INSTRUCTION MANUAL

FOR

DECS-150

Digital Excitation Control System

B Basler Electric®

Preface

This instruction manual provides information about the installation and operation of the DECS-150 Digital Excitation Control System. To accomplish this, the following information is provided:

- General information
- Functional description
- Installation and connections
- BESTCOMS*Plus*® software
- Communication and configuration
- Testing and troubleshooting
- Specifications

Conventions Used in this Manual

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.

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Warning!
READ THIS MANUAL. Read this manual before installing, operating, or maintaining the DECS-150. 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.

Basler Electric does not assume any responsibility to compliance or noncompliance with national code, local code, or any other applicable code. This manual serves as reference material that must be well understood prior to installation, operation, or maintenance.
For terms of service relating to this product and software, see the *Commercial Terms of Products and Services* document available at www.basler.com/terms.
This publication contains confidential information of Basler Electric Company, an Illinois corporation. It is loaned for confidential use, subject to return on request, and with the mutual understanding that it will not be used in any manner detrimental to the interests of Basler Electric Company and used strictly for the purpose intended.
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.

Contents

Introduction

DECS-150 Digital Excitation Control Systems offer precise excitation control and machine protection in a compact package. DECS-150 adaptability to many applications is assured through configurable contact inputs and outputs, flexible communication capabilities, and programmable logic implemented with the provided BESTCOMS*Plus*® software.

Applications

The DECS-150 is intended for brushless ac synchronous generator applications. The DECS-150 controls the machine output through the application of regulated dc excitation power to the exciter field. The level of excitation power is based on the monitored voltage and current, and a regulation setpoint established by the user.

Excitation power is supplied from the DECS-150 by means of a filtered, switching power module that uses pulse-width modulation. It is capable of supplying 7 Adc (70°C ambient) continuously and 10 Adc (55°C ambient) continuously at nominal voltages of 63 or 125 Vdc. With nominal operating voltage applied, it has a forcing capability of 11 Adc for 10 seconds (70°C ambient) or 14 Adc for 10 seconds (55°C ambient).

Features and Functions

DECS-150 features and functions include:

- Four excitation control modes:
  - Automatic Voltage Regulation (AVR)
  - Field Current Regulation (FCR)
  - Power Factor Regulation (PF)
  - Var Regulation (var)
- Three pre-position setpoints for each excitation control mode
- Internal tracking between operating mode setpoints and optional external tracking of a second DECS excitation setpoint
- Two PID stability groups with Auto Tune feature
- Remote setpoint control input accepts analog voltage or current control signal
- Optional network load sharing
- Real-time metering
- Optional integrated power system stabilizer (PSS)
  - Generator or motor control modes, accommodates phase rotation changes between modes
  - Speed and power sensing or speed-only sensing
- Soft start and voltage buildup control
- Four limiting functions:
  - Overexcitation: summing point and takeover
  - Underexcitation
  - Stator current
  - Underfrequency
- Seventeen protection functions:
  - Generator undervoltage (27)
  - Generator overvoltage (59)
  - Loss of sensing (LOS)
  - Overfrequency (81O)
  - Underfrequency (81U)
  - Field overvoltage
  - Exciter diode failure
  - Sync-check (25)
  - Eight configurable protection elements

- Eight programmable contact-sensing inputs
- Three contact outputs
  - One, fixed-function output: Watchdog (SPDT configuration)
  - Two programmable outputs
- Flexible communication
  - Serial communication through optional front- or rear-panel USB port
  - Optional CAN communication for external setpoint tracking
  - Optional Modbus® communication through Modbus TCP
  - Ethernet communication through an RJ-45 port
- Data logging and sequence of events
- USB powered for programming via BESTCOMS*Plus* software

Package

A single, compact package contains all excitation control and power components.

The front panel provides local annunciation through light-emitting diodes (LEDs). Remote annunciation and control is provided through a flexible communication interface which accommodates Ethernet and USB.

Optional Features and Capabilities

DECS-150 optional features and capabilities are defined by a style number. The model number 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 defines the electrical characteristics and operational features available in the DECS-150.
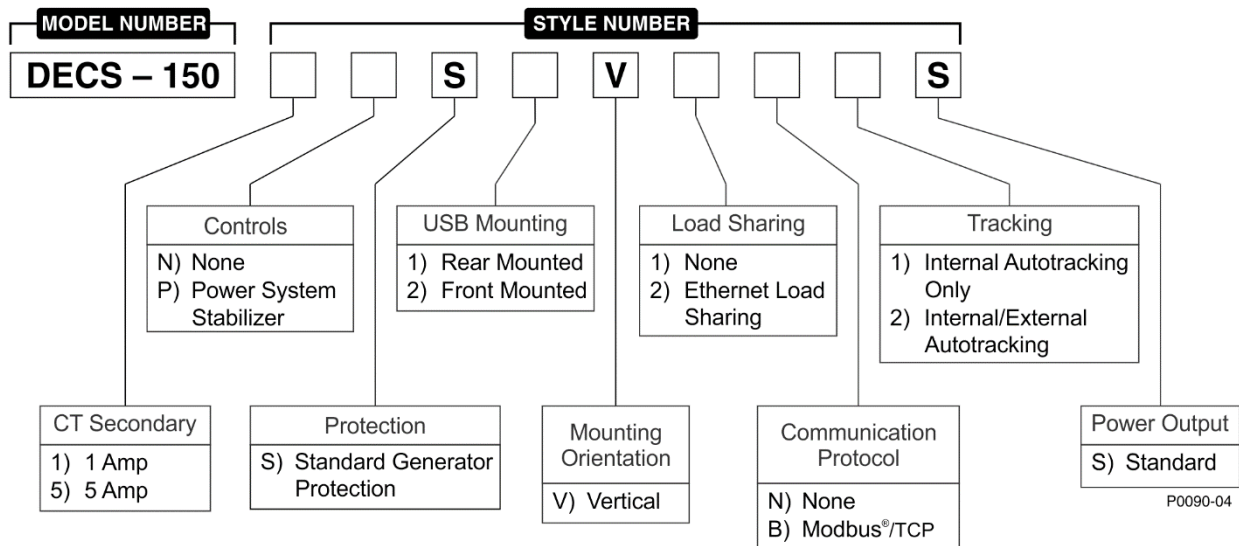
Figure 1. DECS-150 Style Chart

Storage

If a DECS-150 will not be placed in service right away, store it in the original shipping carton in a moisture- and dust-free environment. The temperature of the storage environment must be within the range of –40 to 85°C (–40 to 185°F).

Electrolytic Capacitor Considerations

The DECS-150 contains long-life aluminum electrolytic capacitors. For a DECS-150 kept in storage as a spare, the life of these capacitors can be maximized by energizing the device for 30 minutes once per year. Refer to the energizing procedures provided in the *Maintenance* chapter.

When energizing the DECS-150 from a low impedance source (such as a wall outlet), use of an Inrush Current Reduction Module (ICRM) is recommended to prevent damage to the DECS-150. For a detailed description of the Inrush Current Reduction Module, refer to Basler publication 9387900990. ICRM connections are illustrated in the *Typical Connections* chapter.
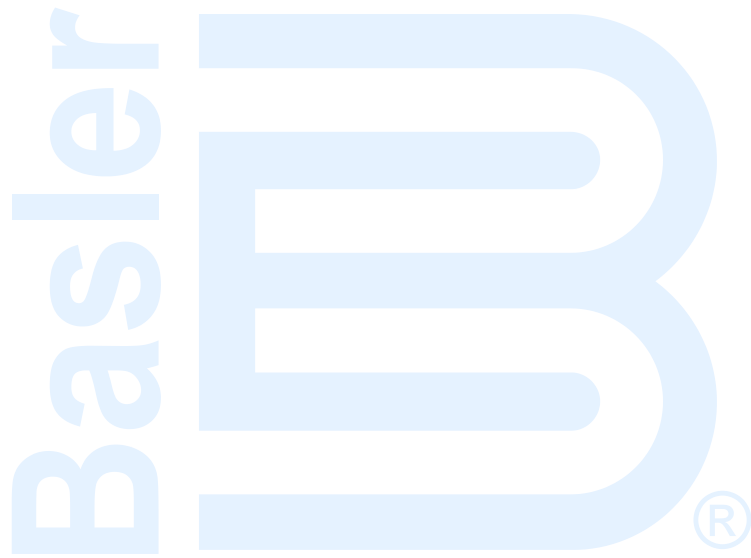
Front Panel

The DECS-150 front panel consists of 11 status LEDs. A USB port may be mounted on the front or rear panel of the DECS-150. Refer to the USB Mounting Option in the style chart in the *Introduction* chapter.

Front Panel Illustration and Description

DECS-150 indicators are illustrated in Figure 2 and described in Table 1.

Digital
Excitation
Control
System

Basler
DECS-150

○ Manual Mode Active
○ VAR/PF Active
● Loss of Generator Sensing
● Overexcitation Limter Active
● Underexcitation Limter Active
● Generator Overvoltage
● Overexcitaton Shutdown
● Underfrequency Active
● Exciter Field Current Limit
● PSS Active
● Custom Alarm

USB

P0074-73
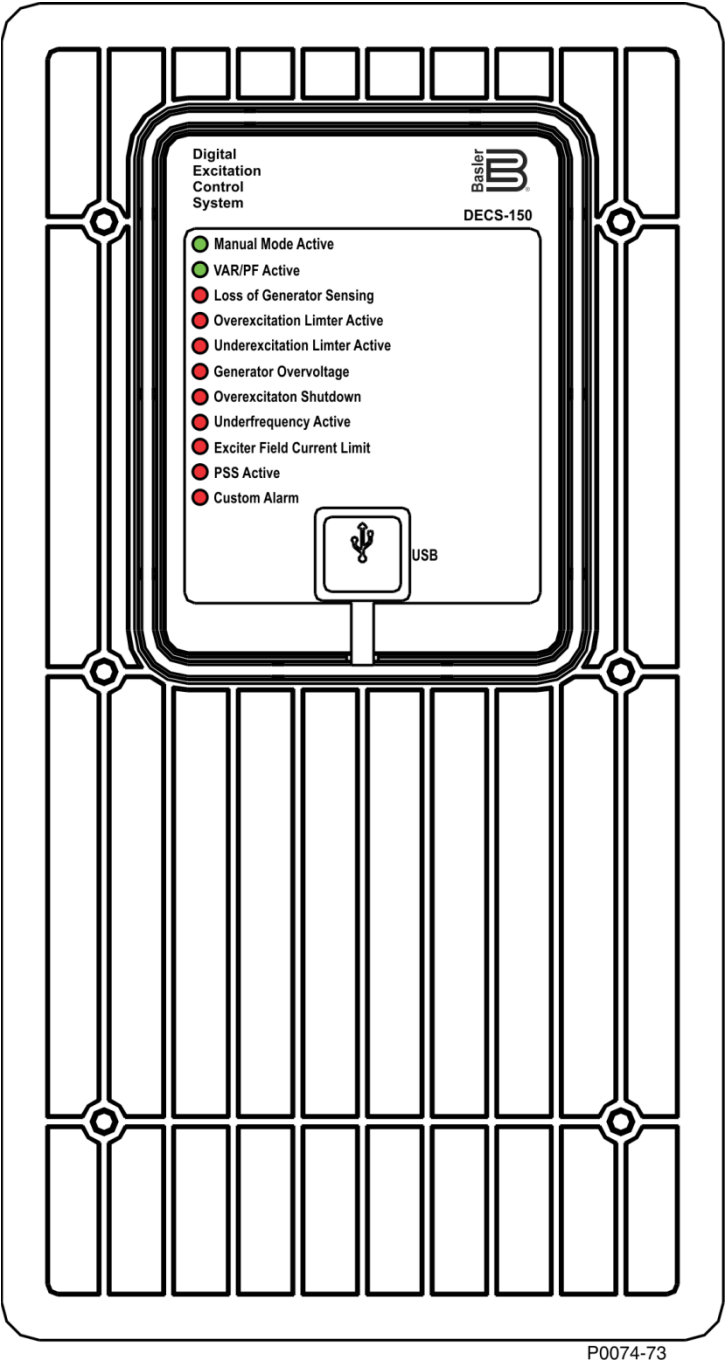
Figure 2. Front Panel Indicators

Table 1. Front Panel Indicators Descriptions

LED Name	LED Description
Manual Mode Active	This green LED lights when the DECS-150 is operating in Manual (FCR) mode. Manual mode is enabled through BESTCOMS*Plus*® software.
VAR/PF Active	This green LED lights when the DECS-150 is operating in either var or power factor mode. Var/power factor control is enabled through BESTCOMS*Plus* software. By default logic, Contact Input 7 (52 J/K) disables var/power factor control. An open contact enables the DECS-150 to control the generator reactive power in either the var or power factor mode. The contact has no effect when this function is not enabled in BESTCOMS*Plus*.
Loss of Generator Sensing	This red LED lights when a loss of generator sensing voltage is detected. In BESTlogic™*Plus*, status inputs can be connected to other logic elements and to a physical relay output to annunciate the condition and to initiate corrective action. Depending on the protective action selected, the DECS-150 will either shut down or transfer to Manual mode. The Loss of Generator Sensing LED will light for five seconds when the DECS-150 is powered up following a loss of generator sensing shutdown.
Overexcitation Limiter Active	This red LED lights when the field current exceeds the programmed overexcitation limit. It stays lit until the overexcitation condition ceases or the overexcitation time delay expires and the DECS-150 shuts down. The Overexcitation Limiter Active LED will light for five seconds when the DECS-150 is powered up following an overexcitation limiting shutdown.
Underexcitation Limiter Active	This red LED lights when the sensed, reactive power (leading vars) decreases below the programmed underexcitation limit. It stays lit until the underexcitation condition ceases or the underexcitation time delay expires and the DECS-150 shuts down. The Underexcitation Limiter Active LED will light for five seconds when the DECS-150 is powered up following an underexcitation limiting shutdown.
Generator Overvoltage	This red LED lights when generator output voltage exceeds the adjustable setpoint for the duration of the adjustable time delay. The DECS-150 shuts down (if hardware shutdown is enabled). In BESTlogic*Plus*, status inputs can be connected to other logic elements and to a physical relay output to annunciate the condition and to initiate corrective action. The Generator Overvoltage LED will light for five seconds when the DECS-150 is powered up following a generator overvoltage shutdown.
Overexcitation Shutdown	This red LED flashes when the field voltage exceeds the field overvoltage pickup threshold for the duration of the time delay. After the time delay expires, this red LED will light continuously and the DECS-150 will shut down. The Overexcitation Shutdown LED will light for five seconds when the DECS-150 is powered up following an overexcitation shutdown.
Underfrequency Active	This red LED lights when the generator frequency decreases below the underfrequency setpoint and the DECS-150 is regulating on the selected volts per hertz curve.
Exciter Field Current Limit	This red LED lights when the field current is too high, which could result in damage to the regulator. This condition also shuts down excitation. A restart is required to begin regulating again.
PSS Active	This red LED lights when the optional integrated power system stabilizer (PSS) is enabled and can generate a stabilizing signal in response to power system disturbances.
Custom Alarm	This red LED lights when the Set input of the CUSTOM_LED logic element is true. Refer to the *BESTlogicPlus* chapter for more information.

USB Port

This type B USB jack connects the DECS-150 with a PC operating BESTCOMS*Plus* for local communication. BESTCOMS*Plus* is supplied with the DECS-150.

Caution
In accordance with the guidelines defined in USB standards, the USB port on this device is not isolated. To prevent damage to a connected PC or laptop, the DECS-150 must be properly tied to ground.

Power Input and Output

Power Input

The DECS-150 uses the operating power input as the source for the converted excitation power that it applies to the field.

Operating Power

Power input terminals are labeled 3, 4, 5, and GND. Single-phase or three-phase power may be applied. Single-phase power may be applied to any two of the three terminals.

The DECS-150 can be powered directly from a variety of sources as long as the DECS-150 input power specifications are followed (see the *Specifications* chapter).

Examples of DECS-150 operating power sources are:

- Generator (shunt fed)
- Permanent magnet generator (PMG)
- Auxiliary winding

To achieve the desired level of excitation, the appropriate operating power input voltage must be applied. Table 2 lists the acceptable operating power voltage ranges for the DECS-150. The operating power frequency range for the DECS-150 is 50 to 500 hertz for all voltages.

Table 2. DECS-150 Operating Power Specifications

Desired Nominal Excitation Power Voltage	Applied Operating Power Voltage Range
63 Vdc	100 to 139 Vac, or 125 Vdc
125 Vdc	190 to 277 Vac, or 250 Vdc

Inrush Current Reduction Module (ICRM)

During DECS-150 power-up, the optional ICRM prevents damage to the DECS-150 by limiting inrush current to a safe level. When operating power is applied to the DECS-150, the ICRM limits the inrush current by adding a high level of resistance between the DECS-150 and the power source. Once the inrush current subsides, the series resistance diminishes quickly to allow nominal, steady-state current flow.

Caution
To prevent damage to the DECS-150, the use of the ICRM is recommended when using a low impedance source, such as a wall outlet.

For a detailed description of the Inrush Current Reduction Module, refer to Basler publication 9387900990. ICRM connections are illustrated in the *Typical Connections* chapter.

Power Output

The power output supplies regulated dc excitation power to the field of a brushless exciter. Excitation power is supplied at terminals F+ and F–.

The DECS-150 power output supplies excitation power by means of a filtered, switching power module that uses pulse-width modulation. It is capable of supplying 7 Adc (70°C ambient) continuously or 10 Adc (55°C ambient) continuously at nominal voltages of 63 or 125 Vdc. With nominal operating voltage applied, it has a forcing capability of 11 Adc for 10 seconds (70°C ambient) or 14 Adc for 10 seconds (55°C ambient).

Voltage and Current Sensing

The DECS-150 senses generator voltage, generator current, and bus voltage through dedicated, isolated inputs.

Generator Voltage

Three-phase generator sensing voltage is applied to DECS-150 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 600 Vac and has a burden of less than 1 VA.

The transformer primary and secondary winding voltages are entered in settings that the DECS-150 uses to interpret the applied sensing voltage and calculate system parameters. The phase rotation of the generator sensing voltage can be configured as ABC or ACB. Information about configuring the DECS-150 for the generator sensing voltage is provided in the *Configuration* chapter.

Typical generator voltage sensing connections are illustrated in Figure 3.
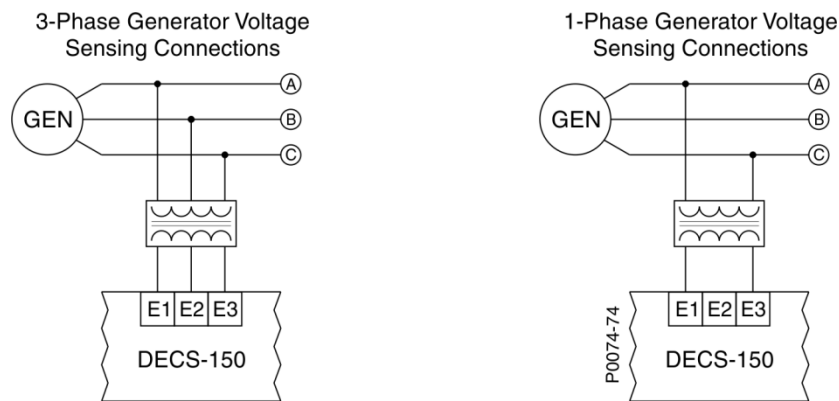
Figure 3. Typical Generator Voltage Sensing Connections

Generator Current

Generator current sensing inputs consist of three phase-sensing inputs and a sensing input for cross-current compensation.

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

Phase Sensing

Three-phase generator sensing current is applied to DECS-150 terminals IA+ and IA–, IB+ and IB–, and IC+ and IC– through user-supplied current transformers (CTs). Single-phase generator sensing current is applied to DECS-150 terminals IB+ and IB–. The DECS-150 is compatible with CTs having 5 Aac or 1 Aac nominal secondary ratings. The DECS-150 uses this secondary rating, along with the CT nominal primary ratings to interpret the sensed current and calculate system parameters. Information about configuring the DECS-150 for the generator sensing voltage is provided in the *Configuration* chapter of this manual. Typical generator phase-current sensing connections are shown in Figure 4.
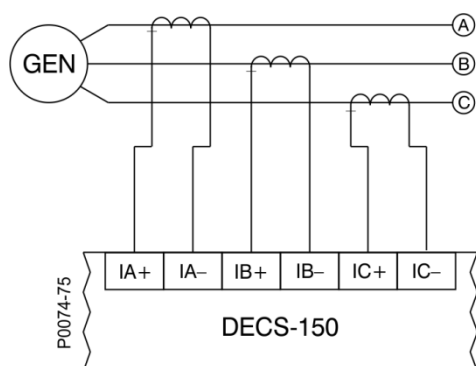
NOTES
1. If only one CT is used, connect it to B-phase.
2. Three-phase current sensing is required for PSS applications.

Figure 4. Typical Generator Current Sensing Connections

Cross-Current Compensation

Cross-current compensation (reactive differential) mode allows two or more paralleled generators to share a common reactive load. As shown in Figure 5, each generator is controlled by a DECS-150 using the DECS-150 cross-current compensation input (terminals CC+ and CC–) and a dedicated, external current transformer (CT) to sense generator current. The resistors shown in Figure 5 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.
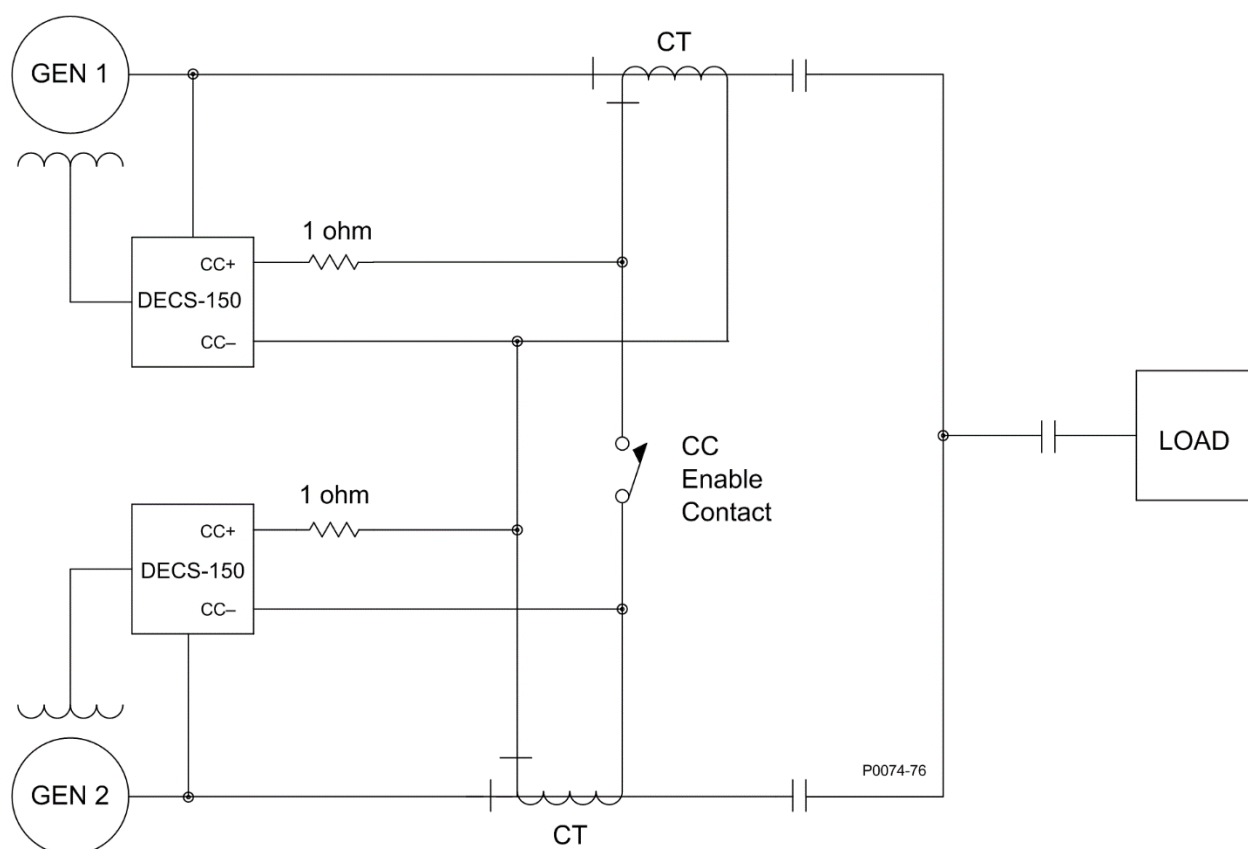
Figure 5. Connections for Cross-Current Compensation

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.

Bus Voltage

Bus voltage monitoring enables bus failure detection and a 25 sync-check element, along with generator and bus voltage matching. Three-phase bus sensing voltage is applied to DECS-150 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 600 Vac and has a burden of less than 1 VA.

The transformer primary and secondary winding voltages are entered in settings that the DECS-150 uses to interpret the applied sensing voltage. Information about configuring the DECS-150 for the bus sensing voltage is provided in the *Configuration* chapter of this manual.

Typical bus voltage sensing connections are illustrated in Figure 6.
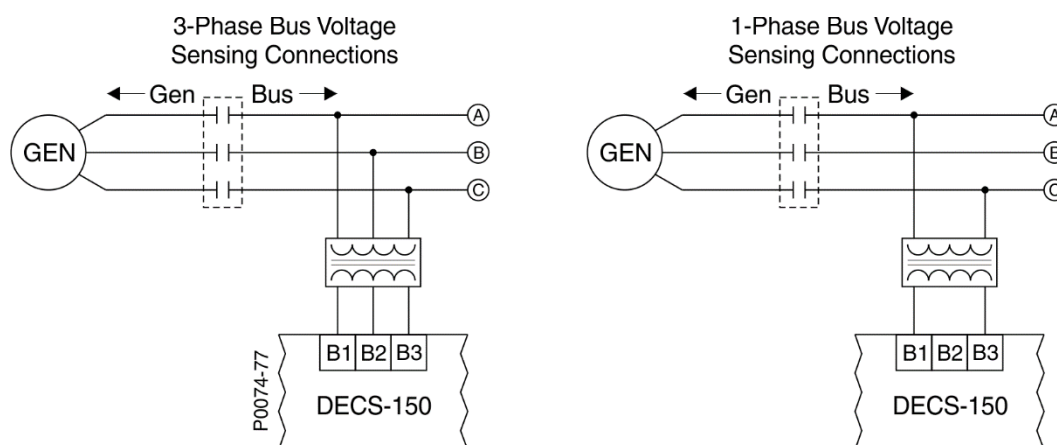
Figure 6. Typical Bus Voltage Sensing Connections

Regulation

The DECS-150 precisely regulates the level of supplied excitation power in each of the four available regulation modes. 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-150 to be configured for multiple system and application needs.

Regulation Modes

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, AVR/FCR and VAR/PF

The DECS-150 provides four regulation modes: Automatic Voltage Regulation (AVR), Field Current Regulation (FCR), var, and Power Factor (PF).

AVR

When operating in AVR (Automatic Voltage Regulation) mode, the DECS-150 regulates the excitation level in order to maintain the generator terminal voltage setpoint despite changes in load and operating conditions. AVR setpoint (or operating point) adjustment is made through any one of the following methods:

- Application of contacts at DECS-150 contact inputs configured for raising and lowering the active setpoint
- Application of an analog control signal at the DECS-150 Auxiliary Control input.
- The BESTCOMS*Plus* Control Panel screen (available in the BESTCOMS*Plus*® Metering Explorer)
- A raise or lower command transmitted through the DECS-150 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/FCR Setpoints screen is illustrated in Figure 7. Setting ranges and defaults are summarized in Table 3.

FCR

When operating in FCR (Field Current Regulation) mode, the DECS-150 regulates the level of current it supplies 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 any one of the following methods:

- Application of contacts at DECS-150 contact inputs configured for raising and lowering the active setpoint
- Application of an analog control signal at the DECS-150 Auxiliary Control input
- The BESTCOMS*Plus*® Control Panel screen (available in the BESTCOMS*Plus* Metering Explorer)
- A raise or lower command transmitted through the DECS-150 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 AVR/FCR Setpoints screen is illustrated in Figure 7. Setting ranges and defaults are summarized in Table 3.

Figure 7. AVR/FCR Setpoints Screen

Table 3. AVR/FCR Settings

Setting	Range	Default
AVR Setpoint	Based on the rated generator voltage and limited by the AVR Min and Max settings.	120 V
AVR Min	70 to AVR Max setting in 0.1% increments	70%
AVR Max	AVR Min setting to 120% in 0.1% increments	120%
AVR Traverse Rate	1 to 200 s in 1 s increments	20 s
FCR Setpoint	Based on the rated current − full load and limited by the FCR Min and Max settings.	0.1 A
FCR Min	0 to FCR Max setting in 0.1% increments	0%
FCR Max	FCR Min setting to 120% in 0.1% increments	120%
FCR Traverse Rate	1 to 200 s in 1 s increments	20 s

Var

When operating in var mode, the DECS-150 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 any one of the following methods:

- Application of contacts at DECS-150 contact inputs configured for raising and lowering the active setpoint
- Application of an analog control signal at the DECS-150 Auxiliary Control input
- The BESTCOMS*Plus* Control Panel screen (available in the BESTCOMS*Plus* Metering Explorer)
- A raise or lower command transmitted through the DECS-150 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 var/PF Setpoints screen is illustrated in Figure 8. Setting ranges and defaults are summarized in Table 4.

Power Factor

When operating in Power Factor (PF) mode, the DECS-150 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-150 is operating in var or Power Factor regulation modes. PF Active Power Level establishes the level of

generator output power (kW) where the DECS-150 switches to/from Droop Compensation/Power Factor mode. If the level of power decreases below the setting, the DECS-150 switches from Power Factor mode to Droop Compensation mode. Conversely, as the level of power increases above the setting, the DECS-150 switches from Droop Compensation mode to Power Factor mode. A setting of 0 to 30% may be entered in 0.1% increments.

The var/PF Setpoints screen is illustrated in Figure 8. Setting ranges and defaults are summarized in Table 4.

Figure 8. Var/PF Setpoints Screen

Table 4. Var/PF Settings

Setting	Range	Default
Fine Voltage Adjustment Band	0 to 30% in 0.01% increments	20%
PF Active Power Level	0 to 30% in 0.1% increments	0%
var Setpoint	Based on the generator ratings and limited by the var Min and var Max settings.	0 kvar
Var Min	−100 to var Max setting in 0.1% increments	0%
Var Max	Var Min setting to 100% in 0.1% increments	100%
Var Traverse Rate	1 to 200 s in 1 s increments	20 s
PF Setpoint	Determined by the PF Leading and Lagging settings.	1
PF Leading	−1 to −0.5 in increments of 0.001	−0.8
PF Lagging	0.5 to 1 in increments of 0.001	0.8
PF Traverse Rate	1 to 200 s in 1 s increments	20 s

Pre-Position Setpoints

Each regulation mode has three pre-position setpoints which allow the DECS-150 to be configured for multiple system and application needs. Each pre-position setpoint can be assigned to a programmable contact input. When the appropriate contact input is closed, 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 length of time required to adjust from one preposition setpoint to another is controlled by the Traverse Rate setting. A setting of zero (0) implements an instantaneous step.

Mode

The Mode setting determines whether or not the DECS-150 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 are ignored while the appropriate contact input is closed. 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 var and PF modes are illustrated in Figure 9. (Pre-Position Setpoints for AVR and FCR modes are similar and not shown here.) Setting ranges and defaults are summarized in Table 5.
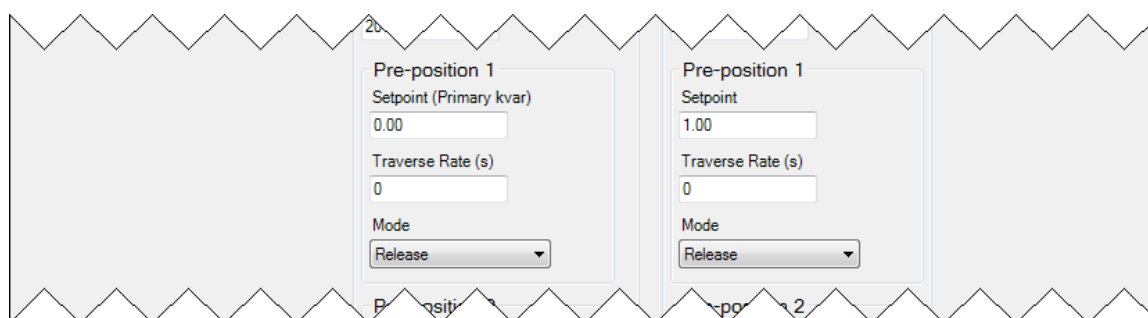
Figure 9. Pre-Position Setpoints

Table 5. Pre-Position Settings

Setting	Range	Default
Setpoint	Based on the generator ratings and limited by the var Minimum and var Maximum settings.	0 kvar
Traverse Rate	0 to 200 s in 1 s increments	0 s
Mode	Release or Maintain	Release

Operation with Paralleled Generators

The DECS-150 can be used to control the excitation level of two or more generators operating in parallel so that the generators share the reactive load. The DECS-150 can employ either droop compensation or cross-current compensation (reactive differential) schemes for reactive load sharing.

The Parallel/Line Drop Compensation screen is illustrated in Figure 10. Setting ranges and defaults are summarized in Table 6.

Droop Compensation

Droop compensation serves as a method of controlling reactive current when the generator is connected in parallel with another energy source. Droop compensation utilizes the B-phase CT. 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.

By default logic, closing Contact Input 6 (52 L/M) disables parallel operation. An open contact enables parallel operation and the DECS-150 operates in reactive droop compensation mode.

Note
For droop compensation to operate, the PARALLEL_EN_LM logic block must be set true in BESTlogic*Plus* programmable logic.

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-150 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 1 is used to calculate the Line Drop Value.

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

Equation 1. Line Drop Value

LD$_{Value}$ =   Line drop value (per unit)
V$_{avg}$ =   Average voltage, metered value (per unit)
LD   =   Line Drop % / 100
I^{avg} =   Average Current, metered value (per unit)
I$_{bang}$ =   Angle of phase B current (no compensation)

The LD$_{Value}$ is the per-unit value seen down the line from the generator. Equation 2 is used to determine the voltage needed to adjust for line drop.

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

Equation 2. Voltage Needed to Adjust for Line Drop

Equation 3 is used to obtain primary units.

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

Equation 3. Obtain Primary Units

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

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

Equation 4. Line Drop Adjusted Setpoint

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-150 cross-current compensation input (terminals IB+ and IB–). Improper 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-150 to respond with the proper level of regulation. The response of the DECS-150 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* chapter of this manual.

Network Load Sharing

In a multiple-generator application, the 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-150 controllers is accomplished through the Ethernet port of each DECS-150 communicating over a peer-to-peer network dedicated for the load sharing function. Each DECS-150 measures the reactive current of its associated generator and broadcasts its measurement to all other DECS-150 controllers on the network. Each DECS-150 compares its level of reactive current to the sum of all measured currents and adjusts its excitation level accordingly.

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.

A Load Share ID setting identifies the DECS-150 as a load sharing unit in the network. Checking a Load Sharing Unit number box allows any DECS-150 load sharing units on the network with that Load Share ID number to share load with the currently connected DECS-150. It is not necessary for the Load Share ID to be unique for each unit. This allows for load sharing units to be grouped.

Load sharing settings consist of an Enable checkbox and Droop, Gain, and Load Share ID settings.

Figure 10. Parallel/Line Drop Compensation Screen

Table 6. Parallel/Line Drop Compensation Settings

Setting	Range	Default
Droop Compensation Enable	Checked (enabled) or unchecked (disabled)	Disabled
Reactive Droop Compensation	0 to 30% in 0.1% increments	5%
Line Drop Compensation Enable	Checked (enabled) or unchecked (disabled)	Disabled

Setting	Range	Default
Line Drop Compensation	0 to 30% in increments of 0.1%	5%
Cross Current Compensation Enable	Checked (enabled) or unchecked (disabled)	Disabled
Cross Current Compensation Gain	−30 to 30% in 0.1% increments	0%
Load Share Enable	Checked (enabled) or unchecked (disabled)	Disabled
Load Share Droop	0 to 30% in 0.1% increments	0%
Load Share Gain	0 to 1,000 in increments of 0.01	0
Configuration Mismatch Delay	0.2 to 10 s in 0.1 s increments	0.5
Load Share ID	1 to 16 in increments of 1	1

Autotracking

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, Autotracking

Internal regulation mode setpoint tracking is a standard feature on the DECS-150. External setpoint tracking is optional (style xxxxxxx2). The Auto Tracking screen is illustrated in Figure 11. Setting ranges and defaults are summarized in Table 7.

Internal Setpoint Tracking

In applications using a single DECS-150, internal tracking can be enabled so that the inactive regulation modes 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. Autotracking minimizes the impact that a loss of sensing condition has on the exciter's ability to maintain the proper excitation level.
- While performing routine testing of the DECS-150 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. The Delay setting determines the time delay between a large system disturbance and the start of setpoint tracking. The Traverse Rate setting configures the length of time 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-150 can provide backup excitation control. The DECS-150 (style xxxxxxx2) allows for excitation redundancy by providing external tracking and transfer provisions between DECS-150 controllers. The secondary DECS-150 can be configured to track the primary DECS-150 setpoint. Proper redundant excitation system design allows for removal of the failed system.

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

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

Figure 11. Autotracking Screen

Table 7. Autotracking Settings

Setting	Range	Default
Internal Tracking Enabled	Checked (enabled) or unchecked (disabled)	Disabled
Internal Tracking Delay	0 to 8 s in 0.1 s increments	0.1 s
Internal Tracking Traverse Rate	1 to 80 s in 0.1 s increments	20 s
External Tracking Enabled	Checked (enabled) or unchecked (disabled)	Disabled
External Tracking Delay	0 to 8 s in 0.1 s increments	0.1 s
External Tracking Traverse Rate	1 to 80 s in 0.1 s increments	20 s

Setpoint Configure

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, Setpoint Configure

When the Auto Save setting is enabled, the DECS-150 automatically saves the active, externally driven, raise/lower, pre-position, and tracking setpoints in ten-minute intervals. Otherwise, the setpoint which was last sent to the DECS-150 via BESTCOMS*Plus* is retained. The Setpoint Configure screen is illustrated in Figure 12.

Figure 12. Setpoint Configure Screen

Voltage Matching

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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 Band setting defines the window in which the generator voltage must be for voltage matching to occur.

The Gen to Bus PT Match Level setting is provided to compensate for step-up or step-down transformers in the system. The DECS-150 adjusts the sensed generator voltage by this percentage.

The Voltage Matching screen is illustrated in Figure 13. Setting ranges and defaults are summarized in Table 8.

Figure 13. Voltage Matching Screen

Table 8. Voltage Matching Settings

Setting	Range	Default
Voltage Matching Enabled	Checked (enabled) or unchecked (disabled)	Disabled
Band	0 to 20% in 0.01% increments	0.5%
Gen to Bus PT Match Level	0 to 700% in 0.1% increments	100%
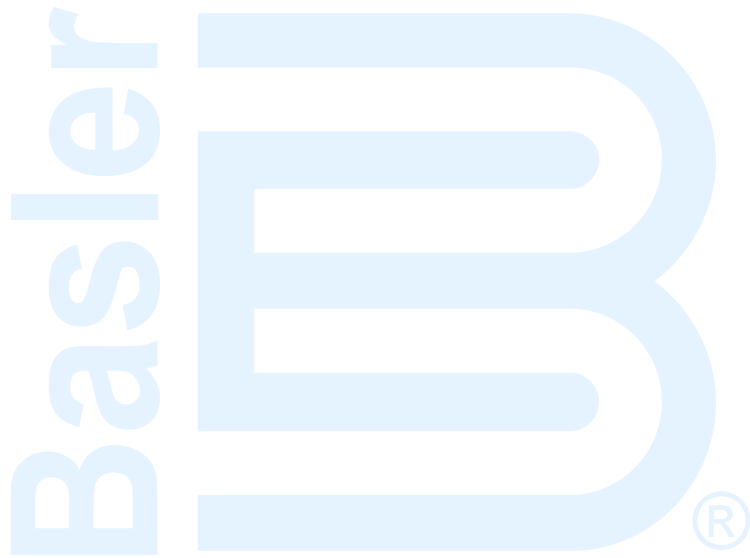
Auxiliary Control

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, Auxiliary Input

The DECS-150 accepts an external analog control signal for auxiliary control of the regulation setpoint. Auxiliary setpoint control is possible in all regulation modes: AVR, PF, Var, and FCR. The control signal can also be used for power system stabilizer control.

The Auxiliary Input screen is illustrated in Figure 14. Setting ranges and defaults are summarized in Table 9.

Figure 14. Auxiliary Input Screen

Table 9. Auxiliary Input Settings

Setting	Range	Default
Input Type	Voltage or Current	Voltage
Input Function	DECS Input or PSS Test Input	DECS Input
With Limit	Checked (enabled) or unchecked (disabled)	Disabled
Summing Type	Inner Loop or Outer Loop	Inner Loop
AVR (Mode) Gain	−99 to 99 in 0.01 increments	0
FCR (Mode) Gain	−99 to 99 in 0.01 increments	0
Var (Mode) Gain	−99 to 99 in 0.01 increments	0
PF (Mode) Gain	−99 to 99 in 0.01 increments	0

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 mAdc signal. Terminals V+ and V− accept a −10 to +10 Vdc signal. The input type is selected in BESTCOMS*Plus*®.

Auxiliary Control Input Function

The analog control input can be used for auxiliary control of the regulation setpoint or as a power system stabilizer test input.

PSS Test Input

The auxiliary control input can be used for control of the optional power system stabilizer function during testing and validation. More information is provided in the *Power System Stabilizer* chapter.

Setpoint Limits

Minimum and maximum setpoint limits are observed when the With Limit box is checked.

Auxiliary Control Gains

When a current input type is selected, the input current is converted internally by the DECS-150 into a voltage signal in the range of –10 to +10 Vdc. The DECS-150 uses the following equation 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 5. 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.

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.

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

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 field current.

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

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).

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

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 and FCR modes. Selecting the outer loop limits auxiliary control to PF and Var modes.

Contact Inputs and Outputs

Eight internally-wetted, contact-sensing inputs are available for initiating DECS-150 actions. Three sets of output contacts provide annunciation and control.

Contact Inputs

BESTCOMS*Plus* Navigation Path: Settings Explorer, Programmable Inputs, Contact Inputs

Eight programmable contact inputs are provided for initiating DECS-150 actions. All inputs have pre-assigned default logic. Refer to the BESTlogic™*Plus* chapter for contact input assignments.

All contact inputs are compatible with dry relay/switch contacts. Each contact input has an interrogation voltage and current of 12 Vdc at 1.2 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.

The eight programmable inputs can be connected to monitor the status of excitation system contacts and switches. Then, using BESTlogic*Plus* programmable logic, these inputs can be used as part of a user-configured logic scheme 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 *BESTlogicPlus* chapter.

To make the programmable contact inputs easier to identify, you can assign a custom name (up to 64 alphanumeric characters) that relates to the inputs/functions of your system. Figure 15 shows the BESTCOMS*Plus*® Contact Inputs screen with the pre-assigned labels shown.

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

Figure 15. Contact Input Label Text

Contact Outputs

BESTCOMS*Plus* Navigation Path: Settings Explorer, Programmable Outputs, Contact Outputs

DECS-150 contact outputs consist of a dedicated watchdog output, two programmable outputs, and a breaker shunt trip output.

Watchdog Output

This SPDT (Form C) output changes state during the following conditions:
- Operating power is lost
- Normal firmware execution ceases
- Transfer Watchdog Trip is asserted in BESTlogic*Plus*
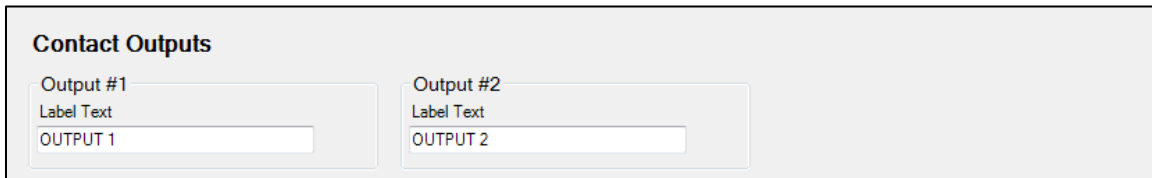
Watchdog output connections are made at terminals WD3 (normally open), WD2 (common), and WD1 (normally closed).

During normal operating conditions, the WD3 contact is closed and the WD1 contact is open.

Programmable Outputs

The two programmable, normally-open contact outputs can be configured to annunciate DECS-150 status, active alarms, active protection functions, and active limiter functions. Using BESTlogic*Plus* programmable logic, these outputs can be used as part of a user-configured logic scheme 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* chapter.

To make the programmable contact outputs easier to identify, you can assign a custom name (up to 64 alphanumeric characters) that relates to the functions of your system. Figure 16 shows the BESTCOMS*Plus* Contact Outputs screen where each output can be assigned a custom name.

Figure 16. Contact Output Label Text

Breaker Shunt Trip Output

This output provides an electronic switch capable of 100 milliamps (ac or dc) that can be used to control an external circuit breaker. The breaker shunt trip output terminals are labeled ST+ and ST−.

Protection

The DECS-150 offers protection relating to generator voltage, frequency, power, field parameters, rotating exciter diodes, power input failure, and sync check over 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*.

Voltage Protection

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Voltage

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

Generator Undervoltage

An undervoltage pickup condition occurs when any phase of 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 can be enabled and disabled without altering the pickup and time delay settings. Undervoltage pickup and trip elements in BESTlogic*Plus* can be used in a logic scheme to initiate corrective action in response to the condition.

The Generator Undervoltage screen is illustrated in Figure 17. Setting ranges and defaults are summarized in Table 10.

Shutdown Enable

When checked, Shutdown Enable causes the DECS-150 to stop excitation when the generator undervoltage element trips.

Block Logic Input

The Block input provides logic-supervision control of the element. When true, the Block input disables the element and resets the timer. Connect the element Block input to the desired logic in BESTlogic*Plus*.

Figure 17. Generator Undervoltage Screen

Table 10. Generator Undervoltage Settings

Setting	Range	Default
Mode	Disabled or Enabled	Disabled
Pickup	0 to 99,999 V in 1 V increments	0 V
Time Delay	0.1 to 60 s in 0.1 s increments	0.1 s

Setting	Range	Default
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled

Generator Overvoltage

An overvoltage pickup condition occurs when any phase of 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 can be enabled and disabled without altering the pickup and time delay settings. Overvoltage pickup and trip elements in BESTlogic*Plus* can be used in a logic scheme to initiate corrective action in response to the condition.

The Generator Overvoltage screen is illustrated in Figure 18. Setting ranges and defaults are summarized in Table 11.

Shutdown Enable

When checked, Shutdown Enable causes the DECS-150 to stop excitation when the generator overvoltage element trips.

Figure 18. Generator Overvoltage Protection Settings

Table 11. Generator Undervoltage Settings

Setting	Range	Default
Mode	Disabled or Enabled	Disabled
Pickup	0 to 99,999 V in 1 V increments	0 V
Time Delay	0.1 to 60 s in 0.1 s increments	0.1 s
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled

Loss of Sensing

The generator voltage is monitored for a loss of sensing (LOS) condition.

In the DECS-150, a loss of sensing event is calculated using sequence components. A loss of sensing event occurs when the positive sequence voltage (V1) drops below the Voltage Balanced Level setting of the AVR setpoint, or when the negative sequence voltage (V2) increases above the Voltage Unbalanced Level setting of the positive sequence voltage. A time delay is started when the event occurs, delaying the alarm by a predetermined time.

A loss of sensing condition can be used to initiate transfer to manual (FCR) control mode. It also can be configured in BESTlogic*Plus* to initiate other actions. Protection can be enabled and disabled without altering the individual loss of sensing settings.

Loss of sensing 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 (I1) is greater than twice the rated current for a three-phase CT connection.

Table 12 defines loss of sensing trip criteria. All criteria in a single column must be met.

Table 12. Loss of Sensing Trip Criteria

3 Phase Sensing Selected		Single Phase Sensing Selected
V1 > Balanced Voltage* % of AVR Setpoint	V1 < Balanced Voltage* % of AVR Setpoint	Generator V_{AVG} < Balanced Voltage* % of AVR Setpoint
V2 > Unbalanced Voltage* % of V1		$I1 < 200\%\ I_{rated}$
I2 < 17.7% I1 or $I1 < 1\%\ I_{rated}$	$I1 < 200\%\ I_{rated}$	I2 < 17.7% I1 or $I1 < 1\%\ I_{rated}$

* Denotes the value used for the loss of sensing settings.

The Loss of Sensing screen is illustrated in Figure 19. Setting ranges and defaults are summarized in Table 13.

Figure 19. Loss of Sensing Screen

Table 13. Loss of Sensing Settings

Setting	Range	Default
Mode	Disabled or Enabled	Disabled
Time Delay	0 to 30 s in 0.1 s increments	2 s
Voltage Balance Level	Adjustable from 0 to 100% in 0.1% increments	8.8%
Voltage Unbalanced Level	0 to 100% in 0.1% increments	25%
Loss of Sensing Alarm Mode	Status Only, Transfer to Manual, or Shutdown	Status Only

Frequency Protection

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Frequency

The frequency of the generator terminal voltage is monitored for overfrequency and underfrequency 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. The Voltage Inhibit setting, expressed as a percentage of the rated generator voltage, can be implemented to prevent an overfrequency trip from occurring during startup when the generator voltage is rising toward the nominal level. Overfrequency protection can be enabled and disabled without altering the Pickup and Time Delay settings. Overfrequency pickup and trip elements in BESTlogic*Plus* can be used in a logic scheme to initiate corrective action in response to the condition.

The Overfrequency screen is illustrated in Figure 20. Setting ranges and defaults are summarized in Table 14.

Shutdown Enable

When checked, Shutdown Enable causes the DECS-150 to stop excitation when the overfrequency element trips.

Figure 20. Overfrequency Screen

Table 14. Overfrequency Settings

Setting	Range	Default
Mode	Disabled or Over	Disabled
Pickup	0 or 30 to 70 Hz in 0.01 Hz increments	30 Hz
Time Delay	0.1 to 300 s in 0.1 s increments	0.1 s
Voltage Inhibit	0 or 5 to 100% in 1% increments	50%
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled

Underfrequency

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. The Voltage Inhibit setting, expressed as a percentage of the rated generator voltage, can be implemented to prevent an underfrequency trip from occurring during startup when the generator voltage is rising toward the nominal level. Underfrequency protection can be enabled and disabled without altering the Pickup, Time Delay, and Inhibit settings. Underfrequency pickup and trip elements in BESTlogic*Plus* can be used in a logic scheme to initiate corrective action in response to the condition.

The Underfrequency screen is illustrated in Figure 21. Setting ranges and defaults are summarized in Table 15.

Shutdown Enable

When checked, Shutdown Enable causes the DECS-150 to stop excitation when the underfrequency element trips.

Figure 21. Underfrequency Screen

Table 15. Underfrequency Settings

Setting	Range	Default
Mode	Disabled or Under	Disabled
Pickup	0 or 30 to 70 Hz in 0.01 Hz increments	30 Hz
Time Delay	0.1 to 300 s in 0.1 s increments	0.1 s
Voltage Inhibit	0 or 5 to 100% in 1% increments	50%
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled

Field Protection

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Field

Field protection provided by the DECS-150 includes exciter field current limit, field overvoltage, and an exciter diode monitor.

