ARTICLE BEGINNING

1993 ENGINE PERFORMANCE
Honda Theory & Operation

Accord, Civic, Civic Del Sol, Prelude

INTRODUCTION

This article covers basic description and operation of engine performance-related systems and components. Read this article before diagnosing vehicles or systems with which you are not completely familiar.

AIR INDUCTION SYSTEM

Air Intake System

System consists of an air cleaner, air intake pipe, throttle body, Idle Air Control (IAC) valve, fast idle mechanism and intake manifold. On Accord with 2.2L (F22A6) engine and Prelude except 2.2L (F22A1) engine, a by-pass control system is used. A resonator chamber in the air intake pipe reduces noise as air is drawn into system.

By-Pass Control System

By-pass control system consists of 2 separate intake paths in intake manifold, a by-pass valve, a by-pass control diaphragm and a normally open by-pass control solenoid valve. ECM selects air intake path(s) most favorable for engine performance by operating by-pass valves to direct airflow through one or both intake paths. On Accord, the longer, smaller intake path is used for operation when engine speed is less than 4700 RPM. On Prelude, the longer, smaller intake path is used for operation when engine speed is less than 4600 RPM on 2.2L (H22A1) engine and 4800 RPM on 2.3L engine. The shorter, larger intake path is opened in addition to the smaller path for better performance at high RPM.

Intake Control System

The intake control system consists of an intake control diaphragm and an intake control solenoid valve. When engine speed drops to less than 3500-4000 RPM and engine air requirements drop, the ECM activates the intake control solenoid valve. This supplies intake manifold vacuum to intake control diaphragm. Intake control diaphragm closes off one of the 2 air intakes and, along with resonator chamber, reduces intake air noise.

Throttle Body

Throttle body is a single-barrel sidedraft type. Lower portion of throttle valve is heated by engine coolant from cylinder head. Idle adjusting screw (to increase and decrease by-pass air) and canister/purge port are both located on top of throttle body.

VARIABLE VALVE TIMING

VARIABLE VALVE TIMING & LIFT ELECTRONIC CONTROL SYSTEM (VTEC)

Civic 1.5L (D15Z1)

Engine is equipped with 4 valves per cylinder. At low engine speeds, the primary intake valve operates with normal lift characteristics and secondary intake valve lifts slightly to prevent fuel accumulation in intake port.

When engine speed exceeds 2500 RPM and other conditions are met (determined by ECM), oil pressure is applied through a spool valve to timing and synchronizing pistons located in valve rocker arms. Synchronizing piston locks primary and secondary rocker arms together. In this way both valves operate at the higher lift and duration of the primary cam and valve. This system of locking rocker arms together is designated VTEC-E.

Civic & Civic Del Sol 1.6L (D16Z6)

VTEC system used on the 1.6L engine differs from the VTEC-E system used on the 1.5L engine. This system utilizes 3 different intake cam lobes and rocker arms. At low speed, the primary and secondary intake valves are operated by their own separate cam lobes. The connecting (middle) rocker is being operated by the high speed cam lobe at all times. At low speed the connecting rocker arm is not connected to either primary or secondary rocker arms or valves and has no effect on engine operation.

When engine speed exceeds 4800 RPM and other conditions are met (as determined by ECM), oil pressure is applied (through spool valve) to synchronizer pistons located in primary and connecting rocker arms. This locks primary, connecting (middle) and secondary rocker arms together so they are driven as a single unit by the higher lift and duration cam that operates the connecting (middle) rocker arm.

Prelude 2.2L (H22A1)

VTEC system used on the 2.2L (DOHC) engine functions in the same manner as the system on 1.6L engine in Civic and Civic Del Sol. Valve function changeover is accomplished when engine speed exceeds 4900 RPM and other conditions are met (as determined by ECM).

COMPUTERIZED ENGINE CONTROLS

ENGINE CONTROL MODULE (ECM)

Computerized engine controls are used to control fuel, ignition and emission control systems. Engine Control Module (ECM) receives input signals from various sensors and components. ECM then compares each signal with a preprogrammed parameter in its memory. Based on this comparison, output signals are then adjusted to allow vehicle to perform optimally under all operating conditions. ECM is located under passenger-side carpet on Accord and Prelude. On Civic and Civic Del Sol, ECM is located behind passenger-side kick panel.

NOTE: Components are grouped into 2 categories. First category covers INPUT DEVICES, which control or produce voltage signals monitored by ECM. Second category is OUTPUT SIGNALS, which are components controlled by ECM.

INPUT DEVICES

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine component usage of a specific model, see appropriate wiring diagram in L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section. Available input signals include the following:

A/C Switch Signal

This switch signals ECM of demand for air conditioning. ECM then increases engine RPM to compensate for additional engine load.

