Module 11
Thermistor Inputs

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11 Thermistor Inputs

11.1 General Overview

The Honda PGMFI fuel injection system uses several different types of inputs to determine injector pulse width (PW), ignition timing control and a whole host of other outputs. This chapter looks at the two thermistor inputs, the intake air temperature (IAT) sensor and the engine coolant temperature (ECT) sensor.

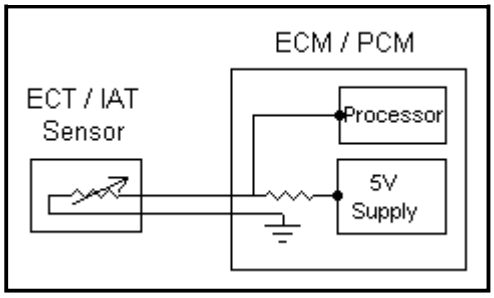
The IAT sensor and ECT sensor use a thermistor to monitor the temperature change. A thermistor is a special resistor that changes its resistance value when the temperature changes. You can easily see this by looking at a temperature/resistance relationship graph (Table 1- at end of chapter) on these components. Most Honda service manuals show this graph.

Both of these sensors use the very same thermistor. They have the same temperature/resistance relationship, which means that they can be tested the same way.

11.2 How Do They Work?

These sensors have two wires that go back to the engine control module (ECM). The ECM applies a voltage across the sensors and measures the voltage drop across the sensor for its input.

Illustration 11-1

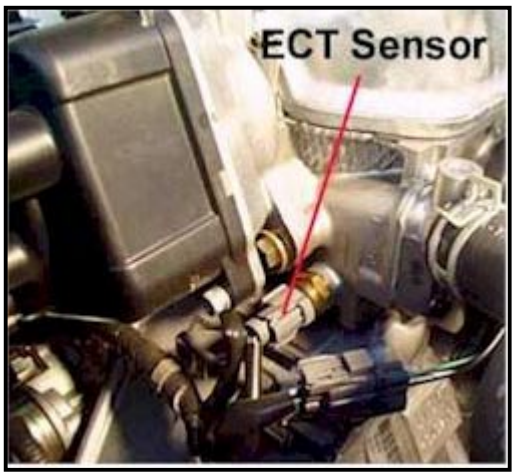


Some of you real sharp techs are thinking... how can a resistor that is supplied a voltage by the ECM have a difference in voltage drop by changing its resistance? That should just change the current in the circuit not the voltage across the thermistor. Actually the thermistor is a second resistor in a series circuit (see Illustration 11-1). The other resistor is inside the ECM. The ECM applies approximately 5 volts to the whole circuit and the resistor inside the ECM and the thermistor in the sensor share the 5-volt voltage drop.

The thermistor starts off with a high (10K+ ohms) resistance when cold and drops to a lower reading (about 300 ohms) when at full operating temperature. So when the car is cold (thermistor resistance is high) most of the 5 volts is dropped across the thermistor. When the temperature is cold (resistance is low) most of the voltage is dropped across the resistor inside the ECM. This temperature/voltage relationship is shown in Table 2.

11.3 Component Location

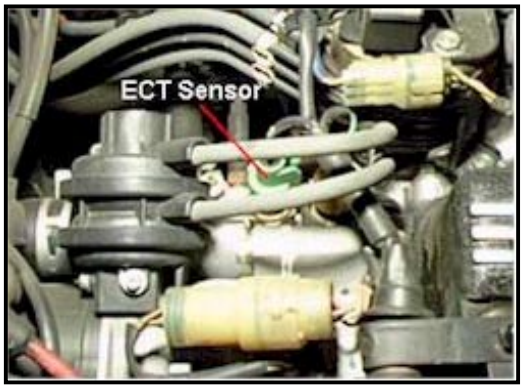
Image 11-1 ECT Location - Head



Typical "On Head"
ECT Sensor Location

90-98 Accord
85-98 Civic
95-98 Odyssey
92-96 Prelude
Note that on some Hondas there are two sensors right under the distributor. The ECT Sensor is usually the one further back on the engine

