

⚠ WARNING

- Read and follow all instructions carefully.
- Disconnect and lock-out power before installation and maintenance. Working on or near energized equipment can result in severe injury or death.
- Do not operate equipment without guards in place. Exposed equipment can result in severe injury or death.

⚠ CAUTION

- Periodic inspections should be performed. Failure to perform proper maintenance can result in premature product failure and personal injury.

NOTICE

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

SAFETY

READ AND SAVE THESE INSTRUCTIONS SAFETY INSTRUCTIONS

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

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

WARNING! DEFINITION: The words "generator" or "generators", as used in this publication, refers to only Marathon[®] generator or generators, respectively. Marathon generators are manufactured and/or sold by Regal Beloit America, Inc. or its affiliated companies. Marathon generators do not include the prime mover or any of the prime mover related systems or accessories.

ELECTRICAL SAFETY

WARNING! ELECTRICAL HAZARD

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

WARNING! ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.

Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.

Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.

Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

WARNING! MAGNETIC FIELD HAZARD

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

WARNING! EXPLOSION HAZARD

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

MECHANICAL SAFETY

WARNING! ROTATING PARTS HAZARD

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

WARNING! OVERSPEED HAZARD

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

WARNING! DO NOT DISASSEMBLE

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

GENERAL

OVERVIEW

This guide provides introductory details on installation and commissioning of the DVR®2400 or DVR2500 digital voltage regulator with Marathon® synchronous generators. A separate, full length Installation, Operation and Maintenance Manual (SB056E) is available at <http://www.marathonelectric.com/generators/iomManuals.jsp>

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

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

REGULATION MODES

Five regulation modes:

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

FEATURES

The digital voltage regulator has the following features:

- Preset stability settings based on generator frame size
- Adjustable soft start in AVR1 or AVR3 regulation modes
- Under frequency (Volts/Hertz) regulation
- True RMS three-phase or single-phase generator voltage sensing
- True RMS current sensing, single phase on DVR2400, three phase on DVR2500; (optional CT's required)
- True RMS power metering, single phase on DVR2400, three phase on DVR2500; (optional CT's required)
- Field current sensing
- Contact inputs for system interface capability
- Contact output for fault indication
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Front-panel human-machine interface (HMI) for status and configuration
- MODBUS protocol via USB2.0 for external communication
- DVRPortal™ Windows®-based software for configuration and monitoring
- "Power on" LED indicator
- Configurable auxiliary input for metering and control
- Simulated reactive power for droop set-up
- CAN interface with CAN 2.0B J1939 protocol for metering and control (DVR2500 only)
- Generator power limiting mode (DVR2500 only)
- Configurable Parameter Presets selectable through digital inputs (DVR2500 only)
- 8 Channel 3-wire PT100 RTD metering (DVR2500 only) through an external module

PROTECTION

The digital voltage regulator has the following protection features:

- Field Over Excitation Shutdown
- Field Under Excitation Shutdown
- Generator Over Voltage Shutdown
- Generator Under Voltage Shutdown
- Generator Voltage Imbalance Shutdown
- Generator Reverse Power Shutdown
- Loss of Generator Sensing Shutdown
- Instantaneous Field Over Current Shutdown
- Regulator Over Temperature Shutdown
- Generator Parallel Start-Up Shutdown
- Generator Parallel Shutdown Shutdown
- RTD Over Temperature Shutdown (DVR2500 only)
- Loss of CAN Communication Alarm (DVR2500 only)
- RTD Pre Alarm Temperature (DVR2500 only)
- Loss of Aux Input Control Current Alarm (DVR2500 only)
- Loss of RTD Element -Open Alarm (DVR2500 only)
- Loss of RTD Element - Short Alarm (DVR2500 only)
- Genset Battery Low Alarm (DVR2500 only)

LIMITERS

- Exciter Field Current Limit
- Generator Under Frequency Limit
- Generator Power Limit (DVR2500 only)

SPECIFICATIONS

Voltage Regulation – 0.25% over load range at rated power factor and constant generator frequency.

Output Power – 100 Vdc, 4.0 Adc continuous rating and 190 Vdc, 7.5 Adc forcing capability for 10 seconds.

