



# DECS-450

## Digital Excitation Control System

*Instruction Manual*



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# Preface

This instruction manual provides information about the installation and operation of the DECS-450. To accomplish this, the following information is provided:

- General information
- Human-machine interface
- Functional description
- Installation
- BESTCOMSPi<sup>us</sup>® software
- Setup
- Communication protocols
- Maintenance
- Specifications
- Expansion modules
- Math model

## ***Conventions Used in this Manual***

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Important safety and procedural information is emphasized and presented in this manual through warning, caution, and note boxes. Each type is illustrated and defined as follows.

### **Warning!**

Warning boxes call attention to conditions or actions that may cause personal injury or death.

### **Caution**

Caution boxes call attention to operating conditions that may lead to equipment or property damage.

### **Note**

Note boxes emphasize important information pertaining to installation or operation.



12570 State Route 143  
Highland IL 62249-1074 USA

[www.basler.com](http://www.basler.com)

[info@basler.com](mailto:info@basler.com)

Tel: +1 618.654.2341

Fax: +1 618.654.2351

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### Warning!

READ THIS MANUAL. Read this manual before installing, operating, or maintaining this equipment. Note all warnings, cautions, and notes in this manual as well as on the product. Keep this manual with the product for reference. Only qualified personnel should install, operate, or service this system. Failure to follow warning and cautionary labels may result in personal injury or property damage. Exercise caution at all times.

### Caution

Installing previous versions of firmware may result in compatibility issues causing the inability to operate properly and may not have the enhancements and resolutions to issues that more recent versions provide. Basler Electric highly recommends using the latest version of firmware at all times. Using previous versions of firmware is at the user's risk and may void the warranty of the unit.

### Note

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It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Over time, improvements and revisions may be made to this publication. Before performing any of the following procedures, contact Basler Electric for the latest revision of this manual.

The English-language version of this manual serves as the only approved manual version.

Be sure that the device is hard-wired to earth ground with no smaller than 12 AWG (3.3 mm<sup>2</sup>) copper wire attached to the case ground terminal. When the device is configured in a system with other devices, a separate lead should be connected from the ground bus to each device.

Current transformer (CT) grounding should be applied in accordance with local codes and conventions.

### Note

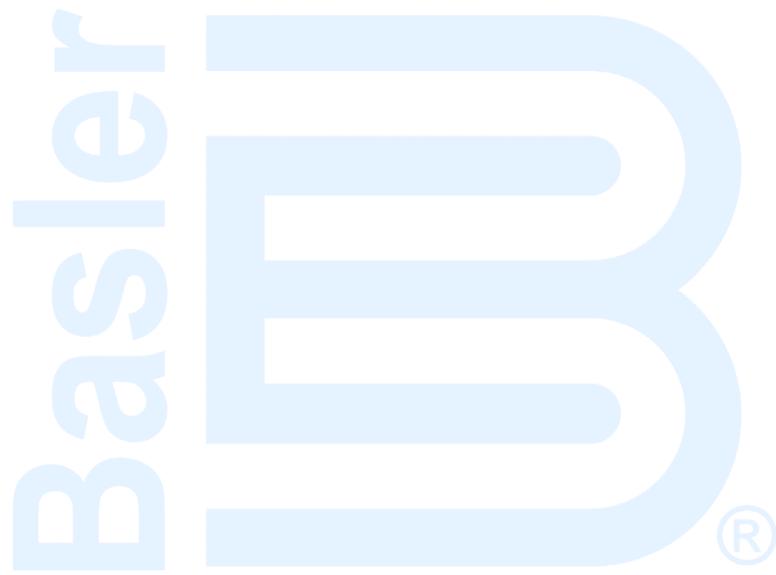
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# Revision History

A historical summary of the changes made to this instruction manual is provided below. Revisions are listed in reverse chronological order.

Visit [www.basler.com](http://www.basler.com) to download the latest hardware, firmware, and BESTCOMSPlus® revision histories.

## Instruction Manual Revision History

| Manual Revision and Date | Change  |
|--------------------------|---|
| F, Apr 2025              | <ul style="list-style-type: none"> <li>Added references to the CEM-125</li> <li>Clarified or updated descriptions in <i>Synchronizer, Regulation, Auxiliary Control, Limiters, Metering, Stability Tuning, BESTlogic™ Plus, Analog Expansion Module, and Contact Expansion Module</i></li> <li>Updated drawings in <i>PSS and Mounting</i></li> <li>Removed wording about activating the DECS-450 plugin</li> <li>Removed IE 5.01 requirement</li> <li>Updated Windows compatibility</li> <li>Removed references to CD-ROM</li> <li>Added Viewing the Security Log section</li> <li>Corrected Modbus register numbers/bits</li> <li>Added resolution increments to <i>Modbus Communication</i></li> <li>Corrected USB driver location</li> <li>Updated China RoHS compliance</li> <li>Added FCC credentials</li> <li>Removed EAC credentials from <i>CEM-2020</i> and <i>AEM-2020</i></li> <li>Added <i>Math Model</i></li> </ul> |
| E, Dec 2023              | <ul style="list-style-type: none"> <li>Added China RoHS compliance</li> </ul>   |
| D, Mar 2023              | <ul style="list-style-type: none"> <li>Added a note box about simultaneous application of contact inputs</li> <li>Replaced Gain conversion screenshot</li> <li>Updated Transition Plate section and added new drawings</li> <li>Added a figure for BCM-2/IT-2 connections</li> <li>Added Operation Mode section and figure</li> <li>Changed UL 6200 to UL 6200:2019</li> </ul>  |
| C, Jul 2022              | <ul style="list-style-type: none"> <li>Added impedance specification for meter driver outputs</li> <li>Adjusted CE compliance information and added UKCA compliance information for the DECS-450, AEM-2020, and CEM-2020</li> <li>Added maritime recognition for the AEM-2020 and CEM-2020</li> <li>Made assorted, minor edits and corrections</li> </ul>   |
| B1, Aug 2021             | <ul style="list-style-type: none"> <li>Removed hazardous location compliance for CEM-2020</li> </ul>  |
| B, Jul 2021              | <ul style="list-style-type: none"> <li>Clarified that the DECS-450 senses and responds to rms generator voltage</li> <li>Added ABS maritime certification</li> <li>Clarified operation of the DECS-400 gain converter</li> <li>Enhanced the description of analog output logic operation</li> <li>Added caution statement advising against downgrading DECS-450 firmware</li> </ul>   |
| A, Dec 2020              | <ul style="list-style-type: none"> <li>Added instructions for installing a transition plate</li> <li>Added relative humidity to <i>Specifications</i></li> <li>Minor text edits</li> </ul>  |
| —, Aug 2020              | <ul style="list-style-type: none"> <li>Initial release</li> </ul>   |



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# 1 • Introduction

The DECS-450 Digital Excitation Control System is a microprocessor-based controller that offers excitation control, logic control, and optional power system stabilization in an integrated package. The DECS-450 controls field excitation by providing an analog signal used to control the output of an external power bridge. The DECS-450 monitors generator or motor parameters and acts to control, limit, and protect the machine from operating outside its capability.

The optional, onboard power system stabilizer (PSS) is an IEEE-defined PSS2A/2B/2C, dual-input, “integral of accelerating power” stabilizer that provides supplementary damping for low-frequency, local mode and power system oscillations.

BESTCOMSP*Plus*® PC software provides a point-and-click means to set and monitor the DECS-450 and makes the configuration of one or several DECS-450 controllers fast and efficient. BESTlogic™ *Plus* Programmable Logic, within BESTCOMSP*Plus*, is used to program DECS-450 logic for protection elements, inputs, outputs, alarms, etc. The user can easily drag and drop elements, components, inputs, and outputs onto the program grid and make connections between them to create the desired logic scheme with up to 256 logic gates per diagram.

The DECS-450 is designed for use with Basler Electric’s Bridge Control Module (BCM-2) or Interface Firing Module (IFM-150), and three- or six-SCR power bridges. However, it will work equally well with any power bridge with a controller that is compatible with the output signal from the DECS-450.

## Features and Functions

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DECS-450 features and functions include:

- Precise excitation control for synchronous generator or synchronous motor applications
  - Power factor and var metering values will be opposite in motor mode
- Five excitation control modes:
  - Automatic Voltage Regulation (AVR)
  - Field Current Regulation (FCR)
  - Field Voltage Regulation (FVR)
  - Power Factor Regulation (PF)
  - Var Regulation (var)
- Three pre-position setpoints for each excitation control mode
- Internal tracking between operating mode setpoints and external tracking of a second DECS excitation setpoint
- Two PID stability groups
- Auto Tune feature: The revolutionary auto-tuning function automatically establishes optimum PID and gain settings, taking the guesswork out of system setup, reducing commissioning time and cost while maximizing overall system performance.
- Programmable analog control output selectable for 4 to 20 mA<sub>dc</sub>, –10 to +10 V<sub>dc</sub>, or 0 to +10 V<sub>dc</sub>
- Remote setpoint control input accepts analog voltage or current control signal
- Real-time metering
- Automatic synchronizer
- Optional integrated PSS (IEEE Std 421.5 type PSS2A/2B/2C)
  - Generator or motor control modes, accommodates phase rotation changes between modes
  - Speed and power sensing or speed-only sensing
  - Three-wattmeter method of power measurement
- Soft start and voltage buildup control
- Five limiting functions:
  - Overexcitation: summing point and takeover
  - Underexcitation
  - Stator current

- Reactive power (var)
  - Underfrequency or volts per hertz
- Twenty-five protection functions:
  - Volts per hertz (24)
  - Generator undervoltage (27)
  - Generator overvoltage (59)
  - Loss of sensing (LOS)
  - Overfrequency (81O)
  - Two Underfrequency (81U)
  - Reverse power (32R)
  - Loss of excitation (40Q)
  - Field overvoltage
  - Field overcurrent
  - Field overtemperature
  - Loss of Field Isolation Transducer
  - Exciter diode failure
  - Sync-check (25)
  - Generator below 10 hertz
  - Watchdog timer
  - Eight configurable protection elements
- External crowbar activation alarm support
- BESTCOMSP*Plus*® software
- BESTlogic™ *Plus* programmable logic
  - Drag-and-drop interface
  - 256 logic gates per diagram
- Network Load Sharing over Ethernet provides easy implementation in complex paralleled systems.
- IRIG or network time synchronization
- Sixteen contact sensing inputs
  - Two fixed-function inputs: Start and Stop
  - Fourteen programmable inputs
- Twelve contact outputs
  - One, fixed-function output: Watchdog (SPDT configuration)
  - Eleven programmable outputs
- Flexible communication
  - Front-panel USB port
  - Modbus communication through RS-485 port or Modbus TCP
  - Ethernet communication through an optional copper or fiber optic port
  - CAN communication with an external control system, optional AEM-2020 Analog Expansion Module, or optional CEM-125 or CEM-2020 Contact Expansion Module
  - Optional Profibus communication protocol
- Data logging, sequence of events recording, and trending
- Optional CEM-125 or CEM-2020 Contact Expansion Module provides:
  - Ten contact inputs
  - Twenty-four contact outputs
  - Customizable input and output functions assigned through BESTlogic™ *Plus* programmable logic
  - Communication via CAN protocol
- Optional AEM-2020 Analog Expansion Module provides:
  - Eight analog inputs
  - Eight resistive thermocouple device (RTD) inputs
  - Two thermocouple inputs
  - Four analog outputs
  - Customizable input and output functions assigned through BESTlogic*Plus* programmable logic
  - Communication via CAN protocol

## Applications

The DECS-450 is intended for synchronous generator or synchronous motor applications. The DECS-450 controls field excitation by providing an analog signal used to control the output of an external power bridge. The level of excitation power is based on the monitored voltage and current, and a regulation setpoint established by the user.

## Package

A front panel HMI provides local annunciation and control through a backlit liquid crystal display (LCD), light-emitting diodes (LEDs), and pushbuttons. The DECS-450 provides multiple communication interfaces: CAN Bus, Ethernet, Modbus®, optional Profibus, and optional Interactive Display Panels: IDP-801 and IDP-1201.

## Optional Features and Capabilities

DECS-450 optional features and capabilities are defined by a combination of letters and numbers that make up the style number. The model and style number describe options and characteristics in a specific device and appear on a label affixed to the device.

### Style Number

The style number identification chart in Figure 1-1 defines the electrical characteristics and operational features available in the DECS-450.

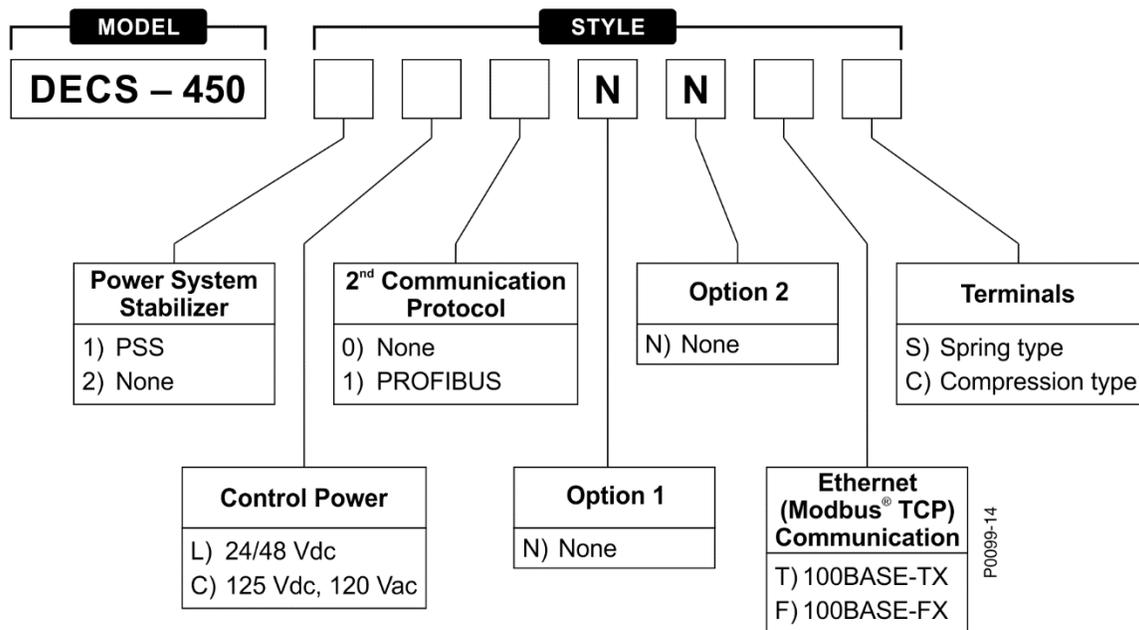


Figure 1-1. DECS-450 Style Chart

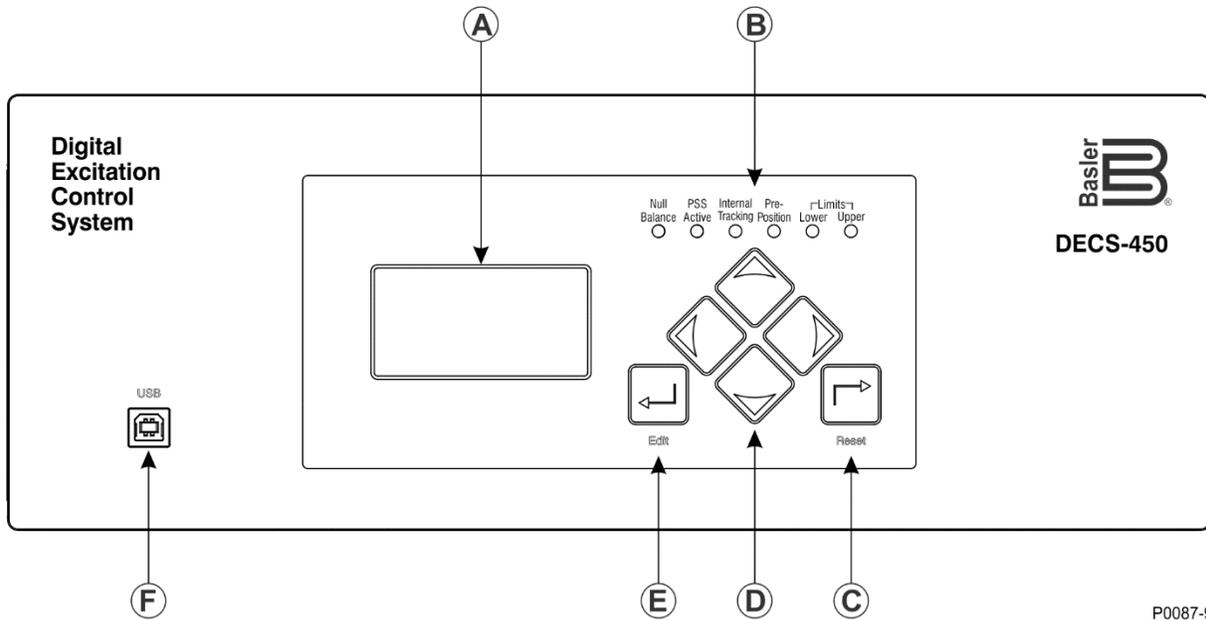


## 2 • Controls and Indicators

All controls and indicators are located on the front panel and consist of pushbuttons, LED indicators, and a liquid-crystal display (LCD).

### *Front Panel Illustration and Description*

DECS-450 controls and indicators are illustrated in Figure 2-1 and described in Table 2-1. The locators and descriptions of Table 2-1 correspond to the locators shown in Figure 2-1.



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**Figure 2-1. Front Panel Controls and Indicators**

Table 2-1. Front Panel Control and Indicators Descriptions

| Locator | Description   |
|---------|---|
| A       | <i>Display.</i> The liquid crystal display (LCD) serves as a local source of information provided by the DECS-450. The LCD displays operating setpoints, loop gains, metering, protection functions, system parameters, and general settings. The 128 by 64 dot pixel, backlit LCD displays white characters on a blue background.  |
| B       | <i>Null Balance Indicator.</i> This green light emitting diode (LED) lights when the setpoint of the inactive operating modes (AVR, FCR, FVR, Var, and PF) match the setpoint of the active mode.   |
|         | <i>PSS Active Indicator.</i> This red LED lights when the integrated power system stabilizer is enabled and can generate a stabilizing signal in response to a power system disturbance.  |
|         | <i>Internal Tracking Indicator.</i> This red LED lights when any inactive mode (AVR, FCR, FVR, Var, or Power Factor) is tracking the setpoint of the active mode to achieve a “bumpless” transfer when changing active modes.   |
|         | <i>Pre-Position Indicator.</i> This red LED lights when the active mode setpoint is at any of the three pre-position (predefined) settings.   |
|         | <i>Limit Indicators.</i> Two red LEDs indicate when the active mode setpoint reaches the minimum or maximum value.  |
| C       | <i>Reset Pushbutton.</i> This button cancels editing sessions, resets alarm annunciations and latched alarm relays, and can be used for quick access to the metering screen.  |
| D       | <i>Scrolling Pushbuttons.</i> These four buttons are used to scroll up, down, left, and right through the menus displayed on the LCD (locator A). During an editing session, the left and right scrolling pushbuttons select the variable to be changed and the up and down scrolling pushbuttons change the value of the variable. |
| E       | <i>Edit Pushbutton.</i> Pressing this button starts an editing session and enables changes to DECS-450 settings. At the conclusion of the editing session, the Edit pushbutton is pressed to save the settings changes.   |
| F       | <i>Communication Port.</i> This type B USB jack connects the DECS-450 with a PC operating BESTCOMSPPlus® for local communication. BESTCOMSPPlus is supplied with the DECS-450.  |

## Menu Navigation

The DECS-450 provides local access to DECS-450 settings and metering values through a menu structure displayed on the front panel LCD. An overview of the menu structure is illustrated in Table 2-2. Movement through the menu structure is achieved by pressing the four scrolling pushbuttons.

**Table 2-2. DECS-450 Menu Structure Overview**

| <b>Metering</b><br>(Metering Explorer)   | <b>Settings</b><br>(Settings Explorer)  | <b>Metering Summary Screen</b>   |
|--|---|--|
| Generator<br>Power<br>Bus<br>Field<br>PSS (optional)<br>Synchronization<br>Aux Input<br>Tracking<br>Network Load Share<br>Control Panel<br>Status<br>Reports | General Settings<br>Communication<br>System Parameters<br>Report Configuration<br>Operating Settings<br>PSS (optional)<br>Sync/Voltage Matching<br>Protection<br>Prog. Inputs<br>Prog. Outputs<br>Logic | Generator Voltage<br>Field Current<br>Vars<br>Alarms Status<br>Limiter Status<br>Setpoint Status<br>DECS Unit Status |

## Adjusting Settings

Make setting adjustments at the front panel by performing the following steps.

1. Navigate to the screen listing the setting to be changed.
2. Press the Edit button and enter the appropriate username and password to gain the needed level of security access. (Information about implementing and using username and password protection is provided in the *Security* section of this manual.)
3. Highlight the desired setting and press the Edit button to view the setting editing screen. This screen lists the setting range or the permissible setting selection.
4. Use the scrolling pushbuttons to select the setting digits/selections and adjust/change the setting.
5. Press the Edit button to save the change.

## Display Setup

**BESTCOMSPlus Navigation Path:** Settings Explorer, General Settings, Front Panel HMI

**HMI Navigation Path:** Settings, General Settings, Front Panel HMI

Front panel display appearance and behavior can be customized to meet user preferences and site conditions. These BESTCOMSPlus settings are illustrated in Figure 2-3.

### LCD

LCD setup includes a contrast adjustment to suit the viewing angle used or compensate for environmental conditions. The ability to reverse the display colors is provided to accommodate lighting conditions and user preferences.

### Sleep Mode

Sleep mode reduces the demand on control power by turning off the LCD backlight when no pushbutton activity is seen for the duration of the LCD Backlight Timeout setting.

## Language

Language modules are available for the DECS-450. Once a language module is implemented, it can be enabled via the Language Selection setting.

## Screen Scrolling

The display can be set to automatically scroll through a user-selected list of metered values. This feature is enabled and disabled with the Enable Scroll setting. The rate at which scrolling occurs is configured with the Scroll Time Delay setting.

### Front Panel HMI

#### LCD Setup

Contrast Value (%)

Invert Display

#### Sleep Mode Setup

Sleep Mode

LCD Backlight Timeout (s)

#### Language Setup

Language Selection

#### Screen Scrolling Setup

Enable Scroll

Scroll Time Delay (s)

#### Scrollable Metering Settings

- GV Primary
- GC Primary
- CC Primary
- Frequency
- Power Primary
- PF Primary
- Energy Primary
- BV Primary
- Field Primary
- Synchronization Primary
- Aux Input
- Tracking
- Real Time Clock
- Contact Inputs
- Contact Outputs
- Device ID

Figure 2-2. Front Panel HMI Settings

## 3 • Power Input

The control power input supplies power to an internal power supply that provides power for logic, protection, and control functions. Control power input voltage is determined by the DECS-450 style number.

Style XLXXXXX has one, dc-only input that accepts 16 to 60 Vdc (24 or 48 Vdc nominal).

Style XCXXXXX has two inputs, one for ac and one for dc. The ac input accepts 82 to 132 Vac at 50/60 Hz (120 Vac nominal). The dc input accepts 90 to 150 Vdc (125 Vdc nominal). One input, either ac or dc, is sufficient for operation, but two inputs provide redundancy (for style XCXXXXX only). AC control power is applied at terminals L and N. DC control power is applied at terminals BATT+ and BATT-.

### Caution

When both control power inputs are used (style XCXXXXX only), an isolation transformer is required for the ac input.

Refer to the *Terminals and Connectors* and *Typical Connections* sections for more information.



## 4 • Voltage and Current Sensing

The DECS-450 senses generator voltage, generator current, and bus voltage through dedicated, isolated inputs. Field sensing values are supplied to DECS-450 from the Field Isolation Transducer (supplied with the DECS-450).

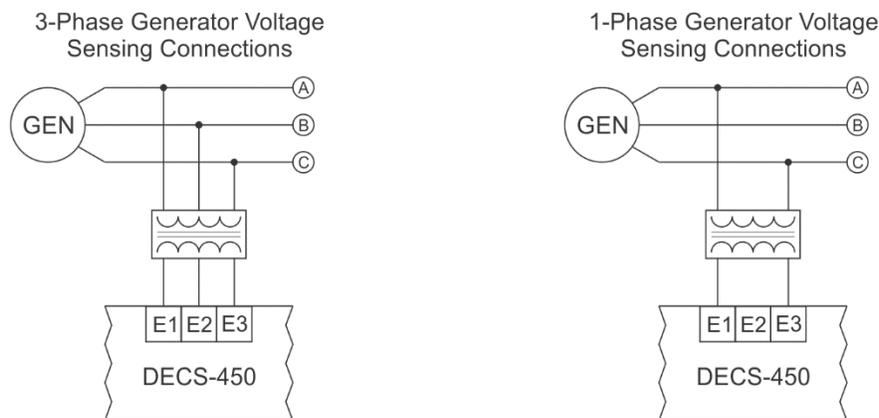
### Generator Voltage

Three-phase generator sensing voltage is applied to DECS-450 terminals E1, E2, and E3. This sensing voltage is typically applied through a user-supplied voltage transformer, but may be applied directly. These terminals accept three-phase, three-wire connections at terminals E1 (A), E2 (B), and E3 (C) or single-phase connections at E1 (A) and E3 (C).

The generator voltage sensing input accepts a maximum voltage of 240 Vac (nominal) and has a burden of less than 1 VA per phase.

The transformer primary and secondary winding voltages are entered in settings that the DECS-450 uses to interpret the applied sensing voltage and calculate system parameters. The phase rotation of the generator sensing voltage may be configured as ABC or ACB. Information about configuring the DECS-450 for the generator sensing voltage is provided in the *Configuration* section of this manual.

Typical generator voltage sensing connections are illustrated in Figure 4-1.



P0100-07

Figure 4-1. Typical Generator Voltage Sensing Connections

### Generator Current

Generator current sensing inputs consist of A-phase, B-phase, C-phase, and cross-current compensation.

#### Notes

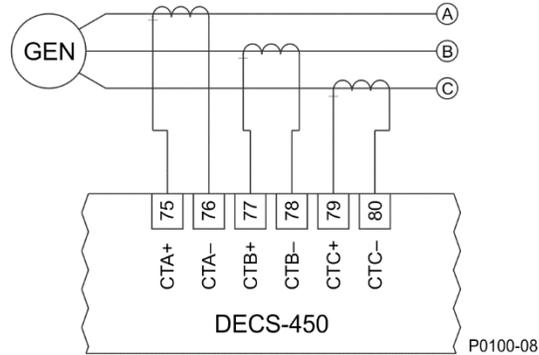
- Current transformer (CT) grounding should be applied in accordance with local codes and conventions.
- In this manual, CT terminals are shown with polarity designations (+/-) and terminal numbers, however, physical DECS-450 CT terminals are labeled with terminal numbers only.

## Phase Sensing

For single- or three-phase configurations, apply A-phase sensing current to DECS-450 terminals 75 (CTA+) and 76 (CTA–), B-phase to terminals 77 (CTB+) and 78 (CTB–) and, C-phase to terminals 79 (CTC+) and 80 (CTC–) through user-supplied current transformers.

The DECS-450 is compatible with CTs having 5 Aac or 1 Aac nominal secondary ratings. The DECS-450 uses this secondary rating, along with the CT nominal primary ratings to interpret the sensed current and calculate system parameters.

For information on sensing transformer settings, refer to the *Configuration* section of this manual. Typical generator phase-current sensing connections are shown in Figure 4-2.



**Figure 4-2. Typical Generator Current Sensing Connections**

### Note

Three-phase sensing is required for PSS applications.

## Cross-Current Compensation

Cross-current compensation (reactive differential) mode allows two or more paralleled generators to share a common load. As shown in Figure 4-3, each generator is controlled by a DECS-450 using the DECS-450 cross-current compensation terminals 81 (CCCT+) and 82 (CCCT-) and a dedicated, external CT to sense generator current (B phase only). The resistors shown in Figure 4-3 are used to set the burden and may be adjusted to suit the application. Ensure that the power rating of the resistors is adequate for the application.

### Note

If a machine is taken offline, then the secondary winding of that machine's cross-current compensation CT must be shorted. Otherwise, the cross-current compensation scheme will not function.

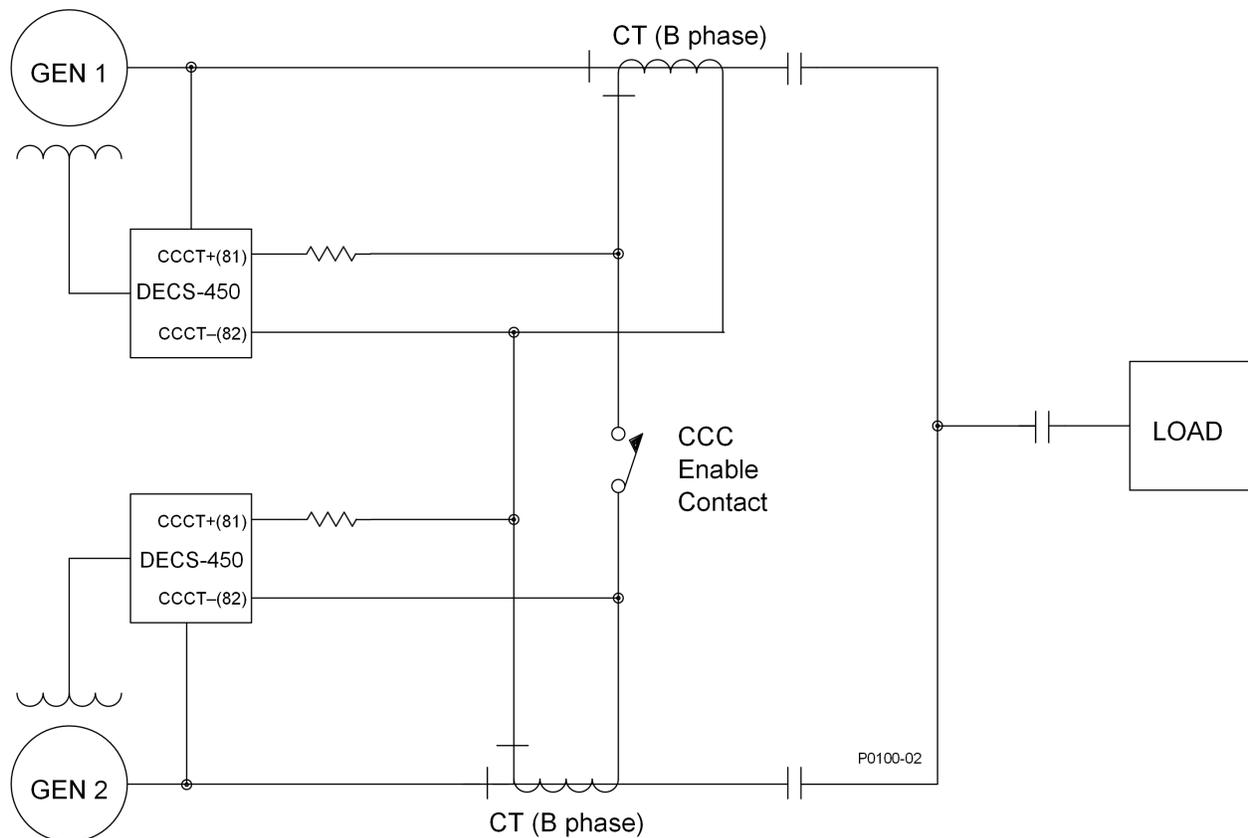


Figure 4-3. Connections for Cross-Current Compensation

## Bus Voltage

Bus voltage monitoring provides bus failure detection, generator and bus voltage matching, and synchronization of the generator with the utility/bus. These features are discussed in the *Synchronizer* section of this manual. Three-phase bus sensing voltage is applied to DECS-450 terminals B1, B2, and B3. This sensing voltage is typically applied through a user-supplied voltage transformer, but may be applied directly. These terminals accept three-phase, three-wire connections at terminals B1 (A), B2 (B), and B3 (C) or single-phase connections at B3 (C) and B1 (A).

The bus voltage sensing input accepts a maximum voltage of 240 Vac (nominal) and has a burden of less than 1 VA per phase.

The transformer primary and secondary winding voltages are entered in settings that the DECS-450 uses to interpret the applied sensing voltage. Information about configuring the DECS-450 for the bus sensing voltage is provided in the *Configuration* section of this manual.

Typical bus voltage sensing connections are illustrated in Figure 4-4.

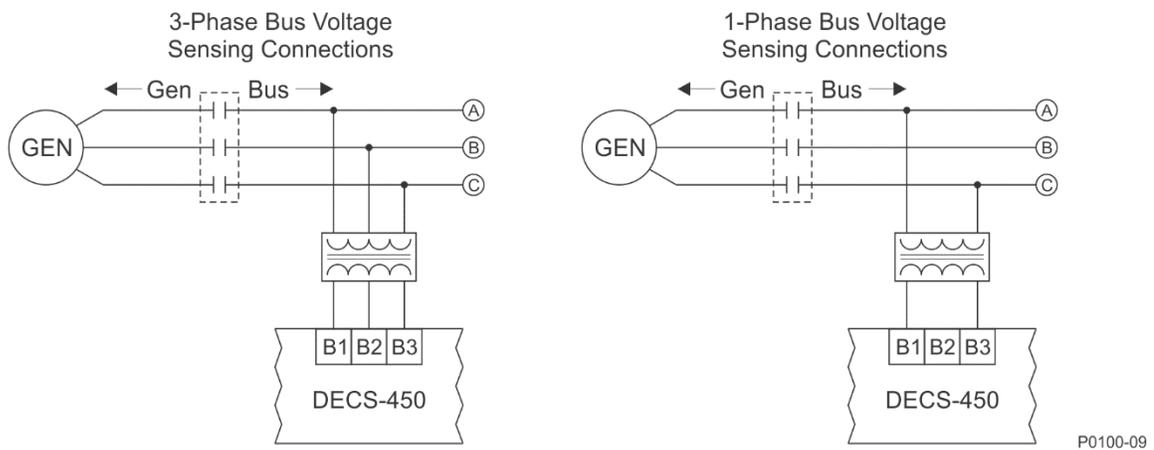


Figure 4-4. Typical Bus Voltage Sensing Connections

## Field Voltage and Current

The DECS-450 receives field voltage and current signals from the Field Isolation Transducer (supplied). The Field Isolation Transducer transmits field voltage and current signals through a dedicated cable terminated at the DECS-450 rear panel Field Isolation Transducer connector.

For field voltage sensing, the Field Isolation Transducer accepts the following range of nominal voltages: 63 Vdc, 125 Vdc, 250 Vdc, 375 Vdc, or 625 Vdc. The applied field voltage may be  $\pm 300\%$  of the nominal value. The Field Isolation Transducer supplies the DECS-450 with a field voltage signal over the range of 0.9 to 9.1 Vdc, where 5.0 Vdc equals zero field voltage.

For field current sensing, the Field Isolation Transducer accepts nominal current shunt output voltages of 0 to 50 mVdc or 0 to 100 mVdc. The applied shunt voltage may be up to 300% of either range. The Field Isolation Transducer supplies the DECS-450 with a field current signal over the range of 2.0 to 9.5 Vdc, where 2.0 Vdc equals zero field current.

## 5 • Synchronizer

DECS-450 controllers are equipped with an automatic synchronizer that aligns the voltage, phase angle, and frequency of the generator with the bus. The synchronizer function includes compensation settings for the generator breaker and bias control settings for the generator governor. Related synchronizer features include voltage matching and bus condition detection.

### Caution

Because the DECS-450 sync-check and automatic synchronizer functions share internal circuitry, the sync-check function is disabled if the automatic synchronizer function is enabled.

A Basler Electric sync-check (25) relay is recommended for independent supervision.

### Generator Synchronization

**BESTCOMSPi<sup>us</sup> Navigation Path:** Settings Explorer, Synchronizer/Voltage Matching, Synchronizer  
**HMI Navigation Path:** Settings, Sync/Voltage Matching, Synchronizer

Two modes of automatic generator synchronization are available: phase lock loop (PLL) and anticipatory. In PLL mode, the DECS-450 matches the voltage, phase angle, and frequency of the generator with the bus and then connects the generator to the bus by closing the generator breaker. In anticipatory mode, the DECS-450 drives the generator frequency close to the bus frequency and closes the breaker at a phase angle of zero by compensating for the breaker closing time. Breaker closing time is the delay between the issuance of a breaker close command and closure of the breaker contacts. The DECS-450 compensates for the breaker closing time by monitoring the slip frequency between the generator and bus and calculating the advance phase angle required to close the breaker at a zero-degree phase angle.

#### Frequency Correction

The Slip Frequency setting establishes the maximum slip allowed for breaker closure. When the measured slip frequency is less than the value of the Min Slip Control Limit setting, the error output is set to zero. When the measured slip frequency is between the values of the Max Slip Control Limit and Min Slip Control Limit settings, the error output is proportional to the difference between the measured slip frequency and the value of the Min Slip Control Limit setting with the opposite polarity. When the measured slip frequency is greater than the value of the Max Slip Control Limit setting, the error output is set to maximum with the opposite polarity.

To minimize the impact on the bus during synchronization, the generator frequency can be forced to exceed the bus frequency at the moment of breaker closure. If this is the case, the DECS-450 will drive the generator frequency higher than the bus frequency before closing the breaker. The breaker closing angle setting defines the maximum allowable phase angle difference between the generator and bus. To close the breaker, the slip angle must remain less than the value of this setting for the duration of the sync activation delay.

The Min Slip Control Limit, Max Slip Control Limit, and Breaker Closing Angle settings are used only in the PLL mode.

#### Voltage Correction

Voltage correction is initiated when the generator voltage is outside the defined voltage window. The voltage window setting is expressed as a percentage of the bus voltage and determines the band of generator voltage surrounding the bus voltage where breaker closure will be considered. Enabling the Vgen>Vbus setting causes the DECS-450 to drive the generator voltage higher than the bus voltage prior to synchronizing. A generator to bus PT matching level setting is provided to compensate for step-up or step-down transformers in the system. The DECS-450 adjusts the sensed bus voltage by this percentage. This setting also appears on the Voltage Matching screen, below. When the value is changed, it is reflected in both places.

## Angle Compensation

An angle compensation setting is provided to offset phase shift caused by transformers in the system. The angle compensation value is added only to the generator angle. For example, it is given that the generator and bus are synchronized but the DECS-450 metered slip angle reads  $-30^\circ$ . Equation 5-1, below, illustrates the DECS-450 slip angle calculation. This means that the generator angle is lagging behind the bus angle by  $30^\circ$  due to transformer phase shift. To compensate for this phase shift, the angle compensation setting should contain a value of  $30^\circ$ . This value is added to the metered bus angle resulting in an adjusted slip angle of zero degrees. Only the metered bus angle is affected by the angle compensation setting, the metered generator angle is not biased by the DECS-450.

$$G - B + A = \text{Slip Angle}$$

**Equation 5-1. DECS-450 Metered Slip Angle**

Where:

- G = metered generator angle
- B = metered bus angle
- A = angle compensation value

## Gen to Bus PT Match Level

A generator to bus PT matching level setting is provided to compensate for step-up or step-down transformers in the system. The DECS-450 adjusts the sensed bus voltage by this percentage. This setting also appears on the Voltage Matching screen, below. When the value is changed, it is reflected in both places. To calculate the appropriate Gen to Bus PT Match Level value, refer to Equation 5-2.

$$\left( \frac{\text{Gen Primary}}{\text{Bus Primary}} \right) \times 100 = \text{Gen to Bus PT Match Level (\%)} \text{ Setting}$$

**Equation 5-2. Gen to Bus PT Match Level Calculation**

## Failure of Synchronization

Generator synchronization is aborted if it fails to occur within a timeframe established by the user.

When generator voltage rotation does not match bus voltage rotation a Phase Rotation Mismatch alarm is annunciated and generator synchronization is aborted.

BESTCOMSPi<sup>us</sup>® generator synchronization settings are illustrated in Figure 5-1.

| Synchronizer  |   | Note                                  |   |
|---|---|---------------------------------------|---|
| Synchronizer<br>Enabled <input type="checkbox"/>      | Fgen > Fbus<br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable | Sync Activation Delay (s)<br>0.1      | If the Automatic Synchronizer is enabled, the Sync Check (25) element is Disabled |
| Sync Type<br>Phase Lock Loop <input type="checkbox"/> | Vgen > Vbus<br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable | Sync Fail Activation Delay (s)<br>5.0 |   |
| Slip Frequency (Hz)<br>0.30                           | Angle Compensation (°)<br>0.0   |                                       |   |
| Min Slip Control Limit (Hz)<br>0.00                   | Gen to Bus PT Match Level (%)<br>100.000  |                                       |   |
| Max Slip Control Limit (Hz)<br>0.30                   |   |                                       |   |
| Voltage Window (%)<br>2.0                             |   |                                       |   |
| Breaker Closing Angle (°)<br>10.0                     |   |                                       |   |

**Figure 5-1. Generator Synchronizer Settings**

## Voltage Matching

**BESTCOMSPlus Navigation Path:** Settings Explorer, Synchronizer/Voltage Matching, Voltage Matching

**HMI Navigation Path:** Settings, Sync/Voltage Matching, Voltage Matching

When enabled, voltage matching is active in AVR control mode and automatically adjusts the AVR mode setpoint to match the sensed bus voltage. Voltage matching is based on two parameters: band and matching level.

The voltage matching band defines how close in magnitude generator and bus voltage must be to each other for voltage matching to be active. The band level setting is a percentage of rated generator voltage.

A generator to bus PT matching level setting is provided to compensate for error between generator and bus PTs in the system. The DECS-450 adjusts the sensed bus voltage by this percentage. This setting also appears on the Synchronizer screen, above. When the value is changed, it is reflected in both places. To calculate the appropriate Gen to Bus PT Match Level value, refer to Equation 5-2.

Voltage matching settings are illustrated in Figure 5-2.

Figure 5-2. Voltage Matching Settings

## Breaker Hardware Configuration

**BESTCOMSPlus Navigation Path:** Settings Explorer, Synchronizer/Voltage Matching, Breaker Hardware

**HMI Navigation Path:** Settings, Sync/Voltage Matching, Breaker Hardware

The DECS-450 can control and monitor a generator breaker. Breaker hardware settings are illustrated in Figure 5-3.

### Breaker Failure

When a close command is issued to the breaker, the DECS-450 monitors the breaker status and annunciates a breaker failure if the breaker does not close within the time defined by the breaker close wait delay. Typically, the wait delay is set to be longer than the actual breaker closing time.

### Generator Breaker

The DECS-450 must be configured with the generator breaker characteristics before the breaker can be controlled by the DECS-450. Breakers controlled by pulse or continuous control inputs are supported. During anticipatory-mode synchronization, if the generator breaker is serving to tie the generator to the bus, the DECS-450 uses the breaker closing time to calculate the optimum time to close the breaker. For a pulse-controlled generator breaker, the breaker open and close pulse times are used by the DECS-450 when issuing open and close commands to the breaker. When setting the pulse times, the open and close times should be set at or longer than the breaker closing time setting.

If desired, breaker closure is possible during a dead bus condition and/or dead generator condition.

### Caution

Use caution when connecting a dead generator to a dead bus. Undesired system damage can occur if the bus becomes energized while connected to a dead generator.

Figure 5-3. Breaker Hardware Configuration Settings

## Generator and Bus Condition Detection

**BESTCOMSPlus Navigation Path:** Settings Explorer, Synchronizer/Voltage Matching, Bus Condition Detection

**HMI Navigation Path:** Settings, Sync/Voltage Matching, Bus Condition

The DECS-450 monitors the voltage and frequency of the generator and bus for determining when a breaker closure is appropriate. Generator and bus condition detection settings are illustrated in Figure 5-4.

### Generator Condition

A dead generator is recognized by the DECS-450 when the generator voltage decreases below the dead generator threshold for the duration of the dead generator activation delay.

A failed generator is recognized when the generator voltage or frequency does not meet the established generator stability criteria for the duration of the failed generator activation delay. Generator stability parameters are described in *Generator Stability*.

### Generator Stability

Before initiating a breaker closure (tying the generator to a stable or dead bus), the generator voltage must be stable. Several settings are used to determine generator stability. These settings include pickup and dropout levels for overvoltage, undervoltage, overfrequency, and under-frequency. Recognition of generator stability is further controlled by a generator stability activation delay. Breaker closure is not considered if the voltage conditions are not within the stability pickup and dropout settings for the duration of the stability activation delay.

### Bus Condition

A dead bus is recognized by the DECS-450 when the bus voltage decreases below the dead bus threshold for the duration of the dead bus activation delay.

A failed bus is recognized when the bus voltage or frequency does not meet the established stability criteria for the duration of the failed bus activation delay. Bus stability parameters are described in *Bus Stability*.

## Bus Stability

Before initiating a breaker closure (tying the generator to a live bus), the bus voltage must be stable. Several settings are used to determine bus stability. These settings include pickup and dropout levels for overvoltage, undervoltage, overfrequency, and underfrequency. Recognition of bus stability is further controlled by a bus stability activation delay. Breaker closure is not considered if the voltage conditions are not within the stability pickup and dropout settings for the duration of the stability activation delay.

### Bus Condition Detection

#### Generator Sensing

##### Generator Condition

|   |                                  |
|---|----------------------------------|
| Dead Gen Threshold                          | Dead Gen Activation Delay (s)    |
| <input type="text" value="30"/> Primary V   | <input type="text" value="0.1"/> |
| <input type="text" value="0.250"/> Per Unit |                                  |

Gen Failed Activation Delay (s)

#### Generator Stable

|   |   |   |   |
|---|---|---|---|
| <b>Overvoltage Settings</b>                 |   | <b>Undervoltage Settings</b>                |   |
| Pickup (V L-L)                              | Dropout                                     | Pickup (V L-L)                              | Dropout                                     |
| <input type="text" value="130"/> Primary V  | <input type="text" value="127"/> Primary V  | <input type="text" value="115"/> Primary V  | <input type="text" value="117"/> Primary V  |
| <input type="text" value="1.083"/> Per Unit | <input type="text" value="1.058"/> Per Unit | <input type="text" value="0.958"/> Per Unit | <input type="text" value="0.975"/> Per Unit |
| <b>Overfrequency Settings</b>               |   | <b>Underfrequency Settings</b>              |   |
| Pickup (Hz)                                 | Dropout (Hz)                                | Pickup (Hz)                                 | Dropout (Hz)                                |
| <input type="text" value="62.00"/>          | <input type="text" value="61.80"/>          | <input type="text" value="58.00"/>          | <input type="text" value="58.20"/>          |

Gen Stable Activation Delay (s)

#### Bus Sensing

##### Bus Condition Settings

|   |                                  |
|---|----------------------------------|
| Dead Bus Threshold                          | Dead Bus Activation Delay (s)    |
| <input type="text" value="30"/> Primary V   | <input type="text" value="0.1"/> |
| <input type="text" value="0.250"/> Per Unit |                                  |

Bus Failed Activation Delay (s)

#### Bus Stable

|   |   |   |   |
|---|---|---|---|
| <b>Overvoltage Settings</b>                 |   | <b>Undervoltage Settings</b>                |   |
| Pickup (V L-L)                              | Dropout                                     | Pickup (V L-L)                              | Dropout                                     |
| <input type="text" value="130"/> Primary V  | <input type="text" value="127"/> Primary V  | <input type="text" value="115"/> Primary V  | <input type="text" value="117"/> Primary V  |
| <input type="text" value="1.083"/> Per Unit | <input type="text" value="1.058"/> Per Unit | <input type="text" value="0.958"/> Per Unit | <input type="text" value="0.975"/> Per Unit |
| <b>Overfrequency Settings</b>               |   | <b>Underfrequency Settings</b>              |   |
| Pickup (Hz)                                 | Dropout (Hz)                                | Pickup (Hz)                                 | Dropout (Hz)                                |
| <input type="text" value="62.00"/>          | <input type="text" value="61.80"/>          | <input type="text" value="58.00"/>          | <input type="text" value="58.20"/>          |

Bus Stable Activation Delay (s)

Figure 5-4. Generator and Bus Condition Detection Settings

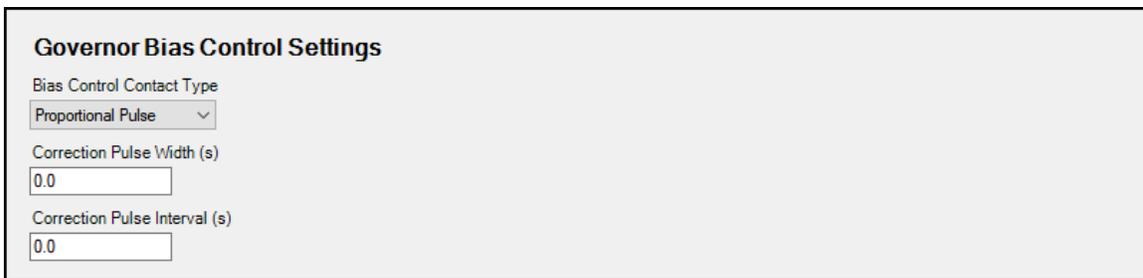
## Generator Governor Control

**BESTCOMSPlus Navigation Path:** Settings Explorer, Synchronizer/Voltage Matching, Governor Bias Control Settings

**HMI Navigation Path:** Settings, Sync/Voltage Matching, Governor Bias Control

During synchronization, the DECS-450 adjusts the generator voltage and frequency by issuing speed correction signals to the speed governor. Correction signals are issued in the form of DECS-450 output contact closures. These correction signals may be either continuous, fixed, or proportional. When fixed correction is selected, the correction pulses and intervals are determined by the Correction Pulse Width and Correction Pulse Interval settings respectively. When proportional correction is selected, the correction pulse width varies in proportion to the error and the intervals are determined by the Correction Pulse Interval setting. Initially, long pulses are issued when the frequency difference between the generator and bus is large. As the correction pulses take effect and the frequency difference becomes smaller, the correction pulse widths are proportionally decreased.

Governor bias control settings are illustrated in Figure 5-5.



The screenshot shows a control panel titled "Governor Bias Control Settings". It contains three main settings:

- Bias Control Contact Type:** A dropdown menu currently set to "Proportional Pulse".
- Correction Pulse Width (s):** A text input field containing the value "0.0".
- Correction Pulse Interval (s):** A text input field containing the value "0.0".

**Figure 5-5. Generator Governor Control Settings**

## 6 • Regulation

The DECS-450 provides a control signal to a power amplifier (typically a firing circuit and rectifier bridge) and adjusts the control signal as needed to achieve precise regulation of the controlled parameter such as terminal voltage, field current, field voltage, reactive power or power factor. Stable regulation is enhanced by the automatic tracking of the active-mode setpoint by the inactive regulation modes. Pre-position setpoints within each regulation mode enable the DECS-450 to be configured for multiple system and application needs.

### ***Per Unit Settings***

---

Some BESTCOMSP<sup>Plus</sup>® settings provide fields for primary and per unit values. When one of these fields is edited, BESTCOMSP<sup>Plus</sup> automatically recalculates the other field based on the new value and the associated rated data (on the System Parameters, Rated Data screen).

If the Rated Data parameters are changed after all per unit values are assigned, BESTCOMSP<sup>Plus</sup> automatically recalculates all actual unit settings.

### ***Regulation Modes***

---

**BESTCOMSP<sup>Plus</sup> Navigation Path:** Settings Explorer, Operating Settings, AVR/FCR/FVR and VAR/PF  
**HMI Navigation Path:** Settings, Operating Settings, AVR/FCR/FVR Setpoints and VAR/PF Setpoints

The DECS-450 provides five regulation modes: Automatic Voltage Regulation (AVR), Field Current Regulation (FCR), Field Voltage Regulation (FVR), var, and Power Factor (PF).

#### **AVR**

When operating in AVR (Automatic Voltage Regulation) mode, the DECS-450 regulates the excitation level in order to maintain the generator terminal voltage setpoint in response to changes in load and operating conditions. AVR setpoint (or operating point) adjustment is made through:

- Application of contacts at DECS-450 contact inputs configured for raising and lowering the active setpoint
- Application of an analog control signal at the DECS-450 Auxiliary Control input.
- The BESTCOMSP<sup>Plus</sup>® Control Panel screen (available in the BESTCOMSP<sup>Plus</sup> Metering Explorer)
- A raise or lower command transmitted through a DECS-450 CAN bus or Modbus port

The range of adjustment is defined by Minimum and Maximum settings that are expressed as a percentage of the rated generator voltage. The length of time required to adjust the AVR setpoint from one limit to the other is controlled by a Traverse Rate setting.

The AVR setpoint has an actual unit of Primary Volts and the rated data associated with it is Machine Rated Data, Voltage (on the System Parameters, Rated Data screen).

These settings are illustrated in Figure 6-1.

#### **FCR**

When operating in FCR (Field Current Regulation) mode, the DECS-450 regulates the level of current supplied to the field based on the FCR setpoint. The setting range of the FCR setpoint depends on the field rated data and other associated settings. FCR setpoint adjustment is made through:

- Application of contacts at DECS-450 contact inputs configured for raising and lowering the active setpoint
- Application of an analog control signal at the DECS-450 Auxiliary Control input
- The BESTCOMSP<sup>Plus</sup>® Control Panel screen (available in the BESTCOMSP<sup>Plus</sup> Metering Explorer)
- A raise or lower command transmitted through a DECS-450 CAN bus or Modbus port

The range of adjustment is defined by Minimum and Maximum settings that are expressed as a percentage of the rated field current. The length of time required to adjust the FCR setpoint from one limit to the other is controlled by a Traverse Rate setting.

The FCR setpoint has a native unit of Primary Amps and the rated data associated with it is Field Rated Data, Current – Full Load (on the System Parameters, Rated Data screen).

These settings are illustrated in Figure 6-1.

## FVR

FVR (Field Voltage Regulation) mode enables generator modeling and validation testing in accordance with WECC testing requirements. FVR mode can also be used in synchronous motor applications.

When operating in FVR mode, the DECS-450 regulates the level of field voltage supplied to the field based on the FVR setpoint. The setting range of the FVR setpoint depends on the field rated data and other associated settings. FVR setpoint adjustment is made through:

- Application of contacts at DECS-450 contact inputs configured for raising and lowering the active setpoint
- Application of an analog control signal at the DECS-450 auxiliary Control input
- The BESTCOM*Plus* Control Panel screen (available in the BESTCOM*Plus* Metering Explorer)
- A raise or lower command transmitted through a DECS-450 CAN bus or Modbus port

The range of adjustment is defined by Minimum and Maximum settings that are expressed as a percentage of the rated field voltage. The length of time required to adjust the FVR setpoint from one limit to the other is controlled by a Traverse Rate setting.

The FVR setpoint has a native unit of Primary Volts and the rated data associated with it is Field Rated Data, Voltage – Full Load (on the System Parameters, Rated Data screen).

These settings are illustrated in Figure 6-1.

| Parameter               | AVR (Automatic Voltage Regulator) | FCR (Field Current Regulator) | FVR (Field Voltage Regulator) |
|-------------------------|-----------------------------------|-------------------------------|-------------------------------|
| Setpoint                | 120.0 Primary V                   | 0.10 Primary A                | 10.00 Primary V               |
| Per Unit                | 1.000                             | 0.010 (Full Load)             | 0.159 (Full Load)             |
| Min (% of rated)        | 70.0                              | 0.0                           | 0.0                           |
| Max (% of rated)        | 120.0                             | 120.0                         | 150.0                         |
| Traverse Rate (s)       | 20                                | 20                            | 20                            |
| Pre-position 1 Setpoint |                                   |                               |                               |

Figure 6-1. AVR, FCR, and FVR Regulation Settings

## Var

When operating in var mode, the DECS-450 regulates the reactive power (var) output of the generator based on the var setpoint. The setting range of the var setpoint depends on the generator ratings and other associated settings. Var setpoint adjustment is made through:

- Application of contacts at DECS-450 contact inputs configured for raising and lowering the active setpoint
- Application of an analog control signal at the DECS-450 Auxiliary Control input
- The BESTCOM*Plus* Control Panel screen (available in the BESTCOM*Plus* Metering Explorer)
- A raise or lower command transmitted through a DECS-450 CAN bus or Modbus port

The range of adjustment is defined by Minimum and Maximum settings that are expressed as a percentage of the generator rated kVA output. The length of time required to adjust the Var setpoint from one limit to the other is controlled by a Traverse Rate setting. A Fine Voltage Adjustment Band setting defines the upper and lower boundaries of voltage correction when operating in var or power factor regulation modes.

The Reactive Power Control setpoint has a native unit of Primary kvar and the rated data associated with it is Machine Rated Data, Rating (kVA) (on the System Parameters, Rated Data screen).

Var mode settings are illustrated in Figure 6-2.

## Power Factor

When operating in Power Factor (PF) mode, the DECS-450 controls the var output of the generator to maintain the Power Factor setpoint as the kW load on the generator varies. The setting range of the PF setpoint is determined by the PF – Leading and PF – Lagging settings. The length of time required to adjust the PF setpoint from one limit to the other is controlled by a Traverse Rate setting. A Fine Voltage Adjustment Band setting defines the upper and lower boundaries of voltage correction when the DECS-450 is operating in Var or Power Factor regulation modes. PF Active Power Level establishes the level of generator output power (kW) where the DECS-450 switches to/from Droop Compensation/Power Factor mode. If the level of power decreases below the setting, the DECS-450 switches from Power Factor mode to Droop Compensation mode. Conversely, as the level of power increases above the setting, the DECS-450 switches from Droop Compensation mode to Power Factor mode.

Power Factor mode settings are illustrated in Figure 6-2.

The screenshot displays the 'var/PF Setpoints' configuration interface, which is organized into three main columns of settings:

- Fine Voltage Adjustment Band:**
  - Fine Voltage Adjustment Band (%): 20.00
  - PF Active Power Level (%): 0.0
- Reactive Power Control (var):**
  - Setpoint: 0.0 Primary kvar
  - 0.000 Per Unit
  - Min (% of rated): 0.0
  - Max (% of rated): 100.0
  - Traverse Rate (s): 20
  - Pre-position 1 Setpoint: 1.000
- Power Factor Control (PF):**
  - Setpoint: 1.000
  - PF - Leading: -0.800
  - PF - Lagging: 0.800
  - Traverse Rate (s): 20
  - Pre-position 1 Setpoint: 1.000

Figure 6-2. Var and Power Factor Regulation Settings

## Pre-Position Setpoints

Each regulation mode has three pre-position setpoints that allow the DECS-450 to be configured for multiple system and application needs. Each pre-position setpoint is associated with a programmable logic element in BESTlogicPlus. When a pre-position logic element receives a true input, the setpoint is driven to the corresponding pre-position value.

Each pre-position function has three settings: Setpoint, Traverse Rate, and Mode. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint. The Traverse Rate setting establishes the time it takes to adjust from one end of the full setpoint range to the other (Min to Max). To determine the actual traverse rate, divide 100% by the traverse rate value. For example, a Traverse Rate setting of 8 seconds, results in a 12.5% per second traverse rate ( $100\% / 8s = 12.5\%/s$ ). This rate is used when adjusting from the current setpoint to the pre-position setpoint. A Traverse Rate setting of zero implements an instantaneous step.

## Mode

The Mode setting determines whether or not the DECS-450 will respond to further setpoint change commands while the pre-position command is being asserted.

If the pre-position mode is Release, setpoint change commands are accepted to raise and lower the setpoint while the pre-position command is being asserted. Additionally, if the inactive pre-position mode is Release and internal tracking is enabled, the pre-position value will respond to the tracking function.

If the pre-position mode is Maintain, further setpoint change commands will be ignored or granted based on priority while the appropriate contact input is closed. Pre-position 3 has the highest priority and pre-position 1 has the lowest priority. For example, if pre-position 1 (maintaining) is active and pre-position 3 closes, the setpoint will change to pre-position 3. However, if pre-position 2 (maintaining) is active and pre-position 1 closes, the setpoint will not change because pre-position 2 is a higher priority than pre-position 1. Additionally, if the inactive pre-position mode is Maintain and internal tracking is enabled, the inactive mode will maintain the inactive setpoint at the pre-position value and override the tracking function.

A portion of the pre-position setpoints for AVR, FCR, and FVR modes are illustrated in Figure 6-3. (Pre-Position Setpoints for var and PF modes are similar and not shown here.)

Figure 6-3. Pre-Position Setpoints

## Inner Loop Field Regulator

This setting (Figure 6-4) enables the inner control loop of the field regulator for compensation of the exciter gains and time constants. When the inner control loop is enabled, the regulator response depends upon the AVR gains and inner loop gains. Inner loop gains are selected on the Operating Settings, Gain, Inner Loop Field Regulator screen. See the *Stability Tuning* section in this manual for more information on inner loop gain settings.

Figure 6-4. Inner Loop Field Regulator

## Transient Boost

The transient excitation boosting function improves response to successive faults by providing increased excitation support. When a simultaneous line current increase and line voltage decrease occurs, the DECS-450 compensates by elevating the voltage setpoint above the nominal setpoint. When the line voltage recovers, the voltage setpoint is restored to the nominal value.

Fault detection is controlled by a voltage threshold setting, a current threshold setting, and a minimum duration setting. Fault voltage threshold is expressed as a percentage of the AVR setpoint and fault current threshold is expressed as a percentage of the rated generator current. The duration setting determines how long a fault condition is tolerated before the setpoint is adjusted.

Setpoint adjustment is controlled by a voltage setpoint boosting level, a clearing voltage threshold, and a clearing voltage delay. The setpoint boosting level is expressed as a percentage above the AVR setpoint. Transient boost is disabled once the line voltage recovers above the clearing voltage threshold. The clearing voltage threshold is expressed as a percentage above the AVR setpoint. The clearing voltage delay determines how long the line voltage must exceed the clearing voltage threshold before setpoint adjustment is terminated.

Figure 6-5. Transient Boost Settings

## Operation with Paralleled Generators

**BESTCOMSPlus Navigation Path:** Settings Explorer, Operating Settings, Parallel Compensation

**HMI Navigation Path:** Settings, Operating Settings, Parallel Compensation

The DECS-450 provides several functions for load sharing among paralleled generators: reactive droop compensation, line drop compensation, cross-current compensation, and network load sharing. The DECS-450 can employ either droop compensation or cross-current compensation (reactive differential) schemes for reactive load sharing. A separate load sharing function enables each machine to share the load proportionally without incurring a voltage and frequency droop.

Paralleled generator settings are illustrated in Figure 6-6 and described in the following paragraphs.

### Reactive Droop Compensation

Droop compensation serves as a method of controlling reactive current when the generator is connected in parallel with another energy source. When droop compensation is enabled, the generator voltage is adjusted in proportion to the measured generator reactive power. The reactive droop compensation setting is expressed as a percentage of the generator rated terminal voltage.

#### Note

For droop compensation to operate, the PARALLEL\_ENABLE\_LM logic block must be set true in BESTlogic™ Plus programmable logic.

### Cross-Current Compensation

Cross-current compensation (reactive differential) mode serves as a method of connecting multiple generators in parallel to share reactive load. When reactive load is shared properly, no current is fed into the DECS-450 cross-current compensation input (which is connected to the B-phase transformer). Unbalanced sharing of reactive load causes a differential current to be fed into the cross-current

compensation input. When cross-current compensation is enabled, this input causes the DECS-450 to respond with the proper level of regulation. The response of the DECS-450 is controlled by the cross-current compensation gain setting which is expressed as a percentage of the system nominal CT setting.

Application information about cross-current compensation is available in the *Voltage and Current Sensing* section of this manual.

## Network Load Sharing

In a multiple-generator application, the Network Load Sharing function ensures equal generator reactive-power sharing. It operates in a similar manner to cross-current compensation but without the external hardware requirements and distance limitations. Instead of sharing load based on the CT ratio, load is shared on a per-unit basis calculated from the generator rated data. Sharing of load information between DECS-450 controllers is accomplished through the Ethernet port of each DECS-450 communicating over a peer-to-peer network dedicated for the load sharing function. Each DECS-450 measures the reactive current of its associated generator and broadcasts its measurement to all other DECS-450 controllers on the network. Each DECS-450 compares its level of reactive current to the sum of all measured currents and adjusts its excitation level accordingly.

A Load Share ID setting identifies the DECS-450 as a load sharing unit in the network. Checking a Load Sharing Unit number box allows any DECS-450 load sharing units on the network with that Load Share ID number to share load with the currently connected DECS-450. It is not necessary for the Load Share ID to be unique for each unit. This allows for load sharing units to be grouped.

When the unit's configuration does not match the configuration of the other units with load sharing enabled, the Network Load Share Config Mismatch logic element becomes true. The Configuration Mismatch Delay setting adds a delay before the element becomes true.

Load sharing settings consist of an Enable checkbox and Droop, Kg, Ki, Max Vc, Configuration Mismatch Delay, and Load Share ID settings.

## Line Drop Compensation

When enabled, line drop compensation can be used to maintain voltage at a load located at a distance from the generator. The DECS-450 achieves this by measuring the line current and calculating the voltage for a specific point on the line. Line drop compensation is applied to both the real and reactive portion of the generator line current. It is expressed as a percentage of the generator terminal voltage.

Equation 6-1 is used to calculate the Line Drop Value.

$$LD_{Value} = \sqrt{\left(V_{avg} - \left[LD \times I_{avg} \times \cos\left(I_{bang}\right)\right]\right)^2 + \left(LD \times I_{avg} \times \sin\left(I_{bang}\right)\right)^2}$$

**Equation 6-1. Line Drop Value**

|                     |   |  |
|---------------------|---|--|
| LD <sub>Value</sub> | = | Line drop value (per unit)                 |
| V <sub>avg</sub>    | = | Average voltage, metered value (per unit)  |
| LD                  | = | Line Drop % / 100                          |
| I <sub>avg</sub>    | = | Average Current, metered value (per unit)  |
| I <sub>bang</sub>   | = | Angle of phase B current (no compensation) |

The LD<sub>Value</sub> is the per-unit value seen down the line from the synchronous machine. Equation 6-2 is used to determine the voltage needed to adjust for line drop.

$$V_{adjust,PU} = V_{rms,PU} - LD_{Value}$$

**Equation 6-2. Voltage Needed to Adjust for Line Drop**

Equation 6-3 is used to obtain primary units.

$$V_{adjust} = V_{adjust,PU} \times V_{rated}$$

**Equation 6-3. Obtain Primary Units**

The new line drop adjusted setpoint is calculated using Equation 6-4.

$$V_{Adjusted\ Setpoint} = V_{Setpoint} + V_{adjust}$$

**Equation 6-4. Line Drop Adjusted Setpoint**

Refer to Figure 6-6 for an illustration of the Line drop compensation settings.

### Parallel Compensation

**Droop Compensation**

Droop Compensation

Reactive Droop Compensation (% of rated)

**Line Drop Compensation**

Line Drop Compensation

Line Drop Compensation (% of rated)

**Cross Current Compensation**

Cross Current Compensation

Cross Current Compensation Gain (% of rated)

**Network Load Share**

Network Load Share

|  |   |  |
|--|---|--|
| Droop (%)<br><input type="text" value="0.0"/>                        | Load Sharing Unit 1<br><input type="text" value="Enabled"/> | Load Sharing Unit 9<br><input type="text" value="Enabled"/>  |
| Kg<br><input type="text" value="0.00"/>                              | Load Sharing Unit 2<br><input type="text" value="Enabled"/> | Load Sharing Unit 10<br><input type="text" value="Enabled"/> |
| Ki<br><input type="text" value="0.00"/>                              | Load Sharing Unit 3<br><input type="text" value="Enabled"/> | Load Sharing Unit 11<br><input type="text" value="Enabled"/> |
| Max Vc<br><input type="text" value="0.05"/>                          | Load Sharing Unit 4<br><input type="text" value="Enabled"/> | Load Sharing Unit 12<br><input type="text" value="Enabled"/> |
| Configuration Mismatch Delay (s)<br><input type="text" value="0.5"/> | Load Sharing Unit 5<br><input type="text" value="Enabled"/> | Load Sharing Unit 13<br><input type="text" value="Enabled"/> |
| Load Share ID<br><input type="text" value="1"/>                      | Load Sharing Unit 6<br><input type="text" value="Enabled"/> | Load Sharing Unit 14<br><input type="text" value="Enabled"/> |
|  | Load Sharing Unit 7<br><input type="text" value="Enabled"/> | Load Sharing Unit 15<br><input type="text" value="Enabled"/> |
|  | Load Sharing Unit 8<br><input type="text" value="Enabled"/> | Load Sharing Unit 16<br><input type="text" value="Enabled"/> |

**Figure 6-6. Paralleled Generators and Line Drop Compensation Settings**

## Autotracking

**BESTCOMSPi+ Navigation Path:** Settings Explorer, Operating Settings, Autotracking

**HMI Navigation Path:** Settings, Operating Settings, Autotracking

Internal and external regulation mode setpoint tracking are standard features on the DECS-450. Autotracking settings are illustrated in Figure 6-7.

### Internal Setpoint Tracking

In applications using a single DECS-450, internal tracking can be enabled so that the inactive regulation modes continuously track the active regulation mode.

The following examples demonstrate the advantages of internal tracking:

- If the excitation system is operating online with internal tracking enabled, a loss of sensing condition could trigger a transfer to FCR mode.
- While performing routine testing of the DECS-450 in backup mode, the internal tracking feature allows a transfer to an inactive mode that will result in no disturbance to the system.

Two parameters control the behavior of internal tracking: Delay and Traverse Rate. When a large system disturbance is detected, the non-active mode setpoints do not track to the new setpoint until after the time delay has expired. A traverse rate setting establishes the length of time it takes for the inactive mode setpoints to traverse the full setting range of the active mode setpoint.

### External Setpoint Tracking

For critical applications, a second DECS-450 can provide backup excitation control. The DECS-450 provides excitation redundancy with its external tracking and transfer provisions between DECS-450 controllers. The secondary DECS-450 can be configured to track the primary DECS-450 setpoint. Proper redundant excitation system design allows for removal of the failed system.

#### Note

Periodic testing of the backup system must be performed to ensure that it is operational and can be placed in service without warning.

Like internal tracking, external setpoint tracking uses enable/disable, delay, and traverse rate settings.

The screenshot displays the 'Autotracking' settings interface. It is divided into two main sections: 'Internal Tracking' and 'External Tracking (Secondary DECS)'. Each section contains a dropdown menu for the tracking status (both set to 'Enabled'), a text input field for 'Delay (s)' (both set to '0.1'), and another text input field for 'Traverse Rate (s)' (both set to '20.0').

Figure 6-7. Autotracking Settings

## Setpoint Configure

---

When Auto Save is enabled, the DECS-450 automatically saves the active setpoint in 10-minute intervals. Otherwise, the last setpoint sent to the DECS-450 is retained. Figure 6-8 illustrates the Setpoint Configure screen.

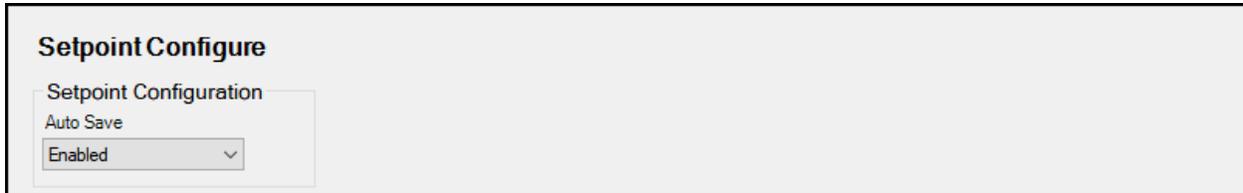


Figure 6-8. Setpoint Configure Setting



# 7 • Auxiliary Control

**BESTCOMSPlus® Navigation Path:** Settings Explorer, Operating Settings, Auxiliary Input

**HMI Navigation Path:** Settings, Operating Settings, Auxiliary Input

The DECS-450 accepts an external analog control signal for auxiliary control of the regulation setpoint (in all modes), limiter scaling, or power system stabilizer. A No Control mode provides auxiliary input metering only. Auxiliary control settings are illustrated in Figure 7-1.

## ***Auxiliary Control Input Type***

---

Either a voltage or current control signal may be used for auxiliary control. Terminals I+ and I– accept a 4 to 20 mA<sub>dc</sub> signal. Terminals V+ and V– accept a –10 to +10 V<sub>dc</sub> signal. An adjacent terminal labeled GND provides the connection for a recommended cable shield.

## ***Auxiliary Control Input Function***

---

The auxiliary input can be used to bias the regulation setpoint, as a power system stabilizer test input, for limiter scaling, or for metering only.

When using the current auxiliary input, the DECS-450 responds to out-of-range inputs in the following ways. If the applied signal decreases below 2 mA<sub>dc</sub>, the DECS-450 assumes the bias signal has been lost and reverts to an unbiased state. An applied current that exceeds 20 mA<sub>dc</sub> is interpreted as full bias.

### **DECS-450 Input**

When the auxiliary input is used for auxiliary control of the regulation setpoint, it provides a bias signal to the regulator, shifting the regulation setpoint. The setpoint shown in BESTCOMSPlus® or communicated via CAN Bus, Modbus®, or PROFIBUS will not reflect the bias contribution of the auxiliary input. The displayed setpoint will remain at the same level as if there is zero auxiliary input applied.

#### Setpoint Limits

Minimum and maximum setpoint limits are observed regardless of auxiliary input level when the “With Limit” setting is enabled.

### **PSS Test Input**

The auxiliary input can be used as a test input for the optional power system stabilizer function during testing and validation. More information is provided in the *Power System Stabilizer* section of this manual.

### **Limiter Scaling**

When the auxiliary input is configured for limiter scaling, the stator current limiter (SCL) and overexcitation limiter (OEL) low-level values can be automatically adjusted. Automatic adjustment of the SCL and OEL is based on six parameters: signal and scale for three points. The signal value for each point represents the accessory input voltage. The scale value defines the limiter low level as a percentage of rated full load field current for the OEL and rated stator current for the SCL. For accessory input voltages between two of the three defined points, the low-level limiter setting is linearly adjusted between the two scale values. Limiter settings and limiter scaling are discussed in detail in the *Limiters* section of this manual.

### **No Control**

A No Control mode provides auxiliary input metering only. In this mode, the input signal controls no functions, but it retains all monitoring, scaling, and labeling features of the other modes.

## Auxiliary Control Gains

When a current input type is selected, the input current is converted internally by the DECS-450 into a voltage signal in the range of –10 to +10 Vdc. The DECS-450 uses Equation 7-1 when converting the applied current into a voltage.

$$V_{aux} = (I_{aux} - 0.004) \times \left( \frac{20.0}{0.016} \right) - 10.0$$

### Equation 7-1. Input Current to Voltage Signal Conversion

Where:  $V_{aux}$  is the calculated voltage signal and  $I_{aux}$  is the applied current in amperes.

For setpoint control,  $V_{aux}$  is multiplied by the appropriate regulation mode auxiliary gain setting.

If the auxiliary input is unused, all auxiliary control gains should be set to zero.

If the auxiliary input is actively biasing an inactive mode's regulation setpoint while internal tracking is enabled, then internal tracking will allow a transfer to the inactive mode with no disturbance to the system. This may limit the effective range of the auxiliary control input.

The following example demonstrates how the effective range of the auxiliary input could be limited:

- If the excitation system is operating in FCR mode while the AVR mode's setpoint is being biased by a +1 Vdc signal to the auxiliary input, when a transfer to AVR mode is triggered, there would be no change in generator voltage if internal tracking is enabled. However, the auxiliary input would still be at +1 Vdc regardless of generator voltage magnitude. This leaves an effective adjustment range of 9 Vdc in the upward direction and 11 Vdc in the lower direction since the auxiliary input's range is –10 to +10 Vdc.

### AVR Mode

In AVR mode, the auxiliary control signal is multiplied by the AVR gain setting. The result defines the setpoint change as a percentage of the rated generator voltage.

$$\text{Generator Voltage Adjust} = V_{aux} \times 0.01 \times \text{AVR Gain} \times \text{Rated Voltage}$$

For example, applying +10 Vdc with an AVR gain of 1.0 raises the AVR setpoint 10% of rated generator voltage. This example also applies to the following modes.

### FCR Mode

In FCR mode, the auxiliary control signal is multiplied by the FCR gain setting. The resulting value relates to a percentage of the rated no load field current.

$$\text{FCR Adjust} = V_{aux} \times 0.01 \times \text{FCR Gain} \times \text{No Load Rated Field Current}$$

### FVR Mode

In FVR mode, the auxiliary control signal is multiplied by the FVR gain setting. The resulting value relates to a percentage of the rated no load field voltage.

$$\text{FVR Adjust} = V_{aux} \times 0.01 \times \text{FVR Gain} \times \text{No Load Rated Field Voltage}$$

### Var Mode

In var mode, the auxiliary control signal is multiplied by the Var gain setting. The resulting value relates to a percentage of the rated apparent power (kVA).

$$\text{var Adjust} = V_{aux} \times 0.01 \times \text{var Gain} \times 1.7321 \times \text{Rated Voltage} \times \text{Rated Current (Outerloop selected)}$$

### Power Factor Mode

In Power Factor mode, the auxiliary control signal is multiplied by the PF gain setting to define the PF setpoint change.

$PF\ Adjust = V_{aux} \times 0.01 \times PF\ Gain\ (Outerloop\ selected)$

## Summing Type

The auxiliary control signal can be configured to control the inner or outer regulation control loop. Selecting the inner loop limits auxiliary control to AVR, FCR, and FVR modes. Selecting the outer loop limits auxiliary control to PF and Var modes.

## No Control Settings

### Label Text

A customizable label is provided to identify the auxiliary input in metering.

### Ranges

Ranges must be set for the No Control input function. Param Min correlates to Min Input Current or Min Input Voltage and Param Max correlates to Max Input Current or Max Input Voltage.

| Auxiliary Input |                     |              |
|-----------------|---------------------|--------------|
| Input Type      | DECS Input Settings |              |
| Input Type      | AVR (Mode) Gain     | With Limit   |
| Voltage         | 0.00                | Disabled     |
| Input Function  | FCR (Mode) Gain     | Summing Type |
| DECS Input      | 0.00                | Inner Loop   |
|                 | FVR (Mode) Gain     |              |
|                 | 0.00                |              |
|                 | var (Mode) Gain     |              |
|                 | 0.00                |              |
|                 | PF (Mode) Gain      |              |
|                 | 0.00                |              |

| No Control Settings |                        |                       |
|---------------------|------------------------|-----------------------|
| Label Text          |                        |                       |
| Scaled              |                        |                       |
| Ranges              |                        |                       |
| Param Min           | Min Input Current (mA) | Min Input Voltage (V) |
| -2,000,000.000      | 4.0                    | -10.0                 |
| Param Max           | Max Input Current (mA) | Max Input Voltage (V) |
| 2,000,000.000       | 20.0                   | 10.0                  |

Figure 7-1. Auxiliary Input Settings



## 8 • Programmable Inputs and Outputs

Sixteen isolated contact sensing inputs (14 programmable, 2 fixed) are available for initiating DECS-450 actions. Twelve sets of output contacts provide annunciation and control. A dedicated Control Output provides analog control signals to a power amplifier. Four analog outputs provide meter driver signals and may be configured to represent DECS-450 metered values.

An analog input is provided for auxiliary control of the regulation setpoint, power system stabilizer test input, limiter scaling, or for metering only. Refer to the *Auxiliary Control* section in this manual for more information.

### Contact Inputs

**BESTCOMSPlus Navigation Path:** Settings Explorer, Programmable Inputs, Contact Inputs

**HMI Navigation Path:** Not available through HMI.

Sixteen contact inputs are provided for initiating DECS-450 actions. Two of the contact inputs are fixed-function inputs: Start and Stop. The remaining 14 contact inputs are programmable. An additional 10 contact inputs are available with the optional Contact Expansion Module (CEM-125 or CEM-2020). Contact Basler Electric for ordering information.

All DECS-450 contact inputs are compatible with dry relay/switch contacts or open-collector outputs from a PLC. Each contact input has an isolated interrogation voltage of 12 Vdc at 4 mAdc. Appropriate switches/contacts should be selected for operation with this signal level.

#### Note

The length of wiring connected to each contact input terminal must not exceed 150 feet (45.7 meters). Longer wiring lengths may allow induced electrical noise to interfere with the recognition of contact inputs.

### Start and Stop Inputs

The Start and Stop inputs accept a momentary contact closure that enables (Start) and disables (Stop) the DECS-450. If the DECS-450 receives Start and Stop contact inputs simultaneously, the Stop input takes priority. Start contact input connections are made at terminals START (pin 1) and COM (pin 2). Stop contact input connections are made at terminals STOP (pin 3) and COM (pin 4).

### Programmable Inputs

The 14 programmable inputs may be used to monitor the status of excitation system contacts and switches. Using BESTlogic™Plus programmable logic, the inputs may be configured to control and annunciate a variety of system conditions and contingencies. Information about using the programmable inputs in a logic scheme is provided in the *BESTlogic™Plus* section.

To make the programmable contact inputs easier to identify, customized labels may be assigned that relate to the inputs/functions of your system. Figure 8-1 shows a portion of the BESTCOMSPlus® Contact Inputs screen where each of the 14 inputs may be assigned a custom name.

### Note

Simultaneous application of contacts at contact inputs configured for:

- Raising and lowering the active setpoint will result in no change to the setpoint
- Auto and manual mode selection will result in selection of manual mode

The screenshot displays a grid of 14 contact input configuration fields. Each field consists of a label 'Input #X' and a text input box for 'Label Text'. The labels and their corresponding text values are as follows:

| Input #   | Label Text    |
|-----------|---------------|
| Input #1  | AUTO_MODE     |
| Input #2  | MANUAL_MODE   |
| Input #3  | RAISE         |
| Input #4  | LOWER         |
| Input #5  | PREPOSITION_1 |
| Input #6  | PREPOSITION_2 |
| Input #7  | PREPOSITION_3 |
| Input #8  | 52 L/M        |
| Input #9  | 52 J/K        |
| Input #10 | AUTOTRANSFER  |
| Input #11 | ALARM_RESET   |
| Input #12 | SETTINGS_GRP2 |
| Input #13 | INPUT 13      |
| Input #14 | INPUT 14      |

Figure 8-1. Contact Input Label Text

See the *Terminals and Connectors* section for an illustration of the programmable input terminals.

## Contact Outputs

**BESTCOMSPlus Navigation Path:** Settings Explorer, Programmable Outputs, Contact Outputs

**HMI Navigation Path:** Not available through HMI.

DECS-450 contact outputs consist of a dedicated watchdog output and 11 programmable outputs. The optional CEM-125 or CEM-2020 provides an additional 24 contact outputs. Contact Basler Electric for ordering information.

### Watchdog Output

This SPDT (Form C) output changes state during the following conditions:

- Control power is lost
- Normal firmware execution ceases
- Transfer Watchdog Trip is asserted in *BESTlogicPlus*.

Watchdog output connections are made at terminals WTCHD1 (normally open when de-energized), WTCHD (common), and WTCHD2 (normally closed when de-energized).

### Programmable Outputs

The 11 programmable, normally-open contact outputs may be configured to annunciate DECS-450 status, active alarms, active protection functions, and active limiter functions. Using *BESTlogicPlus* programmable logic, these outputs may be configured to control and annunciate a variety of system conditions and contingencies. Information about using the programmable outputs in a logic scheme is provided in the *BESTlogicPlus* section.

To make the programmable contact outputs easier to identify, customized labels may be assigned that relate to the functions of your system. Figure 8-2 shows the *BESTCOMSPlus* Contact Outputs screen where each of the 11 outputs may be assigned a custom name.

The screenshot displays a configuration window titled "Contact Outputs". It contains 11 individual configuration boxes, each for an output. Each box has a "Label Text" field. The values entered in these fields are as follows:

| Output #   | Label Text         |
|------------|--------------------|
| Output #1  | START/STOP         |
| Output #2  | LIMITER_ACTIVE     |
| Output #3  | ALARM              |
| Output #4  | MANUAL_MODE        |
| Output #5  | PREPOSITION_ACTIVE |
| Output #6  | FIELD_FLASH_ACTIVE |
| Output #7  | OUTPUT 7           |
| Output #8  | OUTPUT 8           |
| Output #9  | OUTPUT 9           |
| Output #10 | OUTPUT 10          |
| Output #11 | OUTPUT 11          |

Figure 8-2. Contact Output Label Text

## Control Output

**BESTCOMSPlus Navigation Path:** Settings Explorer, Programmable Outputs, Analog Outputs, Control Output

**HMI Navigation Path:** Settings, Programmable Outputs, Analog Outputs, Control Output

A dedicated analog output provides a control signal over the range of 0 to 10 Vdc, –10 to +10 Vdc, or 4 to 20 mAdc. Settings consist of Output Type, Invert Output, and Power Amplifier Type. These settings are described below and shown in Figure 8-3.

### Output Type

The control output may be configured to transmit a voltage or current signal. Selections for the signal ranges are 0 to 10 Vdc, –10 to +10 Vdc, or 4 to 20 mAdc.

### Invert Output

When using the DECS-450 with an exciter that requires an inverted output, enable to invert the DECS-450 control output.

### Power Amplifier Type

The Power Amplifier Type setting establishes whether the controlled power amplifier is capable of positive voltage only or capable of negative forcing.

### Regulator Output Range

These read-only fields display the selected control output configuration.

Figure 8-3. Control Output Screen

## Logic Connections

Logic connections for the "Control Output Out of Range" status input are made on the BESTlogicPlus screen in BESTCOMSPlus. The Control Output Out of Range status input logic block is illustrated in Figure 8-4. The output is true during a trip condition.

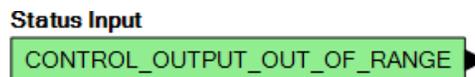


Figure 8-4. Control Output Out of Range Status Input

## Meter Driver Circuits

**BESTCOMSPlus Navigation Path:** Settings Explorer, Programmable Outputs, Analog Outputs, Analog Output X

**HMI Navigation Path:** Settings, Programmable Outputs, Analog Outputs, Analog Output X

Four analog outputs provide meter driver signals over a range of either 4 to 20 mA or -10 to +10 Vdc. Settings consist of parameter selection, output type, out of range activation delay, and ranges. These settings are described below and shown in Figure 8-5.

### Parameter Selection

The following parameters can be selected:

- Analog Inputs 1 through 8 (optional AEM-2020 required)
- Auxiliary Input Current (mA)
- Auxiliary Input Voltage
- Bus Frequency
- Bus Voltage: VAB, VBC, or VCA
- Control Output pu (per unit)
- EDM Ripple
- Exciter Field Current
- Exciter Field Temperature
- Exciter Field Voltage
- Gen Current: IA, IB, IC, or Average
- Gen Frequency
- Gen Power Factor and Scaled Power Factor
- Gen Voltage: VAB, VBC, VCA, or Average
- Kilovarhours
- Kilowatthours

- Negative Sequence Current
- Negative Sequence Voltage
- NLS Error Percent
- Positive Sequence Current
- Positive Sequence Voltage
- PSS Output
- RTD Inputs 1 through 8 (optional AEM-2020 required)
- Setpoint Position
- Thermocouples 1 and 2 (optional AEM-2020 required)
- Total kVA
- Total kvar
- Total kW
- Tracking Error

## Output Type

Each analog output may be configured to transmit a voltage or current signal.

The minimum and maximum output current may be set to any value between 4 and 20 mA<sub>dc</sub> and the minimum and maximum output voltage may be set to any value between -10 and +10 V<sub>dc</sub>.

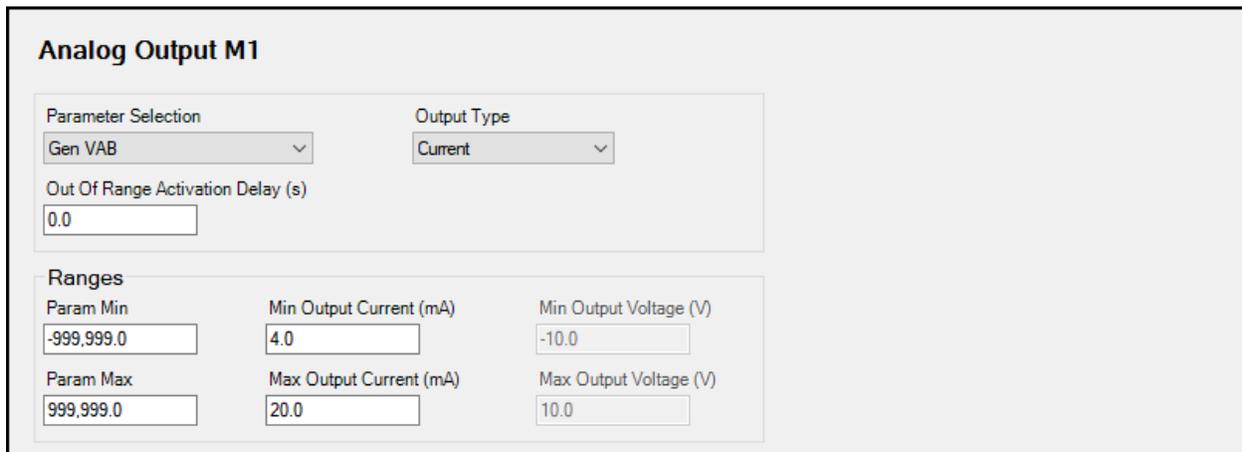
This accommodates for the typical ranges, 4 to 20 mA<sub>dc</sub>, 0 to 10 V<sub>dc</sub>, and -10 to +10 V<sub>dc</sub>, as well as custom ranges.

## Out of Range Activation Delay

When the value of the selected parameter is out of range for the duration of the Out of Range Activation Delay, the condition is annunciated in logic. See Logic Connections, below.

## Ranges

Ranges must be set for the selected output type. Param Min is represented by Min Output Current or Min Output Voltage and Param Max is represented by Max Output Current or Max Output Voltage.



**Analog Output M1**

Parameter Selection: Gen VAB      Output Type: Current

Out Of Range Activation Delay (s): 0.0

**Ranges**

| Param Min  | Min Output Current (mA) | Min Output Voltage (V) |
|------------|-------------------------|------------------------|
| -999,999.0 | 4.0                     | -10.0                  |
| Param Max  | Max Output Current (mA) | Max Output Voltage (V) |
| 999,999.0  | 20.0                    | 10.0                   |

Figure 8-5. Analog Output M1 Screen

## Logic Connections

Logic connections for the four "Analog Output Out of Range" status inputs are made on the BESTlogicPlus screen in BESTCOMSPPlus. The Analog Output 1 Out of Range status input logic block is illustrated in Figure 8-6. The output is true during a trip condition.

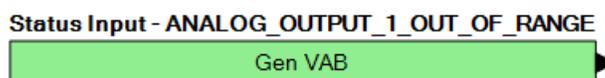


Figure 8-6. Analog Output 1 Out of Range Status Input



## 9 • Protection

The DECS-450 offers protection relating to machine voltage, frequency, power, field parameters, rotating exciter diodes, and generator-to-bus synchronism. Configurable protection elements supplement this protection with additional, user-defined system parameters that have multiple pickup thresholds per parameter. Most protection functions have two groups of settings labeled Primary and Secondary. Two setting groups enable independent protection coordination which is selectable in BESTLogic™ Plus.

### Per Unit Settings

Some BESTCOMSPPlus® settings provide fields for actual and per unit values. When one of these fields is edited, BESTCOMSPPlus automatically recalculates the other field based on the new value and the associated rated data (on the System Parameters, Rated Data screen).

If the Rated Data parameters are changed after all per unit values are assigned, BESTCOMSPPlus automatically recalculates all actual unit settings.

### Voltage Protection

**BESTCOMSPPlus Navigation Path:** Settings Explorer, Protection, Voltage

**HMI Navigation Path:** Settings, Protection, Voltage Protection

Voltage protection includes overexcitation, generator undervoltage, generator overvoltage, and loss of sensing voltage.

#### Overexcitation (Volts per Hertz)

Volts per hertz protection is annunciated if the ratio of the per-unit voltage to the per-unit frequency (volts/hertz) exceeds one of the Volts per Hertz Pickup Level settings for a definite amount of time. If the Volts per Hertz Pickup level is exceeded, timing will continue until the volts per hertz ratio drops below the dropout ratio (95%). Volts per hertz protection also guards against other potentially damaging system conditions such as a change in system voltage and reduced frequency conditions that can exceed the system's excitation capability.

Several volts per hertz settings enable the DECS-450 to provide flexible generator and generator step-up transformer overexcitation protection. An inverse square timing characteristic is provided through the Inverse Time Pickup Setpoint and Time Dial settings. These settings enable the DECS-450 to approximate the heating characteristic of the generator and generator step-up transformer during overexcitation. A linear reset characteristic is provided through the Reset Dial setting. Volts per hertz protection may be enabled and disabled without altering the pickup and time delay settings.

Two sets of fixed-time, overexcitation pickup settings are available through the Definite Time Pickup #1, #2 and Definite Time Delay #1, #2 settings.

The following equations represent the trip time and reset time for a constant V/Hz level. Volts per hertz characteristic curves are illustrated in Figure 9-1 and Figure 9-2.

$$T_T = \frac{D_T}{\left( \frac{V / \text{Hz}_{\text{MEASURED}}}{V / \text{Hz}_{\text{NOMINAL}}} - 1 \right)^n}$$

Equation 9-1. Trip Time

$$T_R = D_R \times \frac{E_T}{FST} \times 100$$

Equation 9-2. Reset Time

Where:

- T<sub>T</sub> = time to trip
- T<sub>R</sub> = time to reset
- D<sub>T</sub> = time dial trip
- D<sub>R</sub> = time dial, reset

- $E_T$  = elapsed time
- $n$  = curve exponent (0.5, 1, 2)
- FST = full scale trip time ( $T_T$ )
- $E_T/FST$  = fraction of total travel toward trip that integration had progressed to. (After a trip, this value will be equal to 1.)

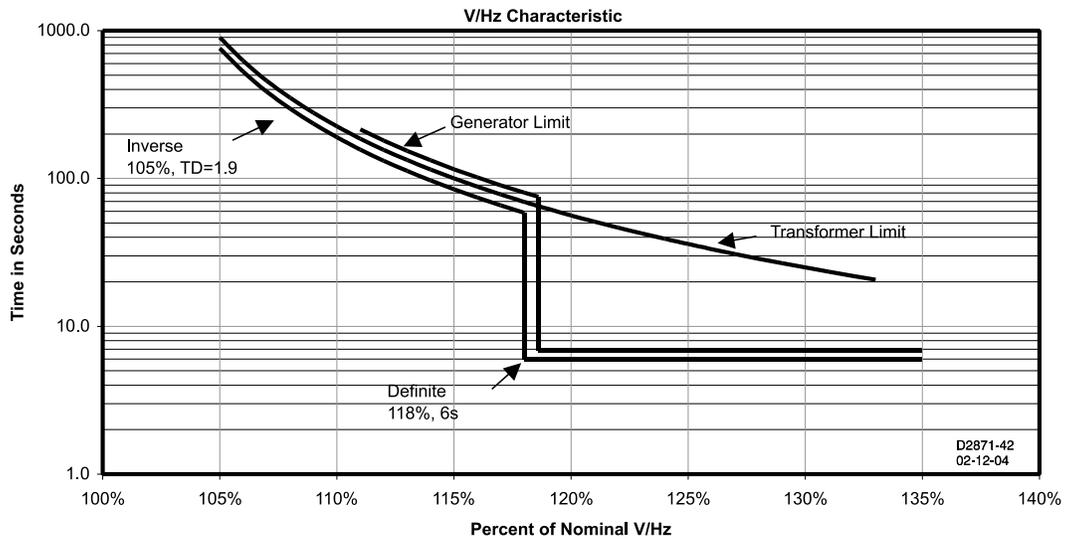


Figure 9-1. V/Hz Characteristic – Time Shown on Vertical Axis

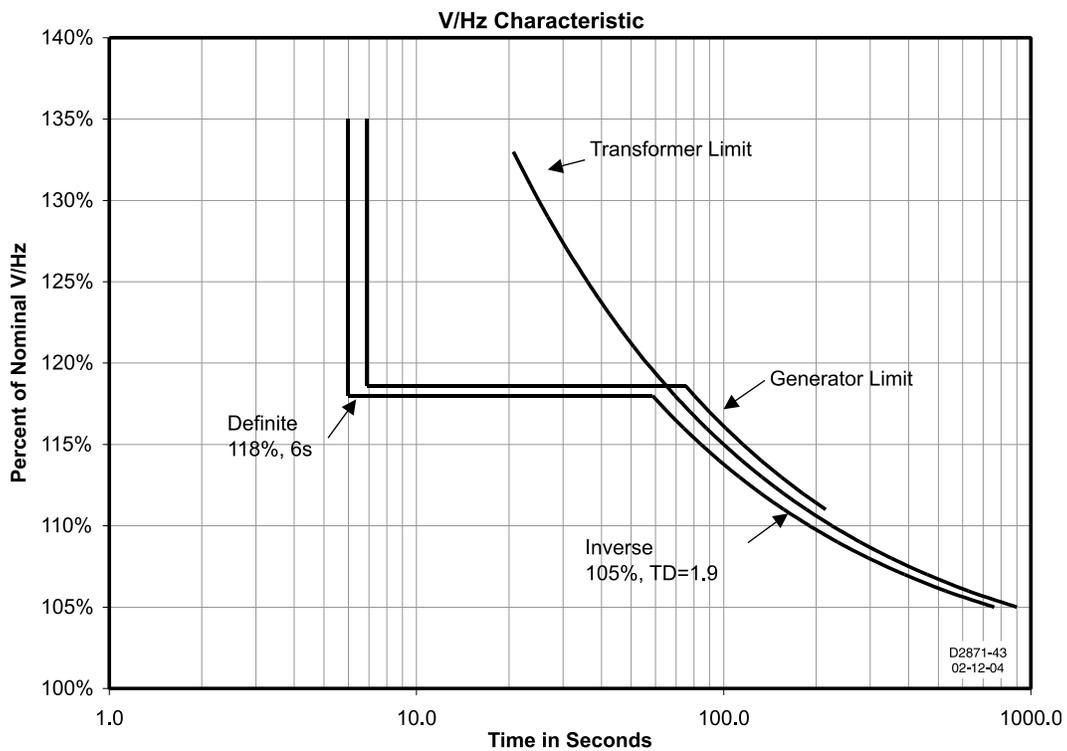


Figure 9-2. V/Hz Characteristic – Time Shown on Horizontal Axis

**Overexcitation (24)**

| Primary                            | Secondary                          |
|------------------------------------|------------------------------------|
| Mode<br>Enabled                    | Mode<br>Enabled                    |
| Curve Exponent<br>1                | Curve Exponent<br>1                |
| Inverse Time Pickup<br>0.00        | Inverse Time Pickup<br>0.00        |
| Time Dial<br>0.0                   | Time Dial<br>0.0                   |
| Reset Dial<br>0.0                  | Reset Dial<br>0.0                  |
| Definite Time Pickup 1<br>0.00     | Definite Time Pickup 1<br>0.00     |
| Definite Time Delay 1 (s)<br>0.050 | Definite Time Delay 1 (s)<br>0.050 |
| Definite Time Pickup 2<br>0.00     | Definite Time Pickup 2<br>0.00     |
| Definite Time Delay 2 (s)<br>0.050 | Definite Time Delay 2 (s)<br>0.050 |

Figure 9-3. Overexcitation Protection Settings

## Generator Undervoltage

An undervoltage pickup condition occurs when the sensed generator terminal voltage decreases below the pickup setting. An undervoltage trip condition occurs if the generator voltage remains below the pickup threshold for the duration of the time delay setting. Generator undervoltage protection may be enabled and disabled without altering the pickup and time delay settings. Undervoltage pickup and trip elements in BESTLogicPlus may be used in a logic scheme to initiate corrective action in response to the condition.

The Undervoltage pickup has a native unit of Primary Volts and the rated data associated with it is Machine Rated Data, Voltage (on the System Parameters, Rated Data screen).

BESTCOMSPPlus® generator undervoltage settings are illustrated in Figure 9-4.

**Generator Undervoltage**

27 Element

| Primary                                 | Secondary                               |
|---|---|
| Mode<br>Enabled                         | Mode<br>Enabled                         |
| Pickup<br>0 Primary V<br>0.000 Per Unit | Pickup<br>0 Primary V<br>0.000 Per Unit |
| Time Delay (s)<br>0.1                   | Time Delay (s)<br>0.1                   |

Figure 9-4. Generator Undervoltage Protection Settings

## Generator Overvoltage

An overvoltage pickup condition occurs when the sensed generator terminal voltage increases above the pickup setting. An overvoltage trip condition occurs if the generator voltage remains above the pickup threshold for the duration of the time delay setting. Generator overvoltage protection may be enabled and

disabled without altering the pickup and time delay settings. Overvoltage pickup and trip elements in BESTlogicPlus may be used in a logic scheme to initiate corrective action in response to the condition.

The Overvoltage pickup has a native unit of Primary Volts and the rated data associated with it is Machine Rated Data, Voltage (on the System Parameters, Rated Data screen).

BESTCOMSPPlus® generator overvoltage settings are illustrated in Figure 9-5.

Figure 9-5. Generator Overvoltage Protection Settings

## Loss of Sensing

The generator voltage is monitored for a loss of sensing (LOS) condition. LOS protection settings are illustrated in Figure 9-6.

In the DECS-450, an LOS event is calculated using sequence components. LOS trip criteria is listed in Table 9-1.

Table 9-1. Loss of Sensing Trip Criteria

| Loss of either 1 or 2 phases<br>(3-phase sensing)        | Loss of all 3 phases<br>(3-phase sensing) | Loss of single-phase<br>sensing                          |
|--|---|--|
| 3-phase, 3-wire sensing selected                         | 3-phase, 3-wire sensing selected          | Single-phase sensing selected                            |
| $V1 > BV\%$ of AVR setpoint                              | $BV\%$ of AVR Setpoint $> V1$             | $BV\%$ of AVR Setpoint $> VGEN$                          |
| $V2 > UV\%$ of $V1$                                      | $200\%$ of $I_{rated} > I1$               | $200\%$ of $I_{rated} > I1$                              |
| $17.7\%$ of $I1 > I2$<br>OR<br>$1\%$ of $I_{rated} > I1$ |   | $17.7\%$ of $I1 > I2$<br>OR<br>$1\%$ of $I_{rated} > I1$ |

$V1$  = Positive sequence voltage

$V2$  = Negative sequence voltage

$I1$  = Positive sequence current

$I2$  = Negative sequence current

$I_{rated}$  = Rated current

$BV\%$  = Balanced voltage percent

$UV\% V1$  = Unbalanced voltage percent

$VGEN$  = Average generator voltage

When all criteria in a column are true for the duration of the time delay setting, an LOS trip condition occurs.

An LOS condition may be used to initiate a transfer to manual (FCR) control mode. It may be configured in BESTlogicPlus to initiate other actions as well. Protection may be enabled and disabled without altering the individual loss of sensing settings.

LOS protection is automatically disabled when a short circuit exists. A short circuit is detected when the measured current is greater than twice the rated current for a single-phase CT connection and when the positive sequence current is greater than twice the rated current for a three-phase CT connection.

**Loss of Sensing**

LOS Element

Mode  
Enabled

Time Delay (s)  
2.0

Voltage Balanced Level (%)  
8.8

Voltage Unbalanced Level (%)  
25.0

Transfer To Manual  
Disabled

Figure 9-6. Loss of Sensing Protection Settings

## Frequency Protection

**BESTCOMSPlus Navigation Path:** Settings Explorer, Protection, Frequency

**HMI Navigation Path:** Settings, Protection, Frequency Protection 81

The frequency of the generator terminal voltage is monitored for overfrequency and under-frequency conditions.

### Overfrequency

An overfrequency condition occurs when the frequency of the generator voltage exceeds the 81O pickup threshold for the duration of the 81O time delay setting. Overfrequency protection may be enabled and disabled without altering the pickup and time delay settings. Overfrequency pickup and trip elements in BESTlogicPlus may be used in a logic scheme to initiate corrective action in response to the condition. BESTCOMSPlus overfrequency settings are illustrated in Figure 9-7.

**Frequency**

81O Element

| Primary                   | Secondary                 |
|---------------------------|---------------------------|
| Mode<br>Over              | Mode<br>Over              |
| Pickup (Hz)<br>30.00      | Pickup (Hz)<br>30.00      |
| Time Delay (s)<br>0.1     | Time Delay (s)<br>0.1     |
| Voltage Inhibit (%)<br>50 | Voltage Inhibit (%)<br>50 |

Figure 9-7. Overfrequency Protection Settings

### Underfrequency

The DECS-450 provides two underfrequency elements designated 81U-1 and 81U-2. An underfrequency condition occurs when the frequency of the generator voltage decreases below the 81U pickup threshold for the duration of the 81U time delay setting. A voltage inhibit setting, expressed as a percentage of the rated generator voltage, may be implemented to prevent an underfrequency trip from occurring during startup when the generator voltage is rising toward the nominal level. Underfrequency protection may be enabled and disabled without altering the pickup, delay, and inhibit settings. Underfrequency pickup and trip elements in BESTlogicPlus may be used in a logic scheme to initiate corrective action in response to the condition. BESTCOMSPlus underfrequency settings are illustrated in Figure 9-8.

**Frequency**

81U-1 Element

**Primary**

Mode: Under

Pickup (Hz): 30.00

Time Delay (s): 0.1

Voltage Inhibit (%): 50

**Secondary**

Mode: Under

Pickup (Hz): 30.00

Time Delay (s): 0.1

Voltage Inhibit (%): 50

Figure 9-8. Underfrequency Protection Settings

## Power Protection

**BESTCOMSPiplus Navigation Path:** Settings Explorer, Protection, Power

**HMI Navigation Path:** Settings, Protection, Power

Generator power levels are monitored to protect against reverse power flow and loss of excitation.

### Reverse Power

Reverse power protection guards against reverse power flow that may result from a loss of prime mover torque (and lead to generator motoring). A reverse power condition occurs when the flow of reverse power exceeds the 32R pickup threshold for the duration of the 32R time delay. Reverse power protection may be enabled and disabled without altering the pickup and time delay settings. The DECS-450 does not initiate a shutdown, however, reverse power pickup and trip elements in BESTlogicPiplus may be used to initiate corrective action in response to the condition.

The Reverse Power pickup setting may be set in Primary Kilowatts or Per Unit and the rated data associated with it is Machine Rated Data, Rating (kVA) (on the System Parameters, Rated Data screen).

BESTCOMSPiplus reverse power protection settings are illustrated in Figure 9-9.

**Reverse Power**

32R Element

**Primary**

Mode: Enabled

Pickup: 0 Primary kW, 0.000 Per Unit

Time Delay (s): 0.0

**Secondary**

Mode: Enabled

Pickup: 0 Primary kW, 0.000 Per Unit

Time Delay (s): 0.0

Figure 9-9. Reverse Power Protection Settings

### Loss of Excitation

The loss of excitation element operates on excessive var flow into the machine, indicating abnormally low field excitation. This element protects controlled generators as well as motors. A diagram of the 40Q pickup response is illustrated in Figure 9-10. BESTCOMSPiplus settings are described below and shown in Figure 9-11.

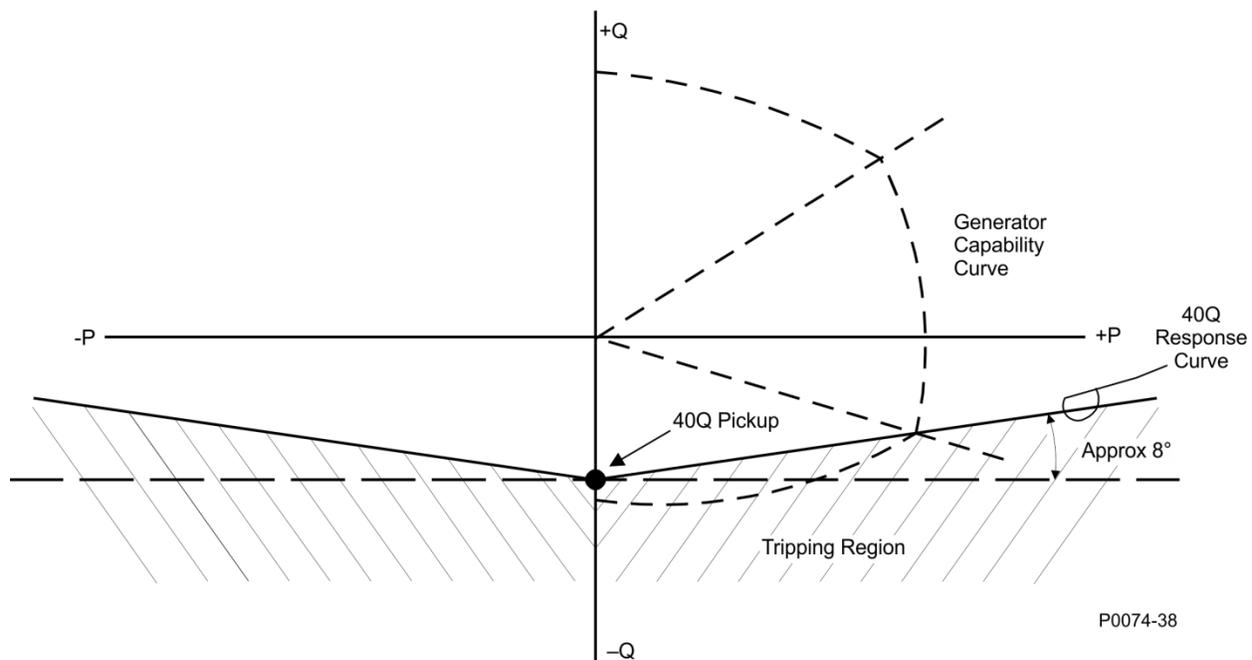
### Generator Protection

During loss of excitation, the generator absorbs reactive power from the power system which can overheat the stator windings. The loss of excitation element acts on the principle that if a generator begins to absorb vars outside its steady-state capability curve, it has likely lost its normal excitation supply. The element is always calibrated to the equivalent three-phase power even if the connection is single-phase.

The loss of excitation element compares the reactive power to a map of the allowed reactive power as defined by the Pickup setting. The loss of excitation element remains in a pickup condition until power flow falls below the dropout ratio of 95% of the actual pickup. A time delay is recommended for tripping. For settings well outside the generator capability curve, adding a 0.5 second time delay helps prevent transient fault conditions. However, recovery from power system swings after a major fault may take several seconds. Therefore, if the unit is to pick up near the steady-state capability curve of the generator, longer time delays are recommended. See Figure 9-10 for details.

### Motor Protection

The DECS-450 compares the real power (kW) flowing into the motor with the reactive power (kvar) being supplied. Operation of synchronous motors drawing reactive power from the system can result in overheating in parts of the rotor that do not normally carry current. The 40Q pickup response is shown in Figure 9-10.



**Figure 9-10. Generator Capability Curve vs. 40Q Response**

### Pickup and Trip

A loss of excitation condition exists when the level of absorbed vars exceeds the loss of excitation (40Q) threshold for the duration of the 40Q time delay. A time delay setting of zero makes the loss of excitation element instantaneous with no intentional time delay. If the pickup condition subsides before the time delay expires, the timer and pickup are reset, no corrective action is taken, and the element is rearmed for any further occurrences of loss of excitation. Loss of excitation protection may be enabled and disabled without altering the pickup and time delay settings.

The Loss of Excitation pickup setting may be set in Primary Kilovars or Per Unit and the rated data associated with it is Machine Rated Data, Rating (kVA) (on the System Parameters, Rated Data screen).

BESTCOMSP*Plus* loss of excitation settings are illustrated in Figure 9-11.

Figure 9-11. Loss of Excitation Protection Settings

## Field Protection

**BESTCOMSPlus Navigation Path:** Settings Explorer, Protection, Field

**HMI Navigation Path:** Settings, Protection, Field

Field protection provided by the DECS-450 includes field overvoltage, field overcurrent, field overtemperature, loss of field isolation transducer, and an exciter diode monitor.

### Field Overvoltage

A field overvoltage condition occurs when the field voltage exceeds the field overvoltage threshold for the duration of the field overvoltage time delay. Field overvoltage protection may be enabled and disabled without altering the pickup and time delay settings. Field overvoltage pickup and trip elements in BESTlogicPlus may be used in a logic scheme to initiate corrective action in response to the condition.

The Overvoltage pickup has a native unit of Primary Volts and the rated data associated with it is Field Rated Data, Voltage – Full Load (on the System Parameters, Rated Data screen).

BESTCOMSPlus field overvoltage settings are illustrated in Figure 9-12.

Figure 9-12. Field Overvoltage Protection Settings

### Field Overcurrent

A field overcurrent condition is annunciated when the field current exceeds the field overcurrent pickup level for the duration of the field overcurrent time delay. Depending on the selected timing mode, the time delay may be fixed or related to an inverse function. Definite timing mode uses a fixed time delay. In inverse timing mode, the time delay is shortened in relation to the level of field current above the pickup level. The time dial setting acts as a linear multiplier for the time to an annunciation. This enables the DECS-450 to approximate the heating characteristic of the generator and generator step-up transformer during overexcitation. The field current must fall below the dropout ratio (95%) for the function to begin timing to reset. The following equations are used to calculate the field overcurrent pickup (Equation 9-3) and reset time (Equation 9-4) delays.

$$t_{pickup} = \frac{A \times TD}{B + \sqrt{C + D \times MOP}}$$

Equation 9-3. Inverse Field Overcurrent Pickup

Where:

$t_{pickup}$  = time to pick up in seconds

A = -95.908

B = -17.165

C = 490.864

D = -191.816

TD = time dial setting <0.1, 20>

MOP = multiple of pickup <1.03, 2.5>

$$Time_{reset} = \frac{0.36 \times TD}{1 - (MOP_{reset})^2}$$

Equation 9-4. Inverse Field Overcurrent Reset

Where:

$Time_{reset}$  = maximum time to reset in seconds

TD = time dial setting <0.1, 20>

$MOP_{reset}$  = multiple of pickup <0.0, 0.95>

Primary and secondary setting groups provide additional control for two distinct machine operating conditions.

Field overcurrent protection may be enabled and disabled without altering the pickup and time delay settings. Field overcurrent pickup and trip elements in *BESTlogicPlus* may be used in a logic scheme to initiate corrective action in response to the condition.

The Overcurrent pickup has a native unit of Primary Amps and the rated data associated with it is Field Rated Data, Current – Full Load (on the System Parameters, Rated Data screen).

*BESTCOMSPPlus* field overcurrent settings are illustrated in Figure 9-13. In *BESTCOMSPPlus*, a plot of the field overcurrent setting curve is displayed. The plot can display the primary or secondary setting curves.

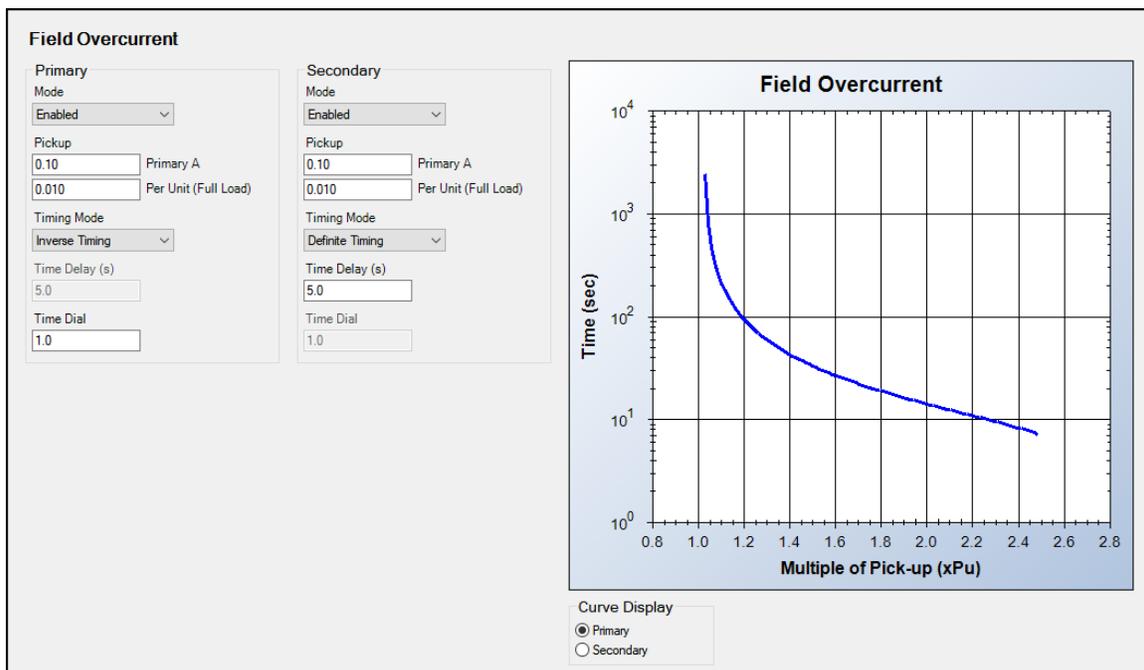


Figure 9-13. Field Overcurrent Protection Settings

## Field Overtemperature

The DECS-450 calculates field temperature based on the generator main field resistance, the field ambient temperature, and the voltage drop across the generator main field brushes. Field overtemperature protection is intended for static exciter applications supplying a generator's main field or for rotary exciter applications where the field voltage and current is measured at the slip rings and main field current shunt on the brush-type rotary exciter.

A field overtemperature condition occurs when the field temperature exceeds the field overtemperature threshold for the duration of the field overtemperature time delay. Field overtemperature protection may be enabled and disabled without altering the pickup and time delay settings. Field overtemperature pickup and trip elements in *BESTLogicPlus* may be used in a logic scheme to initiate corrective action in response to the condition.

BESTCOMS*Plus* field overvoltage settings are illustrated in Figure 9-14.

The screenshot displays the 'Field Overtemperature' settings interface. It is divided into two main sections: 'Primary' and 'Secondary'. Each section contains a 'Mode' dropdown menu currently set to 'Enabled', a 'Pickup (°F)' text input field containing the value '150', and a 'Time Delay (s)' text input field containing the value '5.0'.

Figure 9-14. Field Overtemperature Protection Settings

## Loss of Field Isolation Transducer

A loss of field isolation transducer condition occurs when the field current signal from the field isolation transducer decreases below a predetermined level for the duration of the time delay. Loss of field isolation transducer protection may be enabled and disabled without altering the pickup and time delay settings. Loss of field isolation transducer pickup and trip elements in *BESTLogicPlus* may be used in a logic scheme to initiate corrective action in response to the condition.

The screenshot displays the 'Loss of Field Isolation Transducer' settings interface. It features a 'Mode' dropdown menu set to 'Enabled' and a 'Time Delay (s)' text input field containing the value '1.0'.

Figure 9-15. Loss of Field Isolation Transducer Settings

## Exciter Diode Monitor

The exciter diode monitor (EDM) monitors the condition of a brushless exciter's power semiconductors by monitoring the exciter field current. The EDM detects both open and shorted rotating diodes in the exciter bridge. EDM settings are illustrated in Figure 9-16. When implementing the EDM, it is imperative that the user specify the number of poles for the exciter armature and the generator rotor. A pole ratio calculator, available in *BESTCOMSPlus*, may be used to calculate the pole ratio from the number of exciter armature and generator rotor poles.

## Notes

If the number of poles for the exciter armature and the generator rotor is unknown, the EDM function will still operate. However, only a shorted diode may be detected. If the number of poles is unknown, disable all exciter open diode protection and set the generator and exciter pole parameters to 1.0 to prevent false tripping. All of the EDM setup guidelines presented here assume that the exciter diodes are not open or shorted at the time of setup and testing.

The EDM estimates the fundamental harmonic of the exciter field current using discrete Fourier transforms (DFTs). The harmonic, expressed as a percentage of the field current, is then compared to the pickup level for open diode detection and shorted diode detection. If the percentage of field current exceeds the open diode or shorted diode pickup level, then the appropriate time delay will begin. After the time delay for the open diode or shorted diode condition expires and if the percentage of field current continues to exceed the open or shorted diode pickup setting, the condition is annunciated. EDM pickup and trip elements in *BESTlogicPlus* may be used in a logic scheme to initiate corrective action in response to an open or shorted diode condition.

An EDM disable level setting prevents nuisance annunciations due to low excitation current or the generator frequency being out of range. A disable level setting may be used to disable both open- and shorted-diode protection when the field current drops below the user-defined percentage of rated. EDM protection may be disabled and enabled by the user without altering the individual protection settings.

### Applying EDM Protection

It is especially difficult to detect open diode conditions when the number of generator and exciter poles is unknown. For this reason, the ratio of the number of brushless exciter armature poles to the number of generator rotor poles should be entered to ensure detection of both open and shorted diodes.

### Finding the Maximum Field Ripple Current

To set the open diode pickup level and shorted diode pickup level, the maximum ripple current on the field must be known. This may be accomplished by running the generator unloaded and at rated speed. Vary the generator voltage from minimum to maximum while monitoring the EDM ripple level on the HMI display. Record the highest value.

### Setting the Pickup Level—Number of Generator Poles Known

Multiply the highest EDM ripple value, obtained in the preceding paragraph, by 2. The result is the open diode pickup level setting. The multiplier may be varied between 1.5 and 5 to increase or decrease the trip margin. However, reducing the multiplier could result in nuisance open diode indications.

Multiply the highest EDM ripple value, obtained in the preceding paragraph by 50. The result is the shorted diode pickup level setting. The multiplier may be varied between 40 and 70 to increase or decrease the trip margin. However, reducing the multiplier could result in nuisance shorted diode indications.

The DECS-450 has fixed EDM inhibit levels to prevent nuisance failed-diode indications while the generator frequency is less than 40 hertz or greater than 70 hertz. EDM operation is also inhibited when the level of field current is below the disable level setting.

### Setting the Pickup Level—Number of Generator Poles Unknown

The DECS-450 can detect shorted diode conditions when the number of generator poles is not known. To provide this protection, disable open diode protection, set the pole ratio to 1.0, and enable shorted diode protection. Multiply the maximum EDM ripple level, obtained under *Finding the Maximum Field Ripple Current*, by 30. The multiplier may be varied between 20 and 40 to increase or decrease the pickup margin. However, reducing the multiplier could result in nuisance shorted diode indications.

### Testing the EDM Settings

Start the generator from rest and increase the speed and voltage to the rated value. Load the machine to its rating and confirm that no failed diode annunciations occur. All of the EDM setup guidelines presented here assume that the exciter diodes were not opened or shorted at the time of setup and testing.

Figure 9-16. Exciter Diode Monitor Protection Settings

## Sync-Check Protection

**BESTCOMSPlus Navigation Path:** Settings Explorer, Protection, Sync Check (25)

**HMI Navigation Path:** Settings, Protection, Sync Check (25)

### Caution

Because the DECS-450 sync-check and automatic synchronizer functions share internal circuitry, the sync-check function is disabled if the automatic synchronizer function is enabled. If using the DECS-450 automatic synchronizer, consider separate sync-check supervision.

When enabled, the sync-check (25) function supervises the automatic or manual synchronism of the controlled generator with a bus/utility. During synchronizing, the 25 function compares the voltage, slip angle, and slip frequency differences between the generator and bus. When the generator/bus differences fall within the setting for each parameter, the 25 status virtual output asserts. This virtual output may be configured (in BESTlogicPlus) to assert a DECS-450 contact output. This contact output can, in turn, enable the closure of a breaker tying the generator to the bus.

An angle compensation setting is provided to offset phase shift caused by transformers in the system. For more details on the angle compensation setting, see the *Synchronizer* section.

When the Gen Freq > Bus Freq setting box is checked, the 25 status virtual output will not assert unless the generator frequency is greater than the bus frequency. Sync-check protection settings are illustrated in Figure 9-17.

Figure 9-17. Sync-Check Protection Settings

## Generator Frequency Less Than 10 Hertz

A *Generator Below 10 Hz* condition is annunciated when the generator frequency decreases below 10 Hz or when residual voltage is low at 50/60 Hz. A *Generator Below 10 Hz* annunciation is automatically reset when the generator frequency increases above 10 Hz or the residual voltage increases above the threshold.

## Configurable Protection

**BESTCOMSPlus Navigation Path:** Settings Explorer, Protection, Configurable Protection

**HMI Navigation Path:** Settings, Protection, Configurable Protection

The DECS-450 has eight configurable protection elements that may be used to supplement the standard DECS-450 protection. BESTCOMSPlus configurable protection settings are illustrated in Figure 9-18. To make the protection elements easier to identify, each element may be renamed through BESTCOMSPlus. A protection element is configured by selecting the parameter to be monitored and then establishing the operating characteristics for the element. Any one of the following parameters may be selected.

- Analog Inputs 1 through 8 (optional AEM-2020 required)
- Auxiliary Input Current (mA)
- Auxiliary Input Voltage
- Bus Frequency
- Bus Voltage:  $V_{AB}$ ,  $V_{BC}$ , or  $V_{CA}$
- Control Output
- EDM Ripple
- Exciter Field Current
- Exciter Field Temperature
- Exciter Field Voltage
- Gen Current:  $I_A$ ,  $I_B$ ,  $I_C$ , or Average
- Gen Frequency
- Gen Power Factor and Scaled Power Factor
- Gen Voltage:  $V_{AB}$ ,  $V_{BC}$ ,  $V_{CA}$ , or Average
- Kilovarhours
- Kilowatthours
- Negative Sequence Current
- Negative Sequence Voltage
- NLS Error Percent
- Positive Sequence Current
- Positive Sequence Voltage
- PSS Output
- RTD Inputs 1 through 8 (optional AEM-2020 required)
- Setpoint Position
- Thermocouples 1 and 2 (optional AEM-2020 required)
- Total kVA
- Total kvar
- Total kW
- Tracking Error

When the Stop Mode Inhibit setting is enabled, the configurable protection element is disabled when the DECS-450 is in STOP mode. When the DECS-450 enters START mode, the arming delay timer begins counting down and, when it expires, the configurable protection element is enabled. If Stop Mode Inhibit is disabled, the arming delay is ignored.

A hysteresis function holds the protection function active for a user-defined percentage above/below the pickup threshold. This prevents repeated pickups and dropouts where the monitored parameter is hovering around the pickup threshold. For example, with a hysteresis setting of 5% on a protection element configured to pick up at 100 Aac of A-phase generator overcurrent, the protection element would

pick up when the current rises above 100 Aac and remain picked up until the current decreases below 95 Aac.

Each of the eight configurable protection elements has four adjustable thresholds. Each threshold may be set to pick up when the monitored parameter increases above the pickup setting (Over) or decreases below the pickup setting (Under). The pickup level for the monitored parameter is defined by a threshold setting. The threshold setting range is very broad, so be sure to use appropriate values for the selected parameter or else the protection function may not operate as intended.

