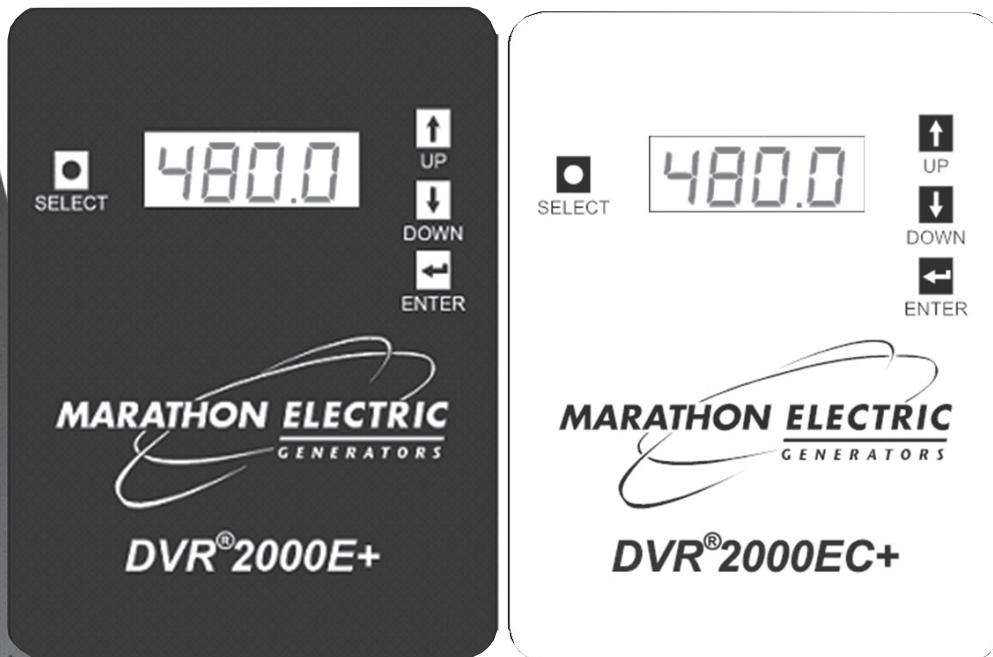


# marathon™

Generators

**DVR®2000E+/EC+**

**User Manual**



A Regal Brand

**REGAL**

## Read and Save These Instructions

### Safety Instructions



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.




Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



Caution indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.



Notice indicates a situation not related to personal injury which, if not avoided, may result in generator or equipment damage.

 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 listing of all details for installation, 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.

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**DEFINITION:** The word Generator, as used in this publication, includes only the products of Marathon Electric, a subsidiary of RBC Manufacturing Corporation, and does not include the prime mover or any of the prime mover related systems or accessories.





## ELECTRICAL SAFETY

### **WARNING** ELECTRICAL HAZARD

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

### **WARNING** ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may 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, lockout 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) regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

### **WARNING** MAGNETIC FIELD HAZARD

Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which may 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.

### **WARNING** 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.

## MECHANICAL SAFETY

### **WARNING** 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.

### **WARNING** 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.

### **WARNING** 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.

# General

2

## OVERVIEW

This manual provides details on how to install, operate and maintain a DVR®2000E+ or DVR®2000EC+ digital voltage regulator (DVR®) with Marathon Electric synchronous generators. Additional publications are available for Controller Area Network (CAN) communications and MODBUS communications.

The DVR® 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 DVR® is derived from a single phase permanent magnet generator (PMG).

The DVR® 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 DVR®. The front panel display annunciates regulator status and system conditions.

## MANUAL CONVENTIONS

This manual describes details for the DVR®2000E+ and DVR®2000EC+.

Features that are exclusive to the DVR®2000EC+ are noted.

## NEW/ENHANCED FUNCTIONS

New and enhanced functions are indicated in the lists below. Legacy DVR's may not support new and enhanced functions.

## REGULATION MODES

Three regulation modes:

- Single phase automatic voltage regulation (AVR1)
- Three phase automatic voltage regulation (AVR3)
- Field current regulation (FCR).

The DVR®2000EC+ adds two regulation modes:

- Reactive power regulation (VAR)
- Power factor regulation (PF)

## FEATURES

The DVR® 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 Three-phase or single-phase generator current sensing (optional CT's required)
- True RMS three-phase power metering (optional CT's required)
- Field current sensing
- Field voltage monitoring
- Contact inputs for system interface capability
- Contact output for fault indication
- Generator paralleling with reactive droop compensation and reactive differential compensation (Enhanced)
- Front-panel human-machine interface (HMI) for status and configuration
- MODBUS protocol via RS232 for external communication (Enhanced)
- DVRPortal™ Windows®-based software for configuration and monitoring (Enhanced)
- CAN interface with CAN 2.0B J1939 protocol for metering and control (Enhanced)
- "Power on" LED indicator
- Configurable auxiliary input for metering and control (Enhanced)
- Simulated reactive power for droop set-up (New)
- Generator power limiting mode (New)

## PROTECTION

The DVR® has the following protection features:

- Field Over Excitation Shutdown
- Field Under Excitation Shutdown (New)
- Generator Over Voltage Shutdown (Enhanced)
- Generator Under Voltage Shutdown
- Generator Voltage Imbalance Shutdown (Enhanced)
- Loss of Generator Sensing Shutdown
- Instantaneous Field Over Current Shutdown
- Regulator Over Temperature Shutdown
- Generator Reverse Power Shutdown (Enhanced)
- Generator Start Up Fault Shutdown (EC+ only) (New)
- Field Current Limiting Alarm (Enhanced)
- Generator Under Frequency Alarm
- Generator Power Limit Alarm (New)
- Loss of CAN Communication Alarm (Enhanced)

# Specifications

## Operating Power

Type: 1-phase, ungrounded PMG  
Range: 180 - 240 Vac, 250 - 300 Hz  
Burden: 350 VA  
Fuse Type : Time delay 250V - 4.0 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)/3-phase  
Rating: 5 Aac continuous, 50/60Hz  
Input Impedance: <10 mΩ  
Terminals: CT1, CT2 for 1-phase (BØ)  
J2-1, J2-12 for 3-phase (AØ)  
J2-2, J2-11 for 3-phase (BØ)  
J2-3, J2-10 for 3-phase (CØ)

## Contact Inputs

Type: Dry Contact  
Input PU Voltage: 3.3 Vdc  
Terminals:  
DROOP\_OFF: J1-10, J1-4  
UP: J1-2, J1-4  
DOWN: J1-3, J1-4  
EXCITATION\_OFF: J1-11, J1-4  
VAR/PF\_OFF: J1-9, J1-4 (EC+ only)

## Fault Contact Output

Type: Form A  
Rated Load: 3 A continuous  
Break: 3 Aac / 0.1 Adc  
Operating Voltage: 240 Vac / 250 Vdc maximum  
Terminals: J1-6, J1-7

## Field Output

Continuous Rating: 75 Vdc, 3.0 Adc  
10 Second Forcing Rating  
200 Vac Power Input: 150 Vdc, 6.5 Adc  
Field Resistance: 18 to 35 Ω  
Terminals: F+, F-

## AVR1 and AVR3 Operating Modes

Range: 100.0 to 600.0 Vac  
Voltage Regulation: ±0.25 % over load range at rated power factor and constant generator frequency.  
Temperature Drift: ±0.0125 % per degree C  
Under frequency (V/Hz)  
Slope: 1.00 to 3.00 PU  
Knee: 40.0 to 70.0 Hz

## FCR Operating Mode

Range: 0.000 to 3.000 Adc  
Current Regulation: ±1.0% over 18 to 35 Ohms of exciter resistance  
Temperature Drift: ±0.0125% per degree C

## VAR Operating Mode (EC+ Only)

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

## PF Operating Mode (EC+ Only)

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 %

## Serial Communication Port

Interface: Full Duplex RS-232  
Connector: DB-9 connector (rear panel)  
Baud: 4800  
Data Bits: 8  
Parity: None  
Stop Bit: 1 or 2  
Handshaking: None

## CAN Communication Port

Connector: J3  
Protocol: SAE J1939  
Data Rate: 250 kbits/sec



# Specifications

3

## Over Excitation Protection

Threshold: 0.500 to 4.000 Adc  
Timer: 1.0 to 15.0 seconds

## Under Excitation Protection

Threshold: -100.0% to -5.0% of rated  
kVAR  
Timer: 1.0 to 15.0 seconds

## Field Current Limit

Threshold: 0.500 to 6.500 Adc

## Power Limit

Threshold: 5.0 to 115.0 % of rated kW

## Field Instantaneous Over Current Protection

Threshold: 11 Adc

## Generator Over Voltage Protection

Threshold: 5.0 to 20.0 % of voltage  
set point  
Timer: 0.1 to 15.0 seconds

## Generator Under Voltage Protection

Threshold: 5.0 to 50.0 % of voltage  
set point  
Timer: 1.0 to 15.0 seconds

## Generator Reverse Power Protection

Threshold: 5.0 to 100.0 % of rated kW  
Timer: 1.0 to 15.0 seconds

## Soft-Start Function

Range: 2 to 120 seconds

## Auxiliary Input

### Auxiliary – Control1 Mode (AVR3, AVR1, VAR or PF regulation)

Voltage Range: -3 Vdc to +3 Vdc  
Set Point Range: -X to +X % shift where  
X = 1.0 to 30.0  
Burden: 2260 Ω  
Terminals: J1-1 (+), J1-12 (-)

### Auxiliary – Control1 Mode (FCR regulation)

Voltage Range: -3 Vdc to +3 Vdc  
Set Point Range: -3.000 Adc to + 3.000 Adc  
Increment: 1 mA per 1mV  
Burden: 2260 Ω  
Terminal: J1-1 (+), J1-12 (-)

### Auxiliary – Control2 Mode (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: J1-1 (+), J1-12 (-)  
Jumper: J1-5 to J1-8

### Auxiliary – Control2 Mode (FCR regulation)

Current Range 4 mA to 20 mA  
Set Point Range: -3.000 Adc to + 3.000 Adc  
Increment: 1 mA per 2.67 uA  
Burden: 250 Ω  
Terminal: J1-1 (+), J1-12 (-)  
Jumper: J1-5 to J1-8

### Auxiliary – Meter (Voltage input)

Voltage Range: -5 Vdc to 5 Vdc  
Scale Factor: User-defined  
Burden: 2260 Ω  
Terminal: J1-1 (+), J1-12 (-)

### Auxiliary – Meter (Current input)

Current Range: 4 mA to 20 mA  
Scale Factor: User-defined  
Burden: 250 Ω  
Terminal: J1-1 (+), J1-12 (-)  
Jumper: J1-5 to J1-8

## 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  
Accuracy: 0.5 %

#### Generator Current

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



# Specifications

**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 Voltage**

Range: 0 to 200 Vdc

Accuracy: 5.0 %

**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 %

**Environmental**

Operating Temperature:  
-40° C - +70° C (-40° F - +158° F)

Storage Temperature:  
-40° C - +85° C (-40° F - +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

Salt Fog: Tested per MIL-STD-810E

**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

**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**

**J1:**

Mating Plug Housing: Deutsch DT06-12SB-P012

Mating Plug Wedge Lock: W12S-P012

Mating Plug Terminals: 0462-201-16141

**J2:**

Mating Plug Housing: Deutsch DT06-12SA-P012

Mating Plug Wedge Lock: W12S-P012

Mating Plug Terminals: 0462-201-16141

**J3:**

Mating Plug Housing: Amp/Tyco 172166-1

Mating Plug Terminals: 170366-3

# Features and Protection

## INTRODUCTION

This section describes how the DVR<sup>®</sup> functions and explains its operating features. DVR<sup>®</sup> functions are illustrated in the block diagram of Figure 4-1.

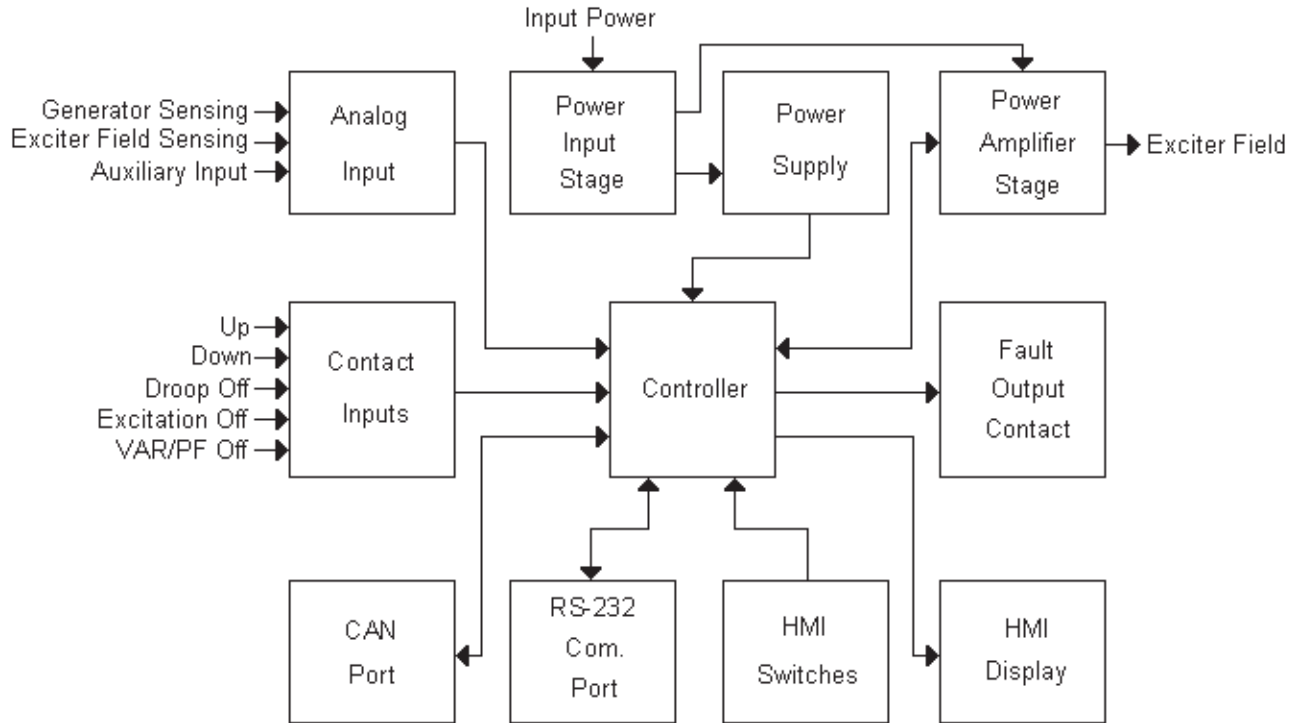


Figure 4-1. Simplified Block Design

## DVR<sup>®</sup> 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 CT's at connector J2 or terminals CT1 and CT2. Current up to 5 Arms may be monitored at these terminals. These currents are scaled, conditioned and applied to the controller. Refer to *Section 3 – Specifications*, for connector pin assignments.

### Field Voltage

Voltage across the regulator field is monitored at terminals, F+ and F-.

### 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

Five contact input circuits powered from an internal 3.3 Vdc supply provide input control from user-supplied contacts: UP, DOWN, DROOP\_OFF, EXCITATION\_OFF and VAR/PF\_OFF (EC+ only).

### UP

Closing the UP contact across terminals J1-2 and J1-4 causes the active operating set point to increase.

# Features and Protection

## DOWN

Closing the DOWN contact across terminals J1-3 and J1-4 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™. The effect generated by the contacts is displayed in DVRPortal™ on the Set Points Tab as the value “Contact Offset.”

**Note:** If power is removed from the DVR®, the settings from the remote UP/DOWN contacts will be lost.

## DROOP\_OFF

This function enables reactive load sharing between generators operating in parallel. Closing the DROOP\_OFF contact across terminals J1-10 and J1-4 disables voltage droop. Opening the contact enables voltage droop.

## EXCITATION\_OFF

This contact input enables removal of excitation without removing power to the regulator. Closing the EXCITATION\_OFF contact across terminals J1-11 and J1-4 disables field excitation. Opening the contact enables field excitation with a soft start and clears any alarms or faults.

## VAR/PF\_OFF (EC+ only)

**NOTE:** 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 J1-9 and J1-4 enables VAR or PF control. Closing the contact disables VAR or PF regulation and defaults to AVR3 regulation.

## Communication Port (RS-232)

The communication port provides an isolated interface for user programming of the DVR® through DVRPortal™. The connection is made to the female RS-232 (DB-9) connector with a user-supplied,

standard 9-pin cable. A null modem cable will not function.

## CAN Port

The CAN port provides an isolated interface for communication with and control of the DVR®. This permits the integration of the DVR® as a node on a CAN network. The connection is made to the J3 connector with a user-supplied Amp/Tyco Mini Mate-N-Lok plug. The communication is powered from a transformer-isolated supply. Refer to *Section 3 – Specifications*, for connector details.

## Controller

The controller portion of the DVR® 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 DVR®.

