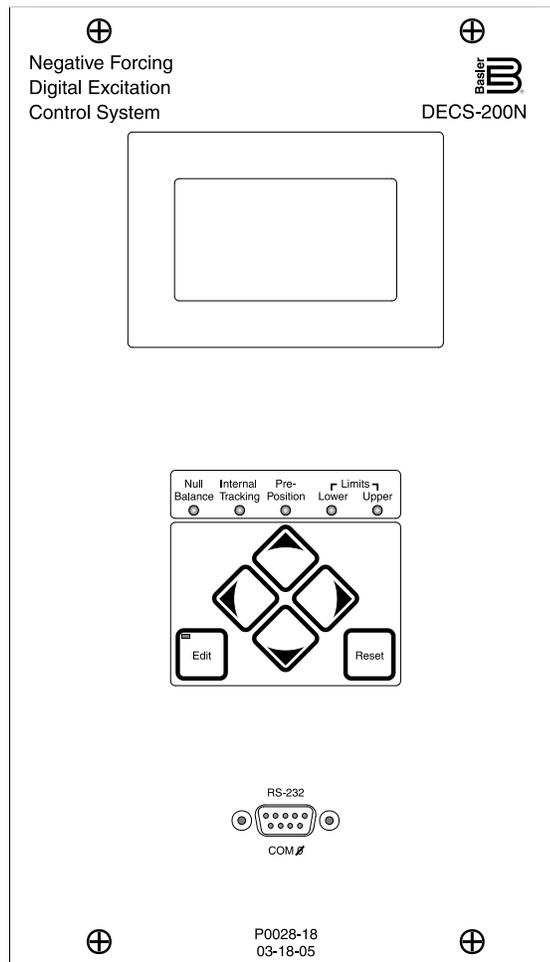# INSTRUCTION MANUAL

FOR

DIGITAL EXCITATION CONTROL SYSTEM DECS-200N

Basler Electric®

INTRODUCTION

This instruction manual provides information about the operation and installation of the DECS-200N 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 device is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

A resistor module (P/N 9388816100) is supplied with the DECS-200N and recommended for use in all DECS-200N installations. Section 4, *Installation* provides information regarding mounting and wiring of the resistor module.

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It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. 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-200N hardware, firmware, and software. The corresponding revisions made to this instruction manual (9388800990) are also summarized. Revisions are listed in reverse chronological order.

Manual Revision and Date	Change
R, 07/17	• Corrected Fahrenheit value for elevation de-rating in section 1. • Corrected Field Overcurrent pickup range to "0.1 to 20 Adc". • Added UL certification to section 1. • Removed GOST-R certification from section 1. • Added nonvolatile memory caution statement to section 5 and appendix B. • Added Windows® 8 compatibility for BESTCOMS in section 5. • Changed Modbus™ to Modbus® throughout manual.
Q	• This revision letter not used.
P, 02/14	• Removed product registration information. • Added electrolytic capacitor maintenance recommendation. • Removed expired Belarus conformity certification.
O	• This revision letter not used.
N, 03/12	• Removed references to high current relays in section 5. • Updated BESTCOMS screenshots in Figures 5-28, 5-29, and 5-33. • Improved description of register 47564 in Appendix B.
M, 03/11	• Added Windows 7 compatibility for BESTCOMS in section 5. • Changed High Current Level from 0-30 to 0-40 Adc in Figures 3-6 and 3-7. • Added Initial Delay Time in Figure 3-10. • Added Droop and Line-Drop Compensation in Section 3. • Enhanced Figure 4-1, *Overall Dimensions.* • Improved description of register 47295 in Appendix B.
L, 09/09	• Replaced Figures 5-18 and 6-12, *Setting Adjustments Screen, UEL Tab.* • Updated *UEL Settings* description in Section 5, *BESTCOMS Software.* • In Section 5, added NOTE about saving settings before updating firmware. • Section 1, *General Information,* combined specs for Relays 1, 2, 3, 4, and 5.
K, 03/09	• Revised manual to accommodate change from discrete suppression resistor assembly (P/N 9388806100) to resistor module (P/N 9388816100). • Updated operating power and environment specifications to reflect the operating temperature limitations of style X3 controllers.
J, 02/09	• Added GOST-R certification in Section 1. • Added Republic of Belarus certification in Section 1. • Added information on Resistor Assembly under *Application.* • Added Figure 4-5, *Resistor Assembly and Hole Drilling Dimensions.* • Added Figure 4-9, *Resistor Assembly Connections.* • Minor text edits throughout manual.

Manual Revision and Date	Change
I	• This revision letter not used.
H, 08/08	• Updated Figure 5-6 and associated paragraphs to illustrate and describe firmware version fields added to System Options tab of System Configuration screen.
G, 03/08	• Added coverage of Power Input Failure and Crowbar Active protection settings. • Corrected data error in Table B-10.
F, 01/07	• Updated procedure for uploading embedded firmware. • Updated BESTCOMS requirements.
E, 09/07	• Added SCL Initial Delay setting description.
D, 04/07	• Updated HMI illustrations (Figures 2-2, 2-4, 2-8, 2-9, and 2-10) and associated descriptions to cover added settings. • Changed description of auxiliary input to include limiter scaling. • Updated BESTCOMS illustrations and descriptions of Section 5 to accommodate new 52 Contacts tab on the System Configuration screen and new Scaling tab on the Setting Adjustments screen. Removed the Setting Adjustments screen OEL Type tab illustration and setting descriptions. • Updated setup instructions and illustrations of Section 6 to reflect added features/settings. • Created new Appendix C with information about using Setting Adjustments screen OEL Type tab with units having firmware older than version 1.03.00. • Added publication number and revision letter to page footers.
C, 08/06	• Updated all descriptions of "Bridge input below 12 Hz" protection and annunciation to include the loss of one of three phases of bridge power. Replaced all references to "bridge input below 12 Hz" with "power input failure".
B, 03/06	• Revised all operating power frequency ranges: 50 to 160 Hz, 161 to 420 Hz, and 421 to 500 Hz. • Added *Full-Load Continuous Excitation Current* value of 20 Adc to Table 1-2, *Field Output Ratings.* • In Table 2-5, changed duration of message for BRIDGE BELOW 12 HZ from *Clears 2 s after end of event* to *Maintained until reset.* • In Appendix B, removed description from unused register 47587. In registers 47306 and 47307, changed bit 2 description from *safe mode activated* to *bridge < 12 Hz.*
A, 01/06	• Corrected RLY4 and RLY5 terminal numbering in Figure 4-9. • Corrected escutcheon part number listed in Section 4.
—, 07/05	• Initial release

BESTCOMS Software Version and Date	Change
1.06.00, 10/14	• Added Windows® 8 compatibility.
1.05.02, 04/12	• Improved resolution of PF analysis screen.
1.05.01, 09/11	• Improved analysis screens.
1.05.00, 10/10	• Added Windows® 7 compatibility.

BESTCOMS Software Version and Date	Change
1.04.00, 09/09	• On the *Settings, UEL* screen, added 3 point, 4 point, and 5 point selections under *UEL Curve Type Selection.* • Improved the *Analysis, PF* screen.
1.03.04, 08/08	• System Options tab of System Configuration screen modified to show version levels for all three DECS-200N firmware types (main processor, DSP, and bridge processor).
1.03.00, 03/08	• Added Power Input Failure and Crowbar Active protection functions.
1.02.02, 01/08	• Added Windows® Vista compatibility.
1.02.01, 10/07	• Added SCL Initial Delay Setting.
1.01.00, 04/07	• Added limiter scaling capability by way of the auxiliary input. • Added secondary gain switching by a contact input. • Added null balance indication to programmable relay outputs.
1.00.05, 01/07	• Updated daylight saving time to new US dates and for worldwide use.
1.00.02, 08/06	• Protection selections and annunciations were modified to reflect expanded Power Input Failure protection implemented in firmware version 1.02.00.
1.00.01, 03/06	• Operating-power frequency range extended to 500 Hz and split into three ranges.
1.00.00, 07/05	• Initial release

Application Firmware Version and Date	Change
1.03.06, 09/09	• Set maximum setting for Generator Overvoltage to 30,000 on HMI. • Expanded UEL MW points.
1.03.04, 04/08	• Improved power input failure alarm.
1.03.03, 03/08	• Added Power Input Failure and Crowbar Active protection functions.
1.03.02, 11/07	• Minor improvements.
1.03.01, 10/07	• Added SCL Initial Delay setting.
1.03.00, 04/07	• Added limiter scaling capability by way of the auxiliary input. • Added secondary gain switching by a contact input. • Added null balance indication to programmable relay outputs. • Added primary/secondary active DECS indication (for redundant DECS applications). • Implemented new daylight saving time switching algorithm for the US in 2007.
1.02.00, 03/07	• Expanded "bridge input below 12 Hz" protection function to include the loss of one of three phases of bridge power. Detection of either condition results in a "Power Input Failure" annunciation.
1.01.03, 03/06	• Operating-power frequency range extended to 500 Hz and split into three ranges.
1.01.00, 07/05	• Modified to accommodate firmware loading during production.
1.00.00, 07/05	• Initial release

Hardware Version and Date	Change

Hardware Version and Date	Change
V, 05/11	• Improved contact input EMI immunity.
U, 09/10	• Replaced obsolete RAM chip.
T, 09/09	• Released firmware version 1.03.06 and BESTCOMS version 1.04.00.
S, 04/08	• Improved reliability of U62 and U63.
R, 03/08	• Released firmware version 1.03.03 and BESTCOMS version 1.03.00.
P, 01/08	• Release of BESTCOMS version 1.02.02.
N, 11/07	• Release of firmware version 1.03.02
M, 10/07	• Release of firmware version 1.03.01 and BESTCOMS 1.02.01.
L, 07/07	• Changed transformer T3 and relays K1 - K5. Raised F1 and F2 off board.
K, 04/07	• Release of firmware version 1.03.
J, 03/07	• Release of firmware version 1.02.
H, 01/07	• Release of BESTCOMS software version 1.00.05.
F, 04/06	• Firmware version 1.01 released for DECS-200N part numbers 9388800106 and 9388800107.
E, 01/06	• Operating-power frequency range extended to 500 Hz and split into three ranges.
D, 12/05	• Incorporated firmware version 1.01.
C, 11/05	• Implemented new Digital circuit board to ease loading of firmware during production.
B, 07/05	• Initial release

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SECTION 1 • GENERAL INFORMATION

INTRODUCTION

The DECS-200N Negative Forcing, Digital Excitation Control System is a microprocessor-based control device intended for generator power management. Programmability of system parameters and regulation settings enables the DECS-200N to be used in a wide variety of applications. The DECS-200N regulates the output voltage of a synchronous ac generator by controlling the current supplied to the generator exciter field. The DECS-200N output has a six-SCR (silicon controlled rectifier or thyristor) power stage that can supply up to 20 Adc of field current continuously and 40 Adc of forcing current for 10 seconds. The full-inverting, negative forcing output can provide either positive or negative field forcing for optimal system performance.