Alternator (FR) Signal

This signals ECM when alternator field circuit is energized. ECM compensates for changes in idle speed and low battery voltage which can cause erratic injector pulse width.

Atmospheric Pressure (PA) Sensor

PA sensor converts atmospheric pressure into electrical signals and relays information to ECM.

Automatic Transmission Shift Position Signal

This signals ECM when transmission selector lever is in Park, Neutral or D4 position.

Battery Voltage (IGN.1)

This provides ECM with a battery voltage signal from ignition circuit when ignition is on.

Brake Switch Signal

This signals ECM when brake pedal is depressed.

Electric Load Detector (ELD)

This signals ECM when an electrical load (headlights, radio, etc.) exists so ECM can compensate for additional engine load.

Engine Coolant Temperature (ECT) Sensor

Coolant temperature sensor is a temperature-dependent variable resistor (thermistor). Resistance of thermistor decreases as coolant temperature increases.

Exhaust Gas Recirculation Valve Lift Sensor

EGR valve lift sensor detects amount of EGR valve lift and sends information to ECM. ECM uses this information, along with other sensor inputs, to determine regulation of EGR control solenoid valve.

Intake Air Temperature (IAT) Sensor

Intake air temperature sensor is a temperature-dependent variable resistor (thermistor). Thermistor resistance decreases as intake air temperature increases.

Knock Sensor (Prelude)

Sensor is located on engine block near oil filter. Sensor signals ECM when a knock condition exists. ECM adjusts timing to compensate.

Manifold Absolute Pressure (MAP) Sensor

MAP sensor converts manifold absolute pressure into electrical signals and sends signals to ECM. MAP sensor signals are a measurement of engine load.

Manual Transmission Clutch Switch (Civic)

Switch is mounted above clutch pedal. Switch signals ECM when clutch is engaged to provide for idle speed adjustment.

Oxygen (O2) Sensor

Oxygen sensor detects oxygen content of exhaust gases and sends signal to ECM, which varies air/fuel ratio to maintain a 14.7:1 ratio under most conditions. This ratio is most efficient for combustion and catalytic converter operation.

All models, except Civic with D15Z1 engine, use heated oxygen sensors. Civic with D15Z1 engine uses a heated linear air/fuel ratio type oxygen sensor which performs the same function as standard oxygen sensor, but over a wider range.

Power Steering Pressure Switch

This switch signals ECM when power steering load is high. ECM then compensates for load by increasing engine RPM.

Starter Signal

Signals ECM when engine is cranking.

TDC/CKP/CYP Sensor

TDC/CKP/CYP sensor is a combination sensor located inside distributor. Each sensor generates a separate signal. CKP sensor detects engine RPM to determine fuel injection timing and ignition of each cylinder. TDC sensor determines ignition timing at start-up (cranking) and detects when crank angle signal is abnormal. CYP sensor detects position of cylinder No. 1 for sequential fuel injection to each cylinder.

Throttle Position (TP) Sensor

Throttle position sensor is a 3-wire potentiometer connected to throttle shaft. As throttle position changes, throttle position sensor varies voltage signal monitored by ECM. Sensor voltage ranges from about one volt at closed throttle to about 5 volts at wide open throttle.

Valve Timing Oil Pressure Switch

Located on Variable Valve Timing Electronic Control (VTEC) spool valve, switch signals ECM when VTEC system is operating. Switch will set a code in case of failure in circuit.

Vehicle Speed Sensor/Pulser (VSS)

Vehicle speed signal is generated by speed sensor (sometimes called a speed pulser), which produces 4 pulses (switch closures to ground) per speedometer cable revolution.

OUTPUT SIGNALS

NOTE: Vehicles are equipped with different combinations of computer-controlled components. Not all components listed below are used on every vehicle. For theory and operation on each output component, refer to system indicated after component.

A/C Clutch Engagement Delay

See IDLE SPEED under FUEL SYSTEM.

Alternator

See CHARGING SYSTEM under MISCELLANEOUS CONTROLS.

By-Pass Control Solenoid Valve

See AIR INDUCTION SYSTEM.

CHECK ENGINE Light

See SELF-DIAGNOSTIC SYSTEM.

Cooling Fan Timer Unit

See COOLING SYSTEM under MISCELLANEOUS CONTROLS.

EGR Control Solenoid Valve

See EXHAUST GAS RECIRCULATION (EGR) SYSTEM under EMISSION SYSTEMS.

Fuel Injector

See FUEL CONTROL under FUEL SYSTEM.

