



POWERTRAIN SPECIALIST

**HONDA POWERTRAIN CONTROL
SYSTEMS – DIAGNOSTICS 2**

COURSE NUMBER: PT240-02



Notice

Due to the wide range of vehicles makes and models, the information given during the class will be general in nature and should not be taken as specific to any vehicle/unit. Please consult manufacturer specifications for the correct number/specifications and repair procedures for the vehicle you are testing. This document is meant to be used as a guideline only.

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Introduction

OBJECTIVES

Upon successful completion of this segment the participant will be able to:

- Provide expanded information and diagnostics concerning:
 - Variable Valve Timing with Electronic Lift Control:
 - SOHC/DOHC VTEC
 - SOHC VTEC-E (Economy) P1259
 - HO2S Circuit & Rich/Lean P0130-P0175
 - Air/Fuel Ratio Sensor P1149-P1167

Honda Powertrain Control Systems

Honda Powertrain Control Systems Module 2

Understanding Honda's unique engine management systems will help keep diagnostic time to a minimum. In the recent past and present, conventional Honda vehicle engines have included a variety of VTEC in-line 4 cylinder and V6 cylinder designs. The J30 V6 engine features a 3 rocker arm VTEC system, 10:1 compression ratio and a novel exhaust manifold cast as one piece with the cylinder head. Wards Automotive placed this engine on its "10 Best" engine list for 2003 and 2004.

- A J35A91 V6 engine is used in Honda Ridgeline trucks.
- Variable Cylinder Management (VCM) has been added to the J35 engine featured in 2005 Odyssey and 2006 Pilot vehicles.
- The Honda J35 V6 is also currently used by General Motors as the optional engine in their Saturn VUE.
- Service Information for Honda engines is often categorized within a service manual by engine number. Engines may look alike but different engine numbers could have different specifications.

The following chart gives some examples of engine numbers and their applications:

Sample Honda Engine Numbers				
Year	Civic	Accord	CR-V	Odyssey
1996-99	D16Y7-1.6L SOHC 4 D16Y8-1.6L SOHC VTEC D16Y5-1.6L SOHC-E	C27A4-2.7L SOHC V6 F22B1-SOHC VTEC 4 F22B2-2.2L SOHC 4		
1999-02		F23A1-2.3L SOHC VTEC 4 F23A4-2.3L SOHC VTEC 4 F23A5-2.3L SOHC 4		
2000	B16A2-1.6L DOHC VTEC 4 D16Y7-1.6L SOHC VTEC 4 D18Y8-1.6L SOHC VTEC 4			J35A1-3.5L SOHC VTEC V6
2001			B20Z2-2.0L DOHC 4	
2002				J35A4-3.5L SOHC VTEC V6
2003	LDA-MF3-1.3L SOHC 4			
2005/06			K24A1-2.4L DOHC i-VTEC 4	