Exciter Field Current Limit

When checked, Shutdown Enable causes the DECS-150 to shut down excitation when the field current is too high, which could result in damage to the regulator. A restart is required to begin regulating again. The Exciter Field Current Limit screen is illustrated in Figure 22.

Figure 22. Exciter Field Current Limit Screen

Field Overvoltage

A field overvoltage condition occurs when the field voltage exceeds the pickup level for the duration of the Time Delay. Field overvoltage protection can be enabled and disabled without altering the Pickup and Time Delay settings. Field overvoltage pickup and trip elements in BESTlogic*Plus* can be used in a logic scheme to initiate corrective action in response to the condition.

The Field Overvoltage screen is illustrated in Figure 23. Setting ranges and defaults are summarized in Table 16.

Shutdown Enable

When checked, Shutdown Enable causes the DECS-150 to stop excitation when the field overvoltage element trips.

Figure 23. Field Overvoltage Screen

Table 16. Field Overvoltage Settings

Setting	Range	Default
Mode	Disabled or Enabled	Disabled
Pickup	0 to 300 V in 1 V increments	1 V
Time Delay	0 to 30 s in 0.1 s increments	0.2 s
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled

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.

Notes
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 ripple of the exciter field current using root-mean-square (rms). The ripple, expressed as a percentage of the field current, is then compared to the pickup level for open or shorted diode detection. If the field current ripple exceeds the pickup level for the duration of the Time Delay, the condition is annunciated. EDM pickup and trip elements in BESTlogic*Plus* can be used in a logic scheme to initiate corrective action in response to an open or shorted diode condition.

EDM protection can be disabled and enabled by the user without altering the individual protection settings.

The Exciter Diode Monitor screen is illustrated in Figure 24. Setting ranges and defaults are summarized in Table 11.

Finding the Maximum Field Ripple Current

To set the pickup level, the maximum ripple current on the field must be known. This can 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.

The DECS-150 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.

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.

Shutdown Enable

When checked, Shutdown Enable causes the DECS-150 to stop excitation when the exciter diode monitor element trips.

Figure 24. Exciter Diode Monitor Screen

Table 17. Exciter Diode Monitor Settings

Setting	Range	Default
Mode	Disabled or Enabled	Disabled
Pickup	0 or 1 to 10 A in 0.1 A increments	2 A
Delay	0 or 0.2 to 30 s in 0.1 s increments	5 s
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled

Sync-Check Protection

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

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 logic output asserts. This logic output can be configured (in BESTlogic*Plus*) to assert a DECS-150 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. The angle compensation value is added only to the bus angle. For example, it is given that the generator and bus are synchronized but the DECS-150 metered slip angle reads −30°. Equation 6, below, illustrates the DECS-150 slip angle calculation. This means that the generator angle is lagging behind the bus angle by 30° due to transformer phase shift. To compensate for this phase shift, the Angle Compensation setting should contain a value of 330°. 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-150.

$$G - (B + A) = Slip\ Angle$$

Equation 6. DECS-150 Metered Slip Angle

Where:

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

When the Gen Freq > Bus Freq box is checked, the 25 status virtual output will not assert unless the generator frequency is greater than the bus frequency.

The Sync Check screen is illustrated in Figure 25. Setting ranges and defaults are summarized in Table 18.

Figure 25. Sync Check Screen

Table 18. Sync Check Settings

Setting	Range	Default
Mode	Disabled or Enabled	Disabled
Voltage Difference	0.1 to 50% in 0.1% increments	1%
Slip Angle	1 to 99° in 1° increments	10°
Angle Compensation	0 to 359.9° in 0.1° increments	0°
Slip Freq	0.01 to 0.5 Hz in 0.01 Hz increments	0.01 Hz
Gen Freq > Bus Freq	Checked (enabled) or unchecked (disabled)	Enabled

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

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Configurable Protection

The DECS-150 has eight configurable protection elements which can be used to supplement the standard DECS-150 protection. To make the protection elements easier to identify, each element can be given a user-assigned name of up to 16 alphanumeric characters. A protection element is configured by selecting the parameter to be monitored and then establishing the operating characteristics for the element.

Protection will always be enabled when Stop mode is not inhibited. When Stop mode is inhibited, protection can be enabled only when the DECS-150 is enabled and supplying excitation. When protection is enabled only in Start mode, an arming time delay can be used to delay protection following the start of excitation.

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 individually-adjustable thresholds. Each threshold can be set for pickup when the monitored parameter increases above the pickup setting (Over), pickup when the monitored parameter decreases below the pickup setting (Under), or no pickup (Disabled). The pickup level for the monitored parameter is defined by a Threshold setting. While the threshold setting range is broad, you must use a value within the setting range limits for the monitored parameter. Using an out-of-limits threshold will prevent the protection element from functioning. An activation delay serves to delay a protective trip after the threshold (pickup) level is exceeded.

The Configurable Protection #1 screen is illustrated in Figure 26. Setting ranges and defaults are summarized in Table 19.

Figure 26. Configurable Protection #1 Screen

Table 19. Configurable Protection Settings

Setting	Range	Default
Parameter Selection	Gen VAB, Gen VBC, Gen VCA, Gen V Average, Bus Freq, Bus VAB, Bus VBC, Bus VCA, Gen Freq, Gen PF, kWh, kvarh, Gen IA, Gen IB, Gen IC, Gen I Average, kW Total, kVA Total, kvar Total, EDM Ripple, Exciter Field Voltage, Exciter Field Current, Auxiliary Input Voltage, Auxiliary Input Current, Setpoint Position, Tracking Error, Negative Sequence Voltage, Negative Sequence Current, Positive Sequence Voltage, Positive Sequence Current, PSS Output, Power Input, kW A, kW B, kW C, kvar A, kvar B, kvar C, kVA A, kVA B, kVA C, Gen VAN, Gen VBN, Gen VCN, Cross Current, or Gen Scaled PF	Gen VAB
Stop Mode Inhibit	No or Yes	No
Arming Delay	0 to 300 s in 1 s increments	0 s
Hysteresis	0 to 100% of the threshold setting in 0.1% increments	2%
Mode	Disabled, Over, or Under	Disabled
Threshold	−999,999 to 999,999 in increments of 0.01	0
Activation Delay	0 to 300 s in 1 s increments	0 s

Limiters

DECS-150 limiters ensure that the controlled machine does not exceed its capabilities. Overexcitation, underexcitation, stator current, and reactive power are limited by the DECS-150. It also limits the generator voltage during underfrequency conditions.

Overexcitation Limiter

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, Limiters, OEL

Operating in the overexcited region of a generator's capability curve can cause excessive field current and field winding heating. The overexcitation limiter (OEL) monitors the level of field current supplied by the DECS-150 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-150: Summing Point or Takeover. OEL configuration settings are illustrated in Figure 27. Setting ranges and defaults are summarized in Table 20.

OEL Voltage Dependency

The OEL voltage dependency function is applicable to only Summing Point style. It is used to enable the OEL High-Level setting when a fault is present. The OEL High-Level setting is enabled when the dv/dt level is less than the setting. Otherwise, only the Medium-Level and Low-Level settings are enabled.

OEL Shutdown

When this setting is enabled and the OEL limiter is active, the DECS-150 will shut down after the Shutdown Delay time expires.

Figure 27. OEL Configure Screen

Table 20. OEL Configuration Settings

Setting	Range	Default
OEL Enable	Checked (enabled) or unchecked (disabled)	Disabled
OEL Mode	Summing Point or Takeover	Summing Point
dv/dt Enable	Checked (enabled) or unchecked (disabled)	Disabled

Setting	Range	Default
dv/dt Level	−10 to 0 in increments of 0.1	−5
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled
Shutdown Delay	0 to 30 s in 0.1 s increments	10 s

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 28 illustrates the relationship of the high-level and low-level OEL thresholds.
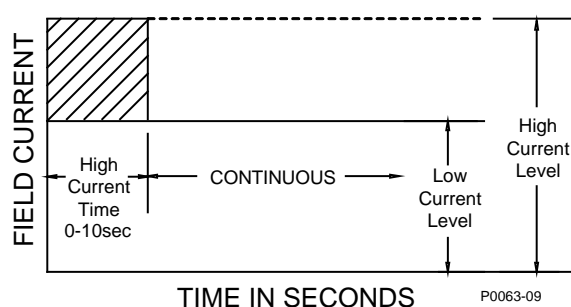
Figure 28. Summing Point, Offline, Overexcitation Limiting

The offline, high-level OEL threshold is determined by the High Level and High Time settings. When the excitation level exceeds the high level setting, the DECS-150 acts to limit the excitation to the value of the High Level setting. If this level of excitation persists for the duration of the High Time setting, the DECS-150 acts to limit the excitation to the value of the Low Level setting. The Ambient Temperature setting on the Rated Data Settings screen determines the high-level range.

The offline, low-level OEL threshold is determined by the Low Level setting. When the excitation level is below the Low Level setting, no action is taken by the DECS-150. The generator is permitted to operate indefinitely with this level of excitation. The Ambient Temperature setting on the Rated Data Settings screen determines the low-level range.

Online Operation

For online operation, there are three levels of summing-point overexcitation limiting: low, medium, and high. Figure 29 illustrates the relationship of the high-, medium-, and low-level OEL thresholds.
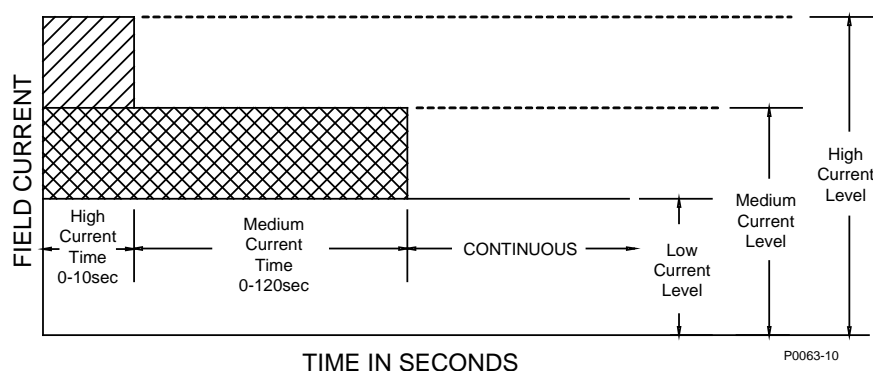
Figure 29. Summing Point, Online, Overexcitation Limiting

The online, high-level OEL threshold is determined by the High Level and High Time settings. When the excitation level exceeds the High Level setting, the DECS-150 instantaneously acts to limit the excitation to the value of the High Level setting. If this level of excitation persists for the duration of the High Time setting, the DECS-150 acts to limit the excitation to the value of the High Level setting. The Ambient Temperature setting on the Rated Data Settings screen determines the high-level range.

The online, medium-level OEL threshold is determined by the Medium Level and Medium Time settings. When the excitation level exceeds the Medium Level setting for the duration of the Medium Time setting, the DECS-150 acts to limit the excitation to the value of the Low Level setting. The Ambient Temperature setting on the Rated Data Settings screen determines the medium-level range.

The online, low-level OEL threshold is determined by the Low Level setting. When the excitation level is below the Low Level setting, no action is taken by the DECS-150. The generator is permitted to operate indefinitely with this level of excitation. When the excitation level exceeds the Low Level setting for the duration of the high and medium time settings, the DECS-150 acts to limit the excitation to the value of the Low Level setting. The Ambient Temperature setting on the Rated Data Settings screen determines the low-level range.

Summing point OEL settings are illustrated in Figure 30. Setting ranges and defaults are summarized in Table 21.

Figure 30. Summing Point OEL Screen

Table 21. Summing Point OEL Settings

Setting	Range	Default
Offline High Level	0 to 11 A (when ambient temperature setting is 70°C) and 0 to 14 A (when ambient temperature setting is 55°C) in 0.1 A increments	0 A
Offline High Time	0 to 10 s in 1 s increments	0 s
Offline Low Level	0 to 7 A (when ambient temperature setting is 70°C) and 0 to 10 A (when ambient temperature setting is 55°C) in 0.1 A increments	0 A

Setting	Range	Default
Online High Level	0 to 11 A (when ambient temperature setting is 70°C) and 0 to 14 A (when ambient temperature setting is 55°C) in 0.1 A increments	0 A
Online High Time	0 to 10 s in 1 s increments	0 s
Online Medium Level	0 to 9 A (when ambient temperature setting is 70°C) and 0 to 12 A (when ambient temperature setting is 55°C) in 0.1 A increments	0 A
Online Medium Time	0 to 120 s in 1 s increments	0 s
Online Low Level	0 to 7 A (when ambient temperature setting is 70°C) and 0 to 10 A (when ambient temperature setting is 55°C) in 0.1 A increments	0 A

Takeover OEL

Takeover OEL limits the field current level in relation to an inverse time characteristic similar to that shown in Figure 31. 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 7.

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

Equation 7. 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, 205>

Primary and secondary setting groups provide additional control for two distinct machine operating conditions. Each mode of takeover OEL operation (offline and online) has a Low-Level, High-Level, and Time Dial setting. The Ambient Temperature setting on the Rated Data Settings screen determines the low- and high-level ranges.

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.
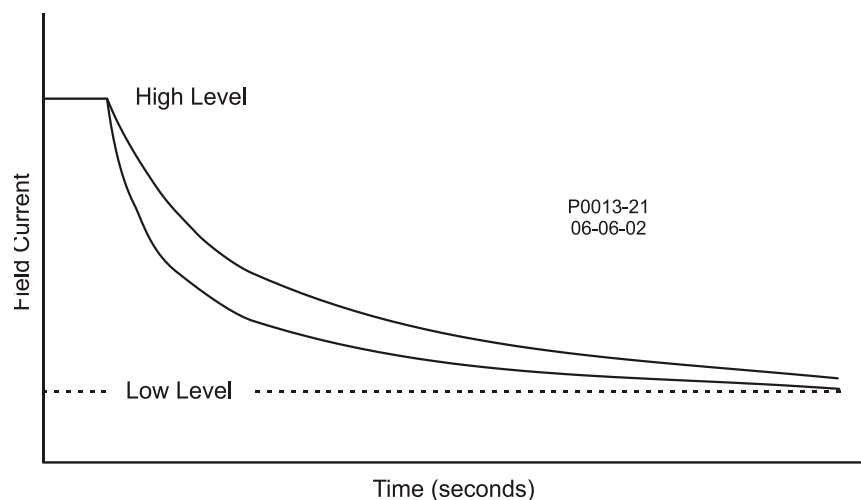
Figure 31. Inverse Time Characteristic for Takeover OEL

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 8) to calculate maximum reset time.

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

Equation 8. Inverse Reset Time Characteristic

Where:
Time_reset = maximum time to reset in seconds
RC   = reset coefficient setting <0.01, 100>
TD   = time dial setting <0.1, 20>
MOP_reset = multiple of pickup <1.03, 205>

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.

In BESTCOMS*Plus®,* a plot of the takeover OEL setting curves is displayed. Settings enable selection of the displayed curves. The plot can display the primary or secondary setting curves, the offline or online settings curves, and the pickup or reset settings curves.

Takeover OEL settings are illustrated in Figure 32. Setting ranges and defaults are summarized in Table 22.
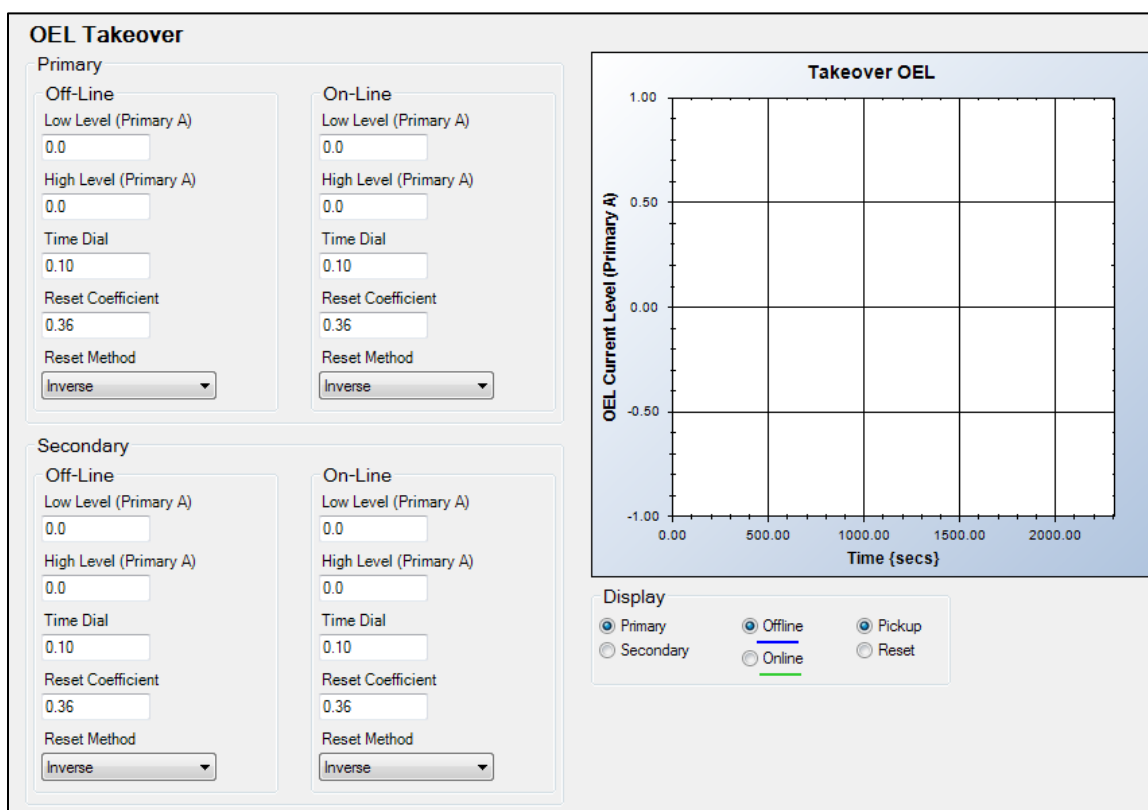
Figure 32. Takeover OEL Screen

Table 22. Takeover OEL Settings

Setting	Range	Default
Low Level	0 to 7 A (when ambient temperature setting is 70°C) and 0 to 10 A (when ambient temperature setting is 55°C) in 0.1 A increments	0 A
High Level	Adjustable range varies depending on value of Low Level setting.	0 A
Time Dial	0.1 to 20 in increments of 0.1	0.1
Reset Coefficient	0.01 to 100 in increments of 0.01	0.36
Reset Method	Inverse, Integrating, or Instantaneous	Inverse

Underexcitation Limiter

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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 to limit end-iron heating. 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 BESTlogic*Plus*.

Note
For UEL to operate, the PARALLEL_ENABLE_LM logic block must be set true in BESTlogic*Plus* programmable logic.

UEL Voltage Dependency

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 to 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 Shutdown

When this setting is enabled and the UEL limiter is active, the DECS-150 will shut down after the shutdown delay time expires.

UEL configuration settings are illustrated in Figure 33. Setting ranges and defaults are summarized in Table 23.

Figure 33. UEL Configure Screen

Table 23. UEL Configuration Settings

Setting	Range	Default
Enable	Checked (enabled) or unchecked (disabled)	Disabled
Real Power Exponent	1 or 2	2
Real Power Filter Time Constant	0 to 20 s in 0.1 s increments	5 s
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled
Shutdown Delay	0 to 30 s in 0.1 s increments	10 s

UEL Curve

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.

UEL configuration settings are illustrated in Figure 34. Setting ranges and defaults are summarized in Table 24.
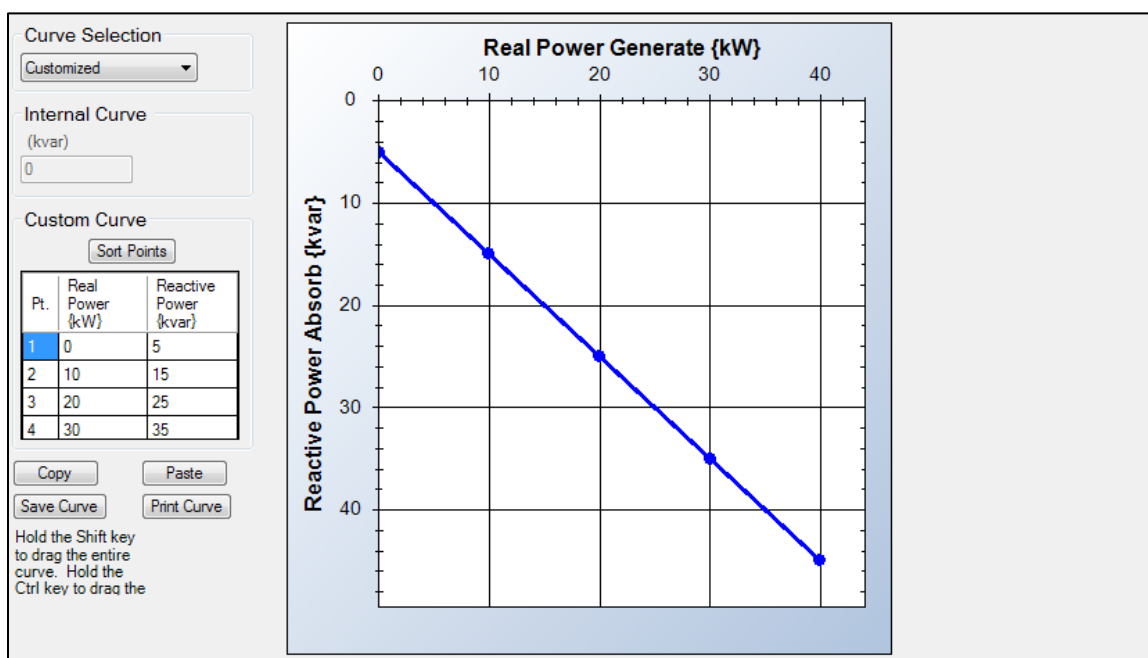
Figure 34. UEL Custom Curve Screen

Table 24. UEL Custom Curve Settings

Setting	Range	Default
Curve Selection	Internal or Customized	Internal
Internal Curve	0 to 62 kvar in 1 kvar increments	0 kvar

Stator Current Limiter

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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-150 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 35).
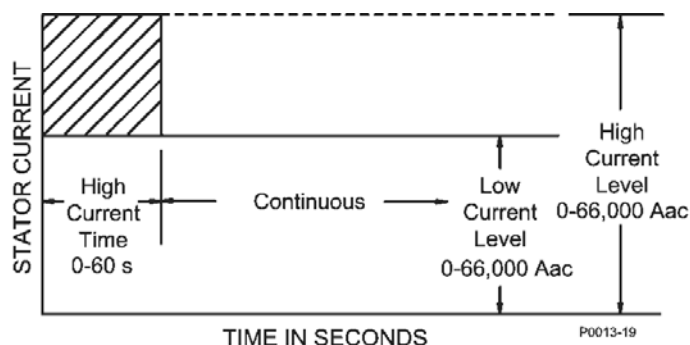
Figure 35. Stator Current Limiting

SCL settings are illustrated in Figure 36. Setting ranges and defaults are summarized in Table 25.

Low Level Limiting

When the stator current exceeds the Low Level setting, the DECS-150 annunciates the elevated level. If this condition persists for the duration of the High SCL Time setting, the DECS-150 acts to limit the current to the Low Level SCL setting. 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-150 acts to limit the current to the high-level value. If this level of current persists for the duration of the High Level Time setting, the DECS-150 acts to limit the current to 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.

SCL Shutdown

When this setting is enabled and the SCL limiter is active, the DECS-150 will shut down after the shutdown delay time expires.

Figure 36. SCL Screen

Table 25. SCL Settings

Setting	Range	Default
Enable	Checked (enabled) or unchecked (disabled)	Disabled
Initial Delay	0 to 10 s in 0.1 s increments	0 s
High SCL Level	0 to 66,000 A in 0.1 A increments	0 A
High SCL Time	0 to 60 s in 0.1 s increments	0 s
Low SCL Level	0 to 66,000 Aac in 0.1 A increments	0 A
Shutdown Enable	Checked (enabled) or unchecked (disabled)	Enabled
Shutdown Delay	0 to 30 s in 0.1 s increments	10 s

Underfrequency Limiter

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

If the generator frequency decreases below the corner frequency for the selected underfrequency slope (Figure 37), the DECS-150 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-150 to precisely match the operating characteristics of the prime mover and the loads being applied to the generator.
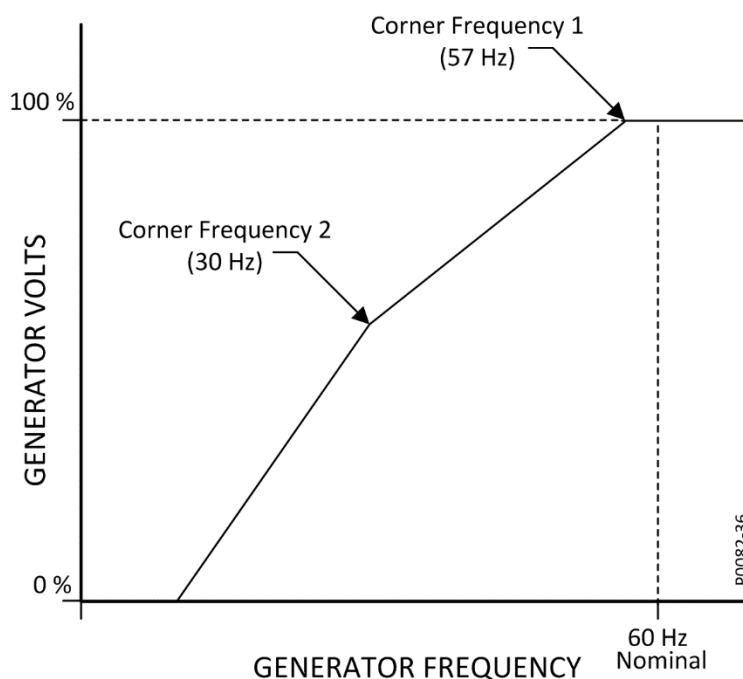
Figure 37. Typical Underfrequency Compensation Curve

Reset Time

The reset function introduces a time-based response to the recovery of the voltage based upon the recovery of the speed, magnitude of the voltage dip, and the Reset Time setting in BESTCOMS*Plus*. After speed begins to recover, the reset time is used to calculate the voltage recovery ramp time. The reset time reduces the generator kW below the available engine kW during the recovery period, thus allowing an improved speed recovery. This control is effective only during load switching when the speed decreases below the underfrequency knee setting. If the speed stays above the knee during a load transient, the reset function will have no effect on the recovery. This feature is typically used with a generator coupled to a turbocharged engine with limited block load acceptance. When the reset time is set to zero (0), the response will follow the V/Hz curve selected.

Volts per Hertz

The volts per hertz limiter prevents the regulation setpoint from exceeding the volts per hertz ratio defined by the Underfrequency Slope setting. A typical volts per hertz limiter curve is illustrated in Figure 38.

Beside the Underfrequency Slope setting, volts per hertz limiter operation is determined by the High Limiter setting, Low Limiter setting, and Time Limiter setting. The High Limiter setting establishes the

maximum threshold for volts per hertz limiting, the Low Limiter setting establishes the minimum threshold for volts per hertz limiting, and the Time Limiter setting establishes the time delay for limiting.

Underfrequency and volts per hertz limiter settings are illustrated in Figure 39. Setting ranges and defaults are summarized in Table 26.
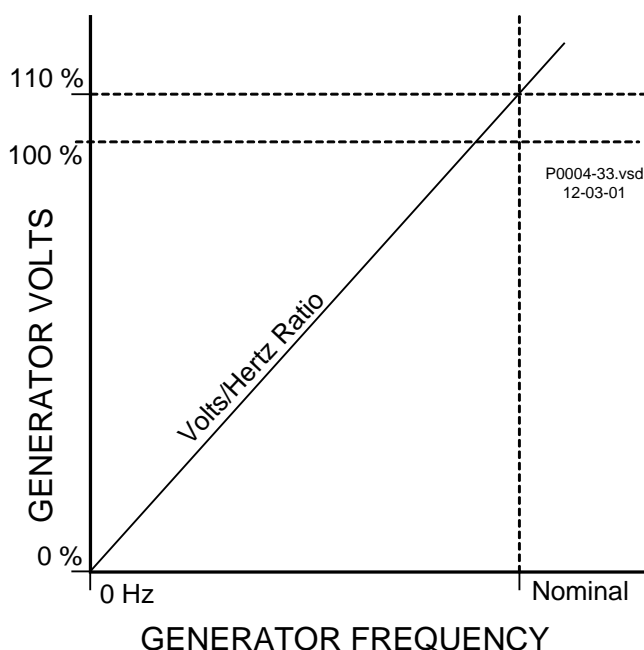
Figure 38. Typical 1.1 PU Volts per Hertz Limiter Curve

Underfrequency Volts/Hz Disable

When true, the UNDERFREQUENCY_VHZ_DISABLE logic block disables the Volts/Hz limiter. Refer to the *BESTlogicPlus* chapter for more information.

Figure 39. Underfrequency Screen

Table 26. Underfrequency Settings

Setting	Range	Default
Mode	UF Limiter or V/Hz Limiter	UF Limiter
Corner Frequency	10 to 75 Hz in 0.1 Hz increments	57 Hz
Slope	0 to 3 in increments of 0.01	1
Corner Frequency 2	10 to 75 Hz in 0.1 Hz increments	57 Hz
Slope 2	0 to 3 in increments of 0.01	1
Reset Time	0 to 100 s in 0.1 s increments	0
V/Hz High Limiter	1 to 3 V/Hz in 0.01 V/Hz increments	1
V/Hz Low Limiter	0 to 3 V/Hz in 0.01 V/Hz increments	1

Setting	Range	Default
V/Hz Time Limiter	0 to 10 s in 0.2 s increments	10 s

Metering

The DECS-150 provides comprehensive metering of internal and system conditions. These capabilities include extensive parameter metering, status indication, reporting, and real-time metering analysis.

BESTCOMSPlus® Metering Explorer

DECS-150 metering is accessed through the BESTCOMS*Plus*® metering explorer. The metering explorer is located in the upper left portion of the application window.

Note
BESTCOMS*Plus* metering is <u>not</u> available when the DECS-150 is powered through the USB port when no operating power is applied.

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 40.
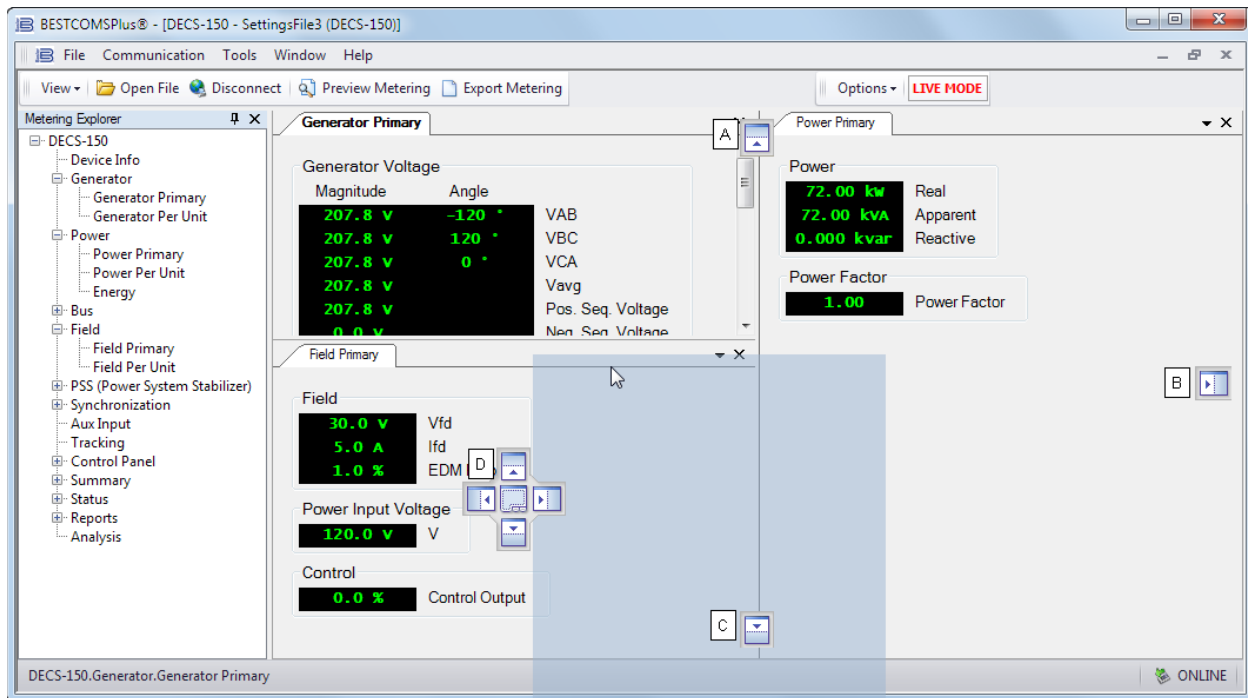
Figure 40. Metering Screen Docking Controls

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. Double-click near the top of the screen to dock.

Metered Parameters

DECS-150 metering categories include generator, power, bus, field, power system stabilizer (PSS), and generator synchronization parameters.

Generator

BESTCOMS*Plus* 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 41 illustrates the generator primary-values metering screen.
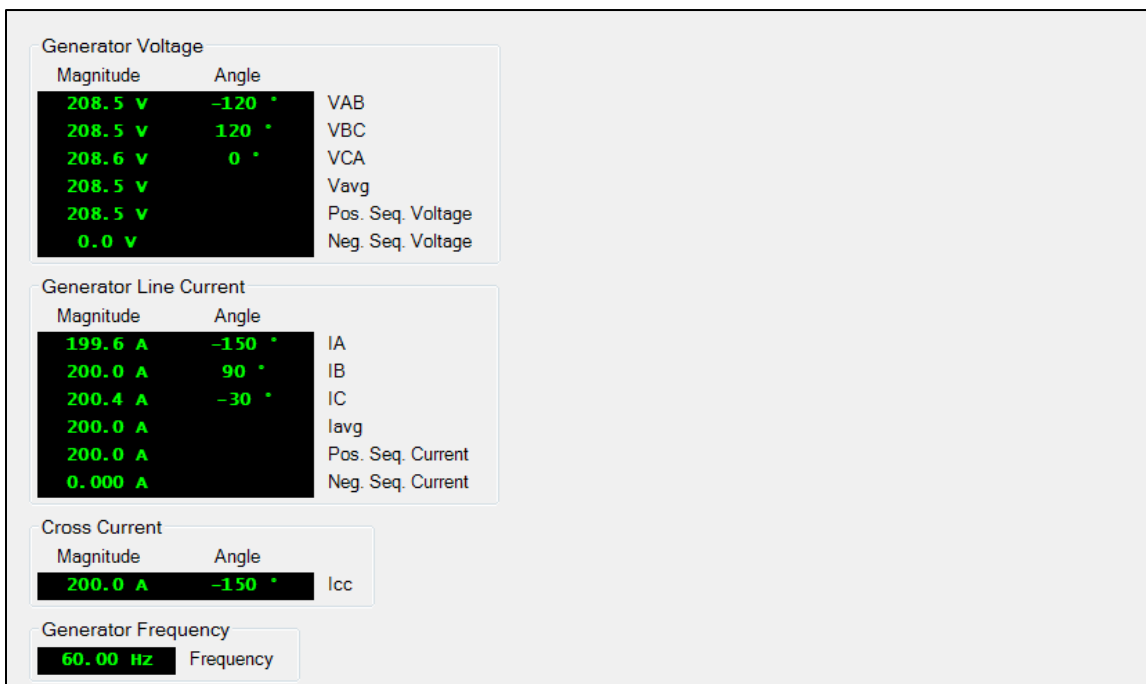
Figure 41. Generator Primary-Values Metering

Power

BESTCOMS*Plus* 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. The Power Primary-Values screen is illustrated in Figure 42.

Figure 42. Power Primary-Values

Energy

Energy parameters include accumulated watthours (positive and negative kWh), varhours (positive and negative kvarh), and voltampere hours (kVAh). The Energy screen is illustrated in Figure 43. Click the Edit button to open the Meter Energy Editor and manually enter values.
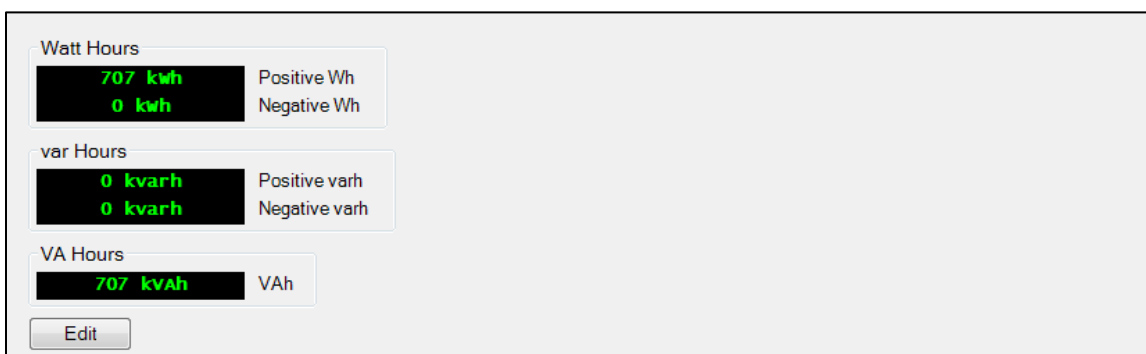
Figure 43. Energy

Bus

BESTCOMS*Plus* 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 44 illustrates the bus primary-values metering screen.
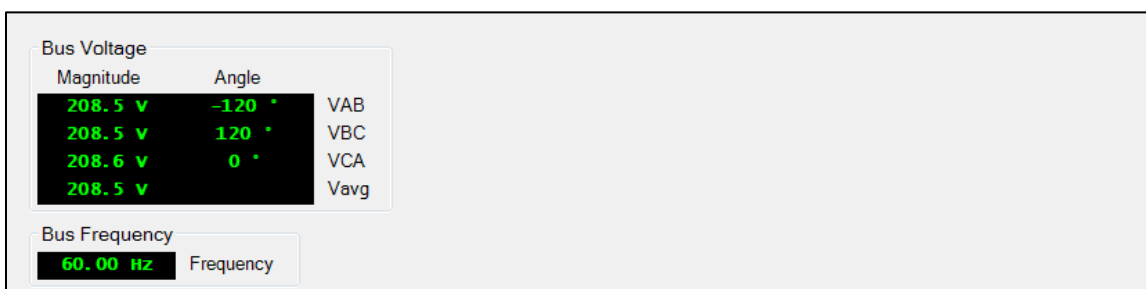
Figure 44. Bus Primary-Values Metering

Field

BESTCOMS*Plus* Navigation Path: Metering Explorer, Field

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

To achieve the desired level of excitation, the appropriate level of operating power input voltage must be applied. This value is displayed as the power input voltage.

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 45 illustrates the field primary-values metering screen.
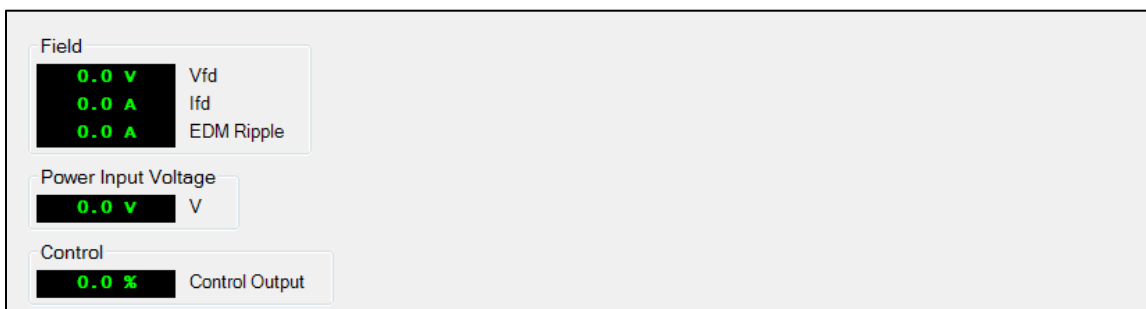
Figure 45. Field Primary-Values Metering

PSS

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

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, and the per-unit PSS output level. The PSS function on/off status is also reported. Primary- and per-unit values are available. Figure 46 illustrates the PSS primary-values metering screen.
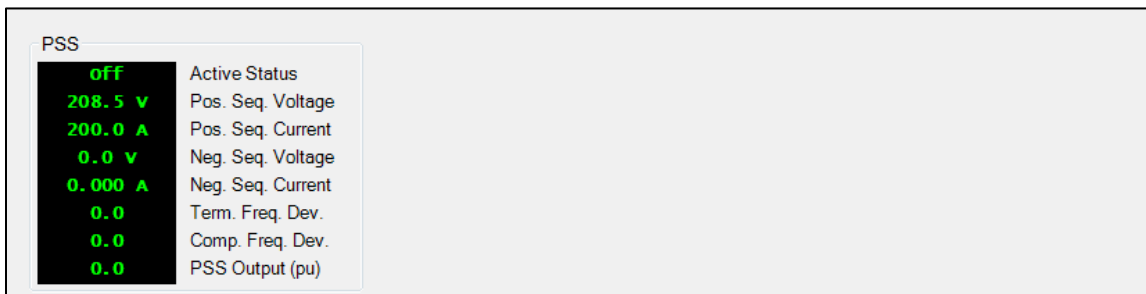
Figure 46. PSS Primary-Values Metering

Synchronization

BESTCOMS*Plus* Navigation Path: Metering Explorer, Synchronization

Metered generator-to-bus synchronization parameters include the slip frequency, slip angle, and voltage difference. Primary- and per-unit values are available. Figure 47 illustrates the synchronization primary-values metering screen.

Figure 47. Synchronization Primary-Values Metering

Auxiliary Control Input

BESTCOMS*Plus* Navigation Path: Metering Explorer, Aux Input

The control signal applied at the DECS-150 auxiliary control input is indicated on the Aux Input metering screen (Figure 48). As configured in BESTCOMS*Plus*®, a dc voltage or dc current signal may be applied.

Figure 48. Auxiliary Control Input Metering

Tracking

BESTCOMS*Plus* Navigation Path: Metering Explorer, Tracking

The metered setpoint tracking error between DECS-150 operating modes is displayed on the Tracking screen (Figure 49). Status fields are also provided for the on/off status for internal and external setpoint tracking. An additional status field indicates when the setpoint of an inactive operating mode matches the metered value.
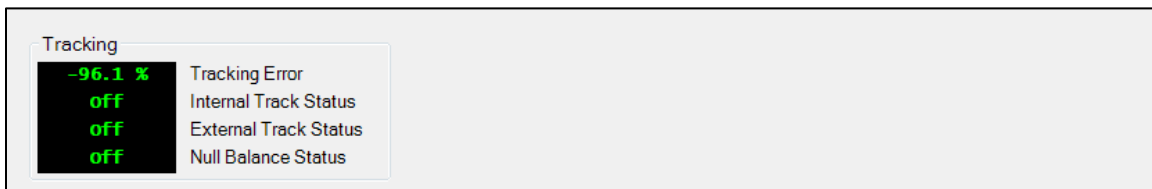
Figure 49. Tracking Metering

Control Panel

BESTCOMS*Plus* Navigation Path: Metering Explorer, Control Panel

The Control Panel (Figure 50) provides options for changing operating modes, selecting setpoint pre-positions, fine tuning setpoints, and toggling virtual switches. The setpoints for AVR, var, and PF are displayed, as well as Alarm status, PSS status, and Null Balance status.
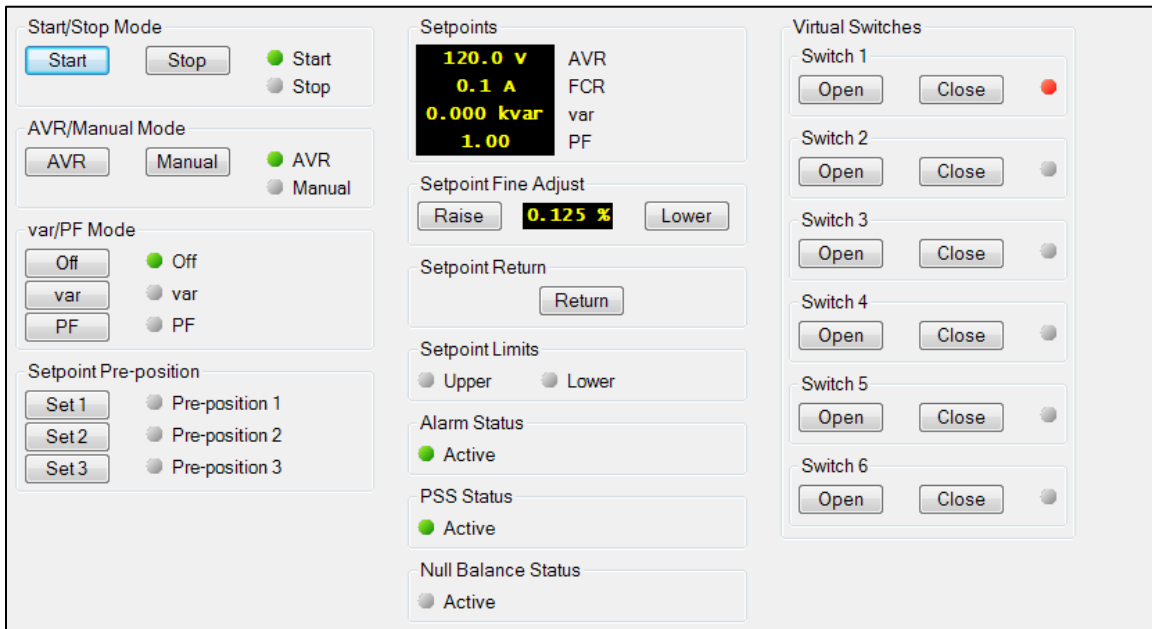
Figure 50. Control Panel

Start/Stop Mode: Two indicators show the start/stop mode of the DECS-150. When a mode is active, its corresponding indicator changes from gray to green. To select the DECS-150 Start status, click the Start button. Click the Stop button to select DECS-150 Stop status.

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.

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. Var or power factor correction is disabled by clicking the Off button. Only one mode can be enabled at any time.

Setpoint Pre-Position: A control button and indicator are 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 the Set 2 and Set 3 buttons respectively.

Setpoints: Two status fields display the active setpoints for AVR mode, FCR mode, var mode, and Power Factor mode. These active setpoints, displayed with yellow characters, are not to be confused with metered analog values which are displayed with green characters throughout BESTCOMS*Plus*. For details on operating setpoint settings, see the *Regulation* chapter.

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.

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 optional power system stabilizer is active.

Null Balance: The Null Balance indicator changes from gray to green when the setpoint of the inactive operating modes (AVR, FCR, var, or 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. After clicking either button, you will be prompted to confirm your selection.

Metering Summary

BESTCOMS*Plus* Navigation Path: Metering Explorer, Summary

All of the metering values displayed on the individual, previously-described metering screens are consolidated on the metering summary screen. Primary- and per-unit values are available. Figure 51 illustrates the primary-values metering summary screen.
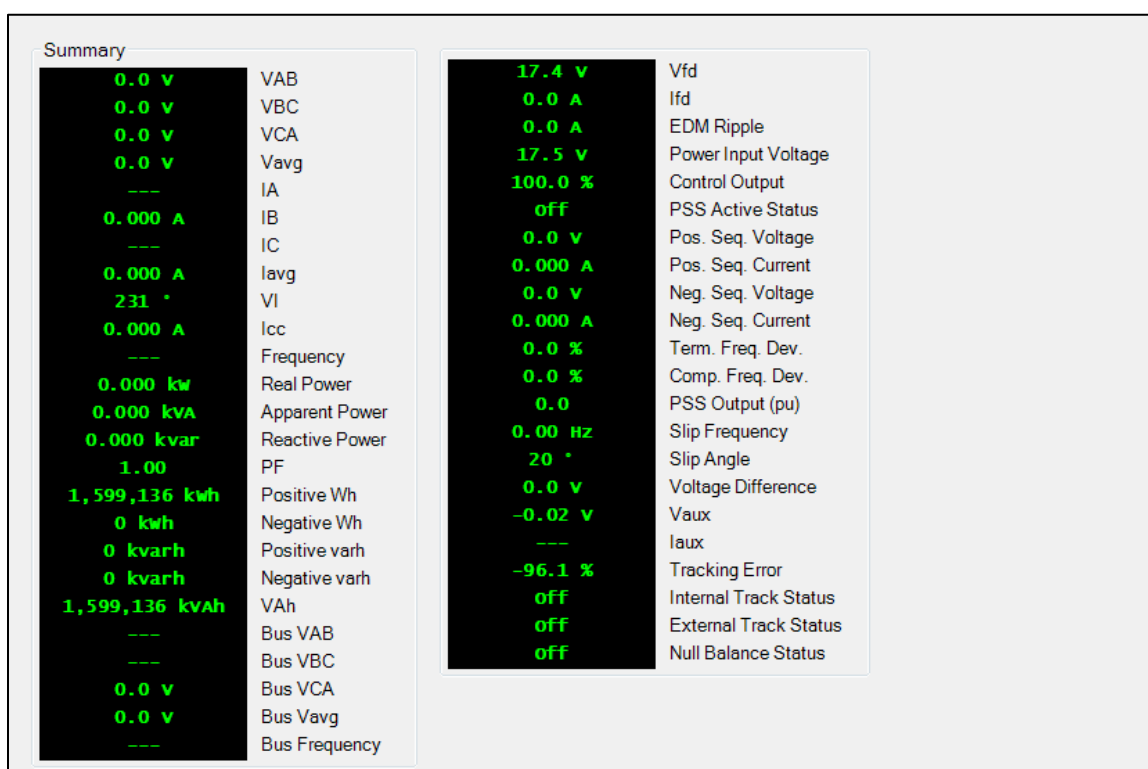
Figure 51. Metering Summary Screen

Status Indication

Status indication is provided for DECS-150 system functions, inputs, outputs, network load share, configurable protection, alarms, and the real-time clock.

System Status

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

When any of the system functions illustrated in Figure 52 are active, the corresponding indicator changes from gray to green. An inactive function is represented by a gray indicator.

Figure 52. System Status Indication Screen

Inputs

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

Status indication for the DECS-150's eight contact sensing inputs is provided on the BESTCOMS*Plus* contact inputs status screen illustrated in Figure 53. An indicator changes from gray to red when a closed contact is sensed at the corresponding input.
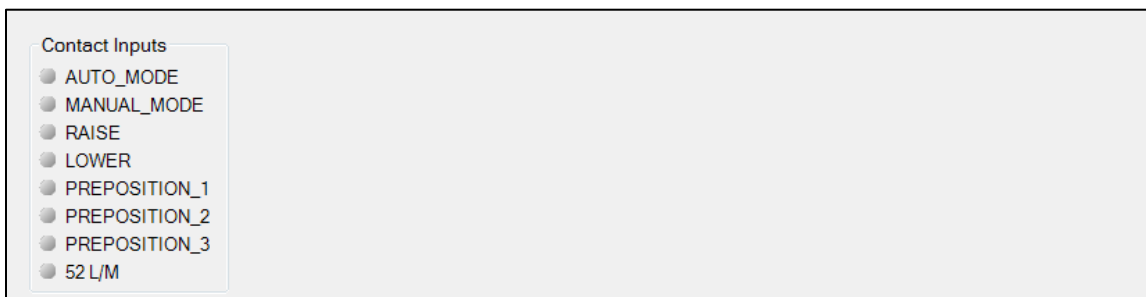
Figure 53. DECS-150 Contact Inputs Status Indication Screen

Outputs

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

Status indication for the DECS-150's Watchdog, Breaker Shunt Trip, and two contact outputs is provided on the BESTCOMS*Plus* contact outputs status screen illustrated in Figure 54. An indicator changes from gray to green when the corresponding output changes state (Watchdog output) or closes (Outputs 1 and 2).

