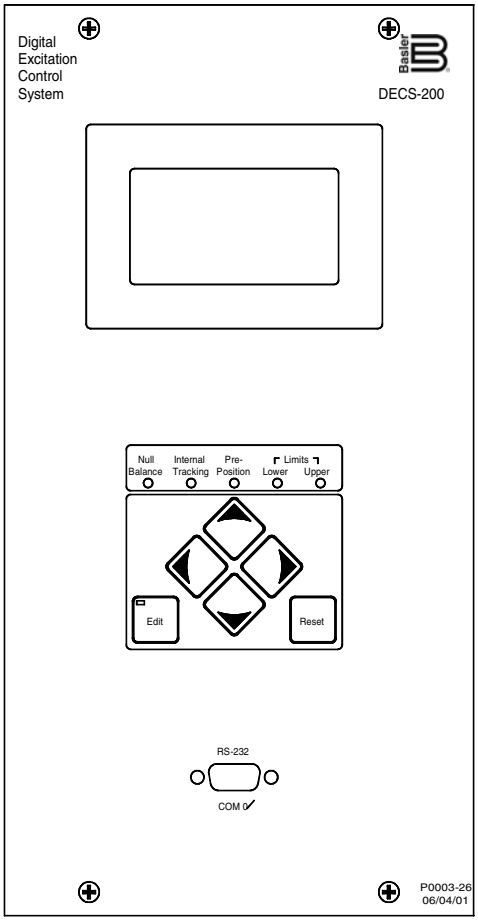
INSTRUCTION MANUAL

FOR

DIGITAL EXCITATION CONTROL SYSTEM

DECS-200



Basler Electric

Publication: 9360100990
Revision: F 08/06

INTRODUCTION

This instruction manual provides information about the operation and installation of the DECS-200 Digital Excitation Control System. To accomplish this, the following information is provided:

- General Information and Specifications
- Controls and Indicators
- Functional Description
- Installation
- Maintenance

WARNING!

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures in this manual.

NOTE

Be sure that the device is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the unit case. When the DECS-200 is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

First Printing: January 2002

Printed in USA

August 2006

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. Should further information be required, contact Basler Electric.

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REVISION HISTORY

The following information provides a historical summary of the changes made to the DECS-200 hardware, firmware, and software. The corresponding revisions made to this instruction manual (9360100990) are also summarized. Revisions are listed in chronological order.

Hardware Version and Date	Change
A, B, 11/01	• Pre-production manufacturing improvements and releases
C, 01/02	• Released hardware to production • Added CSA, UL, and CE logos to the part number labels
D, 03/02	• Revised engineering documents
E, 05/02	• Revised packing material
F, 05.02	• Implemented firmware version 1.01.02
G, 06/02	• Implemented BESTCOMS version 1.03.04 and updated production test
H, 08/02	• Improved circuit board component labeling
I	• Revision level not used
J, 10/02	• Revised terminal numbering overlays
K, 01/03	• Began using new front panel LCD (display)
L, 05/04	• Improved dielectric strength of “C” power supply (P/N 9360100100, 102 only)
L, M, 06/04	• Released firmware version 1.02.00. (9360100100, 102 advanced to revision M, 9360100101, 103 advanced to revision L.)
M, N, 07/04	• Updated power supply circuit boards. (9360100100, 102 advanced to revision N, 9360100101, 103 advanced to revision M.)
N, P, 07/04	• Released firmware version 1.02.01 and BESTCOMS version 1.04.01. (9360100100, 102 advanced to revision P, 9360100101, 103 advanced to revision N. Revision level O not used.)
P, Q, 03/05	• Improved mounting of front panel communication connector. (9360100100, 102 advanced to revision Q, 9360100101, 103 advanced to revision P.)
Q, R, 06/05	• Released firmware version 1.02.03 (9360100100, 102 advanced to revision R, 9360100101, 103 advanced to revision Q.)
R, S, 07/05	• Updated packing material. (9360100100, 102 advanced to revision S, 9360100101, 103 advanced to revision R.)

Firmware Version and Date	Change
1.01.01, 09/01	• Initial release
1.01.02, 05/02	• Resolved field overcurrent indication problem when field overvoltage alarm was triggered • Improved var to AVR mode (online) tracking • Resolved nuisance EDM indication on secondary DECS in dual DECS applications • Resolved field overvoltage and field overcurrent alarm indication of secondary DECS during startup in dual DECS applications
1.01.03, 11/02	• Added the EDM pole ratio calculator. Removed the Number of Poles parameter
1.02.00, 06/04	• Added takeover-style OEL • Added option of specifying on-line/off-line OEL activation via the 52J/K and 52L/M contact inputs • Added stator current limiting and loss of field protection • Added automatic alarm reset when generator frequency decreases below 10 Hz • Improved crosscurrent compensation
1.02.02, 04/05	• Improved Auxiliary input measurement accuracy
1.02.03, 06/05	• Modified firmware for compatibility with new LCD

Software Version and Date	Change
1.03.00, 09/01	• Initial Release
1.03.03, 05/02	• Updated BESTCOMS to add oscillography trigger to step response
1.03.04, 06/02	• Improved overall functionality. Allowed V/Hz Slope Setting adjustments to be made in increments of 0.01 instead of 0.1. The default value of the Analysis screen was changed from 10% steps to 2% steps.
1.03.05, 11/02	• Added the EDM pole ratio calculator. Removed the Number of Poles parameter.
1.04.00, 06/04	• Added takeover-style OEL, SCL, and loss of field settings to interface.

Manual Revision and Date	Change
—, 01/02	• Initial release
A, 01/02	• Changed introduction section to reflect the January first printing date. Repaginated the introduction so that the table of contents begins on an odd page. Edited the table of contents entries for sections five and seven to reflect the appropriate names.
B, 10/02	• Updated Figure 4-3 to correct error in terminal numbers. Updated terminal assignments in Section 1 to correct the error reflected from old Figure 4-3. Added Section 8, *Troubleshooting*. Corrected various minor errors.
C, 11/02	• Changed *Exciter Diode Monitor (EDM) Protection* in Section 1 to reflect the pole ratio and increment. Removed Gen Poles and added Pole Ratio to Figure 2-2. Made changes to Figures 2-6 and 2-8. Deleted reference to Generator Poles and Exciter Poles in Sec. 3, Exciter *Diode Monitor (EDM) Function* but added Pole Ratio. Updated the list of internal variable on page 3-14.Revised the *Installation* portion in Sec. 5 for using a CD-ROM disc. Added the Pole Ratio Calculator in Sec 5 as well as updated the screen shots. Updated screen shots in Figures 6-1, 6-3, 6-7 and 6-14. Changed increment levels of register 47747-48, Table 7-17. Updated Table 7-25.
D, 06/04	• *Section 1*: Updated output contact ratings. • *Section 2*: Modified tables and menu branch drawings to show added settings. • *Section 3*: Added functional description of takeover OEL and SCL. Removed reference to A-phase and C-phase as acceptable sensing current source for crosscurrent compensation applications. • *Section 4*: Added Crosscurrent Sensing sub-section with table listing crosscurrent sensing terminals. • *Section 5*: Revised or added all applicable BESTCOMS screens and setting descriptions to accommodate new settings/features. • *Section 6*: Added/changed BESTCOMS screens and DECS-200 settings to accommodate changed BESTCOMS screens and new DECS-200 settings. • *Section 7*: Added/revised Modbus register tables to accommodate new DECS-200 settings.
E, 12/05	• Removed expired patent information from Section 1. • Added missing setting descriptions to Section 5 • In Section 4, added caution box regarding the length of screws used to attach escutcheon plate to DECS-200 • Made various minor corrections/changes throughout manual
F, 08/06	• Added illustrations showing left-side terminals and typical connections to Section 4, *Installation*. (These figures were omitted in revision E of the manual.) • Corrected minor errors in Section 2, *Human-Machine Interface, Front Panel Operation*.

CONTENTS

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SECTION 1 • GENERAL INFORMATION

TABLE OF CONTENTS

Figures

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SECTION 1 • GENERAL INFORMATION

INTRODUCTION

The Basler Digital Excitation Control System (DECS-200) is a microprocessor-based control device intended for generator power management. Programmability of system parameters and regulation settings enables the DECS-200 to be used in a wide range of applications and provides greater flexibility in excitation system optimization. The DECS-200 can accommodate generator exciter field requirements up to 15 Adc continuously in 32, 63 or 125 Vdc applications with one model.

FEATURES

DECS-200 units have the following features and capabilities.

Functions

- Four control modes
  - Automatic voltage regulation (AVR)
  - Manual or field current regulation (FCR)
  - Power factor (PF)
  - Reactive power (var)
- Soft start buildup with an adjustable ramp in AVR and FCR control modes
- One adjustment range or pre-position setpoint for each control mode
- Overexcitation limiting (OEL) and underexcitation limiting (UEL) in AVR, var and PF control modes
- Twenty stability selections
- Underfrequency compensation or volts per hertz ratio limiter
- Autotracking between operating modes and between DECS-200 units (optional)
- Automatic transfer to a backup DECS-200 unit (optional)
- Eight generator protection features
  - Field overvoltage
  - Field overcurrent
  - Generator overvoltage
  - Generator undervoltage
  - Watchdog timer
  - Loss of sensing
  - Exciter diode monitor (EDM)
  - Loss of field
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Data logging and event recording

Inputs and Outputs

- Single-phase rms bus voltage sensing
- Single-phase or three-phase rms generator voltage sensing
- Single-phase generator current sensing (1 or 5 amperes, nominal)
- Analog inputs (±10 Vdc and 4 to 20 mAdc) provide proportional, remote control of the setpoint
- Eleven PLC-compatible contact sensing inputs for system interface
- Separate ac and dc power inputs accommodate redundant operating power sources
- Pulse-width modulated output power stage rated at a maximum of 15 amperes, continuous
- Five output relays for system control or annunciation
  - Three programmable output relays
  - Two fixed-function output relays

HMI Interface

- Front panel HMI includes pushbutton controls, LED indicators and a backlit, liquid crystal display (LCD)
- BESTCOMS Windows® based software provides easy, fast and accurate setup and control

- Three communication ports
  - o Front RS-232 port for communication with a PC using BESTCOMS software
  - o Right-side panel RS-232 port for dedicated communication with a redundant DECS-200
  - o RS-485 communication port for communication with a remote terminal
- Modbus™ protocol for the RS-485 port allows communication at distances of up to 1,200 meters (3,937 feet)

APPLICATION

Introduction

In the typical application shown in Figure 1-1, the DECS-200 controls the exciter field of a synchronous generator. Front panel controls, indicators and serial communication ports using PC software make the system easy to operate locally or from remote locations. DECS-200 operation, settings and safety setup procedures in this manual should be studied before implementing your application. For detailed application assistance, contact Basler Electric or your local sales representative.

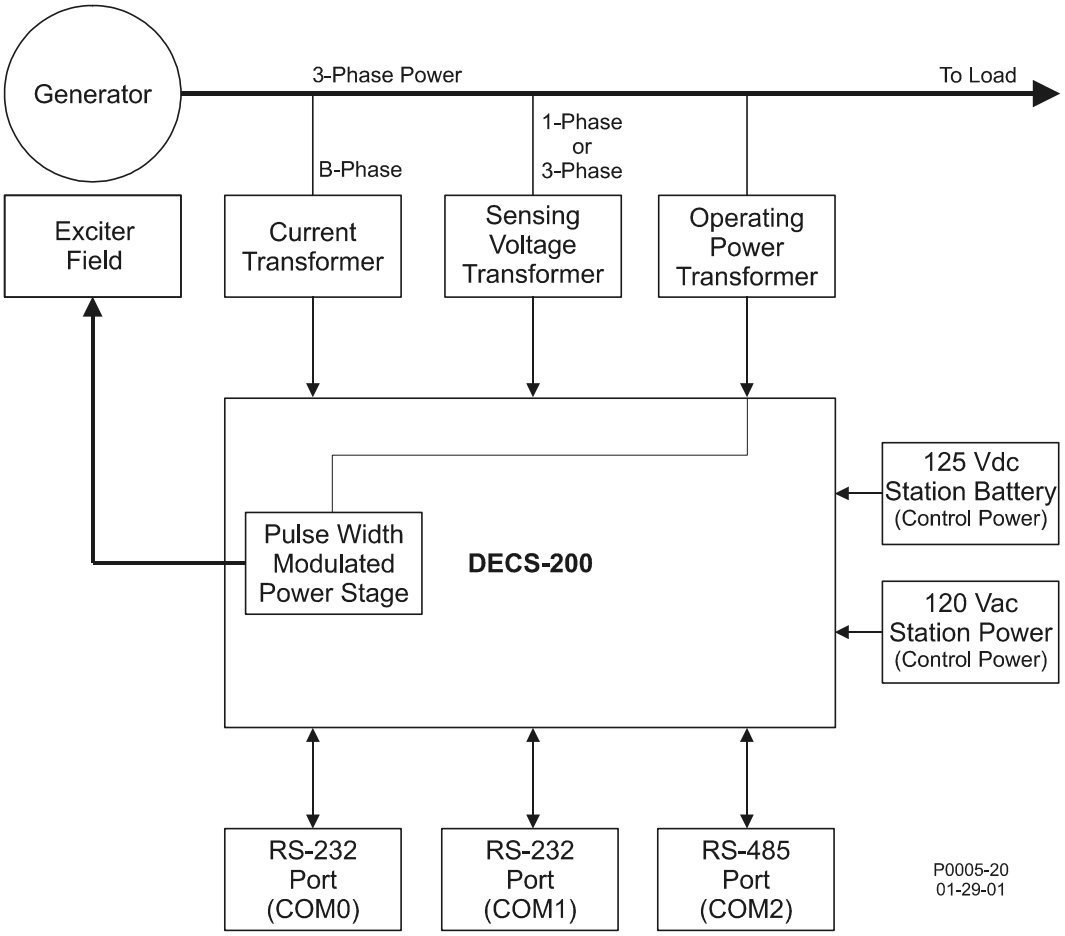

Figure 1-1. Block Diagram of Typical DECS-200 Application

Operating Power

Operating power for the pulse-width modulated (PWM) excitation output is typically obtained from the generator output through a power transformer. Alternately, operating power can be supplied from a permanent magnet generator (PMG).

Control Power

If power supply option C (120/125 Vac/Vdc) is selected, a redundant power source can be used with the DECS-200. (See Figure 1-1.) In this configuration, if one of the two sources fails, the other source will continue to supply DECS-200 operating power. If power supply option L (24/48 Vdc) is selected, no redundant power source is available.

Sensing

The DECS-200 senses generator voltage and current through voltage and current transformers. Field voltage and field current values are sensed internally.

Excitation Limiters

Integrated overexcitation and underexcitation limiters (OEL and UEL) are available for both on-line and off-line protection.

External Tracking and Transfer Between DECS-200 Units (Optional)

For critical applications, a second DECS-200 can provide backup excitation control. The DECS-200 allows for excitation system redundancy by providing external tracking and transfer provisions between DECS-200 units. The secondary DECS-200 operating modes can be programmed to track the primary DECS-200 operating mode. Proper, redundant excitation system design allows for removal of the failed system. Periodic testing of the backup system must be performed to ensure that it is operational and can be put into service without warning.

Internal Tracking Between DECS-200 Operating Modes

In applications using a single DECS-200, the DECS-200 can be programmed so that the inactive operating modes track the active operating mode. Operating modes include AVR, FCR, PF and var. If the excitation system is normally operating on-line in Internal mode and a loss of sensing occurs, the DECS-200 could be transferred to manual (FCR) mode where the loss of sensing has no impact on the exciter's ability to maintain proper excitation levels. While performing routine testing of the DECS-200 in backup mode, the internal tracking feature allows a transfer to an inactive mode that will result in no disturbance to the system.

Communication With a PC

Communication between the DECS-200 (front panel RS-232 port) and a PC is possible through BESTCOMS software. BESTCOMS enables fast and easy programming of setpoints and ranges and allows for step changes to facilitate proper stability settings. BESTCOMS also provides easy start and stop control and operator adjustment of the excitation system with real-time metering. The software catalog number is BESTCOMS-DECS200. BESTCOMS is provided with the DECS-200 as part of the software/manual package.

MODEL AND STYLE NUMBER DESCRIPTION

DECS-200 operating characteristics are defined by letters and numbers that make up the style number. The model number and style number describe the options included in the DECS-200 and appear on a label attached to the side of the case. Upon receipt of a DECS-200 unit, be sure to check the style number against the requisition and packing list to ensure that they agree.

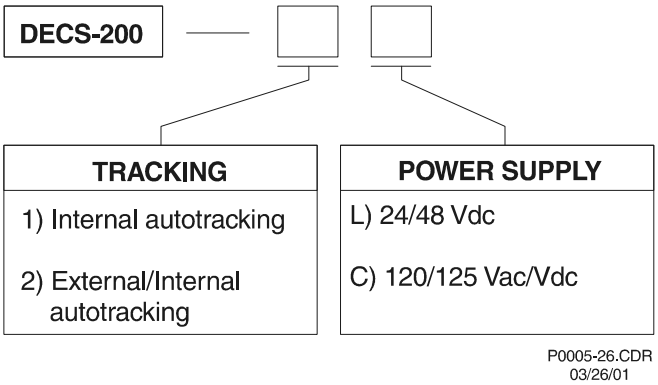

Figure 1-2. Style Number Identification Chart

Sample Style Number

The style number identification chart (Figure 1-2) defines the electrical characteristics and operational features included in the DECS-200. For example, if the style number were DECS-200-1L, the device would have the following characteristics and features.

DECS-200 -- Digital Excitation Control System
1 --- Internal autotracking/transfer
L --- 24/48 Vdc control power supply

SPECIFICATIONS

DECS-200 electrical and physical characteristics are listed in the following paragraphs.

Control Power

Input Voltage

DC Input:	16 to 60 Vdc (style XL) or 90 to 150 Vdc (style XC)
AC Input:	85 to 132 Vac, 50/60 Hz (style XC only) Note: Isolation transformer for ac input is required when dual control power sources are used.

Burden

DC Input:	30 W
AC Input:	50 VA

Terminals

DC Input:	B7 (+), B8 (–)
AC Input:	B9 (L), B10 (N) (style XC only)

Operating Power

To achieve the proper DECS-200 output voltage, the appropriate operating power input voltage must be provided.

32 Vdc PWM Output

Nominal:	60 Vac
Operating Range:	56 to 70 Vac, ±10%
Frequency Range:	50 to 500 Hz
Configuration:	1-phase or 3-phase
Burden:	780 VA

63 Vdc PWM Output

Nominal:	120 Vac
Operating Range:	100 to 139 Vac, ±10%
Frequency Range:	50 to 500 Hz
Configuration:	1-phase or 3-phase
Burden:	1,570 VA

125 Vdc PWM Output

Nominal:	240 Vac
Operating Range:	190 to 277 Vac, ±10%
Frequency Range:	50 to 500 Hz
Configuration:	1-phase or 3-phase
Burden:	3,070 VA

Voltage Buildup

From a minimum of 3 Vac

Terminals

C2 (A-phase), C3 (B-phase), C4 (C-phase)

Generator Voltage Sensing

Type:	1-phase/3-phase, 4 ranges
Burden:	<1 VA per phase
Terminals:	A1, A2, A3

50 Hertz Sensing

Range 1:	100 Vac (85 to 127 Vac)
Range 2:	200 Vac (170 to 254 Vac)
Range 3:	400 Vac (340 to 508 Vac)
Range 4:	500 Vac (425 to 625 Vac)

60 Hertz Sensing

Range 1:	120 Vac (94 to 153 Vac)
Range 2:	240 Vac (187 to 305 Vac)
Range 3:	400 Vac (374 to 600 Vac)
Range 4:	600 Vac (510 to 660 Vac)

Generator Current Sensing

Type:	Two ranges, two channels
Frequency:	50/60 Hz
Ranges:	1 A or 5 A nominal, continuous
Burden:	<1 VA per phase

Terminals

1 A Sensing:	B1, B3 (phase B, metering, var/PF, UEL) B4, B6 (phase B, crosscurrent compensation)
5 A Sensing:	B2, B3 (phase B, metering, var/PF, UEL) B5, B6 (phase B, crosscurrent compensation)

Bus Voltage Sensing

Type:	1-phase, 4 ranges,
Burden:	<1 VA
Sensing Ranges:	Identical to generator voltage sensing
Terminals:	A4, A5

Accessory Inputs

Current Input

Range:	4 to 20 mAdc
Terminals:	A6 (+), A7 (–)

Voltage Input

Range:	–10 to +10 Vdc
Terminals:	A9 (+), A10 (–)

Communication Ports

Interface

RS-232:	Full duplex
RS-485:	Half duplex

Connections

Com 0:	Front panel DB-9 connector
Com 1:	Right-side panel DB-9 connector
Com 2:	Left-side panel screw terminals (A40, A41, A42)

Parameters

Baud:	1200 to 19200
Data Bits:	8
Parity:	None
Stop Bits:	1 (Com 0, Com 1) or 2 (Com 2)

Contact Inputs

Type:	Dry contact, accept PLC open-collector outputs
Interrogation Voltage:	12 Vdc

Terminal Assignments

Start:	A21, A22
Stop:	A23, A24
Auto (AVR):	A25, A26
Manual (FCR):	A27, A28
Raise:	A29, A30
Lower:	A31, A32
Pre-Position:	A33, A34
Unit/Parallel (52L/M):	A35, A36
Var/PF (52J/K):	A37, A38
Secondary Enable:	A39, A40
Alarm Reset:	A41, A42

Contact Outputs

Make and Break Ratings

24 Vdc:	8.0 A
48 Vdc:	0.7 A
125 Vdc:	0.2 A
120/240 Vac:	10.0 A

Carry Ratings

24/48/125 Vdc:	8.0 A
120/240 Vac:	10.0 A

Terminal Assignments

Start/Stop (ON, OF):	A11, A12
Watchdog (WTCHD):	A13, A14
Relay 1 (RLY1):	A15, A16
Relay 2 (RLY2):	A17, A18
Relay 3 (RLY3):	A19, A20

Field Output

Continuous Output Rating

60 Vac Input:	32 Vdc, 15 Adc
120 Vac Input:	63 Vdc, 15 Adc
240 Vac Input:	125 Vdc, 15 Adc

10 Second Forcing Output Rating

60 Vac Input:	50 Vdc, 30 Adc
120 Vac Input:	100 Vdc, 30 Adc
240 Vac Input:	200 Vdc, 30 Adc

Minimum Field Resistance

32 Vdc Application:	2.13 Ω
63 Vdc Application:	4.2 Ω
125 Vdc Application:	8.3 Ω

Regulation

AVR Operating Mode

Accuracy:	±0.25% over load range at rated PF and constant generator frequency
Steady State Stability:	±0.1% at constant load and generator frequency
Temperature Drift:	±0.5% for a 0 to 50°C change
V/Hz Characteristic:	Slope from 0 to 3 PU is adjust-able in 0.1 PU increments. Voltage regulation error is within ±2.0% of the nominal voltage.
Response Time:	<1 cycle

Accuracy

FCR Mode:	±1.0% of the nominal value for 10% of the bridge input voltage change or 20% of the field resistance change. Otherwise, ±5.0%.
Var Mode:	±2.0% of the nominal VA rating at the rated frequency
Power Factor Mode:	±0.02 PF of the PF setpoint for the real power between 10 and 100% at the rated frequency.
Internal Tracking:	0.5%

Parallel Compensation

Modes:	Reactive Droop and Reactive Differential (cross-current) *
Burden: *	Can exceed 1 VA if external resistors are added to the CT circuit for crosscurrent compensation.

Adjustment Range

Reactive Droop:	0 to 30%
Reactive Differential:	–30 to 0%

Field Overvoltage Protection

Pickup

Range:	1.0 to 325 Vdc
Increment:	1.0 Vdc

Time Delay

Range:	0.2 to 30 s
Increment:	0.1 s

Field Overcurrent Protection

Pickup

Range:	0 to 16 Adc
Increment:	0.1 Adc

Time Delay

Characteristic:	Inverse per ANSI C50.13

Exciter Diode Monitor (EDM) Protection

Pole Ratio

Range:	1 to 10 (0 if unknown)
Increment:	0.01

Ripple Threshold

Open and Shorted Diode:	0 to 100%

Time Delay

Open Diode Protection:	10 to 60 s
Shorted Diode Protection:	5 to 30 s

Open and Shorted Diode Inhibit Levels

Range:	0 to 100% or <1 Adc field current <45 Hz and >70 Hz generator frequency

Generator Undervoltage Protection

Pickup

Range:	0 to 30 kVac
Increment:	1.0 Vac

Time Delay

Range:	0.5 to 60 s
Increment:	0.1 s

Generator Overvoltage Protection

Pickup

Range:	0 to 30 kVac
Increment:	1.0 Vac

Time Delay

Range:	0.1 to 60 s
Increment:	0.1 s

Loss of Sensing Protection

Unbalance Generator Volts:	0 to 100%
Balanced Generator Volts:	0 to 100%

Time Delay

Range:	0 to 30 s
Increment:	0.1 s

Loss of Field Protection

Pickup

Range:	0 to 3,000,000 kvar
Increment:	1 kvar

Time Delay

Range:	0.0 to 9.9 s
Increment:	0.1 s

Soft Start Function

Setting Range

Soft Start Bias Level:	0 to 90% in 1% increments
Soft Start Bias Time Delay:	1 to 7,200 seconds in 1 second increments

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

Response time:	<3 cycles

High Current Level

Pickup Range:	0 to 30.0 Adc
Pickup Increment:	0.1 Adc
Time Range:	0 to 10 s
Time Increment:	1 s

Medium Current Level

Pickup Range:	0 to 20.0 Adc
Pickup Increment:	0.1 Adc
Time Range:	0 to 120 s
Time Increment:	1 s

Low Current Level

Pickup Range:	0 to 15 Adc
Pickup Increment:	0.1 Adc
Time Range:	continuous

Off-Line Overexcitation Limiting

High Current Level

Pickup Range:	0 to 30.0 Adc
Pickup Increment:	0.1 Adc
Time Range:	0 to 10 s
Time Increment:	1 s

Low Current Level

Pickup Range:	0 to 30.0 Adc
Pickup Increment:	0.1 Adc
Time Range:	0 to 10 s
Time Increment:	1 s

Underexcitation Limiting

Adjustment Range:	0 to 100% of the generator rated apparent power (kvar) at 0 kW real power. Or customizable to generator curve capability.

Manual Excitation Control

Range:	0 to 15.0 Adc
Increment:	0.1 Adc

Metering

Generator Voltage

Range:	0 to 160% of nominal
Accuracy:	<1% (50/60 Hz)

Generator Current

Range:	0 to 200% of nominal
Accuracy:	<1% (50/60 Hz)

Generator Frequency

Range:	10 to 90 Hz
Accuracy:	±0.1 Hz

Bus Voltage

Range:	0 to 160% of nominal
Accuracy:	<1% (50/60 Hz)

Bus Frequency

Range:	10 to 90 Hz
Accuracy:	±0.1 Hz

Phase Angle

Range:	–90 to +90
Accuracy:	±1.0

Field Voltage

Range:	0 to 375 Vdc
Accuracy:	±1.25 V or ±1.0% (whichever is greater)

Field Current

Range:	0 to 31 Adc
Accuracy:	±0.15 A or ±1.0% (whichever is greater)

Power Factor

Range:	–0.5 to +0.5 PF
Accuracy:	<0.02 PF

Real Power and Reactive Power

Range:	0 to 200% of nominal
Accuracy:	<1.0% of nominal

Sequence of Event Recording (SER)

127 event report, stored in volatile memory (retrievable via BESTCOMS) SER triggered by: Input/Output status changes, system operating status changes or alarm annunciations

Data Logging (Oscillograpy)

Stores 8 records in volatile memory. Up to 6 variables can be logged in a record. Sampling rate is 600 data points per log, up to 599 pre-trigger, 4 ms to 10 second intervals, (2.4 sec to 6,000 sec. total log duration).

Temperature Range

Operating:	–40 to +60°C (–40 to +140°F)
Storage:	–40 to +85°C (–40 to +185°F)
CD-ROM:	0 to +50°C (32 to +122°F)

Type Tests

Shock

15 G in 3 perpendicular planes

Vibration

5 to 26 Hz:	1.2 G
27 to 52 Hz:	0.914 mm (0.036") double amplitude
53 to 500 Hz:	5 G

Surge Withstand Capability and Fast Transient

Tested per IEEE C37.90.1-1989

Dielectric Strength

Tested per IEEE 421.3

Salt Fog

Tested per MIL-STD-810E, Method 509.3

Physical

Weight:	6.35 kg (14 lb)
Dimensions:	Refer to Section 4, *Installation*

UL Recognition

UL recognized per standard 508, UL file number E90735.

CSA Certification

Certified per CSA Standard CAN/CSA-C22.2 Number 14, CSA File Number LR23131.

CE Compliance

The DECS-200 meets the criteria set forth by the following standards:

EN 50081-2

Electromagnetic compatibility (EMC) emissions standard: EN 55011, Level A.

EN 50082-2

Electromagnetic Compatibility (EMC) Immunity

Electrostatic Discharge (ESD)

EN 61000-4-2, Level B/IEC 1000-4-2

Radiated Susceptibility

EN 61000-4-3, Level A/IEC 1000-4-3

Electrical Fast Transient

EN 61000-4-4, Level B/IEC 1000-4-4

Radio Frequency Conducted

EN 61000-4-6, Level A/IEC 1000-4-6

Power Frequency Magnetics

EN 61000-4-8, Level A/IEC 1000-4-8

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SECTION 2 • HUMAN-MACHINE INTERFACE

TABLE OF CONTENTS

Figures

Tables

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SECTION 2 • HUMAN-MACHINE INTERFACE

INTRODUCTION

This section describes the DECS-200 human-machine interface (HMI), illustrates how to navigate through the menu screens, and explains how to use the front panel interface to view and change settings.

FRONT PANEL CONTROLS AND INDICATORS

The front panel HMI consists of a backlit liquid crystal display (LCD), six pushbutton switches, six LED indicators, and an RS-232 communication connector. The LCD displays DECS-200 settings and excitation system information through the use of a structured menu. Menu screens are viewed and settings are changed by operating the front panel pushbuttons. Active conditions are annunciated by the front panel LEDs. The RS-232 connector (Com 0) enables communication between the DECS-200 and a PC operating BESTCOMS software.

Front panel HMI components are shown in Figure 2-1 and described in Table 2-1.

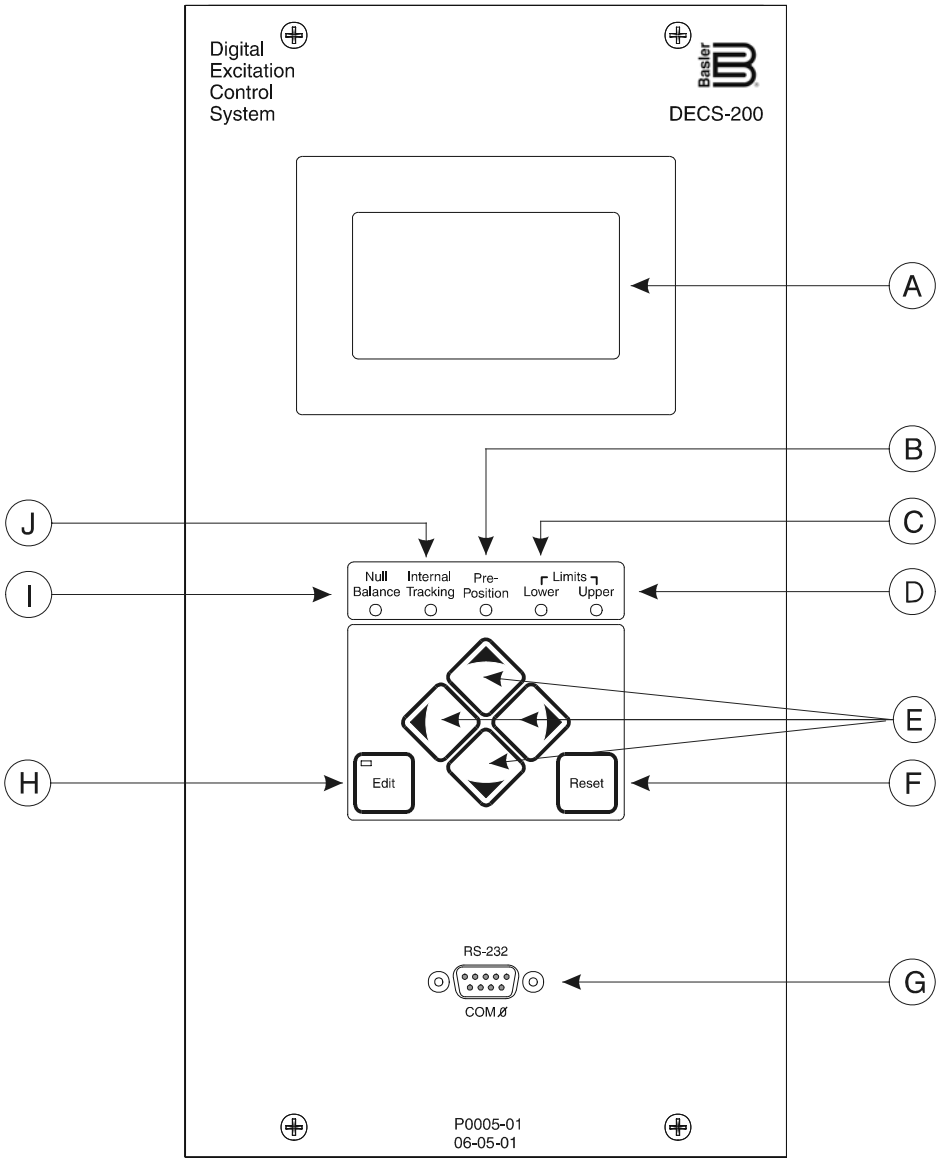

Figure 2-1. Front Panel Controls and Indicators

Table 2-1. DECS-200 HMI Component Descriptions

Locator	description
A	*LCD.* Backlit liquid crystal display is 64 by 128 pixels in size and serves as the primary source of information from the DECS-200. Displays operations, setpoints, loop gains, metering, protection functions, system parameters, and general settings.
B	*Pre-Position LED.* Lights at the predefined, pre-position setpoint of the active mode.
C	*Lower Limit LED.* Lights at the minimum setpoint value of the active mode.
D	*Upper Limit LED.* Lights at the maximum setpoint value of the active mode.
E	*Scrolling Pushbuttons.* Pushbutton switches are used to scroll up, down, left, and right through the menu structure. When operating in Edit mode, the Left and Right pushbuttons select the variable to change and the Up and Down pushbuttons change the variable value.
F	*Reset Pushbutton.* Cancels editing sessions, resets alarm annunciations and latched alarm relays, and can be used for quick access to the metering screen.
G	*Serial Port (Com 0).* This port is dedicated to RS-232 communication with a computer terminal or PC running a terminal emulation program such as BESTCOMS. See Section 1 and Section 3 for more information about the DECS-200 serial ports.
H	*Edit Pushbutton.* Enables settings changes. When the Edit pushbutton is first pushed, an LED within the pushbutton lights to indicate that Edit mode is active. When settings changes are complete (using the scrolling pushbuttons) and the Edit pushbutton is pressed again, the LED turns off to indicate that the changes are saved.
I	*Null Balance LED.* Lights when the inactive modes (AVR, FCR, var, or PF) match the active mode.
J	*Internal Tracking LED.* Lights when any inactive mode (AVR, FCR, var, or PF) is tracking the active mode to accomplish a bumpless transfer when changing active modes.

Menu Navigation

The front panel scrolling pushbuttons are used to move through the menu structure displayed by the LCD. Pressing the Reset pushbutton (when an edit session is not in progress) gives quick access to the Metering screen. Metering values cannot be viewed during an edit session.

Navigation Aids

On-screen navigation assists the user in moving from screen to screen. These navigation aids are contained in the top and bottom lines of the LCD.

The top line contains a menu path that is similar to the DOS prompt on a personal computer. When the menu path exceeds the width of the LCD, the first part of the menu path is replaced with two dots (..) so that the last part will be seen. Regardless of the menu path length, the current screen name is always shown.

The bottom line displays the menu screens that can be accessed from the current screen with the Left, Down and Right pushbuttons on the front panel. The Left pushbutton listing consists of a “<”, followed by an abbreviated menu name. The Down pushbutton listing consists of the letter v, followed by an abbreviated menu name. The right-pushbutton listing consists of a “>”, followed by an abbreviated menu name.

If the Left and Right pushbutton listings are blank, then the current screen is the only one on this level. If the Down pushbutton listing is blank, then there are no screens below the current screen.

Edit Sessions

Password access is required before entering an edit session. To initiate an edit session, press the Edit pushbutton. The Edit pushbutton lights to indicate that the front panel is in edit mode. If the appropriate access level is not active, then a prompt to enter a password appears. (Paragraphs titled *Password Defaults* and *Password Protection* in this section have more information about using passwords.)

Editing Settings

Once the password is entered and security access is obtained, the first editable field of the current screen is underlined. The setting in this field can be modified by pressing the Up pushbutton to increase the setting or the Down pushbutton to decrease the setting. To edit another setting on the current screen, use the Left pushbutton to advance the underline upward or the Right pushbutton to advance the underline downward to the other editable fields.

NOTE

On most screen, setting changes are used immediately by the DECS-200. However, these changes are not saved in nonvolatile memory until the Edit pushbutton is pressed to terminate the edit session.

After all desired editing on the current screen is complete, the changes can be saved or the values that were in use prior to the edit session can be restored. Changes are saved by pressing the Edit pushbutton which terminates the edit session and saves the changes in nonvolatile memory. Changes are aborted by pressing the Reset pushbutton which terminates the edit session without saving the changes. The previous values are then restored by reading them from nonvolatile memory. In both cases, the Edit pushbutton LED turns off to indicate that the edit session is terminated.

Security (password) access is not immediately lost when an edit session is terminated. Security access terminates after 10 minutes of pushbutton inactivity at the front panel. (Security access timeout is different from edit session timeout;. see *Edit Session Timeout*.) If this period of inactivity occurs during an edit session, any changes made are saved in nonvolatile memory and will be used or continue to be used by the DECS-200. At this time, both edit access and security access are terminated.

CAUTION

Pressing the Reset pushbutton after changing the active mode setpoint will cause a step change in the operating setpoint that may have the potential to adversely affect the system.

In order to modify settings on another screen with the same access level, the user merely navigates to that screen and presses the Edit pushbutton to start a new edit session on the new screen.

Edit Session Timeout

If the front panel is left in the Edit mode after any setting changes are made, the changes will be saved and the edit session terminated after 10 minutes of pushbutton inactivity.

Changing Settings

All settings that are viewable at the front panel are password protected and require security access to change.

Global access grants the right to change any viewable setting at the front panel.

Setpoint access grants the right to change only a few settings. These include basic operating settings like Start/Stop, AVR/FCR, PF/var, control setpoints and pre-positions.

See Table 2-2 for a complete setting list that shows the range, increments and default values. In Table 2-2, note that the Ref. column refers to numbers associated with the menu screens shown later in this section. These numbers should help you find the specific screen that contains the setpoint or parameter that you want to change. For a list of settings that are accessible with the Setpoint access level, see Table 2-3. All editable settings on a single menu screen are at the same access level.

Table 2-2. Front Panel Setting Parameters

Ref.	Parameter	Minimum	Maximum	Increment	Default
1.1	Start/Stop Selection	Stop, Start		N/A	Stop
	AVR/FCR Selection	AVR, FCR		N/A	AVR
	PF/Var Control Enable	Off, PF Control, Var Control		N/A	Off
	Load Comp. Selection	Off, Droop		N/A	Droop
	Pre-Position Enable	Off, On		N/A	On
1.2	Voltage Matching	Off, On		N/A	Off
	Internal Tracking Enable	Off, On		N/A	Off
	External Tracking Enable	Off, On		N/A	Off
	Underfrequency	UF, V/Hz		N/A	UF
2.1	AVR Setpoint	AVR min. setpoint	AVR max. setpoint	0.1 V	120 V
	FCR Setpoint	FCR min. setpoint	FCR max setpoint	0.01 A	0.1 A
	Droop Compensation	–30% nom.	30% nom.	0.1% nom.	5% nom.
	Var Setpoint	var min. setpoint	var max. setpoint	1 var	0 var
	PF Setpoint	PF min. setpoint	PF max. setpoint	0.005	1.00
2.1.1	Fine Voltage Band	0% (nom.)	30% (nom.)	0.01% (nom.)	20% (nom.)
	AVR Min. Setpoint	70% (nom.)	100% (nom.)	0.1% (nom.)	70% (nom.)
	AVR Max. Setpoint	100% (nom.)	110% (nom.)	0.1% (nom.)	110% (nom.)
	FCR Min. Setpoint	0.0% (nom.)	100% (nom.)	0.1% (nom.)	0% (nom.)
	FCR Max. Setpoint	0.0% (nom.)	120% (nom.)	0.1% (nom.)	120% (nom.)
2.1.2	Var Min. Setpoint	–100% (of rated VA)	100% (of rated VA)	1% (of rated VA)	0%
	Var Max. Setpoint	–100% (of rated VA)	100% (of rated VA)	1% (of rated VA)	0%
	Max Lag PF	0.5	1.0	0.005	0.8
	Max Lead PF	1.0	–0.5	0.005	–0.8
	Voltage Matching Band	0% (nom.)	20% (nom.)	0.01% (nom.)	10% (nom.)
	Volt. Matching Ref.	90.0%	120.0%	0.1%	100%
2.2	AVR Prep. Setpoint	AVR min. setpoint	AVR max. setpoint	0.1 VA	120.0 V
	FCR Prep. Setpoint	FCR min. setpoint	FCR max. setpoint	0.01 A	0.1 A
	Var Prep. Setpoint	var min. setpoint	var max. setpoint	1 var	0 var
	PF Prep. Setpoint	PF min. setpoint	PF max. setpoint	0.005	1.000
3.1	Gain Table Index	1	21	1	21
	AVR/FCR Kp	0.0	1,000.0	0.1	30.0
	AVR/FCR Ki	0.0	1,000.0	0.1	150.0
	AVR/FCR Kd	0.0	1,000.0	0.1	2.0
	AVR/FCR Td	0.0	1.0	0.01	0.08
3.2	AVR Kg	0	1,000.0	0.1	1.0
	FCR Kg	0	1,000.0	0.1	25.0
3.3	OEL Ki	0.0	1,000.0	0.1	10.0
	OEL Kg	0.0	1,000.0	0.1	1.0
	UEL Ki	0.0	1,000.0	0.1	10.0
	UEL Kg	0.0	1,000.0	0.1	2.0
	SCL Ki	0.0	1,000.0	0.1	10.0
	SCL Kg	0.0	1,000.0	0.1	1.0
3.4	PF Ki	0.0	1,000.0	0.1	120.0
	PF Kg	0.0	1,000.0	0.1	1.0
	Var Ki	0.0	1,000.0	0.01	120.0
	Var Kg	0.0	1,000.0	0.01	1.00
	Voltage Matching Kg	0.0	1,000.0	0.1	1.0

Ref.	Parameter	Minimum	Maximum	Increment	Default
4.1	1st Metering Field	Va-b, Vb-c, Vc-a, V Avg, Line I, VA, watts, var, PF Gen Hz, Bus Hz, Bus V, Fld V, Fld I, V Aux, EDM OC, EDM SC			V Avg
	2nd Metering Field				Vc-a
	3rd Metering Field				Fld I
5.1	Corner Frequency	15.0 Hz	90.0 Hz	0.1 Hz	57.0 Hz
	Underfrequency Slope	0.00 x V/Hz	3.00 x V/Hz	0.01 V/Hz	1.00 x V/Hz
5.2	Field OV Enable	Off, On		N/A	Off
	Field OC Enable	Of, On		N/A	Off
	Stator OV Enable	Off, On		N/A	Off
	Stator UV Enable	Off, On		N/A	Off
	Loss of Sensing Enable	Off, On		N/A	Off
	Loss of Sensing Xfr to FCR Enable	Off, On		N/A	Off
5.3	Exciter Open Diode Enable	Off, On		N/A	Off
	Exciter Shorted Diode Enable	Off, On		N/A	Off
	Loss of Field Enable	Off, On		N/A	Off
5.4	Field OV Threshold	1 V	325 V	1 V	20 V
	Field OC Base Value	0.1 A	16 A	0.1 A	0.1 A
	Stator OV Threshold	0 V	30,000 V	1 V	150 V
	Stator UV Threshold	0 V	30,000 V	1 V	90 V
	EDM OD Ripple	0%	100%	0.1%	5.0%
	EDM SD Ripple	0%	100%	0.1%	5.0%
5.5	EDM Inhibit Level	0%	100%	0.1%	10%
	LOS Balanced Voltage	0%	100%	0.1%	50%
	LOS Unbalanced Voltage	0%	100%	0.1%	20%
	Loss of Field Level	0	3,000,000 kvar	1 kvar	50.00 kvar
5.6	Field OV Delay	0.2 s	30.0 s	0.1 s	5.0 s
	Exc OC Time Dial Mult.	0.1	20.0	0.1	1.0
	Stator OV Delay	0.1 s	60.0 s	0.1 s	5.0 s
	Stator UV Delay	0.5 s	60.0 s	0.1 s	5.0 s
	Loss of Voltage Sensing	0.0 s	30.0 s	0.1 s	2.0 s
	Open Exciter Diode Delay	10.0 s	60.0 s	0.1 s	10.0 s
5.7	Shorted Exciter Diode Delay	5.0 s	30.0 s	0.1 s	5.0 s
	Loss of Field TD	0.0	9.9	0.1	9.9 s
6.1	OEL Style	Summing Point/Takeover		N/A	Summing Pnt
	OEL Option	Option 1/Option 2/Option 3		N/A	Option 1
6.2	On-Line OEL Inst. Limit	0.0A	30.0 A	0.1 A	3.0 A
	On-Line OEL Inst Time	0 s	10 s	1 s	10 s
	On-Line OEL Med. Limit	0.0 A	20.0 A	0.1 A	2.0 A
	On-Line OEL Med. Time	0 s	120 s	1 s	120 s
	On-Line OEL Cont. Limit	0.0 A	15.0 A	0.1 A	1.0 A
6.3	Off-Line OEL Hi Limit	0.0 A	30 A	0.1 A	3.0 A
	Off-Line OEL Hi Time	0 s	10 s	1 s	10 s
	Off-Line OEL Low Limit	0.0 A	15 A	0.1 A	1.0 A
6.4	Off-Line Takeover OEL Max. Current	0.0 A	15.0 A	0.1 A	0.0 A
	Off-Line Takeover OEL High Current	0.0 A	30.0 A	0.1 A	0.0 A

Ref.	Parameter	Minimum	Maximum	Increment	Default
	Off-Line Takeover OEL Time Delay	0.1 s	20.0 s	0.1 s	0.1 s
6.5	On-Line Takeover OEL Max Current	0.0 A	30.0 A	0.1 A	0.0 A
	On-Line Takeover OEL Min Current	0.0 A	15.0 A	0.1 A	0.0 A
	On-Line Takeover TD	0.1 s	20.0 s	0.1 s	0.1 s
6.6	UEL Curve, Pnt 1 Watts	0 kW	49 kW	1 kW	0 kW
	UEL Curve, Pnt 2 Watts	0 kW	49 kW	1 kW	0 kW
	UEL Curve, Pnt 3 Watts	0 kW	49 kW	1 kW	0 kW
	UEL Curve, Pnt 4 Watts	0 kW	49 kW	1 kW	0 kW
	UEL Curve, Pnt 5 Watts	0 kW	49 kW	1 kW	0 kW
6.7	UEL Curve, Pnt 1 Vars	0 kvar	49 kvar	1 kvar	0 kvar
	UEL Curve, Pnt 2 Vars	0 kvar	49 kvar	1 kvar	0 kvar
	UEL Curve, Pnt 3 Vars	0 kvar	49 kvar	1 kvar	0 kvar
	UEL Curve, Pnt 4 Vars	0 kvar	49 kvar	1 kvar	0 kvar
	UEL Curve, Pnt 5 Vars	0 kvar	49 kvar	1 kvar	0 kvar
6.8	SCL High Limit	0.0 A	66,000.0 A	1.0 A	0.0 A
	SCL High Limit Time	0.0 s	60.0 s	1.0 s	0 s
	SCL Low Limit	0.0 A	66,000.0 A	1.0 A	0 A
7.1.1	Gen. Rated Output V	85 V	30,000 V	1 V	120 V
	Gen. Rated Output I	10.0 A	60,000 A	0.1 A	200.0 A
	Gen. Rated Frequency	50 Hz	60 Hz	10 Hz	60 Hz
7.2.1	Rated Field Voltage	1.0 V	180.0 V	0.1 V	32.0 V
	Rated Field Current	0.1 A	15.0 A	0.1 A	5.0 A
	Pole Ratio	0	10	0.01	0
7.3.1	Gen. Sensing PT Pri.	1 V	30,000 V	1 V	120 V
	Gen. Sensing PT Sec.	1 V	600 V	1 V	120 V
	Bus Sensing PT Pri.	1 V	500,000 V	1 V	120 V
	Bus Sensing PT Sec.	1 V	600 V	1 V	120 V
	Gen. CT Pri.	1 A	60,000 A	1 A	200 A
	Gen. CT Sec.	1 A	5 A	4 A	5 A
7.4.1	Sensing Configuration	1-phase A-C, 3-phase		N/A	1-ph A-C
	Auxiliary Input Type	Voltage, Current		N/A	voltage
	Cross Current Gain	–30.00	30	0.01	0
7.4.2	AVR Mode Aux. Gain	–99.00	99	0.01	1
	FCR Mode Aux. Gain	–99.00	99	0.01	1
	Var Mode Aux. Gain	–99.00	99	0.01	1
	PF Mode Aux. Gain	–99.00	99	0.01	1
	Inner or Outer Loop	Inner, Outer		N/A	Inner
7.5.1	Relay 1 Contact Sense	NC, NO		N/A	NO
	Relay 1 Annunc. Type	Momentary, Maintained, Latched		N/A	Maintained
	Relay 1 Moment Time	0.10 s	5.00 s	50 ms	0.10 s
	Field Overvoltage	On, Off		N/A	Off
	Field Overcurrent	On, Off		N/A	Off
	Stator Undervoltage	On, Off		N/A	Off
7.5.2	Stator Overvoltage	On, Off		N/A	Off
	Underfrequency	On, Off		N/A	Off
	Overexcitation Limit	On, Off		N/A	Off
	Underexcitation Limit	On, Off		N/A	Off
	FCR Mode	On, Off		N/A	Off

Ref.	Parameter	Minimum	Maximum	Increment	Default
	No Voltage Sensing	On, Off		N/A	Off
7.5.3	Setpoint at Low Limit	On, Off		N/A	Off
	Setpoint at High Limit	On, Off		N/A	Off
	System Below 10 Hz	On, Off		N/A	Off
	Open Exciter Diode	On, Off		N/A	Off
	Shorted Exciter Diode	On, Off		N/A	Off
7.5.4	Relay 2 Contact Sense	NC, NO		N/A	NO
	Relay 2 Annunc. Type	Momentary Maintained, Latched		N/A	Maintained
	Relay 2 Moment Time	0.10 s	5.00 s	50 ms	0.10 s
	Field Overvoltage	On, Off		N/A	Off
	Stator Undervoltage	On, Off		N/A	Off
7.5.5	Stator Overvoltage	On, Off		N/A	Off
	Underfrequency	On, Off		N/A	Off
	Overexcitation	On, Off		N/A	Off
	Underexcitation	On, Off		N/A	Off
	FCR Mode	On, Off		N/A	Off
	No Voltage Sensing	On, Off		N/A	Off
7.5.6	Setpoint at Low Limit	On, Off		N/A	Off
	Setpoint at High Limit	On, Off		N/A	Off
	System Below 10 Hz	On, Off		N/A	Off
	Open Exciter Diode	On, Off		N/A	Off
	Shorted Exciter Diode	On, Off		N/A	Off
7.5.7	Relay 3 Contact Sense	NC, NO		N/A	NO
	Relay 3 Annunc. Type	Momentary, Maintained, Latched		N/A	Maintained
	Relay 3 Moment Time	0.10 s	5.00 s	50 ms	0.10 s
	Field Overvoltage	On, Off		N/A	Off
	Field Overcurrent	On, Off		N/A	Off
	Stator Undervoltage	On, Off		N/A	Off
7.5.8	Stator Overvoltage	On, Off		N/A	Off
	Underfrequency	On, Off		N/A	Off
	Overexcitation Limit	On, Off		N/A	Off
	Underexcitation Limit	On, Off		N/A	Off
	FCR Mode	On, Off		N/A	Off
	No Voltage Sensing	On, Off		N/A	Off
7.5.9	Setpoint at Low Limit	On, Off		N/A	Off
	Setpoint at High Limit	On, Off		N/A	Off
	System Below 10 Hz	On, Off		N/A	Off
	Open Exciter Diode	On, Off		N/A	Off
	Shorted Exciter Diode	On, Off		N/A	Off
7.6.1	AVR Traverse Rate	10 s	200 s	1 s	20 s
	FCR Traverse Rate	10 s	200 s	1 s	20 s
	Var Traverse Rate	10 s	200 s	1 s	20 s
	PF Traverse Rate	10 s	200 s	1 s	20 s
7.7.1	AVR Prep Mode	Maintain, Release		N/A	Release
	FCR Prep Mode	Maintain, Release		N/A	Release
	Var Prep Mode	Maintain, Release		N/A	Release
	PF Prep Mode	Maintain, Release		N/A	Release
7.8.1	Soft Start Level	0%	90%	1%	5%
	Soft Start Time	1 s	7,200 s	1 s	5 s
7.9.1	Internal Track rate	1.0 s	80 s	0.1 s	20.0 s

Ref.	Parameter	Minimum	Maximum	Increment	Default
	Internal Track Delay	0.0 s	8 s	0.1 s	0.1 s
	External Track Rate	1.0 s	80 s	0.1 s	20.0 s
	External Track Delay	0.0 s	8 s	01. s	0.1 s
8.1.1	Com0 RS232 Baud	1200 bps	19,200 bps	↑ by x2 ↓ by x ½	9600 bps
	Com1 RS232 Baud	1200 bps	19,200 bps	↑ by x2 ↓ by x ½	9600 bps
	Com2 RS232 Baud	1200 bps	19,200 bps	↑ by x2 ↓ by x ½	9600 bps
8.1.2	Com2 Address	0	247	1	247
	Com2 Delay	0 ms	200 ms	10 ms	10 ms
	Parity	None, Odd, Even		N/A	None
	Stop Bits	1	2	1	2
8.2	LCD Contrast	40	80	1	60
8.3	Real-Time Clock Setting	N/A		1	N/A
	Real-Time Clock Date Setting	N/A		1	01-01-01
8.3.1	Time Format	12 hr, 24 hr		N/A	12 hr
	Daylight Saving Time	DS ON, DS OFF		N/A	DS Off
	Date Format	d-m-y, m/d/y		N/A	d-m-y

PASSWORD PROTECTION

All editable settings on the front panel are password protected. Passwords can be a maximum of six characters in length and may contain all letters, all numbers, or a mixture of both. Passwords are not case sensitive; the DECS-200 will accept a correct password consisting of uppercase or lowercase letters. There are two levels of access: global and setpoint. Global access grants the user the right to change any editable setting through the front panel. Setpoint access grants the user the right to change a limited number of settings. These settings include the basic operational settings like Start, Stop, AVR/FCR, PF/var, control setpoints and pre-position. For a complete list, refer to Table 2-3. All editable settings on a single menu screen are at the same access level.

Table 2-3. Settings Accessible with Setpoint Access Level

Screen	Setting
OPERATE_1 (1.1)	Start/Stop Control
OPERATE_1 (1.1)	AVR/FCR Mode
OPERATE_1 (1.1)	PF/Var Mode
OPERATE_1 (1.1)	Load Compensation Type
OPERATE_1 (1.1)	Pre-Position Enable
OPERATE_2 (1.2)	Voltage Matching Enable
OPERATE_2 (1.2)	Autotracking Enable
OPERATE_2 (1.2)	Autotransfer Enable
MODE_SET (2.1)	AVR Mode Setpoint
MODE_SET (2.1)	FCR Mode Setpoint
MODE_SET (2.1)	Var Mode Setpoint
MODE_SET (2.1)	PF Mode Setpoint
MODE_SET (2.1)	Droop Setting
PREP_SET (2.2)	AVR Mode Setpoint Pre-Position
PREP_SET (2.2)	FCR Mode Setpoint Pre-Position
MODE_SET (2.2)	Var Mode Setpoint Pre-Position
ADJUST (4.1)	1ST Metering Field Display Quantity
ADJUST (4.1)	2nd Metering Field Display Quantity
ADJUST (4.1)	3rd Metering Field Display Quantity
ADJUST (4.1)	Active Setpoint
CONTRAST (8.2)	LCD Contrast

DECS-200 units are delivered with the global and setpoint passwords set at decs2. When a password is entered, software first checks for a match between the entered password and the global password. Because the two passwords are the same, global access is always granted. This means that in order to allow setpoint access only, the global and setpoint passwords must be changed so that they are not the same. Passwords may be changed using BESTCOMS software. It is suggested that the user change the passwords in order to provide security against unauthorized parameter changes. Once changed, the passwords should be stored in a secure location.

CAUTION

Pressing the Edit and Reset pushbuttons during DECS-200 power-up will cause all user-programmed settings to be replaced with the default settings.

If the user-defined passwords are lost or forgotten, the default passwords may be restored by simultaneously pressing the Edit and Reset pushbuttons during power-up of the DECS-200. Restoring the passwords to the default values will also change all previously programmed settings to the default values. Before restoring the default passwords (and settings), all DECS-200 settings should be downloaded to a file by using BESTCOMS software. After the default settings are loaded, the user-programmed settings can be uploaded to the DECS-200 from the saved settings file. The user may also reprogram the passwords.

A password is required the first time any DECS-200 setting is changed or when the password access expires (after 10 minutes with no additional entries). If a user with settings access attempts to begin an edit session on a screen requiring global access, the settings access is revoked and the user is prompted to enter a password to gain global access.

METERING SCREEN

Information displayed by the metering screen is grouped into five field types: metering, setpoint, percent of range, mode message, and alarm annunciation.

Metering Fields

Three user-programmable fields display up to three different metering quantities at a given time. Table 2-4 lists the metering quantities that may be selected.

Table 2-4. User-Selectable Metering Quantities

Metering Labels	Metering Quantities
Va-b	Generator A-B (L-L) rms voltage
Vb-c	Generator B-C (L-L) rms voltage
Vc-a	Generator C-A (L-L) rms voltage
Vavg	Average of three generator L-L voltages
Line I	Generator line current
VA	Generator load VA
Watts	Generator load watts
Var	Generator load var
PF	Generator load power factor
Gen Hz	Generator frequency
Bus Hz	Bus frequency
Bus V	Bus rms L-L voltage
Fld V	Field voltage
Fld I	Field current
V Aux	Voltage proportional to auxiliary input
EDM OD	Open exciter diode ripple
EDM SD	Shorted exciter diode ripple

The values in all three metering fields are automatically scaled by an autoranging function to display up to four digits of resolution, a decimal point, and if needed, a multiplier such as k for 1,000 or M for 1,000,000. For negative values with magnitudes greater than 999.9, only three digits of resolution are displayed.

Setpoint Field

The setpoint field displays the setpoint for the present mode of operation. Table 2-5 lists the relationship between the operating mode and the setpoint field quantity.

Table 2-5. Setpoint Field as a Function of Operating Mode

Operating Mode	Setpoint Field Quantity	Mode Message
Off	Setpoint from last mode	UNIT IS OFF
Voltage Matching	AVR setpoint	VOLTAGE MATCHING
FCR (Manual)	FCR setpoint	FCR (MANUAL)
AVR (Auto)	AVR setpoint	AVR (AUTO)
Droop	AVR setpoint	DROOP
Var Control	Var setpoint	VAR CONTROL
PF Control	PF setpoint	POWER FACTOR CONTROL

Percent-of-Range Field

The percent-of-range field displays the setpoint expressed as a percentage of the available adjustment range. This relationship is linear. For example, a setpoint that is midway between minimum and maximum would be displayed as 50.0%. A setpoint that is at the maximum limit would be displayed as 100%.

