# Troubleshooting Ford 6G warning lamps

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Your customer calls: "The alternator you sold me is charging, but the battery warning lamp will not go out." Then he asks why. Fact is, there's no single answer.

The first step toward solving a lamp problem is knowing which Ford charging system you are dealing with and then verifying that both the alternator and the regulator match the application. Once you know for a fact that the correct regulator is on the vehicle, you can begin a series of tests that will determine why the charge warning lamp is not going out. Ford charging systems can be divided into two groups: those with internal voltage control and those with external voltage control. You have to identify which type you are working with, because they are as different as apples and oranges, and each must be tested differently.

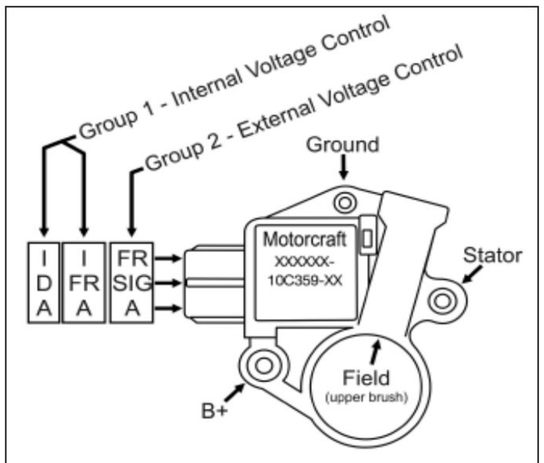



**Figure 1— 6G regulator plug codes.**

**Internal voltage control**

Usually found on V-8 engines, this group of charging systems includes all applications in which the voltage regulator controls system voltage. In these vehicles the voltage regulator controls both the voltage set point and charge lamp illumination. In some cases, the regulator "I" terminal is connected directly to the lamp itself. In other vehicles, more typical in later production years, the regulator controls the lamp through the engine control module (ECM) and a microprocessor inside the instrument cluster. The voltage regulators in Table 1 are used in internal voltage controlled alternators.

| OE PART # | COLOR | TERMINALS |
|---|---|---|
| F8WU-10C359- AB | Grey/Grey | I-D-A (*Fig.1*) |
| VP3C3U-10C359-AA | Grey/Green | I-D-A (*Fig.1*) |
| XS7U-10C359-AC | White/White | I-FR-A (*Fig.2*) |
| XS7U-10C359-AC | White/Orange | I-FR-A (*Fig.2*) |
| VP4L1U-10C359-AA | Black/Black | I-FR-A (*Fig.2*) |

**Table 1— Internal voltage control regulators.**

All of these regulators and charging circuits have two things in common. They all use the "A" terminal as a voltage sense point, and they all use the "I" terminal for excitation and warning lamp control. The grey regulators do not use the center terminal. The "D" stands for dummy. The white regulators in this group use the center terminal to send a field duty cycle signal to the ECM. The FR terminal (field rate monitor) is an output terminal and has nothing to do with actual regulator operation. It is used by the ECM to monitor the field duty cycle, which is directly proportional to the mechanical load that the alternator is placing on the engine (Figures 3 and 5).

In early applications, the charge lamp is connected directly to the regulator "I" terminal (Figures 2 and 3). Voltage passes through the lamp to turn on the regulator. Once the alternator begins charging normally, a driver inside the regulator turns the lamp off by removing the ground from the lamp circuit. These conventional lamp circuits seldom cause false warning lamp problems. When they do, you can check it fairly easily. If the lamp goes out when you unplug the regulator, then the problem is inside the alternator.

However, in later applications, the "I" terminal is connected to the ECM (Figures 4 and 5) or directly to a microprocessor in the instrument cluster (Figure 6), which turns on the regulator by applying low voltage. If you read the voltage on an unplugged "I" terminal wire with the key on, you can read this low voltage signal. This is called an open circuit reading because voltage is present—but the circuit is incomplete until it is plugged in. If you plug the connector into the regulator, the voltage at the "I" terminal will drop. This is often referred to as pull-down voltage. Once the alternator begins to charge normally, the regulator changes the pull-down voltage. That change of pull-down voltage is what tells the ECM that the charging system is working normally. The ECM will then send that information over the vehicle's data network to the microprocessor inside of the instrument cluster. The charge warning lamp then should be turned off by the instrument cluster processor.