Variable Valve Timing and Lift Electronic Control (VTEC) Variations

1. Single Overhead Cam (SOHC) VTEC

- 3 Rocker System
- 3 Rocker “Resting Valve” System

2. SOHC VTEC-E (Economy)

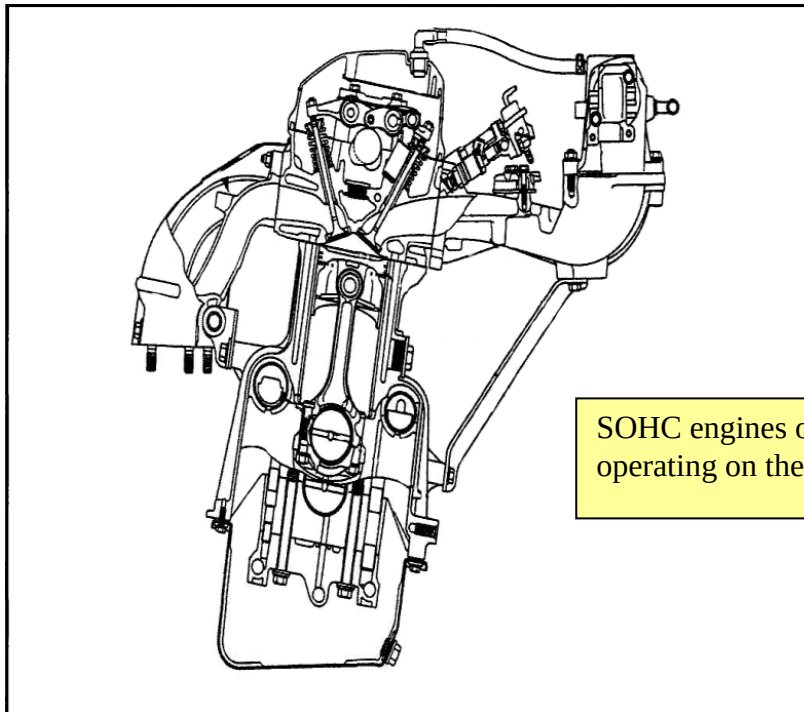
3. Dual Overhead Cam (DOHC) VTEC

4. i-VTEC - with Variable Timing Control (VTC)

5. i-VTEC - with Variable Cyl. Management (VCM)

- VTEC is a valve rocker arm control system that improves combustion efficiency throughout a wide RPM range
- The intake rocker arm’s control system changes valve lift and timing by controlling intake rocker arm actuation
- Activation depends on engine speed, vehicle speed, engine load and other sensor inputs
- The system gets good torque and consumption when operating in the low engine speed range, while maintaining high power output when operating in the high engine speed range
- Most non-VTEC engines have a camshaft design that compromises ideal valve lift and duration for best performance in the relatively narrow range of RPM where an engine operates most of the time.

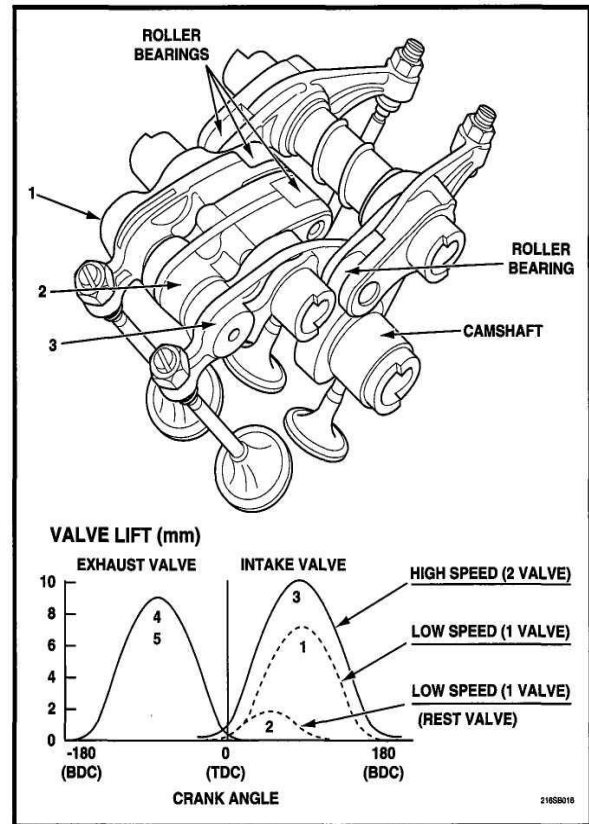
1. Single Overhead Cam (SOHC) VTEC 3 Rocker System



SOHC engines only have the VTEC mechanism operating on the intake valves

Three Rocker “Resting Valve” SOHC VTEC

- Used in 1999 Acura 3.2 L TL, 2001 Accord 2.3 L 4 cylinder
- “Resting valve” because it operates one intake valve at low engine speeds and two intake valves at high speeds, 5 rocker arms per cylinder
- Primary intake valve operates with normal lift
- The secondary intake valve “rests” during low RPM operation
- Like other VTEC systems, above the 2300 to 3200 RPM range, the PCM directs the system over to full opening, two intake valve operation, locking three rocker arms together and using the more aggressive mid-position rocker arm cam lobe profile