## 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 Display

A four-character light-emitting-diode (LED) display indicates various operating modes, protective functions, and adjustments. *Section 6 – Human-Machine Interface* provides more information about the front panel display.

## HMI Buttons

Changes to settings can be made at the front panel using the four buttons:

SELECT , UP , DOWN  and ENTER 

Refer to *Section 6 – Human-Machine Interface* for more information about the front panel switches.

# Features and Protection

## Fault Output Contact

A fault output contact is provided through terminals J1-6 and J1-7. This normally-open, form-A contact closes in the event of a protective shutdown.

## DVR® OPERATING FEATURES

### Regulation Modes

The DVR®2000E+ provides three modes of regulation selectable through the HMI or through DVRPortal™. The DVR2000EC+ adds two more regulation modes.

### Automatic Voltage Regulation Modes

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 DVR® regulates the RMS generator 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™. The Droop and Under Frequency functions may influence the regulation set point.

### Field Current Regulation Mode

In FCR mode, the DVR® 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 DVRPortal™.

### Reactive Power Regulation Mode (EC+ only)

In Reactive Power Regulation (VAR) mode, the DVR® 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 DVRPortal™. 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 (EC+ Only)

In Power Factor Regulation (PF) mode, the DVR® 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 DVRPortal™. 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 Meter modes through the HMI or DVRPortal™. The effect of the auxiliary input on the set point is displayed in DVRPortal™.

### Auxiliary – Off

In this mode, any signal applied to the auxiliary input will be displayed in DVRPortal™, 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 J1-1 (+) and J1-12 (-). A voltage up to +/- 3 Vdc may be applied at this input.

*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.

**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 -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 +/- 3.000 Vdc signal corresponds to a -3.000 to 3.000 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.*

# Features and Protection

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

*When in VAR (EC+ only):*

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 (EC+ only):*

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

This mode allows modification of the regulation set point by the application of a 4 mA to 20 mA current control signal in terminals J1-1 (+) and J1-12 (-). This mode requires the placement of a jumper across terminals J1-5 and J1-8 (AUX\_LOOP).

*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 -3.000 to +3.000 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:** A field current set point of 1.000 Adc with the application of a 10.67 mA signal will result in a total field current of 0.500 Adc.

*When in VAR (EC+ only):*

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 (EC+ only):*

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 – Meter

In this mode, the auxiliary input functions as a meter with user-defined scaling. A voltage up to +/- 5.000 Vdc or a current of 4 mA to 20 mA may be applied to terminals J1-1 (+) and J1-12 (-). The circuit imposes a 2260-ohm burden on the DC source for voltage input. The circuit imposes a 250-ohm burden on the DC source for current input when a jumper is applied across terminals J1-5 and J1-8 (AUX\_LOOP). The default scaling is 5000 PU counts for a +5.000 Vdc voltage input and 5000 PU counts for a 20 mA current input. The user provides further scaling through DVRPortal™.

**Example:** For a scale factor of 0.20 units, the metered value corresponding to a +5.000 Vdc voltage input will be +100 units. The metered value corresponding to a 20 mA current input will be +100 units.

## Load Sharing

**NOTE:** The machine nameplate rated power, rated power factor, CT Ratio and PT Ratio (if applicable) MUST be entered in DVRPortal™ (and cannot be

# Features and Protection

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*entered via the HMI) to calculate the proper rated reactive power for the droop reference.*

The DVR® provides a reactive droop compensation feature to enable reactive load sharing during parallel generator operation. When this feature is enabled, the DVR® 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 DVRPortal™. The droop feature is enabled and disabled through the DROOP\_OFF contact input circuit (terminals J1-10 and J1-4). 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.

## Generator Soft Start

The DVR® 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 DVRPortal™ 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.



# Features and Protection

## DVR® PROTECTION FUNCTIONS

Protection Feature	Configurable	Threshold Range	Threshold Units	Basis	Timer Range	Timer Units	Alarm Code	Fault Code
Field Over Excitation	Yes	0.500 - 4.000	A	N/A	1.0 - 15.0	S	A008	F008
Field Under Excitation	Yes	-100.0 to -5.0	%	Rated Reactive Power (kVAR)	1.0 - 15.0	S	A002	F002
Generator Over Voltage	Yes	5.0 - 20.0	%	Voltage Set Point	0.1 - 15.0	S	A013	F013
Generator Under Voltage	Yes	5.0 - 50.0	%	Voltage Set Point	1.0 - 15.0	S	A012	F012
Generator Imbalance	Yes	20.0 - 50.0	%	Voltage Set Point	1.0 - 15.0	S	A016	F016
Generator Loss of Sensing	No	N/A	N/A	N/A	N/A	N/A	N/A	F011
Instantaneous Field Over Current	No	11	Adc	N/A	N/A	N/A	N/A	F009
Regulator Over Temperature	No	N/A	N/A	N/A	N/A	N/A	A007	F007
Generator Reverse Power	Yes	5.0 - 100.0	%	Rated Power (kW)	1.0 - 15.0	S	A014	F014
Generator Start Up	No	N/A	N/A	N/A	N/A	N/A	N/A	F004
Generator Under Frequency	Yes	40.0 - 70.0	Hz	N/A	N/A	N/A	A015	N/A
Field Current Limiting	Yes	0.5 - 6.5	A	N/A	N/A	N/A	A010	N/A
Power Limiting	Yes	5.0 - 115.0	%	Rated Power (kW)	N/A	N/A	A001	N/A
Loss of CAN	Yes	N/A	N/A	N/A	1.0 - 45.0	S	A006	N/A

Table 4-1



# Features and Protection

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## Configurable Protection Shutdowns

All configurable protection features have a user-defined threshold and timer value. If the threshold condition for a particular protection feature is met, an alarm is triggered. The DVR® displays an alarm signal on the HMI and in DVRPortal™. An independent timer starts at the moment the alarm condition is triggered.

If the timer threshold is exceeded before the alarm condition is removed, a fault is then triggered and the excitation current to the field is shutdown. A fault signal is displayed on the HMI and in DVRPortal™. Table 4-1 shows the details of the timer-based protection features in the DVR®.

## Field Over Excitation Shutdown

The Field Over Excitation protection feature is triggered if field current exceeds the threshold. The fault is triggered if field current doesn't fall below 90% of the threshold within the timer period.

## Field Under Excitation Shutdown

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

## Generator Over Voltage Shutdown

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

## Generator Under Voltage Shutdown

The Generator Under Voltage protection feature is triggered if generator voltage drops below the threshold. The fault is triggered if generator voltage stays below the threshold 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 of more than the threshold is interpreted as a voltage imbalance. The fault is triggered if the voltage imbalance condition continues 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 threshold for the duration of the timer.

## Non-Configurable Protection Shutdowns

Non-configurable protection features have factory-defined settings for thresholds and timers, if applicable. Each shutdown feature below describes the details of the conditions for the shutdown event to occur.

## Loss of Generator Sensing Shutdown

The Loss of Generator Sensing protection feature is triggered if sensing input continuity is lost. There is no alarm for this condition – the fault and shutdown is triggered shortly after the condition is met.

**Note:** In AVR1, AVR3, VAR and PF regulation modes, Loss of Sensing is not enabled until a speed of 850 RPM is detected.

## 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.

# Features and Protection

## Generator Start Up Shutdown (EC+ Only)

The Generator Start Up Shutdown protection feature is triggered if the generator is started up in either VAR or PF regulation modes with the VAR/PF\_OFF input contact open.

## CONFIGURABLE PROTECTION ALARMS

### Generator Under Frequency Alarm

The Generator Under Frequency Alarm triggers if generator frequency drops below the under frequency knee. The voltage set point is automatically adjusted by the DVR<sup>®</sup> so that generator voltage follows the selected V/Hz curve. If generator frequency drops below 25 Hz, the regulator will stop providing generator excitation and AC metering.

**Note:** If generator frequency drops below a detectable level and generator speed is greater than 850 RPM, a short circuit condition is assumed and the regulator will force current up to the Field Current Limit value (see Field Current Limiting below).

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 4-2):

- 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 between 50.1 and 60.0 Hz, the base slope is 1/60 (0.0167) VPU/Hz,
- For an under frequency 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 4-3 for examples.

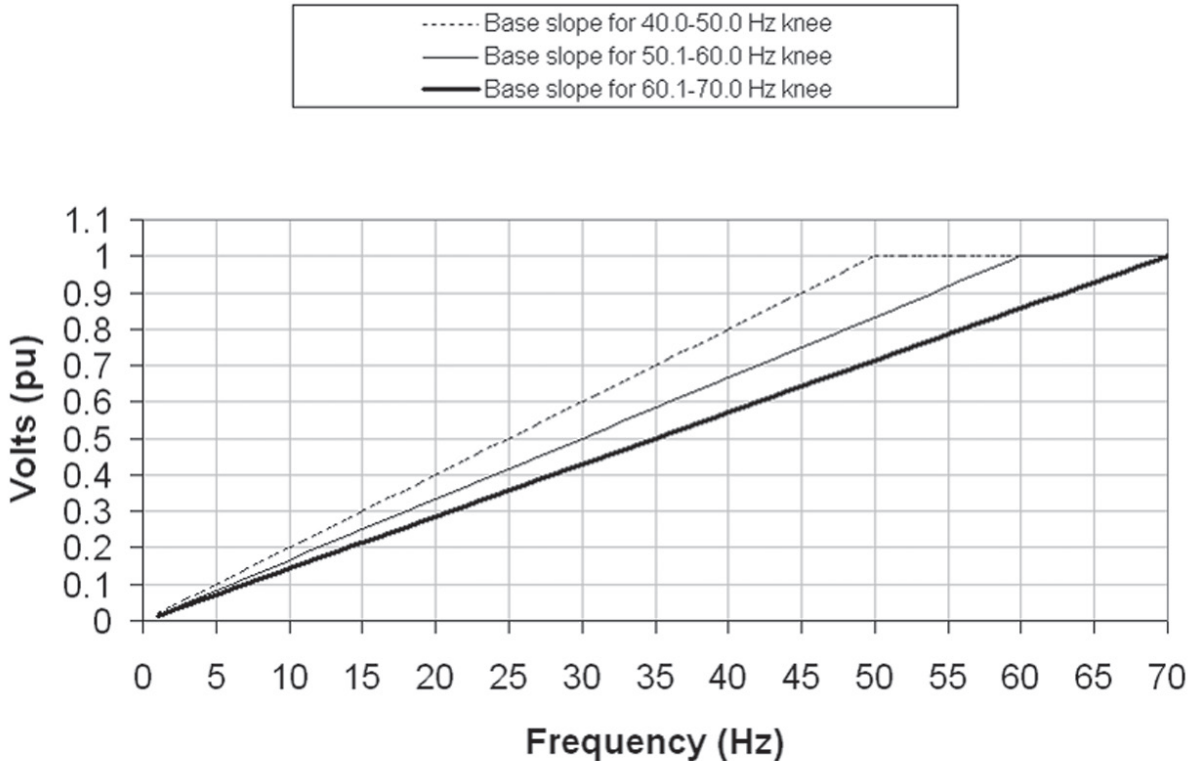
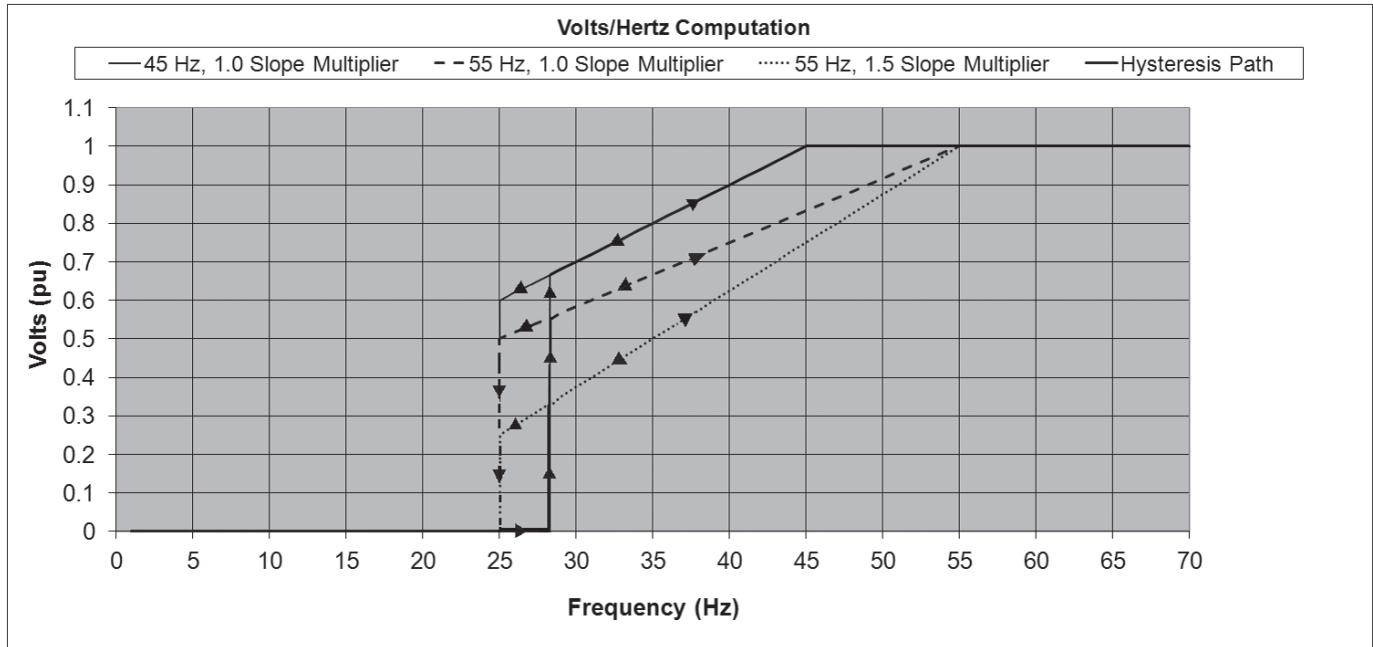


Figure 4-2. Volts/Hertz Slopes vs. Knee Frequency

# Features and Protection

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**Figure 4-3. Examples of Under Frequency and Slope**

**Note:** Arrows indicate hysteresis of cut-in and cut-out transitions between IDLE and RUN states.

### Field Current Limiting Alarm

The Field Current Limit protection feature limits the amount of DC current that flows in 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 in DVRPortal™. The HMI and DVRPortal™ display this alarm condition.

### 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 HMI and DVRPortal@ display an alarm when this condition is met. This limiter can be enabled or disabled in the Protection Settings Tab in DVRPortal@ under the Limits panel. The limiter dynamics (PID gains) can also be adjusted in the Operating Modes Tab in DVRPortal@.

### Loss of CAN Communication Alarm

The Loss of CAN Communication protection feature indicates an alarm if communication traffic between the DVR® and any Electronic Control Unit (ECU) on the CAN bus. The alarm is triggered if the regulator does not receive a “VR Heartbeat” message within the threshold time. Refer to the *DVR2000E+/EC+ CAN Bus Interface User Guide* for details.

## **⚠️ WARNING ELECTRICAL HAZARD**

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

## **⚠️ WARNING ELECTRICAL SHOCK HAZARD**

Failure to follow these instructions may 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, lockout 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) regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

## **⚠️ WARNING MAGNETIC FIELD HAZARD**

Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which may 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.

## **⚠️ WARNING 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.

## **MECHANICAL SAFETY**

### **⚠️ WARNING 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.

### **⚠️ WARNING 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.

### **⚠️ WARNING 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.

## **GENERAL**

Generally the DVR<sup>®</sup> 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 DVR<sup>®</sup> 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 DVR<sup>®</sup> 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 DVR<sup>®</sup>. The recommended torque range for the steel mounting screws is 36 to 40 inch-pounds (4.1 to 4.5 Newton-

# Installation

meters). Refer to *Section 3 – Specifications*, for environmental requirements.

DVR® front panel and uncovered rear dimensions are shown in Figure 5-1.

DVR® rear panel with cover dimensions are shown in Figure 5-2.

Cutout and drilling dimensions are shown in Figure 5-3.

