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# Honda's Dual-Mode Charging System

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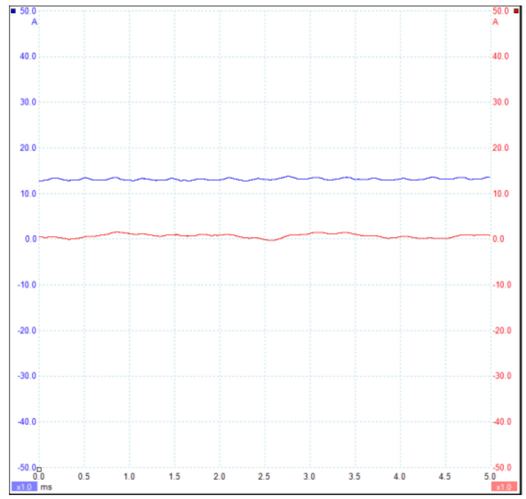
## Honda’s Dual Mode Charging System

For many years Honda and Acura have utilized a dual mode charging system to increase fuel efficiency and to decrease the drag on the engine when starting. The two modes can accomplish as much as 10% load reduction on the engine by allowing the Electric Control Module (ECM) to determine charging rates based on information gathered from an Electric Load Detector (ELD) and various other sensors.
During heavy electrical or mechanical loads (i.e., if the AC clutch is engaged), the ECM will set the charging voltage to 14.4-14.9V (high output mode); during startup and light electrical load conditions, the ECM will set the charging voltage to 12.4-12.9V (low output mode). In the latter case this anomaly might cause a technician to try to diagnose a low charge problem, although it is normal to have 12.5-12.7 charging voltage when the parameters are met.

This might confuse most technicians because it takes more than 12.6 volts to charge a battery. However, while in the low output mode, the alternator is not actually “charging” the battery but it is just holding the battery voltage at 12.5-12.7 volts. The main draw on the battery occurs during startup and after the battery has been charged there is no need to keep the voltage higher than what the vehicle needs. After the battery has been charged most of the current is drawn from the alternator as illustrated in figure 1. Thus, this system increases efficiency by charging the battery only when needed.

Figure 1: Current Flow




Alternator: ■ Battery: ■

**Components**

Honda/Acura charging systems appear to be similar to other manufacturers. They still use a belt driven three phased alternator and an internal electronically controlled voltage regulator that has three main functions.

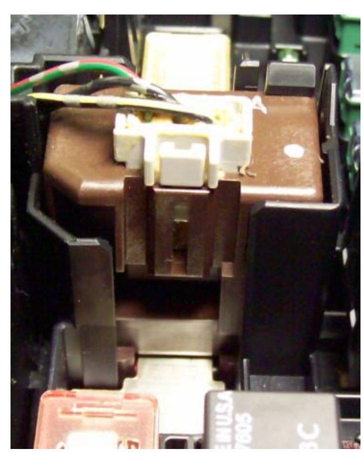
1. The regulator controls the pulse-width of the field rotor voltage. The longer the field rotor is on the more current will be supplied to the electrical system.

2. The regulator informs the ECM of field rotor status. This will indicate the rate at which the alternator is charging.

3. The regulator directly controls the charge warning indicator lamp by toggling the ground side of the circuit. In newer vehicles, the regulator does not control the indicator lamp. When a problem occurs, the regulator informs the ECM of the situation and the ECM will signal the gauge control module to turn on the indicator lamp.

The single component that makes Honda's charging system unique is the electric load detector located inside the fuse box. In some cases the fuse box will have to be dismantled to gain access to the ELD.  This sensor informs the ECM of the amount of electrical energy being used by the vehicle. The ECM sends a 5V reference to the ELD and the ELD pulls the reference voltage to ground as electrical load increases. There should be 2-4 volts found at the ELD terminal when the vehicle is under low electrical load and 1-2 volts under high electrical load.

