	ON or OFF	OFF	OFF	OFF
Generator	0-100%	35%	34%	34%
Generator Control Volts	0-25.5v	14.4v	14.4v	14.3v
BARO Sensor	0-5.1v	2.76	2.74	2.73
Battery Voltage	0-25.5v	14.4v	14.4v	14.3v
Calculated Load Value	0-100%	25%	36%	40%
DTC Number	0-255	N/A	N/A	N/A
Electronic Load Detector	0-100 amps	4.1	8.1	10.2
Engine Speed	0-10,000 rpm	722	1420	2265
ECT Sensor	-40 to 304°F	190	192	193
EVAP Duty Cycle	0-100%	0	0-80	0-90
Fan Relay	ON or OFF	ON	OFF	OFF
Fuel Status 1	OPEN / CLOSED	CLOSED	CLOSED	CLOSED
HO2S-11 (front)	0-1100 millivolts	390	750	240
HO2S-12 (rear)	0-1100 millivolts	490	560	620
HO2S-11 HTR (front)	ON or OFF	ON	ON	ON
HO2S-12 HTR (rear)	ON or OFF	ON	ON	ON
IAC Motor	0-255 counts	50	50	50
IAT Sensor	-40 to 304°F	144	139	138
Knock Advance	0-99° BTDC	2	0	0
LONGFT (%)	0-100%	+2	+1	+1
Main Relay Status	ON or OFF	ON	ON	ON
MAP Sensor (V)	0-5.1v	0.85	1.11	1.31
MIL Status	ON or OFF	OFF	OFF	OFF
PSP Switch	ON or OFF	OFF	OFF	OFF
SCS Connector Status	OPEN or CLOSED	OPEN	OPEN	OPEN
Shift Lock	HIGH or LOW	HIGH	HIGH	HIGH
Spark Advance	0-99° BTDC	10	15	24
SHRTFT (%)	0-100%	-1	-1	0
Starter Switch	ON or OFF	OFF	OFF	OFF
TP Sensor (%)	0-100%	9.8	1.10v	1.15v
VTEC Pressure Switch	ON or OFF	ON	ON	ON
VTEC Pressure Solenoid	ON or OFF	OFF	OFF	OFF
Vehicle Speed (mph)	0-255	0	30	55

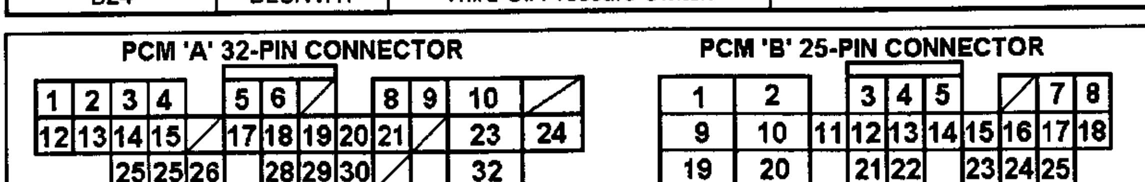
1999 ACCORD (2.3L I4 VTEC VIN CG6)

1999 Honda Accord 2.3L I4 VTEC Engine Pin Voltage Table (32-Pin 'A' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
A1	---	Not Used	---
A2	GRN/WHT	Engine Mount Solenoid Control	Low rpm: 0v, High rpm: 12v
A3	BLU	EVAP Bypass Solenoid Control	12-14v
A4	LTGRN/WHT	EVAP Vent Solenoid Control	12-14v
A5	BLU/GRN	Cruise Control Signal	N/A
A6	RED/YEL	EVAP Purge Solenoid Control	12-14v
A8	BLK/WHT	Rear HO2S-12 Heater Control	Digital Signals
A9	BLU/WHT	VSS Output Signal	Moving: 0-5-0-5v signals
A10	BRN	Service Check System Signal	Open: 5v or 12v
A12	PNK	Immobilizer Indicator Light	Light On: 0v, Off: 12v
A13, A25	BLU, RED	Immobilizer Enable, Code Signals	Digital signals
A14	GRN/WHT	A/T: D4 Indicator Light	Light On: 0v, Off: 12v
A15	GRN/YEL	Immobilizer Fuel Pump Relay	Relay On: <1v, Off: 12-14v
A17	RED	A/C Clutch Relay Control	Relay On: <1v, Off: 12-14v
A18	GRN/ORN	Check Engine Light (MIL lamp)	MIL On: <1v, Off: 12-14v
A19	BLU	Tachometer Engine Speed Pulse	Pulse signals
A20	GRN	Radiator Fan Relay Control	Relay On: 1v, Off: 12v
A21	GRY	K-Line DLC Signal	0v or 12v
A23	WHT/RED	Rear HO2S-12 Signal	0-1100 mv
A24	BLU/ORN	Starter Switch Signal	KOEC: 9-11v
A26	GRN	Power Steering Pressure Switch	Straight: 0v, Turning: 12v
A27	BLU/RED	A/C Switch Signal	A/C On: 0v, Off: 5v
A28	WHT/RED	Interlock Control Unit Signal	Key On & Brake On: 12v
A29	LT GRN	Fuel Tank Pressure Sensor	Fuel Cap Off: 2.5v
A30	GRN/RED	ELD Sensor Signal	Hot Idle w/lights on: 2.5-3.5v
A32	WHT/BLK	Brake Switch Signal	Brake On: 0v, Off: 12v

1999 Honda Accord 2.3L I4 VTEC Engine Pin Voltage Table (25-Pin 'B' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
B1, B9	YEL/BLK	Ignition Power Source to PCM	12-14v
B2, B10	BLK	Power Ground (PG1, PG2)	<0.1v
B3, B4	RED, BLU	Injector 2, Injector 3 Control	2.0-3.3 ms
B5	YEL	Injector 4 Control	2.0-3.3 ms
B11	BRN	Injector 1 Control	2.0-3.3 ms
B7	PNK	Electric EGR Solenoid	Duty Cycle Signal: 0-12-0-12v
B8, B17	WHT, RED	Clutch Press. Solenoid 'A' (-), (+)	AC Pulse Signals
B12	GRN/YEL	VTEC Solenoid Valve Control	Low rpm: 0v, High rpm: 12v
B13	YEL/GRN	Ignition Control Module Signal	Varying voltage: 8-11v
B14	BLU/BLK	Second Oil Pressure Switch	12-14v
B16 (ULEV)	GRN/RED	HO2S Heater Relay Control	Relay On: 1v, Off: 12v
B18, B25	GRN, ORN	Clutch Press. Solenoid 'B' (-), (+)	AC Pulse Signals
B19 (ULEV)	BLK/WHT	Front HO2S-11 Heater Control	Duty cycle signals
B20, B22	BRN/BLK	Sensor Ground (LG1, LG2)	<0.050v
B21	WHT/YEL	Battery Direct (B+)	12-14v
B23	BLK/BLU	Idle Air Control Solenoid Signal	Varying Voltage: 7-10v
B24	BLU/WHT	Third Oil Pressure Switch	12-14v



1999 ACCORD (2.3L I4 VTEC VIN CG6)

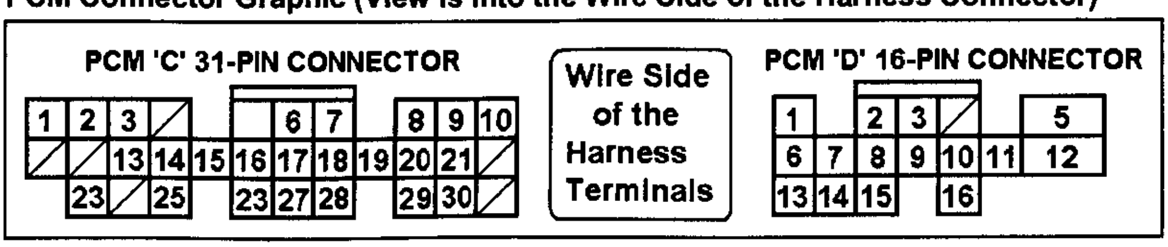
1999 Honda Accord 2.3L I4 VTEC Engine Pin Voltage Table (31-Pin 'C' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
C1	BLU/WHT	Front HO2S-11 Heater Control	Digital Signals
C4, C11-12, 16	---	Not Used	---
C2	WHT/GRN	Generator Control Signal	Varies: 7-8v
C3	RED/BLU	Knock Sensor Signal	Knocking: pulse signals
C5	WHT/RED	Generator 'FR' Signal	Varies: 0.5-4.5v
C6	WHT/BLK	EGR Lift Sensor Signal	Hot Idle: 1.2v
C7, C18	GRN/WHT	Sensor Ground (SG1, SG2)	<0.050v
C8	BLU	CKP Sensor (+) Signal	900 mv AC
C9	WHT	CKP Sensor (-) Signal	900 mv AC
C10	BLU/BLK	VTEC Pressure Switch Signal	Low rpm: 0v, High rpm: 12v
C13	WHT	Front HO2S-11 Heater Control	Digital Signals
C14	RED	Front HO2S-11 Signal	0-1100 mv
C14 (ULEV)	RED	Front HO2S-11 (+) Signal	3.0v
C15 (ULEV)	BLU	Front HO2S-11 (-) Signal	3.0v
C17	RED/GRN	MAP Sensor Signal	Hot Idle: 0.9v (sea level)
C19	YEL/RED	Sensor VREF	4.9-5.1v
C20, C21	GRN, RED	TDC Sensor (+), TDC (-) Signal	100 mv AC
C22, 23-24, 31	---	Not Used	---
C25	RED/YEL	IAT Sensor Signal	1-3v (ambient air dependent)
C26	RED/WHT	ECT Sensor Signal	Hot Idle: 0.7v
C27	RED/BLK	TP Sensor Signal	Hot Idle: 0.5v
C28	YEL/BLU	Sensor VREF	4.9-5.1v
C29, C30	YEL, BLK	CYP Sensor (+), CYP (-) Signal	250 mv AC

1999 Honda Accord 2.3L I4 VTEC Engine Pin Voltage Table (16-Pin 'D' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
D1	YEL	A/T: Lockup Control Solenoid	No Lockup: 12v, Lockup On: 0v
D2	GRN/WHT	A/T: Shift Solenoid Valve 'B'	In 1st & 2nd gear: 12v, other: 0v
D3	GRN	A/T: Shift Solenoid Valve 'C'	In 1st & 3rd gear: 12v, other: 0v
D5	BLK/YEL	A/T: Power to Solenoid Valve	12-14v
D6	WHT	A/T: Gear Position (Reverse)	In Reverse: 0v, all others: 12v
D7	BLU/YEL	A/T: Shift Solenoid Valve 'A'	In 2nd & 3rd gear: 12v, other: 0v
D8	PNK	A/T: Gear Position (Drive 3)	In D3: 0v, all others: 12v
D9	YEL	A/T: Gear Position (Drive 4)	In D4: 0v, all others: 12v
D10, D16	BLU, GRN	Countershaft Speed (+), (-) Signal	A/C pulse signals
D11, D12	RED, WHT	Main Shaft Speed (+), (-) Signal	A/C pulse signals
D13	BLU/BLK	A/T: Gear Position (Park/Neutral)	In P/N: 0v, all others: 12v
D14	BLU	A/T: Gear Position (Drive 2)	In D2: 0v, all others: 12v
D15	BRN	A/T: Gear Position (Drive 1)	In D1: 0v, all others: 12v

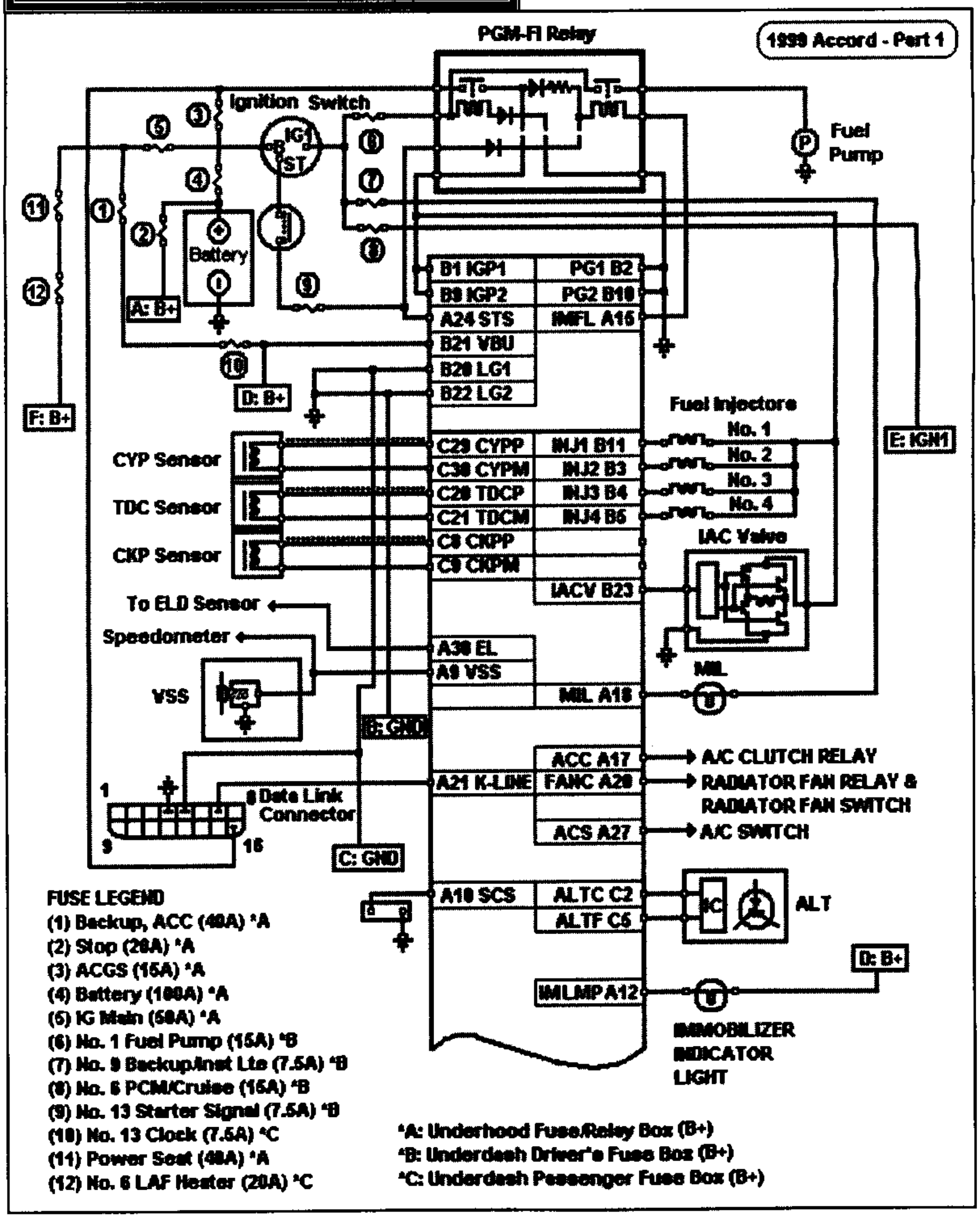
PCM Connector Graphic (View is into the Wire Side of the Harness Connector)



1999 ACCORD (2.3L I4 VTEC VIN CG6)

PCM Wiring Diagrams

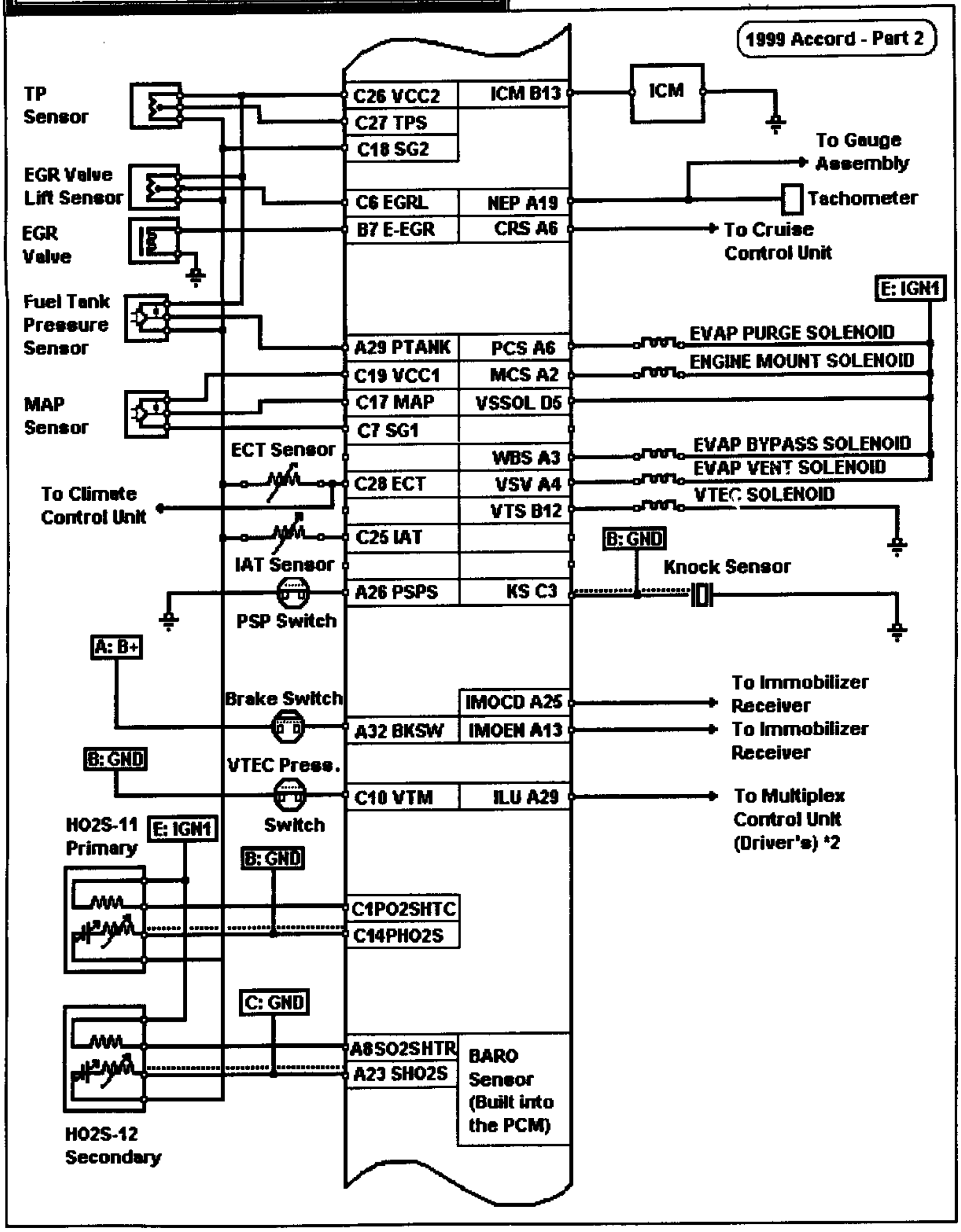
Fuel & Ignition System Diagrams (1 of 3)



1999 ACCORD (2.3L I4 VTEC VIN CG6)

PCM Wiring Diagrams

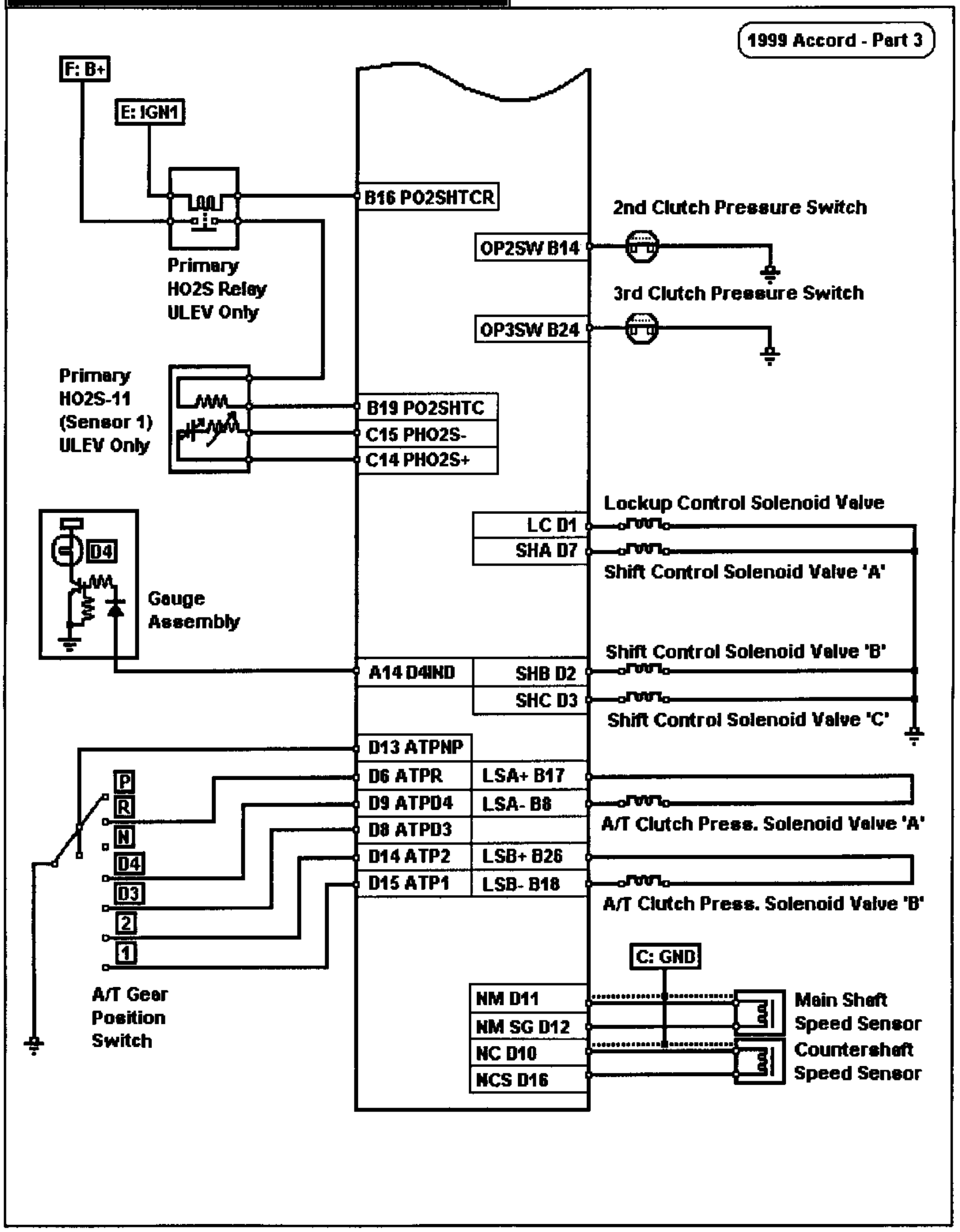
Fuel & Ignition System Diagrams (2 of 3)



1999 ACCORD (2.3L I4 VTEC VIN CG6)

PCM Wiring Diagrams

Fuel & Ignition System Diagrams (3 of 3)



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electronic Ignition System

Introduction

The PCM controls the Electronic Ignition (EI) system on this vehicle by sending signals to the ignition control (IC) unit or igniter. The ignition coil is supplied battery voltage from Fuse 11 in the Driver's Underdash Fuse/Relay Box (refer to the EI system schematic).

The PCM, located under the dash to the right of the steering column, contains memory tables that it uses to calculate the IC signals sent to the IC module (igniter) for each coil.

The PCM sends a command signal to the Coil/Igniter unit that indicates when to switch the ignition coil primary "on" and "off" in order to control the amount of spark advance during all engine-operating conditions. In effect, this signal controls the coil dwell period.

<u>System Components</u>

The EI system on this vehicle application includes the following components:

- The CKP sensor (mounted at the bottom of the right side of the engine)
- The TDC1 and TDC2 sensors (mounted at the bottom of the right side of the engine)
- The Knock Sensor (mounted at the front side middle of the engine)
- Six (6) high energy coils (mounted above each of the spark plugs)
- Six (6) igniter units integrated into the each of the coil assemblies

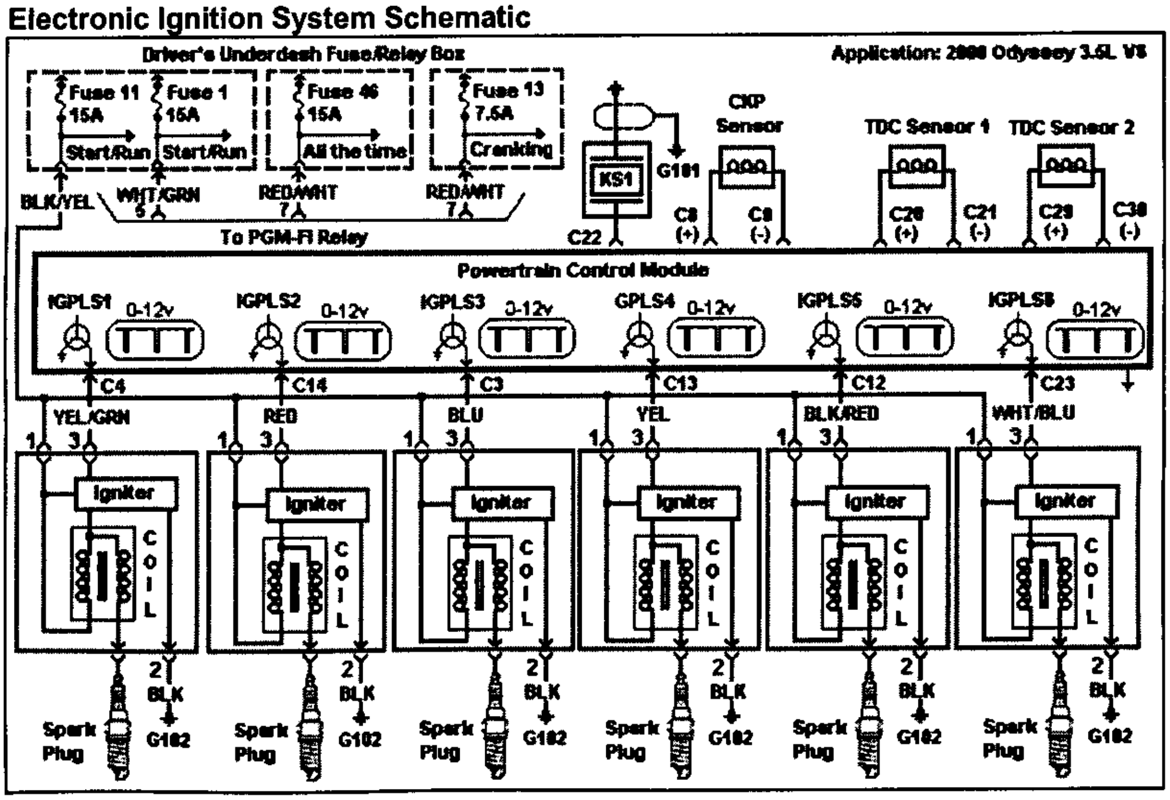
<u>Ignition Spark Timing</u>

The PCM controls the ignition timing during all engine modes by using information stored in its lookup tables that contain the correct amount of spark advance for all conditions.

<u>Ignition Coil Operation</u>

There are six (6) coil assemblies that include a primary (low primary resistance) and high secondary circuit. The PCM controls the separate coils through an internal ICM circuit.

Electronic Ignition System Schematic

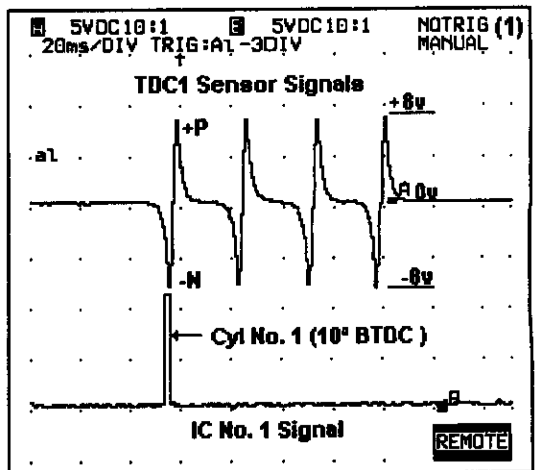


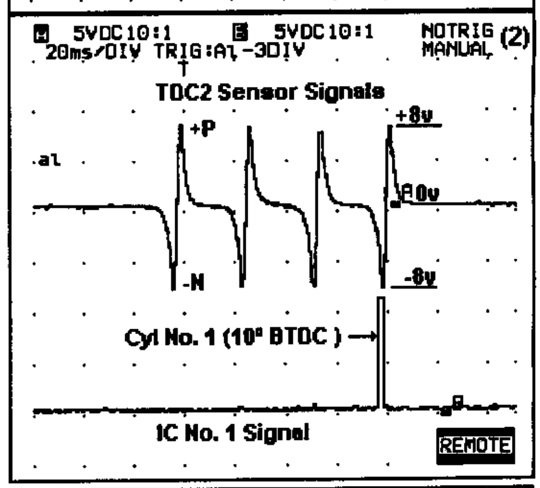
2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electronic Ignition System

Lab Scope Test (IC Signals)

The Lab Scope is the tool of choice to monitor the ignition control (IC) and TDC sensor signals to the PCM for possible glitches.





Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the example.

Scope Connections (TDC1 & TDC 2 Sensor)

To view the TDC1 sensor signals, connect the Channel 'A' positive probe to Pin C20 (GRN wire) of the 31-Pin 'C' connector. To view the TDC2 sensor signals, connect the Channel 'A' positive probe to Pin C29 (YEL wire). Connect the Channel 'A' Negative probe to the ground.

Scope Connections (IC No. 1 Signal)

To view the IC signal for Coil No. 1, connect the Channel 'B' positive probe to Pin C4 (YEL/GRN wire) of the 31-Pin connector.

Lab Scope Explanation - Example (1)

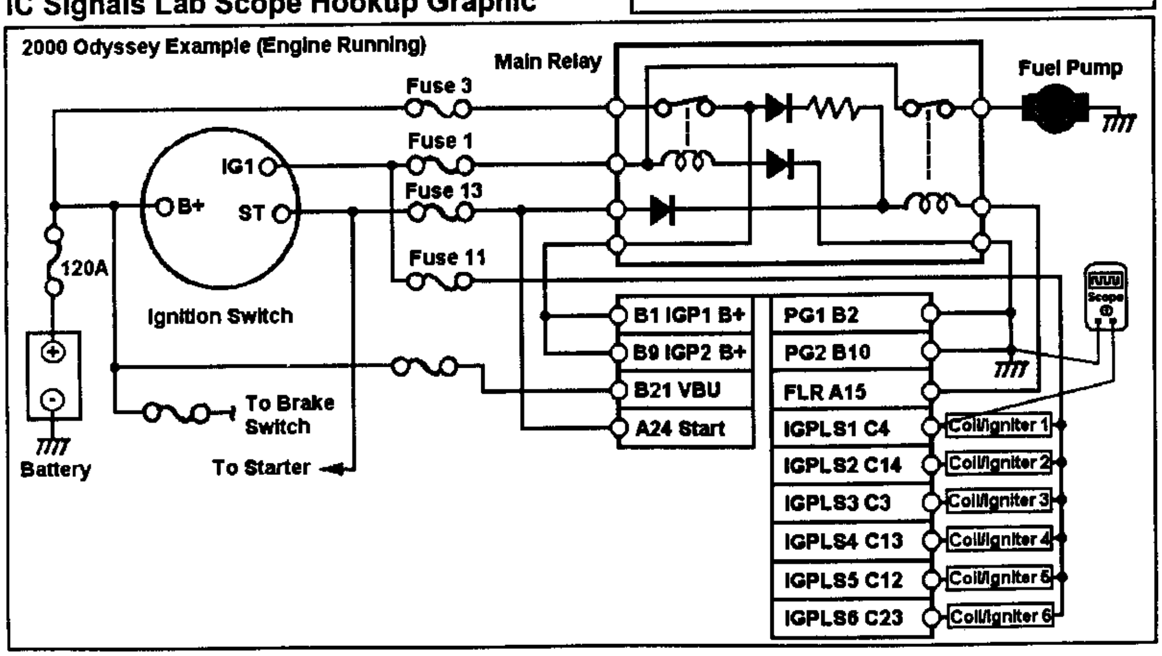
In this example, the top trace shows the TDC1 sensor signals (18v peak to peak) and the bottom trace shows the IC No. 1 signal.

Lab Scope Explanation - Example (2)

In this example, the top trace shows the TDC2 sensor signals (16v peak to peak) and the bottom trace shows the IC No. 1 signal.

Note the relationship of each pair of signals - this is how the PCM determines TDC for Cyl 1.

IC Signals Lab Scope Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

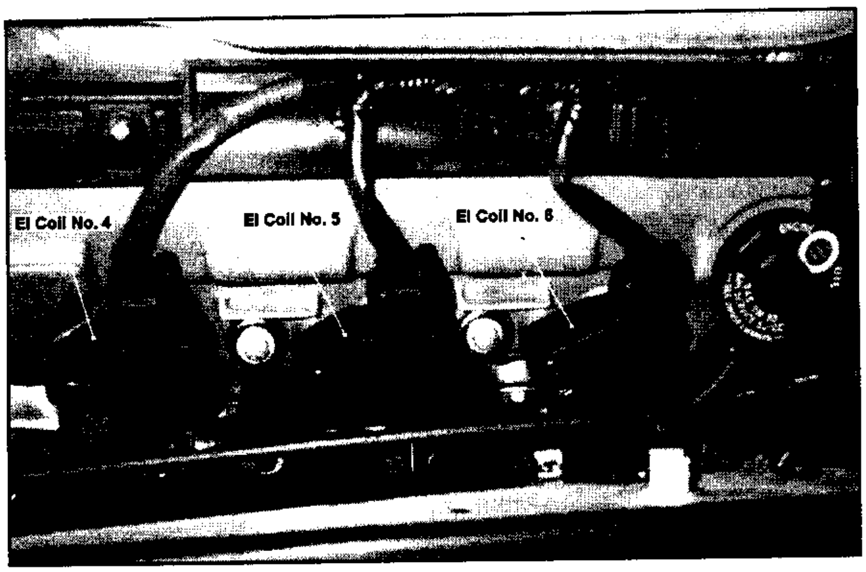
Electronic Ignition System

Lab Scope Test (Coil Primary)

The Lab Scope can be used to view the ignition coil primary circuit and IC control signals as it provides an accurate view of their waveforms and of any glitches. Prior to starting the test, place the gearshift selector in Park and block the drive wheels for safety.

The ignition coils for this engine are the coil-on-plug (COP) design. They are mounted on top of the spark plugs as can be seen in Graphic on this page. The coils receive power from the ignition switch through Fuse No. 11 (a 15 amp fuse). Refer to the Schematic on the previous page to determine their actual connections and pin numbers.

There are no primary terminals available to connect to the primary circuit. However, the IC signal circuits can be viewed at the coil terminals and also at the PCM wiring harness.



Lab Scope Tests

The coil primary current and IC signals can be checked with the engine cranking, at idle speed or at cruise speed with the engine cold or warm.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples. Connect the low amp probe to Channel 'A' and set the probe to the 100 mv per amp scale.

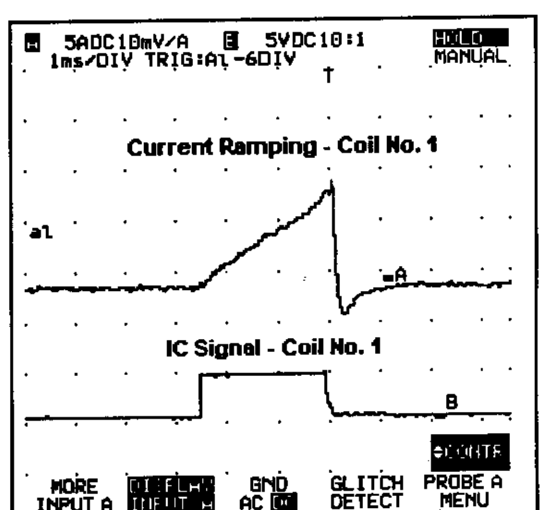
Scope Connections

To read the ignition coil current for Coil No. 1 (engine cylinder number one).

The low amp probe should be connected to Channel 'A'. Zero the probe and then clamp the probe around the BLK/YEL wire.

Connect the Channel 'A' ground probe to the battery negative ground post.

To read the IC signal for Coil No. 1 along with the coil current level for that cylinder, connect the Channel 'B' positive probe to the IC control circuit (YEL/GRN wire) for that coil.



2001 Odyssey

Lab Scope Explanation

In this example, the top trace shows the current signal (current ramping) for Coil No. 1 at idle speed. The current level reached almost eight (8) amps during this firing event.

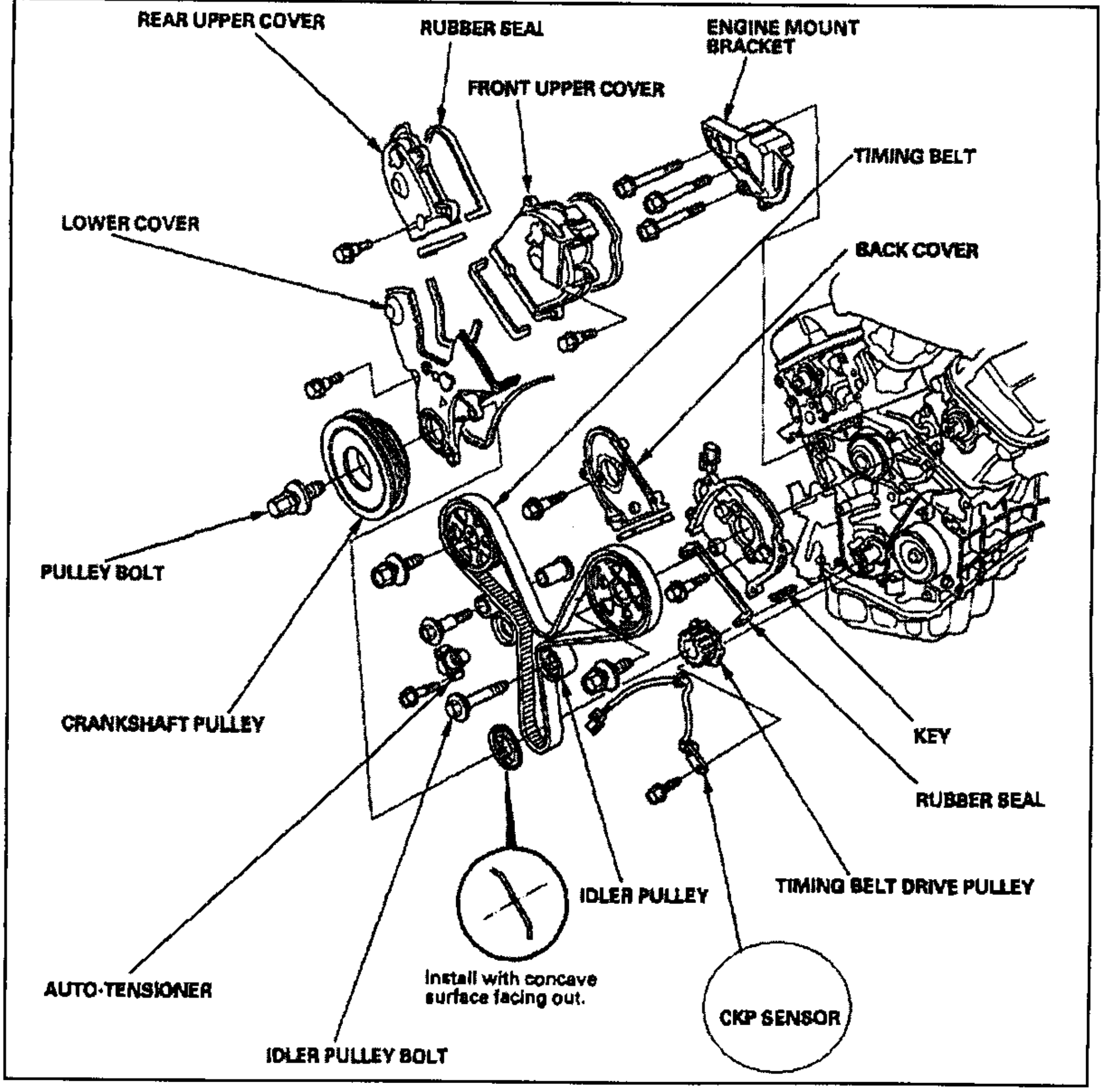
The bottom trace shows the IC control signal for Coil No. 1. The voltage level reached almost 5 volts during this firing event.

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electronic Ignition

Component Location

Component Location Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electronic Ignition System

CKP Sensor Overview

The crankshaft position (CKP) sensor is located at the bottom of the right side of the engine. The PCM uses the inputs from the CKP sensor to determine the fuel injection timing for each cylinder and to detect the engine speed. The CKP sensor is positioned to detect slots in the crankshaft gear as the engine rotates. The sensor output is an AC pulse that changes in amplitude with changes in the engine speed.

The PCM contains tables that contain the base ignition timing at various engine speeds and manifold airflow rates. It adjusts the amount of ignition advance according to these tables along with several other sensor inputs.

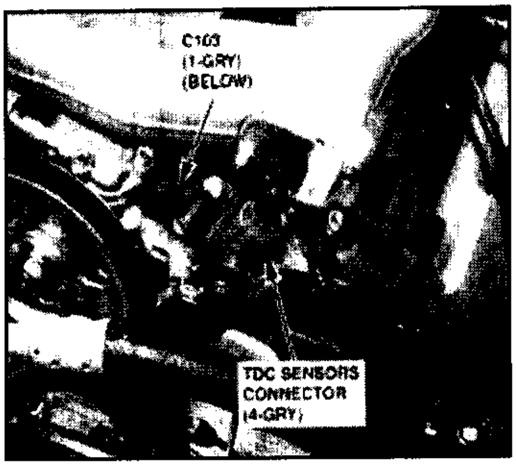
TDC Sensor 1 & 2 Overview

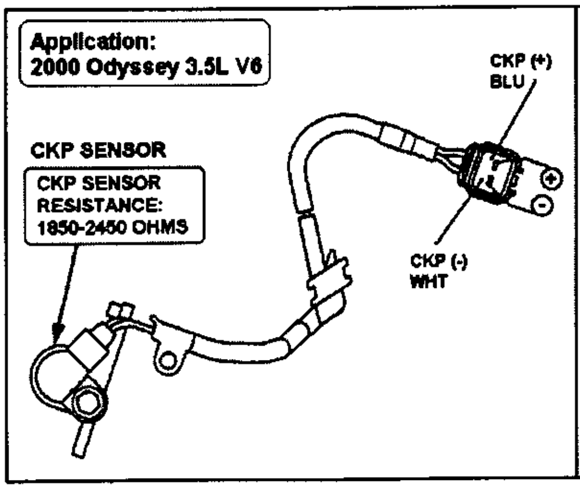
This engine is equipped with a pair of top dead center (TDC) sensors located at the right side of the engine. The sensor output is an AC pulse that changes with engine speed.

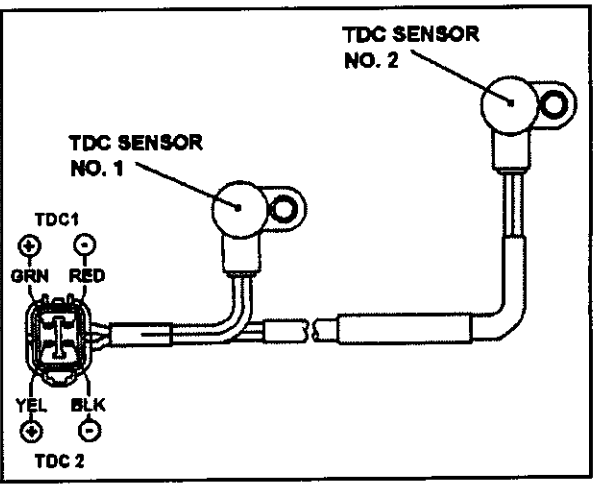
The PCM uses inputs from these two sensors to determine the ignition timing at startup (while the engine is cranking) and to determine when the crank angle signal is abnormal.

Misfire Diagnostics
The PCM uses the CKP sensor signal to monitor erratic changes in the engine speed in order to determine when a misfire condition is present.

CKP & TDC Sensor Graphics



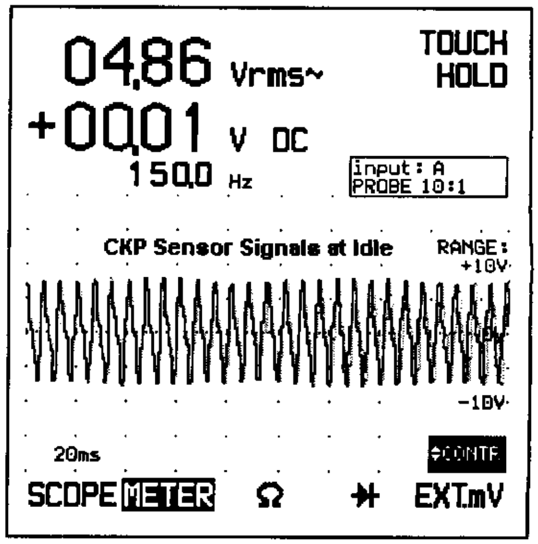




2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electronic Ignition System

DVOM Test (CKP Sensor)



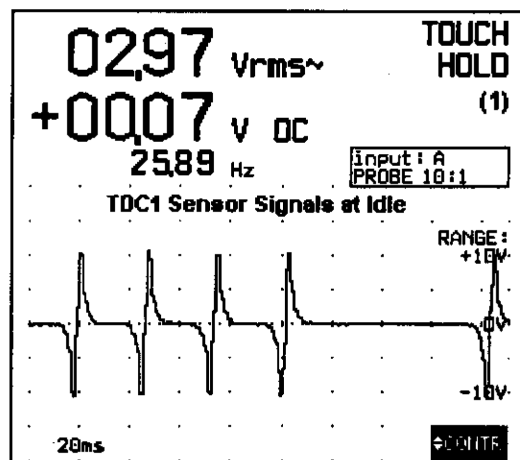
The DVOM can be used to test the signals from the CKP and TDC sensors. The tool of choice to view the signals from these sensors is the Lab Scope. Place the gearshift selector in Park (A/T) and block the drive wheels.

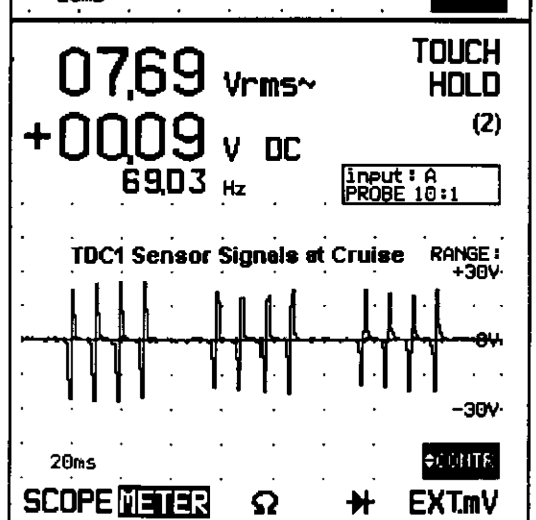
<u>DVOM CKP Sensor Test</u>
The CKP sensor can be checked at both idle and cruise speeds with the engine cold or hot.

<u>DVOM Settings</u>
If you are using a Graphing Meter, set the scope settings to match the examples to make the meter display as clear as possible.

<u>DVOM Connections (CKP Sensor)</u>
Connect the DVOM positive probe to the CKP (+) signal at Pin C8 (BLU wire) and the negative probe to the CKP (-) signal at Pin C9 (WHT wire) of the PCM 31-Pin connector.

DVOM Test (TDC1 Sensor)





The TDC 1 (and TDC2) sensor signals can be checked at both idle and cruise speeds with the engine cold or at normal temperature.

<u>DVOM Connections (TDC1 Sensor)</u>
Connect the DVOM positive probe to the TDC1 (+) signal at Pin C20 (GRN wire) of the PCM 31-Pin 'C' connector.

Connect the negative probe to the TDC1 (-) signal at Pin C21 (RED wire) of the PCM 31-Pin 'C' connector or to the battery negative ground post. A 10:1 probe was used in these captures.

<u>DVOM Explanation - Example (1)</u>
In this example, the trace shows the 4x TDC1 sensor signals of about 20v peak to peak at hot idle speed.

The TDC1 signal is 2.97 Vrms at a frequency of 25.89 Hz under these operating conditions.

<u>DVOM Explanation - Example (2)</u>
In this example, the trace shows the 4x TDC1 sensor signals at cruise speed (about 50v peak to peak).

The TDC1 signal is 7.69 Vrms at a frequency of 69.03 Hz under these operating conditions.

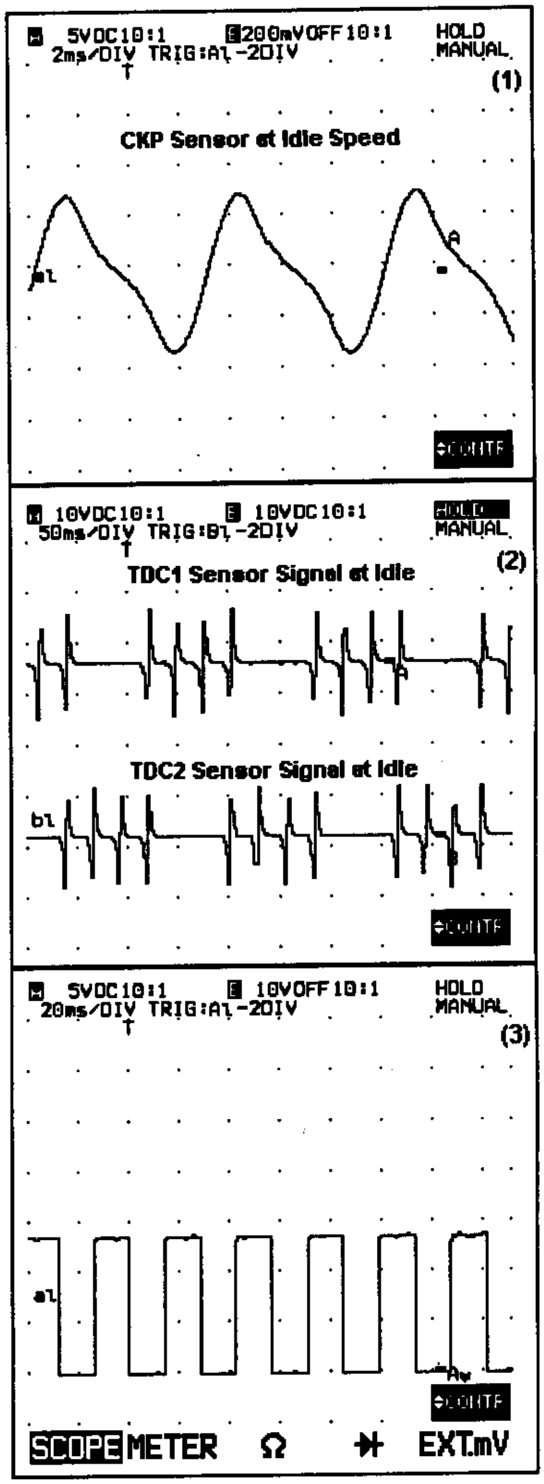
The time base setting used for both of these captures was 20 ms.

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electronic Ignition System

Lab Scope Test (CKP Sensor)

The Lab Scope can be used to test the signals from the CKP and TDC sensors. It is the tool of choice to use to view the signals from these sensors for possible glitches. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels.



Lab Scope CKP Sensor Test

The CKP sensor can be checked at both idle and cruise speeds with the engine cold or hot.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (CKP Sensor)

Connect the Channel 'A' positive probe to the CKP (+) signal at Pin C8 (BLU wire) and the negative probe to the CKP (-) signal at Pin C9 (the WHT wire) of the PCM connector.

Lab Scope Test (TDC Sensors)

The TDC 1 and TDC 2 sensor signals can be checked at both idle and cruise speeds with the engine cold or at normal temperature.

Scope Connections (TDC1 Sensor)

Connect the Channel 'A' positive probe to the TDC1 (+) signal at Pin C20 (GRN wire) and the negative probe to the TDC1 (-) signal at Pin C21 (RED wire) of the 31-Pin connector.

Scope Connections (TDC2 Sensor)

Connect the Channel 'B' positive probe to the TDC2 (+) signal at Pin C29 (YEL wire) and the negative probe to the TDC2 (-) signal at Pin C30 (BLK wire) of the PCM 31-Pin connector.

NEP or Engine Speed (Tachometer) Signal

Connect the Channel 'A' positive probe to the NEP signal at Pin A19 (BLU wire) and connect the Channel 'A' negative probe to the battery negative ground post.

Scope Explanation - Example (1)

In this example, the trace shows the 24x CKP sensor signals at hot idle (20v peak to peak).

Scope Explanation - Example (2)

In Example (2), the trace shows the 4x TDC1 and 4X TDC2 sensor signals at idle speed.

Scope Explanation - Example (3)

In this example, the trace shows the NEP signals at idle speed. The squarewave signal shows a pattern that exceeds 13.8 volts.

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electronic Ignition System

Lab Scope Test (CKP & TDC Sensors)

The Lab Scope can be used to test the signals from the CKP and TDC sensors. It is the tool of choice to use to view the signals from these sensors for possible glitches. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels.

<ins>Lab Scope CKP & TDC Sensors Test</ins>
These sensors can be checked at both idle and cruise speeds with the engine cold or hot.

<ins>Scope Settings</ins>
To make the waveforms as clear as possible, set the scope settings to match the examples.

<ins>Scope Connections (CKP Sensor)</ins>
Connect the Channel 'A' positive probe to the CKP (+) signal at Pin C8 (BLU wire) and the negative probe to the CKP (-) signal at Pin C9 (the WHT wire) of the PCM connector.

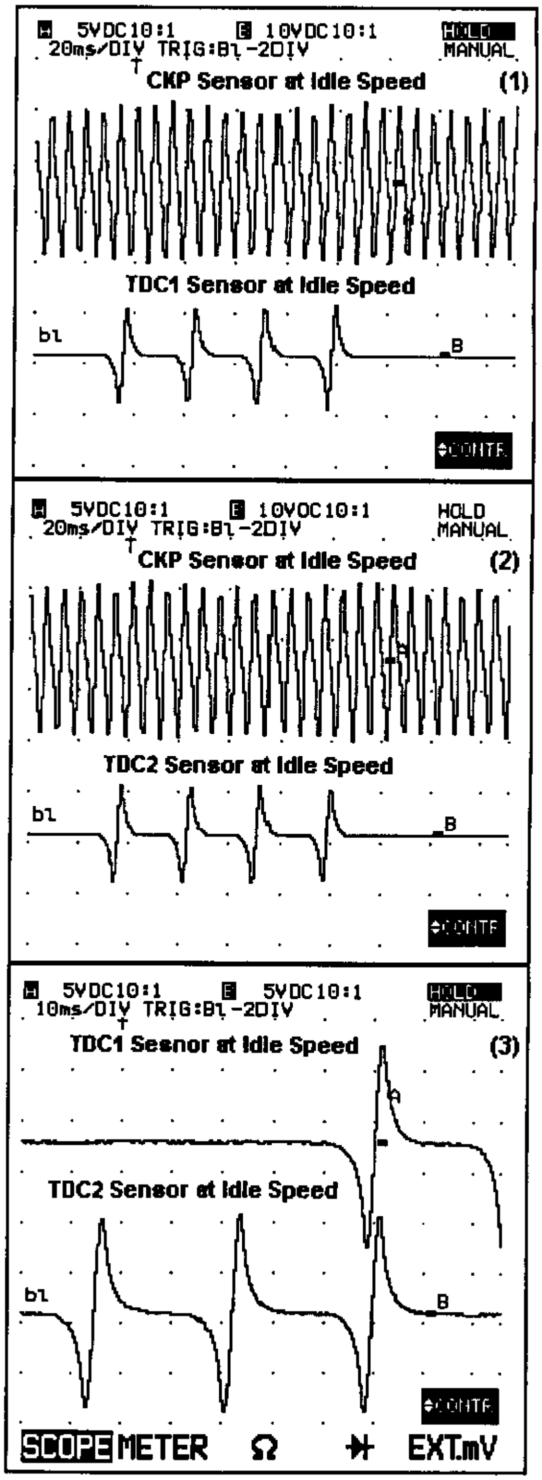
<ins>Scope Connections (TDC1 Sensor)</ins>
Connect the Channel 'A' positive probe to the TDC1 (+) signal at Pin C20 (GRN wire) and the negative probe to the TDC1 (-) signal at Pin C21 (RED wire) of the 31-Pin connector.

<ins>Scope Connections (TDC2 Sensor)</ins>
Connect the Channel 'B' positive probe to the TDC2 (+) signal at Pin C29 (YEL wire) and the negative probe to the TDC2 (-) signal at Pin C30 (BLK wire) of the PCM 31-Pin connector.

<ins>Scope Explanation - Example (1)</ins>
In this example, the trace shows the 24x CKP sensor signals and TDC1 sensor signals at hot idle. Note the amplitude of the CKP sensor and the TDC1 sensor at idle speed.

<ins>Scope Explanation - Example (2)</ins>
In this example, the trace shows the 24x CKP sensor signals and TDC2 sensor signals at hot idle. Note the amplitude of the CKP sensor and the TDC2 sensor at idle speed.

<ins>Scope Explanation - Example (3)</ins>
In this example, the trace shows the 4x TDC1 sensor signals and 4X TDC2 sensor signals at hot idle. Note the amplitude of the TDC1 sensor and the TDC2 sensor at hot idle speed.

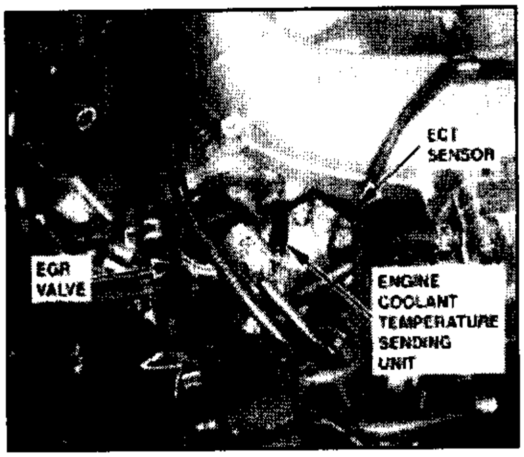


2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Exhaust Gas Recirculation System

Introduction

The Exhaust Gas Recirculation (EGR) system is designed to lower peak combustion temperatures and reduce the level of oxides of nitrogen (NOx) emissions in the exhaust by recirculating exhaust gas through the electronic EGR valve (E-EGR) into the intake manifold and into the combustion chambers so that it can be burnt during combustion.



Electronic EGR Valve

This vehicle application is equipped with an electronic exhaust gas recirculation (E-EGR) valve. The E-EGR valve is located near the ECT sensor at the top of the engine.

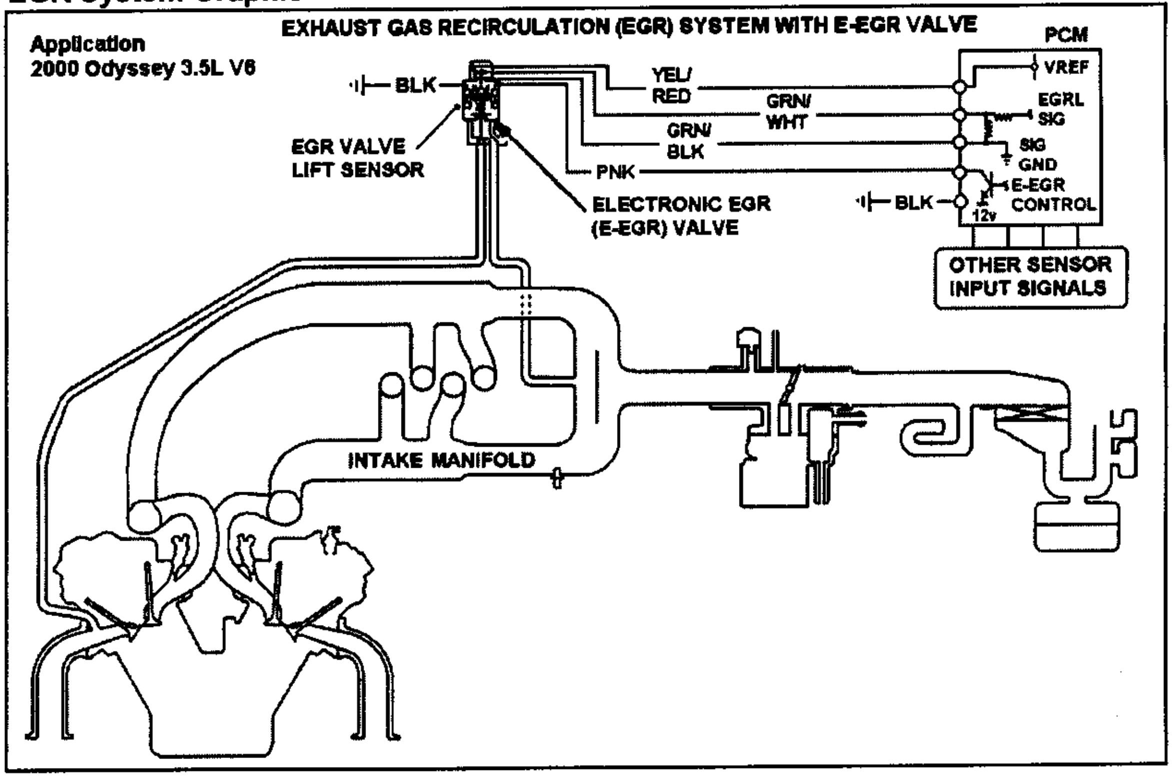
EGR Valve Lift Sensor

This sensor detects the amount of valve lift and sends a signal to the PCM. The PCM compares the actual EGR valve lift value to a value stored in its memory tables (these tables contain the values for the ideal amount of E-EGR valve lift).

PCM Memory Tables

During certain engine conditions, the PCM compares the "actual" EGR valve lift value with an "ideal" valve lift value (determined from other sensor inputs). If there is any difference between the "actual" and "ideal" values, the PCM opens the duty cycle control circuit to the EGR valve to stop the flow of current to the E-EGR valve, and reduces the amount of vacuum applied to the valve to bring the lift sensor into the correct operating range.

EGR System Graphic



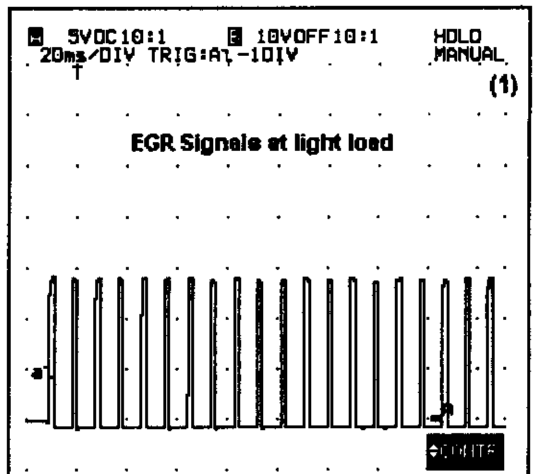
2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

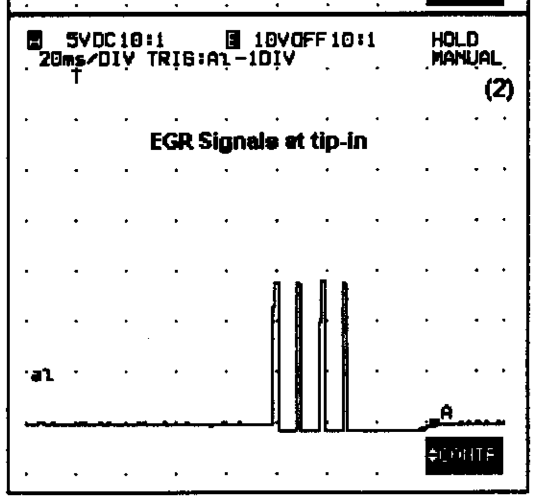
Electronic EGR Valve

Lab Scope Test (E-EGR Valve)

The Lab Scope can be used to test the control signals to the E-EGR valve as it provides an excellent view of the signal waveform to check for possible glitches. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels.

The E-EGR valve can be checked at both idle speed and cruise (off-idle) speeds with a cold engine or at normal operating temperature.





Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (E-EGR Valve)

Connect the Channel 'A' positive probe to the E-EGR signal at PCM Pin B7 (PNK wire) and the negative probe to the battery ground post.

Lab Scope Explanation - Example (1)

In example (1), the trace shows the E-EGR control signal at cruise speed with a light engine load. Note the even space of the duty cycle signals (the signals are system voltage).

Lab Scope Explanation - Example (2)

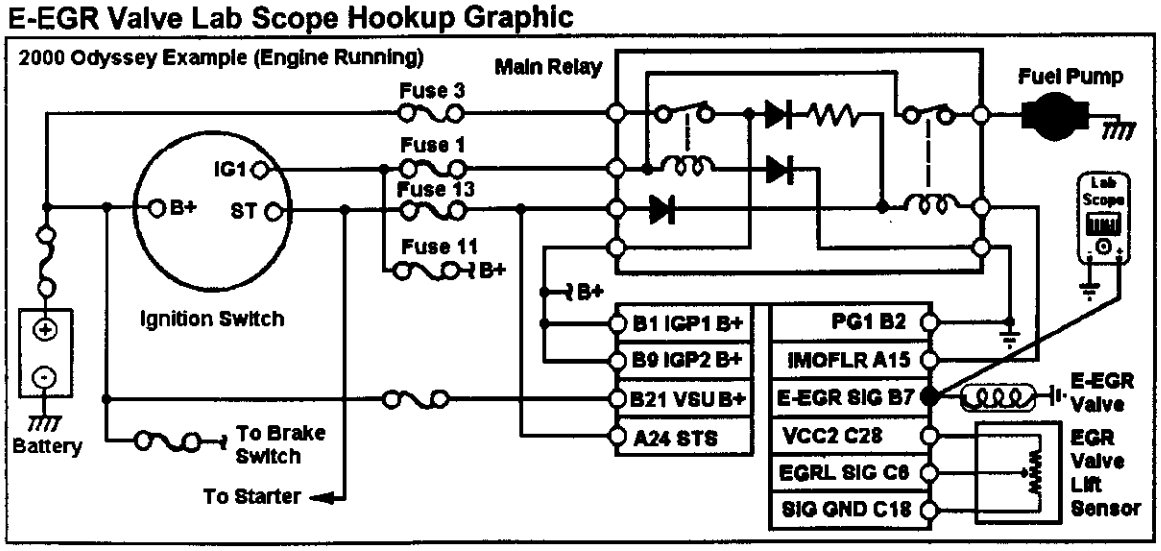
In example (2), the trace shows the E-EGR control signal during a "tip-in" condition. Note how the PCM stopped the duty cycle signals for a short period of time during the "tip-in".

EGR Valve Lift Sensor Signal

To view the EGRL signal, connect the Channel 'B' positive probe to the EGRL circuit at PCM Pin C6 (WHT/BLK wire).

Connect the Channel 'B' Negative probe to the battery negative ground post.

E-EGR Valve Lab Scope Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Evaporative Loss System

Introduction

The Evaporative Loss (EVAP) system is designed to prevent hydrocarbon (HC) emissions in the fuel tank from escaping into the atmosphere by temporarily storing them in a charcoal canister. During diagnosis of the Emission and Fuel systems, keep in mind that the EVAP system can have an effect on your diagnostic decisions.

System Components

The EVAP system includes the following devices:

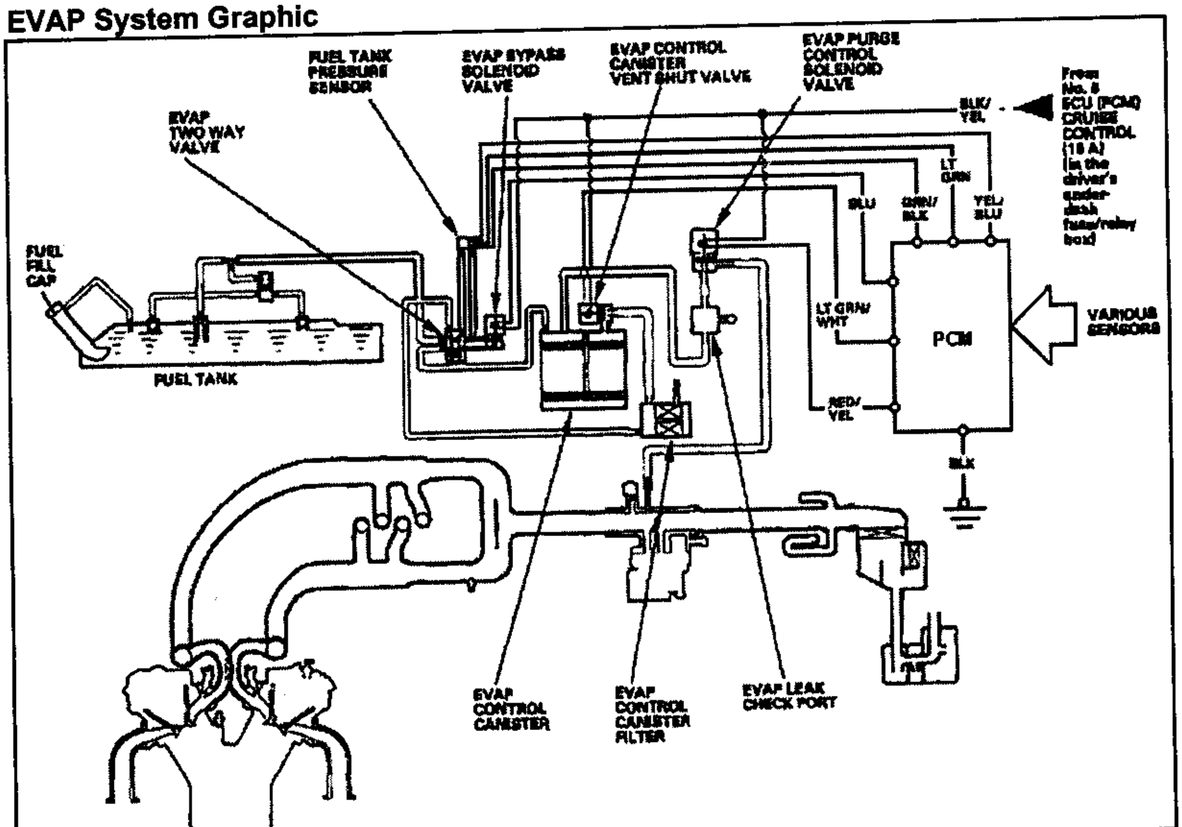
- EVAP Purge Control, Bypass and Canister Vent solenoid valves
- EVAP Two-Way Valve
- EVAP Leak Check Port
- Fuel tank and Fuel tank cap with integral check valve
- Charcoal canister
- Purge port on the throttle body

System Operation

The EVAP system is used to minimize the amount of fuel vapor that escapes into the atmosphere. Fuel vapors from the fuel tank are temporarily stored in the EVAP charcoal canister until they can be purged into the engine and then burned. The EVAP canister is purged by drawing fresh air through it and into a port on the throttle body. The EVAP purge (control) solenoid valve control the purge vacuum. This valve is opened by the PCM whenever the engine coolant temperature is above 147°F.

When vapor pressure in the fuel tank is higher than the set value of the EVAP two-way valve, the valve opens and regulates the flow of fuel vapor into the EVAP canister.

EVAP System Graphic



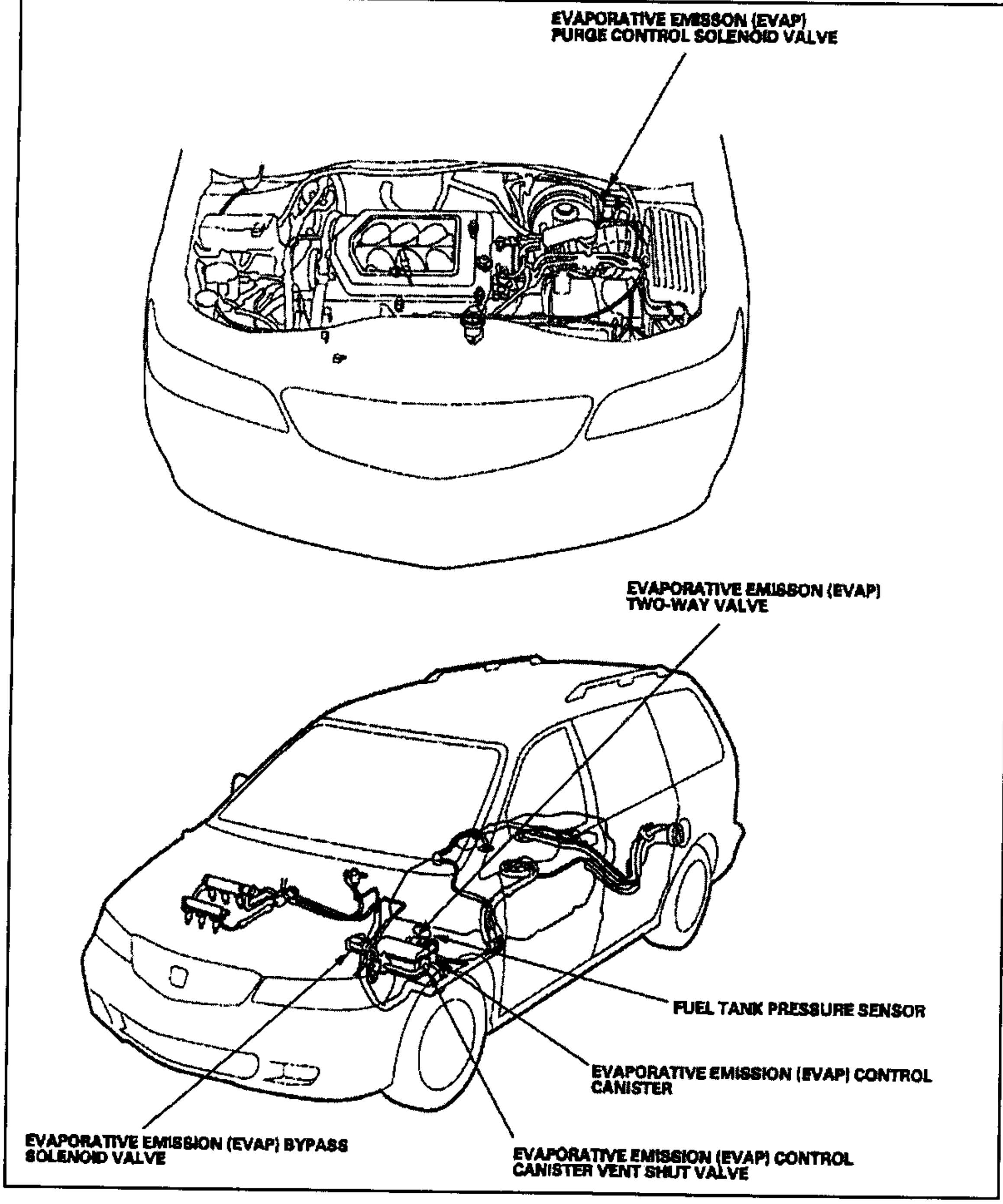
2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Evaporative Loss System

Component Locations

The EVAP Loss System component locations are shown in the Graphic below.

Component Locations Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

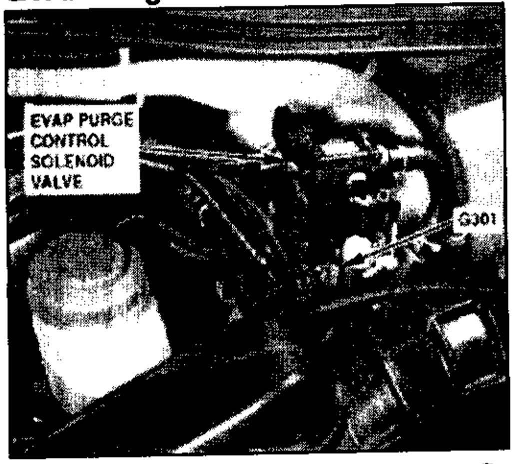
EVAP Purge Control, Bypass and Vent Solenoids

General Description

The PCM controls when the EVAP canister is purged. This task is accomplished by using ported vacuum to draw fresh air into the canister to a port on the throttle body.

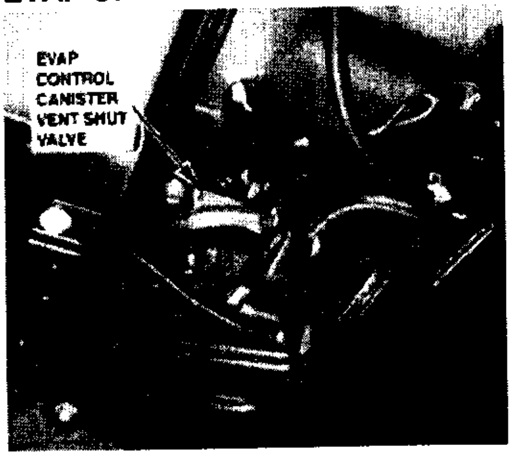
The purge control and bypass valves control the ported vacuum signal to the canister. The purge valve is opened by the PCM when engine temperature is over 147°F.

EVAP Purge Control Solenoid Location Graphic



EVAP Bypass Solenoid Location Graphic

EVAP Canister Vent Shut Valve Location Graphic



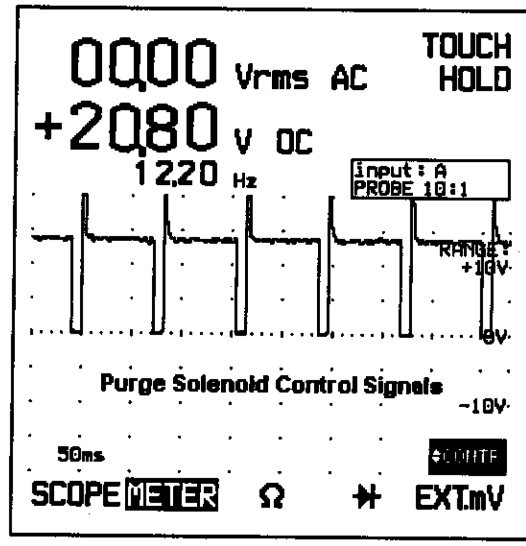
2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

EVAP Purge Control Solenoid

DVOM Test (Purge Solenoid)

A DVOM can be used to test the EVAP purge control solenoid (valve) signal from the PCM with the engine cold or running at normal operating temperature. This test method can be used to provide an indication that command signals to the device are present.

The DVOM example on this page was captured with a Fluke 99-B with the DVOM positive (10:1) probe connected to the Lab Scope Input 'A'.



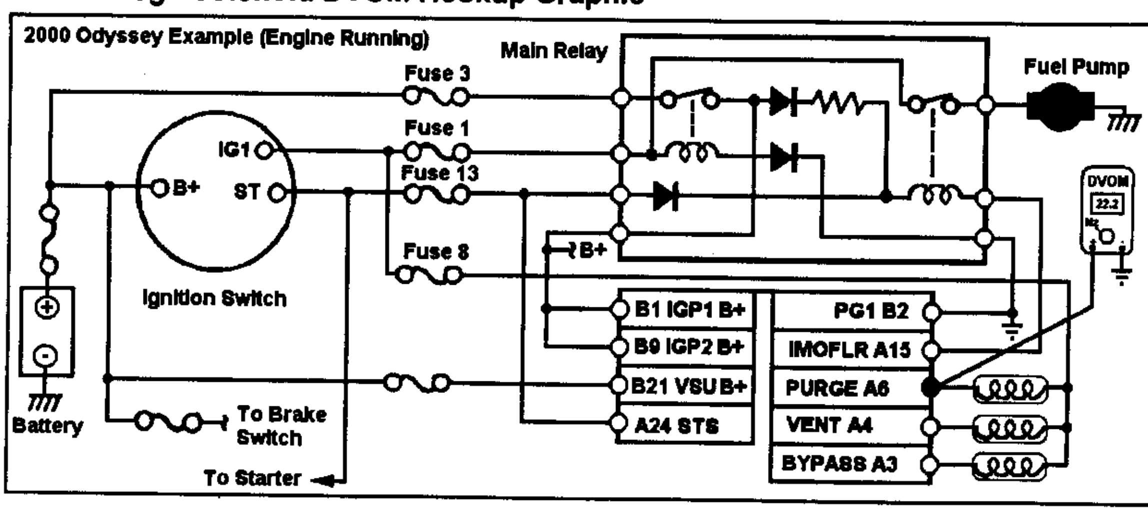
Scope Connections (EVAP Purge Solenoid)
To view the duty cycle control signals from the EVAP purge solenoid, connect the DVOM positive probe to the purge control circuit at Pin A6 (RED/YEL wire) at the PCM 32-Pin 'A' connector. Connect the DVOM negative probe to the battery ground post.

Scope Connections (EVAP Bypass Solenoid)
To view the control signal to the EVAP bypass solenoid, connect the DVOM positive probe to Pin A3 of the PCM 32-Pin 'A' connector. Connect the DVOM negative probe to the battery negative ground post.

Scope Connections (EVAP Vent Solenoid)
To view the control signal to the EVAP vent solenoid, connect the DVOM positive probe to Pin A4 of the PCM 32-Pin 'A' connector. Connect the DVOM negative probe to the battery negative ground post.

Test Summary
The DVOM should show a voltage near 20v DC Vrms~(12.20 Hz) at idle speed. The time base setting was 50 ms and the voltage setting was set to +10v range.

EVAP Purge Solenoid DVOM Hookup Graphic



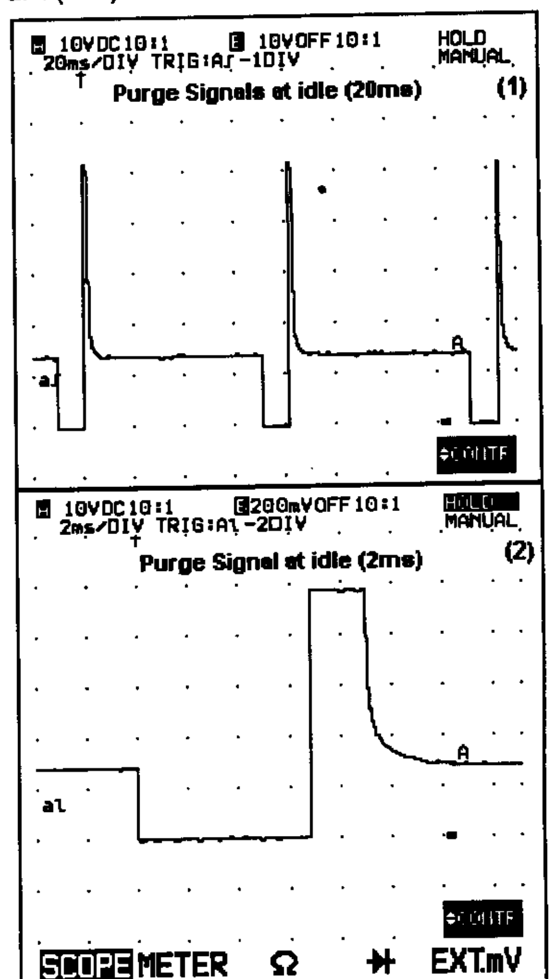
2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

EVAP Purge Control Solenoid

Lab Scope Test (Purge Solenoid)

The Lab Scope can be used to test the control signals to the purge solenoid as it provides an excellent view of the signal waveform to check for possible glitches. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels.

The purge solenoid can be checked at both idle and cruise speeds with the engine cold or at normal operating temperature.



Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (Purge Solenoid)

Connect the Channel 'A' positive probe to the purge control circuit at Pin A6 (RED/YEL wire). Connect the Channel 'A' negative probe to the battery negative ground post.

EVAP Bypass & Vent Solenoid Connections

To view the control signal to the bypass or vent solenoid, connect the Channel 'A' positive probe to Pin A3 (Bypass) or Pin A4 (Vent). Connect the negative probe to battery ground.

Lab Scope Explanation - Example (1)

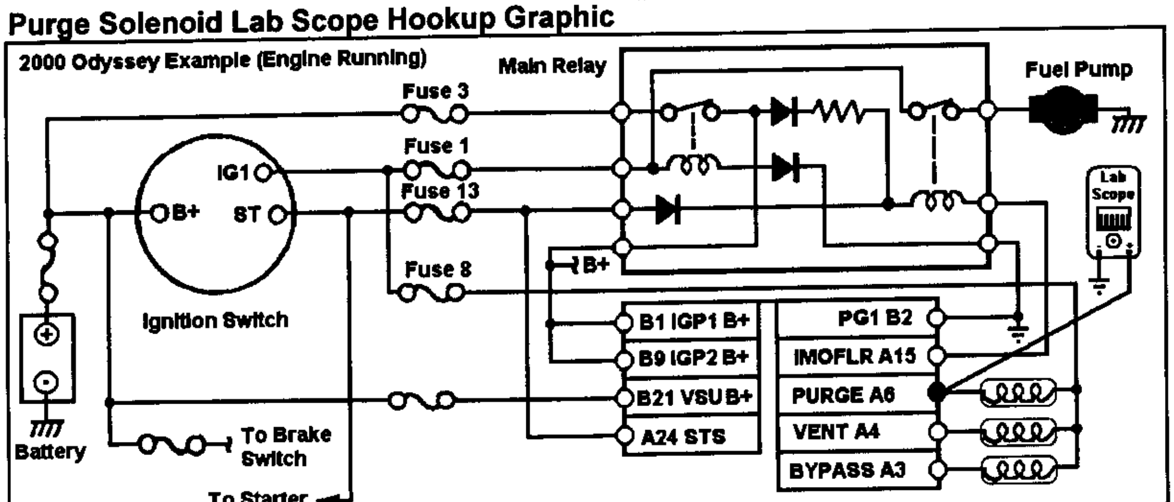
In this example, the trace shows the purge signal at idle speed with the gearshift selector in Park. Note the even space of the duty cycle signals (the signals ontime is 10 ms).

Lab Scope Explanation - Example (2)

In this example, the trace shows the purge control signal at idle speed with the time base changed from 20 to 2 ms.

Note the height of the inductive kick (50v) from the purge solenoid coil during its operation.

Purge Solenoid Lab Scope Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Fuel System

Introduction

The Fuel Delivery system on this vehicle application is designed to deliver fuel at a regulated high pressure to the fuel rail and injectors. Additionally, this Fuel system is also designed to cutoff fuel pressure if the engine stops running.

System Components

The Fuel system on this application includes the fuel tank, fuel pump, fuel filter, pressure regulator, fuel injectors, fuel tube/quick connect fittings, fuel lines and hoses and fuel rail.

The electrical portion of the Fuel system consists of the PGM-FI main relay, in-tank fuel pump, fuel injectors, battery feed and fuel control circuits from the PCM to the injectors.

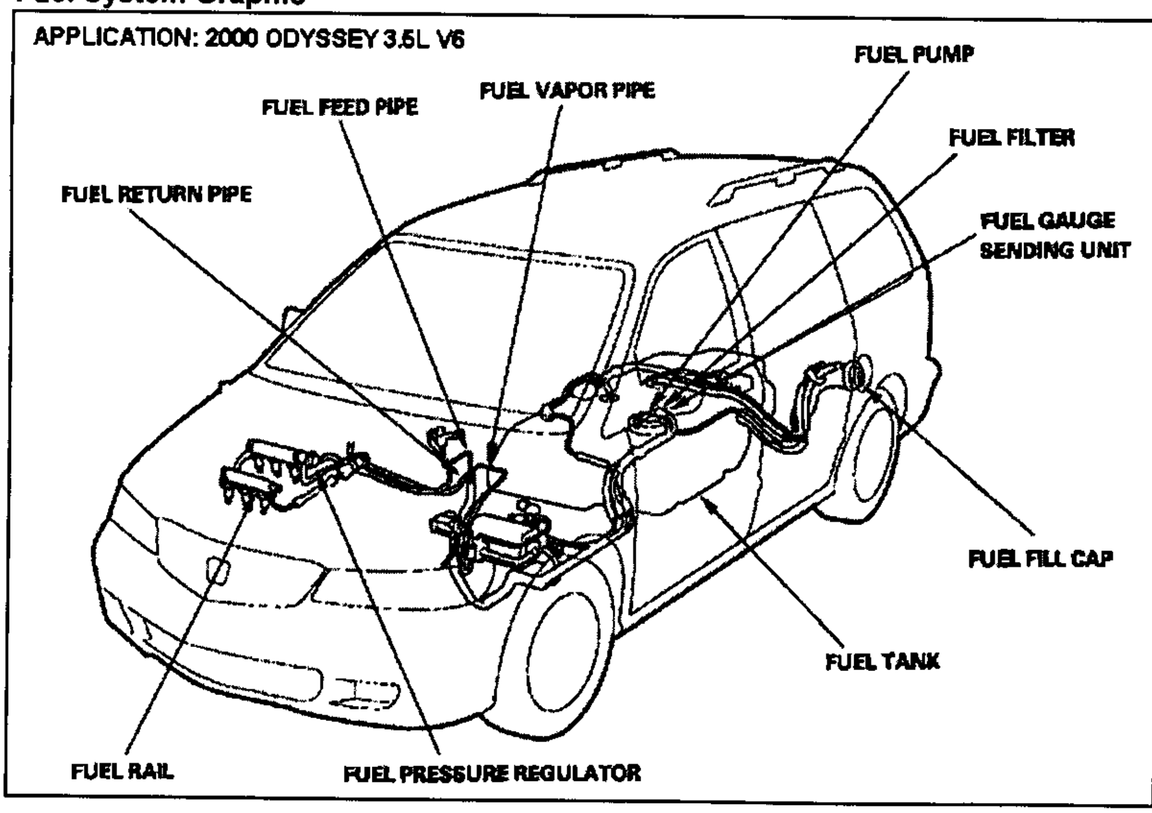
Fuel Pump Control Unit

With the ignition turned to "on", the PCM grounds the PGM-FI relay and this action closes the circuit that feeds current to the fuel pump for two seconds to pressurize the Fuel system. Once the engine starts, the PCM grounds the PGM-FI relay and continues to provide power to the fuel pump. If the engine is not running (with the ignition "on"), the PCM removes the ground to the PGM-FI relay and this action stops current to the pump.

Fuel Cutoff Mode

During deceleration periods at engine speed over 1,000 rpm with the throttle valve closed, the PCM stops current to the fuel injectors (fuel cutoff) to improve fuel economy. It also enables the fuel cutoff mode with the vehicle moving at engine speeds over 6,000 rpm (regardless of the throttle valve position) to protect the engine from over-revving. If the vehicle is stopped, it enables fuel cutoff mode at engine speed over 5,000 rpm.

Fuel System Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electric Fuel Pump

General Description

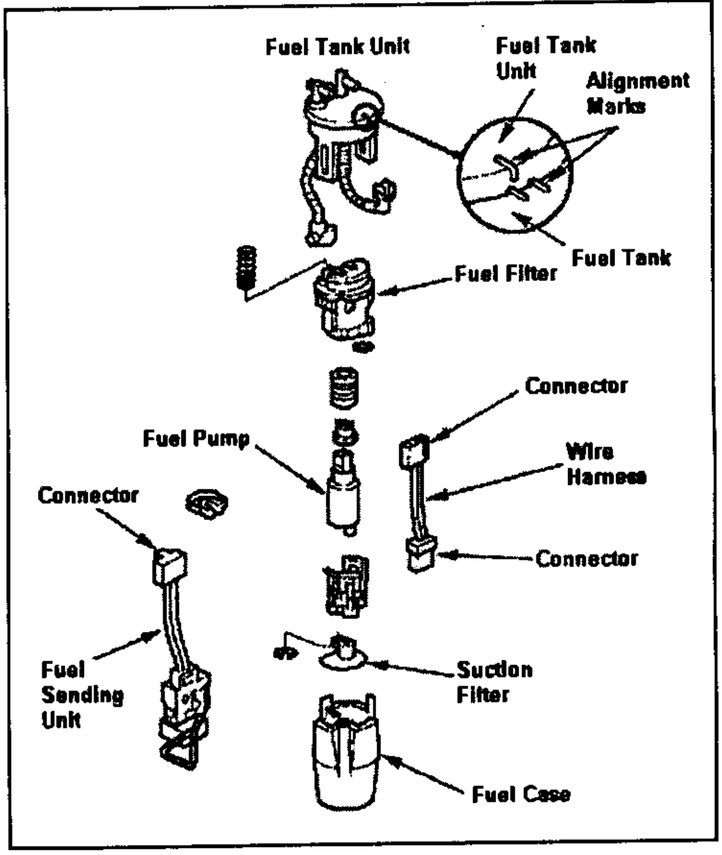
This vehicle application uses an in-line, impeller-type electric fuel pump. Fuel is drawn from the fuel tank through a one-way check valve and delivered to the fuel rail in the engine compartment. A baffle is provided to prevent fuel pulsation on the direct drive fuel pump.

An external fuel filter (sock) is used on the impeller type pump, while an internal fuel filter is used on the direct drive pump. A check valve is used to maintain fuel pressure in the fuel line for a short time after shutdown to ease restarting on all models.

The fuel pump has an internal relief valve to prevent excessive pressure in the fuel delivery system. This valve opens if there is a blockage in the discharge side. If the relief valve opens, fuel flows from the high-pressure side to the low-pressure side of the fuel pump.

<u>System Operation</u>

The fuel pump is energized for two seconds when the key is first turned on to pressurize the fuel delivery system. Once the engine starts, the main relay turns the fuel pump on and the motor turns along with the impeller. Pressure changes are created by the numerous grooves around the impeller. Refer to the Graphic to the right.



Fuel enters the inlet port and flows inside the motor from the pumping chamber and is forced through the discharge port through the check valve.

If fuel flow is obstructed at the discharge side of the fuel line, the relief valve will open to bypass fuel to the inlet port to prevent high fuel pressure.

<u>Pump Shutoff</u>

Once the engine stops, the PCM turns off the fuel pump through the main relay due to the loss of ignition reference (rpm) signals.

<u>Residual Pressure</u>

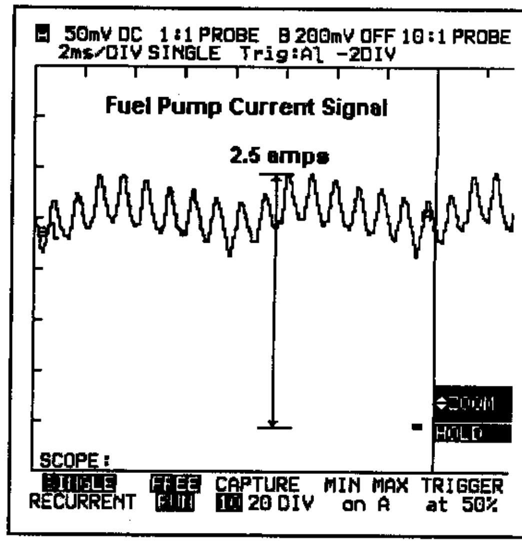
An internal check valve closes by spring action to retain residual pressure for quick restarts.

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Electric Fuel Pump

Lab Scope Test (Fuel Pump)

If you suspect that the fuel pump is faulty, you can use an amp probe with an inductive pickup to monitor the operation of the fuel pump and its related circuits.



An example of a "known good" fuel pump motor waveform from this vehicle application is shown in the Graphic on this page. If the fuel pump on this vehicle is in good condition, the current draw will be less than 4 amps.

Lab Scope Settings

Set the Lab Scope to these initial settings:

- Volts per division: 50 mv
- Time per division: 2 ms
- Trigger setting: 50% of the waveform

Scope Connections (Amp Probe)

Set the amp probe to 100 mv. Zero the amp probe prior to starting the test. Locate the main relay and install the amp probe around the wire between the relay and the fuel pump. Start the engine and allow the amp probe reading to stabilize.

Lab Scope Explanation

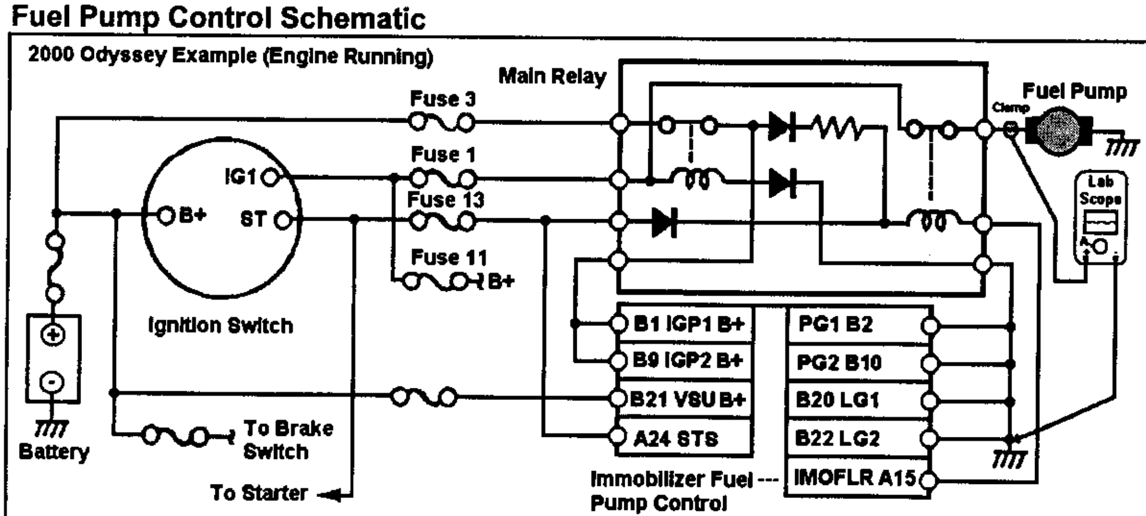
In this example, the trace shows the fuel pump current with the engine at idle speed. Note the even pattern from this known good fuel pump. Note how the fuel pump portion of the main relay is energized by the PCM by controlling the Immobilizer Fuel Pump Control circuit (Pin A15) to provide power to the fuel pump. This is a known good pump (providing 36 psi at 2.5 amps) on a vehicle with 49,500 miles.

Symptom Diagnosis

Depending upon the type of problem, you may want to let the engine run for a period of time until it occurs - this allows you to monitor the amount of change in the fuel pump current trace (this period of time gives the fuel pump motor time to ramp up).

In some cases, you may need to let the engine run until the engine stalls or begins to stall and then capture the waveform at that particular moment.

Fuel Pump Control Schematic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

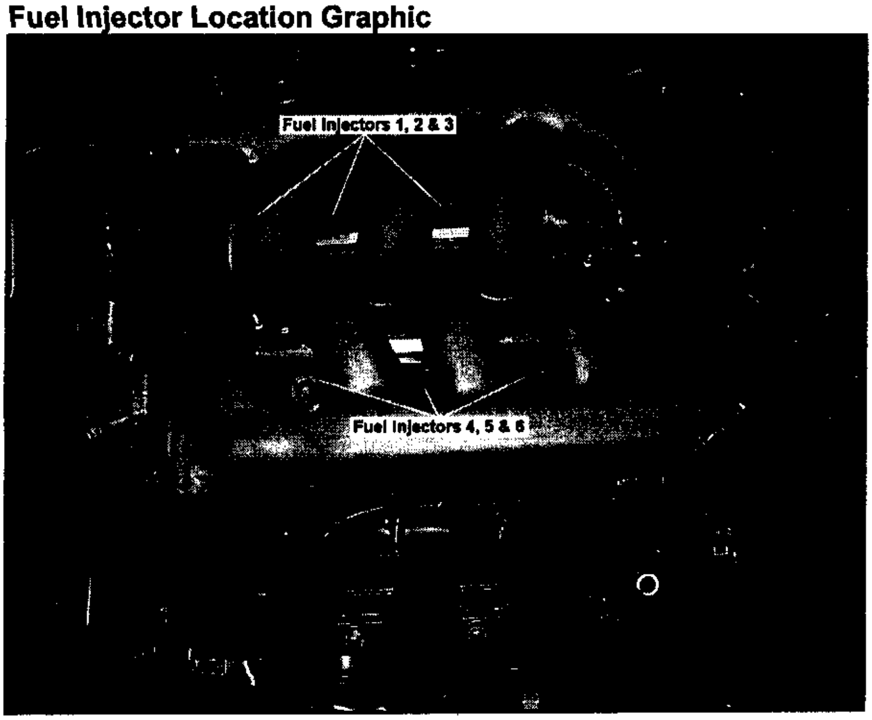
Fuel Injectors

General Description

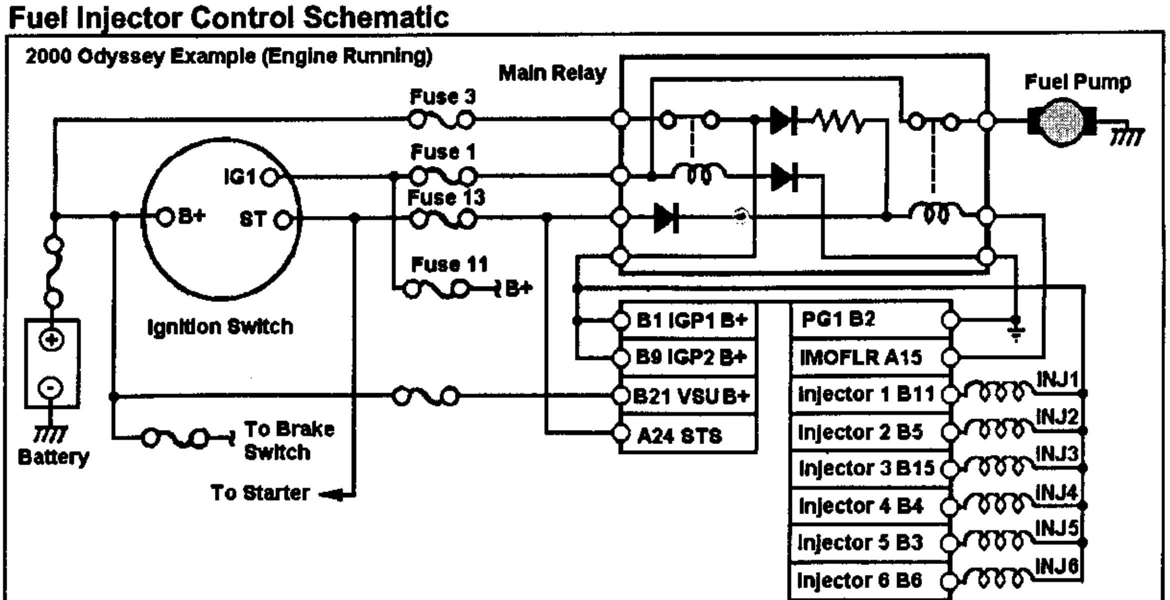
The fuel injectors on this engine are solenoid-operated (N.C.) valves that are designed to meter the fuel flow to each combustion chamber. Each injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel delivered is controlled by the length of time the injector is held open (injector pulsewidth). These injectors are referred as a "saturated switch" or "saturated driver" injectors.

The fuel injectors are connected to a battery power through the PGM-FI main relay. The PCM controls the injector driver circuits that connect the injectors to ground at the correct time. These circuits are identified in the Injector Control Schematic on this page.

Fuel Injector Location Graphic



Fuel Injector Control Schematic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Fuel Injectors

Lab Scope Test (Fuel Injector)

The Lab Scope is the tool of choice to test the operation of the fuel injector and its circuits.

Scope Connections - Example (1)

Connect the Channel 'A' positive 10:1 probe to the injector No. 1 control wire at Pin B11 of the PCM 25 Pin 'B' connector.

Connect the Channel 'A' negative 10:1 probe to Pin B2 (PG1) of the 32 Pin 'A' connector or to the battery negative ground post.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example (1) Explanation

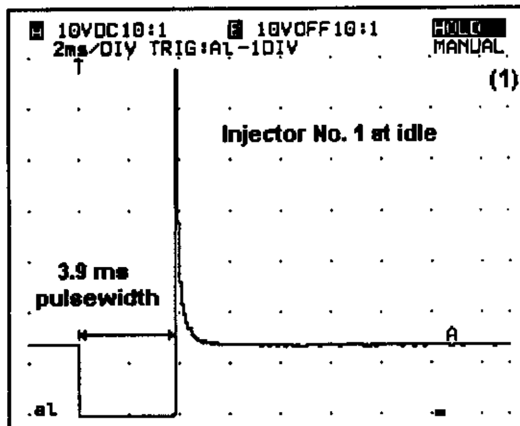
In example (1), the trace shows the fuel injector control signal at idle speed with the engine at normal operating temperature.

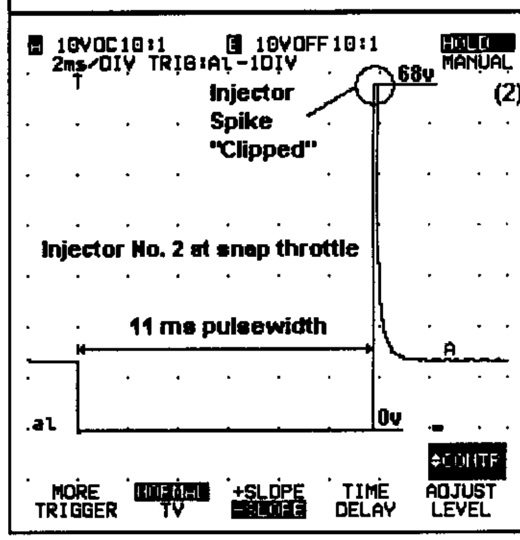
Lab Scope Example (2) Explanation

In example (2), the trace shows an injector spike (near 68v) during a snap throttle event.

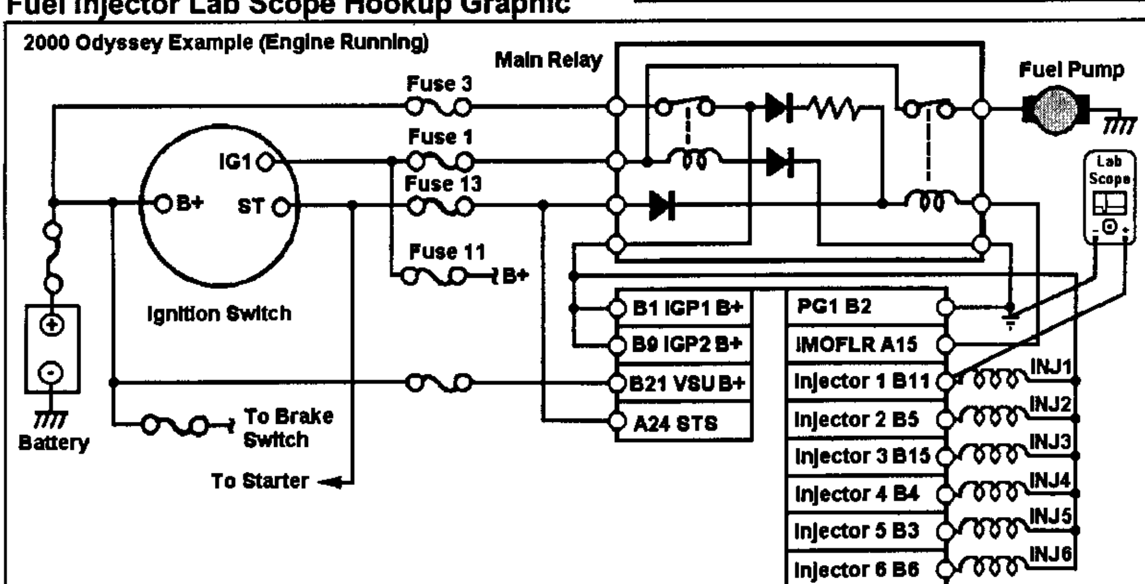
Note how the diode inside the PCM "clips" the fuel injector "spike" at this point. This action is shown in the Graphic inside the circle.

Also note how the injector pulsewidth changed from 3.9 ms to close to 11 ms during the snap throttle event with the engine warm.





Fuel Injector Lab Scope Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Intake Air System

Introduction

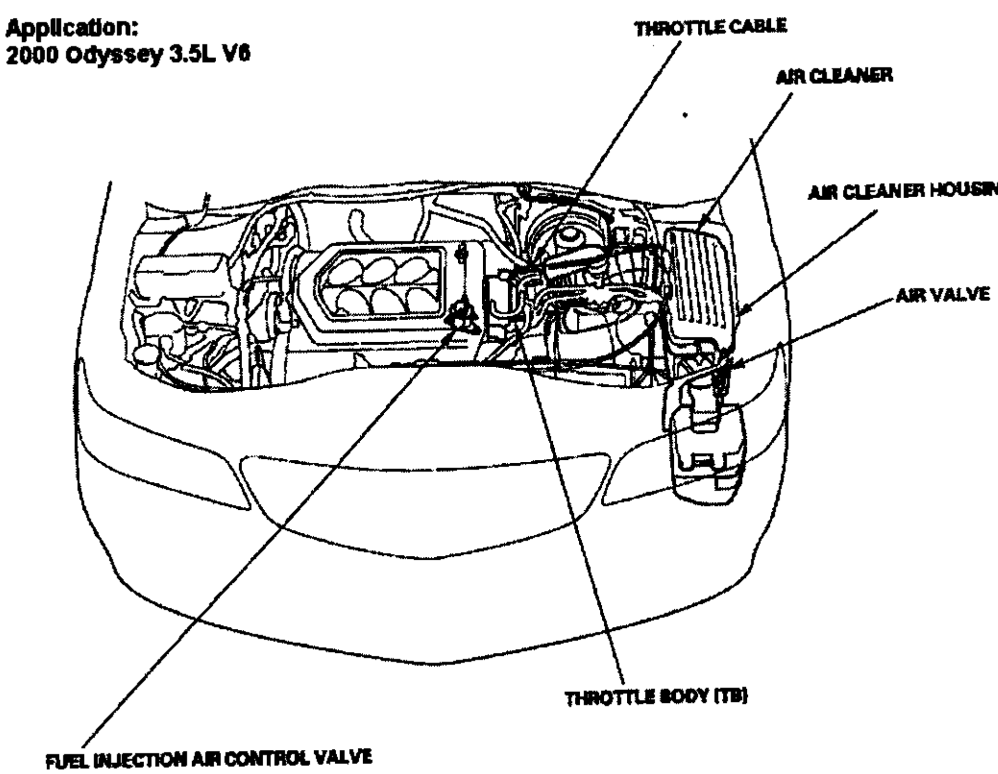
The Air Intake system supplies air for all of the engine needs. A resonator in the intake pipe provides additional silencing as air is drawn into the engine. An idle air control (IAC) valve is used to control the engine idle speed under all engine-operating conditions.

System Components

The Intake Air system on this vehicle application includes these components:

- Air Cleaner
- Air Cleaner Housing
- AIR Valve
- Fuel Injection Idle Air Control Valve
- Throttle Body
- Throttle Cable

Intake Air System Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Idle Air Control Solenoid

General Description

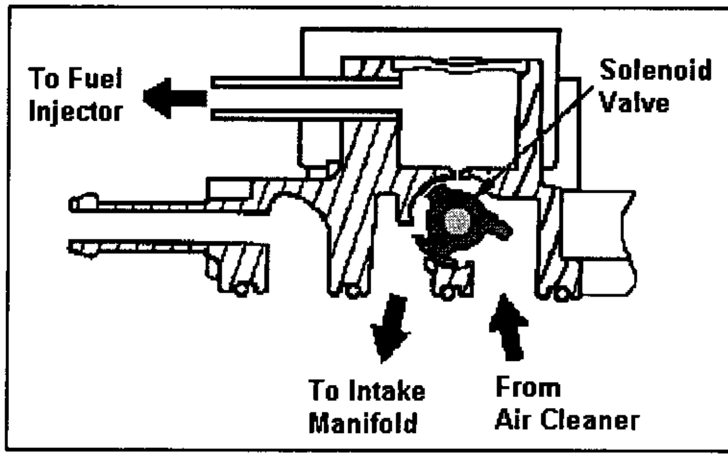
The PCM controls the engine idle speed by adjusting the position of the IAC solenoid valve under all engine-operating conditions. The PCM contains information for the desired idle speed under various conditions in its memory tables.

Note: The IAC solenoid (valve) was introduced in 1993 on all engines with fuel injection.

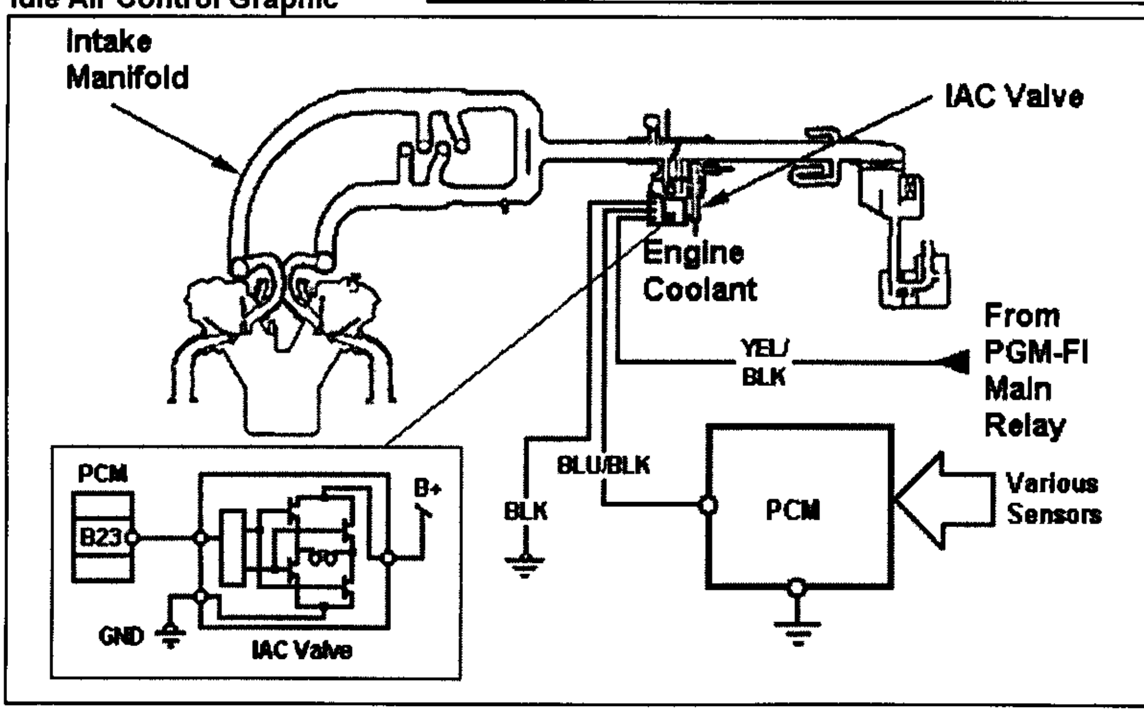
System Operation

The PCM accomplishes the task of controlling the idle speed by sending electric current pulses to the IAC solenoid to change the amount of air that bypasses the throttle body into the intake manifold.

This action energizes the solenoid valve (opens it) in order to maintain the correct idle speed for all conditions.



Idle Air Control Graphic



Technical Service Bulletin

Honda TSB 99064 (12/99) describes a "Hesitation during Acceleration" condition on this vehicle. The "fix" is to adjust the base idle speed setting (monitor idle speed on a Scan Tool). The adjusting screw should be lightly seated and then backed out 3 1/2 turns.

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

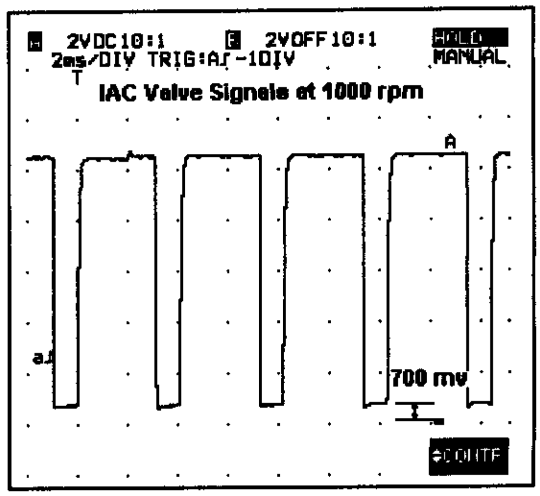
Idle Air Control Solenoid

Lab Scope Test (IAC Solenoid)

The Lab Scope can be used to test the operation of the IAC solenoid and its circuits. The two examples on this page represent two separate captures of the IAC solenoid signals.

Scope Connections

Connect the Channel 'A' positive probe to the IAC valve control signal (BLK/BLU wire) at B23 of the 25-Pin connector. Connect the Channel 'A' negative probe to the battery negative post or the BLK wire at the IAC valve.



Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the example.

IAC Solenoid Lab Scope Test

Start the engine and allow it to fully warm up. Then capture the IAC solenoid waveform with the gear selector in Park or Neutral.

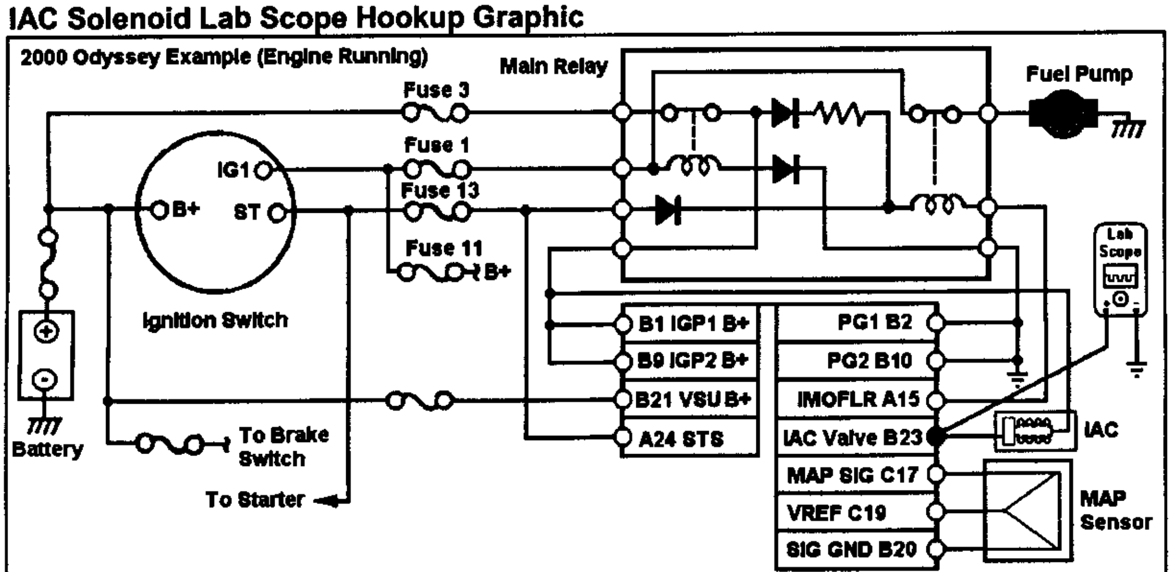
Then with the gear selector still in P/N, turn on the air conditioning and select the high blower position. Also turn on the lights and radio. These loads should cause the PCM to adjust the IAC solenoid valve position (under load).

Lab Scope Example (1) - Explanation

This trace shows an IAC solenoid waveform without any load applied (ontime is 1 ms). Note the amount of voltage drop between ground and the lowest point of the waveform.

To check the operation of the IAC solenoid, apply one or more engine electrical loads (i.e., turn on the A/C, blower motor to high speed and then turn the headlights on). The average IAC signal ontime should change under conditions with a load applied. You can compare the amount of difference in ontime by using the cursors and then reading the amount of time between them (the low point of the waveform) on this capture.

IAC Solenoid Lab Scope Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Manifold Absolute Pressure Sensor

General Description

The manifold absolute pressure (MAP) sensor converts the value of the manifold absolute pressure into an analog signal that is used by the PCM to determine the amount of fuel delivery, idle speed and ignition timing.

MAP Sensor Circuits

The MAP sensor circuits can be checked with a DVOM as discussed next:

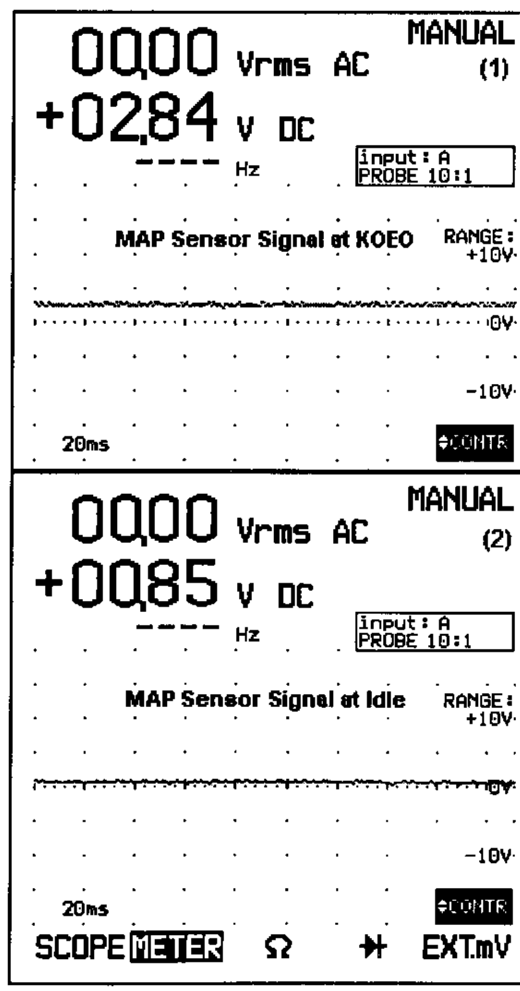
MAP VREF Circuit - Disconnect the MAP sensor connector, turn the key on and backprobe the VREF circuit (YEL/RED wire). This circuit should read from 4.9-5.1v.

MAP Ground Circuit - Connect one lead to the MAP sensor ground circuit in the 3-P connector and the other lead to battery negative. Then turn the key "on". The DVOM should read less than 50 millivolts if the ground circuit is okay.

MAP Signal Circuit - This circuit should be checked for an open circuit condition and for a short-to-ground condition. Backprobe the RED/GRN wire at the 3-pin connector. The reading on this circuit with the key on should closely match the reading on a Scan Tool.

DVOM Test (MAP Sensor)

The DVOM can be used to test the MAP sensor signal. Connect the positive probe to the signal (RED/GRN wire) at Pin C17 of the 31-Pin 'C' connector. Connect the negative probe to the battery negative post. Turn the key on or start the engine and compare the readings to the values in the Pin Voltage tables at the end of this vehicle section.



Sweep Test - Connect a vacuum pump to the sensor and slowly apply vacuum to the sensor (sweep the sensor through its complete range). If the reading drops off or changes too quickly, replace the MAP sensor.

MAP Sensor Calibration Test

Connect the DVOM leads to the MAP signal and battery negative. Turn the key on, connect a vacuum pump to the sensor and slowly apply 10" Hg to the sensor. Record the reading at 10" Hg. At sea level, the reading should be 1.8-2.0v. The value should be under 1.8-2.0v at over 4,000 ft. (for each 1,000 ft., the signal should drop 0.25v).

If the voltage change is not as specified, replace the sensor and repeat the test. If the sensor is okay, check the vacuum source to the MAP for leaks or a restriction.

Summary - Problems with the MAP sensor or its vacuum source can cause the engine to run extremely rich. If engine vacuum is low due to a mechanical problem, the MAP signal will be over 1.1v at idle speed (normal is from 0.85-0.85v at hot idle) and the engine will run rich.

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Manifold Absolute Pressure Sensor

Lab Scope Test (MAP Sensor)

The Lab Scope can be used to test the MAP sensor as it provides a very accurate view of sensor response and any glitches. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels for safety.

Scope Connections

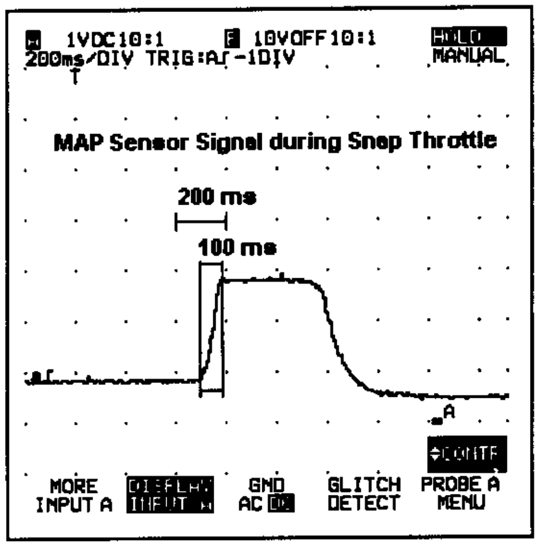
Connect the Channel 'A' positive probe to the MAP sensor signal at PCM Pin C17 of the 31-Pin connector (RED/GRN wire) and the negative probe to the battery ground post.

Scope Settings

To make the waveform as clear as possible, set the scope settings to match the examples. The MAP sensor waveform may have slight differences from one Lab Scope to another depending upon the scope settings.

Lab Scope Tests

Start the engine and raise the engine speed to 2500 rpm for 2 minutes to allow it to warmup. With the engine at hot idle (in Park), perform a snap throttle test of the MAP sensor signal by quickly opening and closing the throttle while monitoring the waveform for any problems.



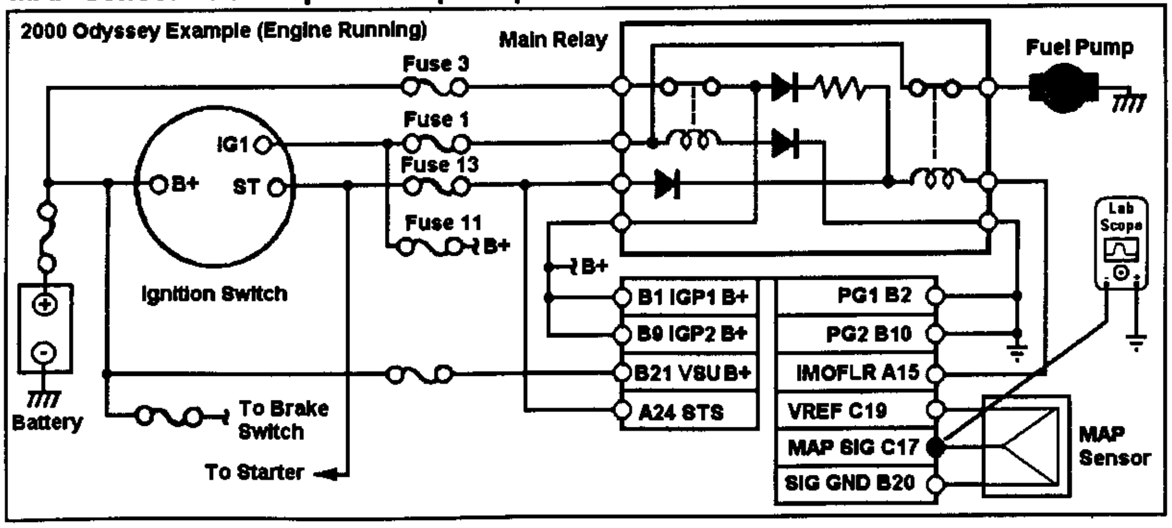
Lab Scope Example

There is one division between the vertical cursors in the 200 ms example (note that each division equals 200 ms).

There is about one half a division between the cursors in the 100 ms example. Note that the MAP sensor signal took about 100 ms to reach its peak in this known good example.

If the engine is sluggish, the exhaust system may be restricted or the timing chain may have "jumped" out of phase. Perform the test outlined here and compare your capture to the known good example (less than 100 ms).

MAP Sensor Lab Scope Hookup Graphic

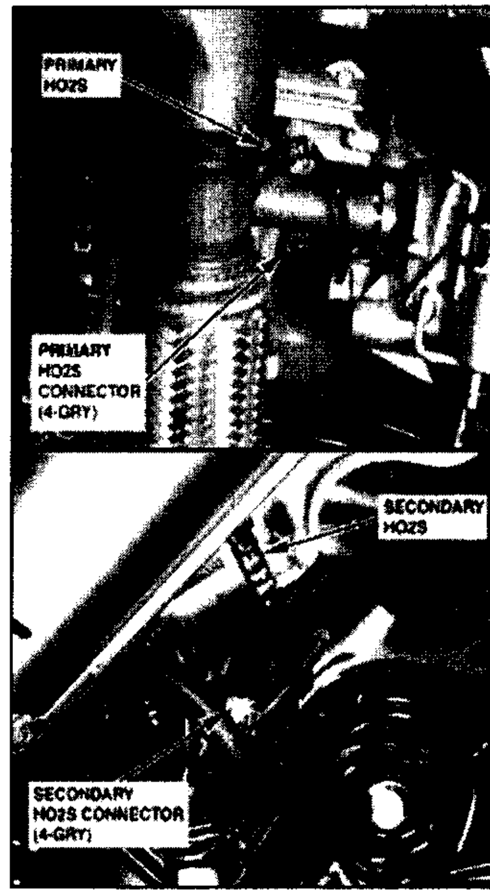


2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Oxygen Sensor

General Description

The heated oxygen sensor (HO2S) is mounted in the exhaust where it can monitor the oxygen content of the exhaust stream and send signals to the PCM. The PCM uses the HO2S signal to determine the amount of fuel injection pulsewidth and any change to the long-term and short-term fuel trim values.



The PCM controls the A/F ratio by using the signals from both the primary (front) and secondary (rear) oxygen sensors.

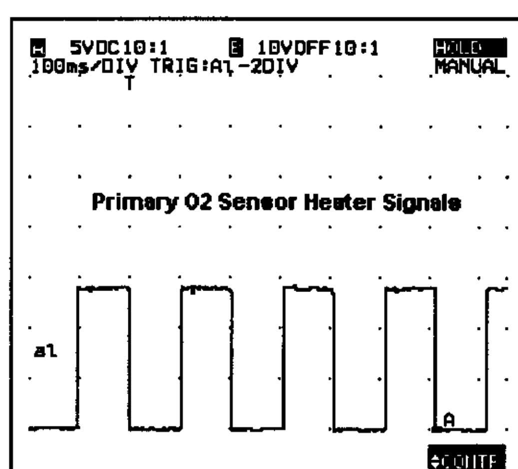
The PCM can detect deterioration in the primary sensor by evaluating the feedback period between the signals from the sensors. If the feedback period exceeds a certain value during "stable driving conditions", the PCM determines if the front or rear HO2S has deteriorated to a point that would adversely affect tailpipe emissions. If this occurs, the PCM will set a trouble code.

<u>Oxygen Sensor Locations</u>
The primary (or front) oxygen sensor is mounted in the exhaust pipe (in front of the three-way catalyst (TWC) in the catalytic converter. The secondary (rear) oxygen sensor is mounted in the three-way catalyst in the converter.

<u>Oxygen Sensor Heaters</u>
To stabilize their output signal, the oxygen sensors on this vehicle are equipped with an internal heater. The heater control circuits to the oxygen sensors are controlled by the PCM. They are activated a short time after engine startup.

Lab Scope Test (HO2S Heater)

The Lab Scope can be used to monitor the operation of the primary (front) and secondary (rear) oxygen sensor heater circuits. Refer to the example in the Graphic to the right.



<u>Scope Connections</u>
Connect the Channel 'A' positive probe to the HO2S-11 (BLK/WHT wire) heater control circuit at Pin C1 of PCM 31-Pin 'C' connector and negative probe to the battery ground post.

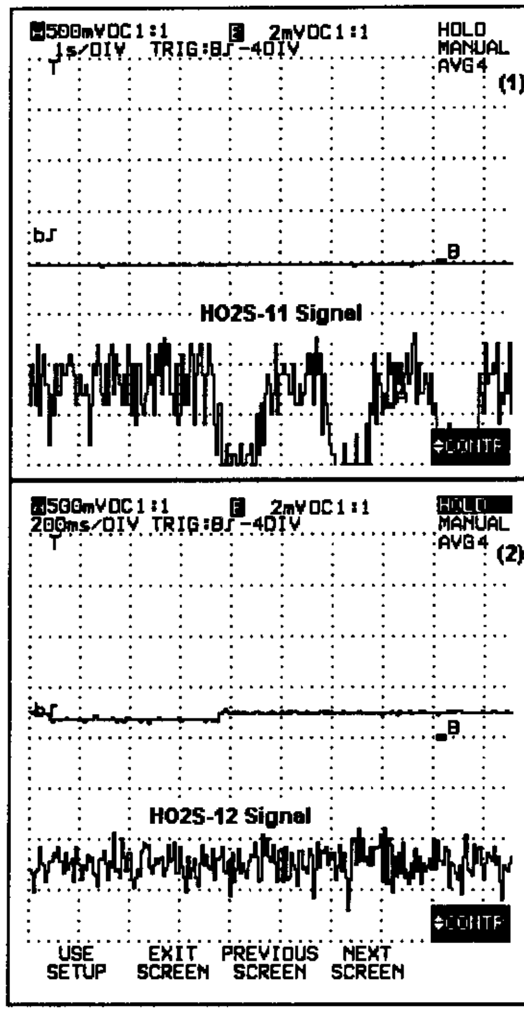
<u>Lab Scope Example Explanation</u>
The trace in this example shows a known good HO2S-11 heater control signal with the engine at normal operating temperature. Note how long (100 ms) that the primary sensor heater circuit is toggled "on" and "off" in this example.

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Oxygen Sensor

Lab Scope Test (HO2S)

The Lab Scope is the tool of choice to monitor the operation of the primary (front) and secondary (rear) sensor circuits. Refer to the example in the Graphics on this page.



Scope Connections (Example 1)

Connect the Channel 'A' positive probe to Pin C16 (WHT wire) of the PCM 31-Pin 'C' connector. This is the front heated oxygen sensor (HO2S-11) signal circuit.

Connect the Channel 'A' negative probe to the battery ground post.

Scope Connections (Example 2)

Connect the Channel 'A' positive probe to Pin A23 (WHT/RED wire) of the PCM 32-Pin 'A' connector. This is the rear heated oxygen sensor (HO2S-12) signal circuit.

Connect the Channel 'A' negative probe to the battery ground post.

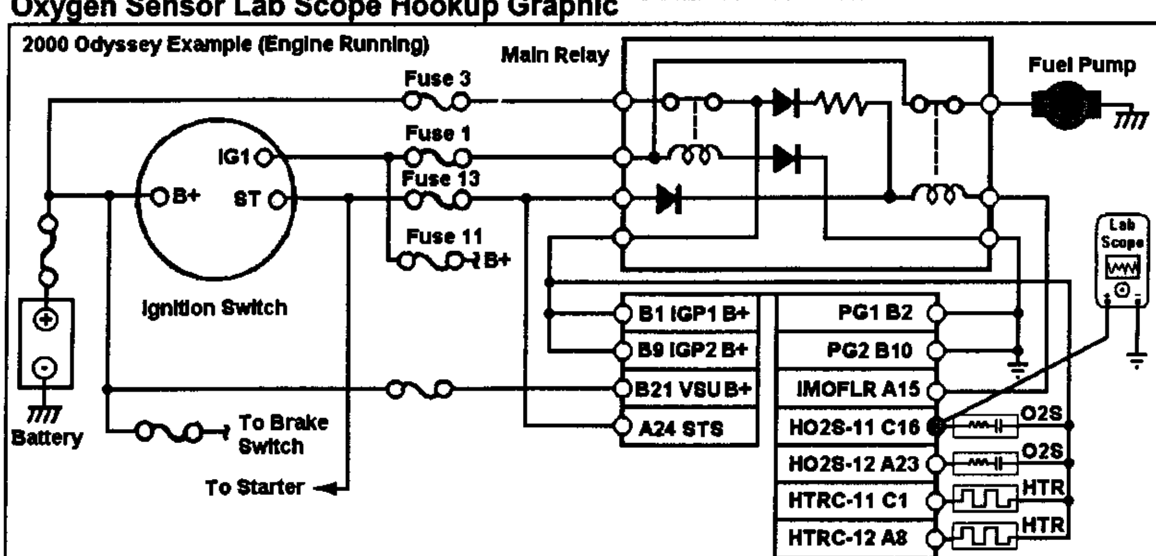
Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Examples 1 & 2

The traces in these examples show a normal front and rear oxygen sensor waveform with the engine at hot idle speed. Note: These captures were made using a 1:1 probe. Use a 10:1 probe to obtain a clearer O2S waveform.

Oxygen Sensor Lab Scope Hookup Graphic



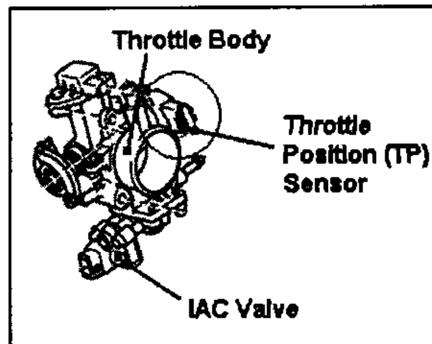
2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

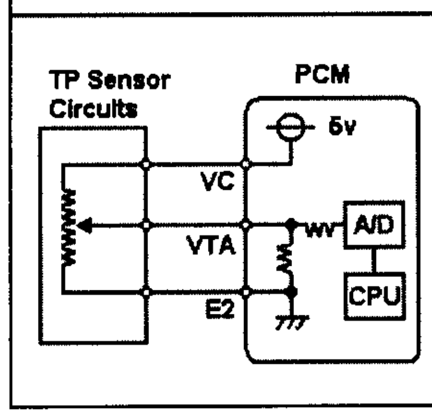
Throttle Position Sensor

General Description

The Throttle Position (TP) sensor is mounted to the throttle body where it detects the throttle valve angle.

Note that the TP sensor cannot be adjusted or removed from the throttle body unit on this vehicle application!





TP Sensor Circuits

The circuits that connect the TP sensor to the PCM are listed below:

- The VREF circuit (reference voltage)
- The TP sensor signal circuit
- The sensor or logic ground circuit

Circuit Description

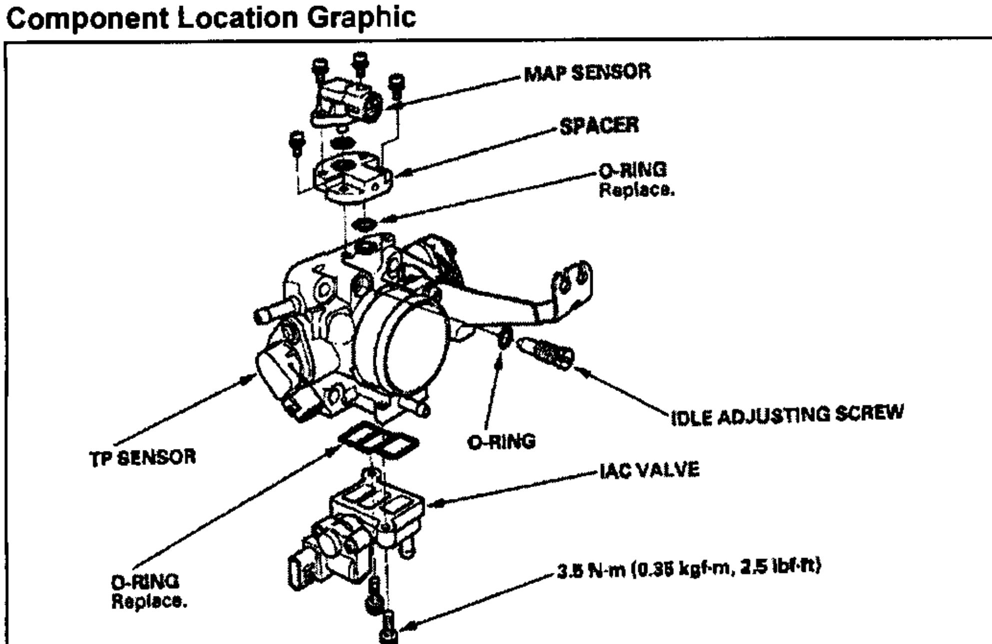
With the throttle fully closed, the TP sensor input to the PCM should be close to 0.6v at Pin C27 of PCM 31-Pin connector (TP sensor signal).

The TP sensor voltage increases in proportion to the throttle valve-opening angle (e.g., it should be from 3.8-4.9v with the throttle fully open).