Figure 54. DECS-150 Contact Outputs Status Indication Screen

Network Load Share

The screen shown in Figure 55 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.
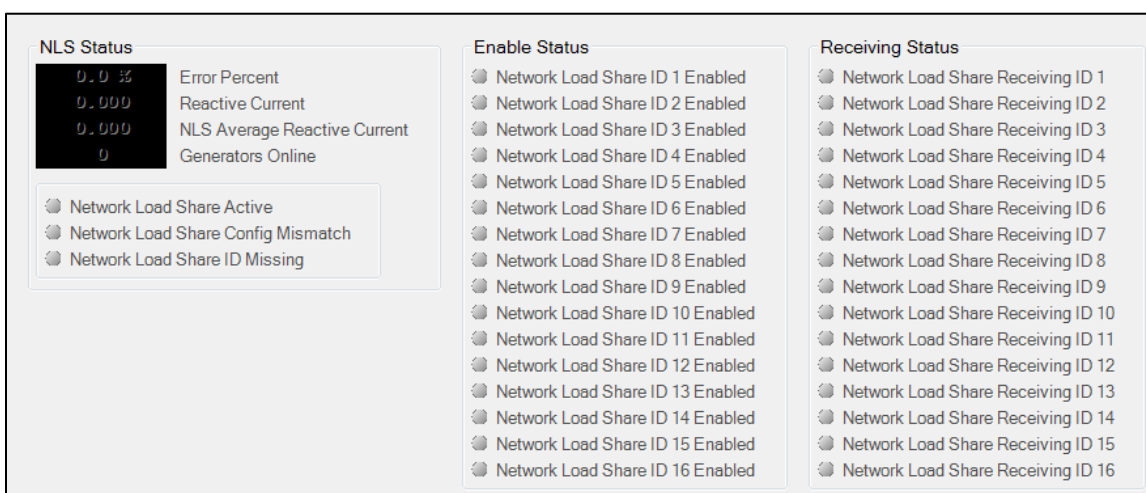
Figure 55. NLS Status Screen

Configurable Protection

BESTCOMS*Plus* Navigation Path: Metering Explorer, Status, Configurable Protection

Trip status for the eight configurable, supplemental protection elements is annunciated on the BESTCOMS*Plus* configurable protection screen (Figure 56). An indicator for each protection element's four trip thresholds changes from gray to green when the corresponding trip threshold is exceeded.
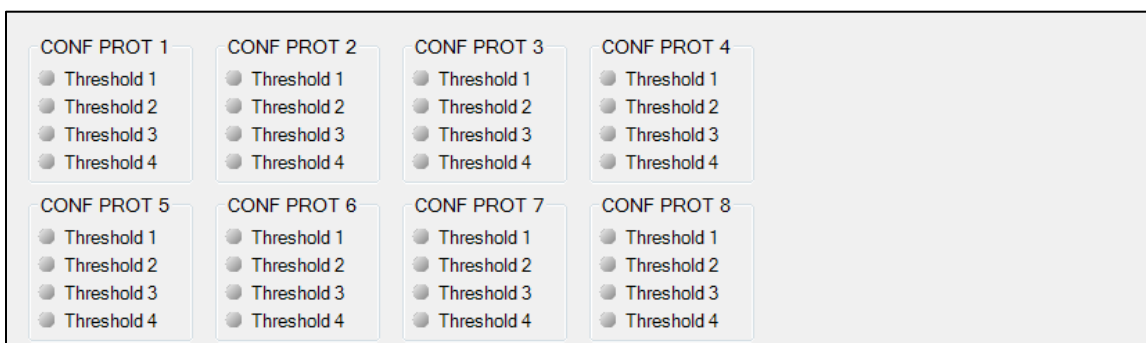
Figure 56. Configurable Protection Indication Status Screen

Alarms

System parameters, communication links, and protection functions are constantly monitored for alarm conditions. Active and previously latched alarms are listed on the Alarms screen of BESTCOMS*Plus*. A Reset Alarms button on the Alarms screen is clicked to clear all inactive alarms in BESTCOMS*Plus*. The BESTCOMS*Plus* Alarms screen is illustrated in Figure 57. All possible DECS-150 alarms are listed below.
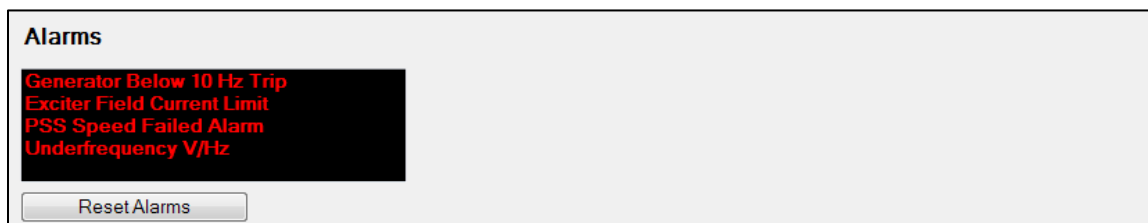
Figure 57. DECS-150 Alarm Annunciation and Reset Screen
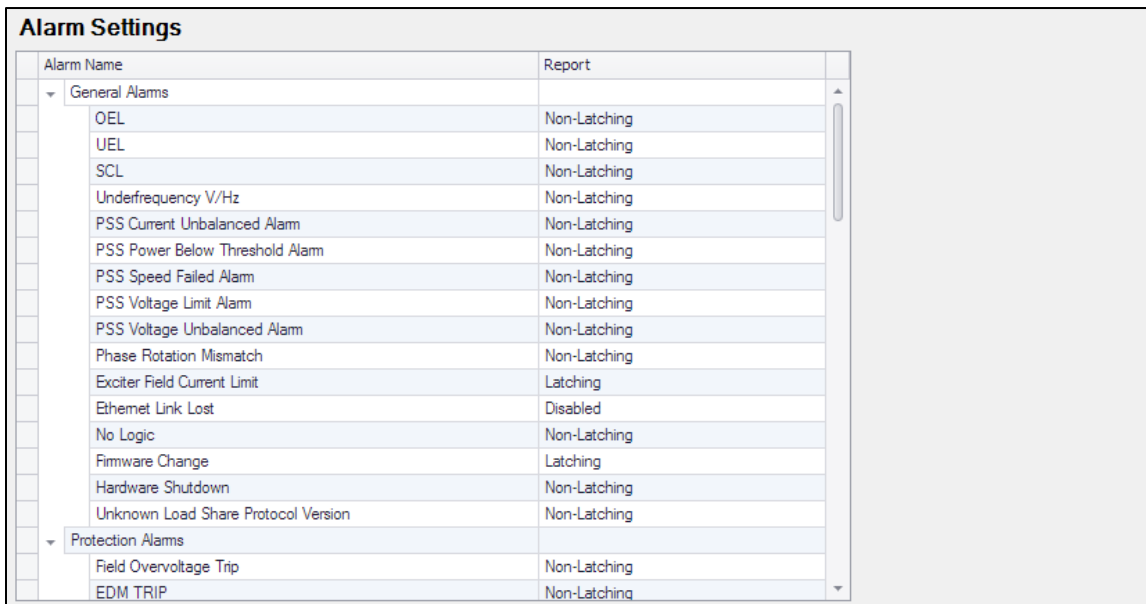
27P Trip
59P Trip
81O Trip
81U Trip
Configurable Protection 1 Threshold 1 Trip
Configurable Protection 1 Threshold 2 Trip
Configurable Protection 1 Threshold 3 Trip
Configurable Protection 1 Threshold 4 Trip
Configurable Protection 2 Threshold 1 Trip
Configurable Protection 2 Threshold 2 Trip
Configurable Protection 2 Threshold 3 Trip
Configurable Protection 2 Threshold 4 Trip
Configurable Protection 3 Threshold 1 Trip
Configurable Protection 3 Threshold 2 Trip
Configurable Protection 3 Threshold 3 Trip
Configurable Protection 3 Threshold 4 Trip
Configurable Protection 4 Threshold 1 Trip
Configurable Protection 4 Threshold 2 Trip
Configurable Protection 4 Threshold 3 Trip
Configurable Protection 4 Threshold 4 Trip
Configurable Protection 5 Threshold 1 Trip
Configurable Protection 5 Threshold 2 Trip
Configurable Protection 5 Threshold 3 Trip
Configurable Protection 5 Threshold 4 Trip
Configurable Protection 6 Threshold 1 Trip
Configurable Protection 6 Threshold 2 Trip
Configurable Protection 6 Threshold 2 Trip
Configurable Protection 6 Threshold 3 Trip
Configurable Protection 6 Threshold 4 Trip
Configurable Protection 7 Threshold 1 Trip
Configurable Protection 7 Threshold 2 Trip
Configurable Protection 7 Threshold 3 Trip
Configurable Protection 7 Threshold 4 Trip
Configurable Protection 8 Threshold 1 Trip
Configurable Protection 8 Threshold 2 Trip
Configurable Protection 8 Threshold 3 Trip
Configurable Protection 8 Threshold 4 Trip
EDM Trip

Ethernet Link Lost
Exciter Field Current Limit
Field Overvoltage Trip
Firmware Change
Generator Below 10Hz
Hardware Shutdown
Loss of Sensing Trip
No Logic
OEL
Phase Rotation Mismatch
Power Input Failure
Programmable Alarm 1 Name
Programmable Alarm 10 Name
Programmable Alarm 11 Name
Programmable Alarm 12 Name
Programmable Alarm 13 Name
Programmable Alarm 14 Name
Programmable Alarm 15 Name
Programmable Alarm 16 Name
Programmable Alarm 2 Name
Programmable Alarm 3 Name
Programmable Alarm 4 Name
Programmable Alarm 5 Name
Programmable Alarm 6 Name
Programmable Alarm 7 Name
Programmable Alarm 8 Name
Programmable Alarm 9 Name
PSS Current Unbalanced Alarm
PSS Power Below Threshold Alarm
PSS Speed Failed Alarm
PSS Voltage Limit Alarm
PSS Voltage Unbalanced Alarm
SCL
Transfer Watchdog Alarm
UEL
Underfrequency V/Hz
Unknown Load Share Protocol Version

Alarm Configuration

BESTCOMS*Plus* **Navigation Path:** Settings Explorer, Alarm Configuration, Alarms

Alarms are configured using BESTCOMS*Plus.* 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 operating power to the DECS-150 is lost. Active alarms are shown on the front panel and in BESTCOMS*Plus* until they are cleared. Non-latching alarms are cleared when operating 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 BESTCOMS*Plus* Alarm Settings screen is illustrated in Figure 58 below.

Alarm Settings

Alarm Name	Report
General Alarms	
OEL	Non-Latching
UEL	Non-Latching
SCL	Non-Latching
Underfrequency V/Hz	Non-Latching
PSS Current Unbalanced Alarm	Non-Latching
PSS Power Below Threshold Alarm	Non-Latching
PSS Speed Failed Alarm	Non-Latching
PSS Voltage Limit Alarm	Non-Latching
PSS Voltage Unbalanced Alarm	Non-Latching
Phase Rotation Mismatch	Non-Latching
Exciter Field Current Limit	Latching
Ethernet Link Lost	Disabled
No Logic	Non-Latching
Firmware Change	Latching
Hardware Shutdown	Non-Latching
Unknown Load Share Protocol Version	Non-Latching
Protection Alarms	
Field Overvoltage Trip	Non-Latching
EDM TRIP	Non-Latching

Figure 58. Alarm Settings Screen

User-Programmable Alarms

BESTCOMS*Plus* **Navigation Path:** Settings Explorer, Alarm Configuration, User Programmable Alarms

Sixteen user programmable alarms are available. User alarm labels[A] are entered on the User Programmable Alarms screen (Figure 59). If the trip condition exists for the duration of the activation delay[B], the alarm is tripped. When active, the label of a user programmable alarm is displayed on the BESTCOMS*Plus* Alarms screen 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* chapter for more information on setting up alarm logic.

Figure 59. User Programmable Alarms Screen

A *Label Text:* Enter a string of alphanumeric characters.
B *Activation Delay:* Adjustable from 0 to 300 seconds in 1 second increments.

Retrieving Alarm Information

Alarms are displayed in the sequence of events reports. Certain alarm LEDs are automatically lit on the front panel display when active. Refer to the *Front Panel* chapter for a list of alarm LEDs on the front panel. To view active alarms using BESTCOMS*Plus*, use the Metering Explorer to open the Status, Alarms screen.

Resetting Alarms

A BESTlogic*Plus* expression can be used to reset the alarms. Use the Settings Explorer within BESTCOMS*Plus* to open the BESTlogic*Plus* 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* chapter for more information.

Real-Time Clock

BESTCOMS*Plus* Navigation Path: Metering Explorer, Status, Real Time Clock

The DECS-150 time and date is displayed and adjusted on the BESTCOMS*Plus* Real-Time Clock screen (Figure 60). Manual adjustment of the DECS-150 clock is made by clicking the Edit button. This displays a window where the DECS-150 time and date can be adjusted manually or according to the connected PC clock's date and time.

Figure 60. Real-Time Clock Screen

Auto Export Metering

Found under the Tools menu, the auto export metering function is an automated method for saving multiple metering data files at specific intervals over a period of time while connected to a DECS-150. The user specifies the Number of Exports and the Interval between each export. Enter a base filename for the metering data and a folder in which to save. The exports are counted and the count number will be appended to the base filename, making each filename unique. The first export is performed immediately after clicking the Start button. Figure 61 illustrates the Auto Export Metering screen.
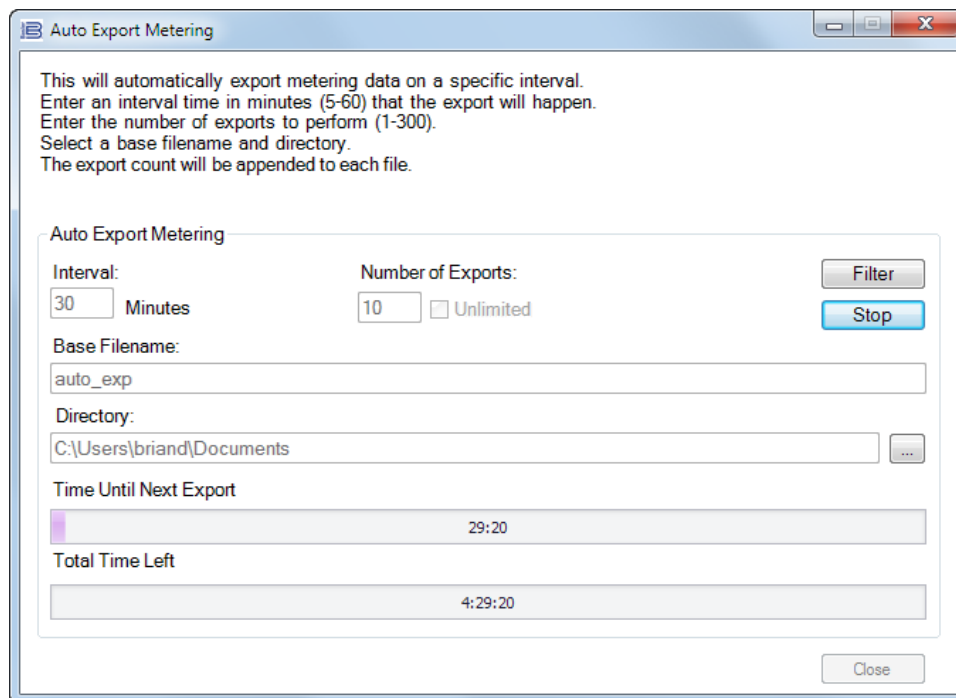
Figure 61. Auto Export Metering

Reports

DECS-150 reporting functions include sequence-of-events recording (SER) and data logging (oscillography).

Sequence-of-Events Recording

BESTCOMS*Plus* Navigation Path: Metering Explorer, Reports, Sequence of Events

A sequence-of-events recorder monitors the internal and external status of the DECS-150. Events are scanned at 16 millisecond intervals for 60-hertz units and 20 millisecond intervals for 50-hertz units, with 63 events stored per record. All changes of state that occur during each scan are time- and date-stamped. Sequence-of-events reports are available through BESTCOMS*Plus*®.

Any one of over 400 monitored data/status points can be recorded in a sequence-of-events record. All points are enabled by default.

If an active connection to a DECS-150 is present, the sequence of events will automatically download. Using the Options button, you can copy, print, or save the sequence of events. The Refresh button is used to refresh/update the list of events. The Clear button will clear all events. The Toggle Sorting button enables sorting. Click on a column header to sort.

The Sequence-of-Events screen is illustrated in Figure 62.

Time Stamp	Description	Status
1970-01-01 02:46:38.594	Exciter Field Current Limit	On
1970-01-01 02:46:38.594	OUTPUT 2	On
1970-01-01 02:46:38.594	Alarm Output	On
1970-01-01 00:00:31.214	PSS Active	Off
1970-01-01 00:00:31.214	Exciter Field Current Limit	Off
1970-01-01 00:00:31.214	OUTPUT 2	Off
1970-01-01 00:00:31.230	Generator Below 10 Hz Pickup	On
1970-01-01 00:00:31.230	Soft Start Active	On
1970-01-01 00:00:31.330	Generator Below 10 Hz Trip	On
1970-01-01 00:00:31.397	PSS Speed Failed Alarm	On
1970-01-01 00:00:31.697	Ethernet Link Lost	On
1970-01-01 00:00:32.097	Underfrequency V/Hz	On
1970-01-01 00:00:34.197	Ethernet Link Lost	Off
1970-01-01 00:00:36.230	Soft Start Active	Off

Figure 62. Sequence-of-Events Screen

Data Logging

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

The data logging function of the DECS-150 can record up to four oscillography records. DECS-150 oscillography records use the IEEE Standard Common Format for Transient Data Exchange (COMTRADE). Each record is time- and date-stamped. After four records have been recorded, the DECS-150 begins recording the next record over the oldest record. Because oscillography records are stored in nonvolatile memory, interruptions in DECS-150 operating power will not affect the integrity of the records.

Setup

When oscillography is enabled, each record can consist of up to six user-selectable parameters with up to 600 data points recorded for each parameter.

A pre-trigger-points setting enables a user-defined number of data points recorded prior to the event trigger to be included in a data log. 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.

The Data Log Setup Screen is illustrated in Figure 63. Setting ranges and defaults are summarized in Table 27.

Figure 63. Data Log Setup Screen

Table 27. Data Log Settings

Setting	Range	Default
Enable	Enabled or Disabled	Disabled
Pre-Trigger Points	0 to 599 in increments of 1	0
Sample Interval	4 to 10,000 ms in 4 ms increments (60 Hz nominal) or 5 to 12,500 ms in 5 ms increments (50 Hz nominal)	4.166 ms
Log Parameters	No Level Trigger, Vab, Vbc, Vca, Vbus, Ia, Ib, Ic, Vavg, Iavg, Iaux, Vfd, Ifd, Vaux, W, var, VA, PF, V1, V2, I1, I2, S1, S2, S3, S4, S5, S6, G Hz, B Hz, Test, Ptest, TermF, CompF, PssW, Vtmag, x2, WashW, x5, WashP, x7, x8, x9, x10, x11, MechP, Synth, Tflt1, x29, x15, x16, x17, x31, Prelim, Post, POut, CntOp, TrnOp, ErrIn, Oel Output, Uel Output, Scl Output, Null Balance, Null State, PositionInd, AvrOut, FcrErr, FcrState, FcrOut, var/PfErr, var/PfState, var/PfOut, Oel State, Uel State, Scl State, Droop, Network Load Share, Oel Ref, Uel Ref, Scli Ref, Scl PfRef, or Power Input	Ic, Iaux, Vfd, V2, I1, and SclOutput

Triggers

BESTCOMS*Plus* Navigation Path: Settings Explorer, Report Configuration, DataLog

Data logging may be triggered by mode change, logic change, level changes, or manually through BESTCOMS*Plus*.

Mode Triggers

Mode triggers initiate data logging as a result of an internal or external DECS-150 status change.

The Mode Triggers screen is illustrated in Figure 64. Setting ranges and defaults are summarized in Table 28.

Figure 64. Mode Triggers Screen

Table 28. Mode Triggers Settings

Setting	Range	Default
Start/Stop	Trigger on stop mode, Trigger on start mode, or No Trigger	No Trigger
Soft Start	Soft Start Mode Off, Soft Start Mode Active, or No Trigger	No Trigger
Underfrequency	Inactive Trigger, Active Trigger, or No Trigger	No Trigger
Auto/Manual	Manual Control Trigger, AVR Control Trigger, or No Trigger	No Trigger
Power Factor/var	Operating Mode Off Trigger, Operating Mode PF Trigger, Operating Mode VAR Trigger, or No Trigger	No Trigger
Limiters	Limiter Off Trigger, Limiter UEL Trigger, Limiter OEL Trigger, Limiter UEL OEL Trigger, Limiter SCL Trigger, Limiter UEL SCL Trigger, Limiter OEL SCL Trigger, Limiter UEL OEL SCL Trigger, or No Trigger	No Trigger
Voltage Matching	VMM Off Trigger, VMM On Trigger, or No Trigger	No Trigger
PSS	Disabled Trigger, Enabled Trigger, or No Trigger	No Trigger
Droop	Disabled Trigger, Enabled Trigger, or No Trigger	No Trigger
Network Load Share	Disabled Trigger, Enabled Trigger, or No Trigger	No Trigger
Line Drop	Disabled Trigger, Enabled Trigger, or No Trigger	No Trigger
Cross Current Comp.	Disabled Trigger, Enabled Trigger, or No Trigger	No Trigger
Test	Disabled Trigger, Enabled Trigger, or No Trigger	No Trigger

Level Triggers

Level triggering initiates a data log based on the value of an internal variable. The variable can be a minimum or maximum value and can be specified to trigger a record when the monitored variable crosses a minimum threshold from above, or a maximum threshold from below. A minimum and maximum threshold may also be selected for the monitored variable, causing the monitored value to trigger a record when it rises above its maximum threshold or decreases below its minimum threshold.

Level triggers are configured in BESTCOMS*Plus* on the Level Triggers tab (Figure 65) in the Data Log area of the Report Configuration. The Level Triggers tab consists of a list of parameters that can be selected to trigger a data log. Each parameter has a level trigger enable setting which configures triggering of a data log when the parameter increases above the upper threshold setting or decreases below the lower threshold setting. The parameters available to trigger a data log are listed below.

Figure 65. Level Triggers Screen

- 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
- Field voltage
- Frequency response
- 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
- Negative sequence current
- Negative sequence voltage
- Null balance level
- OEL controller output
- OEL ref.
- OEL state
- Internal State
- Network Load Share
- Position Indication

- Positive sequence current
- Positive sequence voltage
- PSS electrical power
- PSS filtered mech. Power
- PSS final output
- 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 signal
- UEL controller output
- UEL ref.
- UEL state
- Var/PF error
- Var/PF output
- Var/PF state

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 66.

Figure 66. Logic Triggers Screen

Viewing and Downloading Data Logs through BESTCOMS*Plus*®

BESTCOMS*Plus* Navigation Path: Metering Explorer, Reports, Data Log

The Data Log screen (Figure 67) shows a list of records along with log number, number of points, date, time, and record type.

Click the Download button to download and save the selected log as a Binary Comtrade, ASCII Comtrade, or ASCII log file. Click the Refresh button to refresh the list of fault reports on the screen. Click the Reset New button to clear the new records. Click the Reset Total button to clear all records.

Click the Trigger Record button to start the recorder. Click the Stop Record button to stop the recorder and save the record to the list.

Click the Print Summary button to open the Print Preview screen and view or print a summary of the selected data log. Click the Print Record button to open the Print Preview screen and view or print the full details of the selected data log.

Figure 67. Data Log Screen

Power System Stabilizer

The optional (style xPxxx), integrated power system stabilizer (PSS) is an IEEE type PSS2A, dual-input, "integral of accelerating power" stabilizer that provides supplementary damping for low-frequency, local-mode oscillations and power system oscillations.

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

Note
Three-phase sensing current is required for PSS operation.

A summary of the operational settings appears at the end of this chapter.

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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, the 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* chapter 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, the 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, the Hysteresis setting determines the level of (decreasing) power where a transfer back to the primary gain settings will occur.

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.

PSS function is illustrated by the function blocks and software switches shown in Figure 68. This illustration is also available in BESTCOMS*Plus* by clicking the PSS Model Info button located on the Control tab.
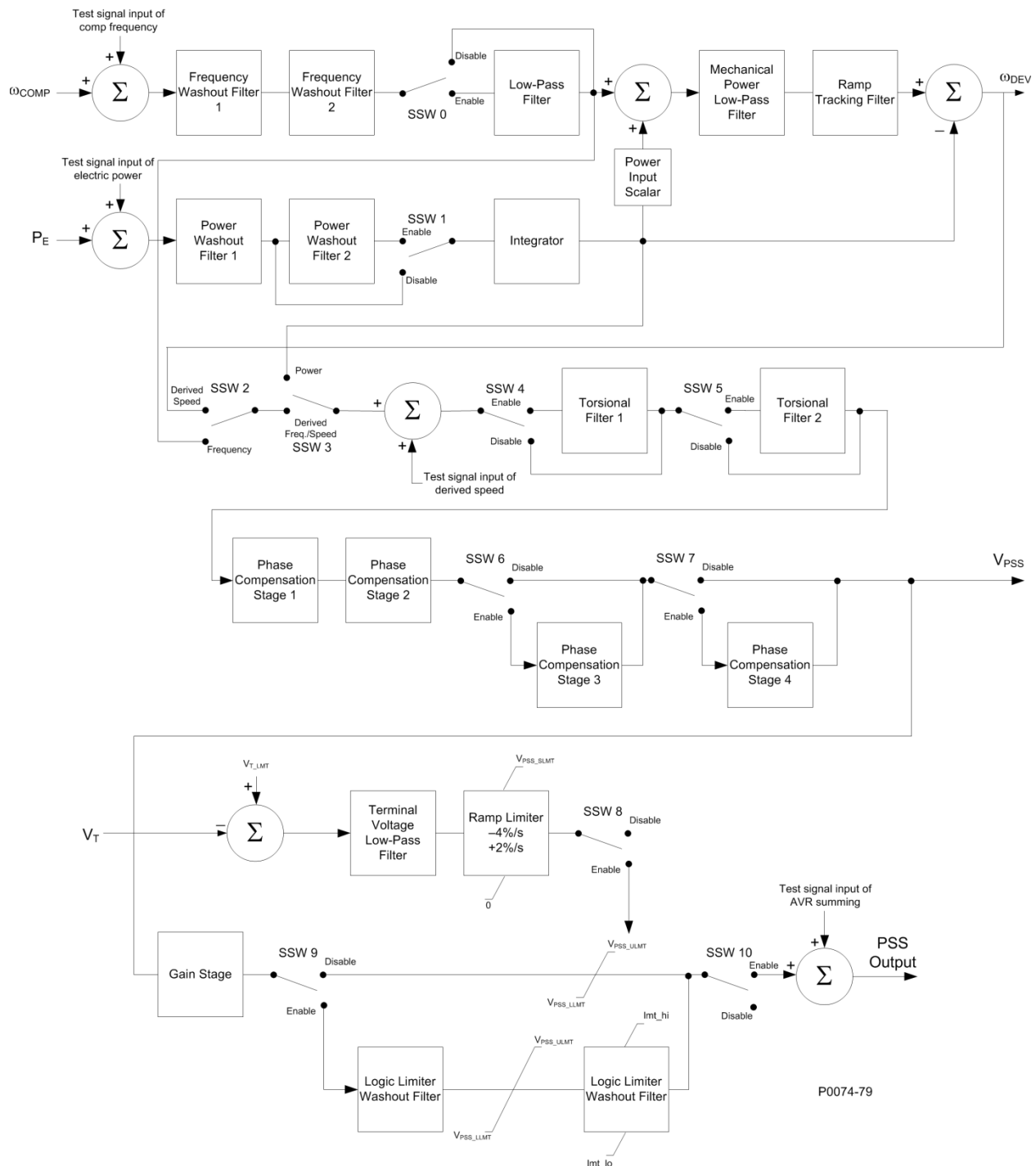
Figure 68. PSS Function Blocks and Software Switches

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 Tw1 and Tw2. 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 TI1 setting.

Figure 69 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.
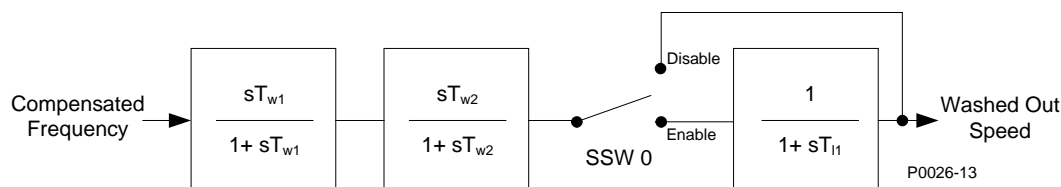
PSS Frequency Input Signal

Figure 69. 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-150 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 Xq setting.

Generator Electrical Power Signal

Figure 70 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-150. Three-phase current sensing is required for PSS operation.

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 Tw3 and the second high-pass filter is controlled by time constant setting Tw4.
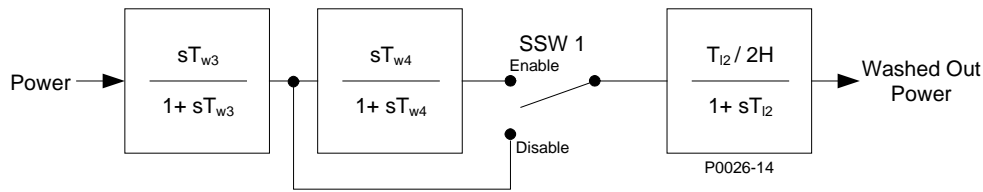
PSS Power Input Signal

Figure 70. 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 TI2.

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, Kpe, 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 TI3 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 Tr. 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 71.
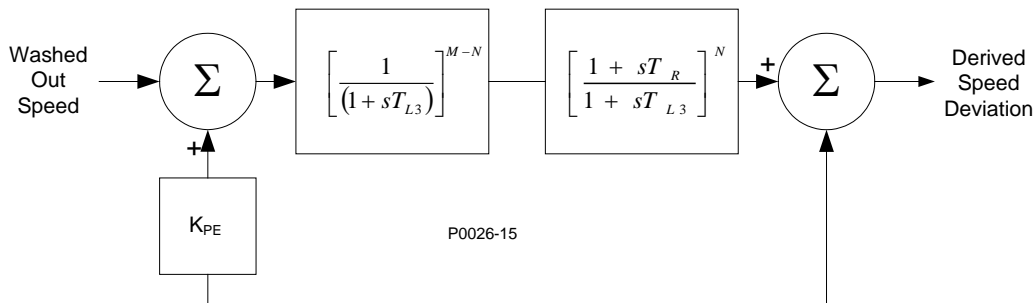
Figure 71. Derived Mechanical Power Signal

Stabilizing Signal Selection

Figure 72 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.
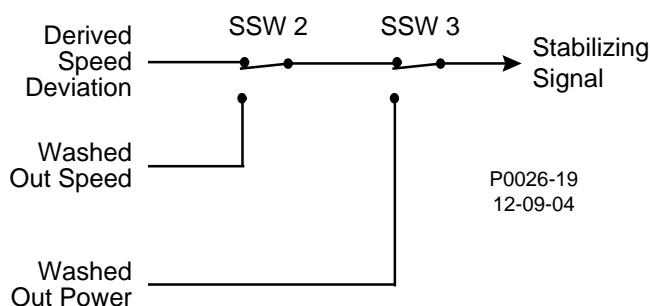
Figure 72. Stabilizing Signal Selection

Torsional Filters

Two torsional filters, shown in Figure 73, 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.
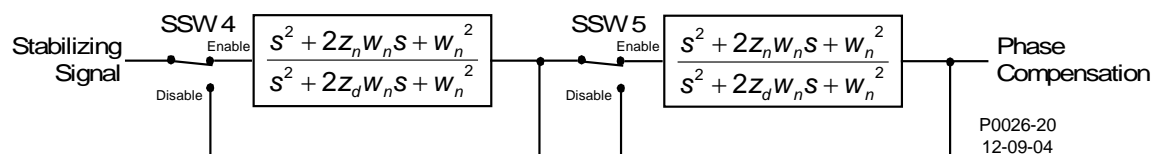
Figure 73. Torsional Filters

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 (Wn).

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 (T1, T3, T5, T7) and a phase lag time constant (T2, T4, T6, T8). 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 74 illustrates the phase compensation stages and associates software switches.
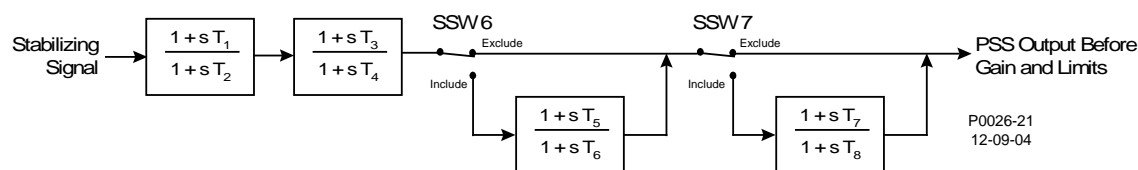
Figure 74. Phase Compensation

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 75 illustrates the washout filter and logic limiter.
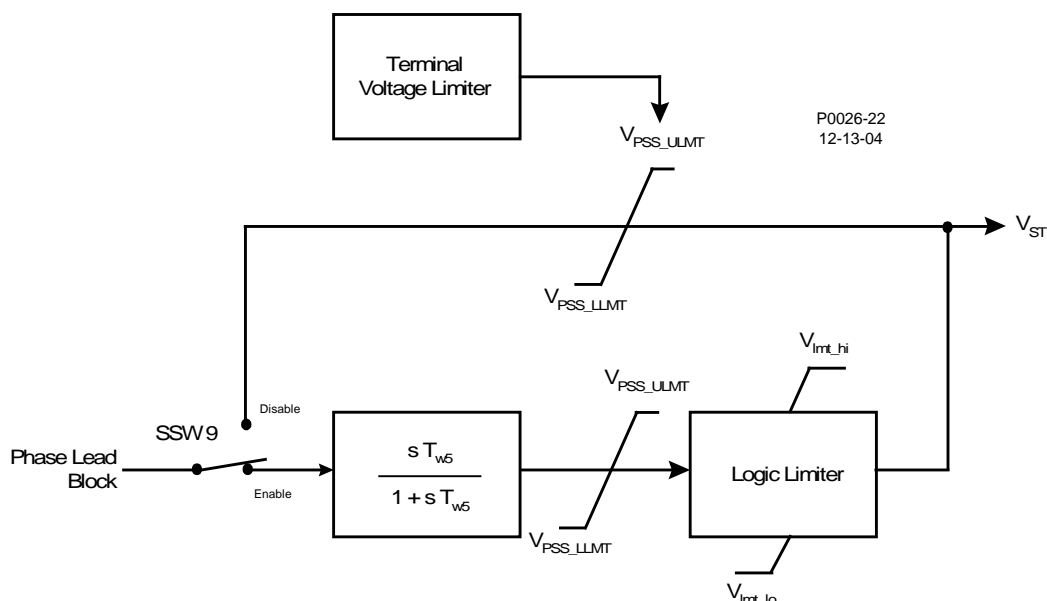
Figure 75. Washout Filter and Logic Limiter

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 76.
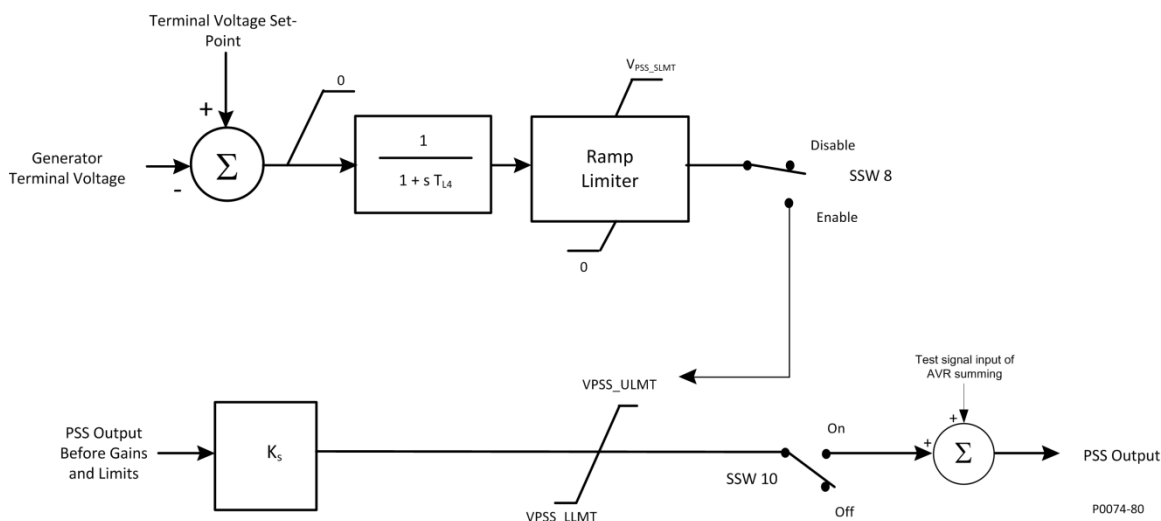
Figure 76. Output Stage

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 75) 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.

Operational Settings

PSS settings are configured exclusively through the BESTCOMS*Plus*® interface. These settings are illustrated in Figures 77 through 80. Setting ranges and defaults are summarized in Tables 29 through 32.

Figure 77. PSS Configure Screen

Table 29. PSS Configure Settings

Setting	Range	Default
Enable	Checked (enabled) or unchecked (disabled)	Disabled
Threshold	0 to 1 in increments of 0.01	0
Hysteresis	0 to 1 in increments of 0.01	0

Figure 78. PSS Control Screen

Table 30. PSS Control Settings

Setting	Range	Default
Enable	Checked (enabled) or unchecked (disabled)	Disabled
Power-On Threshold	0 to 1 in increments of 0.01	0
Power Hysteresis	0 to 1 in increments of 0.01	0
SSW 0 - Speed Low Pass Filter	Enabled or Disabled	Disabled
SSW 1 - Power Washout Filter #2	Enabled or Disabled	Disabled
SSW 2 - PSS Signal	Frequency or Der. Speed	Der. Speed
SSW 3 - PSS Signal	Power or Der. Freq/Speed	Der. Freq/Speed
SSW 4 - Torsional Filter 1	Enabled or Disabled	Disabled
SSW 5 - Torsional Filter 2	Enabled or Disabled	Disabled
SSW 6 - 3rd Lead/Lag Stage	Exclude or Include	Exclude
SSW 7 - 4th Lead/Lag Stage	Exclude or Include	Exclude
SSW 8 - Term. Voltage Limiter	Enabled or Disabled	Disabled

Setting	Range	Default
SSW 9 - Logic Limiter	Enabled or Disabled	Disabled
SSW 10 - PSS Output	Off or On	Off

Figure 79. PSS Parameter Screen

Table 31. PSS Parameter Settings

Setting	Range	Default
TI1 - Time Constant 1	0 to 20 s in 0.01 s increments	0 s
TI2 - Time Constant 2	0.01 to 20 s in 0.01 s increments	1 s
TI3 - Time Constant 3	0.05 to 20 s in 0.01 s increments	0.1 s
Tr - Ramp Tracking Filter Time Constant	0.01 to 1 s in 0.01 s increments	0.5 s
N - Numerator Exponent	0 or 1 in increments of 1	1
M - Denominator Exponent	1 to 5 in increments of 1	5
Tw1 - Tw4 High Pass Filter (Washout) Time Constants	1 to 20 s in 0.01 s increments	1 s
H - Inertia	1 to 25 in increments of 0.01	1
Zeta Num 1 - 2	0 to 1 in increments of 0.01	0.5
Zeta Den 1 - 2	0 to 1 in increments of 0.01	0.25
Wn Frequency Response Parameter 1 - 2	10 to 150 in increments of 0.05	42.05
Quadrature Xq	0 to 5 in increments of 0.001	0
Kpe Electrical Power Input Gain	0 to 2 in increments of 0.01	1
T1 - T8 Phase Compensation Time Constants	0.001 to 6 s in 0.001 s increments	1 s

Figure 80. PSS Output Limiter Screen

Table 32. PSS Output Limiter Settings

Setting	Range	Default
PSS Output Limiting - Upper Limit	0 to 0.5 in increments of 0.001	0
PSS Output Limiting - Lower Limit	−0.5 to 0 in increments of 0.001	0
Stabilizer Gain - Ks	−50 to 50 in increments of 0.01	0
Terminal Voltage Limiter - Time Constant	0.02 to 5 s in 0.001 s increments	1 s
Terminal Voltage Limiter - Setpoint	0 to 10 in increments of 0.001	1
Logic Limiter Washout Filter - Normal Time	5 to 30 s in 0.1 s increments	10 s
Logic Limiter Washout Filter - Limit Time	0 to 1 s in 0.01 s increments	0.3 s

Setting	Range	Default
Logic Output Limiter - Upper Limit	0.01 to 0.04 in increments of 0.001	0.02
Logic Output Limiter - Lower Limit	−0.04 to −0.01 in increments of 0.001	−0.02
Logic Output Limiter - Time Delay	0 to 2 s in 0.01 s increments	0.5 s

Stability Tuning

Generator stability tuning in the DECS-150 is achieved through the calculation of PID parameters. PID stands for Proportional, Integral, Derivative. The word proportional indicates that the response of the DECS-150 output is proportional or relative to the difference of change observed. Integral means that the DECS-150 output is proportional to the amount of time that a difference is observed. Integral action eliminates offset. Derivative means that the DECS-150 output is proportional to the required rate of excitation change. Derivative action avoids excitation overshoot.

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

AVR Mode

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, Gain, AVR

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 can provide improved damping of first swing oscillations when the PSS is offline.

BESTCOMS*Plus*® primary and secondary AVR stability settings are shown in Figure 81. Setting ranges and defaults are summarized in Table 33.

Predefined Stability Settings

Twenty predefined sets of stability settings are available with the DECS-150. Appropriate PID values are implemented based on the nominal generator frequency selected (see the *Configuration* chapter) and the combination of generator (T'do) and exciter (Texc) 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).

Custom Stability Settings

Stability tuning can be tailored for optimum generator transient performance. Selecting a primary gain option of "custom" 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 Kp. 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.

Figure 81. AVR Screen

Table 33. AVR Settings

Setting	Range	Default
Kp	0 to 1,000 in increments of 0.001	80
Ki	0 to 1,000 in increments of 0.001	20
Kd	0 to 1,000 in increments of 0.001	10
Td	0 to 1 in increments of 0.01	0
Ka	0 to 1 in increments of 0.001	0.1
Primary Gain Option	T'do=1.0 Te=0.17, T'do=1.5 Te=0.25, T'do=2.0 Te=0.33, T'do=2.5 Te=0.42, T'do=3.0 Te=0.50, T'do=3.5 Te=0.58, T'do=4.0 Te=0.67, T'do=4.5 Te=0.75, T'do=5.0 Te=0.83, T'do=5.5 Te=0.92, T'do=6.0 Te=1.00, T'do=6.5 Te=1.08, T'do=7.0 Te=1.17, T'do=7.5 Te=1.25, T'do=8.0 Te=1.33, T'do=8.5 Te=1.42, T'do=9.0 Te=1.50, T'do=9.5 Te=1.58, T'do=10.0 Te=1.67, T'do=10.5 Te=1.75, or Custom	Custom

PID Calculator

The PID calculator is accessed by clicking the PID calculator button (see Figure 81) and is available only when the primary gain option is "Custom". The PID calculator (Figure 82) 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.

Setting ranges and defaults are summarized in Table 34.

> **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 82. Primary PID Calculator Screen

Table 34. Primary PID Calculator Settings

Setting	Range	Default
Generator Information	Up to 30 alphanumeric characters	Blank
T'do - Gen. Time Constant	1 to 15 in increments of 0.05	2
Use Default Exciter Time Constant	Checked (enabled) or unchecked (disabled)	Disabled
Te - Exciter Time Constant	0.04 to 1 in increments of 0.01	0.33
Td - Derivative Time Constant	0 to 1 in increments of 0.01	0
Ka - Voltage Regulator Gain	0 to 1 in increments of 0.001	0.1

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.

The auto tuning function is accessed by clicking the Auto Tune button (Figure 81). BESTCOMS*Plus*® must be in Live Mode in order to begin the auto tuning process. The auto tuning window (Figure 83) provides options for choosing the PID Design Mode and the Power Input Mode. When the desired settings are selected, the Start Auto Tune button is clicked to start the process. After the process is complete, click the Save PID Gains (Primary) button to save the data. The File menu contains options for importing, exporting, and printing graph (*.gph) files.

Setting ranges and defaults are summarized in Table 35.

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.
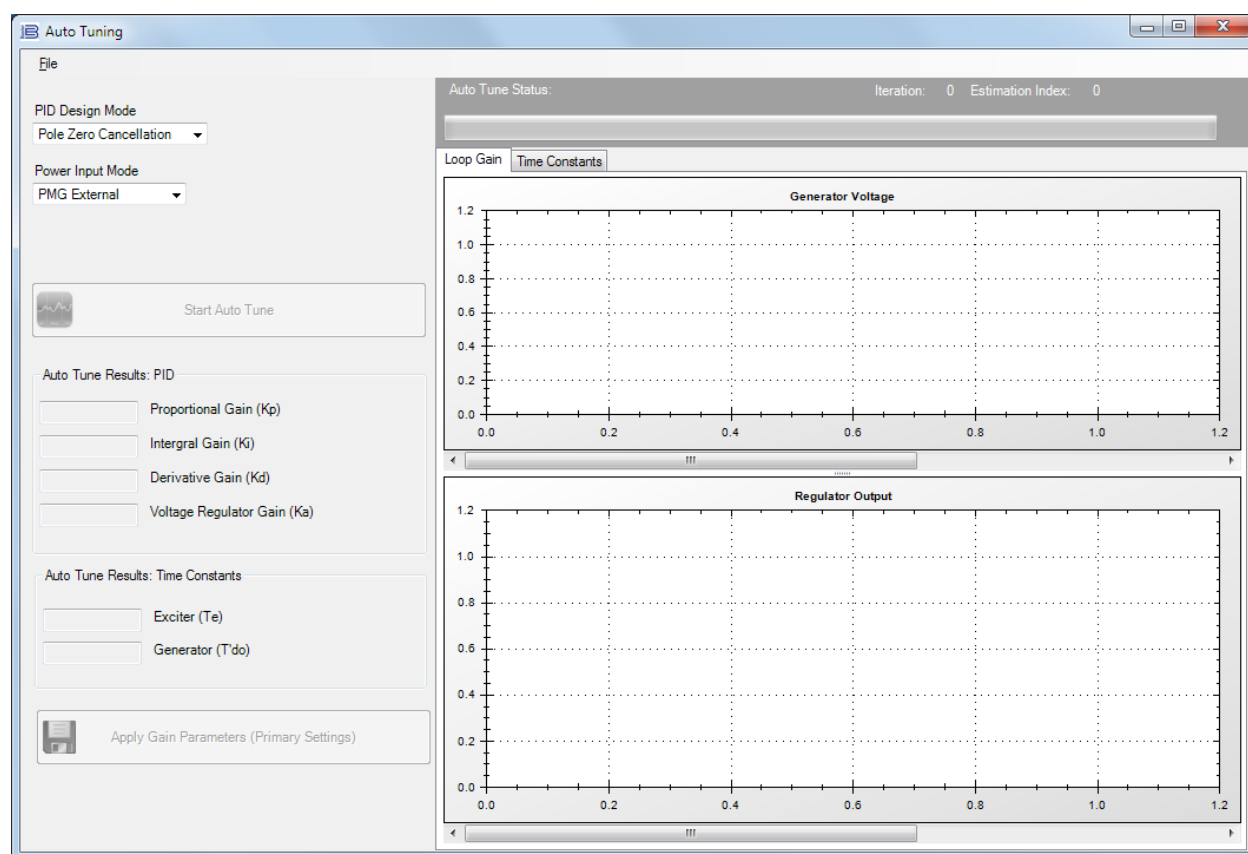
Figure 83. Auto Tuning Screen

Table 35. Auto Tuning Settings

Setting	Range	Default
PID Design Mode	Pole Zero Cancellation or Pole Placement	Pole Zero Cancellation
Power Input Mode	PMG External or Shunt	PMG External

FCR Mode

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, Gain, FCR

Stability tuning can be tailored for optimum performance when operating in field current regulation mode.

BESTCOMS*Plus* FCR stability settings are illustrated in Figure 84. Setting ranges and defaults are summarized in Table 36.

FCR Mode Stability Settings

The DECS-150 bases its field current output 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 Ki 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) with recommended gain calculation.

Figure 84. FCR Screen

Table 36. FCR Settings

Setting	Range	Default
Kp - Proportional Gain	0 to 1,000 in increments of 0.001	10
Ki - Integral Gain	0 to 1,000 in increments of 0.001	50
Kd - Derivative Gain	0 to 1,000 in increments of 0.001	0
Td - Derivative Time Constant	0 to 1 in increments of 0.01	0
Ka - Voltage Regulator Gain	0 to 1 in increments of 0.001	0.1

Other Modes and Functions

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

Settings for stability tuning of the Var and Power Factor modes are provided in the DECS-150 along with settings for stability tuning of limiters, the voltage matching function, and main field voltage response.

Figure 85 illustrates these settings as they appear in BESTCOMS*Plus*. Setting ranges and defaults are summarized in Table 37.

Var Mode

The integral gain (K_i) adjusts the Var mode integral gain which determines the characteristic of the DECS-150 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 Power Factor mode integral gain which determines the characteristic of the DECS-150 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-150 responds during an overexcitation condition.

The integral 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-150 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-150 limits stator current.

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

Voltage Matching

The integral gain (K_i) adjusts the rate at which the DECS-150 matches the generator voltage to the bus voltage.

Figure 85. Var, PF, OEL, UEL, SCL Screen

Table 37. Var, PF, OEL, SCL Settings

Setting	Range	Default
Var Ki - Integral Gain	0 to 1,000 in increments of 0.001	0.1
Var Kg - Loop Gain	0 to 1,000 in increments of 0.001	1
PF Ki - Integral Gain	0 to 1,000 in increments of 0.001	0.1
PF Kg - Loop Gain	0 to 1,000 in increments of 0.001	1
OEL Ki - Integral Gain	0 to 1,000 in increments of 0.001	10
OEL Kg - Loop Gain	0 to 1,000 in increments of 0.001	0.1
UEL Ki - Integral Gain	0 to 1,000 in increments of 0.001	0.1
UEL Kg - Loop Gain	0 to 1,000 in increments of 0.001	0.5
SCL Ki - Integral Gain	0 to 1,000 in increments of 0.001	1
SCL Kg - Loop Gain	0 to 1,000 in increments of 0.001	0.2
Voltage Matching Kg - Loop Gain	0 to 1,000 in increments of 0.001	0.05

Mounting

The DECS-150 is normally located in the generator conduit box. It is designed for behind-the-panel mounting and requires a cutout for front panel viewing and access to the front-panel USB jack (if so equipped). Supplied mounting hardware consists of six #12 thread-forming screws. The screws pass through mounting holes in the conduit box and thread into the plastic shell of the DECS-150. The screws are equipped with O-ring seals. The recommended torque for the steel mounting screws is 3.95 newton-meters (35 inch-pounds). The unit must be mounted where the ambient temperature does not exceed the allowable environmental conditions called out in the *Specifications* chapter. DECS-150 package dimensions are shown in Figure 86. Cutout and drilling dimensions are shown in Figure 87. Drawing dimensions are shown in inches and millimeters (in parenthesis).