FEATURES

DECS-200N systems 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)
- Voltage matching of the generator to the bus
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Autotracking between operating modes and a second, optional DECS-200N
- Automatic transfer to an optional, backup DECS-200N
- 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 preprogrammed stability selections and one set of user-programmable stability parameters
- Underfrequency compensation or volts per hertz ratio limiting
- Ten protection features
    - Field overvoltage
    - Field overcurrent
    - Generator overvoltage
    - Generator undervoltage
    - Loss of sensing voltage
    - Generator frequency below 10 hertz
    - Loss of field protection
    - Exciter diode monitor
    - Crowbar circuit
    - Power input failure: bridge frequency below 12 hertz or one of three bridge power phases lost
- Data logging and event recording

Inputs and Outputs

- Single- or three-phase rms generator voltage sensing
- Single-phase rms bus voltage sensing
- Single-phase generator current sensing (1 or 5 amperes, nominal)
- Cross-current compensation input (1 or 5 amperes, nominal)
- Accessory inputs ($\pm$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 control power inputs accommodate redundant power sources
- Full inverting, negative forcing, six-SCR output power stage rated at 20 Adc, continuous
- Seven output relays for system control or annunciation
    - Two fixed function output relays
    - Five user-programmable output relays

Human-Machine Interface (HMI)

- Front panel HMI includes pushbutton controls, LED indicators, and a backlit, liquid-crystal display (LCD)
- Windows®-based BESTCOMS software provides fast, simple DECS-200N setup and control
- Three communication ports
  - Front-panel RS-232 port for communication with a PC using BESTCOMS software
  - Right-side panel RS-232 port for dedicated communication with an optional, redundant DECS 200N
  - RS-485 port for communication with a remote terminal using Modbus® protocol

APPLICATION

In the typical application shown in Figure 1-1, the DECS-200N controls the exciter field of a synchronous generator. Front panel controls and indicators make the system easy to operate locally; serial communication ports enable system operation from remote locations. The DECS-200N setup, operation, and safety information presented in this manual should be read and understood before implementing your application. For detailed application assistance, contact the Basler Electric Technical Sales Support department or your local sales representative.
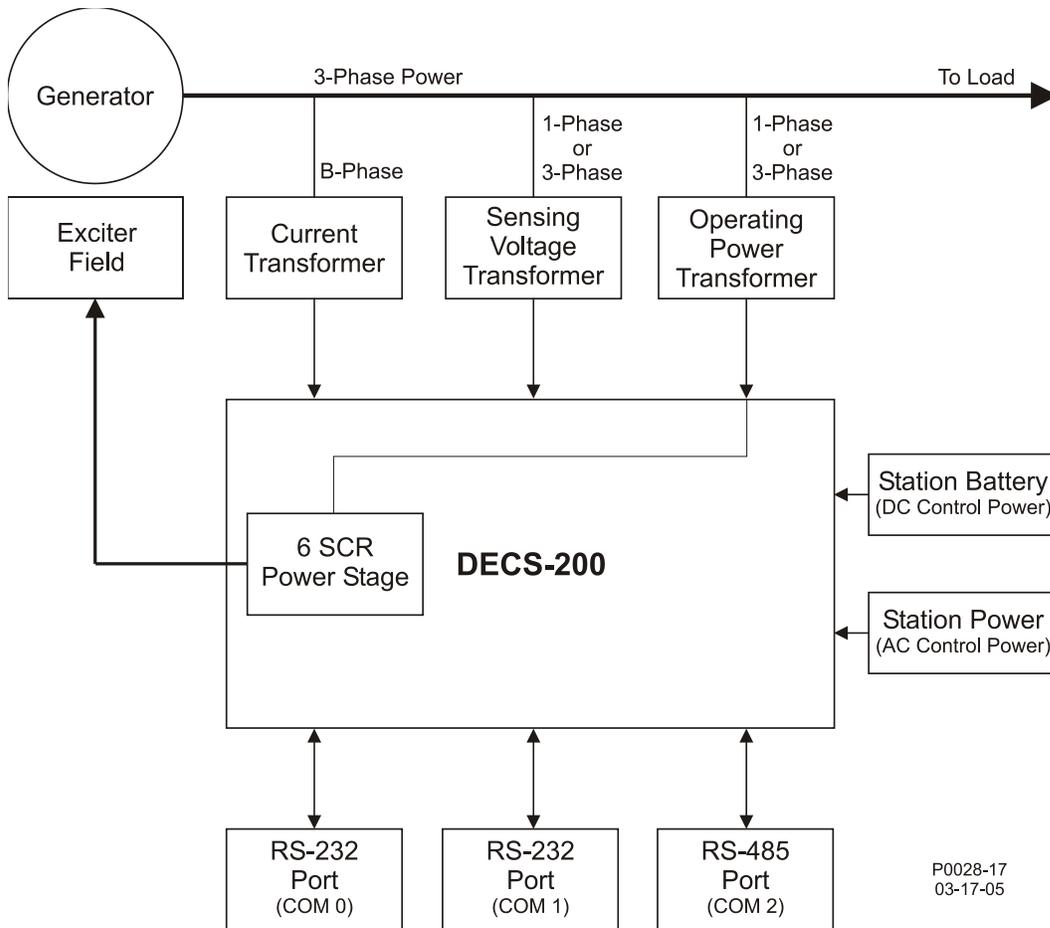
Figure 1-1. Block Diagram of Typical DECS-200N Application

Control Power

A dc control power input and an ac control power input enable a redundant control power source to be used with the DECS-200N. A DECS-200N with style number CX accepts control power inputs of 125 Vdc and 120 Vac. A DECS-200N with style number LX accepts control power inputs of 24 Vdc and 24 Vac or 48 Vdc and 24 Vac.

Operating Power

Operating power for the full inverting, negative forcing, six SCR power stage is typically obtained from the generator output through a power transformer. Alternately, operating power can be supplied from a permanent magnet generator (PMG).

Sensing

The DECS-200N senses generator and bus voltage through external voltage transformers. Generator current is sensed through an external current transformer. An additional current sensing input is available for cross-current compensation (reactive differential) applications. Field voltage and field current levels are sensed internally.

Limiters

Integrated overexcitation and underexcitation limiters (OEL and UEL) are available. The OEL provides both on-line and off-line protection. A volts per hertz ratio limiter and stator current limiter are also available.

Internal Tracking Between DECS-200N Operating Modes

In applications using a single DECS-200N, the DECS-200N 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-200N 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-200N in backup mode, the internal tracking feature allows a transfer to an inactive mode that will result in no disturbance to the system.

External Tracking and Transfer Between DECS-200N Units

For critical applications, a second DECS-200N can provide backup, excitation control. The DECS-200N allows for excitation redundancy by providing external tracking and transfer provisions between DECS-200N units. The secondary DECS-200N operating modes can be programmed to track the primary DECS-200N 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.

Communication with a PC

BESTCOMS software enables communication between a PC and the DECS-200N (front panel RS-232 port). BESTCOMS simplifies 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. BESTCOMS is provided with the DECS-200N as part of the instruction manual/software package.

Resistor Module

In brushless-excited, synchronous generator applications, the presence of ripple currents/voltages in the exciter field is a normal phenomenon. In most cases, the voltage developed is small and of no consequence. The main factor contributing to field voltage transients is the construction of the machine being controlled. On some machines the voltage transients can be large enough to trigger the DECS-200N's crowbar circuit and cause nuisance tripping. The resistor module (P/N 9388816100) supplied with the DECS-200N suppresses these voltage transients and is recommended for use in all DECS-200N installations. The resistor module connects across the DECS-200N field output and provides a high-impedance path for the ripple current to flow. This dissipates the level of voltage on the field and greatly reduces the possibility of nuisance crowbar trips.

For information on mounting and connections of the resistor module, refer to Section 4, *Installation.*

MODEL AND STYLE NUMBER

DECS-200N electrical characteristics and operational features are defined by a combination of letters and numbers that make up the style number. The model number, together with the style number, describes the options included in a specific device and appears on a label affixed to the rear panel.

Style Number

The style number identification chart in Figure 1-2 defines the electrical characteristics and operational features available in the DECS-200N.
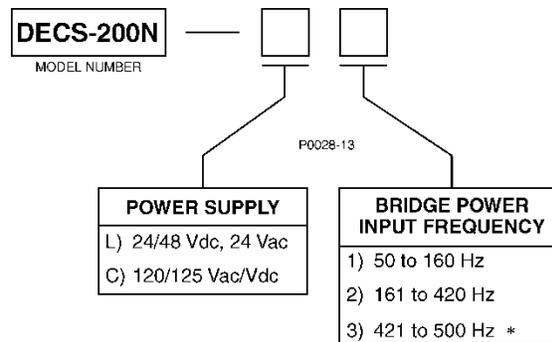
Figure 1-2. DECS-200N Style Chart

SPECIFICATIONS

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

Control Power

DC Input

Nominal Voltage:	24/48 Vdc (style LX) or 125 Vdc (style CX)
Voltage Range:	18 to 60 Vdc (style LX) or 90 to 150 Vdc (style CX)
Burden:	30 W maximum
Terminals:	B13 (BAT–), B14 (BAT+)

AC Input

Isolation transformer for ac input is required when dual control power sources are used.

Nominal Voltage:	24 Vac (style LX) or 120 Vac (style CX)
Voltage Range:	20 to 40 Vac (style LX) or 82 to 132 Vac (style CX)
Frequency:	50/60 Hz
Burden:	40 VA maximum
Terminals:	B11 (N), B12 (L)

Operating Power

Configuration:	1-phase or 3-phase
Voltage Range:	80 to 277 Vac ∗
Frequency Range	
Style X1:	50 to 160 Hz
Style X2:	161 to 420 Hz
Style X3:	421 to 500 Hz †
Terminals:	C5 (A), C6 (B), C7 (C)

Table 1-1. Operating Power Requirements

Parameter	For 63 Vdc Continuous Applications		For 125 Vdc Continuous Applications	
Input Power Configuration ‡	1-Phase	3-Phase	1-Phase	3-Phase
Nominal Input Voltage	208 Vac	120 Vac		240 Vac
Minimum Residual Voltage for Buildup	24 Vac	12 Vac	Not Recommended	24 Vac
Operating Power Input Burden at 20 Adc Excitation Output	4,160 VA	3,400 VA		6,800 VA

∗ To achieve the proper bridge output, the appropriate operating power input voltage must be applied. Table 1-1 lists the required nominal operating power voltage and configuration required to obtain 63 Vdc or 125 Vdc continuous field power.

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† Controllers with an operating power frequency range of 421 to 500 Hz have a minimum operating temperature of 0°C (32°F).

‡ Refer to Section 3, *Functional Description, Protection Functions, Exciter Diode Monitor (EDM)* for information about determining the operating power configuration when applied to brushless generators.