Mode Message Field

The bottom of the metering screen contains the mode message field which displays a message indicating the DECS-200's current mode of operation.

Alarm Annunciation Field

The alarm annunciation field, located directly below the metering fields, remains blank during normal operating conditions. When an alarm condition occurs, the message "ALARMS (PRESS < OR >) appears in the alarm annunciation field. The message appears as an inverse display—light colored characters appear on a dark background. See *Alarm Message Screen* for information about how to identify which alarm condition was annunciated.

Alarm Message Screen

From the metering screen, pressing either the Left or Right scrolling pushbutton will cause the alarm message screen to appear. This screen displays up to six messages identifying the conditions that led to the most recent annunciations. Table 2-6 lists the messages that may appear as annunciations on the alarm message screen. When more than one message is listed, the newest annunciations are appended to the bottom of the list. Once the list contains six messages, any further annunciations will cause the oldest messages to be deleted from the top of the list.

Table 2-6. Annunciation Messages

Annunciation Message	Duration of Message
FIELD OVERVOLTAGE	Maintained until reset
FIELD OVERCURRENT	Maintained until reset
GEN. UNDERVOLTAGE	Maintained until reset
GEN. OVERVOLTAGE	Maintained until reset
UNDERFREQUENCY	Clears 2 s after end of event
OVEREXCITATION LIMIT	Clears 2 s after end of event
UNDEREXCITATION LIMIT	Clears 2 s after end of event

Annunciation Message	Duration of Message
LOST VOLTAGE SENSING	Maintained until reset
FAILED TO BUILD UP	Clears 2 s after end of event
SYSTEM BELOW 10 HZ	Maintained until reset
EXCITER DIODE OPEN	Maintained until reset
EXCITER DIODE SHORT	Maintained until reset

Once the list of annunciation messages has been viewed, it may be cleared by pressing the Reset pushbutton. If a condition that LED to an annunciation is still present when the alarm message screen is cleared, then a new annunciation message will be generated.

Pressing the Reset pushbutton will also send the display back to the Metering screen. Furthermore, the alarms message on the Metering screen will also be cleared. However, if the user leaves the alarm message screen by pressing the Left, Right or Up scrolling pushbuttons, then the annunciation messages list remains intact. This allows the user to maintain a short history of annunciations. In addition, the alarms message on the Metering screen will also remain. The disadvantage of this is that the metering screen would no longer indicate that a new annunciation occurred because the alarms message would always be present.

Screens with Special Editing Modes

There are several screens that operate differently while in the edit mode. OPERATE_1 (1.1), BAUD_RATE (8.1.1), and MODBUS (8.1.2) are examples of such screens. In each case, any changes made to a setting are not used by the system (nor saved in nonvolatile memory) until the Edit pushbutton is pressed again. The programmable inputs for output relays 1 through 4 work in the same manner. These are on screens RELAY_1 (7.5.1) through RELAY_3B (7.5.9).

The REG_GAIN (3.1) screen also operates in a different manner when in the Edit mode. The first four parameters on this screen represent a table containing twenty sets of predefined PID values and one set of user-definable values. The first of these, STAB SET #, which means stability settings number, is the index to the table. The second, third, and fourth parameters (AVR/FCR Kp, Ki, and Kd), are the actual entries in the table. Stability setting numbers 1 to 20 are the predefined values, and 21 is the set of user-definable values.

Editing these parameters works as follows: As long as STAB SET # is set to 21, then AVR/FCR Kp, Ki, and Kd may be individually edited and customized. The values displayed are not used by the system until they are saved by pressing the Edit pushbutton. This means that if a change is aborted by pressing the Reset pushbutton, the PID numbers currently being used by the system remain unchanged.

If STAB SET # is 1 to 20, then AVR/FCR Kp, Ki and Kd may not be edited from the display (although the cursor can be moved to their display fields). If the STAB SET # is changed, the values shown in the display fields will not change until the selected STAB SET # is saved. When the STAB SET # is saved, the table entries are saved, used by the system and displayed on the LCD.

If the DECS-200 is using the user-defined values previously set at STAB SET # 21 and a STAB SET # of 1 to 20 is saved, the user-defined values are lost. The next time that user-defined values for STAB SET # 21 are required, they must be manually entered and then saved. It is assumed that the table entries for STAB SET # 1 to 20 will be used as starting points from which users will arrive at their own customized values after the selected starting point has been saved (and thus copied into STAB SET # 21).

Menu Tree

The menu tree has eight branches:

1. OPERATING. Displays mode status and on or off status (AVR, FCR, var, PF, etc.)
2. SETPOINTS. Display and setting of mode values (AVR, FCR, var, PF, etc.)
3. LOOP GAINS. Loop gains for each element are set here (Kp, Ki, Kd, Kg)
4. METERING. Real-time metering of user-selected values and alarm messages.
5. PROTECTION. Display and setting of protective function parameters such as pickups.
6. LIMITERS. Display and setting of system limiters (OEL, UEL, etc.)

7. SYSTEM PARAMETERS. Display and setting of system parameters. This menu item consists of nine sub-branches:
    - Generator Data
    - Field Data
    - Transformers
    - Configuration
    - Output Contacts
    - Traverse Rates
    - Pre-position Modes
    - Startup
    - Tracking
8. GENERAL SETTINGS. Display and setting of communication setting parameters and LCD contrast.

Figures 2-2 through 2-11 illustrate all branches in the menu tree. In Figures 2-2 through 2-11, the upper left corner of each screen displays a one, two or three digit number with decimal points between each digit. These numbers are reference numbers to the screens in the menu tree. A letter at the upper right corner (G, S, and N) indicates the security access level (global, setpoint and not applicable) required to edit that screen.

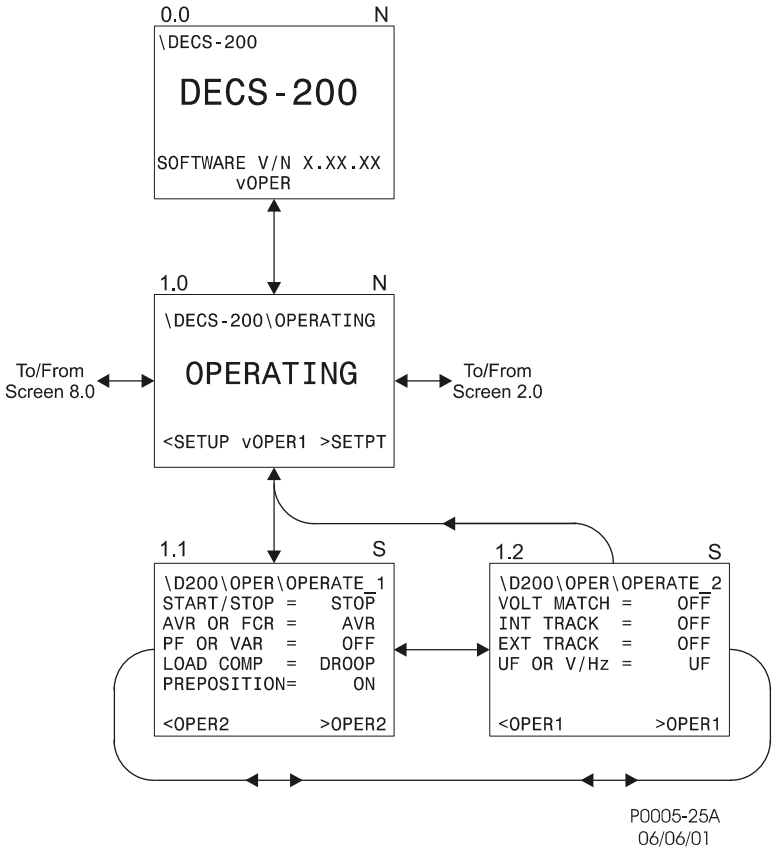

Figure 2-2.Operating Menu Branch

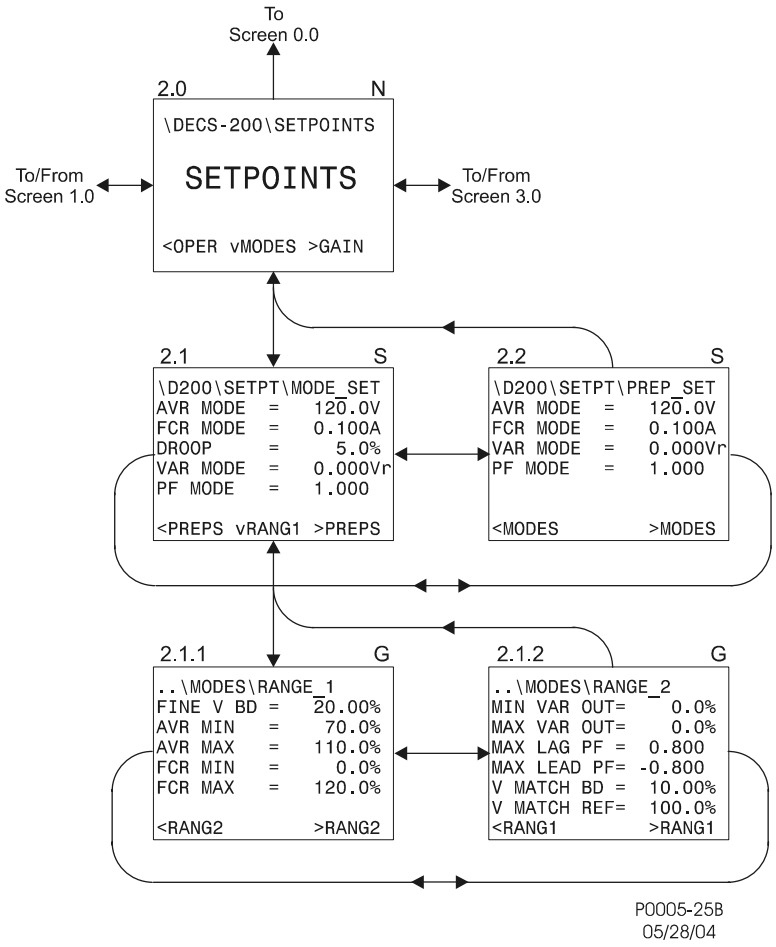

Figure 2-3. Setpoint Menu Branch

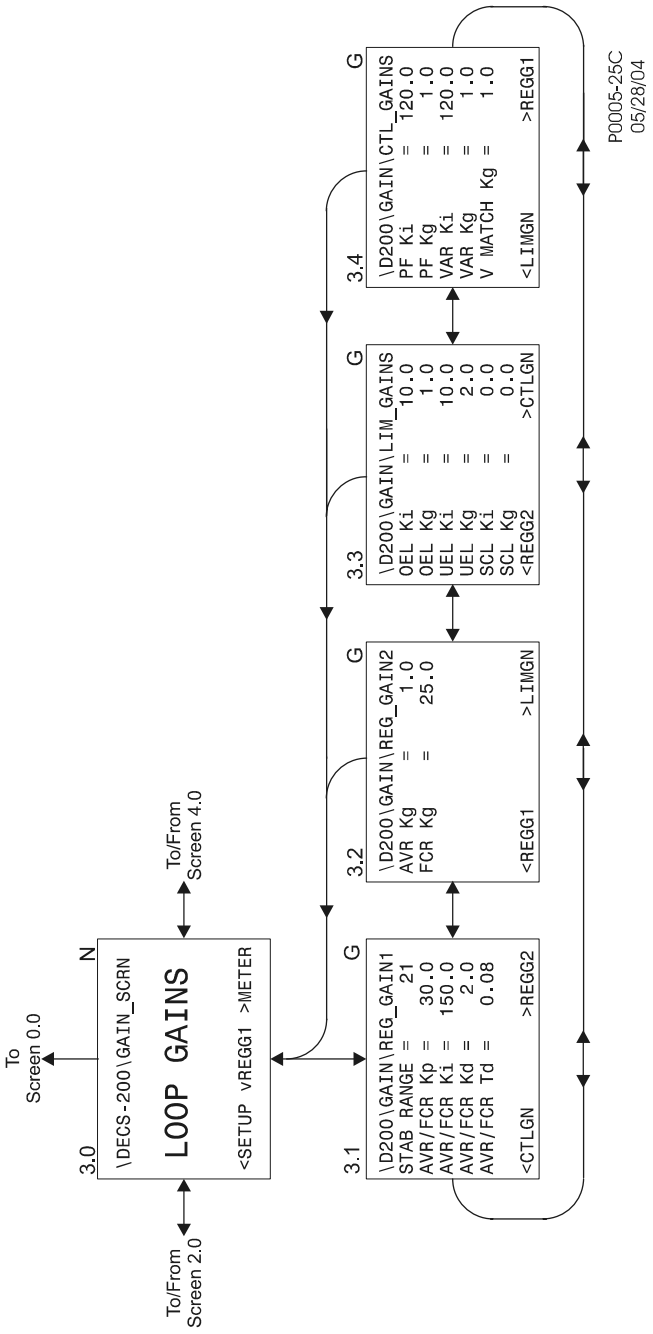

Figure 2-4. Loop Gains Menu Branch

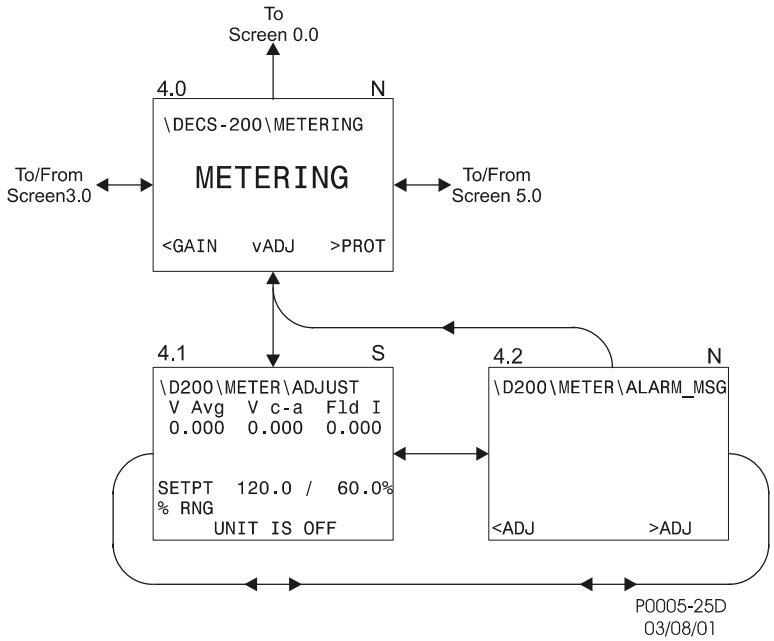

Figure 2-5. Metering Menu Branch

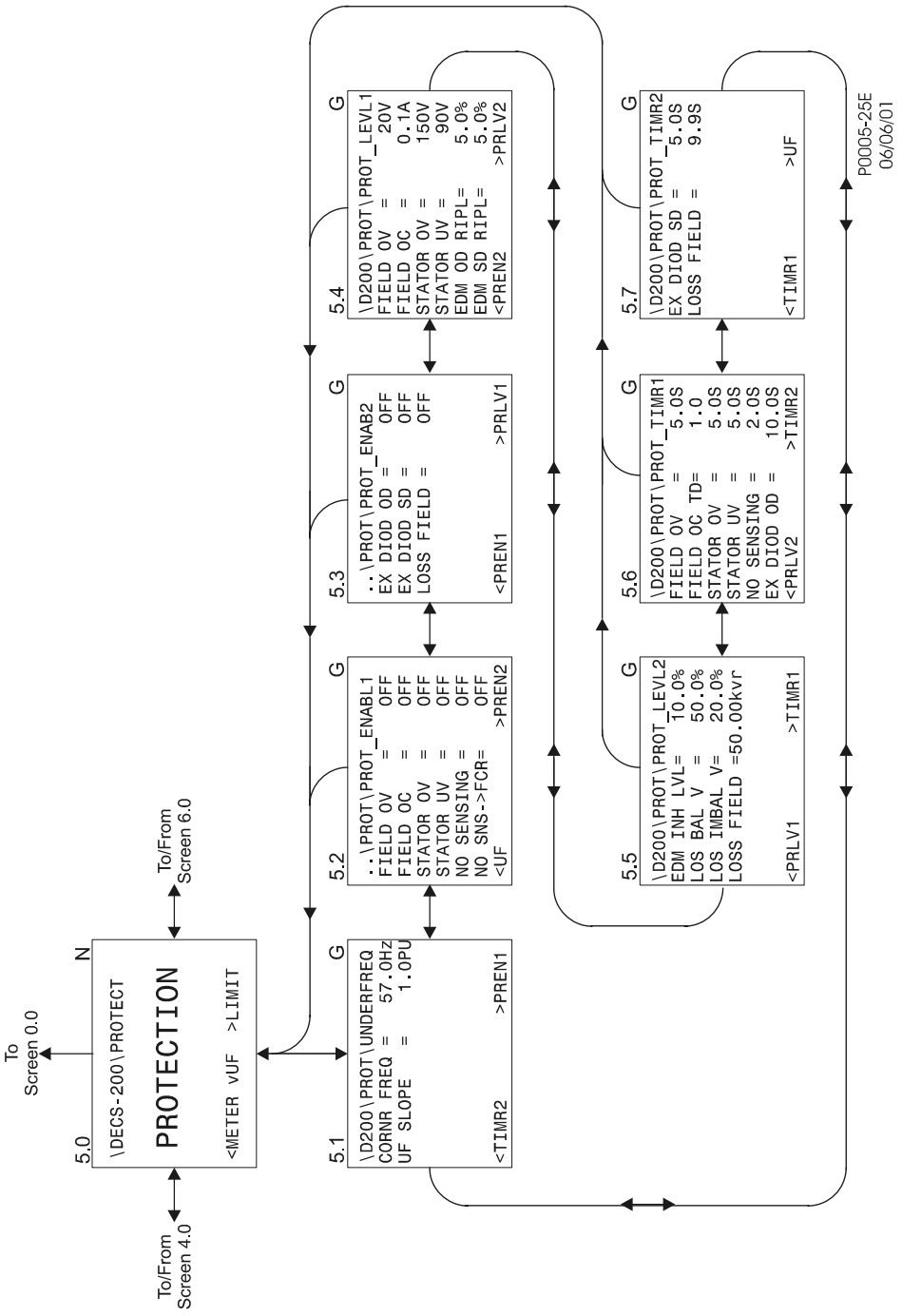

Figure 2-6. Protection Menu Branch

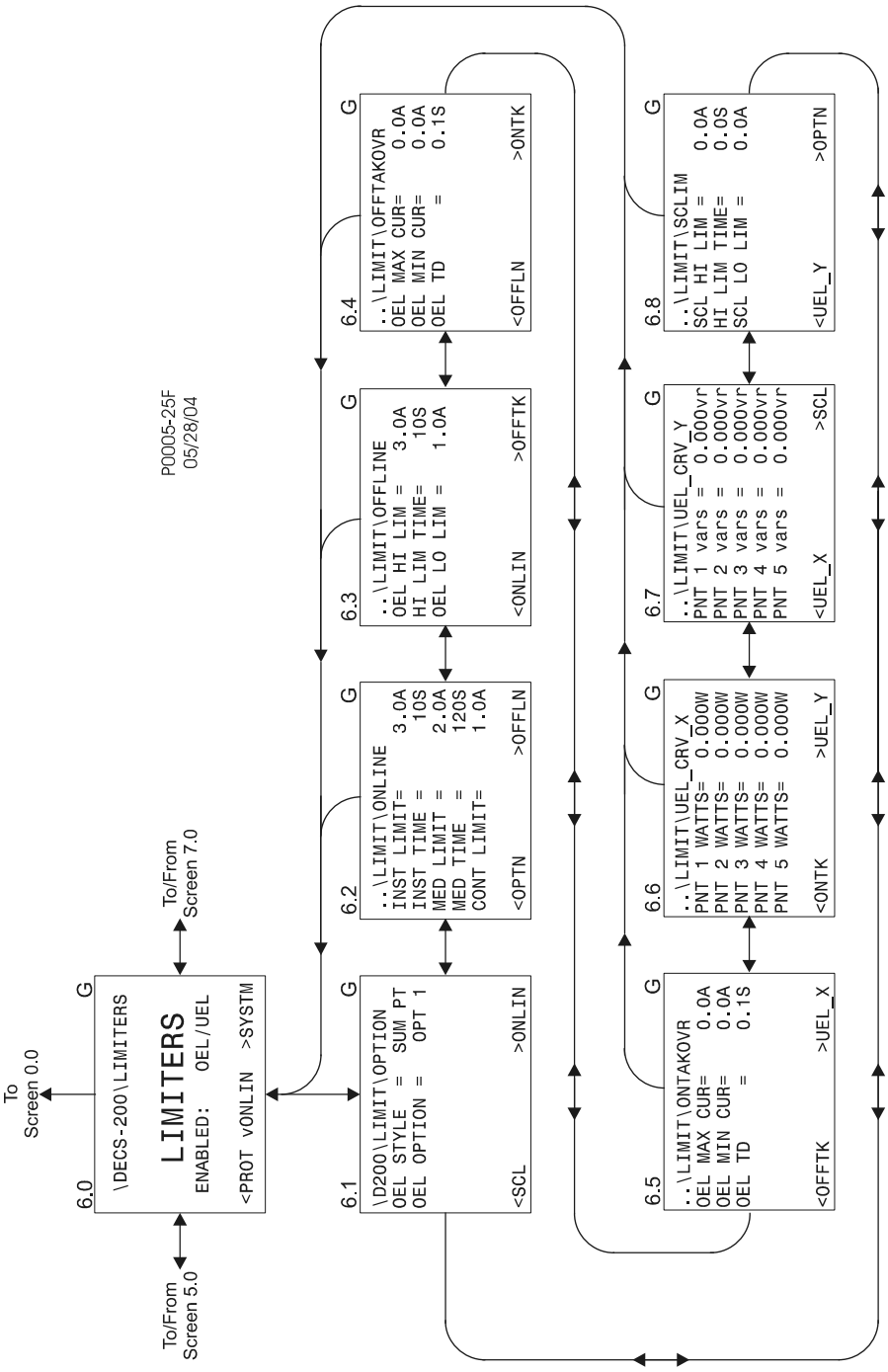

Figure 2-7. Limiters Menu Branch

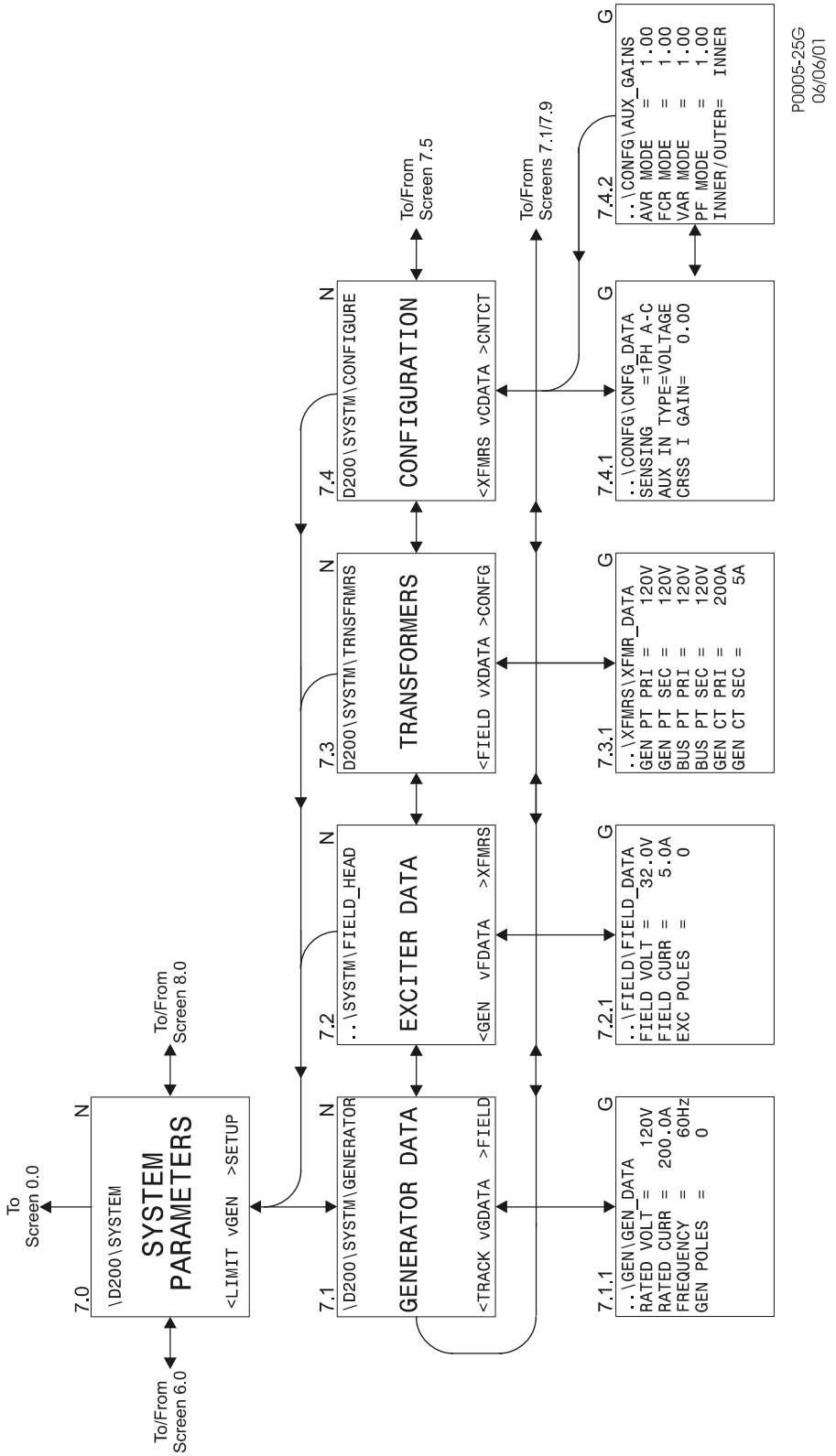

Figure 2-8. System Parameters Menu Branch (Part 1 of 3)

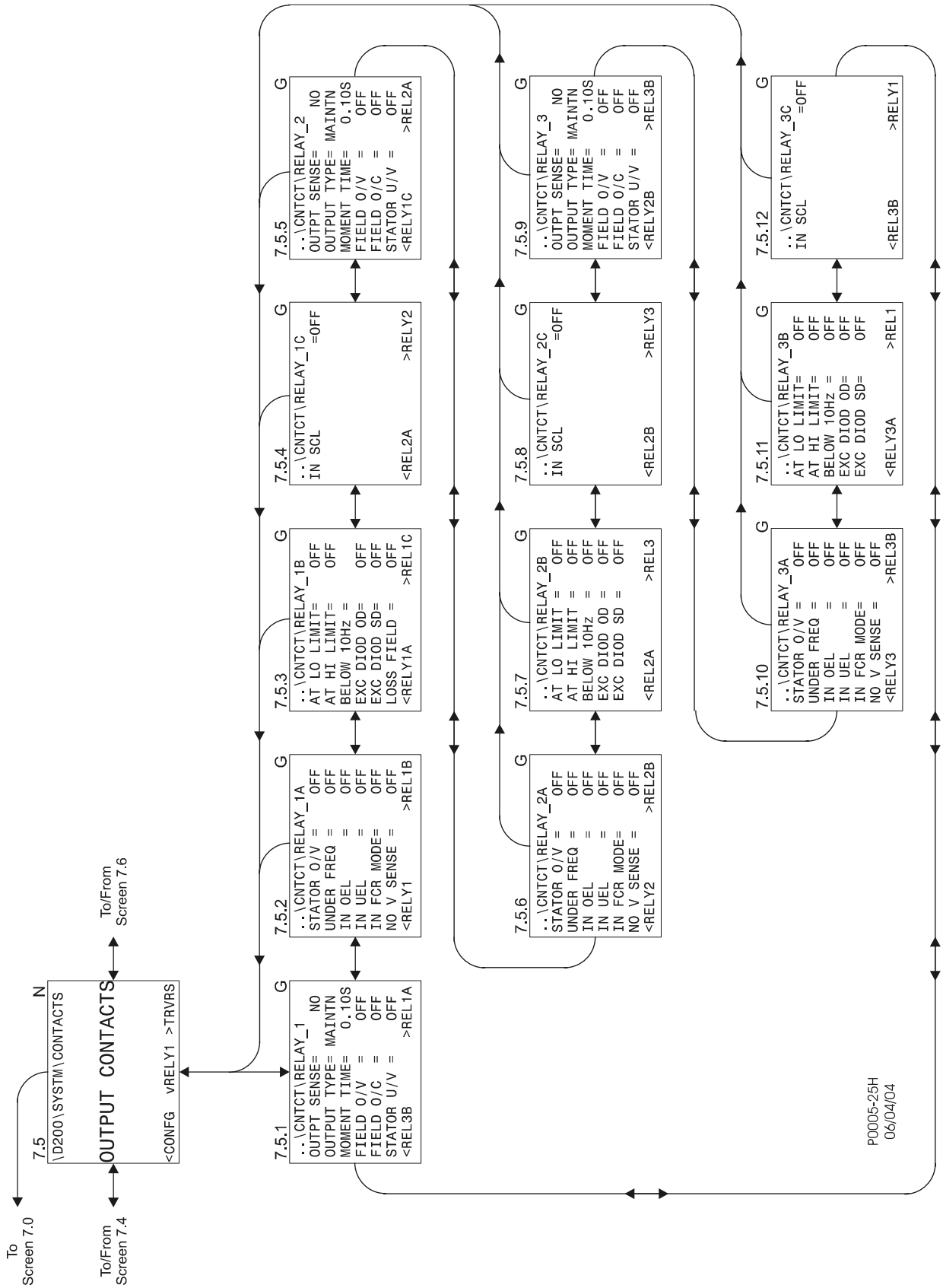

Figure 2-9. System Parameters Menu Branch (Part 2 of 3)

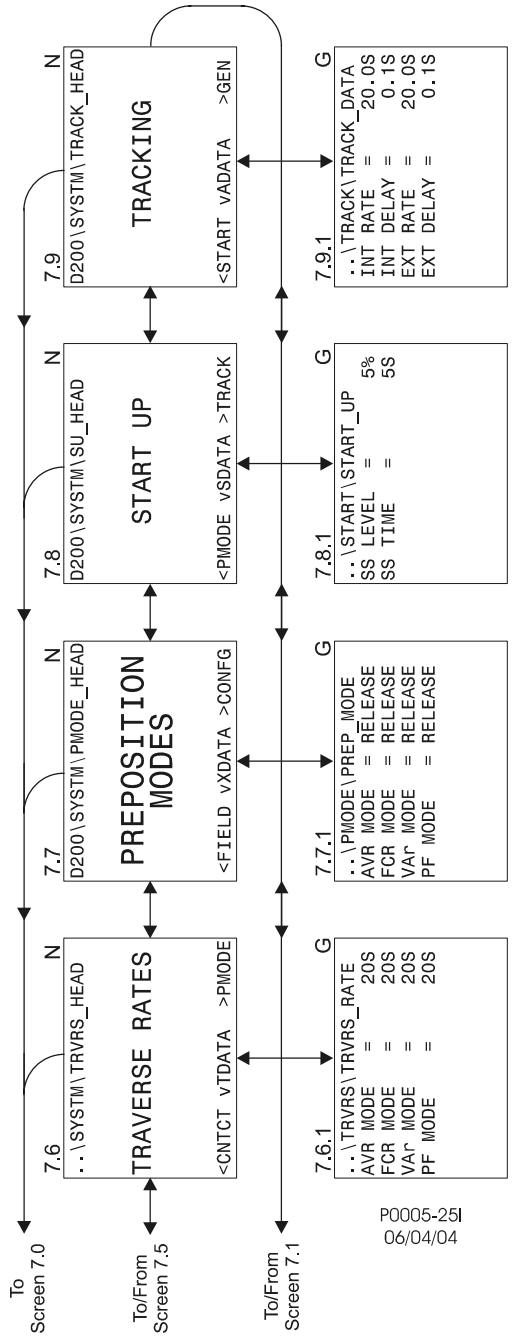

Figure 2-10. System Parameters Menu Branch (Part 3 of 3)

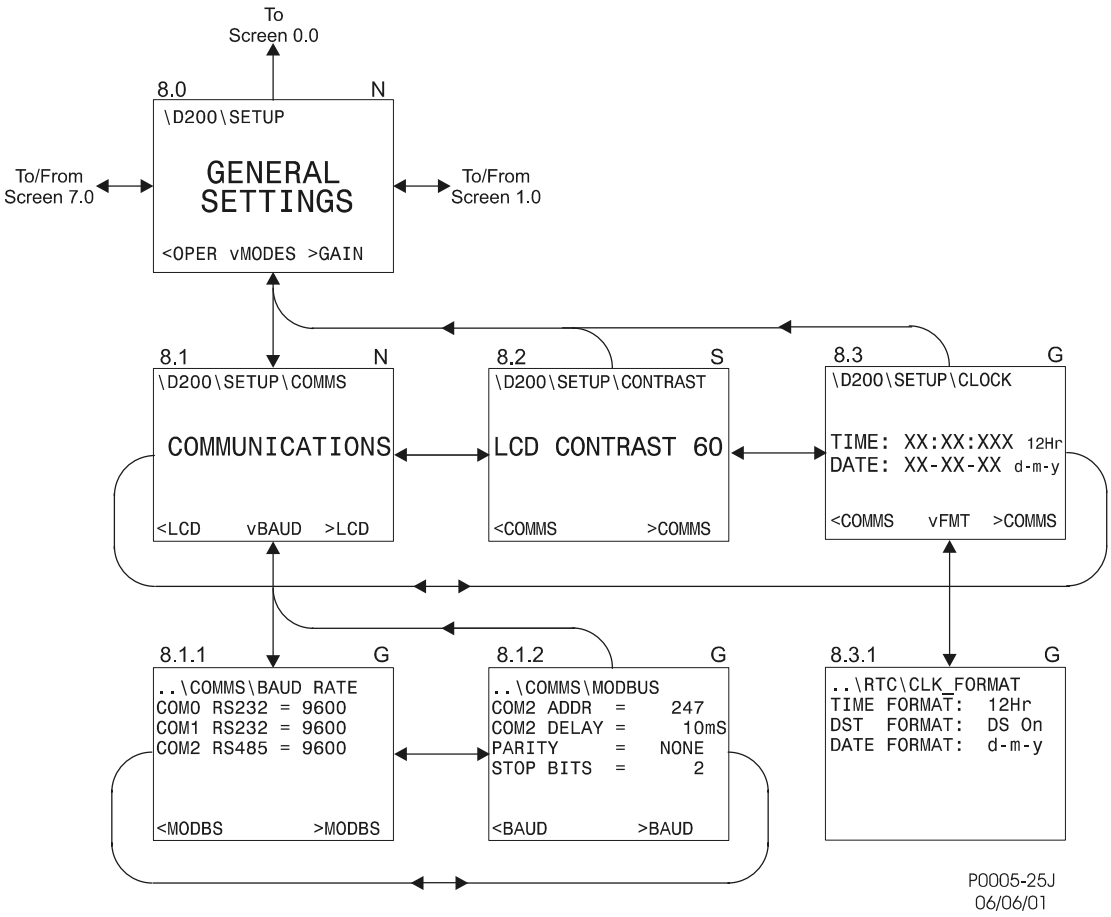

Figure 2-11. General Settings Menu Branch

FRONT PANEL OPERATION

The following paragraphs describe the settings and adjustments that are available via the DECS-200 front panel. They are grouped into eight main categories which include: operating modes, setpoints, loop gains, metering, protection, limiters, system parameters, and general settings.

Front panel settings and adjustments are listed and described in the following paragraphs. Settings are organized by category and by screen.

Operating Modes

Screen: \OPER\OPERATE_1 (1.1)

START/STOP - starts and stops the regulator

AVR OR FCR - selects the regulator mode: AVR for automatic voltage regulator, FCR for field current regulator (also known as MANUAL mode)

PF OR var - selects the controller mode: OFF for none, var for var control, PF for power factor control

LOAD COMP - selects the load compensation type: OFF for none, DROOP for voltage droop.

PRE-POSITION - enables/disables the pre-position function: OFF to disable, ON to enable

Screen: \OPER\OPERATE_2 (1.2)

VOLT MATCH - turns the voltage matching function on and off (Internal tracking between modes)

INT TRACK - turns the internal tracking function on and off

EXT TRACK - turns the external tracking function on and off

UF OR V/HZ - selects either underfrequency or volts-per-hertz limiting

Setpoints

Screen: \SETPT\MODE_SET (2.1)

AVR MODE - the automatic voltage regulation setpoint in actual generator voltage

FCR MODE - the field current regulation setpoint in Amps

DROOP - the amount of voltage droop as a % of rated generator voltage when the kvar load numerically equals the rated kW

Var MODE - the var controller regulation setpoint in var

PF MODE - the power factor controller regulation setpoint

Screen: \SETPT\MODES\RANGE_1 (2.1.1)

FINE V BD - the adjustable voltage band (var volt band) around the generator's output voltage as a % of rated generator voltage when var/PF mode is active

AVR MIN - the minimum automatic voltage regulator setpoint as a % of rated generator voltage

AVR MAX - the maximum automatic voltage regulator setpoint as a % of rated generator voltage

FCR MIN - the minimum field current regulator setpoint as a % of rated field current

FCR MAX - the maximum field current regulator setpoint as a % of rated field current

Screen: \SETPT\MODES\RANGE_2 (2.1.2)

MIN var OUT - the minimum generated var setpoint as a numerical % of rated generator kW (negative for absorbing)

MAX var OUT - the maximum generated var setpoint as a numerical % of rated generator kW (negative for absorbing)

MAX LAG PF - maximum lagging power factor setpoint

MAX LEAD PF - maximum leading power factor setpoint

V MATCH BD - the adjustable voltage band allows the voltage matching function to activate if the bus voltage is within this band. This setting is a numerical % of rated generator voltage.

V MATCH REF - (Gen to Bus PT Match Level) the bus voltage setpoint for the voltage matching function as a numerical % of bus voltage

Screen: \SETPT\PREP_SET (2.2)

The present control mode operating setpoint is driven to the pre-position value when the unit receives a pre-position command.

AVR MODE - the automatic voltage regulator setpoint pre-position value

FCR MODE - the field current regulator setpoint pre-position value

Var MODE - the var controller setpoint pre-position value

PF MODE - the power factor setpoint pre-position value

Loop Gains

Screen: \GAIN\REG_GAIN1 (3.1)

STAB RANGE - the index into the internally defined PID table. Table 2-7 lists the automatic pre-defined stability gain settings for the exciter field and the 20 stability settings.

AVR/FCR Kp - proportional gain coefficient used in the AVR/FCR loop

AVR/FCR Ki - integral gain coefficient used in the AVR/FCR loop

AVR/FCR Kd - derivative gain coefficient used in the AVR/FCR loop

AVR/FCR Td - derivative time constant used in AVR/FCR loop

Table 2-7. Automatic Stability Range Gain Settings Index

Excitation Mode	Setting	Generator Open Circuit Time Constant (T'do)	Generator Exciter Time Constant (Texc)	Kp	Ki	Kd
Exciter Field	1	1.0	0.17	42.20	115.20	4.433
	2	1.5	0.25	66.50	150.00	8.750
	3	2.0	0.33	87.16	167.90	13.670
	4	2.5	0.42	104.50	175.80	18.960
	5	3.0	0.50	119.00	177.80	24.500
	6	3.5	0.58	131.30	176.40	30.220
	7	4.0	0.67	141.80	173.10	36.060
	8	4.5	0.75	150.90	168.80	42.000
	9	5.0	0.83	158.80	163.90	48.010
	10	5.5	0.92	165.70	158.70	54.080
	11	6.0	1.00	171.80	153.60	60.200
	12	6.5	1.08	177.20	148.50	66.350
	13	7.0	1.17	182.10	143.60	72.540
	14	7.5	1.25	186.50	138.90	78.750
	15	8.0	1.33	190.50	134.40	84.980
	16	8.5	1.42	194.10	130.10	91.230
	17	9.0	1.50	197.40	125.90	97.500
	18	9.5	1.58	200.40	122.10	103.800
	19	10.0	1.67	203.20	118.40	110.100
	20	10.5	1.75	205.70	114.80	116.400

Screen: \GAIN\REG GAIN2 (3.2)

AVR Kg - loop gain used in AVR mode

FCR Kg - loop gain used in FCR mode

Screen: \GAIN\LIM_GAINS (3.3)

OEL Ki - integral gain coefficient used in the overexcitation limiter loop

OEL Kg - loop gain used in the overexcitation limiter

UEL Ki - integral gain coefficient used in the underexcitation limiter loop

UEL Kg - loop gain used in the underexcitation limiter

SCL Ki - integral gain coefficient used in the stator current limiter

SCL Kg - loop gain used in the stator current limiter

Controller Gains

Screen: \GAIN\CTL_GAINS (3.4)

PF Ki - integral gain coefficient used in the power factor controller

PF Kg - loop gain used for the power factor controller

Var Ki - integral gain coefficient used in the var controller

Var Kg - loop gain used for the var controller

V MATCH Kg - loop gain used for the voltage matching function

Metering

Screen: \METER\ADJUST (4.1)

1st metering field - displays any one of several metering quantities

2nd metering field - displays any one of several metering quantities

3rd metering field - displays any one of several metering quantities

SETPT - the present control mode operating setpoint

Screen: \METER\ALARM_MSG (4.2)

Reset Button - clears any displayed alarm messages (and returns to the ADJUST metering screen).

Protection

Screen: \PROT\UNDERFREQ (5.1)

CORNR FREQ - the corner frequency for the underfrequency curve

UF SLOPE - the slope of the underfrequency curve

Screen: \PROT\PROT_ENABL1 (5.2)

FIELD OV - field overvoltage detection enable

FIELD OC - field overcurrent detection enable

STATOR OV - generator output overvoltage detection enable

STATOR UV - generator output undervoltage detection enable

NO SENSING – loss of voltage sensing detection enable

NO SNS→FCR – transfer to FCR mode enable (when a loss of voltage sensing is detected). Loss of voltage sensing detection must also be enabled for this feature to work.

Screen: \PROT\PROT_ENAB2 (5.3)

EX DIOD OD - exciter open diode detection enable

EX DIOD SD - exciter shorted diode detection enable

LOSS FIELD - enables and disables loss of field protection

Screen: \PROT\PROT_LEVL (5.4)

FIELD OV - field overvoltage threshold

FIELD OC - field overcurrent base value (100%)

STATOR OV - generator output overvoltage threshold

STATOR UV - generator output undervoltage threshold

EDM OD RIPL - open exciter diode ripple threshold

EDM SD RIPL - shorted exciter diode ripple threshold

Screen: \PROT\PROT_LEVL2 (5.5)

EDM INH LVL - exciter diode detection inhibit level

LOS BAL V - loss of balanced sensing voltage threshold

LOS IMBAL V - loss of unbalanced sensing voltage threshold

LOSS FIELD - loss of field time delay

Screen: \PROT\PROT_TIMER (5.6)

FIELD OV - field overvoltage time delay

FIELD OC TD - field overcurrent time dial multiplier

STATOR OV - generator output overvoltage time delay

STATOR UV - generator output undervoltage time delay

NO SENSING - lost sensing voltage time delay

EX DIOD OD - exciter open diode time delay

Screen: \PROT\PROT_TIMR2 (5.7)

EX DIOD SD - exciter shorted diode time delay

LOSS FIELD - loss of field time delay

Limiters

Screen: LIMITERS (6.0)

ENABLED - selects which limiters are enabled: NONE, UEL, OEL, OEL/UEL, SCL, SCL/UEL, SCL/OEL, or SCL/OEL/UEL

Screen: \LIMIT\OPTION (6.1)

On-line overexcitation limiter style and options.

OEL STYLE - selects Summing Point or Takeover style overexcitation limiter

OEL OPTION - selects on-line and off-line overexcitation limiter control options:

Option 1: On-line OEL settings are active when either the 52 J/K or 52 L/M contacts are open. Off-line OEL settings are active when either the 52 J/K or 52 L/M contacts are closed.

Option 2: On-line OEL settings are active when the 52 J/K contact is open. Off-line OEL settings are active when the 52 J/K contact is closed.

Option 3: On-line OEL settings are active at all times.

Screen: \LIMIT\ONLINE (6.2)

On-line overexcitation limiter (summing point) settings.

INST LIMIT - on-line overexcitation limiter instantaneous limit threshold

INST TIME - on-line overexcitation limiter instantaneous limit time delay

MED LIMIT - on-line overexcitation limiter medium current threshold

MED TIME - on-line overexcitation limiter medium current time delay

CONT LIMIT - on-line overexcitation limiter continuous (low) current threshold

Screen \LIMIT\OFFLINE (6.3)

Off-line overexcitation limiter (summing point) settings.

OEL HI LIM - off-line overexcitation limiter high current threshold

HI LIM TIME - off-line overexcitation limiter high current time delay

OEL LO LIM - off-line overexcitation limiter low current threshold

Screen \LIMIT\OFFTAKOVR (6.4)

Off-line overexcitation limiter (takeover) settings.

OEL MAX CUR - off-line takeover overexcitation limiter maximum current threshold

OEL MIN CUR - off-line takeover overexcitation limiter minimum current threshold

OEL TD - off-line takeover overexcitation limiter time delay

Screen \LIMIT\ONTAKOVR (6.5)

On-line overexcitation limiter (takeover) settings.

OEL MAX CUR - on-line takeover overexcitation limiter maximum current threshold

OEL MIN CUR - on-line takeover overexcitation limiter minimum current threshold

OEL TD - on-line takeover overexcitation limiter time delay

Screen \LIMIT\UEL_CRV_X (6.6)

Underexcitation limiter real-power curve points.

PNT 1 WATTS - underexcitation limiter real-power curve point 1

PNT 2 WATTS - underexcitation limiter real-power curve point 2

PNT 3 WATTS - underexcitation limiter real-power curve point 3

PNT 4 WATTS - underexcitation limiter real-power curve point 4

PNT 5 WATTS - underexcitation limiter real-power curve point 5

Screen \LIMIT\UEL_CRV_Y (6.7)

Underexcitation limiter reactive-power curve points.

PNT 1 vars - underexcitation limiter reactive-power curve point 1

PNT 2 vars - underexcitation limiter reactive-power curve point 2

PNT 3 vars - underexcitation limiter reactive-power curve point 3

PNT 4 vars - underexcitation limiter reactive-power curve point 4

PNT 5 vars - underexcitation limiter reactive-power curve point 5

Screen \LIMIT\SCLIM (6.8)

Stator current limiter settings.

SCL HI LIM - stator current limiter high current setpoint

HI LIM TIME - stator current limiter time delay

SCL LO LIM - stator current limiter low current setpoint

System Parameters

Screen: \GEN\GEN_DATA (7.1.1)

RATED VOLT - generator rated output voltage

RATED CURR - generator rated output current

FREQUENCY - generator rated frequency

Screen: \EXCTR\EXCTR_DATA (7.2.1)

FIELD VOLT - rated field voltage

FIELD CURR - rated field current

POLE RATIO - ratio between exciter poles to the number of generator poles

Screen: \XFMRS\XFMR_DATA (7.3.1)

GEN PT PRI - generator sensing transformer primary voltage rating

GEN PT SEC - generator sensing transformer secondary voltage rating

BUS PT PRI - bus sensing transformer primary voltage rating

BUS PT SEC - bus sensing transformer secondary voltage rating

GEN CT PRI - generator sensing transformer primary current rating

GEN CT SEC - generator sensing transformer secondary current rating

Screen: \CONFG\CNFG_DATA (7.4.1)

SENSING - sensing configuration: single-phase or three-phase

AUX IN TYPE - selects the auxiliary input type as voltage or current

CRSS I GAIN - cross current compensation input gain

Screen: \CNFG AUX Gains (7.4.2)

The auxiliary input allows an analog signal to be externally applied to the DECS-200 to modify the operating setpoint. The amount of change that may be induced is proportional to the magnitude of the signal and the input gain.

AVR MODE – auxiliary input gain in AVR mode

FCR MODE – auxiliary input gain in FCR mode

Var MODE – auxiliary input gain in var mode

PR MODE – auxiliary input gain in PF mode

INNER/OUTER – control loop summing point location where the auxiliary input signal is to be injected. For AVR or FCR mode, select INNER. For var or PF mode, select outer. Once selected, the injection point remains fixed across all modes of operation.

Screen: \CNTCT\RELAY_1 (7.5.1)

There are three types of relay annunciation: momentary, maintained and latched. A relay that is programmed for momentary annunciation will do so for a (programmable) time interval and then cease. The momentary annunciation for an existing condition will not repeat. A relay that is programmed for maintained annunciation will do so for the duration of the condition that is being annunciated. A relay programmed for a latched annunciation will continue to annunciate the condition until an alarm reset command is given through the front panel, BESTCOMS software (via the front RS-232 port) or Modbus™ (via the rear RS-485 port).

OUTPUT SENSE - relay 1 contact normal state: NO for normally open, NC for normally closed

OUTPUT TYPE - type of contact annunciation: MOMENT for momentary, MAINTN for maintained, LATCHED for latched

MOMENT TIME - the duration of a momentary annunciation

FIELD O/V - assignment of field overvoltage annunciation to output relay 1

FIELD O/C - assignment of field overcurrent annunciation to output relay 1

STATOR U/V - assignment of stator undervoltage annunciation to output relay 1

Screen: \CNTCT\RELAY_1A (7.5.2)

STATOR O/V - assignment of stator overvoltage annunciation to output relay 1

UNDER FREQ - assignment of underfrequency annunciation to output relay 1

IN OEL - assignment of overexcitation limit annunciation to output relay 1

IN UEL - assignment of underexcitation limit annunciation to output relay 1

IN FCR MODE - assignment of FCR mode (Manual) annunciation to output relay 1

NO V SENSE - assignment of lost voltage sensing annunciation to output relay 1

Screen: \CNTCT\RELAY_1B (7.5.3)

AT LO LIMIT - assignment of setpoint at low limit annunciation to output relay 1

AT HI LIMIT - assignment of setpoint at high limit annunciation to output relay 1

BELOW 10 HZ - assignment of generator frequency below 10 hertz annunciation to output relay 1

EXC DIOD OD - assignment of open exciter diode to output relay 1

EXC DIOD SD - assignment of shorted exciter diode to output relay 1

LOSS FIELD - enables and disables annunciation of loss of field protection

Screen: \CNTCT\RELAY_1C (7.5.4)

IN SCL - enables and disables stator current limiting annunciation

Screen: \CNTCT\RELAY_2 (7.5.5)

OUTPUT SENSE - relay 2 contact normal state: NO for normally open, NC for normally closed

OUTPUT TYPE - duration of contact annunciation: MOMENT for momentary, MAINTN for maintained, LATCHED for latched

MOMENT TIME - the duration of a momentary annunciation

FIELD O/V - assignment of field overvoltage annunciation to output relay 2

FIELD O/C - assignment of field overcurrent annunciation to output relay 2

STATOR U/V - assignment of stator undervoltage annunciation to output relay 2

Screen: \CNTCT\RELAY_2A (7.5.6)

STATOR O/V - assignment of stator overvoltage annunciation to output relay 2

UNDER FREQ - assignment of underfrequency annunciation to output relay 2

IN OEL - assignment of overexcitation limit annunciation to output relay 2

IN UEL - assignment of underexcitation limit annunciation to output relay 2

IN FCR MODE - assignment of FCR mode (manual) annunciation to output relay 2

NO V SENSE - assignment of lost voltage sensing annunciation to output relay 2

Screen: \CNTCT\RELAY_2B (7.5.7)

AT LO LIMIT - assignment of setpoint at low limit annunciation to output relay 2

AT HI LIMIT - assignment of setpoint at high limit annunciation to output relay 2

BELOW 10 HZ – assignment of generator frequency below 10 hertz annunciation to output relay 2

EXC DIOD OD - assignment of open exciter diode to output relay 2

EXC DIOD SD - assignment of shorted exciter diode to output relay 2

Screen: \CNTCT\RELAY_2C (7.5.8)

IN SCL - enables and disables stator current limiting annunciation

Screen: \CNTCT\RELAY_3 (7.5.9)

OUTPUT SENSE - relay 3 contact normal state: NO for normally open, NC for normally closed

OUTPUT TYPE - duration of contact annunciation: MOMENT for momentary, MAINTN for maintained, LATCHED for latched

MOMENT TIME - the duration of a momentary annunciation

FIELD O/V - assignment of field overvoltage annunciation to output relay 3

FIELD O/C - assignment of field overcurrent annunciation to output relay 3

STATOR U/V - assignment of stator undervoltage annunciation to output relay 3

Screen: \CNTCT\RELAY_3A (7.5.10)

STATOR O/V - assignment of stator overvoltage annunciation to output relay 3

UNDER FREQ - assignment of underfrequency annunciation to output relay 3

IN OEL - assignment of overexcitation limit annunciation to output relay 3

IN UEL - assignment of underexcitation limit annunciation to output relay 3

IN FCR MODE - assignment of FCR mode (Manual) annunciation to output relay 3

NO V SENSE - assignment of lost voltage sensing annunciation to output relay 3

Screen: \CNTCT\RELAY_3B (7.5.11)

AT LO LIMIT - assignment of setpoint at low limit annunciation to output relay 3

AT HI LIMIT - assignment of setpoint at high limit annunciation to output relay 3

BELOW 10 HZ – assignment of generator frequency below 10 hertz annunciation to output relay 3

EXC DIOD OD - assignment of open exciter diode to output relay 3

EXC DIOD SD - assignment of shorted exciter diode to output relay 3

Screen: \CNTCT\RELAY_3C (7.5.12)

IN SCL - enables and disables stator current limiting annunciation

Screen: \TRVRS\TRVRS_RATE (7.6.1)

The traverse rate is the time required to adjust the present control mode setpoint from one extreme of the programmed adjustment range to the other extreme.

AVR MODE - the automatic voltage regulator mode traverse rate

FCR MODE - the field current regulator mode traverse rate

Var MODE - the var control mode traverse rate

PF MODE - the power factor control mode traverse rate

Screen: \PMODE\PREP_MODE (7.7.1)

The pre-position mode for the present control mode determines whether or not the unit will respond to further setpoint change commands once the operating setpoint is driven to the pre-position value. If the pre-position mode is set for MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is set for RELEASE, then subsequent setpoint change commands are followed.

AVR MODE - automatic voltage regulator pre-position mode

FCR MODE - field current regulator pre-position mode

Var MODE - var controller pre-position mode

PF MODE - power factor controller pre-position mode

Screen: \START\START_UP (7.8.1)

SS LEVEL - soft start level

SS TIME - soft start time

Screen: \TRACK\TRACK_DATA (7.9.1)

Internal tracking (autotracking) and external tracking (auto-transfer)

INT RATE - the traverse rate of internal tracking from minimum setpoints to maximum setpoints

INT DELAY - the time delay before internal tracking begins after it is turned on

EXT RATE - the traverse rate of external tracking from minimum setpoints to maximum setpoints

EXT DELAY - the time delay before external tracking begins after it is turned on

General Settings

Screen: \COMMS\BAUD_RATE (8.1.1)

COM0 RS232 - the front panel RS232 communications port baud rate

COM1 RS232 - the rear panel RS232 autotracking communications port baud rate

COM2 RS485 - the rear panel RS485 Modbus™ communications port baud rate

Screen: \COMMS\MODBUS (8.1.2)

Settings for the rear panel RS485 Modbus™ communications port

COM2 ADDR - device address

COM2 DELAY - response delay time

PARITY - parity: NONE, ODD, or EVEN

STOP BITS - number of stop bits: 1 or 2

Screen: \SETUP\CONTRAST (8.2)

Front panel LCD contrast setting

Screen: \D200\SETUP\CLOCK (8.3)

TIME - displays and sets the current time

DATE - displays and sets the current date

Screen: \RTC\CLK_FORMAT (8.3.1)

TIME FORMAT - selects the format for displaying time on Screen 8.3

DST FORMAT - selects the DECS-200 RTC for day light savings time

DATE FORMAT - selects the format for displaying the date on Screen 8.3

SECTION 3 • FUNCTIONAL DESCRIPTION

TABLE OF CONTENTS

Figures

Tables

SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

This section illustrates and describes the functional capabilities of the DECS-200.

FUNCTION BLOCK DESCRIPTIONS

The function blocks of the DECS-200 are illustrated in Figure 3-1 and described in the following paragraphs.

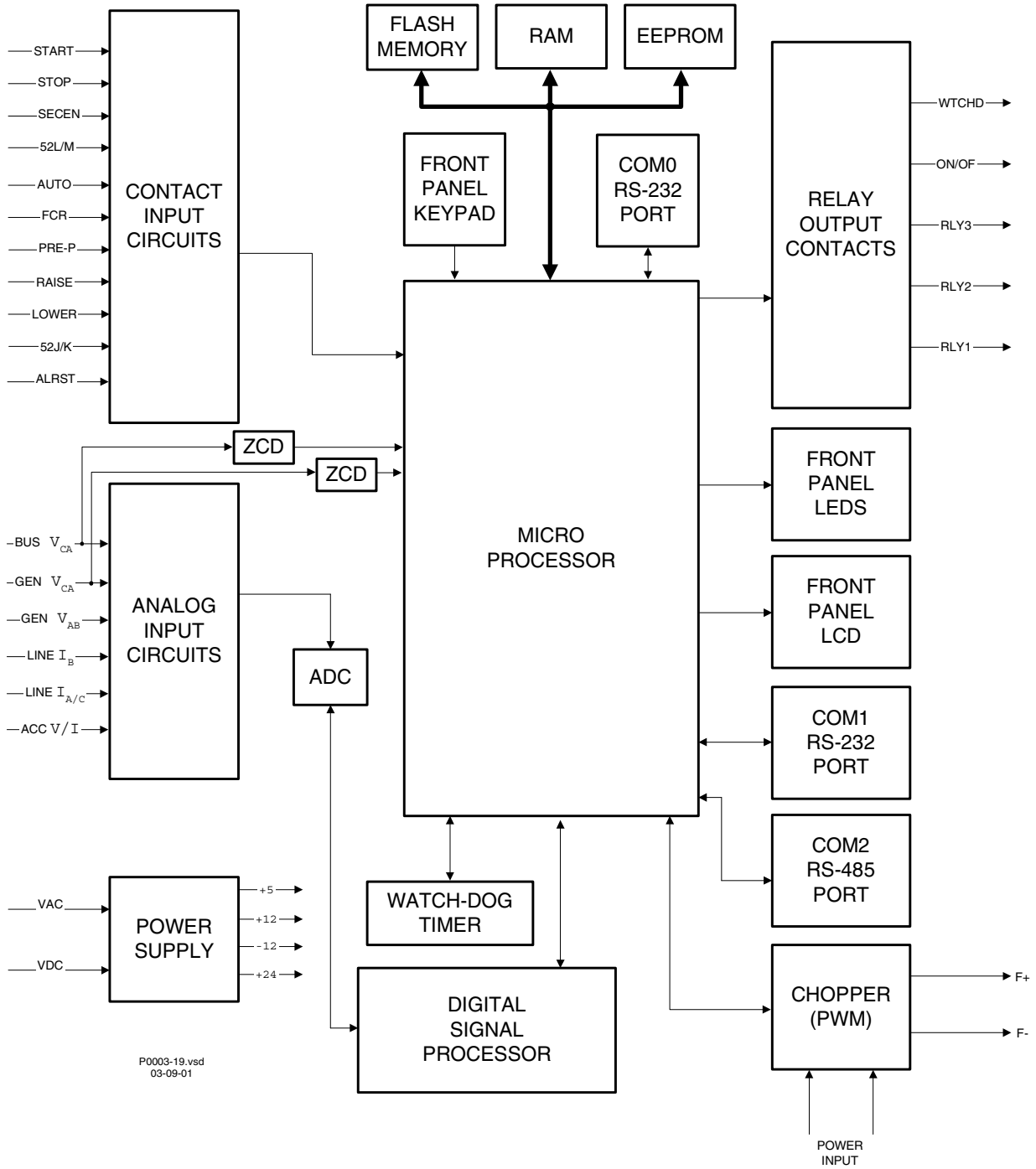

Figure 3-1. Simplified Block Diagram

Contact Input Circuits

Eleven contact input circuits, powered by isolated 12 Vdc, provide operational input control for the DECS-200. If the start and stop inputs should become active at the same time, the stop input has priority. If the AVR and FCR inputs should become active at the same time, the FCR input has priority. Each of the eleven inputs, their functions, and types of input required are defined in the following paragraphs.