Exciter Field DC Resistance – 16 to 35Ω range

Voltage Adjustment – ±30% of nominal via analog input, ±15% via external contacts

Input Power – 180 to 240 Vac, 250 to 300 Hz PMG power supply

Regulator Sensing – 100 to 600 Vac, 50/60 Hz, 1-phase/3-phase

Operating Temperature – From -40°C to +70°C (-40°F to +158°F)

Storage Temperature – From -40°C to +85°C (-40°F to +185°F)

Ingress Protection – IP52 (front side mounted in conduit box along with swing cover); IP10 (rear side with protective cover)

Shock – 20 G in 3 perpendicular planes

Vibration – 2.5 G at 5 to 26 Hz; 0.050" double amplitude (27 to 52 Hz); 7 G at 53 to 500 Hz

Weight – 3.5 lb. (1590 g)

Humidity Testing – Per MIL-STD-705B, Method 711-D

Salt Fog Testing – Per MIL-STD-810E

CAN Protocol – SAE J1939

EMI Compatibility

Immunity

- Meets EN 61000-6-2: 2005 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – immunity for industrial environments.
- Meets EN 61000-6-4: 2007 Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – emission standard for industrial environments

EMI 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
- Immunity to conduct transients on Power leads

SAE J1113-11, test pulse waveforms 1c, 2a, 2b, 3a, 3b, 4 & 5a (DVR2500)

Emission

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

CONNECTIONS

Digital voltage regulator connections are dependent on the application.

MOUNTING GUIDELINES:

- Wires performing common functions, such as voltage sensing leads, should be grouped together.
- The 14 and 18 position plugs P1 and P2 need to be screwed down to the regulator during operation.
- Maximum recommended torque for the P1 and P2 mounting screws is 2.7 inch•lbf [0.3 N•m].
- Wiring terminated to P1 and P2 needs to be strain relieved to reduce stress on the wiring due to vibration.
- P1 and P2 can accept either bare wire (stranded only) or ferrules.
- Recommended strip/ferrule length of 0.393 in (10 mm) should be used for connections terminated to P1 and P2.
- Wiring routed to P1 and P2 should be strain relieved at least 6 inches from the P1 and P2.
- Wiring terminated to P1 needs to be bundled together with tie wraps to reduce strain. This is applicable to P2 also. Do not bundle wiring connected to P1 and P2 together as this adds more strain to the connections.
- Loctite* 242 or similar should be used on the screws before connecting the DB25 cable to the RTD module and DVR for better vibration withstand.
- Recommended torque for the DB25 cable connecting digital voltage regulator and RTD module is 7.0 inch•lbf [0.8 N•m].

REMOTE MOUNTING GUIDELINES:

- All digital and analog inputs connected to the digital voltage regulator should be separately routed from F+, F-, E1, E2, E3, 3 and 4 terminals.
- All digital and analog input wiring needs to be shielded.
- Shield needs to be grounded at remote end of wiring.
- For digital voltage regulator to detect the digital inputs properly, the resistance of the cable used for wiring should not exceed 50 ohms.
- Analog input may be supplied from a source up to 150 feet away.
- USB communication has a limited range of about 3 meters. For longer distance communication please use USB booster cables.
- IOGEAR GUE2118 (39 feet) is recommended for longer distances with the DVR2400/2500.
- Digital voltage regulator may need to be externally powered (DVR2500 only) for proper communication during setup.

Refer to the section on Grounding Practices for additional information.

GROUNDING AND CONNECTION PRACTICES

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

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

DVR[®] CONNECTORS

DVR[®] units have five types of interface connectors:

1. Nine (9) (DVR2400), Eleven (11) (DVR2500) 1/4" quick-connect terminals for generator connections;
2. One (1) 14 position 5.08mm cage clamp style plug for B-phase CT and system interface connections;
3. One (1) 18 position 5.08mm cage clamp style plug for A and C-phase CTs, system interface and Controlled Area Network (CAN) bus interface connections (DVR2500 only);
4. One (1) 5-pin USB 2.0 Mini B type connector for the communication between the digital voltage regulator and DVRPortal[™] software on the front panel; and,
5. One (1) 25 position d-sub connector for 3-wire eight (8) channel measurement through RTD module. (DVR2500 only).