After the threshold has been exceeded for the duration of the activation delay, the configurable protection element trips. If the threshold detection drops out before the activation delay time expires, the activation delay timer is reset.

Configurable protection pickup and trip elements in *BESTlogicPlus* may be used in a logic scheme to initiate corrective action in response to the condition.

### Configurable Protection #1

Label Text  
CONF PROT 1

Parameter Selection  
Gen VAB

Stop Mode Inhibit  
No

Arming Delay (s)  
0

Hysteresis (%)  
2.0

| Threshold #1 |           |                      |
|--------------|-----------|----------------------|
| Mode         | Threshold | Activation Delay (s) |
| Disabled     | 0.00      | 0                    |

| Threshold #2 |           |                      |
|--------------|-----------|----------------------|
| Mode         | Threshold | Activation Delay (s) |
| Disabled     | 0.00      | 0                    |

| Threshold #3 |           |                      |
|--------------|-----------|----------------------|
| Mode         | Threshold | Activation Delay (s) |
| Disabled     | 0.00      | 0                    |

| Threshold #4 |           |                      |
|--------------|-----------|----------------------|
| Mode         | Threshold | Activation Delay (s) |
| Disabled     | 0.00      | 0                    |

Figure 9-18. Configurable Protection Settings

# 10 • Limiters

DECS-450 limiters ensure that the controlled machine does not exceed its capabilities. Limiters include overexcitation, underexcitation, stator current, var, and underfrequency/volts per hertz.

## ***Per Unit Settings***

---

Some BESTCOMSP<sup>Plus</sup>® settings provide fields for actual and per unit values. When one of these fields is edited, BESTCOMSP<sup>Plus</sup> automatically recalculates the other field based on the new value and the associated rated data (on the System Parameters, Rated Data screen).

If the Rated Data parameters are changed after all per unit values are assigned, BESTCOMSP<sup>Plus</sup> automatically recalculates all actual unit settings.

## ***Overexcitation Limiter***

---

**BESTCOMSP<sup>Plus</sup> Navigation Path:** Settings Explorer, Operating Settings, Limiters, OEL

**HMI Navigation Path:** Settings, Operating Settings, Limiters, OEL

The overexcitation limiter (OEL) monitors the level of field current supplied by the DECS-450 and limits it to prevent field overheating.

The OEL can be enabled in all regulation modes. OEL behavior in manual mode can be configured to limit excitation or issue an alarm. This behavior is configured in BESTlogic™ *Plus*.

Two styles of overexcitation limiting are available in the DECS-450: summing point or takeover. The summing point-type OEL provides a control signal to the summing point of the voltage regulator's control loop, whereas the takeover-type OEL overrides the voltage regulator's primary control loop. Refer to the *Math Model* chapter for more details.

OEL settings are illustrated in Figure 10-3, Figure 10-4, and Figure 10-6.

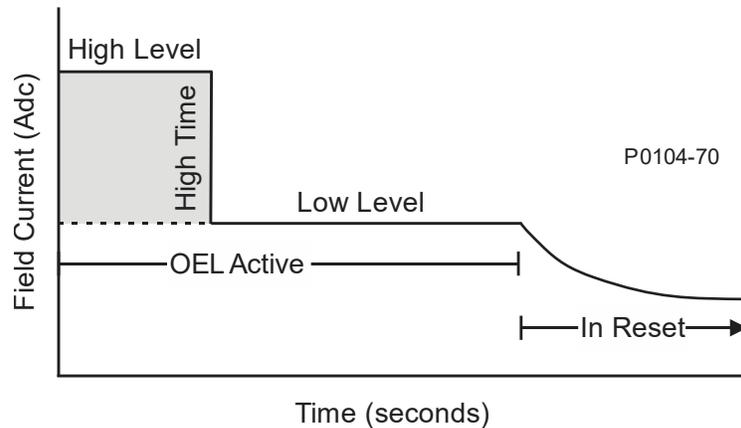
### **Summing Point OEL**

Summing point overexcitation limiting compensates for field overcurrent conditions while the machine is offline or online. Offline and online OEL behavior is dictated by two separate groups of settings. Primary and secondary setting groups (selectable in configurable logic) provide additional control for two distinct machine operating conditions.

#### Offline Operation

For offline operation, there are two levels of summing-point overexcitation limiting: High and Low. Figure 10-1 illustrates the relationship of these levels.

Initially, excitation current will not be permitted to exceed the High Level threshold. Upon expiration of the High Time delay, excitation current will be limited to the value of the Low Level setting. Excitation current will be permitted to remain indefinitely at this level as needed by the application. The OEL is active any time that excitation current is equal to or above the Low Level threshold.



**Figure 10-1. Summing Point, Offline, Overexcitation Limiting**

#### Offline OEL Reset

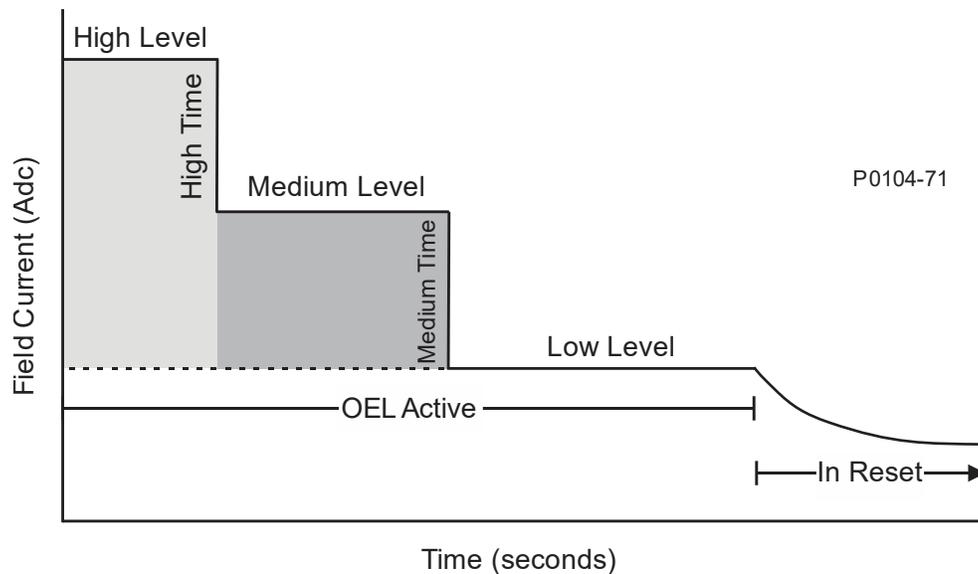
Once excitation current drops below the Low Level threshold, a Reset Timer becomes active. If the OEL reactivates prior to the Reset Timer expiring, then the OEL Timing will begin from a value equal to the previous OEL Active duration plus 100 electrical cycles minus the time in reset. Once the Reset Timer is allowed to expire, then the OEL Active timer is completely reset.

Reset Timer:

1. If the OEL Active duration is less than the High Time delay minus 100 cycles, then the Reset Timer will be equal to the OEL Active duration plus 100 cycles.
2. If the OEL Active duration is equal to or greater than the High Time delay minus 100 cycles, then the Reset Timer is equal to the High Time delay.

#### Online Operation

For online operation, there are three levels of summing-point overexcitation limiting: Low, Medium, and High. Figure 10-2 illustrates the relationship of these levels.



**Figure 10-2. Summing Point, Online, Overexcitation Limiting**

Initially, excitation current will not be permitted to exceed the High Level threshold. Upon expiration of the High Time delay, excitation current will no longer be allowed to exceed the Medium Level threshold. After the expiration of the Medium Time delay, excitation current will be limited to the value of the Low Level

setting. Excitation current will be permitted to remain indefinitely at this level as needed by the application. The OEL will be active any time that excitation current is equal to or above the Low Level threshold.

#### Online OEL Reset

Once excitation current drops below the Low Level threshold, a Reset Timer becomes active. If the OEL reactivates prior to the Reset Timer expiring, then the OEL Timing will begin from a value equal to the previous OEL Active duration plus 100 electrical cycles minus the time in reset. Once the Reset Timer is allowed to expire, then the OEL Active timer is completely reset.

Reset Timer:

1. If the OEL Active duration is less than the High Time delay minus 100 cycles, then the Reset Timer will be equal to the OEL Active duration plus 100 cycles.
2. If the OEL Active duration is equal to or greater than the High Time delay minus 100 cycles but less than the sum of the High Time and Medium Time delays, then the Reset Timer will be equal to the High Time delay.
3. If the OEL Activation duration is equal to or greater than the sum of the High Time and Medium Time delays, then the Reset Timer is equal to the sum of the High Time and Medium Time delays.

#### OEL Voltage Dependency

The OEL voltage dependency option is used with the Online Summing Point OEL. When enabled, the Online OEL High-Level limit is not activated during normal OEL activity. Only the Medium-Level and Low-Level settings are enabled. While the OEL is active, if a fault occurs which causes terminal voltage to drop rapidly (-dV), then the High Level will become available for a period equal to the High Time delay. Activation of the High Level requires that the quotient of the negative per-unit drop in terminal voltage divided by the duration of time (dV/dt) is less than the dV/dt Level setting.

#### Per Unit Settings

Settings that are related to machine ratings can be set in either actual units or in per unit values. When a native unit is edited, BESTCOMSP<sup>lus</sup> automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the System Parameters, Rated Data screen) associated with it. When a per-unit value is edited, BESTCOMSP<sup>lus</sup> automatically recalculates the native value based on the per-unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSP<sup>lus</sup> automatically recalculates all native unit settings based on the modified rated data parameters.

The levels have native units of Primary Amps and the rated data associated with them is full load rated field current (on the System Parameters, Rated Data screen).

**OEL Configure**

OEL Configuration

OEL Enable  
Disabled

OEL Mode  
Summing Point

OEL Voltage Dependency

dv/dt Enable  
Enabled

dv/dt Level  
-5.00

Figure 10-3. OEL Configuration Settings

### OEL Summing Point

|  |  |
|--|--|
| <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <b>Primary</b><br/> <b>Off-Line</b><br/>           High Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)<br/>           High Time (s)<br/> <input style="width: 60px;" type="text" value="0"/><br/>           Low Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)         </div> <div style="border: 1px solid #ccc; padding: 5px;"> <b>On-Line</b><br/>           High Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)<br/>           High Time (s)<br/> <input style="width: 60px;" type="text" value="0"/><br/>           Middle Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)<br/>           Medium Time (s)<br/> <input style="width: 60px;" type="text" value="0"/><br/>           Low Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)         </div> | <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <b>Secondary</b><br/> <b>Off-Line</b><br/>           High Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)<br/>           High Time (s)<br/> <input style="width: 60px;" type="text" value="0"/><br/>           Low Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)         </div> <div style="border: 1px solid #ccc; padding: 5px;"> <b>On-Line</b><br/>           High Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)<br/>           High Time (s)<br/> <input style="width: 60px;" type="text" value="0"/><br/>           Middle Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)<br/>           Medium Time (s)<br/> <input style="width: 60px;" type="text" value="0"/><br/>           Low Level<br/> <input style="width: 60px;" type="text" value="0.00"/> Primary A<br/> <input style="width: 60px;" type="text" value="0.000"/> Per Unit (Full Load)         </div> |
|--|--|

Figure 10-4. Summing Point OEL Settings

### Takeover OEL

Takeover overexcitation limiting limits the field current level in relation to an inverse time characteristic similar to that shown in Figure 10-5. It overrides the voltage regulator's primary control loop (refer to the *Math Model* chapter for more details). Separate curves may be selected for online and offline operation. If the system enters an overexcitation condition, the field current is limited and forced to follow the selected curve. The inverse time characteristic is defined by Equation 10-1.

$$t_{pickup} = \frac{A \times TD}{B + \sqrt{C + D \times MOP}}$$

Equation 10-1. Inverse Pickup Time Characteristic

Where:

$t_{pickup}$  = time to pick up in seconds

A = -95.908

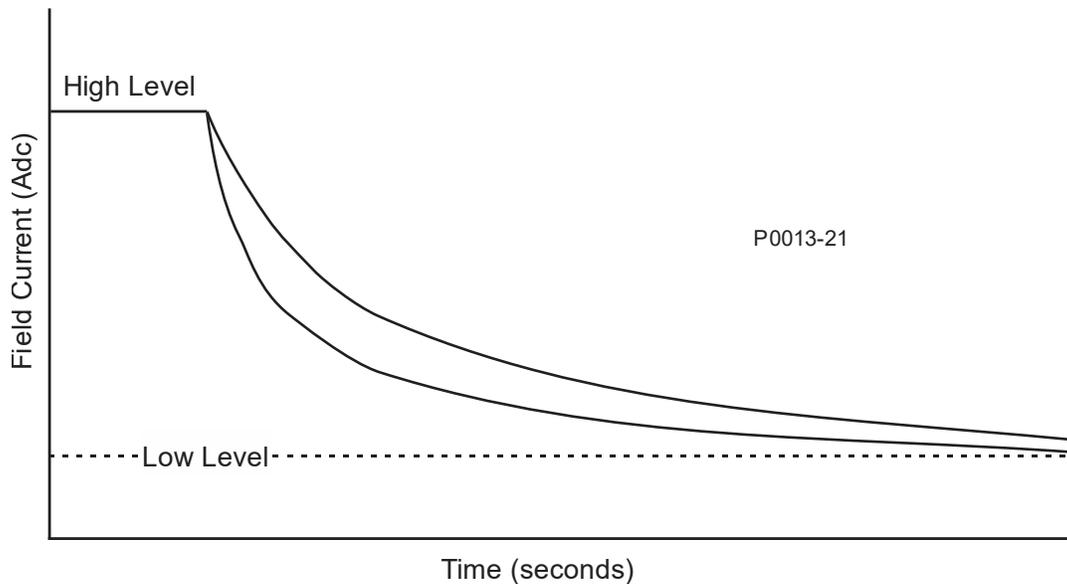
B = -17.165

C = 490.864

D = -191.816

TD = time dial setting <0.1, 20>

MOP = multiple of pickup <1.03, 2.5>



**Figure 10-5. Inverse Time Characteristic for Takeover OEL**

Primary and secondary setting groups provide additional control for two distinct machine operating conditions. Each mode of takeover OEL operation (offline and online) has low-level, high-level, and time dial settings.

Once the field current decreases below the dropout level (95% of pickup), the function is reset based on the selected reset method. The available reset methods are inverse, integrating, and instantaneous.

Using the inverse method, the OEL is reset based on time versus multiple of pickup (MOP). The lower the field current level, the less time is required for reset. Inverse reset uses the following curve (Equation 10-2) to calculate maximum reset time.

$$\text{Reset Time Constant} = \frac{RC \times TD \times 0.05}{1 - (MOP \times 1.03)^2}$$

**Equation 10-2. Inverse Reset Time Characteristic**

Where:

Reset Time Constant = maximum time to reset in seconds

RC = reset coefficient setting <0.01, 100>

TD = time dial setting <0.1, 20>

MOP = multiple of pickup

For the integrating reset method, the reset time is equal to the pickup time. In other words, the amount of time spent above the low level threshold is the amount of time required to reset.

Instantaneous reset has no intentional time delay.

BESTCOMSPi<sup>us</sup>® displays a plot of the takeover OEL setting curves as shown in Figure 10-6.

The levels have native units of Primary Amps and the rated data associated with them is Machine Rated Data, Current – Full Load (on the System Parameters, Rated Data screen).

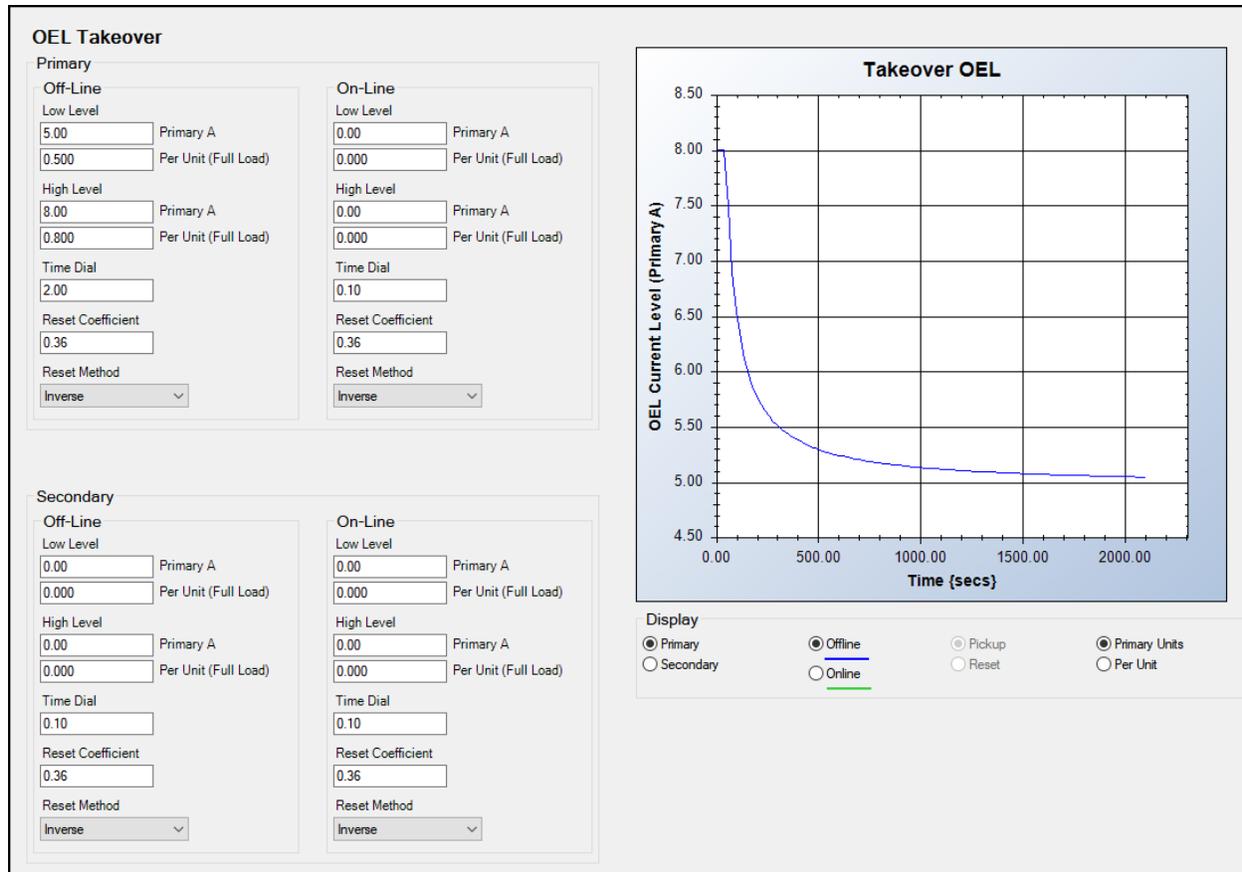


Figure 10-6. Takeover OEL Settings

## Underexcitation Limiter

**BESTCOMSPius Navigation Path:** Settings Explorer, Operating Settings, Limiters, UEL

**HMI Navigation Path:** Settings, Operating Settings, Limiters, UEL

Operating a generator in an underexcited condition can cause the stator end iron to overheat. Extreme underexcitation may lead to a loss of synchronism. The underexcitation limiter (UEL) senses the leading var level of the generator and limits decreases in excitation. When enabled, the UEL operates in all regulation modes. UEL behavior in manual mode can be configured to limit excitation or issue an alarm. This behavior is configured in BESTlogicPlus.

### Note

For UEL to operate, the PARALLEL\_EN\_LM logic block must be set true in BESTlogicPlus programmable logic.

UEL settings are illustrated in Figure 10-7 and Figure 10-8.

Underexcitation limiting is implemented through an internally-generated UEL curve or a user-defined UEL curve. The internally-generated curve is based on the desired reactive power limit at zero real power with respect to the generator voltage and current rating. The absorbed reactive power axis of the curve on the UEL Custom Curve screen can be tailored for your application.

A user-defined curve can have a maximum of five points. This curve allows the user to match a specific generator characteristic by specifying the coordinates of the intended leading reactive power (kvar) limit at the appropriate real power (kW) level.

The levels entered for the user-defined curve are defined for operation at the rated generator voltage. The user-defined UEL curve can be automatically adjusted based on generator operating voltage by using the UEL voltage dependency real-power exponent. The user-defined UEL curve is automatically adjusted based on the ratio of the generator operating voltage divided by the generator rated voltage raised to the power of the UEL voltage dependency real-power exponent. UEL voltage dependency is further defined by a real power filter time constant that is applied to the low-pass filter for the real power output.

### UEL Configure

UEL Configuration

UEL Configuraiton

Disabled ▼

UEL Voltage Dependency

Real Power Exponent

2.00

Real Power Filter Time Constant (s)

5.0

Figure 10-7. UEL Configuration Settings

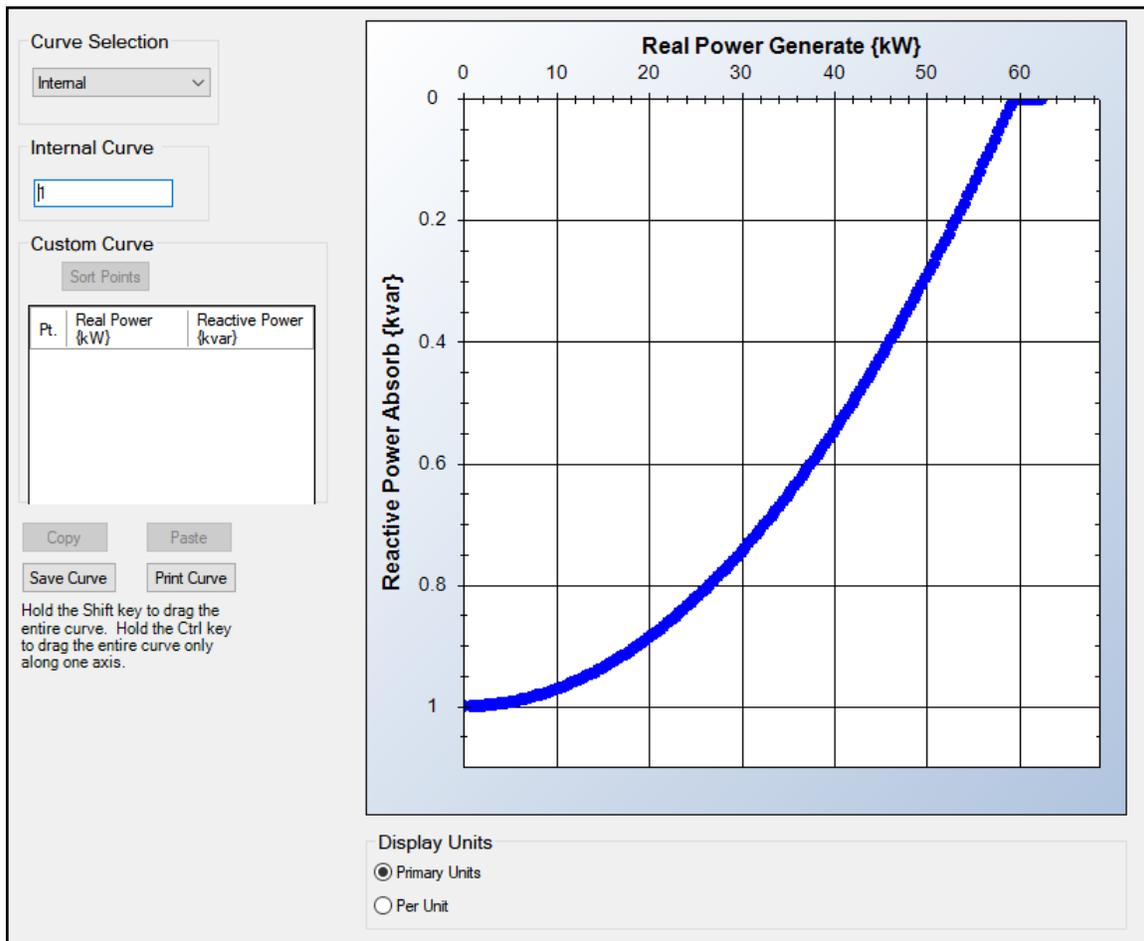


Figure 10-8. UEL Custom Curve Screen

## Stator Current Limiter

**BESTCOMSPPlus Navigation Path:** Settings Explorer, Operating Settings, Limiters, SCL

**HMI Navigation Path:** Settings, Operating Settings, Limiters, SCL

The stator current limiter (SCL) monitors the level of stator current and limits it to prevent stator overheating. To limit the stator current, the SCL modifies the excitation level according to the direction of var flow into or out of the generator. Excessive stator current with leading power factor calls for increased excitation. Excessive stator current with lagging power factor calls for reduced excitation.

The SCL can be enabled in all regulation modes. When operating in Manual mode, the DECS-450 will announce high stator current but will not act to limit it. Primary and secondary SCL setting groups provide additional control for two distinct machine operating conditions. Stator current limiting is provided at two levels: low and high (see Figure 10-9). SCL settings are illustrated in Figure 10-10.

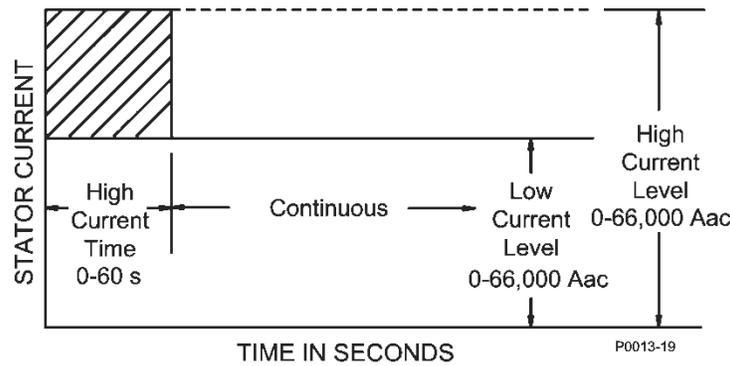


Figure 10-9. Stator Current Limiting

The levels have native units of Primary Amps and the rated data associated with them is Machine Rated Data, Current (on the System Parameters, Rated Data screen).

### SCL

Stator Current Limiter

Stator Current Limiter

|  |  |
|--|--|
| <p><b>Primary</b></p> <p>Initial Delay (s)<br/> <input type="text" value="0.0"/></p> <p>High SCL Level<br/> <input type="text" value="0.0"/> Primary A<br/> <input type="text" value="0.000"/> Per Unit</p> <p>High SCL Time (s)<br/> <input type="text" value="0.0"/></p> <p>Low SCL Level<br/> <input type="text" value="0.0"/> Primary A<br/> <input type="text" value="0.000"/> Per Unit</p> | <p><b>Secondary</b></p> <p>Initial Delay (s)<br/> <input type="text" value="0.0"/></p> <p>High SCL Level<br/> <input type="text" value="0.0"/> Primary A<br/> <input type="text" value="0.000"/> Per Unit</p> <p>High SCL Time (s)<br/> <input type="text" value="0.0"/></p> <p>Low SCL Level<br/> <input type="text" value="0.0"/> Primary A<br/> <input type="text" value="0.000"/> Per Unit</p> |
|--|--|

Figure 10-10. Stator Current Limiter Settings

### Low-Level Limiting

When the stator current exceeds the low-level setting, the DECS-450 annunciates the elevated level. If this condition persists for the duration of the High SCL Time setting, the DECS-450 acts to limit the current to the low-level SCL Setting. When the stator current is below the Low-Level SCL setting, no SCL limiting action is taken by the DECS-450. The High Current Timer counts down either from the high time,

if the High Current Timer has expired, or from the amount of time spent at high level, if the High Current Timer has not expired. The generator is permitted to operate indefinitely at or below the low-level threshold.

## High-Level Limiting

When the stator current exceeds the High-Level setting, the DECS-450 acts to limit the current to the value of the High-Level setting and a High Level Timer is initiated. If this level of current persists until this timer reaches the High-Level Time setting, the DECS-450 acts to limit the current to the value of the Low-level SCL setting.

## Initial Delay

In the case of low- or high-level stator current limiting, the limiting function will not respond until an initial time delay expires.

## Var Limiter

**BESTCOMSPlus Navigation Path:** Settings Explorer, Operating Settings, Limiters, var

**HMI Navigation Path:** Settings, Operating Settings, Limiters, VAR

The var limiter can be enabled to limit the level of reactive power exported from the generator. Primary and secondary setting groups provide additional control for two distinct machine operating conditions. The var limiter setpoint is expressed as a percentage of the calculated, maximum VA rating for the machine. A delay setting establishes a time delay between when the var threshold is exceeded and the DECS-450 acts to limit the var flow.

Var limiter settings are illustrated in Figure 10-11.

The screenshot shows the 'var' settings page. At the top, there is a 'var Limiter' section with a dropdown menu currently set to 'Disabled'. Below this, there are two columns: 'Primary' and 'Secondary'. Each column contains two input fields: 'Setpoint (%)' and 'Delay (s)'. The 'Setpoint (%)' fields both contain the value '100.0', and the 'Delay (s)' fields both contain the value '0.0'.

Figure 10-11. Var Limiter Settings

## Limiter Scaling

**BESTCOMSPlus Navigation Path:** Settings Explorer, Operating Settings, Limiters, Scaling

**HMI Navigation Path:** Settings, Operating Settings, Limiters, Scaling

Automatic adjustment (scaling) of the overexcitation limiter and stator current limiter is possible through the DECS-450 auxiliary control input and through the optional AEM-2020 Analog Expansion Module RTD inputs. Limiter scaling settings are illustrated in Figure 10-12. OEL and SCL scaling may be independently enabled and disabled. Automatic adjustment of the OEL and SCL is based on six parameters: signal and scale for three points (levels).

With the scaling input set to *Auxiliary Input*, the signal value for each point represents the auxiliary control input. This input can be a 4 to 20 mAdc signal applied to terminals I+ and I– or a –10 to +10 Vdc signal applied to terminals V+ and V–. See the *Auxiliary Control* section of this manual for details.

With the scaling input set to *AEM RTD #*, the signal value for each point represents an AEM RTD input in degrees Fahrenheit. See the *Analog Expansion Module* section of this manual for details.

The scale value for each point defines the limiter low level as a percent of rated full-load field current for the OEL and rated stator current for the SCL.

**Scaling**

OEL Scale Enable

SCL Scale Enable

| Summing Point OEL Scaling                                 | Takeover OEL Scaling                                      | SCL Scaling  |
|---|---|--|
| Point 1 - Signal<br><input type="text" value="77.00"/>    | Point 1 - Signal<br><input type="text" value="77.00"/>    | Point 1 - Signal (V)<br><input type="text" value="-5.00"/> |
| Point 1 - Scale (%)<br><input type="text" value="80.0"/>  | Point 1 - Scale (%)<br><input type="text" value="80.0"/>  | Point 1 - Scale (%)<br><input type="text" value="80.0"/>   |
| Point 2 - Signal<br><input type="text" value="212.00"/>   | Point 2 - Signal<br><input type="text" value="212.00"/>   | Point 2 - Signal (V)<br><input type="text" value="0.00"/>  |
| Point 2 - Scale (%)<br><input type="text" value="100.0"/> | Point 2 - Scale (%)<br><input type="text" value="100.0"/> | Point 2 - Scale (%)<br><input type="text" value="100.0"/>  |
| Point 3 - Signal<br><input type="text" value="347.00"/>   | Point 3 - Signal<br><input type="text" value="347.00"/>   | Point 3 - Signal (V)<br><input type="text" value="5.00"/>  |
| Point 3 - Scale (%)<br><input type="text" value="120.0"/> | Point 3 - Scale (%)<br><input type="text" value="120.0"/> | Point 3 - Scale (%)<br><input type="text" value="120.0"/>  |

Figure 10-12. Limiter Scaling Settings

## Underfrequency Limiter

**BESTCOMSPPlus Navigation Path:** Settings Explorer, Operating Settings, Limiters, Underfrequency  
**HMI Navigation Path:** Settings, Operating Settings, Limiters, UEL

The underfrequency limiter is selectable for underfrequency limiting or volts per hertz limiting. These limiters protect the generator from damage due to excessive magnetic flux resulting from low frequency and/or overvoltage.

Underfrequency and volts per hertz limiter settings are illustrated in Figure 10-15.

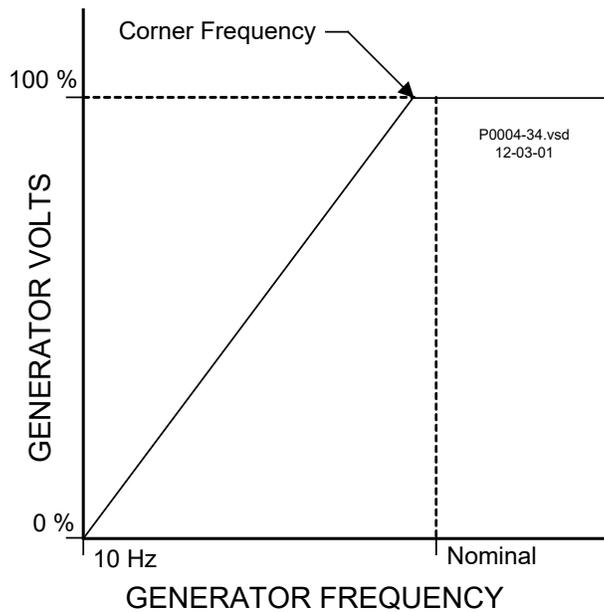


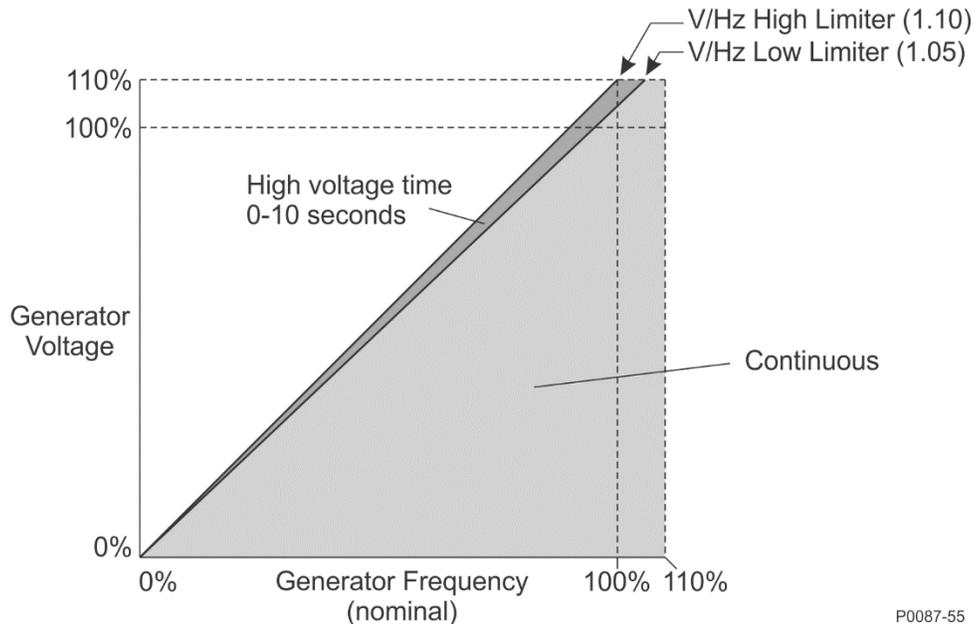
Figure 10-13. Typical Underfrequency Compensation Curve

If the generator frequency decreases below the corner frequency for the selected underfrequency slope (Figure 10-13), the DECS-450 adjusts the voltage setpoint so that the generator voltage follows the underfrequency slope. The adjustment range of the corner frequency and slope settings enables the

DECS-450 to precisely match the operating characteristics of the prime mover and the loads being applied to the generator.

### Volts per Hertz

The volts per hertz limiter prevents the regulation setpoint from exceeding the volts per hertz ratio defined by the V/Hz High Limiter and V/Hz Low Limiter settings. A typical volts per hertz limiter curve is illustrated in Figure 10-14.



**Figure 10-14. Typical Volts per Hertz Limiter Slopes**

Volts per hertz limiter operation is established by the V/Hz High Limiter, V/Hz Low Limiter, and V/Hz Time Limiter settings. The generator may operate continuously at setpoints below the low limit threshold. When the regulation setpoint is greater than the low limit threshold for the duration of the time delay, the setpoint is reduced to the low limit threshold and is prevented from exceeding the low limit threshold. The regulation setpoint is prevented from exceeding the value of the high limit threshold at all times.

**Underfrequency**

|   |  |   |
|---|--|---|
| <p><b>Limiter Mode</b></p> <p>Mode</p> <p>UF Limiter <span style="float: right;">▼</span></p> | <p><b>Underfrequency Limiter</b></p> <p>Corner Frequency (Hz)</p> <p><input type="text" value="57.0"/></p> <p>Slope</p> <p><input type="text" value="1.00"/></p> | <p><b>Volts/Hz Limiter</b></p> <p>V/Hz High Limiter</p> <p><input type="text" value="1.00"/></p> <p>V/Hz Low Limiter</p> <p><input type="text" value="1.00"/></p> <p>V/Hz Time Limiter (s)</p> <p><input type="text" value="10.0"/></p> |
|---|--|---|

**Figure 10-15. Underfrequency/Volts per Hertz Limiter Settings**



# 11 • Metering

The DECS-450 provides comprehensive metering of internal and system conditions. These capabilities include extensive parameter metering, status indication, reporting, and real-time metering analysis.

## Metering Explorer

DECS-450 metering is accessed through the metering explorer menu on the front panel HMI or the BESTCOMSPiUs® metering explorer.

### HMI

On the front panel HMI, the metering explorer is accessed through the Metering branch of the HMI menu.

### BESTCOMSPiUs®

In BESTCOMSPiUs, the metering explorer is located in the upper left portion of the application window.

### Metering Screen Docking

A docking feature within the metering explorer allows arrangement and docking of multiple metering screens. Clicking and dragging a metering screen tab displays a blue, transparent square, several arrow boxes, and a tab box. These docking elements are illustrated in Figure 11-1.

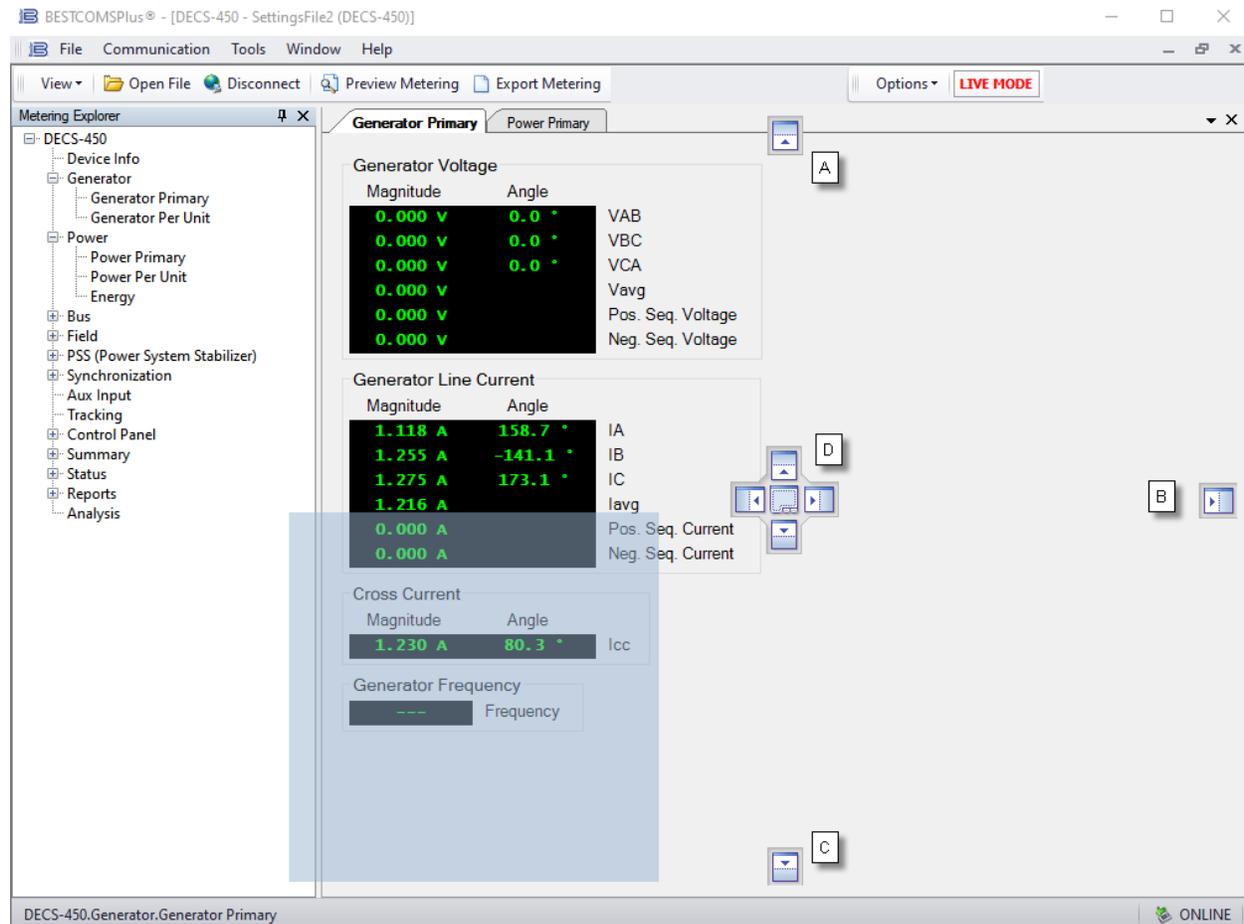


Figure 11-1. Metering Screen Docking Controls

Dragging the blue square to the “up” (locator A), “right” (locator B), or “down” (locator C) arrow box places the selected metering screen across the top, along the side, or at the bottom of the window. Once placed,

the screen's thumbtack icon can be clicked to dock the screen on the corresponding top, right, or lower bar. A docked screen is viewed by hovering the mouse pointer over the docked screen.

Dragging the blue square to one of the four arrow boxes (locator D) places the screen inside the selected window according to the arrow box selected. A metering screen can be placed as a tab inside the selected window by dropping the screen on the tab box at the center of the four arrow boxes.

Dragging the blue square anywhere other than one of the arrow/tab boxes places the selected metering screen as a floating window.

## Metered Parameters

DECS-450 metering categories include generator, power, bus, field, power system stabilizer (PSS), and generator synchronization parameters.

### Generator

**BESTCOMSPlus Navigation Path:** Metering Explorer, Generator

**HMI Navigation Path:** Metering Explorer, Generator

Metered generator parameters include the voltage (magnitude and angle), current (magnitude and angle), and frequency. Primary- and per-unit values are available. Figure 11-2 illustrates the generator primary-values metering screen.

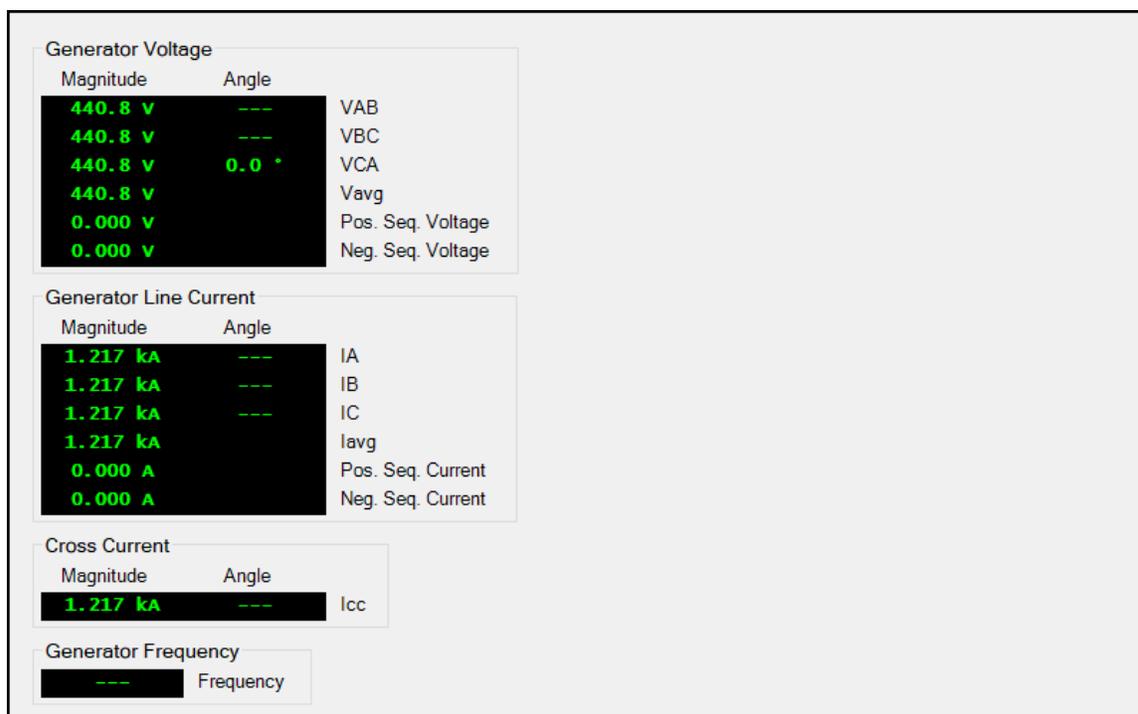


Figure 11-2. Generator Primary-Values Metering

### Power

**BESTCOMSPlus Navigation Path:** Metering Explorer, Power

**HMI Navigation Path:** Metering Explorer, Power

Metered power parameters include real power (kW), apparent power (kVA), reactive power (kvar), and machine power factor. Primary- and per-unit values are available. Accumulated kilowatthours (positive and negative kWh), kilovarhours (positive and negative kvarh), and kilovoltampere hours (kVAh) are also metered. Figure 11-3 illustrates the power primary-values screen and Figure 11-4 illustrates the energy screen.



Figure 11-3. Power Primary-Values



Figure 11-4. Energy

When operating in motor mode, values for var and power factor are opposite in BESTCOMSP*lus* and on the front-panel HMI.

## Bus

**BESTCOMSP*lus* Navigation Path:** Metering Explorer, Bus

**HMI Navigation Path:** Metering Explorer, Bus

Metered bus parameters include the voltage across phases A and B (Vab), phases B and C (Vbc), phases A and C (Vca), and the average bus voltage. The frequency of the bus voltage is also metered. Primary- and per-unit values are available. Figure 11-5 illustrates the bus primary-values metering screen.

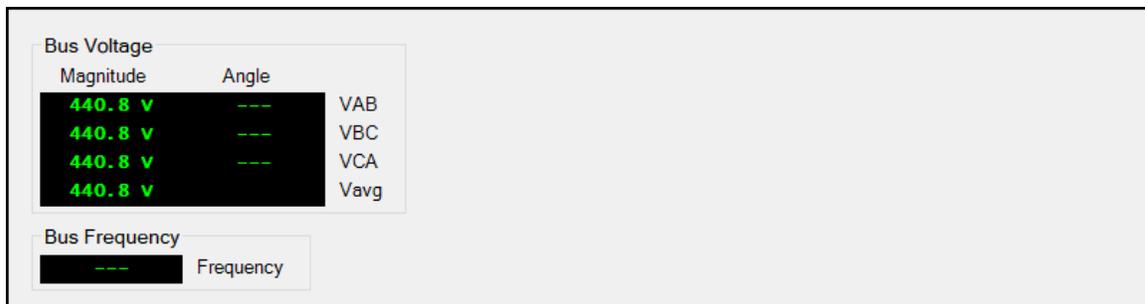


Figure 11-5. Bus Primary-Values Metering

## Field

**BESTCOMSP*lus* Navigation Path:** Metering Explorer, Field

**HMI Navigation Path:** Metering Explorer, Field

Metered field parameters include the field voltage (Vfd), current (Ifd), temperature, and exciter diode ripple. The exciter diode ripple is reported by the exciter diode monitor (EDM) as a percentage of the induced ripple in the exciter field current.

The DECS-450 requires the field current to be at least 20% of the shunt current rating in order to calculate the field temperature. For field current less than 20%, the ambient settings value will be reported.

The level of excitation power supplied to the field is displayed as a percentage, with 0% being the minimum and 100% being the maximum.

Primary- and per-unit values are available. Figure 11-6 illustrates the field primary-values metering screen.



Figure 11-6. Field Primary-Values Metering

## PSS

**BESTCOMSPlus Navigation Path:** Metering Explorer, PSS (Power System Stabilizer)

**HMI Navigation Path:** Metering Explorer, PSS

Values metered by the power system stabilizer function display positive sequence voltage and current, negative sequence voltage and current, terminal frequency deviation, compensated frequency deviation, per-unit PSS output level and PSS frequency rate of change. The PSS function on/off status is also reported. Primary- and per-unit values are available. Figure 11-7 illustrates the PSS primary-values metering screen.

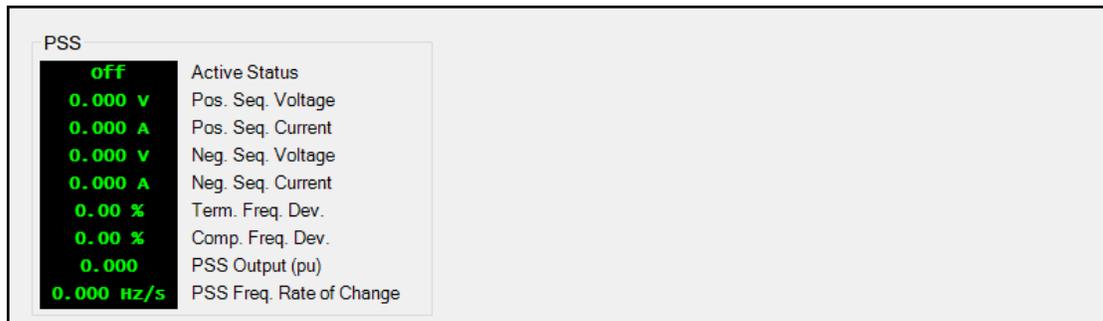


Figure 11-7. PSS Primary-Values Metering

## Synchronization

**BESTCOMSPlus Navigation Path:** Metering Explorer, Synchronization

**HMI Navigation Path:** Metering Explorer, Synchronization

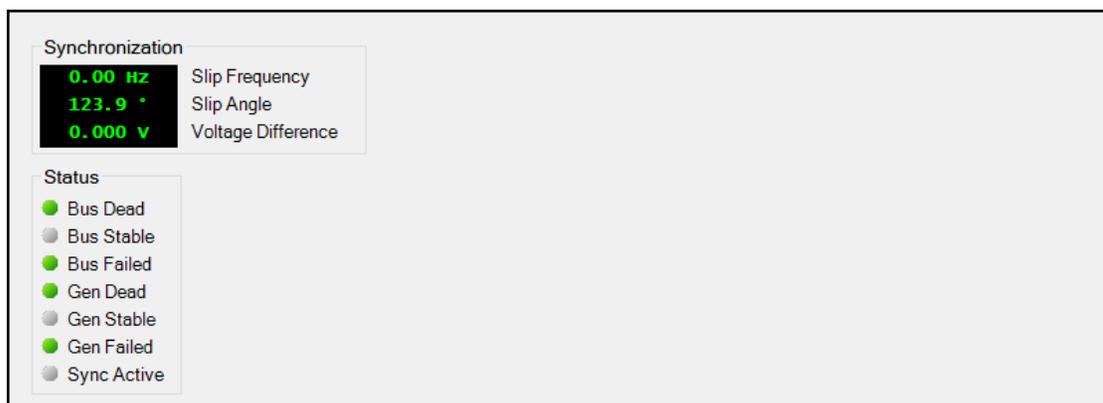


Figure 11-8. Synchronization Primary Values Metering

Metered generator-to-bus synchronization parameters include the slip frequency, slip angle, and voltage difference. Primary- and per-unit values are available. Figure 11-8 illustrates the synchronization primary-values metering screen.

### Auxiliary Control Input

**BESTCOMSPius Navigation Path:** Metering Explorer, Aux Input

**HMI Navigation Path:** Metering Explorer, Aux Input

The control signal applied at the DECS-450 auxiliary control input is indicated on the Aux Input metering screen (Figure 11-9). As configured in BESTCOMSPius, a dc voltage or dc current signal may be applied.

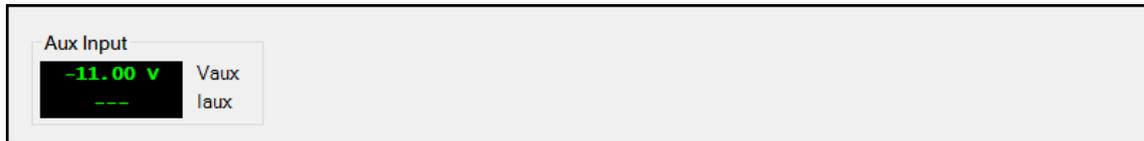


Figure 11-9. Auxiliary Control Input Metering

### Tracking

**BESTCOMSPius Navigation Path:** Metering Explorer, Tracking

**HMI Navigation Path:** Metering Explorer, Tracking

The metered setpoint tracking error between DECS-450 operating modes is displayed on the Tracking metering screen (Figure 11-10). Status fields are provided for the on/off status for internal setpoint tracking, external setpoint tracking and null balance, which indicates when the setpoint of an inactive operating mode matches the metered value.

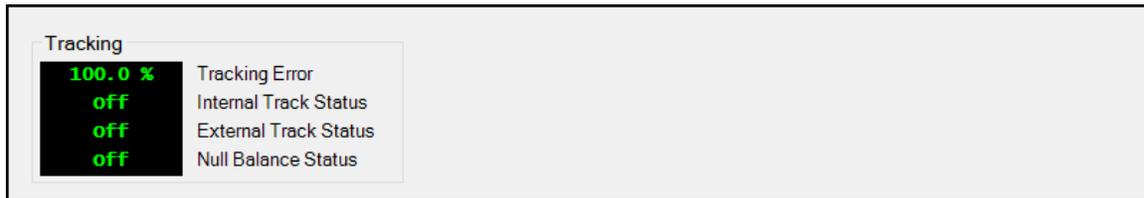


Figure 11-10. Tracking Metering

### Control Panel

**BESTCOMSPius Navigation Path:** Metering Explorer, Control Panel

**HMI Navigation Path:** Metering Explorer, Control Panel

The Control Panel (Figure 11-11) provides options for changing operating modes, selecting setpoint pre-positions, fine tuning setpoints, and toggling virtual switches. The setpoints for AVR, FCR, FVR, var, and PF are displayed, as well as Alarm status, PSS status, and Null Balance status.

**Start/Stop Mode:** Two indicators show the start/stop mode of the DECS-450. When a mode is active, its corresponding indicator changes from gray to green. To Start DECS-450 regulation, click the Start button. Click the Stop button to stop DECS-450 regulation.

**AVR/Manual Mode:** AVR and Manual Mode status is reported by two indicators. When a mode is active, its corresponding indicator changes from gray to green. AVR mode is selected by clicking the *AVR* button and manual mode is selected by clicking the *Manual* button.

**FCR/FVR Mode:** FCR and FVR mode status is reported by two indicators. When a mode is active, its corresponding indicator changes from gray to green. FCR mode is selected by clicking the *FCR* button and FVR mode is selected by clicking the *FVR* button.

**Var/PF Mode:** Three indicators report whether Var mode, Power Factor mode, or neither mode is active. When a mode is active, its corresponding indicator changes from gray to green. When neither mode is active, the Off indicator changes from gray to green. Var mode is enabled by clicking the *var* button and

Power Factor mode is enabled by clicking the *PF* button. Neither mode is enabled by clicking the *Off* button. Only one mode can be enabled at any time.

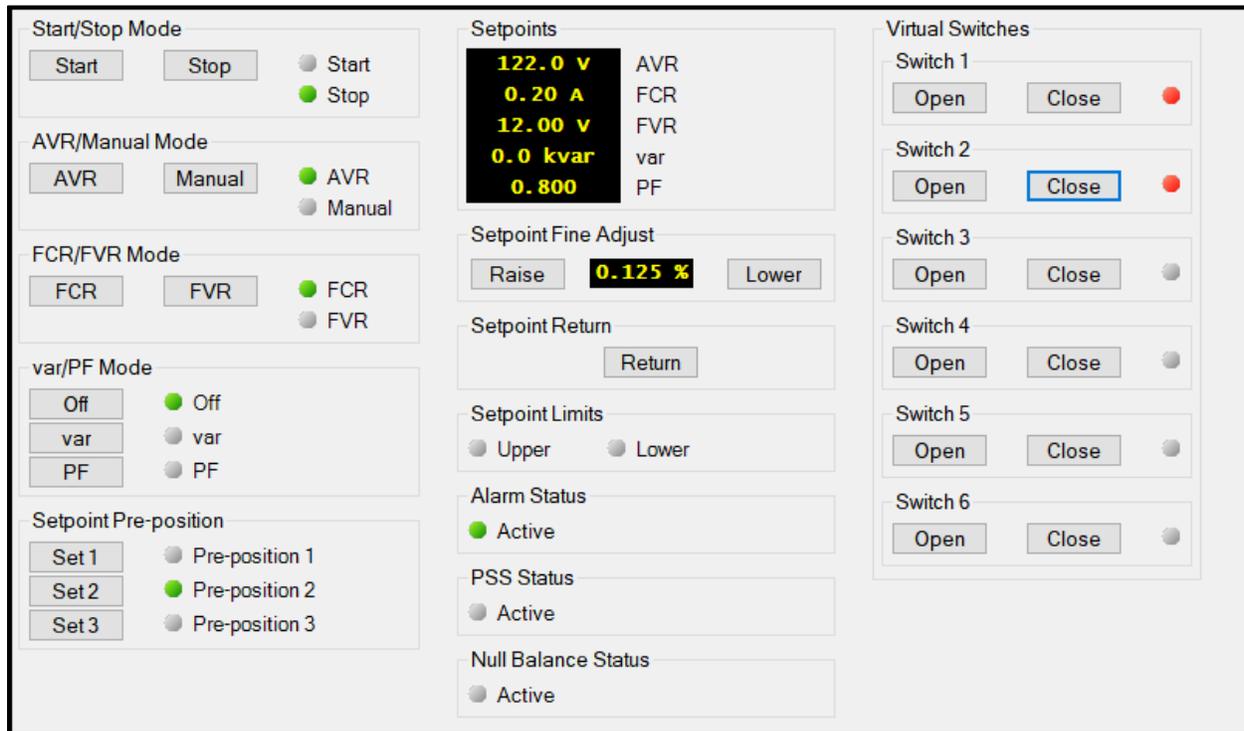


Figure 11-11. Control Panel

**Setpoint Pre-position:** A control button and indicator is provided for the three setpoint pre-positions. Clicking the *Set 1* button adjusts the excitation setpoint to the Pre-position 1 value and changes the Pre-position 1 indicator to green. Pre-positions 2 and 3 are selected by clicking either the *Set 2* or *Set 3* button.

**Setpoints:** Five status fields display the active setpoints for AVR mode, FCR mode, FVR mode, var mode, and Power Factor mode. These active setpoints, represented by a yellow font, are not to be confused with metered analog values which are represented by a green font throughout BESTCOMSPius. For details on operating setpoint settings, see the *Regulation* section.

**Setpoint Fine Adjust:** Clicking the *Raise* button increases the active operating setpoint. Clicking the *Lower* button decreases the active operating setpoint. The raise and lower increment is directly proportional to the adjustment range and inversely proportional to the traverse rate.

**Setpoint Return:** Clicking the *Return* button changes the active operating setpoint back to the original value before it was adjusted.

**Setpoint Limits:** The *Upper* indicator changes from gray to green when the upper setpoint limit threshold has been exceeded. The *Lower* indicator changes from gray to green when the lower setpoint limit threshold has been exceeded.

**Alarm Status:** The *Alarm Status* indicator changes from gray to green when there is an active alarm.

**PSS Status:** The *PSS Status* indicator changes from gray to green when the PSS is active.

**Null Balance:** The *Null Balance* indicator changes from gray to green when the setpoint of the inactive operating modes (AVR, FCR, FVR, var, and PF) match the setpoint of the active mode.

**Virtual Switches:** These buttons control the open or closed status of the six virtual switches. Clicking the *Open* button sets the switch to the open position and changes the switch indicator to gray. Clicking the *Close* button sets the switch to the closed position and changes the switch indicator to red. A dialog will appear asking if you are sure you want to open or close the switch.

## Metering Summary

**BESTCOMSPlus Navigation Path:** Metering Explorer, Summary

**HMI Navigation Path:** Not available via HMI

All of the metering values displayed on the individual, previously described metering screens are consolidated on the metering summary screen (Figure 11-12). The primary- and per-unit metering summary screens are available only in BESTCOMSPlus.



Figure 11-12. Metering Summary Screen

## Status Indication

Status indication is provided for DECS-450 system functions, inputs, outputs, network load share, configurable protection, alarms, and the real-time clock.

## System Status

**BESTCOMSPlus Navigation Path:** Metering Explorer, Status, System Status

**HMI Navigation Path:** Metering Explorer, Status, System Status

When any of the system functions illustrated in Figure 11-13 are active, the corresponding indicator changes from gray to green. An inactive function is represented by a gray indicator.

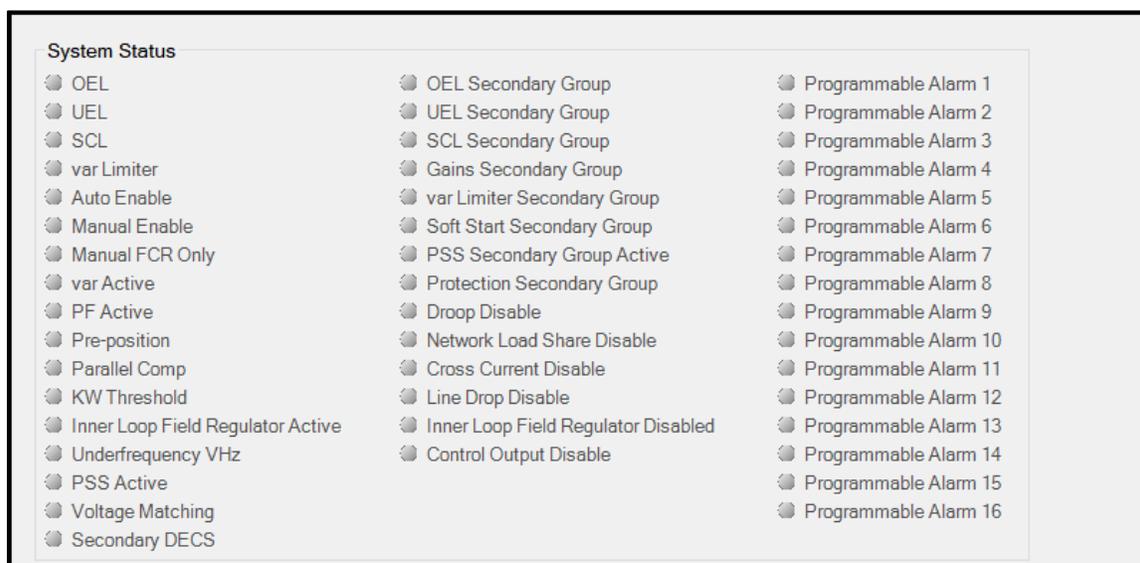


Figure 11-13. System Status Indication Screen

## Inputs

**BESTCOMSPlus Navigation Path:** Metering Explorer, Status, Inputs

**HMI Navigation Path:** Metering Explorer, Status, Inputs

Status annunciation is provided for the DECS-450, optional Contact Expansion Module (CEM-125 or CEM-2020) inputs and optional Analog Expansion Module (AEM-2020) inputs.

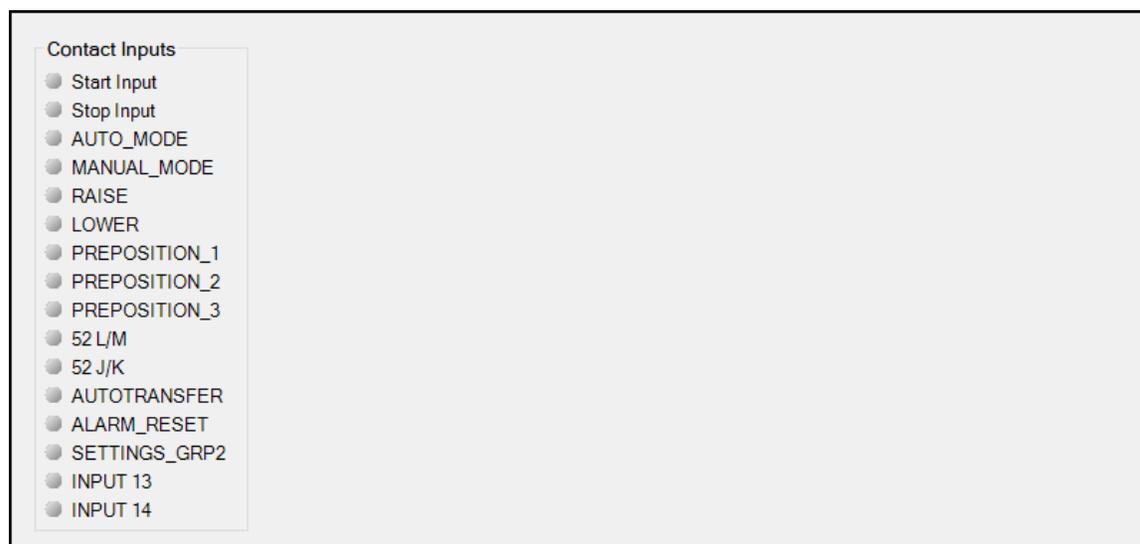


Figure 11-14. DECS-450 Contact Inputs Status Indication Screen

### DECS-450 Contact Inputs

Status indication for the DECS-450's 16 contact sensing inputs is provided on the BESTCOMSPlus contact inputs screen illustrated in Figure 11-14. An indicator changes from gray to red when a closed contact is sensed at the corresponding input.

### AEM-2020 Inputs

Status annunciations for the optional AEM-2020 Analog Expansion Module's analog, RTD, thermocouple, and analog metering inputs are provided on the BESTCOMSPlus remote analog inputs, remote RTD inputs, remote thermocouple inputs, and remote analog input values screens. These screens are described and illustrated in the *Analog Expansion Module* section of this manual.

### CEM-125 and CEM-2020 Contact Inputs

The status of the 10 contact sensing inputs of the optional CEM-125 or CEM-2020 Contact Expansion Module is provided on the BESTCOMS*Plus* remote contact inputs screen. See the *Contact Expansion Module* section of this manual for a description and illustration of this screen.

## Outputs

**BESTCOMS*Plus* Navigation Path:** Metering Explorer, Status, Outputs

**HMI Navigation Path:** Metering Explorer, Status, Outputs

Status annunciation is provided for the DECS-450 contact outputs and optional Contact Expansion Module (CEM-125 or CEM-2020) contact outputs. Annunciation is also provided for the optional Analog Expansion Module (AEM-2020) analog outputs.

### DECS-450 Contact Outputs

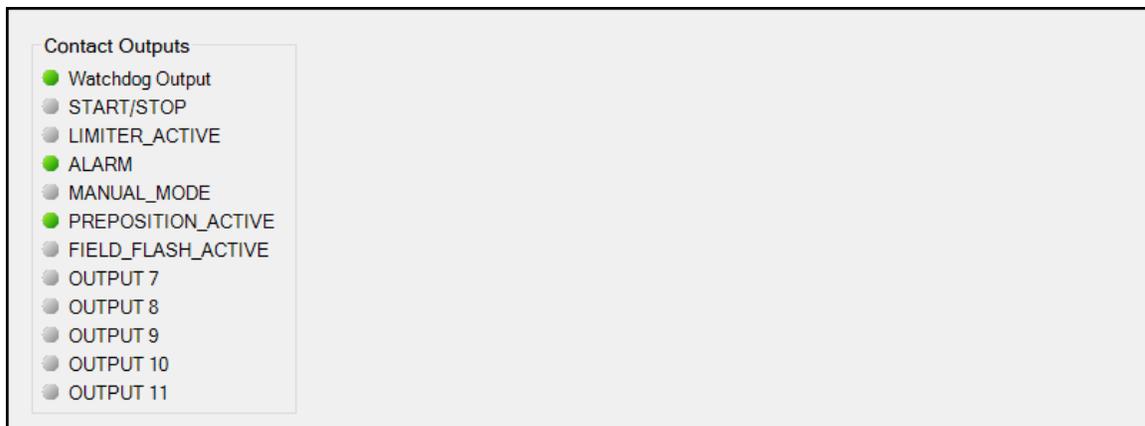
Status indication for the DECS-450's Watchdog and 11 programmable contact outputs is provided on the BESTCOMS*Plus* contact outputs screen illustrated in Figure 11-15. An indicator changes from gray to green when the corresponding output changes state (Watchdog output) or closes (Output 1 through 11).

### CEM-125 and CEM-2020 Contact Outputs

The status of the 24 contact outputs of the optional CEM-125 or CEM-2020 Contact Expansion Module is provided on the BESTCOMS*Plus* remote contact inputs screen. See the *Contact Expansion Module* section of this manual for a description and illustration of this screen.

### AEM-2020 Analog Outputs

Metering and status indications provided by the optional AEM-2020 Analog Expansion Module are shown on the BESTCOMS*Plus* remote analog outputs screen. This screen is described and illustrated in the *Analog Expansion Module* section of this manual.



**Figure 11-15. DECS-450 Contact Outputs Status Indication Screen**

## Network Load Share

The screen shown in Figure 11-16 reports the error percent, reactive current, NLS average reactive current, and number of generators online. The status indicators change from gray to green when a status is active.

The Error percent is the deviation of the unit's reactive current from the system average. The NLS Average Reactive Current is the average of the reactive current of every unit in the system. Generators Online is the number of units actively load sharing.

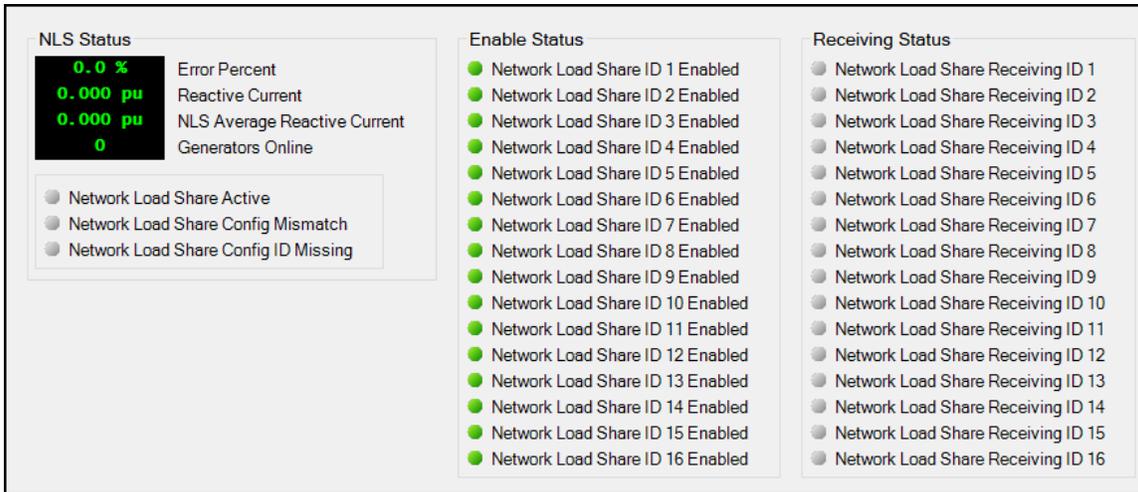


Figure 11-16. NLS Status Screen

### Configurable Protection

**BESTCOMSPlus Navigation Path:** Metering Explorer, Status, Configurable Protection

**HMI Navigation Path:** Metering Explorer, Status, Configurable Protection

Trip status for the eight configurable, supplemental protection elements is annunciated on the BESTCOMSPlus configurable protection screen (Figure 11-17). An indicator for each protection element's four trip thresholds changes from gray to green when the corresponding trip threshold is exceeded.

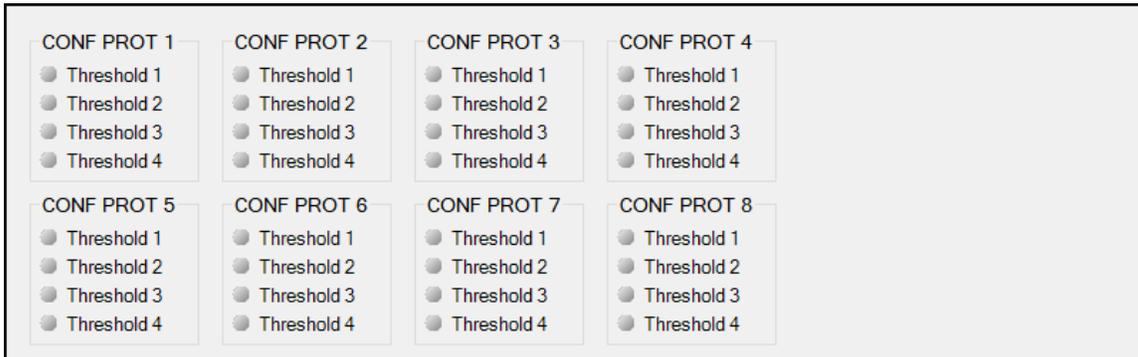


Figure 11-17. Configurable Protection Indication Status Screen

### Alarms

**BESTCOMSPlus Navigation Path:** Metering Explorer, Status, Alarms

**HMI Navigation Path:** Alarms automatically displayed when active

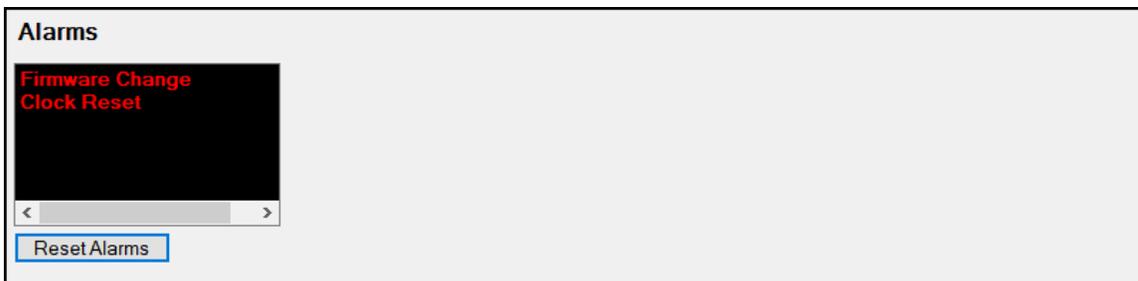


Figure 11-18. DECS-450 Alarm Annunciation and Reset Screen

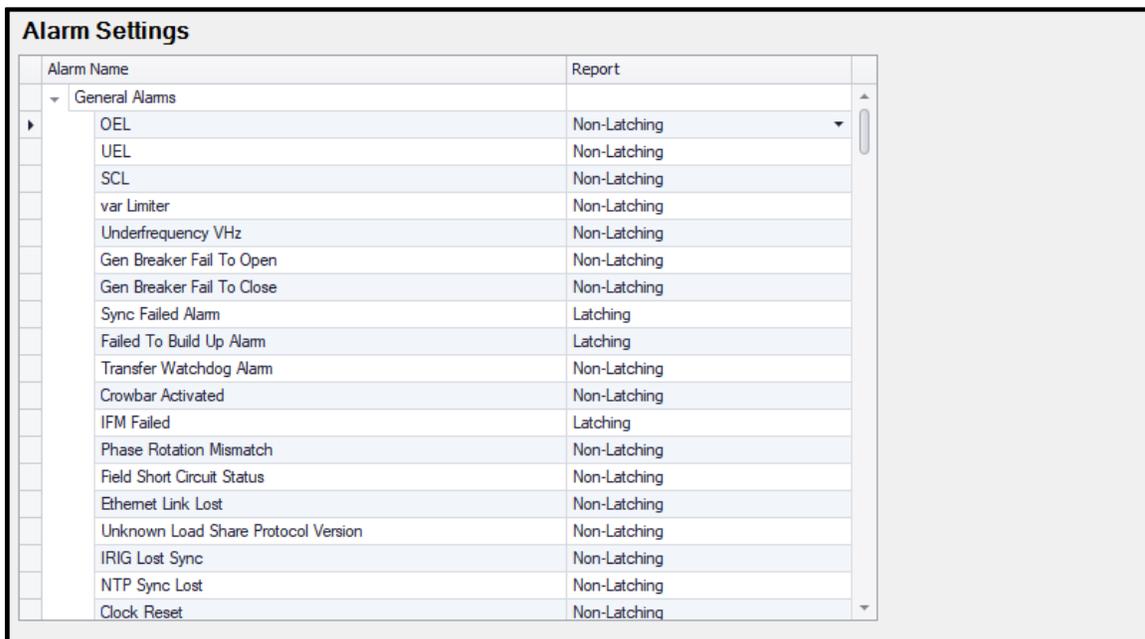
System parameters, communication links, protection functions, and remote inputs/outputs are monitored for alarm conditions. Active and previously latched alarms are listed on the front panel display and the Alarms screen of BESTCOMSP<sub>Plus</sub>. At the front panel, an inactive alarm is reset by selecting the alarm and then pressing the Reset pushbutton. Click the Reset Alarms button on the Alarms screen to clear all inactive alarms in BESTCOMSP<sub>Plus</sub>. The BESTCOMSP<sub>Plus</sub> Alarms screen is illustrated in Figure 11-18.

### Alarm Configuration

#### **BESTCOMSP<sub>Plus</sub> Navigation Path:** Settings Explorer, Alarm Configuration, Alarms

Alarms are configured using BESTCOMSP<sub>Plus</sub>. Customize the reporting style of each alarm by choosing *Disabled*, *Latching*, or *Non-Latching*. Latching alarms are stored in nonvolatile memory and are retained even when control power to the DECS-450 is lost. Active alarms are shown on the front panel HMI and in BESTCOMSP<sub>Plus</sub> until they are cleared. Non-latching alarms are cleared when control power is removed. Disabling an alarm affects only the annunciation of the alarm and not the actual operation of the alarm. This means that the alarm will still trip when trip conditions are met and the occurrence will appear on the sequence of events reports.

The BESTCOMSP<sub>Plus</sub> Alarm Settings screen is shown in Figure 11-19 below.



| Alarm Name                          | Report       |
|-------------------------------------|--------------|
| General Alarms                      |              |
| OEL                                 | Non-Latching |
| UEL                                 | Non-Latching |
| SCL                                 | Non-Latching |
| var Limiter                         | Non-Latching |
| Underfrequency VHz                  | Non-Latching |
| Gen Breaker Fail To Open            | Non-Latching |
| Gen Breaker Fail To Close           | Non-Latching |
| Sync Failed Alarm                   | Latching     |
| Failed To Build Up Alarm            | Latching     |
| Transfer Watchdog Alarm             | Non-Latching |
| Crowbar Activated                   | Non-Latching |
| IFM Failed                          | Latching     |
| Phase Rotation Mismatch             | Non-Latching |
| Field Short Circuit Status          | Non-Latching |
| Ethernet Link Lost                  | Non-Latching |
| Unknown Load Share Protocol Version | Non-Latching |
| IRIG Lost Sync                      | Non-Latching |
| NTP Sync Lost                       | Non-Latching |
| Clock Reset                         | Non-Latching |

**Figure 11-19. Alarm Settings Screen**

### User-Programmable Alarms

#### **BESTCOMSP<sub>Plus</sub> Navigation Path:** Settings Explorer, Alarm Configuration, User Programmable Alarms

Sixteen user programmable alarms are available. User alarm labels are entered on the User Programmable Alarms screen (Figure 11-20). If the trip condition exists for the duration of the Activation Delay, the alarm trips. When active, the label of a user programmable alarm is displayed on the BESTCOMSP<sub>Plus</sub> Alarms screen, on the front panel display, and in the sequence of events reports.

Each alarm provides a logic output that can be connected to a physical output or other logic input using BESTlogic™ *Plus* Programmable Logic. Refer to the *BESTlogicPlus* section for more information on setting up alarm logic.

### Retrieving Alarm Information

Alarms are automatically displayed in the sequence of events reports and on the front panel display when active. To view active alarms using BESTCOMSP<sub>Plus</sub>, open the Metering Explorer, Status, Alarms screen.

### Resetting Alarms

BESTlogicPlus may be used to reset alarms. Use the Settings Explorer within BESTCOMSPPlus to open the BESTlogicPlus Programmable Logic screen. Select the ALARM\_RESET logic block from the list of *Elements*. Use the drag and drop method to connect a variable or series of variables to the *Reset* input. When this input is set TRUE, this element resets all active alarms. Refer to the *BESTlogicPlus* section for more information.

The screenshot displays the 'User Programmable Alarms' configuration screen. It features a grid of 16 individual alarm configuration panels, labeled 'User Programmable Alarm #1' through '#16'. Each panel contains the following fields:

- Label Text:** A text input field with a default value of 'Programmable Alarm #N Name' (where N is the alarm number).
- Activation Delay (s):** A numeric input field with a default value of '0'.

Figure 11-20. User Programmable Alarms Screen

### Real-Time Clock

**BESTCOMSPPlus Navigation Path:** Metering Explorer, Status, Real Time Clock

**HMI Navigation Path:** Metering Explorer, Status, Real Time Clock

The DECS-450's time and date is displayed and adjusted on the Real-Time Clock screen (Figure 11-21). In BESTCOMSPPlus, clicking the Edit button displays a window where the time and date may be adjusted either manually or synchronized with the connected PC's clock. Through the HMI, time and date may be edited manually only.

Advanced clock settings such as time and date format, daylight saving time, network time protocol, and IRIG are described in the *Timekeeping* section of this manual.

The screenshot shows the 'Real Time Clock' screen. It displays the current time and date in a digital format. The time is shown as '14:33:39' and the date as '2020-02-24'. Below the time and date, there is an 'Edit' button.

Figure 11-21. Real-Time Clock Screen

## Auto Export Metering

The Auto Export Metering function, in the BESTCOMSP*lus* Tools menu, automatically saves metering data files at specific intervals over a period of time while connected to a DECS-450. Enter the number of exports and the interval between each export. Click the Filter button to choose which parameters are included in the data file. Enter a base filename for the data files and specify a directory for storing the files. Click Start to begin the Auto Export Metering session. The first export is performed immediately upon clicking the Start button. Figure 11-22 illustrates the Auto Export Metering screen.

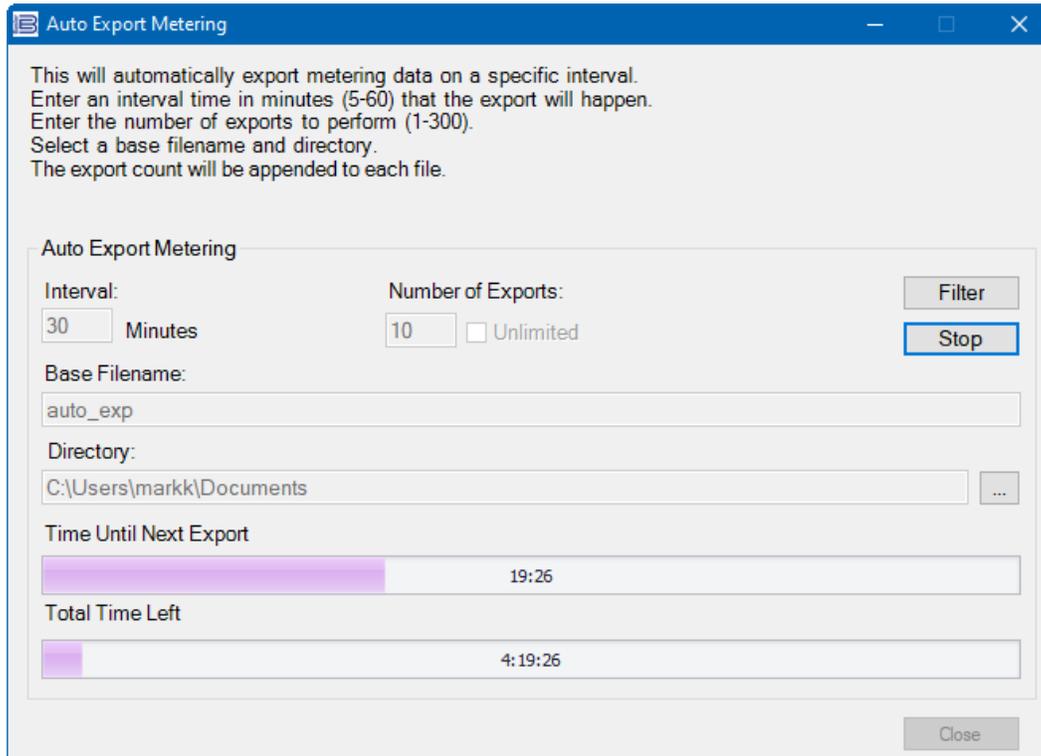


Figure 11-22. Auto Export Metering



# 12 • Event Recorder

DECS-450 event recorder functions include sequence-of-events recording (SER), data logging (oscillography), and trending.

## Sequence-of-Events Recording

**BESTCOMSPlus Navigation Path:** Settings Explorer, Report Configuration, Sequence of Events Setup  
**HMI Navigation Path:** Not available through the HMI

The DECS-450 SER scans parameters at four-millisecond intervals and records any changes of state (event) with a time and date stamp. Up to 2,047 events are stored in the record and, if the record is full, the oldest events are overwritten as new events occur.

More than 400 different parameters are scanned by default, but each parameter may be filtered on or off to suit user preference. To adjust parameter filters, use the BESTCOMSPlus Settings Explorer to open Report Configuration, Sequence of Events Setup (Figure 12-1). Parameter filter settings are not available through the HMI.

To view the current SER record, use the BESTCOMSPlus Metering Explorer to open Reports, Sequence of Events.



Figure 12-1. Sequence of Events Setup

## Data Logging

**BESTCOMSPlus Navigation Path:** Settings Explorer, Report Configuration, Data Log  
**HMI Navigation Path:** Settings, Report Configuration, Datalog

The data logging function of the DECS-450 can record up to six oscillography records. DECS-450 oscillography records use the IEEE Standard Common Format for Transient Data Exchange (COMTRADE). Each record is time- and date-stamped. After six records have been recorded, the

DECS-450 begins recording the next record over the oldest record. Because oscillography records are stored in nonvolatile memory, interruptions in DECS-450 control power will not affect the integrity of the records. Data log settings are configured in BESTCOMSP $Plus$  and illustrated in Figure 12-2 through Figure 12-5.

## Setup

When oscillography is enabled, the records consist of up to six user-selectable parameters with up to 1,200 data points recorded for each parameter. Data log setup settings are illustrated in Figure 12-2.

A Pre-Trigger Points setting specifies the number of data points to include in a data log that were recorded prior to the event trigger. The value of this setting affects the duration of the recorded pre-trigger points, the recorded post-trigger points, and the duration of the post-trigger points. A sample interval setting establishes the sample rate of the data points recorded. The value of this setting affects the pre- and post-trigger duration values and the total recording duration for a data log.

Figure 12-2. Data Log Setup

## Triggers

**BESTCOMSP $Plus$  Navigation Path:** Settings Explorer, Report Configuration, Data Log

**HMI Navigation Path:** Settings, Configuration Settings, Data Log

Data logging may be triggered by mode triggers, logic triggers, level triggers, or manually through BESTCOMSP $Plus$ .

### Mode Triggers

Mode triggers initiate data logging as a result of an internal or external DECS-450 status change. A data log can be triggered by any of the following status changes:

- Start or Stop mode selected
- Soft Start mode enabled or disabled
- Underfrequency condition
- Manual or AVR mode selected
- Power Factor or Var mode selected
- Limiter active
- Voltage matching enabled or disabled
- Primary or secondary DECS selected
- PSS enabled or disabled
- Auto Sync enabled or disabled

- FCR or FVR mode selected
- Droop mode enabled or disabled
- Network Load Share enabled or disabled
- Line drop compensation enabled or disabled
- Cross-current compensation enabled or disabled
- Test mode enabled or disabled

Mode trigger settings are illustrated in Figure 12-3.

| Mode Triggers          |                  |            |                     |
|------------------------|------------------|------------|---------------------|
| Data Log Mode Triggers |                  |            |                     |
| Start/Stop             | Power Factor/var | PSS        | Network Load Share  |
| No Trigger             | No Trigger       | No Trigger | No Trigger          |
| Soft Start             | Limiters         | Auto Sync  | Line Drop           |
| No Trigger             | No Trigger       | No Trigger | No Trigger          |
| Underfrequency         | Voltage Matching | FCR/FVR    | Cross Current Comp. |
| No Trigger             | No Trigger       | No Trigger | No Trigger          |
| Auto/Manual            | Pri/Sec DECS     | Droop      | Test                |
| No Trigger             | No Trigger       | No Trigger | No Trigger          |

Figure 12-3. Data Log Mode Triggers

### Level Triggers

Level triggering initiates a data log when the value of a system parameter crosses an upper threshold, lower threshold, or both. The parameters available to trigger a data log are listed below.

Level triggers are configured in the BESTCOMSP<sup>Plus</sup> Settings Explorer, Report Configuration, Data Log, Level Triggers screen (Figure 12-4).

| Level Triggers                      |                 |                      |
|-------------------------------------|-----------------|----------------------|
| Auxiliary Voltage Input (pu)        |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| Positive Sequence Current (pu)      |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| AVR Output (pu)                     |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| Positive Sequence Voltage (pu)      |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| AVR PID Error Signal Input (pu)     |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| PSS Electrical Power (pu)           |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| Bus Frequency (Hz)                  |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| PSS Filtered Mech. Power (pu)       |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| Bus Voltage (pu)                    |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| PSS Final Output (pu)               |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| Comp. Frequency Deviation (pu*1000) |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |
| PSS Frequency Rate of Change (Hz/s) |                 |                      |
| Lower Threshold                     | Upper Threshold | Level Trigger Enable |
| 0.00                                | 0.00            | No Trigger           |

Figure 12-4. Data Log Level Triggers

- Auxiliary voltage input
- AVR output
- AVR PID error signal input
- Bus frequency
- Bus voltage
- Comp. frequency deviation
- Control output
- Cross current input
- Droop
- FCR error
- FCR output
- FCR state
- Field current (Full Load)
- Field voltage (Full Load)
- Field temperature
- Frequency response

- FVR error
- FVR output
- FVR state
- Generator apparent power
- Generator average current
- Generator average voltage
- Generator current Ia
- Generator current Ib
- Generator current Ic
- Generator frequency
- Generator power factor
- Generator reactive power
- Generator real power
- Generator voltage Vab
- Generator voltage Vbc
- Generator voltage Vca
- Internal State
- Negative sequence current
- Negative sequence voltage
- Network Load Share
- Null balance level
- OEL controller output
- OEL ref.
- OEL state
- Position Indication
- Positive sequence current
- Positive sequence voltage
- PSS electrical power
- PSS filtered mech. Power
- PSS final output
- PSS frequency rate of change
- PSS lead/lag #1
- PSS lead/lag #2
- PSS lead/lag #3
- PSS lead/lag #4
- PSS mechanical power
- PSS mechanical power LP #1
- PSS mechanical power LP #2
- PSS mechanical power LP #3
- PSS mechanical power LP #4
- PSS post-limit output
- PSS power HP #1
- PSS pre-limit output
- PSS speed HP #1
- PSS synthesized speed
- PSS terminal voltage
- PSS torsional filter #1
- PSS torsional filter #2
- PSS washed out power
- PSS washed out speed
- SCL controller output
- SCL PF ref.
- SCL ref.
- SCL state
- Terminal frequency deviation
- Time response
- UEL controller output
- UEL ref.
- UEL state
- Var limit output
- Var limit ref
- Var limit state
- Var/PF error
- Var/PF output
- Var/PF state

### Logic Triggers

Logic triggering initiates a data log as a result of an internal or external status change. A data log can be triggered by any combination of alarm, contact output, or contact input state changes. The available logic triggers are illustrated in Figure 12-5.

| Alarm States                       |                           | Relay Outputs   | Contact Inputs |
|------------------------------------|---------------------------|-----------------|----------------|
| Generator Overvoltage              | Under Freq Limiter        | Watchdog Output | Start Input    |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Generator Undervoltage             | Set Point Upper Limit     | Relay1 Output   | Stop Input     |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Excess Volts Per Hz                | Set Point Lower Limit     | Relay2 Output   | Switch1 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Loss Of Excitation                 | EDM Open Diode            | Relay3 Output   | Switch2 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Loss Of Field Isolation Transducer | EDM Shorted Diode         | Relay4 Output   | Switch3 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Loss Of Sensing Voltage            | PSS Power Below Threshold | Relay5 Output   | Switch4 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Below 10 Hz                        | PSS Volt Unbalanced       | Relay6 Output   | Switch5 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Failed To Build Up                 | PSS Current Unbalanced    | Relay7 Output   | Switch6 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Field Overvoltage                  | PSS Speed Failure         | Relay8 Output   | Switch7 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Field Overcurrent                  | PSS Voltage Limit Alarm   | Relay9 Output   | Switch8 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| Field Overtemperature              | Power Input Failure       | Relay 10 Output | Switch9 Input  |
| Disabled                           | Disabled                  | Disabled        | Disabled       |
| OEL                                |                           | Relay11 Output  | Switch10 Input |
| Disabled                           |                           | Disabled        | Disabled       |
| UEL                                |                           |                 | Switch11 Input |
| Disabled                           |                           |                 | Disabled       |
| SCL                                |                           |                 | Switch12 Input |
| Disabled                           |                           |                 | Disabled       |
| var Limiter                        |                           |                 | Switch13 Input |
| Disabled                           |                           |                 | Disabled       |
|                                    |                           |                 | Switch14 Input |
|                                    |                           |                 | Disabled       |

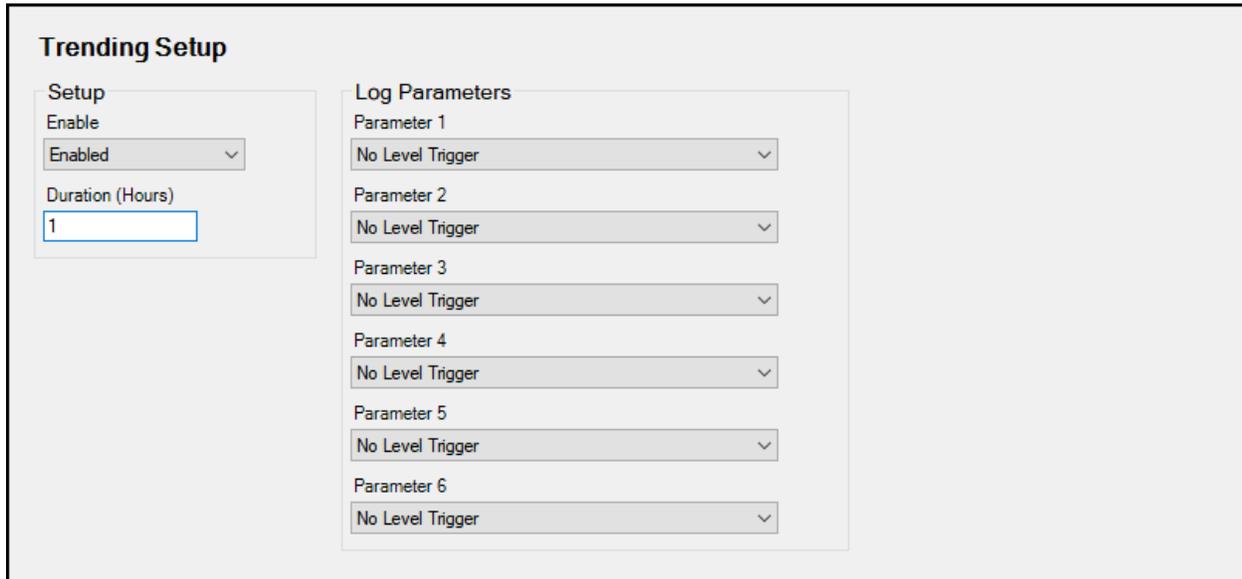
Figure 12-5. Data Log Logic Triggers

## Trending

**BESTCOMSPi.us Navigation Path:** Settings Explorer, Report Configuration, Trending

**HMI Navigation Path:** Settings, Configuration Settings, Trending

The trend log records the activity of DECS-450 parameters over an extended period of time. When enabled, up to six parameters can be monitored over a user-defined duration ranging from 1 to 720 hours. Trend log settings are illustrated in Figure 12-6.



The screenshot shows a 'Trending Setup' window with two main sections: 'Setup' and 'Log Parameters'. The 'Setup' section includes an 'Enable' dropdown menu set to 'Enabled' and a 'Duration (Hours)' text input field containing the number '1'. The 'Log Parameters' section lists six parameters, each with a dropdown menu set to 'No Level Trigger'.

| Section        | Field Name       | Value            |
|----------------|------------------|------------------|
| Setup          | Enable           | Enabled          |
|                | Duration (Hours) | 1                |
| Log Parameters | Parameter 1      | No Level Trigger |
|                | Parameter 2      | No Level Trigger |
|                | Parameter 3      | No Level Trigger |
|                | Parameter 4      | No Level Trigger |
|                | Parameter 5      | No Level Trigger |
|                | Parameter 6      | No Level Trigger |

Figure 12-6. Trend Log Setup

# 13 • Power System Stabilizer

The optional, integrated power system stabilizer (PSS) (DECS-450 style 1XXXXXX) is an IEEE Std 421.5 type PSS2A/2B/2C, dual-input, “integral of accelerating power” stabilizer that provides supplementary damping for low-frequency, local-mode oscillations and power system oscillations. For more detailed information on the model used, refer to the *Math Model* chapter.

PSS features include user-selectable, speed-only sensing, three-wattmeter power measurement, optional frequency-based operation, generator and motor control modes, and rate of frequency change blocking.

| Note  |
|---|
| Three-phase current sensing and three-phase voltage sensing are required for PSS operation. |

PSS settings are illustrated in Figure 13-9, Figure 13-10, Figure 13-11, and Figure 13-12.

**BESTCOMSPPlus Navigation Path:** Settings Explorer, PSS

**HMI Navigation Path:** Settings, PSS

## ***Supervisory Function and Setting Groups***

A supervisory function enables PSS operation only when a sufficient load is applied to the generator. Two separate groups of PSS settings enable stabilizer operation tailored for two distinct load conditions.

### **Supervisory Function**

When PSS control is enabled, a power-on threshold setting determines the level of power (watts) where PSS operation is automatically enabled. This threshold is a per-unit setting based on the generator ratings. (The *Configuration* section of this manual provides information about entering the generator and system ratings.) A hysteresis setting provides a margin below the power-on threshold so that transient dips in power (watts) will not disable stabilizer operation. This hysteresis is a per-unit setting based on the generator ratings.

### **Setting Groups**

When setting group selection is enabled, a threshold setting establishes the power level where the PSS gain settings are switched from the primary group to the secondary group. After a transfer to the secondary gain settings, a hysteresis setting determines the level of (decreasing) power where a transfer back to the primary gain settings will occur.

### **Frequency Rate of Change**

The PSS rate-of-change function adjusts the PSS output to compensate for a generator rate-of-frequency change that exceeds the user-defined threshold. This threshold has an adjustment range of 0 to 10 hertz per second. When the generator frequency rate of change threshold is exceeded for the duration of a user-defined time delay, the PSS output is driven to zero and then ramped up to its previous, nominal value over the duration of a user-specified block timer. The delay time and block time are each adjustable from 0 to 20 seconds. The low-pass filter time constant and washout filter time constant settings are used to calculate the rate of change. These two settings have an adjustment range of 0 to 20 seconds.

## ***Theory of Operation***

The PSS uses an indirect method of power system stabilization that employs two signals: shaft speed and electrical power. This method eliminates the undesirable components from the speed signal (such as noise, lateral shaft run-out, or torsional oscillations) while avoiding a reliance on the difficult-to-measure mechanical power signal.

More information on PSS function can be found in the *Math Model* chapter. An illustration is also available in BESTCOMSPUs<sup>®</sup> by clicking the PSS Model Info button located on the Control tab.

### Speed Signal

The speed signal is converted to a constant level that is proportional to the shaft speed (frequency).

Two high-pass (frequency washout) filter stages are applied to the resulting signal to remove the average speed level and produce a speed deviation signal. This ensures that the stabilizer reacts only to changes in speed and does not permanently alter the generator terminal voltage reference.

The frequency washout filter stages are controlled by time constant settings  $T_{w1}$  and  $T_{w2}$ . Low-pass filtering of the speed deviation signal can be enabled or disabled through software switch SSW 0. The low-pass filter time constant is adjusted by the  $T_{I1}$  setting.

Figure 13-1 shows the high-pass and low-pass filter transfer function blocks in frequency domain form. (The letter  $s$  is used to represent the complex frequency of Laplace operator.)

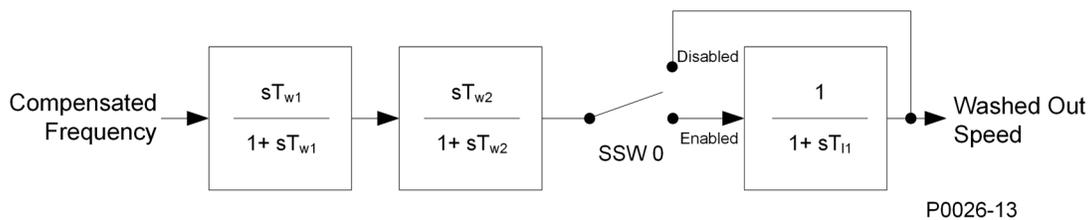


Figure 13-1. Speed Signal

### Rotor Frequency Calculation

During steady-state conditions, the terminal frequency of the generator is a good measure of rotor speed. However, this may not be the case during low frequency transients, due to the voltage drop across the machine reactance. To compensate for this effect, the DECS-450 first calculates the terminal voltages and currents. It then adds the voltage drop across the quadrature reactance to the terminal voltages to obtain internal machine voltages. These voltages are then used to calculate the rotor frequency. This gives a more accurate measure of rotor speed during low frequency transients when stabilizing action is required.

The quadrature axis compensation used in the rotor frequency calculation is entered through the Quadrature  $X_q$  setting.

### Generator Electrical Power Signal

Figure 13-2 illustrates the operations performed on the power input signal to produce the integral of electrical power deviation signal.

The generator electrical power output is derived from the generator VT secondary voltages and generator CT secondary currents applied to the DECS-450. Three-phase current sensing is required for PSS.

The power output is high-pass (washout) filtered to produce the required power deviation signal. If additional washout filtering is desired, a second high-pass filter can be enabled by software switch SSW 1. The first high-pass filter is controlled by time constant setting  $T_{w3}$  and the second high-pass filter is controlled by time constant setting  $T_{w4}$ .

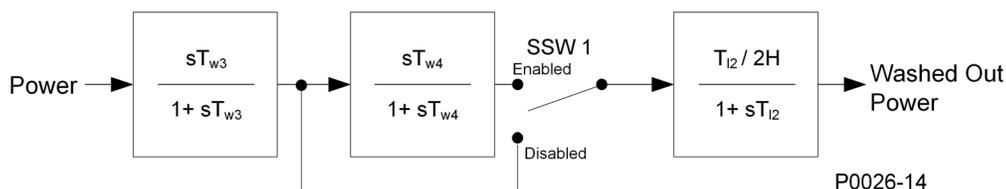


Figure 13-2. Generator Electrical Power Signal

After high-pass filtering, the electrical power signal is integrated and scaled, combining the generator inertia constant (2H) with the speed signal. Low-pass filtering within the integrator is controlled by time constant  $T_{I2}$ .

### Derived Mechanical Power Signal

The speed deviation signal and integral of electrical power deviation signal are combined to produce a derived, integral of mechanical power signal.

An adjustable gain stage,  $K_{PE}$ , establishes the amplitude of the electrical power input used by the PSS function.

The derived integral of mechanical power signal is then passed through a mechanical-power, low-pass filter and ramp tracking filter. The low-pass filter is controlled by time constant  $T_{L3}$  and provides attenuation of torsional components appearing in the speed input path. The ramp tracking filter produces a zero, steady-state error to ramp changes in the integral of electric power input signal. This limits the stabilizer output variation to very low levels for the mechanical power rates of change that are normally encountered during operation of utility-scale generators. The ramp tracking filter is controlled by time constant  $T_R$ . An exponent consisting of a numerator and denominator is applied to the mechanical power filter.

Processing of the derived integral of mechanical power signal is illustrated in Figure 13-3.

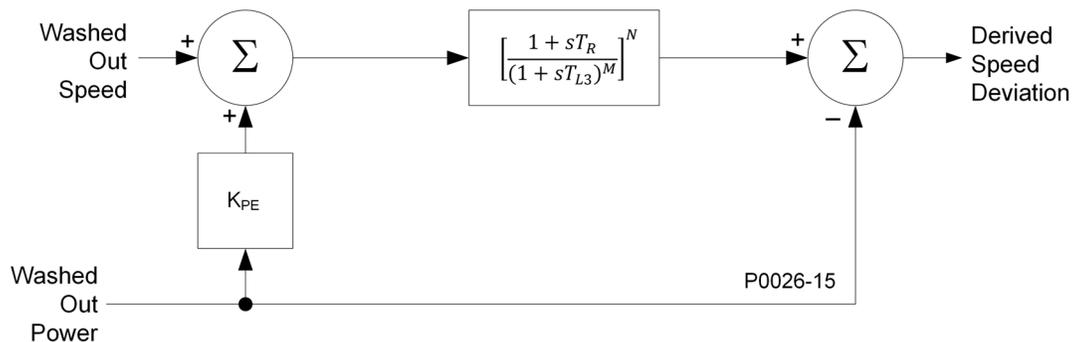


Figure 13-3. Derived Mechanical Power Signal

### Stabilizing Signal Selection

Figure 13-4 illustrates how software switches SSW 2 and SSW 3 are used to select the stabilizing signal. Derived speed deviation is selected as the stabilizing signal when the SSW 2 setting is Derived Speed and the SSW 3 setting is Derived Frequency/Speed. Washed out speed is selected as the stabilizing signal when the SSW 2 setting is Frequency and the SSW 3 setting is Derived Frequency/Speed. Washed out power is selected as the stabilizing signal when the SSW 3 setting is Power. (When the SSW 3 setting is Power, the SSW 2 setting has no effect.)

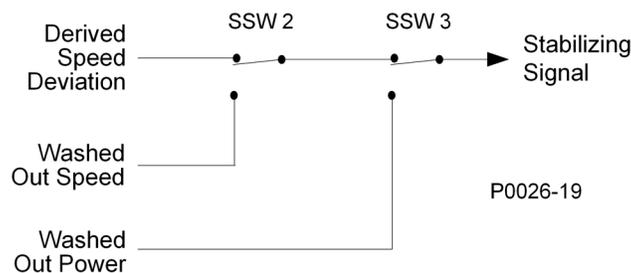


Figure 13-4. Stabilizing Signal Selection

## Torsional Filters

Two torsional filters, shown in Figure 13-5, are available after the stabilizing signal and before the phase compensation blocks. The torsional filters provide the desired gain reduction at a specified frequency. The filters compensate the torsional frequency components present in the input signal.

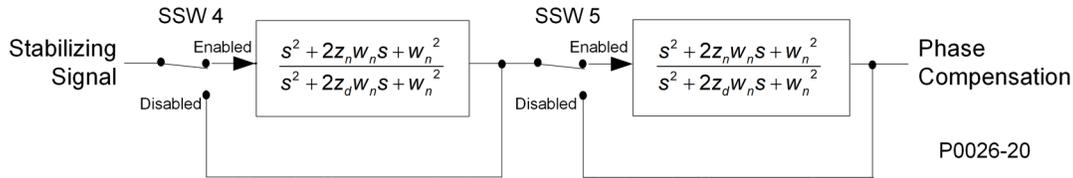


Figure 13-5. Torsional Filters

Software switch SSW 4 enables and disables torsional filter 1 and SSW 5 enables and disables torsional filter 2.

Torsional filters 1 and 2 are controlled by a zeta numerator (Zeta Num), zeta denominator (Zeta Den), and a frequency response parameter ( $W_n$ ).

## Phase Compensation

The derived speed signal is modified before it is applied to the voltage regulator input. Filtering of the signal provides phase lead at the electromechanical frequencies of interest (0.1 to 5 Hz). The phase lead requirement is site-specific and is required to compensate for phase lag introduced by the closed-loop voltage regulator.

Four phase compensation stages are available. Each phase compensation stage has a phase lead time constant ( $T_1, T_3, T_5, T_7$ ) and a phase lag time constant ( $T_2, T_4, T_6, T_8$ ). Normally, the first two lead-lag stages are adequate to match the phase compensation requirements of a unit. If needed, the third and fourth stages may be added through the settings of software switches SSW 6 and SSW 7. Figure 13-6 illustrates the phase compensation stages and associated software switches.

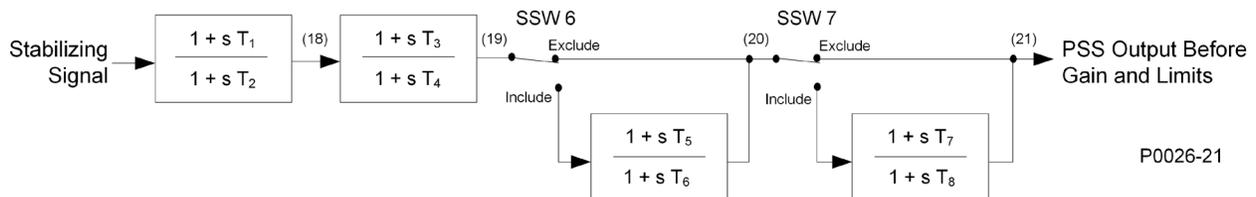


Figure 13-6. Phase Compensation

## Washout Filter and Logic Limiter

The output of the phase compensation stages is connected, through a stabilizer gain stage, to the washout filter and logic limiter.

Software switch SSW 9 enables and bypasses the washout filter and logic limiter. The washout filter has two time constants: normal and limit (less than normal).

The logic limiter compares the signal from the washout filter with the logic limiter upper and lower limit settings. If the counter reaches the set delay time, the time constant for the washout filter changes from the normal time constant to the limit time constant. When the signal returns to within the specified limits, the counter resets and the washout filter time constant changes back to the normal time constant.

Figure 13-7 illustrates the washout filter and logic limiter.

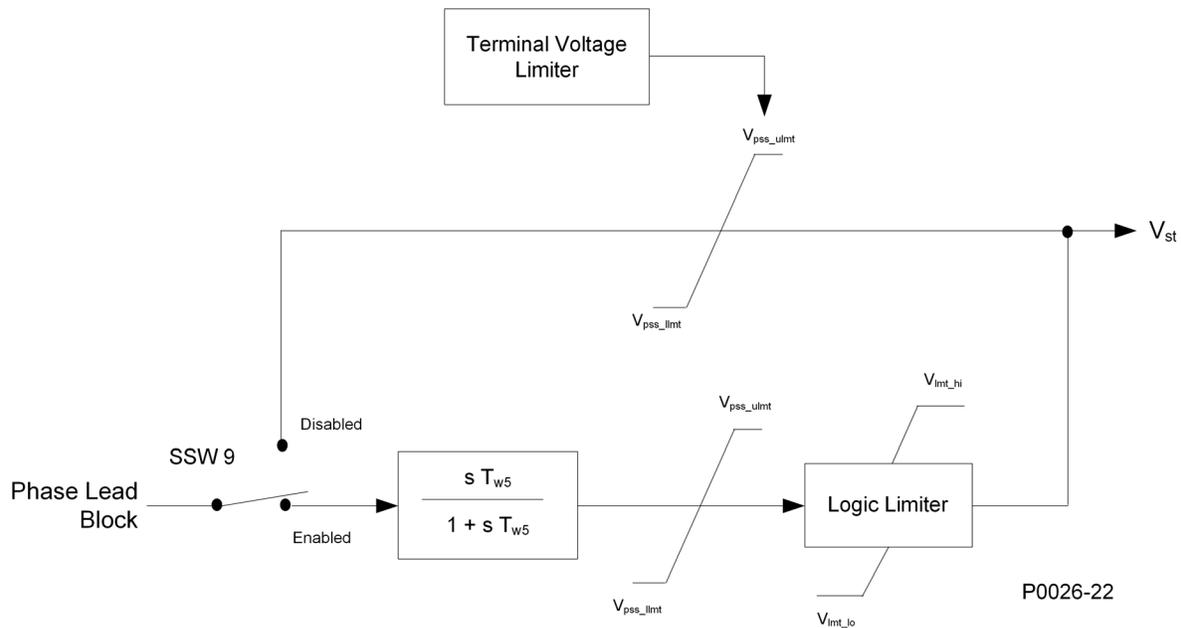


Figure 13-7. Washout Filter and Logic Limiter

### Output Stage

Prior to connecting the stabilizer output signal to the voltage regulator input, adjustable gain and upper and lower limits are applied. The stabilizer output is connected to the voltage regulator input when the software switch SSW 10 setting is On. Processing of the stabilizer output signal is illustrated in Figure 13-8.

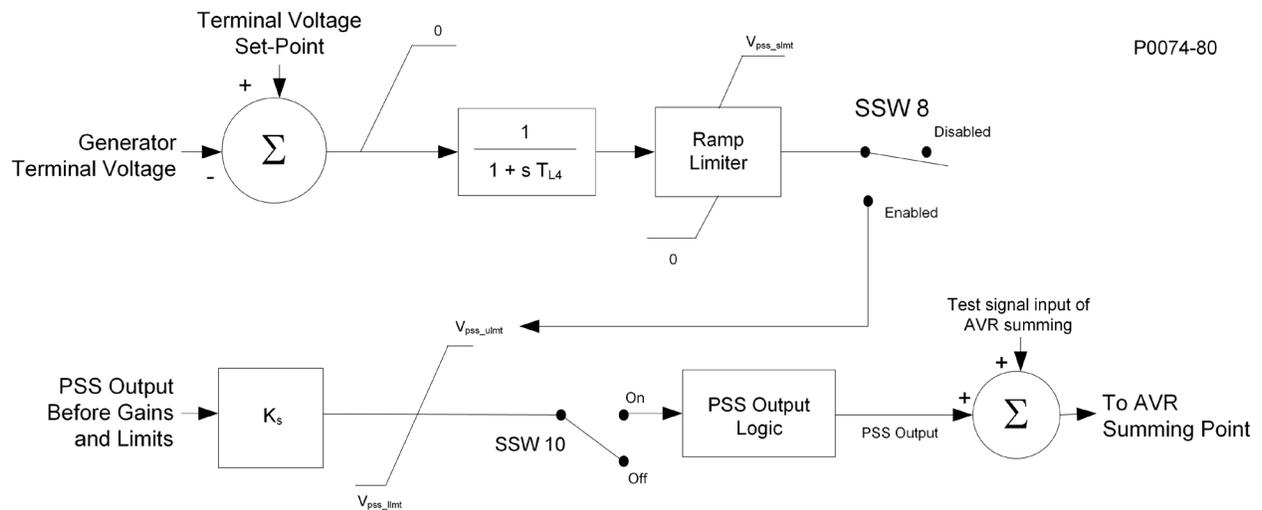


Figure 13-8. Output Stage

### Terminal Voltage Limiter

Since the PSS operates by modulating the excitation, it may counteract the voltage regulator's attempts to maintain terminal voltage within a tolerance band. To avoid creating an overvoltage condition, the PSS has a terminal voltage limiter (shown in Figure 13-7) that reduces the upper output limit to zero when the generator voltage exceeds the terminal voltage setpoint. The terminal voltage limiter is enabled and disabled by software switch SSW 8. The limit setpoint is normally selected such that the limiter will eliminate any contribution from the PSS before the timed overvoltage or volts per hertz protection operates.

The limiter reduces the stabilizer’s upper limit,  $V_{PSS\_ULMT}$ , at a fixed rate until zero is reached or overvoltage is no longer present. The limiter does not reduce the AVR reference below its normal level; it will not interfere with system voltage control during disturbance conditions. The error signal (terminal voltage minus the limit start point) is processed through a conventional low-pass filter to reduce the effect of measurement noise. The low-pass filter is controlled by a time constant.

**Configure**

**Setting Group Logic**  
 Setting Group Logic: Enabled

**Power Level**  
 Threshold: 0.00  
 Hysteresis: 0.00

**Rate of Change**  
 Rate of Change: Enabled  
 Threshold (Hz/s): 0.050  
 Time Delay (s): 0.50  
 Block Time (s): 5.00  
 Low Pass Filter Time Const (s): 0.50  
 Wash Out Filter Time Constant (s): 1.00

Figure 13-9. PSS Configuration Settings

**Control**

**PSS Control**  
 PSS Control: Enabled

**Primary**

**Supervisory Function**  
 Power-On Threshold: 0.00  
 Power Hysteresis: 0.00

**Software Switch (SSW) Settings**

|   |   |
|---|---|
| SSW 0 - Speed Low Pass Filter: Disabled   | SSW 6 - 3rd Lead/Lag Stage: Exclude     |
| SSW 1 - Power Washout Filter #2: Disabled | SSW 7 - 4th Lead/Lag Stage: Exclude     |
| SSW 2 - PSS Signal: Der. Speed            | SSW 8 - Term. Voltage Limiter: Disabled |
| SSW 3 - PSS Signal: Der. Freq/Speed       | SSW 9 - Logic Limiter: Disabled         |
| SSW 4 - Torsional Filter 1: Disabled      | SSW 10 - PSS Output: Off                |
| SSW 5 - Torsional Filter 2: Disabled      |   |

**Secondary**

**Supervisory Function**  
 Power-On Threshold: 0.00  
 Power Hysteresis: 0.00

**Software Switch (SSW) Settings**

|   |   |
|---|---|
| SSW 0 - Speed Low Pass Filter: Disabled   | SSW 6 - 3rd Lead/Lag Stage: Exclude     |
| SSW 1 - Power Washout Filter #2: Disabled | SSW 7 - 4th Lead/Lag Stage: Exclude     |
| SSW 2 - PSS Signal: Der. Speed            | SSW 8 - Term. Voltage Limiter: Disabled |
| SSW 3 - PSS Signal: Der. Freq/Speed       | SSW 9 - Logic Limiter: Disabled         |
| SSW 4 - Torsional Filter 1: Disabled      | SSW 10 - PSS Output: Off                |
| SSW 5 - Torsional Filter 2: Disabled      |   |

Figure 13-10. PSS Control Settings

| Parameter   |   |
|---|---|
| <b>Primary</b>  |   |
| <b>Low-Pass/Ramp Tracking</b>                                 |   |
| T11 - Time Const. (s)<br><input type="text" value="0.00"/>    | Tr - Time Const. (s)<br><input type="text" value="0.50"/>     |
| T12 - Time Const. (s)<br><input type="text" value="1.00"/>    | N - Num Exp.<br><input type="text" value="1"/>                |
| T13 - Time Const. (s)<br><input type="text" value="0.10"/>    | M - Den Exp.<br><input type="text" value="5"/>                |
| <b>High-Pass Filtering/Integration</b>                        |   |
| Tw1 - Time Const. (s)<br><input type="text" value="1.00"/>    | Tw4 - Time Const. (s)<br><input type="text" value="1.00"/>    |
| Tw2 - Time Const. (s)<br><input type="text" value="1.00"/>    | H - Inertia<br><input type="text" value="1.00"/>              |
| Tw3 - Time Const. (s)<br><input type="text" value="1.00"/>    |   |
| <b>Torsional Filters</b>                                      |   |
| Zeta Num 1<br><input type="text" value="0.50"/>               | Zeta Num 2<br><input type="text" value="0.50"/>               |
| Zeta Den 1<br><input type="text" value="0.25"/>               | Zeta Den 2<br><input type="text" value="0.25"/>               |
| Wn 1<br><input type="text" value="42.05"/>                    | Wn 2<br><input type="text" value="42.05"/>                    |
| <b>Rotor Freq Calculation</b>                                 |   |
| Quadrature Xq<br><input type="text" value="0.000"/>           |   |
| <b>Power Input</b>  |   |
| Kpe<br><input type="text" value="1.00"/>                      |   |
| <b>Phase Comp - Time Constants</b>                            |   |
| T1 - 1st Phase Lead (s)<br><input type="text" value="1.000"/> | T5 - 3rd Phase Lead (s)<br><input type="text" value="1.000"/> |
| T2 - 1st Phase Lag (s)<br><input type="text" value="1.000"/>  | T6 - 3rd Phase Lag (s)<br><input type="text" value="1.000"/>  |
| T3 - 2nd Phase Lead (s)<br><input type="text" value="1.000"/> | T7 - 4th Phase Lead (s)<br><input type="text" value="1.000"/> |
| T4 - 2nd Phase Lag (s)<br><input type="text" value="1.000"/>  | T8 - 4th Phase Lag (s)<br><input type="text" value="1.000"/>  |
| <b>Secondary</b>  |   |
| <b>Low-Pass/Ramp Tracking</b>                                 |   |
| T11 - Time Const. (s)<br><input type="text" value="0.00"/>    | Tr - Time Const. (s)<br><input type="text" value="0.50"/>     |
| T12 - Time Const. (s)<br><input type="text" value="1.00"/>    | N - Num Exp.<br><input type="text" value="1"/>                |
| T13 - Time Const. (s)<br><input type="text" value="0.10"/>    | M - Den Exp.<br><input type="text" value="5"/>                |
| <b>High-Pass Filtering/Integration</b>                        |   |
| Tw1 - Time Const. (s)<br><input type="text" value="1.00"/>    | Tw4 - Time Const. (s)<br><input type="text" value="1.00"/>    |
| Tw2 - Time Const. (s)<br><input type="text" value="1.00"/>    | H - Inertia<br><input type="text" value="1.00"/>              |
| Tw3 - Time Const. (s)<br><input type="text" value="1.00"/>    |   |
| <b>Torsional Filters</b>                                      |   |
| Zeta Num 1<br><input type="text" value="0.50"/>               | Zeta Num 2<br><input type="text" value="0.50"/>               |
| Zeta Den 1<br><input type="text" value="0.25"/>               | Zeta Den 2<br><input type="text" value="0.25"/>               |
| Wn 1<br><input type="text" value="42.05"/>                    | Wn 2<br><input type="text" value="42.05"/>                    |
| <b>Rotor Freq Calculation</b>                                 |   |
| Quadrature Xq<br><input type="text" value="0.000"/>           |   |
| <b>Power Input</b>  |   |
| Kpe<br><input type="text" value="1.00"/>                      |   |
| <b>Phase Comp - Time Constants</b>                            |   |
| T1 - 1st Phase Lead (s)<br><input type="text" value="1.000"/> | T5 - 3rd Phase Lead (s)<br><input type="text" value="1.000"/> |
| T2 - 1st Phase Lag (s)<br><input type="text" value="1.000"/>  | T6 - 3rd Phase Lag (s)<br><input type="text" value="1.000"/>  |
| T3 - 2nd Phase Lead (s)<br><input type="text" value="1.000"/> | T7 - 4th Phase Lead (s)<br><input type="text" value="1.000"/> |
| T4 - 2nd Phase Lag (s)<br><input type="text" value="1.000"/>  | T8 - 4th Phase Lag (s)<br><input type="text" value="1.000"/>  |

Figure 13-11. PSS Parameter Settings

### Output Limiter

| Primary   | Secondary   |
|---|---|
| <b>PSS Output Limiting</b><br>Upper Limit<br><input type="text" value="0.000"/><br>Lower Limit<br><input type="text" value="0.000"/>  | <b>PSS Output Limiting</b><br>Upper Limit<br><input type="text" value="0.000"/><br>Lower Limit<br><input type="text" value="0.000"/>  |
| <b>Stabilizer Gain</b><br>Ks<br><input type="text" value="0.00"/>   | <b>Stabilizer Gain</b><br>Ks<br><input type="text" value="0.00"/>   |
| <b>Terminal Voltage Limiter</b><br>Time Constant (s)<br><input type="text" value="1.000"/><br>Setpoint<br><input type="text" value="1.000"/>  | <b>Terminal Voltage Limiter</b><br>Time Constant (s)<br><input type="text" value="1.000"/><br>Setpoint<br><input type="text" value="1.000"/>  |
| <b>Washout Filter</b><br>Normal Time<br><input type="text" value="10.00"/><br>Limit Time<br><input type="text" value="0.30"/>   | <b>Washout Filter</b><br>Normal Time<br><input type="text" value="10.00"/><br>Limit Time<br><input type="text" value="0.30"/>   |
| <b>Logic Output Limiter</b><br>Upper Limit<br><input type="text" value="0.020"/><br>Lower Limit<br><input type="text" value="-0.020"/><br>Time Delay<br><input type="text" value="0.50"/> | <b>Logic Output Limiter</b><br>Upper Limit<br><input type="text" value="0.020"/><br>Lower Limit<br><input type="text" value="-0.020"/><br>Time Delay<br><input type="text" value="0.50"/> |

Figure 13-12. PSS Output Limiter Settings

# 14 • Stability Tuning

A PID control loop is used to tune the transient performance of a DECS-450-based excitation system. The word proportional indicates that the response of the DECS-450 output is proportional or relative to the amount of difference observed. Integral means that the DECS-450 output is proportional to the amount of time that a difference is observed. Integral action eliminates steady state error. Derivative means that the DECS-450 output is proportional to the required rate of excitation change. Derivative action minimizes overshoot.

## Caution

All stability tuning must be performed with no load on the system or equipment damage may occur.

## AVR Mode

**BESTCOMSPPlus Navigation Path:** Settings Explorer, Operating Settings, Gain, AVR

**HMI Navigation Path:** Settings, Operating Settings, Gains, AVR Gains

Two sets of PID settings are provided to optimize performance under two distinct operating conditions, such as with the power system stabilizer (PSS) in or out of service. A fast controller provides optimum transient performance with the PSS in service while a slower controller may provide stable operation when the PSS is disabled. BESTCOMSPPlus® primary and secondary AVR stability settings are shown in Figure 14-1.

### Predefined Stability Settings

Twenty predefined sets of stability settings are available with the DECS-450. Appropriate PID values are implemented based on the nominal generator frequency selected (see the *Configuration* section of this manual) and the combination of generator ( $T_{do}$ ) and exciter ( $T_{exc}$ ) time constants selected from the gain option list. (The default value for the exciter time constant is the generator time constant divided by six.)

Additional settings are available to remove the effects of noise on numerical differentiation (AVR derivative time constant  $T_d$ ) and set the voltage regulator gain level of the PID algorithm ( $K_a$ ). Using the recommended  $K_a$  value will per unitize the PID control loop, simplifying system modeling and validation.

### Custom Stability Settings

Stability tuning can be tailored for optimum generator transient performance. Selecting the *Custom* primary gain option enables entry of custom proportional ( $K_p$ ), integral ( $K_i$ ), and derivative ( $K_d$ ) gains.