Start

This input accepts a momentary contact closure and enables the DECS-200. Once the DECS-200 is enabled, this input has no effect.

Stop

This input accepts a momentary contact closure and disables the DECS-200. Once the DECS-200 is disabled, this input has no effect. The Stop input also take precedence over the Start input.

AVR (Automatic Voltage Regulation)

This input accepts a momentary contact closure that places the DECS-200 in AVR mode. Once the DECS-200 is in AVR mode, this input has no effect.

FCR (Field Current Regulation)

This input accepts a momentary contact closure that places the DECS-200 in FCR mode. Once the unit is in FCR mode, this input has no effect. The FCR input takes precedence over the AVR input.

Raise

This input increases the active operating setpoint. This function is active as long as the contact is closed. The raise increment is a function of the setpoint range of adjustment and the active mode traverse rate. The increments are directly proportional to the adjustment range and inversely proportional to the traverse rate. This input has no effect when the active pre-position mode is Maintain.

Lower

This input decreases the active operating setpoint. This function is active as long as the contact is closed. The lower increment is a function of the setpoint range of adjustment and the active mode traverse rate. The increments are directly proportional to the adjustment range and inversely proportional to the traverse rate. This input has no effect when the active pre-position mode is Maintain.

PRE-P (Pre-Position)

This input accepts a continuous contact closure that causes all setpoints to be changed to the pre-position (predefined) value. If the active pre-position mode is Maintain, then the pre-position input will override the raise and lower inputs to maintain the setpoint at the pre-position value while the contact is closed. If the active pre-position mode is Release, then the pre-position input will change the setpoint to the pre-position value and respond to raise and lower inputs.

If the non-active pre-position mode is Maintain and internal tracking is enabled, the non-active mode will maintain the non-active setpoint at the pre-position value and override the tracking function. If the non-active pre-position is Release and internal tracking is enabled, then the pre-position input will change the setpoint to the pre-position value and respond to the tracking function.

Typically, this input is connected to a 52b auxiliary contact on the generator breaker. When the generator breaker opens, all setpoints are forced to the pre-position settings. This is especially helpful if FCR mode is active and the generator is under a load. Utilizing a 52b contact will force the FCR setpoint to its pre-position setting which could be preset to the generator's no-load, nominal voltage.

52L/M (Unit/Parallel)

This input informs the DECS-200 that the system is operating in single-unit operation or paralleled to another generator or power grid in droop mode. It also switches between which overexcitation limiter (off-line limiter or on-line limiter) is activated when excitation levels exceed the OEL settings. This input is typically connected to a 52b auxiliary contact of the generator breaker and requires a continuous contact closure to switch modes. Refer to the *52J/K (Var/PF Enable)* paragraph for more information.

If both the 52L/M and 52J/K contact inputs are closed, AVR mode is active while the off-line overexcitation limiter is enabled and will limit if the settings are exceeded. This mode is intended for stand-alone (single unit) generator operation.

If the 52L/M contact input is open and 52J/K contact input is closed, droop mode is active while the on-line overexcitation limiter is enabled and will limit if the settings are exceeded. This mode is intended for

two or more generators paralleled together on an isolated bus (islanded) or paralleled directly to the utility grid. Cross-current compensation (CCC) can also be utilized in this contact configuration. However, this mode (CCC) is not intended for paralleling to the utility grid.

If both 52L/M is open and 52J/K are open, var/power factor mode is active while the on-line overexcitation limiter is enabled and will limit if the settings are exceeded. This mode is intended for applications requiring var or power factor regulation when paralleled to the utility grid.

Table 3-1 describes 52 L/M and 52 J/K contact functionality for default OEL option 1. OEL options 2 and 3 are discussed in *Overexcitation Limiter, On-Line/Off-Line OEL Options*.

Table 3-1. 52L/M and 52J/K Truth Table (Option 1, Default Settings)

DECS-200 Operating Mode	52L/M	52J/K	Generator Operating Mode
AVR mode active, off-line OEL enabled, no droop, no var/PF	Closed	Closed	Single unit/stand-alone
Droop mode active, on-line OEL enabled, no var/PF	Open	Closed	Paralleled to the utility grid (droop) or two or more generators islanded (droop or cross-current comp.)
Var/PF mode active, on-line OEL enabled	Open	Open	Paralleled to utility grid

52J/K (Var/Power Factor Enable)

This input accepts a continuous contact closure that disables var/power factor operation. An open contact enables the DECS-200 to control the generator reactive power in either the var or power factor modes. These functions must be enabled via HMI, BESTCOMS or Modbus™ before use. For more information, refer to the *52L/M (Unit/Parallel)* paragraphs. If neither var nor power factor mode is desired, it is recommended that a jumper wire be placed across the 52J/K and common terminals, and switch the 52L/M input with the generator breaker auxiliary contact (52b).

SECEN (Secondary Enable)

This input accepts a continuous contact closure and enables the DECS-200 unit as the secondary unit to another excitation control system.

ALRST (Alarm Reset)

This input accepts a momentary contact closure to clear all latched relay annunciations and front panel alarm messages.

Analog Inputs

The following analog inputs are used to sense the following quantities:

- Generator voltage (three-phase/single-phase)
- Bus voltage (single-phase)
- Phase B (line) current
- Cross current loop input
- Accessory input (remote setpoint control)
- Field voltage (internal)
- Field current (internal)

Generator Voltage Sensing Ranges

The ac voltage sensing range of the DECS-200 is split into four operating ranges: 120 volts nominal, 240 volts nominal, 480 volts nominal, and 600 volts nominal. The range selection is the same for generator and bus voltages and is based on the secondary VT voltage for the generator voltage sensing. The 120 volt range is selected if the generator secondary VT voltage is between 85 and 153 Vac. The 240 volts range is selected if the generator secondary VT voltage is between 170 and 300 Vac. The 480 volt range is selected if the generator secondary VT voltage is between 340 and 528 Vac. The 600 volt range is selected if the generator VT voltage is between 540 and 690 Vac.

Generator Voltage (V_{CA})

The GEN V_{CA} input senses the generator voltage across phases A and C. This voltage is used to estimate the generator rms voltage and frequency.

Generator Voltage (V_{AB})

The GEN V_{AB} input senses the generator voltage across phases A and B and is used to estimate the generator rms voltage. This voltage is used with the V_{CA} voltage to estimate the bus rms voltage and frequency. This input is not internally isolated.

Bus Voltage (BUS V_{CA})

The BUS V_{CA} input senses the bus voltage across phases A and C. This voltage is used to estimate the bus rms voltage and frequency. The BUS V_{CA} input is not internally isolated.

Phase B Line Current

This internally isolated input is developed from a current transformer (CT) and used to calculate the B-phase generator line current.

Cross-Current Loop Input

This input is developed from a current transformer (CT) connected to phase B of a generator and used when generators are operating in cross-current compensation mode.

Accessory Input (Remote Setpoint Control)

This internally isolated input may be either an analog voltage (–10 to +10 Vdc) or current (4 to 20 milliamperes). Separate terminals provide convenient terminations but only one input may be used in any application. This input is typically supplied by a power system stabilizer or similar device.

The accessory voltage input signal changes the setpoint of the selected operating mode. This input may be in the range of –10 to +10 Vdc or 4 to 20 milliamperes. The input signal is named a voltage signal even though one input mode may be 4 to 20 milliamperes. When the current input mode is selected, the input current (4 to 20 milliamperes) is converted by the DECS-200 to –5 to +5 Vdc voltage signal. The following equation is used when converting current signals to voltage signals.

$$V_{AUX} = 0.625(I - 12)$$

Where: V_{AUX} is the voltage signal
I is the current in milliamperes

The accessory voltage input signal is multiplied by the accessory gain setting. The gain setting is in the range of –99 to +99. If the gain is set to zero, the accessory voltage input signal is made inactive. The accessory voltage input can be active in all four operating modes.

In AVR mode, the accessory voltage input signal is multiplied by the voltage gain setting which defines the setpoint change as a percentage of the rated generator voltage.

In FCR mode, the accessory voltage input signal is multiplied by the current gain setting which defines the setpoint change as a percentage of the rated field current.

In var mode, the accessory voltage input signal is multiplied by the var gain setting which defines the setpoint change as a percentage of the rated apparent power of the generator.

In power factor mode, the accessory voltage input signal is multiplied by the power factor gain setting and divided by 100 which defines the power factor setpoint change.

Field Current and Field Voltage

These signals are sensed internally. The field voltage signal is used for field overvoltage protection. The field current signal is used for: off-line and on-line overexcitation limiting, auto-tracking, and field over-current protection.

Operating Power

The DECS-200 operating power input accepts three-phase or single-phase voltage over the range of 50 to 277 Vac (depending on the nominal field voltage) at 50 to 500 hertz. The input is rectified and filtered by the input's low-pass filter, which feeds the chopper stage. Depending on the operating power applied, three nominal output voltages are possible: 32, 63, or 125 Vdc.

Control Power

Control power may be either of two types:. nominal 24/48 Vdc or nominal 120 Vac/125 Vdc. For the 120 Vac/125 Vdc control power type, both ac and dc input power voltage may be applied for redundant power supply operation. Refer to Section 1, *General Information, Specifications*, for voltage ranges. The power

supply provides +5 Vdc, ±12 Vdc, and +24 Vdc for the DECS-200 internal circuitry. When dual power sources are used, an isolation transformer is required for the ac input.

Analog-to-Digital Converter (ADC)

All analog input signals are brought to the input of the 12-bit ADC. Each input signal is sampled at a rate that is controlled by the digital signal processor (DSP).

Microprocessor

The microprocessor is the heart of the DECS-200 and performs control, computation, self testing, and communication functions. The main processor (labeled microprocessor in Figure 3-1) generally performs low speed tasks such as protective functions, frequency measurements, communication, watchdog alarm, and other system functions. The microprocessor generates the PWM (pulse width modulated) control signal needed for chopper control and monitors its status.

Digital Signal Processor (DSP)

The DSP supports measurement, control (output and converters), metering functions and filtering. It controls both the ADC and the digital-to-analog converter (DAC). All eight analog input signals from the ADC are filtered by the finite impulse response (FIR) filters. AC signals are also filtered by the infinite impulse response (IIR) filters and dc signals (field voltage and current) are filtered by averaging filters. The DSP provides the microprocessor with the signal defining the chopper duty cycle/PWM control.

Operational Settings

Operational settings that affect the system are stored in nonvolatile memory. These settings may be changed through BESTCOMS or the front panel interface. Password access is required to change settings. Settings may be viewed without obtaining password access.

Watchdog Timer

If the microprocessor fails for any reason, output pulses to the watchdog timer stop and, after a brief interval, the watchdog timer takes the system off line and closes the watchdog output contacts.

Real-Time Clock

The real-time clock is used by the event and data logging functions to timestamp events. Time can be displayed in either 12- or 24-hour formats and can be selected to allow for daylight saving time. Two date formats are available: d-m-y or m/d/y. All formats may be selected either through the front panel HMI or BESTCOMS. Any cycling of power to the DECS-200 will reset the clock.

Pulse-Width Modulated (PWM) Output

The pulse-width modulated signal provided by the microprocessor controls the field voltage by modulating the duty cycle of the chopper (power module).

Relay Output Circuits

There are five output relays. These relay outputs are controlled by the microprocessor and sustain seven amperes at 240 Vac. Each output relay has 300 volt surge protectors across the contacts to protect against arcing from inductive loads. Relay outputs one through three are fully programmable via all interfaces. Two output relays (one form A and one form B) have predetermined functions. All output relays are described in the following paragraphs.

Programmable Outputs

Output relays RLY1, RLY2, and RLY3 may be programmed using the front panel HMI, BESTCOMS software (using the front RS-232 port (COM0)) or through the Modbus™ protocol (using the left RS-485 port (COM2)).

The three output relays labeled RLY1, RLY2, and RLY3 have the following programmable features.

- Selection of contact functionality (normally open or normally closed)
- Selection of output type (momentary, maintained for as long as the condition is present, or latched until reset)
- Program duration of momentary annunciation (from 0.1 to 5 seconds in 50 millisecond steps)
- Selection of conditions to be annunciated, including:

- Field overvoltage
- Field overcurrent
- Generator undervoltage
- Generator overvoltage
- Volts per hertz or underfrequency limit
- Overexcitation limit
- Underexcitation limit
- FCR mode
- Loss of sensing (LOS) voltage
- Active setpoint at low limit
- Active setpoint at high limit
- Generator frequency below 10 hertz
- Open exciter diode
- Shorted exciter diode
- Loss of field
- Stator current limit

NOTE

If the contacts of a programmable output relay are configured as normally closed, the normally closed contact state is maintained only while the DECS-200 has control power applied. When power is removed from the DECS-200, these contacts will open.

Watchdog Output

The Watchdog (WTCHD) output indicates a software execution problem within the DECS-200. The contact closes under the following circumstances:

- No control power is applied to the DECS-200
- After application of power for approximately eight seconds
- Software in the DECS-200 stops executing normally

On/Off Output

The On/Off (ON/OF) output indicates the enabled/disabled status of the DECS-200. the On/Off output closes when the DECS-200 is enabled and opens when the DECS-200 is disabled.

Communication

The RS-232 port (Com 0), located on the front panel, is dedicated for communication with a PC running BESTCOMS software.

The RS-232 port (Com 1), located on the right side of the unit, is dedicated for communication with a second DECS-200. This port provides tracking between units in a redundant DECS-200 system.

The RS-485 Port (Com 2), located on the left side of the unit, is dedicated for communication in remote terminal unit (RTU) mode using the Modbus™ protocol.

NOTE

Changing the baud rate or data format while that interface is in use will result in a loss of data and probably a complete loss of communication.

All three ports have a default baud rate of 9600. However, the baud rate for each port can be set independently. Available baud rates are 1200, 2400, 4800, 9600, and 19200. Ports Com) and Com 1 use a data format of 8N1 which stands for 8 data bits, no parity, and 1 stop bit. Port Com 2 has a default data format of 8N2 but the parity and number of stop bits are programmable. The choices for parity include: None, Odd, and Even. The number of stop bits may be either 1 or 2.

Memory Circuits

There are three types of memory circuits: flash memory, random access memory (RAM) and electrically erasable programmable read-only memory (EEPROM). Flash memory is nonvolatile and stores the

operating software. RAM is volatile and serves as temporary storage for data. EEPROM is nonvolatile and stores the settings and configuration.

Protection Functions

Eight protection functions are available in the DECS-200:

- Field overvoltage
- Field overcurrent
- Generator undervoltage
- Generator overvoltage
- Loss of sensing
- Generator frequency below 10 hertz
- Loss of field
- Exciter diode monitor

Each protection function can be indicated locally on the front panel display, remotely through communication port Com 0 or Com 2, and any of the three programmable output relays.

Field Overvoltage

When the field voltage increases above the Exciter Field Overvoltage Level setting for the duration of the Field Overvoltage Delay setting, a field overvoltage condition is annunciated. A field overvoltage condition is annunciated on the front panel metering screen and may be assigned to a programmable output relay for external annunciation. The Exciter Field Overvoltage Level setting is adjustable from 1 to 325 Vdc in 1 Vdc increments. The Exciter Field Overvoltage Delay setting is adjustable from 0.2 to 30.0 seconds in 0.1 second increments. If the field overvoltage timer is timing down and the field voltage drops below the Exciter Field Overvoltage Level setting, the field overvoltage timer is reset. The field overvoltage function may be disabled without changing the level or time delay settings.

Field Overcurrent

When the field current increases above the Exciter Field Overcurrent Level setting for the duration of the Exciter Field Overcurrent Delay setting, a field overcurrent condition is annunciated. Field overcurrent is annunciated on the front panel metering screen and may be assigned to a programmable output relay for external annunciation. The Exciter Field Overcurrent Level and Exciter Field Overcurrent Delay settings are related by an inverse function. This means that the higher the field current goes above the threshold, the shorter the time to an annunciation. The Exciter Field Overcurrent Delay setting is a linear multiplier for the time to an annunciation. The Exciter Field Overcurrent Level setting is adjustable from 0.1 to 20 Adc in 0.1 Adc increments. The Exciter Field Overcurrent Delay setting is adjustable from 0.1 to 20.0 in increments of 0.1. The field overcurrent protection function may be disabled without changing the level or time delay settings. Figure 3-2 shows a set of typical field overcurrent timing curves. Notice that field current levels below 103% of the field overcurrent setpoint value are unpredictable and may not cause an annunciation. Also, field current levels greater than 250% (field current multiple of 2.5 in Figure 3-2) of the setpoint value cause an annunciation in the same amount of time as the 250% level.

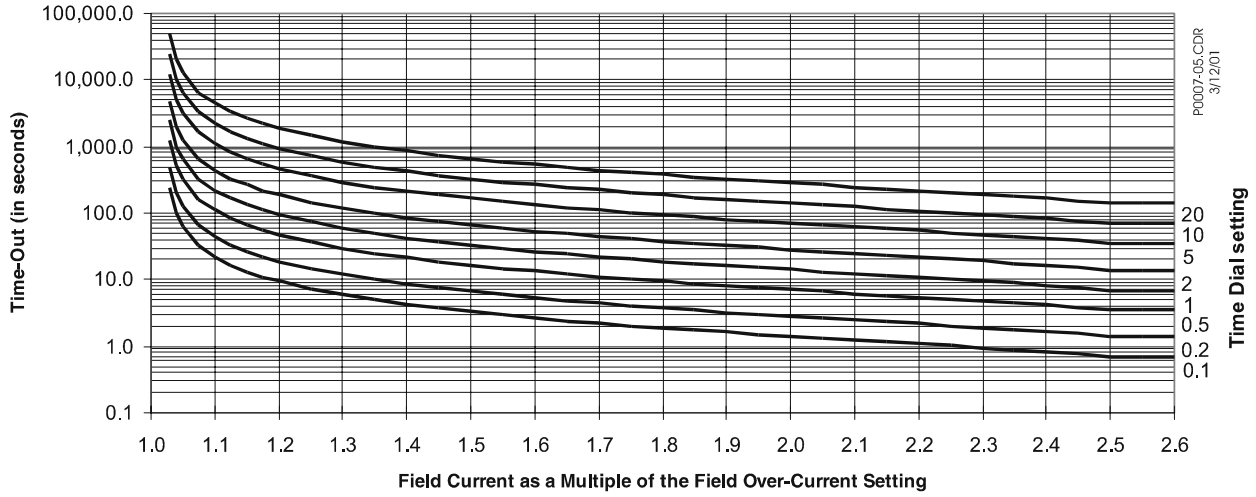

Figure 3-2. Field Overcurrent Timing Curves

Generator Overvoltage

When the generator voltage increases above the Generator Overvoltage Level setting for the duration of the Generator Overvoltage Delay setting, a generator overvoltage condition is annunciated. A generator overvoltage condition is annunciated on the front panel metering screen and may be assigned to a programmable output relay for external annunciation. The Generator Overvoltage Level setting is adjustable from 0 to 30,000 Vac in 1 Vac increments. The Generator Overvoltage Delay setting is adjustable from 0.1 to 60.0 seconds in 0.1 second increments. If the generator voltage drops below the Generator Overvoltage Level setting while the delay timer is timing down, the delay timer is reset. Generator overvoltage protection may be disabled without changing the level or time delay settings.

Loss of Sensing

A loss of sensing voltage is annunciated when either of two conditions exist:

- All three phases of generator voltage decrease below the Loss of Sensing Voltage–Balanced Level setting for the duration of the Loss of Sensing Voltage Time Delay setting.
- Any individual phase of generator sensing voltage differs by more than the Loss of Sensing Voltage–Unbalanced Level setting for the duration of the Loss of Sensing Voltage Time Delay setting.

A loss of sensing voltage is annunciated on the front panel Metering screen and may be assigned to a programmable output relay for external annunciation. The Balanced and Unbalanced Level settings are adjustable from 0 to 100% in 0.1% increments. The Time Delay setting is adjustable from 0 to 30.0 seconds in 0.1 second increments.

Below 10 Hertz

When the generator frequency decreases below 10 hertz, the condition is annunciated on the front panel display as SYSTEM BELOW 10 Hz. The programmable output relays may be configured to initiate additional annunciations or actions. A system below 10 hertz annunciation is reset automatically when the generator frequency increases above 10 hertz.

Loss of Field

When the reactive power absorbed by the generator exceeds the Loss of Field Level setting for the duration of the Loss of Field Delay setting, a loss of field condition is annunciated. A loss of field is annunciated on the front panel metering screen and may be assigned to a programmable output relay for external annunciation. The Loss of Field Level setting is adjustable from 0 to 3,000 Mvar in 1 kvar increments. The Loss of Field Delay setting is adjustable from 0 to 9.9 seconds in 0.1 second increments. If the absorbed reactive power decreases below the Loss of Field Level setting while the delay timer is timing down, the delay timer is reset. Loss of field protection can be disabled without changing the level or time delay settings.

Exciter Diode Monitor (EDM)

The DECS-200 monitors the output of the brushless exciter power semiconductors through the exciter field current and protects against both open and shorted diodes in the exciter bridge. When implementing the EDM, it is imperative that the user know and specify the number of poles for the exciter armature and the number of poles for the generator rotor.

NOTE

If the number of poles for the exciter armature and the generator rotor is unknown, the EDM function will still operate. However, only a shorted diode can be detected. If the number of poles is not known, it is best to select all parameters for the exciter open diode to off. In this situation, the generator and exciter pole parameters must be set at zero to prevent false tripping.

The EDM function estimates the fundamental harmonic of the exciter field current using discrete Fourier transforms (DFTs). The harmonic, expressed as a percentage of the field current, is then compared to the trip levels for open diode detection (OD ripple) and shorted diode detection (SD ripple). If the percentage of field current exceeds the OD Level or SD Level setting, then the appropriate delay will begin. After the programmable delay for the OD or SD event expires, and if the percentage of field current still exceeds the OD Level or SD Level setting, the event is annunciated. An exciter diode failure is annunciated on the front panel HMI and can be assigned to a programmable output relay for external annunciation. EDM

inhibit parameters prevent nuisance annunciations due to low excitation current or out-of-range generator frequency. The following parameters are required for complete operation of the EDM function.

- Pole ratio
- Trip level of EDM OD ripple
- Trip level of EDM SD ripple
- Open exciter diode delay
- Shorted exciter diode delay
- EDM inhibit level

Exciter Diode Monitor Settings

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

Setting the Trip Level

To set the trip level of the EDM OD (open diode) ripple and EDM SD (shorted diode) ripple parameters, 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 voltage while monitoring the EDM OD and EDM SD % ripple on the DECS-200 HMI metering screen. Record the highest value for each. See Section 2, *Human-Machine Interface* for more details on displaying metering quantities.

With Number of Generator Poles Known

Multiply the highest EDM OD value, obtained under Setting the Trip Level , by 3. The result is the Exciter Open Diode % Ripple Level (EDM OD % Ripple). The multiplier can be varied between 2 and 5 to increase or decrease the trip margin. However, reducing the multiplier could result in nuisance EDM OD indications. A time delay is also adjustable from 10 to 60 seconds.

Multiply the highest EDM SD value, obtained under Setting the Trip Level by 50. The result is the Exciter Shorted Diode % Ripple Level (EDM SD % Ripple). The multiplier can be varied between 40 and 70 to increase or decrease the trip margin. However, reducing the multiplier could result in nuisance EDM SD indications. A time delay is also adjustable from 5 to 30 seconds.

The DECS-200 has fixed EDM inhibit levels to prevent nuisance EDM indications while the generator sensing voltage is less than 45 Hz, greater than 70 Hz, or when the field current is less than 1 Adc. Although the user can adjust the field current inhibit level from 0 to 100%, the fixed EDM inhibit levels take priority. Pole ratios must be in the range of 1 to 10 with 0 used if the ratio is unknown.

With Number of Generator Poles Unknown

The DECS-200 can detect shorted diode conditions when the number of generator poles are not known. To provide this protection, disable EDM OD protection and set the pole ratio to zero. Enable EDM SD protection. Multiply the maximum EDM SD % ripple value, obtained under *Setting the Trip Level*, by 30. The multiplier can be varied between 20 and 40 to increase or decrease the trip margin. Reducing the multiplier could result in nuisance EDM SD indication.

Test the EDM Settings

Start the generator from a dead stop condition and increase its speed and voltage to the rated value. Load the machine to its rating and confirm no EDM alarm indications occur. All of the EDM setup guidelines presented here assume the exciter diodes were not opened or shorted at the time of setup and testing.

SOFT START

DECS-200 soft start capability provides for an orderly buildup of terminal voltage from residual to the voltage setpoint in the desired time with minimal overshoot. When the system is in startup, the voltage reference is adjusted by the amount calculated based on two parameters. These parameters are level and time. Soft start bias level is adjustable from 0 to 90 percent of the active mode setpoint in increments of 1 percent with a default setting of 5 percent. Soft start time is adjustable from 1 to 7,200 seconds in increments of 1 second with a default setting of 5 seconds. Figure 3-3 illustrates a plot of the voltage reference showing soft-start bias at 30%, soft-start time at 8 seconds and a voltage setpoint of 100%. Soft start level is the same parameter as soft-start bias when accessed on the Startup tab of the BESTCOMS System Settings screen.

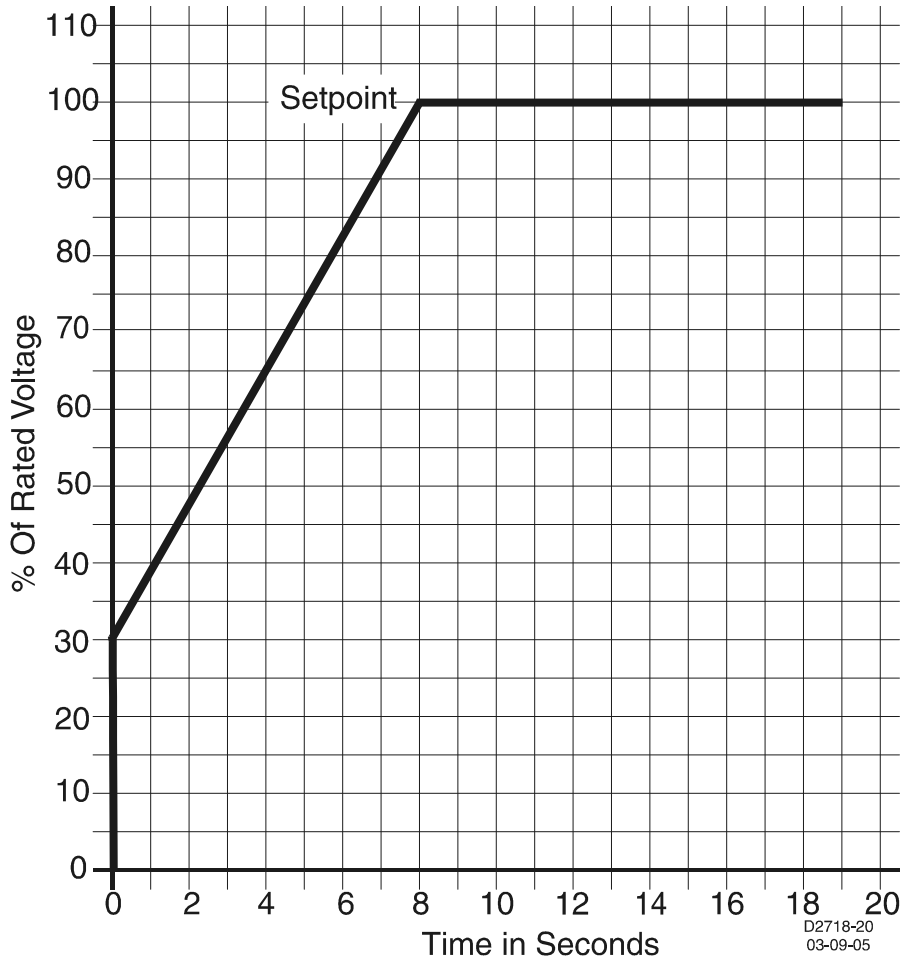

Figure 3-3. Soft Start Voltage Reference

LIMITER FUNCTIONS

DECS-200 limiter functions include an underfrequency limiter, V/Hz ratio limiter, overexcitation limiter, underexcitation limiter, and a stator current limiter.

Underfrequency Limiter

When the generator frequency drops below the corner frequency for the underfrequency slope (Figure 3-4), the voltage setpoint is automatically adjusted by the DECS-200 so that generator voltage will follow the underfrequency slope and an underfrequency annunciation occurs. The underfrequency slope can be tuned to have zero to three times the volts/hertz slope in 0.01 increments. The corner frequency can be set across a range of 45 to 65 hertz in 0.1 hertz increments. This adjustability enables the DECS-200 to precisely match the operating characteristics of the prime mover and the loads being applied to the generator. The generator underfrequency function may be effectively disabled by setting the slope to zero. However, if the system frequency is below the corner frequency, underfrequency will be annunciated even if the slope is set at zero.

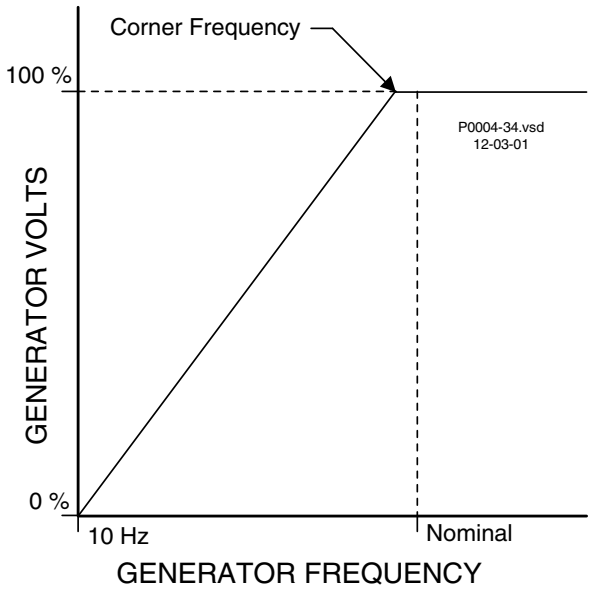

Figure 3-4. Typical Underfrequency Compensation Curve

When the underfrequency function is active, an underfrequency annunciation occurs. Underfrequency is annunciated on the front panel Metering screen and may be assigned to a programmable output relay for external annunciation.

Volts per Hertz Ratio Limiter

The volts per hertz ratio limiter prevents the regulation setpoint from exceeding the volts per hertz ratio that is prescribed by the slope setting of the DECS-200 as stated in the previous paragraphs. This feature is also useful for other potentially damaging system conditions such as a change in system voltage and reduced frequency situations that could exceed the systems volts per hertz ratio limit. Figure 3-5 illustrates a typical 1.10 PU volts per hertz limiter curve.

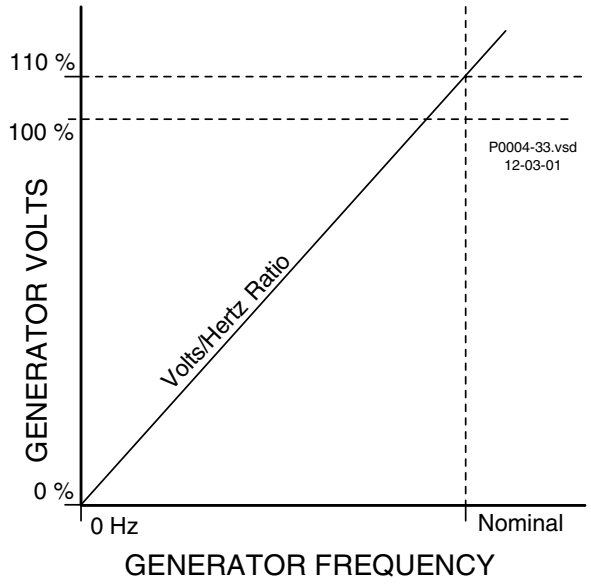

Figure 3-5. Typical 1.10 PU V/Hz Limiter Curve

Overexcitation Limiter (OEL)

Overexcitation limiting operates in all modes except FCR mode. The DECS-200 senses the field current output and limits the field current to prevent field overheating. In FCR mode, the DECS-200 announces that all conditions for OEL are fulfilled. The DECS-200 provides two types of overexcitation limiting: Summing Point and Takeover.

Summing Point OEL

Two OEL current levels are defined for off-line operation: high and low (see Figure 3-6). The generator can operate continuously at the low OEL current level and for a programmed time at the high OEL current level.

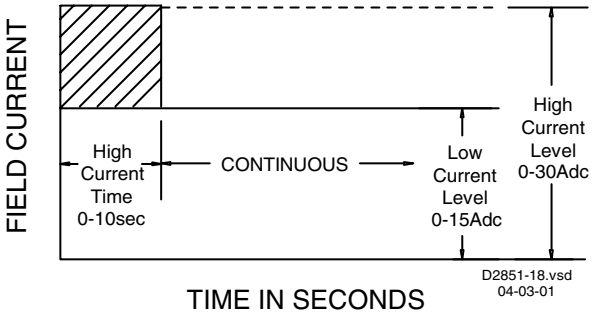

Figure 3-6. Off-Line Overexcitation Limiting

Three OEL current levels are defined for on-line operation: high, medium, and low (see Figure 3-7). The high and medium current levels can be maintained only for a user-defined amount of time. The generator can operate continuously at the low OEL current level.

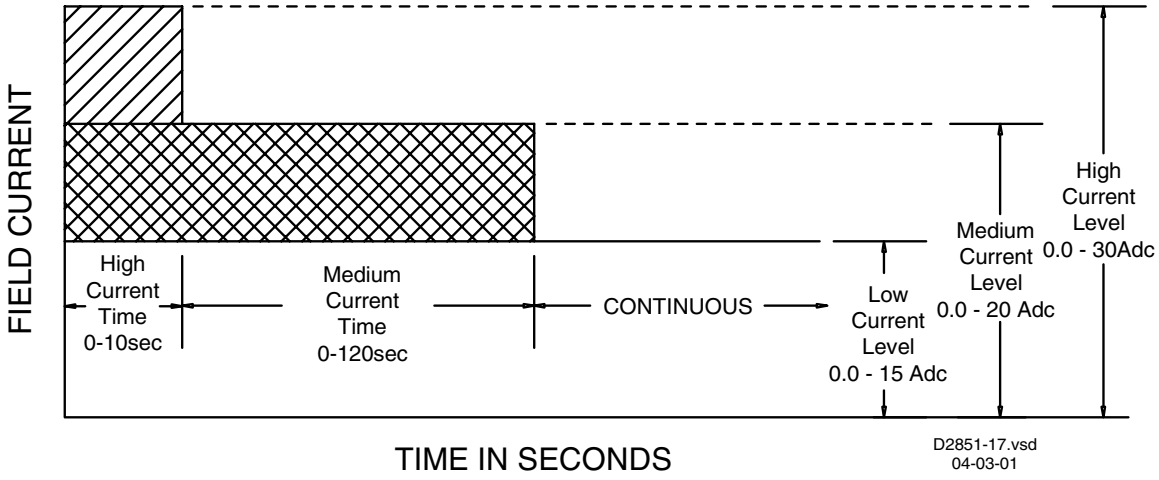

Figure 3-7. On-Line Overexcitation Limiting

The 52L/M (unit/parallel) contact input status determines which limiter is active (on-line or off-line). When the 52L/M input is closed, the off-line limiter is active. When the 52L/M input is open, the on-Line limiter setting is active.

In addition to the three current levels, the DECS-200 also uses embedded timers to prevent excessive heating of the exciter field that may be a result of repetitive overexcitation conditions. A duration timer monitors the accumulated time actually spent in an overexcitation condition and a reset timer is used to count backward from either the High OEL Current Time setting or the sum of the high plus the Medium OEL Current Time setting depending on the duration timer value. The reset timer countdown begins when the excitation current falls below the low OEL current limit level. In the event a subsequent overexcitation condition occurs before the reset timer reaches zero, the OEL limiter will resume from its state prior to the excitation current falling below the low OEL current limit level. A full OEL cycle cannot occur until the reset timer has counted down to zero after a previous OEL condition.

When the system is limiting overexcitation, an OEL condition is annunciated on the front panel Metering screen and may be assigned to a programmable output relay for external annunciation.

Takeover OEL

When takeover-style overexcitation limiting is used, the level of field current at which limiting occurs is determined by an inverse time characteristic. This inverse time characteristic is similar to that shown in Figure 3-8. Two current levels and a time dial setting are defined for the takeover OEL. Separate curves may be selected for on-line operation. If the system enters an overexcitation condition, the field current is limited and forced to follow the selected curve.

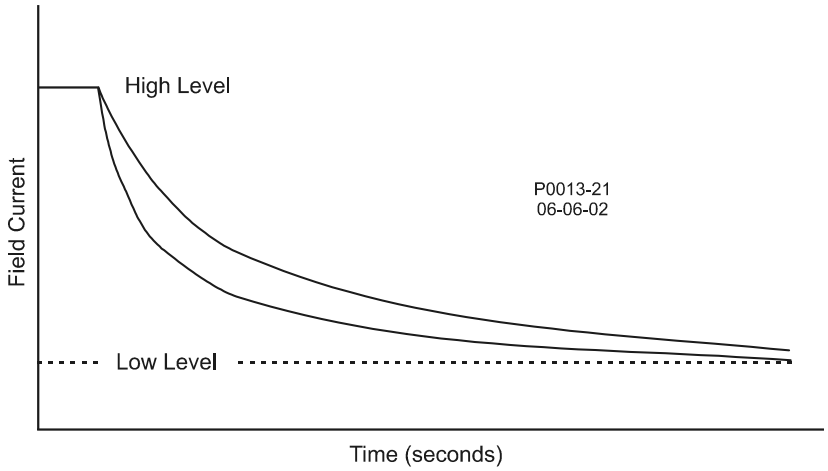

Figure 3-8. Inverse Time Characteristic for Takeover-Style OEL

On-Line/Off-Line OEL Options

Selection of on-line or off-line OEL levels/curves is determined by an OEL option selection. The following options are available.

Option 1 (default). When option 1 is selected, on-line overexcitation limiter settings are active when either the 52J/K contact input or 52L/M contact input are open. Off-line OEL settings are active when both the 52J/K contact input and 52L/M contact input are closed. The 52J/K contact input can be used to switch between on-line OEL and off-line OEL when the 52L/M contact input is jumpered. If var/power factor correction is disabled, Droop mode will be active when the 52J/K contact input is opened and AVR mode will be active when the 52J/K contact input is closed.

Option 2. Option 2 allows the 52J/K contact input to define when the off-line and on-line limiters are active. When option 2 is selected, on-line overexcitation limiter settings are active when the 52J/K contact input is open. Off-line OEL settings are active when the 52J/K contact input is closed. Option 2 is intended for cross-compound generator applications where both machines are paralleled at low rpm. Therefore, Droop mode needs to be active (52L/M contact input opened) as the speed of the machines are increased. However, off-line OEL settings for both machines need to be active.

Option 3. When option 3 is selected, on-line overexcitation limiting settings are active at all times. Option 3 allows the DECS-200 to operate in AVR mode (stand-alone application) without restriction from the off-line OEL settings. In this case, the on-line OEL settings are active to limit excessive excitation current. This option also eliminates the need for the DECS-200 to operate in Droop mode when applied in a single unit application. Therefore, voltage should not droop as reactive load increases.

Underexcitation Limiter

Underexcitation limiting (UEL) operates in all modes except FCR mode. UEL senses the leading var output of the generator and limits any further decrease in excitation to prevent loss of synchronization and end-iron heating during parallel operation. In FCR mode, the DECS-200 announces that all conditions for UEL are fulfilled. The reactive power level is selected at zero active power and the UEL limiting curve is calculated based on this value and the generator voltage and current rating. Typical leading kvar curves and a user-selected, five-point curve are shown in 3-9.

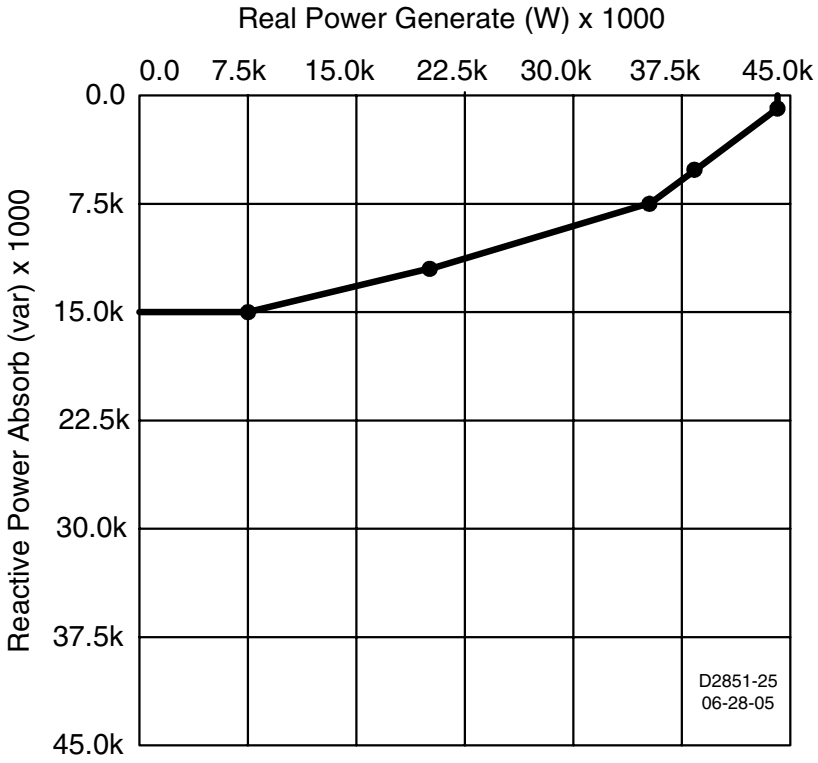

Figure 3-9. Custom Five-Point Curve

When the system is limiting underexcitation, a UEL annunciation occurs. Underexcitation is annunciated on the front panel Metering screen and may be assigned to a programmable output relay for external annunciation.

Stator Current Limiting

The stator current limiter (SCL) senses the level of stator current and limits it to prevent stator overheating. The SCL operates in all modes except FCR. In FCR mode, the DECS-200 only announces that a stator overcurrent condition exists; it does not provide current limiting.

Two SCL current levels are provided: high and low (see Figure 3-10). The generator can operate continuously at the low SCL level and for a programmed time at the high SCL level.

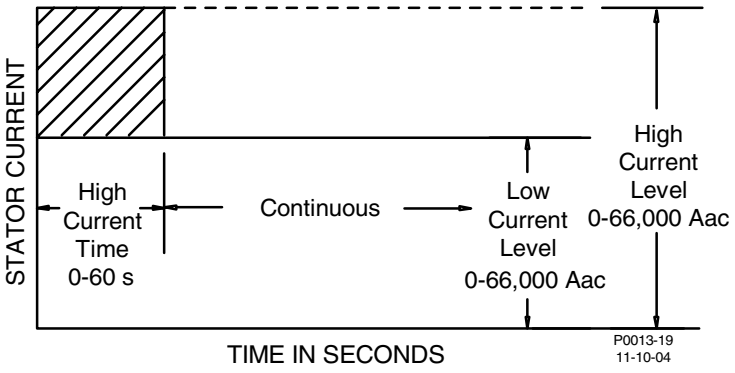

Figure 3-10. Stator Current Limiting

DROOP AND LINE-DROP COMPENSATION

Droop and line-drop compensation are accomplished through the load compensation equation:

$$V_{C1} = \left| \bar{V}_T + (R_C + jX_C)\bar{I}_T \right|$$

Where: V_{C1} is the compensated output voltage
$\bar{V}_T$ is the measured terminal-voltage vector
$(R_c + jX_C)$ are the compensation impedance values
$\bar{I}_T$ is the measured terminal-current vector

When the droop percentage is a positive quantity, reactive droop compensation is performed. Droop is the product of the output voltage and the kvar that the generator is exporting. This is equivalent to the above compensation equation with R_C equal to zero and neglecting the real part of the vector, $\bar{I}_T$.

When the droop percentage is a negative quantity, line-drop compensation (LDC) is preformed. LDC takes into account the real part of the vector, $\bar{I}_T$. Since LDC is typically used to compensate for reactive impedance losses in transformers, R_C is assumed to be zero. For LDC, the above equation becomes:

$$V_{C1} = \left| \bar{V}_T + (jX_C)\bar{I}_T \right|$$

DATA LOGGING AND REPORTING

DECS-200 data logging and reporting features include a sequence of events recorder that records up to eight oscillography records.

Sequence of Events Reporting

A sequence of events recorder monitors the internal and external status of the DECS-200. Events are scanned at 50 millisecond intervals with 127 events stored per record. All changes of state that occur during each scan are time tagged. Sequence of events reports are available through BESTCOMS. All monitored events are listed below.

System Contact Input State Changes

- Alarm reset
- AVR mode enable
- FCR mode enable
- Pre-Position
- Secondary enable
- Start
- Stop
- Unit/Parallel (52 L/M)*
- VAR/PF enable (52 J/K)*

* The 52 contacts are reported as disabled when the input is jumpered to common and reported as enabled when the input is not jumpered. All other contacts are reported as enabled when the inputs are jumpered to common.

System Output State Changes

- On/Off relay output
- Relay 1 output
- Relay 2 output
- Relay 3 output
- Watchdog relay output

System Alarm State Changes

- Exciter diode open
- Exciter diode shorted
- Field overcurrent
- Field overvoltage
- Generator overvoltage
- Generator undervoltage
- Loss of field
- Lost voltage sensing
- Overexcitation limit
- Stator current limit
- Underexcitation limit
- Underfrequency

Changes in State of System Status

- Auto tracking mode
- Control mode
- Limiter mode
- Load compensation mode
- Operating mode
- Soft-start mode
- Stop/Start
- Underfrequency mode
- Voltage matching mode

Oscillography

The data recording function of the DECS-200 can record up to eight oscillography records. Oscillography records recorded by the DECS-200 use the IEEE Standard Common Format for Transient Data Exchange (COMTRADE). Each record is time and date stamped. After eight records have been recorded, the DECS-200 begins recording the next record over the oldest record. Because all oscillography records are stored in volatile memory, the records will be lost if power is lost.

A record consists of six user selectable variables with 600 data points recorded for each variable. The sample rate or time between data point samples is user selectable from 4 milliseconds to 10 seconds. Therefore, the recording duration for a variable can range from 2.4 seconds to 6,000 seconds.

Data points may be selected for pre-trigger operation in order to capture events prior to a fault. Up to 599 pre-trigger data points may be selected. Data points that are not designated for pre-trigger recording are assigned to the post-trigger portion of the fault record. This feature combined with the adjustable sample rate allows for flexible data sampling around the fault.

The DECS-200 monitors six user-selectable internal variables. The following internal variables may be selected:

Internal Variables

- Auto tracking output (for future use)
- Auxiliary input voltage*
- AVR Error Signal
- Bus frequency
- Bus voltage
- Control output
- Crosscurrent input*
- Exciter field current Ifd
- Exciter field voltage Vfd
- Generator average L-L voltage
- Generator frequency
- Generator Ib in amps
- Generator kVA
- Generator kvar
- Generator kW
- Generator power factor
- Generator Vab
- Generator Vbc
- Generator Vca
- Generator V-I phase angle*
- Internal PID Integrator State

* Typically, these are used when commissioning or troubleshooting.

Data recording may be triggered manually using BESTCOMS, logic triggers, or level triggers.

Logic triggers allow data recording to occur as a result of an internal or external status change of the DECS-200.

Level triggering allows the user to select triggering of a data record based on the value of one of the internal variables. The value 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 goes above its maximum or falls below its minimum.

Figure 3-11 shows an example of a data record as it would look when viewed with BESTwave software. The example illustrates a voltage step change while monitoring average voltage, field voltage, and field current over a time period of 2.75 seconds.

For more information about selecting triggering types or levels, selecting internal variables for monitoring or viewing oscillography records, see Section 5, *BESTCOMS Software*.

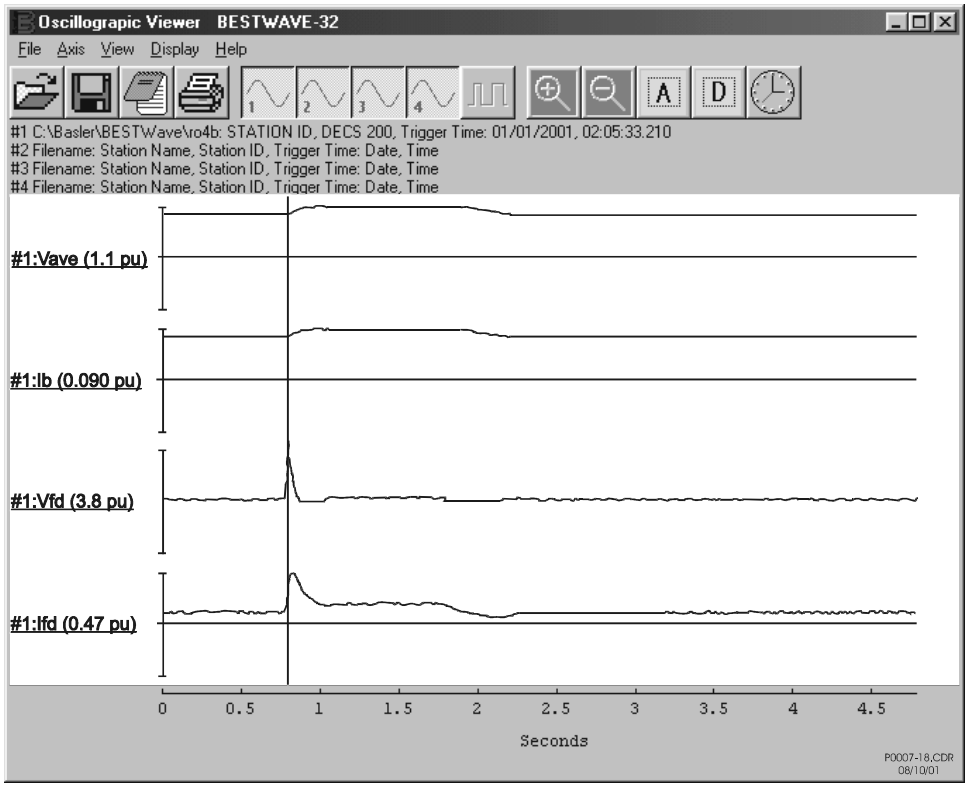

Figure 3-11. Data Record Example

SECTION 4 • INSTALLATION

TABLE OF CONTENTS

Figures

Tables

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SECTION 4 • INSTALLATION

GENERAL

DECS-200 Digital Excitation Control Systems are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a system, check the part number against the requisition and packaging list for agreement. Inspect for damage, and if there is evidence of such immediately file a claim with the carrier and notify the Basler Electric Regional Sales Office, your sales representative or a sales representative at Basler Electric, Highland, Illinois.

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

PRODUCT REGISTRATION

Registering with Basler Electric enables you to receive important information updates on your product plus new product announcements. Register your product by directing your web browser to http://www.basler.com/Register.

MOUNTING

The orientation of the DECS-200 heat sink requires vertical mounting for maximum cooling. Any other mounting angle will reduce the DECS-200's heat dissipation capability and possibly lead to premature failure of critical components. The DECS-200 may be mounted anywhere that the ambient temperature does not exceed the environmental conditions listed in Section 1, *General Information, Specifications*.

Overall DECS-200 dimensions are shown in Figure 4-1.

Two DECS-200 mounting configurations are possible: projection mounting and panel mounting. The panel drilling diagram for projection mounting of a DECS-200 is shown in Figure 4-2. Panel mounting of a DECS-200 is possible with the optional escutcheon plate (part number 9360107100). Escutcheon plate dimensions are shown in Figure 4-3. The panel cutting and drilling diagram for the escutcheon plate is illustrated in Figure 4-4.

CAUTION

The hardware provided with the escutcheon plate should be used to attach the plate to the DECS-200. If other screws are used, ensure that the screw length is no greater than ¼" (0.25") and no less than 7/32" (0.219").

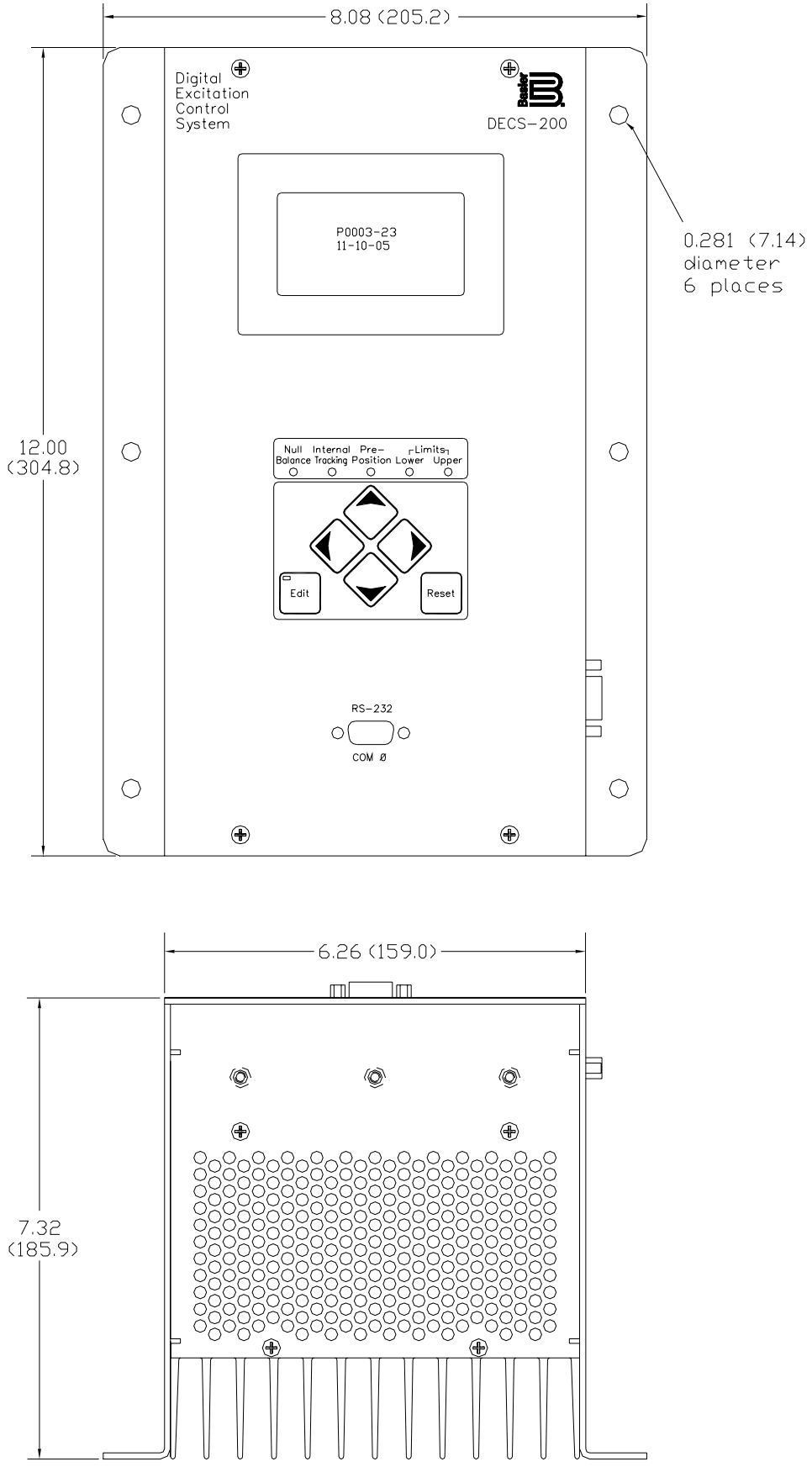


Figure 4-1. Overall Dimensions

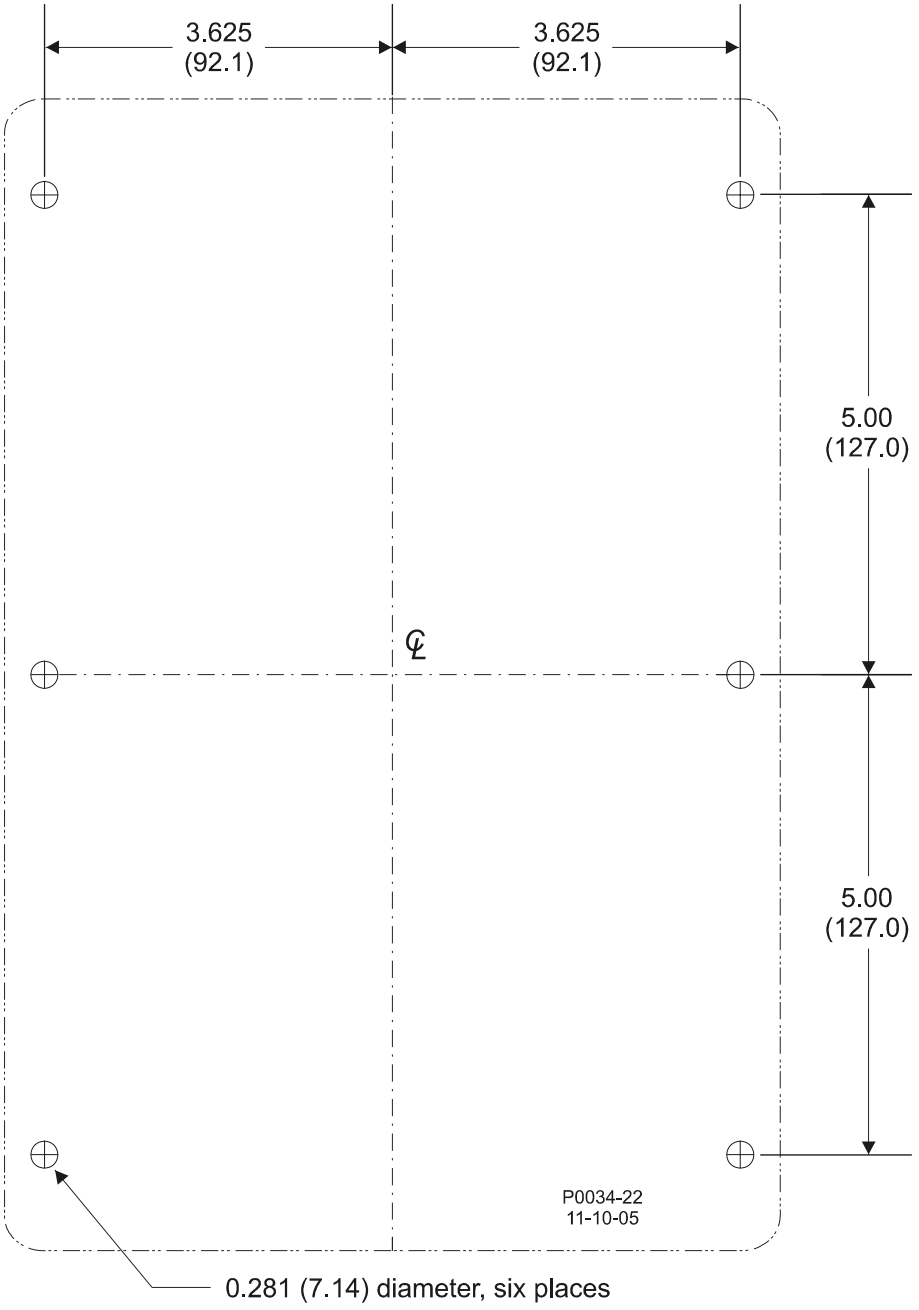


Figure 4-2. Panel Drilling Diagram, Projection Mount

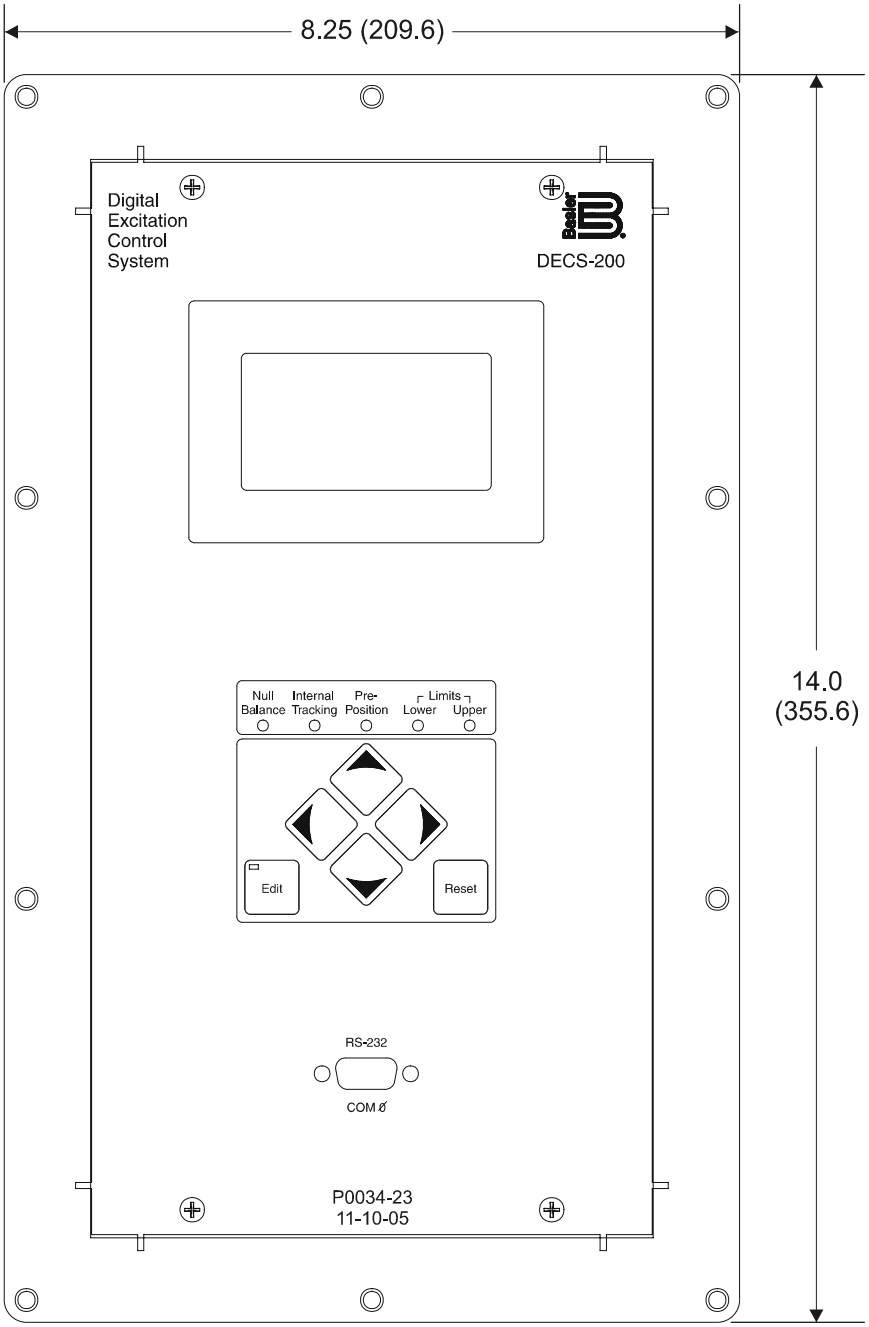
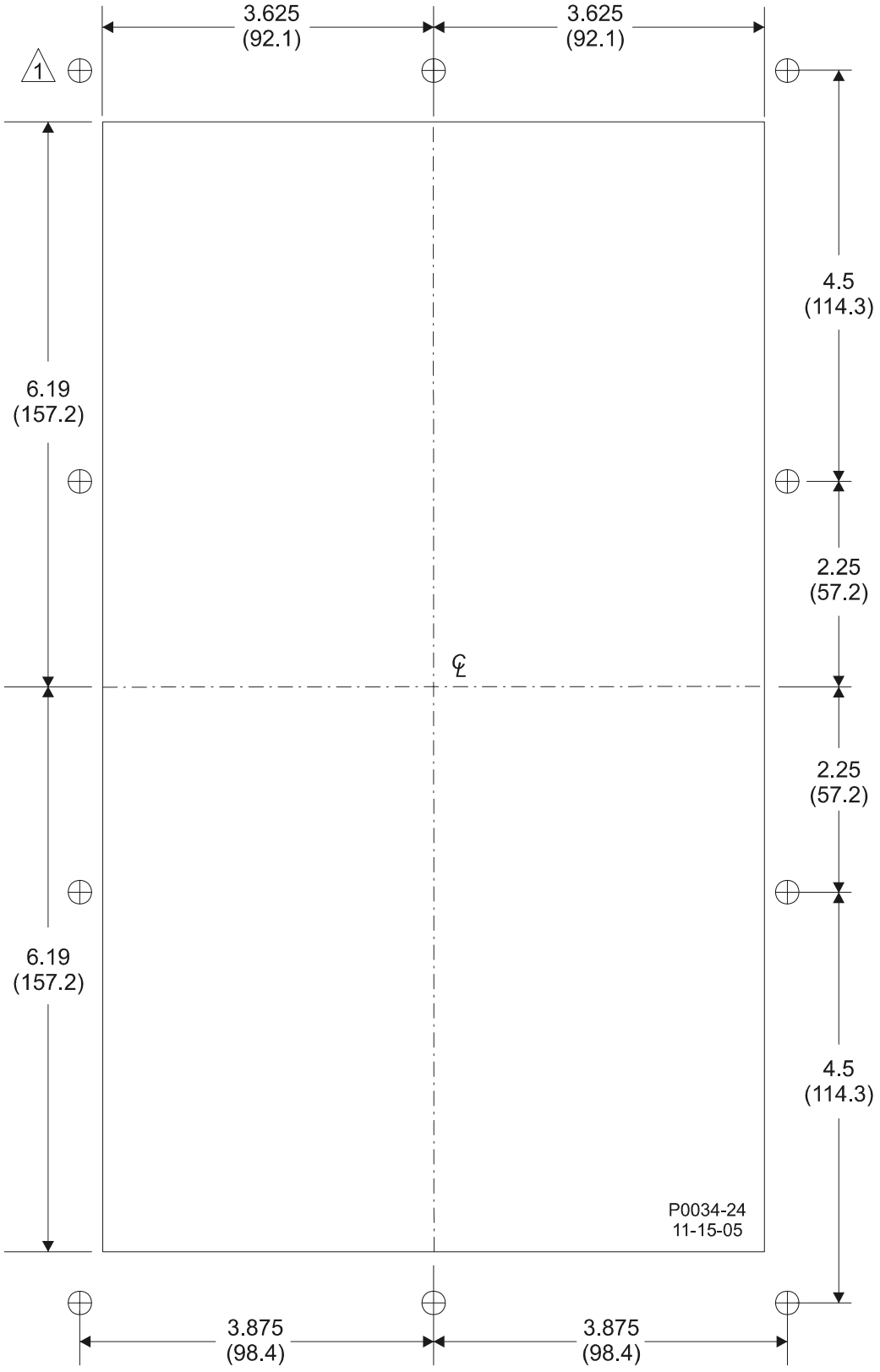


Figure 4-3. Escutcheon Plate Dimensions



1 Mounting holes (10 places) are 0.218 (5.54) diameter.
2 Use provided hardware when attaching escutcheon plate to DECS-200.