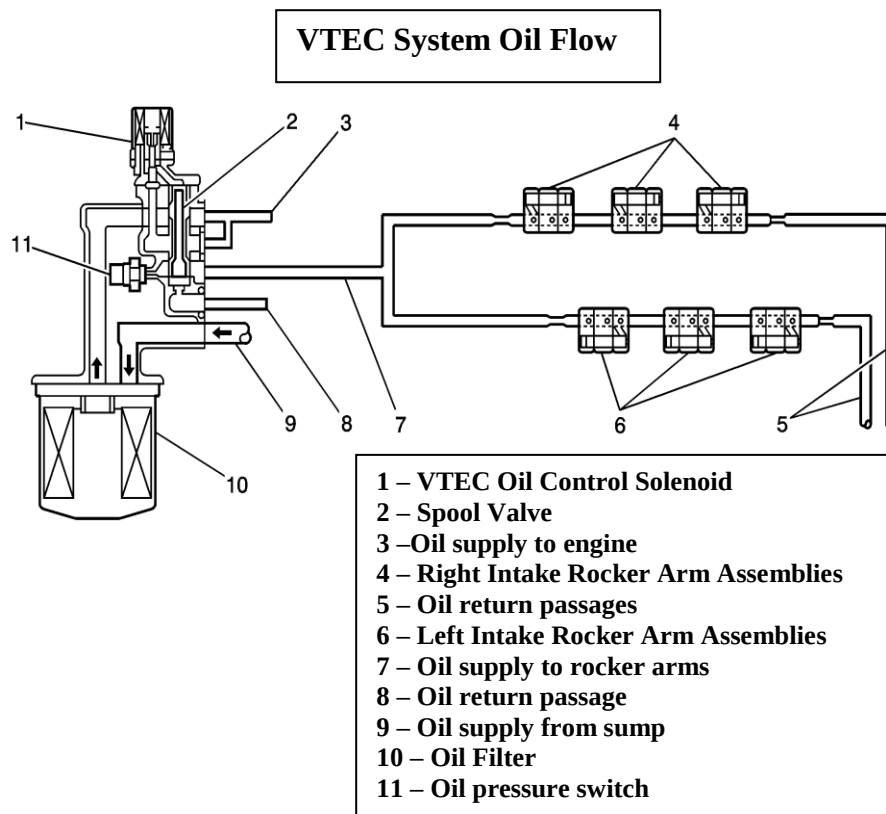
2. SOHC VTEC-E (Economy)

- VTEC-E was adopted to increase engine efficiency at low speeds instead of optimizing performance at high RPM
- Found on several Honda fuel efficient cars (1992 to 1995 Civic VX and 1996 to 2000 Civic HX 4 cylinder models)
- Two intake rocker arms per cylinder.
- The primary arm operates on a normal profile cam lobe during all RPM ranges
- At low RPM, the secondary rocker arm is operated by an almost round (0.65 in./1.6cm lift) cam lobe which opens the second intake valve a small amount
- 2500 RPM (approx): PCM energizes the VTEC solenoid, directing pressurized engine oil to the rocker arms to pin the two rocker arms together—system changes from single intake valve operation to a dual intake valve operation, using the same cam lift and duration the valves had at lower speeds.

3. Dual Overhead Cam (DOHC) VTEC

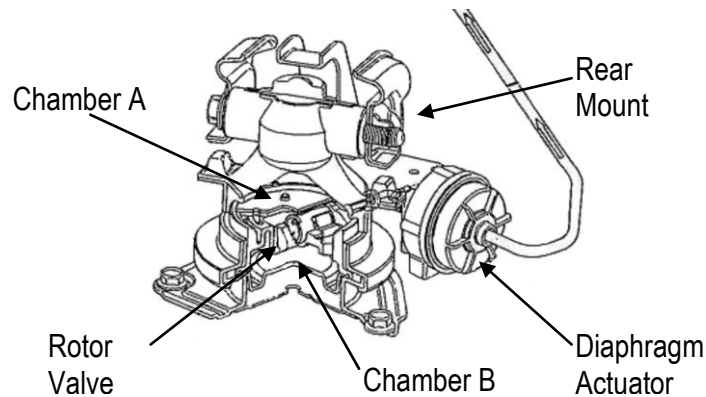
- 3.0 L DOHC V6 engines are used on high performance vehicles such as the Acura NSX and Honda S2000.
- Three rocker VTEC is adapted to both the intake and exhaust valves for increased performance at high RPM. This configuration has the potential to produce 100 horse-power per litre of displacement.
- In a fashion similar to SOHC VTEC versions, switching of the rocker arms/cam lobes is controlled by a PCM operated solenoid.
- As engine RPM increases, a locking pin is pushed by oil pressure to connect the primary rocker arms to the high RPM mid-rocker arm cam followers for operation based on the center higher lift, more aggressive cam lobe profile.