Figure 2: ELD



**Terminals & Modes**

The voltage regulator utilizes five terminals: Ignition (IG), Control (C), Field Reference (FR), Battery, (B) and Lamp (L). The B terminal is the high current circuit that's responsible for charging the battery.  The other circuits are located in a single connector and are responsible for controlling the voltage regulator located within the alternator.

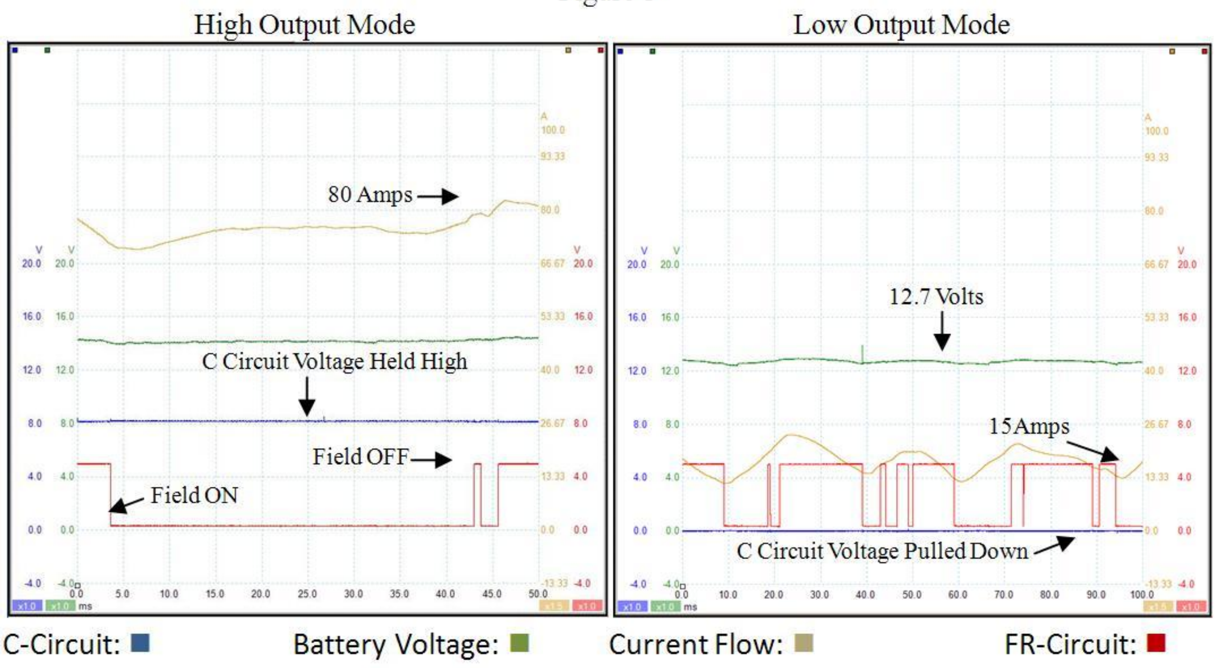
The IG circuit is crucial to proper charging system operation. Turning the ignition switch to the Run position will send source voltage to the IG terminal, which is required to energize the voltage regulator.

The C circuit is responsible for controlling the charge mode.  The voltage regulator sends a voltage to the ECM through the C circuit. Depending on the charging systems needs, the ECM either holds the voltage high to signal the high output mode, or it pulls the voltage low to signal the low output mode. When the circuit C voltage is pulled low by the ECM: the charging voltage at the battery will range from 12.4-12.9V. The ECM uses the low output mode when the engine is starting or if all of the following parameters are met:

- electrical Load below 15 Amps (varies with vehicle),
- vehicle speed between 10-45 mph or at idle while in drive,
- engine speed below 3,000 rpm,
- coolant temperature above 167°F (75°C),
- A/C Switch Off
- intake air temperature above 68°F (20°C).