When tuning the stability gain settings, consider the following guidelines:

- If the transient response has too much overshoot, decrease  $K_p$ . If the transient response is too slow, with little or no overshoot, increase  $K_p$ .
- If the time to reach steady-state is too long, increase  $K_i$ .
- If the transient response has too much ringing, increase  $K_d$ .

**AVR**

**Primary**

AVR

Kp - Proportional Gain  
80.000

Ki - Integral Gain  
20.000

Kd - Derivative Gain  
10.000

Td - Derivative Time Constant  
0.00

Ka - Voltage Regulator Gain (Recommended Ka)  
0.100 0.100

PID Pre-Settings  
Primary Gain Option  
Custom Primary PID Calculator

**Secondary**

AVR

Kp - Proportional Gain  
80.000

Ki - Integral Gain  
20.000

Kd - Derivative Gain  
10.000

Td - Derivative Time Constant  
0.00

Ka - Voltage Regulator Gain (Recommended Ka)  
0.100 0.100

PID Pre-Settings  
Secondary Gain Option  
Custom Secondary PID Calculator

**Auto Tuning**  
Auto Tune

Figure 14-1. AVR Stability Settings

### PID Calculator

The PID calculator is accessed by clicking the PID calculator button (Figure 14-1) and is available only when the primary gain option is *Custom*. The PID calculator (Figure 14-2) calculates the gain parameters  $K_p$ ,  $K_i$ , and  $K_d$  based on the generator time constants ( $T'do$ ) and exciter time constant ( $T_e$ ). If the exciter time constant is not known, it can be forced to the default value, which is the generator time constant divided by six. A derivative time constant ( $T_d$ ) setting field enables the removal of noise effects on numerical differentiation. A voltage regulator gain ( $K_a$ ) setting field sets the voltage regulator gain level of the PID algorithm. Calculated and entered parameters can be applied upon closure of the PID calculator.

Generator information appears in the PID Record List where records can be added or removed.

A group of settings can be saved with a unique name and added to a list of gain setting records available for application. Upon completion of stability tuning, undesired records can be removed from the record list.

### Caution

Calculated or user-defined PID values are to be implemented only after their suitability for the application has been verified by the user. Incorrect PID numbers can result in poor system performance or equipment damage.

Figure 14-2. PID Calculator

## Auto Tuning

During commissioning, excitation system parameters may not be known. These unknown variables traditionally cause the commissioning process to consume large amounts of time and fuel. With the development of auto tuning, the excitation system parameters are now automatically identified and the PID gains are calculated using well-developed algorithms. Automatically tuning the PID controller greatly reduces commissioning time and cost.

Auto tuning uses a patented particle swarm optimization algorithm to determine system parameters and calculates corresponding PID gains. The auto tuning function is accessed by clicking the *Auto Tune* button (Figure 14-1). BESTCOMSPlus must be in Live Mode in order to begin the auto tuning process. The auto tuning window (Figure 14-3) provides options for choosing the PID Design Mode and the Power Input Mode. When the desired settings are selected, click the *Start Auto Tune* button to start the process. After the process is complete, click the *Save PID Gains (Primary)* button to save the data.

### Caution

PID values calculated by the Auto Tuning function are to be implemented only after their suitability for the application has been verified by the user. Incorrect PID numbers can result in poor system performance or equipment damage.

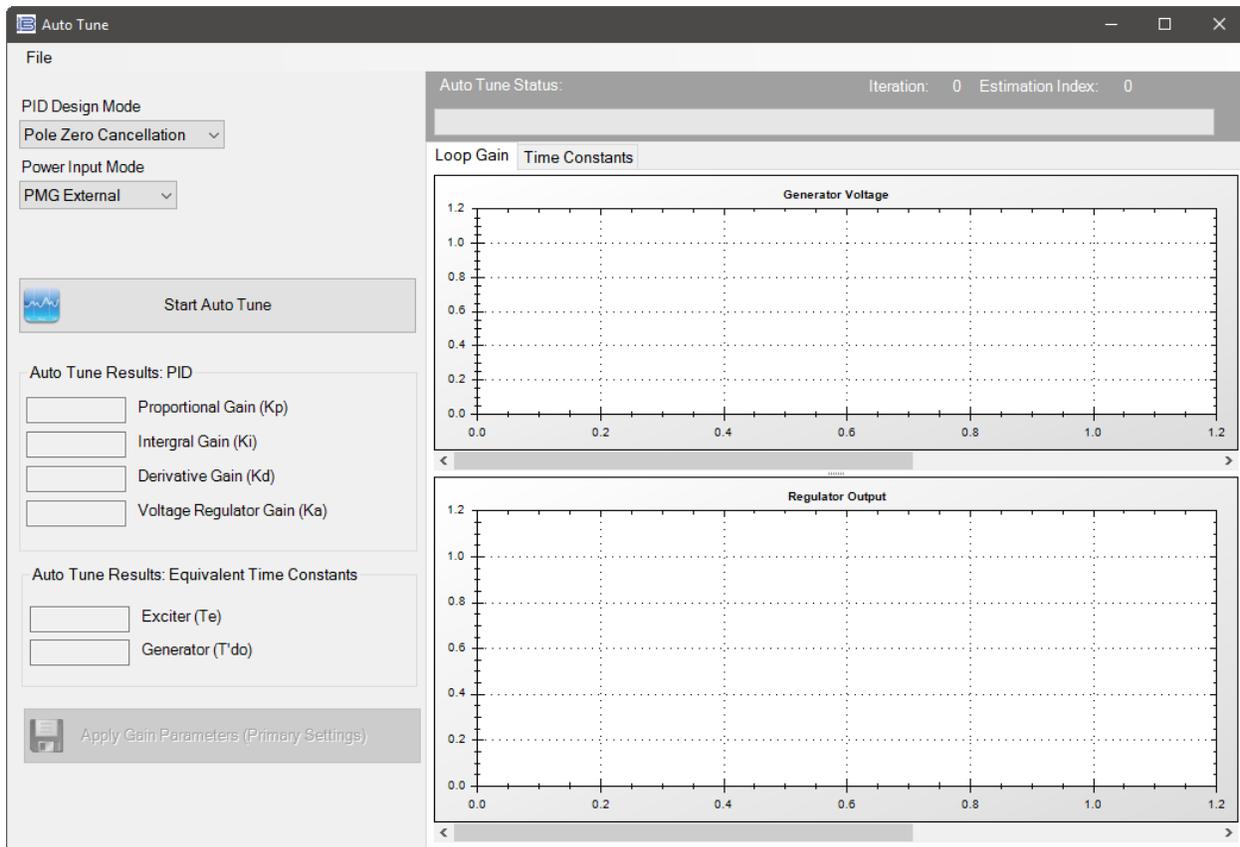


Figure 14-3. Auto Tuning Window

The File menu contains options for importing, exporting, and printing a graph (.gph) file.

## FCR and FVR Modes

**BESTCOMSPiplus Navigation Path:** Settings Explorer, Operating Settings, Gain, FCR/FVR

**HMI Navigation Path:** Settings, Operating Settings, Gains, FCR Gains or FVR Gains

Stability tuning can be tailored for optimum performance when operating in field current regulation or field voltage regulation mode. BESTCOMSPiplus FCR stability settings and FVR stability settings are illustrated in Figure 14-4.

### FCR Mode Stability Settings

The DECS-450 bases its field current response upon the following settings.

The proportional gain ( $K_p$ ) is multiplied by the error between the field current setpoint and the actual field current value. Decreasing  $K_p$  reduces overshoot in the transient response. Increasing  $K_p$  speeds the transient response.

The integral gain ( $K_i$ ) is multiplied by the integral of the error between the current setpoint and the actual field current value. Increasing  $K_i$  reduces the time to reach a steady state.

The derivative gain ( $K_d$ ) is multiplied by the derivative of the error between the current setpoint and the actual field current value. Increasing  $K_d$  reduces ringing in the transient response.

Additional FCR stability settings remove the noise effect on numerical differentiation (derivative time constant  $T_d$ ) and set the voltage regulator gain level of the PID algorithm ( $K_a$ ). Using the recommended  $K_a$  value will per unitize the PID control loop, simplifying system modeling and validation.

## FVR Mode Stability Settings

The DECS-450 bases its field voltage response upon the following settings.

The proportional gain ( $K_p$ ) is multiplied by the error between the field voltage setpoint and the actual field voltage value. Decreasing  $K_p$  reduces overshoot in the transient response. Increasing  $K_p$  speeds the transient response.

The integral gain ( $K_i$ ) is multiplied by the integral of the error between the voltage setpoint and the actual field voltage value. Increasing  $K_i$  reduces the time to reach a steady state.

The derivative gain ( $K_d$ ) is multiplied by the derivative of the error between the voltage setpoint and the actual field voltage value. Increasing  $K_d$  reduces ringing in the transient response.

Additional FVR stability settings remove the noise effect on numerical differentiation (derivative time constant  $T_d$ ) and set the voltage regulator gain level of the PID algorithm ( $K_a$ ). Using the recommended  $K_a$  value will per unitize the PID control loop, simplifying system modeling and validation.

| FCR                           |                  | FVR                           |                  |
|-------------------------------|------------------|-------------------------------|------------------|
| Kp - Proportional Gain        | 10.000           | Kp - Proportional Gain        | 10.000           |
| Ki - Integral Gain            | 50.000           | Ki - Integral Gain            | 100.000          |
| Kd - Derivative Gain          | 0.000            | Kd - Derivative Gain          | 0.000            |
| Td - Derivative Time Constant | 0.00             | Td - Derivative Time Constant | 0.00             |
| Ka - Voltage Regulator Gain   | 0.100            | Ka - Voltage Regulator Gain   | 0.100            |
|                               | (Recommended Ka) |                               | (Recommended Ka) |
|                               | 0.100            |                               | 0.100            |

Figure 14-4. FCR and FVR Gain Settings

## Other Modes and Functions

**BESTCOMSPiplus Navigation Path:** Settings Explorer, Operating Settings, Gain, var, PF, OEL, UEL, SCL, VAR Limiter

**HMI Navigation Path:** Settings, Operating Settings, Gains, Other Gains

Settings for stability tuning of the Var and Power Factor modes are provided in the DECS-450 along with settings for stability tuning of limiters, the voltage matching function, and main field voltage response. Figure 14-5 illustrates these settings as they appear in BESTCOMSPiplus.

### Var Mode

The integral gain ( $K_i$ ) adjusts the Var mode integral gain which determines the characteristic of the DECS-450 dynamic response to a changed var setpoint.

The loop gain ( $K_g$ ) adjusts the coarse loop-gain level of the PI algorithm for var control.

### Power Factor Mode

The integral gain ( $K_i$ ) adjusts the integral gain which determines the characteristic of the DECS-450 dynamic response to a changed power factor setpoint.

The loop gain ( $K_g$ ) adjusts the coarse loop-gain level of the PI algorithm for power factor control.

### Overexcitation Limiter (OEL)

The integral gain ( $K_i$ ) adjusts the rate at which the DECS-450 responds during an overexcitation condition.

The loop gain ( $K_g$ ) adjusts the coarse loop-gain level of the PI algorithm for the overexcitation limiter function.

### Underexcitation Limiter (UEL)

The integral gain ( $K_i$ ) adjusts the rate at which the DECS-450 responds during an underexcitation condition.

The loop gain ( $K_g$ ) adjusts the coarse loop-gain level of the PI algorithm for the underexcitation limiter function.

### Stator Current Limiter (SCL)

The integral gain ( $K_i$ ) adjusts the rate at which the DECS-450 limits stator current.

The loop gain ( $K_g$ ) adjusts the coarse loop-gain level of the PI algorithm for the stator current limiter function.

### Var Limiter

The integral gain ( $K_i$ ) adjusts the rate at which the DECS-450 limits reactive power.

The loop gain ( $K_g$ ) adjusts the coarse loop-gain level of the PID algorithm for the reactive power limiter function.

### Voltage Matching

The loop gain ( $K_g$ ) adjusts the rate at which the DECS-450 matches the generator voltage to the bus voltage.

| var, PF, OEL, UEL, SCL, var Limiter |                    |                    |                         |
|-------------------------------------|--------------------|--------------------|-------------------------|
| <b>var</b>                          | <b>OEL</b>         | <b>SCL</b>         | <b>Voltage Matching</b> |
| Ki - Integral Gain                  | Ki - Integral Gain | Ki - Integral Gain | Kg - Loop Gain          |
| 0.100                               | 10.000             | 1.000              | 0.050                   |
| Kg - Loop Gain                      | Kg - Loop Gain     | Kg - Loop Gain     |                         |
| 1.000                               | 0.100              | 0.200              |                         |
| <b>PF</b>                           | <b>UEL</b>         | <b>varL</b>        |                         |
| Ki - Integral Gain                  | Ki - Integral Gain | Ki - Integral Gain |                         |
| 0.100                               | 0.100              | 10.000             |                         |
| Kg - Loop Gain                      | Kg - Loop Gain     | Kg - Loop Gain     |                         |
| 1.000                               | 0.500              | 1.000              |                         |

Figure 14-5. Other Mode and Function Gain Settings

## Inner Loop Field Regulation

**BESTCOMSPius Navigation Path:** Settings Explorer, Operating Settings, Gain, Inner Loop Field Regulator

**HMI Navigation Path:** Settings, Operating Settings, Gains, Inner Loop Field Regulator

When the inner control loop is enabled, the regulator response depends upon the AVR gains and inner loop gains.

The  $K_i$  - Integral Gain setting adjusts the rate at which the DECS-450 responds to changes in the main field voltage. The  $K_g$  - Loop Gain setting adjusts the coarse loop-gain level of the PI algorithm for the inner loop field regulator. Figure 14-6 illustrates these settings as they appear in BESTCOMSPius.



**Inner Loop Field Regulator**

Gain

Ki - Integral Gain  
0.000

Kg - Loop Gain  
1.000

Figure 14-6. Inner Loop Field Regulator Gain Settings

## Converting Gains from a DECS-300 or DECS-400

The DECS-450 uses a per-unitized control loop while the DECS-300 and DECS-400 do not. A software conversion tool is included to make upgrading to a DECS-450 easier. It can calculate per-unitized gains for a DECS-450 to match the response of a DECS-300 or DECS-400 in a specific application. In *BESTCOMSPi*us, click Tools, Convert Gains to open the screen.

### Note

All settings in the System Parameter's settings group must be programmed prior to running the converter tool. These settings include Rated Data, Sensing Transformers, and Field Isolation Transducer. Refer to the *Configuration* section of this manual for additional information on these settings.

Gains not included in the converter utility must be entered manually and do not require modification.

Simply enter the DECS-300 or DECS-400 gains into the appropriate fields in the DECS-300 / DECS-400 column. Select whether OEL Mode is Summing Point or Takeover. Click Convert to review the new gain values displayed in the DECS-450 Equivalent column. The Apply Gain button automatically enters the new gain values into the appropriate DECS-450 gain settings. Figure 14-7 illustrates these settings as they appear in *BESTCOMSPi*us.

Convert Gains

| DECS-300 / DECS-400  | DECS-450 Equivalent  | DECS-450 Active     |
|----------------------|----------------------|---------------------|
| AVR Kg (Primary)     | AVR Ka (Primary)     | AVR Ka (Primary)    |
| <input type="text"/> | <input type="text"/> | 0.05                |
| AVR Kg (Secondary)   | AVR Ka (Secondary)   | AVR Ka (Secondary)  |
| <input type="text"/> | <input type="text"/> | 0.05                |
| FCR Kg               | FCR Ka               | FCR Ka              |
| <input type="text"/> | <input type="text"/> | 0.05                |
| FVR Kg               | FVR Ka               | FVR Ka              |
| <input type="text"/> | <input type="text"/> | 0.1                 |
| VAR Kg               | VAR Kg               | VAR Kg              |
| <input type="text"/> | <input type="text"/> | 0.5                 |
| PF Kg                | PF Kg                | PF Kg               |
| <input type="text"/> | <input type="text"/> | 0.3                 |
| OEL Kg               | OEL Kg               | OEL Kg              |
| <input type="text"/> | <input type="text"/> | 0.05                |
| UEL Kg               | UEL Kg               | UEL Kg              |
| <input type="text"/> | <input type="text"/> | 0.3                 |
| SCL Kg               | SCL Kg               | SCL Kg              |
| <input type="text"/> | <input type="text"/> | 0.5                 |
| VarL Kg              | VarL Kg              | VarL Kg             |
| <input type="text"/> | <input type="text"/> | 0.5                 |
| Voltage Matching Kg  | Voltage Matching Kg  | Voltage Matching Kg |
| <input type="text"/> | <input type="text"/> | 3                   |

Convert  
Apply Gain  
Cancel

OEL Mode  
Summing Point

Inner Loop  
Disabled

AVR Ka (Primary) conversion is affected by the inner loop mode.

NOTE: Gains not included in the converter utility must be entered manually and do not require modification.

Figure 14-7. Convert Gains Screen

# 15 • Mounting

When not shipped as part of assembled equipment, DECS-450 Digital Excitation Control Systems are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a DECS-450, check the model and style number against the requisition and packing list for agreement. Inspect for damage and, if there is evidence of such, file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric.

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

## ***Mounting Considerations***

---

Because the DECS-450 and Field Isolation Transducer are of solid-state design, they can be mounted at any convenient angle in an environment where the temperature does not decrease below  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) or exceed  $60^{\circ}\text{C}$  ( $140^{\circ}\text{F}$ ).

### **DECS-450**

An escutcheon plate is required for panel (or cubicle door) mounting. Overall dimensions for the DECS-450 and escutcheon plate are shown in Figure 15-1. Figure 15-2 shows the panel cutting and drilling dimensions for mounting a DECS-450 with the escutcheon plate.

Brackets are also available for mounting the DECS-450 in a 19-inch rack. Order part number 9365207030 (two brackets required).

A retrofit kit is available for installing a DECS-450 into a DECS-300 panel cutout. Order part number 9369707009.

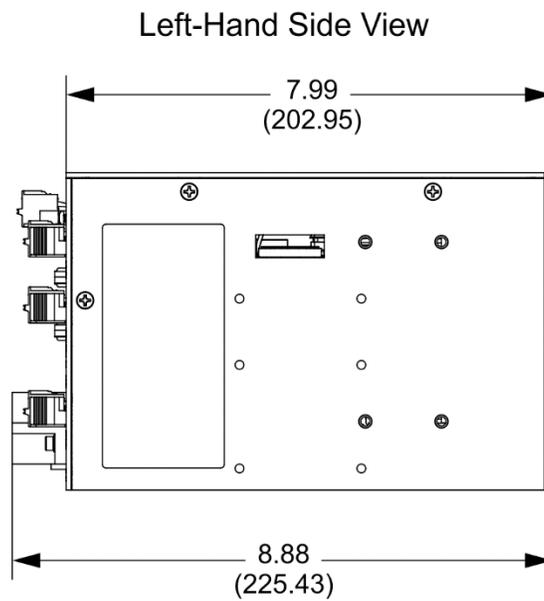
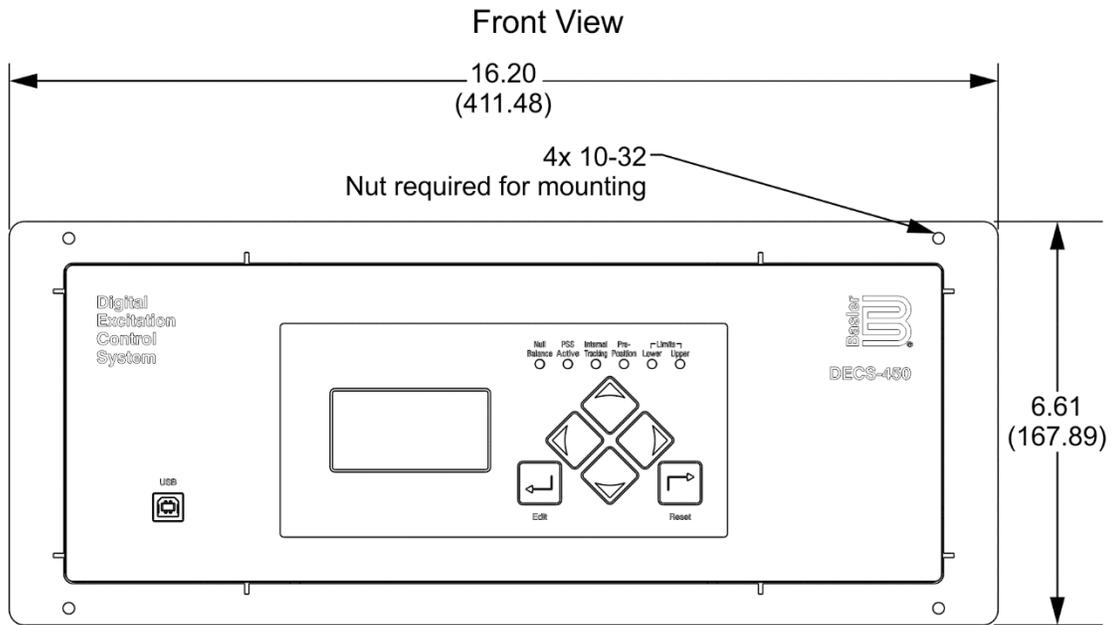
The DECS-450 can be installed directly into a DECS-400 panel cutout and existing escutcheon. A transition plate simplifies the process of wiring a DECS-450 with existing DECS-400 wiring. Order part number 9597106100. See *Transition Plate* below for installation instructions.

### **Field Isolation Transducer**

The Field Isolation Transducer is intended for surface mounting and no panel cutout is required. Figure 15-3 shows the Field Isolation Transducer dimensions and hole drilling locations.

### **Isolation Power Transformer**

In applications where redundant control power is used, ac control power must be applied to the DECS-450 through an isolation transformer. Basler Electric part number BE31449001 is recommended. Figure 15-4 illustrates the dimensions and mounting hole locations of part number BE31449001.



P0087-98

**Figure 15-1. DECS-450 with Escutcheon Plate, Overall Dimensions**

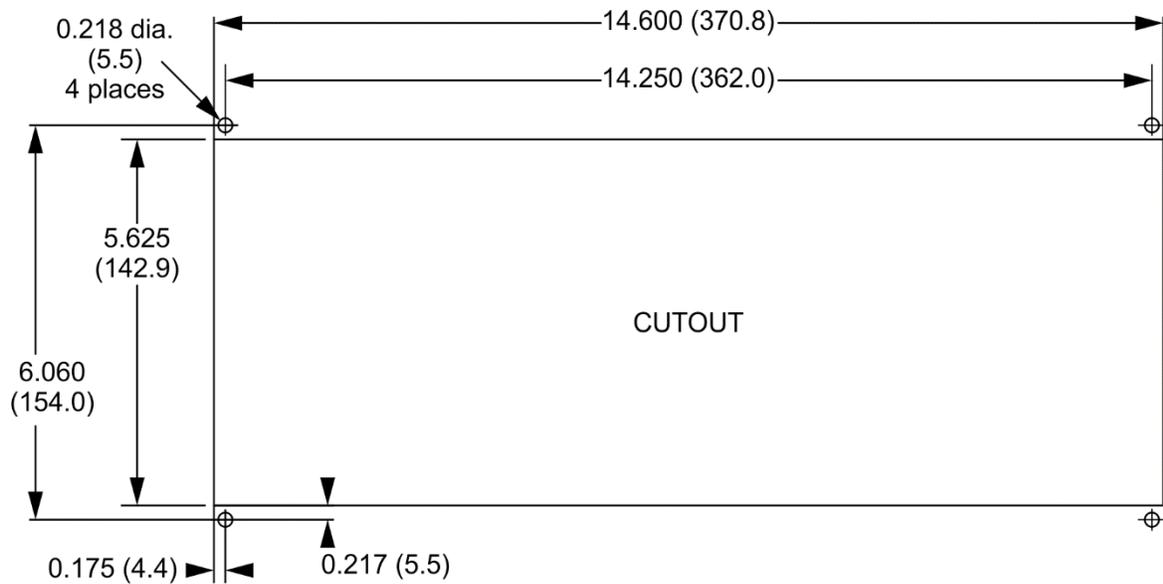


Figure 15-2. Panel Cutting and Drilling Dimensions

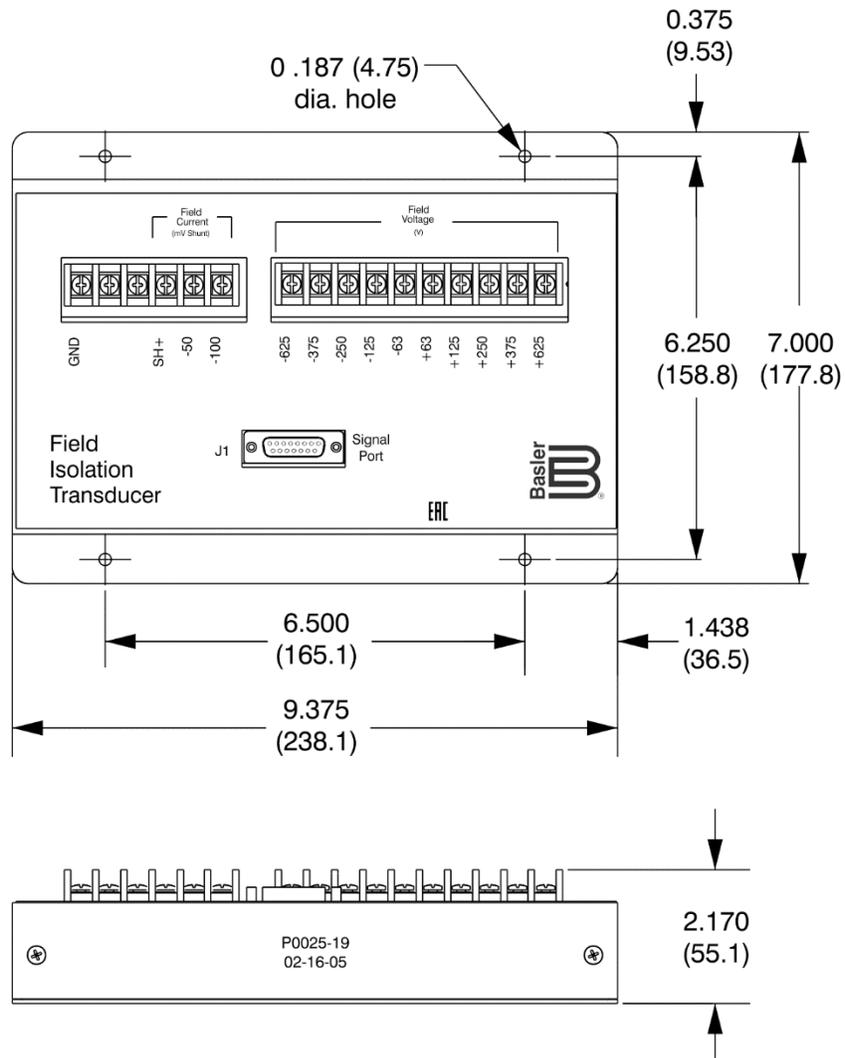
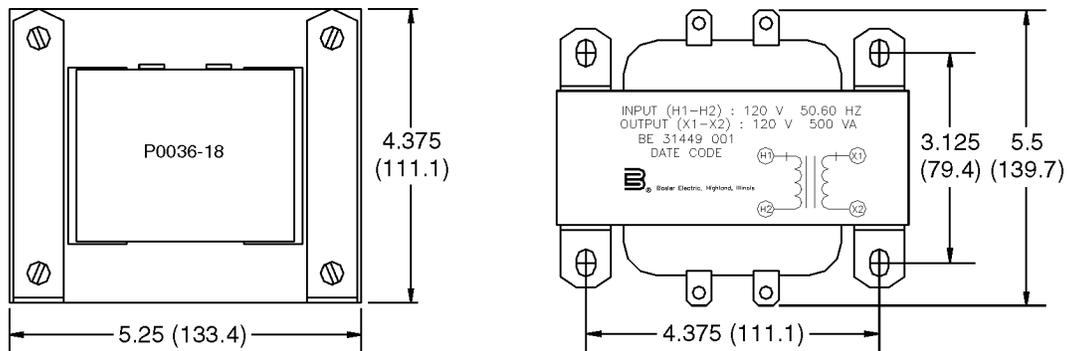


Figure 15-3. Field Isolation Transducer Dimensions



**Figure 15-4. Isolation Transformer (BE31449001) Dimensions**

### Transition Plate

Upgrading from a DECS-400 to the DECS-450 is simplified by an optional transition plate. The transition plate (Figure 15-5) relocates the DECS-450 terminals so that they align with the wiring previously connected to a DECS-400.



P0102-46

**Figure 15-5. Transition Plate Wiring to DECS-450**

Transition plate terminals are prewired to connectors and ring lugs that mate with the headers, connectors, and terminal screws of the DECS-450. The transition plate attaches to the back of the DECS-450 and its terminals align with those of the removed DECS-400. While the terminal layout of the transition plate matches that of the DECS-400, its terminal function labeling matches that of the DECS-450. Transition plate terminals are shown in Figure 15-6.

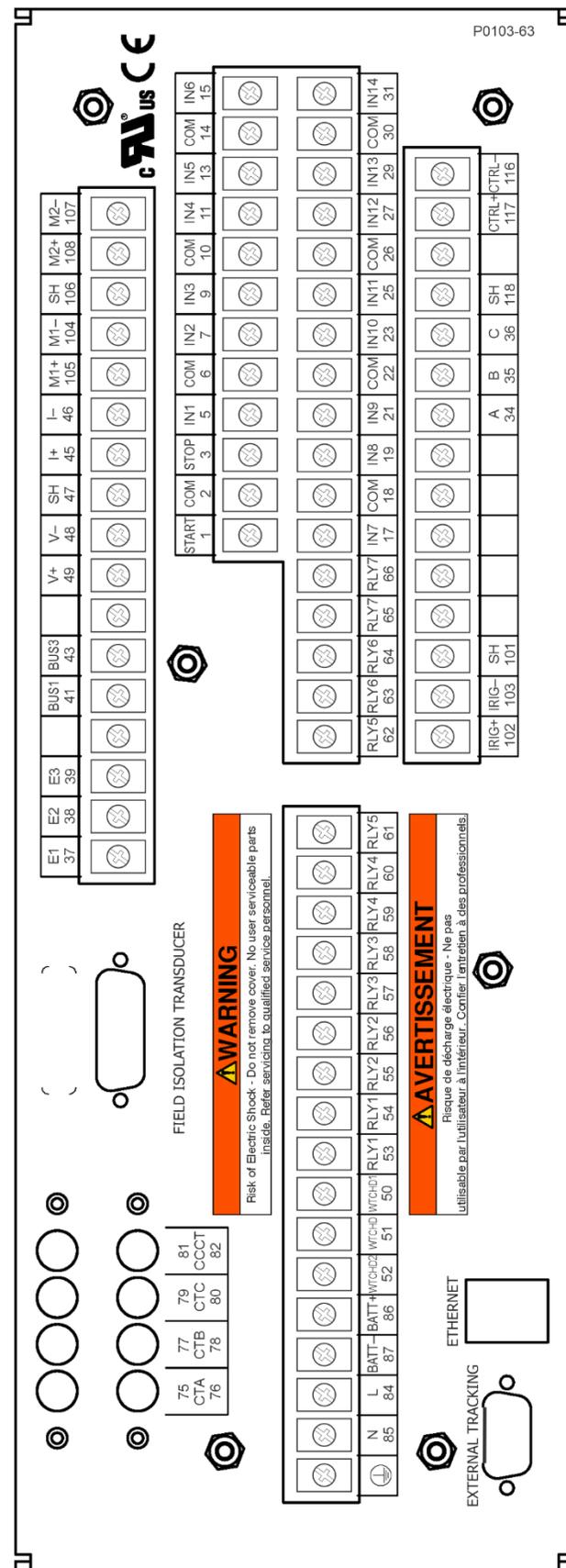


Figure 15-6. Transition Plate Terminal Assignments

### Installation

To install the transition plate, perform the following steps.

1. Remove the six DECS-450 screws shown in Figure 15-7 (locators A, B, and C). Three screws are located on the left side of the DECS-450 and three screws are located on the right side of the DECS-450.

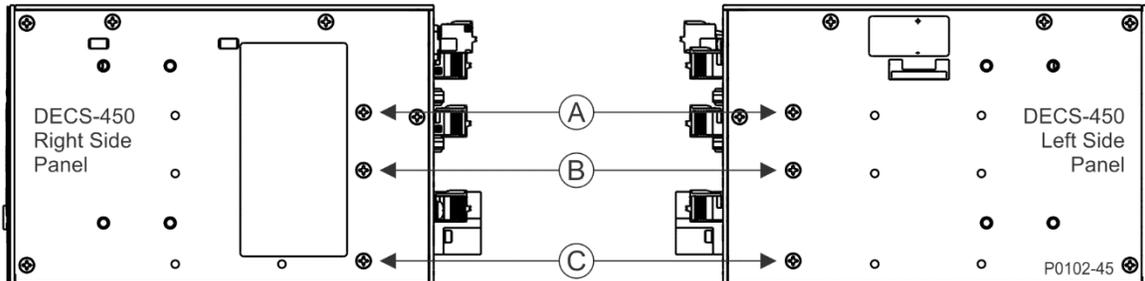


Figure 15-7. Mounting Screw Locations

2. Slide the transition plate assembly onto the rear of the DECS-450 as shown in Figure 15-5. Align the lowermost mounting holes of the transition plate assembly with those of the DECS-450 (Figure 15-7 locator C). Install two of the supplied screws in the lowermost mounting holes so that the transition plate is attached to the DECS-450 but can be rotated away from the DECS-450 and allow access to the DECS-450 terminals. See Figure 15-5.
3. Connect the ground wire (labeled GND) of the transition plate to the ground terminal of the DECS-450. Maximum torque for the ground terminal screw is 21 in-lb (2.4 N•m).
4. Connect the wires from the CT terminals of the transition plate to the corresponding CT terminals of the DECS-450. These wires are stamped with numbers that correspond to the CT terminals of the DECS-450. Maximum torque for these screws is 21 in-lb (2.4 N•m).
5. Connect the following cables from the transition plate assembly to their corresponding ports on the DECS-450:
  - a. Field Isolation Transducer (15-pin, D-type connector)
  - b. External Tracking (9-pin, D-type connector)
  - c. Ethernet (RJ-45 connector)
6. Plug the nine remaining cables from the transition plate assembly into the corresponding connector headers of the DECS-450. The cable connectors of the transition plate assembly are keyed to prevent connection errors.
7. Rotate the transition plate assembly into position on the DECS-450 and align the remaining mounting holes. Ensure that no wires or cables are pinched between the DECS-450 and transition plate. Install the remaining four supplied screws, two per side, as shown in Figure 15-7 (locators A and B).
8. Tighten the six screws (locators A, B, and C) with a maximum torque of 11 in-lb (1.2 N•m).

If removing a transition plate, perform the installation procedure in reverse order.

## 16 • Terminals and Connectors

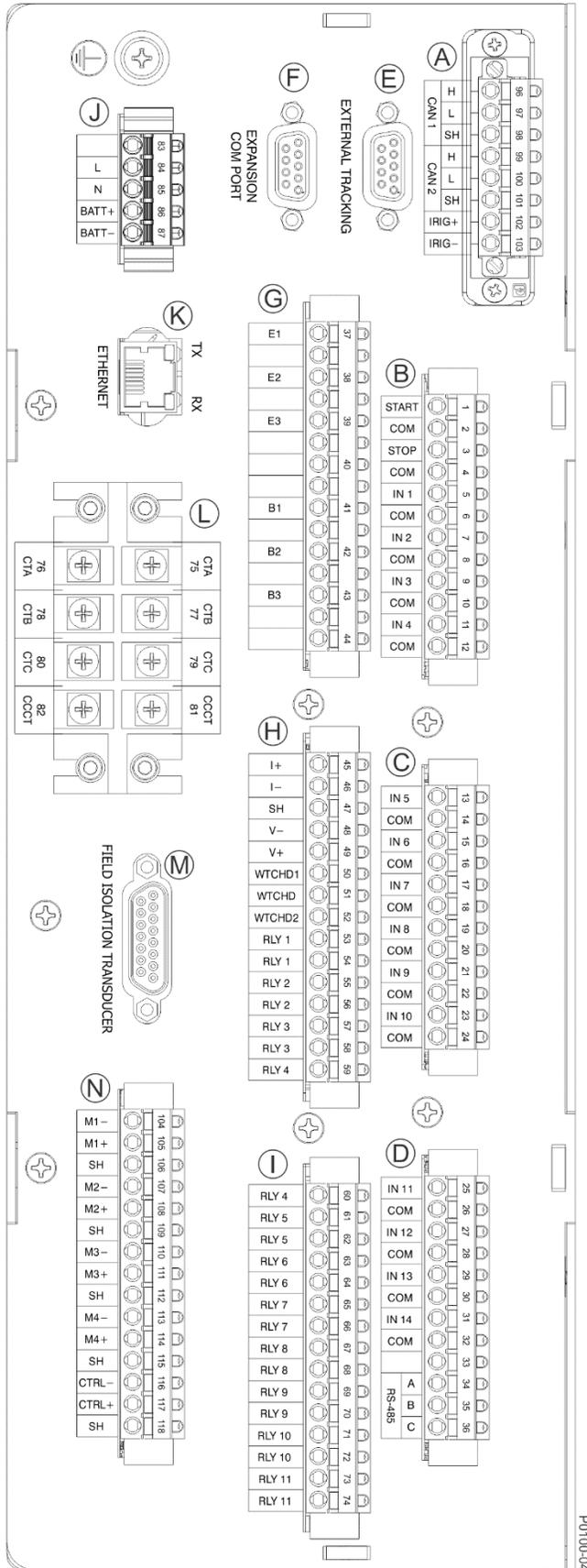
This section describes the terminals and connectors of the DECS-450 and the Field Isolation Transducer.

### ***DECS-450 Connections***

---

DECS-450 terminals and connectors are located on the rear panel. DECS-450's current sensing transformer connections consist of screw terminals and the remaining connections have single-row, multiple-pin headers that mate with removable connectors wired by the user. DECS-450 connectors vary according to their function and the specified options.

Figure 16-1 illustrates the DECS-450 rear panel terminals and connectors. Locator letters in the illustration correspond to the terminal block and connector descriptions in Table 16-1. The front-panel USB port is illustrated and described in the *Controls and Indicators* section of this manual.



P0100-04

Figure 16-1. Rear Panel Terminals and Connectors

**Table 16-1. DECS-450 Rear Panel Terminal and Connector Descriptions**

| <b>Locator</b> | <b>Description</b>   |
|----------------|--|
| A              | Three terminal sets within this block include two CAN communication ports and an IRIG input. Both CAN ports are SAE J1939 compliant. CAN 1 is used to communicate with add-on modules such as the Basler Electric CEM-125, CEM-2020, and AEM-2020. CAN 2 is used to communicate with an external controller. The IRIG terminals connect to an IRIG source for synchronization of DECS-450 timekeeping. |
| B              | Contact inputs for the Start and Stop functions and programmable contact inputs 1 through 4 are applied to these terminals.  |
| C              | Programmable contact inputs 5 through 10 are applied to these terminals.   |
| D              | A portion of these terminal block pins accept connections for programmable contact inputs 11 through 14.<br>The remaining terminal block pins serve as connections for RS-485 communication.   |
| E              | A second DECS-450 connects through a standard serial cable to this DB-9 connector for external setpoint tracking.  |
| F              | This DB-9 connector is provided for PROFIBUS communication (style XX1XXXX).  |
| G              | Three-phase generator and bus sensing voltage, obtained from user-supplied voltage transformers (VTs), connect to these terminals.   |
| H              | A portion of this terminal block accepts an external analog control signal for auxiliary control of the regulation setpoint. Terminals I+, I-, V+, and V- are used for external control of the regulation setpoint with the SH terminal serving as a cable shield connection.<br>The remaining terminal block pins serve as connections for the Watchdog and programmable relay outputs 1 through 4.   |
| I              | Relay contact outputs for programmable relay outputs 4 through 11 connect to these terminals.  |
| J              | These terminals accept ac and dc control power to enable DECS-450 operation.   |
| K              | This optional Ethernet communication port uses the Modbus TCP protocol to provide remote metering, annunciation, and control. A copper (100BASE-TX) port (style XXXXXTX) uses a standard RJ-45 jack (as shown) and a fiber optic (100BASE-FX) port (style XXXXXFX) uses two fiber optic connectors.  |
| L              | These terminals connect to user-supplied current transformers (CTs) providing three phases of generator sensing current and a cross-current compensation signal.   |
| M              | This 15-pin, D-type connector is provided for communication with the Field Isolation Transducer.   |
| N              | A portion of this terminal block provides outputs for the four programmable meter drivers.<br>The remaining terminal block pins supply analog excitation control output.   |

### DECS-450 Wiring

All pluggable headers may have either spring or compression terminals, specified by style. Spring terminals (style XXXXXXS) secure each wire with a spring-loaded contact. Compression terminals (style XXXXXXC) secure each wire with a screw compression contact.

All headers accept a maximum wire size of 12 AWG with a recommended wire strip length of 0.4 inches (10 mm). For compression terminals, the maximum screw torque is 5.3 in-lb (0.6 N•m). All headers are keyed to help prevent misconnections.

Current sensing connections are made through #8 screw terminals (locator L in Figure 17-1) and accept a maximum lug width of 0.32 inches (8.1 mm) and a maximum wire size of 14 AWG. The maximum screw torque is 21 in-lb (2.4 N•m).

## Field Isolation Transducer Connections

Field Isolation Transducer connections consist of #6 screw terminals and a 15-pin, female, D-type connector designated J1. Figure 16-2 illustrates the Field Isolation Transducer terminals.

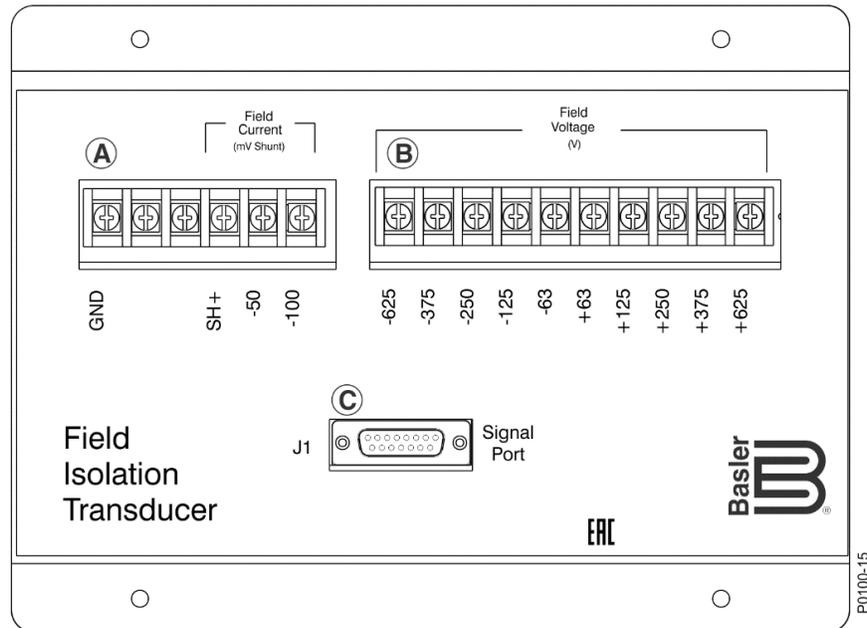


Figure 16-2. Field Isolation Transducer Terminals and Connectors

Table 16-2. Field Isolation Transducer Terminal and Connector Descriptions

| Locator | Description  |
|---------|--|
| A       | GND: The GND terminal serves as the chassis ground connection. Be sure that the Field Isolation Transducer is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to terminal GND.<br>SH+: Connects to positive output terminal of current shunt<br>-50: Connects to negative output terminal of 50 mVdc current shunt (if used)<br>-100: Connects to negative output terminal of 100 mVdc current shunt (if used) |
| B       | The field voltage sensing input accepts field voltage at one of five nominal levels. Terminal sets are provided for a nominal field voltage of 63, 125, 250, 375, and 625 Vdc. Each voltage input has a positive and negative terminal.  |
| C       | Signal port connector J1 receives operating power from the DECS-450 and sends field current and field voltage signals to the DECS-450. J1 connects to the DECS-450 Field Isolation Transducer connector through a cable (Basler P/N 9372900021) supplied with the DECS-450.  |

### Field Isolation Transducer Wiring

All connections are made through #6 screw terminals and accept a maximum wire size of 12 AWG. The recommended screw torque is 9 in-lb (1.01 N•m).

# 17 • Typical Connections

Typical connection diagrams are provided in this section as a guide when wiring the DECS-450 for communication and sensing. For cross-current compensation connections, refer to the *Voltage and Current Sensing* section in this manual.

Typical connections with an IFM-150 are shown in Figure 17-1. Typical connections with a BCM-2 are shown in Figure 17-2. The “Machine” in Figures 17-1 and 17-2 represents a generator when the DECS-450 is operating in generator mode and a motor when it is operating in motor mode. The numbered note locators in Figures 17-1 and 17-2 correspond to the descriptions in Table 17-1.

## Notes

- Current transformer (CT) grounding should be applied in accordance with local codes and conventions.
- In this manual, CT terminals are shown with polarity designations (+/–) and terminal numbers, however, physical DECS-450 CT terminals are labeled with terminal numbers only.

DECS-450 contact inputs and outputs are shown in Figure 17-3.

**Table 17-1. Typical Connection Drawing Notes**

| Locator | Description  |
|---------|--|
| 1       | Generator voltage sensing input. Potential transformer required if line voltage exceeds 240 Vac.   |
| 2       | Connections required only if voltage matching, sync-check, or auto synchronizer functions are used.  |
| 3       | See the <i>Power Inputs or Specifications</i> section for control power input ratings. When redundant ac <i>and</i> dc control power is used, an isolation transformer must be connected between the ac voltage source and the ac control power terminals of the DECS-450. |
| 4       | If the DECS-450 is providing one end of the J1939 bus, a 120-ohm, 0.5-watt terminating resistor must be installed across terminals 96 (H) and 97 (L) for CAN 1 and 99 (H) and 100 (L) for CAN 2.   |

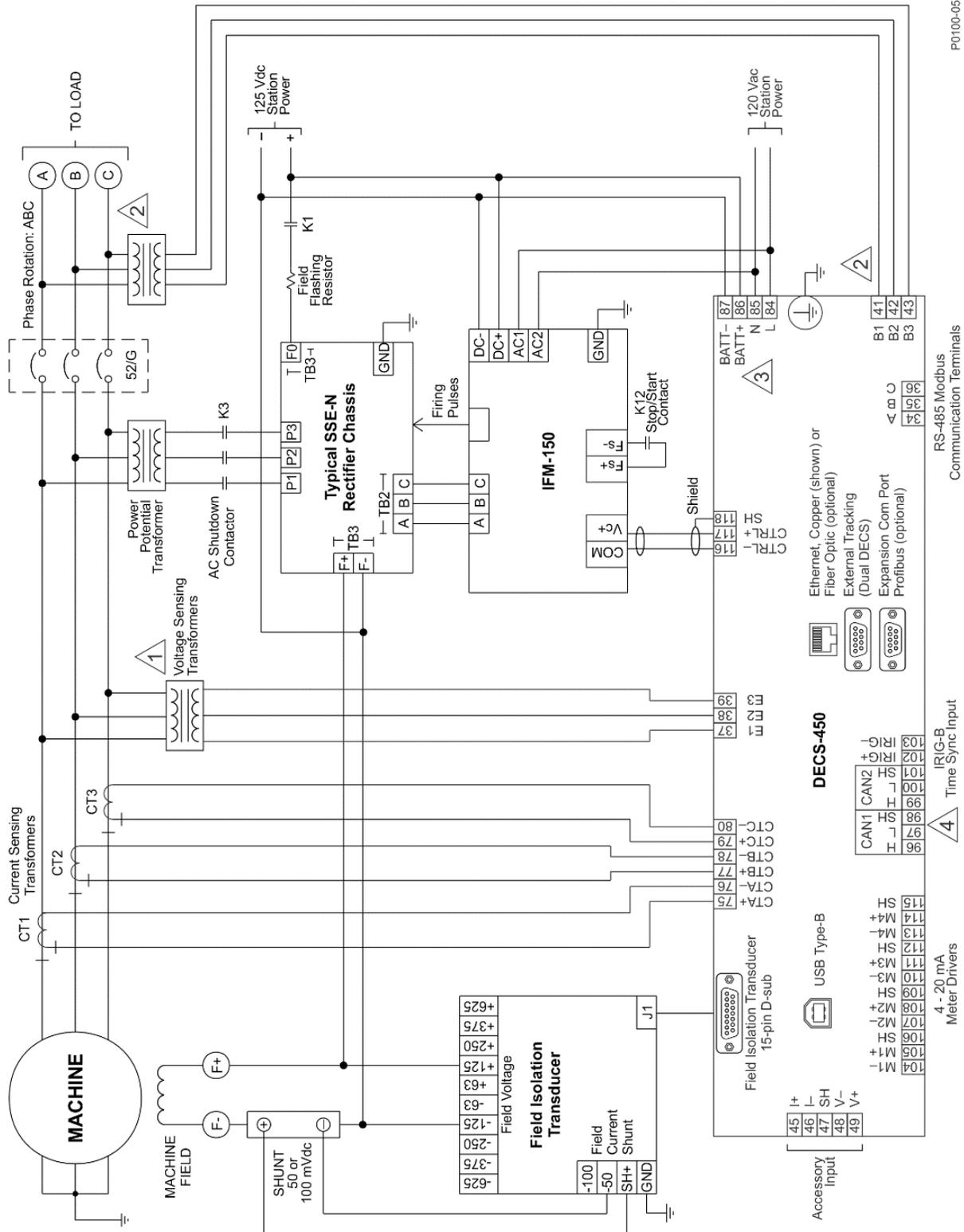


Figure 17-1. Typical DECS-450 Connections with IFM-150

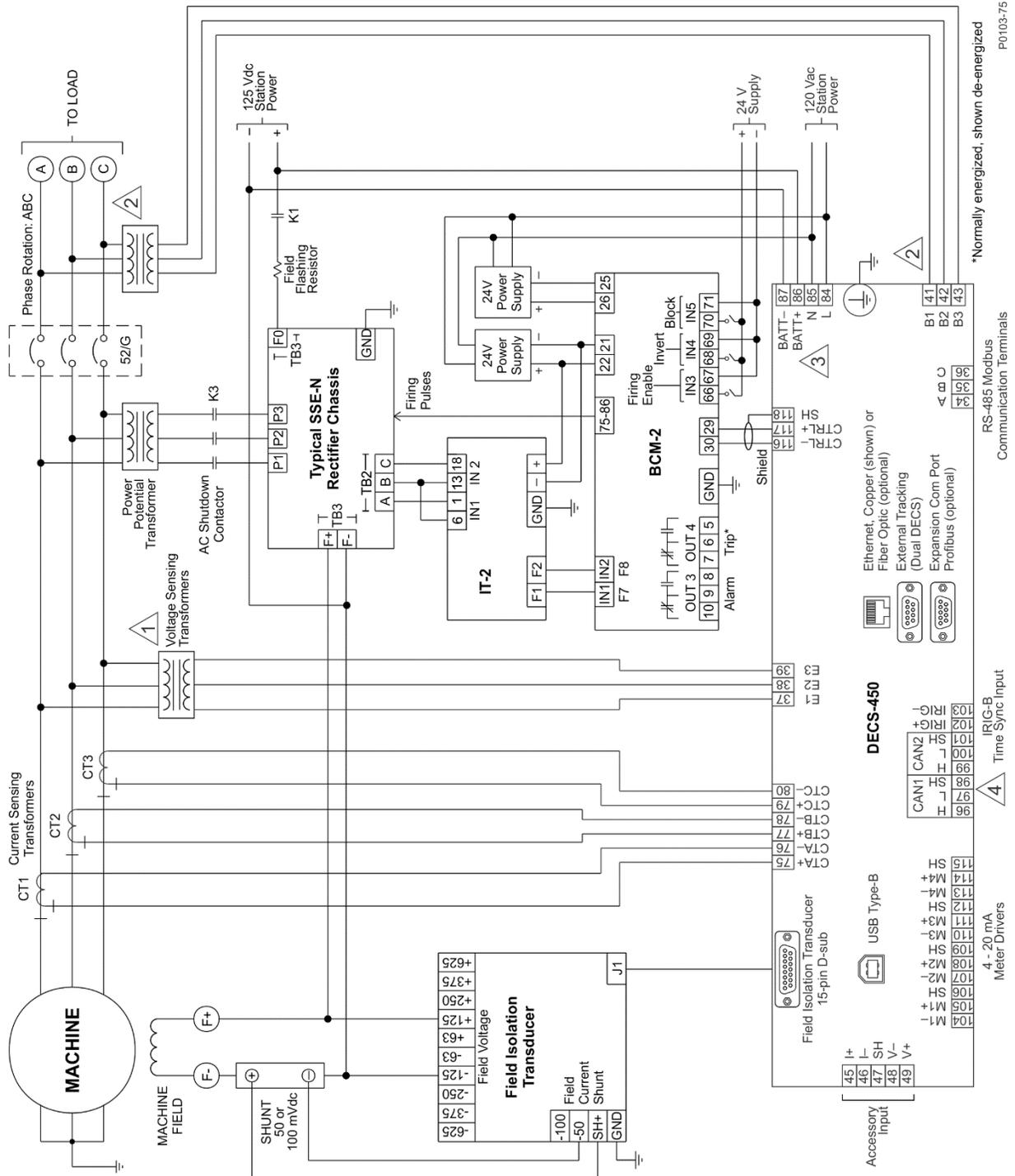


Figure 17-2. Typical DECS-450 Connections with BCM-2

\*Normally energized, shown de-energized  
P0103-75

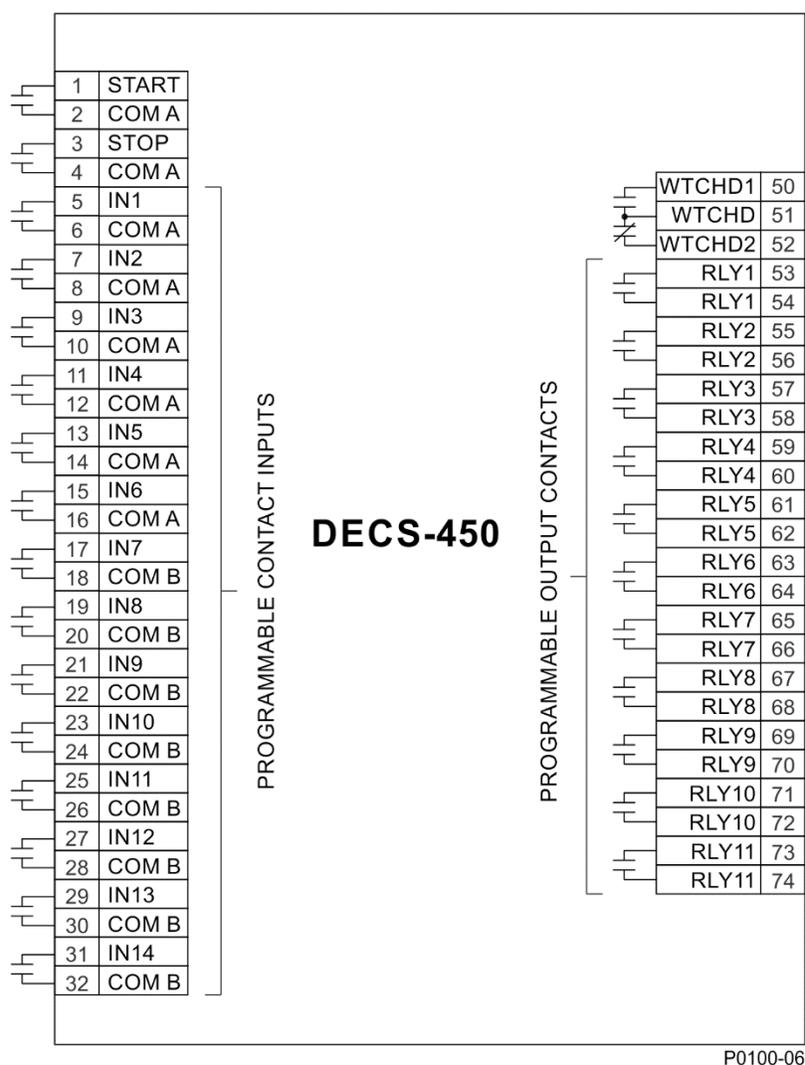


Figure 17-3. DECS-450 Contact Inputs and Outputs

## Installation for CE Compliant Systems

To meet EMC requirements for CE compliant systems, install the following:

- A Field Isolation Transducer (FIT) assembly (Basler P/N: 9372900104 or 9372900105)
- An FIT Cable (Basler P/N: 9372900021 [included with 9372900104 and -105] or 9372900022)
- A single ferrite bead around all control power wires near DECS-450 terminals 84 through 87 (Basler P/N: 37995, Fair Rite 0444164181)
- A single ferrite bead around both control output wires near DECS-450 terminals 116 and 117 (Basler P/N: 37995, Fair Rite 0444164181)
- If 100BASE-TX (copper) Ethernet is used, the Ethernet cable must be shielded.

# 18 • BESTCOMSPPlus® Software

## General Description

BESTCOMSPPlus® is a Windows®-based, PC application that provides a user-friendly, graphical user interface (GUI) for use with Basler Electric communicating products. The name BESTCOMSPlus is an acronym that stands for Basler Electric Software Tool for Communications, Operations, Maintenance, and Settings.

BESTCOMSPPlus provides the user with a point-and-click means to set and monitor the DECS-450. The capabilities of BESTCOMSPPlus make the configuration of one or more DECS-450 controllers fast and efficient. A primary advantage of BESTCOMSPPlus is that a settings scheme can be created, saved as a file, and then uploaded to the DECS-450 when convenient.

BESTCOMSPPlus uses plugins that enable the user to manage multiple Basler Electric products. The DECS-450 plugin opens inside the BESTCOMSPPlus main shell.

The DECS-450 plugin opens inside the BESTCOMSPPlus main shell. The same default logic scheme that is shipped with the DECS-450 is brought into BESTCOMSPPlus by downloading settings and logic from the DECS-450. This gives the user the option of developing a custom setting file by modifying the default logic scheme or by building a unique scheme from scratch.

BESTlogic™ Plus Programmable Logic is used to program DECS-450 logic for protection elements, inputs, outputs, alarms, etc. Simply drag and drop elements, components, inputs, and outputs onto the program grid and draw connections between them to create the desired logic scheme.

BESTCOMSPPlus also allows for downloading industry-standard COMTRADE files for analysis of stored oscillography data. Detailed analysis of the oscillography files can be accomplished using BESTwave™ software.

Figure 18-1 illustrates the typical user interface components of the DECS-450 plugin with BESTCOMSPPlus.

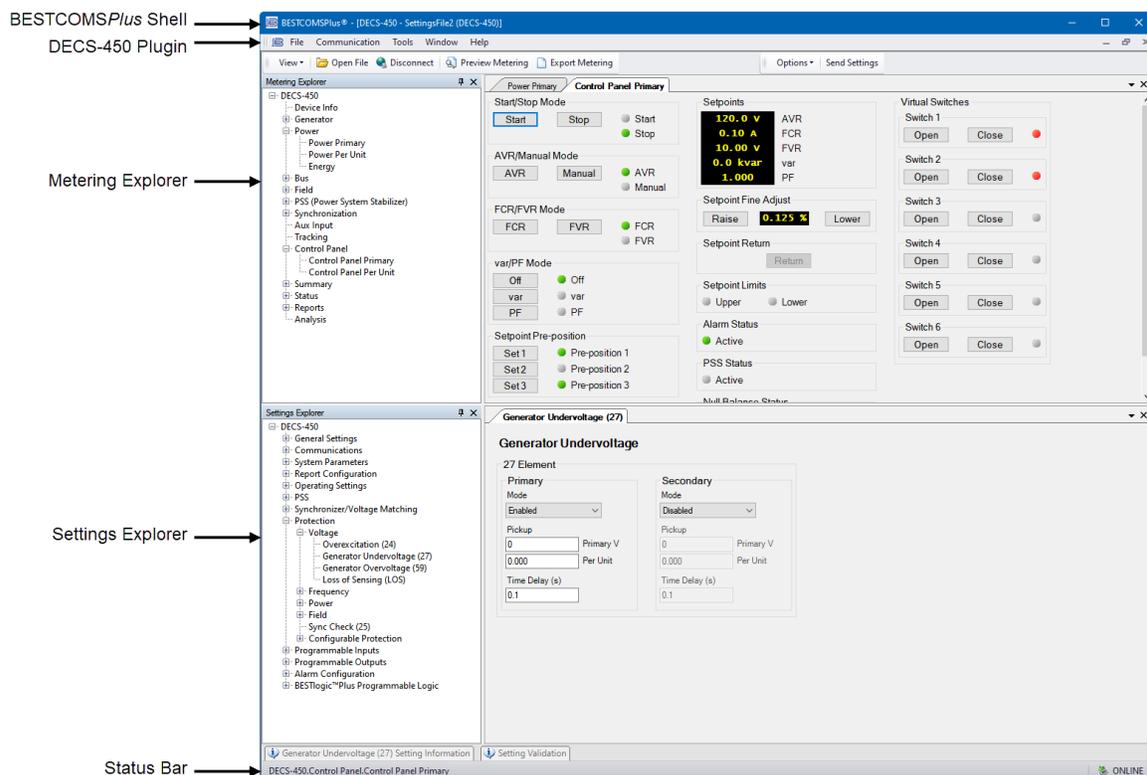


Figure 18-1. Typical User Interface Components

## Installation

BESTCOMSPi<sup>us</sup> operates with systems using Windows® 7 SP1, Windows 8.1, Windows 10, and Windows 11. BESTCOMSPi<sup>us</sup>® software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMSPi<sup>us</sup> on your PC also installs the DECS-450 plugin and the required version of .NET Framework (if not already installed). System recommendations for the .NET Framework and BESTCOMSPi<sup>us</sup> are listed in Table 18-1.

**Table 18-1. System Recommendations for BESTCOMSPi<sup>us</sup> and the .NET Framework**

| System Type | Component  | Recommendation   |
|-------------|------------|--|
| 32/64 bit   | Processor  | 2.0 GHz  |
| 32/64 bit   | RAM        | 1 GB minimum, 2 GB recommended                             |
| 32/64 bit   | Hard Drive | 200 MB (if .NET Framework is already installed on PC.)     |
|             |            | 4.5 GB (if .NET Framework is not already installed on PC.) |

To install and run BESTCOMSPi<sup>us</sup>, a Windows user must have Administrator rights. A Windows user with limited rights may not be permitted to save files in certain folders.

### Install BESTCOMSPi<sup>us</sup>®

#### Warning!

Do not connect a USB cable until setup completes successfully. Connecting a USB cable before setup is complete may result in unwanted or unexpected errors.

1. Download BESTCOMSPi<sup>us</sup> from [www.basler.com](http://www.basler.com).
2. Click the installation button for BESTCOMSPi<sup>us</sup>. The setup utility installs BESTCOMSPi<sup>us</sup>, the .NET Framework (if not already installed), the USB driver, and the DECS-450 plugin for BESTCOMSPi<sup>us</sup> on your PC.

When BESTCOMSPi<sup>us</sup> installation is complete, a Basler Electric folder is added to the Windows programs menu. This folder is accessed by clicking the Windows Start button and then accessing the Basler Electric folder in the Programs menu. The Basler Electric folder contains an icon that starts BESTCOMSPi<sup>us</sup> when clicked.

### Connect the DECS-450 and Start BESTCOMSPi<sup>us</sup>®

The DECS-450 plugin is a module that runs inside the BESTCOMSPi<sup>us</sup> shell and it contains specific operational and logic settings for the DECS-450.

#### Connect a USB Cable

The USB driver was copied to your PC during BESTCOMSPi<sup>us</sup>® installation and is installed automatically after connecting to the DECS-450. USB driver installation progress is shown in the Windows Taskbar area. Windows will notify you when installation is complete.

#### Note

In some instances, the Found New Hardware Wizard will prompt you for the USB driver. If this happens, direct the wizard to the following folder:

C:\Program Files\Basler Electric\USB Connect Driver\

If the USB driver does not install properly, refer to the *Maintenance and Troubleshooting* section for a troubleshooting procedure.

Connect a USB cable between the PC and your DECS-450. Apply control power to the DECS-450 and wait until the boot sequence is complete.

### Start BESTCOMSPPlus®

To start BESTCOMSPPlus, click the *Start* button, point to *Programs, Basler Electric*, and then click the *BESTCOMSPPlus* icon. During initial startup, the *BESTCOMSPPlus Select Language* screen is displayed (Figure 18-2). You can choose to have this screen displayed each time BESTCOMSPPlus is started, or you can select a preferred language and this screen will be bypassed in the future. Click *OK* to continue. This screen can be accessed later by selecting *Tools* and *Select Language* from the menu bar.

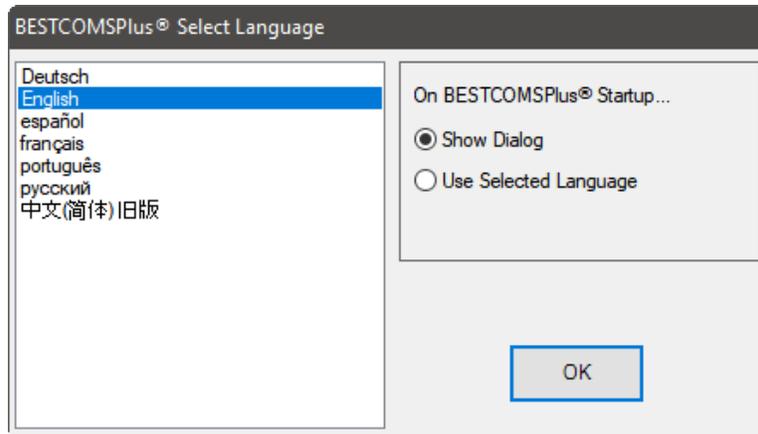


Figure 18-2. BESTCOMSPPlus Select Language Screen

The BESTCOMSPPlus® platform window opens. Select *New Connection* from the *Communication* pull-down menu and select *DECS-450*. See Figure 18-3.

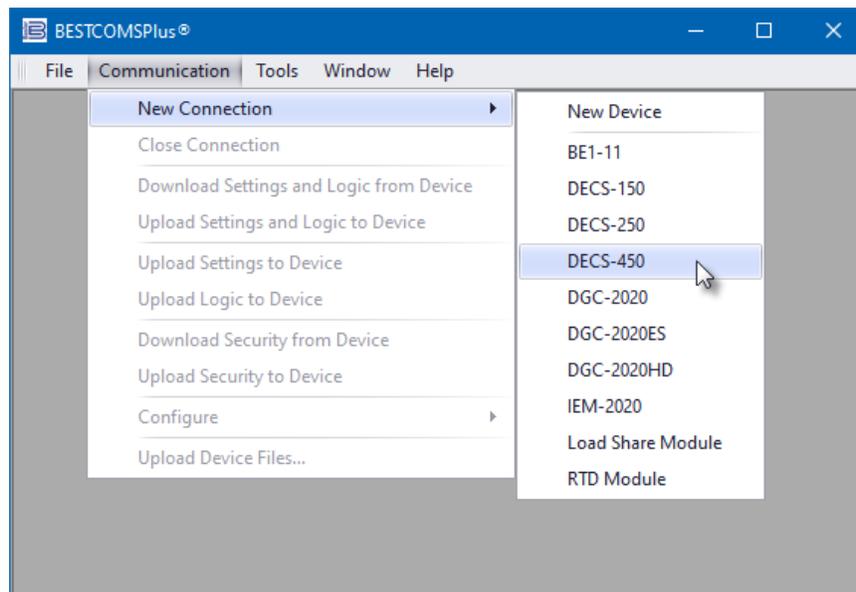


Figure 18-3. Communication Pull-Down Menu

The *DECS-450 Connection* screen shown in Figure 18-4 appears. Select *USB Connection* and click *Connect*.

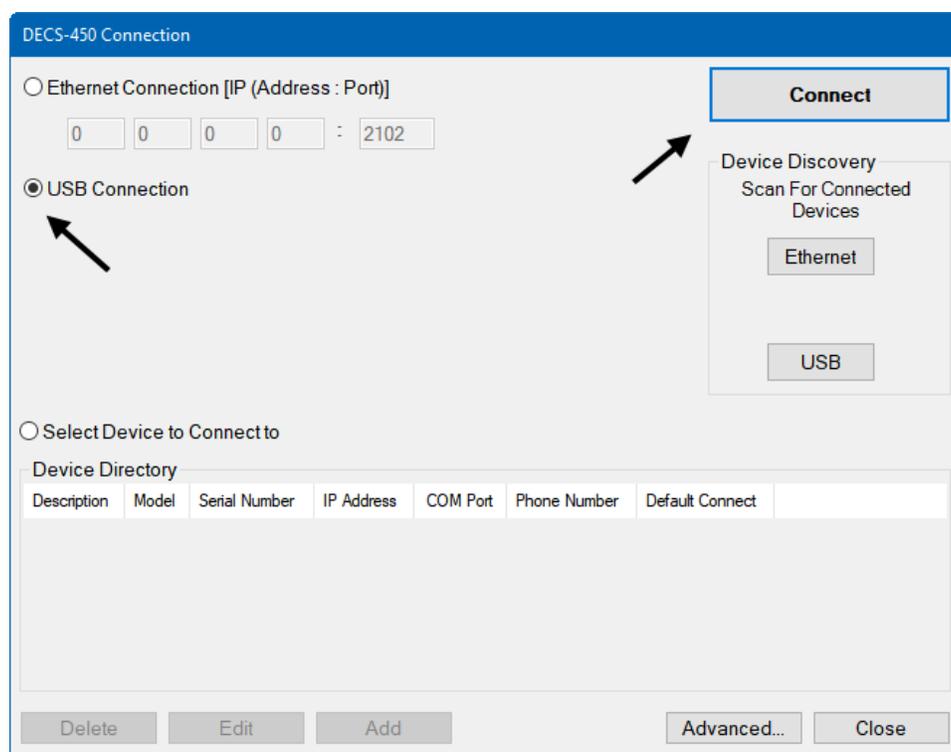


Figure 18-4. DECS-450 Connection Screen

## Establishing Communication

Communication between BESTCOMSP*lus* and the DECS-450 is established by clicking the *Connect* button on the *DECS-450 Connection* screen (see Figure 18-4) or by clicking the *Connect* button on the lower menu bar of the main BESTCOMSP*lus* screen (Figure 18-1). If you receive an “Unable to Connect to Device” error message, verify that communications are configured properly. Only one Ethernet connection is allowed at one time. Download all settings and logic from the device by selecting *Download Settings and Logic* from the *Communication* pull-down menu. BESTCOMSP*lus* will read all settings and logic from the DECS-450 and load them into BESTCOMSP*lus* memory.

## Menu Bars

The menu bars are located near the top of the BESTCOMSP*lus*<sup>®</sup> screen (see Figure 18-1). The upper menu bar has five pull-down menus. With the upper menu bar, it is possible to manage settings files, configure communication settings, upload and download settings and security files, and compare settings files. The lower menu bar consists of clickable icons. The lower menu bar is used to change BESTCOMSP*lus* views, open a settings file, connect/disconnect, preview metering printout, switch to live mode, and send settings after a change is made when not in live mode.

### Upper Menu Bar (BESTCOMSP*lus*<sup>®</sup> Shell)

Upper menu bar functions are listed and described in Table 18-2.

Table 18-2. Upper Menu Bar (BESTCOMSP*lus*<sup>®</sup> Shell)

| Menu Item         | Description                                      |
|-------------------|--|
| <i>File</i>       |  |
| New               | Create a new settings file                       |
| Open              | Open an existing settings file                   |
| Open File As Text | Generic file viewer for *.csv, *.txt, etc. files |
| Close             | Close settings file                              |

| <b>Menu Item</b>                          | <b>Description</b>   |
|---|--|
| Save                                      | Save settings file   |
| Save As                                   | Save settings file with a different name   |
| Export To File                            | Save settings as a *.csv file  |
| Print                                     | Open the print menu  |
| Properties                                | View properties of a settings file   |
| History                                   | View history of a settings file  |
| Recent Files                              | Open a previously opened file  |
| Exit                                      | Close BESTCOMSP <i>l</i> us program  |
| <b><u>Communication</u></b>               |  |
| New Connection                            | Choose new device or DECS-450  |
| Close Connection                          | Close communication between BESTCOMSP <i>l</i> us and DECS-450   |
| Download Settings and Logic from Device   | Download operational and logic settings from the device  |
| Upload Settings and Logic to Device       | Upload operational and logic settings to the device  |
| Upload Settings to Device                 | Upload operational settings to the device  |
| Upload Logic to Device                    | Upload logic settings to the device  |
| Download Security from Device             | Download security settings from the device   |
| Upload Security to Device                 | Upload security settings to the device   |
| Configure                                 | Ethernet settings  |
| Upload Device Files                       | Upload firmware to the device  |
| <b><u>Tools</u></b>                       |  |
| Check for Updates                         | Check for BESTCOMSP <i>l</i> us® updates via the internet  |
| Select Language                           | Select BESTCOMSP <i>l</i> us language  |
| Set File Password                         | Password protect a settings file   |
| Compare Settings Files                    | Compare two settings files   |
| Auto Export Metering                      | Exports metering data on a user-defined interval   |
| Convert Gains                             | Converts DECS-400 AVR Kg gain value for use in the DECS-450. Refer to the <i>Stability Tuning</i> section for details. |
| Event Log - View                          | View the BESTCOMSP <i>l</i> us event log   |
| Event Log - Verbose Logging               | Enable/disable verbose logging   |
| Event Log - Verbose Communication Logging | Enable/disable verbose communication logging   |
| Generate Certificate                      | Generate a certificate (not applicable to DECS-450)  |
| Accepted Devices                          | View and delete accepted devices (not applicable to DECS-450)  |
| <b><u>Window</u></b>                      |  |
| Cascade All                               | Cascade all windows  |
| Tile                                      | Tile horizontally or vertically  |
| Maximize All                              | Maximize all windows   |
| <b><u>Help</u></b>                        |  |
| Check for Updates                         | Check for BESTCOMSP <i>l</i> us® updates via the internet  |
| Check for Update Settings                 | Enable or change automatic checking for update   |
| About                                     | View general, detailed build, and system information   |

## Lower Menu Bar (DECS-450 Plugin)

Lower menu bar functions are listed and described in Table 18-3.

**Table 18-3. Lower Menu Bar (DECS-450 Plugin)**

| Menu Button               | Description   |
|---------------------------|---|
| <i>View</i>               | Enables you to view the Metering Panel, Settings Panel, or Show Settings Information. Opens and saves workspaces. Customized workspaces make switching between tasks easier and more efficient. |
| <i>Open File</i>          | Opens a saved settings file.  |
| <i>Connect/Disconnect</i> | Opens the <i>DECS-450 Connection</i> screen, which enables you to connect to the DECS-450 via USB or Ethernet. Also used to disconnect a connected DECS-450.                                    |
| <i>Preview Metering</i>   | Displays the <i>Print Preview</i> screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.   |
| <i>Export Metering</i>    | Enables all metering values to be exported into a *.csv file.   |
| <i>Options</i>            | Displays a drop-down list entitled <i>Live Mode Settings</i> , which enables <i>Live</i> mode where settings are automatically sent to the device in real time as they are changed.             |
| <i>Send Settings</i>      | Sends settings to the DECS-450 when BESTCOMSP <i>lus</i> is not operating in Live Mode. Click on this button after making a setting change to send the modified setting to the DECS-450.        |

## Settings Explorer

The Settings Explorer is a convenient tool within BESTCOMSP*lus*® used to navigate through the various settings screens of the DECS-450 plugin. Descriptions of these configuration settings are organized as follows:

- General Settings
- Communications
- System Parameters
- Report Configuration
- Operating Settings
- PSS
- Synchronizer/Voltage Matching
- Protection
- Programmable Inputs
- Programmable Outputs
- Alarm Configuration
- BESTlogic*Plus* Programmable Logic

Logic setup will be necessary after making certain setting changes. For more information, refer to the BESTlogic*Plus* chapter.

## Settings Entry

When entering settings in BESTCOMSP*lus*, each setting is validated against prescribed limits. Entered settings that do not conform to the prescribed limits are accepted but flagged as noncompliant. Figure 18-5 illustrates an example of flagged, noncompliant settings (locator A) and the Setting Validation window (locator B) used to diagnose faulty settings.

**Setting Validation**

2 Errors | 1 Warnings | 0 Messages | Revalidate | Click on the Setting Name link to open the screen the setting is on.

| Setting Name  | Device Value | Error Message  |
|---|--------------|--|
| <a href="#">DecsSetpoint.GenVolSetpoint</a>         | 155.0        | DecsSetpoint.GenVolSetpoint. Value 155.0 is out of range (84 - 144)        |
| <a href="#">DecsSetpoint.ExcCurMinSetpointLimit</a> | 0            | Cannot validate. One or more supporting settings are invalid.              |
| <a href="#">DecsSetpoint.ExcCurMaxSetpointLimit</a> | 180.0        | DecsSetpoint.ExcCurMaxSetpointLimit. Value 180.0 is out of range (0 - 120) |

AVR/FCR/FVR Setpoints Setting Information | Setting Validation

DECS-450.Operating Settings.AVR/FCR/FVR Setpoints

**Figure 18-5. Flagged, Noncompliant Settings and the Setting Validation Window**

The Setting Validation window, viewed by selecting the Setting Validation tab (locator C), displays three types of annunciations: errors, warnings, and messages. An error describes a problem such as a setting that is out of range. A warning describes a condition where supporting settings are invalid, causing other settings to be noncompliant with the prescribed limits. A message describes a minor setting issue that was automatically resolved by BESTCOMSPPlus. An example of a condition triggering a message is entry of a settings value with a resolution that exceeds the limit imposed by BESTCOMSPPlus. In this situation, the value is automatically rounded and a message is triggered. Each annunciation lists a hyperlinked name for the noncompliant setting and an error message describing the issue. Clicking the hyperlinked setting name takes you to the setting screen with the offending setting. Right-clicking the hyperlinked setting name will restore the setting to its default value.

### Note

It is possible to save a DECS-450 settings file in BESTCOMSPPlus with noncompliant settings. However, it is not possible to upload noncompliant settings to the DECS-450.

## Metering Explorer

The Metering Explorer is used to view real-time system data including generator voltages and currents, input/output status, alarms, reports, and other parameters. Refer to the *Metering* section for more information about the Metering Explorer.

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## Settings File Management

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A settings file contains all DECS-450 settings and logic and its file extension is “bst4”.

It is possible to save only the DECS-450 logic displayed on the *BESTlogicPlus* Programmable Logic screen as a separate logic library file. This is helpful when similar logic is required for multiple DECS-450 systems. The file extension of a logic file created in *BESTCOMSPPlus* is “bsl4”.

It is important to note that settings and logic can be uploaded to the device separately or together, but are always downloaded together. For more information on logic files, refer to the *BESTlogicPlus* section.

### Opening a Settings File

To open a DECS-450 settings file with *BESTCOMSPPlus*, click the *File* menu and choose *Open*. The *Open* dialog box appears. This dialog box allows you to use normal Windows techniques to select the file that you want to open. Select the file and choose *Open*. You can also open a file by clicking on the *Open File* button on the lower menu bar. If connected to a device, you will be asked to upload the settings and logic from the file to the current device. If you choose *Yes*, the settings displayed in *BESTCOMSPPlus* instance will be overwritten with the settings of the opened file.

### Saving a Settings File

Select *Save* or *Save As* from the *File* pull-down menu. A dialog box pops up allowing you to enter a filename and location to save the file. Select the *Save* button to complete the save.

### Upload Settings and/or Logic to Device

To upload a settings file to the DECS-450, open the file or create a new file through *BESTCOMSPPlus*. Then pull down the *Communication* menu and select *Upload Settings and Logic to Device*. If you want to upload operational settings without logic, select *Upload Settings to Device*. If you want to upload logic without operational settings, select *Upload Logic to Device*. You are prompted to enter the username and password. The default username is “A” and the default password is “A”. If the username and password are correct, the upload begins and the progress bar is shown.

### Download Settings and Logic from Device

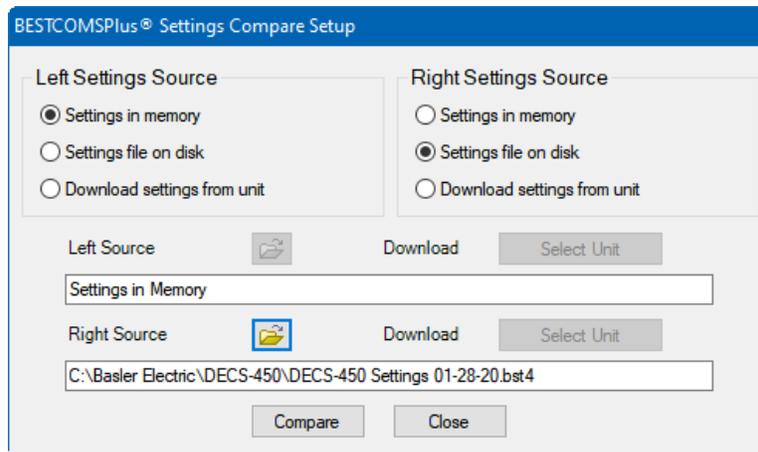
To download settings and logic from the DECS-450, pull down the *Communication* menu and select *Download Settings and Logic from Device*. If the settings in *BESTCOMSPPlus*® have changed, a dialog box will open asking if you want to save the current settings changes. You can choose *Yes* or *No*. After you have taken the required action to save or discard the current settings, downloading begins. *BESTCOMSPPlus* reads all settings and logic from the DECS-450 and loads them into *BESTCOMSPPlus* memory.

### Printing a Settings File

To view a preview of the settings printout, select *Print* from the *File* pull-down menu. To print the settings, select the printer icon in the upper left corner of the *Print Preview* screen.

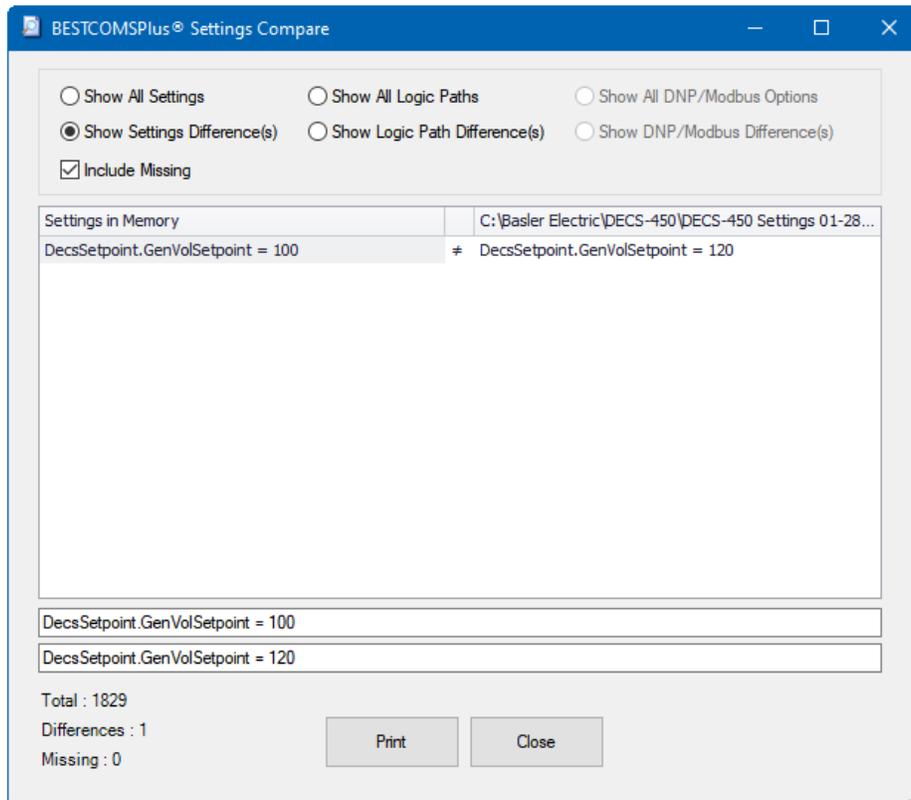
### Comparing Settings Files

*BESTCOMSPPlus* has the ability to compare two settings files. To compare files, pull down the *Tools* menu and select *Compare Settings Files*. The *BESTCOMSPPlus Settings Compare Setup* dialog box appears (Figure 18-6). Select the location of the first file under *Left Settings Source* and select the location of the second file under *Right Settings Source*. If you are comparing a settings file located on your PC hard drive or portable media, click the folder button and navigate to the file. If you want to compare settings downloaded from a unit, click the *Select Unit* button to set up the communication port. Click the *Compare* button to compare the selected settings files.



**Figure 18-6. BESTCOMSPPlus® Settings Compare Setup**

A dialog box will appear and notify you if any differences were found. The BESTCOMSPPlus® *Settings Compare* dialog box (Figure 18-7) is displayed where you can view all settings (*Show All Settings*), view only the differences (*Show Settings Differences*), view all logic (*Show All Logic Paths*), or view only logic differences (*Show Logic Path Differences*). Select *Close* when finished.



**Figure 18-7. BESTCOMSPPlus® Settings Compare**

## Automatic Metering Export

The auto export metering function automatically exports metering data over a user-defined period when a DECS-450 connection is active. The user specifies the *Number of Exports* and the *Interval* between each export. Enter a filename for the metering data and a folder in which to save. The first export is performed immediately after clicking the *Start* button. Click the *Filter* button to select specific metering screens. Figure 18-8 illustrates the *Auto Export Metering* screen.

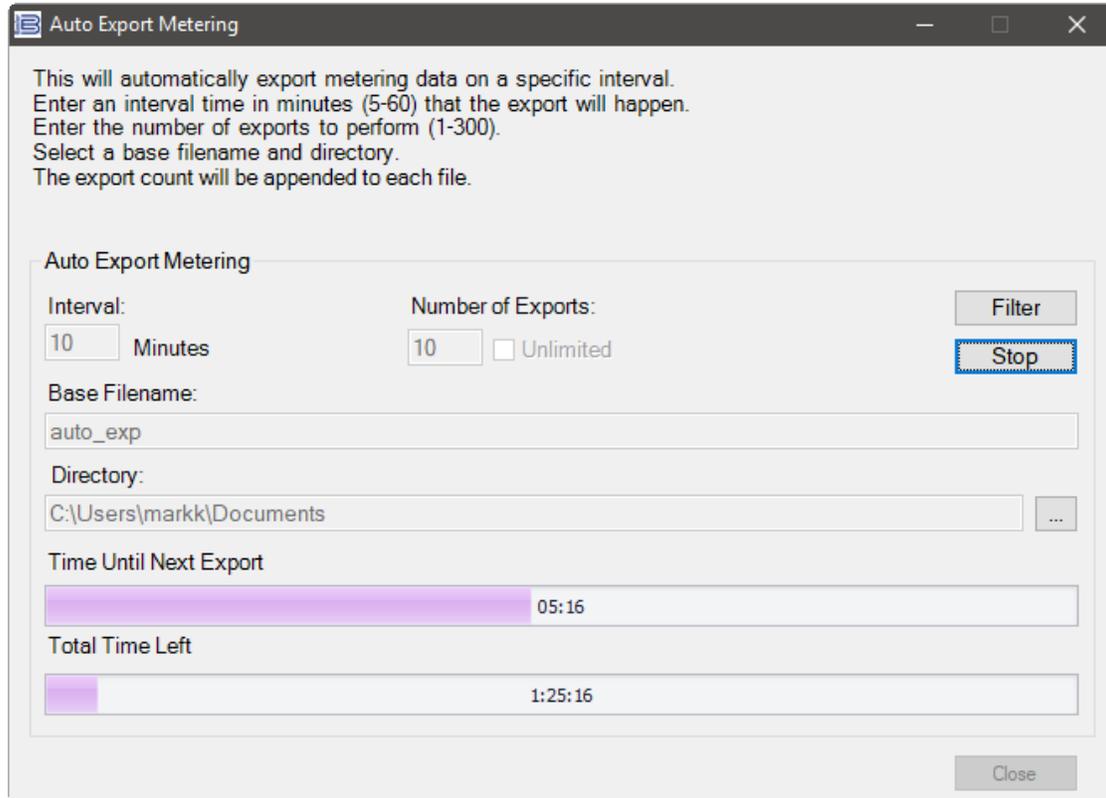


Figure 18-8. Auto Export Metering Screen

## Firmware Updates

Future enhancements to the DECS-450 functionality may require a firmware update. Because default settings are loaded when DECS-450 firmware is updated, your settings should be saved in a file prior to upgrading firmware.

### Warning!

Before performing any maintenance procedures, remove the DECS-450 from service. Refer to the appropriate site schematics to ensure that all steps have been taken to properly and completely de-energize the DECS-450.

**Caution – Settings will be lost!**

Default settings will be loaded into the DECS-450, reports and events will be cleared, and the DECS-450 will reboot when firmware is updated. BESTCOMSP<sup>Plus</sup>® can be used to download settings and save the settings in a file so that they can be restored after updating firmware. Refer to *Settings File Management* for help with saving a settings file.

**Caution**

Installing previous versions of firmware may result in compatibility issues causing the inability to operate properly and may not have the enhancements and resolutions to issues that more recent versions provide. Basler Electric highly recommends using the latest version of firmware at all times. Using previous versions of firmware is at the user's risk and may void the warranty of the unit. □

**Note**

The latest version of BESTCOMSP<sup>Plus</sup> software should be downloaded from the Basler Electric website and installed before performing a firmware upgrade.

A device package contains firmware for the DECS-450, the optional Contact Expansion Module (CEM-125 or CEM-2020), and the optional Analog Expansion Module (AEM-2020). Embedded firmware is the operating program that controls the actions of the DECS-450. The DECS-450 stores firmware in nonvolatile flash memory that can be reprogrammed through the communication ports. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

The DECS-450 can be used in conjunction with CEM-125, CEM-2020, or AEM-2020 expansion modules which expand the DECS-450 capabilities. When upgrading the firmware in any component of this system, the firmware in ALL of the components of the system should be upgraded to ensure compatibility of communications between the components.

**Caution**

The order in which the components are upgraded is critical. **Expansion modules must be upgraded before the DECS-450.** This is necessary because the DECS-450 must be able to communicate with the expansion modules in order send firmware to them. If the DECS-450 is upgraded first, and the new firmware included a change to the expansion module communication protocol, it is possible that the expansion modules could no longer communicate with the upgraded DECS-450. Without communications between the DECS-450 and the expansion modules, upgrading the expansion modules is not possible.

### Note

If power is lost or communication is interrupted during file transfer to the DECS-450, the firmware upload will fail. The device will continue to use the previous firmware. Once communication has been restored, the user must start the firmware upload again. Select Upload Device Files from the Communication pull-down menu and proceed normally.

## Upgrading Firmware in Expansion Modules

The following procedure is used to upgrade firmware in the expansion modules. This must be completed before upgrading firmware in the DECS-450. If no expansion module is present, proceed to *Upgrading Firmware in the DECS-450*.

1. Remove the DECS-450 from service. Refer to the appropriate site schematics to ensure that all steps have been taken to properly and completely de-energize the DECS-450.
2. Apply control power to the DECS-450.
3. Enable the expansion modules that are present in the system. If they have not already been enabled, enable the expansion modules in the BESTCOMS*Plus* Settings Explorer, Communications, CAN Bus, Remote Module Setup screen.
4. Verify that the DECS-450 and the associated expansion modules are communicating. This can be verified by examining the alarm status using the Metering Explorer in BESTCOMS*Plus* or from the front panel by navigating to Metering > Status > Alarms. When communications are functioning properly, there should be no active AEM or CEM Communications Failure alarms.
5. Connect to the DECS-450 through the USB or Ethernet port if not already connected.
6. Select Upload Device Files from the Communication pull-down menu.
7. You will be asked to save the current settings file. Select Yes or No.
8. When the Basler Electric Device Package Uploader screen (Figure 18-9) appears, click on the Open button to browse for the device package you have received from Basler Electric. The Package Files along with File Details are listed. Place a check in the boxes next to the individual files you want to upload.

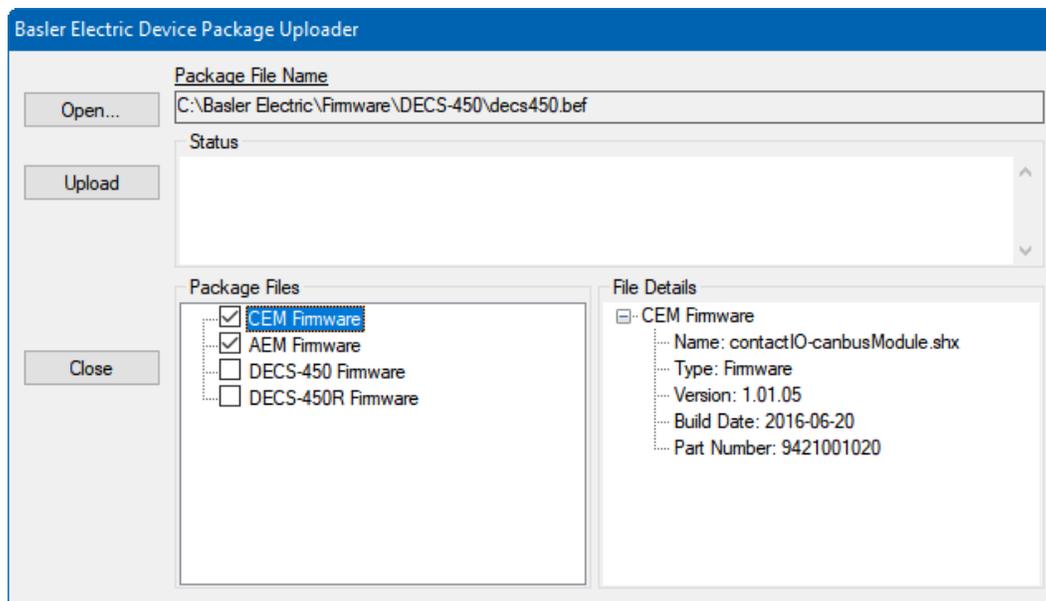


Figure 18-9. Basler Electric Device Package Uploader

9. Click on the Upload button and the Proceed with Device Upload screen will appear. Select Yes or No.
10. After selecting Yes, the DECS-450 Selection screen will appear. Select either USB or Ethernet.
11. After file(s) have been uploaded, click the *Close* button on the Basler Electric Device Package Uploader screen and disconnect communication to the DECS-450.

### Upgrading Firmware in the DECS-450

The following procedure is used to upgrade firmware in the DECS-450. This must be completed after upgrading firmware in any expansion modules.

1. Remove the DECS-450 from service. Refer to the appropriate site schematics to ensure that all steps have been taken to properly and completely de-energize the DECS-450.
2. Apply control power to the DECS-450.
3. Connect to the DECS-450 with BESTCOMSP*lus*. Check the firmware Application Version on the General Settings > Device Info screen.
4. Select Upload Device Files from the Communication pull-down menu. You do not have to be connected to the DECS-450 at this time. Save settings when prompted, if desired.
5. Open the desired device package file (decs450.bef).
6. Check the box for DECS-450 Firmware. Note the version number of the DECS-450 firmware; this is the version that will be used to set the Application Version in the settings file in a later step.
7. Click the Upload button and follow the instructions that appear to begin the upgrade process.
8. After the upload is complete, disconnect communication to the DECS-450.
9. Load the saved settings file into the DECS-450.
  - a. Close all settings files.
  - b. From the File pull-down menu, select New, DECS-450.
  - c. Connect to the DECS-450.
  - d. Once all settings have been read from the DECS-450, open the saved settings file by selecting File, Open File in the BESTCOMSP*lus* menu. Then browse for the file to upload.
  - e. When BESTCOMSP*lus* asks if you wish to upload settings and logic to the device, click Yes.
  - f. If you are receiving upload failures and indications that the logic is incompatible with the firmware version, check that the DECS-450 style number in the saved file matches that of the DECS-450 into which the file is being uploaded. The style number in the settings file is found under General Settings > Style Number in BESTCOMSP*lus*.
  - g. If the style number of the settings file does not match that of the DECS-450 into which it is to be loaded, disconnect from the DECS-450, then modify the style number in the settings file. Then repeat the steps titled *Load the Saved Settings File into the DECS-450*.

## **BESTCOMSP*lus*<sup>®</sup> Updates**

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Enhancements to DECS-450 firmware typically coincide with enhancements to the DECS-450 plugin for BESTCOMSP*lus*<sup>®</sup>. When a DECS-450 is updated with the latest version of firmware, the latest version of BESTCOMSP*lus* should also be obtained.

- You can download the latest version of BESTCOMSP*lus* at [www.basler.com](http://www.basler.com).

- BESTCOMS*Plus* automatically checks for updates when enabled. To enable, click *Help*, then *Check for Update Settings*. When the dialog opens, click the *Check Automatically* box and *Save*. (An internet connection is required.)
- You can use the manual “check for updates” function in BESTCOMS*Plus* to ensure that the latest version is installed by selecting Check for Updates in the *Help* menu. (An internet connection is required.)

# 19 • BESTlogic™ Plus

## Introduction

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BESTlogic™ Plus Programmable Logic is a programming method used for managing the input, output, protection, control, monitoring, and reporting capabilities of Basler Electric's DECS-450 Digital Excitation Control System. Each DECS-450 has multiple, self-contained logic blocks that have all of the inputs and outputs of its discrete component counterpart. Each independent logic block interacts with control inputs and hardware outputs based on logic variables defined in equation form with BESTlogicPlus. BESTlogicPlus equations entered and saved in the DECS-450 system's nonvolatile memory integrate (electronically wire) the selected or enabled protection and control blocks with control inputs and hardware outputs. A group of logic equations defining the logic of the DECS-450 is called a logic scheme.

Two default active logic schemes are preloaded into the DECS-450. One default logic scheme is tailored for a system with the PSS option disabled and the other is for a system with PSS enabled. The proper default logic scheme is loaded depending on the PSS option selected in the system style number. These schemes are configured for a typical protection and control application of a synchronous generator and virtually eliminate the need for "start-from-scratch" programming. BESTCOMSPPlus® can be used to open a logic scheme that was previously saved as a file and upload it to the DECS-450. The default logic schemes can also be customized to suit your application. Detailed information about logic schemes is provided later in this section.

BESTlogicPlus is not used to define the operating settings (modes, pickup thresholds, and time delays) of the individual protection and control functions. Operating settings and logic settings are interdependent but separately programmed functions. Changing logic settings is similar to rewiring a panel and is separate and distinct from making the operating settings that control the pickup thresholds and time delays of a DECS-450. Detailed information about operating settings is provided in other sections of this instruction manual.

### Caution

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

## Overview of BESTlogic™ Plus

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Use BESTCOMSPPlus to make BESTlogicPlus settings. Use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 19-1.

The *BESTlogicPlus Programmable Logic* screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

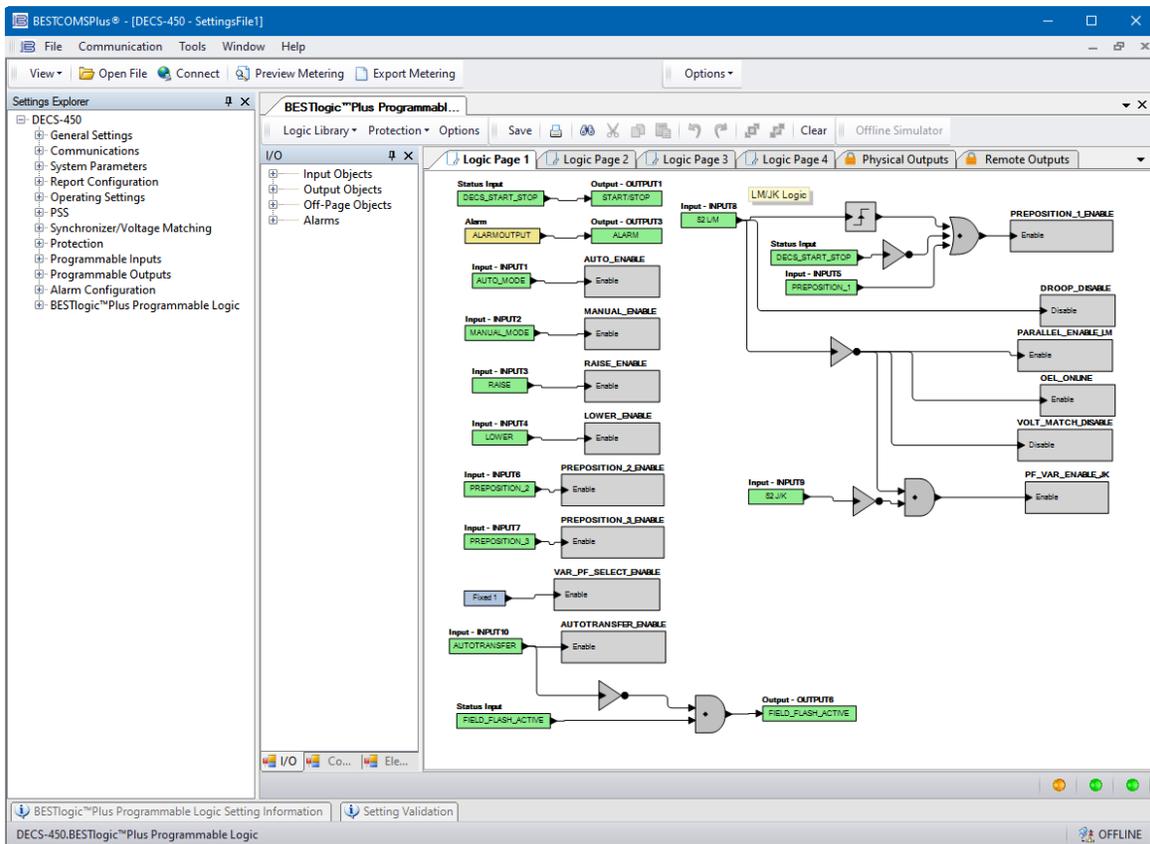


Figure 19-1. BESTlogicPlus Programmable Logic Tree Branch

### BESTlogic™ Plus Composition

There are three main groups of objects used for programming BESTlogicPlus. These groups are *I/O*, *Components*, and *Elements*. For details on how these objects are used to program BESTlogicPlus, see the paragraphs on *Programming BESTlogicPlus*.

#### I/O

This group contains Input Objects, Output Objects, Off-Page Objects, and Alarms. Table 19-1 lists the names and descriptions of the objects in the *I/O* group.

Table 19-1. I/O Group, Names and Descriptions

| Name                               | Description  | Symbol |
|------------------------------------|--|--------|
| <b>Input Objects</b>               |  |        |
| Logic 0                            | Always FALSE (Low).                                      |        |
| Logic 1                            | Always TRUE (High).                                      |        |
| <i>Status, Front Panel Buttons</i> |  |        |
| Down Button                        | True while the front panel Down arrow button is pressed. |        |
| Edit Button                        | True while the front panel Edit button is pressed.       |        |
| Left Button                        | True while the front panel Left arrow button is pressed. |        |

| Name                        | Description  | Symbol  |
|-----------------------------|--|---|
| Reset Button                | True while the front panel Reset button is pressed.  | <b>Status Input</b><br>ResetButton                |
| Right Button                | True while the front panel Right arrow button is pressed.  | <b>Status Input</b><br>RightButton                |
| Up Button                   | True while the front panel Up arrow button is pressed.   | <b>Status Input</b><br>UpButton                   |
| <i>Physical Inputs</i>      |  |   |
| Start Input                 | True when the physical Start input is active.  | <b>Input - STARTINPUT</b><br>STARTINPUT           |
| Stop Input                  | True when the physical Stop input is active.   | <b>Input - STOPINPUT</b><br>STOPINPUT             |
| IN1 - IN14                  | True when Physical Input x is active.  | <b>Input - INPUT1</b><br>INPUT 1                  |
| <i>Remote Inputs</i>        |  |   |
| IN15 - IN24                 | True when Remote Input x is active.<br>(Available when an optional CEM-2020 is connected.)   | <b>Input - IN15</b><br>INPUT 15                   |
| <i>Virtual Inputs</i>       |  |   |
| VIN1 - VIN6                 | True when Virtual Input x is active.   | <b>Input - VIRTUALSEWITCH1</b><br>VIRTUALSEWITCH1 |
| <i>Status Inputs</i>        |  |   |
| Anticipatory Sync Selected  | True when Anticipatory is selected. (Synchronizer screen)  | <b>Status Input</b><br>ANTICIPATORY_SYNC_SELECT   |
| Auto Mode Active            | True when the unit is in Auto mode (AVR).  | <b>Status Input</b><br>AUTO_ACTIVE                |
| Auto Sync Enabled           | True when DECS auto-sync is enabled.   | <b>Status Input</b><br>DECS_AUTOSYNC_ENABLE       |
| Bus Dead                    | True when the Bus Dead condition settings have been exceeded.  | <b>Status Input</b><br>BUS_DEAD                   |
| Bus Failed                  | True when the Bus Stable condition settings are not met.   | <b>Status Input</b><br>BUS_FAILED                 |
| Bus Stable                  | True when the Bus Stable condition settings have been exceeded.  | <b>Status Input</b><br>BUS_STABLE_COND            |
| Control Power Input Failure | True when the DECS-450 power supply is lost.   | <b>Status Input</b><br>CONTROLPOWERINPUTFAILURE   |
| Crowbar Activated           | True when the CROWBARSTATUS logic element has a TRUE input.  | <b>Status Input</b><br>CROWBARACTIVATED           |
| Dead Bus Close Request      | True when this option is user-enabled; a dead bus is closed automatically upon detection. False when this option is disabled; a dead bus will remain open. | <b>Status Input</b><br>DEAD_BUS_CLOSE_REQUEST     |

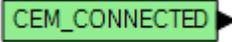
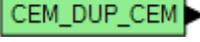
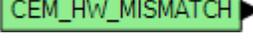
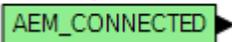
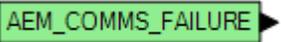
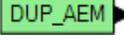
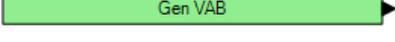
| Name                              | Description  | Symbol   |
|-----------------------------------|--|--|
| External Tracking Active          | True when external tracking is running.  | <b>Status Input</b><br>EXT_TRACKING_ACTME                |
| Failed To Buildup                 | True when the Failed to Buildup alarm is active.                                 | <b>Status Input</b><br>FAILEDTOBUILDUP                   |
| FCR Active                        | True when the unit is in FCR mode.   | <b>Status Input</b><br>FCR_Active                        |
| Field Flash Active                | True when field flash is active.   | <b>Status Input</b><br>FIELD_FLASH_ACTIVE                |
| Field Short Circuit Status        | True when a field short circuit condition is detected.                           | <b>Status Input</b><br>FIELDSHORTCIRCUITSTATUS           |
| FVR Active                        | True when the unit is in FVR mode.   | <b>Status Input</b><br>FVR_Active                        |
| Gen Breaker Fail to Close         | The generator breaker did not close in the close wait time period.               | <b>Status Input</b><br>GEN_BREAKER_FAIL_TO_CLOSE         |
| Gen Breaker Fail to Open          | The generator breaker did not open in the close wait time period.                | <b>Status Input</b><br>GEN_BREAKER_FAIL_TO_OPEN          |
| Gen Breaker Sync Fail             | True when generator breaker sync has failed.                                     | <b>Status Input</b><br>GEN_BREAKER_SYNC_FAIL             |
| Gen Dead                          | True when the Generator Breaker Dead condition settings have been exceeded.      | <b>Status Input</b><br>GEN_DEAD                          |
| Gen Failed                        | True when the Generator Breaker Stable condition settings are not met.           | <b>Status Input</b><br>GEN_FAILED                        |
| Gen Stable                        | True when the Generator Breaker Stable condition settings have been exceeded.    | <b>Status Input</b><br>GEN_STABLE                        |
| GOV Contact Type Proportional     | True when this option is selected. (Governor Bias Control Settings screen)       | <b>Status Input</b><br>CONTACT_TYPE_PROPORTIONAL         |
| Inner Loop Field Regulator Active | True when the inner loop field regulator is active.                              | <b>Status Input</b><br>INNER_LOOP_FIELD_REGULATOR_ACTIVE |
| Internal Tracking Active          | True when internal tracking is running.  | <b>Status Input</b><br>INT_TRACKING_ACTME                |
| IRIG Sync Lost                    | True when IRIG signal is not being received.                                     | <b>Status Input</b><br>IRIG_SYNC_LOST_ALM                |
| KW Threshold                      | True when kW output is below the standard (non-Grid Code) PF Active Power Level. | <b>Status Input</b><br>KW_THRESHOLD_STATUS               |
| Manual Mode Active                | True when the unit is in Manual mode (FCR/FVR).                                  | <b>Status Input</b><br>MANUAL_ACTIVE                     |
| Network Load Share Active         | True when network load sharing is active.  | <b>Status Input</b><br>NLS_ACTIVE                        |

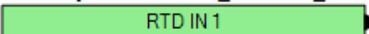
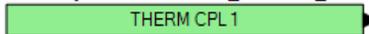
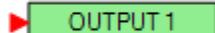
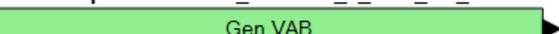
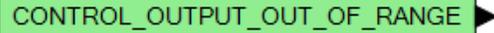
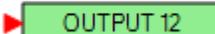
| Name                                   | Description  | Symbol   |
|--|--|--|
| Network Load Share Config Mismatch     | True when the unit's configuration does not match the configuration of the other units with load sharing enabled.  | <b>Status Input</b><br>NLS_CONFIG_MISMATCH       |
| Network Load Share ID Missing          | True when any of the load sharing enabled units are not detected on the network.   | <b>Status Input</b><br>NLS_ID_MISSING            |
| Network Load Share Receiving ID 1 - 16 | True when data is being received from a specific unit on the load share network.   | <b>Status Input</b><br>RCC_RECEIVING_ID_1        |
| Network Load Share Status 1-4          | This element functions in conjunction with the Network Load Share Broadcast elements on all units on the network. True when the corresponding Network Load Share Broadcast element input is TRUE on another unit on the network. | <b>Status Input</b><br>NLS_STATUS_1              |
| No Network Load Share Data Received    | True when Network Load Sharing is enabled but there is no data being received from other network load sharing devices.   | <b>Status Input</b><br>NO_NETWORK_LOADSHARE_DATA |
| NTP Sync Lost                          | True when NTP server has lost communications.  | <b>Status Input</b><br>NTP_SYNC_LOST_ALM         |
| Null Balance                           | True when Null Balance is achieved in both external and internal tracking.   | <b>Status Input</b><br>NULL_BALANCE              |
| OEL                                    | True when the Overexcitation Limiter is active.  | <b>Status Input</b><br>OEL                       |
| PF Controller Active                   | True when the unit is in PF mode.  | <b>Status Input</b><br>PF_Active                 |
| PLL Sync Selected                      | True when phase locked loop (PLL) is selected. (Synchronizer screen)   | <b>Status Input</b><br>PLL_SYNC_SELECTED         |
| Preposition Active                     | True when any preposition is active.   | <b>Status Input</b><br>DECS_PREPOSITION          |
| Preposition 1 Active                   | True when Preposition 1 is active.   | <b>Status Input</b><br>PREPOSITION_1_ACTME       |
| Preposition 2 Active                   | True when Preposition 2 is active.   | <b>Status Input</b><br>PREPOSITION_2_ACTME       |
| Preposition 3 Active                   | True when Preposition 3 is active.   | <b>Status Input</b><br>PREPOSITION_3_ACTME       |
| PSS Active (Optional)                  | True when the power system stabilizer (PSS) is turned on and running.  | <b>Status Input</b><br>PSS_ACTIVE                |
| PSS Current Unbalanced (Optional)      | True when the phase current is unbalanced and the PSS is active.   | <b>Status Input</b><br>PSSCURRENTUNBALANCED      |
| PSS Power Below Threshold (Optional)   | True when the input power is below the Power Level threshold and the PSS is active.  | <b>Status Input</b><br>PSSPOWERBELOWTHRESHOLD    |

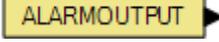
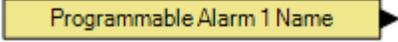
| Name  | Description   | Symbol                                  |
|---|---|---|
| PSS Secondary Group Active (Optional)       | True when the PSS is using secondary settings.  | Status Input<br>PSS_USING_SEC_SETTINGS  |
| PSS Speed Failed (Optional)                 | True when the frequency is out of range for a length of time calculated internally by the DECS-450 and the PSS is active.                   | Status Input<br>PSSSPEEDFAILED          |
| PSS Test On (Optional)                      | True when the power system stabilizer test signal (Frequency Response) is active.   | Status Input<br>PSS_TEST_MODE           |
| PSS Voltage Limit (Optional)                | True when the calculated terminal voltage upper or lower limit is reached and the PSS is active.  | Status Input<br>PSSVOLTAGELIMIT         |
| PSS Voltage Unbalanced (Optional)           | True when the phase voltage is unbalanced and the PSS is active.  | Status Input<br>PSSVOLTAGEUNBALANCED    |
| SCL   | True when the Stator Current Limiter is active.   | Status Input<br>SCL                     |
| Setpoint at Lower Limit                     | True when the active mode's setpoint is at the lower limit.   | Status Input<br>Setpoint_At_Lower_Limit |
| Setpoint at Upper Limit                     | True when the active mode's setpoint is at the upper limit.   | Status Input<br>Setpoint_At_Upper_Limit |
| Soft Start Active                           | True during softstart.  | Status Input<br>SOFTSTART_ACTME         |
| Start Status                                | True when the unit is in Start mode.  | Status Input<br>DECS_START_STOP         |
| Sync Active                                 | True when synchronization is active.  | Status Input<br>SYNC_ACTIVE             |
| Transfer Watchdog                           | True when watchdog has timed out and system control will switch to an alternate redundant DECS-450.   | Status Input<br>TRANSFERWATCHDOG        |
| Transient Boost Active                      | True when transient boost is active.  | Status Input<br>TRANSIENT_BOOST_ACTME   |
| UEL   | True when the Under Excitation Limiter is active.   | Status Input<br>UEL                     |
| Under Frequency V/Hz                        | True when the Under Frequency or the Volts/Hz Limiter is active.  | Status Input<br>UNDERFREQUENCYHZ        |
| Unknown Network Load Share Protocol Version | True when there is another unit on the network whose load share protocol version is not the same as this units load share protocol version. | Status Input<br>UNKNOWN_LOAD_SHARE_VER  |
| Var Controller Active                       | True when the unit is in VAR mode.  | Status Input<br>VAR_Active              |
| Var Limiter Active                          | True when the Var Limiter is active.  | Status Input<br>VAR_LIMITER_ACTIVE      |

| Name                         | Description   | Symbol  |
|------------------------------|---|---|
| Voltage Matching Active      | True when Voltage Matching is active.                 | <b>Status Input</b><br>VOLTAGE_MATCHING_ACTIVE  |
| <i>Status, Protection</i>    |   |   |
| 24 Pickup                    | True when this protective element has picked up.      | <b>Status Input</b><br>PROTECTION24PICKUP       |
| 24 Trip                      | True when this protective element has tripped.        | <b>Status Input</b><br>PROTECTION24TRIP         |
| 25-1 Status                  | True when the conditions for synchronization are met. | <b>Status Input</b><br>PROTECTION25STATUS       |
| 27 Pickup                    | True when this protective element has picked up.      | <b>Status Input</b><br>PROTECTION27PICKUP       |
| 27 Trip                      | True when this protective element has tripped.        | <b>Status Input</b><br>PROTECTION27TRIP         |
| 32R Pickup                   | True when this protective element has picked up.      | <b>Status Input</b><br>PROTECTION32RPICKUP      |
| 32R Trip                     | True when this protective element has tripped.        | <b>Status Input</b><br>PROTECTION32RTRIP        |
| 40Q Pickup                   | True when this protective element has picked up.      | <b>Status Input</b><br>PROTECTION40QPICKUP      |
| 40Q Trip                     | True when this protective element has tripped.        | <b>Status Input</b><br>PROTECTION40QTRIP        |
| 59 Overvoltage Pickup        | True when this protective element has picked up.      | <b>Status Input</b><br>PROTECTION59PICKUP       |
| 59 Overvoltage Trip          | True when this protective element has tripped.        | <b>Status Input</b><br>PROTECTION59TRIP         |
| 81 Overfrequency Pickup      | True when this protective element has picked up.      | <b>Status Input</b><br>PROTECTION81O1PICKUP     |
| 81 Overfrequency Trip        | True when this protective element has tripped.        | <b>Status Input</b><br>PROTECTION81O1TRIP       |
| 81 Underfrequency Pickup     | True when this protective element has picked up.      | <b>Status Input</b><br>PROTECTION81U1PICKUP     |
| 81 Underfrequency Trip       | True when this protective element has tripped.        | <b>Status Input</b><br>PROTECTION81U1TRIP       |
| Exciter Open Diode Pickup    | True when this protective element has picked up.      | <b>Status Input</b><br>EXCITEROPENDIODEPICKUP   |
| Exciter Open Diode Trip      | True when this protective element has tripped.        | <b>Status Input</b><br>EXCITEROPENDIODETRIP     |
| Exciter Shorted Diode Pickup | True when this protective element has picked up.      | <b>Status Input</b><br>EXCITERSHORTEDIODEPICKUP |

| Name                                      | Description  | Symbol   |
|---|--|--|
| Exciter Shorted Diode Trip                | True when this protective element has tripped.   | <b>Status Input</b><br>EXCITERSHORTEDDIODETRIP   |
| Field Overcurrent Pickup                  | True when this protective element has picked up.   | <b>Status Input</b><br>PROTFIELDOVERCURRENTPU  |
| Field Overcurrent Trip                    | True when this protective element has tripped.   | <b>Status Input</b><br>PROTFIELDOVERCURRENTTRIP  |
| Field Overtemperature Pickup              | True when this protective element has picked up.   | <b>Status Input</b><br>PROTFIELDOVERTEMPERATUREPU  |
| Field Overtemperature Trip                | True when this protective element has tripped.   | <b>Status Input</b><br>PROTFIELDOVERTEMPERATURETRIP  |
| Field Overvoltage Pickup                  | True when this protective element has picked up.   | <b>Status Input</b><br>PROTFIELDOVERVOLTAGEPU  |
| Field Overvoltage Trip                    | True when this protective element has tripped.   | <b>Status Input</b><br>PROTFIELDOVERVOLTAGETRIP  |
| Gen Below 10 Hz Pickup                    | True when this protective element has picked up.   | <b>Status Input - PROTECTGENBELOW10HZPICKUP</b><br>Gen Below 10Hz Pickup                     |
| Gen Below 10 Hz Trip                      | True when this protective element has tripped.   | <b>Status Input - PROTECTGENBELOW10HZTRIP</b><br>Gen Below 10Hz Trip                         |
| Loss of Field Isolation Transducer Pickup | True when this protective element has picked up.   | <b>Status Input</b><br>LOSSOFFIELDISOTRANSDUCERPICKUP  |
| Loss of Field Isolation Transducer Trip   | True when this protective element has tripped.   | <b>Status Input</b><br>LOSSOFFIELDISOTRANSDUCERTRIP  |
| Loss of Sensing Pickup                    | True when this protective element has picked up.   | <b>Status Input</b><br>LOSSOFSENSINGPICKUP   |
| Loss of Sensing Trip                      | True when this protective element has tripped.   | <b>Status Input</b><br>LOSSOFSENSINGTRIP   |
| <i>Status, Configurable Protection</i>    |  |  |
| Configurable Protection 1-8               | There are four thresholds for each of the eight Configurable Protection blocks. Each threshold can be set to Over or Under mode and the threshold limit and activation delay can each be set. See the <i>Protection</i> section in this manual for more details. Each threshold has a separate logic block for the pickup and the trip. Configurable Protection #1 with its Threshold #1 Pickup and Trip blocks is shown to the right. The pickup block is TRUE when the threshold is exceeded. The trip block is TRUE when the corresponding pickup block threshold is exceeded for the duration of the time delay. | <b>Status Input</b><br>ConfProt1Thresh1Pickup<br><b>Status Input</b><br>ConfProt1Thresh1Trip |

| Name   | Description  | Symbol   |
|--|--|--|
| <i>Status, Contact Expansion Module</i>                        |  |  |
| Contact Expansion Module Connected                             | Contact Expansion Module Connected. True when an optional CEM-125 or CEM-2020 is connected to the DECS-450.  | <b>Status Input</b><br>  |
| Contact Expansion Module Comms Failure                         | True when there is no communication from the CEM.  | <b>Status Input</b><br>  |
| Contact Expansion Module Duplicate CEM                         | True when more than one CEM is detected. Only one CEM is supported at a time.  | <b>Status Input</b><br>  |
| Contact Expansion Module Hardware Mismatch                     | True when selected CEM type differs from detected CEM type. Go to <i>Settings Explorer, Communications, CAN Bus, Remote Module Setup</i> to select the CEM type (18 or 24 contacts).   | <b>Status Input</b><br>  |
| <i>Status, Analog Expansion Module</i>                         |  |  |
| Analog Expansion Module Connected                              | Analog Expansion Module Connected. True when an optional AEM-2020 is connected to the DECS-450.  | <b>Status Input</b><br>  |
| Analog Expansion Module Comms Failure                          | True when there is no communication from the AEM.  | <b>Status Input</b><br>  |
| Analog Expansion Module Duplicate AEM                          | True when more than one AEM is detected. Only one AEM is supported at a time.  | <b>Status Input</b><br>   |
| Analog Expansion Module, Remote Analog Inputs 1-8              | There are four thresholds for each of the eight Remote Analog Input blocks. Each threshold has a separate logic block for the pickup and the trip. Remote Analog Input #1 with its Threshold #1 Pickup and Trip blocks is shown to the right. For more details on configuring the Remote Analog Inputs, see the <i>Analog Expansion Module</i> section in this manual. The pickup block is TRUE when the threshold is exceeded. The trip block is TRUE when the corresponding pickup block threshold is exceeded for the duration of the time delay. | <b>Status Input - PROT1_THRESH1_PICKUP</b><br><br><b>Status Input - PROT1_THRESH1_TRIP</b><br> |
| Analog Expansion Module Remote Analog Inputs, Out of Range 1-8 | Each Remote Analog Input has one Out of Range Block. True when parameters exceed out of range threshold. This function alerts the user of an open or damaged analog input wire.  | <b>Status Input - PROT1_OUT_OF_RANGE</b><br>   |
| Analog Expansion Module Remote Analog Outputs 1-4              | True when the analog output connection is open.  | <b>Status Input - AEM_OUTPUT_1_OUT_OF_RANGE</b><br>  |

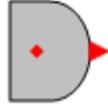
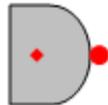
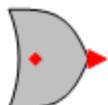
| Name  | Description  | Symbol   |
|---|--|--|
| Analog Expansion Module<br>Remote RTD Inputs 1-8  | There are four thresholds for each of the eight Remote RTD Input blocks. Each threshold has a separate logic block for the pickup and the trip. Remote RTD Input #1 with its Threshold #1 Pickup and Trip blocks is shown to the right. For more details on configuring the Remote RTD Inputs, see the <i>Analog Expansion Module</i> section in this manual. The pickup block is TRUE when the threshold is exceeded. The trip block is TRUE when the corresponding pickup block threshold is exceeded for the duration of the time delay.                      | Status Input - RTDPROT1_THRESH1_PU<br><br>Status Input - RTDPROT1_THRESH1_TRIP<br>         |
| Analog Expansion Module<br>Remote RTD Inputs, Out of Range 1-8                            | Each Remote RTD Input has one Out of Range Block. True when parameters exceed out of range threshold. This function alerts the user of an open or damaged analog input wire.   | Status Input - RTD_INPUT_1_OUT_OF_RANGE<br>  |
| Analog Expansion Module<br>Remote Thermocouple Inputs 1-2                                 | There are four thresholds for both of the Remote Thermocouple Input blocks. Each threshold has a separate logic block for the pickup and the trip. Remote Thermocouple Input #1 with its Threshold #1 Pickup and Trip blocks is shown to the right. For more details on configuring the Remote Thermocouple Inputs, see the <i>Analog Expansion Module</i> section in this manual. The pickup block is TRUE when the threshold is exceeded. The trip block is TRUE when the corresponding pickup block threshold is exceeded for the duration of the time delay. | Status Input - THERMPROT1_THRESH1_PICKUP<br><br>Status Input - THERMPROT1_THRESH1_TRIP<br> |
| <b>Output Objects</b>   |  |  |
| <i>Physical Outputs</i><br>OUT1 - OUT11   | Physical Contact Outputs 1 through 11.   | Output - OUTPUT1<br>   |
| <i>Analog Outputs</i><br>Analog Output M1 Out of Range –<br>Analog Output M4 Out of Range | True when the selected parameter exceeds the set range.  | Status Input - ANALOG_OUTPUT_1_OUT_OF_RANGE<br>  |
| <i>Analog Outputs</i><br>Control Output Out of Range                                      | True when the control output exceeds the selected range.   | Status Input<br>   |
| <i>Remote Outputs</i><br>OUT12 - OUT35  | Remote Contact Outputs 12 through 35. (Available when an optional CEM-125 or CEM-2020 is connected.)   | Output - OUTPUT12<br>  |

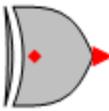
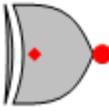
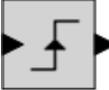
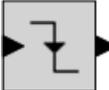
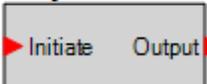
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|----------------------------|---|--|
| <b>Off-Page Objects</b>    |   |  |
| Off-Page Output            | Used in conjunction with the Off-Page Input to transform an output on one logic page into an input on another logic page. Outputs can be renamed by right-clicking and selecting Rename Output. Right-clicking will also show pages that the corresponding inputs can be found on. Selecting the page will take you to that page. | <b>Off-Page Output</b><br>               |
| Off-Page Input             | Used in conjunction with the Off-Page Output to transform an output on one logic page into an input on another logic page. Inputs can be renamed by right-clicking and selecting Rename Input. Right-clicking will also show pages that the corresponding outputs can be found on. Selecting the page will take you to that page. | <b>Off-Page Input</b><br>                |
| <b>Alarms</b>              |   |  |
| Global Alarm               | True when one or more alarms are set.   | <b>Alarm</b><br>                         |
| Programmable Alarms 1 - 16 | True when a programmable alarm is set.  | <b>Alarm - PROGRAMMABLE_ALARM_1</b><br> |

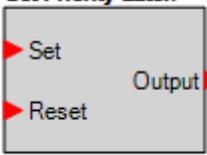
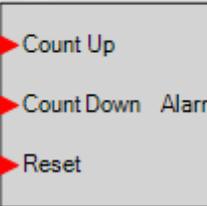
Components

This group contains Logic Gates, Pickup and Dropout Timers, Latches, and Comment Blocks. Table 19-2 lists the names and descriptions of the objects in the *Components* group.