4. i-VTEC - with Variable Timing Control (VTC) and i-VTEC - with Variable Cyl. Management (VCM)



Honda i-VTEC Engines with Variable Cylinder Management (VCM)

- In 2004, Honda introduced an i-VTEC V6 engine (J-series) on U.S. Odysseys.
- On this engine, i-VTEC does not feature cam phasing but rather adds cylinder deactivation technology known as Variable Cylinder Management (VCM)
- During light load and reasonable speed conditions, a PCM controlled solenoid unlocks the cam followers on the rear cylinder bank from their respective rockers. The rear cam followers then float freely while the valve springs hold the rear valves closed.
- The engines drive-by wire throttle, vibration and noise reduction technology assists in smoothing out the power delivery, making this systems operation almost imperceptible.



Controlled Engine Mount - Style # 1 (Pre-2004)

- Honda used PCM controlled, liquid filled, rear engine mounts on some pre-2004 Accords and Odysseys with i-VTEC engines.
- The purpose of a controlled mount is to reduce engine vibration in the idle rpm range, without affecting vibration damping at higher speeds.

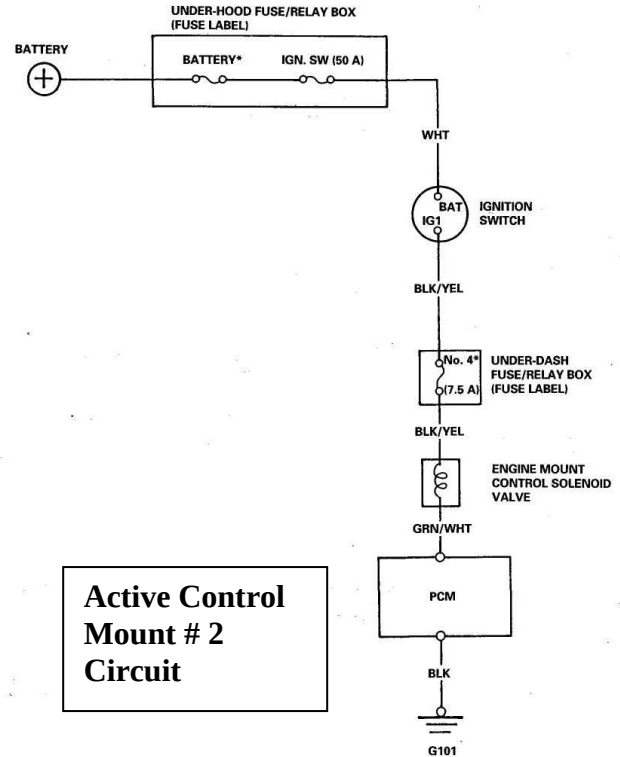
Major Components:

PCM

- A control solenoid valve
- Rotary valve
- Rear engine mounts with a built-in diaphragm actuator
- Vacuum source

Controlled (Active) Engine Mount - Style # 2 (Post 2004 i-VTEC V/6 with VCM)

- Some 2004 and later Honda 4 cylinder and V6 i-VTEC VCM engines with Variable Cylinder Management (VCM) use engine mounts which function at idle and low torque conditions
- V6 operation in the 3 cylinder mode (combustion every 240 degrees) results in better fuel economy and emissions but creates noise and vibrations
- “Active Control” engine mounts and “Active Noise Control” systems to counteract these effects
- PCM uses crankshaft and camshaft position sensors’ input to estimate engine vibration in 3 cylinder mode
- PCM provides ground (as needed) to energize and de-energize the engine mount control solenoids in each active mount
- The plunger assembly is pulled downward when energized, causing the top of the fluid filled mount to drop down and the engine to move down with the mount
- A spring pushes the plunger assembly, upper mount and engine upward when the solenoids are de-energized
- Based on the frequency determined by the PCM, the engine mount will push and pull on the engine, physically counteracting the vibration motion.



