marathon® Generators

DVR®2400 and DVR®2500 Digital Voltage Regulator

Installation, Operation and Maintenance Manual

Regal Beloit America, Inc.
100 East Randolph Street
Wausau, WI 54402-8003
www.regalbeloit.com/Brands/
Marathon-Generators

FORM
SB0056E
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GENERAL SAFETY INSTRUCTIONS

Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, and safety notice statements. To reduce risk of personal injury, death and/or property damage, follow all instructions for proper generator installation, operation and maintenance.

Although you should read and follow these instructions, they are not intended as a complete list of all details for installations, operation, and maintenance. If you have any questions concerning any of the procedures, or if you have a safety concern not covered by the instructions, STOP, and contact the generator manufacturer.

DEFINITION: The word Generator, as used in this publication, includes only the products of Regal Beloit America, Inc., and does not include the prime mover or any of the prime mover related systems or accessories.

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

EXPLOSION HAZARD

- Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

ROTATING PARTS HAZARD

- Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

OVERSPEED HAZARD

- Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

DO NOT DISASSEMBLE

- Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and voltage regulators. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING

MAGNETIC FIELD HAZARD

- Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which could cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

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GENERAL

OVERVIEW

This manual provides details on how to install, operate and maintain a DVR®2400 or DVR®2500 digital voltage regulator with Marathon® synchronous generators. A separate publication is available for Controller Area Network (CAN) communications.

The regulator is a control device that regulates the output voltage of a brushless, AC generator by controlling the current into the generator exciter field. Input power to the regulator is derived from a single phase permanent magnet generator (PMG).

The regulator is supplied in an encapsulated package designed for behind-the-panel mounting. It is held in place by thread-forming screws that thread into mounting holes in the face of the regulator. The front panel display annunciates regulator status and system conditions.

MANUAL CONVENTIONS

This manual describes details of the DVR®2400 and DVR®2500 voltage regulators. Features that are exclusive to the DVR®2500 regulator are noted.

REGULATION MODES

Five regulation modes:

- Single phase automatic voltage regulation (AVR1)
- Three phase automatic voltage regulation (AVR3)
- Field current regulation (FCR).
- Reactive power regulation (VAR)
- Power factor regulation (PF)

FEATURES

The DVR® regulator has the following features:

- Preset stability settings based on generator frame size
- Adjustable soft start in AVR1 or AVR3 regulation modes
- Under frequency (Volts/Hertz) regulation
- True RMS Three-phase or single-phase generator voltage sensing
- True RMS current sensing, single phase on the 2400, three phase on the 2500; (optional CT's required)
- True RMS power metering, single phase on the 2400, three phase on the 2500; (optional CT's required)
- Field current sensing
- Contact inputs for system interface capability
- Contact output for fault indication
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Front-panel human-machine interface (HMI) for status and configuration
- MODBUS protocol via USB2.0 for external communication
- DVRPortal™ software for configuration and monitoring
- "Power on" LED indicator
- Configurable auxiliary input for metering and control
- Simulated reactive power for droop set-up
- CAN interface with CAN 2.0B J1939 protocol for metering and control (2500)
- Generator power limiting mode (2500)
- Configurable Parameter Presets selectable through digital inputs (2500)
- 8 Channel 3-wire PT100 RTD metering (2500) through an external module

PROTECTION

The DVR® regulator has the following protection features:

- Field Over Excitation Shutdown
- Field Under Excitation Shutdown
- Generator Over Voltage Shutdown
- Generator Under Voltage Shutdown
- Generator Voltage Imbalance Shutdown
- Generator Reverse Power Shutdown
- Loss of Generator Sensing Shutdown
- Instantaneous Field Over Current Shutdown
- Regulator Over Temperature Shutdown
- Generator Parallel Start-Up Shutdown
- Generator Parallel Shutdown Shutdown
- RTD Over Temperature Shutdown (2500)
- Loss of CAN Communication Alarm (2500)
- RTD Pre Alarm Temperature (2500)
- Loss of Aux Input Control Current Alarm (2500)
- Loss of RTD Element -Open Alarm (2500)
- Loss of RTD Element - Short Alarm (2500)
- Genset Battery Low Alarm (2500)

LIMITERS

- Exciter Field Current Limit
- Generator Under Frequency Limit
- Generator Power Limit (2500)

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SPECIFICATIONS

OPERATING POWER

PMG Input:	
Type:	1-phase, ungrounded PMG
Range:	180 - 240 Vac, 250 - 300 Hz
Burden:	350 VA
Fuse Type:	Time delay 250V - 5.0 A
Terminals:	3, 4

GENERATOR VOLTAGE SENSING

Type:	1-phase/3-phase
Range:	100 to 600 Vac, 50/60 Hz
Burden:	<1 VA per phase
Terminals:	E1, E2, E3

GENERATOR CURRENT SENSING

Type:	1-phase (Bø) (2400) / 3-phase (2500)
Rating:	5 Aac continuous, 50/60Hz
Input Impedance:	<10 mΩ
Terminals:	IB1, IB2 for 1-phase (BØ)
	IA1, IA2 for 3-phase (AØ) (2500)
	IC1, IC2 for 3-phase (CØ) (2500)

BATTERY INPUT (DVR 2500 REGULATOR)

Type:	DC
Range:	12 - 24 Vdc
Burden:	10 VA
Terminals:	P2-12 (BT+), P2-13 (BT-)

CONTACT INPUTS

Type:	Dry Contact
Input PU Voltage:	3.3 Vdc
Source Current:	up to 5mA DC
Terminals:	
EXCITATION_OFF:	P1-6 (EXC), P1-11 (DG)
UP:	P1-7 (UP), P1-11 (DG)
DOWN:	P1-8 (DN), P1-11 (DG)
DROOP_OFF:	P1-9 (DRP), P1-11 (DG)
VAR/PF_OFF:	P1-10 (QPF), P1-11 (DG)
DVR® RESET:	P2-6 (RST), P2-10 (DG) (2500)
PS0 (Presets):	P2-7 (PS0), P2-10 (DG) (2500)
PS1 (Presets):	P2-8 (PS1), P2-10 (DG) (2500)

FAULT CONTACT OUTPUT

Type:	Form C
Carry Current:	7 Aac/5 Adc continuous
Break Current:	7 Aac / 0.1 Adc
Operating Voltage:	240 Vac / 30 Vdc maximum
Terminals:	P1-12 (NO), P1-13 (COM), P1-14 (NC)

FIELD OUTPUT

Continuous Rating:	100 Vdc, 4.0 Adc
10 Second Forcing Rating	
200 Vac Power Input:	190 Vdc, 7.5 Adc
Field Resistance:	15 to 35 Ω
Terminals:	F+, F-

AVR1 and AVR3 OPERATING MODES

Range:	100.0 to 630.0 Vac
Voltage Regulation:	±0.25 % over load range at rated power factor and constant generator frequency.
Temperature Drift:	±0.0125 % per degree C
Soft-Start Range:	2 to 120 seconds
Under frequency (V/Hz)	
Under Frequency Slope:	1.00 to 5.00 PU
Under Frequency Knee:	40.0 to 70.0 Hz

FCR OPERATING MODE

Range:	0.000 to 4.000 Adc
Current Regulation:	±1.0% over 15 to 35 Ohms of exciter resistance
Temperature Drift:	±0.0125% per degree C
Setpoint Integration Time:	0.0 to 15.0 seconds

VAR OPERATING MODE

Range:	-100.0% to +100.0% of rated kVAR
VAR Regulation:	±3.0 % of rated kVAR
Temperature Drift:	±0.0125 % per degree C

PF OPERATING MODE

Range:	-0.600 to +0.600 PU
PF Regulation:	±0.02 PU
Temperature Drift:	±0.0125 % per degree C

PARALLEL COMPENSATION

Modes:	Reactive droop and reactive differential (cross-current)
Droop Range:	0.0 to 10.0 %

PC COMMUNICATION PORT

Interface:	USB 2.0
Connector:	Mini B type (HMI/front panel access)

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CAN COMMUNICATION PORT (2500)

Connector:	P2-14 (TR), 16 (CH), 17 (CL), 18 (CG)
Protocol:	SAE J1939
Data Rate:	250 kbits/sec

AUXILIARY INPUT

Auxiliary – Control1 Mode

AVR3, AVR1, VAR or PF regulation:

Voltage Range:	-3.00 Vdc to +3.00 Vdc -10.00 Vdc to +10.00 Vdc (2500)
Set Point Range:	-X to +X % shift where X = 1.0 to 30.0
Burden:	2260 Ω
Terminals:	P1-4 (AU+), P1-5 (AU-)

FCR regulation:

Voltage Range:	0.000 Vdc to +4.000 Vdc
Set Point Range:	0.000 Adc to + 4.000 Adc
Increment:	1 mA per 1mV
Burden:	2260 Ω
Terminal:	P1-4 (AU+), P1-5 (AU-)

Auxiliary – Control2 Mode (2500):

AVR3, AVR1, VAR or PF regulation

Current Range	4 mA to 20 mA
Set Point Range:	-X to +X % shift where X = 1.0 to 30.0
Burden:	250 Ω
Terminals:	P1-4 (AU+), P1-5 (AU-)
Jumper:	P1-3 (A_L) to P1-4 (AU-)

FCR regulation

Current Range	4 mA to 20 mA
Set Point Range:	0.000 Adc to + 4.000 Adc
Increment:	1 mA per 2.0 uA
Burden:	250 Ω
Terminal:	P1-4 (AU+), P1-5 (AU-)
Jumper:	P1-3 (A_L) to P1-4 (AU-)

Dynamic Under-Frequency (UF) Slope Modifier

(AVR1 and AVR3 modes) (2500)

Voltage Range:	0.00 Vdc to +5.00 Vdc
UF Slope Range:	0.0 to 5.0
Increment:	0.8 PU slope per 1.00 V
Burden:	2260 Ω
Terminals:	P1-4 (AU+), P1-5 (AU-)

METERING

Accuracy of all metering values assumes 25° C, 50/60 Hz and less than 20 % THD.

Regulator-side Metering

Generator Voltage

Range:	10 Vac to 600 Vac
Resolution:	0.1V
Accuracy:	0.5 %

Generator Current

Range:	0.1 to 5.000 Aac (5 Aac CTs)
Accuracy:	0.5 %

Power (Apparent, Real and Reactive)

Range:	0 to 5200 VA and W 0 to 4160 VAR leading/lagging
Accuracy:	3.0 %

Power Factor

Range:	0.6 to 1.0 leading/lagging
Accuracy:	0.02

Frequency

Range:	40 to 75 Hz
Accuracy:	0.2 Hz

Field Current

Range:	0 to 8.0 Adc
Accuracy:	0.5 %

Generator-side (Scaled) Metering

Generator Voltage

Range:	10 V to 15 kV
Accuracy:	0.5 %

Generator Current

Range:	0.1 to 5,000 Aac (5 Aac CTs)
Accuracy:	0.5 %

Power (Apparent, Real and Reactive)

Range:	0 to 10 MVA and MW 0 to 8 MVAR leading/lagging
Accuracy:	3.0 %

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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
Ingress Protection:	IP52 (Front, mounted)
	IP10 (rear with cover)

ENVIRONMENTAL TESTS

Humidity:	Tested per MIL-STD-705B, Method 711-D in vertically mounted position
Salt Fog:	Tested per MIL-STD-810F Method 509 in vertically mounted position

ELECTROMAGNETIC COMPATIBILITY

Immunity: Meets EN 61000-6-2: 2005 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments

Emission: Meets EN 61000-6-4: 2007 Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments

Electromagnetic Compatibility Tests

Immunity

Electrostatic Discharge (ESD):	IEC 61000-4-2
Radiated RF:	IEC 61000-4-3
Electrical Fast Transient (EFT) / Burst:	IEC 61000-4-4
Conducted RF:	IEC 61000-4-6
Power Frequency and Magnetic Field:	IEC 61000-4-8

Emission

Radiated RF: EN 61000-6-4: 2007, 30 MHz to 1000 MHz

SAE J1113-11:2007 (2500) (BT+ & BT- Terminals)
Immunity to conducted transients on power leads.
Pulse 1c, 2a, 2b, 3A, 3B, 4 and 5a

MECHANICAL TESTS

Shock:	20 Gs in 3 perpendicular planes
Vibration:	2.5 Gs at 5 to 26 Hz
	0.050" double amplitude (27 to 52 Hz)
	7 Gs at 53 to 500 Hz

PHYSICAL

Weight:	3.5 lb. (1590 g)

MATING CONNECTORS

H1:

Mating Plug Housing:	P1, Phoenix®* Contact 1873320 or equivalent

H2:

Mating Plug Housing:	P2, Phoenix* Contact 1707942 or equivalent

USB:

Mating Cable:	Molex®* Connector 88732-8900 or equivalent
Maximum Length:	3 meters

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⚠ WARNING

Before proceeding forward, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual. Failure to do so could cause severe injury, death, and/or equipment damage.

FEATURES AND PROTECTION

INTRODUCTION

This section describes how the regulator functions and explains its operating features. Regulator functions are illustrated in the block diagram of Figure 4-1.

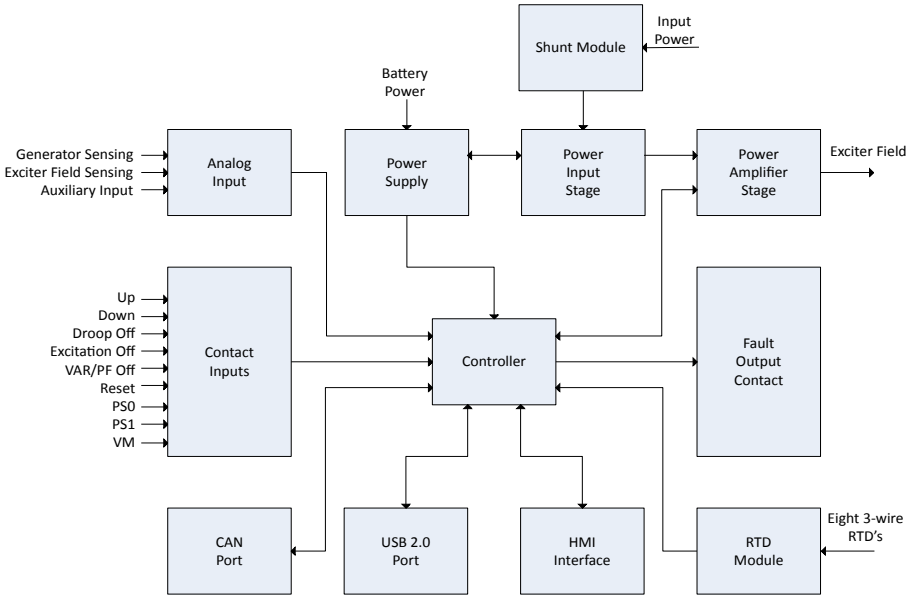


Figure 4-1. Simplified Block Design

DVR® REGULATOR FUNCTION BLOCKS

The following paragraphs describe each of the function blocks, inputs and outputs. Refer to Figure 4-1.

Generator Voltage

Generator voltage is measured at terminals E1 (A-phase), E2 (B-phase), and E3 (C-phase), for ABC rotation, or E1 (C-phase), E2 (B-phase), and E3 (A-phase) for CBA rotation. Nominal voltages of up to 600Vac may be sensed at these terminals. Voltage applied to these inputs is scaled, conditioned and applied to the controller.

Line Currents

Generator line currents (IA, IB, IC) are measured via CTs at connectors P1 and P2. Current up to 5 Arms may be monitored at these terminals. These currents are scaled, conditioned and applied to the controller. Refer to Section - Specifications, for connector pin assignments.

Field Current

Current through the exciter field winding is measured at terminal F+. Field current is scaled, conditioned and applied to the input of the controller.

Contact Input Circuits

Nine contact input circuits powered from an internal 3.3 Vdc supply provide input control from user-supplied contacts: UP, DOWN, DROOP_OFF, EXCITATION_OFF, VAR/PF_OFF, *PS0, *PS1, *DVR_RESET and *VM (*2500 only)

UP

Closing the UP contact across terminals P1-7 (UP) and P1-11 (DG) causes the active operating set point to increase.

DOWN

Closing the DOWN contact across terminals P1-8 (DN) and P1-11 (DG) causes the active operating set point to decrease.

Keeping either contact closed will continue to increase (UP) or decrease (DOWN) the operating set point until a limit is reached. The limit is determined by the Maximum External Contact Adjust field of DVRPortal™ software. The effect generated by the contacts is displayed in DVRPortal™ software on the Set Points Tab as the value "Contact Offset."

Note:

1. The regulator incorporates an adjustable ramp rate for UP/DOWN contacts. This value can be used to adjust ramp rate at which the setpoint changes when a UP or DOWN contact is closed. This can be adjusted from 0.1 %/sec to 15.0 %/Sec.
2. The regulator incorporates a RETAIN/ RESET feature for external contact adjust (UP and DOWN) which allows the regulator to either save (RETAIN) the offset caused by UP or DOWN contact or forget (RESET) the offset after power cycle. This feature is only enabled in AVR1/AVR3 modes. Refer to Section 8 - Graphical User Interface, Digital I/O.
3. In FCR mode, UP/DOWN contact can be used to adjust the field current between 0 and 4.000 Adc. Maximum external contact adjust setting is not applicable in FCR mode.

Note: Saving the offset will happen once the UP/DOWN contact change is detected and the the regulator is in AVR1/AVR3 mode.

DROOP_OFF

This function enables reactive load sharing between generators operating in parallel. Closing the DROOP_OFF contact across terminals P1-9 (DRP) and P1-11 (DG) disables voltage droop. Opening the contact enables voltage droop. Reactivate load sharing is enabled in AVR1, AVR3, PF and VAR regulation modes through this contact. Ensure that QPF contact sets the VAR/PF regulation to disable.

EXCITATION_OFF

This contact input disables field excitation without removing power to the regulator. Closing the EXCITATION_OFF contact across terminals P1-6 (EXC) and P1-11 (DG) disables field excitation. Opening the contact enables field excitation with a soft start and clears any alarms or faults.

VAR/PF_OFF

Caution: Operation in VAR or PF modes should only be enabled when generator is paralleled with utility (infinite bus).

This function enables VAR or PF regulation when the generator is paralleled to utility. Opening the VAR/PF_OFF contact across terminals P1-10 (QPF) and P1-11 (DG) enables VAR or PF control. Closing the contact disables VAR or PF regulation and defaults to AVR3 regulation.

Note: DROOP OFF, EXCITATION OFF and VAR/PF OFF polarity can be configured using DVRPortal™ software. By default, these are set to active low. Polarities of these contacts can be set only in Preset 1 in case of the 2500. Refer to Section - Graphical User Interface, Digital I/O.

PS0 & PS1:

The DVR®2500 voltage regulator provides the ability for the user to select one of the four available configurations in the regulator. This is achieved by changing the contact inputs P2-7 (PS0) and P2-8 (PS1) with respect to P2-10 (DG).

PS1	PS0	Preset
Open	Open	Preset1
Open	Closed	Preset2
Closed	Open	Preset3
Closed	Closed	Preset4

Note: Changes will only take effect when in standby mode.

DVR_RESET:

The DVR®2500 voltage regulator provides the ability for user to reset the regulator without requiring a power cycle by toggling the RESET contact across terminals P2-6 (RST) and P2-10 (DG).

Communication Port (USB 2.0)

The communication port provides an interface for user programming the regulator through DVRPortal™ software. The connection is made to the female USB mini B type connector with a user-supplied, standard USB 2.0 A to mini B type USB cable.

Note:

A. The DVR®2500 voltage regulator can be programmed through the USB connection without additional power provided by an AC supply or a battery (2500).
   Note: Power ON LED or HMI will not be illuminated
B. USB port should be able to provide 400mAdc current while powering only through the USB.
C. In case of using USB extender/booster cable, the regulator needs to be powered either through AC power or battery (2500). Recommended USB 2.0 booster cable GUE2118 or similar.
D. In order for the regulator to communicate properly via USB, proper USB drivers need to be installed. Driver is typically installed during DVRPortal™ software installation. This can be downloaded from the following link http://www.ftdichip.com/Drivers/VCP.htm for FT232 chipset.
E. Use of USB hubs is not recommended for communication purposes.

CAN Port (2500)

The CAN port provides an isolated interface for communication and control of the regulator. This permits the integration of the regulator as a node on a CAN network. The connection is made to the P2-14 (TR), 16 (CH), 17(CL) 18 (CG) terminals. The CAN communication is powered from an on-board isolated supply.

Note: Jumpering terminals CL and TR will provide an internal terminating resistor of 120 ohms.

Controller

The controller portion of the regulator includes the microprocessor and performs measurement, computation, control and communication functions.

Power Input Stage

Input power is applied to terminals 3 and 4 from a PMG. It is rectified and filtered before being applied to the power amplifier and the power supply.

Power Supply

The internal switch-mode power supply is fed from the power input stage and supplies power at the required DC voltage levels to the internal circuitry of the regulator.

Note: Sudden loss of excitation power could lead to the 2500 RESET even though battery voltage is present.

Power Amplifier Stage

The power amplifier is fed from the power input stage and supplies a controlled amount of power to the exciter field via terminals F+ and F-.

HMI Interface

A four-character light-emitting-diode (LED) display indicates various operating modes, protective functions, and adjustments. Section - Human-Machine Interface provides more information about the front panel display. Changes to settings can be made at the front panel using the four buttons:

- SELECT, UP, DOWN and ENTER
  Refer to Section - Human-Machine Interface for more information about the front panel switches.

- RTD Module (2500):
  An eight (8) three-wire RTD interface to the 2500 can be provided through the RTD module. This module is interfaced to the J2 connector on the regulator via a DB25 cable. Refer to Section - Auxiliary Modules for more information about RTD protection configuration.

Fault Output Contact

A fault output contact is provided through terminals P1-12, P1-13 and -P1-14. This Form-C relay closes contacts between P1-12 and P1-13 or opens contacts between P1-13 and P1-14 in the event of a protective shutdown.

DVR® REGULATOR OPERATING FEATURES

REGULATION MODES

The 2400 and 2500 provide five modes of regulation selectable through the HMI or through the DVRPortal™ software.

Automatic Voltage Regulation Modes (AVR)

There are two automatic voltage regulation modes. AVR1 should be selected if the regulator is connected for single phase voltage sensing and AVR3 should be selected if the regulator is connected for three phase voltage sensing. In either mode, the regulator regulates the generator RMS output voltage. Regulation is accomplished by sensing generator output voltage and adjusting dc output excitation current to maintain voltage at the regulation set point. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or DVRPortal™ software. The Droop and Under Frequency functions may influence the regulation set point.

Field Current Regulation Mode (FCR)

In FCR mode, the regulator maintains DC excitation current at a commanded level. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or the portal.

Reactive Power Regulation Mode (VAR)

In Reactive Power Regulation (VAR) mode, the regulator maintains the generator's reactive power at a commanded level. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or the portal. This mode can only be entered by selecting "VAR" as the regulation mode and opening the VAR/PF_OFF contact input.

Power Factor Regulation Mode (PF)

In Power Factor Regulation (PF) mode, the regulator maintains the generator's power factor at a commanded level. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or the portal. This mode can only be entered by selecting "PF" as the regulation mode and opening the VAR/PF_OFF contact input.

AUXILIARY INPUT

Note: If the DC voltage is removed from the auxiliary input, the operating set point will no longer be modified and the regulator will regulate to the programmed regulation set point.

Functionality of the auxiliary input is dependent on the configuration of the modes described below. The auxiliary input can be set to Off, Control1, Control2 or Dynamic Slope mode through the HMI or the DVRPortal™ software. The effect of the auxiliary input on the set point is displayed in DVRPortal™ software.

Auxiliary – Off

In this mode, any signal applied to the auxiliary input will be displayed in DVRPortal™ software, but will have no effect on the set point of the regulator.

Auxiliary – Control1

This mode allows modification of the regulation set point by the application of a positive or negative DC voltage across terminals P1-4 (AU+) and P1-5 (AU-). A voltage up to +/- 3 Vdc may be applied at this input.
Note: The 2500 provides selectable ranges of +/-5 Vdc or +/-10 Vdc through DVRPortal™ software and configurable range up to 30%. These ranges are selectable only for AVR1, AVR3, VAR of PF regulation modes.

When in AVR3 or AVR1:
The application of a +/- 3.000 Vdc signal corresponds to a percentage offset of up to +/- 30.0% to the set point. If the voltage range is selected as +/-10V in the 2500, the application of a +/-10.000 signal will correspond to a percentage offset of up to +/-30% to the set point.

Example: A programmed regulation set point of 480 Vrms, with an auxiliary input scale factor of 30% and an auxiliary input of -1 Vdc will result in a -10% (–48 Vrms) offset to the set point. Therefore, the regulator will regulate to a reference voltage of 432 Vrms.

When in FCR:
The application of a -/+ 4.000 Vdc signal corresponds to a 0.000 to +4.000 Adc field current set point. The auxiliary input scale factor is disabled in FCR mode.

Note: Any field current reference less than 0.000 Adc will become 0.000 Adc.

Example: The application of a 1.25 Vdc signal will result in a field current of 1.250 Adc.

When in VAR:
The application of a +/- 3.000 Vdc signal corresponds to a percentage offset of up to +/- 30.0% to the VAR set point.

Example: A programmed VAR regulation set point of 50.0% with an auxiliary input scale factor of 30.0% and an auxiliary input of -1 Vdc will result in a –10.0% offset to the VAR set point. Therefore, the regulator will regulate to 40.0% of rated VAR's.

When in PF:
The application of a +/- 3.000 Vdc signal corresponds to an offset of up to +/- 0.300 PU to the power factor set point.