Ignitor Unit

See IGNITION SYSTEM.

Intake Air Control Valve

See IDLE SPEED under FUEL SYSTEM.

Intake Control Solenoid Valve

See AIR INDUCTION SYSTEM.

Main Relay

See FUEL DELIVERY under FUEL SYSTEM.

Oxygen Sensor Heater

See FUEL CONTROL under FUEL SYSTEM.

Purge Control Cut-Off Solenoid Valve

See EVAPORATIVE EMISSION SYSTEM (EVAP) under EMISSION SYSTEMS.

Spool Solenoid Valve

See VARIABLE VALVE TIMING.

FUEL SYSTEM

FUEL DELIVERY

Fuel Injection

Fuel system consists of an in-tank high pressure electric fuel pump, main relay, fuel filter, pressure regulator, injectors and injector resistor(s). This system delivers pressure-regulated fuel to injectors and cuts fuel delivery when engine is not running.

Fuel Pump

Fuel pump consists of a DC motor, a circumference flow pump assembly, an internal relief valve for protecting fuel line system, an internal check valve for retaining residual pressure, an inlet port and discharge port. Pump assembly consists of impeller (driven by motor), pump casing (which forms pumping chamber) and pump cover.

Fuel Pressure Regulator

Fuel pressure regulator maintains proper fuel pressure to injectors. Regulator uses manifold vacuum to sense engine load and modifies fuel pressure to maintain driveability.

When manifold vacuum is high, vacuum diaphragm is drawn back, overcoming spring pressure. Excess fuel passes through pressure regulator and is returned to tank via fuel return line. When manifold vacuum decreases (engine load increases), spring pressure closes off return passage, thereby maintaining fuel pressure and volume.

Injector Resistor(s)

Injector resistor(s) lowers current supplied to injectors to prevent damage to injector coils, allowing injectors a faster response time.

Main Relay

Main relay contains 2 individual relays. One relay is energized whenever ignition is on. It supplies battery voltage to ECM, power to injectors and power for second relay. Second relay supplies power to fuel pump. Second relay is energized for 2 seconds when ignition switch is initially turned on and when engine is running.

FUEL CONTROL

Programmed Fuel Injection

Programmed fuel injection system is controlled by Powertrain Control Module (ECM). See **POWERTRAIN CONTROL MODULE (ECM)** in **COMPUTERIZED ENGINE CONTROLS**. The basic fuel injector duration is built into ECM memory. The ECM modifies basic injector duration according to input signals from various sensors to obtain final injector duration for fuel delivery.

Fuel Injector

Fuel injector consists of a solenoid, plunger needle valve and housing. When current is applied to solenoid coil, valve lifts and pressurized fuel is injected close to intake valve. Since needle valve lift and fuel pressure are constant, air/fuel ratio is determined by time valve is open (duration of current supplied to solenoid coil).

Injector is sealed by an "O" ring and seal ring at top and bottom. All seals, "O" rings and rubber mounts reduce injector operating noise and heat transfer.

Oxygen Sensor Heater

The oxygen sensor detects the oxygen content in exhaust gas and signals the ECM. ECM bases fuel injection duration on these signals. An internal heater, activated by the ECM, stabilizes sensor output for more accurate readings.

IDLE SPEED

A/C Clutch Engagement Delay

When ECM receives a demand for cooling from air conditioning system (A/C switch), it delays A/C clutch relay activation for a short time. This prevents compressor clutch from being energized until ECM enriches the fuel injection mixture, ensuring smooth transition into A/C mode without overloading engine.

Idle Air Control (IAC) Valve

Engine idle speed is controlled by IAC and fast idle valve. IAC varies amount of air by-passing throttle plate (into intake manifold) in response to signals from ECM. After engine starts, IAC opens for a short time to increase idle speed. Activation time is dependent upon engine coolant temperature. When coolant temperature is low, IAC is held open to obtain proper fast idle speed. After engine reaches normal operating temperature, IAC is activated only to maintain minimum idle speed.

Fast Idle Valve

Fast idle valve allows additional air to by-pass throttle plate into intake manifold. Increased idle speed prevents engine from running erratically during warm-up. Valve is controlled by a thermowax plunger, which contracts when cold and expands when hot.

IGNITION SYSTEM

IGNITION TIMING CONTROL

ECM has complete control of ignition timing. Timing is controlled in response to signals from various sensors. Input signals from TDC, CRANK and CYL, throttle angle, coolant temperature, and MAP sensors are all used by ECM to determine optimum ignition timing control.

Battery voltage is supplied through ignition switch to ignition coil and ignitor unit. ECM triggers ignitor unit based upon signals from TDC, CRANK and/or CYL and other sensors. High voltage from ignition coil is distributed to each spark plug by distributor.