The PCM uses the TP sensor (analog signal) to detect these (vehicle) driving conditions:

- Air Fuel (A/F) Ratio correction
- Fuel Cut Control
- Power Increase correction

Component Location Graphic

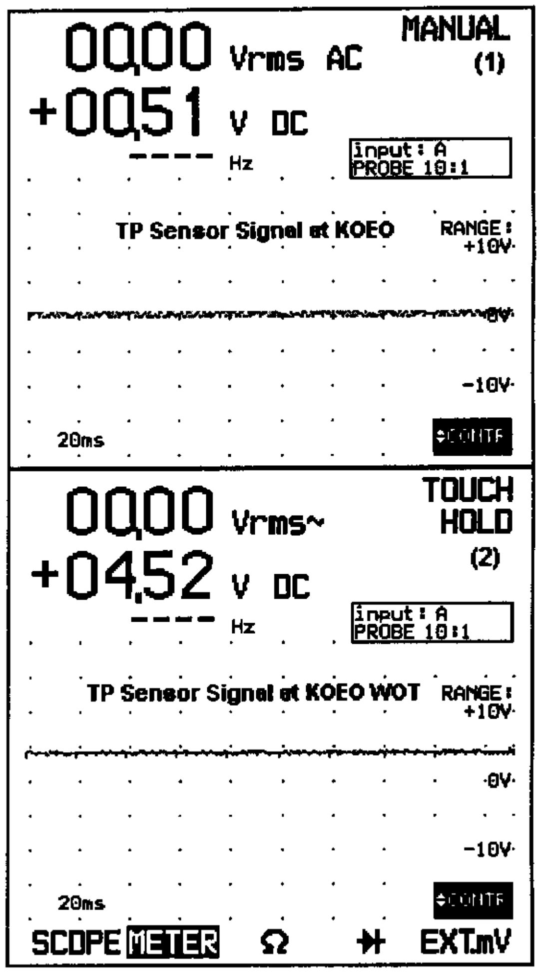


2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Throttle Position Sensor

DVOM Test (TP Sensor)

The DVOM or a Graphing Meter can be used to test the operation of the TP sensor and its circuits, but is not the tool of choice for this device. The Scan Tool is a much easier tool to use to test the operation of this device.



DVOM Connections

To test the TP sensor signal on this vehicle, connect the DVOM positive probe to the Pin C27 (RED/BLK wire) of the PCM C31-Pin connector (the TP sensor signal circuit).

Connect the DVOM negative probe to the battery negative post.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

DVOM Example Explanation

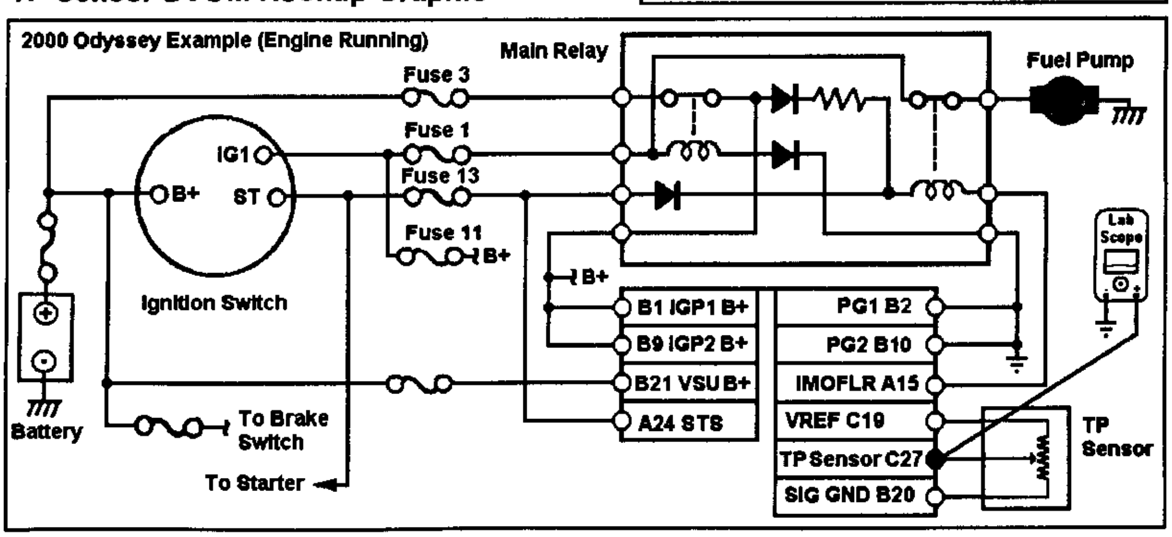
In this example, the trace shows the TP sensor (analog signal) at KOEO (key on, engine off) with the throttle closed and again at wide open throttle.

The TP sensor signal should also be checked for breaks in the sensor resistor.

One way to find this type of problem is to turn to key on, engine off and with the DVOM connected as shown in the Graphic below, slowly open and close the throttle.

Watch the DVOM display or bar graph for any sudden increase or decrease in the linear action of the pattern.

TP Sensor DVOM Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Throttle Position Sensor

Lab Scope Test (TP Sensor)

The Lab Scope can be used to test the operation of the TP sensor and its circuits. However, the Scan Tool is a much easier tool to use to test the operation of this device.

Scope Connections (A/T)

To test the TP sensor signal on this vehicle, connect the Channel 'A' positive probe to the Pin C27 (RED/BLK wire) of the PCM C31-Pin connector (this is the TP sensor signal circuit). Connect the Channel 'A' negative probe to the battery negative post.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

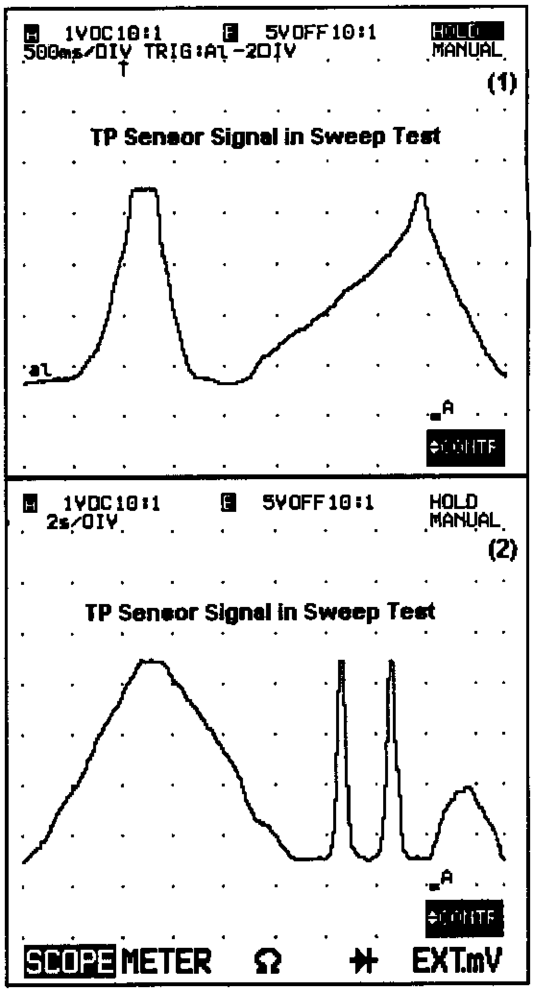
Scope Explanation - Examples (1) & (2)

In these examples, the traces show the TP sensor at KOEO during a period where the throttle was opened and closed several times.

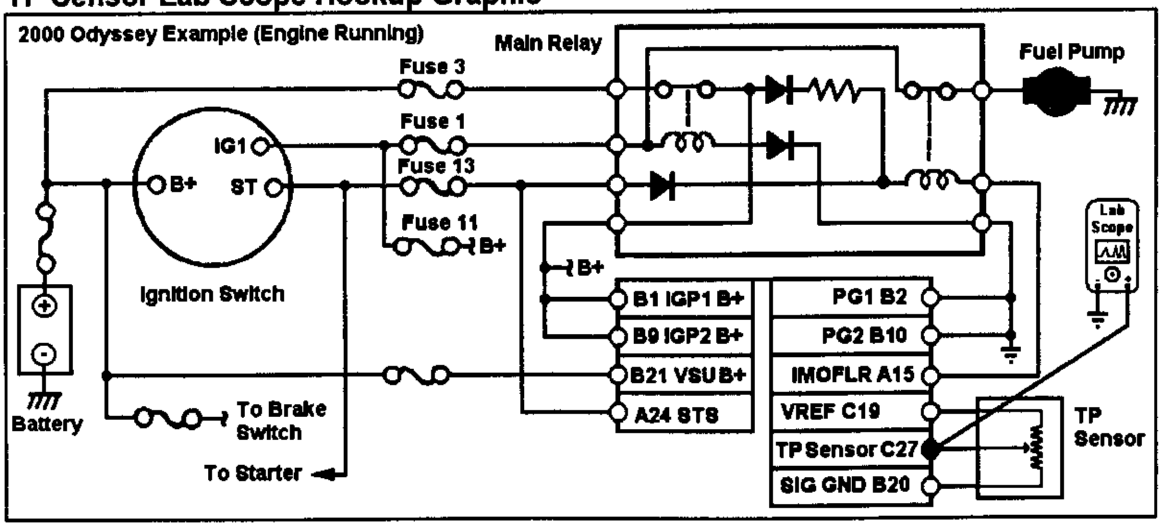
The TP sensor signal can also be checked for breaks in the sensor resistor. One way to find this type of problem is to turn to key on, engine off and with the Lab Scope connected as discussed above, open and close the throttle several times (with the key on, engine off).

Watch the TP sensor waveform for any sudden increase or decrease in the linear action of the pattern.

A dropout (e.g., a sudden downward spike) in the TP sensor signal trace would indicate a short while a sudden upward spike would indicate an open circuit.



TP Sensor Lab Scope Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Main Shaft & Countershaft Speed Sensors

General Description

The Main Shaft and Countershaft Speed sensors are magnetic pickup design sensors that output an AC signal during periods of time when these different shafts are moving. The Lab Scope is the "tool of choice" to test the operation of these two sensors.

Lab Scope Test Example

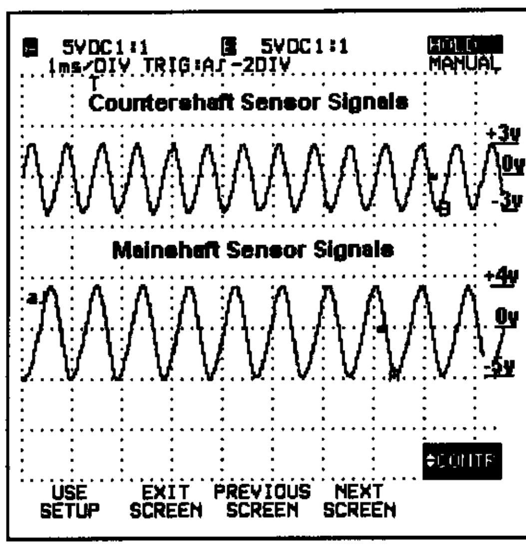
Connect the Lab Scope to the correct terminals at the PCM (inside the vehicle) and then drive the vehicle at low or medium speed to set up the desired capture speed.

Scope Connections (Countershaft Sensor)

Connect the Channel 'B' positive probe at Pin D10 (BLU wire) of the PCM 16-Pin connector. Connect the negative probe at Pin D16 (GRN wire) of the same connector or to the battery negative ground post.

Scope Connections (Main Shaft Sensor)

Connect the Channel 'A' positive probe to Pin D11 of the 16-Pin connector (RED wire). Connect the negative probe to Pin D12 (WHT wire) of the same connector or to the battery negative ground post.



Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Explanation

The top trace in this example shows a known good Countershaft speed sensor waveform. Note that the signal is 6v peak to peak (it was captured with the vehicle traveling at 30 mph).

The bottom trace shows a known good Main Shaft Speed sensor waveform. Note that the signal is 9v peak to peak (it was captured with the vehicle traveling at 30 mph).

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

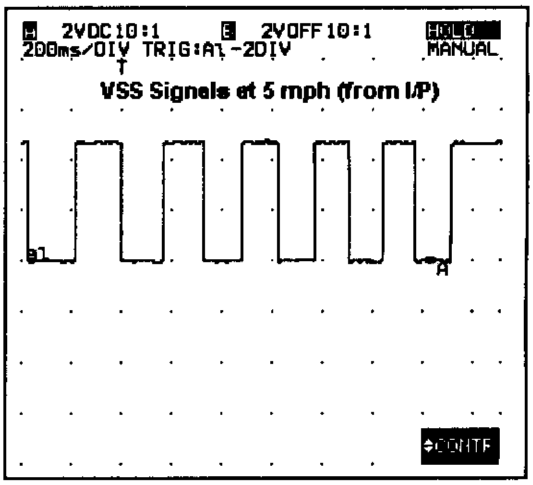
Vehicle Speed Sensor

General Description

The vehicle speed sensor signal for this vehicle is obtained from the Combination meter (it gets its signal from the ABS controller through inputs from the wheel speed sensors). The number of cycles per second increases or decreases with the speed of the vehicle.

Lab Scope Test (VSS)

Scope Connections (Vehicle Speed Sensor)
Connect the Channel 'A' positive probe to the VSS signal at Pin A9 (BLU/WHT wire) of the PCM 32-Pin connector. Connect the negative probe to the battery negative post.



Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Vehicle Speed Sensor Test
Start the engine and drive the vehicle at the desired speed to set up the VSS capture.

Lab Scope Example
The trace in this example shows a known good Vehicle Speed sensor waveform (0-5-0-5v).

Multiplex Communication System

General Description

A set of Multiplex shared data lines are used to on this vehicle to reduce the number of wire harnesses (rather than sending normal electrical signals through individual wires).

- The input signals from each switch are converted into digital signals at the CPU. The digital signals are sent from the transmitter unit to the receiver unit as serial data.
- The transmitted signal is converted to a switch signal at the receiver unit, and it operates the related component (i.e., the signal between the door and driver's multiplex control unit or the signal between the passenger's door and the unit).
- The control units always communicate via these lines when the system is operating, and they stop communicating when the system is off.

Wakeup and Sleep Modes
The multiplex system has wakeup and sleep modes to decrease the amount of parasitic draw on the battery when the ignition key is turned off.

- While in sleep mode, the multiplex control unit stops the functions (communication with CPU control) when it is not necessary for the system to operate.
- As soon as any operation is requested (e.g., a door is unlocked), the related control unit (which is in sleep mode) is awakened and begins to function. The control unit sends a wake up signal to the other control units via the communication lines.
- When the ignition switch is turned off, and the driver or passenger doors are opened, there is a 10 second delay before the control units go from wake up to sleep mode.
- If any door remains open, the sleep mode will not function.

Failsafe Mode
The multiplex system has a failsafe mode to prevent improper operation. If part of the system fails, the output signal is fixed (e.g., a faulty control unit or communication line).

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Controlled Generator

General Description

The purpose of the PGM-FI system is to provide optimum control of the engine and transmission while meeting the objectives of regulations related to OBD systems.

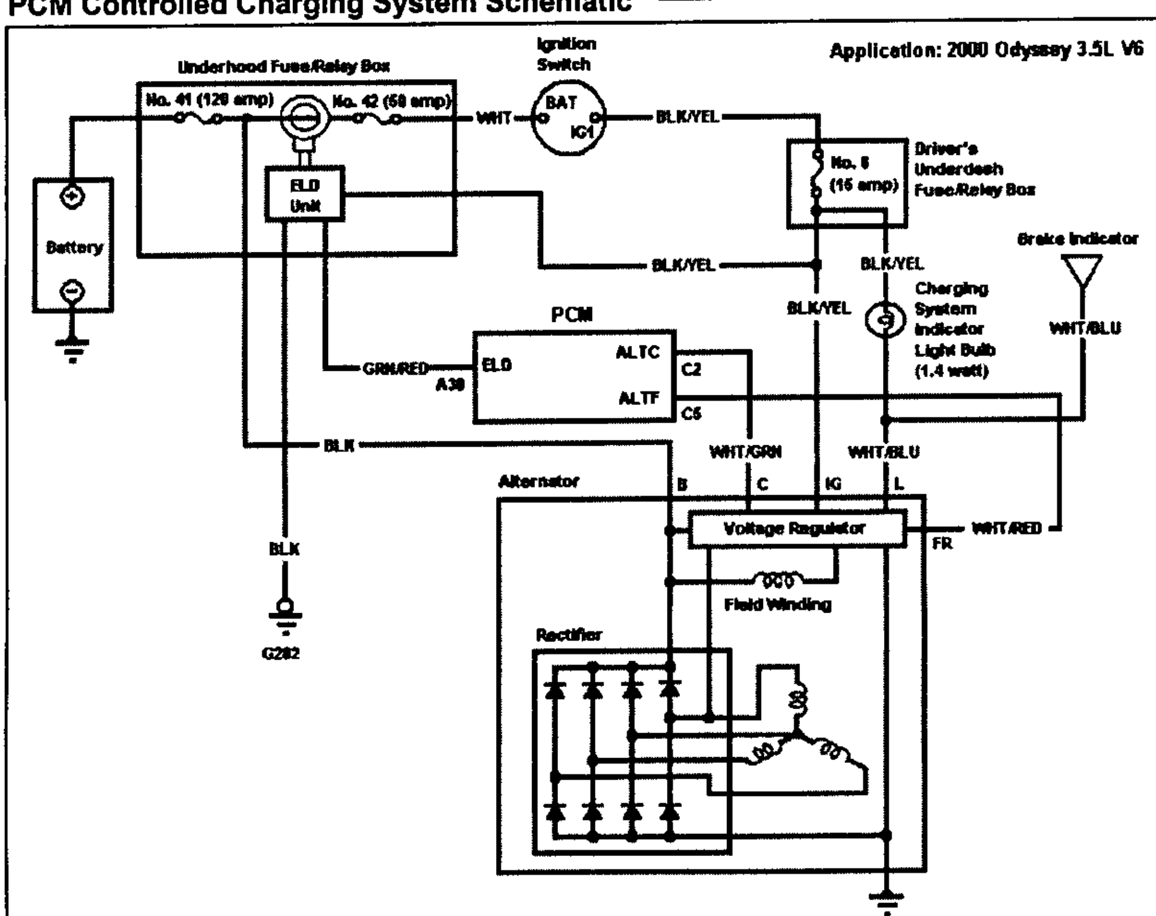
At the heart of this system is a PCM connected to various input and output devices through a wiring harness and several connectors. The PCM receives information from sensors and switches, performs calculations based on data stored in its internal tables in Keep Alive Memory in order to control the output devices (i.e., actuators, relays, and solenoids).

<u>Generator Charging System Requirements</u>

The PCM monitors the generator control signals whenever the generator is charging.

The PCM controls the amount of charging system output voltage according to the electrical load requirement (demand) it determines from the electrical load detector (ELD) signal and the various driving modes. By controlling the generator output, the PCM can improve the overall fuel economy.

PCM Controlled Charging System Schematic

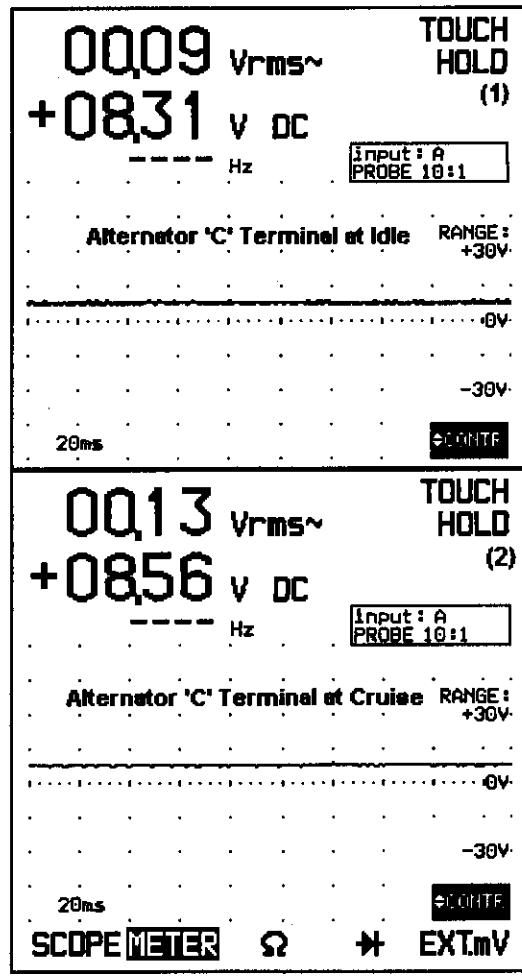


2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Controlled Generator

DVOM Test (Generator)

The DVOM can be used to test the operation of the generator and the electronic load detector (ELD) circuit voltage. The Scan Tool is an easier tool to use to test the circuits.



DVOM Test Example

Connect the DVOM probe to the ELD terminal at the PCM (or to the generator) and also to ground. Operate the engine at low or medium speed to set up the desired capture speed.

DVOM Connections (Generator Control)

Connect the DVOM positive probe to the generator control circuit at Pin C2 of the PCM 31-Pin connector (WHT/GRN wire). Connect the DVOM negative probe to chassis ground or to the battery negative ground post.

DVOM Connections (Generator Output)

To test the Generator output, zero the inductive amp probe from the Charging system tester. Then connect the probe clamp around the generator output circuit (the BLK wire).

DVOM Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

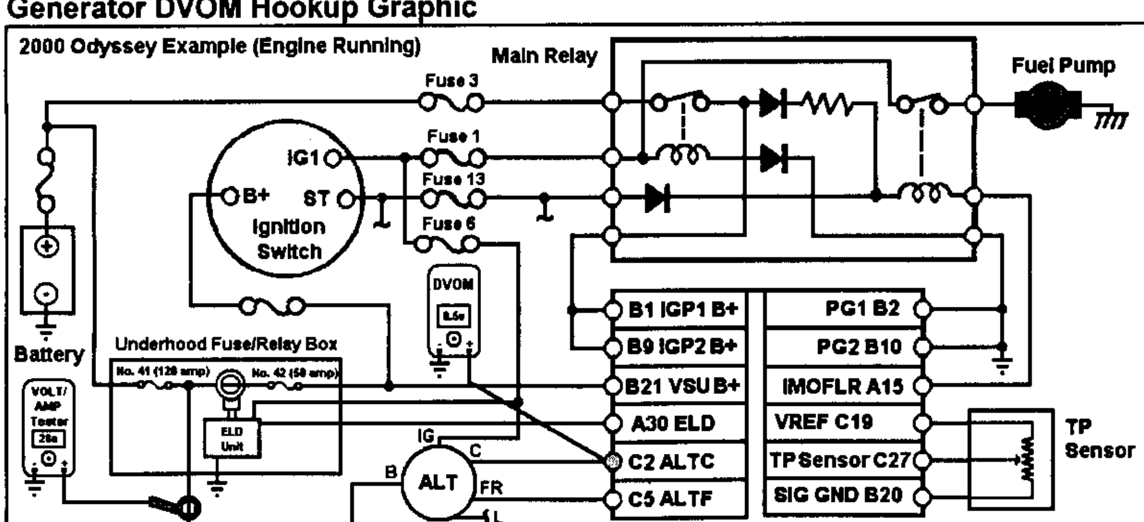
DVOM Explanation - Example (1)

In this example, the trace shows the voltage level of the generator control circuit with the lights, rear defroster and A/C on at idle speed.

DVOM Explanation - Example (2)

In this example, the trace shows the voltage level of the generator control circuit with the lights, rear defroster and A/C on at 2500 rpm.

Generator DVOM Hookup Graphic

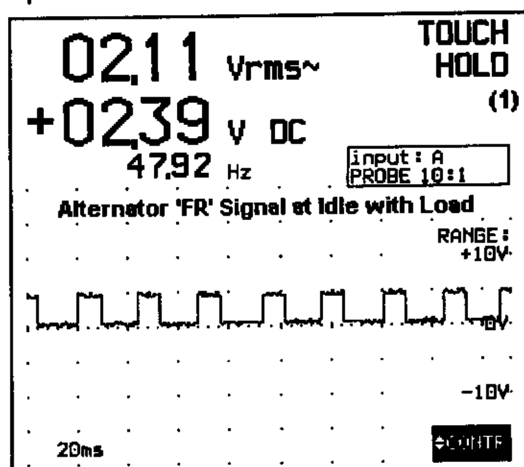


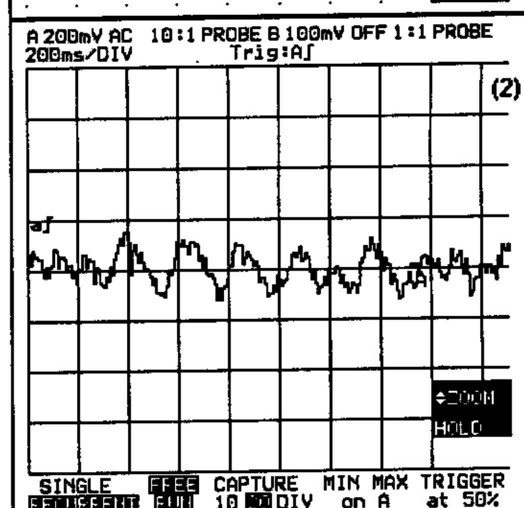
2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Controlled Generator

Lab Scope Test (Generator)

The Lab Scope is one of the tools that can be used to test the operation of the Generator and the electronic load detector (ELD) circuit as it provides an accurate view of the generator signal (AC ripple) and the ELD DC voltage. The Scan Tool is an easier tool to use for this test because of its quick hookup and display of the Charging system information.





<u>Lab Scope Test Example</u>
Connect the Lab Scope to the 'FR' terminal at the PCM inside the vehicle or at the generator and drive at the desired capture speed.

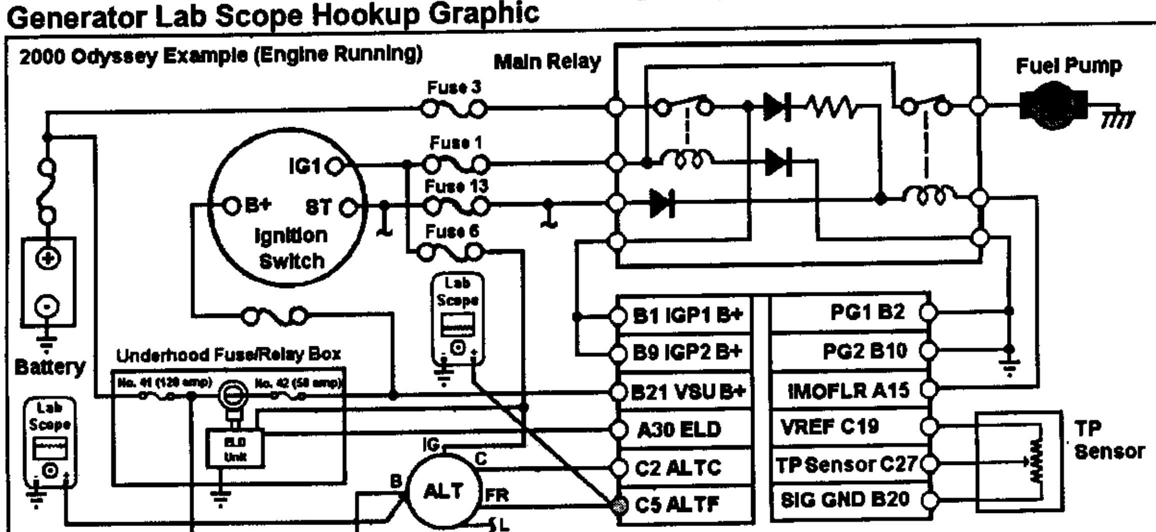
<u>Scope Connections ('FR' Control Circuit)</u>
Connect the Channel 'A' positive probe to Pin C5 of the 32-Pin 'A' connector (WHT/RED wire). Connect the Channel 'A' negative probe to the battery negative ground post.

<u>Scope Connections (Generator AC Signal)</u>
To test the generator AC signal, connect the Channel 'A' positive probe to the Generator output terminal. Connect the Channel 'A' negative probe to the battery ground post.

<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Lab Scope Example Explanations</u>
In Example (1), the trace shows a known good 'FR' waveform with the lights turned on during the test. In Example (2), the trace shows a known good Generator AC ripple captured at 55 mph with the headlights turned on.

Generator Lab Scope Hookup Graphic



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Reference Information

How To Access & Use Generic PID Information

The Scan Tool Parameter Identification (PID) Mode allows access to certain data values, analog and digital input and output signals, calculated values and system status information.

The Generic OBD II PID list is an example of the PIDs that all OBD II compatible Scan Tools must be able to access and display.

Scan Tool PID Menus

An example of how to navigate through the Vetronix Scan Tool menus to locate the Generic PID information is shown in the Graphic to the right.

This Graphic contains an example of how to read the engine related parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column of the example represent known good values for this engine application.

If all of these PID values are within normal range, refer to the Symptom Diagnosis information in Section 1.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete Generic PID list for this vehicle is shown in the Graphic.

1) Select F1: SCANTEST from the opening menu).
2) Select Global OBD II from the Applications menu.
3) Select F0: Powertrain from the Main menu.
4) Initializing OBD II Communications screen appears.
5) Select F0: DATALIST from the Select Mode menu. To view the I/M Readiness status of the OBD II Main Monitors, select F1: Readiness (or another choice).
6) Select F0: Display Data from the Data List Menu.

Some of the sixteen PID items available in the Generic PID list for this vehicle are shown in the last frame.

Diagnostic Tip

The Typical Values in the example on this page should be used after the following conditions are met:

- The Honda PGM-FI Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

(1)
FUNCTION MENU
F1: SCANTEST
F2: DIGITAL METER
F3: OSCILLOCOPE
F4: EMISSION TESTS
F8: TECH TOOLBOX
F9: SETUP

(2)
APPLICATIONS ↑↓
-> GLOBAL OBD II
GM P/T
GM CHASSIS

(3)
MAIN MENU
F0:Powertrain
F1:Replay Data
F9:OBDII Toolpak

(4)
Initializing
OBD II
Communications

(5)
SELECT MODE ↑↓
F0:Datalist
F1:Readiness
F2:DTCs

SELECT MODE ↑↓
F3:Snapshot
F4:OBD Controls
F5:System Tests

SELECT MODE ↑↓
F8:Information
F9:OBDII Toolpak

(6)
DATA LIST MENU
F0:Display Data
F1:Data Setup

ENGINE SPD	756RPM
VSS	0MPH
ECT SENSOR	84°C
IAT SENSOR	46°C
MAP SENSOR	27kPa
CLV	27%
BARO S	88kPa
TP SENSOR	-0.2°
HO2S S1	0.88V
ST FUEL TRIM	0.98
LT FUEL TRIM	0.96
O2 FB COND	CLOSED

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Reference Information

How To Access & Use OEM PID Information

The OEM PID List on the next page contains the engine related parameters available on the Scan Tool. The list is arranged in alphabetical order. The items under "Typical Value" represent known good readings for this engine.

If all of the PID values are within normal range, refer to the Symptom Diagnosis information in Section 1.

Scan Tool PID Menus

An example of how to navigate through Vetronix Scan Tool menus to locate PID data is shown in the Graphic.

1) Insert the Honda OEM cartridge and press ENTER.
2) Select HONDA SYSTEMS from the Program Menu.
3) Select HONDA SYSTEMS from the Program Menu.
4) Verify the correct vehicle during the Vehicle Check.
5) Enter the correct VIN code as well as the odometer reading and then verify both entries.
6) Answer YES or NO to the Power Steering question.
7) Answer YES or NO to the factory A/C question.
8) Select 2: Data List from the Test Mode Menu.

Parameter ID (PID) Information

The parameters in the PCM PID Tables in this manual are listed in alphabetical order. The Data List selection in the Scan Tool is used to view all of the PID items for this particular vehicle.

The other Test Menu choices available while using the OEM side of the Scan Tool include DTC's, Freeze Data, Snapshot, Clear, Inspection and Setup Modes.

This vehicle application has a total of forty-seven (47) parameter identification (PID) items that can be viewed with the OEM side of the Scan Tool.

You can find more detailed information on "known good" PID data examples for this vehicle application on the next page.

Diagnostic Tip

The Typical Values in this article should be used after the following conditions are met:

- The Honda PGM-FI Self-Check has been completed.
- The engine is at idle (unless otherwise specified).
- The throttle is closed (unless otherwise specified).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

(1)
ASIAN IMPORTS
OEM
DIAGNOSTIC
SOFTWARE
HONDA/ACURA
Version 8.20
02/8/00
Press [ENTER]

(2)
1: HONDA SYSTEMS
2: SPORT UTIL.VEH.

(3)
1: HONDA SYSTEMS
2: SCS

(4)
VEHICLE CHECK
MODEL: ODYSSEY
ENGINE: F23A7
TRANS: A/T
Does the data match with the vehicle?
Press [YES] or [NO]

(5)
VEHICLE DATA
Enter odometer reading:
343457.0
Press [ENTER]

(6)
SYSTEM SELECT
1: PGM-FI
2: A/T
3: DBW

(7)
VEHICLE EQUIPMENT
Is vehicle equipped with power steering?
Is vehicle equipped with power steering?
Press [YES] or [NO]

(8)
TEST MODE MENU
PGM-FI
1: DTCs
2: DATA LIST
3: FREEZE DATA
4: SNAPSHOT
5: CLEAR
6: INSPECTION
7: SETUP

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

Reference Information

PCM PID Tables

Note: ***The following readings were obtained with the engine at idle speed, radiator hose hot, throttle closed, gear selector in Park and all accessories turned off.***

Serial Data Name	Range or Value	Hot Idle	30 MPH	55 MPH
A/C Switch	ON or OFF	OFF	OFF	OFF
A/C Clutch	ON or OFF	OFF	OFF	OFF
Generator	0-100%	37	34	36
Generator Control Volts	0-25.5v	14.5	14.5	14.5
BARO Sensor	10-110 kPa	88	2.74	2.73
Battery Voltage	0-25.5v	14.0	14.0	14.3
Brake Switch	ON or OFF	OFF	OFF	OFF
Calculated Load Value	0-100%	27	57	40
ECT Sensor	-40 to 304°F	183	190	191
EGR Valve Lift Sensor	0-5.1v	1.13	1.58	1.76
Electronic Load Detector	0-100 amps	17.7	21.7	20.2
Engine Speed	0-10,000 rpm	756	1406	2413
EVAP Purge Duty Cycle	0-100%	42	71	71
EVAP Bypass	ON or OFF	OFF	OFF	OFF
EVAP CVS Valve	ON or OFF	OFF	OFF	OFF
Fan Relay Control	ON or OFF	ON	OFF	OFF
Fuel Injector	0-99.9 milliseconds	2.90	5.65	4.44
Fuel Tank Press. Sensor	0-5.1v	1.8	1.7	1.3
HO2S-11 (front)	0-1100 millivolts	880	720	240
HO2S-12 (rear)	0-1100 millivolts	490	080	620
HO2S-11 HTR (front)	ON or OFF	ON	ON	ON
HO2S-12 HTR (rear)	ON or OFF	ON	ON	ON
IAC Motor Command	0-255 counts	38	64	64
IAT Sensor	-40 to 304°F	116	147	158
Immobilizer	RUN or OFF	RUN	RUN	RUN
Knock Retard	0-99° BTDC	26	26	24
Long Term Fuel Trim	0-100%	0.96	0.95	0.96
MAP Sensor (kPa)	10-110 kPa	27	57	54
Main Relay (FP) Status	ON or OFF	ON	ON	ON
MIL	ON or OFF	OFF	OFF	OFF
MIL Status	ON or OFF	OFF	OFF	OFF
Mount Control Solenoid	ON or OFF	ON	OFF	OFF
O2 Feedback Condition	OPEN or CLOSED	CLOSED	CLOSED	CLOSED
PNP Switch	GEAR or P-N	P-N	GEAR	GEAR
PSP Switch	ON or OFF	OFF	OFF	OFF
SCS Connector Status	OPEN or CLOSED	OPEN	OPEN	OPEN
Spark Advance	0-99° BTDC	12	29	32
Short Term Fuel Trim	0-100%	0.90	0.98	0.96
Starter Switch	ON or OFF	OFF	OFF	OFF
TP Sensor (°)	0-100 degrees	0.2	6.0	8.0
Vehicle Speed (mph)	0-255	0	30	55
VTEC Pressure Switch	ON or OFF	ON	ON	ON
VTEC Pressure Solenoid	ON or OFF	OFF	OFF	OFF

2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

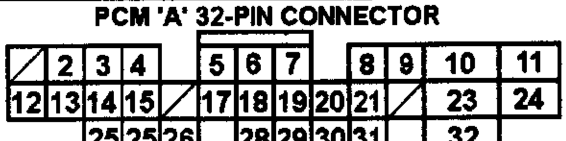
2000 Odyssey 3.5L V6 SOHC Engine Pin Voltage Table (32-Pin 'A' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
A2	GRN/WHT	Engine Mount Solenoid Control	Low rpm: 0v, High rpm: 12v
A3	BLU	EVAP Bypass Solenoid Control	12-14v
A4	LG/WHT	EVAP Vent Solenoid Control	12-14v
A5	BLU/GRN	Cruise Control Signal	Pulse signals
A6	RED/YEL	EVAP Purge Solenoid Control	Digital signals: 0-12-0-12v
A7	WHT/RED	Reference Voltage	4.9-5.1v
A8	BLK/WHT	Rear HO2S-12 Heater Control	Digital signals: 0-12-0-12v
A9	BLU/WHT	VSS Output Signal	Moving: 0-5-0-5v pulses
A10	BRN	Service Check System Signal	Open: 5v, Closed: 0v
A11	PNK	A/T: Gear Position Signal	In Park: 4v, others: 0v
A12	PNK	Immobilizer Indicator Light Control	Light On: 0v, Off: 12v
A13, A25	BLU, RED	Immobilizer Enable, Code Signal	Digital signals
A14	GRN/WHT	A/T: D4 Indicator Light	Light On: 0v, Off: 12v
A15	GRN/YEL	Fuel Pump Relay Control	Relay On: <1v, Off: 12-14v
A17	RED	A/C Clutch Relay Control	Relay On: <1v, Off: 12-14v
A18	GRN/ORN	Check Engine Light (MIL lamp)	MIL On: <1v, Off: 12-14v
A19	BLU	Engine Speed (Tachometer) NEP	Digital signals: 0-12-0-12v
A20	BLU/RED	Radiator Fan Relay Control	Relay On: 1v, Off: 12v
A21	GRY	K-Line Signal (OBD II DLC)	Digital signals: 0-12-0-12v
A23	WHT/RED	Rear HO2S-12 Signal	0-1100 mv
A24	BLU/ORN	Starter Switch Signal	KOEC: 9-11v
A26	GRN	Power Steering Pressure Switch	Straight: 0v, Turning: 12v
A27	BLU/RED	A/C Switch Signal	A/C On: 0v, Off: 5v
A28	WHT/RED	Interlock Control Unit Signal	Key On & Brake On: 12v
A29	LT GRN	Fuel Tank Pressure Sensor	Fuel Cap Off: 2.5v
A30	GRN/RED	ELD Sensor Signal	Parking lights on: 2.5-3.5v
A31	RED/BLK	TP Sensor Signal Out	Hot idle: 0.6v
A32	WHT/BLK	Brake Switch Signal	Brake On: 0v, Off: 12v

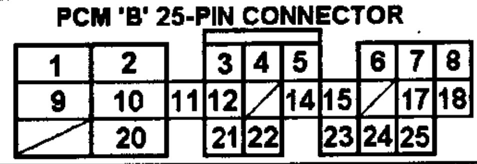
2000 Odyssey 3.5L V6 SOHC Engine Pin Voltage Table (25-Pin 'B' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
B1, B9	YEL/BLK	IGP1, IGP2 Power Source	12-14v
B2, B10	BLK	PG1, PG2 Power Ground	<0.1v
B3	BLK/RED	Injector 5 Control	2.0-4.0 ms
B4, B5	BLU, RED	Injector 4, Injector 2 Control	2.0-4.0 ms
B6	WHT/BLU	Injector 6 Control	2.0-4.0 ms
B7	PNK	E-EGR Solenoid Control Signal	Duty signals: 0-12-0-12v
B8, B17	WHT, RED	Clutch Press. Solenoid 'A' (-), (+)	AC pulse signals
B11, B15	BRN, BLU	Injector 1, Injector 3 Control	2.0-4.0 ms
B12	GRN/YEL	VTEC Solenoid Valve Control	Low rpm: 0v, High rpm: 12v
B14	BLU/WHT	A/T: Gear Indicator PNP Signal	In P/N: 0v, others: 12v
B18, B25	GRN, ORN	Clutch Pressure solenoid B (+), (-)	AC Pulse Signals
B20, B22	BRN/BLK	LG1, LG2 Logic (Sensor) Ground	<0.050v
B21	WHT/YEL	Voltage Backup (VBU) Power	12-14v
B23	BLK/BLU	Idle Air Control Solenoid Signal	Pulse signals
B24	WHT/RED	Third Oil Pressure Switch	12-14v

PCM 'A' 32-PIN CONNECTOR



PCM 'B' 25-PIN CONNECTOR



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

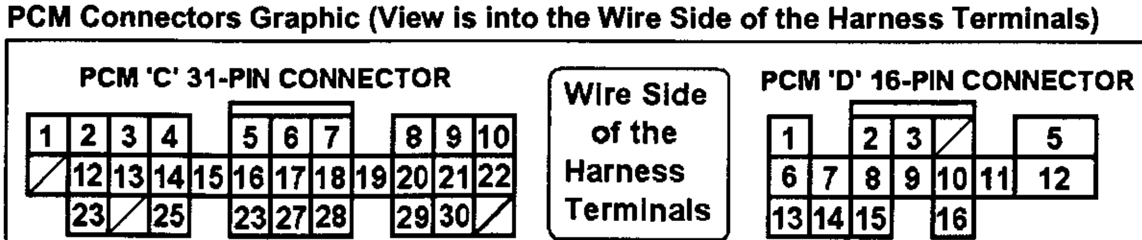
2000 Odyssey 3.5L V6 SOHC Engine Pin Voltage Table (31-Pin 'C' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
C1	BLK/WHT	Front HO2S-11 Heater Control	Digital Signals (0-12-0-12v)
C2	WHT/GRN	Generator Control Signal	Varies: 7-8v
C3	BLU	Ignition Coil 3 Control (IGPLS3)	Pulse signals
C4	YEL/ORN	Ignition Coil 1 Control (IGPLS1)	Pulse signals
C5	WHT/RED	Generator 'FR' Signal	Varies: 0.5-4.5v
C6	WHT/BLK	EGR Valve Lift Sensor Signal	Hot Idle: 1.2v
C7, C18	GRN/WHT	Sensor Ground (SG1, SG2)	<0.050v
C8, C9	BLU, WHT	CKP Sensor (+), CKP (-) Signal	AC Pulse signals
C10	BLU/BLK	VTEC Pressure Switch Signal	Low rpm: 0v, High rpm: 12v
C12	BLK/RED	Ignition Coil 5 Control (IGPLS5)	Pulse signals
C13	YEL	Ignition Coil 4 Control (IGPLS4)	Pulse signals
C14	RED	Ignition Coil 2 Control (IGPLS2)	Pulse signals
C16	WHT	Front HO2S-11 Signal	0-1100 mv
C17	RED/GRN	MAP Sensor Signal	Hot Idle: 0.92v (sea level)
C19, C28	YEL/RED	Sensor VREF (VCC1, VCC2)	4.9-5.1v
C20, C21	GRN, RED	TDC1 Sensor (+), TDC1 (-) Signal	AC Pulse signals
C-22	RED/BLU	Knock Sensor Signal	Engine knocking: pulse signals
C23	WHT/BLU	Ignition Coil 6 Control (IGPLS6)	Pulse signals
C25	RED/YEL	IAT Sensor Signal	1-3v (ambient air dependent)
C26	RED/WHT	ECT Sensor Signal	0.6v (engine coolant dependent)
C27	RED/BLK	TP Sensor Signal	Hot Idle: 0.6v
C29, C30	YEL, BLK	TDC2 Sensor (+), TDC2 (-) Signal	AC Pulse signals

2000 Odyssey 3.5L V6 SOHC Engine Pin Voltage Table (16-Pin 'C' Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
D1	YEL	A/T: Lockup Control Solenoid	No Lockup: 12v, Lockup On: 0v
D2	GRN/WHT	A/T: Shift Solenoid Valve 'B'	In 1st & 2nd gear: 12v, other: 0v
D3	GRN	A/T: Shift Solenoid Valve 'C'	In 1st & 3rd gear: 12v, other: 0v
D5	BLK/YEL	A/T: Power to Solenoid Valve	12-14v
D6	WHT	A/T: Gear Position (Reverse)	In Reverse: 0v, all others: 12v
D7	BLU/YEL	A/T: Shift Solenoid Valve 'A'	In 2nd & 3rd gear: 12v, other: 0v
D8	PNK	A/T: Gear Position (Drive 3)	In D3: 0v, all others: 12v
D9	YEL	A/T: Gear Position (Drive 4)	In D4: 0v, all others: 12v
D10, D16	BLU, GRN	Countershaft Speed (+), (-) Signal	AC pulse signals
D11, D12	RED, WHT	Main Shaft Speed (+), (-) Signal	AC pulse signals
D13	BLU/BLK	2nd Oil Pressure Switch	12v
D14	BLU	A/T: Gear Position (Drive 2)	In D2: 0v, all others: 12v
D15	BRN	A/T: Gear Position (Drive 1)	In D1: 0v, all others: 12v

PCM Connectors Graphic (View is into the Wire Side of the Harness Terminals)

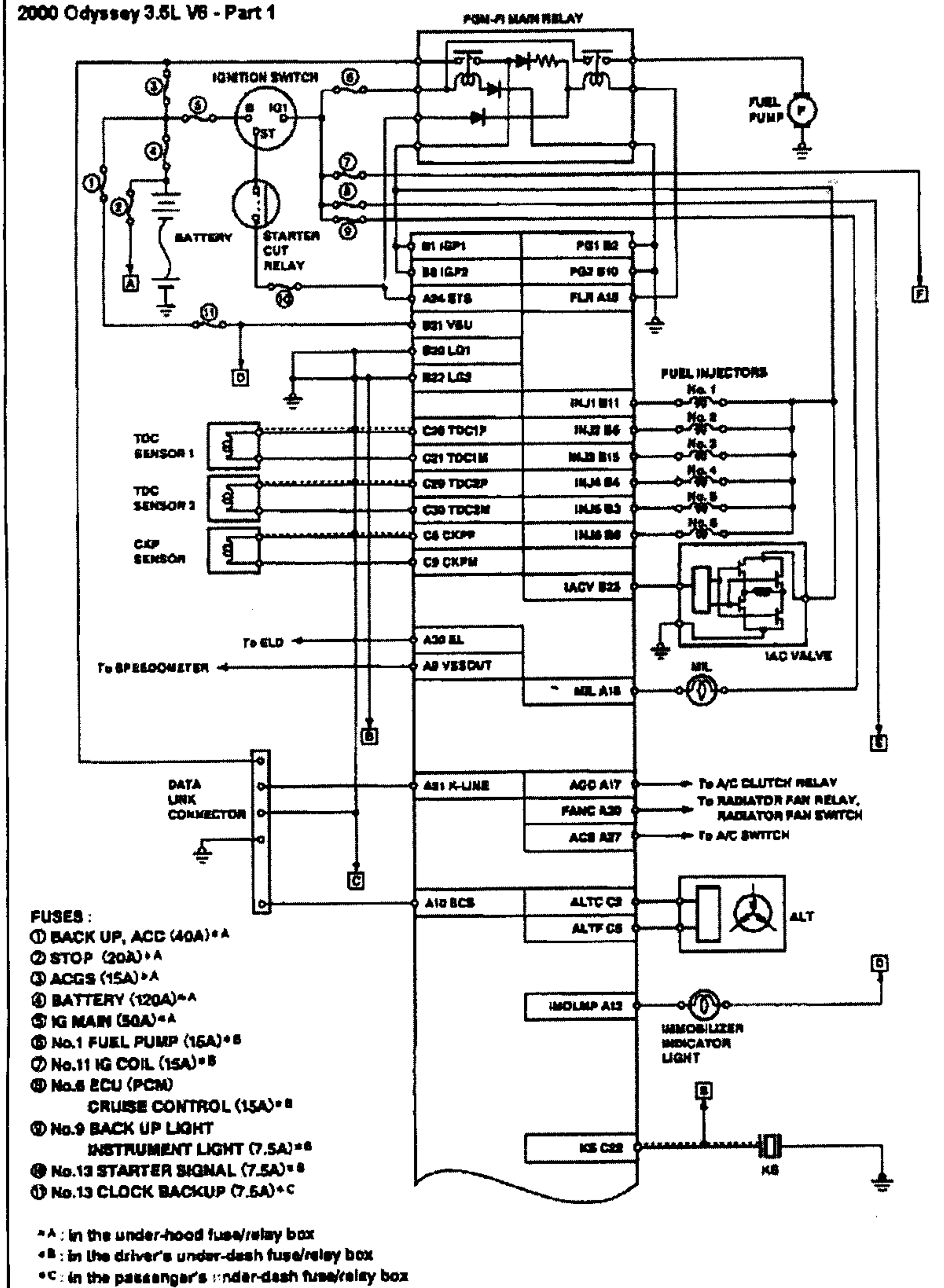


2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Wiring Diagrams

Fuel & Ignition System Diagrams (1 of 6)

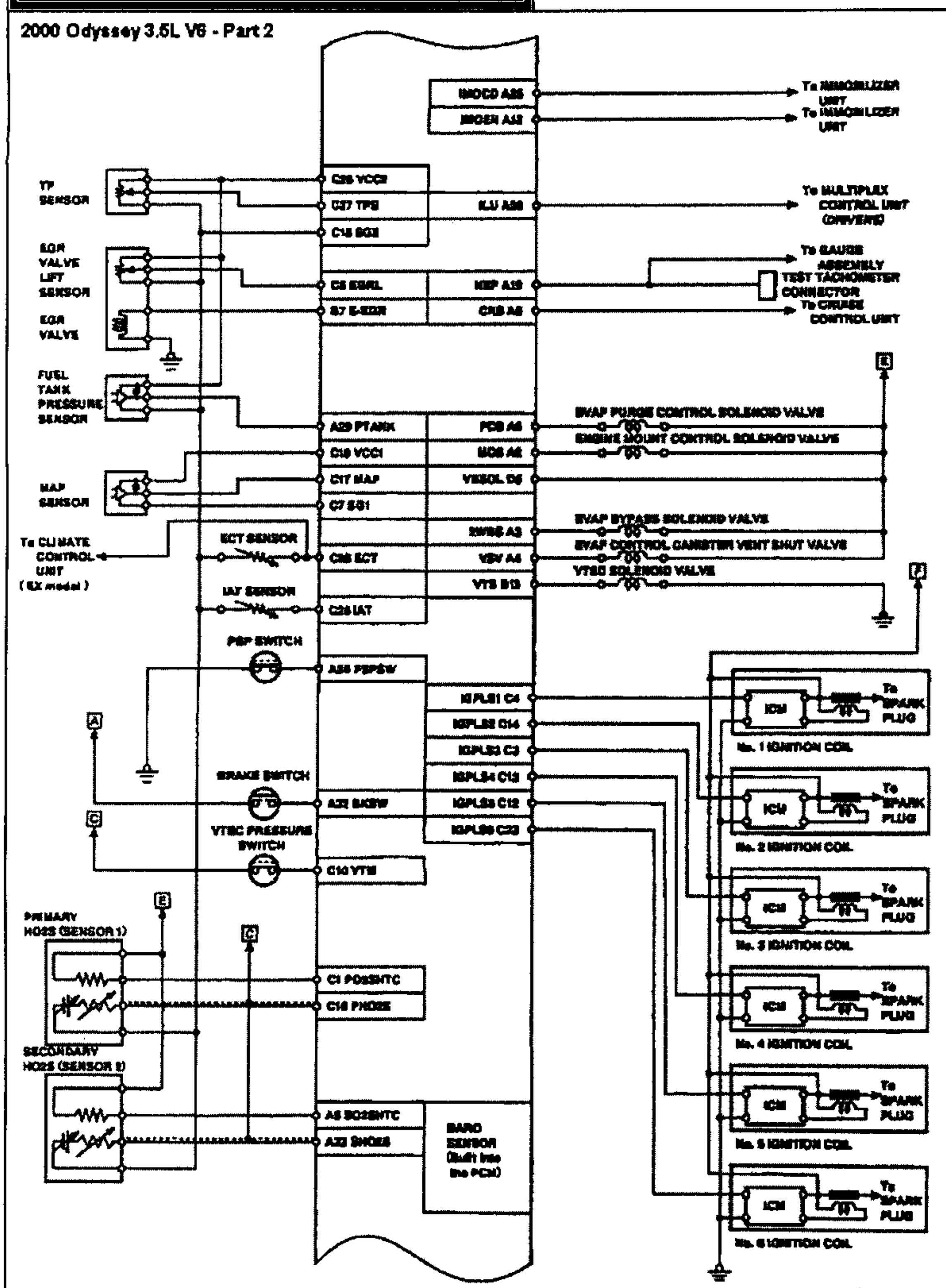
2000 Odyssey 3.5L V6 - Part 1



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Wiring Diagrams

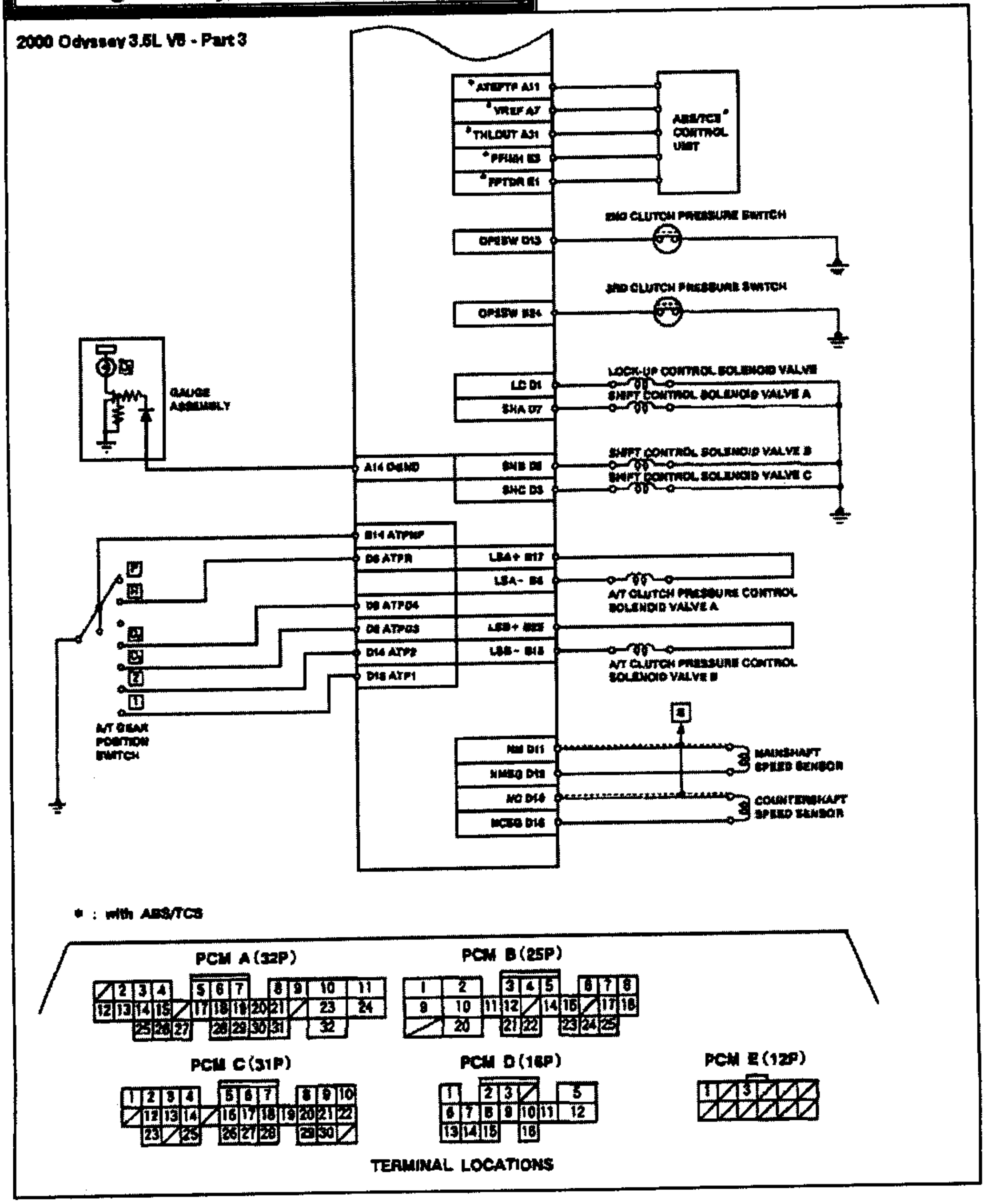
Fuel & Ignition System Diagrams (2 of 6)



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Wiring Diagrams

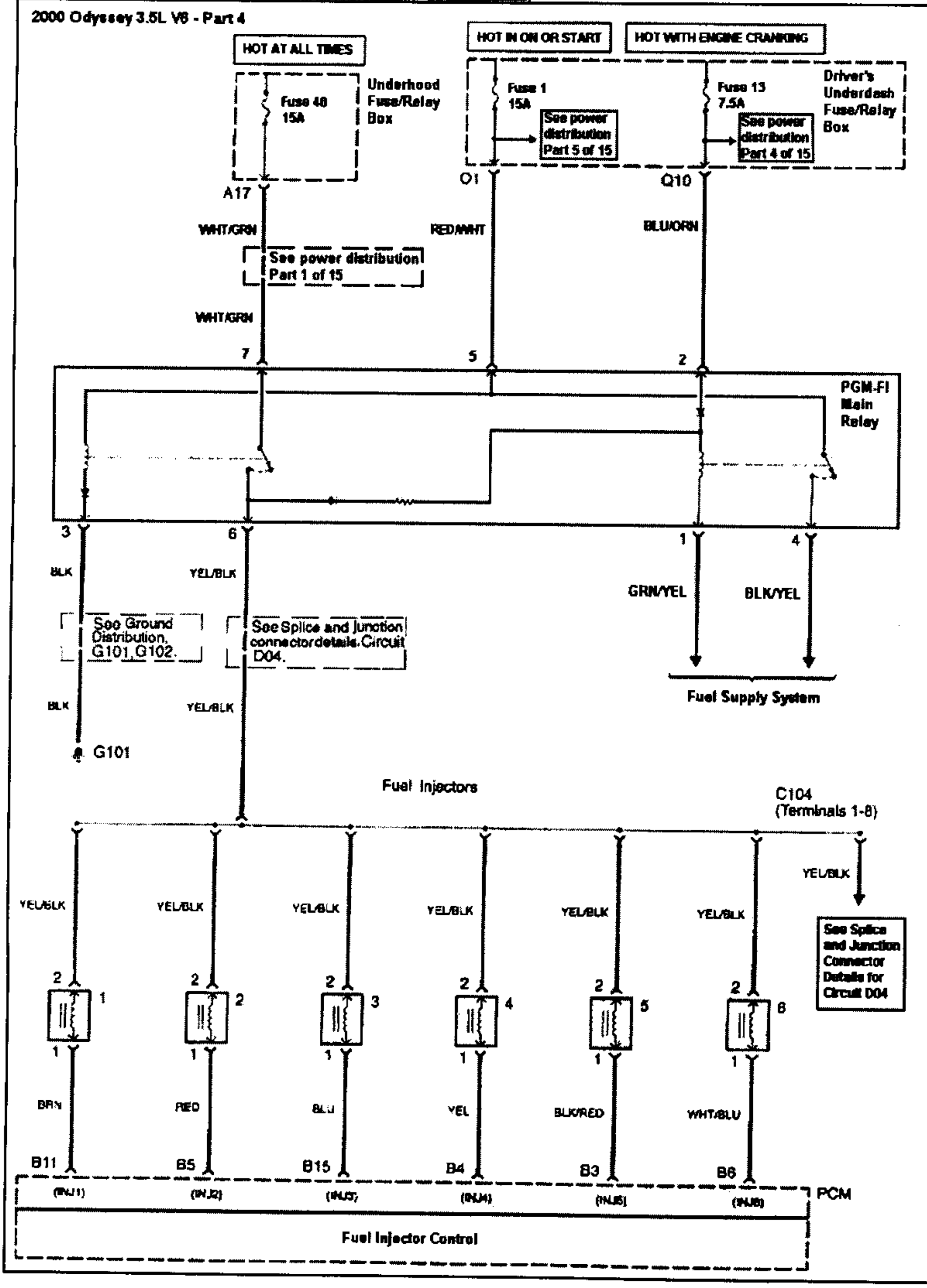
Fuel & Ignition System Diagrams (3 of 6)



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Wiring Diagrams

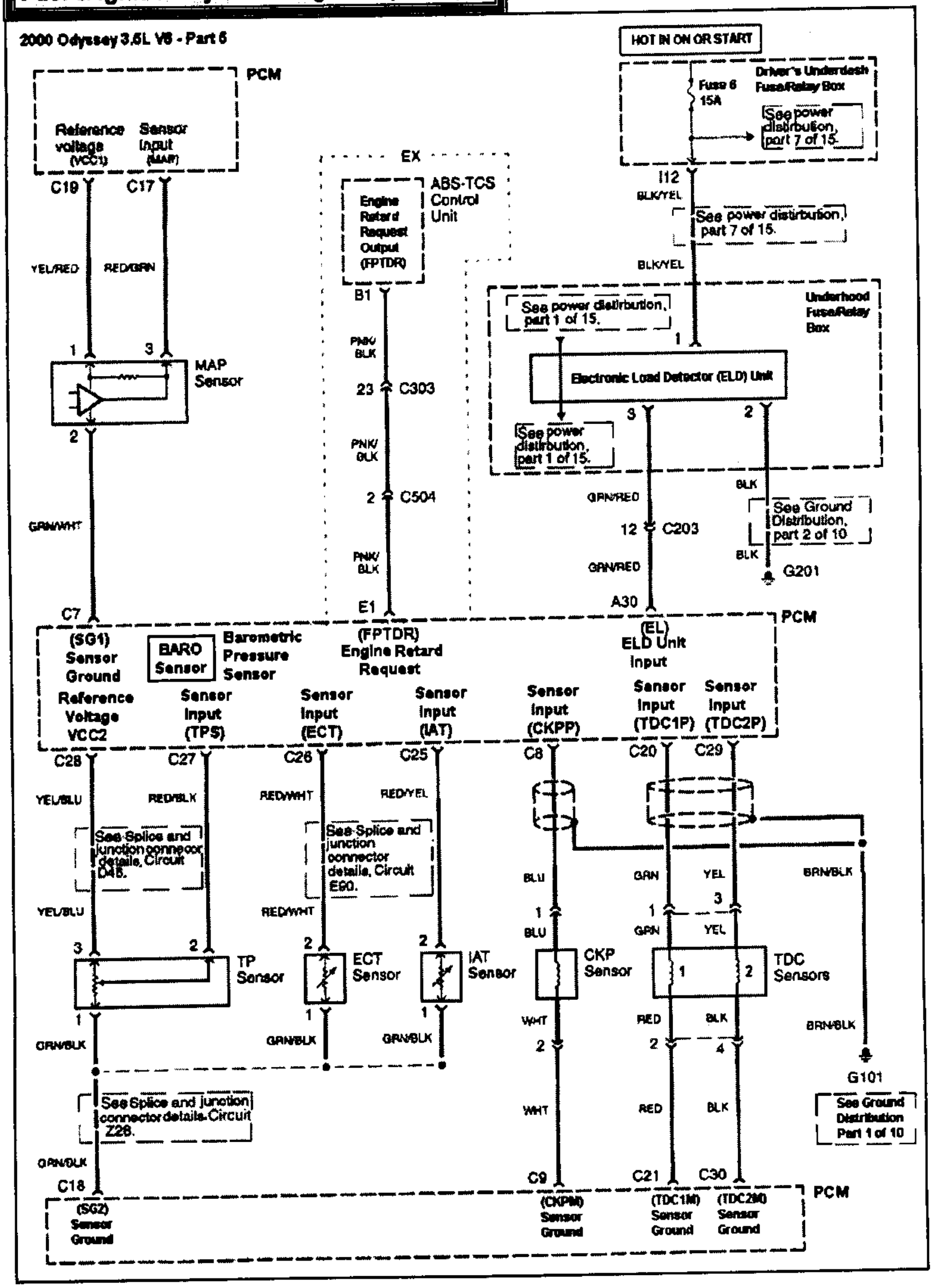
Fuel & Ignition System Diagrams (4 of 6)



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Wiring Diagrams

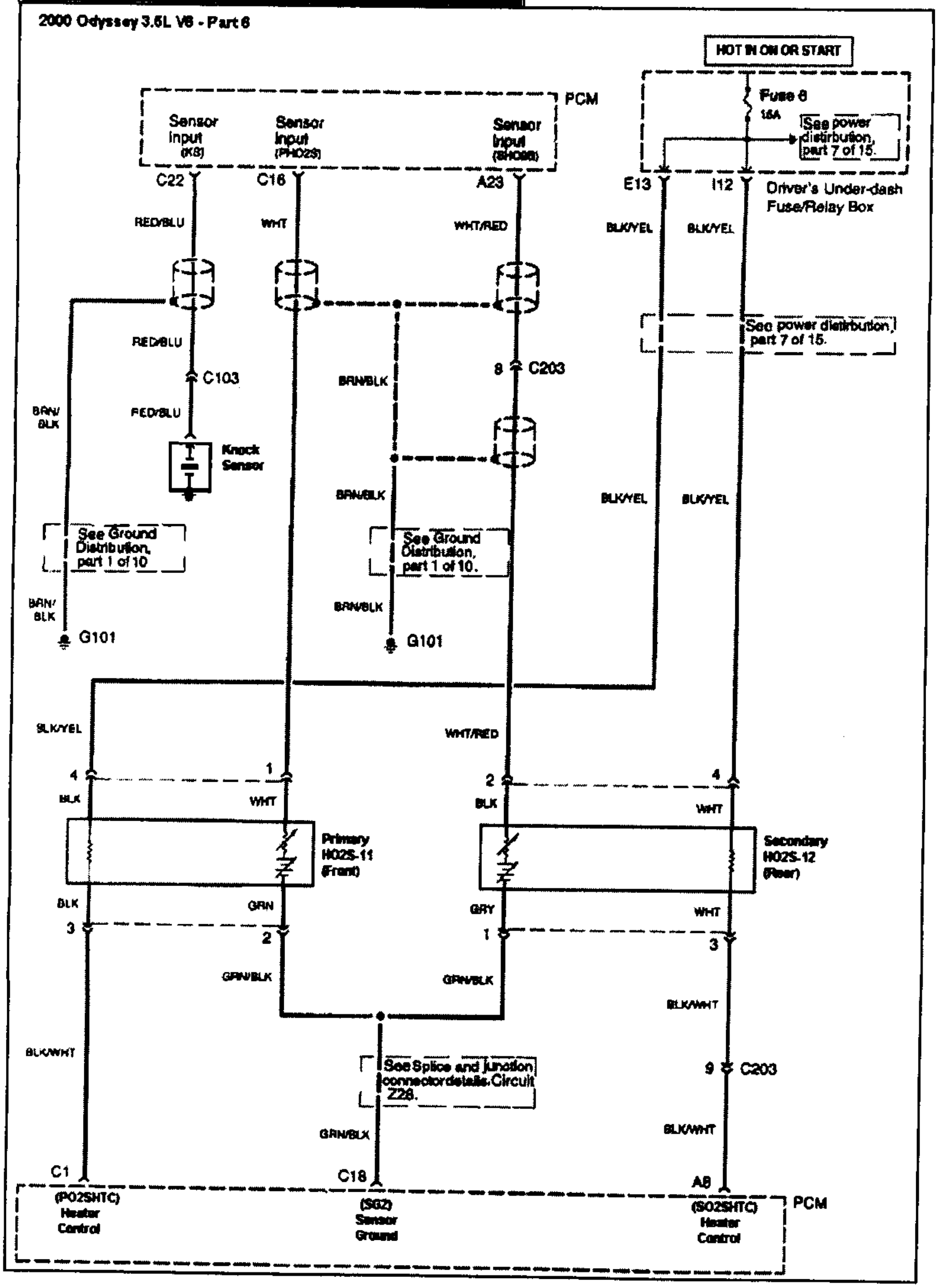
Fuel & Ignition System Diagrams (5 of 6)



2000 ODYSSEY (3.5L V6 SOHC VIN RD1)

PCM Wiring Diagrams

Fuel & Ignition System Diagrams (6 of 6)



1995 CIVIC (1.5L I4 VTEC VIN EH2)

Lean Air/Fuel Oxygen Sensor

General Description

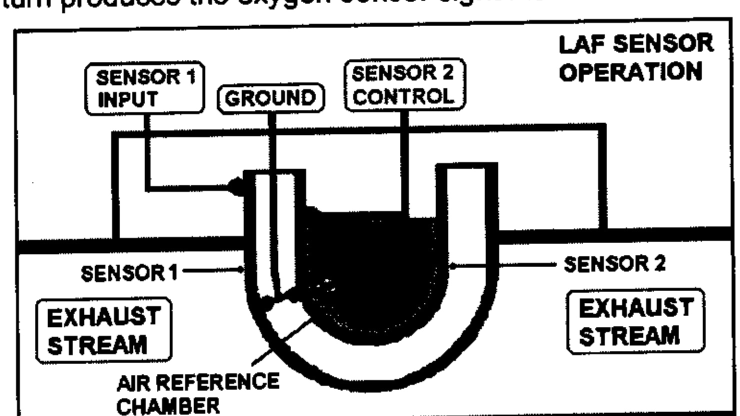
This vehicle application is equipped with a Lean Air/Fuel (LAF) design oxygen sensor that allows the vehicle to achieve improved fuel efficiency while at cruise speeds. This increase in fuel economy is accomplished by maintaining an A/F mixture that is leaner than 14.7:1. The LAF sensor is also referred to as a wide range oxygen sensor.

This device includes a unique 2-cell Zirconia oxygen sensor designed to hold the A/F mixture at 14.7:1 during certain driving conditions and leaner than 14.7:1 during other driving conditions. The LAF sensor can monitor exhaust oxygen conditions over a wider operating range (from 14:1 up to 23:1), hence the name wide range oxygen sensor.

<u>Zirconia Oxygen Sensor Review</u>

Before we discuss how the LAF sensor operates, let's review how a Zirconia oxygen sensor operates. This oxygen sensor contains a thimble-shaped Zirconia element with two sides or electrodes. The inside of the element is the reference "air chamber", and this chamber is vented to atmosphere. The outside element is exposed to the exhaust gas. The sensor ground circuit is connected to the outside of the sensor element.

The flow of oxygen ions through the sensor element is what creates the oxygen sensor signal. An oxygen ion is an oxygen atom with an electrical charge. In effect, a flow of oxygen is also a flow of oxygen atoms. The lower amount or concentration of oxygen in the exhaust (when compared to the amount in the atmosphere) creates a flow of oxygen ions in the sensor. This action in turn produces the oxygen sensor signal to the PCM.



<u>LAF Sensor Components</u>

The LAF sensor has two Zirconia elements (not just one as in a conventional sensor). These two Zirconia elements share a common diffusion chamber.

In effect, the LAF sensor contains two oxygen sensors mounted inside one unit. The heater control (HTRC) circuit is connected to ground at the sensor shell. The remaining circuits are used to control and monitor the two air chambers inside the unit.

The three (3) chambers inside the LAF sensor are described below:

- The first chamber (used to contact the exhaust flow)
- The second chamber is the diffusion chamber (between the elements)
- The third chamber is the air reference chamber

The first chamber is really the outside of the sensor (it contacts the exhaust). The diffusion chamber is the area between the two Zirconia elements. The air reference chamber is the other end of the device. The basic operating principle of the LAF sensor is that by controlling the amount of oxygen in the diffusion chamber, the operating range of the sensor can be controlled. One of the Zirconia elements acts as an oxygen pump. As previously discussed, the flow of oxygen ions in the sensor works like an air pump. An inverse flow of oxygen ions in an oxygen sensor also causes a similar action. In effect, a flow of electrons applied to the LAF sensor causes a flow of oxygen ions.

1995 CIVIC (1.5L I4 VTEC VIN EH2)

Lean Air/Fuel Oxygen Sensor

LAF Sensor Operation

The Zirconia elements are connected in parallel at a common ground point between the sensors. This is a reference point for the PCM (do not confuse it with chassis ground).

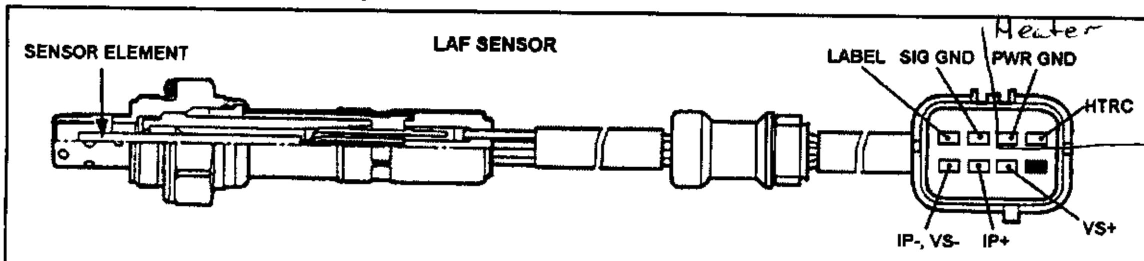
The PCM monitors the voltage between sensor No. 1 input and the sensor ground. The PCM is constantly attempting to hold the voltage difference between sensor No. 1 and sensor ground to a level of 450 mv.

When the LAF sensor shifts rich, oxygen ions flow from the diffusion chamber into the exhaust. When this occurs, the voltage at the sensor No. 1 input increases. The PCM detects the voltage increase and reduces the voltage on the sensor No. 2 input. This causes the voltage on sensor No. 2 to shift to a more negative value than the ground voltage, and this causes sensor No. 2 to pump oxygen out of the diffusion chamber into the air reference chamber. When the oxygen content in the diffusion chamber drops, the voltage signal from sensor No. 1 drops. At the same time, the PCM reduces the voltage on sensor No. 2 input and this action results in a reduced fuel delivery command.

The change in fuel delivery command results in a leaner A/F mixture, and this causes the opposite affect on the LAF sensor. As the mixture goes leaner, oxygen ions in the exhaust flow into the diffusion chamber. This causes the sensor No. 1 voltage to decrease. The PCM detects this voltage decrease and increases the voltage on the sensor No. 2 input. The voltage on sensor No. 2 then goes to a more positive value (than the ground reference). This action causes sensor No. 2 to pump oxygen into the diffusion chamber from the air reference section. The voltage between sensor No. 1 input and ground is consistently held at 450 mv.

The PCM uses these signal changes to determine the rich/lean condition of the exhaust stream at any given moment by detecting how much amperage it takes the sensor No. 2 input to hold the sensor No. 1 input voltage to 450 mv. This information allows the PCM to control the operation of the LAF sensor.

Lean Air/Fuel Sensor Graphic



LAF Sensor Diagnostics

Problems in the LAF sensor are diagnosed in the same manner as any other oxygen sensor - through the use of the Onboard Diagnostics. A fault in a LAF sensor circuit or component will cause the PCM to set a trouble code in memory. If a fault is detected in the A/F sensor on OBD I system, the PCM will set DTC 48.

LAF Sensor - Code 48

This trouble code indicates one of the LAF sensor circuits has an open condition or short to ground condition, or that the LAF sensor has failed internally.

1995 CIVIC (1.5L I4 VTEC VIN EH2)

Lean Air/Fuel Oxygen Sensor

DVOM Test (LAF Sensor)

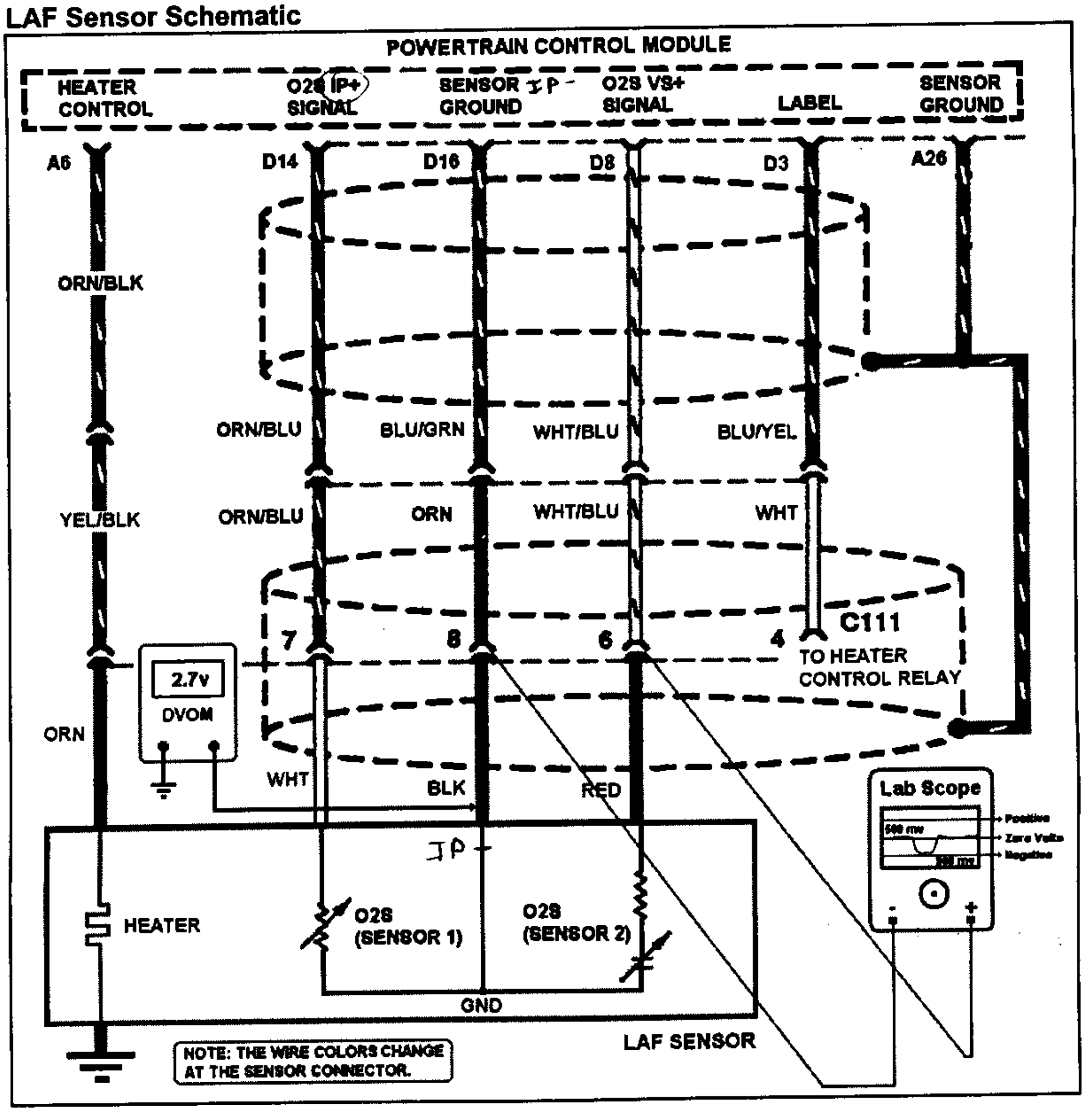
Connect the DVOM positive probe to the LAF sensor ground and the negative probe to chassis ground. The sensor should read near 2.7v with the key turned "on". Then connect the DVOM between Sensor No. 1 (D14) and Sensor Ground (D16). The meter should read close to 450 mv with the engine running and fully warmed up.

The heater relay supplies B+ to the PCM (Pin D3). The heater receives power on Pin A6.

LAF Sensor Tests

Connect the Lab Scope positive probe to the LAF O2S VS+ circuit (Sensor #2). Connect the negative probe to the sensor ground circuit. Do not connect it to chassis ground! Force the exhaust stream rich (with propane or a snap throttle test in P/N). The signal should go negative (indicating a rich mixture). Force the exhaust stream lean (shutoff the propane or return to idle). The signal should go positive (indicating a lean mixture).

LAF Sensor Schematic



1995 CIVIC (1.5L I4 VTEC VIN EH2)

Lean Air/Fuel Oxygen Sensor

Lab Scope Test (LAF Sensor)

The Lab Scope is the tool of choice to monitor the operation of the Lean Air/Fuel (LAF) sensor output and circuits.

Wire Color Changes

The wire colors for the LAF sensor change at the sensor connector. These changes have been noted in the Scope Connections instructions on this page.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to *match the* example.

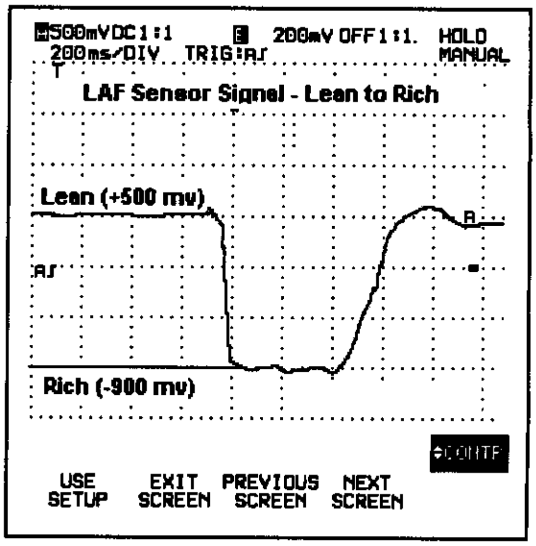
Scope Connections

Connect the Channel 'A' positive probe to the LAF Sensor O2S VS+ signal (WHT/BLU) wire at D8 of the PCM or connect the probe to the WHT/BLU wire at the sensor connector.

Note that the wire colors change at the sensor. The wire color changes from a WHT/BLU wire to a RED wire on the O2S VS+ signal circuit.

Connect the Channel 'A' negative probe to the LAF sensor ground circuit (BLU/GRN wire) at Pin D16 of the PCM or connect the probe to the BLU/GRN wire at the sensor connector.

Note that the wire colors change at the sensor. The wire color changes from a BLU/GRN wire to a BLK wire on the sensor ground circuit.



Test Explanation

If the LAF sensor is at normal temperature and operating correctly, the LAF signal voltage should change more than 1.0 volt (1000 mv) during this type of test.

In this example, the engine was at idle speed, and then a snap acceleration event was performed. As can be seen by the information in the capture, the signal changed from a value (above ground) of near 500 mv to a value of near -900 mv.

To check the sensor operation, add the two values together (e.g., 500 mv + 900 mv = 1400 mv) to determine if the LAF sensor change was within its operating parameters. If the sensor does not respond in this manner when hot, it may need to be changed.

No Code Faults

As previously mentioned, if there is a fault in the LAF sensor or one of its circuits, the PCM will set Code 48. However, if the sensor is lazy you will need to use a Lab Scope to properly determine if the LAF sensor has failed.

1.0 Volt Change within 100 mS

NISSAN CONTENTS

NISSAN CONTENTS

NISSAN CONTENTS

NISSAN CONTENTS

ADVANCED ENGINE DIAGNOSTICS

Introduction

How To Use This Section

This section of the manual was developed to provide theory of operation and testing information for Engine and Transmission Control devices on Nissan Motor Co. vehicles.

This information was written in a manner that will allow you to easily compare how to connect up to a similar vehicle component and make a test measurement. In many cases we have recommended which piece of diagnostic or test equipment to use first (depending upon the trouble code or related symptom) for a particular component.

This information includes various articles for the following vehicles:

1) 1997 Maxima (3.0L V6 VIN C Engine)

2) 1999 Sentra (1.6L I4 VIN A Engine)

Key Subject Areas

A description of the Engine Control devices included in this section is provided below:

Automatic Transmission Controls
- Inhibitor Switch & Park Neutral Switch
- Overdrive Control Switch
- Vehicle Speed Sensor

Crankshaft Position Sensors
- CKP Sensor

Camshaft Position Sensor
- CMP Sensor

Combination Meter
- Malfunction Indicator Lamp

Electric Fuel Pump

Fuel Injectors

Idle Air Control Motor

Information Sensors
- MAF Sensor
- MAP Sensor
- Oxygen Sensor
- TP Sensor

Reference Information

This section includes important reference information in the following categories:
- PCM Computer Locations (1990-2001)
- Parameter Identification (PID) examples for the Powertrain Control Module (PCM)
- Pin Voltage Table examples for the Powertrain Control Module (PCM)
- Wiring Diagram examples for the Powertrain Control Module (PCM)

Diagnostic Help

All of the articles in this section contain separate component tests along with "real world" test examples and results that you can use to compare to a similar vehicle and engine application. All of this information was captured using conventional automotive repair tools and software (i.e., a DVOM, a Lab Scope and a Scan Tool).

ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

Vehicle Identification Number

The vehicle identification number (VIN) is a seventeen (17) digit legal identifier of the vehicle. It is located on a plate that is attached to the upper left corner of the instrument panel. It can be seen through the windshield from outside the vehicle.

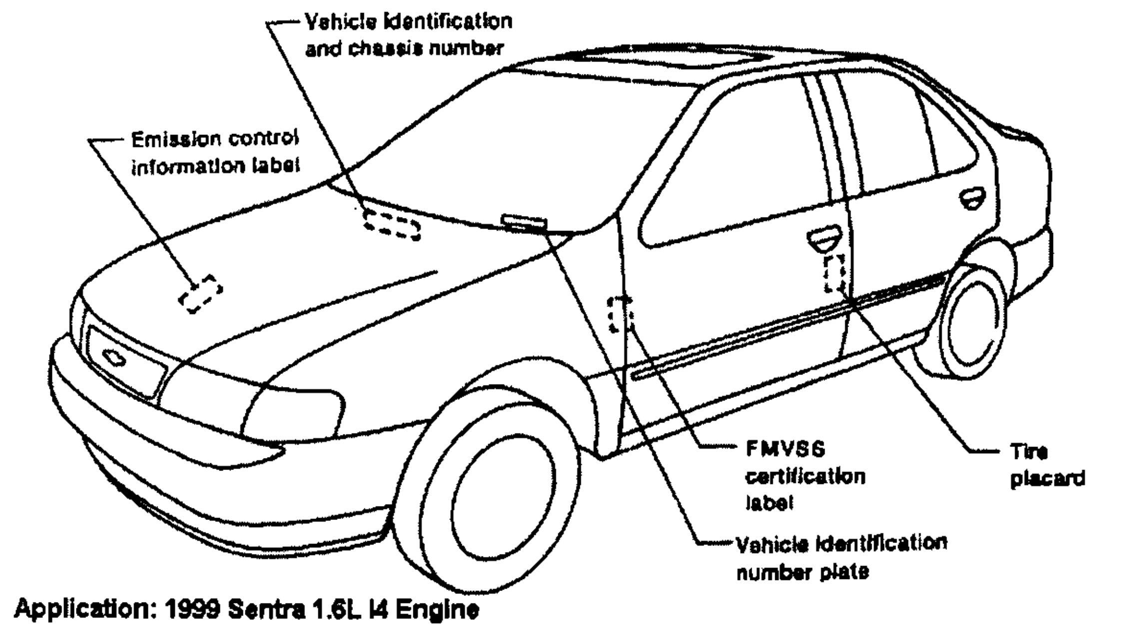
The VIN information includes the country of origin, the make, the vehicle type, the passenger safety equipment, the car line, the body style, the engine, a check digit, the model year, the assembly plant and vehicle build sequence.

Nissan Vehicle Identification Number (VIN) Code Example

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	N	4	B	B	4	1	D	0	Y	C	7	0	0	0	0	1

VIN Code Decoding Table (2000 Sentra Example)

Position	Interpretation	Code = Description
1, 2 & 3	Manufacturer, Make & Type	Manufacturer: 1N4: USA produced, 3N1: Mexico produced Vehicle
4	Engine Type	A = GA16DE (1.6L I4), B = SR20DE (2.0L I4)
5	Vehicle Line	B: Nissan Sentra
6	Model Change	4
7	Body Type	1: 4-Door Sedan
8	Restraint System	D: Driver and front passenger air bags & 3-point belts S: 3-point manual seatbelts only
9	Check Digit	0 to 9, or X (determined by mathematical computation)
10	Model Year (Also located at Driver's Door)	L = 1990 1994 = R 1998 = W M = 1991 1995 = S 1999 = X N = 1992 1996 = T 2000 = Y P = 1993 1997 = V 2001 = 1
11	Manufacturing Plant	C = Smyma, Tennessee; L = Aguascalientes, Mexico
12 through 17	Vehicle Serial Number	-----



Application: 1999 Sentra 1.6L I4 Engine

ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

<u>Vehicle Emission Control Information</u>

The Vehicle Emission Control Information Label (sticker) is located under the hood. This example is for a 1999 Sentra 1.6L I4 Engine with a 4-speed automatic transmission.

Exhaust Emission Control Type (TWC / HO2S / EGR / SFI)

The items in this designation indicate this vehicle has a three-way catalyst (TWC), two heated oxygen sensors, an EGR system and sequential fuel injection.

OBD II Certified

This designator on the VECI label indicates this vehicle was certified for OBD II use.

50ST (50 States)

If this designator is used, the vehicle conforms to U.S. EPA & State of California regulations applicable to 1999 model year new motor vehicles (50 States).

49ST (49 States/Federal)

If this designator is used, this vehicle conforms to U.S. EPA regulations applicable to 1999 model year new motor vehicles.

CAL (California)

If this designator is used, the vehicle conforms to U.S. EPA and State of California regulations applicable to 1999 model year new passenger cars provided that the vehicle is only introduced into commerce in the State of California.

VEHICLE EMISSION CONTROL INFORMATION

- ENGINE FAMILY: XNSXVQ.631A / OBD-II CERTIFIED
- ENGINE DISPLACEMENT: 1.6L
- EVAPORATIVE FAMILY: XNSXOOROC65RCA
- EXHAUST EMISSION CONTROL TYPE: TWC(2) / HO2S(2) / EGR / SFI
- ENGINE TUNE UP SPECIFICATIONS AND ADJUSTMENTS

IDLE SPEED	MANUAL: 675 R.P.M. (N) AUTOMATIC: 800 R.P.M. (N)
HIGH IDLE SPEED	NO OTHER ADJUSTMENTS NEEDED
IDLE MIXTURE SETTING	NO OTHER ADJUSTMENTS NEEDED
VALVE LASH	NO OTHER ADJUSTMENTS NEEDED
IGNITION TIMING	8° B.T.D.C.

- ENGINE AT NORMAL OPERATING TEMPERATURE
- ALL ACCESSORIES TURNED OFF
- KEEP THE STEERING WHEEL IN A STRAIGHT AHEAD POSITION
- CHECK WHEN RADIATOR COOLING FAN DOES NOT OPERATE
- SEE SERVICE MANUAL AND MAINTENANCE SCHEDULE FOR ADDITIONAL INFORMATION

THIS VEHICLE CONFORMS TO U.S. EPA AND STATE OF CALIFORNIA REGULATIONS APPLICABLE TO 1999 MODEL YEAR NEW LEV PASSENGER CAR PROVIDED THAT THIS VEHICLE IS ONLY INTRODUCED INTO COMMERCE FOR SALE IN THE STATE OF CALIFORNIA

(ML)

NISSAN MOTOR CO., LTD GA16DE

NISSAN

4 M 0 1 5 CATALYST

Model Variation Information (1999 Sentra Example)

Destination	Body	Grade	GA16DE 5-speed manual RS5F31A	GA16DE 4-speed automatic RL4F03A	SR20DE 5-speed manual RS5F32V	SR20DE 4-speed automatic RE4F03A
Non-California USA	4-door Sedan (SENTRA)	Base	BAYALCF-EUA	—	—	—
		XE	BAYALEF-EUA	BAYALEA-EUA	—	—
		GXE	BAYALBF-EUA	BAYALBA-EUA	—	—
		SE	—	—	BBYALSF-EUA	BBYALSA-EUA
California USA	4-door Sedan (SENTRA)	Base	BAYALCF-EVA	—	—	—
		XE	BAYALEF-EVA	BAYALEA-EVA	—	—
		GXE	BAYALBF-EVA	BAYALBA-EVA	—	—
		SE	—	—	BYALSF-EVA	BBYALSA-EVA
Canada	4-door Sedan (SENTRA)	Base	BAYALCF-ENA	—	—	—
		XE	BAYALEF-ENA	BAYALEA-ENA	—	—
		GXE	BAYALBF-ENA	BAYALBA-ENA	—	—
		SE	—	—	BBYALSF-ENA	BBYALSA-ENA

ADVANCED ENGINE DIAGNOSTICS

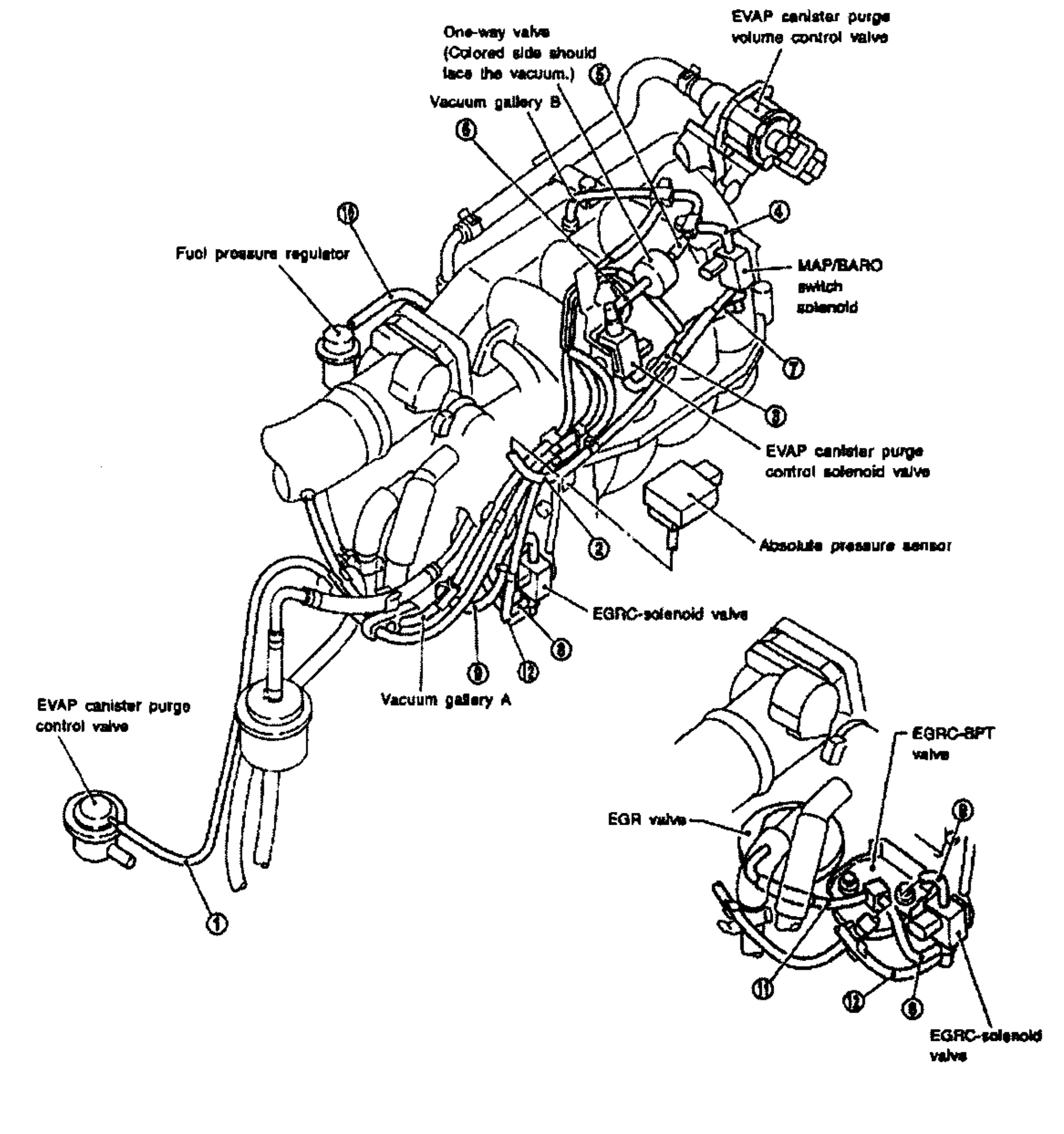
Vehicle Identification

<u>Vacuum and Vapor Hose Diagrams</u>

An example of the Vacuum and Vapor Hose Diagram available from Nissan for a 1999 Sentra is shown in the Graphic on this page.

1999 Sentra GXE Vacuum and Vapor Hose Graphic

Application: 1999 Sentra 1.6L I4 Engine



(1) EVAP canister purge control valve to EVAP canister purge control solenoid valve
(2) Absolute pressure sensor to MAP/BARO switch solenoid valve
(3) EVAP canister purge control solenoid valve to Vacuum gallery A
(4) MAP/BARO switch solenoid valve to Vacuum gallery B
(5) One-way valve to Vacuum gallery B
(6) One-way valve to EVAP canister purge control solenoid valve
(7) MAP/BARO switch solenoid valve to Vacuum gallery A
(8) EGRC-solenoid valve to EGRC-BPT valve
(9) EGRC-solenoid valve to Vacuum gallery A
(10) Fuel pressure regulator to Intake manifold collector
(11) EGR valve to EGRC-BPT valve
(12) EGRC-solenoid valve to Vacuum gallery B

ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

Engine Code Definitions - Altima GLE, GXE, XE, XLE

Code	Definition
B	Altima I4 KA24DE (2.4L I4 DOHC SMFI)
D	Altima I4 KA24DE (2.4L I4 DOHC SMFI)

Engine Code Definitions - Maxima GLE, SE, XLE

Code	Definition
C	Maxima V6 VQ30DE (3.0L V6 DOHC SMFI)

Engine Code Definitions - Sentra SE, XE, GXE

Code	Definition
A	Sentra I4 GA16DE (1.6L I4 DOHC SMFI)
A	Sentra I4 QG18D (1.8L I4 DOHC SMFI)
B	Sentra I4 SR20DE (2.0L I4 DOHC SMFI)

Engine Code Definitions - 200 SX

Code	Definition
A	200 SX I4 GA16DE (1.6L I4 DOHC SMFI)
B	200 SX I4 SR20DE (2.0L I4 DOHC SMFI)

Engine Code Definitions - 240 SX, LE, SE

Code	Definition
A	240 SX I4 KA24DE (2.4L I4 DOHC SMFI)

Engine Code Definitions - 300 SX Z32

Code	Definition
C	300 SX V6 VQ30DE (3.0L V6 DOHC SMFI)
R	300 SX Turbo V6 VQ30DE (3.0L V6 DOHC SMFI)

Engine Code Definitions - Frontier SE, XE

Code	Definition
D	Frontier I4 KA24DE (2.4L I4 DOHC SMFI)
E	Frontier V6 VG33E (3.3L V6 SOHC SMFI)

Engine Code Definitions - Pickup SE, XE

Code	Definition
D	Pickup I4 KA24DE (2.4L I4 DOHC SMFI)

Engine Code Definitions - Pathfinder LE, SE, SE Limited

Code	Definition
A	Pathfinder V6 VG33E (3.3L V6 SOHC SMFI)

Engine Code Definitions - Xterra SE 2WD & 4WD

Code	Definition
D	Xterra I4 KA24DE (2.4L I4 DOHC SMFI)
A	Xterra V6 VG33E (3.3L V6 SOHC SMFI)

Engine Code Definitions - Quest XE & GXE

Code	Definition
D	Quest V6 VG30E (3.0L V6 SOHC SMFI)
A	Quest V6 VG33E (3.3L V6 SOHC SMFI)

ADVANCED ENGINE DIAGNOSTICS

PCM Location Tables

Car Applications

This table can be used to identify the location of the Powertrain Control Module (PCM) for 1990-2001 Nissan Motor Company Car, SUV, Truck and Van applications.

PCM Location Table - Cars

Year	Car Models	Car Models	Car Models
1990	**Maxima Models** • Located beneath center console in front of gearshift **Stanza Models** • Located behind the console below the instrument panel	**Pulsar Models** • Located beneath the passenger seat area **Sentra Models (2WD)** • Located under the front passenger's seat **Sentra Models (4WD)** • Located under driver's seat	**240 SX Models** • Located behind the right side kick panel **300 ZX Models** • Located behind the glove compartment right of dash
1991-92	**Maxima Models** • Located beneath center console in front of gearshift **NX Models** • Located behind the center console	**Sentra Models** • Located behind the console below the instrument panel **Stanza Models** • Located behind console below the instrument panel	**240 SX Models** • Located behind the right side kick panel **300 ZX Models** • Located behind center of dash
1993-97	**Altima Models** • Located beneath center console in front of gearshift **Maxima Models** • Located below center of dash	**Sentra Models** • Located behind the lower center of the dash area **200 SX Models** • Located below center of dash	**240 SX Models** • Located behind the right side kick panel **300 ZX Models** • Located below center of dash
1998	**Altima Models** • Located behind instrument panel lower cover **Maxima Models** • Located below the center of the dash (near the glove box)	**Sentra Models** • Located behind the lower center of the dash area	**200 SX Models** • Located under the center of the dash **240 SX Models** • Located behind the right side kick panel
1999	**Altima Models** • Located behind instrument panel lower cover	**Maxima Models** • Located below the center of the dash (near the glove box)	**Sentra Models** • Located behind the lower center of the dash area
2000-01	**Altima Models** • Located behind instrument panel lower cover	**Maxima Models** • Located below the center of the dash (near the glove box)	**Sentra Models** • Located behind the lower center of the dash area
Year	**SUV Models**	**Truck Models**	**Van Models**
1990-92	**Pathfinder Models** • Located under the front passenger's seat	**Pickup Models** • Located under the front passenger's seat	**Van Models** • Located in the side trim panel behind driver's seat
1993-96	**Pathfinder Models** • Located under the front passenger's seat	**Pickup Models** • Located under the front passenger's seat	**Quest Models** • Located behind the glove compartment
1997	**Pathfinder Models** • Located under the center of the dash area	**Pickup Models** • Located under the front passenger's seat	**Quest Models** • Located behind the right side of the dash area
1998-99	**Pathfinder Models** • Located under the center of the dash area	**Frontier Models** • Located below the center of the dash behind lower cover	**Quest Models** • Located behind the right side of the dash area
2000-01	**Pathfinder Models** • Located below center of dash	**Passport Models** • Located below center console	**Quest Models** • Located below right side dash

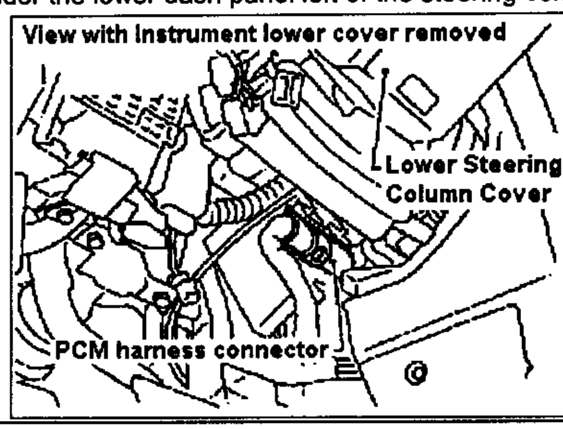
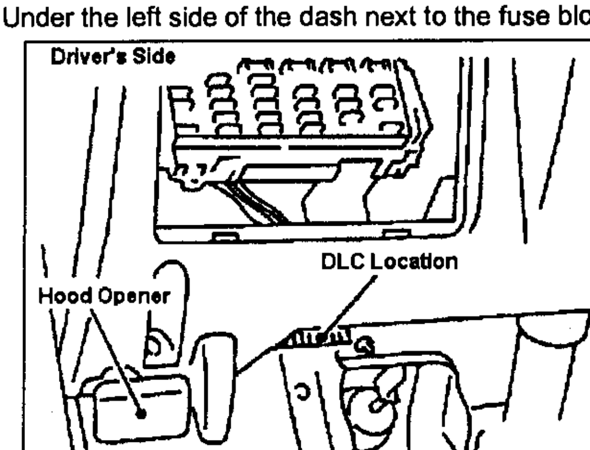
ADVANCED ENGINE DIAGNOSTICS

DLC Location Tables

Introduction

This table can be used to identify the location of the Data Link Connector (DLC) for 1996-2001 Nissan Motor Company Car, SUV, Truck and Van applications.

OBD II Connector (DLC) Location Table - Nissan

Year	Model	Location
1996-2001	Altima	Behind the lower left side of dash area
1996	Maxima	Below right center of dash near the PCM
1997-2001	Maxima	Behind the lower right side of dash area
1996-1997	Sentra	Behind the dash near the Automatic Speed Control unit
1996-2001	Sentra	Behind the left dash panel near the fuse box cover
1996-1997	200 SX	Behind the dash near the Automatic Speed Control unit
1998	200 SX	Behind the left dash panel near the fuse box cover
1996-1998	240 SX	Below the dash to the left of the steering column
1996	300 ZX	Behind the left side kick panel
1996	Pathfinder	Under the dash next to the fuse block
1997-2001	Pathfinder	Under the lower dash panel left of the steering column 
1996-97	Pickup	Under the dash next to the fuse block
1998-2001	Frontier	Behind the left dash panel near the fuse box cover
1997-98	Quest	Under the left side of the dash next to the fuse block
1999-2001	Quest	Behind the left dash panel near the fuse box cover
2000-01	Xterra	Under the left side of the dash next to the fuse block 

ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

Introduction

The Nissan Electronic Concentrated Control System (ECCS) is a computerized system designed to monitor and control the applicable engine and automatic transaxle functions.

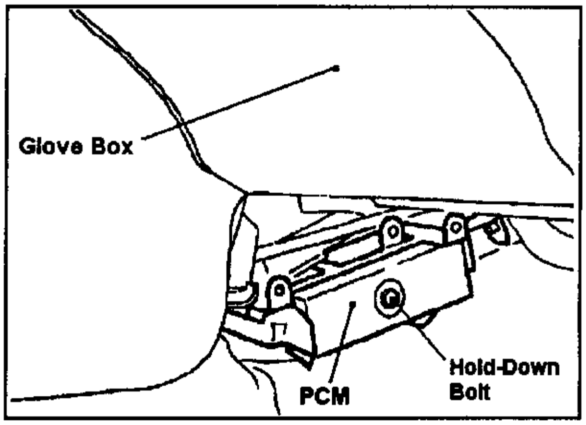
The ECCS fuel control subsystem used with this vehicle application features electronic fuel injection to lower exhaust emissions, while at the same time maintaining good fuel economy and providing improved overall driveability.

At the heart of the ECCS (system) is a powertrain control module (PCM) that includes a central processor unit (CPU) and digital control system. The PCM is also referred to as an ECU in some articles. The CPU is the portion of the PCM that controls the *Fuel*, Ignition, Idle Speed and Emission Control subsystems.

The PCM receives multiple sensor and switch inputs and performs fast calculations so that it can quickly decide how to control the various engine system output devices. It is essential that all input and output signals are correct and stable at all times.

Control of Ignition Timing

The PCM contains information (data lookup tables) that is used to maintain computer control of the ignition timing under all engine-operating conditions. The PCM receives inputs from the CKP POS, CKP REF and CMP sensors that allow it to deliver precise ignition spark timing.



Failsafe Function

The ECCS (system) includes a *failsafe function* that is used to provide minimal engine operation if one or more of the main sensor inputs to the PCM is lost. These devices include the ECT (engine temperature sensor) and the MAF (airflow) sensor.

System Hardware & Software

The Powertrain in the ECCS (system) is divided into system hardware and software.

The hardware components include:

- All related actuators, relays, and solenoids
- All related sensors, switches, interconnecting wires, connectors and terminals
- The EFI main relay and PCM

Operating Strategies

The software components include the programs that contain the strategies used by the PCM to control system outputs based on related inputs.

The PCM contains software strategies for the following subsystems on this application:

- A/T Lockup Converter Control
- Emission Controls (EGR, EVAP and Catalyst)
- Idle Speed System Control
- Ignition Spark Timing Control
- Fuel Injection Control
- PCM (ECU) Diagnostics

ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

Sensor Inputs
The PCM in the ECCS (system) receives signals from these sensors:

- Intake Air Temperature sensor and Barometric Pressure signals
- Engine Coolant Temperature signal (indicates engine temperature)
- CKP Positive, CKP Reference and CMP sensor signals
- Oxygen sensor (front & rear) sensors (indicates amount of oxygen in the exhaust)
- MAF sensor (indicates the amount of engine airflow)
- Throttle Position (TP) sensor (indicates the throttle opening)
- Vehicle Speed sensor (indicates the vehicle speed)

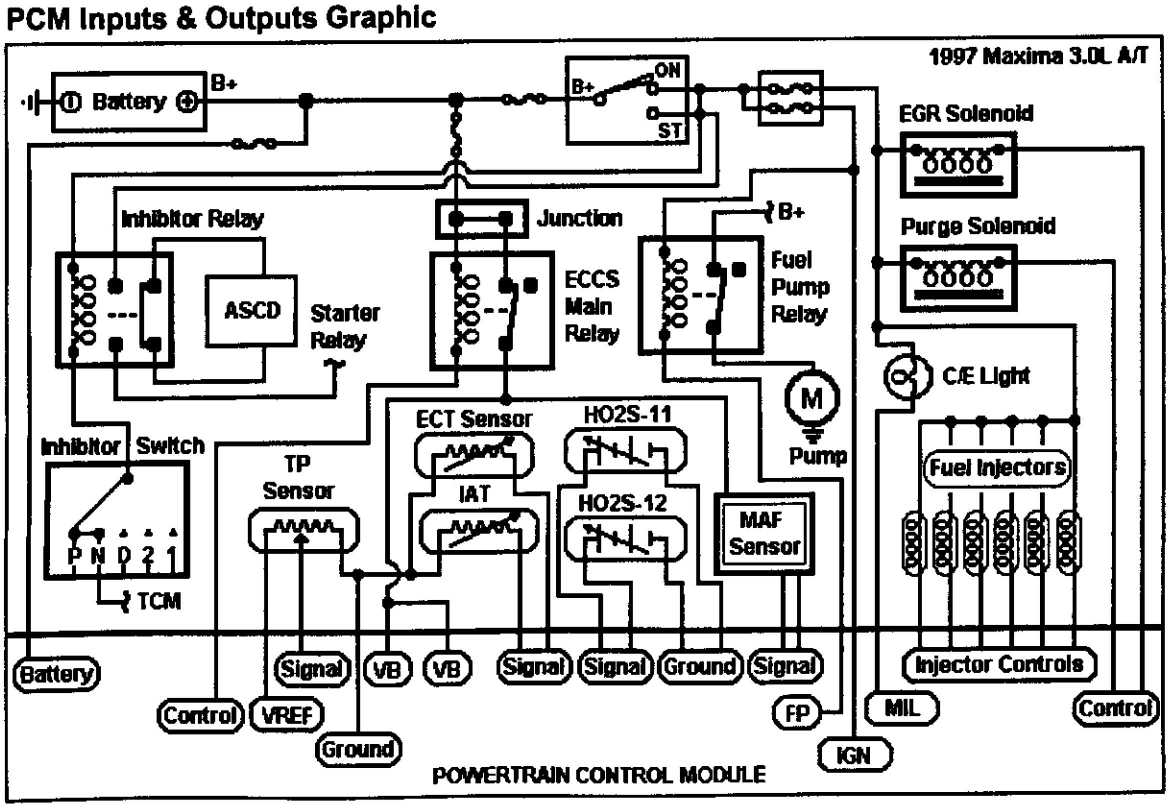
Switch Inputs
The PCM in the ECCS (system) receives signals from these switches:

- Neutral Position switch (indicates the Neutral shift position)
- Neutral Inhibitor switch (indicates the gearshift position)
- Battery Voltage signal (indicates the battery voltage at the Ignition terminal)
- Brake Pedal switch (indicates the switch function - On or Off)

Output Device Signals
The PCM in the ECCS (system) controls the operation of these devices:

- A/C Compressor Clutch operation (control the clutch On/Off function)
- EGR Control and EVAP Purge solenoid operation (turns the solenoid On/Off)
- Fuel Pump Relay operation (controls the fuel pump On/Off operation)
- Fuel injector operation (controls the fuel injector On/Off operation)
- Ignition System operation (controls the ignition coil primary On/Off operation)
- ECCS Main Relay operation (grounds the relay in order to supply vehicle power)

PCM Inputs & Outputs Graphic



ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

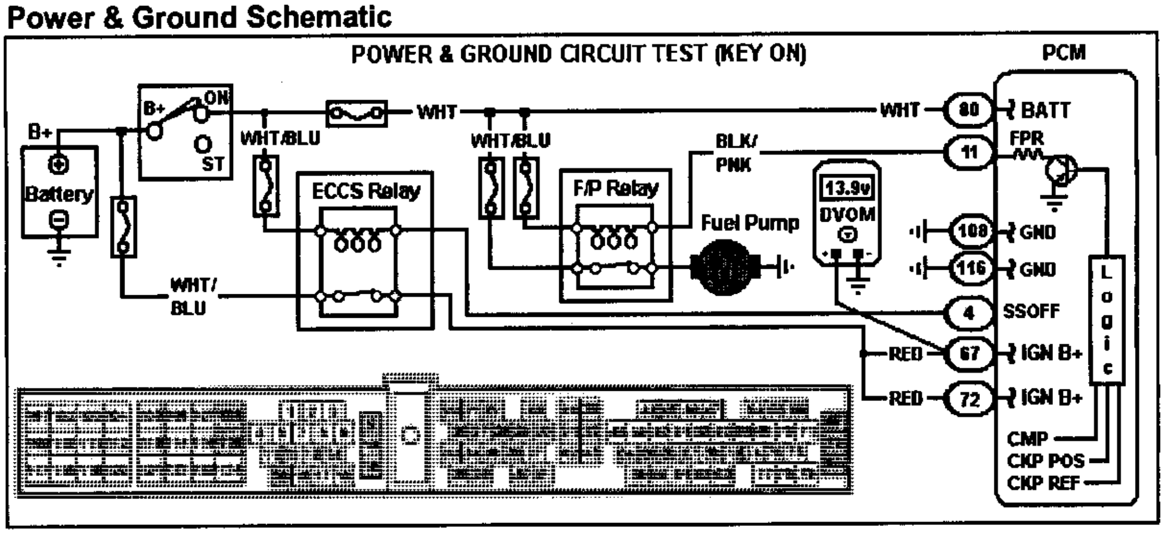
Power & Ground Circuit Tests

The tests in this article should be performed whenever the PCM, an actuator or sensor is suspected of being the cause of a trouble code (Code) or symptom (No Code) problem.

Power & Ground Circuit Repair Table (1997 Maxima 3.0L V6 Example)

Step	Action	Value	Yes	No
1	Turn the key off. Connect a breakout box (BOB) to the PCM (if available). Is this step complete?	-	Go to Step 2.	Connect the Breakout Box.
2	Turn the key on. Connect the DVOM (voltmeter) positive probe to each power ground (pins 10, 19, 25, 32, 108, 116 and 124) and sensor ground terminals (pin 43). Connect the negative probe to the battery negative post. If a BOB is not used, carefully backprobe each individual connector. Does the meter read less than specified value?	<0.1v	Go to Step 3.	Locate and repair the cause of the high resistance ground reading. Then retest for the condition.
3	Connect the DVOM (voltmeter) positive probe to the PCM ignition feed terminals (pins 67 & 72 - RED wires) and the negative probe to the battery negative post. Does the meter read within the specified value with the ignition key turned on?	Within ± 0.3v of battery voltage	Go to Step 4.	Repair cause of low ignition feed circuit reading. Then retest for the condition.
4	Turn the key off. Connect the DVOM (voltmeter) positive probe to the Keep Alive Battery terminal (pin 80 - WHT wire) at the PCM and the negative probe to the battery negative post. Does the meter read within the specified value?	Within ± 0.3v of battery voltage	The power and ground circuits are okay at this time. The test is completed.	Repair cause of low Keep Alive power reading. Then retest for the condition.

Power & Ground Schematic



Battery Ignition Off Draw

The normal amount of current drain on a vehicle without a current drain problem with the key "off" can be from 4-10 milliamps once the vehicle control modules shut down (10-20 seconds after the key is removed). If there is a problem, the current drain will remain.

Electrostatic Discharge Sensitive Devices

Electrostatic discharge sensitive (EDS) devices are solid-state components that should be handled very carefully. Always touch a known good engine ground before handling these parts. This step should be repeated while handling the part or after sliding across the seat. Avoid touching the terminals on the part except with a meter probe as directed.

ADVANCED ENGINE DIAGNOSTICS

Data Bus Communication

Introduction

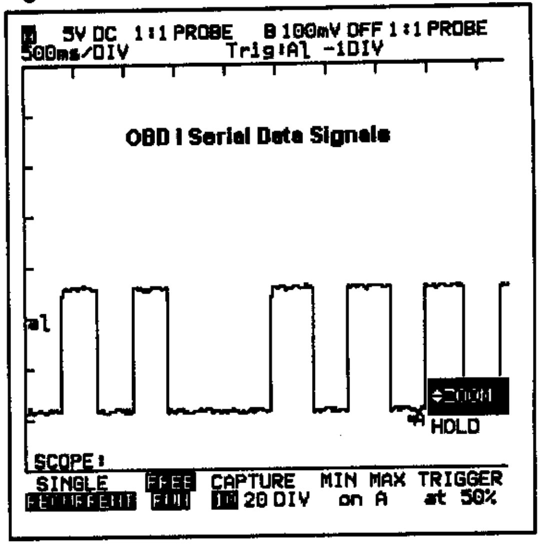
Some Nissan vehicle applications equipped with OBD I diagnostic include a diagnostic connector that can be used to read codes, enable diagnostics and communicate PID data to a Scan Tool. Vehicles equipped with OBD II also use more than one test connector, but OBD II information is available at the DLC on these applications.

Serial Data

Serial data refers to information transferred in a linear fashion over a single line, one bit at a time. During actual communication, serial data captured from the DLC transmit and receive circuits will appear similar to the examples in the Graphics on this page.

ECCS Test Connector (OBD I)

The ECCS test connector is used to read any stored trouble codes. If the Check Engine light remains "on" with the engine running, and the test connector is "jumped", the PCM will flash any stored codes via the Check Engine light.



Data Link Connector (OBD I)

The DLC circuit on an OBD I system is used to transmit and receive data from an Aftermarket or OEM Scan Tool (i.e., the PCM uses this circuit to communicate with the Scan Tool).

Scope Connections (OBD I Example)

Connect the Channel 'A' positive probe to the DLC pin of the connector and the Channel 'A' negative probe to the battery negative post.

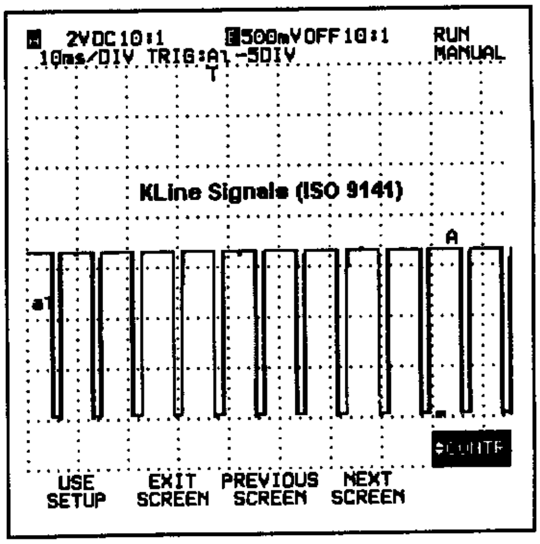
Scope Settings

To make the picture as clear as possible, set the lab scope settings to match the examples.

K-Line Data Link Connector (OBD II)

The PCM exchanges information (i.e., MIL condition, trouble codes, I/M Readiness Status and PID data) with an OBD II certified Scan Tool through the ISO 9141 protocol.

Once the Scan Tool is powered up, seven (7) volts is provided to the K-Line pin of the DLC on these systems. When the ignition is turned "on", the controller and Scan Tool toggle this voltage to generate serial data between these devices.



Scope Connections (OBD II Example)

Connect the Channel 'A' positive probe to the K-Line circuit (WHT wire) of the correct PCM connector. Connect the Channel 'A' negative probe to the battery negative post.

Scope Settings

To make the picture as clear as possible, set the scope settings to match the examples.

Lab Scope Example Explanation

The PCM receives commands and transmits data between itself and the Scan Tool by toggling the K-Line circuit high and low. Note how the 7v signal on the circuit is pulled low during periods of communication. This signal was captured with the Scan Tool removed.

ADVANCED ENGINE DIAGNOSTICS

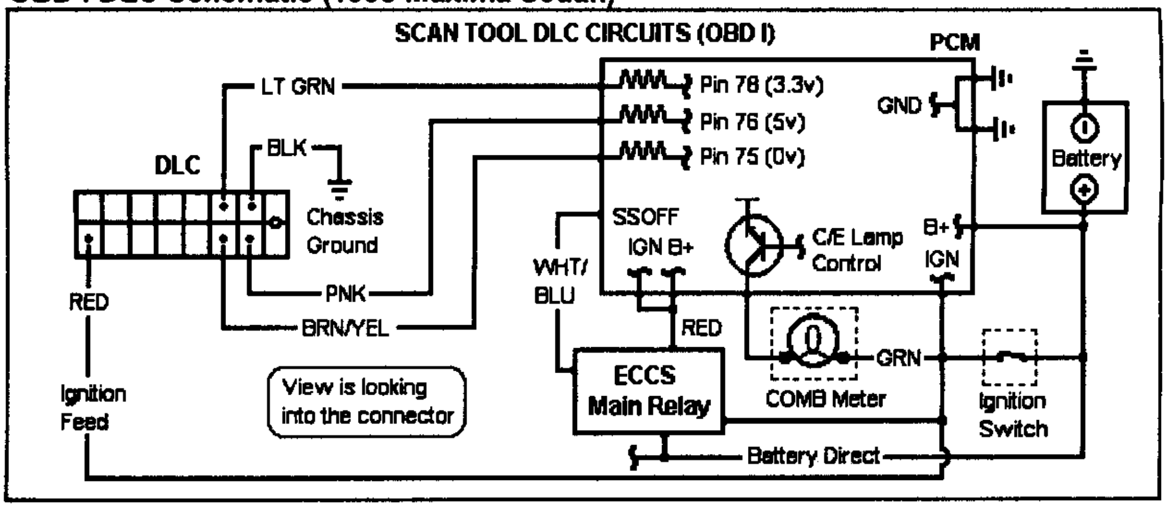
Data Bus Communication

Scan Tool Communication

A Scan Tool can be used to connect to (and communicate with) the PCM controller.

OBD I System - Connect the Scan Tool to the underdash test connector labeled DLC. The first time the PCM detects an electrical circuit fault, a hard code is stored in memory and the C/E Light is illuminated. To read trouble codes manually, connect a compatible Scan Tool and start the engine. A Scan Tool can be used to read any stored codes and access certain data stream information stored in the PCM. The Scan Tool communicates with the PCM on the DLC Transmit and Receive circuits shown in the Schematic below.

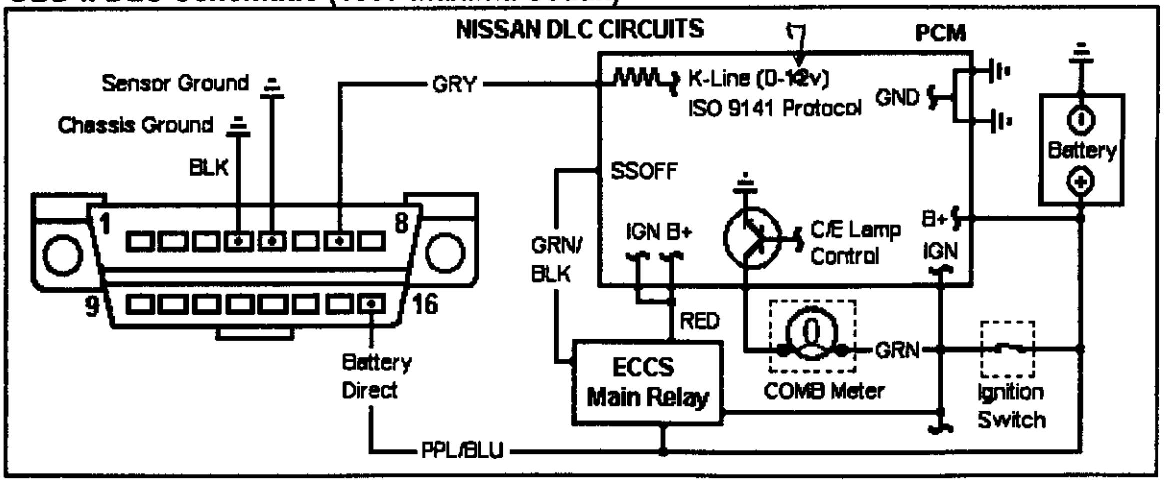
OBD I DLC Schematic (1995 Maxima Sedan)



OBD II Systems - Connect the Scan Tool to the test connector located inside the vehicle labeled DLC. The first time the PCM detects an emissions-related fault, a pending code is set. The second time it fails, the MIL is illuminated and the code matures. OBD II Certified Scan Tools are used to communicate with the PCM to read codes and PIDs.

The Scan Tool communicates with the PCM on the K-Line (ISO 9141) interface circuit. This circuit is used to transfer data between the PCM and an OBD II certified Scan Tool using a circuit toggling from 0-7v. The key on, engine off value at Pin 7 is 7.25v. The DLC is connected to direct battery at Pin 16. It is also connected to a "clean" chassis ground on Pin 4 and to sensor ground on Pin 5 as shown in the Schematic.

OBD II DLC Schematic (1997 Maxima Sedan)



1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

Introduction

The ECCS PCM controls the Electronic Ignition (EI) system on this vehicle by sending signals to the igniter/coil units (one coil per cylinder). The coils are supplied battery power from the Ignition switch through a 30-amp ignition fuse (refer to the schematic).

The PCM, located below the center of the dash near the glove box, contains memory tables that it uses to calculate the ignition control (IC) signals it sends to the igniter/coil units mounted on top of the spark plugs. These signals control the ignition spark timing.

The PCM sends a command signal to each igniter/coil unit that indicates when to switch the coil primary circuit "on" and "off" to control the amount of spark advance. The igniter amplifies the control signal. In effect, this signal controls the coil dwell period.

System Components

The EI system on this vehicle application includes the following components:

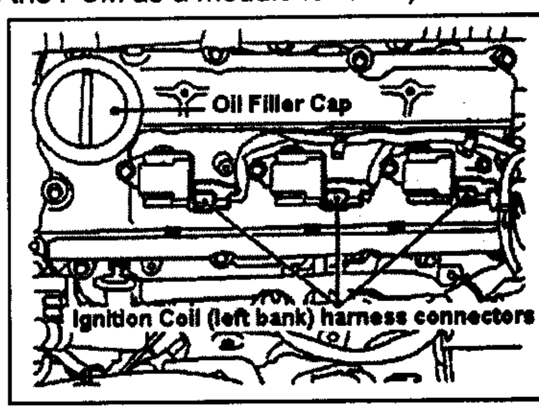
- The CMP PHASE sensor (mounted on top of the engine above the camshaft pulley)
- The CKP POS sensor (mounted on the oil pan facing the gear teeth on the flywheel)
- The CKP REF sensor (mounted below the crankshaft pulley near the oil filter)
- Six (6) high energy coils (mounted on top of the spark plugs - coil on plug design)
- Six (6) igniter units (mounted with the coils on top of the spark plugs)
- The ignition control function (integrated into the PCM as a module function)

Ignition Spark Timing

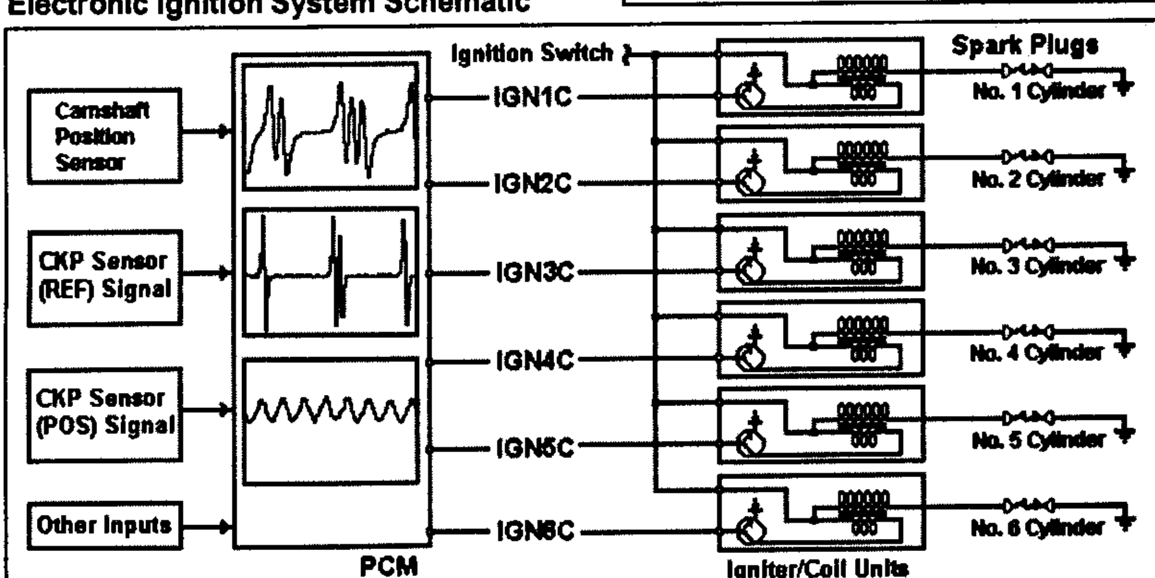
The PCM controls the ignition timing during all engine modes by using information stored in its lookup tables that contain the correct amount of spark advance for all conditions.

Igniter/Coil Assembly

Each igniter/coil assembly consists of a high-energy coil (less than 1 ohm of resistance) mounted with its igniter unit on top of each spark plug (this is a coil-on-plug design).



Electronic Ignition System Schematic



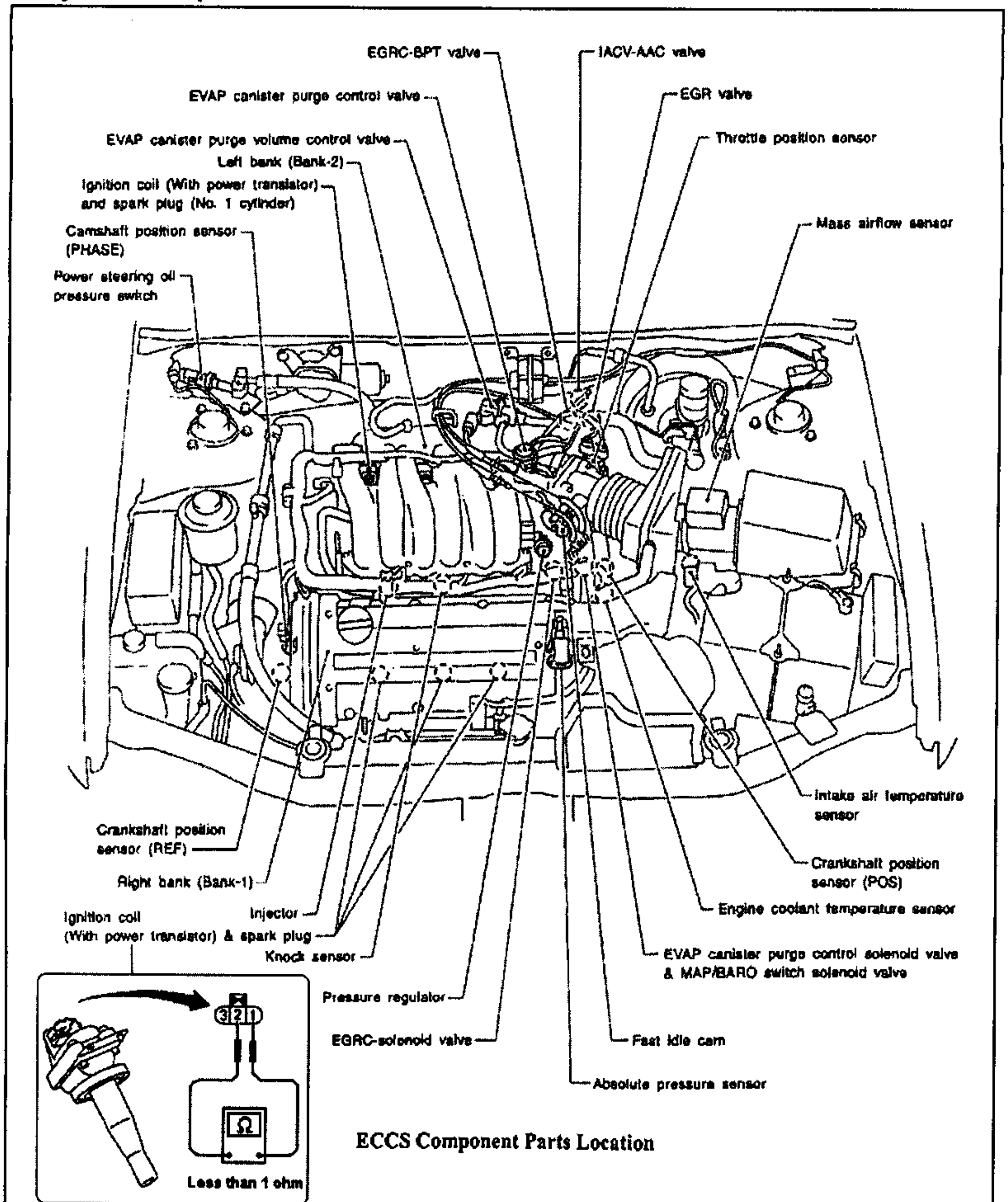
1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

Component Locations

The EI system component locations for this vehicle application are shown in the Graphic.

EI System Component Locations



ECCS Component Parts Location

1997 MAXIMA (3.0L V6 VIN C)

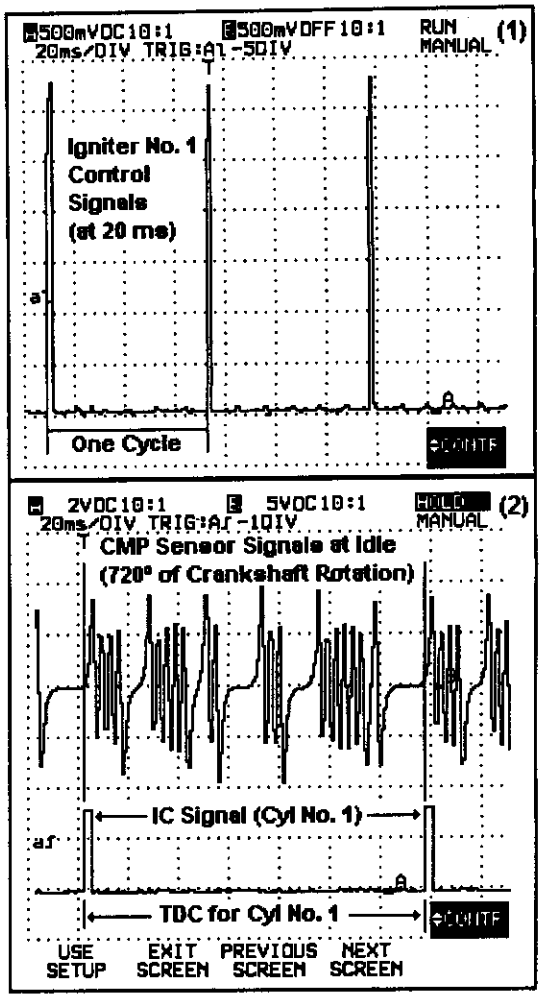
Electronic Ignition

Lab Scope Tests (IC Signals)

The Lab Scope can be used to test the ignition control (IC) signals from the IC module function integrated into the PCM.

The circuit from the PCM to each of the igniter units can be monitored for possible glitches.

If the Ignition fuse (30 amp) is open, there will not be any ignition power available at the EI coils. Prior to starting the test, place the gear selector in Park and block the drive wheels.



Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (IC No. 1 Signal)

Connect the Channel 'A' positive probe to the IGC1 signal at Pin 1 (YEL/RED wire) of the PCM 104-Pin connector. Connect the Channel 'A' negative probe to the battery negative post.

Connect the Channel 'B' positive probe to the CMP sensor at Pin 46 or 47 (WHT wires).

Lab Scope Explanation - Example (1)

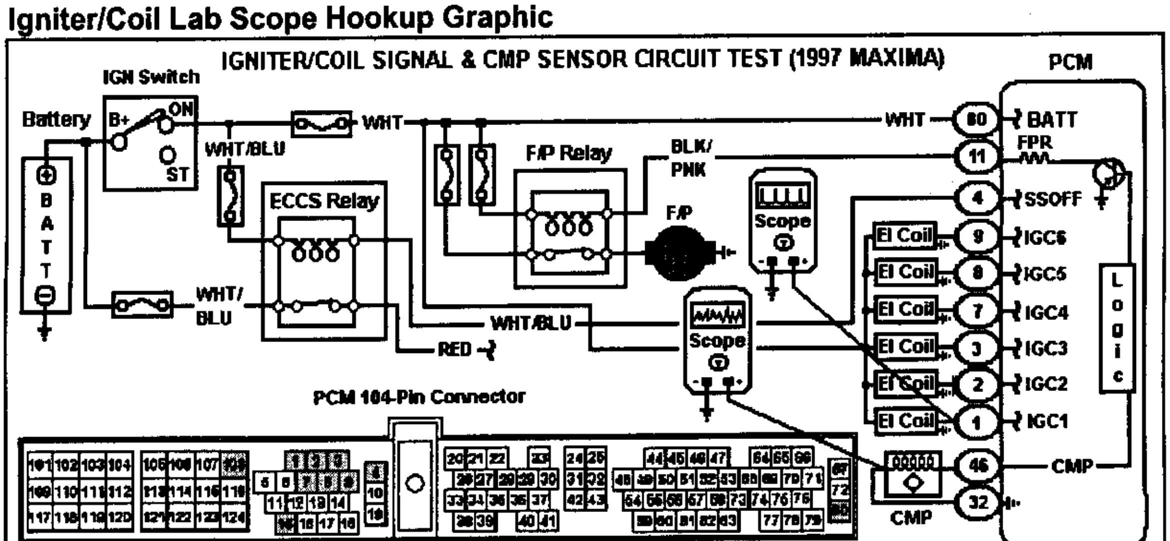
In this example, the trace shows the IC control signals (0-3.3v) from the PCM to the igniter or power transistor for the EI Coil 1.

Lab Scope Explanation - Example (2)

In this example, the top trace shows the CMP sensor signals and the bottom traces shows the IC signals from the PCM for EI Coil No. 1

Note the point at which the CMP sensor signal lines up with the IC signal for Cyl 1. This CMP signal is different than the other CMP signals.

Igniter/Coil Lab Scope Hookup Graphic



1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

Lab Scope Test (Coil Primary)

The Lab Scope can be used to view the ignition coil primary ground circuit as it provides an accurate view of its waveform and of any glitches. Prior to starting the test, place the gearshift selector in Park and block the drive wheels for safety.

Scope Connections

Connect the Channel 'A' positive probe to the IC primary ground (Black wire) for Coil 1. Connect the Channel 'A' negative probe to chassis ground or the battery negative post.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples. The voltage setting for Channel 'A' was set to 200 mv in this example.

Lab Scope Tests

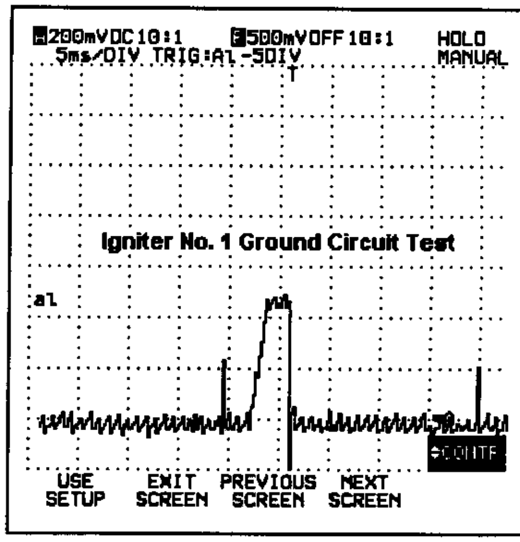
The igniter/coil ground circuit can be checked with the engine running at idle or cruise speeds with a cold or warm engine.