Figure 4-4. Panel Cutting and Drilling Dimensions, Panel Mount

CONNECTIONS

DECS-200 connections are dependent on the application and excitation scheme used. Observe the following guidelines when making DECS-200 connections:

- A given application may not require the use of all DECS-200 inputs and outputs.
- Incorrect wiring may result in damage to the unit.
- Applying incorrect control power, operating power, or sensing values may damage the unit. Compare the unit style number with the style chart (Figure 1-2) before applying control power.

NOTE

The DECS-200 must be hard-wired to earth ground with no smaller than 12 AWG copper wire attached to ground terminal C1. When the DECS-200 is configured in a system with other devices, a separate lead should be used to connect each device to the ground bus.

Terminations for DECS-200 connections are located on the right-hand panel, the front panel, and the left-hand panel.

Right-Hand Panel Connections

Right-hand panel terminations consist of a nine-pin, female, D-type connector (Com 1) that is used for communication with a second DECS-200 unit when operating in a redundant system. A communication cable, part number 9310300032, is available for interconnecting two DECS-200 units. Table 4-1 lists the Com 1 pin numbers and functions. Figure 4-5 illustrates the communication connections between DECS-200 units.

Table 4-1. Com 1 Pin Functions

Pin	Name	Description	Function
1		Not used	N/A
2	XMIT	Transmit	Sends serial data from DECS-200
3	RCV	Receive	Receives serial data from DECS-200
4	DTR	Data Terminal Ready	Receives signal indicating that the sending unit is operational
5	GND	Ground	Provides the signal ground
6	DSR	Data Set Ready	Sends a signal indicating that the DECS-200N is operational
7, 8, 9		Not used	N/A

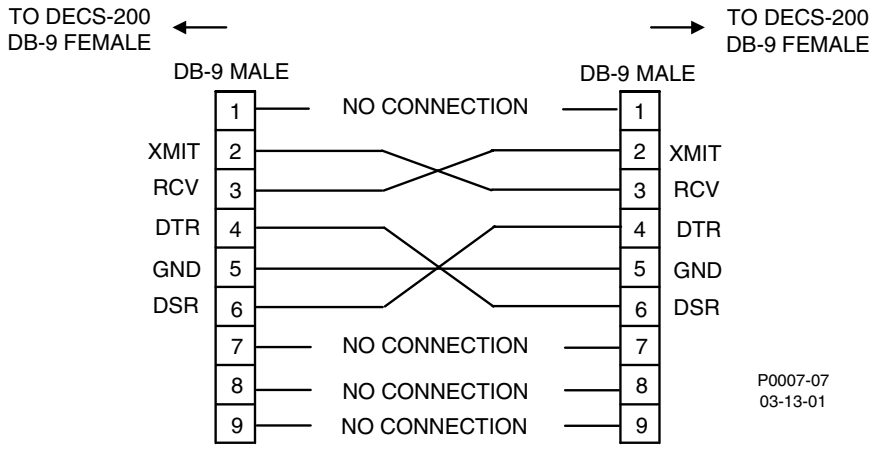


Figure 4-5. DECS-200 to DECS-200 Communication Connections

Front Panel Connections

Front panel terminations consist of a nine-pin, female, D-type connector (Com 0) that is intended for short-term, RS-232 serial communication with a PC operating BESTCOMS software. Refer to Section 5, *BESTCOMS Software* for information about using BESTCOMS to communicate with the DECS-200.

Left-Hand Panel Connections

Left-hand panel terminations consist of screw compression terminals. These terminals are illustrated in Figure 4-6. Table 4-2 lists the wire size capacity and maximum screw torque for each terminal on the left-hand panel.

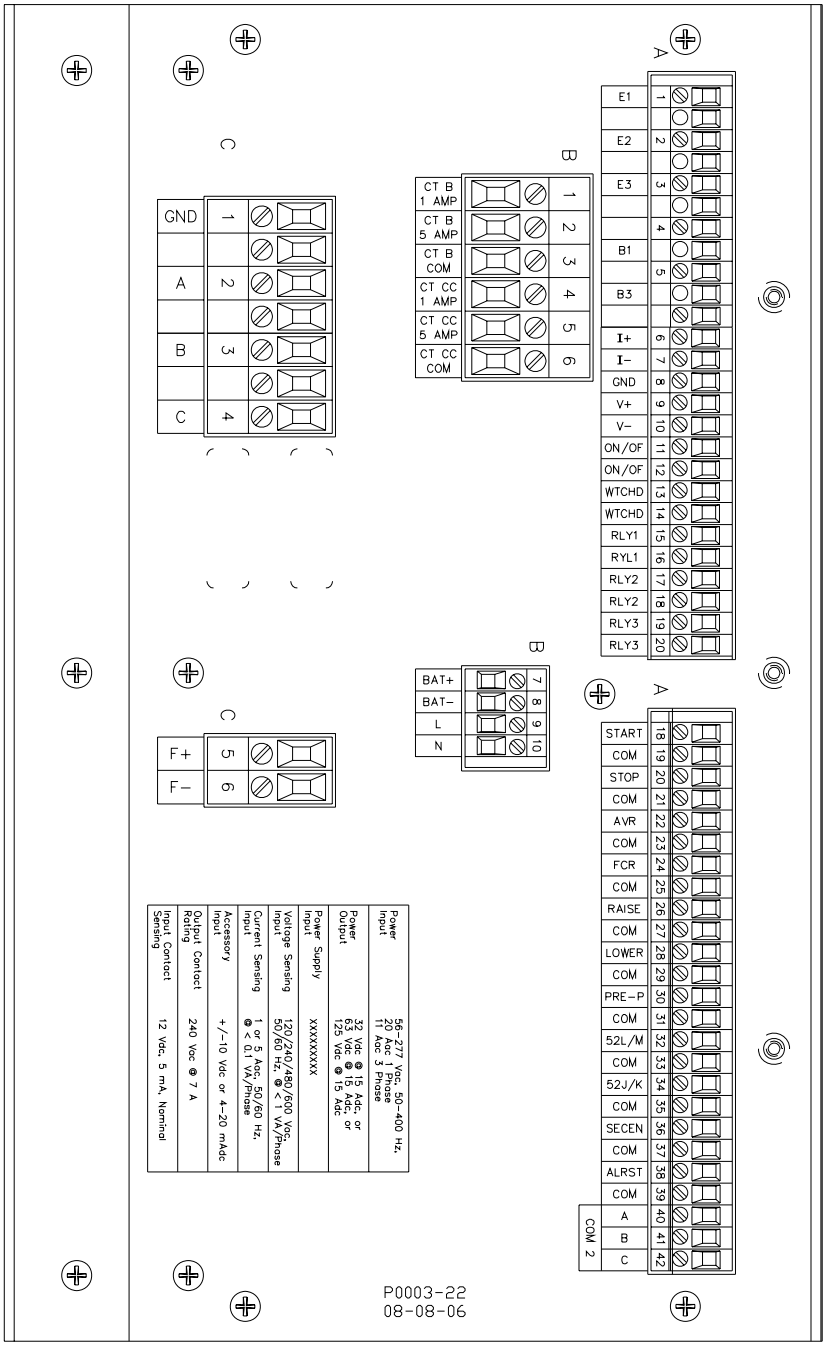


Figure 4-6. DECS-200 Left-Side Terminals

Table 4-2. Left-Hand Panel Terminal Specifications

Terminals	Wire Size Capacity	Maximum Screw Torque
A1 – A45 B7 – B10	14 AWG	0.4 N•m (3.5 in-lb)
B1 – B6 C1 – C6	10 AWG	0.5 N•m (4.4 in-lb)

In the following paragraphs, DECS-200 terminal functions are described and the terminal assignments for each function are listed.

Control Power

DECS-200 units have two sets of power terminals. One set receives dc control power and the other set receives ac control power.

A DECS-200 with a style number of XL accepts nominal dc control power of 24 or 48 Vdc. The ac control power input of a style XL DECS-200 is not used.

A DECS-200 with a style number of XC accepts nominal dc control power of 125 Vdc and nominal ac control power of 120 Vac. One source (either dc or ac) is sufficient for operation, but two sources can be used to provide redundancy. The dc input has internal protection against reversed polarity connections. When dual control power sources are used, an isolation transformer (part number BE31449001) is required for the ac input. Control power terminal functions are listed in Table 4-3.

Table 4-3. Control Power Terminals

Terminal	Description
B7 (BAT+)	Positive side of dc input
B8 (BAT–)	Negative side of dc input
B9 (L)	Line side of ac input
B10 (N)	Return or neutral side of ac input

Operating Power

Operating power for the pulse-width modulated (PWM) excitation output is usually derived from the generator output. This input can also be developed by any suitable source that delivers voltage within the limits specified in Section 1, *General Information, Specifications*.

Operating power may be either three-phase or single-phase. For single phase connections, any terminal combination can be used.

The operating power applied must be of sufficient magnitude to support the required level of excitation voltage. For 32 Vdc field voltage, the operating power voltage should be in the range of 56 to 70 Vac (60 Vac nominal). For 63 Vdc field voltage, the operating power voltage should be in the range of 100 to 139 Vac (120 Vac nominal). For 125 Vdc field voltage, the operating power voltage should be in the range of 190 to 277 Vac (240 Vac nominal). The operating power frequency can be within the range of 50 to 500 hertz.

Table 4-4. Operating Power Terminals

Terminal	Description
C2 (A)	A-phase operating power input
C3 (B)	B-phase operating power input
C4 (C)	C-phase operating power input

Chassis Ground

Terminal C1 (GND) serves as the DECS-200 chassis ground connection.

Generator and Bus Voltage Sensing

The DECS-200 accommodates either three-phase or single-phase generator sensing voltage with four automatically selected ranges: 120, 240, 400, or 600 Vac for 60 hertz systems or 100, 200, 400, or 500 Vac for 50 hertz systems. When single-phase generator sensing voltage is used, use terminals A1 and A3 for the sensing connections.

A single bus sensing voltage input connects from phase A to phase C. The bus voltage sensing input has four automatically selected ranges which are identical to the generator sensing voltage ranges.

Generator and bus voltage sensing terminals are listed in Table 4-5.

Table 4-5. Generator and Bus Voltage Sensing Terminals

Terminal	Description
A1 (E1)	A-phase generator sensing voltage input
A2 (E2)	B-phase generator sensing voltage input
A3 (E3)	C-phase generator sensing voltage input
A4 (B1)	A-phase bus sensing voltage input
A5 (B3)	C-phase bus sensing voltage input

Generator Current Sensing

A single current sensing input connects to a CT monitoring generator current on phase B. Two terminals are provided to accommodate 1 Aac or 5 Aac CTs.

An input is also provided for sensing the current in a cross-current (reactive differential) compensation loop. Two or more paralleled generators can operate in cross-current compensation mode. Figure 4-7 illustrates a typical connection diagram for two paralleled generators using the 5 Aac sensing range on the DECS-200 cross-current input. The 1 Ω resistor is a typical value that can be used to set the burden. (Ensure that the resistor power rating is adequate for the installation.) Like the generator current sensing input, the cross-current input has two terminals to accommodate 1 Aac or 5 Aac CTs.

Generator current sensing terminals are listed in Table 4-6.

Table 4-6. Generator Current Sensing Terminals

Terminal	Description
B1 (CTB 1 AMP)	B-phase generator current input for 1 Aac sensing
B2 (CTB 5 AMP)	B-phase generator current input for 1 Aac sensing
B3 (CTB COM)	B-phase generator sensing current common terminal
B4 (CT CC 1A)	Cross-current input for 1 Aac sensing
B5 (CT CC 5A)	Cross-current input for 5 Aac sensing
B6 (CT CC COM)	Cross-current common terminal

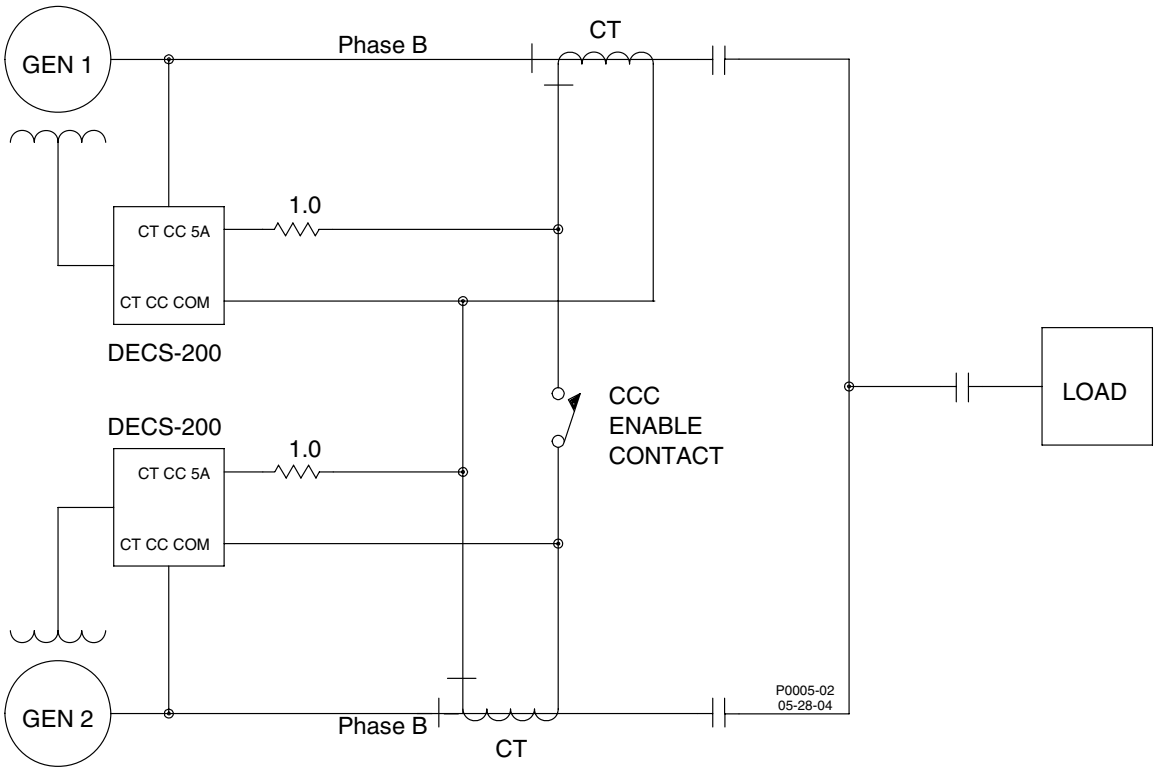


Figure 4-7. Typical Cross-Current Compensation Connections

Accessory Input

DECS-200 units accept analog accessory signals from other controllers (e.g., power system stabilizers) for remote control of the setpoint. Two types of accessory inputs are provided: voltage and current. Only one accessory input (voltage or current) may be used at one time. The voltage input accepts a signal over the range of –10 Vdc to +10 Vdc. The current input accepts a signal over the range of 4 mAdc to 20 mAdc. Shielded cable is recommended for the accessory signal. Terminal A8 is provided for the shield connection. Accessory input terminal assignments are listed in Table 4-7.

Table 4-7. Accessory Input Terminals

Terminal	Description
A6 (I+)	Positive side of current accessory input
A7 (I–)	Negative side of current accessory input
A8 (GND)	Shield connection for accessory input
A9 (V+)	Positive side of voltage accessory input
A10 (V–)	Negative side of voltage accessory input

Contact Inputs

The DECS-200 has 11 fixed-function contact inputs. Each contact input supplies an interrogation voltage of 12 Vdc and accepts dry switch/relay contacts or open-collector PLC outputs. Open-collector devices connected to the contact inputs must be compatible with the 12 Vdc interrogation voltage, be capable of conducting a minimum of 5 mAdc, and have off-state leakage current no greater than 100 μAdc. Table 4-8 lists the contact input terminals.

Table 4-8. Contact Input Terminals

Function	Terminal	Common Terminal	Input Type
Start	A21 (START)	A22 (COM)	Momentary
Stop	A23 (STOP)	A24 (COM	Momentary
AVR Mode Enable	A25 (AUTO)	A26 (COM)	Momentary

Function	Terminal	Common Terminal	Input Type
FCR Mode Enable	A27 (FCR)	A28 (COM)	Momentary
Raise Command	A29 (RAISE)	A30 (COM)	Momentary
Lower Command	A31 (LOWER)	A32 (COM)	Momentary
Pre-Position	A33 (PRE-P)	A34 (COM)	Continuous
Unit/Parallel	A35 (52L/M)	A36 (COM)	Continuous
Var/PF Enable	A37 (52J/K)	A38 (COM)	Continuous
Secondary Enable	A39 (SECEN)	A40 (COM)	Continuous
Alarm Reset	A41 (ALRST)	A42 (COM)	Momentary

Output Contacts

The DECS-200 has two fixed-function contact outputs and three user-programmable contact outputs. All output contacts are normally open (NO) except for the Watchdog output which is normally closed (NC). Output contact terminal assignments are listed in Table 4-9. For additional information about relay output specifications, refer to Section 1, *General Information*. For information about configuring the user-programmable outputs, refer to Section 3, *Functional Description*.

Table 4-9. Output Contact Terminals

Terminal	Description
A11 (ON/OF)	On/Off contact terminals
A12 (ON/OF)	
A13 (WTCHD)	Watchdog contact terminals (normally closed)
A14 (WTCHD)	
A15 (RLY1)	Programmable relay #1 terminals
A16 (RLY1)	
A17 (RLY2)	Programmable relay #2 terminals
A18 (RLY2)	
A19 (RLY3)	Programmable relay #3 terminals
A20 (RLY3)	

Field Output

The DECS-200 output is capable of supplying 15 Adc of continuous excitation current to a field with no less than 2.13 ohms of resistance (at 32 Vdc), 4.2 ohms of resistance (at 63 Vdc), or 8.3 ohms of resistance (at 125 Vdc). Field output terminals are listed in Table 4-10.

Table 4-10. Field Output Terminals

Terminal	Description
C5 (F+)	Field output positive terminal
C6 (F–)	Field output negative terminal

Com 2 Connections

Communication port Com 2 is intended for polled communication over a Modbus network. Twisted-pair cable is recommended for Com 2 connections. Com 2 terminals are listed in Table 4-11. Figure 4-8 illustrates the Com 2 connections used for multiple DECS-200 units communicating over a Modbus network.

Table 4-11. Com 2 Terminals

Terminal	Description
A43 (A)	RS-485 send/receive A terminal
A44 (B)	RS-485 send/receive B terminal
A45 (C)	RS-485 signal ground terminal

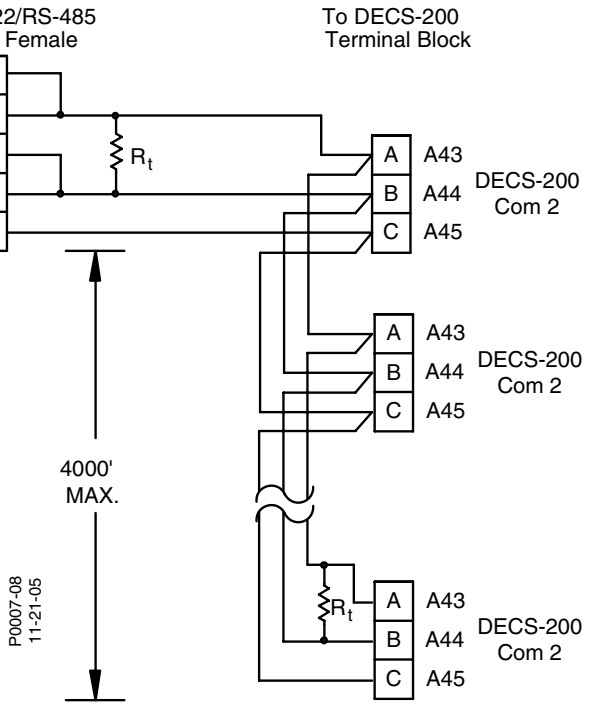


Figure 4-8. RS-485 DB-37 to DECS-200

Typical Connections

Connections for a typical DECS-200 application are illustrated in Figure 4-9.

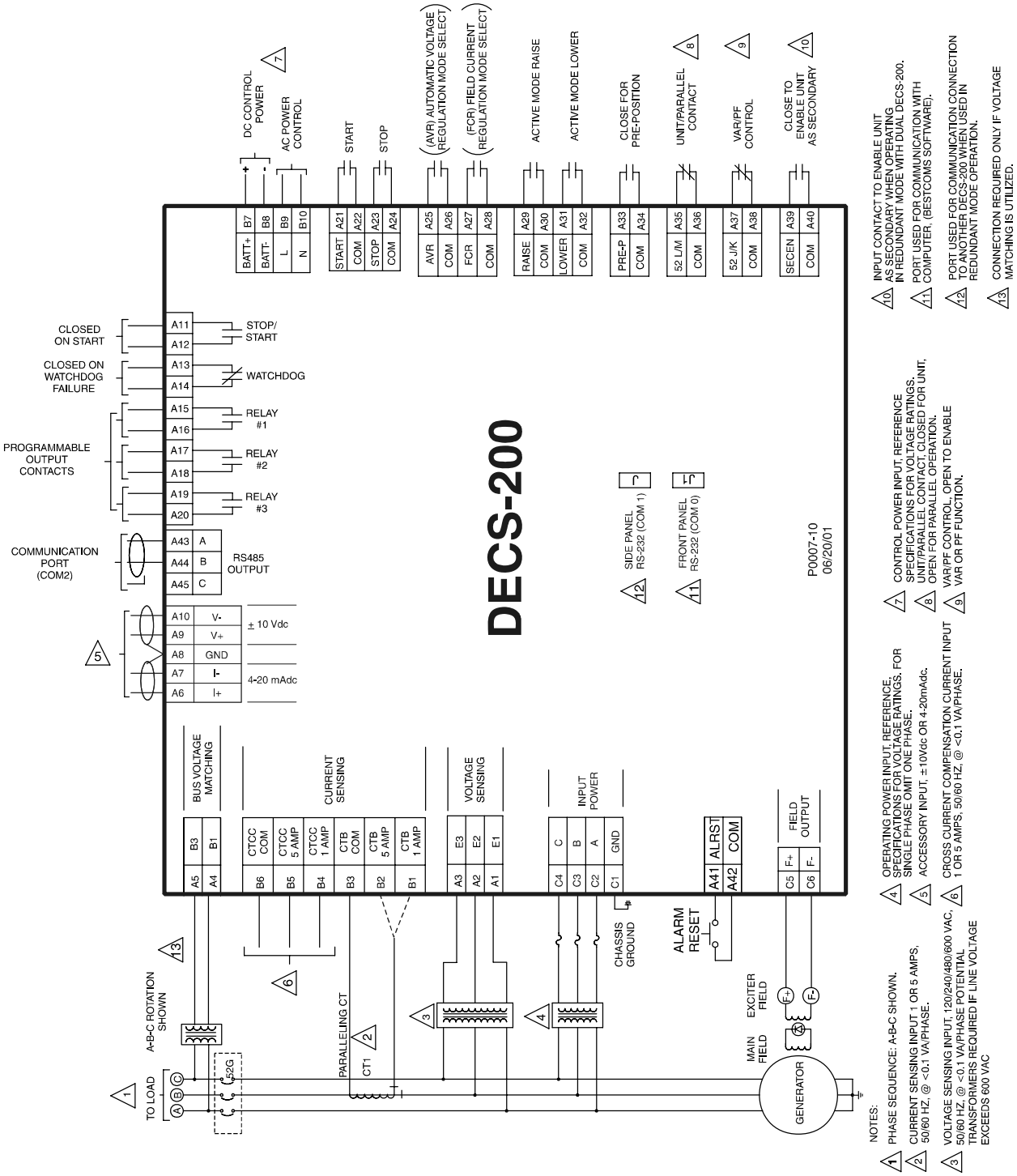


Figure 4-9. Typical Connections

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SECTION 5 • BESTCOMS SOFTWARE

TABLE OF CONTENTS

Figures

Tables

SECTION 5 • BESTCOMS SOFTWARE

INTRODUCTION

BESTCOMS is a Windows®-based application that provides a user-friendly environment for programming and customizing the DECS-200. In addition to screens for configuring DECS-200 settings, BESTCOMS has metering screens for viewing machine and system parameters and control screens for remote control of the excitation system. An integrated PID calculator simplifies the selection of stability settings.

INSTALLATION

BESTCOMS-DECS200 software contains a setup utility that installs the program on your PC. When it installs the program, an uninstall icon is created that you may use to uninstall (remove) the program from your PC. The minimum recommended operating requirements are listed in the following paragraph.

Operating Requirements

- IBM compatible PC, 486 DX2 or faster (100 MHz or higher speed microprocessor recommended), with a minimum 20 megabytes of RAM
- Microsoft, Windows® 95, 98, Me, 2000, XP or NT®
- CD-ROM drive
- One available serial port

Installing BESTCOMS

1. Insert the DECS-200 CD-ROM into the PC CD-ROM drive.
2. When the DECS-200 Setup and Documentation CD Menu appears, click the Install button for BESTCOMS-DECS200. The BESTCOMS setup utility automatically installs BESTCOMS.

When BESTCOMS is installed, a Basler Electric folder is added to the Windows program menu. This folder is accessed by clicking the Start button and pointing to Programs. The Basler Electric folder contains an icon for BESTCOMS-DECS200.

Connecting the DECS-200 and PC

Connect a communication cable between the DECS-200 front panel RS-232 connector (Com 0) and the appropriate communication port of the PC.

STARTING BESTCOMS

BESTCOMS is started by clicking the Windows Start button, pointing to Programs, the Basler Electric folder, and then clicking the BESTCOMS-DECS200 icon. At startup, a dialog box with the program title and version number is displayed briefly. After this dialog box is displayed, the System Configuration Screen is displayed (Figure 5-7).

Establishing Communication

Communication between BESTCOMS and the DECS-200 must be established before viewing metering values or reading or changing settings. BESTCOMS screen settings are updated only after communication is opened or the communication settings have been changed.

Open the DECS-200 communication port by clicking **Communications** on the menu bar, hovering the mouse pointer over Open Comm Port and clicking **Front Port - RS-232** (Figure 5-2). When the Comm Port dialog box appears, select the appropriate PC communication port and click the **Initialize** button. BESTCOMS initiates communication by retrieving the configuration settings from the DECS-200.

NOTE

BESTCOMS may display the dialog box of Figure 5-1 when initiating DECS-200 communication, obtaining DECS-200 configuration settings or performing other tasks. It's important to wait until the box disappears before trying to execute communication commands. Issuing commands while the Reading from DECS-200 dialog box is present may disrupt communication between BESTCOMS and the DECS-200.

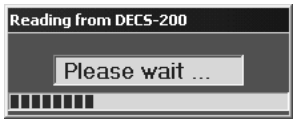

Figure 5-1. Wait Dialog Box

Configuring the Communication Ports

DECS-200 communication settings are changed through the Communication Port Settings screen. To access this screen, click **Communications** on the menu bar and click **Port Configuration**. Communication port settings are illustrated in Figure 5-2 and described in the following paragraphs.

Serial Port. To modify the settings of a communication port, the serial port must first be selected. Each port has a corresponding setting selection. Front-panel communication port settings are adjusted by selecting COM0 RS-232. Right-hand panel communication port settings are adjusted by selecting COM1 RS-232. Left-hand panel communication port settings are adjusted by selecting COM2 RS-485.

Baud Rate. A baud rate of 1200, 2400, 4800, 9600, or 19200 may be selected for each serial port.

Parity. This setting can be adjusted only for port Com 2. A setting of N (no parity) O (odd parity), or E (even parity) may be selected.

Data Bits. The number of data bits is not adjustable and fixed at 8.

Stop Bits. This setting can be adjusted only for port Com 2. One (1) stop bit or two (2) stop bits may be selected.

Modbus Settings, Address. This setting is enabled only for port Com 2. A device address of 1 through 247 may be selected.

Modbus Settings, Response Time Delay. This setting is enabled only for port Com 2. A response time delay of 10 to 200 milliseconds may be entered in 10 millisecond increments.

Once changes are made to the communication settings and the OK button is clicked, the Password dialog box of Figure 5-3 appears and prompts you to enter a password. Each DECS-200 is delivered with "decs2" as the default password. See *Creating a Password* for information about changing the password. After the correct password is entered, the communication setting changes are made active.

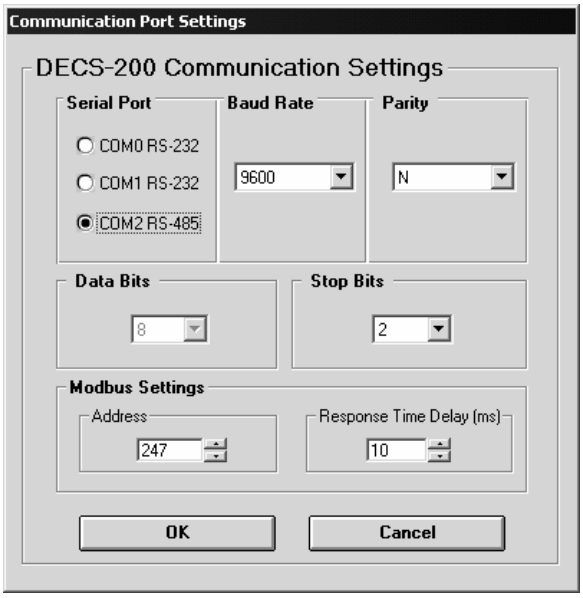

Figure 5-2. Communication Port Settings

Figure 5-3. Password Dialog Box

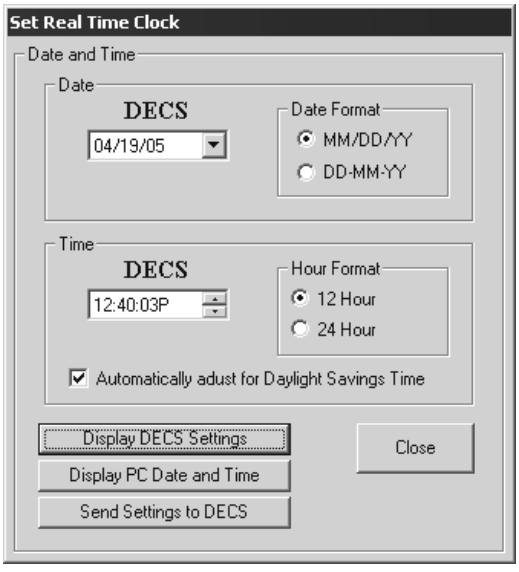

Figure 5-4. Set Real Time Clock Screen

Configuring the Real-Time Clock

DECS-200 timekeeping is set and configured through the Set Real Time Clock screen (Figure 5-4). To access the Set Real Time Clock screen, click **Configure** on the menu bar and click **Real Time Clock**. The DECS-200 date and time are set by altering the date and time fields or by retrieving the PC date and time and then sending the values to the DECS-200. The date format can be selected as MM/DD/YY or DD-MM-YY. Timekeeping can use the 12-hour or 24-hour format. Daylight saving time compensation can be enabled or disabled.

Assigning Identification Labels

Identification labels can be assigned to the DECS-200 through the Device ID screen (Figure 5-5). The information entered on the Device ID screen identifies the DECS-200 unit and associates it with a location and one or two operators. The Device ID screen is accessed by clicking **Configure** on the menu bar and clicking **Device ID Information**. Information entered on the Device ID screen is used in sequence-of-events reporting and settings printouts. Each field of the Device ID screen accepts a maximum of 30 alphanumeric characters.

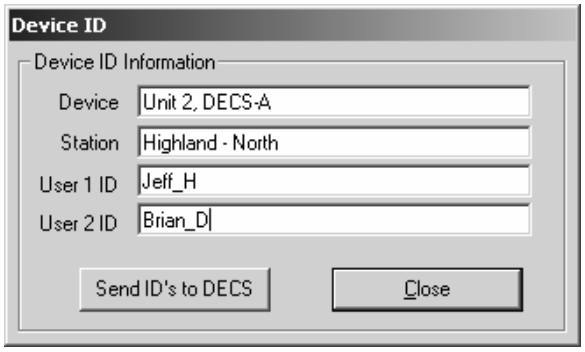

Figure 5-5. Device ID Screen

Creating a Password

Password protection guards against unauthorized changing or viewing of DECS-200 settings. A single password protects all DECS-200 settings. The DECS-200 is delivered with a default password of *decs2*. The password can be changed only after communication between BESTCOMS and the DECS-200 is established. Once the password is changed, it should be stored in a secure location. If the user-defined password is lost or forgotten, BESTCOMS must be reloaded to restore the default password. A user password is entered on the Change DECS Password screen. This screen, illustrated in Figure 5-6, is accessed by clicking **Communications** on the menu bar and clicking **Password Change**. A password containing up to six alphanumeric characters may be entered.

Figure 5-6. Change DECS Password Screen

CHANGING SETTINGS

A setting is changed by clicking within the setting field and typing the new setting value. When the cursor is placed within a setting field, the range limits and increments for the setting are displayed on the status bar. If a value outside the range limits is entered, an Input Error dialog box will appear and display the acceptable range limits for the setting.

Sending Settings to the DECS-200

Once all desired setting changes have been made on a setting group screen, the settings must be sent to the DECS-200 before viewing other screens. Otherwise, the setting changes will be lost. Setting changes can be sent to the DECS-200 by clicking the **SendToDECS** button or by clicking **Communications** on the menu bar and then clicking **Send To DECS**. A single setting change can be sent to the DECS-200 by pressing the keyboard Enter key. Functions controlled by option buttons or checkboxes are immediately sent to the DECS-200 when the option button or checkbox is selected.

Retrieving DECS-200 Settings

Settings are retrieved from the DECS-200 by clicking the **GetFromDECS** button. This causes the current DECS-200 settings to be displayed on the BESTCOMS setting screens. DECS-200 settings can also be retrieved by clicking **Communications** on the menu bar and clicking **Get From DECS**.

Saving Settings in DECS-200 Memory

DECS-200 settings are saved in nonvolatile memory (EEPROM). In the event of a control power loss, these are the settings that are active at power-up. When setting changes are made and sent to the DECS-200, they are automatically saved to EEPROM (if the correct password is entered). When you close communication or exit BESTCOMS, you may be asked for a password. Enter the correct password to ensure that all setting changes are saved.

SYSTEM SETTINGS

DECS-200 settings, metering values, and data records are arranged into seven groups within BESTCOMS:

- System Configuration
- Setting Adjustments
- Control Gain
- Analysis
- Protection/Relay
- Data Log
- Metering/Operation

Each group is contained on a BESTCOMS screen. A screen's settings and parameters are further organized by labeled tabs within the screen. In the following paragraphs, settings, metering values, and data records are arranged and defined according to the organization of the BESTCOMS screen and tabs.

System Configuration

The System Configuration screen consists of four tabs labeled System Options, System Data, Rated Data, and Auxiliary Input. To view the System Configuration screen, click the **Configure** button on the toolbar or click **Screens** on the menu bar and click **System Configuration**.

System Options

System Options tab functions are shown in Figure 5-7 and described in the following paragraphs.

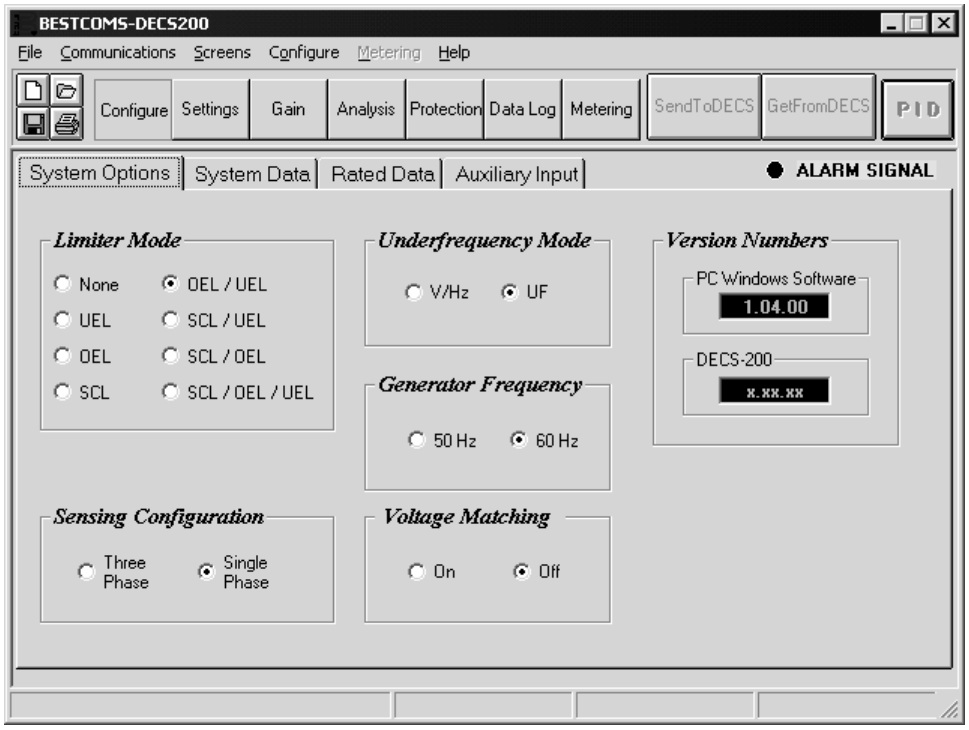

Figure 5-7. System Configuration Screen, System Options Tab

Limiter Mode. This setting disables all limiters or enables the underexcitation limiter (UEL), overexcitation limiter (OEL), or stator current limiter (SCL). Selection of the following limiter combinations is also possible: OEL/UEL, SCL/UEL, SCL/OEL, and SCL/OEL/UEL.

Sensing Configuration. Configures the generator sensing voltage as either single-phase or three-phase.

Underfrequency Mode. Configures underfrequency limiting for V/Hz or underfrequency operation.

Generator Frequency. Selects either 50 hertz or 60 hertz as the nominal system frequency.

Voltage Matching. Enables or disables voltage matching. For voltage matching to be enabled, the DECS-200 must be operating in AVR mode, var/power factor correction must be disabled, and the system must be off line.

Version Numbers. These two read-only fields display the version of BESTCOMS software and the firmware version of the DECS-200 connected to the PC operating BESTCOMS. In order for the DECS-200 firmware version to be displayed, communication must be established between BESTCOMS and the DECS-200.

System Data

System Data tab functions are shown in Figure 5-8 and described in the following paragraphs.

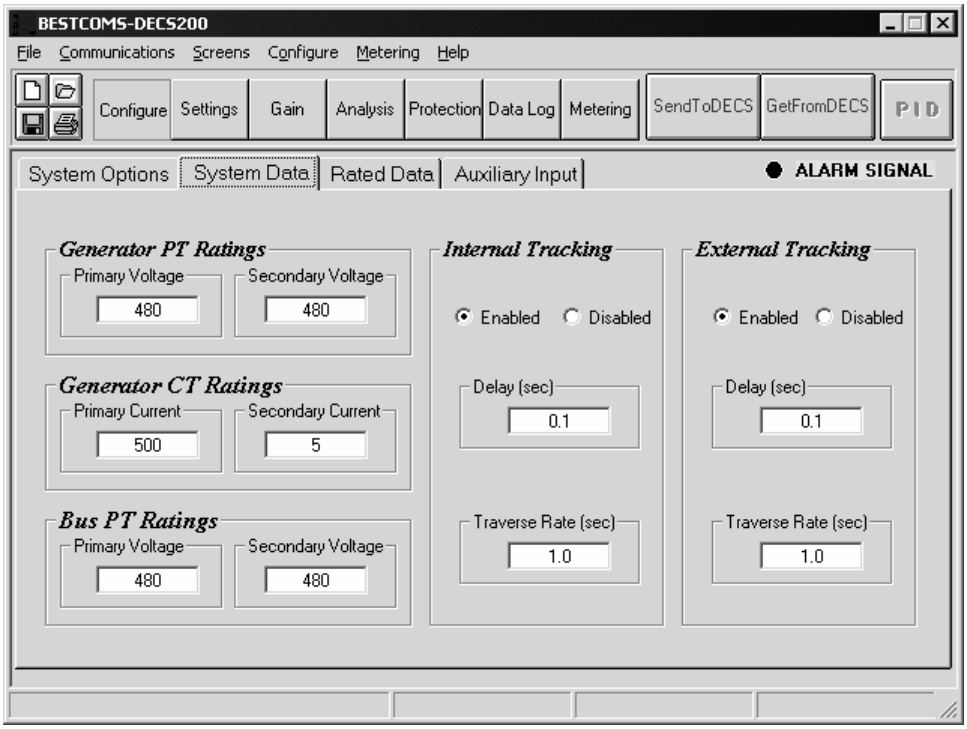

Figure 5-8. System Configuration Screen, System Data Tab

Generator PT Ratings, Primary Voltage. Sets the rated primary voltage of the generator potential transformer (PT). Generator and bus PT ratings must be specified in the same sensing range. A setting of 1 to 30,000 Vac may be entered in 1 Vac increments.

Generator PT Ratings, Secondary Voltage. Sets the rated secondary voltage of the generator potential transformer. Generator and bus PT ratings must be specified in the same sensing range. A setting of 1 to 600 Vac may be entered in 1 Vac increments.

Generator CT Ratings, Primary Current. Sets the rated primary current of the generator current transformer (CT). A setting of 1 to 60,000 Aac may be entered in 1 Aac increments.

Generator CT Ratings, Secondary Current. Sets the rated secondary current of the generator current transformer (CT). A setting of 1 Aac or 5 Aac may be entered.

Bus PT Ratings, Primary Voltage. Sets the rated primary voltage of the bus potential transformer (PT). Generator and bus PT ratings must be specified in the same sensing range. A setting of 1 to 500,000 Vac may be entered in 1 Vac increments.

Bus PT Ratings, Secondary Voltage. Sets the rated secondary voltage of the bus potential transformer (PT). Generator and bus PT ratings must be specified in the same sensing range. A setting of 1 to 600 Vac may be entered in 1 Vac increments.

Internal Tracking, Enabled/Disabled. Enables or disables tracking of the active control mode setpoint by the inactive control modes.

Internal Tracking, Delay. Determines the time delay between a control mode change and setpoint tracking. A setting of 0 to 8 seconds may be entered in 0.1 second increments.

Internal Tracking, Traverse Rate. Determines the amount of time required for the inactive control mode to traverse (cross) the full setting range of the active control mode setpoint. A setting of 1 to 80 seconds may be entered in 0.1 second increments.

External Tracking, Enable/Disable. Enables or disables tracking of a second DECS-200's setpoint.

External Tracking, Delay. Determines the time delay between a transfer to a second DECS-200 and start of tracking of the second DECS-200 setpoint. A setting of 0 to 8 seconds may be entered in 0.1 second increments.

External Tracking, Traverse Rate. Determines the amount of time required for the DECS-200 to traverse (cross) the full setting range of a second, active DECS-200. A setting of 1 to 80 seconds may be entered in 0.1 second increments.

Rated Data

Rated Data tab functions are shown in Figure 5-9 and described in the following paragraphs.

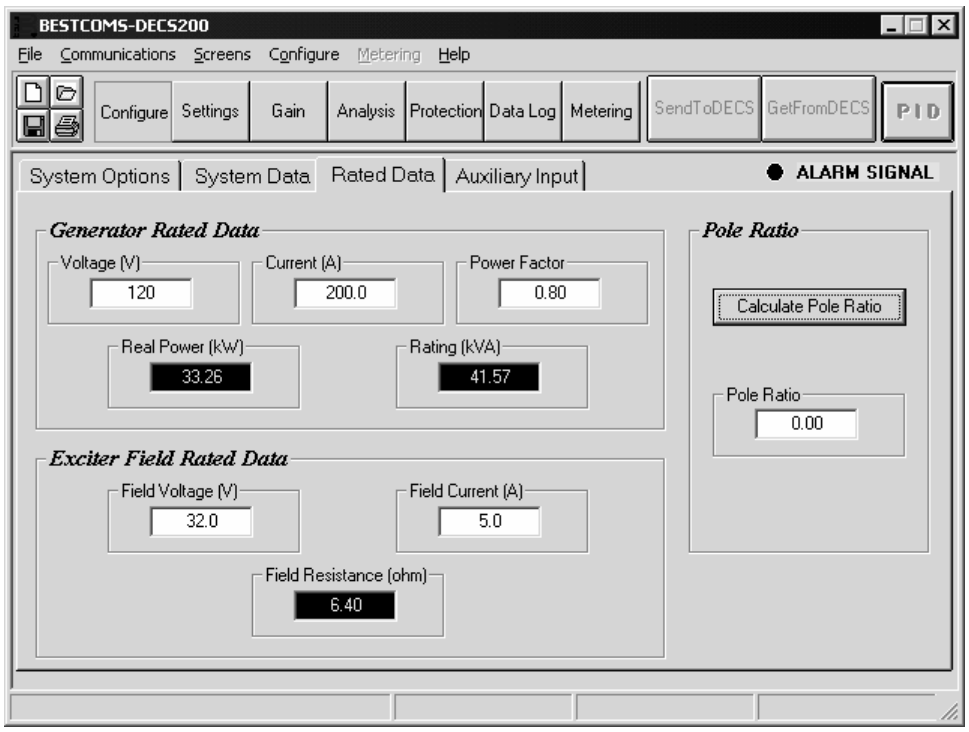

Figure 5-9. System Configuration Screen, Rated Data Tab

Generator Rated Data, Voltage. Sets the rated line-to-neutral generator voltage. A setting of 85 to 30,000 Vac may be entered in 1 Vac increments.

Generator Rated Data, Current. sets the rated generator line current. A setting of 10 to 60,000 Aac may be entered in 0.1 Aac increments.

Generator Rated Data, Power Factor. Sets the rated generator power factor which is used to calculate generator real power. A setting of 0.5 (leading) to –0.5 (lagging) may be entered in 0.01 increments.

Generator Rated Data, Real Power. This read-only field is the calculated product of the voltage field, current field, power factor field, and the square root of 3.

Generator Rated Data, Rating. This read-only field is the calculated product of the voltage field, current field, and the square root of 3.

Exciter Field Rated Data, Field Voltage. Sets the rated exciter field voltage. A setting of 1 to 180 Vdc may be entered in 0.1 Vdc increments.

Exciter Field Rated Data, Field Current. Sets the rated exciter field current. A setting of 0.1 to 15 Adc may be entered in 0.1 Adc increments.

Exciter Field Rated Data, Field Resistance. This read-only field is the calculated result of the field voltage field being divided by the field current field.

Pole Ratio, Calculate Pole Ratio. Clicking this button displays the Pole Ratio Calculator screen (Figure 5-10). Enter the number of exciter poles and generator poles and press the Enter key to view the calculated result. The “Number of EXCITER Poles” field accepts even numbers between 0 and 1,000. The “Number of GENERATOR Poles” field accepts even numbers between 0 and 100. Clicking the Accept button closes the Pole Ratio Calculator screen and enters the ratio in the Pole Ratio field.

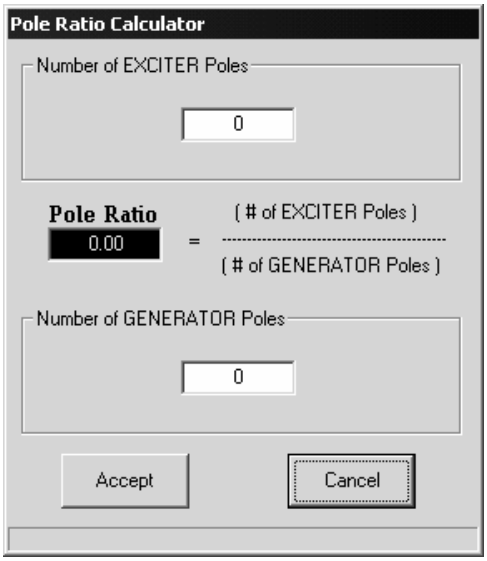

Figure 5-10. Pole Ratio Calculator

Pole Ratio, Pole Ratio. Sets the ratio of the number of exciter poles to the number of generator poles. A setting of 0 to 10 may be entered in 0.01 increments. This value can be calculated automatically using the pole ratio calculator , accessed by clicking the Calculate Pole Ratio button.

Auxiliary Input

The auxiliary voltage input signal changes the setpoint of the selected operating mode. For more information on the auxiliary voltage input, refer to Section 3, *Functional Description*. Auxiliary Input tab functions are shown in Figure 5-11 and described in the following paragraphs.

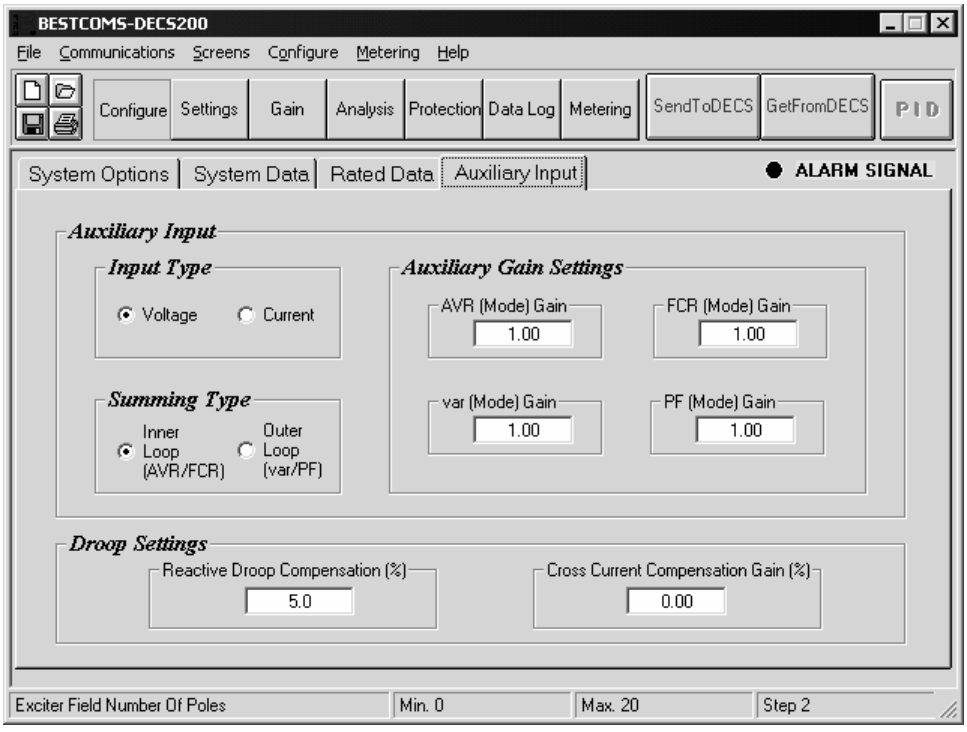

Figure 5-11. System Configuration Screen, Auxiliary Input Tab

Auxiliary Input, Input Type. Selects the accessory input type as voltage or current for remote control of the setpoint.

Auxiliary Input, Summing Type. Selects either Inner Loop or Outer Loop as the summing type. When Inner Loop is selected, the operating mode is either AVR of FCR. When Outer Loop is selected, the operating mode is either var or power factor.

Auxiliary Input, Auxiliary Gain Settings. The four auxiliary gain setting fields, AVR, FCR, var, and PF, select the gain which affects the setpoint of the selected operating mode. The signal applied to the accessory input is multiplied by the auxiliary gain setting. Each gain setting can be adjusted from –99 to +99 in increments of 0.01. For more information on the accessory gain settings, refer to Section 3, *Functional Description*.

Droop Settings, Reactive Droop Compensation. Sets the level of droop compensation for paralleled generators or line-drop compensations. Droop compensation is adjustable from 0 to +30% of the generator nominal, terminal voltage in 0.1% increments. Line-drop compensation is adjustable from –30 to 0% of the generator nominal terminal voltage in 0.1% increments.

Droop Settings, Cross Current Compensation Gain. Sets the level of cross-current compensation (reactive differential) gain for paralleled generators. Cross-current compensation gain is adjustable from –30 to +30% of the rated CTs in 0.01% steps. Refer to Section 4, *Installation*, for more information on cross-current compensation gain.

Setting Adjustments

The Setting Adjustments screen consists of eight tabs labeled AVR/FCR, var/PF, Startup, OEL Type, OEL (Summing), OEL (Takeover), UEL, and SCL. To view the setting adjustment screen, click the **Settings** button on the tool bar or click **Screens** on the menu bar and click **Setting Adjustments**.

AVR/FCR

AVR/FCR tab functions are illustrated in Figure 5-12 and described in the following paragraphs.

