RVC Systems Feature Many Benefits

Traditional charging systems use an internal temperature sensor inside the generator to establish generator voltage set points. When the generator is cold, it raises the voltage output set point. When the generator is hot, it lowers the voltage output set point. This type of system tends to overcharge the battery on long trips at highway speeds and undercharge the battery on short trips with low vehicle speeds.

Regulated Voltage Control (RVC) is a new dynamic control of the vehicle's system voltage. It regulates the generator's output voltage, based mainly on estimated battery temperature and battery state-of-charge. The main benefits of this system are:

- improved fuel economy,
- extended battery life,
- extended lamp life,
- extended switch life.

GM is using three different generations of RVC systems on a number of new models, including Cadillac CTS, SRX and STS, Chevrolet and GMC full-size trucks and SUVs, Chevrolet Cobalt and Uplander, Buick LaCrosse and Terazza, and Pontiac Grand Prix and Montana SV6.

Since the RVC system allows changes to vehicle voltage, up or down, under various scenarios—the battery state of charge and the vehicle's present electrical needs are two conditions taken into account—the voltmeter may fluctuate. Conventional systems usually maintain a consistent reading of 14 volts. The fluctuation of the RVC system may range between 12 and 24 volts. This is normal system operation.

Two RVC Systems

There are two types of RVC systems used today—integrated RVC and standalone RVC (SARVC).

Integrated systems use a battery current sensor to provide a body control module (BCM) the amount the battery is charging or discharging. Accurate voltage measurements are taken through the battery positive voltage and ignition 1-voltage circuits. The BCM then communicates information over serial data circuits for the ECM/PCM to directly control the generator.

SARVC systems do not use the BCM for operation. They have a generator battery control module mounted to the negative battery cable, to interpret battery current, and voltage and battery temperature inputs. The battery current sensor is internal to the module. This module also directly controls the generator L-terminal duty cycle instead of the ECM/PCM.

Both types of system have two types of corrective actions to ensure the battery stays at an 80 percent state of charge. These include up to three levels of load shed and up to three levels of idle boost operation.

System Operation

The basic operation of the RVC system is covered here, but not all systems will enter all modes of operation; refer to the applicable service manual information for more details.

The purpose of the RVC system is to maintain the battery state-of-charge at 80 percent or above and support vehicle loads.

The six modes of operation include charge mode; fuel economy mode; voltage reduction mode; start up mode; windshield de-ice mode; and battery sulfation mode.

The PCM/ECM (generator battery control module on full-size trucks) controls the generator through the generator L-terminal control circuit. It monitors the generator performance through the generator field duty cycle signal circuit. The signal is a 5 volt Pulse Width Modulated (PWM) signal of 128 Hz with a duty cycle of 0 to 100 percent. Normal duty cycle is between 5 and 95 percent. The ranges between 0 to 5 percent and 95 to 100 percent are for diagnostic purposes. Commanded duty cycle and output voltage of the generator are shown below.

Duty Cycle	Generator Voltage Set Point
10 %	11.0V
20 %	11.56V
30 %	12.12V
40 %	12.68V
50 %	13.25V
60 %	13.81V
70 %	14.37V
80 %	14.94V
90 %	15.5V

The generator provides a feedback signal of the generator load through the generator field duty cycle signal circuit to the control module. The signal is a 5 volt PWM signal of 128 Hz, with a duty cycle of 0 to 100 percent. Normal duty cycle is between 5 and 99 percent. The ranges between 0 and 5 percent and 100 percent are for diagnostic purposes.

Charge Mode—The control module enters charge mode whenever one of the following conditions is met:

- Under WOT conditions and when the fuel rate (sent by the ECM/PCM) is greater than 21 g/s and the throttle position is greater than 90 percent.
- The headlamps are on low or high beam.
- The wipers are on for more than eight seconds.
- The electric cooling fans are on high speed.
- The rear defogger is on.
- The battery state of charge is less than 80 percent.

When one of these conditions is met, the control module ramps up the voltage slowly to a level between 13.4 to 15.5 volts (depending upon the mode of operation the system is presently in) at a rate of 8 mV to 50 mV per second.

Fuel Economy Mode—The control module enters fuel economy mode when the following conditions are met:

- The calculated ambient air temperature is above 0 degrees C (32 degrees F).
- The calculated battery current is less than 15 amperes and greater than -8 amperes.
- The battery state of charge is greater than 80 percent.
- The generator field duty cycle is less than 99 percent.

Its targeted generator output voltage is 13.0 volts. The control module will exit this mode once the criteria are met for charge mode.