Lab Scope Example (1)

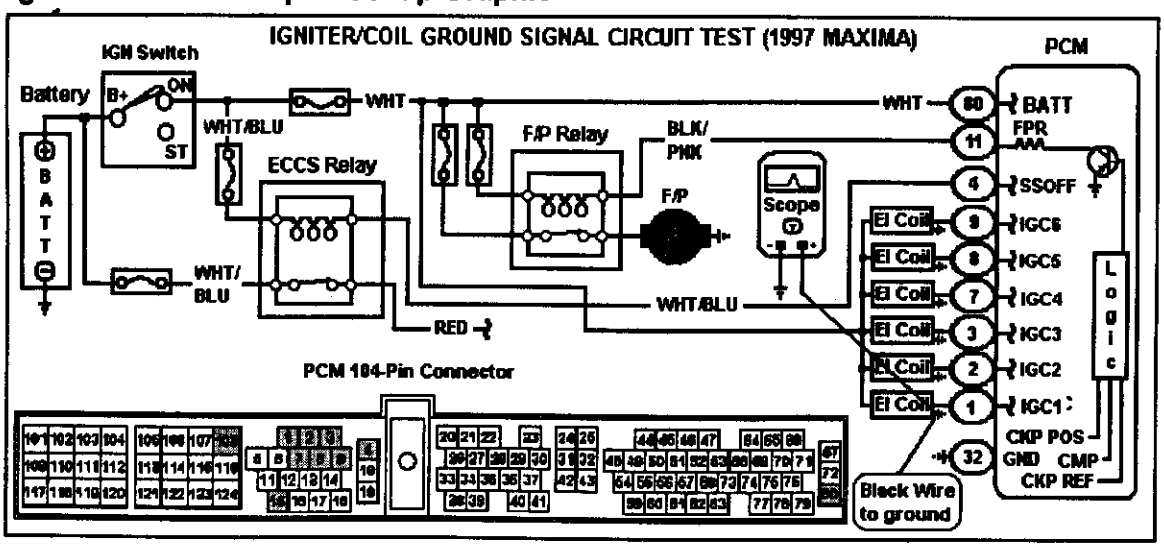
In example (1) the Channel 'A' trace shows the EI Coil '1' secondary signal. The Channel 'B' trace shows the Coil '1' signal at idle speed. The IC signal will have 90° corners (0-0.5v).

This is a voltage over time waveform. Each time that the coil fires the No. 1 spark plug, the transistor inside the igniter must be able to handle the collapse of the ignition coil primary.

This waveform shows a known good example of how the Igniter/Coil for Cylinder No. 1 handled the primary coil circuit collapse.



Igniter/Coil Lab Scope Hookup Graphic

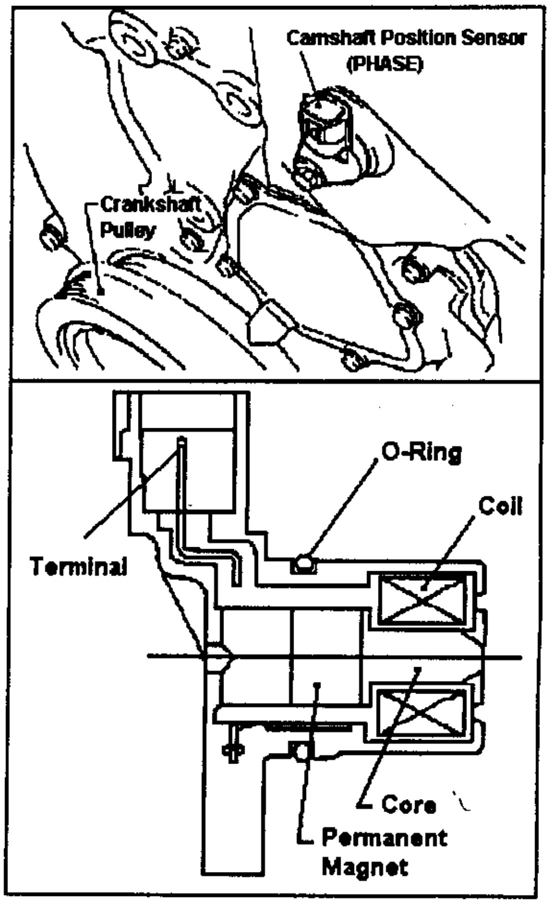


1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

CMP Sensor Overview

The camshaft position (CMP) sensor used with this system is a magnetic transducer located at the engine front cover facing the camshaft sprocket as shown in the Graphic.



It is connected to the PCM by two circuits that supply an AC voltage used to detect the top dead center position of all six cylinders.

The PCM uses this signal as a reference for sequential multiport fuel injection (SMFI).

The sensor consists of a permanent magnet, core and coil. With the engine running, the air gap between the sensor and the camshaft sprocket will periodically change.

The permeability tuning (a method of tuning a circuit by moving a magnetic core into and out of a coil to vary its inductance) near the CMP sensor also changes as the engine turns.

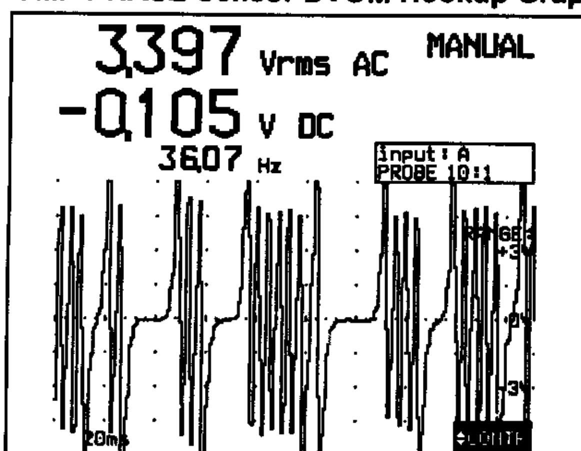
Due to changes in the sensor permeability during running, the gap between the sensor and camshaft sprocket periodically change. The change causes the sensor output voltage.

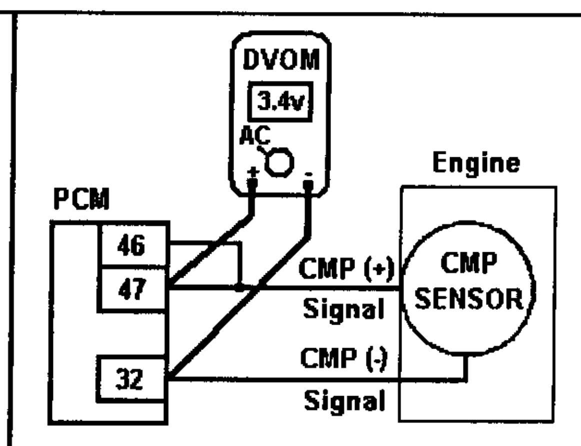
There are three 120° CMP and six 60° CKP signals for each 360° crankshaft revolution.

DVOM Test (CMP Sensor)

A DVOM can be used to test the AC output signals from this sensor to the PCM with the engine running in order to determine if the sensor is okay. Connect the DVOM positive probe to the CMP PHASE signal at PCM Pin 46 or 47 (WHT wires) and connect the negative probe to the negative battery post. The output should be 3.4v at 36 hertz (idle).

CMP PHASE Sensor DVOM Hookup Graphic





1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

Lab Scope Test (CMP Sensor)

The Lab Scope is the tool of choice to use to test the signals from the CMP sensor as it provides an excellent view of the sensor waveforms and of any possible glitches.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example
The CMP sensor signals can be checked at both idle and cruise speeds.

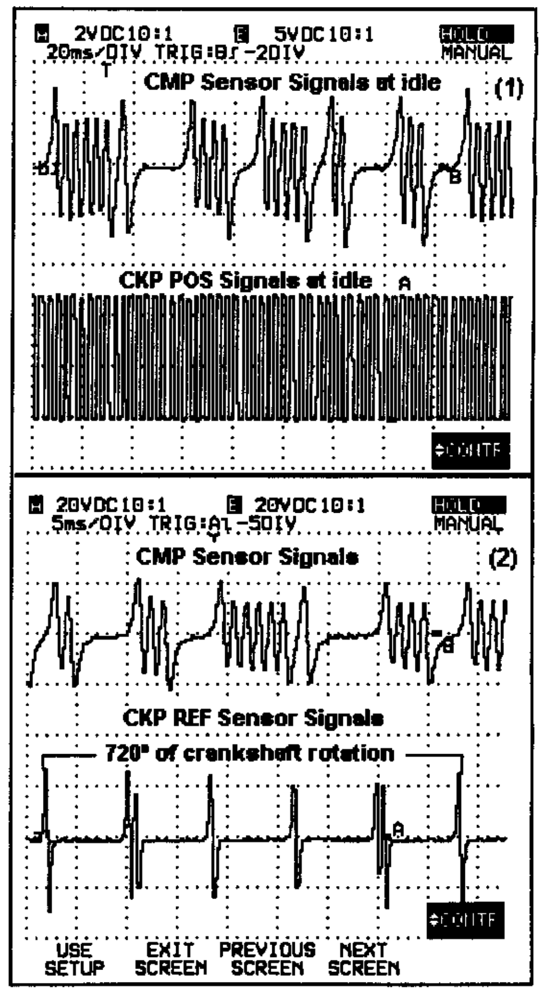
Scope Connections (CMP Sensor)
Connect the Channel 'B' positive probe to the CMP signal at PCM Pin 46 or 47 (WHT wire).

Scope Connections (CKP POS Sensor)
Connect the Channel 'A' positive probe to the CKP POS signal at Pin 49 (WHT wire) and the negative probe to the CKP POS signal at Pin 32 (BLK wire) of the PCM 104-Pin connector.

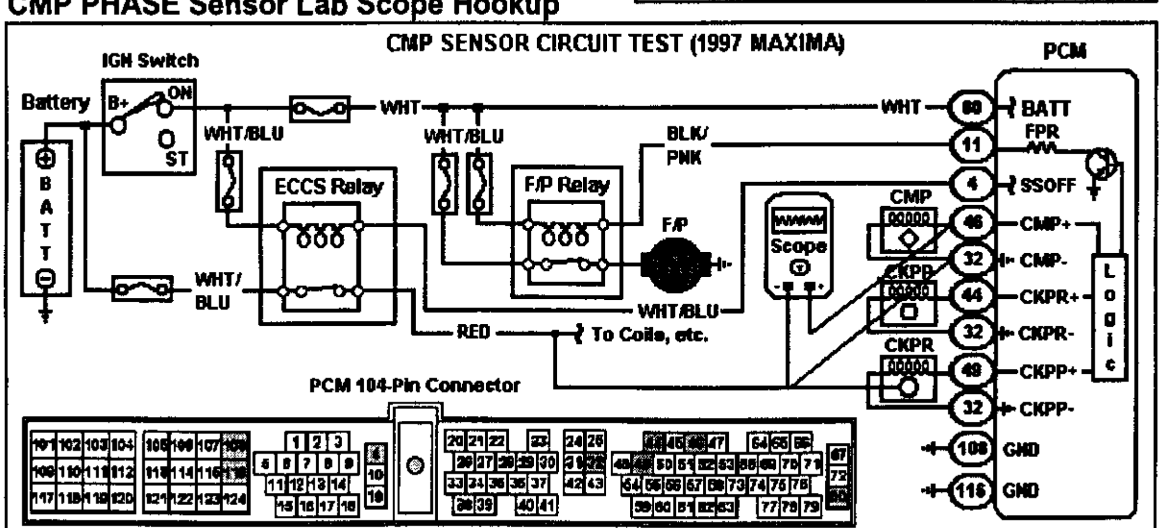
Lab Scope Explanation - Example (1)
In this example, the two traces show the CMP and 48x CKP POS sensor signals at idle speed. The CMP signals are AC signals that are 15v peak to peak. The bottom trace is a digital signal from a Hall effect switch (0-13v).

Lab Scope Explanation - Example (2)
In this example, the two traces show the CMP and 6x CKP REF sensor signals at idle speed. These are AC voltage signals (11v peak to peak) that were captured at 2500 rpm.

Each CKP POS sensor signal represents 120 degrees (120°) of crankshaft rotation.



CMP PHASE Sensor Lab Scope Hookup



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Electronic Ignition

CKP REF Sensor Overview

The crankshaft position (CKP) REF sensor used with this EI system is a magnetic transducer located below the crankshaft pulley next to the oil filter as shown in the Graphic.

It is connected to the PCM by two circuits that supply an AC voltage used to detect the 6x crankshaft reference signal for all six cylinders.

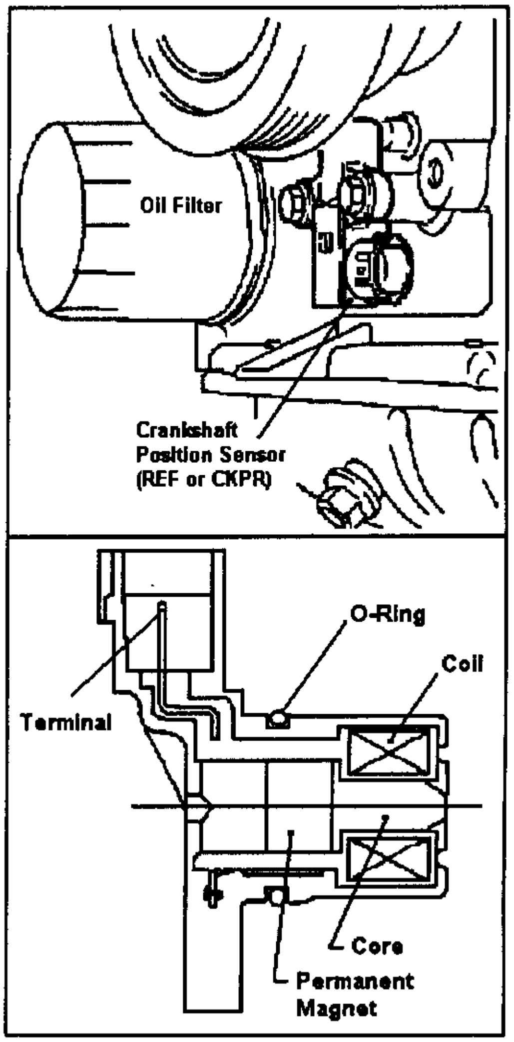
The PCM uses this signal as a reference for sequential multiport fuel injection (SMFI).

The sensor consists of a permanent magnet, core and coil. With the engine running, the air gap between the sensor and the crankshaft sprocket will periodically change.

The permeability tuning (a method of tuning a circuit by moving a magnetic core into and out of a coil to vary its inductance) near the CKP REF sensor also changes as the engine turns.

Due to changes in the sensor permeability during running, the gap between the sensor and crankshaft gear cogs periodically change. The change causes the sensor output voltage.

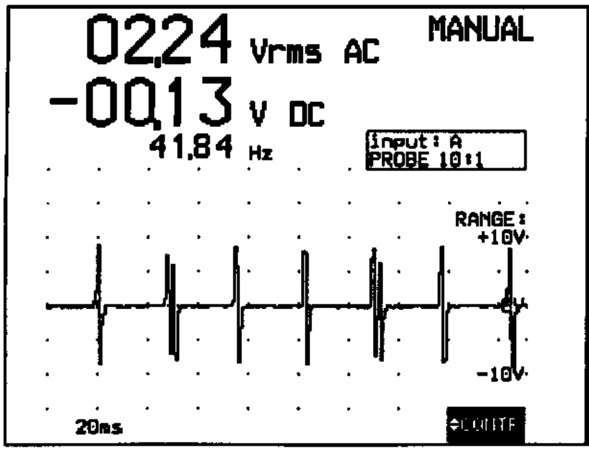
There are six 60° CMP and six 60° CKP signals for each 720° crankshaft revolution.

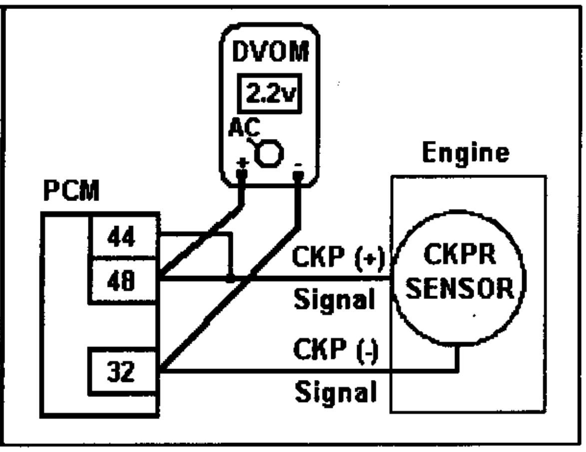


DVOM Test (CKP REF Sensor)

A DVOM can be used to test the AC output signals from this sensor to the PCM with the engine running in order to determine if the sensor is okay. Connect the DVOM positive probe to the CKP REF signal at PCM Pin 44 or 48 (WHT wires) and connect the negative probe to the negative battery post. The output should be 2.2v at 42 hertz (idle).

CKP REF Sensor DVOM Hookup Graphic





1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

Lab Scope Test (CKP REF Sensor)

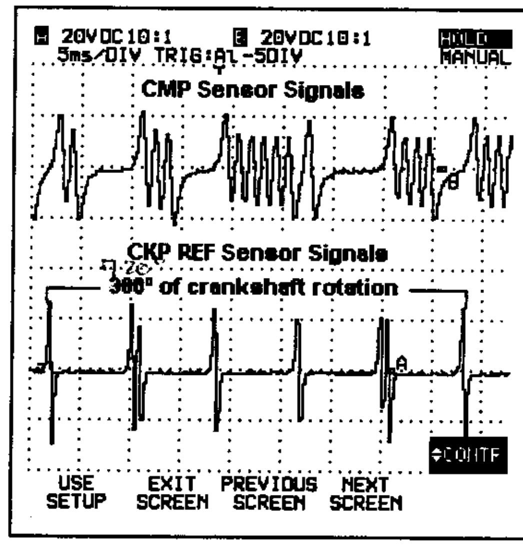
The Lab Scope is the tool of choice to use to test the signals from the CKP REF sensor as it provides an excellent view of the sensor waveforms and of any possible glitches. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels for safety.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example

The CKP REF sensor signals can be checked at both idle and cruise speeds with the engine cold or with the engine at normal temperature.



Scope Connections (CKP REF Sensor)

Connect the Channel 'A' positive probe to the CKP signal at PCM Pin 44 or 48 (WHT wire) and the negative probe to the CKP (-) signal at PCM Pin 32 (the BLK wire).

Scope Connections (CMP Sensor)

Connect the Channel 'B' positive probe to the CMP signal at PCM Pin 46 (the WHT wire).

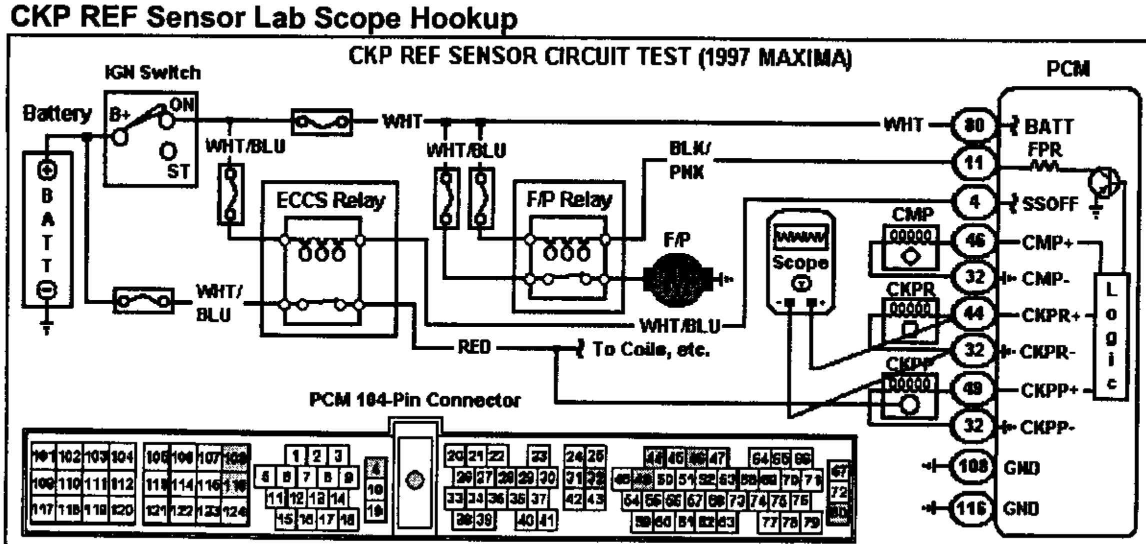
Lab Scope Explanation

In this example, the signal trace shows the 6x CKP and 6x CMP sensor signals at idle speed. Both of these traces show a signal that is from 40-60v AC peak to peak. These traces represent 360 degrees of crankshaft rotation.

Lab Scope Examples

The waveform examples that appear on this page were captured with a Fluke 99-B from a vehicle with a known good CMP sensor and CKP REF sensor.

CKP REF Sensor Lab Scope Hookup



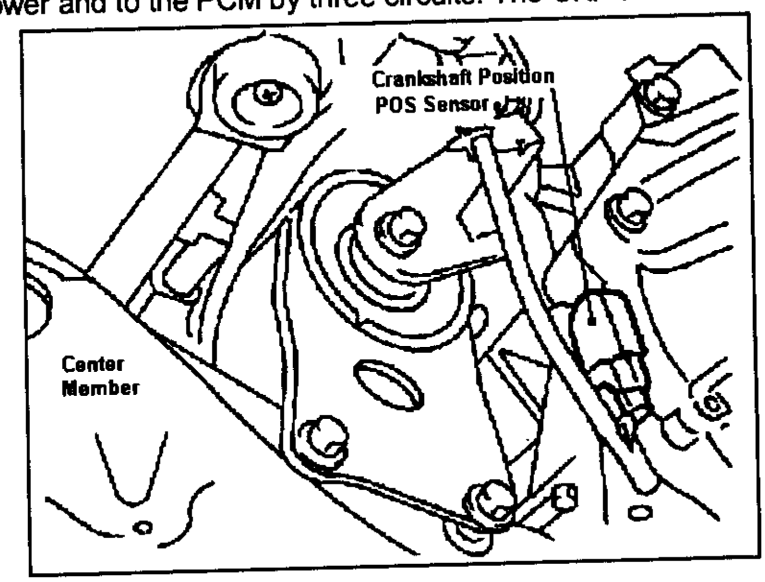
1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

CKP POS Sensor Overview

The crankshaft position (CKP) POS sensor used with this EI system is a Hall effect sensor located above the oil pan near the center member. The sensor is installed facing the flywheel teeth (cogs).

It is connected to the vehicle power and to the PCM by three circuits. The CKP POS circuit supplies the PCM with a DC voltage signal that represents each 1° of crankshaft rotation.



The PCM uses the CKP POS signal to determine when to enable the fuel pump relay.

The sensor includes a Hall effect sensor and its related components and circuits.

With the engine running, the air gap between the sensor and flywheel cogs will cause a change in the sensor voltage.

There are 360 CKP POS (1°) signals for each engine revolution.

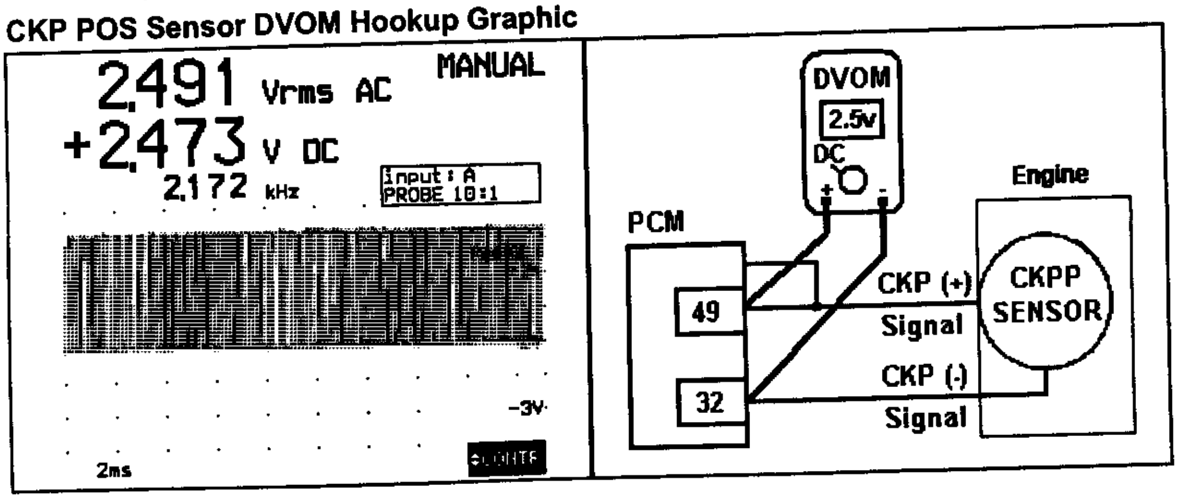
DVOM Test (CKP POS Sensor)

A DVOM can be used to test the DC output signals from this sensor to the PCM with the engine running in order to determine if the sensor is okay.

<u>DVOM Connections (CKP POS Sensor)</u>

Connect the DVOM positive probe to the CKP POS signal at PCM Pin 49 (WHT wire) and connect the negative probe to PCM Pin 32 or to battery ground. The CKP POS sensor output should be 2.5v at 2.17 hertz (idle).

CKP POS Sensor DVOM Hookup Graphic



1997 MAXIMA (3.0L V6 VIN C)

Electronic Ignition

Lab Scope Test (CKP POS Sensor)

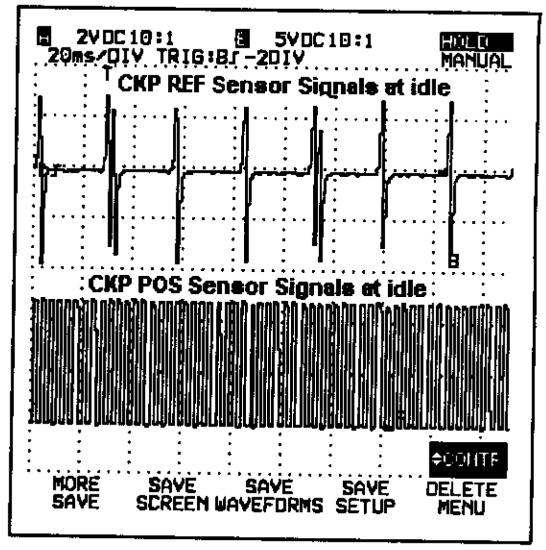
The Lab Scope is the tool of choice to use to test the signals from the CKP POS sensor as it provides an excellent view of the sensor waveforms and of any possible glitches. Prior to starting the test, place the shift selector in Park (A/T) and block the drive wheels.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example

The CKP POS sensor signal can be checked at both idle and cruise speeds with the engine cold or with the engine at normal temperature.



Scope Connections (CKP REF Sensor)

Connect the Channel 'B' positive probe to the CKP REF signal at Pin 44 (WHT wire) of the PCM 104-Pin connector.

Scope Connections (CKP POS Sensor)

Connect the Channel 'A' positive probe to the CKP POS (+) signal at Pin 49 (WHT wire) and the negative probe to the CKP POS (-) signal at Pin 32 of the PCM 104-Pin connector.

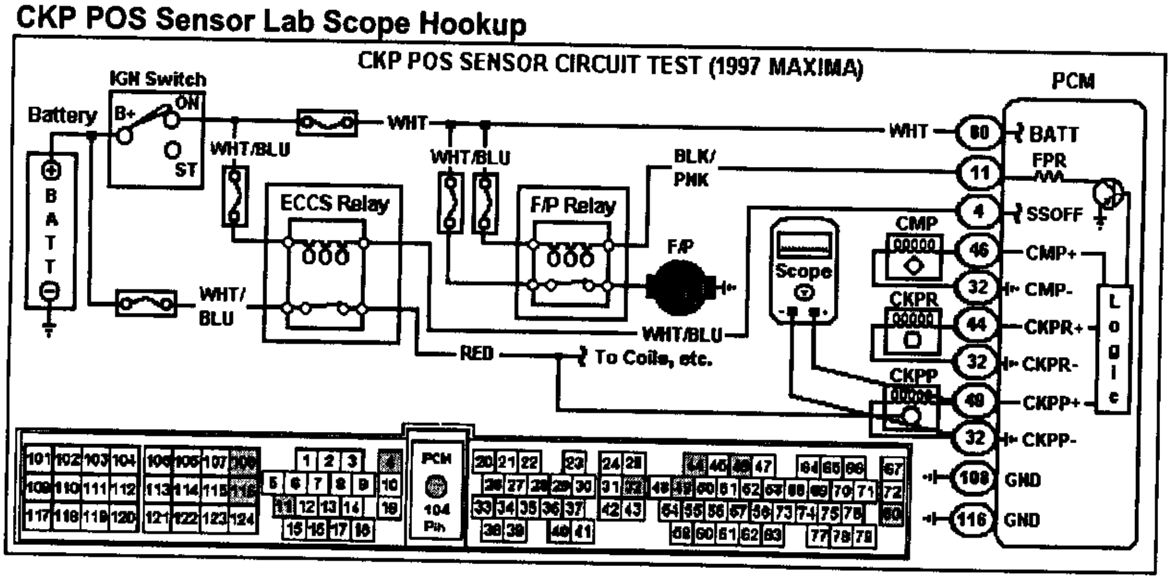
Lab Scope Explanation

In this example, the trace shows the 360 CKP POS and six CKP POS sensor signals at idle speed. The CKP sensor signal should be from 16v AC peak to peak. The CKP POS signal should be a DC squarewave from 0-5 volts.

Lab Scope Examples

The waveform examples that appear on this page were captured with a Fluke 99-B from a vehicle with a known good CKP REF and CKP POS sensor.

CKP POS Sensor Lab Scope Hookup



1997 MAXIMA (3.0L V6 VIN C)

Fuel System

Introduction

The Fuel Delivery system on this vehicle application is designed to deliver fuel at a regulated high pressure to the fuel rail and injectors. Additionally, this Fuel system is also designed to cutoff fuel pressure if the engine stops running.

<u>System Components</u>

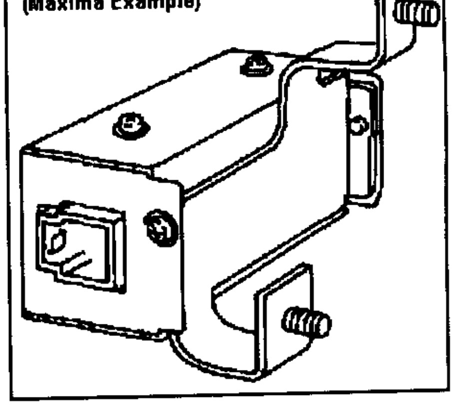
The Fuel system on this application includes the fuel tank, fuel pump, fuel filter, pressure regulator, fuel injectors, fuel tube connect fittings, fuel lines and hoses and fuel rail.

The electrical portion of the Fuel system includes the ECCS relay, fuel pump, fuel pump control module (some models), fuel injectors and related fuel pump control circuits.

<u>Fuel Pump Operation</u>

Once the PCM detects a "start" signal, it activates the fuel pump for several seconds at "key on" to enable the engine to start. If it detects the presence of the CKP POS signals (1°), it knows that the engine is rotating. At this point, it causes the fuel pump to activate. If the CKP POS signal 1° signal is not received at "key on", the fuel pump is disabled to keep from discharging the battery and also for safety reasons. Keep in mind that the PCM does not "drive" the fuel pump. Instead, it controls the operation of the fuel pump relay that in turn drives the operation of the pump.

Fuel Pump Control Module (Maxima Example)



<u>Fuel Pump Control Module Operation</u>

The fuel pump control module (FPCM) controls the operation of the fuel pump. The amount of fuel flow delivered by the fuel pump is altered between two flow rates by the FPCM. This module determines the voltage to be applied to the fuel pump (and therefore the fuel flow) according to the conditions listed below.

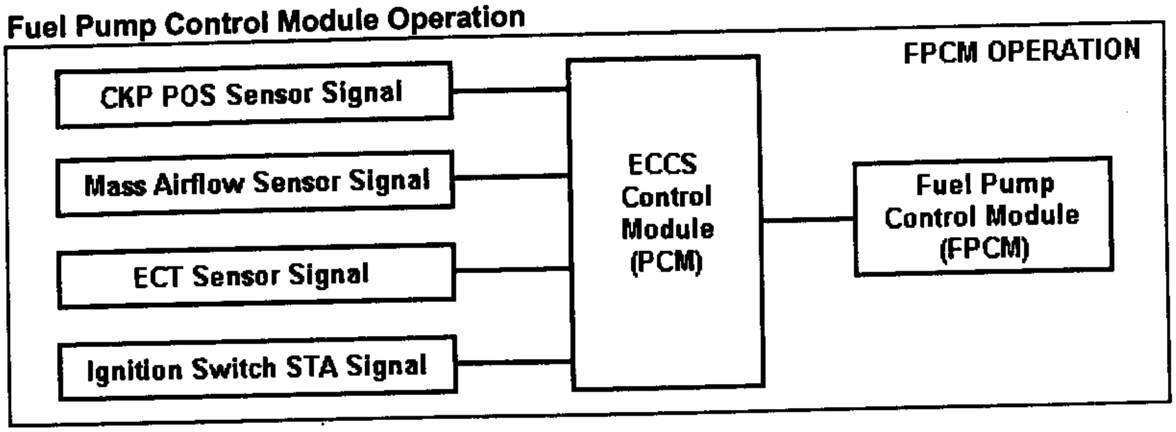
When the FPCM increases the voltage supplied to the fuel pump, the amount of fuel flow is increased (raised). The fuel pump is supplied system voltage:

- At initial key on and during engine cranking
- If the engine temperature is less than 45°F (7°C)
- If the engine is running under heavy load while at high-speed conditions

When the FPCM decreases the voltage supplied to the fuel pump, the amount of fuel flow is decreased (lowered). The fuel pump is supplied approximately 9.5v:

- Under all other conditions

Fuel Pump Control Module Operation



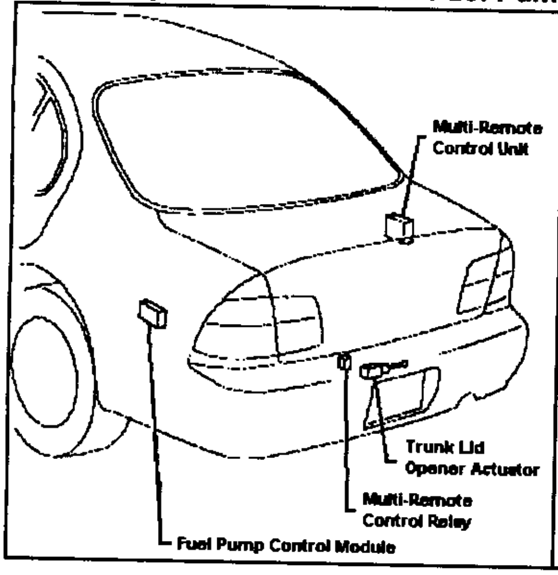
1997 MAXIMA (3.0L V6 VIN C)

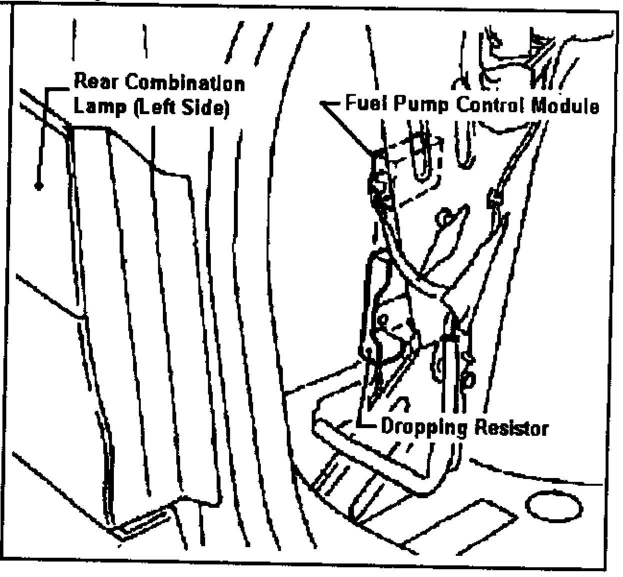
Fuel System

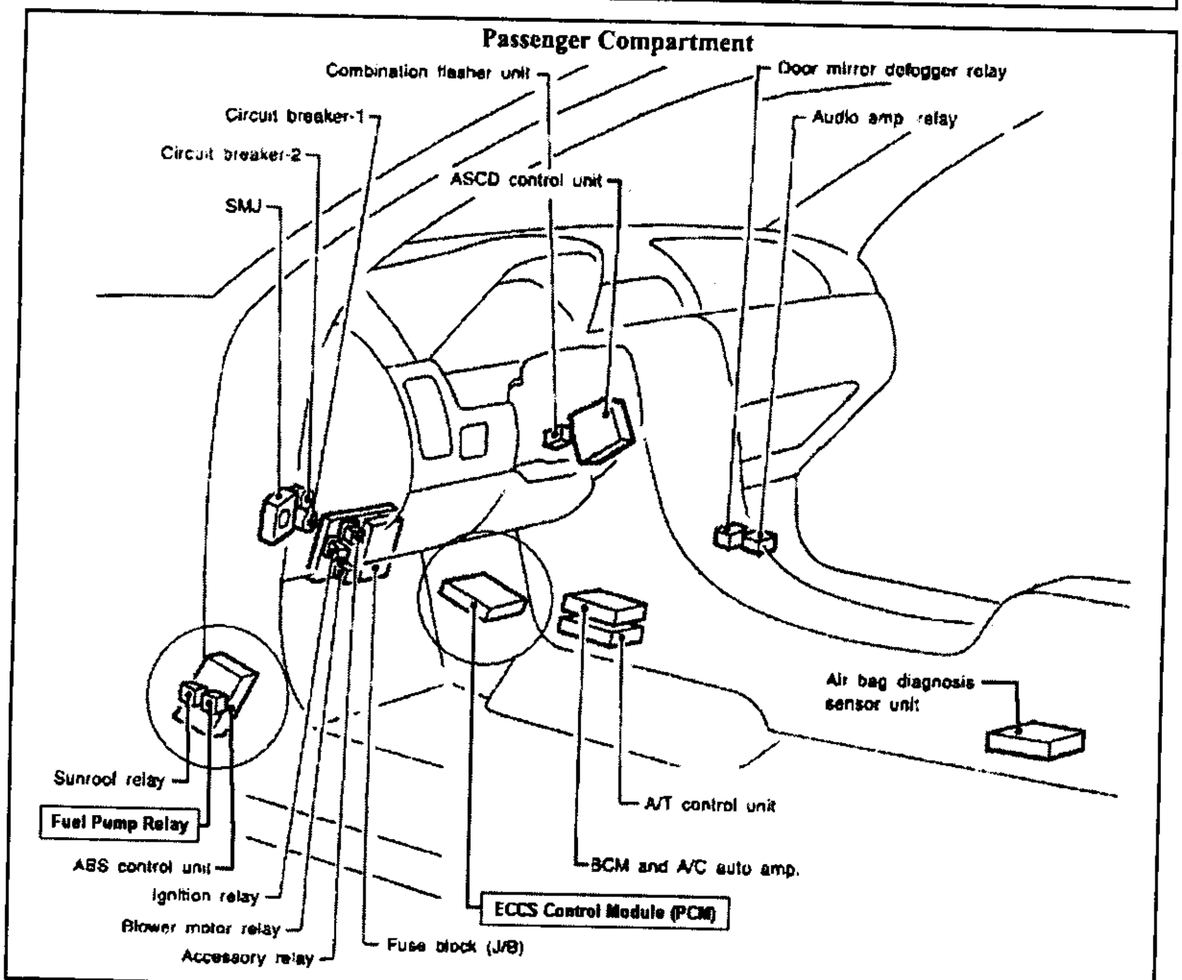
Component Locations

The Fuel system component locations for this vehicle appear in the Graphics below.

Fuel Pump Control Module & Fuel Pump Relay Locations







1997 MAXIMA (3.0L V6 VIN C)

Electric Fuel Pump

General Description

This vehicle application uses an in-line, turbine-type electric fuel pump. Fuel is drawn from the fuel tank through a one-way check valve and then delivered to the fuel rail in the engine compartment.

An external fuel filter (sock) is used on the turbine type pump. A check valve is used to maintain fuel pressure in the fuel line for a short time after shutdown to ease restarting.

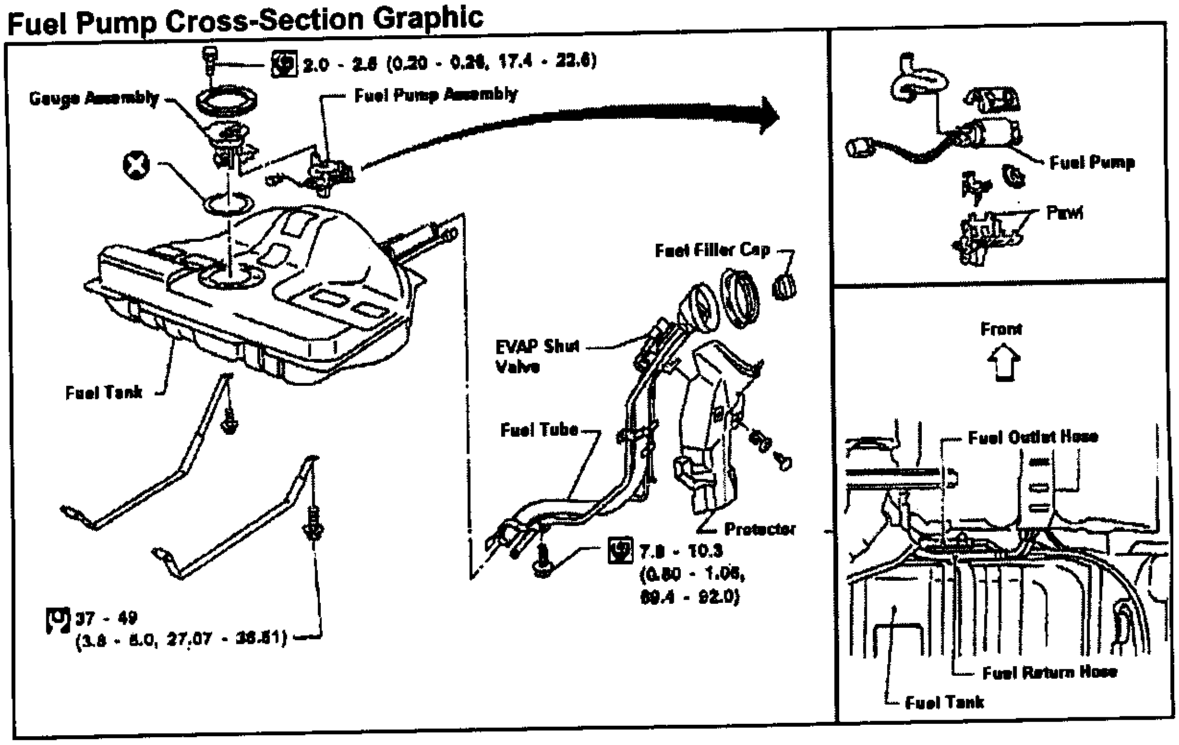
The fuel pump has an internal relief valve to prevent excessive pressure in the fuel delivery system. This valve opens if there is a blockage in the discharge side. If the relief valve opens, fuel flows from the high-pressure side to the low-pressure side of the pump.

<u>System Operation</u>

The fuel pump is energized for two seconds when the key is first turned on by the FPCM to pressurize the fuel delivery system. Once the engine starts, the PCM and FPCM continue to enable the fuel pump so that the motor turns along with the impeller. Pressure changes are created by the numerous grooves around the impeller.

Fuel enters the inlet port and flows inside the motor from the pumping chamber and is forced through the discharge port via the check valve. If fuel flow is obstructed at the discharge side of the fuel line, the relief valve will open to bypass fuel to the inlet port to prevent high fuel pressure. Once the engine stops, the PCM turns off the fuel pump through the FP relay due to the loss of CKP POS sensor 1° signals. An internal check valve closes by spring action to retain residual pressure to allow for quick restarts.

Fuel Pump Cross-Section Graphic



1997 MAXIMA (3.0L V6 VIN C)

Electric Fuel Pump

Lab Scope Test (Fuel Pump)

If you suspect that the fuel pump is faulty, you can use a low amp probe with an inductive pickup to monitor the operation of the fuel pump and its related circuits.

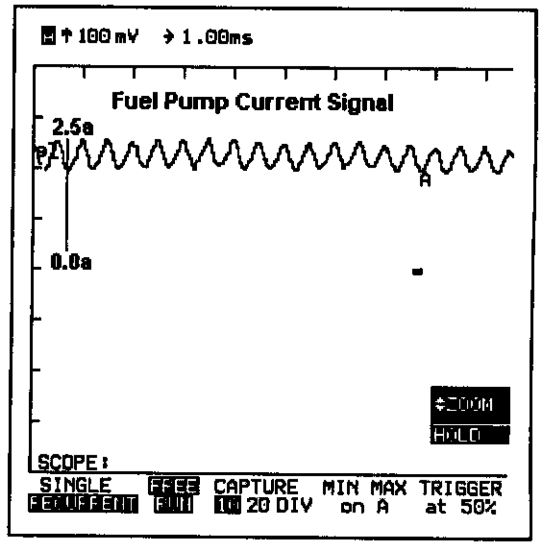
An example of a known good fuel pump motor waveform for this vehicle application is shown in the Graphic on this page. If the pump is operating normally, the current draw *will be* less than 4 amps on this vehicle.

Specification: Fuel Pump resistance: 2.5-5.0 ohms at 68°F.

<u>Scope Connections (Amp Probe)</u>

Set the amp probe to 100 mv and calibrate (zero) it before starting the test procedure.

Locate the fuel pump feed and install the amp probe around the wire between the relay and the fuel pump. Start the engine and allow the amp probe reading to stabilize.



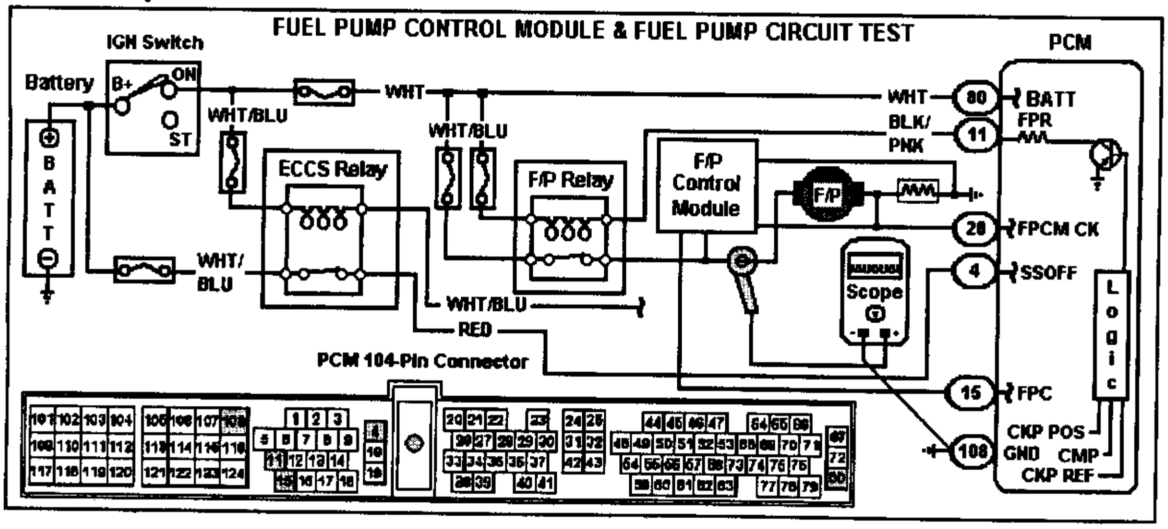
<u>Lab Scope Example Explanation</u>

In this example, the trace shows the fuel pump current of a known good fuel pump at idle speed (the fuel pump pattern is even). Note how the PCM energizes the F/P relay and how the PCM controls the voltage output of the FPCM circuit at Pin 15 (BLK/PNK wire) of the PCM that controls power to the fuel pump. This is a known good pump providing 34 psi at 2.5 amps on a vehicle with 65,000 miles.

<u>Symptom Diagnosis</u>

Depending upon the type of problem, you may want to let the engine run for a period of time until it occurs - this allows you to monitor the amount of change in the fuel pump current trace (as the fuel pump motor ramps up). In some cases, you may need to let the engine run until the engine stalls or begins to stall and then capture the waveform.

Fuel Pump Control Schematic



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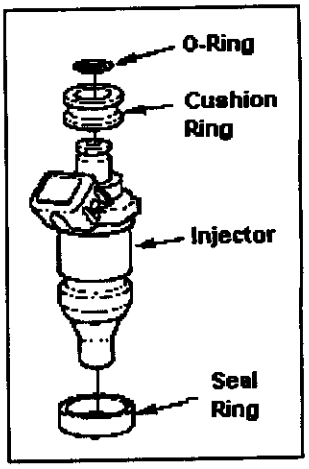
Fuel Injectors

General Description



The fuel injectors on this engine application are solenoid-operated (N.C.) valves that are designed to meter the fuel flow to each combustion chamber. These injectors are the "saturated switch" design. Injector ontime is the time between the downward vertical line and upward vertical spike on a scope.

Each injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel delivered is controlled by the length of time the injector is held open (injector pulsewidth).

The amount of fuel injected from each fuel injector is determined by the PCM (as it controls the length of time the injector remains open - called injector pulsewidth).

The actual amount of fuel injected is determined from a program value stored in the PCM memory. In effect, it is the amount of fuel to be injected under all operating conditions (called fuel trim). The PCM determines the amount of fuel by comparing input signals from the CMP sensor (engine speed) and the MAF sensor (the amount of intake air).

The injectors are connected to a battery feed circuit through the ignition switch. When the PCM supplies a ground signal to the control circuit, the coil is energized. This action pulls the needle valve back to allow fuel flow through the injector to the intake manifold.

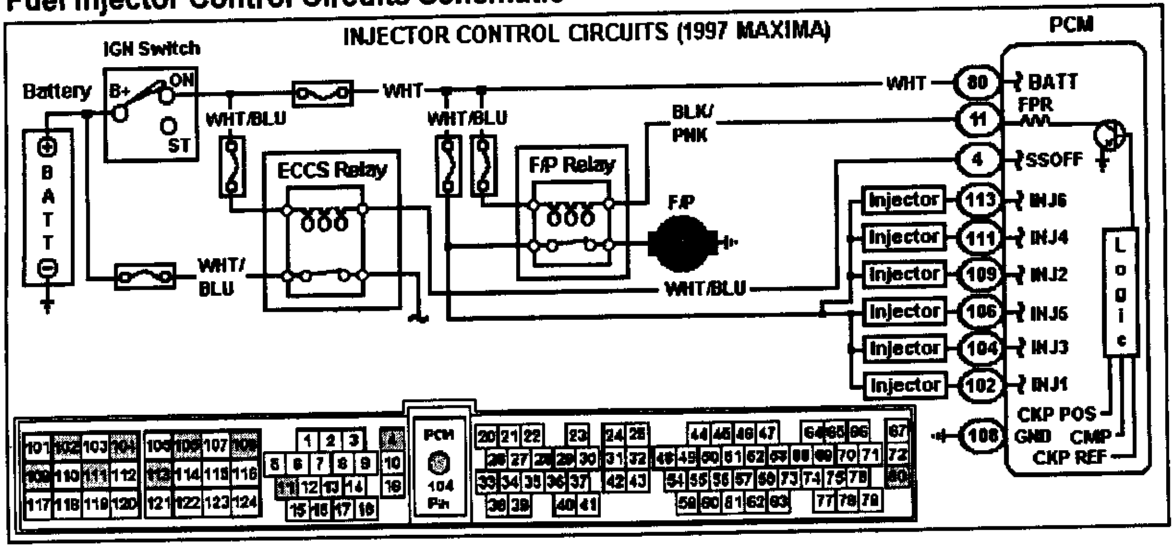
The amount of fuel compensation is increased during these conditions:

- During engine startup and warmup
- During acceleration
- During hot engine operation
- During high-load, high-speed operation

The amount of fuel compensation is decreased during these conditions:

- During deceleration
- During high-speed operation (without a high engine load)

Fuel Injector Control Circuits Schematic



1997 MAXIMA (3.0L V6 VIN C)

Fuel Injectors

Lab Scope Test (Fuel Injector)

The Lab Scope is the "tool of choice" to test operation of the fuel injector and its circuits.

Scope Connections

Connect the Channel 'A' positive probe to the injector signal (PCM Pins 102, 104, 106, 109, 111 or 113) and the negative probe to Pin 108.

Scope Connections (Amp Probe)

Connect the amp probe to Channel 'B' and zero the amp probe before starting the test. Then connect the amp probe around the fuel injector No. 1 control wire (Pin 102-GRN wire).

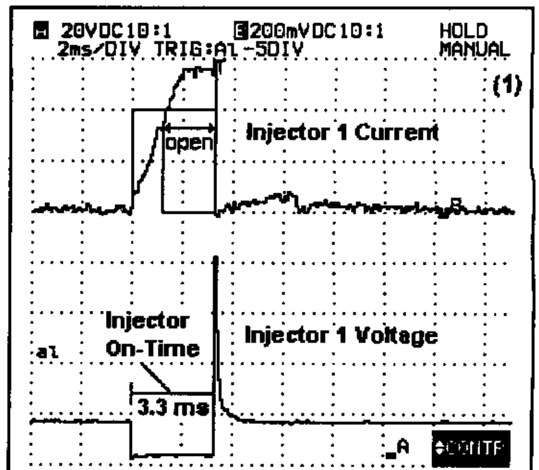
Scope Settings - Channels 'A' and 'B'

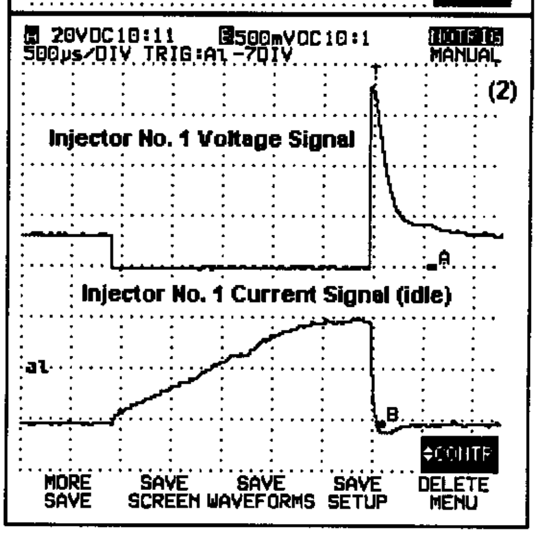
To make the waveforms as clear as possible, set the scope settings to match the examples. Set the amp probe to 100 mv (this setting equals 1 amp with the scope set to 100 mv). Zero the amp probe before starting the test.

Lab Scope Example Explanation

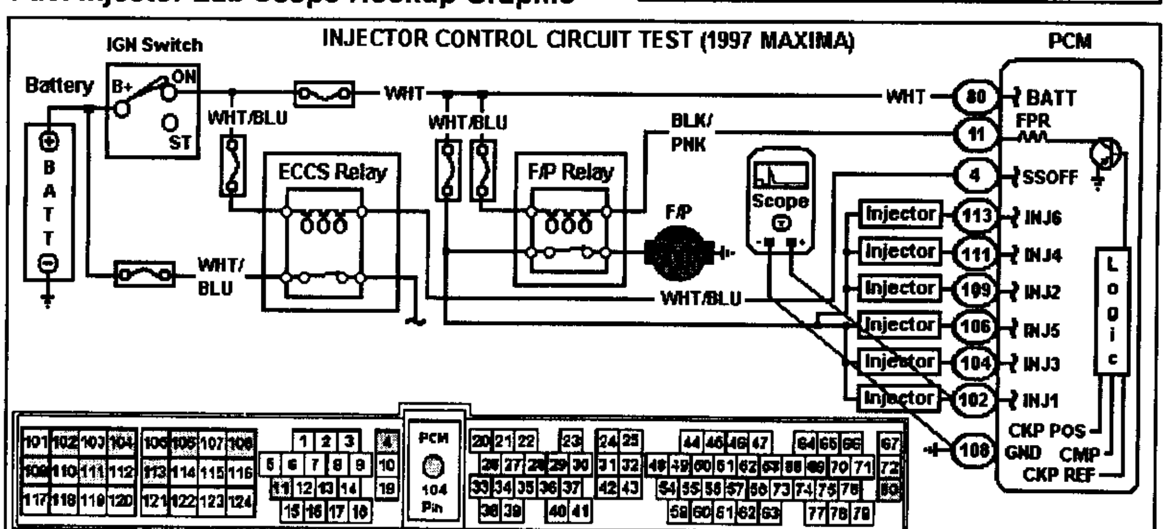
In this example, the two traces show the injector No. 1 control signal and injector No. 1 current signal at idle speed. Note the height of the injector spike (near 70v) and injector on-time (3.3 ms) in the example. Note that the fuel injector required 1.2 ms of current (nearly 3 amps) before it opened. The total current flow in the circuit was near 6 amps.

The time base (in Example 1) was changed from 2 ms to a setting of 500 uS in Example 2. This setting allows a better view of how the injector current ramped up to open the injector.





Fuel Injector Lab Scope Hookup Graphic



1997 MAXIMA (3.0L V6 VIN C)

Oxygen Sensor

General Description

The heated oxygen sensor (HO2S) is mounted in the exhaust stream where it can detect the amount of oxygen in the exhaust stream compared to the outside air. The HO2S has a closed end tube made of ceramic Zirconia. The Zirconia element generates a voltage of approximately 1v in a rich A/F mixture and a voltage close to 0v in a lean A/F mixture.

Heated Oxygen Sensor Locations

The two front heated oxygen sensors are mounted in the front tube well in front of the three-way catalytic (TWC) catalytic converter. Refer to the Graphic on the next page. The rear heated oxygen sensor is mounted after the three-way catalytic converter.

Oxygen Sensor Heaters

To stabilize their output signal, the oxygen sensors on this vehicle are equipped with an internal heater. The heater control circuits to the oxygen sensors are controlled by the PCM. *They are enabled at speeds below 3600 rpm and turned off at speeds above that.*

Lab Scope Test (HO2S Heater)

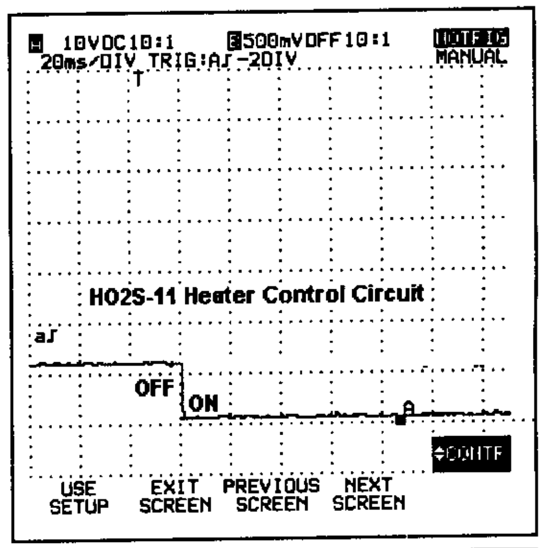
The Lab Scope (or a DVOM) can be used to monitor the operation of the front and the rear oxygen sensor heater circuits.

Scope Connections (4-Speed A/T)

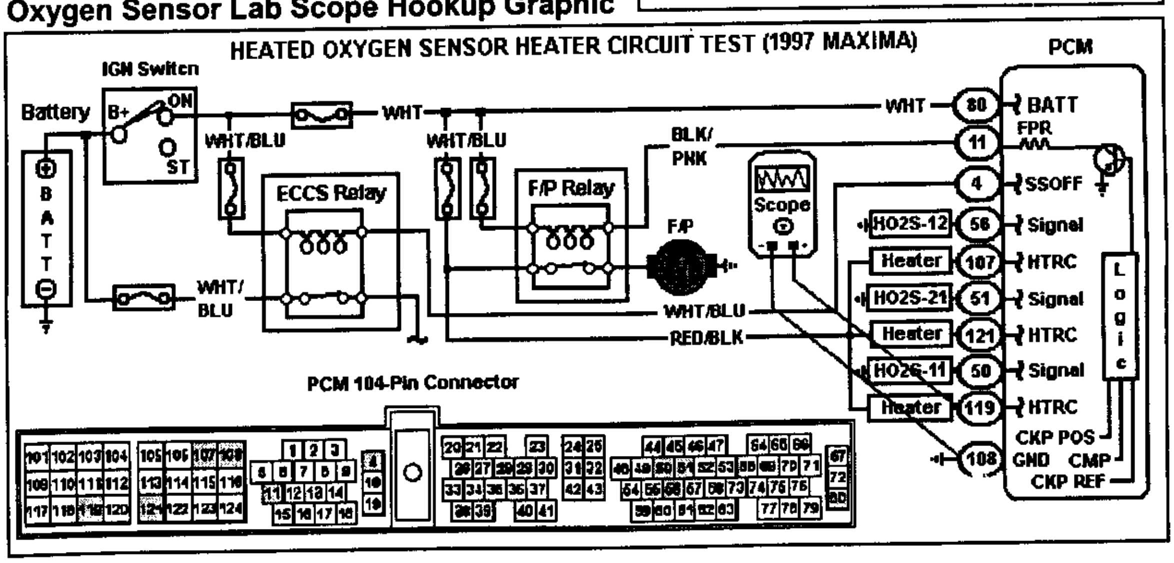
Connect the Channel 'A' positive probe to the right front heater control circuit at Pin 119 (BLY/YEL wire) of the PCM 104-Pin connector. Connect the negative probe to PCM Pin 108 (same connector) or the battery ground post.

Lab Scope Example Explanation

The trace in this example shows a known good HO2S-11 heater control signal after engine startup. Note the point at which the HO2S-11 (right side) heater control circuit is enabled.



Oxygen Sensor Lab Scope Hookup Graphic



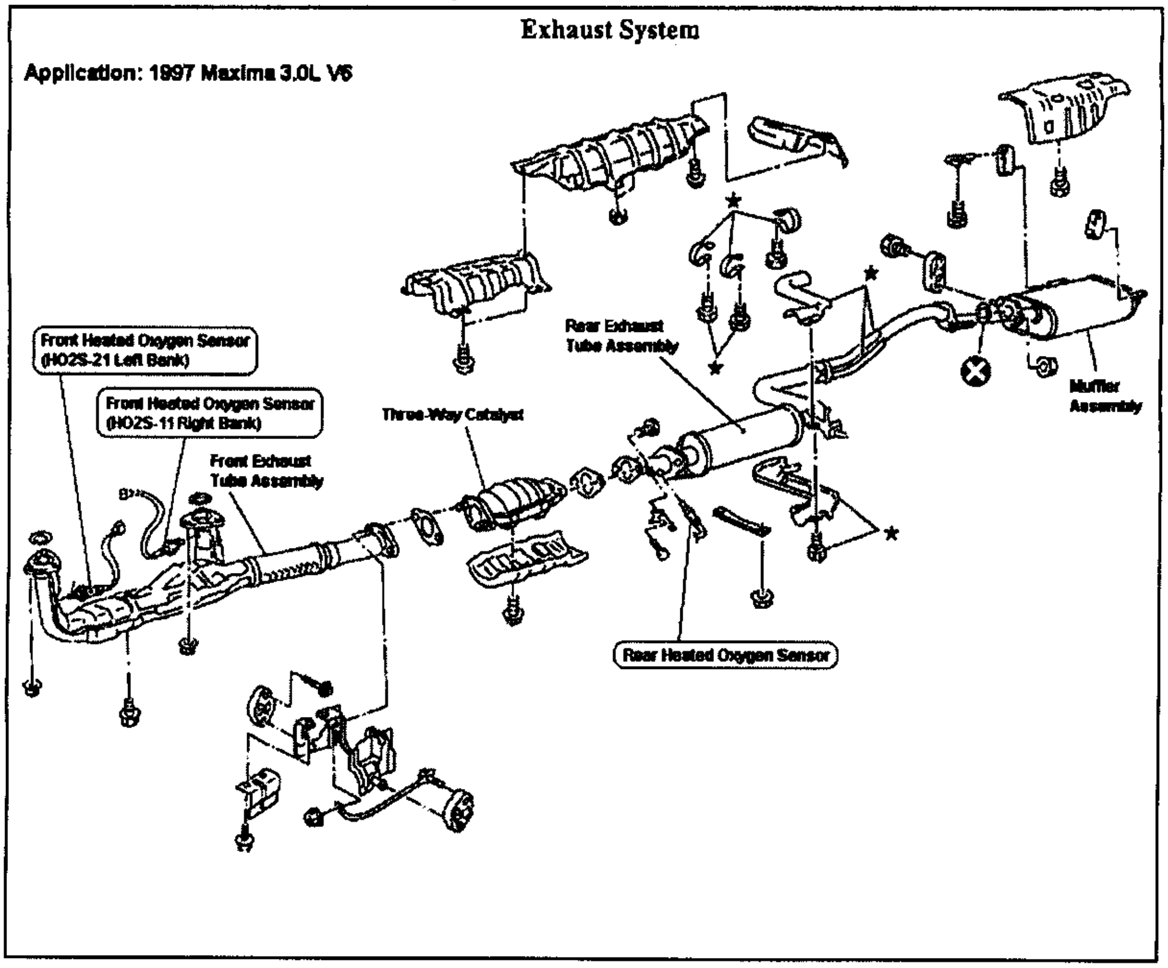
1997 MAXIMA (3.0L V6 VIN C)

Oxygen Sensor

Component Locations

The mounting locations for both the front (2) and rear oxygen sensors are shown in the Graphic on this page. Note that HO2S-11 and HO2S-21 acronyms identify the front oxygen sensors while the HO2S-12 acronym identifies the rear oxygen sensor.

HO2S Component Location Graphic



1997 MAXIMA (3.0L V6 VIN C)

Oxygen Sensor

Lab Scope Test (HO2S Signal)

The Lab Scope is the tool of choice to monitor the operation of left front and right front as well as the rear oxygen sensor circuit. Refer to the example in the Graphics on this page.

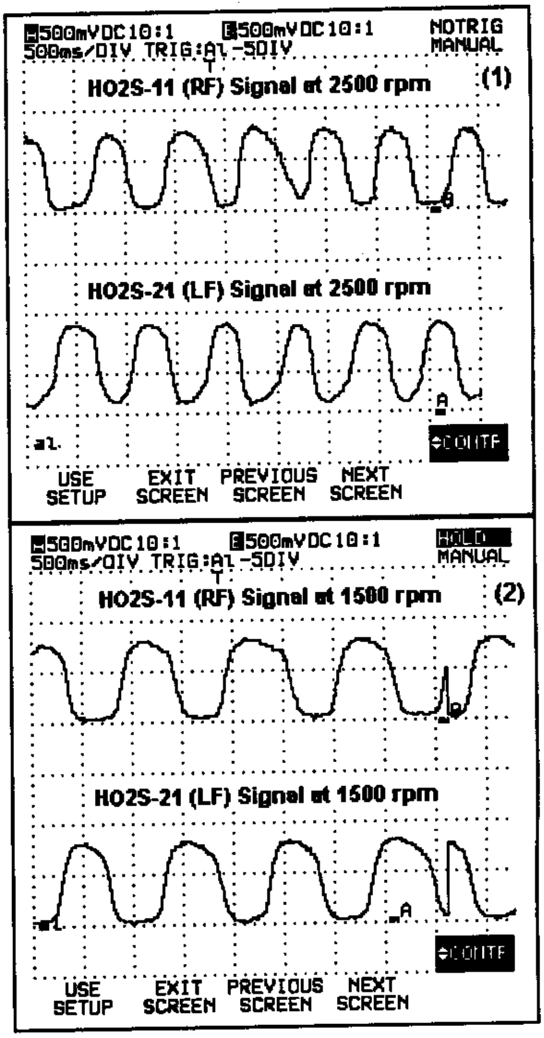
Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (Example 1)
Connect the Channel 'A' positive probe to the Pin 50 (WHT wire) of the 104-Pin connector (HO2S-11 right front) sensor signal. Connect the Channel 'A' negative probe to the battery negative ground post.

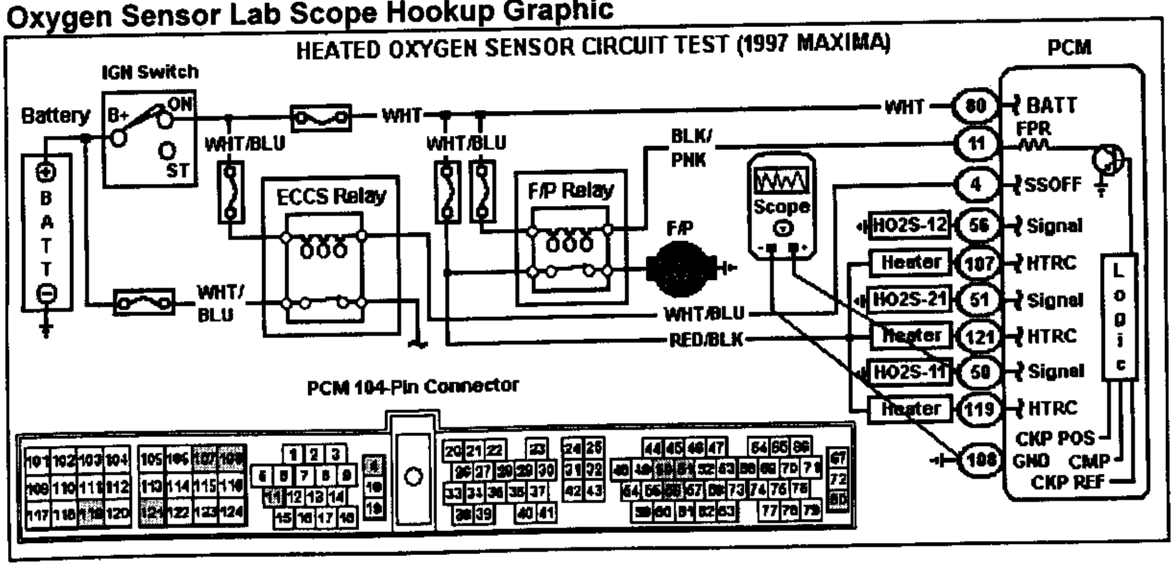
Connect the Channel 'B' positive probe to the PCM Pin 51 (WHT wire).

Scope Connections (Example 2)
Connect the Channel 'A' positive probe to the Pin 50 (WHT wire) of the 104-Pin connector (HO2S-11 right front) sensor signal. Connect the Channel 'A' negative probe to the battery negative ground post. Connect the Channel 'B' positive probe to the PCM Pin 51 (WHT wire).

Lab Scope Example Explanations
The traces in these examples show a normal left and right front HO2S waveform with the engine speed at 2500 (1) and at 1500 (2) rpm. Note: When monitoring an oxygen sensor waveform, use a 10:1 probe if it is available.



Oxygen Sensor Lab Scope Hookup Graphic



1997 MAXIMA (3.0L V6 VIN C)

Idle Air Control Motor

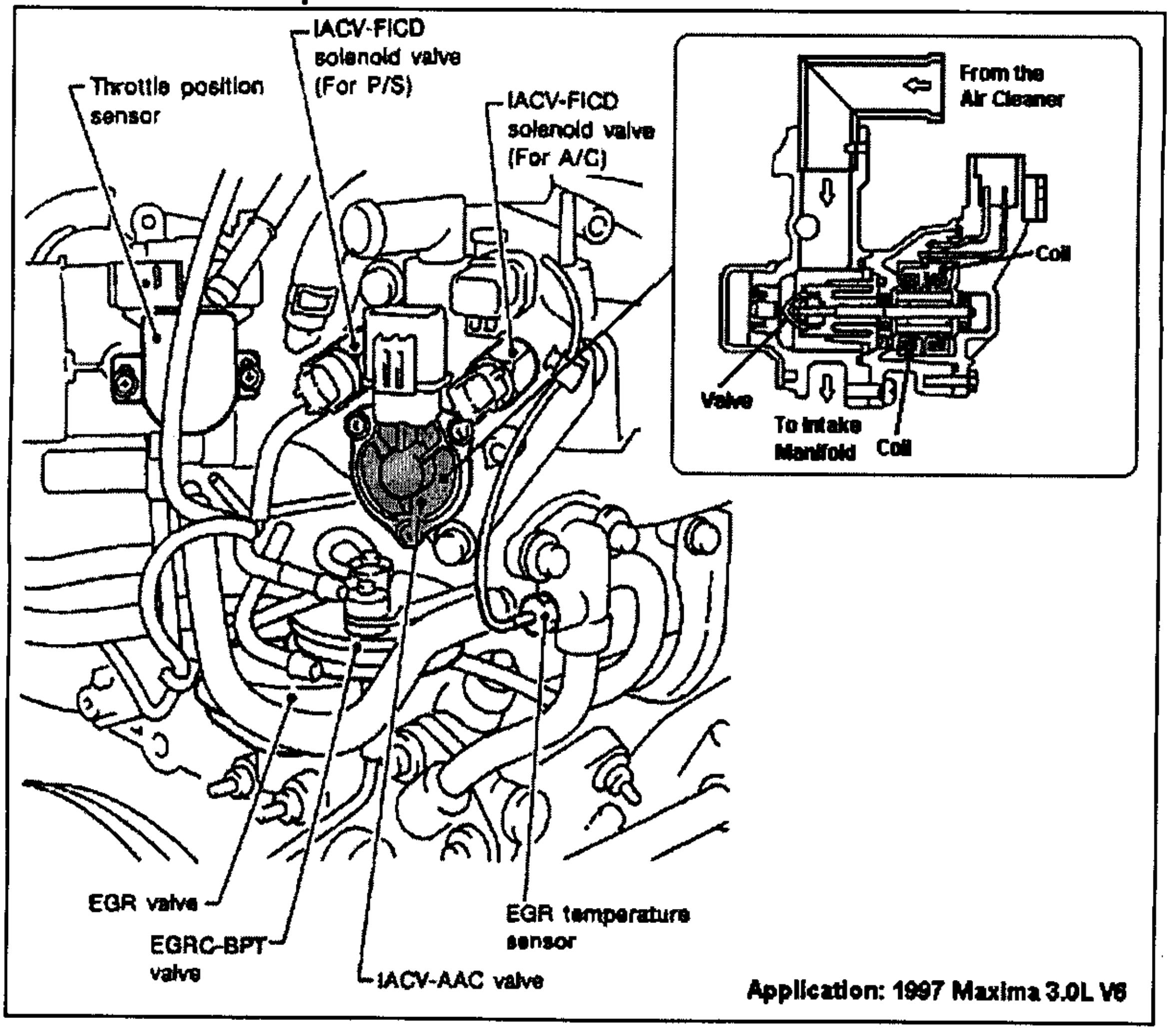
General Description

The PCM controls the position of the stepper motor inside the IACV-AAC valve for centralized control of the auxiliary air supply. The stepper motor has four winding phases that are actuated by control signals from the PCM. During actual operation, the PCM turns "on" and "off" two of the windings in the same sequence.

System Operation

Each time the valve opens and closes to change the auxiliary air quantity; the PCM sends a pulse signal to the stepper motor. If no change in idle speed is required, the PCM does not issue a command (a voltage pulse is issued so that the valve remains at a particular opening position).

IACV-AAC Valve Graphic



Application: 1997 Maxima 3.0L V6

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Idle Air Control Motor

Lab Scope Test (IAC Motor)

The Lab Scope can be used to test the operation of the stepper motor circuits inside the IAC valve. The examples on this page represent known good IAC solenoid signals.

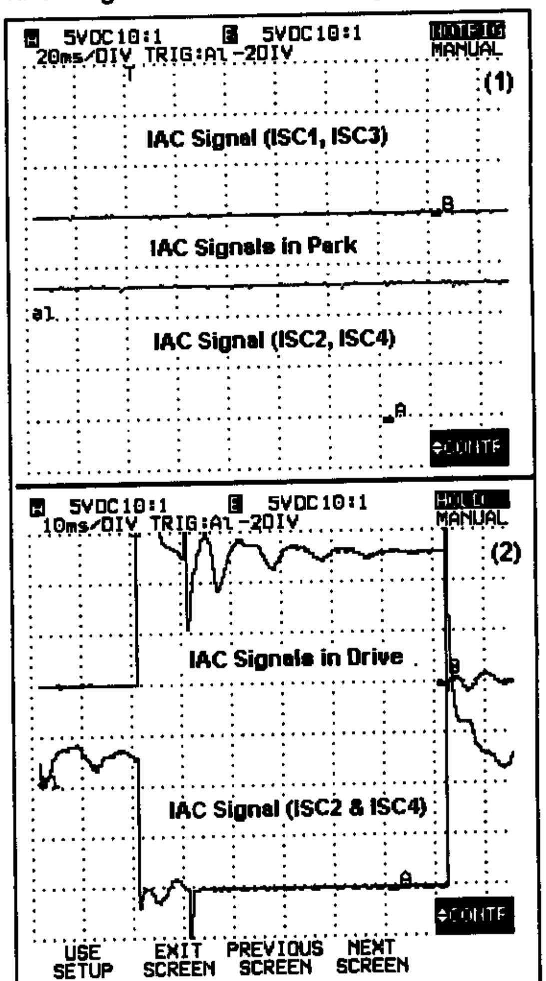
<u>Scope Connections (Examples 1 & 2)</u>
Connect the Channel 'A' positive probe at Pin 101 and its ground probe to Pin 122. Connect the Channel 'B' positive probe at Pin 115 and its ground probe to Pin 123.

<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the example.

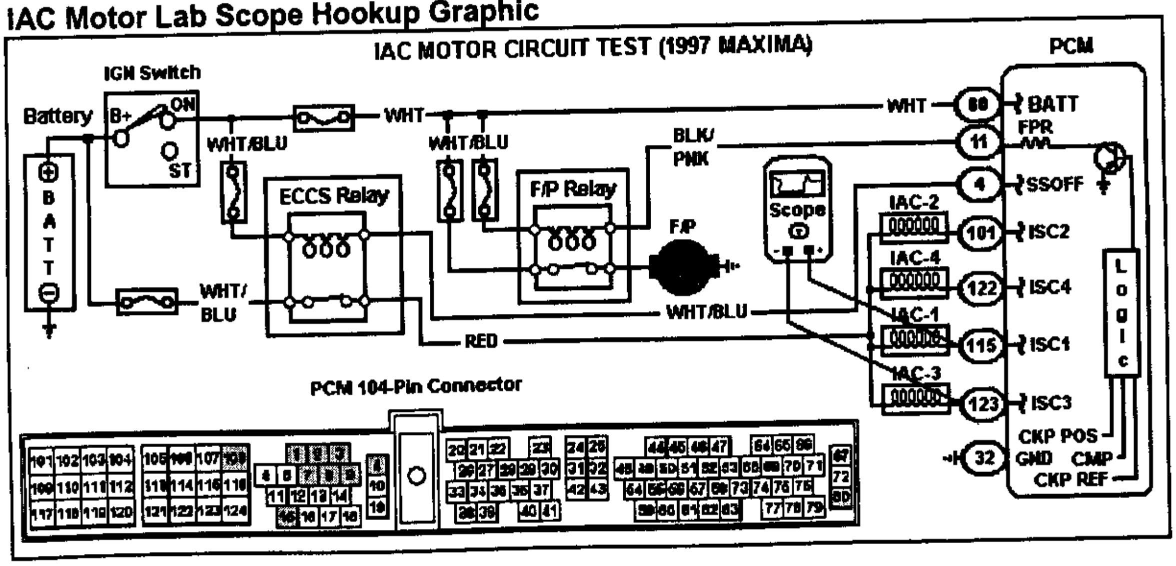
<u>IAC Valve Lab Scope Test</u>
Start the engine and allow it to fully warm up. Then capture the IAC valve waveforms with the gear selector in Park. Then turn on the air conditioner, select the high fan position and turn the lights and radio "on". These loads should cause a change in the IAC valve signal.

<u>Lab Scope Example (1) - Explanation</u>
This trace shows the IAC motor waveform without any load applied with the engine at hot idle speed in Park. Note the steady voltage signal from both phases of this example (the signals appear to be flat-lined).

<u>Lab Scope Example (2) - Explanation</u>
This trace shows the IAC motor waveform after the vehicle was shifted in Drive. The IAC signal ontime changed to slightly over 60 ms under these conditions. These two examples are from a known good vehicle.



IAC Motor Lab Scope Hookup Graphic



1997 MAXIMA (3.0L V6 VIN C)

Automatic Transmission Controls

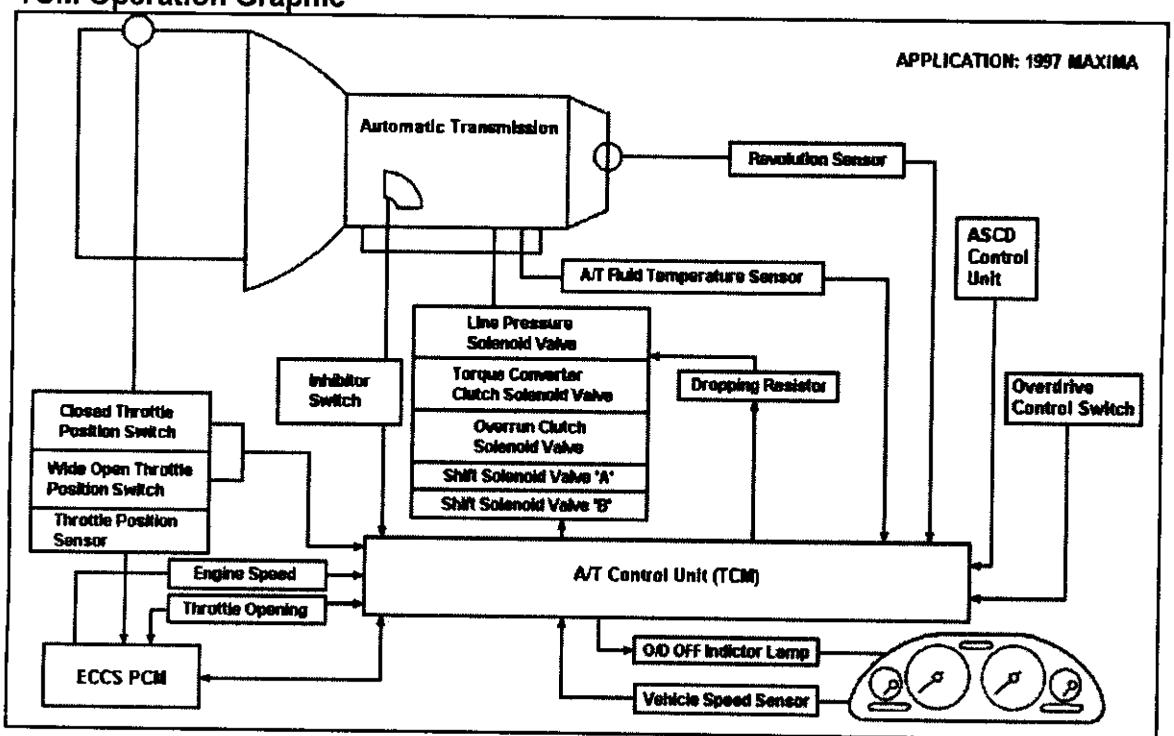
Introduction

This vehicle is equipped with a RE4FOA (V) automatic transmission designed to sense the vehicle operating conditions through various sensor and switch inputs. It controls the optimum output shaft position and reduces the shock from shift and lockup operations.

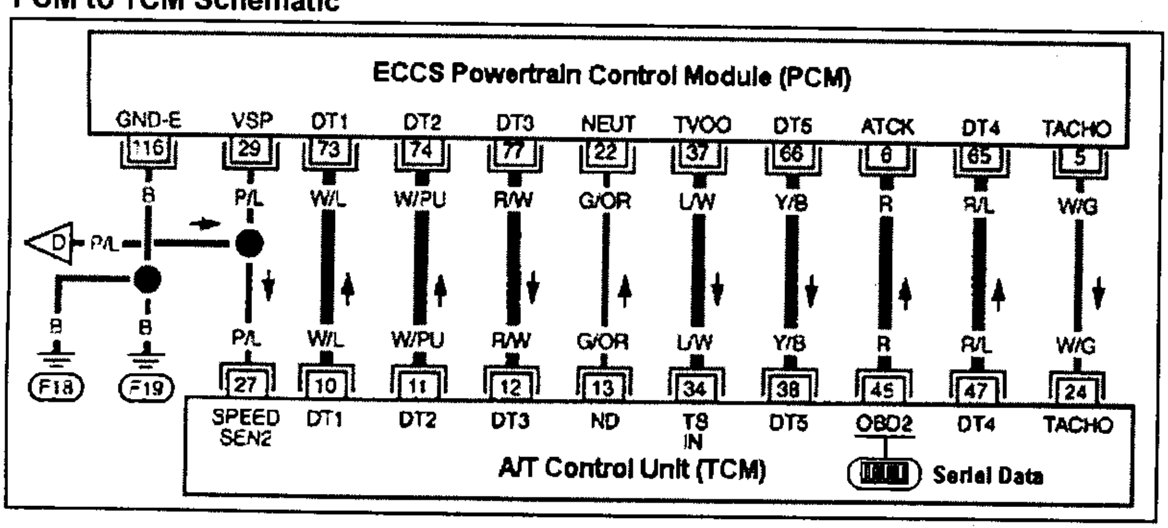
The Automatic Transmission Control Unit (the transmission control module or TCM) is part of this transmission application. It is designed to perform the following functions:

- To receive inputs signals from various sensors and switches
- To determine required line pressure, shift points, lockup and engine brake operation
- To send the required output command to the respective solenoids

TCM Operation Graphic



PCM to TCM Schematic



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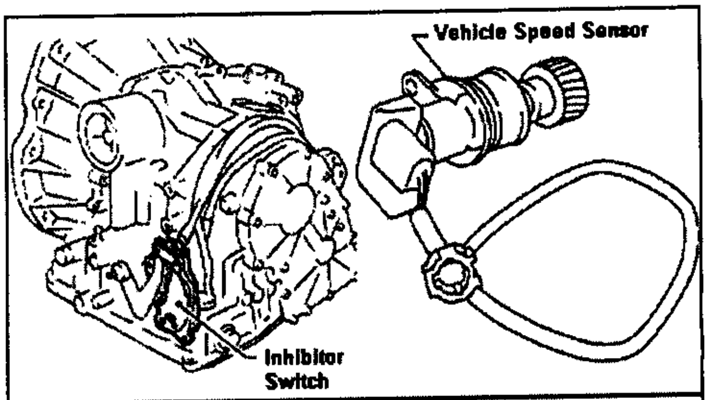
Automatic Transmission Controls

Inhibitor Switch

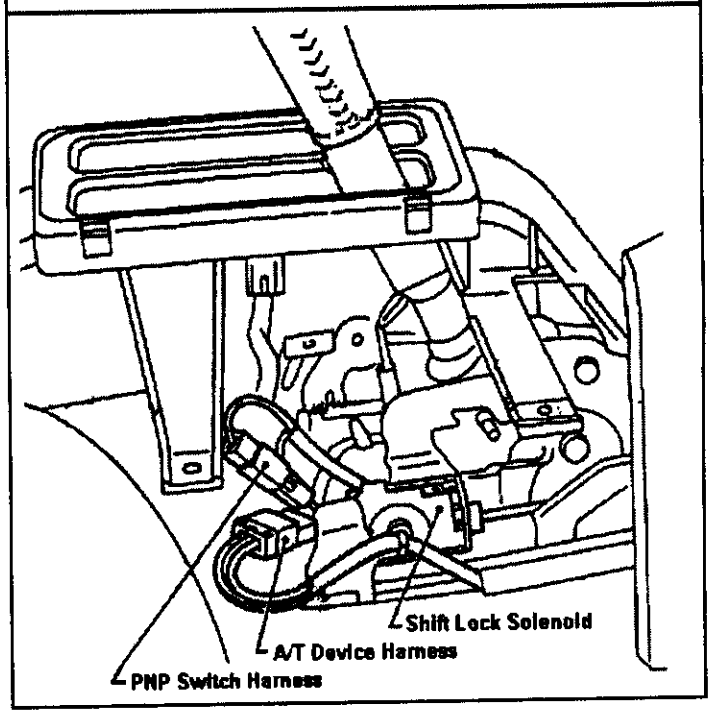
The Inhibitor Switch is mounted on the transmission where it detects the gear selector lever position and then sends a position signal to the PCM and TCM.



P/N Position Switch

The PNP switch provides the PCM with a signal that indicates when the gearshift selector is "in" or "out" of park neutral position.

The PCM uses the signal from this switch to determine ignition spark timing and idle speed.



Vehicle Speed Sensor

The Vehicle Speed Sensor (VSS) is mounted in the transaxle housing. It outputs an AC voltage signal to the Combination Meter connector at Pin 11 and Pin 28 of the meter interface.

The meter converts the VSS AC volts signal to a digital signal and sends this signal (0-5-0-5v) on to the PCM. The VSS signal is connected to the meter at Pin 14 and to the PCM at Pin 29 (PPL/BLU wire).

Failsafe Operation

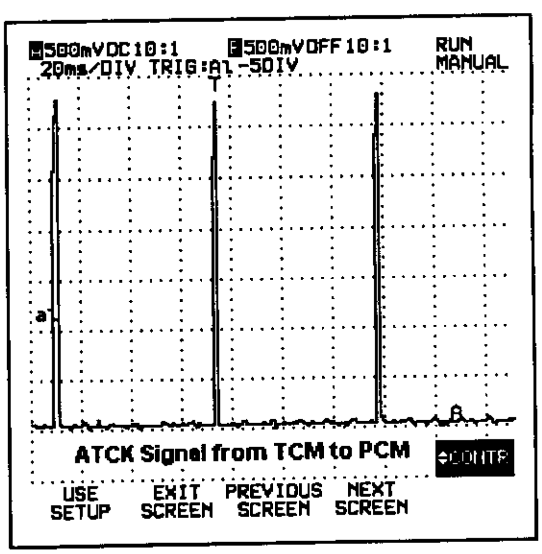
If the TCM determines that the VSS signal is missing, it will default to a signal generated by the VSS MTR circuit built into the speedometer unit (an auxiliary device).

VSS resistance: 500-650 ohms.

PCM to TCM Serial Data

The TCM communicates with the PCM on the ATCK circuit. This circuit connects to the TCM at Pin 45 and to the PCM at Pin 6 (RED wire).

To view these signals with a Lab Scope, refer to the wiring diagram on the previous page that shows this circuit, its wire colors and pin numbers at the TCM and PCM.

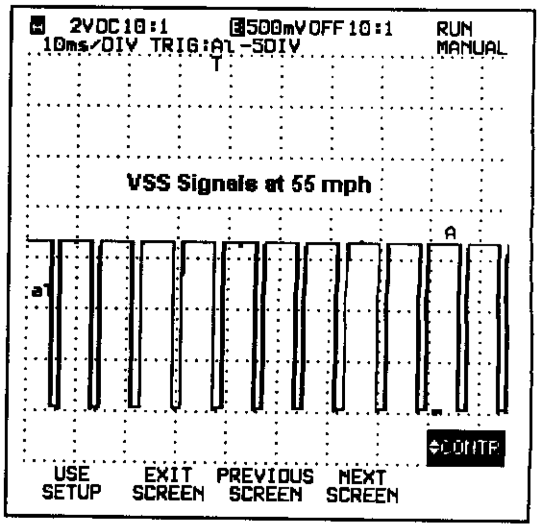


1997 MAXIMA (3.0L V6 VIN C)

Automatic Transmission Controls

Lab Scope Test (VSS)

The vehicle speed sensor is driven by the transaxle. It is a pulsed 0-5v signal from the Combination Meter (the meter converts an AC signal to a digital signal). The number of cycles per second changes with vehicle speed.



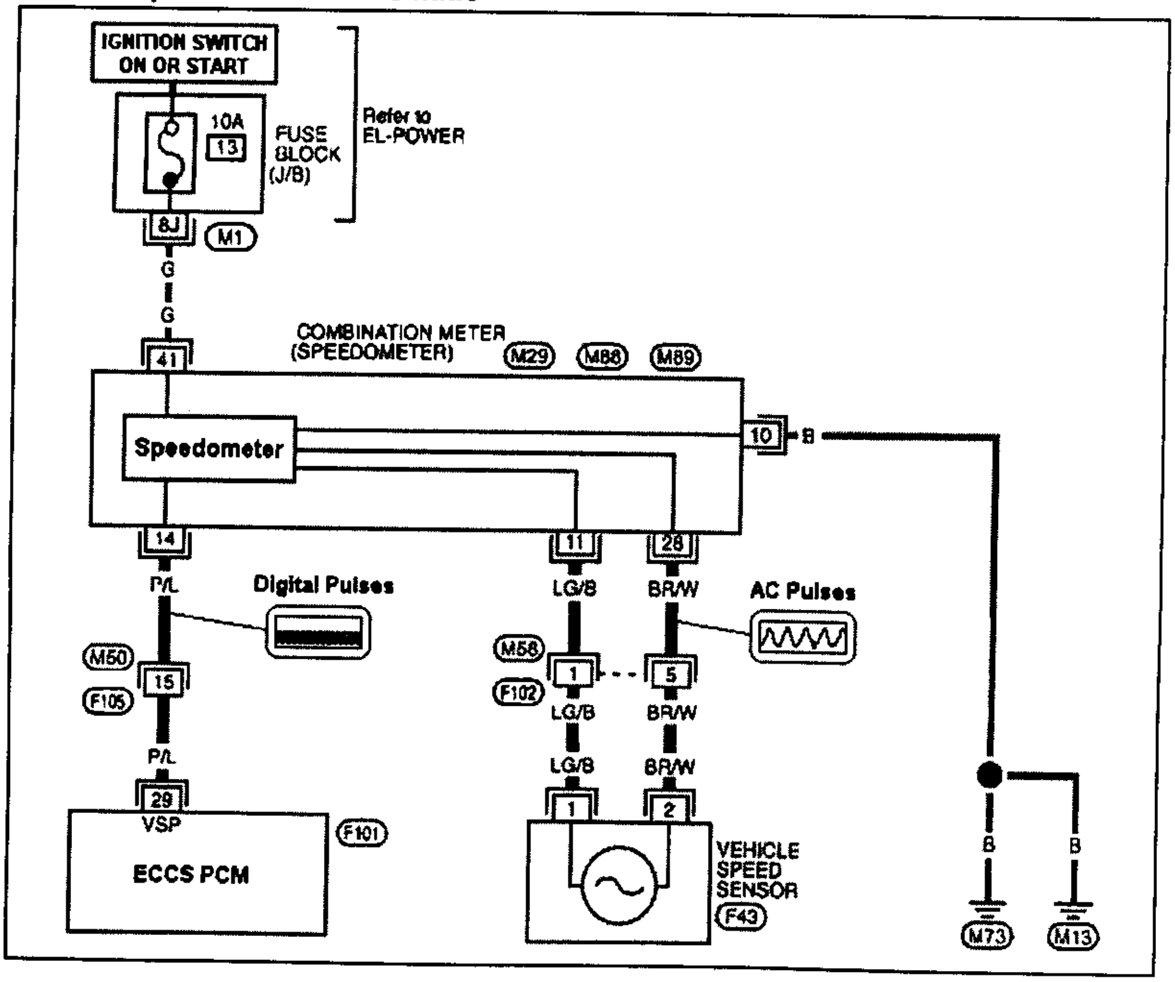
Scope Connections
Connect the Channel 'A' positive probe to Pin 29 (PPL/WHT wire) at the 104-Pin connector. Connect the negative probe to chassis ground.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Vehicle Speed Sensor Test
Connect the Lab Scope as described at the PCM and then drive the vehicle at the desired speed to set up the VSS capture.

Lab Scope Example
The Graphic shows a known good VSS signal.

Vehicle Speed Sensor Schematic



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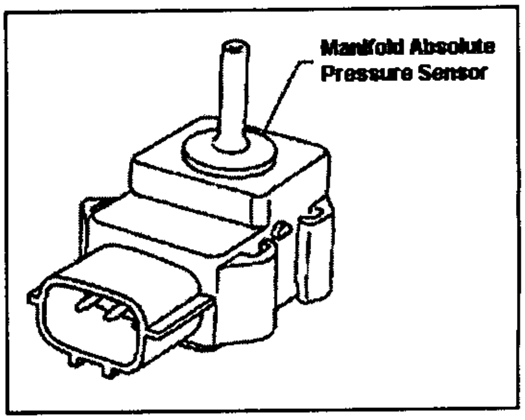
Manifold Absolute Pressure Sensor

General Description

The manifold absolute pressure (MAP) sensor is connected to the MAP/BARO switch solenoid valve through a duct. The PCM uses this sensor input to detect the ambient barometric pressure and intake manifold pressure respectively. This sensor converts this pressure to an analog signal for the PCM.



As the intake manifold pressure increases, the sensor signal voltage increases. The MAP sensor signal is not used directly as an input to the engine management system, but is used as part of the OBD II system diagnostics.

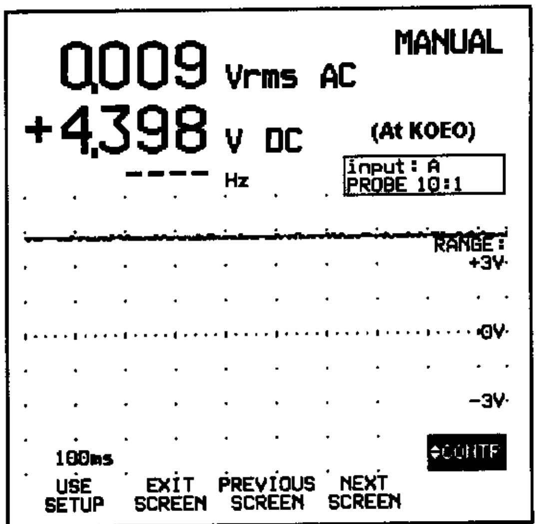
MAP Sensor Circuit Checks

The MAP sensor can be checked as follow:

MAP VREF Circuit - Carefully backprobe the MAP VREF circuit (RED wire) at the MAP sensor connector with the positive probe. Connect the other probe to the battery ground post. Turn the key to "on". This circuit should read from 4.9-5.1v.

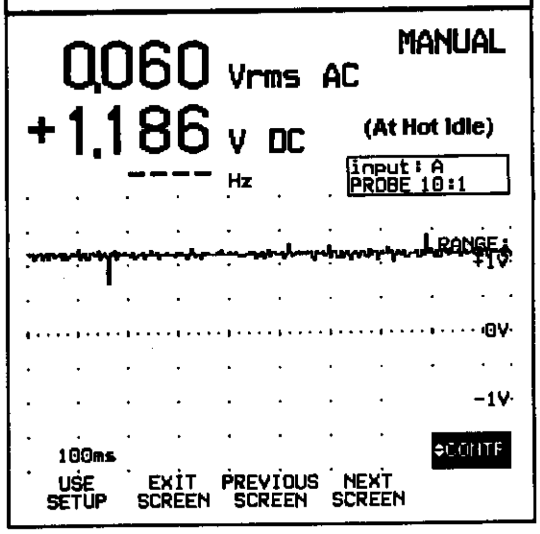
MAP Ground Circuit - Carefully backprobe the MAP ground circuit (BLK wire) at the 3-P connector with the positive probe. Connect the other probe to the battery negative post. The DVOM should read less than 50 mv at KOEO.

MAP Signal Circuit - Carefully backprobe the MAP signal circuit (WHT wire) at the 3-pin connector with the positive probe. Connect the other probe to the negative ground post. Start the engine in Park. The DVOM reading should read close to 1.1v at sea level.



DVOM Test (MAP Sensor)

Dynamic Test - Connect a Graphing Meter to the MAP signal circuit (WHT wire). Read the voltage in KOEO and KOER modes. Then compare the readings to the values in the Pin Voltage Tables. The DC analog volts reading in these examples were captured at KOEO, and at idle with a Fluke 99B in Meter mode.



Diagnostic Tips - MAP Sensor

If engine vacuum is low due to a mechanical problem, the MAP signal will read lower and cause a change in the engine operation. Mechanical faults that can cause a low vacuum reading (i.e., a timing belt one tooth off, valves that are too tight, restricted exhaust or the use of a performance camshaft. Any of these conditions can cause poor performance.

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Manifold Absolute Pressure Sensor

Lab Scope Test (MAP Sensor)

The Lab Scope can be used to test the MAP sensor in place of a DVOM or a Scan Tool. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels for safety. The Scan Tool is the tool of choice for this particular sensor.

Scope Connections

Connect the Channel 'A' positive probe to the MAP sensor signal wire at Pin 61 (WHT wire) of the 104-Pin connector. Connect the negative probe to the battery ground post.

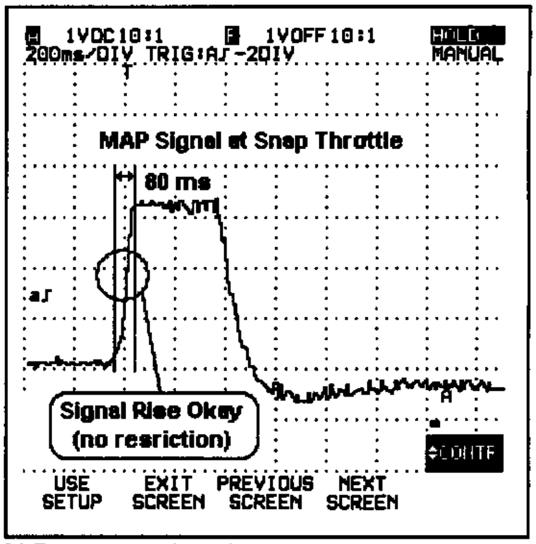
Scope Settings

To make the waveform as clear as possible, set the scope settings to match the examples. The MAP sensor waveform may have slight differences from one Lab Scope to another depending upon the scope capabilities and settings.

Lab Scope Tests

Start the engine and raise the engine speed to 2500 rpm for 2 minutes to allow it to warmup. With the engine at hot idle (in Park), perform a snap throttle test of the MAP sensor signal by quickly opening and closing the throttle while monitoring the waveform for any problems.

Lab Scope Example



There are two subdivisions between the vertical cursors in this example. Each subdivision equals 40 ms (and there are five subdivisions per graticule - 5 x 40 = 200 ms per graticule).

This example shows a good MAP sensor signal during the Snap Throttle Test. Note the signal rise time occurred in 80 ms.

To calculate the rise time of the MAP sensor signal, push the Hold or Record button on the Lab Scope to capture the pattern. Turn on the vertical cursors. Position one cursor at the point where the signal starts to rise and position the second cursor at the point where the signal stops rising. You can use this test procedure to capture the actual rise time of the MAP sensor signal on this vehicle application.

If the MAP sensor signal rise time exceeds 100-120 ms on this vehicle application, check the following:

- Check for a restriction somewhere in the exhaust system
- Check the MAP sensor vacuum source line for a restriction in the line or at the port
- Check for a defective MAP sensor

Summary: If the engine operation is sluggish, the exhaust system may be restricted or the timing chain may have "jumped" out of phase. Perform the test outlined in the example shown above to determine if the MAP sensor will pass or fail this test.

Tips: ***Problems with the vacuum source line to the MAP sensor can cause the engine to be sluggish and run too rich. Check the source vacuum line for leaks, restrictions or kinks, and for a blockage at the vacuum port on the throttle body or intake manifold.***

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Mass Airflow Sensor

General Description

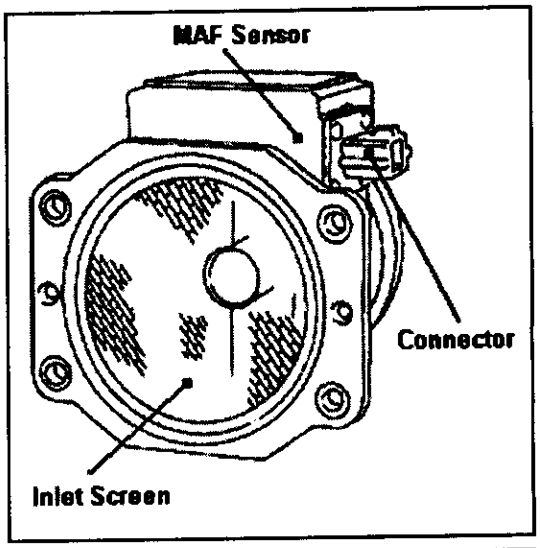
The mass airflow (MAF) sensor is placed in the stream of intake air. It is designed to measure the intake flow rate by measuring a part of the entire intake airflow.

This sensor consists of a hot film that is supplied with electric current from the PCM. The temperature of the hot film is under the control of circuits within the PCM.

The heat generated by the hot film is reduced as the intake air flows around and over it. The more air that flows past, the greater the loss of heat in the hot wire.

Therefore, the PCM must continually supply more electric current to the hot film as the airflow increases (or less as the airflow decreases).

This action (changes in current flow to keep the hot film temperature constant), maintains the temperature of the hot film. This is how the PCM determines the amount of air that is entering the engine.



DVOM Test (MAF Sensor)

Connect a DVOM or Graphing Meter to the MAF signal wire. Read the voltage in KOEO and KOER modes and compare the readings to the values here or in the Pin Voltage Tables.

DVOM Connections

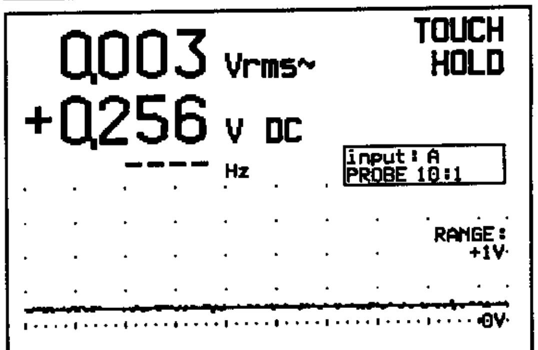
Connect the DVOM positive probe to the MAF sensor signal wire at Pin 54 of the 104-Pin connector. Connect the DVOM negative probe at Pin 55 of the same connector.

DVOM Explanations

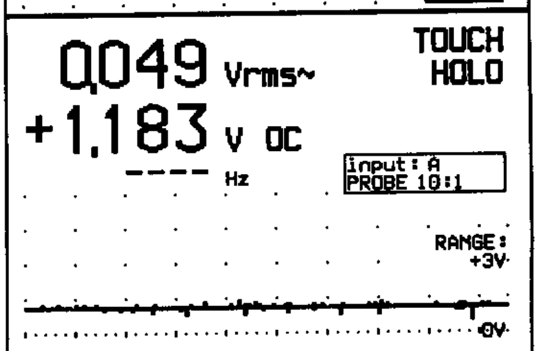
The signals in both examples show a steady DC analog voltage (flat-lined).

The engine running example is slightly higher than the KOEO example. This is due to the fact that air is flowing past the hot film and on into the engine.

These are known good values and waveforms from a Fluke 99B Scopemeter.



MAF Sensor Signal at KOEO



MAF Sensor Signal at Hot Idle

***Tips:* Problems with the MAF sensor ground connection can cause the MAF sensor signal to be out of calibration.**

1997 MAXIMA (3.0L V6 VIN C)

Mass Airflow Sensor

Lab Scope Test (MAF Sensor)

The Lab Scope can be used to test the MAF sensor in place of the DVOM or Scan Tool. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels for safety. The Scan Tool is the tool of choice for this particular sensor.

Lab Scope Connections

Connect the Channel 'A' positive probe to the MAF signal wire at Pin 54 (WHT wire) of the PCM 104-Pin connector or carefully backprobe the MAF sensor signal wire at the sensor harness connector.

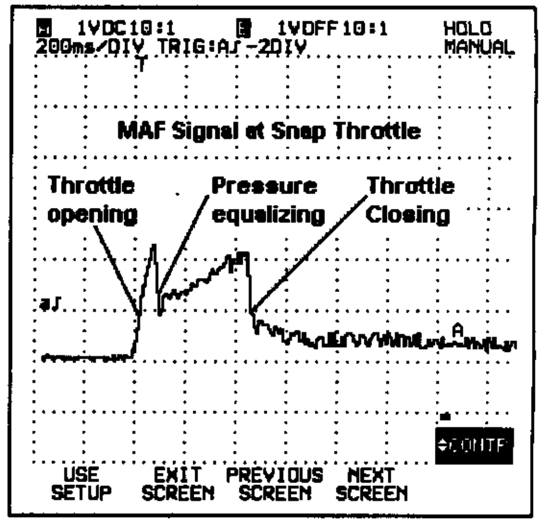
Connect the Lab Scope negative probe to Pin 55 (BLK wire) of the same connector or carefully backprobe the MAF sensor ground wire (BLK) at the sensor harness connector.

Lab Scope Settings

To make the signals as accurate as possible, set the scope settings to match the example.

Lab Scope Test Example

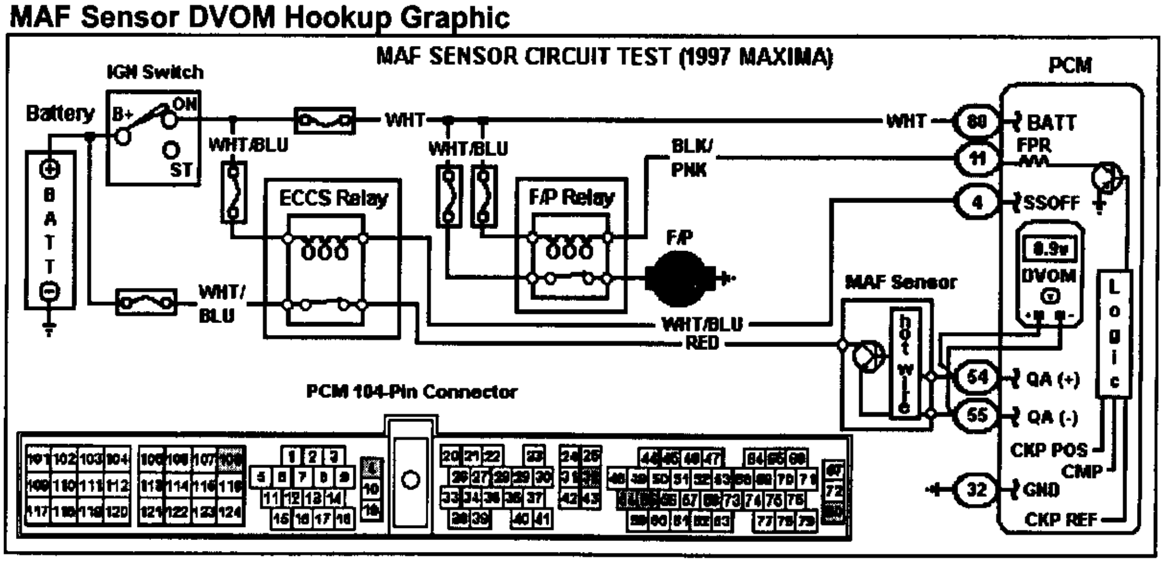
Connect the Lab Scope to the correct terminals at the PCM (inside the vehicle) or at the sensor wire harness connector as previously described.



Then start the engine and bring the engine to the desired speed to set up the capture. The Lab Scope example on this page shows a known good MAF sensor waveform captured during a snap-throttle event.

***Tips:** Problems with intake air leaks after the MAF sensor can cause rough idle and rich running engine conditions.*

MAF Sensor DVOM Hookup Graphic



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Reference Information

How To Access & Use Generic PID Information

The Scan Tool Generic Parameter Identification (PID) Mode allows access to certain data values, analog and digital input and output signals, calculated values and system status information.

The Generic OBD II PID List contains examples of the PIDs that all OBD II compatible Scan Tools must be able to access and display.

Scan Tool PID Menus

An example of how to navigate through the SPX/OTC Scan Tool menus to locate the Generic PID information is shown in the Graphic to the right.

The Graphic contains twelve of the sixteen (16) engine related parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column are known good values at 30 mph.

If all of these PID values are within normal range, refer to Symptom Diagnosis in Section 1 of this training manual.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete Generic PID list for this vehicle is shown in the Graphic.

(1) Scroll through the Computer menu and line up the symbol (>) with the desired choice (ENGINE/PCM).

(2) Scroll through the Transmission menu and line up the symbol (>) with the desired choice (AUTOMATIC).

(3) Scroll through the OBD II Main Menu and line up the symbol (>) with the desired choice (DATASTREAM).

(4) The ENGINE/PCM related PID list appears on the Scan Tool screen once DATASTREAM is selected.

(5) To select another function, back out of this screen to return to the OBD II Menu. Then select another function from the menu (e.g., Diagnostic Codes).

An example of the Generic PID list for this vehicle is shown in the next to last frame of the Graphic.

Diagnostic Tip

The Typical Values in the example on this page should be used after the following conditions are met:

- The Nissan ECCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral and in Closed Loop.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

Computer?

Press:
>1 - ENGINE/PCM
3 - ABS
4 - AIRBAG

Transmission?

Press:
>1 - Automatic
2 - Manual

OBD II Menu

Press:
> 1-Datastream
2-Diagnostic Codes
4-Record/Playback
5-Special Test
7-Monitor Setup

1-DATASTREAM

ENGINE SPEED	905RPM
ECT (°)	192°F
VEHICLE SPEED	30MPH
IGN. TIMING	2.5°
ENGINE LOAD	27%
MAP (P)	1.01v
TPS (%)	0.50v
IAT (°)	89°F
FUEL STAT 1	CL
ST FT 1	1.0%
LT FT 1	+2.0%
O2S B1 S1	0.750v
O2S B1 S2	0.560v

2-DIAGNOSTIC CODES

Press:
1 - DATASTREAM
>2 - TROUBLE CODES
6 - FREEZE FRAME
7 - PCM CONFLICTS

1997 MAXIMA (3.0L V6 VIN C)

Reference Information

How To Access & Use OEM PID Information

The OEM PID list in this example contains engine related parameters available on the Scan Tool. The list is arranged in alphabetical order. The items under "Typical Value" represent known good readings for this engine.

Scan Tool PID Menus

An example of how to navigate through the SPX/OTC Scan Tool menus to locate the OEM proprietary PID information is shown in the Graphic to the right.

The Graphic contains thirteen of the sixteen (16) engine related parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column are known good values at 55 mph.

If all of these PID values are within normal range and the vehicle has an obvious driveability system, refer to Symptom Diagnosis in Section 1 of this training manual.

Parameter ID (PID) Information

The proper sequence to follow on this Scan Tool to obtain an OEM PID list for this vehicle is shown below.

1) Scroll through the Computer menu and line up the symbol (>) with the desired choice (ENGINE/PCM).
2) Scroll through the Transmission menu and line up the symbol (>) with the desired choice (AUTOMATIC).
3) Scroll through the OBD II Main Menu and line up the symbol (>) with the desired choice (DATASTREAM).
4) The ENGINE/PCM related PID list appears on the Scan Tool screen once DATASTREAM is selected.
5) To select another function, back out of this screen to return to the OBD II Menu. Then select another function from the menu (e.g., Diagnostic Codes).

An example of the OEM proprietary PID list for this vehicle is shown in the next to last frame of this Graphic.

Diagnostic Tip

The Typical Values in the example on this page should be used after the following conditions are met:

- The Nissan ECCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral and in Closed Loop.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

Computer?

```
Press:
>1 - ENGINE/PCM
 3 - ABS
 4 - AIRBAG
```

Transmission?

```
Press:
>1 - Automatic
 2 - Manual
```

OBD II Menu

```
Press:
> 1-Datastream
  2-Diagnostic Codes
  4-Record/Playback
  5-Special Test
  7-Monitor Setup
```

1-DATASTREAM

```
ENGINE SPEED··2265RPM
ECT (°)···········193°F
VEHICLE SPEED····55MPH
IGN. TIMING·········24.0°
ENGINE LOAD············40%
MAP (P)················1.31v
TPS (%)················1.15v
IAT (°)·················91°F
FUEL STAT 1·············CL
ST FT 1·················0.0%
LT FT 1················+1.0%
O2S B1 S1·········0.240v
O2S B1 S2·········0.620v
```

2-DIAGNOSTIC CODES

```
Press:
 1 - DATASTREAM
>2 - TROUBLE CODES
 6 - FREEZE FRAME
 7 - PCM CONFLICTS
```

1997 MAXIMA (3.0L V6 VIN C)

Reference Information

PCM PID Tables

Note: ***The following readings were obtained with the engine at idle speed, radiator hose hot, throttle closed, gear selector in Park and all accessories turned off.***

Serial Data Name	Range or Value	Hot Idle	30 MPH	55 MPH
A/C Switch	ON or OFF	OFF	OFF	OFF
A/C Clutch	ON or OFF	OFF	OFF	OFF
Alternator	0-100%	35%	34%	34%
Alternator Control Volts	0-25.5v	14.4v	14.4v	14.3v
BARO Sensor	0-5.1v	2.76	2.74	2.73
Battery Voltage	0-25.5v	14.4v	14.4v	14.3v
Calculated Load Value	0-100%	27%	36%	40%
DTC Number	0-255	N/A	N/A	N/A
Electronic Load Detector	0-100 amps	4.1a	8.1a	10.2a
Engine Speed	0-10,000 rpm	905	1420	2265
ECT Sensor	-40 to 304°F	190	192	193
EVAP Duty Cycle	0-100%	0%	0-80%	0-90%
Fan Relay	ON or OFF	ON	OFF	OFF
Fuel Status 1	OPEN / CLOSED	CLOSED	CLOSED	CLOSED
HO2S-11 (front)	0-1100 millivolts	390 mv	750 mv	240 mv
HO2S-12 (rear)	0-1100 millivolts	490 mv	560 mv	620 mv
HO2S-11 HTR (front)	ON or OFF	ON	ON	ON
HO2S-12 HTR (rear)	ON or OFF	ON	ON	ON
IAC Motor	0-255 counts	50	50	50
IAT Sensor	-40 to 304°F	89	90	91
Knock Advance	0-99° BTDC	2	0	0
LONGFT (%)	0-100%	+2	+1	+1
Main Relay Status	ON or OFF	ON	ON	ON
MAP Sensor (V)	0-5.1v	1.01v	1.11v	1.31v
MIL Status	ON or OFF	OFF	OFF	OFF
PSP Switch	ON or OFF	OFF	OFF	OFF
SCS Connector Status	OPEN or CLOSED	OPEN	OPEN	OPEN
Shift Lock	HIGH or LOW	HIGH	HIGH	HIGH
Spark Advance	0-99° BTDC	2	15	24
SHRTFT (%)	0-100%	-1	-1	0
Starter Switch	ON or OFF	OFF	OFF	OFF
TP Sensor (V)	0-5.1v	0.50v	1.10v	1.15v
VTEC Pressure Switch	ON or OFF	ON	ON	ON
VTEC Pressure Solenoid	ON or OFF	OFF	OFF	OFF
Vehicle Speed (mph)	0-255	0	30	55

Note: ***The example on this page includes the PID data available with a Nissan Factory Scan Tool (the Consult). The amount of information available with an Aftermarket Scan Tool is restricted to the OBD II Generic PID List.***

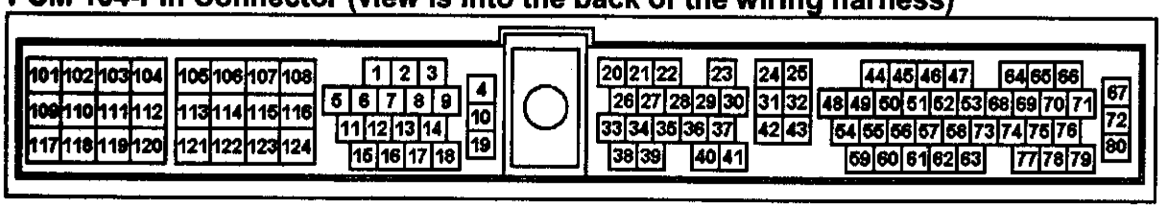
1997 MAXIMA (3.0L V6 VIN C)

PCM Pin Voltage Tables

Pin Voltage Table for the PCM 104-Pin Connector (1997 Maxima 3.0L V6 with A/T)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
1	YEL/GRN	Ignition 1 Control Signal	Pulse signals
2	GRN/RED	Ignition 2 Control Signal	Pulse signals
3	BLU/RED	Ignition 3 Control Signal	Pulse signals
4	WHT/BLU	ECCS Relay Control (self shutoff)	Relay On: 1v, Off: 12v
5	WHT/GRN	Tachometer	Digital signals (average: 7v)
6	RED	A/T Diagnosis Signal	0.5-3.0v
7	GRY	Ignition 4 Control Signal	Pulse signals
8	PPL/WHT	Ignition 5 Control Signal	Pulse signals
9	GRY/RED	Ignition 6 Control Signal	Pulse signals
10	BLK	PCM Ground (ECCS)	<0.1v
11	BLK/PNK	Fuel Pump Relay Control	Relay On: <1v, Off: 12v
12	BLK/RED	Air Conditioner Relay Control	Relay On: <1v, Off: 12v
13	LT GRN	High Speed Cooling Fan Control	Fan On: <1v, Off: 12v
14	LT GRN/RED	Low Speed Cooling Fan Control	Fan On: <1v, Off: 12v
15	BLK/PNK	Fuel Pump Control Module	10v (30 sec's after startup)
16	ORN/YEL	BARO/MAP Switch Solenoid	12-14v
17	---	Not Used	---
18	LT GRN/BLK	MIL (lamp) Control	Lamp On: 1v, Off: 12v
19	BLK	Power Ground (ECCS)	<0.1v
20	BRN/WHT	Starter Signal	KOEC: 9-11v
21	GRN/BLK	Air Conditioner Switch Signal	A/C & Blower On: 0v, Off: 12v
22	GRN/ORN	Inhibitor Switch	In 'P' or 'N': 0v, Others: 5v
23	WHT	Throttle Position Sensor	0.35-0.65v
24	RED	Ignition Switch Signal	System Voltage (12-14v)
25	BLK	Power Ground (ECCS)	<0.1v
26	YEL	EVAP Purge Volume Control #1	Pulse signals
27	GRN	EVAP Purge Volume Control #2	Pulse signals
28	GRN/RED	Fuel Pump Control Module Check	3.3-3.8v (30 sec's after startup)
29	PNK/BLU	Vehicle Speed Sensor	Digital signal: 0-5-0-5v
30	---	Not Used	---
31	YEL	Throttle Position Switch	Switch Closed: 12v, Open: 0v
32	BLK	Power Ground (ECCS)	<0.1v
33	WHT/BLU	Engine Mount Control (EMNT1)	Pulse signals
34	WHT/RED	Engine Mount Control (EMNT2)	Pulse signals
35-36	---	Not Used	---
37	BLU/WHT	Throttle Position Sensor	0.35-0.65v
38	---	Not Used	---
39	GRN	Power Steering Switch	Wheel straight: 0v, Turning: 5v

PCM 104-Pin Connector (view is into the back of the wiring harness)



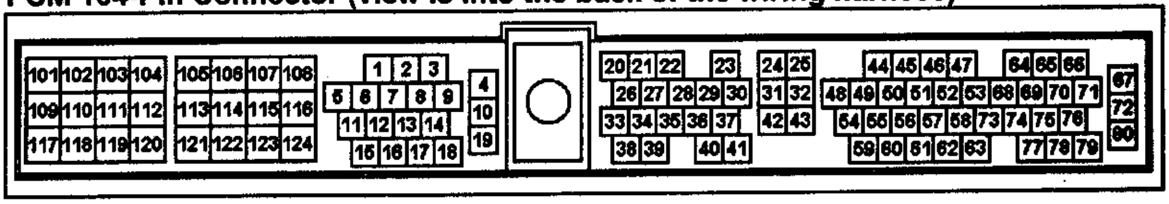
1997 MAXIMA (3.0L V6 VIN C)

PCM Pin Voltage Tables

Pin Voltage Table for the PCM 104-Pin Connector (1997 Maxima 3.0L V6 with A/T)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
40-41	---	Not Used	---
42	RED	Sensor Voltage Reference	4.9-5.1v
43	BLK	Sensor Ground Return	<0.050v
44	WHT	CKP Sensor Reference (REF)	A/C pulse signals (2.3v)
45, 53 & 57	---	Not Used	---
46	WHT	CMP Sensor Signal (PHASE)	A/C pulse signals (4.2v)
47	WHT	CMP Sensor Signal (PHASE)	A/C pulse signals: (4.2v)
48	WHT	CKP Sensor Reference (REF)	A/C pulse signals (2.3v)
49	WHT	CKP Sensor Signal (POS)	A/C pulse signals (2.5v)
50	WHT	Right Front HO2S-11 Signal	0-1.0v (varies)
51	WHT	Left Front HO2S-21 Signal	0-1.0v (varies)
52	PNK/BLU	Fuel Tank Temperature Sensor	0-4.8v (varies with temperature)
54	WHT	Mass Airflow Sensor Signal	1.0-1.7v
55	BLK	Mass Airflow Sensor Ground	<0.050v
56	WHT	Rear HO2S-12 Signal	0-1.0v (varies)
58	LT BLU	Intake Air Temperature Sensor	1.3v (varies with air temp.)
59	YEL	Engine Coolant Temp. Sensor	0.6v (varies with engine temp.)
60	---	Not Used	---
61	WHT	Absolute Pressure Sensor Signal	1.2v (at key on: 4.4v)
62	WHT	EVAP Pressure Sensor Signal	3.4v
63	BLU/ORN	EGR Temperature Sensor Signal	0-3-1.1v
64	WHT	Knock Sensor Signal	2.0-3.0v
65	RED/BLU	A/T Position Signal No. 4	0v
66	YEL/BLK	A/T Position Signal No. 5	0v
67	RED	Power Supply to PCM	12-14v
68, 71-72	---	Not Used	---
69	GRN/BLK	OBD II Signal to DLC	With Scan Tool: 0-12-0-12v
70	ORN/BLU	EVAP Vent Control Solenoid	Solenoid On: 1v, Off: 12v
73	WHT/BLU	A/T Position Signal No. 1	0v
74	WHT/PPL	A/T Position Signal No. 2	6-8v
75	BRN/YEL	SCIRX Input to Consult Scan Tool	3.5v with Scan Tool connected
76	PNK	SCITX Input to Consult Scan Tool	3.5v with Scan Tool connected
77	RED/WHT	A/T Position Signal No. 3	6-8v
78	LG	SCICL Input to Consult Scan Tool	---
79	RED/WHT	Electrical Load Signal	Read Defrost On: 12-14v
80	WHT	Battery Direct (backup power)	System Voltage (12-14v)

PCM 104-Pin Connector (view is into the back of the wiring harness)



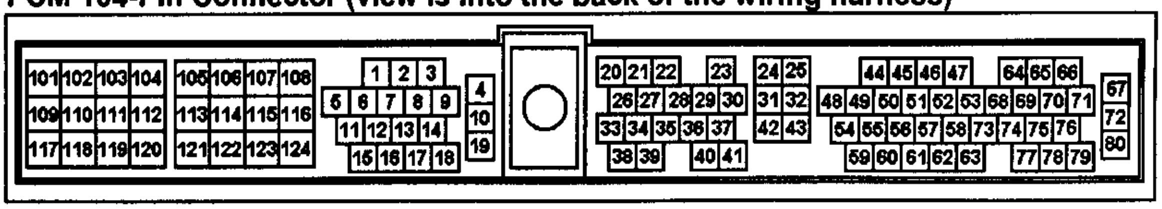
1997 MAXIMA (3.0L V6 VIN C)

PCM Pin Voltage Tables

Pin Voltage Table for the PCM 104-Pin Connector (1997 Maxima 3.0L V6 with A/T)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
101	PPL/GRN	IACV-AAC Valve ISC1 Signal	Pulse signals
102	RED/BLK	Injector No. 1 Control Signal	3.6 ms
103	BLU/BLK	EGRC Solenoid Control	Solenoid On: 1v, Off: 12v
104	RED/YEL	Injector No. 3 Control Signal	3.6 ms
105	---	Not Used	---
106	BLU/WHT	Injector No. 5 Control Signal	3.6 ms
107	RED	Rear HO2S-12 Heater Control	Heater On: 1v, Off: 12v
108	BLK	Power Ground (ECCS)	<0.1v
109	RED/GRN	Injector No. 2 Control Signal	3.6 ms
110	GRN/BLK	EVAP Purge Volume Control #3	Pulse signals
111	BLK/ORN	Injector No. 4 Control Signal	3.6 ms
112	---	Not Used	---
113	PPL/RED	Injector No. 6 Control Signal	3.6 ms
114	BLU/YEL	EVAP Purge Solenoid	Pulse signals
115	GRY/GRN	IACV-AAC Valve ISC2 Signal	Pulse signals
116	BLK	Power Ground (ECCS)	<0.1v
117	---	Not Used	---
118	BLU/RED	EVAP Purge Volume Control #4	Pulse signals
119	BLU/YEL	Front HO2S-12 Heater Control	Heater On: 1v, Off: 12v
120	ORN/GRN	Vacuum Cut Valve Bypass Valve	Solenoid On: 1v, Off: 12v
121	BLU	Front HO2S-21 Heater Control	Heater On: 1v, Off: 12v
122	YEL	IACV-AAC Valve ISC3 Signal	Pulse signals
123	GRY/YEL	IACV-AAC Valve ISC4 Signal	Pulse signals
124	BLK	Power Ground (ECCS)	<0.1v

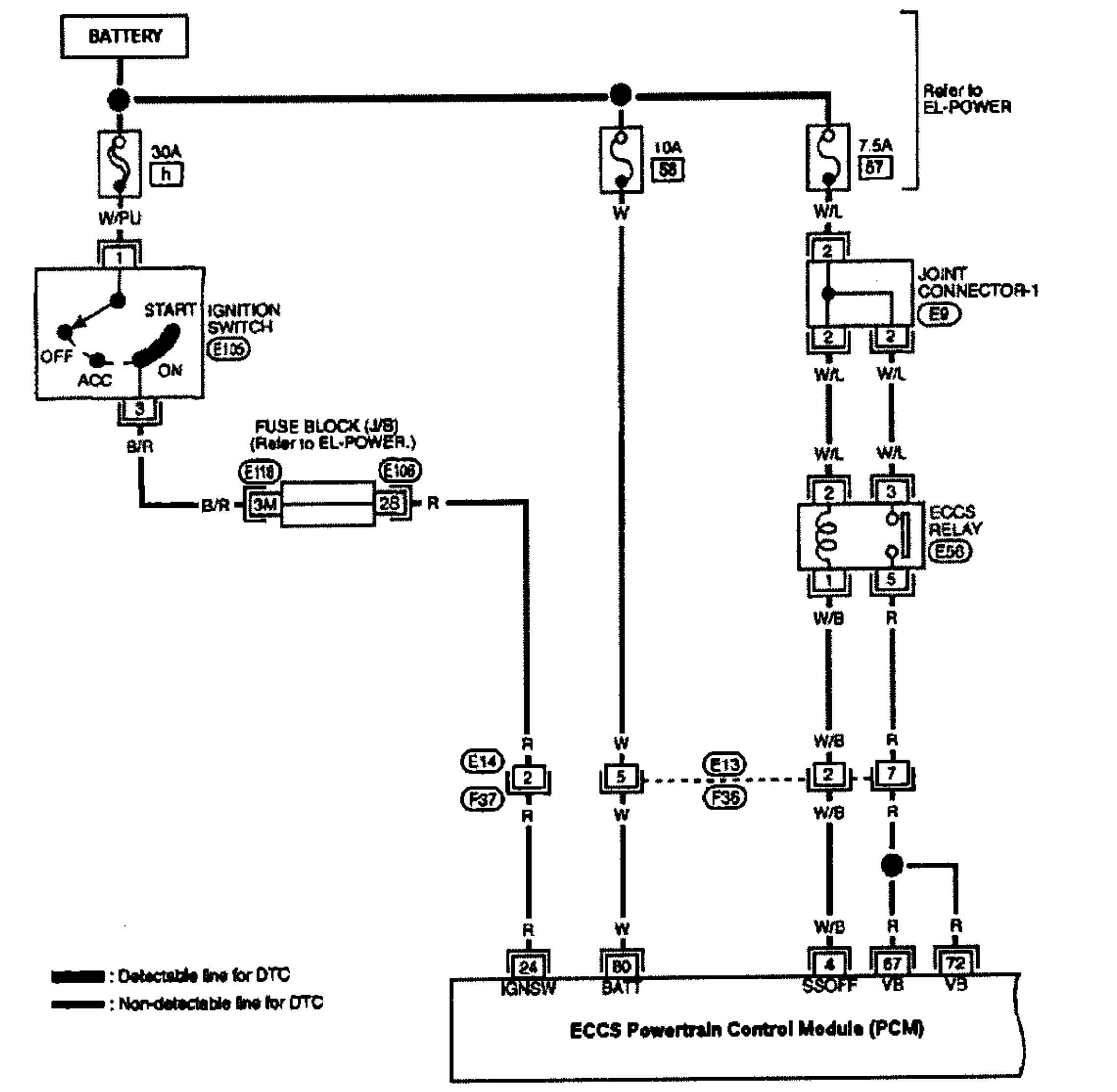
PCM 104-Pin Connector (view is into the back of the wiring harness)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

ECCS Main Relay (1 of 17)

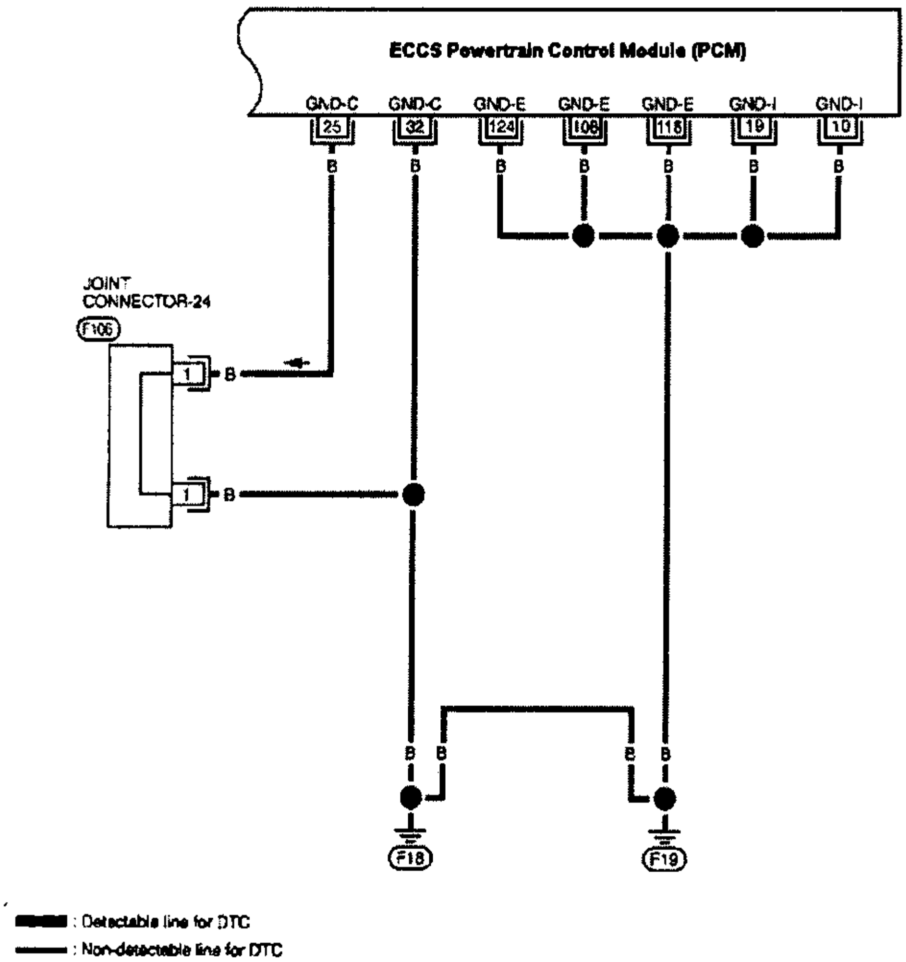


EC-MAIN-01 Main Power Supply And Ground Circuit (Part 1 Of 2)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

ECCS Power Grounds (2 of 17)

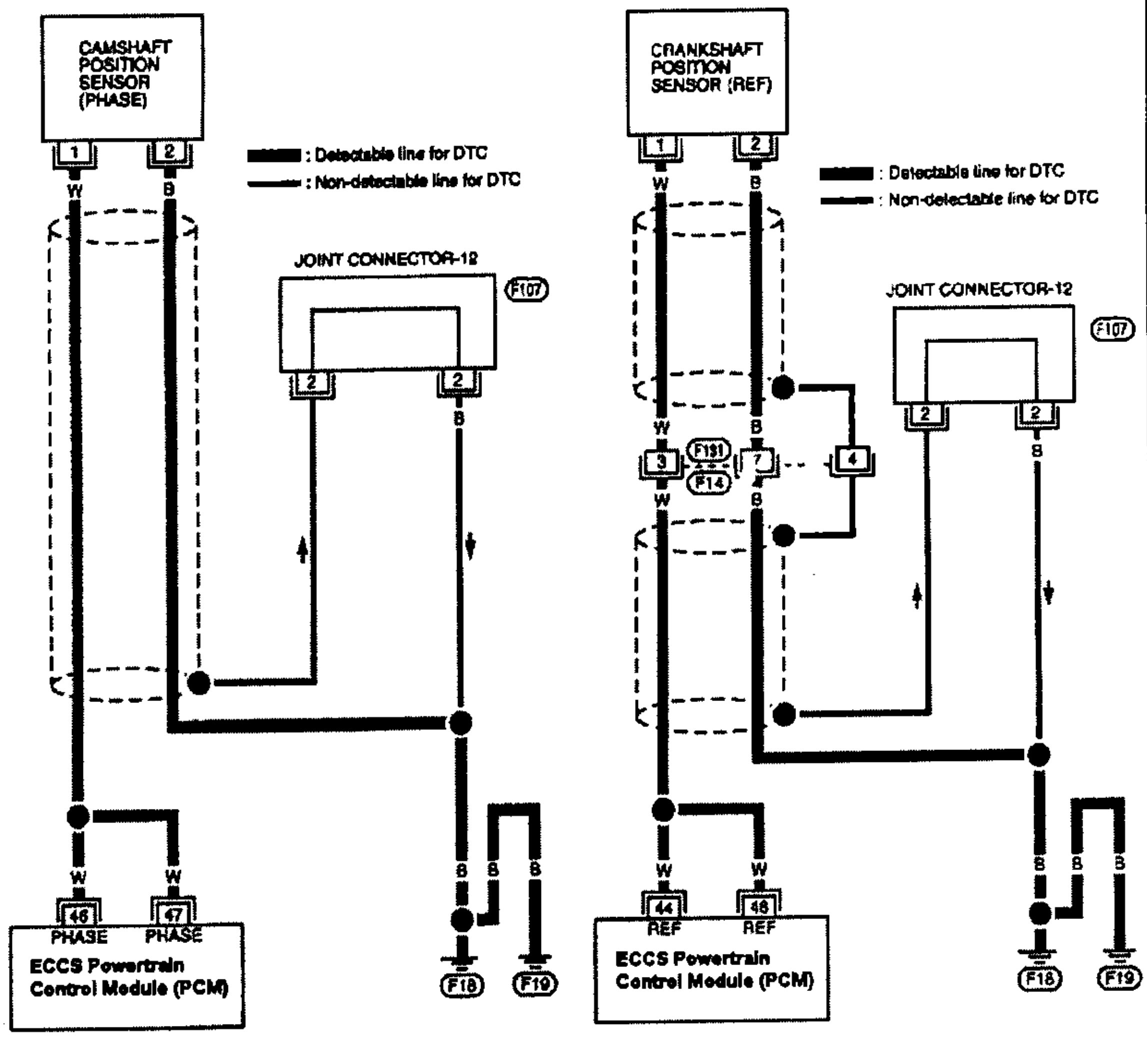


EC-MAIN-02 Main Power Supply And Ground Circuit (Part 2 Of 2)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

CMP & CKP REF Sensor (3 of 17)