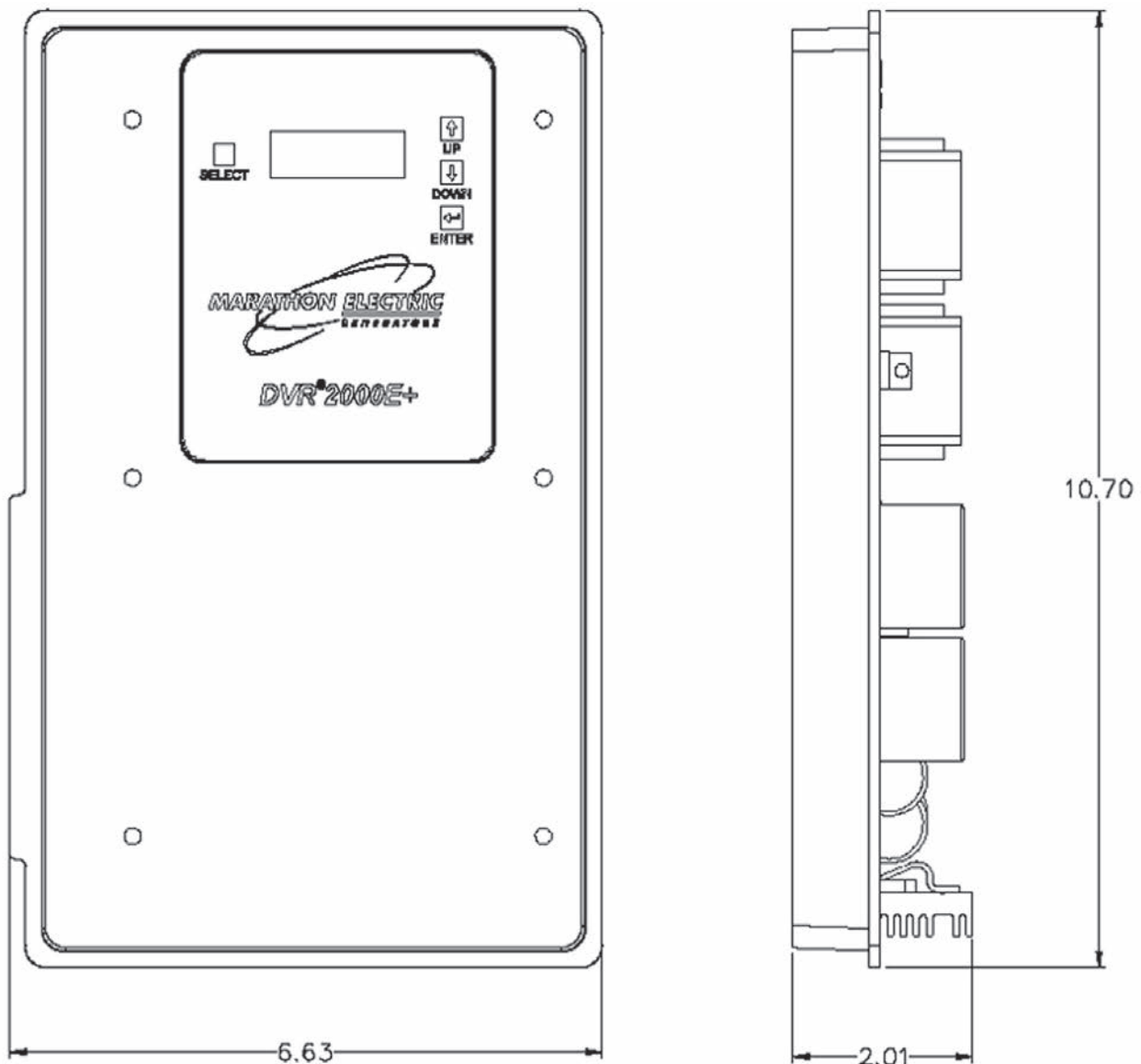


Figure 5-1. DVR® Front dimensions without cover. Valid for E+ & EC+ versions.

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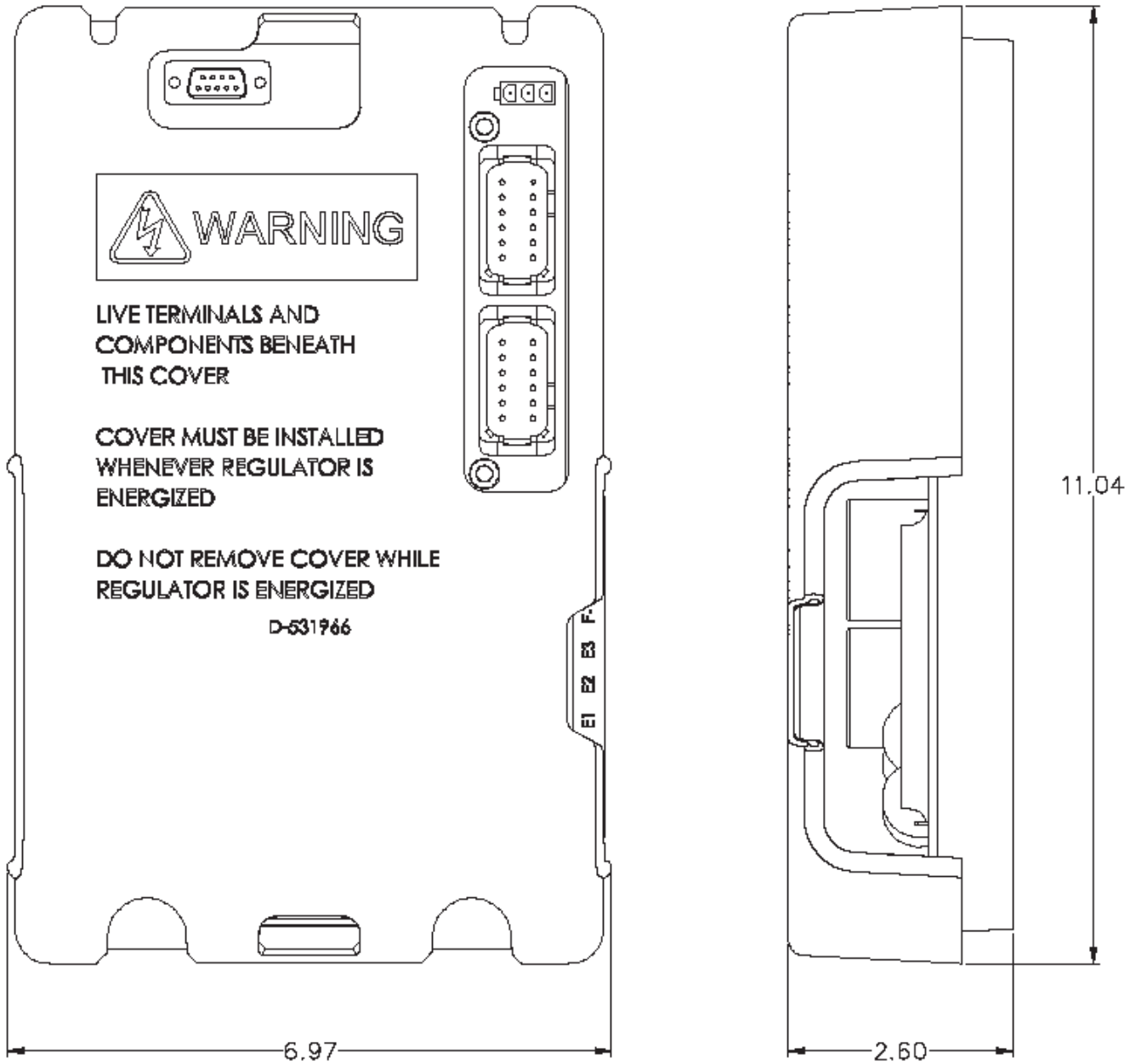


Figure 5-2. DVR® Rear dimensions with cover. Valid for E+ & EC+ versions.

# Installation

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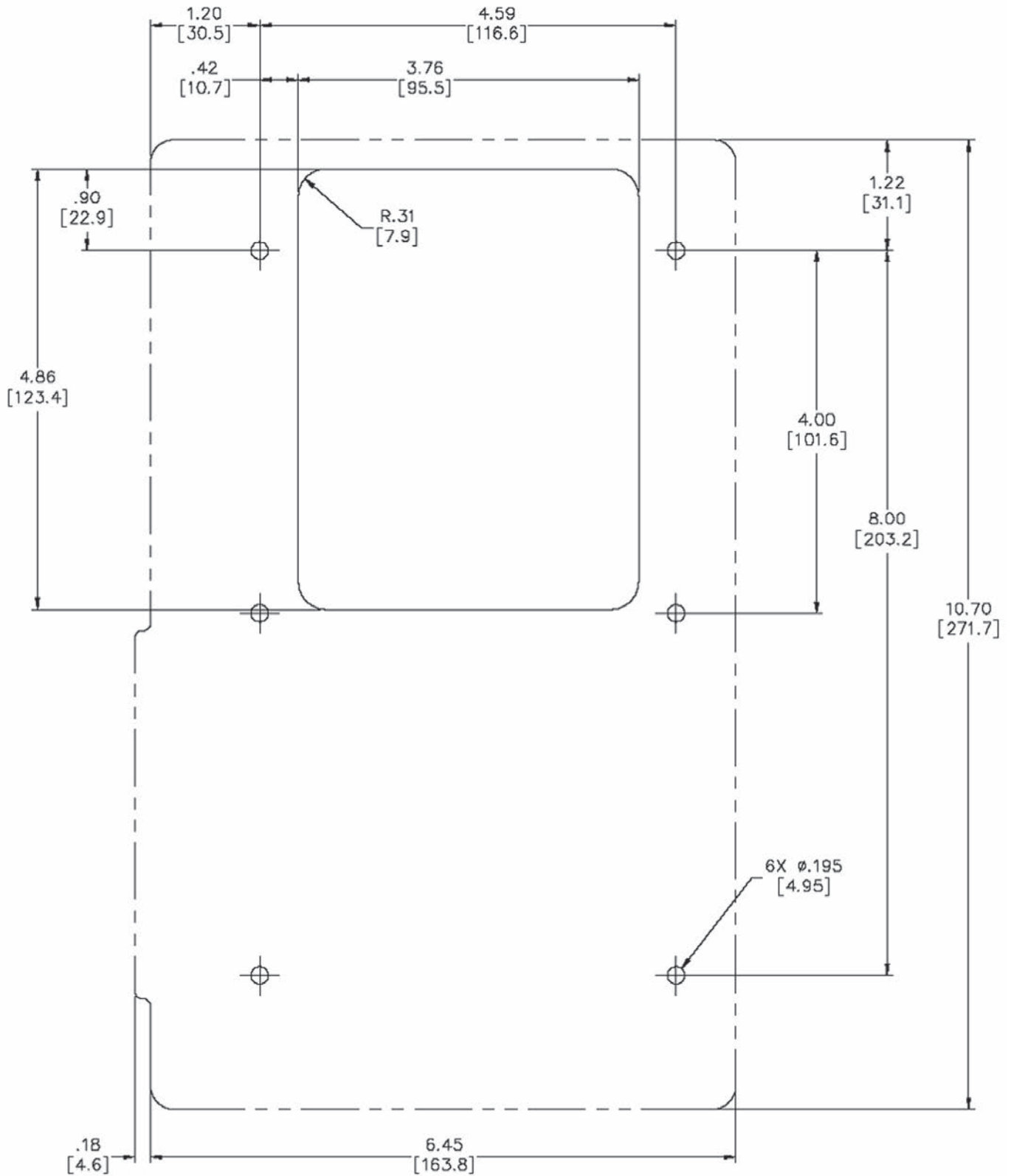


Figure 5-3. Cutout and Drilling Dimensions



## CONNECTIONS

### **⚠️ WARNING** ELECTRICAL HAZARD

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

### **⚠️ WARNING** ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may 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, lockout 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) 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 DVR<sup>®</sup> 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.*

DVR<sup>®</sup> connections are dependent on the application.

### DVR<sup>®</sup> Connectors

DVR<sup>®</sup> units have four types of interface connectors. All connectors are located on the rear of the unit.

1. Ten (10) 1/4", quick-connect terminals for generator connections
2. Two (2) 12-pin Deutsch (DTC style) connectors for current transformer (CT) and system interface connections
3. One (1) 3-pin Amp/Tyco Mini Mate-N-Lok receptacle for the Controlled Area Network (CAN) bus interface.
4. One (1) 9-pin DB-9 type connector for the communication between the DVR<sup>®</sup> and DVRPortal<sup>™</sup>.

Wires performing common functions, such as voltage sensing leads, should be grouped together.

Figure 5-4 shows the quick disconnect terminal connections located on the rear panel of the DVR<sup>®</sup>.

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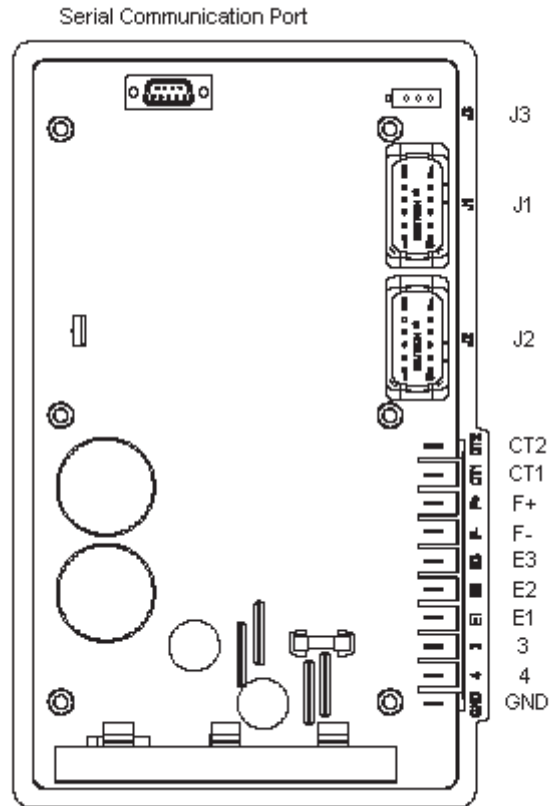


Figure 5-4. DVR® Rear Panel Connectors

Quick Connect Terminals		Application Notes
No.	Description	
CT2	Phase B CT (X2)	For connection of (1) user supplied current transformer with 5A secondary current. H1 must face generator. Observe polarity.
CT1	Phase B CT (X1)	
F+	Exciter Field (+)	Excitation output. Never apply a voltage to these terminals. Observe polarity.
F-	Exciter Field (-)	
E3	Sensing Voltage 3	Phase C for 3 phase output. Jumper to E2 for single phase.
E2	Sensing Voltage 2	Phase B for 3 phase output. L2 input for single phase.
E1	Sensing Voltage 1	Phase A for 3 phase output. L1 input for single phase.
3	PMG Input 1	Protected by regulator fuse. 180-240Vac, 250-300Hz, 350VA
4	PMG Input 2	Do not ground or apply direct current to Terminals 3 or 4.
GND	Chassis Ground	Use #12 AWG (4 sqmm) minimum conductor.

Table 5-1. Quick Connect Terminals

### Chassis Ground (GND)

The chassis ground terminal is labeled GND.

### 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 (CT1 and CT2)

Generator line current is stepped down through a user-supplied CT on Phase B. Secondary current (5A) from that transformer is applied to terminals labeled CT1 and CT2. Consult current transformer instruction manuals for CT polarity identification and install per Figure 5-9. See Figure 5-4 and Table 5-1 for terminal assignments.

### Three Phase Current Sensing Input

Generator line current is stepped down through user-supplied CT's. Secondary current (5A) from these transformers is applied to the J2 connector. Consult CT instruction manuals for polarity identification and install per Figure 5-8. See Figure 5-5 and Table 5-2 for terminal assignments. **Note:** All transformers should have the same CT ratio.

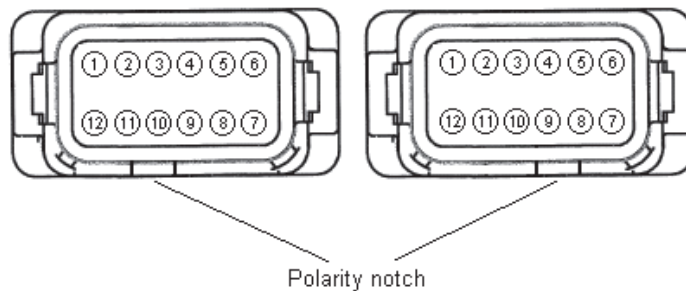


Figure 5-5. System Connectors J2 (left) and J1 (right) Terminal Position

Sensing	Phase	CT "X1" Terminal	CT "X2" Terminal
3-Phase	A	J2-1	J2-12
	B	J2-2	J2-11
	C	J2-3	J2-10
1-Phase	B	CT1	CT2

Table 5-2. CT Connection Terminals

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

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Pin Number	Name	Description
1	AUX IN (+)	Auxiliary input positive
2	UP	UP contact input (active low)
3	DOWN	DOWN contact input (active low)
4	CGND	Input common
5	AUX_LOOP	Auxiliary current loop jumper
6	CONTACT1	Contact output
7	CONTACT2	Contact output
8	AUX_LOOP	Auxiliary current loop jumper
9	VAR/PF_OFF	VAR/PF regulation disable contact (active low, EC+ only)
10	DROOP_OFF	Droop disable contact input (active low)
11	EXCITATION_OFF	Excitation disable contact input (active low)
12	AUX IN (-)	Auxiliary input negative

Table 5-3. Connector J1 System Connections

## UP and DOWN Contact Inputs

Remote set point adjustment may be accomplished by connecting a SPDT momentary contact switch to the J1 connector UP and DOWN contacts. To connect this switch, the common terminal must be connected to J1-4 (CGND). The other two switch terminals are connected to J1-2 (UP) and J1-3 (DOWN). Refer to *Section 4 – 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 opening or closing contact between J1-10 (DROOP OFF) and J1-4 (CGND). Closing the contact disables the droop function. Refer to *Section 4 – 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 opening or closing contact between J1-11 (EXCITATION OFF) and J1-4 (CGND). Closing the contact disables excitation. Refer to *Section 4 – 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 J1-1 (AUX IN +) and J1-12 (AUX IN -). The regulator can also be configured to accept a voltage or current to be metered on this input. Refer to *Section 4 – Features and Protection* for a detailed description of the Auxiliary input function.