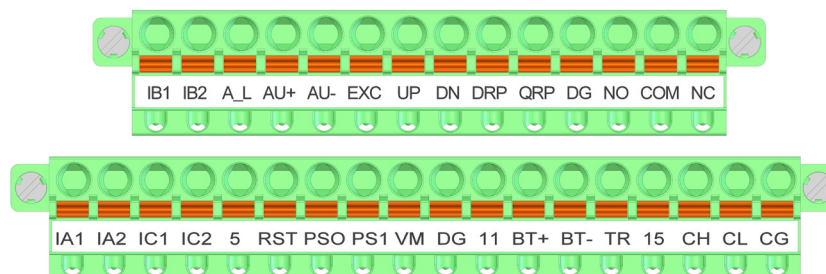


Figure 1. System Connectors P1 (top) and P2 (bottom) Terminal Positions



*Loctite is believed to be the trademark and/or trade name of Henkel Corporation, and is not owned or controlled by Regal Beloit Corporation.

QUICK CONNECT TERMINALS		APPLICATION NOTES
TERMINAL NAME	DESCRIPTION	
GND	Chassis ground	Use #12 AWG (4 mm ²) minimum conductor.
4	PMG/External power input – terminal 2	Protected by fuse.
3	PMG/External power input – terminal 1	Protected by fuse. 180-240Vac, 250 - 300Hz, 350VA
E1	Generator armature – terminal T1	Phase A for 3 phase output. L1 input for single phase.
E2	Generator armature – terminal T2	Phase B for 3 phase output. L2 input for single phase.
E3	Generator armature – terminal T3	Phase C for 3 phase output. Jumper to E2 for single phase.
	Reserved	
	Reserved	
F-	Exciter stator – terminal F1	Excitation output. NOTICE Never apply a voltage to these terminals. Observe polarity.
F+	Exciter stator – terminal F2	

Table 1. Quick Connect Terminals

SENSING	PHASE	CT "X1" TERMINAL	CT "X2" TERMINAL
3-Phase (DVR2500 only)	A	P2-1 (IA1)	P2-2 (IA2)
	B	P1-1 (IB1)	P1-2 (IB2)
	C	P2-3 (IC1)	P2-4 (IC2)
1-Phase	B	P1-1 (IB1)	P1-2 (IB2)

Table 2. Current Transformer Connection Terminals

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

TERMINAL NAME	NAME	DESCRIPTION
IB1	CT-B1	Generator Phase B CT – terminal 1
IB2	CT-B2	Generator Phase B CT – terminal 2
A_L	AUX_LOOP	Auxiliary current loop (DVR2500 only)
AU+	AUX IN +	Auxiliary input positive
AU-	AUX IN -	Auxiliary input negative
EXC	EXCITATION_OFF	Excitation disable contact input (active closed)
UP	UP	UP contact input (active closed)
DN	DOWN	DOWN contact input (active closed)
DRP	DROOP_OFF	Droop disable contact input (active closed)
QRP	VAR/PF_OFF	VAR/PF mode disable (active closed)
DG	DGND	Digital ground
NO	K1-NO	Contact output normally open
COM	K1-COM	Contact output common
NC	K1-NC	Contact output normally closed

Table 3. Connector P1 Terminals

TERMINAL NAME	NAME	DESCRIPTION
IA1	CT-A1	Generator Phase A CT – terminal 1
IA2	CT-A2	Generator Phase A CT – terminal 2
IC1	CT-C1	Generator Phase C CT – terminal 1
IC2	CT-C2	Generator Phase C CT – terminal 2
-	-	Reserved
RST	DVR_RESET	Reset Regulator (active closed)
PS0	PS0	Preset select line 0 (active closed)
PS1	PS1	Preset select line 1 (active closed)
VM	-	Reserved
DG	DGND	Digital ground
-	-	Reserved
BT+	BAT+	Battery input – positive
BT-	BAT-	Battery input – negative
TR	CAN_TR1	CAN terminating resistor - terminal 1
-	-	Reserved
CH	CAN_H	CAN high data line
CL	CAN_L	CAN low data line
CG	CAN_GND	CAN GND

Table 4. Connector P2 Terminals (DVR2500 only)



HUMAN-MACHINE INTERFACE (HMI)

GENERAL

The digital voltage regulator HMI consists of four buttons and a four-character LED display as illustrated in Figure 2. The display indicates status conditions and parameter settings. Button function descriptions are given in Table 5.



