FORD 6G CHARGING SYSTEM VOLTAGE REGULATORS

It seems like Ford 6G series alternators have caused more confusion in the rebuilding industry than all previous Ford alternators combined. This document will try to clarify the differences and explain how they work.

There are, as of this writing, three distinct groups of Ford 6G voltage regulators with the following in common:

1. They all use the same three-terminal design with regulator, brush holder and brushes incorporated into a single component part *(Figure 1*).
2. They all have a direct B+ connection with the rectifier, which supplies field current to the positive brush at all times.
3. They are all *A*-circuit, meaning, the regulator controls the field on the negative side.

That's where the similarities end.

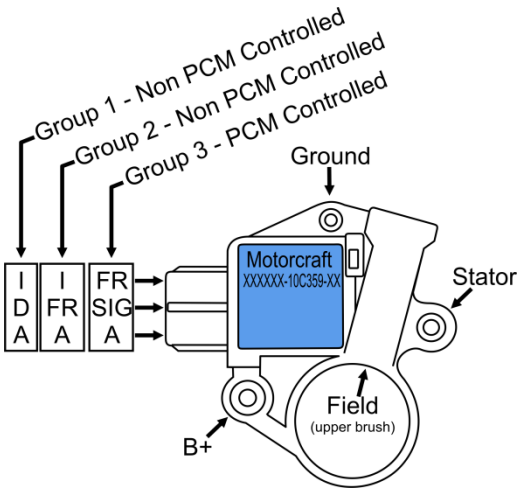


Figure 1 – Ford 6G Regulator Connections

GROUP 1 Non-PCM-Controlled, Center Terminal Not Active

This is the most common group, in which voltage is set and controlled within the regulator itself. It does not incorporate delayed load response. Depending on the application, these regulators may be activated by a charge lamp, the instrument cluster or, in the case of dual alternator systems on diesel vans and trucks, the PCM. They were first introduced in 1998.

While all 6G regulators have three terminals, only two of the terminals are utilized on this type. The center terminal has no connection to the vehicle. The two outer terminals are *I* for lamp or instrument cluster and *A* for sense. The sense terminal is a fused *B+* circuit and is used for sensing voltage only. *Figure 2* shows a typical wiring diagram for this type of regulator. (Note: *Figure 2* shows the *I* terminal connected to a warning light. In some applications, it may be connected directly to the PCM instead.)

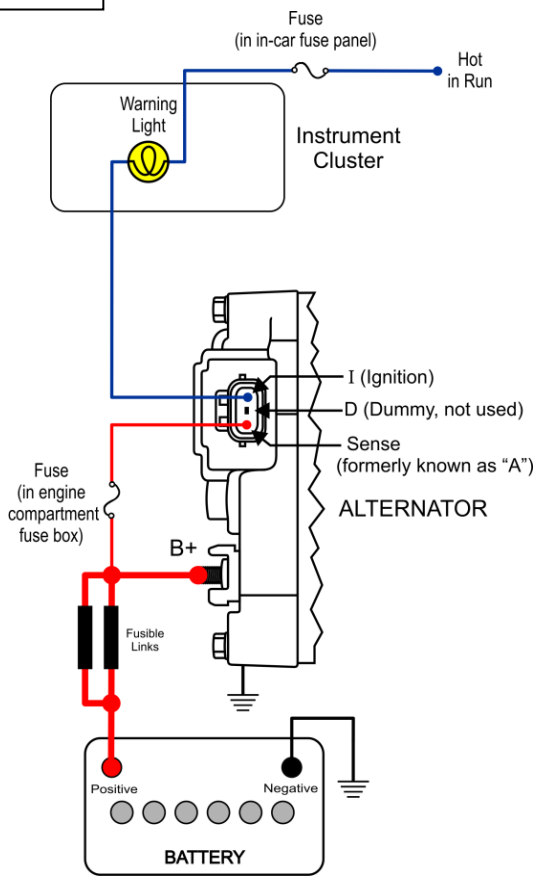
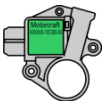


Figure 2 – Typical I-D-A Wiring Diagram

The OE regulators in this group are:

Non-PCM-Controlled, Center Terminal Not Active		
	**F8WU-10C359-AB**	**Grey case Grey cover**
	**VP3C3U-10C359-AA**	**Grey case Green cover**

GROUP 2 Non-PCM-Controlled, Center Terminal FR Signal

The second group of regulators is distinctly different, with all three terminals being utilized. The *I* and *A* terminals function the same as in the first group. The center terminal is designated *FR* for field response. These regulators first appeared in 1999 and have been used primarily on four and six cylinder engines. They may be turned on initially by the charge lamp or the PCM.

All of the regulators in the second group utilize load-response control, meaning, there is a delayed and gradual response when electrical loads are placed on the system. Load-response prevents the alternator from instantly placing a heavy mechanical load on the engine when high electrical loads are applied to the system. This should not be confused with soft-start, a feature that delays alternator turn-on for a few seconds following start up. None of the Ford 6G regulators incorporate soft-start, but those that are turned on by the PCM, could have a delayed start, controlled by the PCM and **not** by the regulator.

