CATERPILLAR®

PRODUCT NEWS

Power Systems Marketing Division January 13, 2004

Caterpillar® Digital Voltage Regulator (CDVR) - Revised

Market	Electric Power, Oil and Gas
Application	All
Description	A Caterpillar® digital voltage regulator is being introduced on Caterpillar® EPG Diesel and Gas Generator Set Packages.
Features/Benefits	The CDVR (Caterpillar® Digital Voltage Regulator) has improved transient performance, added standard features such as VAR/PF control, and expanded flexibility for optimizing performance to individual customer applications. The voltage regulator can be setup or adjusted using the Caterpillar® PC software through the RS232 port located on the voltage regulator. PC software file is available and distributed using SIS Web Download.
Source	All Caterpillar® generator sets manufactured in facilities in Larne, Northern Ireland, Lafayette, Indiana and Griffin, Georgia.
Availability	CDVR will be added to PSQ by Monday (11/17). The CDVR will replace existing digital voltage regulator for low, medium, and high voltage generators.
Compatibility	The CDVR will be used in all EPG products currently available with a standard or optional CDVR and with high voltage applications where analog regulators are standard with current product. The change will only affect PMG generators that have the CDVR as standard or option. Self Excited generators or generators that do not have an option for the digital voltage regulator will not be affected.
General Comments	An overview of product features, functionality and technical specifications is included in the previous Product News (August 2003). Orders placed now with the request for assembly after Jan 5 will be reviewed and the dealers will be contacted about the ability to convert to the CDVR.

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Introduction

Caterpillar's digital voltage regulator (CDVR) for EPG Product has been introduced to allow for increased performance, added features, and optimized reliability. The CDVR is a microprocessor-based control designed to provide precise voltage control, robust transient response, and generator protection with industry leading features and versatility. The CDVR is designed as an improvement to and replacement for the current design. The CDVR is also a replacement for analog voltage regulators utilized in high voltage applications, i.e., KCR760 and K65-12B.

Mounting
The CDVR mounts in the same space with the same hardware as previous models.

Wiring
The new design features wiring via three multiple-pin, plug-type connectors.

Standard Features
The CDVR now includes three operation modes standard: Automatic Voltage Regulation Mode (AVR), Var Control Mode (VAR), and Power Factor Control Mode (PF).

The new design also includes a greater range of 20 preset stability curves to match individual customer applications. The CDVR also offers additional flexibility by providing the customer the option of configuring a customizable stability curve for fine-tuning the regulator for their specific application.

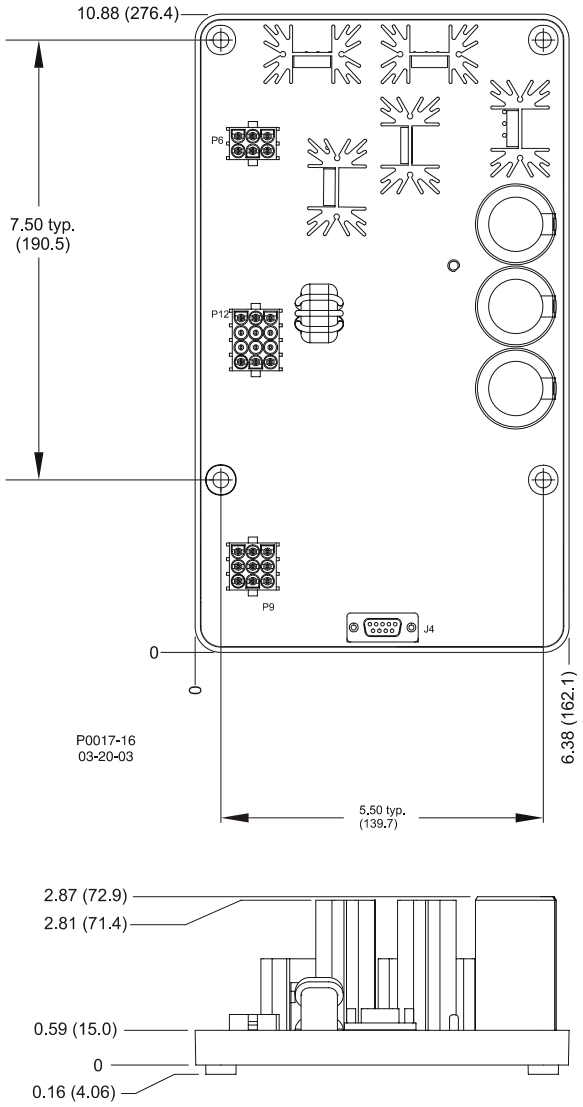
Certifications
The CDVR is UL recognized, CE marked, CSA approved, and meets MIL STD 461C.