Figure 2. DVR2400 and DVR2500 HMI Shown





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

Table 5. DVR[®] 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 digital voltage regulator as described in Table 6. 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 digital voltage regulator as described in Table 7. The display is steady-on while in EDIT mode.
- 3. SLEEP mode** – The HMI turns off the display after 60 seconds of button-press inactivity.

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

Table 6. DVR[®] regulator HMI STATUS Mode Display Descriptions



HMI PARAMETERS:

PARAMETER NAME	PARAMETER VALUE	DESCRIPTION
SIZE	281 to 1040	Frame size of generator
rEG	AVR3	AVR3 – Voltage regulation with three-phase sensing.
	AVR1	AVR1 – Voltage regulation with single-phase sensing.
	FCR	FCR – Field current regulation.
	VAR	VAR – Reactive VAR regulation.
	PF	PF – Power Factor regulation.
StPt	100.0 to 630.0	Voltage set point (Vrms) in AVR3 and AVR1 mode.
	0.000 to 4.000	Field current set point (Adc) in FCR mode.
	0% to 100%	VAR set point (% of rated VAR) in VAR mode.
	-0.600 to 0.600	PF set point (PU) in PF mode.
UFrQ	40.0H to 70.0H	Under frequency knee (Hz).
SLoP	1.00U to 5.00U	Under frequency slope multiplier.
Pr	0 to 6000	Rated power of generator (kW).
PFr	0.600 to 0.900	Rated power Factor of generator (per unit).
Pt	1.0 to 150.0	Potential transformer ratio.
Ct	1 to 2000	Current transformer ratio.
droP	0.0% to 10.0%	Voltage droop (%) at rated reactive power.
AU	OFF	Auxiliary Off – Auxiliary input is disabled.
	CNT1	Auxiliary Control-1 – Auxiliary input modifies regulation set point (± 3 or ± 5 or ± 10 Vdc input).
	CNT2	Auxiliary Control-2 – Auxiliary input modifies regulation set point (4 to 20 mA input) (DVR2500 only).
	SLOP	Dynamic Slope - Auxiliary input modifies under frequency slope multiplier (0 - 5V) (DVR2500 only).

Table 7. DVR® regulator HMI EDIT Mode Parameters

Preliminary Setup

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

ON GENERATOR (Powering DVR® regulator through PMG):

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

1. Before starting the engine, disconnect regulator leads 3, 4, F+ and F-. Temporarily insulate them to prevent accidental shorting. 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. Reconnect 3 and 4 leads.
4. Start and run the generator at rated speed. The regulator may indicate rUn.i or status on the display.
5. At this time, initial adjustments can be made via the HMI.
6. After the initial adjustments are made, shut down the generator and reconnect the regulator leads removed in Step 1. The generator may be started and final adjustments may be performed on the regulator.

ON BENCH:

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

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

(OR)

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

Note: USB should be capable of providing 0.4 Adc to the digital voltage regulator for proper communication. HMI, power on LED indicator and other functions will be non-operational.

(OR)

Connect a 12/24-volt battery input to terminals P2-12 (BT+) and P2-13 (BT-) for DVR2500.

Note: Battery should be capable of providing 0.8 Adc.

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

2. If the regulator is in AVR1 or AVR3 regulation mode, the regulator will indicate STBY on the display. If the regulator is in FCR regulation mode, the regulator will indicate rUn.i on the display.
3. At this time, initial adjustments can be made. If adjusting through HMI see instructions below. If adjusting via the DVRPortal™ Windows® communication software, see IOM Manual.

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

MAKING SETTINGS CHANGES THROUGH HMI

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 7).
3. Press the ENTER button to place the HMI into EDIT mode. In EDIT mode, the HMI will display the current value of the selected parameter.
4. Press or hold the UP and DOWN buttons to modify the displayed parameter to its desired value. Parameter changes take immediate effect.
5. To store the displayed parameter value to non-volatile memory, press the ENTER button. The stored parameter value will flash three times to confirm the entry.

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

APPENDIX A

ALARM CODES

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

Alarm Codes

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

Table A-1. Alarm Codes

FAULT CODES

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

Fault Codes

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

Table A-2. Fault Codes