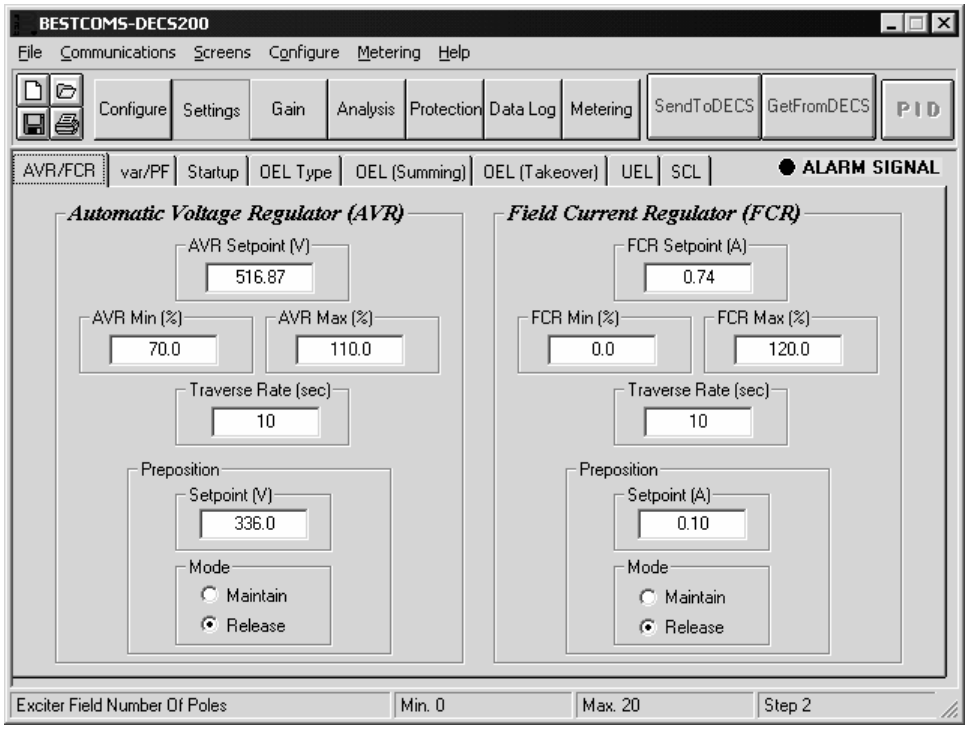

Figure 5-12. Setting Adjustments Screen, AVR/FCR Tab

Automatic Voltage Regulator, AVR Setpoint. Sets the desired generator output voltage when operating in AVR mode. The range of this setting is based on the generator voltage setting entered on the Rated Data tab of the System Configuration screen. This setting is also limited by the settings of the AVR Min and AVR Max fields. If sensing step-down transformers are used, primary voltage should be entered.

Automatic Voltage Regulator, AVR Min. Sets the minimum generator output voltage, expressed as a percentage of the rated generator voltage. A setting of 70 to 100% may be entered in 0.1% increments.

Automatic Voltage Regulator, AVR Max. Sets the maximum generator output voltage, expressed as a percentage of the rated generator voltage. A setting of 70 to 100% may be entered in 0.1% increments.

Automatic Voltage Regulator, Traverse Rate (sec). Determines the time required to adjust the AVR setpoint from the minimum value to the maximum value of the adjustment range. A setting of 10 to 200 seconds may be entered in 1 second increments.

Automatic Voltage Regulator, Pre-position Setpoint. Defines the pre-position setpoint for AVR mode. This value replaces the AVR setpoint value if pre-position is selected and the AVR Pre-Position mode is Maintain. The setting range is identical to the AVR Setpoint setting range. If sensing step-down transformers are being used, primary voltage should be entered.

Automatic Voltage Regulator, Preposition Mode. Determines whether or not the DECS-200 will respond to further setpoint change commands once the operating setpoint is driven to the pre-position value. If Maintain mode is selected, further setpoint changes are ignored. If Release mode is selected, subsequent setpoint changes are possible by using Raise and Lower commands.

Field Current Regulator, FCR Setpoint. Sets the field current setpoint when operating in FCR mode. The range of this setting is based on the field current rating entered on the Rated Data tab of the System Configuration screen. This setting is also controlled by the settings of the FCR Min and FCR Max fields.

Field Current Regulator, FCR Min. Sets the minimum field current setpoint, expressed as a percentage of the rated field current. A setting of 0 to 100% may be entered in 0.1% increments.

Field Current Regulator, FCR Max. Sets the maximum field current setpoint, expressed as a percentage of the rated field current. A setting of 1 to 120% may be entered in 0.1% increments.

Field Current Regulator, Traverse Rate. Determines the time required to adjust the FCR setpoint from the minimum value to the maximum value of the adjustment range. A setting of 10 to 200 seconds may be entered in 1 second increments.

Field Current Regulator, Preposition Setpoint. Defines the pre-position setpoint for FCR mode. This value replaces the FCR setpoint value if pre-position is selected and the FCR Pre-Position mode is Maintain. The setting range is identical to the FCR Setpoint setting range.

Field Current Regulator, Pre-position Mode. Determines whether or not the DECS-200 will respond to further setpoint change commands once the operating setpoint is driven to the pre-position value. If Maintain mode is selected, further setpoint changes are ignored. If Release mode is selected, subsequent setpoint changes are possible by using Raise and Lower commands.

Var/PF

Var/PF tab functions are illustrated in Figure 5-13 and described in the following paragraphs.

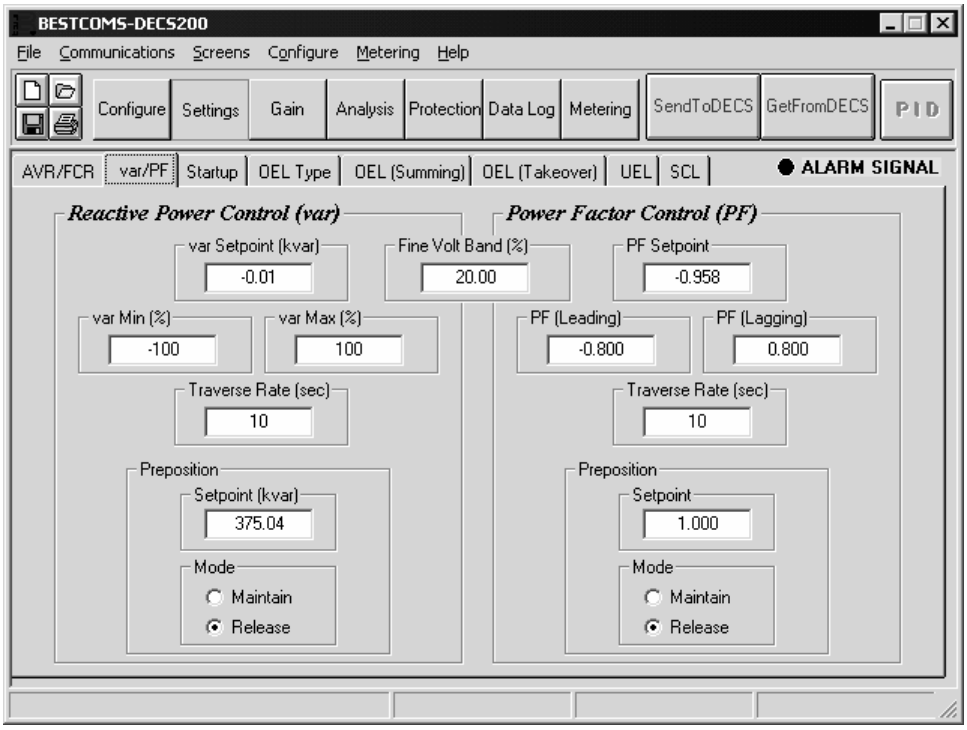

Figure 5-13. Setting Adjustments Screen, var/PF Tab

Reactive Power Control, var Setpoint. Sets the reactive power setpoint when operating in var mode. The range of this setting depends on the generator ratings entered on the Rated Data tab of the System Configuration screen. This setting is also controlled by the settings of the var Min and var Max fields.

Reactive Power Control, var Min. Sets the minimum var setpoint, expressed as a percentage of the rated generator kVA. A setting of –100 to +100% may be entered in 1% increments.

Reactive Power Control, var Max. Sets the maximum var setpoint, expressed as a percentage of the rated generator kVA. A setting of –100 to +100% may be entered in 1% increments.

Reactive Power Control, Traverse Rate. Determines the time required to adjust the var setpoint from the minimum value to the maximum value of the adjustment range. A setting of 10 to 200 seconds may be entered in 1 second increments.

Reactive Power Control, Preposition Setpoint. Defines the pre-position setpoint for var mode. This value replaces the var setpoint value if pre-position is selected and the var Pre-Position mode is Maintain. The setting range is identical to the var Setpoint setting range.

Reactive Power Control, Preposition Mode. Determines whether or not the DECS-200 will respond to further setpoint change commands once the operating var setpoint is driven to the pre-position value. If Maintain mode is selected, further setpoint changes are ignored. If Release mode is selected, subsequent setpoint changes are possible by using Raise and Lower commands.

Reactive Power Control, Var/PF Fine Volt Band. Sets the upper and lower boundaries of voltage correction when operating in var or PF mode.

Power Factor Control, PF Setpoint. Sets the generator operating power factor. The range of this setting is determined by the settings of the PF (Leading) and PF (Lagging) fields.

Power Factor Control, PF (Leading). Sets the limit for leading power factor. A setting of –1 to –0.5 may be entered in 0.005 increments.

Power Factor Control, PF (Lagging). Sets the limit for lagging power factor. A setting of 0.5 to 1 may be entered in 0.005 increments.

Power Factor Control, Traverse Rate (sec). Determines the time required to adjust the power factor setpoint from the minimum value to the maximum value of the adjustment range. A setting of 10 to 200 seconds may be entered in 1 second increments.

Power Factor Control, Preposition Setpoint. Defines the pre-position setpoint for Power Factor mode. This value replaces the PF setpoint value if pre-position is selected and the PF Pre-Position mode is Maintain. The setting range is identical to the PF Setpoint setting range.

Power Factor Control, Preposition Mode. Determines whether or not the DECS-200 will respond to further setpoint change commands once the operating PF setpoint is driven to the pre-position value. If Maintain mode is selected, further setpoint changes are ignored. If Release mode is selected, subsequent setpoint changes are possible by using Raise and Lower commands.

Startup

Startup tab settings are illustrated in Figure 5-14 and described in the following paragraphs.

Startup Control, Soft Start Level. Sets the generator soft-start voltage offset used during startup. A setting of 0 to 90% may be entered in 1% increments.

Startup Control, Soft Start Time. Sets the soft-start time limit used during startup. A setting of 1 to 7,200 seconds may be entered in 1 second increments.

Underfrequency Setting, Corner Frequency. Sets the generator corner frequency for generator under-frequency protection. A setting of 15 to 90 Hz may be entered in 0.1 Hz increments.

Underfrequency Setting, Slope. Sets the generator frequency slope for generator underfrequency protection. A setting of 0 to 3 V/Hz may be entered in 0.01 V/Hz increments.

Voltage Matching, Band. Configures the generator voltage matching band as a percentage of the generator rated voltage. When the bus voltage falls outside this band, no voltage matching occurs. A setting of 0 to 20% may be entered in 0.01% increments.

Voltage Matching, Gen to Bus PT Match Level. Ensures accurate voltage matching by compensation for the error between the generator and bus voltage sensing transformers. The Match Level is expressed as the relationship of the generator voltage to the bus voltage (expressed as a percentage). A setting of 90 to 120% may be entered in 0.1% increments.

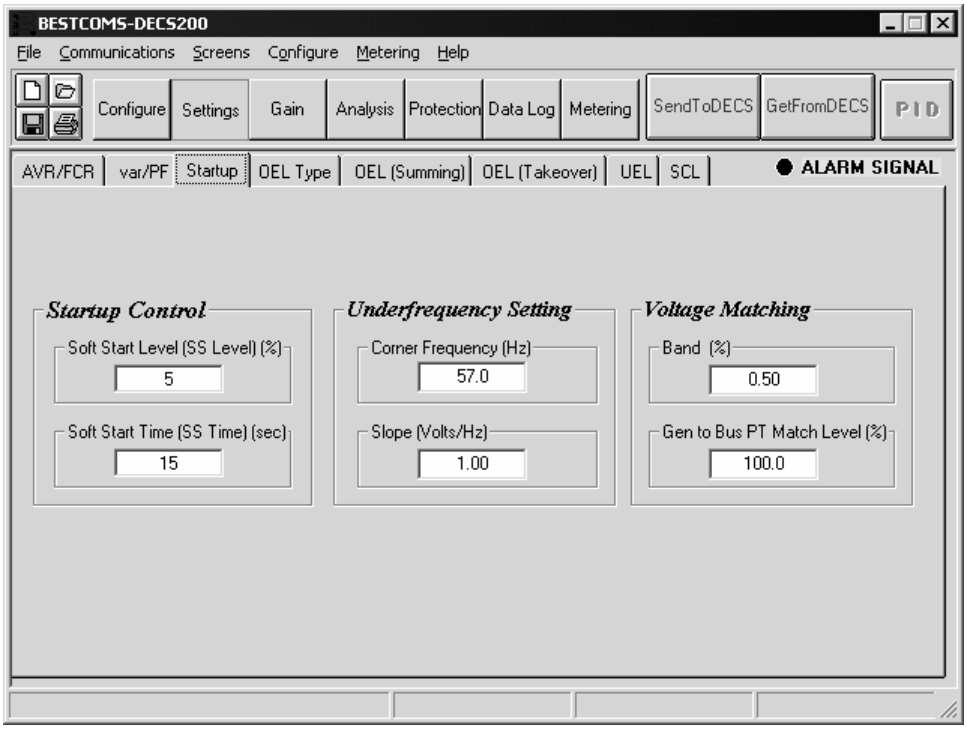

Figure 5-14. System Settings Screen, Startup Tab

OEL Type

Overexcitation Limiter Type tab settings are illustrated in Figure 5-15 and described in the following paragraphs.

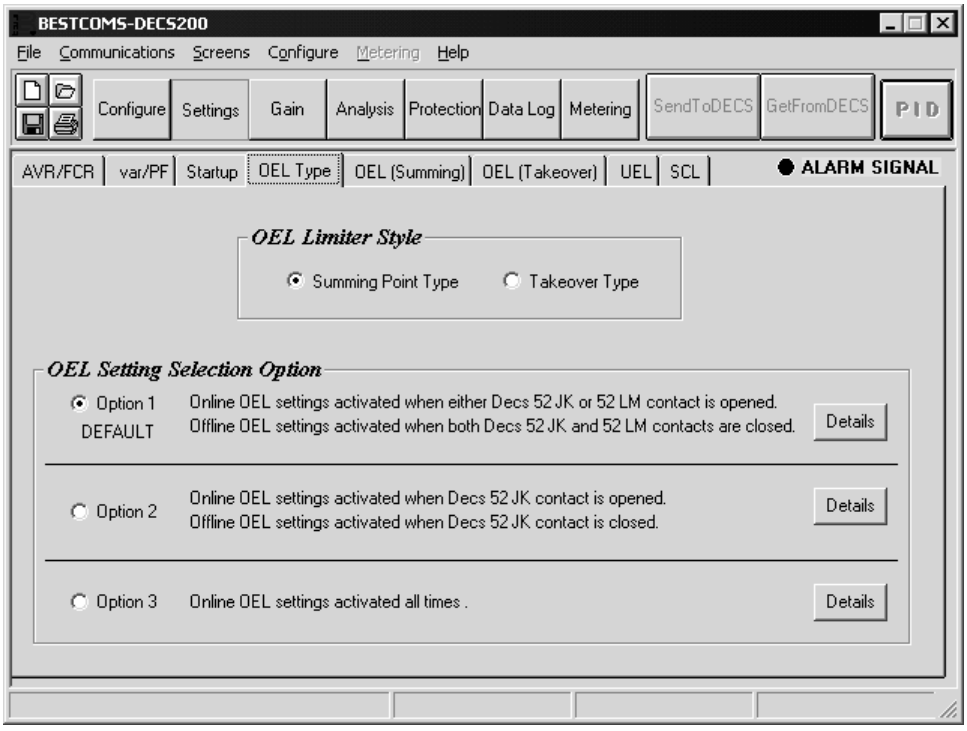

Figure 5-15. System Settings Screen, OEL Type Tab

OEL Limiter Style. Selects either the summing-point type of overexcitation limiter or the takeover-type of overexcitation limiter.

OEL Setting Selection Option. Selects the on-line and off-line OEL settings for various 52J/K and 52L/M contact statuses.

Option 1 activates the on-line OEL settings when either the 52J/K contact or 52L/M contact is opened. The off-line OEL settings are activated when both the 52J/K and 52L/M contacts are closed. When the 52L/M contact input is jumpered, the 52J/K input can be used to switch between the on-line OEL and off-line OEL. If var/PF modes are disabled, a closed 52J/K contact enables AVR mode and an open 52J/K contact enables droop compensation.

Option 2 configures the 52J/K contact to define when the off-line and on-line limiters are active. When the 52J/K contact is closed, the off-line OEL settings are active. When the 52J/K contact is open, the on-line OEL settings are active. This configuration is intended for cross-compound generator applications where both machines are paralleled at low rotational speed. Therefore, droop compensation needs to be active (open 52L/M contact) as the speed of the machines is increased. However, both machines need active, off-line overexcitation limiting protection.

Option 3 activates the on-line OEL at all times. This configuration enables the DECS-200 to operate in AVR mode (stand-alone application) without restriction from the off-line OEL settings. The active on-line OEL is able to limit excitation current if needed. This configuration also eliminates the need for the DECS-200 to operate in Droop mode when applied in a single-unit application. Therefore, generator voltage should not droop as reactive load increases.

OEL (Summing)

Summing-Point Overexcitation Limiter tab settings are illustrated in Figure 5-16 and described in the following paragraphs.

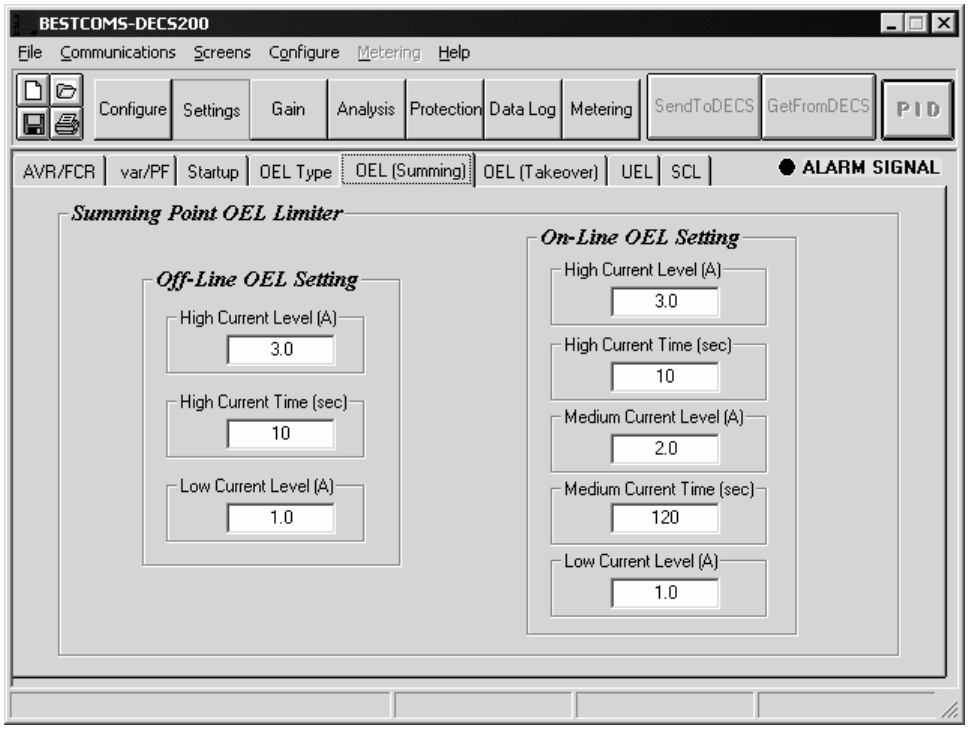

Figure 5-16. System Settings Screen, OEL (Summing) Tab

Off-Line OEL Setting, High Current Level. Establishes the high-level current setpoint for the off-line, summing-point, overexcitation limiter. A setting of 0 to 30 Adc may be entered in 0.1 Adc increments.

Off-Line OEL Setting, High Current Time. Sets the duration for the high current setpoint of the off-line, summing-point, overexcitation limiter. A setting of 0 to 10 seconds may be entered in 1 second increments.

Off-Line OEL Setting, Low Current Level. Establishes the low-level current setpoint for the off-line, summing-point, overexcitation limiter. A setting of 0 to 15 Adc may be entered in 0.1 Adc increments.

On-Line OEL Setting, High Current Level. Establishes the high-level current setpoint for the on-line, summing-point, overexcitation limiter. A setting of 0 to 30 Adc may be entered in 0.1 Adc increments.

On-Line OEL Setting, Medium Current Level. Establishes the medium-level current setpoint for the on-line, summing point, overexcitation limiter. A setting of 0 to 20 Adc may be entered in 0.1 Adc increments.

On-Line OEL Setting, Medium Current Time. Sets the duration for the medium current setpoint of the on-line, summing-point, overexcitation limiter. A setting of 0 to 120 seconds may be entered in 1 second increments.

On-Line OEL Setting, Low Current Level. Establishes the low-level current setpoint for the on-line, summing-point, overexcitation limiter. A setting of 0 to 15 Adc may be entered in 0.1 Adc increments.

OEL (Takeover)

Takeover Overexcitation Limiter tab functions are illustrated in Figure 5-17 and described in the following paragraphs.

Off-Line Settings, Low Current Level. Establishes the low-level current setpoint for the off-line, takeover-style, overexcitation limiter. A setting of 0 to 20 Adc may be entered in 0.1 Adc increments.

Off-Line Settings, High Current Level. Establishes the high-level current setpoint for the off-line, takeover-style, overexcitation limiter. A setting of 0 to 30 Adc may be entered in 0.1 Adc increments.

Off-Line Settings, Time Dial. Sets the time delay for the off-line, takeover-style, overexcitation limiter. A setting of 0.1 to 20 seconds may be entered in 0.1 second increments.

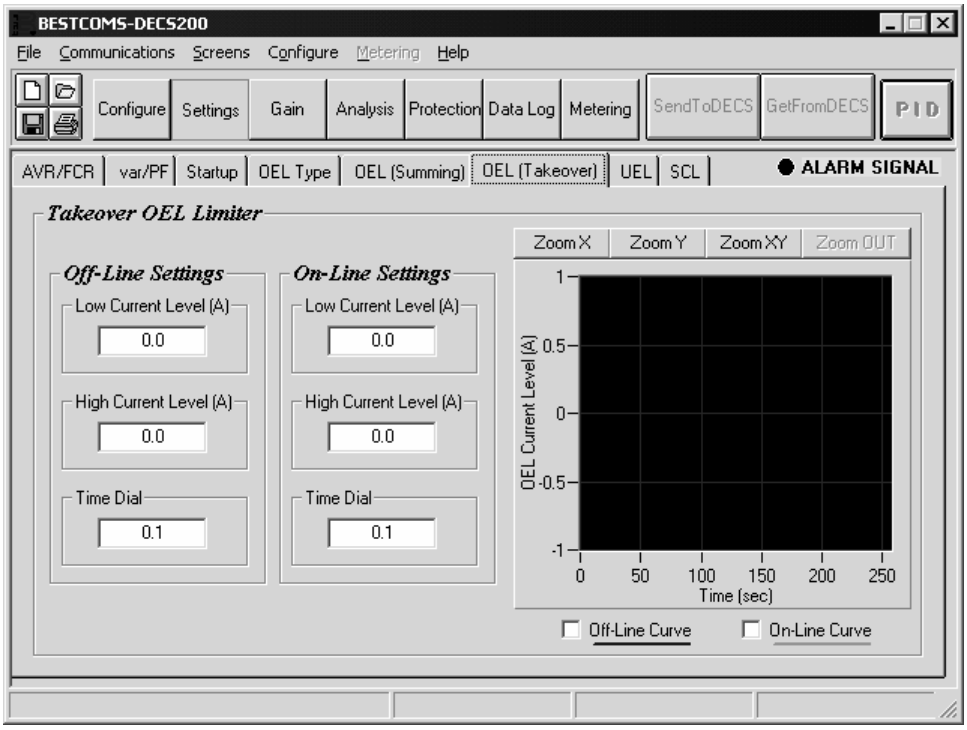

Figure 5-17. Setting Adjustments Screen, OEL (Takeover) Tab

On-Line Settings, Low Current Level. Establishes the low-level current setpoint for the on-line, takeover-style, overexcitation limiter. A setting of 0 to 15 Adc may be entered in 0.1 Adc increments.

On-Line Setting, High Current Level. Establishes the high-level current setpoint for the on-line, takeover-style, overexcitation limiter. A setting of 0 to 30 Adc may be entered in 0.1 Adc increments.

On-Line settings, Time Dial. Sets the time delay for the on-line, takeover-style, overexcitation limiter. A setting of 0.1 to 20 seconds may be entered in 0.1 second increments.

Off-Line Curve and On-Line Curve Checkboxes. Checking these boxes displays a plot of the takeover-style off-line and on-line overexcitation limiter curves. Curve magnification is adjusted by the Zoom X, Zoom Y, Zoom XY, and Zoom OUT buttons.

UEL

Underexcitation Limiter tab functions are illustrated in Figure 5-18 and described in the following paragraphs.

UEL Settings, UEL Curve Type Selection. Selects either a user-configured or internally-configured underexcitation limiting curve. Selecting “Customized” enables the user to create a custom UEL curve that matches specific generator characteristics. When “Internal” is selected, the DECS-200 automatically

creates a UEL curve based on the first point setting of the absorbed, reactive power level. This function operates in all modes except FCR.

UEL Settings, Real Power. Up to five setting fields may be used to establish up to five real-power (kW) points of the underexcitation limiter curve. The UEL Curve Type Selection must be set to “Customized” in order for these setting fields to be enabled. Not all setting fields need be used. For example, entering kW values in three of the five setting fields produces a three-point UEL curve. The range for each setting field is based on the generator ratings entered on the Rated Data tab of the System Configuration screen.

UEL Settings, Reactive Power. When the UEL Curve Type Selection is set to “Customized”, these five setting fields establish the five reactive power points of the underexcitation limiter curve. Not all setting fields need be used. For example, entering kvar values in to of the five setting fields produces a two-point UEL curve. When the UEL curve Type Selection is set to “Internal”, only the first setting field is enabled and a UEL curve is internally generated based on the value entered in the field. The range for each setting field is based on the generator ratings entered on the Rated Data tab of the System Configuration screen.

Curve points are plotted in the UEL graph as values are entered through BESTCOMS. All kW and kvar settings can also be sent at the same time using the Send all UEL Settings to DECS button.

Internal Curve and Customized Curve Buttons. These buttons can be clicked and held to preview the corresponding UEL curve.

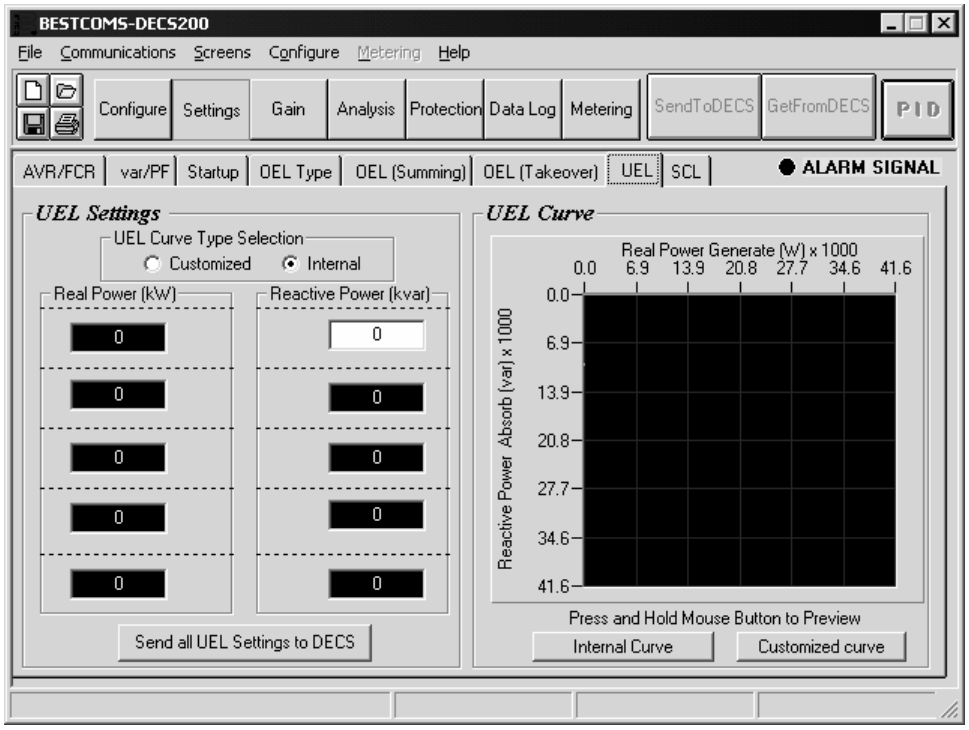

Figure 5-18. Setting Adjustments Screen, UEL Tab

SCL

Stator Current Limiter tab settings are illustrated in Figure 5-19 and described in the following paragraphs.

Stator Current Limiter, High SCL Current Level. Configures the high-level current setpoint for the stator current limiter. A setting of 0 to 66,000 Aac may be entered in 1.0 Aac increments.

Stator Current Limiter, High SCL Current Time. Sets the time limit for high-level current limiting by the stator current limiter. A setting of 0 to 60 seconds may be entered in 1 second increments.

Stator Current Limiter, Low SCL Current Level. Configures the low-level current setpoint for the stator current limiter. A setting of 0 to 66,000 Aac may be entered in 1 Aac increments.

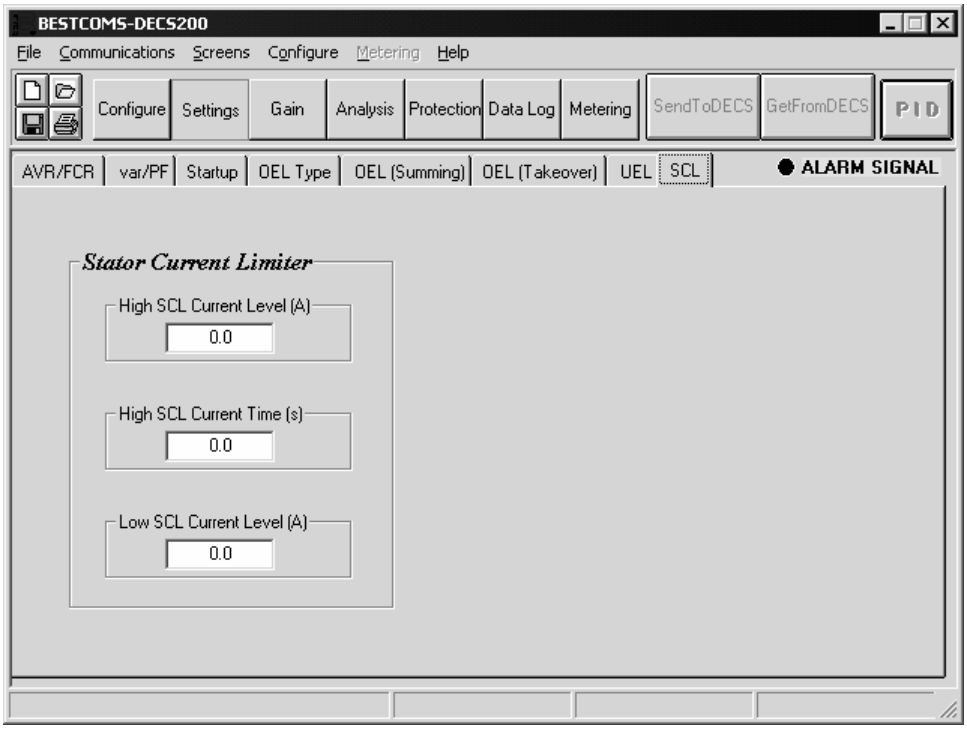

Figure 5-19. Setting Adjustments Screen, SCL Tab

Control Gain

The Control Gain screen consists of a single tab labeled Control Gain. To view the Control Gain screen, click the **Gain** button on the tool bar or click **Screens** on the menu bar and click **Control Gain**.

Control Gain Tab

Control Gain tab settings are illustrated in Figure 5-20 and described in the following paragraphs.

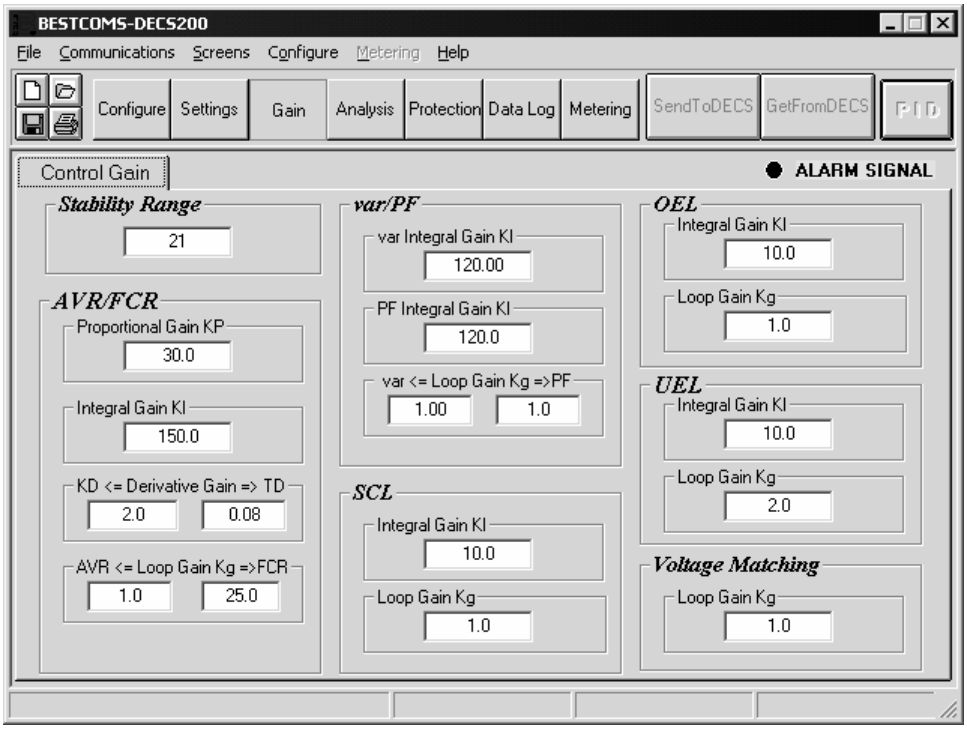

Figure 5-20. Control Gain Screen

Stability Range. Entering a value from 1 to 20 selects one of 20 predefined stability setting groups for exciter field applications. Table 5-1 lists the stability settings for each of the 20 predefined groups. Entering 21 enables the PID function and allows the user to optimize the stability settings. The PID

function provides reference gain settings for user-specified generator and/or exciter time constants. See *PID Window* for information about customizing stability settings.

Table 5-1. Predefined Stability Setting Groups

Setting Group	Generator Open Circuit Time Constant (T'do)	Generator Exciter Time Constant (Texc)	Kp	Ki	Kd
1	1.0	0.17	42.20	115.2	4.433
2	1.5	0.25	66.50	150.0	8.750
3	2.0	0.33	87.16	167.9	13.670
4	2.5	0.42	104.50	175.8	18.960
5	3.0	0.50	119.00	177.8	24.500
6	3.5	0.58	131.30	176.4	30.220
7	4.0	0.67	141.80	173.1	36.060
8	4.5	0.75	150.90	168.8	42.000
9	5.0	0.83	158.80	163.9	48.010
10	5.5	0.92	165.70	158.7	54.080
11	6.0	1.00	171.80	153.6	60.200
12	6.5	1.08	177.20	148.5	66.350
13	7.0	1.17	182.10	143.6	72.540
14	7.5	1.25	186.50	138.9	78.750
15	8.0	1.33	190.50	134.4	84.980
16	8.5	1.42	194.10	130.1	91.230
17	9.0	1.50	197.40	125.9	97.500
18	9.5	1.58	200.40	122.1	103.800
19	10.0	1.67	203.20	118.4	110.100
20	10.5	1.75	205.70	114.8	116.400

AVR/FCR, Proportional Gain KP. Selects the proportional constant (KP) stability parameter. The DECS-200 provides an output value that is equivalent to KP multiplied by the error between the voltage setpoint and the actual generator output voltage. Typical values of KP range from 0 to 1,000. General guidelines for tuning KP are as follows: If the transient response has too much overshoot, decrease KP. If the transient response is too slow with little or no overshoot, increase KP. A setting of 0 to 1,000 may be entered in 0.1 increments.

AVR/FCR, Integral Gain KI. Selects the integral constant (KI) stability parameter. The DECS-200 provides an output value that is equivalent to KI multi-plied by the integral of the error between the voltage setpoint and the actual generator output voltage. Typical values of KI range fro 0 to 1,000. Generally, if the time to reach steady state is deemed too long, then increase the value of KI. A setting of 0 to 1,000 may be entered in 0.1 increments.

AVR/FCR, Derivative Gain KD. Selects the derivative constant (KD) stability parameter. The DECS-200 provides an output value that is equivalent to KD multiplied by the derivative of the error between the voltage setpoint and the actual generator output voltage. A setting of 0 to 1,000 may be entered in 0.1 increments. Typical values of KD range from 1 to 10. If the transient response has too much ringing, then KD should be increased.

AVR/FCR, Derivative Gain TD. Removes the effects of noise on numerical differentiation. A setting of 0 to 1 may be entered in 0.01 increments. Typical TD values range from 0.01 to 0.03.

AVR/FCR, AVR Loop Gain Kg. Sets the coarse loop-gain level of the PID algorithm for AVR mode. A setting of 0 to 1,000 may be entered in 0.1 increments.

_AVR/FCR, FCR Loop Gain Kg. Sets the coarse loop-gain level of the PID algorithm for FCR mode. A setting of 0 to 1,000 may be entered in 0.1 increments.

VAR/PF, var Integral Gain KI. Adjusts the integral gain, which determines the characteristic of the DECS-200 dynamic response to a changed var setting. A setting of 0 to 1,000 may be entered in 0.01 increments.

VAR/PF, PF Integral Gain KI. Adjusts the integral gain, which determines the characteristic of the DECS-200 dynamic response to a changed power factor setting. A setting of 0 to 1,000 may be entered in 0.1 increments.

VAR/PF, var Loop Gain Kg. Sets the coarse loop-gain level of the PID algorithm for var control. A setting of 0 to 1,000 may be entered in 0.01 increments.

VAR/PF, PF Loop Gain Kg. Sets the coarse loop-gain level of the PID algorithm for power factor control. A setting of 0 to 1,000 may be entered in 0.1 increments.

SCL, Integral Gain KI. Adjusts the rate at which the DECS-200 limits stator current. A setting of 0 to 1,000 may be entered in 0.1 increments.

SCL, Loop Gain Kg. Sets the coarse loop-gain level of the PID algorithm for the stator current limiter. A setting of 0 to 1,000 may be entered in 0.1 increments.

OEL, Integral Gain KI. Adjusts the rate at which the DECS-200 responds during an overexcitation condition. A setting of 0 to 1,000 may be entered in 0.1 increments.

OEL, Loop Gain Kg. Sets the coarse loop-gain level of the PID algorithm for the overexcitation limiter. A setting of 0 to 1,000 may be entered in 0.1 increments.

UEL, Integral Gain KI. Adjusts the rate at which the DECS-200 responds during an underexcitation condition. A setting of 0 to 1,000 may be entered in 0.1 increments.

UEL, Loop Gain Kg. Sets the coarse loop-gain level of the PID algorithm for the underexcitation limiter. A setting of 0 to 1,000 may be entered in 0.1 increments

Voltage Matching, Loop Gain Kg. Adjusts the coarse loop-gain level of the PID algorithm for matching the generator voltage to the bus voltage. A setting of 0 to 1,000 may be entered in 0.1 increments.

Analysis

The Analysis screen consists of four tabs labeled AVR, FCR, var, and PF. To view the Analysis screen, click the **Analysis** button on the tool bar or click **Screens** on the menu bar and click **Analysis**.

Trigger Data Logging on Step Change. Checking this box causes an oscillography report to be triggered every time that a step change occurs.

AVR

AVR tab settings are illustrated in Figure 5-21 and described in the following paragraphs.

Voltage Step Response, Increment of AVR Setpoint. Sets the voltage step size that the DECS-200 uses when incrementing the generator terminal voltage setpoint. A setting of 0 to 10% may be entered in 1% increments. A button adjacent to this setting is clicked to increment the terminal voltage setpoint. A read-only field indicates the terminal voltage setpoint that will be achieved when the increment button is clicked. If the specified step size is outside the setpoint limit, a warning message will appear.

Voltage Step Response, AVR Setpoint. This read-only field indicates the generator terminal voltage setpoint that was set on the AVR/FCR tab of the Setting Adjustments screen. A button adjacent to this field is clicked to return the AVR setpoint to the displayed value.

Voltage Step Response, Decrement of AVR Setpoint. Sets the voltage step size that the DECS-200 uses when decrementing the generator terminal voltage setpoint. A setting of 0 to 10% may be entered in 1% increments. A button adjacent to this setting is clicked to decrement the terminal voltage setpoint. A read-only field indicates the terminal voltage setpoint that will be achieved when the decrement button is clicked.

Voltage Step Response, Vrms. This read-only field indicates the value of terminal voltage. The other three fields are described in the corresponding tab setting descriptions.

Alarm Signals. During step response analysis, nine alarm indicators are available to indicate system alarms. The indicators annunciate the following conditions:

- Field overcurrent
- Field overvoltage
- Generator overvoltage
- Generator undervoltage

- Loss of sensing
- Overexcitation limiting
- System frequency below 10 Hz
- Underexcitation limiting
- Underfrequency or volts per hertz

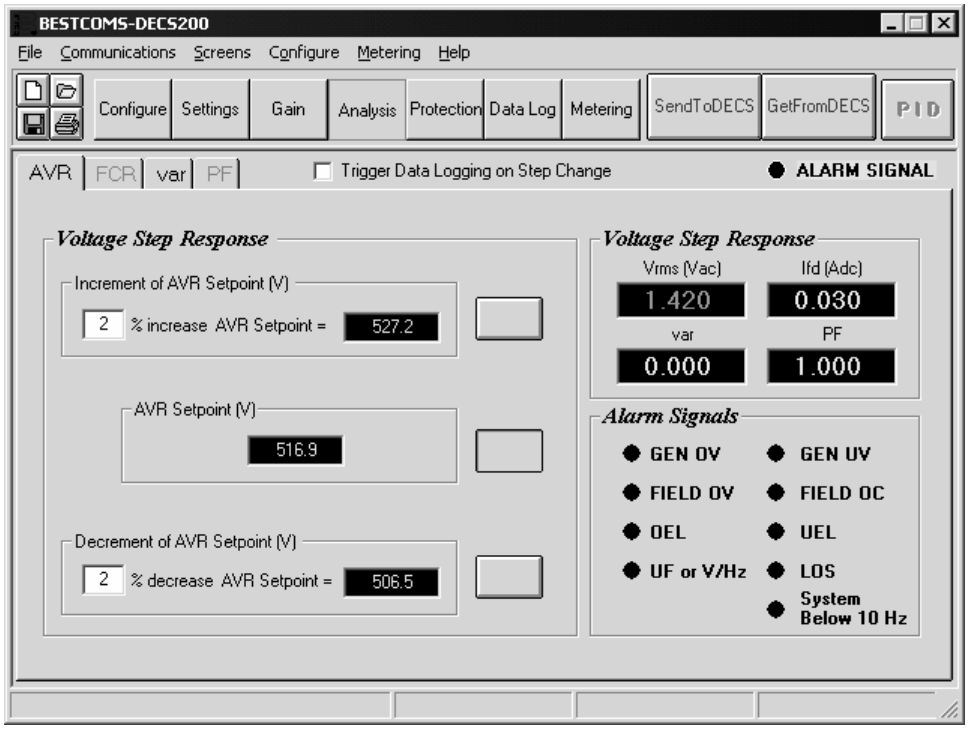

Figure 5-21. Analysis Screen, AVR Tab

FCR

FCR tab settings are illustrated in Figure 5-22 and described in the following paragraphs.

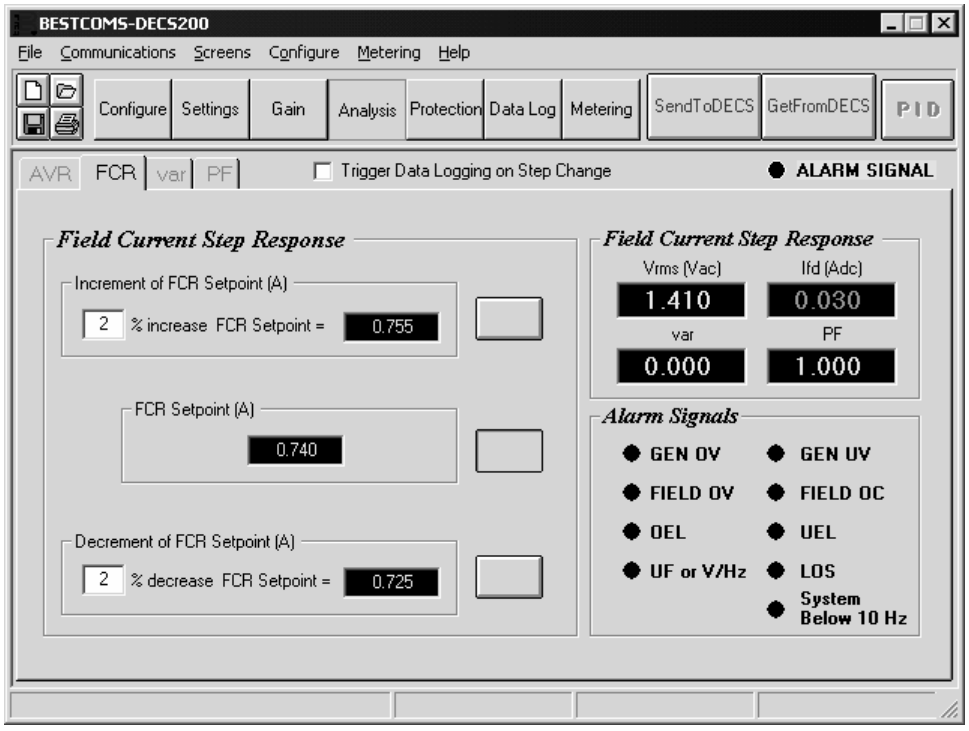

Figure 5-22. Analysis Screen, FCR Tab

Field Current Step Response, Increment of FCR Setpoint. Sets the current step size that the DECS-200 uses when incrementing the field current setpoint. A setting of 0 to 10% may be entered in 1% increments. A button adjacent to this setting is clicked to increment the field current setpoint. A read-only field indicates the field current setpoint that will be achieved when the increment button is clicked. If the specified step size is outside the setpoint limit, a warning message will appear.

Field Current Step Response, FCR Setpoint. This read-only field indicates the field current setpoint that was set on the AVR/FCR tab of the Setting Adjustments screen. A button adjacent to this field is clicked to return the AVR setpoint to the displayed value.

Field Current Step Response, Decrement of FCR Setpoint. Sets the field current step size that the DECS-200 uses when decrementing the field current setpoint. A setting of 0 to 10% may be entered in 1% increments. A button adjacent to this setting is clicked to decrement the field current setpoint. A read-only field indicates the field current setpoint that will be achieved when the decrement button is clicked.

Field Current Step Response, Ifd. This read-only field indicates the value of field current. The other three fields are described in the corresponding tab setting descriptions.

Alarm Signals. During step response analysis, nine alarm indicators are available to indicate system alarms. A list of the indicators is provided under *Analysis, AVR*. Alarm annunciations are updated approximately once every second.

Var

Var tab settings are illustrated in Figure 5-23 and described in the following paragraphs.

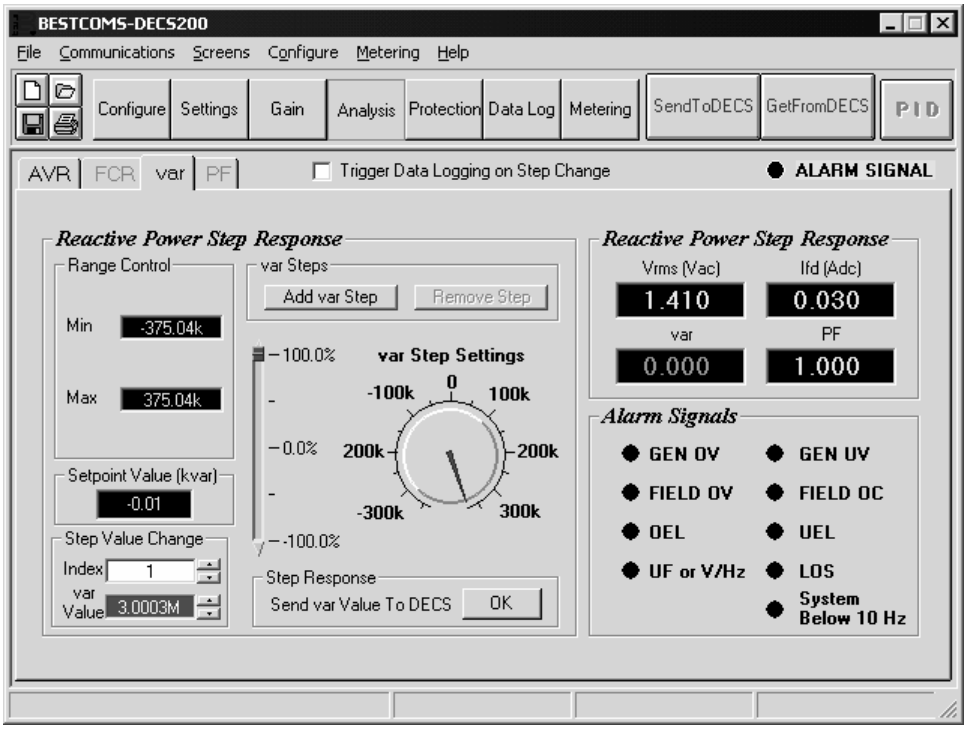

Figure 5-23. Analysis Screen, var Tab

Reactive Power Step Response, Range Control, Min. Changes the range indicated by the var Step Settings dial and the minimum allowable var settings for the generator. To change the minimum dial value, double-click the field value, enter a new minimum limit, and press the Enter key.

Reactive Power Step Response, Range Control, Max. Changes the range indicated by the var Step Settings dial and the minimum allowable var settings for the generator. To change the maximum dial value, double-click the field value, enter a new minimum limit, and press the Enter key.

Reactive Power Step Response, Setpoint Value. This read-only field indicates the reactive power setpoint established on the var/PF tab of the Setting Adjustments screen. If a step-response setpoint change has been made from this screen, the actual setpoint value for the regulator will differ from this read-only indication.

Reactive Power Step Response, Step Value Change var Value. Provides one of three methods for changing the kvar setpoint and observing the generator response. (The other two methods include

adjusting the var Step Settings dial or slide bar.) Once the desired value is entered, the value is sent to the DECS-200 by clicking the **Send var Value to DECS (OK)** button. When clicked and held, the button color changes to red and the button label changes to “Index 1”. Upon release of the button, the new var value setting is sent to the DECS-200 as the reactive power setpoint for the var regulator. If the specified var value is outside the range limit, a dialog box appears and shows the acceptable values for the step response. Changing the var setpoint through the var Value field does not change the dial or slide indicators.

The pointer of the var Step Settings dial can be clicked and dragged to the approximate, desired setting. As the pointer is dragged, the slide bar moves to show the relative percentage of the minimum or maximum var setting. The setpoint can then be fine tuned using the up and down scrolling buttons of the var Value window.

Reactive Power Step Response, Step Value Change Index. Up to three var step-response setpoints (indexes) can be activated. An index is created by using the methods described in the previous paragraphs. Index 2 is added by clicking the **Add var Step** button. (It may be necessary to drag the red index 1 pointer out of the way to access the yellow index 2 pointer.) When the **Send var Value to DECS** button is clicked and held, the button color changes to yellow and the button label changes to “Index 2”. A third index is added n the same manner as index 2, but the third index color is blue.

Reactive Power Step Response, Var Steps, Add Var Step. Adds a setpoint index. A maximum of three setpoint indexes may be created. Refer to the previous paragraph for additional information on adding setpoint indexes (var Steps).

Reactive Power Step Response, Var Steps, Remove Step. Removes the last setpoint index created.

Var, Var Step Response. This read-only field indicates the value of the regulated var level. The other three fields are described in the corresponding tab setting descriptions.

Alarm Signals. During step response analysis, nine alarm indicators are available to indicate system alarms. A list of the indicators is provided under *Analysis, AVR*. Alarm annunciations are updated approximately once every second.

PF

PF tab settings are illustrated in Figure 5-24 and described in the following paragraphs.

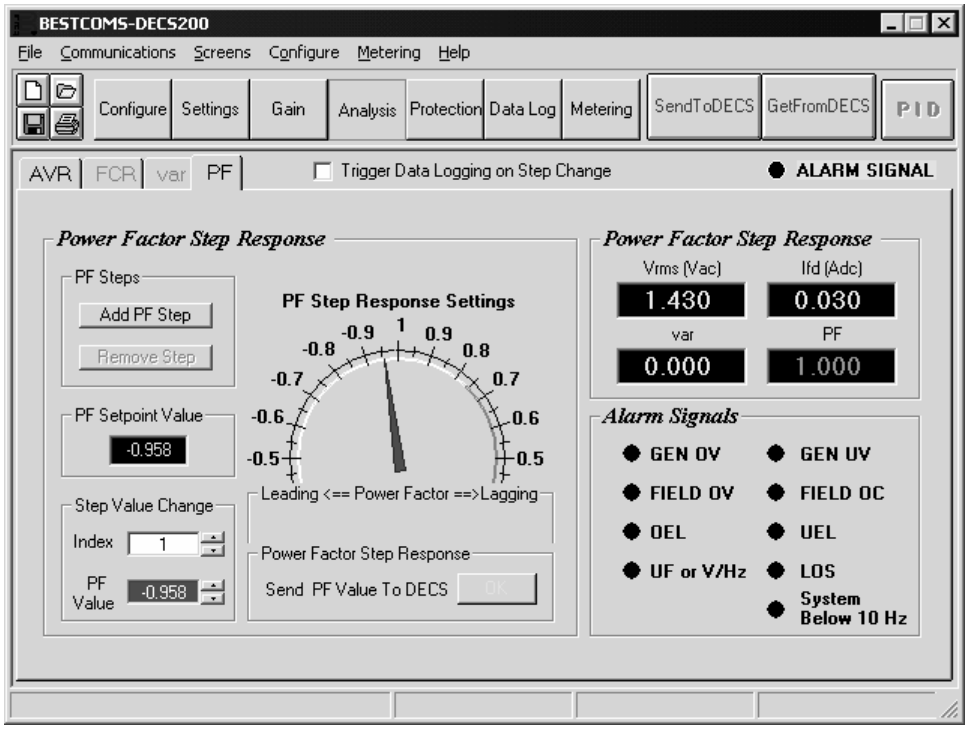

Figure 5-24. Analysis Screen, PF Tab

Power Factor Step Response, Add PF Step. Adds a power factor setpoint index. Up to three setpoint indexes can be created. The addition of indexes is discussed in the paragraphs describing the Step Value Change settings.

Power Factor Step Response, Remove Steps. Removes the last setpoint index created.

Power Factor Step Response, PF Setpoint Value. This read-only field indicates the reactive power setpoint established on the var/PF tab of the Setting Adjustments screen. If a step response setpoint change has been made from this screen, the actual setpoint value for the regulator will differ from this read-only indication.

Power Factor Step Response, Step Value Change PF Value. Provides one of two methods for changing the power factor setpoint and observing the generator response. (The other method consists of adjusting the PF Step Response Settings dial.) Once the desired value is entered, the value is sent to the DECS-200 by clicking the **Send PF Value to DECS** button. When clicked and held, the button color changes to red and the button label changes to "Index 1". Upon release of the button, the new power factor value is sent to the DECS-200 and the PF setpoint for the power factor regulator. If the specified PF value is outside the range limit, a dialog box appears and shows the acceptable values for the step response. Changing the var setpoint through the PF Value field does not change the dial indicator.

The pointer of the PF Step Response Settings dial can be clicked and dragged to the approximate, desired setting. The setpoint can then be fine tuned using the up and down scrolling buttons of the PF Value window.

Power Factor Step Response, Step Value Change Index. Up to three power factor step-response setpoints (indexes) can be activated. An index is created by using the methods described in the previous paragraphs. Index 2 is added by clicking the **Add PF Step** button. (It may be necessary to drag the red Index 1 pointer out of the way to access the yellow index 2 pointer.) When the **Send PF Value to DECS** button is clicked and held, the button color changes to yellow and the button label changes to "Index 2". A third index is added in the same manner as index 2, but the third index color is blue.

Power Factor Step Response, PF. This read-only field indicates the value of the regulated power factor level. The other three fields are described in the corresponding tab setting descriptions.

Alarm Signals. During step response analysis, nine alarm indicators are available to indicate system alarms. A list of the indicators is provided under *Analysis, AVR*. Alarm annunciations are updated approximately once every second.

Protection/Relay

The Protection/Relay screen consists of five tabs labeled Options, Settings, Gain, Relay #1, #2 Logic, Relay #3 Logic, and Relay Settings. To view the Protection/Relay screen, click the Protection button on the tool bar or click **Screens** on the menu bar and click **Protection/Relay**.

Options

Options tab settings are illustrated in Figure 5-25 and described in the following paragraphs.

Protection. DECS-200 protection functions are enabled and disabled using these settings. DECS-200 protection functions include generator overvoltage, exciter field overvoltage, open exciter diode, loss of field, generator undervoltage, exciter field overcurrent, and shorted exciter diode. When a protection function is enabled or disabled, the change is sent immediately to the DECS-200.

Loss of Sensing Voltage, LOS. Enables and disables the loss of sensing function.

Loss of Sensing Voltage, Time Delay. Sets the time delay between when the DECS-200 detects a loss of sensing voltage and when the alarm annunciates and the output relay actuates (if programmed). A setting of 0 to 30 seconds may be entered in 0.1 second increments.

Loss of Sensing Voltage, Balanced Level. When all phases of sensing voltage decrease below this setting, the loss of sensing voltage time delay begins timing out. A setting of 0 to 100% (of nominal) may be entered in 0.1% increments.

Loss of Sensing Voltage, Unbalanced Level. When any one of three phases of sensing voltage decreases below this setting, the loss of sensing voltage time delay begins timing out. This setting applies to three-phase sensing applications only. A setting of 0 to 100% (of nominal) may be entered in 0.1% increments.

Loss of Sensing Voltage, Transfer to FCR Mode. Enables and disables a transfer from AVR mode to FCR mode when a loss of sensing voltage condition occurs.

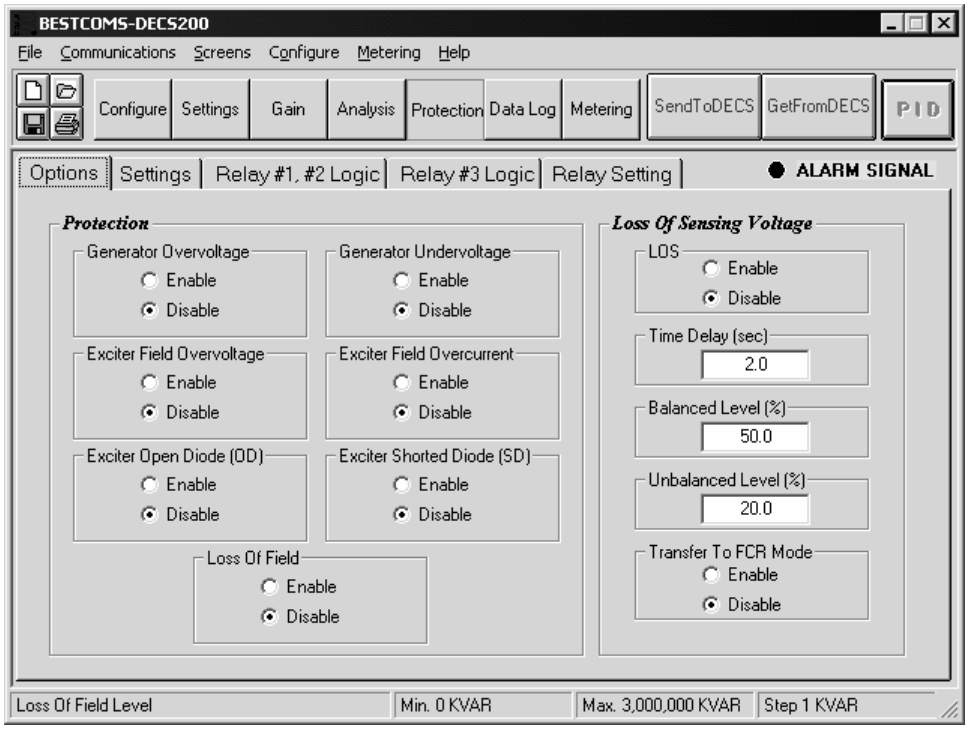

Figure 5-25. Protection Screen, Options Tab

Settings

Settings tab settings are illustrated in Figure 5-26 and described in the following paragraphs.