Example: A programmed power factor regulation set point of 0.950 (lagging power factor) with an auxiliary input scale factor of 30.0% and an auxiliary input of -1 Vdc will result in a –0.100 offset to the power factor set point. Therefore, the regulator will regulate to a power factor of -0.950. In this case, the power factor has gone from a lagging to a leading state.

Auxiliary – Control2 (DVR®2500 regulator only)

This mode allows modification of the regulation set point by the application of a 4 mA to 20 mA current control signal at terminals P1-4 (AU+) and P1-5 (AU-). This mode requires the placement of a jumper across terminals P1-3 (A_L) and P1-4 (AU+).

Note: If loss of auxiliary control current alarm is enabled and if the sensed current is below the alarm threshold the auxiliary bias will be set to zero. If the alarm is disabled, the bias will saturate to lower end of the user chose bias limit.

When in AVR3 or AVR1:
The application of a 4 mA to 20 mA input corresponds to a percentage offset of up to +/- 30.0% to the voltage set point.

Example: A programmed regulation set point of 480 Vrms, with an auxiliary input scale factor of 30% and an auxiliary input of 9.33 mA will result in a –48 Vrms offset to the set point. Therefore, the regulator will regulate to a reference voltage of 432 Vrms.

When in FCR:
The application of a 4 mA to 20 mA signal corresponds to a 0.000 to +4.000 Adc field current set point. The auxiliary input scale factor is disabled in FCR mode.

Note: Any field current reference less than 0.000 Adc will become 0.000 Adc.

REGAL®

Example: A field current set point of 1.000 Adc with the application of a 11.00 mA signal will result in a total field current of 0.500 Adc.

When in VAR:
The application of a 4 mA to 20 mA signal corresponds to a percentage offset of up to +/- 30.0% to the VAR set point.

Example: A programmed VAR regulation set point of 50.0% with an auxiliary input scale factor of 30.0% and an auxiliary input of 9.33 mA will result in a –10.0% offset to the VAR set point. Therefore, the regulator will regulate to 40.0% of rated VARs.

When in PF:
In the PF regulation mode, the application of a 4 mA to 20 mA signal corresponds to an offset of up to +/- 0.300 PU to the power factor set point.

Example: A programmed power factor regulation set point of 0.950 (lagging power factor) with an auxiliary input scale factor of 30.0% and an auxiliary input of 9.33 mA will result in a –0.100 offset to the power factor set point. Therefore, the regulator will regulate to a power factor of -0.950. In this case, the power factor has gone from a lagging to a leading state.

Auxiliary - Dynamic Slope (DVR®2500 regulator only):
The 2500 regulator provides a mode in which an auxiliary voltage of 0 to +5V supplied between terminals P1-4 (AU+) and P1-5 (AU-) can be used to influence the under-frequency slope multiplier from 1.0 - 5.0 or 5.0 - 1.0 based on dynamic slope polarity while in AVR1 and AVR3 regulation modes. See Figure 4-2.

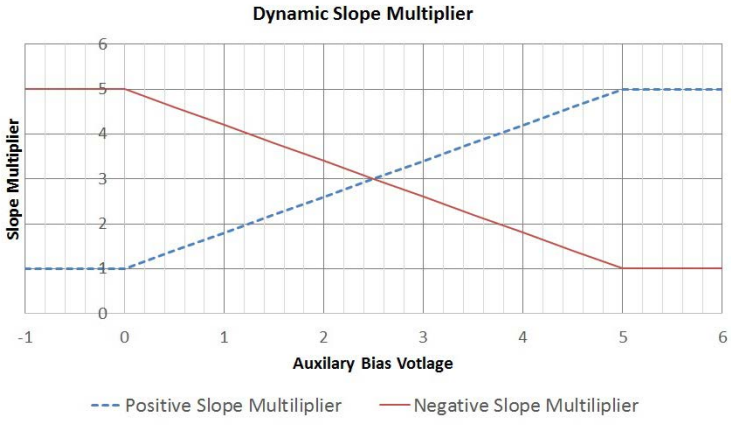


Figure 4-2. Dynamic Slope Multiplier

LOAD SHARING
Note: The machine nameplate rated power, rated power factor, CT Ratio and PT Ratio (if applicable) MUST be entered to calculate the proper rated reactive power for the droop reference.

The regulator provides a reactive droop compensation feature to enable reactive load sharing during parallel generator operation. When this feature is enabled, the regulator calculates the reactive portion of the generator load using the sensed generator output voltage and current quantities and then modifies the voltage regulation set point 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.

Droop is adjustable up to 10.0% with rated reactive power (VAR's) and rated power factor. The effect of droop on the set point is displayed in the DVRPortal™ software. The droop feature is enabled and disabled through the DROOP_OFF contact input circuit (terminals P1-9 (DRP) and P1-11 (GND). When single-phase current sensing is used, the droop function responds to phase B current. When three-phase current sensing is used, the droop function responds to the average phase current. Reactive load sharing in AVR1, AVR3, VAR and PF modes.

GENERATOR SOFT START
The regulator incorporates an adjustable soft start feature that controls the time for generator voltage to ramp to the regulation set point. This feature is enabled in AVR3 and AVR1 regulation modes. The ramp rate is adjustable from 2 to 120 seconds (default of 3 seconds). This adjustment is made through the portal and cannot be made through the HMI. The Generator Under Frequency feature is also active during Generator Soft Start and takes priority in control of the generator voltage.

⚠ WARNING

Before proceeding forward, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual. Failure to do so could cause severe injury, death, and/or equipment damage.

⚠ WARNING

Incorrect setting for the protective functions can harm the DVR regulator and the alternator and can cause severe injury, death, and/or equipment damage.

PROTECTION FUNCTIONS

CONFIGURABLE SHUTDOWNS

Protection Feature	Customer Disable/ Enable	Alarm Variable	Alarm Threshold Range	Alarm Reset Hysteresis	Threshold Units	Basis	Timer Range	Timer Units	Alarm Code	Fault Code
Field Over-excitation	No	Exciter Field Current	0.50 to 5.00	0.5 - 5.0	A	N/A	1.0 to 15.0	S	A008	F008
Field Under-excitation	Yes	Total Reactive Power	-100.0 to -5.0	0.0 - 5.0	%	Rated Reactive Power (kVAR)	1.0 to 15.0	S	A002	F002
Generator Over-voltage	No	AVR1: Generator Line-line Voltage AVR3: Average of Generator Line-line Voltage	5.0 to 20.0	0.0 - 5.0	%	Voltage Set-point	0.1 to 15.0	S	A013	F013
Generator Under-voltage	Yes		5.0 to 50.0	0.0 - 5.0	%	Voltage Set-point	1.0 to 15.0	S	A012	F012
Generator Voltage Imbalance	No	AVR1: Not Enabled AVR3: Difference of Max. & Min. Line-line voltage	20.0 to 35.0	0.0 - 5.0	%	AVR3: Average of Three Generator Line-line Voltages	1.0 to 15.0	S	A016	F016
Generator Loss of Sensing AVR1	Yes	Yes	10.0 - 40.0	N/A	%	Voltage Set Point	2X LOS AVR3 timer	mS	N/A	F011
Generator Loss of Sensing AVR3	Yes	Yes	20.0 - 35.0	N/A	%	Voltage Set Point	10 - 1000	mS	N/A	F011
Generator Reverse Power	Yes	Total Real Power	-5.0 to -100.0	5.0	%	Rated Power (kW)	1.0 to 15.0	S	A014	F014
RTD Over Temperature (1-8)	Yes	RTD Temperature	0 to 260	(0- 100) %	Deg C	N/A	0 to 3600	S	A005	F005

Table 4-2

NON CONFIGURABLE SHUTDOWNS

Protection Feature	Customer Disable/ Enable	Shutdown Variable	Shutdown Threshold	Threshold Units	Alarm Code	Fault Code
Instantaneous Field Over-current	No	Regulator Main Switch Current	11	A	N/A	F009
Regulator Over-temperature	No	DSP Core Temperature	150	Deg C	A007	F007
Generator Parallel Start-up	No	VAR/PF_OFF contact input	VAR/PF_OFF Inactive in STANDBY state *AND* VAR/PF Regulation mode	N/A	N/A	F004
Generator Parallel Shutdown	Yes	EXC_OFF contact input	VAR/PF_OFF Inactive *AND" EXC_OFF active in RUN.P state	N/A	N/A	F003

Table 4-3

CONFIGURABLE ALARMS

Alarm	Customer Disable/ Enable	Alarm Variable	Alarm Threshold Range	Reset Hysteresis	Threshold Units	Timer Range	Timer Units	Alarm Code
Genset Battery Low	Yes	Battery Voltage	10.5 - 13.0	N/A	V	N/A	N/A	A004
RTD Pre Alarm Temperature (1-8)	Yes	RTD temperature	0 to 260	(0-100) %	Deg C	(0- 3600)	S	A005
Loss of CAN	Yes	Time period between incoming CAN messages	No incoming CAN messages	N/A	N/A	1.0 to 45.0	S	A006
Loss of Aux Input Control Current	Yes	Auxiliary Input Current	0.002 - 0.004	N/A	A	N/A	N/A	A011

Table 4-4

NON-CONFIGURABLE ALARMS

Alarm	Customer Disable/ Enable	Alarm Variable	Alarm Threshold	Threshold Units	Alarm Code
Loss of RTD Element - Open	Yes	RTD Resistance	Greater Than 201.48	Ohm	A005
Loss of RTD Element - Short	Yes	RTD Resistance	Less than 69.87	Ohm	A005
Real Time Clock Battery Low	Yes	RTC Battery Voltage	Less than 2.5	V	A003

Table 4-5

CONFIGURABLE LIMITERS

Limiter	Customer Disable/Enable	Limit Variable	Limit Threshold	Limit Units	Limiter Code
Exciter Field Current Limit	No	Exciter Field Current	0.500 - 7.500	A	N/A
Power Limit of Generator Voltage	Yes	Generator Real Power	5.0 - 115.0	V	N/A
Under-frequency Limit of Generator Voltage	No	Generator Frequency	40.0 - 70.0	V	A015

Table 4-6

Note: When limits are active, no event is recorded in the event log.

Configurable Protection Shutdowns

All configurable protection features have a user-defined threshold, hysteresis and timer value. By default, all these protections are enabled, but some of the protections can be disabled by using ENABLE/DISABLE. If the threshold condition for a particular protection feature is met, an alarm is triggered. The regulator displays an alarm signal on the HMI and in the DVRPortal™ software. An independent timer starts at the moment the alarm condition is triggered. The regulator stays in alarm condition unless the measured value recovers to above or below hysteresis value depending on the protection function.

If the timer threshold is exceeded before the alarm condition is resolved, a fault is then triggered and the excitation current to the field is shut down. A fault signal is displayed on the HMI and in the portal. Refer to Section - DVR® Protection Functions for details of the timer-based protection features in the regulator.

Field Over Excitation Shutdown

The Field Over Excitation protection feature is triggered if the field current exceeds the threshold. The fault is triggered if the field current doesn't fall below the set hysteresis level within the timer period.

Field Under Excitation Shutdown

The Field Under Excitation protection feature is triggered if the absorbed VAR's exceeds the threshold. The fault is triggered if the absorbed VAR's do not fall below the hysteresis level within the timer period.

Generator Over Voltage Shutdown

The Generator Over Voltage protection feature is triggered if the generator voltage exceeds the threshold. The fault is triggered if the generator voltage does not fall below the hysteresis level within the timer period.

Generator Under Voltage Shutdown

The Generator Under Voltage protection feature is triggered if the generator voltage drops below the threshold. The fault is triggered if the generator voltage stays below the hysteresis level for the duration of the timer.

Generator Voltage Imbalance Shutdown

The Generator Voltage Imbalance protection feature is triggered if a voltage imbalance is detected in AVR3, VAR or PF regulation modes, imbalance difference between any single phase and the average of the three phases is more than the threshold is interpreted as a voltage imbalance. The fault is triggered if the voltage imbalance condition continues and the average voltage stays below the hysteresis level for the duration of the timer.

In AVR1 and FCR regulation modes, generator voltage imbalance protection is disabled.

Generator Reverse Power Shutdown

The Generator Reverse Power protection feature is triggered if generator reverse power exceeds the threshold. The fault is triggered if generator reverse power stays above the hysteresis level for the duration of the timer.

RTD Over Temperature (2500)

The RTD Over Temperature protection alarm is triggered if the measured RTD temperature exceeds the set threshold on a particular channel. The fault is triggered if RTD temperature stays above the hysteresis level for the duration of the timer. These over temperature protections can be enabled/disabled using ENABLE/DISABLE found under Thermal Protection tab in the DVRPortal™ software.

Loss of Generator Sensing Shutdown

The Loss of Generator Sensing protection feature is triggered if the sensed voltage difference between any single phase and the average of the three phase is more than the percentage threshold of the voltage setpoint. In AVR1 this protection is triggered if the voltage difference between line-line is more than the percentage threshold of the voltage setpoint.

There is no alarm for this condition – the fault and shutdown is triggered shortly after the condition is met and the timer expires.

Note: In AVR1, AVR3, VAR and PF regulation modes, Loss of Sensing is not enabled until a soft start is complete.

Non-Configurable Protection Shutdowns

Non-configurable protection features have factory-defined settings for thresholds and timers, if applicable. Each shutdown feature shown in Non-Configurable Shutdowns describes the details of the conditions for the shutdown event to occur. Refer to Section - DVR® Protection Functions for details of the timer-based protection features in the DVR® regulator.

Instantaneous Field Over Current Shutdown

The Instantaneous Field Over Current protection feature triggers a fault if generator field current exceeds 11 Adc. There is no alarm for this condition – the fault and shutdown is triggered shortly after the condition is met.

Regulator Over Temperature Shutdown

The Regulator Over Temperature protection feature is triggered if the internal regulator temperature exceeds a factory default alarm threshold. A fault is triggered if the regulator temperature exceeds a factory default shutdown threshold.

Generator Parallel Start Up Shutdown

The Generator Start Up Shutdown protection feature is triggered if the generator is started up in either VAR or PF regulation mode with the QPF contact active.

Generator Parallel Shutdown Shutdown

The Generator Parallel Shutdown protection feature is triggered if excitation is shut off using EXC contact input when the regulator is performing VAR or PF regulation.

Configurable Limiters

All configurable limiter features have a user-defined threshold value. By default, most of these are enabled, but can be disabled by using ENABLE/DISABLE (except UF and Field Current Limit). If the threshold condition for a particular limiter feature is met, an indicator is triggered in the portal. Refer Section - DVR® Protection Functions to for details of the limiters.

Generator Under Frequency (UF) Limit

The Generator Under Frequency Limit triggers if the generator frequency drops below the under frequency knee. The voltage set point is automatically adjusted by the regulator so that generator voltage follows the selected V/Hz curve. If generator frequency drops below cut-out frequency, the regulator will stop providing generator excitation and AC metering.

- For an under frequency knee between 40.0 and 50.0 Hz, the base slope is 1/50 (0.02) VPU/Hz
- For an under frequency knee between 50.1 and 60.0 Hz, the base slope is 1/60 (0.0167) VPU/Hz
- For an under frequency knee between 60.1 and 70.0 Hz, the base slope is 1/70 (0.0143) VPU/Hz

Where VPU = 1.0 at regulator voltage set point. The base slope is modified by the slope multiplier to achieve a desired voltage roll-off characteristic. See Figure 4-4 for examples.

To calculate resulting voltage dip:

Vdip = (Base Slope) *(Slope Multiplier) *(Operating Voltage) *(Hz dip below the knee point)

Example: 480V, 59 Hz knee, Slope = 2, 56 Hz output.
(0.0167) *(2) *(480V) *(3Hz) = 48.1V dip or 431.9V

Note: If generator frequency drops below a detectable level and generator speed is greater than run cut-in speed, a short circuit condition is assumed and the regulator will force current up to the Field Current Limit value (see Field Current Limiting).

The V/Hz slope is dependent upon the under frequency knee and the slope multiplier. The base slope is defined according to the following (see Figure 4-3).

Field Current Limiting

The Field Current Limit protection feature limits the amount of DC current that flows into the exciter. It is engaged if load conditions require a field current larger than the limit. Under such conditions, the current is limited to the Field Current Limit value which can be configured through DVRPortal™ software. The portal displays this alarm condition, no HMI indication.

Power Limiting Alarm

The Power Limit protection feature limits the amount of output power from the generator by modifying voltage to maintain constant output power at the limit. The portal displays this alarm condition, no HMI indication.

This limiter can be enabled or disabled in the Protection Settings Tab in portal under the Limits panel. The limiter dynamics (PID gains) can also be adjusted in the Operating Modes Tab in portal.

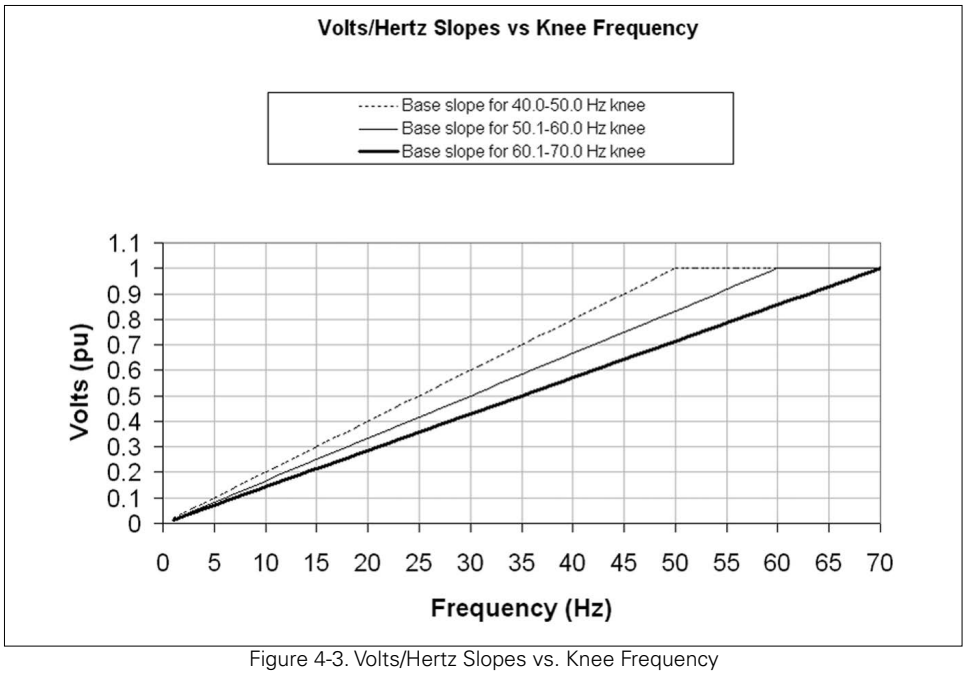


Figure 4-3. Volts/Hertz Slopes vs. Knee Frequency

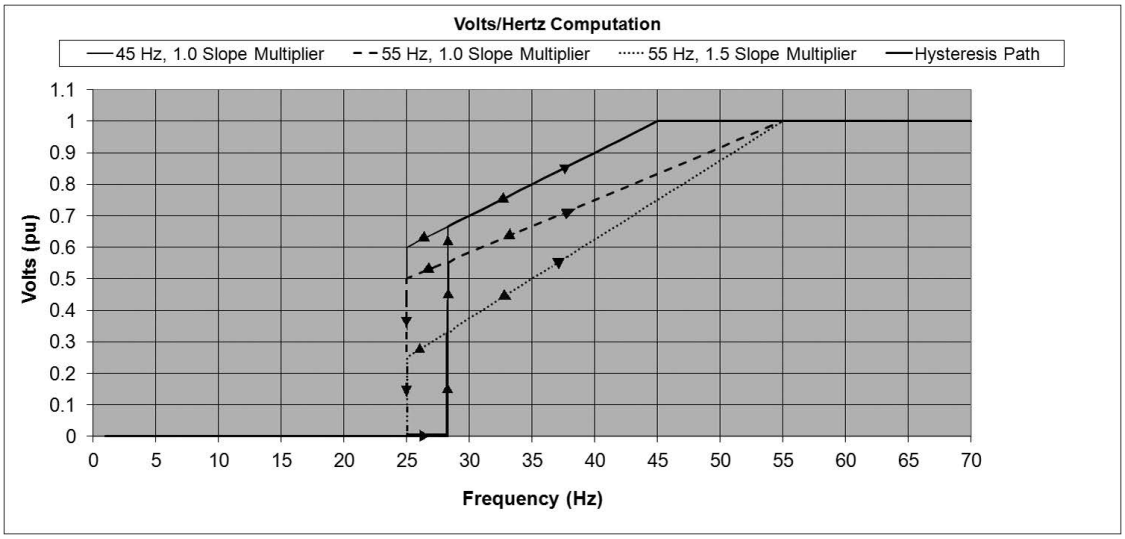


Figure 4-4. Examples of Under Frequency and Slope
Note: Arrows indicate hysteresis of cut-in and cut-out transitions between IDLE and RUN states.

Configurable Protection Alarms

Genset Battery Low Alarm

The Genset Battery Low Alarm is triggered if the measured battery voltage is less than factory defined threshold. The regulator stays in this condition until the battery voltage recovers above the threshold value. This alarm can be enabled or disabled using ENABLE/DISABLE under the protection tab in the DVRPortal™ software.

RTD Pre-Alarm Temperature Alarms

The RTD Pre-Alarm Temperature Alarms are triggered if the measured temperature of the RTD element is greater than the threshold and the set timer expired. The regulator stays in this alarm condition until the measured temperature is below the set alarm hysteresis level. These Pre-Alarms can be enabled/ disabled using ENABLE/DISABLE found under Thermal Protection tab in the portal.

Loss of CAN Communication Alarm

The Loss of CAN Communication protection feature indicates an alarm if communication traffic between the regulator and any Electronic Control Unit (ECU) on the CAN bus is lost. The alarm is triggered if the regulator does not receive a "VR Heartbeat" message within the threshold time. Refer to the DVR®2500 CAN Bus Interface User Guide for details.

Loss of AUX Input Control Current

The Loss of AUX Input Control Current is triggered if the measured control current in AUX Control Mode 2 falls below the user set threshold value mentioned in Configurable Alarms. This alarm can be enabled or disabled using ENABLE/DISABLE under the protection tab in the portal.

Note: If loss of auxiliary control current alarm is enabled and if the sensed current is below the alarm threshold, the auxiliary bias will be set to zero.

Non Configurable Protection Alarms

Loss of RTD Element - Open Alarms

The loss of RTD element open alarm is triggered if the measured RTD element resistance is greater than factory defined threshold. The regulator latches this alarm and stays in this condition until the measured resistance is within the measurable range of the regulator after power cycling. These Loss of RTD Element Alarms can be enabled/disabled using ENABLE/DISABLE found under Thermal Protection tab in the portal.

Note:

1. If the regulator detects an open circuit RTD, the metering for that channel would be saturated to 500°C.
2. If RTDs are not connected to the regulator, the metering would read -200°C for all channels.
3. The regulator detects an open circuit only if either '+' or ' -' terminals are open. If the "C" terminal is open, the regulator saturates to -200°C.

Loss of RTD Element - Short Alarms:

The loss of RTD element short alarm is triggered if the measured RTD element resistance is less than factory defined threshold. The regulator latches this alarm and stays in this condition until the measured resistance is within the measurable range of the regulator after power cycling. These Loss of RTD Element Alarms can be enabled/disabled using ENABLE/DISABLE found under Thermal Protection tab in the portal.

Note:

1. If the regulator detects a short circuit RTD, the metering for that channel would be saturated to -200°C.
2. The regulator detects a short circuit only if '+' and ' -' terminals are short.

Real Time Clock Battery Low Alarm:

The Real Time Clock (RTC) Battery Low Alarm is triggered if the measured RTC battery voltage is less than factory defined threshold. The regulator stays in this condition until the battery voltage recovers above the threshold value. This alarm can be enabled or disabled using ENABLE/DISABLE under the protection tab in the portal.

Note: The battery alarm is cleared once the measured battery voltage is above factory set threshold on power-up.

INSTALLATION

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

EXPLOSION HAZARD

- Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

ROTATING PARTS HAZARD

- Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

OVERSPEED HAZARD

- Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

DO NOT DISASSEMBLE

- Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and voltage regulators. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING

MAGNETIC FIELD HAZARD

- Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which could cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

GENERAL

Generally, the DVR® voltage regulator is supplied mounted to the conduit box of the generator. The purpose of this section is to provide mounting information to customers replacing an existing regulator with the 2400/2500 or those wishing to mount the regulator remotely.

If the unit is not installed immediately, store it in the original shipping package in an environment free of moisture and dust.

MOUNTING

The regulator is normally located in the generator conduit box. It is designed for behind-the-panel mounting and requires a cutout for front panel viewing and access. Mounting hardware consists of six customer-supplied, #12 thread-forming screws that pass through holes in the conduit box and thread into the mounting holes in the regulator. The recommended torque range for the steel mounting screws is 36 to 40 inch-pounds (4.1 to 4.5 Newton-meters). Refer to Section - Specifications, for environmental requirements.

The 2400/2500 front panel and uncovered rear dimensions are shown in Figure 5-1.

The 2400/2500 rear panel with cover dimensions are shown in Figure 5-2. Cutout and drilling dimensions are shown in Figure 5-3.