EMISSION SYSTEMS

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

EGR System

EGR system reduces oxides of nitrogen (NOx) emissions by recirculating exhaust gases through EGR valve into intake manifold and

back to combustion chambers.

System is composed of EGR valve, Constant Vacuum Control (CVC) valve and EGR control solenoid valve. EGR control solenoid valve is controlled by ECM, which analyzes input signals from EGR valve lift sensor and various sensors to provide optimum EGR flow.

EGR flow is cut when combustion gas temperatures are low (when the engine emits a relatively low NOx emission) to assure good colddriveability.

EGR Valve

When opened, EGR valve circulates exhaust gas through intake manifold and back into combustion chamber to be reburned, resulting in reduced combustion chamber temperature. Lower temperature reduces oxides of nitrogen (NOx) and helps to control spark knock.

EGR Control Solenoid Valve

When ECM determines it is necessary to recirculate exhaust gases, it grounds EGR control solenoid valve, regulating vacuum controlling EGR valve. By regulating vacuum to EGR valve, EGR flow is adjusted for optimum control of NOx emission.

Exhaust Gas Recirculation Valve Lift Sensor

The EGR valve lift sensor detects EGR valve lift and sends information to ECM. The ECM uses this information, along with other sensor inputs, to determine regulation of EGR control solenoid valve.

EVAPORATIVE EMISSION SYSTEM (EVAP)

Evaporative emission system minimizes fuel vapor escaping into atmosphere. For emission control applications and components used for each model and engine, see B - EMISSION APPLICATIONS and M - VACUUM DIAGRAMS articles in the ENGINE PERFORMANCE Section.

Charcoal Canister

Charcoal canister temporarily stores fuel vapor until it can be purged, drawn into engine and burned in combustion chamber.

Fuel Tank Vapor Control System

Fuel tank vapor control system consists of a fuel cut-off valve, liquid/vapor separator, a 2-way valve and fuel filler cap. All fuel vapor inside fuel tank is directed to charcoal canister through fuel cut-off valve and liquid/vapor separator.

Fuel cut-off valve and liquid/vapor separator prohibit liquid fuel from entering 2-way valve. When fuel vapor pressure in fuel tank is greater than set value of 2-way valve, valve opens and regulates flow of fuel vapor into canister. The 2-way valve regulates both pressure and vacuum in tank. The filler cap contains a relief valve to prevent excessive pressure or vacuum build-up.

Vapor Purge Control System

The vapor purge control system controls when charcoal canister is to be purged. Canister purging is accomplished when ECM activates purge control cut-off solenoid valve, allowing fresh air to be drawn through bottom of charcoal canister and into a port on throttle body.

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

The Positive Crankcase Ventilation (PCV) system is designed to prevent blow-by gases (in engine crankcase) from escaping into atmosphere. The PCV valve contains a spring-loaded plunger. When engine starts, plunger in PCV valve is lifted in proportion to intake manifold vacuum and blow-by gas is drawn directly into intake manifold.

SELF-DIAGNOSTIC SYSTEM

MALFUNCTION INDICATOR LIGHT (MIL)

When ignition is initially turned on, ECM supplies ground to illuminate Malfunction Indicator Light (MIL). The light remains on until vehicle starts. When an abnormal sensor signal occurs, ECM lights MIL, stores failure code in erasable memory and indicates code when diagnostic check connector is jumpered. For additional information, see G - TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

MISCELLANEOUS CONTROLS

NOTE: Although not considered true engine performance-related systems, some controlled devices may affect driveability if they malfunction.

A/C CLUTCH

When a demand for air conditioning exists in A/C switch circuit, ECM supplies ground to A/C clutch relay to operate the A/C compressor. ECM can also change engine idle RPM to compensate for additional engine load.

CHARGING SYSTEM

Alternator

The internal ECM alternator control system monitors and adjusts voltage generated at alternator. To improve fuel economy, the

ECM reduces alternator output through the voltage regulator when engine is at normal operating temperatures and the ECM detects low amperage demand conditions.

COOLING SYSTEM

Cooling Fan Timer Unit

Located next to ECM on Prelude and in left side kick panel on Accord, timer unit works with ECM to determine when to activate the cooling fans. On Accord, timer unit applies voltage through fuse No. 29 (A/C) and fuse No. 39 (radiator) to fan relays when ECM indicates A/C switch is in ON position. On Prelude, timer unit applies voltage through fuse No. 45 (A/C) and fuse No. 47 (radiator) to fan relays when ECM indicates A/C switch is in ON position.

END OF ARTICLE