Generator Voltage Sensing

Type:	1-phase or 3-phase, four automatically selected ranges
Burden:	<1 VA per phase
Terminals:	A1 (E1), A2 (E2), A3 (E3)

50 Hz 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 Hz Sensing

Range 1:	120 Vac (94 to 153 Vac)
Range 2:	240 Vac (187 to 305 Vac)
Range 3:	480 Vac (374 to 600 Vac)
Range 4:	600 Vac (510 to 660 Vac)

Generator Current Sensing

Ranges:	1 Aac, 5 Aac nominal
Inputs:	B-phase, cross-current compensation
Frequency:	50/60 Hz
Burden:	<1 VA

1 Aac Sensing

Maximum Continuous Rating:	2 Aac
Terminals	
B-Phase Sensing:	B4 (CT B 1 AMP), B6 (CT B COM)
Cross-Current Comp.:	B1 (CT CC 1 AMP), B3 (CT CC COM)

5 Aac Sensing

Maximum Continuous Rating:	10 Aac
Terminals	
B-Phase Sensing:	B5 (CT B 5 AMP), B6 (CT B COM)
Cross-Current Comp.:	B2 (CT CC 5 AMP), B3 (CT CC COM)

Bus Voltage Sensing

Type:	1-phase (A–C), four automatically selected ranges
Ranges:	Identical to generator voltage sensing
Burden:	<1 VA
Terminals:	A4 (B1), A5 (B3)

Accessory Inputs

Current Input

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

Voltage Input

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

Contact Inputs

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

Start:	A22, A23	Pre-Position:	A34, A35
Stop:	A24, A25	Unit/Parallel (52L/M):	A36, A37
Auto (AVR):	A26, A27	Var/PF (52J/K):	A38, A39
Manual (FCR):	A28, A29	Secondary Enable:	A40, A41
Raise:	A30, A31	Alarm Reset:	A42, A43
Lower:	A32, A33		

Communication Ports

COM 0

Type:	RS-232, full duplex
Interface:	DB-9 connector
Location:	Front panel

COM 1

Type:	RS-232, full duplex
Interface:	DB-9 connector
Location:	Right-side panel

COM 2

Type:	RS-485, half-duplex
Interface:	Screw terminals
Location:	Left-side panel
Terminals:	A44 (A), A45 (B), A46 (C)

Communication Parameters

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

Contact Outputs

Start/Stop, Watchdog, Relays 1, 2, 3, 4, and 5

Make and Break Ratings (Resistive)
24 Vdc:	7.0 Adc
48 Vdc:	0.7 Adc
125 Vdc:	0.2 Adc
120/240 Vac:	7.0 Aac

Carry Ratings (Resistive)
24/48/125 Vdc:	7.0 Adc
120/240 Vac:	7.0 Aac

Terminal Assignments
Start/Stop:	A11, A12 (ON/OF)
Watchdog:	A13 (WTCH1 (NC)), A14 (WTCH (COM)), A15 (WTCH2 (NO))
Relay 1:	A16, A17 (RLY1)
Relay 2:	A18, A19 (RLY2)
Relay 3:	A20, A21 (RLY3)
Relay 4:	B9, B10 (RLY4)
Relay 5:	B7, B8 (RLY5)

Field Output

Terminals:	C1 (F–), C2 (F+)

Table 1-2 lists the field output capabilities of the DECS-200N. In order to achieve the listed forcing capabilities, the proper, nominal input voltage must be applied to the DECS-200N operating power terminals (in the appropriate configuration). The impedance of the operating power source may affect the levels of the positive and negative forcing voltage. The forcing values listed assume a source impedance of 10%.

Table 1-2. Field Output Ratings

Parameter	For 63 Vdc Continuous Applications		For 125 Vdc Continuous Applications	
Input Power Configuration	1-Phase	3-Phase	1-Phase	3-Phase
Nominal Input Voltage	208 Vac	120 Vac		240 Vac
Full-Load Continuous Excitation Voltage	63 Vdc	63 Vdc		125 Vdc
Full-Load Continuous Excitation Current	20 Adc	20 Adc	Not Recommended	20 Adc
Maximum Positive Forcing Voltage	130 Vdc	120 Vdc		240 Vdc
Max. Negative Forcing Voltage	−105 Vdc	−100 Vdc		−200 Vdc
Maximum Forcing Current	40 Adc	40 Adc		40 Adc
Minimum Field Resistance	3.15 Ω	3.15 Ω		6.25 Ω

Regulation

AVR Operating Mode

Setpoint Range: 70 to 110% of rated generator voltage

Regulation Accuracy: ±0.25% over load range at rated PF with constant generator frequency and ambient temperature

Steady-State Stability: ±0.25% over the load range at rated PF with constant generator frequency and ambient temperature

Temperature Drift: ±0.5% between 0 and 50°C at constant load and generator frequency

FCR Operating Mode

Setpoint Range: 0 to 20 Adc

Regulation Accuracy: ±1.0% of the nominal value for 10% of the power input voltage change or 20% of the field resistance change. Otherwise, ±5.0%.

Var Operating Mode

Setpoint Range: −100% (leading) to +100% (lagging) of the generator nominal apparent power

Regulation Accuracy: ±2.0% of the nominal generator apparent power rating at the rated generator frequency

Power Factor Operating Mode

Setpoint Range: 0.5 to 1.0 (lagging) and −0.5 to −1.0 (leading)

Regulation Accuracy: ±0.02 PF of the PF setpoint for the real power between 10 and 100% at the rated frequency

Parallel Compensation

Modes: Reactive Droop, Line Drop, and Reactive Differential (Cross-Current) ∗

Burden∗: Can exceed 1 VA if external resistors are added to the CT circuit for cross-current compensation.

Setpoint Range

Reactive Droop: 0 to 30%

Line Drop: 0 to −30%

Generator Overvoltage Protection

Pickup

Range: 0 to 30,000 Vac

Increment: 1 Vac

Time Delay

Range: 0.1 to 60 s

Increment: 0.1 s

Generator Undervoltage Protection

Pickup

Range:	0 to 30,000 Vac
Increment:	1 Vac

Time Delay

Range:	0.5 to 60 s
Increment:	0.1 s

Exciter Field Overvoltage

Pickup

Range:	1 to 325 Vdc
Increment:	1 Vdc

Time Delay

Range:	0.2 to 30 s
Increment:	0.1 s

Exciter Field Overcurrent

Pickup

Range:	0.1 to 20 Adc
Increment:	0.1 Adc

Time Delay

Range:	0.1 to 20
Increment:	0.1

Exciter Diode Protection

Pole Ratio

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

Ripple Threshold

Open, Shorted Diode Range:	0 to 100%
Increment:	0.1%

Time Delay

Open Diode Range:	10 to 60 s
Shorted Diode Range:	5 to 30 s
Increment:	0.1 s

Open and Shorted Diode Inhibit Levels

Range:	0 to 100% or <1.5 Adc field current
	<45 Hz and >70 Hz generator frequency

For proper detection of an open diode on a brushless exciter, the following criteria must be met:

- The ratio between the number of generator poles and exciter poles should be between 1.5 and 10. (Pole Ratio = Number of Exciter Poles ÷ Number of Generator Poles)
- Three-phase operating power is required when input voltage is supplied from the generator output (shunt powered).

Loss of Field Protection

Pickup

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

Time Delay

Range:	0 to 9.9 s
Increment:	0.1 s

Loss of Sensing Protection

Pickup

Unbalanced Generator Voltage: 0 to 100%
Balanced Generator Voltage: 0 to 100%

Time Delay

Range: 0 to 30 s
Increment: 0.1 s

Soft Start Function

Bias Level

Range: 0 to 90%
Increment: 1%

Time Delay

Range: 1 to 7,200 s
Increment: 0.1 s

Field Flashing Function

Dropout Level

Range: 0 to 100%
Increment: 0.1%

Maximum Flashing Time

Range: 0 to 50 s
Increment: 0.1 s

Voltage Matching

Generator rms voltage is matched with the bus rms voltage to within ±0.5% of the generator voltage.

Voltage Matching Band

Range: 0 to 20% of nominal
Increment: 0.01%

Voltage Matching Level (Generator to Bus)

Range: 90 to 120%
Increment: 0.1%

On-Line Overexcitation Limiting

Response Time: <3 cycles

Summing Point Limiting

High Current Level
    Pickup Range: 0 to 40 Adc
    Pickup Increment: 0.1 Adc
    Time Range: 0 to 10 s
    Time Increment: 1 s
Medium Current Level
    Pickup Range: 0 to 30 Adc
    Pickup Increment: 0.1 Adc
    Time Range: 0 to 120 s
    Time Increment: 1 s
Low Current Level
    Pickup Range: 0 to 20 Adc
    Pickup Increment: 0.1 Adc
    Time Range: continuous

Takeover Style Limiting

High Current Level
    Pickup Range: 0 to 40 Adc
    Pickup Increment: 0.1 Adc
Low Current Level

Pickup Range:	0 to 20 Adc
Pickup Increment:	0.1 Adc
Time Dial	
Range:	0.1 to 20
Increment:	0.1

Off-Line Overexcitation Limiting

Response Time:	<3 cycles

Summing Point Limiting

High Current Level	
Pickup Range:	0 to 40 Adc
Pickup Increment:	0.1 Adc
Time Range:	0 to 10 s
Time Increment:	1 s
Low Current Level	
Pickup Range:	0 to 20 Adc
Pickup Increment:	0.1 Adc
Time Range:	continuous

Takeover Style Limiting

High Current Level	
Pickup Range:	0 to 40 Adc
Pickup Increment:	0.1 Adc
Low Current Level	
Pickup Range:	0 to 20 Adc
Pickup Increment:	0.1 Adc
Time Dial	
Range:	0.1 to 20
Increment:	0.1

Underexcitation Limiting

Adjustment Range:	0 to 100% of the generator rated apparent power (kvar) at 0 kW real power. UEL can be customized to generator curve capability.

Metering

Generator Voltage

Range:	0 to 160% of nominal
Accuracy (at 50/60 Hz):	<1% of nominal or metered voltage, whichever is greater

Generator Current

Range:	0 to 200% of nominal
Accuracy	<1% of nominal or metered current, whichever is greater

Generator Frequency

Range:	10 to 90 Hz
Accuracy:	±0.1 Hz

Bus Voltage

Range:	0 to 160% of nominal
Accuracy (at 50/60 Hz):	<1% of nominal or metered voltage, whichever is greater

Bus Frequency

Range:	10 to 90 Hz
Accuracy:	±0.1 Hz

Phase Angle

Range:	−90 to +90°
Accuracy:	±1.0°

Field Voltage

Range:	–375 to 375 Vdc
Accuracy:	±1.25 Vdc or ±1.0% of metered voltage, whichever is greater

Field Current

Range:	0 to 60 Adc
Accuracy:	±0.2 Adc or ±1.0% of metered voltage, whichever is greater

Power Factor

Range:	–0.5 to +0.5 (0.5 leading to 0.5 lagging)
Accuracy:	<0.02 PF

Real Power and Reactive Power

Range:	0 to 200% of nominal
Accuracy:	<1.0% of nominal or metered power, whichever is greater

Sequence of Event Recording (SER)

A 127 event report is stored in volatile memory and retrievable through BESTCOMS software. An SER can be triggered by input/output status changes, system operating status changes, or alarm annunciations.