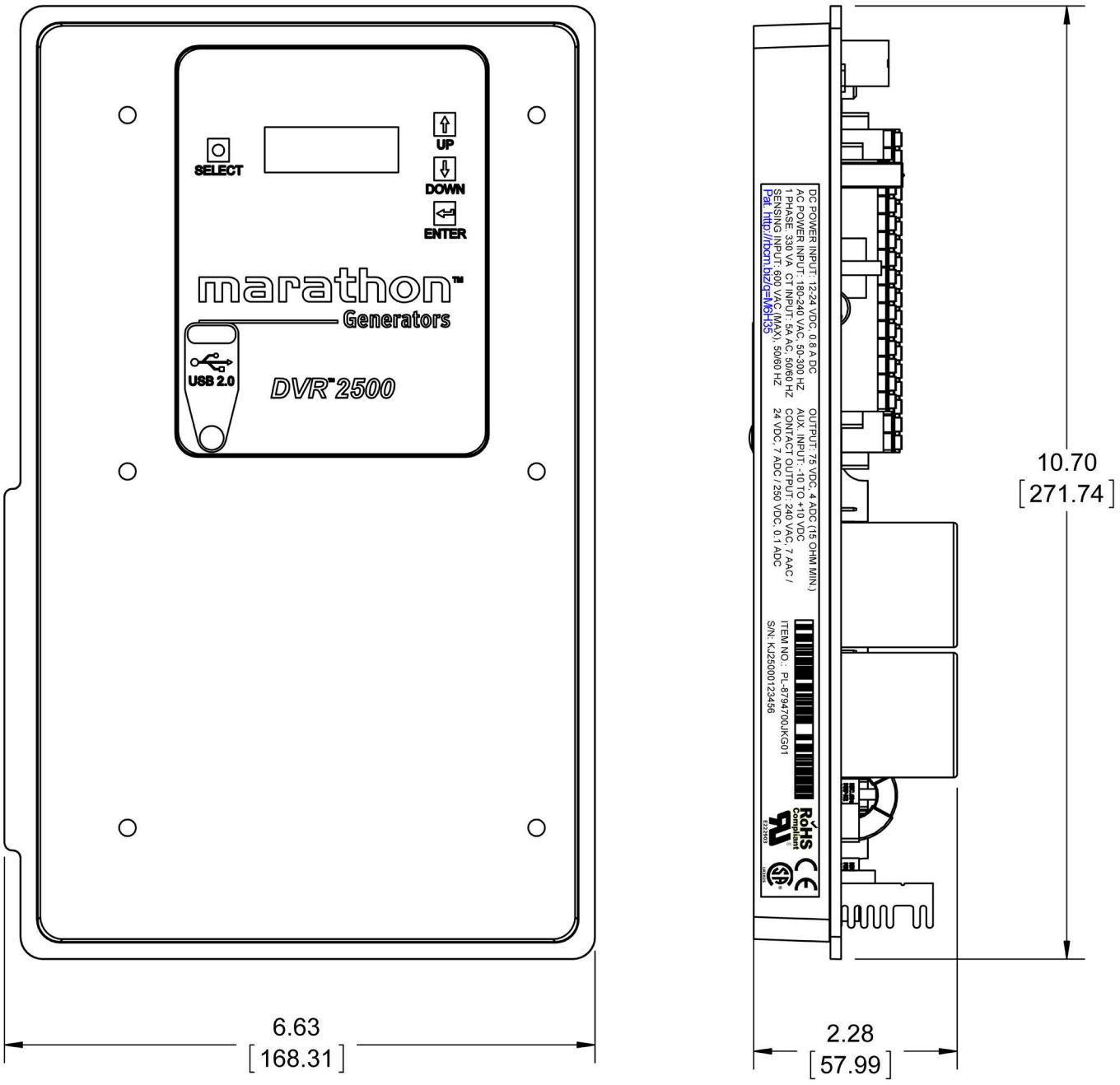


Figure 5-1. The 2500 front dimensions without cover. Valid for 2400 & 2500 versions.

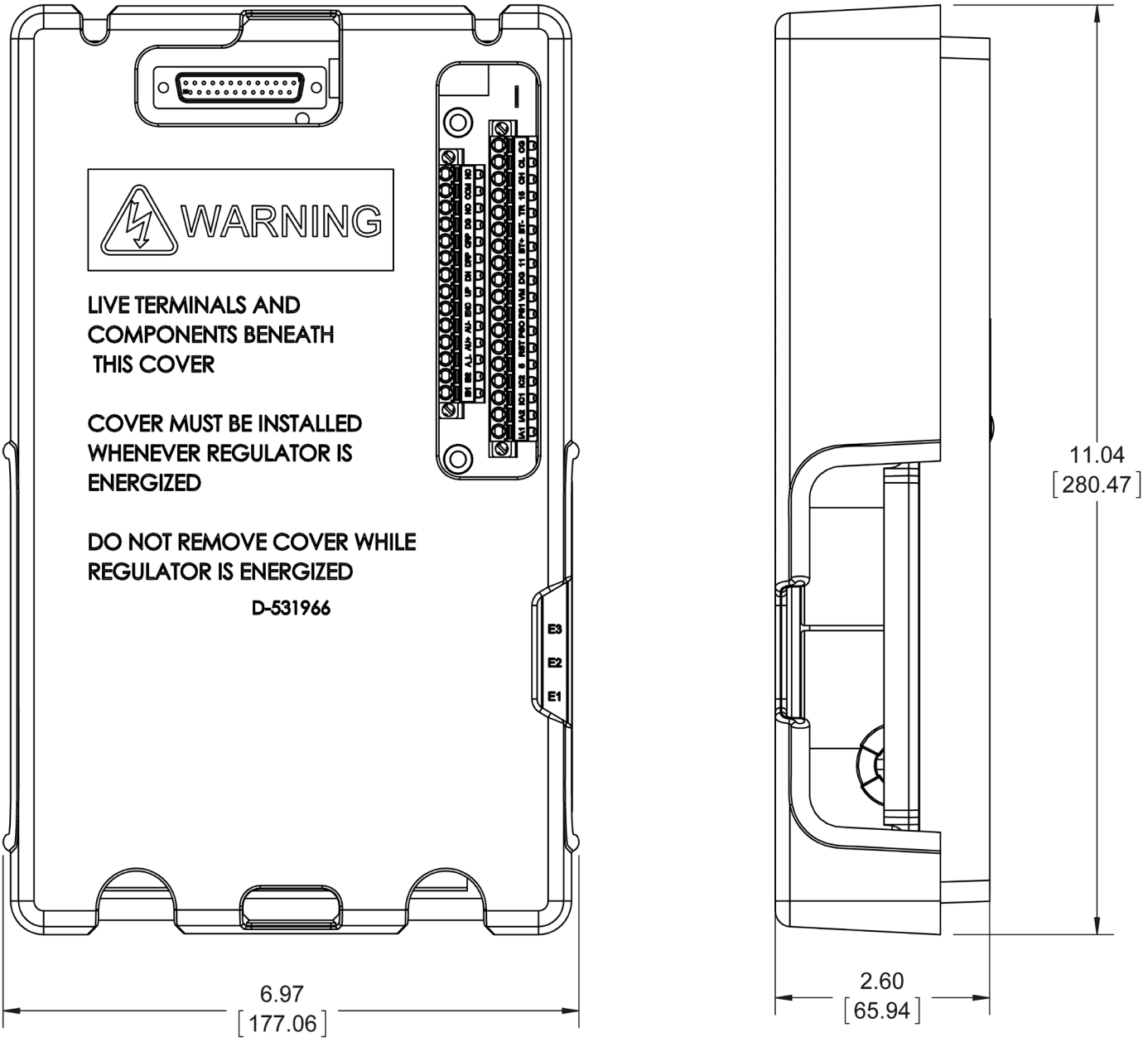


Figure 5-2. The 2500 rear dimensions with cover. Valid for 2400 & 2500 versions.

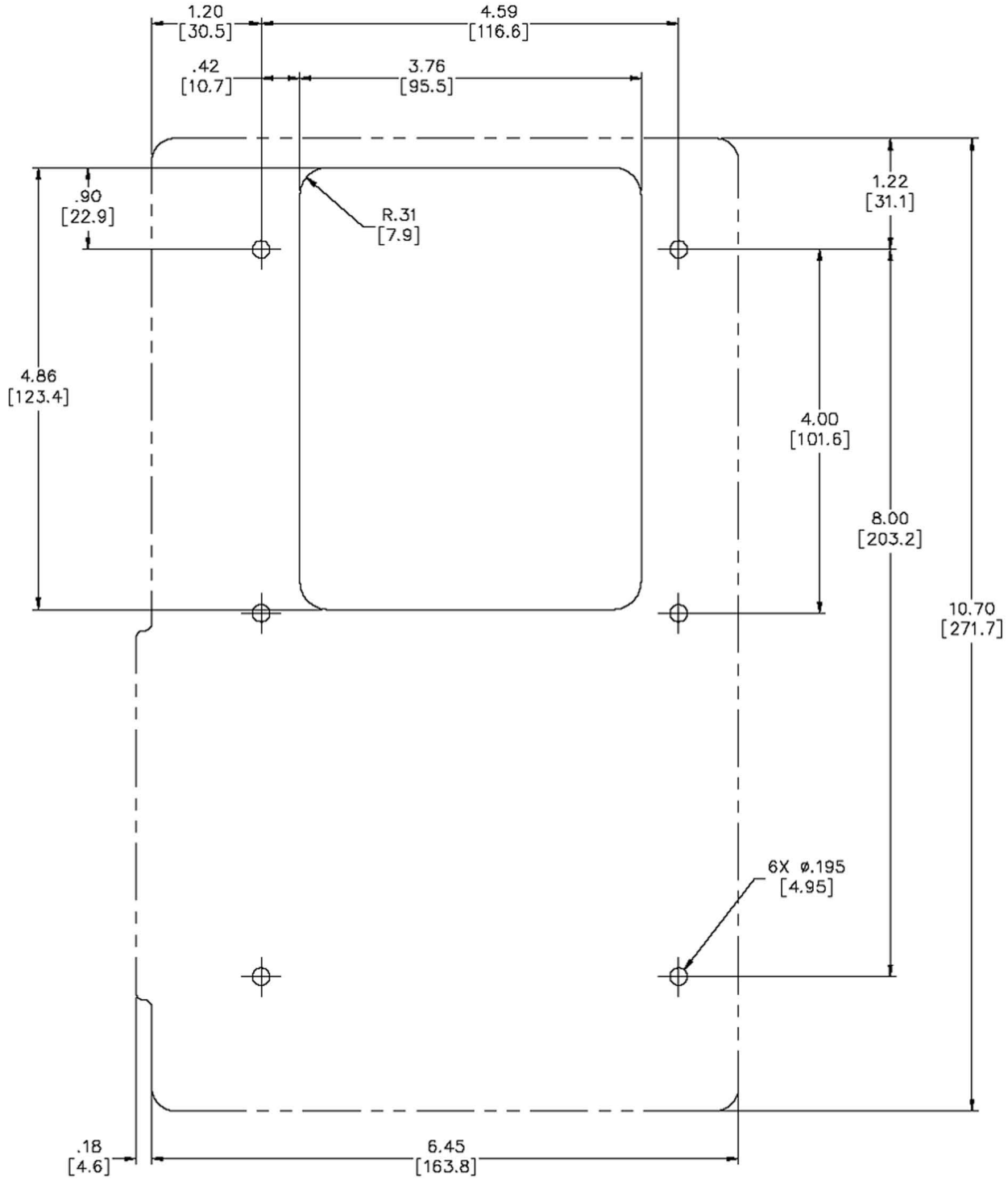


Figure 5-3. Cutout and Drilling Dimensions. Valid for 2400 & 2500 versions.

CONNECTIONS

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

NOTICE

- Incorrect wiring may damage the unit.

Note: Be sure that the regulator is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the unit case. When the unit is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each device.

The DVR® voltage regulator connections are dependent on the application.

The 2400/2500 Connectors

The 2400/2500 regulators have five types of interface connectors.

1. Nine (9) (2400), Eleven (11) (2500) 1/4", quick-connect terminals for generator connections.
2. One (1) 14 position 5.08mm cage clamp style plug for B-phase CT and system interface connections.
3. One (1) 18 position 5.08mm cage clamp style plug for A and C-phase CTs, system interface and Controlled Area Network (CAN) bus interface connections (2500 only).
4. One (1) 5-pin USB 2.0 Mini B type connector for the communication between the regulator and the DVRPortal™ software on the front panel.
5. One (1) 25 position d-sub connector for 3-wire eight (8) channel measurement through RTD module (only).

- Wires performing common functions, such as voltage sensing leads, should be grouped together.
- The 14 and 18 position plugs P1 and P2 need to be screwed down to P1 and P2 during operation.
- Wiring terminated to P1 and P2 need to be strain relieved to reduce stress on the wiring due to vibration.
- P1 and P2 can accept either bare wire (stranded only) or ferrules.
- Recommended strip/ferrule length of 0.393 in (10 mm) should be used for connections terminated to P1 and P2.
- Wiring routed to P1 and P2 should be strain relieved at least 6 inches from the P1 and P2.
- Wiring terminated to P1 need to be bundled together with tie wrap to reduce strain. This is applicable to P2 also. Do not bundle wiring connected to P1 and P2 together this adds more strain to the connections.
- Loctite®* 242 or similar should be used on the screws before connecting the DB25 cable to the RTD module and regulator for better vibration withstand.
- Recommended torque for the DB25 cable connecting regulator and RTD module is 7.0 inch·lbf [0.8 N·m].

Figure 5-4 shows the quick disconnect terminal connections located on the rear panel of the regulator.

REGAL®

Remote Mounting Guidelines:

- All digital and analog inputs connected to the regulator should be separately routed from F+, F-, E1, E2, E3, 3 and 4 terminals
- All digital and analog input wiring needs to be shielded
- Shield needs to be grounded at remote end of wiring
- For the DVR® regulator to detect the digital inputs properly, the cable resistance should not exceed 50 ohms
- Analog input may be supplied from a source up to 150 feet away
- USB communication has a limited range of about 3 meters. For longer distance communication please used USB booster cables
    - » IOGEAR®* GUE2118 (39 feet) is recommended for longer distances with the DVR2400/2500 voltage regulators
    - » The regulator may need to be externally powered for proper communication

Refer to the section on Grounding Practices for additional information.

Grounding and Connection Practices

The following practices must be adhered to in order to ensure proper operation of the regulator and related systems.

1. The chassis ground terminals (2) (GND) must always be connected.
2. Chassis ground (GND) near P1 and P2 need to be terminated as close to the DVR® regulator as possible.
3. Unstable operation might be observed if the GND terminals are not connected.
4. AUX Shield must be grounded at the source only (not at the DVR regulator).
5. CAN shield has to be connected to GND on both end of the cable.

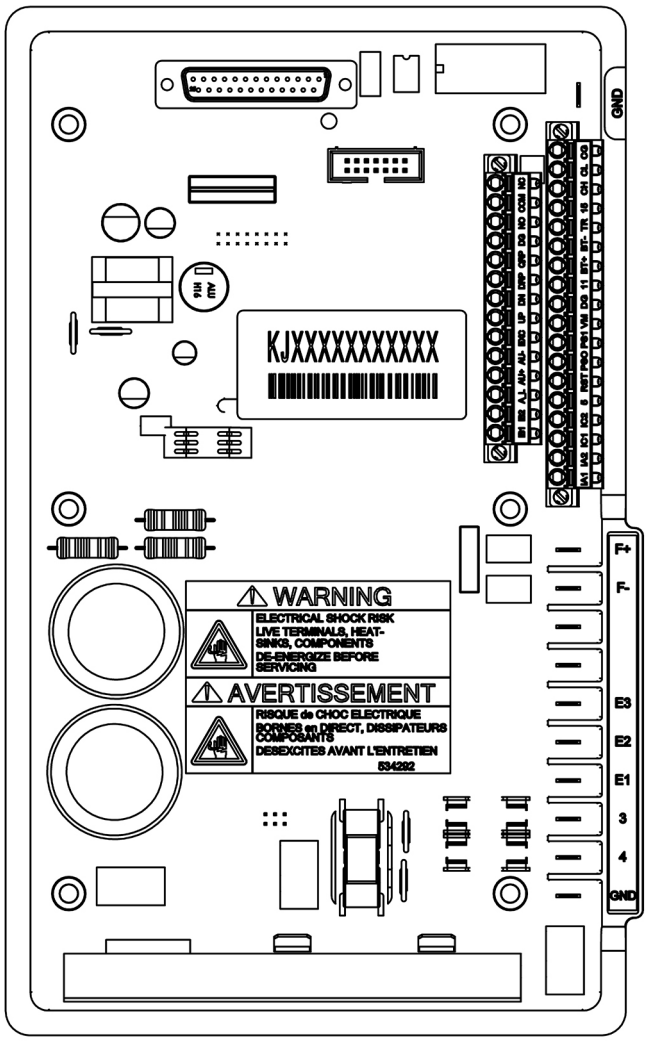


Figure 5-4. The regulator Rear Panel Connectors (DVR®2500 regulator shown)

Quick Connect Terminals		Application Notes
Terminal Name	**Description**	
GND	Chassis ground	Use #12 AWG (4 mm²) minimum conductor.
4	PMG/External power input – terminal 2	Protected by fuse.
3	PMG/External power input – terminal 1	Protected by fuse. 180-240Vac, 250-300Hz, 350VA
E1	Generator armature – terminal T1	Phase A for 3 phase output. L1 input for single phase.
E2	Generator armature – terminal T2	Phase B for 3 phase output. L2 input for single phase.
E3	Generator armature – terminal T3	Phase C for 3 phase output. Jumper to E2 for single phase.
	Reserved	
	Reserved	
F -	Exciter stator – terminal F1	Excitation output. Never apply a voltage to these terminals. Observe polarity.
F +	Exciter stator – terminal F2	

Table 5-1. Quick Connect Terminals

Chassis Ground (GND)
The chassis ground terminal is labeled GND. Two chassis grounds are available on the regulator. GND closer to the P1 and P2 need to be terminated to chassis as close to the regulator as possible.

Power Supply Inputs (3 and 4)
Power input terminals are labeled 3 and 4.

Generator Voltage Sensing Inputs (E1, E2 and E3)
The generator voltage sensing terminals are labeled E1, E2, and E3. A single-phase sensing connection is obtained by connecting the phase C sensing input to terminals E2 and E3.

Exciter Field Output (F+ and F-)
The field output terminals for connection to the generator exciter field are labeled F+ and F-.

Single Phase Current Sensing Input (IB1 and IB2)
Generator line current is stepped down through a user-supplied CT on Phase B. Secondary current (5A) from that transformer is applied to P1 connector terminals labeled IB1 and IB2. Consult current transformer instruction manuals for CT polarity identification and install per Figure 5-7. See Figure 5-5 and Table 5-2 for terminal assignments.

Three Phase Current Sensing Input (2500 only)
Generator line current is stepped down through user-supplied CT's. Secondary current (5A) from these transformers are applied to the P1 connector terminals labeled IB1 and IB2 and P2 connector terminals labeled IA1, IA2 and IC1, IC2. Consult CT instruction manuals for polarity identification and install per Figure 5-6. See Figure 5-5 and Table 5-2 for terminal assignments.
Note: All transformers must have the same CT ratio.

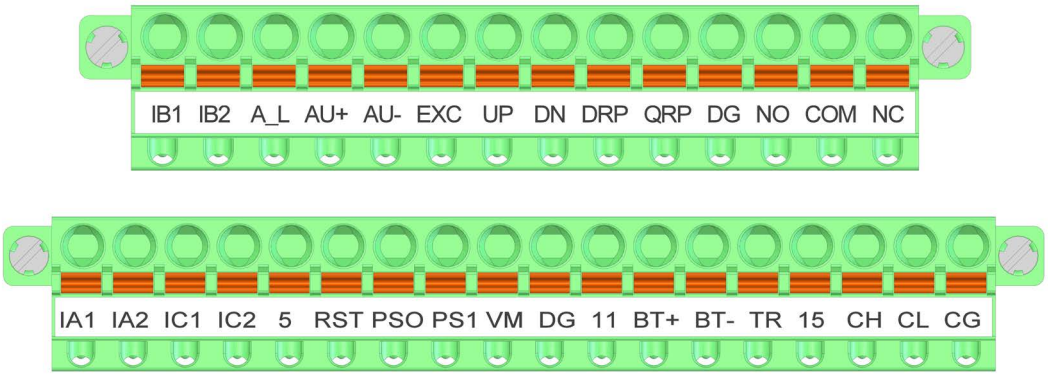


Figure 5-5. System Connectors P1 (top) and P2 (bottom) Terminal Position

Sensing	Phase	CT "X1" Terminal	CT "X2" Terminal
3-Phase (DVR®2500 regulator only)	A	P2-1 (IA1)	P2-2 (IA2)
	B	P1-1 (IB1)	P1-2 (IB2)
	C	P2-3 (IC1)	P2-4 (IC2)
1-Phase	B	P1-1 (IB1)	P1-2 (IB2)

Table 5-2. Current Transformer Connection Terminals

Note: The CT primaries are aligned such that the "H1" (on the CT) face is facing the generator for typical donut-style CT's.

Pin Number	Terminal Name	Name	Description
1	IB1	CT-B1	Generator Phase B CT – terminal 1
2	IB2	CT-B2	Generator Phase B CT – terminal 2
3	A_L	AUX_LOOP	Auxiliary current loop (DVR®2500 regulator only)
4	AU+	AUX IN +	Auxiliary input positive
5	AU-	AUX IN -	Auxiliary input negative
6	EXC	EXCITATION_OFF	Excitation disable contact input (active closed)
7	UP	UP	UP contact input (active closed)
8	DN	DOWN	DOWN contact input (active closed)
9	DRP	DROOP_OFF	Droop disable contact input (active closed)
10	QPF	VAR/PF_OFF	VAR/PF mode disable (active closed)
11	DG	DGND	Digital ground
12	NO	K1-NO	Contact output normally open
13	COM	K1-COM	Contact output common
14	NC	K1-NC	Contact output normally closed

Table 5-3. Connector P1 Terminals

Pin Number	Terminal Name	Name	Description
1	IA1	CT-A1	Generator Phase A CT – terminal 1
2	IA2	CT-A2	Generator Phase A CT – terminal 2
3	IC1	CT-C1	Generator Phase C CT – terminal 1
4	IC2	CT-C2	Generator Phase C CT – terminal 2
5	-	-	Reserved
6	RST	DVR_RESET	Reset Regulator (active closed)
7	PS0	PS0	Preset select line 0 (active closed)
8	PS1	PS1	Preset select line 1 (active closed)
9	VM	-	Reserved
10	DG	DGND	Digital ground
11	-	-	Reserved
12	BT+	BAT+	Battery input – positive
13	BT-	BAT-	Battery input – negative
14	TR	CAN_TR1	CAN terminating resistor - terminal 1
15	-	-	Reserved
16	CH	CAN_H	CAN high data line
17	CL	CAN_L	CAN low data line
18	CG	CAN_GND	CAN GND

Table 5-4. Connector P2 Terminals (2500 only)

Note:

Active Low/Closed: Function is active when connection between the digital input and Digital Ground (DG) is closed

Active Hi/Open: Function is active when connection between the digital input and Digital Ground (DG) is open

E.g.: To enable Drop-off function, close connection between DRP and DG assuming that the polarity of drop-off contact is set to Active Low.

UP and DOWN Contact Inputs

Remote set point adjustment may be accomplished by connecting a SPDT momentary contact switch to the P1 connector UP and DOWN contacts. To connect this switch, the common terminal must be connected to P1-11 (DG). The other two switch terminals are connected to P1-7 (UP) and P1-8 (DN). Refer to Section – Features and Protection for a detailed description of the UP and DOWN contact function.

Parallel Generator Compensation Enable/Disable (DROOP OFF)

A user can enable or disable the integrated load sharing function of the regulator by connecting a contact between P1-9 (DRP) and P1-11 (DG) terminals. Activation polarity (Open/Close) determined by configuration settings. Refer to Section – Features and Protection for a detailed description of the Load Sharing function.

Excitation Enable/Disable (EXCITATION OFF)

A user can enable or disable excitation by connecting a contact between terminals P1-6 (EXC) and P1-11 (DG).

Activation polarity (open/close) determined by configuration setting. Refer to Section – Features and Protection for a detailed description of the Excitation Off function.

Auxiliary Input (AUX_IN (+), AUX_IN (-), and AUX_LOOP)

This input allows a user to control the regulator with an auxiliary piece of equipment by connecting a voltage source to P1-4 (AU+) and P1-5 (AU–). The regulator can also be configured to accept a voltage or current to be metered on this input. Refer to Section – Features and Protection for a detailed description of the Auxiliary input function.

VAR/PF Enable/Disable (VAR/PF_OFF)

A user can enable or disable the VAR or PF regulation modes by connecting a contact between terminals P1-10 (QPF) and P1-11 (DG). Activation polarity (open/close) determined by configuration setting. Refer to Section – Features and Protection for a detailed description of the VAR/PF regulation function.

Note: Operation in VAR or PF modes should only be enabled when the generator is paralleled with utility (infinite bus). If the VAR/PF_OFF is disabled during power up of the regulator in VAR or PF regulation modes, a Generator Start Up Fault occurs.

Contact Output (NO, COM and NC)

The output contact may be accessed at connector P1, via terminals (P1-12 (NO), P1-13 (COM) and P1-14 (NC). The NO-COM / NC-COM output is normally open/closed and closes/opens when the regulator goes into a fault condition.

USB 2.0 Communication Port: The USB 2.0 port on the front panel uses a Mini B type female connector. A standard USB A communication cable terminated with a USB Mini male connector is used for PC interface with the regulator.

CAN J1939 Communication Port (P2-14,16,17,18)

The CAN port can be accessed on the connector P2. Table 5-4 illustrates the pin assignments and functions of the CAN port.