Notes:

Oxygen Sensors and Air Fuel Ratio Sensors

- Stoichiometric (Zirconia) Oxygen Sensor (O2S)
- Lean Air/Fuel Sensor (LAF)
 - 5-Wire “Oxygen Pump” Sensor
 - 4-Wire “Critical Current” Sensor

Stoichiometric (Zirconia) Oxygen Sensor (O2S)

- Important to isolate cause of O2 sensor DTCs, not just replace sensor:

Fixed O2 Sensor Signal diagnosis

Fixed high voltage signals (indicate the mixture is rich) possible causes may include:

- Dripping injector
- High fuel system pressure
- Defective coolant sensor (always signals a cold engine)

Fixed low voltage signals (indicate the mixture is lean) possible causes may include:

- Clogged injectors
- Low fuel pressure
- A vacuum leak
- MAF or MAP out of calibration (indicates less than actual airflow)

Uneven or Partial O2 Sensor Switching (slow or intermittent switching) possible causes may include:

- Sluggish O2 sensor (rise time too slow – more than 100 ms @ 2500 rpm)
- Restricted MAP hose
- Vacuum leak

Converter notes:

- Excessive heat may result from either misfire and/or excessively rich air/fuel ratios.
- Normal converter operating temperatures are typically between 400°C and 600°C (752°F and 1,112°F).
- Internal damage may occur around 800°C (1472°F).

Lean Air Fuel (LAF) Oxygen Sensors (LAF) sensors:

- 5 Wire “Oxygen Pump” Sensor
- 4 Wire “Critical Current” Sensor (newer)

- A conventional zirconia O₂ sensor operates within a very narrow A/F ratio band (14.2 to 15.2)
- Newer Honda vehicles (with lean burn capability) can operate as lean as 23:1—Stoichiometric sensor signals cannot be used with “lean burn” since the oxygen content in the exhaust is higher than the stoichiometric O₂ sensor is capable of measuring.
- Lean burn type engines therefore require “wide band” LAF sensors to function under these conditions.

“Oxygen Pump” Type Lean Air/Fuel (LAF) Sensor

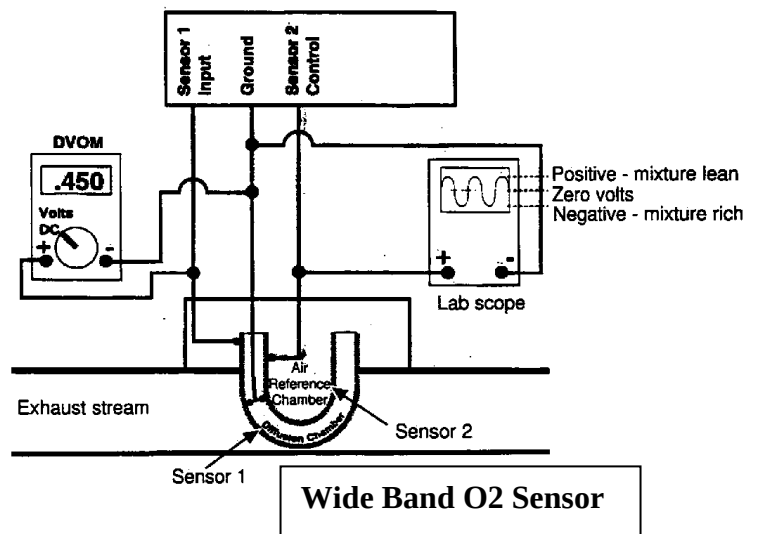
- The 5-wire LAF sensor is essentially made up of two zirconia elements (cells) that share a diffusion chamber.
- The diffusion chamber allows O₂ to move between the two cells.
- The oxygen pump style sensor uses plate type elements instead of thimble style construction.