## VAR/PF Enable/Disable (VAR/PF\_OFF) (EC+ only)

A user can enable or disable the VAR or PF regulation modes by opening or closing contact between J1-9 (VAR/PF\_ON) and J1-4 (CGND). Opening the contact enables VAR/PF regulation if the regulation mode was set to VAR or PF in the HMI or DVRPortal™. Refer to *Section 4 – 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 open during power up of the regulator in VAR or PF regulation modes, a Generator Start Up Fault occurs.**

### Contact Output (CONTACT1 and CONTACT2)

The output contact may be accessed at connector J1, via terminals J1-6 (CONTACT1) and J1-7

(CONTACT2). The relay output is normally open and closes when the regulator goes into a fault condition.



Figure 5-6. RS-232 Communication Port Terminal Positions

Pin Number	Function	Name
1	N/C	
2	Receive Data	RXD
3	Transmit Data	TXD
4	Data Terminal Ready	DTR
5	Signal Ground	GND
6	Data Set Ready	DSR
7	Ready To Send	RTS
8	N/C	
9	N/C	

Table 5-4. RS-232 Communication Port Pin Functions

**Note:** If serial port does not support DTR and RTS functions, then these lines must be connected to serial port positive supply voltage of Data Terminal Equipment.

### Serial Communication Port

The RS-232 port on the rear panel uses a DB-9 female connector. Figure 5-6 and Table 5-4 illustrate the pin assignments of the communication port from the perspective of the PC. A standard communication cable terminated with a DB-9 male connector is used for PC interface with the DVR®. **Note:** Do not use a “cross-over” or “null-modem” cable.

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## CAN J1939 Communication Port (J3)

The CAN port on the rear panel uses an AMP/Tyco Mini Mat-N-Lok connector. Figure 5-7 illustrates

the pin assignments of the CAN port and Table 5-5 identifies the pin functions of the CAN port.

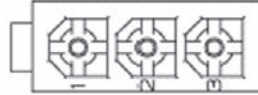


Figure 5-7. Connector J3 CAN Port Pin Assignment

Pin Number	Function	Name
1	CAN High	CAN_H
2	CAN Low	CAN_L
3	CAN Ground	CAN_GND

Table 5-5. Connector J3 CAN Port Pin Functions

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## DVR® Connections for Typical Applications

Figures 5-8 through 5-11 illustrate typical applications using the DVR®.

- 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 three-phase voltage sensing and single-phase current sensing.
- Figure 5-10 shows an application where the regulator is connected for with single-phase voltage sensing and single-phase current sensing.

- Figure 5-11 illustrates an application with a single-phase generator.

Figures 5-12 and 5-13 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 5-12 and 5-13. 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.

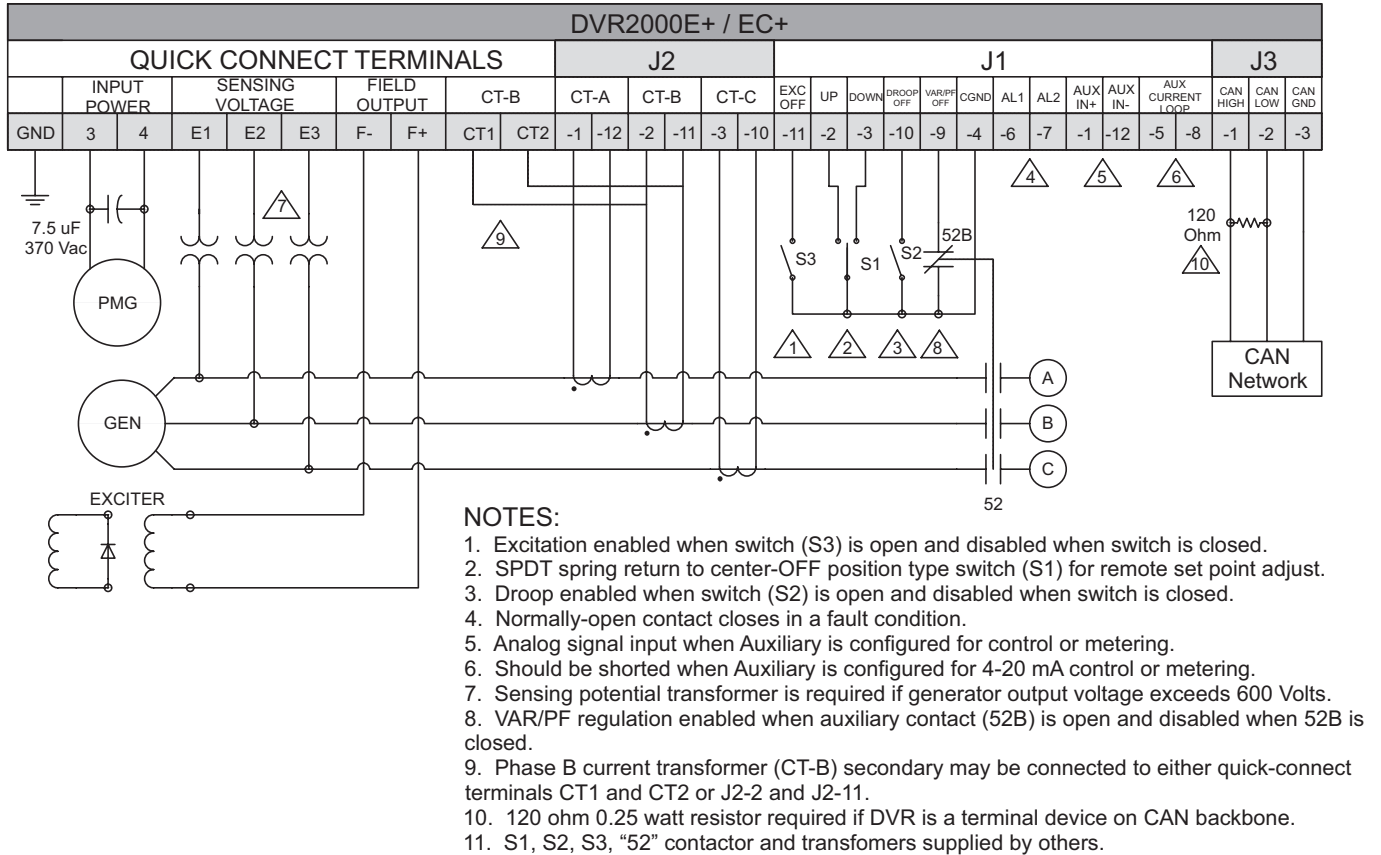


Figure 5-8. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing and Three-Phase Current Sensing





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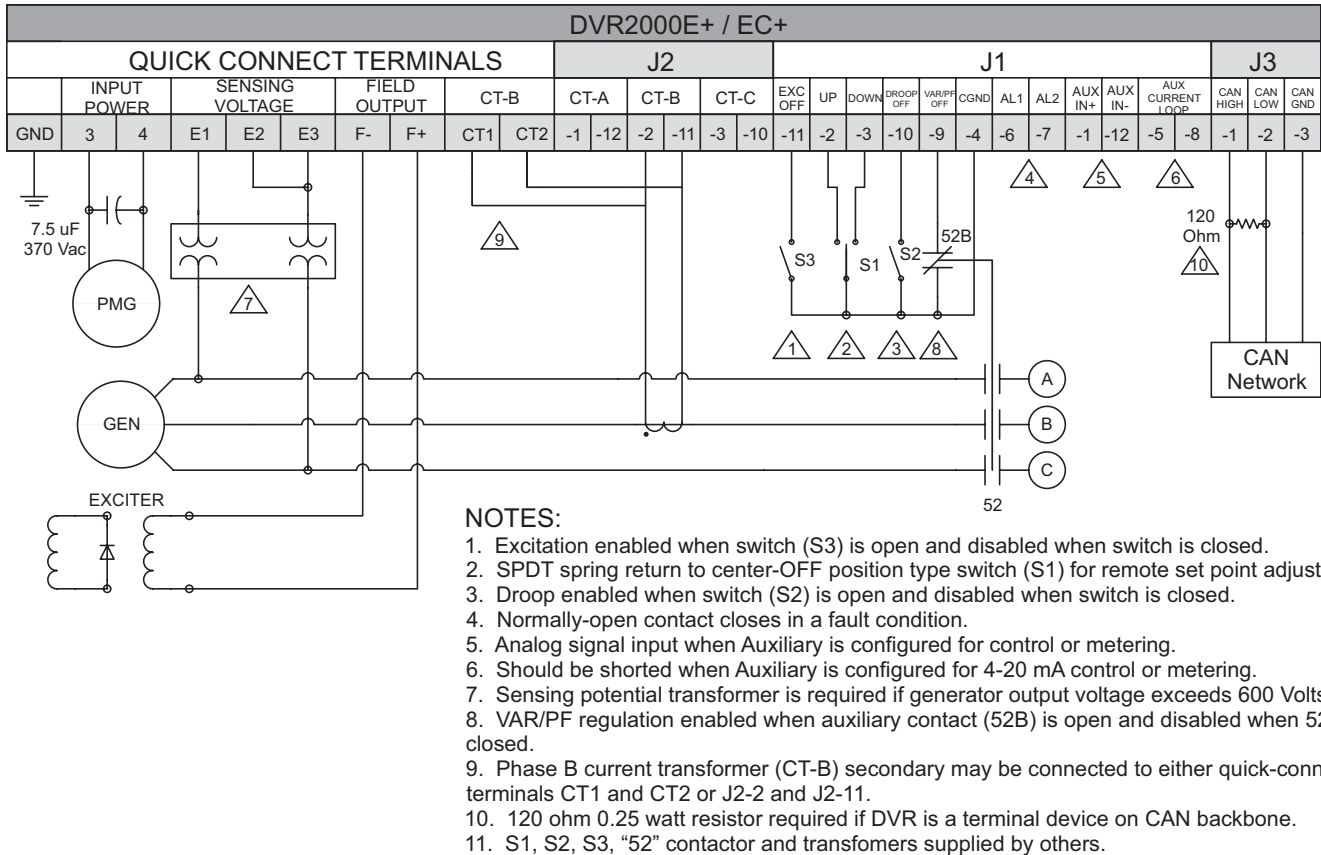


Figure 5-10. Typical Connections with ABC Rotation, Single-Phase Voltage Sensing and Single-Phase Current Sensing

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# Installation

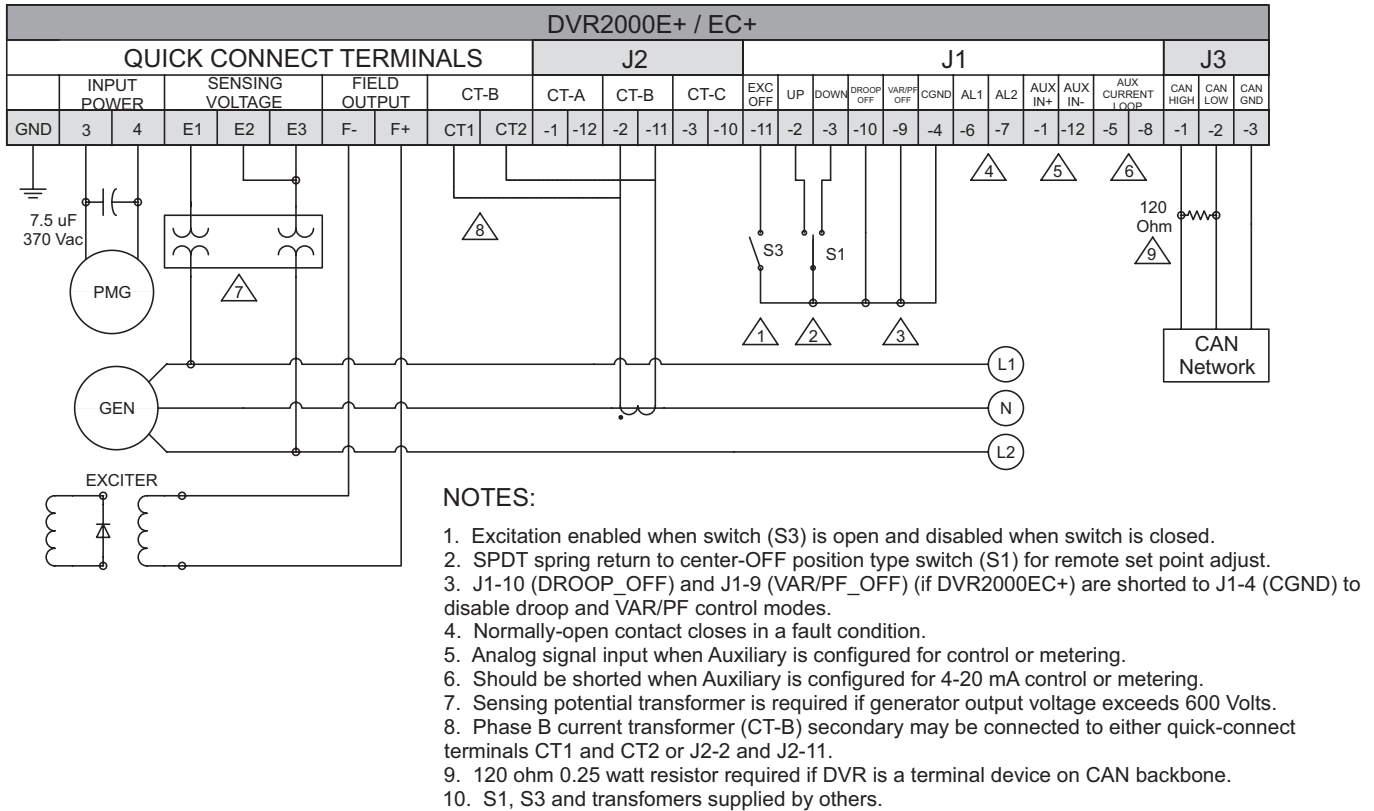


Figure 5-11. Typical Connections to a Single-Phase Generator

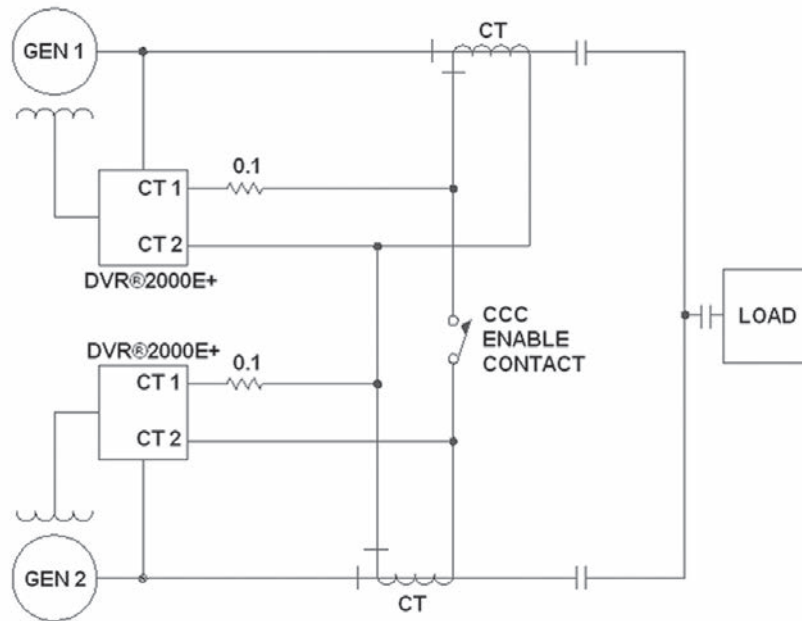


Figure 5-12. Cross-Current (Reactive Differential) Connections for Two Generators

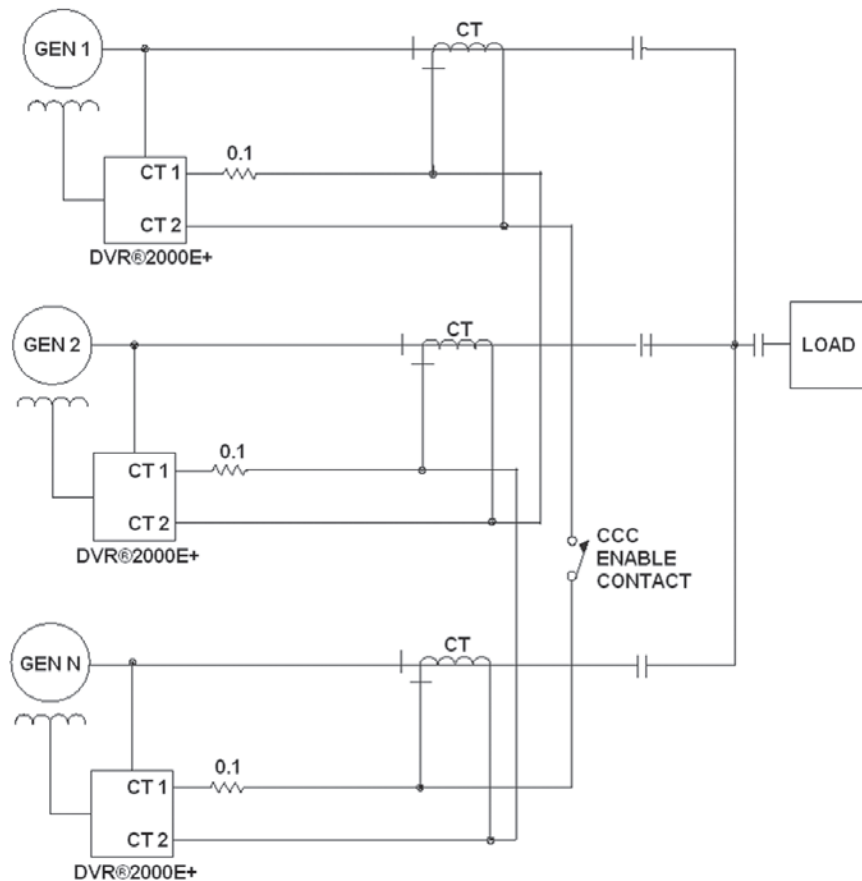


Figure 5-13. Cross-Current (Reactive Differential) Connections for Three or More Generators

# Installation

5

## PRELIMINARY SETUP – SAFETY

### **⚠️ WARNING** ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may 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, lockout 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) generators in accordance with local, national, international and/or other applicable codes, rules or regulations.