Sensing Input Range
The new design allows for adjustable voltage sensing levels from 90-600VAC without modification to the hardware or the addition of transformers or other ancillary equipment.

Communication and Adjustments
The voltage regulator can be setup or adjusted using the Caterpillar® PC software through the RS232 port located on the voltage regulator.

Power Supply Inputs
The CDVR is now fully compatible for use with Shunt, PMG, or AREP (Auxiliary Winding) excited generators.

Dimensions – Figure 1



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Compatibility

The following products' standard configuration or available options will be affected. The change will only affect PMG generators that have the CDVR as standard or option. Self-excited generators or generators that do not have an option for the digital voltage regulator will not be affected.

Description of Changes to Price Lists

Model	Current Price Lists	Changes to Price List
G3306	EPG	No changes
G3406, G3412	PKG	Removed DVR with KVAR/PF option CDVR option includes KVAR/PF control
3306, 3406, 3456, 3412	PKGG - Griffin Source	Removed DVR with KVAR/PF option CDVR option includes KVAR/PF control
3306, 3406, 3412	PKGI - Larne Source	
3406E, 3456	PKGI - Larne Source	No changes
3406, 3412	PKGT - Tianjin Source	Removed DVR with KVAR/PF option CDVR option includes KVAR/PF control
3508, 3512, 3516 G3508, G3512, G3516	PKG	CDVR replaces DVR (LV, MV) CDVR replaces KCR 760 & KCR 65-12B (HV). HV deletion: KCR 760 & KCR 65-12 B Auto Manual Control for KCR regulators, Max Min exciter, Auto Manual Voltage Control, RFI Suppression, Motor Operated Potentiometer.
3508, 3512, 3516, G3516B	PMs	
G3516B	PKG, CHP	
G3520B, G3520C	PKL, CHL	
3508 HV Options	PKG	HV option deleted based on low sales
G3508, G3512, G3516	EPG	VR6 is standard with SE generators CDVR is standard with PM generators

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Product Features

The CDVR includes numerous key features that drive high performance and customer value.

- Microprocessor-based control featuring a choice of three operation modes as standard:
  - Automatic Voltage Regulation (AVR)
  - Power Factor Regulation (PF)
  - Reactive Power Regulation (Var)
- Programmable stability settings
- Soft start control with an adjustable time setting in AVR control mode
- Dual Slope Underfrequency (volts/hertz) regulation
- Three-phase or single-phase generator voltage (RMS) sensing/regulation in AVR mode
- Single-phase generator current sensing for regulation purposes
- Field current and field voltage sensing
- Five contact sensing inputs for system interface
- One common LED for visual indication of Alarm and Shutdown fault conditions
- Fault Shutdown Driver and Alarm Output Driver for indication of Alarm and Shutdown fault conditions
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Line drop compensation
- Remote communication interface via CAN 2.0B or RS 232
- Ten generator protective functions
- UL recognized, CE certified

General Operation

The CDVR provides three modes of operation.

- Automatic Voltage Regulation (AVR)
- Var Regulation
- Power Factor Regulation (PF)

Both the Var mode and PF mode are mutually exclusive modes that both work in conjunction with the AVR mode.

Automatic Voltage Regulation Mode

In Automatic Voltage Regulation (AVR) mode, the CDVR regulates the RMS generator output voltage. The regulator senses the generator output voltage through the sensing leads. The regulator then adjusts the dc output excitation current to the generator exciter field. This excitation current maintains the generator terminal voltage at the regulation setpoint.

Var Control Mode

In Var Control mode, the CDVR maintains generator Vars (voltamperes, reactive) at a set level when paralleling with an infinite bus. The CDVR calculates generator Vars using the sensed generator output voltage and current quantities. It then adjusts the dc excitation current to maintain Vars at the setpoint. Var mode and PF mode are mutually exclusive modes that both work in conjunction with the AVR mode.

Var control can be enabled via the communication port(s) and CDVR Software. The Var setpoint is adjustable from 100 percent absorb to 100 percent generate.