Data Logging (Oscillography)

Up to 8 records, each record logging up to 6 variables, are stored in volatile memory. The sampling rate is 600 data points per log with up to 599 pre-trigger data points recorded at 4 millisecond to 10 second intervals (2.4 to 6,000 second total log duration).

Type Tests

Shock:	Withstands 15 G in three perpendicular planes
Vibration:	Withstands 5 G from 5 to 500 Hz
Humidity:	IEC 68-1, IEC 68-2-28
Salt Fog:	MIL-STD-810F, Method 509.4
Dielectric Strength:	IEEE 421.3

Physical

Weight:	14.0 lb (6.35 kg)
Dimensions:	Refer to Section 4, *Installation*

REGULATORY CERTIFICATION

cURus recognition per UL Standard 508, File E97035 and CSA Standard C22.2 No. 14

UL Certification

This product is covered under UL as a Recognized Component, covered for the USA and Canada under UL file E97035 (CCN FTPM2/FTPM8).

EU Compliance

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

EN 60068-2-6: Vibration (sinusoidal)
EN 55011: Electromagnetic Disturbance Characteristics
EN 61000-4-2: Electrostatic Discharge Immunity
EN 61000-4-3: Radiated Radio Frequency Immunity
EN 61000-4-4: Electrical Fast Transient/Burst Immunity
EN 61000-4-5: Surge Immunity
EN 61000-4-6: Conducted Radio Frequency Immunity
EN 61000-4-8: Power Frequency Magnetic Field Immunity
EN 61000-4-11: Voltage Dips and Interruption Immunity

Environment

Operating Temperature ∗
     All Styles Except X3:   −40 to 60°C (−40 to 140°F)
     Style X3 Only: 0 to 60°C (32 to 140°F)
Storage Temperature: −40 to 85°C (−40 to 185°F)

∗ Applies to altitudes up to 3,300 feet (1,006 meters). For every 1,000 feet (305 meters) above 3,300 feet, de-rate the maximum operating temperature by 2°C (3.6°F).

SECTION 2 • HUMAN-MACHINE INTERFACE

TABLE OF CONTENTS

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SECTION 2 • HUMAN-MACHINE INTERFACE

INTRODUCTION

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

FRONT PANEL

DECS-200N controls and indicators are illustrated in Figure 2-1 and described in Table 2-1. The locators and descriptions of Table 2-1 correspond to the locators shown in Figure 2-1.
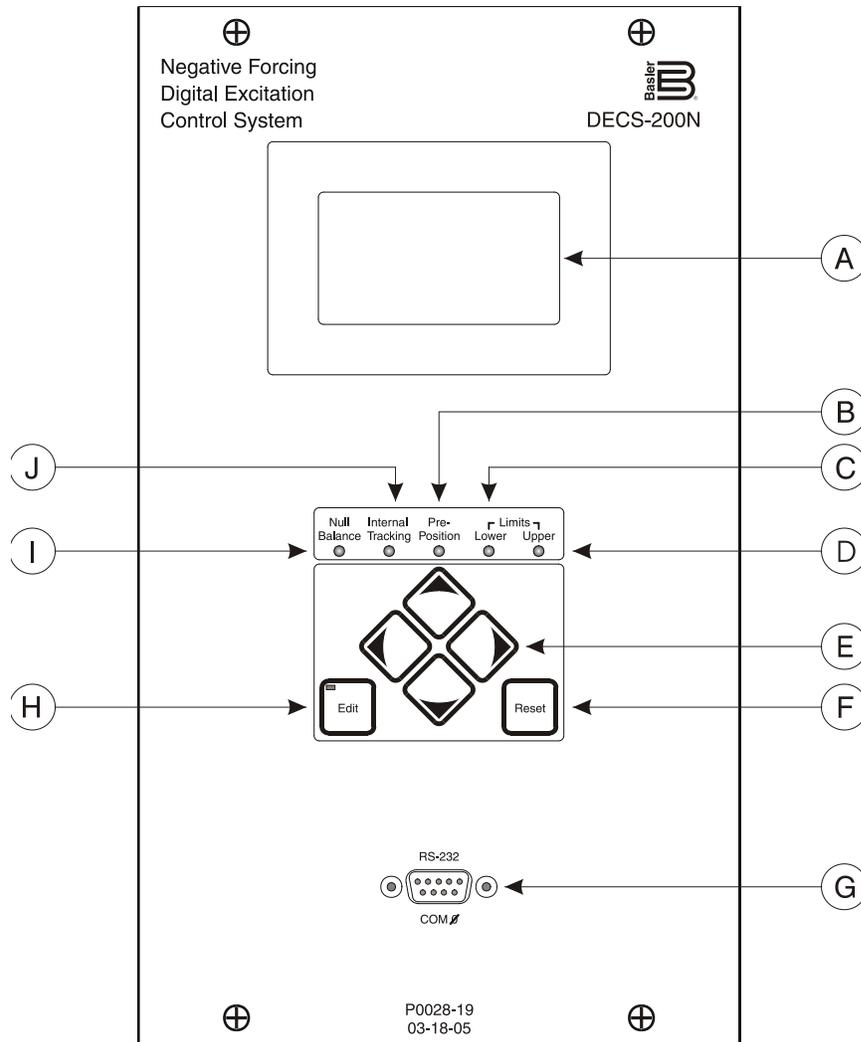
Figure 2-1. Front Panel HMI

Table 2-1. Front Panel HMI Descriptions

Locator	Description
A	*Display.* The display consists of a 128 by 64 pixel, liquid crystal display (LCD) with LED backlighting. It serves as a local source of information provided by the DECS-200N. The LCD displays operations, setpoints, loop gains, metering, protection functions, system parameters, and general settings.
B	Pre-Position LED. This LED lights when the active mode setpoint is at the pre-position (predefined) setting.

Locator	Description
C	*Lower Limit LED.* This LED lights when the active mode setpoint decreases to the minimum value.
D	*Upper Limit LED.* This LED lights when the active mode setpoint increases to the maximum value.
E	*Scrolling Pushbuttons.* These four buttons are used to scroll up, down, left, and right through the menu tree displayed on the front panel display (locator A). During an editing session, the left and right scrolling pushbuttons select the variable to be changed and the up and down scrolling pushbuttons change the value of the variable.
F	*Reset Pushbutton.* This button cancels editing sessions, resets alarm annunciations and latched alarm relays, and can be used for quick access to the metering screen.
G	*Communication Port.* This RS-232 port has a female DB-9 connector for local communication with a PC operating BESTCOMS software (supplied with the DECS-200N).
H	*Edit Pushbutton.* Pressing this button starts an editing session and enables changes to DECS-200N settings. When the Edit pushbutton is pressed to open an editing session, an LED on the button lights. At the conclusion of the editing session, the Edit pushbutton is pressed to save the setting changes and the LED turns off.
I	*Null Balance LED.* This LED lights when the setpoint of the inactive operating modes (AVR, FCR, var, or PF) matches the metered value.
J	*Internal Tracking LED.* This LED lights when any inactive mode (AVR, FCR, var, or PF) is tracking the setpoint of the active mode to achieve a "bumpless" transfer when changing active modes.

MENU SYSTEM

The front panel menu system consists of a network of screens that enable the user to edit DECS-200N settings and view system parameters.

Menu Navigation

Movement through the front panel menu system is achieved by pressing the four scrolling pushbuttons (locator E in Figure 2-1).

Navigation aids assist the user in moving from screen to screen and are provided at the top and bottom lines of each screen.

The top line of each screen contains the menu path which is similar to the file path on a PC. When the menu path exceeds the width of the LCD, the first part of the menu path is replaced with two periods (..) so that the last part of the path remains visible.

The bottom line indicates which menu screens can be accessed from the current screen by using the left, lower, or right scrolling pushbuttons. The screens accessed by the left, lower, and right scrolling push-buttons are indicated by a <, v, and > symbol followed by an abbreviated menu name.

The front panel Reset pushbutton (locator F in Figure 2-1) provides a shortcut to the metering screen when a settings editing session is not in progress.

Menu Structure

The front panel menu system has eight branches:

1. *Operating.* Start/stop, operating mode, pre-position setpoint status, and tracking status.
2. *Setpoints.* Mode setting values such as AVR, FCR, droop, var, and power factor.
3. *Loop Gains.* PID settings.
4. *Metering.* Real-time metering of user-selected values and alarm messages.
5. *Protection.* Protective function setting parameters.
6. *Limiters.* System limiters such as overexcitation, underexcitation, and stator current.
7. *System Parameters.* The system parameters menu consists of nine sub-menus:
   a. Generator Data

    b. Exciter Data

    c. Transformers

    d. Configuration

    e. Output Contacts

    f. Traverse Rates

    g. Pre-Position Modes

    h. Startup

    i. Tracking

8. *General Settings.* Communication port parameters, real-time clock setup, and LCD contrast.

From the DECS-200N title screen, the Operating menu branch is accessed first by pressing the down scrolling pushbutton. Then, the remaining branches are accessed by pressing the right or left push-buttons.

The menu system structure is illustrated in Figures 2-2 through 2-11. A letter at the upper, right corner of each screen indicates the security access level required to edit the screen's settings. G indicates global access, S indicates setpoint access, and N indicates that security access is not applicable.