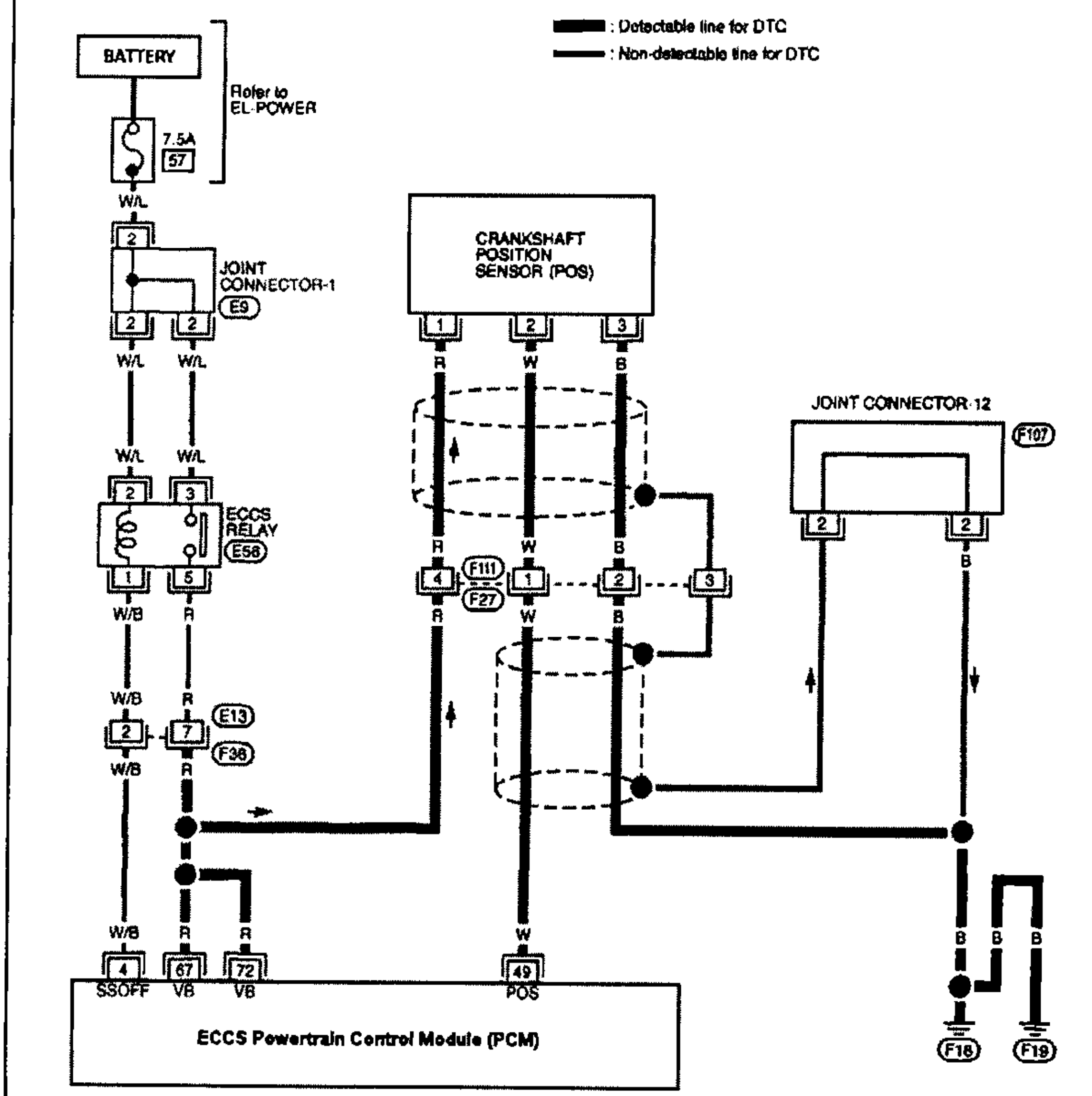
EC-PHASE-01 Camshaft Position Sensor (CMPS) (PHASE) (DTC: P0340)

EC-REF-01 Crankshaft Position Sensor (CKPS) (REF) (DTC: P1335)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

CKP POS Sensor (4 of 17)

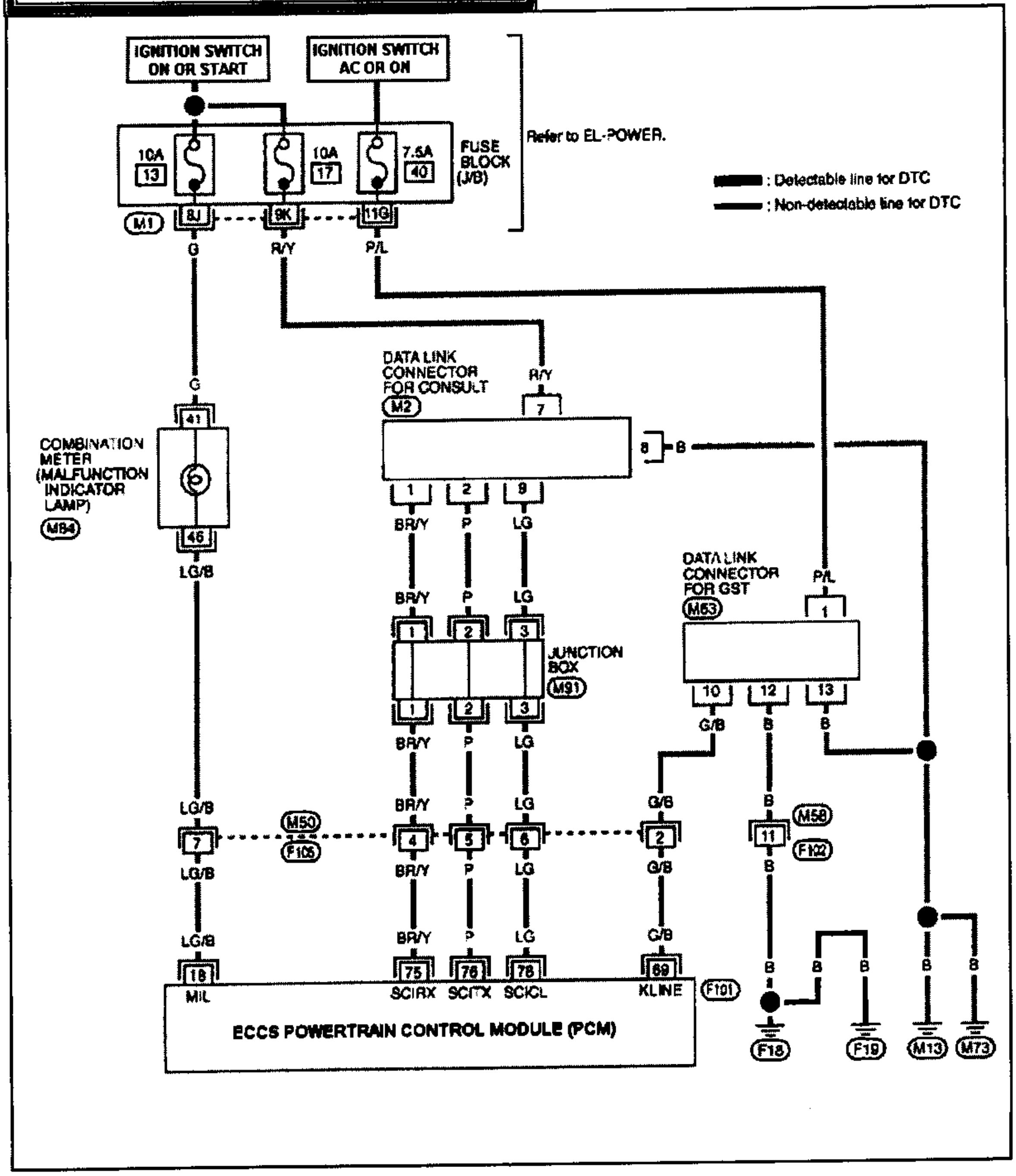


EC-POS-01 Crankshaft Position Sensor (CKPS) (POS) (DTC: P0335)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

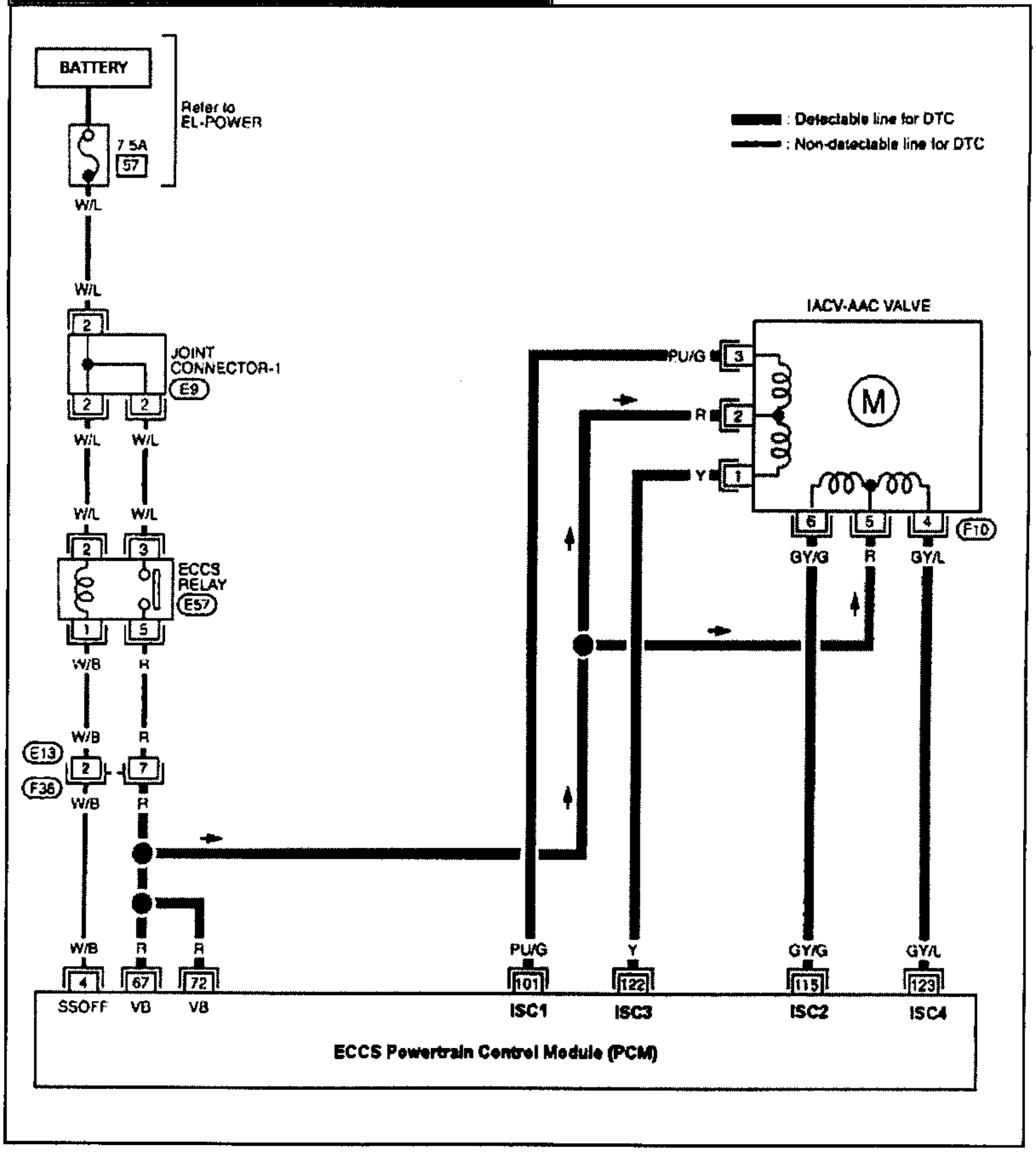
Data Link Connector & MIL (5 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

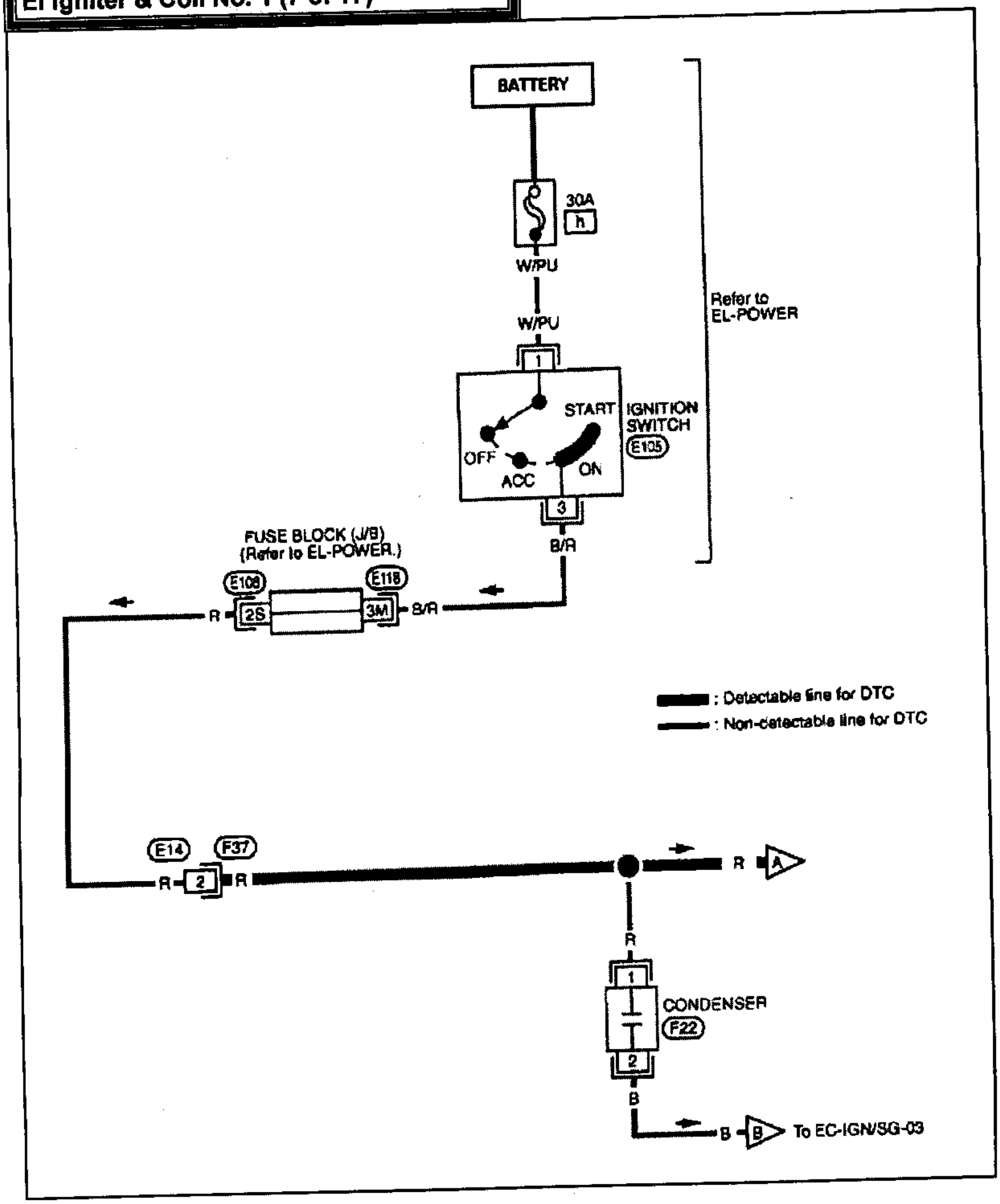
Electronic Idle Air Control Valve (6 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

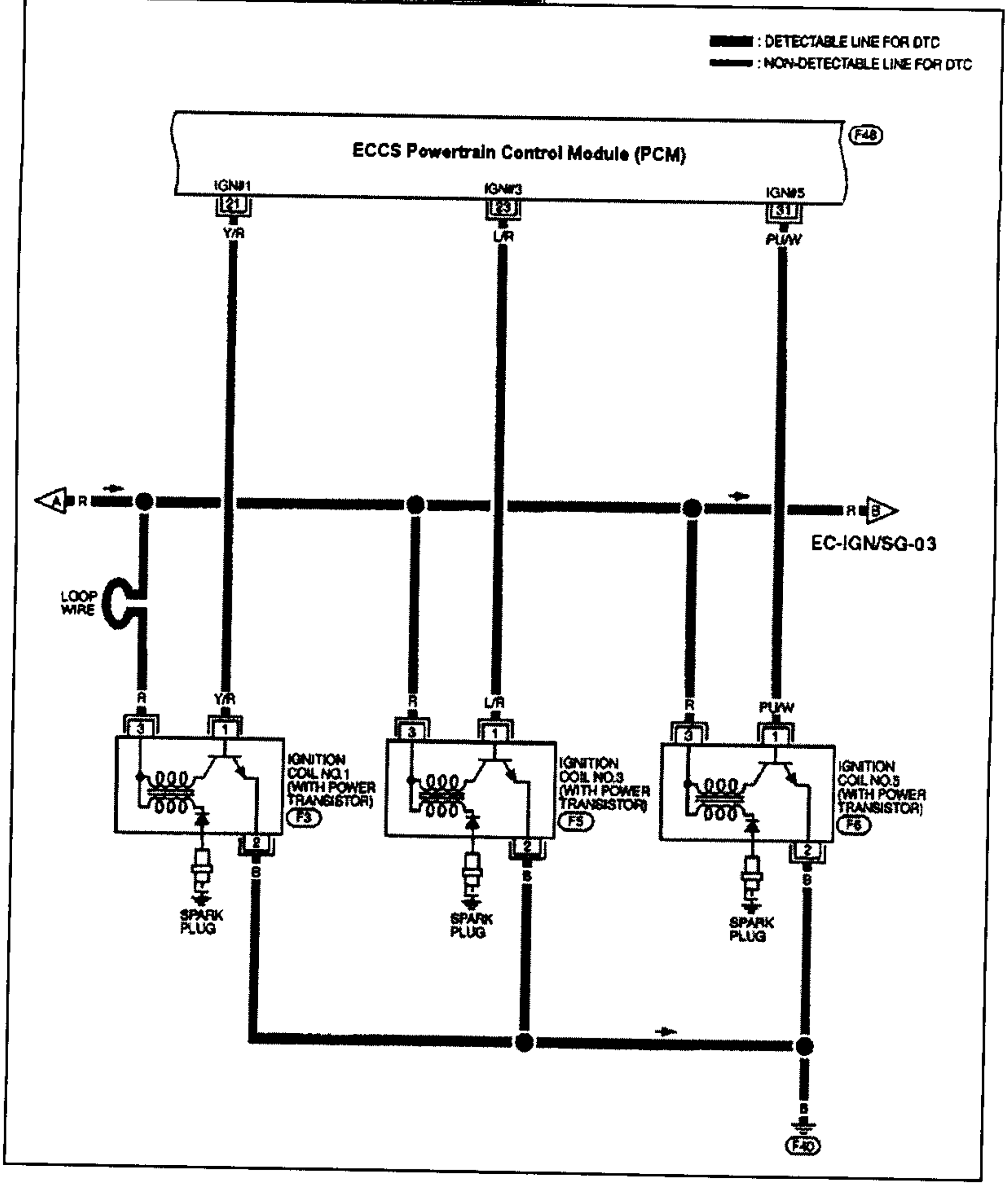
EI Igniter & Coil No. 1 (7 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

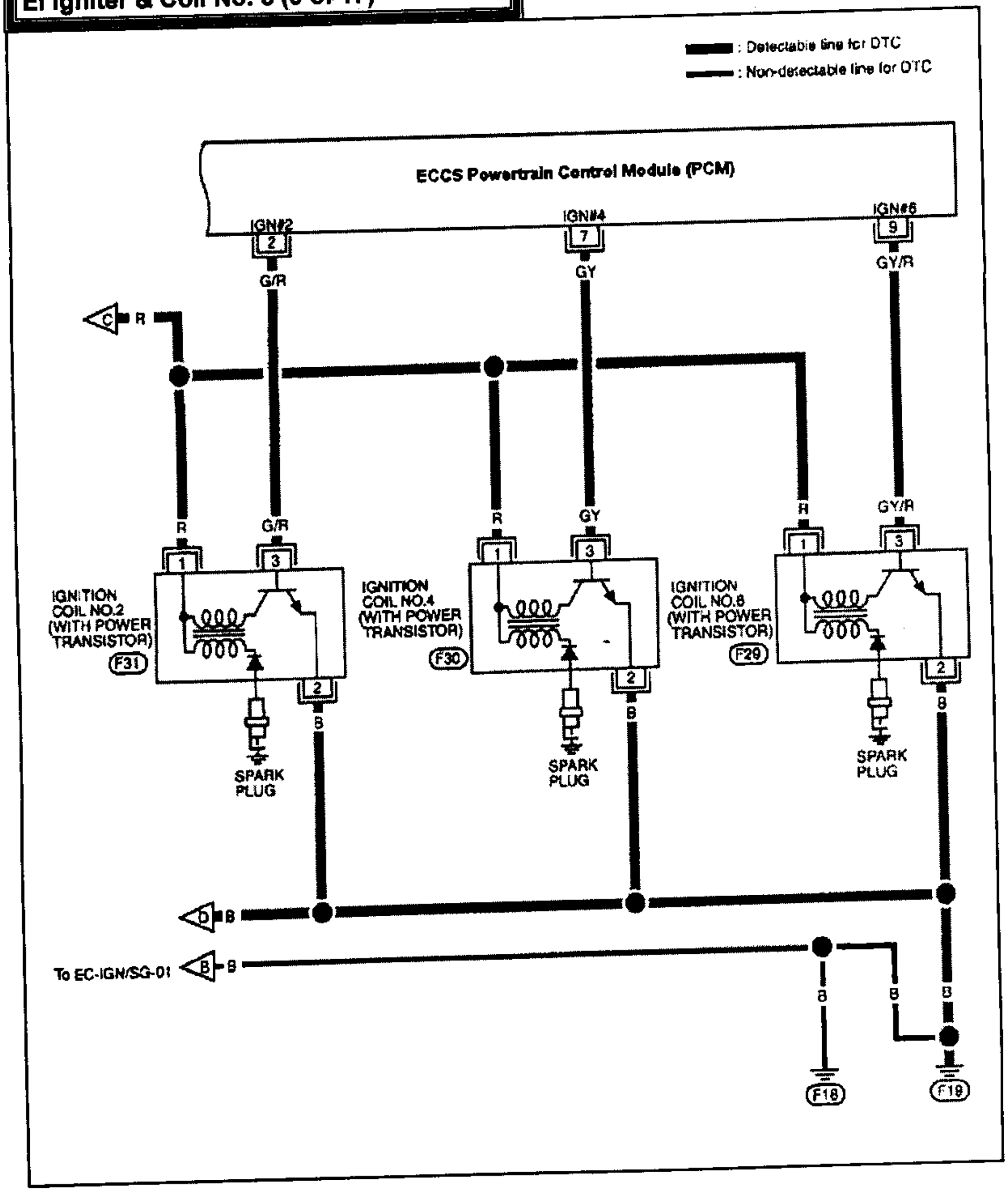
EI Igniter & Coil No. 2 (8 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

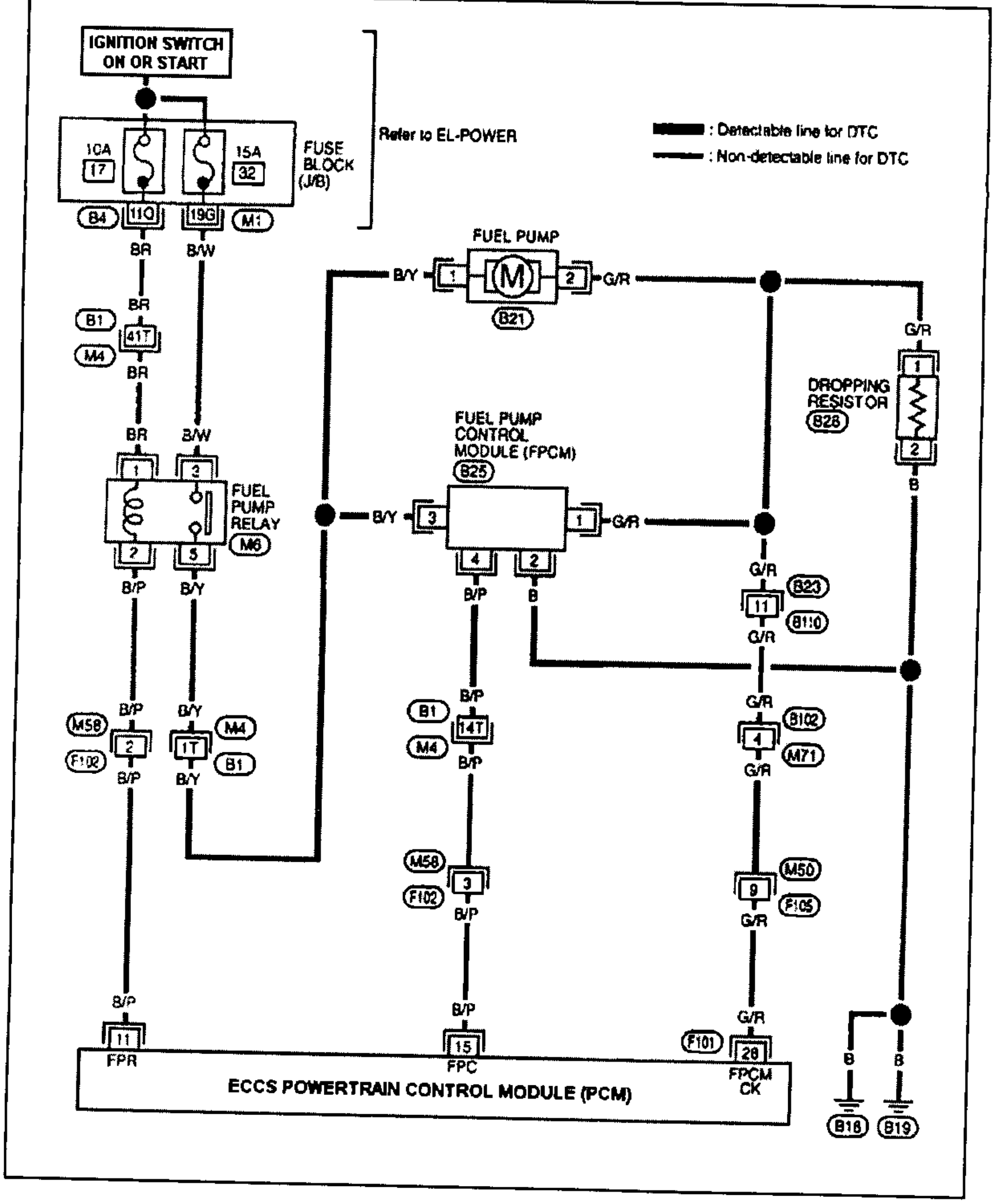
EI Igniter & Coil No. 3 (9 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

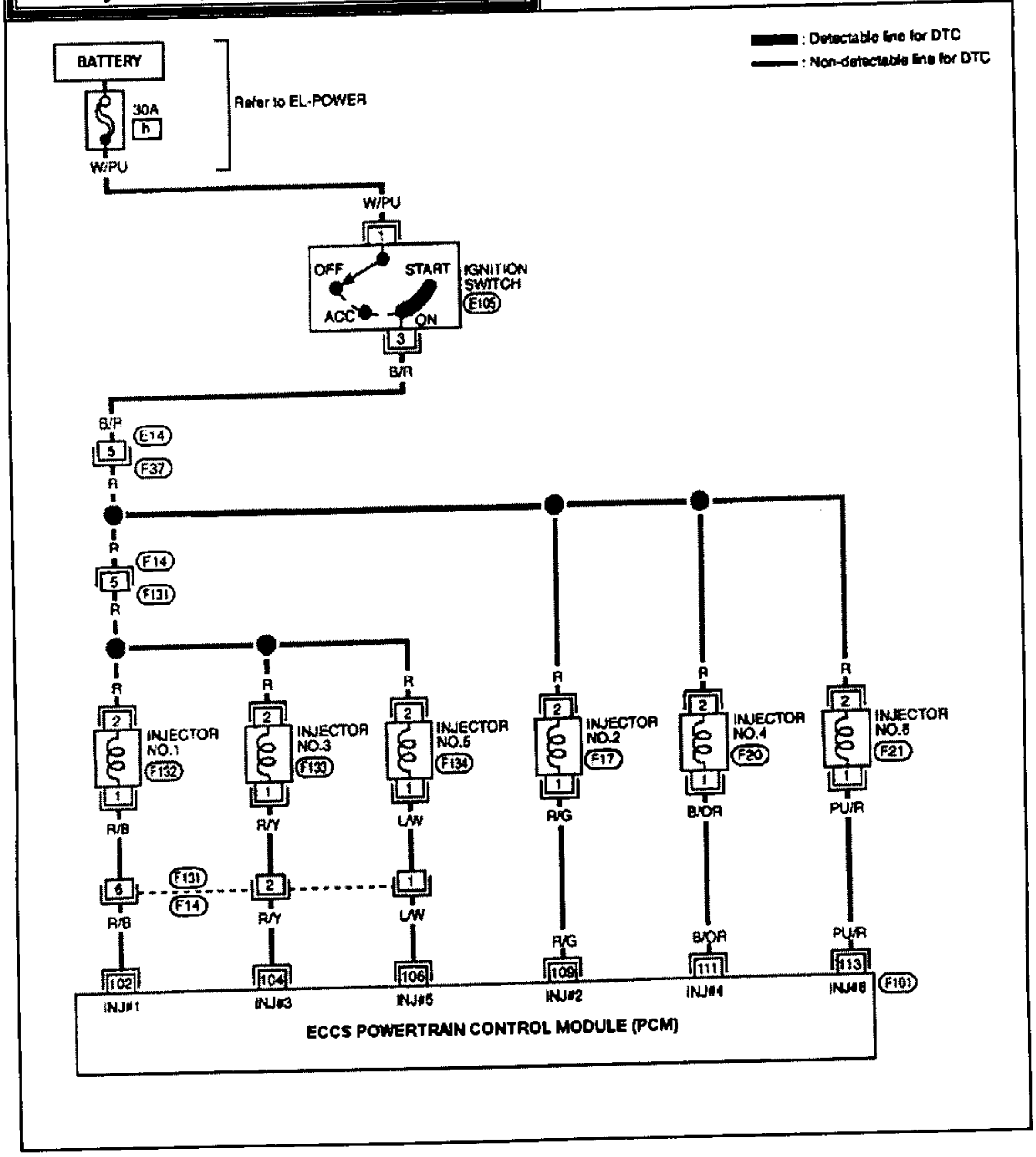
Fuel Pump Control (10 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

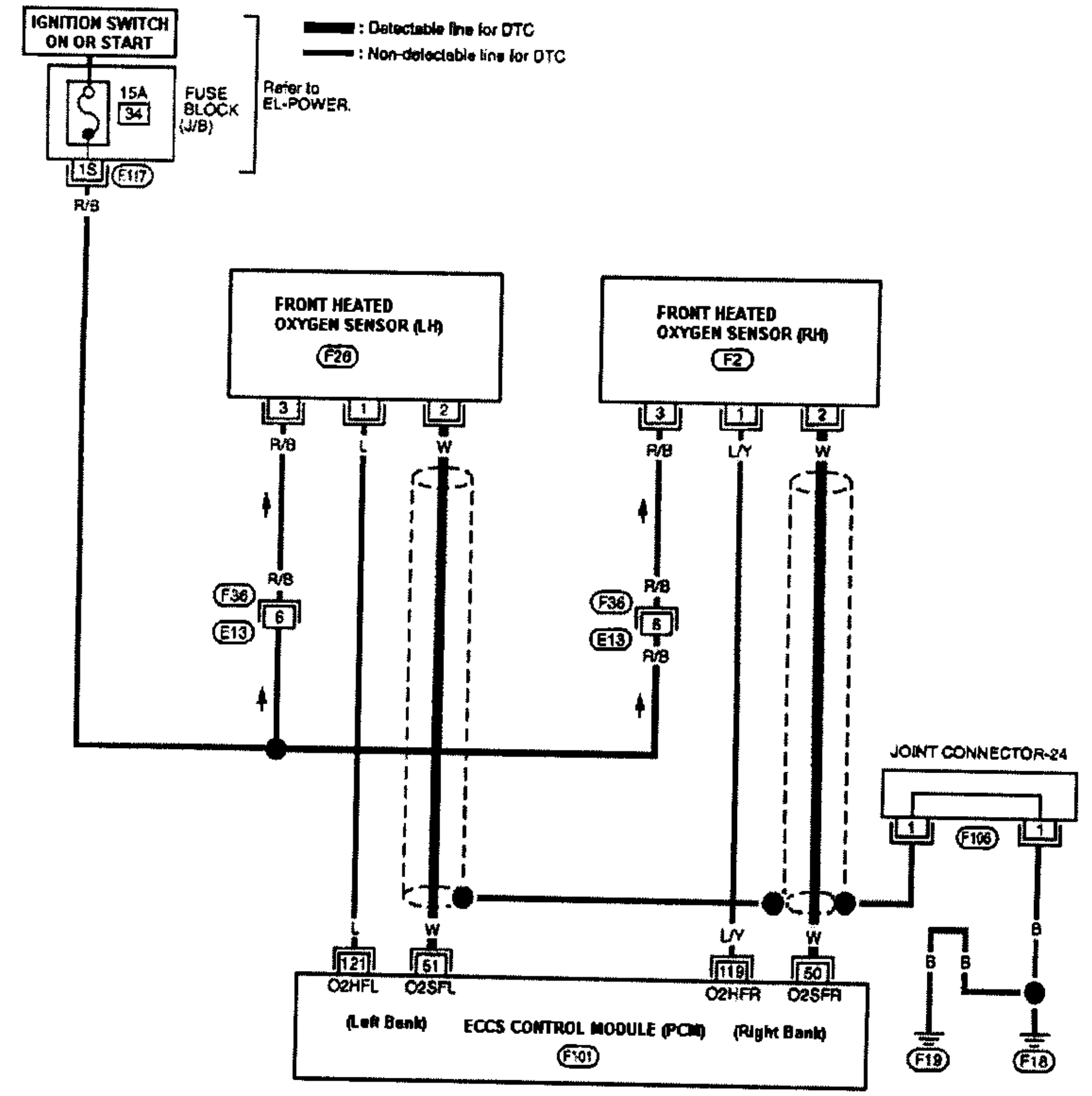
Fuel Injectors (11 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

Front HO2S-11 & HO2S-21 (12 of 17)

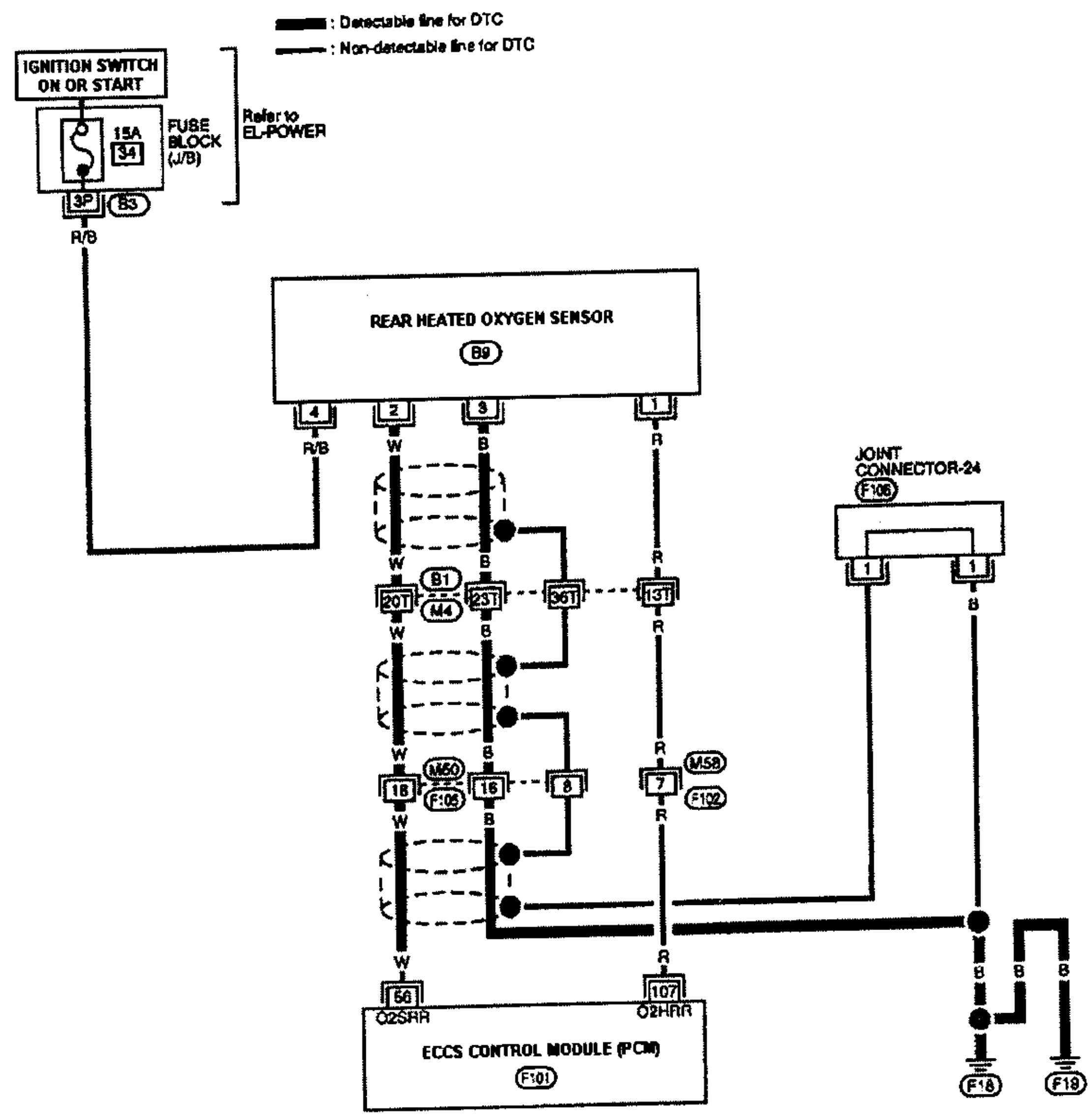


EC-FRO2LH-01 Front HO2S Left Bank (DTC: P0150)
EC-FRO2RH-01 Front HO2S Right Bank (DTC: P0130)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

Rear HO2S-12 (13 of 17)

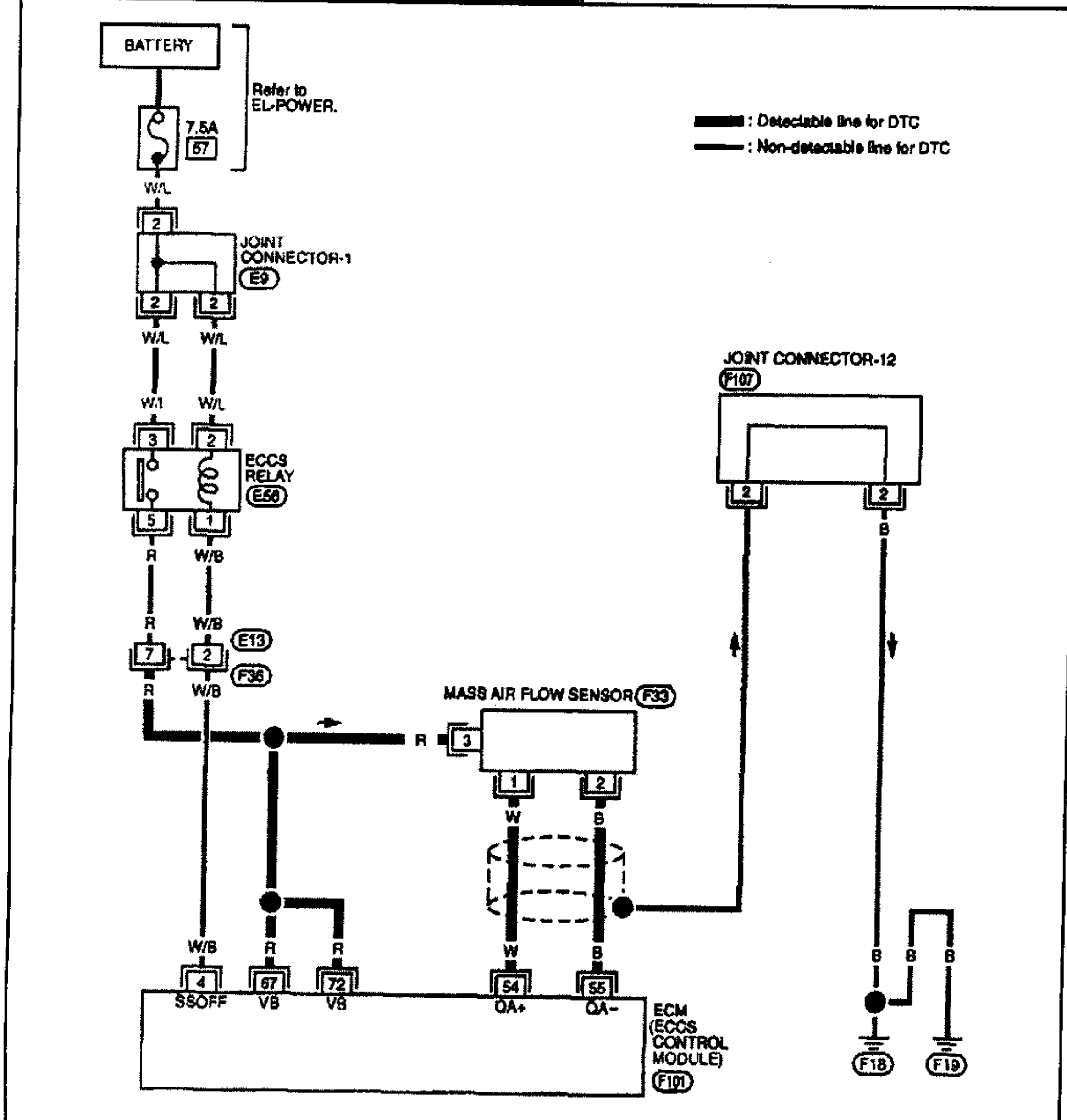


EC-RRO2-01 Rear Heated Oxygen Sensor (Rear HO2S) (DTC: P0136)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

Mass Airflow Sensor (14 of 17)

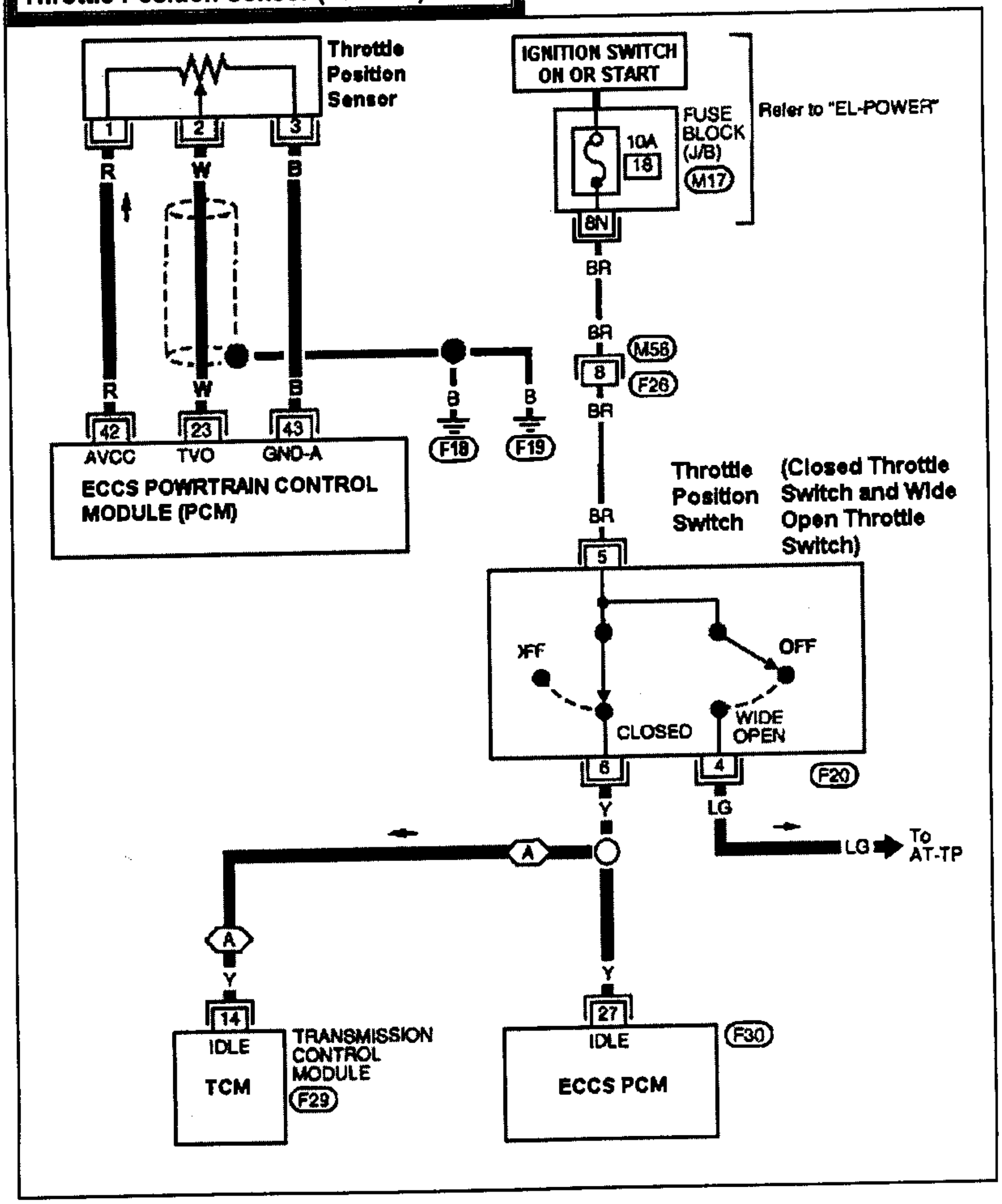


EC-MAFS-01 Mass Air Flow Sensor (MAFS) (DTC: P0100)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

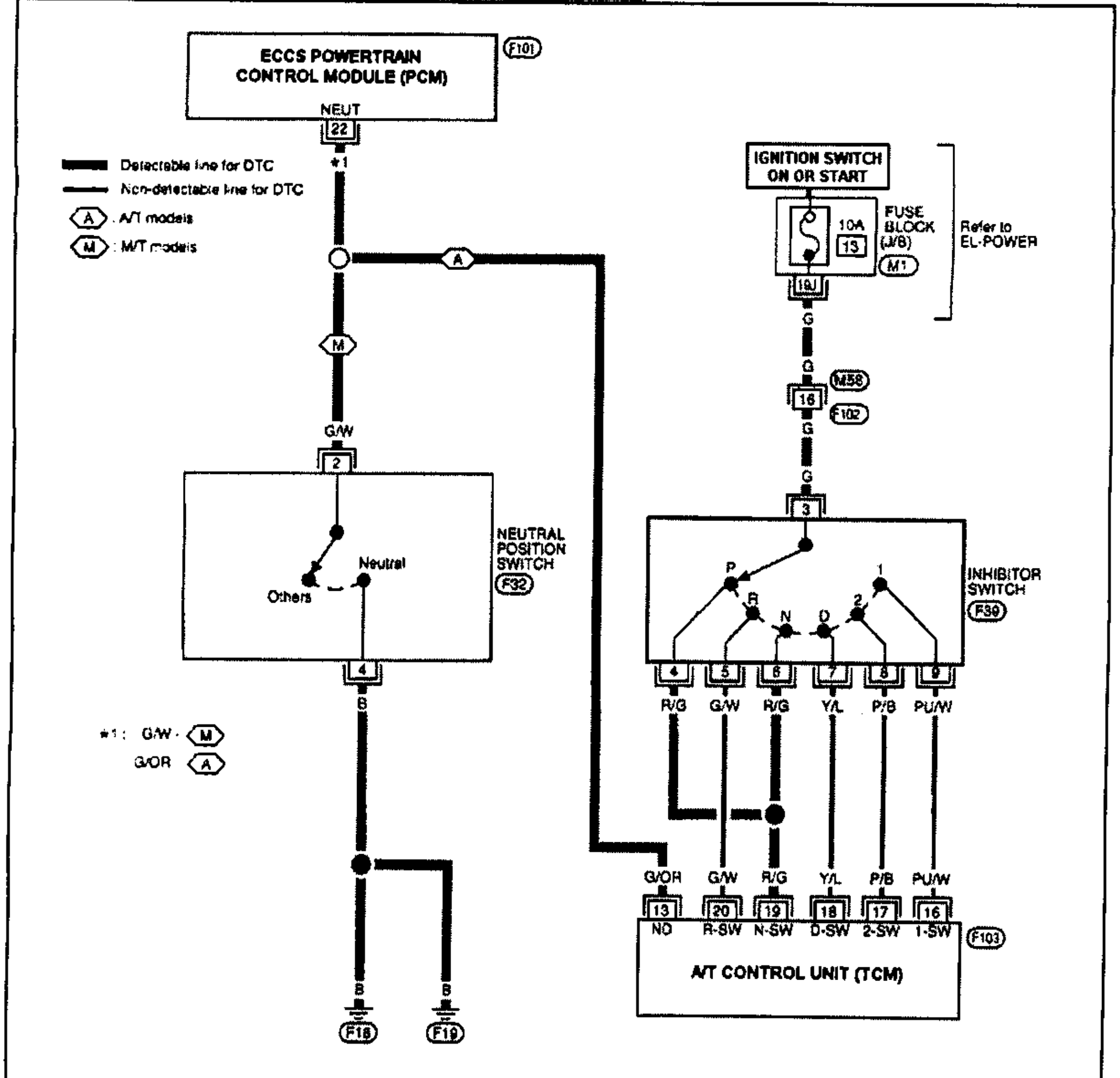
Throttle Position Sensor (15 of 17)



1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

Inhibitor & Neutral Switch Circuits (16 of 17)

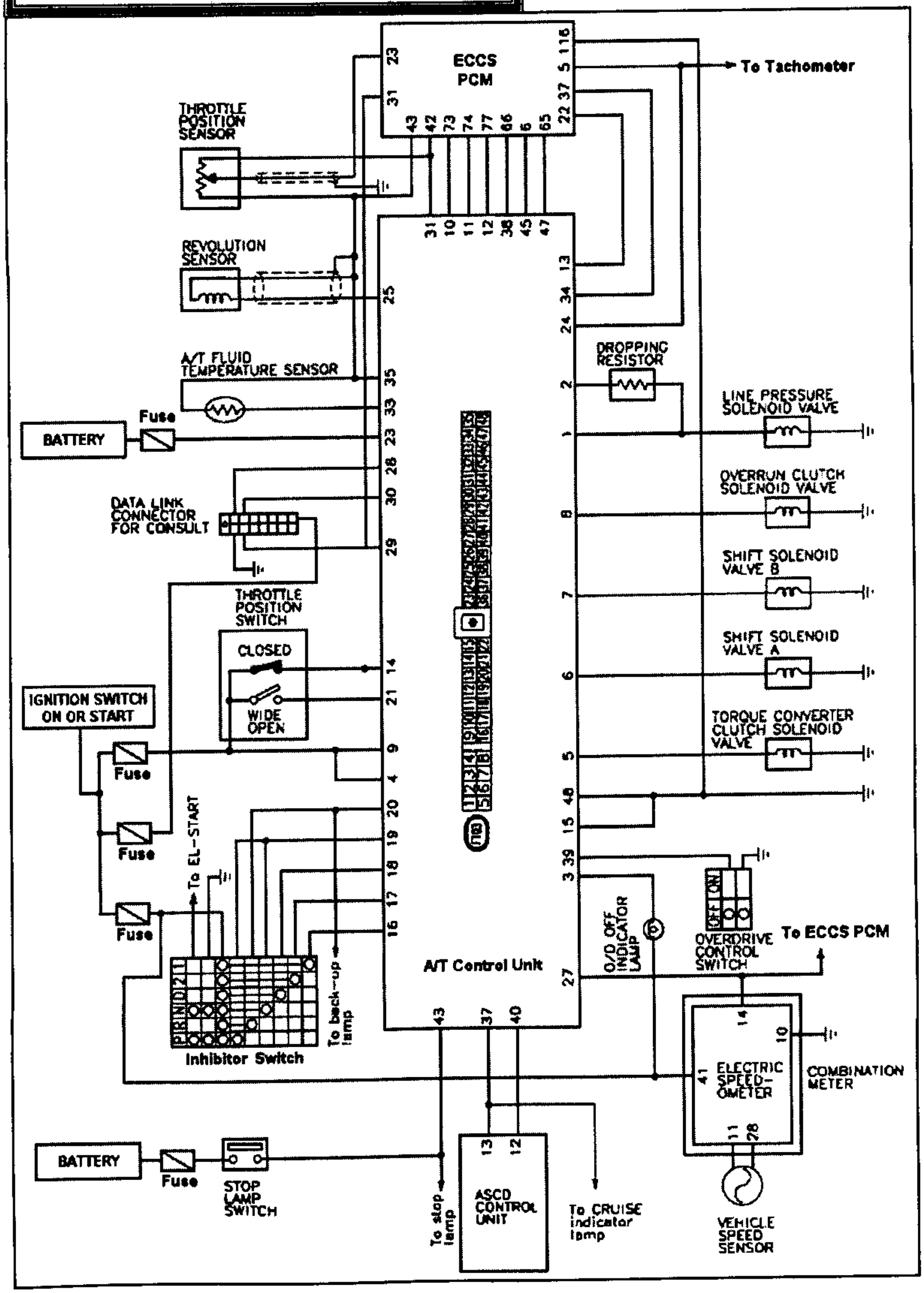


EC-PNP/SW-01 Park/Neutral Position Switch (DTC: P0705)

1997 MAXIMA (3.0L V6 VIN C)

PCM Wiring Diagrams

Transmission Control Module (17 of 17)

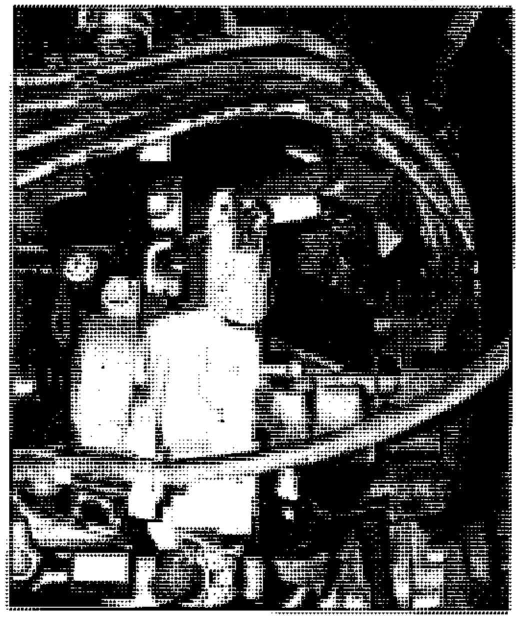


1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

Introduction

The ECCS PCM controls the Electronic Ignition (EI) system on this vehicle by sending signals to the igniter and ignition coil mounted inside the distributor. The coil is supplied battery power by the Ignition switch through a 30-amp ignition fuse.



The PCM, located below the center of the dash area behind the console, contains memory tables that it uses to calculate the ignition control (IC) signal it sends to the igniter or power transistor mounted in the distributor. The IC signal is used to control the ignition spark timing.

The PCM sends a command signal to the power transistor that indicates when to switch the coil primary circuit "on" and "off" to control the spark advance. The igniter amplifies the control signal, and this signal controls the coil dwell period. The ignition check signal confirms that the coil fired.

System Components

The EI system on this vehicle application includes the following components:

- The CMP sensor (mounted on top of the engine above the camshaft pulley)
- The CKP sensor (mounted on the transmission housing facing the flywheel cogs)
- One (1) high energy coil (mounted inside the distributor)
- One (1) igniter (power transistor) unit (mounted inside the distributor)
- The ignition control function (integrated into the PCM as a module function)

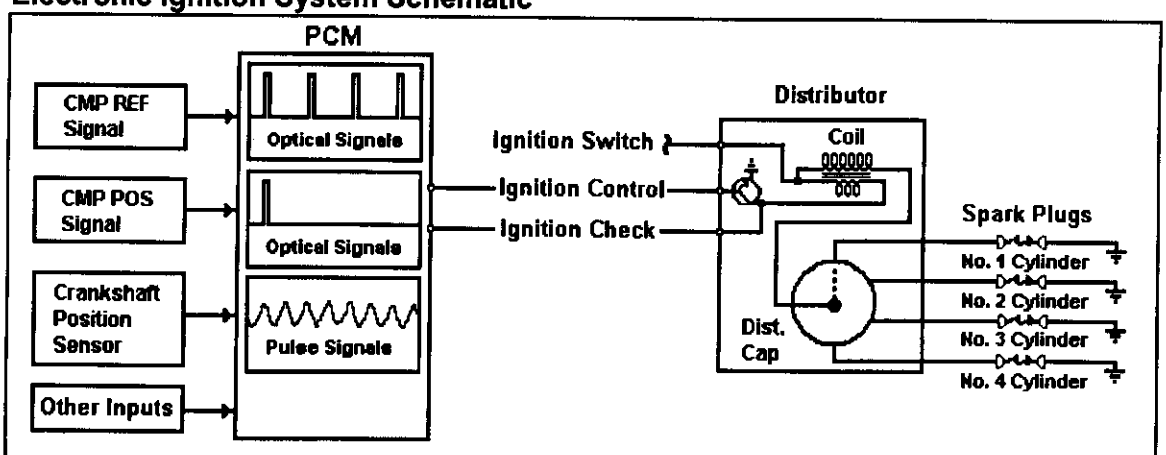
Ignition Spark Timing

The PCM controls the ignition timing during all engine modes by using information stored in its lookup tables that contain the correct amount of spark advance for all conditions. If engine knocking occurs, the knock sensor will transmit a knock signal to the PCM.

Igniter/Coil Assembly

This igniter/coil assembly consists of a high-energy coil (with low primary resistance) mounted with its igniter unit inside the distributor. There are four spark plug wires.

Electronic Ignition System Schematic



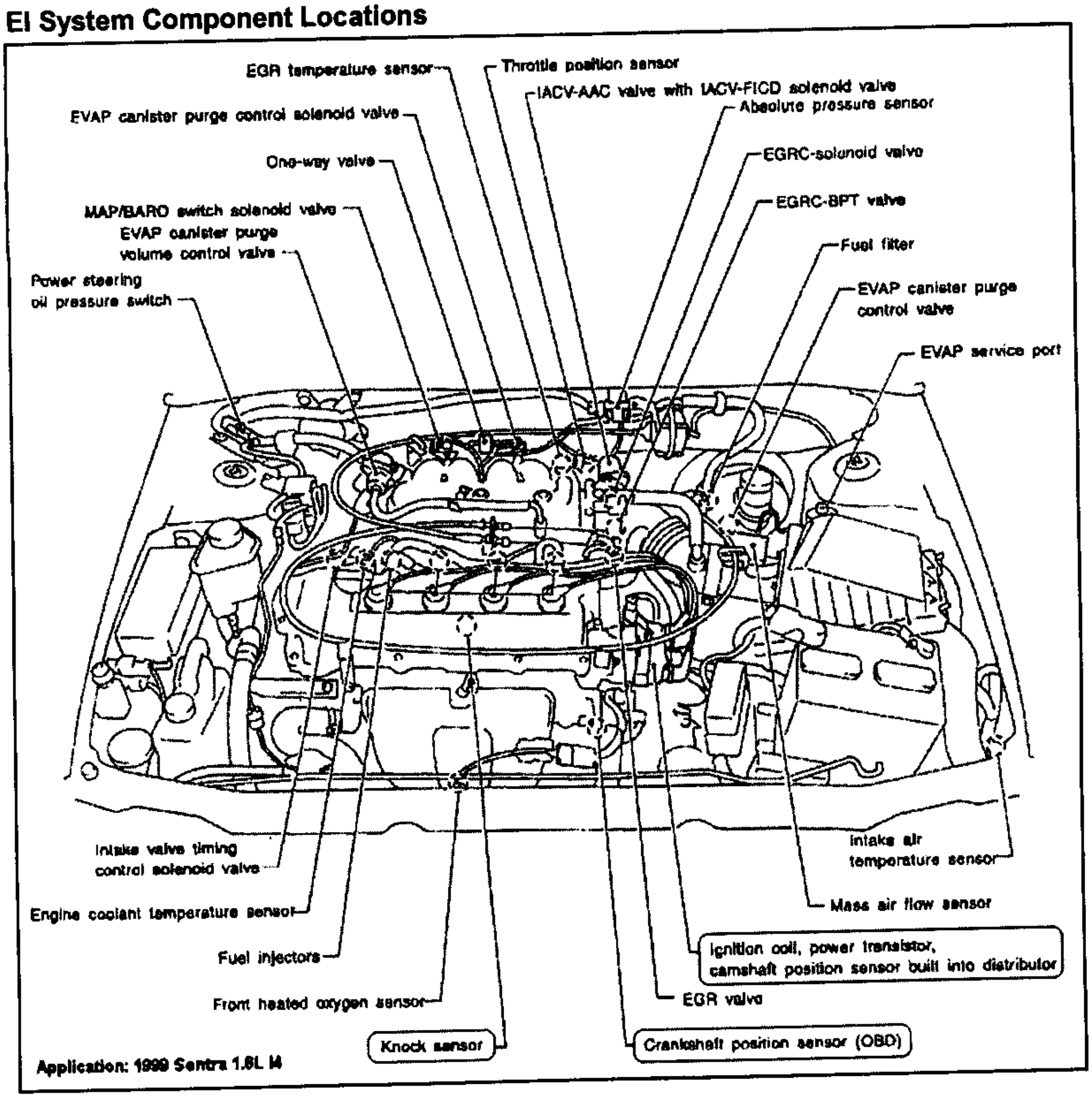
1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

Component Locations

The EI system component locations for this vehicle application are shown in the Graphic.

EI System Component Locations

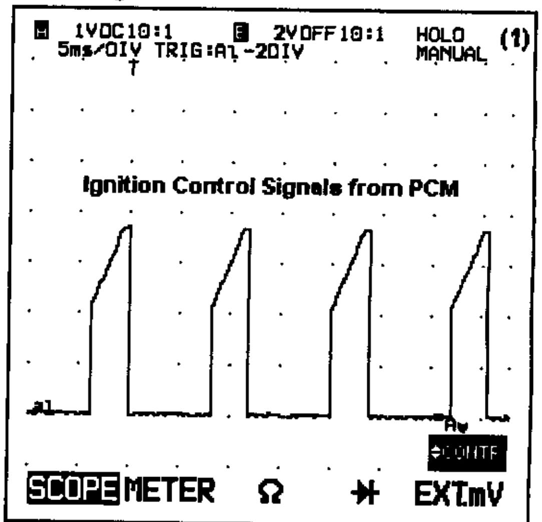


1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

Lab Scope Test (IC Signal)

The Lab Scope can be used to test the ignition control signal from the module function inside the PCM and also the ignition check signal.

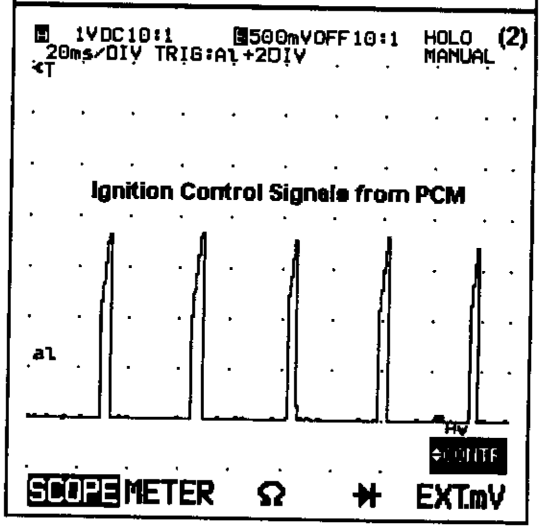


The ignition control circuit from the PCM to the igniter unit can be monitored for any possible glitches.

If the ignition fuse is open, there will not be any ignition power available at the EI coil unit. Prior to starting the test, place the gear selector in Park (A/T) and block the drive wheels for safety.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

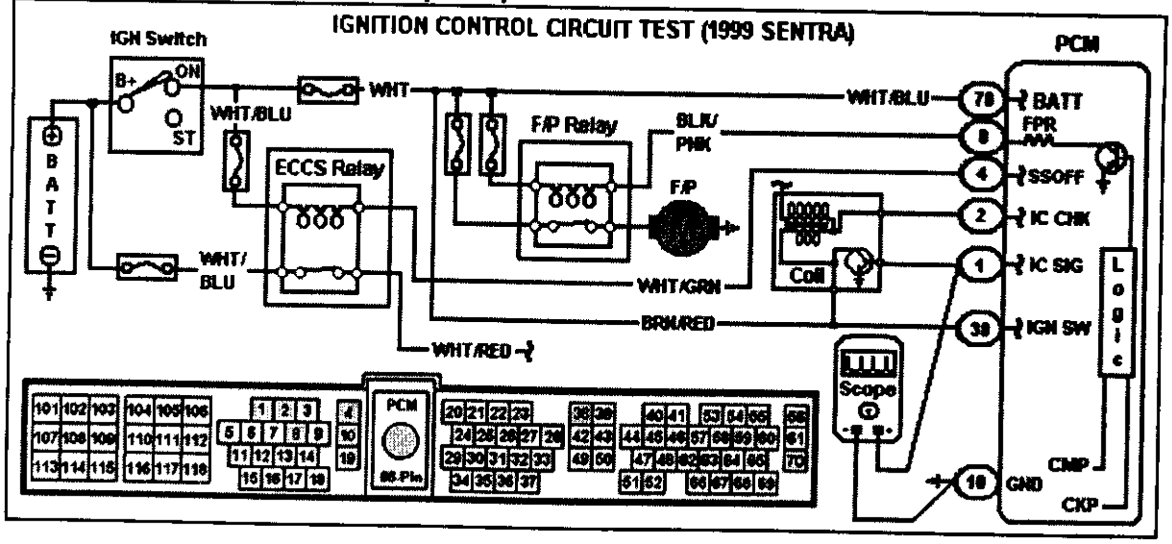
Scope Connections (Ignition Control Signal)
Connect the Channel 'A' positive probe to the IC control signal at Pin 1 (WHT/RED wire) of the 88-Pin connector. Connect the Channel 'A' negative probe to the battery negative ground post or to Pin 10 of the 88-Pin connector.



Lab Scope Explanation - Example (1)
In this example, the trace shows the IC control signals (0-4v) from the PCM to the coil that control when the coil switches on and off.

Lab Scope Explanation - Example (2)
In this example, the trace shows the IC control signals (0-4v) from the PCM to the coil that control when the coil switches on and off. Note the time base change from 5-20 ms.

Igniter/Coil Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

Lab Scope Test (IC CHK Signal)

The Lab Scope can be used to test the ignition check (CHK) signal from the coil primary circuit to the PCM. This circuit is used to check or confirm that the ignition system fired properly.

The ignition check (IC CHK) circuit from the coil to the PCM can be monitored for any possible glitches. Prior to starting the test, place the gear selector in Park (A/T) and block the drive wheels for safety.

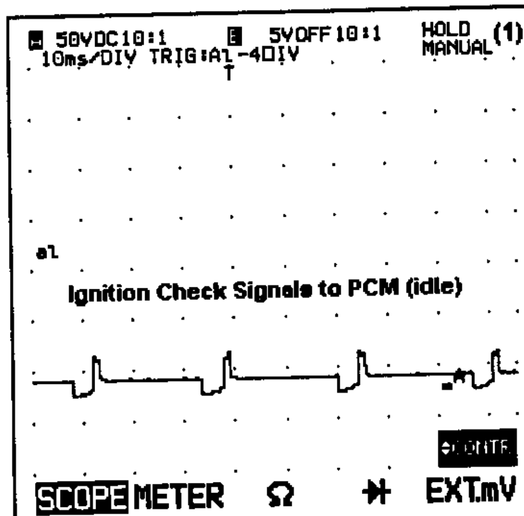
Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

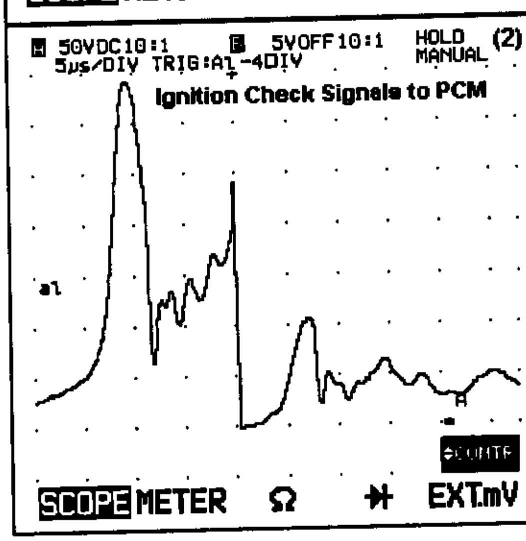
Scope Connections (IC CHK Signal)
Connect the Channel 'A' positive probe to the IC CHK signal at Pin 2 (GRY/RED wire) of the 88-Pin connector.

Connect the Channel 'A' negative probe to the battery negative ground post or to Pin 10 of the 88-Pin connector.

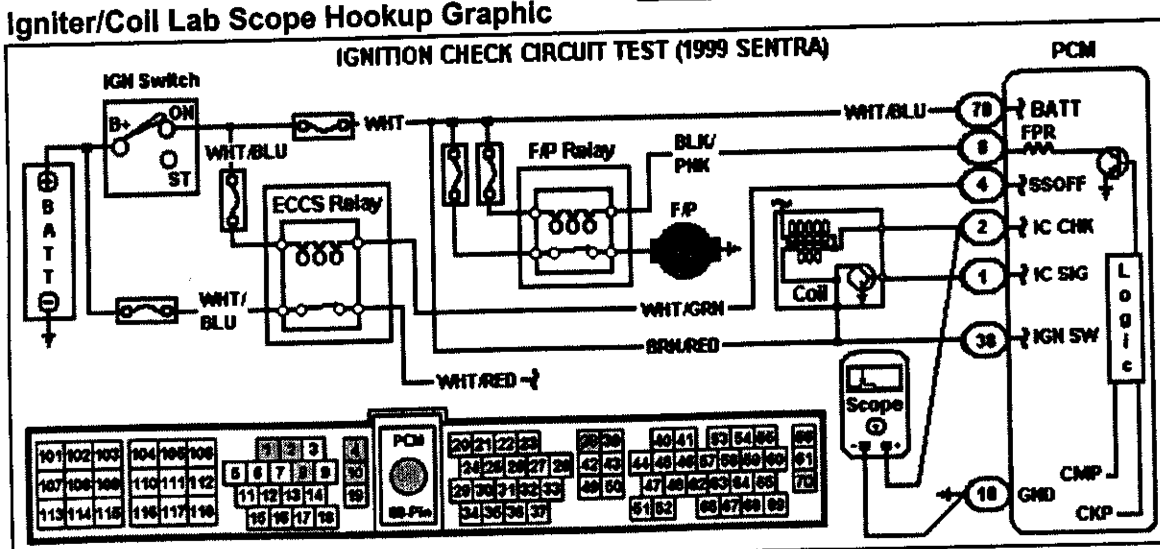
Lab Scope Explanation - Example (1)
In this example the trace shows the IC control CHK signals from the coil to the PCM that are used to confirm the ignition fired.

Lab Scope Explanation - Example (2)
In this example, the trace shows the IC Check signals (350v) from the coil to the PCM (that confirm the ignition coil fired for each event). The time setting change is from 10 ms to 5 µs.





Igniter/Coil Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

Lab Scope Test (Coil Primary)

The Lab Scope can be used to view the ignition coil primary ground circuit as it provides an accurate view of its waveform and of any glitches. Prior to starting the test, place the gearshift selector in Park and block the drive wheels for safety.

Scope Connections

Connect the Channel 'A' positive probe to the Ignition Check wire to the coil (GRY/RED wire) or to the Coil Check circuit at Pin 2 of PCM 104-Pin connector. Connect the Channel 'A' negative probe to battery negative ground post.

Scope Settings

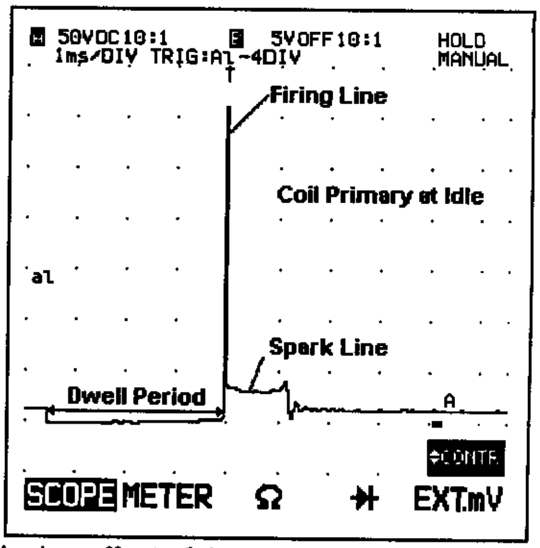
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Tests

The coil primary (Coil Check) circuit can be monitored with the engine running at idle speed or cruise speeds with the engine cold or warm.

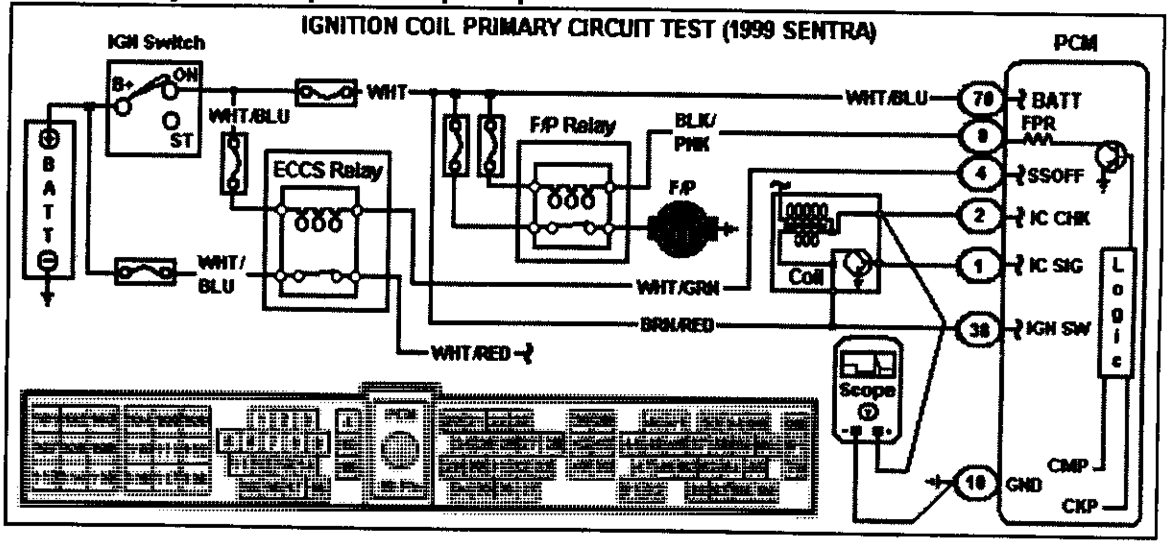
Lab Scope Example

In this example, the Channel 'A' trace shows the EI Coil primary circuit at idle speed. The coil primary signal reached a peak of nearly 310 volts.



Each time that the EI coil fires the spark plug, the ignition primary circuit collapses in order to build up a suitable high voltage of from 3,000 to 8,000 volts in the secondary circuit. Note the ringing effect of the coil primary circuit just to the right of the spark firing line.

Coil Primary Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

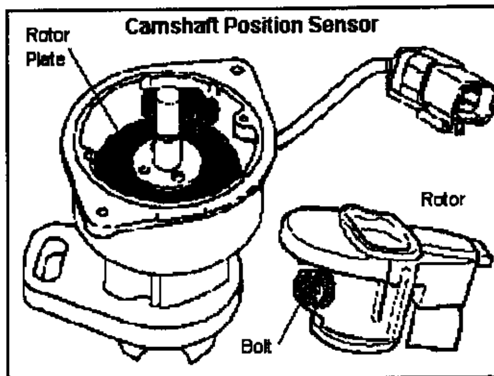
CMP Sensor Overview

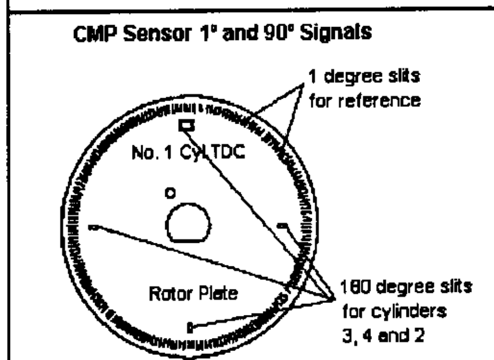
The camshaft position (CMP) sensor is mounted inside the EI distributor. It is a basic component of the engine control system. The CMP sensor is positioned to monitor engine speed and piston position. The PCM uses signals from this sensor to control fuel injection and spark advance.

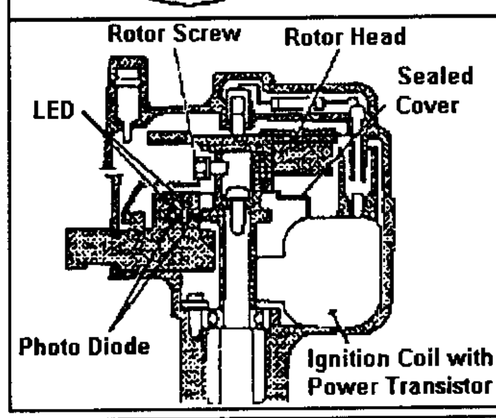
The CMP sensor is designed with a rotor plate and a wave-forming circuit. The rotor plate has 360 slits for CMP POS sensor (1° signal) and 4 slits for CMP REF sensor (180° signal). The 1° signal is called a high data rate signal. The 180° signal is called a low data rate signal. Note that a bolt holds the rotor to the shaft.

The wave-forming circuit includes the light emitting diodes and photo diodes. The rotor plate sits between the LED and photo diode.

As the rotor plate turns, the slits cut the light and this action generates a series of rough-shaped pulses. These pulses are converted into digital signals by the wave-forming circuit and sent to the PCM. The PCM detects when CYL 1 is at top dead center by detecting the larger opening in one of the four sensor slits.



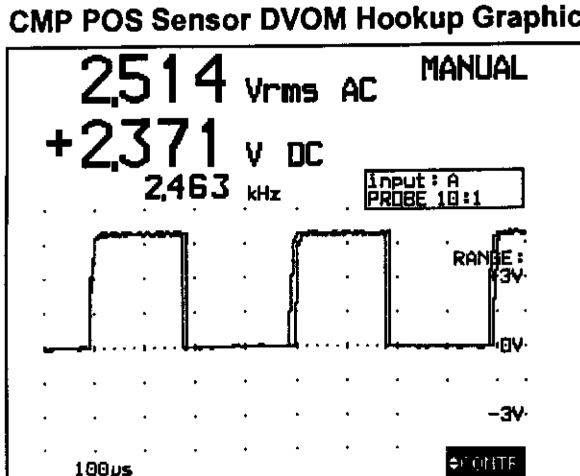


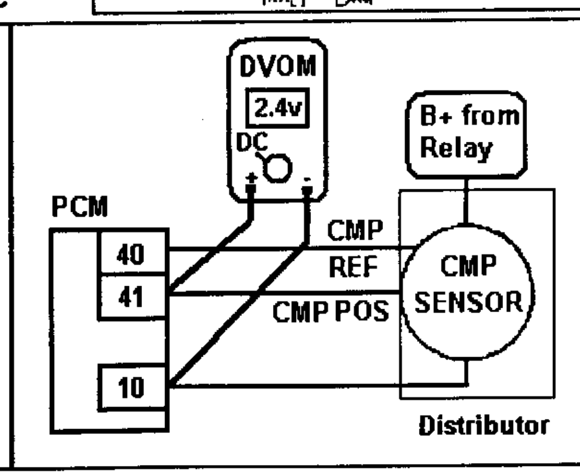


DVOM Test (CMP Sensor)

The DVOM can be used to test for CMP sensor signals. Connect one DVOM probe to the CMP REF signal at Pin 40 (BLU wire) or to the CMP POS signal at Pin 41 (BLK/WHT wire). Connect the other probe to the battery ground post.

CMP POS Sensor DVOM Hookup Graphic





1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

Lab Scope Test (CMP Sensor)

The Lab Scope is the tool of choice to use to test the signals from the CMP sensor as it provides an excellent view of the sensor waveforms and of any possible glitches.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example

The CMP sensor signals can be checked at both idle and cruise speeds.

Scope Connections (CMP POS Sensor)

Connect the Channel 'B' positive probe to the CMP POS signal at Pin 41 (BLKWHT wire).

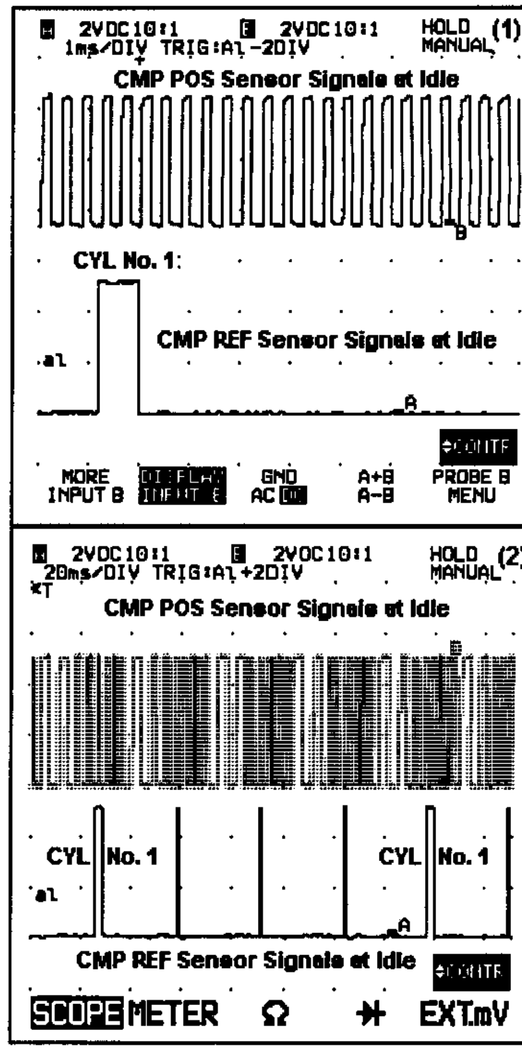
Scope Connections (CMP REF Sensor)

Connect the Channel 'A' positive probe to the CMP REF signal at Pin 40 (BLU wire) and the negative probe to Pin 10 of the 88-Pin connector or to the battery ground post.

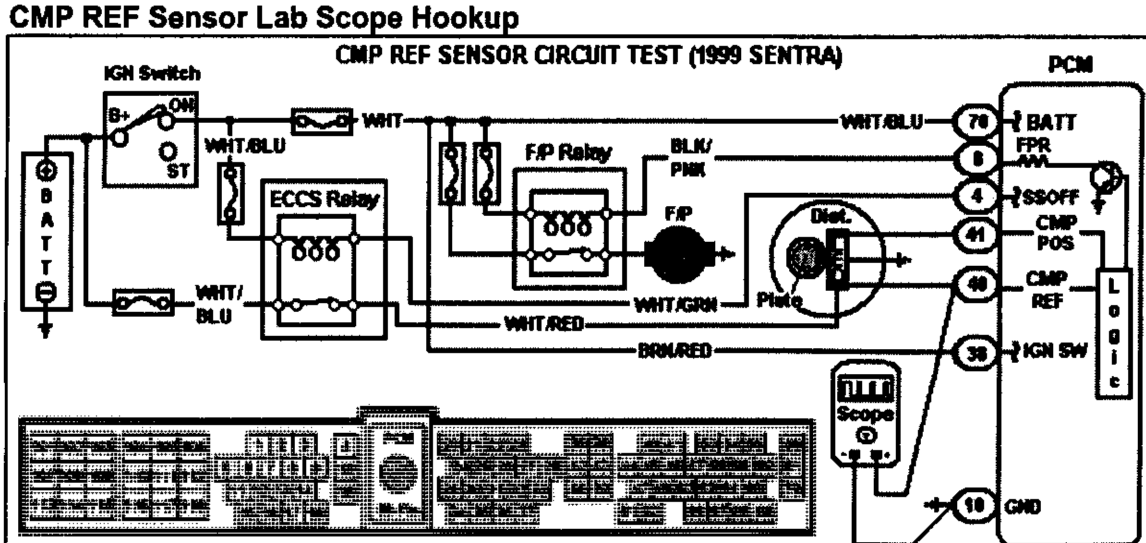
Lab Scope Example Explanation

In example (1), the traces show the CMP POS and CMP REF sensor signals at idle speed. The single CMP REF sensor signal in this trace indicates the TDC position of Cyl No. 1.

In example (2), the traces show the CMP POS and CMP REF sensor signals at idle speed. Note that the time base setting was changed from 1 to 20 ms in this example. In the top trace of each example, each signal represents 1° of engine crankshaft rotation.



CMP REF Sensor Lab Scope Hookup



1999 SENTRA (1.6L I4 VIN A)

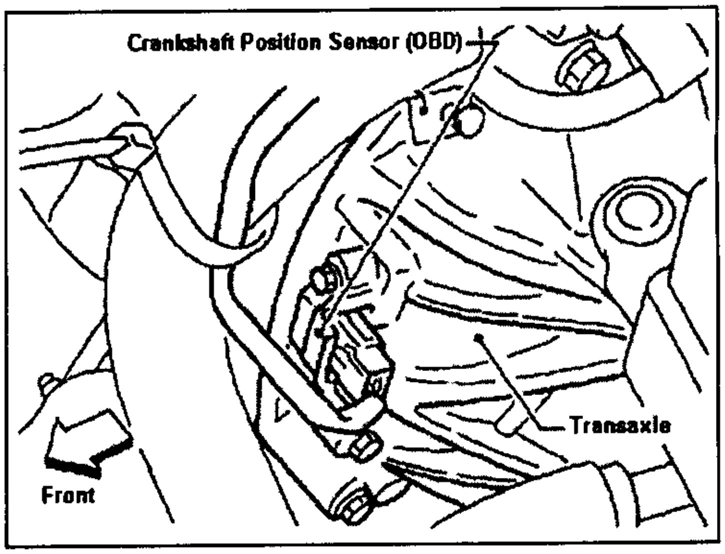
Electronic Ignition

CKP Sensor Overview

The crankshaft position (CKP) sensor used with this EI system is a magnetic transducer located on the transaxle housing near the flywheel cogs as shown in the Graphic.

It is connected to the PCM by two circuits that supply an AC voltage used to detect the crankshaft position signal for all four cylinders.

The PCM uses this signal as a reference for sequential multiport fuel injection (SMFI).



The sensor consists of a permanent magnet, core and coil. With the engine running, the air gap between the sensor and flywheel cog will periodically change.

The permeability tuning (a method of tuning a circuit by moving a magnetic core into and out of a coil to vary its inductance) near the CKP sensor also changes as the engine turns.

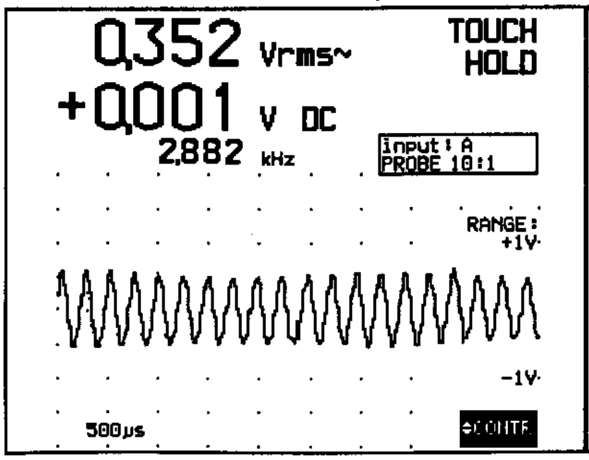
Due to changes in the sensor permeability as the flywheel turns, the gap between the sensor and flywheel gear cogs periodically change. The change causes the sensor output signal voltage.

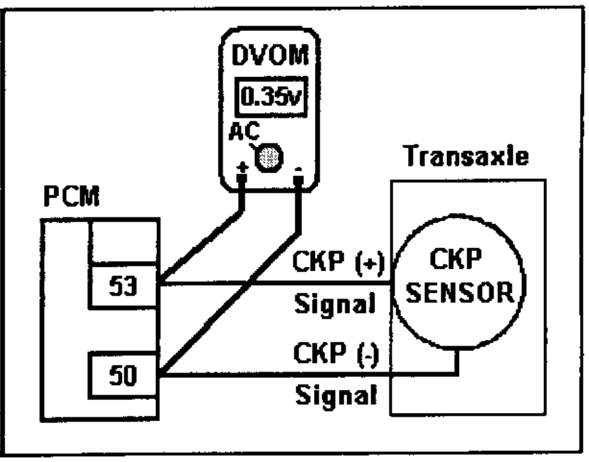
There are 360 CKP sensor signals for each complete crankshaft revolution.

DVOM Test (CKP Sensor)

A DVOM can be used to test the AC output signals from this sensor to the PCM with the engine running in order to determine if the sensor is okay. Connect the DVOM positive probe to the CKP signal at Pin 53 (WHT wire) and the negative probe to Pin 50 of the 88-Pin connector or the battery negative ground post. The output of this sensor should be near 0.35v at 2.882 kHz at idle speed.

CKP Sensor DVOM Hookup Graphic





1999 SENTRA (1.6L I4 VIN A)

Electronic Ignition

Lab Scope Test (CKP Sensor)

The Lab Scope is the tool of choice to use to test the signals from the CKP sensor as it provides an excellent view of the sensor waveforms and any possible glitches. Prior to starting the test, place the gearshift selector in Park and block the drive wheels for safety.

<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples.

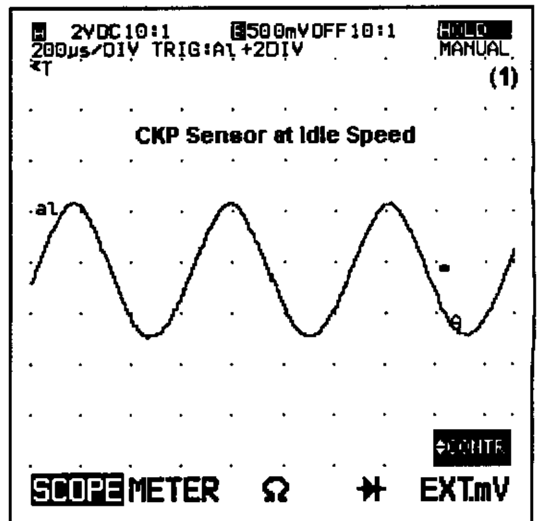
<u>Lab Scope Example</u>
The CKP sensor signals can be checked at both idle and cruise speeds with the engine cold or at normal operating temperature.

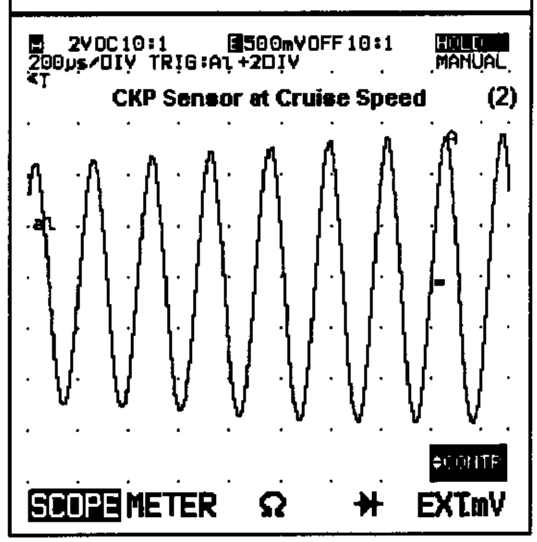
<u>Scope Connections (CKP Sensor)</u>
Connect the Channel 'A' positive probe to the CKP signal at Pin 53 (WHT wire). Connect the negative probe to the CKP (-) signal at Pin 10 (BLK wire) of the PCM 88-Pin connector.

<u>Lab Scope Explanations</u>
In example (1), the trace shows CKP sensor signals of 4v AC peak to peak at idle speed.

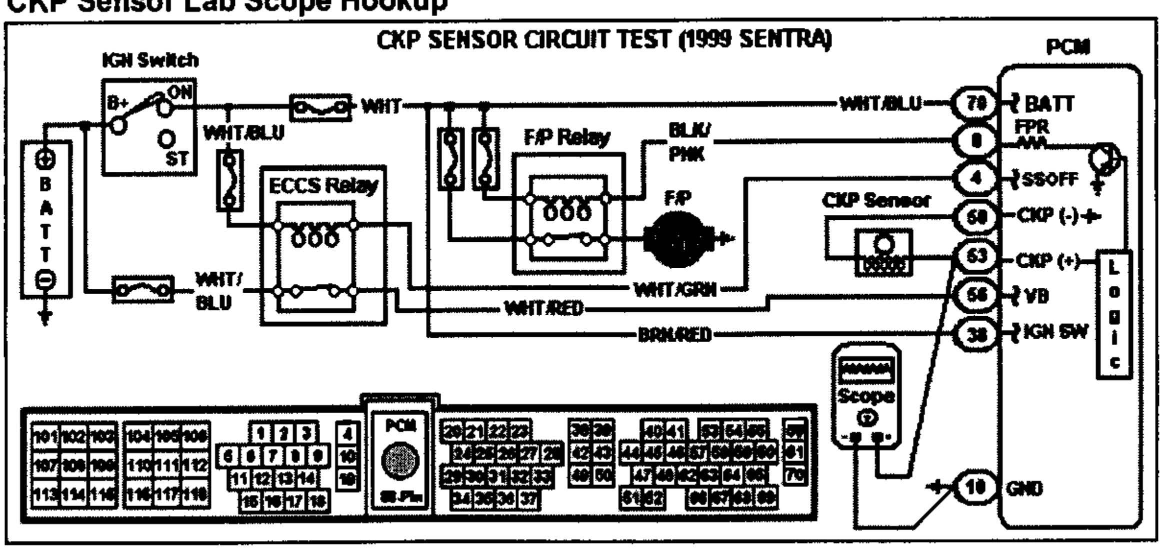
In example (2), the trace shows CKP sensor signals of 10v AC peak to peak. These traces represent one-degree of crankshaft rotation.

<u>Lab Scope Examples</u>
The waveform examples that appear on this page were captured with a Fluke 99-B from a vehicle with a known good CKP sensor.





CKP Sensor Lab Scope Hookup



1999 SENTRA (1.6L I4 VIN A)

Fuel System

Introduction

The Fuel Delivery system on this vehicle application is designed to deliver fuel at a regulated high pressure to the fuel rail and injectors. Additionally, this Fuel system is also designed to cutoff the fuel pressure if the engine stops running.

Fuel Pump Modes of Operation

- Key On: the fuel pump operates for 5 seconds (to help the vehicle to start)
- Engine Running: the fuel pump operates when the CMP REF signal is present
- Engine Stops Running: the fuel pump stops after one (1) second

System Components

The Fuel system on this application includes the fuel tank, fuel pump, fuel filter, pressure regulator, fuel injectors, fuel tube connect fittings, fuel lines and hoses and the fuel rail.

The electrical portion of the Fuel system includes these components and circuits:

- ECCS Main Relay
- Electric Fuel Pump and related electrical circuits
- Fuel Injectors (4)

Fuel Pump Operation

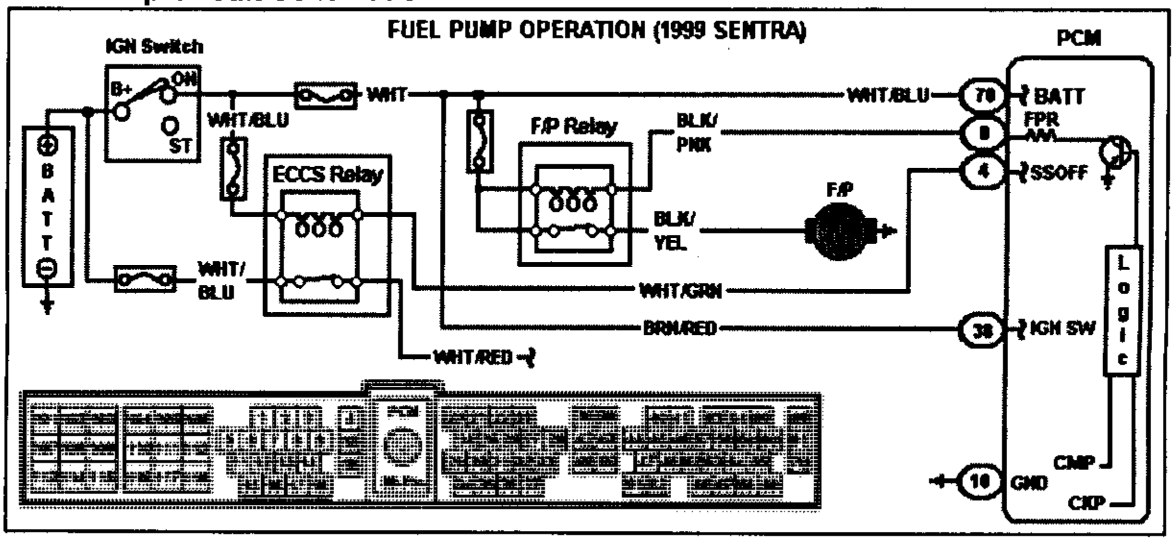
Once the PCM detects a "start" signal, it activates the fuel pump for several seconds at "key on" to enable the engine to start. If it detects the presence of the CMP REF signals (180° signals), it knows that the engine is rotating.

At this point, it activates the fuel pump. If the CMP REF (180°) signal is not received at "key on", the fuel pump is disabled after 5 seconds to keep from discharging the battery. If this signal is lost with the engine running, the fuel pump is disabled for safety reasons.

Key Point

The PCM does not "drive" the fuel pump. Instead, it controls the operation of the fuel pump relay, and in turn, the relay controls the operation of the fuel pump.

Fuel Pump Circuit Schematic



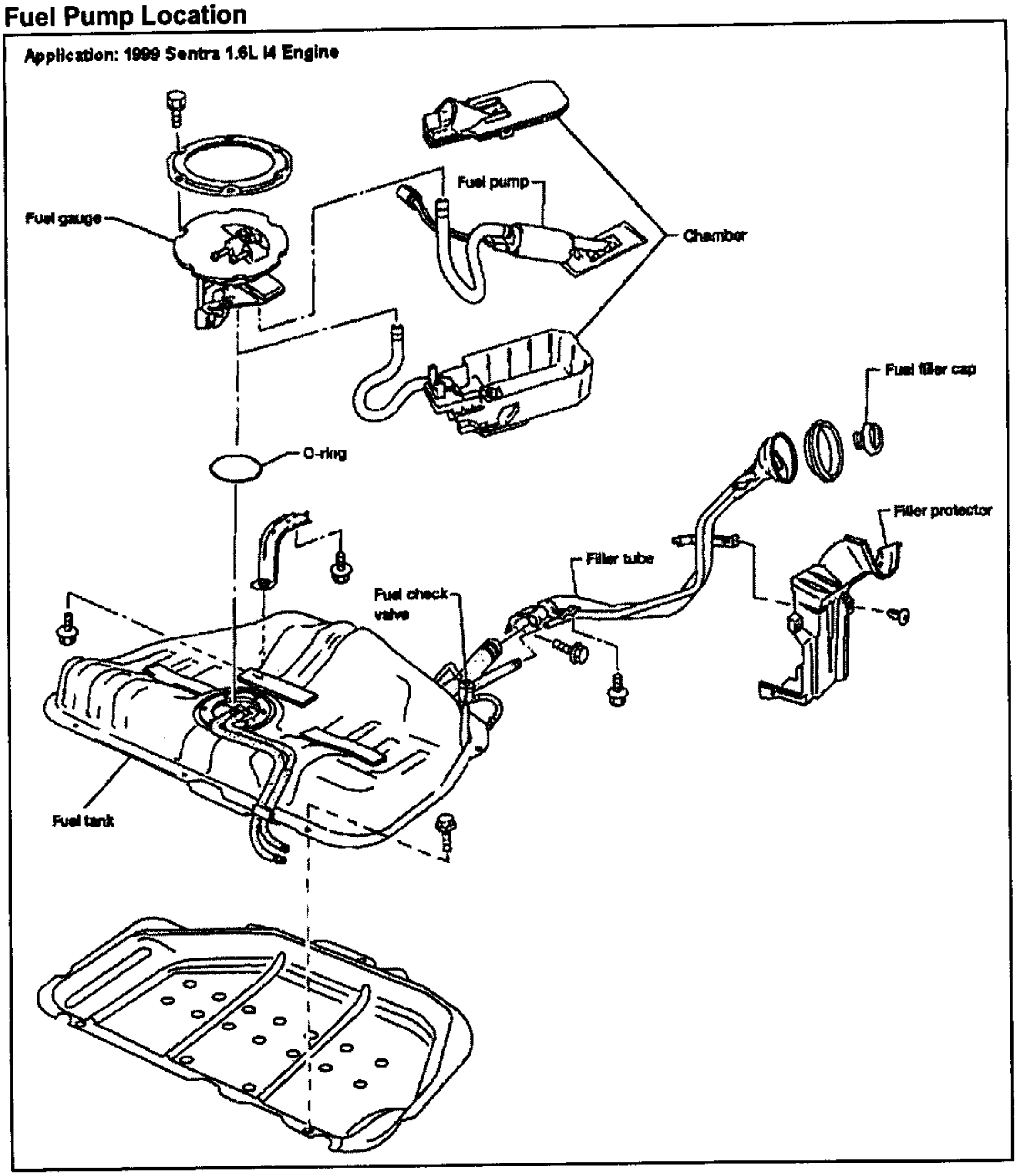
1999 SENTRA (1.6L I4 VIN A)

Fuel System

Component Locations

The Fuel system component locations for this vehicle appear in the Graphics below.

Fuel Pump Location



1999 SENTRA (1.6L I4 VIN A)

Electric Fuel Pump

General Description

This vehicle application uses an in-line, turbine-type electric fuel pump. Fuel is drawn from the fuel tank through a one-way check valve and then delivered to the fuel rail in the engine compartment.

An external fuel filter (sock) is used on the turbine type pump. A check valve is used to maintain fuel pressure in the fuel line for a short time after shutdown to ease restarting.

The fuel pump has an internal relief valve to prevent excessive pressure in the fuel delivery system. This valve opens if there is a blockage in the discharge side. If the relief valve opens, fuel flows from the high-pressure side to the low-pressure side of the pump.

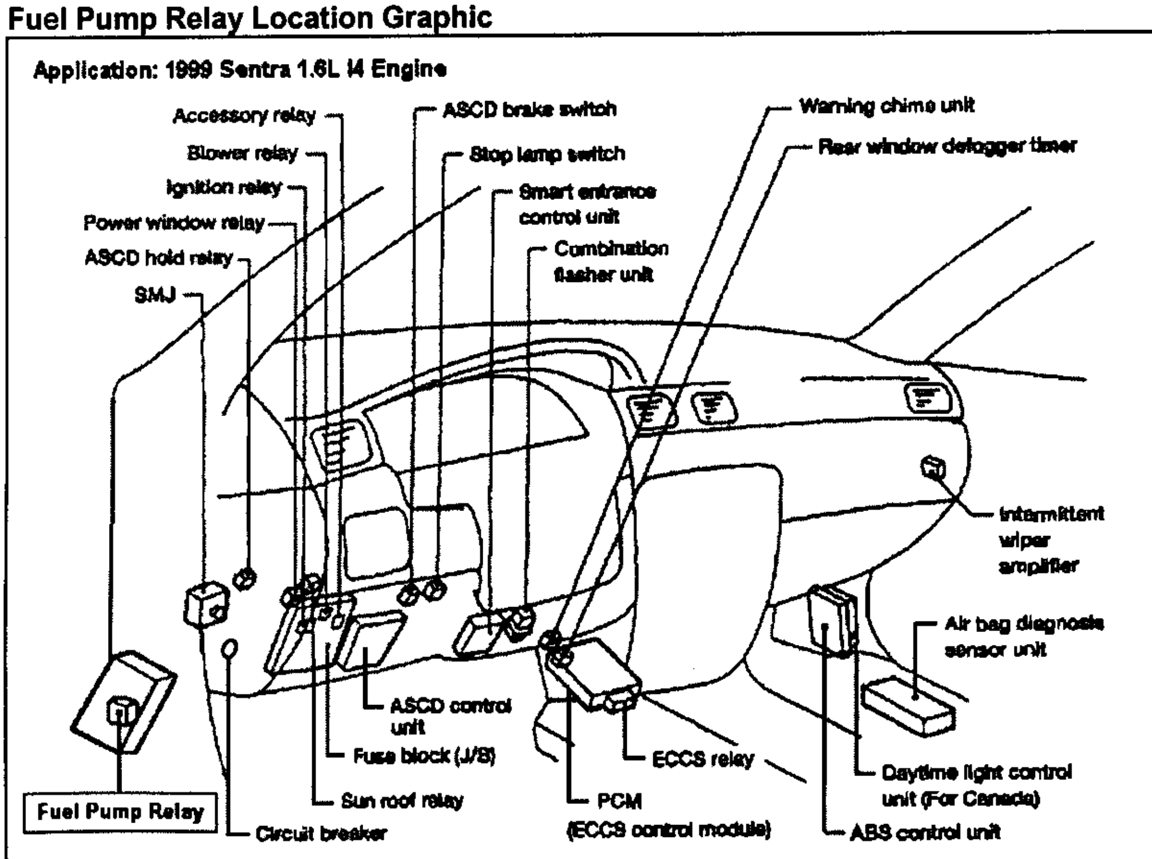
System Operation

The fuel pump is energized for five seconds when the key is first turned on by the PCM to pressurize the fuel delivery system. Once the engine starts, the PCM continues to enable the fuel pump so that the fuel pump motor turns along with the impeller. Pressure changes are created by the numerous grooves around the impeller.

Fuel enters the inlet port and flows inside the motor from the pumping chamber and is forced through the discharge port through the check valve. If fuel flow is obstructed at the discharge side of the fuel line, the relief valve will open to bypass fuel to the inlet port to prevent high fuel pressure.

If the engine stops (due to a loss of CMP sensor 180° signals), the PCM will turn off the fuel pump by disabling the FP relay. If this action occurs, an internal check valve closes by spring action to retain residual pressure to allow for quick restarts.

Fuel Pump Relay Location Graphic



1999 SENTRA (1.6L I4 VIN A)

Electric Fuel Pump

Lab Scope Test (Fuel Pump)

If you suspect that the fuel pump is faulty, you can use a low amp probe with an inductive pickup to monitor the operation of the fuel pump and its related circuits.

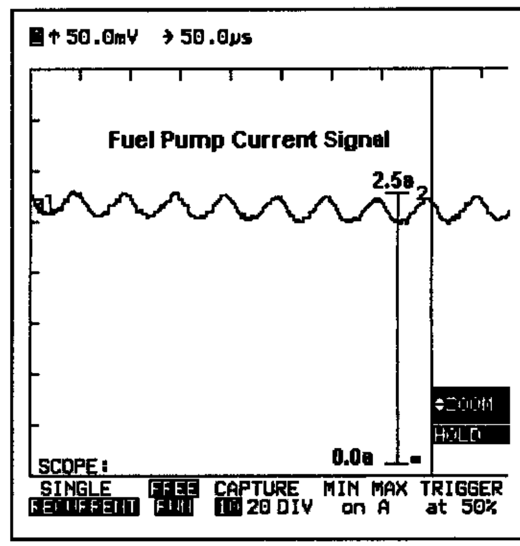
An example of a known good fuel pump motor waveform for this vehicle application is shown in the Graphic on this page. If the pump is operating normally, the current draw will be less than 4 amps on this vehicle.

Specification: Fuel Pump resistance: 2.5-5.0 ohms at 77°F.

Scope Connections (Amp Probe)

Set the amp probe to 50 mv and calibrate (zero) it before starting the test procedure.

Locate the fuel pump feed and install the amp probe around the wire between the fuel pump relay and the fuel pump. Start the engine and allow the amp probe reading to stabilize.



Lab Scope Example Explanation

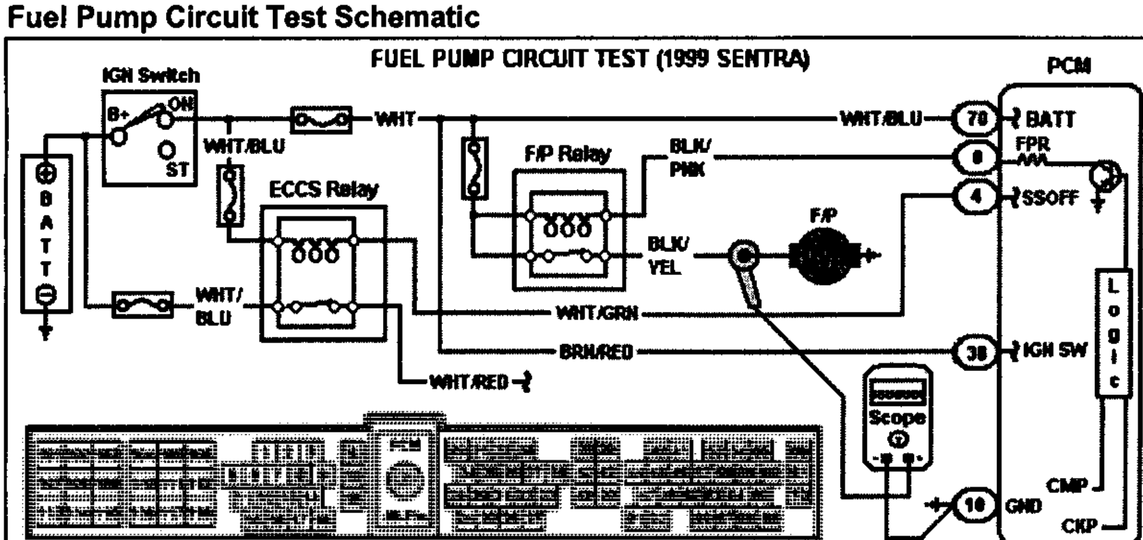
In this example, the trace shows the fuel pump current of a known good fuel pump at idle speed (the fuel pump pattern is even).

Note that the PCM energizes the F/P relay at Pin 8 (BLK/PNK wire) to control the operation of the fuel pump relay. This circuit controls the battery feed (power) to the fuel pump. This is a known good pump providing 34 psi (vacuum hose to the pressure regulator connected).

Symptom Diagnosis

Depending upon the type of problem, you may want to let the engine run for a period of time until it occurs - this allows you to monitor the amount of change in the fuel pump current trace (as the fuel pump motor ramps up). In some cases, you may need to let the engine run until the engine stalls or begins to stall and then capture the waveform.

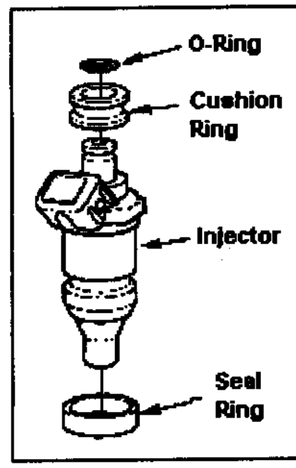
Fuel Pump Circuit Test Schematic



1999 SENTRA (1.6L I4 VIN A)

Fuel Injectors

General Description



The fuel injectors on this engine application are solenoid-operated (N.C.) valves that are designed to meter the fuel flow to each combustion chamber. These injectors are the "saturated switch" design. Injector ontime is the time between the downward vertical line and upward vertical spike on a scope.

Each injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel delivered is controlled by the length of time the injector is held open (injector pulsewidth).

The amount of fuel injected from each fuel injector is determined by the PCM (as it controls the length of time the injector remains open - called injector pulsewidth).

The actual amount of fuel injected is a program value stored in the PCM memory. Under most conditions, the injection pulsewidth is preset (from fuel trim values) based on engine operating conditions. These conditions are determined by input signals from the CMP sensor (the engine speed) and the MAF sensor (the amount of intake air).

The injectors are connected to a battery feed circuit through the ignition switch. When the PCM supplies a ground signal to the control circuit, the coil is energized. This action pulls the needle valve back to allow fuel flow through the injector to the intake manifold.

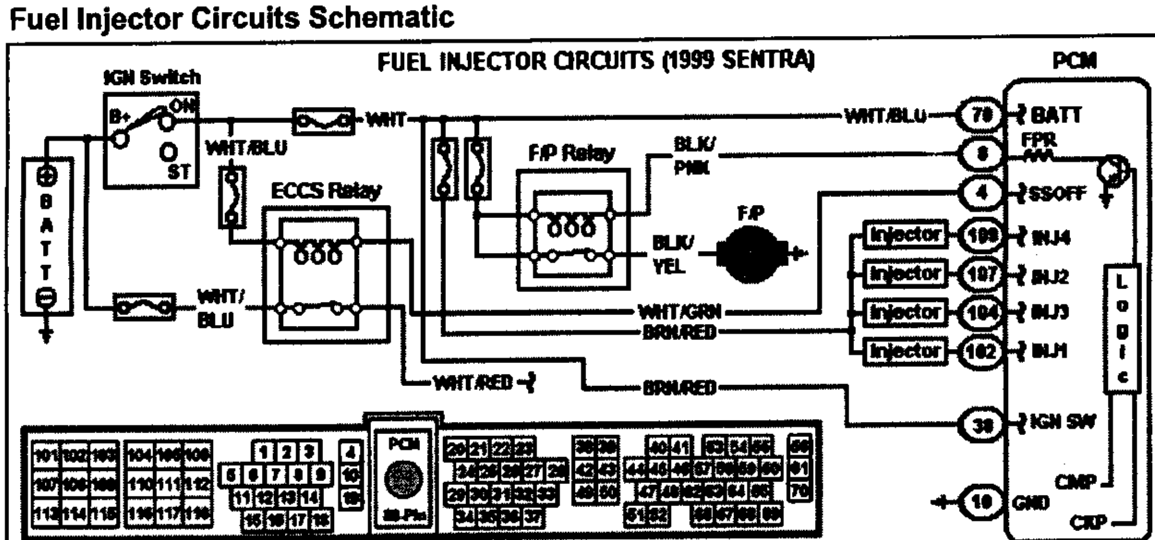
The amount of fuel compensation is increased during these conditions:

- During engine startup and warmup
- During acceleration
- During hot engine operation
- During high-load, high-speed operation

The amount of fuel compensation is decreased during these conditions:

- During deceleration
- During high-speed operation (without a high engine load)

Fuel Injector Circuits Schematic



1999 SENTRA (1.6L I4 VIN A)

Fuel Injectors

Lab Scope Test #1 (Fuel Injector)

The Lab Scope is the "tool of choice" to test operation of the fuel injector and its circuits.

Scope Connections

Connect the Channel 'A' positive probe to the one of the fuel injector control signals (Pin 102, 104, 107 or 109 at the PCM).

In this example, the Channel 'A' positive probe was connected to the Injector No. 1 control signal wire at Pin 102 (the GRN wire).

Connect the Channel 'A' negative probe to Pin 10 of the PCM or to the battery negative ground post.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Explanation - Example (1)

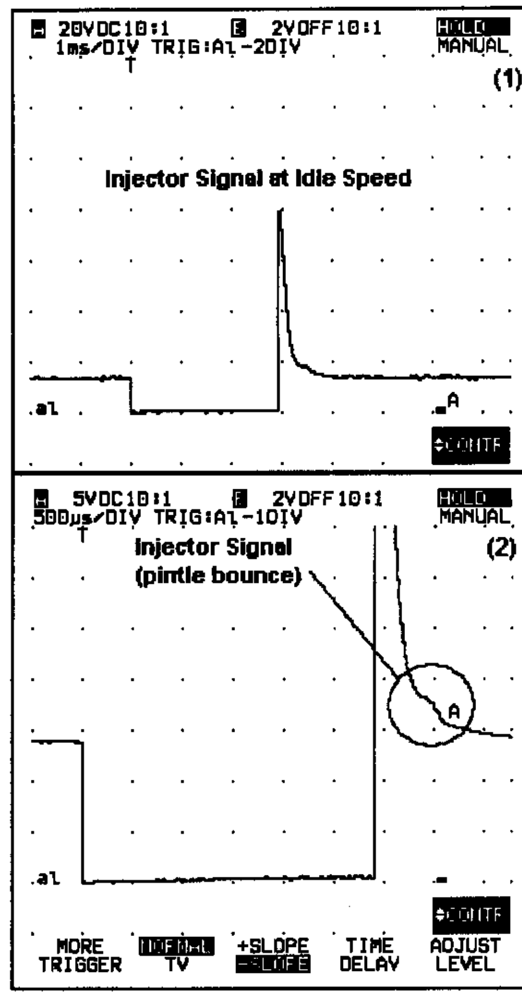
In this example, the trace shows the Injector No. 1 control signal at idle speed. Note the height of the injector spike (near 80v) and injector on-time (3 ms) in the example.

Lab Scope Explanation - Example (2)

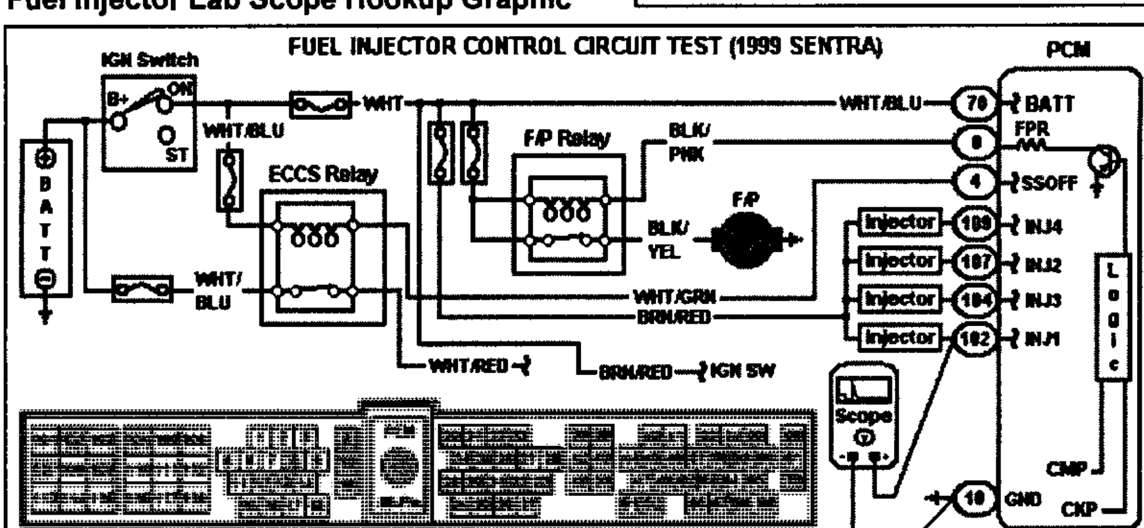
In this example, the trace shows the Injector No. 1 signal with a different time base (it was changed to 500 μs for this capture).

In this example, the trace shows the injector control signal at idle speed. Note the height of the injector spike (over 60v) in this example.

Note the mechanical action (pintle bounce) of the injector at the point where it closed.



Fuel Injector Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Fuel Injectors

Lab Scope Test #2 (Fuel Injector)

The Lab Scope is the "tool of choice" to test operation of the fuel injector and its circuits.

Scope Connections

Connect the Channel 'A' positive probe to the one of the fuel injector control signals (Pin 102, 104, 107 or 109 at the PCM).

In this example, the Channel 'A' positive probe was connected to the Injector No. 1 control signal wire at Pin 102 (the GRN wire).

Connect the Channel 'A' negative probe to Pin 10 of the PCM or to the battery negative ground post.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example (3) Explanation

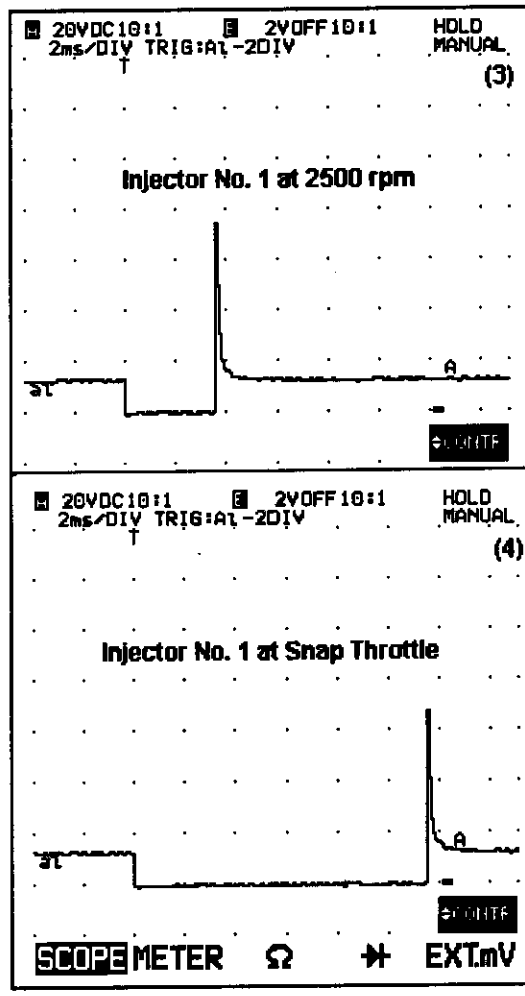
In this example, the trace shows the Injector 1 control signal at Cruise speed (2500 rpm). Note that the fuel injector pulsewidth was almost 4 ms under these operating conditions.

Lab Scope Example (4) Explanation

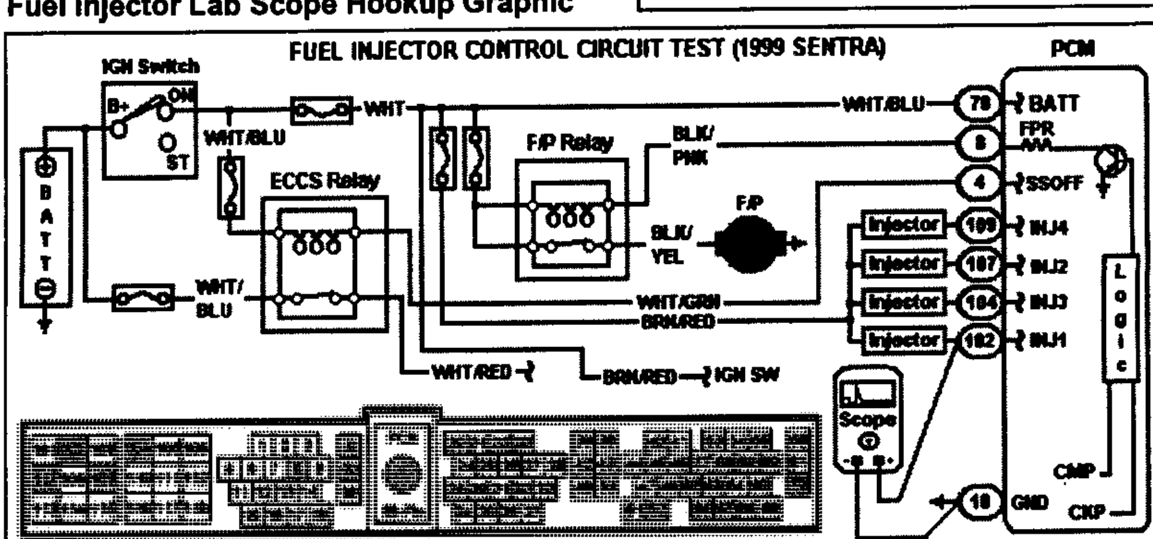
In this example, the trace shows the Injector 1 control signal during a Snap Throttle event.

Note the injector pulsewidth changed from about 4 ms to more than 11 ms under these operating conditions.

These are both known good signals for this vehicle under these conditions.



Fuel Injector Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Idle Air Control Motor

General Description

The PCM automatically controls the engine idle speed to a specified value. The idle speed is controlled through fine adjustments to the amount of air that bypasses the throttle valve via the IACV-AAC valve (IAC motor). This device is a two-phase motor.

The IACV-AAC valve opens and closes according to signals received from the PCM. The PCM calculates the actual idle speed using signals received from the CMP sensor. It controls the IAC motor to achieve an engine speed that coincides with the target idle speed value stored in memory. The target idle speed is the lowest speed at which the engine can operate steadily. The optimum value stored in the PCM is determined by taking into consideration various engine conditions (i.e., warmup, deceleration and engine load - through inputs from the A/C switch, power steering and cooling fan).

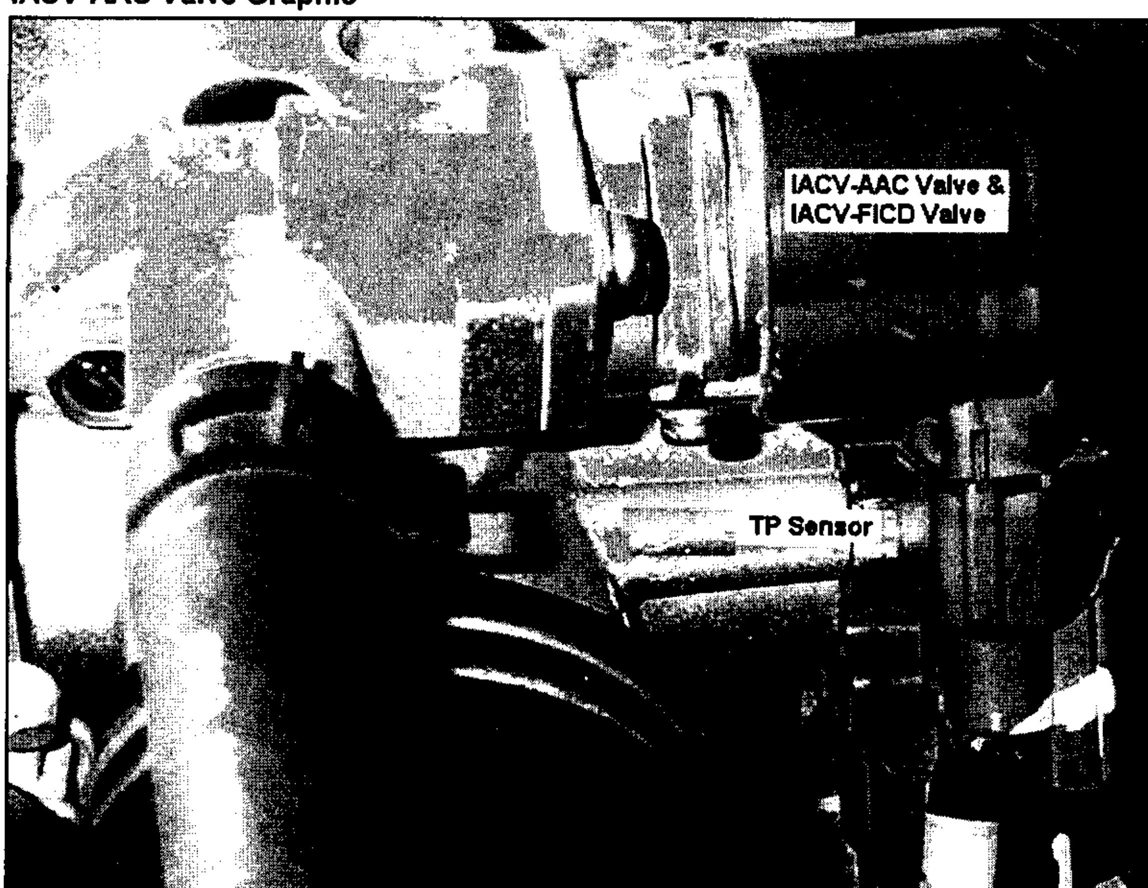
Component Operation

The IACV-AAC valve is moved to an open and closed position by commands from the PCM. When the valve receives an open command, the amount of air that passes through the valve increases. When the motor receives a closed command, the amount of air decreases.

FICD Solenoid Valve

The IACV-FICD solenoid valve is built into the IAC motor body. This solenoid is enabled whenever the air conditioner is enabled (it supplies extra air to offset the additional load).

IACV-AAC Valve Graphic

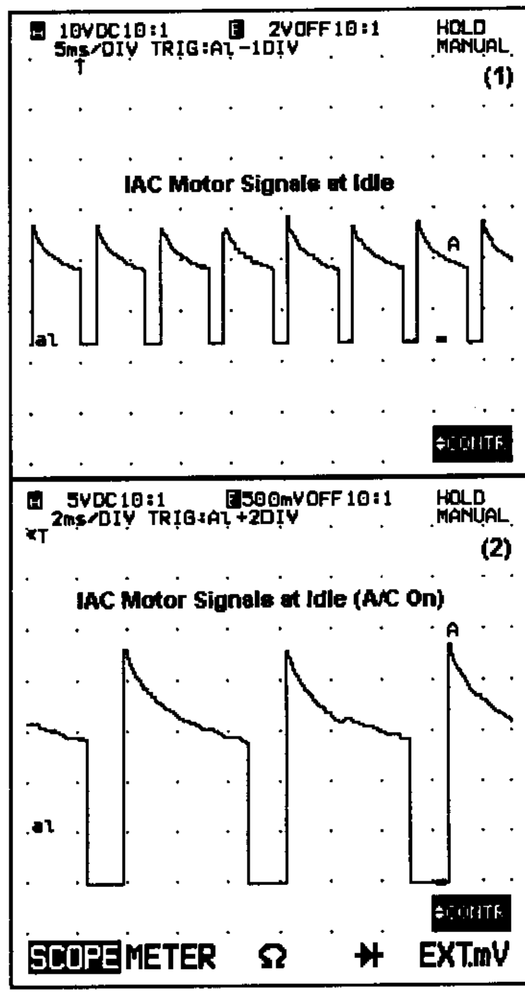


1999 SENTRA (1.6L I4 VIN A)

Idle Air Control Motor

Lab Scope Test #1 (IAC Motor)

The Lab Scope can be used to test the operation of the stepper motor circuits inside the IAC valve. The examples on this page represent known good IAC solenoid signals.



Scope Connections (Examples 1 & 2)
Connect the Channel 'A' positive probe at Pin 101 and the negative ground probe to Pin 10 of the 88-Pin connector. Connect the Channel 'B' positive probe at Pin 42 (same connector).

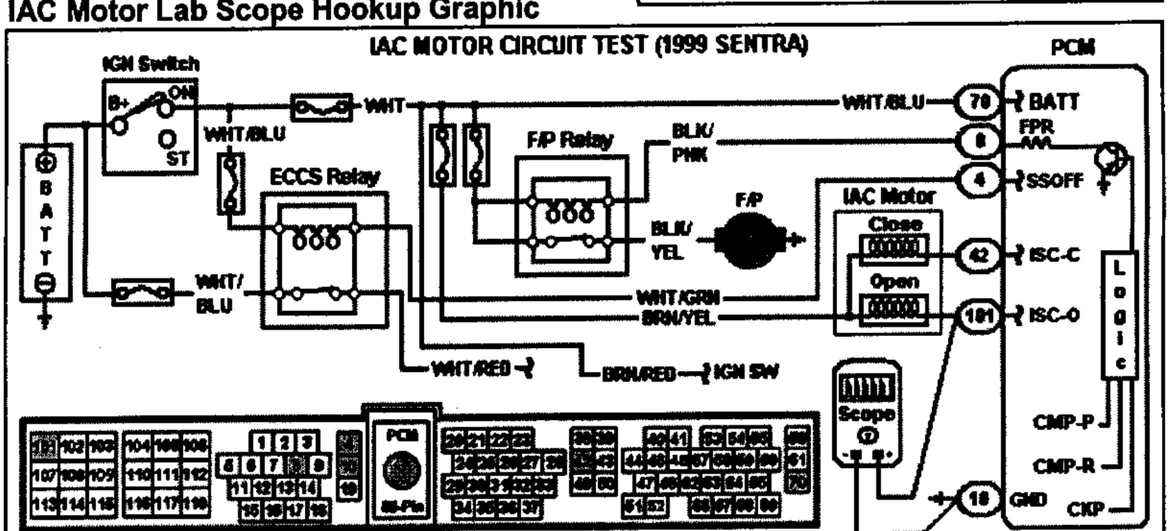
Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the example.

IAC Valve Lab Scope Test
Start the engine and allow it to fully warm up. Then capture the IAC valve waveforms with the gear selector in Park. Then turn on the air conditioner and select the high fan blower position. These loads should cause a change in the IAC valve signal with the A/C "on".

Lab Scope Explanation - Example (1)
This trace shows the IAC motor waveform without any load applied with the engine at hot idle speed in Park. Note the steady voltage signal from the IAC motor windings. Also note the jagged edge to the IAC motor signals.

Lab Scope Explanation - Example (2)
This trace shows the IAC motor waveform with the engine at Hot Idle speed with the A/C on and high fan selected. Note the lack of change in the IAC motor ontime with the A/C enabled due to the use of a FICV valve on this engine.

IAC Motor Lab Scope Hookup Graphic

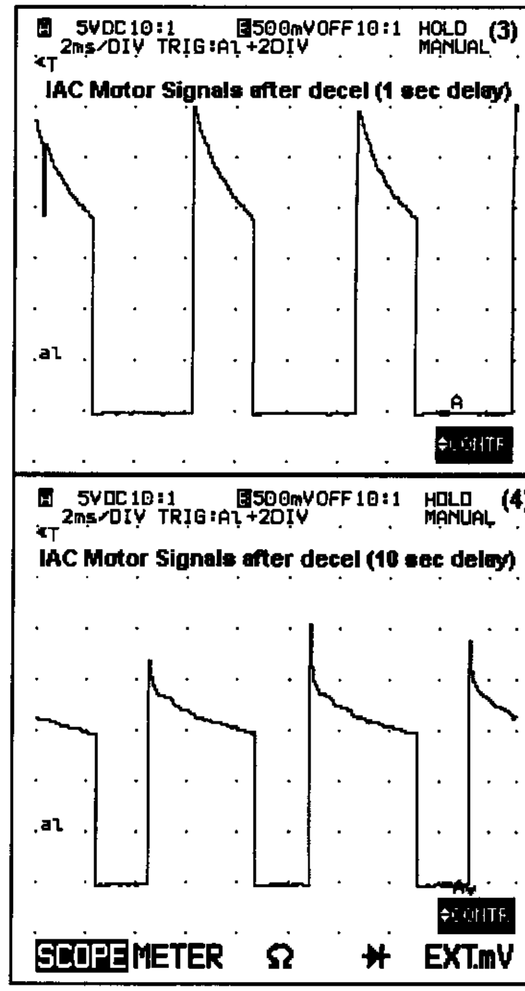


1999 SENTRA (1.6L I4 VIN A)

Idle Air Control Motor

Lab Scope Test #2 (IAC Motor)

The Lab Scope can be used to test the operation of the stepper motor circuits inside the IAC valve. The examples on this page represent known good IAC solenoid signals.



Scope Connections (Examples 3 & 4)

Connect the Channel 'A' positive probe at Pin 101 and the negative ground probe to Pin 10 of the 88-Pin connector. Connect the Channel 'B' positive probe at Pin 42 (same connector).

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the example.

IAC Valve Lab Scope Test (Examples 3 & 4)

Start the engine and allow it to fully warm up. Then capture the IAC valve waveforms during deceleration with the gear selector in Park. Then turn on the Air Conditioner and capture the IAC motor signals with it enabled.

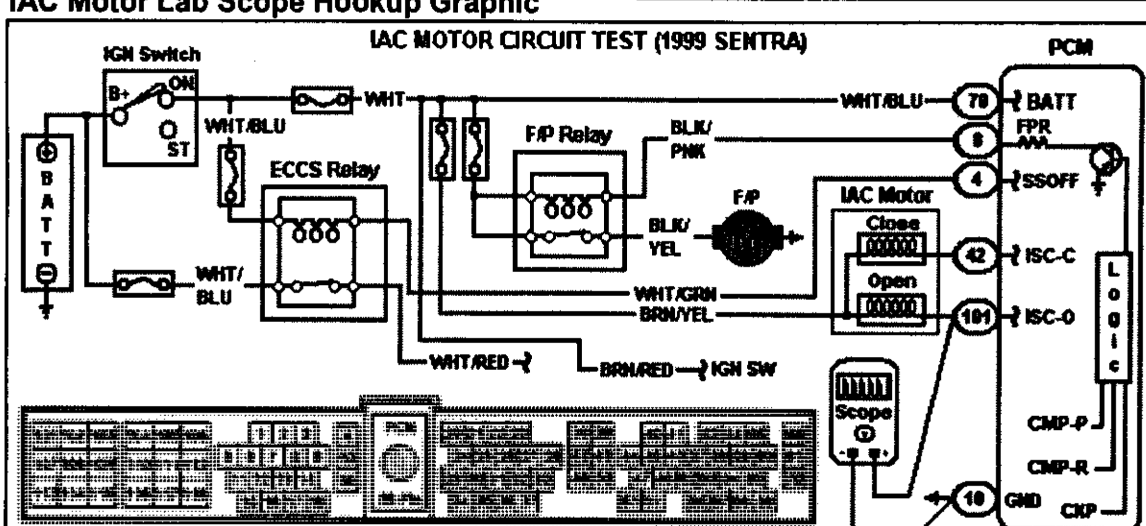
Lab Scope Explanation - Example (3)

This trace shows the IAC motor waveform appears one second after decelerating to idle. Note that the IAC motor winding ontime of about 4 ms under these engine conditions.

Lab Scope Explanation - Example (4)

This trace is an example of the IAC motor waveform 10 seconds after a Decel to idle. Note the IAC motor winding ontime of more than 2 ms under these engine conditions. The examples are from a known good vehicle.

IAC Motor Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Automatic Transmission Controls

Introduction

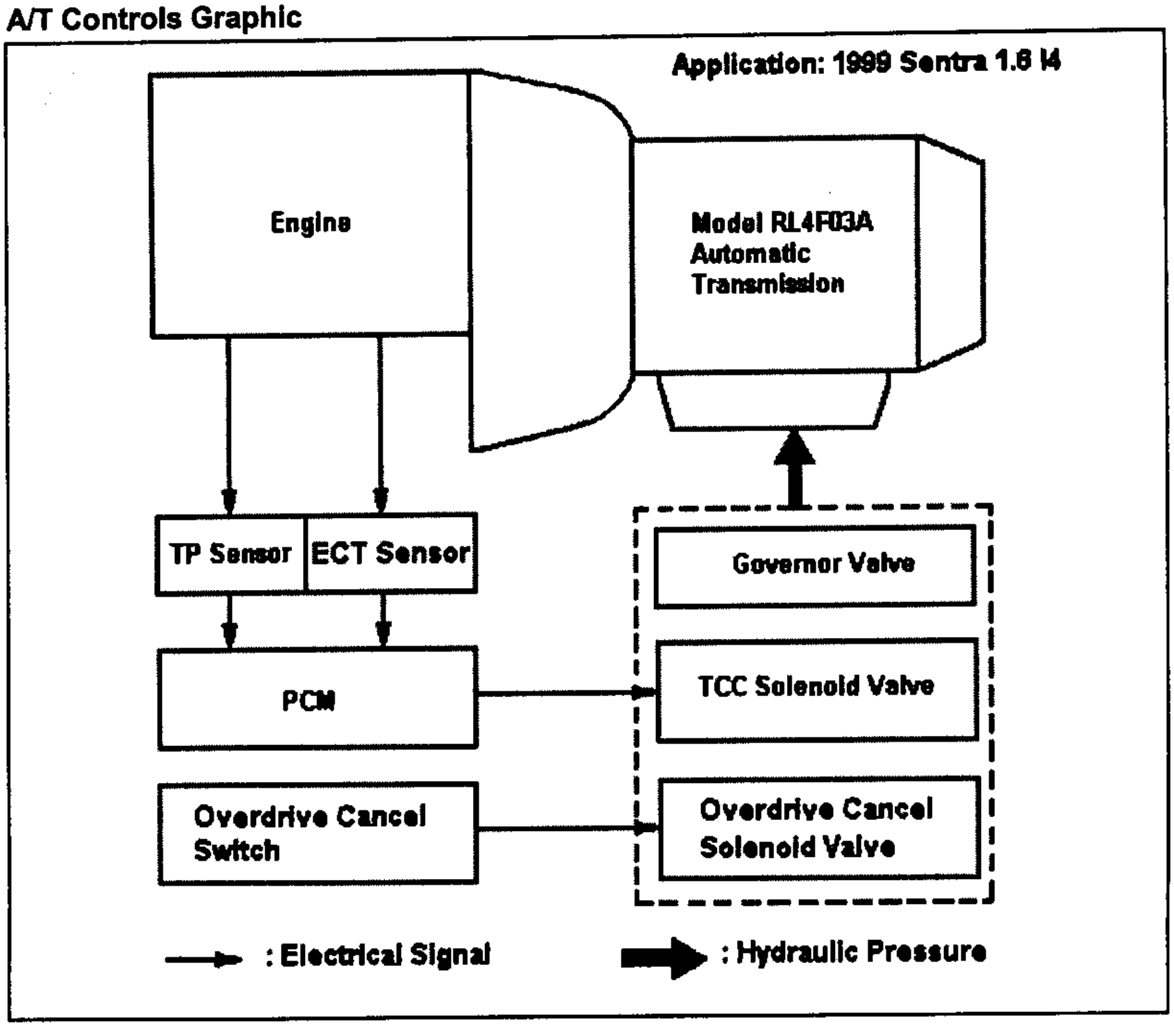
This vehicle is equipped with a RL4F03A 4-speed automatic transmission designed to sense the vehicle operating conditions in order to control the optimum output shaft position and reduce the shock from shifting and lockup operations.