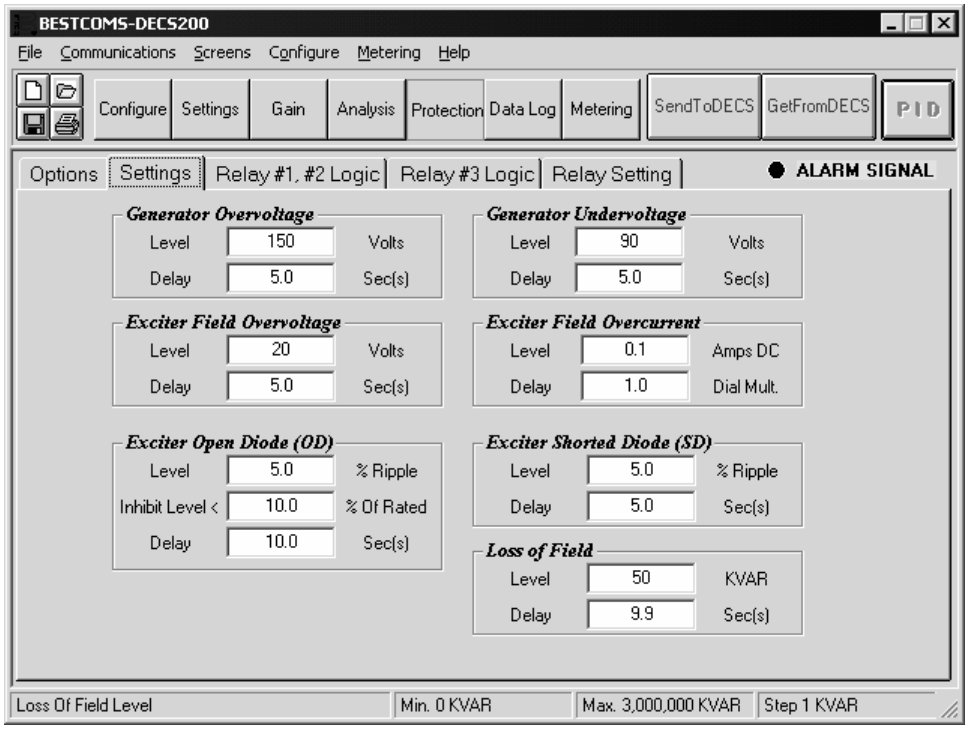

Figure 5-26. Protection Screen, Settings Tab

Generator Overvoltage, Level. Configures the setpoint, in primary voltage, for generator overvoltage protection. This setting is active only when generator overvoltage protection is enabled on the Options tab. When the generator terminal voltage reaches the level of this setting and the associated time delay expires, the corresponding protection alarm LED lights. (See the Alarm/Status or Analysis screens for the location of the specific alarm signal LEDs.) If programmed for the overvoltage function, one or more of the three programmable output relays are actuated. A setting of 0 to 30,000 Vac may be entered in 1 Vac increments.

Generator Overvoltage, Delay. Sets the time delay for the generator overvoltage protection function. This setting is active only when generator overvoltage protection is enabled on the Options tab. A setting of 0.1 to 60 seconds may be entered in 0.1 second increments.

Exciter Field Overvoltage, Level. Configures the setpoint for field overvoltage protection. This setting is active only when field overvoltage protection is enabled on the Options tab. When the field voltage reaches the level of this setting and the associated time delay expires, the corresponding protection alarm indicator lights. (See the Alarm/Status or Analysis Screen for the detailed alarm LED signals.) If programmed for the field overvoltage function, one or more of the three programmable output relays are actuated. A setting of 1 to 325 Vdc may be entered in 1 Vdc increments.

Exciter Field Overvoltage, Delay. Sets the time delay for the field overvoltage protection function. This setting is active only when field overvoltage protection is enabled on the Options tab. A setting of 0.2 to 30 seconds may be entered in 0.1 second increments.

Exciter Open Diode, Level. Configures the percent of rated field current that indicates an open exciter diode. This setting is active only when open exciter diode protection is enabled on the Options tab. A setting of 0 to 100% may be entered in 0.1% increments.

Exciter Open Diode, Inhibit Level. Configures the percent of rated field current that disables both open- and shorted-diode protection. This setting is active only when open exciter diode protection is enabled on the Options tab. A setting of 0 to 100% may be entered in 0.1% increments.

Exciter Open Diode, Delay. Sets the time delay between when an open exciter diode is detected and annunciated. This setting is active only when open exciter diode protection is enabled on the Options tab. A setting of 10 to 60 seconds may be entered in 0.1 second increments.

Generator Undervoltage, Level. Configures the setpoint for generator undervoltage protection. This setting is active only when generator undervoltage protection is enabled on the Options tab. When the generator terminal voltage reaches the level of this setting and the associated time delay expires, the corresponding protection alarm LED lights. (See the Alarm/Status or Analysis screen for the detailed alarm LED signals.) If programmed for the undervoltage function, one or more of the three programmable output relays are actuated. A setting of 0 to 30,000 Vac may be entered in 1 Vac increments.

Generator Undervoltage, Delay. Sets the time delay for the generator undervoltage protection function. This setting is active only when generator undervoltage protection is enabled on the Options tab. A setting of 0.5 to 60 seconds may be entered in 0.1 second increments.

Exciter Field Overcurrent, Level. Configures the setpoint for field overcurrent protection. This setting is active only when field overcurrent protection is enabled on the Options tab. When the field current exceeds the level of this setting and the associated time delay expires, the corresponding protection alarm LED lights. (See the Alarm/Status or Analysis Screen for the detailed alarm LED signals.) If programmed for the field overcurrent function, one or more of the three programmable output relays are actuated. A setting of 0.1 to 16.0 Adc may be entered in 0.1 Adc increments.

Exciter Field Overcurrent, Delay. Selects the time delay between when the field current reaches the Exciter Field Overcurrent Level setting and when the alarm annunciates. The time delay is initiated when the sensed current exceeds the overcurrent setpoint and is inversely proportional to the overcurrent level. The higher the current level, the less time delay before alarm annunciations. This setting is active only when shorted exciter diode protection is enabled on the Options tab. A setting of 0.1 to 20 seconds may be entered in 0.1 second increments.

Exciter Shorted Diode, Level. Configures the percent of rated field current that indicates a shorted exciter diode. This setting is active only when shorted exciter diode protection is enabled on the Options tab. A setting of 0 to 100% may be entered in 0.1% increments.

Exciter Shorted Diode, Delay. Sets the time delay between when a shorted exciter diode is detected and annunciated. This setting is active only when shorted exciter diode protection is enabled on the Options tab. A setting of 5 to 30 seconds may be entered in 0.1 second increments.

Loss of Field, Level. Configures the setpoint for loss of field protection. This setting is active only when loss of field protection is enabled on the Options tab. When the kvar value decreases below the negative value of this setting for the duration of the Loss of Field Delay setting, the corresponding protection alarm LED lights. (See the Alarm/Status tab of the Metering screen or the Analysis screen for the detailed alarm LED signals.) Any of the three programmable DECS-200 output relays can be programmed to annunciate a loss of field condition. A setting of 0 to 3,000,000 kvar may be entered in1 kvar increments.

Loss of Field, Delay. Sets the loss of field protection time delay. This setting is active only when loss of field protection is enabled. A setting of 0 to 9.9 seconds may be entered in 0.1 second increments.

Relay Logic

Logic settings for the three programmable relays are divided between two tabs labeled Relay #1, #2 Logic and Relay #3 Logic. Because the settings for each programmable relay are identical, only the Relay #1, #2 Logic tab is illustrated here (Figure 5-27).

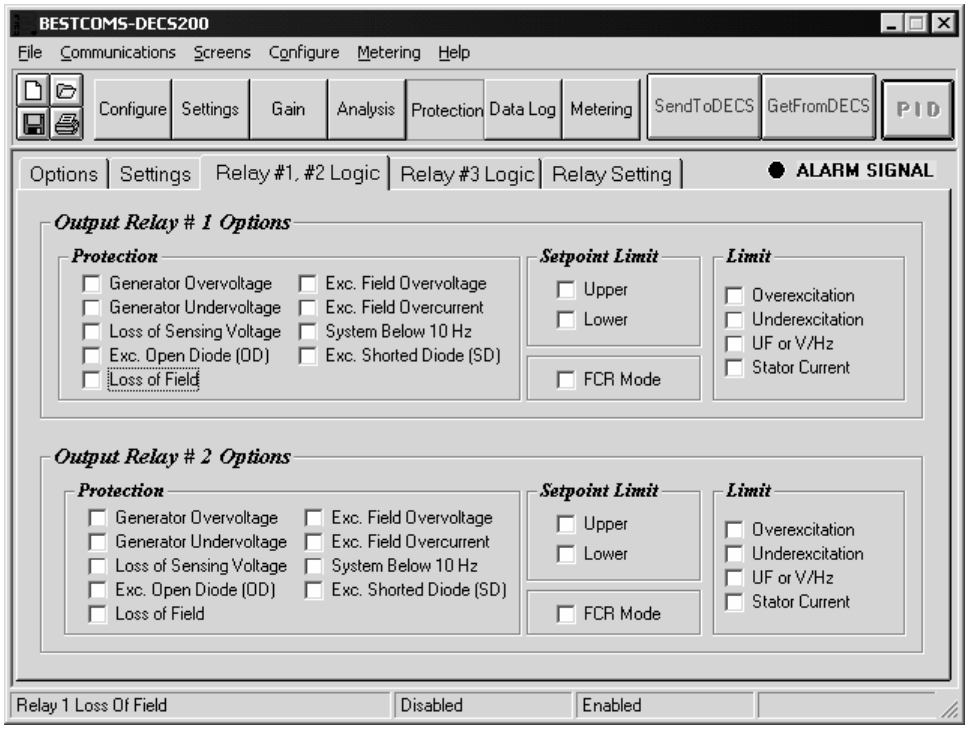

Figure 5-27. Protection Screen, Relay #1, #2 Logic Tab

Protection. A programmable relay can be configured to annunciate any of nine active protection functions. These protection functions include:

- Field overcurrent
- Field overvoltage
- Generator overvoltage
- Generator undervoltage
- Loss of field
- Loss of sensing voltage
- Open exciter diode
- Shorted exciter diode
- System frequency below 10 Hz

Setpoint Limit. A programmable output can be configured to close when the active setpoint reaches the upper limit or lower limit.

FCR Mode. Enabling this setting closes the programmable output when the DECS-200 is operating in FCR (Manual) mode.

Limit. A programmable output can be configured to close when the following limits are reached: overexcitation, stator current, underfrequency or volts per hertz, and underexcitation.

Relay Setting

Contact settings for each of the three programmable relays are adjusted on the Relay Setting tab. Relay Setting tab settings are illustrated in Figure 5-28 and described in the following paragraphs.

Contact Status. Configures the output contacts as normally open (NO) or normally closed (NC). Normally closed, programmable relay outputs do not remain closed when control power is removed from the DECS-200.

Contact Type. Selects one of three contact types: Momentary, Maintained, or Latched. Selecting Momentary closes or opens the relay contacts for the duration determined by the Momentary Time setting. Selecting Maintained closes or opens the relay contact for the duration of the condition triggering the relay's change of state. Selecting Latched latches the relay contacts closed or open until the relay is reset by the user.

Momentary Time. When Momentary is selected as the contact type, this setting controls the duration that the contact is open/closed when the relay output is active. A setting of 0.1 to 5 seconds may be entered in 0.05 second increments.

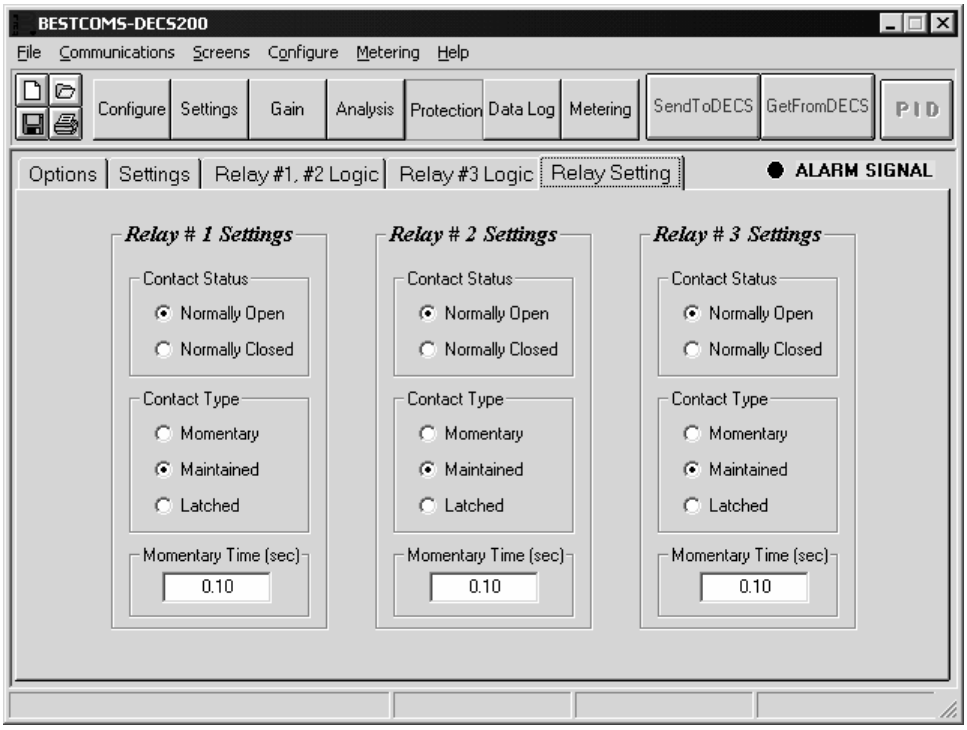

Figure 5-28. Protection Screen, Relay Setting Tab

Data Log

The Data Log screen consists of three tabs labeled Log Setup/Sequence of Events, Logic Triggers, and Level Triggers/Logged Parameters. To view the Data Log screen, click the **Data Log** button on the tool bar or click **Screens** on the menu bar and click **Data Log**.

Log Setup/Sequence Of Events

Log Setup/Sequence of Events tab settings are illustrated in Figure 5-29 and described in the following paragraphs.

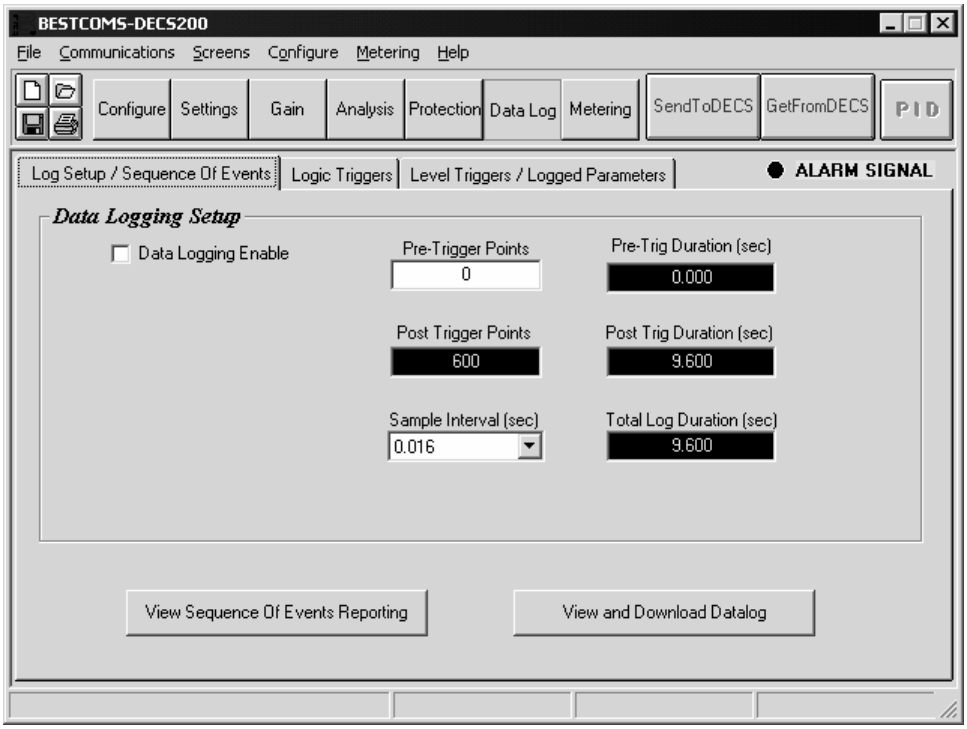

Figure 5-29. Data Log Screen, Log Setup/Sequence of Events Tab

Data Logging Setup, Data Logging Enable. Enables and disables data logging.

Data Logging Setup, Pre-Trigger Points. Selects the number of data points that are recorded prior to a data log being triggered. A setting of 0 to 599 may be entered in increments of 1.

Data Logging Setup, Post Trigger Points. Displays the number of data points that are recorded after a data log is triggered. The value of this read-only field is determined by the Pre-Trigger Points and Sample Interval settings.

Data Logging Setup, Sample Interval. Establishes the sample rate of the data points. When the Generator Frequency setting (System Configuration screen, System Options tab) is 60 hertz, a sample interval of 0.016 to 10 seconds may be selected from the pull-down menu. When the Generator Frequency setting is 50 hertz, a sample interval of 0.004 to 10 seconds may be selected from the pull-down menu.

Data Logging Setup, Pre-Trig Duration. Displays the length of time that pre-trigger data points are recorded. The value of this read-only field is determined by the Pre-Trigger Points and Sample Interval settings.

Data Logging Setup, Post Trig Duration. Displays the length of time that post-trigger data points are recorded. The value of this read-only field is determined by the Pre-Trigger Points and Sample Interval settings.

Data Logging Setup, Total Log Duration. Displays the total recording time for a data log and equals the sum of the values in the Pre-Trig Duration and Post Trig Duration fields. The value of this read-only field is determined by the Pre-Trigger Points and Sample Interval settings.

View Sequence Of Events Reporting. Clicking this button displays the Sequence of Events Reporting screen (Figure 5-30). Sequence of Events Reporting screen displays and controls are described in the following paragraphs.

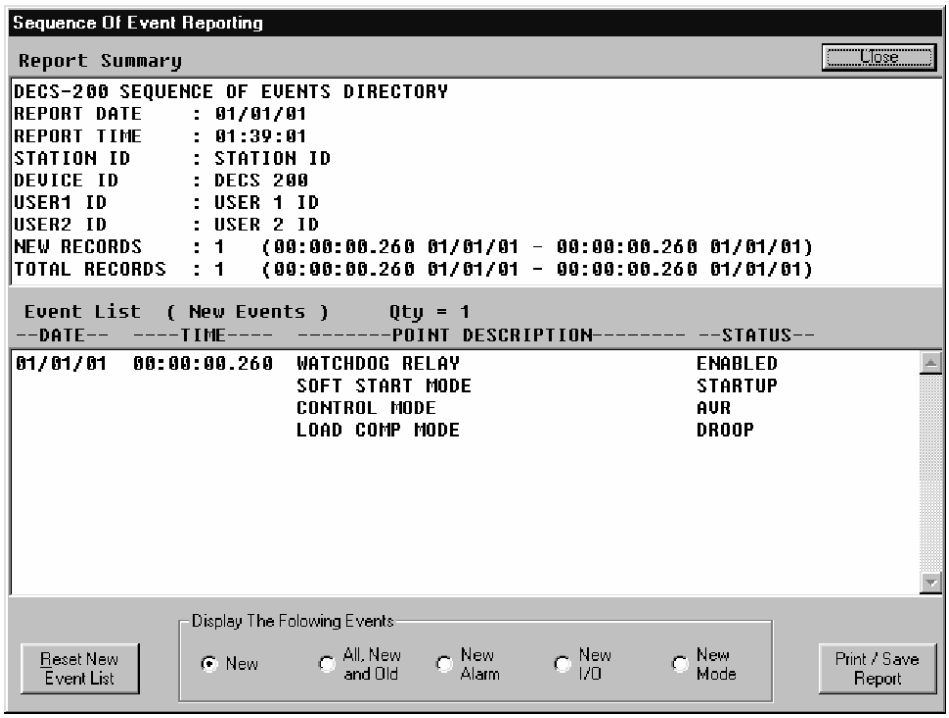

Figure 5-30. Sequence of Event Reporting

Report Summary. This area of the Sequence of Event Recording screen lists the available sequence of events records. The records displayed are determined by the selection made in the Display the Following Events setting area.

Event List. This area of the Sequence of Event Recording screen lists the available sequence of events records. The records displayed are determined by the selection made in the Display the Following Events setting area.

Reset New Event List. Clicking this button clears all new events from the Event List.

Display the Following Events. The event type displayed in the Event List is controlled by selection made here. Available event-type selections are New, All New and Old, New Alarm, New I/O, and New Mode.

Print/Save Report. Clicking this button allows the report to be saved as a text file or printed.

View and Download Data log. Clicking this button displays the Data Logging screen of Figure 5-31. Data Logging screen displays and controls are described in the following paragraphs.

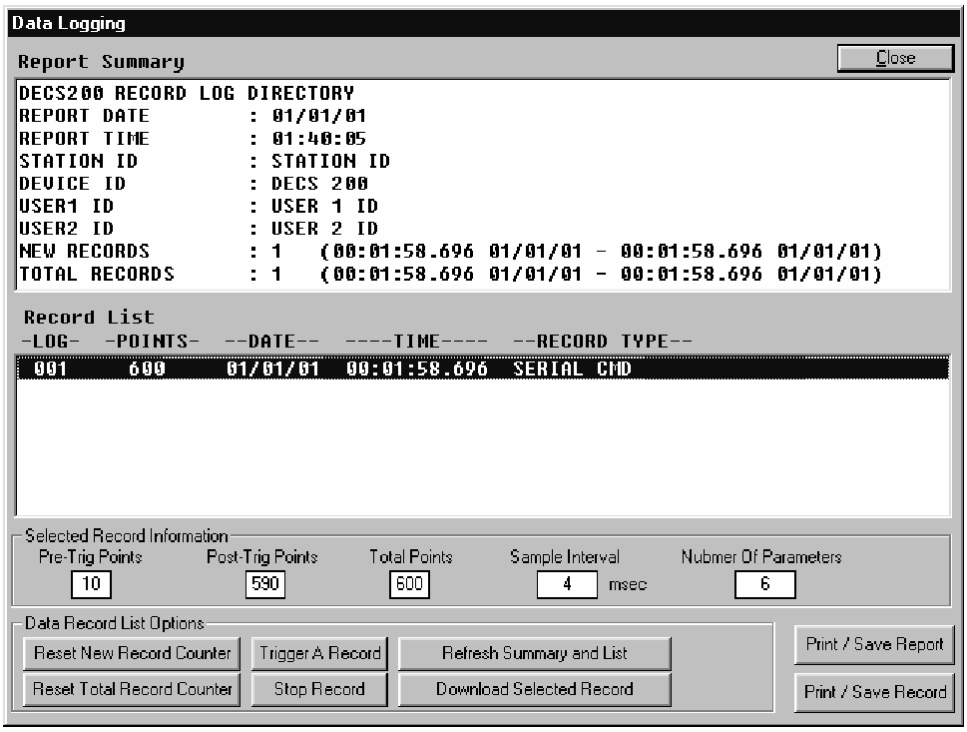

Figure 5-31. Data Logging Screen

Report Summary. This area of the Data Logging screen displays information such as the time and date, station, device and user identification information, and the number of new and total records.

Event List. This area of the Sequence of Event Recording screen lists the available sequence of events records. The records displayed are determined by the selection made in the Display the Following Events setting area.

Selected Record Information. This area of the Data Logging screen displays information relating to the data log record selected in the Record List. Displayed information includes the number of pre-trigger points, number of post-trigger points, total number of points, the sample interval, and the number of parameters reported.

Data Record List Options, Reset New Record Counter. Clicking this button resets the number of new records reported in the Report Summary to zero.

Data Record List Options, Reset Total Record Counter. Clicking this button resets the number of total records reported in the Report Summary to zero.

Data Record List Options, Trigger a Record. Clicking this button manually triggers data record acquisition. A data log cannot be manually triggered unless data logging is enabled on the Log Setup/Sequence of Events tab.

Data Record List Options, Stop Record. Clicking this button ends acquisition of a manually triggered data record.

Data Record List Options, Refresh Summary and List. Clicking this button updates the Report Summary data and Record List with the latest available information.

Data Record List Options, Download Selected Record. Clicking this button downloads the selected record and allows it to be saved as either a text file or a COMTRADE file viewable in BESTwave.

Print/Save Report. Clicking this button allows a report to be either saved as a text file or printed.

Print/Save Record. Clicking this button allows a record to be either saved as a text file or printed.

Logic Triggers

Logic Triggers tab settings are illustrated in Figure 5-32 and described in the following paragraphs.

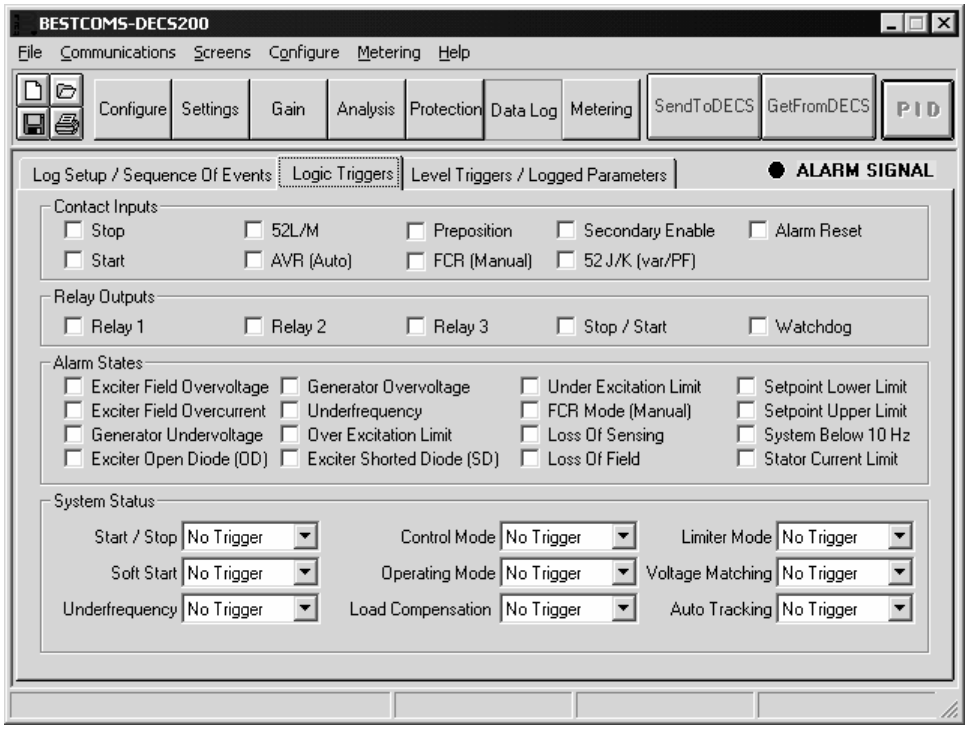

Figure 5-32. Data Log Screen, Logic Triggers Tab

Contact Inputs. This area of the Logic Triggers tab lists the available DECS-200 contact inputs that can be selected to trigger a data log report. The following contact inputs are available for triggering a data log report:

- 52J/K
- 52L/M
- Alarm Reset
- AVR
- FCR
- Pre-Position
- Secondary Enable
- Start
- Stop

Any combination of contact inputs may be selected.

Relay Outputs. This area of the Logic Triggers tab lists the DECS-200 contact outputs that can be selected to trigger a data log report. The following relay outputs are available for triggering a data log report:

- Relay 1
- Relay 2
- Relay 3
- Stop/Start
- Watchdog

Any combination of relay outputs may be selected.

Alarm States. This area of the Logic Triggers tab lists the available alarm conditions that can be selected to trigger a data log report. The following alarm conditions are available for triggering a data log report:

- Exciter field overcurrent
- Exciter field overvoltage
- Exciter open diode
- FCR mode
- Generator overvoltage
- Generator sensing <10 Hz
- Generator undervoltage
- Loss of field
- Loss of sensing
- Overexcitation limit
- Setpoint at lower limit
- Setpoint at upper limit
- Shorted exciter diode
- Stator current limit
- Underexcitation limit
- Underfrequency

Any combination of alarm states may be selected.

System Status, Start/Stop. Enables the Start or Stop mode to trigger a data log report. Selecting “No Trigger” disables a Start or Stop mode trigger.

System Status, Soft Start. Enables a data log report to be triggered when Underfrequency protection is active or inactive. Selecting “No Trigger” disables a Soft Start trigger.

System Status, Underfrequency. Enables a data log report to be triggered when either AVR mode or FCR mode is active. Selecting “No Trigger” disables an Underfrequency trigger.

System Status, Control Mode. Enables a data log report to be triggered when either AVR mode or FCR mode is active. Selecting “No Trigger” disables a control mode trigger.

System Status, Operating Mode. Enables a data log report to be triggered when power factor control is active or var control is active. Selecting “No Trigger” disables an operating mode trigger.

System Status, Load Compensation. Enables a data log report to be triggered when droop compensation is active or inactive. Selecting “No Trigger” disables a load compensation trigger.

System Status, Limiter Mode. Enables a data log report to be triggered when the underexcitation limiter, overexcitation limiter, or stator current limiter are active. Additionally, a data log report can be triggered when two of the limiters are active. The available limiter mode selections are listed below:

- No Trigger (disables a limiter mode trigger)
- OEL (overexcitation limiter active)
- Off (no limiters active)
- SCL (stator current limiter active)
- SCL, OEL (stator current limiter and overexcitation limiter active)
- SCL, UEL (stator current limiter and underexcitation limiter active)
- UEL (underexcitation limiter active)
- UEL, OEL (underexcitation limiter and overexcitation limiter active)

System Status, Voltage Matching. Enables a data log report to be triggered when voltage matching is enabled (On) or disabled (Off). Selecting No Trigger disables a voltage matching trigger.

System Status, Auto Tracking. Enables a data log report to be triggered when the DECS-200 is functioning as the primary controller or the secondary controller in a redundant DECS-200 system. Selecting No Trigger disables an auto-tracking trigger.

Level Triggers/ Logged Parameters

The Level Triggers/Logged Parameters tab (Figure 5-33) consists of a list of parameters that can be selected to trigger a data log report. Up to six parameters can be selected as triggers. Each parameter has Level Trigger Enable buttons that are used to trigger a data log when the parameter increases above the upper threshold setting, decreases below the lower threshold setting, or either increases above or decreases below the upper or lower threshold setting. The available parameters that can be selected to trigger a data log report are listed in Table 5-2.

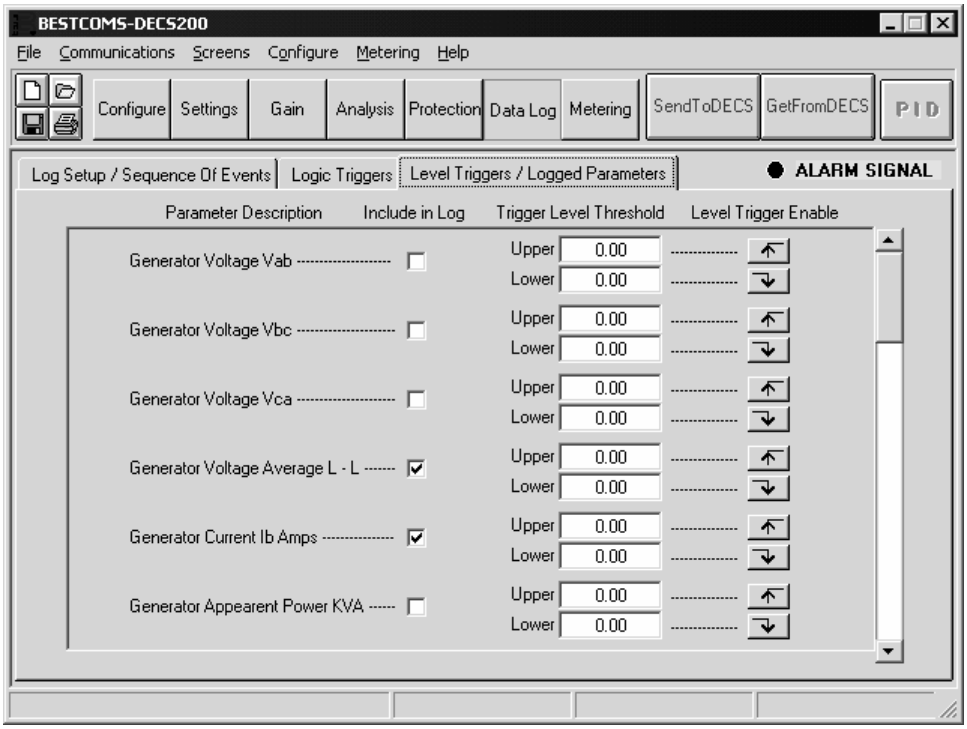

Figure 5-33. Data Log Screen, Level Triggers/Logged Parameters

Table 5-2. Data Log Report Parameter Triggers

Parameter	Unit of Measure	Threshold		Increment
		Lower	Upper	
Auto Tracking Output	N/A	–65535 to 65535	–65535 to 65535	1
Auxiliary Input Voltage	PU	–2 to 2	–2 to 2	0.01
Average Gen. Voltage, L-L	PU	–2 to 2	–2 to 2	0.01
AVR Error Signal	N/A	–65535 to 65535	–65535 to 65535	1
Bus Frequency	Hz	0 to 90	0 to 90	0.01
Bus Voltage	PU	–2 to 2	–2 to 2	0.01
Control Output	N/A	–65535 to 65535	–65535 to 65535	1
Cross-Current Input	PU	–2 to 2	–2 to 2	0.01
Field Current	PU	–2 to 2	–2 to 2	0.01
Field Voltage	PU	–2 to 2	–2 to 2	0.01
Gen. Apparent Power kVA	PU	–2 to 2	–2 to 2	0.01
Gen. Reactive Power kvar	PU	–2 to 2	–2 to 2	0.01
Gen. Real Power kW	PU	–2 to 2	–2 to 2	0.01
Generator Current Ib	PU	–2 to 2	–2 to 2	0.01
Generator Frequency	Hz	0 to 90	0 to 90	0.01
Generator Power Factor	PF	–1 to 1	–1 to 1	0.01
Generator Voltage Vab	PU	–2 to 2	–2 to 2	0.01
Generator Voltage Vbc	PU	–2 to 2	–2 to 2	0.01
Generator Voltage Vca	PU	–2 to 2	–2 to 2	0.01
Phase Angle, V-I	Degrees	–180 to 180	–180 to 180	0.01
PID Integrator State	N/A	–65535 to 65535	–65535 to 65535	1
Var/PF Controller Output	N/A	–65535 to 65535	–65535 to 65535	1

Metering

The Metering screen consists of two tabs labeled Operation and Alarm/Status. To view the Metering screen, click the **Metering** button on the tool bar or click **Screens** on the menu bar and click **Metering/Operation**.

Operation

Operation tab parameters and controls are illustrated in Figure 5-34 and described in the following paragraphs.

DECS-200 BESTCOMS software provides real-time monitoring of the following data. This data is refreshed approximately once every second. Metering is enabled or disabled through the pull-down menu or by clicking the **Metering** button.

Real-time metering values on the Operation tab are refreshed approximately once per second. Metering is enabled or disabled through the Metering menu on the menu bar or by clicking the **Metering** button.

Gen Voltage. Displays three values of generator voltage: Vab, Vbc, and Vca.

Gen Current. Displays phase B generator current.

Field Voltage. Displays the level of field voltage.

Field Current. Displays the level of field current.

EDM SD/OD Ripple. Displays the percentage of ripple detected across the exciter diodes by the exciter diode monitor.

Bus Voltage. Displays the level of bus voltage.

Phase Angle. Displays the phase angle between the generator voltage and current.

Position Indication. Displays the relative position (in percent) of the current setpoint value to the programmed minimum or maximum setpoint.

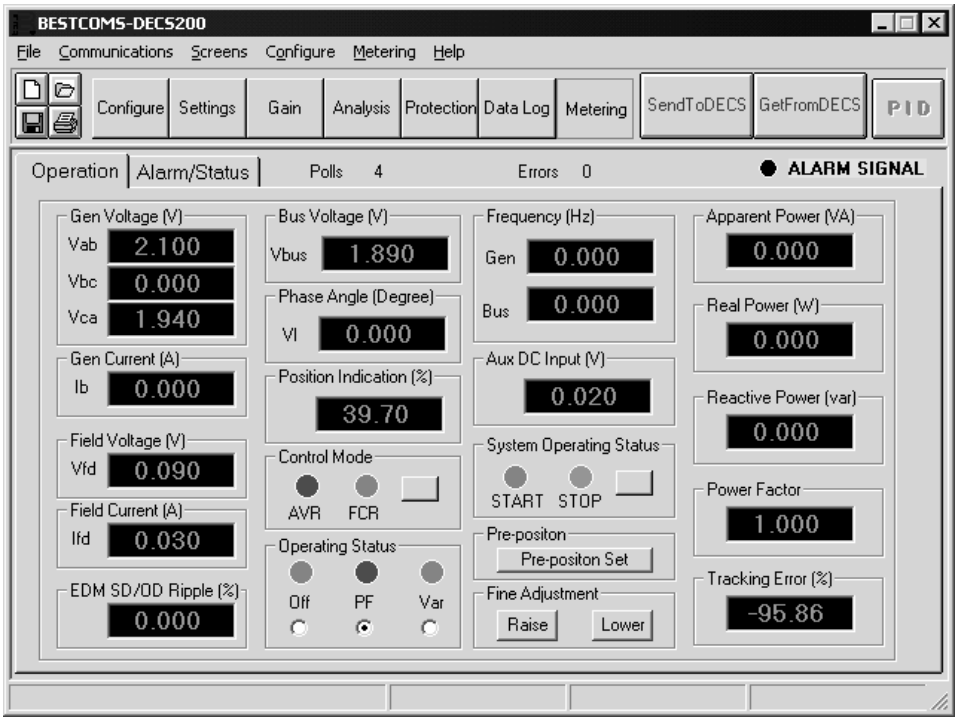

Figure 5-34. Metering Screen, Operation Tab

Frequency. Displays the frequency of the generator voltage and bus voltage.

Aux DC Input. Displays a value of voltage that is relative to the accessory input voltage or current, depending on the mode selected.

Apparent Power. Displays the apparent power, in VA, being supplied by the generator.

Real Power. Displays the real power, in watts, being supplied by the generator.

Reactive Power. Displays the reactive power, in vars, being supplied by the generator.

Power Factor. Displays the operating power factor of the generator.

Tracking Error. Displays the ratio, expressed as a percentage, of the nominal value of the tracking mode to the mode being tracked. For example, if operating in AVR mode with 100 Vac nominal generator voltage and a tracking error of –0.5%, a transfer to another operating mode would cause a decrease in generator output voltage to 99.5 Vac.

Control Mode. AVR and FCR mode status is reported by two indicators. When the DECS-200 is operating in AVR mode, the AVR indicator changes from gray to red. When operating in FCR mode, the FCR indicator changes from gray to green. A button is provided to toggle between AVR and FCR modes.

Operating Status. Three indicators report whether Var mode is active, Power Factor mode is active, or neither mode is active. An option button below each indicator is used to select the corresponding operating mode. When Var mode is active, the Var indicator changes from gray to green. When Power Factor mode is active, the PF indicator changes from gray to red. When neither mode is active, the Off indicator changes from gray to blue. If the control mode is FCR and Var of PF mode is selected, that selection will be ignored by the DECS-200. Even if the Var or PF indicator turns on, the system will not be in those modes unless the DECS-200 52J/K input is open. See Table 5-3 for additional information on 52J/K and 52L/M logic.

Table 5-3. 52J/K and 52L/M Logic

DECS-200 Operating Mode	52 L/M	52 J/K	Generator Operating Mode
AVR mode active, off-line OEL enabled, no droop, no var/PF	Closed	Closed	Single unit/stand-alone
Droop mode active, on-line OEL enabled, no var/PF	Open	Closed	Paralleled to the utility grid (droop) or two or more generators islanded (droop or cross-current compensation)
Var/PF mode active, on-line OEL enabled	Open	Open	Paralleled to utility grid

NOTE: If neither var or power factor modes are selected via the operator interfaces, then the operating mode is droop.

System Operating Status. Two indicators show the start/stop mode status of the DECS-200. in Start mode, the START indicator changes from gray to red. In Stop mode, the STOP indicator changes from gray to green. A button is provided for toggling between Start and Stop modes.

Pre-position Set. Clicking this button adjusts the excitation setpoint to the pre-position value.

Fine Adjustment. Clicking the Raise button increases the active operating setpoint. Clicking the Lower button decreases the active operating setpoint. The raise and lower increment is a function of the setpoint range of adjustment and the active operating setpoint. The raise and lower increment is a function of the setpoint range of adjustment and the active mode traverse rate. The increments are directly proportional to the adjustment range and inversely proportional to the traverse rate.

Alarm/Status

Alarm/Status tab indicators and controls are illustrated in Figure 5-35 and described in the following paragraphs.

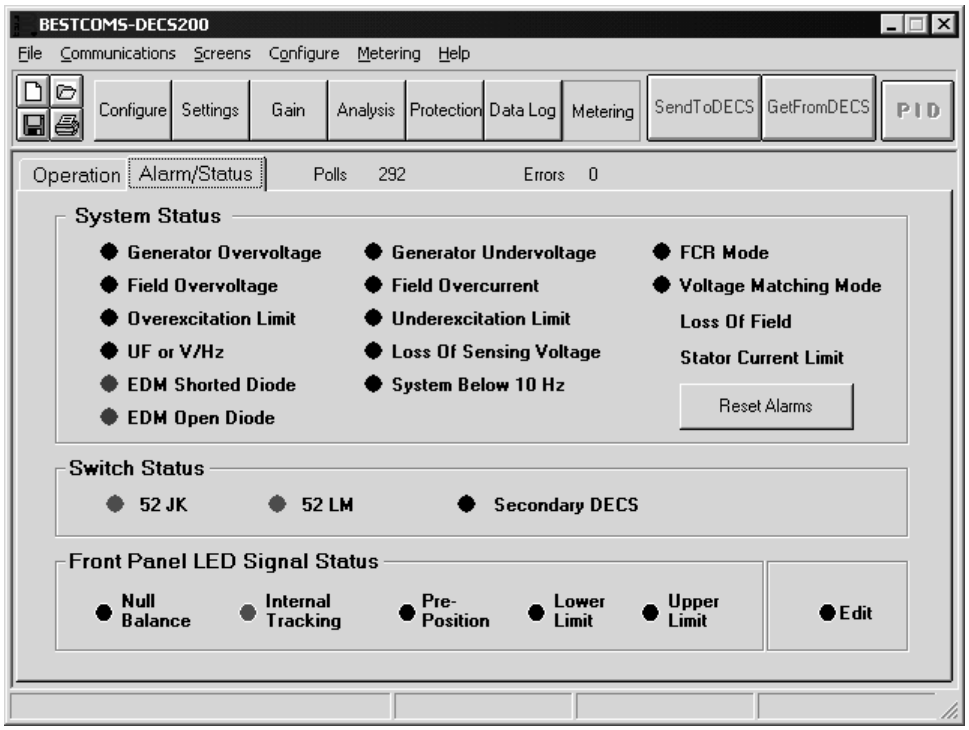

Figure 5-35. Metering Screen, Alarm/Status Tab

System Status. When any of the 15 conditions listed in Figure 5-35 exist, the corresponding indicator changes from gray to red. Clicking the Reset Alarms button resets the system status annunciations. Any condition that remains active will annunciate again after the Reset Alarms button is clicked.

Switch Status. Three indicators provide contact input status. The 52 JK indicator turns on when the 52J/K contact input is open. The 52 LM indicator turns on when the 52L/M contact is open. The Secondary DECS indicator turns on when the SECEN (secondary enable) contact input is closed.

Front Panel LED Signal Status. Six indicators provide remote indication of the front panel LEDs. Refer to Section 2, *Human-Machine Interface* for information regarding the function of the front panel indicators.

SAVING, PRINTING, AND OPENING FILES

BESTCOMS provides the ability to save DECS-200 settings in a file for reference or future use. Using a settings file can save setup time when configuring multiple units with the same configuration. Settings files may be opened and edited using any text editing application. A settings file can also be printed from BESTCOMS.

Saving Files

A DECS-200 settings file is saved through a Save As dialog box. The Save As dialog box is accessed by using any of three methods:

- Click the **Save File** button on the tool bar
- Press **Ctrl** + **A** on the keyboard
- Click **File, Save As** on the menu bar

The Save As dialog box enables you to navigate to the desired folder and save the DECS-200 settings file. DECS-200 setting files are saved with a .de2 extension.

Printing Files

A printed copy of DECS-200 settings can be made for record keeping or as a reference. Settings are printed by accessing the print preview screen. The print preview screen is accessed by using any of three methods:

- Click the **Print Data** button on the tool bar
- Press **Ctrl** + **P** on the keyboard
- Click **File, Print** on the menu bar

Executing a print command displays a user information box with fields for adding a title and comments to the printout. Clicking OK or Cancel displays a print preview of the settings. The print preview screen enables you to select a printer and configure the page layout (Print Setup button), print the settings list (printer icon button), and save the list of settings in a text file (Save button). The BESTCOMS software version, the DECS-200 firmware version, and the time and date are printed along with the settings.

Opening/Uploading Files

DECS-200 settings files can be opened by BESTCOMS and uploaded to a DECS-200 communicating with the PC running BESTCOMS. A DECS-200 settings file is retrieved through the BESTCOMS Open dialog box. The Open dialog box is accessed by using any of three methods:

- Click the **File Open** button on the tool bar
- Press **Ctrl** + **O** on the keyboard
- Click **File, Open** on the menu bar

The Open dialog box enables you to navigate to the desired settings file and retrieve the settings. Settings can be retrieved into BESTCOMS and uploaded to the DECS-200 or retrieved into BESTCOMS without uploading to the DECS-200. When you execute the Open command, a warning dialog box appears. This dialog box warns you that equipment damage may occur as a result of the changes that were made in the computer file. If you have confidence that no damage will occur, you may send the data to the DECS-200.

CAUTION

A file data transfer while the DECS-200 is on-line may result in poor system performance or equipment damage. Make sure that the new settings are safe to upload before you transfer the data file.

If you select Yes, then 17 blocks of DECS-200 setting data are sent to the DECS-200 block by block. Please wait until all 17 blocks of data have been transferred. When power is next applied to the DECS-200 unit, the previously saved settings will become the current settings.

PID WINDOW

The PID window of BESTCOMS provides the ability to increase generator stability by changing the PID (proportional + integral + derivative) parameters. PID parameters are calculated automatically after the user selects the generator time constant (T'do) and/or exciter time constant (Texc).

The PID window is accessed by clicking the PID button on the tool bar. This button is enabled only when the Control Gain screen is being viewed and the Stability Range setting is 21.

PID window functions are shown in Figure 5-36 and described in the following paragraphs.

Field Input Data, Generator Information. This setting field is used to enter and display a descriptive name for the selected group of PID settings. The Generator Information field accepts up to 27 alphanumeric characters.

Field Input Data, Generator Time Constant T'do. The time constant of the generator is entered in this field. The generator time constant and exciter time constant are used to calculate gain parameters Kp, Ki, and Kd. A setting of 1 to 15 may be selected from the pull-down menu.

Field Input Data, Exciter Time Constant Texc. The time constant of the exciter is entered in this field. The exciter time constant and generator time constant are used to calculate gain parameters Kp, Ki, and Kd. The exciter time constant setting range varies according to the generator time constant value selected. The default value for the exciter time constant is the generator time constant divided by six.

Field Output Data, Gain Kp. This read-only field displays the calculated value of Kp based on the generator time constant (T'do) and exciter time constant (Texc).

Field Output Data, Gain Ki. This read-only field displays the calculated value of Ki based on the generator time constant (T'do) and exciter time constant (Te).

Field Output Data, Gain Kd. This read-only field displays the calculated value of Kd based on the generator time constant (T'do) and exciter time constant (Texc).

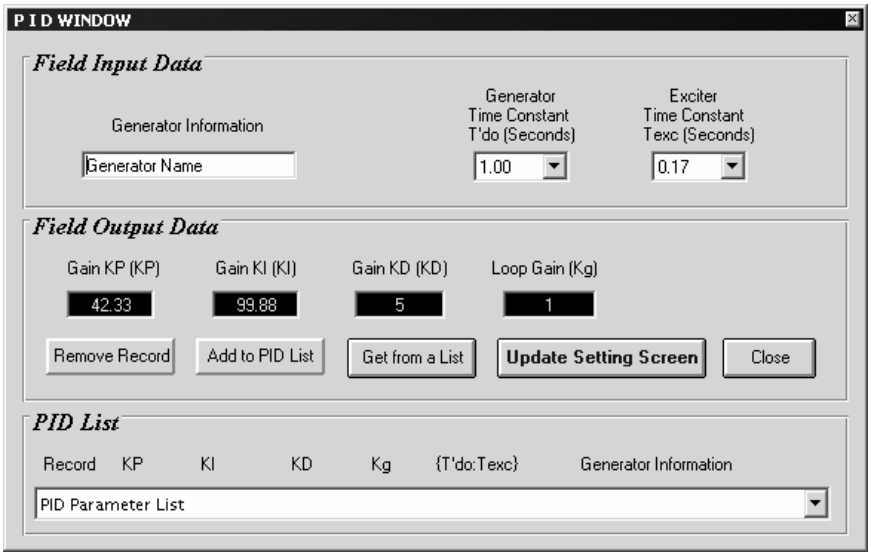

Figure 5-36. PID Window

Field Output Data – Gain Kg. This read-only field displays the calculated value of Kg based on the generator time constant (T'do) and exciter time constant (Texc).

Buttons below the Field Output Data fields enable existing PID records to be deleted (Remove Record), enable calculated setting to be saved in a record (Add to PID List), enable a set of PID parameters to be retrieved from the PID list and invoked, and update the PID settings displayed in the PID window and used by the DECS-200N (Update Setting Screen). Clicking the Close button exits the PID window and returns to the Control Gain screen.

PID List. This area of the PID window displays the groups of available PID settings.

PID Calculations Based On Input Values

The available exciter time constant range is determined by the generator time constant input value. (The default value for the exciter time constant is the generator time constant divided by six (T'do ÷ 6).) The generator time constant input value must be in the range of 1.0 to 15.0 seconds and in 0.05 second increments. When the generator time constant value is 1.00, the available exciter time constant range is 0.03 to 0.50 in 0.01 second increments. When the generator time constant value is 15.00, the available exciter time constant range is 0.30 to 3.00 in 0.01 second increments.

For example, when you set T'do = 2.0 seconds, Texc is 0.33. After specifying the input values, a set of PID parameters (Output Data) is generated automatically. If you set T'do = 5.00 seconds, then Texc will be 0.83 seconds. The calculated KP is 155.47, KI is 138.72, KD is 48, and Kg is 1.

PID parameters can be directly removed from, added to, or modified in the PID List Data. PID parameters may also be saved into a file (pidlist.dat).

Adding To PID List

CAUTION

Improper PID numbers can result in poor system performance or equipment damage.

PID parameters can be added to a list and recalled for operational use and comparison. To add to the list, type the name for the generator (or other appropriate information) in the generator information box. Choose the generator time constant and, if appropriate, the exciter time constant. Observe the PID gain parameters in the Field Output Data boxes. If these gain parameters are appropriate, select the **Add to PID List** button. To check for the new parameters, pull down the **PID Parameters List** (click on the down arrow). The new gain and time constant parameters will be displayed.

Removing A PID List Record

PID parameters can also be removed from the list. To remove a list (record), pull down the **PID Parameters List** and select the record or list so that the gain and time constant parameters are displayed. Click the **Remove Record** button and the listed record is deleted.

Retrieving Existing Data From PID List

To retrieve existing data, pull down the **PID Parameters List** and select the record or list so that the gain and time constant parameters are displayed and highlighted. Click the **Get from a list** button and the listed record input and output data displays in the text boxes.

TERMINATING COMMUNICATION

Communication between BESTCOMS and the DECS-200 is terminated by clicking **Communications** on the menu bar and clicking **Close Comm Port**.

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SECTION 6 • SETUP

TABLE OF CONTENTS

Figures

Tables

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SECTION 6 • SETUP

INTRODUCTION

This section provides generic setup and operation procedures for excitation systems using the DECS-200. These procedures are provided only as a guide and are not intended as a replacement for the setup and operation procedures required by a specific system. In these procedures, DECS-200 settings are entered through the BESTCOMS interface. Therefore, a PC operating with BESTCOMS software will need to be connected to the DECS-200 being configured. For information about using BESTCOMS, refer to Section 5, *BESTCOMS Software*.

Equipment Required

The following equipment is required to perform the procedures presented here:

- Two-channel chart recorder or the DECS-200's oscillography. First channel measures the generator voltage at DECS-200 terminals A1 (E1) and A3 (E3). Second channel measures the field voltage at DECS-200 terminals C5 (F+) and C6 (F–).
- Oscilloscope
- Personal computer (PC) running BESTCOMS. The minimum requirements for a PC running BESTCOMS are provided in Section 5, *BESTCOMS Software*.
- Nine-pin serial communication cable to connect the DECS-200 to the PC.

Basler Electric Application Note 126, while not required, provides helpful information about paralleling circuits. This application note is available for downloading (in PDF format) from the Basler Electric website at www.basler.com.

System Data

Record your system ratings in Table 6-1.

Table 6-1. Generator and Field Ratings

Generator Ratings		Exciter Field Ratings	
Voltage:	Vac	No-Load Voltage:	Vdc
Frequency:	Hz	No-Load Current:	Adc
Reactive Power:	kvar	Full-Load Voltage:	Vdc
Rotational Speed:	rpm	Full-Load Current:	Adc

SETTINGS ENTRY

The DECS-200 settings entered on each BESTCOMS screen should be evaluated to ensure that they are appropriate for the application. When entering settings, remember to press the **Enter** key to save individual settings or click the **SendToDECS** button to save all of the settings on a screen.

System Configuration Screen

As shown in the following paragraphs, enter the desired settings on each tab of the Configuration screen. Review those settings and enable the functions that apply.

System Options

Select the desired system options illustrated in Figure 6-1.

Select the limiter mode ..... _____

Select the sensing configuration ..... _____

Select the underfrequency mode ..... _____

Select the nominal generator frequency ..... _____

Enable or disable voltage matching ..... _____

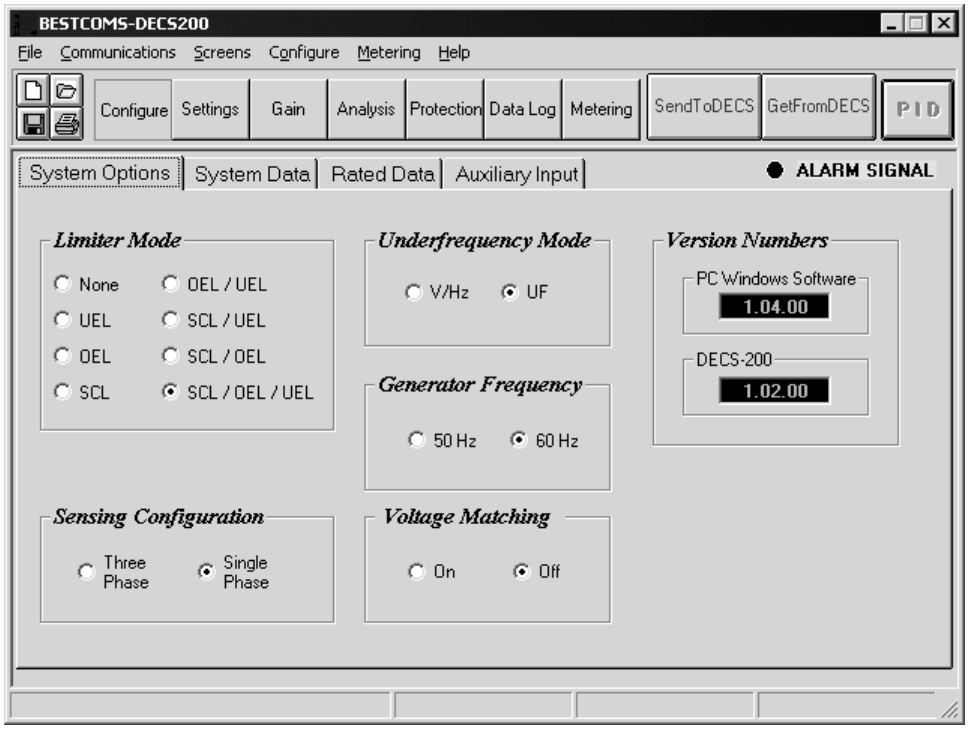

Figure 6-1. System Options Tab

System Data

Enter the system PT and CT ratings and configure the internal and external tracking settings illustrated in Figure 6-2.

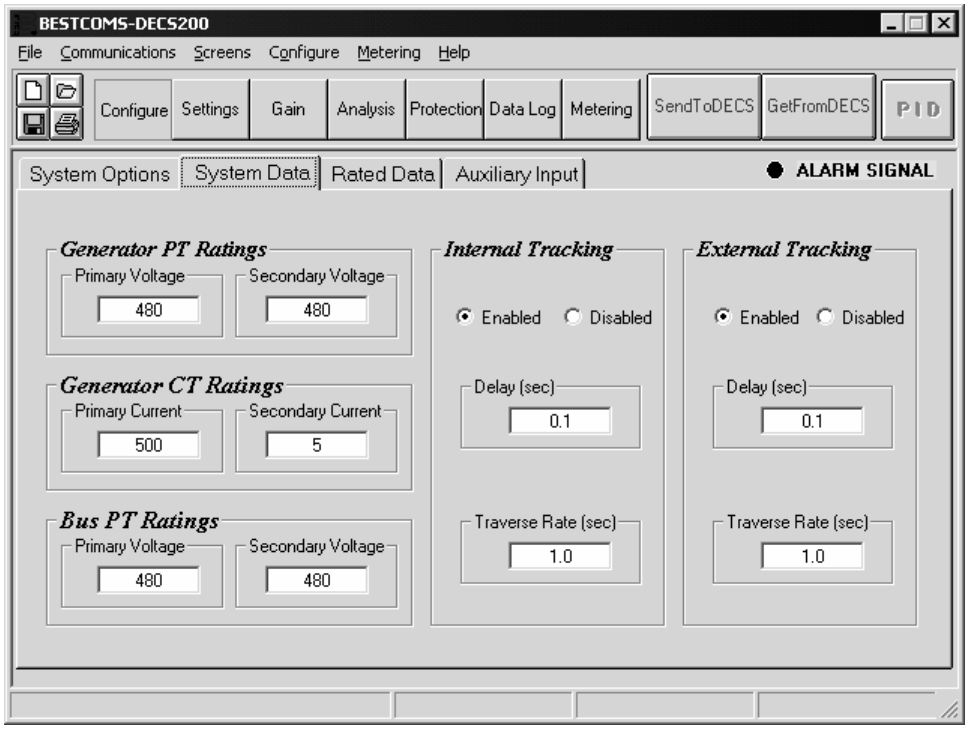

Figure 6-2. System Data Tab

Enter the generator PT primary voltage rating..... _____

Enter the generator PT secondary voltage rating..... _____

Enter the generator CT primary current rating..... _____

Enter the generator CT secondary current rating ..... _____

Enter the bus PT primary voltage rating (if applicable)..... _____

Enter the bus PT secondary voltage rating (if applicable) ..... _____

Enable or disable internal tracking..... _____

Set the internal tracking delay (1 second is suggested) ..... _____

Set the internal tracking traverse rate (10 seconds is suggested)..... _____

Enable or disable external tracking (applies only to redundant DECS-200 systems) ..... _____

Set the external tracking delay (applies only to redundant DECS-200 systems) ..... _____

Set the external tracking traverse rate (applies only to redundant DECS-200 systems) ..... _____

Rated Data

Enter the generator and exciter field ratings and exciter-to-generator pole ratio settings illustrated in Figure 6-3.