**⚠️ WARNING** Use caution when working around the component side of the DVR®. 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

The DVR® may be configured on the generator using the following procedure:

1. Before starting the engine, remove the regulator's 4.0 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 4.0 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 will enter a Loss of Sensing shutdown mode, indicated by F011 on the display.
5. At this time, initial adjustments can be made. If adjusting via the HMI, see *Section 6 – Making Settings Changes*. If adjusting via DVRPortal™, see *Section 7*.
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 BENCH

The DVR® 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

**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 **RUN** on the display. If the regulator is in FCR regulation mode, the regulator will indicate **F011** on the display.
3. At this time, initial adjustments can be made. If adjusting via the HMI, see *Section 6 – Making Settings Changes*. If adjusting via the Windows® communication software, see *Section 7*.

After the initial adjustments are made, disconnect the 120 Vac source and install the regulator onto the generator. The generator may be started and final adjustments may be performed on the regulator.

# Human-Machine Interface (HMI)

## GENERAL

The DVR® 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®2000E+ HMI shown





Button	Description
SELECT 	This button steps the user through a menu list of editable parameters. It also serves as an escape key in EDIT mode.
UP 	This button increases the setting level of the parameter being adjusted.
DOWN 	This button decreases the setting level of the parameter being adjusted.
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® HMI Button Function Descriptions



# Human-Machine Interface (HMI)

## FRONT PANEL DISPLAY

The HMI display has three display modes:

1. **STATUS mode** – the HMI displays the non-editable operating state of the DVR® 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 DVR® 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 a period 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.
RUN	This display indicates that the regulator is operating normally with excitation
OFF	This display indicates that the regulator is operating normally and excitation is disabled.
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® HMI **STATUS** Mode Display Descriptions

# Human-Machine Interface (HMI)








Parameter Name	Parameter Value	Description
SIZE	281 to 1040	Frame size of generator
REG	AVR3	AVR3 – Voltage regulator with three-phase sensing
	AVR1	AVR1 – Voltage regulator with single-phase sensing
	FCR	FCR – Field current regulator
	VAR	VAR – Reactive VAR regulation (EC+ only)
	PF	PF – Power Factor regulation (EC+ only)
STPT	100.0 to 630.0	Voltage set point (Vrms) in AVR3 and AVR1 mode
	0.000 to 3.000	Field current set point (Adc) in FCR mode
	0.0% to 10.0%	VAR set point (% of rated VAR) in VAR mode. (EC+ only)
	0.000 to 0.999	PF set point (PU) in PF mode (EC+ only)
UFRQ	40.0H to 70.0H	Under frequency knee (Hz)
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 to +3 Vdc input)
	SCLF	Auxiliary Meter – Auxiliary input is used as a meter with user-defined scale factor
	CNT2	Auxiliary Control-2 – Auxiliary input modifies regulation set point (4 to 20 mA input)



Table 6-3. DVR® HMI EDIT Mode Parameters

# Human-Machine Interface (HMI)

---

## 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, the following procedure is used:
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 takes 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.

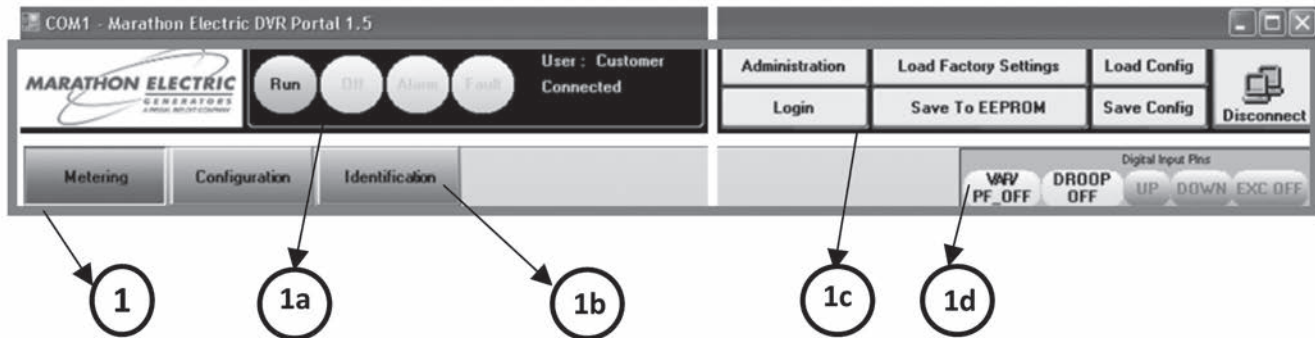
# DVRPortal™ Graphical User Interface (GUI)

DVRPortal™ offers a means of programming the regulator and monitoring generator performance. This Windows® application software is available as a free download from the Marathon Electric website, [www.marathonelectric.com](http://www.marathonelectric.com). With this software, the user will be able to change all of the programmable parameters.

DVRPortal™ consists of a header, and three panels (Metering, Configuration and Identification). 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.

## HEADER (1)

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



### DVR® Status (1a)

The header panel includes four indicators that enunciate the DVR® status:

- **Run State:** If the DVR® is in a run state, the header will display a green run indicator.
- **Off State:** If the DVR® is in an excitation off state, the header will display a gray off indicator.
- **Alarm State:** If the DVR® is in an alarm state, the header will display a yellow alarm indicator.
- **Fault State:** If the DVR® is in a fault state, the header will display a red fault indicator.

## 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 DVRPortal™ to the DVR® RAM.

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

**Refresh** – Pressing this button loads the values that are presently in the DVR® RAM into the currently active tab of DVRPortal™.

### Configuration tabs (1b)

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

### Administrative Buttons (1c)

The administrative buttons provide communication port settings, user access, file manipulation and storing to DVR® non-volatile memory.

#### Administration

This button allows the user to change serial port communication settings and modify passwords.

#### Login

The default user type is Customer. The type of user logged in is displayed in the header area. The

# DVRPortal™

## Graphical User Interface (GUI)

Superuser type is intended for Marathon Electric use only.

### Load Factory Settings

When this button is pressed, the default factory settings for the regulator are loaded into the DVR's 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.

### Save to EEPROM

When this button is pressed, all parameter values in the DVR's 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.

### Load Config

When this button is pressed, the user will be prompted to select 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 DVR®. These settings can be transferred to the user settings in non-volatile EEPROM by pressing the "Save to EEPROM" button.

**Note:** When a file is transferred from a computer to the regulator, the operating status will switch to "OFF" 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 select a .xml file name. 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.

**Note:** .xml files are text files that can be printed for reference.

### Connect

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

### Digital Input Pins (1d)

There are five indicators labeled VAR/PF OFF (EC+ only), DROOP OFF, UP, DOWN and EXC OFF in the header. These indicators show the status of the five input signals to 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.

# DVRPortal™ Graphical User Interface (GUI)

## METERING (2)

This panel has five sub-panels: AC Metering, DC

Metering, Step Change, Simulated Reactive Power and the Alarms/Faults.



### AC Metering (2a)

This panel displays the measured AC quantities of the generator and regulator. Specifically, the panel displays line-to-line voltage, line-to-neutral voltages, line currents, real power, apparent power, reactive power and power factor. 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).

### DC Metering (2b)

This panel displays the measured DC values of field current, field voltage, DVR® temperature, engine speed and auxiliary input voltage.

### Step Change (2c)

This panel for enables a voltage step function intended for monitoring DVR® 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

# DVRPortal™

## Graphical User Interface (GUI)

-10 to 10%. When the “Apply” button below this field is clicked, the DVR® 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 DVR®. When the “Historical” tab is active, the panel displays the faults and alarms that were present (if any) the previous time the DVR® was energized. The alarms and faults can be in any of four possible states:

- **Run State:** If the DVR® 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 DVR® is in an alarm state, there will be a yellow indicator next to the corresponding condition causing the alarm.
- **Fault State:** If the DVR® is in a fault state, there will be a red indicator next to the corresponding condition causing the fault.

**Note:** The historical fault data will clear 15 seconds after regulator power-up or until another alarm or fault is detected.

### CONFIGURATION

This panel has four sub panels: Operating Modes, Set Points, Protection Settings and CAN Bus Configuration.

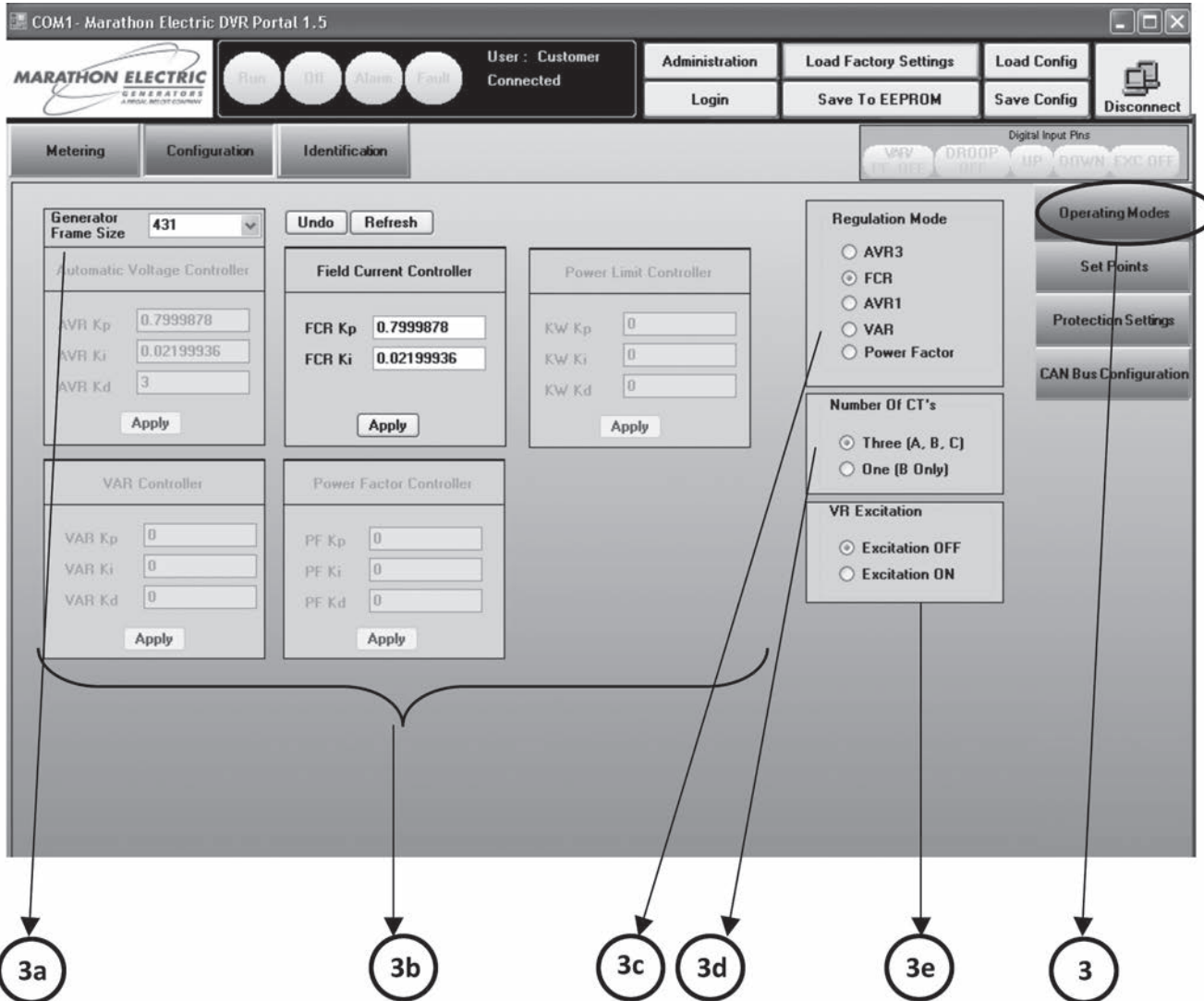


# DVRPortal™ Graphical User Interface (GUI)

## OPERATING MODES (3)

This panel contains controls for altering the

operating mode of the DVR® including dynamic response and regulation.



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### 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. For the EC+, this

is also true for VAR and PF regulation modes. 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® will maintain a fixed level of field current.
- **VAR Regulating Mode (EC+ Only)** is used for reactive VAR regulation. This mode is only enabled when the VAR/PF\_OFF input is open. Otherwise, the DVR® will regulate as if AVR3 mode were selected.
- **PF Regulating Mode (EC+ Only)** is used for power factor regulation. This mode is only enabled when the VAR/PF\_OFF input is open. Otherwise, the DVR® 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.
- **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.

### VR Excitation (3e)

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

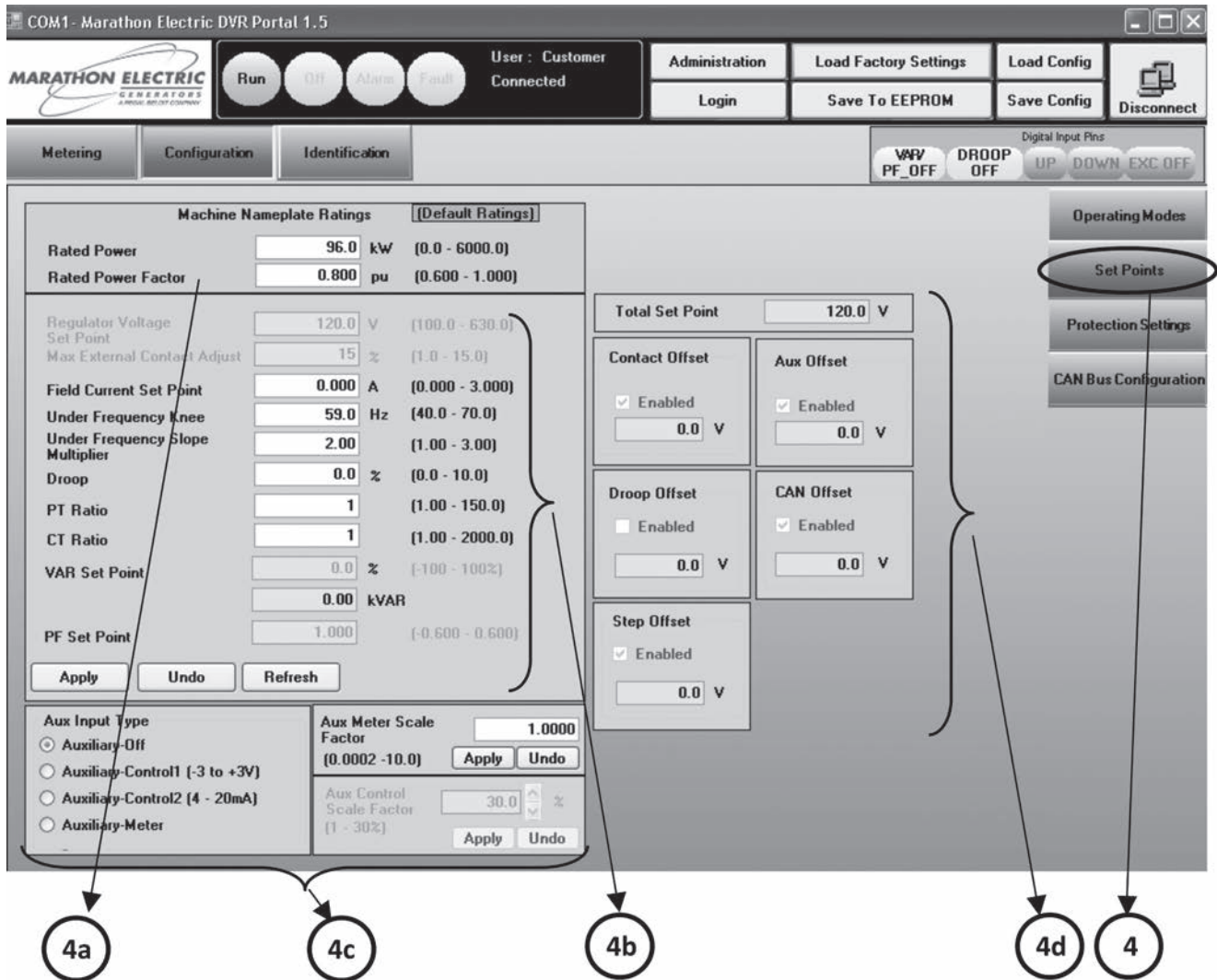
- **Excitation Off** is used to disable excitation to the generator exciter field. The status indicator in the header will display a gray "Off" state. This state is recommended for making adjustments to DVR® settings.
- **Excitation On** is used to enable excitation to the generator exciter field. If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

*Note: Any changes to DVR® 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.*

# DVRPortal™ Graphical User Interface (GUI)

## SET POINTS (4)

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



### Machine Nameplate Rating (4a)

This panel contains the fields for the rated power and rated power factor of the machine the DVR® 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 and, in the EC+, for VAR and PF regulation modes.

