

DVR®2000E+ **DIGITAL VOLTAGE REGULATOR** **INSTALLATION, OPERATION AND** **MAINTENANCE MANUAL**



CONTENTS

SECTION 1 – OVERVIEW

General	5
Features	5
Protections	6
Warranty	6

SECTION 2 – SPECIFICATIONS

Operating Power	7
Generator Voltage Sensing	7
Generator Current Sensing	7
Contact Inputs	7
Fault Contact Output	7
Field Output	7
AVR1 and 3 Operating Modes	8
FCR Operating Mode	8
Parallel Compensation	8
Serial Communication Port	8
CAN Communication Port	8
Over Excitation Protection	8
Field Current Limit Protection	8
Field Instantaneous Over Current Protection	8
Generator Over Voltage Protection	9
Generator Under Voltage Protection	9
Soft-Start Function	9
Auxiliary Input	9
Metering	10
Environmental	11
Environmental Test	11
Electromagnetic Compatibility	11
Electromagnetic Compatibility Tests	11
Mechanical Tests	11
Physical	11
Mating Connectors	11

SECTION 3 – FEATURES AND PROTECTION

Introduction	12
DVR®2000E+ Function Blocks	12
DVR®2000E+ Operating Features	15
Regulation Modes	15
Auxiliary Input	15
Load Sharing	16
Generator Soft Start	16
DVR®2000E + Protection Features	17
Field Over Excitation Shutdown	17
Generator Over Voltage Shutdown	17
Generator Under Voltage Shutdown	18
Generator Voltage Imbalance Shutdown	18
Loss of Generator Sensing Shutdown	18
Field Current Limiting Shutdown	19

CONTENTS cont.

Instantaneous Field Over Current Shutdown	19
Regulator Over Temperature Shutdown	19
Generator Under Frequency Alarm	20
Generator Reverse Power Flow Alarm.....	21
Loss of CAN Communication Alarm	21
SECTION 4 – INSTALLATION	
General	22
Mounting	22
Connections	25
Preliminary Set-up on Generator	35
Preliminary Set-up on Bench	36
SECTION 5 – HUMAN-MACHINE INTERFACE	
General	37
Front Panel Display	38
Making Settings Changes.....	39
SECTION 6 – GRAPHICAL USER INTERFACE	
Header Buttons.....	40
Administration	40
Login.....	40
Load Factory Settings.....	40
Save to EEPROM	40
Load Config	40
Save Config	41
Connect	41
Parameter Screen Selection Buttons	41
Metering Tab	41
Configuration Tab	42
Operating Modes Sub Panel	42
Set Points Sub Panel	43
Protection Settings Sub Panel	44
CAN Bus Configuration Sub Panel	45
Identification Tab	45
SECTION 7 – MAINTENANCE AND TROUBLESHOOTING	
Preventative Maintenance.....	46
Troubleshooting	46
SECTION 8 – CAN BUS INTERFACE	
Message Format	53
Outbound Messages From DVR@2000E+	55
Inbound Messages From ECU1 or ECU2 or ECU3	70
APPENDIX A	
Alarm Codes	74
Fault Codes.....	74
APPENDIX B	
Connector Pin-out Figures and Tables.....	75
APPENDIX C	
Quick Start Programming Guide.....	78

SECTION 1 - OVERVIEW

SAFETY AND PRECAUTIONS

When the DVR®2000E+ Voltage regulator is mounted on the generator at the factory a molded cover is provided. This cover prevents exposure and unintentional contact. This cover must be installed whenever the voltage regulator is energized.

 **WARNING** : Use caution when working around the component side of the DVR®2000E+. Voltage levels may be present at the exposed components and contacts when the unit is energized.

GENERAL

The DVR®2000E+ is a microprocessor-based 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®2000E+ is derived from a single phase, multi-pole, high-frequency, permanent magnet generator (PMG).

The DVR®2000E+ is supplied in an encapsulated package designed for behind-the-panel mounting. The DVR®2000E+ is held in place by thread-forming screws that thread into its plastic shell. The front panel display annunciates regulator status and system conditions. DVR®2000E+ connections are made through four types of connectors:

- Ten quarter-inch, quick-connect terminals for generator connections
- Two 12-pin Deutsch (DTC style) connectors for current transformer (CT) and system interface connections
- One 3-pin Amp/Tyco Mini Mate-N-Lok receptacle for CAN bus interface.
- One 9-pin DB-9 type connector for communication between the DVR®2000E+ and a Windows® compatible PC.

FEATURES

DVR®2000E+ has the following features:

- Three regulation modes: single phase automatic voltage regulation (AVR1), three phase automatic voltage regulation (AVR3) and field current regulation (FCR)
- Preset stability settings
- Adjustable soft start in AVR1 or AVR3 regulation modes
- Under frequency (volts/hertz) regulation
- Three-phase or single-phase generator voltage (RMS) sensing
- Three-phase or single-phase generator current (RMS) sensing
- True three-phase power metering
- 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
- Front-panel human-machine interface (HMI) for status and configuration
- MODBUS protocol via RS232 for external communication
- DVR®2000E+ Windows® based software for configuration and monitoring
- Controller Area Network (CAN) interface with CAN 2.0B J1939 protocol for metering and control
- “Power on” LED indicator
- Configurable auxiliary input for metering and control

PROTECTIONS

DVR®2000E+ has the following protection features:

- Field Over Excitation Shutdown
- Generator Over Voltage Shutdown
- Generator Under Voltage Shutdown
- Generator Voltage Imbalance Shutdown
- Loss of Generator Sensing Shutdown
- Field Current Limiting Shutdown
- Instantaneous Field Over Current Shutdown
- Regulator Over Temperature Shutdown
- Generator Under Frequency Alarm
- Generator Reverse Power Flow Alarm
- Loss of CAN Communication Alarm

WARRANTY

When supplied on a generator, the DVR®2000E+ carries the same warranty as the generator. (a) Marathon warrants Standby Duty Generators manufactured by or for it to be free from defects in materials and workmanship and to conform to Marathon's written specifications for a period of 24 months from date of startup or 30 months from date of shipment or 1000 hours in use, whichever period shall expire first. (b) Marathon warrants Continuous Duty Generators manufactured by or for it to be free from defects in materials and workmanship and to conform to Marathon's written specifications for a period of 12 months from data of startup or 18 months from date of shipment, whichever period shall expire first.

When supplied as a separate component, Marathon warrants the DVR®2000E+ to be free from defects in materials and workmanship and to conform to Marathon's written specifications for a period of 12 months from date of shipment.

SECTION 2 – SPECIFICATIONS

Operating Power

Type:	1-phase, ungrounded PMG
Range:	180 to 240 Vac, 250 to 300 Hz
Burden:	350 VA
Fuse Type :	Time delay 250 V/4.0 A
Terminals:	3, 4

Generator Voltage Sensing

Type:	1-phase/3-phase
Range :	100 to 630 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 maximum continuous 50/60 Hz
Input Impedance:	<10 m
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 Pull-Up 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

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
<u>10 Second Forcing Rating</u>	
200 Vac Power Input:	150 Vdc, 7.5 Adc
Field Resistance:	18 to 35 Ohms
Terminals:	F+, F-

AVR1 and AVR3 Operating Modes

Range: 100.0 to 630.0 Vac
Voltage Regulation: ± 0.25 % over load range at rated power factor
and constant generator frequency.
Temperature Drift: ± 0.0125 %/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 %/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 on rear panel
Baud: 4800
Data Bits: 8
Parity: None
Stop Bit: 2
Handshaking: None

CAN Communication Port

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

Over Excitation Protection

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

Field Current Limit Protection

Threshold: 0.500 to 7.500 Adc
Timer: 1.0 to 10.0 seconds

Field Instantaneous Over Current Protection

Threshold: 11 Adc

Generator Over Voltage Protection

Threshold: 5.0 to 20.0 %
Timer: 0.75 seconds

Generator Under Voltage Protection

Threshold: 5.0 to 50.0 %
Timer: 1.0 to 15.0 seconds

Soft-Start Function

Range: 2 to 120 seconds

Auxiliary Input

Auxiliary – Controller (AVR3 or AVR1 regulation)

Voltage Range: -3 Vdc to +3 Vdc
Set point Range: -30 % to +30 % shift
Burden: 2260 Ohms
Terminals: J1-1 (+), J1-12 (-)

Auxiliary – Controller (FCR regulation)

Voltage Range: 0 Vdc to +3 Vdc
Increment: 1 mA per 1mV
Burden: 2260 Ohms
Terminal: J1-1 (+), J1-12 (-)

Auxiliary – Meter (Voltage input)

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

Auxiliary – Meter (Current input)

Current Range: 4 mA to 20 mA
Scale Factor: User-defined
Burden: 250 Ohms
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 %

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 to +70° C (-40° F to +158° F)
Storage Temperature: -40° C to +85° C (-40° F to +185° F)
Relative Humidity: < 95 %, non-condensating
Ingress Protection: IP52 (front side mounted in conduit box)
IP10 (rear side with protective 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 lb. (1361 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

SECTION 3 – FEATURES AND PROTECTION

INTRODUCTION

This section describes how the DVR®2000E+ functions and explains its operating features. DVR®2000E+ functions are illustrated in the block diagram of Figure 3-1.

DVR®2000E+ FUNCTION BLOCKS

The following paragraphs describe each of the function blocks, inputs and outputs illustrated in Figure 3-1.

Generator Voltage

Generator voltage is measured at terminals E1 (A-phase), E2 (B-phase), and E3 (C-phase). 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 current transformers (CTs) 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 Specifications in Section 1 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

Four contact input circuits powered from an internal 3.3 Vdc supply provide input control from user-supplied contacts (UP, DOWN, DROOP_OFF, EXCITATION_OFF).

UP

Closing the UP contact across terminals J1-2 and J1-4 causes the active operating set point to increase. Keeping the contact closed will continue to increase the operating set point until the limit is reached. The limit is determined by the value entered in the Maximum Voltage Adjust field of the Windows® software. This field is adjustable in 0.1% increments and allows an input range of 0.0% to 15.0%. The effect the UP and DOWN contacts are having on the set point is displayed in the Windows® software.

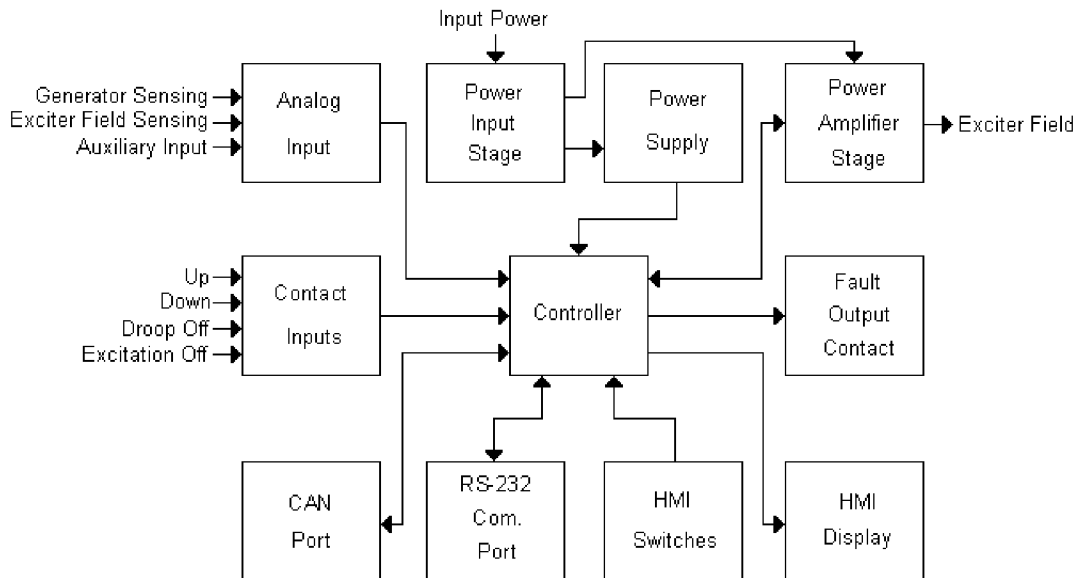


Figure 3-1. Simplified Block Diagram

DOWN

Closing the DOWN contact across terminals J1-3 and J1-4 causes the active operating set point to decrease. Keeping the contact closed will continue to decrease the operating set point until the limit is reached. The limit is determined by the value entered in the Maximum Voltage Adjust field of the Windows® software. This field is adjustable in 0.1% increments and allows an input range of 0.0% to 15.0%. The effect the UP and DOWN contacts are having on the set point is displayed in the Windows® software.

Note: If power is removed from the DVR®2000E+, the settings from the remote UP/DOWN contacts will be lost.

DROOP_OFF

Closing the DROOP_OFF contact across terminals J1-10 and J1-4 disables voltage droop. An open contact enables voltage droop. This function enables reactive load sharing between generators operating in parallel.

EXCITATION_OFF

Closing the EXCITATION_OFF contact across terminals J1-11 and J1-4 disables field excitation. An open contact enables field excitation. This function enables removal of excitation without removing power to the regulator. Opening the EXCITATION_OFF contact will initiate a soft start and clear any alarm or fault conditions.

Communication Port

The communication port provides an isolated interface for user programming (setup) of the DVR®2000E+ through the Windows® communication software. Connection is made to the female RS-232 (DB-9) connector with a user-supplied, standard 9-pin cable. A Null modem cable is unacceptable.

Controlled Area Network (CAN) Port

The CAN port provides an isolated interface for communication with and control of the DVR®2000E+. This permits the integration of the DVR®2000E+ as a node on a CAN network. Connection is made to the J3 connector with a user-supplied Amp/Tyco Mini Mate-N-Lok plug (see Section 2 – Specifications). The communication is powered from a transformer-isolated supply.

Controller

The controller portion of the DVR®2000E+ includes the microprocessor and performs measurement, computation, control and communication functions by the use of its embedded programming and the nonvolatile settings stored in its memory.

Power Input Stage

Input power is applied to terminals 3 and 4 from a Permanent Magnet Generator (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®2000E+.

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-.

Human-Machine Interface Display

A four-character LED display indicates various operating modes, protective functions, and adjustments. Section 5 – Human-Machine Interface provides more information about the front panel display.

Human-Machine Interface Switches

Changes to settings can be made at the front panel using the four pushbuttons, labeled SELECT, UP, DOWN and ENTER. Section 5 – Human-Machine Interface provides more information about the front panel switches.

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®2000E+ OPERATING FEATURES

Regulation Modes

The DVR®2000E+ provides three modes of regulation selectable through the HMI or through the Windows® communication software.

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®2000E+ 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 by the UP and DOWN contact inputs, through the HMI or through the Windows® communication software. The Auxiliary Input, Droop and Under Frequency functions may influence the regulation set point.

Field Current Regulation Mode

In Field Current Regulation (FCR) mode, the DVR®2000E+ maintains dc excitation current at a set level. The regulation set point is adjusted by the UP and DOWN contact inputs, through the HMI or through the Windows® communication software. The Auxiliary Input function may override the regulation set point.

Auxiliary Input

Functionality of the auxiliary input is dependent on the configuration of the modes described below. The auxiliary input is set to the **Auxiliary - Off** mode by default and can be set to the **Auxiliary - Control** or **Auxiliary - Meter** modes through the HMI or the Windows® communication software. The effect of the auxiliary input on the set point is displayed in the Windows® communication software.

Auxiliary - Off

In this mode, any signal applied to the analog input will be displayed in the Windows® communication software, but will have no effect on the set point of the regulator.

Auxiliary - Control

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. The circuit imposes a 2260-ohm burden on the DC source.

In AVR1 or AVR3 regulation modes, the application of a +/- 3 Vdc signal corresponds to a +/- 30% offset to the set point. This offset is not limited by the Maximum Voltage Adjust field of the Windows® communication software. For example, with a programmed regulation set point of 480 Vrms, an 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.