Installation for EMC Compliance

The DECS-150 must be mounted inside a grounded, metal, EMC-type enclosure (conduit box).
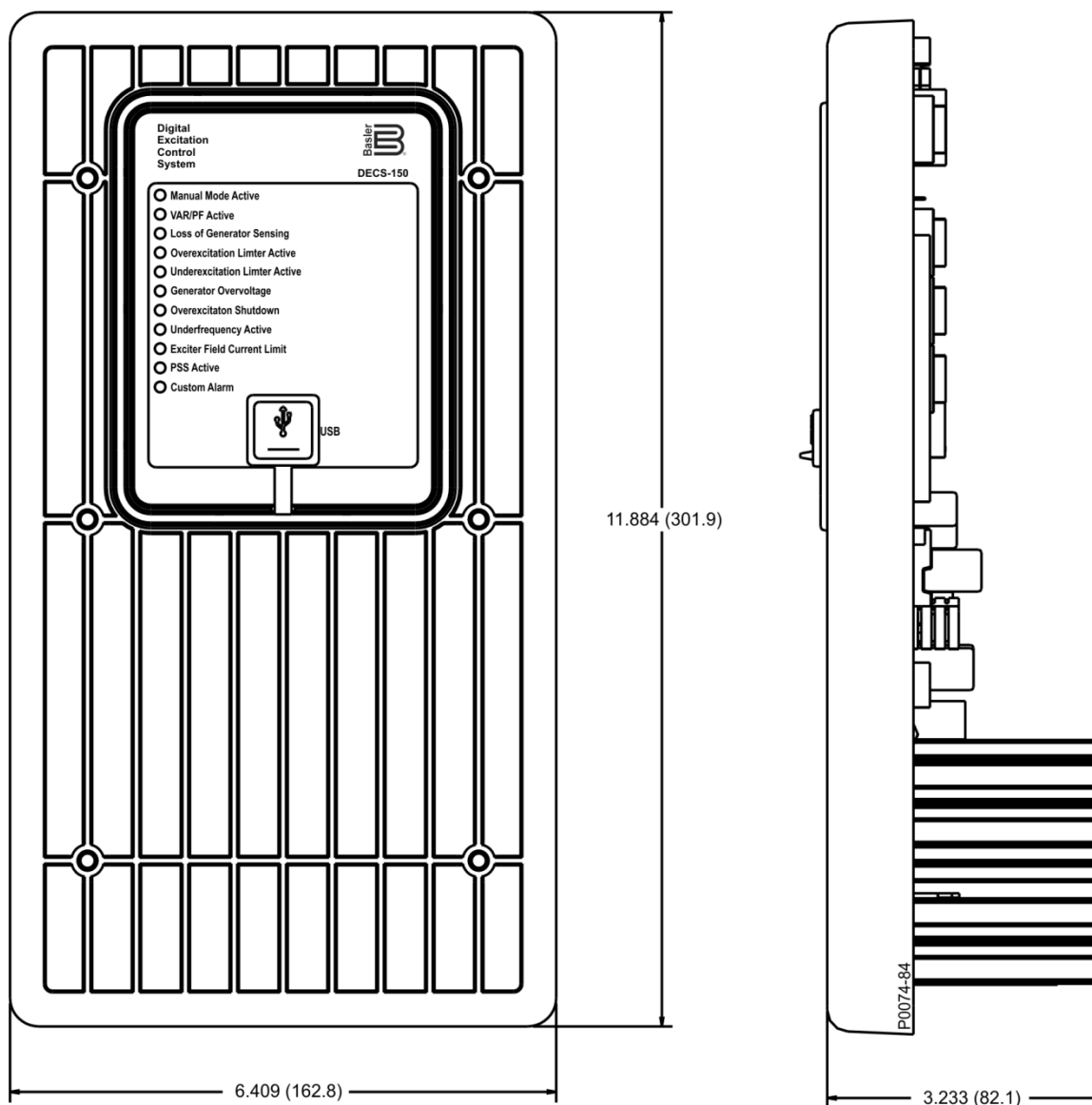
Figure 86. DECS-150 Dimensions
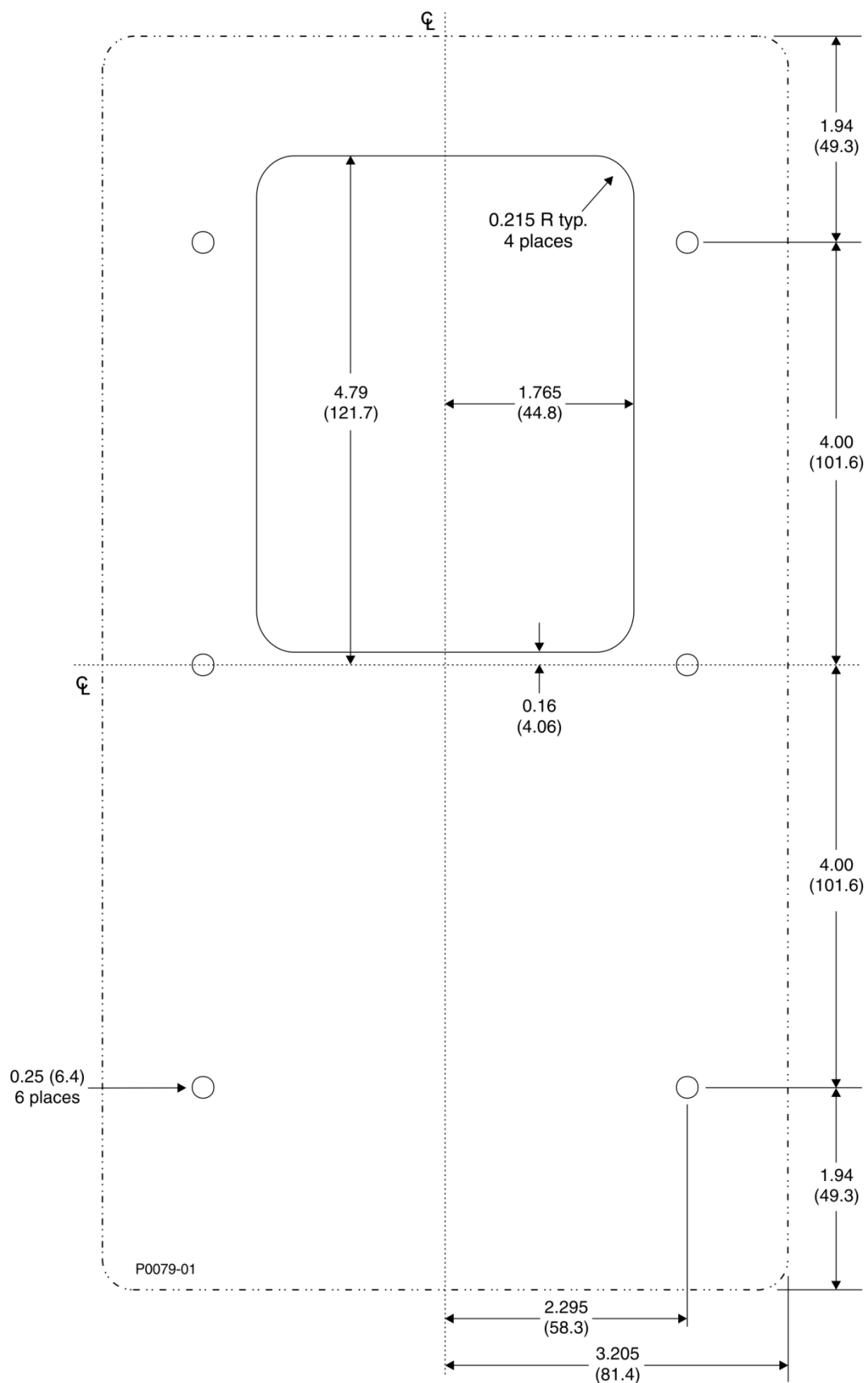
Figure 87. Cutout and Drilling Dimensions

Terminals and Connectors

DECS-150 terminals and connectors are located on the rear panel as illustrated in Figure 88. DECS-150 terminals consist of single-row, multiple-pin headers that mate with removable connectors wired by the user. The USB port is located on the front or rear panel as specified by the DECS-150 style number. The USB port and Ethernet port are described in the *Communications* chapter.

DECS-150 connections are made with connectors with spring compression terminals. These connectors plug into headers on the DECS-150. The connectors and headers have a dovetailed edge that ensures proper connector orientation. The 15-position connectors and headers are uniquely keyed to ensure that a connector mates only with the correct header. Connector terminals accept a maximum wire size of 12 AWG. Connectors and headers may contain tin- or gold-plated conductors.

Caution
By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Terminal Descriptions

DECS-150 terminals are described in the following paragraphs.

Power Supply Inputs (3, 4, 5, GND)

These terminals accept single-phase or three-phase operating power for the excitation power stage of the DECS-150. A ground for the operating power connections is provided at terminal GND.

For more information, refer to the *Power Input and Output* chapter.

Generator Voltage Sensing Inputs (E1, E2, E3)

Three-phase generator sensing voltage, obtained from user-supplied voltage transformers (VTs) if required, connect to these terminals.

For more information, refer to the *Voltage and Current* chapter.

Bus Voltage Sensing Inputs (B1, B2, B3)

Three-phase bus sensing voltage, obtained from user-supplied potential transformers (PTs) if required, connects to these terminals.

For more information, refer to the *Voltage and Current* chapter.

Generator Current Sensing Inputs (IA+, IA–, IB+, IB–, IC+, IC–)

These terminals connect to user-supplied current transformers (CTs) providing three phases of generator sensing current.

For more information, refer to the *Voltage and Current* chapter.

Cross-Current Compensation Input (CC+, CC–)

These terminals connect to user-supplied current transformers (CTs) providing a cross-current compensation signal.

For more information, refer to the *Voltage and Current* chapter.

Power (Field) Output (F+, F–)

Excitation power is supplied to the field through these terminals.

For more information, refer to the *Power Input and Output* chapter.

Accessory Input (I+, I–, V+, V–)

These terminals accept an external analog control signal for auxiliary control of the regulation setpoint.

For more information, refer to the *Auxiliary Control* chapter.

Contact Inputs (IN1, IN2, IN3, IN4, IN5, IN6, IN7, IN8, COM)

Programmable contact inputs 1 through 8 are applied to these inputs.

For more information, refer to the *Contact Inputs and Outputs* chapter.

Watchdog Output (WD1, WD2, WD3)

Watchdog output connections are made at these terminals.

For more information, refer to the *Contact Inputs and Outputs* chapter.

Programmable Outputs (OC1, OC2)

Programmable output connections are made at these terminals.

For more information, refer to the *Contact Inputs and Outputs* chapter.

Breaker Shunt Trip Output (ST+, ST–)

This output provides an electronic switch capable of 100 milliamps (ac or dc) that can be used to control an external circuit breaker.

External Tracking Inputs (GND, C2L, C2H)

A second DECS-150 connects to these terminals for the purpose of setpoint tracking.

For more information, refer to the *Regulation* chapter.
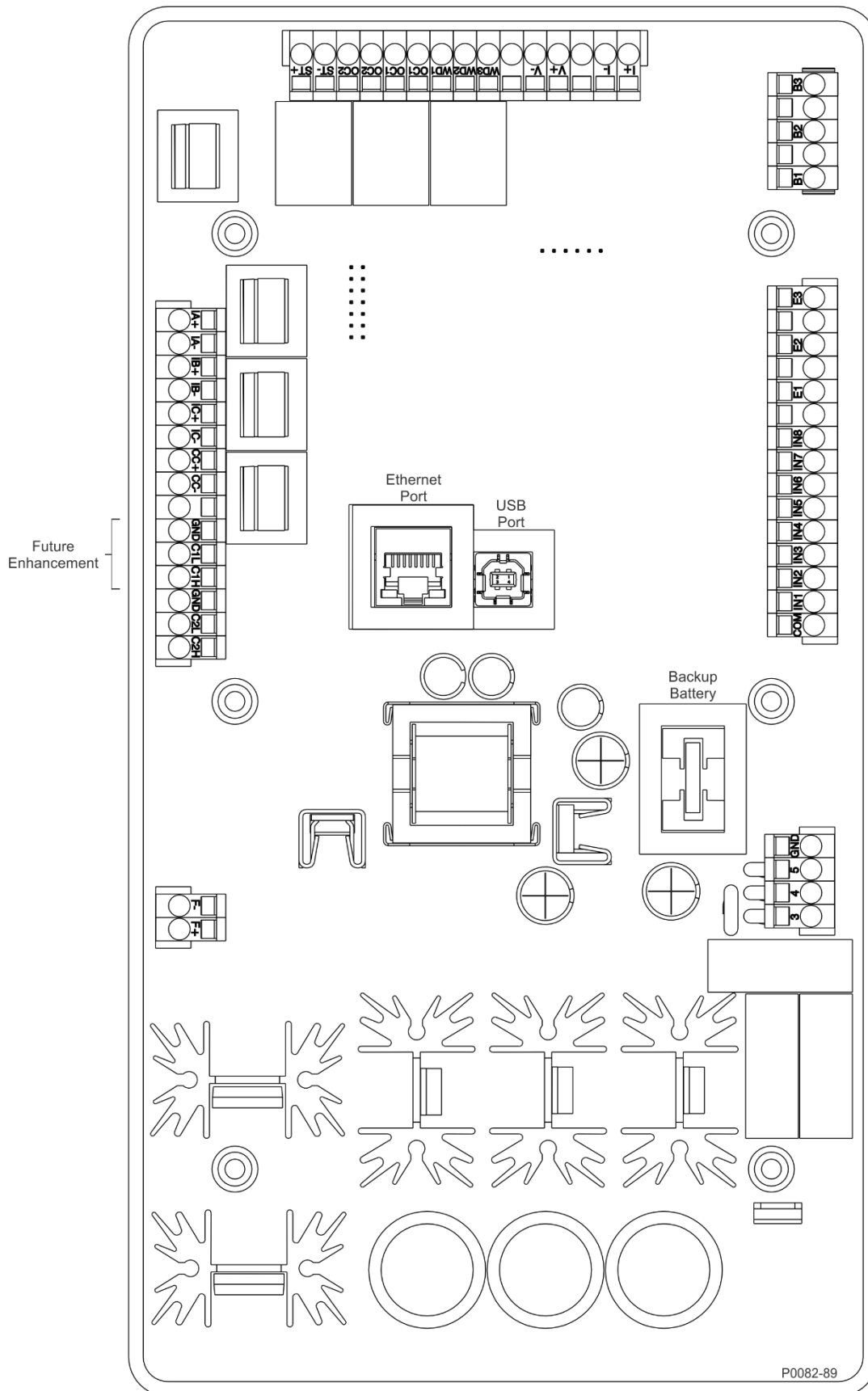
Figure 88. DECS-150 Terminals

Typical Connections

Typical connection diagrams are provided in this chapter as a guide when wiring the DECS-150 for communication, contact inputs, contact outputs, sensing, and operating power.

Typical connections for shunt powered applications are shown in Figure 89. Typical connections for PMG powered applications are shown in Figure 90. Typical connections for station powered applications are shown in Figure 91. Three-phase-delta voltage sensing connections are shown. The drawing notes in Figures 89, 90, 91 and correspond to the descriptions found in Table 38.

Table 38. Typical Connection Drawing Descriptions

Drawing Note	Description
1	Optional - ICRM-7 (Inrush Current Reduction Module), Basler part number 9387900103.
2	Operating (bridge) power input. For single-phase power, omit one phase connection. See the *Power Input* chapter for operating power ratings.
3	Generator voltage sensing input. Potential transformer required if line voltage exceeds 600 Vac.
4	Cross-current compensation input, 1 Aac or 5 Aac.
5	Connections required only if voltage matching or sync-check functions are used.
6	Labels indicate the functions assigned by the default programmable logic to the contact inputs and output contacts.
7	The Breaker Shunt Trip Output provides a switch capable of 100 mA to operate an external circuit breaker.
8	Type B USB jack for temporary, local communication. **Caution** In accordance with the guidelines defined in USB standards, the USB port on this device is not isolated. To prevent damage to a connected PC or laptop, the DECS-150 must be properly tied to ground.
9	Ethernet communication port that uses the Modbus communication protocol.
10	The accessory input accepts voltage or current. Refer to the *Auxiliary Control* chapter for more information.
11	Bussmann type KTK-15 or equivalent fuses recommended.
12	CAN2 communication port used to communicate with a second DECS-150 for external tracking.
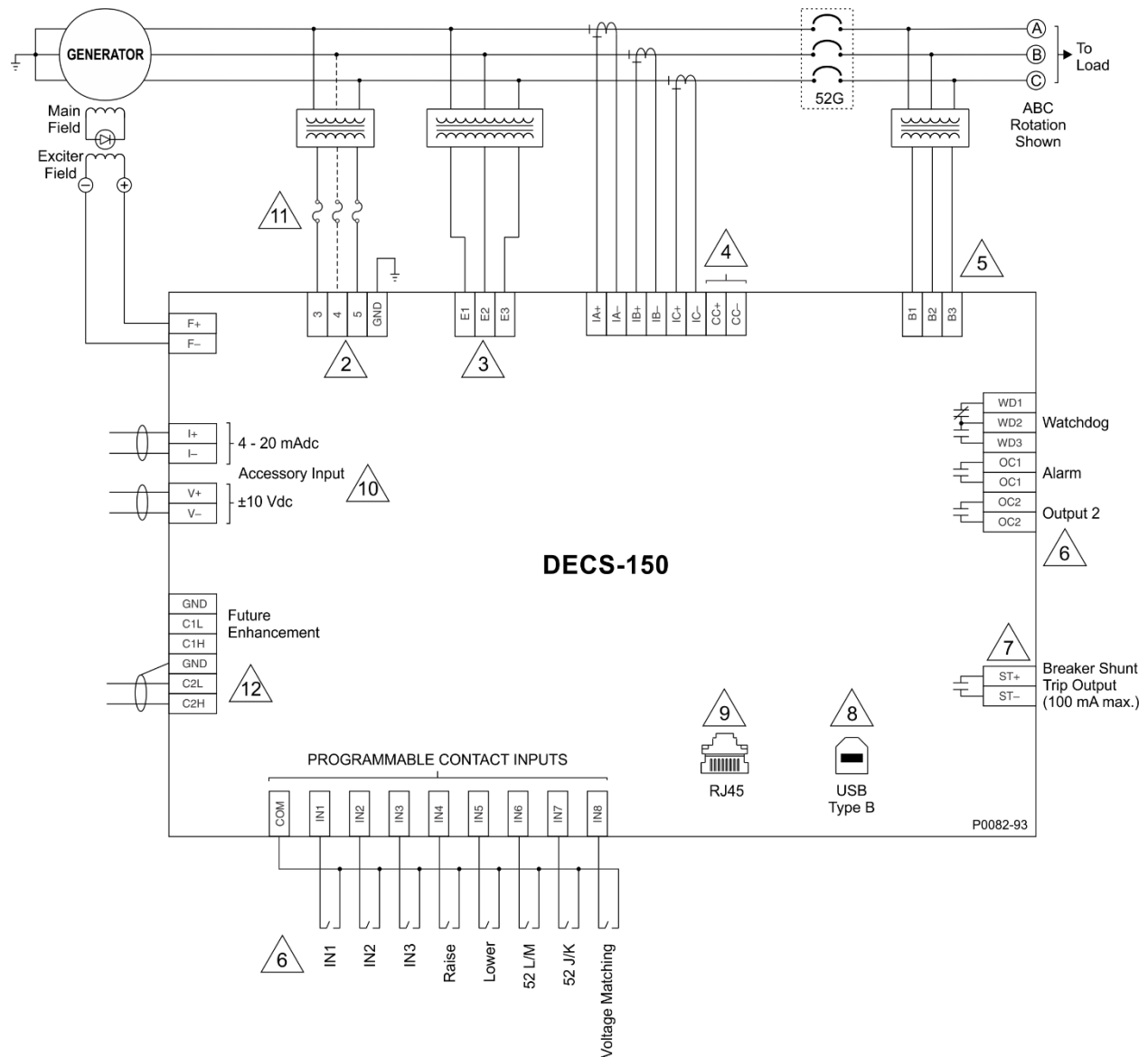
Figure 89. Typical DECS-150 Connections for Shunt Powered Applications
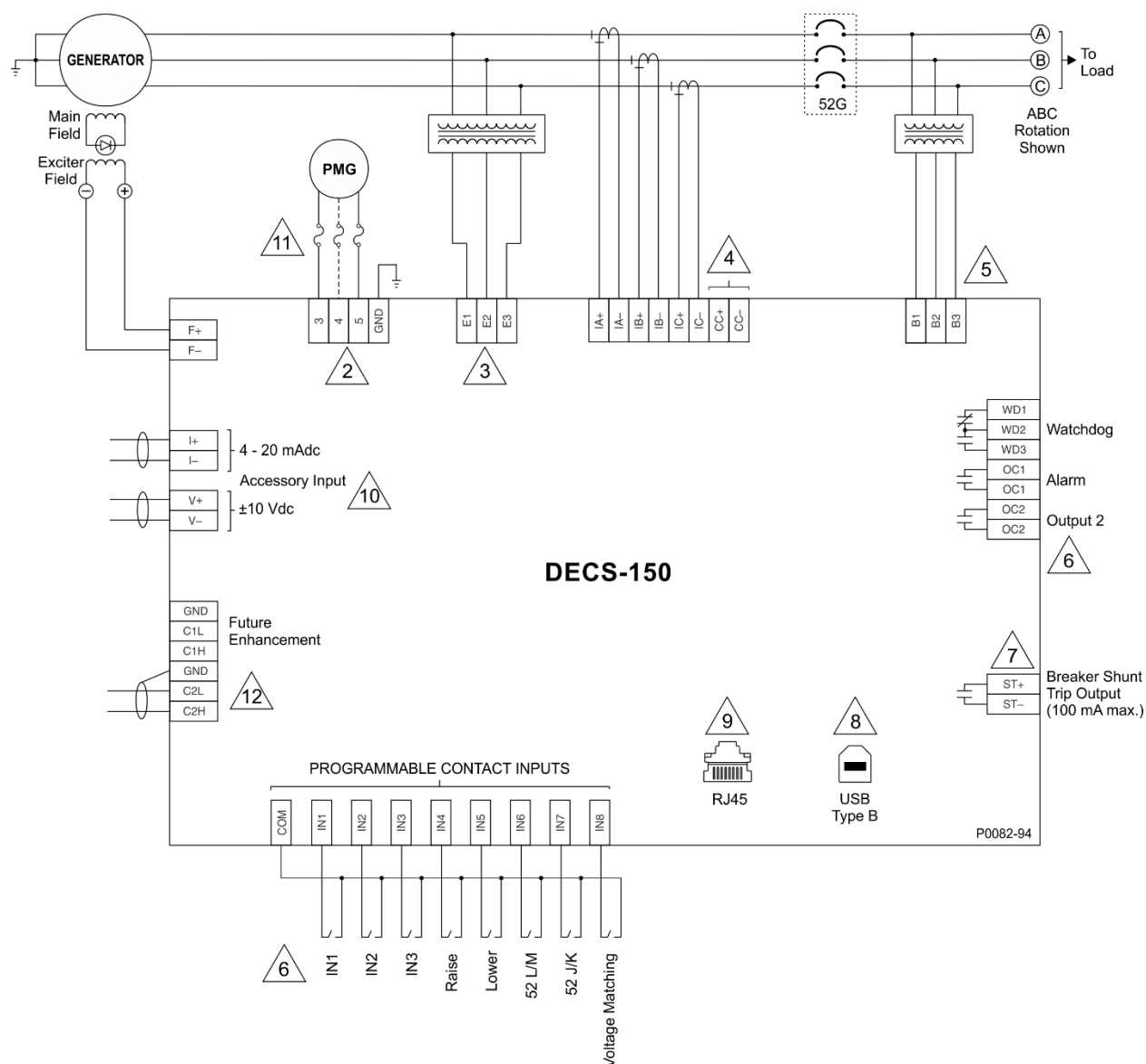
Figure 90. Typical DECS-150 Connections for PMG Powered Applications
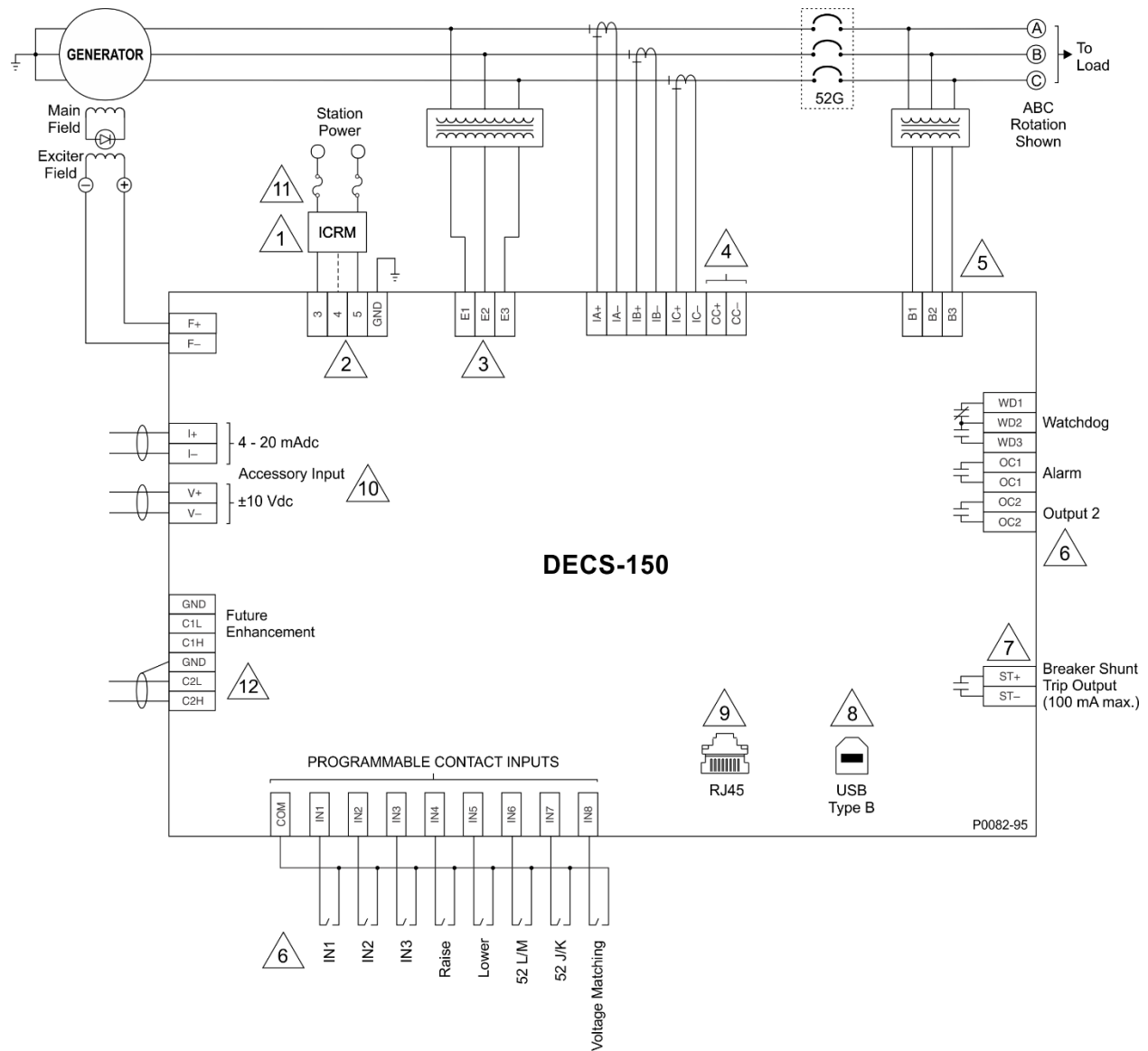
Figure 91. Typical DECS-150 Connections for Station Powered Applications

BESTCOMS*Plus*® Software

General Description

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

BESTCOMS*Plus* provides the user with a point-and-click means to set and monitor the DECS-150. The capabilities of BESTCOMS*Plus* make the configuration of one or several DECS-150 controllers fast and efficient. A primary advantage of BESTCOMS*Plus* is that a settings scheme can be created, saved as a file, and then uploaded to the DECS-150 at the user's convenience.

BESTCOMS*Plus* uses plugins allowing the user to manage several different Basler Electric products. The DECS-150 plugin must be activated before use. The plugin can be activated automatically by connecting to a DECS-150 or activated manually by requesting an activation key from Basler Electric.

The DECS-150 plugin opens inside the BESTCOMS*Plus* main shell. The same default logic scheme that is shipped with the DECS-150 is brought into BESTCOMS*Plus* by downloading settings and logic from the DECS-150. 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-150 logic for protection elements, inputs, outputs, alarms, etc. This is accomplished by the drag-and-drop method. The user can drag elements, components, inputs, and outputs onto the program grid and make connections between them to create the desired logic scheme.

BESTCOMS*Plus* 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 92 illustrates the typical user interface components of the DECS-150 plugin with BESTCOMS*Plus*.
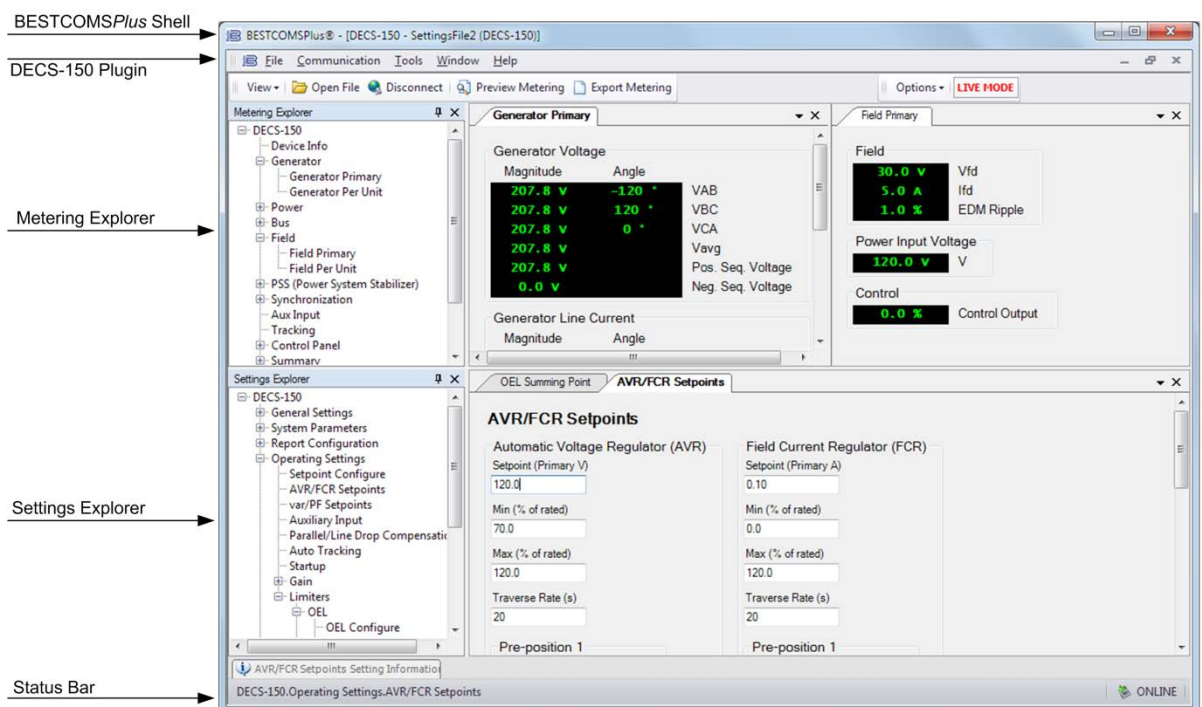
Figure 92. Typical User Interface Components

Installation

BESTCOMS*Plus* software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMS*Plus* on your PC also installs the DECS-150 plugin and the required version of .NET Framework (if not already installed). BESTCOMS*Plus* operates with systems using Windows® XP 32-bit SP2/SP3, Windows Vista 32-bit (all editions), Windows 7 32-bit (all editions), Windows 7 64-bit (all editions), Windows 8, and Windows 10. Microsoft Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMS*Plus*. System recommendations for the .NET Framework and BESTCOMS*Plus* are listed in Table 39.

Table 39. System Recommendations for BESTCOMS*Plus* 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 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC.)
		950 MB (if .NET Framework is not already installed on PC.)
64 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC.)
		2.1 GB (if .NET Framework is not already installed on PC.)

To install and run BESTCOMS*Plus*, a Windows user must have Administrator rights. A Windows user with limited rights may not have sufficient access to save files in certain folders.

Install BESTCOMS*Plus*

Note
Do not connect a USB cable until setup completes successfully. Connecting a USB cable before setup is complete may cause errors.

1. Insert the BESTCOMS*Plus* CD-ROM into the PC CD-ROM drive.
2. When the BESTCOMS*Plus* Setup and Documentation CD menu appears, click the Install button for the BESTCOMS*Plus* application. The setup utility installs BESTCOMS*Plus*, the .NET Framework (if not already installed), the USB driver, and the DECS-150 plugin for BESTCOMS*Plus* on your PC.

When BESTCOMS*Plus* 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 BESTCOMS*Plus* when clicked.

Powering the DECS-150 through the USB Port

The DECS-150 can be partially powered from the USB port when no input power is applied. The following capabilities are functional in this mode:

*   The settings interface will operate as expected.
*   Settings and all reports can be downloaded from the unit.
*   Settings and firmware can be uploaded to the unit.

The following capabilities will not function in this mode:

*   Voltage regulation
*   Ethernet communication
*   Metering (including the alarm panel)

If the unit is partially powered by USB followed by application of input power, the USB connection may have to be re-established by removing and re-inserting the USB connector. Likewise, if a USB connection

is established while input power is applied and input power is lost, the USB connection may have to be re-established by removing and re-inserting the USB connector.

Activation of the DECS-150 Plugin for BESTCOMSPlus®

The DECS-150 plugin is a module that runs inside the BESTCOMS*Plus* shell. The DECS-150 plugin contains specific operational and logic settings for only the DECS-150. Uploading settings to the DECS-150 is possible only after activating the DECS-150 plugin.

The DECS-150 plugin can be activated automatically or manually. Automatic activation is achieved by using a USB cable to establish communication between the DECS-150 and BESTCOMS*Plus*. Manual activation is initiated by contacting Basler Electric for an activation key and entering the key into BESTCOMS*Plus*. Manual activation is useful if you want to create a settings file prior to receiving your digital excitation system. Note that if a DECS-150 is not connected, you will not be able to configure certain Ethernet settings. Ethernet settings can be changed only when an active USB or Ethernet connection is present. Refer to *Manual Activation of DECS-150 Plugin.*

Connect a USB Cable

The USB driver was copied to your PC during BESTCOMS*Plus* installation and is installed automatically after powering the DECS-150. USB driver installation progress is shown in the Windows Taskbar area. Windows will notify you when installation is complete.

Connect a USB cable between the PC and your DECS-150. Apply operating power (per style chart in the *Introduction* chapter) to the DECS-150 at rear terminals 3, 4, and 5. Wait until the boot sequence is complete.

Caution
In accordance with the guidelines defined in USB standards, the USB port on this device is not isolated. To prevent damage to a connected PC or laptop, the DECS-150 must be properly tied to ground.

Start BESTCOMS*Plus* and Activate DECS-150 Plugin Automatically

To start BESTCOMS*Plus*, click the Start button, point to Programs, Basler Electric, and then click the BESTCOMS*Plus* icon. During initial startup, the BESTCOMS*Plus* Select Language screen is displayed (Figure 93). You can choose to have this screen displayed each time BESTCOMS*Plus* 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.
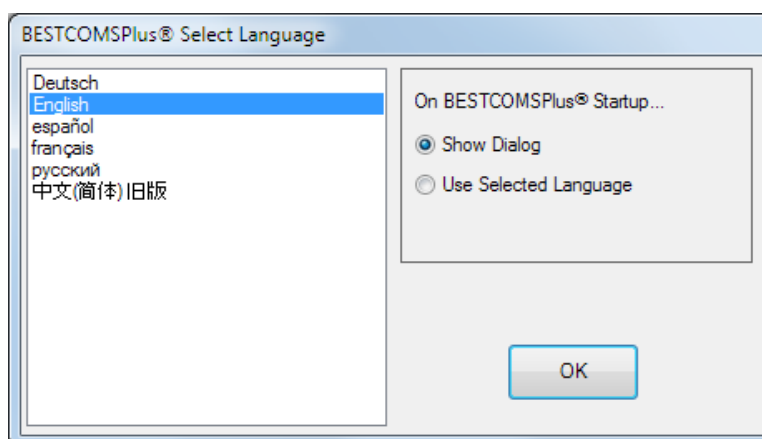
Figure 93. BESTCOMS*Plus* Select Language Screen

The BESTCOMS*Plus* platform window opens. Select <u>N</u>ew Connection from the <u>C</u>ommunication pull-down menu and select DECS-150. See Figure 94. The DECS-150 plugin is activated automatically after connecting to a DECS-150.
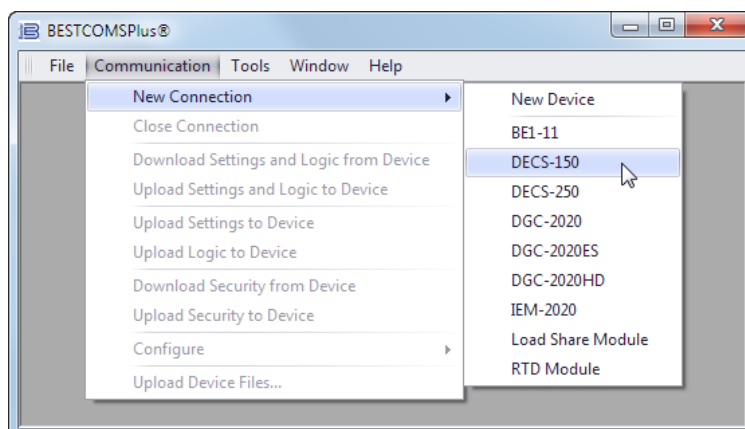
Figure 94. Communication Pull-Down Menu

The DECS-150 Connection screen shown in Figure 95 appears. Select USB Connection and click Connect.
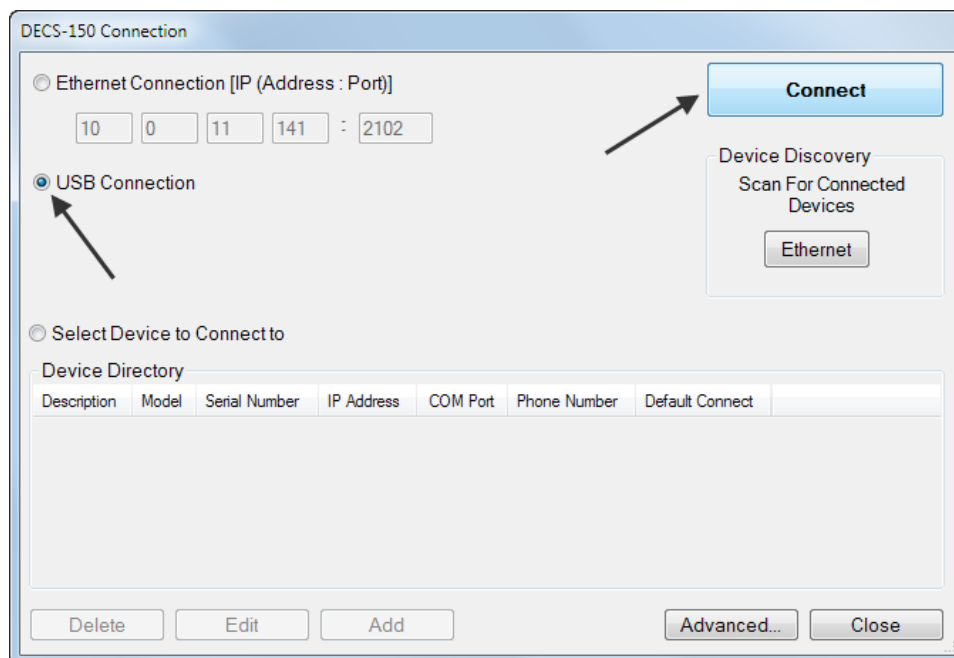
Figure 95. DECS-150 Connection Screen

The DECS-150 plugin opens indicating that activation was successful. You can now configure the DECS-150 communication ports and other DECS-150 settings.

Manual Activation of the DECS-150 Plugin

Manual activation of the DECS-150 plugin is required only if the initial use of BESTCOMS*Plus* will be on a PC that is not connected to a DECS-150. Manual activation is described in the following paragraphs.

Request an Activation Key

When initially running the DECS-150 plugin, the Activate Device Plugin pop-up appears. You must contact Basler Electric for an activation key before you can activate the DECS-150 plugin. You can request an activation key through email or the Basler Electric website. Click either the Website or Email

button. Click the Activate button when you are ready to enter the activation key you received from Basler Electric. The Activate Device Plugin pop-up appears. Refer to Figure 96.
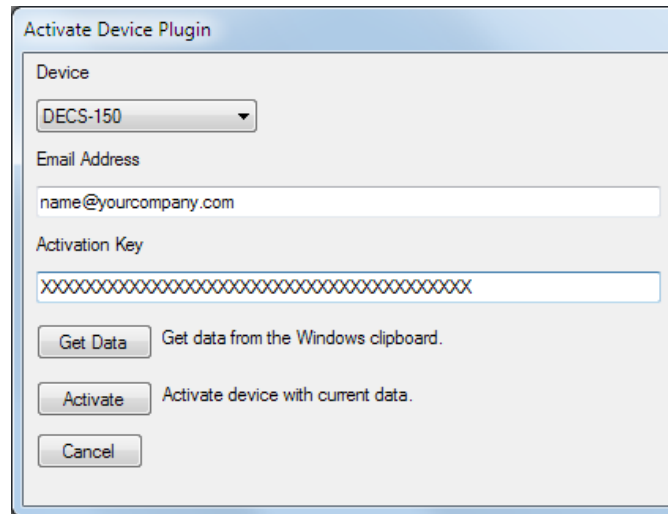
Figure 96. Activate Device Plugin Screen

Enter Your Activation Key

Select DECS-150 from the Device pull-down menu. Enter your Email Address and Activation Key provided by Basler Electric. If you received an email containing the Activation Key, you can select all of the text in the email and copy it to the Windows clipboard using normal Windows techniques. The Get Data button extracts the Device, Email Address, and Activation Key from the Windows clipboard and pastes it into the appropriate fields. Click the Activate button to continue. The Activate Device Plugin screen is also found by selecting Activate Device from the Tools pull-down menu of the BESTCOMS*Plus* main screen.

Establishing Communication

Communication between BESTCOMS*Plus* and the DECS-150 is established by clicking the Connect button on the DECS-150 Connection screen (see Figure 95) or by clicking the Connect button on the lower menu bar of the main BESTCOMS*Plus* screen (Figure 92). 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 relay by selecting Download Settings and Logic from the Communication pull-down menu. BESTCOMS*Plus* will read all settings and logic from the DECS-150 and load them into BESTCOMS*Plus* memory.

Menu Bars

The menu bars are located near the top of the BESTCOMS*Plus* screen (see Figure 92). 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 BESTCOMS*Plus* 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 (BESTCOMS*Plus* Shell)

Upper menu bar functions are listed and described in Table 40.

Table 40. Upper Menu Bar (BESTCOMS*Plus*® Shell)

Menu Item	Description
File	
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
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 BESTCOMS*Plus* program
Communication	
New Connection	Choose new device or DECS-150
Close Connection	Close communication between BESTCOMS*Plus* and DECS-150
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
Tools	
Select Language	Select BESTCOMS*Plus* language
Activate Device	Activate the DECS-150 plugin
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
Event Log - View	View the BESTCOMS*Plus* event log
Event Log - Verbose Logging	Enable enhanced logging (used for troubleshooting)
Window	
Cascade All	Cascade all windows
Tile	Tile horizontally or vertically
Maximize All	Maximize all windows
Help	
Check for Updates	Check for BESTCOMS*Plus* updates via the internet
Check for Update Settings	Enable or change automatic checking for updates
About	View general, detailed build, and system information

Lower Menu Bar (DECS-150 Plugin)

Lower menu bar functions are listed and described in Table 41.

<p align="center">Table 41. Lower Menu Bar (DECS-150 Plugin)</p>

Menu Button	Description
View	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.
Open File	Opens a saved settings file.
Connect/Disconnect	Opens the DECS-150 Connection screen which enables you to connect to the DECS-150 via USB or Ethernet. Also used to disconnect a connected DECS-150.
Preview Metering	Displays the Print Preview screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.
Export Metering	Enables all metering values to be exported into a *.csv file.
Options	Displays a drop-down list entitled Live Mode Settings which enables Live mode where settings are automatically sent to the device in real time as they are changed.
Send Settings	Sends settings to the DECS-150 when BESTCOMS*Plus* is not operating in Live Mode. Click on this button after making a setting change to send the modified setting to the DECS-150.

Settings Explorer

The BESTCOMS*Plus* settings explorer is used to navigate through the settings screens of the DECS-150 plugin. Descriptions of these configuration settings are organized as follows:

- General Settings
- System Parameters
- Report Configuration
- Operating Settings
- PSS
- 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 *BESTlogicPlus* chapter.

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* chapter for full details about the Metering Explorer.

Settings File Management

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.

A settings file contains all DECS-150 settings including logic. A settings file assumes a file extension of "∗.bstx". It is possible to save the logic only as a separate logic library file on the BESTlogic*Plus* Programmable Logic screen. This function is helpful when similar logic is required for several devices. A logic library file assumes a file extension of "∗.bslx". 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* chapter.

Opening a Settings File

To open a DECS-150 settings file with BESTCOMS*Plus*, pull down 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 BESTCOMS*Plus* 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 prompts 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-150, open the file or create a new file through BESTCOMS*Plus*. 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-150, pull down the Communication menu and select Download Settings and Logic from Device. If the settings in BESTCOMS*Plus* 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. BESTCOMS*Plus* reads all settings and logic from the DECS-150 and loads them into BESTCOMS*Plus* 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

BESTCOMS*Plus* has the ability to compare two settings files. To compare files, pull down the Tools menu and select Compare Settings Files. The BESTCOMS*Plus* Settings Compare Setup dialog box appears (Figure 97). 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.
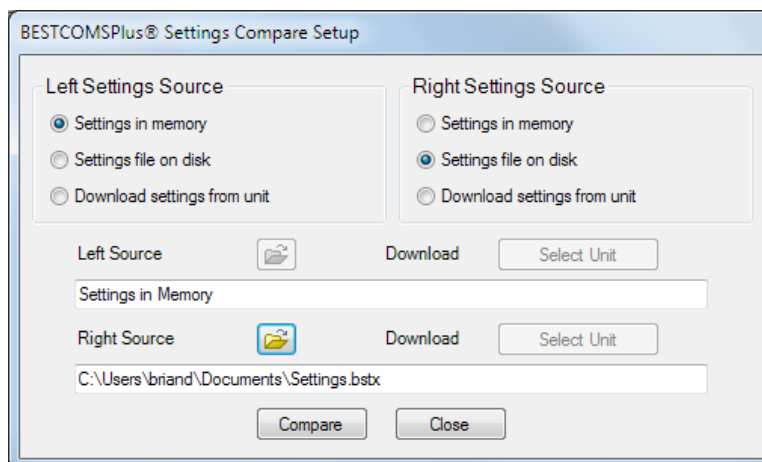
Figure 97. BESTCOMS*Plus* Settings Compare Setup

A dialog box will appear and notify you if any differences were found. The BESTCOMS*Plus* Settings Compare dialog box (Figure 98) 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.
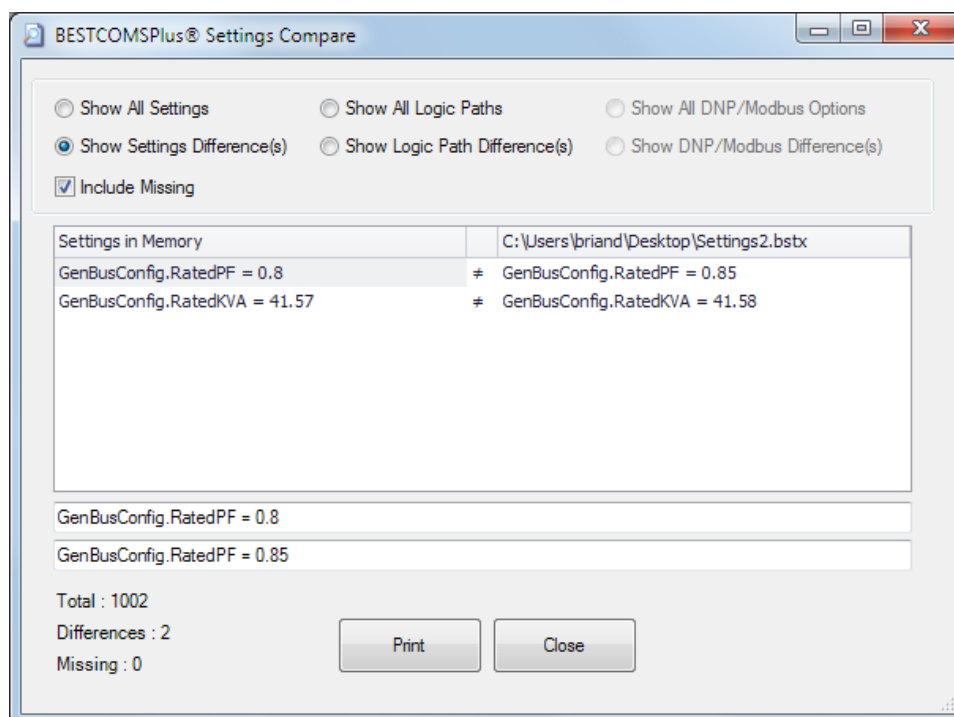
Figure 98. BESTCOMS*Plus*® Settings Compare

Firmware Updates

Future enhancements to DECS-150 functionality will require a firmware update. Because default settings are loaded when DECS-150 firmware is updated, your settings should be saved in a file prior to upgrading firmware.

Warning!
Before performing any maintenance procedures, remove the DECS-150 from service. Refer to the appropriate site schematics to ensure that all steps have been taken to properly and completely de-energize the DECS-150.

Caution – Settings will be lost!
Default settings will be loaded into the DECS-150, and reports and events will be cleared when firmware is updated. BESTCOMS*Plus* 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.

Notes
Firmware upgrades from version 1.xx.xx to 2.xx.xx cannot be performed using BESTCOMS*Plus*. The DECS-150 must be sent to Basler Electric to perform the upgrade. Contact technical support for more information.
The latest version of BESTCOMS*Plus* software should be downloaded from the Basler Electric website and installed before performing a firmware upgrade.

A device package contains firmware for the DECS-150. Embedded firmware is the operating program that controls the actions of the DECS-150. The DECS-150 stores firmware in nonvolatile memory that can be reprogrammed through the communication ports.