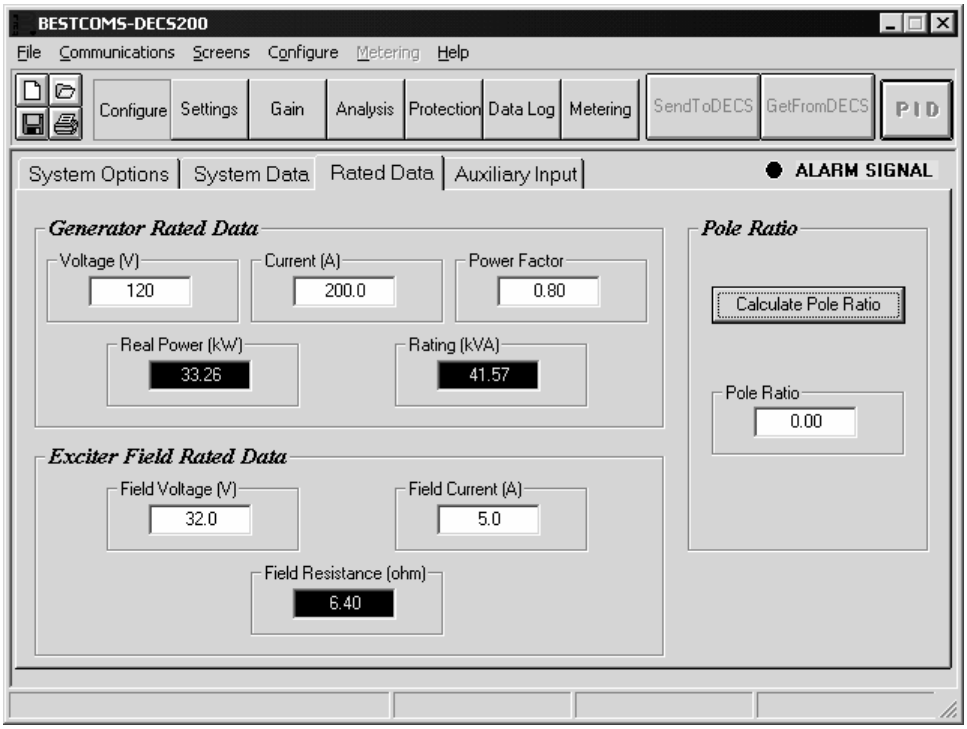

Figure 6-3. Rated Data Tab

Enter the rated generator terminal voltage ..... _____

Enter the rated generator current ..... _____

Enter the rated generator power factor..... _____

Enter the exciter-to-generator pole ratio ..... _____

Enter the rated exciter field voltage ..... _____

Enter the rated exciter field current..... _____

Auxiliary Input

Configure the accessory input selections and settings illustrated in Figure 6-4.

Select either voltage or current as the accessory input type ..... _____

Select either inner loop (AVR/FCR) or outer loop (var/PF) as the summing type ..... _____

Enter the accessory input gain (multiplier) setting for AVR mode ..... _____

Enter the accessory input gain (multiplier) setting for FCR mode ..... _____

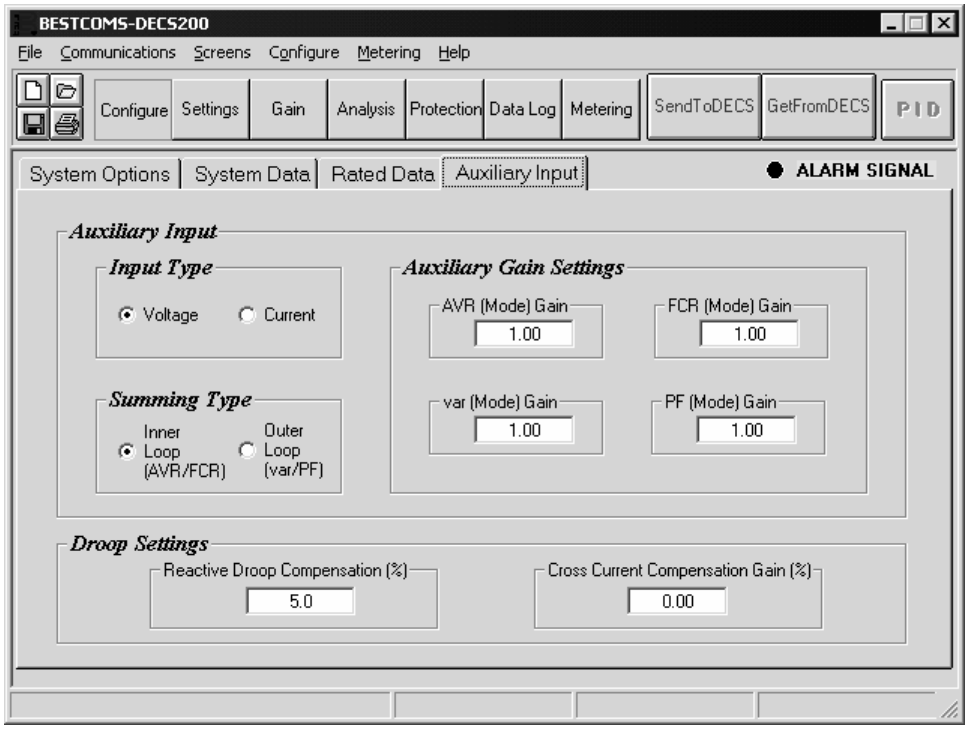

Figure 6-4. Auxiliary Input Tab

Enter the accessory input gain (multiplier) setting for var mode..... _____

Enter the accessory input gain (multiplier) setting for Power Factor mode ..... _____

Enter the droop compensation level for paralleled generators or line-drop compensation ..... _____

Enter the cross-current compensation (reactive differential) gain for paralleled generators..... _____

Setting Adjustments Screen

Enter the desired settings and enable the desired functions on each tab of the BESTCOMS Setting Adjustments screen. Figures 6-5 through 6-9 illustrate the settings of each System Configuration screen tab.

AVR/FCR

Configure the AVR mode and FCR mode settings illustrated in Figure 6-5. During commissioning, review setpoints unique for starting; especially review those for the FCR (manual) mode where the system would be started at the no-load excitation value or less. If pre-position is used, set the pre-position values as required.

Enter the AVR setpoint based on the generator terminal voltage ..... _____

Enter the minimum desired AVR mode setpoint, expressed as a percent of nominal ..... _____

Enter the maximum desired AVR mode setpoint, expressed as a percent of nominal ..... _____

Enter the AVR mode traverse rate..... _____

Enter the AVR mode pre-position setpoint ..... _____

Select either maintain or release as the AVR pre-position mode ..... _____

Enter the field current setpoint for FCR mode ..... _____

Enter the minimum desired FCR mode setpoint, expressed as a percent of nominal ..... _____

Enter the maximum desired FCR mode setpoint, expressed as a percent of nominal ..... _____

Enter the FCR mode traverse rate..... _____

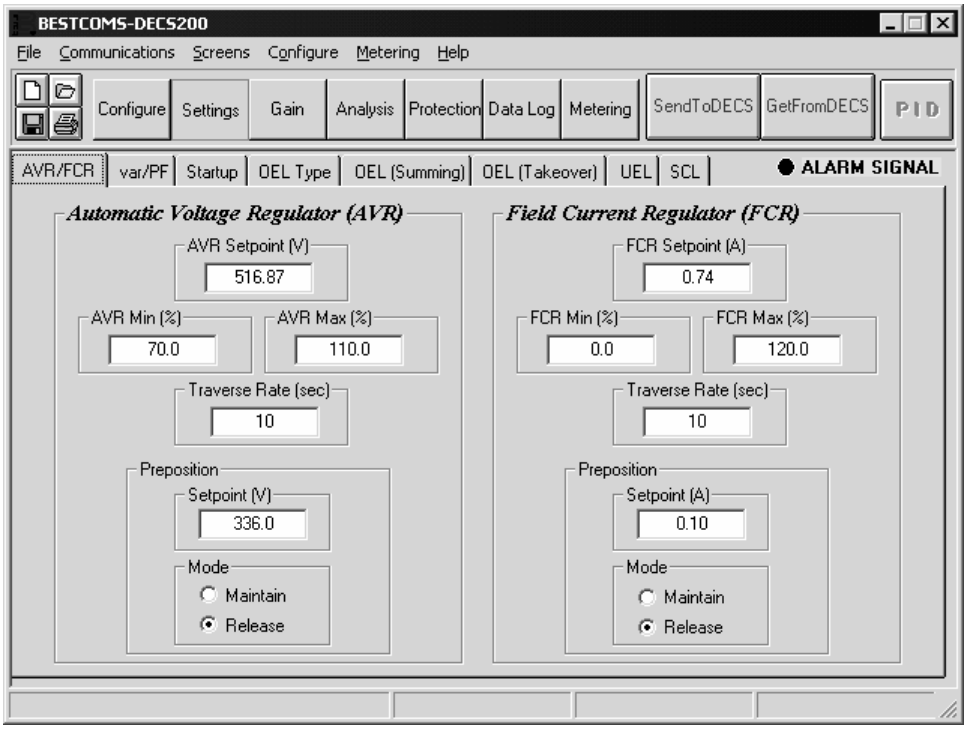

Figure 6-5. AVR/FCR Tab

Enter the FCR mode pre-position setpoint ..... _____

Select either maintain or release as the FCR pre-position mode ..... _____

Var/PF

Configure the var mode and power factor mode settings illustrated in Figure 6-7. If var or PF mode is enabled, the setpoint will be active only after transfer occurs into the specific mode because autotracking always forces a null condition to any operating mode.

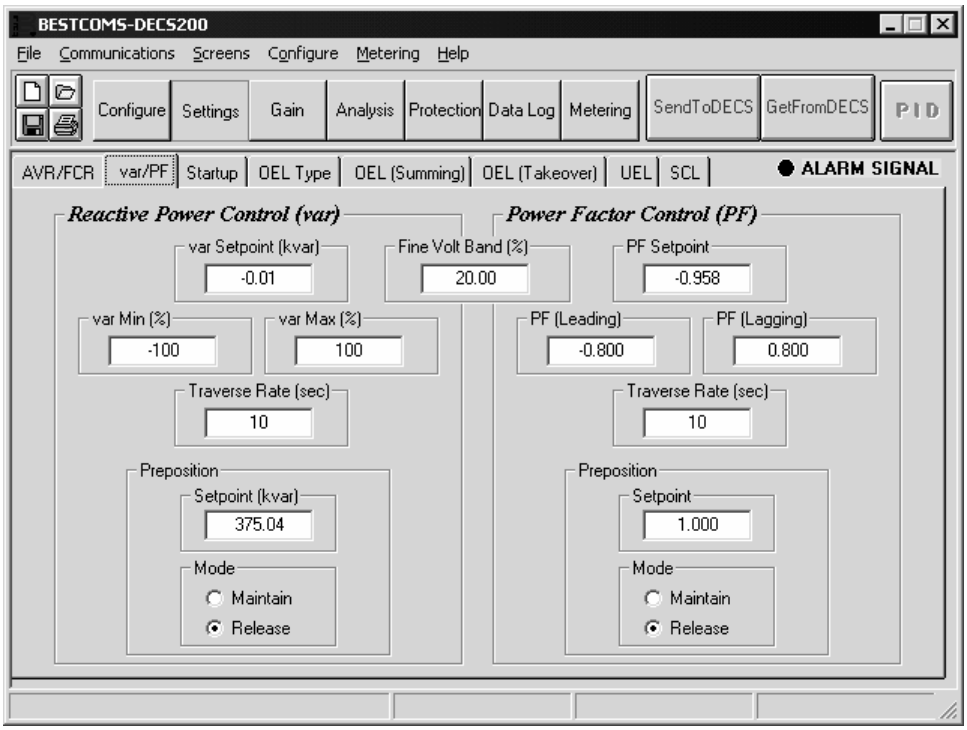

Figure 6-6. Var/PF Tab

Enter the var mode setpoint ..... _____

Enter the minimum desired var mode setpoint, expressed as a percent of nominal ..... _____

Enter the maximum desired var mode setpoint, expressed as a percent of nominal ..... _____

Enter the var mode traverse rate ..... _____

Enter the var mode pre-position setpoint ..... _____

Select either maintain or release as the var pre-position mode ..... _____

Set the voltage correction band for var and PF modes ..... _____

Enter the PF mode setpoint ..... _____

Enter the limit for leading power factor ..... _____

Enter the limit for lagging power factor ..... _____

Enter the PF mode traverse rate ..... _____

Enter the PF mode pre-position setpoint ..... _____

Select either maintain or release as the PF pre-position mode ..... _____

Startup

Configure the startup control, underfrequency, and voltage matching settings illustrated in Figure 6-7.

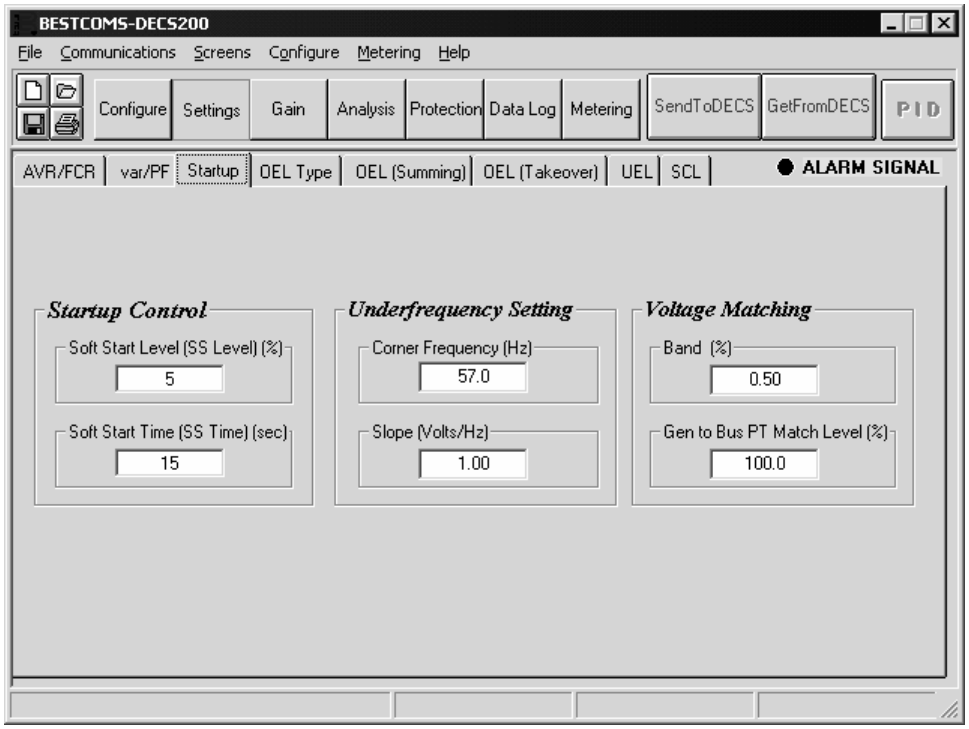

Figure 6-7. Startup Tab

Enter the soft-start voltage offset used during startup ..... _____

Enter the soft-start time limit used during startup ..... _____

Enter the corner frequency for generator underfrequency protection ..... _____

Enter the generator frequency slope for underfrequency protection ..... _____

Enter the voltage matching band, expressed as a percent of the rated generator voltage ..... _____

Enter the ratio (percentage) of the generator PT output to the bus PT output ..... _____

OEL Type

Select either Summing Point or Takeover as the overexcitation limiter style. Select the desired OEL setting selection option. OEL Type tab selections are illustrated in Figure 6-8.

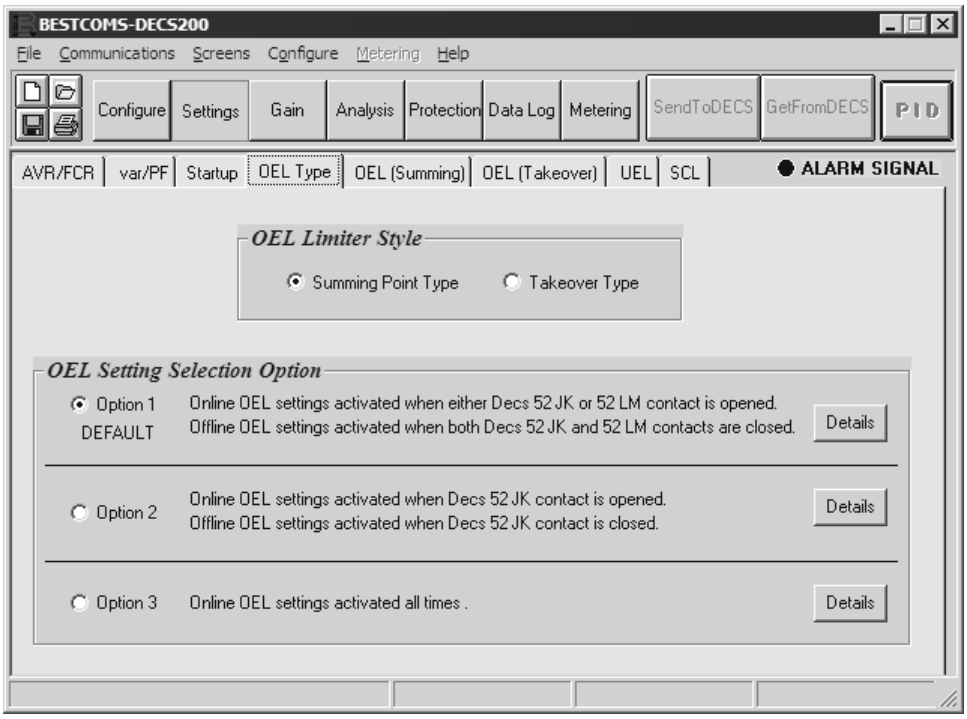

Figure 6-8. Setting Adjustments Screen, OEL Type Tab

Summing-Point OEL

If summing-point overexcitation limiting is enabled, configure the off- and on-line OEL settings illustrated in Figure 6-10.

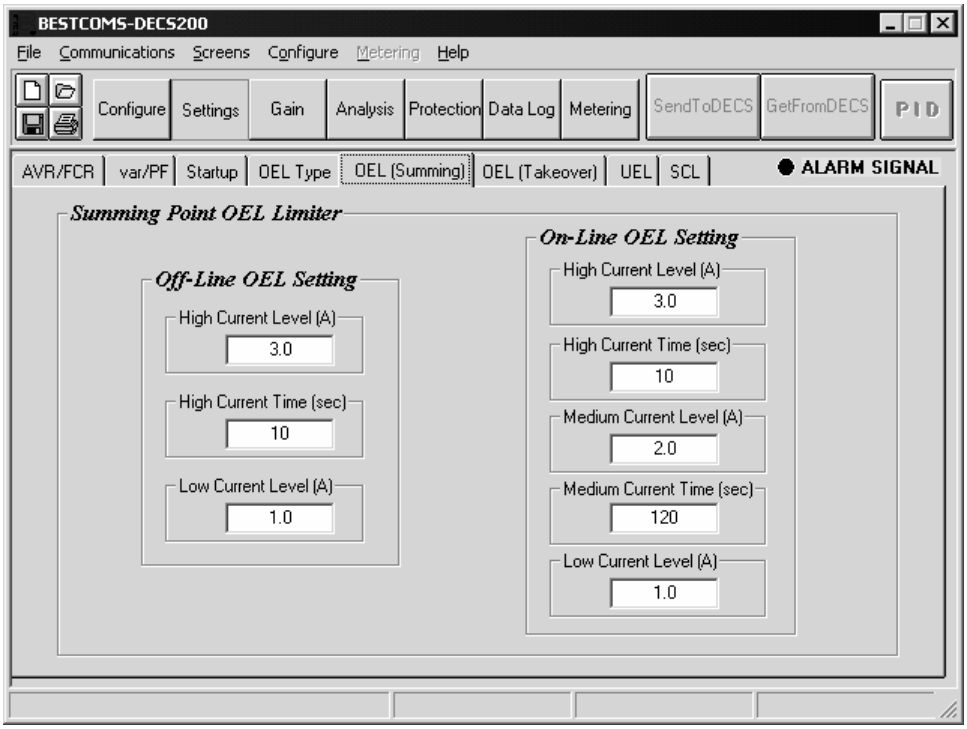

Figure 6-9. OEL Summing Tab

Enter the high-level current setpoint for off-line overexcitation limiting ..... _____

Enter the duration for high-level, off-line overexcitation limiting ..... _____

Enter the low-level current setpoint for off-line overexcitation limiting..... _____

Enter the high-level current setpoint for on-line overexcitation limiting ..... _____

Enter the duration for high-level, on-line overexcitation limiting ..... _____

Enter the medium-level current setpoint for on-line overexcitation limiting ..... _____

Enter the duration for medium-level, on-line overexcitation limiting ..... _____

Enter the low-level current setpoint for on-line overexcitation limiting..... _____

Takeover OEL

If takeover style overexcitation limiting is enabled, configure the off- and on-line OEL settings illustrated in Figure 6-10.

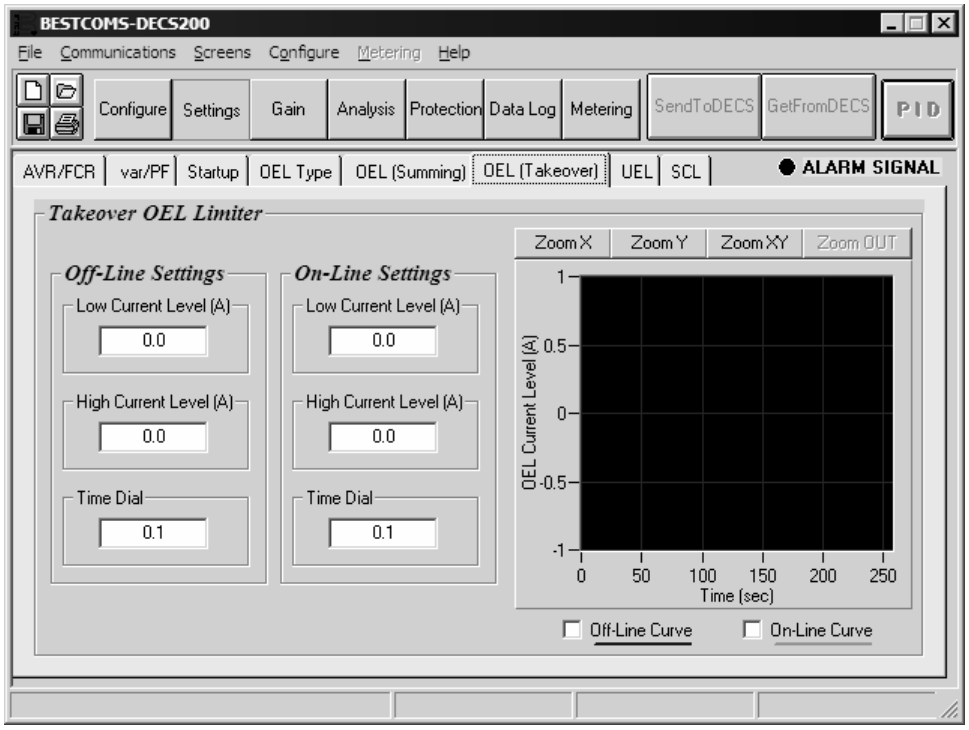

Figure 6-10. Setting Adjustments Screen, OEL (Takeover) Tab

Enter the low-level current setpoint for off-line overexcitation limiting..... _____

Enter the high-level current setpoint for off-line overexcitation limiting ..... _____

Enter the time delay for off-line overexcitation limiting ..... _____

Enter the low-level current setpoint for on-line overexcitation limiting..... _____

Enter the high-level current setpoint for on-line overexcitation limiting ..... _____

Enter the time delay for on-line overexcitation limiting ..... _____

UEL

Set the underexcitation limiter values based on the generator capability curve. Either internal or customized UEL settings can be applied. When internal UEL settings are used, only one data point is required. When customized UEL settings are used, up to five data coordinates may be entered to match a specific generator curve. Figure 6-11 illustrates the settings of the UEL tab.

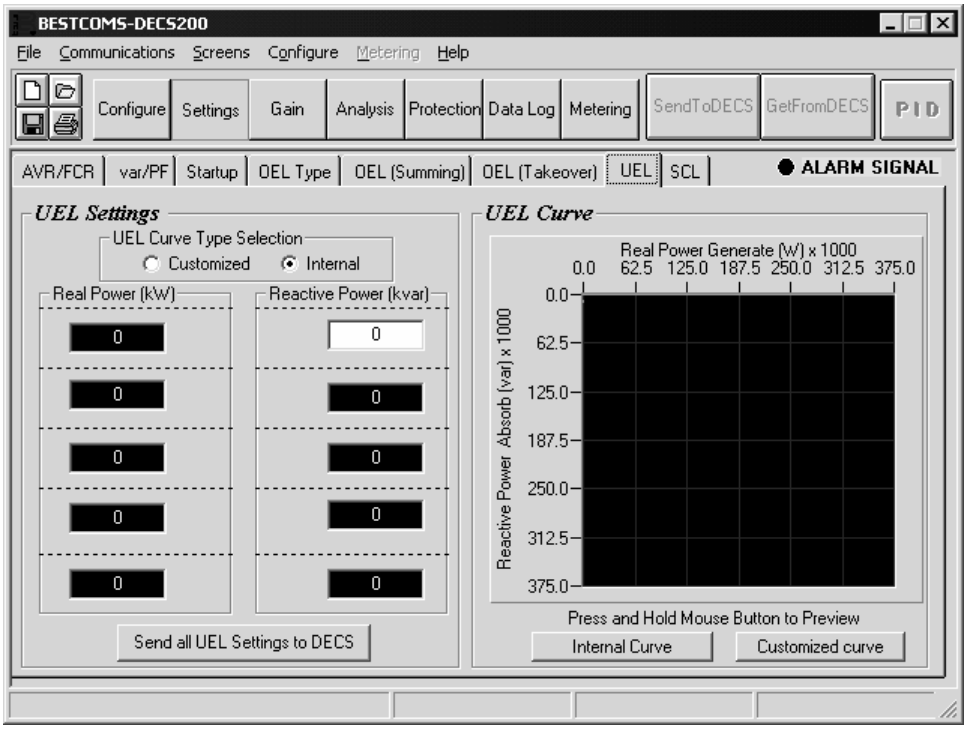

Figure 6-11. UEL Tab

SCL

Configure the stator current limiter settings illustrated in Figure 6-12.

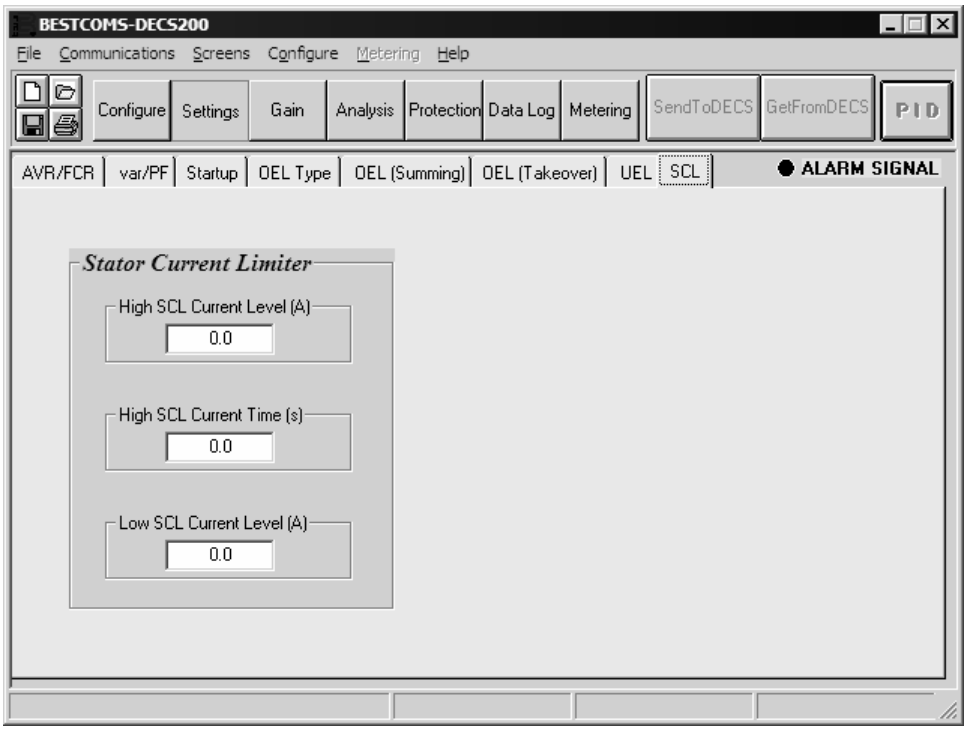

Figure 6-12. Setting Adjustments Screen, SCL Tab

Enter the high-level current setpoint for stator current limiting ..... _____

Enter the duration for high-level stator current limiting ..... _____

Enter the low-level current setpoint for stator current limiting..... _____

Protection/Relay Screen

Enter the desired settings and enable the desired functions on each tab of the BESTCOMS Protection/Relay screen. Figures 6-13 through 6-16 illustrate the settings of each Protection/Relay screen tab.

Options

Enable/disable the protection functions and configure the loss of sensing voltage settings illustrated in Figure 6-13.

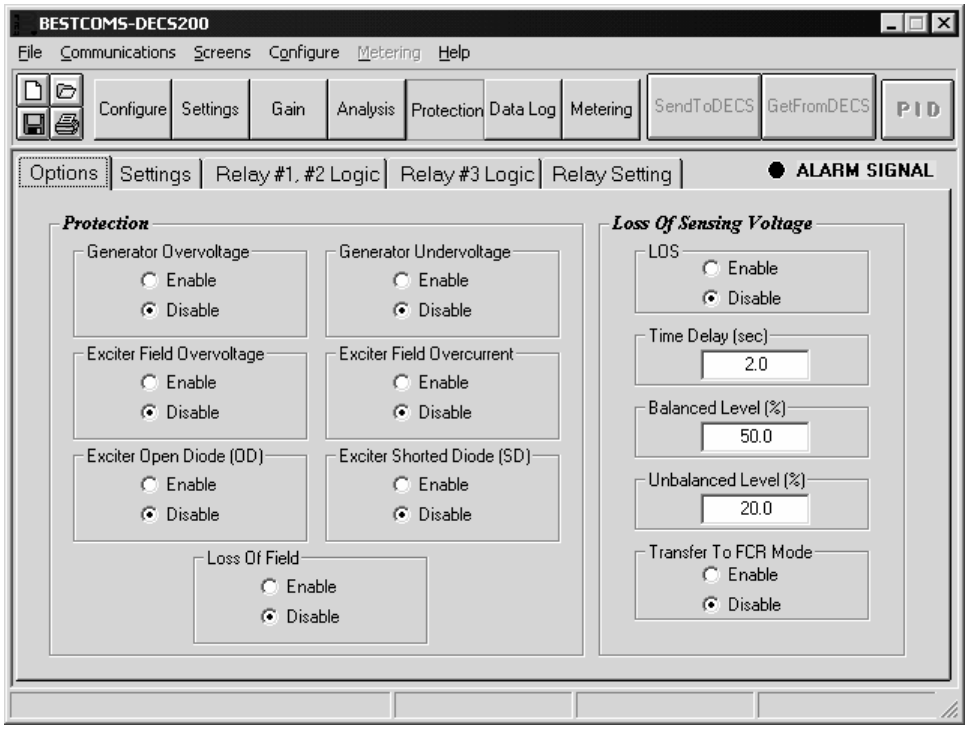

Figure 6-13. Protection Options Tab

Enable or disable generator overvoltage protection ..... _____

Enable or disable field overvoltage protection ..... _____

Enable or disable open exciter diode protection ..... _____

Enable or disable generator undervoltage protection ..... _____

Enable or disable field overcurrent protection ..... _____

Enable or disable shorted exciter diode protection ..... _____

Enable or disable loss of field protection ..... _____

Enable or disable loss of sensing voltage protection ..... _____

Enter the time delay for loss of sensing annunciation ..... _____

Enter the balanced loss of sensing threshold ..... _____

Enter the unbalanced loss of sensing threshold ..... _____

Enable or disable a transfer to FCR mode when loss of sensing is detected ..... _____

Settings

Enter the protection settings illustrated in Figure 6-14. Only protection functions enabled on the Options tab need to be configured here.

Enter the threshold for generator overvoltage protection ..... _____

Enter the time delay for generator overvoltage protection ..... _____

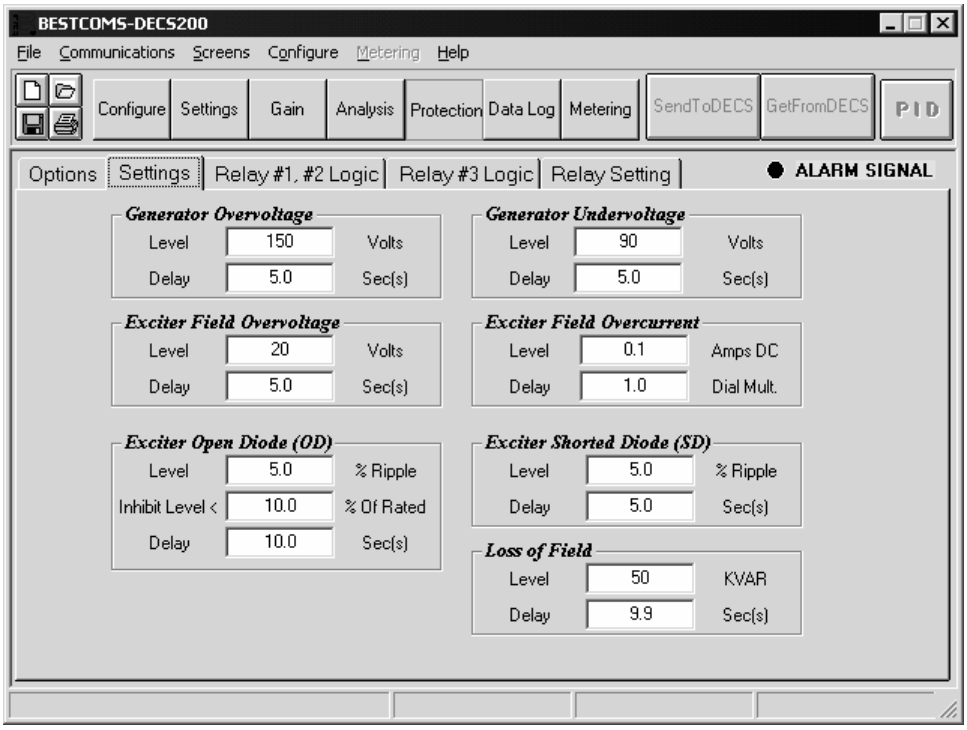

Figure 6-14. Protection Settings Tab

Enter the threshold for field overvoltage protection ..... _____

Enter the time delay for field overvoltage protection..... _____

Enter the percent of rated field current that indicates an open exciter diode ..... _____

Enter the percent of rated field current that disables open- and shorted-diode protection ..... _____

Enter the annunciation time delay for open exciter diode protection..... _____

Enter the threshold for generator undervoltage protection..... _____

Enter the time delay for generator undervoltage protection ..... _____

Enter the threshold for field overcurrent protection ..... _____

Enter the time delay for field overcurrent protection..... _____

Enter the percent of rated field current that indicates a shorted exciter diode ..... _____

Enter the annunciation time delay for shorted exciter diode protection..... _____

Enter the threshold for loss of field protection ..... _____

Enter the time delay for loss of field protection..... _____

Relay Logic

Review the excitation system interconnection drawings and verify the relay configurations. Relay logic settings for each of the three DECS-200 programmable outputs are contained on two tabs with identical configuration options. Only the tab for Relays 1 and 2 is illustrated here (Figure 6-15). Table 6-2 lists all of the available functions that can be assigned to the programmable outputs. Checkmarks may be placed in Table 6-2 to identify the functions assigned to each relay output.

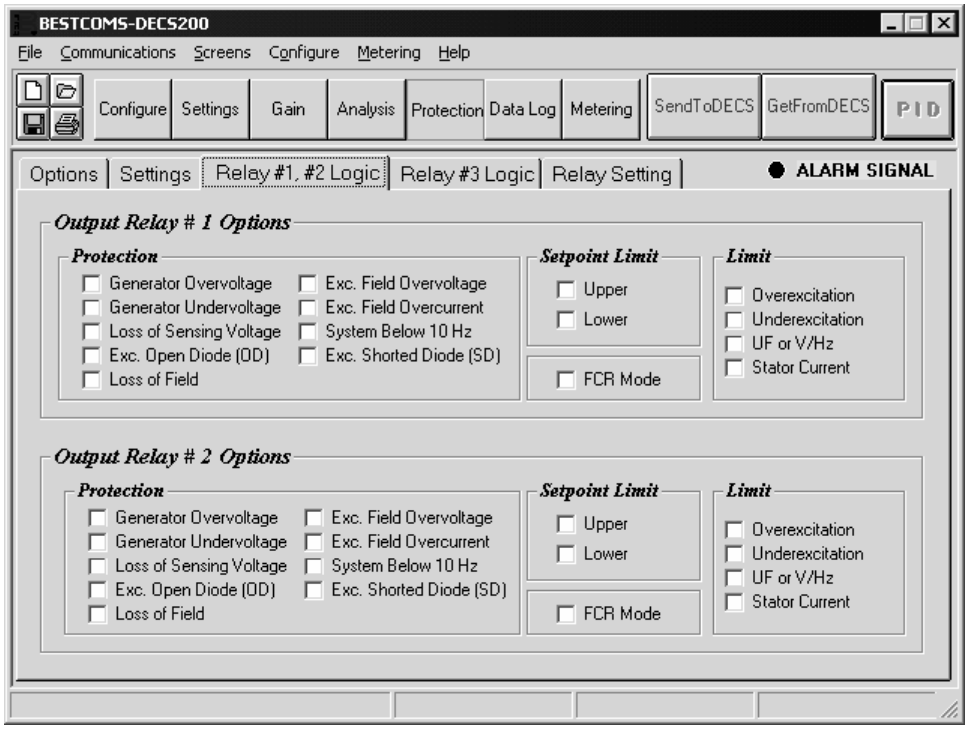

Figure 6-15. Relay #1, #2 Logic Tab

Table 6-2. Programmable Output Function Assignments

Function	Relay		
	1	2	3
Generator overvoltage			
Generator undervoltage			
Loss of sensing voltage			
Open exciter diode			
Loss of field			
Field overvoltage			
Field overcurrent			
Sensing input below 10 Hz			
Shorted exciter diode			
FCR mode			
Upper setpoint limit			
Lower setpoint limit			
Overexcitation limit			
Underexcitation limit			
Underfrequency or V/Hz limit			
Stator current limit			

Relay Setting

Configure the contact status and type settings illustrated in Figure 6-16.

Select the Relay #1 contact status as normally open (NO) or normally closed (NC) ..... _____

Configure the Relay #1 contact type as momentary, maintained, or latched ..... _____

If the Relay #2 contact type is momentary, enter the open/closed contact duration ..... _____

Select the Relay #2 contact status as normally open (NO) or normally closed (NC) ..... _____

Configure the Relay #2 contact type as momentary, maintained, or latched ..... _____

If the Relay #2 contact type is momentary, enter the open/closed contact duration ..... _____

Select the Relay #2 contact status as normally open (NO) or normally closed (NC) ..... _____

Configure the Relay #2 contact type as momentary, maintained, or latched ..... _____

If the Relay #2 contact type is momentary, enter the open/closed contact duration ..... _____

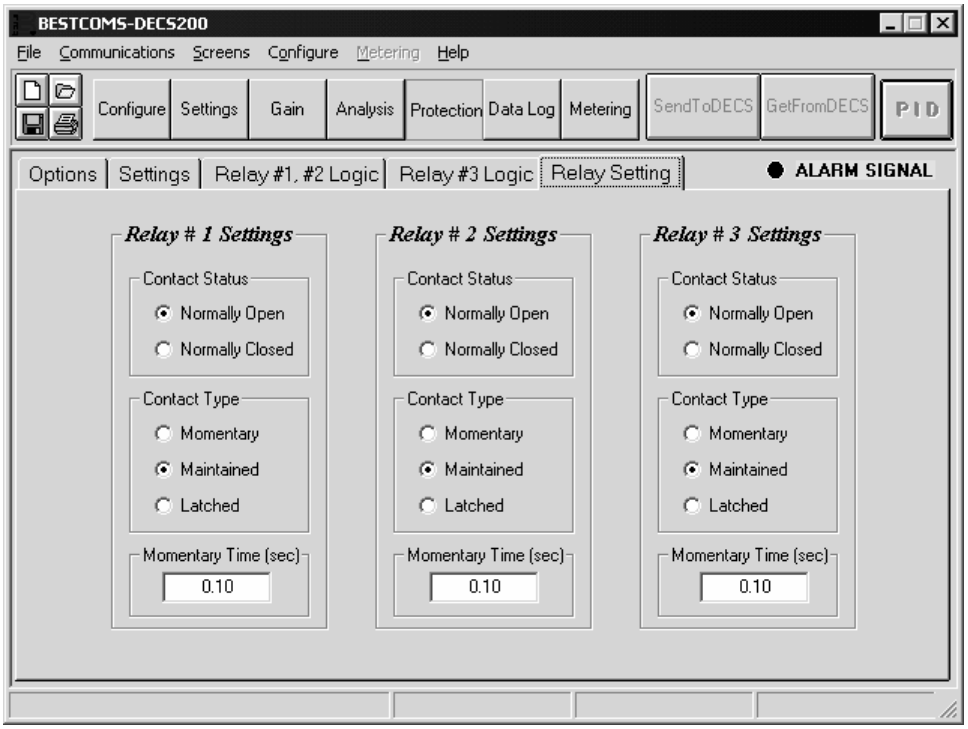

Figure 6-16. Relay Setting Tab

OFF-LINE TESTS - TURBINE NOT SPINNING

In the following tests, control of the machine is demonstrated via BESTCOMS, front panel HMI, and user-supplied, remote switches. These tests ensure that the machine is not stressed because of incorrect wiring or faulty components. The parameters listed here are only temporary, initial settings.

Start/Stop Tests

Check the operation of the following start and stop controls.

BESTCOMS Metering Screen, Operation tab ..... _____

DECS-200 front panel ..... _____

Remote switches ..... _____

With excitation off, check AVR/FCR transfer from the BESTCOMS, the front panel, and remote switches ..... _____

Verify transfer indications from the remote status indicators, front panel HMI, or BESTCOMS interface ..... _____

Check the raise and lower limits ..... _____

Verify raise/lower limit indications from the remote status indicators, front panel HMI, or BESTCOMS interface ..... _____

Control Gain Settings

Configure the initial gain settings.

Set the generator no-load setpoint in FCR mode (20% of exciter rated current recommended). _____

On the Control Gain screen, enter 200 in the FCR loop gain settings field ..... _____

Enter the following recommended gain settings for OEL, UEL, and Var/PF.

Set OEL KI at 3 ..... _____

Set OEL Kg at 5 ..... _____

Set UEL KI at 3 ..... _____

Set UEL Kg at 5 ..... _____

Set var/PF KI at 3 ..... _____

Set var/PF Kg at 5 ..... _____

PID Settings

On the Control Gain screen, click the tool bar PID button to open the PID window. (The Control Gain screen Stability Range setting must be 21.) Use the PID window to select the correct PID values based on generator time constant T'do and exciter time constant Te. For more information about PID settings, refer to Section 5, *BESTCOMS Software, PID Window*.

NOTE

If proper startup is not achieved, increase the value of loop gain (Kg) for AVR and FCR modes.

The following suggested settings may be used for AVR and FCR modes when the generator and exciter time constants are unknown.

Set KP at 80 ..... _____

Set KI at 20 ..... _____

Set KD at 15 ..... _____

Set AVR Kg at 7 ..... _____

Set TD at 0.01 ..... _____

Set FCR Kg at 400 ..... _____

Verify transfer indications from the remote status indicators, front panel HMI or BESTCOMS

OFF-LINE TESTS - TURBINE SPINNING

For off-line tests with the turbine spinning, the generator circuit breaker is open.

FCR Mode

Initial testing should be conducted in FCR (manual) mode and minimum generated voltage.

Place the DECS-200 in FCR mode ..... _____

Place the Start/Stop switch in the Start position ..... _____

Generator output voltage should build to a percentage of the rated voltage. (The FCR setpoint was set at 20% of the no-load excitation current in a previous step.)..... _____

Increase the exciter field rated current to 75% of current..... _____

The generator output voltage should build to a percentage of the rated voltage ..... _____

Use an oscilloscope to check the field voltage for proper output (see Figure 6-17)..... _____

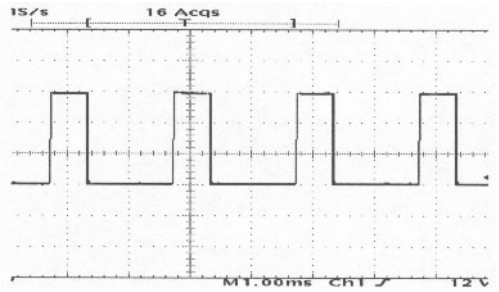

Figure 6-17. Field Voltage Output Waveform

Use a voltmeter to check for correct voltage at generator sensing voltage terminals A1 (E1), A2 (E2), and A3 (E3)..... _____

Measure the PT secondary voltages ..... _____

Use the Raise/Lower control to raise the terminal voltage to the rated generator level..... _____

Place the Start/Stop switch in the Stop position and let the generator voltage decrease to the residual level..... _____

Place the Start/Stop switch in the Start position to initiate buildup again in FCR mode ..... _____

Record the voltage buildup characteristic as it reaches full, rated output ..... _____

Using the BESTCOMS Analysis Screen, perform 5% step change in FCR mode..... _____

Decrease value, then increase the value. Observe stable performance with chart recorder..... _____

Note the Overshoot and settling time. (The FCR output should be very stable.) ..... _____

Verify that the AVR setpoint tracks the FCR setpoint, then transfer. During this test, use the

NOTE

In the following steps, verify that, if the pre-position setpoint is enabled, the setpoint changes to the assigned value.

Verify that FCR autotracking follows, and is nulled to AVR, then transfer ..... _____

Use a chart recorder or BESTCOMS oscillography to perform a step response in AVR mode... _____

Review the PID numbers ..... _____

On the System Options tab of the BESTCOMS System Configuration screen, turn all limiters off..... _____

Perform a 2% voltage step response and record performance to verify stability ..... _____

Adjust the PID values until desired performance is achieved. If performance appears stable, repeat step change at 5%.. ..... _____

NOTE

Assuming Te (exciter field) is known (as applicable for exciter field voltage regulator applications), increasing Kg will decrease the response time of the generator. See Figure 6-21.

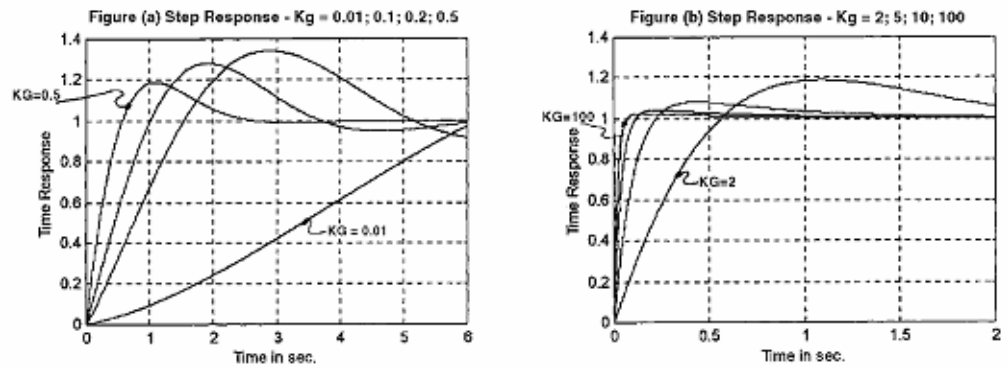

Figure 6-18. K_G Gain Effect on Generator Performance

When individual adjustment is needed to further refine performance, Figures 6-22 through 6-25 demonstrate the effect that PID changes have for additional control. These figures have a one second major division.

In Figure 6-22, the generator voltage exhibits one under-damp (overshoot) and one over-damp (undershoot) before settling. The total time (five seconds) is too long. Here KP (proportional gain) needs to be increased.

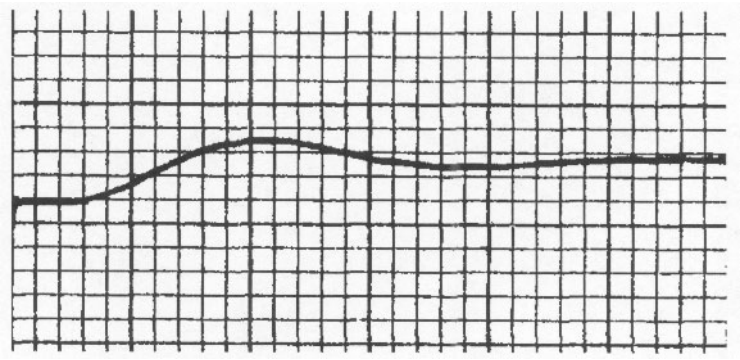

Figure 6-19. Insufficient Proportional Gain

Figure 6-23 demonstrates that the terminal voltage has prolonged instability after a voltage step change because there is too much integral gain (I). Integral gain value needs to be decreased.

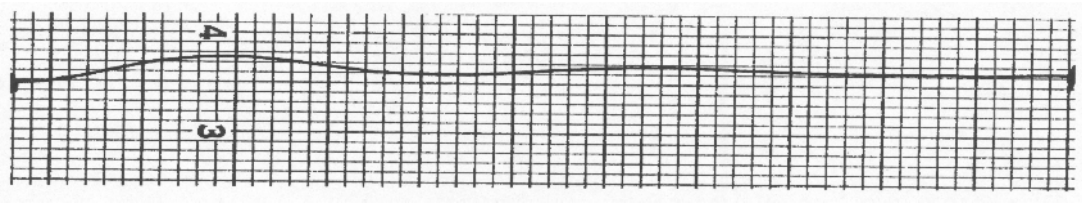

Figure 6-20. Prolonged Instability

In Figure 6-24, less overshoot is desired, KD (derivative gain) is increased.

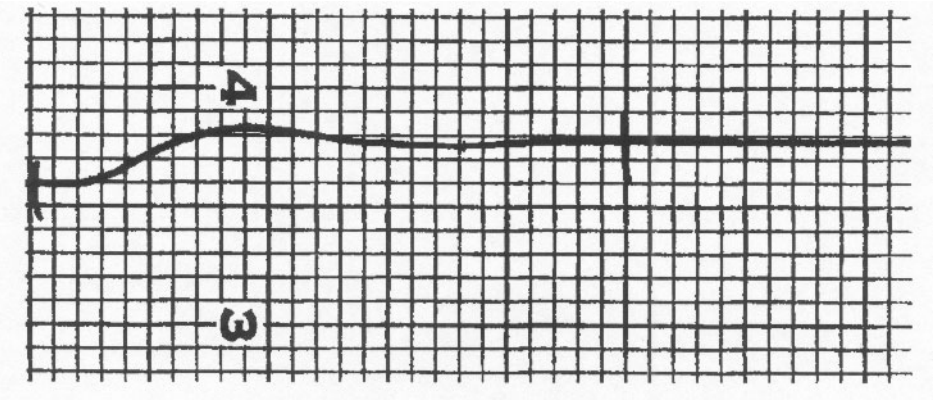

Figure 6-21. Insufficient Derivative Gain

Figure 6-25 illustrates the final solution. Increased KD (derivative gain) decreases voltage overshoot.

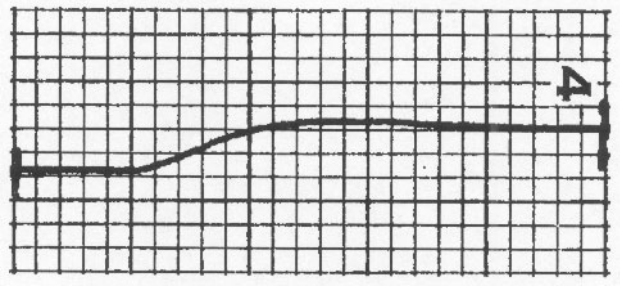

Figure 6-22. Final Solution Step Response

Place the Start/Stop Switch in the Stop position..... _____

Place the system in AVR mode ..... _____

Monitor the generator voltage soft start time ..... _____

Place the Start/Stop Switch in the Start position ..... _____

Use the Raise/Lower control to increase the terminal voltage to the setpoint..... _____

EXCITATION PERFORMANCE EVALUATION

In this performance evaluation, temporarily settings will be used to enable the testing of excitation performance without stressing the machine or exceeding ancillary protection device settings. Procedures are provided that will allow you to set your final operating values. This evaluation is a continuation of the previous tests.

Off-Line Excitation Limiter Operation

In this test, with the generator set below the rated voltage output, the AVR setpoint will be set above the maximum setting and the system should annunciate an alarm. If an alarm is not annuciated, the OEL gain (KI and Kg) may be set too low. If an alarm is annunciated and the system oscillates, the OEL gain, (KI and Kg) may be set too high.

Enable the Off-Line Overexcitation Limiter (OEL) ..... _____

Determine the field current required to reach 105% of the rated generator voltage. ..... _____

Set the off-line OEL for a value equal to the no load field current..... _____

Lower the terminal voltage to 10% below rated..... _____

To speed performance in the following test, you may increase the OEL gain (KI and Kg terms).

On the AVR/FCR tab of the BESTCOMS Setting Adjustments screen, adjust the AVR setpoint to 110% of the rated output. (the AVR Max setting should remain at 105%.) ..... _____

If an output relay is programmed to alarm, the output, BESTCOMS, front panel HMI, and any remote indicator should annunciate the alarm. ..... _____

Reset the AVR setpoint to the rated output ..... _____

Limit and Protection Check

In this test, operation of generator overvoltage protection, generator undervoltage protection, field overvoltage protection, and field overcurrent protection will be verified.

Review the overvoltage protection settings in BESTCOMS ..... _____

Reduce the Generator Overvoltage Level setting to the alarm threshold..... _____

Verify that all alarms and annunciation function as programmed..... _____

Reset the generator Overvoltage Level setting to the desired value..... _____

Raise the Generator Undervoltage Level setting to the alarm threshold..... _____

Verify that all alarms and annunciations function as programmed ..... _____

Reset the Generator Undervoltage Level setting to the desired value ..... _____

Reduce the Exciter Field Overvoltage Level setting to the alarm threshold..... _____

Verify that all alarms and annunciations function as programmed ..... _____

Reduce the Exciter Field Overvoltage Level setting to the desired value ..... _____

Reduce the Exciter Field Overcurrent Level setting to the alarm threshold ..... _____

Verify all alarms and annunciations function as programmed ..... _____

Reset the Exciter Field Overcurrent Level setting to the desired value..... _____

Parallel Operation, Generator On Line

In this test, the generator is connected to the bus and the phase relationship between the current and sensed voltage is checked. If the polarity of the CT is incorrect, a shorting terminal block can be used to reverse the CT polarity. If sensed voltage has the wrong phasing, the generator breaker must be opened, and the wiring corrected. In the following procedures, overexcitation and underexcitation protection is exercised, and var and power factor performance evaluations are conducted at levels that will not stress the machine. For more information about paralleling circuits, download Application Note 126 from the Basler Electric website at www.basler.com.

Phase Relationship Test

Transfer to FCR mode ..... _____

Parallel the generator with the bus ..... _____

Set the machine kilowatt level at approximately 25% of the machine rating at 0 vars ..... _____

Check for phase shift at the voltage and current sensing inputs of the DECS-200. The B-phase current should lag the sensed voltage (between E1 and E3) by 90°. If the phase relationship is correct, proceed with testing. If the phase relationship is incorrect, troubleshoot the system, resolve the problem, and retest as appropriate before transferring to AVR mode. ..... _____

Verify that the AVR setpoint is nulled to the FCR setpoint ..... _____

Verify that all null status indicators provide the null indication..... _____

Verify that AVR Pre-position mode is disabled or that the external pre-position contacts are open. ..... _____

In the following step, be prepared to transfer back to Manual mode if the excitation voltage increases suddenly.

Transfer to AVR ..... _____

OEL Test

Disable overexcitation limiting on the System Options tab of the BESTCOMS System Configuration screen ..... _____

Set the three on-line, OEL current limits at 15% above the no-load field current, with a 5 second time delay ..... _____

Using a chart recorder, prepare to check the OEL response time. If the response time is too slow, increase the OEL gain (KI and Kg terms) and repeat the test.

Increase field excitation until the field current reaches 125% of the no load field current setting _____

Enable OEL ..... _____

Verify that the response time is within specified limits ..... _____

Enter final OEL values ..... _____

UEL Test

Disable underexcitation limiting on the System Options tab of the BESTCOMS System Configuration screen ..... _____

Set the UEL var limit for 5% vars into the generator ..... _____

Adjust the var level into the generator for 15% at 25% load ..... _____

Perform a step response into the UEL limit by enabling underexcitation limiting on the System Options tab of the BESTCOMS System Configuration screen ..... _____

Verify stable performance and speed of response ..... _____

If the response time is too slow, increase the UEL gain (KI and Kg terms) and repeat the test .. _____

Verify stable performance of the UEL by testing the machine from 25 through 100% real-power loading, underexcited ..... _____

Increase the excitation above the UEL limit ..... _____

Enter the final UEL values ..... _____

Var Test (If Applicable)

Verify that the var setpoint is nulled to the AVR setpoint ..... _____

Verify that all null status indicators provide a null indication ..... _____

Verify that the var Pre-Position mode is disabled or the external pre-position contacts are open _____

In the following step, be prepared to transfer back to AVR if the excitation voltage increases suddenly.

Transfer to var mode ..... _____

Set the kilowatt level for 25% output ..... _____

Adjust the var level to 30% of rated ..... _____

Monitor the exciter field voltage to determine performance while performing the following step.

Using BESTCOMS, perform 5% step response stability test ..... _____

If necessary, increase the var gain, (KI and Kg terms) to decrease the response time. Repeat the test. .....

Power Factor Test (If Applicable)

Verify that the PF mode setpoint is nulled to the var mode setpoint ..... _____

Verify that all null status indicators provide a null indication ..... _____

Verify that PF Pre-Position mode is disabled or external pre-position contacts are open ..... _____

In the following step, be prepared to transfer back to AVR mode if the excitation voltage increases suddenly.

Transfer to PF ..... _____

Adjust PF for 0.9, lagging..... _____

Perform a step response by changing PF setpoint to 0.85, lagging to determine stability..... _____

If necessary, increase the PF gain (KI and Kg terms) to decrease the response time.
Repeat the test..... _____

Conclusion Of Testing

Configure the excitation system with the required parameters. Once satisfactory performance is achieved, save all information to EEPROM.

SECTION 7 • MODBUS™ COMMUNICATION

TABLE OF CONTENTS

Tables

SECTION 7 • MODBUS™ COMMUNICATION

INTRODUCTION

This section describes the Modbus™ communication protocol employed by the DECS-200 and how to exchange information with the DECS-200 over a Modbus™ network. The DECS-200 communicates by emulating a subset of the Modicon™ 984 Programmable Controller.

DECS-200 MODBUS PROTOCOL

Modbus communications use a master-slave technique in which only the master can initiate a transaction called a query. When appropriate, a slave (DECS-200) 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-200 is grouped characteristically in categories. The following information categories are maintained by the DECS-200:

C1 - Product Information Registers
C2 - Metering Registers
C3 - Reporting Registers
C4 - Control System Configuration Parameters Registers Group 1
C5 - Operating Mode Parameter Registers
C6 - Setpoints Parameter Registers
C7 - Startup Parameter Registers
C8 - Limiter Parameter Registers
C9 - Gains Registers
C10 - Protective Functions Parameter Registers
C11 - Calibration Parameter Registers
C12 - Relay Parameter Registers
C13 - Communications Parameter Registers
C14 - Front Panel Metering Configuration Registers
C15 - Control System Configuration Parameters Registers Group 2

All supported data can be read or written as specified in the register table. Abbreviations are used in the register table to indicate the register access type. Register access types are read/write (RW) and read only (R -).

All categories except Product Information (C1), Metering (C2), Reporting (C3) and Calibration (C11) can generally be written via a Modbus message as well as read. Categories C1 and C2 are strictly read-only. (Categories C3 and C11 are currently not supported and therefore cannot be read or written.)