The five wires on the “oxygen pump” LAF sensor are:

- Heater positive
- Heater negative
- Sensor element positive
- Control element positive
- Common ground for sensor and control elements

Notes:

- Common ground for the two elements goes to the PCM and is not the same as chassis ground.
- It is only the PCM’s ground reference—you will read a small voltage when measuring between the PCM ground and chassis ground.
- Honda scan tool software displays O₂S data in +/- ma instead of volts like the conventional O₂ sensor.



4 Wire “Critical Current” Oxygen Sensors

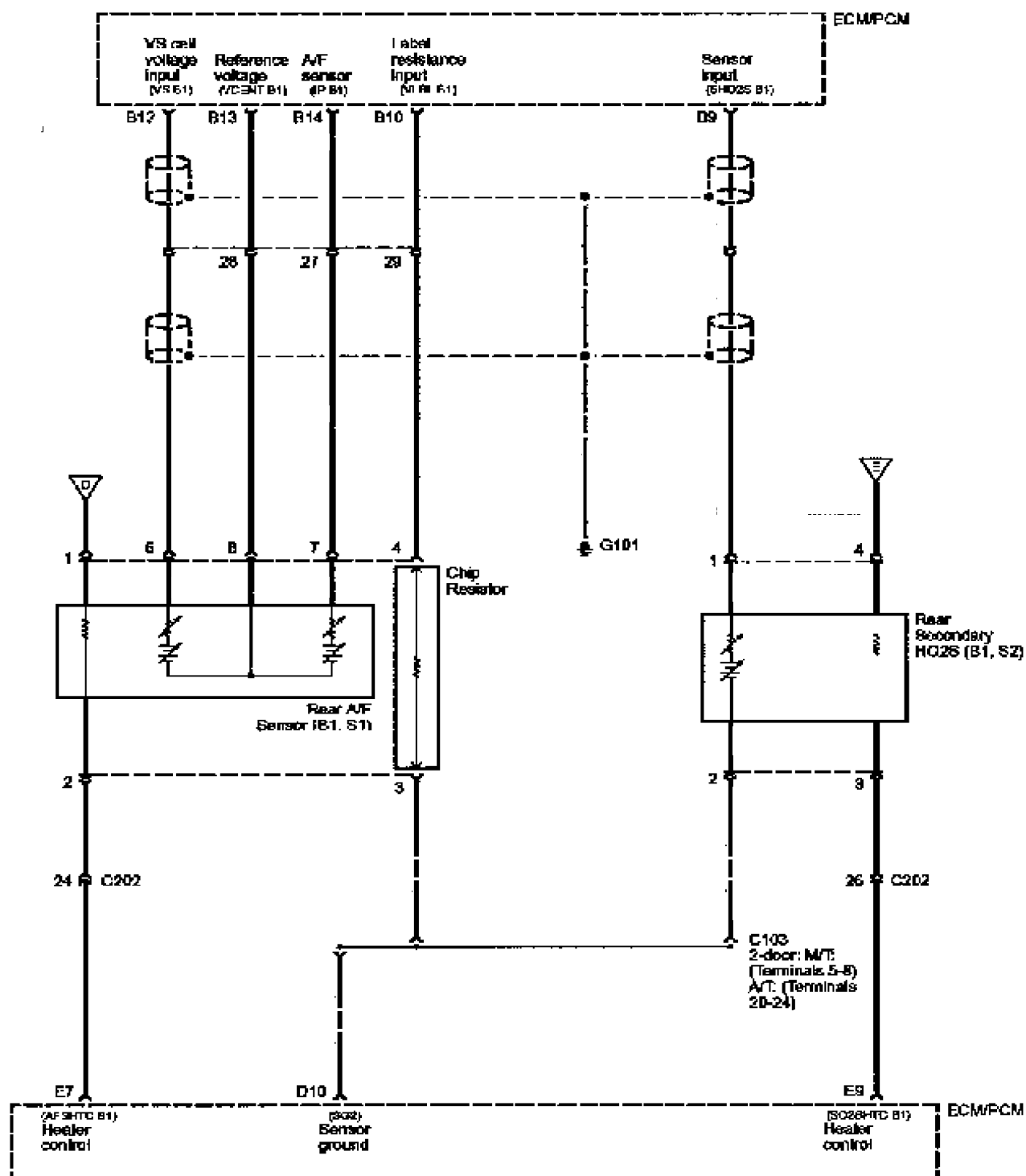
- Most recent wide-band O2S, used on Honda/Acura engines designated as ULEV
- Provides the PCM with faster and more accurate signals than the Oxygen Pump style sensor
- This extra speed plus its location (at the junction point of the exhaust manifold) allows the PCM to modify fuel injector pulse width for each individual cylinder instead of an overall average
- Uses a “thimble type” element similar to the stoichiometric O2S.
- Two wires are connected to a PWM O2S heater
- Two wires are connected to the O2S cell electrodes
- The exhaust electrode is connected to the PCM PHO2S- circuit and the oxygen reference electrode is connected to the PCM PHO2S+ circuit