Notes
When performing a firmware upgrade, only one DECS-150 can be connected to the PC through USB. If a firmware upgrade is initiated when more than one unit is connected through USB, communication will be lost after the unit reboots.
If USB communication is interrupted during file transfer to the DECS-150, the firmware upload will fail. 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 the DECS-150

The following procedure is used to upgrade firmware in the DECS-150.

1. Remove the DECS-150 from service. Refer to the appropriate site schematics to ensure that all steps have been taken to properly and completely de-energize the DECS-150.

2. Connect to the DECS-150 with BESTCOMS*Plus* through the USB port. Check the firmware Application Version on the General Settings > Device Info screen.

3. Select Upload Device Files from the Communication pull-down menu. Save settings when prompted, if desired.

4. Open the desired device package file (decs-150.bef).

5. Check the box for DECS-150 Firmware as shown in Figure 99. Note the version number of the DECS-150 firmware; this is the version that will be used to set the Application Version in the settings file in a later step.

6. Click the Upload button and follow the instructions that appear to begin the upgrade process.

7. After the upload is complete, disconnect communication to the DECS-150.

8. Load the saved settings file into the DECS-150.

   a. Close all settings files.

   b. From the File pull-down menu, select New, DECS-150.

   c. Connect to the DECS-150.

   d. Once all settings have been read from the DECS-150, open the saved settings file by selecting File, Open File in the BESTCOMS*Plus* menu. Then browse for the file to upload.

   e. When BESTCOMS*Plus* asks if you wish to upload settings and logic to the device, click Yes.

   f. If you receive upload failures and indications that the logic is incompatible with the firmware version, check that the DECS-150 style number in the saved file matches that of the DECS-150 into which the file is being uploaded. The style number in the settings file is found under General Settings > Style Number in BESTCOMS*Plus*.

   g. If the style number of the settings file does not match that of the DECS-150 into which it is to be loaded, disconnect from the DECS-150, then modify the style number in the settings file. Then repeat the steps titled *Load the Saved Settings File into the DECS-150.*
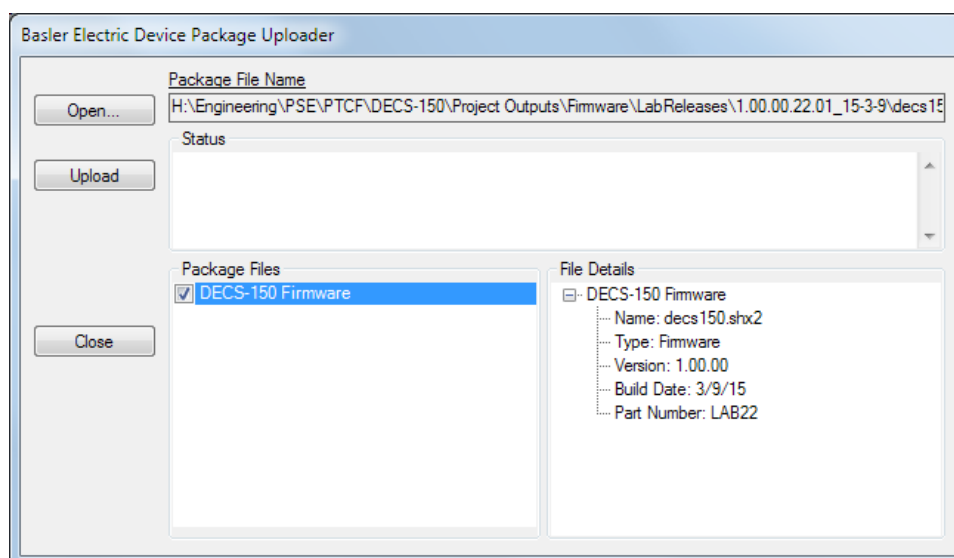
Figure 99. Device Package Uploader Screen

BESTCOMSPlus® Updates

Enhancements to DECS-150 firmware typically coincide with enhancements to the DECS-150 plugin for BESTCOMS*Plus*. When a DECS-150 is updated with the latest version of firmware, the latest version of BESTCOMS*Plus* should also be obtained.

- If you obtained a CD-ROM containing a firmware update from Basler Electric, then that CD-ROM will also contain the corresponding version of BESTCOMS*Plus* software.

- You can download the latest version of BESTCOMS*Plus* by visiting www.basler.com.

- BESTCOMS*Plus* automatically checks for updates when Check Automatically is selected on the Check for Updates User Settings screen. This screen is accessed under the Help drop-down menu. (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 drop-down menu. (An internet connection is required.)

BESTlogic™*Plus*

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.

Introduction

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-150 Digital Excitation Control System. Each DECS-150 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 BESTlogic*Plus*. BESTlogic*Plus* equations entered and saved in the DECS-150 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-150 is called a logic scheme.

Two default active logic schemes are preloaded into the DECS-150. 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. The default logic schemes are configured to provide functionality similar to that of a DECS-100. BESTCOMS*Plus*® can be used to open a logic scheme that was previously saved as a file and upload it to the DECS-150. The default logic schemes can also be customized to suit your application. Detailed information about logic schemes is provided later in this chapter.

BESTlogic*Plus* 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-150. Detailed information about operating settings is provided in other chapters of this instruction manual.

*Overview of BESTlogic™*Plus**

Use BESTCOMS*Plus* to make BESTlogic*Plus* settings. Use the Settings Explorer to open the BESTlogic*Plus* Programmable Logic tree branch as shown in Figure 100.

The BESTlogic*Plus* Programmable Logic screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and logic protection settings.
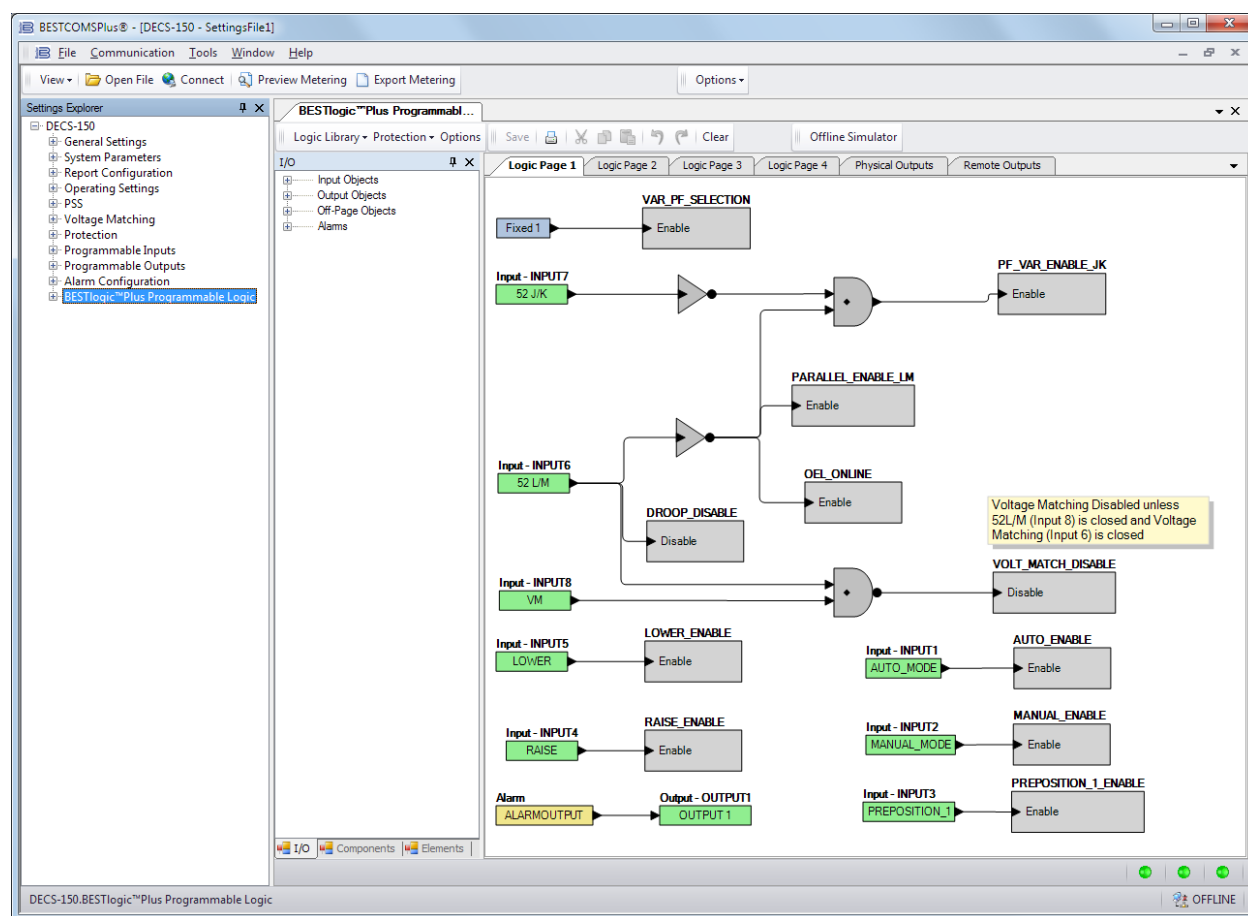
Figure 100. BESTlogic*Plus* Programmable Logic Tree Branch

BESTlogic*Plus* Composition

There are three main groups of objects used for programming BESTlogic*Plus*. These groups are I/O, Components, and Elements. For details on how these objects are used to program BESTlogic*Plus*, see the paragraphs on *Programming BESTlogicPlus.*

I/O

This group contains Input Objects, Output Objects, Off-Page Objects, and Alarms. Table 42 lists the names and descriptions of the objects in the *I/O* group.
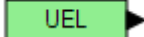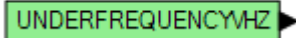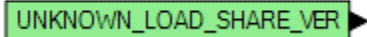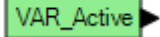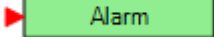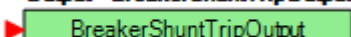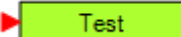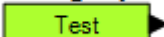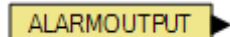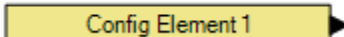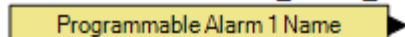
Table 42. I/O Group, Names and Descriptions

Name	Description	Symbol
Input Objects		
Logic 0	Always false (Low).	
Logic 1	Always true (High).	
Physical Inputs		
IN1 - IN8	True when Physical Input x is active.	
Virtual Inputs		
VIN1 - VIN6	True when Virtual Input x is active.	

Name	Description	Symbol
Status Inputs		
25 Sync Status	True when the generator/bus differences fall within the setting for each parameter.	**Status Input** PROTECTION25STATUS
27 Undervoltage Pickup	True when the undervoltage pickup threshold is exceeded and the element is timing towards a trip.	**Status Input** PROTECTION27PICKUP
27 Undervoltage Trip	True when the undervoltage pickup threshold is exceeded for the duration of the time delay.	**Status Input** PROTECTION27TRIP
59 Overvoltage Pickup	True when the overvoltage pickup threshold is exceeded and the element is timing towards a trip.	**Status Input** PROTECTION59PICKUP
59 Overvoltage Trip	True when the overvoltage pickup threshold is exceeded for the duration of the time delay.	**Status Input** PROTECTION59TRIP
81 Overfrequency Pickup	True when the overfrequency pickup threshold is exceeded and the element is timing towards a trip.	**Status Input** PROTECTION81OPICKUP
81 Overfrequency Trip	True when the overfrequency pickup threshold is exceeded for the duration of the time delay.	**Status Input** PROTECTION81OTRIP
81 Underfrequency Pickup	True when the underfrequency pickup threshold is exceeded and the element is timing towards a trip.	**Status Input** PROTECTION81UPICKUP
81 Underfrequency Trip	True when the underfrequency pickup threshold is exceeded for the duration of the time delay.	**Status Input** PROTECTION81UTRIP
Auto Mode Active	True when the unit is in Auto mode (AVR).	**Status Input** AUTO_ACTIVE
Configurable Elements 1-8	True when Configurable Element x is active.	**Status Input - CONFIGELEMENT1OUTPUT** Config Element 1
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 *Protection* chapter 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.	**Status Input - ConfProt1Thresh1Pickup** CONF PROT 1 **Status Input - ConfProt1Thresh1Trip** CONF PROT 1
Custom LED	True when the Set input of the CUSTOM_LED logic element is true. Refer to the *Elements* section.	**Status Input** CustomLED
EDM Pickup	True when the EDM pickup threshold is exceeded and the element is timing towards a trip.	**Status Input** EDM_PICKUP
EDM Trip	True when the EDM pickup threshold is exceeded for the duration of the time delay.	**Status Input** EDM_TRIP

Name	Description	Symbol
Exciter Field Current Limit	True when the field current is too high, which could result in damage to the regulator. This condition also shuts down excitation. A restart is required to begin regulating again.	**Status Input** EXCITERFIELDCURRENTLIMIT
External Tracking Active	True when external tracking is running.	**Status Input** EXT_TRACKING_ACTIVE
Field Overvoltage Pickup	True when the field overvoltage pickup threshold is exceeded and the element is timing towards a trip.	**Status Input** PROTFIELDOVERVOLTAGEPU
Field Overvoltage Trip	True when the field overvoltage pickup threshold is exceeded for the duration of the time delay.	**Status Input** PROTFIELDOVERVOLTAGETRIP
Generator Below 10 Hz Pickup	True when the generator is operating below 10 Hz and the element is timing towards a trip.	**Status Input** PROTECTGENBELOW10HZPICKUP
Generator Below 10 Hz Trip	True when the generator is operating below 10 Hz for 100 ms.	**Status Input** PROTECTGENBELOW10HZTRIP
Hardware Shutdown	True when a user-configured protection element or limiter causes a forced shutdown.	**Status Input** HardwareShutdown
Internal Tracking Active	True when internal tracking is running.	**Status Input** INT_TRACKING_ACTIVE
Loss of Sensing Pickup	True when the Loss of Sensing pickup threshold is exceeded and the element is timing towards a trip.	**Status Input** LOSSOFSENSINGPICKUP
Loss of Sensing Trip	True when the Loss of Sensing pickup threshold is exceeded for the duration of the time delay.	**Status Input** LOSSOFSENSINGTRIP
Manual Mode Active	True when the unit is in Manual mode (FCR).	**Status Input** MANUAL_ACTIVE
Network Load Share Active	True when network load sharing is active.	**Status Input** NLS_ACTIVE
Network Load Share Config Mismatch	True when the unit's configuration does not match the configuration of the other units with load sharing enabled.	**Status Input** NLS_CONFIG_MISMATCH
Network Load Share ID Missing	True when any of the load sharing enabled units are not detected on the network.	**Status Input** 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.	**Status Input** NLS_RECEIVING_ID_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.	**Status Input** NO_NETWORK_LOADSHARE_DATA
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.	**Status Input** NLS_STATUS_1

Name	Description	Symbol
Null Balance	True when Null Balance is achieved in both external and internal tracking.	**Status Input** NULL_BALANCE
OEL	True when the Overexcitation Limiter is active.	**Status Input** OEL
PF Controller Active	True when the unit is in PF mode.	**Status Input** PF_Active
Power Supply Low Alarm	True when power input voltage is below normal operating range.	**Status Input** PowerSupplyLow_ALM
Pre-Position Active	True when any pre-position is active.	**Status Input** DECS_PREPOSITION
Pre-Position 1-3 Active	True when Pre-Position x is active.	**Status Input** PREPOSITION_1_ACTIVE
PSS Active (Optional)	True when the power system stabilizer (PSS) is turned on and running.	**Status Input** PSS_ACTIVE
PSS Current Unbalanced (Optional)	True when the phase current is unbalanced and the PSS is active.	**Status Input** PSSCURRENTUNBALANCED
PSS Power Below Threshold (Optional)	True when the input power is below the Power Level threshold and the PSS is active.	**Status Input** PSSPOWERBELOWTHRESHOLD
PSS Secondary Group (Optional)	True when the PSS is using secondary settings.	**Status Input** 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-150 and the PSS is active.	**Status Input** PSSSPEEDFAILED
PSS Test On (Optional)	True when the power system stabilizer test signal (Frequency Response) is active.	**Status Input** 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** PSSVOLTAGELIMIT
PSS Voltage Unbalanced (Optional)	True when the phase voltage is unbalanced and the PSS is active.	**Status Input** PSSVOLTAGEUNBALANCED
SCL	True when the Stator Current Limiter is active.	**Status Input** SCL
Setpoint at Lower Limit	True when the active modes setpoint is at the lower limit.	**Status Input** Setpoint_At_Lower_Limit
Setpoint at Upper Limit	True when the active modes setpoint is at the upper limit.	**Status Input** Setpoint_At_Upper_Limit
Soft Start Active	True during softstart.	**Status Input** SOFTSTART_ACTIVE
Start Status	True when the unit is in Start mode.	**Status Input** DECS_START_STOP
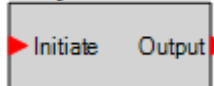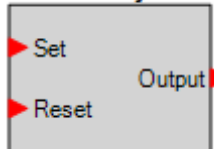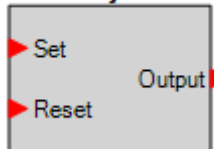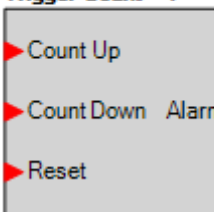
Name	Description	Symbol
UEL	True when the Under Excitation Limiter is active.	**Status Input** UEL
Under Frequency V/Hz	True when the Under Frequency or the Volts/Hz Limiter is active.	**Status Input** UNDERFREQUENCYVHZ
Unknown Network Load Share Protocol Version	True when there is another unit on the network whose load share protocol version is not the same as this units load share protocol version.	**Status Input** UNKNOWN_LOAD_SHARE_VER
Var Controller Active	True when the unit is in var mode.	**Status Input** VAR_Active
Voltage Matching Active	True when voltage matching is active.	**Status Input** VOLTAGE_MATCHING_ACTIVE
Output Objects		
Physical Outputs OUT1 and OUT2	Physical outputs 1 and 2.	**Output – OUTPUT1** Alarm
Physical Outputs Breaker Shunt Trip Output	Breaker Shunt Trip physical output. This output is an electronic switch capable of 100 mA that can be used to control an external circuit breaker.	**Output – BreakerShuntTripOutput** BreakerShuntTripOutput
Off-Page Objects		
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.	**Off-Page Output** Test
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.	**Off-Page Input** Test
Alarms		
Global Alarm	True when one or more alarms are set.	**Alarm** ALARMOUTPUT
Configurable Elements 1-8	True when a configurable element alarm is set.	**Alarm – CONFIGELEMENT1ALM** Config Element 1
Programmable Alarms 1-16	True when a programmable alarm is set.	**Alarm – PROGRAMMABLE_ALARM_1** Programmable Alarm 1 Name

Components

This group contains Logic Gates, Pickup and Dropout Timers, Latches, Comment Blocks, and a counter. Table 43 lists the names and descriptions of the objects in the Components group.

Table 43. Components Group, Names and Descriptions
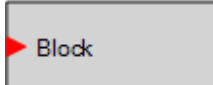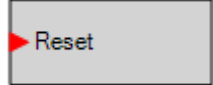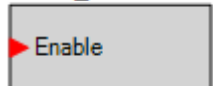
Name	Description	Symbol
Logic Gates		
AND	<table><tr><td>Input</td><td></td><td>Output</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	
NAND	<table><tr><td>Input</td><td></td><td>Output</td></tr><tr><td>0</td><td>0</td><td>1</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></table>	
OR	<table><tr><td>Input</td><td></td><td>Output</td></tr><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>1</td></tr></table>	
NOR	<table><tr><td>Input</td><td></td><td>Output</td></tr><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></table>	
XOR	<table><tr><td>Input</td><td></td><td>Output</td></tr><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></table>	
XNOR	<table><tr><td>Input</td><td></td><td>Output</td></tr><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></table>	
NOT (INVERTER)	<table><tr><td>Input</td><td>Output</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>	
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.	
Pickup and Dropout Timers		
Drop Out Timer	Used to set a delay in the logic. For more information, refer to *Programming BESTlogicPlus, Pickup and Dropout Timers,* later in this chapter.	Drop Out Timer (1) TIMER_1 Delay = 1 ▶ Initiate Output ▶
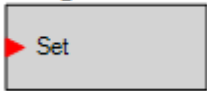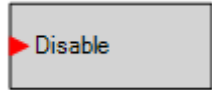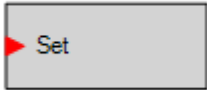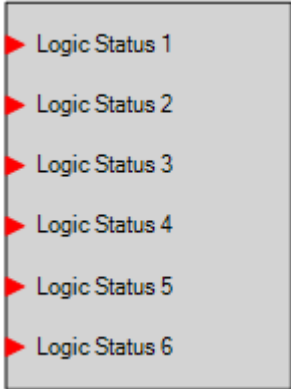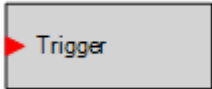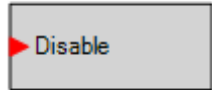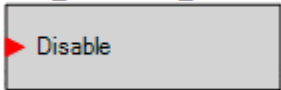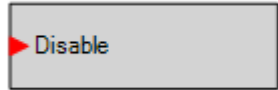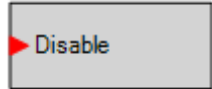
Name	Description	Symbol
Pick Up Timer	Used to set a delay in the logic. For more information, refer to *Programming BESTlogicPlus, Pickup and Dropout Timers,* later in this chapter.	Pick Up Timer (1) TIMER_1 Delay = 1 ►Initiate Output►
Latches		
Reset Priority Latch	When the Set input is on and the Reset 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.	Reset Priority Latch ►Set Output► ►Reset
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.	Set Priority Latch ►Set Output► ►Reset

Name	Description	Symbol
Other		
Comment Block	Enter user comments.	Logic Comment Block
Counter	True when the count reaches a user-selected number. The Count Up input increments the count when a true is received. The Count Down input decrements the count when a true is received. The Reset input resets the count to zero when a true is received. The Alarm output is true when the count reaches the trigger count. The trigger count is set by the user and is found in Settings Explorer, BESTlogicPlus Programmable Logic, Logic Counters.	Counter (1) Counter 1 Trigger Count = 1 ►Count Up ►Count Down Alarm► ►Reset
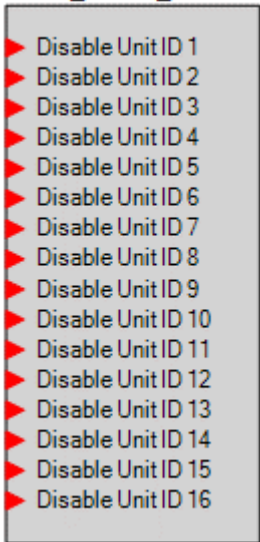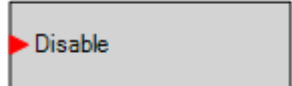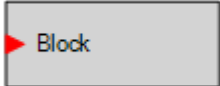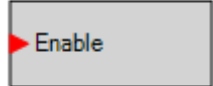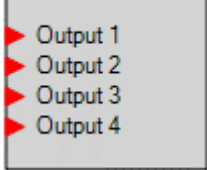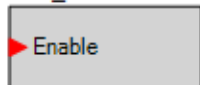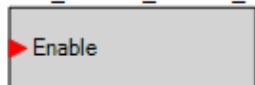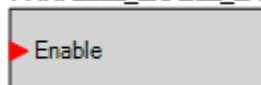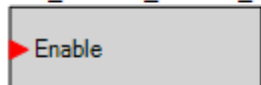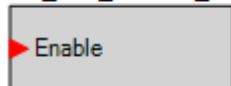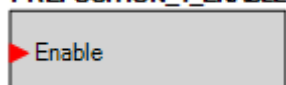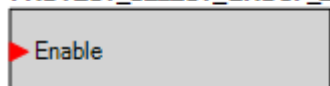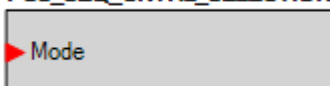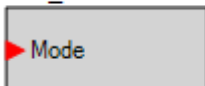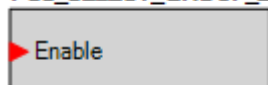
Elements

Table 44 lists the names and descriptions of the elements in the Elements group.
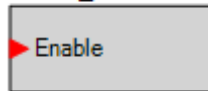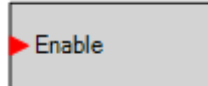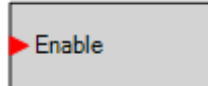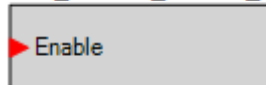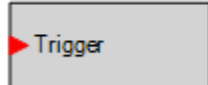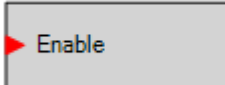
Table 44. Elements Group, Names and Descriptions
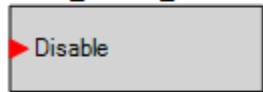
Name	Description	Symbol
27	When true, this element blocks, or disables, the 27 undervoltage protection function.	27 ►Block
Alarm Reset	When true, this element resets all active alarms.	ALARM_RESET ►Reset
Auto Enable	When true, this element sets the unit in Auto mode (AVR).	AUTO_ENABLE ►Enable

Name	Description	Symbol
Configurable Element 1-8	Configurable elements are connected to the logic scheme as outputs. These elements are configurable in BESTCOMS*Plus* under Programmable Outputs, Configurable Elements. The user can assign a string of up to 16 characters, configure whether the element should generate an alarm or provide status only. If used for alarm, the user's text is what will appear in the event log.	**CONFELMNT1** **Config Element 1** ▶ Set
Cross Current Compensation Disable	When true, this element disables cross current compensation.	**CC_DISABLE** ▶ Disable
Custom LED	When true, this element sets the Custom Alarm on the front panel.	**CUSTOM_LED** ▶ Set
Datalog Logic Status 1-6	When true, Logic Status x is displayed in the data log and real-time monitor.	**DATALOG_LOGIC_STATUS** ▶ Logic Status 1 ▶ Logic Status 2 ▶ Logic Status 3 ▶ Logic Status 4 ▶ Logic Status 5 ▶ Logic Status 6
Datalog Trigger	When true, this element triggers the datalog to begin recording data.	**DATALOGTRIGGER** ▶ Trigger
Droop Disable	When true, this element disables droop when the unit is operating in AVR mode.	**DROOP_DISABLE** ▶ Disable
External Tracking Disable	When true, this element disables external tracking.	**EXT_TRACKING_DISABLE** ▶ Disable
Internal Tracking Disable	When true, this element disables internal tracking.	**INT_TRACKING_DISABLE** ▶ Disable
Line Drop Disable	When true, this element disables line drop when the unit is operating in AVR mode.	**LDROP_DISABLE** ▶ Disable

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-150.	LOAD_SHARE_DISABLE Disable Unit ID 1 Disable Unit ID 2 Disable Unit ID 3 Disable Unit ID 4 Disable Unit ID 5 Disable Unit ID 6 Disable Unit ID 7 Disable Unit ID 8 Disable Unit ID 9 Disable Unit ID 10 Disable Unit ID 11 Disable Unit ID 12 Disable Unit ID 13 Disable Unit ID 14 Disable Unit ID 15 Disable Unit ID 16
Loss of Sensing Transfer Disable	When true, this element disables the transfer to Manual mode during a Loss of Sensing condition.	LOS_TRANSFER_DISABLE Disable
Loss of Sensing	When true, this element disables the Loss of Sensing function.	LOSS_OF_SENSING Block
Lower Enable	When true, this element lowers the active setpoint.	LOWER_ENABLE Enable
Manual Enable	When true, this element switches the unit to Manual mode.	MANUAL_ENABLE Enable
Network Load Share Disable	When true, this element disables network load sharing.	NETWORK_LOAD_SHARE_DISABLE Disable
NLS Broadcast	This element functions in conjunction with the Network Load Share Status input 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.	NLS_BROADCAST Output 1 Output 2 Output 3 Output 4
OEL Disabled in Manual Mode	When true, this element disables OEL when the unit is operating in Manual mode.	OEL_DISABLED_IN_MAN_MODE Enable

Name	Description	Symbol
OEL Online	When true, this element enables the use of OEL when the unit is considered online.	**OEL_ONLINE** ►Enable
OEL Select Secondary Settings	When true, this element selects the secondary settings for OEL.	**OEL_SELECT_GROUP_2** ►Enable
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.	**PARALLEL_ENABLE_LM** ►Enable
PID Select Secondary Settings	When true, this element selects secondary settings on the PID.	**PID_SELECT_GROUP_2** ►Enable
PF/var Enable	When true, this element enables the PF and Var controller, and informs the unit that it is online. The Var/PF Selection element must be set to true to use var or PF mode. This element should be enabled when the 52JK is closed.	**PF_VAR_ENABLE_JK** ►Enable
Pre-Position 1-3 Enable	When true, this element informs the unit to use setpoints for Pre-Position x.	**PREPOSITION_1_ENABLE** ►Enable
Protection Select Secondary Settings	When true, this element informs the unit to use secondary values for protection.	**PROTECT_SELECT_GROUP_2** ►Enable
PSS Sequence Control Enabled	When true, PSS sequence (phase rotation) control is enabled. (Available when the controller is equipped with the optional Power System Stabilizer, style number xPxxx.)	**PSS_SEQ_CNTRL_ENABLED** ►Enable
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 xPxxx.)	**PSS_CNTRL_OUT_DISABLE** ►Disable
PSS Sequence Control Selection	When true, phase rotation is selected to be ACB. False when phase rotation is selected to be ABC. (Available when the controller is equipped with the optional Power System Stabilizer, style number xPxxx.)	**PSS_SEQ_CNTRL_SELECTION** ►Mode
PSS Motor	When true, the PSS is in motor mode. False when in generator mode. (Available when the controller is equipped with the optional Power System Stabilizer, style number xPxxx)	**PSS_MOTOR** ►Mode
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 xPxxx.)	**PSS_SELECT_GROUP_2** ►Enable

Name	Description	Symbol
Raise Enable	When true, this element raises the active setpoint.	**RAISE_ENABLE** ► Enable
SCL Select Secondary Settings	When true, this element selects the secondary settings for SCL.	**SCL_SELECT_GROUP_2** ► Enable
Soft Start Select Secondary Settings	When true, this element selects the secondary settings for softstart.	**SOFT_START_SELECT_GROUP_2** ► Enable
Start Enable	When true, this element starts the unit.	**START_ENABLE** ► Enable
Stop Enable	When true, this element stops the unit.	**STOP_ENABLE** ► Enable
UEL Disabled in Manual Mode	When true, this element disables UEL when the unit is operating in Manual mode.	**UEL_DISABLED_IN_MAN_MODE** ► Enable
UEL Select Secondary Settings	When true, this element selects secondary settings for UEL.	**UEL_SELECT_GROUP_2** ► Enable
Underfrequency V/HZ Disable	When true, this element disables the V/Hz Underfrequency limiter.	**UNDERFREQUENCY_VHZ_DISABLE** ► Disable
User Programmable Alarm 1-16	When true, this element triggers a programmable alarm.	**USERALM1** **Programmable Alarm 1 Name** ► Trigger
Var/PF Mode	The var input selects var control and the PF input selects power factor control.	**VAR_PF_MODE** ► Off ► var ► PF
Var/PF Selection Enable	When true, this element allows the selection of var and PF.	**VAR_PF_SELECTION** ► Enable

Name	Description	Symbol
Voltage Matching Disable	When true, this element disables voltage matching when the unit is operating in AVR mode.	**VOLT_MATCH_DISABLE** ▶ Disable
Watchdog Output	When true, this element opens the normally-open watchdog output and closes the normally-closed watchdog output.	**WATCHDOG_OUTPUT** ▶ Trip

Logic Schemes

A logic scheme is a group of logic variables written in equation form that defines the operation of a DECS-150 Digital Excitation System. Each logic scheme is given a unique name. This gives you the ability to select a specific scheme and be confident that the selected scheme is in operation. One logic scheme is configured for a typical protection and control application of a synchronous generator and is the default active logic scheme. Only one logic scheme can be active at a given 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-150 must have an active logic scheme in order to function. All DECS-150 controllers are delivered with a default, active logic scheme preloaded in memory. The logic scheme is tailored for a system with the PSS option disabled or enabled depending on the PSS option selected in the system style number. The functionality of this logic scheme is similar to the functionality of a DECS-100. If the function block configuration and output logic of the default logic scheme meet the requirements of your application, then only the operating settings (system parameters and threshold settings) need to be adjusted before placing the DECS-150 in service.

Sending and Retrieving Logic Schemes

Retrieve a Logic Scheme from the DECS-150

To retrieve settings from the DECS-150, the DECS-150 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be downloaded from the DECS-150 by selecting Download Settings and Logic on the Communication pull-down menu.

Send a Logic Scheme to the DECS-150

To send settings to the DECS-150, the DECS-150 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be uploaded to the DECS-150 by selecting Upload Settings and Logic on the Communication pull-down menu.

Caution
Always remove the DECS-150 from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the DECS-150 is in service could generate unexpected or unwanted outputs. Modifying a logic scheme in BESTCOMS*Plus* does not automatically make that scheme active in the DECS-150. The modified scheme must be uploaded into the DECS-150. 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 101 and the default logic scheme for PSS-enabled systems is shown in Figure 102.
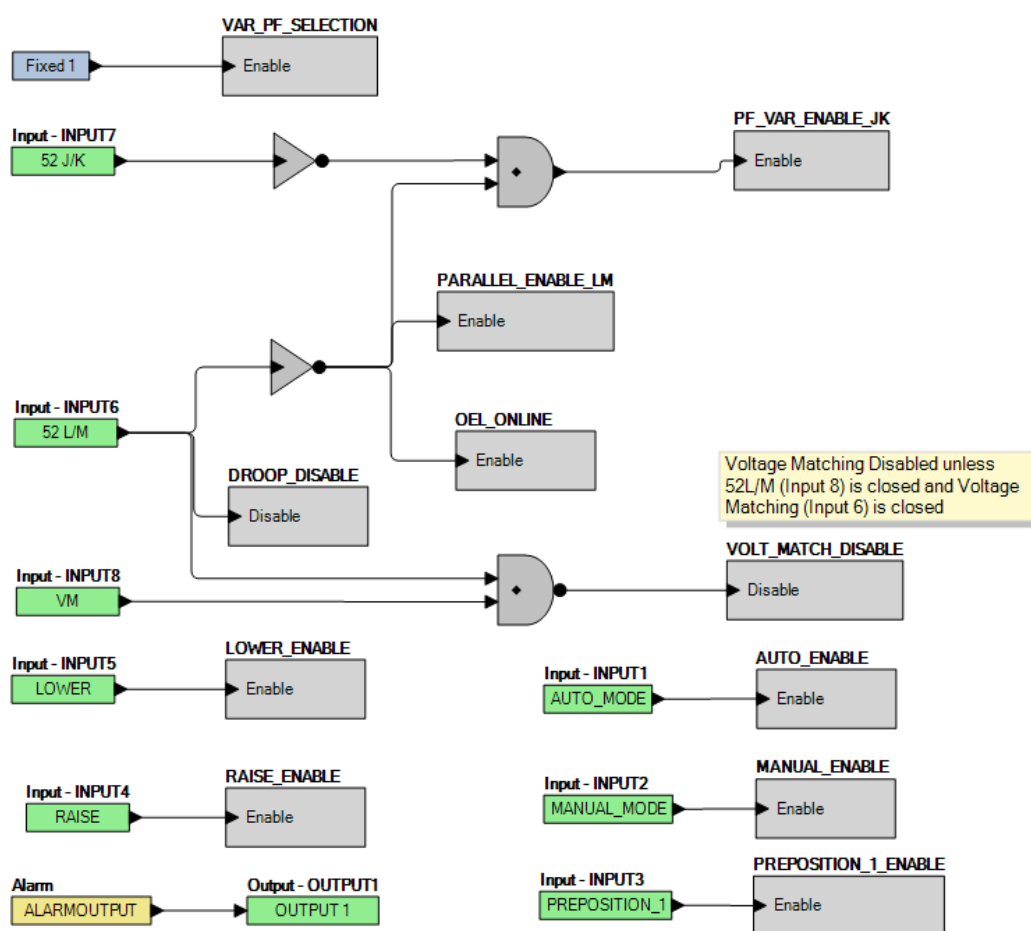
Figure 101. PSS-Disabled Default Logic
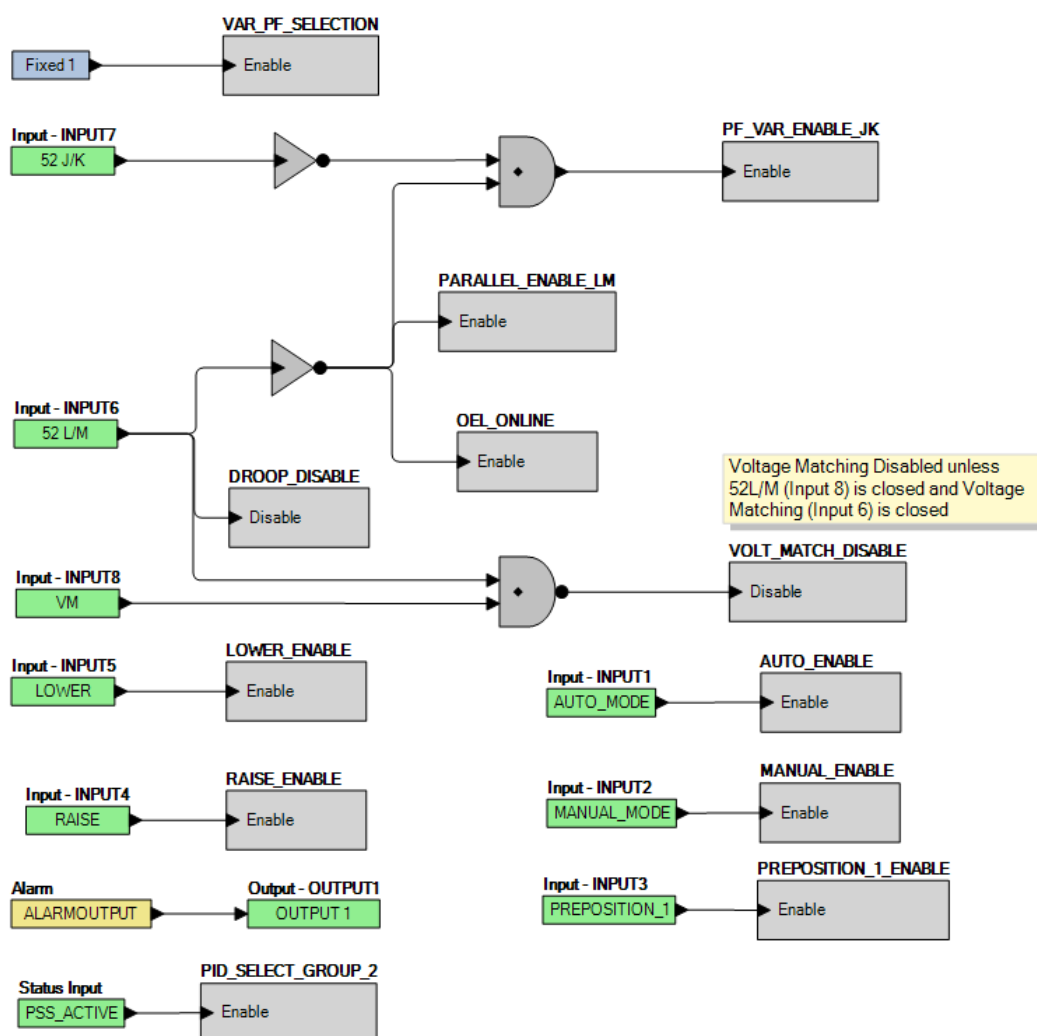
Figure 102. PSS-Enabled Default Logic

Programming BESTlogic™Plus

Use BESTCOMS*Plus*® to program BESTlogic*Plus*. Using BESTlogic*Plus* is analogous to physically attaching wire between discrete DECS-150 terminals. To program BESTlogic*Plus*, use the Settings Explorer within BESTCOMS*Plus* to open the BESTlogicPlus Programmable Logic tree branch as shown in Figure 100.

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 wire/link from port to port (triangles), click the left mouse button on a port, pull the wire onto another port, and release the left mouse button. 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 wires/links from input to input or output to output is not allowed. Only one wire/link can be connected to any one output. If the proximity of the endpoint of the wire/link is not exact, it may attach to an unintended port.

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-150.

The view of the Main Logic and Physical Outputs can be automatically arranged by clicking the right mouse button on the window and selecting Auto-Layout.

The following conditions must be met before BESTCOMS*Plus* will allow logic to be uploaded to the DECS-150:

- 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 being 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 is to include 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 BESTlogic*Plus* window. These indicators show the Logic Save Status, Logic Diagram Status, and Logic Layer Status. Table 45 defines the colors for each indicator.

Table 45. Status Indicators

Indicator	Color		Definition
Logic Save Status (Left Indicator)	🟡	Orange	Logic has changed since last save.
	🟢	Green	Logic has NOT changed since last save.
Logic Diagram Status (Center Indicator)	🔴	Red	Requirements NOT met as listed above.
	🟢	Green	Requirements met as listed above.
Logic Layer Status (Right Indicator)	🔴	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 103.

To program logic timer settings, use the Settings Explorer within BESTCOMS*Plus*® to open the BESTlogicPlus Programmable Logic/Logic Timers tree branch. Enter a Name label that you want to appear on the timer logic block. The Time Delay value range is 0 to 250 hours in 1 hour increments, 0 to 250 minutes in 1 minute increments, or 0 to 1,800 seconds in 0.1 second increments.

Next, open the Components tab inside the BESTlogic*Plus* window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the Logic Timers tree branch. The Logic Timer Properties Dialog Box will appear. Select the timer you want to use.

Timing accuracy is ±15 milliseconds.
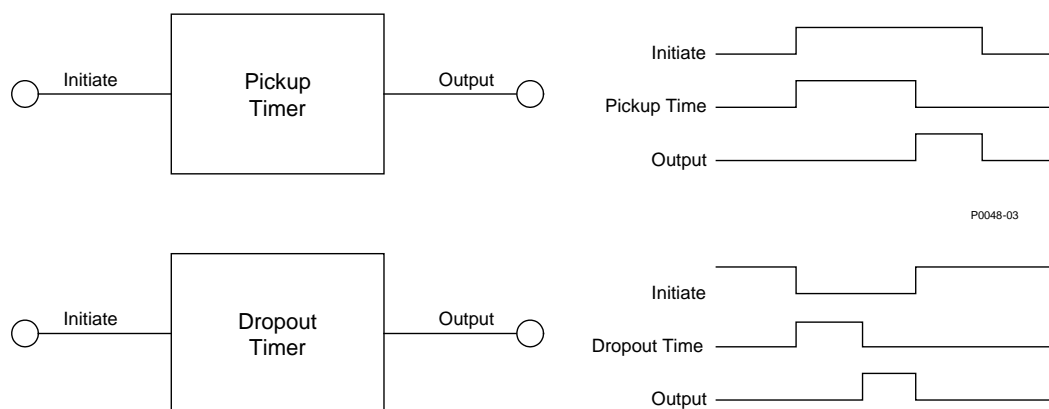
Figure 103. Pickup and Dropout Timer Logic Blocks

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.

Before running the logic simulator, you must click the Save button on the BESTlogic*Plus* 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 BESTlogic*Plus* 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 104. 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).
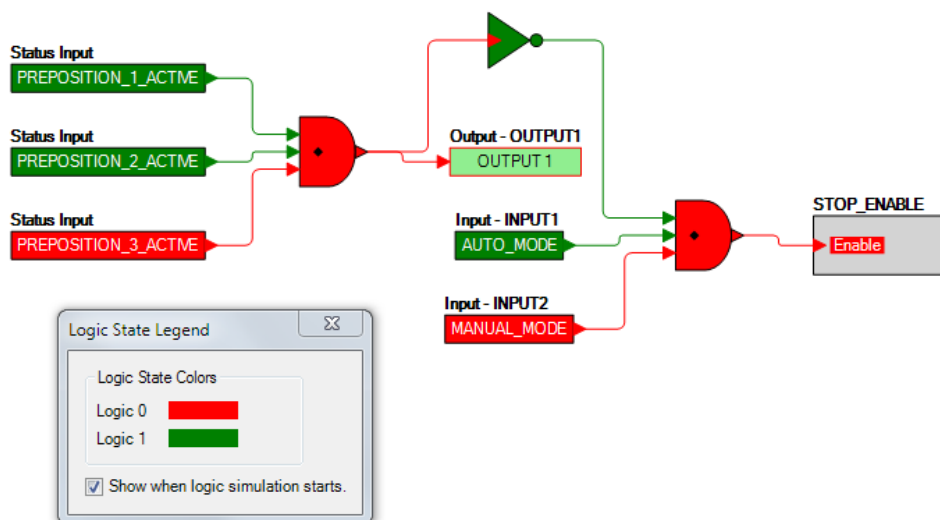
Figure 104. Offline Logic Simulator Example

BESTlogic™Plus File Management

To manage BESTlogic*Plus* files, use the Settings Explorer to open the BESTlogic*Plus* Programmable Logic tree branch. Use the BESTlogic*Plus* Programmable Logic toolbar to manage BESTlogic*Plus* files. Refer to Figure 105. For information on Settings Files management, refer to the *BESTCOMSPlus Software* chapter.

Figure 105. BESTlogic*Plus* Programmable Logic Toolbar

Saving a BESTlogic*Plus* File

After programming BESTlogic*Plus* settings, click on the *Save* button to save the settings to memory.

Before the new BESTlogic*Plus* settings can be uploaded to the DECS-150, you must select *Save* from the File pull-down menu located at the top of the BESTCOMS*Plus* main shell. This step will save both the BESTlogic*Plus* settings and the operating settings to a file.

The user also has the option to save the BESTlogic*Plus* settings to a unique file that contains only BESTlogic*Plus* settings. Click on the Logic Library drop-down button and select Save Logic Library File. Use normal Windows® techniques to browse to the folder where you want to save the file and enter a filename to save as.

Opening a BESTlogic*Plus* File

To open a saved BESTlogic*Plus* file, click on the Logic Library drop-down button on the BESTlogic*Plus* Programmable Logic toolbar and select Open Logic Library File. Use normal Windows techniques to browse to the folder where the file is located.

Protecting a BESTlogic*Plus* File

Objects in a logic diagram can be locked so that when the logic document is protected these objects cannot be changed. Locking and protecting is useful when sending logic files to other personnel to be modified. The 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 drop-down button. Establishing a password is optional.

Uploading a BESTlogic*Plus* File

To upload a BESTlogic*Plus* file to the DECS-150, you must first open the file through BESTCOMS*Plus*® or create the file using BESTCOMS*Plus*. Then pull down the Communication menu and select Upload Logic.

Downloading a BESTlogic*Plus* File

To download a BESTlogic*Plus* file from the DECS-150, you must pull down the Communication menu and select Download Settings and Logic from Device. If the logic in your BESTCOMS*Plus* has changed, a dialog box will open asking you if want to save the current logic changes. You may choose Yes or No. After you have taken the required action to save or not save the current logic, the downloading is executed.

Copying and Renaming Preprogrammed Logic Schemes

Copying a saved logic scheme and assigning a unique name is accomplished by first loading the saved logic scheme into BESTCOMS*Plus*. Click on the Logic Library drop-down button and select Save Logic Library File. Use normal Windows® techniques to browse to the folder where you want to save the new file and enter a filename to save as. Changes are not activated until the new settings have been saved and uploaded to the device.

Printing a BESTlogic*Plus* File

To view a preview of the printout, click on the Print icon located on the BESTlogic*Plus* Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the Print Preview screen.

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 - PREPOSITION_1_ENABLE Logic Block Connections

Figure 106 illustrates the PREPOSITION_1_ENABLE logic block and one input logic block. Pre-Position 1 is enabled when Input 1 is active.
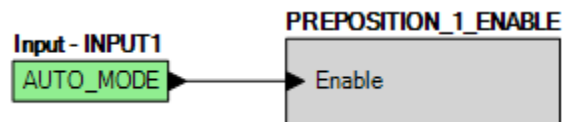
Figure 106. Example 1 - PREPOSITION_1_ENABLE Logic Block Connections

Example 2 - AND Gate Connections

Figure 107 illustrates a typical AND gate connection. In this example, Output 2 will become active when Inputs 7 and 8 are true.
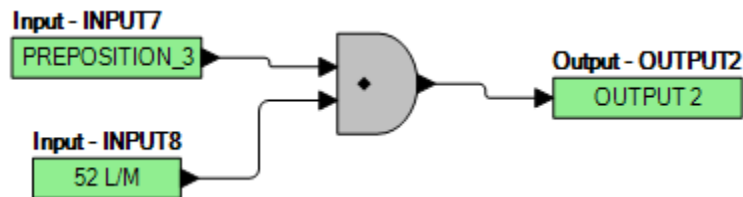
Figure 107. Example 2 - AND Gate Connections

Communication

USB Communication

A type B, USB port connects the DECS-150 with a PC operating BESTCOMS*Plus*® 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 or rear panel depending on style chosen, and illustrated in the *Front Panel* chapter of this manual. A USB device driver for the DECS-150 is automatically installed on your PC during the installation of BESTCOMS*Plus*. Information about establishing communication between BESTCOMS*Plus* and the DECS-150 is provided in the *BESTCOMSPlus Software* chapter of this manual.

Caution
In accordance with the guidelines defined in USB standards, the USB port on this device is not isolated. To prevent damage to a connected PC or laptop, the DECS-150 must be properly tied to ground.

Powering the DECS-150 through the USB Port

The DECS-150 can be partially powered from the USB port when no input power is applied. The following capabilities are functional in this mode:

- The settings interface will operate as expected.
- Settings and all reports can be downloaded from the unit.
- Settings and firmware can be uploaded to the unit.

The following capabilities will <u>not</u> function in this mode:

- Voltage regulation
- Ethernet communication
- Metering (including the alarm panel)

If the unit is partially powered by USB followed by application of input power, the USB connection may have to be re-established by removing and re-inserting the USB connector. Likewise, if a USB connection is established while input power is applied and input power is lost, the USB connection may have to be re-established by removing and re-inserting the USB connector.

Communication with a Second DECS-150

The CAN (controller area network) interface (CAN 2) port facilitates communication between two DECS-150s and enables regulation setpoint tracking to occur in a dual, or redundant, DECS-150 application. External setpoint tracking is possible between two DECS-150s.

Connections

DECS-150 CAN connections should be made with twisted-pair, shielded cable. The CAN port (designated CAN 2) has a CAN high (C2H) terminal, a CAN low (C2L) terminal, and a CAN drain (GND) terminal. CAN port terminals are illustrated in the Terminals and Connectors chapter of this manual.

Modbus® Communication

BESTCOMS*Plus* Navigation Path: Settings Explorer, Communications, Modbus Setup

DECS-150 systems support the Modbus/TCP protocol (Ethernet). DECS-150 Modbus communication registers are listed and defined in the *Modbus Communication* chapter of this manual.

Modbus settings for Ethernet are illustrated in Figure 108.

When Auto Save Settings is enabled, settings are automatically saved to nonvolatile memory after Modbus writes. Alternately, when Auto Save is disabled, you must write to the Save All Settings Modbus register to save settings.

Modbus Setup

Ethernet Settings
Unit ID
`1`

Auto Save Settings
☑ Enabled

Figure 108. Modbus Setup

Ethernet Communication

Located on the rear panel, the Ethernet port provides communication with a PC running BESTCOMS*Plus* and uses the Modbus TCP protocol for polled communication with other networked devices. This 10BASE-T/100BASE-TX port is an eight-pin RJ45 connector that connects to shielded, twisted-pair, Category 5 copper wire media.