Figure 2-2. Operating Modes Menu

To/From
\D200\OPERATING

To/From
\D200\GAIN_SCRN

```
IO
\DECS-200N

                                N
\DECS-200\SETPOINTS

    SETPOINTS

<OPER vMODES >GAIN
```

P0028-21
03/21/05

```
                              S
\D200\SETPT\MODE_SET
AVR MODE  =   120.0V
FCR MODE  =   0.100A
DROOP     =     5.0%
var MODE  =   0.000Vr
PF MODE   =   1.000


<PREPS vRANG1 >PREPS
```

```
                              S
\D200\SETPT\PREP_SET
AVR MODE  =   120.0V
FCR MODE  =   0.100A
var MODE  =   0.000Vr
PF MODE   =   1.000



<MODES         >MODES
```

```
                              G
..\MODES\RANGE_1
FINE V BD =   20.00%
AVR MIN   =    70.0%
AVR MAX   =   110.0%
FCR MIN   =     0.0%
FCR MAX   =   120.0%


<RANG2         >RANG2
```

```
                              G
..\MODES\RANGE_2
MIN VAR OUT=     0.0%
MAX VAR OUT=     0.0%
MAX LAG PF =   0.800
MAX LEAD PF= -0.800
V MATCH BD =  10.00%
V MATCH REF=  100.0%
<RANG1         >RANG1
```

Figure 2-3. Setpoints Menu

Figure 2-4. Loop Gains Menu

Figure 2-5. Metering Menu

\DECS-200\PROTECT
PROTECTION
<METER vUF >LIMIT
N
Io
\DECS-200N
To/From \D200\METERING
To/From \D200\LIMITERS

\D200\PROT\UNDERFREQ
CORNR FREQ = 57.0Hz
UF SLOPE = 1.00PU
<TIMR2 >PREN1
G

..\PROT\PROT_ENABL1
FIELD OV = OFF
FIELD OC = OFF
STATOR OV = OFF
STATOR UV = OFF
NO SENSING = OFF
NO SNS->FCR= OFF
<UF >PREN2
G

..\PROT\PROT_ENAB2
EX DIOD OD = OFF
EX DIOD SD = OFF
LOSS FIELD = OFF
POWER FAIL =SHUTDWN
CROWBAR =SHUTDWN
<PREN1 >PRLV1
G

\D200\PROT\PROT_LEVL1
FIELD OV = 20V
FIELD OC = 0.1A
STATOR OV = 150V
STATOR UV = 90V
EDM OD RIPL= 5.0%
EDM SD RIPL= 5.0%
<PREN2 >PRLV2
G

\D200\PROT\PROT_LEVL2
EDM INH LVL= 10.0%
LOS BAL V = 50.0%
LOS IMBAL V= 20.0%
LOSS FIELD =50.00kvr
<PRLV1 >TIMR1
G

\D200\PROT\PROT_TIMR1
FIELD OV = 5.0S
FIELD OC TD= 1.0
STATOR OV = 5.0S
STATOR UV = 5.0S
NO SENSING = 2.0S
EX DIOD OD = 10.0S
<PRLV2 >TIMR2
G

\D200\PROT\PROT_TIMR2
EX DIOD SD = 5.0S
LOSS FIELD = 9.9S
<TIMR1 >UF
G

Figure 2-6. Protection Menu
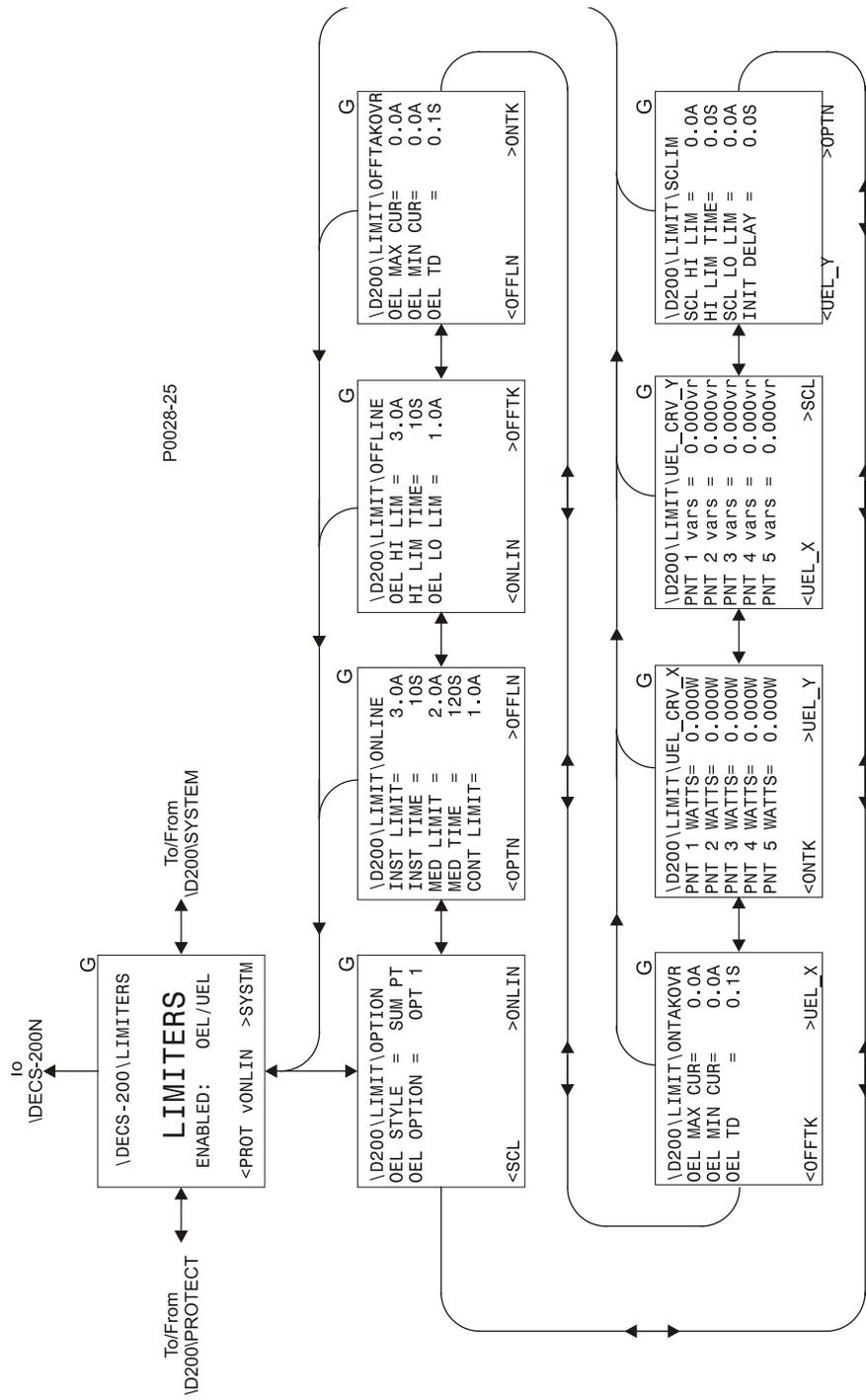
Figure 2-7. Limiters Menu

Figure 2-8. System Parameters Menu - Part 1 of 4

\D200\SYSTM\CONTACTS

OUTPUT CONTACTS

N

<CONFG   vRELY1 >TRVRS

To
\D200\SYSTEM

To/From
\D200\SYSTM\CONFIGURE

To/From
..\SYSTM\TRVRS_HEAD

To/From
..\CNTCT\RELAY_5C

```
..\CNTCT\RELAY_1           G
OUTPT SENSE=   NO
OUTPUT TYPE= MAINTN
MOMENT TIME=  0.10S
FIELD O/V  =    OFF
FIELD O/C  =    OFF
STATOR U/V =    OFF
<REL5C        >REL1A
```

```
..\CNTCT\RELAY_1A          G
STATOR O/V =   OFF
UNDER FREQ =   OFF
IN OEL     =   OFF
IN UEL     =   OFF
IN FCR MODE=   OFF
NO V SENSE =   OFF
<RELY1        >REL1B
```

```
..\CNTCT\RELAY_1B          G
AT LO LIMIT=   OFF
AT HI LIMIT=   OFF
SENSE <10Hz=   OFF
EXC DIOD OD=   OFF
EXC DIOD SD=   OFF
LOSS FIELD =   OFF
<RELY1A       >REL1C
```

```
..\CNTCT\RELAY_1C          G
IN SCL     =   OFF
BLD UP FAIL=   OFF
BUILD UP   =   OFF
PWR IN FAIL=   OFF
CROWBAR    =   OFF
NULL BALNCE=   OFF
<REL1B        >RELY2
```

```
..\CNTCT\RELAY_2           G
OUTPT SENSE=   NO
OUTPUT TYPE= MAINTN
MOMENT TIME=  0.10S
FIELD O/V  =    OFF
FIELD O/C  =    OFF
STATOR U/V =    OFF
<RELY1C       >REL2A
```

```
..\CNTCT\RELAY_2A          G
STATOR O/V =   OFF
UNDER FREQ =   OFF
IN OEL     =   OFF
IN UEL     =   OFF
IN FCR MODE=   OFF
NO V SENSE =   OFF
<RELY2        >REL2B
```

```
..\CNTCT\RELAY_2B          G
AT LO LIMIT =  OFF
AT HI LIMIT =  OFF
SENSE <10Hz =  OFF
EXC DIOD OD =  OFF
EXC DIOD SD =  OFF
LOSS FIELD  =  OFF
<REL2A        >REL2C
```

```
..\CNTCT\RELAY_2C          G
IN SCL     =   OFF
BLD UP FAIL=   OFF
BUILD UP   =   OFF
PWR IN FAIL=   OFF
CROWBAR    =   OFF
NULL BALNCE=   OFF
<REL2B        >RELY3
```

```
..\CNTCT\RELAY_3           G
OUTPT SENSE=   NO
OUTPUT TYPE= MAINTN
MOMENT TIME=  0.10S
FIELD O/V  =    OFF
FIELD O/C  =    OFF
STATOR U/V =    OFF
<REL2C        >REL3A
```

```
..\CNTCT\RELAY_3A          G
STATOR O/V =   OFF
UNDER FREQ =   OFF
IN OEL     =   OFF
IN UEL     =   OFF
IN FCR MODE =  OFF
NO V SENSE =   OFF
<RELY3        >REL3B
```

```
..\CNTCT\RELAY_3B          G
AT LO LIMIT=   OFF
AT HI LIMIT=   OFF
SENSE <10Hz=   OFF
EXC DIOD OD=   OFF
EXC DIOD SD=   OFF
LOSS FIELD =   OFF
<RELY3A       >REL3C
```

```
..\CNTCT\RELAY_3C          G
IN SCL     =   OFF
BLD UP FAIL =  OFF
BUILD UP   =   OFF
PWR IN FAIL =  OFF
CROWBAR    =   OFF
NULL BALNCE=   OFF
<REL3B        >RELY4
```