**Table 19-2. Components Group, Names and Descriptions**

| Name               | Description   | Symbol |        |     |   |     |   |     |   |     |   |   |
|--------------------|---|--------|--------|-----|---|-----|---|-----|---|-----|---|---|
| <b>Logic Gates</b> |   |        |        |     |   |     |   |     |   |     |   |   |
| AND                | <table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>0</td> </tr> <tr> <td>0 1</td> <td>0</td> </tr> <tr> <td>1 0</td> <td>0</td> </tr> <tr> <td>1 1</td> <td>1</td> </tr> </tbody> </table> | Input  | Output | 0 0 | 0 | 0 1 | 0 | 1 0 | 0 | 1 1 | 1 |  |
| Input              | Output  |        |        |     |   |     |   |     |   |     |   |   |
| 0 0                | 0   |        |        |     |   |     |   |     |   |     |   |   |
| 0 1                | 0   |        |        |     |   |     |   |     |   |     |   |   |
| 1 0                | 0   |        |        |     |   |     |   |     |   |     |   |   |
| 1 1                | 1   |        |        |     |   |     |   |     |   |     |   |   |
| NAND               | <table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>1</td> </tr> <tr> <td>0 1</td> <td>1</td> </tr> <tr> <td>1 0</td> <td>1</td> </tr> <tr> <td>1 1</td> <td>0</td> </tr> </tbody> </table> | Input  | Output | 0 0 | 1 | 0 1 | 1 | 1 0 | 1 | 1 1 | 0 |  |
| Input              | Output  |        |        |     |   |     |   |     |   |     |   |   |
| 0 0                | 1   |        |        |     |   |     |   |     |   |     |   |   |
| 0 1                | 1   |        |        |     |   |     |   |     |   |     |   |   |
| 1 0                | 1   |        |        |     |   |     |   |     |   |     |   |   |
| 1 1                | 0   |        |        |     |   |     |   |     |   |     |   |   |
| OR                 | <table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>0</td> </tr> <tr> <td>0 1</td> <td>1</td> </tr> <tr> <td>1 0</td> <td>1</td> </tr> <tr> <td>1 1</td> <td>1</td> </tr> </tbody> </table> | Input  | Output | 0 0 | 0 | 0 1 | 1 | 1 0 | 1 | 1 1 | 1 |  |
| Input              | Output  |        |        |     |   |     |   |     |   |     |   |   |
| 0 0                | 0   |        |        |     |   |     |   |     |   |     |   |   |
| 0 1                | 1   |        |        |     |   |     |   |     |   |     |   |   |
| 1 0                | 1   |        |        |     |   |     |   |     |   |     |   |   |
| 1 1                | 1   |        |        |     |   |     |   |     |   |     |   |   |

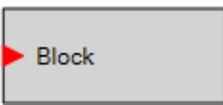
| Name                             | Description   | Symbol   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
|----------------------------------|---|--|--------|--------|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOR                              | <table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>               | Input  |        | Output | 0 | 0 | 1 | 0   | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |  |
| Input                            |   | Output   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0                                | 0   | 1  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0                                | 1   | 0  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                                | 0   | 0  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                                | 1   | 0  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| XOR                              | <table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>               | Input  |        | Output | 0 | 0 | 0 | 0   | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |  |
| Input                            |   | Output   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0                                | 0   | 0  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0                                | 1   | 1  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                                | 0   | 1  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                                | 1   | 0  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| XNOR                             | <table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>               | Input  |        | Output | 0 | 0 | 1 | 0   | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |  |
| Input                            |   | Output   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0                                | 0   | 1  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0                                | 1   | 0  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                                | 0   | 0  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                                | 1   | 1  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| NOT<br>(INVERTER)                | <table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> </tbody> </table>   | Input  | Output | 0      | 1 | 1 | 0 |  |   |   |   |   |   |   |   |   |   |
| Input                            | Output  |  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0                                | 1   |  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                                | 0   |  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rising Edge                      | The output is TRUE when the rising edge of a pulse is detected on the input signal.   |    |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Falling Edge                     | The output is TRUE when the falling edge of a pulse is detected on the input signal.  |   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| <b>Pickup and Dropout Timers</b> |   |  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Drop Out Timer                   | Used to set a delay in the logic.<br>For more information, refer to <i>Programming BESTlogicPlus, Pickup and Dropout Timers</i> , later in this section.  | <b>Drop Out Timer (1)</b><br>TIMER_1<br>Delay = 1<br> |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Pick Up Timer                    | Used to set a delay in the logic.<br>For more information, refer to <i>Programming BESTlogicPlus, Pickup and Dropout Timers</i> , later in this section.  | <b>Pick Up Timer (1)</b><br>TIMER_1<br>Delay = 1<br>  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| <b>Latches</b>                   |   |  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Reset Priority Latch             | When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a reset priority latch will go to the RESET (OFF) state. | <b>Reset Priority Latch</b><br>                       |        |        |   |   |   |   |   |   |   |   |   |   |   |   |   |

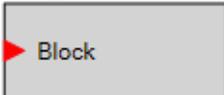
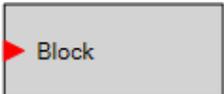
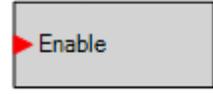
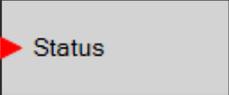
| Name               | Description  | Symbol  |
|--------------------|--|---|
| Set Priority Latch | When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a set priority latch will go to the SET (ON) state.   | <p><b>Set Priority Latch</b></p>                               |
| <b>Other</b>       |  |   |
| Comment Block      | Enter user comments.   |    |
| Counter            | True when the count reaches a user-selected number. COUNT_UP increments the count when a TRUE is received. COUNT_DOWN decrements the count when a TRUE is received. RESET resets the count to zero when a TRUE is received. OUTPUT is TRUE when the count reaches the trigger count. The trigger count is set by the user and is found in <i>Settings Explorer</i> , <i>BESTlogicPlus Programmable Logic</i> , <i>Logic Counters</i> . | <p><b>Counter (1)<br/>Counter 1<br/>Trigger Count = 1</b></p>  |

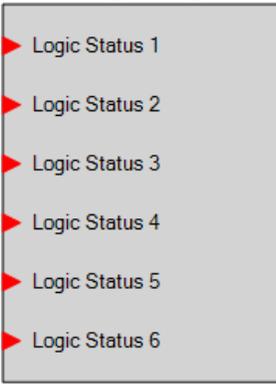
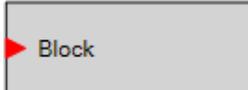
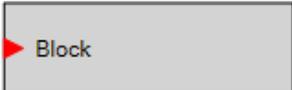
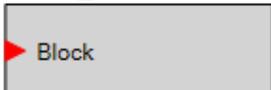
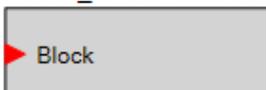
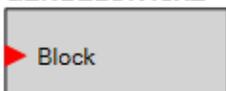
Elements

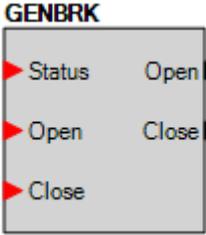
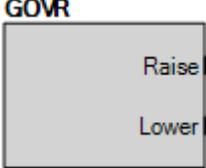
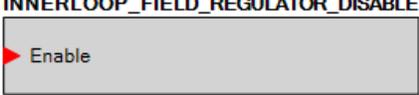
Table 19-3 lists the names and descriptions of the elements in the *Elements* group.

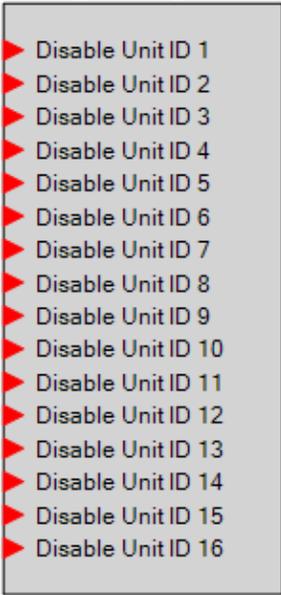
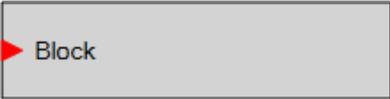
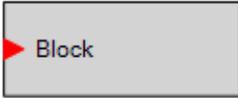
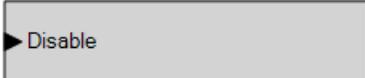
**Table 19-3. Elements Group, Names and Descriptions**

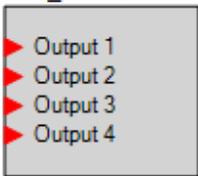
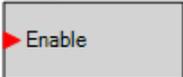
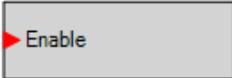
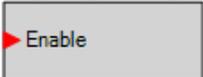
| Name | Description  | Symbol   |
|------|--|--|
| 24   | When TRUE, this element blocks, or disables, the 24 overexcitation protection function.      | <p><b>24</b></p>   |
| 25   | When TRUE, this element blocks, or disables, the 25 sync-check protection function.          | <p><b>25</b></p>   |
| 27P  | When TRUE, this element blocks, or disables, the 27 undervoltage protection function.        | <p><b>27P</b></p>  |
| 32   | When TRUE, this element blocks, or disables, the 32 reverse power protection function.       | <p><b>32</b></p>   |
| 40Q  | When TRUE, this element blocks, or disables, the 40Q loss of excitation protection function. | <p><b>40Q</b></p>  |
| 59P  | When TRUE, this element blocks, or disables, the 59 overvoltage protection function.         | <p><b>59P</b></p>  |

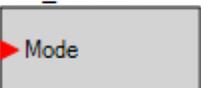
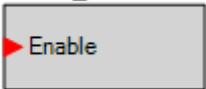
| Name                               | Description   | Symbol  |
|------------------------------------|---|---|
| 81O                                | When TRUE, this element blocks, or disables, the 81O overfrequency protection function.   | <b>81O_1</b><br>                    |
| 81U                                | When TRUE, this element blocks, or disables, the 81U underfrequency protection function.  | <b>81U_1</b><br>                    |
| ALARM RESET                        | When TRUE, this element resets all active alarms.   | <b>ALARM_RESET</b><br>              |
| ANALOG OUTPUT 1-4 DISABLE          | <p>When TRUE, this element disables analog output 1. Similar elements are provided for analog outputs 2 through 4.</p> <p>Analog Output Disable: When TRUE, the analog output signal is electrically removed from the output terminal. (Note that metering in BESTCOMSP<i>lus</i> remains active.) This logic block allows for multiple analog outputs to be paralleled. Paralleling the analog outputs is useful when a primary and redundant DECS share a panel meter or firing circuit controller.</p> | <b>ANALOG_OUTPUT_1_DISABLE</b><br>  |
| AUTO ENABLE                        | When TRUE, this element sets the unit in Auto mode (AVR).   | <b>AUTO_ENABLE</b><br>            |
| AUTO TRANSFER ENABLE               | When TRUE, this element sets the unit as secondary. When FALSE, the unit is primary.  | <b>AUTOTRANSFER_ENABLE</b><br>    |
| CONTROL OUTPUT DISABLE             | When TRUE, this element disables the control output.  | <b>CONTROL_OUTPUT_DISABLE</b><br> |
| CROSS CURRENT COMPENSATION DISABLE | When TRUE, this element disables cross current compensation.  | <b>CC_DISABLE</b><br>             |
| CROWBAR STATUS                     | When TRUE, this element sets the Crowbar Activated Status Input TRUE.   | <b>CROWBARSTATUS</b><br>          |

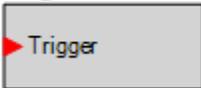
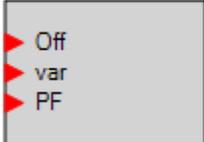
| Name                      | Description  | Symbol   |
|---------------------------|--|--|
| DATALOG LOGIC STATUS      | When TRUE, Logic Status x can be selected and displayed in the data log and the real-time monitor.         | <b>DATALOG_LOGIC_STATUS</b><br>    |
| DATALOG TRIGGER           | When TRUE, this element triggers the datalog to begin recording data.                                      | <b>DATALOGTRIGGER</b><br>          |
| DROOP DISABLE             | When TRUE, this element disables droop when the unit is operating in AVR mode.                             | <b>DROOP_DISABLE</b><br>           |
| EXCITER OPEN DIODE        | When TRUE, this element blocks, or disables, the Exciter Diode Monitor, Open Diode protection function.    | <b>EXCITEROPENDIODE</b><br>       |
| EXCITER SHORTED DIODE     | When TRUE, this element blocks, or disables, the Exciter Diode Monitor, Shorted Diode protection function. | <b>EXCITERSHORTEDIODE</b><br>    |
| EXTERNAL TRACKING DISABLE | When TRUE, this element disables external tracking.  | <b>EXT_TRACKING_DISABLE</b><br>  |
| FIELD OVERCURRENT         | When TRUE, this element blocks, or disables, the Field Overcurrent protection function.                    | <b>FIELD_OVERCURRENT</b><br>     |
| FIELD OVERTEMPERATURE     | When TRUE, this element blocks, or disables, the Field Overtemperature protection function.                | <b>FIELD_OVERTEMPERATURE</b><br> |
| FIELD OVERVOLTAGE         | When TRUE, this element blocks, or disables, the Field Overvoltage protection function.                    | <b>FIELD_OVERVOLTAGE</b><br>     |
| GEN BELOW 10 HZ           | When TRUE, this element blocks, or disables, the Gen Below 10 Hz protection function.                      | <b>GENBELOW10HZ</b><br>          |

| Name  | Description  | Symbol   |
|---|--|--|
| <p><b>GENERATOR BREAKER</b></p>   | <p>This element is used to connect the breaker open and close output signals from the DECS-450 to physical output contacts to open and close the generator breaker, and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests.</p>  |  <p>The symbol for GENBRK is a rectangular block with three red triangles on the left side pointing right, representing inputs. The top input is labeled 'Status', the middle is 'Open', and the bottom is 'Close'. On the right side, there are two black triangles pointing right, representing outputs. The top output is labeled 'Open' and the bottom is 'Close'.</p> |
| <p><u>GENERATOR BREAKER Inputs</u></p> <p><i>Status:</i> This input allows a contact input to be mapped that will provide breaker status feedback to the DECS-450. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open.</p> <p><i>Open:</i> This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed, the breaker opens.</p> <p><i>Close:</i> This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the generator is stable, a close request is initiated. If the Dead Bus Close Enable parameter is TRUE, and the bus is dead, the breaker will close. If the bus is stable, the DECS-450 will synchronize the generator to the bus, and then close the breaker.</p> | <p><u>GENERATOR BREAKER Outputs</u></p> <p>The outputs must be mapped to the contact outputs of the DECS-450 that will be used to drive the breaker.</p> <p><i>Open:</i> This output is pulsed TRUE (closes the output contact it is mapped to) when the DECS-450 is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Synchronizer/Voltage Matching in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually close before the pulse is removed.</p> <p><i>Close:</i> This output is pulsed TRUE (closes the output contact it is mapped to) when the DECS-450 is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Synchronizer/Voltage Matching in the Settings Explorer, and the length is determined by the Close Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> |  |
| <p><b>GOVERNOR</b></p>  | <p>Can be connected to inputs of other logic blocks. When the Governor is being raised, the Raise output is TRUE. When being lowered, the Lower output is TRUE.</p>  |  <p>The symbol for GOVR is a rectangular block with two black triangles on the right side pointing right, representing outputs. The top output is labeled 'Raise' and the bottom is 'Lower'.</p>   |
| <p><b>INNER LOOP FIELD REGULATOR DISABLE</b></p>  | <p>When TRUE, this element disables the inner loop field regulator.</p>  |  <p>The symbol for INNERLOOP_FIELD_REGULATOR_DISABLE is a rectangular block with one red triangle on the left side pointing right, representing an input. The input is labeled 'Enable'.</p>   |
| <p><b>INTERNAL TRACKING DISABLE</b></p>   | <p>When TRUE, this element disables internal tracking.</p>   |  <p>The symbol for INT_TRACKING_DISABLE is a rectangular block with one red triangle on the left side pointing right, representing an input. The input is labeled 'Disable'.</p>   |
| <p><b>LINE DROP DISABLE</b></p>   | <p>When TRUE, this element disables line drop when the unit is operating in AVR mode.</p>  |  <p>The symbol for LDROP_DISABLE is a rectangular block with one red triangle on the left side pointing right, representing an input. The input is labeled 'Disable'.</p>  |

| Name                               | Description  | Symbol  |
|------------------------------------|--|---|
| LOAD SHARE DISABLE                 | This element allows load sharing with specific units on the network to be disabled. When an input to this block is TRUE, load share data received from that unit is ignored by the DECS-450. | <p><b>LOAD_SHARE_DISABLE</b></p>           |
| LOSS OF FIELD ISOLATION TRANSDUCER | When TRUE, this element disables the Loss of Field Isolation Transducer function.  | <p><b>LOSSOFFIELDISOTRANSDUCER</b></p>      |
| LOSS OF SENSING DISABLE            | When TRUE, this element disables the Loss of Sensing function.   | <p><b>LOSS_OF_SENSING</b></p>             |
| LOSS OF SENSING TRANSFER DISABLE   | When TRUE, this element disables the transfer to Manual mode during a Loss of Sensing condition.   | <p><b>LOS_TRANSFER_DISABLE</b></p>        |
| LOWER ENABLE                       | When TRUE, this element lowers the active setpoint.  | <p><b>LOWER_ENABLE</b></p>                |
| MANUAL ENABLE                      | When TRUE, this element switches the unit to Manual mode.  | <p><b>MANUAL_ENABLE</b></p>               |
| MANUAL MODE FCR ONLY               | When TRUE, this element switches the Manual mode to FCR.   | <p><b>MANUAL_MODE_FCR_ONLY</b></p>        |
| NETWORK LOAD SHARE DISABLE         | When TRUE, this element disables network load sharing.   | <p><b>NETWORK_LOAD_SHARE_DISABLE</b></p>  |

| Name                                 | Description  | Symbol  |
|--------------------------------------|--|---|
| NLS BROADCAST                        | This element functions in conjunction with the Network Load Share Status inputs on all units on the network. When an input is TRUE, the corresponding Network Load Share Status input on all units on the network is TRUE. | <b>NLS_BROADCAST</b><br>            |
| OEL DISABLE                          | When TRUE, this element disables the OEL.  | <b>OEL_DISABLE</b><br>              |
| OEL DISABLED IN MANUAL MODE          | When TRUE, this element disables OEL when the unit is operating in Manual mode.  | <b>OEL_DISABLED_IN_MAN_MODE</b><br> |
| OEL ONLINE                           | When TRUE, this element enables the use of OEL when the unit is considered online.   | <b>OEL_ONLINE</b><br>               |
| OEL SELECT SECONDARY SETTINGS        | When TRUE, this element selects the secondary settings for OEL.  | <b>OEL_SELECT_GROUP_2</b><br>       |
| PARALLEL ENABLE LM                   | When TRUE, this element informs the unit that it is online. The element should be enabled when the 52LM is closed. This element also allows UEL and droop compensation to operate when TRUE.                               | <b>PARALLEL_ENABLE_LM</b><br>      |
| PID SELECT SECONDARY SETTINGS        | When TRUE, this element selects secondary PID settings.  | <b>PID_SELECT_GROUP_2</b><br>     |
| PF/VAR ENABLE                        | When TRUE, this element enables the PF and Var controller. The Var/PF Selection element must be set to TRUE to use var or PF mode.   | <b>PF_VAR_ENABLE_JK</b><br>       |
| PREPOSITION 1 ENABLE                 | When TRUE, this element informs the unit to use setpoints for Preposition 1.   | <b>PREPOSITION_1_ENABLE</b><br>   |
| PREPOSITION 2 ENABLE                 | When TRUE, this element informs the unit to use setpoints for Preposition 2.   | <b>PREPOSITION_2_ENABLE</b><br>   |
| PREPOSITION 3 ENABLE                 | When TRUE, this element informs the unit to use setpoints for Preposition 3.   | <b>PREPOSITION_3_ENABLE</b><br>   |
| PROTECTION SELECT SECONDARY SETTINGS | When TRUE, this element informs the unit to use secondary values for protection.   | <b>PROTECT_SELECT_GROUP_2</b><br> |

| Name                                 | Description   | Symbol   |
|--------------------------------------|---|--|
| PSS OUTPUT DISABLE                   | When TRUE, this element disables the output of the PSS. The PSS continues to run, but the output is not used. (Available when the controller is equipped with the optional Power System Stabilizer, style number 1XXXXXX) | <b>PSS_CNTRL_OUT_DISABLE</b><br>       |
| PSS SEQ CNTRL ENABLED                | When TRUE, PSS sequence (phase rotation) control is enabled. (Available when the controller is equipped with the optional Power System Stabilizer, style number 1XXXXXX)  | <b>PSS_SEQ_CNTRL_ENABLED</b><br>       |
| PSS SEQ CNTRL SELECTION              | When TRUE, ACB phase rotation is selected. When FALSE, ABC phase rotation is selected. (Available when the controller is equipped with the optional Power System Stabilizer, style number 1XXXXXX)                        | <b>PSS_SEQ_CNTRL_SELECTION</b><br>     |
| PSS MOTOR                            | When TRUE, the PSS is in motor mode. When FALSE the PSS is in generator mode. (Available when the controller is equipped with the optional Power System Stabilizer, style number 1XXXXXX)                                 | <b>PSS_MOTOR</b><br>                   |
| PSS SELECT SECONDARY SETTINGS        | When TRUE, this element selects secondary settings for the PSS. (Available when the controller is equipped with the optional Power System Stabilizer, style number 1XXXXXX)   | <b>PSS_SELECT_GROUP_2</b><br>          |
| RAISE ENABLE                         | When TRUE, this element raises the active setpoint.   | <b>RAISE_ENABLE</b><br>              |
| SCL DISABLE                          | When TRUE, this element disables the SCL.   | <b>SCL_DISABLE</b><br>               |
| SCL SELECT SECONDARY SETTINGS        | When TRUE, this element selects the secondary settings for SCL.   | <b>SCL_SELECT_GROUP_2</b><br>        |
| SOFT START SELECT SECONDARY SETTINGS | When TRUE, this element selects the secondary settings for soft start.  | <b>SOFT_START_SELECT_GROUP_2</b><br> |
| START ENABLE                         | When TRUE, this element starts the unit.  | <b>START_ENABLE</b><br>              |
| STOP ENABLE                          | When TRUE, this element stops the unit.   | <b>STOP_ENABLE</b><br>               |

| Name                                  | Description   | Symbol   |
|---------------------------------------|---|--|
| Transfer Watchdog Trip                | When TRUE, this element energizes the transfer watchdog output relay.                     | <b>TransferWatchdogTrip</b><br>                          |
| UEL DISABLE                           | When TRUE, this element disables the UEL.   | <b>UEL_DISABLE</b><br>                                   |
| UEL DISABLED IN MANUAL MODE           | When TRUE, this element disables UEL when the unit is operating in Manual mode.           | <b>UEL_DISABLED_IN_MAN_MODE</b><br>                      |
| UEL SELECT SECONDARY SETTINGS         | When TRUE, this element selects secondary settings for UEL.                               | <b>UEL_SELECT_GROUP_2</b><br>                            |
| UNDERFREQUENCY V/HZ DISABLE           | When TRUE, this element disables the V/Hz Underfrequency limiter.                         | <b>UNDERFREQUENCYVHZ_DISABLE</b><br>                     |
| USER PROGRAMMABLE ALARM 1 - 16        | When TRUE, this element triggers a programmable alarm.                                    | <b>USERALM1</b><br><b>Programmable Alarm 1 Name</b><br> |
| VAR LIMITER DISABLE                   | When TRUE, this element disables the var limiter.   | <b>VAR_LIMITER_DISABLE</b><br>                         |
| VAR LIMITER SELECT SECONDARY SETTINGS | When TRUE, this element selects the secondary settings on the Var limiter.                | <b>VAR_LIM_SELECT_GROUP_2</b><br>                      |
| VAR/PF MODE                           | The var input selects var control and the PF input selects power factor control.          | <b>VAR_PF_MODE</b><br>                                 |
| VAR/PF SELECT ENABLE                  | When TRUE, this element allows the selection of Var and PF modes.                         | <b>VAR_PF_SELECT_ENABLE</b><br>                        |
| VOLTAGE MATCHING DISABLE              | When TRUE, this element disables voltage matching when the unit is operating in AVR mode. | <b>VOLT_MATCH_DISABLE</b><br>                          |

## Logic Schemes

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A logic scheme is a group of interconnected logic blocks that define the operation of a DECS-450 Digital Excitation System. Only one logic scheme can be active at a time. In most applications, preprogrammed logic schemes eliminate the need for custom programming. Preprogrammed logic schemes may provide more inputs, outputs, or features than are needed for a particular application. This is because a preprogrammed scheme is designed for a large number of applications with no special programming required. Unneeded logic block outputs may be left open to disable a function or a function block can be disabled through operating settings.

When a custom logic scheme is required, programming time is reduced by modifying the default logic scheme.

### The Active Logic Scheme

The DECS-450 needs an active logic scheme in order to function. All DECS-450 controllers are delivered with a default, active logic scheme preloaded in memory. If the default logic scheme meets the requirements of your application, then only the operating settings (system parameters and threshold settings) need to be adjusted before placing the DECS-450 in service.

### Sending and Retrieving Logic Schemes

#### Retrieving a Logic Scheme from the DECS-450

To retrieve settings from the DECS-450, the unit must be connected to a computer through a communications port. Once connected, settings can be downloaded from the DECS-450 by selecting *Download Settings and Logic* on the Communication menu.

#### Sending a Logic Scheme to the DECS-450

To send settings to the DECS-450, the unit must be connected to a computer through a communications port. Once connected, settings can be uploaded to the DECS-450 by selecting *Upload Settings and Logic* on the Communication menu.

#### Caution

Always remove the DECS-450 from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the DECS-450 is in service could generate unexpected or unwanted outputs.

Modifying a logic scheme in BESTCOMSP<sup>Plus</sup>® does not automatically make that scheme active in the DECS-450. The modified scheme must be uploaded into the DECS-450. See the paragraphs on *Sending and Retrieving Logic Schemes* above.

### Default Logic Schemes

The default logic scheme for PSS-disabled systems is shown in Figure 19-2 and Figure 19-3 and the default logic scheme for PSS-enabled systems is shown in Figure 19-4, Figure 19-5, and Figure 19-6. The default logic for physical outputs is the same for PSS-disabled and PSS-enabled systems and is shown in Figure 19-7.

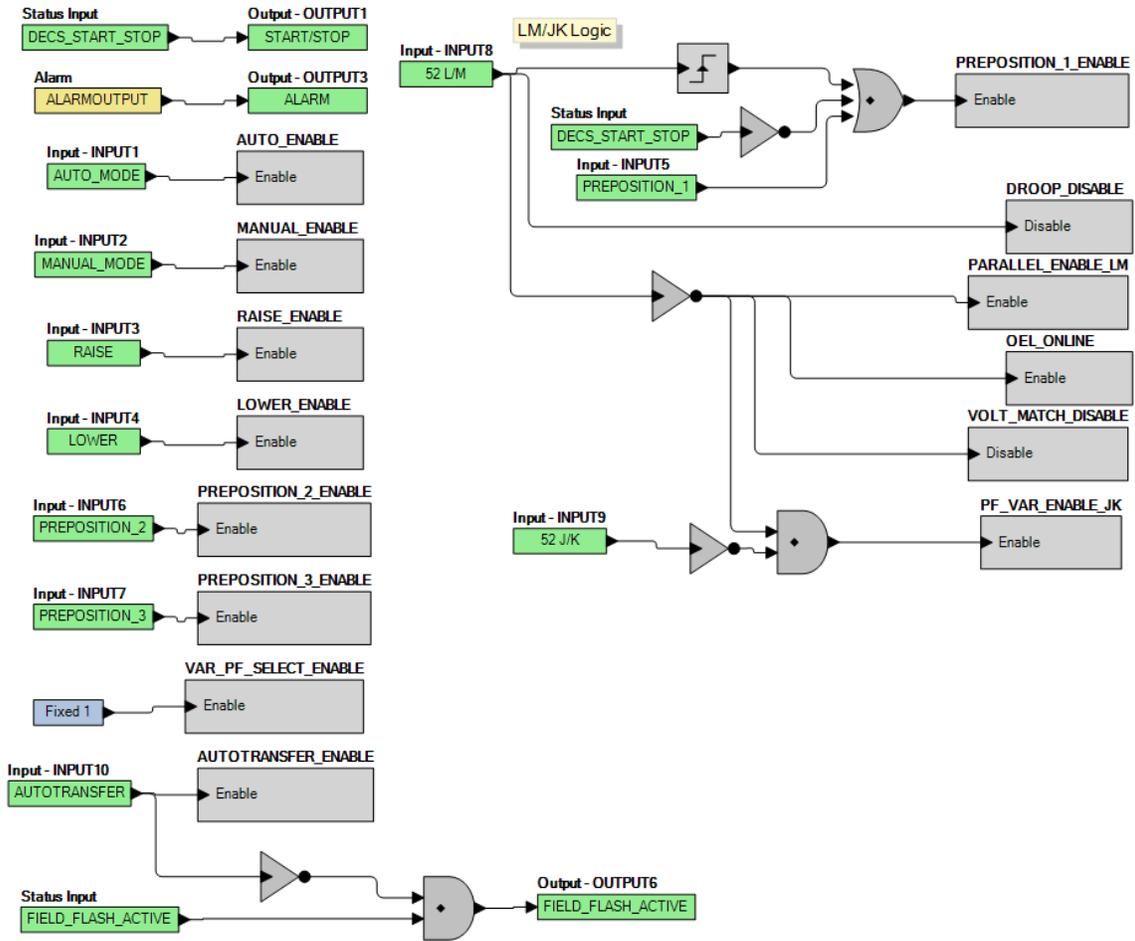


Figure 19-2. PSS-Disabled Default Logic – Logic Page 1 Tab

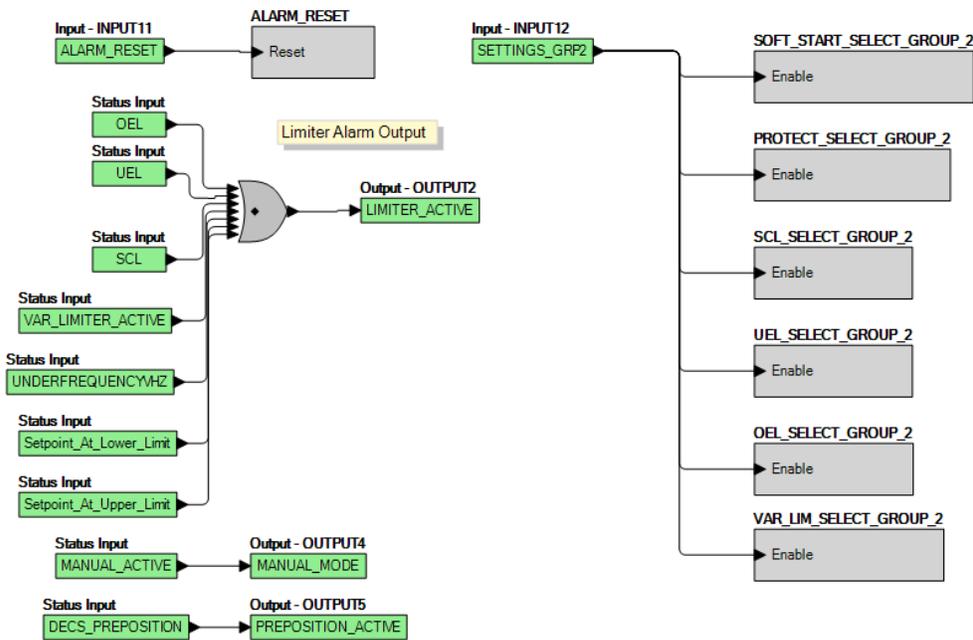


Figure 19-3. PSS-Disabled Default Logic - Logic Page 2 Tab

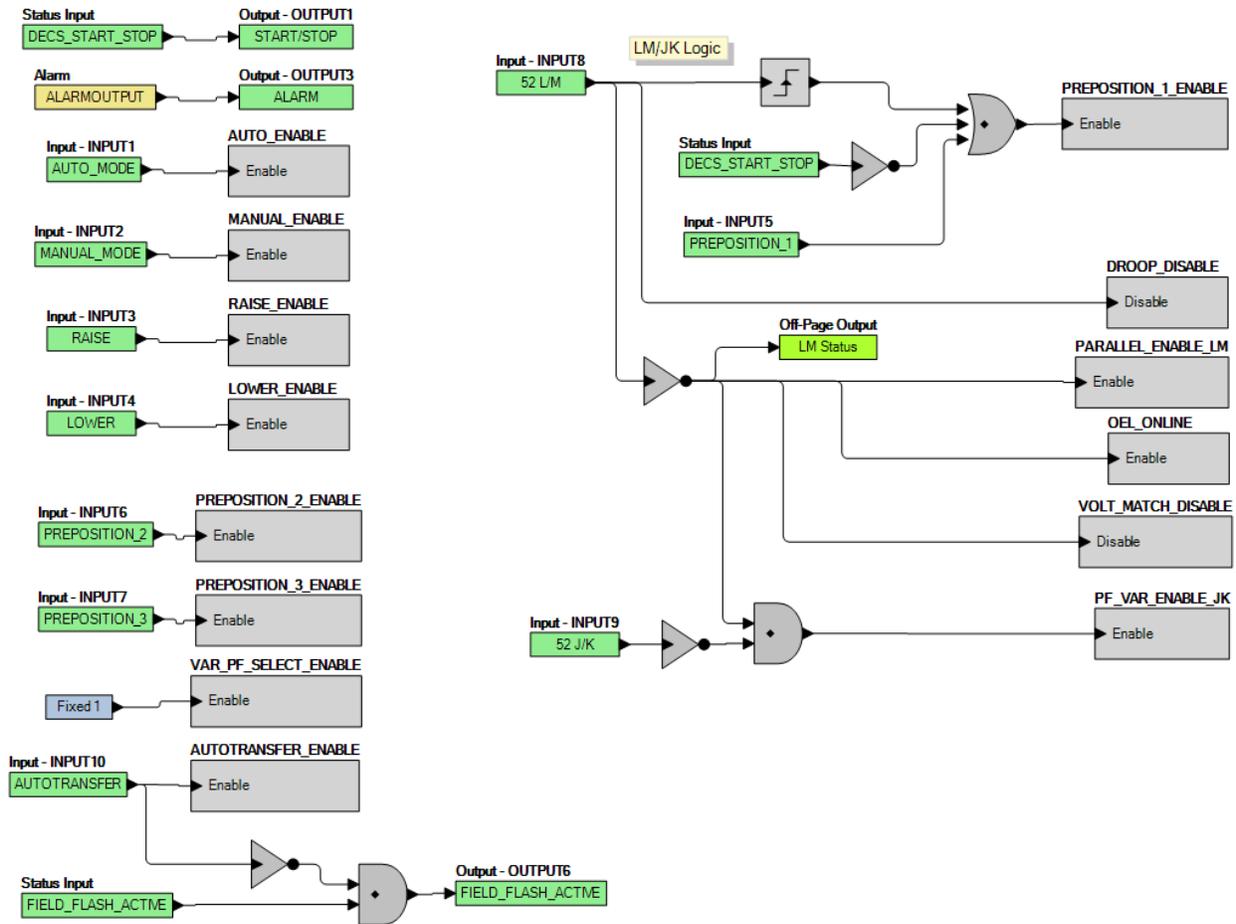


Figure 19-4. PSS-Enabled Default Logic - Logic Page 1 Tab

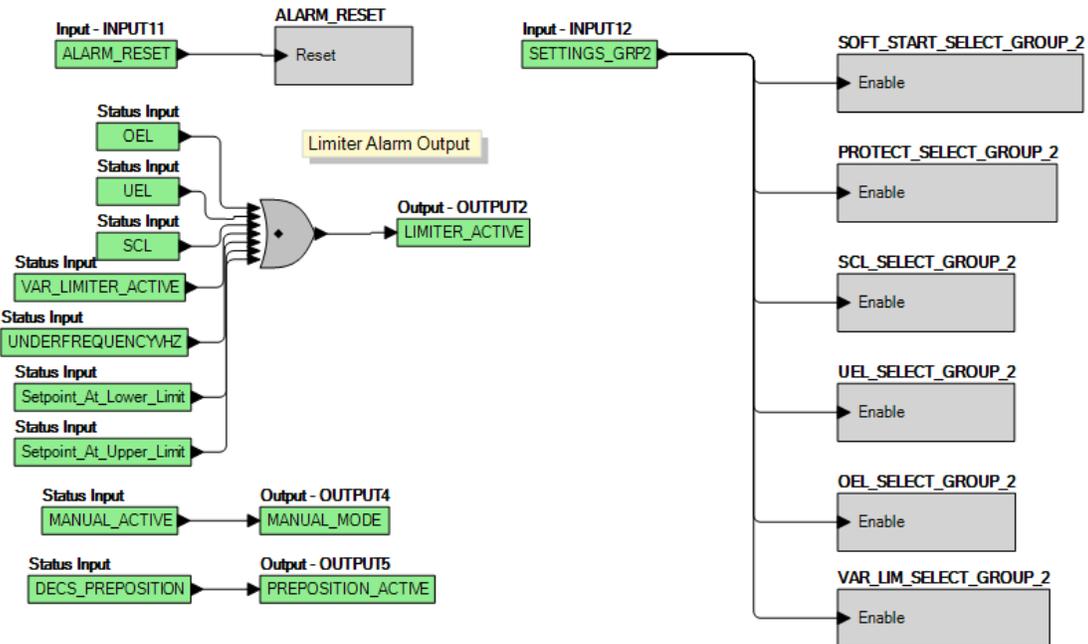


Figure 19-5. PSS-Enabled Default Logic - Logic Page 2 Tab

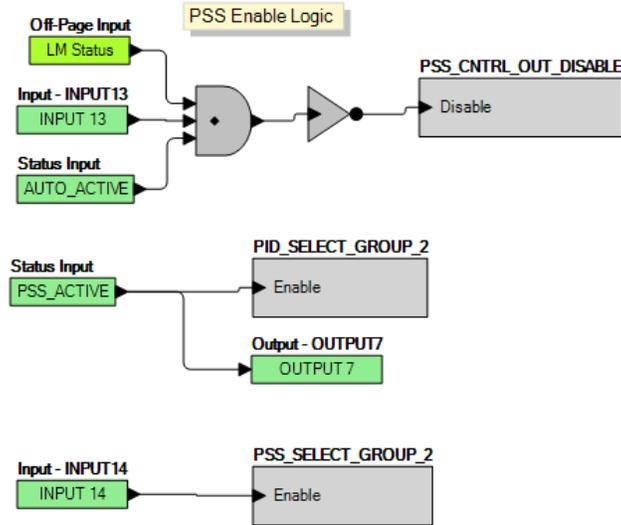


Figure 19-6. PSS-Enabled Default Logic - Logic Page 3 Tab

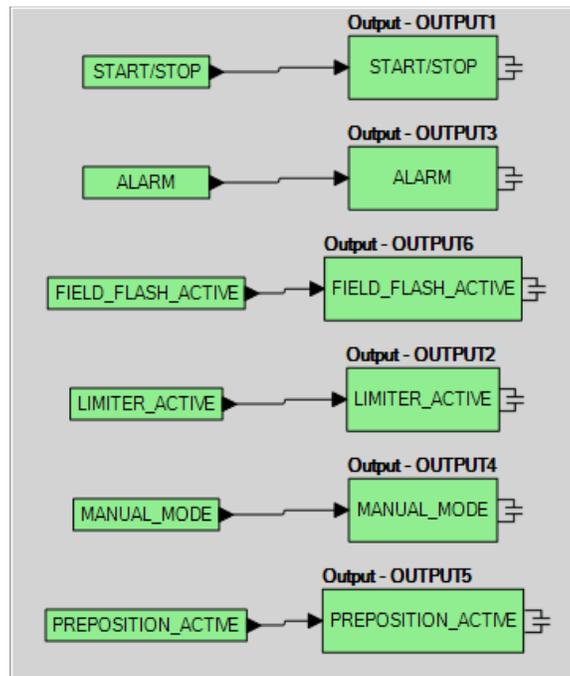


Figure 19-7. Default Logic - Physical Outputs Tab

## Programming in BESTlogic™ Plus

To program BESTlogicPlus, use the Settings Explorer within BESTCOMSPPlus to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 19-1.

The drag and drop method is used to connect a variable or series of variables to the logic inputs, outputs, components, and elements. To draw a link from port to port (triangles), left click on a port, pull the link onto another port, and release the left mouse button. The endpoint of the link automatically snaps to the nearest port when within a certain proximity. A red port indicates that a connection to the port is required or missing. A black port indicates that a connection to the port is not required. Drawing links from input to input or output to output is not allowed. Only one link may be connected to any one output.

If an object or element is disabled, it will have a yellow X on it. To enable the element, navigate to the settings page for that element. A red X indicates that an object or element is not available per the style number of the DECS-450.

Logic blocks may be automatically arranged by right clicking a blank area in the program grid and selecting *Auto-Layout*.

The following conditions must be met before BESTCOMSP<sup>Plus</sup> will allow logic to be uploaded to the DECS-450:

- A minimum of two inputs and a maximum of 32 inputs on any multi-port (AND, OR, NAND, NOR, XOR, and XNOR) gate.
- A maximum of 32 logic levels for any particular path. A path is considered an input block or an output side of an element block through gates to an output block or an input side of an element block. This includes any OR gates on the Physical Outputs page, but not the matched pairs of Physical Outputs blocks.
- A maximum of 256 gates per logic level with a maximum of 256 gates allowed per diagram. All output blocks and input sides of element blocks are at the maximum logic level of the diagram. All gates are pushed forward/upwards in logic levels and buffered to reach the final output block or element block if needed.

Three status indicators are located in the lower right corner of the BESTlogicP<sup>Plus</sup> window. These indicators show the *Logic Save Status*, *Logic Diagram Status*, and *Logic Layer Status*. Table 19-4 defines the colors for each indicator.

**Table 19-4. Status Indicators**

| Indicator                        | Color    | Definition                             |
|----------------------------------|----------|--|
| Logic Save Status<br>(Left)      | ● Orange | Logic has changed since last save.     |
|                                  | ● Green  | Logic has NOT changed since last save. |
| Logic Diagram Status<br>(Center) | ● Red    | Requirements NOT met as listed above.  |
|                                  | ● Green  | Requirements met as listed above.      |
| Logic Layer Status<br>(Right)    | ● Red    | Requirements NOT met as listed above.  |
|                                  | ● Green  | Requirements met as listed above.      |

### Pickup and Dropout Timers

A pickup timer produces a TRUE output when the elapsed time is greater than or equal to the Pickup Time setting after a FALSE to TRUE transition occurs on the Initiate input from the connected logic. Whenever the Initiate input status transitions to FALSE, the output transitions to FALSE immediately.

A drop out timer produces a TRUE output when the elapsed time is greater than or equal to the Dropout Time setting after a TRUE to FALSE transition occurs on the Initiate input from the connected logic. Whenever the Initiate input transitions to TRUE, the output transitions to FALSE immediately.

Refer to Figure 19-8, *Pickup and Dropout Logic Timer Blocks*.

To program logic timer settings, use the Settings Explorer within BESTCOMSP<sup>Plus</sup> to open the *BESTlogicPlus Programmable Logic/Logic Timers* tree branch. Enter a *Name* label that will appear on the timer logic block. The *Time Delay* value range is 0 to 250 hours in 1 hour increments, 0 to 59 minutes in 1 minute increments, or 0 to 59.9 seconds in 0.1 second increments. Next, open the *Components* tab inside the BESTlogicP<sup>Plus</sup> window and drag a timer onto the program grid. Right click on the timer and pick *Select Timer* from the menu to open the *Logic Timer Properties* window. From here, select the desired timer's radio button and click OK.

Timing accuracy is ±15 milliseconds.

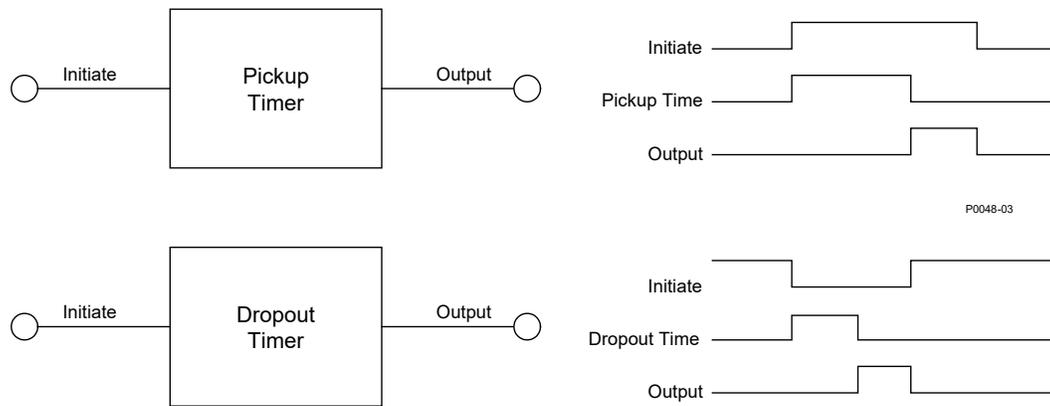


Figure 19-8. Pickup and Dropout Timer Logic Blocks

## Offline Logic Simulator

You can use the offline logic simulator to test your custom logic before placing it in operation. The state of various logic elements can be toggled to verify that the logic states travel through the system as expected.

The offline logic simulator allows you to change the state of various logic elements to illustrate how that state travels through the system. Before running the logic simulator, you must click the Save button on the BESTlogicPlus toolbar to save the logic to memory. Changes to the logic (other than changing the state) are disabled when the simulator is enabled. Colors are selected by clicking the Options button on the BESTlogicPlus toolbar. By default, Logic 0 is red and Logic 1 is green. Using your mouse, double-click on a logic element to change its state.

An example of the offline logic simulator is shown in Figure 19-9. STOP\_ENABLE is Logic 0 (red) when Input 1 is Logic 1 (green), Input 2 is Logic 0 (red), and the inverter is Logic 1 (green).

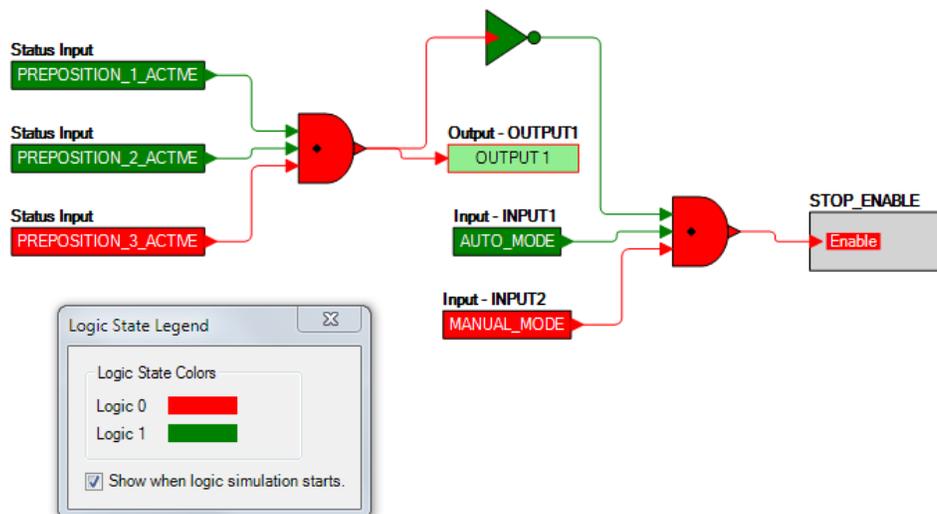


Figure 19-9. Offline Logic Simulator Example

## BESTlogic™ Plus File Management

To manage BESTlogicPlus files, use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch. Use the BESTlogicPlus Programmable Logic toolbar to manage BESTlogicPlus files. Refer to Figure 19-10. For information on Settings Files management, refer to the *BESTCOMSPlus Software* section.



Figure 19-10. BESTlogicPlus Programmable Logic Toolbar

### Saving a BESTlogicPlus File

After programming BESTlogicPlus settings, click on the *Save* button to save the settings to memory.

Before the new BESTlogicPlus settings can be uploaded to the DECS-450, you must select *Save* from the *File* pull-down menu located at the top of the BESTCOMSPlus main shell. This step will save both the BESTlogicPlus settings and the operating settings to a file.

The user also has the option to save the BESTlogicPlus settings to a unique file that contains only BESTlogicPlus settings. Click on the *Logic Library* drop-down button and select *Save Logic Library File*. Use standard Windows® techniques to save the file and enter a filename.

### Opening a BESTlogicPlus File

To open a saved BESTlogicPlus file, click on the *Logic Library* down button on the BESTlogicPlus Programmable Logic toolbar and select *Open Logic Library File*. Use standard Windows techniques to find and open the file.

### Protecting a BESTlogicPlus File

Locking and protecting is useful when sending logic files to other personnel to be modified. Locked object(s) cannot be changed. To view the lock status of the object(s), select *Show Lock Status* from the *Protection* drop-down menu. To lock object(s), use the mouse to select object(s) to be locked, right click on the selected object(s) and select *Lock Object(s)*. The gold colored padlock next to the object(s) will change from an open to a locked state. To protect a logic document, select *Protect Logic Document* from the *Protection* button. Establishing a password is optional.

### Uploading a BESTlogicPlus File

To upload a BESTlogicPlus file to the DECS-450, first open, or create, the file in BESTCOMSPlus. Then click the *Communication* menu and select *Upload Logic*.

### Downloading a BESTlogicPlus File

To download a BESTlogicPlus file from the DECS-450, click the *Communication* menu and select *Download Settings and Logic from Device*. If the logic currently in BESTCOMSPlus has changed, a dialog box will prompt you to save the current logic changes, then the download will begin.

### Copying and Renaming Preprogrammed Logic Schemes

To copying a saved logic scheme and assign a unique name, load the desired logic scheme into BESTCOMSPlus. Click on the *Logic Library* button and select *Save Logic Library File*. Use standard Windows® techniques to save the new file and enter a unique filename.

### Printing a BESTlogicPlus File

Clicking the *Printer* icon, located on the BESTlogicPlus Programmable Logic toolbar, opens the *Print Preview* screen. This screen displays a print preview of the logic scheme and provides many standard printer and page setup settings.

### Clearing the On-Screen Logic Diagram

Click on the *Clear* button to clear the on-screen logic diagram and start over.

## BESTlogic™ Plus Examples

### Example 1 - GOVR Logic Block Connections

Figure 19-11 illustrates the GOVR logic block and two output logic blocks. Output 6 is active while the governor is being raised and Output 9 is active while the governor is being lowered.

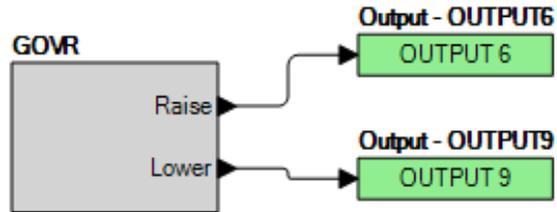


Figure 19-11. Example 1 - GOVR Logic Block Connections

### Example 2 - AND Gate Connections

Figure 19-12 illustrates a typical AND gate connection. In this example, Output 11 will become active when the bus and the generator are dead.

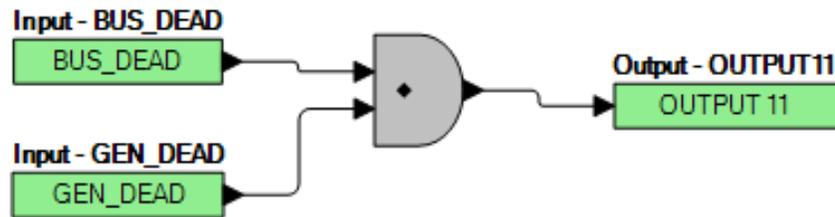


Figure 19-12. Example 2 - AND Gate Connections

## 20 • Communication

### **Local Communication**

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The USB port (type B) connects the DECS-450 with a PC operating BESTCOMSPPlus® for local, short-term communication. This mode of communication is useful for settings configuration and system commissioning. The USB port is located on the front panel and illustrated in the *Controls and Indicators* section of this manual. A USB device driver for the DECS-450 is automatically installed on your PC during the installation of BESTCOMSPPlus. Information about establishing communication between BESTCOMSPPlus and the DECS-450 is provided in the *BESTCOMSPPlus Software* section of this manual.

#### **Caution**

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

### **Communication with a Second DECS-450**

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**BESTCOMSPPlus Navigation Path:** Settings Explorer, Communications, RS232 Setup

**HMI Navigation Path:** Settings, Communications, RS232 Setup.

Communication between two DECS-450s enables external regulation setpoint tracking to occur in a dual, or redundant, application.

DECS-450 controllers use a female DB-9 (RS-232) connector for communication. This connector is located on the rear panel and is illustrated in the *Terminals and Connectors* section of this manual. A five-foot (1.5 meter) cable, part number 9310300032, is available for interconnecting two DECS-450 controllers.

### **Modbus® Communication**

---

**BESTCOMSPPlus Navigation Path:** Settings Explorer, Communications, Modbus Setup

**HMI Navigation Path:** Settings, Communications, Modbus

DECS-450 systems support the RS-485 mode and Modbus TCP (Ethernet) mode at the same time. DECS-450 Modbus communication registers are listed and defined in the *Modbus Communication* section of this manual.

Modbus settings for RS-485 and Ethernet are illustrated in Figure 20-1.

### Modbus Setup

**Ethernet Settings**

Unit ID

**RS485 Settings**

Unit ID

Response Delay (ms)

**Auto Save**

Auto Save

Figure 20-1. Modbus Setup

## RS-485 Communication

**BESTCOMSPlus Navigation Path:** Settings Explorer, Communications, RS-485 Setup

**HMI Navigation Path:** Settings, Communications, RS-485 Setup

An RS-485 port uses the Modbus RTU (remote terminal unit) protocol for polled communication with other networked devices or remote annunciation and control with an IDP-801 Interactive Display Panel. RS-485 terminals are located on the rear panel and are identified as RS-485 A, B, and C. Terminal A serves as the send/receive A terminal, terminal B serves as the send/receive B terminal, and terminal C serves as the signal ground terminal. Figure 20-2 illustrates typical RS-485 connections for multiple DECS-450 controllers communicating over a Modbus network.

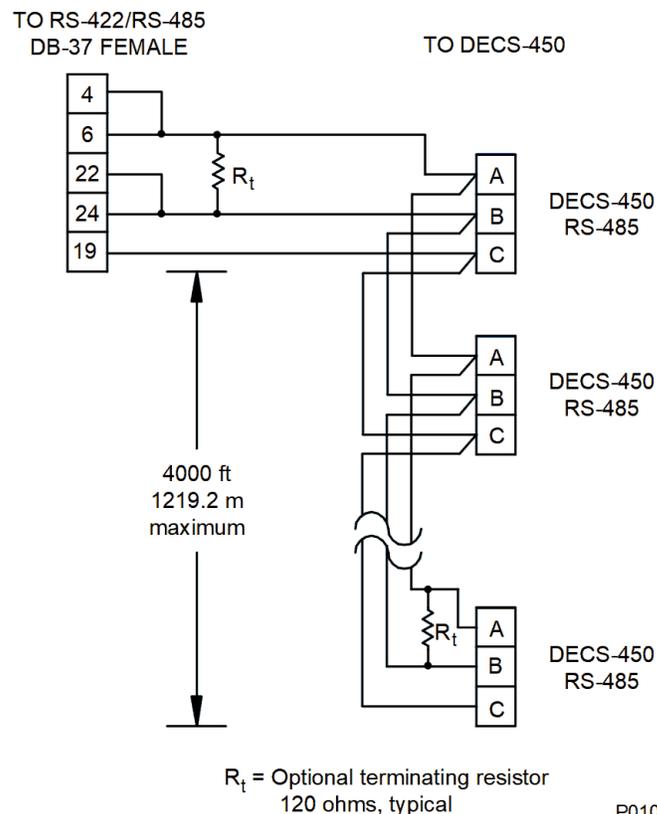


Figure 20-2. Typical RS-485 Connections

RS-485 port communication settings are illustrated in Figure 20-3.

Figure 20-3. RS-485 Port Communication Settings

## CAN Communication

**BESTCOMSPlus Navigation Path:** Settings Explorer, Communications, CAN Bus, CAN Bus Setup

**HMI Navigation Path:** Settings, Communications, CAN Bus, CAN Bus Setup

Two separate CAN (controller area network) ports are provided on the DECS-450. One CAN interface (CAN 1) facilitates communication between the DECS-450 and optional modules such as the contact expansion module (CEM-125 or CEM-2020) or analog expansion module (AEM-2020). A second CAN interface (CAN 2) enables the DECS-450 to transmit generator and system parameters to a generator controller such as Basler's DGC-2020HD. CAN 2 also permits DECS-450 setpoint and mode control from an external device connected to the CAN.

Both CAN bus interfaces utilize the SAE J1939 messaging protocol.

DECS-450 CAN parameters are listed and defined in the *CAN Communication* section of this manual.

### Connections

DECS-450 CAN connections should be made with twisted-pair, shielded cable. Each CAN port (designated CAN 1 and CAN 2) has a CAN high (H) terminal, a CAN low (L) terminal, and a CAN drain (SH) terminal. CAN port terminals are illustrated in the *Terminals and Connectors* section of this manual.

### Port Configuration

Each DECS-450 CAN port must be identified by a unique address number. The baud rate of each port can be configured for 125 kbps or 250 kbps.

The Allowed Command Address is the J1939 address from which the DECS-450 will accept broadcast data. If the address is set to 255 or the same as the DECS-450 CAN Bus Interface address, then broadcast data is accepted from any address. Otherwise, broadcast data is accepted from only the specified address. Port configuration settings are illustrated in Figure 20-4.

Figure 20-4. CAN Port Configuration Settings

## Remote Module Setup

**BESTCOMSPlus Navigation Path:** Settings Explorer, Communications, CAN Bus, Remote Module Setup

**HMI Navigation Path:** Settings, Communications, CAN Bus, Remote Module Setup

Optional, external modules, such as the contact expansion module (CEM-125 or CEM-2020) and analog expansion module (AEM-2020), communicate via the DECS-450 CAN 1 interface and are configured through the DECS-450 front panel HMI and BESTCOMSPlus. These settings are illustrated in Figure 20-5.

The screenshot shows a window titled "Remote Module Setup" with two columns of settings. The left column is for the "Contact Expansion Module" and the right column is for the "Analog Expansion Module". Both columns have a "Disabled" radio button selected and an "Enabled" radio button. Below each column is a text field for the "J1939 Address". The Contact Expansion Module address is 236, and the Analog Expansion Module address is 237.

Figure 20-5. Remote Module Setup

## Ethernet Communication

An Ethernet port uses the Modbus TCP protocol for polled communication with other networked devices or remote annunciation and control with an IDP-801 or IDP-1201 Interactive Display Panel.

Depending upon the style number, each DECS-450 is equipped with either a copper (100BASE-TX) Ethernet communication port (style XXXXXTX) or a fiber optic (100BASE-FX) Ethernet communication port (style XXXXXFX). The ST type fiber optic port uses a 1300 nanometer, near-infrared (NIR) light wavelength transmitted via two strands of multimode optical fiber, one for receive (RX) and the other for transmit (TX). The copper or fiber optic Ethernet connector is located on the rear panel. DECS-450 metering, annunciation, and control is provided through the Ethernet port using the Modbus TCP protocol. DECS-450 Modbus communication registers are listed and defined in the *Modbus Communication* section of this manual.

### Note

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

## Ethernet Connection

1. Connect the DECS-450 to the PC using a standard Ethernet cable.
2. In BESTCOMSPlus, click *Communication, New Connection, DECS-450*, or click the *Connection* button on the lower menu bar. The DECS-450 Connection window appears. (Figure 20-6)
3. If you know the IP address of the DECS-450, click the radio button for the Ethernet Connection IP at the top of the DECS-450 Connection window, enter the address into the fields and click the *Connect* button.
4. If you don't know the IP address, you can perform a scan to search for all connected devices by clicking the *Ethernet* button in the Device Discovery box. After the scan is complete, a window containing the connected devices will be displayed. (Figure 20-7)

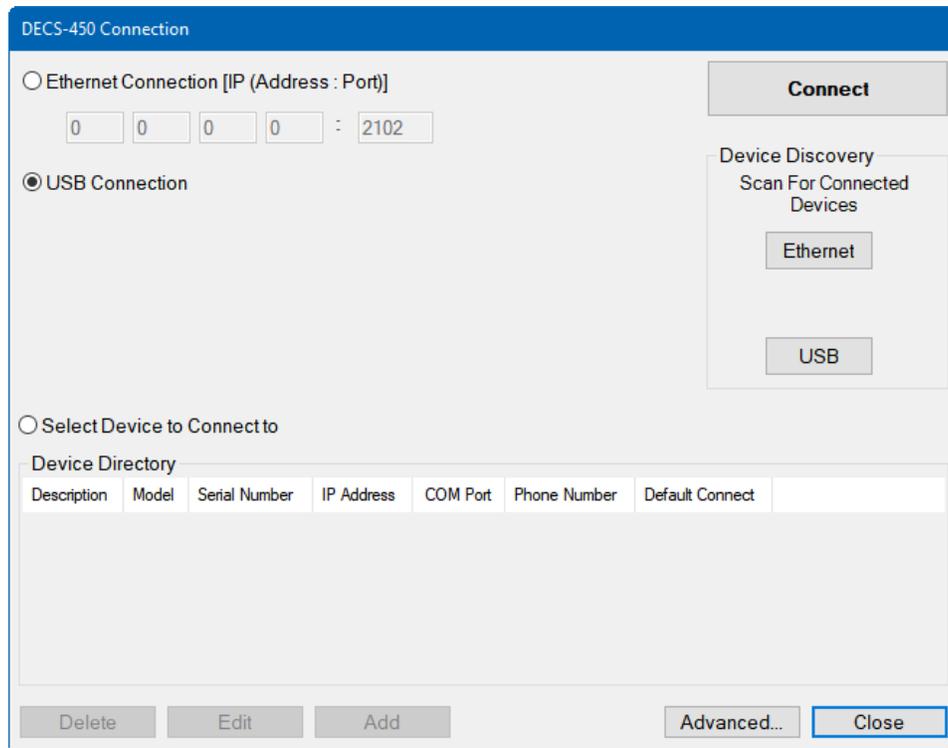


Figure 20-6. DECS-450 Connection Window

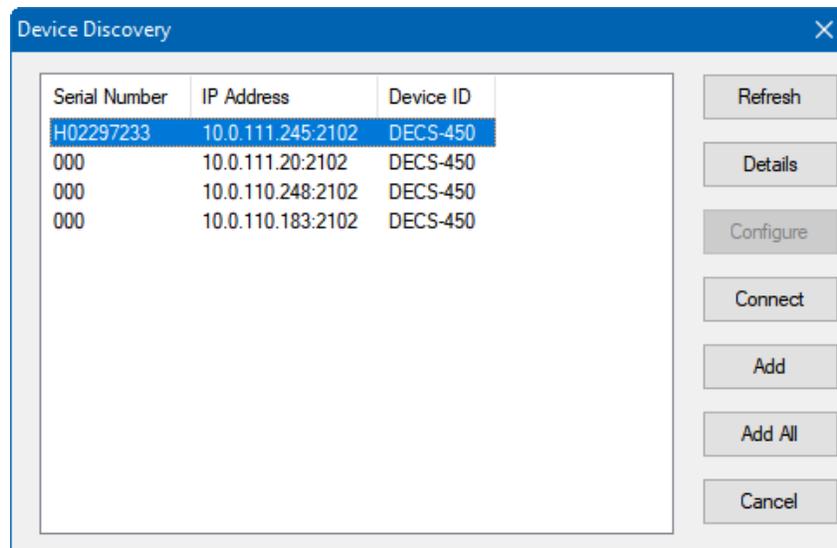
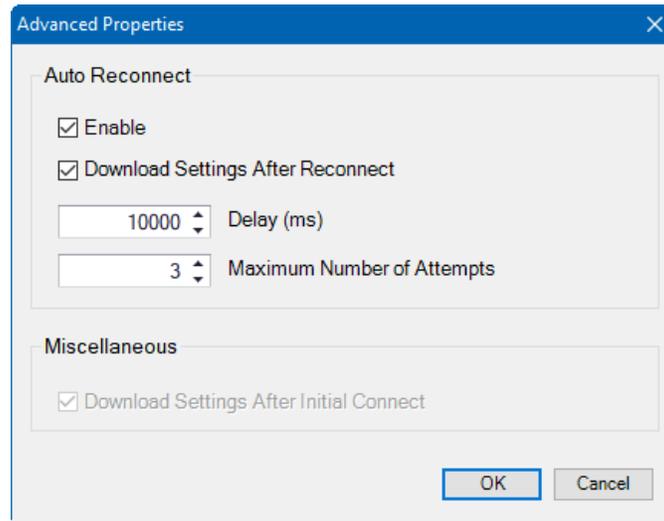


Figure 20-7. Device Discovery Window

- Adding any or all of the detected devices to the Device Directory eliminates the need to scan for connected devices each time a connection is desired. Simply select a device from the list and click *Add*. Clicking *Add All* will add all detected devices from the list to the Device Directory. The Device Directory stores the name, model, and address of devices you have added. Click the radio button for *Select Device to Connect to*, select the device from the Device Directory list, and click the *Connect* button at the top of the DECS-450 Connection window.
- Choose the desired device from the list and click *Connect*. Wait for connection to complete.

7. The *Advanced* button displays the window shown in Figure 20-8. It contains options for enabling Auto Reconnect, downloading settings after reconnect, the delay between retries (in milliseconds), and the maximum number of attempts (Figure 20-8).



**Figure 20-8. Advanced Properties, Auto Reconnect**

### Note

The PC running *BESTCOMSPi* software must be configured correctly to communicate with the DECS-450. The PC must have an IP address in the same subnet range as the DECS-450 if the DECS-450 is operating on a private, local network.

Otherwise, the PC must have a valid IP address with access to the network and the DECS-450 must be connected to a properly configured router. The network settings of the PC depend on the operating system installed. Refer to the operating system manual for instructions.

On most Microsoft Windows based PCs, the network settings can be accessed through the *Network Connections* icon located inside the Control Panel.

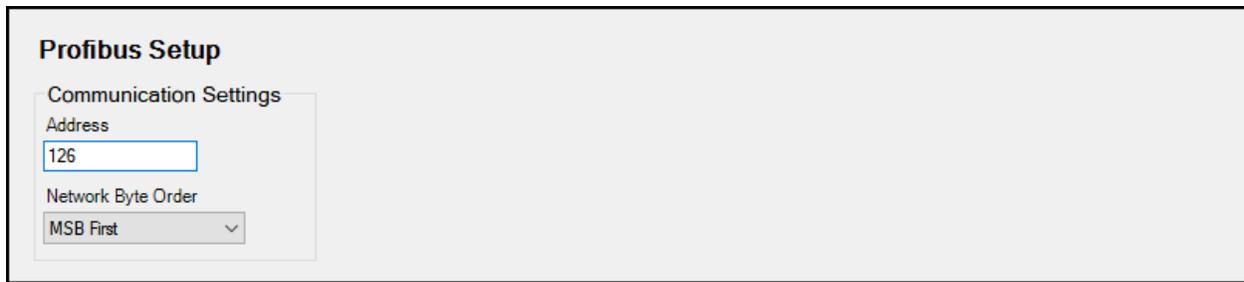
## ***PROFIBUS Communication***

**BESTCOMSPi Navigation Path:** Settings Explorer, Communications, Profibus Setup

**HMI Navigation Path:** Settings, Communications, Profibus

On units equipped with the PROFIBUS communication protocol (style XX1XXXX), the DECS-450 sends and receives PROFIBUS data through a DB-9 port located on the rear panel. DECS-450 PROFIBUS communication parameters are listed and defined in the *PROFIBUS Communication* section of this manual.

PROFIBUS communication settings are illustrated in Figure 20-9.



The image shows a screenshot of a software interface titled "Profibus Setup". Inside the window, there is a section labeled "Communication Settings". Under this section, there are two fields: "Address" and "Network Byte Order". The "Address" field is a text input box containing the number "126". The "Network Byte Order" field is a dropdown menu with "MSB First" selected and a small downward arrow to its right.

Figure 20-9. Profibus Setup



# 21 • Configuration

Before the DECS-450 is placed in service, it must be configured for the controlled equipment and application.

## Operating Mode

**BESTCOMSPlus Navigation Path:** Settings Explorer, Operating Settings, Operating Mode

**HMI Navigation Path:** Settings, Operating Settings, Operating Mode

Operating mode settings are illustrated in Figure 21-1.

### Mode

The mode can be set to accommodate a generator or motor application. Based on this setting, all parameter and setting labels displayed in BESTCOMSPlus and on the HMI display adjust automatically to show the appropriate machine type (generator or motor).

In Motor mode, there is an inverse relationship between excitation (field current) and vars. As excitation increases, the amount of vars supplied to the motor decreases.

### Raise/Lower Configuration

Raise/Lower Configuration settings are available to customize how the DECS-450 responds while operating in Motor mode.

When Adjust Excitation is selected, a Raise command increases excitation and a Lower command decreases excitation.

When Adjust Setpoint is selected, the DECS-450 responds to Raise and Lower commands by Raising or Lowering the setpoint for the mode in control.

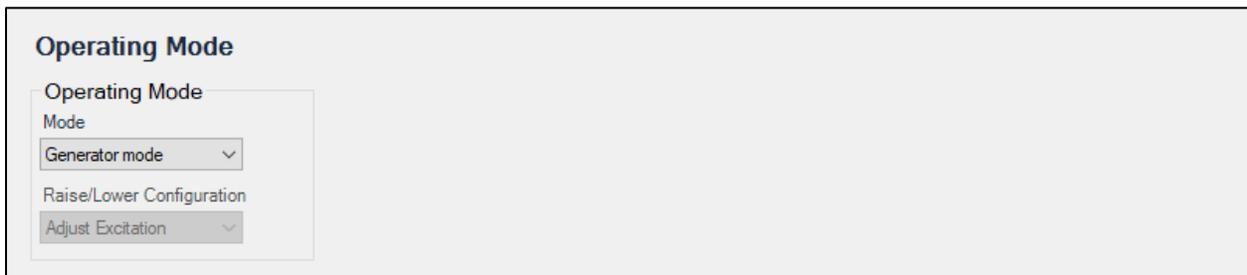


Figure 21-1. Operating Mode

## Generator, Field, and Bus Ratings

**BESTCOMSPlus Navigation Path:** Settings Explorer, System Parameters, Rated Data

**HMI Navigation Path:** Settings, System Parameters, Rated Data

Generator, field, and bus rating settings are illustrated in Figure 21-2.

For proper excitation control and protection, the DECS-450 must be configured with the ratings of the controlled generator and field. These ratings are typically shown on the generator nameplate or can be obtained from the generator manufacturer. Required generator ratings include the voltage, frequency, power factor, and apparent power (kVA). Generator current and real power (kW) are listed with the other generator ratings as read-only settings. These values are automatically calculated from the other generator ratings entered by the user. Required field ratings include the no load dc voltage and current, full load voltage and current, field resistance, ambient temperature and brush voltage drop.

In applications where the generator will be synchronized/paralleled with a bus, the DECS-450 must be configured with the rated bus voltage.

The *Operating Power*, *PPT Secondary Voltage* setting is used to calculate the recommended Ka (Loop Gain) value.

When using the DECS-450 with an exciter requiring an inverted output, enable the *Invert Output* setting to invert the DECS-450 control output. Refer to the *Programmable Inputs and Outputs* section in the manual for more information.

### Caution

Selecting inverted control output with an excitation system that does not require it may result in equipment damage.

| Generator Rated Data    | Field Rated Data              | Bus Rated Data                   |
|-------------------------|-------------------------------|----------------------------------|
| Voltage (V): 120        | Field Type: Exciter Field     | Voltage (V): 120                 |
| Current (A): 200.0      | Voltage - Full Load (V): 63.0 | Operating Power                  |
| Frequency: 60 Hz        | Current - Full Load (A): 10.0 | PPT Secondary Voltage (V): 240.0 |
| PF (Power Factor): 0.80 | Voltage - No Load (V): 32.0   |                                  |
| Rating (kVA): 41.57     | Current - No Load (A): 10.0   |                                  |
| Rating (kW): 33.26      | Field Resistance (Ohm): 4.500 |                                  |
|                         | Ambient Temperature (°F): 77  |                                  |
|                         | Brush Voltage Drop (V): 1.50  |                                  |

Figure 21-2. Generator, Bus, Field, Ratings

## Field Isolation Transducer

**BESTCOMSPlus Navigation Path:** Settings Explorer, System Parameters, Field Isolation Transducer  
**HMI Navigation Path:** Settings, System Parameters, Field Isolation Transducer

| Field Isolation Transducer |
|----------------------------|
| Field Current Sensing      |
| Shunt Rating (A): 10.0     |
| Field Voltage Sensing      |
| Voltage Range (V): ±63     |

Figure 21-3. Field Isolation Transducer Ratings

Field Isolation Transducer configuration consists of settings for shunt rating and field voltage input. See Figure 21-3.

## Sensing Transformer Ratings and Configuration

**BESTCOMSPi**us Navigation Path: Settings Explorer, System Parameters, Sensing Transformers

HMI Navigation Path: Settings, System Parameters, Sensing Transformers

DECS-450 configuration includes entry of the primary and secondary values for the transformers that supply generator and bus sensing values to the DECS-450. These configuration settings are illustrated in Figure 21-4.

### Generator PT

Voltage settings for the generator PT primary and secondary windings establish the nominal PT voltages expected by the DECS-450. Phase rotation (ABC or ACB) can be specified. Options for the generator voltage sensing connections include single-phase (across phases A and C) and three-phase sensing.

### Generator CTs

Current settings for the generator CT primary and secondary windings establish the nominal CT current values expected by the DECS-450. Options for the generator current sensing connections include A-phase, B-phase, C-phase, or three-phase.

### Bus PT

Voltage settings for the bus PT primary and secondary windings establish the nominal bus PT voltages expected by the DECS-450. Options for the bus voltage sensing connections include single-phase (across phases A and C) and three-phase sensing.

The screenshot displays the 'Sensing Transformers' configuration window. It is organized into two main columns. The left column contains three sections: 'Generator PT' with input fields for Primary Voltage (120.00) and Secondary Voltage (120.00); 'Generator CT' with input fields for Primary Current (200.00) and a dropdown for Secondary Current (5A); and 'Bus PT' with input fields for Primary Voltage (120.00) and Secondary Voltage (120.00). The right column is titled 'Sensing Configuration' and contains four dropdown menus: Phase Rotation (ABC), Generator Voltage (Three Phase), CT Phase Connection (Three Phase), and Bus Voltage (Three Phase).

Figure 21-4. Sensing Transformer Ratings and Configuration

## Startup Functions

**BESTCOMSPlus Navigation Path:** Settings Explorer, Operating Settings, Startup

**HMI Navigation Path:** Settings, Operating Settings, Startup

DECS-450 startup functions consist of soft start and field flashing. These settings are illustrated in Figure 21-5.

### Soft Start

During startup, the soft start function prevents voltage overshoot by controlling the rate of generator terminal voltage buildup (toward the setpoint). Soft start is active in AVR, FCR, and FVR regulation modes. Soft start behavior is based on two parameters: level and time. The soft start level is expressed as a percentage of the setpoint of the active mode and determines the starting point for generator voltage buildup during startup. The soft start time defines the amount of time allowed for the buildup of generator voltage during startup. Two groups of soft start settings (primary and secondary) provide for independent startup behavior which is selectable through BESTlogic™ Plus.

### Field Flashing

To ensure generator voltage buildup, the field flashing function applies and removes flashing power from an external field flashing source. Field flashing is active in AVR, FCR, and FVR control modes. During system startup, the application of field flashing is based on two parameters: level and time.

The Field Flash Dropout Level setting determines the level of generator voltage where field flashing is withdrawn. In AVR mode, the field flash dropout level is expressed as a percentage of the setpoint of the active mode. In FCR mode, the level is expressed as a percentage of the field current. In FVR mode, the level is expressed as a percentage of the field voltage.

The Maximum Field Flash Time setting defines the maximum length of time that field flashing may be applied during startup.

To use the field flashing function, one of the DECS-450 programmable contact outputs must be configured as a field flashing output.

The screenshot shows a configuration window titled "Startup". It contains two main sections: "Soft Start" and "Startup Control".

- Soft Start:** This section is divided into two columns: "Primary" and "Secondary".
  - Primary:** "Soft Start Level (%)" is set to 5, and "Soft Start Time (s)" is set to 5.
  - Secondary:** "Soft Start Level (%)" is set to 5, and "Soft Start Time (s)" is set to 5.
- Startup Control:**
  - "Field Flash Dropout Level (%)" is set to 0.
  - "Maximum Field Flash Time (s)" is set to 10.

Figure 21-5. Startup Function Settings

## Device Information

**BESTCOMSPi+ Navigation Path:** Settings Explorer, General Settings, Device Info

**HMI Navigation Path:** Settings, General Settings, Device Information, DECS-450

Device information includes user-assigned identification labeling and read-only firmware version information and product information. Device information (Figure 21-6) is provided for the DECS-450, CEM-125 or CEM-2020 Contact Expansion Module, and AEM-2020 Analog Expansion Module.

### Firmware and Product Information

Firmware and product information can be viewed on the HMI display and Device Info tab of BESTCOMSPi+.

The screenshot displays the 'Device Info' configuration screen. It is organized into several sections:

- Application Information:** Includes a dropdown for 'Application Version Number' (set to '>= 1.01.00'), a text field for 'Application Part Number' (9597100013), a text field for 'Application Version' (1.00.00), a text field for 'Model Number' (DECS-450), a text field for 'Boot Code Version' (1.04.00), a text field for 'Application Build Date' (02/06/20), and a text field for 'Serial Number' (000).
- Identification:** A text field for 'Device ID' (DECS-450).
- Contact Expansion Module:** Fields for 'Application Version', 'Serial Number', 'Boot Code Version', 'Application Part Number', 'Application Build Date' (format: YYYY-MM-DD), and 'Model Number'.
- Analog Expansion Module:** Fields for 'Application Version', 'Serial Number', 'Boot Code Version', 'Application Part Number', 'Application Build Date' (format: YYYY-MM-DD), and 'Model Number'.

Figure 21-6. Device Information

### Firmware Information

Firmware information is provided for the DECS-450, optional CEM-2020, and optional AEM-2020. This information includes the application part number, application version, application build date, and boot code version. Also included is the version of the boot code. When configuring settings in BESTCOMSPi+ while disconnected from a DECS-450, an Application Version Number setting is available to ensure compatibility between the selected settings and the actual settings available in the DECS-450.

### Product Information

Product information for the DECS-450, CEM-125 or CEM-2020, and AEM-2020 includes the device model number and serial number.

### **Device Identification**

The user-assigned *Device ID* is used to identify DECS-450 controllers in reports and during polling.

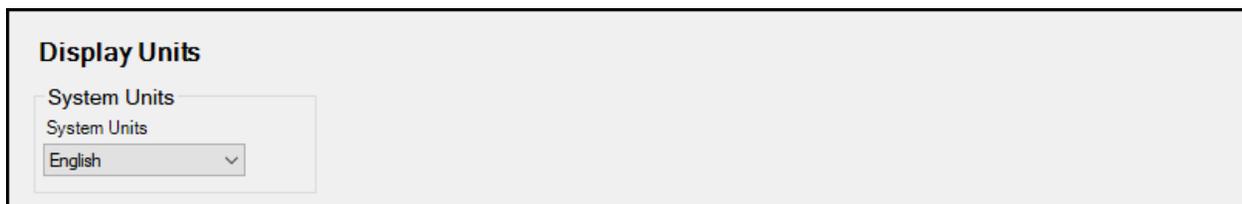
## ***Display Units***

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**BESTCOMSPi+ Navigation Path:** Settings Explorer, General Settings, Display Units

**HMI Navigation Path:** Settings, General Settings, Display Units

When working with DECS-450 settings in BESTCOMSPi+, you have the option of viewing the settings in English or Metric units. The *display units* setting is illustrated in Figure 21-7.



**Figure 21-7. Display Units**

## 22 • Security

DECS-450 units are secured by password-protected user accounts. Each account is assigned an access level that permits certain operations. An additional layer of security controls the type of operations allowed through certain DECS-450 communication ports.

Security settings are uploaded and downloaded separately from the settings and logic. See the *BESTCOMSPiplus*<sup>®</sup> section for more information on uploading and downloading security settings.

### Password Access

**BESTCOMSPiplus Navigation Path:** Settings Explorer, General Settings, Device Security Setup, User Name Setup

User accounts may be created which consist of a user name, password, and an access level. The different access levels are listed in Table 22-1. An account has access to the assigned access level as well as all the levels below it. For example, an account with Settings access level has access to operations granted by the Settings, Operator, Control, and Read access levels.

**Table 22-1. Password Access Levels and Descriptions**

| Access Level | Description  |
|--------------|--|
| Admin (6)    | Create, edit, and delete users and device security. Includes levels 1 through 5 below.                     |
| Design (5)   | Create or change programmable logic. Includes levels 1 through 4 below.                                    |
| Settings (4) | Edit all settings. Does <u>not</u> include logic settings. Includes levels 1, 2, and 3 below.              |
| Operator (3) | Set date and time, reset accumulated metering values, and erase event data. Includes levels 1 and 2 below. |
| Control (2)  | Operate real-time controls. Includes level 1 below.  |
| Read (1)     | Read all system parameters, metering, and logs. No changes or operation allowed.                           |
| None (0)     | All access is denied.  |

### Password Creation and Configuration

User accounts are created and configured on the *BESTCOMSPiplus* User Name Setup screen (Figure 22-1). To create and configure a username and password, perform the following steps.

1. Disable Live Mode in *BESTCOMSPiplus*.
2. In the *BESTCOMSPiplus* settings explorer, navigate to General Settings, Device Security Setup, User Name Setup. When prompted, enter a username of "A" and a password of "A" and log on. This factory-default username and password grants administrator-level access. It is highly recommended that this factory-default password be changed immediately to prevent undesired access.
3. To set up a new account, select an "UNASSIGNED" entry in the user list. To edit an existing account, select it in the user list.
4. Enter a username.
5. Enter a password for the user.
6. Reenter the password created in step 5 to verify.
7. Select the maximum allowed access level for the user.
8. To set an expiration date for a user's access, enter number of days. Otherwise, leave the expiration value at zero.
9. Click the Save User button.

10. Open the Communication menu, and click Upload Security to Device.
11. BESTCOMSPPlus notifies you when the security upload is successful.

| User Name     | Max Access Level |
|---------------|------------------|
| A             | Admin            |
| ADMINISTRATOR | Admin            |
| ANDREA221     | Control          |
| BRIANH149     | Design           |
| JEFFD331      | Admin            |
| SUSANT188     | Operator         |
| UNASSIGNED    | Read             |

**Selected User Information**

User Name  
SUSANT188

Password  
7077FT

Verify Password  
7077FT

Maximum Access Level Allowed  
Operator

Days to Expiration (0 - No Password Expiration)  
0

Save User      Delete User

Figure 22-1. Password Access Settings

## Port Security

**BESTCOMSPPlus Navigation Path:** Settings Explorer, General Settings, Device Security Setup, Port Access Setup

An additional layer of security restricts operations through the DECS-450 communication ports.

The Unsecured Access Level setting sets the maximum level of access allowed without entering a username/password. The Secured Access Level setting sets the maximum level of access allowed with a password.

### Caution

Setting the Secured Access Level to None on any port makes that port unusable. If the Secured Access Level is set to None on all available ports, the DECS-450 must be returned to Basler Electric for repair.

Only one port can be in use at a time by an account with Control access or higher. For example, if a user is logged in with Control access at one port, all users at other ports (even Admins) are granted only Read access until the initial user with Control access logs off.

## Port Access Configuration

Communication port access is configured on the BESTCOMSPPlus Port Access Setup screen (Figure 22-2). To configure communication port access, perform the following steps.

1. Disable Live Mode in BESTCOMSPPlus.
2. In the BESTCOMSPPlus settings explorer, navigate to General Settings, Device Security Setup, Port Access Setup. When prompted, enter a username of "A" and a password of "A" and log on. This factory-default username and password allows administrator-level access. It is highly recommended that this factory-default password be changed immediately to prevent undesired access.
3. Highlight the desired communication port in the port list.

4. Select the highest unsecured access level for the port.
5. Select the highest secured access level for the port.
6. Save the configuration by clicking the Save Port button.
7. Open the Communication menu, and click Upload Security to Device.
8. BESTCOMSPPlus notifies you when the security upload is successful.

| Port                        | Unsecured Access | Secured Access |
|-----------------------------|------------------|----------------|
| BESTCOMSPPlus® via Ethernet | Read             | Admin          |
| BESTCOMSPPlus® via USB      | Read             | Admin          |
| CAN Bus                     | Read             | Admin          |
| HMI                         | Read             | Admin          |
| Modbus via Ethernet         | Read             | Admin          |
| Modbus via Serial           | Read             | Admin          |
| Profibus via Serial         | Read             | Admin          |

**Selected Port Information**

Unsecured Access Level: Read

Secured Access Level: Admin

Save Port

Figure 22-2. Port Access Configuration Settings

## Login and Access Controls

**BESTCOMSPPlus Navigation Path:** Settings Explorer, General Settings, Device Security Setup, Access Control

Additional controls are available to limit login time and login attempts. These control settings are illustrated in Figure 22-3.

### Access Timeout

The Access Timeout setting maintains security by automatically withdrawing password access if a user neglects to log out. If no activity is detected for the duration of the access timeout setting, password access is automatically withdrawn.

**Access Control**

Access Timeout  
Delay (s)  
300

Login Failure  
Login Attempts  
1

Login Time Window (s)  
1

Login Lockout Time (s)  
1

Figure 22-3. Login and Access Control Settings

## Login Failure

A Login Attempts setting limits the number of times that login can be attempted. A Login Time Window setting limits the length of time permitted during the login process. If login is unsuccessful, access is blocked for the duration of the Login Lockout Time setting.

## Security Shutdown Alarm

The DECS-450 verifies its style and serial numbers during power-on self-test. The Security Shutdown alarm is annunciated when the DECS-450 has detected an unauthenticated style or serial number.

When the security shutdown alarm is active, the following occurs:

1. The transfer watchdog will trip and remain latched to indicate that this unit is not in control.
2. The DECS-450 will neither start excitation nor run other control functions.
3. The DECS-450 will retain communication functions to annunciate the alarm.

If your DECS-450 has annunciated this alarm, contact Basler Electric for support.

## Viewing the Security Log

**BESTCOMSPlus Navigation Path:** Metering Explorer, Reports, Security Log

**HMI Navigation Path:** Not available through the front panel

The DECS-450 records information about user logins including the port used to log in, the access level granted, the type of action performed, and the time of logout in the security log. Information will also be recorded when a user attempts to log in, but fails due to an invalid username or incorrect password.

A maximum of 200 entries are stored in nonvolatile memory. When a new entry is generated, the DECS-450 discards the oldest of the 200 entries and replaces it with a new one.

Use the Metering Explorer to open the Reports, Security Log screen. If an active connection to a DECS-450 is present, the security log will automatically download. Using the Options button, you can copy, print, or save the security log. The Refresh button is used to refresh/update the security log. The Clear button clears the security log. The Toggle Sorting button enables sorting. Click on a column header to sort. See Figure 22-4.

| Port                  | Username | Access Level | Login Time              | Logout Time             | Action   |
|-----------------------|----------|--------------|-------------------------|-------------------------|----------|
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:00:24.000 | 2008-01-01 00:05:29.672 | Activate |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:00:37.000 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:00:37.418 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:00:59.826 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:01:00.537 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:01:03.131 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:01:04.993 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:01:05.111 | 2008-01-01 00:13:38.352 | Save     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:01:11.961 | 2008-01-01 00:36:08.238 | Save     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:06:02.839 | 2008-01-01 00:16:07.411 | Save     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:13:08.943 | 2008-01-01 00:13:53.707 | Save     |
| HMI Local             | A        | Read Access  | 2008-01-01 00:16:00.434 | NA                      | None     |
| HMI Local             | A        | Admin Access | 2008-01-01 00:16:13.569 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Read Access  | 2008-01-01 00:17:29.641 | NA                      | None     |
| Bestcoms Via Ethernet | A        | Admin Access | 2008-01-01 00:14:41.7   | 2008-01-01 00:43.18     | Save     |

Figure 22-4. Security Log

## 23 • Timekeeping

The DECS-450 clock is used by the logging functions to timestamp events. DECS-450 timekeeping may be either self-managed by the internal clock or coordinated with an external source through a network or IRIG device. BESTCOMSP<sup>Plus</sup>® Timekeeping settings are shown in Figure 23-1.

**BESTCOMSP<sup>Plus</sup> Navigation Path:** Settings Explorer, General Settings, Clock Setup

**HMI Navigation Path:** Settings, General Settings, Clock Setup

### ***Time and Date Format***

---

Clock display settings enable you to configure the time and date reported by the DECS-450 to match the local conventions. The time may be configured for either the 12- or 24-hour format with the Time Format setting. The Date Format setting configures the reported date for one of three available formats: MM-DD-YYYY, DD-MM-YYYY, or YYYY-MM-DD.

### ***Daylight Saving Time Adjustments***

---

The DECS-450 can automatically compensate for the start and end of daylight saving time (DST) on a fixed- or floating-date basis. An example of a fixed date is “March 2” and an example of a floating date is “Second Sunday of March”. DST compensation may be set in respect to your local time or coordinated universal time (UTC). DST start and end dates are fully configurable and include a bias adjustment.

### ***Network Time Protocol (NTP)***

---

When connected to an Ethernet network, the DECS-450 can use NTP to synchronize with a radio, atomic, or other clock located on the internet/intranet, to maintain accurate timekeeping.

#### **NTP Settings**

NTP is enabled in the DECS-450 by entering the internet protocol (IP) address of the network timeserver in the four decimal-separated fields of the NTP Address setting. Time zone offset settings provide the necessary offset from the coordinated universal time (UTC) standard. Central standard time is six hours and zero minutes behind (–6, 0) UTC and is the default setting.

The Time Priority Setup must be used to enable a connected time source. When multiple time sources are connected, the Time Priority Setup can be used to rank the sources according to their priority.

### ***IRIG***

---

When the IRIG source is enabled, through the Time Priority Setup, it synchronizes the DECS-450 internal clock with the time code signal.

Some older IRIG receivers may use a time code signal compatible with IRIG standard 200-98, format B002, which does not contain year information. To use this standard, select the *IRIG without Year* radio button in the *IRIG Decoding* box. Year information is stored in nonvolatile memory so the year is retained during a control power interruption.

The IRIG input accepts a demodulated (dc level-shifted) signal. For proper recognition, the applied IRIG signal must have a logic high level of no less than 3.5 Vdc and a logic low level that is no higher than 0.5 Vdc. The input signal voltage range is –10 Vdc to +10 Vdc. Input resistance is nonlinear and approximately 4 kΩ at 3.5 Vdc and 3 kΩ at 20 Vdc. IRIG signal connections are made at terminals IRIG+ and IRIG– which are located on the rear panel.

Use Time Priority Setup to enable a connected time source. When multiple time sources are connected, the Time Priority Setup may be used to rank the sources according to their priority.

### Clock Setup

**Time Zone Offset Setup**  
Time Zone Hour Offset:  Time Zone Minute Offset:

**Clock Display Setup**  
Time Format:  Date Format:

**Daylight Saving Time Setup**  
DST Configuration:   
Start/End Time Reference:  
 Respective to Local Time  
 Respective to UTC Time

**Start Day**  
Month:  Occurrence of Day:  Weekday:  Hour:  Minute:

**End Day**  
Month:  Occurrence of Day:  Weekday:  Hour:  Minute:

**Bias Setup**  
Hour:  Minute:

**Time Priority Setup**  
Disabled:   
Ntp:   
Enabled:   
Double-click on an item to move to next Box

**Irig Decoding**  
 IRIG without Year  
 IRIG with Year

**NTP Address**

Figure 23-1. Clock Setup

## 24 • Testing

Testing of the DECS-450's regulation and optional power system stabilizer (PSS) (style 1XXXXXX) performance is possible through the integrated analysis tools of BESTCOMSPPlus®.

### Real-Time Metering Analysis

**BESTCOMSPPlus Navigation Path:** Metering Explorer, Analysis

**HMI Navigation Path:** Analysis functions are not available through front panel HMI.

Proper voltage regulator performance is critical to PSS performance. Step response measurements of the voltage regulator should be performed to confirm the AVR gain and other critical parameters. A transfer function measurement between terminal voltage reference and terminal voltage should be performed with the machine operating at very low load. This test provides an indirect measurement of the PSS phase requirement. As long as the machine is operating at very low load, the terminal voltage modulation does not produce significant speed and power changes.

The BESTCOMSPPlus Real-Time Metering Analysis screen is used to perform and monitor online AVR and PSS testing. Six plots of user-selected data may be generated and the logged data may be stored in a file for later examination. BESTCOMSPPlus must be in *Live Mode* to start plotting. Live Mode is found under the *Options* menu on the lower menu bar. RTM Analysis screen controls and indications are illustrated in Figure 24-1.



Figure 24-1. RTM Analysis Screen

The RTM Analysis screen controls are provided for:

- Selecting the parameters to be graphed
- Adjusting the resolution of the graph x axis and the range of the graph y axis
- Starting and stopping plot captures
- Opening existing graph files, saving captured plots in graph files, and printing captured graphs

## Graph Parameters

Any six of the following parameters may be selected for plotting.

- Auxiliary voltage input (Vaux)
- Average line current (Iavg)
- Average line-to-line voltage (Vavg)
- AVR error signal (ErrIn)
- AVR PID output
- Bus frequency (B Hz)
- Bus voltage (Vbus)
- Compensated frequency deviation (CompF)
- Control output (CntOp)
- Cross-current input (Iaux)
- Droop
- FCR error to PID
- FCR integrator value
- FCR PID output
- Field current (Ifd) (Full Load)
- Field temperature
- Field voltage (Vfd) (Full Load)
- Filtered mechanical power (MechP)
- Final PSS output (Pout)
- Frequency response signal (Test)
- FVR error to PID
- FVR integrator value
- FVR PID output
- Generator frequency (G Hz)
- Inner loop error
- Inner loop field voltage feedback
- Inner loop output
- Inner loop PID input
- Inner loop reference
- Internal state (TrnOp)
- Lead-lag #1 (x15)
- Lead-lag #2 (x16)
- Lead-lag #3 (x17)
- Lead-lag #4 (x31)
- Logic limiter washout filter
- Mechanical power (x10)
- Mechanical power (x11)
- Mechanical power (x7)
- Mechanical power (x8)
- Mechanical power (x9)
- Negative sequence current (I2)
- Negative sequence voltage (V2)
- Network load share error
- Network load share PI output
- Null Balance Level (Null Balance)
- Null Balance State (Null State)
- OEL controller output
- OEL field current reference
- OEL integrator value
- Phase A current (Ia)
- Phase A to B, line-to-line voltage (Vab)
- Phase B current (Ib)
- Phase B to C, line-to-line voltage (Vbc)
- Phase C current (Ic)
- Phase C to A, line-to-line voltage Vca
- Position Indication (PositionInd)
- Positive sequence current (I1)
- Positive sequence voltage (V1)
- Post-limit output (Post)
- Power factor (PF)
- Power HP #1 (x5)
- Pre-limit output (Prelim)
- PSS electrical power (PSSkW)
- PSS terminal voltage (Vt<sub>mag</sub>)
- Rate of frequency change
- Reactive power (kvar)
- Real power (kW)
- S1 Logic status point 1
- S2 Logic status point 2
- S3 Logic status point 3
- S4 Logic status point 4
- S5 Logic status point 5
- S6 Logic status point 6
- SCL controller output
- SCL gen current reference
- SCL integrator value
- SCL PF reference
- Speed HP #1 (x2)
- Synthesized speed (Synth)
- Terminal frequency deviation (TermF)
- Terminal voltage low-pass filter
- Terminal voltage ramp filter
- Time response signal (Ptest)
- Torsional filter #1 (Tft1)
- Torsional filter #2 (x29)
- Total power (kVA)
- Transfer output
- UEL controller output (UelOutput)
- UEL integrator value
- UEL var reference
- Var limiter integrator value

- Var limiter output
- Var limiter reference
- Var/PF error to PID
- Var/PF integrator value
- Var/PF PID output
- Washed out power (WashP)
- Washed out speed (WashW)

## Frequency Response

Frequency response testing functions are available by clicking the Frequency Response button on the RTM Analysis screen. Frequency Response screen functions are illustrated in Figure 24-2 and described below.

### Test Mode

Frequency response testing may be performed in Manual or Auto mode. In Manual mode, a single frequency can be specified to obtain the corresponding magnitude and phase responses. In Auto mode, BESTCOMSPPlus® will sweep the range of frequencies and obtain the corresponding magnitude and phase responses.

#### Manual Test Mode Options

Manual test mode options include settings to select the frequency and magnitude of the applied test signal. A time delay setting selects the time after which the magnitude and phase response corresponding to the specified frequency is computed. This delay allows transients to settle before computations are made.

#### Auto Test Mode Options

Automatic test mode options include settings to select the minimum frequency, maximum frequency, and magnitude of the sinusoidal wave that is applied during a frequency response test.

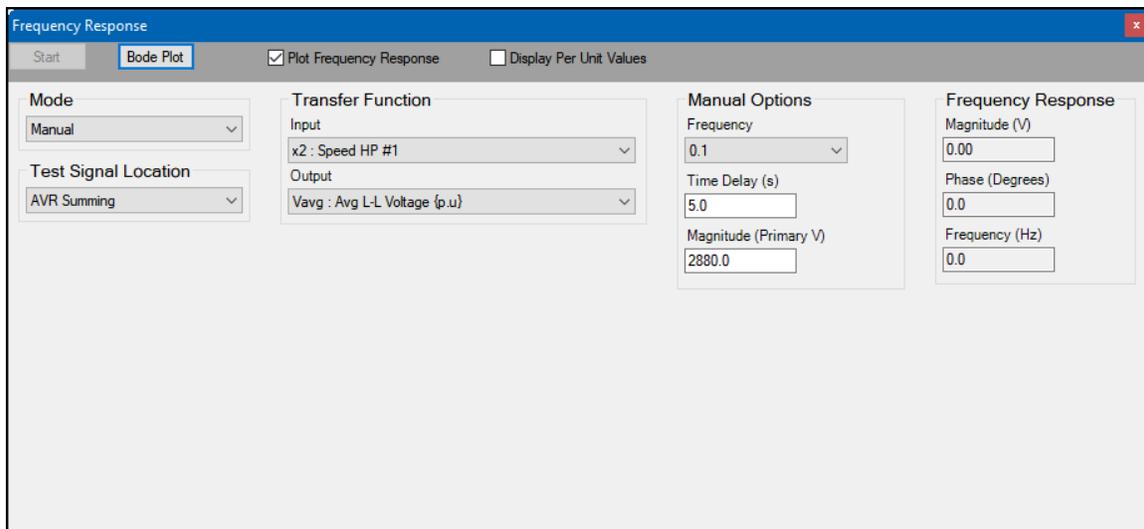


Figure 24-2. Frequency Response Screen

### Bode Plotting

A Bode plot can be printed, opened, and saved in graph (.gph) format.

### Transfer Function

The point in the DECS-450 logic circuitry where a signal is injected for analysis of magnitude and phase responses is selectable. Signal points include PSS Comp Frequency, PSS Electric Power, AVR Summing, AVR PID Input, and Manual PID Input.

The type of input signal to be injected and output point are selectable, and include:

- AvrOut
- B Hz: Bus Frequency {Hz}
- CntOp: Control Output {pu}
- CompF: Compensated Frequency Deviation
- Droop
- ErrIn: AVR Error Signal
- FcrErr
- FcrOut
- FvrErr
- FvrOut
- G Hz: Generator Frequency {Hz}
- I1: Positive Sequence Current {pu}
- I2: Negative Sequence Current {pu}
- Ia: Phase A Current {pu}
- Iaux: Cross Current Input {pu}
- Iavg: Ave Line Current {pu}
- Ib: Phase B Current {pu}
- Ic: Phase C Current {pu}
- Ifd: Field Current {pu} (Full Load)
- kVA: Total Power {pu}
- kvar: Reactive Power {pu}
- kW: Real Power {pu}
- MechP: Filtered Mechanical Power
- Network Load Share
- NullBalance: Null Balance Level
- OelOutput: OEL Controller Output
- PF: Power Factor
- Post: Post-Limit Output {pu}
- POut: Final PSS Output {pu}
- Prelim: Pre-Limit Output {pu}
- PssW: PSS Electric Power {pu}
- Ptest: Time Response Signal {pu}
- SclOutput: SCL Controller Output
- Synth: Synthesized Speed {pu}
- TermF: Terminal Frequency Deviation
- Test: Frequency Response Signal {pu}
- Tflt1: Torsional Filter #1 {pu}
- TrnOp: Internal State {pu}
- UelOutput: UEL Controller Output
- V1: Positive Sequence Voltage {pu}
- V2: Negative Sequence Voltage {pu}
- Vab: PhA-PhB L-L Voltage {pu}
- Var/PfErr
- Var/PfOut
- VarLimOutput: Var Limiter Output
- Vaux: Aux Voltage Input {pu}
- Vavg: Ave L-L Voltage {pu}
- Vbc: PhB-PhC L-L Voltage {pu}
- Vbus: Bus Voltage {pu}
- Vca: PhC-PhA L-L Voltage {pu}
- Vfd: Field Voltage {pu} (Full Load)
- Vtmag: PSS Term Voltage
- WashP: Washed Out Power
- WashW: Washed Out Speed {pu}
- x02: Speed HP #1
- x05: Power HP #1 {pu}
- x07: Mechanical Power {pu}
- x08: Mechanical Power LP #1
- x09: Mechanical Power LP #2
- x10: Mechanical Power LP #3
- x11: Mechanical Power LP #4
- x15: Lead-Lag #1 {pu}
- x16: Lead-Lag #2 {pu}
- x17: Lead-Lag #3 {pu}
- x29: Torsional Filter #2 {pu}
- x31: Lead-Lag #4 {pu}

## Frequency Response

Read-only frequency response fields indicate the magnitude response, phase response, and test signal frequency. The magnitude response and phase response correspond to the test signal previously applied. The test frequency value reflects the frequency of the test signal currently being applied.

### Caution

Exercise caution when performing frequency response testing on a generator connected to the grid. Avoid frequencies that are close to the resonant frequency of the machine or neighboring machines. Frequencies above 3 Hz may correspond to the lowest shaft torsional frequencies of a generator. A torsional profile for the machine should be obtained from the manufacturer and consulted before conducting any frequency response tests.

## Time Response

Tests should be performed at various load levels to confirm that the input signals are calculated or measured correctly. Since the PSS function uses compensated terminal frequency in place of speed, the derived mechanical power signal should be examined carefully to ensure that it does not contain any components at the electromechanical oscillation frequencies. If such components are present, it indicates that the frequency compensation is less than ideal or that the machine inertia value is incorrect.

PSS test signal configuration settings are provided on the Time Response screen shown in Figure 24-3. Click the RTM Analysis screen's Time Response button to access this screen.

## Signal Input

Signal input selections determine the point in the PSS circuitry where the test signal is applied. Test points include AVR Summing, PSS Comp Frequency, PSS Electric Power, PSS Derived Speed, Manual Summing, and var/PF.

A time delay is provided to delay the start of a PSS test after the Time Response screen Start button is clicked.

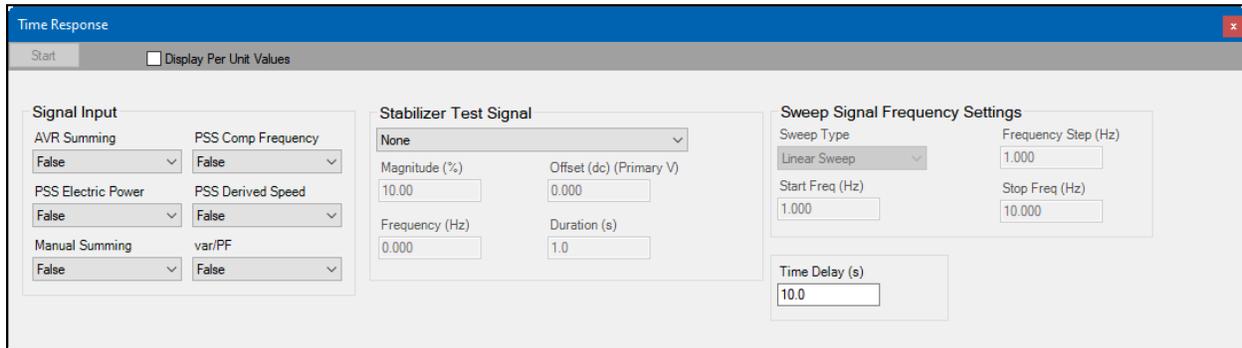


Figure 24-3. Time Response Screen

## Test Signal Characteristics

Test signal characteristics (magnitude, offset, frequency, and duration) may be adjusted according to the type of test signal selected.

### Magnitude

The test signal magnitude is expressed as a percentage and excludes the gain of externally-applied signals.

### Offset

A dc offset can be applied to the PSS test signal. The offset is expressed as a per-unit value used in proper context wherever the test signal is applied. A dc offset cannot be applied to a Step test signal.

### Frequency

The test signal frequency can be adjusted as desired for Step and Sine test signals. See *Swept Sine Test Signal* for information about configuring the frequency attributes of swept sine test signals.

### Duration

A duration setting controls the total test duration for Sine and External test signals. For Step test signals, the duration setting determines the “on” period of the signal. The duration setting does not apply to Swept Sine signals.

### Swept Sine Test Signals

Swept Sine test signals employ a unique set of characteristics that include the sweep style, frequency step, and start/stop frequencies.

### Sweep Type

A Swept Sine test signal may be configured as linear or logarithmic.

### Start and Stop Frequencies

The range of a Swept Sine test signal is determined by Start Frequency and Stop Frequency settings.

## Frequency Step

The frequency of a Swept Sine test signal is incremented according to the sweep type used. For linear sweeps, the test signal frequency is incremented by Frequency Step every half-cycle of the system frequency. For logarithmic sweeps, the test signal frequency is multiplied by 1.0 plus Frequency Step every half-cycle of the system frequency.

## Step Response Analysis

A standard technique for verifying overall system response is through step response measurements. This involves exciting the local electromechanical oscillation modes through a fixed step change in the AVR reference. Damping and frequency of oscillation can be measured directly from recordings of generator speed and power for different operating conditions and settings. Normally this test is performed with variations of the following:

- Generator active and reactive power loading
- Stabilizer gain
- System configuration (e.g., lines out of service)
- Stabilizer parameters (e.g., phase lead, frequency compensation)

As the stabilizer gain is increased, the damping should increase continuously while the natural frequency of oscillation should remain relatively constant. Large changes in the frequency of oscillation, a lack of improvement in damping, or the emergence of new modes of oscillation are all indications of problems with the selected settings.

Step response testing is performed using the Step Response Analysis screen. This screen (Figure 24-4) is accessed by clicking the Step Response button in the RTM Analysis window. The Step Response Analysis screen consists of:

- Metering fields: average generator voltage, vars, total PF, field voltage, and field current
- An alarms window that displays any active alarms possibly triggered by a step change
- A checkbox to select triggering of a data record when a setpoint step change is performed
- Tabs for controlling the application of step changes to the AVR, FCR, FVR, var, and PF setpoints. Tab functions are described in the following paragraphs.

### Note

If logging is in progress, another log cannot be triggered.

Response characteristics displayed on the Step Response Analysis screen are not automatically updated when the DECS-450 operating mode is switched externally. The screen must be manually updated by exiting and then reopening the screen.

## AVR, FCR, and FVR Tabs

The AVR, FCR, and FVR tabs have similar controls that enable the application of step changes to their respective setpoints. The AVR tab controls are illustrated in Figure 24-4. AVR, FCR, and FVR tab controls are described below.

Step changes that increase or decrease the setpoint are applied by clicking the increment (up arrow) or decrement (down arrow) button. Step-change setting fields (one for increase and one for decrease) establish the percent change in the setpoint that occurs when the increment or decrement button is clicked. Three read-only fields indicate the current setpoint, a one-step increase in setpoint, a one-step decrease in setpoint, and the original setpoint. A button is provided to return the setpoint to its original value, which is displayed in the read-only field adjacent to the button.

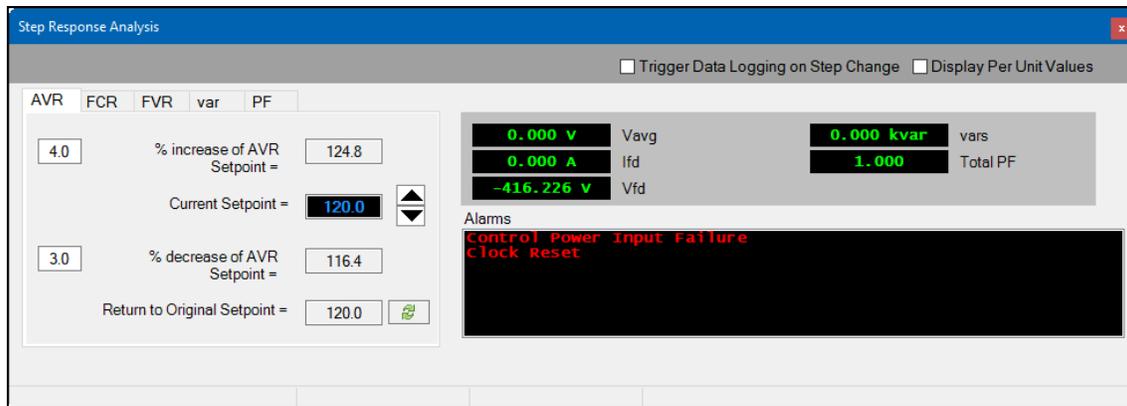


Figure 24-4. Step Response Analysis - AVR Tab

## Var and PF Tabs

The var and PF tabs have similar controls that apply step changes to their respective setpoints. PF tab controls are illustrated in Figure 24-5. Var and PF tab controls are described below.

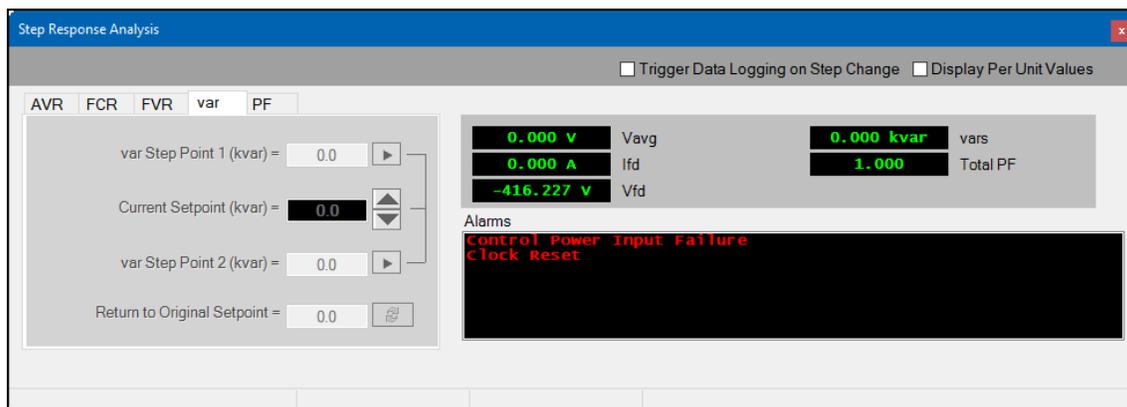


Figure 24-5. Step Response Analysis - Var Tab

The setpoint may be adjusted by clicking the increment (up arrow) or decrement (down arrow) button. Two Var Step Point settings are provided. Clicking the right-arrow button beside the fields initiates a step change to the corresponding setpoint value. A button is provided to return the setpoint to its original value, which is displayed in the read-only field adjacent to the button.

## Analysis Options

Options are provided to arrange the layout of plots and adjust graph display.

### Layout Tab

Up to six data plots may be displayed in three different layouts on the RTM screen. Check the Cursors Enabled box to enable cursors used for measuring between two horizontal points. See Figure 24-6.

### Graph Display Tab

Options are provided to adjust graph history and poll rate. Graph height sets the displayed graphs to a fixed height in pixels. When the Auto Size box is checked, all displayed graphs are automatically sized to equally fit the available space. History length is selectable from 1 to 30 minutes. Poll rate is adjustable between 100 to 500 milliseconds. Lowering the history and poll rate may improve PC performance while plotting.

Check the Sync Graph Scrolling box to sync scrolling of all graphs when any horizontal scroll bar is moved. See Figure 24-7.

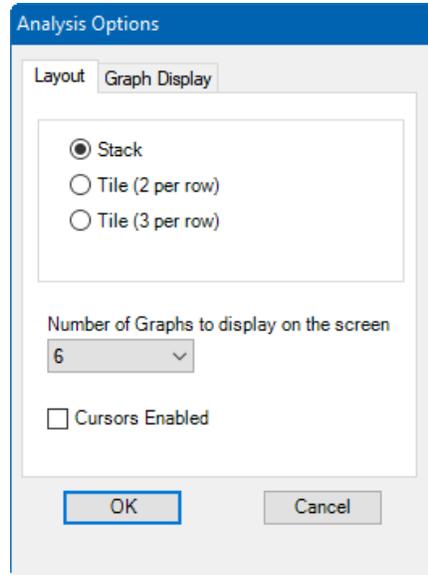


Figure 24-6. Analysis Options Screen, Layout Tab

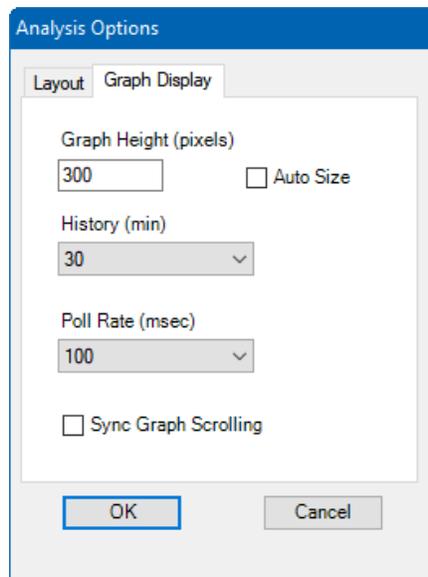


Figure 24-7. Analysis Options Screen, Graph Display Tab

# 25 • CAN Communication

## Introduction

The DECS-450 provides two CAN Bus interfaces, designated as CAN 1 and CAN 2.

CAN Bus interface 1 facilitates communication between the DECS-450 and optional modules such as the Contact Expansion Module (CEM-125 or CEM-2020) and Analog Expansion Module (AEM-2020). Refer to the *Contact Expansion Module* and *Analog Expansion Module* sections for more information.

CAN Bus interface 2 enables the DECS-450 to provide generator and system parameters to a generator controller such as the Basler DGC-2020HD. CAN 2 also permits DECS-450 setpoint and mode control from an external device connected to the CAN. The parameters sent over CAN 2 are listed in this chapter.

Both CAN Bus interfaces use the SAE J1939 messaging protocol.

Refer to the *Communication* section for CAN port configuration and the *Terminals and Connectors* section for wiring.

## CAN Parameters

Supported CAN parameters are listed in Table 25-1. The first column contains the parameter group number (PGN), the second column contains the parameter name, the third column contains the unit of measurement for a parameter, the fourth column contains the suspect parameter number (SPN), and the fifth column contains the broadcast rate for a parameter.

**Table 25-1. CAN Parameters**

| PGN    | Name  | Units   | SPN  | Broadcast Rate |
|--------|---|---------|------|----------------|
| 0xFDA6 | Generator Excitation Field Voltage                    | Volts   | 3380 | 100 ms         |
|        | Generator Excitation Field Current                    | Amps    | 3381 |                |
|        | Generator Output Voltage Bias Percentage              | Percent | 3382 |                |
| 0xFDA7 | Voltage Regulator Load Compensation Mode              | n/a     | 3375 | 1 s            |
|        | Voltage Regulator var/PF Operating Mode               | n/a     | 3376 |                |
|        | Voltage Regulator Underfrequency Compensation Enabled | n/a     | 3377 |                |
|        | Voltage Regulator Soft Start State                    | n/a     | 3378 |                |
|        | Voltage Regulator Enabled                             | n/a     | 3379 |                |
| 0xFDFD | Generator Phase CA L-L AC RMS Voltage                 | Volts   | 2443 | 100 ms         |
|        | (Unsupported)   | n/a     | 2247 |                |
|        | Generator Phase C AC RMS Current                      | Amps    | 2451 |                |
| 0xFE00 | Generator Phase BC L-L AC RMS Voltage                 | Volts   | 2442 | 100 ms         |
|        | (Unsupported)   | n/a     | 2446 |                |
|        | Generator Phase B AC RMS Current                      | Amps    | 2450 |                |
| 0xFE03 | Generator Phase AB L-L AC RMS Voltage                 | Volts   | 2441 | 100 ms         |
|        | (Unsupported)   | n/a     | 2445 |                |
|        | Generator Phase A AC RMS Current                      | Amps    | 2249 |                |
| 0xFE06 | Generator Average L-L AC RMS Voltage                  | Volts   | 2440 | 100 ms         |
|        | (Unsupported)   | n/a     | 2444 |                |
|        | Generator Average AC Frequency                        | Hertz   | 2436 |                |
|        | Generator Average AC RMS Current                      | Amps    | 2448 |                |
| 0xFE04 | Generator Total Reactive Power                        | var     | 2456 | 100 ms         |
|        | Generator Overall PF                                  | n/a     | 2464 |                |
|        | Generator Overall PF Lagging                          | n/a     | 2518 |                |

| PGN    | Name   | Units | SPN  | Broadcast Rate |
|--------|--|-------|------|----------------|
| 0xFE05 | Generator Total Real Power   | Watts | 2452 | 100 ms         |
|        | Generator Total Apparent Power   | VA    | 2460 |                |
| 0xFF00 | <u>Contact I/O Status</u><br>Start Input - Byte 0, bits 0,1<br>Stop Input - Byte 0, bits 2,3<br>Input 1 - Byte 0, bits 4,5<br>Input 2 - Byte 0, bits 6,7<br>Input 3 - Byte 1, bits 0,1<br>Input 4 - Byte 1, bits 2,3<br>Input 5 - Byte 1, bits 4,5<br>Input 6 - Byte 1, bits 6,7<br>Input 7 - Byte 2, bits 0,1<br>Input 8 - Byte 2, bits 2,3<br>Input 9 - Byte 2, bits 4,5<br>Input 10 - Byte 2, bits 6,7<br>Input 11 - Byte 3, bits 0,1<br>Input 12 - Byte 3, bits 2,3<br>Input 13 - Byte 3, bits 4,5<br>Input 14 - Byte 3, bits 6,7<br>Watchdog Output - Byte 4, bits 0,1<br>Output 1 - Byte 4, bits 2,3<br>Output 2 - Byte 4, bits 4,5<br>Output 3 - Byte 4, bits 6,7<br>Output 4 - Byte 5, bits 0,1<br>Output 5 - Byte 5, bits 2,3<br>Output 6 - Byte 5, bits 4,5<br>Output 7 - Byte 5, bits 6,7<br>Output 8 - Byte 6, bits 0,1<br>Output 9 - Byte 6, bits 2,3<br>Output 10 - Byte 6, bits 4,5<br>Output 11 - Byte 6, bits 6,7<br><u>Notes</u><br>0 = Open<br>1 = Closed<br>2 = Reserved<br>3 = Reserved | n/a   | n/a  | 100 ms         |
| 0xFF01 | Requested Generator Excitation Field Voltage (FVR Setpoint)  | Volts | 3380 | n/a            |
|        | Requested Generator Excitation Field Current (FCR Setpoint)  | Amps  | 3381 | n/a            |
| 0xFF02 | <u>Requested Operating Mode</u><br>Byte 0, Bits 0-2<br><u>Notes</u><br>1 = FCR<br>2 = AVR<br>3 = VAR<br>4 = PF<br>5 = FVR<br>Will not override if held by logic.<br>Byte 0, Bits 3-7 unused<br>Bytes 1-7 unused  | n/a   | n/a  | 100 ms         |
| 0xF015 | Requested Generator Total AC Reactive Power (var Setpoint)   | var   | 3383 | n/a            |
|        | Requested Generator Overall PF (PF Setpoint)   | n/a   | 3384 | n/a            |
|        | Requested Generator Overall PF Lagging (PF Setpoint)   | n/a   | 3385 | n/a            |
| 0xF01C | Requested Generator Average L-L AC RMS Voltage (AVR Setpoint)  | Volts | 3386 | n/a            |

## Diagnostic Trouble Codes (DTCs)

The DECS-450 sends an unsolicited message for a currently active diagnostic trouble code (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. Table 25-2 lists the diagnostic information that the DECS-450 obtains over the CAN Bus interface.

DTCs are reported in coded diagnostic information that includes the Suspect Parameter Number (SPN), Failure Mode Identifier (FMI), and Occurrence Count (OC) as listed in Table 3. All parameters have an SPN and are used to display or identify the items for which diagnostics are being reported. The FMI defines the type of failure detected in the subsystem identified by an SPN. The reported problem may not be an electrical failure but a subsystem condition needing to be reported to an operator or technician. The OC contains the number of times that a fault has gone from active to previously active.

**Table 25-2. Diagnostic Information Obtained Over CAN Bus Interface 2**

| PGN     | Name                         |
|---------|------------------------------|
| 0xEA00  | Request DTCs                 |
| 0xFECA  | Currently Active DTCs        |
| 0xFECEB | Previously Active DTCs       |
| 0xFECC  | Clear Previously Active DTCs |
| 0xFED3  | Clear Active DTCs            |

**Table 25-3. Reported DTCs**

| SPN hex (decimal) | Name                     | FMI hex (decimal) * |
|-------------------|--------------------------|---------------------|
| 0x263 (611)       | Loss of Sensing Fault    | 0x00 (0)            |
| 0x264 (612)       | EDM Fault                | 0x0E (14)           |
| 0xD34 (3380)      | Field Overvoltage Fault  | 0x00 (0)            |
| 0xD35 (3381)      | Field Overcurrent Fault  | 0x00 (0)            |
| 0x988 (2440)      | Overvoltage Fault        | 0x0F (15)           |
| 0x988 (2440)      | Undervoltage Fault       | 0x11 (17)           |
| 0x998 (2456)      | Loss of Excitation Fault | 0x11 (17)           |

- \* 0 = Data valid but above normal range, most severe.
- 14 = Special instructions.
- 15 = Data valid but above normal range, least severe.
- 17 = Data valid but below normal range, least severe.



# 26 • Modbus® Communication

## Introduction

This document describes the Modbus® communications protocol employed by DECS-450 systems and how to exchange information with DECS-450 systems over a Modbus network. DECS-450 systems communicate by emulating a subset of the Modicon 984 Programmable Controller.

### Caution

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

Modbus communications use a master-slave technique in which only the master can initiate a transaction. This transaction is called a query. When appropriate, a slave (DECS-450) responds to the query. When a Modbus master communicates with a slave, information is provided or requested by the master. Information residing in the DECS-450 is grouped categorically as follows:

- General
- Binary Points
- Metering
- Limiters
- Setpoints
- Global Settings
- Relay Settings
- Protection Settings
- Gains
- Legacy Modbus

All supported data can be read as specified in the Register Table. Abbreviations are used in the Register Table to indicate the register type. Register types are:

- Read/Write = RW
- Read Only = R

When a slave receives a query, the slave responds by either supplying the requested data to the master or performing the requested action. A slave device never initiates communications on the Modbus and will always generate a response to the query unless certain error conditions occur. The DECS-450 is designed to communicate on the Modbus network only as slave devices.

Refer to the *Communication* chapter for Modbus communication setup and the *Terminals and Connectors* chapter for wiring.

## Message Structure

### Device Address Field

The device address field contains the unique Modbus address of the slave being queried. The addressed slave repeats the address in the device address field of the response message. This field is 1 byte.

Although Modbus protocol limits a device address from 1 - 247. The address is user-selectable at installation and can be altered during real-time operation.

### Function Code Field

The function code field in the query message defines the action to be taken by the addressed slave. This field is echoed in the response message and is altered by setting the most significant bit (MSB) of the field to 1 if the response is an error response. This field is 1 byte in length.

The DECS-450 maps all available data into the Modicon 984 holding register address space supports the following function codes:

- Function 03 (03 hex) - read holding registers
- Function 06 (06 hex) - preset single register
- Function 08 (08 hex), subfunction 00 - diagnostics: return query data
- Function 08 (08 hex), subfunction 01 - diagnostics: restart communications option
- Function 08 (08 hex), subfunction 04 - diagnostics: force listen only mode
- Function 16 (10 hex) - preset multiple registers

### Data Block Field

The query data block contains additional information needed by the slave to perform the requested function. The response data block contains data collected by the slave for the queried function. An error response will substitute an exception response code for the data block. The length of this field varies with each query.

### Error Check Field

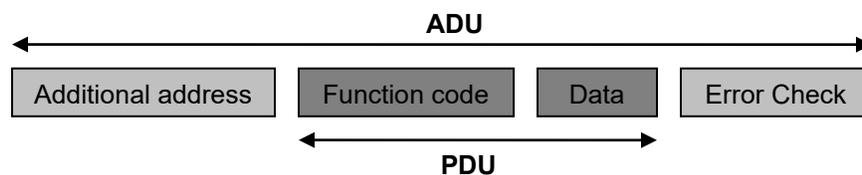
The error check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

## ***Modbus Modes of Operation***

A standard Modbus network offers the remote terminal unit (RTU) transmission mode and Modbus TCP mode for communication. DECS-450 systems support the Modbus TCP mode and RS-485 mode at the same time. To enable editing over Modbus TCP, or RS-485, the unsecured access level for the port must be configured to the appropriate access level. See the *Security* chapter of this manual for more information on security and access levels. These two modes of operation are described below.