The Regulator Connections for Typical Applications

Figures 5-6 through 5-10 illustrate typical applications using the DVR® regulator.

- Figure 5-6 shows an application where the regulator is connected for three-phase voltage sensing without current sensing.
- Figure 5-7 shows an application where the regulator is connected for three-phase voltage sensing and single-phase current sensing.
- Figure 5-8 shows an application where the regulator is connected for three-phase voltage sensing and three-phase current sensing.
- Figure 5-9 shows an application where the regulator is connected for single-phase voltage sensing without current sensing.
- Figure 5-10 shows an application where the regulator is connected for single-phase voltage sensing and single-phase current sensing.

Figures 5-11 and 5-12 illustrate how the regulators can be interconnected for use in Cross-Current (Reactive Differential) applications. When operating in Cross-Current mode, attention must be paid to the use of the burden resistor shown in Figures 5-10 and 5-11. The burden resistor should have a value of approximately 10 times the cross current loop resistance for proper differential operation. The value of 0.1 ohm is a suggested value. The volt-ampere (VA) capacity of the paralleling current transformers should be considered when sizing the burden resistor.

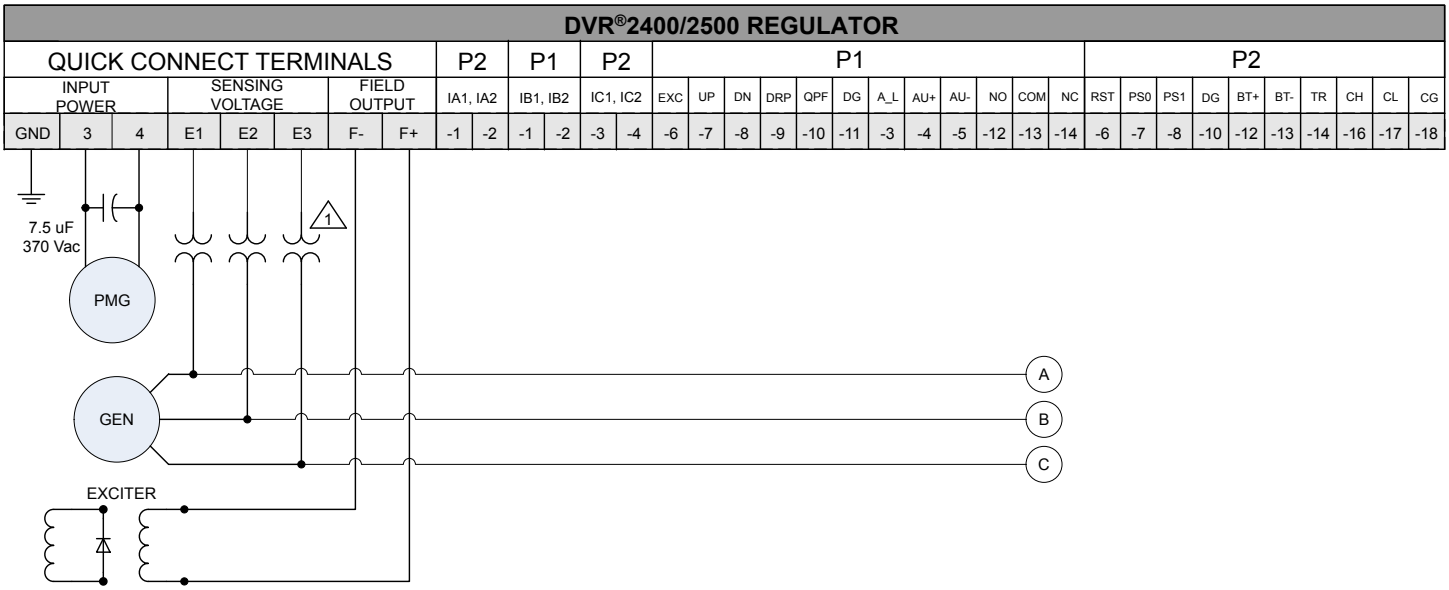


Figure 5-6. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing Without Current Sensing

Note:

1. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.

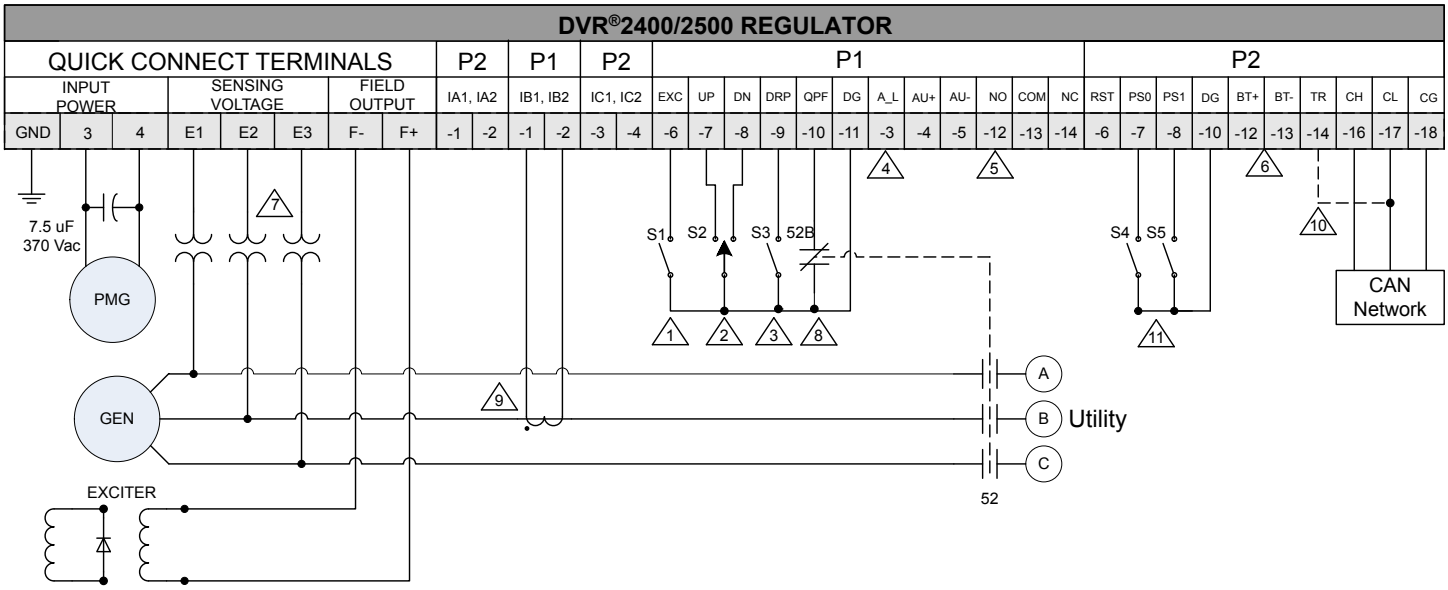


Figure 5-7. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing and Single-Phase Current Sensing

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Droop enabled/disabled by S3. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation enabled/disabled by auxiliary contact 52B. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
9. Current transformer is optional and is necessary only if the application requires Droop, VAR, PF or Power Limiting features.
10. The 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
11. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 in one (1) of the four (4) preset configurations (refer to Digital I/O section).
12. Optional S1, S2, S3, S4, S5, 52 and "52B" contacts/relays supplied by customers. Current and voltage transformers may be installed by Regal.
13. P1 is common for both 2400 and 2500. P2 available only on the 2500.

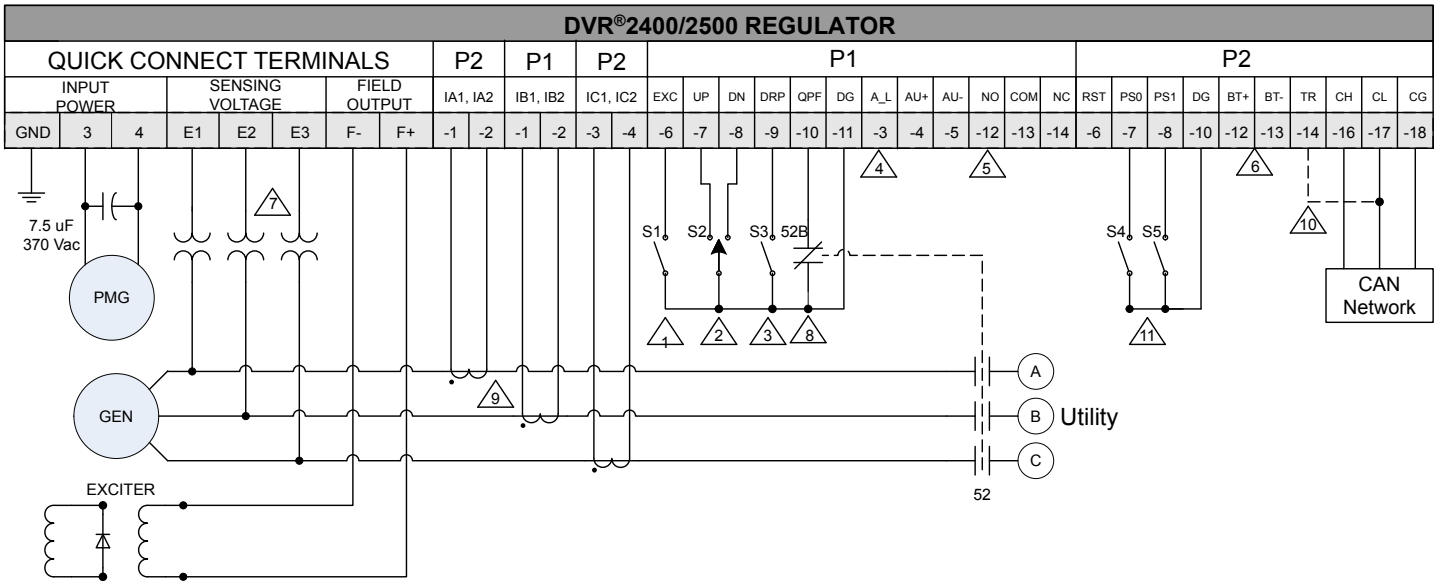


Figure 5-8. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing and Three-Phase Current Sensing

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Droop enabled/disabled by S3. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation enabled/disabled by auxiliary contact 52B. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
9. Current transformers are optional and are necessary only if the application requires Droop, VAR, PF or Power Limiting features.
10. If the 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
11. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 In one (1) of the four (4) preset configurations (refer to Digital I/O section).
12. Optional S1, S2, S3, S4, S5, 52 and "52B" contacts/relays supplied by customers. Current and voltage transformers may be installed by Regal.
13. P1 is common for both 2400 and 2500. P2 available only on the 2500.

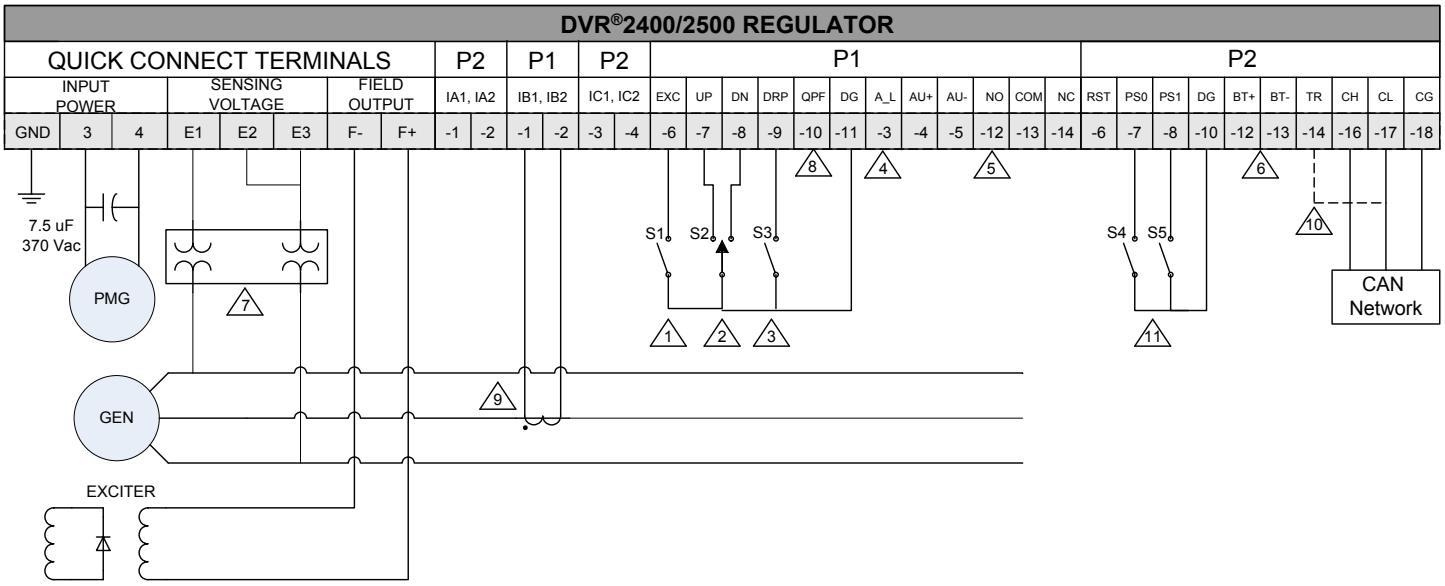


Figure 5-9. Typical Connections to a Single-Phase Generator

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Reactive Droop is not possible in this configuration.
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation is not possible In this configuration
9. If the 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
10. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 In one (1) of the four (4) preset configurations (refer to Digital I/O section).
11. Optional S1, S2, S4 and S5 contacts supplied by customers. Voltage transformers may be installed by Regal.
12. P1 is common for both 2400 and 2500. P2 available only on the 2500.

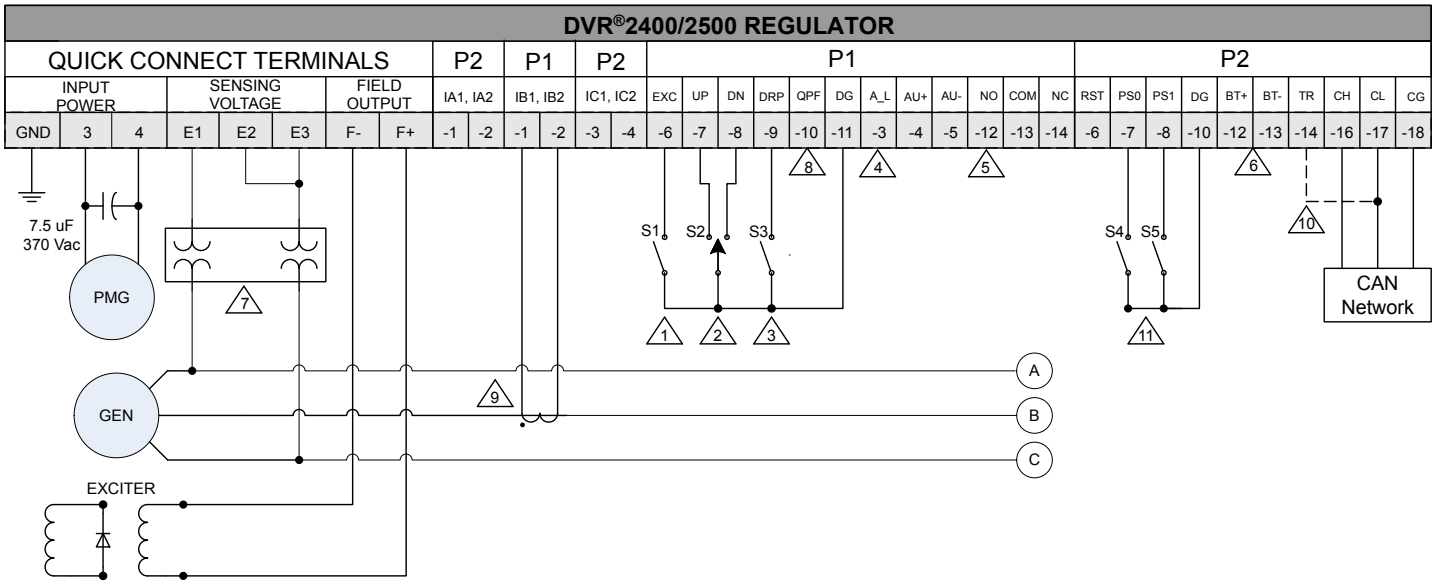


Figure 5-10. Typical Connections with ABC Rotation, Single-Phase Voltage Sensing and Single-Phase Current Sensing

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Droop enabled/disabled by S3. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation not possible in this configuration.
9. Current transformer is optional and is necessary only if the application requires Droop, VAR, PF or Power Limiting features.
10. If the 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
11. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 In one (1) of the four (4) preset configurations (refer to Digital I/O section).
12. Optional S1, S2, S3, S4, S5, 52 and "52B" contacts/relays supplied by customers. Current and voltage transformers may be installed by Regal.
13. P1 is common for both 2400 and 2500. P2 available only on the 2500.

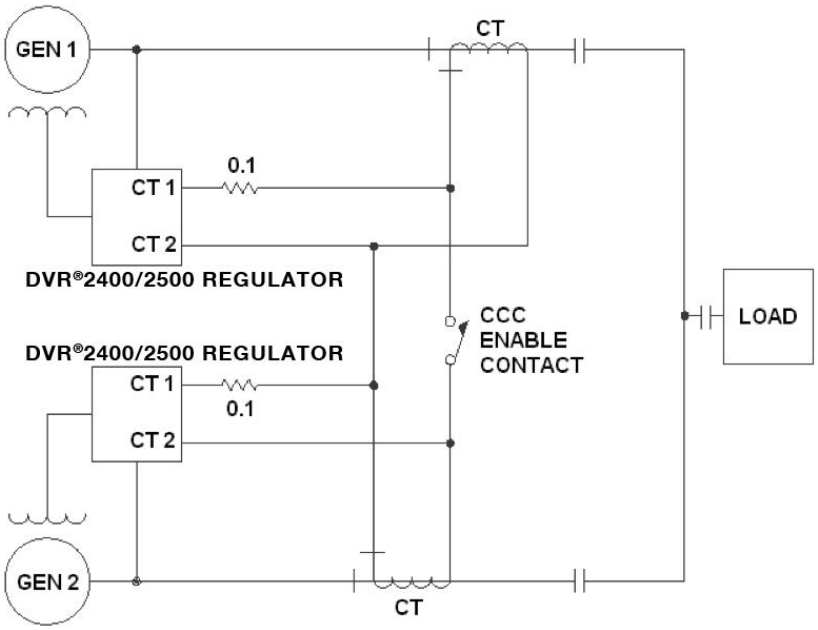


Figure 5-11. Cross-Current (Reactive Differential) Connections for Two Generators

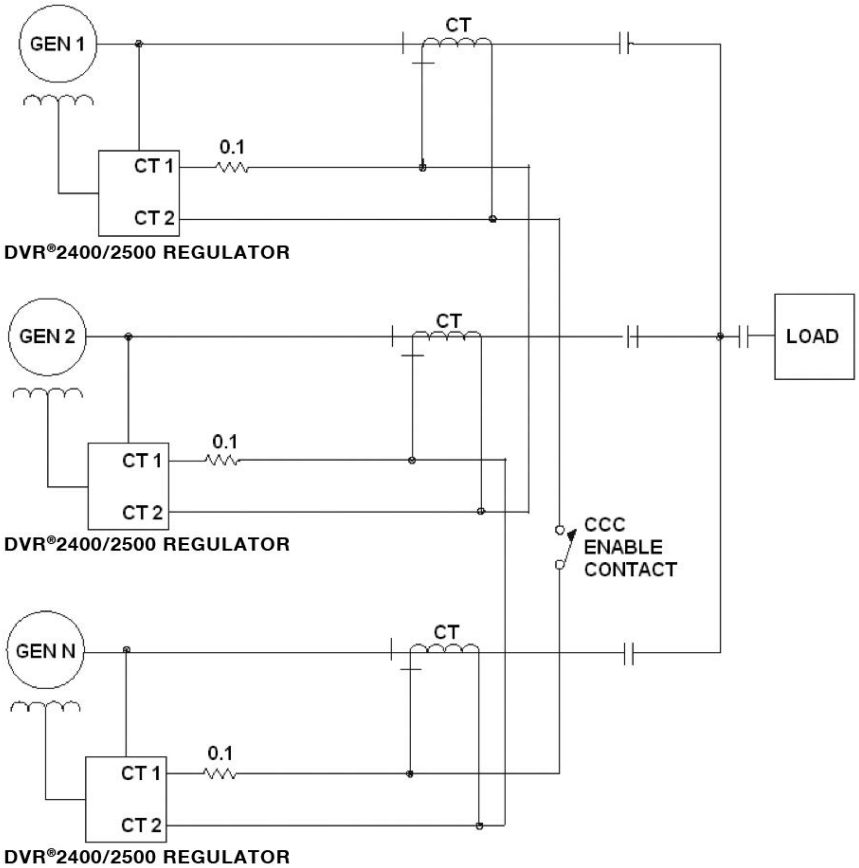


Figure 5-12. Cross-Current (Reactive Differential) Connections for Three or More Generators

PRELIMINARY SETUP – SAFETY

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.
- Use caution when working around the component side of the DVR® regulator. Voltage levels may be present at the exposed components when the unit is energized. The protective cover MUST be installed whenever the regulator is energized.

Note: Read and understand the operation of the individual adjustments before attempting any adjustments.

PRELIMINARY SETUP – ON GENERATOR (Powering the regulator through PMG)

The regulator may be configured on the generator using the following procedure:

1. Before starting the engine, remove the regulator's 5.0 A fuse. This will prevent the generator's PMG from energizing the regulator and prevent unintended operating functions from occurring.
2. Perform all preliminary engine governor adjustments with the regulator de-energized.
3. After initial governor adjustments are complete, shut down the prime mover. Reinstall the 5.0 A fuse. Disconnect the E3 and F+ terminal connectors from the regulator and temporarily insulate them to prevent accidental shorting.
4. Start and run the generator at rated speed. The regulator may enter a Loss of Sensing shutdown mode, indicated by rUn.i / F011 on the display.
5. At this time, initial adjustments can be made. If adjusting via the HMI, see Section – Making Settings Changes. If adjusting via the DVRPortal™ communication software, see Section DVRPortal Graphical User Interface.
6. After the initial adjustments are made, shut down the generator and reconnect the regulator leads removed in Step 3. The generator may be started and final adjustments may be performed on the regulator.

PRELIMINARY SETUP – ON GENERATOR (When generator is not spinning)

1. Before following the instructions below, ensure that the generator is not spinning.
2. Open swing cover and locate the USB mini connector on the regulator.
3. Connect USB cable from your computer to the regulator. This powers up the communication.
4. Establish communication via DVRPortal software and make necessary changes to the setting and save them to the regulator.
5. After necessary changes are made, disconnect from the regulator. The generator may be started to verify proper operation.

Note:

1. Neither HMI or power ON LED will light up when DVR regulator communication is powered only through USB.
2. If cable length greater then 10ft is needed, IOGEAR®* GUE2118 (39 feet) or similar is recommended with the regulator.

PRELIMINARY SETUP – ON BENCH

The regulator may be configured on a bench using the following procedure:

1. Connect a 100-120 Vac 50/60 Hz source to terminals 3, 4 and GND as follows:
   a. 120 V hot – terminal 3
   b. 120 V neutral – terminal 4
   c. 120 V ground – terminal GND

   (OR)

   If configuring through the DVRPortal™ software, regulator communication circuit can be powered through the USB. This will eliminate the necessity of powering the regulator through terminals 3, 4 and GND.

   Note: USB should be capable of providing 0.4 Adc. HMI, power on LED indicator and other functions will be non-operational while powering through USB.

   (OR)

   Connect a 12/24-volt battery input to terminals P2-12 (BT+) and P2-13 (BT-) (2500 only).

   Note: Battery should be capable of providing 0.8 Adc.

   Note: Sudden loss of excitation power on terminals 3 & 4 could lead to the DVR2500 regulator RESET even though battery voltage is present.

NOTICE **Applying voltage larger than 120 Vac without current in-rush limiting may damage the unit.**

2. If the regulator is in AVR1 or AVR3 regulation mode, the regulator will indicate **STBY** on the display. If the regulator is in FCR regulation mode, the regulator will indicate **rUn.i** on the display.

3. At this time, initial adjustments can be made. If adjusting via the HMI, see Section – Making Settings Changes. If adjusting via the DVRPortal™ communication software, see Section DVRPortal Graphical User Interface.

After the initial adjustments are made, disconnect the power source and install the regulator onto the generator. The generator may be started and final adjustments may be performed on the regulator.

REGAL®

HUMAN-MACHINE INTERFACE (HMI)

GENERAL

The DVR® regulator HMI consists of four buttons and a four-character LED display as illustrated in Figure 6-1. The display indicates status conditions and parameter settings. Button function descriptions are given in Table 6-1.