### Regulation Set Points (4b)

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

- **Regulator Voltage Set Point** is editable in AVR1 and AVR3 and, for the EC+, in 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 DVR® sensing leads are connected line-to-line, the desired generator output voltage is identical to the Regulator Voltage Set Point. If the DVR® 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.

- **Maximum External Contact Adjust** is the maximum adjustment percentage of the UP and DOWN contact inputs. In FCR Mode, field current is adjusted from a fixed minimum of -3.000 Adc to a fixed maximum of +3.000 Adc using the UP and DOWN contacts.
- **Field Current Set Point** is editable in FCR Regulation Mode. This value represents the desired field current of the DVR®.
- **Under Frequency Knee** is the value of frequency below which the regulator operates in a Volts-per-Hertz mode. Refer to *Section 4 – Features and Protection* for a detailed description of Generator Under Frequency.
- **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 4 – Features and Protection* for a detailed description of Generator Under Frequency.
- **Droop** is the maximum percentage of Regulator Voltage Set Point allowed for adjustment of voltage during load sharing. Refer to *Section 4 – 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.

#### 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 meter input or disabled. Refer to *Section 4 – Features and Protection* for a detailed description of the Auxiliary Input function.
- **Aux. Meter Scale Factor** is used only when the auxiliary input type is configured as “Auxiliary Meter.” This value scales the auxiliary input. Refer to *Section 4 – Features and Protection* for a detailed description of the Auxiliary Input function.
- **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 4 – Features and Protection* for a detailed description of the Auxiliary Input function

# DVRPortal™

## Graphical User Interface (GUI)

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### Offset Display (4d)

This panel displays the offsets contributing to a 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 4 – 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 4 – 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 4 – 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 *DVR2000E+/EC+ 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 4 – 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.



# DVRPortal™ Graphical User Interface (GUI)

## PROTECTION SETTINGS (5)

This panel contains two sub panels for protection settings and limit settings.

COM1 - Marathon Electric DVR Portal 1.5

Run Off Alarm Fault User : Customer Connected

Administration Load Factory Settings Load Config Login Save To EEPROM Save Config Disconnect

Metering Configuration Identification

Digital Input Pins VWFV PF\_OFF DROOP OFF UP DOWN EXC OFF

Operating Modes Set Points **Protection Settings** CAN Bus Configuration

Description	Threshold	Range	Timer	Timer Range	Basis
<input type="checkbox"/> Generator Over Voltage	20.0 %	(5.0 - 20.0)	0.75 S	(0.1 - 15.0)	120.0 V
<input type="checkbox"/> Generator Under Voltage	25.0 %	(5.0 - 50.0)	6.0 S	(1.0 - 15.0)	120.0 V
<input type="checkbox"/> Field Over Excitation	3.500 A	(0.500 - 4.000)	15.0 S	(1.0 - 15.0)	
<input type="checkbox"/> Field Under Excitation	-100.0 %	(-100.0 to -5.0)	15.0 S	(1.0 - 15.0)	72.0 kVAR
<input type="checkbox"/> Reverse Power	10.0 %	(5.0 - 100.0)	10.0 S	(1.0 - 15.0)	96.0 KW
<input type="checkbox"/> Voltage Imbalance	20.0 %	(20.0 - 50.0)	12 S	(1.0 - 15.0)	120.0 V

Apply Undo Refresh

Protections Configuration status  Disabled  Enabled

5a 5 5b

### Protections (5a)

This panel contains editable threshold and timer fields for configurable faults and alarms. For most applications, the default values of these parameters should be used. For protection settings that have a threshold as a percentage, the “Basis” column indicates the DVR® parameter used for the percentage related to that protection feature.

- **Generator Over Voltage Threshold** is the percentage of Regulator Voltage Set Point that triggers the Generator Over Voltage protection feature. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Over Voltage Shutdown feature.

# DVRPortal™

## Graphical User Interface (GUI)

- **Generator Over Voltage Timer** is the amount of time the regulator operates before shutting down due to a Generator Over Voltage fault. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Under Voltage Shutdown feature.
- **Generator Under Voltage Threshold** is the percentage of Regulator Voltage Set Point that triggers the Generator Under Voltage protection feature. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Over Voltage Shutdown feature.
- **Generator Under Voltage Timer** is the amount of time the regulator operates before shutting down due to a Generator Under Voltage fault. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Under Voltage Shutdown feature.
- **Field Over Excitation Threshold** is the current threshold that triggers the Field Over Excitation protection feature. Refer to *Section 4 – Features and Protection* for a detailed description of the Field Over Excitation Shutdown feature.
- **Field Over Excitation Timer** is the amount of time the regulator operates before shutting down due to a Field Over Excitation fault. Refer to *Section 4 – Features and Protection* for a detailed description of the Field Over Excitation Shutdown feature.
- **Field Under Excitation Threshold** is the reactive power threshold that triggers the Field Under Excitation protection feature. Refer to *Section 4 – Features and Protection* for a detailed description of the Field Over Excitation Shutdown feature.
- **Field Under Excitation Timer** is the amount of time the regulator operates before shutting down due to a Field Under Excitation fault. Refer to *Section 4 – Features and Protection* for a detailed description of the Field Over Excitation Shutdown feature.
- **Reverse Power Threshold** is the percentage of Rated Power flow into the generator triggers the Reverse Power protection feature. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Voltage Imbalance Shutdown protection feature.
- **Reverse Power Timer** is the amount of time the regulator operates before shutting down due to a Reverse Power fault. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Voltage Imbalance Shutdown protection feature.
- **Voltage Imbalance Threshold** is the percentage difference between the average generator voltage and any individual line-to-line voltage that triggers the Generator Voltage Imbalance protection feature. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Voltage Imbalance Shutdown protection feature.
- **Voltage Imbalance Timer** is the amount of time the regulator operates before shutting down due to a Generator Voltage Imbalance fault. Refer to *Section 4 – Features and Protection* for a detailed description of the Generator Voltage Imbalance Shutdown protection feature.

### Protection Table Legend (5b)

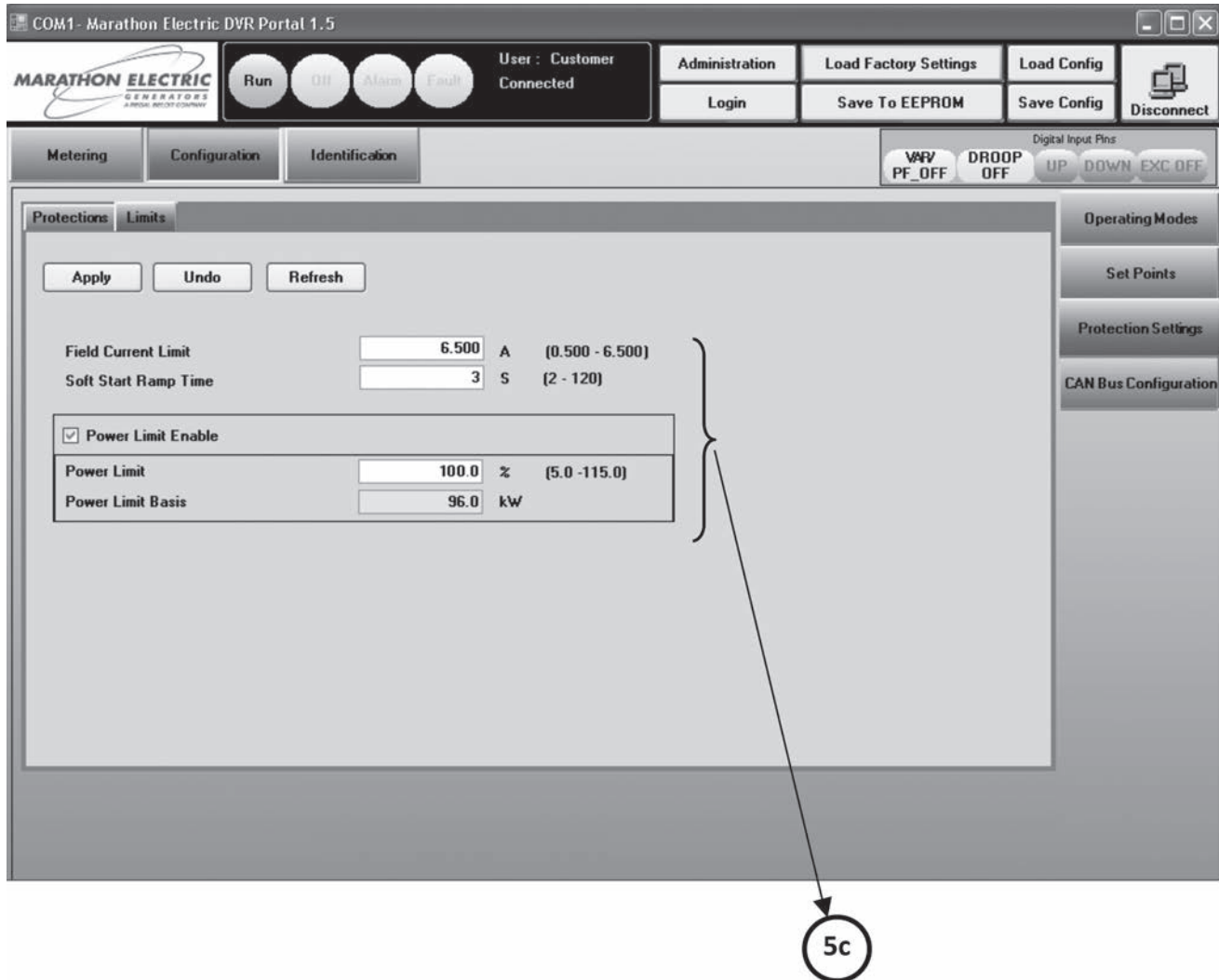
This legend indicates which protection settings are disabled (gray) and enabled (green). The state of protection features is dependent on the selected regulation mode.



# DVRPortal™ Graphical User Interface (GUI)

## Limits (5c)

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.



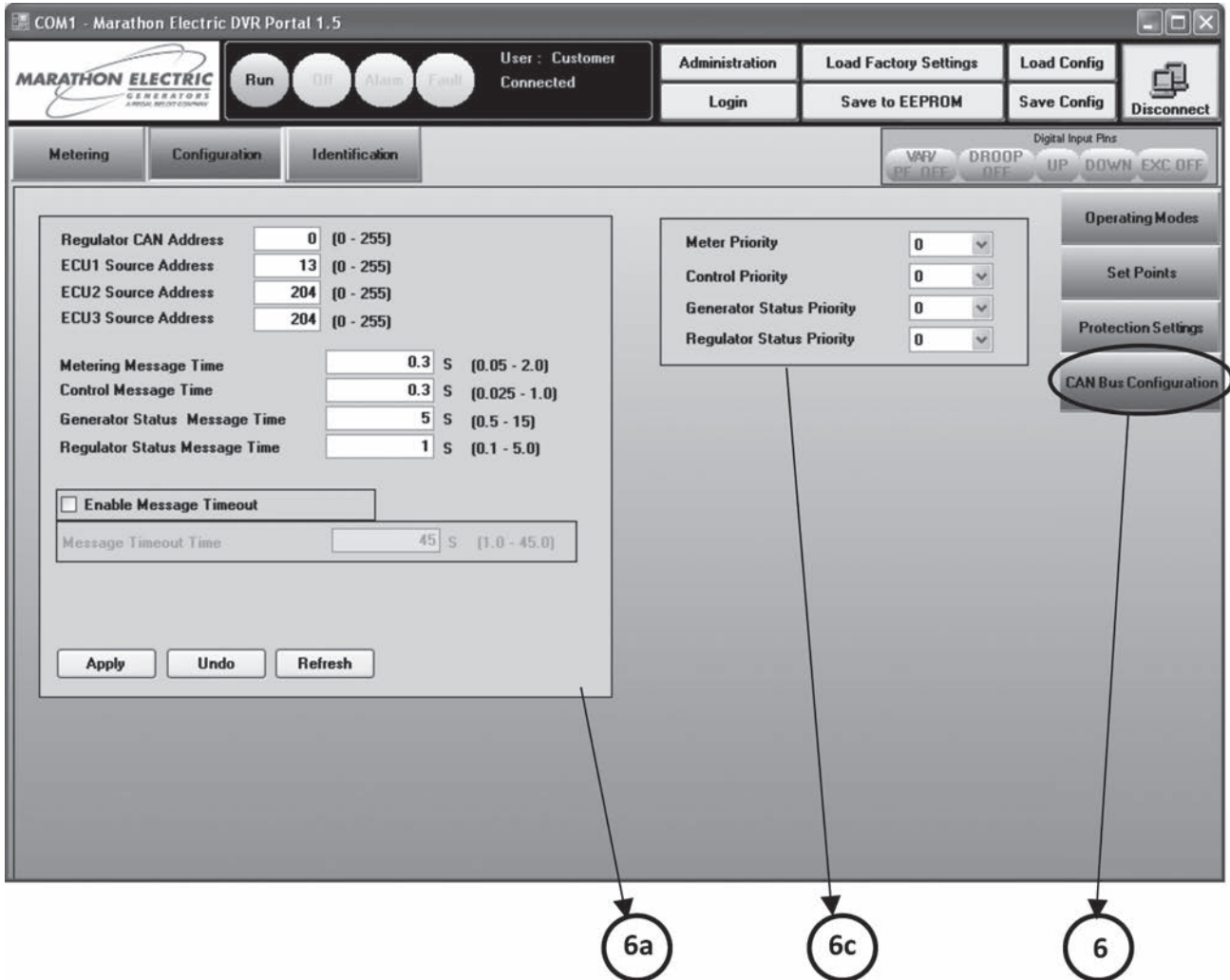
- **Field Current Limit** is the maximum allowable field current output of the regulator. Refer to *Section 4 – Features and Protection* for a detailed description of the Field Current Limiting feature.
- **Soft Start Ramp Time** is the amount of time taken to ramp to the desired voltage at the generator output terminals in AVR1 and AVR3 regulation modes. Refer to *Section 4 – 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 4 – Features and Protection* for a detailed description of the Power Limiting feature.

# DVRPortal™ Graphical User Interface (GUI)

## CAN BUS CONFIGURATION (6)

This panel contains editable fields for parameters associated with the CAN Bus communication of

the DVR®. Refer to the *DVR2000E+/EC+ CAN Bus Interface User Guide* for a detailed description of these features.



### CAN Addresses and Message Times (6a)

This panel allows editing of CAN addresses and message times.

- **Regulator CAN Address** is the CAN address of the DVR®.
- **ECU1 Source Address** is the CAN address of the highest priority Electronic Control Unit that the DVR® will respond to.
- **ECU2 Source Address** is the CAN address

of the second-highest priority Electronic Control Unit that the DVR® will respond to.

- **ECU3 Source Address** is the CAN address of the lowest priority Electronic Control Unit that the DVR® will respond to.

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

- **Metering Message Time** is the amount of time between the transmission of messages in the metering group.
- **Control Message Time** is the amount of time between the transmission of messages in the control group.
- **Generator Status Message Time** is the amount of time between the transmission of messages in the generator status group.
- **Regulator Status Message Time** is the amount of time between the transmission of messages in the regulator status group.
- **Message Timeout Time** is the amount of time before a Loss of Communication alarm is triggered. The checkbox permits enabling/disabling of this feature.

### CAN Priorities (6b)

This panel has pull-down menus for assigning the priorities to the message groups transmitted by the DVR®.