A master can query slaves individually or universally. A universal ("broadcast") query, when allowed, evokes no response from any slave device. If a query to an individual slave device requests actions unable to be performed by the slave, the slave response message contains an exception response code defining the error detected. Exception response codes are quite often enhanced by the information found in the "Error Details" block of holding registers.

The Modbus protocol defines a simple Protocol Data Unit (PDU) independent of the underlying communication layers. The mapping of the Modbus protocol on specific buses or networks can introduce some additional fields on the Application Data Unit (ADU). See Figure 26-1.



**Figure 26-1. General Modbus Frame**

The client that initiates a Modbus transaction builds the Modbus Application Data Unit. The function code indicates to the server which kind of action to perform.

## Modbus® Over Serial Line

### Message Structure

Master initiated queries and DECS-450 responses share the same message structure. Each message is comprised of four message fields. They are:

- Device Address (1 byte)
- Function Code (1 byte)
- Data Block (n bytes)
- Error Check field (2 bytes)

Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with one start bit and either one or two stop bits. Parity checking is performed, when enabled, and can be either odd or even. The transmission baud rate is user-selectable, and can be set at installation and altered during real-time operation. The DECS-450 Modbus supports baud rates up to 115200. The factory default baud rate is 19200.

DECS-450 systems support RS-485 compatible serial interfaces. This interface is accessible from the left side panel of the DECS-450.

### Message Framing and Timing Considerations

When receiving a message via the RS-485 communication port, the DECS-450 requires an inter-byte latency of 3.5 character times before considering the message complete.

Once a valid query is received, the DECS-450 waits a specified amount of time before responding. This time delay is set on the Modbus Setup screen under Communications in BESTCOMSPlus®. This parameter contains a value from 10 - 10,000 milliseconds. The default value is 10 milliseconds.

Table 26-1 provides the response message transmission time (in seconds) and 3.5 character times (in milliseconds) for various message lengths and baud rates.

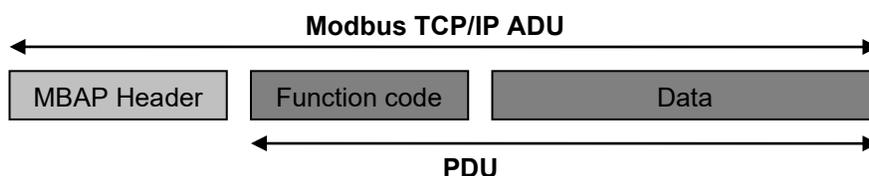
**Table 26-1. Timing Considerations**

| Baud Rate | 3.5 Character Time (ms) | Message Tx Time (s) |           |
|-----------|-------------------------|---------------------|-----------|
|           |                         | 128 Bytes           | 256 Bytes |
| 1200      | 32.08                   | 1.17                | 2.34      |
| 2400      | 16.04                   | 0.59                | 1.17      |
| 4800      | 8.021                   | 0.29                | 0.59      |
| 9600      | 4.0104                  | 0.15                | 0.29      |
| 19200     | 2.0052                  | 0.07                | 0.15      |
| 38400     | 1.0026                  | 0.04                | 0.07      |
| 57600     | 0.6684                  | 0.02                | 0.04      |
| 115200    | 0.3342                  | 0.01                | 0.02      |

## Modbus on TCP/IP

### Application Data Unit

The following describes the encapsulation of a Modbus request or response when it is carried on a Modbus TCP/IP network. See Figure 26-2.



**Figure 26-2. Modbus Request/Response Over TCP/IP**

A dedicated header is used on TCP/IP to identify the Modbus Application Data Unit. It is called the MBAP header (Modbus Application Protocol header).

This header provides some differences compared to the Modbus RTU application data unit used on a serial line:

- The Modbus 'slave address' field usually used on Modbus Serial Line is replaced by a single byte 'Unit Identifier' within the MBAP header. The 'Unit Identifier' is used to communicate via devices such as bridges, routers, and gateways that use a single IP address to support multiple independent Modbus end units.
- All Modbus requests and responses are designed in such a way that the recipient can verify that a message is finished. For function codes where the Modbus PDU has a fixed length, the function code alone is sufficient. For function codes carrying a variable amount of data in the request or response, the data field includes a byte count.
- When Modbus is carried over TCP, additional length information is carried in the MBAP header to allow the recipient to recognize message boundaries even if the message has been split into multiple packets for transmission. The existence of explicit and implicit length rules and use of a CRC-32 error check code (on Ethernet) results in an infinitesimal chance of undetected corruption to a request or response message.

#### MBAP Header Description

The MBAP Header contains the fields listed in Table 26-2.

**Table 26-2. MBAP Header Fields**

| Fields                 | Length  | Description  | Client                               | Server  |
|------------------------|---------|--|--------------------------------------|---|
| Transaction Identifier | 2 Bytes | Identification of a Modbus request/response transaction.                       | Initialized by the client.           | Recopied by the server from the received request. |
| Protocol Identifier    | 2 Bytes | 0 = Modbus protocol.   | Initialized by the client.           | Recopied by the server from the received request. |
| Length                 | 2 Bytes | Number of following bytes.   | Initialized by the client (request). | Initialized by the server (response).             |
| Unit Identifier        | 1 Byte  | Identification of a remote slave connected on a serial line or on other buses. | Initialized by the client.           | Recopied by the server from the received request. |

The header is 7 bytes long:

- *Transaction Identifier* – Used for transaction pairing, the Modbus server copies in the response the transaction identifier of the request.
- *Protocol Identifier* – Used for intra-system multiplexing. The Modbus protocol is identified by the value 0.
- *Length* – A byte count of the following fields, including the Unit Identifier and data fields.
- *Unit Identifier* – Used for intra-system routing purpose. It is typically used to communicate to a Modbus or a Modbus serial line slave through a gateway between an Ethernet TCP/IP network and a Modbus serial line. This field is set by the Modbus Client in the request and must be returned with the same value in the response by the server.

Note: All Modbus TCP ADU are sent via TCP on registered port 502.

### **Error Handling and Exception Responses**

Any query received that contains a non-existent device address, a framing error, or CRC error is ignored. No response is transmitted. Queries addressed to the DECS-450 with an unsupported function or illegal

values in the data block result in an error response message with an exception response code. The exception response codes supported by the DECS-450 are provided in Table 26-3.

**Table 26-3. Supported Exception Response Codes**

| Code | Name                 | Description  |
|------|----------------------|--|
| 01   | Illegal Function     | The query Function/Subfunction Code is unsupported; query read of more than 125 registers; query preset of more than 100 registers.  |
| 02   | Illegal Data Address | A register referenced in the data block does not support queried read/write; query preset of a subset of a numerical register group. |
| 03   | Illegal Data Value   | A preset register data block contains an incorrect number of bytes or one or more data values out of range.                          |

### DECS-450 Modbus® via Ethernet

Modbus can communicate through Ethernet if the IP address of the DECS-450 is configured as described in the *Communications* chapter of this manual.

## Detailed Message Query and Response for RTU Transmission Mode

A detailed description of DECS-450 supported message queries and responses is provided in the following paragraphs.

### Read Holding Registers

#### Query

This query message requests a register or block of registers to be read. The data block contains the starting register address and the quantity of registers to be read. A register address of N will read holding register N+1. If the query is a broadcast (device address = 0), no response message is returned.

Device Address  
 Function Code = 03 (hex)  
 Starting Address Hi  
 Starting Address Lo  
 No. of Registers Hi  
 No. of Registers Lo  
 CRC Hi error check  
 CRC Lo error check

The number of registers cannot exceed 125 without causing an error response with the exception code for an illegal function.

#### Response

The response message contains the data queried. The data block contains the block length in bytes followed by the data (one Data Hi byte and one Data Lo byte) for each requested register.

Reading an unassigned holding register returns a value of zero.

Device Address  
 Function Code = 03 (hex)  
 Byte Count  
 Data Hi (For each requested register, there is one Data Hi and one Data Lo.)  
 Data Lo  
 .  
 .  
 Data Hi  
 Data Lo

CRC Hi error check  
 CRC Lo error check

### Return Query Data

This query contains data to be returned (looped back) in the response. The response and query messages should be identical. If the query is a broadcast (device address = 0), no response message is returned.

Device Address  
 Function Code = 08 (hex)  
 Subfunction Hi = 00 (hex)  
 Subfunction Lo = 00 (hex)  
 Data Hi = xx (don't care)  
 Data Lo = xx (don't care)  
 CRC Hi error check  
 CRC Lo error check

### Restart Communications Option

This query causes the remote communications function of the DECS-450 to restart, terminating an active listen only mode of operation. No effect is made upon primary relay operations. Only the remote communications function is affected. If the query is a broadcast (device address = 0), no response message is returned.

If the DECS-450 receives this query while in the listen only mode, no response message is generated. Otherwise, a response message identical to the query message is transmitted prior to the communications restart.

Device Address  
 Function Code = 08 (hex)  
 Subfunction Hi = 00 (hex)  
 Subfunction Lo = 01 (hex)  
 Data Hi = xx (don't care)  
 Data Lo = xx (don't care)  
 CRC Hi error check  
 CRC Lo error check

### Listen Only Mode

This query forces the addressed DECS-450 to the listen only mode for Modbus communications, isolating it from other devices on the network. No responses are returned.

While in the listen only mode, the DECS-450 continues to monitor all queries. The DECS-450 does not respond to any other query until the listen only mode is removed. All write requests with a query to Preset Multiple Registers (Function Code = 16) are also ignored. When the DECS-450 receives the restart communications query, the listen only mode is removed.

Device Address  
 Function Code = 08 (hex)  
 Subfunction Hi = 00 (hex)  
 Subfunction Lo = 04 (hex)  
 Data Hi = xx (don't care)  
 Data Lo = xx (don't care)  
 CRC Hi error check  
 CRC Lo error check

### Preset Multiple Registers

A preset multiple registers query could address multiple registers in one slave or multiple slaves. If the query is a broadcast (device address = 0), no response message is returned.

Query

A Preset Multiple Register query message requests a register or block of registers to be written. The data block contains the starting address and the quantity of registers to be written, followed by the Data Block byte count and data. The DECS-450 will perform the write when the device address in query is a broadcast address or the same as the DECS-450 Modbus Unit ID (device address).

A register address of N will write Holding Register N+1.

Data will cease to be written if any of the following exceptions occur.

- Queries to write to Read Only registers result in an error response with Exception Code of “Illegal Data Address”.
- Queries attempting to write more than 100 registers cause an error response with Exception Code “Illegal Function”.
- An incorrect Byte Count will result in an error response with Exception Code of “Illegal Data Value”.
- There are several instances of registers that are grouped together to collectively represent a single numerical DECS-450 data value (i.e. - floating point data, 32-bit integer data, and strings). A query to write a subset of such a register group will result in an error response with Exception Code “Illegal Data Address”.
- A query to write a not allowed value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value”.

Device Address  
 Function Code =           10 (hex)  
 Starting Address Hi  
 Starting Address Lo  
 No. of Registers Hi  
 No. of Registers Lo  
 Byte Count  
 Data Hi  
 Data Lo  
 .  
 .  
 Data Hi  
 Data Lo  
 CRC Hi error check  
 CRC Lo error check

Response

The response message echoes the starting address and the number of registers. There is no response message when the query is a broadcast (device address = 0).

Device Address  
 Function Code =           10 (hex)  
 Starting Address Hi  
 Starting Address Lo  
 No. of Registers Hi  
 No. of Registers Lo  
 CRC Hi Error Check  
 CRC Lo Error Check

**Preset Single Register**

A Preset Single Register query message requests a single register to be written. If the query is a broadcast (device address = 0), no response message is returned.

Note: Only data types INT16, INT8, UINT16, UINT8, and String (not longer than 2 bytes), can be preset by this function.

### Query

Data will cease to be written if any of the following exceptions occur.

- Queries to write to Read Only registers result in an error response with Exception Code of “Illegal Data Address”.
- A query to write an unallowed value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value”.

Device Address  
 Function Code =       06 (hex)  
 Address Hi  
 Address Lo  
 Data Hi  
 Data Lo  
 CRC Hi error check  
 CRC Lo error check

### Response

The response message echoes the Query message after the register has been altered.

## **Data Formats**

DECS-450 systems support the following data types:

- Data types mapped to 2 registers
  - Unsigned Integer 32 (Uint32)
  - Floating Point (Float)
  - Strings maximum 4 characters long (String)
- Data types mapped to 1 register
  - Unsigned Integer 16 (Uint16)
  - Unsigned Integer 8 (Uint8)
  - Strings maximum 2 characters long (String)
- Data types mapped to more than 2 registers
  - Strings longer than 4 characters (String)

### **Floating Point Data Format (Float)**

The Modbus floating point data format uses two consecutive holding registers to represent a data value. The first register contains the low-order 16 bits of the following 32-bit format:

- MSB is the sign bit for the floating-point value (0 = positive).
- The next 8 bits are the exponent biased by 127 decimal.
- The 23 LSBs comprise the normalized mantissa. The most-significant bit of the mantissa is always assumed to be 1 and is not explicitly stored, yielding an effective precision of 24 bits.

The value of the floating-point number is obtained by multiplying the binary mantissa times two raised to the power of the unbiased exponent. The assumed bit of the binary mantissa has the value of 1.0, with the remaining 23 bits providing a fractional value. Table 26-4 shows the floating-point format.

**Table 26-4. Floating Point Format**

| <b>Sign</b> | <b>Exponent + 127</b> | <b>Mantissa</b> |
|-------------|-----------------------|-----------------|
| 1 Bit       | 8 Bits                | 23 Bits         |

The floating-point format allows for values ranging from approximately  $8.43 \times 10^{-37}$  to  $3.38 \times 10^{38}$ . A floating-point value of all zeroes is the value zero. A floating-point value of all ones (not a number) signifies a value currently not applicable or disabled.

Example: The value 95,800 represented in floating-point format is hexadecimal 47BB1C00. This number will read from two consecutive holding registers as follows:

| Holding Register | Value  |
|------------------|--------|
| K (Hi Byte)      | hex 1C |
| K (Lo Byte)      | hex 00 |
| K+1(Hi Byte)     | hex 47 |
| K+1(Lo Byte)     | hex BB |

The same byte alignments are required to write.

### Long Integer Data Format (Uint32)

The Modbus long integer data format uses two consecutive holding registers to represent a 32-bit data value. The first register contains the low-order 16 bits and the second register contains the high-order 16 bits.

Example: The value 95,800 represented in long integer format is hexadecimal 0x00017638. This number will read from two consecutive holding registers as follows:

| Holding Register | Value  |
|------------------|--------|
| K (Hi Byte)      | hex 76 |
| K (Lo Byte)      | hex 38 |
| K+1(Hi Byte)     | hex 00 |
| K+1(Lo Byte)     | hex 01 |

The same byte alignments are required to write.

### Integer Data Format (Uint16) or Bit-Mapped Variables in Uint16 Format

The Modbus integer data format uses a single holding register to represent a 16-bit data value.

Example: The value 4660 represented in integer format is hexadecimal 0x1234. This number will read from a holding register as follows:

| Holding Register | Value  |
|------------------|--------|
| K (Hi Byte)      | hex 12 |
| K (Lo Byte)      | hex 34 |

The same byte alignments are required to write.

The Uint16 Data Format is listed in *Binary Points* (Table 26-7), below.

Example: Register 900 occupies 16 rows in the Register Table where each row gives the name of specific bit-mapped data such as 900-0 indicates bit 0 of register 900 is mapped to RF-TRIG.

### Short Integer Data Format/Byte Character Data Format (Uint8)

The Modbus short integer data format uses a single holding register to represent an 8-bit data value. The holding register high byte will always be zero.

Example: The value 132 represented in short integer format is hexadecimal 0x84. This number will read from a holding register as follows:

| Holding Register | Value  |
|------------------|--------|
| K (Hi Byte)      | hex 00 |
| K (Lo Byte)      | hex 84 |

The same byte alignments are required to write.

### String Data Format (String)

The Modbus string data format uses one or more holding registers to represent a sequence, or string, of character values. If the string contains a single character, the holding register high byte will contain the ASCII character code and the low byte will be zero.

Example: The string “PASSWORD” represented in string format will read as follows:

| Holding Register | Value |
|------------------|-------|
| K (Hi Byte)      | 'P'   |
| K (Lo Byte)      | 'A'   |
| K+1(Hi Byte)     | 'S'   |
| K+1(Lo Byte)     | 'S'   |
| K+2(Hi Byte)     | 'W'   |
| K+2(Lo Byte)     | 'O'   |
| K+3(Hi Byte)     | 'R'   |
| K+3(Lo Byte)     | 'D'   |

Example: If the above string is changed to “P”, the new string will read as follows:

| Holding Register | Value  |
|------------------|--------|
| K (Hi Byte)      | 'P'    |
| K (Lo Byte)      | hex 00 |
| K+1(Hi Byte)     | hex 00 |
| K+1(Lo Byte)     | hex 00 |
| K+2(Hi Byte)     | hex 00 |
| K+2(Lo Byte)     | hex 00 |
| K+3(Hi Byte)     | hex 00 |
| K+3(Lo Byte)     | hex 00 |

The same byte alignments are required to write.

### **CRC Error Check**

This field contains a two-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The DECS-450 system recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. If no transmission error has occurred, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

The CRC calculation is performed using all bytes of the device address, function code, and data block fields. A 16-bit CRC-register is initialized to all 1's. Then each eight-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted eight times. The CRC-register MSB is zero-filled with each shift. After each shift, the CRC-register LSB is examined. If the LSB is a 1, the CRC-register is exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the error check field.

### **Secure DECS-450 Login via Modbus**

To login to the DECS-450 via Modbus, write the string *username|password* to the Secure Login register (40500). Substitute “username” with the user name of the desired access level, include the pipe “|” symbol, and substitute “password” with the password of the chosen access level. To view the current access level, read the Current Access register (45420). Write any value to the Logout register (45417) to log out of the DECS-450. Upon disconnecting from Modbus over TCP/IP, the user is automatically logged out of the DECS-450. However, upon disconnecting from Modbus over serial line, the user remains logged in.

## Modbus Parameters

### General

General parameters are listed in Table 26-5.

**Table 26-5. General Group Parameters**

| Group            | Name                     | Register | Type   | Bytes | R/W | Range                |
|------------------|--------------------------|----------|--------|-------|-----|----------------------|
| System Data      | Model Number             | 45000    | String | 64    | R   | 0–64                 |
| System Data      | App Version Information  | 45032    | String | 64    | R   | 0–64                 |
| System Data      | App Sub-version Version  | 45064    | String | 64    | R   | 0–64                 |
| System Data      | Boot Version Information | 45096    | String | 64    | R   | 0–64                 |
| System Data      | Firmware Part Number     | 45128    | String | 64    | R   | 0–64                 |
| Time             | Date                     | 45160    | String | 16    | R   | 0–16                 |
| Time             | Time                     | 45168    | String | 16    | R   | 0–16                 |
| Unit Information | Style Number             | 45176    | String | 32    | R   | 0–32                 |
| Unit Information | Serial Number            | 45192    | String | 32    | R   | 0–32                 |
| DECS Control     | Control Output Var PF    | 45208    | Float  | 4     | R   | n/a                  |
| DECS Control     | Control Output OEL       | 45210    | Float  | 4     | R   | n/a                  |
| DECS Control     | Control Output UEL       | 45212    | Float  | 4     | R   | n/a                  |
| DECS Control     | Control Output SCL       | 45214    | Float  | 4     | R   | n/a                  |
| DECS Control     | Control Output AVR       | 45216    | Float  | 4     | R   | n/a                  |
| DECS Control     | Control Output FCR       | 45218    | Float  | 4     | R   | n/a                  |
| DECS Control     | Control Output FVR       | 45220    | Float  | 4     | R   | n/a                  |
| DECS Control     | Invert Output (SCT/PPT)  | 45222    | Uint32 | 4     | RW  | Disabled=0 Enabled=1 |

### Security

**Table 26-6. Security Group Parameters**

| Group    | Name           | Register | Type   | Bytes | R/W | Increment | Range   |
|----------|----------------|----------|--------|-------|-----|-----------|---|
| Security | Secure Login   | 45400    | String | 34    | RW  | 1         | 0–34  |
| Security | Logout         | 45417    | String | 5     | RW  | 1         | 0–5   |
| Security | Current Access | 45420    | Uint32 | 4     | R   | n/a       | No Access=0,<br>Read Access=1<br>Control Access=2<br>Operator Access=3<br>Setting Access=4<br>Design Access=5<br>Administrator Access=6 |
| Security | Save Changes   | 45422    | Uint32 | 4     | RW  | n/a       | n/a   |

### Binary Points

**Table 26-7. Binary Point Group Parameters**

| Group       | Name                         | Register     | Type   | Bytes | R/W | Range          |
|-------------|------------------------------|--------------|--------|-------|-----|----------------|
| System Data | RF trig                      | 45800 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| System Data | PU logic                     | 45800 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| System Data | Trip logic                   | 45800 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| System Data | Logic trig                   | 45800 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| System Data | Breaker Status               | 45800 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms      | Real Time Clock Alarm        | 45800 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms      | Date Time Set Alarm          | 45800 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms      | Firmware Change Alarm        | 45800 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms      | Frequency out of range alarm | 45800 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Reserved    |                              | 45800 bit 9  |        |       |     |                |
| Alarms      | USB com alarm                | 45800 bit 10 | Uint16 | 2     | R   | True=1 False=0 |

| Group          | Name                            | Register     | Type   | Bytes | R/W | Range          |
|----------------|---------------------------------|--------------|--------|-------|-----|----------------|
| Alarms         | IRIG sync lost alarm            | 45800 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Logic equal none alarm          | 45800 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | No user setting alarm           | 45800 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | NTP sync lost alarm             | 45800 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Microprocessor Reset Alarm      | 45800 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 1            | 45801 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 2            | 45801 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 3            | 45801 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 4            | 45801 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 5            | 45801 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 6            | 45801 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 7            | 45801 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 8            | 45801 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 9            | 45801 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 10           | 45801 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 11           | 45801 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 12           | 45801 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 13           | 45801 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 14           | 45801 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 15           | 45801 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Programmable Alarm 16           | 45801 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Underfrequency V/Hz Alarm       | 45802 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | OEL alarm                       | 45802 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | UEL alarm                       | 45802 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Failed to build up alarm        | 45802 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | SCL alarm                       | 45802 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | PSS voltage unbalanced alarm    | 45802 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | PSS current unbalanced alarm    | 45802 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | PSS power below threshold alarm | 45802 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | PSS speed failed alarm          | 45802 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | PSS voltage limit alarm         | 45802 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Transfer watchdog alarm         | 45802 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Crowbar activated               | 45802 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Var limiter active alarm        | 45802 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Voltage Matching active         | 45802 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Invalid logic alarm             | 45802 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Alarms         | Control Power Input Failure     | 45802 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Alarm Report   | Alarm Output                    | 45803 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Start Input                     | 45803 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Stop Input                      | 45803 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 1                         | 45803 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 2                         | 45803 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 3                         | 45803 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 4                         | 45803 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 5                         | 45803 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 6                         | 45803 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 7                         | 45803 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 8                         | 45803 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 9                         | 45803 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 10                        | 45803 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs | Input 11                        | 45803 bit 13 | Uint16 | 2     | R   | True=1 False=0 |

| Group           | Name                               | Register     | Type   | Bytes | R/W | Range          |
|-----------------|------------------------------------|--------------|--------|-------|-----|----------------|
| Contact Inputs  | Input 12                           | 45803 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs  | Input 13                           | 45803 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Inputs  | Input 14                           | 45804 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Watchdog Output                    | 45804 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 1                           | 45804 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 2                           | 45804 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 3                           | 45804 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 4                           | 45804 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 5                           | 45804 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 6                           | 45804 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 7                           | 45804 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 8                           | 45804 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 9                           | 45804 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 10                          | 45804 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Outputs | Output 11                          | 45804 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Hardware Ports  | Field Short Circuit Status         | 45804 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Virtual Switch  | Virtual Switch 1                   | 45804 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Virtual Switch  | Virtual Switch 2                   | 45804 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Virtual Switch  | Virtual Switch 3                   | 45805 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Virtual Switch  | Virtual Switch 4                   | 45805 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Virtual Switch  | Virtual Switch 5                   | 45805 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Virtual Switch  | Virtual Switch 6                   | 45805 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Manual FCR only                    | 45805 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Droop disable                      | 45805 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Cross-current compensation disable | 45805 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Line drop disable                  | 45805 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Parallel enable LM                 | 45805 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Auto transfer enable               | 45805 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Soft start select group 2          | 45805 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | PSS select group 2                 | 45805 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | OEL select group 2                 | 45805 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | UEL select group 2                 | 45805 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | SCL select group 2                 | 45805 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Protection select group 2          | 45805 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | PID select group 2                 | 45806 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Var PF selection                   | 45806 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | DECS start stop (external)         | 45806 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | DECS manual auto                   | 45806 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Null balance                       | 45806 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | DECS pre-position                  | 45806 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Var limiter select group 2         | 45806 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Pre-position 1 active              | 45806 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Pre-position 2 active              | 45806 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Pre-position 3 active              | 45806 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Var active                         | 45806 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | PF active                          | 45806 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | FVR active                         | 45806 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | FCR active                         | 45806 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Manual active                      | 45806 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control    | Auto active                        | 45806 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| DECS PSS Meter  | PSS active                         | 45807 bit 0  | Uint16 | 2     | R   | True=1 False=0 |

| Group                     | Name                                       | Register     | Type   | Bytes | R/W | Range          |
|---------------------------|--|--------------|--------|-------|-----|----------------|
| DECS Regulator Meter      | Setpoint at lower limit                    | 45807 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Regulator Meter      | Setpoint at upper limit                    | 45807 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Field Overvoltage         | Block                                      | 45807 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Field Overvoltage         | Pickup                                     | 45807 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Field Overvoltage         | Trip                                       | 45807 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Field Overcurrent         | Block                                      | 45807 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Field Overcurrent         | Pickup                                     | 45807 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Field Overcurrent         | Trip                                       | 45807 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Exciter Diode Monitor     | Block open diode                           | 45807 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Exciter Diode Monitor     | Pickup open diode                          | 45807 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Exciter Diode Monitor     | Trip open diode                            | 45807 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Exciter Diode Monitor     | Block shorted diode                        | 45807 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Exciter Diode Monitor     | Pickup shorted diode                       | 45807 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Exciter Diode Monitor     | Trip shorted diode                         | 45807 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Loss of Sensing           | Block                                      | 45808 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Loss of Sensing           | Pickup                                     | 45808 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Loss of Sensing           | Trip                                       | 45808 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| 25                        | Block                                      | 45808 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| 25                        | Status                                     | 45808 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| 25                        | VM1 status                                 | 45808 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| 27P                       | Block                                      | 45808 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| 27P                       | Pickup                                     | 45808 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| 27P                       | Trip                                       | 45808 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| 59P                       | Block                                      | 45808 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| 59P                       | Pickup                                     | 45808 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| 59P                       | Trip                                       | 45808 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| 81O                       | Block                                      | 45808 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| 81O                       | Pickup                                     | 45808 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| 81O                       | Trip                                       | 45808 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| 81U-1                     | Block                                      | 45808 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| 81U-1                     | Pickup                                     | 45809 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| 81U-1                     | Trip                                       | 45809 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Gen Below 10 Hz           | Block                                      | 45809 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Gen Below 10 Hz           | Pickup                                     | 45809 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Gen Below 10 Hz           | Trip                                       | 45809 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| 40Q                       | Block                                      | 45809 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| 40Q                       | Pickup                                     | 45809 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| 40Q                       | Trip                                       | 45809 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| 32R                       | Block                                      | 45809 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| 32R                       | Pickup                                     | 45809 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| 32R                       | Trip                                       | 45809 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 1 Pickup | 45809 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 1 Trip   | 45809 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 2 Pickup | 45809 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 2 Trip   | 45809 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 3 Pickup | 45809 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 3 Trip   | 45810 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 4 Pickup | 45810 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 1 | Configurable Protection Threshold 4 Trip   | 45810 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 2 | Configurable Protection Threshold 1 Pickup | 45810 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 2 | Configurable Protection Threshold 1 Trip   | 45810 bit 4  | Uint16 | 2     | R   | True=1 False=0 |



| Group                     | Name                                       | Register     | Type   | Bytes | R/W | Range          |
|---------------------------|--|--------------|--------|-------|-----|----------------|
| Configurable Protection 8 | Configurable Protection Threshold 3 Trip   | 45813 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 8 | Configurable Protection Threshold 4 Pickup | 45813 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Configurable Protection 8 | Configurable Protection Threshold 4 Trip   | 45813 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Communication Failure                  | 45813 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | Duplicate AEM                              | 45813 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 1 Out of Range                   | 45813 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 2 Out of Range                   | 45813 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 3 Out of Range                   | 45813 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 4 Out of Range                   | 45814 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 5 Out of Range                   | 45814 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 6 Out of Range                   | 45814 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 7 Out of Range                   | 45814 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Input 8 Out of Range                   | 45814 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 1 Out of Range                   | 45814 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 2 Out of Range                   | 45814 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 3 Out of Range                   | 45814 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 4 Out of Range                   | 45814 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 5 Out of Range                   | 45814 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 6 Out of Range                   | 45814 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 7 Out of Range                   | 45814 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | RTD Input 8 Out of Range                   | 45814 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Output 1 Out of Range                  | 45814 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Output 2 Out of Range                  | 45814 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Output 3 Out of Range                  | 45814 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Configuration         | AEM Output 4 Out of Range                  | 45815 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 1 Pickup                         | 45815 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 1 Trip                           | 45815 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 2 Pickup                         | 45815 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 2 Trip                           | 45815 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 3 Pickup                         | 45815 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 3 Trip                           | 45815 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 4 Pickup                         | 45815 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 1          | Threshold 4 Trip                           | 45815 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 1 Pickup                         | 45815 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 1 Trip                           | 45815 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 2 Pickup                         | 45815 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 2 Trip                           | 45815 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 3 Pickup                         | 45815 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 3 Trip                           | 45815 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 4 Pickup                         | 45815 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 2          | Threshold 4 Trip                           | 45816 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 1 Pickup                         | 45816 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 1 Trip                           | 45816 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 2 Pickup                         | 45816 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 2 Trip                           | 45816 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 3 Pickup                         | 45816 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 3 Trip                           | 45816 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 4 Pickup                         | 45816 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 3          | Threshold 4 Trip                           | 45816 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 4          | Threshold 1 Pickup                         | 45816 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 4          | Threshold 1 Trip                           | 45816 bit 10 | Uint16 | 2     | R   | True=1 False=0 |

| Group            | Name               | Register     | Type   | Bytes | R/W | Range          |
|------------------|--------------------|--------------|--------|-------|-----|----------------|
| AEM Protection 4 | Threshold 2 Pickup | 45816 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 4 | Threshold 2 Trip   | 45816 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 4 | Threshold 3 Pickup | 45816 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 4 | Threshold 3 Trip   | 45816 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 4 | Threshold 4 Pickup | 45816 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 4 | Threshold 4 Trip   | 45817 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 1 Pickup | 45817 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 1 Trip   | 45817 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 2 Pickup | 45817 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 2 Trip   | 45817 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 3 Pickup | 45817 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 3 Trip   | 45817 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 4 Pickup | 45817 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 5 | Threshold 4 Trip   | 45817 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 1 Pickup | 45817 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 1 Trip   | 45817 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 2 Pickup | 45817 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 2 Trip   | 45817 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 3 Pickup | 45817 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 3 Trip   | 45817 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 4 Pickup | 45817 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 6 | Threshold 4 Trip   | 45818 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 1 Pickup | 45818 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 1 Trip   | 45818 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 2 Pickup | 45818 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 2 Trip   | 45818 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 3 Pickup | 45818 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 3 Trip   | 45818 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 4 Pickup | 45818 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 7 | Threshold 4 Trip   | 45818 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 1 Pickup | 45818 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 1 Trip   | 45818 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 2 Pickup | 45818 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 2 Trip   | 45818 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 3 Pickup | 45818 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 3 Trip   | 45818 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 4 Pickup | 45818 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| AEM Protection 8 | Threshold 4 Trip   | 45819 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 1 Pickup | 45819 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 1 Trip   | 45819 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 2 Pickup | 45819 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 2 Trip   | 45819 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 3 Pickup | 45819 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 3 Trip   | 45819 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 4 Pickup | 45819 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 1 | Threshold 4 Trip   | 45819 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 2 | Threshold 1 Pickup | 45819 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 2 | Threshold 1 Trip   | 45819 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 2 | Threshold 2 Pickup | 45819 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 2 | Threshold 2 Trip   | 45819 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 2 | Threshold 3 Pickup | 45819 bit 13 | Uint16 | 2     | R   | True=1 False=0 |

| Group            | Name               | Register     | Type   | Bytes | R/W | Range          |
|------------------|--------------------|--------------|--------|-------|-----|----------------|
| RTD Protection 2 | Threshold 3 Trip   | 45819 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 2 | Threshold 4 Pickup | 45819 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 2 | Threshold 4 Trip   | 45820 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 1 Pickup | 45820 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 1 Trip   | 45820 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 2 Pickup | 45820 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 2 Trip   | 45820 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 3 Pickup | 45820 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 3 Trip   | 45820 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 4 Pickup | 45820 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 3 | Threshold 4 Trip   | 45820 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 1 Pickup | 45820 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 1 Trip   | 45820 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 2 Pickup | 45820 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 2 Trip   | 45820 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 3 Pickup | 45820 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 3 Trip   | 45820 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 4 Pickup | 45820 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 4 | Threshold 4 Trip   | 45821 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 1 Pickup | 45821 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 1 Trip   | 45821 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 2 Pickup | 45821 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 2 Trip   | 45821 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 3 Pickup | 45821 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 3 Trip   | 45821 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 4 Pickup | 45821 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 5 | Threshold 4 Trip   | 45821 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 1 Pickup | 45821 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 1 Trip   | 45821 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 2 Pickup | 45821 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 2 Trip   | 45821 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 3 Pickup | 45821 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 3 Trip   | 45821 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 4 Pickup | 45821 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 6 | Threshold 4 Trip   | 45822 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 1 Pickup | 45822 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 1 Trip   | 45822 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 2 Pickup | 45822 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 2 Trip   | 45822 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 3 Pickup | 45822 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 3 Trip   | 45822 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 4 Pickup | 45822 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 7 | Threshold 4 Trip   | 45822 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 1 Pickup | 45822 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 1 Trip   | 45822 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 2 Pickup | 45822 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 2 Trip   | 45822 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 3 Pickup | 45822 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 3 Trip   | 45822 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 4 Pickup | 45822 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| RTD Protection 8 | Threshold 4 Trip   | 45823 bit 0  | Uint16 | 2     | R   | True=1 False=0 |

| Group                     | Name                         | Register     | Type   | Bytes | R/W | Range          |
|---------------------------|------------------------------|--------------|--------|-------|-----|----------------|
| Thermocouple Protection 1 | Threshold 1 Pickup           | 45823 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 1 | Threshold 1 Trip             | 45823 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 1 | Threshold 2 Pickup           | 45823 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 1 | Threshold 2 Trip             | 45823 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 1 | Threshold 3 Pickup           | 45823 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 1 | Threshold 3 Trip             | 45823 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 1 | Threshold 4 Pickup           | 45823 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 1 | Threshold 4 Trip             | 45823 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 1 Pickup           | 45823 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 1 Trip             | 45823 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 2 Pickup           | 45823 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 2 Trip             | 45823 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 3 Pickup           | 45823 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 3 Trip             | 45823 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 4 Pickup           | 45823 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Thermocouple Protection 2 | Threshold 4 Trip             | 45824 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 1                      | 45824 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 2                      | 45824 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 3                      | 45824 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 4                      | 45824 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 5                      | 45824 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 6                      | 45824 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 7                      | 45824 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 8                      | 45824 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 9                      | 45824 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Input 10                     | 45824 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 1                     | 45824 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 2                     | 45824 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 3                     | 45824 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 4                     | 45824 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 5                     | 45824 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 6                     | 45825 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 7                     | 45825 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 8                     | 45825 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 9                     | 45825 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 10                    | 45825 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 11                    | 45825 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 12                    | 45825 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 13                    | 45825 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 14                    | 45825 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 15                    | 45825 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 16                    | 45825 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 17                    | 45825 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 18                    | 45825 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 19                    | 45825 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 20                    | 45825 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 21                    | 45825 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 22                    | 45826 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 23                    | 45826 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Contact Expansion Module  | Output 24                    | 45826 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Synchronizer              | Synchronization failed alarm | 45826 bit 3  | Uint16 | 2     | R   | True=1 False=0 |

| Group              | Name                                      | Register     | Type   | Bytes | R/W | Range          |
|--------------------|---|--------------|--------|-------|-----|----------------|
| Network Load Share | Network load share disable                | 45826 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Unknown load share protocol version       | 45826 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | RCC active                                | 45826 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 1                            | 45826 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 2                            | 45826 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 3                            | 45826 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 4                            | 45826 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 5                            | 45826 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 6                            | 45826 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 7                            | 45826 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 8                            | 45826 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 9                            | 45826 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 10                           | 45827 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 11                           | 45827 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 12                           | 45827 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 13                           | 45827 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 14                           | 45827 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 15                           | 45827 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Receiving ID 16                           | 45827 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Network load share configuration mismatch | 45827 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | Network load share ID missing             | 45827 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 1 enabled                              | 45827 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 2 enabled                              | 45827 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 3 enabled                              | 45827 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 4 enabled                              | 45827 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 5 enabled                              | 45827 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 6 enabled                              | 45827 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 7 enabled                              | 45827 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 8 enabled                              | 45828 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 9 enabled                              | 45828 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 10 enabled                             | 45828 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 11 enabled                             | 45828 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 12 enabled                             | 45828 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 13 enabled                             | 45828 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 14 enabled                             | 45828 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 15 enabled                             | 45828 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | ID 16 enabled                             | 45828 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | NLS status 1                              | 45828 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | NLS status 2                              | 45828 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | NLS status 3                              | 45828 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Network Load Share | NLS status 4                              | 45828 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| 24                 | Block                                     | 45828 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| 24                 | Pickup                                    | 45828 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| 24                 | Trip                                      | 45828 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| 24                 | 24 alarm                                  | 45829 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control       | Transient boost active                    | 45829 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| DECS Control       | KW threshold status                       | 45829 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| More Alarms        | Bridge overtemperature warning            | 45829 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| More Alarms        | Bridge overtemperature alarm              | 45829 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| More Alarms        | Pole slip alarm                           | 45829 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| More Alarms        | Security shutdown alarm                   | 45829 bit 6  | Uint16 | 2     | R   | True=1 False=0 |

| Group                              | Name                         | Register     | Type   | Bytes | R/W | Range          |
|------------------------------------|------------------------------|--------------|--------|-------|-----|----------------|
| More Alarms                        | PSS blocked                  | 45829 bit 7  | Uint16 | 2     | R   | True=1 False=0 |
| Grid Code Parameters               | APC bridge active            | 45829 bit 8  | Uint16 | 2     | R   | True=1 False=0 |
| Grid Code Parameters               | LVRT bride active            | 45829 bit 9  | Uint16 | 2     | R   | True=1 False=0 |
| Field Overtemperature              | Block                        | 45829 bit 10 | Uint16 | 2     | R   | True=1 False=0 |
| Field Overtemperature              | Pickup                       | 45829 bit 11 | Uint16 | 2     | R   | True=1 False=0 |
| Field Overtemperature              | Trip                         | 45829 bit 12 | Uint16 | 2     | R   | True=1 False=0 |
| Loss of Field Isolation Transducer | Block                        | 45829 bit 13 | Uint16 | 2     | R   | True=1 False=0 |
| Loss of Field Isolation Transducer | Pickup                       | 45829 bit 14 | Uint16 | 2     | R   | True=1 False=0 |
| Loss of Field Isolation Transducer | Trip                         | 45829 bit 15 | Uint16 | 2     | R   | True=1 False=0 |
| 81U-2                              | Block                        | 45830 bit 0  | Uint16 | 2     | R   | True=1 False=0 |
| 81U-2                              | Pickup                       | 45830 bit 1  | Uint16 | 2     | R   | True=1 False=0 |
| 81U-2                              | Trip                         | 45830 bit 2  | Uint16 | 2     | R   | True=1 False=0 |
| Analog Output                      | Analog output 1 out of range | 45830 bit 3  | Uint16 | 2     | R   | True=1 False=0 |
| Analog Output                      | Analog output 2 out of range | 45830 bit 4  | Uint16 | 2     | R   | True=1 False=0 |
| Analog Output                      | Analog output 3 out of range | 45830 bit 5  | Uint16 | 2     | R   | True=1 False=0 |
| Analog Output                      | Analog output 4 out of range | 45830 bit 6  | Uint16 | 2     | R   | True=1 False=0 |
| Analog Output                      | Control output out of range  | 45830 bit 7  | Uint16 | 2     | R   | True=1 False=0 |

## Metering

Table 26-8. Metering Group Parameters

| Group          | Name                         | Register | Type  | Bytes | R/W | Unit     | Increment | Range  |
|----------------|------------------------------|----------|-------|-------|-----|----------|-----------|--------|
| Per Unit Meter | Gen Vab pu                   | 45900    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Vbc pu                   | 45902    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Vca pu                   | 45904    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Vavg pu                  | 45906    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Ia pu                    | 45908    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Ib pu                    | 45910    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Ic pu                    | 45912    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Iavg pu                  | 45914    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Kw pu                    | 45916    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Kva pu                   | 45918    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Gen Kvar pu                  | 45920    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Positive sequence voltage pu | 45922    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Negative sequence voltage pu | 45924    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Positive sequence current pu | 45926    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Negative sequence current pu | 45928    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Bus Vab pu                   | 45930    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Bus Vbc pu                   | 45932    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Bus Vca pu                   | 45934    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Bus vavg pu                  | 45936    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Voltage difference pu        | 45938    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Reserved       |                              | 45940    | Float | 4     | R   | Per Unit | 0.001     | n/a    |
| Per Unit Meter | Gen frequency pu             | 45942    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Bus frequency pu             | 45944    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Field current pu             | 45946    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Field voltage pu             | 45948    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Slip frequency pu            | 45950    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | Icc pu                       | 45952    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |
| Per Unit Meter | AVR setpoint pu              | 45954    | Float | 4     | R   | Per Unit | 0.001     | -10-10 |

| Group                               | Name                                 | Register | Type   | Bytes | R/W | Unit     | Increment | Range        |
|-------------------------------------|--------------------------------------|----------|--------|-------|-----|----------|-----------|--------------|
| Per Unit Meter                      | FCR setpoint pu                      | 45956    | Float  | 4     | R   | Per Unit | 0.001     | -10-10       |
| Per Unit Meter                      | FVR setpoint pu                      | 45958    | Float  | 4     | R   | Per Unit | 0.001     | -10-10       |
| Per Unit Meter                      | Var setpoint pu                      | 45960    | Float  | 4     | R   | Per Unit | 0.001     | -10-10       |
| Field Voltage Meter                 | V <sub>x</sub>                       | 45962    | Float  | 4     | R   | Volt     | 0.001     | -1000-1000   |
| Field Current Meter                 | I <sub>x</sub>                       | 45964    | Float  | 4     | R   | Amp      | 0.01      | 0-2000000000 |
| DECS PSS Meter                      | Terminal Frequency Deviation         | 45966    | Float  | 4     | R   | Percent  | n/a       | n/a          |
| DECS PSS Meter                      | Compensated Frequency Deviation      | 45968    | Float  | 4     | R   | Percent  | n/a       | n/a          |
| DECS PSS Meter                      | PSS output                           | 45970    | Float  | 4     | R   | n/a      | n/a       | n/a          |
| DECS Regulator Meter                | Tracking error                       | 45972    | Float  | 4     | R   | Percent  | n/a       | n/a          |
| DECS Regulator Meter                | Control output PU                    | 45974    | Float  | 4     | R   | Per Unit | 0.001     | -10-10       |
| DECS Regulator Meter                | Exciter Diode Monitor Ripple Percent | 45976    | Float  | 4     | R   | Percent  | n/a       | n/a          |
| DECS Regulator Meter                | Control output                       | 45978    | Float  | 4     | R   | Percent  | n/a       | n/a          |
| DECS Regulator Meter                | NLS error percent                    | 45980    | Float  | 4     | R   | Percent  | n/a       | n/a          |
| DECS Regulator Meter                | LL magnitude pu                      | 45982    | Float  | 4     | R   | Per Unit | 0.001     | -10-10       |
| DECS Regulator Meter                | NLS LL magnitude avg pu              | 45984    | Float  | 4     | R   | Per Unit | 0.001     | -10-10       |
| DECS Regulator Meter                | NLS number generators online         | 45986    | Int 32 | 4     | R   | n/a      | n/a       | n/a          |
| Generator Voltage Meter Magnitude 1 | V <sub>AB</sub>                      | 45988    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Magnitude 1 | V <sub>BC</sub>                      | 45990    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Magnitude 1 | V <sub>CA</sub>                      | 45992    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Magnitude 1 | V <sub>AVG LL</sub>                  | 45994    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Primary 1   | V <sub>AB</sub>                      | 45996    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Primary 1   | V <sub>BC</sub>                      | 45998    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Primary 1   | V <sub>CA</sub>                      | 46000    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Primary 1   | V <sub>AVG LL</sub>                  | 46002    | Float  | 4     | R   | Volt     | 0.01      | 0-2000000000 |
| Generator Voltage Meter Angle 1     | V <sub>AB</sub>                      | 46004    | Float  | 4     | R   | Degree   | 0.1       | 0-360        |
| Generator Voltage Meter Angle 1     | V <sub>BC</sub>                      | 46006    | Float  | 4     | R   | Degree   | 0.1       | 0-360        |
| Generator Voltage Meter Angle 1     | V <sub>CA</sub>                      | 46008    | Float  | 4     | R   | Degree   | 0.1       | 0-360        |
| Generator Voltage Meter Angle 1     | V <sub>AB</sub>                      | 46010    | String | 24    | R   | n/a      | n/a       | 0-24         |
| Generator Voltage Meter Angle 1     | V <sub>BC</sub>                      | 46022    | String | 24    | R   | n/a      | n/a       | 0-24         |
| Generator Voltage Meter Angle 1     | V <sub>CA</sub>                      | 46034    | String | 24    | R   | n/a      | n/a       | 0-24         |
| Gen Voltage Meter Primary Angle 1   | V <sub>AB</sub>                      | 46046    | String | 24    | R   | n/a      | n/a       | 0-24         |
| Gen Voltage Meter Primary Angle 1   | V <sub>BC</sub>                      | 46058    | String | 24    | R   | n/a      | n/a       | 0-24         |
| Gen Voltage Meter Primary Angle 1   | V <sub>CA</sub>                      | 46070    | String | 24    | R   | n/a      | n/a       | 0-24         |

| Group                                     | Name                | Register | Type   | Bytes | R/W | Unit   | Increment | Range        |
|---|---------------------|----------|--------|-------|-----|--------|-----------|--------------|
| Bus Voltage Meter Magnitude 1             | V <sub>AB</sub>     | 46082    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Magnitude 1             | V <sub>BC</sub>     | 46084    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Magnitude 1             | V <sub>CA</sub>     | 46086    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Magnitude 1             | V <sub>AVG LL</sub> | 46088    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Primary 1               | V <sub>AB</sub>     | 46090    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Primary 1               | V <sub>BC</sub>     | 46092    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Primary 1               | V <sub>CA</sub>     | 46094    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Primary 1               | V <sub>AVG LL</sub> | 46096    | Float  | 4     | R   | Volt   | 0.01      | 0–2000000000 |
| Bus Voltage Meter Angle 1                 | V <sub>AB</sub>     | 46098    | Float  | 4     | R   | Degree | 0.1       | 0–360        |
| Bus Voltage Meter Angle 1                 | V <sub>BC</sub>     | 46100    | Float  | 4     | R   | Degree | 0.1       | 0–360        |
| Bus Voltage Meter Angle 1                 | V <sub>CA</sub>     | 46102    | Float  | 4     | R   | Degree | 0.1       | 0–360        |
| Bus Voltage Meter Angle 1                 | V <sub>AB</sub>     | 46104    | String | 24    | R   | n/a    | n/a       | 0–24         |
| Bus Voltage Meter Magnitude Angle 1       | V <sub>BC</sub>     | 46116    | String | 24    | R   | n/a    | n/a       | 0–24         |
| Bus Voltage Meter Magnitude Angle 1       | V <sub>CA</sub>     | 46128    | String | 24    | R   | n/a    | n/a       | 0–24         |
| Bus Voltage Meter Primary Angle 1         | V <sub>AB</sub>     | 46140    | String | 24    | R   | n/a    | n/a       | 0–24         |
| Bus Voltage Meter Primary Angle 1         | V <sub>BC</sub>     | 46152    | String | 24    | R   | n/a    | n/a       | 0–24         |
| Bus Voltage Meter Primary Angle 1         | V <sub>CA</sub>     | 46164    | String | 24    | R   | n/a    | n/a       | 0–24         |
| Generator Current Meter Magnitude 1       | I <sub>A</sub>      | 46176    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Magnitude 1       | I <sub>B</sub>      | 46178    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Magnitude 1       | I <sub>C</sub>      | 46180    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Magnitude 1       | I <sub>AVG</sub>    | 46182    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Primary 1         | I <sub>A</sub>      | 46184    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Primary 1         | I <sub>B</sub>      | 46186    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Primary 1         | I <sub>C</sub>      | 46188    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Primary 1         | I <sub>AVG</sub>    | 46190    | Float  | 4     | R   | Amp    | 0.01      | 0–2000000000 |
| Generator Current Meter Angle 1           | I <sub>A</sub>      | 46192    | Float  | 4     | R   | Degree | 0.1       | 0–360        |
| Generator Current Meter Angle 1           | I <sub>B</sub>      | 46194    | Float  | 4     | R   | Degree | 0.1       | 0–360        |
| Generator Current Meter Angle 1           | I <sub>C</sub>      | 46196    | Float  | 4     | R   | Degree | 0.1       | 0–360        |
| Generator Current Meter Magnitude Angle 1 | I <sub>A</sub>      | 46198    | String | 24    | R   | n/a    | n/a       | 0–24         |
| Generator Current Meter Magnitude Angle 1 | I <sub>B</sub>      | 46210    | String | 24    | R   | n/a    | n/a       | 0–24         |

| Group                                     | Name                    | Register | Type   | Bytes | R/W | Unit     | Increment | Range              |
|---|-------------------------|----------|--------|-------|-----|----------|-----------|--------------------|
| Generator Current Meter Magnitude Angle 1 | I <sub>c</sub>          | 46222    | String | 24    | R   | n/a      | n/a       | 0–24               |
| Generator Current Meter Primary Angle 1   | I <sub>a</sub>          | 46234    | String | 24    | R   | n/a      | n/a       | 0–24               |
| Generator Current Meter Primary Angle 1   | I <sub>b</sub>          | 46246    | String | 24    | R   | n/a      | n/a       | 0–24               |
| Generator Current Meter Primary Angle 1   | I <sub>c</sub>          | 46258    | String | 24    | R   | n/a      | n/a       | 0–24               |
| Icc Current Meter Magnitude 1             | I <sub>x</sub>          | 46270    | Float  | 4     | R   | Amp      | 0.01      | 0–2000000000       |
| Icc Current Meter Primary 1               | I <sub>x</sub>          | 46272    | Float  | 4     | R   | Amp      | 0.01      | 0–2000000000       |
| Power Meter                               | Total watts secondary   | 46274    | Float  | 4     | R   | Watt     | 0.01      | n/a                |
| Power Meter                               | Total watts primary     | 46276    | Float  | 4     | R   | Watt     | 0.01      | n/a                |
| Power Meter                               | Total vars secondary    | 46278    | Float  | 4     | R   | Var      | 0.01      | n/a                |
| Power Meter                               | Total vars primary      | 46280    | Float  | 4     | R   | Var      | 0.01      | n/a                |
| Power Meter                               | Total S secondary       | 46282    | Float  | 4     | R   | VA       | 0.01      | n/a                |
| Power Meter                               | Total S primary         | 46284    | Float  | 4     | R   | VA       | 0.01      | n/a                |
| Power Meter                               | Total PF secondary      | 46286    | Float  | 4     | R   | PF       | 0.01      | -1–1               |
| Power Meter                               | Total PF primary        | 46288    | Float  | 4     | R   | PF       | 0.01      | -1–1               |
| Power Meter                               | Positive watthour total | 46290    | Float  | 4     | R   | Watthour | 1         | 0.00E+00–1.00E+12  |
| Power Meter                               | Positive varhour total  | 46292    | Float  | 4     | R   | Varhour  | 1         | 0.00E+00–1.00E+12  |
| Power Meter                               | Negative watthour total | 46294    | Float  | 4     | R   | Watthour | 1         | -1.00E+12–0.00E+00 |
| Power Meter                               | Negative varhour total  | 46296    | Float  | 4     | R   | Varhour  | 1         | -1.00E+12–0.00E+00 |
| Power Meter                               | VA hour total           | 46298    | Float  | 4     | R   | VA hour  | 1         | 0.00E+00–1.00E+12  |
| Power Meter                               | Scaled PF               | 46300    | Float  | 4     | R   | PF       | 0.01      | -1–1               |
| Energy Meter                              | Positive watthour total | 46302    | Float  | 4     | RW  | Watthour | 1         | 0.00E+00–1.00E+12  |
| Energy Meter                              | Positive varhour total  | 46304    | Float  | 4     | RW  | Varhour  | 1         | 0.00E+00–1.00E+12  |
| Energy Meter                              | Negative watthour total | 46306    | Float  | 4     | RW  | Watthour | 1         | -1.00E+12–0.00E+00 |
| Energy Meter                              | Negative varhour total  | 46308    | Float  | 4     | RW  | Varhour  | 1         | -1.00E+12–0.00E+00 |
| Energy Meter                              | VA hour total           | 46310    | Float  | 4     | RW  | Varhour  | 1         | 0.00E+00–1.00E+12  |
| Sync Meter 1                              | Slip Angle              | 46312    | Float  | 4     | R   | Degree   | 0.1       | -359.9–359.9       |
| Sync Meter 1                              | Slip Frequency          | 46314    | Float  | 4     | R   | Hertz    | n/a       | n/a                |
| Sync Meter 1                              | Voltage Difference      | 46316    | Float  | 4     | R   | Volt     | n/a       | n/a                |
| Generator Frequency Meter 1               | Frequency               | 46318    | Float  | 4     | R   | Hertz    | 0.001     | 10–180             |
| Bus Frequency Meter 1                     | Frequency               | 46320    | Float  | 4     | R   | Hertz    | 0.001     | 10–180             |
| Auxiliary Input Voltage 1                 | Value                   | 46322    | Float  | 4     | R   | Volt     | 0.01      | -9999999–9999999   |
| Auxiliary Input Current 1                 | Value                   | 46324    | Float  | 4     | R   | Amp      | 0.01      | -9999999–9999999   |
| Configurable Protection 1                 | Math result             | 46326    | Float  | 4     | R   | n/a      | n/a       | n/a                |
| Configurable Protection 2                 | Math result             | 46328    | Float  | 4     | R   | n/a      | n/a       | n/a                |

| Group                     | Name                           | Register | Type  | Bytes | R/W | Unit      | Increment | Range          |
|---------------------------|--------------------------------|----------|-------|-------|-----|-----------|-----------|----------------|
| Configurable Protection 3 | Math result                    | 46330    | Float | 4     | R   | n/a       | n/a       | n/a            |
| Configurable Protection 4 | Math result                    | 46332    | Float | 4     | R   | n/a       | n/a       | n/a            |
| Configurable Protection 5 | Math result                    | 46334    | Float | 4     | R   | n/a       | n/a       | n/a            |
| Configurable Protection 6 | Math result                    | 46336    | Float | 4     | R   | n/a       | n/a       | n/a            |
| Configurable Protection 7 | Math result                    | 46338    | Float | 4     | R   | n/a       | n/a       | n/a            |
| Configurable Protection 8 | Math result                    | 46340    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 1 raw value       | 46342    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 2 raw value       | 46344    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 3 raw value       | 46346    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 4 raw value       | 46348    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 5 raw value       | 46350    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 6 raw value       | 46352    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 7 raw value       | 46354    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 8 raw value       | 46356    | Float | 4     | R   | MilliAmp  | n/a       | n/a            |
| AEM Metering              | Analog input 1 scaled value    | 46358    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 2 scaled value    | 46360    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 3 scaled value    | 46362    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 4 scaled value    | 46364    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 5 scaled value    | 46366    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 6 scaled value    | 46368    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 7 scaled value    | 46370    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | Analog input 8 scaled value    | 46372    | Float | 4     | R   | n/a       | n/a       | n/a            |
| AEM Metering              | RTD Input 1 Raw Value          | 46374    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 2 Raw Value          | 46376    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 3 Raw Value          | 46378    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 4 Raw Value          | 46380    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 5 Raw Value          | 46382    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 6 Raw Value          | 46384    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 7 Raw Value          | 46386    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 8 Raw Value          | 46388    | Float | 4     | R   | Ohm       | n/a       | n/a            |
| AEM Metering              | RTD Input 1 Scaled Value       | 46390    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | RTD Input 2 Scaled Value       | 46392    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | RTD Input 3 Scaled Value       | 46394    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | RTD Input 4 Scaled Value       | 46396    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | RTD Input 5 Scaled Value       | 46398    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | RTD Input 6 Scaled Value       | 46400    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | RTD Input 7 Scaled Value       | 46402    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | RTD Input 8 Scaled Value       | 46404    | Float | 4     | R   | Deg F     | 1         | -40000–9999999 |
| AEM Metering              | Thermocouple Input 1 raw value | 46406    | Float | 4     | R   | Millivolt | n/a       | n/a            |
| AEM Metering              | Thermocouple Input 2 raw value | 46408    | Float | 4     | R   | Millivolt | n/a       | n/a            |
| AEM Metering              | Analog output 1 raw value      | 46410    | Float | 4     | R   | n/a       | n/a       | n/a            |

| Group                    | Name                               | Register    | Type  | Bytes | R/W | Unit      | Increment | Range            |
|--------------------------|------------------------------------|-------------|-------|-------|-----|-----------|-----------|------------------|
| AEM Metering             | Analog output 2 raw value          | 46412       | Float | 4     | R   | n/a       | n/a       | n/a              |
| AEM Metering             | Analog output 3 raw value          | 46414       | Float | 4     | R   | n/a       | n/a       | n/a              |
| AEM Metering             | Analog output 4 raw value          | 46416       | Float | 4     | R   | n/a       | n/a       | n/a              |
| AEM Metering             | Analog output 1 scaled value       | 46418       | Float | 4     | R   | n/a       | n/a       | n/a              |
| AEM Metering             | Analog output 2 scaled value       | 46420       | Float | 4     | R   | n/a       | n/a       | n/a              |
| AEM Metering             | Analog output 3 scaled value       | 46422       | Float | 4     | R   | n/a       | n/a       | n/a              |
| AEM Metering             | Analog output 4 scaled value       | 46424       | Float | 4     | R   | n/a       | n/a       | n/a              |
| AEM Metering             | Thermocouple Input 1 scaled value  | 46426       | Float | 4     | R   | Deg F     | n/a       | n/a              |
| AEM Metering             | Thermocouple Input 2 scaled value  | 46428       | Float | 4     | R   | Deg F     | n/a       | n/a              |
| AEM Metering             | RTD Input 1 Metric Value           | 46430       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | RTD Input 2 Metric Value           | 46432       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | RTD Input 3 Metric Value           | 46434       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | RTD Input 4 Metric Value           | 46436       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | RTD Input 5 Metric Value           | 46438       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | RTD Input 6 Metric Value           | 46440       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | RTD Input 7 Metric Value           | 46442       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | RTD Input 8 Metric Value           | 46444       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | Thermocouple Input 1 Metric Value  | 46446       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| AEM Metering             | Thermocouple Input 2 Metric Value  | 46448       | Float | 4     | R   | Deg C     | n/a       | n/a              |
| Reserved                 |                                    | 46450-46528 |       |       |     |           |           |                  |
| Independent Meter        | PSS frequency rate of change       | 46530       | Float | 4     | R   | Hz/second | 0.01      | -15-15           |
| Independent Meter        | PSS frequency rate of change pu    | 46532       | Float | 4     | R   | PU/second | 0.01      | -1.5-1.5         |
| Independent Meter        | Field temperature                  | 46534       | Float | 4     | R   | Deg F     | 0.01      | -40-572          |
| Independent Meter        | Inner Loop Reference               | 46536       | Float | 4     | R   | Per Unit  | 0.001     | -10-10           |
| Independent Meter        | Inner Loop Field Voltage Feedback  | 46538       | Float | 4     | R   | Per Unit  | 0.001     | -10-10           |
| Independent Meter        | Inner Loop Error                   | 46540       | Float | 4     | R   | Per Unit  | 0.001     | -10-10           |
| Independent Meter        | Inner Loop PID Output              | 46542       | Float | 4     | R   | Per Unit  | 0.001     | -10-10           |
| Independent Meter        | Inner Loop Output                  | 46544       | Float | 4     | R   | Per Unit  | 0.001     | -10-10           |
| Independent Meter        | Scaled Auxiliary Input Meter Value | 46546       | Float | 4     | R   | n/a       | 0.001     | -2000000-2000000 |
| Analog Output 1 Metering | Raw                                | 46548       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Analog Output 1 Metering | Scaled                             | 46550       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Analog Output 2 Metering | Raw                                | 46552       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Analog Output 2 Metering | Scaled                             | 46554       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Analog Output 3 Metering | Raw                                | 46556       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Analog Output 3 Metering | Scaled                             | 46558       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Analog Output 4 Metering | Raw                                | 46560       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Analog Output 4 Metering | Scaled                             | 46562       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Control Output Metering  | Raw                                | 46564       | Float | 4     | R   | n/a       | n/a       | n/a              |
| Control Output Metering  | Scaled                             | 46566       | Float | 4     | R   | n/a       | n/a       | n/a              |

## Limiters

Table 26-9. Limiter Group Parameters

| Name                                   | Register | Type   | Bytes | R/W | Unit               | Increment | Range   |
|--|----------|--------|-------|-----|--------------------|-----------|---|
| OEL Primary Current Hi                 | 46600    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Current Mid                | 46602    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Current Lo                 | 46604    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Time Hi                    | 46606    | Float  | 4     | R W | Second             | 1         | 0–240   |
| OEL Primary Time Mid                   | 46608    | Float  | 4     | R W | Second             | 1         | 0–240   |
| OEL Primary Current Hi Off             | 46610    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Current Lo Off             | 46612    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Current Time Off           | 46614    | Float  | 4     | R W | Second             | 1         | 0–240   |
| OEL Primary Takeover Current Max Off   | 46616    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Takeover Current Min Off   | 46618    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Takeover Time Dial Off     | 46620    | Float  | 4     | R W | n/a                | 0.1       | 0.1–20  |
| OEL Primary Takeover Current Max On    | 46622    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Takeover Current Min On    | 46624    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Primary Takeover Time Dial On      | 46626    | Float  | 4     | R W | n/a                | 0.1       | 0.1–20  |
| OEL Primary Dvdt Enable                | 46628    | Uint32 | 4     | R W | n/a                | n/a       | Disabled=0 Enabled=1  |
| OEL Primary Dvdt Ref                   | 46630    | Float  | 4     | R W | n/a                | 0.1       | -10–0   |
| OEL Secondary Current Hi               | 46632    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Current Mid              | 46634    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Current Lo               | 46636    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Time Hi                  | 46638    | Float  | 4     | R W | Second             | 1         | 0–240   |
| OEL Secondary Time Mid                 | 46640    | Float  | 4     | R W | Second             | 1         | 0–240   |
| OEL Secondary Current Hi Off           | 46642    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Current Lo Off           | 46644    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Current Time Off         | 46646    | Float  | 4     | R W | Second             | 1         | 0–240   |
| OEL Secondary Takeover Current Max Off | 46648    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Takeover Current Min Off | 46650    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Takeover Time Dial Off   | 46652    | Float  | 4     | R W | n/a                | 0.1       | 0.1–20  |
| OEL Secondary Takeover Current Max On  | 46654    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Takeover Current Min On  | 46656    | Float  | 4     | R W | Amp                | 0.01      | 0–12000   |
| OEL Secondary Takeover Time Dial On    | 46658    | Float  | 4     | R W | n/a                | 0.1       | 0.1–20  |
| OEL Scale Enable                       | 46660    | Uint32 | 4     | R W | n/a                | n/a       | Disabled=0<br>Auxiliary Input=1<br>AEM RTD 1=2<br>AEM RTD 2=3<br>AEM RTD 3=4<br>AEM RTD 4=5<br>AEM RTD 5=6<br>AEM RTD 6=7<br>AEM RTD 7=8<br>AEM RTD 8=9 |
| OEL Scale Takeover Signal 1            | 46662    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10–10  |
| OEL Scale Takeover Signal 2            | 46664    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10–10  |
| OEL Scale Takeover Signal 3            | 46666    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10–10  |
| OEL Scale Takeover Scale 1             | 46668    | Float  | 4     | R W | Percent            | 0.1       | 0–200   |
| OEL Scale Takeover Scale 2             | 46670    | Float  | 4     | R W | Percent            | 0.1       | 0–200   |
| OEL Scale Takeover Scale 3             | 46672    | Float  | 4     | R W | Percent            | 0.1       | 0–200   |
| OEL Scale Summing Signal 1             | 46674    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10–10  |

| Name                                   | Register | Type   | Bytes | R/W | Unit               | Increment | Range   |
|--|----------|--------|-------|-----|--------------------|-----------|---|
| OEL Scale Summing Signal 2             | 46676    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10-10  |
| OEL Scale Summing Signal 3             | 46678    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10-10  |
| OEL Scale Summing Scale 1              | 46680    | Float  | 4     | R W | Percent            | 0.1       | 0-200   |
| OEL Scale Summing Scale 2              | 46682    | Float  | 4     | R W | Percent            | 0.1       | 0-200   |
| OEL Scale Summing Scale 3              | 46684    | Float  | 4     | R W | Percent            | 0.1       | 0-200   |
| UEL Primary Curve X1                   | 46686    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Primary Curve X2                   | 46688    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Primary Curve X3                   | 46690    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Primary Curve X4                   | 46692    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Primary Curve X5                   | 46694    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Primary Curve Y1                   | 46696    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Primary Curve Y2                   | 46698    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Primary Curve Y3                   | 46700    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Primary Curve Y4                   | 46702    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Primary Curve Y5                   | 46704    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Primary Power Filter TC            | 46706    | Float  | 4     | R W | Second             | 0.1       | 0-20  |
| UEL Primary Voltage Dependent Exponent | 46708    | Float  | 4     | R W | n/a                | 1         | 0-2   |
| UEL Secondary Curve X1                 | 46710    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Secondary Curve X2                 | 46712    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Secondary Curve X3                 | 46714    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Secondary Curve X4                 | 46716    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Secondary Curve X5                 | 46718    | Float  | 4     | R W | kilowatt           | 1         | 0-62  |
| UEL Secondary Curve Y1                 | 46720    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Secondary Curve Y2                 | 46722    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Secondary Curve Y3                 | 46724    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Secondary Curve Y4                 | 46726    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| UEL Secondary Curve Y5                 | 46728    | Float  | 4     | R W | kilovar            | 1         | 0-62  |
| SCL Primary Reference Hi               | 46730    | Float  | 4     | R W | Amp                | 0.1       | 0-66000   |
| SCL Primary Reference Lo               | 46732    | Float  | 4     | R W | Amp                | 0.1       | 0-66000   |
| SCL Primary Time Hi                    | 46734    | Float  | 4     | R W | Second             | 0.1       | 0-240   |
| SCL Primary No Response Time           | 46736    | Float  | 4     | R W | Second             | 0.1       | 0-10  |
| SCL Secondary Reference Hi             | 46738    | Float  | 4     | R W | Amp                | 0.1       | 0-66000   |
| SCL Secondary Reference Lo             | 46740    | Float  | 4     | R W | Amp                | 0.1       | 0-66000   |
| SCL Secondary Time Hi                  | 46742    | Float  | 4     | R W | Second             | 0.1       | 0-240   |
| SCL Secondary No Response Time         | 46744    | Float  | 4     | R W | Second             | 0.1       | 0-10  |
| SCL Scale Enable                       | 46746    | Uint32 | 4     | R W | n/a                | n/a       | Disabled=0<br>Auxiliary Input=1<br>AEM RTD 1=2<br>AEM RTD 2=3<br>AEM RTD 3=4<br>AEM RTD 4=5<br>AEM RTD 5=6<br>AEM RTD 6=7<br>AEM RTD 7=8<br>AEM RTD 8=9 |
| SCL Scale Signal 1                     | 46748    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10-10  |
| SCL Scale Signal 2                     | 46750    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10-10  |
| SCL Scale Signal 3                     | 46752    | Float  | 4     | R W | Limiter Scale Volt | 0.01      | -10-10  |

| Name  | Register | Type   | Bytes | R/W | Unit    | Increment | Range   |
|---|----------|--------|-------|-----|---------|-----------|---|
| SCL Scale Point 1                                 | 46754    | Float  | 4     | R W | Percent | 0.1       | 0–200   |
| SCL Scale Point 2                                 | 46756    | Float  | 4     | R W | Percent | 0.1       | 0–200   |
| SCL Scale Point 3                                 | 46758    | Float  | 4     | R W | Percent | 0.1       | 0–200   |
| Var Limit Enable                                  | 46760    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0 Enabled=1                          |
| Var Limit Primary Delay                           | 46762    | Float  | 4     | R W | Second  | 0.1       | 0–300   |
| Var Limit Primary Setpoint                        | 46764    | Float  | 4     | R W | Percent | 0.1       | 0–200   |
| Var Limit Secondary Delay                         | 46766    | Float  | 4     | R W | Second  | 0.1       | 0–300   |
| Var Limit Secondary Setpoint                      | 46768    | Float  | 4     | R W | Percent | 0.1       | 0–200   |
| Var Limit Enable Status                           | 46770    | Uint32 | 4     | R   | n/a     | n/a       | Off=0 On=1                                    |
| OEL Primary Takeover Reset Time Coefficient Off   | 46772    | Float  | 4     | R W | n/a     | 0.01      | 0.01–100                                      |
| OEL Primary Takeover Reset Time Coefficient On    | 46774    | Float  | 4     | R W | n/a     | 0.01      | 0.01–100                                      |
| OEL Secondary Takeover Reset Time Coefficient Off | 46776    | Float  | 4     | R W | n/a     | 0.01      | 0.01–100                                      |
| OEL Secondary Takeover Reset Time Coefficient On  | 46778    | Float  | 4     | R W | n/a     | 0.01      | 0.01–100                                      |
| OEL Primary Takeover Reset Type Off               | 46780    | Uint32 | 4     | R W | n/a     | n/a       | Inverse=0<br>Integrating=1<br>Instantaneous=2 |
| OEL Primary Takeover Reset Type On                | 46782    | Uint32 | 4     | R W | n/a     | n/a       | Inverse=0<br>Integrating=1<br>Instantaneous=2 |
| OEL Secondary Takeover Reset Type Off             | 46784    | Uint32 | 4     | R W | n/a     | n/a       | Inverse=0<br>Integrating=1<br>Instantaneous=2 |
| OEL Secondary Takeover Reset Type On              | 46786    | Uint32 | 4     | R W | n/a     | n/a       | Inverse=0<br>Integrating=1<br>Instantaneous=2 |

## Setpoints

Table 26-10. Setpoint Group Parameters

| Name                                      | Register | Type   | Bytes | R/W | Unit    | Increment | Range  |
|---|----------|--------|-------|-----|---------|-----------|--|
| Excitation Current Setpoint               | 46900    | Float  | 4     | R W | Amp     | 0.01      | 0–12   |
| Excitation Current Traverse Rate          | 46902    | Float  | 4     | R W | Second  | 1         | 10–200   |
| Excitation Current Pre-position Mode 1    | 46904    | Uint32 | 4     | R W | n/a     | n/a       | Maintain=0 Release=1   |
| Excitation Current Pre-position 1         | 46906    | Float  | 4     | R W | Amp     | 0.01      | 0–12   |
| Excitation Current Pre-position Mode 2    | 46908    | Uint32 | 4     | R W | n/a     | n/a       | Maintain=0 Release=1   |
| Excitation Current Pre-position 2         | 46910    | Float  | 4     | R W | Amp     | 0.01      | 0–12   |
| Excitation Current Minimum Setpoint Limit | 46912    | Float  | 4     | R W | Percent | 0.1       | 0–120  |
| Excitation Current Maximum Setpoint Limit | 46914    | Float  | 4     | R W | Percent | 0.1       | 0–120  |
| Generator Voltage Setpoint                | 46916    | Float  | 4     | R W | Volt    | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator Voltage Traverse Rate           | 46918    | Float  | 4     | R W | Second  | 1         | 10–200   |
| Generator Voltage Pre-position Mode 1     | 46920    | Uint32 | 4     | R W | n/a     | n/a       | Maintain=0 Release=1   |
| Generator Voltage Pre-position 1          | 46922    | Float  | 4     | R W | Volt    | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator Voltage Pre-position Mode 2     | 46924    | Uint32 | 4     | R W | n/a     | n/a       | Maintain=0 Release=1   |
| Generator Voltage Pre-position 2          | 46926    | Float  | 4     | R W | Volt    | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |

| Name                                      | Register | Type   | Bytes | R/W | Unit         | Increment | Range  |
|---|----------|--------|-------|-----|--------------|-----------|--|
| Generator Voltage Minimum Setpoint Limit  | 46928    | Float  | 4     | R W | Percent      | 0.1       | 70–120   |
| Generator Voltage Maximum Setpoint Limit  | 46930    | Float  | 4     | R W | Percent      | 0.1       | 70–120   |
| Generator var Setpoint                    | 46932    | Float  | 4     | R W | kilovar      | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator var Traverse Rate               | 46934    | Float  | 4     | R W | Second       | 1         | 10–200   |
| Generator var Pre-position Mode 1         | 46936    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Generator var Pre-position 1              | 46938    | Float  | 4     | R W | kilovar      | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator var Pre-position Mode 2         | 46940    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Generator var Pre-position 2              | 46942    | Float  | 4     | R W | kilovar      | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator var Minimum Setpoint Limit      | 46944    | Float  | 4     | R W | Percent      | 0.1       | -100–100   |
| Generator var Maximum Setpoint Limit      | 46946    | Float  | 4     | R W | Percent      | 0.1       | -100–100   |
| Generator PF Setpoint                     | 46948    | Float  | 4     | R W | Power Factor | 0.01      | -2–2   |
| Generator PF Traverse Rate                | 46950    | Float  | 4     | R W | Second       | 1         | 10–200   |
| Generator PF Pre-position Mode 1          | 46952    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Generator PF Pre-position 1               | 46954    | Float  | 4     | R W | Power Factor | 0.001     | -2–2   |
| Generator PF Pre-position Mode 2          | 46956    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Generator PF Pre-position 2               | 46958    | Float  | 4     | R W | Power Factor | 0.001     | -2–2   |
| Generator PF Minimum Setpoint Limit       | 46960    | Float  | 4     | R W | Power Factor | 0.01      | 0.5–1  |
| Generator PF Maximum Setpoint Limit       | 46962    | Float  | 4     | R W | Power Factor | 0.01      | -1–(-0.5)  |
| Excitation Voltage Setpoint               | 46964    | Float  | 4     | R W | Volt         | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Excitation Voltage Traverse Rate          | 46966    | Float  | 4     | R W | Second       | 1         | 10–200   |
| Excitation Voltage Pre-position Mode 1    | 46968    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Excitation Voltage Pre-position 1         | 46970    | Float  | 4     | R W | Volt         | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Excitation Voltage Pre-position Mode 2    | 46972    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Excitation Voltage Pre-position 2         | 46974    | Float  | 4     | R W | Volt         | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Excitation Voltage Minimum Setpoint Limit | 46976    | Float  | 4     | R W | Percent      | 0.1       | 0–150  |
| Excitation Voltage Maximum Setpoint Limit | 46978    | Float  | 4     | R W | Percent      | 0.1       | 0–150  |
| Sc Set Option                             | 46980    | Int32  | 4     | R W | n/a          | n/a       | Disabled=0 Enabled=1   |
| Sc Set Voltage Level                      | 46982    | Float  | 4     | R W | Percent      | 0.1       | 0–100  |
| Sc Set Current Level                      | 46984    | Float  | 4     | R W | Percent      | 0.1       | 0–400  |
| Sc Set Present Time                       | 46986    | Float  | 4     | R W | Second       | 0.001     | 0–1  |
| Sc Set Ref Change                         | 46988    | Float  | 4     | R W | Percent      | 0.1       | 0–100  |
| Sc Set Resp Change Level                  | 46990    | Float  | 4     | R W | Percent      | 0.1       | 0–50   |
| Sc Set Clear Time                         | 46992    | Float  | 4     | R W | Second       | 0.001     | 0–1  |
| Droop Value                               | 46994    | Float  | 4     | R W | Percent      | 0.1       | 0–30   |
| L-Drop Value                              | 46996    | Float  | 4     | R W | Percent      | 0.1       | 0–30   |
| Auxiliary Limit Enable                    | 46998    | Int32  | 4     | R W | n/a          | n/a       | Disabled=0 Enabled=1   |

| Name  | Register | Type   | Bytes | R/W | Unit         | Increment | Range  |
|---|----------|--------|-------|-----|--------------|-----------|--|
| Excitation Current Regulation Pre-position Mode 3 | 47000    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Excitation Current Regulation Pre-position 3      | 47002    | Float  | 4     | R W | Amp          | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator Voltage Pre-position Mode 3             | 47004    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Generator Voltage Pre-position 3                  | 47006    | Float  | 4     | R W | Volt         | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator var Pre-position Mode 3                 | 47008    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Generator var Pre-position 3                      | 47010    | Float  | 4     | R W | kilovar      | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Generator PF Pre-position Mode 3                  | 47012    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Generator PF Pre-position 3                       | 47014    | Float  | 4     | R W | Power Factor | 0.001     | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Excitation Voltage Pre-position Mode 3            | 47016    | Uint32 | 4     | R W | n/a          | n/a       | Maintain=0 Release=1   |
| Excitation Voltage Pre-position 3                 | 47018    | Float  | 4     | R W | Volt         | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Active Excitation Current Regulation Setpoint     | 47020    | Float  | 4     | R W | Amp          | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Active Generator Voltage Setpoint                 | 47022    | Float  | 4     | R W | Volt         | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Active Generator var Setpoint                     | 47024    | Float  | 4     | R W | kilovar      | 0.1       | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Active Generator PF Setpoint                      | 47026    | Float  | 4     | R W | Power Factor | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Active Excitation Voltage Setpoint                | 47028    | Float  | 4     | R W | Volt         | 0.01      | The range depends on the rated value of the machine and the minimum and maximum setpoint limits. |
| Excitation Current Pre-Position Traverse 1        | 47030    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Excitation Current Pre-Position Traverse 2        | 47032    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Excitation Current Pre-Position Traverse 3        | 47034    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator Voltage Pre-Position Traverse 1         | 47036    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator Voltage Pre-Position Traverse 2         | 47038    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator Voltage Pre-Position Traverse 3         | 47040    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator var Pre-Position Traverse 1             | 47042    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator var Pre-Position Traverse 2             | 47044    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator var Pre-Position Traverse 3             | 47046    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator PF Pre-Position Traverse 1              | 47048    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator PF Pre-Position Traverse 2              | 47050    | Float  | 4     | R W | Second       | 1         | 0-720  |
| Generator PF Pre-Position Traverse 3              | 47052    | Float  | 4     | R W | Second       | 1         | 0-720  |

| Name                                       | Register | Type  | Bytes | R/W | Unit   | Increment | Range |
|--|----------|-------|-------|-----|--------|-----------|-------|
| Excitation Voltage Pre-Position Traverse 1 | 47054    | Float | 4     | R W | Second | 1         | 0–720 |
| Excitation Voltage Pre-Position Traverse 2 | 47056    | Float | 4     | R W | Second | 1         | 0–720 |
| Excitation Voltage Pre-Position Traverse 3 | 47058    | Float | 4     | R W | Second | 1         | 0–720 |

## Global Settings

Table 26-11. Global Settings Group Parameters

| Group                      | Name                    | Register | Type   | Bytes | R/W | Unit       | Increment | Range                  |
|----------------------------|-------------------------|----------|--------|-------|-----|------------|-----------|------------------------|
| System Configuration       | Operating Mode          | 47200    | Int32  | 4     | R W | n/a        | n/a       | Generator=0<br>Motor=1 |
| Gen Current Configuration  | Rotation                | 47202    | UInt32 | 4     | R W | n/a        | n/a       | Forward=0<br>Reverse=1 |
| PLC Timed Element Settings | Timer 1 Timeout Hours   | 47204    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 1 Timeout Minutes | 47206    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 1 Timeout Seconds | 47208    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |
| PLC Timed Element Settings | Timer 2 Timeout Hours   | 47210    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 2 Timeout Minutes | 47212    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 2 Timeout Seconds | 47214    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |
| PLC Timed Element Settings | Timer 3 Timeout Hours   | 47216    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 3 Timeout Minutes | 47218    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 3 Timeout Seconds | 47220    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |
| PLC Timed Element Settings | Timer 4 Timeout Hours   | 47222    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 4 Timeout Minutes | 47224    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 4 Timeout Seconds | 47226    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |
| PLC Timed Element Settings | Timer 5 Timeout Hours   | 47228    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 5 Timeout Minutes | 47230    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 5 Timeout Seconds | 47232    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |
| PLC Timed Element Settings | Timer 6 Timeout Hours   | 47234    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 6 Timeout Minutes | 47236    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 6 Timeout Seconds | 47238    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |
| PLC Timed Element Settings | Timer 7 Timeout Hours   | 47240    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 7 Timeout Minutes | 47242    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 7 Timeout Seconds | 47244    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |
| PLC Timed Element Settings | Timer 8 Timeout Hours   | 47246    | UInt32 | 4     | R W | Hour       | 1         | 0–250                  |
| PLC Timed Element Settings | Timer 8 Timeout Minutes | 47248    | UInt32 | 4     | R W | Minute     | 1         | 0–59                   |
| PLC Timed Element Settings | Timer 8 Timeout Seconds | 47250    | UInt32 | 4     | R W | Decisecond | 1         | 0–599                  |

| Group                      | Name                     | Register | Type   | Bytes | R/W | Unit       | Increment | Range  |
|----------------------------|--------------------------|----------|--------|-------|-----|------------|-----------|--------|
| PLC Timed Element Settings | Timer 9 Timeout Hours    | 47252    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 9 Timeout Minutes  | 47254    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 9 Timeout Seconds  | 47256    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Timer 10 Timeout Hours   | 47258    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 10 Timeout Minutes | 47260    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 10 Timeout Seconds | 47262    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Timer 11 Timeout Hours   | 47264    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 11 Timeout Minutes | 47266    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 11 Timeout Seconds | 47268    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Timer 12 Timeout Hours   | 47270    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 12 Timeout Minutes | 47272    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 12 Timeout Seconds | 47274    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Timer 13 Timeout Hours   | 47276    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 13 Timeout Minutes | 47278    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 13 Timeout Seconds | 47280    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Timer 14 Timeout Hours   | 47282    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 14 Timeout Minutes | 47284    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 14 Timeout Seconds | 47286    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Timer 15 Timeout Hours   | 47288    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 15 Timeout Minutes | 47290    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 15 Timeout Seconds | 47292    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Timer 16 Timeout Hours   | 47294    | Uint32 | 4     | R W | Hour       | 1         | 0-250  |
| PLC Timed Element Settings | Timer 16 Timeout Minutes | 47296    | Uint32 | 4     | R W | Minute     | 1         | 0-59   |
| PLC Timed Element Settings | Timer 16 Timeout Seconds | 47298    | Uint32 | 4     | R W | Decisecond | 1         | 0-599  |
| PLC Timed Element Settings | Counter 1 Output Timeout | 47300    | Float  | 4     | R W | n/a        | 1         | 0-1800 |
| PLC Timed Element Settings | Counter 2 Output Timeout | 47302    | Float  | 4     | R W | n/a        | 1         | 0-1800 |
| PLC Timed Element Settings | Counter 3 Output Timeout | 47304    | Float  | 4     | R W | n/a        | 1         | 0-1800 |
| PLC Timed Element Settings | Counter 4 Output Timeout | 47306    | Float  | 4     | R W | n/a        | 1         | 0-1800 |
| PLC Timed Element Settings | Counter 5 Output Timeout | 47308    | Float  | 4     | R W | n/a        | 1         | 0-1800 |
| PLC Timed Element Settings | Counter 6 Output Timeout | 47310    | Float  | 4     | R W | n/a        | 1         | 0-1800 |
| PLC Timed Element Settings | Counter 7 Output Timeout | 47312    | Float  | 4     | R W | n/a        | 1         | 0-1800 |

| Group                      | Name   | Register | Type   | Bytes | R/W | Unit    | Increment | Range                               |
|----------------------------|--|----------|--------|-------|-----|---------|-----------|-------------------------------------|
| PLC Timed Element Settings | Counter 8 Output Timeout                         | 47314    | Float  | 4     | R W | n/a     | 1         | 0–1800                              |
| DECS PSS                   | PSS Enable                                       | 47316    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0<br>Enabled=1             |
| DECS PSS                   | PSS Enable Status                                | 47318    | Uint32 | 4     | R   | n/a     | n/a       | Off=0 On=1                          |
| DECS PSS                   | PSS Rate of Change Enable                        | 47320    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0<br>Enabled=1             |
| DECS PSS                   | PSS Rate of Change Threshold                     | 47322    | Float  | 4     | R W | Hz/Sec  | 0.01      | 0–10                                |
| DECS PSS                   | PSS Rate of Change Time Delay                    | 47324    | Float  | 4     | R W | Second  | 0.01      | 0–20                                |
| DECS PSS                   | PSS Rate of Change Block Time                    | 47326    | Float  | 4     | R W | Second  | 0.01      | 0–20                                |
| DECS PSS                   | PSS Rate of Change Low Pass Filter Time Constant | 47328    | Float  | 4     | R W | Second  | 0.01      | 0–20                                |
| DECS PSS                   | PSS Rate of Change Washout Filter Time Constant  | 47330    | Float  | 4     | R W | Second  | 0.01      | 0–20                                |
| Synchronizer               | Sync Type  | 47332    | Uint32 | 4     | R W | n/a     | n/a       | Anticipatory=0<br>Phase Lock Loop=1 |
| Synchronizer               | Slip Frequency                                   | 47334    | Float  | 4     | R W | Hertz   | 0.05      | 0.1–0.5                             |
| Synchronizer               | Generator Frequency Greater Than Bus Frequency   | 47336    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0<br>Enabled=1             |
| Synchronizer               | Breaker Closing Angle                            | 47338    | Float  | 4     | R W | Degree  | 0.5       | 3–20                                |
| Synchronizer               | Sync Activation Delay                            | 47340    | Float  | 4     | R W | Second  | 0.1       | 0.1–0.8                             |
| Synchronizer               | Generator Voltage Greater Than Bus Voltage       | 47342    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0<br>Enabled=1             |
| Synchronizer               | Sync Fail Activation Delay                       | 47344    | Float  | 4     | R W | Second  | 0.1       | 0.1–600                             |
| Synchronizer               | Sync Speed Gain                                  | 47346    | Float  | 4     | R W | n/a     | 0.001     | 0.001–1000                          |
| Synchronizer               | Sync Voltage Gain                                | 47348    | Float  | 4     | R W | n/a     | 0.001     | 0.001–1000                          |
| Synchronizer               | Voltage Window                                   | 47350    | Float  | 4     | R W | Percent | 0.5       | 2–15                                |
| Synchronizer               | Sys Option Input Auto Sync Enabled               | 47352    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0<br>Enabled=1             |
| Synchronizer               | Max Slip Control Limit Hz                        | 47354    | Float  | 4     | R W | Hertz   | 0.01      | 0–2                                 |
| Synchronizer               | Min Slip Control Limit Hz                        | 47356    | Float  | 4     | R W | Hertz   | 0.01      | 0–2                                 |
| Synchronizer               | Angle Compensation                               | 47358    | Float  | 4     | R W | Degree  | 0.1       | 0–359.9                             |
| Network Load Share         | Load Share Enable                                | 47360    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0<br>Enabled=1             |
| Network Load Share         | Load Share Droop Percent                         | 47362    | Float  | 4     | R W | Percent | 0.1       | 0–30                                |
| Network Load Share         | Load Share Gain                                  | 47364    | Float  | 4     | R W | n/a     | 0.01      | 0–1000                              |
| Reserved                   |  | 47366    | Float  | 4     | R W | n/a     | 0.01      |                                     |
| Reserved                   |  | 47368    | Float  | 4     | R W | n/a     | 0.01      |                                     |
| Reserved                   |  | 47370    |        |       |     |         | 0.01      |                                     |
| Network Load Share         | Ki Gain  | 47372    | Float  | 4     | R W | n/a     | 0.01      | 0–1000                              |
| Network Load Share         | Max Vc   | 47374    | Float  | 4     | R W | No Unit | 0.01      | 0–1                                 |
| Network Load Share         | Disable Time Delay                               | 47376    | Float  | 4     | R W | Second  | 0.001     | 1–3600                              |

## Relay Settings

Table 26-12. Relay Settings Group Parameters

| Group                | Name                        | Register | Type   | Bytes | R/W | Unit | Increment | Range               |
|----------------------|-----------------------------|----------|--------|-------|-----|------|-----------|---------------------|
| System Configuration | Nominal Frequency           | 47400    | Uint32 | 4     | R W | n/a  | n/a       | 50 Hz=50 60 Hz=60   |
| System Configuration | DECS Auxiliary Summing Mode | 47402    | Uint32 | 4     | R W | n/a  | n/a       | Voltage=0 Var=1     |
| System Configuration | DECS Auxiliary Input Mode   | 47404    | Uint32 | 4     | R W | n/a  | n/a       | Voltage=0 Current=1 |

| Group                     | Name  | Register | Type   | Bytes | R/W | Unit    | Increment | Range   |
|---------------------------|---|----------|--------|-------|-----|---------|-----------|---|
| System Configuration      | DECS Auxiliary Input Function                   | 47406    | Uint32 | 4     | R W | n/a     | n/a       | DECS Input=0<br>PSS Test Input=1<br>Limiter Selection=2<br>No Control=4 |
| System Configuration      | DECS Auxiliary Voltage Gain                     | 47408    | Float  | 4     | R W | n/a     | 0.01      | -99-99  |
| System Configuration      | DECS Auto Track Time Delay                      | 47410    | Float  | 4     | R W | Second  | 0.1       | 0-8   |
| System Configuration      | DECS Auto Track Traverse Rate                   | 47412    | Float  | 4     | R W | Second  | 0.1       | 1-80  |
| System Configuration      | DECS Null Balance Level                         | 47414    | Float  | 4     | R W | Percent | 0.01      | 0-9999  |
| System Configuration      | DECS Auto Trans Time Delay                      | 47416    | Float  | 4     | R W | Second  | 0.1       | 0-8   |
| System Configuration      | DECS Auto Trans Traverse Rate                   | 47418    | Float  | 4     | R W | Second  | 0.1       | 1-80  |
| Gen Volt Configuration    | Ratio Primary                                   | 47420    | Float  | 4     | R W | n/a     | 1         | 1-500000  |
| Gen Volt Configuration    | Ratio Secondary                                 | 47422    | Float  | 4     | R W | n/a     | 1         | 1-600   |
| Gen Volt Configuration    | Rated Primary LL                                | 47424    | Float  | 4     | R W | Volt    | 1         | 1-500000  |
| Bus Volt Configuration    | Ratio Primary                                   | 47426    | Float  | 4     | R W | n/a     | 1         | 1-500000  |
| Bus Volt Configuration    | Ratio Secondary                                 | 47428    | Float  | 4     | R W | n/a     | 1         | 1-600   |
| Bus Volt Configuration    | Rated Primary LL                                | 47430    | Float  | 4     | R W | Volt    | 1         | 1-500000  |
| Gen Current Configuration | Ratio Primary                                   | 47432    | Float  | 4     | R W | n/a     | 1         | 1-99999   |
| Gen Current Configuration | Ratio Secondary                                 | 47434    | Int32  | 4     | R W | n/a     | n/a       | 1=1 5=5   |
| Gen Current Configuration | Rated Primary                                   | 47436    | Float  | 4     | R   | Amp     | 0.1       | 0-180000  |
| Modbus                    | Auto Save                                       | 47438    | Uint16 | 2     | R W | n/a     | n/a       | Off=0 On=1  |
| Virtual Switch            | Virtual Switch 1 State                          | 47439    | Uint32 | 4     | R W | n/a     | n/a       | Open=0 Closed=1   |
| Virtual Switch            | Virtual Switch 2 State                          | 47441    | Uint32 | 4     | R W | n/a     | n/a       | Open=0 Closed=1   |
| Virtual Switch            | Virtual Switch 3 State                          | 47443    | Uint32 | 4     | R W | n/a     | n/a       | Open=0 Closed=1   |
| Virtual Switch            | Virtual Switch 4 State                          | 47445    | Uint32 | 4     | R W | n/a     | n/a       | Open=0 Closed=1   |
| Virtual Switch            | Virtual Switch 5 State                          | 47447    | Uint32 | 4     | R W | n/a     | n/a       | Open=0 Closed=1   |
| Virtual Switch            | Virtual Switch 6 State                          | 47449    | Uint32 | 4     | R W | n/a     | n/a       | Open=0 Closed=1   |
| DECS Control              | Start Stop Request                              | 47451    | Uint32 | 4     | R W | n/a     | n/a       | Stop=0 =1 Start =2  |
| DECS Control              | System Option Underfrequency Hz                 | 47453    | Float  | 4     | R W | Hertz   | 0.1       | 15-90   |
| DECS Control              | System Input COM Port Manual Enabled            | 47455    | Uint32 | 4     | R W | n/a     | n/a       | Manual=1 Automatic=2  |
| DECS Control              | System Input COM Port PF var Enabled            | 47457    | Uint32 | 4     | R W | n/a     | n/a       | Off=0 PF=1 Var=2  |
| DECS Control              | System Input COM Port External Tracking Enabled | 47459    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0 Enabled=1  |
| DECS Control              | System Input COM Port Pre-position Enabled      | 47461    | Uint32 | 4     | R W | n/a     | n/a       | NOT SET=0 SET=1   |
| DECS Control              | System Input COM Port Pre-position Enabled 2    | 47463    | Uint32 | 4     | R W | n/a     | n/a       | NOT SET=0 SET=1   |
| DECS Control              | System Input COM Port Raise Enabled             | 47465    | Uint32 | 4     | R W | n/a     | n/a       | NOT SET=0 Raise=1   |
| DECS Control              | System Input COM Port Lower Enabled             | 47467    | Uint32 | 4     | R W | n/a     | n/a       | NOT SET=0 Lower=1   |
| DECS Control              | System Option Input Voltage Match Enabled       | 47469    | Uint32 | 4     | R W | n/a     | n/a       | Disabled=0 Enabled=1  |
| DECS Control              | System Option Underfrequency Mode               | 47471    | Uint32 | 4     | R W | n/a     | n/a       | UF Limiter=0<br>V/Hz Limiter=1  |

| Group        | Name                                   | Register | Type   | Bytes | R/W | Unit    | Increment | Range   |
|--------------|--|----------|--------|-------|-----|---------|-----------|---|
| DECS Control | System Option Limiter Mode             | 47473    | Uint32 | 4     | R W | n/a     | n/a       | Off=0 UEL=1 OEL=2<br>UEL & OEL=3 SCL=4<br>UEL & SCL=5 OEL &<br>SCL=6 UEL & OEL &<br>SCL=7 |
| DECS Control | System Option Voltage Match Band       | 47475    | Float  | 4     | R W | Percent | 0.01      | 0–20  |
| DECS Control | System Option Voltage Match Reference  | 47477    | Float  | 4     | R W | Percent | 0.001     | 0–700   |
| DECS Control | System Option Underfrequency Slope     | 47479    | Float  | 4     | R W | n/a     | 0.01      | 0–3   |
| DECS Control | System Option PF to Droop kW Threshold | 47481    | Float  | 4     | R W | Percent | 0.1       | 0–30  |
| DECS Control | Startup Primary Soft-start Bias        | 47483    | Float  | 4     | R W | Percent | 1         | 0–90  |
| DECS Control | Startup Primary Soft-start Time        | 47485    | Float  | 4     | R W | Second  | 1         | 1–7200  |
| DECS Control | Startup Secondary Soft-start Bias      | 47487    | Float  | 4     | R W | Percent | 1         | 0–90  |
| DECS Control | Startup Secondary Soft-start Time      | 47489    | Float  | 4     | R W | Second  | 1         | 1–7200  |

## Protection Settings

**Table 26-13. Protection Settings Group Parameters**

| Group                 | Name                             | Register | Type   | Sz | R/W | Unit | Increment | Range                              |
|-----------------------|----------------------------------|----------|--------|----|-----|------|-----------|------------------------------------|
| Field Overvoltage     | Primary Mode                     | 47600    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1               |
| Field Overvoltage     | Primary Pickup                   | 47602    | Float  | 4  | R W | V    | 0.1       | Disabled=0, 1–2400                 |
| Field Overvoltage     | Primary Time Delay               | 47604    | Float  | 4  | R W | ms   | 100       | Instantaneous=0, 200–30000         |
| Field Overvoltage     | Secondary Mode                   | 47606    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1               |
| Field Overvoltage     | Secondary Pickup                 | 47608    | Float  | 4  | R W | V    | 0.1       | Disabled=0, 1–2400                 |
| Field Overvoltage     | Secondary Time Delay             | 47610    | Float  | 4  | R W | ms   | 100       | Instantaneous=0, 200–30000         |
| Field Overcurrent     | Primary Mode                     | 47612    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1               |
| Field Overcurrent     | Primary Pickup                   | 47614    | Float  | 4  | R W | Amp  | 0.1       | Disabled=0, 0.1–20000              |
| Field Overcurrent     | Primary Time Delay               | 47616    | Float  | 4  | R W | ms   | 100       | Instantaneous=0, 200–30000         |
| Field Overcurrent     | Primary Timing Mode              | 47618    | Uint32 | 4  | R W | n/a  | n/a       | Definite Timing=0 Inverse Timing=1 |
| Field Overcurrent     | Primary Time Dial                | 47620    | Float  | 4  | R W | n/a  | 0.1       | 0.1–20                             |
| Field Overcurrent     | Secondary Mode                   | 47622    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1               |
| Field Overcurrent     | Secondary Pickup                 | 47624    | Float  | 4  | R W | Amp  | 0.01      | Disabled=0, 0.1–20000              |
| Field Overcurrent     | Secondary Time Delay             | 47626    | Float  | 4  | R W | ms   | 100       | Instantaneous=0, 200–30000         |
| Field Overcurrent     | Secondary Timing Mode            | 47628    | Uint32 | 4  | R W | n/a  | n/a       | Definite Timing=0 Inverse Timing=1 |
| Field Overcurrent     | Secondary Time Dial              | 47630    | Float  | 4  | R W | n/a  | 0.1       | 0.1–20                             |
| Exciter Diode Monitor | Exciter Open Diode Enable        | 47632    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1               |
| Exciter Diode Monitor | Exciter Shorted Diode Enable     | 47634    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1               |
| Exciter Diode Monitor | Exciter Diode Inhibit Threshold  | 47636    | Float  | 4  | R W | %    | 0.1       | 0–100                              |
| Exciter Diode Monitor | Exciter Open Diode Pickup        | 47638    | Float  | 4  | R W | %    | 0.1       | 0–100                              |
| Exciter Diode Monitor | Exciter Open Diode Time Delay    | 47640    | Float  | 4  | R W | Sec  | 0.1       | 10–60                              |
| Exciter Diode Monitor | Exciter Shorted Diode Pickup     | 47642    | Float  | 4  | R W | %    | 0.1       | 0–100                              |
| Exciter Diode Monitor | Exciter Shorted Diode Time Delay | 47644    | Float  | 4  | R W | Sec  | 0.1       | 5–30                               |
| Exciter Diode Monitor | Exciter Pole Ratio               | 47646    | Float  | 4  | R W | n/a  | 0.01      | Disabled=0, 1–10                   |
| Loss Of Sensing       | Mode                             | 47648    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1               |
| Loss Of Sensing       | Time Delay                       | 47650    | Float  | 4  | R W | Sec  | 0.1       | 0–30                               |

| Group           | Name   | Register | Type   | Sz | R/W | Unit | Increment | Range   |
|-----------------|--|----------|--------|----|-----|------|-----------|---|
| Loss Of Sensing | Voltage Balanced Level                         | 47652    | Float  | 4  | R W | %    | 0.1       | 0–100   |
| Loss Of Sensing | Voltage Unbalanced Level                       | 47654    | Float  | 4  | R W | %    | 0.1       | 0–100   |
| 25              | Mode   | 47656    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 25              | Voltage Monitor Mode                           | 47658    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 DLDA=1 DLLA=2<br>DLDA_DLLA=3 LLDA=4<br>LLDA_DLDA=5 DLLA_LLDA=6<br>DLDA_DLLA_LLDA=7 |
| 25              | Phase Angle                                    | 47660    | Float  | 4  | R W | Deg  | 1         | 1–99  |
| 25              | Slip Frequency                                 | 47662    | Float  | 4  | R W | Hz   | 0.01      | 0.01–0.5  |
| 25              | Voltage Magnitude Error Percent                | 47664    | Float  | 4  | R W | %    | 0.1       | 0.1–50  |
| 25              | Generator Frequency Greater Than Bus Frequency | 47666    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 25              | Dead Voltage                                   | 47668    | Float  | 4  | R W | %    | 1         | Disabled=0, 10–90   |
| 25              | Live Voltage                                   | 47670    | Float  | 4  | R W | %    | 1         | Disabled=0, 10–90   |
| 25              | Dropout Delay                                  | 47672    | Float  | 4  | R W | ms   | 1         | 50–60000  |
| 25              | Angle Compensation                             | 47674    | Float  | 4  | R W | Deg  | 0.1       | 0–359.9   |
| 25              | VMM Dead Line, Dead Aux                        | 47676    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 25              | VMM Dead Line, Live Aux                        | 47678    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 25              | VMM Live Line, Dead Aux                        | 47680    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 27P             | Primary Mode                                   | 47682    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 27P             | Primary Pickup                                 | 47684    | Float  | 4  | R W | V    | 1         | Disabled=0, 1–600000  |
| 27P             | Primary Time Delay                             | 47686    | Float  | 4  | R W | ms   | 100       | 100–60000   |
| 27P             | Secondary Mode                                 | 47688    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 27P             | Secondary Pickup                               | 47690    | Float  | 4  | R W | V    | 1         | Disabled=0, 1–600000  |
| 27P             | Secondary Time Delay                           | 47692    | Float  | 4  | R W | ms   | 100       | 100–60000   |
| 59P             | Primary Mode                                   | 47694    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 59P             | Primary Pickup                                 | 47696    | Float  | 4  | R W | V    | 1         | 0–600000  |
| 59P             | Primary Time Delay                             | 47698    | Float  | 4  | R W | ms   | 100       | 100–60000   |
| 59P             | Secondary Mode                                 | 47700    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 59P             | Secondary Pickup                               | 47702    | Float  | 4  | R W | V    | 1         | 0–600000  |
| 59P             | Secondary Time Delay                           | 47704    | Float  | 4  | R W | ms   | 100       | 100–60000   |
| 81O             | Primary Mode                                   | 47706    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Over=1   |
| 81O             | Primary Pickup                                 | 47708    | Float  | 4  | R W | Hz   | 0.01      | Disabled=0, 15–70   |
| 81O             | Primary Time Delay                             | 47710    | Float  | 4  | R W | ms   | 100       | 100–300000  |
| 81O             | Secondary Mode                                 | 47712    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Over=1   |
| 81O             | Secondary Pickup                               | 47714    | Float  | 4  | R W | Hz   | 0.01      | Disabled=0, 15–70   |
| 81O             | Secondary Time Delay                           | 47716    | Float  | 4  | R W | ms   | 100       | 100–300000  |
| 81U             | Primary Mode                                   | 47718    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Under=2  |
| 81U             | Primary Pickup                                 | 47720    | Float  | 4  | R W | Hz   | 0.01      | Disabled=0, 15–70   |
| 81U             | Primary Time Delay                             | 47722    | Float  | 4  | R W | ms   | 100       | 100–300000  |
| 81U             | Primary Voltage Inhibit                        | 47724    | Float  | 4  | R W | %    | 1         | Disabled=0, 5–100   |
| 81U             | Secondary Mode                                 | 47726    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Under=2  |
| 81U             | Secondary Pickup                               | 47728    | Float  | 4  | R W | Hz   | 0.01      | Disabled=0, 15–70   |
| 81U             | Secondary Time Delay                           | 47730    | Float  | 4  | R W | ms   | 100       | 100–300000  |
| 81U             | Secondary Voltage Inhibit                      | 47732    | Float  | 4  | R W | %    | 1         | Disabled=0, 5–100   |
| 40Q             | Primary Mode                                   | 47734    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 40Q             | Primary Pickup                                 | 47736    | Float  | 4  | R W | kvar | 1         | 0–3000000   |
| 40Q             | Primary Time Delay                             | 47738    | Float  | 4  | R W | ms   | 100       | 0–300000  |

| Group                     | Name                 | Register | Type   | Sz | R/W | Unit | Increment | Range   |
|---------------------------|----------------------|----------|--------|----|-----|------|-----------|---|
| 40Q                       | Secondary Mode       | 47740    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| 40Q                       | Secondary Pickup     | 47742    | Float  | 4  | R W | kvar | 1         | 0-3000000   |
| 40Q                       | Secondary Time Delay | 47744    | Float  | 4  | R W | ms   | 100       | 0-300000  |
| 32R                       | Primary Mode         | 47746    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=4  |
| 32R                       | Primary Pickup       | 47748    | Float  | 4  | R W | kW   | 1         | 0-3000000   |
| 32R                       | Primary Time Delay   | 47750    | Float  | 4  | R W | ms   | 100       | 0-300000  |
| 32R                       | Secondary Mode       | 47752    | Uint32 | 4  | R W | n/a  | n/a       | Disabled=0 Enabled=4  |
| 32R                       | Secondary Pickup     | 47754    | Float  | 4  | R W | kW   | 1         | 0-3000000   |
| 32R                       | Secondary Time Delay | 47756    | Float  | 4  | R W | ms   | 100       | 0-300000  |
| Configurable Protection 1 | Parameter Selection  | 47758    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 1 | Math Operator        | 47760    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 -=2 *=3 /=4  |
| Configurable Protection 1 | Scale Factor 1       | 47761    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 1 | Offset 1             | 47763    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 1 | Scale Factor 2       | 47765    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 1 | Offset 2             | 47767    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 2 | Parameter Selection  | 47769    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 2 | Math Operator        | 47771    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 -=2 *=3 /=4  |
| Configurable Protection 2 | Scale Factor 1       | 47772    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 2 | Offset 1             | 47774    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 2 | Scale Factor 2       | 47776    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 2 | Offset 2             | 47778    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 3 | Parameter Selection  | 47780    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 3 | Math Operator        | 47782    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 -=2 *=3 /=4  |
| Configurable Protection 3 | Scale Factor 1       | 47783    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 3 | Offset 1             | 47785    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 3 | Scale Factor 2       | 47787    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 3 | Offset 2             | 47789    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 4 | Parameter Selection  | 47791    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 4 | Math Operator        | 47793    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 -=2 *=3 /=4  |
| Configurable Protection 4 | Scale Factor 1       | 47794    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 4 | Offset 1             | 47796    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 4 | Scale Factor 2       | 47798    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 4 | Offset 2             | 47800    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |

| Group                     | Name                           | Register | Type   | Sz | R/W | Unit | Increment | Range   |
|---------------------------|--------------------------------|----------|--------|----|-----|------|-----------|---|
| Configurable Protection 5 | Parameter Selection            | 47802    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 5 | Math Operator                  | 47804    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 --2 *=3 /=4  |
| Configurable Protection 5 | Scale Factor 1                 | 47805    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 5 | Offset 1                       | 47807    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 5 | Scale Factor 2                 | 47809    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 5 | Offset 2                       | 47811    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 6 | Parameter Selection            | 47813    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 6 | Math Operator                  | 47815    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 --2 *=3 /=4  |
| Configurable Protection 6 | Scale Factor 1                 | 47816    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 6 | Offset 1                       | 47818    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 6 | Scale Factor 2                 | 47820    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 6 | Offset 2                       | 47822    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 7 | Parameter Selection            | 47824    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 7 | Math Operator                  | 47826    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 --2 *=3 /=4  |
| Configurable Protection 7 | Scale Factor 1                 | 47827    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 7 | Offset 1                       | 47829    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 7 | Scale Factor 2                 | 47831    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 7 | Offset 2                       | 47833    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 8 | Parameter Selection            | 47835    | Int32  | 4  | R W | n/a  | n/a       | See <i>Configurable Protection Parameters</i> at the end of this section for a complete list. |
| Configurable Protection 8 | Math Operator                  | 47837    | Int8   | 1  | R W | n/a  | n/a       | None=0 +=1 --2 *=3 /=4  |
| Configurable Protection 8 | Scale Factor 1                 | 47838    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 8 | Offset 1                       | 47840    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 8 | Scale Factor 2                 | 47842    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| Configurable Protection 8 | Offset 2                       | 47844    | Float  | 4  | R W | n/a  | 0.01      | -999999-999999  |
| 24                        | Primary Mode                   | 47846    | UInt32 | 4  | R W | n/a  | n/a       | Disabled=0,Enabled=1  |
| 24                        | Primary Definite Time Pickup 1 | 47848    | Float  | 4  | R W | n/a  | 0.01      | Disabled=0, 0.5-6   |
| 24                        | Primary Definite Time Pickup 2 | 47850    | Float  | 4  | R W | n/a  | 0.01      | Disabled=0, 0.5-6   |
| 24                        | Primary Definite Time Delay 1  | 47852    | Float  | 4  | R W | ms   | 1         | 50-600000   |
| 24                        | Primary Definite Time Delay 2  | 47854    | Float  | 4  | R W | ms   | 1         | 50-600000   |
| 24                        | Primary Inverse Time Pickup    | 47856    | Float  | 4  | R W | n/a  | 0.01      | Disabled=0, 0.5-6   |

| Group                 | Name                             | Register | Type   | Sz | R/W | Unit  | Increment | Range                 |
|-----------------------|----------------------------------|----------|--------|----|-----|-------|-----------|-----------------------|
| 24                    | Primary Time Dial Trip           | 47858    | Float  | 4  | R W | n/a   | 0.1       | 0–9.9                 |
| 24                    | Primary Time Dial Reset          | 47860    | Float  | 4  | R W | n/a   | 0.1       | 0–9.9                 |
| 24                    | Primary Curve Exponent           | 47862    | Uint32 | 4  | R W | n/a   | n/a       | 0.5=0, 1=1, 2=2       |
| 24                    | Secondary Mode                   | 47864    | Uint32 | 4  | R W | n/a   | n/a       | Disabled=0, Enabled=1 |
| 24                    | Secondary Definite Time Pickup 1 | 47866    | Float  | 4  | R W | n/a   | 0.01      | Disabled=0, 0.5–6     |
| 24                    | Secondary Definite Time Pickup 2 | 47868    | Float  | 4  | R W | n/a   | 0.01      | Disabled=0, 0.5–6     |
| 24                    | Secondary Definite Time Delay 1  | 47870    | Float  | 4  | R W | ms    | 1         | 50–600000             |
| 24                    | Secondary Definite Time Delay 2  | 47872    | Float  | 4  | R W | ms    | 1         | 50–600000             |
| 24                    | Secondary Inverse Time Pickup    | 47874    | Float  | 4  | R W | n/a   | 0.01      | Disabled=0, 0.5–6     |
| 24                    | Secondary Time Dial Trip         | 47876    | Float  | 4  | R W | n/a   | 0.1       | 0–9.9                 |
| 24                    | Secondary Time Dial Reset        | 47878    | Float  | 4  | R W | n/a   | 0.1       | 0–9.9                 |
| 24                    | Curve Exponent                   | 47880    | Uint32 | 4  | R W | n/a   | n/a       | 0.5=0, 1=1, 2=2       |
| Field Overtemperature | Primary Mode                     | 47882    | Uint32 | 4  | R W | n/a   | n/a       | Disabled=0 Enabled=1  |
| Field Overtemperature | Primary Pickup                   | 47884    | Float  | 4  | R W | Deg F | 1         | 0–572                 |
| Field Overtemperature | Primary Time Delay               | 47886    | Float  | 4  | R W | Ms    | 100       | 100–60000             |
| Field Overtemperature | Secondary Mode                   | 47888    | Uint32 | 4  | R W | n/a   | n/a       | Disabled=0 Enabled=1  |
| Field Overtemperature | Secondary Pickup                 | 47890    | Float  | 4  | R W | Deg F | 1         | 0–572                 |
| Field Overtemperature | Secondary Time Delay             | 47892    | Float  | 4  | R W | Ms    | 100       | 100–60000             |
| Loss of FIT           | Mode                             | 47894    | Uint32 | 4  | R W | n/a   | n/a       | Disabled=0 Enabled=1  |
| Loss of FIT           | Time Delay                       | 47896    | Float  | 4  | R W | Ms    | 100       | 0–9900                |
| 81U-2                 | Primary Mode                     | 47898    | Uint32 | 4  | R W | n/a   | n/a       | Disabled=0 Under=2    |
| 81U-2                 | Primary Pickup                   | 47900    | Float  | 4  | R W | Hz    | 0.01      | Disabled=0; 15–70     |
| 81U-2                 | Primary Time Delay               | 47902    | Float  | 4  | R W | Ms    | 100       | 100–300000            |
| 81U-2                 | Primary Voltage Inhibit          | 47904    | Float  | 4  | R W | %     | 1         | Disabled=0; 5–100     |
| 81U-2                 | Secondary Mode                   | 47906    | Uint32 | 4  | R W | n/a   | n/a       | Disabled=0 Under=2    |
| 81U-2                 | Secondary Pickup                 | 47908    | Float  | 4  | R W | Hz    | 0.01      | Disabled=0; 15–70     |
| 81U-2                 | Secondary Time Delay             | 47910    | Float  | 4  | R W | Ms    | 100       | 100–300000            |
| 81U-2                 | Secondary Voltage Inhibit        | 47912    | Float  | 4  | R W | %     | 1         | Disabled=0; 5–100     |

## Gains Settings

Table 26-14. Gains Settings Group Parameters

| Name                | Register | Type   | Bytes | R/W | Unit | Increment | Range  |
|---------------------|----------|--------|-------|-----|------|-----------|--|
| Primary Gain Option | 48200    | Uint32 | 4     | R W | n/a  | n/a       | T'do=1.0 Te=0.17=1 T'do=1.5 Te=0.25=2 T'do=2.0 Te=0.33=3 T'do=2.5 Te=0.42=4 T'do=3.0 Te=0.50=5 T'do=3.5 Te=0.58=6 T'do=4.0 Te=0.67=7 T'do=4.5 Te=0.75=8 T'do=5.0 Te=0.83=9 T'do=5.5 Te=0.92=10 T'do=6.0 Te=1.00=11 T'do=6.5 Te=1.08=12 T'do=7.0 Te=1.17=13 T'do=7.5 Te=1.25=14 T'do=8.0 Te=1.33=15 T'do=8.5 Te=1.42=16 T'do=9.0 Te=1.50=17 T'do=9.5 Te=1.58=18 T'do=10.0 Te=1.67=19 T'do=10.5 Te=1.75=20 Custom=21 |

| Name                  | Register | Type   | Bytes | R/W | Unit | Increment | Range  |
|-----------------------|----------|--------|-------|-----|------|-----------|--|
| Secondary Gain Option | 48202    | Uint32 | 4     | R W | n/a  | n/a       | T'do=1.0 Te=0.17=1 T'do=1.5 Te=0.25=2 T'do=2.0 Te=0.33=3 T'do=2.5 Te=0.42=4 T'do=3.0 Te=0.50=5 T'do=3.5 Te=0.58=6 T'do=4.0 Te=0.67=7 T'do=4.5 Te=0.75=8 T'do=5.0 Te=0.83=9 T'do=5.5 Te=0.92=10 T'do=6.0 Te=1.00=11 T'do=6.5 Te=1.08=12 T'do=7.0 Te=1.17=13 T'do=7.5 Te=1.25=14 T'do=8.0 Te=1.33=15 T'do=8.5 Te=1.42=16 T'do=9.0 Te=1.50=17 T'do=9.5 Te=1.58=18 T'do=10.0 Te=1.67=19 T'do=10.5 Te=1.75=20 Custom=21 |
| AVR Kp Primary        | 48204    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Ki Primary        | 48206    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Kd Primary        | 48208    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Td Primary        | 48210    | Float  | 4     | R W | n/a  | 0.01      | 0-1  |
| FCR Kp                | 48212    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| FCR Ki                | 48214    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| FCR Kd                | 48216    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| FCR Td                | 48218    | Float  | 4     | R W | n/a  | 0.01      | 0-1  |
| FVR Kp                | 48220    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| FVR Ki                | 48222    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| FVR Kd                | 48224    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| FVR Td                | 48226    | Float  | 4     | R W | n/a  | 0.01      | 0-1  |
| PF Ki                 | 48228    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| PF Kg                 | 48230    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| Var Ki                | 48232    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| Var Kg                | 48234    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| OEL Ki                | 48236    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| OEL Kg                | 48238    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| UEL Ki                | 48240    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| UEL Kg                | 48242    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| SCL Ki                | 48244    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| SCL Kg                | 48246    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| Vm Kg                 | 48248    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| Inner Loop Kp         | 48250    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| Inner Loop Ki         | 48252    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Kp Secondary      | 48254    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Ki Secondary      | 48256    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Kd Secondary      | 48258    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Td Secondary      | 48260    | Float  | 4     | R W | n/a  | 0.01      | 0-1  |
| Var Limit Ki          | 48262    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| Var Limit Kg          | 48264    | Float  | 4     | R W | n/a  | 0.001     | 0-1000   |
| AVR Primary Ka        | 48266    | Float  | 4     | R W | n/a  | 0.001     | 0-1  |
| AVR Secondary Ka      | 48268    | Float  | 4     | R W | n/a  | 0.001     | 0-1  |
| FCR Ka                | 48270    | Float  | 4     | R W | n/a  | 0.001     | 0-1  |
| FVR Ka                | 48272    | Float  | 4     | R W | n/a  | 0.001     | 0-1  |