In the FCR regulation mode, the application of a 0-3 Vdc signal corresponds to a 0-3 Adc field current set point. For example, the application of a 1.25 Vdc signal will result in a field current of 1.25 Adc.

⚠ CAUTION : 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.

Auxiliary - Meter

In this mode the auxiliary input functions as a meter with user-defined scaling. A voltage up to ± 5 Vdc or a current of 4 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. The default scaling is 5000 counts for a +5 Vdc voltage input and 5000 counts for a 20 mA current input. The user provides further scaling through the Windows® communication software. For example, if the user provides a scale factor of 0.20 units, the metered value corresponding to a +5 Vdc voltage input will be +100 units. The metered value corresponding to a 20 mA current input will be +100 units.

Load Sharing

The DVR®2000E+ provides a reactive droop compensation feature to assist in the sharing of reactive load during parallel generator operation. When this feature is enabled, the DVR®2000E+ 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 percent with rated line current and 0.8 power factor. The effect of droop on the set point is displayed in the Windows® communication software. 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®2000E+ 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 sec) in one-second increments. This adjustment is made through the Windows® communication software 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.

DVR®2000E+ PROTECTION FEATURES

The DVR®2000E+ has the protective functions listed below:

- Field Over Excitation Shutdown
- Generator Over Voltage Shutdown
- Generator Under Voltage Shutdown
- Generator Voltage Imbalance Shutdown
- Loss of Generator Sensing Shutdown
- Field Current Limiting Shutdown
- Instantaneous Field Over Current Shutdown
- Regulator Over Temperature Shutdown
- Generator Under Frequency Alarm
- Generator Reverse Power Flow Alarm
- Loss of CAN Communication Alarm

Each fault or alarm condition is displayed through the HMI and the Windows® communication software.

Field Over Excitation Shutdown

The DVR®2000E+ has a Field Over Excitation Shutdown threshold that is adjustable from 0.500 to 4.000 A (default of 3.5 A) with a timer that is adjustable from 1.0 to 15.0 seconds (default of 15.0 sec). This setting is modified through the Windows® communication software. If field current exceeds the shutdown threshold the timer is started. The HMI will change from a *run* status to an alarm status with alarm code *A008*. The Windows® communication software also displays this alarm condition. If this current does not fall below 90% of the shutdown threshold within the timer period, the regulator will stop providing excitation to the field and will close the fault output contact. The HMI will change from an alarm status to a fault status with fault code *F008*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power from the regulator for at least 10 seconds or by momentarily shorting the EXCITATION_OFF circuit. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following a Field Over Excitation Shutdown, the fault code *F.0.0.8* will flash for 15 seconds on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen.

Generator Over Voltage Shutdown

The DVR®2000E+ has a Generator Over Voltage Shutdown threshold that is adjustable from 5% to 20% (default of 20%) over set point voltage with a fixed timer of 0.75 seconds. If generator voltage exceeds the over voltage threshold the regulator will stop providing excitation to the field and close the fault output contact. The HMI will change from a *run* status to a fault status with fault code *F013*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power from the regulator for at least 10 seconds or by momentarily shorting the EXCITATION_OFF circuit. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following a Generator Under Voltage Shutdown, the fault code *F.0.1.3* will flash for 15 seconds on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen.

Generator Under Voltage Shutdown

The DVR®2000E+ has a Generator Under Voltage Shutdown threshold that is adjustable from 5% to 50% (default of 25%) with a timer that is adjustable from 1.0 to 15.0 seconds (default of 6.0 sec). If generator voltage drops below the under voltage threshold the timer is started. The HMI will change from a *Run* status to an alarm status with alarm code *AD 12*. The Windows® communication software also displays this alarm condition. If generator voltage stays below the under voltage set point for the duration of the timer, the regulator will stop providing excitation to the field and close the fault output contact. The HMI will change from an alarm status to a fault status with fault code *FD 12*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power from the regulator for at least 10 seconds or by momentarily shorting the EXCITATION_OFF circuit. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following a Generator Under Voltage Shutdown, the fault code *F.D. 1.2* will flash for 15 seconds on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen. This protection feature is inactive when operating in the FCR Regulation Mode.

Generator Voltage Imbalance Shutdown

The DVR®2000E+ has a Generator Voltage Imbalance threshold that is fixed at 20% and with a timer that is adjustable from 1.0 to 15.0 seconds (default of 12.0 sec). If a voltage imbalance is detected, the timer is started. In AVR1 regulation mode, generator voltage imbalance protection is disabled. In AVR3 regulation mode, an imbalance between phases of more than 20% is interpreted as a voltage imbalance. The HMI will change from a *Run* status to an alarm status with alarm code *AD 15*. The Windows® communication software also displays this alarm condition. If the voltage imbalance condition continues for the duration of the timer, the regulator will stop providing excitation to the field and close the fault output contact. The HMI will change from an alarm status to a fault status with fault code *FD 15*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power from the regulator for at least 10 seconds or by momentarily shorting the EXCITATION_OFF circuit. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following a Generator Voltage Imbalance Shutdown, the fault code *F.D. 1.5* will flash on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen.

Loss of Generator Sensing Shutdown

If sensing input continuity is lost, the regulator will stop providing excitation to the field and close the fault output contact. The HMI will change from a *Run* status to a fault status with fault code *FD 11*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power from the regulator for at least 10 seconds or by momentarily shorting the EXCITATION_OFF circuit. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following a Loss of Sensing continuity Shutdown, the fault code *F.D. 1.1* will flash on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen.

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

Field Current Limiting Shutdown

The DVR®2000E+ has a Field Current Limit that is adjustable from 0.500 to 7.500 A (default of 6.5 A) with an adjustable time delay that has a range of 1.0 to 10.0 seconds (default of 10.0 sec). If load conditions dictate that the field current exceed the field current limit, the timer is started and the current is limited. The HMI will change from a *run* status to an alarm status with alarm code *A010*. The Windows® communication software also displays this alarm condition. If the current limiting condition continues for the duration of the timer (the default value is 10 seconds), the regulator will stop providing excitation to the field and close the fault output contact. The HMI will change from an alarm status to a fault status with fault code *F010*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power from the regulator for at least 10 seconds or by momentarily shorting the EXCITATION_OFF circuit. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following a Field Current Limit shutdown, the fault code *F.0.1.0.* will flash on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen.

Instantaneous Field Over Current Shutdown

The DVR®2000E+ has a nominal Instantaneous Field Over Current Shutdown threshold of 11 Adc. If generator field current exceeds this threshold, the regulator will stop providing excitation to the field and close the fault output contact. The HMI will change from a *run* status to a fault status with fault code *F009*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power from the regulator for at least 10 seconds or by momentarily shorting the EXCITATION_OFF circuit. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following an Instantaneous Field Over Current Shutdown, the fault code *F.0.0.9.* will flash on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen.

Regulator Over Temperature Shutdown

The DVR®2000E+ has a fixed Regulator Over Temperature alarm threshold and a fixed fault threshold. If the regulator temperature exceeds the alarm threshold, the HMI will change from a *run* status to an alarm status with alarm code *A007* until the temperature falls below the alarm threshold. If the regulator temperature exceeds the fault threshold, the HMI will change from an alarm status to a fault status with the fault code *F007*. The Windows® communication software also displays this fault condition. This is a latching condition that can be reset by removing power or by shorting the EXCITATION_OFF circuit from the regulator until the regulator's internal temperature has fallen below the fixed fault threshold. When the DVR®2000E+ is powered up or the EXCITATION_OFF short is removed following a regulator over temperature shutdown, the fault code *F.0.0.7.* will flash on the HMI and the fault will be indicated in the Windows® communication software on the History tab of the Faults and Alarms section of the monitor screen.

Generator Under Frequency Alarm

When generator frequency drops below the selected knee frequency set point, the voltage set point is automatically adjusted by the DVR®2000E+ so that generator voltage follows the selected PU (per unit) V/Hz curve. When operating in an under frequency condition, the HMI will change from a *run* status to an alarm status with alarm code *RD 15*. The Windows® communication software also displays this alarm condition. The knee frequency is adjustable from 40.0 to 70.0 Hertz (default of 59.0 Hz) and the base slope of the PU V/Hz curve may be modified by a Slope Multiplier from 1.00 to 3.00 (default of 2.00 PU) through the Windows® communication software. If generator frequency drops below 25 Hz, the regulator will stop providing generator excitation and AC metering.

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).

Under frequency V/Hz slope is dependent upon the knee frequency and the slope multiplier. The base slope is defined according to the following (see Figure 3-2):

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

where Vpu = 1.0 at regulator voltage set point. The base slope is modified by the Slope Multiplier to achieve a desired voltage roll-off characteristic. See Figure 3-3 for examples.

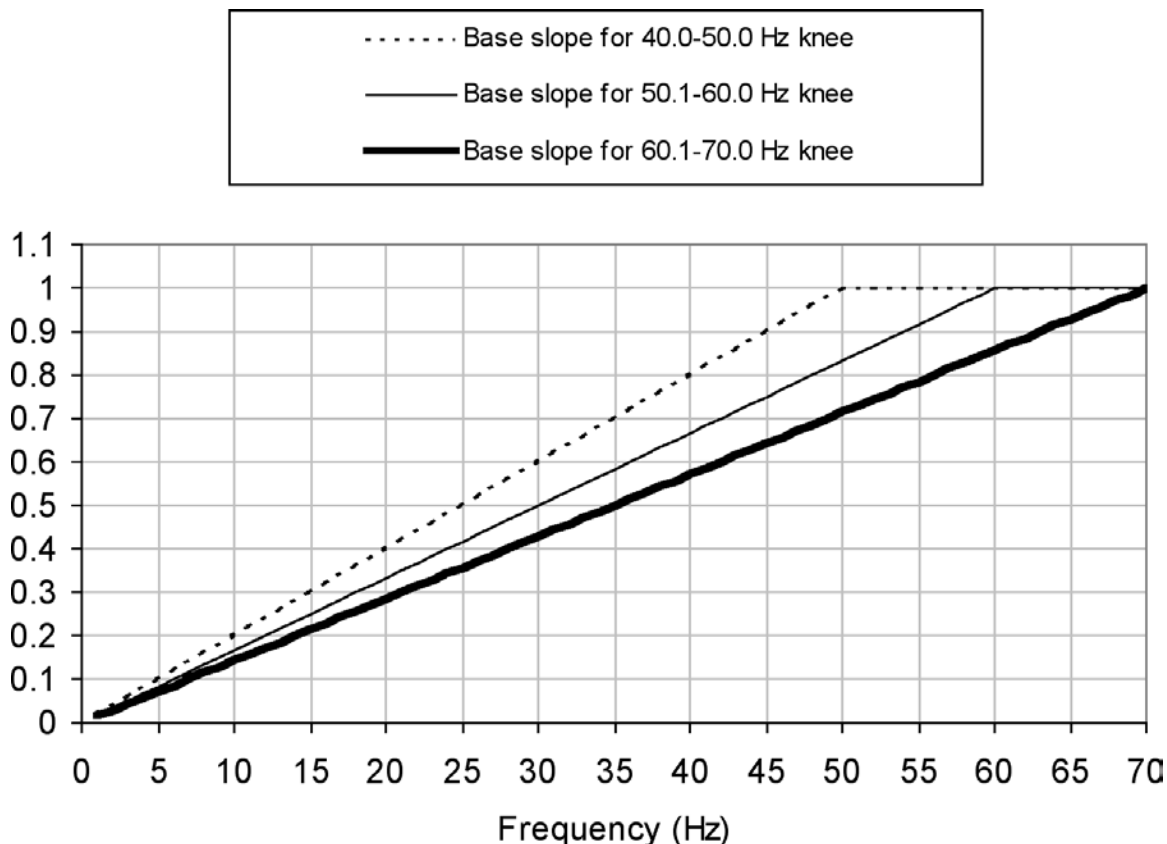


Figure 3-2 Volts/Hertz Slopes vs. Knee Frequency

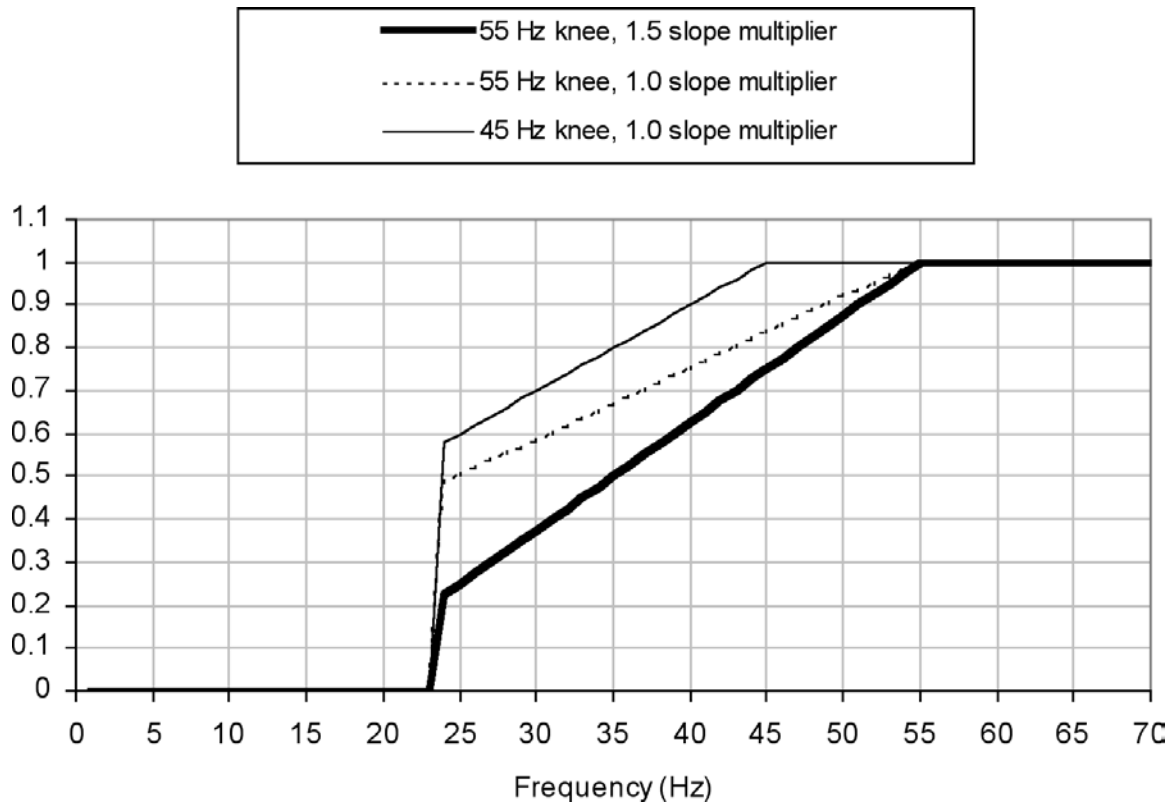


Figure 3-3 Examples of Under Frequency and Slope

Generator Reverse Power Flow Alarm

The DVR®2000E+ has a fixed Generator Reverse Power Flow Alarm threshold. If the regulator senses reverse power flow in excess of alarm threshold, the HMI will change from a *run* status to an alarm status with alarm code *RP14* until the reverse power flow falls below the alarm threshold. The Windows® communication software also displays this alarm condition.

Loss of CAN Communication Alarm

The DVR®2000E+ has an adjustable Loss of CAN Communication timeout threshold of 0.0 to 45.0 seconds (default of 0.0 sec). If the regulator does not receive a “VR Heartbeat” message within the threshold time, the HMI will change from a *run* status to an alarm status with alarm code *RP05* until the regulator receives a “VR Heartbeat” message. This feature is disabled if the timeout is set to 0.0 seconds. Refer to Section 8 – CAN Bus Interface for details.