Voltage Reduction Mode—The control module will enter voltage reduction mode when the following conditions are met:

- The calculated ambient air temperature is above 0 degrees C (32 degrees F).
- The calculated battery current is less than 2 amperes and greater than -7 amperes.
- The generator field duty cycle is less than 99 percent.

Its targeted generator output voltage is 12.9 volts. The control module will exit this mode once the criteria are met

for charge mode.

Start Up Mode—After the engine has started, the control module sets a targeted generator output voltage of 14.5 volts for 30 seconds.

Battery Sulfation Mode—The control module enters this mode when the battery voltage is less than 13.2 volts for 45 minutes. Once in this mode, the generator battery control module will set a targeted output voltage between 13.9 and 15.5 volts for five minutes. The control module will then determine which mode to enter depending on voltage requirements.

RVC Mode—The control module bases the charging voltage on battery state of charge (SOC). Battery SOC is estimated during a key off event every eight hours, after three voltage measurements every 24 hours thereafter, and then monitored constantly while the ignition is on. These measurements of voltage are then compared to estimated battery temperature, as battery temperature vs. battery voltage directly corresponds to battery SOC. While the engine is running, the system uses both the battery voltage and estimated battery temperature to determine the battery current in and out of the battery. The control module then regulates the charging voltage to keep the battery above an 80 percent SOC.

System Components

Battery Current Sensor—The battery current sensor is a serviceable component that is connected to the negative battery cable at the battery. The battery current sensor is a three-wire Hall-effect current sensor that monitors the battery current. It directly inputs to the BCM. It creates a 5 volt PWM signal of 128 Hz with a duty cycle of 0 to 100 percent. Normal duty cycle is between 5 and 95 percent. The ranges between 0 to 5 percent and 95 to 100 percent are for diagnostic purposes.

Body Control Module (BCM), Instrument Panel Module (IPM), and Dash Integration Module (DIM)—The BCM determines the output of the generator and sends the information to the ECM/PCM for control of the generator L-terminal control circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM/PCM that determines the generator electrical load. It monitors the battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge. The BCM performs, or sends, commands to ECM or other controllers to perform idle boost and load management operations.

ECM/PCM—The ECM/PCM directly controls the generator field control circuit input to the generator. The ECM/PCM receives control decisions based on messages from the BCM/IPM. It monitors the generator field duty cycle signal circuit and sends the information to the BCM/IPM. On some vehicles, the ECM/PCM overrides the control decision of the BCM/PCM when the following conditions are met:

- The engine cooling fans are on high speed.
- There is a high fuel demand.
- The calculated ambient air temperature is less than 0 degrees C (32 degrees F).

Instrument Panel Cluster (IPC)—The IPC provides a means of driver notification in case of a charging system failure.

Generator Battery Control Module—It communicates with the PCM, IPC and BCM for RVC operation. It is a serviceable component that is connected to the negative battery cable at the battery. It directly controls the generator field control circuit input to the generator. It monitors the generator field duty cycle signal circuit, its internal battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge.

General System Diagnostics

Diagnostics are specific for each vehicle that uses this system. Refer to the applicable service manual for DTC information.

For L-terminal diagnostics, set your DVOM to monitor frequency. When the system is operating normally, you should read a duty cycle of 5 to 95 percent depending on which mode the system is in and also the battery state of charge. The 5 volt reference signal for the PWM signal is provided by the generator and cycled to ground by the ECM/PCM or generator battery control module, depending on the system.

For F-terminal diagnostics, set your DVOM to monitor frequency. When the system is operating normally, you should read a duty cycle of 5 to 99 percent depending on which mode the system is in and also the battery SOC. The ECM/PCM or generator battery control module, depending on the system, provides the 5 volt reference signal for the PWM signal and is cycled to ground by the generator.

A scan tool may include some of the following parameters: ECM/PCM—generator L-terminal, generator F-terminal, battery voltage; BCM/DIM/IPM—battery current sensor, battery voltage, ignition voltage, load shed level, idle boost level.

The generator battery control module incorporates most of the scan tool parameters, except load shed and idle boost, as this system does not take corrective actions.

If there is a charging system error, first check for related charging system and low voltage DTCs set in the control module.

In addition, diagnose P codes first, as these DTCs will set if there is a generator or control circuit failure.

If no DTCs are present, refer to the charging system test in the service manual. If this test does not present a failure, it may be necessary to test drive the vehicle and monitor the idle boost and load shed parameters. This may lead you to some type of high load condition that may be normal; compare to a known-good vehicle.

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