Ethernet Setup

Initially you must use a USB connection on the front panel to configure communications.

1. Connect an Ethernet cable between the DECS-150 and your network.

2. Connect a USB cable between the DECS-150 and your PC.

3. Use BESTCOMS*Plus* to connect to the DECS-150 through the USB port.

4. Select Configure, Ethernet from the Communication pull-down menu. If the DECS-150 is connected properly, the Configure Ethernet Port screen shown in Figure 109 will appear.

Configure Ethernet Port

Download   Send to Device   Close

IP Address
`0` `0` `0` `0`

Default Gateway
`0` `0` `0` `1`

Subnet Mask
`255` `0` `0` `0`

☑ Use DHCP

Figure 109. Configure Ethernet Port

DHCP (Dynamic Host Configuration Protocol) is enabled by default and allows the DECS-150 to send a broadcast request for configuration information. The DHCP server receives the request and responds with configuration information. Use the Device Discovery function on the DECS-150 Connection screen in *BESTCOMSPlus* to locate the Active IP address of the DECS-150.

If DHCP is not being used, use BESTCOMS*Plus* to configure the Ethernet port as described in the following paragraphs.

Configurable Ethernet options include:

IP Address:	Internet Protocol Address to be used by the DECS-150.
Default Gateway:	Default host to send data destined for a host not on the network subnet.
Subnet Mask:	Mask used to determine the range of the current network subnet.
Use DHCP:	When this box is checked, the IP Address, Default Gateway, and Subnet Mask are automatically configured via DHCP. This can be used only if the Ethernet network has a properly configured DHCP server running. The DECS-150 does not act as a DHCP server.

5. Obtain the values for these options from the site administrator if the DECS-150 is intended to share the network with other devices.

6. If the DECS-150 is operating on an isolated network, the IP address can be chosen from one of the following ranges as listed in IETF publication RFC 1918, *Address Allocation for Private Networks.*

- 10.0.0.0 - 10.255.255.255
- 172.16.0.0 - 172.31.255.255
- 192.168.0.0 - 192.168.255.255

If the DECS-150 is operating on an isolated network, the Subnet Mask can be left at 0.0.0.0 and the Default Gateway can be chosen as any valid IP address from the same range as the DECS-150 IP address.

Note
The PC running BESTCOMS*Plus* software must be configured correctly to communicate with the DECS-150. The PC must have an IP address in the same subnet range as the DECS-150 if the DECS-150 is operating on a private, local network.
Otherwise, the PC must have a valid IP address with access to the network and the DECS-150 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.

7. Click the Send to Device button located on the Configure Ethernet Port screen. The DECS-150 is now ready to be used on a network.

8. If desired, DECS-150 settings can be verified by selecting Download Settings and Logic from Device from the Communication pull-down menu. Active settings will be downloaded from the DECS-150. Verify that the downloaded settings match the previously sent settings.

Ethernet Connection

1. Connect the DECS-150 to the PC using a standard Ethernet cable.

2. Apply operating power to the DECS-150.

3. In BESTCOMS*Plus*®, click Communication, New Connection, DECS-150, or click the Connection button on the lower menu bar. The DECS-150 Connection window appears as shown in Figure 110.

4. If you know the IP address of the DECS-150, click the radio button for the Ethernet Connection IP at the top of the DECS-150 Connection window, enter the address into the fields and click the Connect button.

5. 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. See Figure 111.

6. At this point you can also add any or all of the detected devices to the Device Directory. This prevents 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-150 Connection window.

7. Choose the desired device from the list and click Connect. Wait for connection to complete.

8. The Advanced button displays the following window. It contains options for enabling Auto Reconnect, downloading settings after reconnect, the delay between retries (in milliseconds), and the maximum number of attempts. See Figure 112.
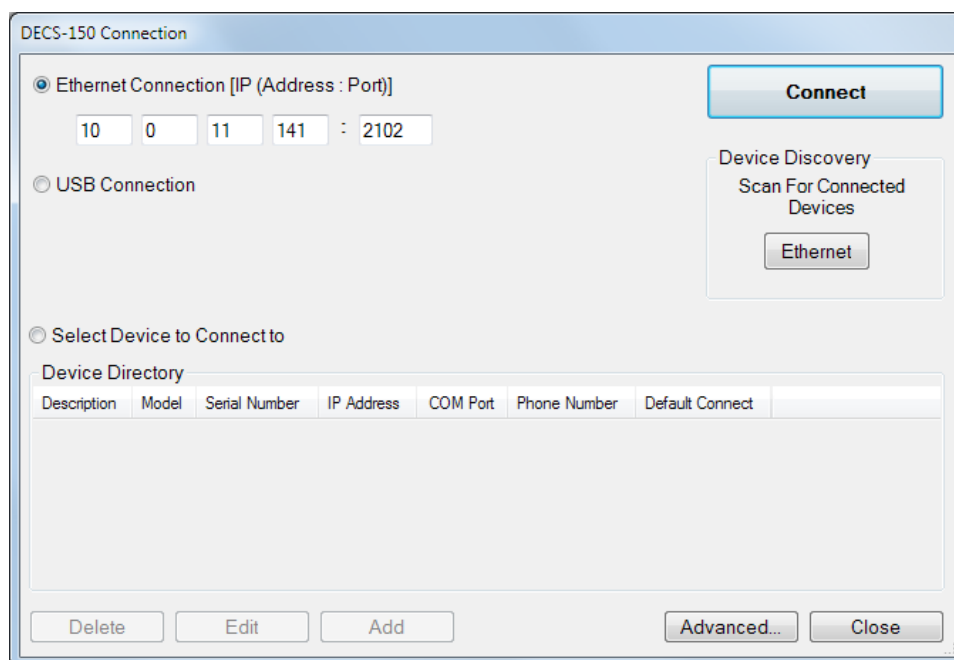
Figure 110. DECS-150 Connection Window
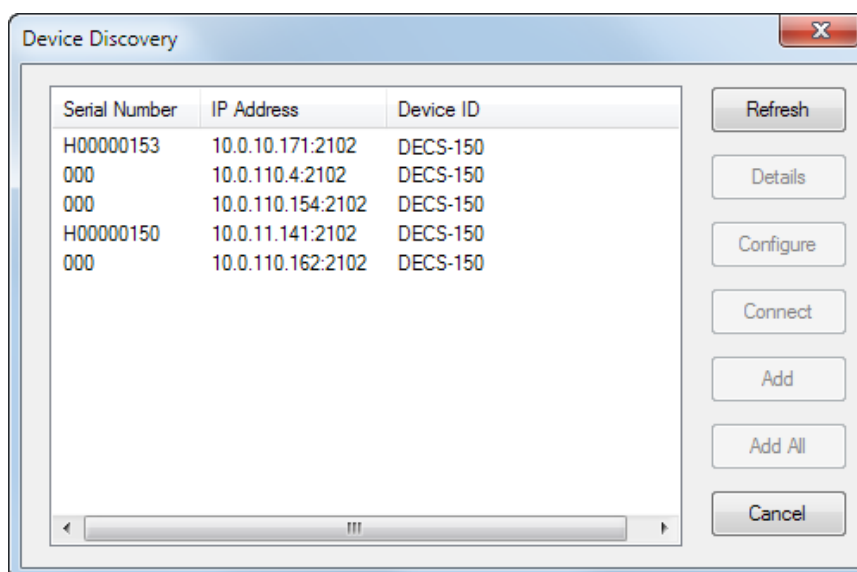
Figure 111. Device Discovery Window
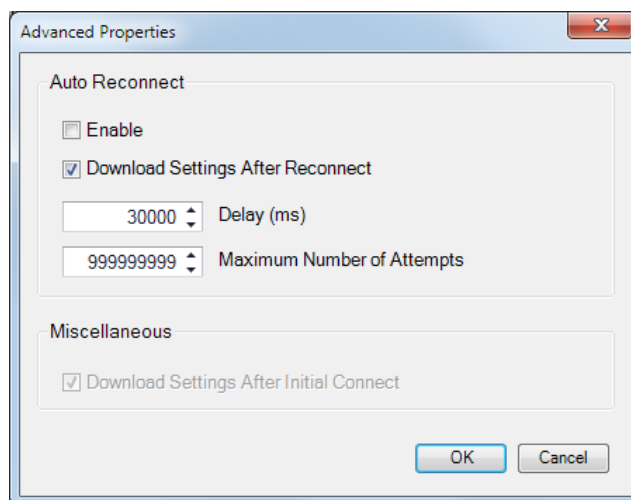
Figure 112. Advanced Properties, Auto Reconnect

Note
The PC running BESTCOMS*Plus* software must be configured correctly to communicate with the DECS-150. The PC must have an IP address in the same subnet range as the DECS-150 if the DECS-150 is operating on a private, local network.
Otherwise, the PC must have a valid IP address with access to the network and the DECS-150 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.

Configuration

Before the DECS-150 is placed in service, it must be configured for the controlled equipment and application.

Generator, Field, and Bus Ratings

BESTCOMS*Plus* **Navigation Path:** Settings Explorer, System Parameters, Rated Data

Generator and field rating settings are illustrated in Figure 113. Setting ranges and defaults are summarized in Table 46.

For proper excitation control and protection, the DECS-150 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 and full-load voltage and current.

In applications where the generator will be paralleled with a bus, the DECS-150 must be configured with the rated bus voltage.

The nominal operating power input voltage is used in metering calculations.

The ambient temperature setting determines the low-level range on the Takeover OEL settings screen.

Caution
Enabling an inverted bridge output with an exciter which does not require an inverted bridge output will result in equipment damage.

Rated Data

Generator Rated Data
- Voltage (V): 120
- Current (A): 481.1
- Frequency: 60 Hz
- PF (Power Factor): 0.80
- Rating (kVA): 100.0
- Rating (kW): 80.00
- Rating (kvar): 60.00

Field Rated Data
- Voltage - Full Load (V): 100.0
- Current - Full Load (A): 10.00
- Voltage - No Load (V): 100.0
- Current - No Load (A): 7.00

Bus Rated Data
- Voltage (V): 120

Operating Power Input
- Power Input Voltage (V): 208.0

Ambient Temperature
- Ambient Temperature: Max Ambient Temperature is 158 degrees Fahrenheit

Figure 113. Rated Data Screen

Table 46. Rated Data Settings

Setting	Range	Default
Gen Voltage	1 to 90,000 V in 1 V increments	120 V
Gen Frequency	50 or 60 Hz	60 Hz
Gen PF	−0.5 to 0.5 in increments of 0.01	0.8
Gen kVA Rating	1 to 1,000,000 kVA in 0.01 kVA increments	41.57 kVA
Field Voltage Full Load	1 to 125 V in 0.1 V increments	63 V
Field Current Full Load	0 to 7 A (70°C ambient) or 0 to 10 A (55°C ambient) in 0.01 A increments	5 A
Field Voltage No Load	1 to 125 V in 0.1 V increments	32 V
Field Current No Load	0 to 7 A (70°C ambient) or 0 to 10 A (55°C ambient) in 0.01 A increments	5 A
Bridge Output Invert	Checked (inverted) or unchecked (not inverted)	Not Inverted
Bus Voltage	1 to 90,000 Vac in 1 V increments	120 V
Power Input Voltage	1 to 277 V. Increment varies.	240 V
Ambient Temperature	70 or 55°C. This setting affects the High, Medium, and Low OEL limiter ranges.	70°C

Sensing Transformer Ratings and Configuration

BESTCOMS*Plus* Navigation Path: Settings Explorer, System Parameters, Sensing Transformers

DECS-150 configuration includes entry of the primary and secondary values for the transformers that supply generator and bus sensing values to the DECS-150.

The Sensing Transformers screen is illustrated in Figure 114. Setting ranges and defaults are summarized in Table 47.

Generator PT

Voltage settings for the generator PT primary and secondary windings establish the nominal PT voltages expected by the DECS-150. ABC or ACB phase rotation can be accommodated. Options for the generator voltage sensing connections include single-phase (across phases C and A) and three-phase sensing using three-wire delta connections.

Generator CTs

Current settings for the generator CT primary and secondary windings establish the nominal CT current values expected by the DECS-150. DECS-150 sensing current can be obtained from B-phase only or all three generator phases.

Bus PT

Voltage settings for the bus PT primary and secondary windings establish the nominal bus PT voltages expected by the DECS-150. Options for the bus voltage sensing connections include single-phase (across phases A and C) and three-phase sensing using three-wire delta connections.

Figure 114. Sensing Transformers Screen

Table 47. Sensing Transformers Settings

Setting	Range	Default
Gen PT Primary Voltage	1 to 500,000 V in 1 Vac increments	120 V
Gen PT Secondary Voltage	1 to 600 V in 1 V increments	120 V
Gen CT Primary Current	1 to 99,999 A in 1 A increments	200 A
But PT Primary Voltage	1 to 500,000 V in 1 V increments	120 V
Bus PT Secondary Voltage	1 to 600 V in 1 V increments	120 V
Phase Rotation	ABC or ACB	ABC
Generator Voltage Sensing	CA or 3W-D (Three-Wire Delta)	3W-D
Phase Connection	B or CT_ABC	CT_ABC
Bus Voltage Sensing	CA or 3W-D (Three-Wire Delta)	3W-D

Startup Functions

BESTCOMS*Plus* Navigation Path: Settings Explorer, Operating Settings, Startup

DECS-150 startup functions consist of soft start settings as shown in Figure 115. Setting ranges and defaults are summarized in Table 48.

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 and FCR regulation modes. Soft start behavior is based on two parameters: level and time. The soft start level is expressed as a percentage of the nominal generator terminal voltage and determines the starting point for generator voltage buildup during startup. The Soft Start Time setting 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*.

The PWM Startup Duty Cycle setting gives the user the ability to adjust the initial startup pulse width of the DECS-150's output to the field of the generator during the soft start sequence.

Figure 115. Startup Screen

Table 48. Startup Settings

Setting	Range	Default
PWM Startup Duty Cycle	0 to 100% in 1% increments	0%
Soft Start Level	0 to 90% in 1% increments	5%
Soft Start Time	1 to 7,200 s in 1 s increments	5 s

Device Information

BESTCOMS*Plus* **Navigation Path:** Settings Explorer, General Settings, Device Info

Device information includes user-assigned identification labeling and read-only firmware version information and product information. See Figure 116.

Firmware and Product Information

Firmware and product information can be viewed on the Device Info tab of BESTCOMS*Plus*.

Firmware Information

Firmware information for the DECS-150 includes the Application Part Number, Version Number, and Build Date. Also included is the Boot Code Version. When configuring settings in BESTCOMS*Plus*® while disconnected from a DECS-150, an Application Version Number setting is available to ensure compatibility between the selected settings and the actual settings available in the DECS-150.

Product Information

Product information for the DECS-150 includes the device model number and serial number.

Device Identification

The user-assigned Device ID (up to 64 alphanumeric characters) can be used to identify DECS-150 controllers in reports and during polling.

Figure 116. Device Information

Display Units

BESTCOMS*Plus* Navigation Path: General Settings, Display Units

When working with DECS-150 settings in BESTCOMS*Plus*, you have the option of viewing the settings in English or Metric units and as primary units or per-unit values. When per-unit values are selected, settings are entered as per-unit values and BESTCOMS*Plus* converts the per-unit inputs to high-side values based on the generator rated data. The Display Units settings are illustrated in Figure 117.

Figure 117. Display Units

Security

DECS-150 security is provided in the form of passwords which control the type of operations allowed by a particular user. Passwords can be tailored to provide access to specific operations. Additional security is available by controlling the type of operations allowed through certain DECS-150 communication ports.

Security settings are uploaded and downloaded separately from the settings and logic. See the *BESTCOMSPlus® Software* chapter for more information on uploading and downloading security.

Password Access

A username and password can be established for one of six functional access areas within the DECS-150. These access areas are listed in Table 49 according to rank. A username and password with higher access can be used to gain access to operations controlled by a password with lower access. For example, a settings-level username and password has access to operations protected by the settings-, operator-, control-, and read-level usernames and passwords. This screen cannot be accessed when in Live Mode.

Table 49. Password Access Levels and Descriptions

Access Level	Description
Admin (1)	Access to security setup, communications settings, and software upgrades. Includes levels 2, 3, 4, 5, and 6 below.
Design (2)	Access to create and edit programmable logic. Includes levels 3, 4, 5, and 6 below.
Settings (3)	Access to edit settings. Does <u>not</u> include logic settings, security setup, communications settings, and software upgrades. Includes levels 4, 5, and 6 below.
Operator (4)	Access to set date and time, trigger and clear logs, and edit energy values. Includes levels 5 and 6 below.
Control (5)	Access to change setpoints, raise and lower, reset alarms, and preposition. Includes level 6 below.
Read (6)	Access to read all system parameters, metering, and logs. No write access.
None (7)	Lowest access level. All access is denied.

Password Creation and Configuration

Usernames and passwords are created and configured in BESTCOMS*Plus* on the Username Setup screen (Figure 118) under the General Settings > Device Security Setup. To create and configure a username and password, perform the following steps:

1. In the BESTCOMS*Plus* settings explorer, select User Name Setup. This selection is located under General Settings, Device Security 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.

2. Highlight an "UNASSIGNED" entry in the user list. (Highlighting a previously-established username will display the password and access level for the user. This enables the password and access level for an existing user to be changed.)

3. Enter the desired username (up to a 16-character label that may include upper and lowercase letters, numbers, and special characters).

4. Enter the desired password for the user (up to a 16-character label that may include upper and lowercase letters, numbers, and special characters).

5. Reenter the password created in step 4 to verify the password.

6. Select the maximum allowed access level for the user (Read, Control, Operator, Settings, Design, or Admin).

7. If a maximum duration is desired for the user's access, enter the limit (0 to 50,000 days). Otherwise, leave the expiration value at zero.

8. Click the Save User button to save the user settings.

9. Open the Communication menu, and click Upload Security to Device.

10. BESTCOMS*Plus* notifies you when the security upload is successful.

Figure 118. User Name Setup Screen

Port Security

An additional dimension of security is provided by the ability to restrict the control available through the DECS-150 communication ports. At any given time, only one port can be in use with read or higher access. For example, if a user gains settings access at one port, users at other ports will be able to gain no higher than read access until the user with settings access logs off. This screen cannot be accessed when in Live Mode.

Port Access Configuration

Communication port access is configured in BESTCOMS*Plus* on the Port Access Setup tab (Figure 119) of the Device Security Setup area. To configure communication port access, perform the following steps:

1. In the BESTCOMS*Plus* settings explorer, select Port Access Setup. This selection is located under General Settings, Device Security 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.

2. Highlight the desired communication port in the port list.

3. Select the unsecured access level for the port (None, Read, Control, Operator, Settings, Design, or Admin).

4. Select the secured access level for the port (None, Read, Control, Operator, Settings, Design, or Admin).

5. Save the configuration by clicking the Save Port button.

6. Open the Communication menu, and click Upload Security to Device.

7. BESTCOMS*Plus*® notifies you when the security upload is successful.

Figure 119. Port Access Configuration Settings

Login and Access Controls

BESTCOMS*Plus* 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 120. Setting ranges and defaults are summarized in Table 50.

Access Timeout

The Access Timeout Delay setting maintains security by automatically withdrawing password access if a user neglects to log out. If no activity is seen for the duration of the access timeout setting, password access is automatically withdrawn.

Login Failure

The Login Attempts setting limits the number of times that login can be attempted. The 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.

Figure 120. Access Control Screen

Table 50. Access Control Settings

Setting	Range	Default
Timeout Delay	10 to 3,600 s in 1 s increments	300 s
Login Attempts	1 to 10 in increments of 1	1
Login Time Window	1 to 99,999 s in 1 s increments	1 s
Login Lockout Time	1 to 99,999 s in 1 s increments	1 s

Timekeeping

The DECS-150 provides a real-time clock with an internal backup battery. The backup battery will maintain the clock for approximately five years depending on conditions.

The clock is used by the logging functions to timestamp events. BESTCOMS*Plus*® clock settings are shown in Figure 121.

BESTCOMS*Plus* Navigation Path: Settings Explorer, General Settings, Clock Setup

Time and Date Format

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.

Clock display settings enable you to configure the time and date reported by the DECS-150 to match the conventions used in your organization/facility. The reported time can 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-150 can automatically compensate for the start and end of daylight saving time (DST) on a fixed- or floating-date basis. A fixed-date, for example, is March 2, and an example of a floating-date is, "Second Sunday of March". DST compensation can be made with respect to your local time or coordinated universal time (UTC). DST start and end points are fully configurable and include a bias adjustment.

Figure 121. Clock Setup Screen

Table 51. Clock Settings

Setting	Range	Increment	Unit	Default
Time Zone Hour Offset	−12 to 12	1	hours	−6

Setting	Range	Increment	Unit	Default
Time Zone Minute Offset	−59 to 59	1	minutes	0
Time Format	12 Hour or 24 Hour	n/a	n/a	24 Hour
Date Format	YYYY-MM-DD MM-DD-YYYY DD-MM-YYYY	n/a	n/a	YYYY-MM-DD
DST Configuration	Floating Dates or Fixed Dates	n/a	n/a	Floating Dates
Start/End Time Reference	Respective to Local Time or Respective to UTC Time	n/a	n/a	Respective to Local Time
Bias Setup (Hour)	−12 to 12	1	hours	1
Bias Setup (Minute)	−59 to 59	1	minutes	0

Backup Battery for the Real-Time Clock

The backup battery for the real time clock is a standard feature of the DECS-150. A battery is used to maintain clock function during loss of operating power. In mobile substation and generator applications, the primary battery system that supplies DECS-150 operating power may be disconnected for extended periods (weeks, months) between uses. Without battery backup for the real time clock, clock functions will cease if battery input power is removed.

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.

Caution
Replacement of the backup battery for the real-time clock should be performed only by qualified personnel.
Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings next to the battery socket when inserting a new battery. The battery polarity must be correct in order to provide backup for the real-time clock.
It is recommended that the battery be removed if the DECS-150 is to be operated in a salt-fog environment. Salt-fog is known to be conductive and may short-circuit the battery.

Note
Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

Battery Replacement Procedure

The battery access is located on the back of the DECS-150. See the *Terminals and Connectors* chapter for battery location.

Step 1:   Remove the DECS-150 from service.

Step 2:   Locate the battery socket on the back of the DECS-150. Remove the old battery. Consult your local ordinance for proper battery disposal.

Step 3:   Insert the new battery so that the polarity markings on the battery match the polarity markings on the battery socket.

Step 4:   Return the DECS-150 to service.

Testing

Testing of the DECS-150's regulation and optional power system stabilizer (style xPxxx) performance is possible through the integrated analysis tools of BESTCOMS*Plus*®.

Real-Time Metering Analysis

BESTCOMS*Plus* Navigation Path: Metering Explorer, Analysis

Proper voltage regulator performance is critical to power system stabilizer 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 BESTCOMS*Plus* Real-Time Metering Analysis screen can be used to perform and monitor online AVR and PSS testing. Four plots of user-selected data can be generated and the logged data can be stored in a file for later examination. BESTCOMS*Plus* must be in Live Mode in order 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 122.
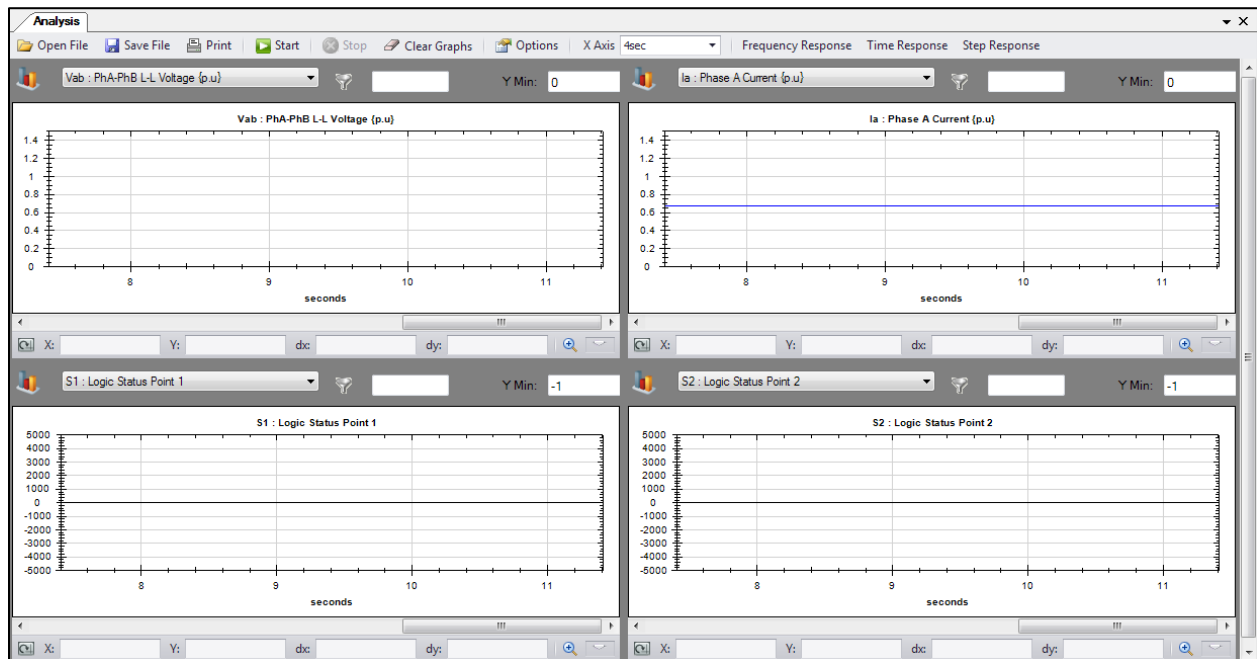
Figure 122. RTM Analysis Screen

With the RTM Analysis screen controls, you can:

- Select the parameters to be graphed
- Adjust the resolution of the graph x axis and the range of the graph y axis
- Start and stop plot captures
- Open an existing graph file, save a captured plot in a graph file, and print a captured graph

Graph Parameters

Any four of the following parameters may be selected for plotting in the graph areas.

- Auxiliary voltage input (Vaux)
- Average line current (Iavg)
- Average line-to-line voltage (Vavg)
- AVR error signal (Errln)
- AVR output
- Bus frequency (B Hz)
- Bus voltage (Vbus)
- Compensated frequency deviation (CompF)
- Control output (CntOp)
- Cross-current input (Iaux)
- Droop
- FCR error
- FCR state
- FCR output
- Field current (Ifd)
- Field voltage (Vfd)
- Filtered mechanical power (MechP)
- Final PSS output (Pout)
- Frequency response signal (Test)
- Generator frequency (G Hz)
- Internal state (TrnOp)
- Lead-lag #1 (x15)
- Lead-lag #2 (x16)
- Lead-lag #3 (x17)
- Lead-lag #4 (x31)
- Logic Limiter Washout Filter
- Logic Status Point 1 (S1)
- Logic Status Point 2 (S2)
- Logic Status Point 3 (S3)
- Logic Status Point 4 (S4)
- Logic Status Point 5 (S5)
- Logic Status Point 6 (S6)
- 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
- Null Balance Level (Null Balance)
- Null Balance State (Null State)
- OEL controller output (OelOutput)
- OEL reference
- OEL state
- 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)
- Power Input
- Pre-limit output (Prelim)
- PSS electrical power (PssW)
- PSS terminal voltage (Vtmag)
- Reactive power (var)
- Real power (W)
- SCL controller output (SclOutput)
- SCL reference
- SCL state
- SCL PF reference
- Speed HP #1 (x2)
- Synthesized speed (Synth)
- Terminal frequency deviation (TermF)
- Terminal Voltage Low Pass Filter
- Terminal Voltage Ramp Limiter
- Time response signal (Ptest)
- Torsional filter #1 (Tflt1)
- Torsional filter #2 (x29)
- Total power (VA)
- UEL controller output (UelOutput)
- UEL reference
- UEL state
- Var/PF error
- Var/PF state
- Var/PF output
- Washed out power (WashP)
- Washed out speed (WashW)

Frequency Response

Frequency response testing functions are available by clicking the RTM Analysis screen Frequency Response button. Frequency Response screen functions are illustrated in Figure 123 and described as follows.

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,

BESTCOMS*Plus* 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. The 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.
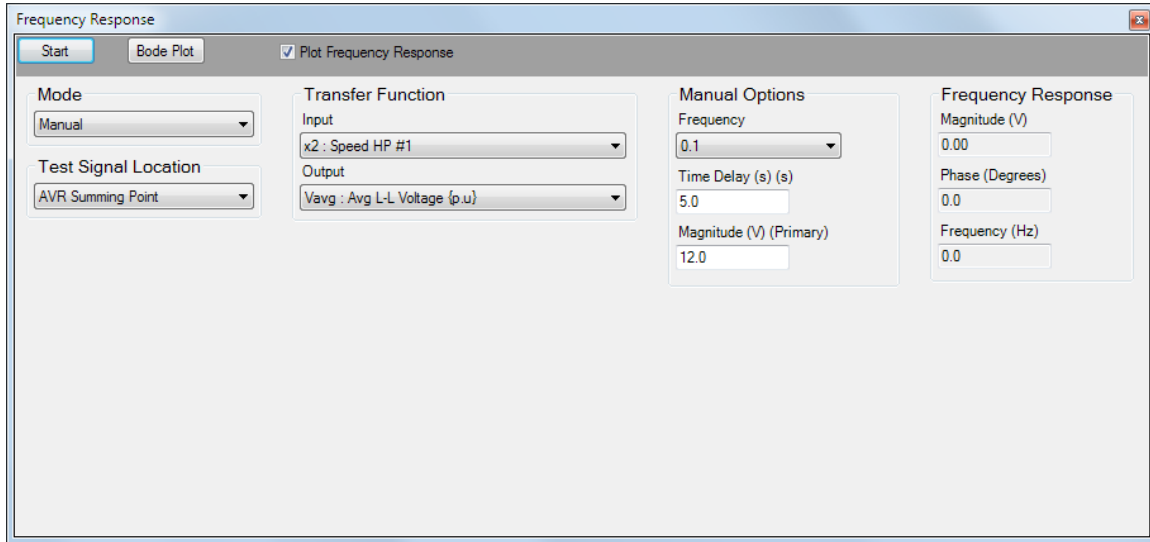
Figure 123. Frequency Response Screen

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.

Bode Plotting

A Bode plot can be printed, opened, and saved in graph (.gph) format.

Test Signal Location

The point in the DECS-150 logic circuitry where a signal is injected for analysis of magnitude and phase responses is selectable. Signal points include AVR Summing Point, PID Block Output, AVR PID Input, PSS Compensation Frequency, PSS Electric Power, and Manual PID Input.

Transfer Function

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
- ErrIn: AVR Error Signal
- FcrErr
- FcrOut
- 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}
- 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}
- PsskW: PSS Electric Power {pu}
- Ptest: Time Response Signal {pu}
- SclOutput: SCL Controller Output
- Synth: Synthsized 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
- 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}
- Vtmag: PSS Term Voltage
- WashP: Washed Out Power
- WashW: Washed Out Speed {pu}
- 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}
- x2: Speed HP #1
- x29: Torsional Filter #2 {pu}
- x31: Lead-Lag #4 {pu}
- x5: Power HP #1 {pu}
- x7: Mechanical Power {pu}
- x8: Mechanical Power LP #1
- x9: Mechanical Power LP #2

Frequency Response

Read-only frequency response fields indicate the magnitude response, phase response, and test signal frequency. The magnitude response and phase response corresponds 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. Frequencies that are close to the resonant frequency of the machine or neighboring machines are to be avoided. 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 124. 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.
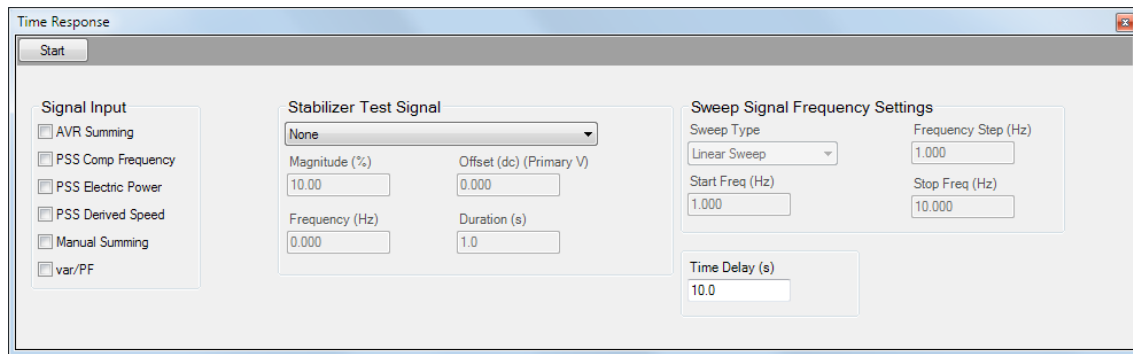
Figure 124. Time Response Screen

Test Signal Characteristics

Test signal characteristics (magnitude, offset, frequency, and duration) can 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 Signal

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 can 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 "step" every half-cycle of the system frequency. For logarithmic sweeps, the test signal frequency is multiplied by 1.0 + 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 125) is accessed by clicking the Step Response button in the RTM Analysis window. The Step Response Analysis screen consists of:

- Metering fields: generator VA, total vars and PF, field voltage, and field current
- An alarms window that displays any active alarms triggered by a step change
- Control buttons to start and stop step response analysis and a button to close the screen
- 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, 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-150 operating mode is switched externally. The screen must be manually updated by exiting and then reopening the screen.

AVR and FCR Tabs

The AVR and FCR tabs are similar in their controls that enable the application of step changes to their respective setpoints. AVR tab controls are illustrated in Figure 125. AVR and FCR tab controls operate as follows.

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. A read-only setpoint field indicates the current setpoint and what the setpoint will be when a step change occurs. A button is provided to return the setpoint to its original value. This original value is the setpoint established in the Setpoints section of the BESTCOMS*Plus* settings explorer and is displayed in the read-only field adjacent to the button.
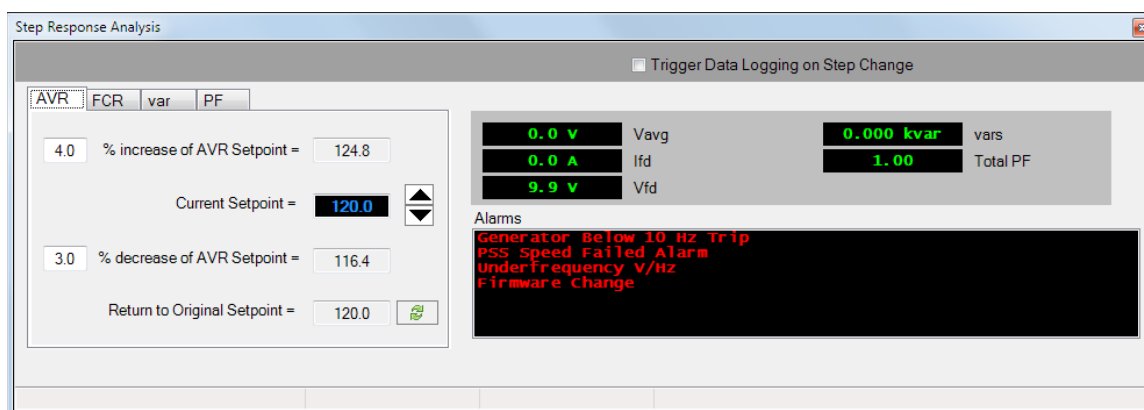
Figure 125. Step Response Analysis - AVR Tab

Var and PF Tabs

The var and PF tabs are similar in their controls that enable the application of step changes to their respective setpoints. PF tab controls are illustrated in Figure 126. Var and PF tab controls operate as follows.
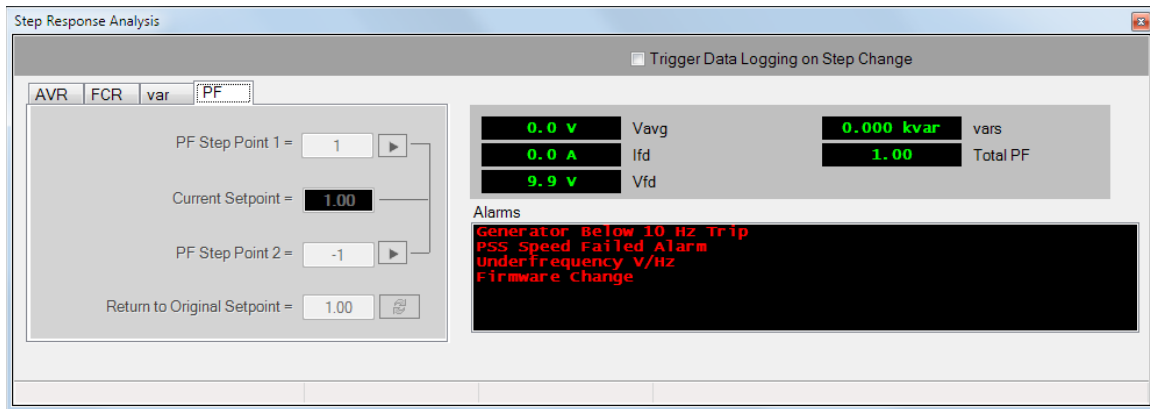
Figure 126. Step Response Analysis - PF Tab

Step changes that increase or decrease the setpoint can be applied by clicking the increment (up arrow) or decrement (down arrow) button. Step-change setpoints can be entered in two setting fields. Clicking the right-arrow button beside one of the two fields initiates a step change to the corresponding setpoint value. A button is provided to return the setpoint to its original value before any step changes were invoked. This original value is the setpoint established in the Setpoints section of the BESTCOMS*Plus* settings explorer and 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 four data plots may be displayed in three different layouts on the RTM screen. Place a check in the Cursors Enabled box to enable cursors used for measuring between two horizontal points. See Figure 127.

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 also result in improved PC performance while plotting.

Place a check in the Sync Graph Scrolling box to sync scrolling between all graphs when any horizontal scroll bar is moved. See Figure 128.
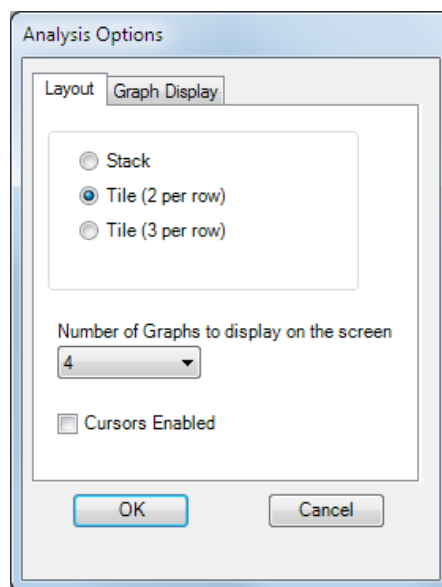
Figure 127. Analysis Options Screen, Layout Tab
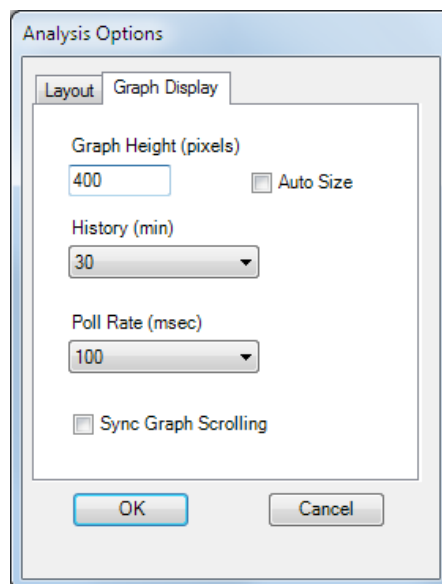
Figure 128. Analysis Options Screen, Graph Display Tab

Modbus® Communication

Introduction

This document describes the Modbus® communications protocol employed by DECS-150 systems and how to exchange information with DECS-150 systems over a Modbus network. DECS-150 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-150) 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-150 is grouped categorically as follows:

- General
- Security
- Binary Points
- Metering
- Limiters
- Setpoints
- Global Settings
- Configuration Settings
- Protection Settings
- Gains
- PSS

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-150 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-150 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 Modbus/TCP mode for communication. To enable editing over Modbus TCP, 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 129.
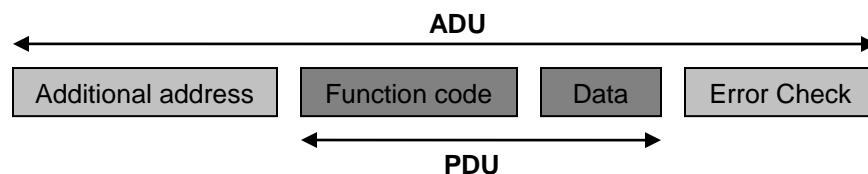
Figure 129. General Modbus Frame

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 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 130.
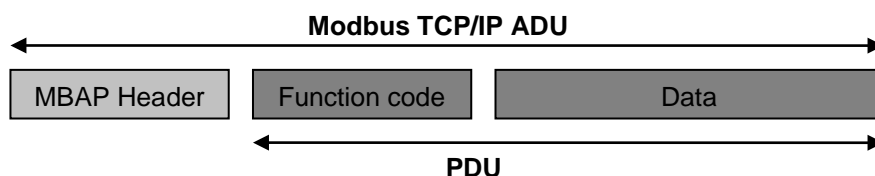
Figure 130. Modbus Request/Response Over TCP/IP

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 52.

Table 52. 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-150 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-150 are provided in Table 53.

Table 53. 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-150 Modbus® via Ethernet

Modbus can communicate through Ethernet if the IP address of the DECS-150 is configured as described in the *Communications* chapter of this manual.

Detailed Message Query and Response

A detailed description of DECS-150 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-150 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-150 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-150 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-150 continues to monitor all queries. The DECS-150 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-150 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-150 will perform the write when the device address in query is a broadcast address or the same as the DECS-150 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-150 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-150 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 54 shows the floating-point format.

Table 54. Floating Point Format

Sign	Exponent + 127	Mantissa
1 Bit	8 Bits	23 Bits

The floating-point format allows for values ranging from approximately 8.43×10^{-37} to 3.38×10^{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 57), 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-150 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-150 Login via Modbus

To login to the DECS-150 via Modbus, write the string *username|password* to the Secure Login register (500). 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 (520). Write any value to the Logout register (517) to log out of the DECS-150. Upon disconnecting from Modbus over TCP/IP, the user is automatically logged out of the DECS-150.

Modbus Parameters

General

General parameters are listed in Table 55.

Table 55. General Group Parameters

Group	Name	Register	Type	Bytes	R/W	Unit	Range
System Data	Model Number	1	String	64	R	n/a	0 - 64
System Data	Firmware Part Number	33	String	64	R	n/a	0 - 64
Time	Date	97	String	16	R	n/a	0 - 16
Time	Time	105	String	16	R	n/a	0 - 16
Unit Information	Style Number	113	String	32	R	n/a	0 - 32
Unit Information	Serial Number	129	String	32	R	n/a	0 - 32
Configurable Element 1	Contact Recognition	147	Uint32	4	R W	n/a	Always=0 Alarm=1
Configurable Element 1	Alarm Configuration	149	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 1	Activation Delay	151	Uint32	4	R W	Second	0 - 300
Configurable Element 2	Contact Recognition	153	Uint32	4	R W	n/a	Always=0 Alarm=1
Configurable Element 2	Alarm Configuration	155	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 2	Activation Delay	157	Uint32	4	R W	Second	0 - 300
Configurable Element 3	Contact Recognition	159	Uint32	4	R W	n/a	Always=0 Alarm=1
Configurable Element 3	Alarm Configuration	161	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 3	Activation Delay	163	Uint32	4	R W	Second	0 - 300
Configurable Element 4	Contact Recognition	165	Uint32	4	R W	n/a	Always=0 Alarm=1
Configurable Element 4	Alarm Configuration	167	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 4	Activation Delay	169	Uint32	4	R W	Second	0 - 300
Configurable Element 5	Contact Recognition	171	Uint32	4	R W	n/a	Always=0 Alarm=1
Configurable Element 5	Alarm Configuration	173	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 5	Activation Delay	175	Uint32	4	R W	Second	0 - 300
Configurable Element 6	Contact Recognition	177	Uint32	4	R W	n/a	Always=0 Alarm=1
Configurable Element 6	Alarm Configuration	179	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 6	Activation Delay	181	Uint32	4	R W	Second	0 - 300
Configurable Element 7	Contact Recognition	183	Uint32	4	R W	n/a	Always=0 Alarm=1

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Configurable Element 7	Alarm Configuration	185	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 7	Activation Delay	187	Uint32	4	R W	Second	0 - 300
Configurable Element 8	Contact Recognition	189	Uint32	4	R W	n/a	Always=0 Alarm=1
Configurable Element 8	Alarm Configuration	191	Uint32	4	R W	n/a	Status Only=0 Alarm=1
Configurable Element 8	Activation Delay	193	Uint32	4	R W	Second	0 - 300

Security

Table 56. Security Group Parameters

Group	Name	Register	Type	Bytes	R/W	Range
Security	Secure Login	500	String	34	RW	0 – 34
Security	Logout	517	String	5	RW	0 – 5
Security	Current Access	520	Uint32	4	R	No Access=0 Read Access=1 Control Access=2 Operator Access=3 Setting Access=4 Design Access=5 Administrator Access=6
Security	Save Changes	522	Uint32	4	R W	n/a

Binary Points

Table 57. Binary Point Group Parameters

Group	Name	Register	Type	Bytes	R/W	Range
Alarms	Firmware Change Alarm	900 bit 0	Uint16	2	R	True=1 False=0
Alarms	Ethernet Link Lost Alarm	900 bit 1	Uint16	2	R	True=1 False=0
Alarms	Logic Equal None Alarm	900 bit 2	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 1	900 bit 3	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 2	900 bit 4	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 3	900 bit 5	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 4	900 bit 6	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 5	900 bit 7	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 6	900 bit 8	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 7	900 bit 9	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 8	900 bit 10	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 9	900 bit 11	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 10	900 bit 12	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 11	900 bit 13	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 12	900 bit 14	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 13	900 bit 15	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 14	901 bit 0	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 15	901 bit 1	Uint16	2	R	True=1 False=0
Alarms	Programmable Alarm 16	901 bit 2	Uint16	2	R	True=1 False=0
Alarms	Underfrequency V/Hz Alarm	901 bit 3	Uint16	2	R	True=1 False=0
Alarms	OEL Alarm	901 bit 4	Uint16	2	R	True=1 False=0
Alarms	UEL Alarm	901 bit 5	Uint16	2	R	True=1 False=0
Alarms	SCL Alarm	901 bit 6	Uint16	2	R	True=1 False=0
Alarms	Power Supply Low Alarm	901 bit 7	Uint16	2	R	True=1 False=0
Alarms	PSS Voltage Unbalanced Alarm	901 bit 8	Uint16	2	R	True=1 False=0
Alarms	PSS Current Unbalanced Alarm	901 bit 9	Uint16	2	R	True=1 False=0
Alarms	PSS Power Below Threshold Alarm	901 bit 10	Uint16	2	R	True=1 False=0
Alarms	PSS Speed Failed Alarm	901 bit 11	Uint16	2	R	True=1 False=0

Group	Name	Register	Type	Bytes	R/W	Range
Alarms	PSS Voltage Limit Alarm	901 bit 12	Uint16	2	R	True=1 False=0
Alarms	VM Active	901 bit 13	Uint16	2	R	True=1 False=0
Alarms	Phase Rotation Mismatch	901 bit 14	Uint16	2	R	True=1 False=0
Alarm Report	Alarm Output	901 bit 15	Uint16	2	R	True=1 False=0
Contact Inputs	Input 1	902 bit 0	Uint16	2	R	True=1 False=0
Contact Inputs	Input 2	902 bit 1	Uint16	2	R	True=1 False=0
Contact Inputs	Input 3	902 bit 2	Uint16	2	R	True=1 False=0
Contact Inputs	Input 4	902 bit 3	Uint16	2	R	True=1 False=0
Contact Inputs	Input 5	902 bit 4	Uint16	2	R	True=1 False=0
Contact Inputs	Input 6	902 bit 5	Uint16	2	R	True=1 False=0
Contact Inputs	Input 7	902 bit 6	Uint16	2	R	True=1 False=0
Contact Inputs	Input 8	902 bit 7	Uint16	2	R	True=1 False=0
Contact Outputs	Watchdog Output	902 bit 8	Uint16	2	R	True=1 False=0
Contact Outputs	Output 1	902 bit 9	Uint16	2	R	True=1 False=0
Contact Outputs	Output 2	902 bit 10	Uint16	2	R	True=1 False=0
Contact Outputs	Breaker Shunt Trip Output	902 bit 11	Uint16	2	R	True=1 False=0
Hardware Ports	Field Short Circuit Status	902 bit 12	Uint16	2	R	True=1 False=0
Virtual Switch	Virtual Switch 1	902 bit 13	Uint16	2	R	True=1 False=0
Virtual Switch	Virtual Switch 2	902 bit 14	Uint16	2	R	True=1 False=0
Virtual Switch	Virtual Switch 3	902 bit 15	Uint16	2	R	True=1 False=0
Virtual Switch	Virtual Switch 4	903 bit 0	Uint16	2	R	True=1 False=0
Virtual Switch	Virtual Switch 5	903 bit 1	Uint16	2	R	True=1 False=0
Virtual Switch	Virtual Switch 6	903 bit 2	Uint16	2	R	True=1 False=0
DECS Control	Internal Tracking Disable	903 bit 3	Uint16	2	R	True=1 False=0
DECS Control	External Tracking Disable	903 bit 4	Uint16	2	R	True=1 False=0
DECS Control	OEL Online	903 bit 5	Uint16	2	R	True=1 False=0
DECS Control	Droop Disable	903 bit 6	Uint16	2	R	True=1 False=0
DECS Control	CC Disable	903 bit 7	Uint16	2	R	True=1 False=0
DECS Control	Line Drop Disable	903 bit 8	Uint16	2	R	True=1 False=0
DECS Control	Voltage Matching Disable	903 bit 9	Uint16	2	R	True=1 False=0
DECS Control	PF Var Enable JK	903 bit 10	Uint16	2	R	True=1 False=0
DECS Control	Loss of Transfer Disable	903 bit 11	Uint16	2	R	True=1 False=0
DECS Control	Parallel Enable LM	903 bit 12	Uint16	2	R	True=1 False=0
DECS Control	Soft Start Select Group 2	903 bit 13	Uint16	2	R	True=1 False=0
DECS Control	PSS Select Group 2	903 bit 14	Uint16	2	R	True=1 False=0
DECS Control	OEL Select Group 2	903 bit 15	Uint16	2	R	True=1 False=0
DECS Control	UEL Select Group 2	904 bit 0	Uint16	2	R	True=1 False=0
DECS Control	SCL Select Group 2	904 bit 1	Uint16	2	R	True=1 False=0
DECS Control	Protect Select Group 2	904 bit 2	Uint16	2	R	True=1 False=0
DECS Control	PID Select Group 2	904 bit 3	Uint16	2	R	True=1 False=0
DECS Control	Var PF Selection	904 bit 4	Uint16	2	R	True=1 False=0
DECS Control	DECS Start/Stop External	904 bit 5	Uint16	2	R	True=1 False=0
DECS Control	DECS Manual/Auto	904 bit 6	Uint16	2	R	True=1 False=0
DECS Control	DECS Preposition	904 bit 7	Uint16	2	R	True=1 False=0
DECS Control	Softstart Active	904 bit 8	Uint16	2	R	True=1 False=0
DECS Control	Var Limiter Select Group 2	904 bit 9	Uint16	2	R	True=1 False=0
DECS Control	Preposition 1 Active	904 bit 10	Uint16	2	R	True=1 False=0
DECS Control	Preposition 2 Active	904 bit 11	Uint16	2	R	True=1 False=0
DECS Control	Preposition 3 Active	904 bit 12	Uint16	2	R	True=1 False=0
DECS Control	Var Active	904 bit 13	Uint16	2	R	True=1 False=0
DECS Control	PF Active	904 bit 14	Uint16	2	R	True=1 False=0