The ECCS Powertrain Control Module (PCM) receives inputs from the ECT sensor, TP sensor, P/N switch and Overdrive Cancel switch. This information is used to determine when to apply or disable the TCC solenoid valve and Overdrive Cancel solenoid valve.

The PCM is designed to perform the following functions:

- To receive input signals from various sensors and switches
- To determine when to apply or release the TCC and Overdrive Cancel solenoids
- To send the required output command to these solenoid valves

A/T Controls Graphic



1999 SENTRA (1.6L I4 VIN A)

Automatic Transmission Controls

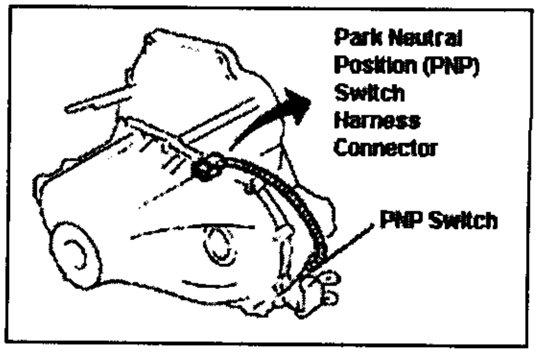
Park Neutral Switch (A/T)

The Park Neutral (P/N) switch is mounted to the transmission case. The P/N switch includes a transmission range (TR) switch used to detect the selector lever position.

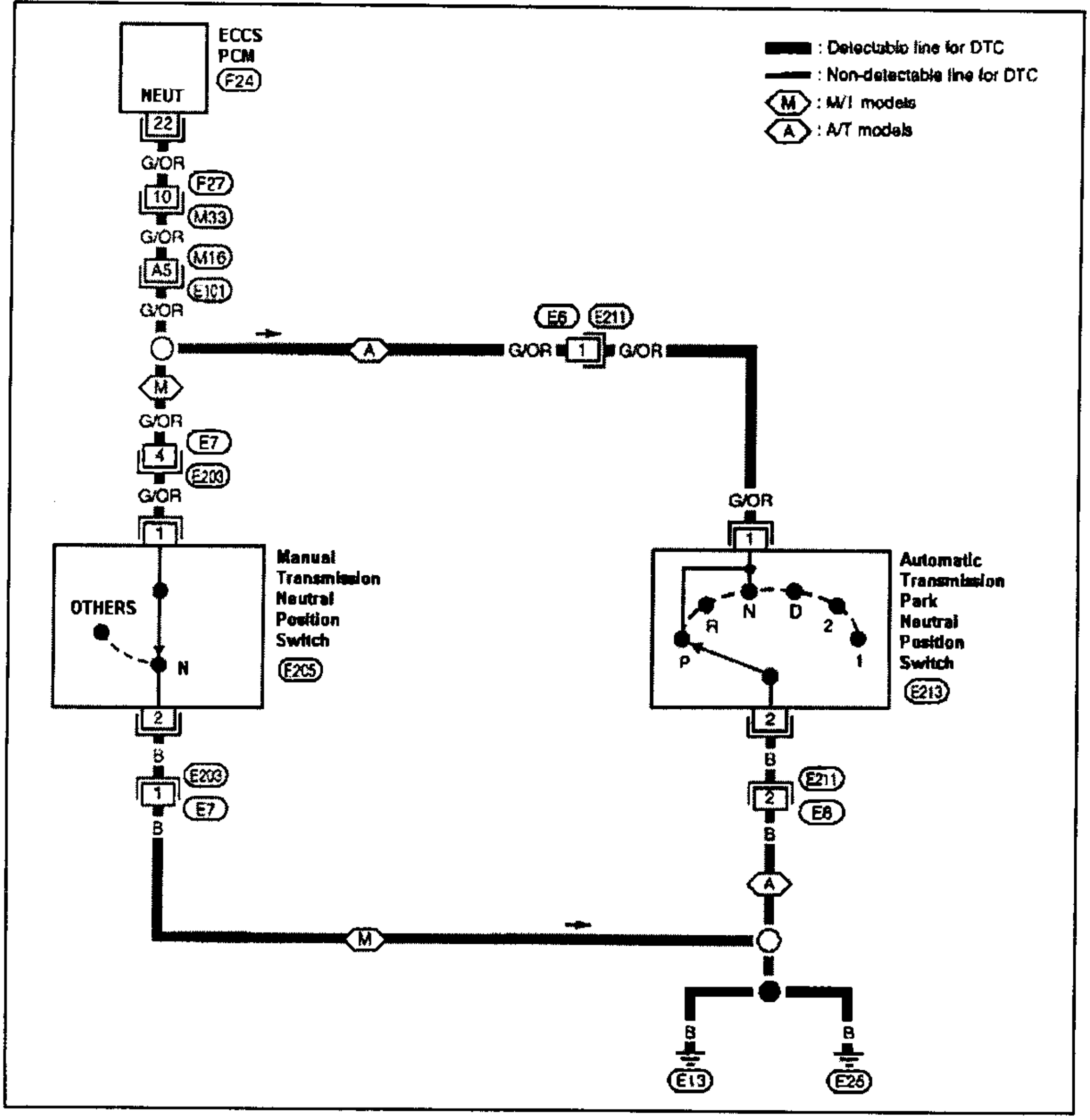
Component Operation

When the gear selector position is in Park or Neutral, the switch contacts are closed (the circuit has continuity to ground at this point).

The Scan Tool PID will display ON with the gear selector in 'P' or 'N' and display OFF for all other gear selector positions. A DVOM will read near zero (0) volts in 'P' or 'N', and should read near 12v in all other positions.



Park Neutral Switch Schematic



1999 SENTRA (1.6L I4 VIN A)

Automatic Transmission Controls

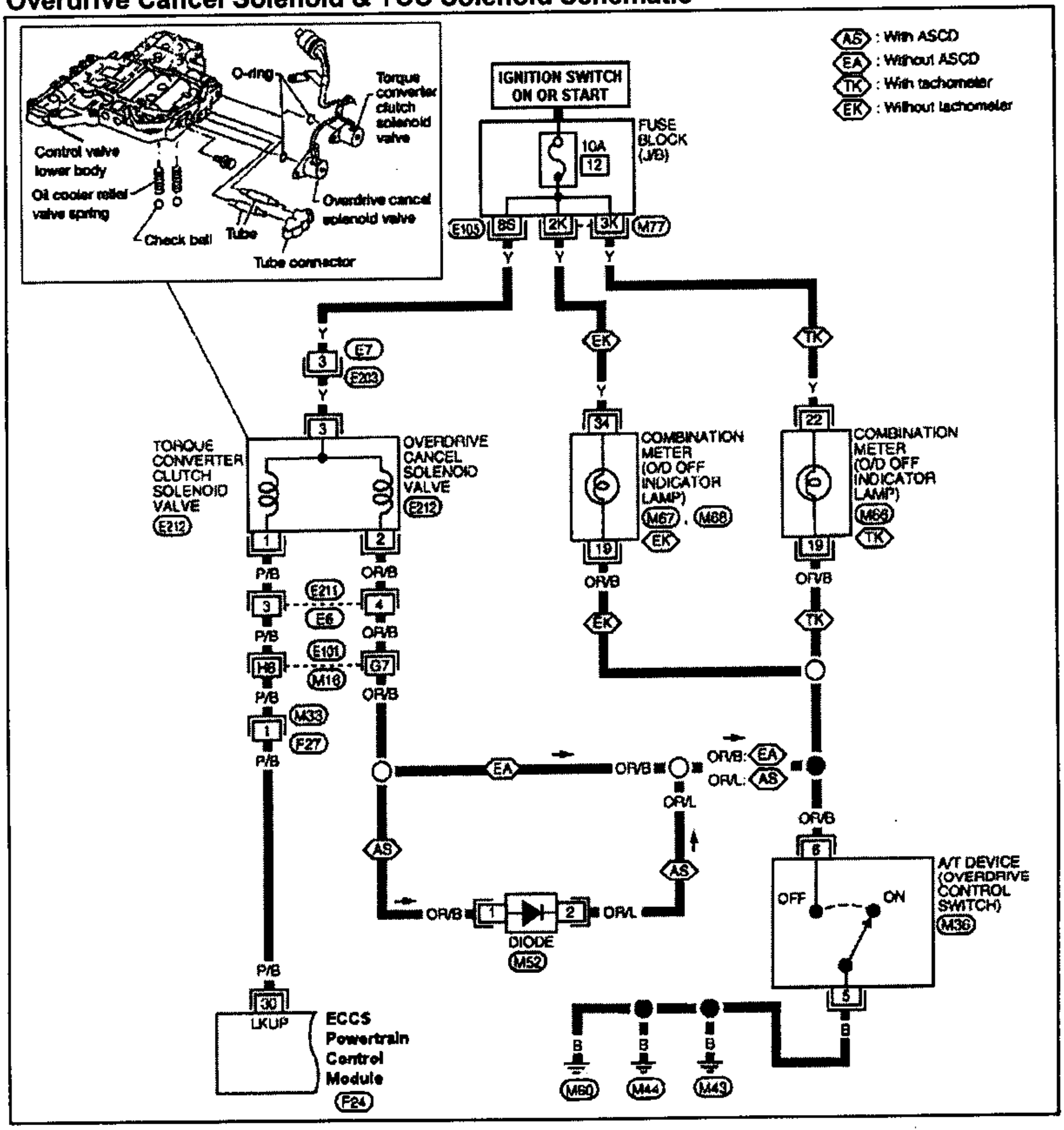
Overdrive Control Switch

The Overdrive Control switch is mounted on the gearshift handle. This switch is used to enable and/or disable the overdrive cancel solenoid on the RL4F03A 4-speed automatic transmission.

Torque Converter Clutch Solenoid

The torque converter clutch (TCC) solenoid is mounted in the transmission on the RL4F03A 4-speed automatic transmission. The PCM controls the operation of the TCC solenoid (valve) on this application. Under certain conditions it enables and/or disables the TCC solenoid (valve) to allow or disallow torque converter clutch operation.

Overdrive Cancel Solenoid & TCC Solenoid Schematic



1999 SENTRA (1.6L I4 VIN A)

Automatic Transmission Controls

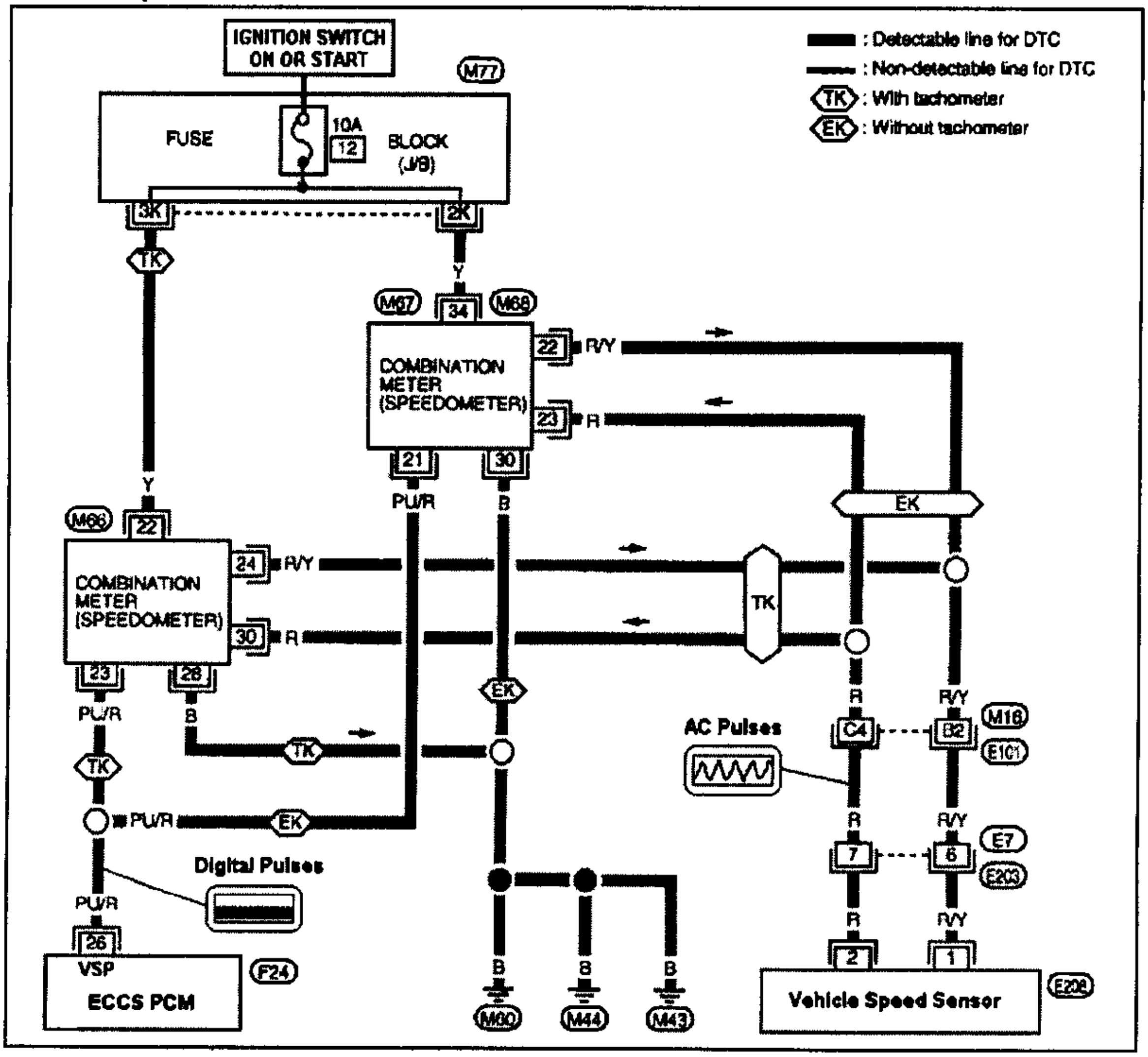
Vehicle Speed Sensor

The Vehicle Speed Sensor (VSS) is mounted in the transaxle housing. During operation, the VSS signal is an AC voltage to the Combination Meter connector at Pins 22 and 23 of the meter.

The meter converts the AC pulse signals from the VSS into digital pulse signals. The Combination Meter sends the digital signals (0-5-0-5v squarewave) to the PCM for processing.

The VSS signal from the Combination Meter to the PCM connects to the PCM at Pin 26 (PPL/RED wire) of the 88-Pin connector.

Vehicle Speed Sensor Schematic

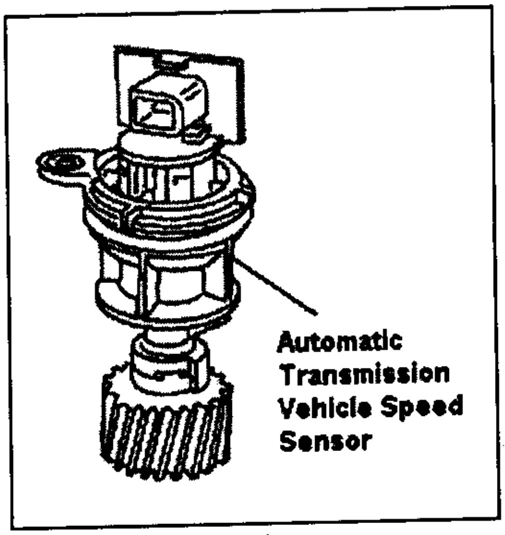


1999 SENTRA (1.6L I4 VIN A)

Automatic Transmission Controls

DVOM Test (VSS)

The vehicle speed sensor (VSS) is driven by the transaxle. Once the vehicle begins to move, the sensor will output an AC voltage signal to the Combination Meter. The meter converts this signal to a digital pulse (0-5-0-5v) as described on the previous page.



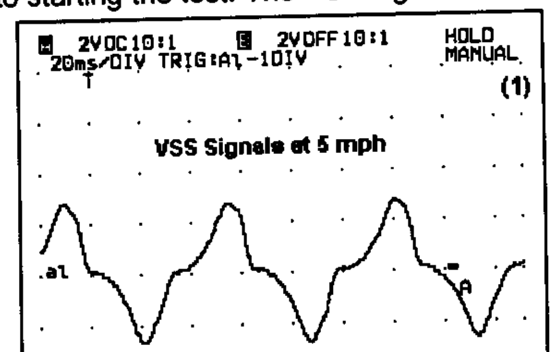
This sensor can be tested manually by removing it from the vehicle and then testing the VSS output signal with a DVOM as described next.

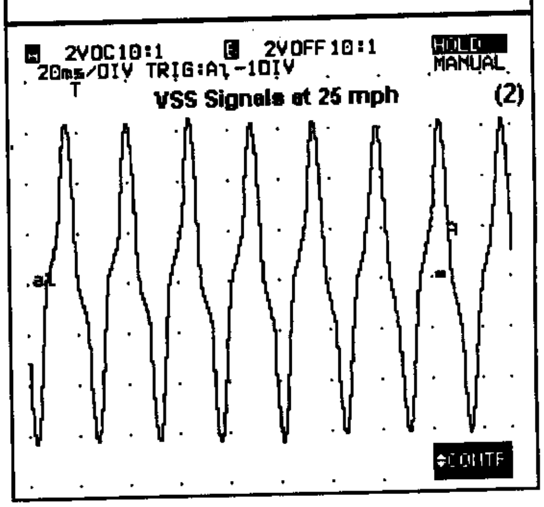
Remove the vehicle speed sensor from the transmission. Connect the DVOM positive lead to one sensor terminal and the negative lead to the other sensor terminal.

Set the meter (DVOM) to AC volts. Then rapidly rotate the sensor gear while observing the meter. The sensor output should be close to 0.5v AC under these conditions.

Lab Scope Test (VSS)

The Lab Scope is the tool of choice to test the vehicle speed sensor. This test is performed with the Lab Scope connected prior to starting the test. The VSS signals are captured with the vehicle moving at the desired capture speed.





Examples of known good signals from this sensor for this vehicle application are included on this page.

Scope Connections

Connect the Channel 'A' positive probe to Pin 26 (PPL/RED wire) at the PCM 88-Pin connector. Connect the negative probe to the battery negative ground cable or to chassis ground.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Vehicle Speed Sensor Test

Connect the Lab Scope as described at the PCM and then drive the vehicle at the desired speed to set up the capture of the VSS signal.

Lab Scope Example

In Example (1), the trace shows a known good VSS signal from this vehicle at 5 mph.

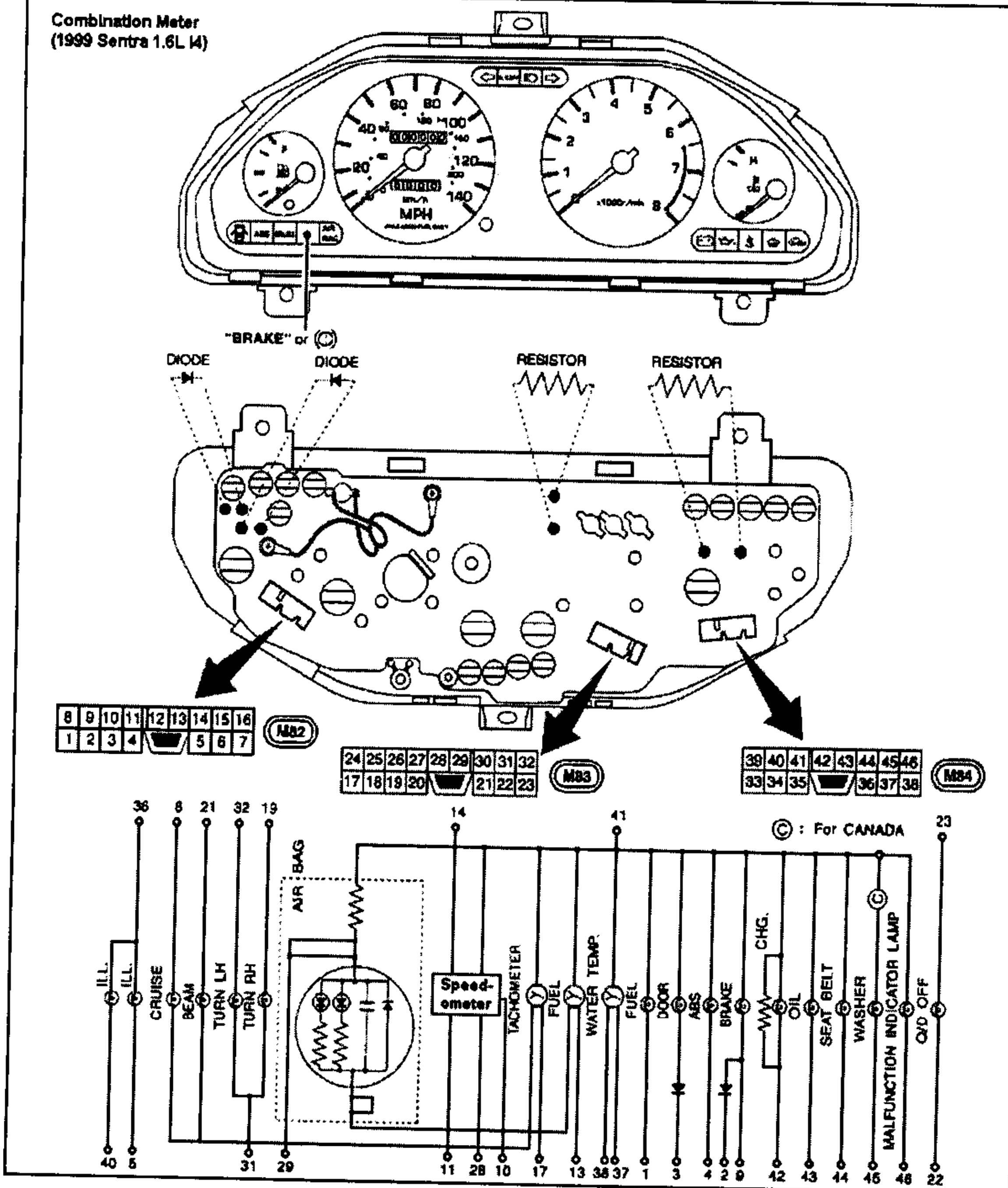
In Example (2), the trace shows a known good VSS signal from this vehicle at 25 mph.

1999 SENTRA (1.6L I4 VIN A)

Combination Meter

General Description

The combination meter receives power at Pins 14, 22 and 41 with the ignition on. The meter is supplied ground via Pins 10 and 28. The MIL is controlled as described below.



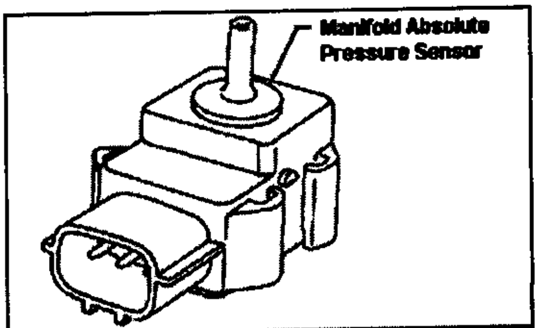
Malfunction Indicator Lamp Operation

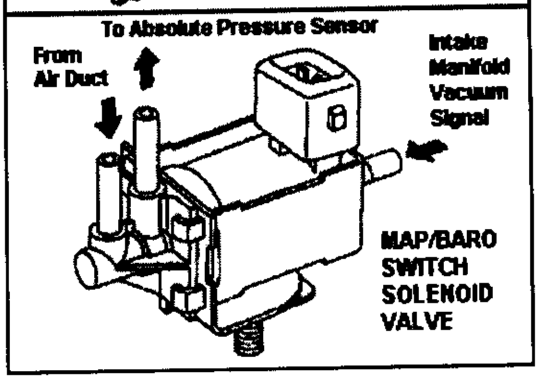
The Malfunction Indicator Lamp (MIL) receives power from the No. 12 fuse (10A) in the fuse panel. If the PCM detects an emissions related fault, it turns the MIL "on" by grounding the circuit at Pin 18 that connects to Pin 46 of the combination meter. A wiring diagram of the MIL and PCM circuits is included at the end of this section.

1999 SENTRA (1.6L I4 VIN A)

Manifold Absolute Pressure Sensor

General Description





The manifold absolute pressure (MAP) sensor connects to MAP/BARO switch solenoid valve through its air duct connection. The PCM uses this sensor input to detect the ambient barometric pressure and intake manifold pressure respectively. This sensor converts this pressure to an analog signal for the PCM.

As the intake manifold pressure increases, the sensor signal voltage increases. The MAP sensor signal is not used directly as an input to the engine management system, but is used as part of the OBD II system diagnostics.

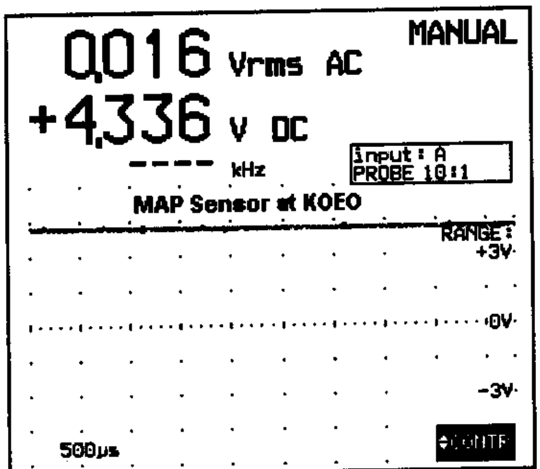
MAP Sensor Circuit Checks

The MAP sensor can be checked as follow:

MAP VREF Circuit - Carefully backprobe the MAP VREF circuit (RED wire) at the MAP sensor connector with the positive probe. Connect the other probe to the battery ground post. Turn the key to "on". This circuit should read from 4.9-5.1v.

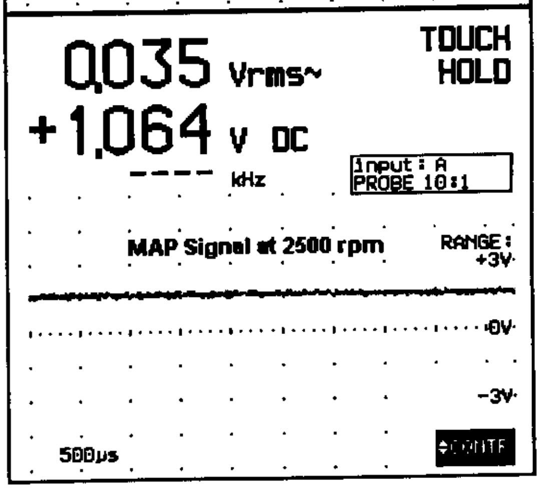
MAP Ground Circuit - Carefully backprobe the MAP ground circuit (BLK wire) at the 3-P connector with the positive probe. Connect the other probe to the battery negative post. The DVOM should read less than 50 mv at KOEO.

MAP Signal Circuit - Carefully backprobe the MAP signal circuit (WHT wire) at the 3-pin connector with the positive probe. Connect the other probe to the negative ground post. Start the engine in Park. The DVOM reading should read from 1.0-1.1v at sea level.



DVOM Test (MAP Sensor)

Dynamic Test - Connect the DVOM to the MAP signal circuit (WHT wire). Read the voltage in KOEO and KOER modes. The DC volt readings in these examples were captured at KOEO, and at idle with a Fluke 99B Meter.



Diagnostic Tips - MAP Sensor

If engine vacuum is low due to a mechanical problem, the MAP signal will read lower and can cause a change in the engine operation.

These faults include a timing belt one tooth off, valves that are too tight, restricted exhaust or the use of a performance camshaft.

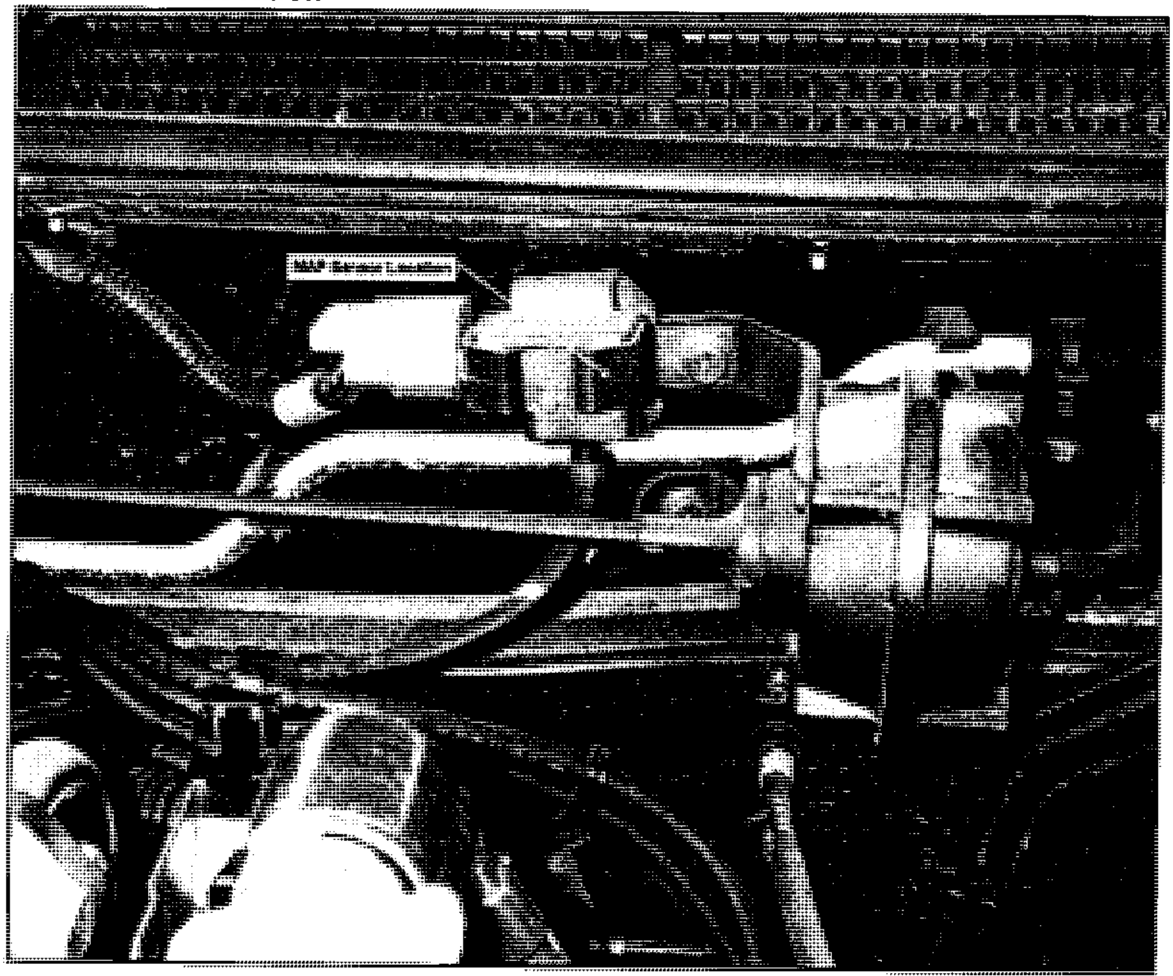
1999 SENTRA (1.6L I4 VIN A)

Manifold Absolute Pressure Sensor

Component Locations

The Manifold Absolute Pressure (MAP) sensor is located on the cowl as shown below.

MAP Sensor Location



1999 SENTRA (1.6L I4 VIN A)

Manifold Absolute Pressure Sensor

Lab Scope Test (MAP Sensor)

The Lab Scope can be used to test the MAP sensor in place of a DVOM or a Scan Tool. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels for safety. The Scan Tool is the tool of choice for this particular sensor.

Scope Connections

Connect the Channel 'A' positive probe to the MAP sensor signal at Pin 66 (WHT wire) of the 88-Pin connector. Connect the negative probe to the battery ground post.

Scope Settings

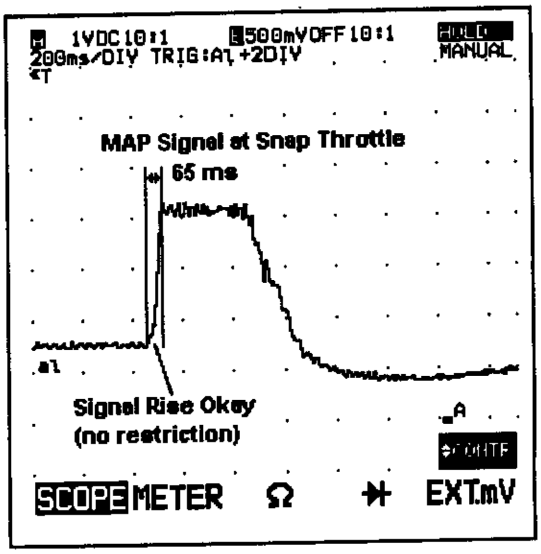
To make the waveform as clear as possible, set the scope settings to match the examples. The MAP sensor waveform may have slight differences from one Lab Scope to another depending upon the scope capabilities and settings.

Lab Scope Tests

Start the engine and raise the engine speed to 2500 rpm for 2 minutes to allow it to warmup. With the engine at hot idle in Park, perform a snap throttle test of the MAP sensor signal by quickly opening and closing the throttle while monitoring the waveform for any problems.

Lab Scope Example

There are 1.5 subdivisions between the vertical cursors in this example. Each graticule equals 200 ms. There are five subdivisions per graticule (5 x 40 = 200 ms per graticule).



This example shows a good MAP sensor signal during the Snap Throttle Test. Note the signal rise time occurred in 65 ms.

To calculate the rise time of the MAP sensor signal, push the Hold or Record button on the Lab Scope to capture the pattern. Turn on the vertical cursors. Position one cursor at the point where the signal starts to rise and position the second cursor at the point where the signal stops rising. You can use this test procedure to capture the actual rise time of the MAP sensor signal on this vehicle application.

If the MAP sensor signal rise time exceeds 100-120 ms on this vehicle application, check the following:

- Check for a restriction somewhere in the exhaust system
- Check the MAP sensor vacuum source line for a restriction in the line or at the port
- Check for a defective MAP sensor

Summary: If the engine operation is sluggish, the exhaust system may be restricted or the timing chain may have "jumped" out of phase. Perform the test outlined in the example shown above to determine if the MAP sensor will pass or fail this test.

Tips: ***Problems with the vacuum source line to the MAP sensor can cause the engine to be sluggish and run too rich. Check the source vacuum line for leaks, restrictions or kinks, and for a blockage at the vacuum port on the throttle body or intake manifold.***

1999 SENTRA (1.6L I4 VIN A)

Mass Airflow Sensor

General Description

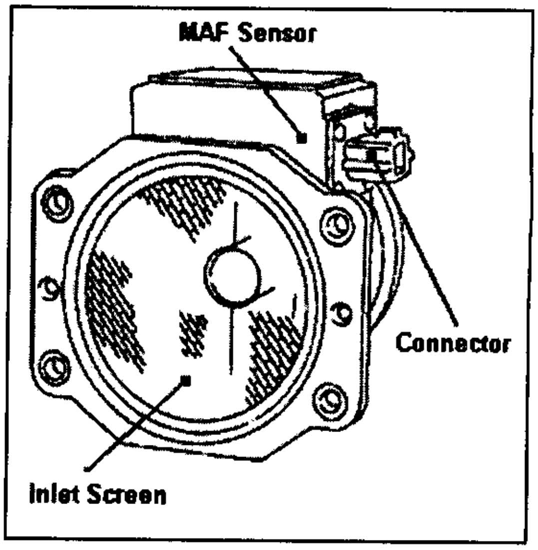
The mass airflow (MAF) sensor is placed in the stream of intake air. It is designed to measure the intake flow rate by measuring a part of the entire intake airflow.

This sensor consists of a hot film that is supplied with electric current from the PCM. The temperature of the hot film is under the control of circuits within the PCM.

The heat generated by the hot film is reduces as the intake air flows around and over it. The more air that flows past, the greater the loss of heat in the hot wire.

Therefore, the PCM must continually supply more electric current to the hot film as the airflow increases (or less as the airflow decreases).

This action (changes in current flow to keep the hot film temperature constant), maintains the temperature of the hot film. This is how the PCM determines the amount of air that is entering the engine.



DVOM Test (MAF Sensor)

Connect a DVOM or Graphing Meter to the MAF signal wire. Read the voltage in KOEO and KOER modes and compare the readings to the values here or in the Pin Voltage Tables.

DVOM Connections

Connect the DVOM positive probe to the MAF sensor signal wire at Pin 47 (GRN wire) of the 88-Pin connector and the DVOM negative probe at Pin 10 of the same connector.

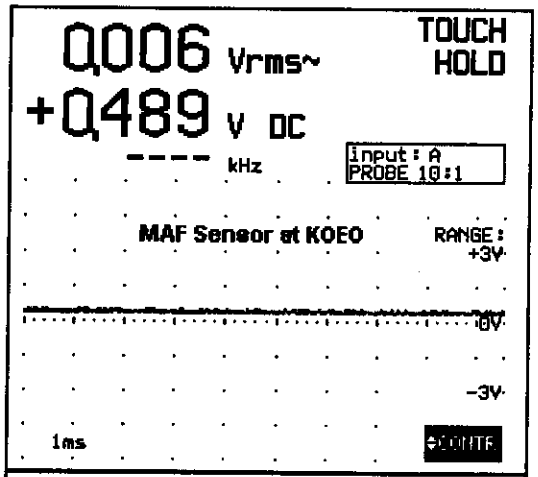
DVOM Explanations

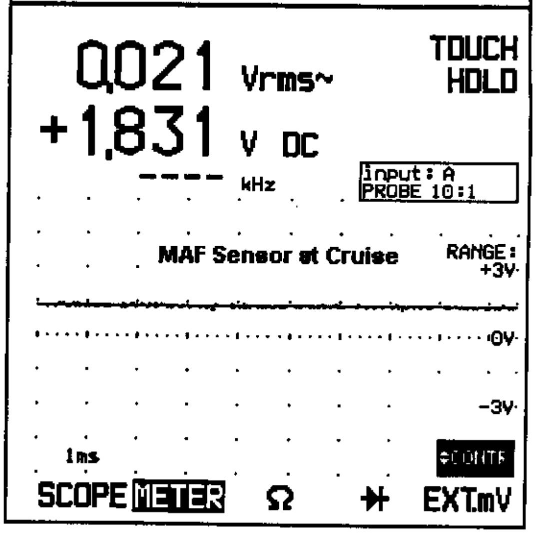
The signals in both examples show a steady DC analog voltage (flat-lined).

The engine running at Cruise speed example is slightly higher than the KOEO example. This is due to the fact that air is flowing past the hot film and on into the engine.

Note: Problems with the MAF sensor ground connection can cause the MAF sensor signal to be out of calibration.

These are known good values and waveforms from a Fluke 99B Scopemeter.





1999 SENTRA (1.6L I4 VIN A)

Mass Airflow Sensor

Component Locations

The Mass Airflow (MAF) sensor is located at the air duct hose as shown below.

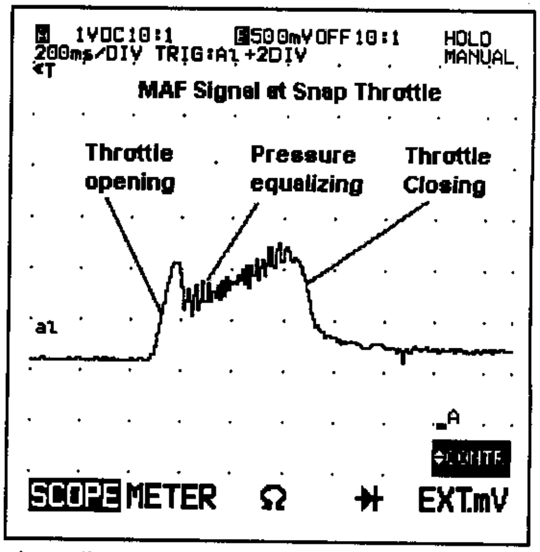
MAF Sensor Location

1999 SENTRA (1.6L I4 VIN A)

Mass Airflow Sensor

Lab Scope Test (MAF Sensor)

The Lab Scope can be used to test the MAF sensor in place of the DVOM or Scan Tool. Prior to starting the test, place the gearshift selector in Park (A/T) and block the drive wheels for safety. The Scan Tool is the tool of choice for this particular sensor.



Lab Scope Connections

Connect the Channel 'A' positive probe to the MAF signal wire at Pin 47 (GRN wire) of the PCM 88-Pin connector or carefully backprobe the MAF sensor signal wire at the sensor harness connector.

Connect the Lab Scope negative probe to Pin 48 (RED wire) of the same connector or carefully backprobe the MAF sensor ground wire (BLK) at the sensor harness connector.

Lab Scope Settings

To make the signals as accurate as possible, set the scope settings to match the example.

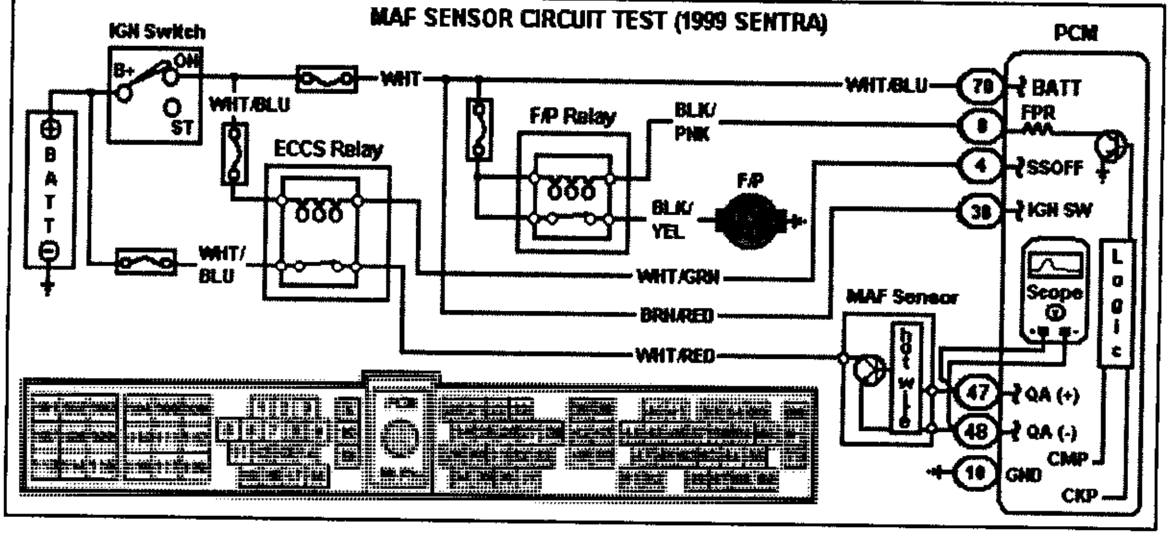
Lab Scope Test Example

Connect the Lab Scope to the correct terminals at the PCM (inside the vehicle) or at the sensor wire harness connector as previously described.

Then start the engine and bring the engine to the desired speed to set up the capture. The Lab Scope example on this pages shows a known good MAF sensor waveform captured during a snap-throttle event.

Tips: ***Problems with intake air leaks after the MAF sensor can cause rough idle and rich running engine conditions.***

MAF Sensor Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Oxygen Sensor

General Description

The heated oxygen sensor (HO2S) is mounted in the exhaust stream where it can detect the amount of oxygen in the exhaust stream compared to the outside air. The HO2S has a closed end tube made of ceramic Zirconia. The Zirconia element generates a voltage of approximately 1v in a rich A/F mixture and a voltage close to 0v in a lean A/F mixture.

Heated Oxygen Sensor Locations
The two front heated oxygen sensors are mounted in the front tube well in front of the three-way catalytic (TWC) catalytic converter. Refer to the Graphic on the next page. The rear heated oxygen sensor is mounted after the three-way catalytic converter.

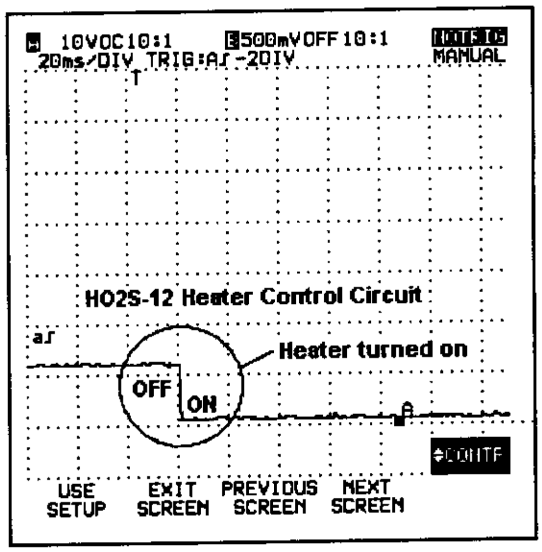
Oxygen Sensor Heaters
To stabilize their output signal, the oxygen sensors on this vehicle are equipped with an internal heater. The heater control circuits to the oxygen sensors are controlled by the PCM. *They are enabled at speeds below 3600 rpm and turned off at speeds above that.*

Lab Scope Test (HO2S Heater)

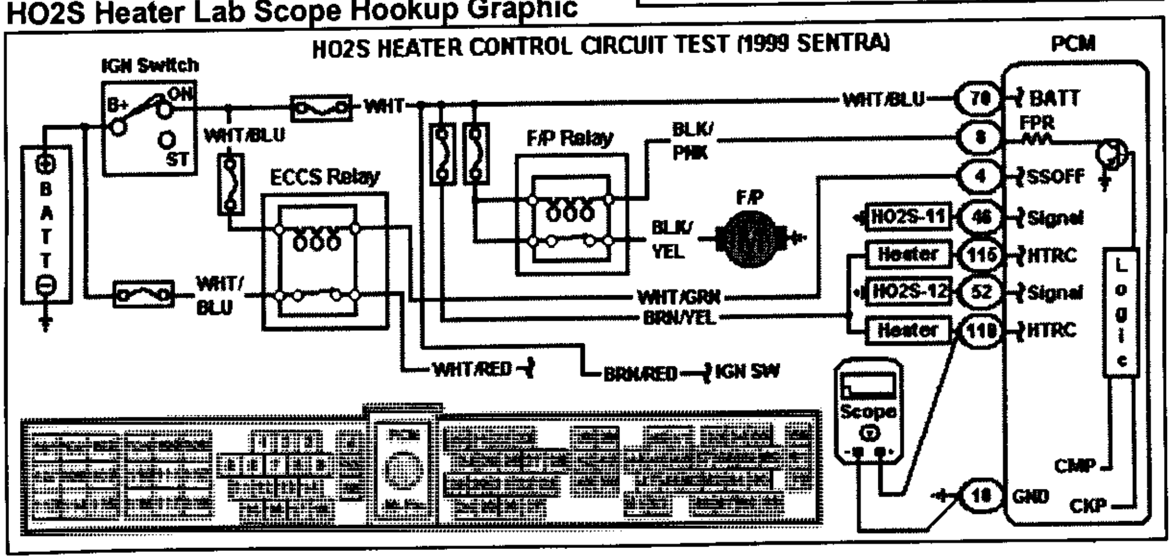
The Lab Scope (or a DVOM) can be used to monitor the operation of the both front and the rear oxygen sensor heater circuits.

Scope Connections
Connect the Channel 'A' positive probe to the rear HO2S-12 control circuit (RED/WHT wire) at Pin 110 of the PCM 88-Pin connector. Connect the negative probe to Pin 10 of the same connector or to the battery ground post.

Lab Scope Example Explanation
The trace in this example shows a known good HO2S-12 heater control signal after engine startup. Note the point in the circle where the rear HOS-12 heater circuit is enabled.



HO2S Heater Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Oxygen Sensor

Component Locations

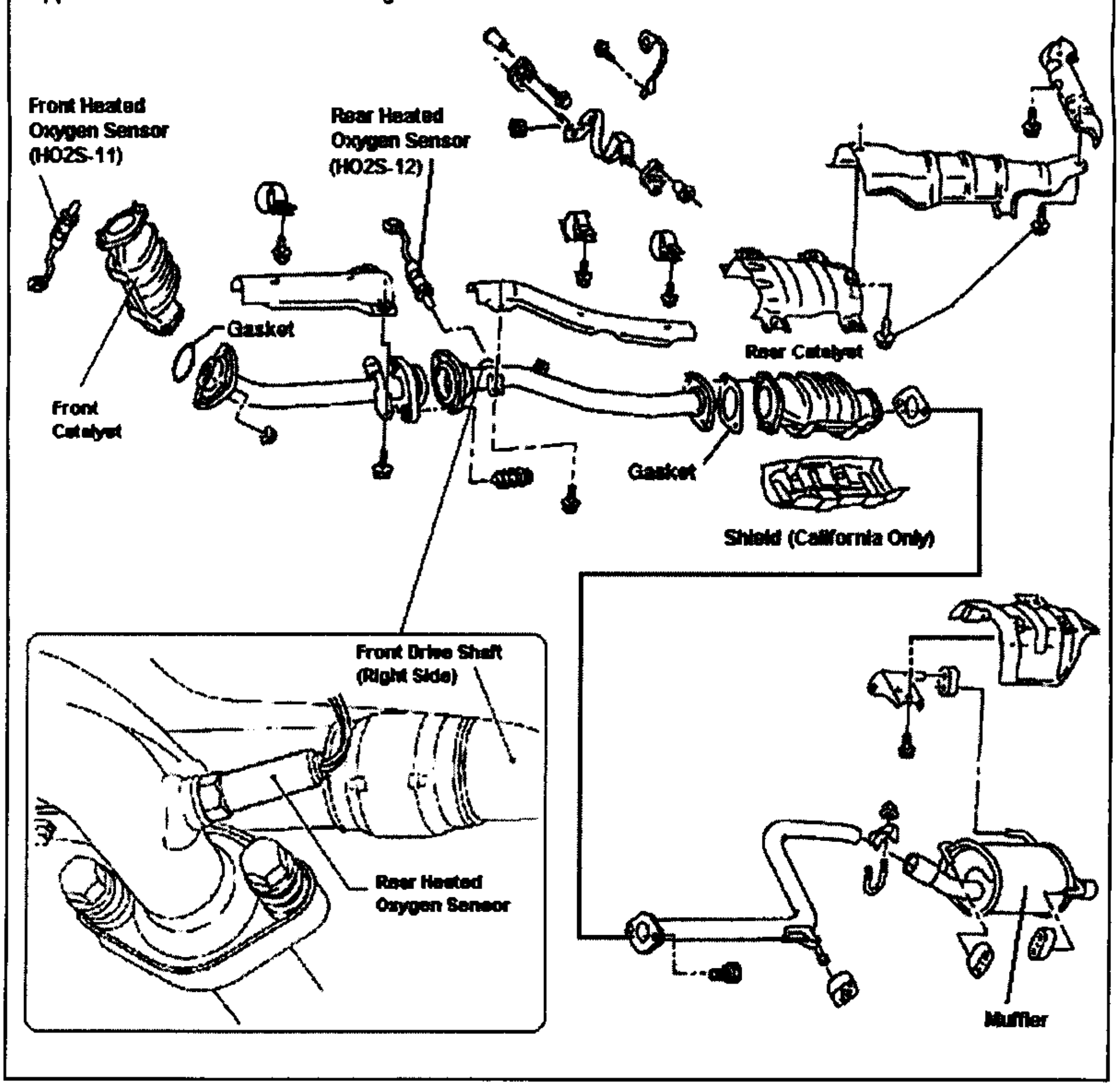
The mounting locations for the front and rear heated oxygen sensors are shown in the Graphic on this page. This engine application has two (2) catalytic converters.

Oxygen Sensor Identification

Note that the front heated oxygen sensor is identified with the acronym HO2S-11 and the rear heated oxygen sensor is identified with the acronym HO2S-12 in this Graphic.

HO2S Component Location Graphic

Application: 1999 Sentra 1.6L I4 Engine

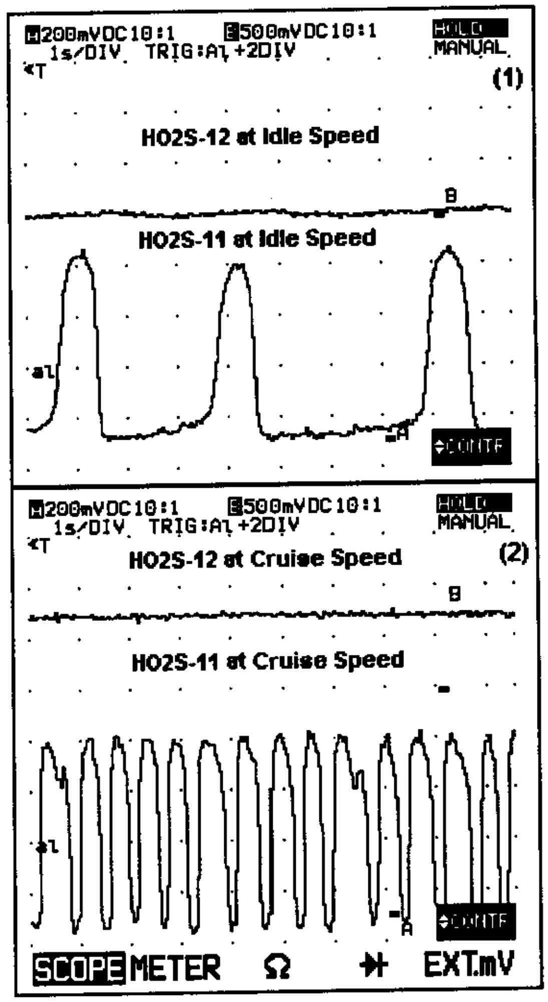


1999 SENTRA (1.6L I4 VIN A)

Oxygen Sensor

Lab Scope Test (HO2S Signal)

The Lab Scope is the tool of choice to monitor the operation of both the front and rear heated oxygen sensor signal circuits. Refer to the examples in the Graphic on this page.



Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (Example 1)

Connect the Channel 'A' positive probe front HO2S-11 signal at Pin 46 (WHT wire) of the 88-Pin connector. Connect the Channel 'A' negative probe to Pin 10 or to the battery negative ground post.

Connect the Channel 'B' positive probe to the rear HO2S-12 signal at Pin 52 (WHT wire).

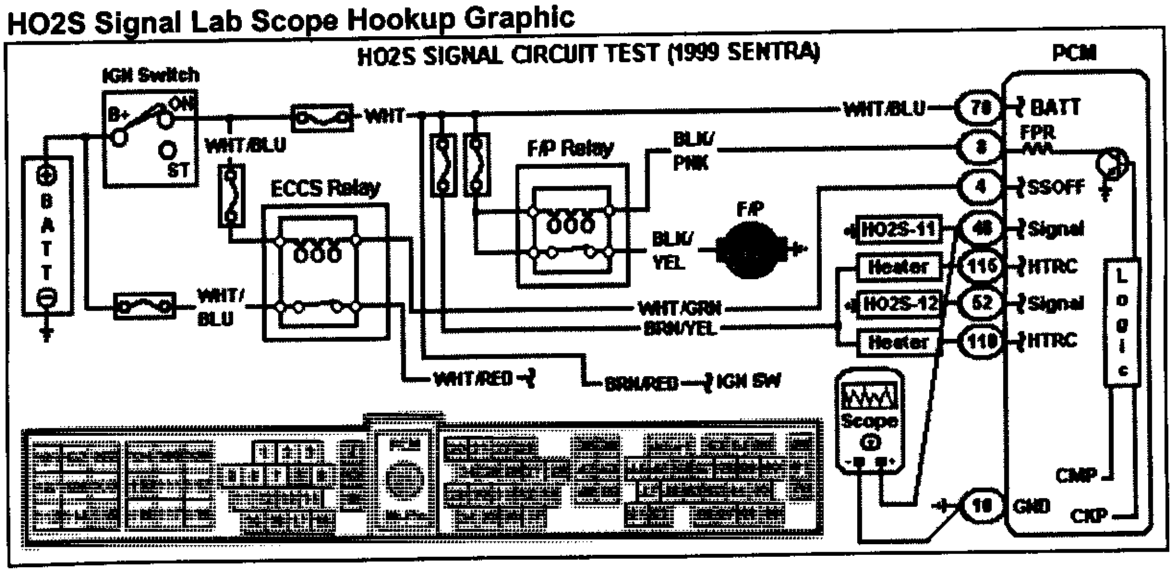
Scope Connections (Example 2)

Connect the Channel 'A' positive probe front HO2S-11 signal at Pin 46 (WHT wire) of the 88-Pin connector. Connect the Channel 'A' negative probe to Pin 10. Connect the Channel 'B' positive probe to the rear HO2S-12 signal at Pin 52 (WHT wire) of the same connector.

Lab Scope Example Explanations

The traces in the examples show known good HO2S-11 and HO2S-12 waveforms with the engine speed at idle (1) and Cruise speed (2). Note: When monitoring an oxygen sensor waveform, use a 10:1 probe if it is available.

HO2S Signal Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

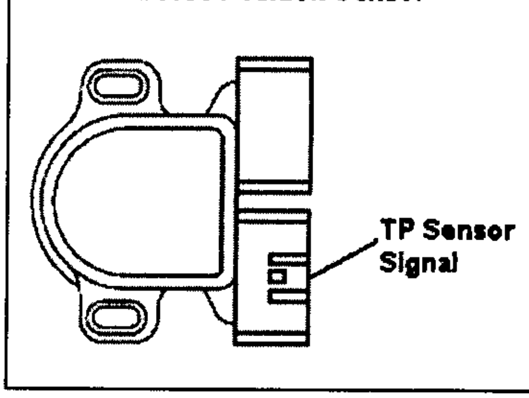
Throttle Position Sensor

General Description

The Throttle Position (TP) sensor is mounted to the throttle body where it detects the throttle valve angle. The three (3) circuits that connect the TP sensor are listed below:

- The Sensor Reference Voltage (5v) circuit
- The TP sensor signal circuit
- The Sensor Ground circuit

Throttle Position Sensor



Circuit Operation

With the throttle fully closed, the TP sensor signal is 0.35-0.65v at Pin 23 (YEL wire).

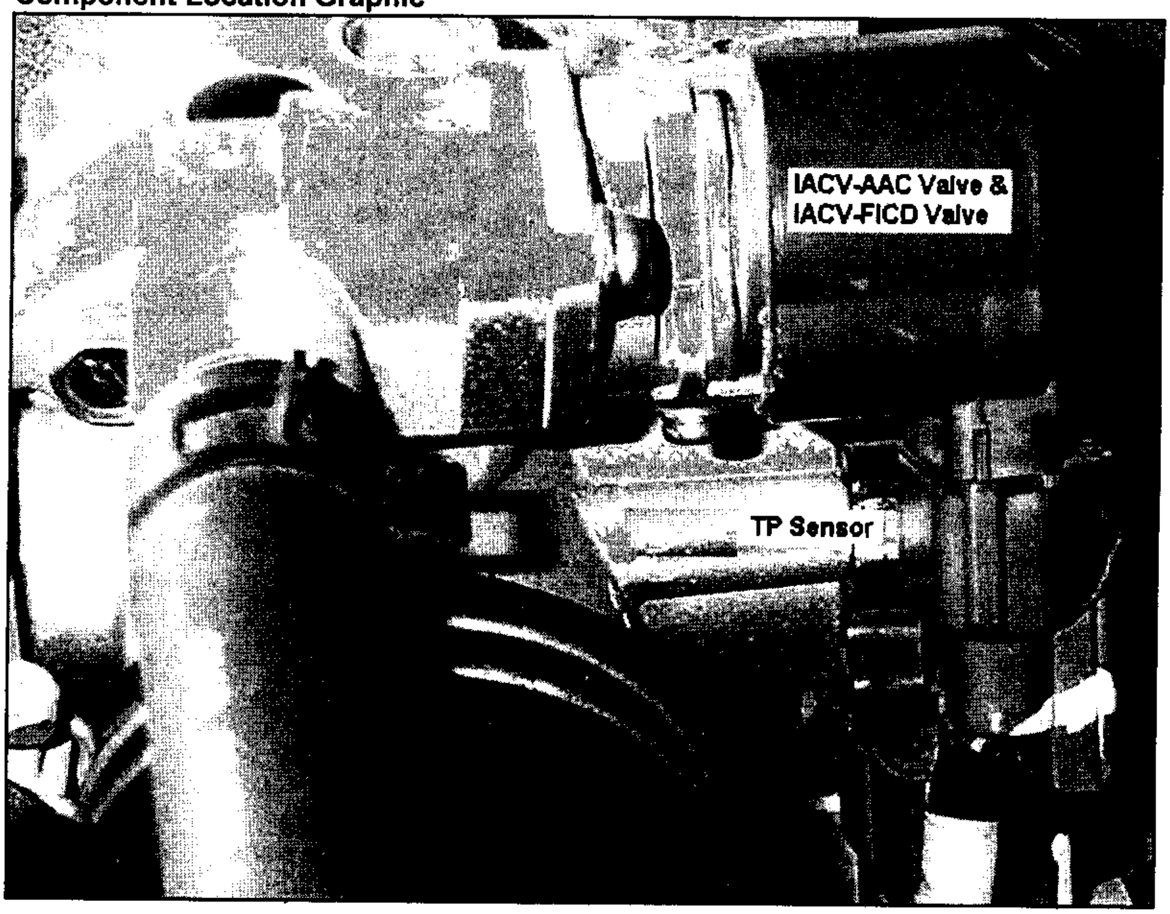
The TP sensor voltage increases in proportion to the throttle valve-opening angle. The TP sensor signal is from 3.2-4.9v at WOT.

The PCM uses the TP sensor signal to help calculate the Fuel Cut Control and to determine when to add additional fuel.

Throttle Position Switch

A throttle position switch is not used on this vehicle application.

Component Location Graphic

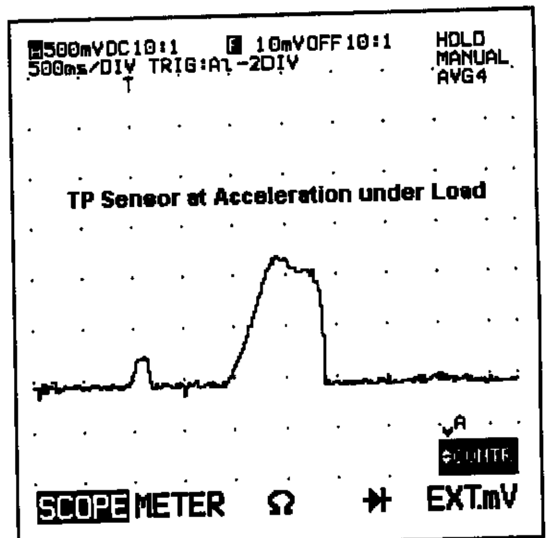


1999 SENTRA (1.6L I4 VIN A)

Throttle Position Sensor

Lab Scope Test (TP Sensor)

The Lab Scope can be used to test the operation of the TP sensor and its circuits, but is not the tool of choice for this device. The Scan Tool is a much easier tool to use to test the operation of this device. However, the Lab Scope will help find a circuit "glitch"



Scope Connections

Connect the Channel 'A' positive probe to the TP sensor signal (YEL wire) at Pin 23 of the 88-Pin connector.

Connect the Channel 'A' negative probe to the battery negative post or to Pin 50 (BLK wire) of same connector.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

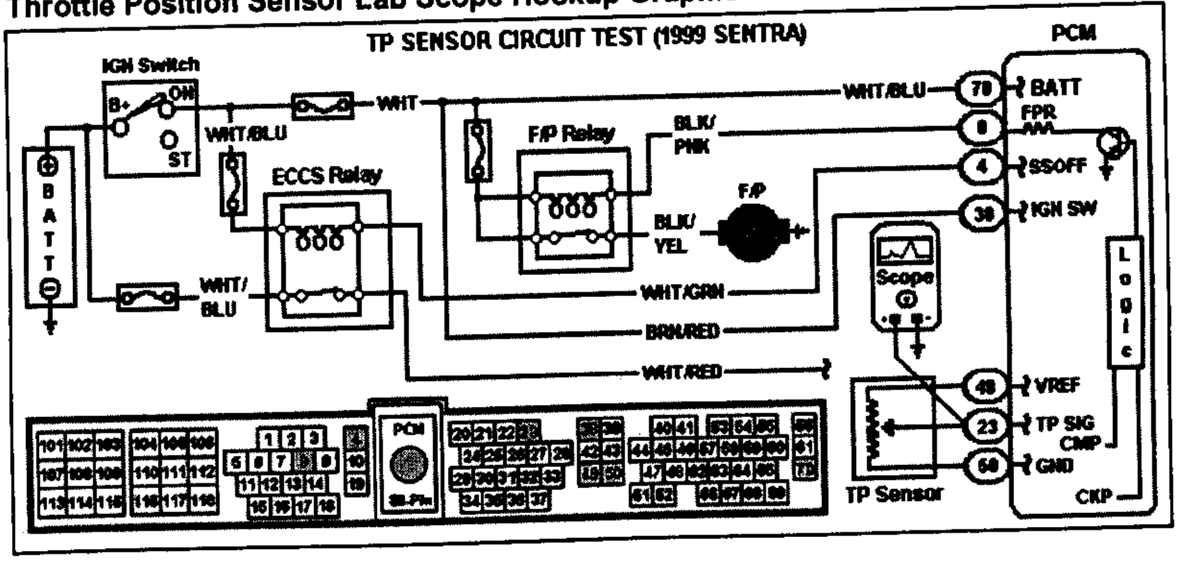
Lab Scope Example Explanation

In this example, the trace shows a known good TP sensor (analog signal) during a brief acceleration period during loaded mode (in gear with the Air Conditioning enabled).

The TP sensor signal should also be checked for breaks in the sensor resistor. One way to find this type of problem is to turn to key on, engine off and with the Lab Scope connected as shown in the Graphic below, slowly open and close the throttle while watching the TP sensor waveform for any sudden increase or decrease in the linear action of the pattern.

Any dropout (e.g., a sudden downward spike) in the TP sensor signal trace would indicate a short while a sudden upward spike would indicate an open circuit.

Throttle Position Sensor Lab Scope Hookup Graphic



1999 SENTRA (1.6L I4 VIN A)

Reference Information

How To Access & Use Generic PID Information

The Scan Tool Generic Parameter Identification (PID) Mode allows access to certain data values, analog and digital input and output signals, calculated values and system status information.

The Generic OBD II PID List contains examples of the PIDs that all OBD II compatible Scan Tools must be able to access and display.

Scan Tool PID Menus

An example of how to navigate through the SPX/OTC Scan Tool menus to locate the Generic PID information is shown in the Graphic to the right.

The Graphic contains twelve of the sixteen (16) engine related parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column are known good values at 30 mph.

If all of these PID values are within normal range, refer to Symptoms Diagnosis in Section 1 of this training manual.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete Generic PID list for this vehicle is shown in the Graphic.

(1) Scroll through the Computer menu and line up the symbol (>) with the desired choice (ENGINE/PCM).
(2) Scroll through the Transmission menu and line up the symbol (>) with the desired choice (AUTOMATIC).
(3) Scroll through the OBD II Main Menu and line up the symbol (>) with the desired choice (DATASTREAM).
(4) The ENGINE/PCM related PID list appears on the Scan Tool screen once DATASTREAM is selected.
(5) To select another function, back out of this screen to return to the OBD II Menu. Then select another function from the menu (e.g., Diagnostic Codes).

An example of the Generic PID list for this vehicle is shown in the next to last frame of this Graphic.

Diagnostic Tip

The Typical Values in the example on this page should be used after the following conditions are met:

- The Nissan ECCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral and in Closed Loop.
- The vehicle accessories are turned off.

***Note:** A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.*

SCAN TOOL MENUS

Computer?

Press:
>1 - ENGINE/PCM
3 - ABS
4 - AIRBAG

Transmission?

Press:
>1 - Automatic
2 - Manual

OBD II Menu

Press:
>1-Datastream
2-Diagnostic Codes
4-Record/Playback
5-Special Test
7-Monitor Setup

1-DATASTREAM

ENGINE SPEED	1550RPM
ECT (°)	189°F
VEHICLE SPEED	30MPH
IGN. TIMING	28°
ENGINE LOAD	49%
MAP (P)	17.7in.Hg
TPS (%)	5.4%
IAT (°)	97°F
FUEL STAT 1	CL
ST FT 1	+1.1%
LT FT 1	+1.4%
O2S B1 S1	0.380v
O2S B1 S2	0.720v

2-DIAGNOSTIC CODES

Press:
1 - DATASTREAM
>2 - TROUBLE CODES
6 - FREEZE FRAME
7 - PCM CONFLICTS

1999 SENTRA (1.6L I4 VIN A)

Reference Information

How To Access & Use OEM PID Information

The OEM PID list in this example contains engine related parameters available on the Scan Tool. The list is arranged in alphabetical order. The items under "Typical Value" represent known good readings for this engine.

If all of the PID values are within normal range, refer to Symptom Diagnosis in Section 1 of this training manual.

<u>Scan Tool PID Menus</u>

An example of how to navigate through the SPX/OTC Scan Tool menus to locate the OEM proprietary PID information is shown in the Graphic to the right.

The Graphic contains thirteen of the sixteen (16) engine related parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column are known good values at 55 mph.

If all of these PID values are within normal range, refer to Symptoms Diagnosis in Section 1 of this training manual.

<u>Parameter ID (PID) Information</u>

The proper sequence to follow to obtain a complete Generic PID list for this vehicle is shown in the Graphic.

(1) Scroll through the Computer menu and line up the symbol (>) with the desired choice (ENGINE/PCM).
(2) Scroll through the Transmission menu and line up the symbol (>) with the desired choice (AUTOMATIC).
(3) Scroll through the OBD II Main Menu and line up the symbol (>) with the desired choice (DATASTREAM).
(4) The ENGINE/PCM related PID list appears on the Scan Tool screen once DATASTREAM is selected.
(5) To select another function, back out of this screen to return to the OBD II Menu. Then select another function from the menu (e.g., Diagnostic Codes).

An example of the OEM proprietary PID list for this vehicle is shown in the next to last frame of this Graphic.

<u>Diagnostic Tip</u>

The Typical Values in the example on this page should be used after the following conditions are met:

- The Nissan ECCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral and in Closed Loop.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

Computer?

Press:
>1 - ENGINE/PCM
3 - ABS
4 - AIRBAG

Transmission?

Press:
>1 - Automatic
2 - Manual

OBD II Menu

Press:
> 1-Datastream
2-Diagnostic Codes
4-Record/Playback
5-Special Test
7-Monitor Setup

1-DATASTREAM

ENGINE SPEED	2225RPM
ECT (°)	188°F
VEHICLE SPEED	55MPH
IGN. TIMING	30.0°
ENGINE LOAD	65%
MAP (P)	22.7in.Hg
TPS (%)	14.1%
IAT (°)	75°F
FUEL STAT 1	CL
ST FT 1	+1.2%
LT FT 1	+1.4%
O2S B1 S1	0.380v
O2S B1 S2	0.720v

2-DIAGNOSTIC CODES

Press:
1 - DATASTREAM
>2 - TROUBLE CODES
6 - FREEZE FRAME
7 - PCM CONFLICTS

1999 SENTRA (1.6L I4 VIN A)

Reference Information

PCM PID Tables (available with a Nissan Consult Scan Tool)

***Note:** The following readings were obtained with the engine at idle speed, radiator hose hot, throttle closed, gear selector in Park and all accessories turned off.*

Serial Data Name	Range of Value	Hot Idle	30 MPH	55 MPH
ABSOL PRES/SE	0-5.1v	1.2v	1.8v	2.1v
ABSOL TH-P/S	0-100%	0.0	12.2	22.5
A/F ALPHA	0-5100%	N/A	N/A	56-155
AIR COND RLY	ON or OFF	OFF	OFF	OFF
AIR COND SIG	ON or OFF	OFF	OFF	OFF
Battery Voltage	0-25.5v	12-14	12-14	12-14
B/FUEL SCHDL	0-1,000 ms	1.1	1.4	1.6
CAL/LF VALUE	0-100%	20	49	65
CLSD THL/P SW	ON or OFF	ON	OFF	OFF
CMPS-RPM (REF)	0-10,000 Hz	650	1440	2250
COOLING FAN	ON or OFF	OFF	OFF	OFF
ECT Sensor	-40 to 304°F	190	189	188
EGRC SOL/V	ON or OFF	OFF	OFF	OFF
EGR Temp. Sensor	0-5.1v	1.3v	1.8v	2.1v
Engine Speed	0-10,000 rpm	812	1550	2225
EVAP SYS PRESS	0-5.1v	3.4v	3.4v	3.4v
FUEL PUMP RLY	ON or OFF	ON	ON	ON
Heater Fan Signal	ON or OFF	OFF	OFF	OFF
HO2S-11 (front)	0-1100 millivolts	330 mv	780 mv	220 mv
HO2S-12 (rear)	0-1100 millivolts	480 mv	660 mv	660 mv
HO2S-11 HTR (front)	ON or OFF	ON	ON	ON
HO2S-12 HTR (rear)	ON or OFF	ON	ON	ON
HO2S Monitor (both)	LEAN or RICH	LEAN	RICH	LEAN
IACV-AACV	0-100%	20-60	---	---
IAT Sensor	-40 to 304°F	113	97	75
Ignition Switch	ON or OFF	ON	ON	ON
Ignition Timing	0-99°	6	28	30
Injector Pulse	0-999.9 ms	2.8	3.1	3.2
INT/V TIM SOL	ON or OFF	OFF	OFF	OFF
Load Signal	ON or OFF	OFF	OFF	OFF
MAP (Pressure)	0-30" Hg	9.6	17.7	22.7
MAS AIR/FL SE	0-5.1v	1.10v	1.18v	1.35v
MASS AIRFLOW	0-1,000 gm/s	2.7	9.03	19.52
PNP SW/CIRC	ON or OFF	ON	OFF	OFF
PURG CONT S/V	ON or OFF	OFF	OFF	ON
PURG VOL C/V	ON or OFF	OFF	OFF	OFF
PW/ST Signal	ON or OFF	OFF	OFF	OFF
Starter Switch	ON or OFF	OFF	OFF	OFF
TP Sensor	0-100%	0.0	5.4	14.1
TCC SOL/V	ON or OFF	OFF	OFF	ON
Vehicle Speed (mph)	0-255	0	30	55
VC/V BYPASS/V	ON or OFF	OFF	OFF	OFF
VENT CONT/V	ON or OFF	OFF	OFF	OFF

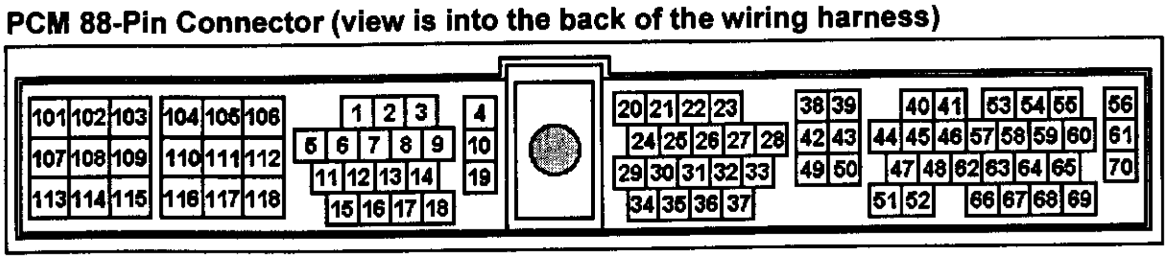
1999 SENTRA (1.6L I4 VIN A)

PCM Pin Voltage Tables

Pin Voltage Table for the PCM 88-Pin Connector

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
1	WHT/RED	Ignition Control Signal	Pulse signals
2	GRY/RED	Ignition Check Signal	Pulse signals
3	BLU/ORN	Tachometer	Digital signals (average: 7v)
4	WHT/GRN	ECCS Relay Control (self shutoff)	Relay On: 1v, Off: 12v
5	BLU	EVAP Purge Volume Control Sol.	0.4v
6	GRN	EVAP Purge Volume Control Sol.	0.4v
7	---	Not Used	---
8	BLK/PNK	Fuel Pump Relay Control	Relay On: <1v, Off: 12v
9	---	Not Used	---
10	BLK	ECCS Power Ground	<0.1v
11-12	---	Not Used	----
13 (A/T)	LT GRN	High Speed Cooling Fan Control	Fan On: <1v, Off: 12v
14	LT GRN/RED	Low Speed Cooling Fan Control	Fan On: <1v, Off: 12v
15	GRN/YEL	Air Conditioner Relay	Relay On: <1v, Off: 12v
16	YEL	EVAP Purge Volume Control Sol.	12-14v
17	ORN	EVAP Purge Volume Control Sol.	12-14v
18	ORN/YEL	MIL (lamp) Control	Lamp On: 1v, Off: 12v
19	BLK	ECCS Power Ground	<0.1v
20	BLK/YEL	Starter Signal	KOEC: 9-11v
21	BLU/WHT	Air Conditioner Switch Signal	A/C & Blower On: 0v, Off: 12v
22	GRN/ORN	Park Neutral Switch	A/T: In 'P' or 'N': 0v, Others: 12v
23	YEL	Throttle Position Sensor	0.35-0.65v
24	LG/BLK	Blower Switch Signal	Switch On: 0v, Off: 12v
25	LT BLU	Power Steering Switch	Wheel straight: 0v, Turning: 5v
26	PPL/RED	Vehicle Speed Sensor Signal	Digital signal: 0-5-0-5v
27, 29	---	Not Used	---
28	RED/YEL	Intake Air Temperature Sensor	1.3v (varies with air temp.)
30	PNK/BLK	Torque Converter Clutch Valve	0v (at over 40 mph in 'D': 12v)
31-37	---	Not Used	---
38	BLK/RED	Ignition Switch Feed	12-14v
39	BLK	ECCS Power Ground	<0.1v
40	BLU	Camshaft Position Sensor (REF)	0.1-0.4v
41	BLK/WHT	Camshaft Position Sensor (POS)	Digital Signal: 0-5-0-5v
42	PPL/WHT	IACV-AAC Valve	Pulse Signals
43	BLK	ECCS Power Ground	<0.1v
44	BLU	Camshaft Position Sensor (REF)	0.1-0.4v
45	---	Not Used	---
46	WHT	Front HO2S-11 Sensor Signal	0-1.0v (varies)
47	GRN	MAF Sensor Signal (QA+)	1.0-1.1v

PCM 88-Pin Connector (view is into the back of the wiring harness)



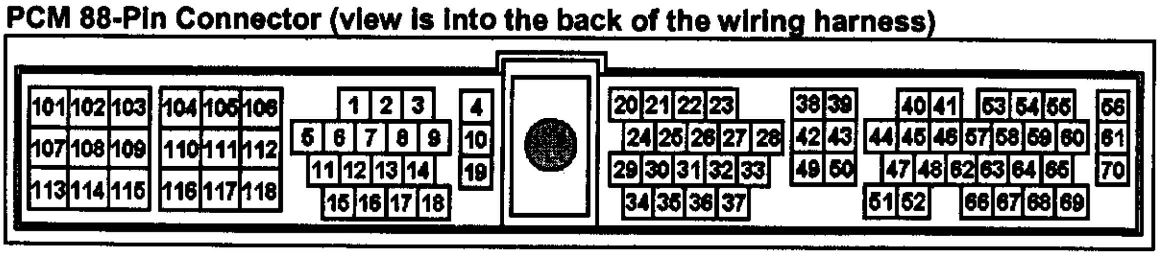
1999 SENTRA (1.6L I4 VIN A)

PCM Pin Voltage Tables

Pin Voltage Table for the PCM 88-Pin Connector

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
48	RED	MAF Sensor Ground (QA-)	<0.050v
49	PNK/BLU	Sensor Reference Voltage	4.9-5.1v
50	BLK	Sensor Ground	<0.050v
51	BRN/YEL	Engine Coolant Temp. Sensor	0.6v (varies with engine temp.)
52	WHT	Rear HO2S-12 Sensor Signal	0-1.0v (varies)
53	WHT	Crankshaft Position Sensor	Pulse Signals (0.3v AC)
54	WHT	Knock Sensor	2.0-3.0v
55	BLU/RED	Rear Window Defroster Signal	Switch On: 12v, Off: 0v
56	WHT/RED	PCM Ignition Feed	12-14v
57	---	Not Used	---
58	BLU/BLK	OBD II Signal to DLC	6-10v
59	---	Not Used	---
60	RED/BLU	Headlamp Switch Signal	Switch On: 12v, Off: 0v
61	WHT/RED	PCM Ignition Feed	12-14v
62	RED/BLK	EGR Temperature Sensor Signal	Less than 4.5v
63	LT GRN/RED	Fuel Tank Temperature Sensor	0-4.8v (varies with temperature)
64	GRN/BLK	Data Link Connector for Consult	0v
65	GRY/BLU	Data Link Connector for Consult	4-9v
66	W	Absolute Pressure (MAP) Sensor	1.4v (KOEO: 4.3v)
67	WHT	EVAP Pressure Sensor Signal	3.4v
68	GRN/WHT	Data Link Connector for Consult	3.5v
69	GRY/RED	MAP/BARO Switch Solenoid	12-14v (5 sec's after startup: 0v)
70	WHT/BLU	Power Supply (Keep Alive Power)	12-14v
101	LT BLU	IACV-AAC Valve Open Signal	Pulse signals
102	RED/BLK	Injector No. 1 Control Signal	3.0 ms
103	PNK	EGRC Solenoid Control	Hot Idle: 12v, at 2000 rpm: 1v
104	GRN/BLK	Injector No. 3 Control Signal	3.0 ms
105	PPL	EVAP Purge Control Valve	Hot Idle: 12v, at 2000 rpm: 1v
106	BLK	ECCS Power Ground	<0.1v
107	YEL/BLU	Injector No. 2 Control Signal	3.0 ms
108	PPL/WHT	EVAP Vent Control Valve	12-14v
109	BLU/BLK	Injector No. 4 Control Signal	3.0 ms
110	RED/WHT	Rear HO2S-12 Heater Control	1v (above 3200 rpm: 12v)
111, 113, 116	---	Not Used	---
112	BLK	ECCS Power Ground	<0.1v
114	YEL/RED	Intake Valve Timing Control Sol.	12-14v (above 2000 rpm: 1v)
115	ORN	Front HO2S-11 Heater Control	1v (above 3200 rpm: 12v)
117	PPL/RED	Vacuum Cut Valve Bypass Sol.	12-14v
118	BLK	ECCS Power Ground	<0.1v

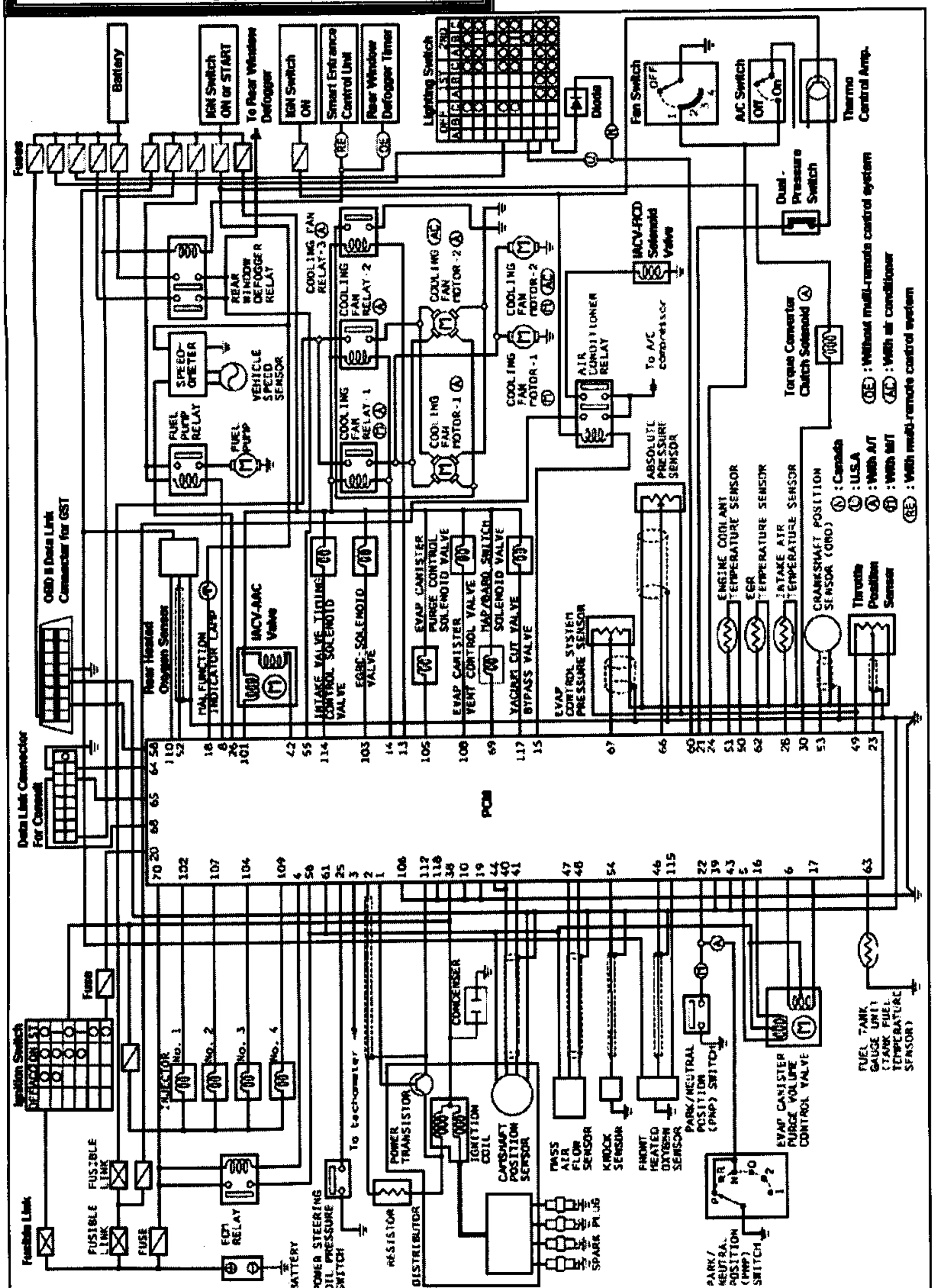
PCM 88-Pin Connector (view is into the back of the wiring harness)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

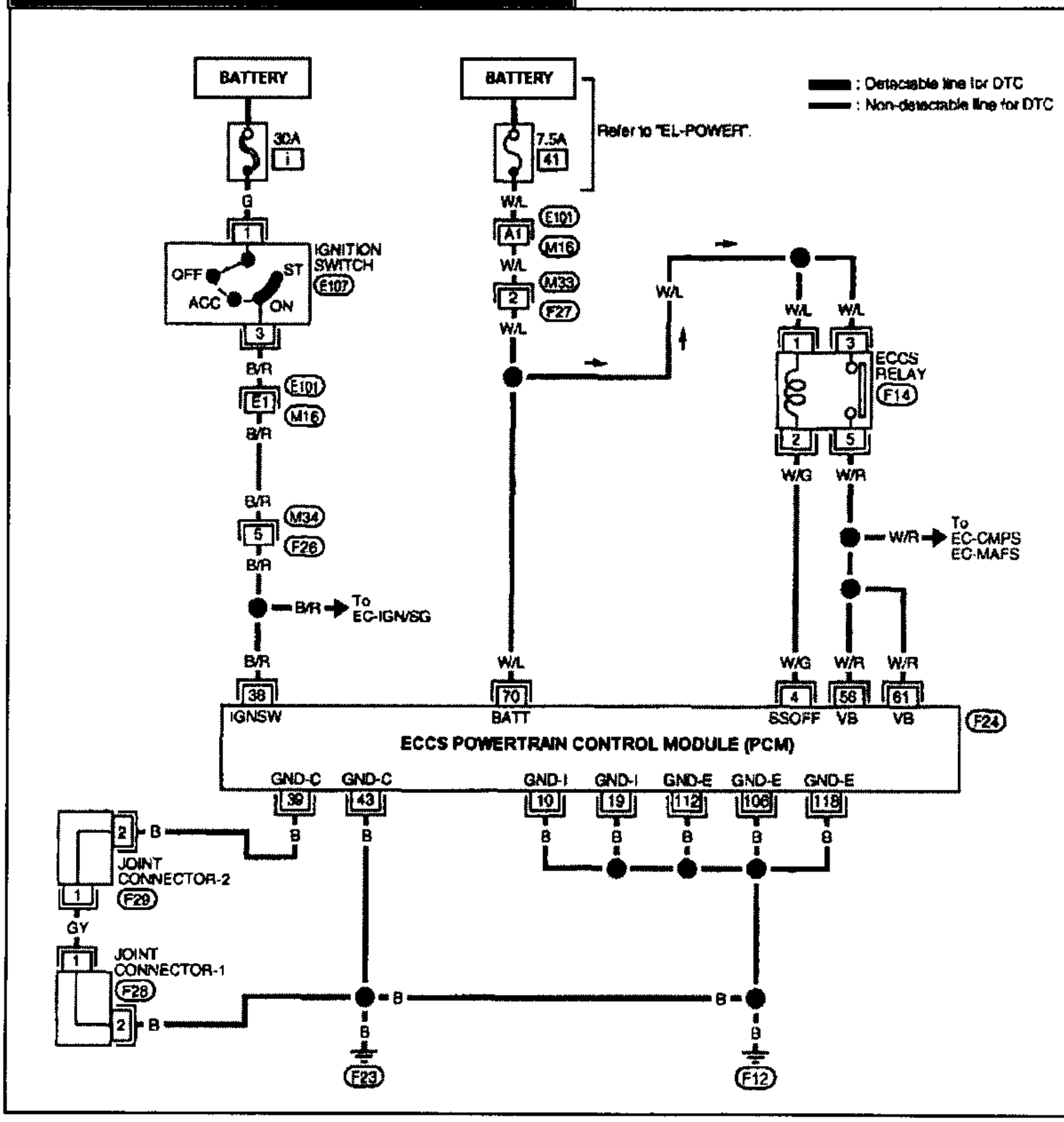
ECCS PCM Wiring (1 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

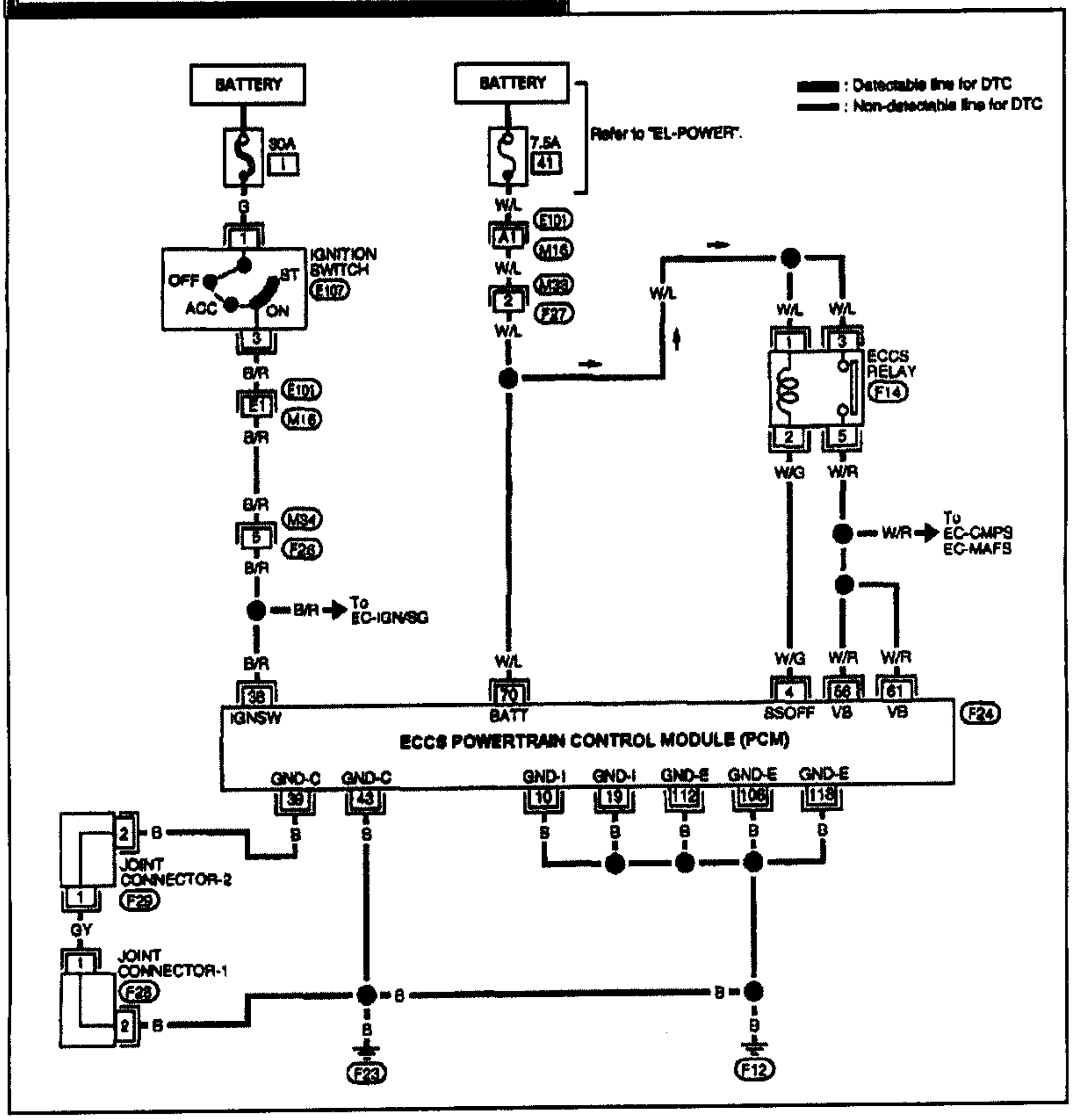
ECCS Main Relay (2 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

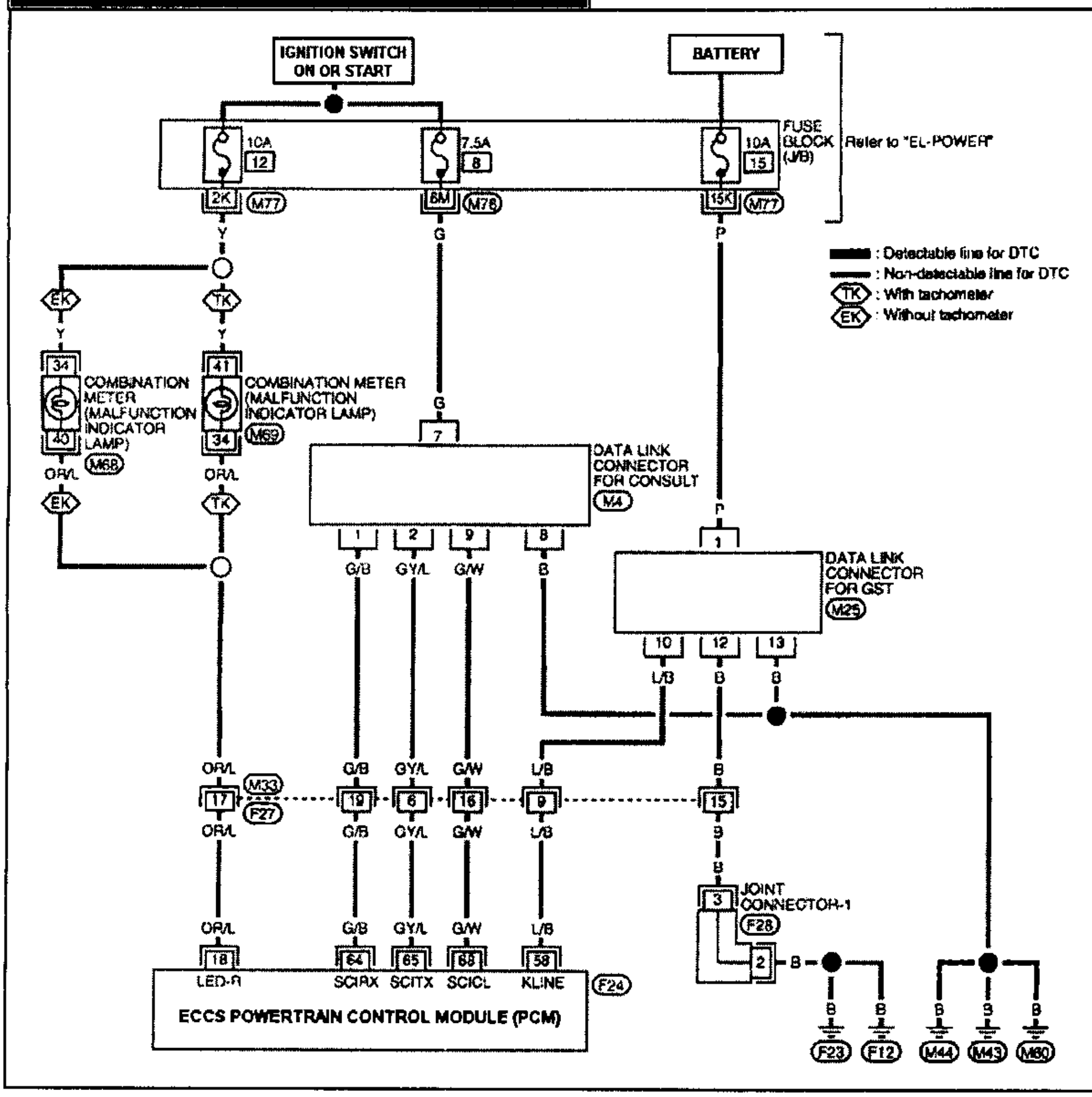
ECCS Power Grounds (3 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

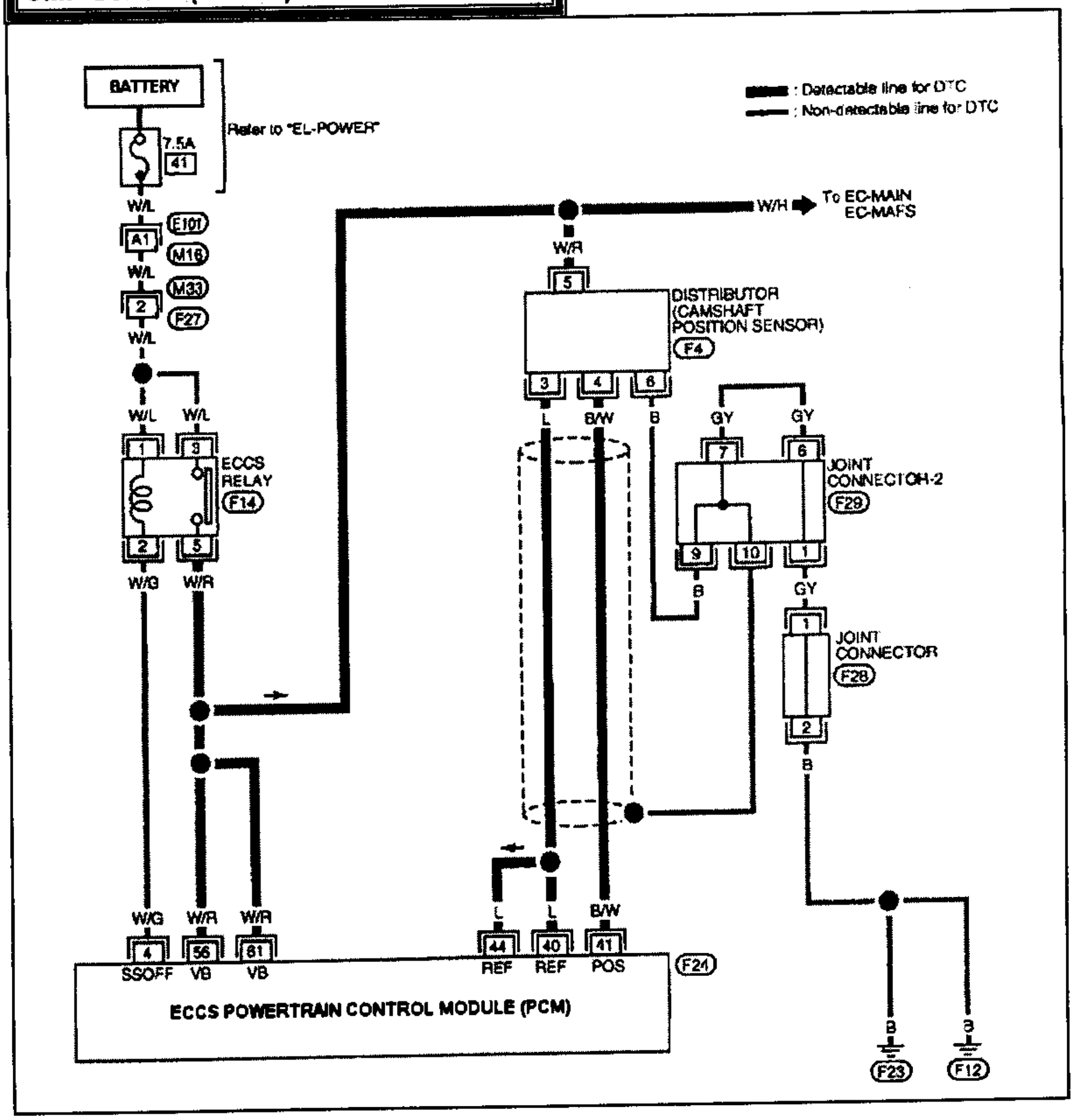
MIL & Data Link Connector (4 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

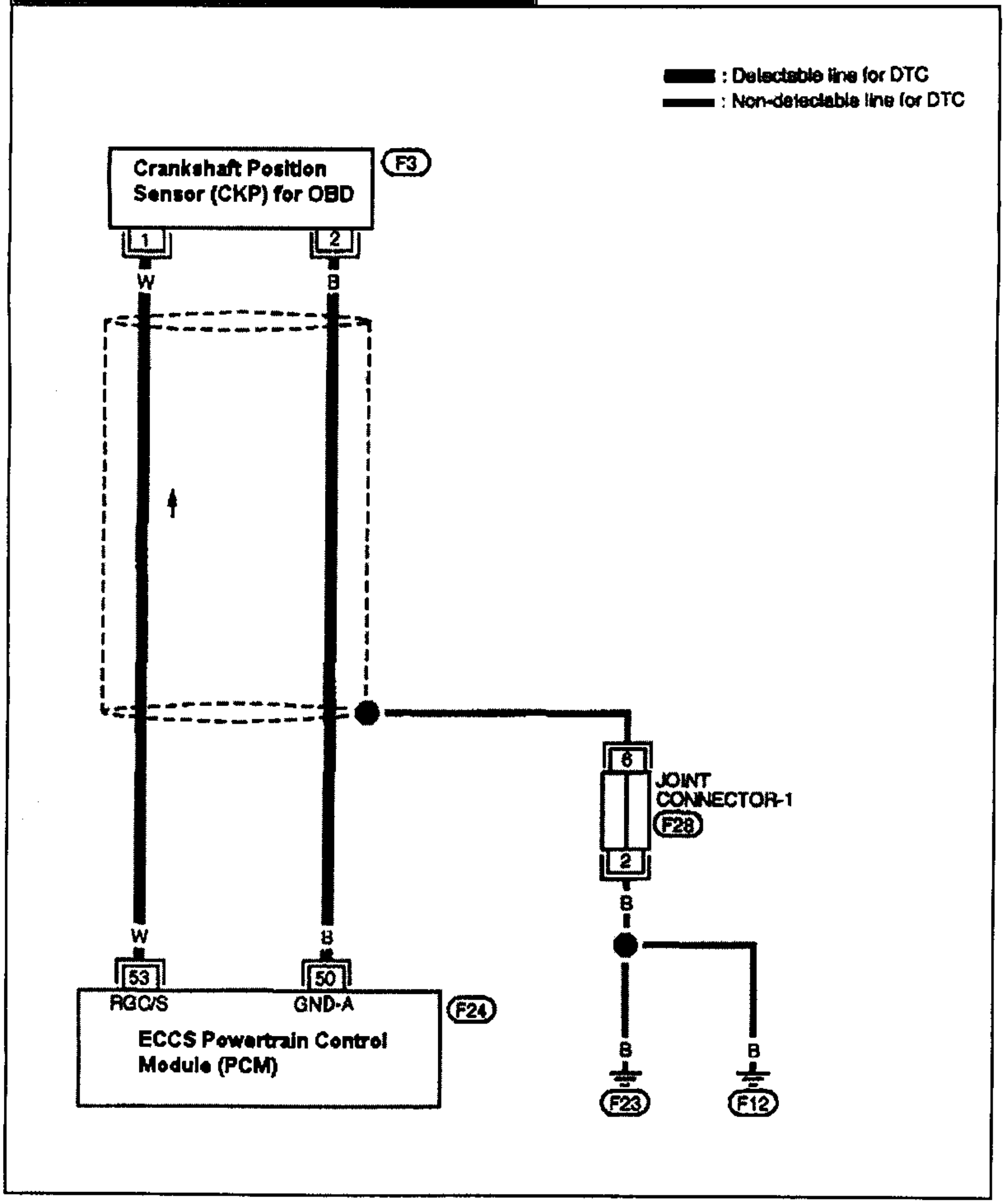
CMP Sensor (5 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

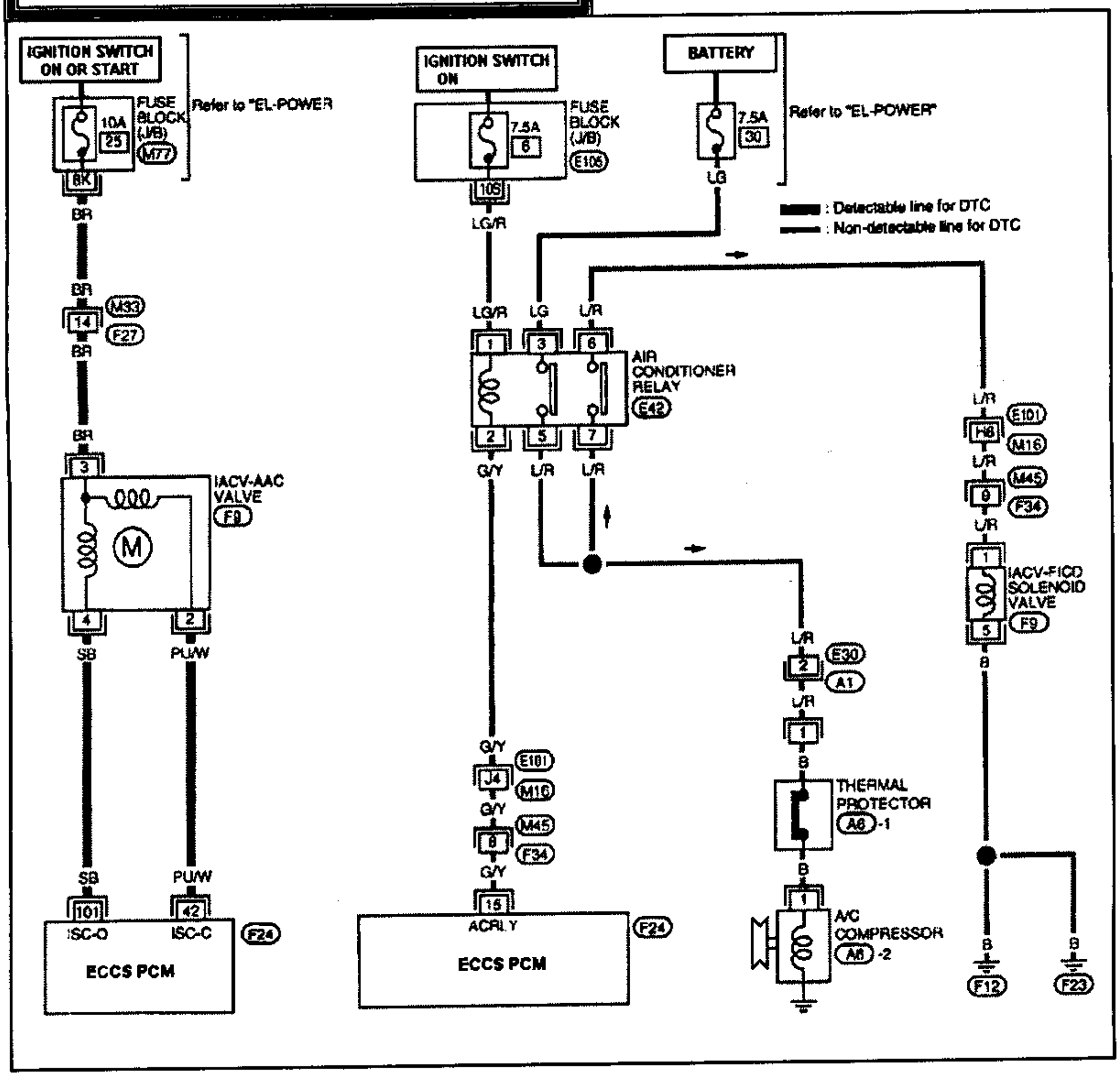
CKP Sensor (6 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

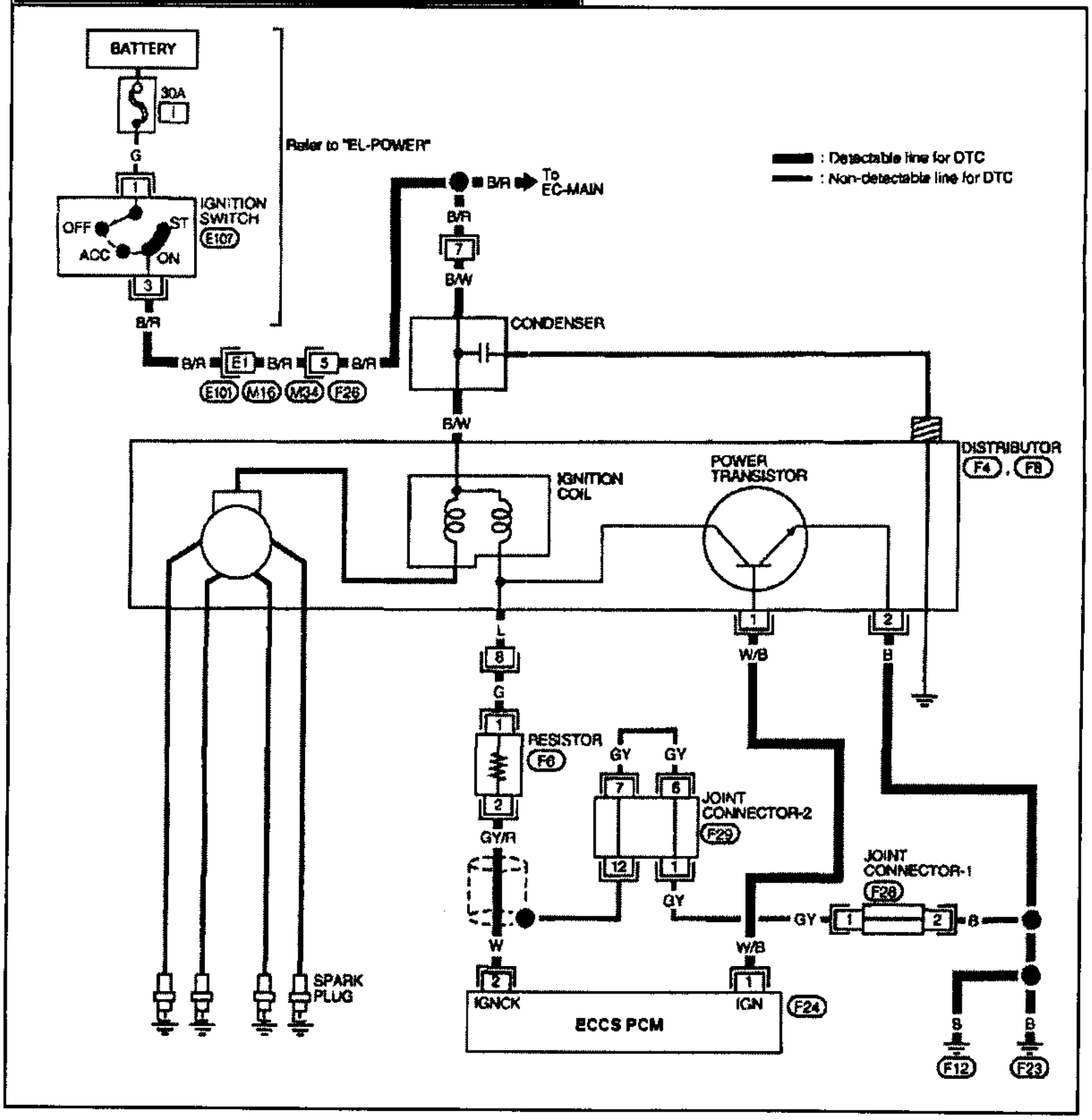
IACV-AAC & IACV-FICD Valve (7 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

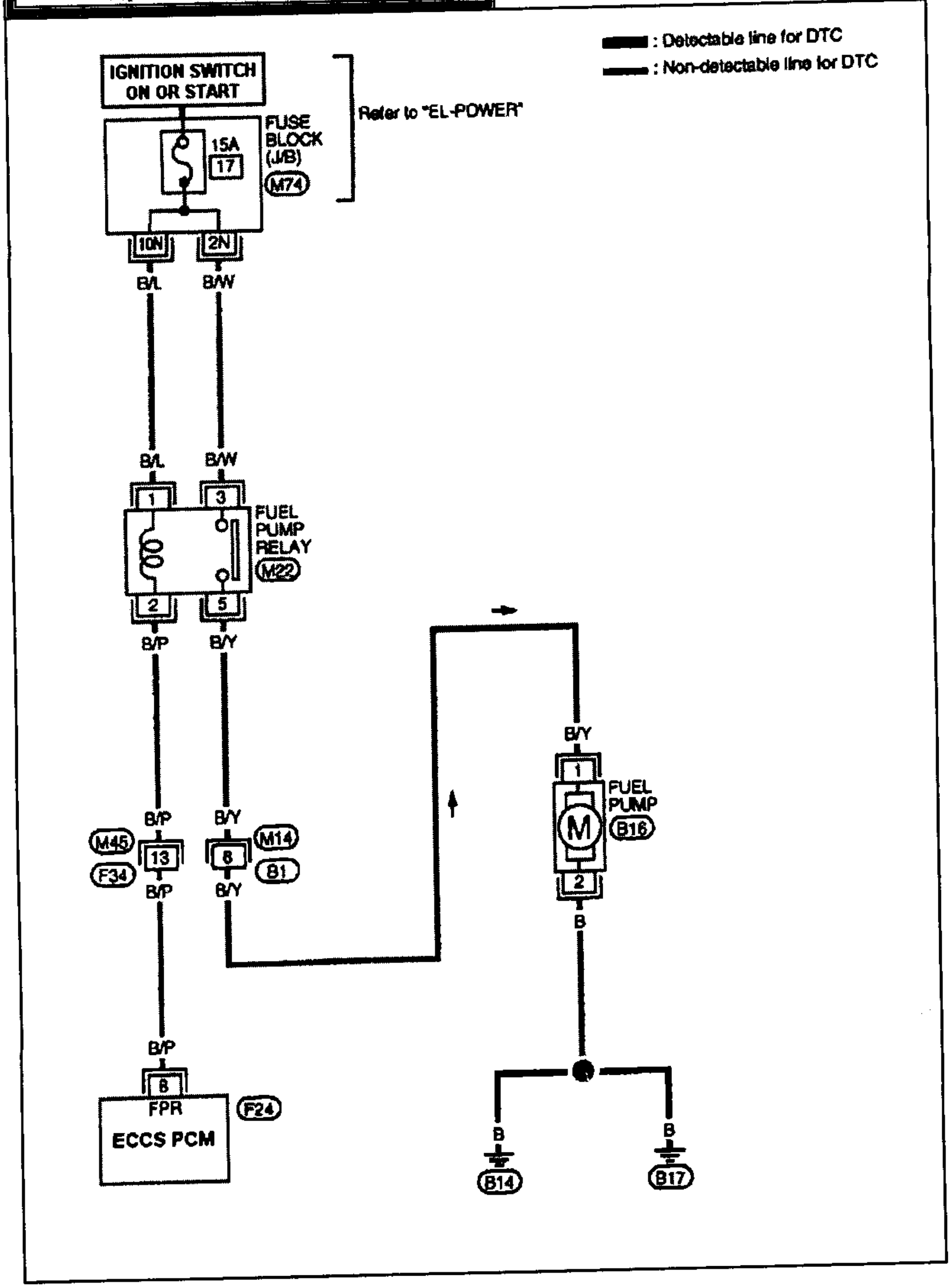
Ignition System (8 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

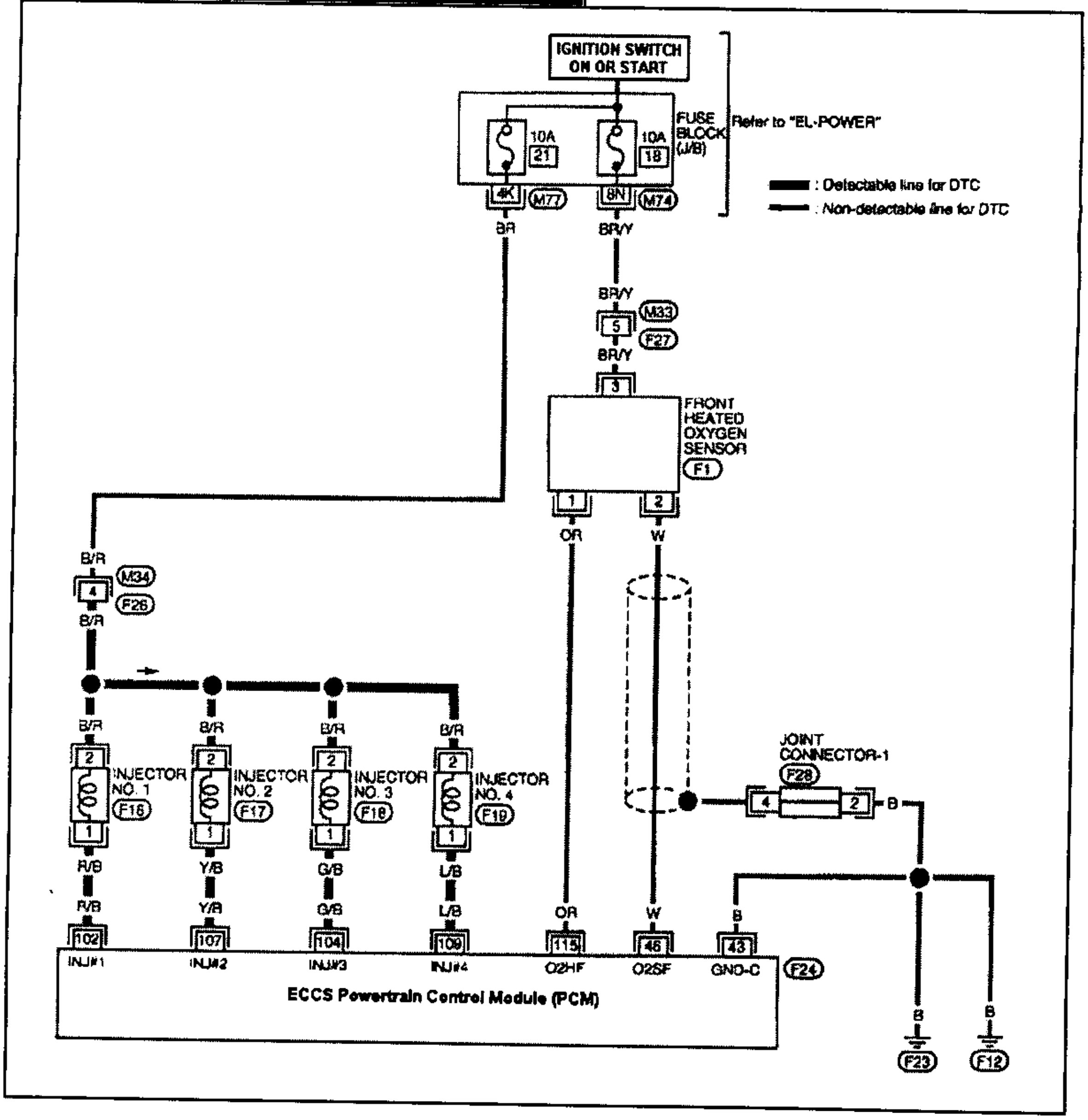
Fuel Pump Control (9 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

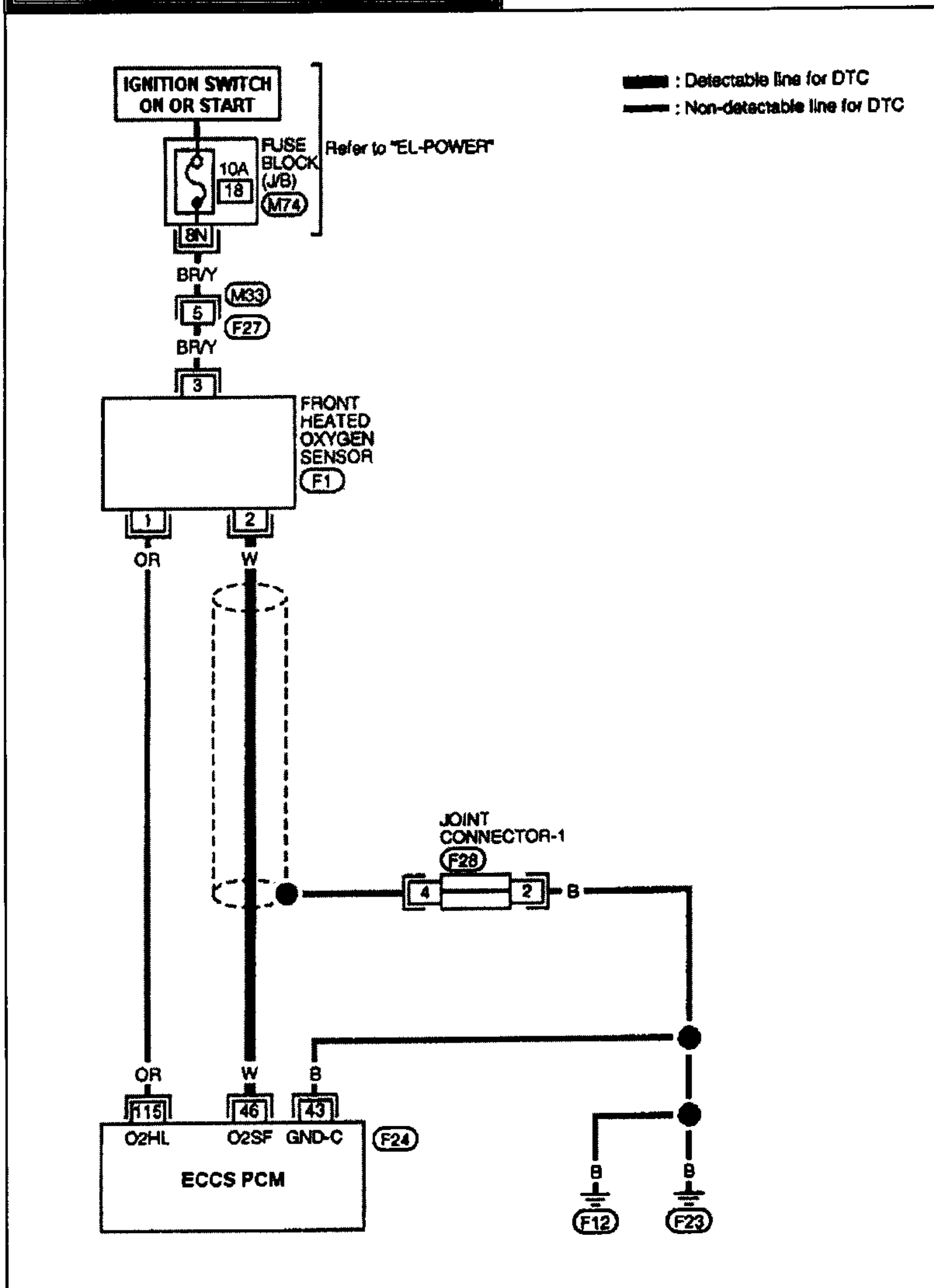
Fuel Injectors (10 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

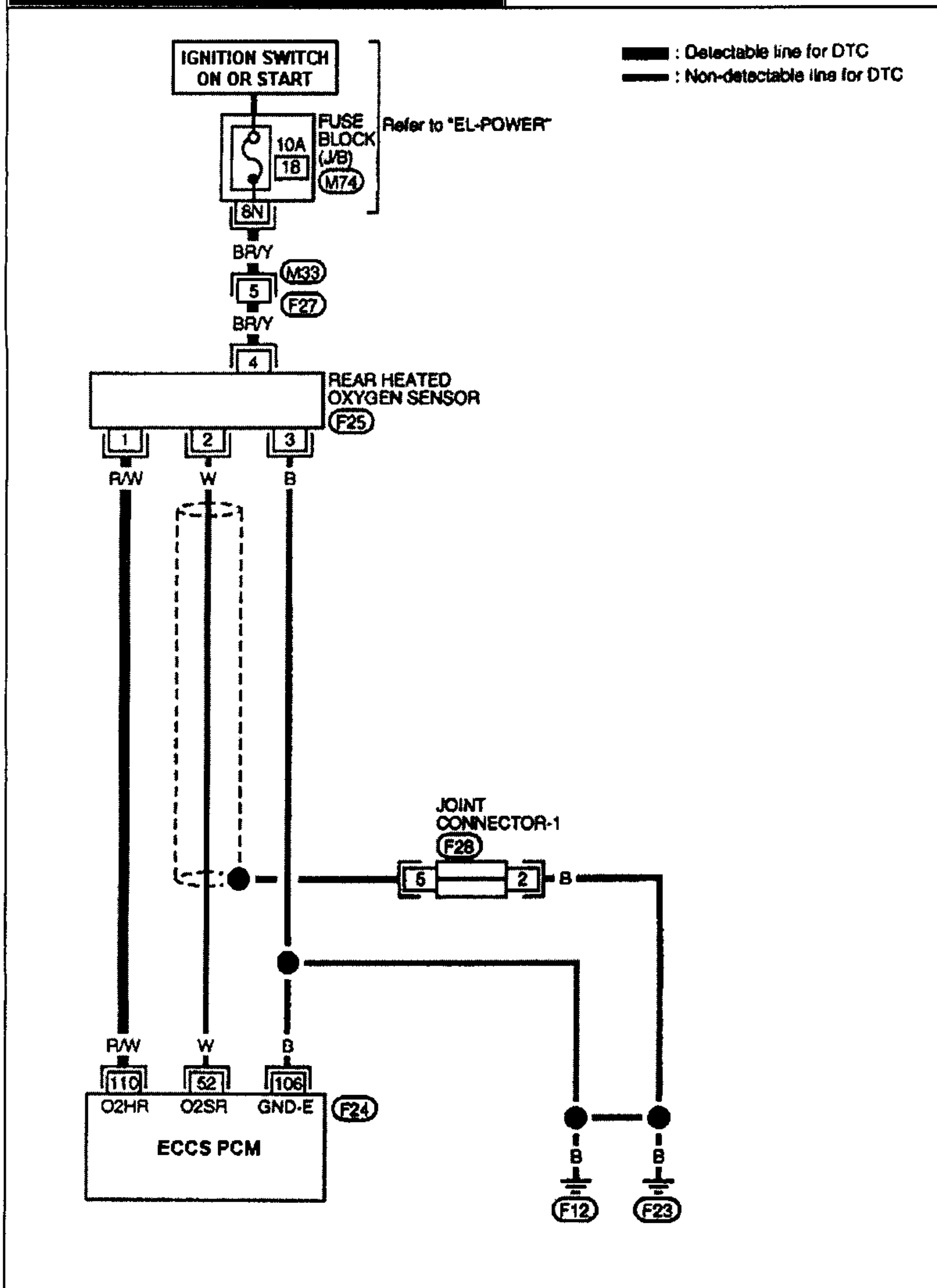
Front Heated Oxygen Sensor (11 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

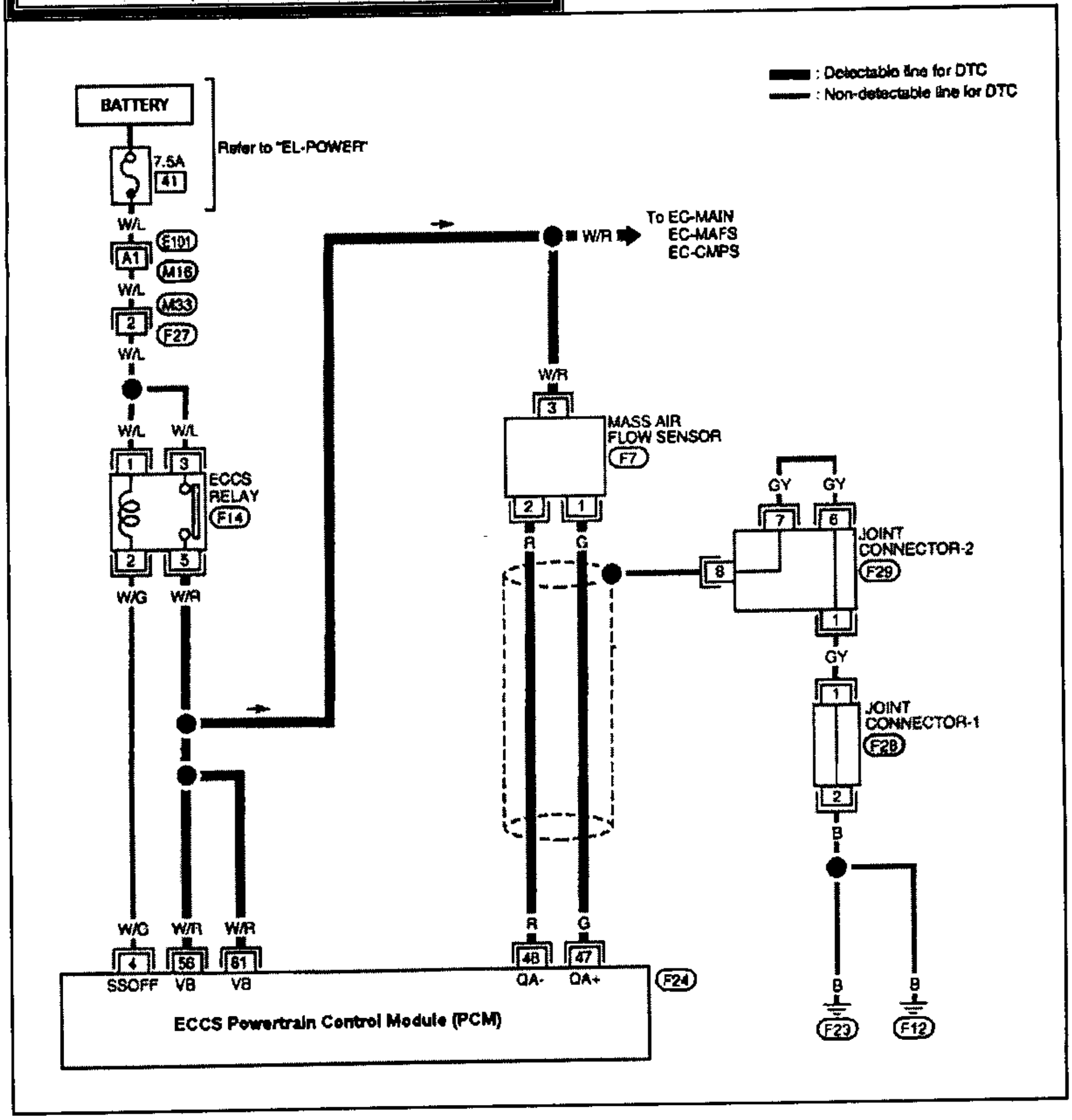
Front Heated Oxygen Sensor (12 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

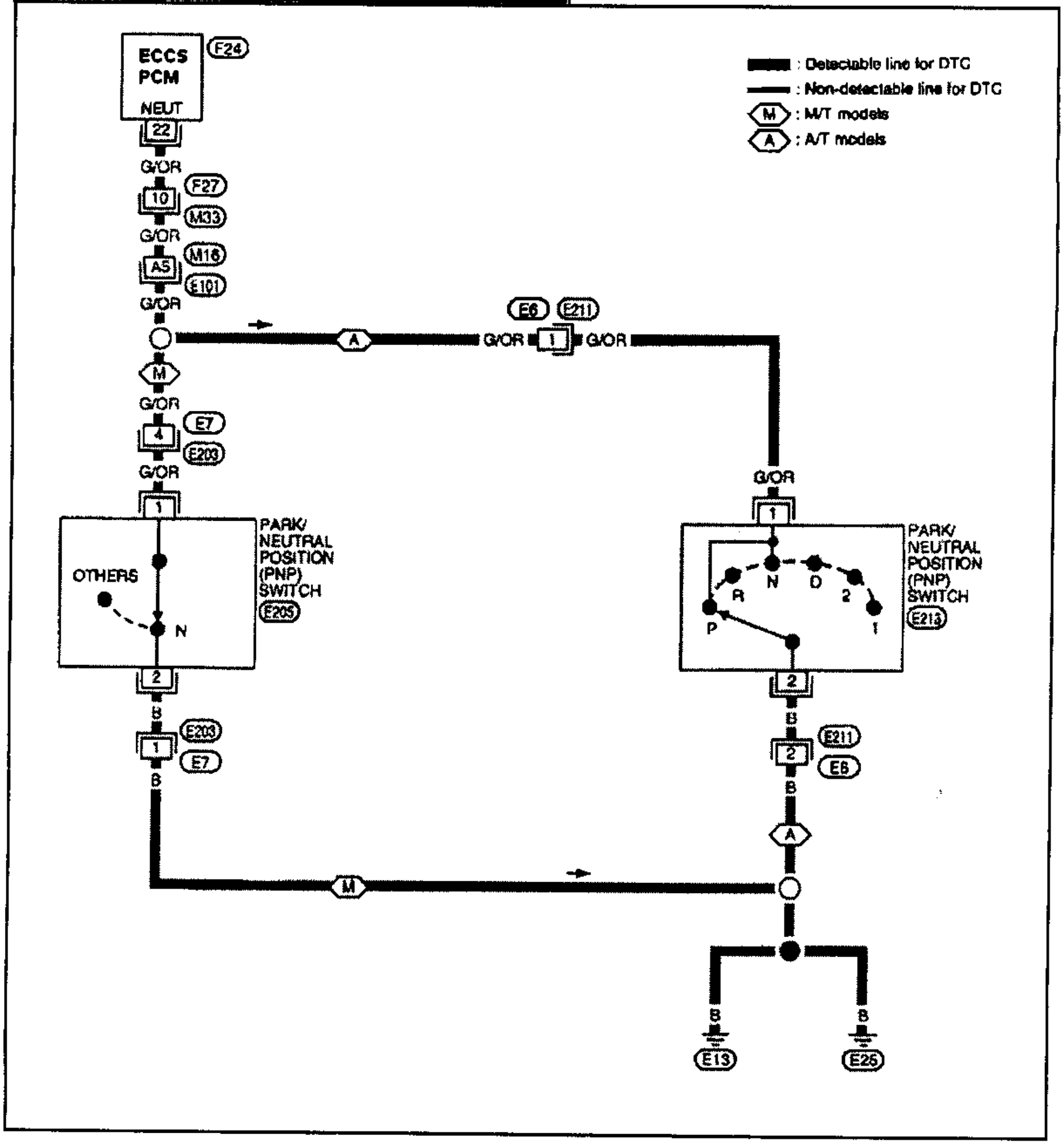
MAF Sensor (13 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

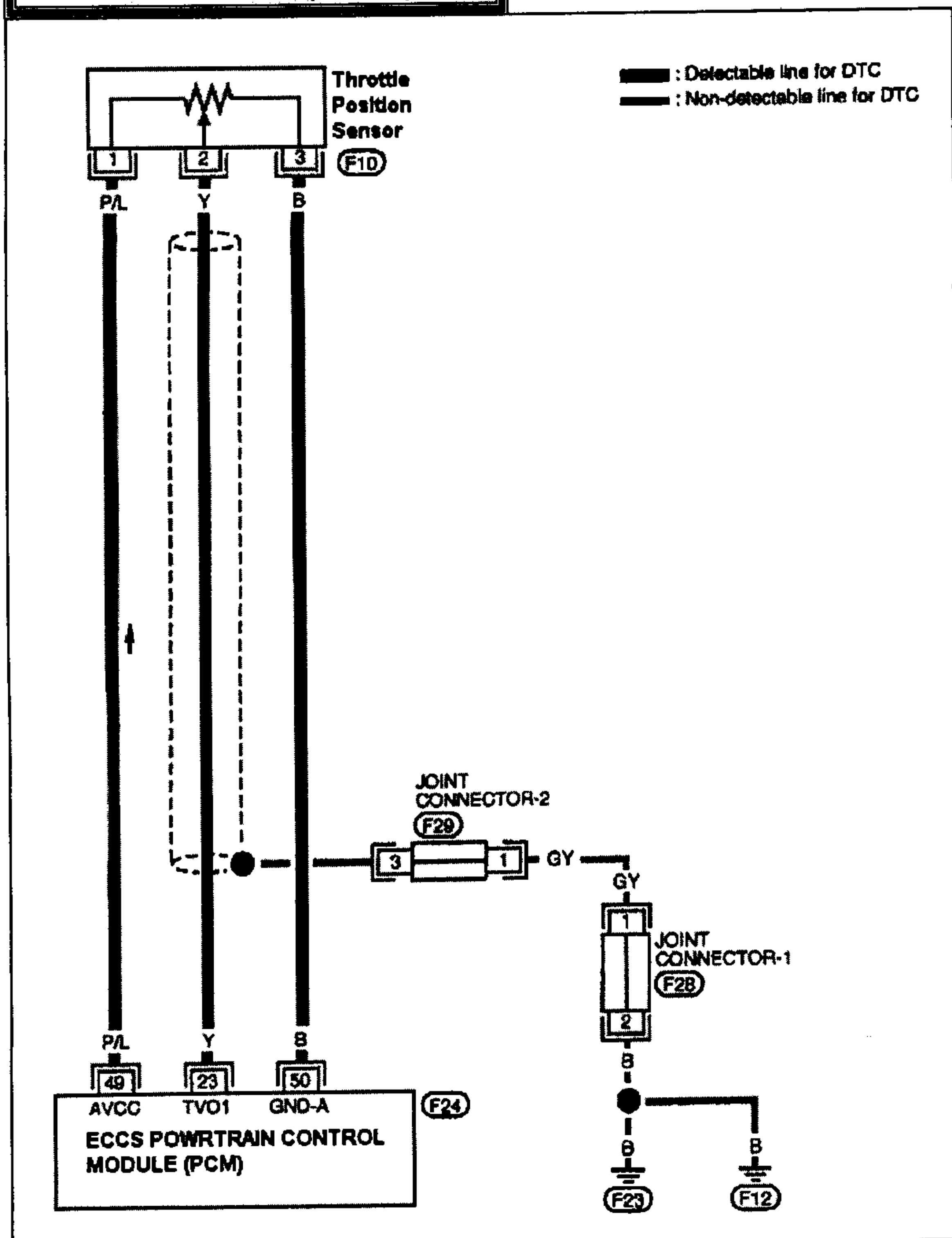
Park Neutral Position Switch (14 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

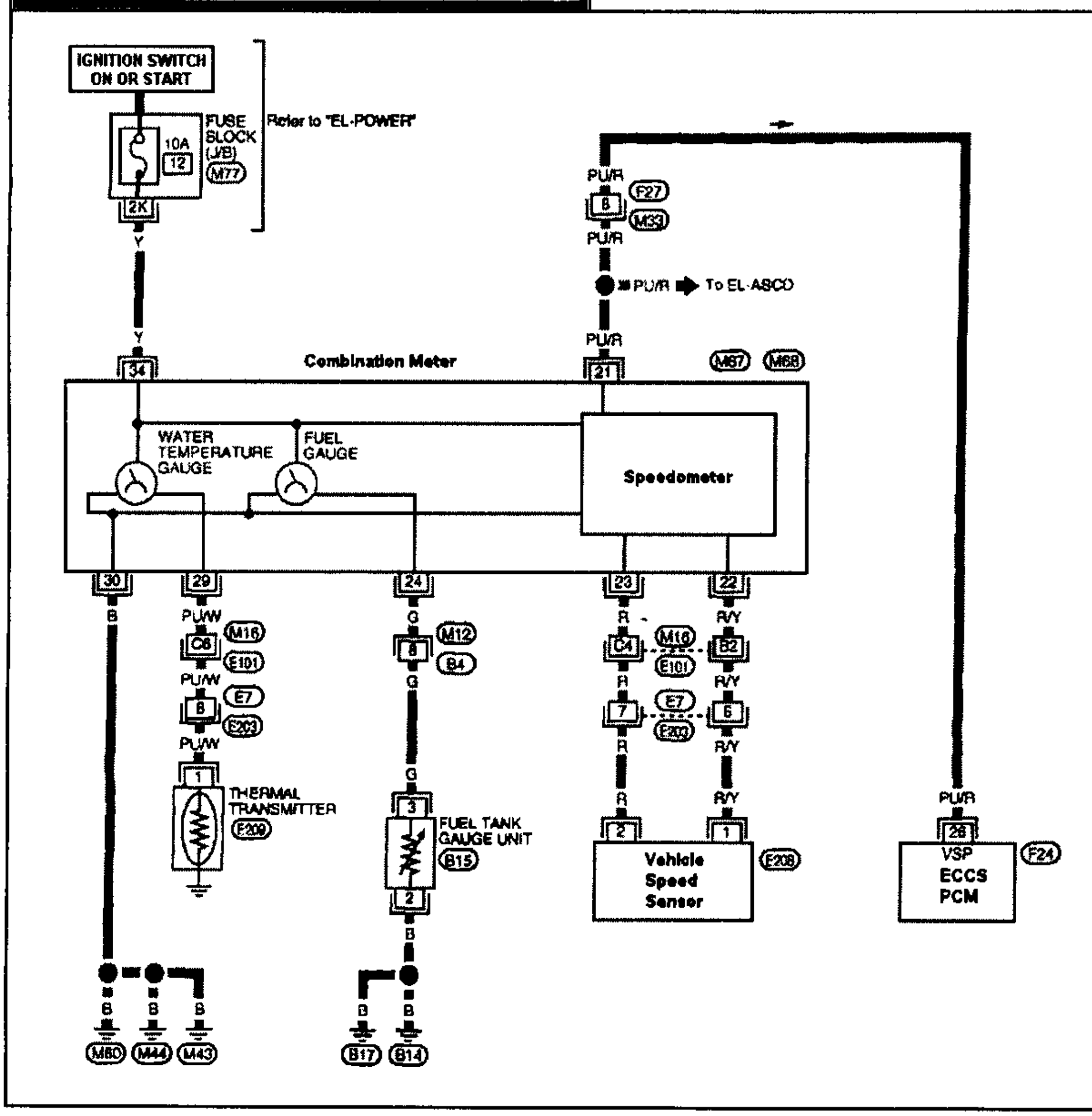
Throttle Position Sensor (15 of 16)



1999 SENTRA (1.6L I4 VIN A)

PCM Wiring Diagrams

Combination Meter (16 of 16)



TOYOTA CONTENTS

TOYOTA CONTENTS

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ADVANCED ENGINE DIAGNOSTICS

Introduction

How To Use This Section

This section of the manual was developed to provide you with theory of operation and testing information for the Engine Control devices found on Toyota Motor Sales vehicles.