SECTION 4 – INSTALLATION

GENERAL

Generally the DVR®2000E+ 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®2000E+ or those wishing the 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®2000E+ 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 mounting holes in the conduit box and thread into the plastic shell of the DVR®2000E+. The unit must be mounted where the ambient temperature does not exceed the allowable environmental conditions called out in Section 2, Specifications. DVR®2000E+ package dimensions are shown in Figure 4-1. Cutout and drilling dimensions are shown in Figure 4-2.

When the DVR®2000E+ Voltage regulator is mounted on the generator at the factory a molded cover is provided. This cover prevents exposure and unintentional contact. This cover must be installed whenever the voltage regulator is energized.

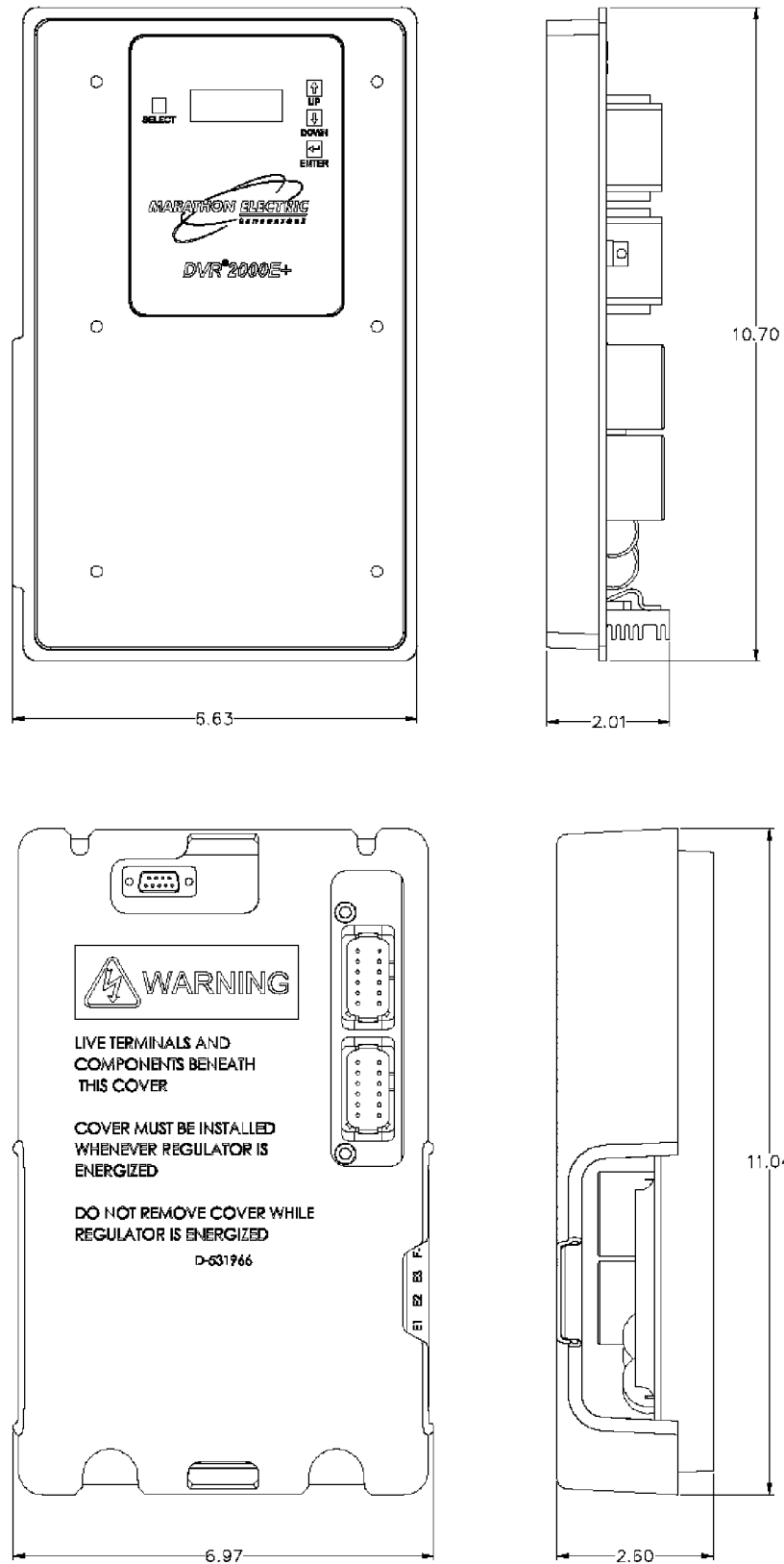


Figure 4-1. DVR®2000E+ Dimensions with and without cover

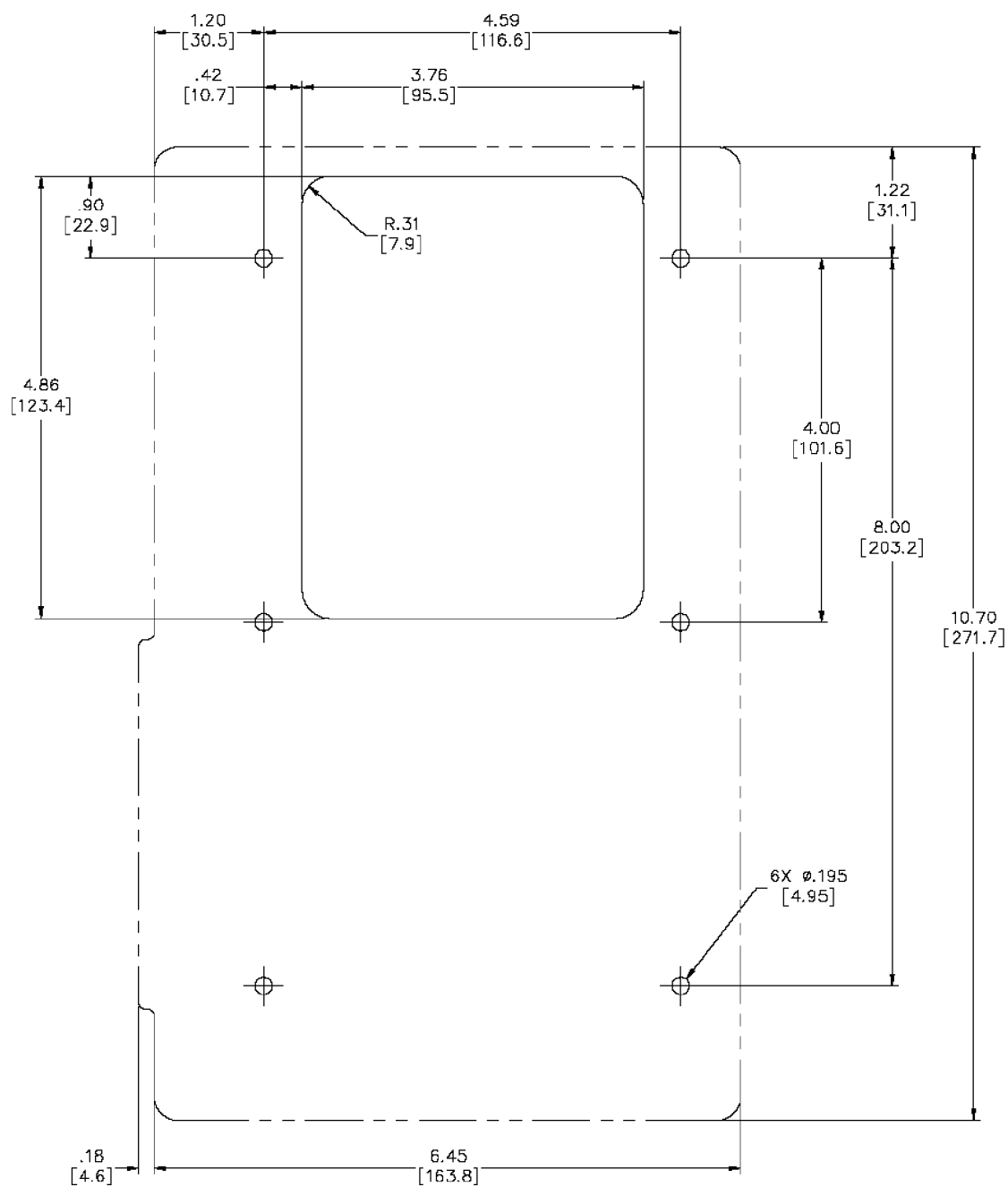


Figure 4-2. Cut out and Drilling Dimensions

CONNECTIONS

DVR®2000E+ connections are dependent on the application. **Incorrect wiring may damage the unit.**

Note: Be sure that the DVR®2000E+ 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®2000E+ Connectors

DVR®2000E+ units have four types of interface connectors (see Section 1 – Overview, General). All connectors are located on the rear of the unit. Wires performing common functions, such as voltage sensing leads, should be grouped together. Figure 4-3 shows the quick disconnect terminal connections located on the rear panel of the DVR®2000E+.

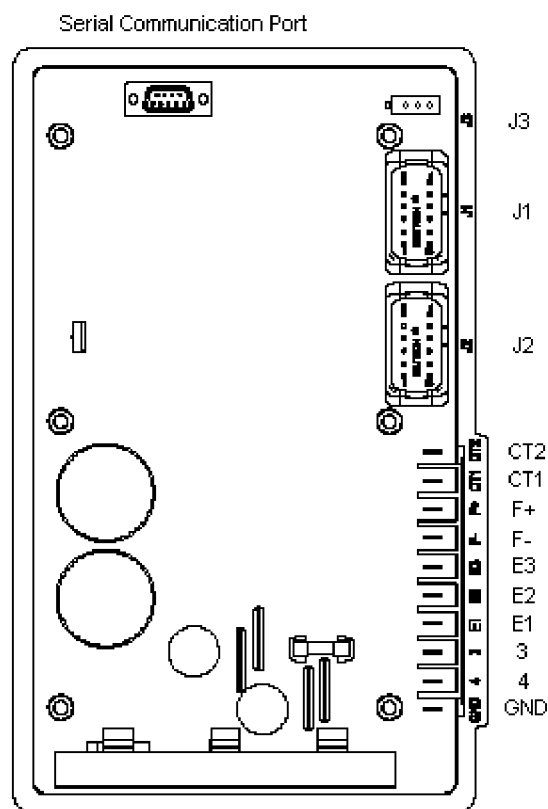


Figure 4-3. DVR®2000E+ Rear Panel Connectors

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

Table 4-1. Quick Disconnect 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 C-phase 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 current transformer (CT) on Phase B. Secondary current (5A) from that transformer is applied to terminals labeled CT1 and CT2. Consult current transformer instruction manual for CT polarity identification and install per Figure 4-7. See Figure 4-4 and Table 4-2 for terminal assignments.

Three Phase Current Sensing Input

Generator line current is stepped down through user-supplied current transformers. Secondary current (5A) from these transformers is applied to the J2 connector. Consult current transformer instruction manual for CT polarity identification and install per Figure 4-6. See Figure 4-4 and Table 4-2 for terminal assignments. *Note: All transformers should have the same CT ratio.*

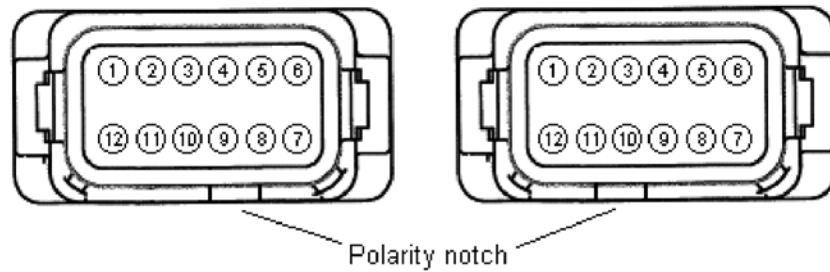


Figure 4-4. System Connectors J1 (left) and J2 (right) Terminal Position

Sensing	Phase	X1 Terminal	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 4-2. Current Transformer Connection Terminals

Note: The current transformer primaries are aligned such that the H1 face is nearest to the generator for typical donut-style current transformers.

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		Reserved
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 4-3. 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 3 – 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 3 – 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 3 – 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 3 – Features and Protection for a detailed description of the Auxiliary input function.

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 4-5. MODBUS 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 4-4. MODBUS 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 4-5 and Table 4-4 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®2000E+.

Note: Do not use a “cross-over” or “null-modem” cable.

CAN J1939 Communication Port (J3)

The CAN port on the rear panel uses an AMP/Tyco Mini Mat-N-Lok connector. Figure 4-6 illustrates the pin assignments of the CAN port and Table 4-5 identifies the pin functions of the CAN port.

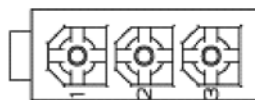


Figure 4-6. Connector J3 CAN Port Pin Assignments

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

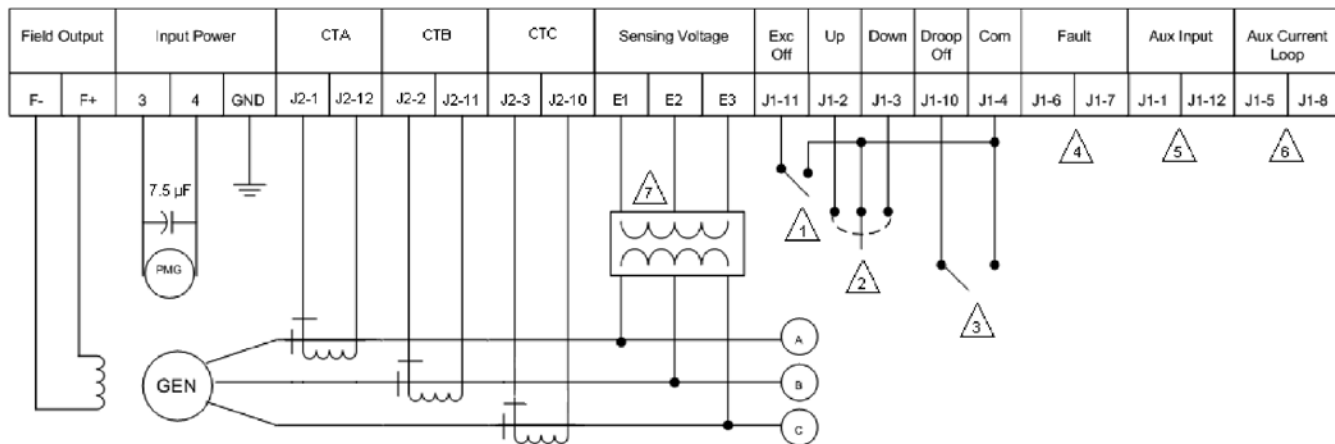
Table 4-5. Connector J3 CAN Port Pin Functions

DVR®2000E+ Connections for Typical Applications

Figures 4-7 through 4-10 illustrate typical applications using the DVR®2000E+.

- Figure 4-7 shows an application where the regulator is connected for three-phase voltage sensing and three-phase current sensing.
- Figure 4-8 shows an application where the regulator is connected for three-phase voltage sensing and single-phase current sensing.
- Figure 4-9 shows an application where the regulator is connected for with single-phase voltage sensing and single-phase current sensing.
- Figure 4-10 illustrates an application with a single-phase generator.