Group	Name	Register	Type	Bytes	R/W	Range
DECS Control	Manual Active	904 bit 15	Uint16	2	R	True=1 False=0
DECS Control	Auto Active	905 bit 0	Uint16	2	R	True=1 False=0
DECS PSS Meter	PSS Active	905 bit 1	Uint16	2	R	True=1 False=0
DECS Regulator Meter	Setpoint at Lower Limit	905 bit 2	Uint16	2	R	True=1 False=0
DECS Regulator Meter	Setpoint at Upper Limit	905 bit 3	Uint16	2	R	True=1 False=0
DECS Regulator Meter	Internal Tracking Active	905 bit 4	Uint16	2	R	True=1 False=0
DECS Regulator Meter	External Tracking Active	905 bit 5	Uint16	2	R	True=1 False=0
Field Overvoltage	Pickup	905 bit 6	Uint16	2	R	True=1 False=0
Field Overvoltage	Trip	905 bit 7	Uint16	2	R	True=1 False=0
Loss of Sensing	Pickup	905 bit 8	Uint16	2	R	True=1 False=0
Loss of Sensing	Trip	905 bit 9	Uint16	2	R	True=1 False=0
EDM	Pickup	905 bit 10	Uint16	2	R	True=1 False=0
EDM	Trip	905 bit 11	Uint16	2	R	True=1 False=0
25 Element	Status	905 bit 12	Uint16	2	R	True=1 False=0
27P Element	Block	905 bit 13	Uint16	2	R	True=1 False=0
27P Element	Pickup	905 bit 14	Uint16	2	R	True=1 False=0
27P Element	Trip	905 bit 15	Uint16	2	R	True=1 False=0
59P Element	Pickup	906 bit 0	Uint16	2	R	True=1 False=0
59P Element	Trip	906 bit 1	Uint16	2	R	True=1 False=0
81-1 Element	Pickup	906 bit 2	Uint16	2	R	True=1 False=0
81-1 Element	Trip	906 bit 3	Uint16	2	R	True=1 False=0
81-2 Element	Pickup	906 bit 4	Uint16	2	R	True=1 False=0
81-2 Element	Trip	906 bit 5	Uint16	2	R	True=1 False=0
Gen Below 10 Hz	Pickup	906 bit 6	Uint16	2	R	True=1 False=0
Gen Below 10 Hz	Trip	906 bit 7	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 1 Pickup	906 bit 8	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 1 Trip	906 bit 9	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 2 Pickup	906 bit 10	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 2 Trip	906 bit 11	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 3 Pickup	906 bit 12	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 3 Trip	906 bit 13	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 4 Pickup	906 bit 14	Uint16	2	R	True=1 False=0
Configurable Protection 1	Configurable Protection Threshold 4 Trip	906 bit 15	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 1 Pickup	907 bit 0	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 1 Trip	907 bit 1	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 2 Pickup	907 bit 2	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 2 Trip	907 bit 3	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 3 Pickup	907 bit 4	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 3 Trip	907 bit 5	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 4 Pickup	907 bit 6	Uint16	2	R	True=1 False=0
Configurable Protection 2	Configurable Protection Threshold 4 Trip	907 bit 7	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 1 Pickup	907 bit 8	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 1 Trip	907 bit 9	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 2 Pickup	907 bit 10	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 2 Trip	907 bit 11	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 3 Pickup	907 bit 12	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 3 Trip	907 bit 13	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 4 Pickup	907 bit 14	Uint16	2	R	True=1 False=0
Configurable Protection 3	Configurable Protection Threshold 4 Trip	907 bit 15	Uint16	2	R	True=1 False=0
Configurable Protection 4	Configurable Protection Threshold 1 Pickup	908 bit 0	Uint16	2	R	True=1 False=0
Configurable Protection 4	Configurable Protection Threshold 1 Trip	908 bit 1	Uint16	2	R	True=1 False=0

Group	Name	Register	Type	Bytes	R/W	Range
Configurable Protection 4	Configurable Protection Threshold 2 Pickup	908 bit 2	Uint16	2	R	True=1 False=0
Configurable Protection 4	Configurable Protection Threshold 2 Trip	908 bit 3	Uint16	2	R	True=1 False=0
Configurable Protection 4	Configurable Protection Threshold 3 Pickup	908 bit 4	Uint16	2	R	True=1 False=0
Configurable Protection 4	Configurable Protection Threshold 3 Trip	908 bit 5	Uint16	2	R	True=1 False=0
Configurable Protection 4	Configurable Protection Threshold 4 Pickup	908 bit 6	Uint16	2	R	True=1 False=0
Configurable Protection 4	Configurable Protection Threshold 4 Trip	908 bit 7	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 1 Pickup	908 bit 8	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 1 Trip	908 bit 9	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 2 Pickup	908 bit 10	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 2 Trip	908 bit 11	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 3 Pickup	908 bit 12	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 3 Trip	908 bit 13	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 4 Pickup	908 bit 14	Uint16	2	R	True=1 False=0
Configurable Protection 5	Configurable Protection Threshold 4 Trip	908 bit 15	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 1 Pickup	909 bit 0	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 1 Trip	909 bit 1	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 2 Pickup	909 bit 2	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 2 Trip	909 bit 3	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 3 Pickup	909 bit 4	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 3 Trip	909 bit 5	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 4 Pickup	909 bit 6	Uint16	2	R	True=1 False=0
Configurable Protection 6	Configurable Protection Threshold 4 Trip	909 bit 7	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 1 Pickup	909 bit 8	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 1 Trip	909 bit 9	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 2 Pickup	909 bit 10	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 2 Trip	909 bit 11	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 3 Pickup	909 bit 12	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 3 Trip	909 bit 13	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 4 Pickup	909 bit 14	Uint16	2	R	True=1 False=0
Configurable Protection 7	Configurable Protection Threshold 4 Trip	909 bit 15	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 1 Pickup	910 bit 0	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 1 Trip	910 bit 1	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 2 Pickup	910 bit 2	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 2 Trip	910 bit 3	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 3 Pickup	910 bit 4	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 3 Trip	910 bit 5	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 4 Pickup	910 bit 6	Uint16	2	R	True=1 False=0
Configurable Protection 8	Configurable Protection Threshold 4 Trip	910 bit 7	Uint16	2	R	True=1 False=0
Network Load Share	Network Load Share Disable	910 bit 8	Uint16	2	R	True=1 False=0
Network Load Share	No Network Load Share Data	910 bit 9	Uint16	2	R	True=1 False=0
Network Load Share	Unknown Load Share Protocol Version	910 bit 10	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 1	910 bit 11	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 2	910 bit 12	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 3	910 bit 13	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 4	910 bit 14	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 5	910 bit 15	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 6	911 bit 0	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 7	911 bit 1	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 8	911 bit 2	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 9	911 bit 3	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 10	911 bit 4	Uint16	2	R	True=1 False=0

Group	Name	Register	Type	Bytes	R/W	Range
Network Load Share	Receiving ID 11	911 bit 5	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 12	911 bit 6	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 13	911 bit 7	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 14	911 bit 8	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 15	911 bit 9	Uint16	2	R	True=1 False=0
Network Load Share	Receiving ID 16	911 bit 10	Uint16	2	R	True=1 False=0
Network Load Share	NLS Configuration Mismatch	911 bit 11	Uint16	2	R	True=1 False=0
Network Load Share	NLS ID Missing	911 bit 12	Uint16	2	R	True=1 False=0
Network Load Share	NLS Status 1	911 bit 13	Uint16	2	R	True=1 False=0
Network Load Share	NLS Status 2	911 bit 14	Uint16	2	R	True=1 False=0
Network Load Share	NLS Status 3	911 bit 15	Uint16	2	R	True=1 False=0
Network Load Share	NLS Status 4	912 bit 0	Uint16	2	R	True=1 False=0
Reserved		912 bit 1				
Configurable Element 1	Output	912 bit 2	Uint16	2	R	True=1 False=0
Configurable Element 1	Alarm	912 bit 3	Uint16	2	R	True=1 False=0
Configurable Element 2	Output	912 bit 4	Uint16	2	R	True=1 False=0
Configurable Element 2	Alarm	912 bit 5	Uint16	2	R	True=1 False=0
Configurable Element 3	Output	912 bit 6	Uint16	2	R	True=1 False=0
Configurable Element 3	Alarm	912 bit 7	Uint16	2	R	True=1 False=0
Configurable Element 4	Output	912 bit 8	Uint16	2	R	True=1 False=0
Configurable Element 4	Alarm	912 bit 9	Uint16	2	R	True=1 False=0
Configurable Element 5	Output	912 bit 10	Uint16	2	R	True=1 False=0
Configurable Element 5	Alarm	912 bit 11	Uint16	2	R	True=1 False=0
Configurable Element 6	Output	912 bit 12	Uint16	2	R	True=1 False=0
Configurable Element 6	Alarm	912 bit 13	Uint16	2	R	True=1 False=0
Configurable Element 7	Output	912 bit 14	Uint16	2	R	True=1 False=0
Configurable Element 7	Alarm	912 bit 15	Uint16	2	R	True=1 False=0
Configurable Element 8	Output	913 bit 0	Uint16	2	R	True=1 False=0
Configurable Element 8	Alarm	913 bit 1	Uint16	2	R	True=1 False=0
Hardware Shutdown	Hardware Shutdown	913 bit 2	Uint16	2	R	True=1 False=0
Network Load Share	ID 1 Enabled	913 bit 3	Uint16	2	R	True=1 False=0
Network Load Share	ID 2 Enabled	913 bit 4	Uint16	2	R	True=1 False=0
Network Load Share	ID 3 Enabled	913 bit 5	Uint16	2	R	True=1 False=0
Network Load Share	ID 4 Enabled	913 bit 6	Uint16	2	R	True=1 False=0
Network Load Share	ID 5 Enabled	913 bit 7	Uint16	2	R	True=1 False=0
Network Load Share	ID 6 Enabled	913 bit 8	Uint16	2	R	True=1 False=0
Network Load Share	ID 7 Enabled	913 bit 9	Uint16	2	R	True=1 False=0
Network Load Share	ID 8 Enabled	913 bit 10	Uint16	2	R	True=1 False=0
Network Load Share	ID 9 Enabled	913 bit 11	Uint16	2	R	True=1 False=0
Network Load Share	ID 10 Enabled	913 bit 12	Uint16	2	R	True=1 False=0
Network Load Share	ID 11 Enabled	913 bit 13	Uint16	2	R	True=1 False=0
Network Load Share	ID 12 Enabled	913 bit 14	Uint16	2	R	True=1 False=0
Network Load Share	ID 13 Enabled	913 bit 15	Uint16	2	R	True=1 False=0
Network Load Share	ID 14 Enabled	914 bit 0	Uint16	2	R	True=1 False=0
Network Load Share	ID 15 Enabled	914 bit 1	Uint16	2	R	True=1 False=0
Network Load Share	ID 16 Enabled	914 bit 2	Uint16	2	R	True=1 False=0

Metering

Table 58. Metering Group Parameters

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Per Unit Meter	Vab Pickup	1000	Float	4	R	n/a	-10 - 10

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Per Unit Meter	Vbc Pickup	1002	Float	4	R	n/a	-10 - 10
Per Unit Meter	Vca Pickup	1004	Float	4	R	n/a	-10 - 10
Per Unit Meter	V Average Pickup	1006	Float	4	R	n/a	-10 - 10
Per Unit Meter	Ia Pickup	1008	Float	4	R	n/a	-10 - 10
Per Unit Meter	Ib Pickup	1010	Float	4	R	n/a	-10 - 10
Per Unit Meter	Ic Pickup	1012	Float	4	R	n/a	-10 - 10
Per Unit Meter	I Average Pickup	1014	Float	4	R	n/a	-10 - 10
Per Unit Meter	kW Pickup	1016	Float	4	R	n/a	-10 - 10
Per Unit Meter	kVA Pickup	1018	Float	4	R	n/a	-10 - 10
Per Unit Meter	Kvar Pickup	1020	Float	4	R	n/a	-10 - 10
Per Unit Meter	Positive Sequence Voltage Pickup	1022	Float	4	R	n/a	-10 - 10
Per Unit Meter	Negative Sequence Voltage Pickup	1024	Float	4	R	n/a	-10 - 10
Per Unit Meter	Positive Sequence Current Pickup	1026	Float	4	R	n/a	-10 - 10
Per Unit Meter	Negative Sequence Current Pickup	1028	Float	4	R	n/a	-10 - 10
Per Unit Meter	Bus Vab Pickup	1030	Float	4	R	n/a	-10 - 10
Per Unit Meter	Bus Vbc Pickup	1032	Float	4	R	n/a	-10 - 10
Per Unit Meter	Bus Vca Pickup	1034	Float	4	R	n/a	-10 - 10
Per Unit Meter	Bus V Average Pickup	1036	Float	4	R	n/a	-10 - 10
Per Unit Meter	Voltage Difference Pickup	1038	Float	4	R	n/a	-10 - 10
Per Unit Meter	Power in Voltage Pickup	1040	Float	4	R	n/a	-10 - 10
Per Unit Meter	Control Out Var PF	1042	Float	4	R	n/a	-10 - 10
Per Unit Meter	Control Out OEL	1044	Float	4	R	n/a	-10 - 10
Per Unit Meter	Control Out UEL	1046	Float	4	R	n/a	-10 - 10
Per Unit Meter	Control Out SCL	1048	Float	4	R	n/a	-10 - 10
Per Unit Meter	Control Out AVR	1050	Float	4	R	n/a	-10 - 10
Per Unit Meter	Control Out FCR	1052	Float	4	R	n/a	-10 - 10
Per Unit Meter	Null Balance Percent	1054	Float	4	R	n/a	-10 - 10
Per Unit Meter	Generator Frequency Pickup	1056	Float	4	R	n/a	-10 - 10
Per Unit Meter	Bus Frequency Pickup	1058	Float	4	R	n/a	-10 - 10
Per Unit Meter	Ifd Pickup	1060	Float	4	R	n/a	-10 - 10
Per Unit Meter	Vfd Pickup	1062	Float	4	R	n/a	-10 - 10
Per Unit Meter	Slip Frequency Pickup	1064	Float	4	R	n/a	-10 - 10
Per Unit Meter	Icc Pickup	1066	Float	4	R	n/a	-10 - 10
Per Unit Meter	AVR Setpoint Pickup	1068	Float	4	R	n/a	-10 - 10
Per Unit Meter	FCR Setpoint Pickup	1070	Float	4	R	n/a	-10 - 10
Per Unit Meter	FVR Setpoint Pickup	1072	Float	4	R	n/a	-10 - 10
Per Unit Meter	Var Setpoint Pickup	1074	Float	4	R	n/a	-10 - 10
Field Current Meter	I$_X$	1076	Float	4	R	Amp	0 - 2000000000
DECS PSS Meter	Terminal Frequency Deviation	1078	Float	4	R	n/a	n/a
DECS PSS Meter	Compensated Frequency Deviation	1080	Float	4	R	n/a	n/a
DECS PSS Meter	PSS Output	1082	Float	4	R	n/a	n/a
DECS Regulator Meter	Tracking Error	1084	Float	4	R	Percent	n/a
DECS Regulator Meter	Control Output PU	1086	Float	4	R	n/a	-10 - 10
DECS Regulator Meter	Exciter Diode Monitor Ripple	1088	Float	4	R	Amp	0 - 2000000000
DECS Regulator Meter	Power Input	1090	Float	4	R	Volt	0 - 2000000000
DECS Regulator Meter	Control Output	1092	Float	4	R	Percent	n/a
DECS Regulator Meter	V1 Phase Angle	1094	Float	4	R	Degree	0 - 360

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Reserved		1096-1106					
Generator Voltage Meter Primary 1	V$_{AB}$	1108	Float	4	R	Volt	0 - 2000000000
Generator Voltage Meter Primary 1	V$_{BC}$	1110	Float	4	R	Volt	0 - 2000000000
Generator Voltage Meter Primary 1	V$_{CA}$	1112	Float	4	R	Volt	0 - 2000000000
Generator Voltage Meter Primary 1	V1 L	1114	Float	4	R	Volt	0 - 2000000000
Generator Voltage Meter Primary 1	V2 L	1116	Float	4	R	Volt	0 - 2000000000
Generator Voltage Meter Primary 1	V$_{AVG}$ LL	1118	Float	4	R	Volt	0 - 2000000000
Generator Voltage Meter Angle 1	V$_{AB}$	1120	Float	4	R	Degree	0 - 360
Generator Voltage Meter Angle 1	V$_{BC}$	1122	Float	4	R	Degree	0 - 360
Generator Voltage Meter Angle 1	V$_{CA}$	1124	Float	4	R	Degree	0 - 360
Reserved		1126-36					
Bus Voltage Meter Primary 1	V$_{AB}$	1138	Float	4	R	Volt	0 - 2000000000
Bus Voltage Meter Primary 1	V$_{BC}$	1140	Float	4	R	Volt	0 - 2000000000
Bus Voltage Meter Primary 1	V$_{CA}$	1142	Float	4	R	Volt	0 - 2000000000
Bus Voltage Meter Primary 1	V1 L	1144	Float	4	R	Volt	0 - 2000000000
Bus Voltage Meter Primary 1	V2 L	1146	Float	4	R	Volt	0 - 2000000000
Bus Voltage Meter Primary 1	V$_{AVG}$ LL	1148	Float	4	R	Volt	0 - 2000000000
Bus Voltage Meter Angle 1	V$_{AB}$	1150	Float	4	R	Degree	0 - 360
Bus Voltage Meter Angle 1	V$_{BC}$	1152	Float	4	R	Degree	0 - 360
Bus Voltage Meter Angle 1	V$_{CA}$	1154	Float	4	R	Degree	0 - 360
Reserved	I$_A$	1156-69					
Generator Current Meter Primary 1	I$_A$	1168	Float	4	R	Amp	0 - 2000000000
Generator Current Meter Primary 1	I$_B$	1170	Float	4	R	Amp	0 - 2000000000
Generator Current Meter Primary 1	I$_C$	1172	Float	4	R	Amp	0 - 2000000000
Generator Current Meter Primary 1	I1	1174	Float	4	R	Amp	0 - 2000000000
Generator Current Meter Primary 1	I2	1176	Float	4	R	Amp	0 - 2000000000
Generator Current Meter Primary 1	I$_{AVG}$	1178	Float	4	R	Amp	0 - 2000000000
Generator Current Meter Angle 1	I$_A$	1180	Float	4	R	Degree	0 - 360
Generator Current Meter Angle 1	I$_B$	1182	Float	4	R	Degree	0 - 360
Generator Current Meter Angle 1	I$_C$	1184	Float	4	R	Degree	0 - 360
Icc Current Meter Magnitude 1	I$_X$	1186	Float	4	R	Amp	0 - 2000000000
Icc Current Meter Primary 1	I$_X$	1188	Float	4	R	Amp	0 - 2000000000
Power Meter	Total watts primary	1190	Float	4	R	Watt	n/a
Power Meter	Total vars primary	1192	Float	4	R	var	n/a
Power Meter	Total S primary	1194	Float	4	R	VA	n/a
Power Meter	Total PF primary	1196	Float	4	R	PF	-1 – 1
Sync Meter 1	Slip Angle	1198	Float	4	R	Degree	-359.9 – 359.9
Sync Meter 1	Slip Frequency	1200	Float	4	R	Hertz	n/a
Sync Meter 1	Voltage Difference	1202	Float	4	R	Volt	n/a

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Generator Frequency Meter 1	Frequency	1204	Float	4	R	Hertz	10 - 180
Bus Frequency Meter 1	Frequency	1206	Float	4	R	Hertz	10 - 180
Auxiliary Input Voltage 1	Value	1208	Float	4	R	Volt	-9999999 - 9999999
Auxiliary Input Current 1	Value	1210	Float	4	R	Amp	-9999999 - 9999999
Energy Meter	Positive watthour total	1212	Float	4	RW	Watthour	0.00E+00 - 1.00E+09
Energy Meter	Positive varhour total	1214	Float	4	RW	Varhour	0.00E+00 - 1.00E+09
Energy Meter	Negative watthour total	1216	Float	4	RW	Watthour	-1.00E+09 - 0.00E+00
Energy Meter	Negative varhour total	1218	Float	4	RW	Varhour	-1.00E+09 - 0.00E+00
Energy Meter	VA hour total	1220	Float	4	RW	Varhour	0.00E+00 - 1.00E+09
DECS Regulator Meter	NLS Error Percent	1222	Float	4	R	Percent	n/a
DECS Regulator Meter	Current Magnitude Pickup	1224	Float	4	R	n/a	-10 - 10
DECS Regulator Meter	NLS Current Magnitude Average Pickup	1226	Float	4	R	n/a	-10 - 10
DECS Regulator Meter	NLS Number of Generators Online	1228	Int32	4	R	n/a	n/a

Limiters

Table 59. Limiter Group Parameters

Name	Register	Type	Bytes	R/W	Unit	Range
OEL Primary Current Hi	1700	Float	4	R W	Amp	0 – 11
OEL Primary Current Mid	1702	Float	4	R W	Amp	0 – 9
OEL Primary Current Lo	1704	Float	4	R W	Amp	0 - 7
OEL Primary Time Hi	1706	Float	4	R W	Second	0 - 10
OEL Primary Time Mid	1708	Float	4	R W	Second	0 - 120
OEL Primary Current Hi Off	1710	Float	4	R W	Amp	0 - 11
OEL Primary Current Lo Off	1712	Float	4	R W	Amp	0 - 7
OEL Primary Current Time Off	1714	Float	4	R W	Second	0 - 10
OEL Primary Takeover Current Max Off	1716	Float	4	R W	Amp	0 - 11
OEL Primary Takeover Current Min Off	1718	Float	4	R W	Amp	0 - 7
OEL Primary Takeover Time Dial Off	1720	Float	4	R W	n/a	0.1 - 20
OEL Primary Takeover Current Max On	1722	Float	4	R W	Amp	0 - 11
OEL Primary Takeover Current Min On	1724	Float	4	R W	Amp	0 - 7
OEL Primary Takeover Time Dial On	1726	Float	4	R W	n/a	0.1 - 20
OEL Primary Dvdt Enable	1728	Uint32	4	R W	n/a	Disabled=0 Enabled=1
OEL Primary Dvdt Ref	1730	Float	4	R W	n/a	-10 - 0
OEL Secondary Current Hi	1732	Float	4	R W	Amp	0 - 11
OEL Secondary Current Mid	1734	Float	4	R W	Amp	0 - 9
OEL Secondary Current Lo	1736	Float	4	R W	Amp	0 - 7
OEL Secondary Time Hi	1738	Float	4	R W	Second	0 - 10
OEL Secondary Time Mid	1740	Float	4	R W	Second	0 - 120
OEL Secondary Current Hi Off	1742	Float	4	R W	Amp	0 - 11
OEL Secondary Current Lo Off	1744	Float	4	R W	Amp	0 - 7
OEL Secondary Current Time Off	1746	Float	4	R W	Second	0 - 10
OEL Secondary Takeover Current Max Off	1748	Float	4	R W	Amp	0 - 11
OEL Secondary Takeover Current Min Off	1750	Float	4	R W	Amp	0 – 7
OEL Secondary Takeover Time Dial Off	1752	Float	4	R W	n/a	0.1 – 20

Name	Register	Type	Bytes	R/W	Unit	Range
OEL Secondary Takeover Current Max On	1754	Float	4	R W	Amp	0 – 11
OEL Secondary Takeover Current Min On	1756	Float	4	R W	Amp	0 – 7
OEL Secondary Takeover Time Dial On	1758	Float	4	R W	n/a	0.1 – 20
UEL Primary Curve X1	1760	Float	4	R W	kilowatt	0 – 62
UEL Primary Curve X2	1762	Float	4	R W	kilowatt	0 – 62
UEL Primary Curve X3	1764	Float	4	R W	kilowatt	0 – 62
UEL Primary Curve X4	1766	Float	4	R W	kilowatt	0 – 62
UEL Primary Curve X5	1768	Float	4	R W	kilowatt	0 – 62
UEL Primary Curve Y1	1770	Float	4	R W	kilovar	0 – 62
UEL Primary Curve Y2	1772	Float	4	R W	kilovar	0 – 62
UEL Primary Curve Y3	1774	Float	4	R W	kilovar	0 – 62
UEL Primary Curve Y4	1776	Float	4	R W	kilovar	0 – 62
UEL Primary Curve Y5	1778	Float	4	R W	kilovar	0 – 62
UEL Primary Power Filter TC	1780	Float	4	R W	Second	0 – 20
UEL Primary Voltage Dependent Exponent	1782	Float	4	R W	n/a	0 – 2
UEL Secondary Curve X1	1784	Float	4	R W	kilowatt	0 – 62
UEL Secondary Curve X2	1786	Float	4	R W	kilowatt	0 – 62
UEL Secondary Curve X3	1788	Float	4	R W	kilowatt	0 – 62
UEL Secondary Curve X4	1790	Float	4	R W	kilowatt	0 – 62
UEL Secondary Curve X5	1792	Float	4	R W	kilowatt	0 – 62
UEL Secondary Curve Y1	1794	Float	4	R W	kilovar	0 – 62
UEL Secondary Curve Y2	1796	Float	4	R W	kilovar	0 – 62
UEL Secondary Curve Y3	1798	Float	4	R W	kilovar	0 – 62
UEL Secondary Curve Y4	1800	Float	4	R W	kilovar	0 – 62
UEL Secondary Curve Y5	1802	Float	4	R W	kilovar	0 – 62
SCL Primary Reference Hi	1804	Float	4	R W	Amp	0 - 66000
SCL Primary Reference Lo	1806	Float	4	R W	Amp	0 - 66000
SCL Primary Time Hi	1808	Float	4	R W	Second	0 - 60
SCL Primary No Response Time	1810	Float	4	R W	Second	0 - 10
SCL Secondary Reference Hi	1812	Float	4	R W	Amp	0 - 66000
SCL Secondary Reference Lo	1814	Float	4	R W	Amp	0 - 66000
SCL Secondary Time Hi	1816	Float	4	R W	Second	0 - 60
SCL Secondary No Response Time	1818	Float	4	R W	Second	0 - 10
OEL Primary Takeover Reset Time Coefficient Off	1820	Float	4	R W	n/a	0.01 – 100
OEL Primary Takeover Reset Time Coefficient On	1822	Float	4	R W	n/a	0.01 – 100
OEL Secondary Takeover Reset Time Coefficient Off	1824	Float	4	R W	n/a	0.01 – 100
OEL Secondary Takeover Reset Time Coefficient On	1826	Float	4	R W	n/a	0.01 – 100
OEL Primary Takeover Reset Type Off	1828	Uint32	4	R W	n/a	Inverse=0 Integrating=1 Instantaneous=2
OEL Primary Takeover Reset Type On	1830	Uint32	4	R W	n/a	Inverse=0 Integrating=1 Instantaneous=2
OEL Secondary Takeover Reset Type Off	1832	Uint32	4	R W	n/a	Inverse=0 Integrating=1 Instantaneous=2
OEL Secondary Takeover Reset Type On	1834	Uint32	4	R W	n/a	Inverse=0 Integrating=1 Instantaneous=2

Setpoints

Table 60. Setpoint Group Parameters

Name	Register	Type	Bytes	R/W	Unit	Range
Field Current Regulation Setpoint	2200	Float	4	R W	Amp	Setpoint adjustment range determined by registers 2212 and 2214.
Field Current Regulation Traverse Rate	2202	Float	4	R W	Second	1 – 200
Field Current Regulation Pre-position Mode 1	2204	Uint32	4	R W	n/a	Maintain=0 Release=1
Field Current Regulation Pre-position 1	2206	Float	4	R W	Amp	Setpoint adjustment range determined by registers 2212 and 2214.
Field Current Regulation Pre-position Mode 2	2208	Uint32	4	R W	n/a	Maintain=0 Release=1
Field Current Regulation Pre-position 2	2210	Float	4	R W	Amp	Setpoint adjustment range determined by registers 2212 and 2214.
Field Current Regulation Minimum Setpoint Limit	2212	Float	4	R W	Percent	0 – 120
Field Current Regulation Maximum Setpoint Limit	2214	Float	4	R W	Percent	0 – 120
Generator Voltage Setpoint	2216	Float	4	R W	Volt	Setpoint adjustment range determined by registers 2228 and 2230.
Generator Voltage Traverse Rate	2218	Float	4	R W	Second	1 – 200
Generator Voltage Pre-position Mode 1	2220	Uint32	4	R W	n/a	Maintain=0 Release=1
Generator Voltage Pre-position 1	2222	Float	4	R W	Volt	Setpoint adjustment range determined by registers 2228 and 2230.
Generator Voltage Pre-position Mode 2	2224	Uint32	4	R W	n/a	Maintain=0 Release=1
Generator Voltage Pre-position 2	2226	Float	4	R W	Volt	Setpoint adjustment range determined by registers 2228 and 2230.
Generator Voltage Minimum Setpoint Limit	2228	Float	4	R W	Percent	70 - 120
Generator Voltage Maximum Setpoint Limit	2230	Float	4	R W	Percent	70 - 120
Generator var Setpoint	2232	Float	4	R W	kilovar	Setpoint adjustment range determined by registers 2244 and 2246.
Generator var Traverse Rate	2234	Float	4	R W	Second	1 - 200
Generator var Pre-position Mode 1	2236	Uint32	4	R W	n/a	Maintain=0 Release=1
Generator var Pre-position 1	2238	Float	4	R W	kilovar	Setpoint adjustment range determined by registers 2244 and 2246.
Generator var Pre-position Mode 2	2240	Uint32	4	R W	n/a	Maintain=0 Release=1
Generator var Pre-position 2	2242	Float	4	R W	kilovar	Setpoint adjustment range determined by registers 2244 and 2246.
Generator var Minimum Setpoint Limit	2244	Float	4	R W	Percent	-100 – 100
Generator var Maximum Setpoint Limit	2246	Float	4	R W	Percent	-100 – 100
Generator PF Setpoint	2248	Float	4	R W	Power Factor	Setpoint adjustment range determined by registers 2260 and 2262.
Generator PF Traverse Rate	2250	Float	4	R W	Second	1 – 200
Generator PF Pre-position Mode 1	2252	Uint32	4	R W	n/a	Maintain=0 Release=1
Generator PF Pre-position 1	2254	Float	4	R W	Power Factor	Setpoint adjustment range determined by registers 2260 and 2262.
Generator PF Pre-position Mode 2	2256	Uint32	4	R W	n/a	Maintain=0 Release=1
Generator PF Pre-position 2	2258	Float	4	R W	Power Factor	Setpoint adjustment range determined by registers 2260 and 2262.
Generator PF Minimum Setpoint Limit	2260	Float	4	R W	Power Factor	0.5 – 1
Generator PF Maximum Setpoint Limit	2262	Float	4	R W	Power Factor	-1 – -0.5
Droop Value	2264	Float	4	R W	Percent	0 - 30
L-Drop Value	2266	Float	4	R W	Percent	0 - 30
Auxiliary Limit Enable	2268	Int32	4	R W	n/a	Disabled=0 Enabled=1
Field Current Regulation Pre-position Mode 3	2270	Uint32	4	R W	n/a	Maintain=0 Release=1

Name	Register	Type	Bytes	R/W	Unit	Range
Field Current Regulation Pre-position 3	2272	Float	4	R W	Amp	Setpoint adjustment range determined by registers 2212 and 2214.
Generator Voltage Pre-position Mode 3	2274	Uint32	4	R W	n/a	Maintain=0 Release=1
Generator Voltage Pre-position 3	2276	Float	4	R W	Volt	Setpoint adjustment range determined by registers 2228 and 2230.
Generator var Pre-position Mode 3	2278	Float	4	R W	n/a	Maintain=0 Release=1
Generator var Pre-position 3	2280	Float	4	R W	kilovar	Setpoint adjustment range determined by registers 2244 and 2246.
Generator PF Pre-position Mode 3	2282	Float	4	R W	n/a	Maintain=0 Release=1
Generator PF Pre-position 3	2284	Float	4	R W	Power Factor	Setpoint adjustment range determined by registers 2260 and 2262.
Active Field Current Regulation Setpoint	2286	Float	4	R W	Amp	Setpoint adjustment range determined by registers 2212 and 2214.
Active Generator Voltage Setpoint	2288	Float	4	R W	Volt	Setpoint adjustment range determined by registers 2228 and 2230. When the With Limit box is checked on the Auxiliary Input screen in BESTCOMS*Plus*, register 2288 equals register 2216 plus the Aux input. When the With Limit box is not checked on the Auxiliary Input screen in BESTCOMS*Plus*, register 2288 equals register 2216.
Active Generator var Setpoint	2290	Float	4	R W	kilovar	Setpoint adjustment range determined by registers 2244 and 2246.
Active Generator PF Setpoint	2292	Float	4	R W	Power Factor	Setpoint adjustment range determined by registers 2260 and 2262.
Field Current Preposition Traverse 1	2294	Float	4	R W	Second	0 - 200
Field Current Preposition Traverse 2	2296	Float	4	R W	Second	0 - 200
Field Current Preposition Traverse 3	2298	Float	4	R W	Second	0 - 200
Generator Voltage Preposition Traverse 1	2300	Float	4	R W	Second	0 - 200
Generator Voltage Preposition Traverse 2	2302	Float	4	R W	Second	0 - 200
Generator Voltage Preposition Traverse 3	2304	Float	4	R W	Second	0 - 200
Generator Var Preposition Traverse 1	2306	Float	4	R W	Second	0 - 200
Generator Var Preposition Traverse 2	2308	Float	4	R W	Second	0 - 200
Generator Var Preposition Traverse 3	2310	Float	4	R W	Second	0 - 200
Generator PF Preposition Traverse 1	2312	Float	4	R W	Second	0 - 200
Generator PF Preposition Traverse 2	2314	Float	4	R W	Second	0 - 200
Generator PF Preposition Traverse 3	2316	Float	4	R W	Second	0 - 200

Global Settings

Table 61. Global Settings Group Parameters

Group	Name	Register	Type	Bytes	R/W	Unit	Range
PLC Timed Element Settings	Logic Timer 1 Output Timeout	2400	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 2 Output Timeout	2402	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 3 Output Timeout	2404	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 4 Output Timeout	2406	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 5 Output Timeout	2408	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 6 Output Timeout	2410	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 7 Output Timeout	2412	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 8 Output Timeout	2414	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 9 Output Timeout	2416	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 10 Output Timeout	2418	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 11 Output Timeout	2420	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 12 Output Timeout	2422	Float	4	R W	Sec	0 - 1800

Group	Name	Register	Type	Bytes	R/W	Unit	Range
PLC Timed Element Settings	Logic Timer 13 Output Timeout	2424	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 14 Output Timeout	2426	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 15 Output Timeout	2428	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Logic Timer 16 Output Timeout	2430	Float	4	R W	Sec	0 - 1800
PLC Timed Element Settings	Counter 1 Output Timeout	2432	Float	4	R W	n/a	0 - 1800
PLC Timed Element Settings	Counter 2 Output Timeout	2434	Float	4	R W	n/a	0 - 1800
PLC Timed Element Settings	Counter 3 Output Timeout	2436	Float	4	R W	n/a	0 - 1800
PLC Timed Element Settings	Counter 4 Output Timeout	2438	Float	4	R W	n/a	0 - 1800
PLC Timed Element Settings	Counter 5 Output Timeout	2440	Float	4	R W	n/a	0 - 1800
PLC Timed Element Settings	Counter 6 Output Timeout	2442	Float	4	R W	n/a	0 - 1800
PLC Timed Element Settings	Counter 7 Output Timeout	2444	Float	4	R W	n/a	0 - 1800
PLC Timed Element Settings	Counter 8 Output Timeout	2446	Float	4	R W	n/a	0 - 1800
Virtual Switch	Virtual Switch 1 State	2448	Uint32	4	R W	n/a	Open=0 Closed=1
Virtual Switch	Virtual Switch 2 State	2450	Uint32	4	R W	n/a	Open=0 Closed=1
Virtual Switch	Virtual Switch 3 State	2452	Uint32	4	R W	n/a	Open=0 Closed=1
Virtual Switch	Virtual Switch 4 State	2454	Uint32	4	R W	n/a	Open=0 Closed=1
Virtual Switch	Virtual Switch 5 State	2456	Uint32	4	R W	n/a	Open=0 Closed=1
Virtual Switch	Virtual Switch 6 State	2458	Uint32	4	R W	n/a	Open=0 Closed=1
Network Load Share	Load Share Enable	2460	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Share Droop Percent	2462	Float	4	R W	%	0 - 30
Network Load Share	Load Share Gain	2464	Float	4	R W	n/a	0 - 1000
Network Load Share	Load Share ID	2466	Uint32	4	R W	n/a	1 - 16
Network Load Share	Load Sharing ID 1	2468	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 2	2470	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 3	2472	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 4	2474	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 5	2476	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 6	2478	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 7	2480	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 8	2482	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 9	2484	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 10	2486	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 11	2488	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 12	2490	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 13	2492	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 14	2494	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Load Sharing ID 15	2496	Uint32	4	R W	n/a	Disabled=0 Enabled=1

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Network Load Share	Load Sharing ID 16	2498	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Network Load Share	Config Mismatch Delay	2500	Float	4	R W	Second	0.2 - 10

Configuration Settings

Table 62. Configuration Settings Group Parameters

Group	Name	Register	Type	Bytes	R/W	Unit	Range
System Configuration	Nominal Frequency	2600	Uint32	4	R W	n/a	50 Hz=50 60 Hz=60
System Configuration	Metric English	2602	Uint32	4	R W	n/a	English=0 Metric=1
System Configuration	DECS Auxiliary Summing Mode	2604	Uint32	4	R W	n/a	Voltage=0 Var=1
System Configuration	DECS Auxiliary Input Mode	2606	Uint32	4	R W	n/a	Voltage=0 Current=1
System Configuration	DECS Auxiliary Input Function	2608	Uint32	4	R W	n/a	DECS Input=0 PSS Test Input=1
System Configuration	DECS Auxiliary Voltage Gain	2610	Float	4	R W	n/a	-99 - 99
System Configuration	DECS Auxiliary Current Gain	2612	Float	4	R W	Percent	-30 - 30
System Configuration	DECS Auxiliary FCR Gain	2614	Float	4	R W	n/a	-99 - 99
System Configuration	DECS Auxiliary var Gain	2616	Float	4	R W	n/a	-99 - 99
System Configuration	DECS Auxiliary PF Gain	2618	Float	4	R W	n/a	-99 - 99
System Configuration	DECS Auto Track Time Delay	2620	Float	4	R W	Second	0 - 8
System Configuration	DECS Auto Track Traverse Rate	2622	Float	4	R W	Second	1 - 80
System Configuration	DECS Null Balance Level	2624	Float	4	R W	Percent	0 - 9999
System Configuration	DECS Auto Trans Time Delay	2626	Float	4	R W	Second	0 - 8
System Configuration	DECS Auto Trans Traverse Rate	2628	Float	4	R W	Second	1 - 80
System Configuration	DECS Power Input Base Voltage	2630	Float	4	R W	Volt	1 - 277
System Configuration	Ambient Temperature	2632	Uint32	4	R W	n/a	Ambient 70°C=0 Ambient 55°C=1
Gen Volt Configuration	Connection	2634	Int32	4	R W	n/a	PT_CA=2 PT_3W_D=7
Gen Volt Configuration	Ratio Primary	2636	Float	4	R W	n/a	1 - 500000
Gen Volt Configuration	Ratio Secondary	2638	Float	4	R W	n/a	1 - 600
Gen Volt Configuration	Rated Primary LL	2640	Float	4	R W	Volt	1 - 90000
Bus Volt Configuration	Connection	2642	Int32	4	R W	n/a	PT_CA=2 PT_3W_D=7
Bus Volt Configuration	Ratio Primary	2644	Float	4	R W	n/a	1 - 500000
Bus Volt Configuration	Ratio Secondary	2646	Float	4	R W	n/a	1 - 600
Bus Volt Configuration	Rated Primary LL	2648	Float	4	R W	Volt	1 - 90000
Gen Current Configuration	Connection	2650	Int32	4	R W	n/a	CT_B=1 CT_ABC=6
Gen Current Configuration	Ratio Primary	2652	Float	4	R W	n/a	1 - 99999

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Gen Current Configuration	Ratio Secondary	2654	Int32	4	R W	n/a	1=1 5=5
Gen Current Configuration	Rated Primary	2656	Float	4	R	Amp	0 - 180000
Gen Bus Configuration	Rated kVA	2658	Float	4	R W	KVA	1 - 1000000
Gen Bus Configuration	Rated PF	2660	Float	4	R W	PF	-2 - 2
Gen Bus Configuration	Rated kW	2662	Float	4	R	kW	-2000000
Gen Bus Configuration	Rated kvar	2664	Float	4	R	Kvar	0 - 1000000
Gen Bus Configuration	Rotation	2666	Int32	4	R W	n/a	ABC=0 ACB=1
Field Voltage Configuration	Rated Field Voltage Full Load	2668	Float	4	R W	Volt	1 – 125
Field Voltage Configuration	Rated Field Voltage No Load	2670	Float	4	R W	Volt	1 – 125
Field Current Configuration	Rated Field Current No Load	2672	Float	4	R W	Amp	0 – 7
Field Current Configuration	Rated Field Current Full Load	2674	Float	4	R W	Amp	0 - 7
Boot Configuration	Pwm Duty	2676	Uint32	4	R W	Percent	0 - 100
DECS Control	Start Stop Request	2678	Uint32	4	R W	n/a	Stop=0 =1 Start =2
DECS Control	System Option Underfrequency Hz	2680	Float	4	R W	Hertz	10 - 75
DECS Control	System Input COM Port Manual Enabled	2682	Uint32	4	R W	n/a	Manual=1 Automatic=2
DECS Control	System Input COM Port PF var Enabled	2684	Uint32	4	R W	n/a	Off=0 PF=1 Var=2
DECS Control	System Input COM Port Internal Tracking Enabled	2686	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Input COM Port External Tracking Enabled	2688	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Input COM Port Pre-position Enabled	2690	Uint32	4	R W	n/a	NOT SET=0 SET=1
DECS Control	System Input COM Port Pre-position Enabled 2	2692	Uint32	4	R W	n/a	NOT SET=0 SET=1
DECS Control	System Input COM Port Raise Enabled	2694	Uint32	4	R W	n/a	NOT SET=0 Raise=1
DECS Control	System Input COM Port Lower Enabled	2696	Uint32	4	R W	n/a	NOT SET=0 Lower=1
DECS Control	System Option Input Droop Enabled	2698	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Option Input Line Drop Enabled	2700	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Option Input Cross Current Enabled	2702	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Option Input OEL Style Enabled	2704	Uint32	4	R W	n/a	Summing=0 Takeover=1
DECS Control	System Option Input Voltage Match Enabled	2706	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Option Input OEL Enabled	2708	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Option Input UEL Enabled	2710	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Option Input SCL Enabled	2712	Uint32	4	R W	n/a	Disabled=0 Enabled=1
DECS Control	System Option Loss of Sensing Transfer to Manual Mode	2714	Uint32	4	R W	n/a	Status Only=0 Transfer to Manual=1 Shutdown=2
DECS Control	System Option Underfrequency Mode	2716	Uint32	4	R W	n/a	UF Limiter=0 V/Hz Limiter=1
DECS Control	System Option PSS Power Level Enabled	2718	Uint32	4	R W		Disabled=0 Enabled=1
DECS Control	System Option Volts per Hertz Slope High	2720	Float	4	R W	n/a	0 - 3
DECS Control	System Option Volts per Hertz Slope Low	2722	Float	4	R W	n/a	0 - 3
DECS Control	System Option Volts per Hertz Slope Time	2724	Float	4	R W	Second	0 - 10
DECS Control	System Option Voltage Match Band	2726	Float	4	R W	Percent	0 - 20
DECS Control	System Option Voltage Match Reference	2728	Float	4	R W	Percent	0 - 700

Group	Name	Register	Type	Bytes	R/W	Unit	Range
DECS Control	System Option Fine Adjust Band	2730	Float	4	R W	Percent	0 - 30
DECS Control	System Option Underfrequency Slope	2732	Float	4	R W	n/a	0 - 3
DECS Control	System Option PF to Droop kW Threshold	2734	Float	4	R W	Percent	0 - 30
DECS Control	Startup Primary Soft-start Bias	2736	Float	4	R W	Percent	0 - 90
DECS Control	Startup Primary Soft-start Time	2738	Float	4	R W	Second	1 - 7200
DECS Control	Startup Secondary Soft-start Bias	2740	Float	4	R W	Percent	0 - 90
DECS Control	Startup Secondary Soft-start Time	2742	Float	4	R W	Second	1 - 7200
DECS Control	System Input COM Port Preposition 3 Enabled	2744	Uint32	4	R W	n/a	NOT SET=0 SET=1
DECS Control	System Option Underfrequency Hz 2	2746	Float	4	R W	Hertz	1 - 75
DECS Control	System Option Underfrequency Slope 2	2748	Float	4	R W	n/a	0 - 3
Auto Save	Enable	2750	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Modbus	Auto Save	2752	Uint16	2	R W	n/a	Off=0 On=1

Protection Settings

Table 63. Protection Settings Group Parameters

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Programmable Alarms	Programmable Alarm 1 Delay	3100	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 2 Delay	3102	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 3 Delay	3104	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 4 Delay	3106	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 5 Delay	3108	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 6 Delay	3110	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 7 Delay	3112	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 8 Delay	3114	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 9 Delay	3116	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 10 Delay	3118	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 11 Delay	3120	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 12 Delay	3122	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 13 Delay	3124	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 14 Delay	3126	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 15 Delay	3128	Float	4	R W	Second	0 - 300
Programmable Alarms	Programmable Alarm 16 Delay	3130	Float	4	R W	Second	0 - 300
Field Overvoltage	Primary Mode	3132	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Field Overvoltage	Primary Pickup	3134	Float	4	R W	V	Disabled=0, 1 - 300
Field Overvoltage	Primary Time Delay	3136	Float	4	R W	Millisecond	Instantaneous=0, 0 - 30000
Field Overvoltage	Secondary Mode	3138	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Field Overvoltage	Secondary Pickup	3140	Float	4	R W	V	Disabled=0, 1 - 300
Field Overvoltage	Secondary Time Delay	3142	Float	4	R W	Millisecond	Instantaneous=0, 0 - 30000
Loss Of Sensing	Mode	3144	Uint32	4	R W	n/a	Disabled=0 Enabled=1

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Loss Of Sensing	Time Delay	3146	Float	4	R W	Second	0 - 30
Loss Of Sensing	Voltage Balanced Level	3148	Float	4	R W	Percent	0 - 100
Loss Of Sensing	Voltage Unbalanced Level	3150	Float	4	R W	Percent	0 - 100
EDM	Mode	3152	Uint32	4	R W	n/a	Disabled=0 Enabled=1
EDM	Pickup	3154	Float	4	R W	Amp	0; 1 - 10
EDM	Time Delay	3156	Float	4	R W	Millisecond	0; 200 - 30000
25	Mode	3158	Uint32	4	R W	n/a	Disabled=0 Enabled=1
25	Slip Angle	3160	Float	4	R W	Degree	1 - 99
25	Slip Frequency	3162	Float	4	R W	Hertz	0.01 - 0.5
25	Voltage Difference	3164	Float	4	R W	Percent	0.1 - 50
25	Generator Frequency Greater Than Bus Frequency	3166	Uint32	4	R W	n/a	Disabled=0 Enabled=1
25	Angle Compensation	3168	Float	4	R W	Degree	0 – 359.9
27P	Primary Mode	3170	Uint32	4	R W	n/a	Disabled=0 Enabled=1
27P	Primary Pickup	3172	Float	4	R W	Volt	Disabled=0, 0 - 99999
27P	Primary Time Delay	3174	Float	4	R W	Millisecond	100 - 60000
27P	Secondary Mode	3176	Uint32	4	R W	n/a	Disabled=0 Enabled=1
27P	Secondary Pickup	3178	Float	4	R W	Volt	Disabled=0, 0 - 999999
27P	Secondary Time Delay	3180	Float	4	R W	Millisecond	100 - 60000
59P	Primary Mode	3182	Uint32	4	R W	n/a	Disabled=0 Enabled=1
59P	Primary Pickup	3184	Float	4	R W	Volt	Disabled=0, 0 - 99999
59P	Primary Time Delay	3186	Float	4	R W	Millisecond	100 - 60000
59P	Secondary Mode	3188	Uint32	4	R W	n/a	Disabled=0 Enabled=1
59P	Secondary Pickup	3190	Float	4	R W	Volt	Disabled=0, 0 - 99999
59P	Secondary Time Delay	3192	Float	4	R W	Millisecond	100 - 60000
81O	Primary Mode	3194	Uint32	4	R W	n/a	Disabled=0 Over=1
81O	Primary Pickup	3196	Float	4	R W	Hertz	Disabled=0, 30 - 70
81O	Primary Time Delay	3198	Float	4	R W	Millisecond	100 - 300000
81O	Primary Voltage Inhibit	3200	Float	4	R W	Percent	0; 5 - 100
81O	Secondary Mode	3202	Uint32	4	R W	n/a	Disabled=0 Over=1
81O	Secondary Pickup	3204	Float	4	R W	Hertz	Disabled=0, 30 - 70
81O	Secondary Time Delay	3206	Float	4	R W	Millisecond	100 - 300000
81O	Secondary Voltage Inhibit	3208	Float	4	R W	Percent	0; 5 - 100
81U	Primary Mode	3210	Uint32	4	R W	n/a	Disabled=0 Under=2
81U	Primary Pickup	3212	Float	4	R W	Hertz	Disabled=0, 30 - 70
81U	Primary Time Delay	3214	Float	4	R W	Millisecond	100 - 300000
81U	Primary Voltage Inhibit	3216	Float	4	R W	Percent	Disabled=0, 5 - 100
81U	Secondary Mode	3218	Uint32	4	R W	n/a	Disabled=0 Under=2
81U	Secondary Pickup	3220	Float	4	R W	Hertz	Disabled=0, 30 - 70
81U	Secondary Time Delay	3222	Float	4	R W	Millisecond	100 - 300000
81U	Secondary Voltage Inhibit	3224	Float	4	R W	Percent	Disabled=0, 5 – 100

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Configurable Protection 1	Parameter Selection	3226	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 1	Hysteresis	3228	Float	4	R W	Percent	0 - 100
Configurable Protection 1	Arming Delay	3230	Float	4	R W	Second	0 - 300
Configurable Protection 1	Stop Mode Inhibit	3232	Int32	4	R W	n/a	No=0 Yes=1
Configurable Protection 1	Threshold 1 Type	3234	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 1	Threshold 1 Pickup	3236	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 1	Threshold 1 Activation Delay	3238	Float	4	R W	Second	0 - 300
Configurable Protection 1	Threshold 2 Type	3240	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 1	Threshold 2 Pickup	3242	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 1	Threshold 2 Activation Delay	3244	Float	4	R W	Second	0 - 300
Configurable Protection 1	Threshold 3 Type	3246	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 1	Threshold 3 Pickup	3248	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 1	Threshold 3 Activation Delay	3250	Float	4	R W	Second	0 - 300
Configurable Protection 1	Threshold 4 Type	3252	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 1	Threshold 4 Pickup	3254	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 1	Threshold 4 Activation Delay	3256	Float	4	R W	Second	0 – 300
Configurable Protection 1	Label	3258	String	16	R W	n/a	0 - 16
Configurable Protection 2	Parameter Selection	3266	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 2	Hysteresis	3268	Float	4	R W	Percent	0 - 100
Configurable Protection 2	Arming Delay	3270	Float	4	R W	Second	0 - 300
Configurable Protection 2	Stop Mode Inhibit	3272	Int32	4	R W	n/a	No=0 Yes=1