If the pull-down voltage is more or less than what is expected, the ECM may not send the OK message, even though system voltage shows that the alternator is charging. If the OK message is not sent, the instrument cluster will not turn off the lamp. It is worth mentioning here that the ECM also monitors system voltage. If at any time the voltage is too high or too low, it will set a fault code and send a message to the instrument cluster that there is a problem with the charging system. As you can see, there is a lot that can go wrong here to cause the lamp to stay on—even if the alternator is charging normally.

If everything seems to be charging correctly, but the lamp will not go out, perform this simple test with the engine off:

Unplug the alternator. Using a digital multimeter, measure the resistance between the regulator "I" terminal and ground (Figure 7). On some applications, you may be able do this on the vehicle without removing the alternator. If you do not read between 1.1kΩ (kilo-ohms) and 1.5kΩ, there is a high probability that the voltage regulator is returning a pull-down voltage that is outside acceptable parameters. An OE regulator will read 1.3kΩ. It should be noted that some aftermarket regulators will give readings that are much lower—even as low as 15 ohms. Those regulators will function fine in applications where the lamp is controlled directly by the regulator. However, there is a high probability that they will cause a problem if they are used on a vehicle where the ECM and/or the instrument cluster processor is between the regulator and the charge warning lamp. You can test regulators on the bench this way, before or after assembly of the alternator. Please note that this test is valid only for regulators contained in the internal voltage control group.

**External voltage control**

This group of charging systems includes all applications in which the ECM controls system voltage and is most commonly found on smaller

engines. In these vehicles, the ECM signals the regulator and commands the desired voltage, which may change, depending on throttle position, temperature, vehicle speed and other conditions. The ECM also controls the illumination of the charge warning lamp. The regulators in Table 2 are used with this type of system.

| OE PART # | COLOR | TERMINALS |
|---|---|---|
| XW4U-10C359-AB | White/White | FR-SIG-A (*Fig.3*) |
| VP3C3U-10C359-AA | White/Black | FR-SIG-A (*Fig.3*) |
| VPL43U-10C359-AA | White/Grey | FR-SIG-A (*Fig.3*) |
| XS7U-10C359-AC | White/Orange | FR-SIG-A (*Fig.3*) |

**Table 2— External control voltage regulators.**

All of these regulators sense from the "A" terminal and are activated by the ECM using the SIG terminal (Figure 8). Activation is usually delayed until the engine idle has stabilized. In addition, the voltage set point of all of these regulators is variable and is controlled remotely by the ECM. This is accomplished via a burst of pulses to ground to the SIG terminal of the regulator. These "pulse trains" are sent at intervals of about five seconds. The frequency of the pulse train determines the voltage set point, which can be anywhere from 12.5 volts to 16 volts. A higher frequency will command a lower voltage. If the signal is lost for any reason (broken wire, faulty terminal plug or failed ECM) the regulator will continue to operate in a default mode at 13.8 volts.

The FR terminal sends the duty cycle of the alternator back to the ECM using a frequency signal. The frequency is directly correlated to the field duty cycle, which represents the mechanical load that the alternator is placing on the engine. This information is used by the ECM to adjust the idle speed and to maintain the desired voltage set point.

The charge lamp on all of these applications is controlled within the instrument cluster based on messages from the ECM via the vehicle's data network. The charge lamp will illuminate if the ECM fails to see a signal from the FR terminal for a period of time as short as half a second. It will also illuminate if there is an overcharge or undercharge condition—even if the condition lasts for only a short period of time. The ECM can also set fault codes listed in the following chart, which can be retrieved using a variety of scan tools.

| CODE | MEANING |
|---|---|
| P1244 | Alternator load input low |
| P1245 | Alternator load input high |
| P1246 | Alternator load input failed |