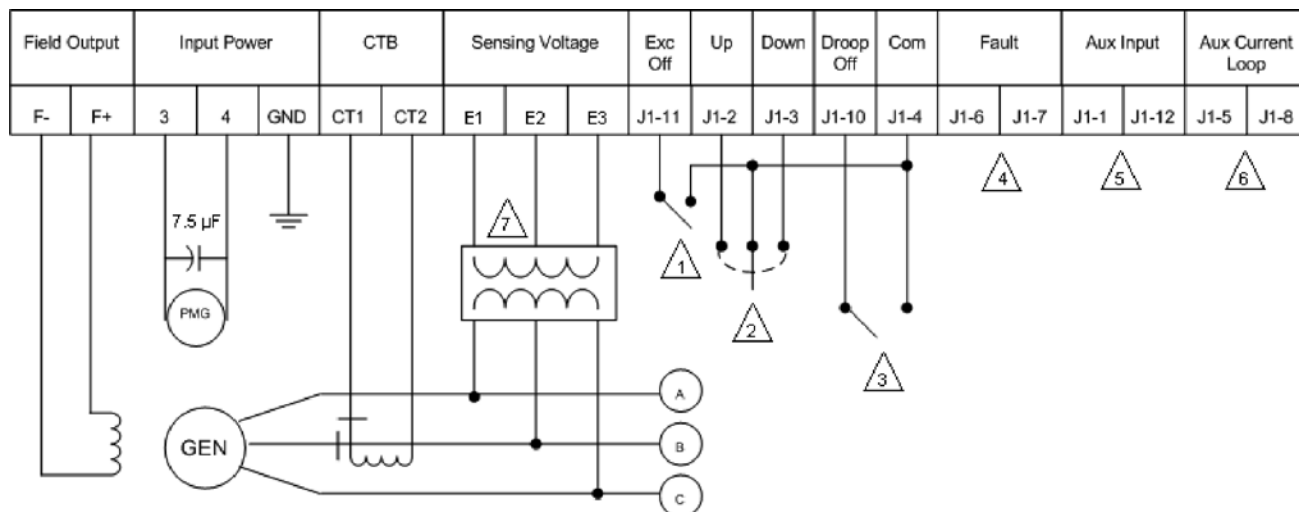
Figure 4-11 and 4-12 illustrate how the regulators can be interconnected for use in Cross-Current (Reactive Differential) applications. When operating in Cross-Current mode, attention must be paid to the use of the burden resistor shown in Figure 4-11 and 4-12. The burden resistor should have a value 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.



NOTES :

1. Excitation enabled when switch is open and disabled when switch is closed. Switch supplied by others.
2. SPDT, spring return to center-off position type switch for remote set point adjust. Switch supplied by others.
3. Droop enabled when switch is open and disabled when switch is closed. Switch supplied by others.
4. Normally open contact closes in a fault condition.
5. Analog signal input when Auxiliary is configured for control or metering.
6. Should be shorted when Auxiliary is configured as 4-20 mA metering input.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.

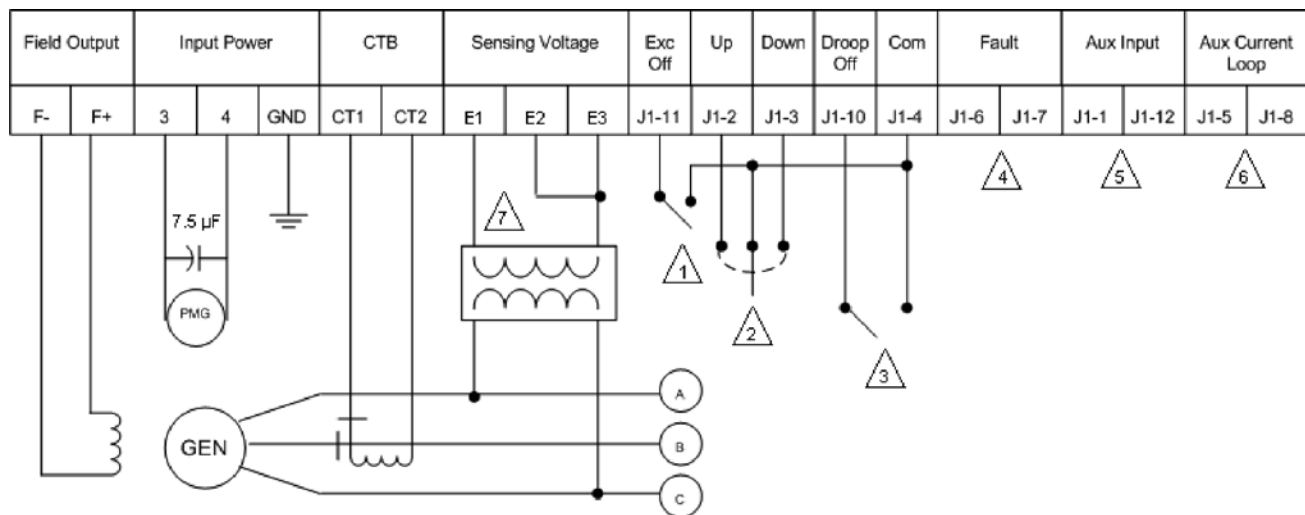
Figure 4-7. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing and Three-Phase Current Sensing



NOTES  :

1. Excitation enabled when switch is open and disabled when switch is closed. Switch supplied by others.
2. SPDT, spring return to center-off position type switch for remote set point adjust. Switch supplied by others.
3. Droop enabled when switch is open and disabled when switch is closed. Switch supplied by others.
4. Normally open contact closes in a fault condition.
5. Analog signal input when Auxiliary is configured for control or metering.
6. Should be shorted when Auxiliary is configured as 4-20 mA metering input.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.

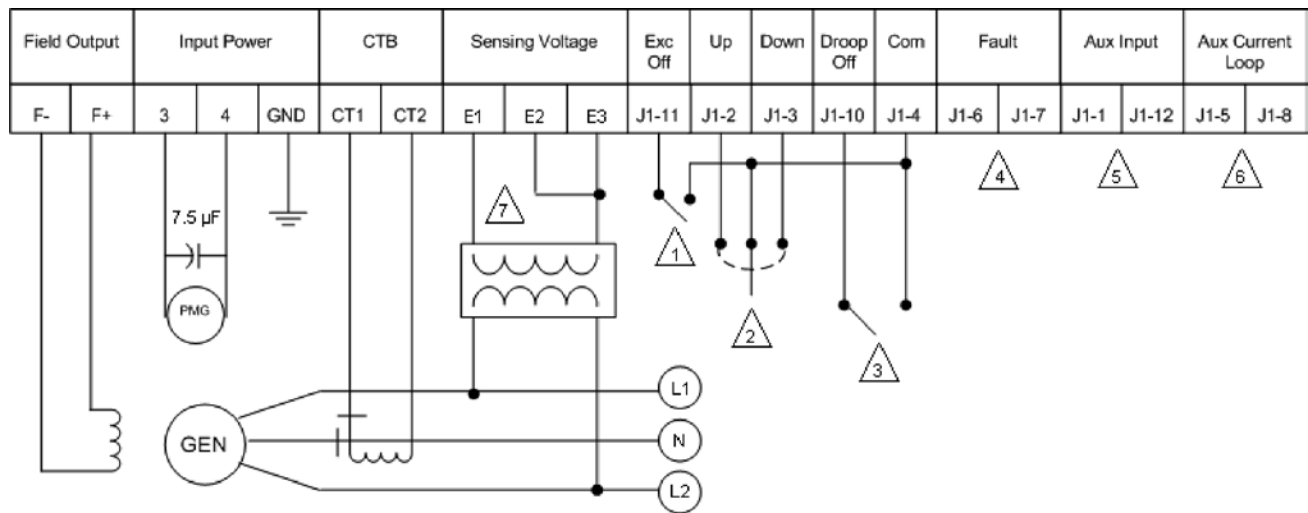
Figure 4-8. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing and Single-Phase Current Sensing



NOTES  :

1. Excitation enabled when switch is open and disabled when switch is closed. Switch supplied by others.
2. SPDT, spring return to center-off position type switch for remote set point adjust. Switch supplied by others.
3. Droop enabled when switch is open and disabled when switch is closed. Switch supplied by others.
4. Normally open contact closes in a fault condition.
5. Analog signal input when Auxiliary is configured for control or metering.
6. Should be shorted when Auxiliary is configured as 4-20 mA metering input.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts

Figure 4-9. Typical Connections with ABC Rotation, Single-Phase Voltage Sensing and Single-Phase Current Sensing



NOTES  :

1. Excitation enabled when switch is open and disabled when switch is closed. Switch supplied by others.
2. SPDT, spring return to center-off position type switch for remote set point adjust. Switch supplied by others.
3. Droop enabled when switch is open and disabled when switch is closed. Switch supplied by others.
4. Normally open contact closes in a fault condition.
5. Analog signal input when Auxiliary is configured for control or metering.
6. Should be shorted when Auxiliary is configured as 4-20 mA metering input.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.

Figure 4-10. Typical Connections to a Single-Phase Generator

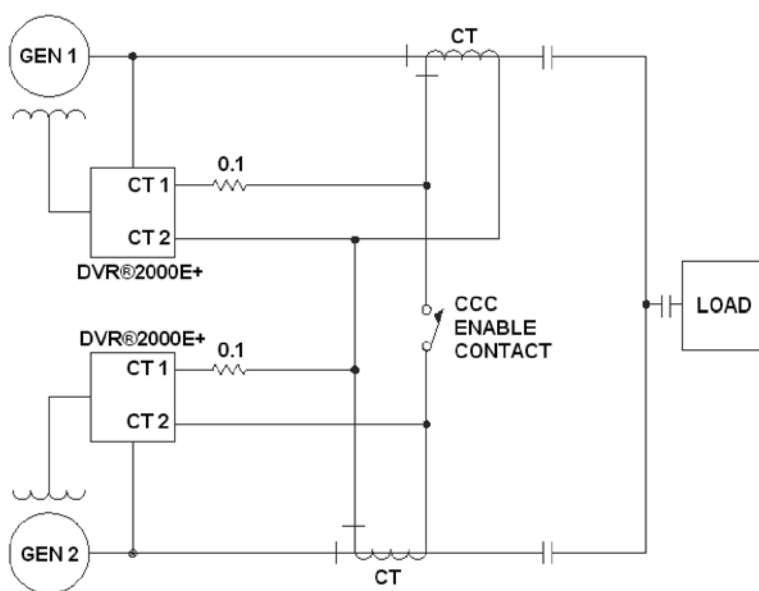


Figure 4-11. Cross-Current (Reactive Differential) Connections for Two Generators

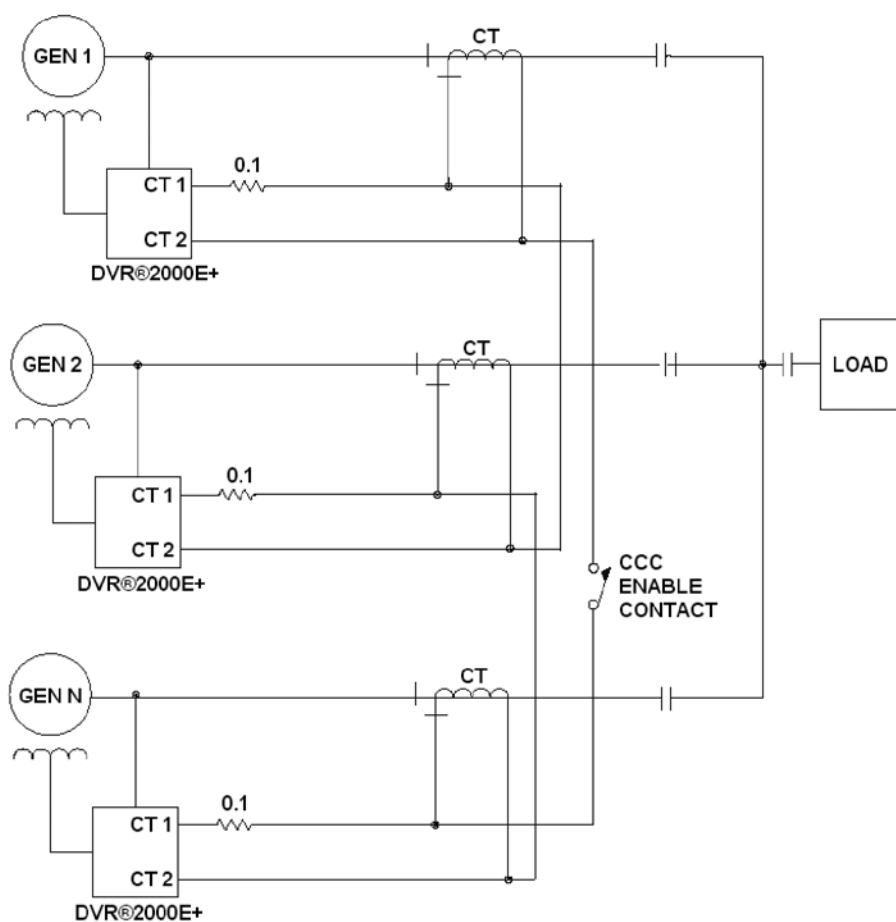


Figure 4-12. Cross-Current (Reactive Differential) Connections for Three or More Generators

PRELIMINARY SETUP – ON GENERATOR

⚠ WARNING : Use caution when working around the component side of the DVR®2000E+. 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.

⚠ CAUTION : Read and understand the operation of the individual adjustments before attempting any initial adjustments.

The regulator 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 *FD II* on the display.
5. At this time, initial adjustments can be made. If adjusting via the HMI, see "MAKING SETTINGS CHANGES" in Section 5. If adjusting via the Windows Communication Software, see Section 6.
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

⚠ WARNING : Use caution when working around the component side of the DVR®2000E+. 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.

⚠ CAUTION : Read and understand the operation of the individual adjustments before attempting any initial adjustments.

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

1. Connect a 120 Vac 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
2. If the regulator is in AVR1 or AVR3 regulation mode, the regulator will indicate V_{UN} on the display. If the regulator is in FCR regulation mode, the regulator will indicate $F\overline{D} \overline{I} \overline{I}$ on the display
3. At this time, initial adjustments can be made. If adjusting via the HMI, see “MAKING SETTINGS CHANGES” in Section 5. If adjusting via the Windows® communication software, see Section 6.

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.

SECTION 5 - HUMAN-MACHINE INTERFACE

GENERAL

The DVR®2000E+ human-machine interface (HMI) consists of a four-button keypad and four-character LED display as illustrated in Figure 5-1. The display indicates status conditions and parameter settings. Button function descriptions are given in Table 5-1.



Figure 5-1. DVR®2000E+ Human-machine Interface (HMI)

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

Table 5-1. DVR®2000E+ HMI Button Function Descriptions

FRONT PANEL DISPLAY

The HMI display has three display modes:

1. **STATUS mode** – the HMI displays the non-editable operating state of the DVR®2000E+ as described in Table 5-2. 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®2000E+ as described in Table 5-3. 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 enabled.
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 5-2. DVR®2000E+HMI STATUS Mode Display Descriptions

Parameter Name	Parameter Value	Description
<i>SIZE</i>	<i>281 to 1040</i>	Frame size of generator
<i>REG</i>	<i>AVR3</i>	AVR3 – Voltage regulator with three-phase sensing
	<i>AVR1</i>	AVR1 – Voltage regulator with single-phase sensing
	<i>FCR</i>	FCR – Field current regulator
<i>SetPt</i>	<i>100.0 to 630.0</i>	Voltage set point (Vrms) in AVR3 and AVR1 mode
	<i>0.000 to 3.000</i>	Field current set point (Adc) in FCR mode
<i>UFr9</i>	<i>40.0Hz to 70.0Hz</i>	Under frequency knee (Hz)
<i>droP</i>	<i>0.0 to 10.0</i>	Voltage droop (%) at rated reactive current
<i>AUX</i>	<i>OFF</i>	Auxiliary Off – Auxiliary input is disabled
	<i>Ctrl</i>	Auxiliary Control – Auxiliary input modifies regulation set point
	<i>SCALE</i>	Auxiliary Meter – Auxiliary input is used as a meter with user-defined scale factor

Table 5-3. DVR®2000E HMI EDIT Mode Parameters

MAKING SETTINGS CHANGES

1. The default state of the HMI display is *SLEEP* mode. The HMI will enter the *SLEEP* mode after 60 seconds of inactivity (no button presses). Any HMI button press will place the HMI into *STATUS* mode. In order to make changes to settings, the following procedure is used:
2. Repeatedly press the **SELECT** button, stepping through the main menu until the desired parameter is displayed (see Table 5-3). 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. For parameters other than *SetPt*, pressing the **SELECT** button escapes EDIT mode without modifying the parameter. For *SetPt*, 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 SetPt EDIT mode. This feature allows a shortcut to set point adjustment.