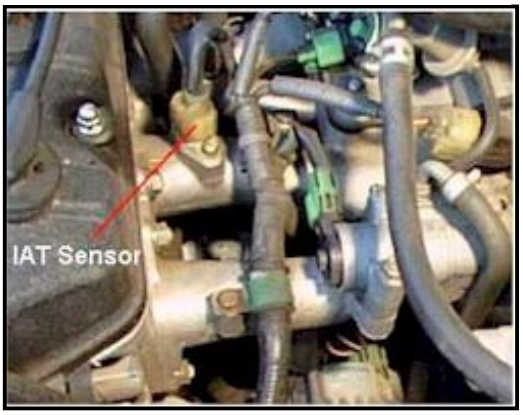
Image 11-2 ECT Sensor Location



Typical Thermostat Housing
ECT Sensor Location

85-89 Accord
85-91 Prelude

Image 11-3 IAT Sensor Location



Typical Intake Runner
IAT Sensor Location

The ECT sensor is either screwed into the top of the thermostat housing or into the very back of the cylinder head (usually under the distributor). The IAT sensor is located somewhere in the incoming air stream. Certain Acura models use a mass airflow (MAF) sensor to monitor intake airflow. These models will have the IAT sensor made into the MAF sensor. The IAT sensor is sometimes on the air intake chamber, but sometimes is located on an intake runner. The general location for each model is shown in Images 11-1,11-2, and 11-3.

11.4 How Do You Test Them?

11.4.1 Resistance Test

The only ECT/IAT sensor test procedure covered in the factory service manual is the resistance test. The sensor's resistance changes proportionately to its temperature. Table 1 (at end of chapter) gives the resistance values at various temperatures. The disadvantage to this procedure is that the sensor cannot be checked "live". You have to unplug the sensor to check its resistance, which will set a DTC if the car is running. It is also somewhat difficult to hold two probes on the sensor's terminals.

If you are testing this sensor while it is on the car, the voltage test is much easier to do and more effective.

11.4.2 Voltage Test

Now that we know about this voltage drop scheme, we can test thermistors by monitoring their voltage, which is much easier and more effective than measuring their resistance. You can check the thermistor voltage "live" with the car running. When you check these sensors the way that the service manual recommends, you have to stop the car, unplug the sensor, and measure the resistance. Now we can just monitor the voltage at the sensor with a standard Digital Volt-Ohm Meter (DVOM) and monitor the sensor continuously, even when driving if necessary.

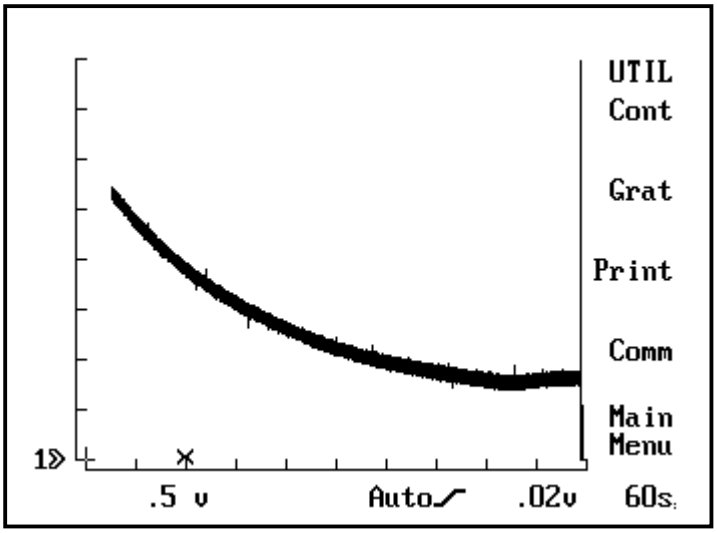
Just hook the DVOM black lead to vehicle ground and the DVOM red lead to the sensor input voltage wire at the sensor. There is really no need to worry about which wire is the correct wire. One wire is a ground and the other wire is the input voltage wire. If the first wire you check is approximately 0v, it is the other wire, just that simple.