**Table 3— Trouble codes.**

A scan tool is required to properly troubleshoot a lamp problem within this group of alternators. However, you can test the alternator on the vehicle to ensure that the regulator is responding properly to ECM commands (assuming you have a meter capable of reading frequency). The Hz readings will verify that the ECM is sending a signal, and the voltage readings will confirm that the regulator is responding properly. Note that a lower frequency should cause a higher voltage, while a higher frequency should result in a lower voltage. Of course, voltage readings may vary slightly due to the condition and state of charge of the battery. On a cold startup, the ECM should signal a voltage of 14.2 volts or higher. As the engine warms to full operating temperature with no loads, the voltage should gradually reduce. Table 4 lists readings you should expect to see.

| FREQUENCY | CHARGING VOLTAGE |
|---|---|
| 250 Hz | 13 Volts |
| 125 Hz | 14 Volts |
| 102 Hz | 14.7 Volts |

**Table 4— Frequency vs. voltage.**

Next, check to ensure that the regulator is sending out the FR signal to the ECM. With the engine running, backprobe the FR terminal using the black (negative) meter lead. Put the red (positive) lead on the B+. If you read negative voltage on the FR terminal while the alternator is charging, then the signal is being sent out by the regulator. However, it has been reported that interference from a bad ignition wire can alter the FR signal in transit and can cause the ECM to read the signal as not matching the command. This can trigger a fault code and illuminate the charge indicator lamp.

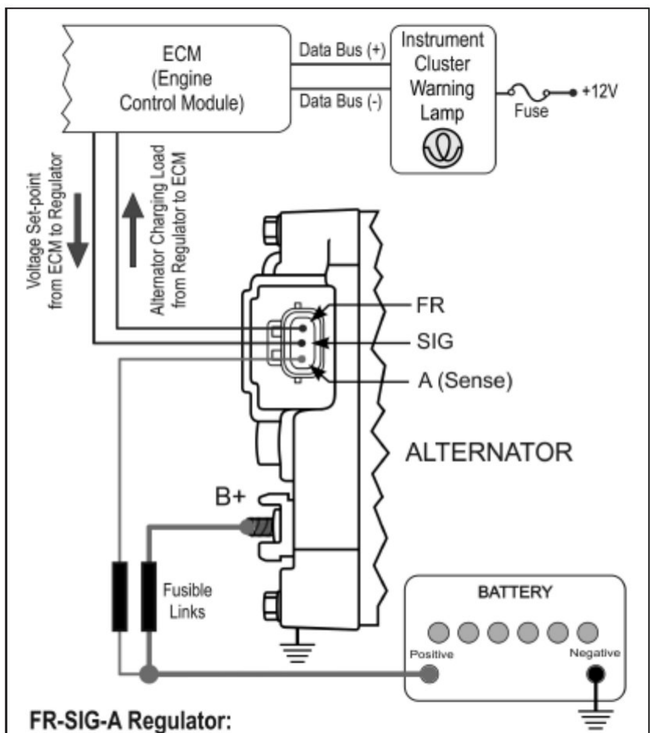
Finally, with the engine running, check the voltage at the "A" terminal. It should be within one tenth of a volt of the voltage at the battery B+ terminal. If there is significant resistance in the sense circuit, the resulting lower voltage at the "A" terminal will cause the alternator to overcharge the battery. This can cause an overcharge fault code and charge lamp illumination. A common point of resistance in 6G charging systems is in the harness to regulator plug. However, the resistance could be a bad connection anywhere in the sense wire circuit.

Charge lamp problems on Ford vehicles using 6G series alternators have been all too common for most rebuilders. Sometimes these problems are caused by the alternator, even though it is charging normally. We have tried to help you determine whether or not the alternator is at fault when this happens. However, there are other electronic components in the lamp circuit outside of the alternator. Any one of these components may cause problems. As explained, broken wires in the harness, poor connections, shorted wires in the harness, faulty ECM, faulty instrument cluster module or even a shorted battery can also cause the lamp to remain illuminated. The tests described above cannot tell you why the lamp is not going out, but they can verify whether or not it is being caused by the alternator.