SECTION 6 – GRAPHICAL USER INTERFACE

The DVR®2000E+ Graphical User Interface (GUI) offers the user a means of programming the regulator and monitoring generator performance. This Windows® based software is available as a free download from the Marathon Electric website, www.marathonelectric.com. With this software, the user will be able to change all of the user programmable parameters.

The GUI consists of a header, and three tabbed 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 regulator setting of all user programmable parameters. The identification tab contains information specific to the regulator and allows for customer tags.

HEADER BUTTONS

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.

Load Factory Settings

When this button is pressed, the default factory settings for the regulator are loaded into the regulator's volatile memory (Random Access Memory or RAM). These factory settings can be transferred to the user settings in non-volatile memory (Electrically Erasable Programmable Read Only Memory or EEPROM) by pressing the "Save to EEPROM" button.

Save to EEPROM

When this button is pressed, all parameter values in the regulator'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. Any parameters adjusted before saving are lost.

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 are loaded into the volatile RAM memory of the DVR®2000E+ from the selected .xml file. 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 be disabled. To enable excitation, go to the Operating Modes sub panel of the Configure tab and click the "Excitation ON" button.

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

PARAMETER SELECTION BUTTONS

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

Apply – This button sends the values in a given area presently being displayed to the regulator's RAM. These values can be sent to the regulator's EEPROM by pressing the Save to EEPROM button in the header area of the GUI.

Undo – This button displays the values in a given parameter area previous to the last change the user made. These values can be sent to the regulators RAM by clicking on the Apply button. From there, these values can be sent to the regulator's EEPROM by pressing the Save to EEPROM button in the header area of the GUI.

Refresh – This button displays the values in a given parameter area that are presently in the regulators RAM. These values can be sent to the regulator's

Metering Tab

This panel displays Line-to-Line Voltages, Line-to-Neutral Voltages, Line Currents, Real Power, Apparent Power and Reactive Power. 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 terminals (secondary sides of potential and current transformers). In addition, values for Power Factor, Field Current, Field Voltage, Regulator Temperature, Speed and Auxiliary Input Voltage are displayed.

There is also a tabbed panel for the display of faults and alarms. When the Current Faults and Alarms tab is active, the panel displays faults and alarms that are currently active on the regulator. When the Historical tab is active, the panel displays the faults and alarms that were present (if any) the previous time the regulator was energized.

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

If the regulator is in an alarm state, there will be a yellow indicator next to the corresponding condition causing the alarm and the status indicator in the header will display a yellow “Alarm” state. If the regulator is in a fault state, there will be a red indicator next to the corresponding condition causing the fault and the status indicator in the header will display a red “Fault” state. If the regulator is in a run state, there will be a green indicator next to all active alarm and fault conditions in this panel and the status indicator in the header will display a green “Run” 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.

Configuration Tab

In this panel there are four tabbed sub panels: Operating Modes (default), Set Points, Protection Settings and CAN Bus Configuration.

Operating Modes Sub Panel

This panel contains a pull-down menu for selecting Generator Frame Size and radio buttons to change the configuration of the following settings:

- Regulation Mode (AVR3, FCR or AVR1)
- Current Sensing Phases (Three Phase or Single Phase)
- Excitation (Excitation Off or Excitation On)

AVR3 Regulation Mode corresponds to Automatic Voltage Regulation for three-phase generator voltage sensing.

AVR1 Regulating Mode corresponds to Automatic Voltage Regulation for single phase generator voltage sensing.

FCR Regulation Mode corresponds to Field Current Regulation. In this mode the regulator will maintain a fixed level of field current.

Three Phase Current Sensing activates metering of all three phase currents. This sensing mode should only be selected when using three current transformers.

Single Phase Current Sensing activates metering of phase-B current. 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.

Excitation Off deactivates 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 the user settings.

Excitation On activates excitation to the generator exciter field. If the regulator was previously “Off,” selecting this state will initiate a new soft start ramp.

Generator Frame Size selects stability settings for the chosen frame size. Settings are displayed with gray numbers in the panel. Selecting the appropriate frame size chooses 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 frame size. The grayed gains will then become active for editing. Saving to EEPROM will store the edited gains to the user settings.

Set Points Sub Panel

This panel contains editable fields for Regulator Voltage Set Point, Maximum Voltage Adjust, Field Current Set Point, Under Frequency Knee, Under Frequency Slope, Droop, Auxiliary Input Scale Factor, PT Ratio and CT Ratio and a radio button for configuration of the auxiliary input port. Offsets to the regulator set point are also displayed in this panel.

Regulator Voltage Set Point is editable in AVR1 or AVR3 Regulation Modes. This value represents the desired voltage at the regulator voltage sensing terminals, regardless of potential transformers. Offsets from the UP and DOWN contacts, auxiliary input port, droop and/or the CAN bus are derived from this set point.

If there are no PTs (potential transformers) in the system, and the regulator sensing leads are connected line-to-line, the desired generator output voltage is the Regulator Voltage Set Point. If the regulator sensing leads are connected midpoint-to-midpoint of a series wye configuration, the desired generator output voltage is twice the Regulator Voltage Set Point.

If there are PTs 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 Voltage Adjust is the maximum adjustment percentage of the Regulator Voltage Set Point allowed through use of the UP and DOWN contact inputs.

Field Current Set Point is editable in FCR Regulation Mode. This value represents the desired field current of the regulator. The regulator will maintain this fixed level of field current regardless of changes in load.

Under Frequency Knee is the value of frequency below which the regulator operates in a Volts-per-Hertz mode. Refer to Section 3 – 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 Volts-per-Hertz mode. Refer to Section 3 – 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 with another generator. Refer to Section 3 – Features and Protection for a detailed description of Load Sharing.

Auxiliary Input Scale Factor is used when the auxiliary input port is configured as “Auxiliary – Meter.” This value scales the auxiliary input. Refer to Section 3 – Features and Protection for a detailed description of the Auxiliary Input function.

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 times this value. Example: A PT with a 13,200 Volt primary rating and a 230 Volt secondary rating would have a PT ratio of 57.39.

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 times 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 Type configures the auxiliary input port as a controller, a meter or off. Refer to Section 3 – Features and Protection for a detailed description of the Auxiliary Input function.

Contact Offset displays the effect that the contact inputs have on the regulator set point value. Refer to Section 3 – 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 3 – 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 3 – 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 Section 8 – CAN Bus Interface for a detailed description of the Set Point Adjust message.

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

Protection Settings Sub Panel

This panel contains editable fields for Soft Start Ramp Time, Over Voltage Level, Over Excitation Level and Timer, Under Voltage Level and Timer, Field Current Level and Timer and Voltage Imbalance Timer. For most applications, the default values of these parameters should be used. These settings should be modified only in special circumstances.

Soft Start Ramp Time is the amount of time taken to ramp to the desired voltage at the generator output terminals. Refer to Section 3 – Features and Protection for a detailed description of the Generator Soft Start function.

Over Voltage Level is the percentage of Regulator Voltage Set Point that triggers the Generator Over Voltage protection feature. Refer to Section 3 – Features and Protection for a detailed description of the Generator Over Voltage Shutdown feature.

Over Excitation Level is the current threshold that triggers the Field Over Excitation protection feature. Refer to Section 3 – Features and Protection for a detailed description of the Field Over Excitation Shutdown feature.

Over Excitation Timer is the amount of time the regulator operates before shutting down due to an Over Excitation fault. Refer to Section 3 – Features and Protection for a detailed description of the Field Over Excitation Shutdown feature.

Under Voltage Level is the percentage of Regulator Voltage Set Point that triggers the Generator Under Voltage protection feature. Refer to Section 3 – Features and Protection for a detailed description of the Generator Over Voltage Shutdown feature.

Under Voltage Timer is the amount of time the regulator operates before shutting down due to an Under Voltage fault. Refer to Section 3 – Features and Protection for a detailed description of the Generator Under Voltage Shutdown feature.

Field Current Limit is the current threshold limit of the regulator. Refer to Section 3 – Features and Protection for a detailed description of the Field Current Limiting protection feature.

Field Current Timer is the amount of time the regulator operates at its Field Current Limit before shutting down due to a Field Current Limit fault. Refer to Section 3 – Features and Protection for a detailed description of the Field Current Limiting 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 3 – Features and Protection for a detailed description of the Generator Voltage Imbalance Shutdown protection feature.

CAN Bus Configuration Sub Panel

This panel contains editable fields for Regulator CAN Address, ECU Source Addresses and Message Timers. It also contains pull-down menus for message priorities. Refer to Section 8 – CAN Bus Interface for a detailed description of these features.

Regulator CAN Address is the CAN address of the regulator.

ECU1 Source Address is the CAN address of the highest priority Electronic Control Unit that the regulator will respond to.

ECU2 Source Address is the CAN address of the second-highest priority Electronic Control Unit that the regulator will respond to.

ECU3 Source Address is the CAN address of the lowest priority Electronic Control Unit that the regulator will respond to.

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. Setting this value to zero disables the Loss of Communication alarm.

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.

Identification Tab

This panel contains non-editable fields for Serial Number, Software Version, Settings Version and MODBUS Address. It also contains editable fields for Customer Tags.

Serial Number is the serial number of the regulator.

Software Version is the version of regulator firmware.

Settings Version is the version of factory default settings for the regulator.

MODBUS Address is the MODBUS address of the regulator.

Customer Tag 1 is a 15-character string that can be stored to the regulator's non-volatile memory when the Save to EEPROM button is pressed.

Customer Tag 2 is a 15-character string that can be stored to the regulator's non-volatile memory when the Save to EEPROM button is pressed.

SECTION 7 – MAINTENANCE AND TROUBLESHOOTING

PREVENTATIVE MAINTENANCE

The only preventive maintenance required on the DVR®2000E+ is to periodically check that the connections between the DVR®2000E+ and the system are clean and tight. The only user serviceable part on this regulator 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.

TROUBLESHOOTING

If you do not get the results that you expect from the DVR®2000E+, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your excitation system.

Generator Voltage Does Not Build Above Residual

- Step 1. Verify that all wiring is properly connected. Refer to Figures 4-5 through 4-9.
If wiring is improperly connected or loose, reconnect wiring properly.
If wiring is connected properly, proceed to step 2.
- Step 2. Verify that the generator is spinning at rated speed.
If the generator is not up to rated speed, adjust generator speed to the rated value.
If the generator is spinning at rated speed, proceed to Step 3.
- Step 3. Check for correct input power to the DVR®2000E+. Refer to Section 2, Specifications, for input power requirements.
If proper voltage is not present, refer to the generator manual for repair procedures.
If proper voltage is present, proceed to Step 4.
- Step 4. Verify that the fuse is not open.
Replace open fuse.
If fuse is not open, proceed to Step 5.
- Step 5. Verify that the front panel display is not indicating an alarm or fault status. If the display indicates an alarm or fault status, refer to Appendix A – Alarm and Fault Codes to determine what alarm or fault condition is being indicated. Check the generator and/or load conditions. Determine what is causing the alarm or fault condition and resolve the issue. Interrupt input power or shutdown the generator for a minimum of 30 seconds.
Repeat Step 5 until all alarm and fault conditions have been resolved. When the display shows a status of $\overline{UN}$, the regulator is functioning properly. If the generator voltage still does not build, proceed to Step 6.

- Step 6. Verify that the DVR®2000E+ soft start settings are correct. Too long of a soft start setting may give the appearance of no buildup.
If the soft start settings are incorrect, adjust the settings.
If the soft start settings have no effect, proceed to Step 7.
- Step 7. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

Low Generator Output Voltage

- Step 1. Verify that the voltage adjustment is not set too low.
If the voltage adjustment is too low, adjust it to the correct set point.
If the voltage adjustment is correct, proceed to Step 2.
- Step 2. Verify that the under frequency knee set point is not greater than the generator frequency.
If the under frequency set point is too high, adjust the set point below the rated generator frequency.
If the under frequency set point is correct, proceed to Step 3.
- Step 3. Verify that the generator is spinning at rated speed.
If the generator is not up to rated speed, increase the generator speed to the rated level.
If the generator is spinning at rated speed, proceed to Step 4.
- Step 4. Check for correct input power to the DVR®2000E+. Refer to Section 1 (General Information, Specifications) for input power requirements.
If the DVR®2000E+ input voltage is low, refer to the PMG manual.
If the voltage is at the required level, proceed to Step 5.
- Step 5. Verify that the sensing potential transformer (if used) has the correct turns ratio and is operating correctly.
If the turns ratio of the sensing potential transformer is incorrect, replace the sensing potential transformer.
If the sensing potential transformer is operating correctly, proceed to Step 6.
- Step 6. Verify that the front panel display is not indicating an alarm or fault status. If the display indicates an alarm or fault status, refer to Appendix A – Alarm and Fault Codes to determine what alarm or fault condition is being indicated. Check the generator and/or load conditions. Determine what is causing the alarm or fault condition and resolve the issue. Interrupt input power or shutdown the generator for a minimum of 30 seconds.
Repeat Step 6 until all alarm and fault conditions have been resolved. When the display shows a status of RUN, the regulator is functioning properly. If the generator voltage is still low, proceed to Step 7.
- Step 7. Low generator output voltage may occur when operating in droop mode with an inductive load. Refer to Section 3 – Features and Protection for more information about the Load Sharing function.
If the low voltage condition is not caused by the droop function, proceed to Step 8.
- Step 8. Low generator output voltage may occur when the regulator input is being influenced by the auxiliary input. Refer to Section 3 – Features and Protection for more information about the Auxiliary Input function.
If the low voltage condition is not caused by the auxiliary input, proceed to Step 9.

Step 9. Low generator output voltage may occur when the regulator input is being influenced by the UP and DOWN contacts. Refer to Section 3 – Features and Protection for more information about the UP and DOWN contacts.

If the low voltage condition is not caused by the UP and DOWN contacts, proceed to Step 10.

Step 10. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

High Generator Output Voltage

Step 1. Verify that the voltage adjustment is not set too high.

If the voltage adjustment is too high, adjust it to the correct set point.

If the voltage adjustment is correct, proceed to Step 2.

Step 2. Verify that the sensing potential transformer (if used) has the correct turns ratio.

If the turns ratio of the sensing potential transformer is incorrect, replace the sensing potential transformer with the correct one.

If the sensing potential transformer is correct, proceed to Step 3.

Step 3. High generator output voltage may occur when operating in droop mode with a capacitive load. Refer to Section 3 – Features and Protection for more information about the Load Sharing function.

If the high voltage condition is not caused by the droop function, proceed to Step 4.

Step 4. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

Poor Voltage Regulation

Step 1. Verify that the DVR®2000E+ Frame Size is set to the proper generator frame.

If the Frame Size setting is incorrect, re-enter the proper frame size.

If the Frame Size setting is correct, proceed to Step 2.

Step 2. Verify that the ground terminal of the DVR®2000E+ is properly grounded.

If the DVR®2000E+ is not properly grounded, connect a dedicated ground wire to the quarter-inch fast-on connector labeled GND on the rear of the DVR®2000E+ case.

If the DVR®2000E+ is properly grounded, proceed to Step 3.