Critical Current Oxygen Sensor Operation

- During operation, the PCM applies approximately 2.18 volts to the PHO2S+ circuit and 1.80 volts to the PHO2S- circuit
- There is a 0.38 volt difference between the two circuits
- This voltage difference causes current to flow between the (+) and (–) circuits
- As the mixture richens (lack of O2) the element resistance increases and when lean (excess O2) the resistance decreases.
- By applying voltage and monitoring the voltage changes, the PCM can accurately determine the mixture over a much wider operating range than traditional O2 sensors.

HO2S Circuit	Voltage
KOEO, HO2S Disconnected	
Heater control	4.6-5.0v
Heater Supply Voltage	B+
Reference Voltage	2.6-3.1v
Low reference	2.2-2.7v
Pump current	Less than 0.5v
Input pump current	Less than 0.5v

Typical Readings—
always consult service
information



Typical Schematics—always consult service information

Acronym List

Acronym	Description
AAI	Air Assist Injection
ACL	Air Cleaner
A/C	Air Conditioning
A/D	Analog to Digital
A/F	Air/Fuel
ANC	Active Noise Cancellation
ATTS	Active Torque Transfer System
BARO	Barometric
BOB	Break Out Box
CARB	Calif. Air Research Board
CD-ROM	Compact Disc-Read Only Memory
CKP	Crank Position Sensor
CL	Closed Loop
CLV	Calculated Load Value
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
COM	Communication
CVT	Continuously Variable Trans
CYP	Cylinder Position
DIC	Driver Input Centre
DIS	Distributorless Ign. System
DTC	Diagnostic Trouble Code
DLC	Data Link Connector
EBD	Electronic Brake Distribution
E-EGR	Electronic EGR
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EGR	Exhaust Gas Recirculation
ELD	Electrical Load Detector
EPA	Environ. Prot. Agency
EVAP	Evaporative
FIA	Fuel Injection Air (System)
FT	Fuel Trim
FTP	Fuel Tank Pressure
FTVR	Fuel Tank Vapour Recovery
HC	Hydrocarbons

Acronym	Description
Hg	Mercury
IAB	Intake Air Bypass
IAC	Idle Air Control
IAR	Intake Air Resonator
IAT	Intake Air Temperature
ICM	Ignition Control Module
IMA	Integrated Motor Assist
KS	Knock Sensor
LAF	Lean Air Fuel
LEV	Low Emission Vehicle
LT FT	Long Term Fuel Trim
MAP	Manifold Absolute Pressure
M/T	Manual Transmission
NO _x	Oxides of Nitrogen
OBD	On-board Diagnostics
OL	Open Loop
ORVR	On-board Refueling Vapour Recovery
OSM	Output State Monitor
O ₂ S	Oxygen
PGM-FI	Programmed Fuel Injection
PID	Parameter Identifier
PSP	Power Steering Pressure
PW	Pulse Width
ST FT	Short Term Fuel Trim
TCC	Torque Converter Clutch
TCM	Transmission Control Module
TP	Throttle Position
TWC	3-Way Catalyst
ULEV	Ultra Low Emission Vehicle
VCM	Variable Cyl. Management
VSS	Vehicle Speed Sensor
VSA	Vehicle Stability Assist
VTC	Variable Timing Control
VTEC	Variable Valve Timing & Lift Electronic Control
WU-TWC	Warm-up 3 Way Catalyst