## Legacy Modbus

Table 26-15. Legacy Modbus Parameters

| Name                          | Register | Type  | Bytes | R/W | Unit | Increment | Range |
|-------------------------------|----------|-------|-------|-----|------|-----------|-------|
| Model Information Character 1 | 40001    | Uint8 | 1     | R   | n/a  | n/a       | n/a   |
| Model Information Character 2 | 40002    | Uint8 | 1     | R   | n/a  | n/a       | n/a   |
| Model Information Character 3 | 40003    | Uint8 | 1     | R   | n/a  | n/a       | n/a   |

| Name                                    | Register      | Type      | Bytes | R/W | Unit | Increment | Range                   |
|---|---------------|-----------|-------|-----|------|-----------|-------------------------|
| Model Information Character 4           | 40004         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Model Information Character 5           | 40005         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Model Information Character 6           | 40006         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Model Information Character 7           | 40007         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Model Information Character 8           | 40008         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Model Information Character 9           | 40009         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 1 | 40010         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 2 | 40011         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 3 | 40012         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 4 | 40013         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 5 | 40014         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 6 | 40015         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 7 | 40016         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Program Version Character 8 | 40017         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 1    | 40018         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 2    | 40019         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 3    | 40020         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 4    | 40021         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 5    | 40022         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 6    | 40023         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 7    | 40024         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 8    | 40025         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Application Version Date Character 9    | 40026         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Reserved 8 bit: 1-17                    | 40027 - 40043 | UInt8     | 1     | R   | n/a  | 1         | 0-255                   |
| Boot Program Version Character 1        | 40044         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Boot Program Version Character 2        | 40045         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Boot Program Version Character 3        | 40046         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Boot Program Version Character 4        | 40047         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Boot Program Version Character 5        | 40048         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Boot Program Version Character 6        | 40049         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Boot Program Version Character 7        | 40050         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Boot Program Version Character 8        | 40051         | UInt8     | 1     | R   | n/a  | n/a       | n/a                     |
| Reserved 8 bit: 18-29                   | 40052 - 40063 | UInt8     | 1     | R   | n/a  | 1         | 0-255                   |
| Reserved 1                              | 40064         | C1 filler | 274   | R   | n/a  | n/a       | n/a                     |
| Leading Lagging Indicator               | 40201         | UInt16    | 2     | R   | n/a  | n/a       | Leading=0 Lagging=1     |
| Motoring Generating Indicator           | 40202         | UInt16    | 2     | R   | n/a  | n/a       | Motoring=0 Generating=1 |
| Status of Front Panel LEDs              | 40203         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Contact Input States                    | 40204         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Voltage Matching Status Indicator       | 40205         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Active Setpoint Adjustment Range        | 40206         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Annunciation Status Bit Flags 1         | 40207         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Annunciation Status Bit Flags 2         | 40208         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Protection Status Bit Flags 1           | 40209         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Protection Status Bit Flags 2           | 40210         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Relay Output States                     | 40211         | UInt16    | 2     | R   | n/a  | n/a       | n/a                     |
| Unused Registers 1                      | 40212         | U1 filler | 78    | R   | n/a  | n/a       | n/a                     |
| RMS Generator Volts Phase A to B        | 40251         | Float     | 4     | R   | n/a  | n/a       | n/a                     |
| RMS Generator Volts Phase B to C        | 40253         | Float     | 4     | R   | n/a  | n/a       | n/a                     |
| RMS Generator Volts Phase C to A        | 40255         | Float     | 4     | R   | n/a  | n/a       | n/a                     |

| Name   | Register | Type  | Bytes | R/W | Unit | Increment | Range |
|--|----------|-------|-------|-----|------|-----------|-------|
| RMS Bus Voltage in Volts                       | 40257    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Generator Current Ia in Amps                   | 40259    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Generator Current Ib in Amps                   | 40261    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Generator Current Ic in Amps                   | 40263    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Average RMS L-L Volts                          | 40265    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Average Generator Phase Current                | 40267    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Field Voltage in Volts                         | 40269    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Field Current in Amps                          | 40271    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Auxiliary Input in Volts                       | 40273    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Magnitude of A-B Voltage Fundamental Phasor    | 40275    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Magnitude of B-C Voltage Fundamental Phasor    | 40277    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Magnitude of C-A Voltage Fundamental Phasor    | 40279    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Magnitude of Line A Current Fundamental Phasor | 40281    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Magnitude of Line B Current Fundamental Phasor | 40283    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Magnitude of Line C Current Fundamental Phasor | 40285    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Current Input for Load Compensation            | 40287    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Angle Between Vab and Vca                      | 40289    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Angle Between Vbc and Vca                      | 40291    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Angle Between Ia and Vca                       | 40293    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Angle Between Ib and Vca                       | 40295    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Angle Between Ic and Vca                       | 40297    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Angle Between Iaux and Vca                     | 40299    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Real Power in kW                           | 40301    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Reactive Power in kvar                     | 40303    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Apparent Power in kVA                      | 40305    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Power Factor                                   | 40307    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Positive Sequence Voltage                  | 40309    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Negative Sequence Voltage                  | 40311    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Positive Sequence Current                  | 40313    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Negative Sequence Current                  | 40315    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Gen Frequency in Hertz                         | 40317    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Bus Frequency in Hertz                         | 40319    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Null Balance in Percent                        | 40321    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Active Controller Output                       | 40323    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Error Signal to Autotracking Loop              | 40325    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Rotor Temperature                              | 40327    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Shorted Diode Harmonic Current                 | 40329    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Open Diode Harmonic Current                    | 40331    | Float | 4     | R   | n/a  | n/a       | n/a   |
| Var/PF Controller Output in Volts              | 40333    | Float | 4     | R   | n/a  | n/a       | n/a   |
| PSS Terminal Frequency Deviation               | 40335    | Float | 4     | R   | n/a  | n/a       | n/a   |
| PSS Compensated Frequency Deviation            | 40337    | Float | 4     | R   | n/a  | n/a       | n/a   |
| PSS Washed Out Speed Deviation                 | 40339    | Float | 4     | R   | n/a  | n/a       | n/a   |
| PSS Washed Out Power Deviation                 | 40341    | Float | 4     | R   | n/a  | n/a       | n/a   |
| PSS Mechanical Power Filter Output             | 40343    | Float | 4     | R   | n/a  | n/a       | n/a   |
| PSS Signal Before Phase Lead-Lag Blocks        | 40345    | Float | 4     | R   | n/a  | n/a       | n/a   |
| PSS Signal After Phase Lead-Lag Blocks         | 40347    | Float | 4     | R   | n/a  | n/a       | n/a   |

| Name                                      | Register | Type      | Bytes | R/W | Unit    | Increment | Range  |
|---|----------|-----------|-------|-----|---------|-----------|--|
| PSS Signal After Terminal Voltage Limiter | 40349    | Float     | 4     | R   | n/a     | n/a       | n/a  |
| Final PSS Output                          | 40351    | Float     | 4     | R   | n/a     | n/a       | n/a  |
| Reserved 2                                | 40353    | C2 Filler | 96    | R   | n/a     | n/a       | n/a  |
| Sensing Mode                              | 40401    | Uint16    | 2     | R W | n/a     | n/a       | ABC=0 ACB=1  |
| Auxiliary Input Summing Mode              | 40402    | Uint16    | 2     | R W | n/a     | n/a       | Voltage=0 var=1  |
| Power Output Mode                         | 40403    | Uint16    | 2     | R   | n/a     | n/a       | n/a  |
| Gen Field Type                            | 40404    | Uint16    | 2     | R W | n/a     | n/a       | Exciter Field=0 Main Field=1                                   |
| Voltage Sensing HW Gain Control           | 40405    | Uint16    | 2     | R   | n/a     | n/a       | n/a  |
| Auxiliary Input Mode                      | 40406    | Uint16    | 2     | R W | n/a     | n/a       | Voltage=0 Current=1  |
| Rotor Temperature Mode                    | 40407    | Uint16    | 2     | R   | n/a     | n/a       | n/a  |
| Number of CTs                             | 40408    | Uint16    | 2     | R W | n/a     | n/a       | n/a  |
| Selected CTs                              | 40409    | Uint16    | 2     | R W | n/a     | n/a       | n/a  |
| Motor/Gen Mode                            | 40410    | Uint16    | 2     | R   | n/a     | n/a       | Generator=0 Motor=1  |
| Auxiliary Input Function                  | 40411    | Uint16    | 2     | R W | n/a     | 1         | DECS Input=0 PSS Test Input=1 Limiter Selection=2 No Control=3 |
| Unused Registers 2                        | 40412    | U2 Filler | 78    | R   | n/a     | n/a       | n/a  |
| Gen Rated Frequency                       | 40451    | Float     | 4     | R W | n/a     | 10        | 50.0–60.0  |
| Gen PT Primary Voltage Rating             | 40453    | Float     | 4     | R W | n/a     | 1         | 1–500000   |
| Gen PT Secondary Voltage Rating           | 40455    | Float     | 4     | R W | n/a     | 1         | 1–600  |
| Gen CT Primary Current Rating             | 40457    | Float     | 4     | R W | n/a     | 1         | 1–99999  |
| Gen CT Secondary Current Rating           | 40459    | Float     | 4     | R W | n/a     | 10        | 1.0–5.0  |
| Field Current Shunt Rating                | 40461    | Float     | 4     | R W | Amp     | 0.1       | 1–10000  |
| Field Voltage Isolation Module Input      | 40463    | Float     | 4     | R W | n/a     | 1         | 63–625   |
| Bus Sensing PT Primary Rating             | 40465    | Float     | 4     | R W | n/a     | 1         | 1–500000   |
| Bus Sensing PT Secondary Rating           | 40467    | Float     | 4     | R W | n/a     | 1         | 1–600  |
| Maximum Field Flash Time                  | 40469    | Float     | 4     | R W | n/a     | 1         | 1–50   |
| Field Flash Dropout Level                 | 40471    | Float     | 4     | R W | n/a     | 1         | 0–100  |
| Gen Rated Voltage                         | 40473    | Float     | 4     | R W | Volt    | 1         | 1–500000   |
| Gen Rated kVA                             | 40475    | Float     | 4     | R W | KiloVA  | 0.01      | 1–2000000  |
| Gen Rated Field Voltage                   | 40477    | Float     | 4     | R W | Volt    | 0.1       | 1–1000   |
| Gen Rated Field Current                   | 40479    | Float     | 4     | R W | Amp     | 0.1       | 0.1–10000  |
| Nominal Bus Voltage                       | 40481    | Float     | 4     | R W | Volt    | 1         | 1–500000   |
| Auxiliary Input Gain for AVR Mode         | 40483    | Float     | 4     | R W | n/a     | 0.01      | -99–99   |
| Time Delay Before Autotracking            | 40485    | Float     | 4     | R W | Second  | 0.1       | 0–8  |
| Traverse Rate of Autotracking             | 40487    | Float     | 4     | R W | Second  | 0.1       | 1–80   |
| Reserved 3                                | 40489    | Float     | 4     | R   | n/a     | n/1       | n/a  |
| Gain for Cross Current Compensation       | 40491    | Float     | 4     | R W | Percent | 0.01      | -30–30   |
| External Tracking Time Delay              | 40493    | Float     | 4     | R W | Second  | 0.1       | 0–8  |
| External Tracking Traverse Rate           | 40495    | Float     | 4     | R W | Second  | 0.1       | 1–80   |
| Auxiliary Input Gain for FCR Mode         | 40497    | Float     | 4     | R W | n/a     | 0.01      | -99–99   |
| Auxiliary Input Gain for VAR Mode         | 40499    | Float     | 4     | R W | n/a     | 0.01      | -99–99   |
| Auxiliary Input Gain for PF Mode          | 40501    | Float     | 4     | R W | n/a     | 0.01      | -99–99   |
| Exciter Field Resistance                  | 40503    | Float     | 4     | R W | ohm     | 0.001     | 0.001–99.999   |
| Ambient Temperature                       | 40505    | Float     | 4     | R W | Deg F   | 1         | 32–572   |
| Brush Voltage Drop                        | 40507    | Float     | 4     | R W | Volt    | 0.01      | 0–20   |
| Gen Power Factor                          | 40509    | Float     | 4     | R W | PF      | 0.01      | -2–2   |
| Auxiliary Input Gain for FVR Mode         | 40511    | Float     | 4     | R W | n/a     | 0.01      | -99–99   |

| Name  | Register | Type      | Bytes | R/W | Unit | Increment | Range   |
|---|----------|-----------|-------|-----|------|-----------|---|
| Reserved 4  | 40513    | C3 Filler | 176   | R   | n/a  | n/a       | n/a   |
| Unit Mode Virtual Toggle                              | 40601    | Uint16    | 2     | R W | n/a  | n/a       | No Change=0 Change State=1  |
| Control Mode Virtual Toggle                           | 40602    | Uint16    | 2     | R W | n/a  | n/a       | No Change=0 Change State=1  |
| Parallel Mode Virtual Toggle                          | 40603    | Uint16    | 2     | R W | n/a  | n/a       | No Change=0 Change State=1  |
| Operating Mode Virtual Switch                         | 40604    | Uint16    | 2     | R W | n/a  | n/a       | Off=0 PF=1 var=2  |
| AutoTrack Enabled Status                              | 40605    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| Pre-position Enable                                   | 40606    | Uint16    | 2     | R W | n/a  | n/a       | =0 SET=1  |
| Raise Enabled Status                                  | 40607    | Uint16    | 2     | R W | n/a  | n/a       | =0 Raise=1  |
| Lower Enabled Status                                  | 40608    | Uint16    | 2     | R W | n/a  | n/a       | =0 Lower=1  |
| Limiter Mode Options                                  | 40609    | Uint16    | 2     | R W | n/a  | n/a       | Off=0 UEL=1 OEL=2 UEL & OEL=3 SCL=4 UEL & SCL=5 OEL & SCL=6 UEL & OEL & SCL=7 |
| Voltage Matching Mode Status                          | 40610    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| Operating Mode Status                                 | 40611    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| Unit Mode Status                                      | 40612    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| Control Mode Status                                   | 40613    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| AutoTrack Status                                      | 40614    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| Pre-position Enable Status                            | 40615    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| Autotransfer Status                                   | 40616    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| Load Compensation Mode Status                         | 40617    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| Alarm Reset Enable                                    | 40618    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| Loss-of-Sensing Detection Enable                      | 40619    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| Loss-of-Sensing Triggered Transfer-to-FCR-mode Enable | 40620    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| External Tracking Enabled                             | 40621    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| Under Frequency or V/Hz Mode Enable                   | 40622    | Uint16    | 2     | R W | n/a  | n/a       | UF Limiter=0 V/Hz Limiter=1   |
| Reserved 5  | 40623    | Float     | 4     | R   | n/a  | n/a       | n/a   |
| Reserved 6  | 40625    | Float     | 4     | R   | n/a  | n/a       | n/a   |
| Reserved 7  | 40627    | Float     | 4     | R   | n/a  | n/a       | n/a   |
| Reserved 8  | 40629    | Float     | 4     | R   | n/a  | n/a       | n/a   |
| Droop Enabled   | 40631    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| L Drop Enabled  | 40632    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| CC Enabled  | 40633    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| OEL Style Mode  | 40634    | Uint16    | 2     | R   | n/a  | n/a       | No Change=0 Change State=1  |
| Autotransfer Enable Status                            | 40635    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| OEL Style Virtual Toggle                              | 40636    | Uint16    | 2     | R W | n/a  | n/a       | No Change=0 Change State=1  |
| Pre-position 2 Enable Status                          | 40637    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| UEL Style Mode  | 40638    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| OEL Option Mode                                       | 40639    | Uint16    | 2     | R   | n/a  | n/a       | Offline=0 Online=1  |
| Pre-position Selection                                | 40640    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| UEL Style Enabled                                     | 40641    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| Volt Match Mode                                       | 40642    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| OEL Enabled   | 40643    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| UEL Enabled   | 40644    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| SCL Enabled   | 40645    | Uint16    | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1  |
| Internal Tracking Mode                                | 40646    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |
| External Tracking Mode                                | 40647    | Uint16    | 2     | R   | n/a  | n/a       | n/a   |

| Name                                     | Register | Type      | Bytes | R/W | Unit    | Increment | Range                |
|--|----------|-----------|-------|-----|---------|-----------|----------------------|
| Voltage Matching Mode                    | 40648    | Uint16    | 2     | R   | n/a     | n/a       | n/a                  |
| Unused Registers 3                       | 40649    | U3 Filler | 52    | R   | n/a     | n/a       | n/a                  |
| Var Limiter Enable                       | 40675    | Uint16    | 2     | R W | n/a     | n/a       | Disabled=0 Enabled=1 |
| Unused Registers 4                       | 40676    | U4 Filler | 50    | R   | n/a     | n/a       | n/a                  |
| FCR Pre-Position Mode                    | 40701    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| AVR Pre-Position Mode                    | 40702    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| Var Pre-Position Mode                    | 40703    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| PF Pre-Position Mode                     | 40704    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| FCR Pre-Position 2 Mode                  | 40705    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| AVR Pre-Position 2 Mode                  | 40706    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| Var Pre-Position 2 Mode                  | 40707    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| PF Pre-Position 2 Mode                   | 40708    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| FVR Pre-Position Mode                    | 40709    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| FVR Pre-Position 2 Mode                  | 40710    | Uint16    | 2     | R W | n/a     | n/a       | Maintain=0 Release=1 |
| Unused Registers 5                       | 40711    | U5 Filler | 80    | R   | n/a     | n/a       | n/a                  |
| FCR Mode Setpoint                        | 40751    | Float     | 4     | R W | Amp     | 0.01      | 0–12                 |
| AVR Mode Setpoint                        | 40753    | Float     | 4     | R W | Volt    | 0.1       | 84–144               |
| Var Mode Setpoint in kvar                | 40755    | Float     | 4     | R W | kvar    | 0.1       | 0–0                  |
| PF Mode Setpoint                         | 40757    | Float     | 4     | R W | PF      | 0.01      | -2–2                 |
| Droop Setting in Percent                 | 40759    | Float     | 4     | R W | Percent | 0.1       | 0–30                 |
| FCR Minimum Setpoint                     | 40761    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| AVR Minimum Setpoint                     | 40763    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| Var Minimum Setpoint                     | 40765    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| PF Minimum Setpoint                      | 40767    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| FCR Maximum Setpoint                     | 40769    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| AVR Maximum Setpoint                     | 40771    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| Var Maximum Setpoint                     | 40773    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| PF Maximum Setpoint                      | 40775    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| FCR Mode Traverse Rate                   | 40777    | Float     | 4     | R W | Second  | 1         | 10–200               |
| AVR Mode Traverse Rate                   | 40779    | Float     | 4     | R W | Second  | 1         | 10–200               |
| Var Mode Traverse Rate                   | 40781    | Float     | 4     | R W | Second  | 1         | 10–200               |
| PF Mode Traverse Rate                    | 40783    | Float     | 4     | R W | Second  | 1         | 10–200               |
| FCR Mode Setpoint Pre-Position           | 40785    | Float     | 4     | R W | Amp     | 0.01      | 0–12                 |
| AVR Mode Setpoint Pre-Position           | 40787    | Float     | 4     | R W | Volt    | 0.1       | 84–144               |
| Var Mode Setpoint Pre-Position in kvar   | 40789    | Float     | 4     | R W | kvar    | 0.1       | 0–0                  |
| PF Mode Setpoint Pre-Position            | 40791    | Float     | 4     | R W | PF      | 0.001     | -2–2                 |
| FCR Mode Setpoint Step Size              | 40793    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| AVR Mode Setpoint Step Size              | 40795    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| Var Mode Setpoint Step Size              | 40797    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| PF Mode Setpoint Step Size               | 40799    | Float     | 4     | R   | n/a     | n/a       | n/a                  |
| FCR Mode Setpoint Adjustable Minimum     | 40801    | Float     | 4     | R W | Percent | 0.1       | 0–120                |
| AVR Mode Setpoint Adjustable Minimum     | 40803    | Float     | 4     | R W | Percent | 0.1       | 70–120               |
| Var Mode Setpoint Adjustable Minimum     | 40805    | Float     | 4     | R W | Percent | 0.1       | -100–100             |
| PF Mode Setpoint Adjustable Minimum      | 40807    | Float     | 4     | R W | PF      | 0.01      | 0.5–1                |
| FCR Mode Setpoint Adjustable Maximum     | 40809    | Float     | 4     | R W | Percent | 0.1       | 0–120                |
| AVR Mode Setpoint Adjustable Maximum     | 40811    | Float     | 4     | R W | Percent | 0.1       | 70–120               |
| Var Mode Setpoint Adjustable Maximum     | 40813    | Float     | 4     | R W | Percent | 0.1       | -100–100             |
| PF Mode Setpoint Adjustable Maximum      | 40815    | Float     | 4     | R W | PF      | 0.01      | -1–(-0.5)            |
| Minimum Value for FCR Adjustable Minimum | 40817    | Float     | 4     | R   | n/a     | n/a       | n/a                  |

| Name                                     | Register | Type      | Bytes | R/W | Unit    | Increment | Range                    |
|--|----------|-----------|-------|-----|---------|-----------|--------------------------|
| Minimum Value for AVR Adjustable Minimum | 40819    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Minimum Value for Var Adjustable Minimum | 40821    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Minimum Value for PF Adjustable Minimum  | 40823    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Maximum Value for FCR Adjustable Maximum | 40825    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Maximum Value for AVR Adjustable Maximum | 40827    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Maximum Value for Var Adjustable Maximum | 40829    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Maximum Value for PF Adjustable Maximum  | 40831    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Step Size for FCR Adjustable Maximum     | 40833    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Step Size for AVR Adjustable Maximum     | 40835    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Step Size for Var Adjustable Maximum     | 40837    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Step Size for PF Adjustable Maximum      | 40839    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| FCR Mode Setpoint Pre-Position 2         | 40841    | Float     | 4     | R W | Amp     | 0.01      | 0–12                     |
| AVR Mode Setpoint Pre-Position 2         | 40843    | Float     | 4     | R W | Volt    | 0.1       | 84–144                   |
| Var Mode Setpoint Pre-Position 2         | 40845    | Float     | 4     | R W | kvar    | 0.1       | 0–0                      |
| PF Mode Setpoint Pre-Position 2          | 40847    | Float     | 4     | R W | PF      | 0.001     | -2–2                     |
| Line Drop Compensation Setpoint          | 40849    | Float     | 4     | R W | n/a     | n/a       | n/a                      |
| FVR Mode Setpoint                        | 40851    | Float     | 4     | R W | Volt    | 0.01      | 0–75                     |
| FVR Minimum Setpoint                     | 40853    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| FVR Maximum Setpoint                     | 40855    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| FVR Mode Traverse Rate                   | 40857    | Float     | 4     | R W | Second  | 1         | 10–200                   |
| FVR Mode Setpoint Pre-Position           | 40859    | Float     | 4     | R W | Volt    | 0.01      | 0–75                     |
| FVR Mode Setpoint Step Size              | 40861    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| FVR Mode Setpoint Adjustable Minimum     | 40863    | Float     | 4     | R W | Percent | 0.1       | 0–150                    |
| FVR Mode Setpoint Adjustable Maximum     | 40865    | Float     | 4     | R W | Percent | 0.1       | 0–150                    |
| Minimum Value for FVR Adjustable Minimum | 40867    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Maximum Value for FVR Adjustable Maximum | 40869    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| Step Size for FVR Adjustable Maximum     | 40871    | Float     | 4     | R   | n/a     | n/a       | n/a                      |
| FVR Mode Setpoint Pre-Position 2         | 40873    | Float     | 4     | R W | Volt    | 0.01      | 0–75                     |
| Reserved 9                               | 40875    | C5 Filler | 50    | R   | n/a     | n/a       | n/a                      |
| Exc Cur Preposition 1Traverse Rate       | 40900    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Exc Cur Preposition 2Traverse Rate       | 40902    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Gen Volt Preposition 1Traverse Rate      | 40904    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Gen Volt Preposition 2Traverse Rate      | 40906    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Gen Var Preposition 1Traverse Rate       | 40908    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Gen Var Preposition 2Traverse Rate       | 40910    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Gen PF Preposition 1Traverse Rate        | 40912    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Gen PF Preposition 2Traverse Rate        | 40914    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Exc Volt Preposition 1Traverse Rate      | 40916    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Exc Volt Preposition 2Traverse Rate      | 40918    | Float     | 4     | R W | Second  | 1         | 0–720                    |
| Unused Registers 6                       | 40920    | U6 Filler | 462   | R   | n/a     | n/a       | n/a                      |
| Setting Group Indication, Soft Start     | 41151    | Uint16    | 2     | R   | n/a     | n/a       | Primary=1<br>Secondary=2 |
| PSS Power Level Enable                   | 41152    | Uint16    | 2     | R   | n/a     | n/a       | n/a                      |
| Unused Registers 7                       | 41153    | U7 Filler | 36    | R   | n/a     | n/a       | n/a                      |

| Name  | Register | Type       | Bytes | R/W | Unit    | Increment | Range                    |
|---|----------|------------|-------|-----|---------|-----------|--------------------------|
| Soft Start Threshold                              | 41171    | Float      | 4     | R W | Percent | 1         | 0-90                     |
| Soft Start Duration                               | 41173    | Float      | 4     | R W | Second  | 1         | 1-7200                   |
| Underfrequency Corner Frequency                   | 41175    | Float      | 4     | R W | Hertz   | 0.1       | 15-90                    |
| Volts per Hz High Setting                         | 41177    | Float      | 4     | R W | n/a     | 0.01      | 0-3                      |
| Volts per Hz Low Setting                          | 41179    | Float      | 4     | R W | n/a     | 0.01      | 0-3                      |
| Volts per Hz Time Setting                         | 41181    | Float      | 4     | R W | Second  | 0.2       | 0-10                     |
| Width of Voltage Matching Window                  | 41183    | Float      | 4     | R W | Percent | 0.01      | 0-20                     |
| Voltage Matching Reference                        | 41185    | Float      | 4     | R W | Percent | 0.001     | 0-700                    |
| Fine Voltage Adjust Band                          | 41187    | Float      | 4     | R W | Percent | 0.01      | 0-30                     |
| Time Required for Loss of Sensing                 | 41189    | Float      | 4     | R W | Second  | 0.1       | 0-30                     |
| Loss of Sensing Level Under Balanced Conditions   | 41191    | Float      | 4     | R W | Percent | 0.1       | 0-100                    |
| Loss of Sensing Level Under Unbalanced Conditions | 41193    | Float      | 4     | R W | Percent | 0.1       | 0-100                    |
| Reserved 10                                       | 41195    | Float      | 4     | R   | n/a     | 0.001     | 0-10000                  |
| Slope of Underfrequency Curve                     | 41197    | Float      | 4     | R W | n/a     | 0.01      | 0-3                      |
| Reserved 11                                       | 41199    | Float      | 4     | R W | n/a     | 0.001     | 0-10000                  |
| Reserved 12                                       | 41201    | Float      | 4     | R W | n/a     | 0.001     | 0-10000                  |
| PF Active Power Level                             | 41203    | Float      | 4     | R W | Percent | 0.1       | 0-30                     |
| Unused Registers 8                                | 41205    | U8 Filler  | 132   | R   | n/a     | n/a       | n/a                      |
| Soft Start Threshold Secondary                    | 41271    | Float      | 4     | R W | Percent | 1         | 0-90                     |
| Soft Start Duration Secondary                     | 41273    | Float      | 4     | R W | Second  | 1         | 1-7200                   |
| Reserved 13                                       | 41275    | C6 Filler  | 152   | R   | n/a     | n/a       | n/a                      |
| Active OEL Limiter Setting Group                  | 41351    | Uint16     | 2     | R   | n/a     | n/a       | Primary=1<br>Secondary=2 |
| OEL dvdt Enable                                   | 41352    | Uint16     | 2     | R W | n/a     | n/a       | Disabled=0 Enabled=1     |
| Setting Group Selection for Var Limiter           | 41353    | Uint16     | 2     | R   | n/a     | n/a       | Primary=1<br>Secondary=2 |
| Unused Registers 9                                | 41354    | U9 Filler  | 14    | R   | n/a     | n/a       | n/a                      |
| On-line High OEL Level                            | 41361    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Time Allowed for On-line High OEL Level           | 41363    | Float      | 4     | R W | Second  | 1         | 0-240                    |
| On-line Medium OEL Level                          | 41365    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Time Allowed for On-line Medium OEL Level         | 41367    | Float      | 4     | R W | Second  | 1         | 0-240                    |
| On-line Low OEL Level                             | 41369    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Off-line High OEL Level                           | 41371    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Off-line Low OEL Level                            | 41373    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Time Allowed for Off-line High OEL                | 41375    | Float      | 4     | R W | Second  | 1         | 0-240                    |
| Takeover OEL Offline High Limit Level             | 41377    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Offline Low Limit Level              | 41379    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Offline Time Dial                    | 41381    | Float      | 4     | R W | n/a     | 0.1       | 0.1-20                   |
| Takeover OEL Online High Limit Level              | 41383    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Online Low Limit Level               | 41385    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Online Time Dial                     | 41387    | Float      | 4     | R W | n/a     | 0.1       | 0.1-20                   |
| Unused Registers 10                               | 41389    | U10 Filler | 44    | R   | n/a     | n/a       | n/a                      |
| Active UEL Limiter Setting Group                  | 41411    | Uint16     | 2     | R   | n/a     | n/a       | Primary=1<br>Secondary=2 |
| Unused Registers 11                               | 41412    | U11 Filler | 18    | R   | n/a     | n/a       | n/a                      |
| First UEL Point kW Value                          | 41421    | Float      | 4     | R W | KW      | 1         | 0-62                     |
| Second UEL Point kW Value                         | 41423    | Float      | 4     | R W | KW      | 1         | 0-62                     |

| Name  | Register | Type       | Bytes | R/W | Unit    | Increment | Range                    |
|---|----------|------------|-------|-----|---------|-----------|--------------------------|
| Third UEL Point kW Value                            | 41425    | Float      | 4     | R W | KW      | 1         | 0-62                     |
| Fourth UEL Point kW Value                           | 41427    | Float      | 4     | R W | KW      | 1         | 0-62                     |
| Fifth UEL Point kW Value                            | 41429    | Float      | 4     | R W | KW      | 1         | 0-62                     |
| First UEL Point kvar Value                          | 41431    | Float      | 4     | R W | kvar    | 1         | 0-62                     |
| Second UEL Point kvar Value                         | 41433    | Float      | 4     | R W | kvar    | 1         | 0-62                     |
| Third UEL Point kvar Value                          | 41435    | Float      | 4     | R W | kvar    | 1         | 0-62                     |
| Fourth UEL Point kvar Value                         | 41437    | Float      | 4     | R W | kvar    | 1         | 0-62                     |
| Fifth UEL Point kvar Value                          | 41439    | Float      | 4     | R W | kvar    | 1         | 0-62                     |
| Primary UEL Bias                                    | 41441    | Float      | 4     | R W | Var     | 1         | 0-99                     |
| Real Power Filter Time Constant                     | 41443    | Float      | 4     | R W | Second  | 0.1       | 0-20                     |
| Real Power Exponent                                 | 41445    | Float      | 4     | R W | n/a     | 1         | 0-2                      |
| Unused Registers 12                                 | 41447    | U12 Filler | 48    | R   | n/a     | n/a       | n/a                      |
| Active SCL Limiter Setting Group                    | 41471    | Uint16     | 2     | R   | n/a     | n/a       | Primary=1<br>Secondary=2 |
| Unused Registers 13                                 | 41472    | U13 Filler | 18    | R   | n/a     | n/a       | n/a                      |
| SCL High Limit Level                                | 41481    | Float      | 4     | R W | Amp     | 0.1       | 0-66000                  |
| Time Allowed at SCL High Limit Level                | 41483    | Float      | 4     | R W | Second  | 0.1       | 0-240                    |
| Reserved 14   | 41485    | Float      | 4     | R   | n/a     | 0.001     | 0-10000                  |
| Reserved 15   | 41487    | Float      | 4     | R   | n/a     | 0.001     | 0-10000                  |
| SCL Low Limit Level                                 | 41489    | Float      | 4     | R W | Amp     | 0.1       | 0-66000                  |
| Primary SCL No Response Time                        | 41491    | Float      | 4     | R W | Second  | 0.1       | 0-10                     |
| Unused Registers 14                                 | 41493    | U14 Filler | 184   | R   | n/a     | n/a       | n/a                      |
| OEL dvt Setting                                     | 41585    | Float      | 4     | R W | n/a     | 0.1       | -10-0                    |
| Var Limiter Setpoint for Primary Selection          | 41587    | Float      | 4     | R W | Percent | 0.1       | 0-200                    |
| Var Limiter Initial Delay for Primary Selection     | 41589    | Float      | 4     | R W | Second  | 0.1       | 0-300                    |
| Unused Registers 15                                 | 41591    | U15 Filler | 260   | R   | n/a     | n/a       | n/a                      |
| On-line High OEL Level Secondary                    | 41721    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Time Allowed for On-line High OEL Level Secondary   | 41723    | Float      | 4     | R W | Second  | 1         | 0-240                    |
| On-line Medium OEL Level Secondary                  | 41725    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Time Allowed for On-line Medium OEL Level Secondary | 41727    | Float      | 4     | R W | Second  | 1         | 0-240                    |
| On-line Low OEL Level Secondary                     | 41729    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Off-line High OEL Level Secondary                   | 41731    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Off-line Low OEL Level Secondary                    | 41733    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Time Allowed for Off-line High OEL Secondary        | 41735    | Float      | 4     | R W | Second  | 1         | 0-240                    |
| Takeover OEL Offline High Limit Level Secondary     | 41737    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Offline Low Limit Level Secondary      | 41739    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Offline Time Dial Secondary            | 41741    | Float      | 4     | R W | n/a     | 0.1       | 0.1-20                   |
| Takeover OEL Online High Limit Level Secondary      | 41743    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Online Low Limit Level Secondary       | 41745    | Float      | 4     | R W | Amp     | 0.01      | 0-12000                  |
| Takeover OEL Online Time Dial Secondary             | 41747    | Float      | 4     | R W | n/a     | 0.1       | 0.1-20                   |
| Unused Registers 16                                 | 41749    | U16 Filler | 64    | R   | n/a     | n/a       | n/a                      |
| First UEL Point kW Value Secondary                  | 41781    | Float      | 4     | R W | KW      | 1         | 0-62                     |

| Name  | Register | Type          | Bytes | R/W | Unit     | Increment | Range                    |
|---|----------|---------------|-------|-----|----------|-----------|--------------------------|
| Second UEL Point kW Value Secondary               | 41783    | Float         | 4     | R W | Kilowatt | 1         | 0-62                     |
| Third UEL Point kW Value Secondary                | 41785    | Float         | 4     | R W | Kilowatt | 1         | 0-62                     |
| Fourth UEL Point kW Value Secondary               | 41787    | Float         | 4     | R W | Kilowatt | 1         | 0-62                     |
| Fifth UEL Point kW Value Secondary                | 41789    | Float         | 4     | R W | Kilowatt | 1         | 0-62                     |
| First UEL Point kvar Value Secondary              | 41791    | Float         | 4     | R W | Kilovar  | 1         | 0-62                     |
| Second UEL Point kvar Value Secondary             | 41793    | Float         | 4     | R W | Kilovar  | 1         | 0-62                     |
| Third UEL Point kvar Value Secondary              | 41795    | Float         | 4     | R W | Kilovar  | 1         | 0-62                     |
| Fourth UEL Point kvar Value Secondary             | 41797    | Float         | 4     | R W | Kilovar  | 1         | 0-62                     |
| Fifth UEL Point kvar Value Secondary              | 41799    | Float         | 4     | R W | Kilovar  | 1         | 0-62                     |
| Secondary UEL Bias                                | 41801    | Float         | 4     | R W | Var      | 1         | 0-99                     |
| Unused Registers 17                               | 41803    | U17<br>Filler | 76    | R   | n/a      | n/a       | n/a                      |
| SCL High Limit Level Secondary                    | 41841    | Float         | 4     | R W | Amp      | 0.1       | 0-66000                  |
| Time Allowed at SCL High Limit Level Secondary    | 41843    | Float         | 4     | R W | Second   | 0.1       | 0-240                    |
| Reserved 16                                       | 41845    | Float         | 4     | R   | n/a      | 0.001     | 0-10000                  |
| Reserved 17                                       | 41847    | Float         | 4     | R   | n/a      | 0.001     | 0-10000                  |
| SCL Low Limit Level Secondary                     | 41849    | Float         | 4     | R W | Amp      | 0.1       | 0-66000                  |
| Secondary SCL No Response Time                    | 41851    | Float         | 4     | R W | Second   | 0.1       | 0-10                     |
| Var Limiter Setpoint for Secondary Selection      | 41853    | Float         | 4     | R W | Percent  | 0.1       | 0-200                    |
| Var Limiter Initial Delay for Secondary Selection | 41855    | Float         | 4     | R W | Second   | 0.1       | 0-300                    |
| Reserved 18                                       | 41857    | C7<br>Filler  | 1238  | R   | n/a      | n/a       | n/a                      |
| Active Gain Setting Group                         | 42476    | Uint16        | 2     | R   | n/a      | n/a       | Primary=1<br>Secondary=2 |
| Unused Registers 18                               | 42477    | U18<br>Filler | 48    | R   | n/a      | n/a       | n/a                      |
| Index into Table of Gain Constants                | 42501    | Float         | 4     | R W | n/a      | 1         | 1-21                     |
| Primary AVR Mode Proportional Gain                | 42503    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Primary AVR Mode Integral Gain                    | 42505    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Primary AVR Mode Derivative Gain                  | 42507    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| OEL Proportional Gain - Kp                        | 42509    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| OEL Integral Gain - Ki                            | 42511    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| PF Mode Integral Gain - Ki                        | 42513    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Var Mode Integral Gain - Ki                       | 42515    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| FCR Mode Loop Gain - Kg                           | 42517    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Primary AVR Mode Loop Gain - Kg                   | 42519    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Var Mode Loop Gain - Kg                           | 42521    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| PF Mode Loop Gain - Kg                            | 42523    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| OEL Loop Gain - Kg                                | 42525    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| UEL Loop Gain - Kg                                | 42527    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Voltage Matching Loop Gain - Kg                   | 42529    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Voltage Matching Proportional Gain - Kp           | 42531    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Voltage Matching Integral Gain - Ki               | 42533    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Reserved 19                                       | 42535    | Float         | 4     | R   | n/a      | 0.001     | 0-10000                  |
| Reserved 20                                       | 42537    | Float         | 4     | R   | n/a      | 0.001     | 0-10000                  |
| Reserved 21                                       | 42539    | Float         | 4     | R   | n/a      | 0.001     | 0-10000                  |
| UEL Proportional Gain - Kp                        | 42541    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| UEL Integral Gain - Ki                            | 42543    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |
| Primary AVR Mode Derivative Time Constant - Td    | 42545    | Float         | 4     | R W | n/a      | 0.01      | 0-1                      |
| SCL Loop Gain - Kg                                | 42547    | Float         | 4     | R W | n/a      | 0.001     | 0-1000                   |

| Name  | Register | Type       | Bytes | R/W | Unit | Increment | Range  |
|---|----------|------------|-------|-----|------|-----------|--|
| SCL Proportional Gain - Kp                      | 42549    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| SCL Integral Gain - Ki                          | 42551    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Primary FCR Mode Proportional Gain              | 42553    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Primary FCR Mode Integral Gain                  | 42555    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Primary FCR Mode Derivative Gain                | 42557    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Primary FCR Mode Derivative Time Constant - Td  | 42559    | Float      | 4     | R W | n/a  | 0.01      | 0-1  |
| FVR Mode Proportional Gain                      | 42561    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| FVR Mode Integral Gain                          | 42563    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| FVR Mode Derivative Gain                        | 42565    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| FVR Mode Derivative Time Constant - Td          | 42567    | Float      | 4     | R W | n/a  | 0.01      | 0-1  |
| FVR Mode Loop Gain - Kg                         | 42569    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Unused Registers 19                             | 42571    | U19 Filler | 76    | R   | n/a  | n/a       | n/a  |
| Loop Gain for Var Limiter - Kg                  | 42609    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Integral Gain for Var Limiter - Ki              | 42611    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Unused Registers 20                             | 42613    | U20 Filler | 126   | R   | n/a  | n/a       | n/a  |
| Secondary Gain Option Index                     | 42676    | Uint32     | 4     | R W | n/a  | n/a       | T'do=1.0 Te=0.17=1<br>T'do=1.5 Te=0.25=2<br>T'do=2.0 Te=0.33=3<br>T'do=2.5 Te=0.42=4<br>T'do=3.0 Te=0.50=5<br>T'do=3.5 Te=0.58=6<br>T'do=4.0 Te=0.67=7<br>T'do=4.5 Te=0.75=8<br>T'do=5.0 Te=0.83=9<br>T'do=5.5 Te=0.92=10<br>T'do=6.0 Te=1.00=11<br>T'do=6.5 Te=1.08=12<br>T'do=7.0 Te=1.17=13<br>T'do=7.5 Te=1.25=14<br>T'do=8.0 Te=1.33=15<br>T'do=8.5 Te=1.42=16<br>T'do=9.0 Te=1.50=17<br>T'do=9.5 Te=1.58=18<br>T'do=10.0 Te=1.67=19<br>T'do=10.5 Te=1.75=20<br>Custom=21 |
| Secondary AVR Mode Proportional Gain - Kp       | 42678    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Secondary AVR Mode Integral Gain - Ki           | 42680    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Secondary AVR Mode Derivative Gain - Kd         | 42682    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Secondary AVR Mode Loop Gain - Kg               | 42684    | Float      | 4     | R W | n/a  | 0.001     | 0-1000   |
| Secondary AVR Derivative Time Constant - Td     | 42686    | Float      | 4     | R W | n/a  | 0.01      | 0-1  |
| Reserved 22                                     | 42688    | C8 Filler  | 626   | R   | n/a  | n/a       | n/a  |
| Field Overvoltage Alarm Enable                  | 43001    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Field Overcurrent Alarm Enable                  | 43002    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Stator Undervoltage Alarm Enable                | 43003    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Stator Overvoltage Alarm Enable                 | 43004    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Field Over Temperature Alarm Enable             | 43005    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Loss of Field Alarm Enable                      | 43006    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Loss of Field Isolation Transducer Alarm Enable | 43007    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Control Power Low Alarm Enable                  | 43008    | Uint16     | 2     | R W | n/a  | n/a       | Disabled=0 Enabled=1   |
| Protection 24 Volts per Hz Mode                 | 43009    | Uint16     | 2     | R W | n/a  | n/a       | n/a  |
| Reserved 23                                     | 43010    | Uint16     | 2     | R   | n/a  | 1         | 0-65535  |
| Reserved 24                                     | 43011    | Uint16     | 2     | R   | n/a  | 1         | 0-65535  |
| Reserved 25                                     | 43012    | Uint16     | 2     | R   | n/a  | 1         | 0-65535  |

| Name  | Register | Type       | Bytes | R/W | Unit        | Increment | Range                    |
|---|----------|------------|-------|-----|-------------|-----------|--------------------------|
| Protection 24 Inverse Time Curve Exponent     | 43013    | Uint16     | 2     | R W | n/a         | n/a       | 0.5=0 1=1 2=2            |
| Unused Registers 21                           | 43014    | U21 Filler | 22    | R   | n/a         | n/a       | n/a                      |
| Active Protection Setting Group               | 43025    | Uint16     | 2     | R   | n/a         | n/a       | Primary=1<br>Secondary=2 |
| Field Overvoltage Level                       | 43026    | Float      | 4     | R W | Volt        | 0.1       | 0; 1–2400                |
| Field Overcurrent Base Level                  | 43028    | Float      | 4     | R W | Amp         | 0.01      | 0.1–20000                |
| Stator Undervoltage Level                     | 43030    | Float      | 4     | R W | Volt        | 1         | 0; 1–600000              |
| Stator Overvoltage Level                      | 43032    | Float      | 4     | R W | Volt        | 1         | 0–600000                 |
| Field Overvoltage Delay                       | 43034    | Float      | 4     | R W | Second      | 0.1       | 0; 0.2–30.0              |
| Field Overcurrent Delay                       | 43036    | Float      | 4     | R W | Second      | 0.1       | 0; 0.2–30.0              |
| Stator Undervoltage Delay                     | 43038    | Float      | 4     | R W | Second      | 0.1       | 0.1–60.0                 |
| Stator Overvoltage Delay                      | 43040    | Float      | 4     | R W | Second      | 0.1       | 0.1–60.0                 |
| Field Over Temperature Level                  | 43042    | Float      | 4     | R W | Deg F       | 1         | 0–572                    |
| Field Over Temperature Time Delay             | 43044    | Float      | 4     | R W | Millisecond | 100       | 100–60000                |
| Loss of Field Pickup Level                    | 43046    | Float      | 4     | R W | KiloVAr     | 1         | 0–3000000                |
| Loss of Field Time Delay                      | 43048    | Float      | 4     | R W | Second      | 0.1       | 0; 0–300.0               |
| Loss of Field Isolation Transducer Level      | 43050    | Float      | 4     | R   | n/a         | n/a       | n/a                      |
| Loss of Field Isolation Transducer Time Delay | 43052    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Control Power Low Level                       | 43054    | Float      | 4     | R   | n/a         | n/a       | n/a                      |
| Control Power Low Time Delay                  | 43056    | Float      | 4     | R   | n/a         | n/a       | n/a                      |
| Protection 24 Inverse Time Pickup Setpoint    | 43058    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Protection 24 Inverse Time Pickup Time Dial   | 43060    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Protection 24 Reset Time Dial                 | 43062    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Protection 24 Definite Time Pickup 1          | 43064    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Protection 24 Definite Time Delay 1           | 43066    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Protection 24 Definite Time Pickup 2          | 43068    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Protection 24 Definite Time Delay 2           | 43070    | Float      | 4     | R W | n/a         | n/a       | n/a                      |
| Reserved 26                                   | 43072    | C9 Filler  | 608   | R   | n/a         | n/a       | n/a                      |
| Reserved 27                                   | 43376    | Uint16     | 2     | R   | n/a         | 1         | 0–65535                  |
| Reserved 28                                   | 43377    | Uint16     | 2     | R   | n/a         | 1         | 0–65535                  |
| Exciter Open Diode Protection Enable          | 43378    | Uint16     | 2     | R W | n/a         | n/a       | Disabled=0 Enabled=1     |
| Exciter Shorted Diode Protection Enable       | 43379    | Uint16     | 2     | R W | n/a         | n/a       | Disabled=0 Enabled=1     |
| Unused Registers 22                           | 43380    | U22 Filler | 42    | R   | n/a         | n/a       | n/a                      |
| Exciter Open Diode Ripple Pickup Level        | 43401    | Float      | 4     | R W | Percent     | 0.1       | 0–100                    |
| Exciter Shorted Diode Ripple Pickup Level     | 43403    | Float      | 4     | R W | Percent     | 0.1       | 0–100                    |
| EDM Protection Disable Level                  | 43405    | Float      | 4     | R W | Percent     | 0.1       | 0–100                    |
| Exciter Open Diode Time Delay                 | 43407    | Float      | 4     | R W | Second      | 0.1       | 10–60                    |
| Exciter Shorted Diode Time Delay              | 43409    | Float      | 4     | R W | Second      | 0.1       | 5–30                     |
| Pole Ratio                                    | 43411    | Float      | 4     | R W | n/a         | 0.01      | 0; 1–10                  |
| Reserved 29                                   | 43413    | C10 Filler | 226   | R   | n/a         | n/a       | n/a                      |
| Output for Relay 1                            | 43526    | Uint16     | 2     | R   | n/a         | n/a       | n/a                      |
| Unused Registers 23                           | 43527    | U23 Filler | 98    | R   | n/a         | n/a       | n/a                      |
| Output for Relay 2                            | 43576    | Uint16     | 2     | R   | n/a         | n/a       | n/a                      |
| Unused Registers 23-2                         | 43577    | U23 Filler | 98    | R   | n/a         | n/a       | n/a                      |
| Output for Relay 3                            | 43626    | Uint16     | 2     | R   | n/a         | n/a       | n/a                      |

| Name                                    | Register | Type       | Bytes | R/W | Unit        | Increment | Range  |
|---|----------|------------|-------|-----|-------------|-----------|--|
| Unused Registers 23-3                   | 43627    | U23 Filler | 98    | R   | n/a         | n/a       | n/a  |
| Output for Relay 4                      | 43676    | Uint16     | 2     | R   | n/a         | n/a       | n/a  |
| Unused Registers 23-4                   | 43677    | U23 Filler | 98    | R   | n/a         | n/a       | n/a  |
| Output for Relay 5                      | 43726    | Uint16     | 2     | R   | n/a         | n/a       | n/a  |
| Unused Registers 23-5                   | 43727    | U23 Filler | 98    | R   | n/a         | n/a       | n/a  |
| Output for Relay 6                      | 43776    | Uint16     | 2     | R   | n/a         | n/a       | n/a  |
| Reserved 30                             | 43777    | C11 Filler | 698   | R   | n/a         | n/a       | n/a  |
| RS232 Baud Rate                         | 44126    | Uint16     | 2     | R W | n/a         | n/a       | 4800 Baud=4800<br>9600 Baud=9600<br>19200 Baud=19200<br>38400 Baud=38400<br>57600 Baud=57600<br>115200 Baud=115200                                     |
| Reserved 31                             | 44127    | Uint16     | 2     | R W | n/a         | 1         | 0-65535  |
| RS485 Baud Rate                         | 44128    | Uint16     | 2     | R W | n/a         | n/a       | 1200 Baud=1200<br>2400 Baud=2400<br>4800 Baud=4800<br>9600 Baud=9600<br>19200 Baud=19200<br>38400 Baud=38400<br>57600 Baud=57600<br>115200 Baud=115200 |
| RS485 Parity                            | 44129    | Uint16     | 2     | R W | n/a         | 1         | 69-79  |
| RS485 Stop Bits                         | 44130    | Uint16     | 2     | R W | n/a         | n/a       | 1 Stop Bit=1 2 Stop Bits=2   |
| DECS-250 Polling Address                | 44131    | Uint16     | 2     | R W | n/a         | 1         | 1-247  |
| Modbus Response Time Delay              | 44132    | Uint16     | 2     | R W | Millisecond | 10        | 10-10000   |
| System Clock Month                      | 44133    | Uint16     | 2     | R W | n/a         | 1         | 1-12   |
| System Clock Day                        | 44134    | Uint16     | 2     | R W | n/a         | 1         | 1-31   |
| System Clock Year                       | 44135    | Uint16     | 2     | R W | n/a         | 1         | 2000-2099  |
| System Clock Daylight Savings Time      | 44136    | Uint16     | 2     | R W | n/a         | n/a       | On=0 Off=1   |
| System Clock Hour                       | 44137    | Uint16     | 2     | R W | n/a         | 1         | 0-23   |
| System Clock Minute                     | 44138    | Uint16     | 2     | R W | n/a         | 1         | 0-59   |
| System Clock Second                     | 44139    | Uint16     | 2     | R W | n/a         | 1         | 0-59   |
| System Clock Twelve Hour Mode           | 44140    | Uint16     | 2     | R W | n/a         | n/a       | 12 Hour Mode=0 24 Hour Mode=1  |
| System Clock AM PM                      | 44141    | Uint16     | 2     | R W | n/a         | n/a       | AM=0 PM=1  |
| Reserved 32                             | 44142    | C12 Filler | 118   | R   | n/a         | n/a       | n/a  |
| Reserved 33                             | 44201    | C13 Filler | 100   | R   | n/a         | n/a       | n/a  |
| PSS Enable                              | 44251    | Uint16     | 2     | R W | n/a         | n/a       | Disabled=0 Enabled=1   |
| Active PSS Setting Group                | 44252    | Uint16     | 2     | R   | n/a         | n/a       | Primary=1<br>Secondary=2   |
| PSS RoC Enable                          | 44253    | Uint16     | 2     | R   | n/a         | n/a       | Disabled=0 Enabled=1   |
| Block PSS RoC mode                      | 44254    | Uint16     | 2     | R   | n/a         | n/a       | Disabled=0 Enabled=1   |
| Unused Registers 24                     | 44255    | U24 Filler | 10    | R   | n/a         | n/a       | n/a  |
| Power System Stabilizer Primary Switch0 | 44260    | Uint16     | 2     | R W | n/a         | n/a       | Disabled=0 Enabled=1   |
| Power System Stabilizer Primary Switch1 | 44261    | Uint16     | 2     | R W | n/a         | n/a       | Disabled=0 Enabled=1   |
| Power System Stabilizer Primary Switch2 | 44262    | Uint16     | 2     | R W | n/a         | n/a       | Disabled=0 Enabled=1   |
| Power System Stabilizer Primary Switch3 | 44263    | Uint16     | 2     | R W | n/a         | n/a       | Frequency=0 Der. Speed=1   |
| Power System Stabilizer Primary Switch4 | 44264    | Uint16     | 2     | R W | n/a         | n/a       | Power=0 Der. Freq/Speed=1  |
| Power System Stabilizer Primary Switch5 | 44265    | Uint16     | 2     | R W | n/a         | n/a       | Exclude=0 Include=1  |

| Name   | Register | Type       | Bytes | R/W | Unit   | Increment | Range                |
|--|----------|------------|-------|-----|--------|-----------|----------------------|
| Power System Stabilizer Primary Switch6                                    | 44266    | Uint16     | 2     | R W | n/a    | n/a       | Disabled=0 Enabled=1 |
| Power System Stabilizer Primary Switch7                                    | 44267    | Uint16     | 2     | R W | n/a    | n/a       | Off=0 On=1           |
| Power System Stabilizer Primary Switch8                                    | 44268    | Uint16     | 2     | R W | n/a    | n/a       | Disabled=0 Enabled=1 |
| Power System Stabilizer Primary Switch9                                    | 44269    | Uint16     | 2     | R W | n/a    | n/a       | Exclude=0 Include=1  |
| Power System Stabilizer Primary Switch10                                   | 44270    | Uint16     | 2     | R W | n/a    | n/a       | Disabled=0 Enabled=1 |
| Unused Registers 25  | 44271    | U25 Filler | 60    | R   | n/a    | n/a       | n/a                  |
| Power System Stabilizer Primary Tw1  | 44301    | Float      | 4     | R W | Second | 0.01      | 1–20                 |
| Power System Stabilizer Primary Tw2  | 44303    | Float      | 4     | R W | Second | 0.01      | 1–20                 |
| Power System Stabilizer Primary H  | 44305    | Float      | 4     | R W | n/a    | 0.01      | 0.01–25              |
| Power System Stabilizer Primary T1pf1 (time constant, low-pass filter)     | 44307    | Float      | 4     | R W | Second | 0.01      | 0–20                 |
| Power System Stabilizer Primary T1   | 44309    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary T2   | 44311    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary T3   | 44313    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary T4   | 44315    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary T5   | 44317    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary T6   | 44319    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary T7   | 44321    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary T8   | 44323    | Float      | 4     | R W | Second | 0.001     | 0.001–6              |
| Power System Stabilizer Primary EtLmtT1pf (time constant, low pass filter) | 44325    | Float      | 4     | R W | Second | 0.001     | 0.02–5               |
| Power System Stabilizer Primary EtLmtVref                                  | 44327    | Float      | 4     | R W | n/a    | 0.001     | 0–10                 |
| Power System Stabilizer Primary Zn1  | 44329    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Zd1  | 44331    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Wn1  | 44333    | Float      | 4     | R W | n/a    | 0.05      | 10–150               |
| Power System Stabilizer Primary Zn2  | 44335    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Zd2  | 44337    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Wn2  | 44339    | Float      | 4     | R W | n/a    | 0.05      | 10–150               |
| Power System Stabilizer Primary LmtVhi                                     | 44341    | Float      | 4     | R W | n/a    | 0.001     | 0.01–0.04            |
| Power System Stabilizer Primary LmtVlo                                     | 44343    | Float      | 4     | R W | n/a    | 0.001     | -0.04–(-0.01)        |
| Power System Stabilizer Primary LmtTDelay                                  | 44345    | Float      | 4     | R W | n/a    | 0.01      | 0–2                  |
| Power System Stabilizer Primary Tw5Normal                                  | 44347    | Float      | 4     | R W | n/a    | 0.1       | 5–30                 |
| Power System Stabilizer Primary Tw5Limit                                   | 44349    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Ks   | 44351    | Float      | 4     | R W | n/a    | 0.01      | -100–100             |
| Power System Stabilizer Primary Limit Plus                                 | 44353    | Float      | 4     | R W | n/a    | 0.001     | 0–0.5                |
| Power System Stabilizer Primary Limit Minus                                | 44355    | Float      | 4     | R W | n/a    | 0.001     | -0.5–0               |
| Power System Stabilizer Primary Xq   | 44357    | Float      | 4     | R W | n/a    | 0.001     | 0–5                  |
| Power System Stabilizer Primary Output Scale                               | 44359    | Float      | 4     | R W | n/a    | 0.01      | -3–3                 |
| Power System Stabilizer Primary Power On Threshold                         | 44361    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Power Hysteresis                           | 44363    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Power On Threshold Inst                    | 44365    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Power System Stabilizer Primary Power Hysteresis Inst                      | 44367    | Float      | 4     | R W | n/a    | 0.01      | 0–1                  |
| Unused Registers 26  | 44369    | U26 Filler | 52    | R   | n/a    | n/a       | n/a                  |

| Name  | Register | Type       | Bytes | R/W | Unit             | Increment | Range                     |
|---|----------|------------|-------|-----|------------------|-----------|---------------------------|
| Power System Stabilizer Primary Power Level Percentage                      | 44395    | Float      | 4     | R W | n/a              | 0.01      | 0–1                       |
| Power System Stabilizer Primary Power Level Hysteresis                      | 44397    | Float      | 4     | R W | n/a              | 0.01      | 0–1                       |
| Unused Registers 27   | 44399    | U27 Filler | 40    | R   | n/a              | n/a       | n/a                       |
| Power System Stabilizer Rate of Change Threshold                            | 44419    | Float      | 4     | R W | Hertz Per Second | 0.01      | 0–10                      |
| Power System Stabilizer Rate of Change Time Delay                           | 44421    | Float      | 4     | R W | Second           | 0.01      | 0–20                      |
| Power System Stabilizer Rate of Change Block Time                           | 44423    | Float      | 4     | R W | Second           | 0.01      | 0–20                      |
| Power System Stabilizer Rate of Change Low Pass Filter Time Constant        | 44425    | Float      | 4     | R W | Second           | 0.01      | 0–20                      |
| Power System Stabilizer Rate of Change Washout Filter Time Constant         | 44427    | Float      | 4     | R W | Second           | 0.01      | 0–20                      |
| Power System Stabilizer Frequency Rate of Change                            | 44429    | Float      | 4     | R   | Hertz Per Second | 0.01      | -15–15                    |
| Unused Registers 28   | 44431    | U28 Filler | 158   | R   | n/a              | n/a       | n/a                       |
| Power System Stabilizer Secondary Switch0                                   | 44510    | Uint16     | 2     | R W | n/a              | n/a       | Disabled=0 Enabled=1      |
| Power System Stabilizer Secondary Switch1                                   | 44511    | Uint16     | 2     | R W | n/a              | n/a       | Disabled=0 Enabled=1      |
| Power System Stabilizer Secondary Switch2                                   | 44512    | Uint16     | 2     | R W | n/a              | n/a       | Disabled=0 Enabled=1      |
| Power System Stabilizer Secondary Switch3                                   | 44513    | Uint16     | 2     | R W | n/a              | n/a       | Frequency=0 Der. Speed=1  |
| Power System Stabilizer Secondary Switch4                                   | 44514    | Uint16     | 2     | R W | n/a              | n/a       | Power=0 Der. Freq/Speed=1 |
| Power System Stabilizer Secondary Switch5                                   | 44515    | Uint16     | 2     | R W | n/a              | n/a       | Exclude=0 Include=1       |
| Power System Stabilizer Secondary Switch6                                   | 44516    | Uint16     | 2     | R W | n/a              | n/a       | Disabled=0 Enabled=1      |
| Power System Stabilizer Secondary Switch7                                   | 44517    | Uint16     | 2     | R W | n/a              | n/a       | Off=0 On=1                |
| Power System Stabilizer Secondary Switch8                                   | 44518    | Uint16     | 2     | R W | n/a              | n/a       | Disabled=0 Enabled=1      |
| Power System Stabilizer Secondary Switch9                                   | 44519    | Uint16     | 2     | R W | n/a              | n/a       | Exclude=0 Include=1       |
| Power System Stabilizer Secondary Switch10                                  | 44520    | Uint16     | 2     | R W | n/a              | n/a       | Disabled=0 Enabled=1      |
| Unused Registers 25-2   | 44521    | U25 Filler | 60    | R   | n/a              | n/a       | n/a                       |
| Power System Stabilizer Secondary Tw1                                       | 44551    | Float      | 4     | R W | Second           | 0.01      | 1–20                      |
| Power System Stabilizer Secondary Tw2                                       | 44553    | Float      | 4     | R W | Second           | 0.01      | 1–20                      |
| Power System Stabilizer Secondary H   | 44555    | Float      | 4     | R W | n/a              | 0.01      | 0.01–25                   |
| Power System Stabilizer Secondary T1pf1 (time constant, low-pass filter)    | 44557    | Float      | 4     | R W | Second           | 0.01      | 0–20                      |
| Power System Stabilizer Secondary T1  | 44559    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary T2  | 44561    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary T3  | 44563    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary T4  | 44565    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary T5  | 44567    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary T6  | 44569    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary T7  | 44571    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary T8  | 44573    | Float      | 4     | R W | Second           | 0.001     | 0.001–6                   |
| Power System Stabilizer Secondary EtLmt1pf (time constant, low-pass filter) | 44575    | Float      | 4     | R W | Second           | 0.001     | 0.02–5                    |

| Name  | Register | Type       | Bytes | R/W | Unit | Increment | Range         |
|---|----------|------------|-------|-----|------|-----------|---------------|
| Power System Stabilizer Secondary EtLmtVref               | 44577    | Float      | 4     | R W | n/a  | 0.001     | 0–10          |
| Power System Stabilizer Secondary Zn1                     | 44579    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Zd1                     | 44581    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Wn1                     | 44583    | Float      | 4     | R W | n/a  | 0.05      | 10–150        |
| Power System Stabilizer Secondary Zn2                     | 44585    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Zd2                     | 44587    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Wn2                     | 44589    | Float      | 4     | R W | n/a  | 0.05      | 10–150        |
| Power System Stabilizer Secondary Lmt Vhi                 | 44591    | Float      | 4     | R W | n/a  | 0.001     | 0.01–0.04     |
| Power System Stabilizer Secondary Lmt Vlo                 | 44593    | Float      | 4     | R W | n/a  | 0.001     | -0.04–(-0.01) |
| Power System Stabilizer Secondary Lmt T Delay             | 44595    | Float      | 4     | R W | n/a  | 0.01      | 0–2           |
| Power System Stabilizer Secondary Tw5 Normal              | 44597    | Float      | 4     | R W | n/a  | 0.1       | 5–30          |
| Power System Stabilizer Secondary Tw5 Limit               | 44599    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Ks                      | 44601    | Float      | 4     | R W | n/a  | 0.01      | -100–100      |
| Power System Stabilizer Secondary Limit Plus              | 44603    | Float      | 4     | R W | n/a  | 0.001     | 0–0.5         |
| Power System Stabilizer Secondary Limit Minus             | 44605    | Float      | 4     | R W | n/a  | 0.001     | -0.5–0        |
| Power System Stabilizer Secondary Xq                      | 44607    | Float      | 4     | R W | n/a  | 0.001     | 0–5           |
| Power System Stabilizer Secondary Output Scale            | 44609    | Float      | 4     | R W | n/a  | 0.01      | -3–3          |
| Power System Stabilizer Secondary Power On Threshold      | 44611    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Power Hysteresis        | 44613    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Power On Threshold Inst | 44615    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Power System Stabilizer Secondary Power Hysteresis Inst   | 44617    | Float      | 4     | R W | n/a  | 0.01      | 0–1           |
| Reserved 34   | 44619    | C14 Filler | 760   | R   | n/a  | n/a       | n/a           |

## Configurable Protection Parameters

All selectable parameters available to configurable protection elements are listed below.

Gen VAB=0

Gen VBC=1

Gen VCA=2

Gen V Average=3

Bus Frequency=4

Bus VAB=5

Bus VBC=6

Bus VCA=7

Gen Frequency=8

Gen Power Factor=9

kWh=10

kvarh=11

Gen IA=12

Gen IB=13

Gen IC=14

Gen I Average=15

kW Total=16

KVA Total=17

Kvar Total=18

EDM Ripple=19

Field Voltage=20

Field Current=21

Aux Input Voltage=22

Aux Input Current (mA)=23

Setpoint Position=24

Tracking Error=25

Neg V=26

Neg I=27

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|                   |                                     |
|-------------------|-------------------------------------|
| Pos V=28          | RTD Input 3=41                      |
| Pos I=29          | RTD Input 4=42                      |
| PSS Output=30     | RTD Input 5=43                      |
| Analog Input 1=31 | RTD Input 6=44                      |
| Analog Input 2=32 | RTD Input 7=45                      |
| Analog Input 3=33 | RTD Input 8=46                      |
| Analog Input 4=34 | Thermocouple 1=47                   |
| Analog Input 5=35 | Thermocouple 2=48                   |
| Analog Input 6=36 | Network Load Share Error Percent=50 |
| Analog Input 7=37 | Gen Scaled PF=51                    |
| Analog Input 8=38 | Control Output Per Unit=52          |
| RTD Input 1=39    | Field Temperature=53                |
| RTD Input 2=40    |                                     |



## 27 • PROFIBUS Communication

On units equipped with the PROFIBUS communication protocol (style XX1XXXX), the DECS-450 sends and receives PROFIBUS data through a DB-9 port located on the rear panel.

### Caution

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

Refer to the *Communication* chapter for PROFIBUS communication settings in BESTCOMSPlus® and the *Terminals and Connectors* chapter for wiring.

The DECS-450 utilizes PROFIBUS DP (Decentralized Peripherals) to operate sensors and actuators via a centralized controller in production (factory) automation applications.

Per IEC 61158, PROFIBUS, consists of digitized signals transmitted over a simple, two-wire bus. It is intended to replace the industry-standard, 4 to 20 mA signal used in the transmission of system parameters. PROFIBUS expands the amount of information shared by system devices and makes the exchange of data faster and more efficient.

### Data Types

#### Float/UINT32

Parameters listed in Table 27-6 as Float or UINT32 types are “Input 2 word” (4 byte) parameters. The Network Byte Order setting allows the byte order of these parameters to be set to MSB first or LSB first. This setting can be found by using the following navigation paths.

**BESTCOMSPlus® Navigation Path:** Settings Explorer, Communications, Profibus Setup

**HMI Navigation Path:** Settings, Communications, Profibus Setup

#### UINT8

Parameters listed in Table 27-6 as UINT8 types are bit-packed binary data. This allows transmission of up to eight single-bit parameters in each byte of data. When configuring an instance of UINT8 type parameters, the data type is “Input 1 byte” and the size is determined by the number of parameters in the instance divided by eight, rounding up to the next integer. Table 27-1 illustrates the sizes of the UINT8 cyclic data instances.

Table 27-1. Instance Data Size Calculation

| Instance Number | Number of Parameters in the Instance | Number of Parameters Divided by Eight | Total Data Size |
|-----------------|--------------------------------------|---------------------------------------|-----------------|
| 6               | 5                                    | 0.625                                 | 1 byte          |
| 7               | 7                                    | 0.875                                 | 1 byte          |
| 8               | 5                                    | 0.625                                 | 1 byte          |

| Instance Number | Number of Parameters in the Instance | Number of Parameters Divided by Eight | Total Data Size |
|-----------------|--------------------------------------|---------------------------------------|-----------------|
| 9               | 6                                    | 0.75                                  | 1 byte          |
| 10              | 16                                   | 2                                     | 2 bytes         |
| 11              | 12                                   | 1.5                                   | 2 bytes         |
| 12              | 8                                    | 1                                     | 1 byte          |

Within these instances, the data is packed in the order listed in Table 27-6. The first item is the lowest bit of the first byte. If there are unused bits, they are filled with a value of zero. Parameters of UINT8 type are not affected by the DECS-450 Network Byte Order setting. The examples, below, show the bit packing order for instances 8 (Controller Status Cyclic) and 11 (Local Contact Outputs Cyclic).

*Example 1: Bit Packing Order for Instance 8*

The total data size of Instance 8 is one byte. Table 27-2 shows the parameters of instance 8 as they appear in Table 27-6. The first parameter in instance 8, with key name DECSCONTROL IN AVR MODE, is represented by the lowest bit in the byte (bit 0). Bit 1 represents the next parameter with key name DECSCONTROL IN FCR MODE and so on. The three highest bits in this instance are unused and thus always return a value of zero.

**Table 27-2. Instance 8 Parameters**

| Instance Name            | Inst. # | Type  | RW | Key Name                 | Range                            |
|--------------------------|---------|-------|----|--------------------------|----------------------------------|
| Controller Status Cyclic | 8       | UINT8 | R  | DECS control in AVR mode | Not in AVR mode=0, In AVR mode=1 |
| Controller Status Cyclic | 8       | UINT8 | R  | DECS control in FCR mode | Not in FCR mode=0, In FCR mode=1 |
| Controller Status Cyclic | 8       | UINT8 | R  | DECS control in FVR mode | Not in FVR mode=0, In FVR mode=1 |
| Controller Status Cyclic | 8       | UINT8 | R  | DECS control in PF mode  | Not in PF mode=0, In PF mode=1   |
| Controller Status Cyclic | 8       | UINT8 | R  | DECS control in VAR mode | Not in var mode=0, In var mode=1 |

Table 27-3 shows the bit number of each parameter in instance 8 and an example packet returned from a DECS-450. Reading a value of 0x02 (0000 0010) for instance 8 indicates that the device is operating in FCR mode.

**Table 27-3. Instance 8 Bit Order**

| Instance Number | Bit Number | Key Name                 | Packet Returned from DECS-450 |
|-----------------|------------|--------------------------|-------------------------------|
| 8               | 0          | DECS control in AVR mode | 0                             |
|                 | 1          | DECS control in FCR mode | 1                             |
|                 | 2          | DECS control in FVR mode | 0                             |
|                 | 3          | DECS control in PF mode  | 0                             |
|                 | 4          | DECS control in VAR mode | 0                             |
|                 | 5          | 0 (unused)               | 0                             |
|                 | 6          | 0 (unused)               | 0                             |
|                 | 7          | 0 (unused)               | 0                             |

*Example 2: Bit Packing Order for Instance 11*

The total size of Instance 11 is two bytes. Table 27-4 shows the parameters of instance 11 as they appear in Table 27-6. The first parameter in instance 11, with key name CONTACTOUTPUTS WATCHDOGOUTPUT, is represented by the lowest bit in the first byte (bit 0). The ninth parameter, with key name CONTACTOUTPUTS OUTPUT8, is represented by the lowest bit in the second byte (bit 0). The four highest bits in the second byte are unused and thus always return a value of zero.

**Table 27-4. Instance 11 Parameters**

| Instance Name                | Inst. # | Type  | RW | Key Name                           | Range            |
|------------------------------|---------|-------|----|------------------------------------|------------------|
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs<br>Watchdog output | Open=0, Closed=1 |

| Instance Name                | Inst. # | Type  | RW | Key Name                  | Range            |
|------------------------------|---------|-------|----|---------------------------|------------------|
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 1  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 2  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 3  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 4  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 5  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 6  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 7  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 8  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 9  | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 10 | Open=0, Closed=1 |
| Local Contact Outputs Cyclic | 11      | UINT8 | R  | Contact outputs output 11 | Open=0, Closed=1 |

Table 27-5 shows the bit number of each parameter in instance 11 and an example packet returned from a DECS-450. Reading a value of 0xA4 06 (1010 0100 0000 0110) for instance 11 indicates that contact outputs 2, 5, 7, 9, and 10 are closed. The first byte is 1010 0100 and the second is 0000 0110.

**Table 27-5. Instance 11 Bit Order**

| Instance Number | Byte Number | Bit Number | Key Name                  | Packet Returned from DECS-450 |
|-----------------|-------------|------------|---------------------------|-------------------------------|
| 11              | 1           | 0          | Contact outputs watchdog  | 0                             |
|                 |             | 1          | Contact outputs output 1  | 0                             |
|                 |             | 2          | Contact outputs output 2  | 1                             |
|                 |             | 3          | Contact outputs output 3  | 0                             |
|                 |             | 4          | Contact outputs output 4  | 0                             |
|                 |             | 5          | Contact outputs output 5  | 1                             |
|                 |             | 6          | Contact outputs output 6  | 0                             |
|                 |             | 7          | Contact outputs output 7  | 1                             |
|                 | 2           | 0          | Contact outputs output 8  | 0                             |
|                 |             | 1          | Contact outputs output 9  | 1                             |
|                 |             | 2          | Contact outputs output 10 | 1                             |
|                 |             | 3          | Contact outputs output 11 | 0                             |
|                 |             | 4          | 0 (unused)                | 0                             |
|                 |             | 5          | 0 (unused)                | 0                             |
|                 |             | 6          | 0 (unused)                | 0                             |
|                 | 7           | 0 (unused) | 0                         |                               |

## Setup

The following steps are provided to assist in setting up the DECS-450 as a slave on a PROFIBUS network. Please refer to the documentation included with your PLC configuration software for installation and operation instructions.

1. Download the DECS-450 GSD file from the Basler website: [www.basler.com](http://www.basler.com)
2. Using PLC configuration software, import the GSD file. This allows the DECS-450 to be included in the bus configuration as a slave.
3. Assign a unique PROFIBUS address to the DECS-450. This allows the master to exchange data with the DECS-450.

4. Select modules from the GSD file to be part of the data exchange. Selecting the cyclic parameters is recommended. The cyclic parameters are comprised of the first 12 instances in the PROFIBUS parameters table (Table 27-6). Instances 1 through 5 consist of 26 float types. Instances 6 through 12 consist of 9 UINT8 types.
5. Set each selected module to an address in the master's memory bank.
6. Compile and download the configuration to the master before going online.

When the PROFIBUS network is initialized, the master connects to each slave checking for address mismatches and sending configuration data. The configuration data is sent so that the master and slave agree on the data exchange to occur. Then, the master begins polling each slave in a cyclic order.

### Note

It is not possible to write a portion of an instance by specifying a length smaller than the size of the instance. To modify a single parameter, read the entire instance, update the desired parameter, and write the entire instance back to the device.

## PROFIBUS Parameters

PROFIBUS parameters are listed in Table 27-6. Instances with names ending in “cyclic” are automatically transmitted at a periodic rate. All other instances are acyclic and transmitted only when requested by the PLC.

**Table 27-6. PROFIBUS Parameters**

| Instance Name                | Inst. # | Type  | RW | Key Name                       | Unit  | Range                |
|------------------------------|---------|-------|----|--------------------------------|-------|----------------------|
| Gen Metering Cyclic          | 1       | Float | R  | VAB GG                         | V     | 0 - 2000000000       |
| Gen Metering Cyclic          | 1       | Float | R  | VBC GG                         | V     | 0 - 2000000000       |
| Gen Metering Cyclic          | 1       | Float | R  | VCA GG                         | V     | 0 - 2000000000       |
| Gen Metering Cyclic          | 1       | Float | R  | IA GG                          | Amp   | 0 - 2000000000       |
| Gen Metering Cyclic          | 1       | Float | R  | IB GG                          | Amp   | 0 - 2000000000       |
| Gen Metering Cyclic          | 1       | Float | R  | IC GG                          | Amp   | 0 - 2000000000       |
| Gen Metering Cyclic          | 1       | Float | R  | Frequency GG                   | Hz    | 10 - 180             |
| Gen Metering Cyclic          | 1       | Float | R  | Total Watts AVG GG             | Watt  | -3.00E+14 - 3.00E+14 |
| Gen Metering Cyclic          | 1       | Float | R  | Total VARS AVG GG              | Var   | -3.00E+14 - 3.00E+14 |
| Gen Metering Cyclic          | 1       | Float | R  | Total S GG                     | VA    | -3.00E+14 - 3.00E+14 |
| Gen Metering Cyclic          | 1       | Float | R  | Total PF GG                    | PF    | -1 - 1               |
| Bus Metering Cyclic          | 2       | Float | R  | VAB GG                         | V     | 0 - 2000000000       |
| Bus Metering Cyclic          | 2       | Float | R  | VBC GG                         | V     | 0 - 2000000000       |
| Bus Metering Cyclic          | 2       | Float | R  | VCA GG                         | V     | 0 - 2000000000       |
| Bus Metering Cyclic          | 2       | Float | R  | Frequency GG                   | Hz    | 10 - 180             |
| Field Metering Cyclic        | 3       | Float | R  | VX GG                          | V     | -1000 - 1000         |
| Field Metering Cyclic        | 3       | Float | R  | IX GG                          | Amp   | 0 - 2000000000       |
| Field Metering Cyclic        | 3       | Float | R  | Field Temperature GG           | Deg F | -40 – 572            |
| Setpoint Metering Cyclic     | 4       | Float | R  | Gen Voltage Setpoint GG        | V     | 84 - 144             |
| Setpoint Metering Cyclic     | 4       | Float | R  | Excitation Current Setpoint GG | Amp   | 0 - 12               |
| Setpoint Metering Cyclic     | 4       | Float | R  | Excitation Voltage Setpoint GG | V     | 0 - 75               |
| Setpoint Metering Cyclic     | 4       | Float | R  | Gen Var Setpoint GG            | kvar  | n/a                  |
| Setpoint Metering Cyclic     | 4       | Float | R  | Gen Pf Setpoint GG             | PF    | n/a                  |
| Synchronizer Metering Cyclic | 5       | Float | R  | Slip Angle GG                  | Deg   | -359.9 - 359.9       |

| Instance Name                | Inst. # | Type  | RW | Key Name   | Unit    | Range  |
|------------------------------|---------|-------|----|--|---------|--|
| Synchronizer Metering Cyclic | 5       | Float | R  | Slip Frequency GG                                  | Hz      | n/a  |
| Synchronizer Metering Cyclic | 5       | Float | R  | Voltage Diff GG                                    | V       | n/a  |
| Limiter Status Cyclic        | 6       | UINT8 | R  | Alarms OEL ALM                                     | No Unit | Not Active=0, Active=1   |
| Limiter Status Cyclic        | 6       | UINT8 | R  | Alarms UEL ALM                                     | No Unit | Not Active=0, Active=1   |
| Limiter Status Cyclic        | 6       | UINT8 | R  | Alarms SCL ALM                                     | No Unit | Not Active=0, Active=1   |
| Limiter Status Cyclic        | 6       | UINT8 | R  | Alarms VAR Limiter Active                          | No Unit | Not Active=0, Active=1   |
| Limiter Status Cyclic        | 6       | UINT8 | R  | Alarms Underfrequency V/Hz ALM                     | No Unit | Not Active=0, Active=1   |
| HMI Indicators Cyclic        | 7       | UINT8 | R  | DECS control DECS null balance                     | No Unit | Not Active=0, Active=1   |
| HMI Indicators Cyclic        | 7       | UINT8 | R  | DECS PSS meter DECS PSS active                     | No Unit | Not Active=0, Active=1   |
| HMI Indicators Cyclic        | 7       | UINT8 | R  | DECS regulator meter DECS Internal tracking active | No Unit | Not Active=0, Active=1   |
| HMI Indicators Cyclic        | 7       | UINT8 | R  | DECS control DECS preposition                      | No Unit | Active setpoint is not at a pre-position value=0, Active setpoint is at a pre-position value=1 |
| HMI Indicators Cyclic        | 7       | UINT8 | R  | DECS regulator meter setpoint At lower limit       | No Unit | Active setpoint is not at minimum value=0, Active setpoint is at minimum value=1               |
| HMI Indicators Cyclic        | 7       | UINT8 | R  | DECS regulator meter setpoint At upper limit       | No Unit | Active setpoint is not at maximum value=0, Active setpoint is at maximum value=1               |
| Controller Status Cyclic     | 8       | UINT8 | R  | DECS control in AVR mode                           | No Unit | Not in AVR mode=0, In AVR mode=1   |
| Controller Status Cyclic     | 8       | UINT8 | R  | DECS control in FCR mode                           | No Unit | Not in FCR mode=0, In FCR mode=1   |
| Controller Status Cyclic     | 8       | UINT8 | R  | DECS control in FVR mode                           | No Unit | Not in FVR mode=0, In FVR mode=1   |
| Controller Status Cyclic     | 8       | UINT8 | R  | DECS control in PF mode                            | No Unit | Not in PF mode=0, In PF mode=1   |
| Controller Status Cyclic     | 8       | UINT8 | R  | DECS control in var mode                           | No Unit | Not in var mode=0, In var mode=1   |
| System Status Cyclic         | 9       | UINT8 | R  | DECS control DECS start stop                       | No Unit | Stopped=0, Started=1   |
| System Status Cyclic         | 9       | UINT8 | R  | Alarms if limit                                    | No Unit | No field short circuit condition=0, Field short circuit condition=1                            |
| System Status Cyclic         | 9       | UINT8 | R  | DECS control DECS Soft start active                | No Unit | Not in soft start=0, In soft start=1   |
| System Status Cyclic         | 9       | UINT8 | R  | Alarm report alarm output                          | No Unit | No active alarms=0, Active alarms=1  |
| System Status Cyclic         | 9       | UINT8 | R  | DECS control DECS pf var Enable 52 j k             | No Unit | PF/var not enabled via PLC=0, PF/var enabled via PLC=1   |
| System Status Cyclic         | 9       | UINT8 | R  | DECS control DECS parallel Enable 52 l m           | No Unit | Parallel not enabled via PLC=0, Parallel enabled via PLC=1                                     |
| System Status Cyclic         | 9       | UINT8 | R  | More alarms: bridge overtemperature alarm          | No Unit | Not Active=0, Active=1   |
| Local Contact Inputs Cyclic  | 10      | UINT8 | R  | Contact inputs start input                         | No Unit | Open=0, Closed=1   |
| Local Contact Inputs Cyclic  | 10      | UINT8 | R  | Contact inputs stop input                          | No Unit | Open=0, Closed=1   |
| Local Contact Inputs Cyclic  | 10      | UINT8 | R  | Contact Inputs Input 1                             | No Unit | Open=0, Closed=1   |
| Local Contact Inputs Cyclic  | 10      | UINT8 | R  | Contact Inputs Input 2                             | No Unit | Open=0, Closed=1   |
| Local Contact Inputs Cyclic  | 10      | UINT8 | R  | Contact Inputs Input 3                             | No Unit | Open=0, Closed=1   |

| Instance Name                    | Inst. # | Type  | RW | Key Name   | Unit    | Range   |
|----------------------------------|---------|-------|----|--|---------|---|
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 4                                     | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 5                                     | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 6                                     | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 7                                     | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 8                                     | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 9                                     | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 10                                    | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 11                                    | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 12                                    | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 13                                    | No Unit | Open=0, Closed=1  |
| Local Contact Inputs Cyclic      | 10      | UINT8 | R  | Contact Inputs Input 14                                    | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Watchdog Output                            | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 1                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 2                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 3                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 4                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 5                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 6                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 7                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 8                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 9                                   | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 10                                  | No Unit | Open=0, Closed=1  |
| Local Contact Outputs Cyclic     | 11      | UINT8 | R  | Contact Outputs Output 11                                  | No Unit | Open=0, Closed=1  |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS soft start<br>Select secondary settings  | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS PSS select<br>Secondary settings         | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS OEL select<br>Secondary settings         | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS UEL select<br>Secondary settings         | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS SCL select<br>Secondary settings         | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS protect<br>Select secondary settings     | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS PID<br>Select secondary settings         | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Settings Group Indication Cyclic | 12      | UINT8 | R  | DECS control DECS var limiter<br>Select secondary settings | No Unit | Primary settings active=0,<br>Secondary settings active=1 |
| Gen Metering                     | 16      | Float | R  | VAB GG (Gen Voltage Magnitude)                             | V       | 0 - 2000000000  |
| Gen Metering                     | 16      | Float | R  | VBC GG (Gen Voltage Magnitude)                             | V       | 0 - 2000000000  |

| Instance Name           | Inst. # | Type  | RW | Key Name                       | Unit     | Range                |
|-------------------------|---------|-------|----|--------------------------------|----------|----------------------|
| Gen Metering            | 16      | Float | R  | VCA GG (Gen Voltage Magnitude) | V        | 0 - 2000000000       |
| Gen Metering            | 16      | Float | R  | VAB GG (Gen Voltage Angle)     | Deg      | 0 - 360              |
| Gen Metering            | 16      | Float | R  | VBC GG (Gen Voltage Angle)     | Deg      | 0 - 360              |
| Gen Metering            | 16      | Float | R  | VCA GG (Gen Voltage Angle)     | Deg      | 0 - 360              |
| Gen Metering            | 16      | Float | R  | IA GG (Gen Current Magnitude)  | Amp      | 0 - 2000000000       |
| Gen Metering            | 16      | Float | R  | IB GG (Gen Current Magnitude)  | Amp      | 0 - 2000000000       |
| Gen Metering            | 16      | Float | R  | IC GG (Gen Current Magnitude)  | Amp      | 0 - 2000000000       |
| Gen Metering            | 16      | Float | R  | IA GG (Gen Current Angle)      | Deg      | 0 - 360              |
| Gen Metering            | 16      | Float | R  | IB GG (Gen Current Angle)      | Deg      | 0 - 360              |
| Gen Metering            | 16      | Float | R  | IC GG (Gen Current Angle)      | Deg      | 0 - 360              |
| Gen Metering            | 16      | Float | R  | Iavg GG                        | Amp      | 0 - 2000000000       |
| Gen Metering            | 16      | Float | R  | Frequency GG                   | Hz       | 10 - 180             |
| Gen Metering Per Unit   | 17      | Float | R  | Vab per unit GG                | Per Unit | -10 - 10             |
| Gen Metering Per Unit   | 17      | Float | R  | Vbc per unit GG                | Per Unit | -10 - 10             |
| Gen Metering Per Unit   | 17      | Float | R  | Vca per unit GG                | Per Unit | -10 - 10             |
| Gen Metering Per Unit   | 17      | Float | R  | Vavg per unit GG               | Per Unit | -10 - 10             |
| Gen Metering Per Unit   | 17      | Float | R  | Ia per unit GG                 | Per Unit | -10 - 10             |
| Gen Metering Per Unit   | 17      | Float | R  | Ib per unit GG                 | Per Unit | -10 - 10             |
| Gen Metering Per Unit   | 17      | Float | R  | Ic per unit GG                 | Per Unit | -10 - 10             |
| Gen Metering Per Unit   | 17      | Float | R  | Iavg per unit GG               | Per Unit | -10 - 10             |
| Power Metering          | 18      | Float | R  | Total Watts Primary GG         | Watt     | n/a                  |
| Power Metering          | 18      | Float | R  | Total VARS Primary GG          | var      | n/a                  |
| Power Metering          | 18      | Float | R  | Total S Primary GG             | VA       | n/a                  |
| Power Metering          | 18      | Float | R  | Total PF GG                    | PF       | -1 - 1               |
| Power Metering          | 18      | Float | R  | POS Watthour Total GG          | watthour | 0.00E+00 - 1.00E+12  |
| Power Metering          | 18      | Float | R  | POS varhour Total GG           | varhour  | 0.00E+00 - 1.00E+12  |
| Power Metering          | 18      | Float | R  | NEG Watthour Total GG          | watthour | -1.00E+12 - 0.00E+00 |
| Power Metering          | 18      | Float | R  | NEG varhour Total GG           | varhour  | -1.00E+12 - 0.00E+00 |
| Power Metering Per Unit | 19      | Float | R  | kW per unit GG                 | Per Unit | -10 - 10             |
| Power Metering Per Unit | 19      | Float | R  | kVA per unit GG                | Per Unit | -10 - 10             |
| Power Metering Per Unit | 19      | Float | R  | kvar per unit GG               | Per Unit | -10 - 10             |
| Bus Metering            | 20      | Float | R  | VAB GG (Bus Voltage Magnitude) | V        | 0 - 2000000000       |
| Bus Metering            | 20      | Float | R  | VBC GG (Bus Voltage Magnitude) | V        | 0 - 2000000000       |
| Bus Metering            | 20      | Float | R  | VCA GG (Bus Voltage Magnitude) | V        | 0 - 2000000000       |
| Bus Metering            | 20      | Float | R  | VAB GG (Bus Voltage Angle)     | Deg      | 0 - 360              |
| Bus Metering            | 20      | Float | R  | VBC GG (Bus Voltage Angle)     | Deg      | 0 - 360              |
| Bus Metering            | 20      | Float | R  | VCA GG (Bus Voltage Angle)     | Deg      | 0 - 360              |
| Bus Metering            | 20      | Float | R  | Frequency GG                   | Hz       | 10 - 180             |
| Bus Metering Per Unit   | 21      | Float | R  | Bus Vab per unit GG            | Per Unit | -10 - 10             |
| Bus Metering Per Unit   | 21      | Float | R  | Bus Vbc per unit GG            | Per Unit | -10 - 10             |
| Bus Metering Per Unit   | 21      | Float | R  | Bus Vca per unit GG            | Per Unit | -10 - 10             |
| Bus Metering Per Unit   | 21      | Float | R  | Bus Vavg per unit GG           | Per Unit | -10 - 10             |

| Instance Name                   | Inst. # | Type  | RW | Key Name   | Unit     | Range                                 |
|---------------------------------|---------|-------|----|--|----------|---------------------------------------|
| Field Metering                  | 22      | Float | R  | VX GG  | V        | -1000 - 1000                          |
| Field Metering                  | 22      | Float | R  | IX GG  | Amp      | 0 - 2000000000                        |
| Field Metering                  | 22      | Float | R  | EDM Ripple Percent GG                                    | %        | n/a                                   |
| Field Metering                  | 22      | Float | R  | Field Temperature GG                                     | Deg F    | -40 - 572                             |
| PSS Metering                    | 23      | Float | R  | V1 GG  | V        | 0 - 2000000000                        |
| PSS Metering                    | 23      | Float | R  | V2 GG  | V        | 0 - 2000000000                        |
| PSS Metering                    | 23      | Float | R  | I1 GG  | Amp      | 0 - 2000000000                        |
| PSS Metering                    | 23      | Float | R  | I2 GG  | Amp      | 0 - 2000000000                        |
| PSS Metering                    | 23      | Float | R  | Term Frequency DEV GG                                    | Percent  | n/a                                   |
| PSS Metering                    | 23      | Float | R  | Comp Frequency DEV GG                                    | Percent  | n/a                                   |
| PSS Metering                    | 23      | Float | R  | PSS Output GG  | No Unit  | n/a                                   |
| PSS Metering                    | 23      | Float | R  | PSS Frequency Rate of Change GG                          | Hz/s     | -15 - 15                              |
| PSS Metering Per Unit           | 24      | Float | R  | Pos Seq V per unit GG                                    | Per Unit | -10 - 10                              |
| PSS Metering Per Unit           | 24      | Float | R  | Neq Seq V per unit GG                                    | Per Unit | -10 - 10                              |
| PSS Metering Per Unit           | 24      | Float | R  | Pos Seq I per unit GG                                    | Per Unit | -10 - 10                              |
| PSS Metering Per Unit           | 24      | Float | R  | Neq Seq I per unit GG                                    | Per Unit | -10 - 10                              |
| PSS Metering Per Unit           | 24      | Float | R  | PSS Frequency Rate of Change per unit GG                 | PU/s     | -1.5 - 1.5                            |
| Synchronization                 | 25      | Float | R  | Slip Angle GG  | Deg      | -359.9 - 359.9                        |
| Synchronization                 | 25      | Float | R  | Slip Frequency GG  | Hz       | n/a                                   |
| Synchronization                 | 25      | Float | R  | Voltage Diff GG  | V        | n/a                                   |
| Aux Input Metering              | 26      | Float | R  | Value GG (Aux Input Voltage)                             | V        | -9999999 - 9999999                    |
| Aux Input Metering              | 26      | Float | R  | Value GG (Aux Input Current)                             | Amp      | -9999999 - 9999999                    |
| Tracking                        | 27      | Float | R  | Tracking Error GG  | %        | n/a                                   |
| Tracking Status                 | 28      | UINT8 | R  | DECS Regulator Meter<br>DECS<br>Internal Tracking Active | No Unit  | Not active=0, Active=1                |
| Tracking Status                 | 28      | UINT8 | R  | DECS Regulator Meter<br>DECS<br>External Tracking Active | No Unit  | Not active=0, Active=1                |
| Tracking Status                 | 28      | UINT8 | R  | DECS Control DECS Null<br>Balance                        | No Unit  | Not active=0, Active=1                |
| Control Panel Setpoint Metering | 29      | Float | R  | Gen Voltage Setpoint GG                                  | V        | 84 - 144                              |
| Control Panel Setpoint Metering | 29      | Float | R  | Excitation Current Setpoint GG                           | Amp      | 0 - 12                                |
| Control Panel Setpoint Metering | 29      | Float | R  | Excitation Voltage Setpoint GG                           | V        | 0 - 75                                |
| Control Panel Setpoint Metering | 29      | Float | R  | Gen Var Setpoint GG                                      | Kvar     | n/a                                   |
| Control Panel Setpoint Metering | 29      | Float | R  | Gen Pf Setpoint GG                                       | PF       | n/a                                   |
| Control Panel Status            | 30      | UINT8 | R  | DECS Control DECS Start<br>Stop                          | No Unit  | Stopped=0, Started=1                  |
| Control Panel Status            | 30      | UINT8 | R  | DECS Control DECS is in<br>Automatic Mode                | No Unit  | Not in automatic=0, In<br>automatic=1 |
| Control Panel Status            | 30      | UINT8 | R  | DECS Control DECS is in<br>Manual Mode                   | No Unit  | Not in manual=0, In<br>manual=1       |
| Control Panel Status            | 30      | UINT8 | R  | DECS Control DECS FCR<br>Controller Active               | No Unit  | FCR not active=0, FCR<br>active=1     |
| Control Panel Status            | 30      | UINT8 | R  | DECS Control DECS FVR<br>Controller Active               | No Unit  | FVR not active=0, FVR<br>active=1     |
| Control Panel Status            | 30      | UINT8 | R  | DECS Control DECS VAR<br>Controller Active               | No Unit  | VAR not active=0, VAR<br>active=1     |

| Instance Name        | Inst. # | Type  | RW | Key Name  | Unit    | Range  |
|----------------------|---------|-------|----|---|---------|--|
| Control Panel Status | 30      | UINT8 | R  | DECS Control DECS PF Controller Active                  | No Unit | PF not active=0, PF active=1   |
| Control Panel Status | 30      | UINT8 | R  | DECS Control DECS Preposition 1 Active                  | No Unit | Active setpoint is not at pre-position 1 value=0, Active setpoint is at pre-position 1 value=1 |
| Control Panel Status | 30      | UINT8 | R  | DECS Control DECS Preposition 2 Active                  | No Unit | Active setpoint is not at pre-position 2 value=0, Active setpoint is at pre-position 2 value=1 |
| Control Panel Status | 30      | UINT8 | R  | DECS Control DECS Preposition 3 Active                  | No Unit | Active setpoint is not at pre-position 3 value=0, Active setpoint is at pre-position 3 value=1 |
| Control Panel Status | 30      | UINT8 | R  | Virtual Switch 1  | No Unit | Open=0, Closed=1   |
| Control Panel Status | 30      | UINT8 | R  | Virtual Switch 2  | No Unit | Open=0, Closed=1   |
| Control Panel Status | 30      | UINT8 | R  | Virtual Switch 3  | No Unit | Open=0, Closed=1   |
| Control Panel Status | 30      | UINT8 | R  | Virtual Switch 4  | No Unit | Open=0, Closed=1   |
| Control Panel Status | 30      | UINT8 | R  | Virtual Switch 5  | No Unit | Open=0, Closed=1   |
| Control Panel Status | 30      | UINT8 | R  | Virtual Switch 6  | No Unit | Open=0, Closed=1   |
| Control Panel Status | 30      | UINT8 | R  | Alarm Report Alarm Output                               | No Unit | No active alarms=0, Active alarms=1  |
| Control Panel Status | 30      | UINT8 | R  | DECS PSS Meter DECS PSS Active                          | No Unit | PSS not active=0, PSS active=1   |
| Control Panel Status | 30      | UINT8 | R  | DECS Control DECS Null Balance                          | No Unit | Not active=0, Active=1   |
| System Status        | 31      | UINT8 | R  | Alarms OEL ALM  | No Unit | Not active=0, Active=1   |
| System Status        | 31      | UINT8 | R  | Alarms UEL ALM  | No Unit | Not active=0, Active=1   |
| System Status        | 31      | UINT8 | R  | Alarms SCL ALM  | No Unit | Not active=0, Active=1   |
| System Status        | 31      | UINT8 | R  | Alarms VAR LIMITER ACTIVE                               | No Unit | Not active=0, Active=1   |
| System Status        | 31      | UINT8 | R  | Alarms VOLTAGE MATCHING ACTIVE                          | No Unit | Not active=0, Active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS Soft Start Select Secondary Settings  | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS CONTROL DECS PSS Select Secondary Settings         | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS OEL Select Secondary Settings         | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS UEL Select Secondary Settings         | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS SCL Select Secondary Settings         | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS Protect Select Secondary Settings     | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS PID Select Secondary Settings         | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS VAR Limiter Select Secondary Settings | No Unit | Primary settings active=0, Secondary settings active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS Preposition                           | No Unit | Active setpoint is not at a pre-position value=0, Active setpoint is at a pre-position value=1 |
| System Status        | 31      | UINT8 | R  | DECS Control DECS VAR Controller Active                 | No Unit | VAR not active=0, VAR active=1   |
| System Status        | 31      | UINT8 | R  | DECS Control DECS PF Controller Active                  | No Unit | PF not active=0, PF active=1   |

| Instance Name          | Inst. # | Type  | RW | Key Name                                     | Unit    | Range  |
|------------------------|---------|-------|----|--|---------|--|
| System Status          | 31      | UINT8 | R  | DECS Control DECS Auto Mode Enable           | No Unit | Auto mode not enabled via PLC=0, Auto mode enabled via PLC=1     |
| System Status          | 31      | UINT8 | R  | DECS Control DECS Manual Mode Enable         | No Unit | Manual mode not enabled via PLC=0, Manual mode enabled via PLC=1 |
| System Status          | 31      | UINT8 | R  | DECS Control DECS FVR Controller Active      | No Unit | FVR not active=0, FVR active=1                                   |
| System Status          | 31      | UINT8 | R  | DECS Control DECS FCR Controller Active      | No Unit | FCR not active=0, FCR active=1                                   |
| System Status          | 31      | UINT8 | R  | DECS Control DECS Field Flashing in Progress | No Unit | Field flashing not in progress=0, Field flashing in progress=1   |
| System Status          | 31      | UINT8 | R  | DECS Control DECS IS in Manual Mode          | No Unit | Not in manual=0, In manual=1                                     |
| System Status          | 31      | UINT8 | R  | DECS Control DECS is in Automatic Mode       | No Unit | Not in automatic=0, In automatic=1                               |
| System Status          | 31      | UINT8 | R  | DECS Control DECS PSS Output Disable         | No Unit | PSS not disabled via PLC=0, PSS disabled via PLC=1               |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Start Input                   | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Stop Input                    | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 1                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 2                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 3                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 4                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 5                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 6                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 7                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 8                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 9                       | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 10                      | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 11                      | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 12                      | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 13                      | No Unit | Open=0, Closed=1   |
| Contact Input Status   | 32      | UINT8 | R  | Contact Inputs Input 14                      | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 1                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 2                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 3                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 4                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 5                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 6                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 7                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 8                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 9                                  | No Unit | Open=0, Closed=1   |
| CEM Input Status       | 33      | UINT8 | R  | CEM Input 10                                 | No Unit | Open=0, Closed=1   |
| AEM Analog Input Meter | 34      | Float | R  | Analog Input 1 Raw Value GG                  | V or mA | 0 - 10 V or 4 - 20 mA  |
| AEM Analog Input Meter | 34      | Float | R  | Analog Input 2 Raw Value GG                  | V or mA | 0 - 10 V or 4 - 20 mA  |
| AEM Analog Input Meter | 34      | Float | R  | Analog Input 3 Raw Value GG                  | V or mA | 0 - 10 V or 4 - 20 mA  |
| AEM Analog Input Meter | 34      | Float | R  | Analog Input 4 Raw Value GG                  | V or mA | 0 - 10 V or 4 - 20 mA  |
| AEM Analog Input Meter | 34      | Float | R  | Analog Input 5 Raw Value GG                  | V or mA | 0 - 10 V or 4 - 20 mA  |

| Instance Name           | Inst. # | Type  | RW | Key Name                            | Unit    | Range                                  |
|-------------------------|---------|-------|----|-------------------------------------|---------|--|
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 6 Raw Value GG         | V or mA | 0 - 10 V or 4 - 20 mA                  |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 7 Raw Value GG         | V or mA | 0 - 10 V or 4 - 20 mA                  |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 8 Raw Value GG         | V or mA | 0 - 10 V or 4 - 20 mA                  |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 1 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 2 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 3 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 4 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 5 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 6 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 7 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Meter  | 34      | Float | R  | Analog Input 8 Scaled Value GG      | No Unit | n/a                                    |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 1 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 2 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 3 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 4 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 5 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 6 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 7 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Config AEM Input 8 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 1 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 1 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 1 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 1 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 2 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 2 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 2 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 2 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 3 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 3 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 3 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 3 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |

| Instance Name           | Inst. # | Type  | RW | Key Name                       | Unit    | Range                    |
|-------------------------|---------|-------|----|--------------------------------|---------|--------------------------|
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 4 Thresh 1 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 4 Thresh 2 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 4 Thresh 3 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 4 Thresh 4 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 5 Thresh 1 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 5 Thresh 2 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 5 Thresh 3 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 5 Thresh 4 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 6 Thresh 1 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 6 Thresh 2 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 6 Thresh 3 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 6 Thresh Trip   | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 7 Thresh 1 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 7 Thresh 2 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 7 Thresh 3 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 7 Thresh 4 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 8 Thresh 1 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 8 Thresh 2 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 8 Thresh 3 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM Analog Input Status | 35      | UINT8 | R  | AEM Protection 8 Thresh 4 Trip | No Unit | Not tripped=0, Tripped=1 |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 1 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 2 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 3 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 4 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 5 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 6 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 7 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 8 Raw Value GG       | Ohm     | n/a                      |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 1 Scaled Value GG    | Deg F   | -40000 - 9999999         |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 2 Scaled Value GG    | Deg F   | -40000 - 9999999         |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 3 Scaled Value GG    | Deg F   | -40000 - 9999999         |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 4 Scaled Value GG    | Deg F   | -40000 - 9999999         |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 5 Scaled Value GG    | Deg F   | -40000 - 9999999         |
| AEM RTD Input Meter     | 36      | Float | R  | RTD Input 6 Scaled Value GG    | Deg F   | -40000 - 9999999         |

| Instance Name        | Inst. # | Type  | RW | Key Name                            | Unit    | Range                                  |
|----------------------|---------|-------|----|-------------------------------------|---------|--|
| AEM RTD Input Meter  | 36      | Float | R  | RTD Input 7 Scaled Value GG         | Deg F   | -40000 - 9999999                       |
| AEM RTD Input Meter  | 36      | Float | R  | RTD Input 8 Scaled Value GG         | Deg F   | -40000 - 9999999                       |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 1 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 2 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 3 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 4 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 5 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 6 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 7 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | AEM Config RTD Input 8 Out of Range | No Unit | Value in range=0, Value out of range=1 |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 1 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 1 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 1 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 1 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 2 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 2 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 2 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 2 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 3 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 3 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 3 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 3 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 4 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 4 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 4 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 4 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 5 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 5 Thresh 2 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 5 Thresh 3 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 5 Thresh 4 Trip      | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status | 37      | UINT8 | R  | RTD Protection 6 Thresh 1 Trip      | No Unit | Not tripped=0, Tripped=1               |

| Instance Name         | Inst. # | Type  | RW | Key Name                                | Unit    | Range                                  |
|-----------------------|---------|-------|----|---|---------|--|
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 6 Thresh 2 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 6 Thresh 3 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 6 Thresh 4 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 7 Thresh 1 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 7 Thresh 2 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 7 Thresh 3 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 7 Thresh 4 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 8 Thresh 1 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 8 Thresh 2 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 8 Thresh 3 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM RTD Input Status  | 37      | UINT8 | R  | RTD Protection 8 Thresh 4 Trip          | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Meter    | 38      | Float | R  | Thermocouple Input 1 Raw Value GG       | mV      | n/a                                    |
| AEM TC Input Meter    | 38      | Float | R  | Thermocouple Input 2 Raw Value GG       | mV      | n/a                                    |
| AEM TC Input Meter    | 38      | Float | R  | Thermocouple Input 1 Scaled Value GG    | Deg F   | n/a                                    |
| AEM TC Input Meter    | 38      | Float | R  | Thermocouple Input 2 Scaled Value GG    | Deg F   | n/a                                    |
| AEM TC Input Status   | 39      | UINT8 | R  | AEM Config Thermocouple 1 Out of Range  | No Unit | Value in range=0, Value out of range=1 |
| AEM TC Input Status   | 39      | UINT8 | R  | AEM Config Thermocouple 2 Out of Range  | No Unit | Value in range=0, Value out of range=1 |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 1 Thresh 1 Trip | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 1 Thresh 2 Trip | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 1 Thresh 3 Trip | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 1 Thresh 4 Trip | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 2 Thresh 1 Trip | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 2 Thresh 2 Trip | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 2 Thresh 3 Trip | No Unit | Not tripped=0, Tripped=1               |
| AEM TC Input Status   | 39      | UINT8 | R  | Thermocouple Protection 2 Thresh 4 Trip | No Unit | Not tripped=0, Tripped=1               |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Watchdog Output         | No Unit | Open=0, Closed=1                       |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Output 1                | No Unit | Open=0, Closed=1                       |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Output 2                | No Unit | Open=0, Closed=1                       |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Output 3                | No Unit | Open=0, Closed=1                       |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Output 4                | No Unit | Open=0, Closed=1                       |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Output 5                | No Unit | Open=0, Closed=1                       |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Output 6                | No Unit | Open=0, Closed=1                       |
| Contact Output Status | 40      | UINT8 | R  | Contact Outputs Output 7                | No Unit | Open=0, Closed=1                       |

| Instance Name                  | Inst. # | Type  | RW | Key Name   | Unit    | Range                                  |
|--------------------------------|---------|-------|----|--|---------|--|
| Contact Output Status          | 40      | UINT8 | R  | Contact Outputs Output 8   | No Unit | Open=0, Closed=1                       |
| Contact Output Status          | 40      | UINT8 | R  | Contact Outputs Output 9   | No Unit | Open=0, Closed=1                       |
| Contact Output Status          | 40      | UINT8 | R  | Contact Outputs Output 10  | No Unit | Open=0, Closed=1                       |
| Contact Output Status          | 40      | UINT8 | R  | Contact Outputs Output 11  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 1   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 2   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 3   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 4   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 5   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 6   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 7   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 8   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 9   | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 10  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 11  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 12  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 13  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 14  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 15  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 16  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 17  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 18  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 19  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 20  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 21  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 22  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 23  | No Unit | Open=0, Closed=1                       |
| CEM Output Status              | 41      | UINT8 | R  | CEM Output 24  | No Unit | Open=0, Closed=1                       |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 1 Raw Value GG                                       | V or mA | 0 – 10 V or 4 – 20 mA                  |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 2 Raw Value GG                                       | V or mA | 0 – 10 V or 4 – 20 mA                  |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 3 Raw Value GG                                       | V or mA | 0 – 10 V or 4 – 20 mA                  |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 4 Raw Value GG                                       | V or mA | 0 – 10 V or 4 – 20 mA                  |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 1 Scaled Value GG                                    | No Unit | n/a                                    |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 2 Scaled Value GG                                    | No Unit | n/a                                    |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 3 Scaled Value GG                                    | No Unit | n/a                                    |
| AEM Analog Output Meter        | 42      | Float | R  | Analog Output 4 Scaled Value GG                                    | No Unit | n/a                                    |
| AEM Analog Output Status       | 43      | UINT8 | R  | Remote Analog Output 1 Out of Range                                | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Output Status       | 43      | UINT8 | R  | Remote Analog Output 2 Out of Range                                | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Output Status       | 43      | UINT8 | R  | Remote Analog Output 3 Out of Range                                | No Unit | Value in range=0, Value out of range=1 |
| AEM Analog Output Status       | 43      | UINT8 | R  | Remote Analog Output 4 Out of Range                                | No Unit | Value in range=0, Value out of range=1 |
| Configurable Protection Status | 44      | UINT8 | R  | Configurable Protection 1 Configurable Protection Threshold 1 Trip | No Unit | Not tripped=0, Tripped=1               |



| Instance Name                           | Inst. # | Type   | RW | Key Name   | Unit    | Range   |
|---|---------|--------|----|--|---------|---|
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 6<br>Configurable Protection<br>Threshold 4 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 7<br>Configurable Protection<br>Threshold 1 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 7<br>Configurable Protection<br>Threshold 2 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 7<br>Configurable Protection<br>Threshold 3 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 7<br>Configurable Protection<br>Threshold 4 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 8<br>Configurable Protection<br>Threshold 1 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 8<br>Configurable Protection<br>Threshold 2 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 8<br>Configurable Protection<br>Threshold 3 Trip | No Unit | Not tripped=0, Tripped=1  |
| Configurable Protection Status          | 44      | UINT8  | R  | Configurable Protection 8<br>Configurable Protection<br>Threshold 4 Trip | No Unit | Not tripped=0, Tripped=1  |
| Real Time Clock                         | 45      | String | R  | Date GG  | No Unit | 0 – 16 characters   |
| Real Time Clock                         | 45      | String | R  | Time GG  | No Unit | 0 – 16 characters   |
| Front Panel Settings                    | 46      | UINT32 | R  | LCD Contrast GG  | %       | 0 - 100   |
| Front Panel Settings                    | 46      | UINT32 | R  | LCD Invert Display GG  | No Unit | No=0 Yes=1  |
| Front Panel Settings                    | 46      | UINT32 | R  | LCD Sleep Mode GG  | No Unit | Disabled=0 Enabled=1  |
| Front Panel Settings                    | 46      | UINT32 | R  | LCD Backlight Timeout GG   | Sec     | 1 - 120   |
| Front Panel Settings                    | 46      | UINT32 | R  | LCD Language Selection<br>GG   | No Unit | English=0 Chinese=1<br>Russian=2 French=3<br>Spanish=4 German=5<br>Portuguese=6 |
| Front Panel Settings                    | 46      | UINT32 | R  | Enable Scroll GG   | No Unit | Disabled=0 Enabled=1  |
| Front Panel Settings                    | 46      | UINT32 | R  | Scroll Time Delay GG   | Sec     | 1 - 600   |
| DECS-450 Device Info App<br>Version     | 47      | String | R  | External Version GG  | No Unit | 0 - 25 characters   |
| DECS-450 Device Info Boot<br>Version    | 48      | String | R  | External Boot<br>Version GG  | No Unit | 0 - 25 characters   |
| DECS-450 Device Info App<br>Build Date  | 49      | String | R  | App Build Date GG  | No Unit | 0 - 25 characters   |
| DECS-450 Device Info<br>Serial          | 50      | String | R  | Serial Number GG   | No Unit | 0 - 32 characters   |
| DECS-450 Device Info App<br>Part Number | 51      | String | R  | Firmware Part<br>Number GG   | No Unit | 0 - 64 characters   |
| DECS-450 Device Info<br>Model           | 52      | String | R  | Model Number GG  | No Unit | 0 - 64 characters   |
| AEM Device Info App<br>Version          | 53      | String | R  | App Version Number GG  | No Unit | 0 - 25 characters   |
| AEM Device Info Boot<br>Version         | 54      | String | R  | Boot Version Number GG   | No Unit | 0 - 25 characters   |
| AEM Device Info Build Date              | 55      | String | R  | App Build Date GG  | No Unit | 0 - 25 characters   |
| AEM Device Info Serial                  | 56      | String | R  | Serial Number GG   | No Unit | 0 - 25 characters   |
| AEM Device Info App Part<br>Number      | 57      | String | R  | App Part Number GG   | No Unit | 0 - 25 characters   |
| AEM Device Info Model                   | 58      | String | R  | Model Number GG  | No Unit | 0 - 25 characters   |
| CEM Device Info App<br>Version          | 59      | String | R  | App Version Number GG  | No Unit | 0 - 25 characters   |

| Instance Name                   | Inst. # | Type   | RW  | Key Name                                 | Unit    | Range                |
|---------------------------------|---------|--------|-----|--|---------|----------------------|
| CEM Device Info Boot Version    | 60      | String | R   | Boot Version Number GG                   | No Unit | 0 - 25 characters    |
| CEM Device Info App Build Date  | 61      | String | R   | App Build Date GG                        | No Unit | 0 - 25 characters    |
| CEM Device Info Serial          | 62      | String | R   | Serial Number GG                         | No Unit | 0 - 25 characters    |
| CEM Device Info App Part Number | 63      | String | R   | App Part Number GG                       | No Unit | 0 - 25 characters    |
| CEM Device Info Model           | 64      | String | R   | Model Number GG                          | No Unit | 0 - 25 characters    |
| System Parameter                | 65      | UINT32 | R/W | Nominal Frequency GG                     | No Unit | 50 Hz=50 60 Hz=60    |
| System Parameter                | 66      | Float  | R/W | Rated Primary LL GG (Gen Voltage Config) | V       | 1 - 500000           |
| System Parameter                | 66      | Float  | R/W | Rated Primary LL GG (Bus Voltage Config) | V       | 1 - 500000           |
| System Parameter                | 66      | Float  | R/W | Rated PF GG                              | PF      | 0.5 - -0.5           |
| System Parameter                | 66      | Float  | R/W | Rated KVA GG                             | KVA     | 1 - 2000000          |
| System Parameter                | 66      | Float  | R/W | Rated Field Volt Full Load GG            | V       | 1 - 1000             |
| System Parameter                | 66      | Float  | R/W | Rated Field Volt No Load GG              | V       | 1 - 1000             |
| System Parameter                | 66      | Float  | R/W | Rated Field Current Full Load GG         | Amp     | 0.1 - 10000          |
| System Parameter                | 66      | Float  | R/W | Rated Field Current No Load GG           | Amp     | 0.1 - 10000          |
| System Parameter                | 66      | Float  | R/W | Exciter Pole Ratio GG                    | No Unit | 1 - 10               |
| AVR Setpoints                   | 67      | UINT32 | R/W | Gen Voltage Preposition Mode 1 GG        | No Unit | Maintain=0 Release=1 |
| AVR Setpoints                   | 67      | UINT32 | R/W | Gen Voltage Preposition Mode 2 GG        | No Unit | Maintain=0 Release=1 |
| AVR Setpoints                   | 67      | UINT32 | R/W | Gen Voltage Preposition Mode 3 GG        | No Unit | Maintain=0 Release=1 |
| AVR Setpoints                   | 68      | Float  | R/W | Gen Voltage Traverse Rate GG             | Sec     | 10 - 200             |
| AVR Setpoints                   | 68      | Float  | R/W | Gen Voltage Setpoint GG                  | V       | 84 - 144             |
| AVR Setpoints                   | 68      | Float  | R/W | Gen Voltage Min Setpoint Limit GG        | %       | 70 - 120             |
| AVR Setpoints                   | 68      | Float  | R/W | Gen Voltage Max Setpoint Limit GG        | %       | 70 - 120             |
| AVR Setpoints                   | 68      | Float  | R/W | Gen Voltage Preposition1 GG              | V       | 84 - 144             |
| AVR Setpoints                   | 68      | Float  | R/W | Gen Voltage Preposition2 GG              | V       | 84 - 144             |
| AVR Setpoints                   | 68      | Float  | R/W | Gen Voltage Preposition3 GG              | V       | 84 - 144             |
| FCR Setpoints                   | 69      | UINT32 | R/W | Excitation Current Preposition Mode 1 GG | No Unit | Maintain=0 Release=1 |
| FCR Setpoints                   | 69      | UINT32 | R/W | Excitation Current Preposition Mode 2 GG | No Unit | Maintain=0 Release=1 |
| FCR Setpoints                   | 69      | UINT32 | R/W | Excitation Current Preposition Mode 3 GG | No Unit | Maintain=0 Release=1 |
| FCR Setpoints                   | 70      | Float  | R/W | Excitation Current Traverse Rate GG      | Sec     | 10 - 200             |
| FCR Setpoints                   | 70      | Float  | R/W | Excitation Current Setpoint GG           | Amp     | 0 - 12               |
| FCR Setpoints                   | 70      | Float  | R/W | Excitation Current Min Setpoint Limit GG | %       | 0 - 120              |
| FCR Setpoints                   | 70      | Float  | R/W | Excitation Current Max Setpoint Limit GG | %       | 0 - 120              |

| Instance Name | Inst. # | Type   | RW  | Key Name                                 | Unit     | Range                |
|---------------|---------|--------|-----|--|----------|----------------------|
| FCR Setpoints | 70      | Float  | R/W | Excitation Current Preposition 1 GG      | Amp      | 0 - 12               |
| FCR Setpoints | 70      | Float  | R/W | Excitation Current Preposition 2 GG      | Amp      | 0 - 12               |
| FCR Setpoints | 70      | Float  | R/W | Excitation Current Preposition 3 GG      | Amp      | 0 - 12               |
| FVR Setpoints | 71      | UINT32 | R/W | Excitation Voltage Preposition Mode 1 GG | No Unit  | Maintain=0 Release=1 |
| FVR Setpoints | 71      | UINT32 | R/W | Excitation Voltage Preposition Mode 2 GG | No Unit  | Maintain=0 Release=1 |
| FVR Setpoints | 71      | UINT32 | R/W | Excitation Voltage Preposition Mode 3 GG | No Unit  | Maintain=0 Release=1 |
| FVR Setpoints | 72      | Float  | R/W | Excitation Voltage Traverse Rate GG      | Sec      | 10 - 200             |
| FVR Setpoints | 72      | Float  | R/W | Excitation Voltage Setpoint GG           | V        | 0 - 75               |
| FVR Setpoints | 72      | Float  | R/W | Excitation Voltage Min Setpoint Limit GG | %        | 0 - 150              |
| FVR Setpoints | 72      | Float  | R/W | Excitation Voltage Max Setpoint Limit GG | %        | 0 - 150              |
| FVR Setpoints | 72      | Float  | R/W | Excitation Voltage Preposition 1 GG      | V        | 0 - 75               |
| FVR Setpoints | 72      | Float  | R/W | Excitation Voltage Preposition 2 GG      | V        | 0 - 75               |
| FVR Setpoints | 72      | Float  | R/W | Excitation Voltage Preposition 3 GG      | V        | 0 - 75               |
| VAR Setpoints | 73      | UINT32 | R/W | Gen Var Preposition Mode1 GG             | No Unit  | Maintain=0 Release=1 |
| VAR Setpoints | 73      | UINT32 | R/W | Gen Var Preposition Mode2 GG             | No Unit  | Maintain=0 Release=1 |
| VAR Setpoints | 73      | UINT32 | R/W | Gen Var Preposition Mode 3 GG            | No Unit  | Maintain=0 Release=1 |
| VAR Setpoints | 74      | Float  | R/W | Sys Option Fine Adjust Band GG           | %        | 0 - 30               |
| VAR Setpoints | 74      | Float  | R/W | Gen Var Traverse Rate GG                 | Sec      | 10 - 200             |
| VAR Setpoints | 74      | Float  | R/W | Gen Var Setpoint GG                      | Per Unit | 0 - 1.001            |
| VAR Setpoints | 74      | Float  | R/W | Gen Var Min Setpoint Limit GG            | %        | -100 - 100           |
| VAR Setpoints | 74      | Float  | R/W | Gen Var Max Setpoint Limit GG            | %        | -100 - 100           |
| VAR Setpoints | 74      | Float  | R/W | Gen var Preposition 1 GG                 | Per Unit | 0 - 1.001            |
| VAR Setpoints | 74      | Float  | R/W | Gen var Preposition 2 GG                 | Per Unit | 0 - 1.001            |
| VAR Setpoints | 74      | Float  | R/W | Gen var Preposition 3 GG                 | Per Unit | 0 - 1.001            |
| PF Setpoints  | 75      | UINT32 | R/W | Gen PF Preposition Mode 1 GG             | No Unit  | Maintain=0 Release=1 |
| PF Setpoints  | 75      | UINT32 | R/W | Gen PF Preposition Mode 2 GG             | No Unit  | Maintain=0 Release=1 |
| PF Setpoints  | 75      | UINT32 | R/W | Gen PF Preposition Mode 3 GG             | No Unit  | Maintain=0 Release=1 |
| PF Setpoints  | 76      | Float  | R/W | Gen PF Traverse Rate GG                  | Sec      | 10 - 200             |
| PF Setpoints  | 76      | Float  | R/W | Gen PF Setpoint GG                       | PF       | 0.5 - -0.5           |
| PF Setpoints  | 76      | Float  | R/W | Gen PF Min Setpoint Limit GG             | PF       | 0.5 - 1              |

| Instance Name      | Inst. # | Type   | RW  | Key Name                               | Unit    | Range  |
|--------------------|---------|--------|-----|--|---------|--|
| PF Setpoints       | 76      | Float  | R/W | Gen Pf Max Setpoint Limit GG           | PF      | -1 - -0.5  |
| PF Setpoints       | 76      | Float  | R/W | Gen PF Preposition 1 GG                | PF      | 0.5 -- -0.5  |
| PF Setpoints       | 76      | Float  | R/W | Gen PF preposition 2 GG                | PF      | 0.5 -- -0.5  |
| PF Setpoints       | 76      | Float  | R/W | Gen PF Preposition 3 GG                | PF      | 0.5 -- -0.5  |
| Aux Input Settings | 77      | UINT32 | R/W | DECS Aux Input Mode GG                 | No Unit | Voltage=0 Current=1  |
| Aux Input Settings | 77      | UINT32 | R/W | DECS Aux Summing Mode GG               | No Unit | Voltage=0 Var=1  |
| Aux Input Settings | 77      | UINT32 | R/W | DECS Aux Input Function GG             | No Unit | DECS Input=0 PSS Test Input=1 Limiter Selection=2 No Control=4 |
| Aux Input Settings | 78      | Float  | R/W | DECS Aux Voltage Gain GG               | No Unit | -99 - 99   |
| Aux Input Settings | 78      | Float  | R/W | DECS Aux FCR Gain GG                   | No Unit | -99 - 99   |
| Aux Input Settings | 78      | Float  | R/W | DECS Aux FVR Gain GG                   | No Unit | -99 - 99   |
| Aux Input Settings | 78      | Float  | R/W | DECS Aux var Gain GG                   | No Unit | -99 - 99   |
| Aux Input Settings | 78      | Float  | R/W | DECS Aux PF Gain GG                    | No Unit | -99 - 99   |
| Parallel/Line Drop | 79      | UINT32 | R/W | Sys Option Input Droop Enabled GG      | No Unit | Disabled=0 Enabled=1   |
| Parallel/Line Drop | 79      | UINT32 | R/W | Sys Option Input L Drop Enabled GG     | No Unit | Disabled=0 Enabled=1   |
| Parallel/Line Drop | 79      | UINT32 | R/W | Sys Option Input CC Enabled GG         | No Unit | Disabled=0 Enabled=1   |
| Parallel/Line Drop | 80      | Float  | R/W | Droop Value GG                         | %       | 0 - 30   |
| Parallel/Line Drop | 80      | Float  | R/W | L Drop Value GG                        | %       | 0 - 30   |
| Parallel/Line Drop | 80      | Float  | R/W | DECS Aux Amp Gain GG                   | %       | -30 - 30   |
| Load Share         | 81      | UINT32 | R/W | LS Enable GG                           | No Unit | Disabled=0 Enabled=1   |
| Load Share         | 82      | Float  | R/W | LS Droop Percent GG                    | %       | 0 - 30   |
| Load Share         | 82      | Float  | R/W | LS Gain GG                             | No Unit | 0 - 1000   |
| Load Share         | 82      | Float  | R/W | Washout Filter Time Constant GG        | No Unit | 0 - 1  |
| Load Share         | 82      | Float  | R/W | Washout Filter Gain GG                 | No Unit | 0 - 1000   |
| Load Share         | 82      | Float  | R/W | Disable Time Delay GG                  | Sec     | 1 - 3600   |
| Load Share         | 82      | Float  | R/W | Reserved GG                            | No Unit | 0 - 1000   |
| Load Share         | 82      | Float  | R/W | LS Ki Gain GG                          | No Unit | 0 - 1000   |
| Load Share         | 82      | Float  | R/W | LS Max Vc GG                           | No Unit | 0 - 1  |
| Auto Tracking      | 83      | UINT32 | R/W | Sys Input Comport Int Track Enabled GG | No Unit | Disabled=0 Enabled=1   |
| Auto Tracking      | 83      | UINT32 | R/W | Sys Input Comport Ext Track Enabled GG | No Unit | Disabled=0 Enabled=1   |
| Auto Tracking      | 84      | Float  | R/W | DECS Auto Track T Delay GG             | Sec     | 0 - 8  |
| Auto Tracking      | 84      | Float  | R/W | DECS Auto Track T Rate GG              | Sec     | 1 - 80   |
| Auto Tracking      | 84      | Float  | R/W | DECS Auto Trans T Delay GG             | Sec     | 0 - 8  |
| Auto Tracking      | 84      | Float  | R/W | DECS Auto Trans T Rate GG              | Sec     | 1 - 80   |
| Startup            | 86      | Float  | R/W | Startup Primary Soft Start Bias GG     | %       | 0 - 90   |
| Startup            | 86      | Float  | R/W | Startup Primary Soft Start Time GG     | Sec     | 1 - 7200   |
| Startup            | 86      | Float  | R/W | Startup Sec Soft Start Bias GG         | %       | 0 - 90   |
| Startup            | 86      | Float  | R/W | Startup Sec Soft Start Time GG         | Sec     | 1 - 7200   |

| Instance Name | Inst. # | Type   | RW  | Key Name                  | Unit    | Range  |
|---------------|---------|--------|-----|---------------------------|---------|--|
| Startup       | 86      | Float  | R/W | DECS Field Flash Level GG | No Unit | 0 - 100  |
| Startup       | 86      | Float  | R/W | DECS Field Flash Time GG  | No Unit | 1 - 50   |
| AVR Gains     | 87      | UINT32 | R/W | Primary Gain Option GG    | No Unit | TpdoEQ1pt0 TeEQ0pt17=1<br>TpdoEQ1pt5 TeEQ0pt25=2<br>TpdoEQ2pt0 TeEQ0pt33=3<br>TpdoEQ2pt5 TeEQ0pt42=4<br>TpdoEQ3pt0 TeEQ0pt50=5<br>TpdoEQ3pt5 TeEQ0pt58=6<br>TpdoEQ4pt0 TeEQ0pt67=7<br>TpdoEQ4pt5 TeEQ0pt75=8<br>TpdoEQ5pt0 TeEQ0pt83=9<br>TpdoEQ5pt5<br>TeEQ0pt92=10<br>TpdoEQ6pt0<br>TeEQ1pt00=11<br>TpdoEQ6pt5<br>TeEQ1pt08=12<br>TpdoEQ7pt0<br>TeEQ1pt17=13<br>TpdoEQ7pt5<br>TeEQ1pt25=14<br>TpdoEQ8pt0<br>TeEQ1pt33=15<br>TpdoEQ8pt5<br>TeEQ1pt42=16<br>TpdoEQ9pt0<br>TeEQ1pt50=17<br>TpdoEQ9pt5<br>TeEQ1pt58=18<br>TpdoEQ10pt0<br>TeEQ1pt67=19<br>TpdoEQ10pt5<br>TeEQ1pt75=20 Custom=21 |
| AVR Gains     | 87      | UINT32 | R/W | Secondary Gain Option GG  | No Unit | TpdoEQ1pt0 TeEQ0pt17=1<br>TpdoEQ1pt5 TeEQ0pt25=2<br>TpdoEQ2pt0 TeEQ0pt33=3<br>TpdoEQ2pt5 TeEQ0pt42=4<br>TpdoEQ3pt0 TeEQ0pt50=5<br>TpdoEQ3pt5 TeEQ0pt58=6<br>TpdoEQ4pt0 TeEQ0pt67=7<br>TpdoEQ4pt5 TeEQ0pt75=8<br>TpdoEQ5pt0 TeEQ0pt83=9<br>TpdoEQ5pt5<br>TeEQ0pt92=10<br>TpdoEQ6pt0<br>TeEQ1pt00=11<br>TpdoEQ6pt5<br>TeEQ1pt08=12<br>TpdoEQ7pt0<br>TeEQ1pt17=13<br>TpdoEQ7pt5<br>TeEQ1pt25=14<br>TpdoEQ8pt0<br>TeEQ1pt33=15<br>TpdoEQ8pt5<br>TeEQ1pt42=16<br>TpdoEQ9pt0<br>TeEQ1pt50=17<br>TpdoEQ9pt5<br>TeEQ1pt58=18<br>TpdoEQ10pt0<br>TeEQ1pt67=19<br>TpdoEQ10pt5<br>TeEQ1pt75=20 Custom=21 |
| AVR Gains     | 88      | Float  | R/W | AVR Kp Primary GG         | No Unit | 0 - 1000   |
| AVR Gains     | 88      | Float  | R/W | AVR Ki Primary GG         | No Unit | 0 - 1000   |
| AVR Gains     | 88      | Float  | R/W | AVR Kd Primary GG         | No Unit | 0 - 1000   |
| AVR Gains     | 88      | Float  | R/W | AVR Td Primary GG         | No Unit | 0 - 1  |
| AVR Gains     | 88      | Float  | R/W | AVR Kg Primary GG         | No Unit | 0 - 1000   |
| AVR Gains     | 88      | Float  | R/W | AVR Kp Sec GG             | No Unit | 0 - 1000   |
| AVR Gains     | 88      | Float  | R/W | AVR Ki Sec GG             | No Unit | 0 - 1000   |
| AVR Gains     | 88      | Float  | R/W | AVR Kd Sec GG             | No Unit | 0 - 1000   |

| Instance Name       | Inst. # | Type   | RW  | Key Name                                 | Unit    | Range                |
|---------------------|---------|--------|-----|--|---------|----------------------|
| AVR Gains           | 88      | Float  | R/W | AVR Td Sec GG                            | No Unit | 0 - 1                |
| AVR Gains           | 88      | Float  | R/W | AVR Kg Sec GG                            | No Unit | 0 - 1000             |
| FCR Gains           | 90      | Float  | R/W | FCR Kp GG                                | No Unit | 0 - 1000             |
| FCR Gains           | 90      | Float  | R/W | FCR Ki GG                                | No Unit | 0 - 1000             |
| FCR Gains           | 90      | Float  | R/W | FCR Kd GG                                | No Unit | 0 - 1000             |
| FCR Gains           | 90      | Float  | R/W | FCR Td GG                                | No Unit | 0 - 1                |
| FCR Gains           | 90      | Float  | R/W | FCR Kg GG                                | No Unit | 0 - 1000             |
| FVR Gains           | 92      | Float  | R/W | FVR Kp GG                                | No Unit | 0 - 1000             |
| FVR Gains           | 92      | Float  | R/W | FVR Ki GG                                | No Unit | 0 - 1000             |
| FVR Gains           | 92      | Float  | R/W | FVR Kd GG                                | No Unit | 0 - 1000             |
| FVR Gains           | 92      | Float  | R/W | FVR Td GG                                | No Unit | 0 - 1                |
| FVR Gains           | 92      | Float  | R/W | FVR Kg GG                                | No Unit | 0 - 1000             |
| VAR Gains           | 94      | Float  | R/W | Var Ki GG                                | No Unit | 0 - 1000             |
| VAR Gains           | 94      | Float  | R/W | Var Kg GG                                | No Unit | 0 - 1000             |
| PF Gains            | 96      | Float  | R/W | PF Ki GG                                 | No Unit | 0 - 1000             |
| PF Gains            | 96      | Float  | R/W | PF Kg GG                                 | No Unit | 0 - 1000             |
| OEL Gains           | 98      | Float  | R/W | OEL Ki GG                                | No Unit | 0 - 1000             |
| OEL Gains           | 98      | Float  | R/W | OEL Kg GG                                | No Unit | 0 - 1000             |
| UEL Gains           | 100     | Float  | R/W | UEL Ki GG                                | No Unit | 0 - 1000             |
| UEL Gains           | 100     | Float  | R/W | UEL Kg GG                                | No Unit | 0 - 1000             |
| SCL Gains           | 102     | Float  | R/W | SCL Ki GG                                | No Unit | 0 - 1000             |
| SCL Gains           | 102     | Float  | R/W | SCL Kg GG                                | No Unit | 0 - 1000             |
| VAR Limiter Gains   | 104     | Float  | R/W | Var Limit Ki GG                          | No Unit | 0 - 1000             |
| VAR Limiter Gains   | 104     | Float  | R/W | Var Limit Kg GG                          | No Unit | 0 - 1000             |
| Voltage Match Gains | 106     | Float  | R/W | Vm Ki GG                                 | No Unit | 0 - 1000             |
| Voltage Match Gains | 106     | Float  | R/W | Vm Kg GG                                 | No Unit | 0 - 1000             |
| OEL Configure       | 107     | UINT32 | R/W | Sys Option Input<br>OEL Enabled GG       | No Unit | Disabled=0 Enabled=1 |
| OEL Configure       | 107     | UINT32 | R/W | Sys Option Input OEL<br>Style Enabled GG | No Unit | Summing=0 Takeover=1 |
| OEL Configure       | 107     | UINT32 | R/W | OEL Pri Dvdt Enable GG                   | No Unit | Disabled=0 Enabled=1 |
| OEL Configure       | 108     | Float  | R/W | OEL Pri Dvdt Ref GG                      | No Unit | -10 - 0              |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Cur Hi GG                        | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Cur Mid GG                       | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Cur Lo GG                        | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Time Hi GG                       | Sec     | 0 - 240              |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Time Mid GG                      | Sec     | 0 - 240              |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Cur Hi Off GG                    | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Cur Lo Off GG                    | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Pri Cur Time Off GG                  | Sec     | 0 - 240              |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Cur Hi GG                        | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Cur Mid GG                       | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Cur Lo GG                        | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Time Hi GG                       | Sec     | 0 - 240              |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Time Mid GG                      | Sec     | 0 - 240              |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Cur Hi Off GG                    | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Cur Lo Off GG                    | Amp     | 0 - 12000            |
| OEL Summing Point   | 110     | Float  | R/W | OEL Sec Cur Time Off GG                  | Sec     | 0 - 240              |
| OEL Takeover        | 112     | Float  | R/W | OEL Pri Takeover<br>Cur Max Off GG       | Amp     | 0 - 12000            |
| OEL Takeover        | 112     | Float  | R/W | OEL Pri Takeover<br>Cur Min Off GG       | Amp     | 0 - 12000            |