The *FR* terminal is a direct connection to the switching side of the field, and is connected through the wiring harness to the PCM. This provides continuous monitoring of the load the alternator is placing on the engine. All regulators within this group provide information to the PCM to aid in engine management, but once working, voltage set-point is still controlled within the regulator. A typical wiring diagram for an *I-FR-A* can be seen in *Figure 3.* (Note: *Figure 3* shows the *I* terminal connected to a warning light. In some applications, it may be connected directly to the PCM instead.)

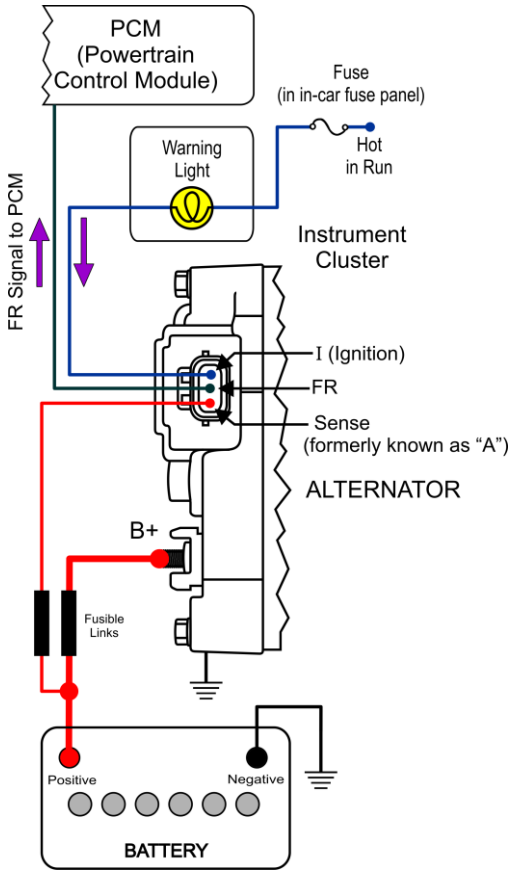
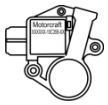


Figure 3 – Typical I-FR-A Wiring Diagram

The OE regulators in this group are:

Non-PCM-Controlled, Center Terminal FR Signal		
	**XS7U-10C359-AC**	**White case White cover**
	**XS7U-10C359-BA**	**White case Orange cover**
	**VP4L1U-10C359-AA**	**Black case Black cover**

GROUP 3 PCM-Controlled

The PCM-controlled group seems to give rebuilders the most problems. These regulators use the same three-connector plug as the others, but the terminals are all different. Most importantly, these regulators interface directly with the PCM. The PCM not only turns the alternator on after startup, but it also controls the voltage set-point, within a range from 12.5 to 16 volts.

Ford began using PCM-controlled alternators in 1999 on the Windstar. As of 2006, there were 15 different Ford alternators utilizing this technology. The benefits of this charging system are: better idle stability, improved fuel economy, easier starting, more engine power at wide open throttle and longer battery life. By turning control of the voltage set-point over to the PCM, it can be optimized based on engine speed, electrical loads, temperature and the length of time the engine has been running since startup.

All of the alternators in this group use the same plug configuration, but Ford has changed the names of the terminals and wire colors so many times, it can cause confusion.

The battery-sense wire is the same as that used with all other Ford regulators and is powered through a fuse on all vehicles using PCM-controlled regulators. There should be battery voltage on this wire at all times. Its purpose is to let the regulator monitor the voltage at the battery.

The other two wires in the plug are what make this charging system unique. You can think of each as a one-way communication circuit. One regulator terminal communicates to the PCM precisely what load the alternator is placing on the engine. The other terminal is used by the PCM both to turn on the regulator and then control the voltage set- point. It's really just that simple (see *Figure 4*).

Ford has complicated the matter by frequently changing the names of the two circuits. The terminals for PCM-controlled alternators were initially called *FR-SIG-A*. When alternators were first introduced, Ford called their sense wire *A* because *S* was used to label the stator terminal. It has taken them several decades, but the *A* terminal is now called *S* (for sense) in the latest applications.

FR was the original name of the terminal that sends the field response, or duty cycle, from the regulator to the PCM. From this signal, the PCM can tell how hard the alternator is working and precisely what horsepower load the alternator is placing on the engine. Later, Ford began calling this circuit other names, including: *GEN-MON* for generator monitor, *GFS* for generator field sense, or *GENLI* for generator load input. You may also see it simply called *LI* in some places. Don't let the names confuse you. They all send the same information from the alternator to the PCM.

SIG was the original name for the wire the PCM uses both to turn on the alternator and to control the voltage set-point. This is done using a pulsing ground signal, sent at least once every five seconds. The PCM can change the voltage set-point by changing the frequency of the pulses. Taking into consideration many factors, including coolant temperature, air temperature, throttle position and vehicle speed, the PCM will determine the best voltage setting. Ford decided to rename this circuit, more than once. It has also been called *GEN-COM* or *GENRC* for generator field command, *GENFDC* for generator field-control output, or simply *RC* in some places. All of these names mean the same thing and work the same way.