Step 3. Check for grounded field leads.

If the field leads are grounded, isolate them from ground.

If the field leads are not grounded, proceed to Step 4.

Step 4. Check for grounded PMG leads.

If the PMG leads are grounded, isolate them from ground.

If the PMG leads are not grounded, proceed to Step 5.

- Step 5. Verify that the front panel display is not indicating an alarm status. If the display indicates an alarm status, refer to Appendix A – Alarm and Fault Codes to determine what alarm condition is being indicated. Check the generator and/or load conditions. Determine what is causing the alarm condition and resolve the issue. Interrupt input power or shutdown the generator for a minimum of 30 seconds. Repeat Step 6 until all alarm conditions have been resolved. When the display shows a status of RUN, the regulator is functioning properly. If the generator voltage regulator is still poor, proceed to Step 6.
- Step 6. Low generator output voltage may occur when operating in droop mode with an inductive load. Refer to Section 3 – Features and Protection for more information about the Load Sharing function. If the low voltage condition is not caused by the droop function, proceed to Step 7.
- Step 7. Low generator output voltage may occur when the regulator input is being influenced by the auxiliary input. Refer to Section 3 – Features and Protection for more information about the Auxiliary Input function. If the low voltage condition is not caused by the auxiliary input, proceed to Step 8.
- Step 8. Low generator output voltage may occur when the regulator input is being influenced by the UP and DOWN contacts. Refer to Section 3 – Features and Protection for more information about the UP and DOWN contacts. If the low voltage condition is not caused by the UP and DOWN contacts, proceed to Step 9.
- Step 9. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

Generator Output Unstable (Hunting)

- Step 1. Verify that the governor for the prime mover is operating properly. If the governor is not operating properly, troubleshoot using the manufacturer's suggested procedures. If the governor is operating properly, proceed to Step 2.
- Step 2. Verify that the sensing and input power leads are connected securely. If the sensing or input power leads are not connected securely, tighten the connections. If the sensing or input power lead connections are secure, proceed to Step 3.
- Step 3. Verify that the DVR®2000E+ Frame Size is set to the proper generator frame. If the Frame Size setting is incorrect, re-enter the proper frame size. If the Frame Size setting is correct, proceed to Step 4.
- Step 4. Verify that the front panel display is not indicating an alarm status. If the display indicates an alarm status, refer to Appendix A – Alarm and Fault Codes to determine what alarm condition is being indicated. Check the generator and/or load conditions. Determine what is causing the alarm condition and resolve the issue. Interrupt input power or shutdown the generator for a minimum of 30 seconds. Repeat Step 4 until all alarm conditions have been resolved. When the display shows a status of RUN, the regulator is functioning properly. If the generator voltage regulator is still poor, proceed to Step 5.

- Step 5. Low generator output voltage may occur when operating in droop mode with an inductive load. Refer to Section 3 – Features and Protection for more information about the Load Sharing function.
- If the low voltage condition is not caused by the droop function, proceed to Step 6.
- Step 6. Low generator output voltage may occur when the regulator input is being influenced by the auxiliary input. Refer to Section 3 – Features and Protection for more information about the Auxiliary Input function.
- If the low voltage condition is not caused by the auxiliary input, proceed to Step 7.
- Step 7. Low generator output voltage may occur when the regulator input is being influenced by the UP and DOWN contacts. Refer to Section 3 – Features and Protection for more information about the UP and DOWN contacts.
- If the low voltage condition is not caused by the UP and DOWN contacts, proceed to Step 8.
- Step 8. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

Field Over Excitation Shutdown (F008) is displayed on the HMI

- Step 1. Verify that the field over excitation set point is adjusted properly.
- If not properly adjusted, readjust the field over excitation set point. Refer to Section 3 – Features and Protection for more information about the Field Over Excitation Shutdown.
- If properly adjusted, proceed to Step 2.
- Step 2. Check for generator overloading.
- If the generator is operating with a larger than rated load, shed load.
- If the generator is operating at rated or less than rated load, proceed to Step 3.
- Step 3. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

Loss of Generator Sensing (F011) is displayed on the HMI

- Step 1. Verify that the voltage sensing leads are properly connected.
If the sensing leads are not properly connected, correct the connections.
If the sensing lead connections are correct, proceed to Step 2.
- Step 2. Verify that the sensing leads E1, E2 and E3 are all connected per the appropriate figure in Section 4 for the regulator mode being used.
If E2 and E3 are not connected properly, connect them per the appropriate figure in Section 4.
If E2 and E3 are properly connected, proceed to Step 3.
- Step 3. Verify that the sensing potential transformer (if used) has the correct turns ratio and is functioning properly.
If the sensing potential transformer has the wrong turns ratio or is malfunctioning, replace it.
If the sensing potential transformer is correct and functioning properly, proceed to Step 4.
- Step 4. Verify that the generator output voltage is present on all phases.
If the generator is missing a phase, refer to the generator manual for further system troubleshooting.
If generator output voltage is balanced on all phases, proceed to Step 5.
- Step 5. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

Field Current Limiting (F010) is displayed on the HMI

- Step 1. Check for generator overloading.
If the generator is operating with a larger than rated load, shed load.
If the generator is operating at rated or less than rated load, proceed to Step 2.
- Step 2. Verify that the DVR®2000E+ Field Current Limit is not set too low.
If the output current limit set point is too low, adjust for the proper setting.
If the output current limit is set properly, proceed to Step 3.
- Step 3. Verify that the generator exciter field is not shorted.
If the generator exciter field is shorted, replace the generator exciter.
If the generator exciter field is not shorted, proceed to Step 4.
- Step 4. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

Generator Under Frequency Alarm (A015) is displayed

- Step 1. Verify that the generator is operating at rated speed.
If the generator is not operating at rated speed, adjust the generator speed.
If the generator is operating at the rated speed, proceed to Step 2.
- Step 2. Verify that the under frequency set point is correct.
If the under frequency set point is incorrect, adjust it to the correct value.

No Droop

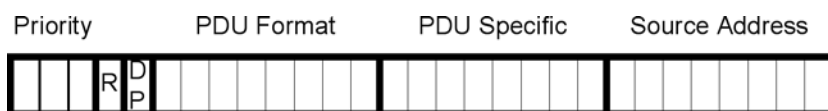
- Step 1. Verify that the DVR®2000E+ DROOP_OFF contact input is open.
If the DROOP_OFF contact input is not open, it must be opened to enable the droop function.
If the DROOP_OFF contact input is open, proceed to Step 2.
- Step 2. Verify that the DVR®2000E+ droop setting is not adjusted to 0% droop.
If the droop setting is adjusted to 0% droop, increase the set point above 0%.
If the droop setting is adjusted to above 0%, proceed to Step 3.
- Step 3. Check for an open in the circuit connected to any CTs used for current sensing.
If there is an open circuit, repair as necessary.
If there is no open circuit, proceed to Step 4.
- Step 4. Verify that all connections are correct according to Figures 4-? and 4-?.
If connections are incorrect, correct the problem.
If connections are correct, proceed to Step 5.
- Step 5. Verify that the load being applied to the generator for droop testing is not purely resistive.
If only a resistive load is being applied to the generator, apply an inductive load and retest.
If the load being applied to the generator is inductive, proceed to Step 6.
- Step 6. Verify that the DVR®2000E+ is compatible with the current sensing transformer (5 A secondary) being used. For example, a current sensing transformer with a 1 ampere output rating would produce very little droop since your DVR®2000E+ has a 5 ampere current transformer input.
If the current transformer input is incorrect, replace the current sensing transformer for compatibility.
If the current transformer input is correct, proceed to Step 7.
- Step 7. Further system troubleshooting may be required. If it is determined that the rest of the system is not the source of the problem, the DVR®2000E+ may need to be replaced.

SECTION 8 – CAN BUS INTERFACE

The DVR®2000E+ utilizes a CAN BUS interface for reporting metered quantities and providing set point control. The protocol for the CAN is CAN 2.0B with the J1939 Superset per ISO 11898, SAE J1939-11 and SAE J1939-21.

MESSAGE FORMAT

The message format for the DVR®2000E+ is the 29-bit extended frame identifier followed by 8 bytes of data. All messages use the Proprietary PDU2 Format in Section 5.3 of SAE J1939-21, Revision APR 2001. For the DVR®2000E+ protocol, the 29 bit identifier is defined as follows:



- The Priority Bits field is user-settable from 0-5 for a given message group.
- The Reserved Bit (R) is set to zero (0) for all messages.
- The Data Page (DP) bit is set to zero (0) for all messages.
- The Proprietary PDU2 Format byte is 0xFF for all messages
- The PDU Specific byte is uniquely defined for each message as a group extender of the PDU2 format
- The Source Address is the user-settable regulator address for outbound messages or the address of the control ECU communicating to the regulator for inbound messages

The message identifier field is followed by 8 bytes (64 bits) of data. No message shall require more than one packet to complete the exchange of data. Multi-packet messaging is not used in the DVR®2000E+ protocol. Message contents in the tables below defined as “0x??” indicate a variable quantity within a data byte. Fixed quantities are identified where applicable. By default, unused data bytes are filled with the “0xFF” byte.

The source address for the DVR®2000E+ and the electronic control units (ECUs) that it responds to can be edited in the Windows® communication software. The default DVR®2000E+ address is 0 and the range is 0-255d. The regulator will respond to messages from up to three different ECUs with addresses also in the range 0-255d.

Outbound messages from the DVR®2000E+ are divided into 4 message groups: meter, control, generator status and regulator status. Inbound messages are not included in these groups. Each of these groups has a configurable message rate and data priority. Priority has a default value of 0 but can be in the range of 0-5. Message transmission rates are editable as follows:

- Metering Group (0.05 – 2.0 sec, default 0.3)
- Control Group (0.025 – 1.0 sec, default 0.3)
- Generator Status Group (0.5 – 15.0 sec, default 5.0)
- Regulator Status Group (0.1 – 5.0 sec, default 1.0)

The DVR®2000E+ also has a timeout feature defined by the timeout message time. This feature is disabled if the timeout time is set to 0 seconds. For any other value of timeout time, the DVR®2000E+ will enunciate a Loss of Communication alarm (Alarm Code A006) unless any ECU delivers a VR Heartbeat message to the DVR®2000E+ within the prescribed timeout time. This alarm is latched until the regulator receives a VR Heartbeat message.

The DVR®2000E+ message set is defined in the following tables. For each message, the message ID is the hexadecimal value of the PDU Format and PDU Specific fields combined. Since the DVR®2000E+ uses PDU2 format, the first two bytes of all of the identifiers are 0xFF. The message group field identifies which group an outbound message belongs to for purposes of its priority and transmission rate. The source field identifies messages coming from the DVR®2000E+ (outbound) or to the regulator from an ECU (inbound).

Data byte 0 is the first data byte after the message identifier and data byte 7 is the last data byte. For bit fields within these data bytes, bit 7 is the most significant bit (leftmost) within a byte and bit 0 is the least significant bit (rightmost) within a byte. Unless otherwise specified, all values are unsigned bytes. For values containing a Least Significant Byte (LSB) and a Most Significant Byte (MSB), the result is an unsigned 16-bit word composed of the two bytes unless otherwise stated.

DVR®2000E+ CAN Message PGNs		
PGN	Group	Message Data
0xFF19	Metering	Vavg (Generator), Iavg(Generator), PT Ratio
0xFF39	Metering	Vavg (Sensed), Iavg (Sensed) CT Ratio
0xFF1A	Metering	Ia, Ib, Ic (Generator)
0xFF1E	Metering	Ia, Ib, Ic (Sensed)
0xFF1B	Metering	Vab, Vbc, Vca (Generator), Voltage Units
0xFF3B	Metering	Vab, Vbc, Vca (Sensed)
0xFF1C	Metering	Va, Vb, Vc (Generator), Voltage Units
0xFF3C	Metering	Va, Vb, Vc (Sensed)
0xFFBA	Metering	Aux. Input Mode, Aux. Voltage, Aux. Scale Factor
0xFF10	Control	PF, Power, Apparent Power, Reactive Power (Generator)
0xFF30	Control	PF, Power, Apparent Power, Reactive Power (Sensed)
0xFF2A	Control	Field Current, Engine Speed, Field Voltage, Regulator Temperature
0xFF5A	Regulator Status	Regulator Software Version and Date
0xFF5B	Regulator Status	Regulator Operating Modes
0xFF5C	Regulator Status	DVR®2000E+ Alarms and Faults
0xFF00	None	Regulator Reset Command
0xFF01	None	CAN Heartbeat Command
0xFFA1	None	Voltage or Current Set Point Adjustment Command
0xFFA2	None	Excitation Enable/Disable Command

Table 8-1. Summary of Message Identifiers and Data

OUTBOUND MESSAGES FROM DVR®2000E+

GENERATOR AVERAGE VOLTAGE AND CURRENT (GENERATOR OUTPUT) – This message contains average generator line voltage and phase current at the generator output after possible step-up from potential and current transformers.

Message ID (0xFF19) – Generator Average Voltage and Current (Generator Output)

Source:	DVR®2000E+
Message Group:	Metering
PDU Format:	255 (PDU2)
PDU Specific:	25

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Avg RMS Current (LSB)	Avg RMS Current (MSB)	Avg RMS Voltage (LSB)	Avg RMS Voltage (MSB)	PT Ratio Scalar (LSB)	PT Ratio Scalar (MSB)	PT Ratio Exp	Unused
0x??	0x??	0x??	0x??	0xFF	0x??	0x??	0xFF

Byte 0	Average RMS Current (LSB) – this is the Least Significant Byte of the average three-phase root-mean-square current. (1 bit = 1 Arms)
Byte 1	Average RMS Current (MSB) – this is the Most Significant Byte of the average three-phase root-mean-square current (1 bit = 1 Arms)
Byte 2	Average Line-to-Line RMS Voltage (LSB) – this is the Least Significant Byte of the average of all three line-to-line voltages. (see Voltage Units in message 0xFF1B for scaling)
Byte 3	Average Line-to-Line RMS Voltage (MSB) – this is the Most Significant Byte of the average of all three line-to-line voltages. (see Voltage Units in message 0xFF1B for scaling)
Byte 4-6	PT Ratio – these three bytes comprise the potential transformer ratio as a fixed-point number. The PT ratio is calculated as: $\text{Scalar} \times 2^{(-\text{Exp})}$ where Scalar is a 16-bit word with LSB and MSB given by bytes 4 and 5 and the exponent is given by byte 6. See Message 0xFF39 For a similar representation of the CT Ratio
Byte 7	Unused

GENERATOR AVERAGE VOLTAGE AND CURRENT (REGULATOR SENSING) – This message contains average generator line voltage and phase current sensed at the regulator after possible step-down from potential and current transformers.

Message ID (0xFF39) – Generator Average Voltage and Current (Regulator Output)

Source:	DVR®2000E+
Message Group:	Metering
PDU Format:	255 (PDU2)
PDU Specific:	57

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Avg RMS Current (LSB)	Avg RMS Current (MSB)	Avg RMS Voltage (LSB)	Avg RMS Voltage (MSB)	CT Ratio Scalar (LSB)	CT Ratio Scalar (MSB)	CT Ratio Exp	Unused
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0xFF

Byte 0	Average RMS Current (LSB) – this is the Least Significant Byte of the average three-phase root-mean-square current. (1 bit = 0.001 Arms)
Byte 1	Average RMS Current (MSB) – this is the Most Significant Byte of the average three-phase root-mean-square current. (1 bit = 0.001 Arms)
Byte 2	Average Line-to-Line RMS Voltage (LSB) – this is the Least Significant Byte of the average of all three line-to-line voltages. (1 bit = 0.1 Vrms)
Byte 3	Average Line-to-Line RMS Voltage (MSB) – this is the Most Significant Byte of the average of all three line-to-line voltages. (1 bit = 0.1 Vrms)
Byte 4-6	CT Ratio – these three bytes comprise the current transformer ratio as a fixed-point number. The CT ratio is calculated as: $\text{Scalar} \times 2^{(-\text{Exp})}$ where Scalar is a 16-bit word with LSB and MSB given by bytes 4 and 5 and the exponent is given by byte 6. See Message 0xFF19 For a similar representation of the PT Ratio
Byte 7	Unused

GENERATOR PHASE PHASE CURRENT (GENERATOR OUTPUT) – This message contains the root-mean-square phase currents for each individual phase at the output of the generator after step-up from a current transformer.