To/From
..\CNTCT\RELAY_4

P0030-02

Figure 2-9. System Parameters Menu - Part 2 of 4

Figure 2-10. System Parameters Menu - Part 3 of 4

Figure 2-11. System Parameters Menu - Part 4 of 4

```
              IO
           \DECS-200N
               ↑
                            N
        \D200\SETUP

            GENERAL
   To/From  SETTINGS  To/From                    P0030-05
\D200\SYSTEM ↔       ↔ \D200\OPERATING            03/21/05

        <OPER vMODES >GAIN


           N                        S                        G
  \D200\SETUP\COMMS        \D200\SETUP\CONTRAST      \D200\SETUP\CLOCK


  COMMUNICATIONS          LCD CONTRAST 60           TIME: XX:XX:XXX 12Hr
                                                    DATE: XX-XX-XX d-m-y


  <RTC    vBAUD  >LCD     <COMMS       >COMMS        <COMMS   vFMT  >COMMS



           G                        G                        G
  ..\COMMS\BAUD RATE       ..\COMMS\MODBUS           ..\RTC\CLK_FORMAT
  COM0 RS232 = 19200       COM2 ADDR  =    247       TIME FORMAT:  12Hr
  COM1 RS232 = 19200       COM2 DELAY =   10mS       DST  FORMAT:  DS On
  COM2 RS485 = 19200       PARITY     =   NONE       DATE FORMAT:  d-m-y
                           STOP BITS  =      2


  <MODBS       >MODBS      <BAUD        >BAUD
```
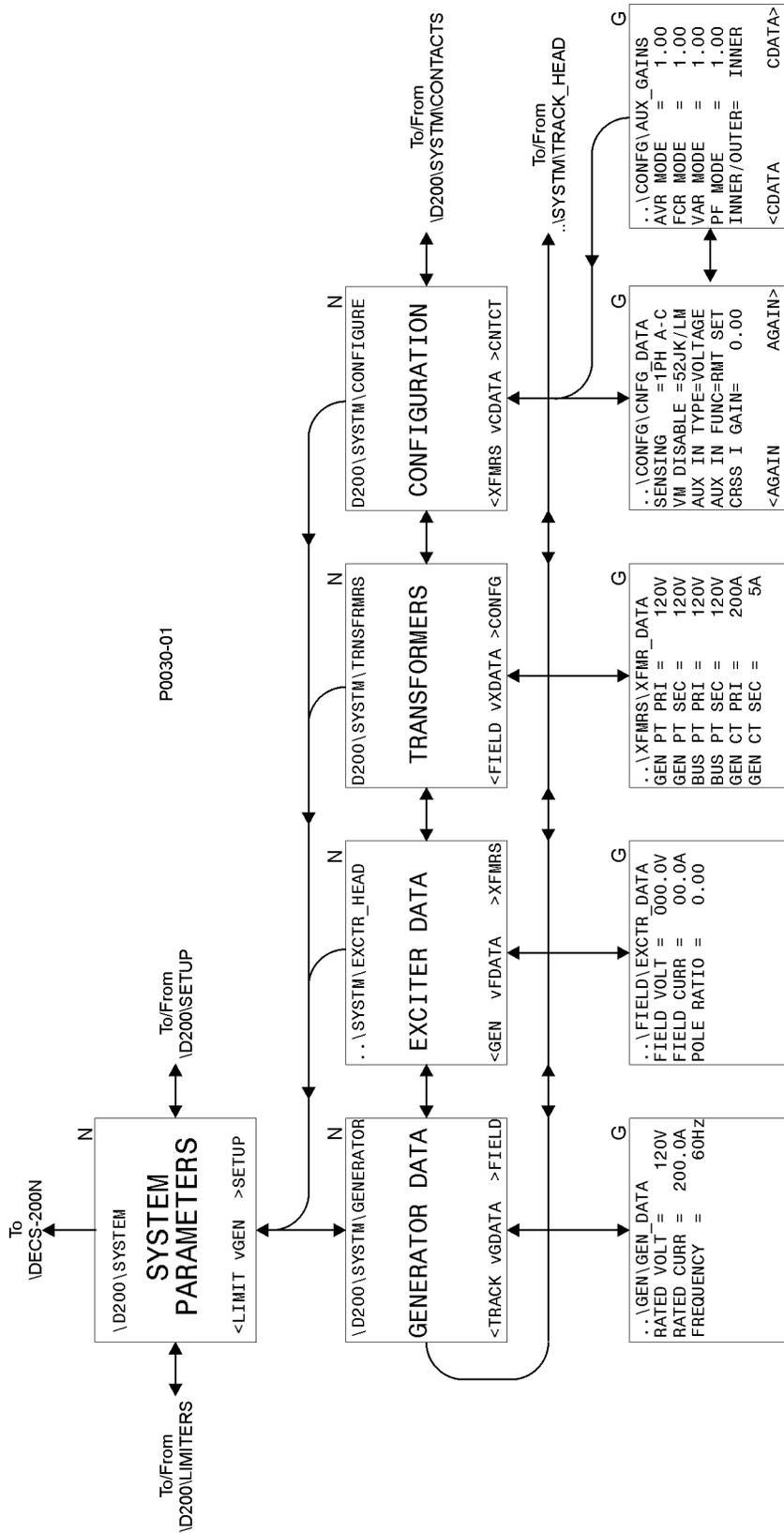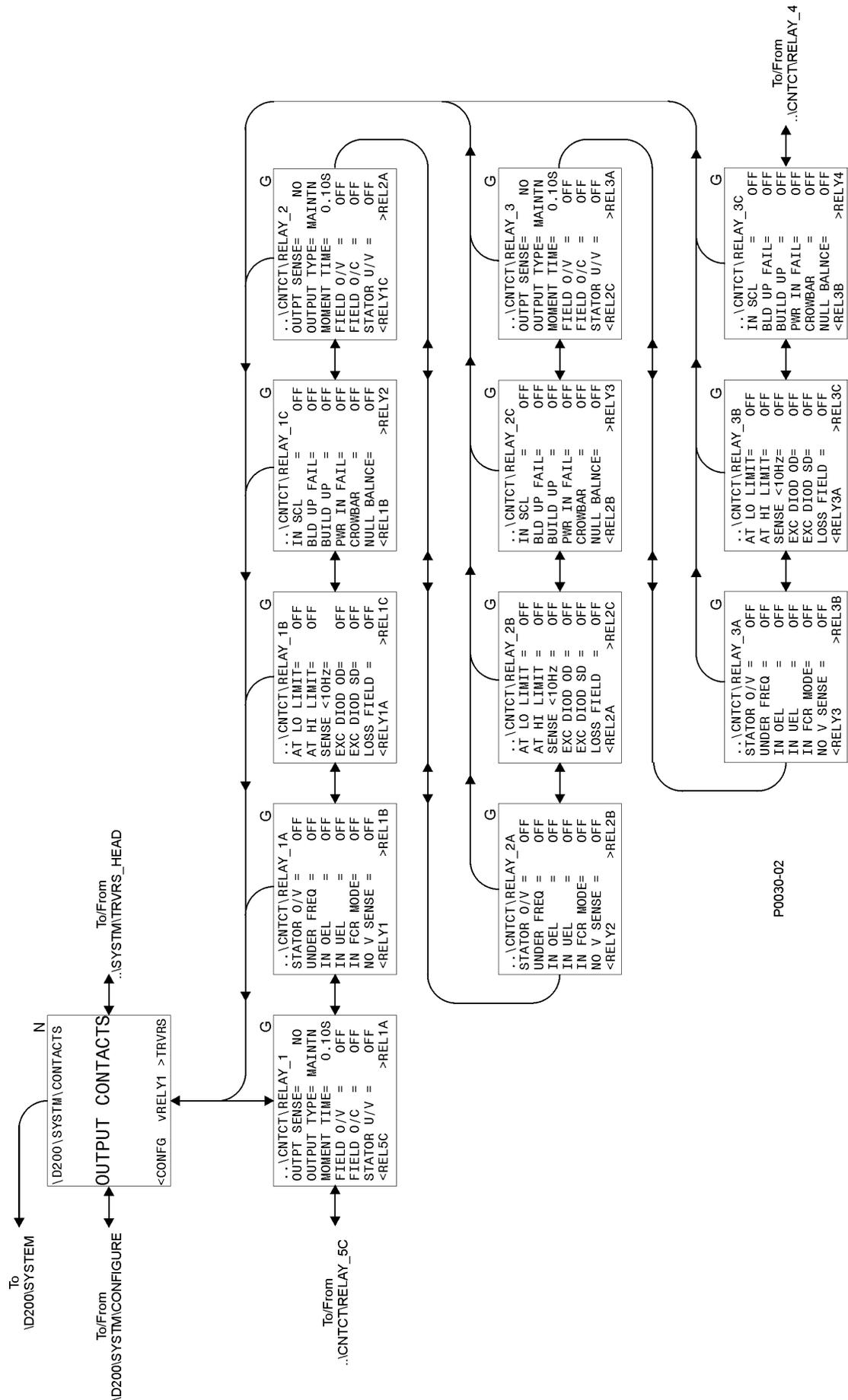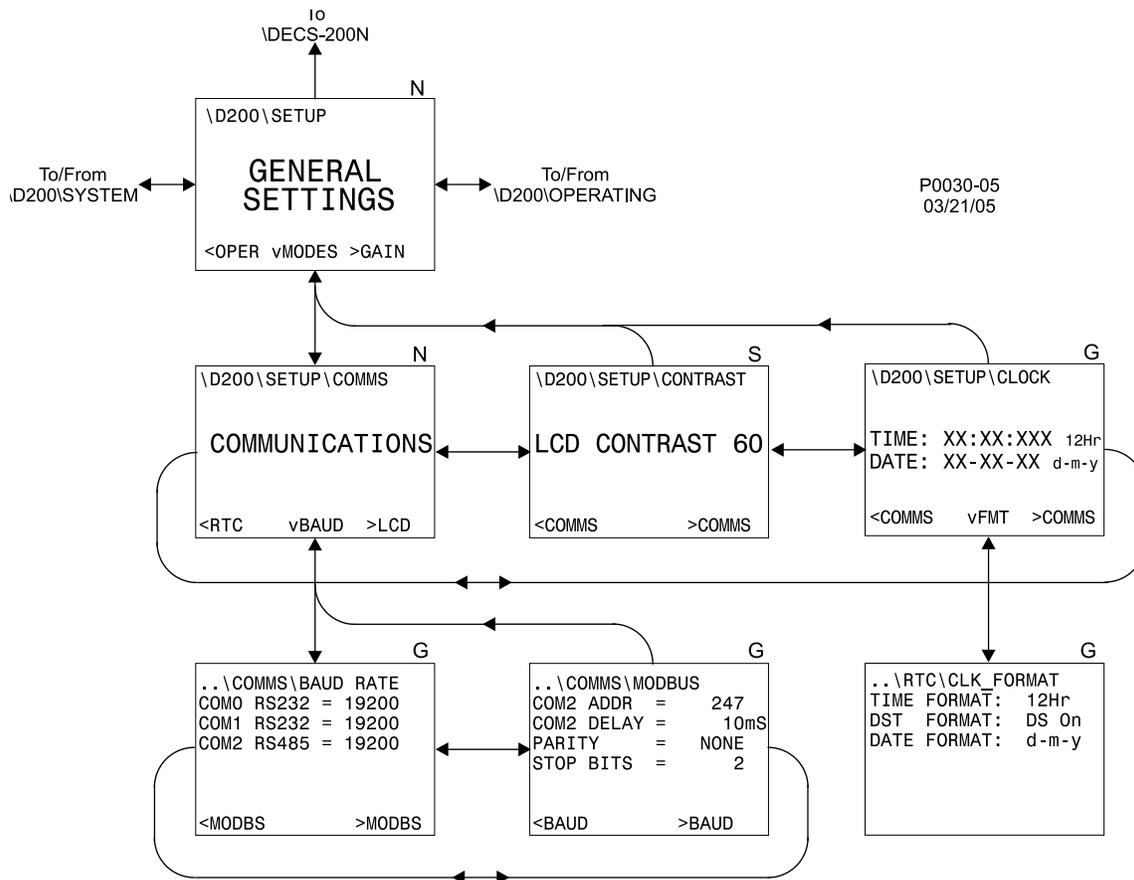
Figure 2-12. General Settings Menu

Setting Definitions

The following paragraphs describe the settings and adjustments available through the front panel menu system. Parameters are organized by setting screen. Screens that contain no adjustable parameters are not listed.