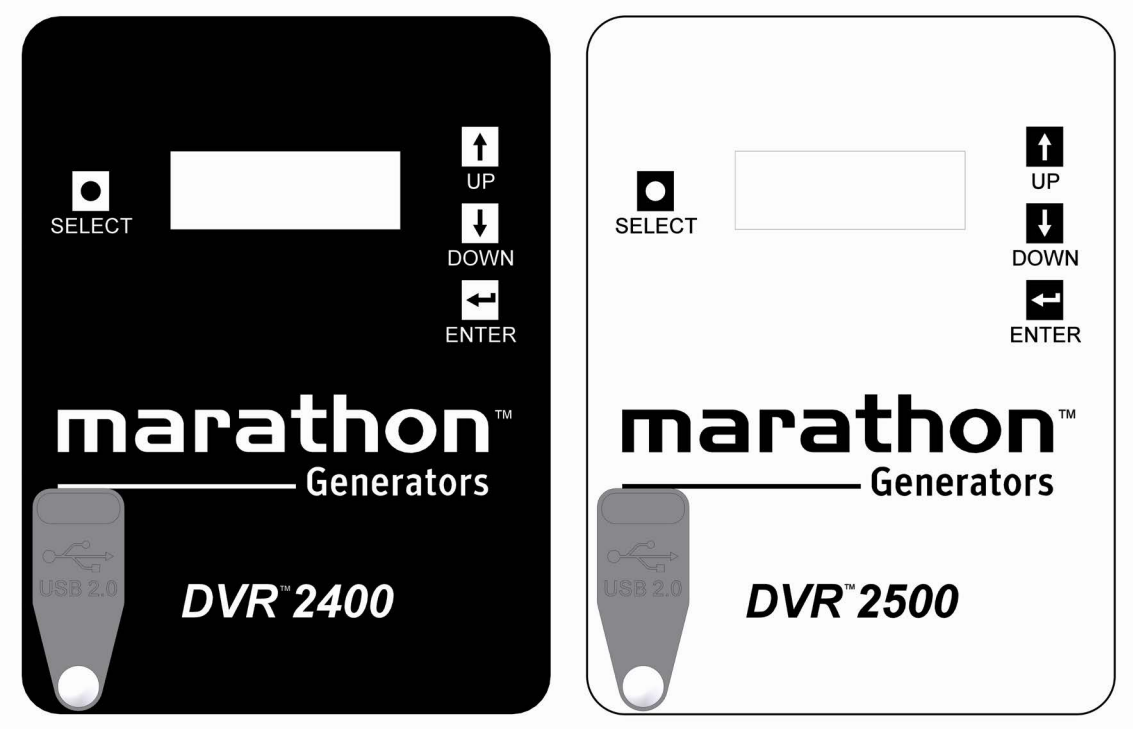


Figure 6-1. DVR®2400/2500 HMI shown

Button	Description
SELECT	This button steps the user through a menu list of editable parameters. It also serves as an excape key in EDIT mode.
UP	This button increases the setting level fo the parameter being adjusted.
DOWN	This button decreases the setting level of the parameter being adjuted.
ENTER	This button stores the current value of the parameter being adjusted and returns the user to the main menu list.

Table 6-1. DVR® Regulator HMI Button Function Descriptions

FRONT PANEL DISPLAY

The HMI display has three display modes:

1. **STATUS mode** – the HMI displays the non-editable operating state of the DVR® regulator as described in Table 6-2. The display flashes while in STATUS mode.
2. **EDIT mode** - The HMI displays a multi-layer menu for reading and editing operating parameters of the regulator as described in Table 6-3. The display is steady-on while in EDIT mode.
3. **SLEEP mode** – The HMI turns off the display after 60 seconds of button-press inactivity.

Display	Description
(no display)	No display is the default mode of the HMI. No display indicates that the regulator is operating normally, but operating in a sleep mode.
STBY	This display indicates that the regulator is operating normally and is in stand-by mode waiting for the STRT state.
STRT	This display indicates that the regulator is in a Soft Start State.
RUN.V	This display indicates that the regulator is operating normally with excitation in AVR mode.
RUN.I	This display indicates that the regulator is operating normally with excitation in FCR mode.
RUN.P	This display indicates that the regulator is operating normally with excitation in VAR or PF mode.
FLSH	This display indicates that the regulator is operating in field flashing mode.
IDLE	This display indicates that the regulator is operating normally and is in Idle mode waiting for the speed to take off.
AXXX (where xxx indicates a three-digit alarm code)	This display indicates that the regulator is in an alarm state. During this state, the regulator continues to provide excitation if excitation is enabled. See Appendix for description of Alarm Codes.
FXXX (where xxx indicates a three-digit alarm code)	This display indicates that the regulator is in a fault state. During this state, the regulator ceases to provide excitation. See Appendix for description of Fault Codes.

Table 6-2. DVR® Regulator HMI STATUS Mode Display Descriptions

Parameter Name	Parameter Value	Description
SIZE	**281 to 1040**	Frame size of generator
rEG	**AVR3**	AVR3 – Voltage regulation with three-phase sensing
	AVR1	AVR1 – Voltage regulation with single-phase sensing
	FCR	FCR – Field current regulation
	VAR	VAR – Reactive VAR regulation
	PF	PF – Power factor regulation
StPt	**100.0 to 630.0**	Voltage set point (Vrms) in AVR3 and AVR1 mode
	0.000 to 4.000	Field current set point (Adc) in FCR mode
	0% to 100%	VAR set point (% of rated VAR) in VAR mode.
	-0.60 to 0.60	PF set point (PU) in PF mode.
UFrQ	**40.0H to 70.0H**	Under frequency knee (Hz)
SLoP	**1.00U to 5.00U**	Under frequency slope multiplier
Pr	**0 to 6000**	Rated power of generator (kW)
PFr	**0.600 to 0.900**	Rated power factor of generator (per unit)
Pt	**1.0 to 150.0**	Potential transformer ratio
Ct	**1 to 2000**	Current transformer ratio
droP	**0.0% to 10.0%**	Voltage droop (%) at rated reactive power
AU	**OFF**	Auxiliary Off – Auxiliary input is disabled
	CNT1	Auxiliary Control-1 – Auxiliary input modifies regulation set point (±3 or ±5 or ±10 Vdc input) (±5 or ±10Vdc for 2500 only)
	CNT2	Auxiliary Control-2 – Auxiliary input modifies regulation set point (4 to 20 mA input)
	SLOP	Auxiliary Dynamic Slope - Auxiliary input modifies under frequency slope multiplier (0 - 5V)

Table 6-3. DVR® Regulator HMI EDIT Mode Parameters

MAKING SETTINGS CHANGES

1. The default state of the HMI display is SLEEP mode. The HMI will enter the SLEEP mode after 60 seconds of inactivity (no button presses). Any HMI button press will place the HMI into STATUS mode. In order to make changes to settings, follow the procedure described in items 2-5 below.
2. Repeatedly press the SELECT button, stepping through the main menu until the desired parameter is displayed (see Table 6-3). If no button is pressed within 60 seconds, the display will return to STATUS mode.
3. Press the ENTER button to place the HMI into EDIT mode. In EDIT mode, the HMI will display the current value of the selected parameter.
4. Press or hold the UP and DOWN buttons to modify the displayed parameter to its desired value. Parameter changes take immediate effect. For parameters other than StPt, pressing the SELECT button escapes EDIT mode without modifying the parameter. For StPt, pressing the SELECT button escapes EDIT mode but preserves any modification.
5. To store the displayed parameter value to non-volatile memory, press the ENTER button. The stored parameter value will flash three times to confirm the entry.

Note: While in STATUS mode, pressing either the UP or DOWN button places the regulator directly into **STPT** EDIT mode. This feature allows a shortcut to set point adjustment.

AUXILIARY MODULES

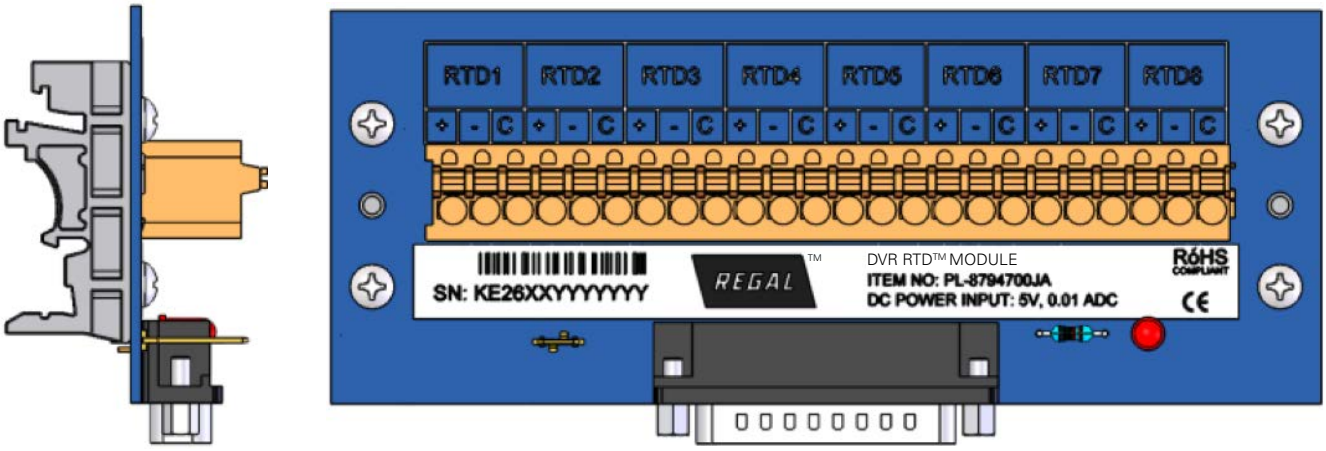
GENERAL

The DVR®2500 regulator is equipped with features that require the use of external auxiliary modules which are supplied separately from the base regulator.

RTD INTERFACE MODULE

The RTD Interface Module is a DIN rail-mounted component that provides termination points for up to eight 3-wire 100 Ohm Platinum RTDs. The RTD wires are terminated via PCB mounted screwless spring clamp connectors. The RTD module and DVR®2500 regulator are interconnected via onboard 25 pole D-sub connectors (DB25) and a cable supplied with the module.

See Section - Protection Functions for RTD protections features.

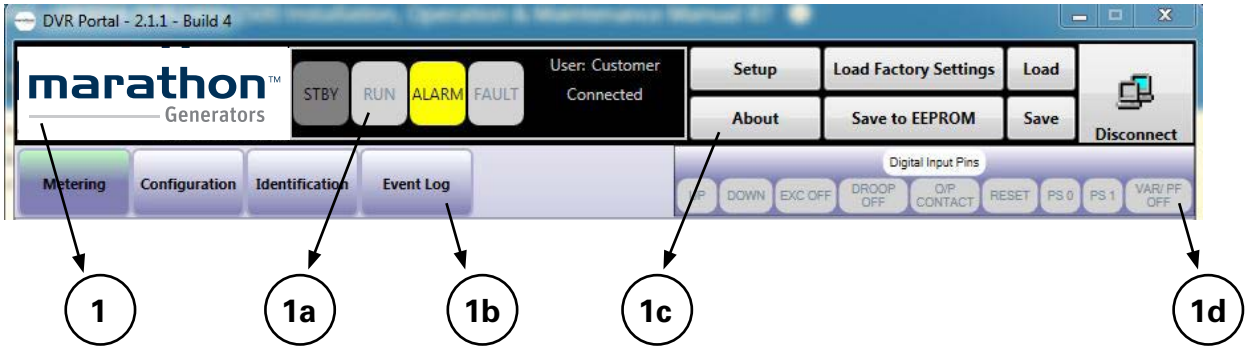


Note: Loctite®* 242 or similar should be used on the screws before connecting the DB25 cable to the RTD module and DVR® regulator for better vibration withstand. Recommended torque is 7.0 inch·lbf [0.8 N·m].

DVRPORTAL™ GRAPHICAL USER INTERFACE (GUI)

The DVRPortal™ software offers a means of programming the regulator and monitoring generator performance. This Windows® application software is available as a free download from the website https://www.marathongenerators.com/generators/dvrDownload.jsp. With this software, the user will be able to change all of the programmable parameters.

DVRPortal™ software consists of a header, and four panels (Metering, Configuration, Identification and Event Log). The header displays regulator status and basic administration functions. The Metering tab displays metered quantities and fault information. The Configuration tab permits editing of all programmable parameters. The Identification tab contains information specific to the regulator and allows for custom identification tags. The Event Log tab allows user to access the Event Log information saved in the regulator memory.



PARAMETER EDIT BUTTONS

On some of the parameter selection screens, you will find the following buttons:

Apply – Pressing this button sends the values in the currently active tab of the DVRPortal software to the regulator RAM.

Undo – Pressing this button displays the values just prior to the last edit in the currently active tab of the DVRPortal software. These values can then be sent to the regulator RAM by clicking on the Apply button.

Refresh – Pressing this button loads the values that are presently in the regulator RAM into the currently active tab of the DVRPortal software.

HEADER (1)

This is the main panel in the DVRPortal software. It is present on all screens.

Regulator Status (1a)

The header panel includes four indicators that enunciate the regulator status:

- Run State: If the regulator is in a run state, the header will display a green RUNV/ RUNI/ RUNP indicator, respectively, for Voltage/Field Current/ VAR or PF regulation.
- Alarm State: If the regulator is in an alarm state, the header will display a yellow alarm indicator.
- Fault State: If the regulator is in a fault state, the header will display a red fault indicator.
- STBY: If the regulator is in Standby State, the header will display STBY indicator.
- IDLE: If the regulator is in Idle State, the header will display IDLE indicator.
- STRT: If the regulator is in Soft Start State, the header will display STRT indicator.
- FLSH: If the regulator is in Field Flashing state, the header will display FLSH Indicator.

Configuration tabs (1b)

The configuration tabs are buttons that access the Metering, Configuration, Identification and Event Log tabs.

Administrative Buttons (1c)

The administrative buttons provide communication port settings, file manipulation and storing to regulator non-volatile memory.

Setup
This button allows the user to change serial port communication settings.

About
Provides information about the DVRPortal™ software.

Load Factory Settings
When this button is pressed, the default factory settings for the regulator are loaded into the regulators Random Access Memory (RAM). These factory settings can be transferred to the user settings in Electrically Erasable Programmable Read Only Memory (EEPROM) by pressing the "Save to EEPROM" button.

Note: If Load Factory Settings is selected, all setting for various presets will be lost. Make sure that you have saved these settings to an ".xml" file if these are needed in future.

Save to EEPROM
When this button is pressed, all parameter values in the regulators RAM (Configuration and Identification tabs) are transferred to the regulator's user settings in EEPROM. These user settings are loaded into RAM whenever the regulator is powered up.

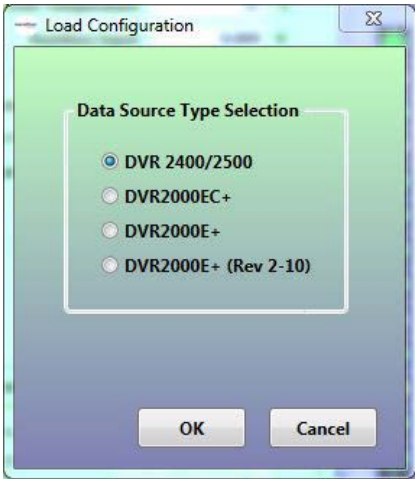


Figure 8-1

Load
When this button is pressed, the user will be given the option (see Figure 8-1) to choose the configuration(s) to load from a previously saved .xml file. When the file is selected, all user-adjustable settings from the selected .xml file are loaded into the volatile RAM memory of the regulator. These settings can be transferred to the user settings in non-volatile EEPROM by pressing the "Save to EEPROM" button.

Notes:

1. The regulator needs to be in Standby Mode to load configurations.
2. When a file is transferred from a computer to the regulator, the operating status will switch to "STBY" and excitation is disabled. To enable excitation with the new settings, save settings to EEPROM and then click the "Excitation ON" button on the Operating Modes sub panel of the Configure tab.

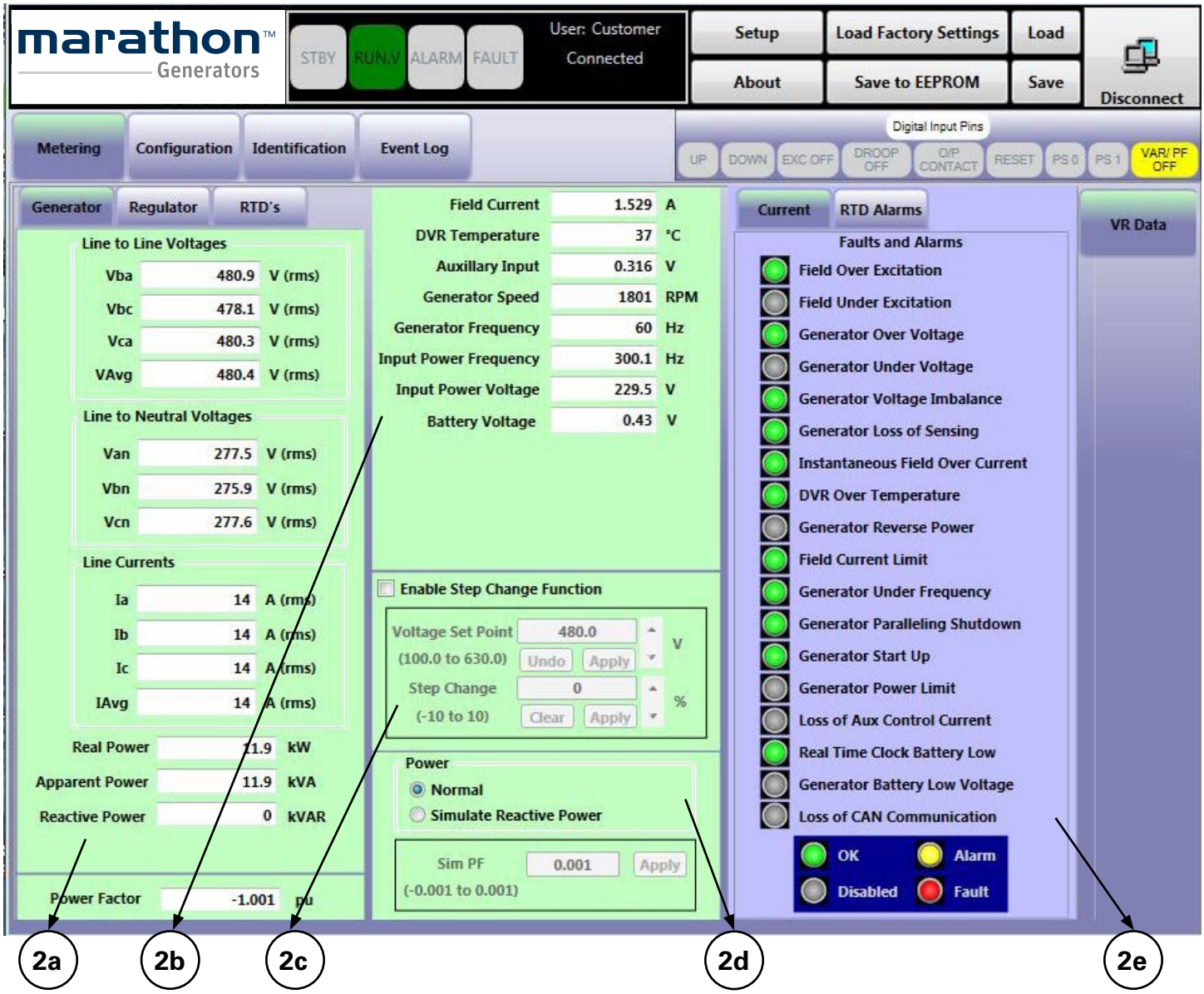
Save Config
When this button is pressed, the user will be prompted to save the configuration(s) to an .xml file. When the file is selected, all user adjustable settings presently in the volatile RAM memory are saved into the selected .xml file. These settings can be edited and loaded to the regulator's volatile RAM memory by pressing the "Load Config" button.

Notes:

1. The regulator needs to be in Standby Mode if multiple presets are to be saved.
2. .xml files are text files that can be printed for reference.

Connect
When this button is pressed, the DVRPortal software establishes communication with the regulator. Communication must be established before data can be transferred between the regulator and the DVRPortal software. When connected, this button displays "Disconnect" to permit disconnection of communication.

Digital Input Status Indicators (1d)
There are nine indicators labeled UP, DOWN, EXC OFF, DROOP OFF, O/P CONTACT, RESET (2500), PS0 (2500), PS1 (2500) and VAR/PF OFF in the header. These indicators show the status of the nine input/output signals to/from the regulator. If their corresponding input contacts are closed, they will show as yellow. If the corresponding input contacts are open, they will show as gray (depending upon whether the inputs are configured as active high or active low under the Digital I/O tab).



METERING (2)

This panel has five sub-panels: AC and RTD Metering, DC and Input Metering, Step Change and Simulated Reactive Power, and the Alarms/Faults.

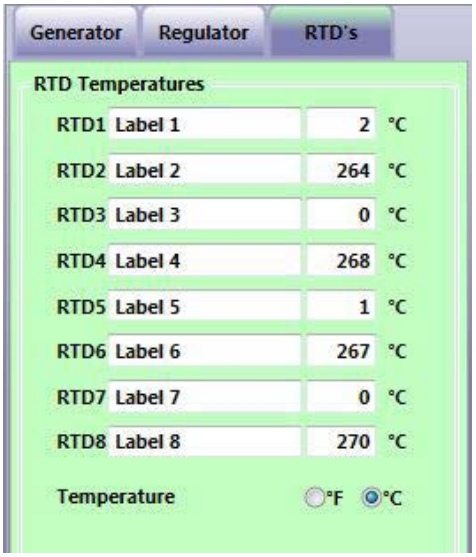
AC and RTD Metering (2a)

This Generator and Regulator panel displays the measured AC quantities of the generator and regulator respectively. Specifically, the panel displays line-to-line voltages, line-to-neutral voltages, line currents, real power, apparent power, reactive power and power factor. The RTD panel (2500 only) displays the measured temperatures of the 8 RTD channels (additional RTD module required). When the Generator tab is active (default), the values displayed correspond to the generator output terminals (primaries of potential and current transformers). When the Regulator tab is active, the values displayed correspond to the regulator input terminals (secondary sides of potential and current transformers).

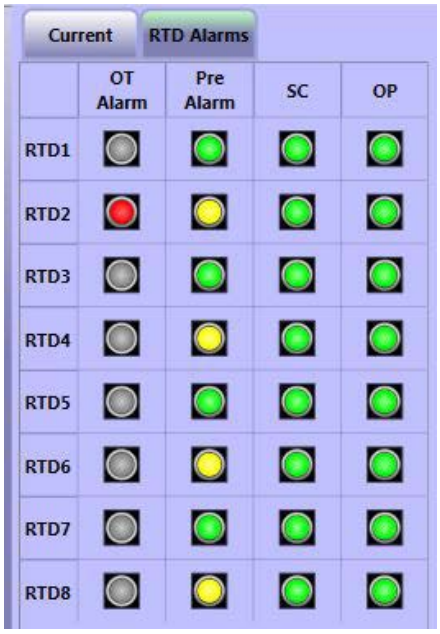
Note: If the regulator detects an OPEN or a SHORT on RTDs, the measured temperature saturates to a very low or very high value, respectively, and the corresponding SC or OP circuit indicator/'s may be indicated if the SC or OP detection is enabled. When the regulator is only powered by USB for communication, RTD's temperatures are measured as -200° C. If RTD SC alarms are enabled, this may trigger an event in the event log.

DC and Input Metering (2b)

This panel displays the measured DC values of field current and field voltage, regulator temperature, generator speed, auxiliary input voltage, Generator frequency, input power frequency, input power voltage and battery voltage (2500 only).



RTD Metering



RTD Faults and Alarms

Step Change (2c)

This panel enables a voltage step function intended for monitoring the regulator performance. This function is only utilized in AVR1 or AVR3 regulation modes. The panel displays the voltage set point reference from the Configurations panel with arrow keys to permit voltage adjustment up and down. Below the set point is a field called Step Change with a valid range of -10 to 10%. When the "Apply" button below this field is clicked, the regulator will add the given percentage as an offset to the voltage set point. Pressing "Clear" will remove the offset and restore the original set point.