*Thanks to Gene Kaiser at Regitar USA for his help.*

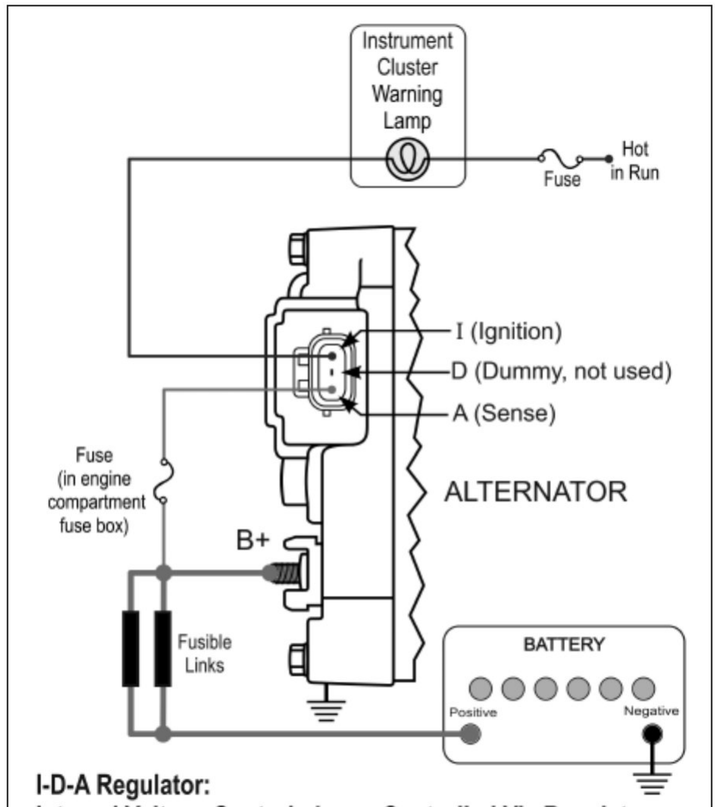
*Courtesy of the Electrical Rebuilder's Association. This Technical Document (CS201204A) along with other technical and membership information, may be accessed at electricalrebuilders.org.*

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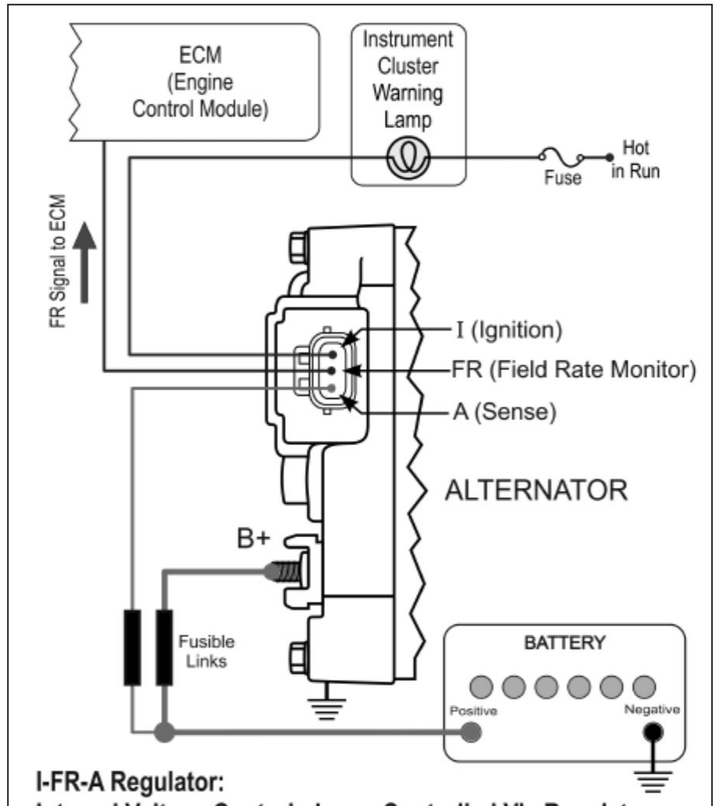