Message ID (0xFF1A) – Generator Phase Currents (Generator Output)

Source: DVR®2000E+
 Message Group: Metering
 PDU Format: 255 (PDU2)
 PDU Specific: 26

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Ia RMS (LSB)	Ia RMS (MSB)	Ib RMS (LSB)	Ib RMS (MSB)	Ic RMS (LSB)	Ic RMS (MSB)	Unused	Unused
0x??	0x??	0x??	0x??	0x??	0x??	0xFF	0xFF

Byte 0	Average Phase-A AC RMS Current (LSB) – this is the Least Significant Byte of the average phase-A root-mean-square current. (1 bit = 1 Arms)
Byte 1	Average Phase-A AC RMS Current (MSB) – this is the Most Significant Byte of the average phase-A root-mean-square current. (1 bit = 1 Arms)
Byte 2	Average Phase-B AC RMS Current (LSB) – this is the Least Significant Byte of the average phase-B root-mean-square current. (1 bit = 1 Arms)
Byte 3	Average Phase-B AC RMS Current (MSB) – this is the Most Significant Byte of the average phase-B root-mean-square current. (1 bit = 1 Arms)
Byte 4	Average Phase-C AC RMS Current (LSB) – this is the Least Significant Byte of the average phase-C root-mean-square current. (1 bit = 1 Arms)
Byte 5	Average Phase-C AC RMS Current (MSB) – this is the Most Significant Byte of the average phase-C root-mean-square current. (1 bit = 1 Arms)
Byte 6-7	Unused

GENERATOR PHASE CURRENT (REGULATOR SENSING) – This message contains the root-mean-square phase currents for each individual phase at the regulator sensing terminals with a 5 Amp secondary on the current transformer.

Message ID (0xFF1E) – Generator Phase Currents (Regulator Sensing)

Source:	DVR®2000E+
Message Group:	Metering
PDU Format:	255 (PDU2)
PDU Specific:	30

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Ia RMS (LSB)	Ia RMS (MSB)	Ib RMS (LSB)	Ib RMS (MSB)	Ic RMS (LSB)	Ic RMS (MSB)	Unused	Unused
0x??	0x??	0x??	0x??	0x??	0x??	0xFF	0xFF

Byte 0	Average Phase-A AC RMS Current (LSB) – this is the Least Significant Byte of the average phase-A root-mean-square current. (1 bit = 0.001 Arms)
Byte 1	Average Phase-A AC RMS Current (MSB) – this is the Most Significant Byte of the average phase-A root-mean-square current. (1 bit = 0.001 Arms)
Byte 2	Average Phase-B AC RMS Current (LSB) – this is the Least Significant Byte of the average phase-B root-mean-square current. (1 bit = 0.001 Arms)
Byte 3	Average Phase-B AC RMS Current (MSB) – this is the Most Significant Byte of the average phase-B root-mean-square current. (1 bit = 0.001 Arms)
Byte 4	Average Phase-C AC RMS Current (LSB) – this is the Least Significant Byte of the average phase-C root-mean-square current. (1 bit = 0.001 Arms)
Byte 5	Average Phase-C AC RMS Current (MSB) – this is the Most Significant Byte of the average phase-C root-mean-square current. (1 bit = 0.001 Arms)
Byte 6-7	Unused

GENERATOR LINE-TO-LINE VOLTAGES (GENERATOR OUTPUT) – This message contains the root-mean-square line-to-line voltages for each individual phase at the output of the generator after possible step-up from a potential transformer.

Message ID (0xFF1B) – Generator Line-to-Line Voltages (Generator Output)

Source:	DVR®2000E+
Message Group:	Metering
PDU Format:	255 (PDU2)
PDU Specific:	27

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Vab RMS (LSB)	Vab RMS (MSB)	Vbc RMS (LSB)	Vbc RMS (MSB)	Vca RMS (LSB)	Vca RMS (MSB)	Voltage Units	Unused
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0xFF

Byte 0	Average Line-to-Line AC RMS Voltage Vab (LSB) – this is the Least Significant Byte of the average line-to-line AC root-mean-square voltage, Vba.
Byte 1	Average Line-to-Line AC RMS Voltage Vab (MSB) – this is the Most Significant Byte of the average line-to-line AC root-mean-square voltage, Vba.
Byte 2	Average Line-to-Line AC RMS Voltage Vbc (LSB) – this is the Least Significant Byte of the average line-to-line AC root-mean-square voltage, Vac.
Byte 3	Average Line-to-Line AC RMS Voltage Vbc (MSB) – this is the Most Significant Byte of the average line-to-line AC root-mean-square voltage, Vac.
Byte 4	Average Line-to-Line AC RMS Voltage Vca (LSB) – this is the Least Significant Byte of the average line-to-line AC root-mean-square voltage, Vbc.
Byte 5	Average Line-to-Line AC RMS Voltage Vca (MSB) – this is the Most Significant Byte of the average line-to-line AC root-mean-square voltage, Vbc.
Byte 6	Voltage Units – an enumerated quantity used to define the scaling for output voltages as follows: 0x00 – scaling for all voltages are 1 bit = 0.1 Vrms 0x01 – scaling for all voltages are 1 bit = 0.1 kVrms Note: this scaling also applies to output voltages in messages 0xFF19
Byte 7	Unused

GENERATOR LINE-TO-LINE VOLTAGES (REGULATOR SENSING) – This message contains the root-mean-square line-to-line voltages for each individual phase at the sensing inputs of the regulator after possible step-down from a potential transformer.

Message ID (0xFF3B) – Generator Line-to-Line Voltages (Regulator Sensing)

Source:	DVR®2000E+
Message Group:	Metering
PDU Format:	255 (PDU2)
PDU Specific:	59

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Vab RMS (LSB)	Vab RMS (MSB)	Vbc RMS (LSB)	Vbc RMS (MSB)	Vca RMS (LSB)	Vca RMS (MSB)	Unused	Unused
0x??	0x??	0x??	0x??	0x??	0x??	0xFF	0xFF

Byte 0	Average Line-to-Line AC RMS Voltage Vab (LSB) – this is the Least Significant Byte of the average line-to-line AC root-mean-square voltage, Vba. (1 bit = 0.1 Vrms)
Byte 1	Average Line-to-Line AC RMS Voltage Vab (MSB) – this is the Most Significant Byte of the average line-to-line AC root-mean-square voltage, Vba. (1 bit = 0.1 Vrms)
Byte 2	Average Line-to-Line AC RMS Voltage Vbc (LSB) – this is the Least Significant Byte of the average line-to-line AC root-mean-square voltage, Vac. (1 bit = 0.1 Vrms)
Byte 3	Average Line-to-Line AC RMS Voltage Vbc (MSB) – this is the Most Significant Byte of the average line-to-line AC root-mean-square voltage, Vac. (1 bit = 0.1 Vrms)
Byte 4	Average Line-to-Line AC RMS Voltage Vca (LSB) – this is the Least Significant Byte of the average line-to-line AC root-mean-square voltage, Vbc. (1 bit = 0.1 Vrms)
Byte 5	Average Line-to-Line AC RMS Voltage Vca (MSB) – this is the Most Significant Byte of the average line-to-line AC root-mean-square voltage, Vbc. (1 bit = 0.1 Vrms)
Byte 6-7	Unused

GENERATOR LINE-TO-NEUTRAL VOLTAGES (GENERATOR OUTPUT) – This message contains the root-mean-square line-to-neutral voltages for each individual phase at the generator output after possible step-up from a potential transformer.

Message ID (0xFF1C) – Generator Line-to-Neutral Voltages (Generator Output)

Source:	DVR®2000E+
Message Group:	Metering
PDU Format:	255 (PDU2)
PDU Specific:	28

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Va RMS (LSB)	Va RMS (MSB)	Vb RMS (LSB)	Vb RMS (MSB)	Vc RMS (LSB)	Vc RMS (MSB)	Voltage Units	Unused
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0xFF

Byte 0	Average Line-to-Neutral AC RMS Voltage Va (LSB) – this is the Least Significant Byte of the average line-to-neutral root-mean-square voltage, Va.
Byte 1	Average Line-to-Neutral AC RMS Voltage Va (MSB) – this is the Most Significant Byte of the average line-to-neutral root-mean-square voltage, Va.
Byte 2	Average Line-to-Neutral AC RMS Voltage Vb (LSB) – this is the Least Significant Byte of the average line-to-neutral root-mean-square voltage, Vb.
Byte 3	Average Line-to-Neutral AC RMS Voltage Vb (MSB) – this is the Most Significant Byte of the average line-to-neutral root-mean-square voltage, Vb.
Byte 4	Average Line-to-Neutral AC RMS Voltage Vc (LSB) – this is the Least Significant Byte of the average line-to-neutral root-mean-square voltage, Vc.
Byte 5	Average Line-to-Neutral AC RMS Voltage Vc (MSB) – this is the Most Significant Byte of the average line-to-neutral root-mean-square voltage, Vc.
Byte 6	Voltage Units – an enumerated quantity used to define the scaling for output voltages as follows: 0x00 – scaling for all voltages are 1 bit = 0.1 Vrms 0x01 – scaling for all voltages are 1 bit = 0.1 kVrms
Byte 7	Unused

GENERATOR LINE-TO-NEUTRAL VOLTAGES (REGULATOR SENSING) – This message contains the root-mean-square line-to-neutral voltages for each individual phase at the generator output after possible step-up from a potential transformer.

Message ID (0xFF3C) – Generator Line-to-Neutral Voltages (Regulator Sensing)

Source:	DVR®2000E+
Message Group:	Metering
PDU Format:	255 (PDU2)
PDU Specific:	60

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Va RMS (LSB)	Va RMS (MSB)	Vb RMS (LSB)	Vb RMS (MSB)	Vc RMS (LSB)	Vc RMS (MSB)	Unused	Unused
0x??	0x??	0x??	0x??	0x??	0x??	0xFF	0xFF

Byte 0	Average Line-to-Neutral AC RMS Voltage Va (LSB) – this is the Least Significant Byte of the average line-to-neutral root-mean-square voltage, Va. (1 bit = 0.1 Vrms)
Byte 1	Average Line-to-Neutral AC RMS Voltage Va (MSB) – this is the Most Significant Byte of the average line-to-neutral root-mean-square voltage, Va. (1 bit = 0.1 Vrms)
Byte 2	Average Line-to-Neutral AC RMS Voltage Vb (LSB) – this is the Least Significant Byte of the average line-to-neutral root-mean-square voltage, Vb. (1 bit = 0.1 Vrms)
Byte 3	Average Line-to-Neutral AC RMS Voltage Vb (MSB) – this is the Most Significant Byte of the average line-to-neutral root-mean-square voltage, Vb. (1 bit = 0.1 Vrms)
Byte 4	Average Line-to-Neutral AC RMS Voltage Vc (LSB) – this is the Least Significant Byte of the average line-to-neutral root-mean-square voltage, Vc. (1 bit = 0.1 Vrms)
Byte 5	Average Line-to-Neutral AC RMS Voltage Vc (MSB) – this is the Most Significant Byte of the average line-to-neutral root-mean-square voltage, Vc. (1 bit = 0.1 Vrms)
Byte 6-7	Unused

AUXILIARY INPUT METERING - This message displays the mode and metered value of the auxiliary input.

Message ID: (0xFFBA) Auxiliary Input Metering

Source: DVR®2000E+
 Message Group: Metering
 PDU Format: 255 (PDU2)
 PDU Specific: 186

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Auxiliary Input Mode	Scaled Meter Value (LSB)	Scaled Meter Value (MSB)	Scale Factor Scalar (LSB)	Scale Factor Scalar (MSB)	Scale Factor Exp	Unused	Unused
0x??	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Byte 0	Auxiliary Input Mode – displays the mode selected for the auxiliary input channel (enumerated) 0x00 Auxiliary Off (default) 0x01 Auxiliary Control 0x02 Auxiliary Meter
Byte 1-2	Scaled Meter Value – displays the metered value of the analog input channel. If Auxiliary Input Mode is Auxiliary Off or Auxiliary Control, this value corresponds to a value representing a voltage with 1 bit = 0.001 Volts, signed 16 bit If Auxiliary Input Mode is Auxiliary Meter, this value represents a scaled, metered quantity with scale factor given by bytes 3-5.
Byte 3-5	Scale Factor – these three bytes comprise the metering scale factor as a fixed-point number. The scale factor is calculated as: $\text{Scalar} \times 2^{(-\text{Exp})}$ where Scalar is a 16-bit word with LSB and MSB given by bytes 3 and 4 and the exponent is given by byte 5. This scale factor is multiplied by the quantity 0.001 V/bit to obtain the scaled value represented in bytes 1-2.

GENERATOR POWER AND POWER FACTOR (GENERATOR OUTPUT) – This message contains the generator power factor, average total real power, total reactive power and average apparent power as seen at the output of the generator, possibly stepped up by potential and current transformers.

Message ID (0xFF10) – Generator Power and Power Factor (Generator Output)

Source:	DVR®2000E+
Message Group:	Control
PDU Format:	255 (PDU2)
PDU Specific:	16

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Power Factor (LSB)	Power Factor (MSB)	Real Power (LSB)	Real Power (MSB)	Apparent Power (LSB)	Apparent Power (MSB)	Reactive Power (LSB)	Reactive Power (MSB)
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0x??

Byte 0	Generator Power Factor (LSB) – this is the Least Significant Byte of the generator power factor. (1 bit = 0.001 pu)
Byte 1	Generator Power Factor (MSB) – this is the Most Significant Byte of the generator power factor. (1 bit = 0.001 pu)
Byte 2	Generator Real 3-phase Power (LSB) – this is the Least Significant Byte of the generator real power. (1 bit = 0.1kW)
Byte 3	Generator Real 3-phase Power (MSB) – this is the Most Significant Byte of the generator real power. (1 bit = 0.1kW)
Byte 4	Generator Apparent 3-phase Power (LSB) – this is the Least Significant Byte of the generator total real power. (1 bit = 0.1kVA)
Byte 5	Generator Apparent 3-phase Power (MSB) – this is the Most Significant Byte of the generator total real power. (1 bit = 0.1kVA)
Byte 6	Generator Reactive 3-phase Power (LSB) – this is the Least Significant Byte of the generator total real power. (1 bit = 0.1kVAR)
Byte 7	Generator Reactive 3-phase Power (MSB) – this is the Most Significant Byte of the generator total real power. (1 bit = 0.1kVAR)

GENERATOR POWER AND POWER FACTOR (REGULATOR SENSING) – This message contains the generator power factor, average total real power, total reactive power and average apparent power as seen at the regulator sensing terminals, possibly stepped down by potential and current transformers.

Message ID (0xFF30) – Generator Power and Power Factor (Regulator Sensing)

Source:	DVR®2000E+
Message Group:	Control
PDU Format:	255 (PDU2)
PDU Specific:	48

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Power Sense	Unused	Real Power (LSB)	Real Power (MSB)	Apparent Power (LSB)	Apparent Power (MSB)	Reactive Power (LSB)	Reactive Power (MSB)
0x??	0xFF	0x??	0x??	0x??	0x??	0x??	0x??