Power Factor Control Mode

In Power Factor Control mode, the CDVR maintains generator power factor at a set level when paralleling with an infinite bus. The CDVR calculates generator power factor using the sensed generator output voltage and current quantities. It then adjusts the dc excitation current to maintain power factor at the setpoint.

Power Factor control can be enabled via the communication port(s) and Digital Voltage Regulator Software. The power factor setpoint is adjustable from 0.6 lag and 0.6 lead.

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Reactive Droop Compensation

The CDVR provides a Reactive Droop Compensation feature for three phase generators to assist in the sharing of reactive load during parallel generator operation. The CDVR calculates the reactive portion of the generator load using the sensed generator output voltage and current quantities and then modifies the voltage regulation setpoint accordingly. A unity power factor generator load results in almost no change in generator output voltage. A lagging power factor generator load (inductive) results in a reduction of generator output voltage. A leading power factor generator load (capacitive) results in an increase of generator output voltage. The Reactive Droop Compensation is adjustable up to 10 percent.

In addition, the Reactive Droop Compensation feature allows paralleling of three phase generators when connected for Cross Current Compensation (CCC). This method of connection allows reactive load to be shared between generators with very little voltage droop. The droop level adjustment acts as the sensitivity adjustment when connected for CCC.

Reactive droop compensation and line droop compensation are mutually exclusive features.

Refer to the service manual for complete guidance on how to provide the Reactive Droop Compensation function.

Line Drop Compensation

The CDVR provides a Line Drop Compensation feature for three phase generators to assist in compensating for voltage drops in the lines between the generator and the load. The CDVR calculates the magnitude of generator output current and modifies the voltage setpoint accordingly. An increase in generator output current results in an increase in generator output voltage. The Line Drop Compensation is adjustable up to 10 percent.

Line drop compensation and reactive droop compensation are mutually exclusive features.

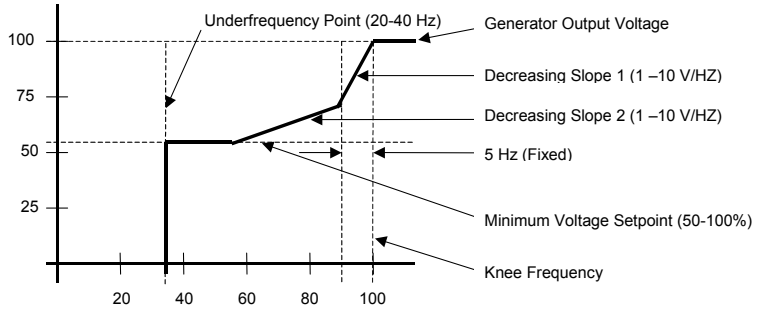
Refer to the service manual for complete guidance on how to provide the Line Drop Compensation function.

Underfrequency

The underfrequency characteristic is illustrated in Figure 2. The CDVR senses generator frequency. When generator frequency is below the selected Knee Frequency setpoint, the voltage setpoint is automatically adjusted so that generator voltage follows a programmed curve based on generator frequency. When generator frequency is between the Knee Frequency and Knee Frequency minus 5 hertz, operation is determined by the Slope 1 setting. When generator frequency is between the Knee Frequency minus 5 hertz and the Underfrequency Point, operation is determined by the Slope 2 setting down to the Minimum Voltage Setpoint. When generator frequency is below the Underfrequency Point, excitation is removed.

Knee Frequency is adjustable from 45 to 65Hz. Slope 1 is adjustable from 1 to 10 PU V/Hz. Slope 2 is adjustable from 1 to 10 PU V/Hz. The Underfrequency Point is adjustable from 20 to 40Hz. The Minimum Voltage Setpoint is adjustable from 50 to 100% of rated generator voltage.