It is also worth noting here, that the charge warning lamp is controlled by the PCM via the instrument cluster in all of these systems. If the PCM detects a charging system problem, it will send a message via a data line to the instrument cluster, which will then illuminate the warning lamp.

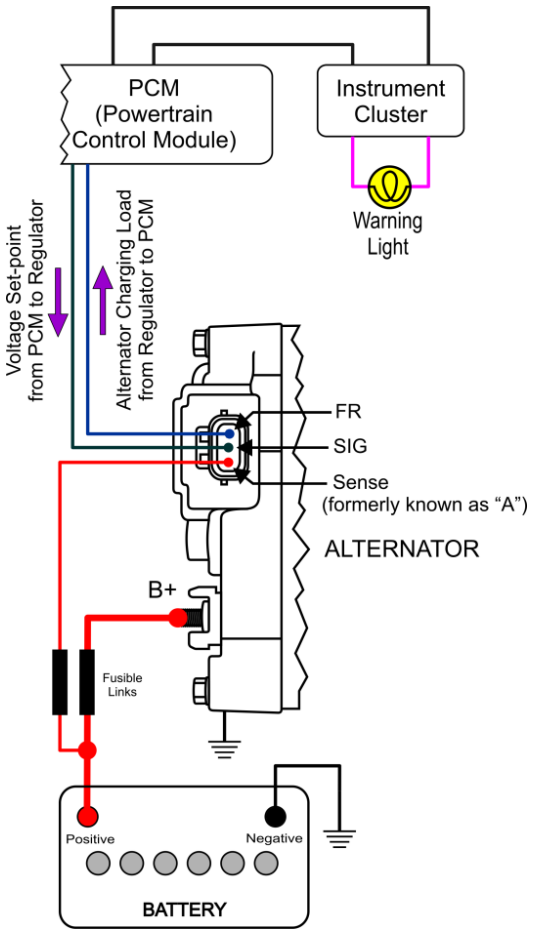


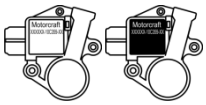
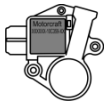
Figure 4 – Typical FR-SIG-A Wiring Diagram

While this circuit works essentially the same on all of Ford's PCM-controlled charging systems to date, the electronics within the PCMs and regulators have changed considerably since 1999. Operating speeds within electronic circuits have increased dramatically, and Ford has made changes to their regulators to take advantage of this. There have been three different PCM-controlled regulator part numbers up to 2006. In most cases, the latest part number can be used in earlier applications without any problems. However, using the earlier part numbers in later applications **will** cause problems in most cases (even though the regulator works on a test bench). It is because of these increased switching speeds, that substituting "early for late" can cause problems. If the regulator sends an *FR* signal that is different from what the PCM is programmed to expect, it will turn on the warning lamp and set a fault code.

Since we are talking about the *FR* signal (field response), it's also worth pointing out that the rotor plays a part too. A new or rewound rotor that does not match OE specs could set a fault code if the difference was enough to affect the duty cycle, even though it may seem to work perfectly on a test bench.

A final complication from Ford is the small wire size used in the 6G harness plug. In nearly all vehicles, the wire gauge is very small and the wire is prone to break inside the insulation. This will cause a good alternator to fail to work properly on the vehicle. It can often appear as an intermittent no-charge or charge with warning lamp on.

The OE regulators in this group are:

PCM-Controlled		
	**XW4U-10C359-AB**	**white case white or black cover**
	**VPL43U-10C359-AA**	**white case blue cover**
	**7L4E-10C359-AA**	**white case grey cover**

Below is a list of PCM fault codes for the charging system, an explanation of what each means and a list of possible causes as described by Ford.

P1244: Alternator Load Output high – input is higher than the load should be during normal operation.
Possible Causes:

1. Battery has shorted cell
2. FR circuit shorted to voltage
3. SIG circuit is shorted to voltage
4. Battery positive circuit has an open circuit prior to startup
5. SIG circuit open prior to startup
6. Faulty PCM

P1245: Alternator Load Output Low – input is lower than the load should be during normal operation, or the alternator has no output.
Possible Causes:

1. SIG circuit is shorted to ground
2. FR circuit is shorted to ground
3. Battery positive terminal has been open during cranking
4. Low system voltage due to alternator or battery problem
5. Defective alternator
6. Broken belt
7. Faulty PCM

P1246: Alternator Load Output Failed – for some reason, the PCM is not receiving the FR signal from the alternator.

Possible Causes:

1. Damaged or defective wiring going to the alternator
2. Defective alternator
3. Broken belt
4. Faulty PCM

NOTE: BE CAREFUL! Ford produced non-PCM-controlled regulators using the same color configuration as some PCM-controlled regulators. Always identify a regulator by its number or application, not by the color of the case and cover.

NOTE: In cases where the charge lamp is being controlled by the PCM, there have been documented cases where a later version of the same regulator would not replace an earlier version. It seems that in those cases, the alternator might charge perfectly on the vehicle, but the PCM detects something wrong in the behavior of the regulator, and illuminates the charge lamp. It is always best to match the regulator to the specific application.