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 network and will always generate a response to the query unless certain error conditions occur. The DECS-200 is designed to communicate on the Modbus network only as a slave device.

A master can only query slaves individually. If a query requests actions unable to be performed by the slave, the slave response message contains an exception response code defining the error detected.

MESSAGE STRUCTURE

Master initiated queries and DECS-200 (slave) responses share the same message structure. Each message is comprised of four message fields. They are:

- Device Address (1 byte)
- Function Code (1 byte)
- Data Block (n bytes)
- Error Check field (2 bytes)

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 one byte.

Modbus protocol limits a device address from 1 to 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.

The DECS-200 maps all registers into the Modicon™ 984 holding register address space (4XXXX) and supports the following function codes:

- **READ OUTPUT REGISTERS** (function code 3),
- **PRESET SINGLE REGISTER WRITE** (function code 6)
- **PRESET MULTIPLE REGISTERS** (function code 16), and
- **LOOPBACK DIAGNOSTIC TEST** (function code 8) with diagnostic sub-functions:
  - **Return Query Data** (diagnostic code 0),
  - **Restart Comm. option** (diagnostic code 1), and
  - **Force Slave To Listen Only Mode** (LOM, diagnostic code 4).

DECS-200 Modbus performs all of the above functions when a Modbus message has its unique address which is numbered from 1 to 247. DECS-200 also recognizes a broadcast (group) address of 0. Only functions 16 and 8 are recognized as valid for broadcast. The DECS-200 does not send a response message for a broadcast query.

In listen-only mode (LOM), received data is monitored (but no responses are transmitted). The only query that will be recognized and processed while in LOM is a maintenance restart command (function code 8, diagnostic code 1).

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. See the paragraphs on *Register Definitions* in this manual for interpretation of register data.

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 there validity. This field is 2 bytes.

SERIAL TRANSMISSION DETAILS

A standard Modbus network offers two transmission modes for communication: ASCII or Remote Terminal Unit (RTU). The DECS-200 supports only the RTU mode via rear RS-485 serial interface.

Communication settings for the DECS-200 Rear RS-485 port are listed in Table 7-1.

Table 7-1. DECS-200 Communication Settings

Setting	Programmable Y(Yes) / N(No)	Default Value	Value Range
Baud Rate	Y	9600	1200/2400/4800/9600/19200
Data Size in Bits	N	8	N/A
Parity	Y	None	‘N’=None, ‘O’=Odd, ‘E’=Even
Stop Bits	Y	2	1 or 2
Modbus Slave Address	Y	247	0 for broadcast, 1 to 247 for slave
Modbus Response Delay Time in ms	Y	10 ms	From 0 to 200 ms in increments of 10 ms

Communication settings are user-selectable and can be set at installation and altered during real-time operation.

Message Framing and Timing Considerations

When receiving a message, the DECS-200 requires an inter-byte latency of 3.5 character times before considering the message complete.

Once a valid query is received, the DECS-200 waits a specified amount of time as specified in the Modbus Response Delay Time Register (48108) before responding. This Register contains a value from 0 to 200 milliseconds. The default value is 10 milliseconds. The user may set the remote delay time parameter to 0 to minimize response latency.

Table 7-2 provides the response message transmission time (in milliseconds) and 3.5 character times (in milliseconds) for the maximum response message length (225 characters), response to a read query for 125 points and various baud rates.

Table 7-2. Timing Considerations For 10 Character Bits (8 Data Bits + 1 Start Bit + 1 Stop Bit)

Baud Rate	1 Character Time (ms)	3.5 Characters Time (ms)	Max. Read Register Response Message (255 characters) Transmission Time (ms)
1,200	8.33	29.17	2,124.15
2,400	4.17	14.58	1,063.35
4,800	2.083	7.292	531.165
9,600	1.0417	3.645	265.6335
19,200	0.52083	1.823	132.812

Error Handling and Exception Responses

Any query received that contains a nonexistent device address, a framing error, or CRC error is ignored. No response is transmitted. Queries addressed to a DECS-200 with an unsupported function code, unsupported register references or illegal values in the data block result in an error response message with an exception response code.

Each error response message consists of a slave (DECS-200) address, function code with the high order bit set, error code and error check (CRC) field.

The exception response error codes supported by the DECS-200 are provided in Table 7-3.

Table 7-3. Supported Exception Response Codes

Code	Name	Meaning
01	Illegal Function	The query Function/Sub-function Code is unsupported; query read of more than 125 registers; query “preset multiple registers” of more than 100 registers
02	Illegal Data Address	A register referenced in the data block does not support queried read/write; For Function Codes 3 and 16 additionally: 1. Starting Register address is mapped to DECS-200 Modbus address space but is not referenced to the highest order 16 bits of the assigned application data (see explanation in 2.7 Data Formats), and 2. The number of registers is too small to hold entire value of all data (variables) assigned to those registers (see explanation in 2.7 Data Formats).
03	Illegal Data Value	A preset register data block contains an incorrect number of bytes or one or more data values out of range.

COMMUNICATIONS HARDWARE REQUIREMENTS

The DECS-200 RS-485 physical interface consists of three positions of a terminal strip with locations for Send/Receive A (A), Send/Receive B (B) and Signal Ground (C).

DETAILED MESSAGE QUERY AND RESPONSE

A detailed description of DECS-200 supported message queries and responses are 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.

Device Address	Function Code = 03	Starting Address High	Starting Address Low	No. of Registers High	No. of Registers Low	CRC Low	CRC High

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 for each requested register. For each requested register, there is one Data Hi and one Data Lo. Attempting to read an unused register or a register that does not support a read results in an error response with the exception code for an illegal data address. If the query is a broadcast (device address = 0), no response message is returned.

Maximum response message length obtained for query of 125 registers is 5 + (125 x 2) = 255 bytes.

Device Address	Function Code = 03	Byte Count	Data High	Data Low	For each requested register	Data High	Data Low	CRC Low	CRC High
		250 max.	First queried register High	First queried register Low	Data High and data Low	Last queried register High	Last queried register Low		

Preset Multiple Registers

A preset multiple registers query could address multiple registers in one slave or multiple slaves. If the query is broadcast (device address = 0), no response is required.

Query

A Preset Multiple Registers 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-200 will perform the write when the device address is the same as the DECS-200 remote address or when the device address is 0. A device address is 0 for a broadcast query.

A register address of N will write Holding Register N+1.

All Modbus Generic Data Formats can be loaded by this function (see *Data Formats*).

No data will be written if any of the following exceptions occur:

- Queries to write to Read Only or unsupported registers result in an error response with an exception code of Illegal Data Address.
- Queries attempting to write more than 100 registers cause an error response with an exception code of Illegal Function.
- An incorrect Byte Count will result in an error response with an exception code of “Illegal Function.”
- A query to write an illegal value (out of range) to a register results in an error response with an exception code of Illegal Data Value.
- Query Starting Register address is mapped to DECS-200 Modbus address space but is not referenced to the lower order 16 bits of the assigned application data. (See explanation in *Data Formats*.)

- The number of query registers is too small to hold entire value of all data (variables) assigned to those registers. (See explanation in *Data Formats*.)

Query message format is:

Device Address
Function Code = 10 (hex)
Starting Address High
Starting Address Low
Number of Registers High (total number of registers to be loaded)
Number of Registers Low
Byte Count (total number of registers to be loaded times 2)
Data High
Data Low
...
Data High
Data Low
CRC Error Check (Lo, Hi)

Note: The maximum length of a Preset Multiple Registers Query is 9 + (100 x 2) = 209 bytes.

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 of 0).

Device Address	Function Code = 10 (hex)	Starting Address High	Starting Address Low	Number of Registers High	Number of Registers Low	CRC Low	CRC High

Preset Single Register (Write Single Holding Register)

A Preset Single Register query message requests a single register to be written. The DECS-200 will perform the write when the device address is the same as the DECS-200's remote address.

Query

Device Address
Function Code = 06 (hex)
Address Hi
Address Lo
Data Hi
Data Lo
CRC Hi error check
CRC Lo error check

The response message echoes the Query message after the register has been altered.

Error Response

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 out of range value to a register results 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-200 data value (i.e., floating point data and 32-bit integer data). A query to write a subset of such a register group will result in an error response with Exception Code "Illegal Data Address".

NOTE

Variables changed by this function will not be directly saved to nonvolatile memory (EEPROM). If specific categories (one or more) of data have to be saved to EEPROM, then Holding Register 48161 (Data Id=13001, variable "SaveCommand") has to be preset after a category has been changed. The exceptions to this rule are only those Holding Registers dealing with communication port RS-485. They will be changed and immediately saved to EEPROM with the function FC16.

Loop Back Diagnostic Test (FC= 8) with Diagnostic Sub-function, 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)	Sub-function High 00	Sub-function Low 00	Data High XX (don't care)	Data Low XX (don't care)	CRC Low	CRC High

Loop Back Diagnostic Test with Diagnostic Sub-function, Restart Communications Option

This query causes the remote communications function of the DECS-200 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 of 0), no response message is returned.

If the DECS-200 receives this query while in the listen only mode (LOM), 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)	Sub-function High 00	Sub-function Low 01	Data High XX (don't care)	Data Low XX (don't care)	CRC Low	CRC High

Loop Back Diagnostic Test with Diagnostic Sub-function, Force Slave to Listen Only Mode

This query forces the addressed DECS-200 to the listen only mode for Modbus communications, isolating it from other devices on the network.

While in Listen Only Mode (LOM), received data is monitored (but no responses are transmitted). The only query that will be recognized and processed while in LOM is a maintenance restart command (function Code 8, diagnostic code 1).

When the DECS-200 receives the restart communications query, the Listen Only mode is terminated.

Device Address	Function Code = 08 (hex)	Sub-function High 00	Sub-function Low 04	Data High XX (don't care)	Data Low XX (don't care)	CRC Low	CRC High

DATA FORMATS

DECS-200 data does not need to be converted into any special format for transmission over a Modbus network.

Modbus Registers hold original DECS-200 data of the generic (built-in) data types listed in Table 7-4.

Table 7-4. Generic Data Types and Description

Generic Data Types	Corresponding built-in data type (Storage Format)	Data Range	Data Size in bytes	Total number of Modbus Registers to hold data
UI8	UCHAR: unsigned character	0 to 255	1	1
UI6	UINT16: unsigned short integer	0 to 65,535	2	1
UI32	UINT32: unsigned long integer	0 to 4,294,967,295	4	2
I8	CHAR: signed character	-128 to 127	1	1
I16	INT16: signed short integer	-32,768 to 32,767	2	1
I32	INT32: signed long integer	-2,147,483,648 to 2,147,483,647	4	2
R32_23	FLOAT: floating point number	From approximately 8.43×10^{-37} to 3.38×10^{38}	4	2

It should be noted that an ASCII string is not a DECS-200 generic data type. An ASCII string will be considered as a sequence of "(string length + 1)" data of I8 type, and for its transmission via a Modbus network "(string length + 1)" holding registers are needed.

DECS-200 data is copied to assigned Holding Register(s) [HR] by the rules presented in the following paragraphs.

Generic Types UI8 and I8

Data of type UI8 or I8 is copied to one holding register (HR). The high (first) HR byte always contains 0, and second (low) HR byte contains the data.

Example:

Assume that the value of UI8 type data is 0x56, and that the data is mapped to HR 44005. The content of HR 44005 will be as listed in Table 7-5.

Table 7-5. HR 44005 Contents

HR 44004 Low Byte	HR 44005 High Byte	HR 44005 Low Byte	HR 44006 High Byte
...	0x00	0x56	...

Generic Types UI16 and I16

Data of type UINT16 or INT16 is saved in 1 one holding register. The high data byte is copied to the high HR byte and the low data byte to the low HR byte.

Example:

Assume that the DECS-200 UINT16 or INT16 type data value of 0xF067 is mapped to HR 47003. Data is copied to HR 47003 as shown in Table 7-6.

Table 7-6. HR 47003 Mapping

HR 47002 Low Byte	HR 47003 High Byte	HR 47003 Low Byte	HR 47004 High Byte
...	0xF0	0x67	...

Generic Types UI32 and I32

Data of type UI32 or I32 is 4 bytes long. The Modbus 4-byte long data generic types use two consecutive registers to represent a data value. The lower numbered holding register contains the low order 16 bits, Low Order word [LO w] and the higher numbered holding register contains the higher order 16 bits, Higher Order word [HO w].

Example:

The UI32 data type, value is 0xE0234567 and is mapped to two Holding registers (such as 45003 and 45004) as shown in Table 7-7.

Table 7-7. Typical Mapping

Register	45003	45004
Hexadecimal	4567	E023
Binary	0100 0101 0110 0111	1110 0000 0010 0011

HR 45002 LO byte	HR 45003 HO byte	HR 45003 LO byte	HR 45004 HO byte	HR 45004 LO byte	HR 45005 HO byte
...	45	67	E0	23	...

Floating Point (R23_32) Data Format

The specific floating-point format matches the floating-point format used for Modicon 984-8 family of programmable controllers.

Its representation in bit format is:

S EEE EEEE	E MMMM	MMM	MMMM MMMM	MMMM MMMM
byte 3	byte 2		byte 1	Byte 0

where the “S” is the sign bit for the floating point value: 1 if negative and 0 if positive; The “E” field is the two’s complement exponent biased by 127 decimal; The “M” field is the 23-bit 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 7-8 shows the floating-point format.

Table 7-8. Floating Point Format

Sign	2's Complement Of (Exponent + 127)	Mantissa
1 bit	8 bits	23 bits

The floating point format allows a maximum value of 3.38×10^{38}.

Note that bytes 0 and 1 of the floating-point value are stored in the lower numbered register and bytes 2 and 3 are contained in the higher numbered register.

For example: Number 123 in floating point format is mapped to two Holding registers (such as 45005 and 45006) as shown in Table 7-9.

Table 7-9. Number 123 in Floating Point Format

Register	45005	45006
Hexadecimal	0000	42F6
Binary	0000 0000 0000 0000	0100 0010 1111 0110

CAUTION

For DECS-200 Modbus, two consecutive holding registers which are mapped to any of the 4-byte generic data types, are considered to be linked together as one atomic, indivisible unit of information which can be read or written by Modbus message only as one entity (that is, one cannot be read or written without the other).

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-200 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 a 1, the CRC-register is then 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.

DECS-200 MODBUS REGISTER SPACE

Modbus Address space from 40000 to 49999 refers to Functions Code 3, 6 and 16. The DECS-200 uses address space from 47001 to 48250 (1250 registers). This address space is divided into 14 areas referred to as information categories. Table 7-10 provides a statistical summary for each information category.

Table 7-10. Information Category Summary

Information Category ID	Information Category	Total # of Reserved Holding Registers	Holding Register Address Space	Number Of Used Registers	Access Right	Data Types Mapped To Registers (Total # Of Variables)
C1	Product Information	250	47001 to 47250	63	R	UCHAR: 63
C2	Metering	125	47251 to 47375	55	R	FLOAT: 24 UINT16: 7
C3	Reporting (Status)	125	47376 to 47500	None	R	None (for future use)
C4	Control System Configuration Group 1	60	47501 to 47560	59	58 RW 1 R	FLOAT: 26 UINT16: 7
C5	Operating Modes	60	47561 to 47620	23	16 RW 7 R	UINT16: 23
C6	Setpoints	120	47621 to 47740	94	48 R 46 RW	FLOAT: 45 UINT16: 4
C7	Start-up	60	47741 to 47800	16	RW	FLOAT: 8
C8	Limiters	60	47801 to 47860	38	RW	FLOAT: 19
C9	Control Loop Gains	60	47861 to 47920	30	RW	FLOAT: 15
C10	Protective Functions	60	47921 to 47980	37	RW	FLOAT: 15 UINT16: 7
C11	Calibration	60	47981 to 48040	None (for future use)	RW	None (for future use)

Information Category ID	Information Category	Total # of Reserved Holding Registers	Holding Register Address Space	Number Of Used Registers	Access Right	Data Types Mapped To Registers (Total # Of Variables)
C12	Relays	120	48041 to 48160	83	RW	UINT16: 83
C13	General System	60	48161 to 48220	8	2 R 6 RW	UINT16: 6 UCHAR: 2
C14	FP Metering Configuration	30	48221 to 48250	3	3 RW	UINT16: 3
C15	Control System Configuration Group II	50	48501 to 48550	10	RW	FLOAT: 4

DECS-200 REGISTER TABLE

Each data to be transmitted via Modbus network is identified by its holding register(s). The following tables provide the complete list of holding register assignments and descriptions for the DECS-200. There is a separate table for each information category.

Holding Registers for Information Category C1

Table 7-11. Information Category C1 (Product Information)

Registers	Data Description	Access	Data Format
47001	1st character of the ASCII string of model information	R-	UI8
47002	2nd character of the ASCII string of model information	R-	UI8
47003	3rd character of the ASCII string of model information	R-	UI8
47004	4th character of the ASCII string of model information	R-	UI8
47005	5th character of the ASCII string of model information	R-	UI8
47006	6th character of the ASCII string of model information	R-	UI8
47007	7th character of the ASCII string of model information	R-	UI8
47008	8th character of the ASCII string of model information	R-	UI8
47009	Last character of the ASCII string of model information	R-	UI8
47010	1st character of the ASCII string of application program version number	R-	UI8
47011	2nd character of the ASCII string of application program version number	R-	UI8
47012	3rd character of the ASCII string of application program version number	R-	UI8
47013	4th character of the ASCII string of application program version number	R-	UI8
47014	5th character of the ASCII string of application program version number	R-	UI8
47015	6th character of the ASCII string of application program version number	R-	UI8

Table 7-11. Information Category C1 (Product Information)

Registers	Data Description	Access	Data Format
47016	7th character of the ASCII string of application program version number	R-	UI8
47017	Last character of the ASCII string of application program version number	R-	UI8
47018	1st character of the ASCII string of date of the application program	R-	UI8
47019	2nd character of the ASCII string of date of the application program	R-	UI8
47020	3rd character of the ASCII string of date of the application program	R-	UI8
47021	4th character of the ASCII string of date of the application program	R-	UI8
47022	5th character of the ASCII string of date of the application program	R-	UI8
47023	6th character of the ASCII string of date of the application program	R-	UI8
47024	7th character of the ASCII string of date of the application program	R-	UI8
47025	8th character of the ASCII string of date of the application program	R-	UI8
47026	Last character of the ASCII string of date of the application program	R-	UI8
47027	1st character of the ASCII string of DSP program version number	R-	UI8
47028	2nd character of the ASCII string of DSP program version number	R-	UI8
47029	3rd character of the ASCII string of DSP program version number	R-	UI8
47030	4th character of the ASCII string of DSP program version number	R-	UI8
47031	5th character of the ASCII string of DSP program version number	R-	UI8
47032	6th character of the ASCII string of DSP program version number	R-	UI8
47033	7th character of the ASCII string of DSP program version number	R-	UI8
47034	Last character of the ASCII string of DSP program version number	R-	UI8
47035	1st character of the ASCII string of date of the DSP program	R-	UI8
47036	2nd character of the ASCII string of date of the DSP program	R-	UI8
47037	3rd character of the ASCII string of date of the DSP program	R-	UI8
47038	4th character of the ASCII string of date of the DSP program	R-	UI8
47039	5th character of the ASCII string of date of the DSP program	R-	UI8
47040	6th character of the ASCII string of date of the DSP program	R-	UI8
47041	7th character of the ASCII string of date of the DSP program	R-	UI8
47042	8th character of the ASCII string of date of the DSP program	R-	UI8
47043	Last character of the ASCII string of date of the DSP program	R-	UI8
47044	1st character of the ASCII string of Boot program version number	R-	UI8
47045	2nd character of the ASCII string of Boot program version number	R-	UI8
47046	3rd character of the ASCII string of Boot program version number	R-	UI8
47047	4th character of the ASCII string of Boot Program version number	R-	UI8

Table 7-11. Information Category C1 (Product Information)

Registers	Data Description	Access	Data Format
47048	5th character of the ASCII string of Boot program version number	R-	UI8
47049	6th character of the ASCII string of Boot program version number	R-	UI8
47050	7th character of the ASCII string of Boot program version number	R-	UI8
47051	Last character of the ASCII string of Boot program version number	R-	UI8
47052	1st character of the ASCII string of date of the Boot program	R-	UI8
47053	2nd character of the ASCII string of date of the Boot program	R-	UI8
47054	3rd character of the ASCII string of date of the Boot program	R-	UI8
47055	4th character of the ASCII string of date of the Boot program	R-	UI8
47056	5th character of the ASCII string of date of the Boot program	R-	UI8
47057	6th character of the ASCII string of date of the Boot program	R-	UI8
47058	7th character of the ASCII string of date of the Boot program	R-	UI8
47059	8th character of the ASCII string of date of the Boot program	R-	UI8
47060	Last character of the ASCII string of date of the Boot program	R-	UI8
47061	1st character of the ASCII string of style number information	R-	UI8
47062	2nd character of the ASCII string of style number information	R-	UI8
47063	Last character of the ASCII string of style number information	R-	UI8
47064 to 47250	Reserved for future C1 data	Not supported	Not defined

Holding Registers for Information Category C2

Table 7-12. Information Category C2 (Metering)

Registers	Data Description	Access	Data Format
47251-52	Phase A to B rms generator voltage	R -	R32_23
47253-54	Phase B to C rms generator voltage	R-	R32_23
47255-56	Phase C to A rms generator voltage	R-	R32_23
47257-58	Average of the 3 rms line-to-line voltages	R-	R32_23
47259-60	Phase B generator current in amps	R-	R32_23
47261-62	Generator apparent power in kVA	R-	R32_23
47263-64	Generator real power in kW	R-	R32_23
47265-66	Generator reactive power in kvar	R-	R32_23
47267-68	Power factor	R-	R32_23
47269-70	Generator frequency in hertz	R-	R32_23
47271-72	Bus frequency in Hz	R-	R32_23

Table 7-12. Information Category C2 (Metering)

Registers	Data Description	Access	Data Format
47273-74	RMS bus voltage in volts	R-	R32_23
47275-76	Field voltage in volts	R-	R32_23
47277-78	Field current in amps	R-	R32_23
47279-80	Var/PF controller output in volts	R-	R32_23
47281-82	Phase angle between phase B voltage and current in degrees	R-	R32_23
47283-84	Auxiliary input in volts (PSS input)	R-	R32_23
47285-86	Current input for load compensation	R-	R32_23
47287-88	Null balance (tracking error) in percent	R-	R32_23
47289-90	Error signal to autotracking loop	R-	R32_23
47291-92	Active controller output	R-	R32_23
47293	PF state: 0 = leading / 1 = lagging	R-	UI16
47294	Generator state: 0 = generating / 1 = motoring	R-	UI16
47295	Status of the Front panel LEDs (bit flags, where 0=off, 1=on for all LEDs except Null Balance and Internal Tracking which are reversed): b0=Null Balance, b1=Tracking, b2=Pre-position, b3=Upper Limit, b4=Lower Limit, b5=Edit, b6-b15=unassigned	R-	UI16
47296	Voltage matching status: 0=off / 1=on	R-	UI16
47297	Protection status bit flags (0=clear, 1=condition present): b0=field overvoltage, b1=field overcurrent, b2=gen. Undervoltage, b3=gen. overvoltage, b4=underfrequency, b5=in OEL, b6=in UEL, b7=in FCR mode, b8=loss of sensing voltage, b9=setpoint at lower limit, b10=setpoint at upper limit, b11=gen. failed to build up, b12= gen. below 10Hz, b13=unassigned, b14=exciter diode open, b15=exciter diode shorted.	R-	UI16
47298-99	Reserved for future C2 data	R-	R32_23
47300-01	The active operating setpoint expressed as a percent of its present adjustment range.	R-	R32_23
47302	The state of some contact inputs: b0 = 52JK, b1 = 52LM, b2 = Automatic transfer, b3 = External Tracking Enable	R-	UI16
47303	Annunciation status bit flags (0=clear, 1=annunciation present): b0=field overvoltage, b1=field overcurrent, b2=gen. undervoltage, b3=gen. overvoltage, b4=underfrequency, b5=in OEL, b6=in UEL, b7=in FCR mode, b8=loss of sensing voltage, b9=setpoint at lower limit, b10=setpoint at upper limit, b11=gen. failed to build up, b12= gen. below 10Hz, b13=unassigned, b14=exciter diode open, b15=exciter diode shorted..	R-	UI16
47304-05	Reserved	R-	R32_23
47306	Protection status bit flags (0 = clear, 1 = condition present) b0 = loss of field, b1 = in SCL, b2 – b15 are unassigned	R-	UI16
47307	Annunciation status bit flags (0 = clear, 1 = condition present)	R-	UI16

Table 7-12. Information Category C2 (Metering)

Registers	Data Description	Access	Data Format
	b0 = loss of field, b1 = in SCL, b2 – b15 are unassigned		
47308 to 47375	Reserved for C2 data		

Holding Registers for Information Category C3

Table 7-13. Information Category C3 (Reporting)

Registers	Data Description	Access	Data Format
47376 to 47500	Reserved for future C3 data	Not supported	Not defined

Holding Registers for Information Category C4

Table 7-14. Information Category C4 (Control System Configuration Parameters)

Registers	Data Description	Access	Data Format
47501-02	Generator rated frequency, selectable to be 50 or 60 Hz	RW	R32_23
47503-04	Generator PT primary voltage rating, adjustable from 1 to 30,000 Vac in 1 volt increments	RW	R32_23
47505-06	Generator PT secondary voltage rating, adjustable from 1 to 240 Vac in 1 volt increments	RW	R32_23
47507-08	Generator CT primary current rating, adjustable from 1 to 60,000 Aac in 1 amp increments	RW	R32_23
47509-10	Generator CT secondary current rating, selectable to be 1 or 5 Aac	RW	R32_23
47511-12	Field current rating, adjustable from 1 to 18 Adc, in 0.1 amp increments	RW	R32_23
47513-14	Field voltage connections to isolation box, selectable to be 32V, 63V, 125V, 250V or 375V	RW	R32_23
47515-16	Bus sensing PT primary rating, adjustable from 1 to 500,000 Vac in 1 volt increments	RW	R32_23
47517-18	Bus sensing PT secondary rating, adjustable from 1 to 240 Vac in 1 volt increments	RW	R32_23
47519-20	Reserved	RW	R32_23
47521-22	Reserved	RW	R32_23
47523-24	Generator rated voltage, adjustable from 85 to 30,000 Vac in 1 volt increments	RW	R32_23
47525-26	Generator rated output current, adjustable from 10 to 60,000 Aac in 0.1 amp increments	RW	R32_23
47527-28	Generator rated field voltage, adjustable from 1 to 400 Vdc in 1 volt increments	RW	R32_23
47529-30	Generator rated field current, adjustable from 0.1 to 9999.0 Adc in 0.1 amp increments	RW	R32_23
47531-32	Nominal bus voltage, adjustable from 85 to 500,000 Vac in 1 volt	RW	R32_23

Table 7-14. Information Category C4 (Control System Configuration Parameters)

Registers	Data Description	Access	Data Format
	increments		
47533-34	Auxiliary input gain for AVR mode, adjustable from 0 to 99 in 0.01 increments	RW	R32_23
47535-36	Internal tracking time delay, adjustable from 0 to 8 seconds in 0.1-second increments	RW	R32_23
47537-38	Internal tracking traverse rate, adjustable from 1 to 80 seconds in 0.1 second increments	RW	R32_23
47539-40	Null balance level, adjustable from 0 to 9,999 in 0.01 increments	RW	R32_23
47541-42	Gain for cross current compensation, adjustable from 0 to 30 in 0.01 increments	RW	R32_23
47543	Voltage sensing configuration: 0 = 1 phase (A-C) / 1 = 3 phase	RW	UI16
47544	Auxiliary input summing mode: 0 = Inner Loop for AVR and FCR modes / 1 = Outer Loop for var and PF modes	RW	UI16
47545	Control signal output range: 0 or 1 = 0+10V / 2 = -10+10V / 3 = 4-20 mA	RW	UI16
47546	Reserved	RW	UI16
47547	Auxiliary input selection: 0 = voltage input / 1 = current input	RW	UI16
47548	PSS input mode – reserved for future C4 data	RW	UI16
47549-50	External tracking time delay, adjustable from 0 to 8 seconds in 0.1 second increments	RW	R32_23
47551-52	External tracking traverse rate, adjustable from 1 to 80 seconds in 0.1-second increments	RW	R32_23
47553	Voltage sensing hardware gain control signal: 0 = gen. PT secondary <= 160 Vac / 1 = gen. PT secondary > 160 Vac	R-	UI16
47554-55	Auxiliary input gain for FCR mode, adjustable from -99 to 99 in 0.01 increments	RW	R32_23
47556-57	Auxiliary input gain for var mode, adjustable from -99 to 99 in 0.01 increments	RW	R32_23
47558-59	Auxiliary input gain for PF mode, adjustable from -99 to 99 in 0.01 increments	RW	R32_23
47560	Reserved	RW	UI16

Holding Registers for Information Category C5

Table 7-15. Information Category C5 (Operating Mode Parameters)

Registers	Data Description	Access	Data Format
47561	Virtual toggle switch for Start or Stop: 0 = no change / 1 = change state. Holding register 47572 contains unit mode status. Note: Read value of register 47561 is always 0.	RW	UI16
47562	Virtual toggle switch for changing control mode from comm. port between AVR and FCR: 0 = no change / 1 = change state. Holding register 47573 contains Control mode status.	RW	UI16

Table 7-15. Information Category C5 (Operating Mode Parameters)

Registers	Data Description	Access	Data Format
	Note: Read value of register 47562 is always 0.		
47563	Switch for changing operating mode via comm. port, to one of three modes, 0=OFF / 1=PF / 2=var. Holding register 47571 contains Operating mode status. Note: Read value of register 47563 is always 4.	RW	UI16
47564	Internal tracking status from comm. port: 0 = Off / 1 = On	RW	UI16
47565	Preposition enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47566	Raise input enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47567	Lower input enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47568	External tracking enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47569	Limiter Mode options: 0 = both off / 1 = UEL on / 2 = OEL on / 3 = both on / 4 = SCL / 5 = SCL/UEL / 6 = SCL/OEL / 7 = OEL/UEL/SCL	RW	UI16
47570	Voltage matching mode: 0 = Off / 1 = On	RW	UI16
47571	Operating mode: 0 = Off / 1 = PF Control / 2 = var Control	R-	UI16
47572	Unit mode status: 0 = Stop / 1 = Start	R-	UI16
47573	Control mode status: 1 = FCR / 2 = AVR	R-	UI16
47574	Internal (mode-to-mode) tracking status: 0 = Off / 1 = On	R-	UI16
47575	Reserved for future C5 data	R-	UI16
47576	Secondary unit enable status: 0 = primary unit / 1 = secondary unit	R-	UI16
47577	Load compensation mode status: 0 = Off / 1 = Droop / 2 = Line Drop	R-	UI16
47578	Load compensation mode selection via comm. ports: 0 = Off/1 = Droop / 2 = Line Drop. Holding register 47577 contains Load compensation mode status. Note: Read value of register 47578 is always 0.	RW	UI16
47579	Input for resetting front panel annunciations and latched relay annunciations: 0 = no change / 1 = reset. Note: Read value of register 47579 is always 0.	RW	UI16
47580	Loss-of-sensing detection enable: 0 = disable / 1 = enable	RW	UI16
47581	Loss of sensing triggered transfer-to-FCR-mode enable.	RW	UI16
47582	Under frequency or volts per hertz mode enable.	RW	UI16
47583	External Tracking enabled: 0 = disabled /1 = enabled	RW	UI16
47584	Virtual toggle switch for OEL style: 0 = no change, 1 = change Read back: 0 = summing point, 1 = takeover	RW	UI16
47585	OEL option: 0 = Option 1, 1 = Option 2, 3 = Option 3	RW	UI16
47586	PF/var option status: 0 = Off, 1 = PF, 2 = var	R-	UI16
47587 to 47620	Reserved for future C5 data	Not supported	Not defined

Holding Registers for Information Category C6

Table 7-16. Information Category C6 (Setpoint Parameters)

Registers	Data Description	Access	Data Format
47621-22	FCR (field current regulator) mode setpoint; adjustment range is determined by registers (47699-700) and (47707-08)	RW	R32_23
47623-24	AVR (automatic voltage regulator) mode setpoint; adjustment range is determined by registers (47701-02) and (47709-10)	RW	R32_23
47625-26	Var mode setpoint (in kvar); adjustment range is determined by registers (47703-04) and (47711-12)	RW	R32_23
47627-28	PF mode setpoint; adjustment range is determined by registers (47705-06) and (47713-14)	RW	R32_23
47629-30	Droop setting in percent (of rated generator voltage), adjustable from -30 to 30% in 0.1% increments	RW	R32_23
47631-32	FCR mode traverse rate, adjustable from 10 to 200 seconds in 1-second increments	RW	R32_23
47633-34	AVR mode traverse rate, adjustable from 10 to 200 seconds in 1-second increments	RW	R32_23
47635-36	Var mode traverse rate, adjustable from 10 to 200 seconds in 1-second increments	RW	R32_23
47637-38	PF mode traverse rate, adjustable from 10 to 200 seconds in 1-second increments	RW	R32_23
47639-40	FCR mode setpoint preposition; adjustment range is determined by registers (47699-700) and (47707-08)	RW	R32_23
47641-42	AVR mode setpoint preposition; adjustment range is determined by registers (47701-02) and (47709-10)	RW	R32_23
47643-44	Var mode setpoint preposition (in kvar); adjustment range is determined by registers (47703-04) and (47711-12)	RW	R32_23
47645-46	PF mode setpoint preposition; adjustment range is determined by registers (47705-06) and (47713-14)	RW	R32_23
47647-48	FCR mode setpoint step size = setpoint range / (traverse rate x 10): [(regs. 47707-08) - (regs. 47699-700)] / [(regs. 47631-32) x 10]	R	R32_23
47649-50	AVR mode setpoint step size = setpoint range / (traverse rate x 10): [(regs. 47709-10) - (regs. 47701-02)] / [(regs. 47633-34) x 10]	R	R32_23
47651-52	Var mode setpoint step size (in kvar) = setpoint range / (traverse rate x 10): [(regs. 47711-12) - (regs. 47703-04)] / [(regs. 47635-36) x 10]	R	R32_23
47653-54	PF mode setpoint step size = setpoint range / (traverse rate x 10):[2 + (regs.47713-14) - (regs.47705-06)] / [(regs.47635-36) x 10]	R	R32_23
47655-56	FCR mode setpoint minimum (in % of rated field current), adjustable from 0 to 100% in 0.1% increments	RW	R32_23
47657-58	AVR mode setpoint minimum (in % of rated generator output voltage), adjustable from 70 to 100% in 0.1% increments	RW	R32_23
47659-60	Var mode setpoint minimum (in % of rated generator VA), adjustable from -100 to 100% in 0.1% increments	RW	R32_23

Table 7-16. Information Category C6 (Setpoint Parameters)

Registers	Data Description	Access	Data Format
47661-62	PF mode setpoint adjustable minimum, adjustable from 0.5 to 1.0 in 0.005 increments	RW	R32_23
47663-64	FCR mode setpoint maximum (in % of rated field current), adjustable from 100 to 120% in 0.1% increments	RW	R32_23
47665-66	AVR mode setpoint maximum (in % of rated generator output voltage), adjustable from 100 to 110% in 0.1% increments	RW	R32_23
47667-68	Var mode setpoint maximum (in % of rated generator VA), adjustable from -100 to 100% in 0.1% increments	RW	R32_23
47669-70	PF mode setpoint adjustable maximum, adjustable from -1.0 to -0.5 in 0.005 increments	RW	R32_23
47671-72	Minimum value for FCR mode setpoint adjustable minimum (in % of rated field current) = 0%	R	R32_23
47673-74	Minimum value for AVR mode setpoint adjustable minimum (in % of rated generator output voltage) = 80%	R	R32_23
47675-76	Minimum value for var mode setpoint adjustable minimum (in % of rated generator VA) = -100%	R	R32_23
47677-78	Minimum value for PF mode setpoint adjustable minimum	R	R32_23
47679-80	Maximum value for FCR mode setpoint adjustable maximum (in % of rated field current) = 120%	R	R32_23
47681-82	Maximum value for AVR mode setpoint adjustable maximum in (in % of rated generator output voltage) = 110%	R	R32_23
47683-84	Maximum value for var mode setpoint adjustable maximum (in % of rated generator VA) = 100%	R	R32_23
47685-86	Maximum value for PF mode setpoint adjustable maximum	R	R32_23
47687-88	Step size for FCR mode setpoint adjustable maximum (in % of rated field current) = 0.1%	R	R32_23
47689-90	Step size for AVR mode setpoint adjustable maximum (in % of rated generator output voltage) = 0.1%	R	R32_23
47691-92	Step size for var mode setpoint adjustable maximum in % of rated generator VA) = 0.1%	R	R32_23
47693-94	Step size for PF mode setpoint adjustable maximum = 0.005	R	R32_23
47695	FCR preposition mode: 0 = maintained / 1 = release	RW	UI16
47696	AVR preposition mode: 0 = maintained / 1 = release	RW	UI16
47697	Var preposition mode: 0 = maintained / 1 = release	RW	UI16
47698	PF preposition mode: 0 = maintained / 1 = release	RW	UI16
47699-700	FCR minimum setpoint (in amps) = % of nominal x rated field current:(regs. 47655-56) x (regs. 47529-30) / 100	R-	R32_23
47701-02	AVR minimum setpoint (in volts) = % of nominal x rated gen. voltage:(regs. 47657-58) x (regs. 47525-26) / 100	R-	R32_23
47703-04	Var minimum setpoint (in kvar) = % of nominal x rated generator	R-	R32_23

Table 7-16. Information Category C6 (Setpoint Parameters)

Registers	Data Description	Access	Data Format
	VA:(regs. 47659-60) x rated VA / 100		
47705-06	PF minimum setpoint = registers 47661-62	R-	R32_23
47707-08	FCR maximum setpoint (in amps) = % of nominal x rated field current:(regs. 47663-64) x (regs. 47529-30) / 100	R-	R32_23
47709-10	AVR maximum setpoint (in volts) = % of nominal x rated gen. Voltage:(regs. 47665-66) x (regs. 47525-26) / 100	R-	R32_23
47711-12	Var maximum setpoint (in kvar) = % of nominal x rated gen. VA:(regs. 47667-68) x rated VA / 100	R-	R32_23
47713-14	PF maximum setpoint = registers 47669-70	R-	R32_23
47715 to 47740	Reserved for future C6 data	Not supported	Not defined

Holding Registers for Information Category C7

Table 7-17. Information Category C7 (Startup Parameters)

Registers	Data Description	Access	Data Format
47741-42	Soft start level, adjustable from 0 to 90 % (of rated generator voltage) in 1% increments	RW	R32_23
47743-44	Soft start duration, adjustable from 1 to 7,200 seconds in 1 second increments	RW	R32_23
47745-46	Underfrequency corner frequency, adjustable from 15 to 90 Hz in 0.1 Hz increments	RW	R32_23
47747-48	Slope of underfrequency curve, adjustable from 0.00 to 3.00 V/Hz in 0.01 V/Hz increments	RW	R32_23
47749-50	Width of voltage matching window, adjustable from 0 to 20 % (of rated generator voltage) in 0.01 % increments	RW	R32_23
47751-52	Voltage matching reference, adjustable from 90 to 120 % (of rated generator voltage) in 0.01 % increments	RW	R32_23
47753-54	Fine voltage adjust band, adjustable from 0 to 30 % (of rated generator voltage) in 0.1 % increments	RW	R32_23
47755-56	Time delay for loss of sensing, adjustable from 0 to 3 seconds in 0.1-second increments	RW	R32_23
47757-58	Loss of sensing level under balanced conditions, adjustable from 0% to 100% of rated generator voltage in 0.1% increments	RW	R32_23
47759-60	Loss of sensing level under unbalanced conditions, adjustable from 0% to 100% of rated generator voltage in 0.1% increments	RW	R32_23
47761 to 47800	Reserved for future C7 data	Not supported	Not defined

Holding Registers for Information Category C8

Table 7-18. Information Category C8 (Limiter Parameters)

Registers	Data Description	Access	Data Format
47801-02	On-line OEL high limit level, adjustable from 0.1 to 30 Adc in 0.1-amp increments	RW	R32_23
47803-04	Time allowed at on-line OEL high limit level, adjustable from 0 to 10 seconds in 1-second increments	RW	R32_23
47805-06	On-line OEL medium limit level, adjustable from 0.1 to 20 Adc in 0.1-amp increments	RW	R32_23
47807-08	Time allowed at on-line OEL medium limit level, adjustable from 0 to 120 seconds in 1-second increments	RW	R32_23
47809-10	On-line low OEL low limit level, adjustable from 0.1 to 15 Adc in 0.1-amp increments	RW	R32_23
47811-12	Internal UEL curve's starting point (reactive power level at 0 kW). This should be 0 to allow the programmable UEL curve to be used.	RW	R32_23
47813-14	Time allowed at off-line OEL high limit level, adjustable from 0 to 10 seconds in 1-second increments	RW	R32_23
47815-16	Off-line OEL high limit level, adjustable from 0 to 30 Adc in 0.1-amp increments	RW	R32_23
47817-18	Off-line OEL low limit level, adjustable from 0 to 15 Adc in 0.1-amp increments	RW	R32_23
47819-20	1st UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47821-22	2nd UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47823-24	3rd UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47825-26	4th UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47827-28	5th UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47829-30	1st UEL point reactive power value, adjustable from 0 to generator's full rating (in kvar)	RW	R32_23
47831-32	2nd UEL point reactive power value, adjustable from 0 to generator's full rating (in kvar)	RW	R32_23
47833-34	3rd UEL point reactive power value, adjustable from 0 to generator's full rating (in kvar)	RW	R32_23
47835-36	4th UEL point reactive power value, adjustable from 0 to generator's full rating (in kvar)	RW	R32_23
47837-38	5th UEL point reactive power value, adjustable from 0 to generator's full rating (in kvar)	RW	R32_23
47839-40	SCL high limit level, adjustable from 0 to 66,000 A in 0.1 A increments	RW	R32_23

Table 7-18. Information Category C8 (Limiter Parameters)

Registers	Data Description	Access	Data Format
47841-42	Time allowed at SCL high limit level, adjustable from 0 to 60 seconds in 0.1 second increments.	RW	R32_23
47843-44	SCL low limit level, adjustable from 0 to 66,000 A, in 0.1 A increments	RW	R32_23
47845-46	Takeover OEL offline high limit level, adjustable from 0 to 9,999 A in 0.1 A increments	RW	R32_23
47847-48	Takeover OEL offline low limit level, adjustable from 0 to 9,999 A in 0.1 A increments.	RW	R32_23
47849-50	Takeover OEL offline time dial, adjustable from 0.1 to 20, in 0.1 increments	RW	R32_23
47851-52	Takeover OEL online high limit level, adjustable from 0 to 9,999 A in 0.1 A increments.	RW	R32_23
47853-54	Takeover OEL online low limit level, adjustable from 0 to 9,999 A in 0.1 a increments.	RW	R32_23
47855-56	Takeover OEL online time dial, adjustable from 0.1 to 20 in 0.1 increments	RW	R32_23
47857 to 47860	Reserved for future C8 data	Not supported	Not defined

Holding Registers for Information Category C9

Table 7-19. Information Category C9 (Control Loop Gain Parameters)

Registers	Data Description	Access	Data Format
47861-62	Stability setting group number: 1 to 21, where groups 1 to 20 are preprogrammed values and group 21 is user programmable	RW	R32_23
47863-64	AVR/FCR mode proportional gain (Kp), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47865-66	AVR/FCR mode integral gain (Ki), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47867-68	AVR/FCR mode derivative gain (Kd), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47869-70	OEL integral gain (Ki), adjustable from 0 to 1000 in 0.1 increments	RW	R32_23
47871-72	PF mode integral gain (Ki), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47873-74	Var mode integral gain (Ki), adjustable from 0 to 1,000 in 0.01 increments	RW	R32_23
47875-76	FCR mode loop gain (Kg), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47877-78	AVR mode loop gain (Kg), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47879-80	Var mode loop gain (Kg), adjustable from 0 to 1,000 in 0.01 increments	RW	R32_23
47881-82	PF mode loop gain (Kg), adjustable from 0 to 1000 in 0.1 increments	RW	R32_23

47883-84	OEL loop gain (Kg), adjustable from 0 to 1000 in 0.1 increments	RW	R32_23
47885-86	UEL loop gain (Kg), adjustable from 0 to 1000 in 0.1 increments	RW	R32_23
47887-88	UEL integral gain (Ki), adjustable from 0 to 1000 in 0.1 increments	RW	R32_23
47889-90	Voltage matching loop gain (Kg), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47891-92	AVR mode derivative time constant, adjustable from 0 to 1 in 0.01 increments	RW	R32_23
47893 to 47905	Reserved for future C9 data	Not supported	Not defined
47906-07	SCL loop gain (Kg), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47908-09	SCL loop gain (Ki), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47910-20	Reserved for future C9 data	Not supported	Not defined

Holding Registers for Information Category C10

Table 7-20. Information Category C10 (Protective Functions Parameters)

Registers	Data Description	Access	Data Format
47921-22	Field overvoltage level, adjustable from 1 to 325 Vdc in 1-volt increments	RW	R32_23
47923-24	Field overcurrent base level, adjustable from 0.1 to 16 Adc in 0.1-amp increments	RW	R32_23
47925-26	Stator undervoltage level, adjustable from 0 to 30,000 Vac in 1-volt increments	RW	R32_23
47927-28	Stator overvoltage level, adjustable from 0 to 30,000 Vac in 1-volt increments	RW	R32_23
47929-30	Field overvoltage time delay, adjustable from 0.2 to 30 seconds in 0.1-second increments	RW	R32_23
47931-32	Field overcurrent time dial multiplier, adjustable from 0.1 to 20 in 0.1 increments	RW	R32_23
47933-34	Stator undervoltage time delay, adjustable from 0.5 to 60 seconds in 0.1-second increments	RW	R32_23
47935-36	Stator overvoltage time delay, adjustable from 0.1 to 60 seconds in 0.1-second increments	RW	R32_23
47937	Field overvoltage alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47938	Field overcurrent alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47939	Stator undervoltage alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47940	Stator overvoltage alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47941-42	Reserved	RW	R32_23
47943-44	Reserved	RW	R32_23
47945	Reserved	RW	UI16

Registers	Data Description	Access	Data Format
47946-47	Exciter open diode ripple pickup level, adjustable from 0% to 100% in 0.1% increments.	RW	R32-23
47948-49	Exciter open diode time delay, adjustable from 10 to 60 seconds in 0.1 second increments.	RW	R32-23
47950	Exciter open diode protection enable: 0 = disabled / 1 = enabled	RW	UI16
47951-52	Exciter shorted diode ripple pickup level, adjustable from 0% to 100% in 0.1% increments.	RW	R32-23
47953-54	Exciter shorted diode time delay, adjustable from 5 to 30 seconds in 0.1 second increments.	RW	R32-23
47955	Exciter shorted diode protection enable: 0 = disabled / 1 = enabled	RW	UI16
47956-57	Exciter diode protection disable level, adjustable from 0% to 100% of rated exciter field current in 0.1% increments.	RW	R32_23
47958	Loss of field alarm enable: 0 = disabled, 1 = enabled	RW	UI16
47959-60	Loss of field level, adjustable from 0 to 3,000 Mvar in 1 kvar increments	RW	R32_23
47961-62	Loss of field delay (in seconds): adjustable from 0.1 to 9.9 seconds	RW	R32_23
47963 to 47980	Reserved for future C10 data	Not supported	Not defined

Holding Registers for Information Category C11

Table 7-21. Information Category C11 (Calibration related Parameters)

Registers	Data Description	Access	Data Format
47981 to 48040	Reserved for future C11 data	Not supported	Not defined

Holding Registers for Information Category C12

Table 7-22. Information Category C12 (Relay Parameters)

Registers	Data Description	Access	Data Format
48041	Annunciation enable for Relay 1: 0 = disabled, 1 = enabled b0 = field overvoltage, b1 = field overcurrent, b2 = gen. Undervoltage, b3 = gen. Overvoltage, b4 = underfrequency, b5 = in OEL, b6 = in UEL, b7 = in FCR mode, b8 = loss of sensing voltage, b9 = setpoint at lower limit, b10 = setpoint at upper limit, b11 = unassigned, b12 = gen. Below 10 Hz, b13 = field overtemperature, b14, b15 are unassigned.	RW	UI16
48042	Annunciation enable for Relay 1: 0 = disabled, 1 = enabled b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	RW	UI16
48043	Reserved	RW	UI16
48044	Reserved	RW	UI16
48045	Reserved	RW	UI16

Table 7-22. Information Category C12 (Relay Parameters)

Registers	Data Description	Access	Data Format
48046	Reserved	RW	UI16
48047	Reserved	RW	UI16
48048	Reserved	RW	UI16
48049	Reserved	RW	UI16
48050	Reserved	RW	UI16
48051	Reserved	RW	UI16
48052	Reserved	RW	UI16
48053	Reserved	RW	UI16
48054	Reserved	RW	UI16
48055	Reserved	RW	UI16
48056	16th annunciation enable for Relay 1 - Reserved for future C12 data	RW	UI16
48057	Output for Relay 1: 0 = contact open / 1 = contact closed	R	UI16
48058	Relay 1 annunciation: 0 = momentary / 1 = maintained / 2 = latched	RW	UI16
48059	Relay 1 contact sense: 0 = closed for normal operation, open for annunciation; 1 = open for normal operation, closed for annunciation	RW	UI16
48060	Relay 1 output duration for momentary type, adjustable 2 to 100 in unity increments (which is 0.1 to 5 seconds in 0.05-second increments)	RW	UI16
48061	b0 = field overvoltage, b1 = field overcurrent, b2 = gen. Undervoltage, b3 = gen overvoltage, b4 = underfrequency, b5 = in OEL, b6 = in UEL, b7 = in FCR mode, b8 = loss of sensing voltage, b9 = setpoint at lower limit, b10 = setpoint at upper limit, b11 = unassigned, b12 = gen. Below 10 Hz, b13 = field overtemperature, b14-b15 are unassigned.	RW	UI16
48062	b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	RW	UI16
48063	Reserved	RW	UI16
48064	Reserved	RW	UI16
48065	Reserved	RW	UI16
48066	Reserved	RW	UI16
48067	Reserved	RW	UI16
48068	Reserved	RW	UI16
48069	Reserved	RW	UI16
48070	Reserved	RW	UI16
48071	Reserved	RW	UI16
48072	Reserved	RW	UI16
48073	Reserved	RW	UI16
48074	Reserved	RW	UI16

Table 7-22. Information Category C12 (Relay Parameters)

Registers	Data Description	Access	Data Format
48075	Reserved	RW	UI16
48076	16th annunciation enable for Relay 2 – Reserved for future C12 data	RW	UI16
48077	Output for Relay 2: 0 = contact open / 1 = contact closed	R	UI16
48078	Relay 2 annunciation type: 0 = momentary / 1 = maintained / 2 = latched	RW	UI16
48079	Relay 2 contact sense: 0 = closed for normal operation, open for annunciation; 1 = open for normal operation, closed for annunciation	RW	UI16
48080	Relay 2 output duration for momentary type, adjustable from 2 to 100 in unity increments (which is 0.1 to 5 seconds in 0.05 second increments)	RW	UI16
48081	b0 = field overvoltage, b1 = field overcurrent, b2 = gen. Undervoltage, b3 = gen overvoltage, b4 = underfrequency, b5 = in OEL, b6 = in UEL, b7 = in FCR mode, b8 = loss of sensing voltage, b9 = setpoint at lower limit, b10 = setpoint at upper limit, b11 = unassigned, b12 = gen. Below 10 Hz, b13 = field overtemperature, b14-b15 are unassigned.	RW	UI16
48082	b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	RW	UI16
48083	Reserved	RW	UI16
48084	Reserved	RW	UI16
48085	Reserved	RW	UI16
48086	Reserved	RW	UI16
48087	Reserved	RW	UI16
48088	Reserved	RW	UI16
48089	Reserved	RW	UI16
48090	Reserved	RW	UI16
48091	Reserved	RW	UI16
48092	Reserved	RW	UI16
48093	Reserved	RW	UI16
48094	Reserved	RW	UI16
48095	Reserved	RW	UI16
48096	16th annunciation enable for Relay 3 - Reserved for future C12 data	RW	UI16
48097	Output for Relay 3: 0 = contact open / 1 = contact closed	R	UI16
48098	Relay 3 annunciation type: 0 = momentary / 1 = maintained / 2 = latched	RW	UI16
48099	Relay 3 contact sense: 0 = closed for normal operation, open for annunciation; 1 = open for normal operation, closed for annunciation	RW	UI16
48100	Relay 3 output duration for momentary type, adjustable from 2 to 100 in unity increments (which is 0.1 to 5 s in 0.05 s increments)	RW	UI16

Table 7-22. Information Category C12 (Relay Parameters)

Registers	Data Description	Access	Data Format
48101	Reserved	RW	UI16
48102	Reserved	RW	UI16
48103	Reserved	RW	UI16
48104	Reserved	RW	UI16
48105	Reserved	RW	UI16
48106	Reserved	RW	UI16
48107	Reserved	RW	UI16
48108	Reserved	RW	UI16
48109	Reserved	RW	UI16
48110	Reserved	RW	UI16
48111	Reserved	RW	UI16
48112	Reserved	RW	UI16
48113	Reserved	RW	UI16
48114	Reserved	RW	UI16
48115	Reserved	RW	UI16
48116	Reserved	RW	UI16
48117	Reserved	RW	UI16
48118	Reserved	RW	UI16
48119	Reserved	RW	UI16
48120	Reserved	RW	UI16
48121	Reserved	RW	UI16
48122	Reserved	RW	UI16
48123	Reserved	RW	UI16
48124 to 48160	Reserved for future C12 data	Not supported	Not defined

Holding Registers for Information Category C13

Table 7-23. Information Category C13 (Communications Parameters)

Registers	Data Description	Access	Data Format
48161	Save data to EEPROM flags: 0x0001 saves C4 and C6; 0x0002 saves C5 and C7; 0x0004 saves C6; 0x0008 saves C5 and C7; 0x0010 saves C8; 0x0020 saves C9; 0x0040 saves C10; 0x0080 saves C11; 0x0100 saves C12; 0x0800 saves C14. (Changes in C13 are automatically saved.)	RW	UI16
48162	Comm. Port 0, front RS-232, baud rate, selectable to be 1200, 2400, 4800, 9600, or 19200	R	UI16

Registers	Data Description	Access	Data Format
48163	Comm. port 1, rear RS-232, baud rate, selectable to be 1200, 2400, 4800, 9600 or 19200	R	UI16
48164	Comm. port 2, rear RS-485, baud rate, selectable to be 1200, 2400, 4800, 9600 or 19200	RW	UI16
48165	Comm. port 2, Rear RS-485, Parity: 'O' = 79 = 0x4F for Odd Parity,'E' = 69 = 0x45 for Even Parity, and 'N' = 78 = 0x4E for No Parity	RW	UI8
48166	Comm. port 2, Rear RS-485, stop bits, selectable to be 1 or 2	RW	UI8
48167	DECS-200 polling address (Modbus slave address), selectable from 1 to 247 (slave address)	RW	UI16
48168	Modbus Response Time Delay, adjustable from 10 to 200 ms in 10 ms increments	RW	UI16
48169 to 48220	Reserved for future C13	Not supported	Not defined

Holding Registers for Information Category C14

Table 7-24. Information Category C14 (Front Panel Metering Configuration Parameters)

Registers	Data Description	Access	Data Format
48221	1st metering display field on the front panel metering screen: 0 to 14	RW	UI16
48222	2nd metering display field on the front panel metering screen: 0 to 14	RW	UI16
48223	3rd metering display field on the front panel metering screen: 0 to 14	RW	UI16
48224 to 48250	Reserved for future C14 data	Not supported	Not defined

Holding Registers for Information Category C15

Table 7-25. Information Category C15 (Control System Configuration Parameters Group II)

Registers	Data Description	Access	Data Format
48501-02	Reserved	RW	R32_23
48503-04	Reserved	RW	R32_23
48505-06	Reserved	RW	R32_23
48505-07	Reserved	RW	UI16
48505-08	Reserved	RW	UI16
48505-09, 10	EDM Pole Ratio (1 to 10 in steps of 0.01, Enter 0 if unknown)	RW	R32_23

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SECTION 8 • MAINTENANCE

PREVENTIVE MAINTENANCE

The only preventive maintenance required for the DECS-200 is the periodic checking of DECS-200 connections to ensure that they are clean and tight.

WARRANTY AND REPAIR SERVICE

DECS-200 units are manufactured using state-of-the-art, surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric.

The DECS-200 is warranted against defective material and workmanship for 18 months from the date of shipment from Basler Electric. Units submitted for warranty repair should be returned to Basler Electric's Highland, Illinois facility, freight prepaid, with a complete description of the application and the reported problem. Prearrangement with either the nearest Basler Electric sales office or with the Technical Sales Support department at Basler Electric will assure the fastest possible turnaround time.

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-200, first check the programmable settings for the appropriate function.

DECS-200 Appears Inoperative

If the DECS-200 does not power up (no backlighting on front panel display), ensure that the control power applied to the unit is at the correct level. If dc control power is being used, verify that the polarity is correct. Units with style number XL have an input voltage range of 16 to 60 Vdc. Units with style number XC have an input voltage range of 90 to 150 Vdc or 82 to 132 Vac (50/60 Hz). If the correct control power is being applied, return the unit to Basler Electric as described under *Warranty and Repair Service*.

NOTE

When both ac and dc control power is used, an isolation transformer must be connected between the ac voltage source and the ac control power terminals of the DECS-200.

Display Blank or Frozen

If the front panel display (LCD) is blank or frozen (does not scroll), remove control power for about 60 seconds and then reapply control power. If the problem occurred during software uploading, repeat the upload procedures as described in the associated instructions. If the problem persists, return the unit to Basler Electric as described under *Warranty and Repair Service*.

Generator Voltage Does Not Build

Check the DECS-200 settings and system voltages for the following:

a. Generator potential transformer (PT) primary voltage
b. Generator PT secondary voltage
c. AC voltage on the DECS-200 operating (bridge) power terminals (C5 (A), C6 (B), and C7 (C))

Check the DECS-200 soft start bias and soft start time settings. If necessary, increase the generator soft start bias and decrease the generator soft start time.

If the generator voltage still does not build, increase the value of Kg.

Temporarily disable the overexcitation limiter.

Low Generator Voltage in AVR Mode

Check the following DECS-200 settings and system parameters:

a. AVR voltage setpoint
b. Generator potential transformer (PT) primary voltage

c. Generator PT secondary voltage
d. Overexcitation limiter (not activated)
e. Accessory inputs (should be zero)
f. Var/PF and droop (should be disabled)
g. Cut-in underfrequency setting (should be below the generator operating frequency)

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

High Generator Voltage in AVR Mode

Check the following DECS-200 settings and system parameters:

a. AVR voltage setpoint
b. Generator potential transformer (PT) primary voltage
c. Generator PT secondary voltage
d. Accessory inputs (should be zero)
e. Var/PF and droop (should be disabled)

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

Generator Voltage Unstable (Hunting)

Verify that the exciter power converter is working correctly by substituting the appropriate battery voltage in place of the DECS-200 drive voltage. If the problem is caused by the DECS-200, check the gain settings for the specific mode of operation selected.

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

Protection or Limit Annunciation

If a protection function or limiting function is annunciated, check the associated setting values.

If the problem persists, contact the Basler Electric Technical Sales Support department for advice.

HMI Meter Readings Incorrect

If your PF, 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-200 is connected to a CT on phase B and not phases A or C.

No Communication

If communication with the DECS-200 cannot be initiated, check the connections at the communication ports, the baud rate, and supporting software.

DECS-200 Reboots Frequently

If a single DECS-200 control power source is used and the power source is supplying less than the minimum required voltage or is fluctuating below the minimum required voltage, the DECS-200 will reboot. Increase the control power source voltage so that it is within the specified operating range. Units with style number XL have an input voltage range of 16 to 60 Vdc. Units with style number XC have an input voltage range of 90 to 150 Vdc or 82 to 132 Vac (50/60 Hz).

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