Regulation Characteristic – Figure 2



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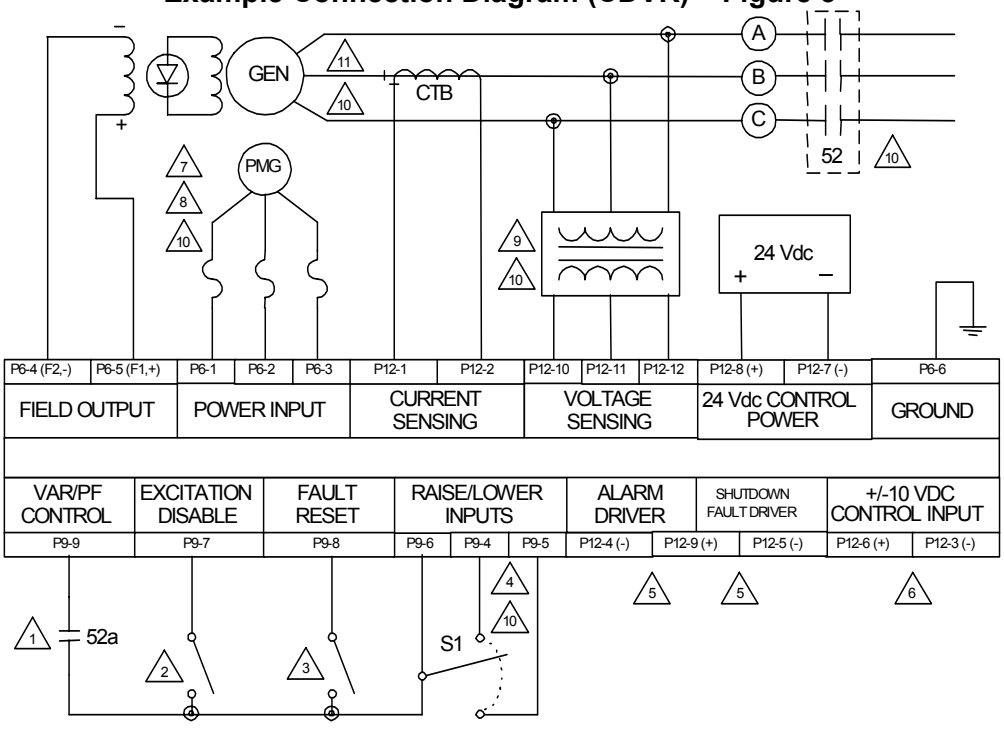
Protection

The CDVR provides standard ten protective functions for the generator:

- Generator Overvoltage
- Generator Undervoltage
- Loss of Excitation
- Instantaneous Field Overcurrent
- Over Excitation
- Loss of Sensing
- Diode Fault Monitor
- Internal Watchdog Failure
- Internal Memory Failure
- Fault Reset Closed Too Long

Example Regulator Connection

Example Connection Diagram (CDVR) – Figure 3



1. Required only for Var/PF control. Var/PF is active with 52a closed, inactive with 52a open.
2. Excitation is disabled when closed, enabled when open.
3. Momentary closure resets any shutdown fault.
4. S1 (SPDT, spring-return to center-off position) adjusts regulator setpoint.
5. Normally-off, turns on for user alarm or trip.
6. Analog input voltage between -10 and +10 Vdc provides adjustment of operating setpoint.
7. External fuses should be sized to match the PMG and protect the field. Maximum fuse size should be limited to Bussmann type KTK-12 or equivalent.
8. Three-phase PMG is shown. For single-phase PMG, omit P6-3 connection.
9. Sensing potential transformer is required if line voltage exceeds 660 Vac.
10. Item not supplied by Caterpillar.
11. When generator rotation is ACB, the connections shown for CTB should be reversed.