\D200\OPER\OPERATE_1

START/STOP: enables and disables DECS-200N excitation control

AVR OR FCR: selects the regulation mode. AVR for automatic voltage regulation or FCR for field current regulation (Manual mode)

PF OR VAR: selects the control mode. OFF for non, VAR for var control, or PF for power factor control

LOAD COMP: selects the load compensation type. OFF to disable, ON to enable

PREPOSITION: enables and disables the pre-position function. OFF to disable, ON to enable

\D200\OPER\OPERATE_2

VOLT MATCH: enables and disables voltage matching

INT TRACK: enables and disables internal tracking between DECS-200N modes

EXT TRACK: enables and disables external tracking between two DECS-200N units

UF OR V/Hz: selects either underfrequency or volts per hertz limiting

\D200\SETPT\MODE_SET

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

FCR MODE: the field current regulation setpoint in amperes

DROOP: the amount of voltage droop, expressed as a percentage of rated generator voltage when the kvar load numerically equals the rated kW

var MODE: the var controller regulation setpoint in vars

PF MODE: the power factor controller regulation setpoint

FINE V BD: the adjustable voltage band (var volt band) around the generator output voltage. Expressed as a percentage of rated generator voltage when the var/PF mode is active.

AVR MIN: the minimum automatic voltage regulation setpoint. Expressed as a percentage of the rated generator voltage.

AVR MAX: the maximum automatic voltage regulation setpoint. Expressed as a percentage of the rated generator voltage.

FCR MIN: the minimum field current regulation setpoint. Expressed as a percentage of the rated field current.

FCR MAX: the maximum field current regulation setpoint. Expressed as a percentage of the rated field current.

\D200\SETPT\PREP_SET

The current 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 regulation setpoint pre-position value

var MODE: the var controller setpoint pre-position value

PF MODE: the power factor setpoint pre-position value

..\MODES\RANGE_2

MIN VAR OUT: the minimum generated var setpoint expressed as a numerical percentage of rated generator kW (negative for absorbing)

MAX VAR OUT: the maximum generated var setpoint expressed as a numerical percentage 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: voltage matching band. Allows the voltage matching function to activate if the bus voltage is within this band. This setting is a numerical percentage of rated generator voltage (Gen to Bus).

V MATCH REF: generator to bus PT matching level. Expressed as a percentage of the bus voltage.

\D200\GAIN\REG_GAIN1

PRI STB RNG: the index number into the internally defined PID table for the primary gain settings group. Table 2-2 lists the automatic, predefined stability gain settings for the exciter field and the 20 stability settings.

AVR/FCR Kp: proportional gain coefficient used in the AVR/FCR loop for the primary gain settings group

AVR/FCR Ki: integral gain coefficient used in the AVR/FCR loop for the primary gain settings group

AVR/FCR Kd: derivative gain coefficient used in the AVR/FCR loop for the primary gain settings group

AVR/FCR Td: derivative time constant used in AVR/FCR loop for the primary gain settings group

\D200\GAIN\REG_GAIN2

AVR Kg: loop gain used in AVR mode for the primary gain settings group

FCR Kg: loop gain used in FCR mode

\D200\GAIN\LIM_GAINS

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

Table 2-2. Automatic Stability Range Gain Settings Index

Excitation Mode	Setting	Generator Open Circuit Time Constant (T'_{do})	Generator Exciter Time Constant (T_{exc})	Kp	Ki	Kd
Exciter Field	1	1.0	0.17	42.2	115.2	4.433
	2	1.5	0.25	66.5	150.0	8.750
	3	2.0	0.33	87.16	167.9	13.670
	4	2.5	0.42	104.5	175.8	18.960
	5	3.0	0.50	119.0	177.8	24.50
	6	3.5	0.58	131.3	176.4	30.220
	7	4.0	0.67	141.8	173.1	36.060
	8	4.5	0.75	150.9	168.8	42.000
	9	5.0	0.83	158.8	163.9	48.010
	10	5.5	0.92	165.7	158.7	54.080
	11	6.0	1.00	171.8	153.6	60.200
	12	6.5	1.08	177.2	148.5	66.350
	13	7.0	1.17	182.1	143.6	72.540
	14	7.5	1.25	186.5	138.9	78.750
	15	8.0	1.33	190.5	134.4	84.980
	16	8.5	1.42	194.1	130.1	91.230
	17	9.0	1.50	197.4	125.9	97.500
	18	9.5	1.58	200.4	122.1	103.800
	19	10.0	1.67	203.2	118.4	110.100
	20	10.5	1.75	205.7	114.8	116.400

\D200\GAIN\CTL_GAINS

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.

\D200\GAIN\2ND_GAINS

SEC STB RNG: the index number into the internally defined PID table for the secondary gain settings group. Table 2-2 lists the automatic, predefined stability gain settings for the exciter field and the 20 stability settings.

AVR/FCR Kp: proportional gain coefficient used in the AVR/FCR loop for the secondary gain settings group

AVR/FCR Ki: integral gain coefficient used in the AVR/FCR loop for the secondary gain settings group

AVR/FCR Kd: derivative gain coefficient used in the AVR/FCR loop for the secondary gain settings group

AVR/FCR Td: derivative time constant used in AVR/FCR loop for the secondary gain settings group

\D200\METER\ADJUST

1st, 2nd, and 3rd Metering Fields: each field can be configured by the user to display any one of several metering quantities See Table 2-3 for list of available metering quantities.

\D200\PROT\UNDERFREQ

CORNR FREQ: the corner frequency for the underfrequency curve

UF SLOPE: the slope of the underfrequency curve

..\PROT\PROT_ENABLE1

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: enables/disables a transfer to FCR mode when a loss of voltage sensing is detected. Loss of voltage sensing detection must also be enabled for this feature to work.

..\PROT\PROT_ENAB2

EX DIOD OD: enables and disables open exciter diode detection

EX DIOD SD: enables and disables shorted exciter diode detection

LOSS FIELD: enables and disables loss of field protection

POWER FAIL: configures a loss of operating (bridge) power to trigger only an alarm or both an alarm and shutdown of the excitation output

CROWBAR: configures the activation of the crowbar to trigger only an alarm or both an alarm and shutdown of the excitation output

\D200\PROT\PROT_LEVEL1

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

\D200\PROT\PROT_LEVL2

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

\D200\PROT\PROT_TIMR1

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: open exciter diode detection time delay

\D200\PROT\PROT_TIMR2

EX DIOD SD: shorted exciter diode detection time delay

LOSS FIELD: loss of field time delay

\D200\LIMIT\OPTION

On-line overexcitation limiter style and options.

OEL STYLE: selects summing point or takeover style overexcitation limiter

CNTCT OPTION: assigns the functionality of the 52JK and 52LM contact inputs with respect to enabling var/PF control, load compensation (droop), on-line OEL, and secondary gain (PID) settings:

> OPT 1: JK opens to enable var/PF; LM opens to enable droop; JK or LM opens to enable on-line OEL

> OPT 2: JK opens to enable var/PF and on-line OEL; LM opens to enable droop

> OPT 3: JK opens to enable var/PF; LM opens to enable droop; on-line OEL is always enabled

> OPT 4: JK opens to enable var/PF; LM opens to enable droop and on-line OEL

OPT 5: JK closes to enable secondary PID; LM opens to enable var/PF or droop; on-line OEL always enabled

OPT 6: JK closes to enable secondary PID; LM opens to enable var/PF or droop and on-line OEL

\D200\LIMIT\ONLINE

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

\D200\LIMIT\OFFLINE

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

\D200\LIMIT\OFFTAKOVR

Off-line overexcitation (takeover) limiter 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

\D200\LIMIT\ONTAKOVR

On-line overexcitation (takeover) limiter 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

\D200\LIMIT\UEL_CRV_X

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

\D200\LIMIT\UEL_CRV_Y

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

\D200\LIMIT\SCLIM

Stator current limiter settings.

SCL HI LIM: stator current limiter high current setpoint

HI LIM TIME: stator current limiter time delay

SCR LO LIM: stator current limiter low current setpoint

\D200\SYSTM\GENERATOR

RATED VOLT: rated generator output voltage

RATED CURR: rated generator output current

FREQUENCY: rated generator frequency

..\FIELD\EXCITR_DATA

FIELD VOLT: rated field voltage

FIELD CURR: rated field current

POLE RATIO: ratio of exciter poles to the generator poles

..\XFMRS\XFMR_DATA

GEN PT PRI: primary voltage rating of generator sensing transformer

GEN PT SEC: secondary voltage rating of generator sensing transformer

BUS PT PRI: primary voltage rating of bus sensing transformer

BUS PT SEC: secondary voltage rating of bus sensing transformer

GEN CT PRI: primary current rating of generator sensing transformer

GEN CT SEC: secondary current rating of generator sensing transformer

..\CONFIG\CNFG_DATA

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

VM DISABLE: selects which of the 52 contacts (JK or LM) will disable voltage matching when it opens

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

AUX IN FUNC: selects the functionality of the auxiliary input—either remote setpoint control or OEL/SCL scaling

CRSS I GAIN: cross current compensation input gain

..\CONFG\AUX_GAINS

AVR MODE: auxiliary input gain in AVR mode

FCR MODE: auxiliary input gain in FCR mode

VAR MODE: auxiliary input gain in var mode

PF MODE: auxiliary input gain in power factor mode

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

NOTE

Each output relay (Relay 1, 2, 3, 4, and 5) has identical settings, with each relay's settings listed on four screens. The following settings use a designator of X to identify the relay, where X can represent output relay 1, 2, 3, 4, or 5.

..\CNTCT\RELAY_X

OUTPT 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 X

FIELD O/C: assignment of field overcurrent annunciation to output relay X

STATOR U/V: assignment of stator undervoltage annunciation to output relay X

..\CNTCT\RELAY_XA

STATOR O/V: assignment of stator overvoltage annunciation to output relay X

UNDER FREQ: assignment of underfrequency annunciation to output relay X

IN OEL: assignment of overexcitation limit annunciation to output relay X

IN UEL: assignment of underexcitation limit annunciation to output relay X

IN FCR MODE: assignment of FCR (Manual) mode annunciation to output relay X

NO V SENSE: assignment of lost voltage sensing annunciation to output relay X

..\CNTCT\RELAY_XB

AT LO LIMIT: assignment of setpoint at low limit annunciation to output relay X

AT HI LIMIT: assignment of setpoint at high limit annunciation to output relay X

SENSE <10 HZ: assignment of generator frequency below 10 hertz annunciation to output relay X

EXC DIOD OD: assignment of open exciter diode annunciation to output relay X

EXC DIOD SD: assignment of shorted exciter diode annunciation to output relay X

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

..\CNTCT\RELAY_XC

IN SCL: assignment of stator current limiting annunciation by output relay X

BLD UP FAIL: assignment of output relay X to annunciate a failure of generator voltage to build up

BUILD UP: assignment of output relay X to annunciate field flashing

PWR IN FAIL: assignment of output relay X to annunciate when the operating (bridge) power frequency is less than 12 hertz <u>or</u> one of the three phases of bridge power is lost

CROWBAR: assignment of output relay X to annunciate when the crowbar circuit energizes

NULL BALNCE: assignment of output relay X to annunciate when the unit is in a null balance state

..\TRVRS\TRVRS_RATE

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.