This information was written in a manner that will allow you to easily compare how to connect up to a similar vehicle component and make a test measurement. In many cases we have recommended which piece of diagnostic or test equipment to use first (depending upon the trouble code or related symptom) for a particular component.

This information includes various articles for the following vehicles:

1) 2000 Corolla (1.8L I4 VIN 'R' Engine)

2) 2000 4Runner (3.4L V6 VIN 'N' Engine)

Key Subject Areas

A description of the Engine Control devices included in this section is provided below:

Information Sensors

- ECT Sensor
- IAT Sensor
- MAP Sensor
- VSS Sensor

Crankshaft Position Sensor

- CKP (NE) Sensor

Cylinder Position Sensor

- CMP (G or G2) Sensor

EGR Control Solenoid

EVAP Control Solenoid

Fuel Injectors

Idle Air Control Motor

Oxygen Sensors

TP Sensor

Reference Information

This section includes important reference information in the following categories:

- PCM Computer Locations (1990-2001)
- Parameter Identification (PID) examples for the Powertrain Control Module (PCM)
- Pin Voltage Table examples for the Powertrain Control Module (PCM)
- Junction Block examples for the Engine and Dash Junction Blocks
- Wiring Diagram examples for the Powertrain Control Module (PCM)
- Wiring Diagram examples for the Transmission Control System (TCM)

Diagnostic Help

All of the articles in this section contain separate component tests along with "real world" test examples and results that you can use to compare to a similar vehicle and engine application. All of this information was captured using conventional automotive repair tools and software (i.e., a DVOM, a Lab Scope and a Scan Tool).

ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

Vehicle Identification Number

The vehicle identification number (VIN) is a seventeen (17) digit legal identifier of the vehicle. It is located on a plate that is attached to the upper left corner of the instrument panel. It can be seen through the windshield from outside the vehicle.

The VIN information includes the country of origin, the make, the vehicle type, the passenger safety equipment, the car line, the body style, the engine, a check digit, the model year, the assembly plant and vehicle build sequence.

Toyota Vehicle Identification Number (VIN) Code Example

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
4	T	A	W	N	8	2	N	6	Y	Z	0	1	1	8	4	2

VIN Code Decoding Table (1998 4Runner Example)

Position	Interpretation	Code = Description
1	**Manufacturing Country**	4 = United States
2	**Manufacturer**	N = New United Motor Mfg., Inc. (United States) T = Toyota
3	**Vehicle Type & Country**	A = Truck
4	**Body Type**	N = 4 x 2 Tacoma Regular Cab P = 4 x 4 Tacoma Regular Cab V = 4 x 4 Tacoma Xtra-Cab W = 4 x 4 Tacoma Xtra-Cab
5	**Engine Type**	L = 2.4L I4 (2RZ-FE Engine) M = 2.7L I4 (3RZ-FE Engine) N = 3.4L V6 (5VZ-FE Engine)
6	**Model**	8 = Standard
7	**Restraint System**	2 = Dual Airbags
8	**Line**	N = Tacoma
9	**Check Digit**	2
10	**Model Year (Driver's Door)**	**L = 1990** **M = 1991** **N = 1992** **P = 1993** **R = 1994** **S = 1995** **T = 1996** **V = 1997** **W = 1998** **X = 1999** **Y = 2000** **1 = 2001**
11	**Assembly Plant**	0 - 9: Japan C: Ontario U: Georgetown, United States Z: Fremont, United States
12 to 17	**Plant Sequential Number**	0-1-1-0-8-4-2

ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

<u>Vehicle Group Identification</u>
The Vehicle Emission Control Information label and Vacuum Hose Routing diagram are both located under the hood. *This example is for a 2001 Toyota 4Runner.*

SFI, A/F S, TWC (2), HO2S, 3.4 LITER
These designators indicate this vehicle is equipped with sequential fuel injection (SFI), an Air Fuel (A/F) Sensor, two three-way catalysts (TWC) and a Heated Oxygen Sensor (HO2S). This vehicle is equipped with a 3.4 liter V6 engine.

OBD II Certified
This designator (located on the VECI label) indicates that this vehicle has been certified as OBD II compliant.

50ST (50 States)
If this designator is used, the vehicle conforms to U.S. EPA & State of California regulations for 2001 model year new motor vehicles.

CAL (California)
If this designator is used, the vehicle conforms to U.S. EPA and State of California regulations applicable to 2001 model year new passenger cars, light trucks or vans for vehicles introduced into commerce in the California.

TOYOTA — IMPORTANT VEHICLE INFORMATION
TOYOTA MOTOR CORPORATION

TEST GROUP : 1TYXT03.4FFP EVAP FAMILY : 1TYXR013SAKO
SFI, A/F S, TWC(2), HO2S 3.4 LITER

ENGINE TUNEUP SPECIFICATIONS FOR ALL ALTITUDES		
VALVE CLEARANCE (ENGINE AT COLD)	INTAKE	0.13-0.23 mm (0.006-0.009 in.)
	EXHAUST	0.27-0.37 mm (0.011-0.014 in.)

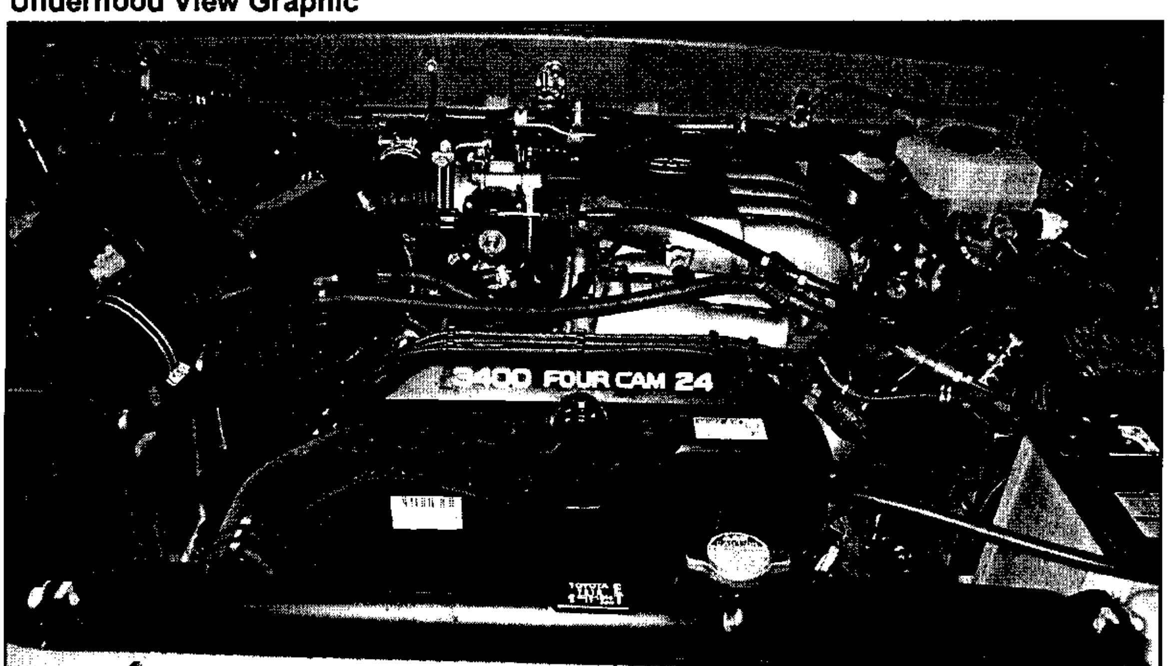
NO OTHER ADJUSTMENTS NEEDED.

THIS VEHICLE CONFORMS TO U.S. EPA NLEV REGULATIONS APPLICABLE TO GASOLINE-FUELED 2001 MODEL YEAR NEW LEV LIGHT DUTY TRUCKS AND TO CALIFORNIA REGULATIONS APPLICABLE TO 2001 MODEL YEAR NEW LEV LIGHT DUTY TRUCKS.

3 4 2 P G F F W
62730 5VZ-FE VZN

CATALYST
OBD II CERTIFIED
USA & CANADA **PE**

Underhood View Graphic



ADVANCED ENGINE DIAGNOSTICS

Vehicle Identification

Engine Code Definitions - Cars

Model Description	Engine Description	Engine ID
Avalon	3.0L V6 (1MZ-FE)	F, G
Camry	2.0L I4 (2S-E)	S
"	2.2L I4 (5S-FE)	G
"	3.0L V6 (1MZ-FE)	F
Camry Solara	2.2L I4 (5S-FE)	G
"	2.5L V6 (2VZ-FE)	V
"	3.0L V6 (1MZ-FE)	F, G
Celica	1.6L I4 (4A-FE), 1.8L I4 (7A-FE)	A, B
"	2.0L I4 (2S-E, 3S-FE)	S
"	2.2L I4 (5S-FE)	G
Corolla	1.6L I4 (4A-FE), 1.8L I4 (4A-GE)	A
"	1.8L I4 (7A-FE)	A, B
"	2.21.8L I4 (5S-FE)	R

Engine Code Definitions - Sport Utility Vehicles

Model Description	Engine Description	Engine ID
4Runner	2.4L I4 (22R, 22R-E)	R
"	2.7L I4 (3RZ-FE)	M
"	3.0L V6 (3VZ-E)	V
"	3.4L V6 (5VZ-FE)	N
Land Cruiser	4.0L I6 (1FZ-FE)	F
"	4.5L I6 (1FZ-FE)	D
"	4.7L V8 (2UZ-FE)	T
Highlander	2.4L I4 (2RZ-FE)	L
"	3.0L V6 (1MZ-FE)	F
RAV4	2.0L I4 (3S-FE)	P
Sequoia	4.7L V8 (2UZ-FE)	T

Engine Code Definitions - Trucks

Model Description	Engine Description	Engine ID
Pickup	2.4L I4 (22R, 22R-E)	R
"	3.0L V6 (3VZ-E)	V
T-100	2.7L I4 (3RZ-FE)	U, M
"	3.0L V6 (3VZ-E)	V
"	3.4L V6 (5VZ-FE)	V, N
Tacoma	2.4L I4 (2RZ-FE)	U, L
"	2.7L I4 (3RZ-FE)	U, M
"	3.4L V6 (5VZ-FE)	V, N
Tundra	3.4L V6 (5VZ-FE)	N
"	4.7L V8 (2UZ-FE)	T

Engine Code Definitions - Vans

Model Description	Engine Description	Engine ID
Previa	2.4L I4 (2TZ-FE), 2.4L I4 (2TZ-FZE Supercharged)	A, K
Sienna	3.0L V6 (1MZ-FE)	F
Van Cargo, Passenger, Window	2.0L I4 (3Y-EC), 2.2L I4 (4Y-EC)	Y

ADVANCED ENGINE DIAGNOSTICS

PCM Location Tables

PCM Location Tables - Cars

This table can be used to identify the location of the Powertrain Control Module (PCM) for 1990-2001 Toyota Motor Sales car applications.

PCM Location Table - Avalon, Camry & Celica

Year	Avalon	Camry	Celica
1990-91	—	**Camry** • Located center of instrument panel, behind console **Camry 2.5L V6 2 WD** • Located behind the center console, combined with ECT	**Celica** • Located under center of dash
1992	—	**Camry** • Located behind glove box, next to A/C blower housing	**Celica** • Located at center console, mounted to floor tunnel
1993-94	—	**Camry** • Located behind the RH dash, above the glove box	**Celica** • Located behind the front of center console
1995-97	**Avalon** • Located behind RH side of dash	**Camry** • Located behind the glove box	**Celica** • Located below the center of the dash, behind the ashtray
1998 - 01	**Avalon** • Located behind RH side of dash	**Camry** • Located behind the RH side of dash, or behind glove box **Camry Solara** • Located behind the RH side of dash	**Celica** • Located below the center of dash, in front of center console

PCM Location Table - Corolla, Cressida & MR-2

Year	Corolla	Cressida	MR-2
1990-91	**Corolla** • Located in dash console	**Cressida** • Located behind glove box	**MR-2** • Located at LR of engine area
1992	**Corolla** • Located under dash console	**Cressida** • Located above right rear of glove box	**MR-2** • Located on left front of rear luggage compartment
1993-94	**Corolla** • Located under dash console	—	**MR-2** • Located on left rear engine firewall, right of relay box #2
1995-97	**Corolla** • Located below center dash	—	**MR-2** • Located in LR luggage area
1998-99	**Corolla** • Located below center dash	—	**MR-2** • Located in LR luggage area

PCM Location Table - Corolla, Echo & MR-2

Year	Corolla	Echo	MR-2
2000-01	**Corolla** • Located under the center of dash, behind the console unit	**Echo** • Located in RH dash area, behind the glove box	**MR-2** • Located on left rear corner of engine compartment

ADVANCED ENGINE DIAGNOSTICS

PCM Location Tables

PCM Location Tables - Cars

This table can be used to identify the location of the Powertrain Control Module (PCM) for 1990-2001 Toyota Motor Sales car applications.

PCM Location Table - Paseo, Supra & Tercel

Year	Paseo	Supra	Tercel
1990-91	**Paseo** • Located under the ash tray, in center instrument panel	**Supra** • Located in RH dash, behind glove box	**Tercel** • Located behind center console
1992	**Paseo** • Located under the ash tray, in center instrument panel	**Supra** • Located above center of glove box	**Tercel** • Located under the ash tray in center instrument panel
1993-94	**Paseo** • Located under the ash tray, behind center of dash	**Supra** • Located left side passenger floor board, under carpet	**Tercel** • Located under the ash tray behind center of dash
1995-97	**Paseo** • Located below center of dash, or behind glove box	**Supra** • Located below right front footrest	**Tercel** • Located behind the RH side of dash
1998	---	**Supra** • Located below the right front footrest	**Tercel** • Located behind the RH side of dash

PCM Location Tables - Sport Utility Vehicle Applications

This table can be used to identify the location of the Powertrain Control Module (PCM) for 1990-2001 Toyota Motor Sales sport utility vehicle applications.

PCM Location Table - Sport Utility Vehicles (4Runner, Land Cruiser & RAV4)

Year	4Runner	Land Cruiser	RAV4
1990-95	**4Runner 2WD & 4WD** • Located behind the right kick panel	**Land Cruiser** • Located behind RH side of the dash, near the glove box	---
1996-99	**4Runner 2WD & 4WD** • Located behind the right side of the dash area	**Land Cruiser** • Located behind RH side of the dash, near the glove box	**RAV4** • Located under center of the dash area
2000-01	**4Runner 2WD & 4WD** • Located behind the right side of dash area near glove box	**Land Cruiser** • Located behind RH side of the dash, near the glove box	**RAV4** • Located under center of the dash area

PCM Location Table - Sport Utility Vehicles (Highlander, Sequoia)

Year	Highlander	Sequoia	
2001	**Highlander 2WD & 4WD** • Located behind RH side of the dash, near the glove box	**Sequoia LTD 2 & 4WD, SR5** • Located behind RH side of the dash, near the glove box	---

ADVANCED ENGINE DIAGNOSTICS

PCM Location Tables

PCM Location Tables - Trucks & Vans

This table can be used to identify the location of the Powertrain Control Module (PCM) for 1990-2001 Toyota Motor Sales Truck and Van applications.

PCM Location Table - Pickup, T100 Pickup & Tacoma

Year	Pickup	T100 Pickup	Tacoma
1990-95	**Pickup** • Located near right kick panel	**T100 Pickup** • Located near right kick panel	**Tacoma** • Located under right dash
1996-99	---	**T100 Pickup (1996)** • Located below the right side of dash, near the kick panel	**Tacoma 2WD (1996-99)** • Located behind RH dash **Tacoma 4WD** • Located at left kick panel **Tacoma 4WD W/2-4 Selector** • Located below center dash

PCM Location Table - Tacoma & Tundra

Year	Tacoma	Tundra	---
2000-01	**Tacoma** • Located behind the right side of dash	**Tundra** • Located behind the right side kick panel	---

PCM Location Table - Previa & Sienna

Year	Previa	Sienna	---
1991-95	**Previa** • Located under driver's seat	---	---
1996-97	**Previa** • Located to the left of driver's seat, under left front seat leg		---
1998-2001		**Sienna** • Located under right dash	---

DLC Location Table - Toyota Applications

Year	Model	Location
1997-2001	4Runner	To the right side of the Steering Column near Console
1996	Avalon	Under cover behind fuse box panel above left kick panel
1997-2001	Avalon	Below the left side of the Center Console
1996	Camry	Behind the coin box
1997-2001	Camry	To the left side of the Steering Column under the dash
1996-2001	Celica	To the right side of the Steering Column near Console
1996-2001	Corolla	To the left side of the Steering Column under the dash
1996-1997	Previa	Under cover at top of right side Instrument Panel
1996-98	Tercel	Behind the fuse box panel above left kick panel
1996-2001	RAV4	Behind the fuse box panel above left kick panel
1998-2001	Sienna	To the right side of the Steering Column near Console
1996-99	T-100 Pickup	To the right side of the Steering Column near Console
2000-01	Tacoma	To the right side of the Steering Column near Console
2001	Tundra	To the right side of the Steering Column near Console

ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

Introduction

The Toyota Computer-Controlled System (TCCS) was introduced on the 5M-GE engine in 1983 and its use has evolved ever since then. This system, designed as the control center of the engine management function, regulates the fuel injection, emission control, and ignition functions on all applicable Toyota applications. The TCCS system is comprised of the PCM, and its various input devices and output actuators.

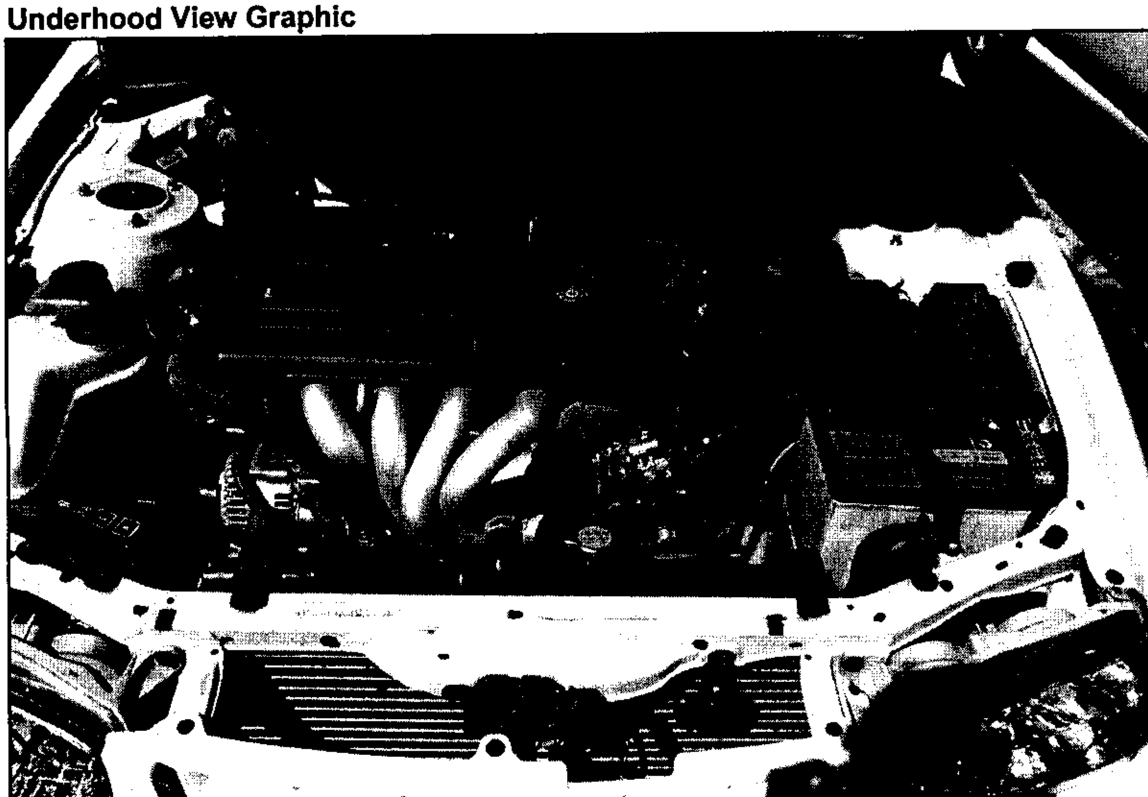
The TCCS constantly monitors information from a series of input and feedback sensors. Using this information, it commands the respective engine subsystems to alter their operating characteristics. These commands change the performance of the engine, emission controls, and if applicable, the operation of the electronic transmission.

Input Devices

A partial list of the sensors and switch inputs used on Toyota systems is shown below:

- Altitude sensor signals
- Closed throttle switch and stop light switch signals
- Clutch start switch signal (M/T applications)
- Camshaft and crankshaft position sensor signals
- Engine cranking and engine detonation signals
- Engine speed (ignition) signals
- Intake air temperature (IAT) and water temperature (ECT) sensors
- MAF (mass airflow), MAP (manifold air pressure) and oxygen (O2S) sensors
- Park neutral switch signal (A/T applications)
- Throttle angle (TA) or throttle position (TP) sensor

Underhood View Graphic



ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

<u>Output Devices</u>

The PCM in the TCCS (system) controls the operation of devices in these subsystems:

Air Intake System

- Idle air control solenoid operation (controls the solenoid On/Off function)

Engine Control System

- A/C clutch operation (controls the clutch On/Off function)
- Combination meter operation (controls the meter On/Off function)
- EFI Main Relay operation (controls the relay On/Off function)
- Heated Oxygen Sensor Relay (controls the relay On/Off function)

Emission Control System

- EGR Control vacuum switching valve operation (controls the On/Off function)
- EVAP Purge vacuum switching valve operation (controls the On/Off function)
- EVAP Vent vacuum switching valve operation (controls the On/Off function)

Fuel Delivery System

- Fuel pump relay operation (controls the relay On/Off function)
- Fuel injector operation (controls the injector On/Off function)

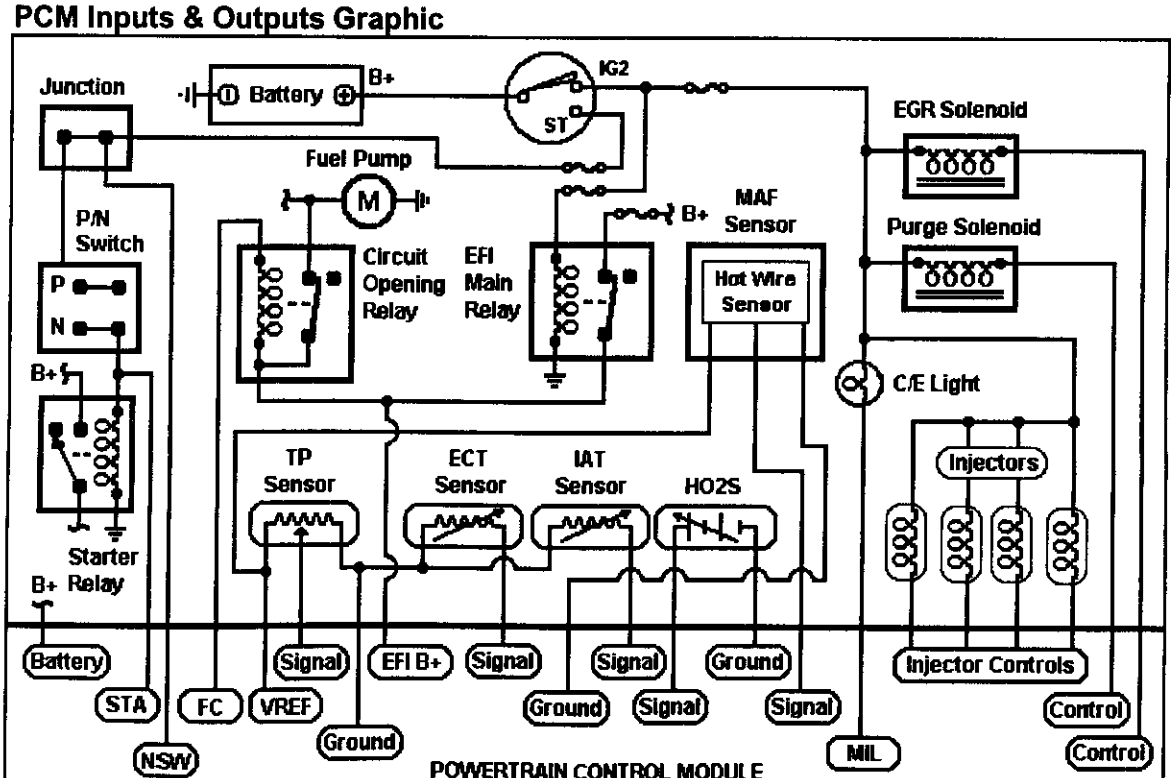
Ignition Control System

- Electronic ignition igniter and coil (controls the coil primary On/Off function)

Body Control Module (Multiplex Communication Network)

The BCM on this vehicle is connected to various devices via discrete circuits in order to control the operation of related devices. The Rear ECU-B connects to the BCM via a multiplex communication network (serial data). The PCM does not connect to the BCM.

<u>PCM Inputs & Outputs Graphic</u>



ADVANCED ENGINE DIAGNOSTICS

Powertrain Control Module

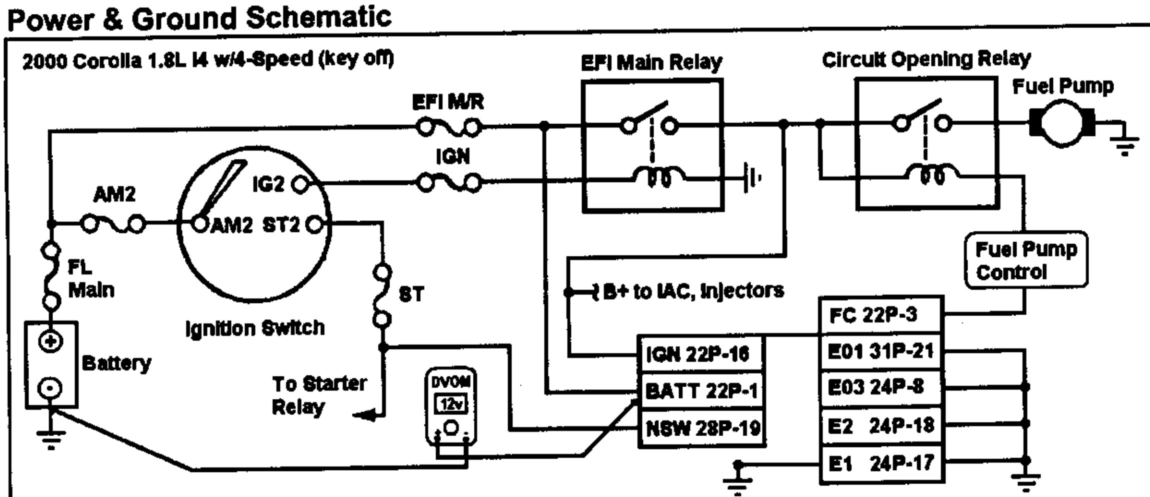
Power & Ground Circuit Tests

The tests in this article should be performed whenever the PCM, an actuator or sensor is suspected of being the cause of a trouble code (Code) or symptom (No Code) problem.

Power & Ground Circuit Repair Table (2000 Corolla 1.8L I4 A/T 4-Speed Example)

Step	Action	Value	Yes	No
1	Turn the key off. Connect a breakout box (BOB) to the PCM (if available). Is this step complete?	-	Go to Step 2.	Connect the Breakout Box.
2 **Power ground test**	Connect the DVOM positive probe to E01 Pin 21 (31P connector). Connect the negative probe to the battery negative post. Repeat this step at E02 Pin 26 (31P connector). If a BOB is not used, carefully backprobe each pin connector. Turn the ignition to key on, engine off. Does the meter read less than specified value?	Less than 100 mv	Go to Step 3.	Repair the cause of the high resistance ground reading in the power ground circuit. Then retest for the condition.
3 **Sensor ground test**	Connect the DVOM positive probe to E1 Pin 17 (24P connector). Connect the negative probe to battery negative post. Repeat this step at Pin E2 Pin 18 (24P connector). If a BOB is not used, carefully backprobe each pin connector. Turn the ignition key to key on, engine off. Does the meter read less than specified value?	Less than 50 mv	Go to Step 4.	Repair the cause of the high resistance ground reading in the sensor ground circuit. Then retest for the condition.
4 **EFI Main Relay test**	Connect the DVOM positive probe to the EFI main relay at Pin 16 (22P connector). Connect the negative probe to the battery negative post. Then turn the ignition key to "on". Does the meter read within the specified key on value?	Within ± 0.3v of battery voltage	Go to Step 5.	Repair cause of low ignition feed circuit reading. Then retest for the condition.
5 **Battery backup test**	Connect the DVOM positive probe to the battery backup circuit at Pin 1 (22P connector). Connect the negative probe to the battery negative post. Turn the ignition key to "off". Does the meter read within the specified value?	Within ± 0.3v of battery voltage	The power and ground circuits are okay at this time. The test is completed.	Repair cause of "low" Keep Alive power reading. Then retest for the condition.

Power & Ground Schematic



Battery Ignition Off Draw

A vehicle without a current drain problem will still have a small amount of current drain on the battery with the ignition key off. This "key off" draw can be from 4-10 milliamps once the vehicle control modules shut down (10-20 seconds after the key is removed).

ADVANCED ENGINE DIAGNOSTICS

Data Bus Communication

Introduction

The 1992-94 Camry (I4), 1992-93 Camry (V6), 1989-92 Cressida, 1992-94 Celica (I4), 1992-94 Celica (I4), 1993-94 Corolla (I4 except 1.6L), 1993-94 MR2, Supra and T100 Pickup (V6), 1992-94 4Runner and Truck (V6), 1994 Paseo and Tercel models.

These vehicles use two connectors to read codes, enable diagnostics and communicate PID data to a Scan Tool. OBD II vehicles also have more than one test connector, but OBD II data is available at the DLC3 connector. Refer to the example on the next page.

Serial Data

Serial data refers to data transferred in a linear fashion over a single line, one bit at a time. During actual transmission, serial data captured from the DLC transmit and receive circuits will appear similar to the examples.

Data Link Connector (OBD I System)

The DLC1 connector can be used to read the trouble codes. If the C/E light remains "on" with the engine running, a code is stored. If the DLC connector is "jumped", the PCM will flash the code number via the C/E light.

The DLC circuit on some applications can be used to transmit and receive data with an OEM or Scan Tool (i.e., the PCM uses this circuit to communicate with the Scan Tool).

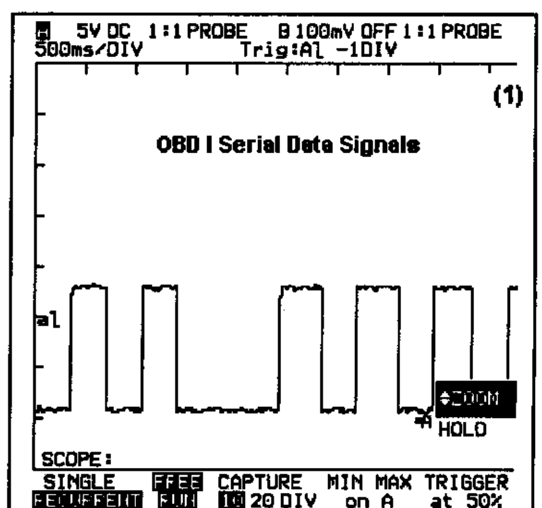
Lab Scope Test ('T' or 'T1' Signal)

Scope Connections (OBD I Example)

Connect the Channel 'A' positive probe to the DLC pin of the connector and the Channel 'A' negative probe to the battery negative post.

Scope Settings

To make the picture as clear as possible, set the lab scope settings to match the examples.



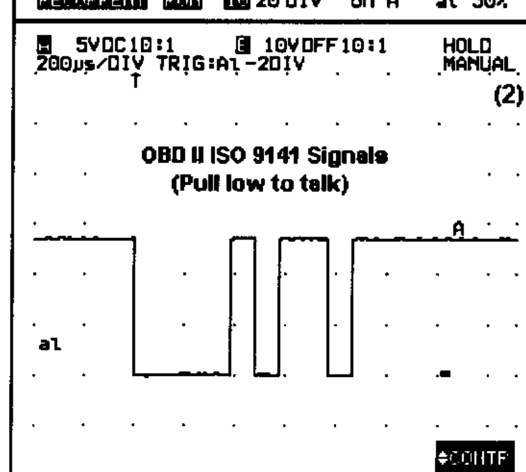
Data Link Connector (OBD II System)

The PCM exchanges information (MIL condition, trouble codes, I/M Readiness Status and PID data) with an OBD II compatible Scan Tool using the ISO 9141 protocol.

Once the Scan Tool is powered up, 12 volts is provided to the K-Line pin of the DLC on these systems. When the ignition is turned "on", the controller and Scan Tool toggle this voltage to communicate between the two devices.

Lab Scope Test (K-Line Signal)

The PCM receives commands and transmits data between itself and the Scan Tool by toggling the K-Line circuit high and low (from 12v to 0v) as shown in the Graphic.



Scope Connections (OBD II Example)

On a 2000 Corolla, connect the Channel 'A' positive probe to Pin 11 (the K-Line circuit) of the PCM 22-Pin connector and the Channel 'A' negative probe to the battery negative post.

ADVANCED ENGINE DIAGNOSTICS

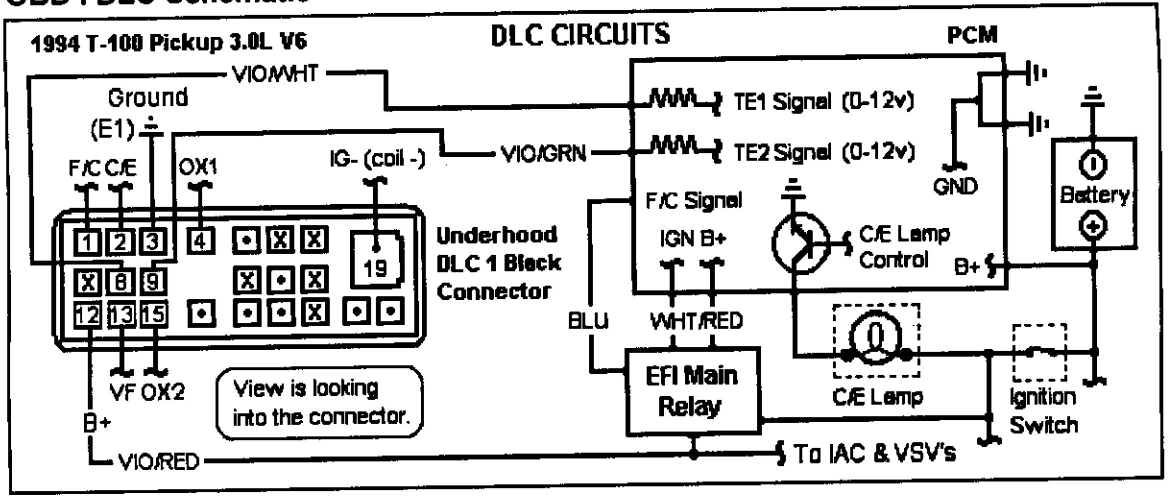
Data Bus Communication

Scan Tool Communication

A Scan Tool can be used to connect to (and communicate with) the PCM controller.

OBD I System - Connect the Scan Tool to the DLC1 test connector near the fuse box. The first time the PCM detects an electrical fault, a code is stored in memory and the C/E Light is illuminated. To read trouble codes manually, turn the key "on" and jumper terminal TE1 to ground. A Scan Tool can also be used to read any stored codes and access data stream information stored in the PCM on applicable models. The Scan Tool communicates with the PCM on the DLC 1 TE1 and TE2 signal circuits in the Graphic.

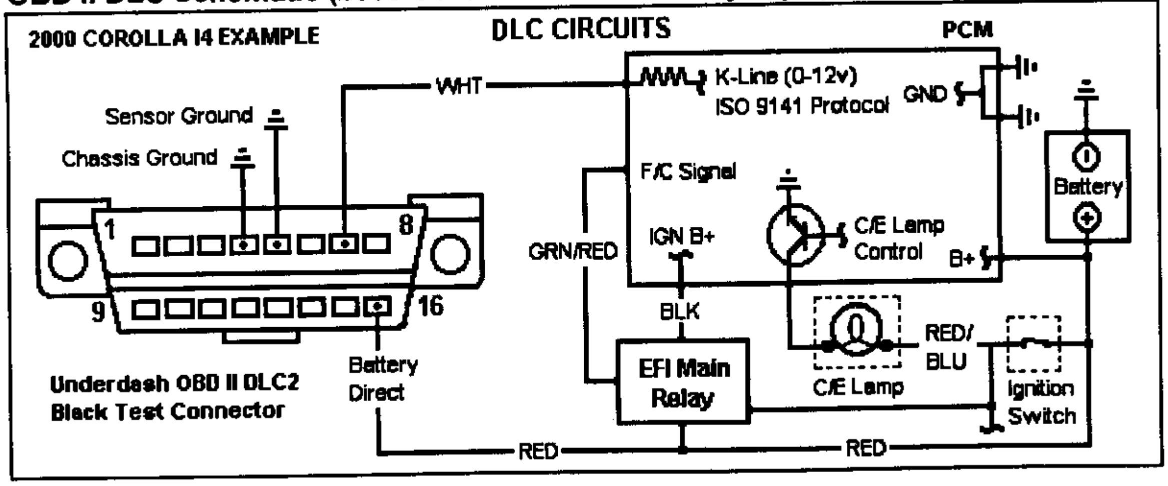
OBD I DLC Schematic



OBD II System - Connect the Scan Tool to the underdash connector located inside the vehicle labeled DLC2. The first time the PCM detects an emissions-related fault it sets a pending code. The second time it fails, the MIL is illuminated and a code is set. OBD II Certified Scan Tools are used to communicate with the PCM to read codes and data.

The Scan Tool communicates with the PCM (transfers data between itself and the tool) on the K-Line ISO 9141 interface circuit. The DLC is connected to the battery at Pin 16 of this same connector. The Scan Tool connects to a "clean" chassis ground (Pin 4) and to sensor ground (Pin 5) of the DLC on OBD II systems as shown in the Schematic.

OBD II DLC Schematic (2000 Corolla Sedan A/T Body Style)



ADVANCED ENGINE DIAGNOSTICS

Data Bus Communication

<u>Check Engine Light Functions</u>

The Check Engine (C/E) light circuit is designed to operate as discussed next:

- The C/E light should illuminate with the ignition turned to key on, engine off. The C/E light should go out if the engine is restarted and there are no trouble codes stored.
- If the 'T' or 'T1' connector is connected to E1 in the connector, the C/E light will flash a normal code display (a pulse every 250 ms) or flash any stored trouble codes.
- Trouble codes are displayed in numerical order (from the lowest to the highest). The trouble codes will continue to be displayed until the jumper wire is removed from between 'T' or 'T1' and ground or the ignition switch is turned to off.

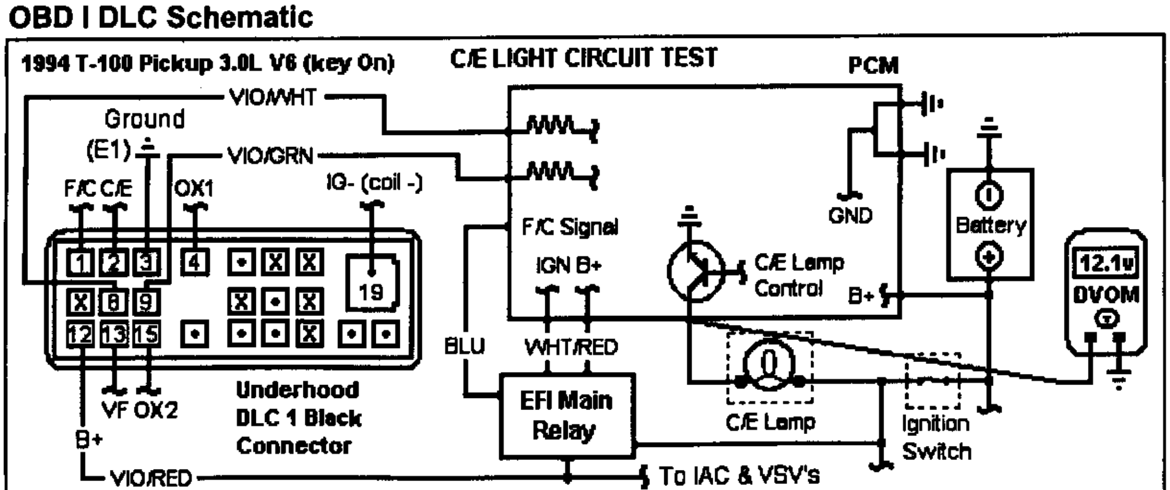
<u>Check Engine Light Circuit Diagnosis (OBD I)</u>

If the Check Engine (C/E) light circuit does not function properly, or if it will not flash any trouble codes, this circuit cannot be used along with the PCM for diagnostic purposes. If you suspect that there is a problem in the C/E light circuit, refer to the table below.

Check Engine Light Circuit Repair Table (OBD I)

Possible Cause	Action to Take / Items to Inspect
1. Faulty fuse in BATT or B+ circuits to the PCM	• Repair the cause of the problem and replace the fuse • Repair the open condition in the BATT circuit • Repair EFI main Relay to PCM B+ terminal
2. Faulty fuse or wiring to IG_1 feed to C/E lamp	• Repair the cause of burned fuse and then replace the fuse • Repair the open condition in the wiring to the C/E lamp
3. Burned out C/E lamp bulb	• Replace the C/E lamp bulb
4. 'W' circuit may be open between the fuse and the PCM (check the terminal)	• Isolate the circuit fault using a DVOM starting at PCM terminal 'W' • Repair the open condition in the BATT circuit • Repair EFI main Relay to PCM B+ terminal
5. Faulty E1 ground circuit	• Isolate the fault using a DVOM and make repairs as necessary
6. Vcc circuit grounded in the wiring or in a sensor	• Turn the key to "on" (PCM connected) and test the Vcc voltage: - Check to determine if the Vcc circuit is grounded - Start disconnecting sensors fed by the Vcc circuit one at a time until the Vcc voltage goes back to 5v (to find the faulty sensor) • If the Vcc voltage remains low with all of the sensors disconnected, turn off the ignition and disconnect the PCM: - Use an ohmmeter to test the harness for continuity to ground on the Vcc circuits. If no fault is detected, the PCM is at fault
7. Faulty PCM or ECU	• Check for good contact at all of the PCM harness and terminal connections (check the terminal contact with a known good gauge)

OBD I DLC Schematic



ADVANCED ENGINE DIAGNOSTICS

Data Bus Communication

Voltage Feedback Circuit

The Voltage Feedback (VF) circuit in the DLC1 or DLC2 connector on an OBD I system can be used to perform two additional functions (depending upon the status of the 'T' or 'T1' terminal and the IDL switch position). These two functions are described next:

- With the ignition "on" and the 'T' or 'T1' terminal in the test connector not grounded, the voltage signal on the 'VF' circuit represents the "learned value" correction factor. This value is the fuel injection correction coefficient that tailors the standard fuel injection duration to minor differences between engines (through the use of fuel trim).
- With the ignition "on" and the 'T' or 'T1' terminal in the test connector grounded, the voltage signal on the 'VF' circuit will indicate whether a trouble code is set in memory with the throttle closed (IDL switch contacts closed) or it will indicate the emulated (default) oxygen sensor signal with the throttle open (IDL switch contacts open).

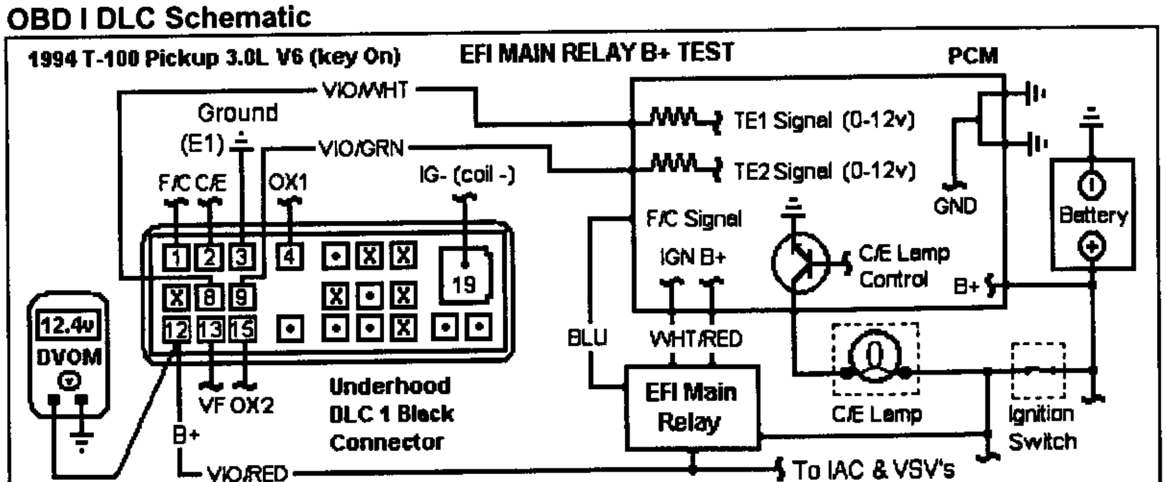
T Terminal	IDL Contacts	C/E Light	VF Terminal Output (Engine at Hot Idle)	
Off (open)	N/A	Lamp Check Function (engine off)	A/F ratio feedback correction amount or A/F ratio learned control amount	5v +11-20% 3.5v: Increased amount +4-10% 2.5: Normal +-3% 1.25v: Decreased amount -4-10% 0v -10% 20%
On (jumped)	OFF	Diagnostic code display	Displays results of O2 sensor signal processing	5v: Rich signal 0v: Lean signal
	ON		Displays diagnostic results	5v: Normal 0v: Trouble Code stored

EFI Main Relay Quick Check

Once the ignition is turned "on", the TCCS system is designed to provide power to the ECM and several output devices through the EFI Main Relay. This action occurs when the EFI Main Relay is energized with the key "on" (thereby providing power to the ECM B+ ignition feed circuits and all of the subsystem Vacuum Switching valves).

If the MIL is on with the key turned to "on" (engine off), the relay is functional and current is flowing to the ECM B+ terminals. If the MIL is off, connect a DVOM between the DLC1 B+ terminal and chassis ground (key still turned "on"). If the DVOM reads near system voltage, the relay is functional and the problem with the MIL is not related to the relay.

OBD I DLC Schematic



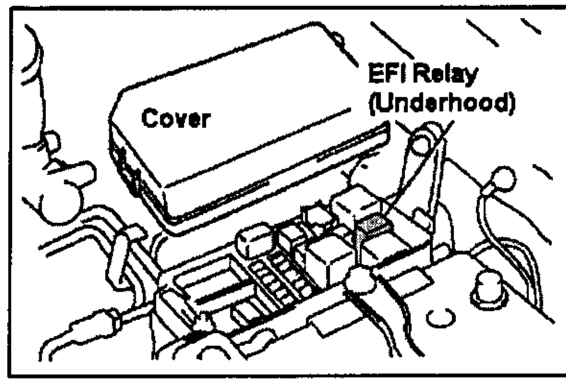
Two stage Pump FC at Start up + Heavy load 12V
at Idle 9V

2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

Introduction

The Powertrain Control Module (PCM) controls all phases of engine electrical operation (the PCM is also referred to as the ECM in various articles). In order to accomplish these tasks, the PCM relies on input signals from a variety of engine operation sensors.



The PCM compares the input signals from its sensors with information on these sensors stored in memory in order to determine what steps should be taken to achieve the maximum engine performance, fuel economy and to meet current emission standards.

Then the PCM sends output commands to various devices in the Emission Control, Fuel and Ignition systems and the Automatic Transmission (if applicable).

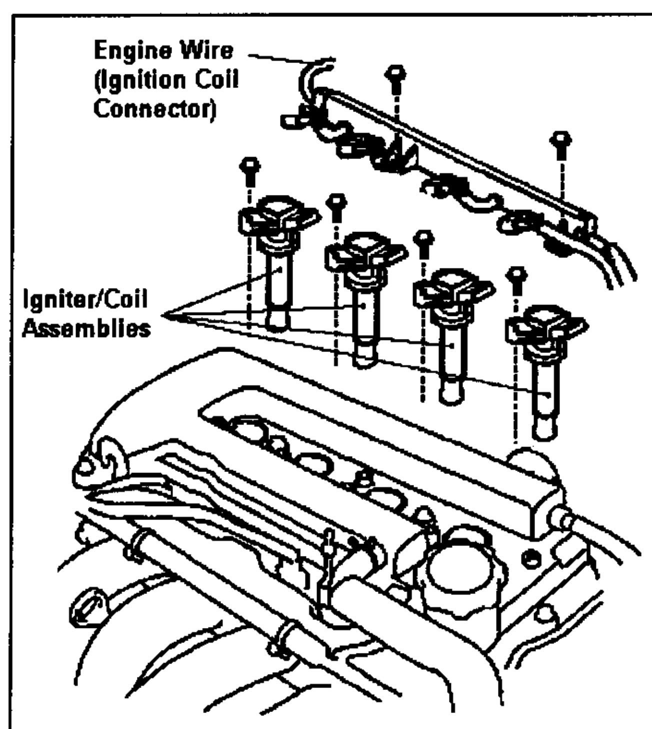
EFI Main Relay

Once the ignition key is turned on, the EFI relay provides power to the Circuit Opening (C/O) relay and to the PCM on the B+ circuit (as explained below):

- M/T or 3-Speed A/T application: B+ circuit at PCM Pin 12 of the E6 22-Pin connector
- 4-Speed A/T application: B+ circuit at PCM Pin 16 of the E10 22-Pin connector

The wiring diagrams for both applications (including the EFI main relay) are provided in the Fuel and Ignition system wiring diagrams at the end of this vehicle section.

EI System Components



The four igniters are integrated into the igniter/coil assemblies. The EI system control logic is included inside the PCM.

There are no spark plug cables, just the boots and insulators.

Ignition Coil Feed Circuits

The four (4) ignition coil/igniter units in this EI system receive power directly from the ignition switch on this application.

The wiring diagrams for the EI system are included in the Fuel and Ignition system wiring diagrams at the end of this vehicle section.

The ignition coils are mounted on top of the engine directly over the spark plugs (a coil-on-plug arrangement) as shown in the Graphic to the right.

2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

EI System Operation

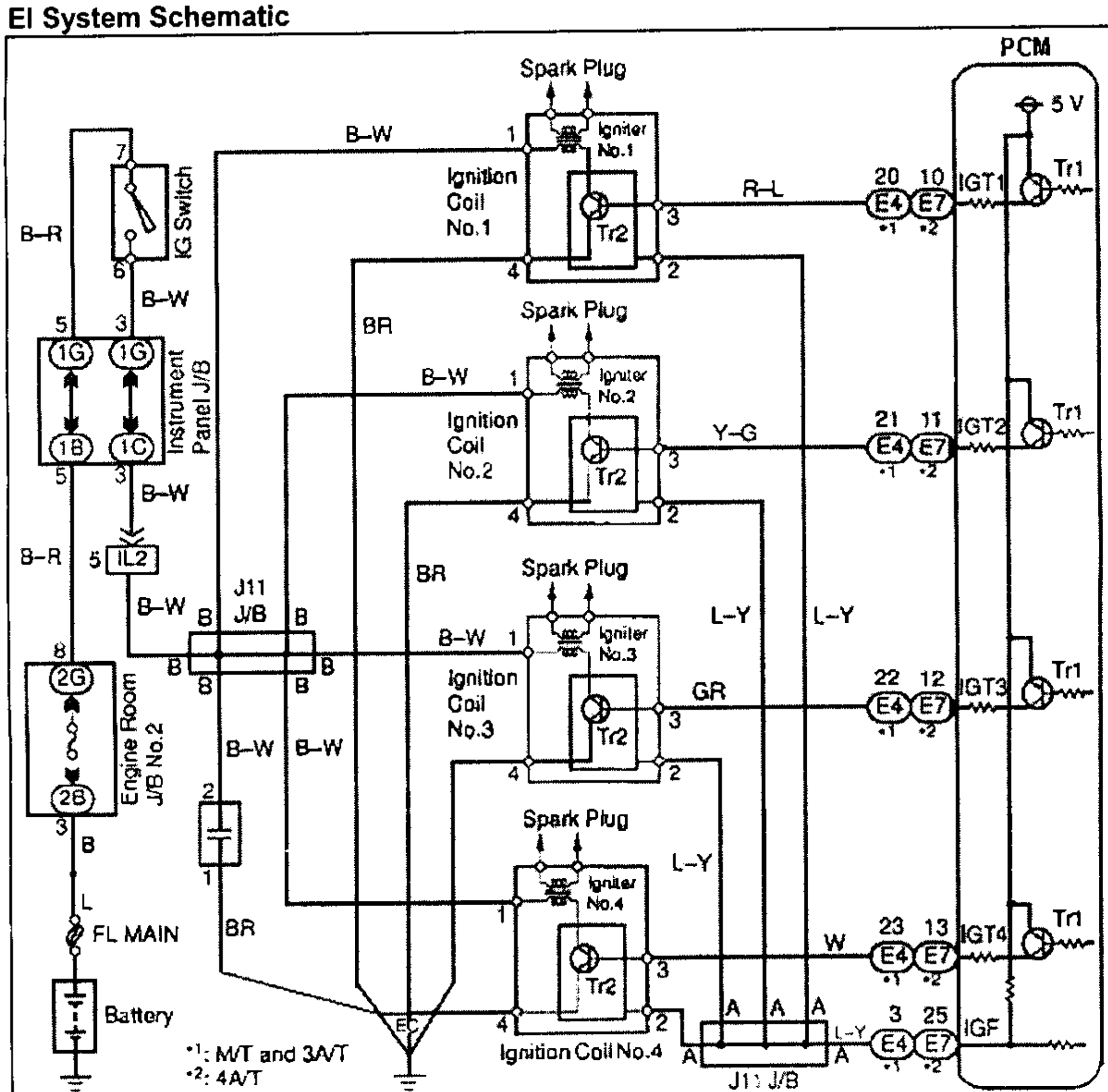
The PCM determines the optimum ignition spark timing from its memory tables, and then sends an IGT signal to turn on the first transistor (Tr1) at a preset angle (° CA).

The width of the IGT signal is constant as the dwell angle control circuit determines the time that the control circuit starts the flow of primary current in the ignition coil. The dwell calculation is based on engine speed and the previous spark timing command in the last revolution. In effect, this is the amount of time the Tr2 control transistor remained "on".

When the correct spark timing is reached, the PCM turns off the Tr1 and outputs the IGT 'O' signal. This action turns off transistor Tr2 and interrupts the flow of primary current (to generate high voltage in the secondary winding of the ignition coil to fire the spark plug).

The counter electromotive force generated by the interruption of flow in the ignition coil causes the igniter to send a confirmation signal (IGF) to the PCM. It should be noted that the PCM stops firing the fuel injectors if it does not receive any (IGF) signals.

EI System Schematic

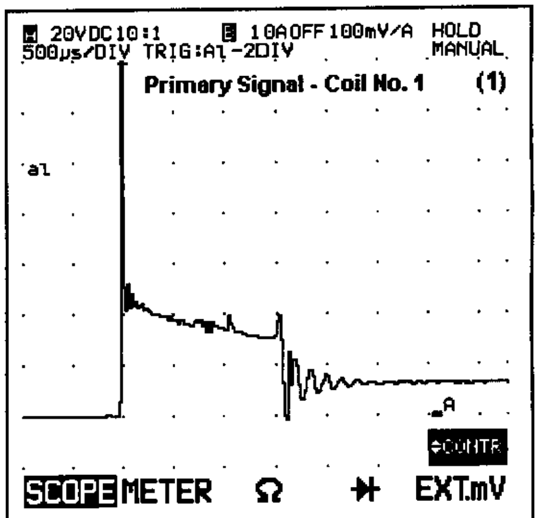


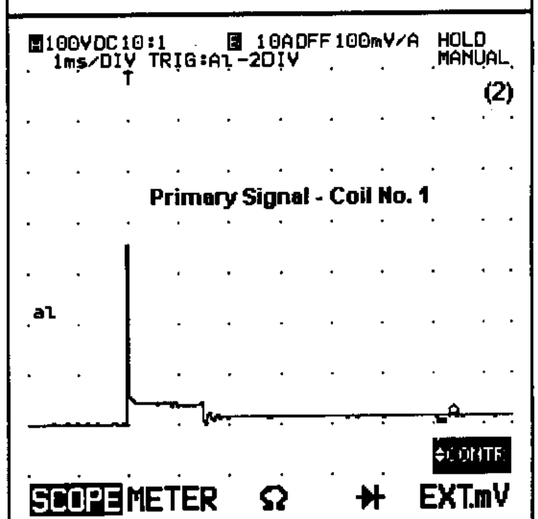
2000 COROLLA (1.8L I4 VIN R)

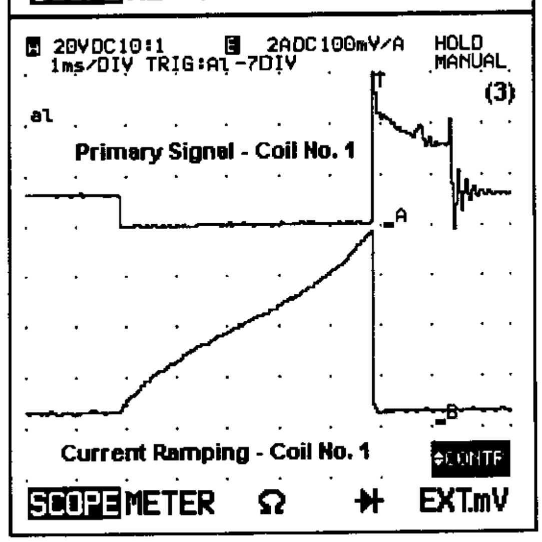
Electronic Ignition System

Lab Scope Test (Coil Primary)

The Lab Scope can be used to view the coil primary and the IC control signals as it provides a very accurate view of their waveforms and of any glitches. Prior to starting the test, place the gearshift selector in Park and block the drive wheels for safety.







<u>Scope Connections for Example (1) & (2)</u>
Connect the Channel 'A' positive probe to a primary circuit for Coil No. 1 (BLK/WHT wire). Connect the Channel 'A' negative probe to the battery negative ground terminal.

<u>Scope Connections for Examples (3)</u>
Connect the Channel 'A' positive probe to a primary circuit for Coil No. 1 (BLK/WHT wire). Connect the Channel 'A' negative probe to the battery negative ground terminal.

Connect the Channel 'B' positive probe with an Amp probe adapter around the B+ feed circuit that connects to coil No. 1 (BLK/WHT wire).

<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples. The amperage probe on Channel 'B' should be set on the 100 mv per amp scale.

<u>Lab Scope Tests</u>
The coil primary signals can be checked at idle or cruise speeds (cold or warm engine).

<u>Lab Scope Explanation - Example (1)</u>
In this example, the trace shows the coil primary signal for Coil No. 1. Note the normal firing and spark lines at hot idle speed.

<u>Lab Scope Explanation - Example (2)</u>
In this example, the trace shows the coil primary signal for Coil No. 1. The voltage setting was changed from 20v to 100v DC for this capture. Note that the primary circuit peaked at around 360 volts using this setting.

<u>Lab Scope Explanation - Example (3)</u>
In this example, the top trace shows the Coil No. 1 primary signal along with the primary current the same ignition coil. Note the primary current ramp up of close to eight (8) amps.

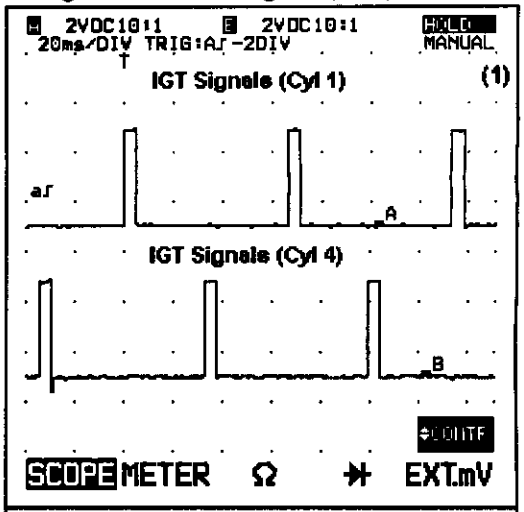
These are known good primary current signals for this vehicle application captured with a Fluke 99B Lab Scope.

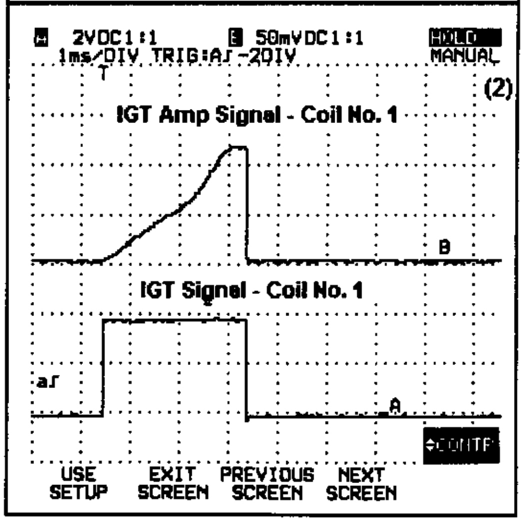
2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

Lab Scope Tests (IGT Signal)

The Lab Scope is the tool of choice to use to test the igniter control signal (IGT) from the PCM the coil/igniter assemblies as it allows a quick check of the circuits for possible glitches. Place the gearshift selector in Park for testing.





<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples. Set the low amp probe switch to 50 mv DC.

<u>Scope Connections (IGT1 & IGT2 Signals)</u>
Connect the Channel 'A' positive probe to the IGT1 signal at Pin 10 or 20 (RED/BLU wire) depending upon the vehicle. Connect the negative probe to the battery negative post.

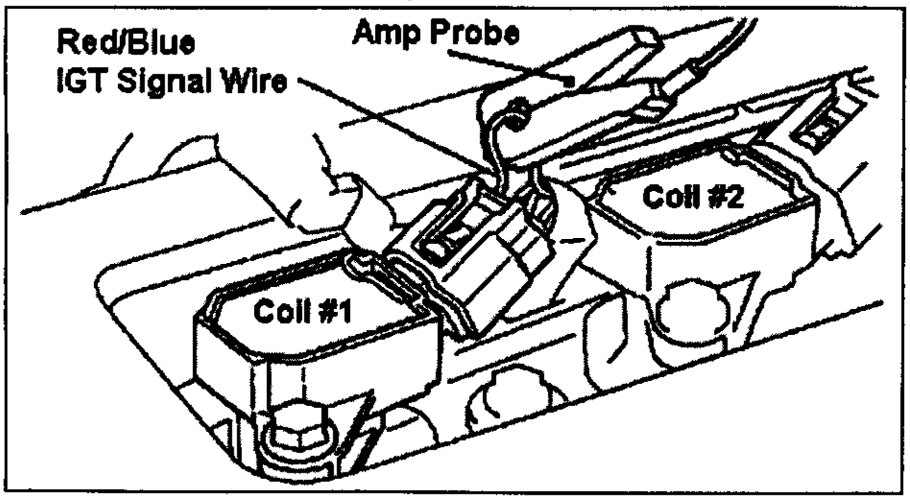
Connect the Channel 'B' positive probe to the IGT2 signal at Pin 11 or Pin 21 (YEL/GRN wire) of the PCM 31-Pin connector.

<u>Scope Connections (IGT Signal - Amp Probe)</u>
Connect a low current amp probe to Channel 'B' (zero the probe). Clamp the probe around the IGT1 signal at the coil (RED/BLU wire).

<u>Lab Scope Explanation - Example (1)</u>
The top trace in this example shows the IGT1 signal and bottom trace shows the IGT4 signal.

<u>Lab Scope Explanation - Example (2)</u>
The top trace in this example shows the current buildup (ramping) of the IGT1 signal while the bottom trace shows how long the IGT1 signal remained on (about 3 ms).

Low Amp Probe Hookup Graphic

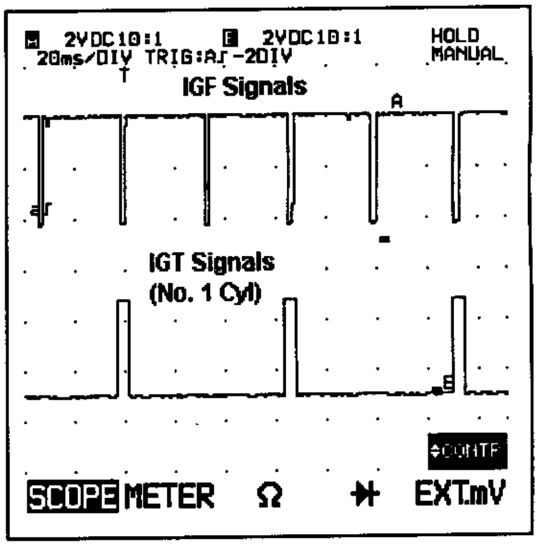


2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

Lab Scope Tests (IGF Signal)

The Lab Scope is the tool of choice to use to test the ignition confirmation signal (IGF) and IGT control signal from each coil/igniter assembly to the PCM as it allows you to monitor these circuits for any possible glitches. Place the gearshift selector in 'P' or 'N' and block the drive wheels prior to starting the test sequence.



Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (IGF Signal)
To view the IGF signals, connect the Channel 'A' positive probe to the IGF circuit (BLU/YEL wire) at Pin 25 or Pin 3 (depending upon the vehicle). Connect the negative probe to the battery negative post.

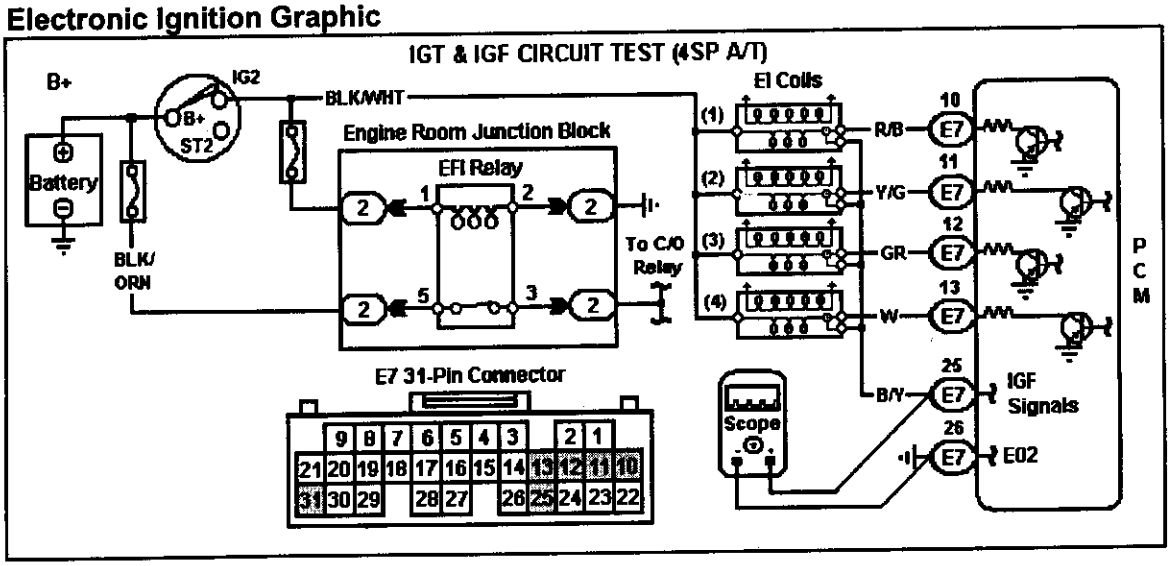
Scope Connections (IGT Signal)
To view the IGT signal with the IGF signal, connect the Channel 'B' positive probe to the Cyl No. 1 IGT circuit (RED/YEL wire) at Pin 10 or Pin 20 (depending upon the vehicle).

Lab Scope Explanation
In this example, the top trace shows the IGF signals while the bottom trace shows the IGT signals for Cylinder No. 1 at idle speed.

Note that they are both 5v DC signals. The IGF signal is high (off) most of the time while the IGT signal is low (on) most of the time.

There are two (2) IGF signals for each IGT signal due to the fact that the IGF signals are created for all four (4) of the ignition coils on this engine application.

Electronic Ignition Graphic

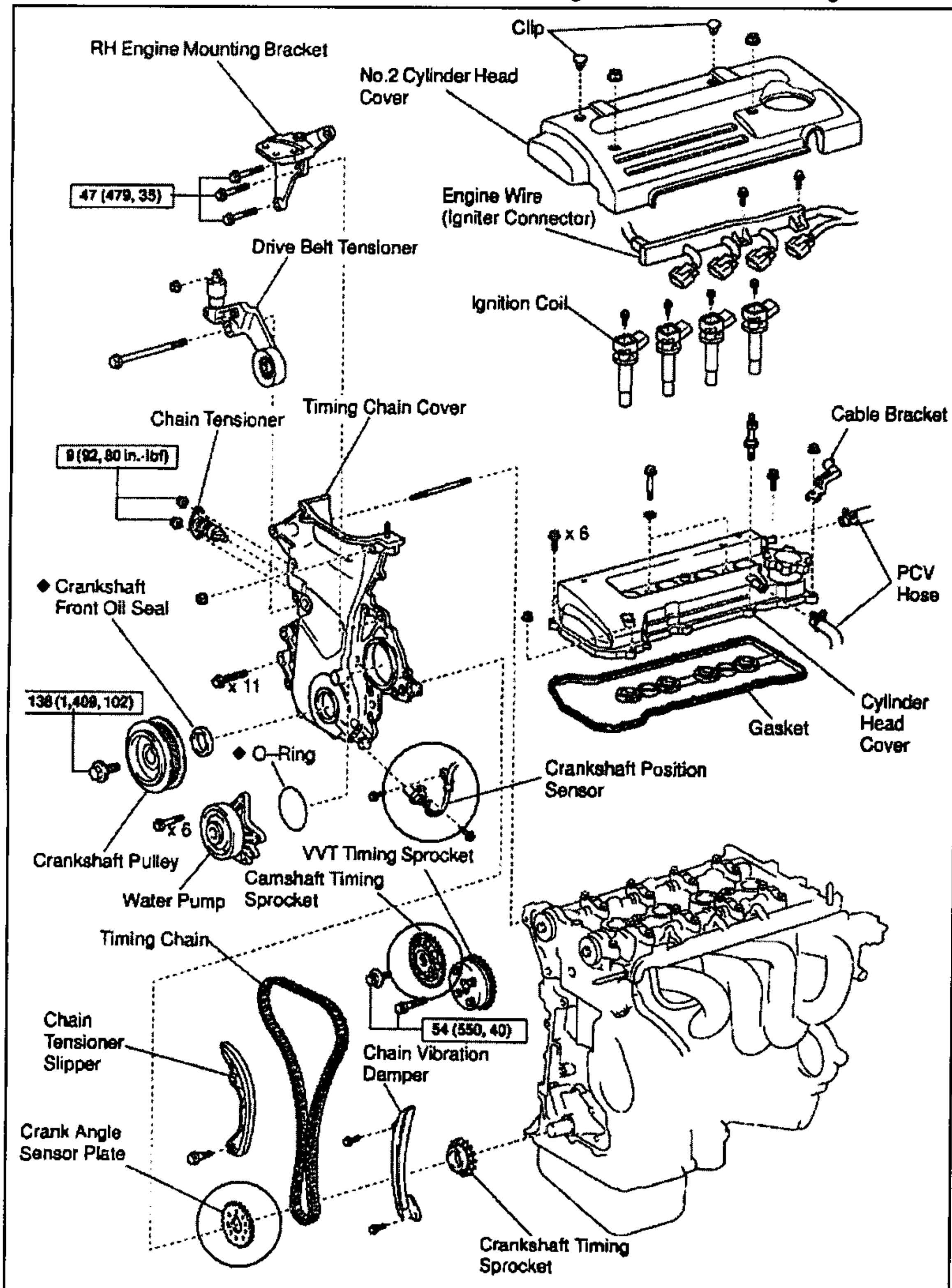


2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

CKP Sensor Location

The CKP sensor is located at the bottom of the timing chain cover on this engine.

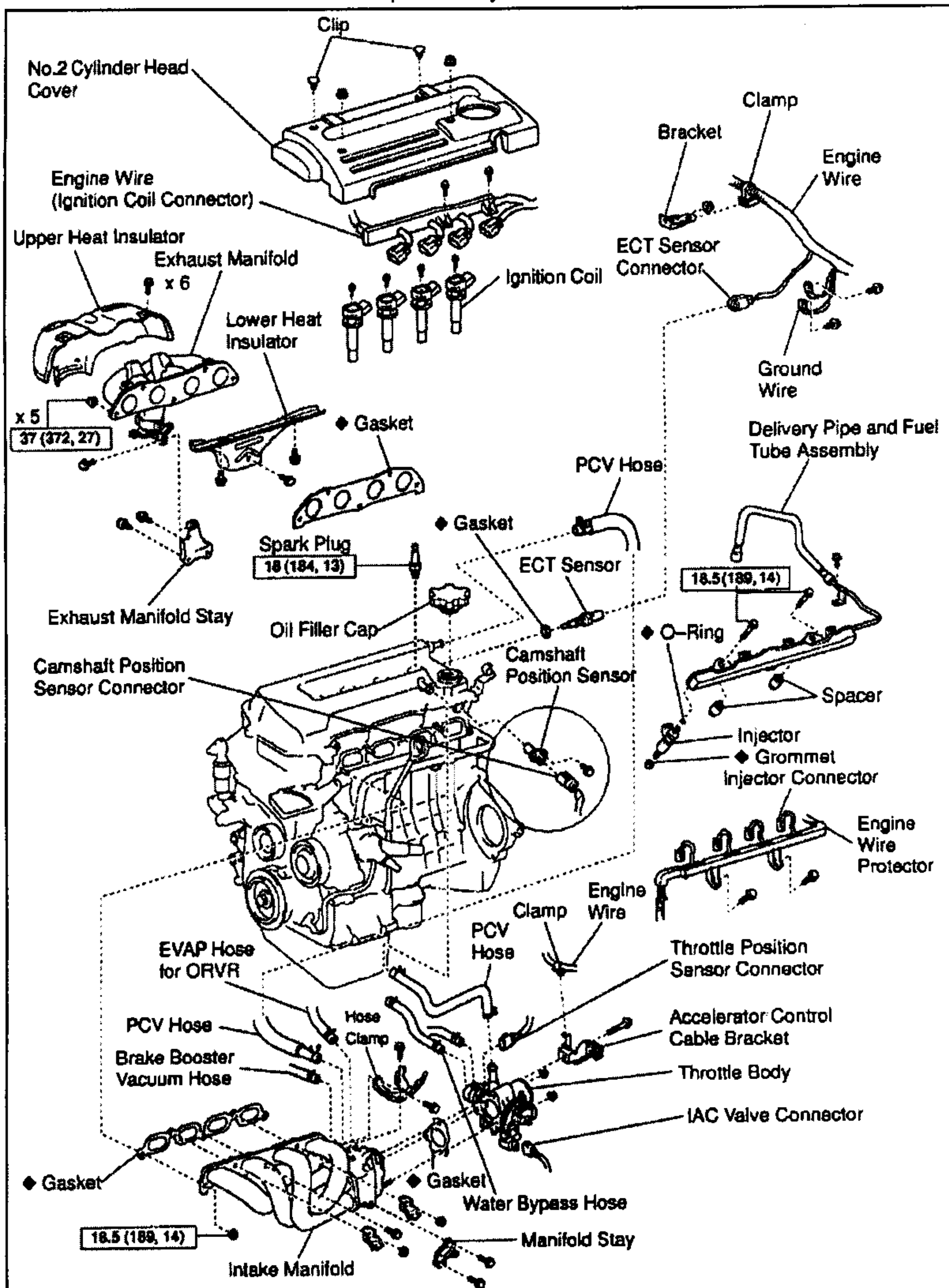


2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

CMP Sensor Location

The CMP sensor is located at the top of the cylinder head cover near the oil filler cap.



2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

CKP (NE) Sensor Overview

The crankshaft position (CKP) sensor on this engine is a magnetic transducer mounted at the bottom of the engine behind the timing chain cover and adjacent to a crank angle sensor plate. This is a magnetic pickup type sensor (36-1 design - there is one missing tooth). The CKP sensor outputs a signal for every 10° of crankshaft rotation.

The PCM uses the CKP sensor signal ('NE' signal) in order to determine the "actual" crankshaft angle and the engine speed.

CMP (G) Sensor Overview

The camshaft position (CMP) sensor on this engine is a magnetic transducer mounted at the top of the cylinder head cover near the oil filler cap. The CMP or 'G' sensor plate is mounted to the exhaust camshaft and has one (1) tooth on its outer circumference.

The PCM is able to determine the standard crankshaft angle based on the 'G' signal. The CKP and CMP sensors are connected to the PCM by two circuits that supply AC voltage signals with the engine cranking or running. As the sensor plate notches pass the sensor, it generates an AC signal that changes in amplitude with the engine speed.

DVOM Test (CKP Sensor)

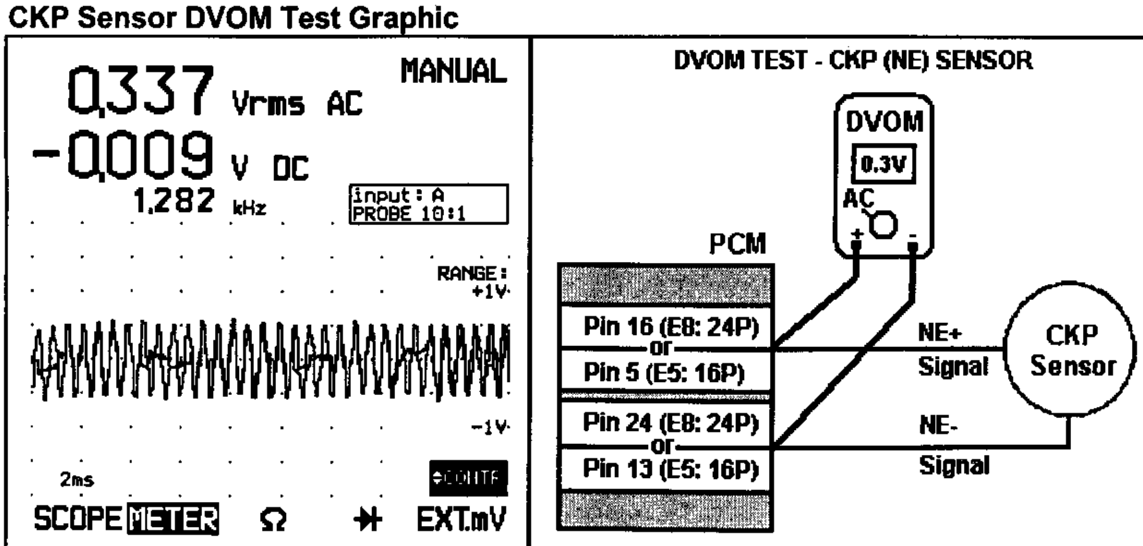
A DVOM can be used to test the AC output signal from the CKP sensor to the PCM with the engine cranking or running. This test method can be used to provide an indication that this sensor is working. The DVOM example shown below was captured with a Fluke 99-B with the DVOM selected and a 10:1 probe connected to the Lab Scope Input 'A'.

<u>DVOM Connections (CKP Sensor)</u>

Connect the DVOM positive probe to the CKP (NE+) signal at Pin 16 (24P connector) or at Pin 5 (16P connector), depending upon the vehicle. Connect the negative probe to the CKP (NE-) signal at Pin 24 (24P connector) or Pin 13 (16P connector), depending upon the vehicle application and transmission type.

The DVOM should show a voltage near 0.37v AC Vrms~(1.282 Hz) at 2500 rpm. The time base setting was 2 ms and the voltage setting was 1v.

CKP Sensor DVOM Test Graphic



2000 COROLLA (1.8L I4 VIN R)

Electronic Ignition System

Lab Scope Test (CKP & CMP Sensors)

The Lab Scope is the "tool of choice" to test the signals from the CKP and CMP sensors as it provides an excellent view of the sensor waveforms and of any possible glitches. Place the gearshift selector in Park or Neutral and block the drive wheels for safety.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to 5 volts per division and the sweep rate to 10 ms (0.010 second). These signals can be checked at idle and cruise speeds with the engine cold or at normal operating temperature.

Scope Connections (CKP Sensor)

Connect the Channel 'A' positive probe to the CKP (+) signal at Pin 16 or Pin 5 (BLK wire). Connect the negative probe to the CKP (-) signal at Pin 24 or Pin 13 (WHT wire).

Scope Connections (CMP Sensor)

Connect the Channel 'B' positive probe to the CMP (+) signal at Pin 15 or Pin 12 (BLK wire) depending upon the vehicle and transmission type (e.g., M/T & 3SP-A/T, 4SP-A/T).

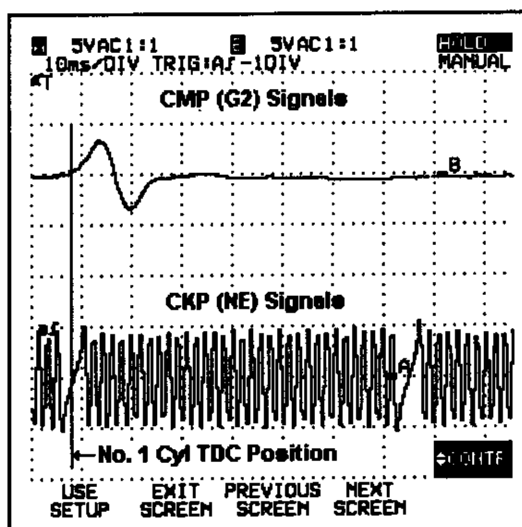
Lab Scope Explanation - CMP (G2) Signal

In this example, the signal trace shows the 1x CMP sensor signal at idle speed. This sensor input shows a signal that is 7v peak to peak and this trace represents 360 degrees of crankshaft rotation. The CMP (G2) sensor outputs one (1) signal in 360 degrees of crankshaft rotation.

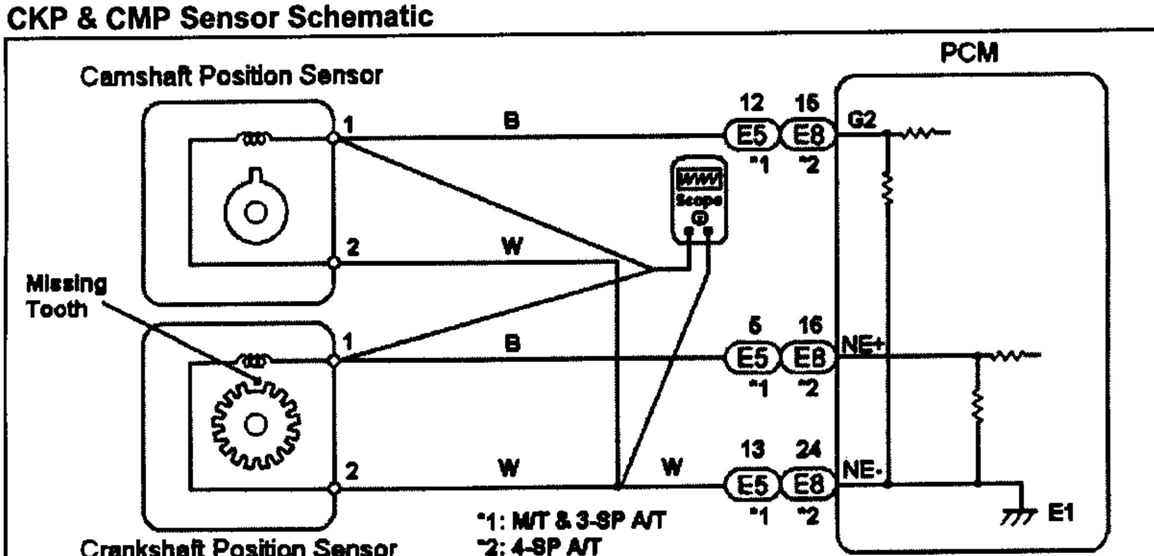
Lab Scope Explanation - CKP (NE) Signals

In this example, the signal trace shows the CKP 36-1 sensor signals at idle speed. These signals show a signal that is 10v peak to peak.

Summary: This example shows one CMP (G2) signal and the 36-1 CKP sensor signals that represent 360 degrees of crankshaft rotation.



CKP & CMP Sensor Schematic



2000 COROLLA (1.8L I4 VIN R)

Knock Sensor

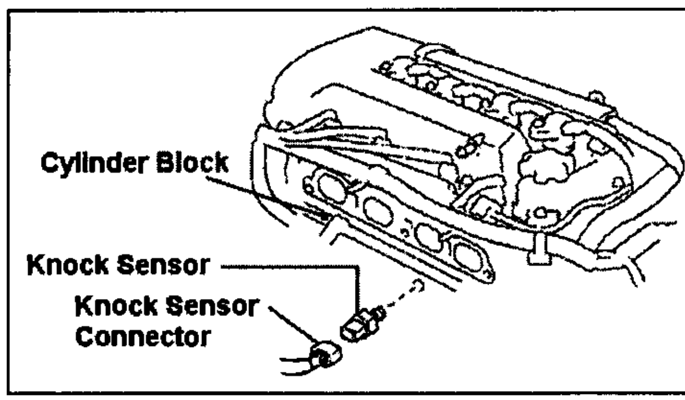
General Description

The knock sensor (KS) is a piezoelectric device that is mounted to the cylinder block. It is designed to generate a voltage whenever it is exposed to vibration.

When engine detonation occurs, the cylinder block vibrates, and this action causes the KS to generate an AC pulse signal. The signal varies in amplitude depending upon the intensity of the vibration (or spark knock).

A typical engine vibration occurs in the 7KHz range (7,000 cycles per second). The KS and the PCM circuitry are designed to take advantage of this range of operation.

The resonance type of sensor is tuned into a very narrow frequency band and only produces a significant signal voltage when it is exposed to vibrations in the 7KHZ range.

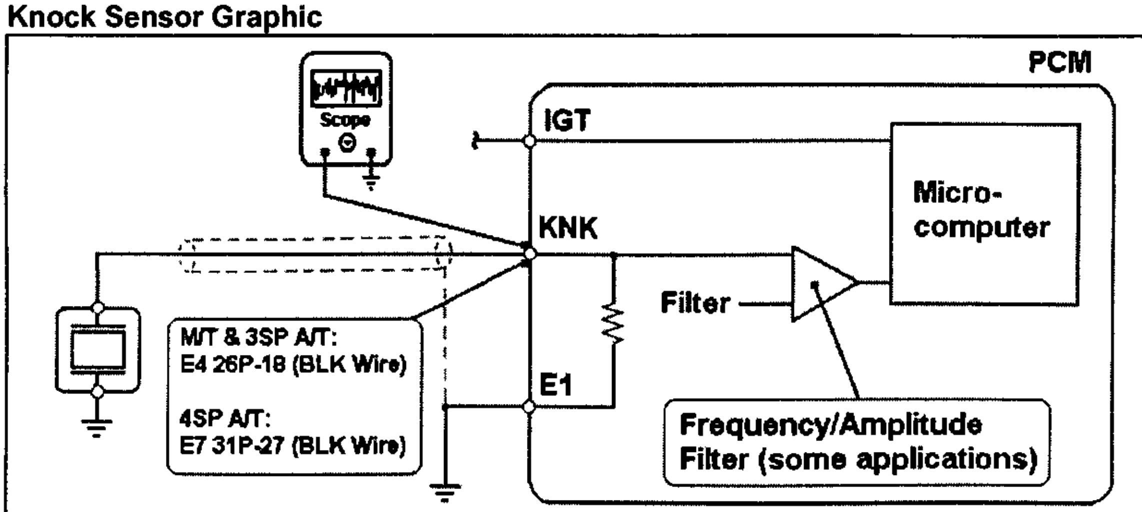


The PCM and KS are wired as shown in the schematic. When engine detonation occurs, the PCM monitors the KS signal to determine the degree of detonation occurring.

If the PCM determines that detonation is taking place, it retards the ignition timing until the knocking stops. Spark timing is then advanced back to a calculated value, or if the detonation returns, it retards the spark timing again until the knocking stops.

In the event that the PCM continues to sense detonation, spark timing retard is limited based on a "clamp" value stored in memory. If the PCM determines that the knock retard is not functional it will enter "fail safe" mode and fix the retard value to prevent engine damage.

Knock Sensor Graphic



2000 COROLLA (1.8L I4 VIN R)

Knock Sensor

Lab Scope Test (Knock Sensor)

The Lab Scope is the "tool of choice" to test the signals from the knock sensor (KS) as it provides an excellent view of the knock sensor waveforms and of any possible glitches. Place the gearshift selector in Park or Neutral and block the drive wheels for safety.

<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples.

The knock sensor signal can be checked at idle and cruise speeds with the engine cold or at normal operating temperature.

<u>Scope Connections (M/T or 3SP A/T)</u>
Connect the Channel 'A' positive probe to the KS signal at PCM Pin 18 of the E4 26 Pin connector (the BLK wire) and the negative probe to battery ground post.

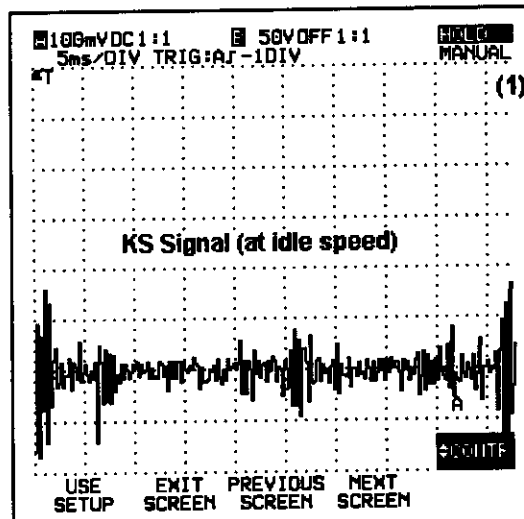
<u>Scope Connections (4SP A/T)</u>
Connect the Channel 'A' positive probe to the KS signal at PCM Pin 27 of the E7 31 Pin connector (the BLK wire) and the negative probe to the battery ground post.

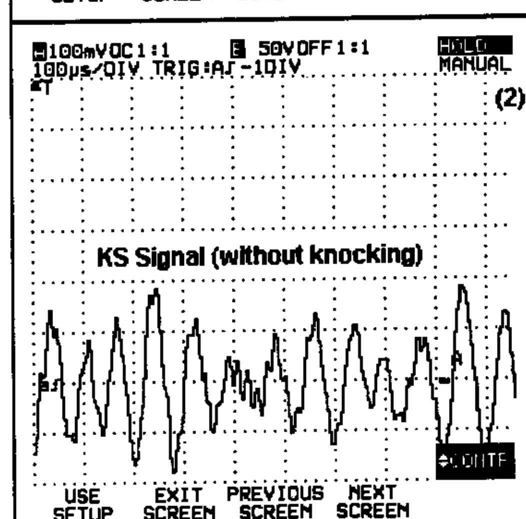
<u>Lab Scope Explanation - Example (1)</u>
In this example, the signal trace shows the KS signal at idle speed with no knock present. This setting does not allow you to look closely at the KS frequency (which can be important).

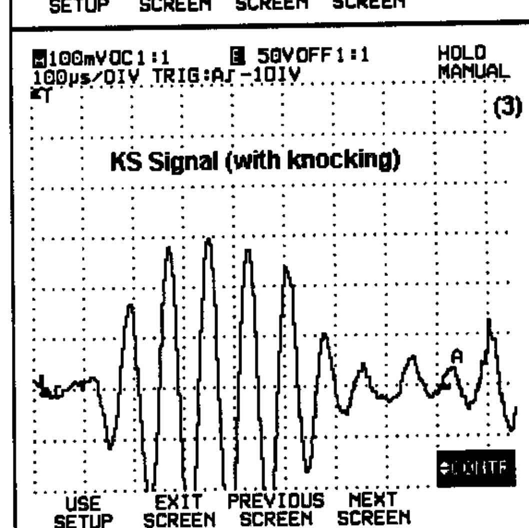
<u>Lab Scope Explanation - Example (2)</u>
In this example, the signal trace shows the KS signal at cruise speed with no knock present. The time base was changed from 5 ms to a more usable setting of 100 µs. The voltage setting was left at 100 mv from Example (1).

<u>Lab Scope Explanation - Example (3)</u>
In this example, the signal trace shows the KS signal at cruise speed with some knocking present. The time base was left at 100 us and the voltage setting was left at 100 mv. Note how these settings allow you to determine if any knocking is occurring on the KS signal circuit at cruise speed (near 2400 rpm).

Summary: These examples show the need to be able to change your Lab Scope settings (depending upon the type of signal under test).







2000 COROLLA (1.8L I4 VIN R)

Fuel Delivery System

Introduction

The Fuel Delivery system includes the following components:

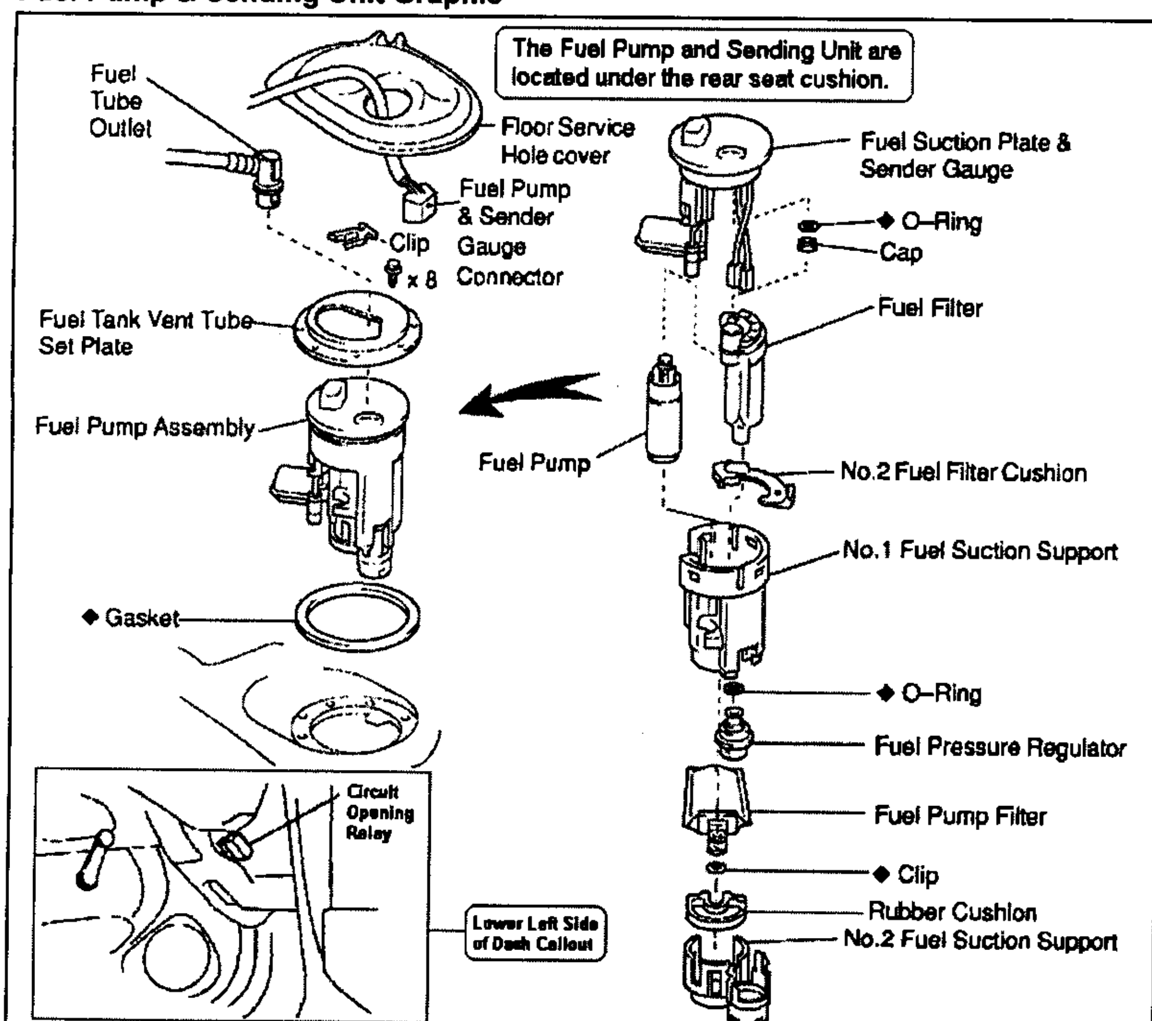
- Fuel tank (with EVAP controls), electric fuel pump, fuel pipe and inline fuel filter
- Fuel injectors (4), fuel pressure regulator and fuel return pipe

System Operation

Fuel in the fuel tank is pumped by an electric fuel pump, which is controlled by the operation of the Circuit Opening relay. Fuel flows through the fuel filter to the fuel rail or fuel delivery pipe and up to the fuel pressure regulator where it is held under pressure.

At startup (during cranking), current flows from the ignition switch ST terminal to the starter relay coil and also to the STA terminal of the PCM. Once the PCM detects that the STA and NE signals are present, it turns on the transistor that controls the FC circuit and current flows to the coil of the circuit opening (C/O) relay. This action causes the relay to energize and battery power is supplied to the fuel pump. After the engine starts (NE signals are received), the PCM continues to hold the FC circuit "on", and the C/O relay remains energized and the fuel pump runs (refer to the Schematic on Page 4-33).

Fuel Pump & Sending Unit Graphic



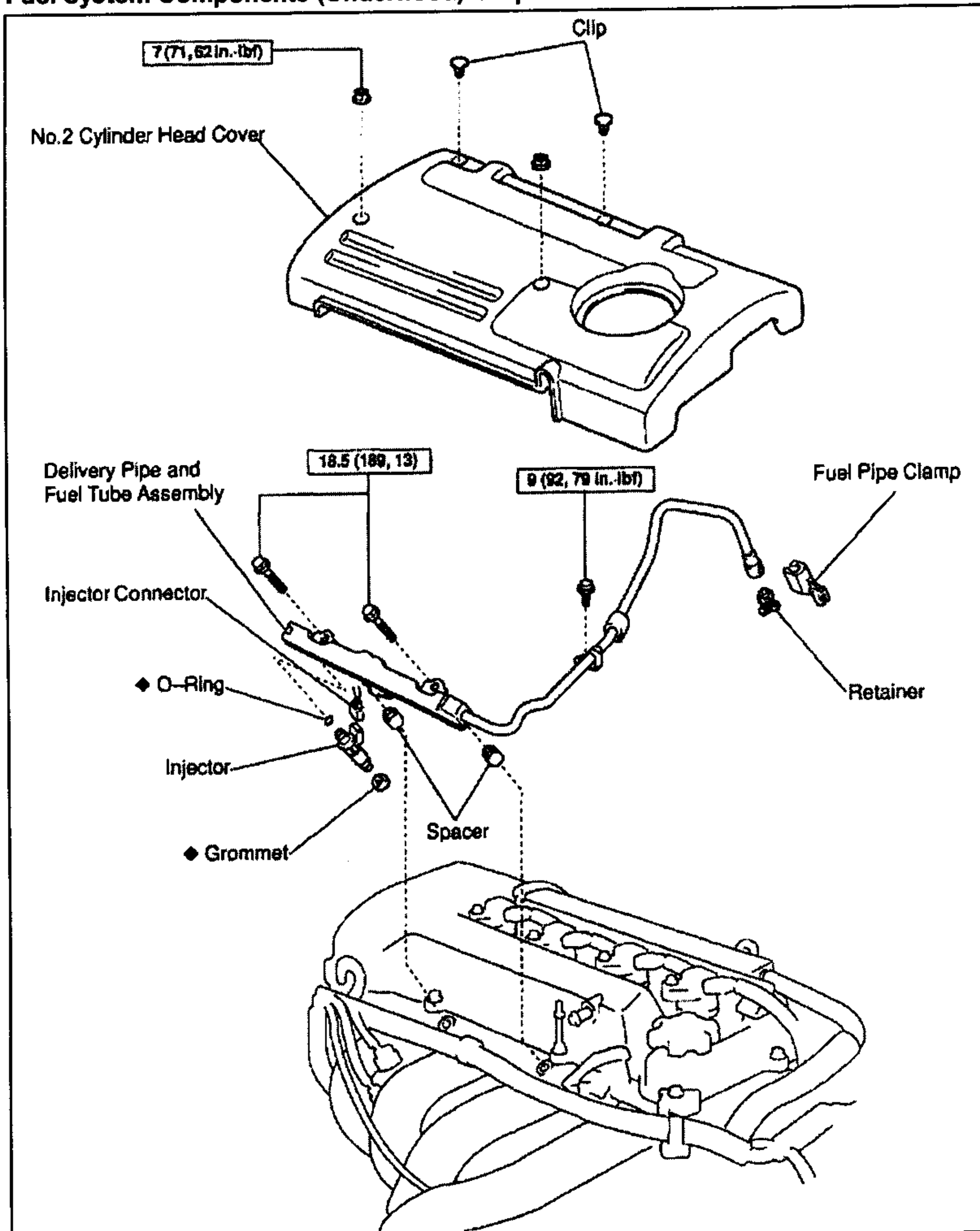
2000 COROLLA (1.8L I4 VIN R)

Fuel Delivery System

Fuel System Components (Part 1)

The Fuel Delivery System "Underhood" components are shown in the Graphic below.

Fuel System Components (Underhood) Graphic



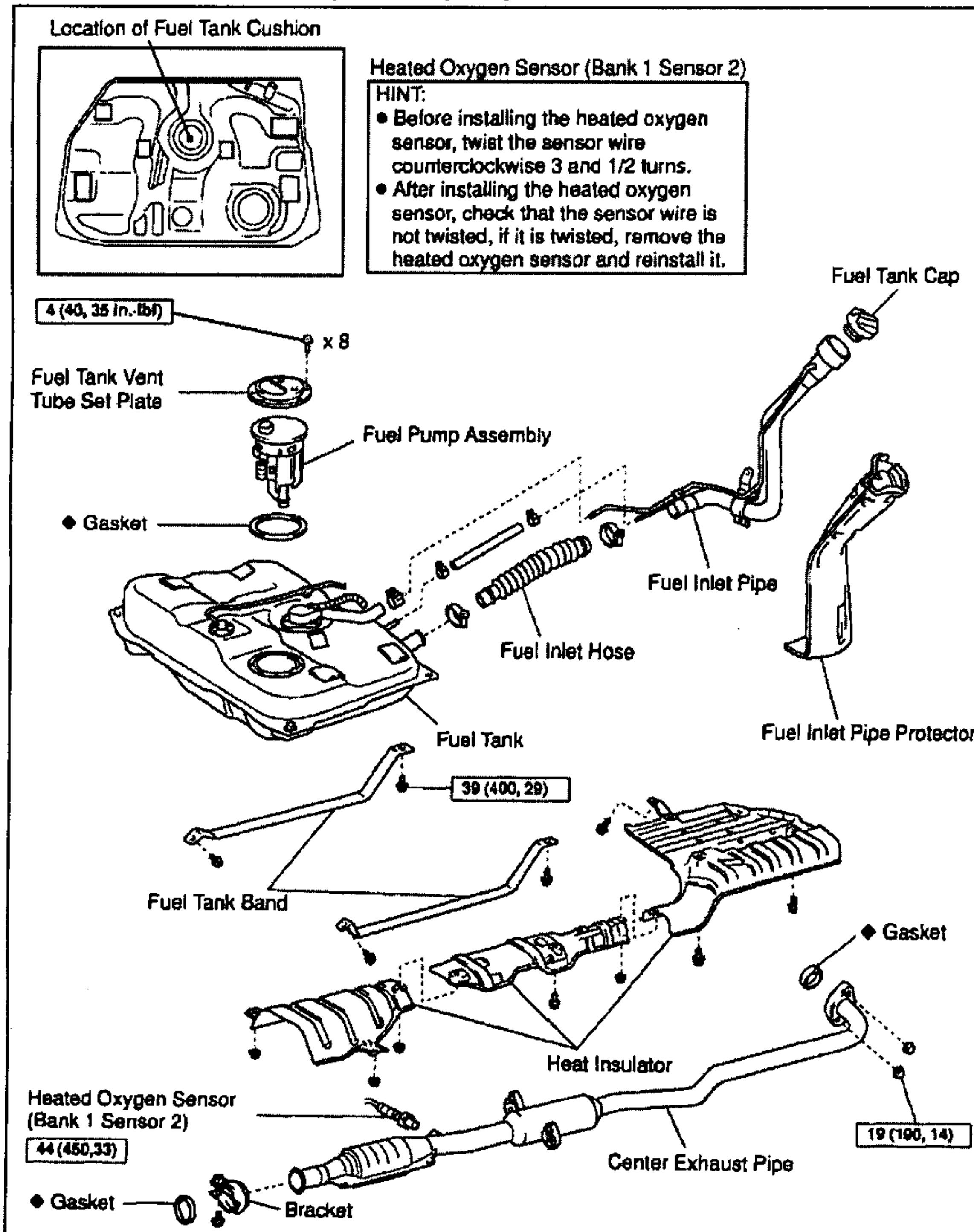
2000 COROLLA (1.8L I4 VIN R)

Fuel Delivery System

Fuel System Components (Part 2)

The Fuel Delivery System "Undercar" components are shown in the Graphic below.

Fuel System Components (Undercar) Graphic

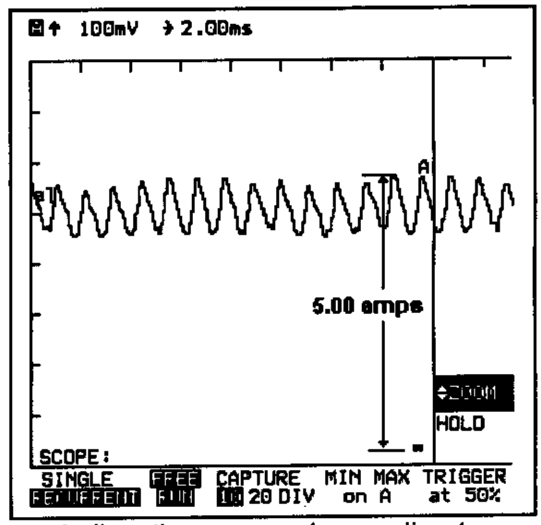


2000 COROLLA (1.8L I4 VIN R)

Electric Fuel Pump

Lab Scope Tests (Fuel Pump)

If you suspect that the fuel pump is faulty, you can use a low amp probe with an inductive pickup to monitor the operation of the fuel pump and its related circuits.



An example of a known good fuel pump motor waveform from this vehicle application is shown in the Graphic on this page. If the fuel pump is in good condition (operating normally), the current draw will be less than 5 amps.

Lab Scope Settings

Set the Lab Scope to these initial settings:

- Volts per division: 100 mv
- Time per division: 1 ms
- Trigger setting: 50% with a positive slope

Scope Connections (Amp Probe)

Set the amp probe to 100 mv (100 mv equals 1 amp) and zero the amp probe before starting the test. Install the amp probe around the C/O relay feed wire to the fuel pump. Start the engine and allow the amp probe reading to stabilize. To test the operation of the fuel pump control circuit, connect the Channel 'A' positive probe to the FC circuit at PCM Pin 3 of the E10 22 pin connector. Connect the Channel 'A' negative probe to the battery ground or to PCM Pin 8 (the E03 circuit).

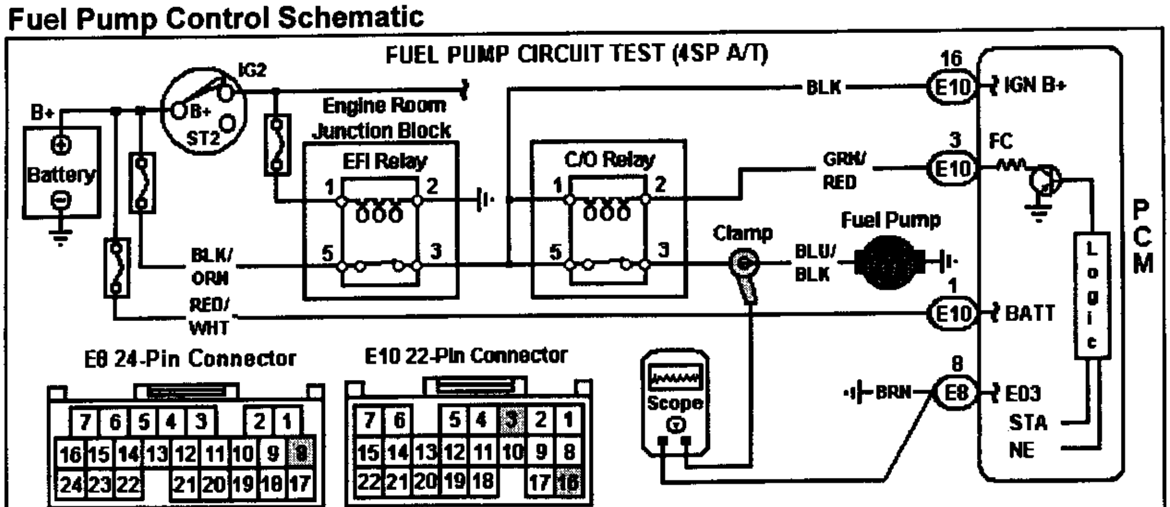
Lab Scope Example Explanation

In this example, the trace shows the fuel pump current with the engine at idle speed. Note the even pattern from this known good fuel pump. Note how the pump is activated by the C/O relay after the PCM receives the correct inputs and grounds the FC circuit.

Symptom Diagnosis

Depending upon the type of problem, you may want to let the engine run for a period of time until it occurs to allow for time to monitor the amount of change in the fuel pump current (in effect, this period of time gives the fuel pump motor time to ramp up). In some cases, you may need to let the engine run until the engine stalls or begins to stall and then capture the waveform at that particular moment.

Fuel Pump Control Schematic



2000 COROLLA (1.8L I4 VIN R)

Fuel Injector

General Description

The injectors are pulsed by the PCM as it completes the injector ground circuit for a certain pulsewidth.

This injector is a hole-type design that helps reduce concerns of fuel injector buildup. The injector valve is recessed from the tip of the injector, and fuel is delivered through holes drilled in a director plate.

This design of injector offers good fuel atomization while demonstrating better resistance to deposit buildup compared to a pintle design injector.

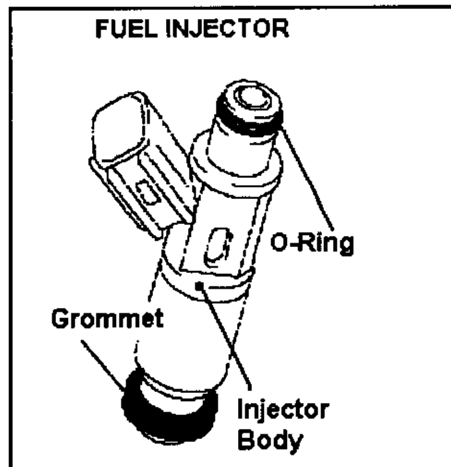
Each injector is positioned directly behind the intake valve. It is installed with an O-ring (insulator/seal) on the manifold end to isolate the injector from heat and to prevent an atmospheric leak to the manifold.

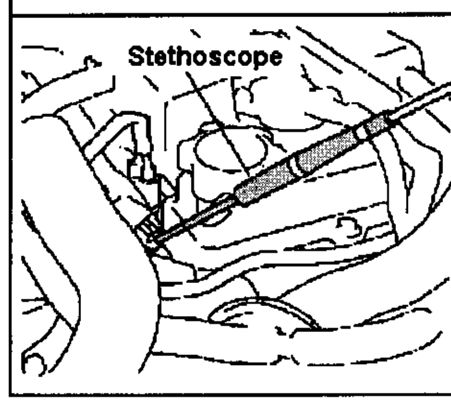
Due to the high resistance of this injector (13.2-14.8 ohms at 68°F), it does not need an external resistor in the voltage controlled injector driver circuit.

<u>Stethoscope Quick Test</u>

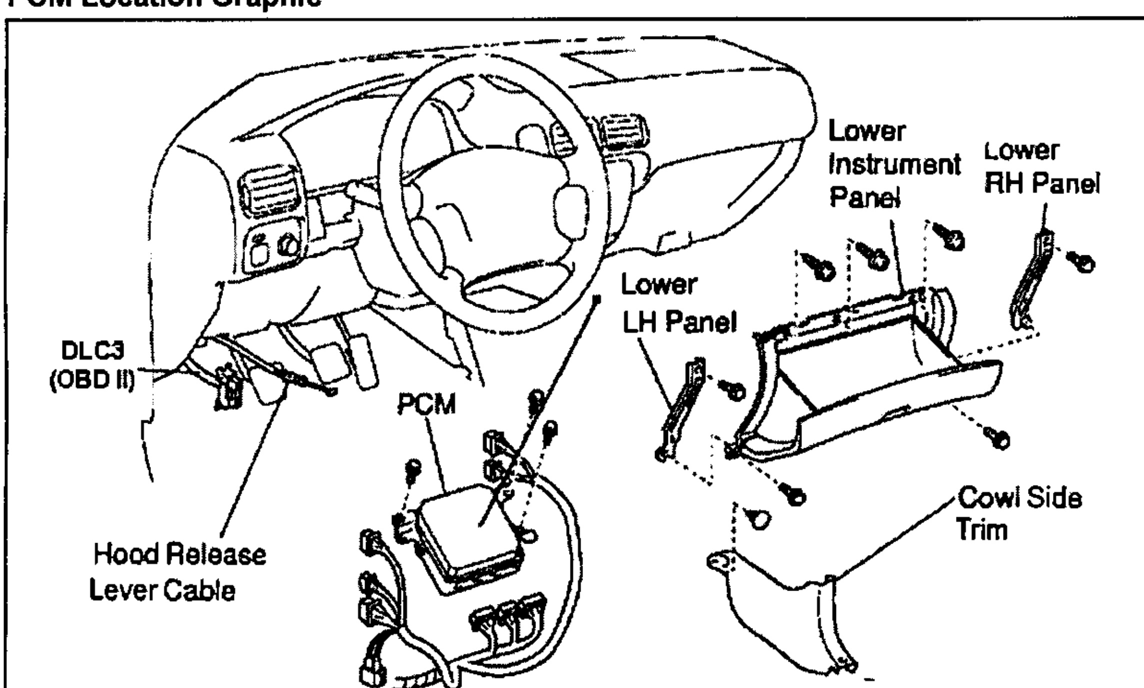
Start the engine and allow it to idle. Locate a stethoscope (or sound scope) that can be used to monitor the operation of each fuel injector.

Listen to the "clicking" sound from each fuel injector. If any injector fails to make a normal clicking sound, replace it and repeat the test with the new injector.





PCM Location Graphic



2000 COROLLA (1.8L I4 VIN R)

Fuel Delivery System

Lab Scope Test (Fuel Injector)

The Lab Scope is the tool of choice to test the operation of the fuel injector and its circuits.

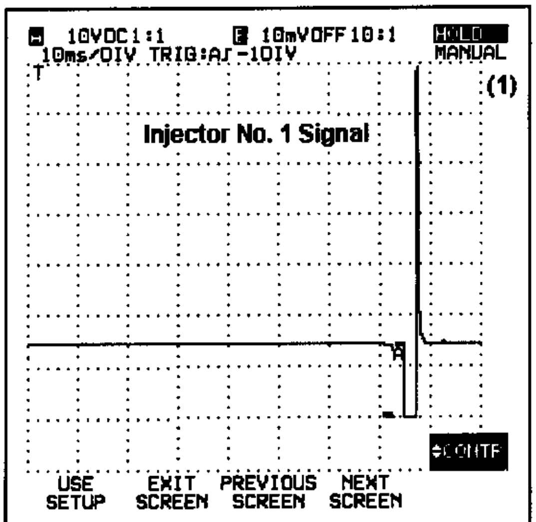
Scope Connections (M/T or 3SP Automatic)
On these applications, connect the Channel 'A' positive probe to the injector No. 1 control signal at PCM Pin 12 of the E4 26P connector (the YEL wire). Connect the Channel 'A' negative probe to battery negative post.

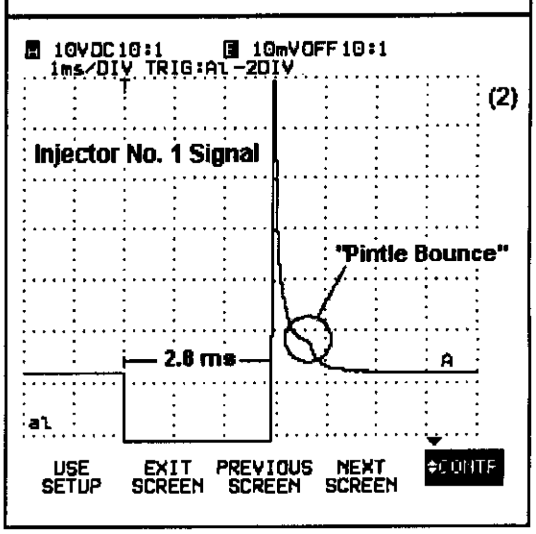
Scope Connections (4SP Automatic)
On this application, connect the Channel 'A' positive probe to the Injector No. 1 control signal at PCM Pin 1 of the E7 31P connector (YEL wire). Connect the Channel 'A' negative probe to E02 at Pin 31 of the same connector.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

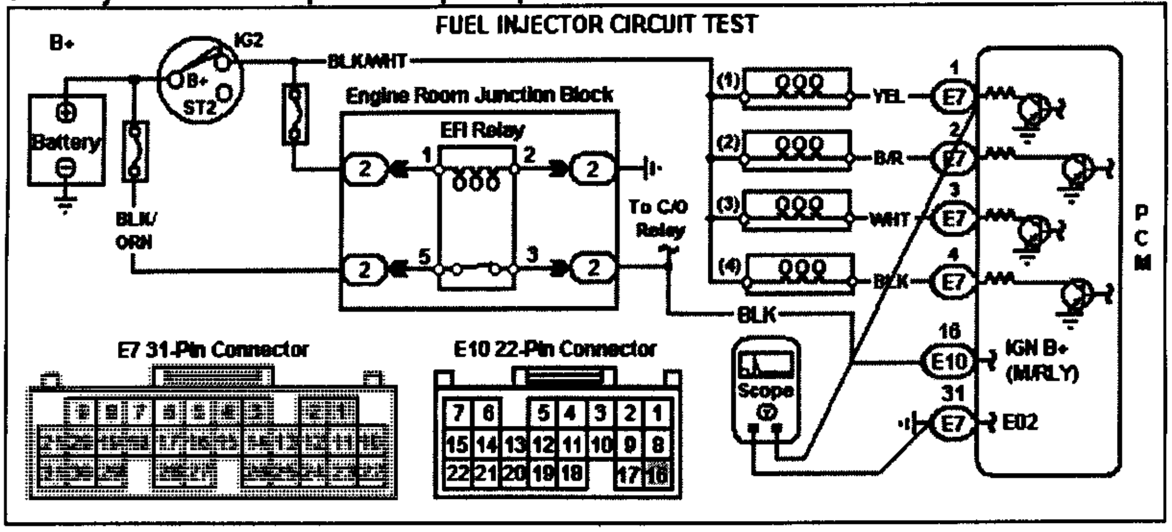
Lab Scope Example (1) Explanation
In this example, the trace shows the injector control signal at idle speed. Note the height of the injector spike (near 70v) in this example.

Lab Scope Example (2) Explanation
In this example, the time base setting was changed (from 10 ms to 1 ms) to get a better view of the amount of time the fuel injector was held open, and to view the mechanical action (pintle bounce) of the injector. Note the length of time (near 2.8 ms) the injector was held open by the driver circuit on this vehicle.





Fuel Injector Lab Scope Hookup Graphic



2000 COROLLA (1.8L I4 VIN R)

Intake Air System

Introduction

The Intake Air system is designed to filter, meter and measure the intake airflow into the engine. In effect, intake air is filtered by the air cleaner and then passed on into the intake manifold in varying volumes.

The amount of air that enters the engine is a function of the throttle valve opening angle and the engine speed (rpm). Air velocity increases as it passes through the long, narrow intake manifold runners, and this action results in improved "volumetric efficiency".

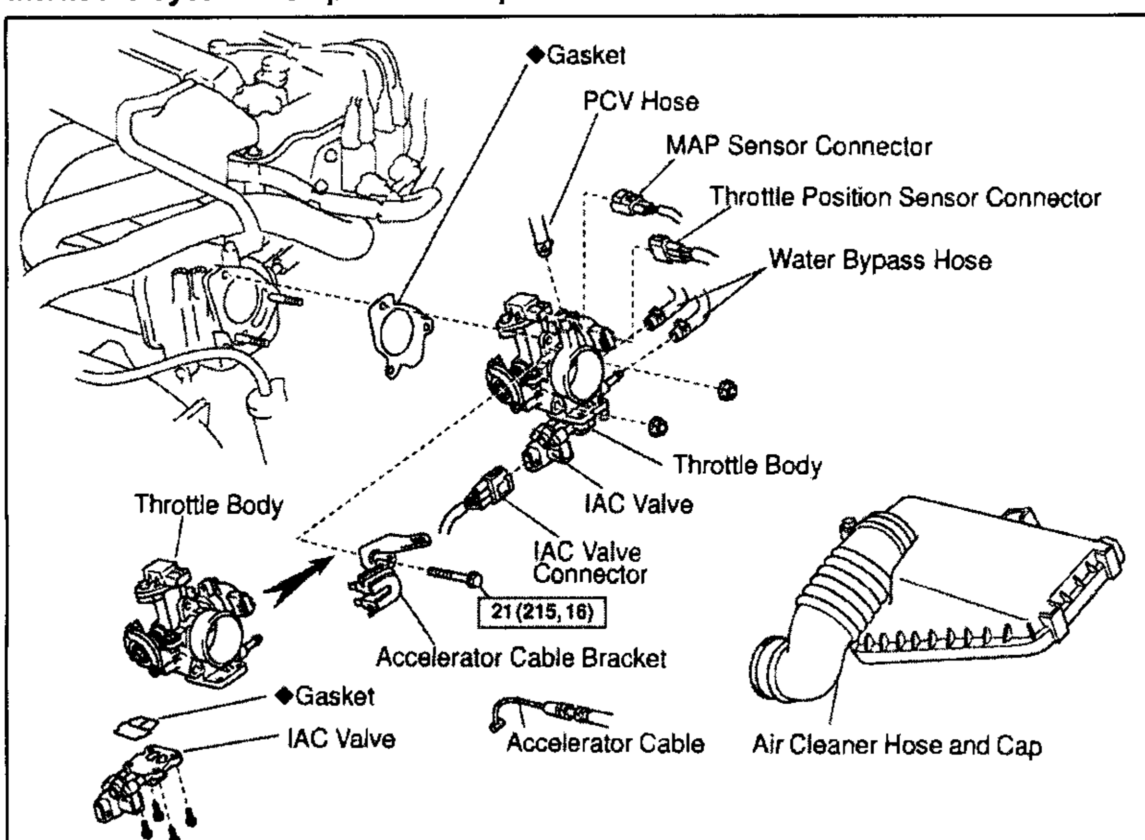
This engine is equipped with electronic fuel injection (EFI). In this system, a MAP sensor (located on the bulkhead) is used to measure the intake air volume by monitoring changes in engine intake manifold pressure (speed density method). Because pressure in the intake manifold is proportional to the amount of air entering it, the MAP sensor can be used to measure the air intake volume on this type of system.

Throttle Body Components

The throttle body consists of the throttle valve, idle air control valve bypass, the throttle position sensor, and related hoses that connect various ported and manifold vacuum sources to the emission control devices.

The throttle valve directly controls the volume of air that enters the engine based on driver demand.

Intake Air System Components Graphic

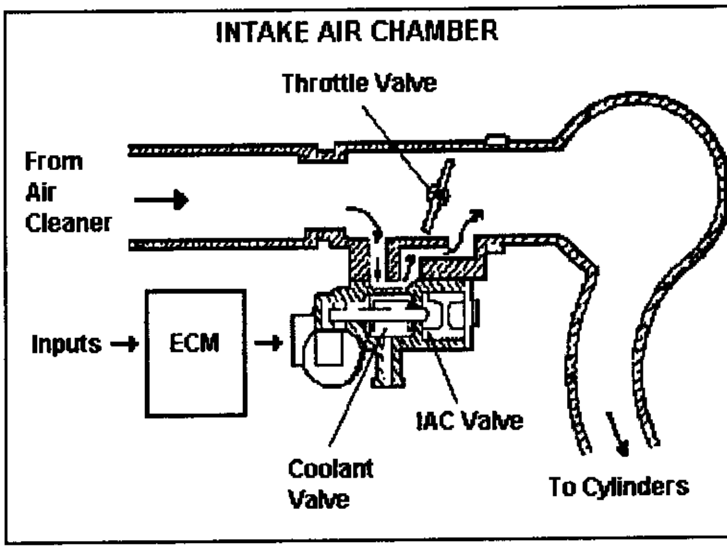


2000 COROLLA (1.8L I4 VIN R)

Idle Air Control System

Idle Air Control Valve

The purpose of the Idle Air Control (IAC) system is to provide a stabilized curb idle whenever loads are applied to the engine. This engine is equipped with a rotary solenoid design IAC valve. The valve is used to regulate the amount of air that flows through its internal passage (this air bypasses the throttle valve located in the throttle body) as shown in the Graphic.



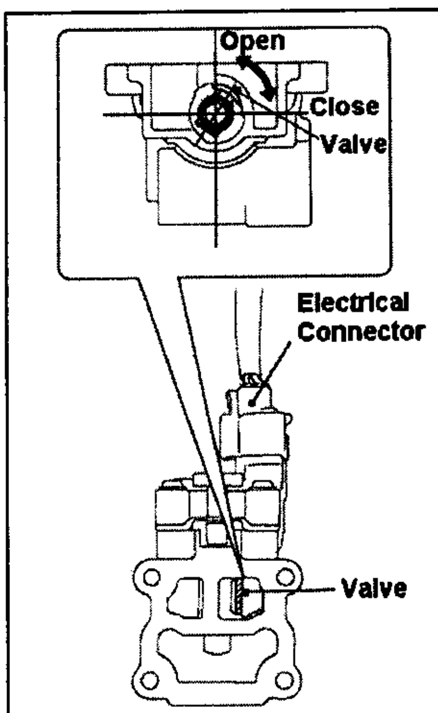
The PCM uses the IAC system in order to control the engine idle speed (it controls the amount of air bypassing the normal regulated airflow flowing past the throttle valve).

The PCM controls the position of the IAC valve, based on inputs it receives from the sensors listed below:

- Engine temperature
- Engine speed
- Vehicle speed

The PCM repositions the IAC valve in order to perform the following functions:

- Idle speed (idle-up) control
- Target idle speed control



<u>IAC Valve Quick Check</u>

To perform a function check of the IAC valve, follow the steps in this procedure:

- Remove the IAC valve unit for inspection.
- Inspect the valve to determine if it is open to about its halfway position.
- Connect the IAC harness connector to the valve.
- Disconnect the ECT sensor wire harness connector.
- Turn the ignition to key on, engine off.
- Verify that the IAC valve moves after the key is turned "on". It may help to repeat this procedure several times (turn the key off each time before turning it back to "on").
- If the IAC valve does not move as described (it may not be functioning properly due to a mechanical problem or it may be binding due to sludge), replace the IAC valve and retest.

Note: ***The IAC Valve Quick Check is only used to determine the functional operation of the IAC valve. It should not be used to determine if the electrical circuits are okay. The OBD diagnostic procedure should be following to check the electrical circuits.***

2000 COROLLA (1.8L I4 VIN R)

Idle Air Control System

DVOM Test (IAC Valve)

Connect the DVOM positive probe to the IAC valve control wire and the negative probe to the battery negative post (refer to the IAC Test hookup explanation in the Graphic).

Start the engine and allow it to idle. Monitor the amount of IAC valve duty cycle on the DVOM. Then apply an engine load (A/C and blower "on") and monitor the duty cycle again.

Specification: The IAC valve duty cycle for this vehicle is from 27-47% at idle with no load.

Lab Scope Test (IAC Valve)

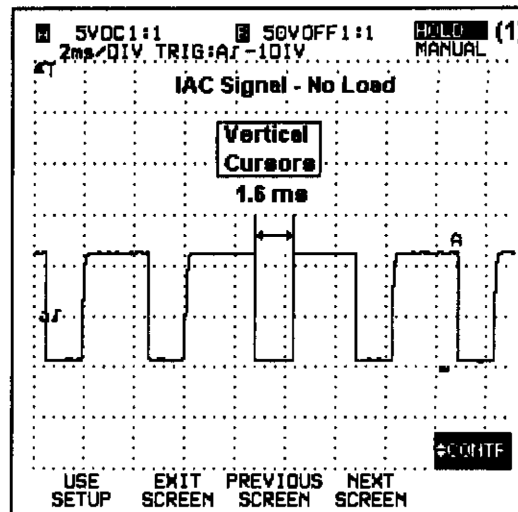
The Lab Scope is the "tool of choice" to test operation of the IAC valve and its circuits.

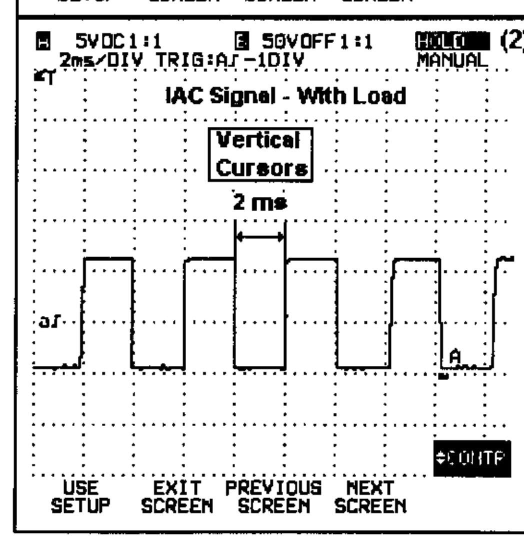
Scope Connections
Connect the Channel 'A' positive probe to the IAC valve RSO control wire and the negative probe to battery negative post (RSO stands for the IAC rotary solenoid open signal wire).

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

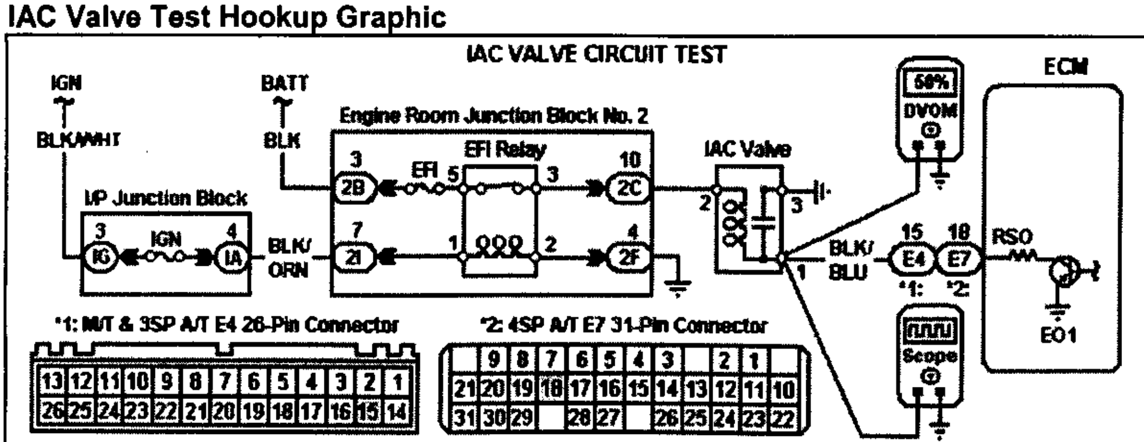
Lab Scope Explanation - Example (1)
In this example, the trace shows the IAC valve control signal at idle speed without any engine load applied. Note that the IAC valve signal on time is 1.6 ms at a frequency of about 250 Hz.

Lab Scope Explanation - Example (2)
In this example, the trace shows the IAC valve control signal at idle speed with the A/C and blower motor on. Note that the IAC valve signal on time is now close to 2 ms while operating at a frequency of about 250 Hz.





IAC Valve Test Hookup Graphic

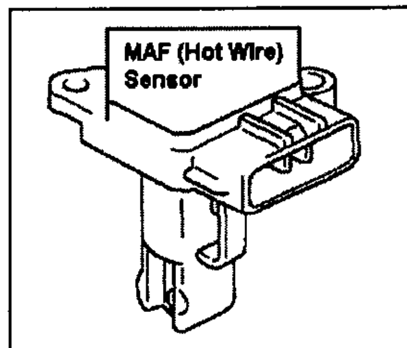


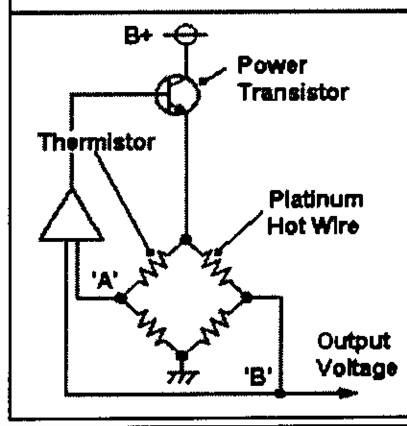
2000 COROLLA (1.8L I4 VIN R)

Mass Airflow Sensor

General Description

The Mass Airflow (MAF) sensor is a Platinum hot-wire design. This MAF sensor works on the principle that the hot wire and the thermistor (which are positioned in the air intake bypass of the housing) detect any changes in the intake air temperature.





System Components

The hot wire airflow meter includes the following components:

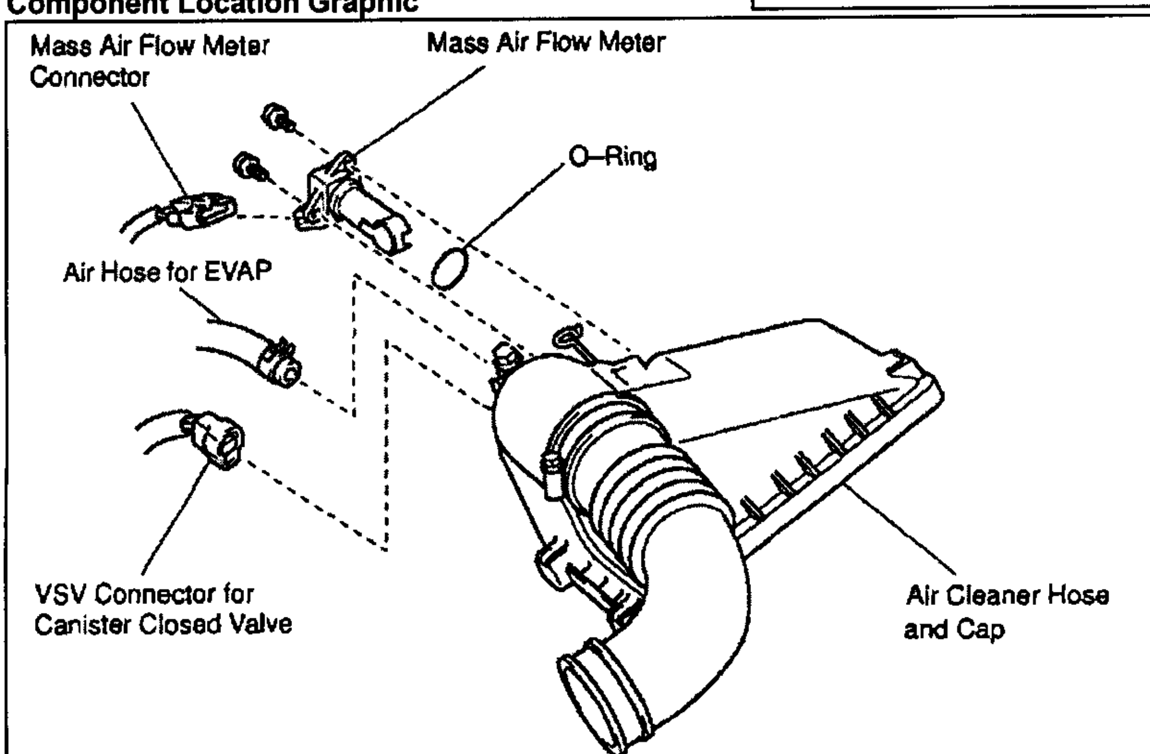
- A Platinum hot wire
- A thermistor
- An airflow meter control circuit installed inside of a plastic housing

Circuit Operation

The airflow meter (control circuitry) maintains the hot wire at a set temperature by controlling the current flow through the hot wire. This amount of current flow is converted by the control unit into a MAF sensor output voltage signal, and is sent on to the PCM.