When the car is checked cold, the sensor should be fairly high (2.5-4.5 volts) depending on the ambient temperature (see table 2 – at the end of the chapter). Another quick check for these two sensors is to see if they read the same when the car is cold. Remember the two thermistors have the same temperature/resistance curve and will be at the same temperature when the car is cold.

As the car warms up the voltage will drop steadily as the car warms up. The ECT sensor will drop to .5-.6 volt when the engine is fully warmed up. This voltage is so sensitive that you can actually watch the voltage vary a few tenths of a volt when the engine cooling fans come on. The actual voltage that the sensor starts at is not as important as it having a steady drop from its initial voltage to the approximately .5-.6 volt at normal operating temperature.

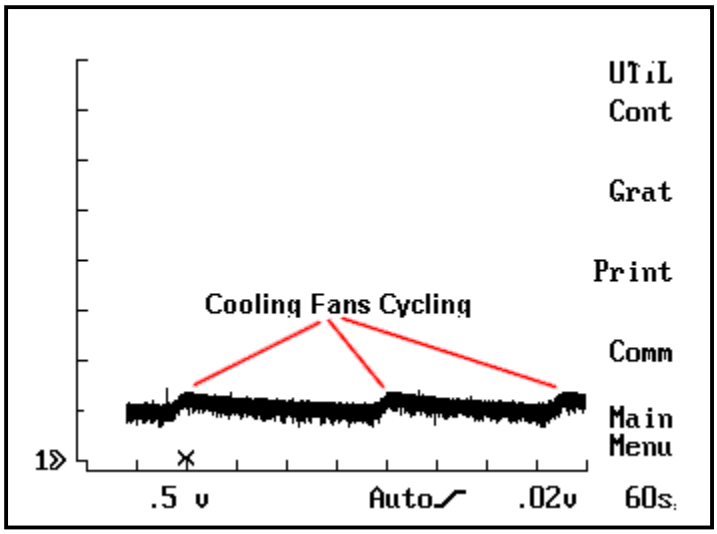
To thoroughly check out these sensors, you can set up a digital storage oscilloscope (DSO) to monitor the voltage during the warming up. Most scopes can display about 10 minutes on the screen in one pass. Any deviation from a nice steady drop indicates a bad ECT. This type of failure has occurred some with the ECT sensor, but not the IAT sensor.

Screen Capture 11-1



Screen Capture 11-1 was taken from a DSO that was monitoring the first 10 minutes of a cold (40° F) 1989 Accord as it is warming up. The voltage should steadily drop to about .5-.6 volts at full warm up. As you can see from Screen Capture 11-1, the voltage is not linear. It will drop fast at first and flatten out as it approaches full warm. The voltage should never make any significant upward movement.

Screen Capture 11-2



This reading was taken using an LS-2000 DSO, using leads with high frequency filters. The voltage was set at .5 volt per division and time set at 60 seconds per division. The screen was captured and stored using AES Wave software.

Screen Capture 11-2 was taken from the

same vehicle, but when fully warmed. The ECT sensor voltage should maintain .5-.6 volts once the Honda has reached normal operating temp. The three small rises in the ECT sensor voltage are showing the slight cooling that occurs when the cooling fans cycle.

11.4.3 Resistance Substitution Test

If you suspect the ECT sensor, you can temporarily replace it with a 330-ohm resistor (Radio Shack # 271-113). Here is the best approach:

- Run the car until it is warmed
- Cut the car off
- Unplug the ECT sensor and substitute it with a 330-ohm resistor. This gives the ECM a fixed resistance that equals a warmed up engine.
- If the problem goes away, you have a bad ECT.