Simulated Reactive Power (2d)

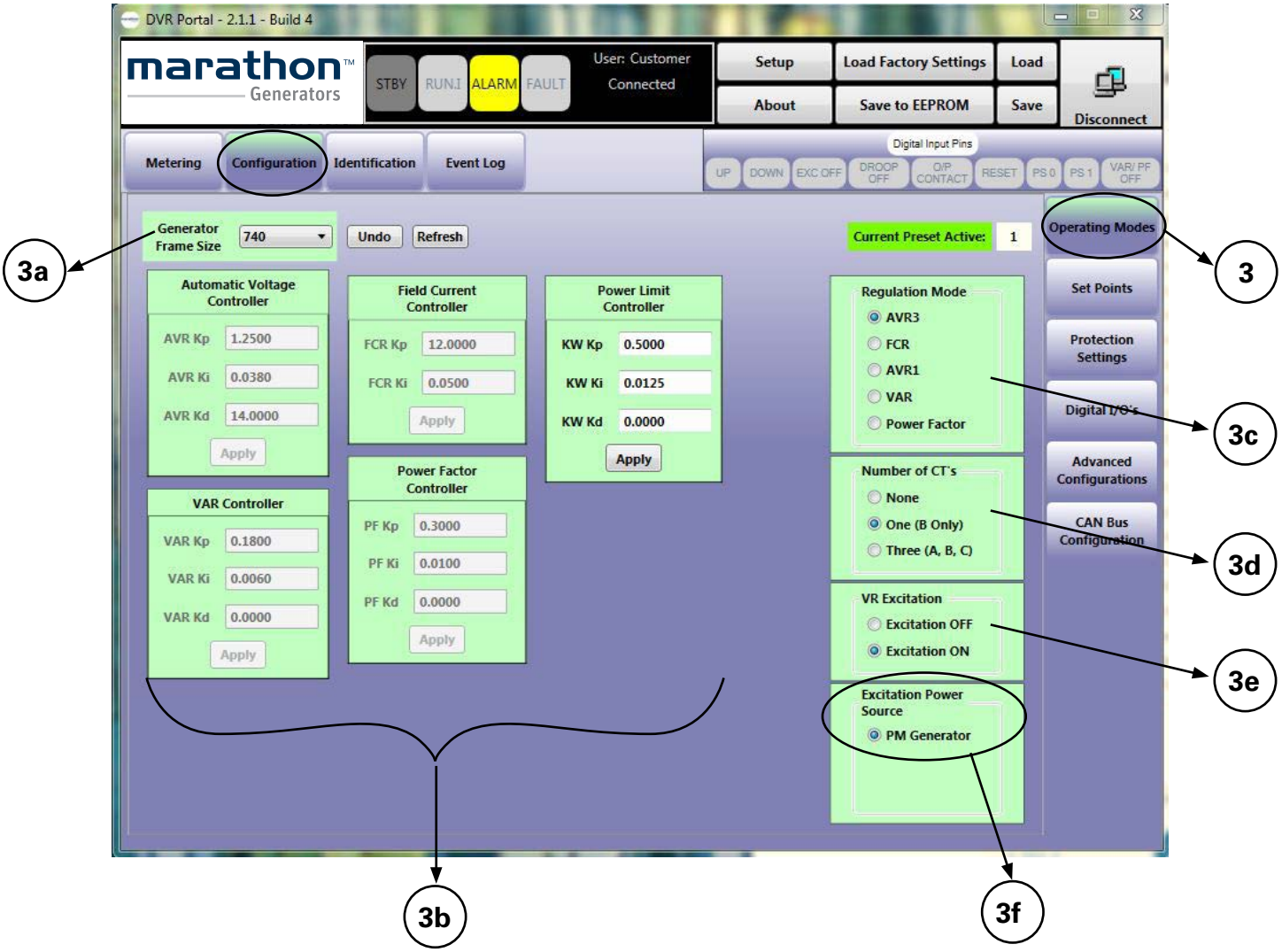
This panel enables the simulation of reactive power. The radio button for reactive power has two options. In Normal mode, the metering panels will display the currents and powers in their actual sense. In Simulated Reactive Power, a flashing indicator will appear in the metering panel that indicates this mode has been selected. The apparent power is calculated just as in Normal mode. The real and reactive powers are created with the simulated power factor. This is intended as a diagnostic mode to assist with the setup of paralleling generators in droop compensation mode with the use of a resistive load bank. Enabling this condition simulates a reactive load on the generator.

Faults/Alarms (2e)

This panel displays alarms and faults. When the "Current" tab is active, the panel displays faults and alarms that are currently active on the regulator. The alarms and faults can be in any of four possible states:

- OK State: If the regulator is in a run state, there will be a green indicator next to all enabled alarm and fault conditions.
- Disabled State: If a given alarm or fault condition is disabled (for example Generator Voltage Imbalance in AVR1 regulation mode), that condition will display a gray indicator.
- Alarm State: If the regulator is in an alarm state, there will be a yellow indicator next to the corresponding condition causing the alarm.
- Fault State: If the regulator is in a fault state, there will be a red indicator next to the corresponding condition causing the fault.

When the RTD Alarm's tab is active, the panel displays faults and alarms that are active for the RTD thermal protections. This tab displays OT (Over Temperature) Alarms, Pre Alarms, SC (RTD Short Circuit) Alarms, OC (RTD Open Circuit) Alarms.



CONFIGURATION

This panel has six sub panels: Operating Modes, Set Points, Protection Settings, Digital I/O, Advanced

Configurations and CAN Bus Configuration.

OPERATING MODES (3)

This panel contains controls for altering the operating mode of the regulator including dynamic response and regulation.

Generator Frame Size (3a)

This pull down menu selects stability settings for the chosen frame size in AVR1 or AVR3 regulation modes. Gains for the controller are displayed with gray numbers in the panel below the pull-down menu. Selecting the appropriate frame size chooses appropriate proportional, integral and derivative gain values. These gain values are not editable. For editable custom gains, Generator Frame Size "CUST" should be selected. Choosing "CUST" will copy the gains from the previous selected frame size. The grayed gains will then become active for editing. Saving to EEPROM will store the edited gains to the user settings.

PID Controller Gains (3b)

There is a separate panel for adjusting the PID controller gains for each regulation mode as well as for power limiting, if that feature is enabled. The PID gains for AVR3 and AVR1 are described above in "Generator Frame Size." For FCR and Power Limiting, gains are editable when the corresponding regulation mode is selected. Some rounding may occur for gain values due to fixed point arithmetic.

Regulation Modes (3c)

This panel contains a radio button for selecting the regulation mode:

- **AVR3 Regulation Mode** is used for Automatic Voltage Regulation with three-phase generator voltage sensing.
- **AVR1 Regulating Mode** is used for Automatic Voltage Regulation with single phase generator voltage sensing.
- **FCR Regulation Mode** is used for field current regulation. In this mode the DVR® regulator will maintain a fixed level of field current.
- **VAR Regulating Mode** is used for reactive VAR regulation. This mode is only enabled when the VAR/PF_OFF input is open. Otherwise, the regulator will regulate as if AVR3 mode were selected.
- **PF Regulating Mode** is used for power factor regulation. This mode is only enabled when the VAR/PF_OFF input is open. Otherwise, the regulator will regulate as if AVR3 mode were selected.

Number of CT's (3d)

This panel contains a radio button for selecting the number of CT's to be used for current and power measurement.

- **Three (A, B, C)** is used for metering of all three phase currents independently. This sensing mode should only be selected when using three current transformers. This is only available on the 2500.
- **One (B Only)** is used for metering of phase B current only. This sensing mode should only be selected when using one current transformer in phase B. Currents for phases A and C will not be metered and power measurements will be based on the assumption phase B current flows equally in phases A and C.
- **None** is used if no current transformers are connected.

VR Excitation (3e)

This panel contains a radio button for disabling or enabling excitation to the field.

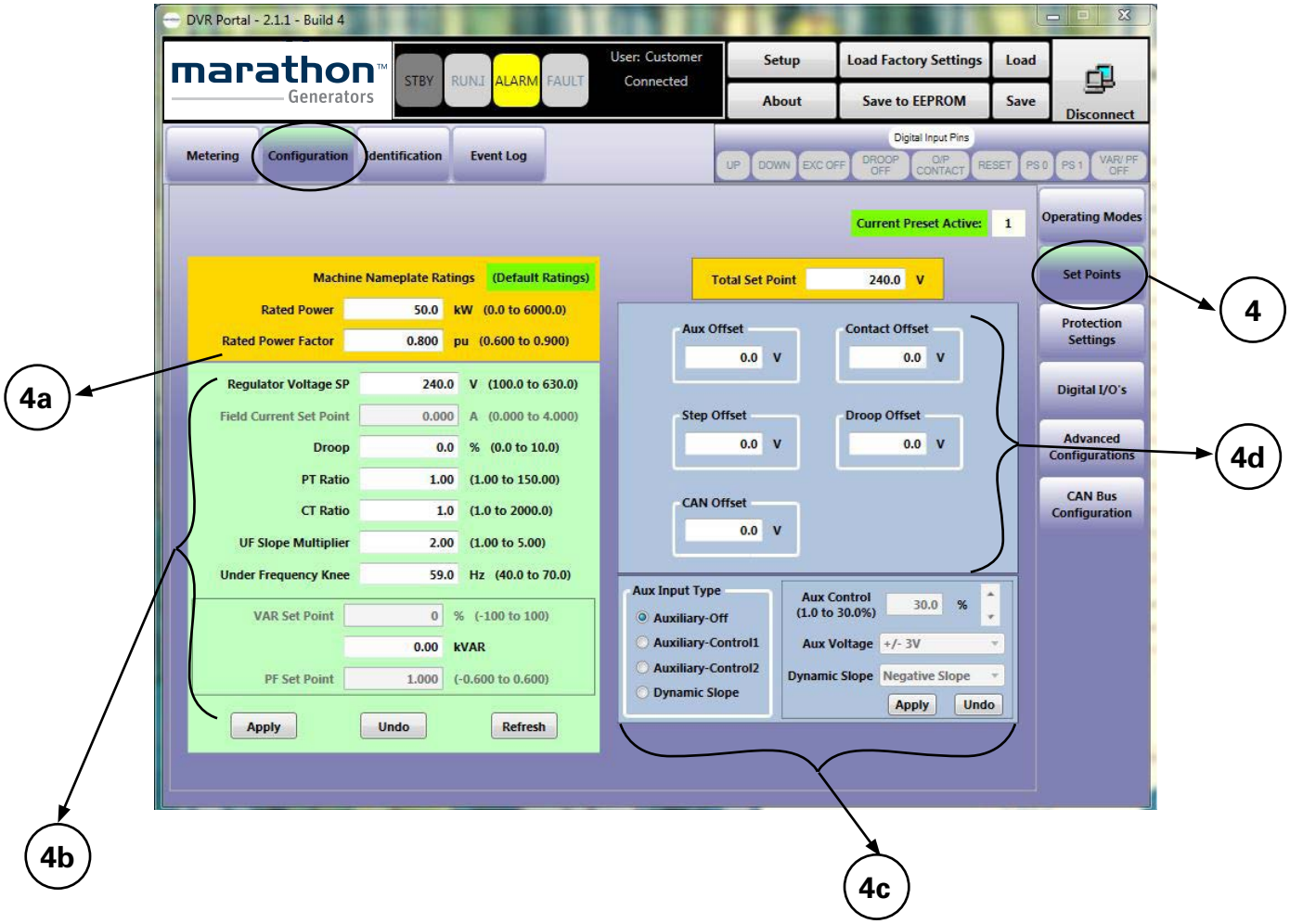
- **Excitation Off** is used to disable excitation to the generator exciter field. The status indicator in the header will display a "STBY" state. This state is recommended for making adjustments to the regulator settings.
- **Excitation On** is used to enable excitation to the generator exciter field. If the regulator was previously "Off," selecting this state will initiate a new soft start for AVR1 and AVR3 regulation modes.

Note: Any changes to the regulator settings made prior to selecting "Excitation On" will be lost unless they are saved to EEPROM. See the Header section above for details on saving settings to EEPROM.

Input Power Source (3f)

This panel contains a radio button for selecting the input power source type.

- **PM Generator** is selected if the input power is derived from a permanent magnet generator.



SET POINTS (4)

This panel contains editable fields for configuring the regulator and displays adjustments to the regulator set points.

Machine Nameplate Rating (4a)

This panel contains the fields for the rated power and rated power factor of the machine the regulator is regulating. If the rated power selected matches the default rated power for a given frame size, an indicator will specify this condition.

Note: These fields are critical for proper regulation in droop compensation, VAR and PF regulation modes. For protection features like reverse power and under excitation, nameplate ratings are used as the basis for these protections.

Regulation Set Points (4b)

This panel contains the editable fields for selecting the regulator set point for the various regulation modes and the frequency characteristics of the regulator.

- Regulator Voltage Set Point is editable in AVR1, AVR3, VAR and PF regulation modes. This value represents the desired voltage at the regulator voltage sensing terminals, regardless of PT ratio. Offsets from the UP and DOWN contacts, auxiliary input, droop, step change and/or the CAN bus are derived from this set point.

- If there are no PT's and the regulator sensing leads are connected line-to-line, the desired generator output voltage is identical to the Regulator Voltage Set Point. If the regulator sensing leads are connected midpoint-to-midpoint of a series wye configuration, the desired generator output voltage is twice the Regulator Voltage Set Point.

  If there are PT's in the sensing circuit, the desired generator output voltage is determined by the multiplication of the PT ratio and the Regulator Voltage Set Point.

- **Field Current Set Point** is editable in FCR Regulation Mode. This value represents the desired field current of the regulator.

- **Droop** is the maximum percentage of Regulator Voltage Set Point allowed for adjustment of voltage during load sharing. Refer to Section – Features and Protection for a detailed description of Load Sharing.

- **PT Ratio** is the value of the potential transformer ratio of the system. The generator output voltages displayed in the Generator tab of the Metering panel are equivalent to the voltages displayed in the Regulator tab multiplied by this value.

Example: A PT with a 13,200 Volt primary rating and a 240 Volt secondary rating would have a PT Ratio of 55.

- **CT Ratio** is the value of the current transformer ratio of the system. The generator output currents displayed in the Generator tab of the Metering panel are equivalent to the currents displayed in the Regulator tab multiplied by this value.

Example: A CT with an 800 A primary rating and a 5 A secondary rating would have a CT ratio of 160.

- **Slope Multiplier** is the factor applied to the base slope for voltage roll-off with respect to frequency in a V/Hz mode. Refer to Section – Features and Protection for a detailed description of Generator Under Frequency.

- **Under Frequency Knee** is the value of frequency below which the regulator operates in a Volts-per-Hertz mode. Refer to Section – Features and Protection for a detailed description of Generator Under Frequency.

Auxiliary Input Configuration (4c)

This panel contains controls for modifying the functionality of the auxiliary input.

- **Auxiliary Input Type** configures the auxiliary input as a set point modifier, a slope multiplier modifier or disabled. Refer to Section – Features and Protection for a detailed description of the Auxiliary Input function.

Note: If Aux input type is selected as Dynamic Slope (2500 only), the UF Slope setpoint field will be locked as this register dynamically updates with the applied AUX voltage.

- ***Aux. Control Scale Factor*** is used when the auxiliary input port is configured as "Auxiliary Control1" or "Auxiliary Control2" This value scales the auxiliary input. Refer to Section – Features and Protection for a detailed description of the Auxiliary Input function.

- **AUX Voltage** is used to select the range of AUX voltage applied to the regulator. This feature is only available in the 2500. For the 2400 this is by default set to +/-3V. The 2500 provides additional selections of +/-5V and +/-10V.

- **Dynamic Slope** Is used to select the polarity of the dynamic slope feature. This determines the direction of slope variation when a 0 - 5V is applied to Aux Input. This feature is only available in the 2500. Refer to Section – Features and Protection for a detailed description of the Dynamic Slope function.

Offset Display (4d)

This panel displays the offsets contributing to the modification of the set point for the currently selected regulation mode.

- **Contact Offset** displays the effect that the contact inputs have on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the UP and DOWN contact input functions.

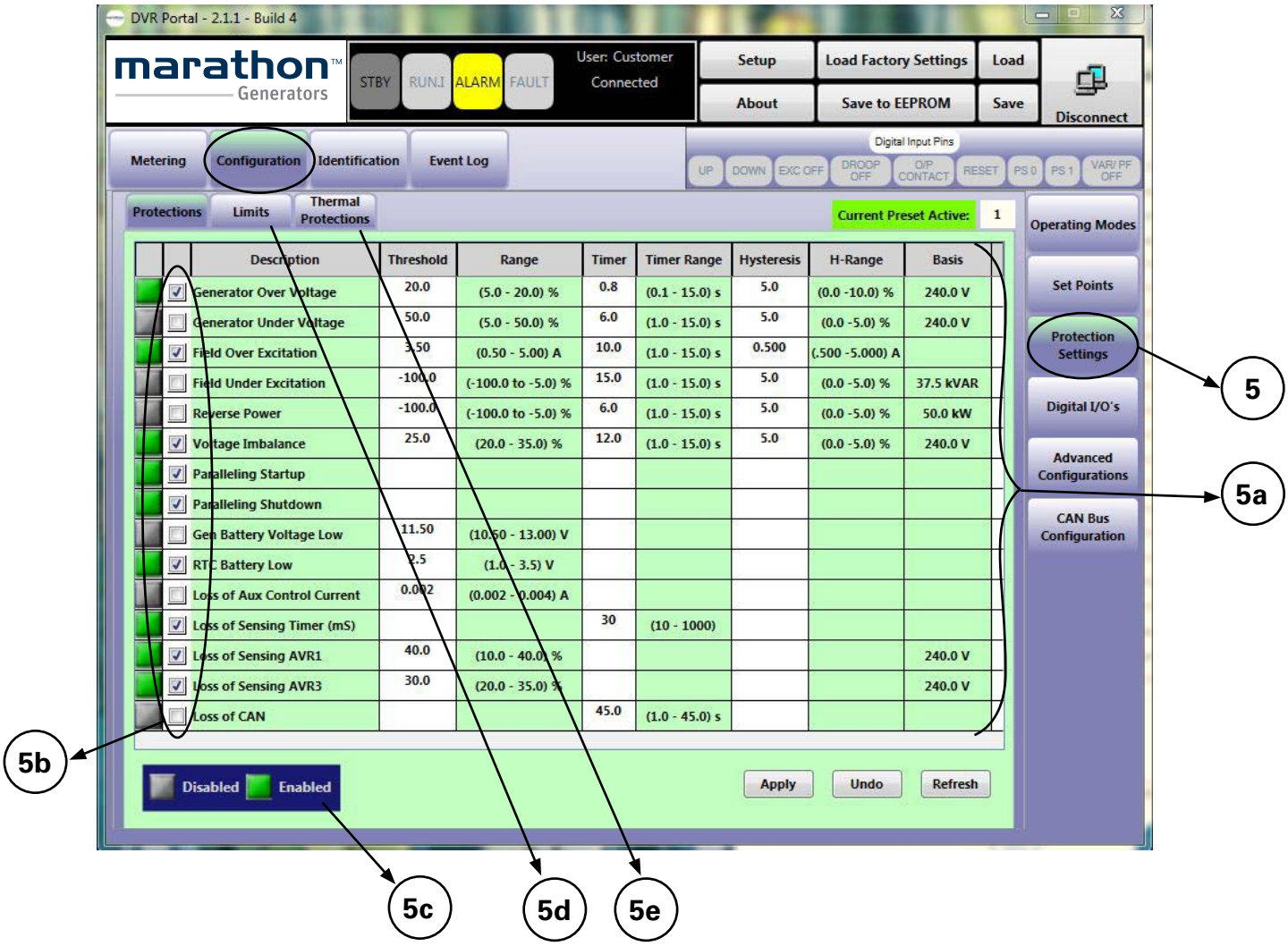
- **Auxiliary Offset** displays the effect that the auxiliary input has on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the Auxiliary Input function.

- **Droop Offset** displays the effect that the regulator's droop function has on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the Load Sharing function.

- **CAN Offset** displays the effect that the Set Point Adjust CAN message has on the regulator set point value. Refer to the DVR®2500 CAN Bus Interface User Guide for a detailed description of the Set Point Adjust message.

- **Step Offset** displays the effect that the step change from the Metering tab has on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the step change input functions.

- **Total Set Point** displays the total reference to the controller. This reference value is comprised of the set point and any offsets currently active.



PROTECTION SETTINGS (5)

This panel contains three sub panels for protection settings, limit settings and thermal protection settings.

Protections (5a)

This panel contains editable Enable/disable threshold, hysteresis and timer fields for configurable faults and alarms. For most applications, the default values of these parameters can be used. For protection settings that have a threshold as a percentage, the "Basis" column indicates the regulator parameter used for the percentage related to that protection feature. Refer to Section 4 for detailed description of these protections.

Enable/Disable (5b)

The panel contains enable/disable options for all protections. Most of these can be either enabled or disabled. But some of the protections can't be disabled. Please refer to Section – Features and Protection to see which protections can be disabled by customers.

Protection Table Legend (5c)

This legend indicates which protection settings are disabled (gray) and enabled (green). The state of protection features is dependent on the selected regulation mode.

Note: Even if the enable is checked, some protections might be shown as disabled as these may not be applicable for that particular regulation mode. For example, in FCR mode, Under Voltage is disabled as this mode is doing field current regulation. Therefore, if this is enabled by user in FCR mode the indicator will shows this as disabled.

Limits (5d)

This panel contains editable limit thresholds for field current and generator power as well as the soft start time. For most applications, the default values of these parameters should be used.

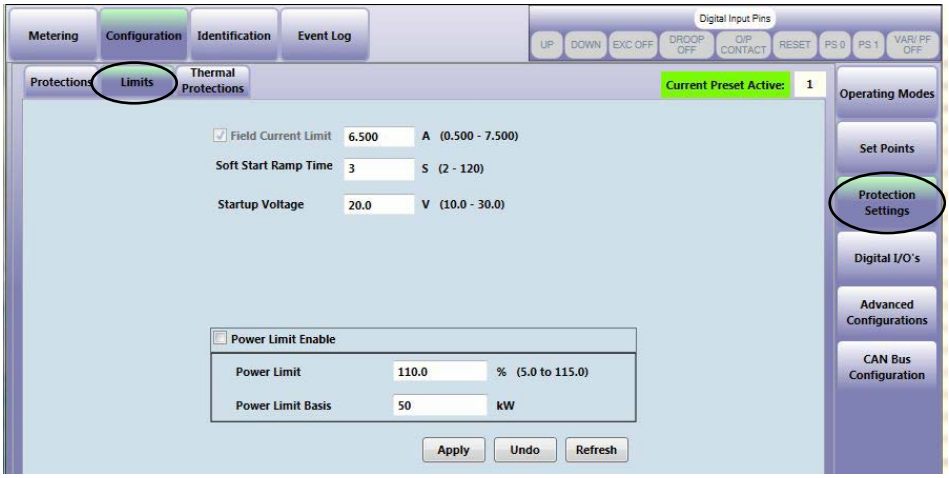
- **Field Current Limit** is the maximum allowable field current output of the regulator. Refer to Section – Features and Protection for a detailed description of the Field Current Limiting feature.

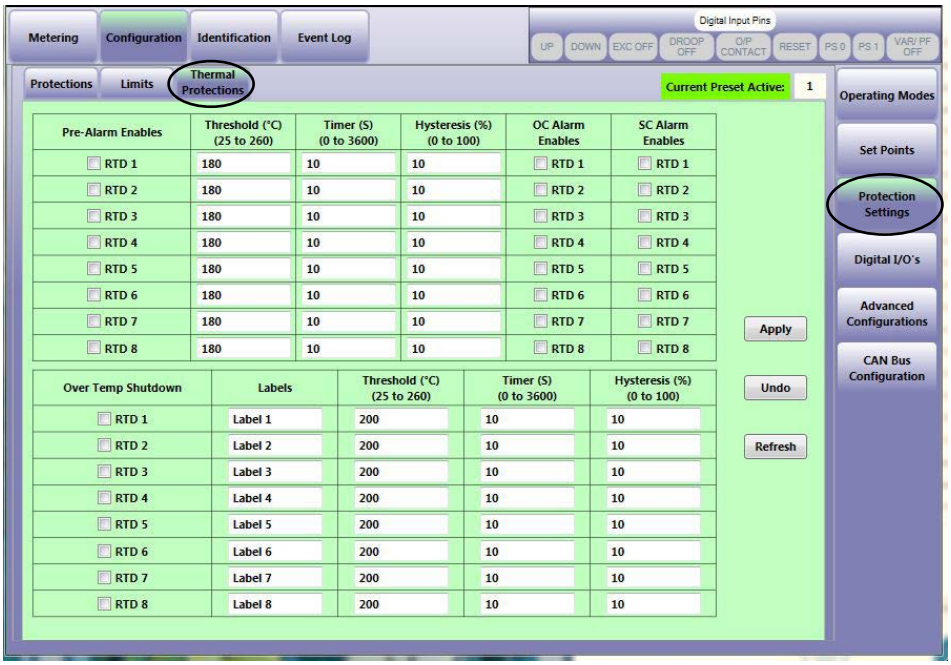
- **Soft Start RampTime** Is the amount of time taken to ramp to the desired voltage at the generator output terminals in AVR1 and AVR3 regulation modes. Refer to Section – Features and Protection for a detailed description of the Generator Soft Start function.

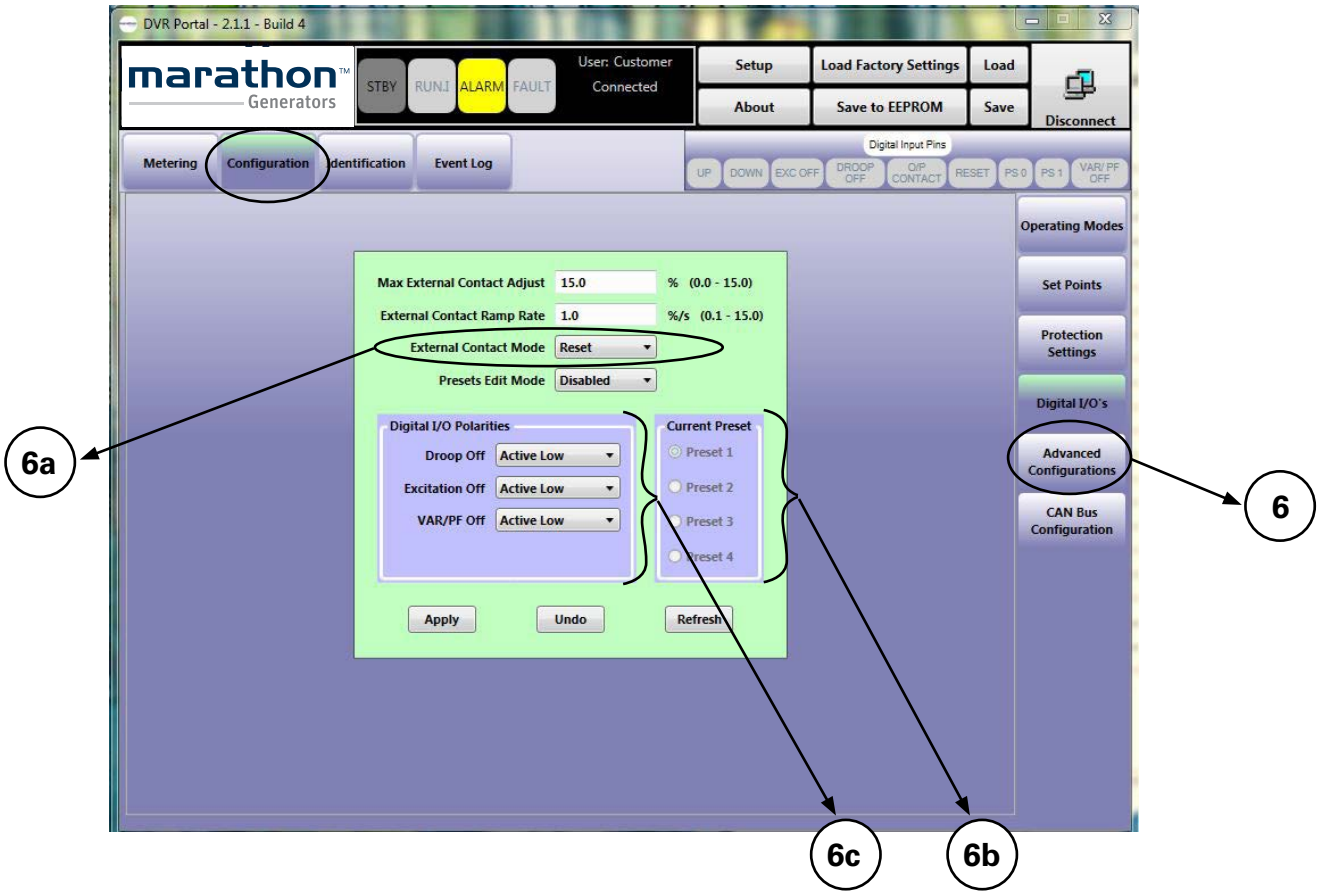
- **Power Limit** is the maximum allowable power output of the generator. The checkbox above the Power Limit permits enabling/disabling of this limit. Enabling the limit also enables the PID controller associated with it on the Operating Modes panel. Refer to Section – Features and Protection for a detailed description of the Power Limiting feature.