The hot wire circuit is constructed so that the Platinum hot wire and thermistor form a "bridge circuit". The internal power transistor is controlled so that the potential of circuit 'A' and circuit 'B' remains the same in order to maintain the correct hot wire temperature.

Component Location Graphic



2000 COROLLA (1.8L I4 VIN R)

Mass Airflow Sensor

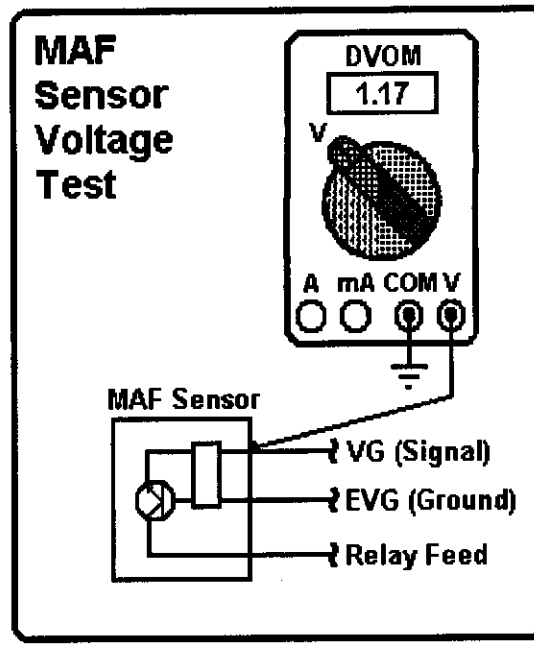
DVOM Test (MAF Sensor)

To test the MAF sensor with a DVOM, first place the gear selector in Park or Neutral (M/T) and block the drive wheels for safety.

DVOM Connections (M/T & 3SP A/T)
Connect one DVOM probe to the MAF sensor signal wire at PCM Pin 2 of 16P connector (GRN wire) and the common probe to PCM Pin 10 (BLU/WHT wire) of same connector.

DVOM Connections (4SP A/T)
Connect one DVOM probe to the MAF sensor signal wire at PCM Pin 11 of 24P connector (GRN wire) and the common probe to PCM Pin 1 (BLU/WHT wire) of same connector.

Start the engine (fully warm) and record the DVOM readings at idle and 2500 rpm. Compare the values to the examples.

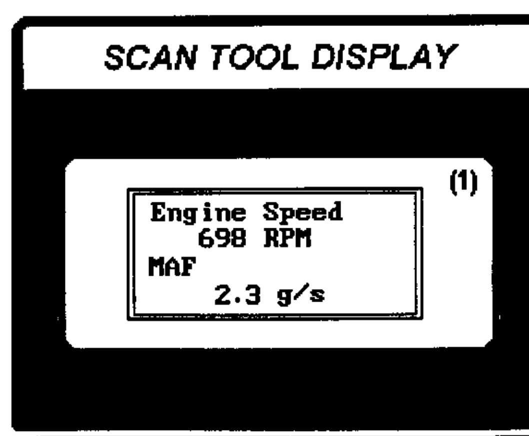


Scan Tool Test (MAF Sensor)

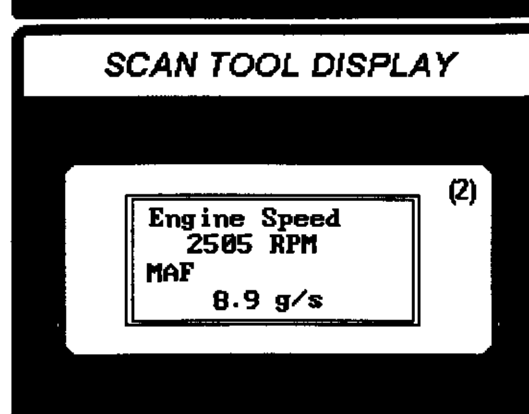
The Scan Tool is the "tool of choice" to use to test the operation of the MAF sensor and its circuits. While a Lab Scope can also be used, it is far easier to obtain information about this sensor with a Scan Tool. MAF sensor information is provided in gms/sec (so that you can compare it to a "known good" vehicle or values in an operating range chart).

Connect the Scan Tool to the OBD II 16-Pin underdash test connector. Follow the Scan Tool menu instructions in order to select PID Data from the main menu so that the Mass Airflow Rate and Engine Speed readings can be displayed as shown in the examples.

Run the engine at 1500 rpm in Park or Neutral (M/T) for 3 minutes until it is fully warmed up. Then allow the engine to return to idle speed to set up the test sequence.



Scan Tool Test (1) Example
With the engine running at idle with the gear selector in Park or Neutral and the Parking Brake applied, record the MAF and RPM PID readings. Compare them to the example.



Scan Tool Test (2) Example
With the engine running at 2500 rpm with the gear selector in Park or Neutral and Parking Brake applied, record the MAF and RPM PID readings. Compare them to the example.

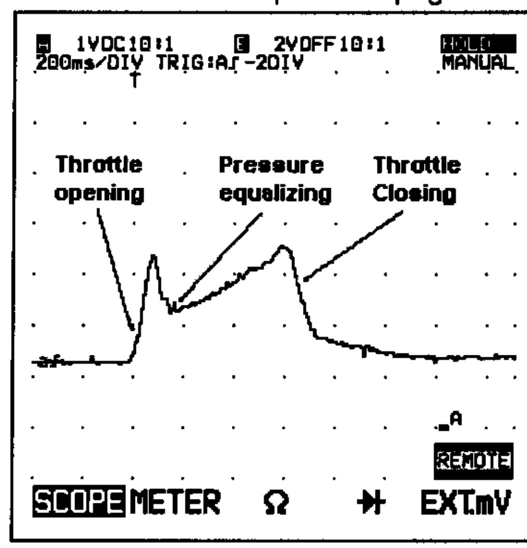
If the MAF PID readings do not match these examples, the MAF sensor may be dirty.

2000 COROLLA (1.8L I4 VIN R)

Mass Airflow Sensor

Lab Scope Test (MAF Sensor)

The Lab Scope can be used to test the operation of the MAF sensor and its circuits, but is not the "tool of choice" for this device. The Scan Tool can be used more effectively. Refer to the article on the Scan Tool Test for the MAF sensor on the previous page.



Scope Connections (M/T & 3SP A/T)
Connect the Channel 'A' positive probe to the MAF sensor signal circuit (GRN wire) at Pin 2 of the PCM 16P connector.

Connect the Channel 'A' negative probe to Pin 10 (BLU/WHT wire) of the same connector.

Scope Connections (4SP A/T)
Connect the Channel 'A' positive probe to the MAF sensor signal circuit (GRN wire) at Pin 11 of the PCM 24P connector.

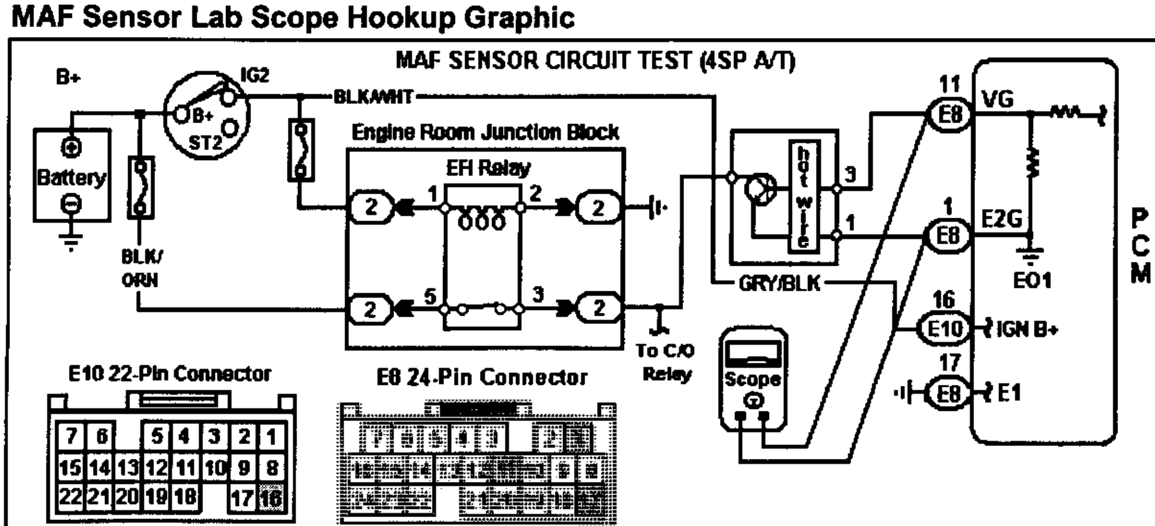
Connect the Channel 'A' negative probe to PCM Pin 1 (BLU/WHT wire) of the same connector or to the battery negative post.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example Explanation
In this example, the trace shows the MAF sensor (analog signal) during a period where a snap throttle condition occurred.

Note the sudden rise in the MAF sensor voltage (to a point over 3v) as the throttle is opened quickly in the example. Note how the signal appears to sag as the pressure in the intake manifold equalizes and then smoothes out. Note also how it climbs back to a high point and then slowly decreases to about 1.5 volts once the throttle is closed.

MAF Sensor Lab Scope Hookup Graphic



2000 COROLLA (1.8L I4 VIN R)

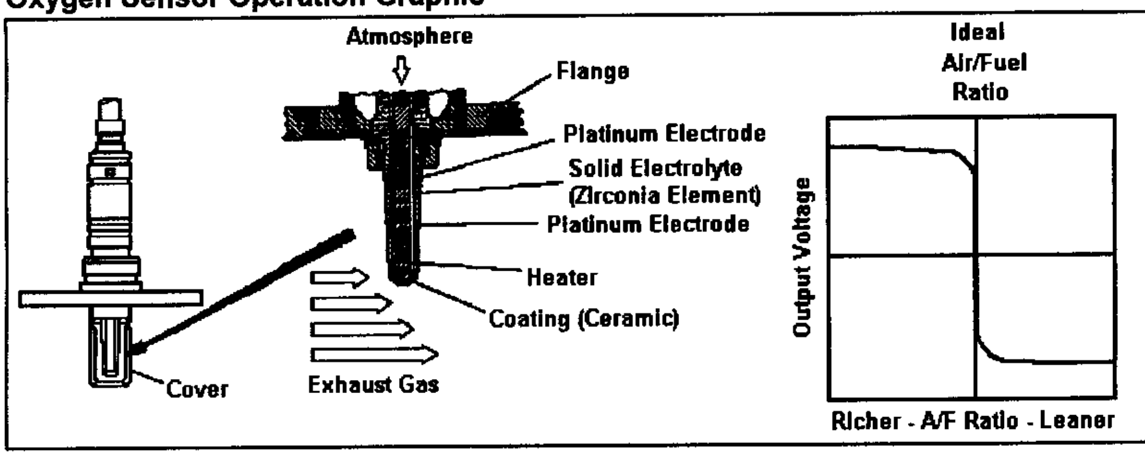
Oxygen Sensors

General Description

The heated oxygen sensor (HO2S) is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust stream. The PCM determines the oxygen density of the exhaust gases through an input signal.

A heater is used along with the oxygen sensor in order to maintain stable oxygen detection performance. The PCM controls the operation of the heater in the oxygen sensor (it turns it "on" and "off"). The PCM connects to the heater control circuit of the front oxygen sensor (HO2S-11) at the PCM terminal identified as HT1A and to the rear oxygen sensor (HO2S-12) at HT1B. The heater resistance is 11-16 ohms at 68°F.

Oxygen Sensor Operation Graphic

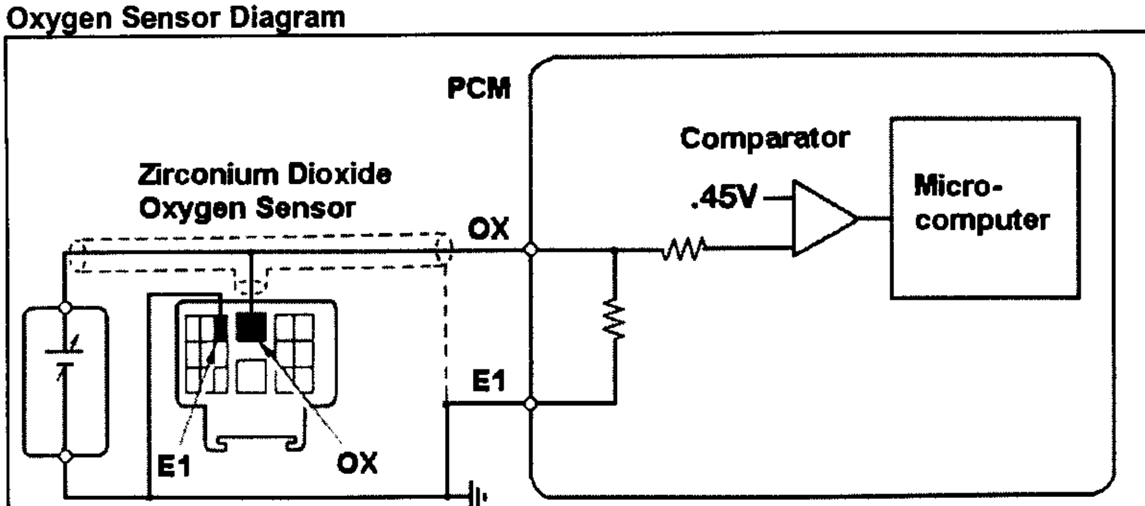


<u>Conventional Oxygen Sensor Operation</u>

In order to obtain a high purification rate for the CO, HC and NOx components of the exhaust gas, a three-way catalytic converter is used on this vehicle. This converter is very efficient when the A/F ratio is controlled at a rate close to stoichiometric A/F ratio.

The heated oxygen sensor has a characteristic whereby its output voltage changes suddenly when it is in the vicinity of the stoichiometric A/F ratio (near 14.7:1). This characteristic is used to detect the oxygen concentration in the exhaust gas and to provide feedback to the PCM for proper control of the A/F ratio.

Oxygen Sensor Diagram



2000 COROLLA (1.8L I4 VIN R)

Oxygen Sensors

Lab Scope Test (Oxygen Sensor)

The Lab Scope is the tool of choice to test the operation of the oxygen sensor and its circuits. Refer to the Oxygen Sensor Lab Scope Hookup Graphic below as needed.

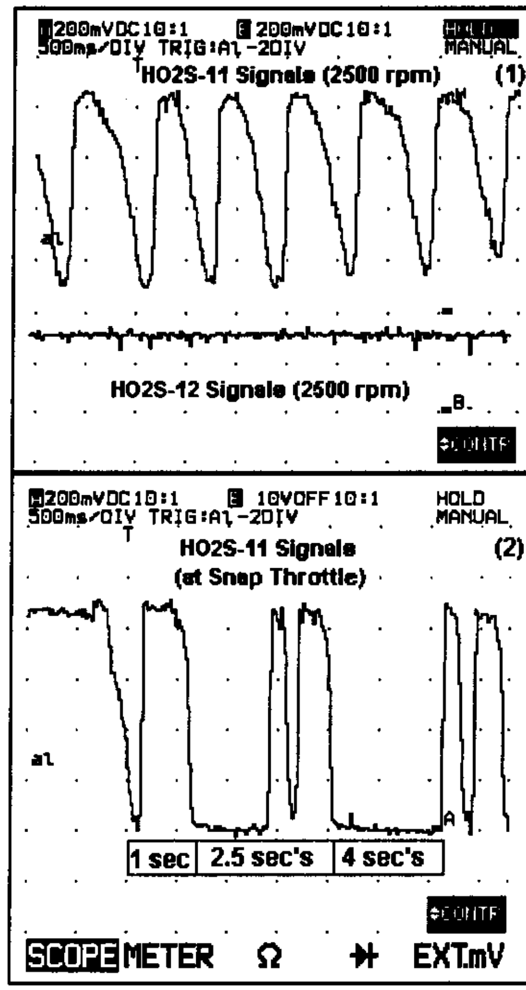
<u>Scope Connections (M/T or 3SP Automatic)</u>
To view the OX1A signal, connect the Channel 'A' positive probe to the HO2S-11 circuit at PCM Pin 6 (WHT wire) of the E5 16P connector. To view the OX1B signal, connect the Channel 'B' positive probe to the HO2S-12 signal at PCM Pin 14 (RED wire) of the E5 16P connector. Connect the Channel 'A' negative probe to battery negative post.

<u>Scope Connections (4SP Automatic)</u>
To view the OX1A signal, connect the Channel 'A' positive probe to the HO2S-11 circuit at PCM Pin 12 (WHT wire) of the E8 24P connector. To view the OX1B signal, connect the Channel 'B' positive probe to the HO2S-12 circuit at Pin 20 (RED wire) of the E8 24P connector. Connect the Channel 'A' negative probe to the battery negative post.

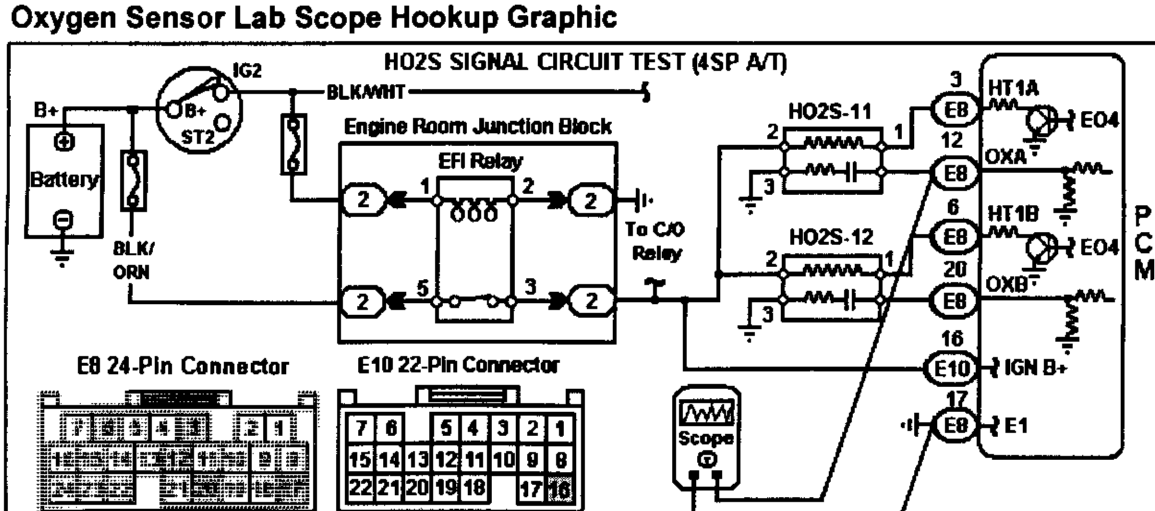
<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Lab Scope Example (1) Explanation</u>
In this example, the trace shows the front oxygen sensor (HO2S-11) signal at 2500 rpm.

<u>Lab Scope Example (2) Explanation</u>
In this example, the trace shows the HO2S-11 signal after three Snap Throttle events (after 1 second, 2.5 second and 4 second delays).



Oxygen Sensor Lab Scope Hookup Graphic

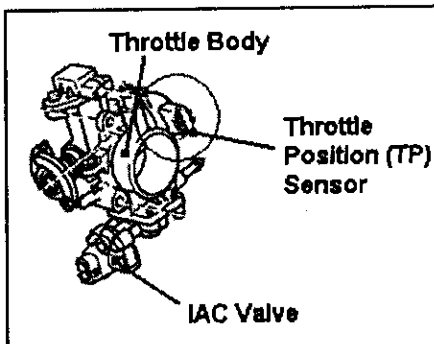


2000 COROLLA (1.8L I4 VIN R)

Throttle Position Sensor

General Description

The Throttle Position (TP) sensor is mounted to the throttle body where it detects the throttle valve angle.



<u>TP Sensor Circuits</u>
The three circuits that connect the TP sensor are:

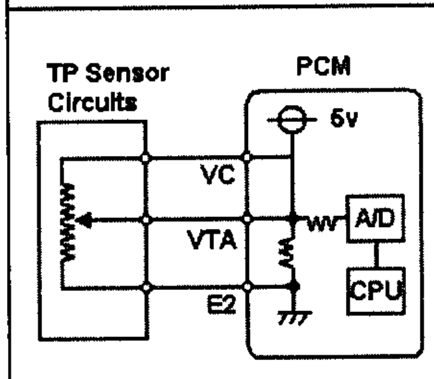
- The VC circuit (the 5v reference voltage circuit)
- The VTA circuit (the TP sensor signal circuit)
- The E2 circuit (the TP sensor ground circuit)

<u>Circuit Operation</u>
With the throttle valve fully closed, the TP sensor signal to the PCM is from 0.3-0.8v at terminal VTA.

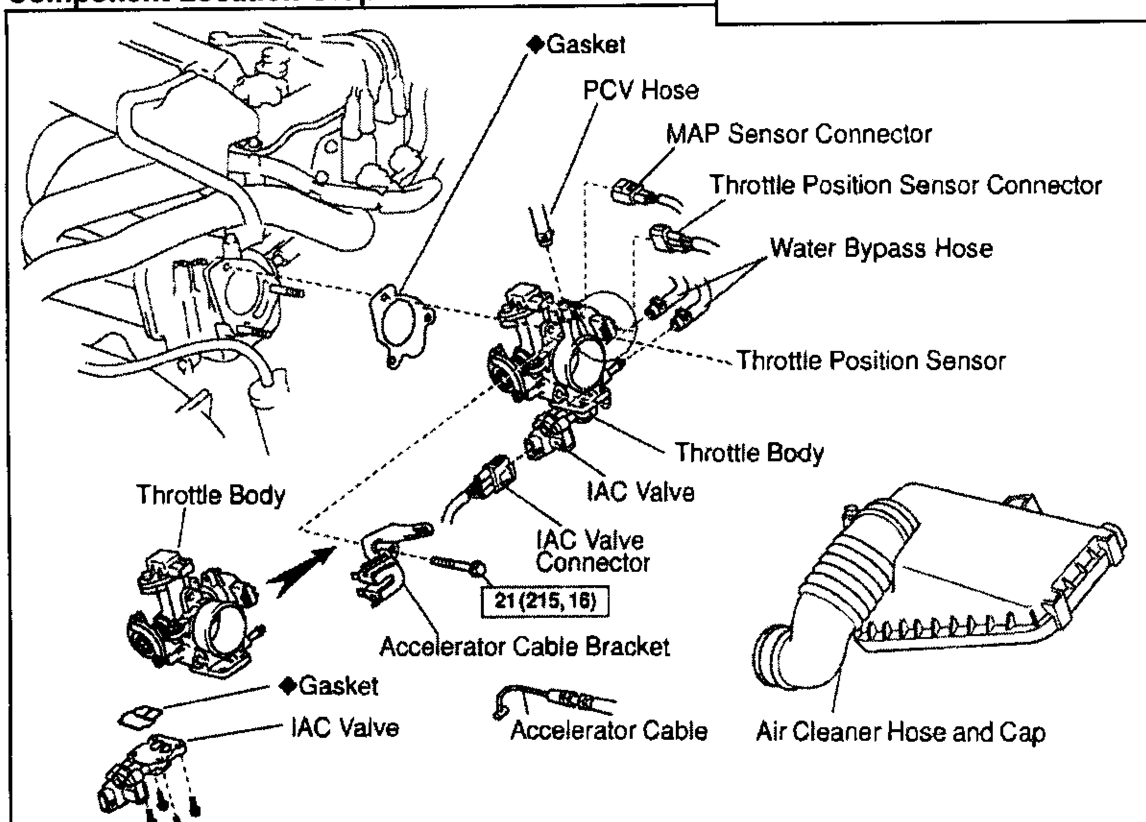
The TP sensor voltage increases in proportion to the throttle valve-opening angle. The TP sensor signal is from 3.2-4.9v with the throttle valve fully open.

The PCM uses the signal (analog DC voltage) to detect the following vehicle driving conditions:

- Air Fuel (A/F) Ratio correction
- Fuel Cut Control
- Power Increase correction



Component Location Graphic



2000 COROLLA (1.8L I4 VIN R)

Throttle Position Sensor

Lab Scope Test (TP Sensor)

The Lab Scope can be used to test the operation of the TP sensor and its circuits, but is not the tool of choice for this device. The Scan Tool is a much easier tool to use to test the operation of this device. However, the Lab Scope will help find a circuit "glitch".

<u>Scope Connections (M/T & 3SP A/T)</u>

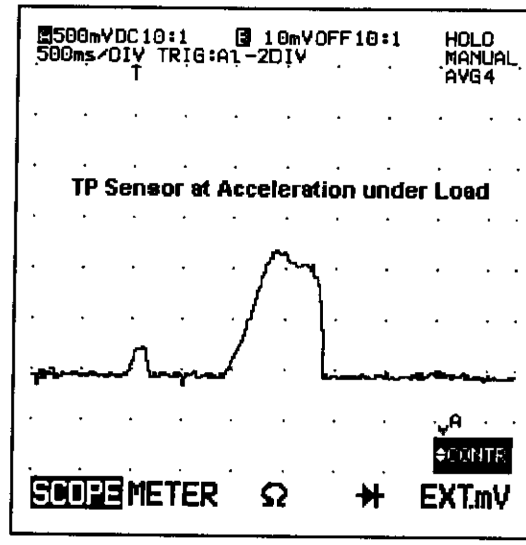
Connect the Channel 'A' positive probe to the TP sensor signal wire at PCM Pin 11 of the 16P connector (LT GRN wire). Then connect the Channel 'A' negative probe to the E2 sensor ground point at PCM Pin 9 (BRN wire) of the 16P connector.

<u>Scope Connections (4SP A/T)</u>

Connect the Channel 'A' positive probe to the TP sensor signal wire at PCM Pin 23 (LT GRN wire) of the 24P connector. Then connect the Channel 'A' negative probe to E1 GND at PCM Pin 17 (BRN wire) of the 24P connector.

<u>Scope Settings</u>

To make the waveforms as clear as possible, set the scope settings to match the examples.

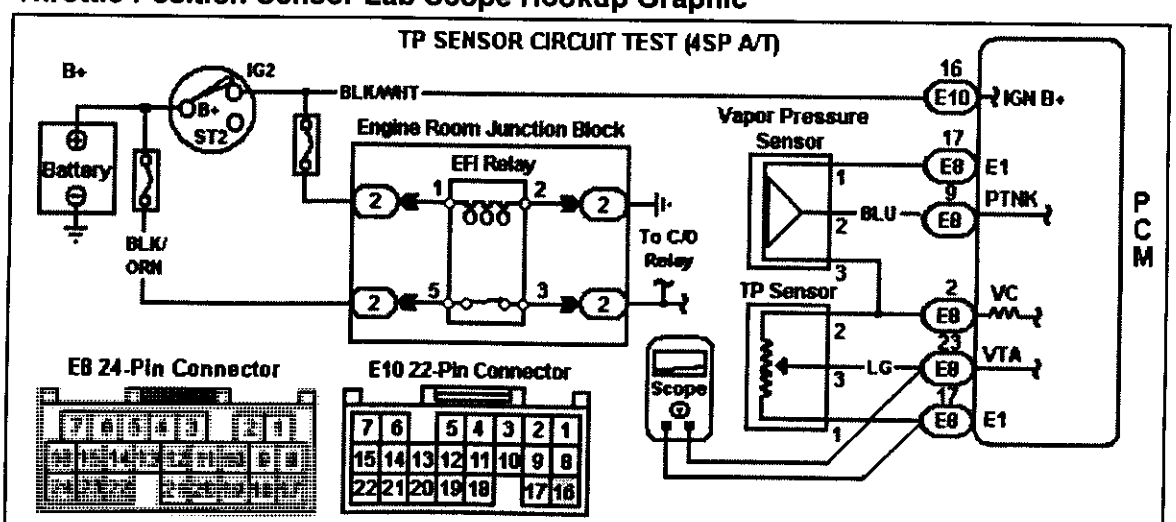


<u>Lab Scope Example Explanation</u>

In this example, the trace shows a known good TP sensor (analog signal) during a brief acceleration period in loaded mode (in gear with the Air Conditioning enabled).

The TP sensor signal should also be checked for breaks in the sensor resistor. One way to find this type of problem is to turn to key on, engine off and with the Lab Scope connected as shown in the Graphic below, slowly open and close the throttle while watching the TP sensor waveform for any sudden increase or decrease in the linear action of the pattern. A dropout (e.g., a sudden downward spike) in the TP sensor signal trace would indicate a short while a sudden upward spike would indicate an open circuit.

Throttle Position Sensor Lab Scope Hookup Graphic



2000 COROLLA (1.8L I4 VIN R)

Reference Information

How To Access & Use Generic PID Information

The Scan Tool Generic Parameter Identification (PID) Mode allows access to certain data values, analog and digital input and output signals, calculated values and system status information.

The Generic OBD II PID list is an example of the PIDs that all OBD II compatible Scan Tools must be able to access and display.

Scan Tool PID Menus

An example of how to navigate through the Vetronix Scan Tool menus to locate the Generic PID information is shown in the Graphic to the right.

The Graphic contains an example of how to read some of the parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column of the example represent known good values for this engine application.

If all of these PID values are within normal range, refer to the Symptom Diagnosis information in Section 1.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete Generic PID list for this vehicle is shown in the Graphic.

1) Select F1: SCANTEST from the opening menu.
2) Select Global OBD II from the Applications menu.
3) Select F0: Powertrain from the Main menu.
4) Initializing OBD II Communications screen appears.
5) Select F0: DATALIST from the Select Mode menu. To view the I/M Readiness status of the OBD II Main Monitors, select F1: Readiness (or another choice).
6) Select F0: Display Data from the Data List Menu.

Some of the eighteen PID items available in the Generic PID list for this vehicle are shown in the last frame.

Diagnostic Tip

The Typical Values in the example on this page should be used after the following conditions are met:

- The Toyota TCCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

(1)
FUNCTION MENU
F1: SCANTEST
F2: DIGITAL METER
F3: OSCILLOCOPE
F4: EMISSION TESTS
F8: TECH TOOLBOX
F9: SETUP

(2)
APPLICATIONS ↑↓
-> GLOBAL OBD II
GM P/T
GM CHASSIS

(3)
MAIN MENU
F0:Powertrain
F1:Replay Data
F9:OBDII Toolpak

(4)
Initializing
OBD II
Communications

(5)
SELECT MODE ↑↓
F0:Data list
F1:Readiness
F2:DTCs

SELECT MODE ↑↓
F3:Snapshot
F4:OBD Controls
F5:System Tests

SELECT MODE ↑↓
F8:Information
F9:OBDII Toolpak

(6)
DATA LIST MENU
F0:Display Data
F1:Data Setup

ENGINE SPEED	868RPM
ECT (°)	180°F
VEHICLE SPEED	0MPH
IGN. TIMING	12.0°
ENGINE LOAD	40.0%
MAP (P)	11.3inHg
TPS (%)	10.5%
IAT (°)	122°F
FUEL STAT 1	OL
ST FT 1	0.0%
LT FT 1	-5.4%
O2S B1 S1	0.045V

2000 COROLLA (1.8L I4 VIN R)

Reference Information

How To Access & Use OEM PID Information

The Toyota Enhanced PID List on the next page contains examples of the engine related parameters available on an Aftermarket Scan Tool with an Asian cartridge.

Toyota has several "data lists" available under the OEM proprietary PID (data) selections. Once you pull up one of the data lists, you can compare the readings in the Hot Idle, 30 and 55 mph columns in the examples on the next page to the examples of the vehicle that is being tested.

If all of the PID values are within normal range, refer to the Symptom Diagnosis in Section 1 of this manual.

Scan Tool PID Menus

An example of how to navigate through the Snap On Scan Tool menus to locate the OEM PID Information is shown in the Graphic to the right.

The Graphic contains an example of how to obtain the vehicle parameters available for this vehicle with an OEM proprietary Scan Tool or Aftermarket Scan Tool with the applicable Toyota or Asian manufacturer cartridge.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete OEM PID list for this vehicle is shown in the Graphic.

1) Select F1: SCANTEST from the opening menu.
2) Select Toyota/Lexus from the Applications menu.
3) Select the letter that identifies the model year ('W').
4) Select the letter that identifies the engine size ('R').
5) Select ENGINE from the Select System menu.
6) Select A/T WITH 4-SPEED from the Options Menu.
7) Select CODES & DATA MENU from the Main Menu.
8) Select CODES & DATA from CODES & DATA Menu.

One of the data lists (twenty-two PID items) from the OEM PID list for this vehicle is shown on the next page.

Diagnostic Tip

The Typical Values in the example on the next page should be used after the following conditions are met:

- The Toyota TCCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are all turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

HONDA/ACURA (1994-00)
MITSUBISHI (1994-00)
NISSAN/INFINITI (1994-00)
~TOYOTA/LEXUS (1994-00)
GENERIC OBD II

VEHICLE ID SCREENS

10th VIN CHARACTER
VIN: --------Y------
VEHICLE: 2000
FOR A/T ID (1994-00):
TURN KEY TO ON

VIN: -- 4--N--R--X--Y
2000 Corolla A/T
ENGINE: 1.8L I4 MPI
PRESS Y TO CONTINUE
PRESS N FOR NEW ID

SELECT SYSTEM:
~ENGINE
4-SPEED TRANS
ANTI-LOCK BRAKES
AIRBAG

SELECT OPTIONS:
M/T WITH A/C
A/T WITH 3-SPEED
~A/T WITH 4-SPEED

MAIN MENU (TOYO ENG)
OTHER SYSTEMS
~CODES & DATA MENU
CUSTOM SETUP
ACTUATOR TESTS

CODES & DATA MENU
~CODES & DATA
1 TRIP CODES

2000 COROLLA (1.8L I4 VIN R)

Reference Information

PCM PID Tables

Note: ***The following readings were obtained with the engine at idle speed, radiator hose hot, throttle closed, gear selector in Park and all accessories turned off.***

OBD II Generic PID Examples

Serial Data Name	Range or Value	Hot Idle	30 MPH	55 MPH
Calculated Load	0-100%	40	29.4	50.5
Engine Coolant Temperature	-40 to 284°F	180	199	194
Engine Speed	0-10,000 rpm	868	1650	1948
Fuel Status BK 1	OPEN or CLOSED	CLOSED	CLOSED	CLOSED
Ignition Timing	-90 to 90 degrees	12.0	20.5	26.0
Intake Air Temperature	-40 to 284°F	122	124	115
Long Term Fuel Trim BK1	0-100%	0.0	-4.6	2.3
MAF Sensor	0-1,000 g/sec	1.9	5.2	22.5
Malfunction Indicator Lamp	ON or OFF	OFF	OFF	OFF
O2S-11 (Bank 1 Sensor 1)	0-1100 millivolts	0.560	0.850	0.230
O2S-12 (Bank 1 Sensor 2)	0-1100 millivolts	0.450	0.050	0.140
O2S-11 (Bank 1 Sensor 2)	0-100%	-3	-1	+1
O2S-11 (Bank 1 Sensor 1)	0-100%	-1	-3	+2
Short Term Fuel Trim BK1	0-100%	0.0	-0.7	-5.8
Stored Trouble Codes	0-255	0	0	0
Throttle Position Sensor	0-100%	10.5	13.3	20.3
Vehicle Speed	0-159 mph	0	30	55

Toyota Enhanced PID Examples

Serial Data Name	Range or Value	Hot Idle	30 MPH	55 MPH
A/C Signal	ON or OFF	OFF	OFF	OFF
CYL 1 Abnormal Variation	0-100%	0%	0%	0%
CYL 2 Abnormal Variation	0-100%	0%	0%	0%
CYL 3 Abnormal Variation	0-100%	0%	0%	0%
CYL 4 Abnormal Variation	0-100%	0%	0%	0%
EVAP Vapor Pressure VSV	ON or OFF	OFF	OFF	OFF
EVAP Purge VSV	ON or OFF	OFF	ON	ON
FC IDL (fuel cut during Decel	ON or OFF	OFF	OFF	OFF
FC TAU (fuel cut light load)	ON or OFF	OFF	OFF	OFF
Fuel Pump Status	ON or OFF	ON	ON	ON
IAC Duty Cycle	0-100%	33	35	35
Ignition (for 1,000 revs)	0-2000	500	700	900
Injector (on-time)	0-99.9 milliseconds	1.5	1.8	2.3
Misfire Load (for 1st misfire)	0-1,000 g/sec	0	0	0
Misfire RPM (for 1st misfire)	0-10,000	0	0	0
O2S LR (B1 S1)	0-1,000 milliseconds	80	90	65
O2S RL (B1 S1)	0-1,000 milliseconds	80	90	65
Park Neutral Switch	ON (P/N) or OFF	ON	OFF	OFF
Starter Signal (cranking)	ON or OFF	OFF	OFF	OFF
Stop Light Switch	ON (braking) or OFF	OFF	OFF	OFF
Total Fuel Trim BK1	Average 0-5v	1.8	1.6	1.9
Vehicle Speed (mph)	0-255	0	30	55

2000 COROLLA (1.8L I4 VIN R)

Reference Information

2000 Corolla (1.8L VIN R) M/T & 3-SP A/T Pin Voltage Table (E4 26-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
26-1	RED	Cam Timing Oil Control Valve (-)	Pulse signals
26-2	BLK	Cam Timing Oil Control Valve (+)	Pulse signals
26-3	BLU/YEL	Igniter IGF Signal	Digital signals (0-12-0-12v)
26-4	RED	Pressure Switching Valve	Valve On:
26-5	LT BLU	EVAP Canister Closed Valve	VSV On: 1v, Off: 12v
26-6	---	Not Used	---
26-7	BLU/BLK	EVAP ORVR VSV Control	VSV On: 1v, Off: 12v
26-8	BLU/RED	Power Steering Pressure Switch	Straight: 12v, turning: 0v
26-9	---	Not Used	---
26-10	RED/BLK	Park Neutral Position Switch	In P/N: 0v, others: 12v
26-11	BLK/RED	Fuel Injector 2 Control	Pulse signals
26-12	YEL	Fuel Injector 1 Control	Pulse signals
26-13	BRN	Power Ground (E01)	<0.1v
26-14	BRN	Power Ground (E1)	<0.1v
26-15	BLK/BLU	IAC Valve RSO Signal	Pulse signals
26-16	---	Not Used	---
26-17	BLU	EVAP Vapor Pressure Sensor	Key On & Fuel Cap Off: 2.5v
26-18	BLK	Knock Sensor 1 Signal	No Knocking: 2.5v
26-19	BLK/WHT	Neutral Start Switch Signal	Cranking: 9-11v
26-20	RED/BLU	Igniter IGT1 Signal	Digital signals (0-5-0-5v)
26-21	YEL/GRN	Igniter IGT2 Signal	Digital signals (0-5-0-5v)
26-22	GRY	Igniter IGT3 Signal	Digital signals (0-5-0-5v)
26-23	WHT	Igniter IGT4 Signal	Digital signals (0-5-0-5v)
26-24	BLK	Fuel Injector 4 Control	Pulse signals
26-25	WHT	Fuel Injector 3 Control	Pulse signals
26-26	BRN	Power Ground (E02)	<0.1v

2000 Corolla (1.8L VIN R) M/T & 3-SP A/T Pin Voltage Table (E5 16-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
16-1	YEL	TP Sensor 5 Volt REF (VC)	4.9-5.1v
16-2	GRN	MAF Sensor Signal (VG)	1-3v
16-3	YEL/BLU	Intake Air Temperature Sensor	1-4v (temperature varies)
16-4	WHT	Engine Coolant Temp. Sensor	1-4v (temperature varies)
16-5	BLK	CKP Sensor (NE+) Signals	Pulse signals (AC volts)
16-6	WHT	HO2S-11 (B1 S1) Signal	0-1100 mv (varies)
16-7	PNK	HO2S-11 Heater Control Signal	Heater On: 1v, Off: 12v
16-8	BRN	Power Ground (E03)	<0.1v
16-9	BRN	Sensor Ground (E2)	<0.050v
16-10	BLU/WHT	MAF Sensor Ground (EVG)	<0.050v
16-11	LT GRN	TP Sensor Signal (VTA)	1-1.9v
16-12	BLK	CMP Sensor (G2+) Signals	AC voltage pulse signals
16-13	WHT	CKP Sensor (NE-) Signals	AC voltage pulse signals
16-14	RED	HO2S-12 (B1 S2) Signal	0-1100 mv (varies)
16-15	PNK	HO2S-12 Heater Control Signal	Heater On: 1v, Off: 12v
16-16	---	Not Used	---

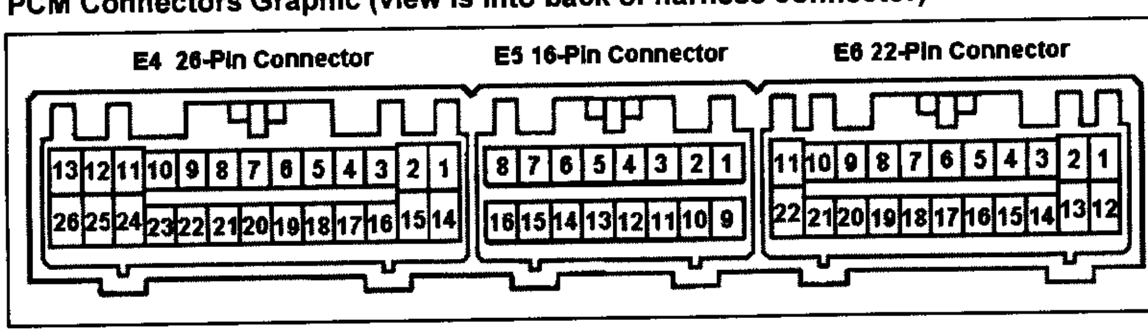
2000 COROLLA (1.8L I4 VIN R)

Reference Information

2000 Corolla (1.8L VIN R) M/T & 3-Speed Pin Voltage Table (E6 22-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
22-1	RED/WHT	Battery Direct (KAPWR)	12-14v
22-2	BLK	Ignition Voltage (ELS)	12-14v
22-3	GRN	Ignition Voltage (ELS2)	12-14v
22-4	---	Not Used	---
22-5	RED/YEL	Malfunction Indicator Lamp	Lamp On: 1v, Off: 12v
22-6	BLU/WHT	DLC TE1 Signal	0v or 12v
22-7	BLU/WHT	Cruise Control ECU Signal	Digital Signals
22-8	---	Not Used	---
22-9	VIO/WHT	Vehicle Speed Signal (from dash)	Pulse signals
22-10	YEL/RED	A/C Amplifier Request Signal	A/C clutch on (idle): 1.5v, off: 12v
22-11	BLK/WHT	STA Signal (P/N & Cranking)	9-11v (cranking)
22-12	BLK	Ignition Feed from EFI Relay	12-14v
22-13	BLK	Tachometer Signal (out)	Pulse signals
22-14	GRN/RED	Fuel Pump Control (FC) Signal	CTO On: 1v, Off: 12v
22-15	---	Not Used	---
22-16	---	Not Used	---
22-17	WHT	OBD II SIL Signal (ISO 9141)	Digital Signals (0-12-0-12v)
22-18	---	Not Used	---
22-19	---	Not Used	---
22-20	RED/WHT	ECT Sensor Signal	Hot Idle: 0.7v
22-21	RED/BLU	A/C Amplifier Cut (ACT) Signal	A/C clutch on (idle): 12v, off: 1.5v
22-22	---	Not Used	---

PCM Connectors Graphic (view is into back of harness connector)



2000 COROLLA (1.8L I4 VIN R)

Reference Information

2000 Corolla (1.8L VIN R) 4-Speed A/T Pin Voltage Table (E7 31-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
31-1	YEL	Fuel Injector 1 Control	Pulse signals
31-2	BRN	Fuel Injector 2 Control	Pulse signals
31-3	WHT	Fuel Injector 3 Control	Pulse signals
31-4	BLK	Fuel Injector 4 Control	Pulse signals
31-5	LT BLU	EVAP Canister Closed Valve	VSV On: 1v, Off: 12v
31-1	RED/YEL	EVAP Purge Solenoid Control	12-14v
31-7			
31-8	BLU/RED	Power Steering Pressure Switch	Straight: 12v, turning: 0v
31-9	---	---	---
31-10	RED/BLU	Igniter IGT1 Signal	Digital signals (0-5-0-5v)
31-11	YEL/GRN	Igniter IGT2 Signal	Digital signals (0-5-0-5v)
31-12	GRY	Igniter IGT3 Signal	Digital signals (0-5-0-5v)
31-13	WHT	Igniter IGT4 Signal	Digital signals (0-5-0-5v)
31-14, 15 & 16	---	Not Used	---
31-17	BLU/BLK	EVAP Canister Closed Valve	VSV On: 1v, Off: 12v
31-18	BLK/BLU	IAC Valve RSO Signal	Pulse signals
31-19	BLK/WHT	Neutral Start Switch Signal	Cranking: 9-11v
31-20	---	Not Used	---
31-21	BRN	Power Ground (E01)	<0.1v
31-22	RED	Pressure Switching Valve	Valve On: 1v, Off: 12v
31-23	RED	Cam Timing Oil Control Valve (-)	Pulse signals
31-24	BLK	Cam Timing Oil Control Valve (+)	Pulse signals
31-25	BLU/YEL	Igniter IGF Signal	Digital signals (0-5-0-5v)
31-26	BRN	Power Ground (E02)	<0.1v
31-27	BLK	Knock Sensor 1 Signal	No knocking: 2.5 VDC
31-28, 29 & 30	---	Not Used	---
31-31	BRN	Power Ground (E02)	<0.1v

2000 Corolla (1.8L VIN R) 4-Speed A/T Pin Voltage Table (E9 28-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
28-1	---	Not Used	---
28-2	RED/BLK	Park Neutral Position Switch	In P/N: 0v, others: 12v
28-3 & 4	---	Not Used	---
28-5	BLU/WHT	DLC TE1 Signal	0v or 12v
28, 6, 7, 8 & 9	---	Not Used	---
28-10	BLK	Ignition Voltage (ELS)	12-14v
28-11	BLK/WHT	STA Signal (P/N & Cranking)	9-11v (cranking)
28-12, 15 & 16	---	Not Used	---
28-13	BLK/WHT	Neutral Start Switch Signal	Cranking: 9-11v
28-14	BLU/RED	Power Steering Pressure Switch	Straight: 12v, turning: 0v
28-17, 18, 19, 21	---	Not Used	---
28-20	GRN	Ignition Voltage (ELS2)	12-14v
28-22	VIO/WHT	Vehicle Speed Signal (from dash)	Pulse signals
28-23	LT GRN	TP Sensor Signal (VTA)	1-1.9v
28-24	WHT	CKP Sensor (NE-) Signals	Pulse signals (AC volts)
28-25, 26 & 28	---	Not Used	---
28-27	BLK	Tachometer Signal (to dash)	Pulse signals

2000 COROLLA (1.8L I4 VIN R)

Reference Information

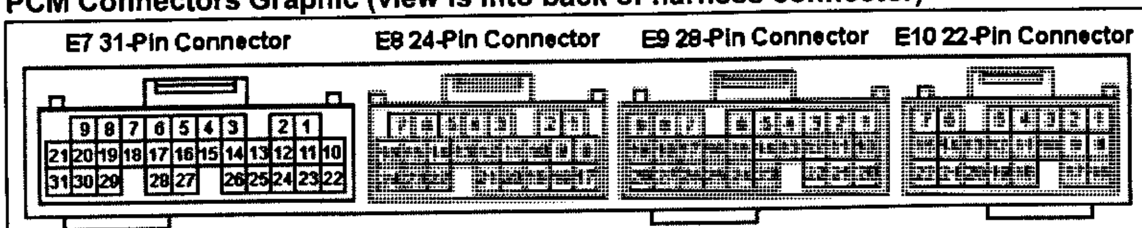
2000 Corolla (1.8L VIN R) 4-Speed A/T Pin Voltage Table (E8 24-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
24-1	BLU/WHT	MAF Sensor Ground (EVG)	<0.050v
24-2	YEL	TP Sensor 5 Volt REF (VC)	4.9-5.1v
24-3	PNK	HO2S-11 Heater Control Signal	Heater On: 1v, Off: 12v
24-4	BLU/BLK	EVAP ORVR VSV Control	VSV On: 1v, Off: 12v
24-5, 7, 10 & 13	---	Not Used	---
24-6	PNK	HO2S-12 Heater Control Signal	Heater On: 1v, Off: 12v
24-8	BRN	Power Ground (E03)	<0.1v
24-9	BLU	EVAP Vapor Pressure Sensor	Key On & Fuel Cap Off: 2.5v
24-11	GRN	MAF Sensor Signal (VG)	1-3v
24-12	WHT	HO2S-11 (B1 S1) Signal	0-1100 mv (varies)
24-14	WHT	Engine Coolant Temp. Sensor	1-4v (temperature varies)
24-15	BLK	CMP Sensor (G2+) Signals	Pulse signals (AC volts)
24-16	BLK	CKP Sensor (NE+) Signals	Pulse signals (AC volts)
24-17	BRN	Power Ground (E1)	<0.1v
24-18	BRN	Sensor Ground (E2)	<0.050v
24-19 & 21	---	Not Used	---
24-20	RED	HO2S-12 (B1 S2) Signal	0-1100 mv (varies)
24-22	YEL/BLK	IAT Sensor Signal	1-3v (ambient air dependent)
24-23	LT GRN	TP Sensor Signal (VTA)	1-1.9v
24-24	WHT	CKP Sensor (NE-) Signals	Pulse signals (AC volts)

2000 Corolla (1.8L VIN R) 4-Speed A/T Pin Voltage Table (E10 22-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
22-1	RED/WHT	Battery Direct (KAPWR)	12-14v
22-2	---	Not Used	---
22-3	GRN/RED	Fuel Pump Control (FC)	Pump On: 1v, Off: 12v
22-4, 5 & 6	---	Not Used	---
22-7, 8 & 9	---	Not Used	---
22-10	BLU/WHT	Cruise Control ECU Signal	Digital Signals
22-11	WHT	OBD II SIL Signal (ISO 9141)	Digital Signals (0-12-0-12v)
22-12	RED/BLU	A/C Amplifier Cut (ACT) Signal	A/C clutch on (idle): 12v, off: 1.5v
22-13, 14	---	Not Used	---
22-15	RED/YEL	MIL (lamp) Control	MIL On: 1v, Off: 12v
22-16	BLK	Ignition Feed from EFI Relay	12-14v
22-17	---	Not Used	--
22-18	YEL/RED	A/C Amplifier Request Signal	A/C clutch on (idle): 1.5v, off: 12v
22-19 & 20	---	Not Used	---
22-21 & 22	---	Not Used	---

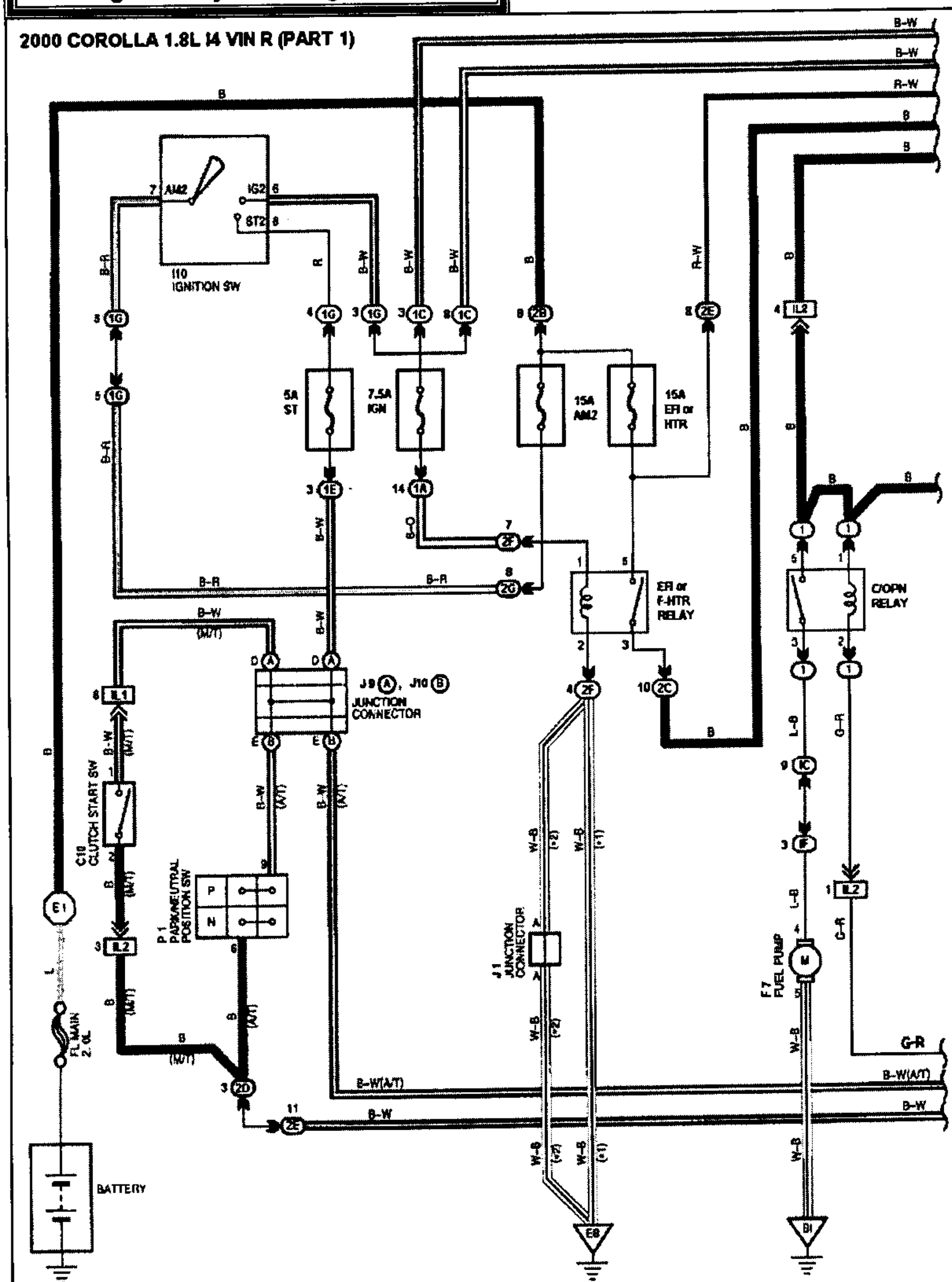
PCM Connectors Graphic (view is into back of harness connector)



2000 COROLLA (1.8L I4 VIN R)

Reference Information

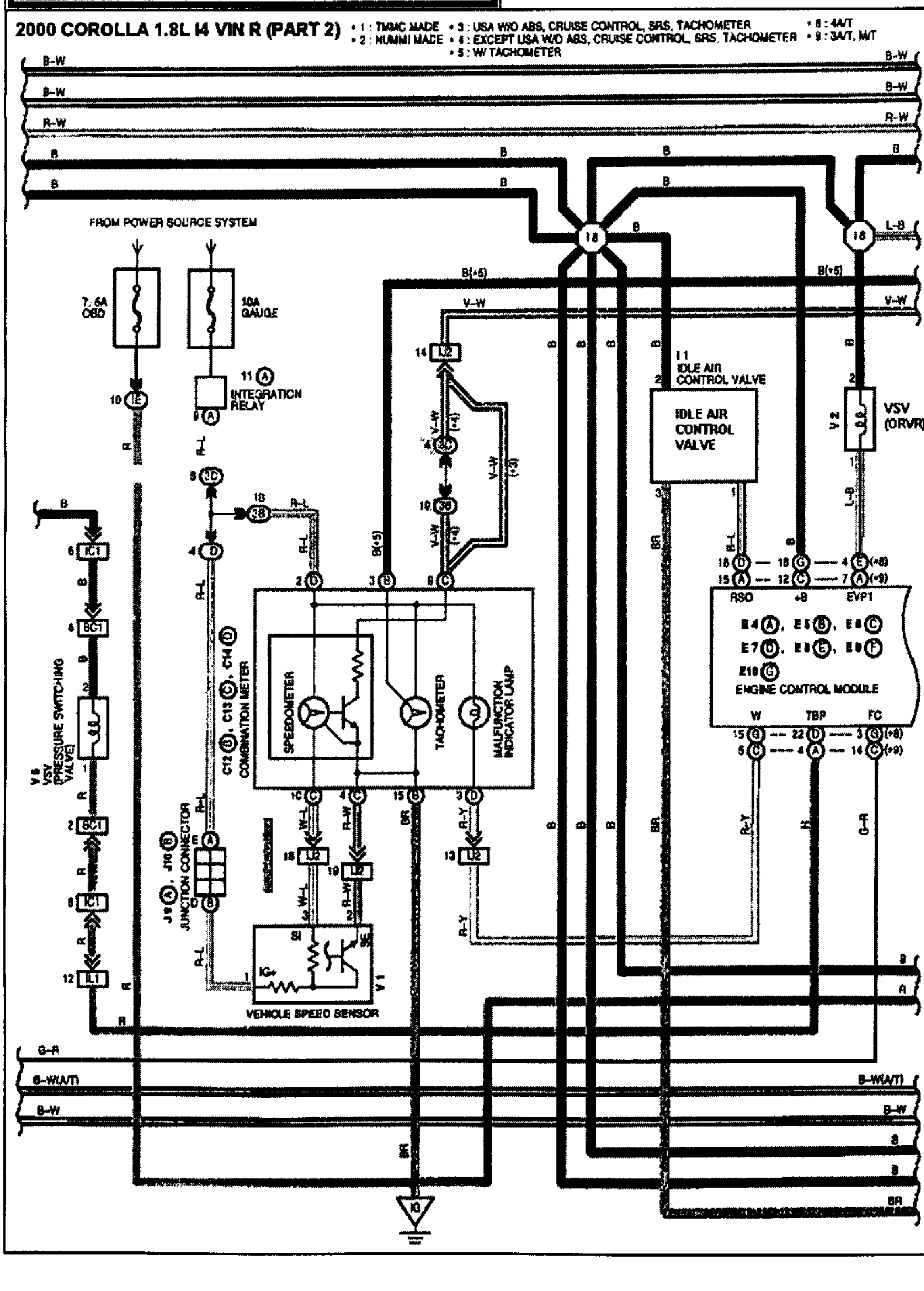
Fuel & Ignition System Diagrams (1 of 5)



2000 COROLLA (1.8L I4 VIN R)

Reference Information

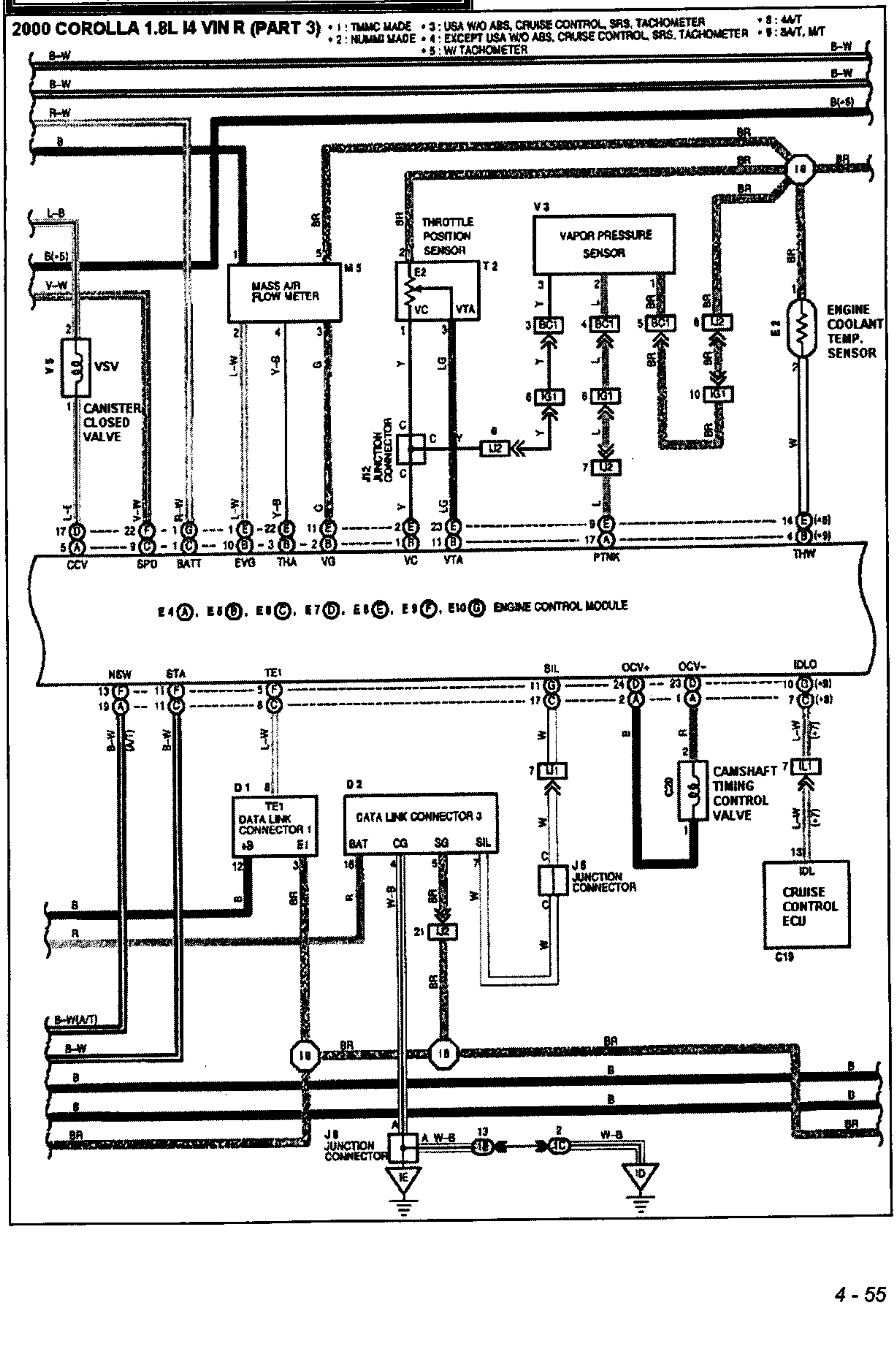
Fuel & Ignition System Diagrams (2 of 5)



2000 COROLLA (1.8L I4 VIN R)

Reference Information

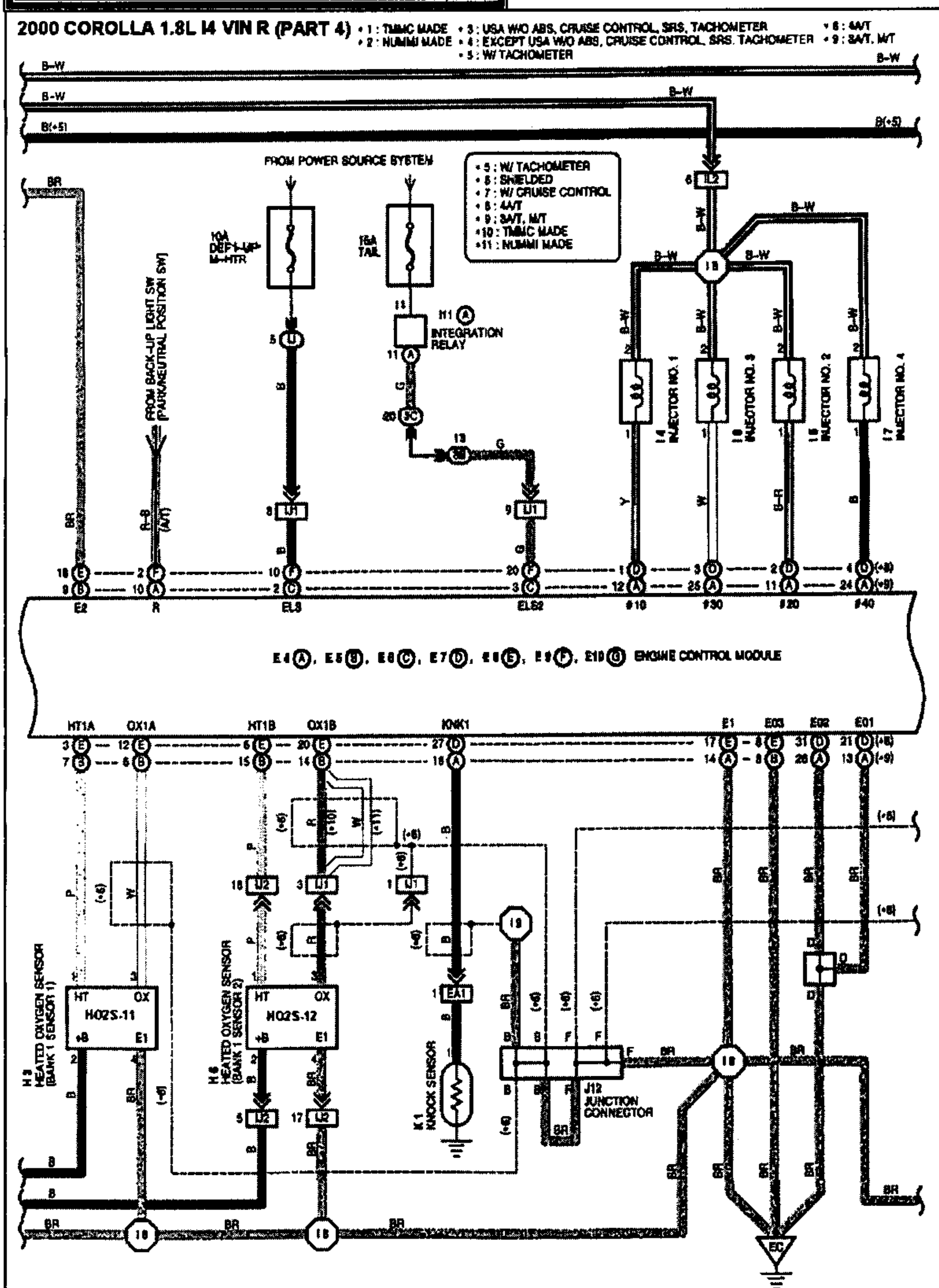
Fuel & Ignition System Diagrams (3 of 5)



2000 COROLLA (1.8L I4 VIN R)

Reference Information

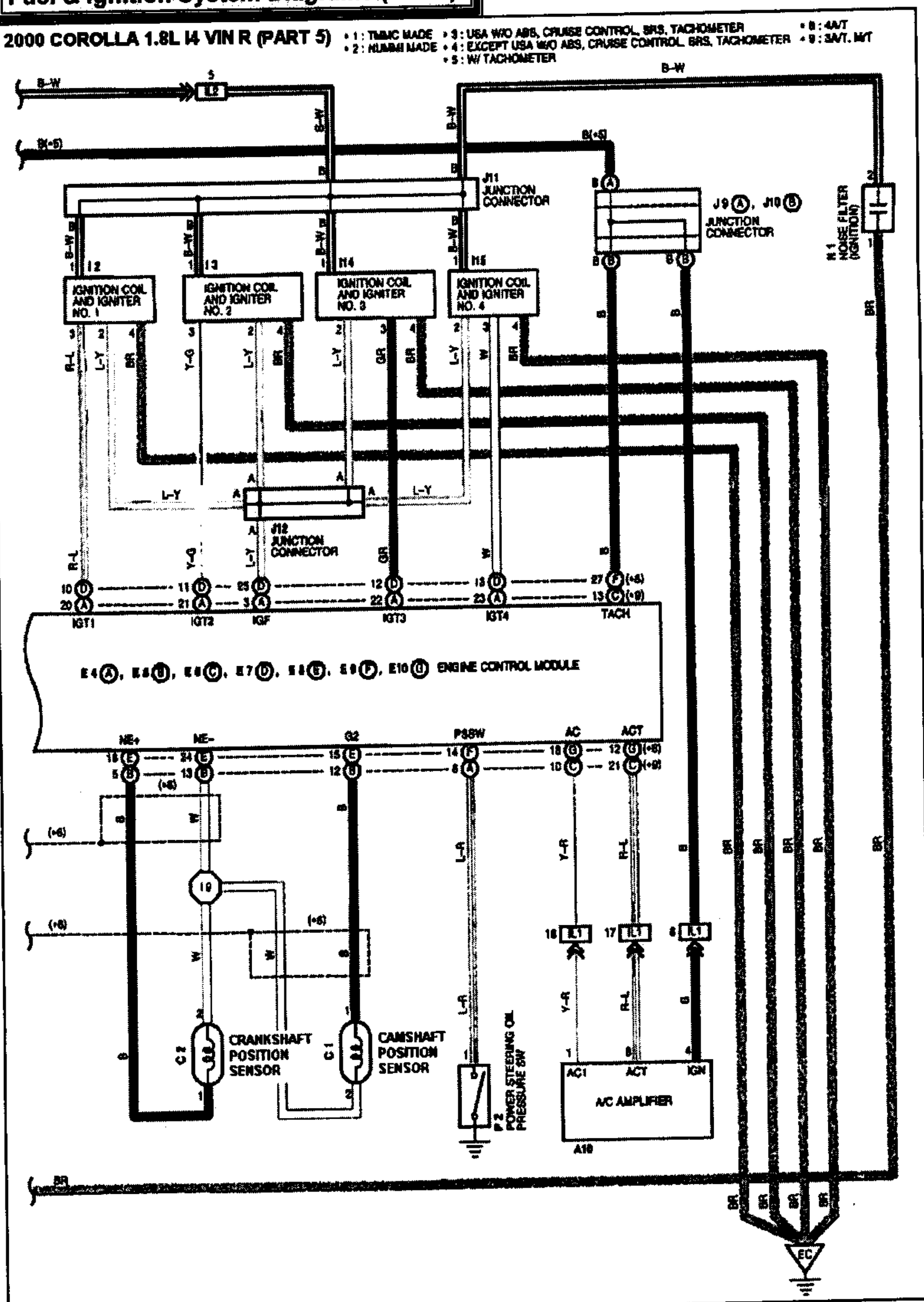
Fuel & Ignition System Diagrams (4 of 5)



2000 COROLLA (1.8L I4 VIN R)

Reference Information

Fuel & Ignition System Diagrams (5 of 5)



2000 4RUNNER (3.4L V6 VIN N)

Electronic Ignition System

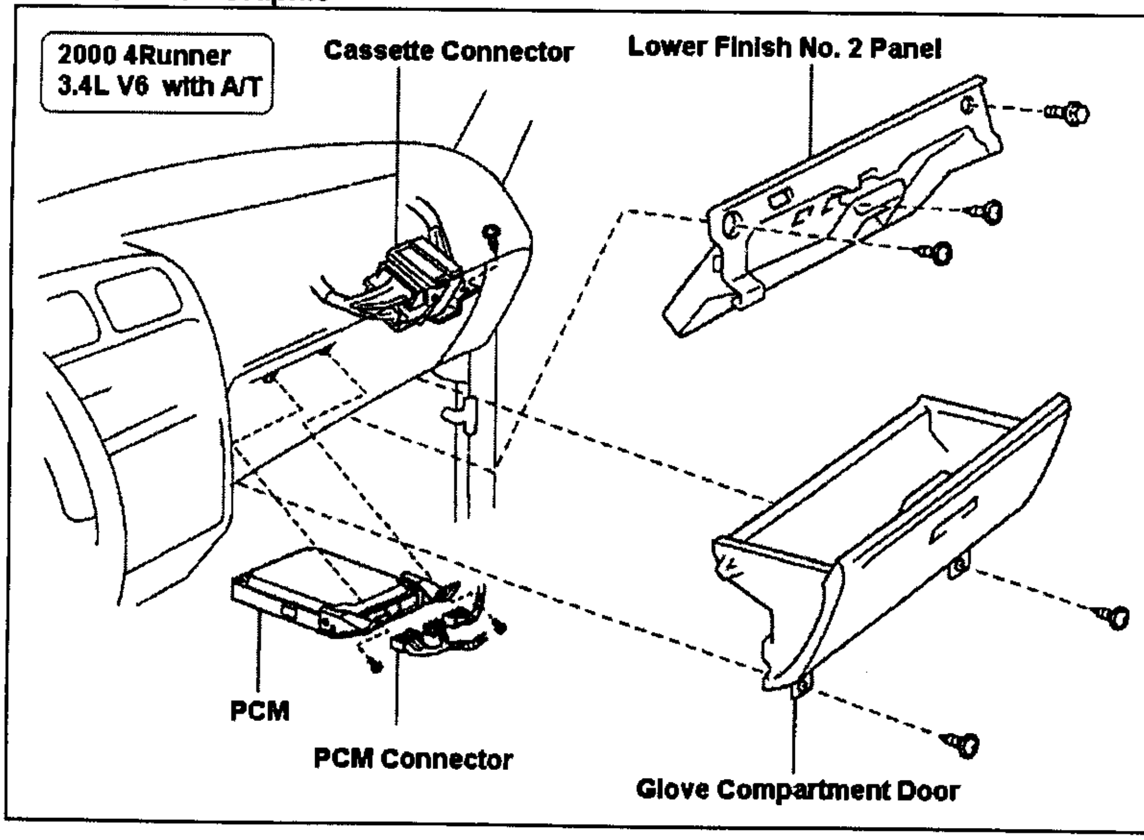
Introduction

The Powertrain Control Module (PCM) controls all phases of the engine electrical operation (the PCM is also referred to as the ECM in various articles).

In order to accomplish these tasks, the PCM relies on input signals from a variety of engine operation sensors. The PCM compares the input signals from its sensors with information on these sensors stored in memory in order to determine what steps should be taken to achieve the maximum engine performance, fuel economy and to meet current emission standards.

Then the PCM sends output commands to the Electronic Ignition (EI) system as well as to the Emission Control and Fuel systems. If the vehicle is equipped with an Electronic Automatic Transmission, it receives transmission inputs and outputs commands to it.

PCM Location Graphic

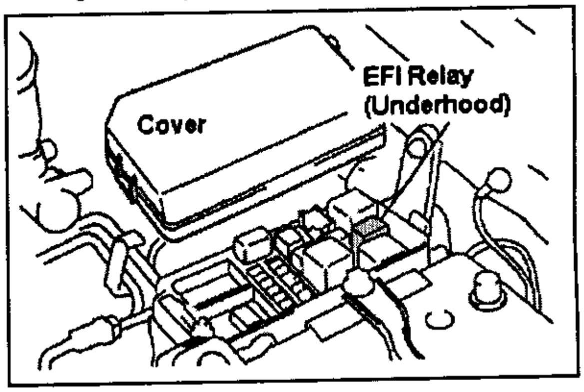


2000 4RUNNER (3.4L V6 VIN N)

Electronic Ignition System

EI System Overview

The Electronic Ignition (EI) system used in this Toyota vehicle is referred to as a Direct Ignition system (DIS). It is designed to improve spark timing accuracy, reduce high voltage loss and enhance overall operation of the Ignition system (without a distributor).



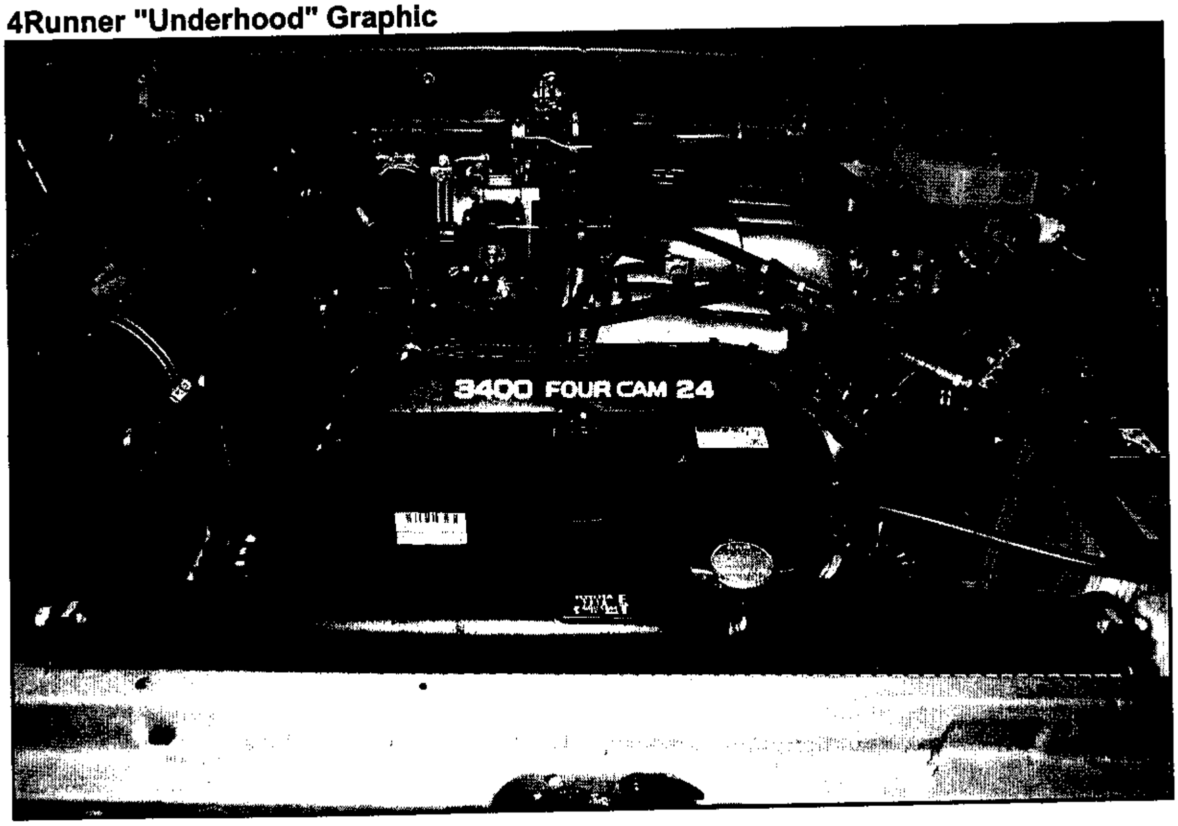
This is a "cylinder simultaneous" system that ignites the spark in two cylinders simultaneously (a waste spark system) where two spark plugs are connected to each secondary coil winding. High voltage generated in the secondary winding is applied directly to each spark plug (the spark passes simultaneously from the center electrode to the ground electrode.

Ignition Coil Feed Circuits

The three (3) ignition coils in this EI system receive power directly from the ignition switch on this application. The ignition coil and six (6) injector feed circuits are protected by the AM2 (30 amp) fuse in the fuse panel. The EFI main relay, located in the underhood power distribution center, is controlled directly by the PCM through the MRLY output circuit and to ground.

The EFI relay provides power to the Circuit Opening relay and to the PCM on the B+ circuit at Pin 16 of the PCM E14 22-Pin connector. The wiring diagrams for the EI system as well as the EFI main relay are included in the Fuel and Ignition system wiring diagrams at the end of this vehicle section.

4Runner "Underhood" Graphic



2000 4RUNNER (3.4L V6 VIN N)

Electronic Ignition System

Lab Scope Test (IGT Signal)

The Lab Scope is the tool of choice to use to test the igniter control signal (IGT) from the PCM to the coil/igniter assemblies for a glitch.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (CMP & IGT Signals)

Connect the Channel 'A' positive probe to the IGT signal at Pin 11 (BLK/BLU wire) of the 31P connector. Connect the negative probe to the battery negative post. Connect the Channel 'B' positive probe to the CMP signal at Pin 10 (RED wire) of the PCM 31-P connector.

Scope Connections (CMP & IGT Signals)

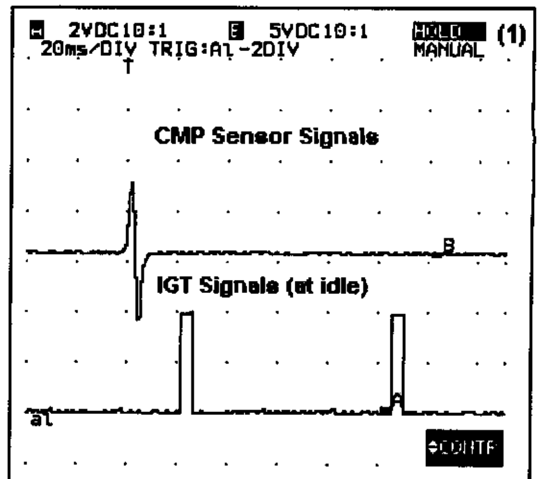
Connect the Channel 'A' positive probe to the IGT signal at Pin 11 (BLK/BLU wire) of the 31P connector. Connect the negative probe to the battery negative post. Connect the Channel 'B' positive probe to the CKP signal at Pin 16 (RED wire) of the PCM 24P connector.

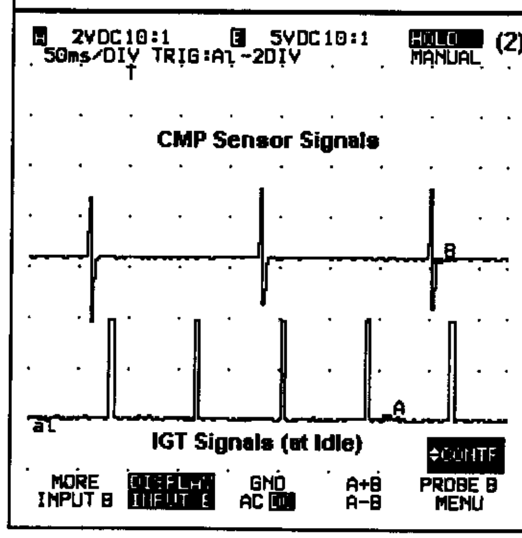
Lab Scope Explanation - Example (1)

The top trace shows the CMP signal while the bottom trace shows the IGT signal at hot idle.

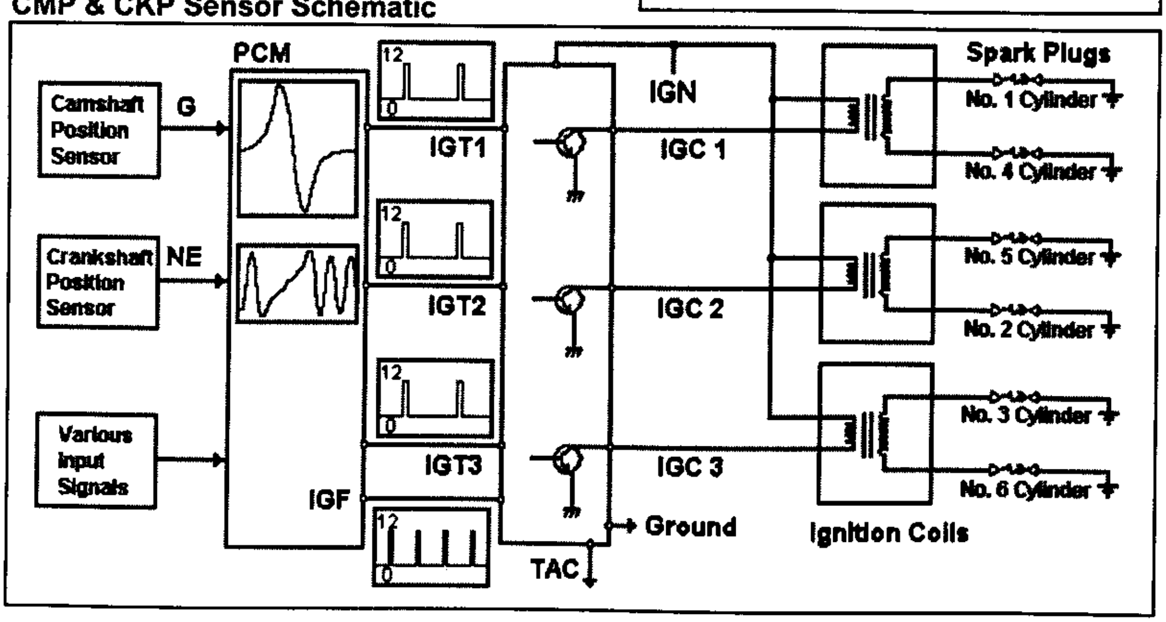
Lab Scope Explanation - Example (2)

The top trace shows the CMP sensor signals while the bottom trace shows the IGT signals at hot idle (these are all "known good" signals).





CMP & CKP Sensor Schematic



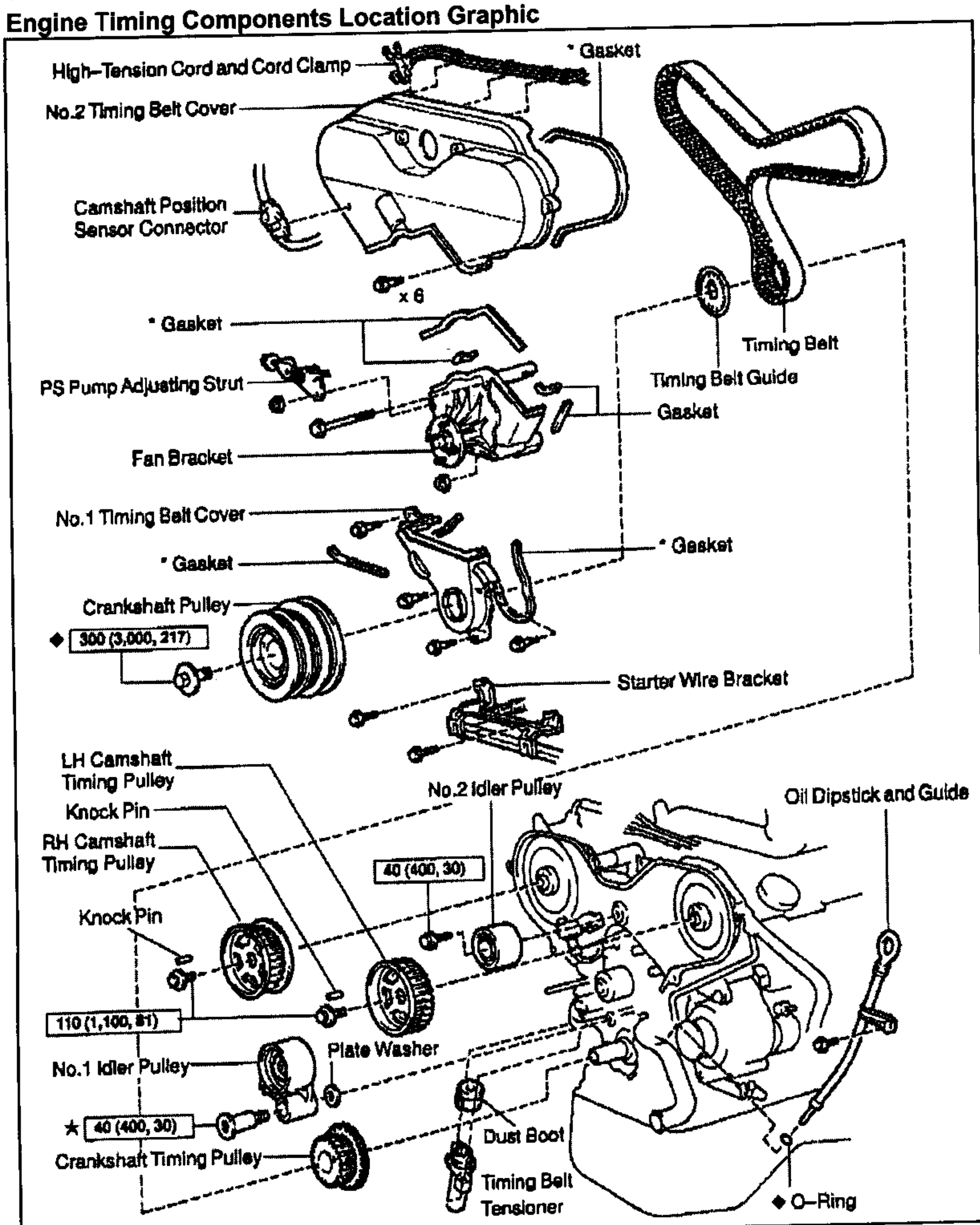
2000 4RUNNER (3.4L V6 VIN N)

Electronic Ignition System

CKP Sensor Overview

The crankshaft position (CKP or 'NE') sensor consists of a magnet, iron core and pickup coil. The signal plate has 36-1 teeth on its circumference. As the crankshaft rotates, the sensor (near the crankshaft pulley) generates 35 signals for each engine revolution (35x). The PCM uses this data to detect the actual crankshaft angle and engine speed.

Engine Timing Components Location Graphic



2000 4RUNNER (3.4L V6 VIN N)

Electronic Ignition System

Lab Scope Test (Coil & CKP Sensor)

The Lab Scope is the tool of choice to test the signals from the CKP sensor and to the coil primary for any possible glitches. Prior to testing, place the gearshift selector in Park or Neutral and block the drive wheels for safety.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

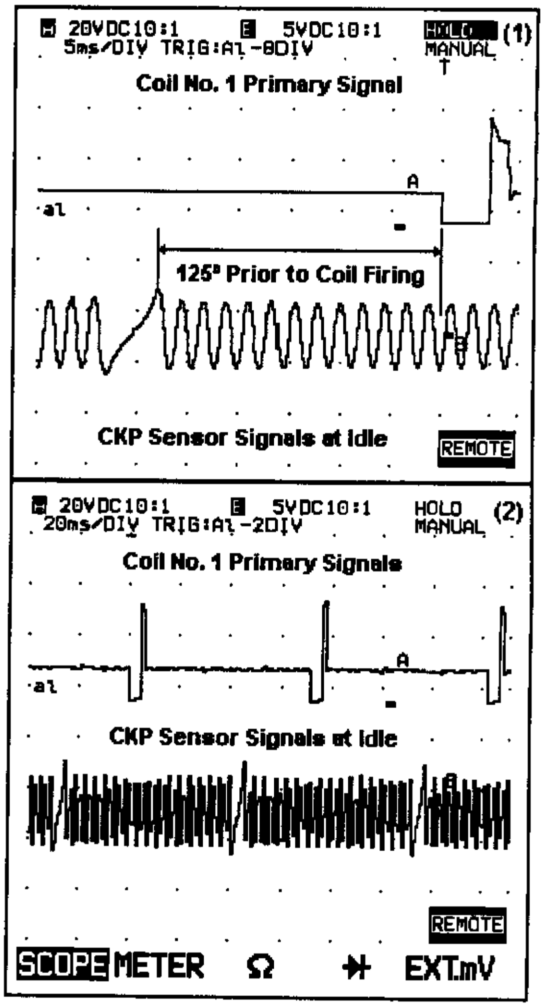
Scope Connections (Coil Primary)
Connect the Channel 'A' positive probe to the IGC1 signal at the Coil No. 1 primary circuit (BRN/RED wire) of the igniter connector.

Connect the Channel 'A' negative probe to the battery negative ground post.

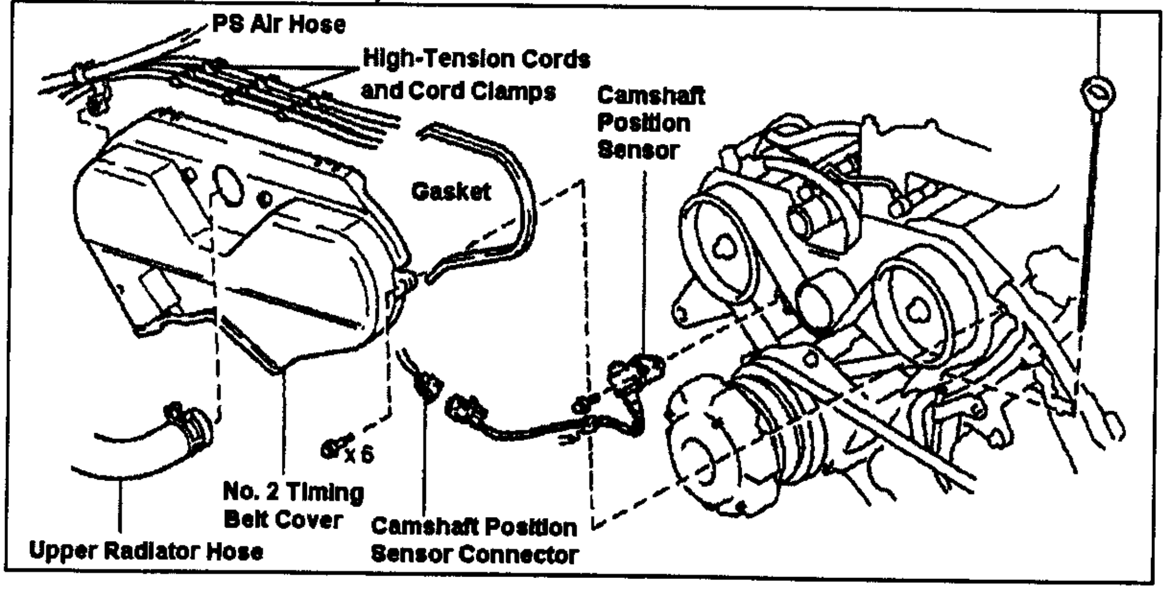
Scope Connections (CKP Sensor)
Connect the Channel 'B' positive probe to the CKP (+) signal at Pin 16 (RED wire) of the PCM E10 24-pin connector.

Lab Scope Explanation - Example (1)
In this example, the relationship between the CKP sensor and the firing of the Coil No. 1 can be clearly seen. The coil primary is fired 125° after the 36-1 missing tooth signal occurs.

Lab Scope Explanation - Example (2)
In this example, the time base was changed from 5 ms to 20 ms to allow a view of several coil primary pulses along with the CKP sensor.



CMP Sensor Location Graphic



2000 4RUNNER (3.4L V6 VIN N)

Electronic Ignition System

CMP Sensor Overview

The camshaft position (CMP or 'G') sensor is located at the front of the engine on the left bank camshaft. The CMP or 'G' signal plate has one (1) tooth on its outer circumference. As the camshaft rotates, a protrusion on the signal plate causes the air gap at the CMP sensor pickup coil to change. This action creates an AC signal pulse from the sensor. The CMP sensor signal is referred to as a 1/2x because it occurs once in every 720° of crankshaft rotation. The PCM determines the standard crankshaft angle from this signal.

Lab Scope Test (CKP & CMP Sensors)

The Lab Scope can be used to test the CMP and CKP sensor signals for possible glitches.

Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Scope Connections (CMP Sensor)

Connect the Channel 'A' positive probe to the CMP (+) signal at Pin 10 (RED wire) of the PCM E9 31-pin connector. Connect the Channel 'A' negative probe to battery ground.

Scope Connections (CKP Sensor)

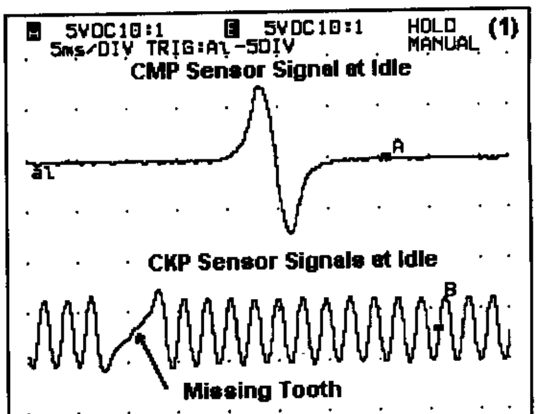
Connect the Channel 'B' positive probe to the CKP (+) signal at Pin 16 (RED wire) of the PCM E10 24-Pin connector.

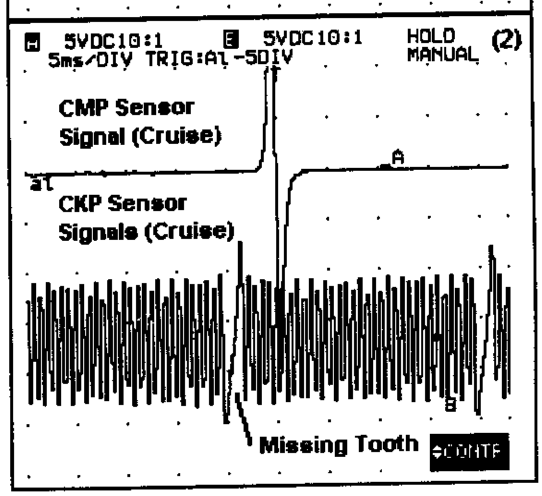
Lab Scope Explanation - Example (1)

The traces show the relationship of the 1/2x CMP sensor signal to the 36-1 CKP sensor signals. The CMP signal occurs 4 pulses after the 36-1 CKP missing tooth signal occurs.

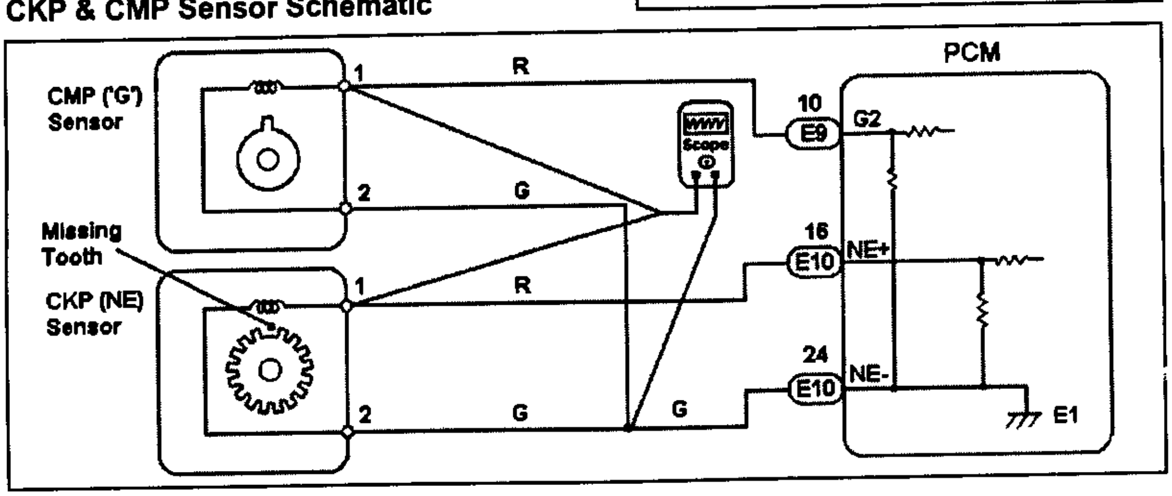
Lab Scope Explanation - Example (2)

The traces show the CMP and CKP sensor signal relationships during Cruise speed.





CKP & CMP Sensor Schematic

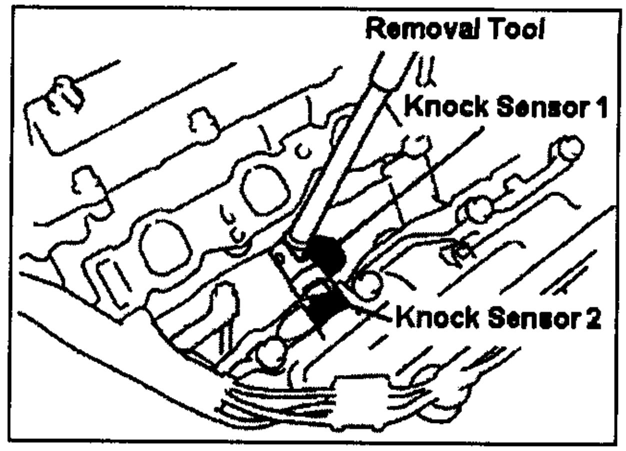


2000 4RUNNER (3.4L V6 VIN N)

Knock Sensor

General Description

The knock sensor (KS) is a piezoelectric device that is mounted to the cylinder block. It is designed to generate a voltage whenever it is exposed to vibration. When engine detonation occurs, the cylinder block vibrates, and this action causes the KS to generate an AC voltage pulse signal. The signal varies in amplitude depending upon the intensity of the vibration (or spark knock).



A typical engine vibration occurs in the 7 KHz range (7,000 cycles per second). The KS and the PCM circuitry are designed to take advantage of this range of operation.

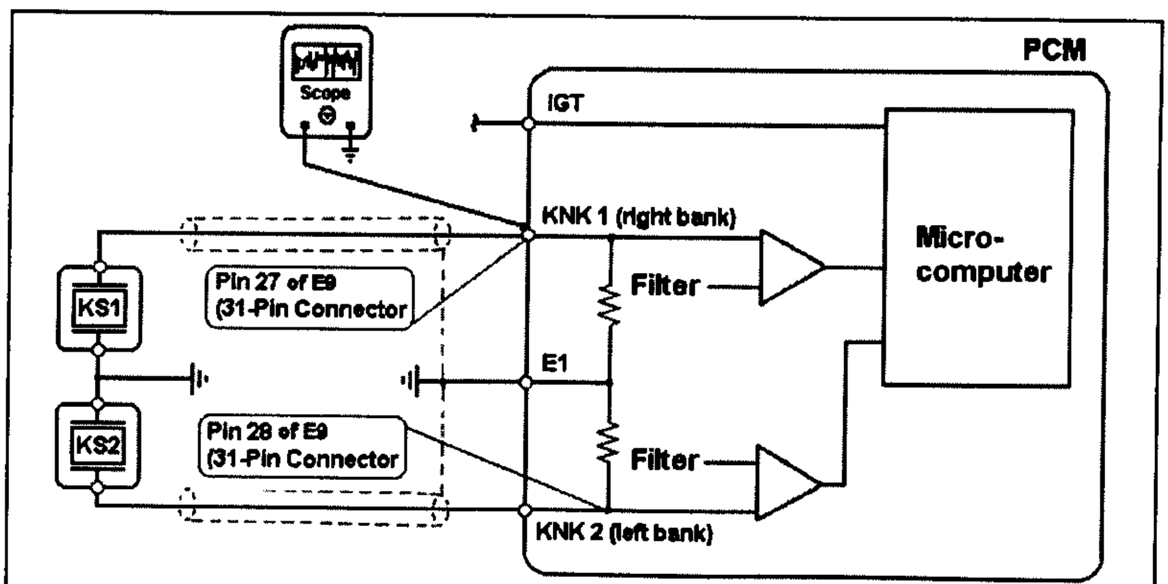
The resonance type of sensor is tuned into a very narrow frequency band and only produces a significant signal voltage when it is exposed to vibrations in the 7 KHz range.

The PCM and Knock sensors are wired as shown in the schematic. When engine detonation occurs, the PCM monitors the KS signals to determine which engine bank has the detonation problem and the degree of detonation that is occurring.

If the PCM determines that detonation is taking place, it retards the ignition timing until the knocking stops. Spark timing is then advanced back to a calculated value, or if the detonation returns, it retards the spark timing again until the knocking stops.

In the event that the PCM continues to sense detonation, spark timing retard is limited based on a "clamp" value stored in memory. If it determines that the knock retard is not functional it will enter "fail safe" mode and fix the retard value to prevent engine damage.

Knock Sensor Schematic



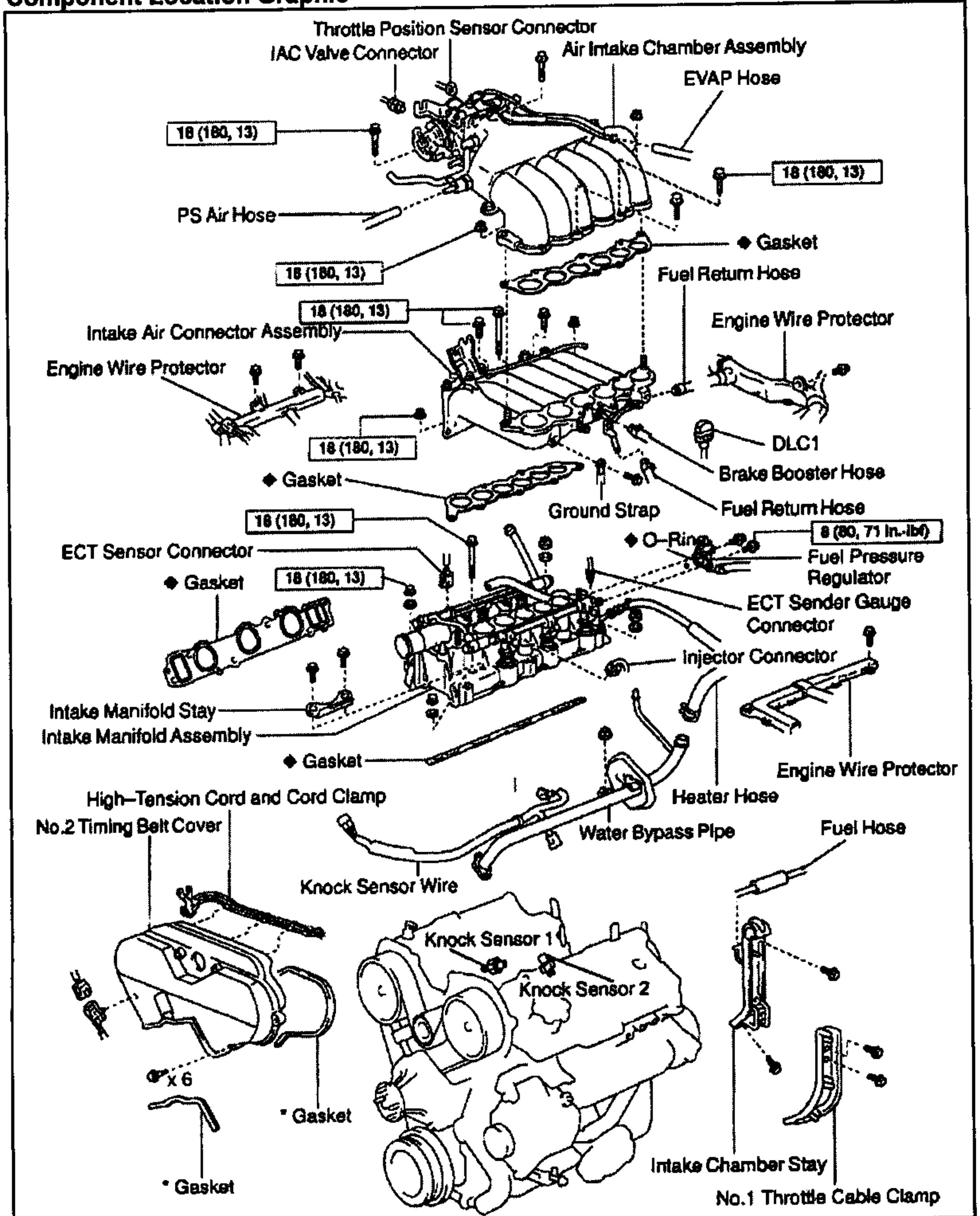
2000 4RUNNER (3.4L V6 VIN N)

Knock Sensor

Knock Sensor Locations

This vehicle application is equipped with two (2) knock sensors - one for each engine cylinder bank. They are located at the top of the engine as shown in the Graphic.

Component Location Graphic



2000 4RUNNER (3.4L V6 VIN N)

Knock Sensor

Lab Scope Test (Knock Sensor)

The Lab Scope is the "tool of choice" to test the signals from the knock sensor (KS) as it provides an excellent view of the knock sensor waveforms and of any possible glitches. Place the gearshift selector in Park or Neutral and block the drive wheels for safety.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

The knock sensor signal can be checked at idle and cruise speeds with the engine cold or at normal operating temperature.

Scope Connections (Knock Sensor 1)
Connect the Channel 'A' positive probe to the KS1 signal at Pin 27 of the PCM E9 31-Pin connector (the BLK wire) and the negative probe to battery ground post.

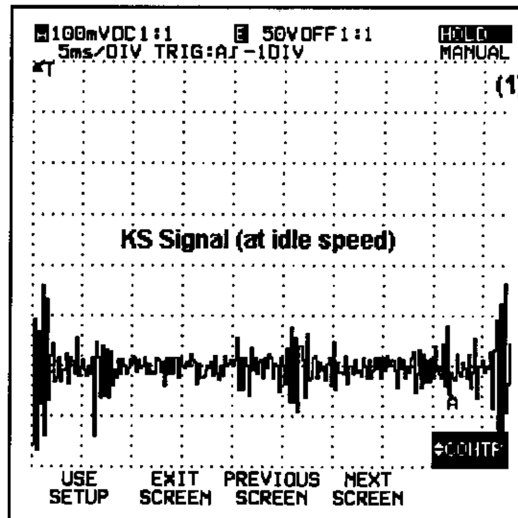
Scope Connections (Knock Sensor 2)
Connect the Channel 'A' positive probe to the KS2 signal at Pin 28 of the PCM E9 31-Pin connector (GRY wire) and the negative probe to the battery ground post.

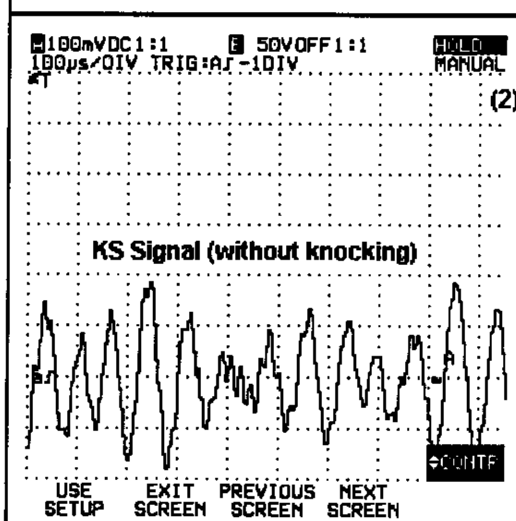
Lab Scope Example (1) Explanation
In this example, the signal trace shows the KS signal at idle speed with no knock present. This setting does not allow you to look closely at the KS frequency (which can be important).

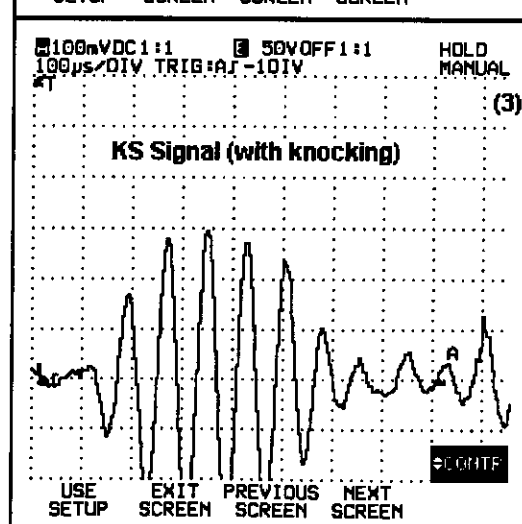
Lab Scope Example (2) Explanation
In this example, the signal trace shows the KS signal at cruise speed with no knock present. The time base was changed from 5 ms to a more usable setting of 100 us. The voltage setting was left at 100 mv from Example (1).

Lab Scope Example (3) Explanation
In this example, the signal trace shows the KS signal at cruise speed with some knocking present. The time base was left at 100 us and the voltage setting was left at 100 mv. Note how these settings allow you to clearly determine if any knocking is occurring on the KS signal circuit.

Summary: These examples show the need to be able to change your Lab Scope settings (depending upon the type of signal under test).







2000 4RUNNER (3.4L V6 VIN N)

Evaporative Loss System

Introduction

The Evaporative Loss (EVAP) system is designed to prevent hydrocarbon (HC) emissions in the fuel tank from escaping into the atmosphere by temporarily storing them in a charcoal canister. During diagnosis of the Emission and Fuel systems, keep in mind that the EVAP system can have an effect on your diagnostic decisions.

<u>System Components</u>

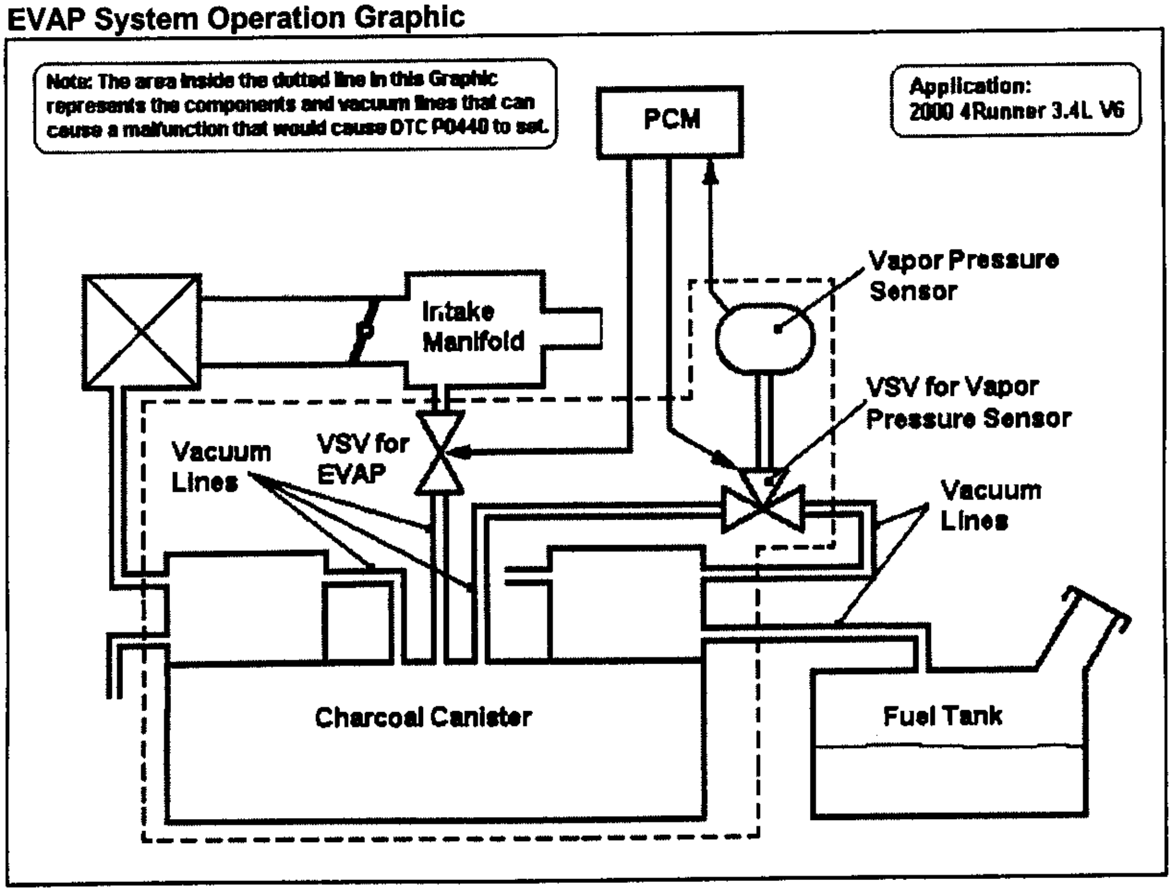
The EVAP system includes the following devices:

- Fuel tank
- Fuel tank cap with integral check valve
- Charcoal canister
- Purge port to the throttle body

<u>System Operation</u>

The EVAP system is designed to maintain a stable fuel tank pressure without allowing any fuel vapor to escape into the atmosphere. When the tank vapor pressure becomes excessive, fuel vapor from the fuel tank is vented into the charcoal canister. The vapors stored in the canister are purged into the intake manifold and burned when operating conditions can tolerate the additional fuel enrichment.

EVAP System Operation Graphic



2000 4RUNNER (3.4L V6 VIN N)

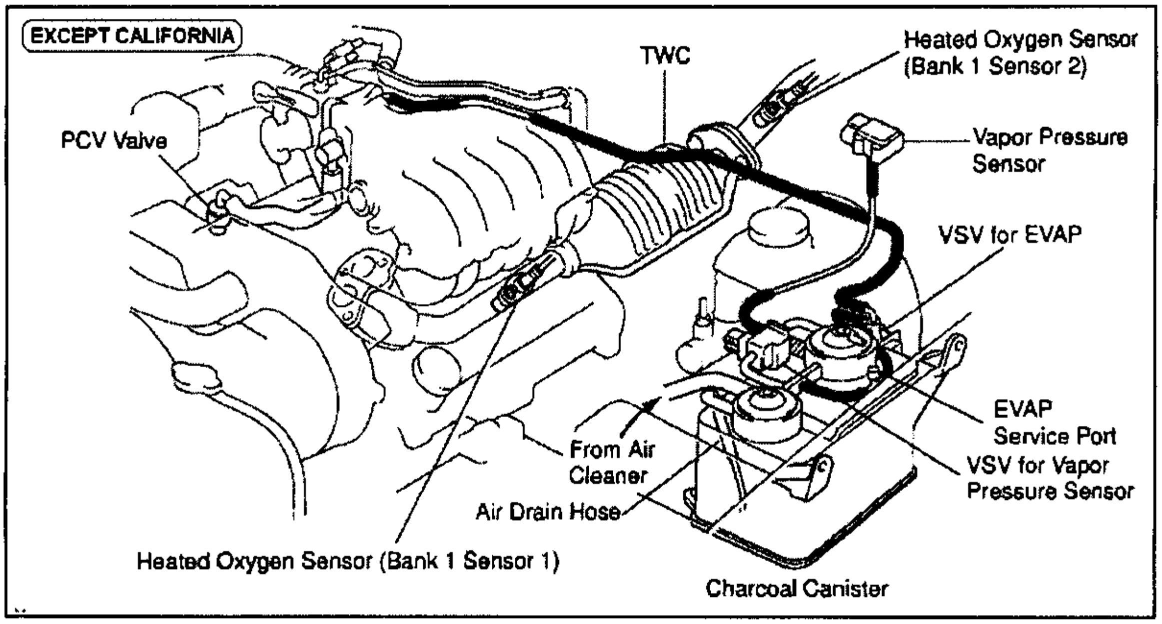
Evaporative Loss System

Component Location (California)

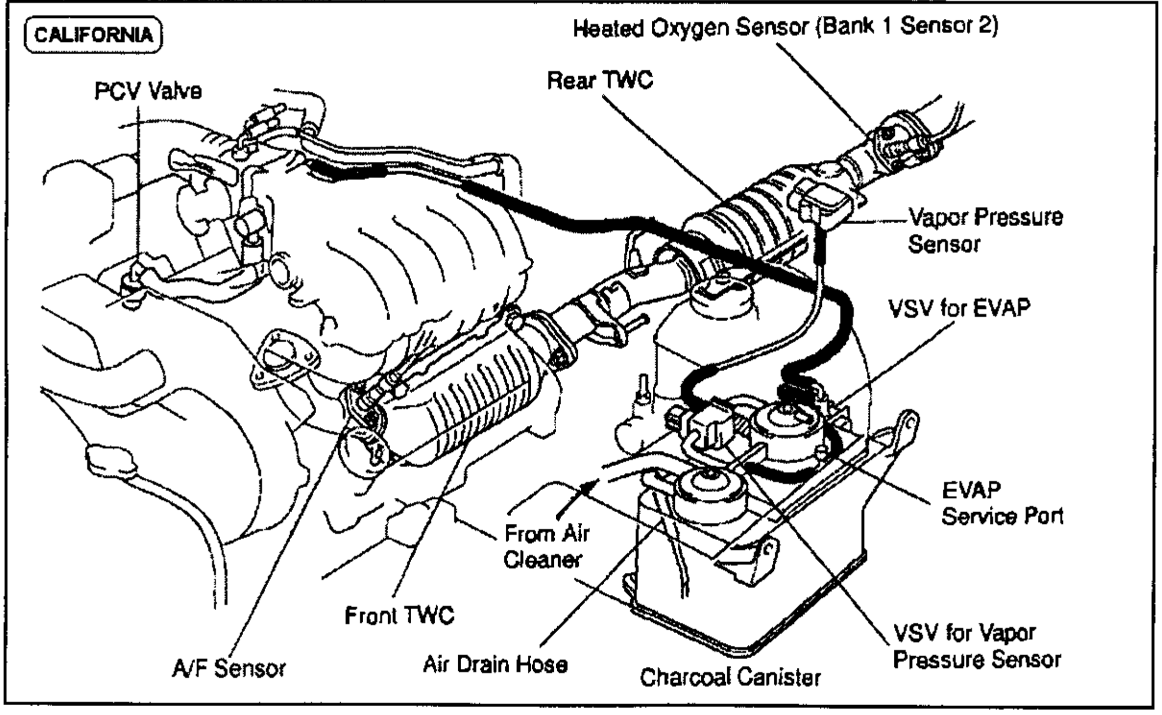
The EVAP system components for this vehicle are shown in the two Graphics below. Note that they are identified as Except California and California.

The California application includes two catalytic converters (a front and rear TWC).

Component Location Graphic (Except California)



Component Location Graphic (California)

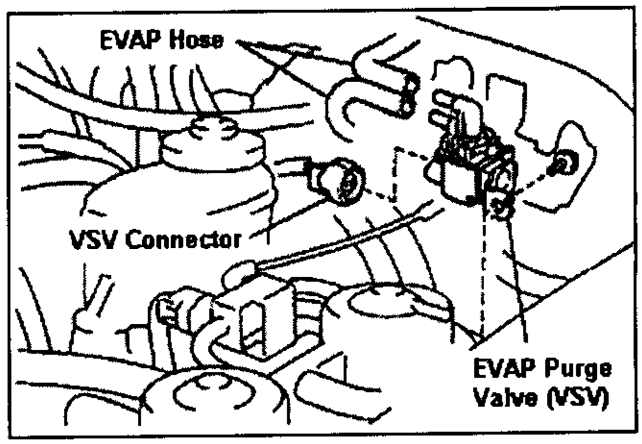


2000 4RUNNER (3.4L V6 VIN N)

Evaporative Purge Valve

General Description

The EVAP purge valve on this system is used to purge fuel vapors stored in the charcoal canister into the intake manifold where they are consumed in the engine.



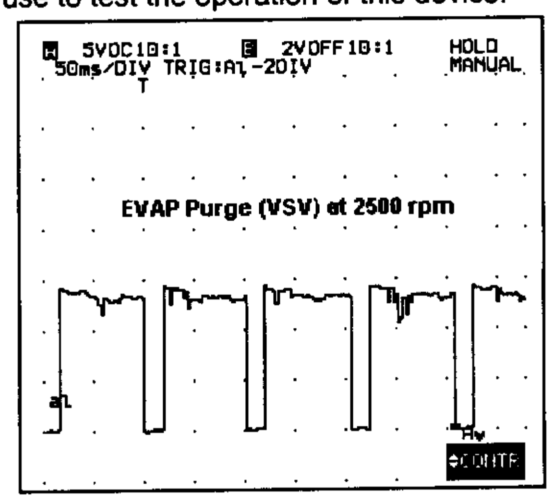
This valve is controlled by the PCM through an output command (a duty cycle pulse) during periods of engine operation when the charcoal canister is purged.

It is also activated during portions of the EVAP System Monitor test for OBD II diagnostics.

Specification: The EVAP purge valve (VSV) resistance is 30-34 ohms at 68°F.

Lab Scope Test (EVAP Purge Valve)

The Lab Scope can be used to test the operation of the EVAP purge valve (VSV) and its circuits. The Scan Tool is a much easier tool to use to test the operation of this device.



Scope Connections (EVAP Purge Valve)

Connect the Channel 'A' positive probe to the EVAP purge control valve at Pin 7 of the 24P connector (WHT/GRN wire). Connect the Channel 'A' negative probe to battery ground.

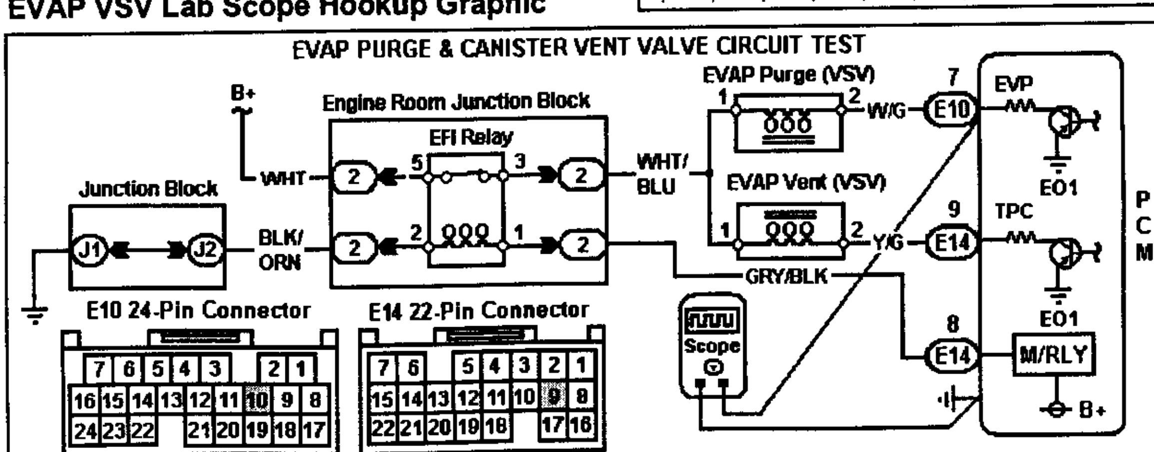
Scope Settings

To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example Explanation

In this example, the trace shows the EVP Purge valve control signals with the canister purge valve enabled at Cruise speed.

EVAP VSV Lab Scope Hookup Graphic



2000 4RUNNER (3.4L V6 VIN N)

EVAP Vapor Pressure Sensor

General Description

The EVAP vapor pressure sensor and EVAP VSV for the vapor pressure sensor are used to detect abnormalities in the Evaporative Loss system. The PCM determines if there is a fault in the EVAP system based on the signal from the vapor pressure sensor.

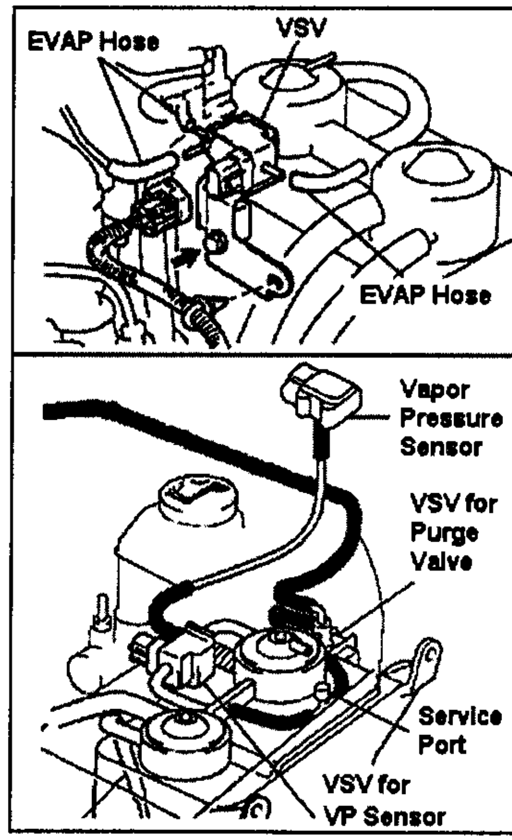
DTC P0450

If the PCM detects an electrical fault (by the Comprehensive Component Monitor or CCM) in the signal circuit to this sensor, it will set a "pending" P0450.

DTC P0451

If the PCM detects that the vapor pressure sensor signal changes too much with the vehicle at idle and the vehicle not moving (with the VSV for this sensor enabled), it will set a "pending" DTC P0451.

If either fault is detected twice in a row (2-trip fault), a code is set and the MIL is activated.



DVOM Test (Vapor Pressure Sensor)

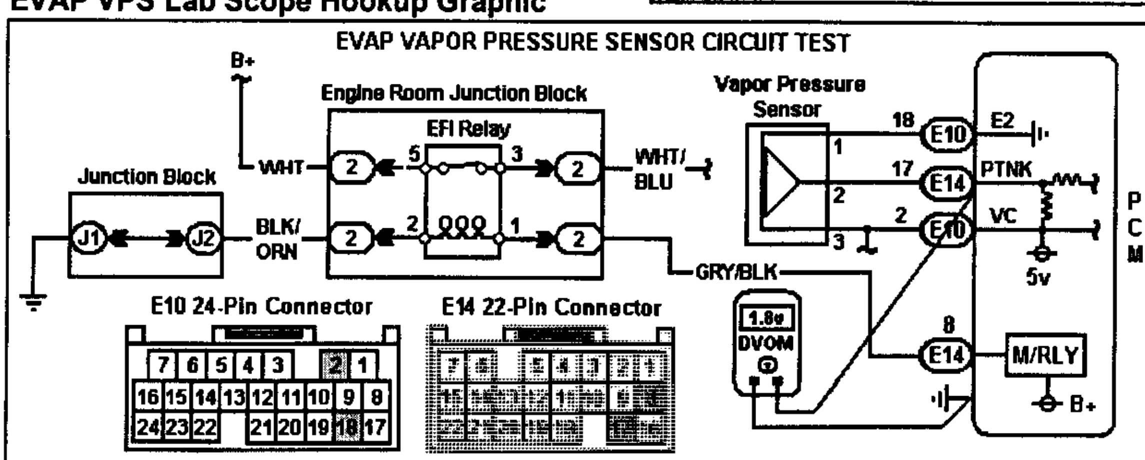
Connect the DVOM positive probe to the vapor pressure sensor circuit at PCM Pin 17 (the YEL wire) of the E14 22-Pin Connector.

Connect the DVOM negative probe to the battery negative post.

EVAP Vapor Pressure Sensor Test

Connect the DVOM positive probe to the correct terminal at the PCM (in the vehicle). Turn the key on or start the engine to set up the test. The EVAP vapor pressure sensor signal with the cap off and the ignition key turned on (engine off) should be near 2.5v.

EVAP VPS Lab Scope Hookup Graphic



2000 4RUNNER (3.4L V6 VIN N)

Fuel Delivery System

Introduction

The Fuel Delivery system includes the following components:

- Fuel tank (with EVAP system controls)
- Electric fuel pump, Fuel pipe and inline fuel filter
- Fuel injectors (6)
- Fuel pressure regulator and fuel return pipe

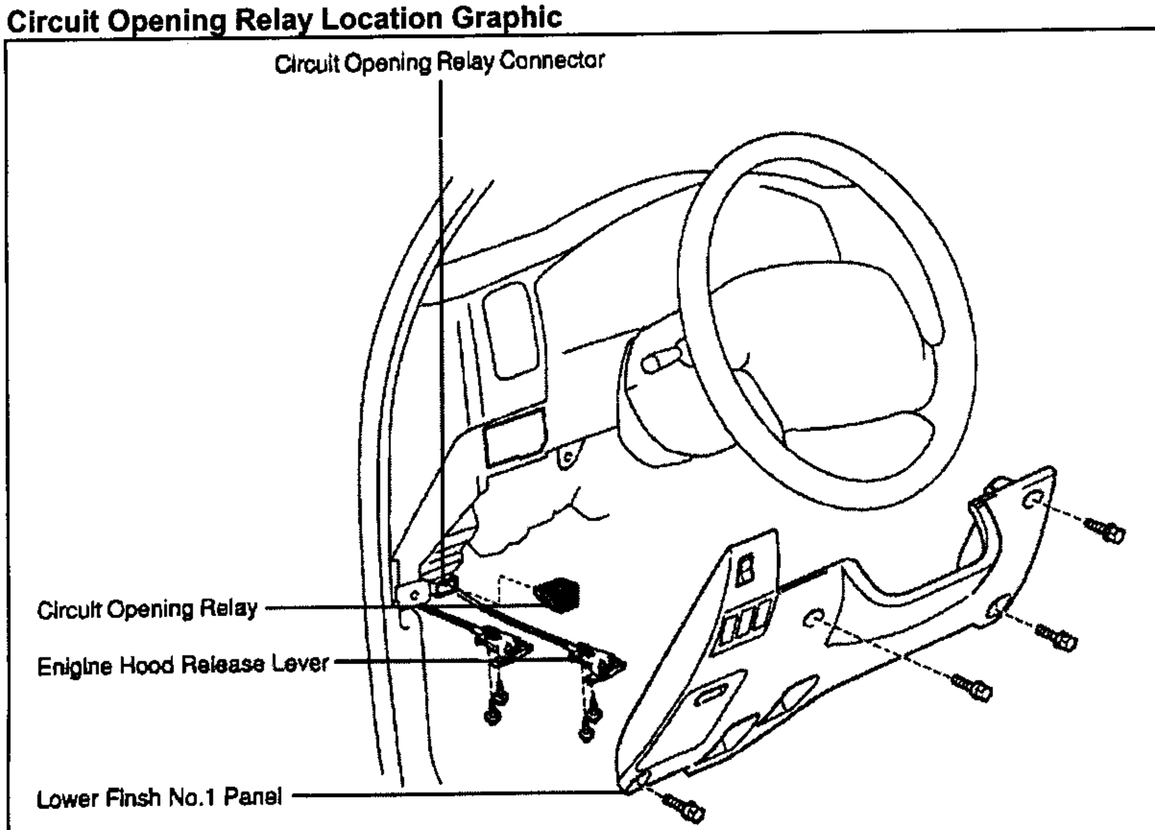
System Operation

Fuel in the fuel tank is pumped by an electric fuel pump, which is controlled by the operation of the Circuit Opening relay. Fuel flows through the fuel filter to the fuel rail or fuel delivery pipe and up to the fuel pressure regulator where it is held under pressure.

The pressure regulator maintains the fuel pressure in the fuel rail at a specified value above the intake manifold pressure. This action maintains the pressure drop across the fuel injectors (regardless of the engine load). Fuel in excess of that consumed by the engine operation is returned to the fuel tank by way of the fuel return pipe.

The PCM determines the optimum A/F ratio for the engine based on inputs from sensors, and by information stored in its Fuel Trim memory table.

Circuit Opening Relay Location Graphic



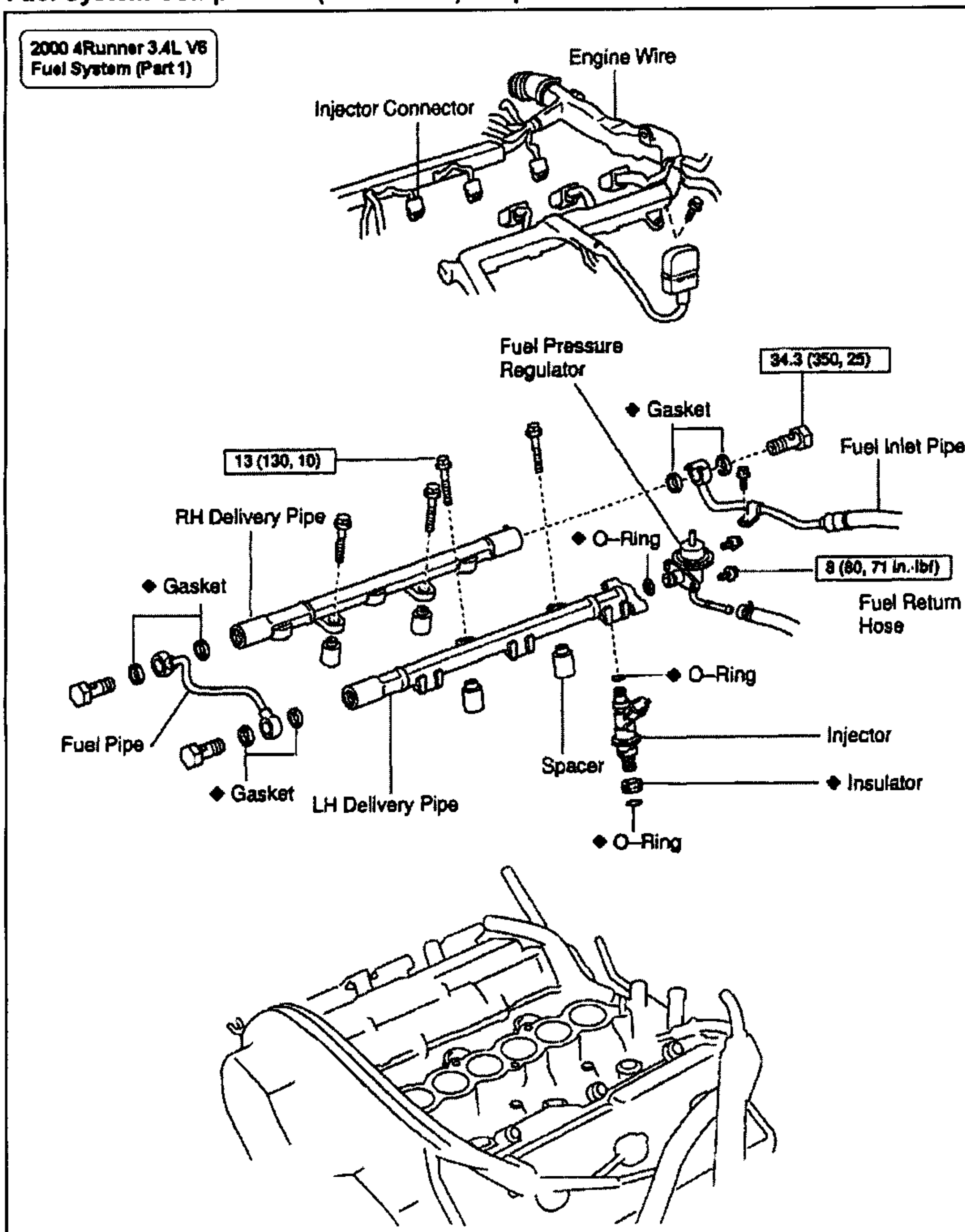
2000 4RUNNER (3.4L V6 VIN N)

Fuel Delivery System

Fuel System Components (Part 1)

The Fuel Delivery System "Underhood" components are shown in the Graphic below.

Fuel System Components (Underhood) Graphic



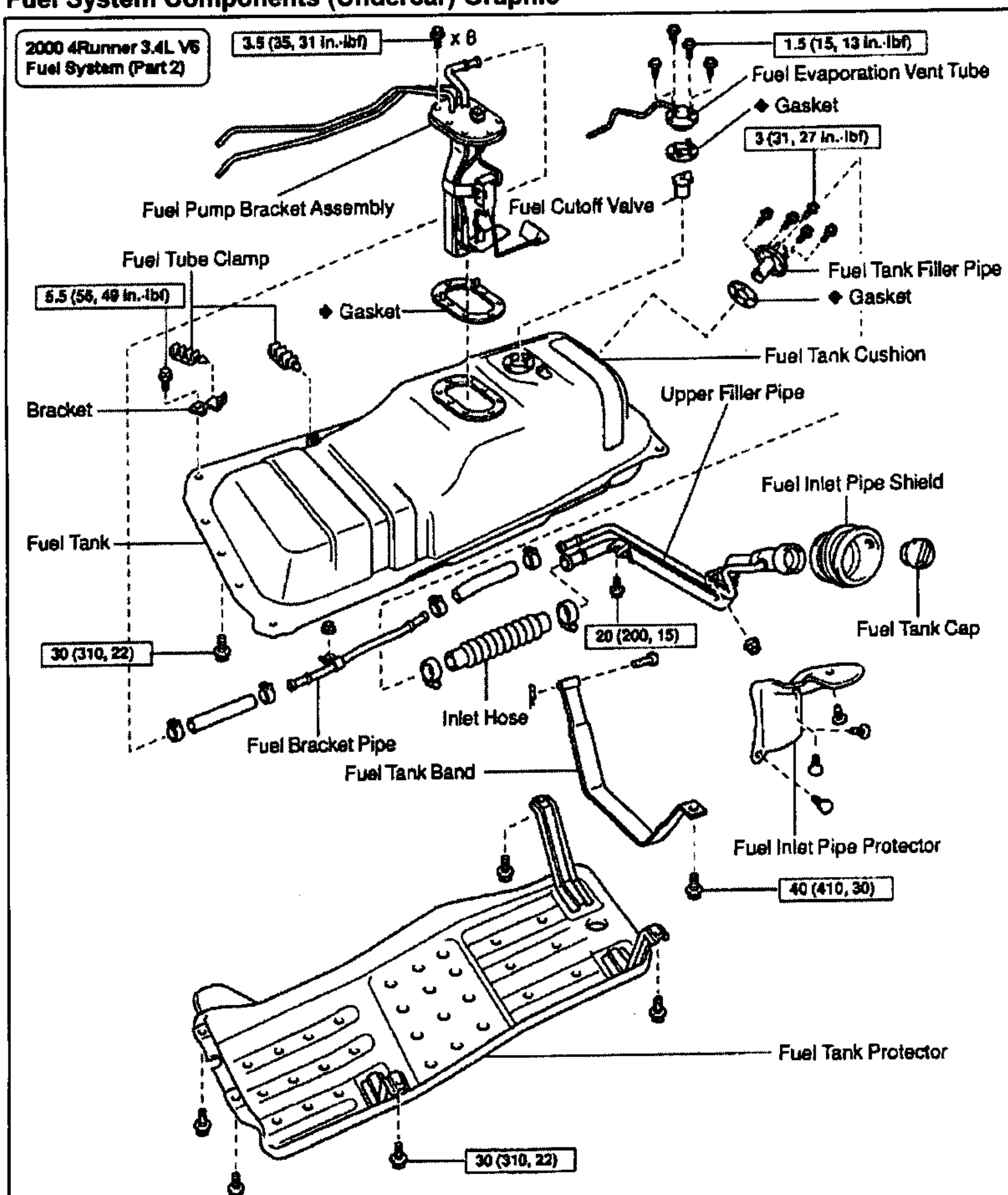
2000 4RUNNER (3.4L V6 VIN N)

Fuel Delivery System

Fuel System Components (Part 2)

The Fuel Delivery System "Undercar" components are shown in the Graphic below.