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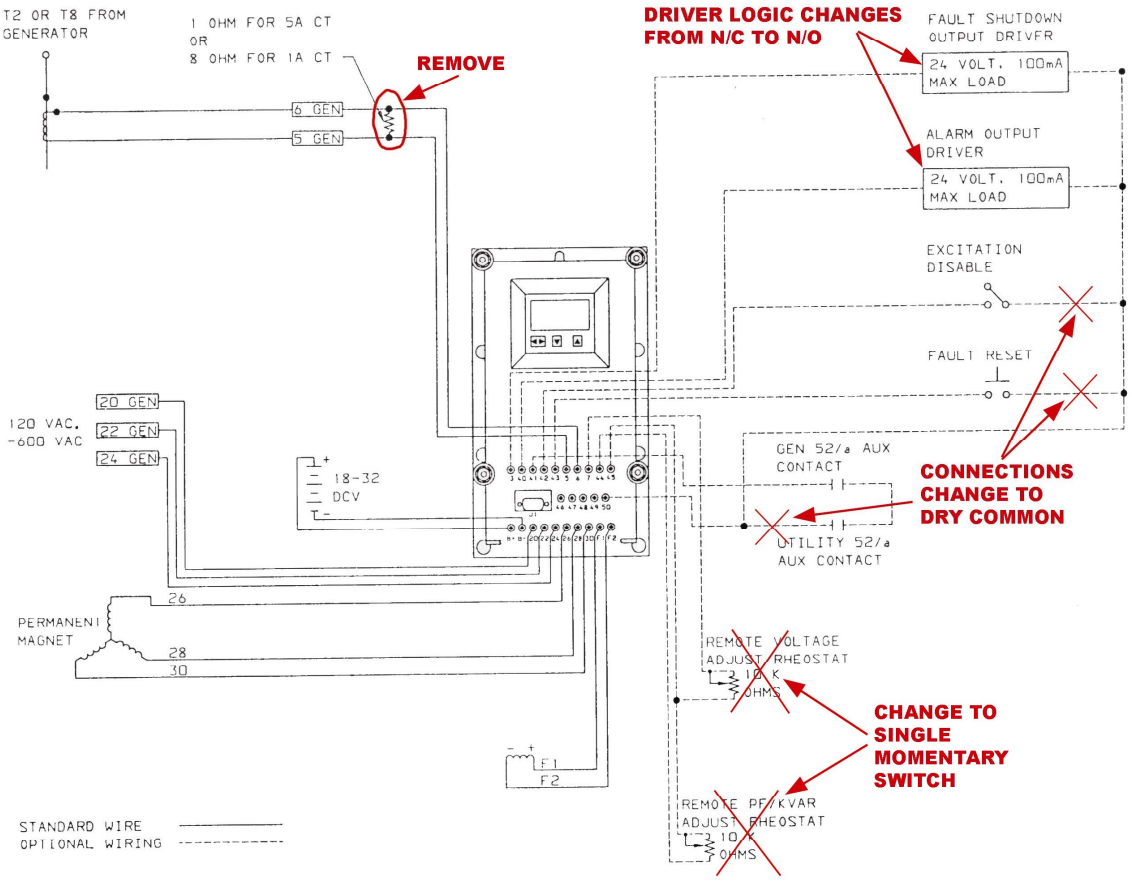
Interface Changes required by the CDVR



1. The 1Ω droop resistor is not required with the CDVR.
2. The driver logic for the fault alarm and shutdown drivers changes from active low (output is normally pulled low and will float to +24VDC when a fault occurs) to active high (output turns on +24VDC when the fault occurs). For those installations using this function, the relay logic will be reversed. With the current CDVR, a relay wired into the output would normally be energized, and would de-energize on an alarm or shutdown. With the CDVR, the relay would normally be de-energized, and would energize on an alarm or shutdown.
3. The VAR/PF enable, fault reset, and excitation disable inputs change from +24VDC for enabling the function to a normally open dry contact to enable the function.
4. The remote voltage adjust and remote VAR/PF adjust change from a 10Ω potentiometer to a single momentary switch with raise/lower contacts.

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SPECIFICATIONS

General Specifications	
Voltage Regulation	± 0.25% no load to full load
Temperature Drift	± 1.0% for a 40°C change
Response Time	Maximum of 10 milliseconds
Variable Sensing Range	90 to 600 Volts
Control Power	24Vdc Supply (18 to 30Vdc, 5VA)
Regulator Filtering	THF 3% per IEC34-1 TIF of 50 NEMA MG1-22.43
Harmonic Tolerance	0.5% Voltage regulation with 40% THD
Power Dissipation	55W max
Weight	1.47 kg (3.25 lb)
Environmental	
Operating Temperature	-40°C to 70°C (-40°F to 158°F)
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Relative Humidity	95% non-condensing 30°C to 60°C
Salt Spray	5% for 48 hrs at 38°C at 115% nominal operating voltage
Vibration	4.5G (peak) 18-2000Hz in 3 perpendicular planes
Shock	20G
Certifications	
CE Marked	
UL Recognized	
CSA Approved	

ADDITIONAL RESOURCES

Additional information on the CDVR operation, optional equipment, and specifications can be found as part of the following resources:

Spec Sheet: LEHE3225
Service Manual: RENR7941

SIS Web Download

Navigate to https://sis.cat.com
Navigate to "Downloads"
Scroll to "Additional Downloads" to see examples of existing files being distributed via SIS Web.
File Title**: CDVR PC Software**
File Description**:** The CDVR PC software is used to configure the CDVR's settings and parameters and allows the customer to read status indicators and metering.
Support Line: The phone number for the Dealer Support Network (DSN) is 309-636-8500.

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