| Instance Name             | Inst. # | Type   | RW  | Key Name                             | Unit    | Range                |
|---------------------------|---------|--------|-----|--------------------------------------|---------|----------------------|
| OEL Takeover              | 112     | Float  | R/W | OEL Pri Takeover<br>Time Dial Off GG | No Unit | 0.1 – 20             |
| OEL Takeover              | 112     | Float  | R/W | OEL Pri Takeover<br>Cur Max On GG    | Amp     | 0 – 12000            |
| OEL Takeover              | 112     | Float  | R/W | OEL Pri Takeover<br>Cur Min On GG    | Amp     | 0 – 12000            |
| OEL Takeover              | 112     | Float  | R/W | OEL Pri Takeover<br>Time Dial On GG  | No Unit | 0.1 – 20             |
| OEL Takeover              | 112     | Float  | R/W | OEL Sec Takeover<br>Cur Max Off GG   | Amp     | 0 – 12000            |
| OEL Takeover              | 112     | Float  | R/W | OEL Sec Takeover<br>Cur Min Off GG   | Amp     | 0 – 12000            |
| OEL Takeover              | 112     | Float  | R/W | OEL Sec Takeover<br>Time Dial Off GG | No Unit | 0.1 – 20             |
| OEL Takeover              | 112     | Float  | R/W | OEL Sec Takeover<br>Cur Max On GG    | Amp     | 0 – 12000            |
| OEL Takeover              | 112     | Float  | R/W | OEL Sec Takeover<br>Cur Min On GG    | Amp     | 0 – 12000            |
| OEL Takeover              | 112     | Float  | R/W | OEL Sec Takeover<br>Time Dial On GG  | No Unit | 0.1 - 20             |
| UEL Configure             | 113     | UINT32 | R/W | Sys Option Input<br>UEL Enabled GG   | No Unit | Disabled=0 Enabled=1 |
| UEL Configure             | 114     | Float  | R/W | UEL Pri Pow Filter TC GG             | Sec     | 0 - 20               |
| UEL Configure             | 114     | Float  | R/W | UEL Pri Volt Dep<br>Exponent GG      | No Unit | 0 - 2                |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve X1 GG                  | KW      | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve X2 GG                  | KW      | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve X3 GG                  | KW      | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve X4 GG                  | KW      | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve X5 GG                  | KW      | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve Y1 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve Y2 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve Y3 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve Y4 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Primary   | 116     | Float  | R/W | UEL Pri Curve Y5 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve X1 GG                  | KW      | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve X2 GG                  | KW      | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve X3 GG                  | KW      | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve X4 GG                  | KW      | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve X5 GG                  | KW      | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve Y1 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve Y2 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve Y3 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve Y4 GG                  | kvar    | 0 - 62               |
| UEL Curve Float Secondary | 118     | Float  | R/W | UEL Sec Curve Y5 GG                  | kvar    | 0 - 62               |
| SCL Settings              | 119     | UINT32 | R/W | Sys Option Input SCL<br>Enabled GG   | No Unit | Disabled=0 Enabled=1 |
| SCL Settings              | 120     | Float  | R/W | SCL Pri Ref Hi GG                    | Amp     | 0 - 66000            |
| SCL Settings              | 120     | Float  | R/W | SCL Pri Ref Lo GG                    | Amp     | 0 - 66000            |
| SCL Settings              | 120     | Float  | R/W | SCL Pri Time Hi GG                   | Sec     | 0 – 240              |
| SCL Settings              | 120     | Float  | R/W | SCL Pri No Response<br>Time GG       | Sec     | 0 - 10               |
| SCL Settings              | 120     | Float  | R/W | SCL Sec Ref Hi GG                    | Amp     | 0 - 66000            |
| SCL Settings              | 120     | Float  | R/W | SCL Sec Ref Lo GG                    | Amp     | 0 - 66000            |
| SCL Settings              | 120     | Float  | R/W | SCL Sec Time Hi GG                   | Sec     | 0 - 240              |

| Instance Name        | Inst. # | Type   | RW  | Key Name                      | Unit                  | Range   |
|----------------------|---------|--------|-----|-------------------------------|-----------------------|---|
| SCL Settings         | 120     | Float  | R/W | SCL Sec No Response Time GG   | Sec                   | 0 - 10  |
| SCL Settings         | 120     | Float  | R/W | SCL Scale Signal 2_GG         | Limiter Scale Voltage | -10 - 10  |
| SCL Settings         | 120     | Float  | R/W | SCL Scale Signal 3_GG         | Limiter Scale Voltage | -10 - 10  |
| SCL Settings         | 120     | Float  | R/W | SCL Scale Point 1_GG          | Percent               | 0 - 200   |
| SCL Settings         | 120     | Float  | R/W | SCL Scale Point 2_GG          | Percent               | 0 - 200   |
| SCL Settings         | 120     | Float  | R/W | SCL Scale Point 3_GG          | Percent               | 0 - 200   |
| VAR Limiter Settings | 121     | UINT32 | R/W | Var Limit Enable GG           | No Unit               | Disabled=0 Enabled=1  |
| VAR Limiter Settings | 122     | Float  | R/W | Var Limit Pri Delay GG        | Sec                   | 0 - 300   |
| VAR Limiter Settings | 122     | Float  | R/W | Var Limit Pri Setpoint GG     | %                     | 0 - 200   |
| VAR Limiter Settings | 122     | Float  | R/W | Var Limit Sec Delay GG        | Sec                   | 0 - 300   |
| VAR Limiter Settings | 122     | Float  | R/W | Var Limit Sec Setpoint GG     | %                     | 0 - 200   |
| OEL Scaling          | 123     | UINT32 | R/W | OEL Scale Enable GG           | No Unit               | DISABLED=0<br>Auxiliary Input=1<br>AEM RTD 1=2<br>AEM RTD 2=3<br>AEM RTD 3=4<br>AEM RTD 4=5<br>AEM RTD 5=6<br>AEM RTD 6=7<br>AEM RTD 7=8<br>AEM RTD 8=9 |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Summing Signal1 GG  | V                     | -10 - 10  |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Summing Signal2 GG  | V                     | -10 - 10  |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Summing Signal3 GG  | V                     | -10 - 10  |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Summing Scale1 GG   | %                     | 0 - 200   |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Summing Scale2 GG   | %                     | 0 - 200   |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Summing Scale3 GG   | %                     | 0 - 200   |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Takeover Signal1 GG | V                     | -10 - 10  |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Takeover Signal2 GG | V                     | -10 - 10  |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Takeover Signal3 GG | V                     | -10 - 10  |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Takeover Scale1 GG  | %                     | 0 - 200   |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Takeover Scale2 GG  | %                     | 0 - 200   |
| OEL Scaling          | 124     | Float  | R/W | OEL Scale Takeover Scale3 GG  | %                     | 0 - 200   |
| SCL Scaling          | 125     | UINT32 | R/W | SCL Scale Enable GG           | No Unit               | DISABLED=0<br>Auxiliary Input=1<br>AEM RTD 1=2<br>AEM RTD 2=3<br>AEM RTD 3=4<br>AEM RTD 4=5<br>AEM RTD 5=6<br>AEM RTD 6=7<br>AEM RTD 7=8<br>AEM RTD 8=9 |
| SCL Scaling          | 126     | Float  | R/W | SCL Scale Signal 1 GG         | V                     | -10 - 10  |
| SCL Scaling          | 126     | Float  | R/W | SCL Scale Signal 2 GG         | V                     | -10 - 10  |
| SCL Scaling          | 126     | Float  | R/W | SCL Scale Signal 3 GG         | V                     | -10 - 10  |
| SCL Scaling          | 126     | Float  | R/W | SCL Scale Point 1 GG          | %                     | 0 - 200   |

| Instance Name                   | Inst. # | Type   | RW  | Key Name                                | Unit    | Range                      |
|---------------------------------|---------|--------|-----|---|---------|----------------------------|
| SCL Scaling                     | 126     | Float  | R/W | SCL Scale Point 2 GG                    | %       | 0 - 200                    |
| SCL Scaling                     | 126     | Float  | R/W | SCL Scale Point 3 GG                    | %       | 0 - 200                    |
| Underfrequency/Volts per hertz  | 127     | UINT32 | R/W | Sys Option Under Freq Mode GG           | No Unit | UF Limiter=0 V2H Limiter=1 |
| Underfrequency /Volts per Hertz | 128     | Float  | R/W | Sys Option Under Freq Hz GG             | Hz      | 15 - 90                    |
| Underfrequency /Volts per Hertz | 128     | Float  | R/W | Sys Option Under Freq Slope GG          | No Unit | 0 - 3                      |
| Underfrequency /Volts per Hertz | 128     | Float  | R/W | Sys Option Voltage Per Hz Slope Hi GG   | No Unit | 0 - 3                      |
| Underfrequency /Volts per Hertz | 128     | Float  | R/W | Sys Option Voltage Per Hz Slope Lo GG   | No Unit | 0 - 3                      |
| Underfrequency /Volts per Hertz | 128     | Float  | R/W | Sys Option Voltage Per Hz Slope Time GG | Sec     | 0 - 10                     |
| PSS Configure                   | 129     | UINT32 | R/W | Sys Option PSS Power Level Enable GG    | No Unit | Disabled=0 Enabled=1       |
| PSS Configure                   | 130     | Float  | R/W | PSS Primary Power Level Percentage GG   | No Unit | 0 - 1                      |
| PSS Configure                   | 130     | Float  | R/W | PSS Primary Power Level Hysteresis GG   | No Unit | 0 - 1                      |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Enable GG                           | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 10 GG                | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 11 GG                | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 3 GG                 | No Unit | Frequency=0 Der. Speed=1   |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 4 GG                 | No Unit | Power=0 Der. Freq/Speed=1  |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 0 GG                 | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 1 GG                 | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 5 GG                 | No Unit | Exclude=0 Include=1        |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 9 GG                 | No Unit | Exclude=0 Include=1        |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 6 GG                 | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 8 GG                 | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 7 GG                 | No Unit | OFF=0 ON=1                 |
| PSS Control Primary             | 131     | UINT32 | R/W | PSS Primary Switch 2 GG                 | No Unit | Disabled=0 Enabled=1       |
| PSS Control Primary             | 132     | Float  | R/W | PSS Primary Power On Threshold GG       | No Unit | 0 - 1                      |
| PSS Control Primary             | 132     | Float  | R/W | PSS Primary Power Hysteresis GG         | No Unit | 0 - 1                      |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 10 GG                    | No Unit | Disabled=0 Enabled=1       |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 11 GG                    | No Unit | Disabled=0 Enabled=1       |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 3 GG                     | No Unit | Frequency=0 Der. Speed=1   |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 4 GG                     | No Unit | Power=0 Der. Freq/Speed=1  |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 0 GG                     | No Unit | Disabled=0 Enabled=1       |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 1 GG                     | No Unit | Disabled=0 Enabled=1       |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 5 GG                     | No Unit | Exclude=0 Include=1        |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 9 GG                     | No Unit | Exclude=0 Include=1        |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 6 GG                     | No Unit | Disabled=0 Enabled=1       |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 8 GG                     | No Unit | Disabled=0 Enabled=1       |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 7 GG                     | No Unit | OFF=0 ON=1                 |
| PSS Control Secondary           | 133     | UINT32 | R/W | PSS Sec Switch 2 GG                     | No Unit | Disabled=0 Enabled=1       |
| PSS Control Secondary           | 134     | Float  | R/W | PSS Sec Power On Threshold GG           | No Unit | 0 - 1                      |
| PSS Control Secondary           | 134     | Float  | R/W | PSS Sec Power Hysteresis GG             | No Unit | 0 - 1                      |

| Instance Name                          | Inst. # | Type   | RW  | Key Name   | Unit    | Range      |
|--|---------|--------|-----|--|---------|------------|
| PSS Filter Parameter Primary Int       | 135     | UINT32 | R/W | PSS Primary Ramp Flt M GG                        | No Unit | 1 - 5      |
| PSS Filter Parameter Primary Int       | 135     | UINT32 | R/W | PSS Primary Ramp Flt N GG                        | No Unit | 0 - 1      |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Time Constant Low Pass Filter 1 GG   | Sec     | 0 - 20     |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Time Constant Low Pass Filter 2 GG   | Sec     | 0.01 - 20  |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Time Constant Low Pass Filter 3 GG   | Sec     | 0.05 - 0.2 |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Tr GG                                | Sec     | 0.01 - 1   |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Tw 1 GG                              | Sec     | 1 - 20     |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Tw 2 GG                              | Sec     | 1 - 20     |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Tw 3 GG                              | Sec     | 1 - 20     |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary Tw 4 GG                              | Sec     | 1 - 20     |
| PSS Filter Parameter Primary Float     | 136     | Float  | R/W | PSS Primary H GG                                 | No Unit | 0.01 - 25  |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Zn 1 GG                              | No Unit | 0 - 1      |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Zn 2 GG                              | No Unit | 0 - 1      |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Zd 1 GG                              | No Unit | 0 - 1      |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Zd 2 GG                              | No Unit | 0 - 1      |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Wn 1 GG                              | No Unit | 10 - 150   |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Wn 2 GG                              | No Unit | 10 - 150   |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Xq GG                                | No Unit | 0 - 5      |
| PSS Parameter Primary Float            | 138     | Float  | R/W | PSS Primary Kpe GG                               | No Unit | 0 - 2      |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T1 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T2 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T3 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T4 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T5 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T6 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T7 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Primary Phase Comp Float | 140     | Float  | R/W | PSS Primary T8 GG                                | Sec     | 0.001 - 6  |
| PSS Parameter Secondary Filters Int    | 141     | UINT32 | R/W | PSS Secondary Ramp Flt M GG                      | No Unit | 1 - 5      |
| PSS Parameter Secondary Filters Int    | 141     | UINT32 | R/W | PSS Secondary Ramp Flt N GG                      | No Unit | 0 - 1      |
| PSS Parameter Secondary Filters Float  | 142     | Float  | R/W | PSS Secondary Time Constant Low Pass Filter 1 GG | Sec     | 0 - 20     |

| Instance Name                            | Inst. # | Type  | RW  | Key Name  | Unit    | Range         |
|--|---------|-------|-----|---|---------|---------------|
| PSS Parameter Secondary Filters Float    | 142     | Float | R/W | PSS Secondary Time Constant Low Pass Filter 2 GG    | Sec     | 0.01 – 20     |
| PSS Parameter Secondary Filters Float    | 142     | Float | R/W | PSS Secondary Time Constant Low Pass Filter 3 GG    | Sec     | 0.05 - 0.2    |
| PSS Parameter Secondary Filters Float    | 142     | Float | R/W | PSS Secondary Tr GG                                 | Sec     | 0.01 - 1      |
| PSS Parameter Secondary Filters Float    | 142     | Float | R/W | PSS Secondary Tw1 GG                                | Sec     | 1 - 20        |
| PSS Parameter Secondary Filters Float    | 142     | Float | R/W | PSS Secondary Tw2 GG                                | Sec     | 1 - 20        |
| PSS Parameter Secondary Filters Float    | 142     | Float | R/W | PSS Secondary Tw3 GG                                | Sec     | 1 - 20        |
| PSS Parameter Secondary Filters Float    | 142     | Float | R/W | PSS Secondary Tw4 GG                                | Sec     | 1 - 20        |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Zn1 GG                                | No Unit | 0 - 1         |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Zn2 GG                                | No Unit | 0 - 1         |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Zd1 GG                                | No Unit | 0 - 1         |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Zd2 GG                                | No Unit | 0 - 1         |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Wn1 GG                                | No Unit | 10 - 150      |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Wn2 GG                                | No Unit | 10 - 150      |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Xq GG                                 | No Unit | 0 - 5         |
| PSS Parameter Secondary Float            | 144     | Float | R/W | PSS Secondary Kpe GG                                | No Unit | 0 - 2         |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T1 GG                                 | Sec     | 0.001 - 6     |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T2 GG                                 | Sec     | 0.001 - 6     |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T3 GG                                 | Sec     | 0.001 - 6     |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T4 GG                                 | Sec     | 0.001 - 6     |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T5 GG                                 | Sec     | 0.001 - 6     |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T6 GG                                 | Sec     | 0.001 - 6     |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T7 GG                                 | Sec     | 0.001 - 6     |
| PSS Parameter Secondary Phase Comp Float | 146     | Float | R/W | PSS Secondary T8 GG                                 | Sec     | 0.001 - 6     |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Limit Plus GG                           | No Unit | 0 - 0.5       |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Limit Minus GG                          | No Unit | -0.5 - 0      |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Ks GG                                   | No Unit | -100 - 100    |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Et Lmt Time Constant Low Pass Filter GG | Sec     | 0.02 - 5      |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Et Lmt Vref GG                          | No Unit | 0 - 10        |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Tw5 Normal GG                           | No Unit | 5 - 30        |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Tw5 Limit GG                            | No Unit | 0 - 1         |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Lmt Vhi GG                              | No Unit | 0.01 - 0.04   |
| PSS Output Limiter Primary               | 148     | Float | R/W | PSS Primary Lmt Vlo GG                              | No Unit | -0.04 - -0.01 |

| Instance Name                         | Inst. # | Type   | RW  | Key Name  | Unit    | Range                            |
|---------------------------------------|---------|--------|-----|---|---------|----------------------------------|
| PSS Output Limiter Primary            | 148     | Float  | R/W | PSS Primary Lmt T Delay GG                            | No Unit | 0 - 2                            |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Limit Plus GG                           | No Unit | 0 - 0.5                          |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Limit Minus GG                          | No Unit | -0.5 - 0                         |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Ks GG                                   | No Unit | -100 - 100                       |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Et Lmt Time Constant Low Pass Filter GG | Sec     | 0.02 - 5                         |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Et Lmt Vref GG                          | No Unit | 0 - 10                           |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Tw5 Normal GG                           | No Unit | 5 - 30                           |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Tw5 Limit GG                            | No Unit | 0 - 1                            |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Lmt Vhi GG                              | No Unit | 0.01 - 0.04                      |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Lmt Vlo GG                              | No Unit | -0.04 - -0.01                    |
| PSS Output Limiter Secondary          | 150     | Float  | R/W | PSS Secondary Lmt T Delay GG                          | No Unit | 0 - 2                            |
| Synchronizer                          | 151     | UINT32 | R/W | Sync Type GG  | No Unit | Anticipatory=0 Phase Lock Loop=1 |
| Synchronizer                          | 151     | UINT32 | R/W | Fgen GT Fbus GG                                       | No Unit | Disabled=0 Enabled=1             |
| Synchronizer                          | 151     | UINT32 | R/W | Vgen GT Vbus GG                                       | No Unit | Disabled=0 Enabled=1             |
| Synchronizer                          | 152     | Float  | R/W | Slip Frequency GG                                     | Hz      | 0.1 - 0.5                        |
| Synchronizer                          | 152     | Float  | R/W | Voltage Window GG                                     | %       | 2 - 15                           |
| Synchronizer                          | 152     | Float  | R/W | Breaker Closing Angle GG                              | Deg     | 3 - 20                           |
| Synchronizer                          | 152     | Float  | R/W | Sync Activation Delay GG                              | Sec     | 0.1 - 0.8                        |
| Synchronizer                          | 152     | Float  | R/W | Sync Fail Activation Delay GG                         | Sec     | 0.1 - 600                        |
| Synchronizer                          | 152     | Float  | R/W | Sync Speed Gain GG                                    | No Unit | 0.001 - 1000                     |
| Synchronizer                          | 152     | Float  | R/W | Sync Voltage Gain GG                                  | No Unit | 0.001 - 1000                     |
| Voltage Matching                      | 153     | UINT32 | R/W | Sys Option Input Volt Match Enabled GG                | No Unit | Disabled=0 Enabled=1             |
| Voltage Matching                      | 154     | Float  | R/W | Sys Option Voltage Match Band GG                      | %       | 0 - 20                           |
| Voltage Matching                      | 154     | Float  | R/W | Sys Option Voltage Match Ref GG                       | %       | 0 - 700                          |
| Breaker Hardware                      | 155     | UINT32 | R/W | Gen Breaker GG  | No Unit | Not Configured=0 Configured=1    |
| Breaker Hardware                      | 155     | UINT32 | R/W | Gen Contact Type GG                                   | No Unit | Pulse=0 Continuous=1             |
| Breaker Hardware                      | 155     | UINT32 | R/W | Dead Bus Close Enable GG                              | No Unit | Disabled=0 Enabled=1             |
| Breaker Hardware                      | 155     | UINT32 | R/W | Dead Gen Close Enable GG                              | No Unit | Disabled=0 Enabled=1             |
| Breaker Hardware                      | 156     | Float  | R/W | Breaker Close Wait Time GG                            | Sec     | 0.1 - 600                        |
| Breaker Hardware                      | 156     | Float  | R/W | Gen Open Pulse Time GG                                | Sec     | 0.01 - 5                         |
| Breaker Hardware                      | 156     | Float  | R/W | Gen Close Pulse Time GG                               | Sec     | 0.01 - 5                         |
| Bus Condition Detection (Gen Sensing) | 158     | Float  | R/W | Dead Gen Threshold GG                                 | V       | 0 - 600000                       |
| Bus Condition Detection (Gen Sensing) | 158     | Float  | R/W | Dead Gen Time Delay GG                                | Sec     | 0.1 - 600                        |

| Instance Name                         | Inst. # | Type  | RW  | Key Name                                       | Unit    | Range       |
|---------------------------------------|---------|-------|-----|--|---------|-------------|
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Over Voltage Pickup GG              | V       | 10 - 600000 |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Over Voltage Dropout GG             | V       | 10 - 600000 |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Under Voltage Pickup GG             | V       | 10 - 600000 |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Under Voltage Dropout GG            | V       | 10 - 600000 |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Over Frequency Pickup GG            | Hz      | 15 - 64     |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Over Frequency Dropout GG           | Hz      | 15 - 64     |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Under Frequency Pickup GG           | Hz      | 15 - 64     |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Under Frequency Dropout GG          | Hz      | 15 - 64     |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Activation Delay GG                 | Sec     | 0.1 - 600   |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Failed Activation Delay GG                 | Sec     | 0.1 - 600   |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Low Line Scale Factor GG            | No Unit | 0.001 - 3   |
| Bus Condition Detection (Gen Sensing) | 158     | Float | R/W | Gen Stable Alternate Frequency Scale Factor GG | No Unit | 0.001 - 100 |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Dead Bus Threshold GG                          | V       | 0 - 600000  |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Dead Bus Time Delay GG                         | Sec     | 0.1 - 600   |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Over Voltage Pickup GG              | V       | 10 - 600000 |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Over Voltage Dropout GG             | V       | 10 - 600000 |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Under Voltage Pickup GG             | V       | 10 - 600000 |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Under Voltage Dropout GG            | V       | 10 - 600000 |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Over Frequency Pickup GG            | Hz      | 15 - 64     |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Over Frequency Dropout GG           | Hz      | 15 - 64     |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Under Frequency Pickup GG           | Hz      | 15 - 64     |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Under Frequency Dropout GG          | Hz      | 15 - 64     |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Activation Delay GG                 | Sec     | 0.1 - 600   |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Failed Activation Delay GG                 | Sec     | 0.1 - 600   |
| Bus Condition Detection (Bus Sensing) | 160     | Float | R/W | Bus Stable Low Line Scale Factor GG            | No Unit | 0.001 - 3   |

| Instance Name                         | Inst. # | Type   | RW  | Key Name                                       | Unit    | Range                               |
|---------------------------------------|---------|--------|-----|--|---------|-------------------------------------|
| Bus Condition Detection (Bus Sensing) | 160     | Float  | R/W | Bus Stable Alternate Frequency Scale Factor GG | No Unit | 0.001 - 100                         |
| Governor Bias Control                 | 161     | UINT32 | R/W | Control Contact Type GG                        | No Unit | Continuous=0 Fixed=1 Proportional=2 |
| Governor Bias Control                 | 162     | Float  | R/W | Correction Pulse Width GG                      | Sec     | 0 - 99.9                            |
| Governor Bias Control                 | 162     | Float  | R/W | Correction Pulse Interval GG                   | Sec     | 0 - 99.9                            |
| Gen Undervoltage                      | 163     | UINT32 | R/W | Mode PP  | No Unit | Disabled=0 Enabled=1                |
| Gen Undervoltage                      | 163     | UINT32 | R/W | Mode PS  | No Unit | Disabled=0 Enabled=1                |
| Gen Undervoltage                      | 164     | Float  | R/W | Pickup PP                                      | V       | 1 - 600000                          |
| Gen Undervoltage                      | 164     | Float  | R/W | Time Delay PP                                  | ms      | 100 - 60000                         |
| Gen Undervoltage                      | 164     | Float  | R/W | Pickup PS                                      | V       | 1 - 600000                          |
| Gen Undervoltage                      | 164     | Float  | R/W | Time Delay PS                                  | ms      | 100 - 60000                         |
| Gen Overvoltage                       | 165     | UINT32 | R/W | Mode PP  | No Unit | Disabled=0 Enabled=1                |
| Gen Overvoltage                       | 165     | UINT32 | R/W | Mode PS  | No Unit | Disabled=0 Enabled=1                |
| Gen Overvoltage                       | 166     | Float  | R/W | Pickup PP                                      | V       | 0 - 600000                          |
| Gen Overvoltage                       | 166     | Float  | R/W | Time Delay PP                                  | ms      | 100 - 60000                         |
| Gen Overvoltage                       | 166     | Float  | R/W | Pickup PS                                      | V       | 0 - 600000                          |
| Gen Overvoltage                       | 166     | Float  | R/W | Time Delay PS                                  | ms      | 100 - 60000                         |
| Loss of Sensing                       | 167     | UINT32 | R/W | Mode GG  | No Unit | Disabled=0 Enabled=1                |
| Loss of Sensing                       | 167     | UINT32 | R/W | Sys Option No Sense To Manual Mode GG          | No Unit | Disabled=0 Enabled=1                |
| Loss of Sensing                       | 168     | Float  | R/W | Time Delay GG                                  | Sec     | 0 - 30                              |
| Loss of Sensing                       | 168     | Float  | R/W | Voltage Balanced Level GG                      | %       | 0 - 100                             |
| Loss of Sensing                       | 168     | Float  | R/W | Voltage Unbalanced Level GG                    | %       | 0 - 100                             |
| 81O                                   | 169     | UINT32 | R/W | Mode PP  | No Unit | Disabled=0 Over=1                   |
| 81O                                   | 169     | UINT32 | R/W | Mode PS  | No Unit | Disabled=0 Over=1                   |
| 81O                                   | 170     | Float  | R/W | Pickup PP                                      | Hz      | 15 - 70                             |
| 81O                                   | 170     | Float  | R/W | Time Delay PP                                  | ms      | 100 - 300000                        |
| 81O                                   | 170     | Float  | R/W | Pickup PS                                      | Hz      | 15 - 70                             |
| 81O                                   | 170     | Float  | R/W | Time Delay PS                                  | ms      | 100 - 300000                        |
| 81O                                   | 170     | Float  | R/W | Voltage Inhibit PP                             | %       | 5 - 100                             |
| 81O                                   | 170     | Float  | R/W | Voltage Inhibit PS                             | %       | 5 - 100                             |
| 81U-1                                 | 171     | UINT32 | R/W | Mode PP  | No Unit | Disabled=0 Under=2                  |
| 81U-1                                 | 171     | UINT32 | R/W | Mode PS  | No Unit | Disabled=0 Under=2                  |
| 81U-1                                 | 172     | Float  | R/W | Pickup PP                                      | Hz      | 15 - 70                             |
| 81U-1                                 | 172     | Float  | R/W | Time Delay PP                                  | ms      | 100 - 300000                        |
| 81U-1                                 | 172     | Float  | R/W | Voltage Inhibit PP                             | %       | 5 - 100                             |
| 81U-1                                 | 172     | Float  | R/W | Pickup PS                                      | Hz      | 15 - 70                             |
| 81U-1                                 | 172     | Float  | R/W | Time Delay PS                                  | ms      | 100 - 300000                        |
| 81U-1                                 | 172     | Float  | R/W | Voltage Inhibit PS                             | %       | 5 - 100                             |
| 81U-2                                 | 173     | UINT32 | R/W | Mode PP  | No Unit | Disabled=0 Under=2                  |
| 81U-2                                 | 173     | UINT32 | R/W | Mode PS  | No Unit | Disabled=0 Under=2                  |
| 81U-2                                 | 174     | Float  | R/W | Pickup PP                                      | Hz      | 15 - 70                             |
| 81U-2                                 | 174     | Float  | R/W | Time Delay PP                                  | ms      | 100 - 300000                        |
| 81U-2                                 | 174     | Float  | R/W | Voltage Inhibit PP                             | %       | 5 - 100                             |
| 81U-2                                 | 174     | Float  | R/W | Pickup PS                                      | Hz      | 15 - 70                             |
| 81U-2                                 | 174     | Float  | R/W | Time Delay PS                                  | ms      | 100 - 300000                        |
| 81U-2                                 | 174     | Float  | R/W | Voltage Inhibit PS                             | %       | 5 - 100                             |

| Instance Name             | Inst. # | Type   | RW  | Key Name                            | Unit    | Range  |
|---------------------------|---------|--------|-----|-------------------------------------|---------|--|
| Reverse Power             | 175     | UINT32 | R/W | Mode PP                             | No Unit | Disabled=0 Enabled=4   |
| Reverse Power             | 175     | UINT32 | R/W | Mode PS                             | No Unit | Disabled=0 Enabled=4   |
| Reverse Power             | 176     | Float  | R/W | Pickup PP                           | kW      | 0 – 3000000  |
| Reverse Power             | 176     | Float  | R/W | Pickup PS                           | kW      | 0 – 3000000  |
| Reverse Power             | 176     | Float  | R/W | Time Delay PP                       | ms      | 0 – 300000   |
| Reverse Power             | 176     | Float  | R/W | Time Delay PS                       | ms      | 0 – 300000   |
| Loss of Excitation        | 177     | UINT32 | R/W | Mode PP                             | No Unit | Disabled=0 Enabled=1   |
| Loss of Excitation        | 177     | UINT32 | R/W | Mode PS                             | No Unit | Disabled=0 Enabled=1   |
| Loss of Excitation        | 178     | Float  | R/W | Pickup PP                           | Kvar    | 0 – 3000000  |
| Loss of Excitation        | 178     | Float  | R/W | Time Delay PP                       | ms      | 0 – 300000   |
| Loss of Excitation        | 178     | Float  | R/W | Pickup PS                           | Kvar    | 0 – 3000000  |
| Loss of Excitation        | 178     | Float  | R/W | Time Delay PS                       | ms      | 0 – 300000   |
| Field Overvoltage         | 179     | UINT32 | R/W | Mode PP                             | No Unit | Disabled=0 Enabled=1   |
| Field Overvoltage         | 179     | UINT32 | R/W | Mode PS                             | No Unit | Disabled=0 Enabled=1   |
| Field Overvoltage         | 180     | Float  | R/W | Pickup PP                           | V       | 1 – 2400   |
| Field Overvoltage         | 180     | Float  | R/W | Time Delay PP                       | ms      | 200 - 30000  |
| Field Overvoltage         | 180     | Float  | R/W | Pickup PS                           | V       | 1 – 2400   |
| Field Overvoltage         | 180     | Float  | R/W | Time Delay PS                       | ms      | 200 – 30000  |
| Field Overcurrent         | 181     | UINT32 | R/W | Mode PP                             | No Unit | Disabled=0 Enabled=1   |
| Field Overcurrent         | 181     | UINT32 | R/W | Mode PS                             | No Unit | Disabled=0 Enabled=1   |
| Field Overcurrent         | 182     | Float  | R/W | Pickup PP                           | Amp     | 0 – 12000  |
| Field Overcurrent         | 182     | Float  | R/W | Time Delay PP                       | ms      | 5000 – 60000   |
| Field Overcurrent         | 182     | Float  | R/W | Pickup PS                           | Amp     | 0 – 12000  |
| Field Overcurrent         | 182     | Float  | R/W | Time Delay PS                       | ms      | 5000 – 60000   |
| Field Overtemperature     | 183     | UINT32 | R/W | Mode PP                             | No Unit | Disabled=0 Enabled=1   |
| Field Overtemperature     | 183     | UINT32 | R/W | Mode PS                             | No Unit | Disabled=0 Enabled=1   |
| Field Overtemperature     | 184     | Float  | R/W | Pickup PP                           | Deg F   | 0 – 572  |
| Field Overtemperature     | 184     | Float  | R/W | Time Delay PP                       | ms      | 100 – 60000  |
| Field Overtemperature     | 184     | Float  | R/W | Pickup PS                           | Deg F   | 0 – 572  |
| Field Overtemperature     | 184     | Float  | R/W | Time Delay PS                       | ms      | 100 - 60000  |
| Exciter Diode Monitor     | 185     | UINT32 | R/W | Exciter Open Diode Enable GG        | No Unit | Disabled=0 Enabled=1   |
| Exciter Diode Monitor     | 185     | UINT32 | R/W | Exciter Shorted Diode Enable GG     | No Unit | Disabled=0 Enabled=1   |
| Exciter Diode Monitor     | 186     | Float  | R/W | Exciter Diode Inhibit Threshold GG  | %       | 0 - 100  |
| Exciter Diode Monitor     | 186     | Float  | R/W | Exciter Open Diode Pickup GG        | %       | 0 - 100  |
| Exciter Diode Monitor     | 186     | Float  | R/W | Exciter Open Diode Time Delay GG    | Sec     | 10 - 60  |
| Exciter Diode Monitor     | 186     | Float  | R/W | Exciter Shorted Diode Pickup GG     | %       | 0 - 100  |
| Exciter Diode Monitor     | 186     | Float  | R/W | Exciter Shorted Diode Time Delay GG | Sec     | 5 - 30   |
| Exciter Diode Monitor     | 186     | Float  | R/W | Exciter Pole Ratio GG               | No Unit | 1 - 10   |
| Sync Check                | 187     | UINT32 | R/W | Mode GG                             | No Unit | Disabled=0 Enabled=1   |
| Sync Check                | 188     | Float  | R/W | Phase Angle GG                      | Deg     | 1 - 99   |
| Sync Check                | 188     | Float  | R/W | Slip Frequency GG                   | Hz      | 0.01 - 0.5   |
| Sync Check                | 188     | Float  | R/W | Voltage Magnitude Error Percent GG  | %       | 0.1 - 50   |
| Configurable Protection 1 | 189     | UINT32 | R/W | Parameter Selection GG              | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Configurable Protection 1 | 189     | UINT32 | R/W | Stop Mode Inhibit GG                | No Unit | NO=0 YES=1   |

| Instance Name             | Inst. # | Type   | RW  | Key Name                        | Unit    | Range  |
|---------------------------|---------|--------|-----|---------------------------------|---------|--|
| Configurable Protection 1 | 189     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 1 | 189     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 1 | 189     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 1 | 189     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 1 | 190     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100  |
| Configurable Protection 1 | 190     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300  |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 4 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 1 | 190     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 2 | 191     | UINT32 | R/W | Parameter Selection GG          | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Configurable Protection 2 | 191     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | NO=0 YES=1   |
| Configurable Protection 2 | 191     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 2 | 191     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 2 | 191     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 2 | 191     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 2 | 192     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100  |
| Configurable Protection 2 | 192     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300  |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold1Pickup GG             | No Unit | -999999 - 999999   |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold 4 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 2 | 192     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 3 | 193     | UINT32 | R/W | Parameter Selection GG          | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Configurable Protection 3 | 193     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1   |
| Configurable Protection 3 | 193     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 3 | 193     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 3 | 193     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |

| Instance Name             | Inst. # | Type   | RW  | Key Name                        | Unit    | Range  |
|---------------------------|---------|--------|-----|---------------------------------|---------|--|
| Configurable Protection 3 | 193     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 3 | 194     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100  |
| Configurable Protection 3 | 194     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300  |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 4 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 3 | 194     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 4 | 195     | UINT32 | R/W | Parameter Selection GG          | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Configurable Protection 4 | 195     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1   |
| Configurable Protection 4 | 195     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 4 | 195     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 4 | 195     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 4 | 195     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 4 | 196     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100  |
| Configurable Protection 4 | 196     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300  |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 4 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 4 | 196     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 5 | 197     | UINT32 | R/W | Parameter Selection GG          | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Configurable Protection 5 | 197     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1   |
| Configurable Protection 5 | 197     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 5 | 197     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 5 | 197     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 5 | 197     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2  |
| Configurable Protection 5 | 198     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100  |
| Configurable Protection 5 | 198     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300  |
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -999999 - 999999   |
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300  |

| Instance Name             | Inst. # | Type   | RW  | Key Name                           | Unit    | Range  |
|---------------------------|---------|--------|-----|------------------------------------|---------|--|
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 5 | 198     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 6 | 199     | UINT32 | R/W | Parameter Selection GG             | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Configurable Protection 6 | 199     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1   |
| Configurable Protection 6 | 199     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 6 | 199     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 6 | 199     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 6 | 199     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 6 | 200     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100  |
| Configurable Protection 6 | 200     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300  |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 1 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 6 | 200     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 7 | 201     | UINT32 | R/W | Parameter Selection GG             | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Configurable Protection 7 | 201     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1   |
| Configurable Protection 7 | 201     | UINT32 | R/W | Threshold1 Type GG                 | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 7 | 201     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 7 | 201     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 7 | 201     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 7 | 202     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100  |
| Configurable Protection 7 | 202     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300  |
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 1 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -999999 - 999999   |

| Instance Name             | Inst. # | Type   | RW  | Key Name                           | Unit    | Range  |
|---------------------------|---------|--------|-----|------------------------------------|---------|--|
| Configurable Protection 7 | 202     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 8 | 203     | UINT32 | R/W | Parameter Selection GG             | No Unit | See <i>Parameter Selection</i> at<br>the end of this section for a<br>complete list. |
| Configurable Protection 8 | 203     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1   |
| Configurable Protection 8 | 203     | UINT32 | R/W | Threshold 1Type GG                 | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 8 | 203     | UINT32 | R/W | Threshold Type GG                  | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 8 | 203     | UINT32 | R/W | Threshold Type GG                  | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 8 | 203     | UINT32 | R/W | Threshold Type GG                  | No Unit | Disabled=0 Over=1<br>Under=2   |
| Configurable Protection 8 | 204     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100  |
| Configurable Protection 8 | 204     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300  |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold 1 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold 2<br>Activation Delay    | Sec     | 0 - 300  |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300  |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -999999 - 999999   |
| Configurable Protection 8 | 204     | Float  | R/W | Threshold<br>Activation Delay GG   | Sec     | 0 - 300  |
| Remote Analog In 1        | 205     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | NO=0 YES=1   |
| Remote Analog In 1        | 205     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Remote Analog In 1        | 205     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Remote Analog In 1        | 205     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Remote Analog In 1        | 205     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2   |
| Remote Analog In 1        | 205     | UINT32 | R/W | Type GG                            | No Unit | Voltage=0 Current=1  |
| Remote Analog In 1        | 206     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100  |
| Remote Analog In 1        | 206     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300  |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 1 Pickup GG              | No Unit | -9999 - 9999   |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -9999 - 9999   |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -9999 - 9999   |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -9999 - 9999   |
| Remote Analog In 1        | 206     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog In 1        | 206     | Float  | R/W | Parameter Min GG                   | No Unit | -9999 - 9999   |
| Remote Analog In 1        | 206     | Float  | R/W | Parameter Max GG                   | No Unit | -9999 - 9999   |
| Remote Analog In 1        | 206     | Float  | R/W | Current Min GG                     | mA      | 4 - 20   |
| Remote Analog In 1        | 206     | Float  | R/W | Current Max GG                     | mA      | 4 - 20   |
| Remote Analog In 1        | 206     | Float  | R/W | Voltage Min GG                     | V       | 0 - 10   |

| Instance Name      | Inst. # | Type   | RW  | Key Name                        | Unit    | Range                     |
|--------------------|---------|--------|-----|---------------------------------|---------|---------------------------|
| Remote Analog In 1 | 206     | Float  | R/W | Voltage Max GG                  | V       | 0 - 10                    |
| Remote Analog In 2 | 207     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1                |
| Remote Analog In 2 | 207     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 2 | 207     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 2 | 207     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 2 | 207     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 2 | 207     | UINT32 | R/W | Type GG                         | No Unit | Voltage=0 Current=1       |
| Remote Analog In 2 | 208     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100                   |
| Remote Analog In 2 | 208     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300                   |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 4 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 2 | 208     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 2 | 208     | Float  | R/W | Parameter Min GG                | No Unit | -9999 - 9999              |
| Remote Analog In 2 | 208     | Float  | R/W | Parameter Max GG                | No Unit | -9999 - 9999              |
| Remote Analog In 2 | 208     | Float  | R/W | Current Min GG                  | mA      | 4 - 20                    |
| Remote Analog In 2 | 208     | Float  | R/W | Current Max GG                  | mA      | 4 - 20                    |
| Remote Analog In 2 | 208     | Float  | R/W | Voltage Min GG                  | V       | 0 - 10                    |
| Remote Analog In 2 | 208     | Float  | R/W | Voltage Max GG                  | V       | 0 - 10                    |
| Remote Analog In 3 | 209     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1                |
| Remote Analog In 3 | 209     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 3 | 209     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 3 | 209     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 3 | 209     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 3 | 209     | UINT32 | R/W | Type GG                         | No Unit | Voltage=0 Current=1       |
| Remote Analog In 3 | 210     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100                   |
| Remote Analog In 3 | 210     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300                   |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 4 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 3 | 210     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 3 | 210     | Float  | R/W | Parameter Min GG                | No Unit | -9999 - 9999              |

| Instance Name      | Inst. # | Type   | RW  | Key Name                        | Unit    | Range                     |
|--------------------|---------|--------|-----|---------------------------------|---------|---------------------------|
| Remote Analog In 3 | 210     | Float  | R/W | Parameter Max GG                | No Unit | -9999 - 9999              |
| Remote Analog In 3 | 210     | Float  | R/W | Current Min GG                  | mA      | 4 - 20                    |
| Remote Analog In 3 | 210     | Float  | R/W | Current Max GG                  | mA      | 4 - 20                    |
| Remote Analog In 3 | 210     | Float  | R/W | Voltage Min GG                  | V       | 0 - 10                    |
| Remote Analog In 3 | 210     | Float  | R/W | Voltage Max GG                  | V       | 0 - 10                    |
| Remote Analog In 4 | 211     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1                |
| Remote Analog In 4 | 211     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 4 | 211     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 4 | 211     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 4 | 211     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 4 | 211     | UINT32 | R/W | Type GG                         | No Unit | Voltage=0 Current=1       |
| Remote Analog In 4 | 212     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100                   |
| Remote Analog In 4 | 212     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300                   |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 4 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 4 | 212     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 4 | 212     | Float  | R/W | Parameter Min GG                | No Unit | -9999 - 9999              |
| Remote Analog In 4 | 212     | Float  | R/W | Parameter Max GG                | No Unit | -9999 - 9999              |
| Remote Analog In 4 | 212     | Float  | R/W | Current Min GG                  | mA      | 4 - 20                    |
| Remote Analog In 4 | 212     | Float  | R/W | Current Max GG                  | mA      | 4 - 20                    |
| Remote Analog In 4 | 212     | Float  | R/W | Voltage Min GG                  | V       | 0 - 10                    |
| Remote Analog In 4 | 212     | Float  | R/W | Voltage Max GG                  | V       | 0 - 10                    |
| Remote Analog In 5 | 213     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1                |
| Remote Analog In 5 | 213     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 5 | 213     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 5 | 213     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 5 | 213     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote Analog In 5 | 213     | UINT32 | R/W | Type GG                         | No Unit | Voltage=0 Current=1       |
| Remote Analog In 5 | 214     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100                   |
| Remote Analog In 5 | 214     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300                   |
| Remote Analog In 5 | 214     | Float  | R/W | Threshold 1 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 5 | 214     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 5 | 214     | Float  | R/W | Threshold 2 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 5 | 214     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300                   |
| Remote Analog In 5 | 214     | Float  | R/W | Threshold 3 Pickup GG           | No Unit | -9999 - 9999              |
| Remote Analog In 5 | 214     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300                   |

| Instance Name      | Inst. # | Type   | RW  | Key Name                           | Unit    | Range                        |
|--------------------|---------|--------|-----|------------------------------------|---------|------------------------------|
| Remote Analog In 5 | 214     | Float  | R/W | Threshold4 Pickup GG               | No Unit | -9999 - 9999                 |
| Remote Analog In 5 | 214     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 5 | 214     | Float  | R/W | Parameter Min GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 5 | 214     | Float  | R/W | Parameter Max GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 5 | 214     | Float  | R/W | Current Min GG                     | mA      | 4 - 20                       |
| Remote Analog In 5 | 214     | Float  | R/W | Current Max GG                     | mA      | 4 - 20                       |
| Remote Analog In 5 | 214     | Float  | R/W | Voltage Min GG                     | V       | 0 - 10                       |
| Remote Analog In 5 | 214     | Float  | R/W | Voltage Max GG                     | V       | 0 - 10                       |
| Remote Analog In 6 | 215     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote Analog In 6 | 215     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 6 | 215     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 6 | 215     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 6 | 215     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 6 | 215     | UINT32 | R/W | Type GG                            | No Unit | Voltage=0 Current=1          |
| Remote Analog In 6 | 216     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote Analog In 6 | 216     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 1 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 6 | 216     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 6 | 216     | Float  | R/W | Parameter Min GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 6 | 216     | Float  | R/W | Parameter Max GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 6 | 216     | Float  | R/W | Current Min GG                     | mA      | 4 - 20                       |
| Remote Analog In 6 | 216     | Float  | R/W | Current Max GG                     | mA      | 4 - 20                       |
| Remote Analog In 6 | 216     | Float  | R/W | Voltage Min GG                     | V       | 0 - 10                       |
| Remote Analog In 6 | 216     | Float  | R/W | Voltage Max GG                     | V       | 0 - 10                       |
| Remote Analog In 7 | 217     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote Analog In 7 | 217     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 7 | 217     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 7 | 217     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 7 | 217     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 7 | 217     | UINT32 | R/W | Type GG                            | No Unit | Voltage=0 Current=1          |
| Remote Analog In 7 | 218     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote Analog In 7 | 218     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 1 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -9999 - 9999                 |

| Instance Name      | Inst. # | Type   | RW  | Key Name                           | Unit    | Range                        |
|--------------------|---------|--------|-----|------------------------------------|---------|------------------------------|
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 7 | 218     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 7 | 218     | Float  | R/W | Parameter Min GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 7 | 218     | Float  | R/W | Parameter Max GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 7 | 218     | Float  | R/W | Current Min GG                     | mA      | 4 - 20                       |
| Remote Analog In 7 | 218     | Float  | R/W | Current Max GG                     | mA      | 4 - 20                       |
| Remote Analog In 7 | 218     | Float  | R/W | Voltage Min GG                     | V       | 0 - 10                       |
| Remote Analog In 7 | 218     | Float  | R/W | Voltage Max GG                     | V       | 0 - 10                       |
| Remote Analog In 8 | 219     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote Analog In 8 | 219     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 8 | 219     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 8 | 219     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 8 | 219     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote Analog In 8 | 219     | UINT32 | R/W | Type GG                            | No Unit | Voltage=0 Current=1          |
| Remote Analog In 8 | 220     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote Analog In 8 | 220     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 1 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 2 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 3 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 4 Pickup GG              | No Unit | -9999 - 9999                 |
| Remote Analog In 8 | 220     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote Analog In 8 | 220     | Float  | R/W | Parameter Min GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 8 | 220     | Float  | R/W | Parameter Max GG                   | No Unit | -9999 - 9999                 |
| Remote Analog In 8 | 220     | Float  | R/W | Current Min GG                     | mA      | 4 - 20                       |
| Remote Analog In 8 | 220     | Float  | R/W | Current Max GG                     | mA      | 4 - 20                       |
| Remote Analog In 8 | 220     | Float  | R/W | Voltage Min GG                     | V       | 0 - 10                       |
| Remote Analog In 8 | 220     | Float  | R/W | Voltage Max GG                     | V       | 0 - 10                       |
| Remote RTD In 1    | 221     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 1    | 221     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote RTD In 1    | 221     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 1    | 221     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 1    | 221     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 1    | 221     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 1    | 222     | Float  | R/W | Cal Offset GG                      | Deg F   | -99999 - 99999               |

| Instance Name   | Inst. # | Type   | RW  | Key Name                           | Unit    | Range                        |
|-----------------|---------|--------|-----|------------------------------------|---------|------------------------------|
| Remote RTD In 1 | 222     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote RTD In 1 | 222     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 1 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 2 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 3 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 4 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 1 | 222     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 2 | 223     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 2 | 223     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote RTD In 2 | 223     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 2 | 223     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 2 | 223     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 2 | 223     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 2 | 224     | Float  | R/W | Cal Offset GG                      | Deg F   | -99999 - 99999               |
| Remote RTD In 2 | 224     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote RTD In 2 | 224     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 1 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 2 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 3 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 4 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 2 | 224     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 3 | 225     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 3 | 225     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote RTD In 3 | 225     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 3 | 225     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 3 | 225     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 3 | 225     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 3 | 226     | Float  | R/W | Cal Offset GG                      | Deg F   | -99999 - 99999               |
| Remote RTD In 3 | 226     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote RTD In 3 | 226     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 1 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |

| Instance Name   | Inst. # | Type   | RW  | Key Name                           | Unit    | Range                        |
|-----------------|---------|--------|-----|------------------------------------|---------|------------------------------|
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 2 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 3 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 4 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 3 | 226     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 4 | 227     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 4 | 227     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote RTD In 4 | 227     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 4 | 227     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 4 | 227     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 4 | 227     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 4 | 228     | Float  | R/W | Cal Offset GG                      | Deg F   | -99999 - 99999               |
| Remote RTD In 4 | 228     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote RTD In 4 | 228     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 1 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 2 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 3 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 4 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 4 | 228     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 5 | 229     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 5 | 229     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote RTD In 5 | 229     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 5 | 229     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 5 | 229     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 5 | 229     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 5 | 230     | Float  | R/W | Cal Offset GG                      | Deg F   | -99999 - 99999               |
| Remote RTD In 5 | 230     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote RTD In 5 | 230     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 1 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 2 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 3 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |

| Instance Name   | Inst. # | Type   | RW  | Key Name                           | Unit    | Range                        |
|-----------------|---------|--------|-----|------------------------------------|---------|------------------------------|
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 4 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 5 | 230     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 6 | 231     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 6 | 231     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote RTD In 6 | 231     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 6 | 231     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 6 | 231     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 6 | 231     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 6 | 232     | Float  | R/W | Cal Off set GG                     | Deg F   | -99999 - 99999               |
| Remote RTD In 6 | 232     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote RTD In 6 | 232     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 1 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 2 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 3 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 4 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 6 | 232     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 7 | 233     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 7 | 233     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |
| Remote RTD In 7 | 233     | UINT32 | R/W | Threshold 1 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 7 | 233     | UINT32 | R/W | Threshold 2 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 7 | 233     | UINT32 | R/W | Threshold 3 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 7 | 233     | UINT32 | R/W | Threshold 4 Type GG                | No Unit | Disabled=0 Over=1<br>Under=2 |
| Remote RTD In 7 | 234     | Float  | R/W | Cal Offset GG                      | Deg F   | -99999 - 99999               |
| Remote RTD In 7 | 234     | Float  | R/W | Hysteresis GG                      | %       | 0 - 100                      |
| Remote RTD In 7 | 234     | Float  | R/W | Arming Delay GG                    | Sec     | 0 - 300                      |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 1 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 1<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 2 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 2<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 3 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 3<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 4 Pickup GG              | Deg F   | -58 - 482                    |
| Remote RTD In 7 | 234     | Float  | R/W | Threshold 4<br>Activation Delay GG | Sec     | 0 - 300                      |
| Remote RTD In 8 | 235     | UINT32 | R/W | Type GG                            | No Unit | 10 Ohm Cu=0 100 Ohm<br>Pt=1  |
| Remote RTD In 8 | 235     | UINT32 | R/W | Stop Mode Inhibit GG               | No Unit | No=0 Yes=1                   |

| Instance Name   | Inst. # | Type   | RW  | Key Name                        | Unit    | Range                     |
|-----------------|---------|--------|-----|---------------------------------|---------|---------------------------|
| Remote RTD In 8 | 235     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote RTD In 8 | 235     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote RTD In 8 | 235     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote RTD In 8 | 235     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote RTD In 8 | 236     | Float  | R/W | Cal Offset GG                   | Deg F   | -99999 - 99999            |
| Remote RTD In 8 | 236     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100                   |
| Remote RTD In 8 | 236     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300                   |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 1 Pickup GG           | Deg F   | -58 - 482                 |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300                   |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 2 Pickup GG           | Deg F   | -58 - 482                 |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300                   |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 3 Pickup GG           | Deg F   | -58 - 482                 |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300                   |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 4 Pickup GG           | Deg F   | -58 - 482                 |
| Remote RTD In 8 | 236     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300                   |
| Remote TC In 1  | 237     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1                |
| Remote TC In 1  | 237     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 1  | 237     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 1  | 237     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 1  | 237     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 1  | 238     | Float  | R/W | Cal Offset GG                   | Deg F   | -99999 - 99999            |
| Remote TC In 1  | 238     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100                   |
| Remote TC In 1  | 238     | Float  | R/W | Arming Delay GG                 | Sec     | 0 - 300                   |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 1 Pickup GG           | Deg F   | 32 - 2507                 |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 1 Activation Delay GG | Sec     | 0 - 300                   |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 2 Pickup GG           | Deg F   | 32 - 2507                 |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 2 Activation Delay GG | Sec     | 0 - 300                   |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 3 Pickup GG           | Deg F   | 32 - 2507                 |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 3 Activation Delay GG | Sec     | 0 - 300                   |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 4 Pickup GG           | Deg F   | 32 - 2507                 |
| Remote TC In 1  | 238     | Float  | R/W | Threshold 4 Activation Delay GG | Sec     | 0 - 300                   |
| Remote TC In 2  | 239     | UINT32 | R/W | Stop Mode Inhibit GG            | No Unit | No=0 Yes=1                |
| Remote TC In 2  | 239     | UINT32 | R/W | Threshold 1 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 2  | 239     | UINT32 | R/W | Threshold 2 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 2  | 239     | UINT32 | R/W | Threshold 3 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 2  | 239     | UINT32 | R/W | Threshold 4 Type GG             | No Unit | Disabled=0 Over=1 Under=2 |
| Remote TC In 2  | 240     | Float  | R/W | Cal Offset GG                   | Deg F   | -99999 - 99999            |
| Remote TC In 2  | 240     | Float  | R/W | Hysteresis GG                   | %       | 0 - 100                   |

| Instance Name       | Inst. # | Type   | RW  | Key Name                            | Unit    | Range  |
|---------------------|---------|--------|-----|-------------------------------------|---------|--|
| Remote TC In 2      | 240     | Float  | R/W | Arming Delay GG                     | Sec     | 0 - 300  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 1 Pickup GG               | Deg F   | 32 - 2507  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 1<br>Activation Delay GG  | Sec     | 0 - 300  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 2 Pickup GG               | Deg F   | 32 - 2507  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 2<br>Activation Delay GG  | Sec     | 0 - 300  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 3 Pickup GG               | Deg F   | 32 - 2507  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 3<br>Activation Delay GG  | Sec     | 0 - 300  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 4 Pickup GG               | Deg F   | 32 - 2507  |
| Remote TC In 2      | 240     | Float  | R/W | Threshold 4<br>Activation Delay GG  | Sec     | 0 - 300  |
| Remote Analog Out 1 | 241     | UINT32 | R/W | Parameter Selection GG              | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Remote Analog Out 1 | 241     | UINT32 | R/W | Output Type GG                      | No Unit | Voltage=0 Current=1  |
| Remote Analog Out 1 | 242     | Float  | R/W | Out of Range<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog Out 1 | 242     | Float  | R/W | Parameter Min GG                    | No Unit | -99999 - 99999   |
| Remote Analog Out 1 | 242     | Float  | R/W | Parameter Max GG                    | No Unit | -99999 - 99999   |
| Remote Analog Out 1 | 242     | Float  | R/W | Current Min GG                      | mA      | 4 - 20   |
| Remote Analog Out 1 | 242     | Float  | R/W | Current Max GG                      | mA      | 4 - 20   |
| Remote Analog Out 1 | 242     | Float  | R/W | Voltage Min GG                      | V       | 0 - 10   |
| Remote Analog Out 1 | 242     | Float  | R/W | Voltage Max GG                      | V       | 0 - 10   |
| Remote Analog Out 2 | 243     | UINT32 | R/W | Parameter Selection GG              | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Remote Analog Out 2 | 243     | UINT32 | R/W | Output Type GG                      | No Unit | Voltage=0 Current=1  |
| Remote Analog Out 2 | 244     | Float  | R/W | Out of Range<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog Out 2 | 244     | Float  | R/W | Parameter Min GG                    | No Unit | -99999 - 99999   |
| Remote Analog Out 2 | 244     | Float  | R/W | Parameter Max GG                    | No Unit | -99999 - 99999   |
| Remote Analog Out 2 | 244     | Float  | R/W | Current Min GG                      | mA      | 4 - 20   |
| Remote Analog Out 2 | 244     | Float  | R/W | Current Max GG                      | mA      | 4 - 20   |
| Remote Analog Out 2 | 244     | Float  | R/W | Voltage Min GG                      | V       | 0 - 10   |
| Remote Analog Out 2 | 244     | Float  | R/W | Voltage Max GG                      | V       | 0 - 10   |
| Remote Analog Out 3 | 245     | UINT32 | R/W | Parameter Selection GG              | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Remote Analog Out 3 | 245     | UINT32 | R/W | Output Type GG                      | No Unit | Voltage=0 Current=1  |
| Remote Analog Out 3 | 246     | Float  | R/W | Out of Range<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog Out 3 | 246     | Float  | R/W | Parameter Min GG                    | No Unit | -99999 - 99999   |
| Remote Analog Out 3 | 246     | Float  | R/W | Parameter Max GG                    | No Unit | -99999 - 99999   |
| Remote Analog Out 3 | 246     | Float  | R/W | Current Min GG                      | mA      | 4 - 20   |
| Remote Analog Out 3 | 246     | Float  | R/W | Current Max GG                      | mA      | 4 - 20   |
| Remote Analog Out 3 | 246     | Float  | R/W | Voltage Min GG                      | V       | 0 - 10   |
| Remote Analog Out 3 | 246     | Float  | R/W | Voltage Max GG                      | V       | 0 - 10   |
| Remote Analog Out 4 | 247     | UINT32 | R/W | Parameter Selection GG              | No Unit | See <i>Parameter Selection</i> at the end of this section for a complete list. |
| Remote Analog Out 4 | 247     | UINT32 | R/W | Output Type GG                      | No Unit | Voltage=0 Current=1  |
| Remote Analog Out 4 | 248     | Float  | R/W | Out of Range<br>Activation Delay GG | Sec     | 0 - 300  |
| Remote Analog Out 4 | 248     | Float  | R/W | Parameter Min GG                    | No Unit | -99999 - 99999   |

| Instance Name            | Inst. # | Type   | RW  | Key Name                       | Unit    | Range          |
|--------------------------|---------|--------|-----|--------------------------------|---------|----------------|
| Remote Analog Out 4      | 248     | Float  | R/W | Parameter Max GG               | No Unit | -99999 - 99999 |
| Remote Analog Out 4      | 248     | Float  | R/W | Current Min GG                 | mA      | 4 - 20         |
| Remote Analog Out 4      | 248     | Float  | R/W | Current Max GG                 | mA      | 4 - 20         |
| Remote Analog Out 4      | 248     | Float  | R/W | Voltage Min GG                 | V       | 0 - 10         |
| Remote Analog Out 4      | 248     | Float  | R/W | Voltage Max GG                 | V       | 0 - 10         |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 1 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 2 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 3 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 4 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 5 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 6 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 7 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 8 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 9 Delay GG  | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 10 Delay GG | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 11 Delay GG | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 12 Delay GG | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 13 Delay GG | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 14 Delay GG | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 15 Delay GG | Sec     | 0 - 300        |
| User Programmable Alarms | 250     | Float  | R/W | Programmable Alarm 16 Delay GG | Sec     | 0 - 300        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 1 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 2 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 3 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 4 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 5 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 6 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 7 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 8 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 9 Timeout Hours GG       | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 10 Timeout Hours GG      | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 11 Timeout Hours GG      | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 12 Timeout Hours GG      | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 13 Timeout Hours GG      | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 14 Timeout Hours GG      | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 15 Timeout Hours GG      | Hour    | 0 - 250        |
| Logic Timers             | 251     | UINT32 | R/W | Timer 16 Timeout Hours GG      | Hour    | 0 - 250        |
| Logic Timers             | 252     | UINT32 | R/W | Timer 1 Timeout Minutes GG     | Minute  | 0 - 59         |
| Logic Timers             | 252     | UINT32 | R/W | Timer 2 Timeout Minutes GG     | Minute  | 0 - 59         |

| Instance Name  | Inst. # | Type   | RW  | Key Name                       | Unit       | Range    |
|----------------|---------|--------|-----|--------------------------------|------------|----------|
| Logic Timers   | 252     | UINT32 | R/W | Timer 3 Timeout Minutes<br>GG  | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 4 Timeout Minutes<br>GG  | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 5 Timeout Minutes<br>GG  | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 6 Timeout Minutes<br>GG  | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 7 Timeout Minutes<br>GG  | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 8 Timeout Minutes<br>GG  | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 9 Timeout Minutes<br>GG  | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 10 Timeout Minutes<br>GG | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 11 Timeout Minutes<br>GG | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 12 Timeout Minutes<br>GG | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 13 Timeout Minutes<br>GG | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 14 Timeout Minutes<br>GG | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 15 Timeout Minutes<br>GG | Minute     | 0 – 59   |
| Logic Timers   | 252     | UINT32 | R/W | Timer 16 Timeout Minutes<br>GG | Minute     | 0 – 59   |
| Logic Timers   | 253     | UINT32 | R/W | Timer 1 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 2 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 3 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 4 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 5 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 6 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 7 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 8 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 9 Timeout Seconds<br>GG  | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 10 Timeout Seconds<br>GG | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 11 Timeout Seconds<br>GG | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 12 Timeout Seconds<br>GG | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 13 Timeout Seconds<br>GG | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 14 Timeout Seconds<br>GG | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 15 Timeout Seconds<br>GG | Decisecond | 0 – 599  |
| Logic Timers   | 253     | UINT32 | R/W | Timer 16 Timeout Seconds<br>GG | Decisecond | 0 – 599  |
| Logic Counters | 255     | Float  | R/W | Counter 1 Output<br>Timeout GG | No Unit    | 0 - 1800 |

| Instance Name           | Inst. # | Type  | RW  | Key Name                             | Unit    | Range    |
|-------------------------|---------|-------|-----|--------------------------------------|---------|----------|
| Logic Counters          | 255     | Float | R/W | Counter 2 Output Timeout GG          | No Unit | 0 - 1800 |
| Logic Counters          | 255     | Float | R/W | Counter 3 Output Timeout GG          | No Unit | 0 - 1800 |
| Logic Counters          | 255     | Float | R/W | Counter 4 Output Timeout GG          | No Unit | 0 - 1800 |
| Logic Counters          | 255     | Float | R/W | Counter 5 Output Timeout GG          | No Unit | 0 - 1800 |
| Logic Counters          | 255     | Float | R/W | Counter 6 Output Timeout GG          | No Unit | 0 - 1800 |
| Logic Counters          | 255     | Float | R/W | Counter 7 Output Timeout GG          | No Unit | 0 - 1800 |
| Logic Counters          | 255     | Float | R/W | Counter 8 Output Timeout GG          | No Unit | 0 - 1800 |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 1 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 2 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 3 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 4 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 5 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 6 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 7 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | RTD Input 8 Metric Value GG          | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | Thermocouple Input 1 Metric Value GG | Deg C   | n/a      |
| AEM RTD TC Metric Meter | 256     | Float | R   | Thermocouple Input 2 Metric Value GG | Deg C   | n/a      |
| Active Setpoint Meter   | 257     | Float | R   | Active Generator Voltage Setpoint    | V       | n/a      |
| Active Setpoint Meter   | 257     | Float | R   | Active Excitation Current Setpoint   | Amp     | n/a      |
| Active Setpoint Meter   | 257     | Float | R   | Active Excitation Voltage Setpoint   | V       | n/a      |
| Active Setpoint Meter   | 257     | Float | R   | Active Generator Var Setpoint        | kvar    | n/a      |
| Active Setpoint Meter   | 257     | Float | R   | Active Generator PF Setpoint         | PF      | n/a      |

## ***Parameter Selection***

---

|                                 |                                     |
|---------------------------------|-------------------------------------|
| Generator VAB=0                 | Negative Sequence Current=27        |
| Generator VBC=1                 | Positive Sequence Voltage=28        |
| Generator VCA=2                 | Positive Sequence Current=29        |
| Generator V Average=3           | PSS Output=30                       |
| Bus Frequency=4                 | Analog Input 1=31                   |
| Bus VAB=5                       | Analog Input 2=32                   |
| Bus VBC=6                       | Analog Input 3=33                   |
| Bus VCA=7                       | Analog Input 4=34                   |
| Generator Frequency=8           | Analog Input 5=35                   |
| Generator Power Factor=9        | Analog Input 6=36                   |
| KWH=10                          | Analog Input 7=37                   |
| KVARH=11                        | Analog Input 8=38                   |
| Generator IA=12                 | RTD Input 1=39                      |
| Generator IB=13                 | RTD Input 2=40                      |
| Generator IC=14                 | RTD Input 3=41                      |
| Generator I Average=15          | RTD Input 4=42                      |
| kW Total=16                     | RTD Input 5=43                      |
| kVA Total=17                    | RTD Input 6=44                      |
| kvar Total=18                   | RTD Input 7=45                      |
| Exciter Diode Monitor Ripple=19 | RTD Input 8=46                      |
| Exciter Field Voltage=20        | Thermocouple 1=47                   |
| Exciter Field Current=21        | Thermocouple 2=48                   |
| Auxiliary Input Voltage=22      | Power Input=49                      |
| Auxiliary Input Current (mA)=23 | Network Load Share Error Percent=50 |
| Setpoint Position=24            | Generator Scaled Power Factor=51    |
| Tracking Error=25               | Control Output Per Unit=52          |
| Negative Sequence Voltage=26    | Field Temperature=53                |

## 28 • Maintenance and Troubleshooting

### Warning!

These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are qualified to do so.

Before performing any maintenance procedures, remove the DECS-450 from service. Refer to the appropriate site schematics to ensure that all steps have been taken to properly and completely de-energize the DECS-450.

### Storage

If the unit is not to be installed immediately, store it in the original shipping package in a moisture- and dust-free environment. The temperature of the storage environment must be within the range of  $-40$  to  $85^{\circ}\text{C}$  ( $-40$  to  $185^{\circ}\text{F}$ ).

### Preventive Maintenance

#### Connections

Periodically check the connections of the DECS-450 to ensure they are clean and tight and remove any accumulation of dust.

#### Electrolytic Capacitors

The DECS-450 contains long-life aluminum electrolytic capacitors. For a DECS-450 kept in storage as a spare, the life of these capacitors can be maximized by energizing the device for 30 minutes once per year. Apply DECS-450 control power as indicated by the device style number. For this maintenance procedure, it is recommended that the applied voltage not exceed the nominal value.

- Style XLXXXXX: 24/48 Vdc (16 to 60 Vdc)
- Style XCXXXXX: 120 Vac (82 to 132 Vac at 50/60 Hz) or 125 Vdc (90 to 150 Vdc)

### Cleaning the Front Panel

Only a soft cloth and water-based solutions should be used to clean the front panel. Do not use solvents.

### Backup Battery Replacement

An internal battery maintains real-time clock information when DECS-450 control power is removed or lost. The 3-volt, lithium, backup battery is secured in a tray located in the left side panel. The backup battery has a life expectancy of approximately five years depending on conditions. After this time, you should contact Basler Electric to order a new battery, Basler Electric P/N 38526.

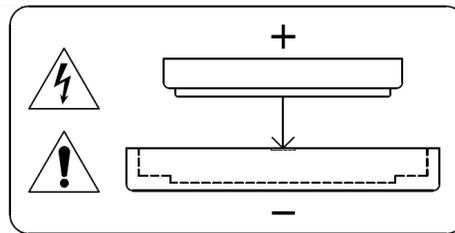
### Warning!

Only qualified personnel should replace the backup battery.

To avoid risk of electric shock, the DECS-450 must be powered down when removing or installing the battery.

Do not short-circuit the battery, reverse the battery polarity, or attempt to recharge the battery as personal injury or equipment damage may result.

1. Obtain a replacement battery (Murata CR2032X, Murata CR2032W, Panasonic CR2032A, Rayovac BR2032-BA, Basler Electric 38526, or equivalent).
2. Remove the DECS-450 from service by observing all applicable safety and shutdown procedures.
3. Locate the battery access slot. Using a small, pointed, non-conductive tool, remove the battery tray from the access slot. Real-time clock information will be lost when the battery is removed.
4. Note the orientation (polarity) of the battery in the tray or refer to the battery polarity label (Figure 28-1) on the DECS-450 side panel. The new battery must be installed with the same orientation.



**Figure 28-1. Shock Hazard and Battery Polarity Label**

5. Remove the battery from the tray and dispose of properly or recycle.

### Note

The battery should be disposed of properly. Consult your local health, solid waste disposal, or recycling agency for battery disposal guidelines.

6. Place the new battery into the battery tray. Ensure that the polarity of the installed battery is correct (+ to + and – to –).
7. Slide the battery tray into battery access slot until fully seated.
8. Place the DECS-450 back in service by observing all applicable safety and startup procedures.
9. Set the DECS-450's real-time clock.

## **Troubleshooting**

The following troubleshooting procedures assume the excitation system components are properly matched, fully operational, and correctly connected. If you do not obtain the results that you expect from the DECS-450, first check the programmable settings for the appropriate function.

### **The DECS-450 Appears to be Inoperative**

If the DECS-450 does not power up (no backlighting on front panel display), ensure that the control power applied to the unit is at the correct level (ac terminals: L and N, dc terminals: BATT+ and BATT–). If dc control power is used, verify that the polarity is correct. Units with style number XLXXXXX have an input voltage range of 16 to 60 Vdc. Units with style number XCXXXXX have an input voltage range of 90 to 150 Vdc or 82 to 132 Vac (50/60 Hz).

**Note**

When ac *and* dc control power is used, an isolation transformer must be connected between the ac voltage source and the ac control power terminals of the DECS-450.

**Display is Blank or Frozen**

If the front panel display (LCD) is blank or frozen (does not scroll), remove control power for about 60 seconds and then reapply control power. If the problem occurred during software uploading, repeat the upload procedures as described in the associated instructions.

**Generator Voltage Does Not Build**

Check the DECS-450 settings for the following system configurations:

- a. Generator potential transformer (PT) primary voltage
- b. Generator PT secondary voltage
- c. Analog control output signal type

Check the DECS-450 soft start settings:

- d. Maximum field flash dropout time
- e. Field flash dropout level
- f. Generator soft start bias
- g. Generator soft start time

Check the external field flashing components:

- h. Field flashing contactor
- i. Field flashing power source fuses
- j. Field flashing current limiting resistor values

If the generator voltage still does not build, increase the soft start setting values in paragraphs d through f, and decrease the setting for paragraph g.

Temporarily turn off the overexcitation limiter.

**Generator Voltage Builds but DECS-450 Fails To Flash**

Check the DECS-450 settings for the following system configurations:

- a. Generator potential transformer (PT) primary voltage
- b. Generator PT secondary voltage
- c. Analog control output signal type

Check the DECS-450 soft start settings:

- d. Maximum field flash dropout time
- e. Field flash dropout level
- f. Generator soft start bias
- g. Generator soft start time

If the generator voltage still does not build, increase the soft start setting values in steps d through f, and decrease the setting for paragraph g.

Temporarily turn off the overexcitation limiter.

Check the exciter power circuitry: rectifier bridge, firing circuit, and power input transformer.

If the problem persists, contact Basler Electric.

**Field Voltage or Current Reading Does Not Change**

Check the status of the Loss of Field Isolation Transducer alarm and ensure it is enabled.

Check the connections and polarity between the Field Isolation Transducer and the DECS-450.

Check the connections and polarity between the Field Isolation Transducer and shunt (field current sensing) and between the Field Isolation Transducer and the output of the exciter (field voltage sensing).

### Low Generator Voltage in AVR Mode

Check the following DECS-450 settings and system parameters:

- a. AVR voltage setpoint
- b. Generator potential transformer (PT) primary voltage
- c. Generator PT secondary voltage
- d. Overexcitation limiter (not activated)
- e. Accessory inputs (should be zero)
- f. Var/PF and droop (should be disabled)
- g. Underfrequency or V/Hz limiters (not activated)

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

### High Generator Voltage in AVR Mode

Check the following DECS-450 settings and system parameters:

- a. AVR voltage setpoint
- b. Generator potential transformer (PT) primary voltage
- c. Generator PT secondary voltage
- d. Accessory inputs (should be zero)
- e. Var/PF and droop (should be disabled)

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

### Generator Voltage Unstable (Hunting)

Switch into FCR operation mode. If the generator voltage becomes stable, check AVR gains.

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

### Poor Voltage Regulation

Poor voltage regulation may result from insufficient  $K_a$  loop gain. Increase the AVR loop gain accordingly.

### No Buildup in FCR Mode

Low  $K_a$  loop gain may hinder buildup when operating in FCR mode.

### No Control Signal at Firing Circuit Input

Ensure that the *Control Output Disable* logic element is not inhibiting the control output.

Check the control signal setting and output of the DECS-450. Depending on the signal selected, the DECS-450 produces a 0 to 10 Vdc, 4 to 20 mAdc, or -10 to +10 Vdc control signal.

### Limiters Do Not Limit at the Desired Level

Insufficient  $K_g$  loop gain for the limiters may hinder limiter operation. Increase the limiter loop gain accordingly.

### Poor Reactive Control

Poor reactive control may result if the AVR droop setting is too low. Adjust the AVR droop accordingly.

### Protection or Limiter Annunciation

If a protection function or limiting function is annunciated, check the associated setting values.

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

### **Meter Readings Incorrect**

If PF, var, or watt readings are significantly different from the expected readings for a known load, verify proper PT and CT connections and phase relationship.

### **No Communication**

If communication with the DECS-450 cannot be initiated, check the connections at the communication ports, the baud rate, and supporting software.

### **Real-Time Clock Information Lost After Loss of Control Power**

A loss of real-time clock information indicates a depleted backup battery. See *Backup Battery Replacement*, above, for the battery replacement procedure.

### **The DECS-450 Reboots Frequently**

Check the status of the Control Power Input Failure alarm.

If a single DECS-450 control power source is used and the power source is supplying less than the minimum required voltage or is fluctuating below the minimum required voltage, the DECS-450 will reboot. Increase the control power source voltage so that it is within the specified operating range. Units with style number XLXXXXX have an input voltage range of 16 to 60 Vdc. Units with style number XCXXXXX have an input voltage range of 90 to 150 Vdc or 82 to 132 Vac (50/60 Hz).

### **USB Drivers Failed to Install Automatically**

Perform the following steps to manually install the DECS-450 USB drivers.

1. In the Windows Device Manager, under Other Devices, right-click on DECS-450 and select Properties. The Properties window appears. (If the DECS-450 is displayed as an "Unknown Device", restart the PC and repeat this step.)
2. In the Properties window, click the Update Driver button on the Driver tab.
3. Select "Browse my computer for driver software".
4. Click Browse and navigate to the following directory: C:\Program Files\Basler Electric\USB Connect Driver\.
5. Click Next to install the drivers.

## ***Support***

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Contact the Basler Electric Technical Services Department at +1 (618) 654-2341 for troubleshooting support or to receive a return authorization number.



## 29 • Specifications

DECS-450 electrical and physical characteristics are listed in the following paragraphs.

### **Control Power**

Two control power inputs enable continued operation if one of the two inputs is lost. The control power voltage rating is determined by the device style number.

#### **AC Input (Style XCXXXXX only)**

|                 |               |
|-----------------|---------------|
| Nominal .....   | 120 Vac       |
| Range .....     | 82 to 132 Vac |
| Frequency ..... | 50/60 Hz      |
| Burden .....    | 50 VA         |
| Terminals.....  | L, N          |

#### **DC Input (Style XCXXXXX, XLXXXXX)**

|                     |               |
|---------------------|---------------|
| Nominal             |               |
| Style XCXXXXX.....  | 125 Vdc       |
| Style XLXXXXX ..... | 24/48 Vdc     |
| Range               |               |
| Style XCXXXXX.....  | 90 to 150 Vdc |
| Style XLXXXXX ..... | 16 to 60 Vdc  |
| Burden.....         | 35 W          |
| Terminals.....      | BATT+, BATT-  |

### **Generator and Bus Voltage Sensing**

|                     |  |
|---------------------|--|
| Nominal Input ..... | 100/200 Vac (50 Hz), 120/240 Vac (60 Hz) |
| Type .....          | 1-phase or 3-phase-3-wire                |
| Burden.....         | <1 VA per phase                          |

#### **Terminals**

|                                |            |
|--------------------------------|------------|
| Generator Voltage Sensing..... | E1, E2, E3 |
| Bus Voltage Sensing.....       | B1, B2, B3 |

#### **50/60 Hz Sensing Voltage Nominal Input Range**

90 to 264 Vac

### **Generator Current Sensing**

|                    |   |
|--------------------|---|
| Configuration..... | 4 inputs: A-, B-, C-phase, and cross-current compensation CT input                                    |
| Type .....         | 1-phase, 1-phase with cross-current compensation, 3-phase,<br>3-phase with cross-current compensation |
| Range.....         | 1 Aac or 5 Aac nominal  |
| Frequency .....    | 50/60 Hz  |
| Burden             |   |
| 1 Aac Sensing..... | <1 VA   |
| 5 Aac Sensing..... | <1 VA   |

#### **Terminals**

|                                  |                            |
|----------------------------------|----------------------------|
| A-Phase.....                     | CTA (terminals 75 and 76)  |
| B-Phase.....                     | CTB (terminals 77 and 78)  |
| C-Phase .....                    | CTC (terminals 79 and 80)  |
| Cross-Current Compensation ..... | CCCT (terminals 81 and 82) |

## Field Voltage and Current Sensing

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The DECS-450 receives field voltage and current signals from the Field Isolation Transducer (supplied). The Field Isolation Transducer transmits field voltage and current signals through a dedicated cable terminated at the DECS-450 rear panel Field Isolation Transducer connector. See *Field Isolation Transducer*.

## Field Isolation Transducer

---

### Electrical Specifications

|                       |  |
|-----------------------|--|
| Operating Power ..... | +5 Vdc, $\pm 12$ Vdc from DECS-450   |
| Sensing Ranges        |  |
| Field Voltage .....   | $\pm 300\%$ of the five nominal ranges: 63 Vdc, 125 Vdc, 250 Vdc, 375 Vdc, and 625 Vdc |
| Field Current .....   | 0 to 300% of the two nominal shunt ranges: 50 mVdc and 100 mVdc                        |
| Signal Output         |  |
| Field Voltage .....   | 0.9 to 9.1 Vdc (5.0 Vdc = zero field voltage)  |
| Field Current .....   | 2.0 to 9.5 Vdc (2.0 Vdc = zero field current)  |

### Physical Specifications

|                 |   |
|-----------------|---|
| Temperature     |   |
| Operating ..... | -40 to 60 °C (-40 to 140°F)   |
| Storage .....   | -40 to 85°C (-40 to 185°F)  |
| Weight .....    | 680 g (1.5 lb)  |
| Size .....      | Refer to the <i>Mounting</i> section for Field Isolation Transducer dimensions. |

## Accessory Inputs

---

### Current Input

|                 |                            |
|-----------------|----------------------------|
| Range .....     | 4 to 20 mAdc               |
| Burden .....    | Approximately 500 $\Omega$ |
| Terminals ..... | I+, I-                     |

### Voltage Input

|                 |                |
|-----------------|----------------|
| Range .....     | -10 to +10 Vdc |
| Burden .....    | >20 k $\Omega$ |
| Terminals ..... | V+, V-         |

## Metering Accuracy

---

|                                   |   |
|-----------------------------------|---|
| Generator and Bus Voltage .....   | $\pm 1\%$ of rated over nominal range<br>The greater of $\pm 0.5\%$ of reading or $\pm 0.1\%$ of full range at 25°C |
| Generator and Bus Frequency ..... | $\pm 0.1$ Hz over range   |
| Generator Line Current .....      | $\pm 1\%$ of rated over nominal range   |
| Power Quantities .....            | $\pm 1\%$ of rated  |
| Power Factor .....                | $\pm 0.02$  |
| Field Current and Voltage .....   | $\pm 2\%$ of nominal range  |
| Accessory Input .....             | $\pm 1\%$ of range<br>The greater of $\pm 0.5\%$ of reading or $\pm 0.1\%$ of full range at 25°C                    |

## Control Output

---

|                 |  |
|-----------------|--|
| Range .....     | 0 to 10 Vdc, -10 to +10 Vdc, or 4 to 20 mAdc |
| Terminals ..... | CTRL+, CTRL-                                 |

**Minimum/Maximum Impedance**

Current Output .....  $\leq 800 \Omega$   
 Voltage Output .....  $\geq 1 \text{ k}\Omega$

**Meter Driver Outputs**

Four analog outputs, each configurable to provide a 0 to 10 Vdc, -10 to +10 Vdc, or 4 to 20 mAdc signal.

**Minimum/Maximum Impedance**

Current Output .....  $\leq 800 \Omega$   
 Voltage Output .....  $\geq 1 \text{ k}\Omega$

Terminals..... M1+, M1-, M2+, M2-, M3+, M3-, M4+, M4-

**Contact Inputs**

Type ..... Dry contact, accept PLC open-collector outputs  
 Interrogation Voltage..... 12 Vdc

**Terminals**

Start..... START, COM  
 Stop ..... STOP, COM  
 Programmable Input 1..... IN 1, COM  
 Programmable Input 2..... IN 2, COM  
 Programmable Input 3..... IN 3, COM  
 Programmable Input 4..... IN 4, COM  
 Programmable Input 5..... IN 5, COM  
 Programmable Input 6..... IN 6, COM  
 Programmable Input 7..... IN 7, COM  
 Programmable Input 8..... IN 8, COM  
 Programmable Input 9..... IN 9, COM  
 Programmable Input 10..... IN 10, COM  
 Programmable Input 11..... IN 11, COM  
 Programmable Input 12..... IN 12, COM  
 Programmable Input 13..... IN 13, COM  
 Programmable Input 14..... IN 14, COM

**Communication Ports****Controller Area Network (CAN)**

Type ..... SAE J1939 message protocol  
 Interface ..... Spring (style XXXXXS) or compression (style XXXXXC) type terminals  
 Location ..... Rear panel  
 Terminals..... CAN 1 H, L, SH  
                   CAN 2 H, L, SH  
 Differential Bus Voltage..... 1.5 to 3 Vdc  
 Maximum Voltage ..... -32 to +32 Vdc  
 Communication Rate..... 250 kb/s

**Ethernet, Copper (style XXXXTX)**

Type ..... 100BASE-TX  
 Interface ..... RJ45 jack  
 Location ..... Rear panel

**Ethernet, Fiber Optic (style XXXXXFX)**

|                                    |  |
|------------------------------------|--|
| Type .....                         | 100BASE-FX, multimode                                      |
| Interface .....                    | ST type connectors for RX and TX BNC style male connectors |
| Maximum Length (Full-Duplex) ..... | 6,562 ft. (2,000 m)  |
| Location .....                     | Rear panel   |

**PROFIBUS**

|                 |   |
|-----------------|---|
| Type .....      | PROFIBUS DP (Decentralized Peripherals) |
| Interface ..... | DB-9 connector                          |
| Location .....  | Rear panel                              |

**RS-232**

|                 |                                    |
|-----------------|------------------------------------|
| Type .....      | RS-232 (for external autotracking) |
| Interface ..... | DB-9 connector                     |
| Location .....  | Rear panel                         |

**RS-485**

|                 |  |
|-----------------|--|
| Type .....      | RS-485, half duplex  |
| Interface ..... | Spring (style XXXXXS) or compression (style XXXXXC) type terminals |
| Location .....  | Rear panel   |
| Terminals ..... | RS-485 A, B, C   |

**Universal Serial Bus (USB)**

|                 |                 |
|-----------------|-----------------|
| Interface ..... | USB type B port |
| Location .....  | Front panel     |

***IRIG Time Synchronization Input***

|                           |   |
|---------------------------|---|
| Standard .....            | 200-98, Format B002, and 200-04, Format B006                                |
| Input Signal .....        | Demodulated (dc level-shifted signal)                                       |
| Logic High Level .....    | 3.5 Vdc, minimum  |
| Logic Low Level .....     | 0.5 Vdc, maximum  |
| Input Voltage Range ..... | -10 to +10 Vdc  |
| Input Resistance .....    | Nonlinear, approximately 4 k $\Omega$ at 3.5 Vdc,<br>3 k $\Omega$ at 20 Vdc |
| Response Time .....       | <1 cycle  |
| Terminals .....           | IRIG+, IRIG-  |

***Contact Outputs*****Make and Break Ratings (Resistive)**

|                   |         |
|-------------------|---------|
| 24 Vdc .....      | 7.0 Adc |
| 48 Vdc .....      | 0.7 Adc |
| 125 Vdc .....     | 0.2 Adc |
| 120/240 Vac ..... | 7.0 Aac |

**Carry Ratings (Resistive)**

|                     |         |
|---------------------|---------|
| 24/48/125 Vdc ..... | 7.0 Adc |
| 120/240 Vac .....   | 7.0 Aac |

**Terminal Assignments**

|                      |                       |
|----------------------|-----------------------|
| Watchdog .....       | WTCHD1, WTCHD, WTCHD2 |
| Relay Output 1 ..... | RLY 1, RLY 1          |
| Relay Output 2 ..... | RLY 2, RLY 2          |
| Relay Output 3 ..... | RLY 3, RLY 3          |
| Relay Output 4 ..... | RLY 4, RLY 4          |
| Relay Output 5 ..... | RLY 5, RLY 5          |

|                      |                |
|----------------------|----------------|
| Relay Output 6.....  | RLY 6, RLY 6   |
| Relay Output 7.....  | RLY 7, RLY 7   |
| Relay Output 8.....  | RLY 8, RLY 8   |
| Relay Output 9.....  | RLY 9, RLY 9   |
| Relay Output 10..... | RLY 10, RLY 10 |
| Relay Output 11..... | RLY 11, RLY 11 |

## ***Regulation***

---

In regulation modes that rely upon the monitoring of the generator terminal voltage, the DECS-450 senses and responds to the measured rms voltage.

### **FCR Operating Mode**

|                           |  |
|---------------------------|--|
| Setpoint Range .....      | 0 to 120% of rated continuous field current, in 0.01 ampere increments   |
| Regulation Accuracy ..... | $\pm 1.0\%$ for a 10% change in ac input power or for a 20% change in field resistance. For greater changes, regulation may be up to $\pm 5.0\%$ . |

### **FVR Operating Mode**

|                           |   |
|---------------------------|---|
| Setpoint Range .....      | 0 to 150% of nominal field voltage, in increments of 0.1% |
| Regulation Accuracy ..... | $\pm 1.0\%$ of nominal                                    |

### **AVR Operating Mode**

|                             |   |
|-----------------------------|---|
| Setpoint Range .....        | 70 to 120% of rated generator voltage, in increments of 0.1%                                      |
| Regulation Accuracy .....   | $\pm 0.2\%$ over load range at rated PF with constant generator frequency and ambient temperature |
| Steady-State Stability..... | $\pm 0.1\%$ at rated PF with constant generator frequency and ambient temperature                 |
| Temperature Drift .....     | $\pm 0.5\%$ between 0 and 50°C ambient temperature at constant load and generator frequency       |

### **Var Operating Mode**

|                           |  |
|---------------------------|--|
| Setpoint Range .....      | 100% rated generator vars absorbing to 100% rated generator vars exporting, based on rated generator kVA and power factor. |
| Regulation Range .....    | 0 to 100% of real power over the rated generator kW range  |
| Regulation Accuracy ..... | $\pm 2.0\%$ of rated generator kVA   |

### **Power Factor Operating Mode**

|                           |   |
|---------------------------|---|
| Setpoint Range .....      | 0.5 per unit leading to 0.5 per unit lagging, in 0.001 per unit increments  |
| Regulation Range .....    | 0 to 100% power factor importing and 0 to 100% power factor exporting   |
| Regulation Accuracy ..... | $\pm 0.02$ per unit of the PF setpoint across the setpoint range for rated generator kW from less than 10% to 100%. |

## ***Parallel Compensation***

---

|                                    |   |
|------------------------------------|---|
| Modes.....                         | Reactive Droop, Line Drop, and Cross-Current with CT network or Ethernet communication            |
| Cross-Current Input Burden.....    | May exceed 1 VA if external balance resistors are added to the cross-current compensation circuit |
| Cross-Current Input Terminals..... | CCCT (terminals 81 and 82)  |

## Compensation Range

Reactive Droop ..... 0 to +30% of Rated Voltage  
 Line Drop ..... 0 to +30% of Rated Voltage  
 Cross-Current..... -30 to +30% of Primary CT Current

## Generator Protection Functions

---

### Overexcitation (24)

#### Inverse Time

Curve Exponent ..... 0.5, 1, or 2  
 Pickup Range ..... 0 or 0.5 to 6 V/Hz  
 Time Dial Range ..... 0.0 to 9.9  
 Reset Dial Range ..... 0.0 to 9.9

#### Definite Time 1 and 2

##### Pickup

Range ..... 0 or 0.5 to 6  
 Increment ..... 0.01

##### Time Delay

Range ..... 0.05 to 600  
 Increment ..... 0.001

### Overvoltage (59) and Undervoltage (27)

#### Pickup

Range ..... 0 to 600,000 Vac  
 Increment ..... 1 Vac  
 Hysteresis..... 2%

#### Time Delay

Range ..... 0.1 to 60 s  
 Increment ..... 0.1 s

### Loss of Sensing

#### Time Delay

Range ..... 0.1 to 30 s  
 Increment ..... 0.1 s

#### Voltage Balanced Level

Range ..... 0 to 100% of Positive Sequence Voltage  
 Increment ..... 0.1%

#### Voltage Unbalanced Level

Range ..... 0 to 100% of Positive Sequence Voltage  
 Increment ..... 0.1%

### Overfrequency (81O) and Underfrequency (81U)

#### Pickup

Range ..... 15 to 70 Hz  
 Increment ..... 0.01 Hz

#### Time Delay

Time Delay Range ..... 0.1 to 300 s

Increment ..... 0.1 s

Voltage Inhibit

Range..... 5 to 100% of rated voltage

Increment ..... 1%

**Reverse Power (32R)**

Pickup

Range..... 0 to 1.5 pu of rated kVA

Increment ..... 0.01 pu

Time Delay

Range..... 0 to 300 s

Increment ..... 0.1 s

**Loss of Excitation (40Q)**

Pickup

Range..... 0 to 1.5 pu of rated kVA

Increment ..... 1%

Time Delay

Range..... 0 to 300 s

Increment ..... 0.1 s

**Field Protection Functions**

---

**Field Overvoltage**

Pickup

Range..... 1.0 to 2.4 pu of rated field voltage

Increment ..... 0.1 pu

Time Delay

Range..... 0.2 to 30 s

Increment ..... 0.1 s

**Field Overcurrent**

Pickup

Range..... 0.1 to 2.0 pu of maximum rated field current

Increment ..... 0.1 Adc

Inverse Time

Time Dial Range ..... 0.1 to 20

Increment ..... 0.1

Definite Time Delay

Range..... 0.2 to 30 s

Increment ..... 0.1 s

**Field Overtemperature**

Pickup

Range..... 0 to 572°F (-18 to 300°C)

Increment ..... 1°

Time Delay

Range..... 0.1 to 60 s  
 Increment ..... 0.1 s

**Loss of Field Isolation Transducer**Time Delay

Range..... 0.0 to 9.9 s  
 Increment ..... 0.1 s

**Exciter Diode Monitor (EDM)**Pole Ratio

Range..... 0 to 10  
 Increment ..... 0.01

Pickup Level

Open and Shorted Diode ..... 0 to 100% of EDM ripple current  
 Increment ..... 0.1%

Delay

Open Diode Protection..... 10 to 60 s  
 Shorted Diode Protection ..... 5 to 30 s  
 Increment ..... 0.1 s

**Synchronism Check (25) Protection****Voltage Difference**

Range..... 0.1 to 50%  
 Increment ..... 0.1%

**Slip Angle**

Range..... 1 to 99°  
 Increment ..... 0.1°

**Angle Compensation**

Range..... 0 to 359.9°  
 Increment ..... 0.1°

**Slip Frequency**

Range..... 0.01 to 0.5 Hz  
 Increment ..... 0.01 Hz

**Startup****Soft Start Level**

Range..... 0 to 90% of Rated Gen Voltage  
 Increment ..... 1%

**Soft Start Time**

Range..... 1 to 7,200 s  
 Increment ..... 1 s

**Field Flash Dropout Level**

Range..... 0 to 100% of Rated Gen Voltage  
 Increment ..... 1%

**Maximum Field Flash Time**

Range..... 1 to 50 s  
 Increment ..... 1 s

***Automatic Synchronizer***

Synchronizer Types ..... Phase-Locked Loop, Anticipatory  
 Contact Output Types ..... Continuous, Proportional

**Voltage Window**

Range..... 2 to 15%  
 Increment ..... 0.5%

**Slip Frequency**

Range..... 0.1 to 0.5 Hz  
 Increment ..... 0.05 Hz

**Breaker Closing Angle**

Range..... 3 to 20°  
 Increment ..... 0.5°

**Sync Activation Delay**

Range..... 0.1 to 0.8 s  
 Increment ..... 0.1 s

**Sync Fail Activation Delay**

Range..... 0.1 to 600.0 s  
 Increment ..... 0.1 s

**Angle Compensation**

Range..... 0.0 to 359.9°  
 Increment ..... 0.1°

**Generator to Bus PT Matching Level**

Range..... 0 to 700%  
 Increment ..... 0.001%

***Voltage Matching***

Accuracy..... Generator rms voltage is matched with the bus rms voltage to within  
 $\pm 0.5\%$  of the generator voltage.

***Power System Stabilizer (Style 1XXXXXX)***

Model..... IEEE Std 421.5 type PSS2A/2B/2C  
 Operating Mode ..... Generator or Motor, ABC or ACB phase sequence  
 Sensing Configuration ..... Power and Speed or Speed only  
 Power Measurement ..... Three Wattmeter method

## ***On-Line Overexcitation Limiting***

---

### **High Current Level**

#### Pickup

Range..... 0 to 12,000 Adc  
Increment ..... 0.01 Adc

#### Time

Range..... 0 to 240 s  
Increment ..... 1 s

### **Middle Current Level**

#### Pickup

Range..... 0 to 12,000 Adc  
Increment ..... 0.01 Adc

#### Time

Range..... 0 to 240 s  
Increment ..... 1 s

### **Low Current Level**

#### Pickup

Range..... 0 to 12,000 Adc  
Increment ..... 0.01 Adc

## ***Off-Line Overexcitation Limiting***

---

### **High Current Level**

#### Pickup

Range..... 0 to 12,000 Adc  
Increment ..... 0.01 Adc

#### Time

Range..... 0 to 240 s  
Increment ..... 1 s

### **Low Current Level**

#### Pickup

Range..... 0 to 12,000 Adc  
Increment ..... 0.01 Adc

## ***Underexcitation Limiting (UEL)***

---

UEL is implemented through an internally-generated UEL curve or a user-defined five-point UEL curve. The internally-generated curve is based on the desired reactive power limit at zero real power with respect to the generator voltage and current rating.

### **Reactive Power**

Range..... 0 to 62  
Increment ..... 0.001

**Real Power**

Range..... 0 to 62  
 Increment ..... 0.001

***Stator Current Limiting (SCL)***

---

**High SCL Level**Pickup

Range..... 0 to 66,000 Adc  
 Increment ..... 0.1 Adc

Time

Range:..... 0 to 240 s  
 Increment: ..... 0.1 s

**Low SCL Level**Pickup

Range..... 0 to 66,000 Adc  
 Increment ..... 0.1 Adc

***Underfrequency Limiting***

---

**Underfrequency**Corner Frequency

Range..... 15 to 90 Hz  
 Increment ..... 0.1 Hz

Slope

Range..... 0 to 3  
 Increment ..... 0.01

**Volts per Hertz**V/Hz High

Range..... 1 to 3  
 Increment ..... 0.01

V/Hz Low

Range..... 0 to 3  
 Increment ..... 0.01

V/Hz Time

Range..... 0 to 10 s  
 Increment ..... 0.2 s

***Var Limiting***

---

Setpoint

Range..... 0 to 200%  
 Increment ..... 0.1%

Delay

Range..... 0 to 300 s  
 Increment ..... 0.1 s

---

## ***Sequence of Events Recording (SER)***

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The SER scans more than 400 parameters in four-millisecond intervals and records any changes of state (events) into a record of up to 2,047 events.

## ***Data Logging***

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Records consist of up to six user-selectable parameters with up to 1,200 data points per parameter and are saved in the IEEE Standard Common Format for Transient Data Exchange (COMTRADE).

## ***Environment***

---

### **Temperature**

Operating Range ..... –40 to +60°C (–40 to +140°F)

Storage Range ..... –40 to +85°C (–40 to +185°F)

### **Humidity**

IEC 60068-2-78 ..... Tested at 40°C and 93% relative humidity

### **Salt Fog**

IEC 60068-2-11

## ***Type Tests***

---

### **Shock**

IEC 60255-21-2 Class 1

### **Vibration**

IEC 60255-21-2 Class 1

### **Impulse**

IEC 60255-5

### **Transients**

IEC 61000-4-4

IEEE C37.90.1

### **Static Discharge**

IEC 61000-4-2

### **Radio Interference**

Type tested using a 5 W, hand-held transceiver operating at random frequencies centered around 144 MHz and 440 MHz with the antenna located within 150 mm (6 inches) of the device in both vertical and horizontal planes.

### **HALT (Highly Accelerated Life Testing)**

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing

conditions, the DECS-450 was subjected to temperature tests (tested over a temperature range of –100 to +120°C (–148 to +248°F)), vibration tests (of 5 to 50 G at +20°C (68°F)), and temperature/vibration tests (tested at 50 G over a temperature range of –95 to +115°C (–139 to +239°F)). Combined temperature and vibration testing at these extremes proves that the DECS-450 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels.

## **Physical**

Dimensions..... Refer to the *Mounting* section.  
Weight ..... 4.4 kg (9.6 lb)

## **Regulatory Certifications and Standards**

### **Maritime Recognition**

Recognized per Standard IACS UR (section E10) by American Bureau of Shipping (ABS).

For current certificate, see [www.basler.com](http://www.basler.com).

### **UL Certification**

This product is a Recognized Component (cURus) covering the US and Canada.

UL File (E97035-FPTM2/FPTM8)

Standards used for evaluation:

- ANSI/CAN/UL/ULC 6200:2019 - Standard for Controllers for Use in Power Production, First Edition, May 31, 2019

### **CE and UKCA Compliance**

This product has been evaluated and complies with the relevant essential requirements set forth by the EU legislation and UK Parliament.

#### EC Directives

LVD ..... 2014/35/EU  
EMC ..... 2014/30/EU  
RoHS2..... 2011/65/EU as amended by (EU) 2015/863

#### UK Designated Standards

LVD ..... SI 2016/1101  
EMC ..... SI 2016.1091  
RoHS2..... SI 2012.3032 as amended by SI 2019/492

This product conforms to the following harmonized standards:

- IEC 62477-1:2016 Ed. 1.0 and BS EN 62477-1:2012/A11:2014, Safety requirements for power electronic converter systems and equipment, Part 1: General
- IEC 61000-6-2:2016 Ed. 3.0 and BS EN 61000-6-2:2005/AC:2005, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - immunity for industrial environments
- IEC 61000-6-4:2018 Ed. 3.0 and BS EN 61000-6-4:2007/A1:2011, Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - emission standard for industrial environments
- IEC 63000:2016 Ed. 1.0 and BS EN 63000:2018, Technical documentation for assessment of electrical and electronic products with respect to restriction of hazardous substances
- IEC 62474:2018 Ed. 2.0, Material declaration for products of and for the electrotechnical industry

The *Typical Connections* section in this manual contains specific installation instructions for meeting EMC requirements.

## FCC Requirements

This product complies with FCC 47 CFR Part 15.

## China RoHS

The following table serves as the declaration of hazardous substances for China in accordance with PRC standard SJ/T 11364-2014. The EFUP (Environment Friendly Use Period) for this product is 40 years.

| PRODUCT: DECS-450  |                              |                      |                      |  |  |   |   |   |   |  |
|--|------------------------------|----------------------|----------------------|--|--|---|---|---|---|--|
| 零件名称<br>Part Name  | 有害物质<br>Hazardous Substances |                      |                      |  |  |   |   |   |   |  |
|  | 铅<br>Lead<br>(Pb)            | 汞<br>Mercury<br>(Hg) | 镉<br>Cadmium<br>(Cd) | 六价铬<br>Hexavalent<br>Chromium<br>(Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated<br>Biphenyls<br>(PBB) | 多溴二苯醚<br>Polybrominated<br>Diphenyl<br>Ethers<br>(PBDE) | 邻苯二甲<br>酸二丁酯<br>Dibutyl<br>Phthalate<br>(DBP) | 邻苯二甲<br>酸丁苄酯<br>Benzyl<br>butyl<br>phthalate<br>(BBP) | 邻苯二甲<br>酸二酯<br>Bis(2-<br>ethylhexyl)<br>phthalate<br>(BEHP) | 邻苯二甲<br>酸二异丁<br>酯<br>Diisobutyl<br>phthalate<br>(DIBP) |
| 金属零件<br>Metal parts  | O                            | O                    | O                    | O  | O  | O   | O   | O   | O   | O  |
| 聚合物<br>Polymers  | O                            | O                    | O                    | O  | O  | O   | O   | O   | O   | O  |
| 电子产品<br>Electronics  | X                            | O                    | O                    | O  | O  | O   | O   | O   | O   | O  |
| 电缆和互连<br>配件<br>Cables &<br>interconnect<br>accessories   | X                            | O                    | O                    | O  | O  | O   | O   | O   | O   | O  |
| 绝缘材料<br>Insulation<br>material   | O                            | O                    | O                    | O  | O  | O   | O   | O   | O   | O  |
| <p>本表格依据 SJ/T11364 的规定编制。</p> <p>O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。</p> <p>X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。</p> <p>This form was prepared according to the provisions of standard SJ/T11364.</p> <p>O: Indicates that the hazardous substance content in all homogenous materials of this part is below the limit specified in standard GB/T 26252.</p> <p>X: Indicates that the hazardous substance content in at least one of the homogenous materials of this part exceeds the limit specified in standard GB/T 26572.</p> |                              |                      |                      |  |  |   |   |   |   |  |

# 30 • Analog Expansion Module

## General Information

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The optional AEM-2020 is a remote auxiliary device that provides additional DECS-450 analog inputs and outputs.

## Features

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The AEM-2020 has the following features:

- Eight Analog Inputs
- Eight RTD Inputs
- Two Thermocouple Inputs
- Four Analog Outputs
- Functionality of Inputs and Outputs assigned by BESTlogic™ *Plus* programmable logic
- Communications via CAN Bus

## Specifications

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### Operating Power

Nominal ..... 12 or 24 Vdc  
 Range ..... 8 to 32 Vdc (Withstands ride-through down to 6 Vdc for 500 ms.)  
 Maximum Consumption ..... 5.1 W

### Analog Inputs

The AEM-2020 contains eight programmable analog inputs.

Rating ..... 4 to 20 mA or 0 to 10 Vdc (user-selectable)  
 Burden  
   4 to 20 mA ..... 470  $\Omega$  maximum  
   0 to 10 Vdc ..... 9.65k  $\Omega$  minimum

### RTD Inputs

The AEM-2020 contains eight programmable RTD inputs.

Rating ..... 100  $\Omega$  Platinum or 10  $\Omega$  Copper (user-selectable)  
 Setting Range ..... -50 to +250°C or -58 to +482°F  
 Accuracy (10  $\Omega$  Copper) .....  $\pm 0.044 \Omega$  @ 25°C,  $\pm 0.005 \Omega/^\circ\text{C}$  drift over ambient temperature  
 Accuracy (100  $\Omega$  Platinum) .....  $\pm 0.39 \Omega$  @ 25°C,  $\pm 0.047 \Omega/^\circ\text{C}$  drift over ambient temperature

### Thermocouple Inputs

The AEM-2020 contains two thermocouple inputs.

Rating ..... 2 K Type Thermocouples  
 Setting Range ..... 0 to 1,375°C or 0 to 2,507°F  
 Display Range ..... Ambient to 1,375°C or Ambient to 2,507°F  
 Accuracy .....  $\pm 40 \mu\text{V}$  @ 25°C,  $\pm 5 \mu\text{V}/^\circ\text{C}$  drift over ambient temperature

### Analog Outputs

The AEM-2020 contains four programmable analog outputs.

Rating ..... 4 to 20 mA or -10 to 10 Vdc (user-selectable)

## Communication Interface

The AEM-2020 communicates with the DECS-450 through CAN1.

### CAN Bus

Differential Bus Voltage..... 1.5 to 3 Vdc  
 Maximum Voltage .....-32 to +32 Vdc with respect to negative battery terminal  
 Communication Rate..... 125 or 250 kb/s

## Type Tests

### Shock

Withstands 15 G in 3 perpendicular planes.

### Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz..... 1.5 G peak for 5 min.  
 29 to 52 to 29 Hz..... 0.036" Double Amplitude for 2.5 min.  
 52 to 500 to 52 Hz..... 5 G peak for 7.5 min.

### HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the AEM-2020 was subjected to temperature tests (tested over a temperature range of -80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of -60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the AEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in the *Specifications* section of this manual.

## Environment

### Temperature

Operating .....-40 to +70°C (-40 to +158°F)  
 Storage .....-40 to +85°C (-40 to +185°F)

Humidity ..... IEC 68-2-38

## Agency, Standards, and Directives

### UL Approval

The AEM-2020 is a Recognized Component for the US and Canada under UL file E97035 (CCN-FTPM2/FTPM8) covered under the Standards below:

- UL 6200:2019
- CSA C22.2 No.14-13

The AEM-2020 is a Recognized Component for the US and Canada under UL file E470837 (CCN-FTWD2/FTWD8) for use in Hazardous Locations:

- Class I Division 2
- Groups A, B, C & D

### CE and UKCA Compliance

This product has been evaluated and complies with relevant essential requirements set forth by the EU legislation and UK Parliament.

**EC Directives**

|            |  |
|------------|--|
| LVD .....  | 2014/35/EU                             |
| EMC .....  | 2014/30/EU                             |
| RoHS2..... | 2011/65/EU as amended by (EU) 2015/863 |

**UK Designated Standards**

|            |  |
|------------|--|
| LVD .....  | SI 2016/1101                           |
| EMC .....  | SI 2016.1091/30/EU                     |
| RoHS2..... | SI 2012.3032 as amended by SI 2019/492 |

This product conforms to the following harmonized standards:

- BS EN 50178:1997, Electronic equipment for use in power installations
- BS EN 61000-6-2:2005/AC:2005, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - immunity for industrial environments
- BS EN 61000-6-4:2007/A1:2011, Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - emission standard for industrial environments
- IEC 63000:2016 Ed. 1.0 and BS EN 63000:2018, Technical documentation for assessment of electrical and electronic products with respect to restriction of hazardous substances
- IEC 62474:2018 Ed. 2.0, Material declaration for products of and for the electrotechnical industry

**FCC Requirements**

This product complies with FCC 47 CFR Part 15.

**Maritime Recognition**

American Bureau of Shipping (ABS) – for current certificates, see [www.basler.com](http://www.basler.com).

**China RoHS**

The following table serves as the declaration of hazardous substances for China in accordance with PRC standard SJ/T 11364-2014. The EFUP (Environment Friendly Use Period) for this product is 40 years.

| PRODUCT: AEM-2020                                      |                              |                      |                      |  |  |   |   |   |   |  |
|--|------------------------------|----------------------|----------------------|--|--|---|---|---|---|--|
| 零件名称<br>Part Name                                      | 有害物质<br>Hazardous Substances |                      |                      |  |  |   |   |   |   |  |
|  | 铅<br>Lead<br>(Pb)            | 汞<br>Mercury<br>(Hg) | 镉<br>Cadmium<br>(Cd) | 六价铬<br>Hexavalent<br>Chromium<br>(Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated<br>Biphenyls<br>(PBB) | 多溴二苯醚<br>Polybrominated<br>Diphenyl<br>Ethers<br>(PBDE) | 邻苯二甲<br>酸二丁酯<br>Dibutyl<br>Phthalate<br>(DBP) | 邻苯二甲<br>酸丁苄酯<br>Benzyl<br>butyl<br>phthalate<br>(BBP) | 邻苯二甲<br>酸二酯<br>Bis(2-<br>ethylhexyl)<br>phthalate<br>(BEHP) | 邻苯二甲<br>酸二异丁<br>酯<br>Diisobutyl<br>phthalate<br>(DIBP) |
| 金属零件<br>Metal parts                                    | ○                            | ○                    | ○                    | ○  | ○  | ○   | ○   | ○   | ○   | ○  |
| 聚合物<br>Polymers  | ○                            | ○                    | ○                    | ○  | ○  | ○   | ○   | ○   | ○   | ○  |
| 电子产品<br>Electronics                                    | X                            | ○                    | ○                    | ○  | ○  | ○   | ○   | ○   | ○   | ○  |
| 电缆和互连<br>配件<br>Cables &<br>interconnect<br>accessories | X                            | ○                    | ○                    | ○  | ○  | ○   | ○   | ○   | ○   | ○  |
| 绝缘材料<br>Insulation<br>material                         | ○                            | ○                    | ○                    | ○  | ○  | ○   | ○   | ○   | ○   | ○  |

本表格依据 SJ/T11364 的规定编制。

○: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

|  |                              |                   |                      |                      |  |  |   |   |   |   |
|--|------------------------------|-------------------|----------------------|----------------------|--|--|---|---|---|---|
| <b>PRODUCT:</b>  | AEM-2020                     |                   |                      |                      |  |  |   |   |   |   |
|  | 有害物质<br>Hazardous Substances |                   |                      |                      |  |  |   |   |   |   |
|  | 零件名称<br>Part Name            | 铅<br>Lead<br>(Pb) | 汞<br>Mercury<br>(Hg) | 镉<br>Cadmium<br>(Cd) | 六价铬<br>Hexavalent<br>Chromium<br>(Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated<br>Biphenyls<br>(PBB) | 多溴二苯醚<br>Polybrominated<br>Diphenyl<br>Ethers<br>(PBDE) | 邻苯二甲<br>酸二丁酯<br>Dibutyl<br>Phthalate<br>(DBP) | 邻苯二甲<br>酸丁苄酯<br>Benzyl<br>butyl<br>phthalate<br>(BBP) | 邻苯二甲<br>酸二酯<br>Bis(2-<br>ethylhexyl)<br>phthalate<br>(BEHP) |
| <p>X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。</p> <p>This form was prepared according to the provisions of standard SJ/T11364.</p> <p>O: Indicates that the hazardous substance content in all homogenous materials of this part is below the limit specified in standard GB/T 26252.</p> <p>X: Indicates that the hazardous substance content in at least one of the homogenous materials of this part exceeds the limit specified in standard GB/T 26572.</p> |                              |                   |                      |                      |  |  |   |   |   |   |

## Physical

Weight ..... 1.80 lb (816 g)

Dimensions..... See *Installation* below.

## Installation

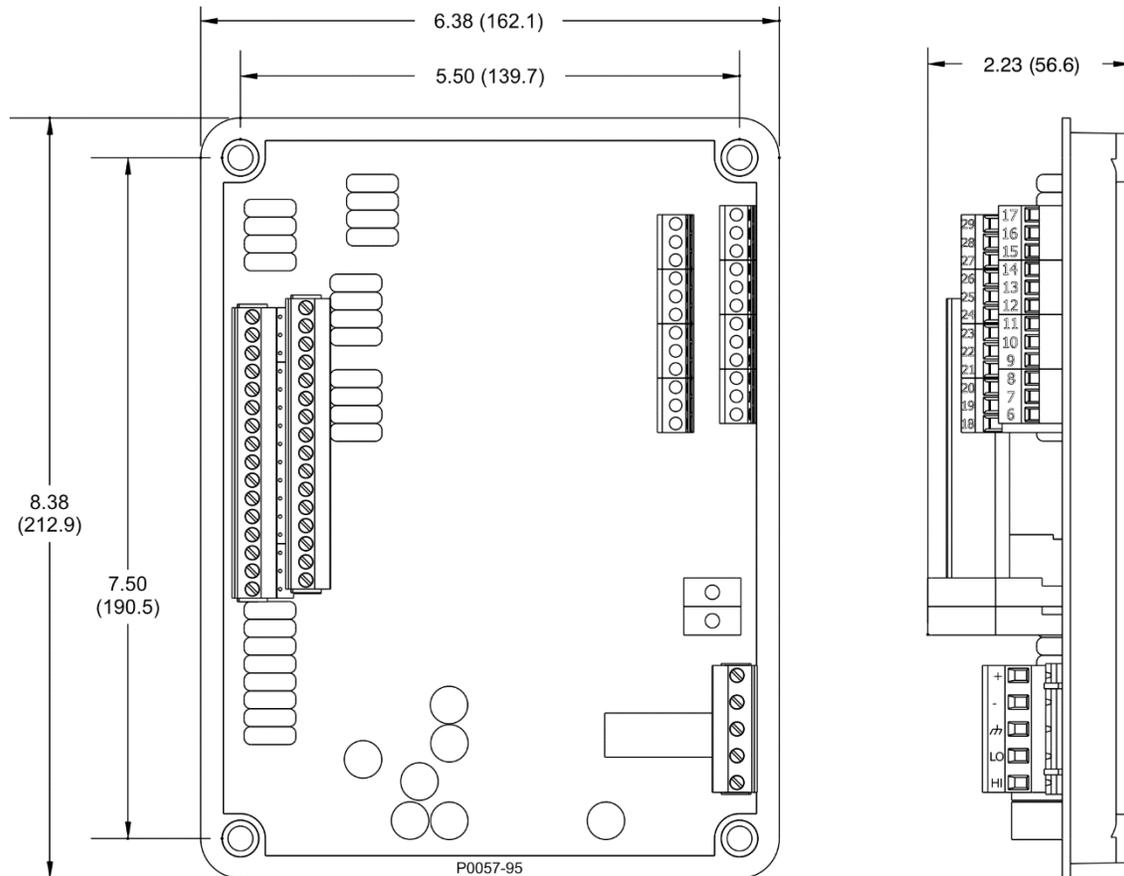
Analog Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

## Mounting

Analog Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of an Analog Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 30-1 for AEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.



**Figure 30-1. AEM-2020 Overall Dimensions**

## Connections

Analog Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

### Note

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate.

Be sure that the AEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

It is recommended to minimize the vibration load on the connector plug by ensuring that wires are well-constrained, with no more than 6 to 8 inches of unconstrained wire length near the connector plugs.

## Terminations

The terminal interface consists of both plug-in connectors and a permanently mounted connector with screw-down compression terminals.

AEM-2020 connections are made with one 5-position connector, two 12-position connectors, two 16-position connectors, and two 2-position thermocouple connectors. The 16, 5, and 2-position connectors plug into headers on the AEM-2020. The connectors and headers have dovetailed edges that ensure

proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers. The 12-position connector is not a plug-in connector and is mounted permanently to the board.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which deteriorates connections and leads to signal loss.

Connector screw terminals accept a maximum wire size of 12 AWG. Thermocouple connectors accept a maximum thermocouple wire diameter of 0.177 inches (4.5 mm). Maximum screw torque is 5 in-lb (0.56 N•m).

#### Operating Power

The Analog Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate. Operating power terminals are listed in Table 30-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Analog Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

**Table 30-1. Operating Power Terminals**

| Terminal   | Description                            |
|--|--|
| P1-  (SHIELD) | Chassis ground connection              |
| P1- - (BATT-)  | Negative side of operating power input |
| P1- + (BATT+)  | Positive side of operating power input |

#### AEM-2020 Inputs and Outputs

Input and output terminals are shown in Figure 30-2 and listed in Table 30-2.

**Table 30-2. Input and Output Terminals**

| Connector | Description                                  |
|-----------|--|
| P1        | Operating Power and CAN bus                  |
| P2        | RTD Inputs 1 - 4                             |
| P3        | Analog Inputs 1 - 8 and Analog Outputs 1 - 4 |
| P4        | Thermocouple 1 Input                         |
| P5        | Thermocouple 2 Input                         |
| P6        | RTD Inputs 5 - 8                             |

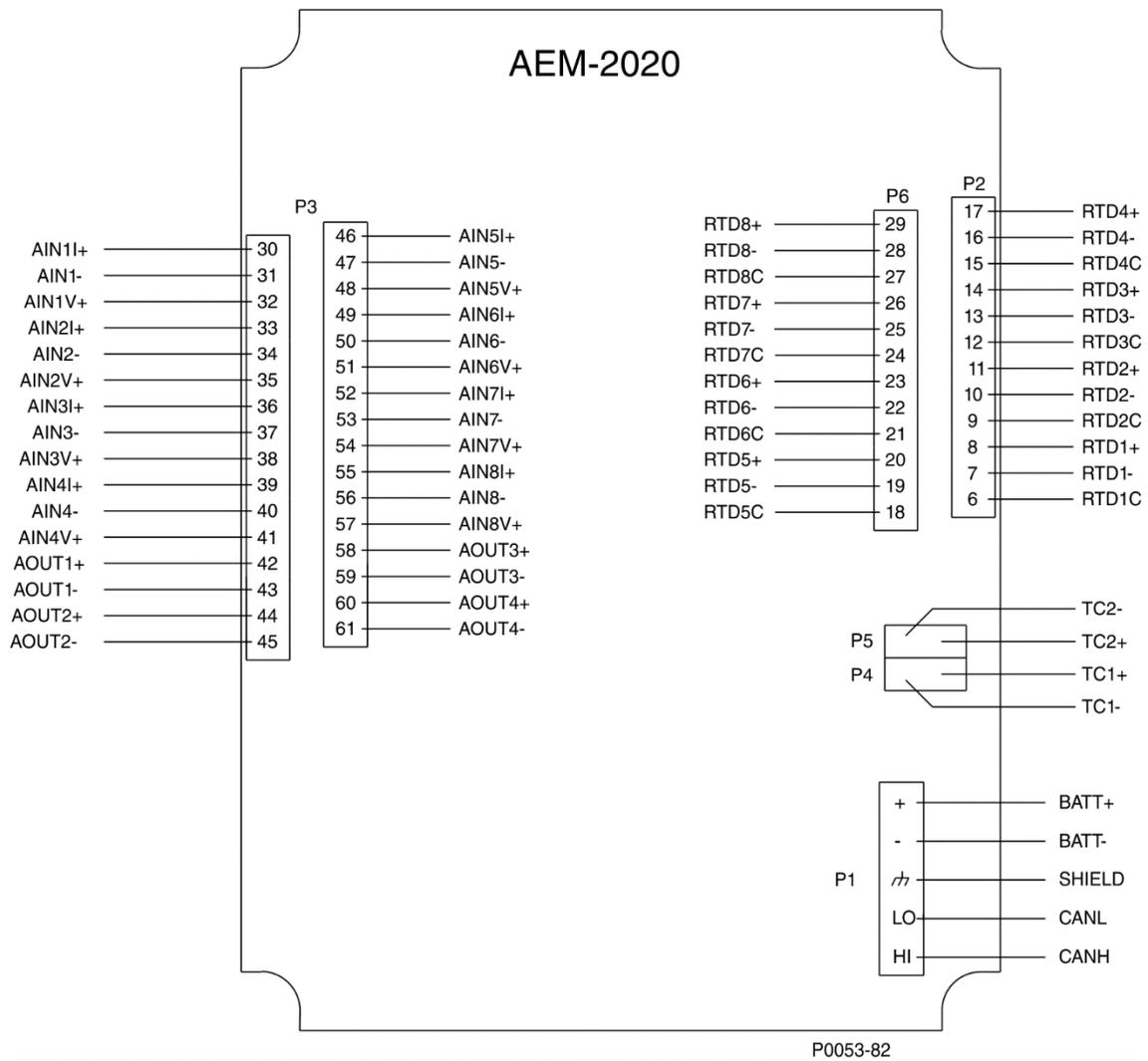


Figure 30-2. Input and Output Terminals

External Analog Input Connections

Voltage input connections are shown in Figure 30-3 and current input connections are shown in Figures 30-4 through 30-6. When using the current input, AIN V+ and AIN I+ must be tied together.

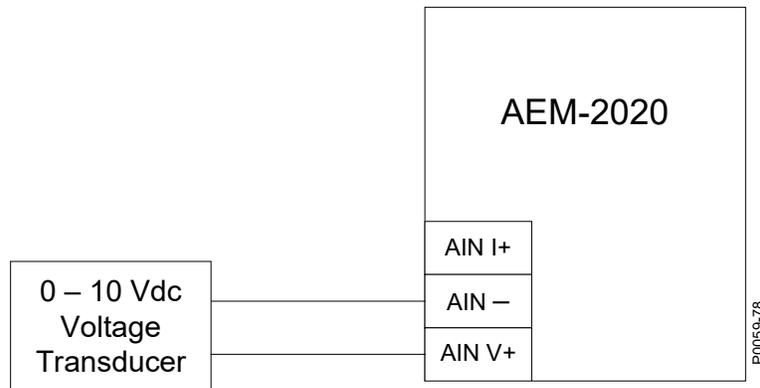


Figure 30-3. Analog Inputs - Voltage Input Connections

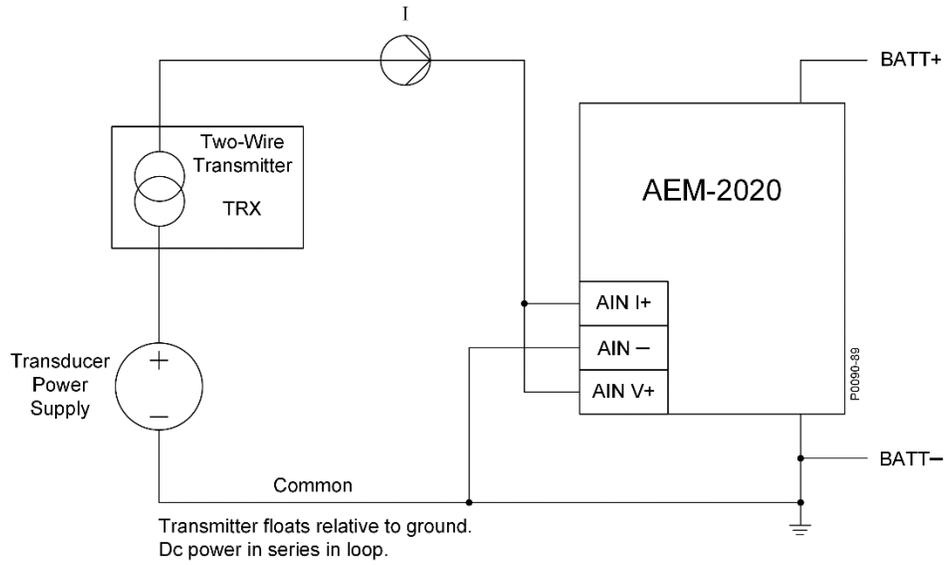


Figure 30-4. Analog Inputs - Current Input Connections, Type II 2-Wire Circuit

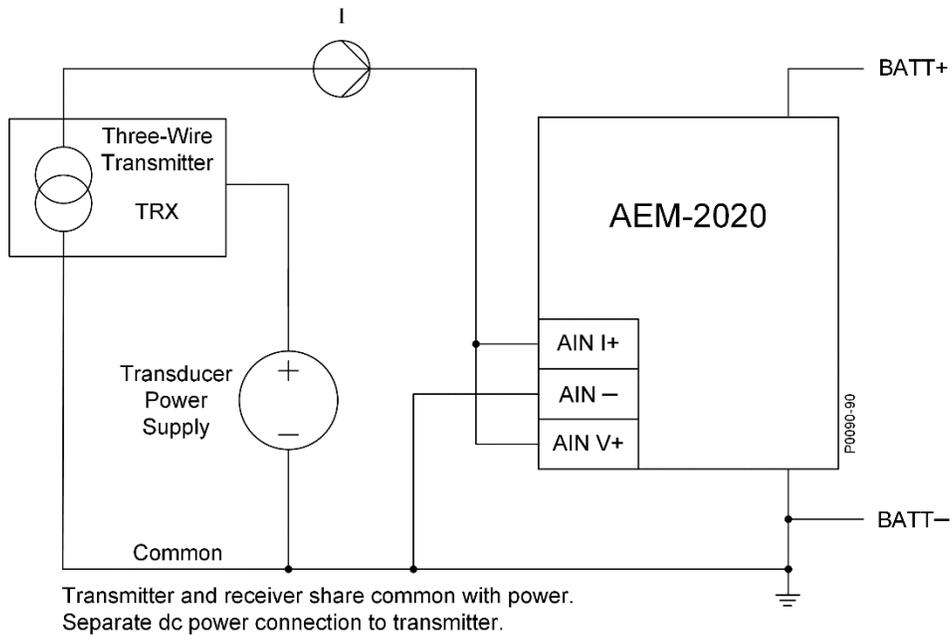
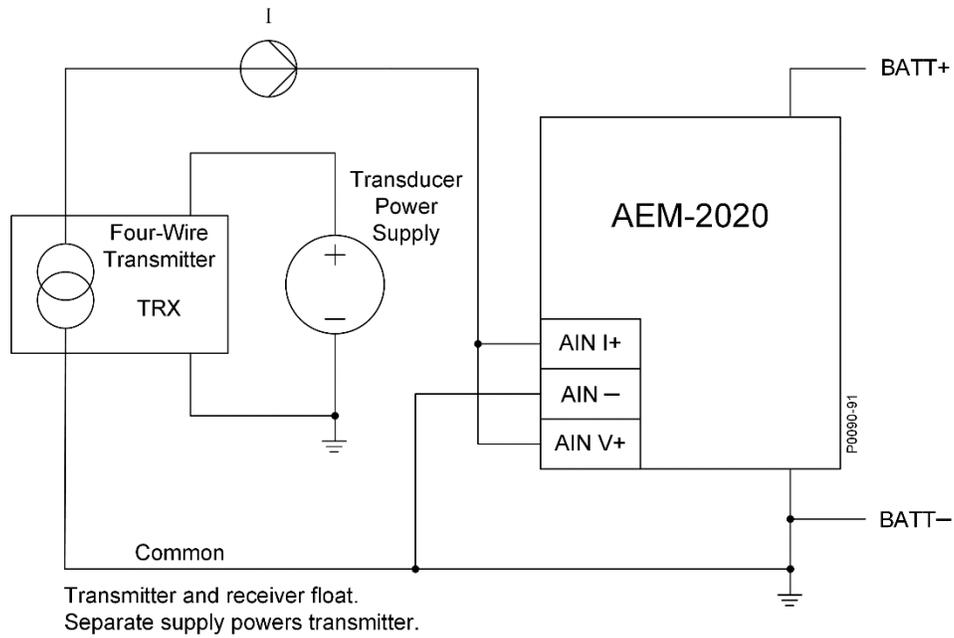


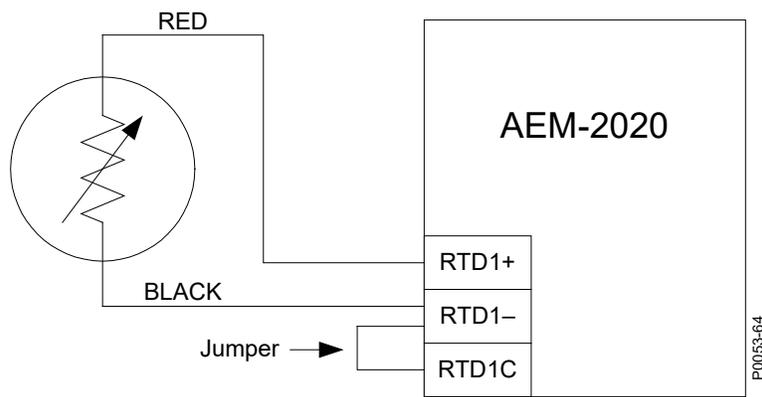
Figure 30-5. Analog Inputs - Current Input Connections, Type III 2-Wire Circuit



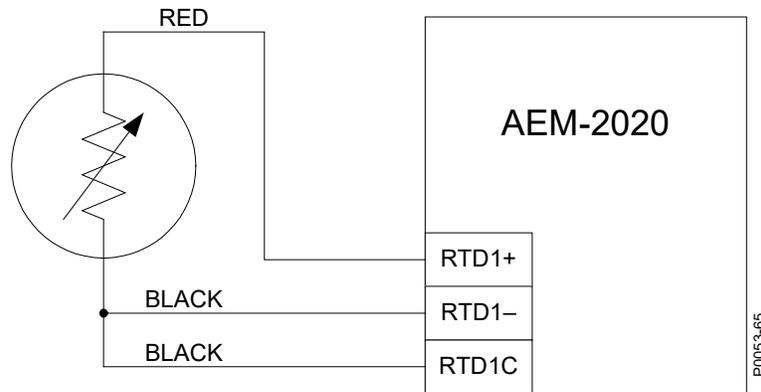
**Figure 30-6. Analog Inputs - Current Input Connections, Type IV 2-Wire Circuit**

External RTD Input Connections

External 2-wire RTD input connections are shown in Figure 30-7. Figure 30-8 shows external 3-wire RTD input connections. RTD cable shields should connect to ground as close to the AEM-2020 as possible with as short a lead as practical.