**FR-SIG-A Regulator:**
**External Voltage Control - Lamp Controlled Via ECM & Cluster**

**Figure 8— FR-SIG-A, ECM & cluster control lamp.**



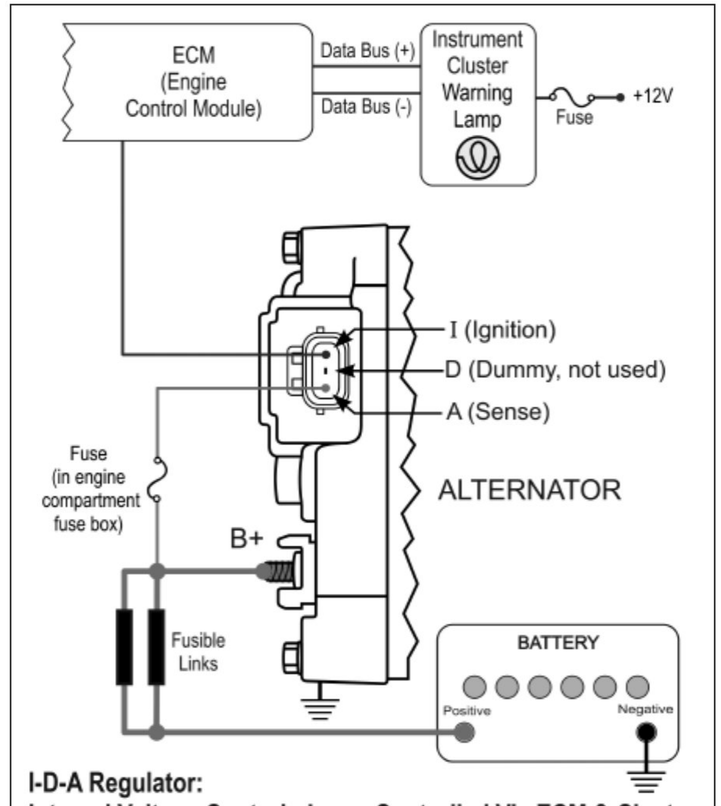

**I-D-A Regulator:**
**Internal Voltage Control - Lamp Controlled Via Regulator**

**Figure 2— I-D-A, regulator controls lamp.**



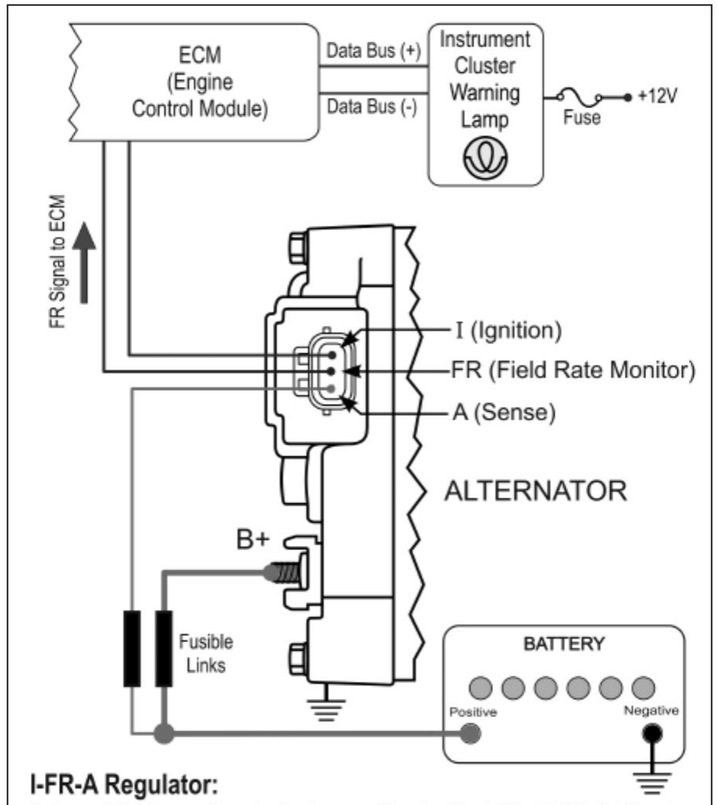

**I-FR-A Regulator:**
**Internal Voltage Control - Lamp Controlled Via Regulator**

**Figure 3— I-FR-A, regulator controls lamp.**



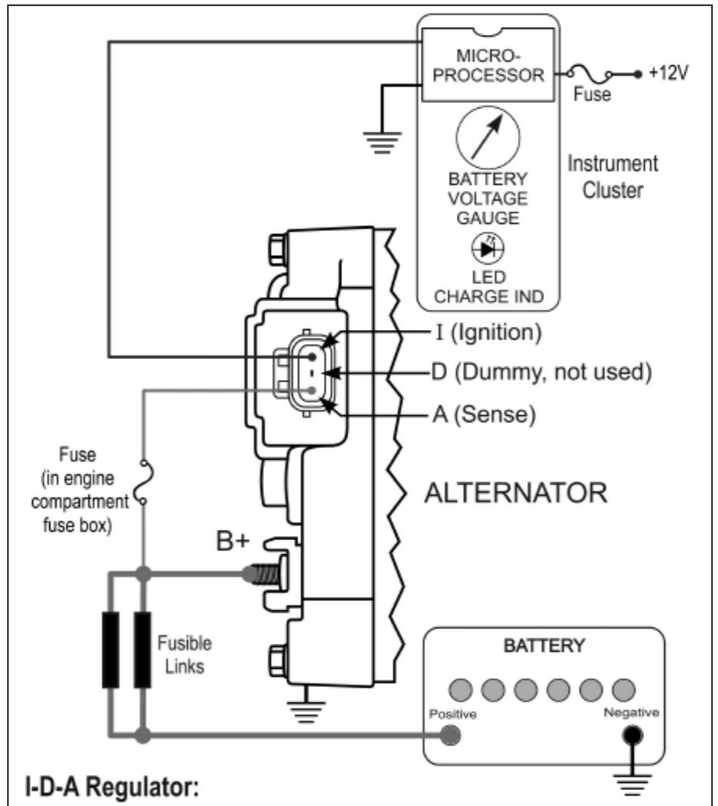