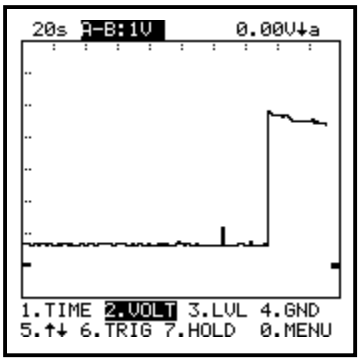
11.5 Service Tips

11.5.1 Cold Start Problems

On any Honda with a customer complaining about a hard starting problem (especially a cold start), check the ECT sensor input voltage against the voltage/temperature chart (Table 2 – at end of the chapter). You can check this without even starting the car. This is nice since you can eliminate one major source of a cold starting problem without loosing valuable diagnostic time with the engine running.

11.5.2 Car Won't Start When Hot?

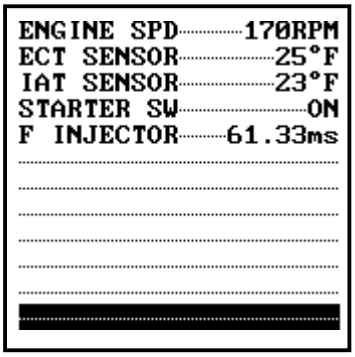
Screen Capture 11-3



The ECT sensor can cause all kinds of running problems, but mainly a hot start problem. The typical pattern is that they look fine at normal temperature, but go "cold" as the car approaches normal operating temperature. You can see this easily by monitoring the sensor voltage with a DSO. The ECT sensor voltage will usually start high and while dropping towards .5 volts, take off to a high voltage reading again.

Screen Capture 11-3 is of an ECT sensor that is jumping from cold to hot. The sensor would jump from normal operating temp to full cold for just a few ms. It finally went full cold and stayed there. If this car were restarted with the ECT at close to 5 volts, it would flood.

Screen Capture 11-4



Screen Capture 11-4 shows the effect a cold ECT signal has on the PW. It can drive the PW to over 60ms while cranking.

If the ECT fails and reports a cold condition, the ECM thinks the car is cold again, when it is actually at normal operating temperature. This really does not create all that much of a problem if the car is running in the closed loop (CL) mode. Most Hondas will ignore the ECT input after entering CL.

The problem is when you cut the car off and do a restart. When the ECM "sees" a start signal and a cold signal at the same time it increases the injector PW from the normal running width of 2-3ms to as high as 60-70ms (see Screen Capture 11-4). A hot engine will usually flood with this much fuel. This is how a defective ECT can cause hot restart problems.

It looks like this problem with an ECT sensor causing a hot start problem may not be as much of a problem with OBD-II equipped Hondas. OBD-II regulations require that input sensors be checked for rational information in addition to just a high / low value. It is not rational for a nearly warmed engine to quickly go to a low temperature. It should set a code, to alert you of the irrational sensor behavior.

If you are in a pinch and need to get a car started that you suspect has a bad ECT sensor, unplug it. When you unplug the ECT sensor the ECM will go into fail-safe mode, disregard the ECT sensor input and use an internal standard. The car will usually start OK this way. Sure it will set a diagnostic trouble code (DTC), but you can reset it.

The DTC for an ECT sensor is 6. The DTC for an IAT sensor is 10. Note that these two sensors rarely set a code, even when they are far enough out of range to cause hot start and running problems. If you have a Honda that seems to be having cold or hot start problems check the ECT sensor, even if a code has not been set!

11.6 **Table 1** - Thermistor Temp / Resistance Table

Thermistor Temp/Resistance Relationship	
Temperature F	Resistance (ohms)
0	15,000
32	5,000
68	3,000
104	1,000
140	500
176	400
212	250

11.7 **Table 2** - Thermistor Temp / Voltage Relationship

Thermistor Temp/Voltage Relationship			
Temp	Volts	Temp	Volts
0	4.70	110	2.00
10	4.50	120	1.74
20	4.29	130	1.52
30	4.10	140	1.33
40	3.86	150	1.15
50	3.61	160	1.00
60	3.35	170	.88
70	3.08	180	.74
80	2.81	190	.64
90	2.50	200	.55
100	2.26	210	.47