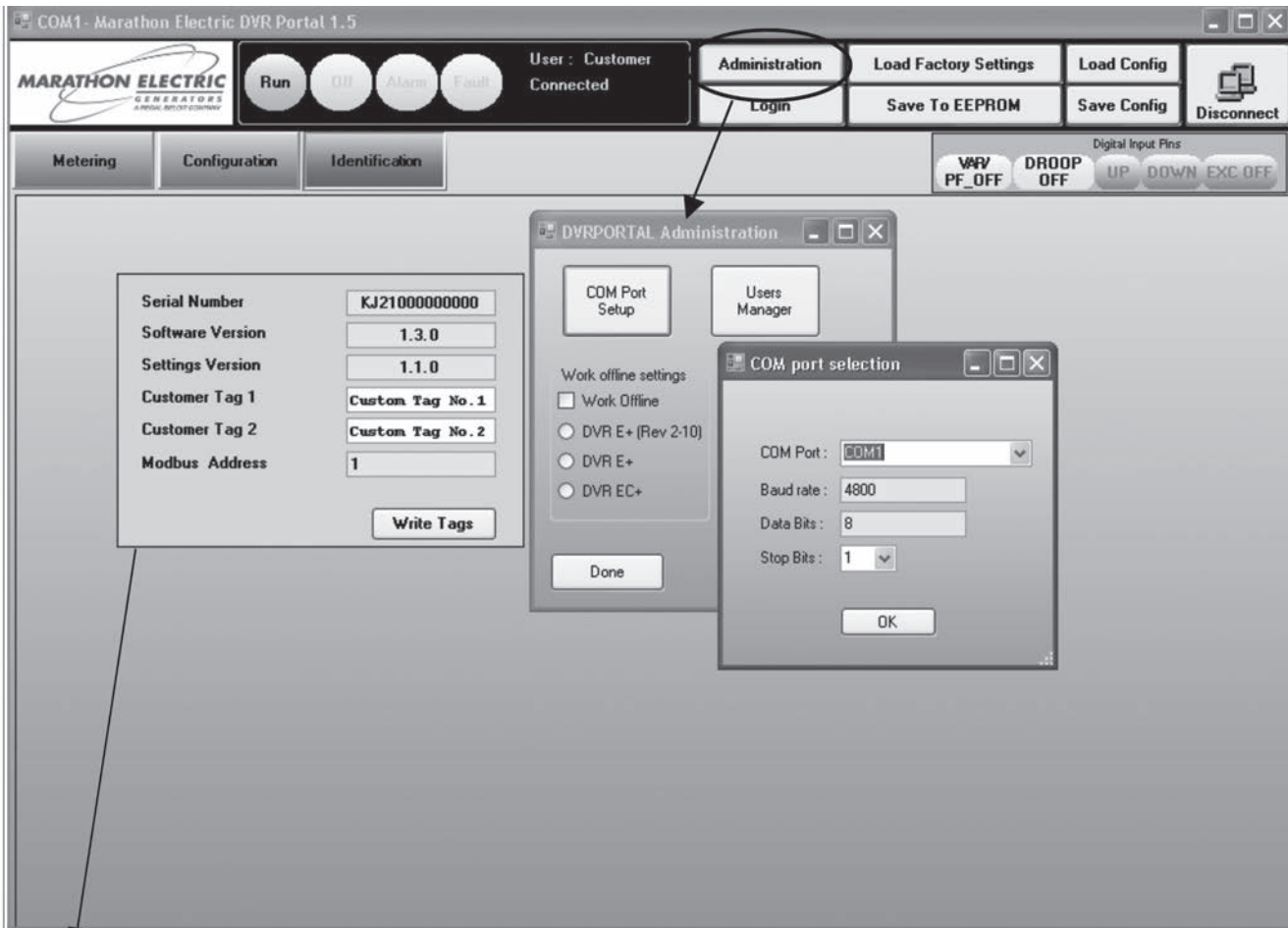
- **Meter Priority** is the priority given to messages in the metering group.
- **Control Priority** is the priority given to messages in the control group.
- **Generator Status Priority** is the priority given to messages in the generator status group.
- **Regulator Status Priority** is the priority given to messages in the regulator status group.

# DVRPortal™ Graphical User Interface (GUI)

## IDENTIFICATION TAB (7)

This panel contains non-editable fields for the DVR® serial number, software version, settings version and

MODBUS address. It also contains editable fields for custom tags.



7

- **Serial Number** is the serial number of the DVR®.
- **Software Version** is the version of DVR® firmware.
- **Settings Version** is the version of factory default settings for the DVR®.
- **MODBUS Address** is the MODBUS address of the DVR®. Currently this is not editable and has a default value of 1.
- **Customer Tag 1** is a 15-character string that can be stored to the DVR®. The Write Tags button will write the string into the DVR® RAM, but a Save to EEPROM is needed to store the tag in the non-volatile memory.
- **Customer Tag 2** is a 15-character string that can be stored to the DVR®.

**Note:** The Write Tags button will write the string into the DVR® RAM, but a Save to EEPROM is needed to store the tag in the non-volatile memory.

# Maintenance and Troubleshooting

## **⚠️ WARNING** ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may 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, lockout 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) regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

## **⚠️ WARNING** MAGNETIC FIELD HAZARD

Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which may 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.

## **⚠️ WARNING** 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.

## MECHANICAL SAFETY

### **⚠️ WARNING** 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.

### **⚠️ WARNING** 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.

### **⚠️ WARNING** 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.

## PREVENTATIVE MAINTENANCE

The only preventive maintenance required on the DVR<sup>®</sup> is to periodically check that the connections between the DVR<sup>®</sup> and the system are clean and tight. The only user serviceable part on the DVR<sup>®</sup> is the fuse. Marathon Electric recommends that no repair procedures, other than replacing the fuse if needed, be attempted by anyone other than Marathon Electric personnel.

# Maintenance and Troubleshooting

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## TROUBLESHOOTING

**⚠ Read and follow all applicable safety instructions in Section 1 and Section 8. 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. 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 DVR<sup>®</sup> 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.

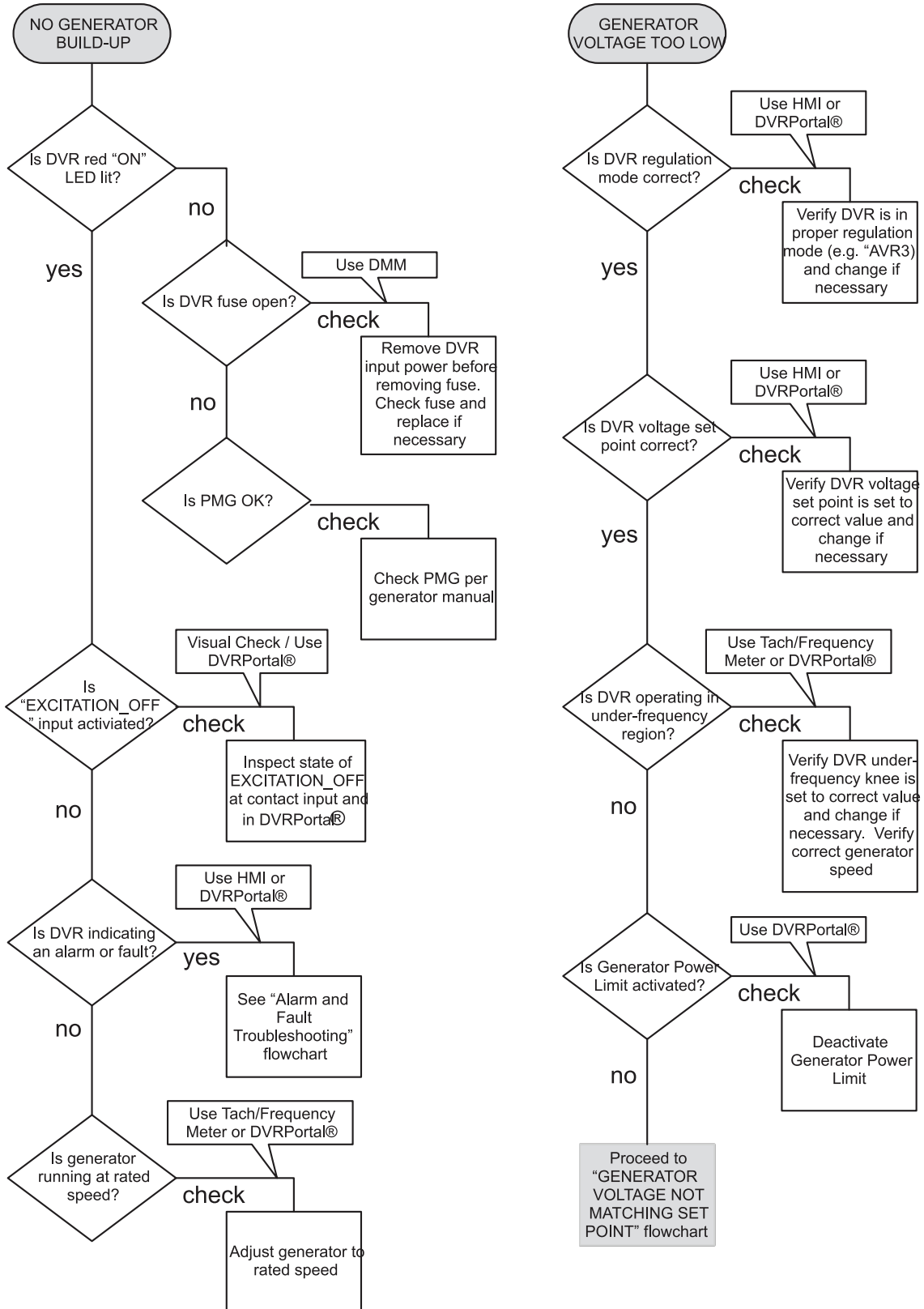
6. **⚠ Follow all applicable safety warnings and cautions while performing this test.**

Verify the output of the PMG (input power of DVR<sup>®</sup>) is within specification.