Outside of these parameters, the ECM will hold the voltage on the C circuit, which will place the charging system in the high output mode.  In this mode, the charging voltage at the battery will range from 14.4-14.9V.
The ECM uses the FR circuit for field rotor status to be able to change engine idle speed. If the alternator is under high load, the ECM will increase idle speed. While the engine is running, the ECM sends 5V to the voltage regulator through the FR circuit. When the field rotor is on, the voltage regulator will pull the voltage down and when the field rotor is off it will hold the voltage high as shown on Figure 3.

Figure 3




The charging system utilizes the L circuit to inform the driver of any charging system faults. Over the years Honda has used two methods for illuminating the charge warning indicator lamp. On older models, the L circuit directly provided ground for the warning lamp if a problem was present. If everything was in spec, the voltage regulator removed the ground by providing positive source voltage on the L circuit.  However, on late model vehicles, the ECM sends source voltage to the L circuit. If a problem occurs, the voltage regulator will pull the voltage on the L circuit to ground. If this occurs, the ECM will sense that the signal voltage has been pulled down and it will then send a “charge warning lamp on” signal through the CAN bus network to the gauge control module. In this case, the gauge control module will directly switch the indicator lamp on.

**Diagnostics**

*No charge:*
A no charge problem can be caused by a defective alternator or battery cable. In addition, not having 12V at the IG terminal will cause the same problem. As long as the IG and B circuits are connected the charging system will function.
*Low charge:*
This problem can occur if the belt is slipping or if the engine rpm is too low. More specific to Honda/Acura, if the C circuit is shorted to ground, the charging system will always charge at the low output mode. This will simulate a low charge problem and the customer will also complain of dimming headlights while turning on other components.
*Warning lamp on:*
The warning lamp will turn on if the system is charging lower than specified. However, there have been many cases where the charging system will pass a performance test and still have a charge warning lamp on. In most cases, design variations are the culprit and most technicians prefer to use OEM alternators to avoid erroneous charging light problems.
If the charging system passes a performance test and the indicator lamp is still on, there could be a short to ground in the wire going to the L circuit.
*Warning lamp does not turn on:*
If there is an open on the wire going to the L circuit, the charge warning indicator lamp will never turn on. This might concern some people because if the connector containing the four main terminals is disconnected the charging system will fail but the warning lamp will never illuminate. The customer will not know that there is a problem until the vehicle comes to a sudden stop.
*Flickering or dimming lights:*
In 2000, most of the vehicles came standard with daytime running lights and numerous customers complained about their headlights dimming or flickering. Honda/Acura advised their technicians to explain to their customers about the dual modes system.

*DTC*

Several diagnostic trouble codes can be set if there are any faults in the charging system. A P1298 (ELD circuit high voltage) can be caused by a faulty solder on the ELD. If this is the case, 5V will be found at the ELD signal terminal at the ECM. At first, technicians were required to replace the whole fuse box. However, technicians are now required to disassemble the fuse box and replace only the ELD. The same voltage will be found if there is a problem on the ground-side of the ELD.

If a problem occurs on the FR circuit, a P16BC (alternator FR terminal circuit/IGP circuit low voltage) will be set. If the ECM senses a charging voltage below 11V for at least 1 minute, it will set a P0562 (charging system low voltage). In some cases, if all of the previously stated codes are set with other P-type codes such as P0102 (MAF sensor circuit low voltage) or P0141 (secondary HO2S [sensor 2] heater circuit malfunction), it might be caused by an open at terminal F5 (YEL) of connector F in the fuse box under the dash.

This charging system has been used by Honda/Acura since the early 90's and the design has not changed much. In fact, the wire colors and terminals from 1990 schematics are consistent with the schematics we have today. There are only two reasons for this, either Honda/Acura just does not want to spend the money for R&D or there is no need to change something that works. Since this system is dependable and efficient, why would Honda/Acura ever want to change that?

# Honda Charging System Schematic