**I-D-A Regulator:**
**Internal Voltage Control - Lamp Controlled Via ECM & Cluster**

**Figure 4— I-D-A, ECM & cluster control lamp.**




**I-FR-A Regulator:**
**Internal Voltage Control - Lamp Controlled Via ECM & Cluster**

**Figure 5— I-FR-A, ECM & cluster control lamp.**




**I-D-A Regulator:**
**Internal Voltage Control - Lamp Controlled Via Cluster Microprocessor**

**Figure 6— I-D-A, cluster controls lamp.**

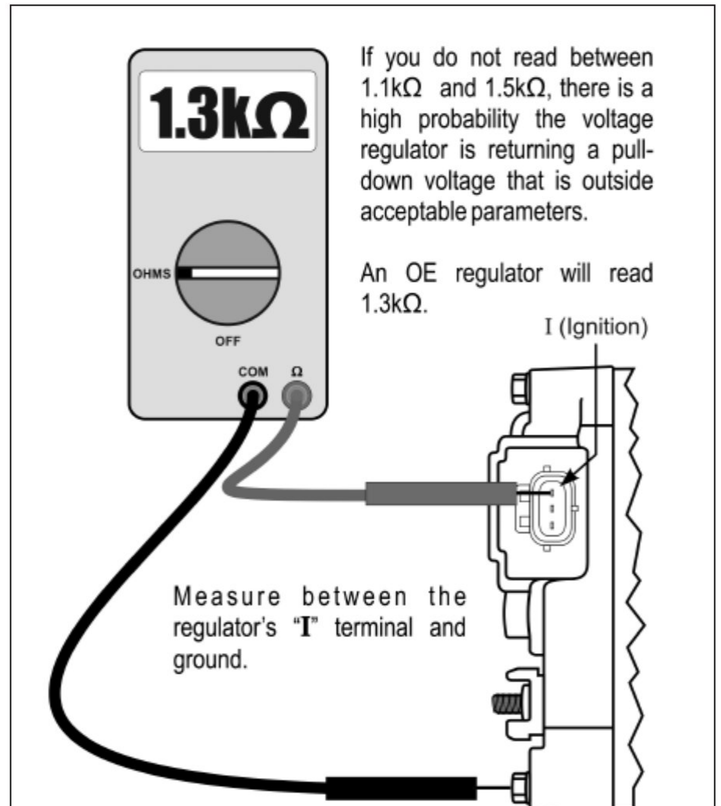



**Figure 7— Test the "I" terminal.**