7. Continue with the following troubleshooting flow charts.

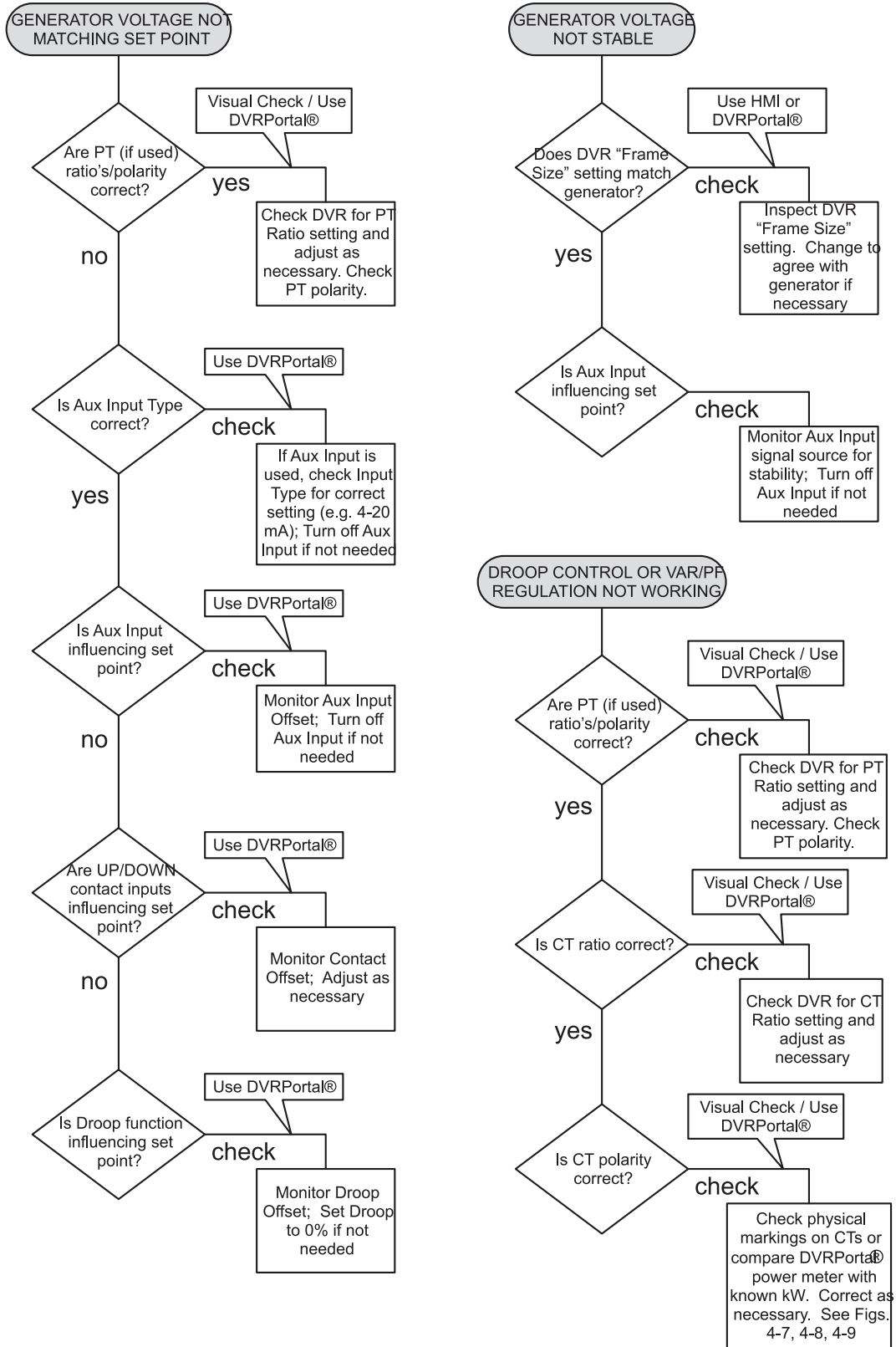
# Maintenance and Troubleshooting

## TROUBLESHOOTING FLOWCHART



# Maintenance and Troubleshooting

## TROUBLESHOOTING FLOWCHART

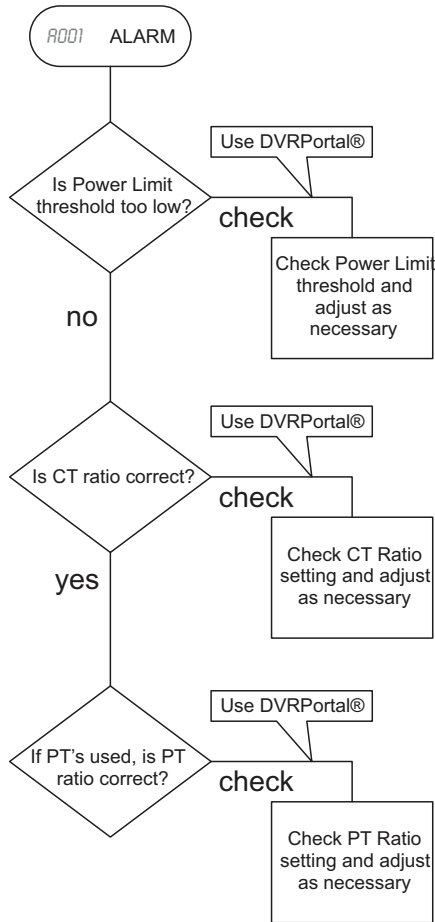




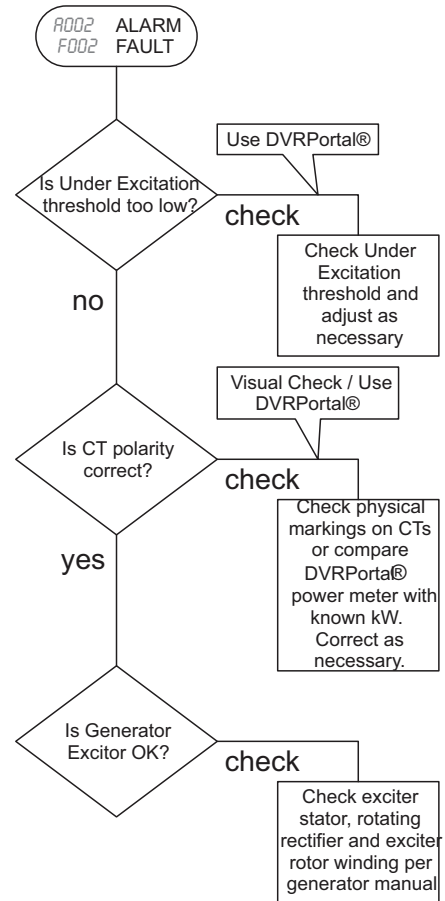
# Maintenance and Troubleshooting

## ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

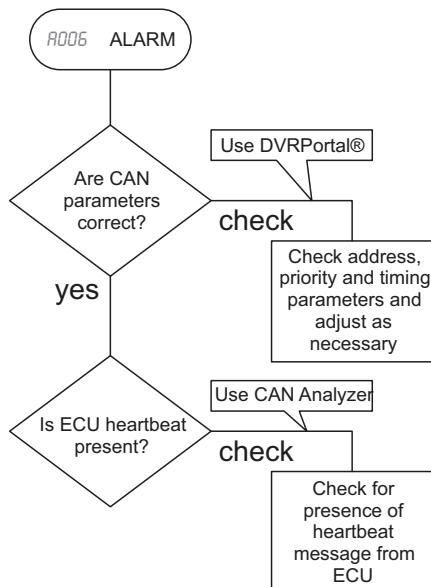
### Generator Power Limit Alarm



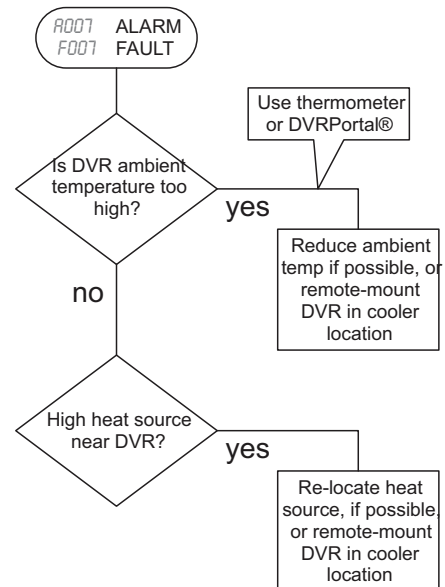
### Under Excitation Alarm/Fault



### Loss of CAN Communication Alarm



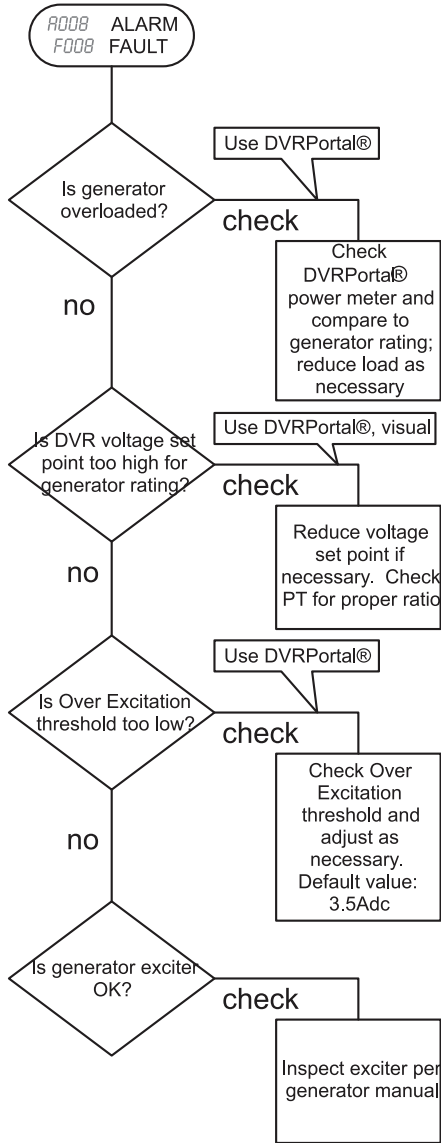
### Regulator Over Temperature Alarm/Fault



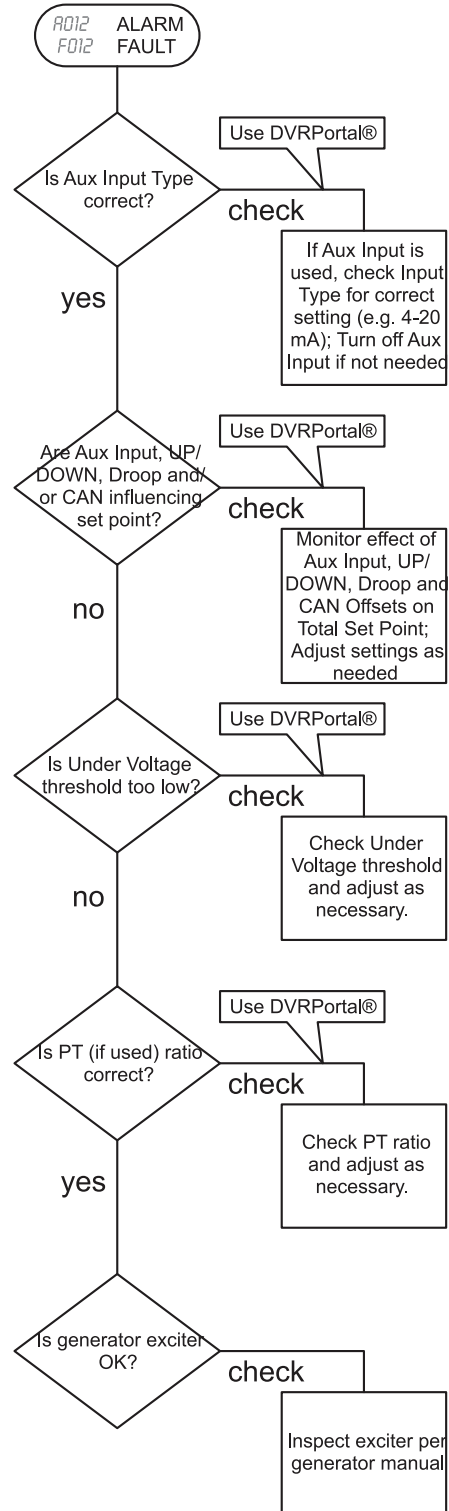
# Maintenance and Troubleshooting

## ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

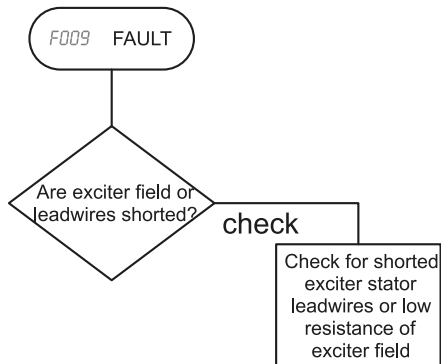
### Field Over Excitation Alarm/Fault



### Generator Under Voltage Alarm/Fault



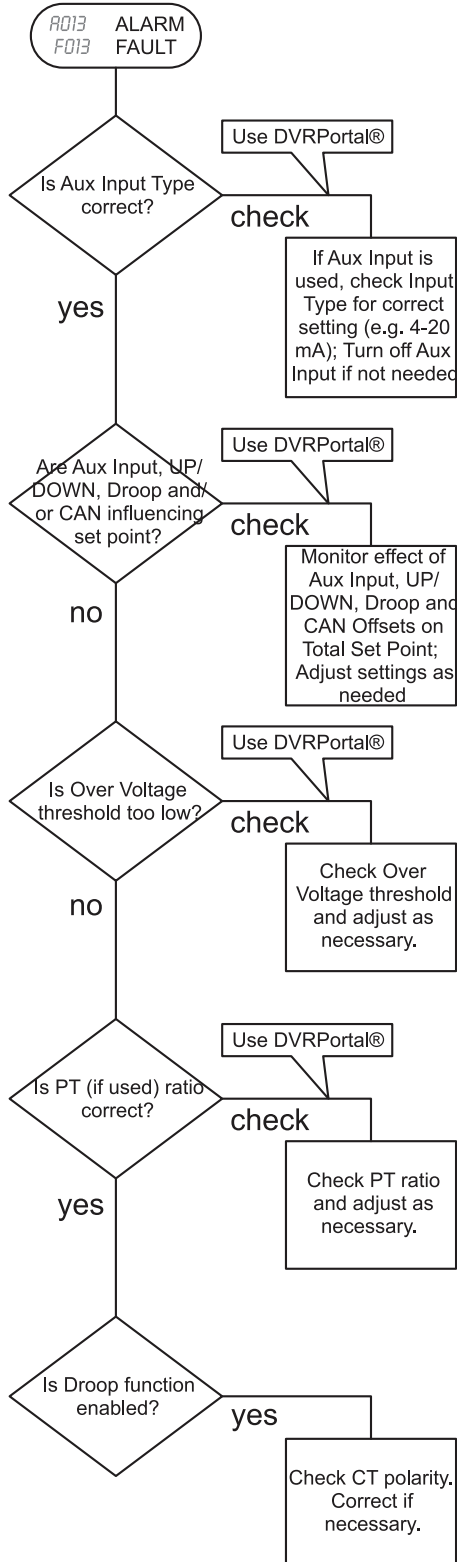
### Instantaneous Field Over Current



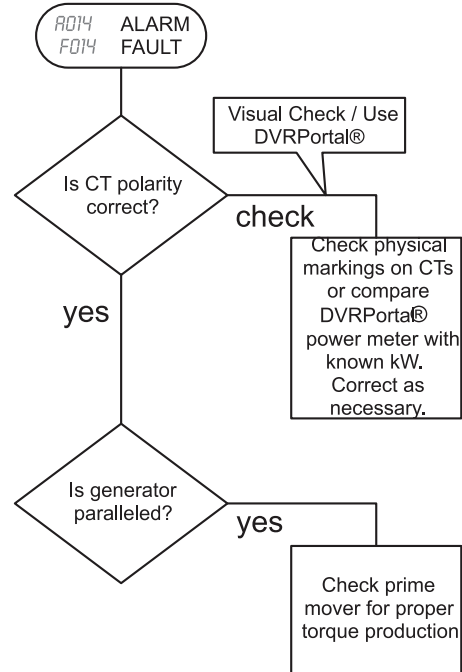
# Maintenance and Troubleshooting

## ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

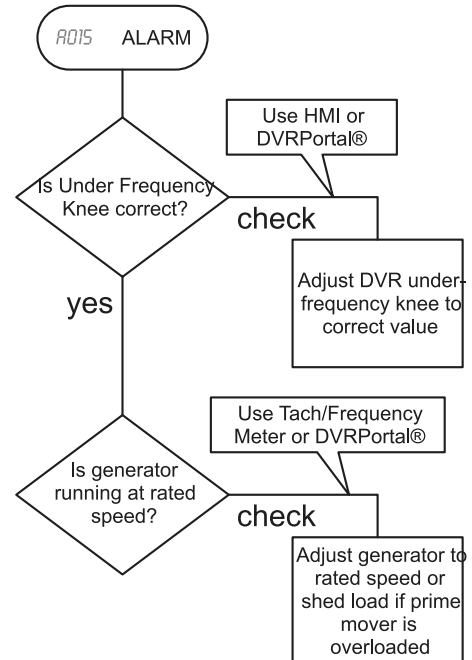
### Generator Over Voltage Alarm/Fault



### Reverse Power Flow Alarm/Fault



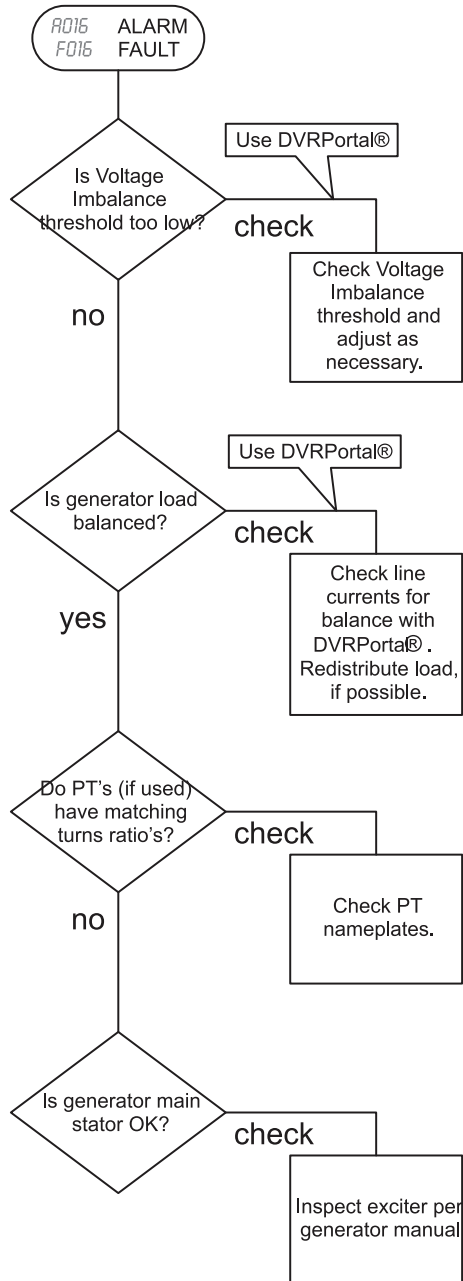
### Generator Under Frequency Alarm



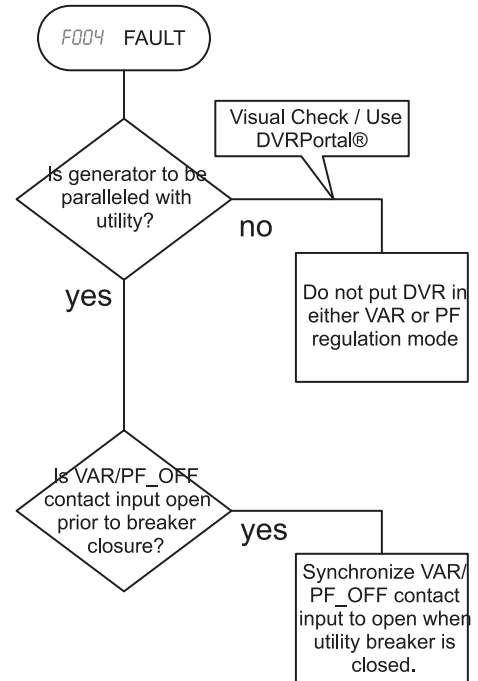
# Maintenance and Troubleshooting

## 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	Generator Power Limiting
A002	Field Under Excitation
A006	Loss of CAN Communication
A007	Regulator Over Temperature
A008	Field Over Excitation
A010	Field Current Limiting
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	
F002	Field Under Excitation
F004	Generator Start Up
F007	Regulator Over Temperature
F008	Field Over Excitation
F009	Instantaneous Field Over Current
F011	Generator Loss of Sensing
F012	Generator Under Voltage
F013	Generator Over Voltage
F014	Generator Reverse Power Flow
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 3 - Specifications*, for mating connector part numbers.

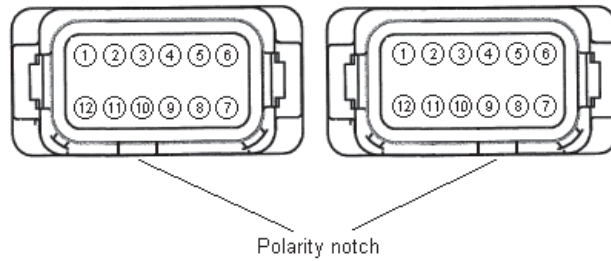


Figure B-1. System Connectors J2 (left) and J1 (right) Terminal Position

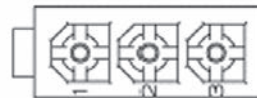


Figure B-2. Connector J3



Figure B-3. RS-232 Communication Port

# Appendix B

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

Terminal Name	Description
<b>GND</b>	Protective earth ground
<b>4</b>	PMG – terminal 1
<b>3</b>	PMG – terminal 2 (Fused)
<b>E1</b>	Generator armature – Phase A
<b>E2</b>	Generator armature – Phase B
<b>E3</b>	Generator armature – Phase C
<b>F-</b>	Exciter stator field (-)
<b>F+</b>	Exciter stator field (+)
<b>CT1</b>	Generator Phase B CT (X1)
<b>CT2</b>	Generator Phase B CT (X2)

Table B-1. Quick Disconnect Terminals

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

Sensing	Phase	CT “X1” Terminal	CT “X2” Terminal
<b>3-Phase</b>	A	J2-1	J2-12
	B	J2-2	J2-11
	C	J2-3	J2-10
<b>1-Phase</b>	B	CT1	CT2

Table B-2. CT Connection Terminals

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

Pin Number	Name	Description
1	AUX IN (+)	Auxiliary input positive
2	UP	UP contact input (active low)
3	DOWN	DOWN contact input (active low)
4	CGND	Input common
5	AUX_LOOP	Auxiliary current loop jumper
6	CONTACT1	Contact output
7	CONTACT2	Contact output
8	AUX_LOOP	Auxiliary current loop jumper
9	VAR/PF_OFF	VAR/PF regulation modes disable contact input (EC+ only, active low)
10	DROOP_OFF	Droop disable contact input (active low)
11	EXCITATION_OFF	Excitation disable contact input (active low)
12	AUX IN (-)	Auxiliary input negative

Table B-3. Connector J1 System Connections

# Appendix B

---

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

Pin Number	Function	Name
1	N/C	
2	Receive Data	RXD
3	Transmit Data	TXD
4	Data Terminal Ready	DTR
5	Signal Ground	GND
6	Data Set Ready	DSR
7	Ready To Send	RTS
8	N/C	
9	N/C	

Table B-4. RS-232 Communication Port Pin Functions

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








Pin Number	Function	Name
1	CAN High	CAN_H
2	CAN Low	CAN_L
3	CAN Ground	CAN_GND




Table B-5. Connector J3 System Connections




















## QUICK START PROGRAMMING GUIDE




As the DVR® is designed to work on many Marathon Electric 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.
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 flash

3 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) 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 **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**.
8. 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**.

9. Remove power from the regulator.
10. Completely reconnect the regulator to the generator.

The regulator is now ready to be placed in service.

# Appendix D

## 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
DVR	Digital Voltage Regulator model DVR®2000E+ or DVR®2000EC+
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







# marathon™

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