Fuel System Components (Undercar) Graphic



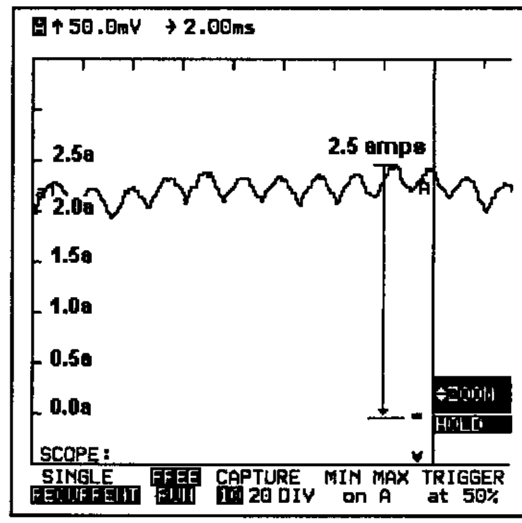
2000 4RUNNER (3.4L V6 VIN N)

Electric Fuel Pump

Lab Scope Tests (Fuel Pump)

If you suspect that the fuel pump is faulty, you can use a low amp probe with an inductive pickup to monitor the operation of the fuel pump and its related circuits.

An example of a known good fuel pump motor waveform for this vehicle is shown in the Graphic. If the fuel pump is in good condition, it will require less than 4 amps to operate.



Lab Scope Settings

Set the Lab Scope to these initial settings:

- Low amp probe set to 100 mv
- Volts per division: 50 mv
- Time per division: 1 ms
- Trigger setting: 50% with a positive slope

Scope Connections (Amp Probe)

Zero the low amp probe before starting the test. Start the engine and allow the amp probe reading to stabilize.

Clamp the low amp probe around the C/O relay feed wire to the pump. Connect the Channel 'A' negative probe to Pin 30 (E03) of the E9 31-Pin connector or to battery ground.

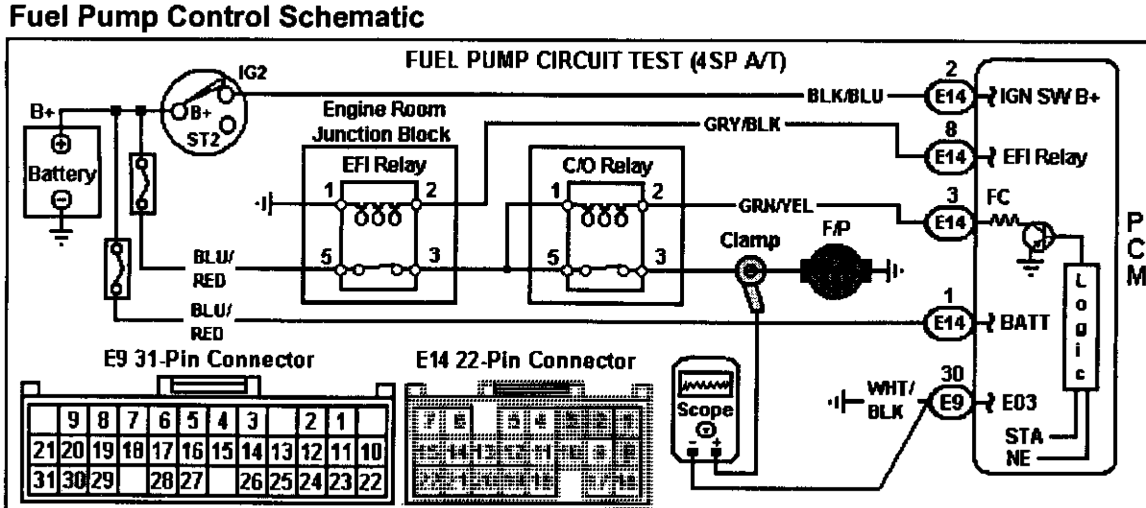
Lab Scope Example Explanation

In this example, the trace shows the fuel pump current with the engine at idle speed. Note the even pattern from this known good fuel pump. Note how the pump is activated by the C/O relay after the PCM receives the correct inputs and grounds the FC circuit.

Symptom Diagnosis

Depending upon the type of problem, you may want to let the engine run for a period of time until it occurs to allow for time to monitor the amount of change in the fuel pump current (in effect, this period of time gives the fuel pump motor time to ramp up). In some cases, you may need to let the engine run until the engine stalls or begins to stall and then capture the waveform at that particular moment.

Fuel Pump Control Schematic



2000 4RUNNER (3.4L V6 VIN N)

Fuel Injector

General Description

The injectors are pulsed by the PCM as it completes the injector ground circuit for a certain period of time (injector pulsewidth).

This injector is a "hole type" design that helps to reduce concerns of fuel injector buildup. The injector valve is recessed from the tip of the injector, and fuel is delivered through holes drilled in a director plate.

This design of injector offers good fuel atomization while demonstrating better resistance to deposit buildup compared to a pintle design injector.

Each injector is positioned directly behind the intake valve. It is installed with an O-ring (insulator/seal) on the manifold end to isolate the injector from heat and to prevent an atmospheric leak into the manifold.

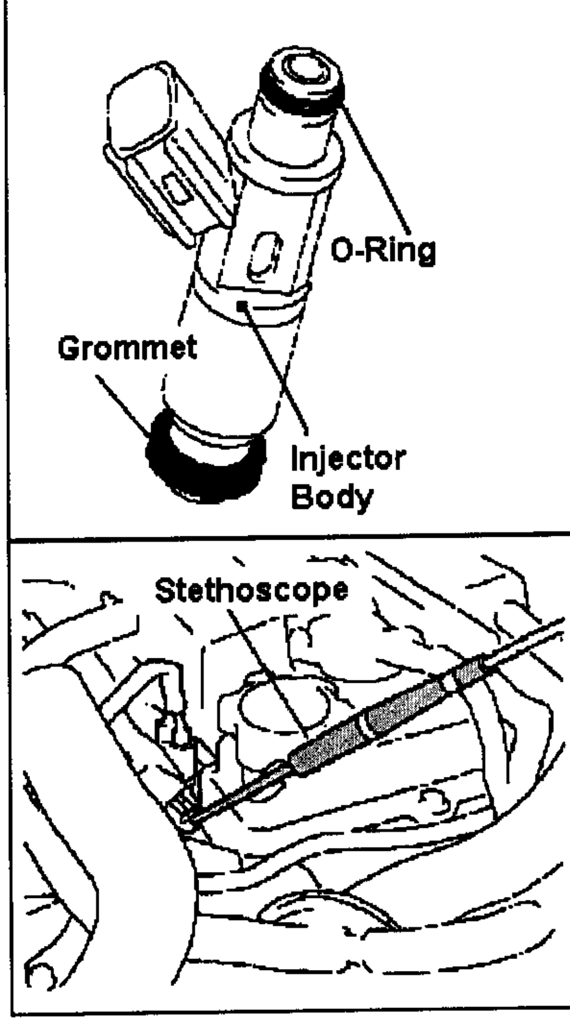
Due to the high resistance of this fuel injector (13.2-14.8 ohms at 68°F), it does not require an external resistor in the voltage controlled injector driver circuit.

Stethoscope Quick Test

Start the engine and allow it to idle. Locate a stethoscope (or sound scope) that can be used to monitor the operation of each fuel injector.

Listen to the "clicking" sound from each fuel injector. If any injector fails to make a normal clicking sound, replace it and repeat the test with the new injector.

FUEL INJECTOR



2000 4RUNNER (3.4L V6 VIN N)

Fuel Delivery System

Lab Scope Test (Fuel Injector)

The Lab Scope is the tool of choice to test the operation of the injector and its circuits.

<u>Scope Settings</u>

To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Scope Connections (1)</u>

To view the fuel injector waveform for the injector No. 6 control signal, connect the Channel 'A' positive probe to Pin 4 (YEL wire) of the PCM E9 31-Pin connector. Connect the Channel 'A' negative probe to E03 at Pin 30.

<u>Scope Connections (2)</u>

To view the fuel injector current waveform along with the injector signal, connect a low amp probe to Channel 'B'. Zero the amp probe and then clamp it around the ignition feed circuit (BRN/RED wire) to Coil No. 6.

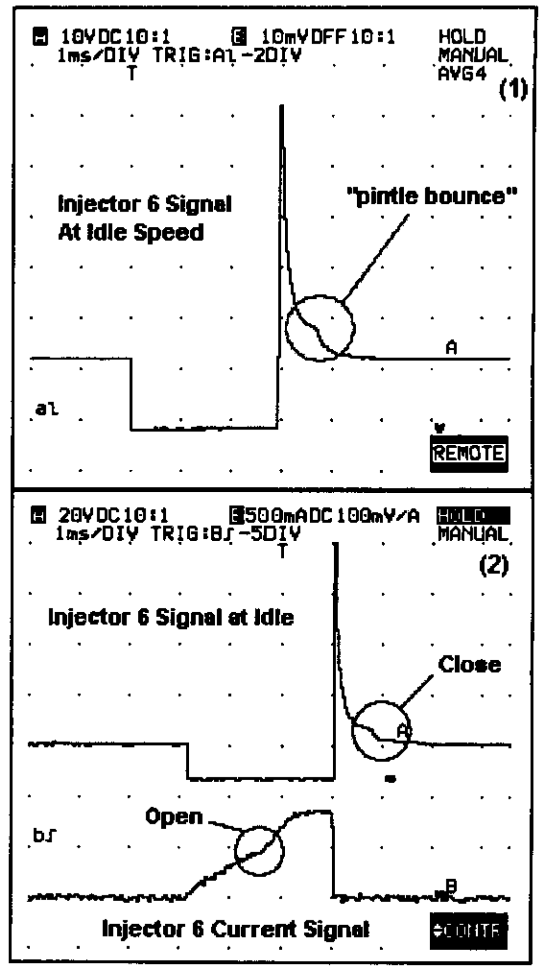
<u>Lab Scope Explanation - Example (1)</u>

In this example, the trace shows the injector control signal at idle speed. Note the height of the injector spike (over 60v) in this example.

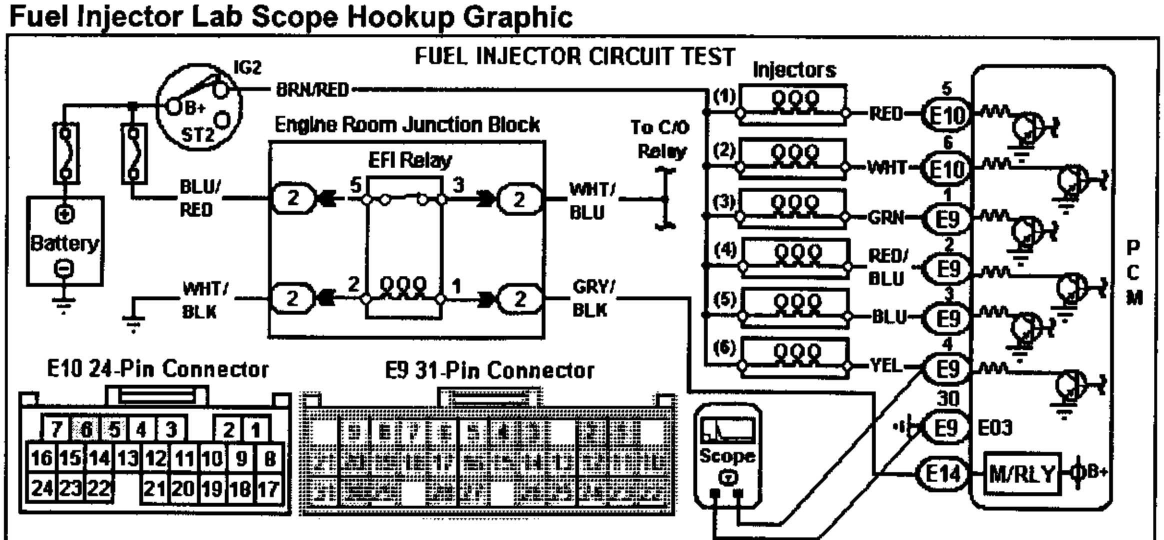
Note the mechanical action (pintle bounce) of the injector and the injector on time (3 ms).

<u>Lab Scope Explanation - Example (2)</u>

In this example, the trace shows the injector current signal (current ramping) at idle speed. Note the point in the injector current signal where the injector opened and the point in the injector voltage signal where the injector closed (the mechanical open/close points).



Fuel Injector Lab Scope Hookup Graphic



2000 4RUNNER (3.4L V6 VIN N)

Intake Air Control System

General Description

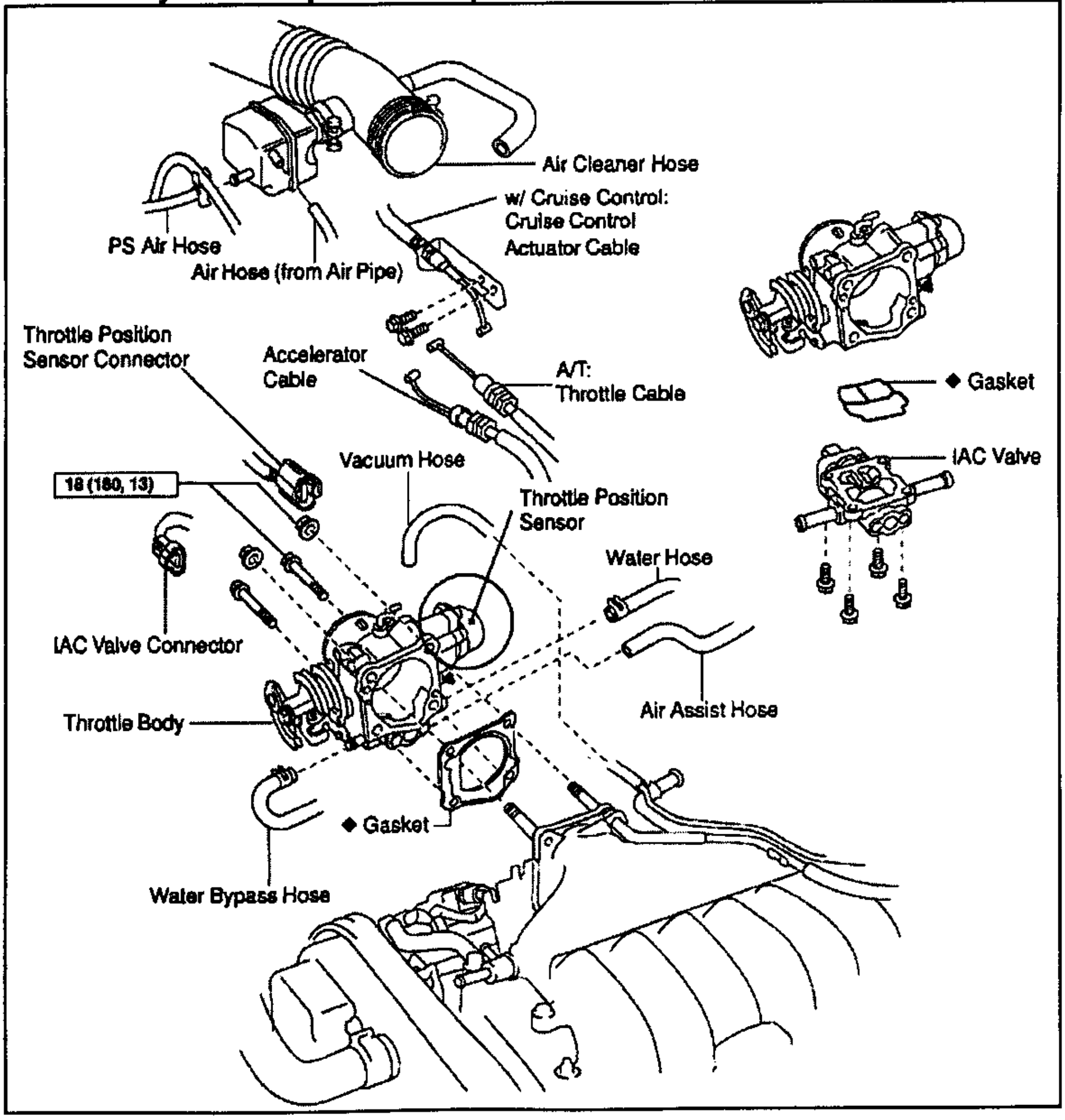
The Intake Air system is designed to filter, meter and measure the intake airflow into the engine. In effect, intake air is filtered by the air cleaner and then passed on into the intake manifold in varying volumes. The amount of air that enters the engine is a function of the throttle valve opening angle and the engine speed (rpm). Air velocity increases as it passes through the long, narrow intake manifold runners.

This engine is equipped with a Mass Airflow (MAF) sensor that works on the principle that the hot wire and the thermistor detect any changes in the intake air temperature.

Throttle Body Components

The throttle body consists of a throttle valve, idle air control valve, the TP sensor and related hoses that connect ported and manifold vacuum sources to the emission control devices. The throttle valve directly controls the volume of air that enters the engine.

Intake Air System Components Graphic



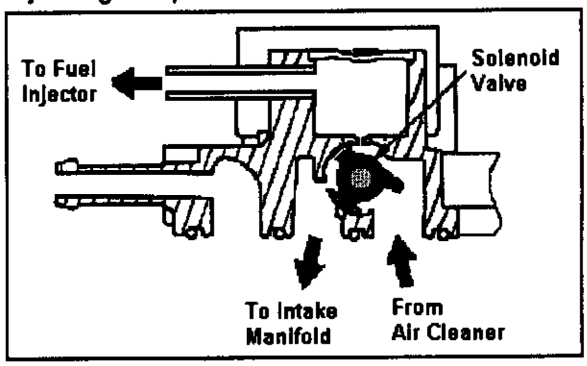
2000 4RUNNER (3.4L V6 VIN N)

Idle Air Control Solenoid

Lab Scope Test (IAC Valve)

The purpose of the Idle Air Control (IAC) system is to provide a stabilized curb idle whenever loads are applied to the engine. This engine is equipped with a rotary solenoid design IAC valve. The valve is used to regulate the amount of air that flows through its internal passage (this air bypasses the throttle valve located in the throttle body) as shown in the Graphic.

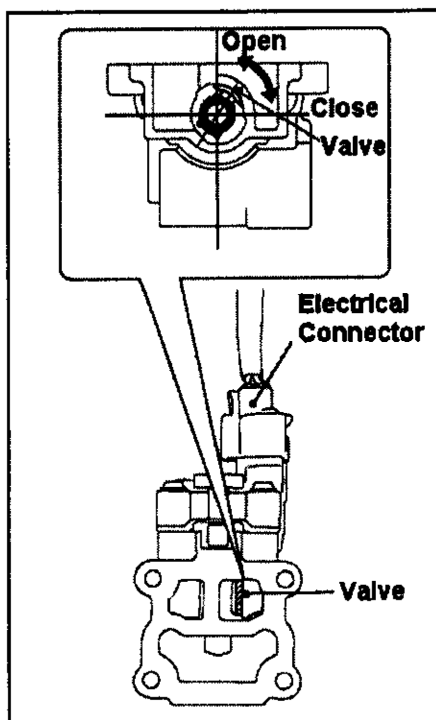
The PCM controls the engine idle speed by adjusting the position of the IAC solenoid valve under all operating conditions by comparing the actual idle valve position to its optimum position stored in memory.



The PCM controls the idle speed through a series of pulses to the IAC solenoid that change the amount of air that bypasses the throttle body to the intake manifold.

This action energizes the valve (opens it) to maintain the correct idle speed.
The PCM controls the position of the IAC valve, based on inputs it receives from the sensors listed below:

- Engine temperature
- Engine speed
- Vehicle speed



The PCM repositions the IAC solenoid valve in order to perform the following functions:

- Idle speed (idle-up) control
- Target idle speed control

<u>IAC Valve Quick Check</u>
To perform a function check of the IAC valve, follow the steps in this procedure:

- Remove the IAC valve unit for inspection.
- Inspect the valve to determine if it is open to about its halfway position.
- Connect the IAC harness connector to the valve.
- Disconnect the ECT sensor wire harness connector.
- Turn the ignition to key on, engine off.
- Verify that the IAC valve moves after the key is turned "on". It may help to repeat this procedure several times (turn the key off each time before turning it back to "on").
- If the IAC valve does not move as described (it may be not functioning due to a mechanical problem or binding due to sludge), replace the IAC valve and retest.

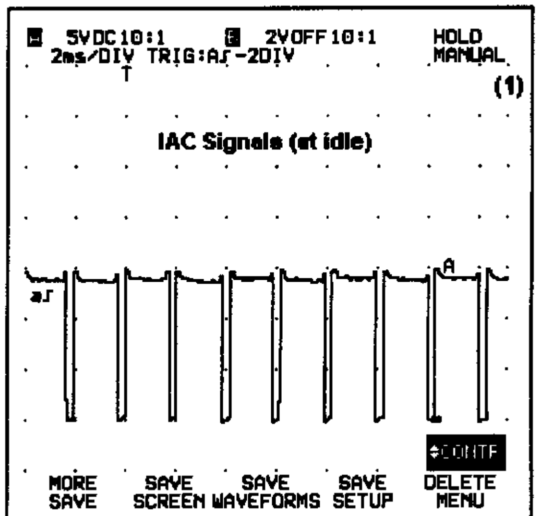
Note: ***The IAC Valve Quick Check is only used to determine the functional operation of the IAC valve. It should not be used to determine if the electrical circuits are okay. The OBD diagnostic procedure should be following to check the electrical circuits.***

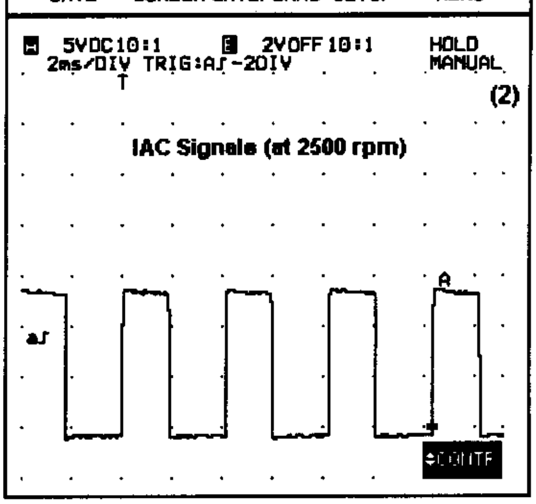
2000 4RUNNER (3.4L V6 VIN N)

Idle Air Control Solenoid

Lab Scope Test (IAC Valve)

The Lab Scope can be used to test the operation of the IAC valve and its circuits. The two examples on this page represent two separate captures of the IAC solenoid signals.





<u>Scope Connections (Examples 1 & 2)</u>
Connect the Channel 'A' positive probe to the RSC IAC valve at Pin 15 (BLK/RED wire) and connect the Channel 'B' negative probe to the IAC RSO circuit at Pin 16 (BRN/RED wire).

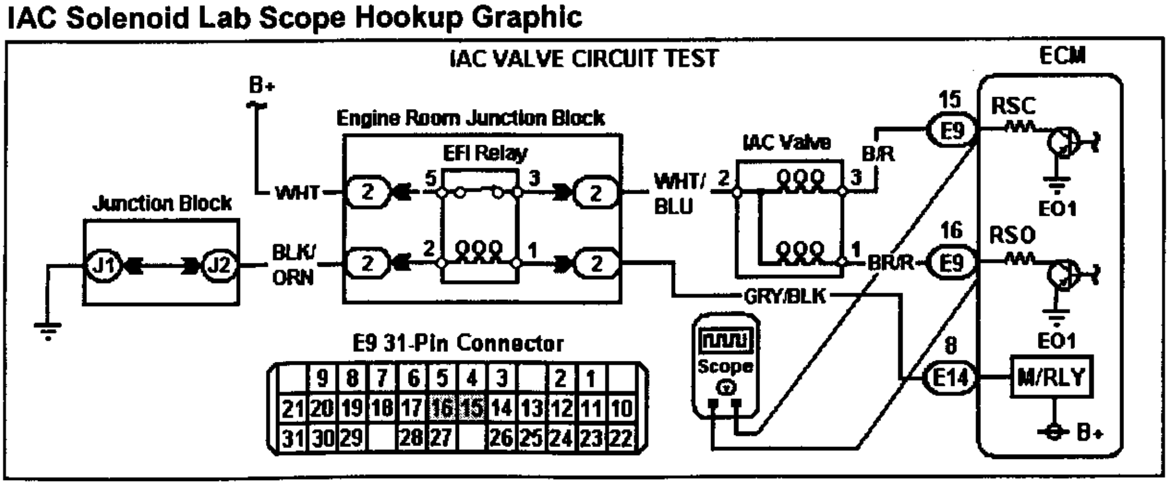
<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the example.

<u>IAC Solenoid Lab Scope Test</u>
Start the engine and allow it to fully warm up. Then capture the IAC solenoid waveform with the gear selector in Park or Neutral. Then with the gear selector still in P/N, turn on the air conditioning and select the high blower position. Also turn on the lights and radio. These loads should cause the PCM to adjust the IAC solenoid valve position (under load).

<u>Lab Scope Explanation - Example (1)</u>
This trace shows the IAC valve waveform without any load applied at hot idle speed in Park. The average IAC signal ontime without any load applied is less than (1) ms.

<u>Lab Scope Explanation - Example (2)</u>
This trace shows the IAC valve waveform with the engine speed at 2500 rpm in Park. Note the change in the amount of time the solenoid is "on" at idle from the amount of time the solenoid is "on" at Cruise speed.

IAC Solenoid Lab Scope Hookup Graphic



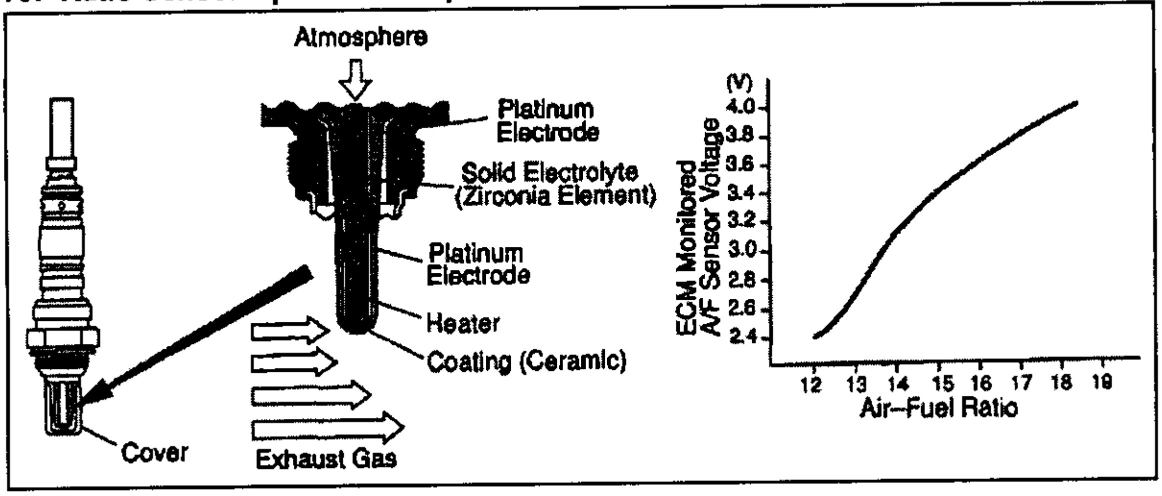
2000 4RUNNER (3.4L V6 VIN N)

Air Fuel Ratio Sensor

General Description

The Air Fuel Ratio sensor (A/F sensor) operates similar to a conventional oxygen sensor. While the outside case of this sensor may look like a conventional oxygen sensor, it is constructed quite differently and has very different operating characteristics.

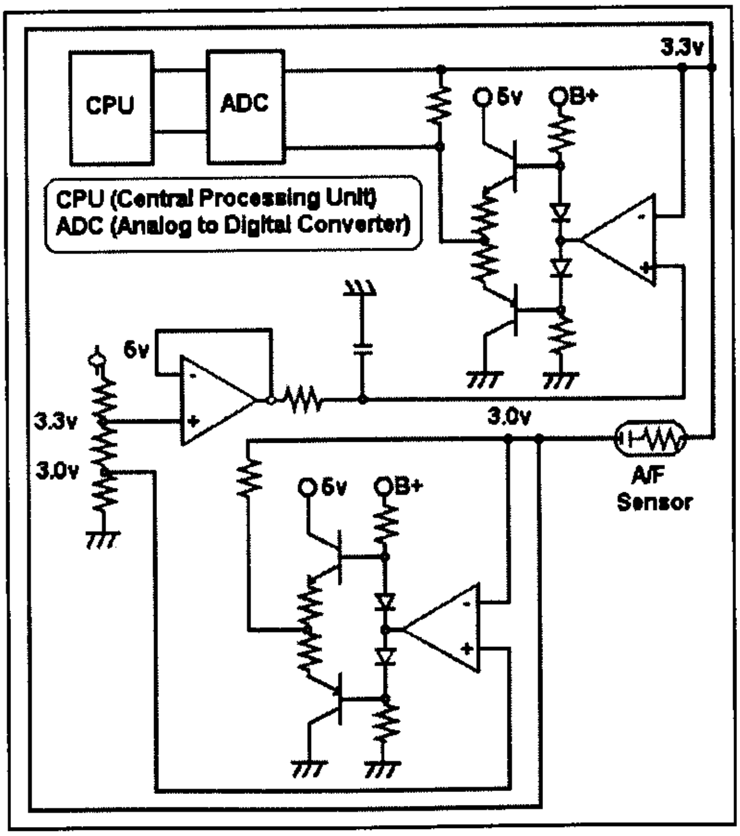
A/F Ratio Sensor Operation Graphic



Wide Range Sensor

The A/F Ratio sensor is referred to as a "wide range" or "wide ratio" sensor because of its ability to detect air fuel ratios over a wide range of engine operation. The A/F sensor provides the PCM with the ability to more accurately meter the fuel reducing emissions.

To accomplish this task, the A/F sensor operates at a hotter temperature (1200°F instead of 750°F for a conventional oxygen sensor) and changes its current output in relation to the amount of oxygen in the exhaust stream.



<u>A/F Sensor Detecting Circuit</u>

The Air Fuel Ratio sensor (A/F sensor) operates similar to a conventional oxygen sensor. While this sensor may look like a conventional oxygen sensor, it is constructed quite differently and has different operating characteristics.

Key Point - The detection circuit detects the change and strength of the current flow of the A/F sensor circuit and outputs a signal proportional to the exhaust oxygen content.

2000 4RUNNER (3.4L V6 VIN N)

Air Fuel Ratio Sensor

A/F Sensor Operation

The A/F sensor is designed so that at stoichiometry, there is no current flow and the voltage output of the detection circuit is 3.3 volts. A rich mixture, which leaves very little oxygen in the exhaust stream, produces a negative current flow.

The detection circuit will produce a voltage below 3.3 volts. A Lean mixture, which has more oxygen in the exhaust stream, produces a positive current flow, and this action causes the detection circuit to produce a voltage signal that is above 3.3 volts.

A/F Sensor Operation Table

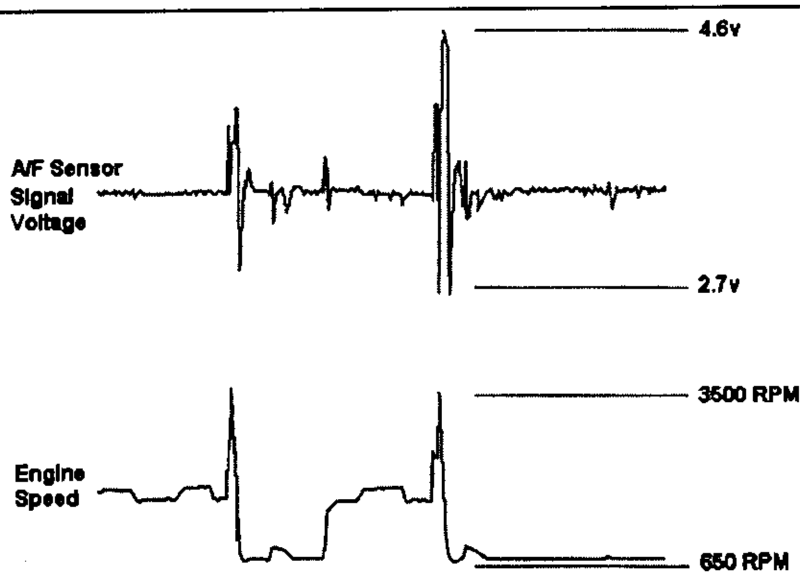
Exhaust Oxygen Content	Current Flow	Voltage Signal	A/F Mixture Judged to Be:
Low Oxygen content	(-) Direction	Less than 3.3 volts	"Rich"
Stoichiometry	(0)	3.3 volts	"14.7:1"
High Oxygen content	(+) Direction	More than 3.3 volts	"Lean"

Key Point - The A/F sensor output is the opposite of what happens in the narrow range oxygen sensor circuit. In effect, instead of the oxygen sensor voltage signal decreasing as the air fuel mixture goes lean (as with a conventional O2S), the voltage output of the detection circuit increases as the air fuel mixture goes lean in the exhaust stream.

A/F Sensor Schematic

A/F Sensor Signal Pattern

The A/F sensor responds to changes in exhaust oxygen. Note that the signal changes with engine RPM and does not move in cycles like the oxygen sensor.



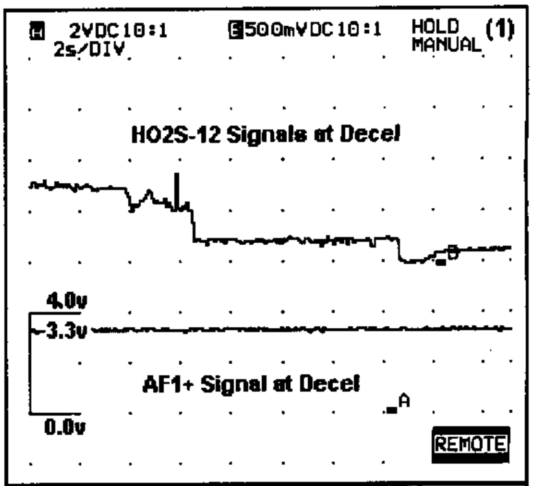
<u>A/F Sensor Summary</u>

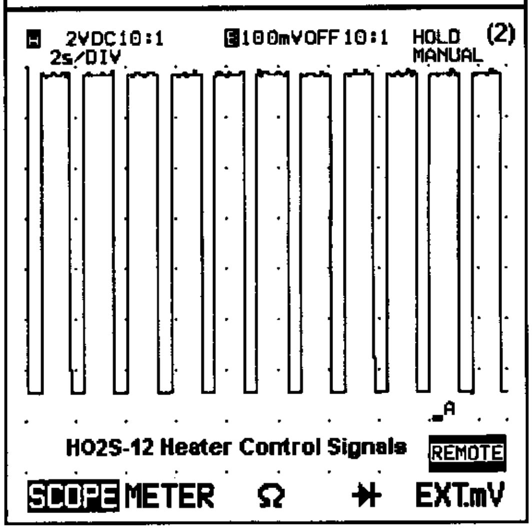
The A/F sensor voltage signal is proportional to the change in the air fuel mixture. By using this sensor, the PCM can more accurately judge the exact A/F ratio under a wide variety of engine operating conditions and then quickly adjust the amount of fuel to the stoichiometric point. This type of rapid correction is not possible with the narrow range oxygen sensor. With an A/F sensor, the PCM does not follow a rich / lean cycle.

2000 4RUNNER (3.4L V6 VIN N)

Air Fuel Ratio Sensor

Lab Scope Test (A/F Sensor)





The Lab Scope is the tool of choice to test the operation of the heated oxygen sensor. It is not the tool of choice to test the A/F sensor.

Scope Connections (HO2S-12 Signal)
Connect the Channel 'B' positive probe to the HO2S-12 signal (RED wire) at Pin 8 of the E12 28-Pin connector. Connect the negative probe to the battery negative ground post.

Scope Connections (AF1+ Signal)
Connect the Channel 'A' positive probe to the AF1+ signal (WHT wire) at Pin 12 of the E10 24P connector. Connect the Channel 'A' negative probe to E21 of the 24P connector.

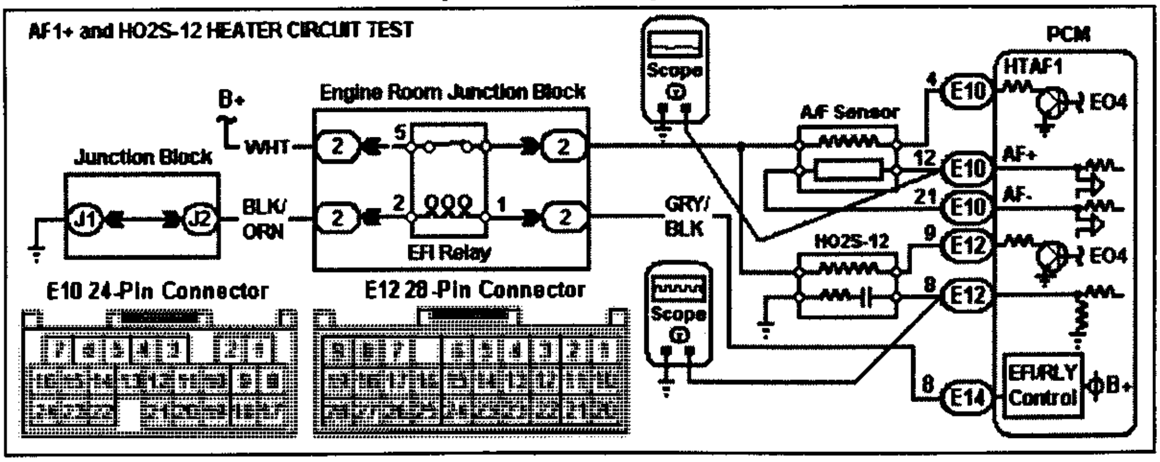
Scope Connections (HO2S-12 Heater Control)
The heater control circuits are activated a short time after engine startup. To view the heater control signals, connect the Channel 'A' positive probe at Pin 9 of the E12 28P connector. Connect the Channel 'A' negative probe to the battery negative ground post.

Scope Settings
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Explanation - Example (1)
In this example, the top trace shows the rear HO2S-12 signal and the bottom trace shows the AF1+ signal during a deceleration period.

Lab Scope Explanation - Example (2)
In this example, the trace shows the HO2S-12 heater control signal after engine startup. Note that this is system voltage signal (14v). Also note the ground circuit resistance.

A/F Sensor & HO2S-11 Lab Scope Hookup Graphic

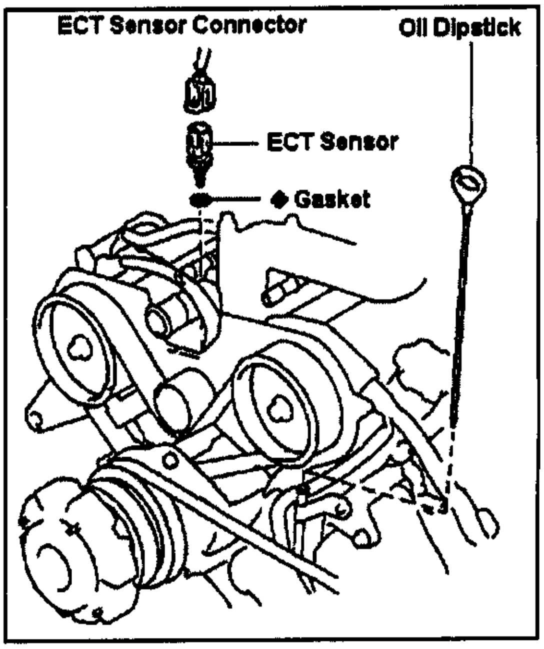


2000 4RUNNER (3.4L V6 VIN N)

Engine Coolant Temperature Sensor

General Description

The engine coolant temperature (ECT) sensor is located at the top of the engine in a water jacket. This device is used to sense the temperature of the engine coolant.



The ECT sensor includes a thermistor that is designed to change its resistance value according to changes in the temperature of coolant in the engine.

The PCM uses the information from the ECT sensor in order to determine the amount of fuel injector ontime, idle speed and spark timing during all engine operating conditions.

Thermistor Operation

The thermistor in this device is designed to work under the following principles:

- The lower the engine coolant temperature, the greater the sensor resistance value
- The higher the engine coolant temperature, the lower the sensor resistance value

Circuit Operation

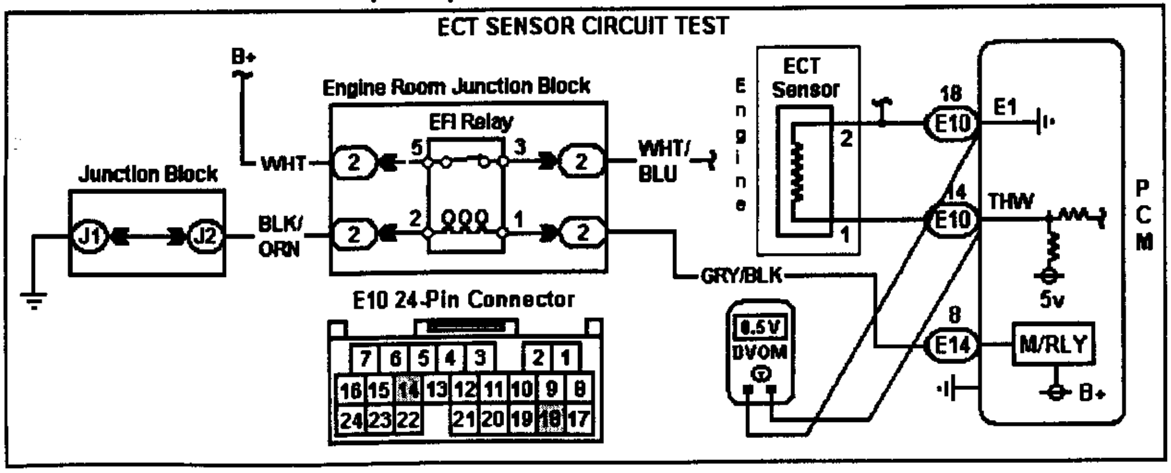
The ECT sensor is connected to the PCM by two wires. The PCM supplies the ECT sensor with a 5v signal and sensor return or ground circuit. The ECT signal circuit is identified as the THW circuit.

The PCM supplies the 5v signal circuit to the ECT sensor through a resistor in series with it. As the resistance value of the sensor changes in accordance with changes in coolant temperature, the voltage potential of the signal circuit (THW) also changes.

DVOM Connections (ECT Sensor)

Connect one DVOM probe to the ECT sensor THW signal wire (GRN wire) at PCM Pin 14 of the E10 24P connector. Connect the other probe to the sensor ground wire (E1) at PCM Pin 18 of the E10 24P connector. The readings taken with a DVOM can be used to determine if a circuit is working, or if the sensor had drifted out of normal range.

ECT Sensor DVOM Hookup Graphic

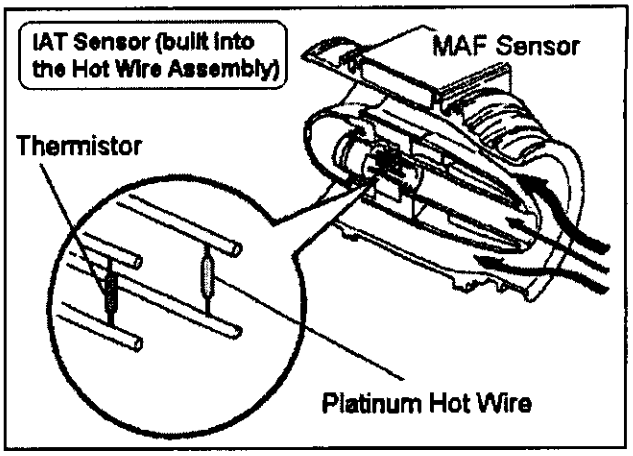


2000 4RUNNER (3.4L V6 VIN N)

Intake Air Temperature Sensor

General Description

The intake air temperature (IAT) sensor is built into the mass airflow sensor (MAF). This sensor is used to sense the temperature of the incoming air stream.



The IAT sensor includes a thermistor that is designed to change its resistance value according to changes in the temperature of the incoming air stream.

The PCM uses the information from the IAT sensor in order to determine the amount of fuel injector ontime during periods of cold engine operation.

Thermistor Operation

The thermistor in this device is designed to work under the following principles:

- The lower the intake air temperature, the greater the sensor resistance value
- The higher the intake air temperature, the lower the sensor resistance value

Circuit Operation

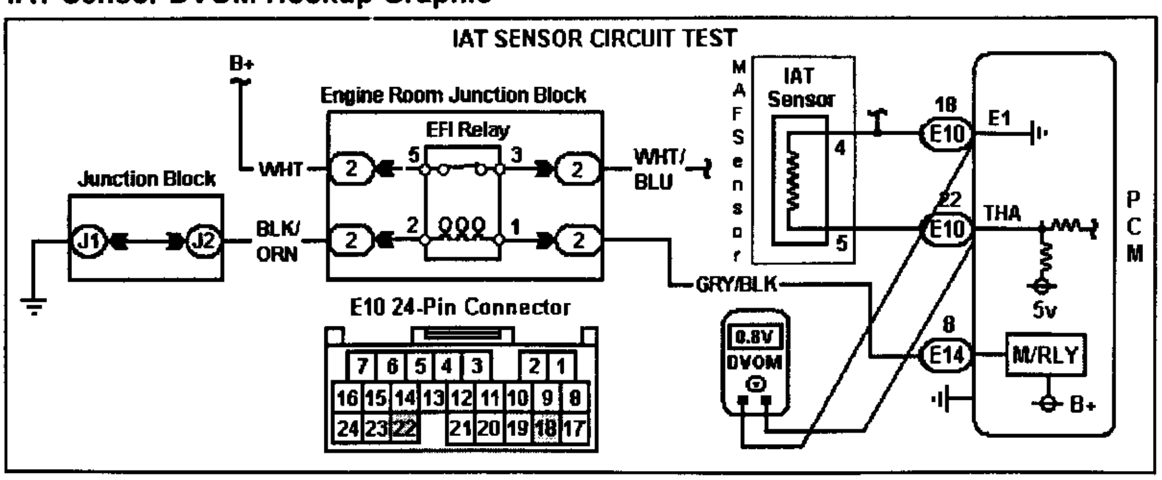
The intake air temperature sensor is connected to the PCM with two (2) circuits. The PCM supplies the IAT sensor with a 5v signal and sensor return or ground circuit. The IAT signal circuit is identified as the THA circuit.

The PCM supplies the 5v signal circuit to the IAT sensor through a resistor in series with it. As the resistance value of the sensor changes in accordance with changes in the air temperature, the voltage potential of the signal circuit (THA) also changes.

DVOM Connections (IAT Sensor)

Connect one DVOM probe to the IAT sensor THA signal wire (YEL/GRN wire) at PCM Pin 22 of the E10 24P connector. Connect the other probe to the sensor ground wire (E1) at PCM Pin 18 of the E10 24P connector. The readings taken with a DVOM can be used to determine if a circuit is working, or if the sensor had drifted out of normal range.

IAT Sensor DVOM Hookup Graphic

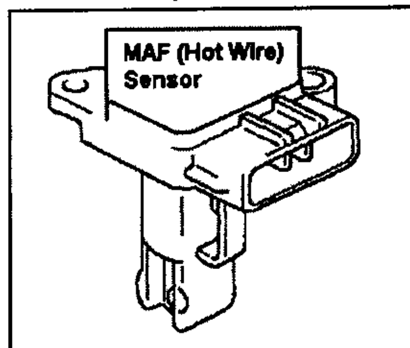


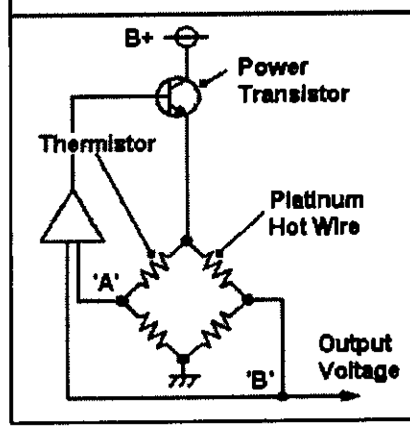
2000 4RUNNER (3.4L V6 VIN N)

Mass Airflow Sensor

General Description

The Mass Airflow (MAF) sensor is a Platinum hot-wire design. This MAF sensor works on the principle that the hot wire and the thermistor (which are positioned in the air intake bypass of the housing) detect any changes in the intake air temperature.





System Components

The hot wire airflow meter includes the following components:

- A Platinum hot wire
- A thermistor
- An airflow meter control circuit installed inside of a plastic housing

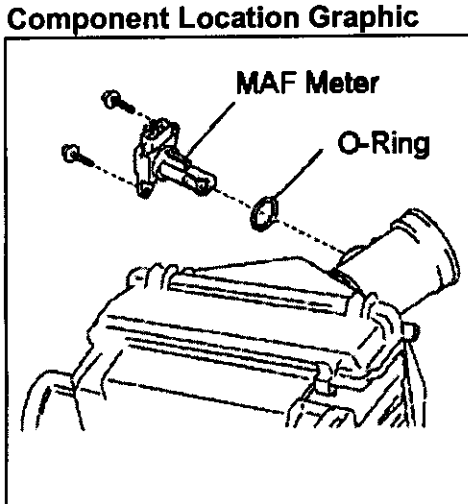
Circuit Operation

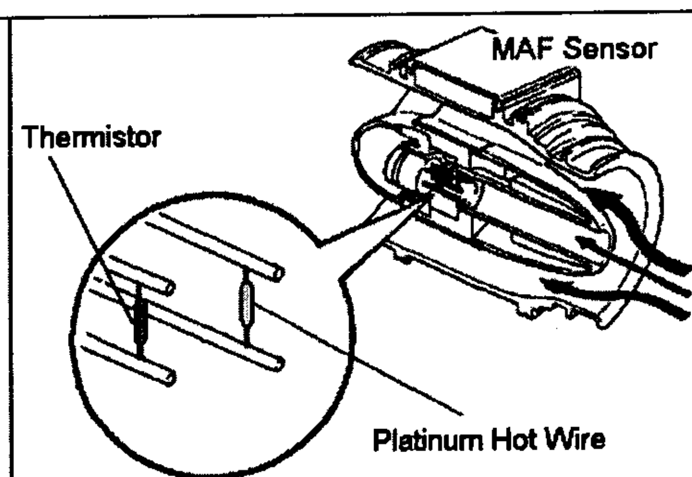
The airflow meter (control circuitry) maintains the hot wire at a set temperature by controlling the current flow through the hot wire. This amount of current flow is converted by the control unit into a MAF sensor output voltage signal, and is sent on to the PCM.

The hot wire circuit is constructed so that the Platinum hot wire and thermistor form a "bridge circuit". The internal power transistor is controlled so that the potential of circuit 'A' and circuit 'B' remains the same in order to maintain the correct hot wire temperature.

Note the location of the Thermistor and Platinum Hot Wire components (in the incoming air stream) in the Component Location Graphic below.

Component Location Graphic



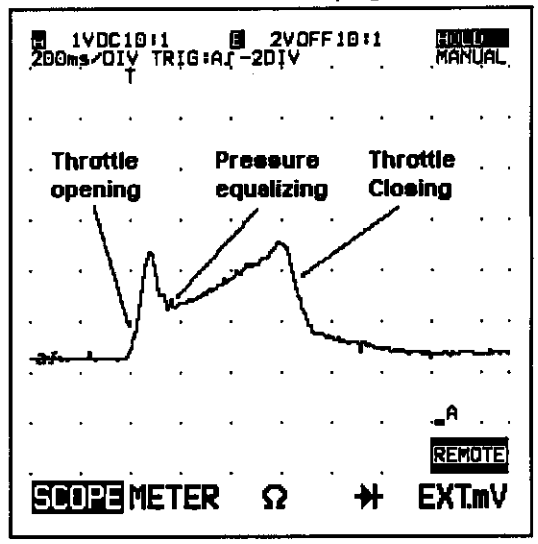


2000 4RUNNER (3.4L V6 VIN N)

Mass Airflow Sensor

Lab Scope Test (MAF Sensor)

The Lab Scope can be used to test the operation of the MAF sensor and its circuits, but is not the "tool of choice" for this device. The Scan Tool can be used more effectively. Refer to the article on the Scan Tool Test for the MAF sensor on the next page.



<u>Scope Connections</u>
To test the operation of the MAF sensor with a Lab Scope, connect the Channel 'A' positive probe to the MAF sensor signal wire (VG -the RED/WHT wire) at Pin 10 of the PCM 24P connector.

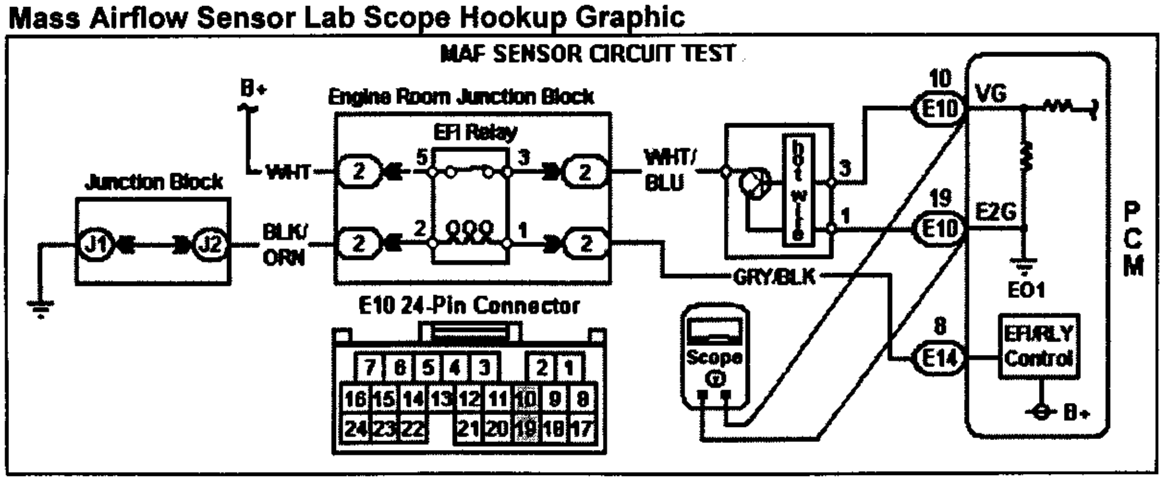
Connect the Channel 'A' negative probe to the MAF sensor ground wire (E2G - BLK/WHT wire) at Pin 19 of the PCM 24P connector or to the battery negative ground post.

<u>Scope Settings</u>
To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Lab Scope Example Explanation</u>
In this example, the trace shows the MAF sensor (analog signal) during a period where a snap throttle condition occurred.

Note the sudden rise in the MAF sensor voltage (to a point over 3v) as the throttle is opened quickly in the example. Note how the signal appears to sag as the pressure in the intake manifold equalizes and then smoothes out. Note also how it climbs back to a high point and then slowly decreases to about 1.5 volts once the throttle is closed.

Mass Airflow Sensor Lab Scope Hookup Graphic

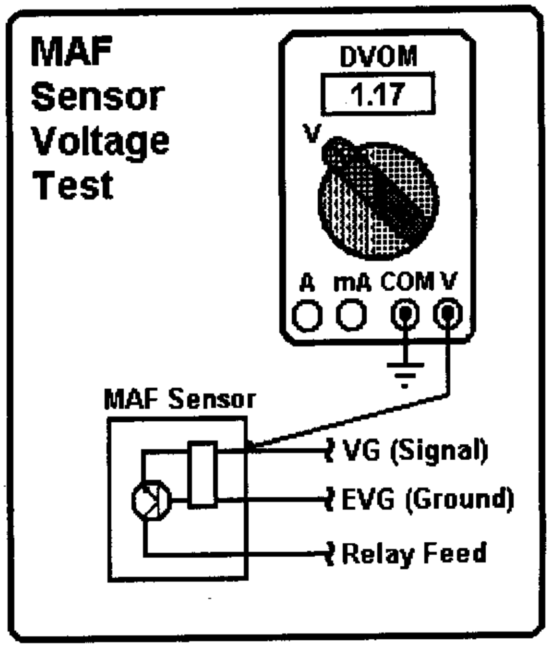


2000 4RUNNER (3.4L V6 VIN N)

Mass Airflow Sensor

DVOM Test (MAF Sensor)

To test the MAF sensor with a DVOM, first place the gear selector in Park or Neutral (M/T) and block the drive wheels for safety.

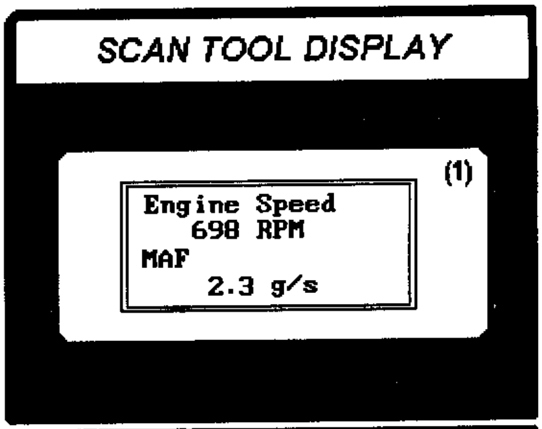


DVOM Connections (MAF Sensor)
Connect the DVOM positive probe to the MAF sensor signal wire at PCM Pin 10 of the 24P connector (RED/WHT wire) and connect the DVOM negative probe to PCM Pin 19 (BLK/WHT wire) of the same connector.

DVOM Connections (IAT Sensor)
Connect the DVOM positive probe to the IAT (THA) sensor signal wire at PCM Pin 22 of the 24P connector (YEL/GRN wire). Connect the DVOM negative probe to PCM Pin 19 (BLK/WHT wire) of the same connector.

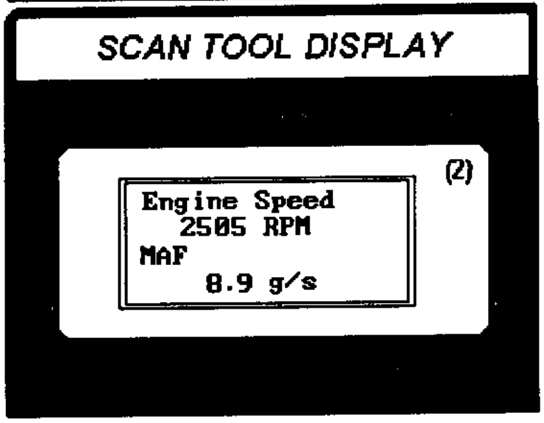
Scan Tool Test (MAF Sensor)

The Scan Tool is the "tool of choice" to use to test the operation of the MAF sensor and its circuits. While a Lab Scope can also be used, it is far easier to obtain information about this sensor with a Scan Tool. MAF sensor information is provided in gms/sec (so that you can compare it to a "known good" vehicle or values in an operating range chart).



Connect the Scan Tool to the OBD II 16-Pin underdash test connector. Follow the Scan Tool menu instructions in order to select PID Data from the main menu so that the Mass Airflow Rate and Engine Speed readings can be displayed as shown in the examples.

Run the engine at 1500 rpm in Park or Neutral (M/T) for 3 minutes until it is fully warmed up. Then allow the engine to return to idle speed to set up the test sequence.



Scan Tool Test (1) Example
With the engine running at idle with the gear selector in Park or Neutral and the Parking Brake applied, record the MAF and RPM PID readings. Compare them to the example.

Scan Tool Test (2) Example
With the engine running at 2500 rpm with the gear selector in Park or Neutral and Parking Brake applied, record the MAF and RPM PID readings. Compare them to the example.

If the MAF PID readings do not match these examples, the MAF sensor may be dirty.

2000 4RUNNER (3.4L V6 VIN N)

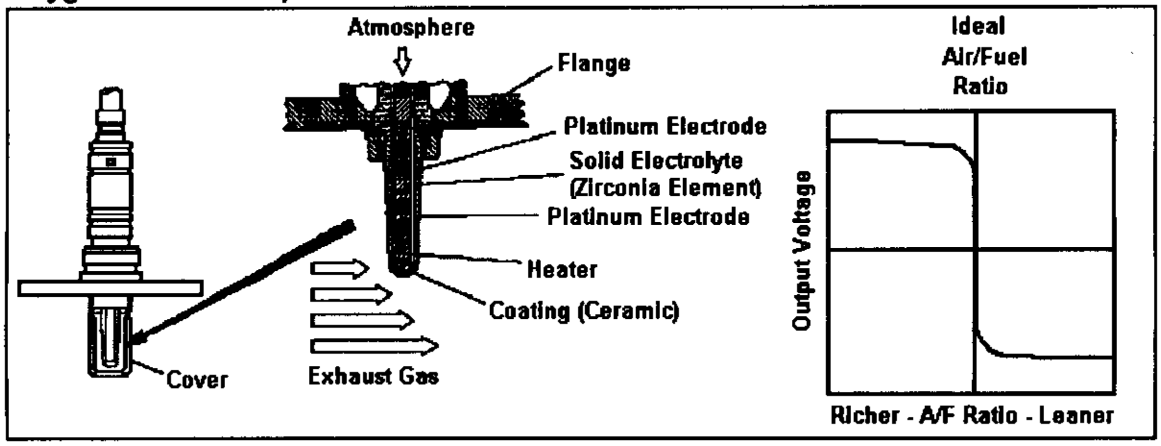
Oxygen Sensor (Non-ULEV Vehicles)

General Description

The heated oxygen sensor (HO2S) is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust stream. The PCM determines the oxygen density of the exhaust gases through an input signal.

A heater is used along with the oxygen sensor in order to maintain stable oxygen detection performance. The PCM controls the operation of the heater in the oxygen sensor (it turns it "on" and "off"). The PCM connects to the heater control circuit of the front oxygen sensor (HO2S-11) at the PCM terminal identified as HT1A and to the rear oxygen sensor (HO2S-12) at HT1B. The heater resistance is 11-16 ohms at 68°F.

Oxygen Sensor Graphic

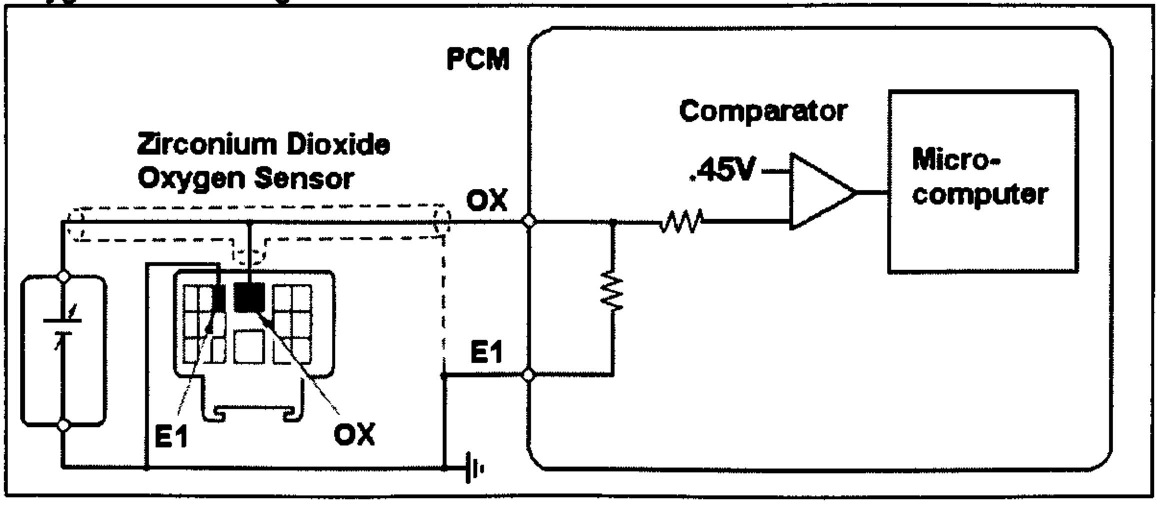


<u>Conventional Oxygen Sensor Operation</u>

In order to obtain a high purification rate for the CO, HC and NOx components of the exhaust gas, a three-way catalytic converter is used on this vehicle. This converter is very efficient when the A/F ratio is controlled at a rate close to stoichiometric A/F ratio.

The heated oxygen sensor has a characteristic whereby its output voltage changes suddenly when it is in the vicinity of the stoichiometric A/F ratio (near 14.7:1). This characteristic is used to detect the oxygen concentration in the exhaust gas and to provide feedback to the PCM for proper control of the A/F ratio.

Oxygen Sensor Diagram



2000 4RUNNER (3.4L V6 VIN N)

Oxygen Sensor (Non-ULEV Vehicles)

Lab Scope Test (Oxygen Sensor)

The Lab Scope is the tool of choice to test the operation of the front and rear oxygen sensors. Refer to the Oxygen Sensor Lab Scope Hookup Graphic below as needed.

<u>Scope Connections (4-SPD Automatic)</u>

To view the front oxygen sensor waveform, connect the Channel 'A' positive probe to Pin 12 (WHT wire) of the PCM E10 24P connector.

Connect the Channel 'A' negative probe to the battery negative ground post.

To view the rear oxygen sensor waveform, connect the Channel 'B' positive probe to Pin 8 (RED wire) of the PCM E12 28P connector.

<u>Scope Connections (HO2S-11 Heater)</u>

A Lab Scope can be used to monitor the control signals to the front oxygen sensor.

The heater control circuits to the front and rear oxygen sensors are controlled by the PCM. They are activated a short time after startup.

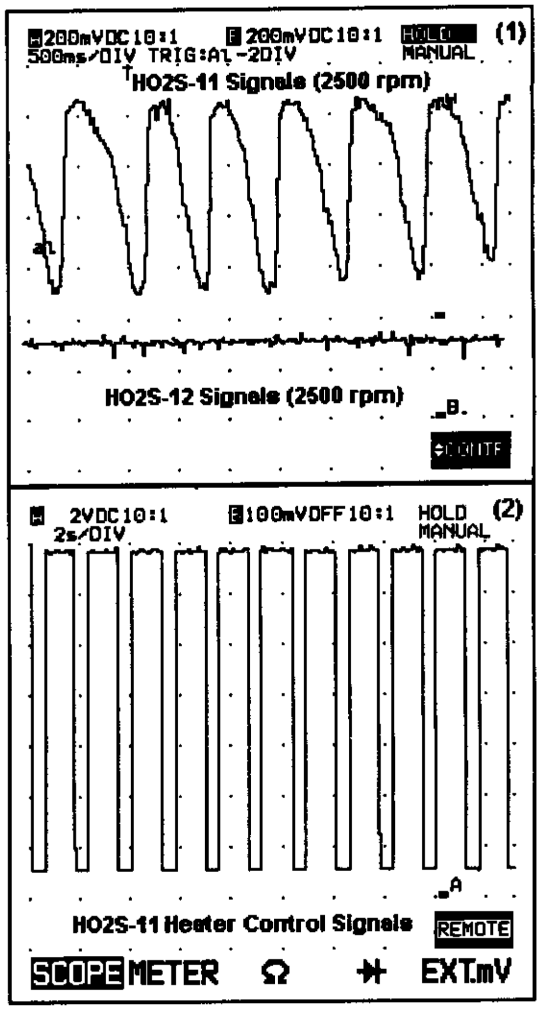
To view the HO2S-11 control signal, connect the Channel 'A' positive probe at Pin 4 (PNK/BLU wire) of the E10 24P connector. Connect the Channel 'A' negative probe to the battery ground post.

<u>Scope Settings</u>

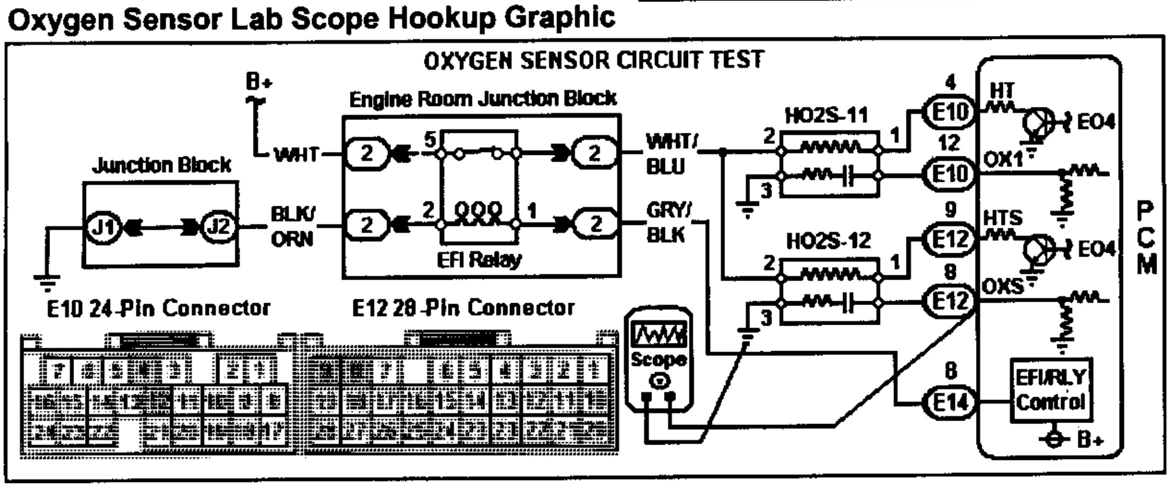
To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Lab Scope Example (1) & (2) Explanation</u>

The top trace shows the HO2S-11 and bottom trace shows the HO2S-12 signals at Cruise speed. The trace in Example (2) shows the heater control signal to the HO2S-11 heater.



Oxygen Sensor Lab Scope Hookup Graphic

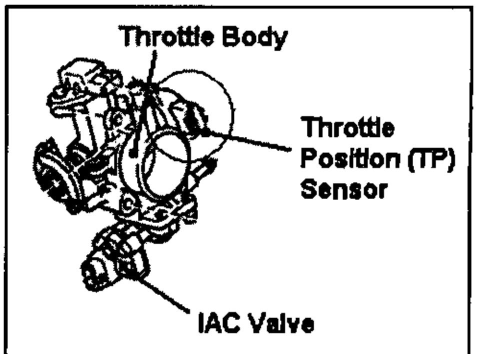


2000 4RUNNER (3.4L V6 VIN N)

Throttle Position Sensor

General Description

The Throttle Position (TP) sensor is mounted to the throttle body to detect the throttle valve angle.



TP Sensor Circuits

The three circuits that connect the TP sensor are:

- The VC circuit (5v reference voltage circuit)
- The VTA circuit (TP sensor signal circuit)
- The E2 circuit (TP sensor ground return circuit)

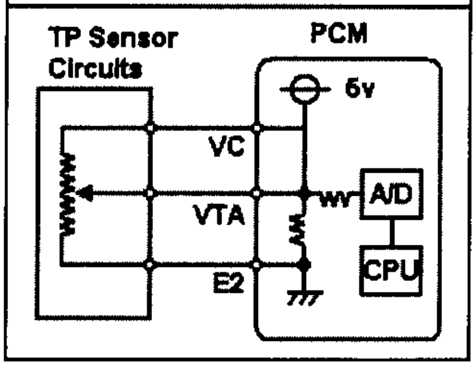
Circuit Operation

With the throttle valve fully closed, the TP sensor signal to the PCM is from 0.3-0.8v at terminal VTA.

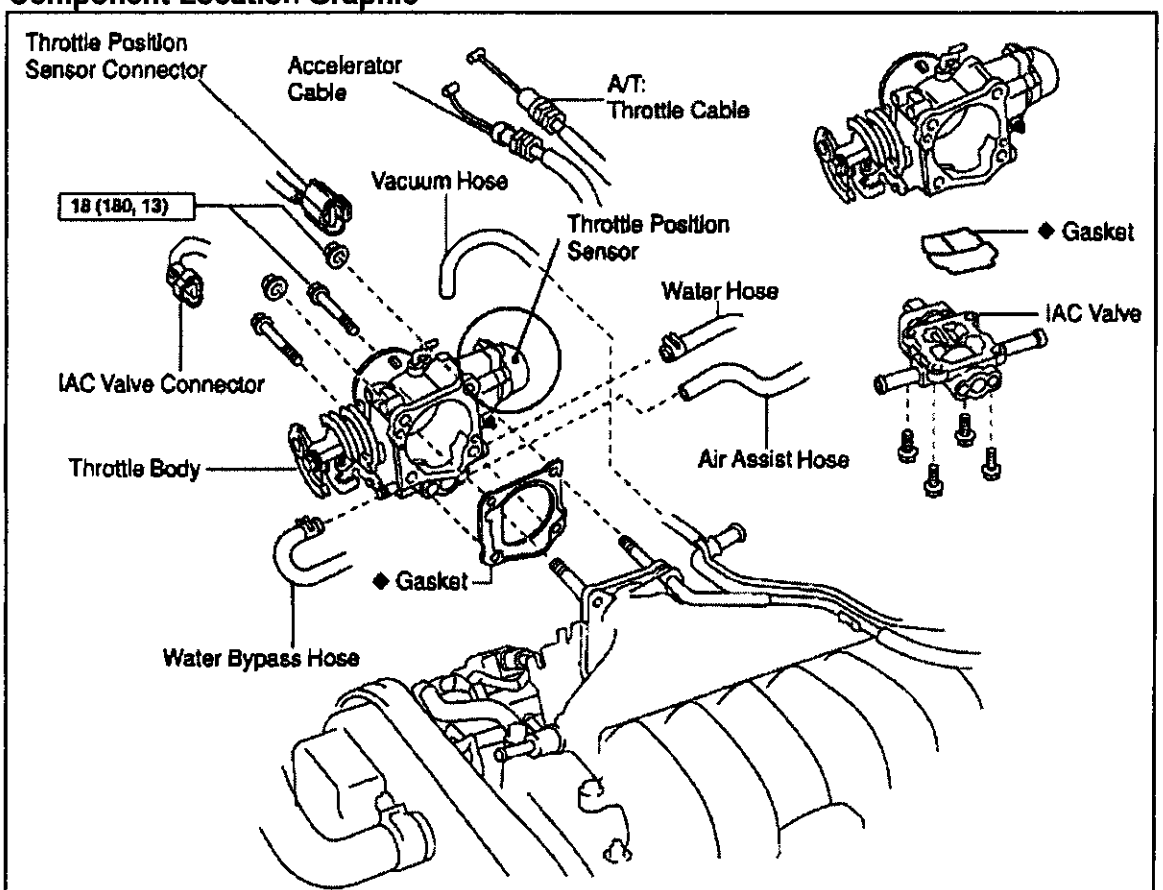
The TP sensor voltage increases in proportion to the throttle valve-opening angle. The TP signal is from 3.2-4.9v with the throttle valve fully open.

The PCM uses the signal (analog DC voltage) to detect the following vehicle driving conditions:

- Air Fuel (A/F) Ratio correction
- Fuel Cut Control
- Power Increase correction



Component Location Graphic

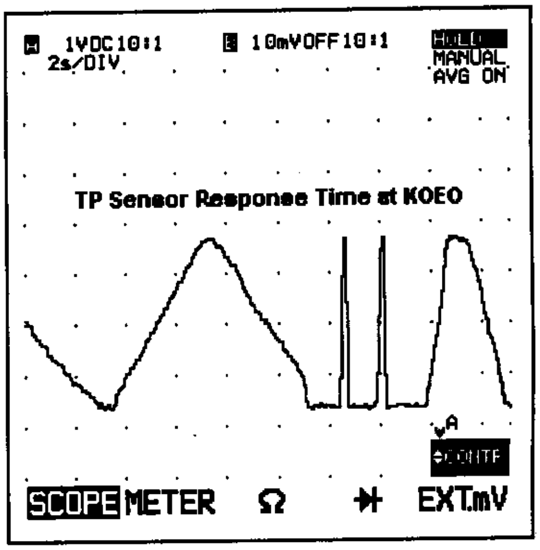


2000 4RUNNER (3.4L V6 VIN N)

Throttle Position Sensor

Lab Scope Test (TP Sensor)

The Lab Scope can be used to test the operation of the TP sensor and its circuits, but is not the "tool of choice" for this device. The Scan Tool is a much easier tool to use to test the operation of this device. However, the Lab Scope will help find a circuit "glitch".



Scope Connections (TP Sensor)

Connect the Channel 'A' positive probe to the TP sensor signal wire at Pin 23 of the 24-Pin connector (BLK/YEL wire).

Then connect the Channel 'A' negative probe to the E2 sensor ground point at PCM Pin 18 (BLU/BLK wire) of the same connector (24P).

Scope Settings

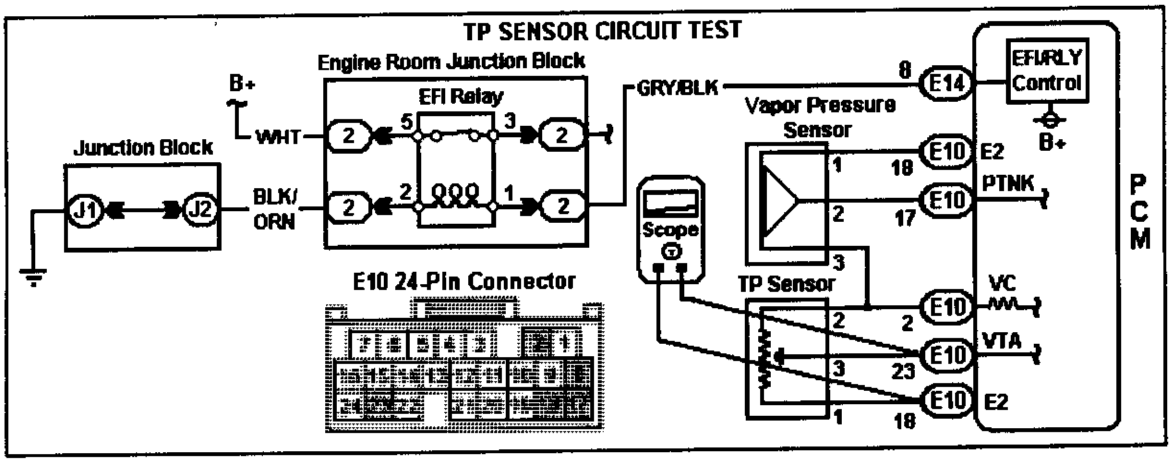
To make the waveforms as clear as possible, set the scope settings to match the examples.

Lab Scope Example Explanation

In this example, the trace shows the TP sensor (analog signal) as the throttle is opened and closed first slowly and then very fast with the key on and engine off (KOEO). Note the smooth transition from high to low voltage in this example from a known good TP sensor.

The TP sensor signal should also be checked for breaks in the sensor resistor. One way to find this type of problem is to turn to key on, engine off and with the Lab Scope connected as shown in the Graphic below, slowly open and close the throttle while watching the TP sensor waveform for any sudden increase or decrease in the linear action of the pattern. A dropout (e.g., a sudden downward spike) in the TP sensor signal trace would indicate a short while a sudden upward spike would indicate an open circuit.

Throttle Position Sensor Lab Scope Hookup Graphic



2000 4RUNNER (3.4L V6 VIN N)

Vehicle Speed Sensor

General Description

The vehicle speed sensor signal for this vehicle application starts with an analog speed sensor signal from the Antilock Brake (ABS) wheel speed sensor (WSS). The signal from the WSS is converted into a digital signal by the A/D converter inside the ABS ECU. The ECU sends a series of four (4) pulse digital signals to the Combination Meter to indicate the correct vehicle speed to the PCM.

The Combination Meter converts this signal into a more precise rectangular waveform (through a waveform shaping circuit) and then sends this signal to the PCM on the vehicle serial data bus. The PCM determines the vehicle speed based on the frequency of the digital pulses.

Lab Scope Test (VSS)

<u>Scope Connections (VSS to PCM Signal)</u>

Connect the Channel 'A' positive probe to the VSS signal circuit at Pin 22 (GRN/ORN wire) of the PCM E12 22-Pin Connector.

Connect the negative probe to chassis ground or to the battery negative ground post.

<u>Scope Settings</u>

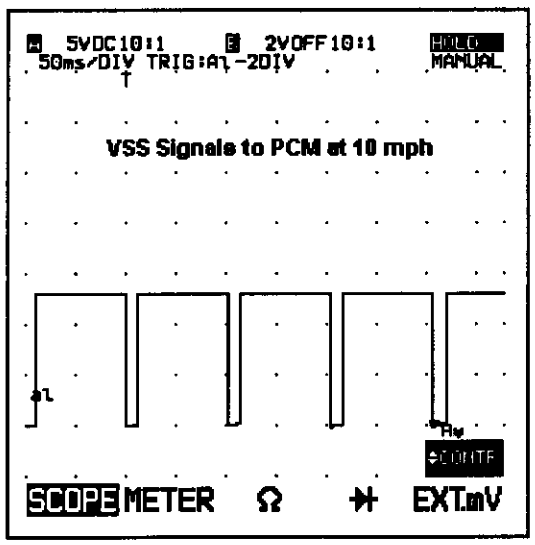
To make the waveforms as clear as possible, set the scope settings to match the examples.

<u>Vehicle Speed Sensor Test</u>

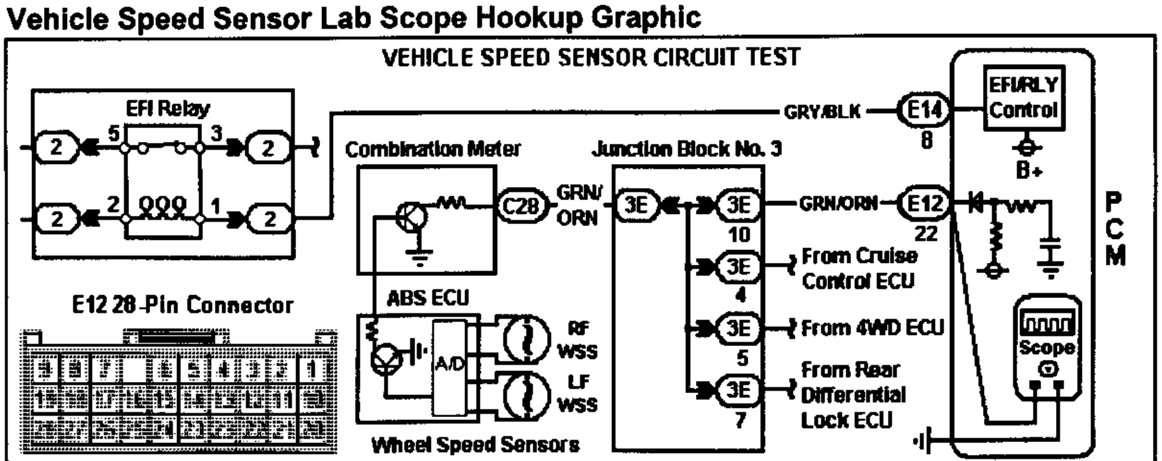
Connect the Lab Scope to the correct terminals at the PCM (inside the vehicle). Then start the engine and drive the vehicle at the desired speed to set up the VSS capture.

<u>Lab Scope Example (VSS at 10 mph)</u>

The trace in this example shows a known good Vehicle Speed sensor waveform at 10 mph.



Vehicle Speed Sensor Lab Scope Hookup Graphic



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

How To Access & Use Generic PID Information

The Scan Tool Generic Parameter Identification (PID) Mode allows access to certain data values, analog and digital input and output signals, calculated values and system status information.

The Generic OBD II PID list contains examples of the PIDs that all OBD II compatible Scan Tools must be able to access and display.

Scan Tool PID Menus

An example of how to navigate through the Vetronix Scan Tool menus to locate the Generic PID information is shown in the Graphic to the right.

The Graphic also contains a total of twelve (12) engine related parameters that are available for this vehicle on an OBD II compatible Scan Tool. The parameters in the right hand column of the example represent known good values for this engine application.

If all of these PID values are within normal range, refer to the Symptom Diagnosis information in Section 1.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete Generic PID list for this vehicle is shown in the Graphic.

1) Select F1: SCANTEST from the function menu.
2) Select Global OBD II from the Applications menu.
3) Select F0: Powertrain from the Main menu.
4) Initializing OBD II Communications screen appears.
5) Select F0: DATALIST from the Select Mode menu. To view the I/M Readiness status of the OBD II Main Monitors, select F1: Readiness (or another choice).

- Select F0: Display Data from the Data List Menu.

Some of the eighteen PID items available in the Generic PID list for this vehicle are shown in the last frame.

Diagnostic Tip

The Typical Values in the example on this page should be used after the following conditions are met:

- The Toyota TCCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

(1)
```
FUNCTION MENU
F1: SCANTEST
F2: DIGITAL METER
F3: OSCILLOCOPE
F4: EMISSION TESTS
F8: TECH TOOLBOX
F9: SETUP
```

(2)
```
APPLICATIONS ↑↓
-> GLOBAL OBD II
   GM P/T
   GM CHASSIS
```

(3)
```
MAIN MENU
F0:Powertrain
F1:Replay Data
F9:OBDII Toolpak
```

(4)
```
Initializing
OBD II
Communications
```

(5)
```
SELECT MODE ↑↓
F0:Datalist
F1:Readiness
F2:DTCs
```

```
SELECT MODE ↑↓
F3:Snapshot
F4:OBD Controls
F5:System Tests
```

```
SELECT MODE ↑↓
F8:Information
F9:OBDII Toolpak
```

(6)
```
DATA LIST MENU
F0:Display Data
F1:Data Setup
```

```
ENGINE SPEED····716RPM
ECT (°)···········190°F
VEHICLE SPEED······0MPH
IGN. TIMING·······13.0°
ENGINE LOAD·······17.2%
MAF (R)········4.28gm/s
TPS (%)···········13.7%
IAT (°)············90°F
FUEL STAT 1···········CL
ST FT 1·············3.9%
LT FT 1·············3.9%
O2S B1 S2········0.680V
```

2000 4RUNNER (3.4L V6 VIN N)

Reference Information

How To Access & Use OEM PID Information

The Toyota Enhanced PID List on the next page contains examples of the engine related parameters available on an Aftermarket Scan Tool with an Asian cartridge.

Toyota has several "data lists" available under the OEM proprietary PID (data) selections. Once you pull up one of the data lists, you can compare the readings in the Hot Idle, 30 and 55 mph columns in the examples on the next page to the examples of the vehicle that is being tested.

If all of the PID values are all within normal range, refer to Symptom Diagnosis in Section 1 of this manual.

Scan Tool PID Menus

An example of how to navigate through the Snap On Scan Tool menus to locate the OEM PID Information is shown in the Graphic to the right.

The Graphic contains an example of how to obtain the vehicle parameters available for this vehicle with an OEM proprietary Scan Tool or Aftermarket Scan Tool with the applicable Toyota or Asian manufacturer cartridge.

Parameter ID (PID) Information

The proper sequence to follow to obtain a complete OEM PID list for this vehicle is shown in the Graphic.

1) Select F1: SCANTEST from the opening menu.
2) Select Toyota/Lexus from the Applications menu.
3) Select the letter that identifies the model year ('Y').
4) Select the letter that identifies the engine size ('N').
5) Select ENGINE from the Select System menu.
6) Select 4-SPEED E-TRANS from the Options Menu.
7) Select CODES & DATA MENU from the Main Menu.
8) Select CODES & DATA from CODES & DATA Menu.

One of the data lists (twenty-four PID items) from the OEM PID list for this vehicle is shown on the next page.

Diagnostic Tip

The Typical Values in the example on the next page should be used after the following conditions are met:

- The Toyota TCCS Self-Test has been completed.
- The engine is at hot engine idle speed.
- The throttle is closed unless checking a value at a specified speed (rpm).
- The vehicle is in Park or Neutral.
- The vehicle is operating in Closed Loop mode.
- The vehicle accessories are all turned off.

Note: ***A Scan Tool that displays faulty data should not be used. The use of a faulty Scan Tool can result in misdiagnosis and unnecessary parts replacement.***

SCAN TOOL MENUS

HONDA/ACURA (1994-00)
MITSUBISHI (1994-00)
NISSAN/INFINITI (1994-00)
~TOYOTA/LEXUS (1994-00)
GENERIC OBD II

VEHICLE ID SCREENS

10th VIN CHARACTER
VIN: --------Y-------
VEHICLE: 2000
FOR A/T ID (1994-00):
TURN KEY TO ON

VIN: -- 4--N--R--X--Y
2000 4RUNNER E-A/T
ENGINE: 3.4L V6 SFI
PRESS Y TO CONTINUE
PRESS N FOR NEW ID

SELECT SYSTEM:
~ENGINE
4-SPEED TRANS
ANTI-LOCK BRAKES
AIRBAG

SELECT OPTIONS:
M/T WITH A/C
~A/T WITH 4-SPEED

MAIN MENU (TOYO ENG)
OTHER SYSTEMS
~CODES & DATA MENU
CUSTOM SETUP
ACTUATOR TESTS

CODES & DATA MENU
~CODES & DATA
1 TRIP CODES

2000 4RUNNER (3.4L V6 VIN N)

Reference Information

PCM PID Tables

Note: ***The following readings were obtained with the engine at idle speed, radiator hose hot, throttle closed, gear selector in Park and all accessories turned off.***

OBD II Generic PID Examples

Serial Data Name	Range or Value	Hot Idle	30 MPH	55 MPH
Calculated Load	0-100%	17	50	12
Coolant Temperature	-40 to 284°F	170	188	190
Engine Speed	0-10,000 rpm	716	1755	1421
Fuel System BK1	OPEN or CLOSED	CLOSED	CLOSED	CLOSED
Ignition Advance	-90 to 90 degrees	13	18.5	18.5
Intake Air Temperature	-40 to 284°F	88	89	93
Long Term Fuel Trim BK1	0-100%	-1	0	0
MAF Sensor	0-1,000 g/sec	4.28	31.18	16.48
O2S-11 (Bank 1 Sensor 1)	0-1100 millivolts	0.760	0.450	0.030
O2S-12 (Bank 1 Sensor 2)	0-1100 millivolts	0.580	0.480	0.680
O2S-11 (Bank 1 Sensor 1)	0-100%	+3.90	-1.5	-1.2
O2S-11 (Bank 1 Sensor 2)	0-100%	+1.20	+1.0	-1.1
Short Term Fuel Trim BK1	0-100%	+3.90	+0.8	+1.6
Throttle Position Sensor	0-100%	13.7	23.1	16.0
Vehicle Speed	0-159 mph	0	30	55

Toyota Enhanced PID Examples

Serial Data Name	Range or Value	Hot Idle	30 MPH	55 MPH
A/C Signal	ON or OFF	OFF	OFF	OFF
CYL 1 Abnormal Variation	0-100%	0	0	0
CYL 2 Abnormal Variation	0-100%	0	0	0
CYL 3 Abnormal Variation	0-100%	0	0	0
CYL 4 Abnormal Variation	0-100%	0	0	0
CYL 5 Abnormal Variation	0-100%	0	0	0
CYL 6 Abnormal Variation	0-100%	0	0	0
EVAP Vapor Pressure VSV	ON or OFF	OFF	OFF	OFF
EVAP Purge VSV	ON or OFF	OFF	ON	ON
FC IDL (fuel cut during Decel	ON or OFF	OFF	OFF	OFF
FC TAU (fuel cut light load)	ON or OFF	OFF	OFF	OFF
Fuel Pump Status	ON or OFF	ON	ON	ON
IAC Duty Cycle	0-100%	33	35	35
Ignition (for 1,000 revs)	0-2000	500	700	900
Injector (on-time)	0-99.9 milliseconds	1.5	1.8	2.3
Misfire RPM (for 1st misfire)	0-10,000	0	0	0
Misfire Load (for 1st misfire)	0-99° BTDC	2	0	0
O2S LR (B1 S1)	0-1,000 milliseconds	80	90	65
O2S RL (B1 S1)	0-1,000 milliseconds	80	90	65
Park Neutral Switch	ON (P/N) or OFF	ON	OFF	OFF
Starter Signal (cranking)	ON or OFF	OFF	OFF	OFF
Stop Light Switch	ON (braking) or OFF	OFF	OFF	OFF
Total Fuel Trim (Bank 1)	Average 0-5v	1.8	1.6	1.9
Vehicle Speed (mph)	0-255	0	30	55

2000 4RUNNER (3.4L V6 VIN N)

Reference Information

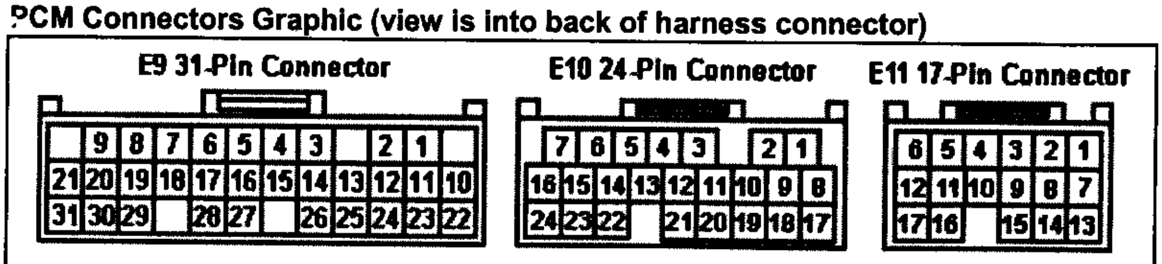
2000 4Runner 3.4L V6 VIN N (A/T) Pin Voltage Table (E9 31-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
31-1	GRN	Fuel Injector 3 Control (#30)	1.6-2.9 ms
31-2	RED/BLK	Fuel Injector 4 Control (#40)	1.6-2.9 ms
31-3	BLU	Fuel Injector 5 Control (#50)	1.6-2.9 ms
31-4	YEL	Fuel Injector 6 Control (#60)	1.6-2.9 ms
31-5		EVAP Canister Closed Valve	VSV On: 1v, Off: 12v
31-6	BLK/WHT	TEI Diagnostic Signal	Digital signals: 0-12-0-12
31-7	LGRN/RED	ECT Solenoid S1	3rd or OD: <1v
31-8	BLU/WHT	ECT Solenoid S2	1st or OD: <1v
31-9	GRN/RED	ECT Solenoid SL	In Lockup: 12-14v
31-10	RED	CMP Position Sensor (+) or G2	AC pulse signals
31-11	BLK/BLU	Igniter IGT1 Signal	Digital signals (0-5-0-5v)
31-12	BLU/YEL	Igniter IGT2 Signal	Digital signals (0-5-0-5v)
31-13	GRN/WHT	Igniter IGT3 Signal	Digital signals (0-5-0-5v)
31-14	YEL/RED	A/T (ECT): VSS+ Signal	Digital Signals
31-15	BLK/RED	IAC Valve RSC Signal	Pulse signals: 8-12v
31-16	BRN/RED	IAC Valve RSO Signal	Pulse signals: 8-12v
31-17, 18, 19, 20	---	Not Used	---
31-21	WHT/BLK	Power Ground (E01)	<0.1v
31-22, 23 & 24	---	Not Used	---
31-25	BLK/YEL	Igniter IGF Signal	Digital signals (0-5-0-5v)
31-26	---	Not Used	---
31-27	BLK	Knock Sensor No. 1	No knocking: 2.5v
31-28	GRY	Knock Sensor No. 2	No knocking: 2.5v
31-30	WHT/BLK	Power Ground (E03)	<0.1v
31-31	WHT/BLK	Power Ground (E02)	<0.1v

2000 4Runner 3.4L VIN N (A/T) Pin Voltage Table (E11 17-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
17-1, 2 & 3	---	Not Used	---
17-4	GRY/RED	Transponder Key Amplifier (Code)	Inserting key: pulses, then 10-14v
17-5	RED/BLK	Transponder Key Amplifier RXCK	Inserting key: pulses, then 10-14v
17-6, 7, 8 & 9	---	Not Used	---
17-10	PNK/BLK	Transponder Key Amplifier TXCT	Inserting key: pulses, then 10-14v
17-11	YEL/RED	Unlock Warning Switch (KSW)	Key on: 10-14v
17-12, 13, 14, 15	---	Not Used	---
17-16	BLU	Security Indicator Light (IMLD)	Digital Signals
17-17	---	Not Used	---

PCM Connectors Graphic (view is into back of harness connector)



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

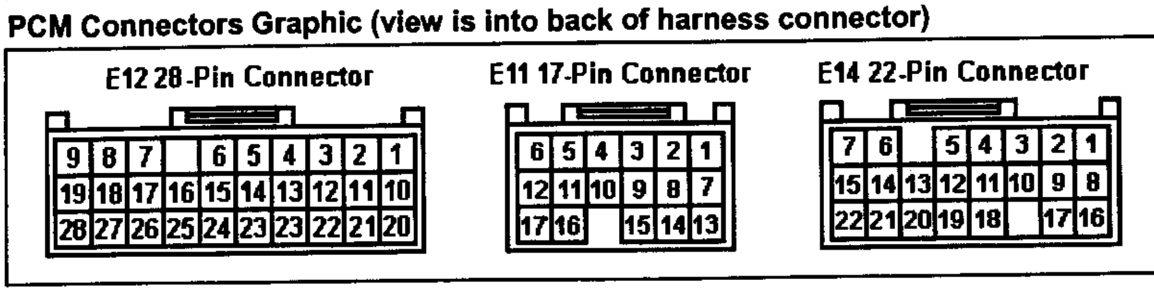
2000 4Runner 3.4L VIN N (A/T) Pin Voltage Table (E12 28-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
28-1, 2 & 3	---	Not Used	---
28-4	YEL/GRN	Cruise Control Actuator (IDLO)	N/A
28-5, 6 & 7	---	Not Used	---
28-8	RED	Oxygen Sensor Signal (HO2S-12)	Varying voltage: 0-1.1v
28-9	RED/WHT	Oxygen Sensor Heater (HO2S-12)	Digital signals: 0-12-0-12v
28-10, 11 & 12	---	Not Used	---
28-13	BLU/BLK	A/C Amplifier Cut (ACT) Signal	A/C clutch on: 12v, off: 1.5v
28-14, 15, 16, 17	---	Not Used	---
28-18	BLK/BLU	ADD Position Switch (4WD)	N/A
28-19	---	Not Used	---
28-20	BLK	Neutral Start Switch Signal	Cranking: 9-11v
28-21	---	Not Used	---
28-22	GRN/ORN	VSS Signal from Comb. Meter	Digital signals (0-12-0-12v)
28-23 & 24	---	Not Used	---
28-25	BLU/YEL	A/C Amplifier (Clutch) Signal	A/C clutch on: 1.5v, off: 12v
28-26, 27 & 28	---	Not Used	---

2000 4Runner 3.4L VIN N (A/T) Pin Voltage Table (E14 22-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
22-1	BLU/RED	Battery Direct (KAPWR)	12-14v
22-2	BLK/BLU	Ignition Switch Feed (IGSW)	12-14v
22-3	GRN/YEL	Fuel Pump Control (FC) Signal	CTO On: 1v, Off: 12v
22-4 & 5	---	Not Used	---
22-6	PNK	Malfunction Indicator Lamp	Lamp On: 1v, Off: 12v
22-7	BLK/WHT	STA Signal (P/N & Cranking)	9-11v (cranking)
22-8	GRY/BLK	Main Relay Control Signal	12-14v
22-9	YEL/GRN	EVAP VSV (Vapor Pressure Valve)	Valve on: 1v, Off: 12v
22-10	---	Not Used	---
22-11	WHT	OBD II SIL Signal (ISO 9141-2)	Digital Signals (0-12-0-12v)
22-12	WHT/BLK	EOM	4.9-5.1v
22-13 & 14	---	Not Used	---
22-15	GRN/WHT	Stop Light Switch Signal (STP)	Brake on: 12v, Off: 0v
22-16	WHT/BLU	Ignition Feed from EFI Relay (B+)	12-14v
22-17	YEL	EVAP Vapor Pressure (PTNK)	2.5v (fuel cap removed)
22-18 & 19	---	Not Used	---
22-20, 21 & 22	---	Not Used	---

PCM Connectors Graphic (view is into back of harness connector)



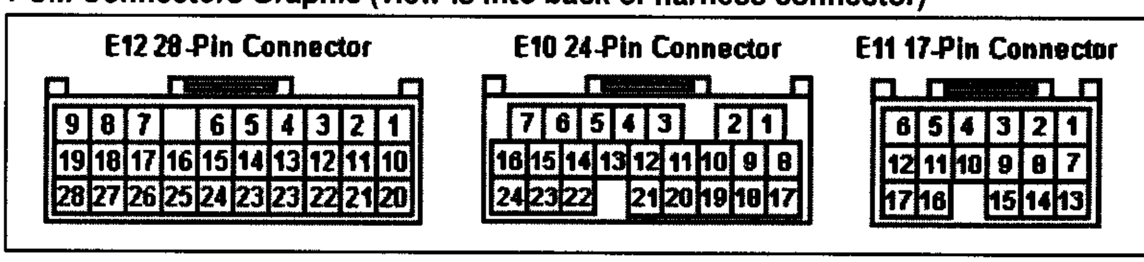
2000 4RUNNER (3.4L V6 VIN N)

Reference Information

2000 4Runner 3.4L V6 VIN N (A/T) Pin Voltage Table (E10 24-Pin Connector)

Pin Number	Wire Color	Application & Circuit	Value at Hot Idle
24-1	---	Not Used	---
24-2	GRN/BLK	TP Sensor VREF (VC)	4.9-5.1v
24-3	---	Not Used	---
24-4	PNK/BLU	Oxygen Sensor Heater (HO2S-11)	Digital signals: 0-12-0-12v
24-4 (California)	BLU	A/F Sensor Heater Control (HTAF1)	Digital signals: 0-12-0-12v
24-5	RED	Fuel Injector 1 Control (#10)	1.6-2.9 ms
24- 6	WHT	Fuel Injector 2 Control (#20)	1.6-2.9 ms
24-7	WHT/GRN	EVAP Purge Valve (EVP1) Signal	Digital signals: 0-12-0-12v
24-9	PNK	Power Steering Pressure Switch	Straight: 12v, turning: 0v
24-8	WHT/BLK	Power Ground (E05)	<0.1v
24-10	RED/WHT	Mass Airflow Sensor Signal (VG)	1-1.1v
24-11	---	Not Used	---
24-12	WHT	Oxygen Sensor Signal (HO2S-11)	Varying voltage
24-12 (California)	WHT	A/F Sensor (+) Signal (AF1+)	Fixed at 3.3v
24-13	---	Not Used	---
24-14	GRN	Engine Coolant Temp. Sensor (THW)	0.5-0.6v
24-16	RED	CKP Sensor (NE) Signal (+)	AC pulse signals
24-17	BRN	Power Ground (E1)	<0.1v
24-18	BLU/BLK	Sensor Ground (E2)	<0.050v
22-19	BLK/WHT	MAF Sensor Ground (E2G)	<0.050v
24-21 (California)	RED	A/F Sensor (-) Signal (AF1-)	Fixed at 3.0v
24-22	YEL/GRN	Intake Air Temp. Sensor (THA)	From 1-4v (temperature varies)
24-23	BLK/YEL	TP Sensor Signal (VTA)	1-1.9v
24-24	GRN	CKP Sensor (NE) Signal (-)	AC pulse signals

PCM Connectors Graphic (view is into back of harness connector)

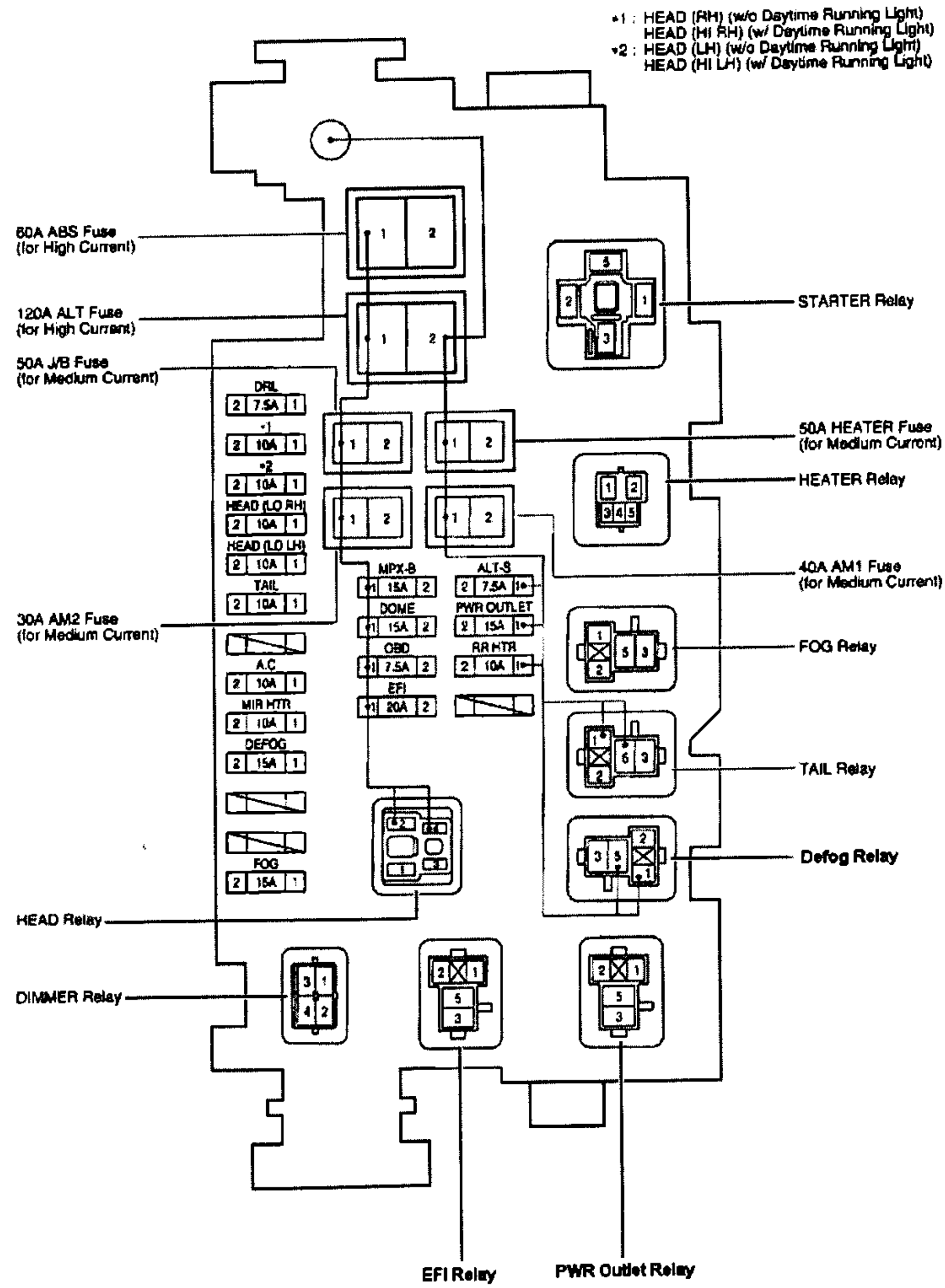


2000 4RUNNER (3.4L V6 VIN N)

Reference Information

Engine Compartment Junction Block

② : Engine Room R/B	Engine Compartment Left

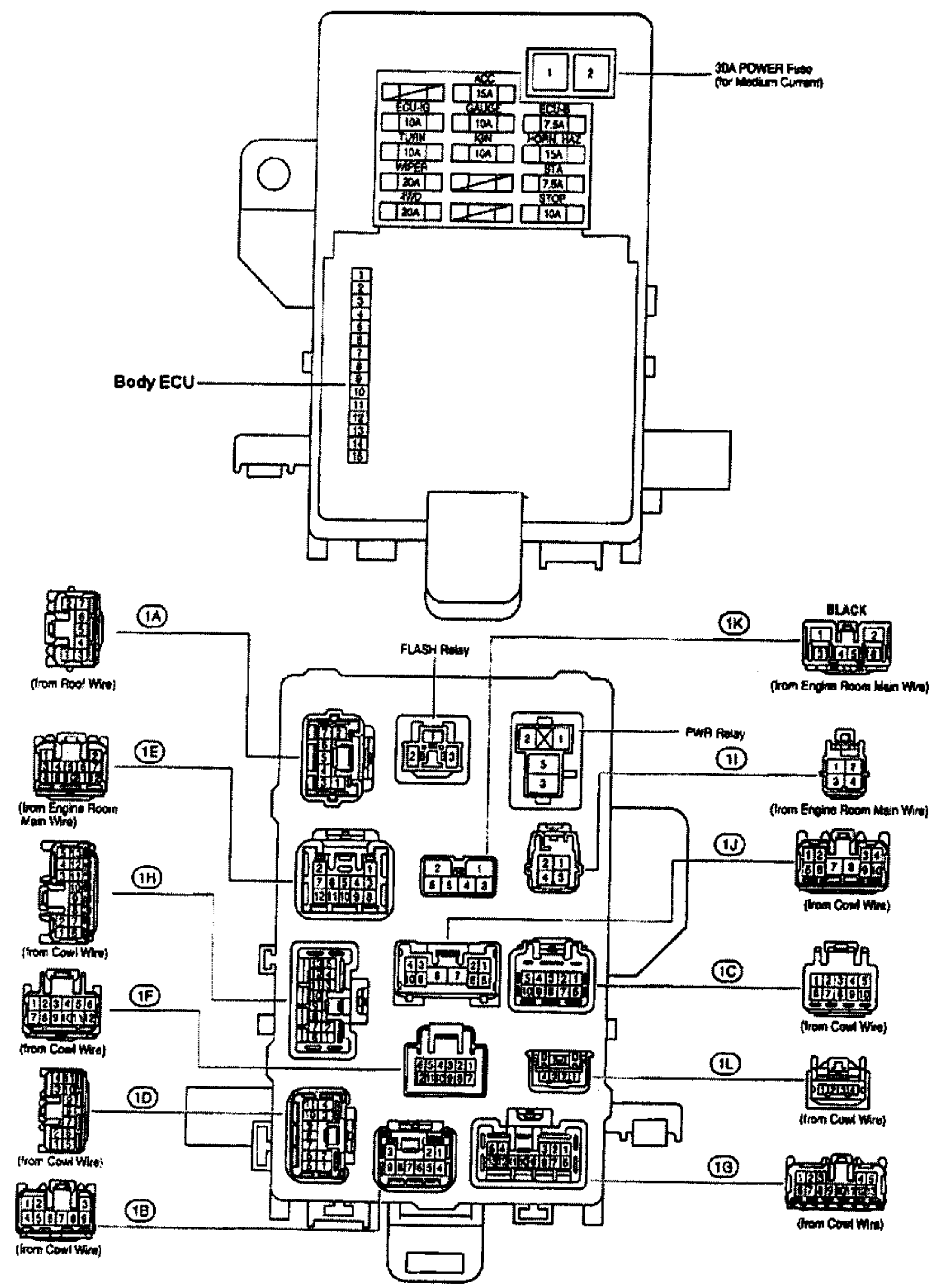


2000 4RUNNER (3.4L V6 VIN N)

Reference Information

Driver's Side Junction Block

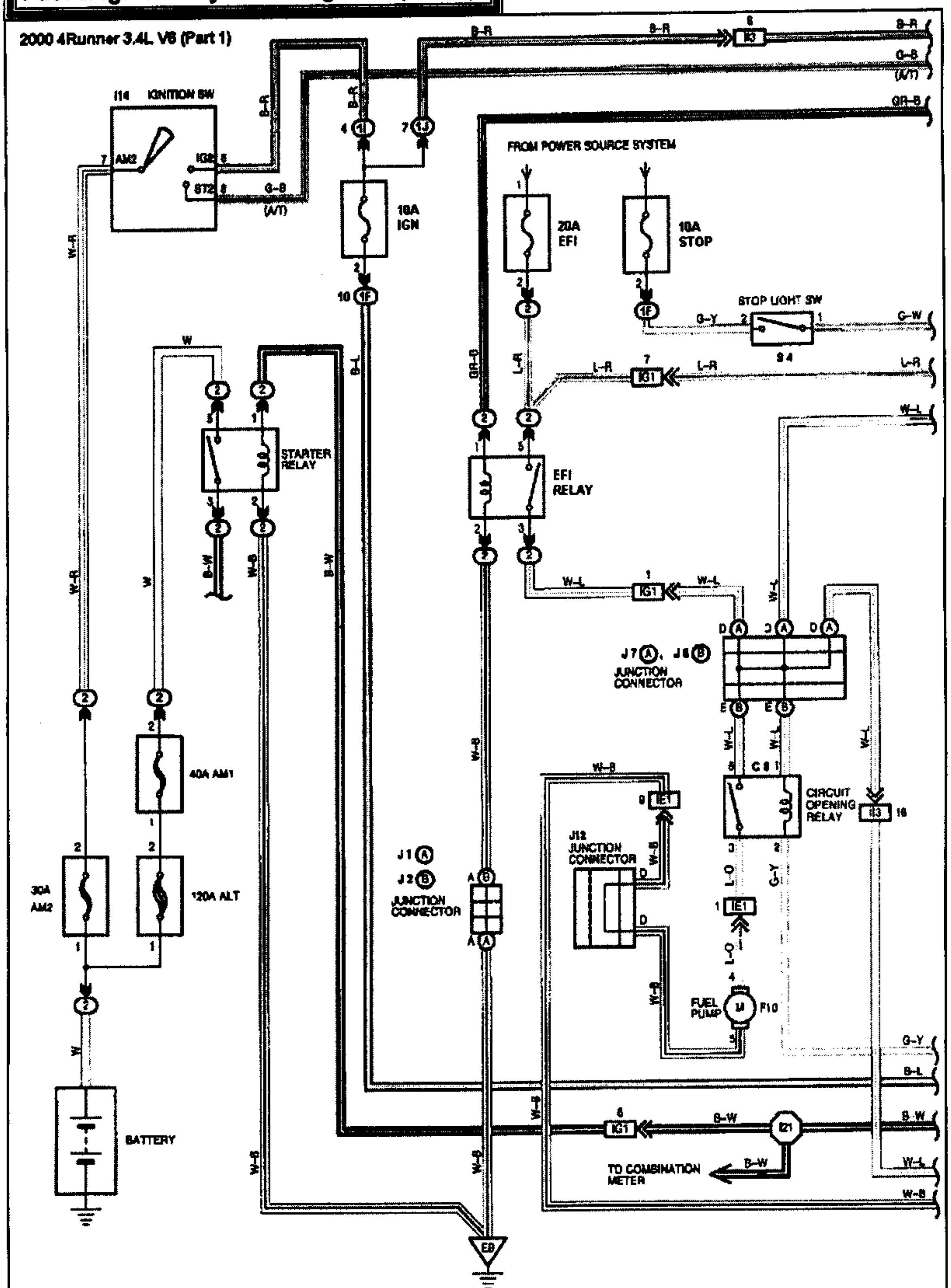
○ : Driver Side J/B	Lower Finish Panel



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

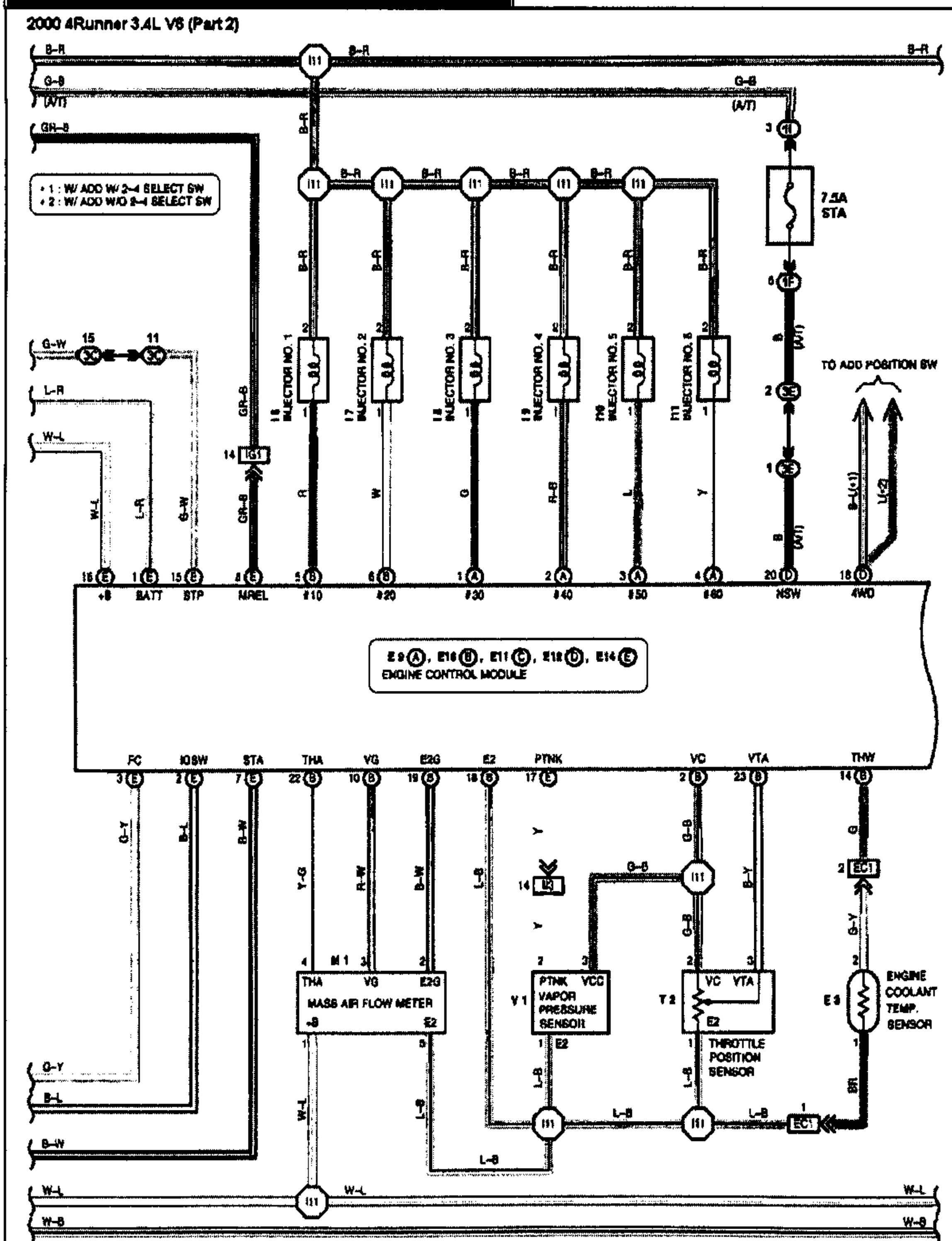
Fuel & Ignition System Diagrams (1 of 4)



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

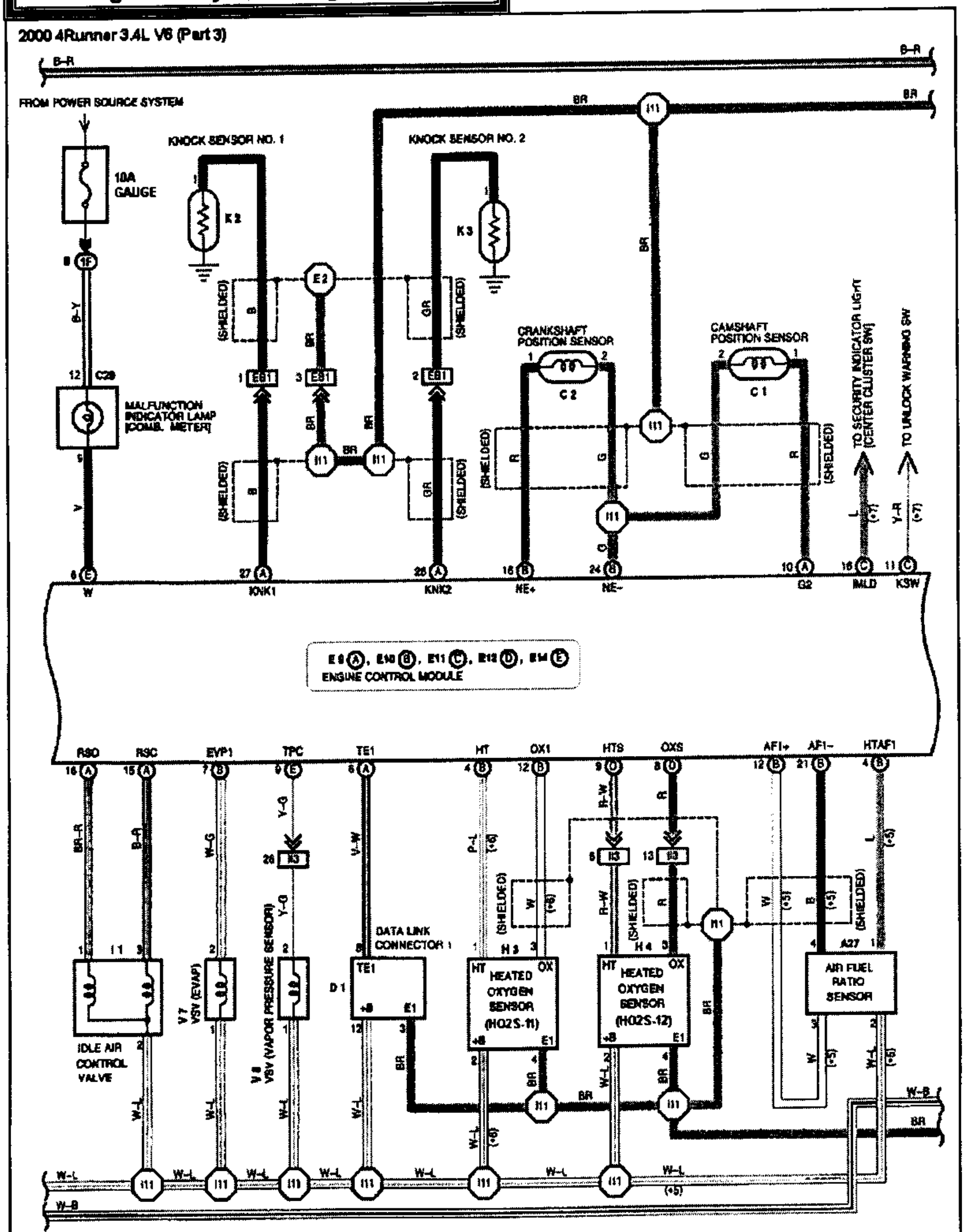
Fuel & Ignition System Diagrams (2 of 4)



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

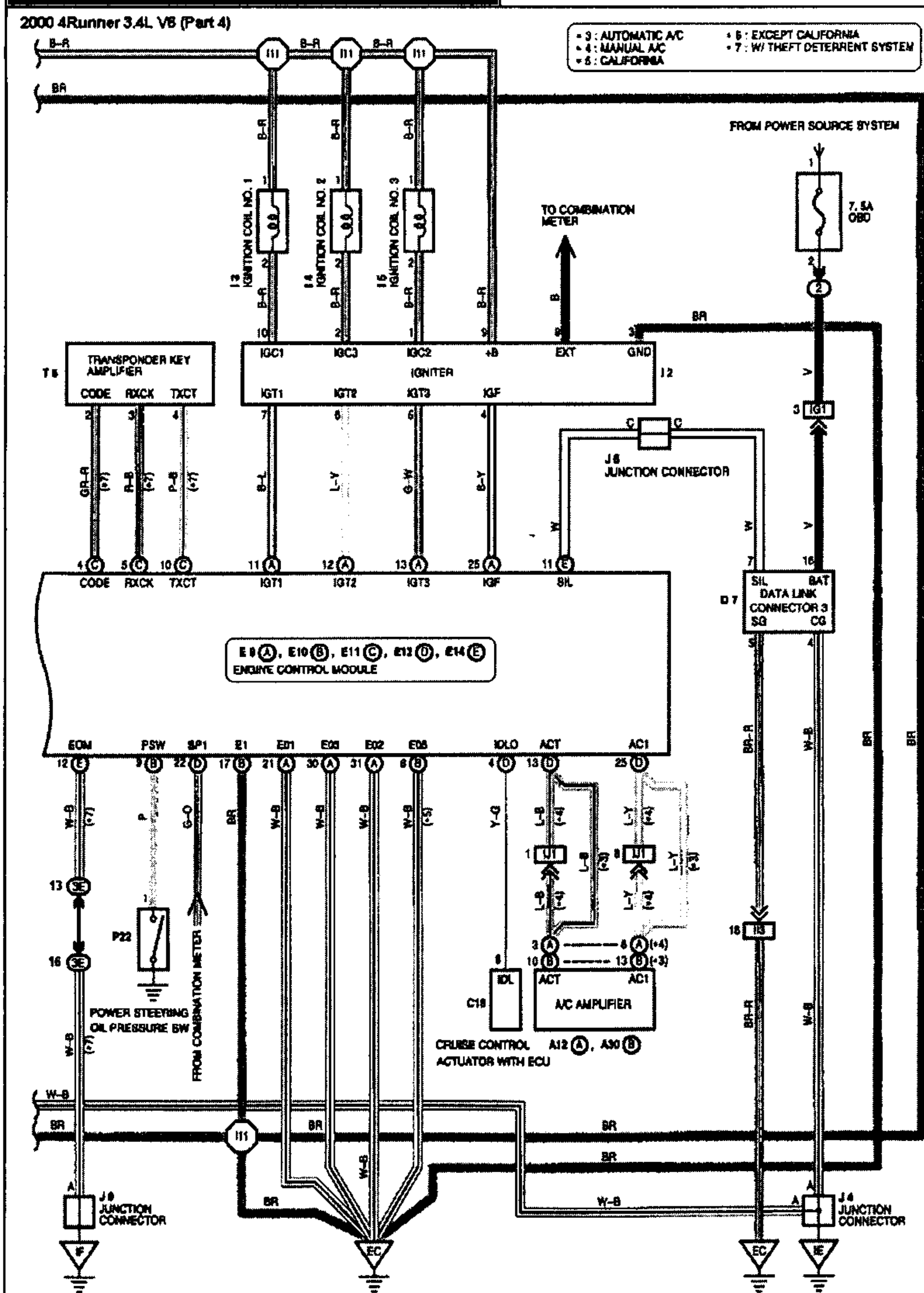
Fuel & Ignition System Diagrams (3 of 4)



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

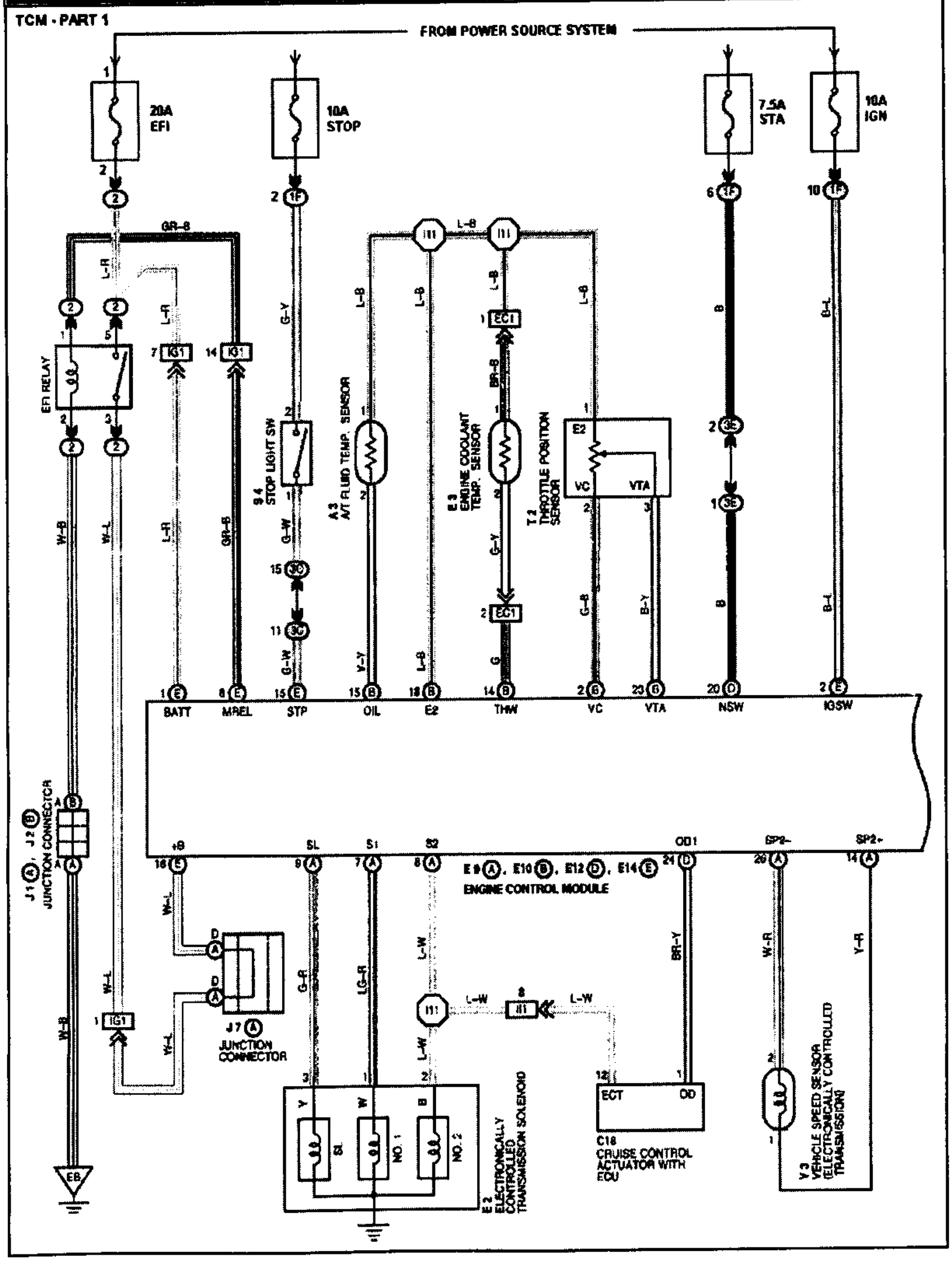
Fuel & Ignition System Diagrams (4 of 4)



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

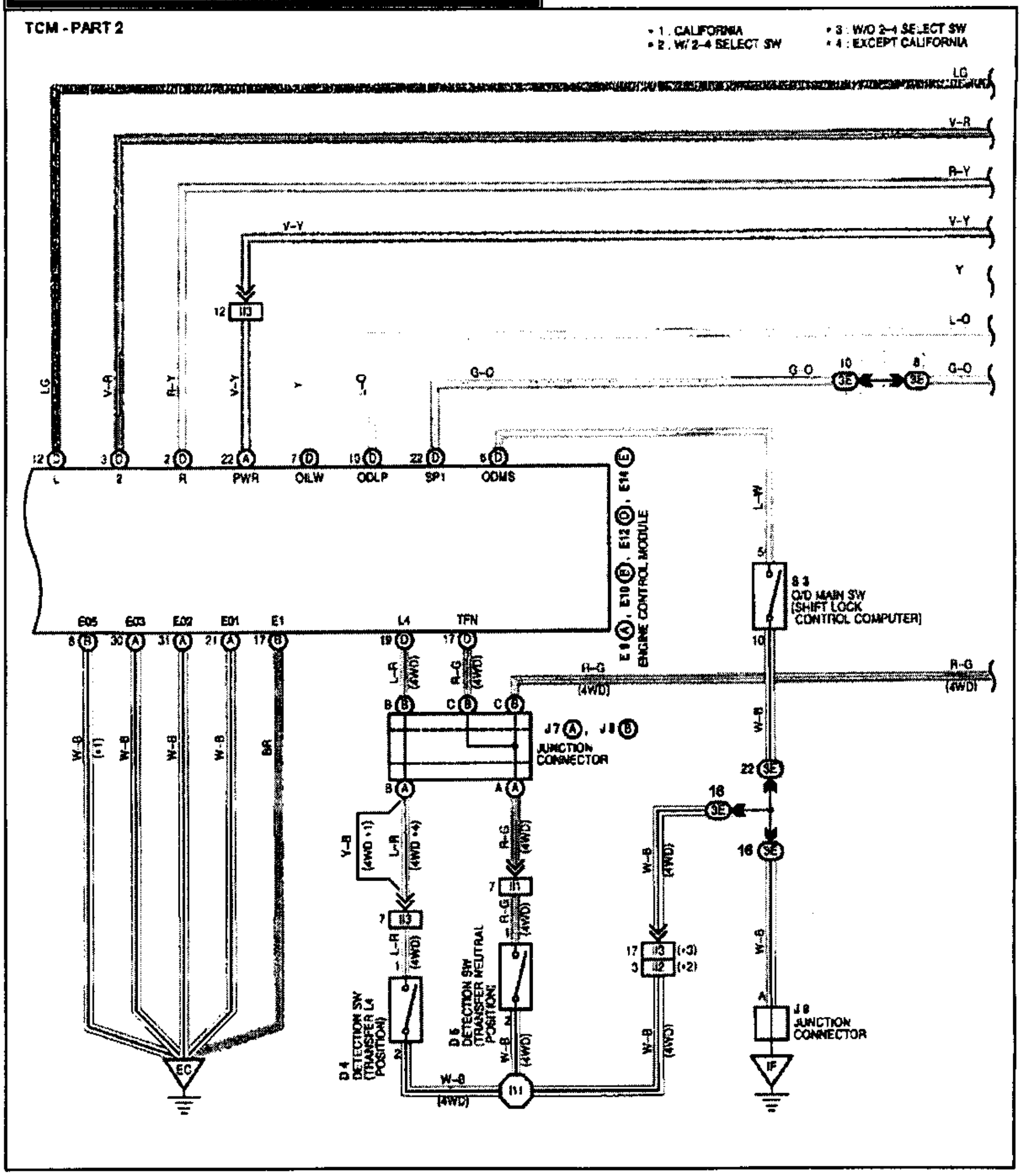
TCM Wiring Diagrams (1 of 3)



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

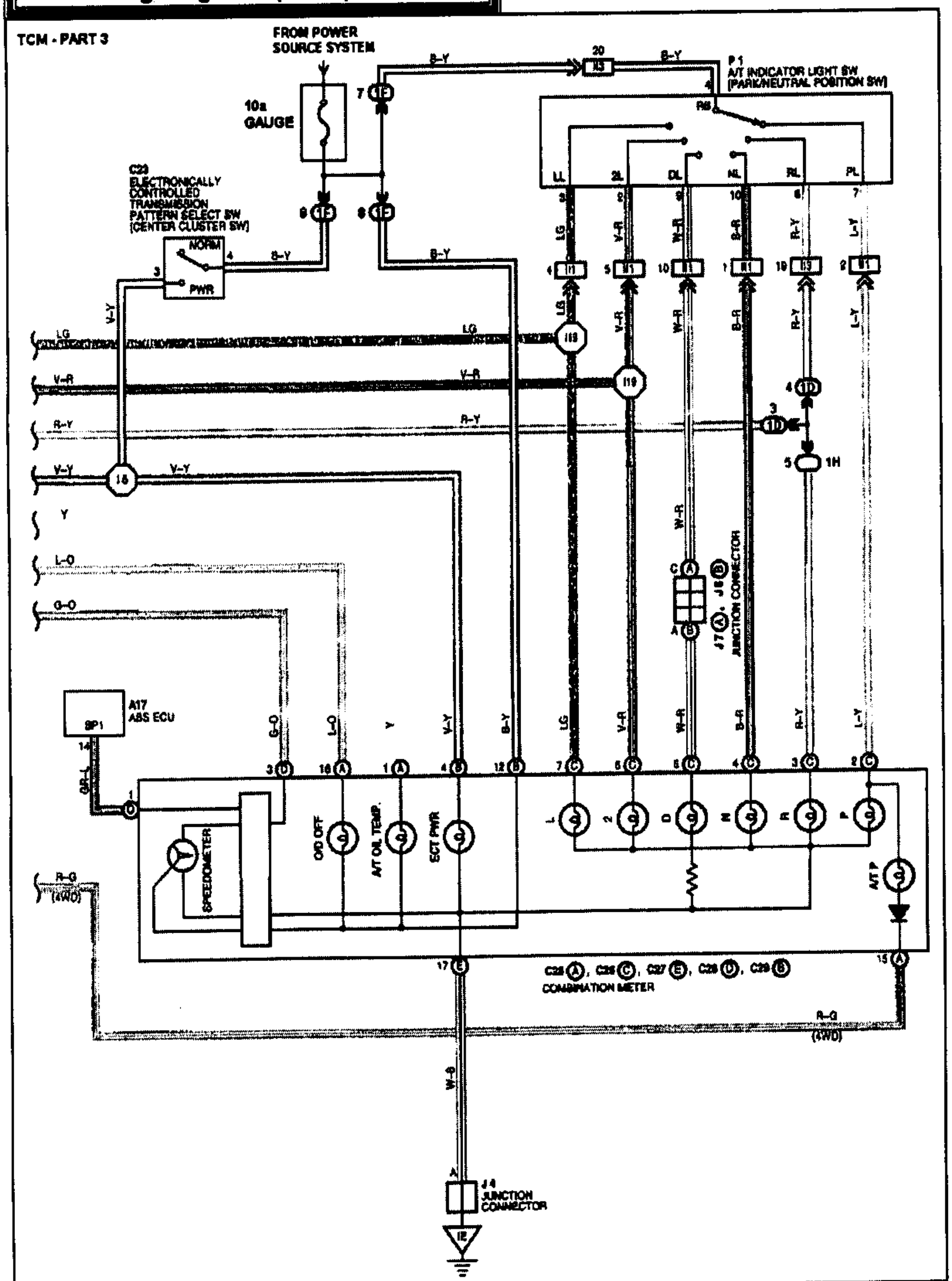
TCM Wiring Diagrams (2 of 3)



2000 4RUNNER (3.4L V6 VIN N)

Reference Information

TCM Wiring Diagrams (3 of 3)



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ASA Mission: The Automotive Service Association advances the professionalism and excellence in the automotive repair industry through education, representation and member services.

ASC Mission: The Automotive Service Councils of California, an association primarily comprised of independently owned automotive repair facilities, exists to promote the continuing success of its members and to advance the professionalism of the automotive industry.

ASE Mission: ASE is a non-profit institute dedicated to improving the quality of automotive service and repair throughout the nation. The primary function of ASE is to test and certify automobile, medium/heavy truck, school bus, and collision repair/refinish technicians as well as engine machinists, collision damage estimators, and parts specialists. ASE also encourages and assists in the development of automotive training programs.

AuTO-CA Mission: Automotive Trade Organizations of California is a non-profit trade association representing automotive service businesses throughout the state of California. Included in AuTO-CA's over 1000 members are service station, automotive repair, convenience stores and car wash owners. AuTO-CA provides its members with legislative and regulatory representation; money-saving member benefits; education and training materials; and offers business counseling and guidance.

IATN Mission: To promote the continued growth, success and image of the Professional Automotive Technician by providing a forum for the exchange of knowledge and the promotion of education, professionalism, and integrity.

MEA Mission: An Association of Technicians, for Technicians, by Technicians featuring the most unique technician support system in the industry: continuous automotive training, telephone "hotline" diagnostic assistance, and on-site vehicle troubleshooting.

STS Mission: Advance the skills and the education of automotive and transportation service professionals. Encourage communication and cooperation among service, engineering, and other industry professionals. Disseminate service information concerning automotive and transportation technology. Inspire excellence and professionalism in our service community. Encourage high ethics and job performance. Help meet the public demand for environmentally responsible, safe and efficient mobile systems.