**Figure 30-7. External Two-Wire RTD Input Connections**



**Figure 30-8. External Three-Wire RTD Input Connections**

### CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Analog Expansion Module and the DECS-450. Connections between the AEM-2020 and DECS-450 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 30-3. Refer to Figure 30-9 and Figure 30-10.

**Table 30-3. CAN bus Interface Terminals**

| Terminal       | Description                       |
|----------------|-----------------------------------|
| P1- HI (CAN H) | CAN high connection (yellow wire) |
| P1- LO (CAN L) | CAN low connection (green wire)   |
| P1- ⚡ (SHIELD) | CAN drain connection              |

### Notes

1. If the AEM-2020 is providing one end of the J1939 bus, a 120  $\Omega$ , ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the AEM-2020 is not part of the J1939 bus, the stub connecting the AEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the AEM-2020.

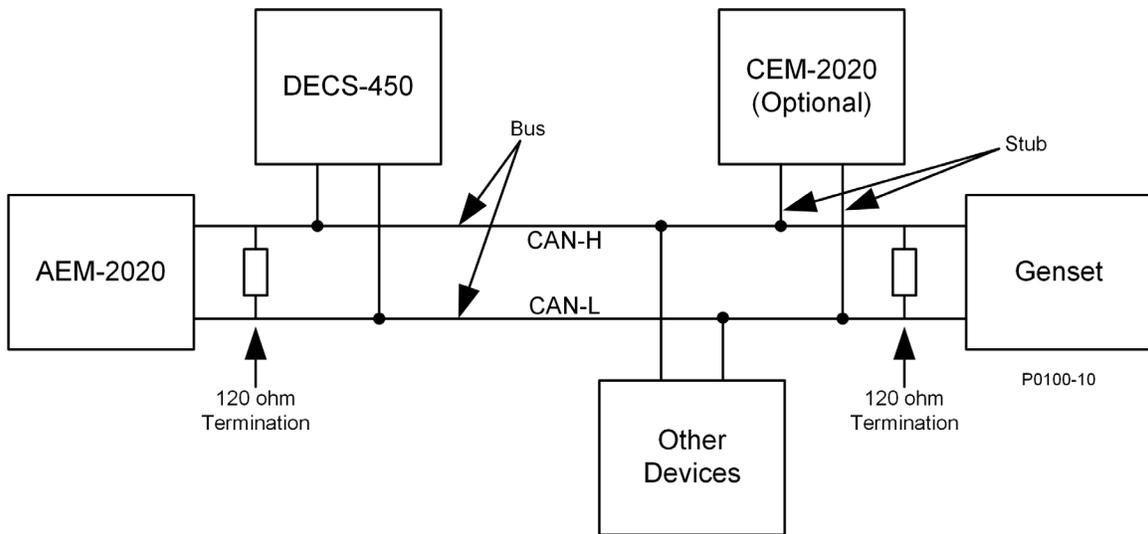


Figure 30-9. CAN Bus Interface with AEM-2020 providing One End of the Bus

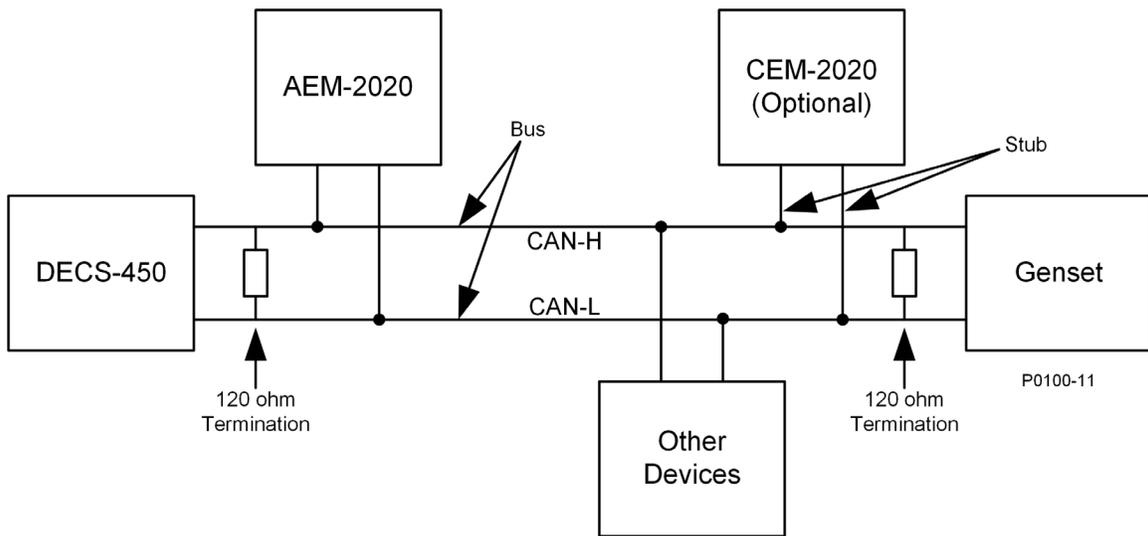


Figure 30-10. CAN Bus Interface with DECS-450 providing One End of the Bus

## Communications

**BESTCOMSPi<sup>us</sup>® Navigation Path:** Settings, Communications, CAN bus, Remote Module Setup

**HMI Navigation Path:** Settings, Communication, CAN bus, Remote Module Setup, Analog Expansion Module

The analog expansion module must be enabled with the correct J1939 address. A Control Area Network (CAN) is a standard interface that enables communication between the AEM-2020 and the DECS-450. The Remote Module Setup screen is illustrated in Figure 30-11.

**Remote Module Setup**

| Contact Expansion Module   | Analog Expansion Module  |
|--|--|
| <input type="radio"/> Disabled<br><input checked="" type="radio"/> Enabled | <input type="radio"/> Disabled<br><input checked="" type="radio"/> Enabled |
| CEM J1939 Address<br>236   | AEM J1939 Address<br>237   |

Figure 30-11. Remote Module Setup

## Functional Description

### Analog Inputs

**BESTCOMSPi<sup>us</sup> Navigation Path:** Settings, Programmable Inputs, Remote Analog Inputs

**HMI Navigation Path:** Settings, Programmable Inputs, Remote Analog Input

The AEM-2020 provides eight analog inputs that can annunciate a latching or non-latching alarm. The analog inputs are always monitored and their status is displayed on the appropriate metering screens. To make identifying the analog inputs easier, a user-assigned name can be given to each input.

**Remote Analog Input #1**

|                           |                                |
|---------------------------|--------------------------------|
| Label Text<br>ANALOG IN 1 | Arming Delay (s)<br>0          |
| Hysteresis (%)<br>2.0     | Stop Mode Inhibit<br>No        |
| Input Type<br>Voltage     |                                |
| <b>Ranges</b>             |                                |
| Param Min<br>-9,999.0     | Min Input Current (mA)<br>4.0  |
|                           | Min Input Voltage (V)<br>0.0   |
| Param Max<br>9,999.0      | Max Input Current (mA)<br>20.0 |
|                           | Max Input Voltage (V)<br>10.0  |
| <b>Threshold #1</b>       |                                |
| Mode<br>Disabled          | Threshold<br>-9,999.0          |
|                           | Activation Delay (s)<br>0      |
| <b>Threshold #2</b>       |                                |

Figure 30-12. Remote Analog Input Settings

Select the input type. Select the amount of hysteresis needed to prevent rapid switching of the alarm. A user-adjustable arming delay allows configuration of the analog input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether or not excitation is enabled. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after system startup is complete. An out-of-range alarm, configured on the *Alarm Configuration, Alarms* screen in *BESTCOMSPPlus*, alerts the user of an open or damaged analog input wire. When enabled, Stop Mode Inhibit turns off analog input protection when excitation is stopped.

Ranges must be set for the selected input type. Param Min correlates to Min Input Current or Min Input Voltage and Param Max correlates to Max Input Current or Max Input Voltage.

Each analog input can be independently configured for over or under mode to annunciate an alarm when the analog input signal falls beyond the threshold. Alarms are configured on the *Alarm Configuration, Alarms* screen in *BESTCOMSPPlus*. A user-adjustable activation delay setting delays alarm annunciation after the threshold has been exceeded.

The remote analog inputs are incorporated into a *BESTlogicPlus* programmable logic scheme by selecting them from the *I/O* group in *BESTlogicPlus*. For more details, refer to the *BESTlogicPlus* section.

*BESTCOMSPPlus* settings for remote analog inputs are illustrated in Figure 30-12. Remote Analog Input #1 is shown.

## RTD Inputs

**BESTCOMSPPlus® Navigation Path:** Settings, Programmable Inputs, Remote RTD Inputs

**HMI Navigation Path:** Settings, Programmable Inputs, Remote RTD Inputs

The AEM-2020 provides eight user-configurable RTD inputs that can annunciate a latching or non-latching alarm. The RTD inputs are always monitored and their status is displayed on the appropriate metering screens. To make identifying the RTD inputs easier, a user-assigned name can be given to each input.

The screenshot displays the configuration interface for 'Remote RTD Input #1'. It features several input fields and dropdown menus:

- Label Text:** A text box containing 'RTD IN 1'.
- Arming Delay (s):** A numeric input field set to '0'.
- Hysteresis (%):** A numeric input field set to '2.0'.
- Stop Mode Inhibit:** A dropdown menu set to 'No'.
- RTD Type:** A dropdown menu set to '100 Ohm Platinum'.
- Threshold #1:** A section containing:
  - Mode:** A dropdown menu set to 'Disabled'.
  - Threshold (°F):** A numeric input field set to '0'.
  - Activation Delay (s):** A numeric input field set to '0'.

**Figure 30-13. Remote RTD Input Settings**

Select the amount of hysteresis needed to prevent rapid switching of the alarm. Select the RTD type. A user-adjustable arming delay allows configuration of the RTD input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether or not excitation is enabled. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after system startup is complete. An out-of-range alarm, configured on the *Alarm Configuration, Alarms* screen in *BESTCOMSPPlus*, alerts the user of an open or damaged RTD input wire. When enabled, Stop Mode Inhibit turns off RTD input protection when excitation is stopped.

Each RTD input can be independently configured for over or under mode to annunciate an alarm when the RTD input signal falls beyond the threshold. Alarms are configured on the *Alarm Configuration,*

*Alarms* screen in *BESTCOMSPPlus*. A user-adjustable activation delay setting delays alarm annunciation after the threshold has been exceeded.

The remote RTD inputs are incorporated into a *BESTlogicPlus* programmable logic scheme by selecting them from the *I/O* group in *BESTlogicPlus*. For more details, refer to the *BESTlogicPlus* section.

*BESTCOMSPPlus*® settings for remote RTD inputs are illustrated in Figure 30-13. Remote RTD Input #1 is shown.

## Thermocouple Inputs

**BESTCOMSPPlus Navigation Path:** Settings, Programmable Inputs, Remote Thermocouple Inputs

**HMI Navigation Path:** Settings, Programmable Inputs, Remote Thermo Input

The AEM-2020 provides two thermocouple inputs. The thermocouple inputs are always monitored and their status is displayed on the appropriate metering screens. To make identifying the thermocouple inputs easier, a user-assigned name can be given to each input.

Select the amount of hysteresis needed to prevent rapid switching of the alarm. A user-adjustable arming delay allows configuration of the thermocouple input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether or not excitation is enabled. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after system startup is complete. An out-of-range alarm, configured on the *Alarm Configuration, Alarms* screen in *BESTCOMSPPlus*, alerts the user of an open or damaged thermocouple input wire. When enabled, Stop Mode Inhibit turns off thermocouple input protection when excitation is stopped.

Each thermocouple input can be independently configured for over or under mode to annunciate an alarm when the thermocouple input signal falls beyond the threshold. Alarms are configured on the *Alarm Configuration, Alarms* screen in *BESTCOMSPPlus*. A user-adjustable activation delay setting delays alarm annunciation after the threshold has been exceeded.

The remote thermocouple inputs are incorporated into a *BESTlogicPlus* programmable logic scheme by selecting them from the *I/O* group in *BESTlogicPlus*. For more details, refer to the *BESTlogicPlus* section.

*BESTCOMSPPlus*® settings for remote thermocouple inputs are illustrated in Figure 30-14. Remote Thermocouple Input #1 is shown.

**Remote Thermocouple Input #1**

|                |                   |                      |
|----------------|-------------------|----------------------|
| Label Text     | Arming Delay (s)  |                      |
| THERM CPL 1    | 0                 |                      |
| Hysteresis (%) | Stop Mode Inhibit |                      |
| 2.0            | No                |                      |
| Threshold #1   |                   |                      |
| Mode           | Threshold (°F)    | Activation Delay (s) |
| Disabled       | 32                | 0                    |

**Figure 30-14. Remote Thermocouple Input Settings**

## Analog Outputs

**BESTCOMSPPlus Navigation Path:** Settings, Programmable Outputs, Remote Analog Outputs

**HMI Navigation Path:** Settings, Programmable Outputs, Remote Analog Output

The AEM-2020 provides four analog outputs.

Make a parameter selection and select the output type. An out-of-range alarm configured on the *Alarm Configuration, Alarms* screen in *BESTCOMSPPlus*, alerts the user of an open or damaged analog output wire. An out-of-range activation delay setting delays alarm annunciation.

Ranges must be set for the selected output type. Param Min correlates to Min Output Current or Min Output Voltage and Param Max correlates to Max Output Current or Max Output Voltage.

The remote analog outputs are incorporated into a *BESTlogicPlus* programmable logic scheme by selecting them from the *I/O* group in *BESTlogicPlus*. For more details, refer to the *BESTlogicPlus* section.

*BESTCOMSPPlus* settings for remote analog outputs are illustrated in Figure 30-15. Remote Analog Output #1 is shown.

Figure 30-15. Remote Analog Output Settings

## Status LED

This red LED flashes to indicate that the AEM-2020 is powered up and functioning properly. The LED lights solid during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

## Metering

### Analog Inputs

**BESTCOMSPPlus® Navigation Path:** Metering, Status, Inputs, Remote Analog Inputs

**HMI Navigation Path:** Metering, Status, Inputs, Remote Analog Input Values

The value and status of the remote analog inputs are shown on this screen. The status is TRUE when the corresponding LED is green. Refer to Figure 30-16. Remote Analog Input #1 is shown.

Figure 30-16. Remote Analog Inputs Metering

## RTD Inputs

**BESTCOMSPlus Navigation Path:** Metering, Status, Inputs, Remote RTD Inputs

**HMI Navigation Path:** Metering, Status, Inputs, Remote Analog Input Values

The value and status of the remote RTD inputs are shown on this screen. The status is TRUE when the corresponding LED is green. Refer to Figure 30-17. Remote RTD Input #1 is shown.

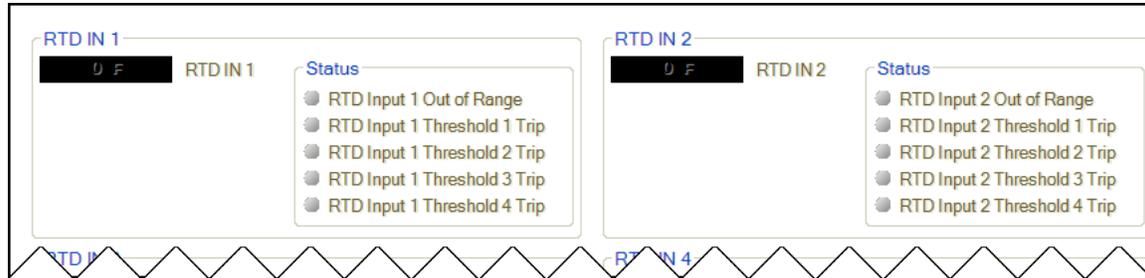


Figure 30-17. Remote RTD Inputs Metering

## Thermocouple Inputs

**BESTCOMSPlus Navigation Path:** Metering, Status, Inputs, Remote Thermocouple Inputs

**HMI Navigation Path:** Metering, Status, Inputs, Remote Analog Input Values

The value and status of the remote thermocouple inputs are shown on this screen. The status is TRUE when the corresponding LED is green. Refer to Figure 30-18. Remote Thermocouple Input #1 is shown.



Figure 30-18. Remote Thermocouple Inputs Metering

## Analog Input Values

**BESTCOMSPlus Navigation Path:** Metering, Status, Inputs, Remote Analog Input Values

**HMI Navigation Path:** Metering, Status, Inputs, Remote Analog Input Values

The values of the scaled analog inputs, raw analog inputs, RTD input temperatures, raw RTD inputs, thermocouple input temperatures, and raw thermocouple inputs are shown on this screen.

For each analog input, the raw metered input value is displayed, and the scaled metered input value. This is useful to check if the AEM-2020 is seeing a valid raw input value (i.e. the raw 0 to 10 volt voltage input or 4 to 20 mA current input). The scaled value is the raw input scaled up to the range specified by the Parameter Minimum and Parameter Maximum value parameters in the Remote Analog Input settings. Refer to Figure 30-19.

When connected to an AEM-2020, the *Calibrate* button shown on the Remote Analog Input Values screen opens the Analog Input Temperature Calibration screen shown in Figure 30-20. This screen is used to calibrate RTD inputs 1 through 8 and thermocouple inputs 1 and 2.

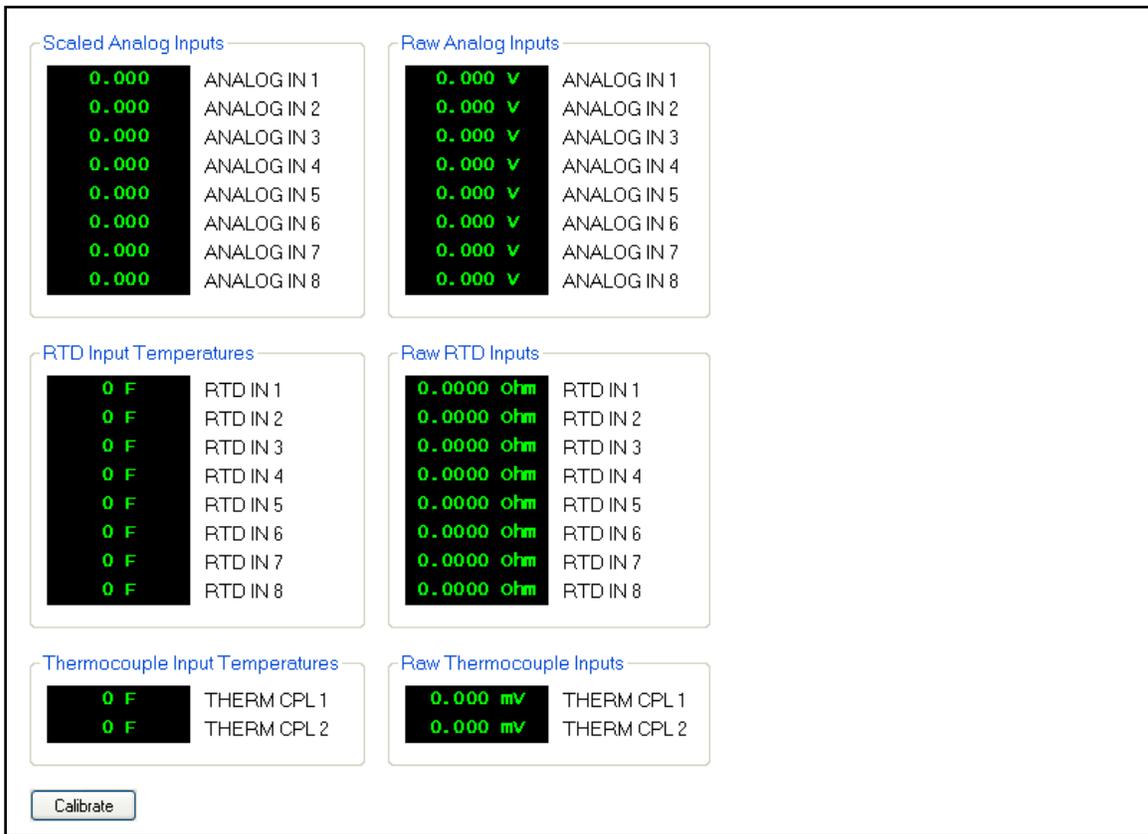


Figure 30-19. Remote Analog Input Values Metering

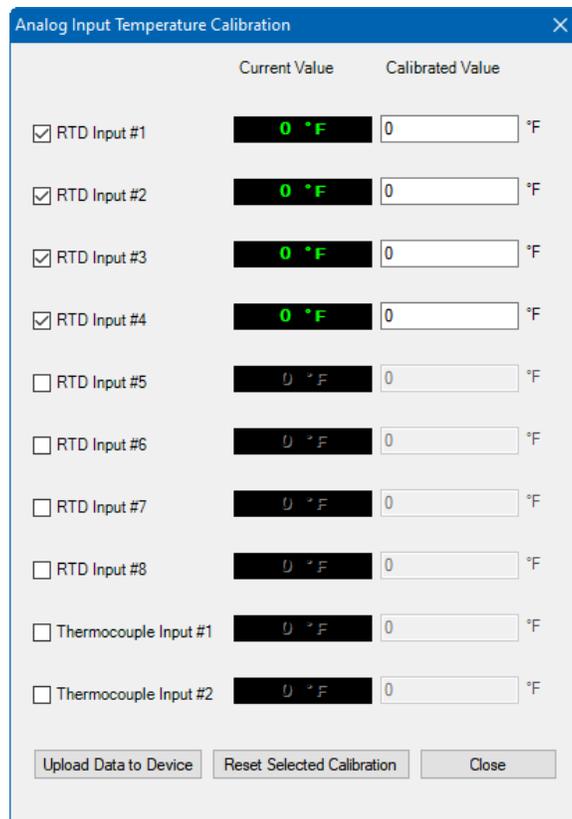


Figure 30-20. Remote Analog Input Temperature Calibration

## Analog Outputs

**BESTCOMSPlus® Navigation Path:** Metering, Status, Outputs, Remote Analog Outputs

**HMI Navigation Path:** Metering, Status, Outputs, Remote Analog Outputs

The status of the remote analog outputs, scaled analog output values, and raw analog output values are shown on this screen. Parameter selections are made on the Remote Analog Outputs screen under settings in BESTCOMSPlus. The status is TRUE when the corresponding LED is green. Refer to Figure 30-21.

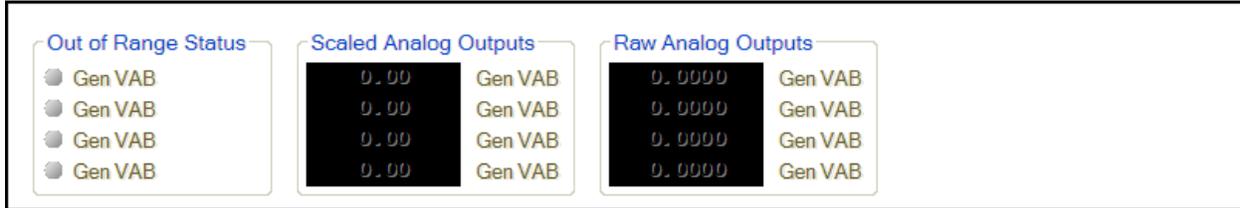


Figure 30-21. Remote Analog Outputs Metering

## Maintenance

Preventive maintenance consists of periodically checking that the connections between the AEM-2020 and the system are clean and tight. Analog Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

## Firmware Updates

Refer to the BESTCOMSPlus® section for instructions on updating firmware in the AEM-2020.

# 31 • Contact Expansion Module

## General Information

The optional CEM-2020 is a remote auxiliary device that provides additional DECS-450 contact inputs and outputs.

This chapter covers the CEM-2020. For information on the CEM-125, refer to Basler publication 9636500990.

## Features

CEM-2020s have the following features:

- Contact sensing inputs: 10
- Output contacts: 24
- Functionality of inputs and outputs assigned by BESTlogic™ *Plus* programmable logic
- Communications via CAN Bus

## Specifications

### Control Power

Nominal ..... 12 or 24 Vdc  
 Range ..... 8 to 32 Vdc (Withstands ride-through down to 6 Vdc for 500 ms.)  
 Burden ..... 14 W

### Contact Inputs

The 14 standard programmable inputs, located on the DECS-450, are numbered 1 through 14 and the 10 programmable inputs, located on the CEM-2020, are numbered 15 through 24.

The CEM-2020 contains 10 programmable inputs that accept normally open and normally closed, dry contacts.

### Contact Outputs

The 11 standard programmable outputs, located on the DECS-450, are numbered 1 through 11 and the 24 programmable outputs, located on the CEM-2020, are numbered 12 through 35.

Outputs 12 through 23 ..... 1 Adc at 30 Vdc, Form C, gold contacts\*  
 Outputs 24 through 35 ..... 4 Adc at 30 Vdc, Form C, 1.2 A pilot duty†

\* Gold contacts intended for low voltage signaling to dry circuits. Not rated for inductive loads or pilot duty.

† For pilot duty, the load must be in parallel with a diode rated at least 3 times the coil current and 3 times the coil voltage.

### Communication Interface

The CEM-2020 communicates with the DECS-450 through CAN1.

#### CAN Bus

Differential Bus Voltage ..... 1.5 to 3 Vdc  
 Maximum Voltage ..... -32 to +32 Vdc with respect to negative battery terminal  
 Communication Rate ..... 125 or 250 kb/s

## Type Tests

### Shock

Withstands 15 G in 3 perpendicular planes.

### Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz ..... 1.5 G peak for 5 min.  
 29 to 52 to 29 Hz ..... 0.036" Double Amplitude for 2.5 min.  
 52 to 500 to 52 Hz ..... 5 G peak for 7.5 min.

### HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the CEM-2020 was subjected to temperature tests (tested over a temperature range of  $-80^{\circ}\text{C}$  to  $+130^{\circ}\text{C}$ ), vibration tests (of 5 to 50 G at  $+25^{\circ}\text{C}$ ), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of  $-60^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ ). Combined temperature and vibration testing at these extremes proves that the CEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in the *Specifications* section of this manual.

## Environment

### Temperature

Operating .....  $-40$  to  $+70^{\circ}\text{C}$  ( $-40$  to  $+158^{\circ}\text{F}$ )

Storage .....  $-40$  to  $+85^{\circ}\text{C}$  ( $-40$  to  $+185^{\circ}\text{F}$ )

Humidity ..... IEC 68-2-38

## Agency, Standards, and Directives

### UL Approval

The CEM-2020 is a Recognized Component for the US and Canada under UL file E97035.

(CCN-FTPM2/FTPM8) covered under the Standards below:

- UL 6200:2019
- CSA C22.2 No.14-13

### CE and UKCA Compliance

This product has been evaluated and complies with relevant essential requirements set forth by the EU legislation and UK Parliament.

### EC Directives

LVD ..... 2014/35/EU

EMC ..... 2014/30/EU

RoHS2 ..... 2011/65/EU as amended by (EU) 2015/863

### UK Designated Standards

LVD ..... SI 2016/1101

EMC ..... SI 2016.1091/30/EU

RoHS2 ..... SI 2012.3032 as amended by SI 2019/492

This product conforms to the following harmonized standards:

- BS EN 50178:1997, Electronic equipment for use in power installations
- BS EN 61000-6-2:2005/AC:2005, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - immunity for industrial environments

- BS EN 61000-6-4:2007/A1:2011, Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - emission standard for industrial environments
- IEC 63000:2016 Ed. 1.0 and BS EN 63000:2018, Technical documentation for assessment of electrical and electronic products with respect to restriction of hazardous substances
- IEC 62474:2018 Ed. 2.0, Material declaration for products of and for the electrotechnical industry

**FCC Requirements**

This product is compliant with FCC 47 CFR Part 15.

**Maritime Recognition**

American Bureau of Shipping (ABS) – for current certificates, see [www.basler.com](http://www.basler.com).

**China RoHS**

The following table serves as the declaration of hazardous substances for China in accordance with PRC standard SJ/T 11364-2014. The EFUP (Environment Friendly Use Period) for this product is 40 years.

| PRODUCT: CEM-2020                            |                |                   |                   |  |  |  |                                     |  |   |  |
|--|----------------|-------------------|-------------------|--|--|--|-------------------------------------|--|---|--|
| 有害物质<br>Hazardous Substances                 |                |                   |                   |  |  |  |                                     |  |   |  |
| 零件名称<br>Part Name                            | 铅<br>Lead (Pb) | 汞<br>Mercury (Hg) | 镉<br>Cadmium (Cd) | 六价铬<br>Hexavalent Chromium (Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated Biphenyls (PBB) | 多溴二苯醚<br>Polybrominated Diphenyl Ethers (PBDE) | 邻苯二甲酸二丁酯<br>Dibutyl Phthalate (DBP) | 邻苯二甲酸丁苄酯<br>Benzyl butyl phthalate (BBP) | 邻苯二甲酸二酯<br>Bis(2-ethylhexyl) phthalate (BEHP) | 邻苯二甲酸二异丁酯<br>Diisobutyl phthalate (DIBP) |
| 金属零件<br>Metal parts                          | ○              | ○                 | ○                 | ○  | ○                                      | ○  | ○                                   | ○  | ○   | ○  |
| 聚合物<br>Polymers                              | ○              | ○                 | ○                 | ○  | ○                                      | ○  | ○                                   | ○  | ○   | ○  |
| 电子产品<br>Electronics                          | X              | ○                 | X                 | ○  | ○                                      | ○  | ○                                   | ○  | ○   | ○  |
| 电缆和互连配件<br>Cables & interconnect accessories | ○              | ○                 | ○                 | ○  | ○                                      | ○  | ○                                   | ○  | ○   | ○  |
| 绝缘材料<br>Insulation material                  | ○              | ○                 | ○                 | ○  | ○                                      | ○  | ○                                   | ○  | ○   | ○  |

本表格依据 SJ/T11364 的规定编制。  
 O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。  
 X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。  
 This form was prepared according to the provisions of standard SJ/T11364.  
 O: Indicates that the hazardous substance content in all homogenous materials of this part is below the limit specified in standard GB/T 26252.  
 X: Indicates that the hazardous substance content in at least one of the homogenous materials of this part exceeds the limit specified in standard GB/T 26572.

**Physical**

Weight .....2.25 lb (1.02 kg)  
 Dimensions.....See *Installation* below.

## Installation

Contact Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

## Mounting

Contact Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of a Contact Expansion Module is durable enough to mount directly on a gasket using 1/4-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 31-1 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

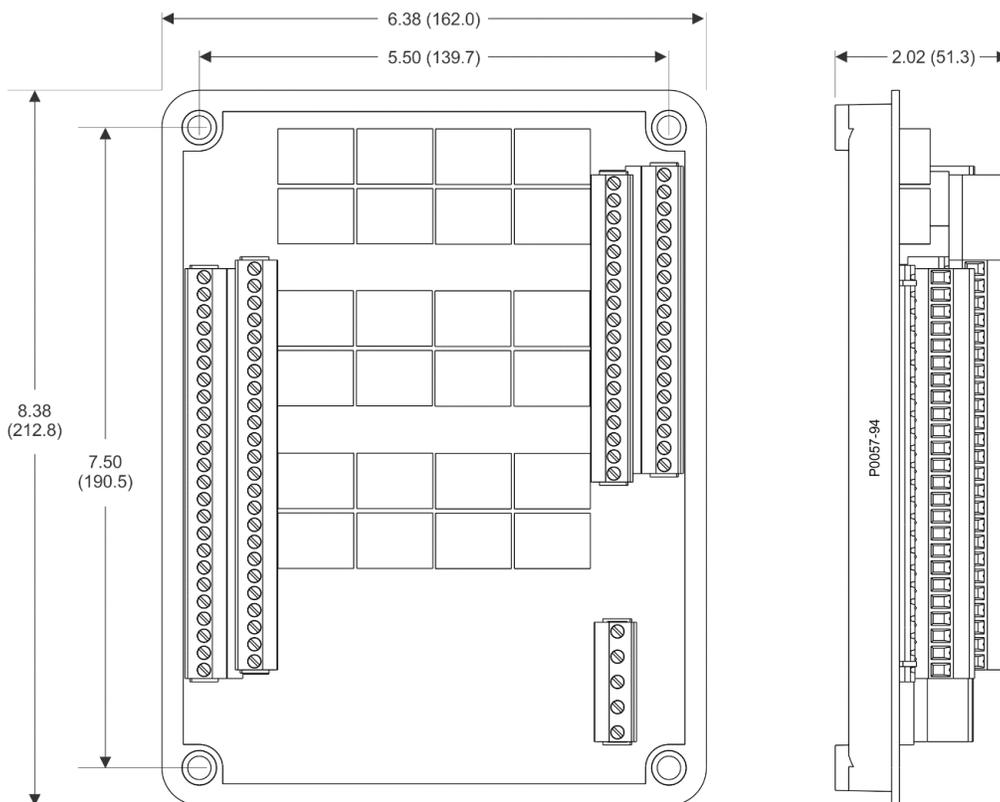


Figure 31-1. CEM-2020 Overall Dimensions

## Connections

Contact Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

### Notes

Control power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate.

Be sure that the CEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

It is recommended to minimize the vibration load on the connector plug by ensuring that wires are well-constrained, with no more than 6 to 8 inches of unconstrained wire length near the connector plugs.

### Terminations

The terminal interface consists of plug-in connectors with screw-down compression terminals.

CEM-2020 connections are made with one 5-position connector, two 18-position connectors, and two 24-position connectors with screw-down compression terminals. These connectors plug into headers on the CEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which deteriorates connections and leads to signal loss.

Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 5 in-lb (0.56 N•m).

### Control Power

The Contact Expansion Module control power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Control power must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate. Control power terminals are listed in Table 31-1.

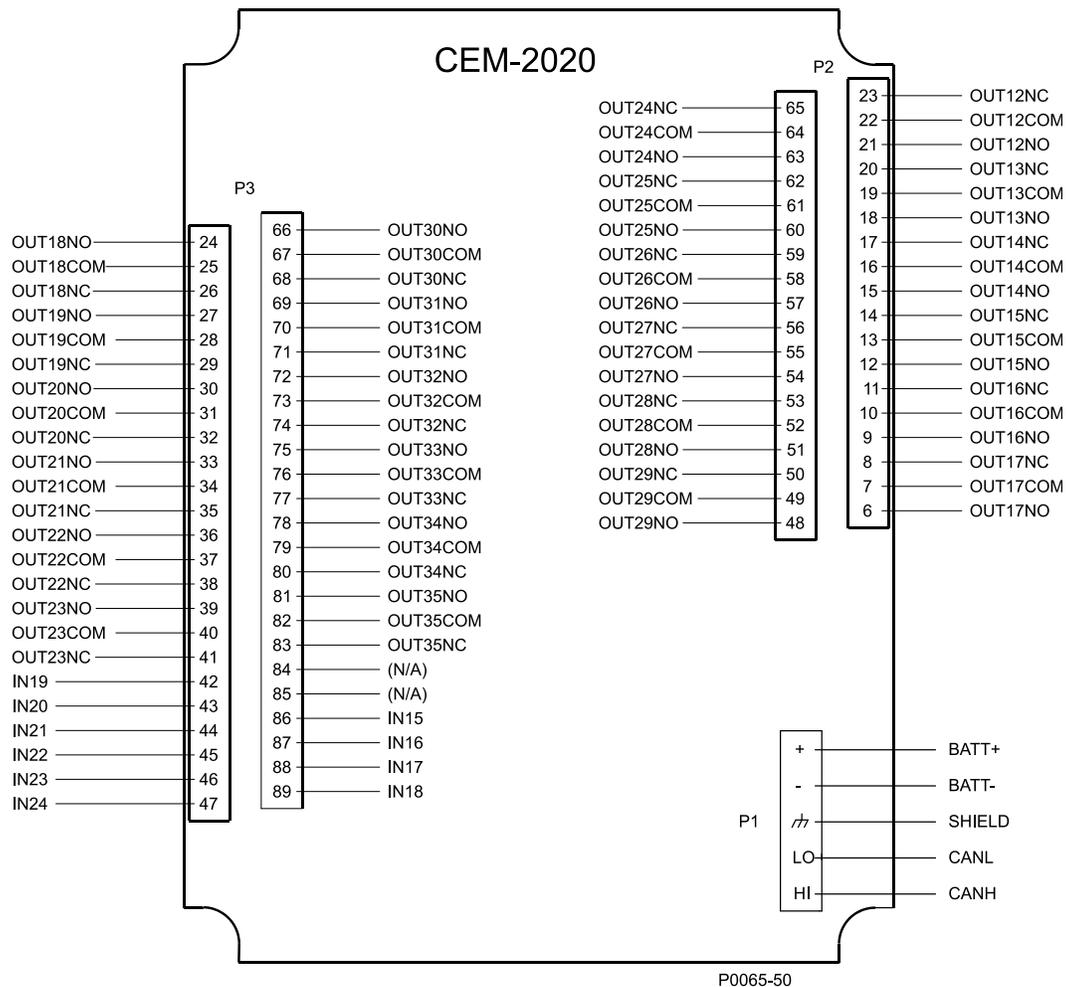
It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Contact Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

**Table 31-1. Control Power Terminals**

| Terminal   | Description                          |
|--|--------------------------------------|
| P1-  (SHIELD) | Chassis ground connection            |
| P1- - (BATT-)  | Negative side of control power input |
| P1- + (BATT+)  | Positive side of control power input |

### Contact Inputs and Contact Outputs

The CEM-2020 (Figure 31-2) has 10 contact inputs and 24 contact outputs.



**Figure 31-2. CEM-2020 Input Contact and Output Contact Terminals**

### CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Contact Expansion Module and the DECS-450. Connections between the CEM-2020 and DECS-450 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 31-2. Refer to Figure 31-3 and Figure 31-4.

**Table 31-2. CAN Bus Interface Terminals**

| Terminal       | Description                       |
|----------------|-----------------------------------|
| P1- HI (CAN H) | CAN high connection (yellow wire) |
| P1- LO (CAN L) | CAN low connection (green wire)   |
| P1- ⏏ (SHIELD) | CAN drain connection              |

### Note

1. If the CEM-2020 is providing one end of the J1939 bus, a 120  $\Omega$ , ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the CEM-2020 is not part of the J1939 bus, the stub connecting the CEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the CEM-2020.

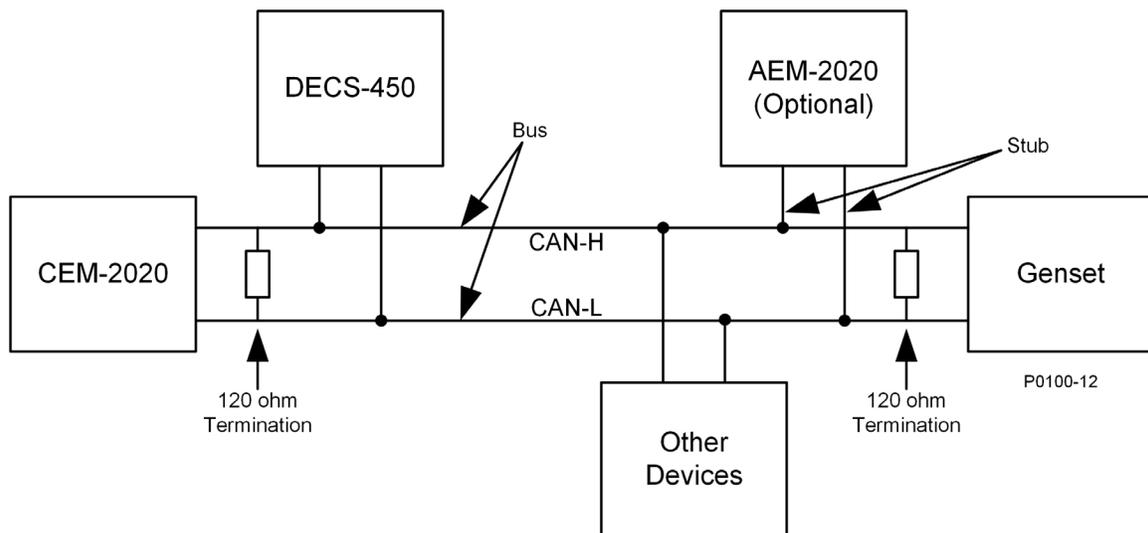


Figure 31-3. CAN Bus Interface with CEM-2020 providing One End of the Bus

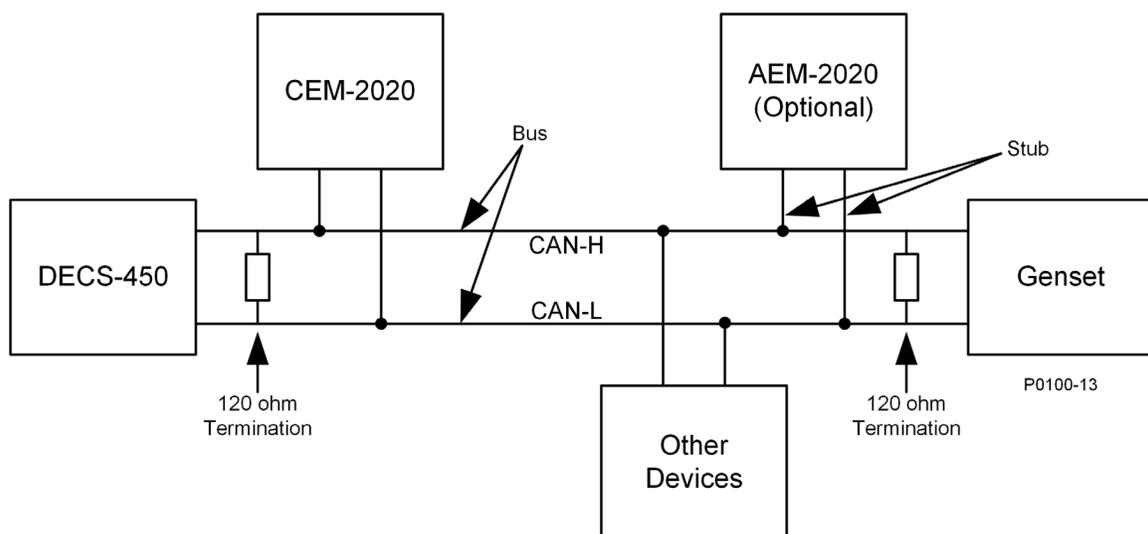


Figure 31-4. CAN Bus Interface with DECS-450 providing One End of the Bus

## Communications

**BESTCOMSPlus® Navigation Path:** Settings, Communications, CAN bus, Remote Module Setup

**HMI Navigation Path:** Settings, Communication, CAN bus, Remote Module Setup, Contact Expansion Module

The contact expansion module must be enabled with the correct J1939 address. A Control Area Network (CAN) is a standard interface that enables communication between the CEM-2020 and the DECS-450. The Remote Module Setup screen is illustrated in Figure 31-5.

**Remote Module Setup**

**Contact Expansion Module**  
 Disabled  
 Enabled  
 CEM J1939 Address

**Analog Expansion Module**  
 Disabled  
 Enabled  
 AEM J1939 Address

Figure 31-5. Remote Module Setup

## Functional Description

### Contact Inputs

**BESTCOMSPlus Navigation Path:** Settings, Programmable Inputs, Remote Contact Inputs

**HMI Navigation Path:** Not available through HMI.

The CEM-2020 provides 10 programmable contact inputs with the same functionality as the contact inputs on the DECS-450. The label text of each contact input is customizable and accepts an alphanumeric character string with a maximum of 64 characters.

The remote contact inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to the BESTlogicPlus section.

BESTCOMSPlus settings for remote contact inputs are illustrated in Figure 31-6.

**Remote Contact Inputs**

|  |  |  |
|--|--|--|
| Input #15<br>Label Text<br><input type="text" value="INPUT 15"/> | Input #16<br>Label Text<br><input type="text" value="INPUT 16"/> | Input #17<br>Label Text<br><input type="text" value="INPUT 17"/> |
| Input #18<br>Label Text<br><input type="text" value="INPUT 18"/> | Input #19<br>Label Text<br><input type="text" value="INPUT 19"/> | Input #20<br>Label Text<br><input type="text" value="INPUT 20"/> |
| Input #21<br>Label Text<br><input type="text" value="INPUT 21"/> | Input #22<br>Label Text<br><input type="text" value="INPUT 22"/> | Input #23<br>Label Text<br><input type="text" value="INPUT 23"/> |
| Input #24<br>Label Text<br><input type="text" value="INPUT 24"/> |  |  |

Figure 31-6. Remote Contact Inputs Settings

## Contact Outputs

**BESTCOMSPlus Navigation Path:** Settings, Programmable Outputs, Remote Contact Outputs

**HMI Navigation Path:** Not available through HMI.

The CEM-2020 provides 24 programmable contact outputs with the same functionality as the contact outputs on the DECS-450. Outputs 12 through 23 can carry 1 A. Outputs 24 through 35 can carry 4 A.

The label text of each contact output is customizable and accepts an alphanumeric character string with a maximum of 64 characters.

The remote analog outputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to the BESTlogicPlus section.

BESTCOMSPlus settings for remote contact outputs are illustrated in Figure 31-7.

Figure 31-7. Remote Contact Outputs Settings

## Status LED

This red LED flashes to indicate that the CEM-2020 is powered up and functioning properly. The LED remains lit during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

## Metering

### Contact Inputs

**BESTCOMSPlus Navigation Path:** Metering, Status, Inputs, Remote Contact Inputs

**HMI Navigation Path:** Metering, Status, Inputs, Remote Contact Inputs

The status of the remote contact inputs are shown on this screen. The status is TRUE when the corresponding indicator is green. Refer to Figure 31-8.

Figure 31-8. Remote Contact Inputs Metering

## Contact Outputs

**BESTCOMSPlus® Navigation Path:** Metering, Programmable Outputs, Remote Contact Outputs

**HMI Navigation Path:** Metering, Status, Outputs, Remote Contact Outputs

The status of the remote contact outputs are shown on this screen. The status is TRUE when the corresponding indicator is green. Refer to Figure 31-9.

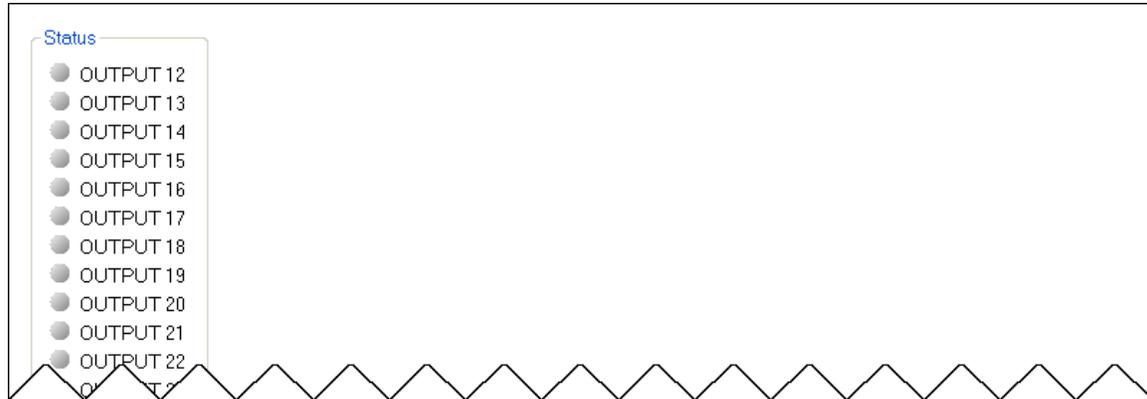


Figure 31-9. Remote Contact Outputs Metering

## Maintenance

Preventive maintenance consists of periodically checking that the connections between the CEM-2020 and the system are clean and tight. Contact Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

## Firmware Updates

Refer to the BESTCOMSPlus® section for instructions on updating firmware in the CEM-2020.

# 32 • BESTCOMSPPlus® Settings Loader Tool

## Introduction

The BESTCOMSPPlus® Settings Loader Tool is a software application, which allows the user to instantly upload settings to Basler BESTCOMSPPlus-compatible products by scanning a pre-registered bar code, which promotes consistency, reduces potential errors, and saves time.

## Setup

The BESTCOMSPPlus Settings Loader Tool software and a bar code reader (acquired separately) must be installed on the same PC.

## BESTCOMSPPlus Settings Loader Tool Installation

### System Recommendations

BESTCOMSPPlus operates with systems using Windows® 7 SP1, Windows 8.1, Windows 10, and Windows 11. The BESTCOMSPPlus® Settings Loader Tool is bundled with BESTCOMSPPlus software. BESTCOMSPPlus software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMSPPlus on your PC also installs the BESTCOMSPPlus Settings Loader Tool and the required version of .NET Framework (if not already installed). System recommendations for the .NET Framework and BESTCOMSPPlus are listed in Table 32-1.

**Table 32-1. System Recommendations for BESTCOMSPPlus and the .NET Framework**

| System Type | Component  | Recommendation  |
|-------------|------------|---|
| 32/64 bit   | Processor  | 2.0 GHz   |
| 32/64 bit   | RAM        | 1 GB (minimum), 2 GB (recommended)                        |
| 32/64 bit   | Hard Drive | 200 MB (if .NET Framework is already installed on PC)     |
|             |            | 4.5 GB (if .NET Framework is not already installed on PC) |

To install and run BESTCOMSPPlus, a Windows user must have Administrator rights.

### Installation

#### Note

Do not connect a USB cable until setup completes successfully. Connecting a USB cable before setup is complete may result in errors.

1. Download BESTCOMSPPlus from [www.basler.com](http://www.basler.com).
2. Click the installation button for BESTCOMSPPlus. The setup utility installs BESTCOMSPPlus, the .NET Framework (if not already installed), the USB driver, and the BESTCOMSPPlus Settings Loader Tool on your PC.

When BESTCOMSPPlus installation is complete, a Basler Electric folder is added to the Windows programs menu. This folder is accessed by clicking the Windows Start button and then accessing the Basler Electric folder in the Programs menu. The Basler Electric folder contains an icon that starts the BESTCOMSPPlus Settings Loader Tool.

## Bar Code Reader and Bar Codes

The BESTCOMSPi<sup>us</sup>® Settings Loader Tool is compatible with bar code readers, which conform to UnifiedPOS specifications. Bar code readers and bar code labels are not provided and must be acquired separately. Refer to the bar code reader's documentation for installation instructions.

Any bar code compatible with your bar code reader may be used.

## ***BESTCOMSPi<sup>us</sup>® Settings Loader Tool Settings***

BESTCOMSPi<sup>us</sup> Settings Loader Tool settings are found on two main screens, the Loader Grid and Configuration screen. The Loader Grid contains management options for the product settings files and their associated bar codes. The Configuration screen contains product-specific options for the default behavior of the BESTCOMSPi<sup>us</sup> Settings Loader Tool. These settings are described in the following paragraphs.

### Loader Grid

One entry, or row, in the Loader Grid contains all of the necessary data to associate a product settings file with a bar code. New entries can be added. Existing entries can be edited, deleted, and uploaded to a Basler product.

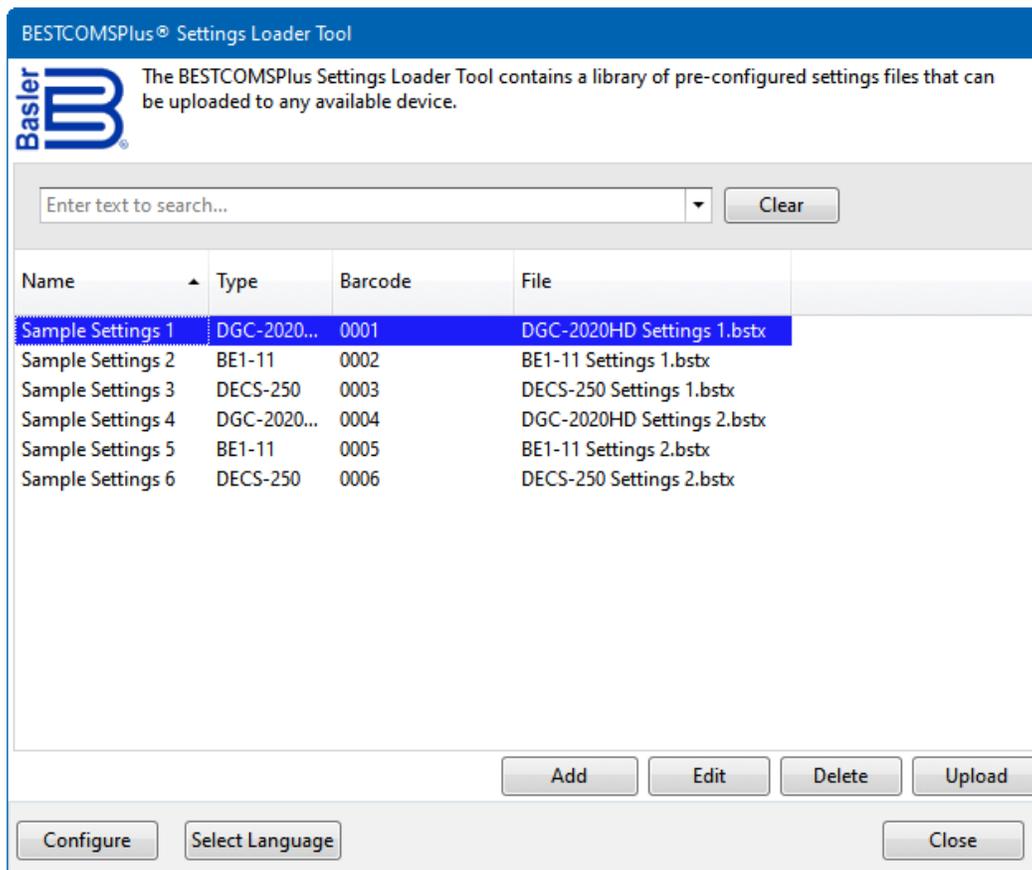


Figure 32-1. Loader Grid

### Scanning Bar Codes

Place the cursor in the text field, found at the top of the Loader Grid screen, and scan a bar code. If successful, the digits which comprise the bar code appear in the text field. The BESTCOMSPi<sup>us</sup> Settings Loader Tool automatically searches for this bar code among the entries in the Loader Grid and displays the matching entry. Click Clear to remove the digits from the text field.

### Adding an Entry

Click Add to create an entry. The BESTCOMSPi<sup>us</sup>® Settings Loader Tool: Add Device dialog box appears (Figure 32-2).

**Figure 32-2. Add Device Screen**

Enter the name of the entry in the Name field. This appears in the first column of the Loader Grid.

Select the product type from the Type drop-down menu. This appears in the second column of the Loader Grid.

Enter the bar code of the entry in the UPC Barcode field by placing the cursor in the UPC Barcode field and scanning the bar code.

To select the product settings file for the entry, click the browse (...) button in the Location field. Use standard Windows methods to navigate to the desired product settings file and click Open. Ensure that the selected product type in the Type field matches that of the product settings file specified in the Location field.

Click OK when finished.

### Editing an Entry

To Edit an existing entry, select the entry in the Loader Grid and click Edit. The BESTCOMSPi<sup>us</sup> Settings Loader Tool: Edit Device dialog box appears. The options are identical to those of the Add Device dialog. When the desired changes have been made, click OK.

### Deleting an Entry

To delete an entry from the Loader Grid, select the entry and click the Delete button. A prompt appears providing the option to confirm or cancel the deletion.

### Uploading an Entry

Select an entry and click Upload. A dialog appears which provides connection options for the appropriate type of device. Refer to the Basler product instruction manual for detailed connection information. Once a connection is established, the product settings associated with the entry are uploaded.

## **Configuration Settings**

For configuration settings, click the Configure button in the bottom left of the Loader Grid. The product tabs on the left represent the compatible Basler products. Each product tab contains tabs for Settings Files and Connection Options. The options on these tabs are described below.

### Setting Files Options

**Use Saved Path:** When enabled, the path specified in the Loader Grid entry is used when uploading the settings file.

**Single Folder:** When enabled, this specifies a single folder, which contains all settings files for the product. The Windows filename specified in the Location field of the Loader Grid entry is searched for in the Single Folder location. For example, all settings files for a product are located in “C:\files”. The Location field in the Loader Grid entry for a device contains “C:\documents\settings\DECS-250 Settings.bstx”. The BESTCOMSPi<sup>us</sup> Settings Loader Tool searches in “C:\files” for the file named “DECS-250 Settings.bstx”.

**Append Bar-Code to Location:** When enabled, the bar code is appended to the specified location when uploading the settings file. For example, an entry with the bar code “0002” is located in C:\files\0002 and an entry with the bar code “0003” is located in C:\files\0003.

**Logon:** If User Name and Password are specified, you will not be prompted for credentials when required.

**Save After Upload:** After uploading a settings file, the settings are downloaded from the connected device and saved to the specified location, when enabled.

**Upload Security:** When enabled, the security settings stored in the settings file are uploaded to the device. Credentials will be requested if not already specified.

Figure 32-3 illustrates the Setting Files tab.

The screenshot shows the 'Configuration' dialog box with the 'Setting Files' tab selected. On the left, a list of devices is shown, including BE1-11, DECS-150, DECS-250, DECS-450, DGC-2020, DGC-2020ES, DGC-2020HD, IEM-2020, Load Share Module, and RTD Module. The main area is divided into three sections: 'Setting Files', 'Save After Upload', and 'Upload Security'. The 'Setting Files' section has three radio buttons: 'Use saved path' (selected), 'Single folder', and 'Append bar-code to location'. It also includes a 'Logon' section with 'User Name' and 'Password' text boxes, and a 'Show Warnings' checkbox. The 'Save After Upload' section has an 'Enable' checkbox and three radio buttons: 'Same location as upload' (selected), 'Single folder', and 'Append bar-code to location'. The 'Upload Security' section has an 'Enable' checkbox and a 'Logon' section with 'User Name' and 'Password' text boxes. At the bottom right, there are 'OK' and 'Cancel' buttons.

Figure 32-3. Configuration, Settings Files Tab

### Connection Options

Connection options consist of the three selections described below. Refer to the Basler product instruction manual for detailed connection information.

**Always Prompt for Connection:** When enabled, a dialog appears which provides connection options for the appropriate type of device each time a connection attempt is made.

**Ethernet Connection:** When enabled, the BESTCOMSP*lus* Settings Loader Tool automatically attempts to connect to the specified IP address before uploading settings.

**USB Connection:** When enabled, the BESTCOMSP*lus*® Settings Loader Tool automatically attempts to connect to the device via USB port before uploading settings.

Figure 32-4 illustrates the Connection Options tab.

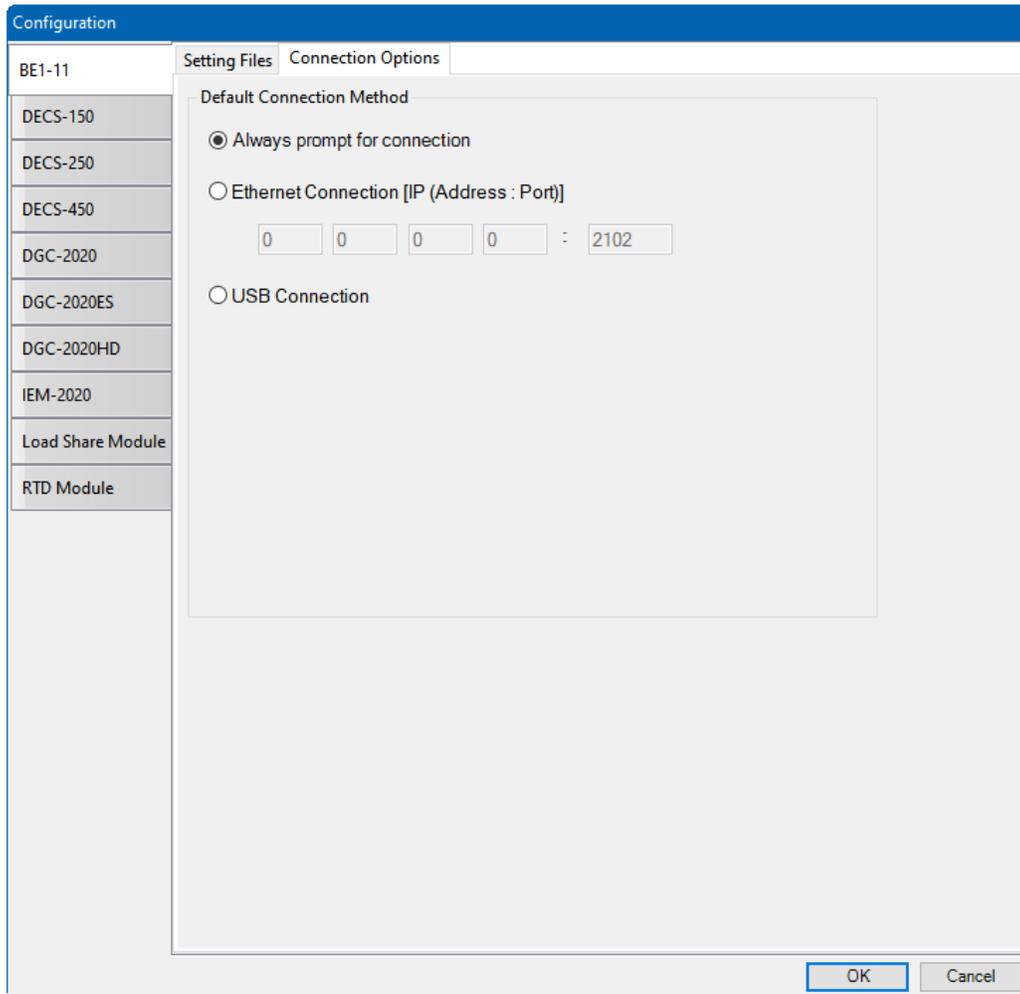


Figure 32-4. Configuration, Connection Options Tab

## General Operation

The steps listed below are provided as a general guideline for how to operate the BESTCOMSP*lus* Settings Loader Tool when the initial setup is complete and the settings files are associated with bar codes.

1. Power on the device that will receive the new settings. Ensure proper communication connections have been made between the device and the PC running BESTCOMSP*lus* Settings Loader Tool.
2. Run BESTCOMSP*lus* Settings Loader Tool.
3. Place cursor in search bar.
4. Scan bar code.
5. Settings file is automatically highlighted and isolated in the grid.

6. Click Upload.
7. BESTCOMSP*lus* Settings Loader Tool automatically connects to device and uploads settings. Device connection is automatic unless “Always prompt for connection” is enabled.

## 33 • Math Model

### ***Introduction***

---

This chapter describes and illustrates the DECS-450 mathematical model.

### **References**

DECS-450 mathematical models and timing characteristics are based on the following.

- IEEE Standard 421.5™-2016, *IEEE Recommended Practice for Excitation System Models for Power System Stability Studies*
- IEEE Standard C37.112™-2018, *IEEE Standard Inverse Time Characteristic Equations for Over Current Relays*
- IEEE Standard C50.13™-2014, *IEEE Standard for Cylindrical-Rotor 50 Hz and 60 Hz Synchronous Generators Rated MVA and Above*
- P. Kundur and O. Malik, “Excitation Systems” in *Power System Stability and Control*, 2nd ed. New York, NY, USA: McGraw-Hill, 2022, ch. 8, sec. 5.7, pp. 255–303.

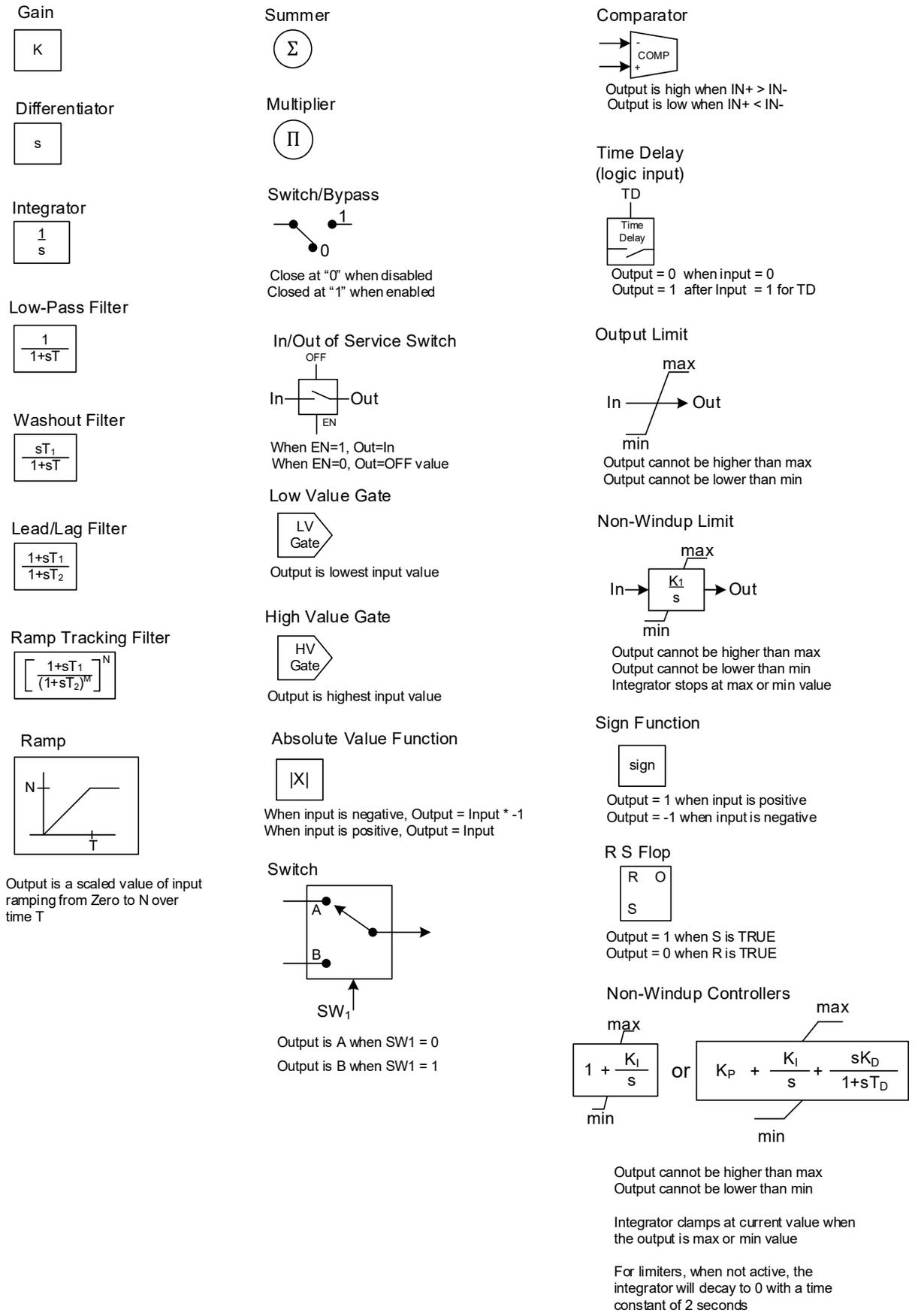


Figure 33-1. Symbol Definitions

## Synchronous Machine Terminal Voltage Transducer and Load Compensator Model

The Basler DECS-450 implements load compensation by using the vector sum of the magnitudes of the terminal voltage and of the terminal current. The model provided in IEEE Std 421.5™-2016 for terminal voltage transducers and load compensators can be used to model this function in the Basler DECS-450 system as shown in Figure 33-2.

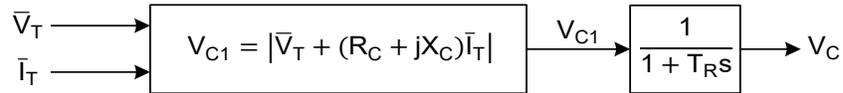


Figure 33-2. Terminal Voltage and Load Compensation Element

The values used in this model can be derived from the Basler DECS-450 settings as follows:

$R_C = 0$  (Resistive load compensation is not available)

$X_C = \pm 0.01 * \text{DRP}$

$T_R = 5 \text{ ms}$

The parameter DRP corresponds to the reactive droop or line drop compensation percentages set by the user. Values for the DRP can range from 0% to 30% of the rated per-unit generator terminal voltage. The value of the reactive component of compensation  $X_C$  is positive for reactive droop compensation and negative for line drop compensation.

## Power Source Model

Figure 33-3 shows the power source model for the DECS-450 with the rectifier regulation function shown in Figure 33-4. The models are described in Annex D of IEEE Std 421.5™-2016. The maximum forcing represented by the regulator potential circuit gain parameter  $K_P$  is related to the power-input voltage ( $V_{P\_VOL}$ ) of the regulator and the nominal exciter field voltage ( $E_{FE\_BASE}$ ) as follows:

$$K_P = 1.17 * \frac{V_{P\_VOL}}{E_{FE\_BASE}} \text{ for the three-phase power input}$$

$$K_P = 0.78 * \frac{V_{P\_VOL}}{E_{FE\_BASE}} \text{ for the single-phase power input}$$

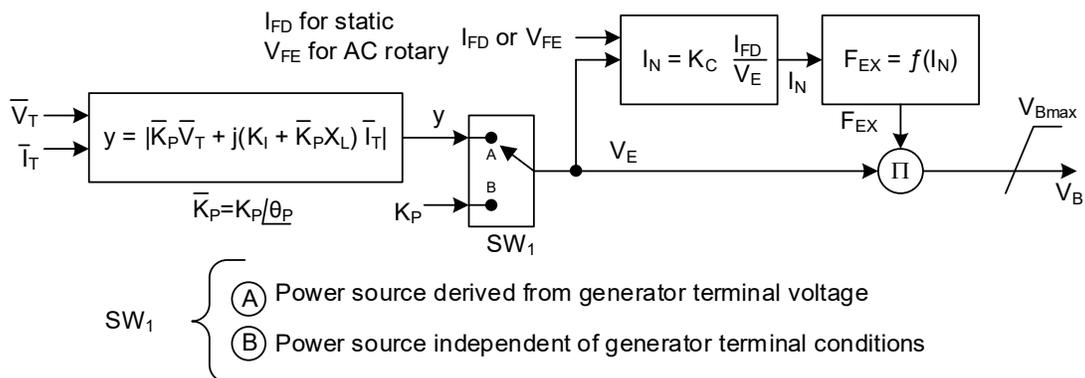


Figure 33-3. Power Source for Excitation

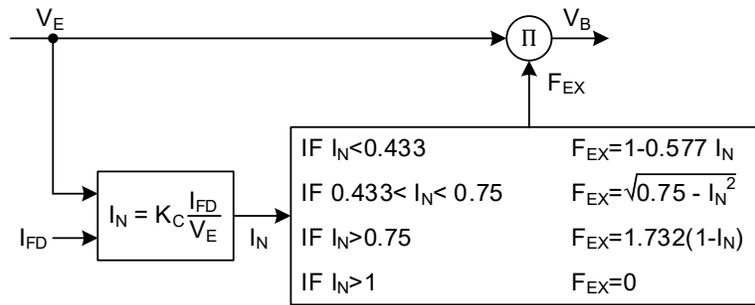


Figure 33-4. Rectifier Regulation Function ( $F_{EX}$ )

## Voltage Regulator

Figure 33-5 shows the model of the Basler DECS-450 voltage regulator. It can be modeled as an AC8C or ST4C model from the IEEE Std 421.5™. The exciter is excluded from Figure 33-5.

The limits,  $V_{RMAX}$  and  $V_{RMIN}$ , are determined as follows:

$$V_{RMAX} = 1$$

$$V_{RMIN} = -1 \text{ for the 6-SCR Bridge}$$

$$V_{RMIN} = 0 \text{ for the 3-SCR Bridge}$$

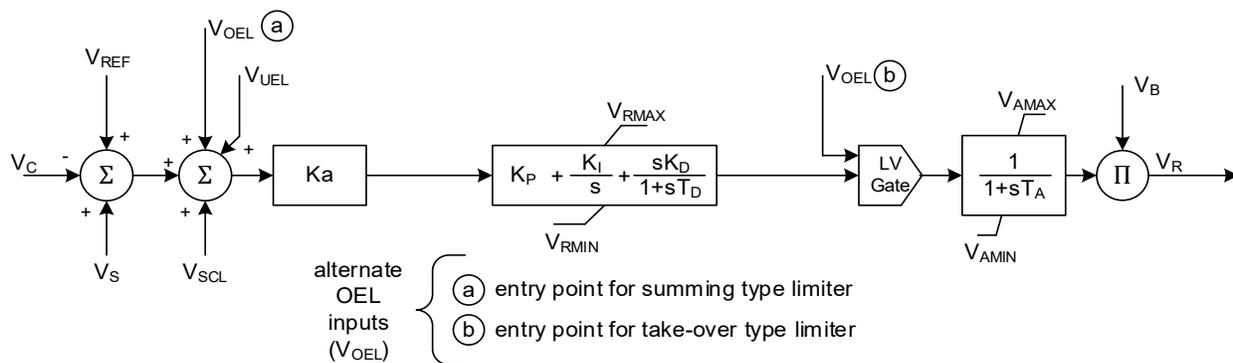


Figure 33-5. Per-Unit AVR Block Diagram

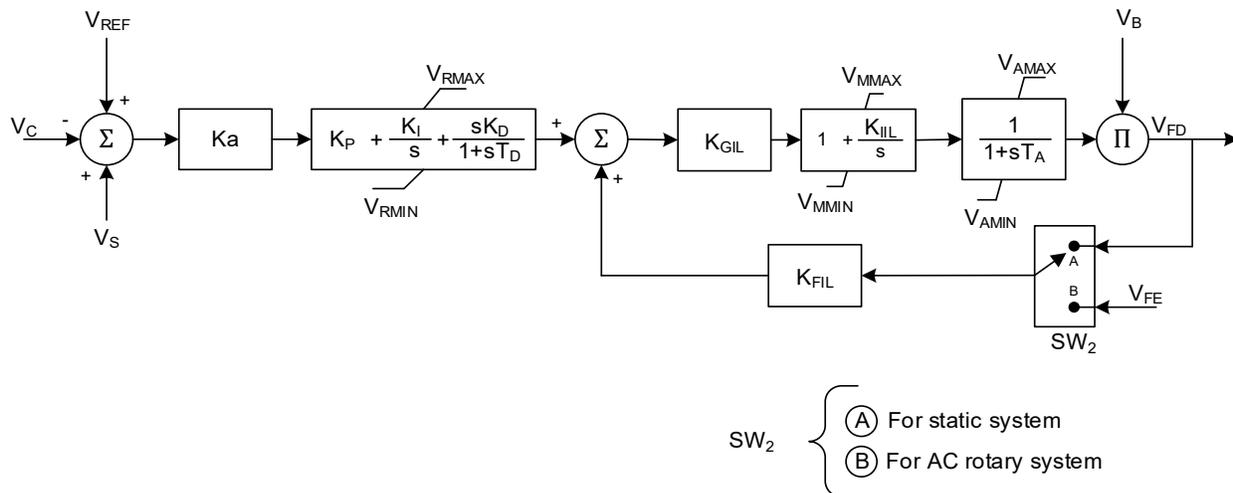


Figure 33-6. Per-Unit AVR Block Diagram with Inner Loop Field Regulator

The PID gains  $K_P$ ,  $K_I$ , and  $K_D$  are custom designed for the best performance for each generator/exciter system. These continuous time gains are discretized and implemented in the DECS-450 digital controller. The PID gains can be read from the tables provided by Basler Electric or can be obtained from a program made available to the user by Basler Electric.

The inner loop field voltage regulator in Figure 33-6 is comprised of the gains  $K_{FIL}$ ,  $K_{GIL}$  and  $K_{IIL}$ , which is used to linearize the exciter control output by compensating the nonlinear characteristics due to power source variation. The inner loop feedback gain  $K_{FIL}$  is set as 0.1.

Figure 33-7 depicts the model of the Basler DECS-450 excitation system used with a simplified rotating exciter, brush or brushless type. The rotary exciter depicted in Figure 33-7 is an ac rotary exciter. If the actual system utilizes a dc rotary exciter instead, the ac rotary exciter's block diagram would be replaced with the block diagram of a dc rotary exciter similar to the one depicted in IEEE Std 421.5™-2016. The rotating exciter parameters are not included in this discussion since they are the responsibility of the exciter manufacturer.

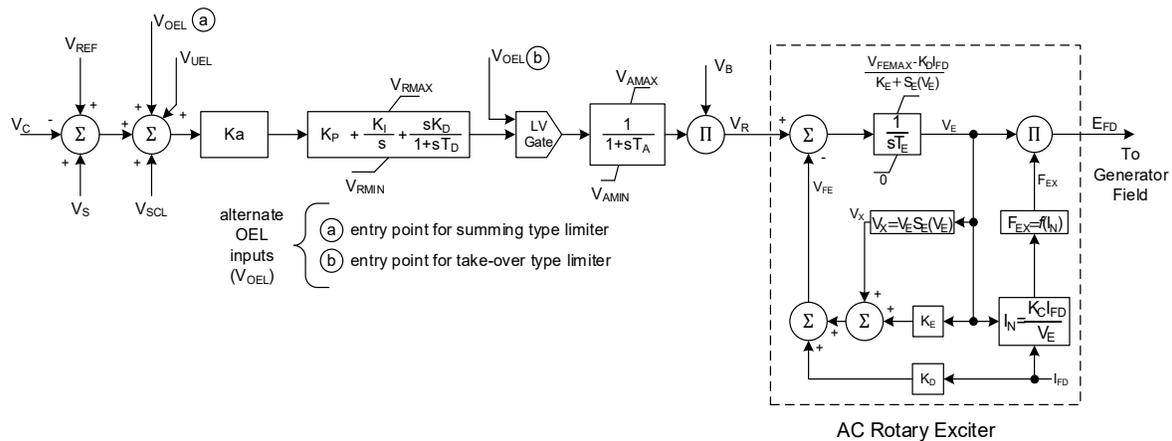


Figure 33-7. Per-Unit Block Diagram for a Simplified Rotating Exciter

## Var/Power Factor Controller

The var and power factor (PF) controllers are summing point type controllers and make up the outside loop of a two-loop system. These controllers are implemented as slow PI-type controllers. The voltage regulator forms the inner loop and is implemented as a fast PID controller.

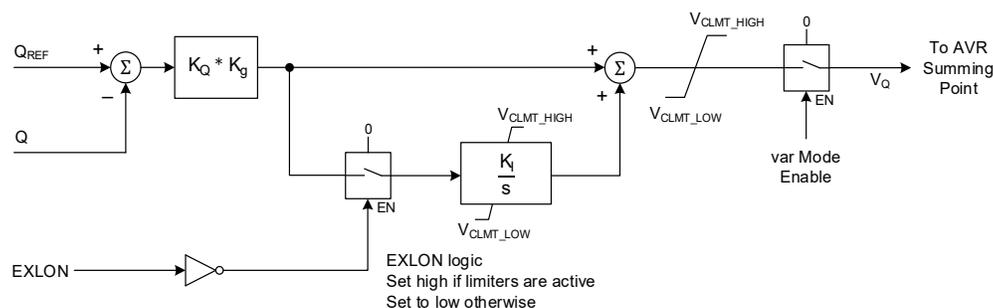


Figure 33-8. Per-Unit Var Controller Block Diagram

The models of the Basler DECS-450 var and power factor controller are shown in Figure 33-8 and Figure 33-9, respectively. They may be modelled as IEEE Std 421.5™ Type 2 Var/Power Factor controllers. The  $P_{TMIN}$  threshold for the PF controller is based on a settable percentage of rated power. The non-windup limit ( $V_{CLMT}$ ) is used for bounding the var and PF controllers' output voltages ( $V_Q$  and  $V_{PF}$ ).  $V_{CLMT}$  is related to the programmed parameter "Fine Voltage Adjustment Band" (FVAB) as follows:

$$V_{CLMT\_HIGH} = \frac{FVAB}{100}$$

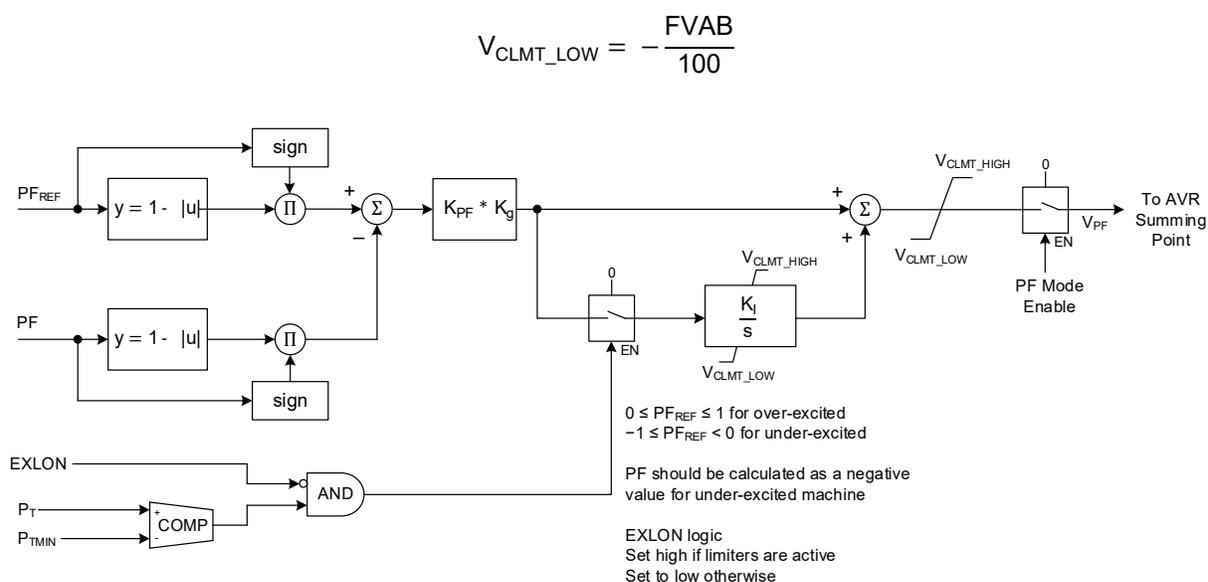


Figure 33-9. Per-Unit Power Factor Controller Block Diagram

## Limiters

The Basler DECS-450 has six limiters: the underexcitation limiter (UEL), the overexcitation limiter (OEL), the stator current limiter (SCL), the var limiter (varL), the underfrequency limiter (UFL), and the volts-per-hertz limiter (V/Hz). The OEL can be implemented as either summing point-type limiters or takeover-type limiters. The UEL, SCL, underfrequency limiter, V/Hz, and varL are only available as summing point-type limiters. With regards to the underfrequency limiter and the volts-per-hertz limiter, only one of these limiters may be enabled at a time.

### Underexcitation Limiter (UEL)

Figure 33-10 shows the DECS-450 model of the summing-point type underexcitation limiter (UEL). It makes up the outer loop, and the voltage regulator makes up the inner loop. The UEL uses a PI-type controller.

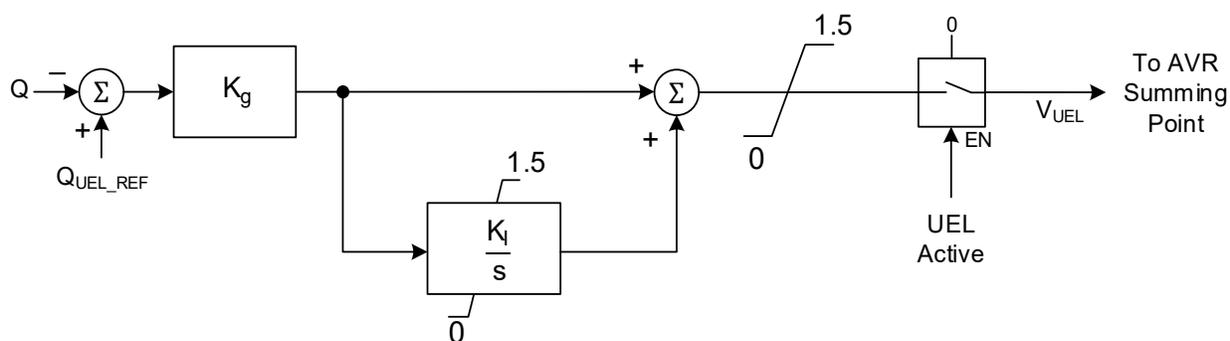


Figure 33-10. Per-Unit Underexcitation Limiter Block Diagram

The UEL operating characteristic is selected from one of the following methods:

1. The internal UEL operating characteristic is designed to mimic the operational limits of the generator on the P-Q plane as illustrated in Figure 33-11. The UEL reference ( $Q_{UEL\_REF}$ ) is generated based on the user input parameter "UEL Bias ( $Q_{BIAS}$ )" and the active power (P) as follows:

$$Q_{UEL\_REF} = (0.49 * P^2 - 1) * Q_{BIAS}$$

2. The levels entered for the user-defined curve are defined for operation at the rated generator voltage. The user-defined UEL curve is automatically adjusted based on generator operating

voltage and real power by using the UEL voltage dependency real-power exponent as shown in Figure 33-12.

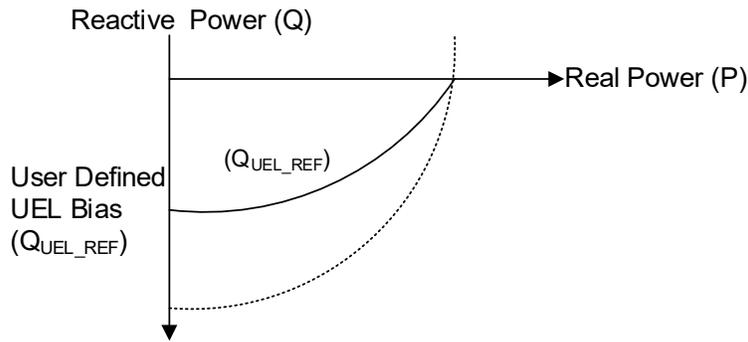


Figure 33-11. Underexcitation Limiter Reference

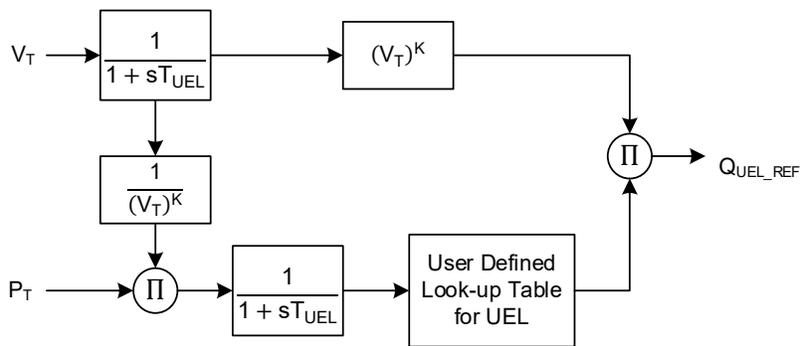


Figure 33-12. Adjustment of UEL Curve based on Generator Voltage and Real Power

Figure 33-13 shows the customized UEL operating characteristic for a UEL in which the limit is comprised of multiple straight-line segments, showing up to six segments.

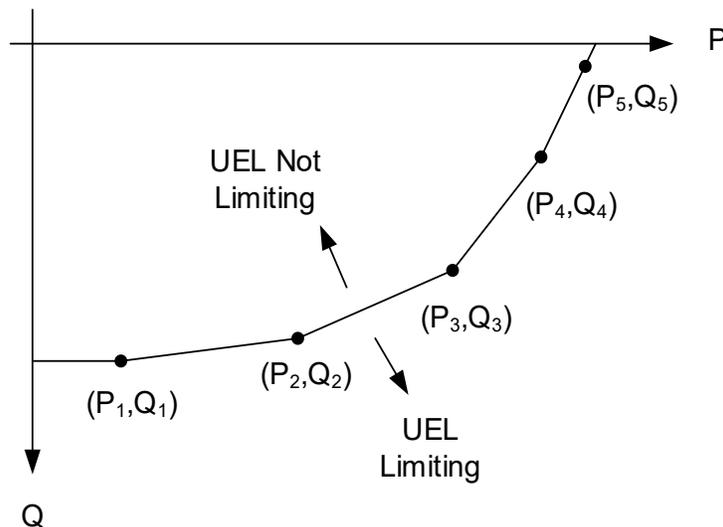


Figure 33-13. User-Defined UEL Curve Characteristic with Five Points

## Overexcitation Limiter (OEL)

The Basler DECS-450 has two types of overexcitation limiter (OEL): summing point type and takeover type. These are shown in Figure 33-14 and Figure 33-15. In the summing point type of the Basler DECS-450 OEL, a PI-type controller is used and the OEL output is added to the summing point of the voltage regulator. In addition to the summing point OEL described above, the DECS-450 has a takeover-style overexcitation limiter. It uses a PI-type controller. In this control scheme, the actual field current is compared with the OEL setpoint. In order to allow large field voltage due to transient response in the AVR loop, the actual field current is filtered before comparing with the OEL setpoint. The integrator of the OEL loop is reinitialized every 4 ms with the current excitation level if it is below the limit. When it is above the limit, the OEL limiter output becomes less than the AVR output, and the OEL takes over to control at a proper excitation level. When the OEL is active, the AVR loop stops integration and compares its output with the OEL output to get out of the OEL loop. Note that the  $I_{FD}$  per-unit base in the OEL model is the shunt rating programmed into the Basler DECS-450.

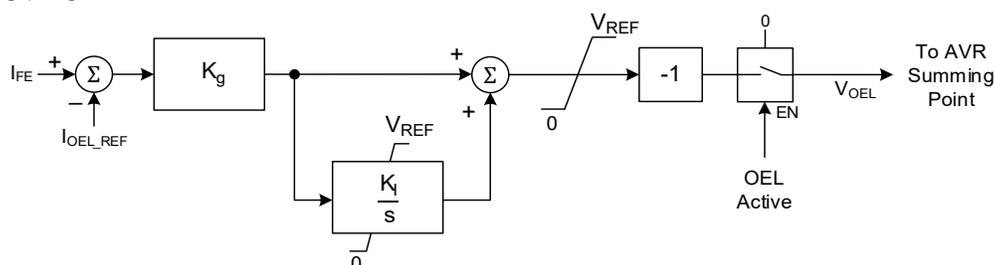


Figure 33-14. Per-Unit Summing Point-Type Overexcitation Limiter Block Diagram

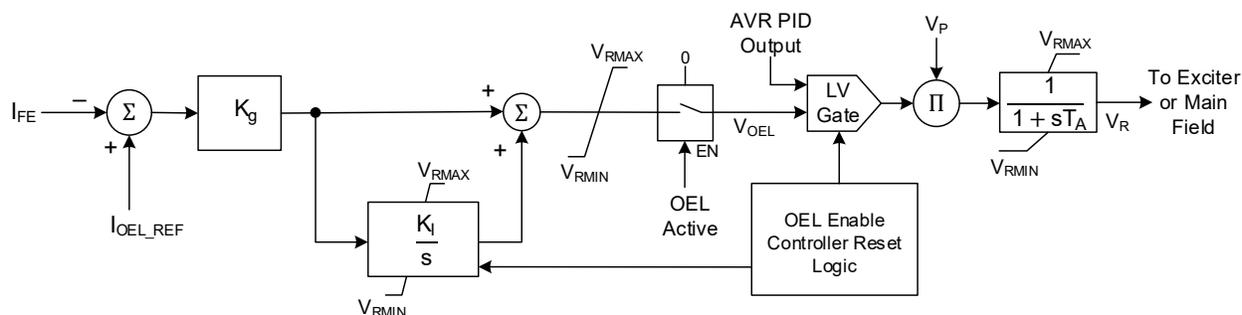


Figure 33-15. Per-Unit Takeover-Type Overexcitation Limiter Block Diagram

Two methods for calculating the field current reference for the OEL loop are implemented in the DECS-450. For the summing point OEL, the reference field current is calculated based on the user input parameters as shown in Figure 33-16. It approximates the field current short-time overload capability given in IEEE C50.13™. The low level (OEI3) is normally set just above the exciter's continuous field current rating. The OEL loop becomes inactive if field current lower than OEI3 is required by an external event. It is illustrated at time  $t_0$  in Figure 33-16.

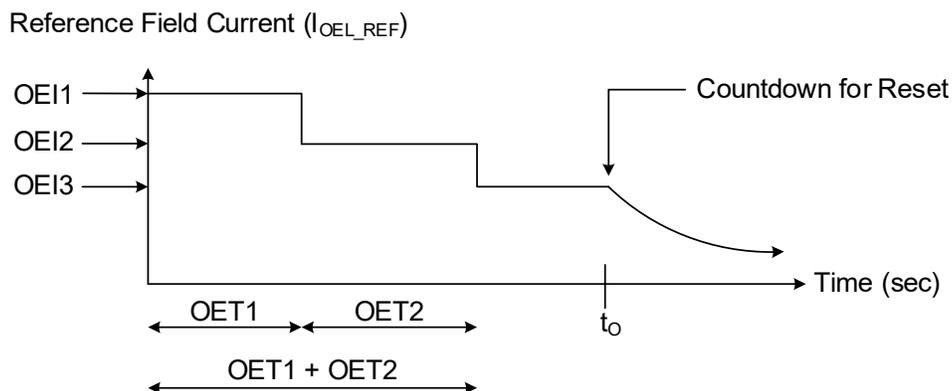


Figure 33-16. Overexcitation Limiter Reference for Summing Point Type

In the takeover OEL, the reference field current ( $I_{OEL\_REF}$ ) is calculated based on the inverse-time characteristic found in IEEE C37.112™. Input parameters from the user are as follows:

$I_{FD\_max}$ : Maximum allowed field current (OEL high level current)

$I_{FD\_min}$ : Maximum continuous field current (OEL low level current)

TD: Time dial setting.

The reference field current ( $I_{OEL\_REF}$ ) in per-unit is obtained by:

$$I_{OEL\_REF} = \frac{1}{192} * \left[ 490 - \left\{ \frac{-95.9 * (TD)}{Time} + 17.17 \right\}^2 \right] * I_{BASE}$$

where  $I_{BASE} = \frac{I_{FD\_min}}{1.03}$ . When the takeover OEL is active, the field current will be limited to follow the curve of the reference field current given by the equation above.

### Stator Current Limiter (SCL)

The stator current limiter (SCL) modifies the excitation level based on whether vars are being absorbed (leading) or exported (lagging) by the synchronous machine. Figure 33-17 shows the model of the stator current limiter. The SCL makes up the outer loop, and the voltage regulator makes up the inner loop. The PI-type controller is used to achieve a desired response. The sign (Q) is defined as positive (+1) for overexcitation and negative (-1) for underexcitation condition. This limiter may be modelled as a type SCL1C model.

The SCL current reference ( $I_{SCL\_REF}$ ) is generated based on a two-step waveform with a high current level ( $I_{high}$ ), a high current time ( $T_{high}$ ), and a low current level ( $I_{low}$ ) as shown in Figure 33-18.

The SCL loop becomes inactive if stator current lower than a low current level ( $I_{low}$ ) is required by an external event. It is illustrated at time  $t_0$  in Figure 33-18.

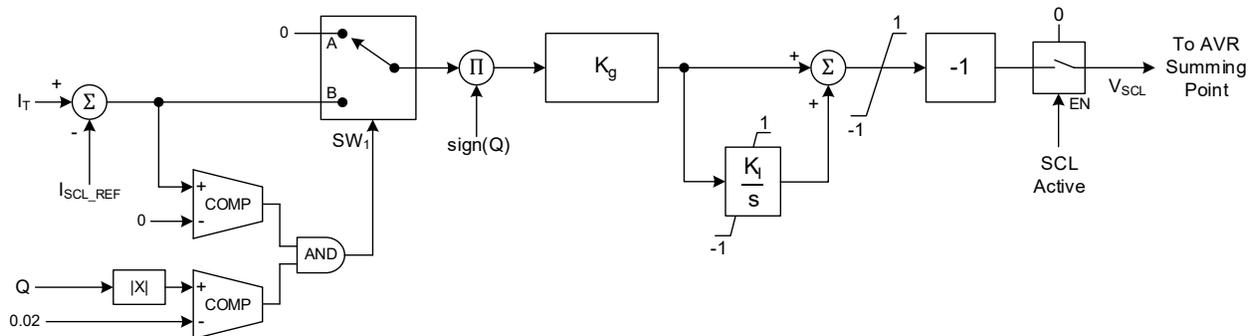


Figure 33-17. Per-Unit Stator Current Limiter Block Diagram

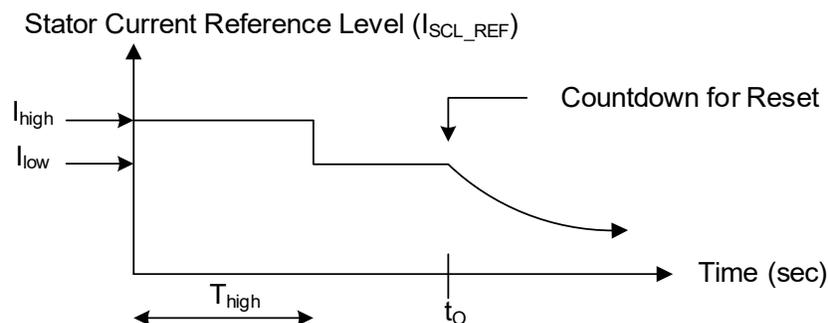
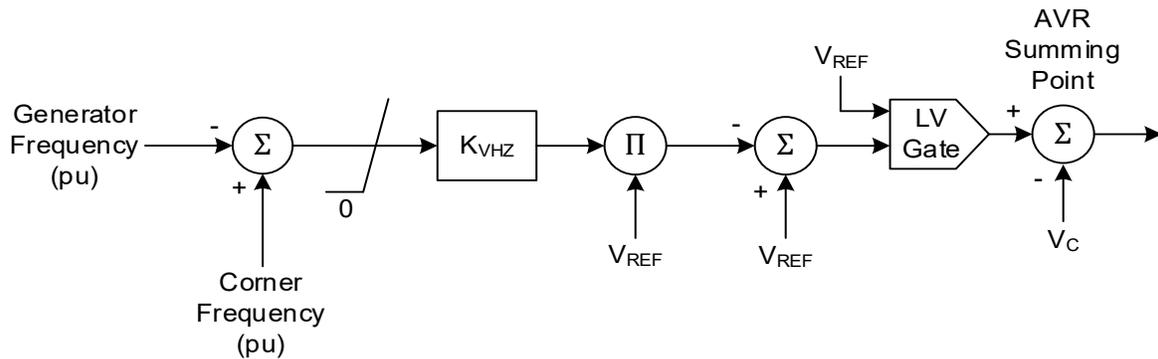


Figure 33-18. Stator Current Limiter Reference

## Volts-Per-Hertz (V/Hz) / Underfrequency (UF) Limiters

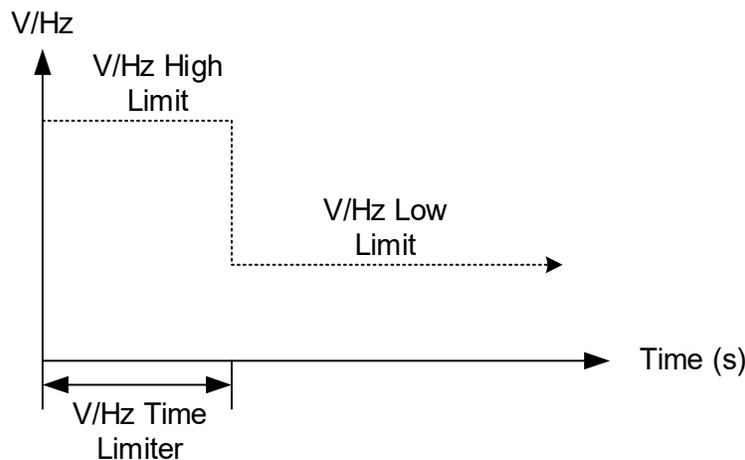
The volts-per-hertz and underfrequency limiters are implemented to prevent excessive magnetic flux from damaging the generator and any connected transformers during low frequency operation or overvoltage events.

The underfrequency limiter has been designed with an adjustable slope ( $K_{VHZ}$ ) from 0 pu to 3 pu [Volts/Hz]. When the system is in an underfrequency condition, the voltage reference is adjusted by the amount calculated based on two programmable parameters: the corner frequency and the volts-per-hertz slope. Its mathematical model is shown in Figure 33-19.



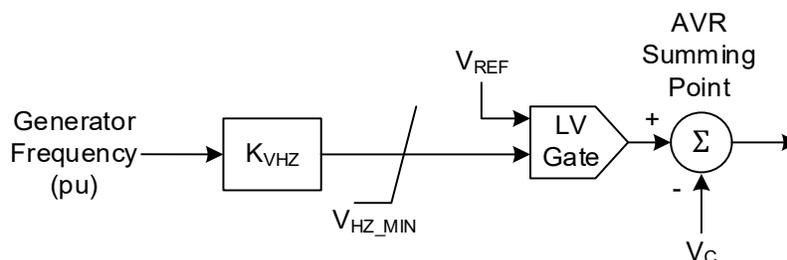
**Figure 33-19. Per-Unit Underfrequency Limiter Block Diagram**

As presented by Figure 33-20,  $K_{VHZ}$  is determined by a two-step waveform with a high limit setpoint and a low limit setpoint. These setpoints are available in BESTCOMSPlus®.



**Figure 33-20. Volts-per-Hertz Slope Selection**

The V/Hz limiter has been designed with an adjustable slope ( $K_{VHZ}$ ) from 0 pu to 3 pu [Volts/Hz]. When the system frequency and voltage are above the volts-per-hertz line, the setpoint is adjusted to maintain operation on the volts-per-hertz line. Its mathematical model is shown in Figure 33-21.



**Figure 33-21. Volts-per-Hertz Limiter**

## Var Limiter (varL)

The var limiter (varL) acts to limit the level of reactive power exported from the generator. A PI type controller is used and the varL output is subtracted from the summing point of the voltage regulator. A delay setting establishes a time delay between when the var threshold is exceeded and when the DECS-450 acts to limit the generator's exported reactive power level.

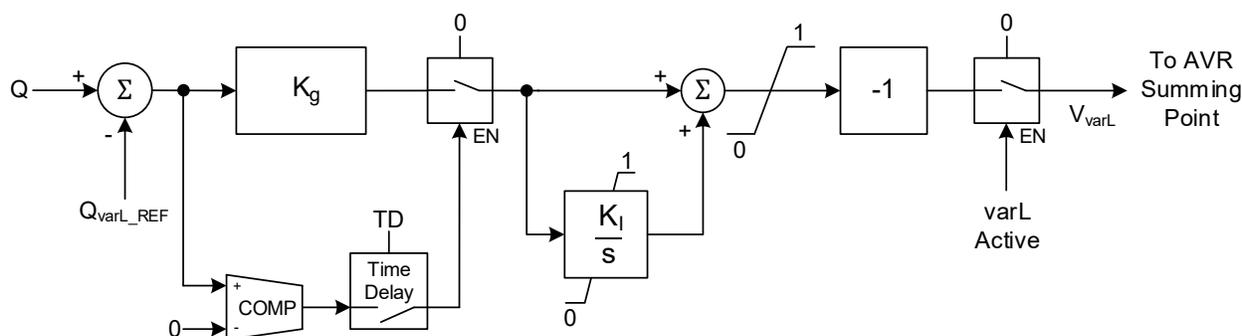


Figure 33-22. Per-Unit Block Diagram of the Var Limiter

## Soft Start Control

The soft start control function is provided to cause orderly build-up of terminal voltage from residual to the rated voltage in the desired time with minimal overshoot. In the Basler DECS-450, the fast dynamic response is used while the voltage reference is adjusted based on the elapsed time. When the system is under the startup condition, the voltage reference is adjusted by the amount calculated based on two programmable parameters: the initial soft start voltage level ( $V_0$ ) and the desired time to build up to the rated voltage ( $T_{SS}$ ). Its mathematical model is shown in Figure 33-23. The soft start gain ( $K_{SS}$ ) is calculated as follows:

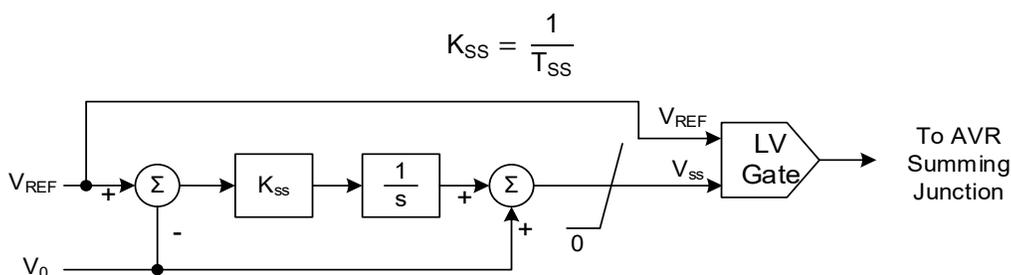


Figure 33-23. Per-Unit Soft Start Control Block Diagram

## Discontinuous Transient Excitation Boost

The transient boost function provides a means to potentially improve system response to successive faults by providing increased excitation support. If a simultaneous increase in line current above the fault current threshold and a decrease in line voltage below the fault voltage threshold occurs for a fixed amount of time, the regulator reference setpoint will be increased. Once the line voltage rises above the clearing voltage threshold for fixed duration, the regulator reference setpoint will be restored to the pre-fault value. Figure 33-24 shows the model of the transient boost function. The transient boost function output ( $V_{TB}$ ) is added to the summing point of the PID controller.

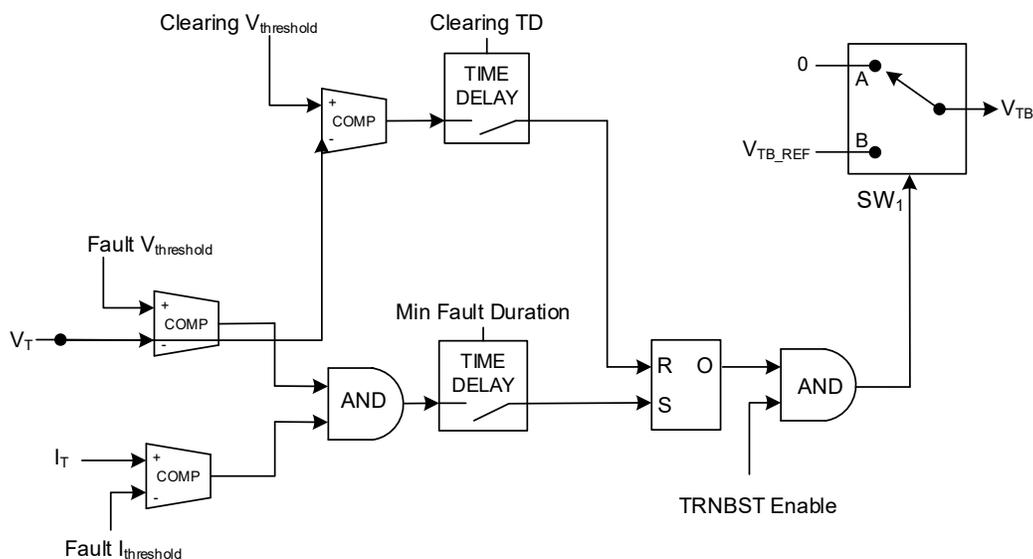


Figure 33-24. Per-Unit Transient Excitation Boost Block Diagram

## Field Current and Field Voltage Regulators

In the DECS-450, the field current and field voltage regulators are the same as that shown in Figure 33-5 with the following changes:

Field Current Regulator:

$V_C$  becomes  $I_{FE}$

$V_{REF}$  becomes  $I_{FE\_REF}$

Field Voltage Regulator:

$V_C$  becomes  $V_{FE}$

$V_{REF}$  becomes  $V_{FE\_REF}$

Also note the derivative terms  $K_D$  and  $T_D$  are typically set to zero for field current and field voltage regulation.

## Dual Input Power System Stabilizer (PSS)

The Basler power system stabilizer (PSS) is a dual input PSS that uses combinations of power and speed to derive the stabilizing signal. It is based on the type PSS2C model available in IEEE Std 421.5™-2016.

The PSS is designed to add damping to the generator rotor oscillations by controlling its excitation using a supplemental stabilizing signal. To supplement the generator's natural damping, it produces a component of electrical torque that opposes changes in rotor speed and introduces a signal proportional to measured rotor speed deviation into the automatic voltage regulator (AVR) input.

As depicted in Figure 33-25, the PSS monitors frequency and power to produce the integral of accelerating power, which is used for obtaining a derived speed deviation signal ( $\omega_{DEV}$ ). Filtering of the derived speed signal provides a phase lead at the electro-mechanical frequency of interest. This phase lead compensates for the phase lag introduced by the closed-loop voltage regulator. Prior to connecting the stabilizer output signal to the voltage regulator input, adjustable gain and limiting are applied as depicted in Figure 33-25.

The PSS performance is configured using filter time constants and software control switches. Figure 33-26 illustrates the detailed block diagram including the default position of each software switch and Table 33-1 contains the list of locations for the PSS variables displayed in BESTCOMSPlus.

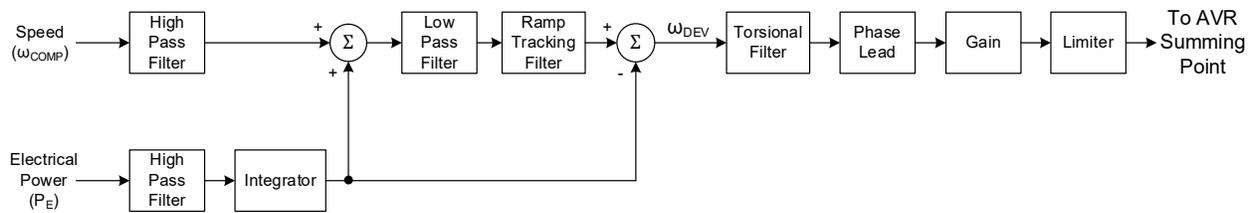


Figure 33-25. Functional Block Diagram of the PSS

## High-Pass Filtering and Integration

High-pass filtering is used to remove low frequency components from electrical power and rotor speed (or compensated frequency) signals. This ensures that the stabilizer does not alter the steady-state reference to the voltage regulator. High-pass filtering is implemented using time constants  $T_{w1}$ ,  $T_{w2}$ , and  $T_{L1}$ . Integration of the electrical power signal is accomplished using time constants ( $T_{w3}$ ,  $T_{w4}$  and  $T_{L2}$ ) and the rotor inertia constant  $H$ . The outputs of these are added together to obtain the integral of mechanical power deviation. Time constants  $T_{w1}$ ,  $T_{w2}$ ,  $T_{w3}$ , and  $T_{w4}$  are also called the washout time constants.

## Low-Pass/Ramp Tracking Filter

A fourth order low-pass filter processes the calculated mechanical power deviation signal. This filtering may be excessive for units with high rates of mechanical power change. An optional filter stage is provided to allow for ramp changes to the input mechanical power.

## Torsional Filter

The torsional filter provides desired gain reduction at the specified frequency. The filter is used to compensate the torsional frequency components present in the input signal. There are two stages of torsional filters that can be selected by SSW 4 and SSW 5.

## Phase Compensation

Filtering of the derived speed signal provides a phase lead at the electromechanical frequency of interest. As depicted in Figure 33-26, the derived speed signal is modified before it is applied to the voltage regulator input. The signal is filtered to provide phase lead at the electromechanical frequencies of interest (i.e., 0.1 Hz to 5.0 Hz). The phase lead requirement is site-specific and is required to compensate for phase lag introduced by the closed-loop voltage regulator. With switches SSW 2 and SSW 3 in the closed position, the derived speed deviation is used as the stabilizing signal. These software switches allow the user to select an alternate configuration based upon the available input signals. The first two lead-lag blocks are normally adequate to match the phase compensation requirements of a unit; however, two additional stages may be added by opening software switches SSW 6 and SSW 7. The transfer function for each stage of phase compensation is a simple pole-zero combination.

## Washout Filter and Logic Limiter

If software switch SSW 9 is set to its enabled position, the scaled PSS signal will be passed through an additional washout filter and logic limiter. The logic limiter allows for the user to automatically change the time constant of the washout filter if the signal from the washout filter exceeds either of the logic limiter's bounds for a user-defined amount of time. The logic limiter will instantaneously return the washout filter's time constant to its original value once the washout filter's output returns to within the bounds of the logic limiter.

## Terminal Voltage Limiter

If software switch SSW 9 is instead set to its disabled position, the scaled PSS signal will be passed through a limiter whose upper bound can be controlled based on the generator's terminal voltage. If the generator's terminal voltage rises above the terminal voltage level selected by the user in the PSS setting's while software switch SSW 8 is enabled, the PSS's terminal voltage limiter will act to reduce the upper limit of the PSS output signal at a fixed rate of  $-4\%$  per second until zero is reached or the overvoltage condition is no longer present. Once the overvoltage condition is no longer present, the upper

limit of the PSS output signal will increase at a rate of 2% per second until the upper limit returns to the user-defined setpoint. If software switch SSW 8 is disabled, then the scaled PSS signal will just be bound by the user-defined limits.

## Output Logic

If the PSS is not enabled; the real power level is below the kW threshold setpoint of the PSS; or the DECS-450 is not regulating in AVR mode, then the final PSS output will be equal to 0.

**Table 33-1. PSS Variable Names Used in BESTCOMSPlus® and Their Corresponding Location in Figure 33-26**

| Callout Number | BESTCOMSPlus® Variable | BESTCOMSPlus® Variable Name      |
|----------------|------------------------|----------------------------------|
| 1              | Ptest                  | Time Response Signal             |
| 2              | CompF                  | Compensated Frequency Deviation  |
| 3              | PssW                   | PSS Electric Power               |
| 4              | Vtmag                  | PSS Term Voltage                 |
| 5              | x2                     | Speed HP #1                      |
| 6              | WashW                  | Washed Out Speed                 |
| 7              | x5                     | Power HP #1                      |
| 8              | WashP                  | Washed Out Power                 |
| 9              | x7                     | Mechanical Power                 |
| 10             | x8                     | Mechanical Power LP #1           |
| 11             | x9                     | Mechanical Power LP #2           |
| 12             | x10                    | Mechanical Power LP #3           |
| 13             | x11                    | Mechanical Power LP #4           |
| 14             | MechP                  | Filtered Mechanical Power        |
| 15             | Synth                  | Synthesized Speed                |
| 16             | Tflt1                  | Torsional Filter #1              |
| 17             | x29                    | Torsional Filter #2              |
| 18             | x15                    | Lead-Lag #1                      |
| 19             | x16                    | Lead-Lag #2                      |
| 20             | x17                    | Lead-Lag #3                      |
| 21             | x31                    | Lead-Lag #4                      |
| 22             | Tvlpf                  | Terminal Voltage Low-Pass Filter |
| 23             | Tvrl                   | Terminal Voltage Ramp Limiter    |
| 24             | Llwf                   | Logic Limiter Washout Filter     |
| 25             | Prelim                 | Pre-Limit Output                 |
| 26             | Post                   | Post-Limit Output                |
| 27             | POut                   | Final PSS Output                 |

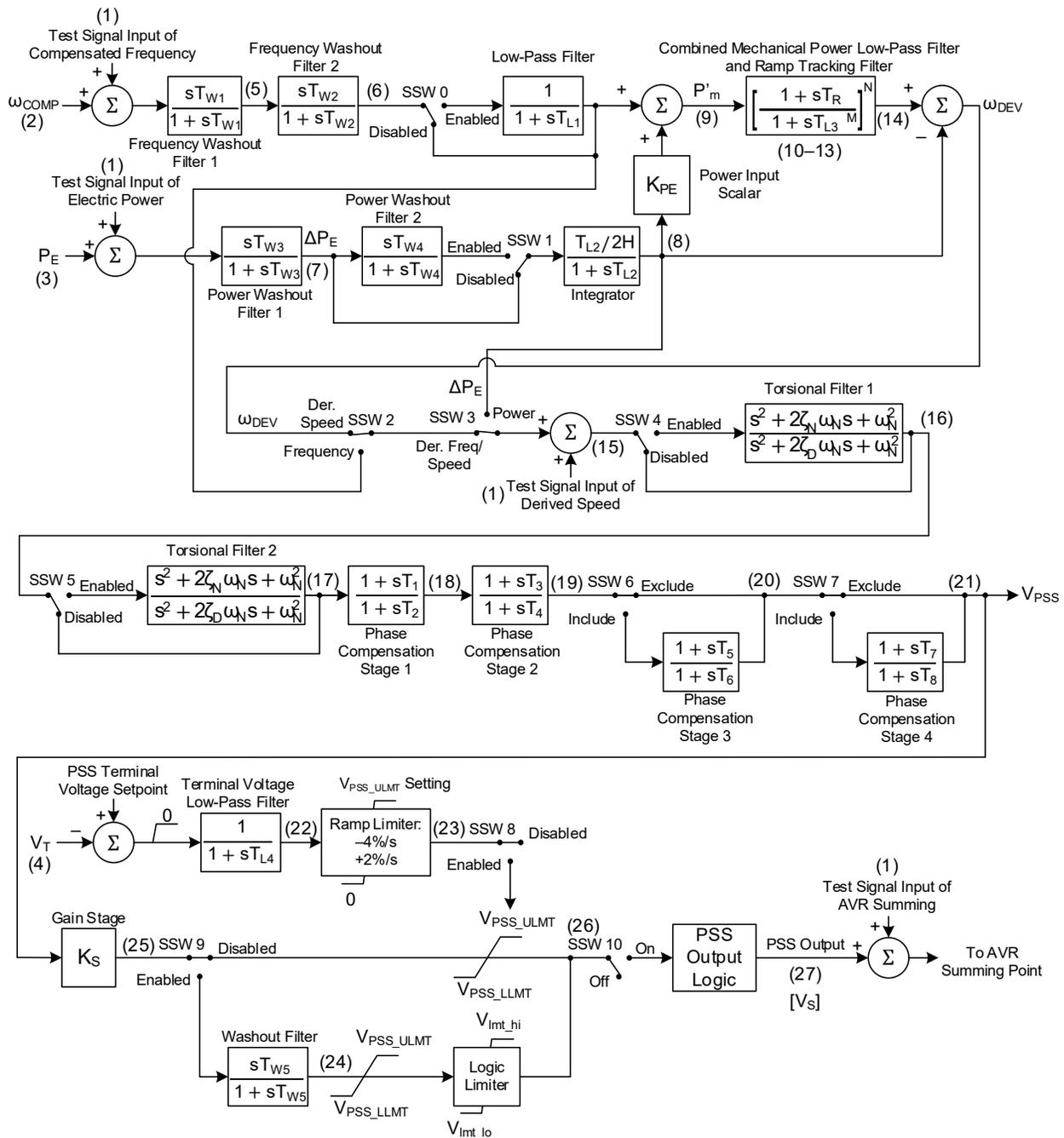


Figure 33-26. Detailed Block Diagram of the PSS

### PSS Blocking with Rate-of-Change (ROC) in Frequency

The PSS output is blocked when the rate-of-change (ROC) in the generator frequency is greater than the programmable level. Figure 33-27 provides a means to measure the rate-of-change of generator frequency. The absolute value of the measured rate-of-change is compared to a programmable threshold value ( $ROC_{THRESHOLD}$ ). If the absolute value of the measured rate-of-change is above the threshold and ROC is enabled, then the algorithm will begin counting. If the count exceeds a programmable timeout ( $ROC_{TD}$ ), then a ramp signal ( $K_{S\_SF}$ ) will be produced with a programmable blocking time duration ( $BLOCK_{TIME}$ ). The maximum ramp output becomes 1.0 after the blocking time duration. The PSS output is multiplied by the ramp signal.

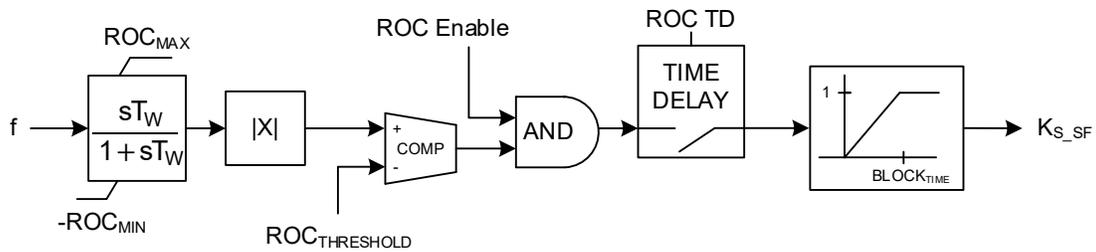


Figure 33-27. Per-Unit PSS Rate-of-Change Blocking Block Diagram

## Network Load Share (NLS) Using Cross-Current Compensation (CCC)

A cross-current compensation (CCC) implementation for network load share (NLS) is depicted in Figure 33-28.

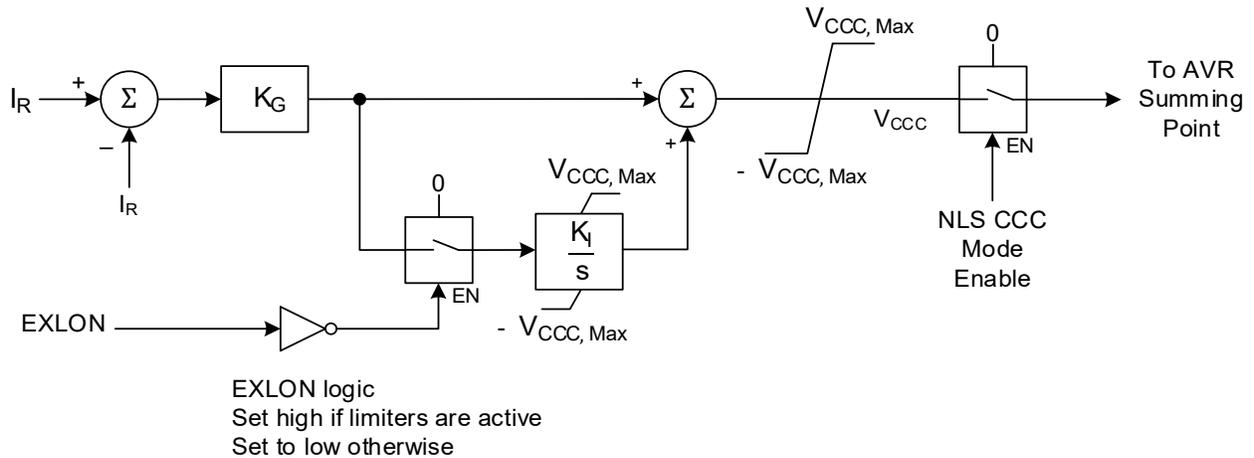


Figure 33-28. Per-Unit Network Load Share Cross-Current Compensation Block Diagram

The block diagram depicted in Figure 33-28 consists of a PI controller whose input is the difference between the reactive current of the target unit ( $I_R$ ) and the average reactive current of the other paralleled units ( $\bar{I}_R$ ). The NLS CCC output  $V_{CCC}$  is limited by the  $V_{CCC, Max}$  variable. If a limiter is active, the integral action of the NLS CCC controller is disabled.





Highland, Illinois USA  
Tel: +1 618.654.2341  
Fax: +1 618.654.2351  
email: [info@basler.com](mailto:info@basler.com)

Suzhou, P.R. China  
Tel: +86 512.8227.2888  
Fax: +86 512.8227.2887  
email: [chinainfo@basler.com](mailto:chinainfo@basler.com)