Thermal Projections (5e)

This panel contains editable Enable/Disable, Thresholds, Hysteresis and timer fields for RTD Pre-Alarms and RTD Over Temperature Shutdowns. This panel also contains editable Enable/Disable for RTD Open Circuit and RTD Short Circuit Alarms. Refer to features and protection for further details.







DIGITAL I/O (6)

This panel contains configurations related to the regulator digital inputs and output.

External Contact Mode (6a)

This field provides users a way to configure UP/DOWN contact mode. Setting this to RETAIN will save contact offset after a change is made to the UP/DOWN contact. The DVR® regulator clears the offset after power cycle if this is set to RESET.

Current Preset (6b)

These radio buttons show which preset is currently active in the 2500. These provide users the ability to set the configurations for each of the presets using these radio buttons. Here the steps that need to be followed in order to edit the preset configurations.

a. Place the regulator is stand-by mode
b. Connect to regulator through the DVRPortal™ software
c. Set "Preset Edit Mode" to "Enable"
d. Select the preset that you would like to edit (6b)
e. Navigate through various tabs and modify the configurations
f. Once the configurations are modified to this particular preset, hit "Save to EEPROM"
g. Repeat steps "c - f" for other presets

Note: Configurations will be lost if current preset is changed in the DVRPortal software program before saving to EEPROM.

Digital I/O Polarity (6c)

This panel provides users the ability to change polarity of the digital inputs to either Active Low or Active High.

Example: Default configuration of Excitation OFF contact is Active Low (excitation turned OFF when contact between EXC and GND is closed). If the user configures this to Active High, excitation will be disabled when the contact is Active High (excitation turned OFF when contact Is open between EXC and GND).

Notes:

1. Digital I/O polarity changes are allowed in Preset 1 only.
2. EXC_OFF polarity change won't take effect until a power cycle
3. Presets 2 through 4 will have same settings as Preset One (1).

ADVANCED CONFIGURATION (7)

This panel contains editable fields for parameters associated with generator and engine operation.

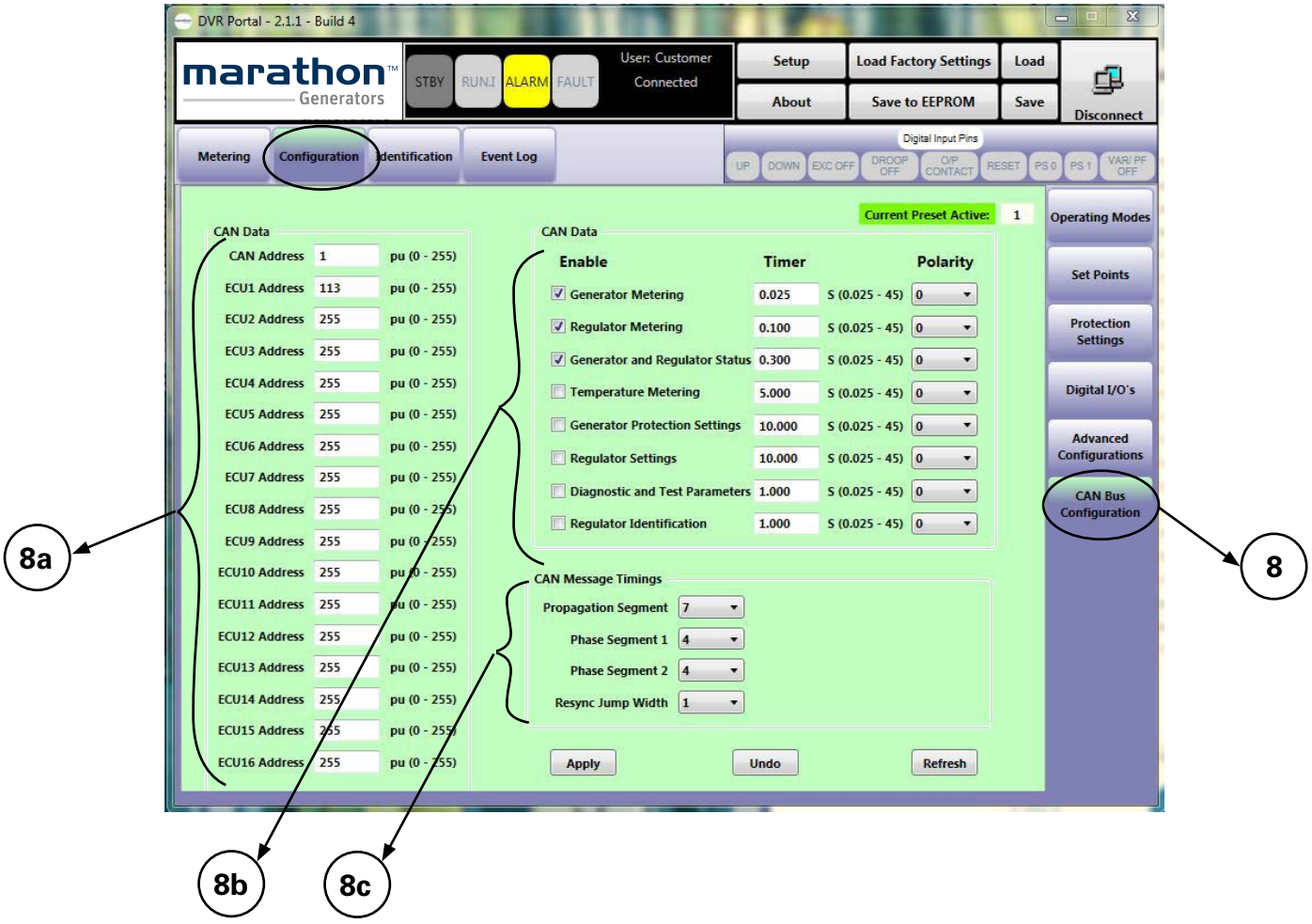
Soft Start Cut in Frequency:
This is the speed at which the regulator will initiate voltage soft start. The HMI and DVR® regulator will show "START" as a status indicator during the soft start.

Run Cut Out Hysteresis:
This is the speed at which the regulator stops providing excitation current to generator.

Idle Cut in Frequency:
This is the speed at which the regulator transitions from Stand-by to Idle mode.

Idle Cut out Hysteresis:
This is the speed at which the regulator transitions from Idle to Stand-by mode.

No. of Generator Poles:
This field lets you select if the generator is a 4 or a 6 pole machine. Changing this would impact the frequency and speed measurement of the regulator.



CAN BUS CONFIGURATION (8)

This panel contains editable fields for parameters associated with the CAN Bus communication of the 2500. Refer to the DVR2500 CAN Bus Interface User Guide for a detailed description of these features.

CAN Addresses (8a)

This panel allows editing of CAN addresses and message times.

- CAN Address is the CAN address of the regulator.
- ECU1 Source Address is the CAN address of the highest priority Electronic Control Unit that the regulator will respond to.
- ECU16 Source Address is the CAN address of the sixteenth-highest priority Electronic Control Unit that the DVR® regulator will respond to.

Note: The ECU addresses can all be assigned to the same control unit. They should only be different if the regulator needs to communicate with more than one ECU.

Time and Priorities (8b)

DVR CAN messaging is divided into seven (7) different groups. Each group time and priorities can be configured through this panel.

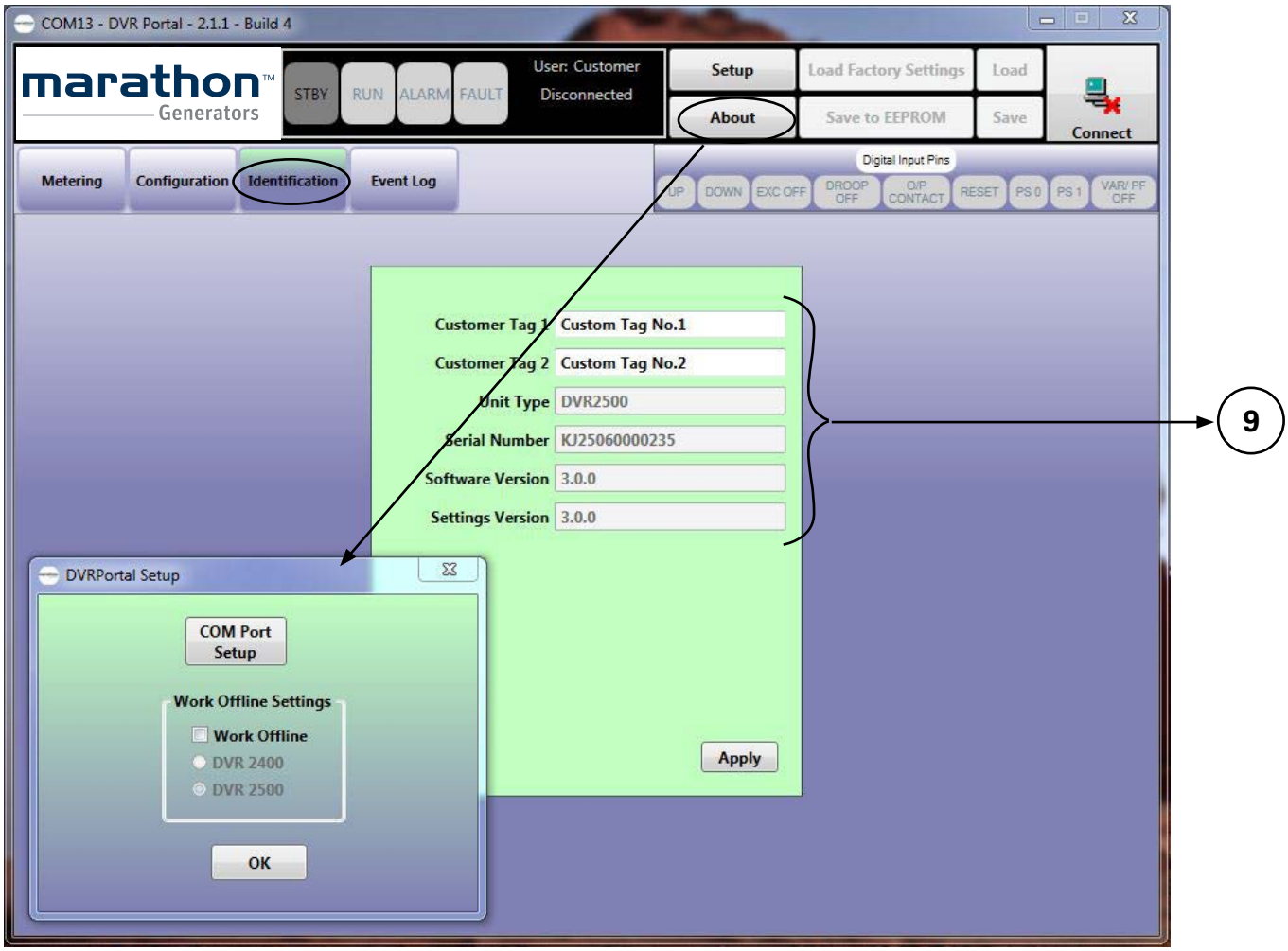
- Message Time is the amount of time between transmission of messages in that particular message group.
- Message Priority is the priority given to this particular message group. Zero (0) being highest priority and Five (5) being the lowest priority.

Refer to the CAN user manual for additional information regarding message groups.

CAN Message Timing (8c)

This panel allows users to edit additional timing settings through this panel. For further information, please refer to standard SAE J1939.

Note: When enabling multiple message groups, care must be taken to ensure that the regulator CAN bus is not over loaded.



IDENTIFICATION TAB (9)

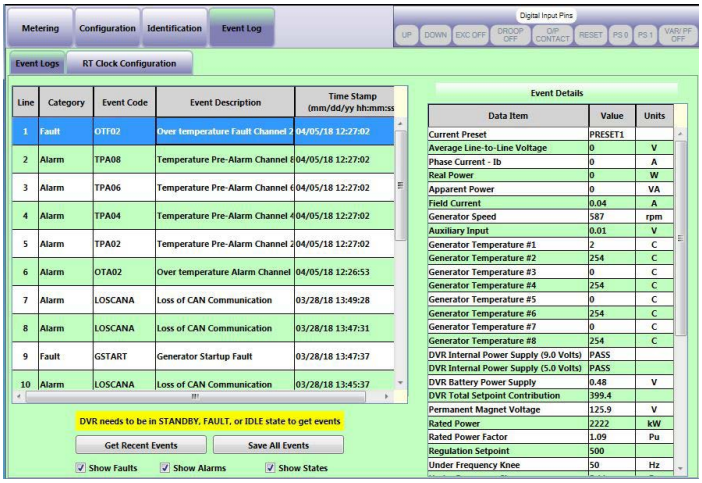
This panel contains non-editable fields for the regulator serial number, software version, and settings version. It also contains editable fields for custom tags.

- **Serial Number** is the serial number of the regulator.
- **Software Version** is the version of regulator firmware.
- **Settings Version** is the version of factory default settings for the regulator.
- **Customer Tag 1** is a 15-character string that can be stored to the regulator.
- **Customer Tag 2** is a 15-character string that can be stored to the regulator.

Note: The Apply button will write the string into the regulator RAM, but a Save to EEPROM is needed to store the tag in the non-volatile memory.

EVENT LOG TAB (10)

This panel provide user access to event information logged by the regulator and ability to set the Real Time Clock (RTC) for the 2500.



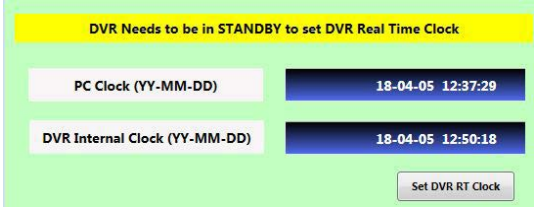
- **Get Recent Events** button lets the DVR®Portal software read events from the regulator. Make sure that the regulator is in either STANDBY, IDLE or FAULT state to ensure the regulator does not malfunction as reading events is memory intensive
- **Save all Events** button lets you export events data from the portal to a .CSV file. This allows users to share event log data.
- The check boxes "Show Faults", "Show Alarms" and "Show States" will allow user to filter the events in the portal.
- Event details can be access by selecting the event user is interested in, event details space will load the details.

Note: If the regulator measures temperatures above 254°C (in case of open circuit), the temperatures under event log are statured to 254°C due to limited memory. Metering will display actual temperature though.

Event Details

Data Item	Value	Units
Current Preset	PRESET1	
Average Line-to-Line Voltage	0	V
Phase Current - Ib	0	A
Real Power	0	W
Apparent Power	0	VA
Field Current	0.043	A
Generator Speed	587	rpm
Auxiliary Input	5.11	V
Generator Temperature #1	2	C
Generator Temperature #2	254	C
Generator Temperature #3	0	C
Generator Temperature #4	254	C
Generator Temperature #5	0	C
Generator Temperature #6	254	C
Generator Temperature #7	0	C
Generator Temperature #8	254	C
DVR Internal Power Supply (9.0 Volts)	PASS	
DVR Internal Power Supply (5.0 Volts)	PASS	
DVR Battery Power Supply	0.48	V
DVR Total Setpoint Contribution	399.4	
Permanent Magnet Voltage	125.9	V
Rated Power	2222	kW
Rated Power Factor	1.09	Pu
Regulation Setpoint	500	
Under Frequency Knee	50	Hz
Under Frequency Slope	5.11	Pu
Droop Percentage	0	%
PT Transformer Turns Ratio	22	V
CT Transformer Turns Ratio	22	A
Regulation Mode	AVR1	
Digital IO UP	INACTIVE	
Digital IO DOWN	INACTIVE	
Digital IO Excitation OFF	INACTIVE	
Digital IO Droop OFF	INACTIVE	
Digital IO VAR/PF OFF	INACTIVE	
Digital IO Reset	INACTIVE	
Digital IO Voltage Match	INACTIVE	
Digital IO Output Contact	INACTIVE	
Generator Frame Size	571	
Threshold Value for Event	200	
Threshold Timer Value for event	10	

- RT Clock Configuration tab lets user synch system clock with the regulator's internal clock for accurate event time stamp. This is only available in the 2500.



MAINTENANCE AND TROUBLESHOOTING

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

EXPLOSION HAZARD

- Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

ROTATING PARTS HAZARD

- Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

OVERSPEED HAZARD

- Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

DO NOT DISASSEMBLE

- Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and voltage regulators. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING

MAGNETIC FIELD HAZARD

- Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which could cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

PREVENTATIVE MAINTENANCE

The only preventive maintenance required on the regulator is to periodically check that the connections between the regulator and the system are clean and tight. The only user serviceable parts on the regulator are the fuse and RTC coincell battery. Regal recommends that no repair procedures, other than replacing the fuse or coincell battery if needed, be attempted by anyone other than Regal personnel.

TROUBLESHOOTING

⚠ WARNING

Read and follow all applicable safety instructions. Failure to do so may result in serious personal injury, death, and/or property damage, particularly when working with safety barriers removed.

If the output of the generator does not meet specifications, the first level of troubleshooting is to verify proper generator and regulator connections. This Installation, Operation and Maintenance Manual of generator should be referenced.

The following steps should be taken if the generator output is incorrect:

1. Verify meter is operating properly.
2. Check the programmable settings of the regulator are correct.
3. Verify the speed of rotation of the generator is correct.
4. Stop the generator and verify that the wiring of the generator and regulator is correct and the connections are good and insulated properly.
5. **Follow all applicable safety warnings and cautions while performing this test.**
   Carefully perform a constant excitation test of the generator and verify the output meets specifications, in accordance with the Installation, Operation and Maintenance Manual for the generator.
6. **Follow all applicable safety warnings and cautions while performing this test.**
   Verify the output of the PMG (input power of the regulator) is within specification.
7. Continue with the following troubleshooting flow charts.

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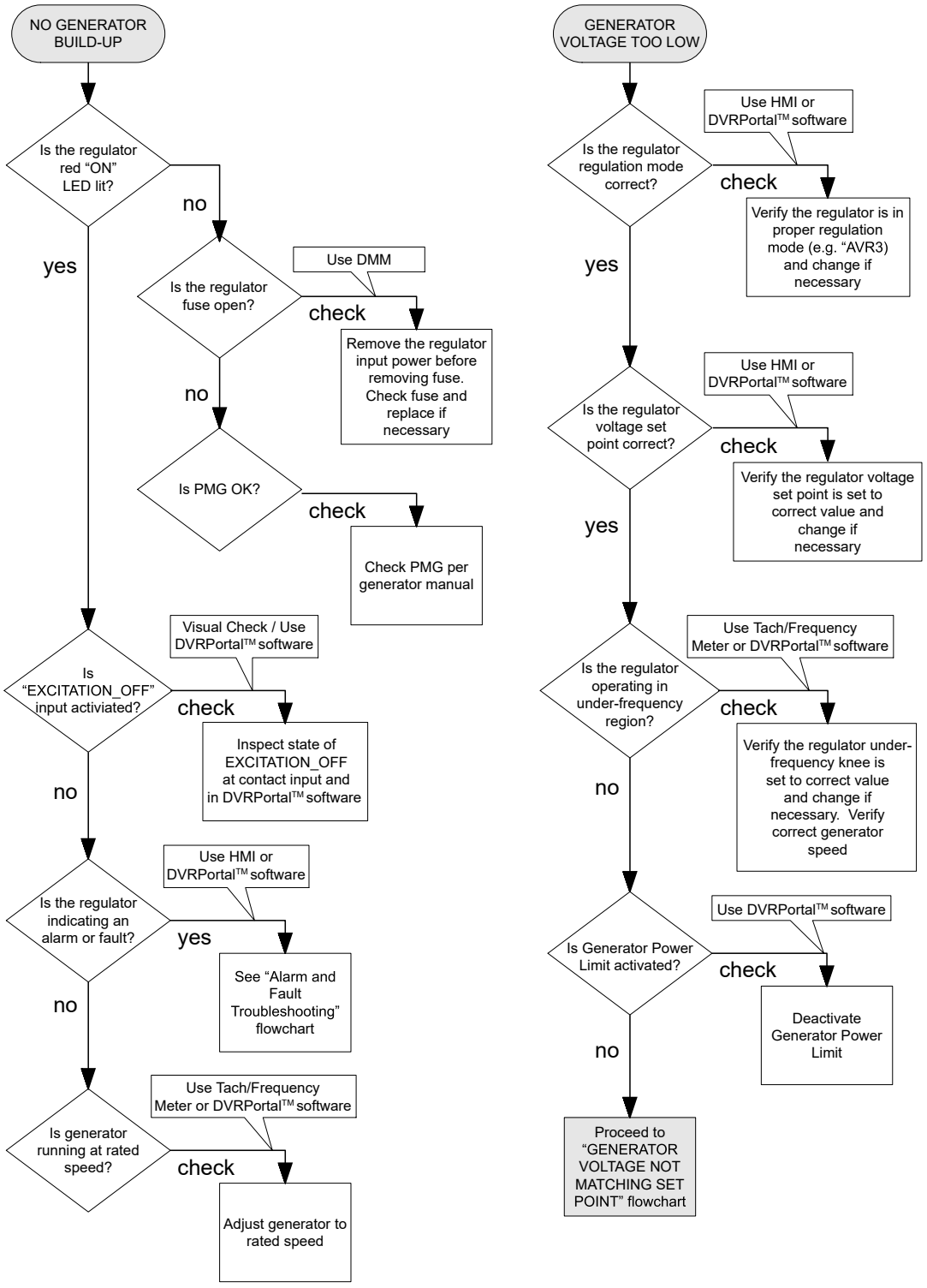
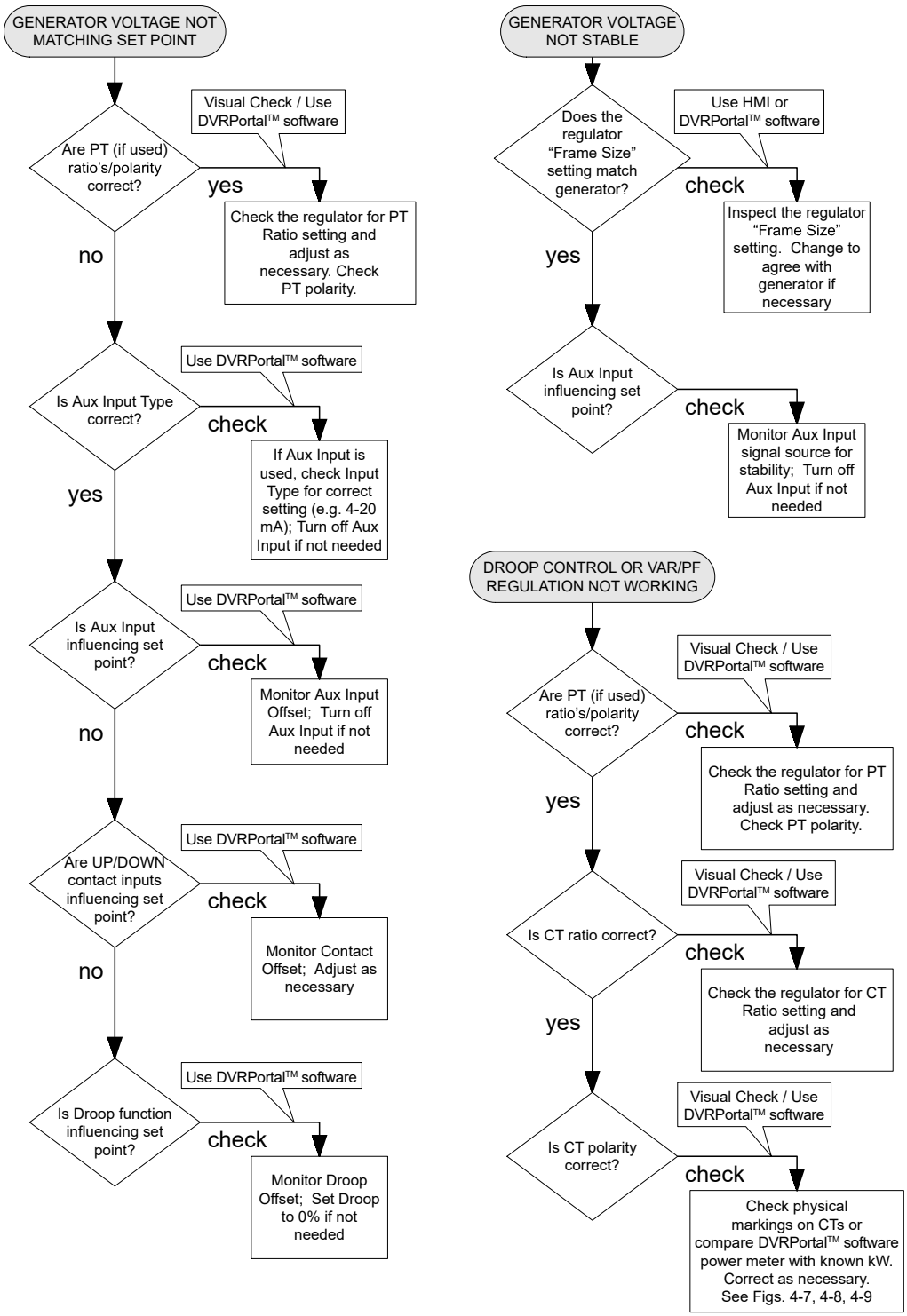
TROUBLESHOOTING FLOWCHART