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Configurable Protection 2	Threshold 1 Type	3274	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 2	Threshold 1 Pickup	3276	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 2	Threshold 1 Activation Delay	3278	Float	4	R W	Second	0 - 300
Configurable Protection 2	Threshold 2 Type	3280	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 2	Threshold 2 Pickup	3282	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 2	Threshold 2 Activation Delay	3284	Float	4	R W	Second	0 - 300
Configurable Protection 2	Threshold 3 Type	3286	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 2	Threshold 3 Pickup	3288	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 2	Threshold 3 Activation Delay	3290	Float	4	R W	Second	0 - 300
Configurable Protection 2	Threshold 4 Type	3292	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 2	Threshold 4 Pickup	3294	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 2	Threshold 4 Activation Delay	3296	Float	4	R W	Second	0 – 300
Configurable Protection 2	Label	3298	String	16	R W	n/a	0 - 16
Configurable Protection 3	Parameter Selection	3306	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 3	Hysteresis	3308	Float	4	R W	Percent	0 - 100
Configurable Protection 3	Arming Delay	3310	Float	4	R W	Second	0 - 300
Configurable Protection 3	Stop Mode Inhibit	3312	Int32	4	R W	n/a	No=0 Yes=1
Configurable Protection 3	Threshold 1 Type	3314	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 3	Threshold 1 Pickup	3316	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 3	Threshold 1 Activation Delay	3318	Float	4	R W	Second	0 - 300
Configurable Protection 3	Threshold 2 Type	3320	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 3	Threshold 2 Pickup	3322	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 3	Threshold 2 Activation Delay	3324	Float	4	R W	Second	0 - 300
Configurable Protection 3	Threshold 3 Type	3326	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 3	Threshold 3 Pickup	3328	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 3	Threshold 3 Activation Delay	3330	Float	4	R W	Second	0 - 300
Configurable Protection 3	Threshold 4 Type	3332	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 3	Threshold 4 Pickup	3334	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 3	Threshold 4 Activation Delay	3336	Float	4	R W	Second	0 – 300
Configurable Protection 3	Label	3338	String	16	R W	n/a	0 - 16

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Configurable Protection 4	Parameter Selection	3346	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 4	Hysteresis	3348	Float	4	R W	Percent	0 - 100
Configurable Protection 4	Arming Delay	3350	Float	4	R W	Second	0 - 300
Configurable Protection 4	Stop Mode Inhibit	3352	Int32	4	R W	n/a	No=0 Yes=1
Configurable Protection 4	Threshold 1 Type	3354	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 4	Threshold 1 Pickup	3356	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 4	Threshold 1 Activation Delay	3358	Float	4	R W	Second	0 - 300
Configurable Protection 4	Threshold 2 Type	3360	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 4	Threshold 2 Pickup	3362	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 4	Threshold 2 Activation Delay	3364	Float	4	R W	Second	0 - 300
Configurable Protection 4	Threshold 3 Type	3366	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 4	Threshold 3 Pickup	3368	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 4	Threshold 3 Activation Delay	3370	Float	4	R W	Second	0 - 300
Configurable Protection 4	Threshold 4 Type	3372	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 4	Threshold 4 Pickup	3374	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 4	Threshold 4 Activation Delay	3376	Float	4	R W	Second	0 – 300
Configurable Protection 4	Label	3378	String	16	R W	n/a	0 - 16
Configurable Protection 5	Parameter Selection	3386	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 5	Hysteresis	3388	Float	4	R W	Percent	0 - 100
Configurable Protection 5	Arming Delay	3390	Float	4	R W	Second	0 - 300
Configurable Protection 5	Stop Mode Inhibit	3392	Int32	4	R W	n/a	No=0 Yes=1

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Configurable Protection 5	Threshold 1 Type	3394	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 5	Threshold 1 Pickup	3396	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 5	Threshold 1 Activation Delay	3398	Float	4	R W	Second	0 - 300
Configurable Protection 5	Threshold 2 Type	3400	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 5	Threshold 2 Pickup	3402	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 5	Threshold 2 Activation Delay	3404	Float	4	R W	Second	0 - 300
Configurable Protection 5	Threshold 3 Type	3406	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 5	Threshold 3 Pickup	3408	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 5	Threshold 3 Activation Delay	3410	Float	4	R W	Second	0 - 300
Configurable Protection 5	Threshold 4 Type	3412	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 5	Threshold 4 Pickup	3414	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 5	Threshold 4 Activation Delay	3416	Float	4	R W	Second	0 – 300
Configurable Protection 5	Label	3418	String	16	R W	n/a	0 - 16
Configurable Protection 6	Parameter Selection	3426	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 6	Hysteresis	3428	Float	4	R W	Percent	0 - 100
Configurable Protection 6	Arming Delay	3430	Float	4	R W	Second	0 - 300
Configurable Protection 6	Stop Mode Inhibit	3432	Int32	4	R W	n/a	No=0 Yes=1
Configurable Protection 6	Threshold 1 Type	3434	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 6	Threshold 1 Pickup	3436	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 6	Threshold 1 Activation Delay	3438	Float	4	R W	Second	0 - 300
Configurable Protection 6	Threshold 2 Type	3440	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 6	Threshold 2 Pickup	3442	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 6	Threshold 2 Activation Delay	3444	Float	4	R W	Second	0 - 300
Configurable Protection 6	Threshold 3 Type	3446	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 6	Threshold 3 Pickup	3448	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 6	Threshold 3 Activation Delay	3450	Float	4	R W	Second	0 - 300
Configurable Protection 6	Threshold 4 Type	3452	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 6	Threshold 4 Pickup	3454	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 6	Threshold 4 Activation Delay	3456	Float	4	R W	Second	0 – 300
Configurable Protection 6	Label	3458	String	16	R W	n/a	0 - 16

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Configurable Protection 7	Parameter Selection	3466	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 7	Hysteresis	3468	Float	4	R W	Percent	0 - 100
Configurable Protection 7	Arming Delay	3470	Float	4	R W	Second	0 - 300
Configurable Protection 7	Stop Mode Inhibit	3472	Int32	4	R W	n/a	No=0 Yes=1
Configurable Protection 7	Threshold 1 Type	3474	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 7	Threshold 1 Pickup	3476	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 7	Threshold 1 Activation Delay	3478	Float	4	R W	Second	0 - 300
Configurable Protection 7	Threshold 2 Type	3480	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 7	Threshold 2 Pickup	3482	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 7	Threshold 2 Activation Delay	3484	Float	4	R W	Second	0 - 300
Configurable Protection 7	Threshold 3 Type	3486	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 7	Threshold 3 Pickup	3488	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 7	Threshold 3 Activation Delay	3490	Float	4	R W	Second	0 - 300
Configurable Protection 7	Threshold 4 Type	3492	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 7	Threshold 4 Pickup	3494	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 7	Threshold 4 Activation Delay	3496	Float	4	R W	Second	0 – 300
Configurable Protection 7	Label	3498	String	16	R W	n/a	0 - 16
Configurable Protection 8	Parameter Selection	3506	Int32	4	R W	n/a	Gen VAB=0 Gen VBC=1 Gen VCA=2 Gen V Average=3 Bus Freq=4 Bus VAB=5 Bus VBC=6 Bus VCA=7 Gen Freq=8 Gen PF=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 Vfd=20 Ifd=21 Auxilary Input Voltage=22 Auxilary Input Current (mA)=23 Setpoint Position=24 Tracking_Error=25 Neg_Seq_V=26 Neg_Seq_I=27 Pos_Seq_V=28 Pos_Seq_I=29 PSS_Output=30 Power Input=49 KW A=50 KW B=51 KW C=52 KVAR A=53 KVAR B=54 KVAR C=55 KVA A=56 KVA B=57 KVA C=58 Gen VAN=59 Gen VBN=60 Gen VCN=61 Cross Current=62 GenScaledPF=63 NetworkLoadShareErrorPercent=65 No Param Selected=64
Configurable Protection 8	Hysteresis	3508	Float	4	R W	Percent	0 - 100
Configurable Protection 8	Arming Delay	3510	Float	4	R W	Second	0 - 300
Configurable Protection 8	Stop Mode Inhibit	3512	Int32	4	R W	n/a	No=0 Yes=1

Group	Name	Register	Type	Bytes	R/W	Unit	Range
Configurable Protection 8	Threshold 1 Type	3514	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 8	Threshold 1 Pickup	3516	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 8	Threshold 1 Activation Delay	3518	Float	4	R W	Second	0 - 300
Configurable Protection 8	Threshold 2 Type	3520	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 8	Threshold 2 Pickup	3522	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 8	Threshold 2 Activation Delay	3524	Float	4	R W	Second	0 - 300
Configurable Protection 8	Threshold 3 Type	3526	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 8	Threshold 3 Pickup	3528	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 8	Threshold 3 Activation Delay	3530	Float	4	R W	Second	0 - 300
Configurable Protection 8	Threshold 4 Type	3532	Int32	4	R W	n/a	Disabled=0 Over=1 Under=2
Configurable Protection 8	Threshold 4 Pickup	3534	Float	4	R W	n/a	-999999 - 999999
Configurable Protection 8	Threshold 4 Activation Delay	3536	Float	4	R W	Second	0 – 300
Configurable Protection 8	Label	3538	String	16	R W	n/a	0 – 16
Hardware Shutdown	OEL Shutdown Enable	3546	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	OEL Shutdown Delay	3548	Float	4	R W	Second	0 - 30
Hardware Shutdown	UEL Shutdown Enable	3550	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	UEL Shutdown Delay	3552	Float	4	R W	Second	0 - 30
Hardware Shutdown	SCL Shutdown Enable	3554	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	SCL Shutdown Delay	3556	Float	4	R W	Second	0 - 30
Hardware Shutdown	27 Shutdown Enable	3558	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	59 Shutdown Enable	3560	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	81O Shutdown Enable	3562	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	81U Shutdown Enable	3564	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	EDM Shutdown Enable	3566	Unit32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	Field Overvoltage Shutdown Enable	3568	Uint32	4	R W	n/a	Disabled=0 Enabled=1
Hardware Shutdown	Field Short Circuit Shutdown Enable	3570	Uint32	4	R W	n/a	Disabled=0 Enabled=1

Gains Settings

Table 64. Gains Settings Group Parameters

Name	Register	Type	Bytes	R/W	Unit	Range
Primary Gain Option	3800	Uint32	4	R W	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

Name	Register	Type	Bytes	R/W	Unit	Range
Secondary Gain Option	3802	Uint32	4	R W	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
AVR Kp Primary	3804	Float	4	R W	n/a	0 - 1000
AVR Ki Primary	3806	Float	4	R W	n/a	0 - 1000
AVR Kd Primary	3808	Float	4	R W	n/a	0 - 1000
AVR Td Primary	3810	Float	4	R W	n/a	0 - 1
FCR Kp	3812	Float	4	R W	n/a	0 - 1000
FCR Ki	3814	Float	4	R W	n/a	0 - 1000
FCR Kd	3816	Float	4	R W	n/a	0 - 1000
FCR Td	3818	Float	4	R W	n/a	0 - 1
PF Ki	3820	Float	4	R W	n/a	0 - 1000
PF Kg	3822	Float	4	R W	n/a	0 - 1000
Var Ki	3824	Float	4	R W	n/a	0 - 1000
Var Kg	3826	Float	4	R W	n/a	0 - 1000
OEL Ki	3828	Float	4	R W	n/a	0 - 1000
OEL Kg	3830	Float	4	R W	n/a	0 - 1000
UEL Ki	3832	Float	4	R W	n/a	0 - 1000
UEL Kg	3834	Float	4	R W	n/a	0 - 1000
SCL Ki	3836	Float	4	R W	n/a	0 - 1000
SCL Kg	3846	Float	4	R W	n/a	0 - 1000
Vm Kg	3840	Float	4	R W	n/a	0 - 1000
AVR Kp Secondary	3842	Float	4	R W	n/a	0 - 1000
AVR Ki Secondary	3844	Float	4	R W	n/a	0 - 1000
AVR Kd Secondary	3846	Float	4	R W	n/a	0 - 1000
AVR Td Secondary	3848	Float	4	R W	n/a	0 - 1
AVR Ka Primary	3850	Float	4	R W	n/a	0 - 1
AVR Ka Secondary	3852	Float	4	R W	n/a	0 - 1
FCR Ka	3854	Float	4	R W	n/a	0 - 1

PSS Settings

Table 65. PSS Settings Group Parameters

Name	Register	Type	Bytes	R/W	Unit	Range
PSS Enable	4300	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Primary M	4302	Uint32	4	R W	n/a	1 - 5
PSS Primary N	4304	Uint32	4	R W	n/a	0 - 1
PSS Primary Switch 0	4306	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Primary Switch 1	4308	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Primary Switch 3	4310	Uint32	4	R W	n/a	Frequency=0 Der. Speed=1
PSS Primary Switch 4	4312	Uint32	4	R W	n/a	Power=0 Der. Freq/Speed=1
PSS Primary Switch 5	4314	Uint32	4	R W	n/a	Exclude=0 Include=1
PSS Primary Switch 6	4316	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Primary Switch 7	4318	Uint32	4	R W	n/a	Off=0 On=1
PSS Primary Switch 8	4320	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Primary Switch 9	4322	Uint32	4	R W	n/a	Exclude=0 Include=1
PSS Primary Switch 10	4324	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Primary Switch 11	4326	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Primary Tw1	4328	Float	4	R W	Second	1 - 20

Name	Register	Type	Bytes	R/W	Unit	Range
PSS Primary Tw2	4330	Float	4	R W	Second	1 - 20
PSS Primary H	4332	Float	4	R W	n/a	1 - 25
PSS Primary Tl1	4334	Float	4	R W	Second	0 - 20
PSS Primary T1	4336	Float	4	R W	Second	0.001 - 6
PSS Primary T2	4338	Float	4	R W	Second	0.001 - 6
PSS Primary T3	4340	Float	4	R W	Second	0.001 - 6
PSS Primary T4	4342	Float	4	R W	Second	0.001 - 6
PSS Primary T5	4344	Float	4	R W	Second	0.001 - 6
PSS Primary T6	4346	Float	4	R W	Second	0.001 - 6
PSS Primary T7	4348	Float	4	R W	Second	0.001 - 6
PSS Primary T8	4350	Float	4	R W	Second	0.001 - 6
PSS Primary Terminal Voltage Limiter Time Constant	4352	Float	4	R W	Second	0.02 - 5
PSS Primary Terminal Voltage Limiter Setpoint	4354	Float	4	R W	n/a	0 - 10
PSS Primary Zeta Num 1	4356	Float	4	R W	n/a	0 - 1
PSS Primary Zeta Den 1	4358	Float	4	R W	n/a	0 - 1
PSS Primary Wn 1	4360	Float	4	R W	n/a	10 - 150
PSS Primary Zeta Num 2	4362	Float	4	R W	n/a	0 - 1
PSS Primary Zeta Den 2	4364	Float	4	R W	n/a	0 - 1
PSS Primary Wn 2	4366	Float	4	R W	n/a	10 - 150
PSS Primary Logic Output Limiter Upper Limit	4368	Float	4	R W	n/a	0.01 – 0.04
PSS Primary Logic Output Limiter Lower Limit	4370	Float	4	R W	n/a	-0.040 - -0.010
PSS Primary Logic Output Limiter Time Delay	4372	Float	4	R W	n/a	0 - 2
PSS Primary Logic Limiter Washout Filter Normal Time	4374	Float	4	R W	n/a	5 - 30
PSS Primary Logic Limiter Washout Filter Limit Time	4376	Float	4	R W	n/a	0 - 1
PSS Primary Stabilizer Gain Ks	4378	Float	4	R W	n/a	-50 - 50
PSS Primary Output Limiting Upper Limit	4380	Float	4	R W	n/a	0 - 0.5
PSS Primary Output Limiting Lower Limit	4382	Float	4	R W	n/a	-0.5 - 0
PSS Primary Xq	4384	Float	4	R W	n/a	0 - 5
PSS Primary Power Level Threshold	4386	Float	4	R W	n/a	0 - 1
PSS Primary Power Level Hysteresis	4388	Float	4	R W	n/a	0 - 1
PSS Primary Tw3	4390	Float	4	R W	Second	1 - 20
PSS Primary Tw4	4392	Float	4	R W	Second	1 - 20
PSS Primary Tl2	4394	Float	4	R W	Second	0.01 - 20
PSS Primary Kpe	4396	Float	4	R W	n/a	0 - 2
PSS Primary Tl3	4398	Float	4	R W	Second	0.05 - 20
PSS Primary Tr	4400	Float	4	R W	Second	0.01 - 1
PSS Primary Supervisory Function Power-On Threshold	4402	Float	4	R W	n/a	0 - 1
PSS Primary Supervisory Function Power-On Hysteresis	4404	Float	4	R W	n/a	0 - 1
PSS Secondary M	4406	Uint32	4	R W	n/a	1 - 5
PSS Secondary N	4408	Uint32	4	R W	n/a	0 - 1

Name	Register	Type	Bytes	R/W	Unit	Range
PSS Secondary Switch 0	4410	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Secondary Switch 1	4412	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Secondary Switch 3	4414	Uint32	4	R W	n/a	Frequency=0 Der. Speed=1
PSS Secondary Switch 4	4416	Uint32	4	R W	n/a	Power=0 Der. Freq/Speed=1
PSS Secondary Switch 5	4418	Uint32	4	R W	n/a	Exclude=0 Include=1
PSS Secondary Switch 6	4420	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Secondary Switch 7	4422	Uint32	4	R W	n/a	Off=0 On=1
PSS Secondary Switch 8	4424	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Secondary Switch 9	4426	Uint32	4	R W	n/a	Exclude=0 Include=1
PSS Secondary Switch 10	4428	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Secondary Switch 11	4430	Uint32	4	R W	n/a	Disabled=0 Enabled=1
PSS Secondary Tw1	4432	Float	4	R W	Second	1 - 20
PSS Secondary Tw2	4434	Float	4	R W	Second	1 - 20
PSS Secondary H	4436	Float	4	R W	n/a	1 - 25
PSS Secondary Tl1	4438	Float	4	R W	Second	0 - 20
PSS Secondary T1	4440	Float	4	R W	Second	0.001 - 6
PSS Secondary T2	4442	Float	4	R W	Second	0.001 - 6
PSS Secondary T3	4444	Float	4	R W	Second	0.001 - 6
PSS Secondary T4	4446	Float	4	R W	Second	0.001 - 6
PSS Secondary T5	4448	Float	4	R W	Second	0.001 - 6
PSS Secondary T6	4450	Float	4	R W	Second	0.001 - 6
PSS Secondary T7	4452	Float	4	R W	Second	0.001 - 6
PSS Secondary T8	4454	Float	4	R W	Second	0.001 - 6
PSS Secondary Terminal Voltage Limiter Time Constant	4456	Float	4	R W	Second	0.02 - 5
PSS Secondary Terminal Voltage Limiter Setpoint	4458	Float	4	R W	n/a	0 - 10
PSS Secondary Zeta Num 1	4460	Float	4	R W	n/a	0 - 1
PSS Secondary Zeta Den 1	4462	Float	4	R W	n/a	0 - 1
PSS Secondary Wn 1	4464	Float	4	R W	n/a	10 - 150
PSS Secondary Zeta Num 2	4466	Float	4	R W	n/a	0 - 1
PSS Secondary Zeta Den 2	4468	Float	4	R W	n/a	0 - 1
PSS Secondary Wn 2	4470	Float	4	R W	n/a	10 - 150
PSS Secondary Logic Output Limiter Upper Limit	4472	Float	4	R W	n/a	0.01 – 0.04
PSS Secondary Logic Output Limiter Lower Limit	4474	Float	4	R W	n/a	-0.040 - -0.010
PSS Secondary Logic Output Limiter Time Delay	4476	Float	4	R W	n/a	0 - 2
PSS Secondary Logic Limiter Washout Filter Normal Time	4478	Float	4	R W	n/a	5 - 30
PSS Secondary Logic Limiter Washout Filter Limit Time	4480	Float	4	R W	n/a	0 - 1
PSS Secondary Stabilizer Gain Ks	4482	Float	4	R W	n/a	-50 - 50
PSS Secondary Output Limiting Upper Limit	4484	Float	4	R W	n/a	0 - 0.5
PSS Secondary Output Limiting Lower Limit	4486	Float	4	R W	n/a	-0.5 - 0
PSS Secondary Xq	4488	Float	4	R W	n/a	0 - 5

Name	Register	Type	Bytes	R/W	Unit	Range
PSS Secondary Power Level Threshold	4490	Float	4	R W	n/a	0 - 1
PSS Secondary Power Level Hysteresis	4492	Float	4	R W	n/a	0 - 1
PSS Secondary Tw3	4494	Float	4	R W	Second	1 - 20
PSS Secondary Tw4	4496	Float	4	R W	Second	1 - 20
PSS Secondary Tl2	4498	Float	4	R W	Second	0.01 - 20
PSS Secondary Kpe	4500	Float	4	R W	n/a	0 - 2
PSS Secondary Tl3	4502	Float	4	R W	Second	0.05 - 20
PSS Secondary Tr	4504	Float	4	R W	Second	0.01 - 1
PSS Enable Status	4506	Uint32	4	R	n/a	Off=0 On=1

Maintenance

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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-150 from service. Refer to the appropriate site schematics to ensure that all steps have been taken to properly and completely de-energize the DECS-150.

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Preventive Maintenance

Connections

Periodically check the connections of the DECS-150 to ensure they are clean and tight and remove any accumulation of dust.

Electrolytic Capacitors

The DECS-150 contains long-life aluminum electrolytic capacitors. For a DECS-150 kept in storage as a spare, the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

To energize the device, apply operating power within one of the following ranges:
- 100 to 139 Vac, or 125 Vdc
- 190 to 277 Vac, or 250 Vdc

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Caution

When energizing the DECS-150 from a low impedance source (such as a wall outlet), use of an Inrush Current Reduction Module (ICRM-7) is recommended to prevent damage to the DECS-150. For a detailed description of the Inrush Current Reduction Module, refer to Basler publication 9387900990. ICRM-7 connections are illustrated in *Typical Connections*.

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Cleaning the Front Panel

Only a soft cloth and water-based solutions should be used to clean the front panel. Do not use solvents.

Storage

If the DECS-150 is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

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-150, first check the programmable settings for the appropriate function.

Communications

BESTCOMS*Plus* Metering Incorrect

If power factor, var, or watt readings are significantly different from the expected readings for a known load, verify that the B-phase current sensing input of the DECS-150 is connected to a CT on phase B and not phases A or C.

No Communication

If communication with the DECS-150 cannot be initiated, check the connections at the communication ports.

No Communication Through the USB Port

A failure to establish communication through the USB port may be caused by a failure of the automatic installation of the DECS-150 USB driver in Windows®. This condition is indicated by a Driver Software Installation error message. To install the DECS-150 USB driver manually, perform the following steps.

Step 1: Open the Windows Device Manager. Under Other Devices, right-click on DECS-150 (or Unknown Device) and select Properties.

Step 2: In the Properties window, select the Driver tab and click the Update Driver button.

Step 3: Select "Browse my computer for driver software" and then navigate to:

C:\Program Files\Basler Electric\USB Device Drivers\USBIO

Install the USB driver software. Successful installation will be indicated by a confirmation message.

General Operation

Generator Voltage Does Not Build

Step 1: Verify that all wiring is properly connected. Refer to the *Typical Connections* chapter.

If wiring is improperly connected or loose, reconnect wiring properly.

If wiring connections are correct, proceed to Step 2.

Step 2: Verify that the generator is spinning at rated speed.

If the generator is not up to rated speed, increase generator speed to the rated value.

If the generator is spinning at rated speed, proceed to Step 3.

Step 3: For PMG power, check for correct input power to the DECS-150. Refer to the *Specifications* chapter for input power requirements.

If voltage is not present, refer to the generator manual for repair procedures (PMG system only).

If voltage is present, proceed to Step 4.

Step 3a: If the DECS-150 is being shunt powered (non-PMG) mode, verify that the residual voltage applied to the power input is at least 6 Vac.

If the applied voltage is less than 6 Vac, refer to the generator manual and flash the generator field.

If the applied voltage is 6 Vac or greater, proceed to Step 4.

Step 4:   Verify that no fuses are open.

Replace any open fuses.

If no fuses are open, proceed to Step 5.

Step 5.   Verify that the generator is not shut down through BESTlogic*Plus*.

Step 6.   Verify that the front panel Overexcitation Shutdown indicator is not lit.

If the front panel Overexcitation Shutdown indicator (field voltage) is lit, check the generator and/or load conditions. Interrupt input power or shut down the generator for a minimum of one minute.

If the front panel Overexcitation Shutdown indicator is not lit, proceed to Step 7.

Step 7.   Verify that the front panel Overexcitation Limiting indicator is not lit.

If the front panel Overexcitation Limiting indicator is lit, check the generator and load conditions. Also check the Field Current Limit setpoint for the correct level. Interrupt input power or shut down the generator for a minimum of 1 minute.

If the front panel Overexcitation Limiting indicator is not lit, proceed to Step 8.

Step 8.   Verify that the DECS-150 soft start settings are correct. Too long of a soft start setting may give the appearance of no buildup.

If the soft start settings are incorrect, adjust the settings.

If the soft start settings have no effect, proceed to Step 9.

Step 9.   Replace the DECS-150 unit.

If replacing the DECS-150 unit does not correct the malfunction, then the generator is defective. Consult with the generator manufacturer.

Low Generator Output Voltage

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

If the voltage adjustment is too low, adjust it to the correct setpoint.

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

Step 2.   Verify that the Underfrequency Knee setpoint is not greater than the generator frequency.

If the Underfrequency setpoint is too high, adjust the setpoint below the rated generator frequency.

If the Underfrequency setpoint is correct, proceed to Step 3.

Step 3.   Verify that the generator is spinning at rated speed.

If the generator is not up to rated speed, increase the generator speed to the rated level.

If the generator is spinning at rated speed, proceed to Step 4.

Step 4.   For PMG power, check for correct input power to the DECS-150. Refer to the *Specifications* chapter for input power requirements.

If the DECS-150 input voltage is low, refer to the PMG manual for PMG repair (PMG system only).

If the voltage is at the required level, proceed to Step 5.

Step 4a. If the DECS-150 is being shunt powered (non-PMG), verify that the power potential transformer (if used) has the correct turns ratio, is sized properly, and is supplying the correct voltage level to the power input.

If the turns ratio of the power potential transformer is incorrect, is sized too small, or is not supplying the correct input power, replace the power potential transformer.

If the power potential transformer is correct, proceed to Step 5.

Step 5. Verify that the sensing potential transformer (if used) has the correct turns ratio and is operating correctly.

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

If the sensing potential transformer is operating correctly, proceed to Step 6.

Step 6. Verify that the front panel Overexcitation Limiter Active indicator is not lit.

If the front panel Overexcitation Limiter Active indicator is lit, check the generator and/or load conditions. Also check the Field-Current Limit setpoint for the correct level. Interrupt input power or shut down the generator for a minimum of one minute.

If the front panel Overexcitation Limiter Active indicator is not lit, proceed to Step 7.

Step 7. Low generator output voltage may occur when operating in droop mode with an inductive load.

If the low voltage condition is not caused by the droop function, proceed to Step 8.

Step 8. Verify that the Voltage setpoint is not being modified by application of voltage or current to the Accessory Input.

If the low voltage condition is not caused by the Accessory Input, proceed to Step 9.

Step 9. Replace the DECS-150 unit.

High Generator Output Voltage

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

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

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

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

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

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

Step 3. High generator output voltage may occur when operating in droop mode with a capacitive load.

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

Step 4. High generator output voltage may occur when operating in line-drop compensation mode with a capacitive load.

If the high voltage condition is not caused by the line-drop compensation function, proceed to Step 5.

Step 5. Verify that the Voltage setpoint is not being modified by application of voltage or current to the Accessory Input.

If the high voltage condition is not caused by voltage applied to the Accessory Input, proceed to Step 6.

Step 6.   Replace the DECS-150 unit.

Poor Voltage Regulation

Step 1.   Verify that the DECS-150 is properly grounded.

If the DECS-150 is not properly grounded, connect a dedicated ground wire to the terminal labeled GND on the DECS-150.

If the DECS-150 is properly grounded, proceed to Step 2.

Step 2.   Check for grounded field leads.

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

If the field leads are not grounded, proceed to Step 3.

Step 3.   If the DECS-150 is powered from a PMG, check for grounded PMG leads.

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

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

Step 4.   Verify that the generator frequency is not dropping below the DECS-150 Underfrequency setpoint when load is applied to the generator.

If the generator frequency is dropping below the Underfrequency setpoint, reduce the setpoint if possible. Also check the prime mover and generator for proper sizing in relation to the applied load.

If poor regulation is not related to DECS-150 underfrequency operation, proceed to Step 5.

Step 5.   Verify that regulation is not being affected by normal droop operation.

If droop operation is not affecting regulation, proceed to Step 6.

Step 6.   Replace the DECS-150 unit.

Generator Output Unstable (Hunting)

Step 1.   Verify that the governor for the prime mover is operating properly.

If the governor is not operating properly, troubleshoot using the manufacturer's suggested procedures.

If the governor is operating properly, proceed to Step 2.

Step 2.   Verify that the sensing and input power leads are connected securely.

If the sensing or input power leads are not connected securely, tighten the connections.

If the sensing or input power lead connections are secure, proceed to Step 3.

Step 3.   Verify that the DECS-150 AVR gains are set properly.

If the gain settings are incorrect, reset the gains.

Overexcitation Shutdown Indicator is Annunciating

Step 1.   Check for generator overloading.

If the generator is operating with a larger than rated load, shed load.

If the generator is operating with a rated or less than rated load, proceed to Step 2.

Step 2.   Verify that the generator exciter field voltage requirements are compatible with the DECS-150.

If the exciter field voltage requirements are not compatible with the DECS-150, contact Basler Electric Customer Service for recommendations.

If the exciter field voltage requirements are compatible with the DECS-150, proceed to Step 3.

Step 3.   Replace the DECS-150.

If replacing the DECS-150 does not correct the malfunction, proceed to Step 4.

Step 4.   Refer to the generator manual. Generator is defective.

Loss of Generator Sensing Indicator is Annunciating

Step 1.   Verify that the voltage sensing leads are properly connected.

If the sensing leads are not properly connected, correct the connections.

If the sensing lead connections are correct, proceed to Step 2.

Step 2.   For single-phase sensing, verify that E1 and E3 are connected.

If E1 and E3 are not connected, connect them as required.

If E1 and E3 are properly connected, proceed to Step 3.

Step 3.   Verify that the sensing potential transformer (if used) has the correct turns ratio and is functioning properly.

If the sensing potential transformer has the wrong turns ratio or is malfunctioning, replace it.

If the sensing potential transformer is correct and functioning properly, proceed to Step 4.

Step 4.   Verify that the generator output voltage is present on all phases.

If the generator is missing a phase, refer to the generator manual. Generator is defective.

If generator output voltage is balanced on all phases, proceed to Step 5.

Step 5.   Replace the DECS-150.

Overexcitation Limiting Indicator is Annunciating

Step 1.   Check for generator overloading.

If the generator is operating with a larger than rated load, shed load.

If the generator is operating with a rated or less than rated load, proceed to Step 2.

Step 2.   Verify that the DECS-150 output (field) current limit is not set too low.

If the Output Current Limit setpoint is too low, adjust for the proper setting.

If the output current limit is set properly, proceed to Step 3.

Step 3.   Verify that the generator exciter field current requirements are compatible with the DECS-150.

If the generator exciter field current requirements are not compatible with the DECS-150, contact Basler Electric Customer Service for recommendations.

If the generator exciter field current requirements are compatible with the DECS-150, proceed to Step 4.

Step 4.   Replace the DECS-150.

If replacing the DECS-150 does not correct the malfunction, proceed to Step 5.

Step 5.   Refer to the generator manual. Generator is defective.

Underexcitation Limiting Indicator is Annunciating

Step 1.   Verify that the DECS-150 Generator Voltage setpoint is not being driven to a lower level.

The setpoint can be affected by the Raise/Lower contact inputs or by the Auxiliary input.

Step 2.   Verify that the DECS-150 output (field) current limit is not set too low.

Adjust the field current limit as needed.

Step 3. Use the connection diagrams of the *Typical Connections* chapter to verify that the sensing voltage and current connections to the DECS-150 provide the proper phasing.

Correct the sensing voltage and current connections as needed.

Step 4. Verify that the generator exciter field current requirements are compatible with the DECS-150.

If the generator exciter field current requirements are not compatible with the DECS-150, contact Basler Electric Technical Sales Support for recommendations.

If the generator exciter field current requirements are compatible with the DECS-150, proceed to Step 5.

Step 5. Replace the DECS-150.

If replacing the DECS-150 does not correct the malfunction, proceed to Step 6.

Step 6. Refer to the generator manual or contact the generator manufacturer.

Underfrequency Active Indicator is Annunciating

Step 1. Verify that the generator is operating at rated speed.

If the generator is not operating at rated speed, adjust the generator speed.

If the generator is operating at the rated speed, proceed to Step 2.

Step 2. Verify that the Underfrequency setpoint is correct.

If the Underfrequency setpoint is incorrect, adjust it to the correct value.

No Droop

Step 1. Verify that the DECS-150 52L/M contact input is open.

If the 52L/M contact input is not open, it must be opened to enable the droop function.

If the 52L/M contact input is open, proceed to Step 2.

Step 2. Verify that the DECS-150 52J/K contact input (if present) is closed or the Var/PF function is disabled via BESTCOMS*Plus*. Var/PF operation must be disabled for droop operation. If var/PF operation is disabled, proceed to Step 3.

Step 3. Verify that the DECS-150 droop setting is not adjusted to 0% droop.

If the droop setting is adjusted to 0% droop, increase the setpoint above 0%.

If the droop setting is adjusted to above 0%, proceed to Step 4.

Step 4. Check for an open in the circuit connected to DECS-150 CT1 and CT2.

If there is an open circuit, repair as necessary.

If there is no open circuit, proceed to Step 5.

Step 5. Verify that all connections are correct. Refer to the *Typical Connections* chapter.

If connections are incorrect, correct the problem.

If connections are correct, proceed to Step 6.

Step 6. Verify that droop is not disabled through BESTlogic*Plus*.

Step 7. Verify that the load applied to the generator for droop testing is not purely resistive.

If only a resistive load is being applied to the generator, apply an inductive load and retest.

If the load being to the generator is inductive, proceed to Step 8.

Step 8. Verify that your DECS-150 is compatible with the current sensing transformer (1 A or 5 A secondary) being used. For example, a current sensing transformer with a 1 ampere output rating would produce very little droop if the DECS-150 has a 5 ampere current transformer input. To check the current transformer input of your DECS-150, refer to the style chart in the *Introduction* chapter.

If the current transformer input is incorrect, replace the current sensing transformer or the DECS-150 for compatibility.

If the current transformer input is correct, proceed to Step 9.

Step 9. If the above steps fail to correct the malfunction, replace the DECS-150 unit.

No Voltage Matching

Step 1. Verify that Voltage Matching is enabled in BESTCOMS*Plus* software.

If not enabled, use the software to turn on voltage matching.

If voltage matching is enabled, proceed to Step 2.

Step 2. Verify that all connections are correct according to the *Typical Connections* chapter as required for voltage matching.

If the interconnection is incorrect, reconnect according to the appropriate interconnect diagram.

If the interconnection is correct, proceed to Step 3.

Step 3. Verify that voltage matching is not disabled through BESTlogic*Plus*.

If voltage matching is not disabled, proceed to Step 2.

Step 4. Check for correct utility reference voltage on DECS-150 terminals B1 and B3.

If the interconnection is incorrect, reconnect according to the appropriate interconnect diagram.

If the interconnection is correct, check for open system fuses.

Verify that the potential sensing transformer, if used, is connected to DECS-150 terminals B1 and B3.

If potential sensing transformer connections are correct, proceed to Step 5.

Step 5. Verify that the Generator Output Voltage setpoint is within 10 percent of the measured utility bus voltage.

If the setpoint is too low or too high, adjust the setpoint to the appropriate level.

If the setpoint is correct, proceed to Step 6.

Step 6. If the above steps fail to correct the voltage matching malfunction, replace the DECS-150.

Support

Contact the Basler Electric Technical Services Department at +1.618.654.2341 for troubleshooting support or to receive a return authorization number.

Specifications

DECS-150 Digital Excitation Control Systems have the following features and capabilities.

Operating Power

Voltage Range
    For 63 Vdc Excitation Power ..... 100 to 139 Vac or 125 Vdc
    For 125 Vdc Excitation Power ... 190 to 277 Vac single-phase, 190 to 260 Vac three-phase,
                                               or 250 Vdc
Frequency Range............................ dc, 50 to 500 Hz
Power Dissipation .... 40 W maximum continuous

Table 66 lists the required nominal operating power voltage and configuration required to obtain 63 and 125 Vdc continuous field power for the DECS-150.

Table 66. Operating Power Requirements

Excitation Power	63 Vdc	125 Vdc
Input Power Configuration	1- or 3-phase	1- or 3-phase
Nominal Input Voltage	120 Vac/125 Vdc	240 Vac/250 Vdc
Full Load Continuous Voltage	63 Vdc	125 Vdc
Full Load Continuous Current at 70°C Ambient Temperature	7 A	
Full Load Continuous Current at 55°C Ambient Temperature	10 A	
Minimum Residual Voltage for Buildup	6 Vac	
Operating Power Input Burden at 7 Adc Excitation Output	698 VA 540 W	1,610 VA 1,025 W
Operating Power Input Burden at 10 Adc Excitation Output	980 VA 770 W	2,248 VA 1,475 W
Operating Temperature at 7 Adc Excitation Output	−40 to +70°C (−40 to +158°F)	
Operating Temperature at 10 Adc Excitation Output	−40 to +55°C (−40 to +131°F)	

Generator and Bus Voltage Sensing

Type .... 1-phase or 3-phase–3-wire
Nominal Input Voltage Range .... 100 to 600 Vac ±10%
Nominal Input Frequency .... 50 or 60 Hz
Burden... <1 VA per phase

Terminals

Generator Voltage Sensing.............. E1, E2, E3
Bus Voltage Sensing........................ B1, B2, B3

Generator Current Sensing

Configuration .... 4 inputs: A-, B-, C-phase, and cross-current compensation CT input
Type .... 1-phase (B-phase), 1-phase with cross-current compensation, 3-phase, 3-phase with cross-current compensation
Range .... 1 Aac or 5 Aac nominal
Frequency .... 50/60 Hz

Burden

1 Aac Sensing .... <0.1 VA
5 Aac Sensing .... <0.3 VA

Terminals

A-Phase .... IA+, IA−
B-Phase .... IB+, IB−
C-Phase .... IC+, IC−
Cross-Current Compensation .... CC+, CC−

Accessory Inputs

Current Input

Range .... 4 to 20 mAdc
Burden .... Approximately 150Ω
Terminals .... I+, I−

Voltage Input

Range .... −10 to +10 Vdc
Burden .... Approximately 100 kΩ
Terminals .... V+, V−

Contact Inputs

Type .... Dry contact
Interrogation Voltage .... 12 Vdc

Terminals

Programmable Input 1 .... IN1, COM
Programmable Input 2 .... IN2, COM
Programmable Input 3 .... IN3, COM
Programmable Input 4 .... IN4, COM
Programmable Input 5 .... IN5, COM
Programmable Input 6 .... IN6, COM
Programmable Input 7 .... IN7, COM
Programmable Input 8 .... IN8, COM

Contact Outputs

General Purpose Rating .... 7 A, 24 Vdc/240 Vac
Pilot Duty Rating .... 2 A, 240 Vac (The load must be in parallel with a diode rated at least three times the coil current and three times the coil voltage.)

Terminal Assignments

Watchdog WD1, WD2, WD3
Relay Output 1 .... OC1, OC1
Relay Output 2 .... OC2, OC2

Field Power Output

Continuous Rating............................ 7 Adc (70°C ambient) or 10 Adc (55°C ambient)
Terminals... F+, F−

Minimum 10-Second Forcing Output Rating

120 Vac Input .... 100 Vdc, 11 Adc
240 Vac Input .... 200 Vdc, 11 Adc

Minimum Field Resistance

63 Vdc Application .... 9 Ω
125 Vdc Application .... 18 Ω

Regulation

FCR Operating Mode

Setpoint Range .... 0 to 7 Adc (70°C ambient) or 0 to 10 Adc (55°C ambient) in 0.1 Adc
increments
Regulation Accuracy .... ±5.0%

AVR Operating Mode

Setpoint Range .... 70 to 120% of rated generator voltage, in increments of 0.1%
Regulation Accuracy .... ±0.25% over load range at rated PF with constant generator
frequency and ambient temperature
Steady-State Stability....................... ±0.25% at rated PF with constant generator frequency and ambient
temperature
Temperature Drift .... ±0.5% between 0 and 40°C at constant load and generator
frequency

Var Operating Mode

Setpoint Range .... −100% (leading) to +100% (lagging) of the generator nominal
apparent power in increments of 0.1%
Regulation Accuracy .... ±2.0% of the nominal generator apparent power rating at the rated
generator frequency

Power Factor Operating Mode

Setpoint Range .... 0.5 to 1.0 (lagging) and −0.5 to −1.0 (leading), in increments of 0.01
Regulation Accuracy .... ±0.02 PF of the PF setpoint for the real power between 10 and 100%
at the rated frequency

Parallel Compensation

Modes.. Reactive Droop, Line Drop, and Reactive Differential (Cross-Current)
Cross-Current Input Burden .... Can exceed 1 VA if external resistors are added to the CT circuit for
cross-current compensation
Cross-Current Input Terminals......... CC+, CC−

Setpoint 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

Overvoltage (59) and Undervoltage (27)

Pickup
Range.. 1 to 99,999 Vac
Increment .... 1 Vac

Time Delay
Range.. 0.1 to 60 s
Increment .... 0.1 s

Loss of Sensing

Time Delay
Range.. 0 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.. 0 or 30 to 70 Hz
Increment .... 0.01 Hz

Time Delay
Time Delay Range .... 0.1 to 300 s
Increment .... 0.1 s

Voltage Inhibit (81U only)
Range.. 0 or 5 to 100% of Rated Voltage
Increment 1%

Field Protection Functions

Field Overvoltage

Pickup
Range.. 0 or 1 to 300 Vdc
Increment .... 1 Vdc

Time Delay
Range.. 0 to 30 s
Increment .... 0.1 s

Exciter Diode Monitor (EDM)

Pickup
Range.. 0 or 1 to 10 A
Increment .... 0.1 A

Delay
Range.. 0 or 0.2 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 .... 1°

Angle Compensation

Range.. 0 to 359°
Increment .... 0.1°

Slip Frequency

Range.. 0.01 to 0.5 Hz
Increment .... 0.01 Hz

Startup

PWM Startup Duty Cycle

Range.. 0 to 100%
Increment 1%

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

Voltage Matching

Accuracy.. Generator rms voltage is matched with the bus rms voltage to within ±0.5% of the generator voltage.

On-Line Overexcitation Limiting

High Current Level

Pickup
Range.. 0 to 11 Adc (70°C ambient) or 0 to 14 Adc (55°C ambient)
Increment .... 0.01 Adc

Time
Range.. 0 to 10 s
Increment .... 1 s

Medium Current Level

Pickup
Range.. 0 to 9 Adc (70°C ambient) or 0 to 12 Adc (55°C ambient)
Increment .... 0.01 Adc

Time
Range.. 0 to 120 s
Increment .... 1 s

Low Current Level

Pickup
Range.. 0 to 7 Adc (70°C ambient) or 0 to 10 Adc (55°C ambient)
Increment .... 0.01 Adc

Off-Line Overexcitation Limiting

High Current Level

Pickup
Range.. 0 to 11 Adc (70°C ambient) or 0 to 14 Adc (55°C ambient)
Increment .... 0.01 Adc

Time
Range:... 0 to 10 s
Increment: .... 1 s

Low Current Level

Pickup
Range.. 0 to 7 Adc (70°C ambient) or 0 to 10 Adc (55°C ambient)
Increment .... 0.01 Adc

Sequence of Events Recording (SER)

See the *Reports* chapter.

Data Logging (Oscillography)

See the *Reports* chapter.

Real-Time Clock

Clock has leap year and selectable daylight saving time correction. Backup battery sustains timekeeping during losses of DECS-150 operating power.

Resolution .... 1 s
Accuracy..±1.73 s/d at 25°C (77°F)

Clock Holdup

Battery Holdup Time .... Approximately 5 years depending on conditions
Battery Type   Rayovac BR2032, coin-type, 3 Vdc, 195 mAh,
                                                                 Basler Electric P/N 38526

Caution
Replacement of the backup battery for the real-time clock should be performed only by qualified personnel.
Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings on the battery socket while inserting a new battery. The battery polarity must be correct in order to provide backup for the real-time clock.
It is recommended that the battery be removed if the DECS-150 is to be operated in a salt-fog environment. Salt-fog is known to be conductive and may short-circuit the battery.

Note
Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

Communication Ports

Universal Serial Bus (USB)

Interface .... USB type B port
Location... Front panel (style xxS2V) or Rear panel (style xxS1V)

Caution
In accordance with the guidelines defined in USB standards, the USB port on this device is not isolated. To prevent damage to a connected PC or laptop, the DECS-150 must be properly tied to ground.

Ethernet

Type .... 10BASE-T/100BASE-TX copper
Interface .... RJ45 jack
Location... Rear panel

Controller Area Network (CAN)

Type .... SAE J1939 message protocol
Interface .... Spring type terminals
Location... Rear panel

Terminals.. CAN 2 H, L, SH
Communication Rate........................ 250 kb/s

Environment

Temperature

Operating Range
     7 Adc Continuous .... −40 to +70°C (−40 to +158°F)
     10 Adc Continuous .... −40 to +55°C (−40 to +131°F)
Storage Range .... −40 to +85°C (−40 to +185°F)

Humidity

Complies with MIL-STD-705B, Method 711-1C

Salt Fog

Complies with IEC 60068-2-11

Elevation

1,000 m (3,300 ft.) maximum

Ingress Protection

Front-Panel USB Port (Style xxS2V) IP42
Rear-Panel USB Port (Style xxS1V) IP54

Type Tests

Shock

Withstands 30 G in 3 perpendicular planes.

Vibration

18 to 2,000 Hz................................. 5 G for 3 hours

Transients

EN61000-4-4

Static Discharge

EN61000-4-2

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-150 was subjected to temperature tests (tested over a temperature range of −90 to +130°C (−130 to +202°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 −80 to +120°C (−112 to +248°F)). Combined temperature and vibration testing at these extremes proves that the DECS-150 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* chapter.
Weight .... 3.95 lb (1.79 kg)

Regulatory Standards

Maritime Recognition

Recognized per standard IACS UR (sections E10 and E22) by the following:

- Bureau Veritas (BV) - BV Rules Pt. C, Ch. 3
- Det Norske Veritas - Germanischer Lloyd (DNV-GL) - GL Guidelines VI-7-2
- American Bureau of Shipping (ABS) - ABS Rules SVR Part 4, Design Assessment

IEC 60092-504 used for evaluation.

UL Approval

This product is recognized to applicable Canadian and US safety standards and requirements by UL.
Standard used for evaluation:

- UL 6200
- CSA C22.2 No. 0
- CSA C22.2 No. 14

Caution
To follow UL guidelines, replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

CSA Certification

This product was tested and has met the certification requirements for electrical, plumbing, and/or mechanical products.
Standards used for evaluation:

- CSA C22.2 No. 0
- CSA C22.2 No. 14

CE Compliance

This product has been evaluated and complies with the relevant essential requirements set forth by the EU legislation.

EC Directives:

- LVD 2014/35/EU
- EMC 2014/30/EU
- RoHS 2 2011/65/EU

Harmonized standards used for evaluation:

- EN 50178 – Electronic Equipment for use in Power Installations
- EN 61000-6-4 – Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments
- EN 61000-6-2 – Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments

EAC Mark (Eurasian Conformity)

- TP TC 004/2011
- TP TC 020/2011

Patent

Basler Electric. Digital Excitation Control Systems Utilizing Self-Tuning PID Gains and an Associated
Method of Use. US Patent 20090195224, filed January 31, 2008 and issued August 6, 2009.

Revision History

Table 67 provides a historical summary of the changes made to the DECS-150 hardware. Firmware changes are listed in Table 68 and software changes are listed in Table 69. The corresponding revisions made to this instruction manual are summarized in Table 70. Revisions are listed in chronological order.

Table 67. Hardware Revision History

Hardware Version and Date	Change
C, Aug-15	• Initial release
D, Sep-15	• Updated factory documentation
E, Dec-15	• Released BESTCOMS*Plus*® version 3.11.00
F, Jul-16	• Released Firmware version 1.01.00 and BESTCOMS*Plus* version 3.14.00
G, Jan-18	• Released Firmware version 2.02.00 and BESTCOMS*Plus* version 3.18.00

Table 68. Firmware Revision History

Firmware Version and Date	Change
1.00.00, Jun-15	• Initial release
1.01.00, Jul-16	• Added Chinese and Russian language support • Corrected communication timeout issue
1.01.01, Sep-17	• Updated datalog function
2.02.00, Jan-18	• Added external tracking, network load sharing, and Modbus • Added Underfrequency Limiter Reset Time setting

Table 69. BESTCOMS*Plus*® Software Revision History

Software Version and Date	Change
3.10.00, Jul-15	• Initial release
3.11.00, Dec-15	• Corrected the Stop Auto Tune button on the Auto Tuning screen
3.12.00, Mar-16	• Added Windows® 10 compatibility
3.14.00, Jul-16	• Added Chinese and Russian language support • Corrected ability to set invalid underfrequency limiter settings • Improved the Auto Tune function's calculation of PID gains • Corrected the display order of data log records
3.15.00, Aug-16	• Maintenance release (DGC-2020HD changes)
3.17.00, May-17	• Maintenance release (DGC-2020HD, BE1-11, and DECS-250 changes)
3.17.01, Jul-17	• Updated USB driver installer for improved Windows 10 compatibility
3.18.00, Jan-18	• Added settings for external tracking, network load sharing, and Modbus • Added Underfrequency Limiter Reset Time setting • Improved frequency response in real-time metering

Table 70. Instruction Manual Revision History

Manual Revision and Date	Change
—, Sep-15	• Initial release
A, Jul-16	• Added information on the backup battery for the real-time clock • Updated connections for Programmable Contact Inputs in the *Typical Connections* chapter • Added Ethernet *Setup* in the *Communications* chapter • Updated Generator and Bus Voltage Sensing Ranges in the *Specifications* chapter • Added Ingress *Protection Ratings* in the *Specifications* chapter • Updated Maritime Recognition specifications • Minor text edits throughout manual
B, Mar-17	• Added caution statement about nonvolatile memory • Added power dissipation and maximum elevation specifications • Added manual USB driver installation instructions • Clarified current-sensing requirements for PSS operation • Corrected description of online OEL operation
C, Jan-18	• Added information on external tracking, network load sharing, and Modbus • Added description of Underfrequency Limiter Reset Time setting

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