Byte 0	Generator Power Factor Sense – this is the direction of the generator power factor as given by the following enumeration: 00 – Lagging Power Factor 01 – Leading Power Factor
Byte 1	Unused
Byte 2	Generator Real 3-phase Power (LSB) – this is the Least Significant Byte of the generator real power. (1 bit = 1 W)
Byte 3	Generator Real 3-phase Power (MSB) – this is the Most Significant Byte of the generator real power. (1 bit = 1 W)
Byte 4	Generator Apparent 3-phase Power (LSB) – this is the Least Significant Byte of the generator total real power. (1 bit = 1 VA)
Byte 5	Generator Apparent 3-phase Power (MSB) – this is the Most Significant Byte of the generator total real power. (1 bit = 1 VA)
Byte 6	Generator Reactive 3-phase Power (LSB) – this is the Least Significant Byte of the generator total real power. (1 bit = 1 VAR)
Byte 7	Generator Reactive 3-phase Power (MSB) – this is the Most Significant Byte of the generator total real power. (1 bit = 1 VAR)

FIELD CURRENT AND ENGINE SPEED - This message reports average DC field current, average DC field voltage, engine speed and regulator temperature.

Message ID: (0xFF2A) Field Current and Engine Speed

Source:	DVR®2000E+
Message Group:	Control
PDU Format:	255 (PDU2)
PDU Specific:	42

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Field Current (LSB)	Field Current (MSB)	Engine Speed (LSB)	Engine Speed (MSB)	Field Voltage (LSB)	Field Voltage (MSB)	Regulator Temp (LSB)	Regulator Temp (MSB)
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0x??

Byte 0	Field Current (LSB) – this is the Least Significant Byte of the regulator field current. (1 bit = 0.001 Adc)
Byte 1	Field Current (MSB) – this is the Most Significant Byte of the regulator field current. (1 bit = 0.001 Adc)
Byte 2	Engine Speed (LSB) – this is the Least Significant Byte of the generator engine speed. (1 bit = 1 rpm)
Byte 3	Engine Speed (MSB) – this is the Most Significant Byte of the generator engine speed. (1 bit = 1 rpm)
Byte 4	Field Voltage (LSB) – this is the Least Significant Byte of the regulator field voltage. (1 bit = 0.1 Vdc)
Byte 5	Field Voltage (MSB) – this is the Most Significant of the regulator field voltage. (1 bit = 0.1 Vdc)
Byte 6	Regulator Temperature (LSB) – this is the Least Significant Byte of the regulator temperature in degrees C. (1 bit = 1 deg C, signed)
Byte 7	Regulator Temperature (MSB) – this is the Most Significant Byte of the regulator temperature in degrees C. (1 bit = 1 deg C, signed)

VR STATUS - This message indicates the regulator software revision level and regulation status of the VR

Message ID: (0xFF5A) VR Status Message

Source:	DVR®2000E+
Message Group:	Regulator Status
PDU Format:	255 (PDU2)
PDU Specific:	90

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
YEAR (LSB)	Year (MSB)	MONTH	DAY	PRIM REV	SECOND REV	TERT REV	Unused*
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0xFF

Byte 0	YEAR (LSB) - The last two digits of the year of the software version date. e.g. for '2006', YEAR (MSB) = 0x06 = 6d 32d
Byte 1	YEAR (MSB) - The first two digits of the year of the software version date. e.g. for '2006', YEAR (LSB) = 0x20 = 32d
Byte 2	MONTH - The month of the software version date. e.g. for '12', MONTH = 0x12 = 18d
Byte 3	DAY - The day of the software version date. e.g. for '31', DAY = 0x31 = 49d
Byte 4	Primary Revision – the primary revision number of the regulator firmware. For Revision 12.34.56, this byte is 12d.
Byte 5	Secondary Revision – the secondary revision number of the regulator firmware. For Revision 12.34.56, this byte is 34d.
Byte 6	Tertiary Revision – the tertiary revision number of the regulator firmware. For Revision 12.34.56, this byte is 56d.
Byte 7	Unused; except for diagnostic and testing modes

VR OPERATING STATUS - This message indicates the current operating status of the regulator. See Section 3 of the IOM for more details on the settings of the DVR®2000E+

Message ID: (0xFF5B) VR Operating Status

Source:	DVR®2000E+
Message Group:	Regulator Status
PDU Format:	255 (PDU2)
PDU Specific:	91

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Excit. Mode	Frame Size (LSB)	Frame Size (MSB)	Input Source	Current Sense Phases	VR Status	Reg. Mode	Device Mode
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0x??

Byte 0	Excitation Mode – this byte indicates the state of the excitation mode: 0x00 – Exciter Off 0x01 – Exciter On
Byte 1	Frame Size – the Least Significant Byte of the frame size used for the controller
Byte 2	Frame Size – the Most Significant Byte of the frame size used for the controller
Byte 3	Input Source – the input source used for providing power to the regulator: 0x00 – Unused 0x01 – Permanent Magnet Generator
Byte 4	Current Sense Phases – the number of current phases sensed directly through current transformers: 0x00 – Three-phase current sensing 0x01 – Single phase current sensing
Byte 5	VR Status – the current operating status of the regulator: 0x00 – Run (regulator operating normally) 0x01 – Off (regulator excitation is off) 0x02 – Alarm (regulator is in alarm state) 0x03 – Fault (regulator is in fault state)
Byte 6	Regulation Mode – the current regulation mode of the regulator: 0x00 – AVR3 (Automatic Voltage Regulation using three phases) 0x01 – FCR (Field Current Regulation) 0x02 – AVR1 (Automatic Voltage Regulation using single phase)
Byte 7	Device Mode – the current device mode for the regulator 0x00 – diagnostics and testing 0x01 – DEVICE_ON (excitation is enabled and regulator is operating normally) 0x02 – diagnostics and testing 0x03 – diagnostics and testing 0x04 – diagnostics and testing 0x05 – diagnostics and testing 0x06 – diagnostics and testing 0x07 – DEVICE_HIST (regulator is displaying historical fault data) 0x0E – diagnostics and testing

VR ALARMS/FAULTS - This message displays the current status of alarms and faults. For the bit fields associated with these alarms and faults, the following enumerations define the status of an individual alarm/fault indicator: 00b = OK, 01b = Alarm active, 10b = Fault active, 11b = Disabled

Message ID: (0xFF5C) VR Alarms/Faults

Source: DVR®2000E+
 Message Group: Regulator Status
 PDU Format: 255 (PDU2)
 PDU Specific: 92

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Current Alarms Faults	Current Alarms Faults	Current Alarms Faults	Unused Alarms Faults	Historic Alarms Faults	Historic Alarms Faults	Historic Alarms Faults	Unused Alarms Faults
0x??	0x??	0x??	0x??	0x??	0x??	0x??	0x00

Byte 0	Alarms and Faults – contains the current state of the following alarm/fault indicators. Bits 7, 6 - Generator Imbalance Bits 5, 4 - Generator Under Frequency Bits 3, 2 - Generator Reverse Power Flow Bits 1, 0 - Generator Over Voltage
Byte 1	Alarms and Faults – contains the current state of the following alarm/fault indicators. Bits 7, 6 - Generator Under Voltage Bits 5, 4 - Generator Loss of Sensing Bits 3, 2 - Generator Field Current Limiting Bits 1, 0 - Generator Instantaneous Field Over Current
Byte 2	Alarms and Faults – contains the current state of the following alarm/fault indicators. Bits 7, 6 - Generator Field Over Excitation Bits 5, 4 - Generator Regulator Over Temperature Bits 3, 2 - Generator Loss of CAN Communication Bits 1, 0 - Unused
Byte 3	Unused
Byte 4	Alarms and Faults – contains the historic value of the following alarm/fault indicators. Bits 7, 6 - Generator Imbalance Bits 5, 4 - Generator Under Frequency Bits 3, 2 - Generator Reverse Power Flow Bits 1, 0 - Generator Over Voltage
Byte 5	Alarms and Faults – contains the historic value of the following alarm/fault indicators. Bits 7, 6 - Generator Under Voltage Bits 5, 4 - Generator Loss of Sensing Bits 3, 2 - Generator Field Current Limiting Bits 1, 0 - Generator Instantaneous Field Over Current
Byte 6	Alarms and Faults – contains the historic value of the following alarm/fault indicators. Bits 7, 6 - Generator Field Over Excitation Bits 5, 4 - Generator Regulator Over Temperature Bits 3, 2 - Generator Loss of CAN Communication Bits 1, 0 - Unused
Byte 7	Unused

INBOUND MESSAGES FROM ECU1 or ECU2 or ECU3

RESET VR - This message from an ECU resets the regulator. The regulator responds by clearing any faults and executing its soft start ramp to a stable regulation point.

Message ID: (0xFF00) Reset VR

Source:	ECU1 or ECU2 or ECU3
Message Group:	None
PDU Format:	255 (PDU2)
PDU Specific:	0

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Unused	Fixed	Fixed	Fixed	Fixed	Fixed	Unused	Unused
0Xff	0x01	0xA5	0x5A	0x49	0x94	0xFF	0xFF

Byte 0	Unused	Unused
Byte 1-5	FIXED	This is a fixed constant. If these bytes are not loaded with the given fixed constants, the reset will not take place.
Byte 6-7	Unused	Unused

VR HEARTBEAT – If the message timeout timer is enabled with a non-zero value, the regulator assumes a heart-beat message will be sent periodically from an ECU. If this message is not received within the timeout time specified, the Loss of CAN Communication Alarm will be in an alarm state. The regulator will continue to regulate normally and broadcast metering messages but may not respond to CAN messages.

Message ID: (0xFF01) VR Heartbeat

Source: ECU1 or ECU2 or ECU3
 Message Group: None
 PDU Format: 255 (PDU2)
 PDU Specific: 1

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused
0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Byte 0-7	Unused
----------	--------

SET POINT ADJUST - this message can be used to adjust the set point of the regulator in its various regulation modes.

Message ID: (0xFFA1) Set Point Adjust

Source:	ECU1 or ECU2 or ECU3
Message Group:	None
PDU Format:	255 (PDU2)
PDU Specific:	161

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Unused	Unused	Field Current Set Point (LSB)	Field Current Set Point (MSB)	Voltage Set Point (LSB)	Voltage Set Point (MSB)	Voltage Adjust (LSB)	Voltage Adjust (LSB)
0xFF	0xFF	0x??	0x??	0x??	0x??	0x??	0x??

Byte 0	Unused
Byte 1	Unused
Byte 2	Field Current Set Point (LSB) – If Regulation Mode is Field Current Regulation, this value represents the Least Significant Byte of the field current set point from 0.000-3.000 A. (1 bit = 1mA)
Byte 3	Field Current Set Point (MSB) – If Regulation Mode is Field Current Regulation, this value represents the Most Significant Byte of the field current set point from 0.000-3.000 A. (1 bit = 1mA)
Byte 4	Regulator Voltage Set Point (LSB) – If Regulation Mode is Automatic Voltage Regulation (3 or 1), this value represents the Least Significant Byte of the regulator voltage set point from 100.0-600.0 V. (1 bit = 0.1 V)
Byte 5	Regulator Voltage Set Point (MSB) – If Regulation Mode is Automatic Voltage Regulation (3 or 1), this value represents the Most Significant Byte of the regulator voltage set point from 100.0-600.0 V. (1 bit = 0.1 V)
Byte 6	Voltage Adjust (LSB) – If Regulation Mode is Automatic Voltage Regulation (3 or 1), this value represents the Least Significant Byte of a voltage adjustment as a signed quantity (1 bit = 0.1 V). If this voltage adjustment exceeds a threshold (+/-30% of the voltage regulation set point), it will be saturated.
Byte 7	Voltage Adjust (MSB) – If Regulation Mode is Automatic Voltage Regulation (3 or 1), this value represents the Most Significant Byte of a voltage adjustment as a signed quantity (1 bit = 0.1 V). If this voltage adjustment exceeds a threshold (+/-30% of the voltage regulation set point), it will be saturated.

EXCITATION ENABLE/DISABLE - this message can be used to disable/enable excitation.

Message ID: (0xFFA2) Excitation Enable/Disable

Source:	ECU1 or ECU2 or ECU3
Message Group:	None
PDU Format:	255 (PDU2)
PDU Specific:	162

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Excit Enable Disable	Unused	Unused	Unused	Unused	Unused	Unused	Unused
0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Byte 0	Excitation Enable/Disable - changes the state of excitation on the regulator: 0x00 – disables excitation, changing regulator to the OFF state 0x01 – enables excitation, changing regulator to the Run state Any other value – no change
Byte 1-7	Unused

APPENDIX A

ALARM CODES

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

Alarm Codes	
<i>AQ 16</i>	Generator Voltage Imbalance
<i>AQ 15</i>	Generator Under Frequency
<i>AQ 14</i>	Generator Reverse Power Flow
<i>AQ 12</i>	Generator Under Voltage
<i>AQ 10</i>	Field Current Limiting
<i>AQ08</i>	Field Over Excitation
<i>AQ07</i>	Regulator Over Temperature
<i>AQ06</i>	Regulator Over Communication

Table A-1. Alarm Codes

FAULT CODES

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

Fault Codes	
<i>FD 16</i>	Generator Voltage Imbalance
<i>FD 13</i>	Generator Over Voltage
<i>FD 12</i>	Generator Under Voltage
<i>FD 11</i>	Generator Loss of Sensing
<i>FD 10</i>	Field Current Limiting
<i>FD09</i>	Instantaneous Field Over Current
<i>FD08</i>	Field Over Excitation
<i>FD07</i>	Regulator Over Temperature
<i>FD06</i>	Regulator Over Communication

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@2000E+ regulator.

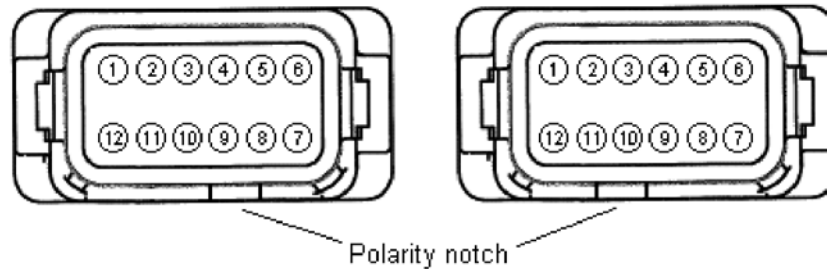


Figure B-1. Connector J1

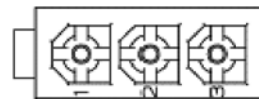


Figure B-2. Connector J3

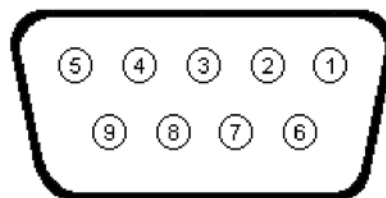


Figure B-3. MODBUS Communication Port

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

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

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. MODBUS 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

APPENDIX C

QUICK START PROGRAMMING GUIDE

As the DVR®2000E+ 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 the SELECT button. The word **5.2E** will appear in the display. Press the ENTER button. 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 **5.2E**.
4. Press the SELECT button. The word **rEG** will appear in the display. Press the ENTER button. 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 the SELECT button. The word **SEtPt** will appear in the display. Press the ENTER button. 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 **SEtPt**.
6. Press the SELECT button. The word **UFR9** will appear in the display. Press the ENTER button. 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 **UFR9**.
7. Press the SELECT button. The word **drOP** will appear in the display. Press the ENTER button. 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 the SELECT button. The word **AU** will appear in the display. Press the ENTER button. 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



RBC Manufacturing Corporation
100 East Randolph Street (54401)
P.O. Box 8003 • Wausau, WI 54402-8003
Ph: (715) 675-3311 • Fax: (715) 675-8026