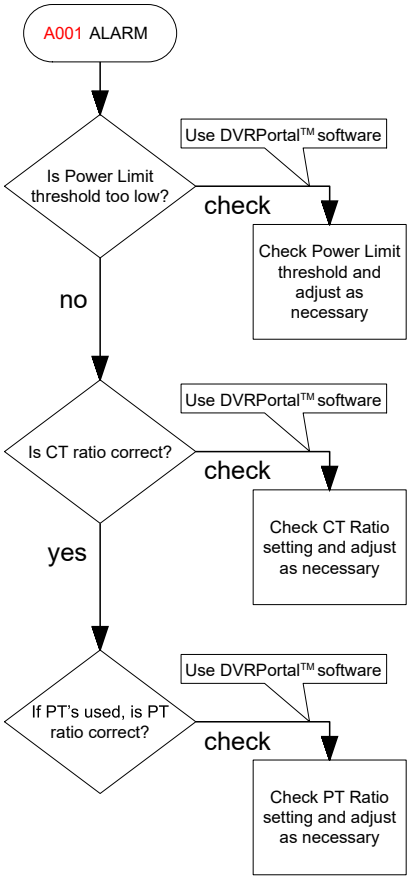


TROUBLESHOOTING FLOWCHART

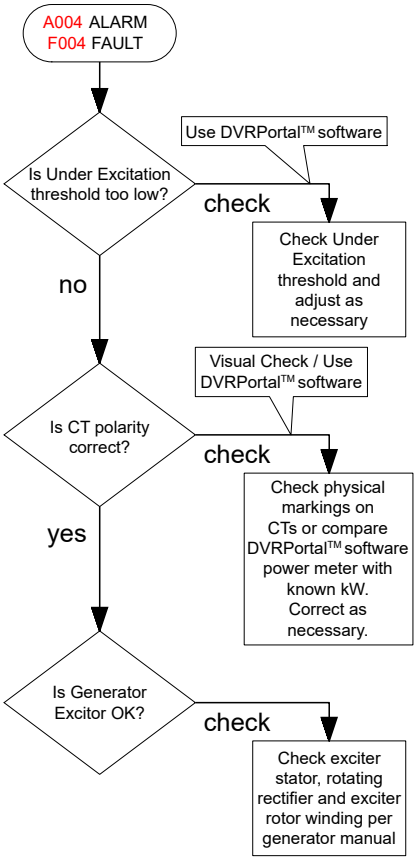


ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

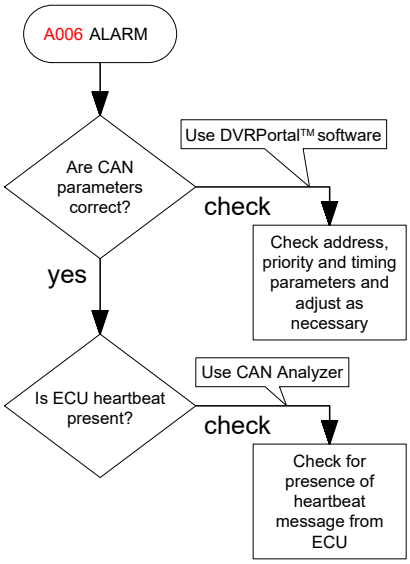
Generator Power Limit Alarm



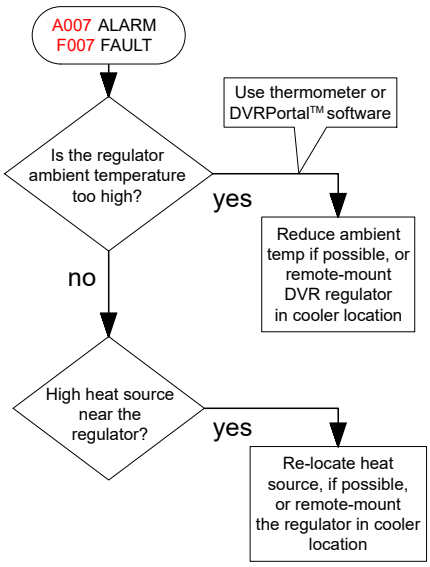
Under Excitation Alarm/Fault



Loss of CAN Communication Alarm

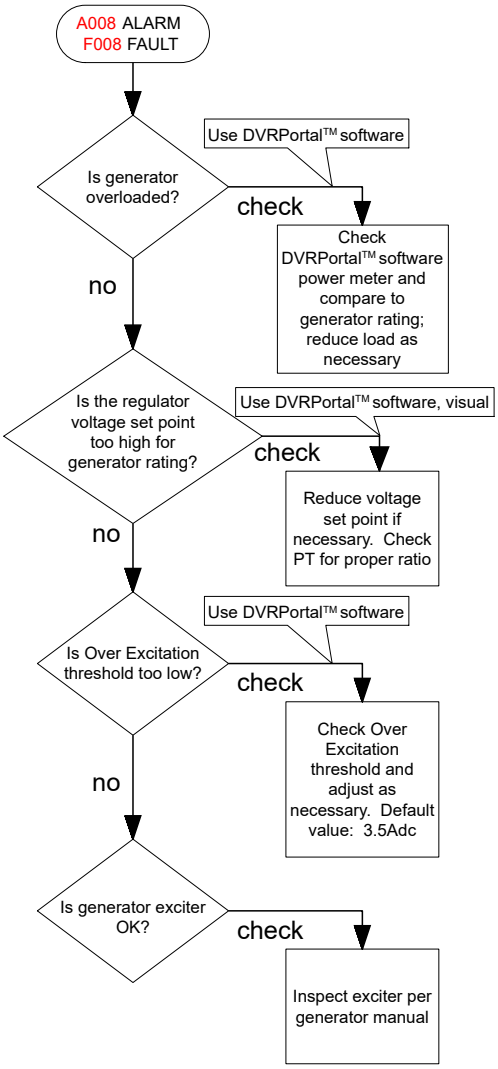


Regulator Over Temperature Alarm/Fault

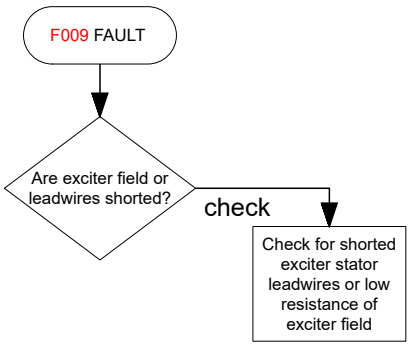


ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

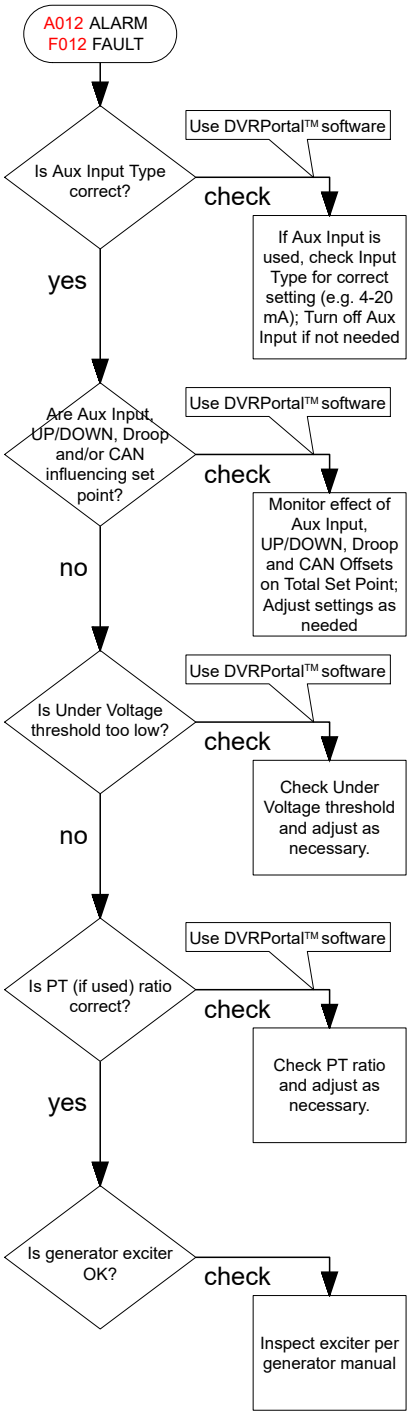
Field Over Excitation Alarm/Fault



Instantaneous Field Over Current

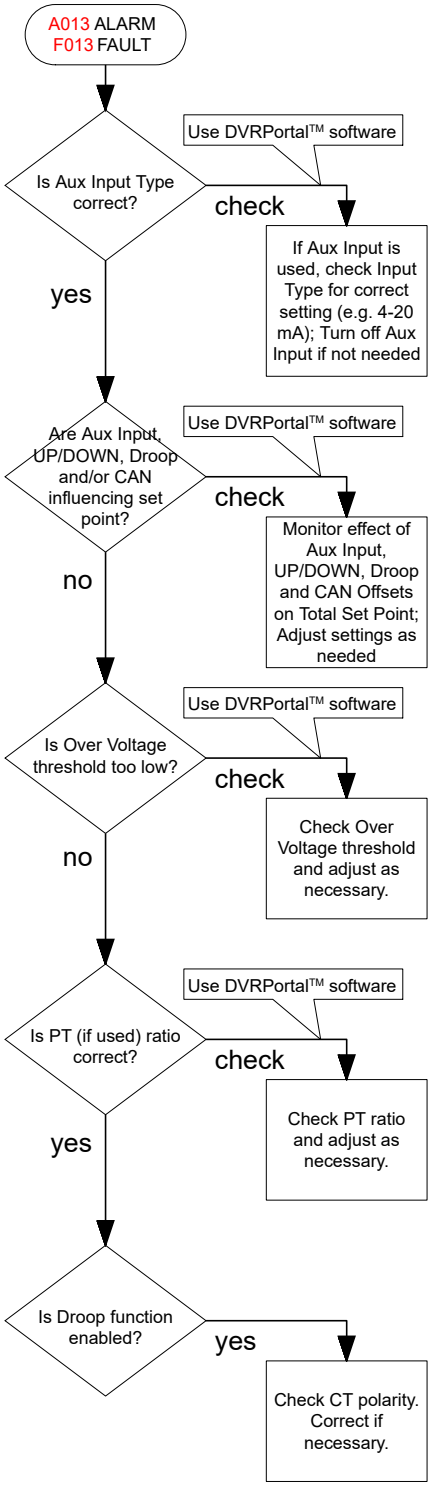


Generator Under Voltage Alarm/Fault

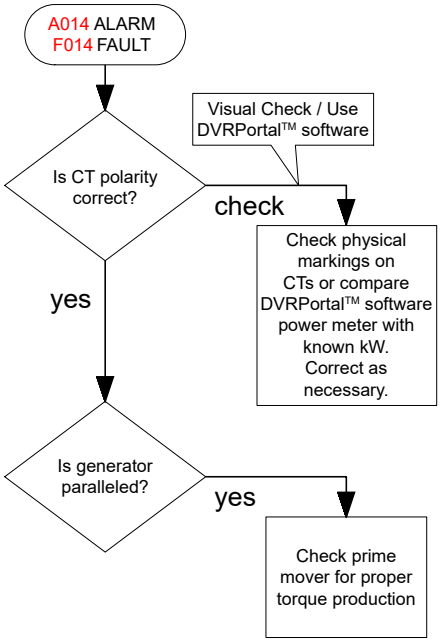


ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

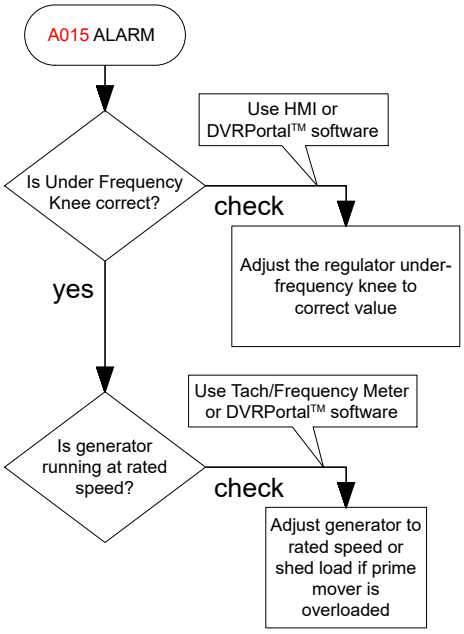
Generator Over Voltage Alarm/Fault



Reverse Power Flow Alarm/Fault

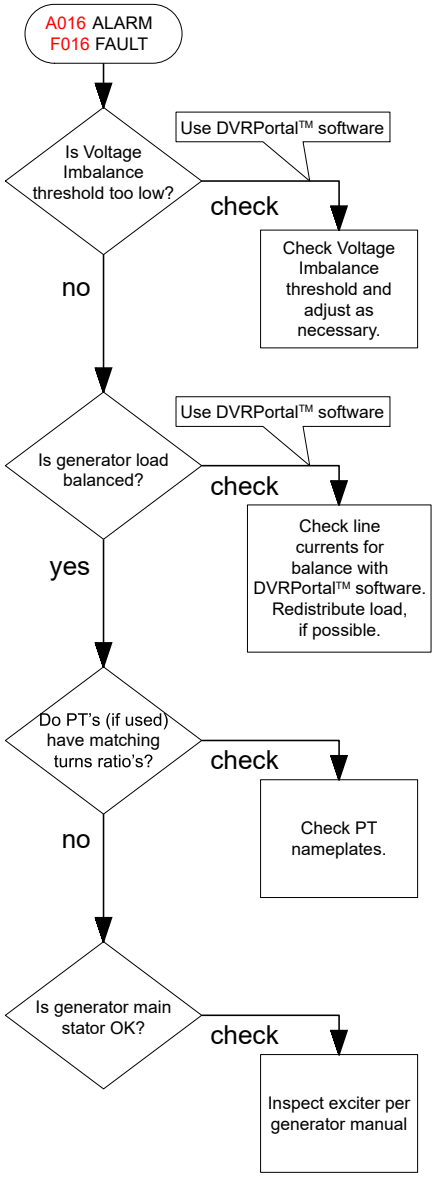


Generator Under Frequency Alarm

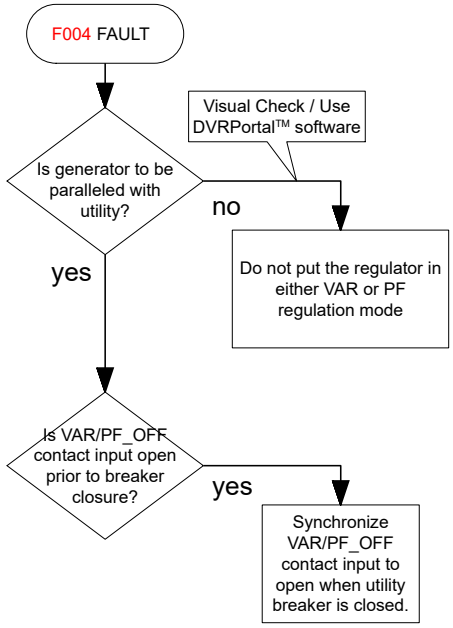


ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

Generator Voltage Imbalance Alarm/Fault



Start Up Fault



APPENDIX A

ALARM CODES

During an alarm condition, the HMI will display the code of the corresponding alarm condition. The table can be used to determine what condition is causing the alarm.

Alarm Codes

A001	Unused
A002	Field Under Excitation
A003	Real Time Clock Battery Low
A004	Generator Battery Low
A005	RTD Pre-Alarm/ Over Temperature/ Open / Short Circuit
A006	Loss of CAN Communication
A007	Regulator Over Temperature
A008	Field Over Excitation
A009	Unused
A010	Unused
A011	Loss of Auxiliary Current Sensing
A012	Generator Under Voltage
A013	Generator Over Voltage
A014	Generator Reverse Power Flow
A015	Generator Under Frequency
A016	Generator Voltage Imbalance

Table A-1. Alarm Codes

FAULT CODES

During a fault condition, the HMI will display the code of the corresponding fault condition. The table can be used to determine what condition is causing the fault.

Fault Codes

F001	Unused
F002	Field Under Excitation
F003	Generator Parallel Shutdown
F004	Generator Parallel Start Up
F005	RTD Over Temperature
F006	Unused
F007	Regulator Over Temperature
F008	Field Over Excitation
F009	Instantaneous Field Over Current
F010	Unused
F011	Generator Loss of Sensing
F012	Generator Under Voltage
F013	Generator Over Voltage
F014	Generator Reverse Power Flow
F015	Unused
F016	Generator Voltage Imbalance

Table A-2. Fault Codes

APPENDIX B

CONNECTOR PIN-OUT FIGURES AND TABLES

The following figures can be used to determine the pin locations for the pin-integrated connectors used on the DVR® regulator. Refer to Section - Specifications, for mating connector part numbers.

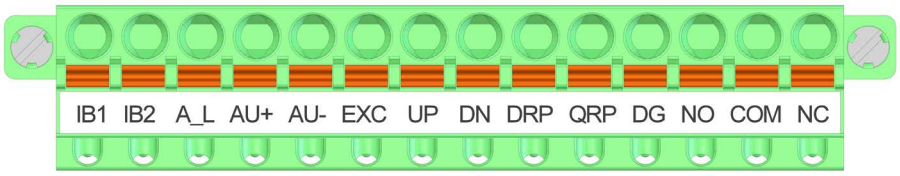


Figure B-1. Connector P1

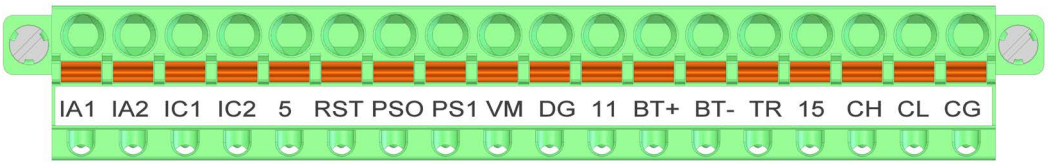


Figure B-2. Connector P2

The following table should be used when making connections via quick disconnect terminals to the regulator.

Terminal	Description
GND	Protective earth ground
4	PMG – terminal 1 (Fused)
3	PMG – terminal 2 (Fused)
E1	Generator armature – Phase A
E2	Generator armature – Phase B
E3	Generator armature – Phase C
-	UNUSED
-	UNUSED
F-	Exciter stator field (-)
F+	Exciter stator field (+)

Table B-1. Quick Disconnect Terminals

The following table should be used when making connections to the regulator.

Terminal	Name	Description
1	IB1	Generator Phase B CT – terminal 1
2	IB2	Generator Phase B CT – terminal 2
3	A_L	Auxiliary current loop (2500 only)
4	AU+	Auxiliary input positive
5	AU-	Auxiliary input negative
6	EXC	Excitation disable contact input (active closed)
7	UP	UP contact input (active closed)
8	DN	DOWN contact input (active closed)
9	DRP	Droop disable contact input (active closed)
10	QPF	VAR/PF mode disable (active closed)
11	DG	Digital ground
12	NO	Contact output normally open
13	COM	Contact output common
14	NC	Contact output normally closed

Table B-2. Connector P1

The following table should be used when making connections to the DVR®2500 regulator.

Terminal	Name	Description
1	IA1	Generator Phase A CT – terminal 1
2	IA2	Generator Phase A CT – terminal 2
3	IC1	Generator Phase C CT – terminal 1
4	IC2	Generator Phase C CT – terminal 2
5	5	Reserved
6	RST	Reset Regulator (active closed)
7	PS0	Preset select line 0 (active closed)
8	PS1	Preset select line 1 (active closed)
9	VM	Reserved
10	DG	Digital ground
11	11	Reserved
12	BT+	Battery input – positive
13	BT-	Battery input – negative
14	TR	CAN terminating resistor - terminal 1
15	15	Reserved
16	CH	CAN high data line
17	CL	CAN low data line
18	CG	CAN GND

Table B-3. Connector P2

⚠ WARNING

Before proceeding forward, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual. Failure to do so could cause severe injury, death, and/or equipment damage.

APPENDIX C

QUICK START PROGRAMMING GUIDE

As the regulator is designed to work on many Marathon® generators in many different applications, it is necessary to program the regulator prior to putting it in service. Please observe the following procedure to program the regulator through the Human-Machine Interface or HMI:

1. Disconnect all connections to the regulator.
2. Apply power to terminals 3 and 4 of the regulator. There are two acceptable ways to power the regulator for programming:
   a. Reconnect the ground lead and the leads from the capacitor in the PMG circuit to regulator terminals 3 and 4. This is how the regulator receives power for normal operation. If using this method, be sure the generator RPM is between 1500 and 1800 RPM to provide proper input power to the regulator.
   b. Connect a 120 Volt AC source to regulator terminals 3 and 4. This will provide the regulator with enough power to accept programming, but not enough power for normal operation.
   Note: Ensure F+ and F- terminals on the regulator are disconnected before powering the regulator for programming.
3. Press SELECT . The word **SIZE** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate generator frame size and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **SIZE**.
4. Press SELECT . The word **REG** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate regulation mode (**AVR3** for 3 phase Automatic Voltage Regulation; **AVR1** for single phase Automatic Voltage Regulation or **FCR** for Field Current Regulation) and then press ENTER . The entered value will flash3 times to indicate that your selection has been saved. The display will again read **REG**.
5. Press SELECT . The word **STPT** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate set point (Sensed Voltage for AVR3 and AVR1 regulation modes; Field Current level for FCR regulation mode or **VAR** for Reactive Power Regulation or **PF** for Power Factor Regulation) and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **STPT**.
6. Press SELECT . The word **UFRQ** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate Under-frequency threshold and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **UFRQ**.
7. Press SELECT . The word **SLOP** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate under-frequency Slope multiplier and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **SLOP**.
8. Press SELECT . The word **PR** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the nameplate Power Rating in kW and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **PR**.
9. Press SELECT . The word **PFR** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate Power Factor and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **PFR**.
10. Press SELECT . The word **PT** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate Potential Transformer ratio and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **PT**.
11. Press SELECT . The word **CT** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate Current Transformer ratio and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **CT**.
12. Press SELECT . The word **DROP** will appear in the display. Press ENTER . Use the UP and DOWN arrows to select the appropriate level of droop as a percentage of desired sensed voltage and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **DROP**.
13. Press SELECT . The word **AU** will appear in the display. Press ENTER .

    Use the UP and DOWN arrows to select the appropriate auxiliary input mode and then press ENTER . The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **AU**.
14. Remove power from the regulator.
15. Complete reconnecting the regulator to the generator.

The regulator is now ready to be placed in service.

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APPENDIX D

ABBREVIATIONS & ACRONYMS

° C	Degrees Celsius
° F	Degrees Fahrenheit
A	Amperes
Aac	AC Current
AC	Alternating Current
Adc	DC Current
AVR1	Automatic Voltage Regulation, Single-phase Sensing
AVR3	Automatic Voltage Regulation, Three-phase Sensing
CAN	Controlled Area Network
CT	Current Transformer
DC	Direct Current
ECU	Electronic Control Unit
EEPROM	Electrically Erasable Programmable Read Only Memory
FCR	Field Current Regulation
g	Gram
G	Unit of gravitational acceleration
HMI	Human Machine Interface.
Hz	Hertz
k	Kilo- (1,000x)
lb	Pound
LED	Light Emitting Diode
LSB	Least Significant Byte
M	Mega- (1,000,000x)
m	Milli- (0.001x)
MSB	Most Significant Byte
PDU	Protocol Data Unit
PF	Power Factor
PMG	Permanent Magnet Generator
PT	Potential Transformer
PU	Per Unit
RAM	Random Access Memory
RMS	Root Mean Square
SPDT	Single Pole, Double Throw
THD	Total Harmonic Distortion
u	Micro- (0.000001x)
V	Volts
VA	Volt-Amps, for Apparent Power
Vac	AC Voltage
VAR	Reactive Volt-Amps, for Reactive Power
Vdc	DC Voltage
W	Watts
Ω	Ohms

NOTES

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REGAL®