AVR MODE: traverse rate for automatic voltage regulation mode

FCR MODE: traverse rate for field current regulation mode

var MODE: traverse rate for the var control mode

PF MODE: traverse rate for the power factor control mode

..\PMODE\PREP_MODE

The pre-position mode for the active 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 MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is RELEASE, then subsequent setpoint change commands are followed.

AVR MODE: pre-position mode for automatic voltage regulation

FCR MODE: pre-position mode for field current regulation

var MODE: pre-position mode for var control

PF MODE: pre-position mode for power factor control

..\START\START_UP

SS LEVEL: configures the soft start level

SS TIME: configures the soft start time

FLASH TIME: sets the time limit for field flashing

FLASH LEVEL: sets the level of generator voltage where flashing is removed. Expressed as a percentage of the rated generator voltage.

..\TRACK\TRACK_DATA

INT RATE: determines the length of time required for the DECS-200N to traverse the full setting range of the active setpoint. Used when autotracking between control modes.

INT DELAY: determines the time delay when switching from one control mode to another. Used when autotracking between control modes.

EXT RATE: determines the length of time required for the DECS-200N to traverse the full setting range of the active setpoint. Used when tracking the setpoint of a second DECS-200N.

EXT DELAY: determines the time delay when switching from one control mode to another. Used when tracking the setpoint of a second DECS-200N.

..\COMMS\BAUD RATE

COM0 RS232: baud rate for the front panel RS-232 communication port

COM1 RS232: baud rate for the right-side panel RS-232 communication port

COM2 RS485: baud rate for the left-side panel RS-485 communication port

..\COMMS\MODBUS

Settings for the left-side panel RS-485 Modbus communication port.

COM2 ADDR: device address

COM2 DELAY: response delay time

PARITY: selects no, odd, or even parity

STOP BITS: selects 1 or 2 stop bits

..\RTC\CLK_FORMAT

TIME FORMAT: configures the real-time clock for 12- or 24-hour format

DST FORMAT: enables/disables daylight saving time

DATE FORMAT: configures the real-time clock date for m-d-y or d-m-y

EDITING SETTINGS

DECS-200N settings can be edited through the front panel. An editing session is initiated by navigating to the screen containing the setting to be changed and pressing the Edit pushbutton. Edit mode is indicated by a lit LED on the Edit pushbutton. A prompt to enter a password will appear on the display. Additional information about using passwords is provided in *Password Protection*.

When security access is obtained through entry of the appropriate password, the first editable field of the current screen is underlined. The underlined setting can be changed by pressing the up or down scrolling pushbuttons to increase or decrease the setting. To edit another setting on the current screen, the left or right scrolling pushbuttons are pressed to move the underline to the other editable setting fields.

NOTE

Most setting changes are used immediately by the DECS-200N. However, the changes are not saved in nonvolatile memory until the Edit pushbutton is pressed to terminate the editing session.

After all desired editing on a screen is completed, the changes can be saved or discarded. Changes are saved by pressing the Edit pushbutton, which ends the edit session and saves the changes in nonvolatile memory. Changes are discarded by pressing the Reset button, which ends the edit session and restores the settings active prior to editing by reading them from nonvolatile memory. In both cases, the Edit pushbutton LED turns off to indicate that the editing session is terminated.

Security (password) access is not immediately lost when a settings editing session is terminated. Security access ends after 10 minutes of no pushbutton activity. 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.

This security access timeout differs from an edit session timeout. If 10 minutes of inactivity elapses during an edit session, any changes that were made will be saved in nonvolatile memory and will be used by the DECS-200N. 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.

Screens with Special Editing Modes

Several screens operate differently while in edit mode. Examples of these screens are \D200\OPER\OPERATE_1, ..\COMMS\BAUD RATE, and ..\COMMS\MODBUS. In each case, any changes made to a setting are not used by the DECS-200N (nor saved in nonvolatile memory) until the Edit button is pushed again. The programmable input screens for relays 1 through 5 operate in the same manner.

Other examples of screens with different behavior in edit mode include the loop gains screens, which are used to establish PID (proportional + integral + derivative) values (\D200\GAIN\REG_GAIN1 and \D200\GAIN\2ND_GAINS). The first four parameters on these screens represent tables (one table for primary gains and one table for secondary gains) containing 20 sets of predefined PID values and one set of user-definable values. The first parameters, PRI STB RNG and SEC STB RNG, represent the stability setting number and are the index for the tables. Stability setting numbers 1 through 20 select predefined values from the table and a setting of 21 enables the selection of user-defined values. The second, third, and fourth parameters, AVR/FCR Kp, AVR/FCR Ki, and AVR/FCR Kd, are the actual entries in the table.

As long as the stability setting number is 21, then the Kp, Ki, and Kd parameters may be individually edited. Changed values are not used by the DECS-200N until they are saved by pressing the Edit push-button. Kp, Ki, and Kd may not be edited when the stability setting number is set at 1 through 20.

If the DECS-200N is operating with user-defined PID values and the stability range number is changed to a value of 1 to 20, the user-defined Kp, Ki, and Kd values are lost. The next time that user-defined values for a stability setting of 21 are required, they must be manually entered and saved.

PASSWORD PROTECTION

All DECS-200N settings that can be edited at the front panel are password protected. A password is required at the start of any settings editing session. Password access expires 10 minutes after the last entry is received at the front panel.

There are two levels of password access: global and setpoint. Global password access permits changes to all settings that can be edited through the front panel. Setpoint password access permits changes to a limited selection of settings. Settings that can be changed with setpoint password access are listed in Table 2-3. All editable settings on a single menu screen have the same password access level.

Table 2-3. Settings Protected by Setpoint Password

Screen	Setting
\D200\OPER\OPERATE_1	Start/Stop control AVR/FCR mode PF/var mode Load compensation type Pre-position enable
\D200\OPERATE_2	Voltage matching enable Internal tracking enable External tracking enable UF or V/Hz protection selection
\D200\SETPT\MODE_SET	AVR mode setpoint FCR mode setpoint Droop setting Var mode setpoint PF mode setpoint
\D200\SETPT\PREP_SET	AVR mode pre-position setpoint FCR mode pre-position setpoint Var mode pre-position setpoint PF mode pre-position setpoint
\D200\METER\ADJUST	1st metering field display parameter 2nd metering field display parameter 3rd metering field display parameter active setpoint
\D200\SETUP\CONTRAST	LCD contrast

DECS-200N units are delivered with the same global and setpoint access password: *decs2*. When the global and setpoint passwords are identical, the DECS-200N grants global access when the correct password is entered. In order to permit setpoint-only access, the setpoint access password must differ from the global access password. If the user attempts to start an edit session on a screen requiring global access while only setpoint access is granted, the setpoint access is revoked and the user is prompted to enter a global access password.

Passwords may be changed using BESTCOMS software (provided with the DECS-200N). A password can contain from one to six alphanumeric characters. To prevent unauthorized setting changes, the passwords should be changed after commissioning. Once changed, the passwords should be stored in a secure location. If the user-defined passwords are lost or forgotten, the default password (decs2) can be restored by simultaneously pressing the Edit and Reset pushbuttons during DECS-200N power-up.

CAUTION

Pressing the Edit and Reset pushbuttons during DECS-200N power-up replaces all user-programmed settings with the default settings.

Restoring the default password also replaces all user-programmed settings with the default values. Before performing this procedure, BESTCOMS software should be used to save a DECS-200N settings file. After the default settings are loaded while restoring the default password, the settings file can be uploaded to the DECS-200N and new passwords can be assigned.

METERING SCREEN

Metering screen information is displayed in five fields: metering values, alarms message, setpoint value, setpoint percent of range, and operating mode. The metering screen fields are illustrated in Figure 2-13.
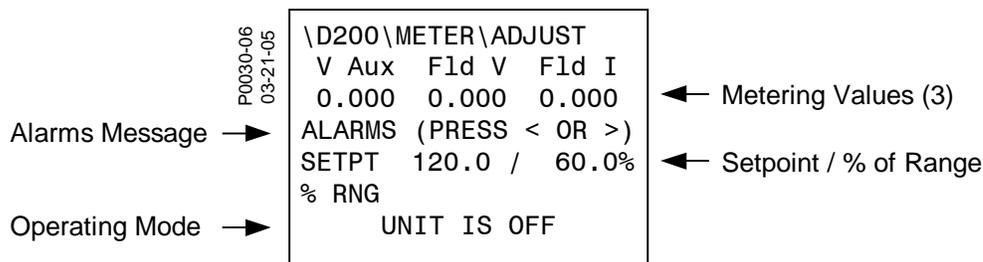

Figure 2-13. Metering Screen Information

Metering Values

Metering values are displayed for three user-selectable parameters. Table 2-4 lists the metering parameters available for display on the DECS-200N metering screen.

Table 2-4. User-Selectable Metering Parameters

Metering Label	Metering Quantity
Vab	Generator phase A-B (L-L) rms voltage
Vbc	Generator phase B-C (L-L) rms voltage
Vca	Generator phase 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

Metering Label	Metering Quantity
Fld V	Field voltage
Fld I	Field current
Vaux	Voltage proportional to auxiliary input
EDM OD	Open exciter diode ripple
EDM SD	Shorted exciter diode ripple

The DECS-200N uses auto-ranging to display up to four digits of resolution plus a decimal point. If needed, a multiplier such as k for kilo (1,000) or M for mega (1,000,000) is used. Negative values with magnitudes greater than 999.9 are displayed with three digits of resolution.

Alarms Message

The alarms message line remains blank during normal operating conditions. If an enunciable condition occurs, "ALARMS (PRESS < OR >)" is displayed. Information about the condition is obtained by viewing the alarm message screen. This screen displays up to six messages identifying the conditions that led to the most recent annunciations. Table 2-5 lists the messages that may appear as annunciations on the alarm message screen. When more than one message is listed, the newest messages are added to the bottom of the list. Once the list contains six messages, any further annunciations will cause the oldest message to be deleted from the top of the list.

Table 2-5. Annunciation Messages

Annunciation Message	Duration of Message
POWER INPUT FAILURE	Maintained until reset
CROWBAR FIRED	Maintained until reset
EXCITER DIODE OPEN	Maintained until reset
EXCITER DIODE SHORT	Maintained until reset
FAILED TO BUILD UP	Clears 2 s after end of event
FIELD OVERCURRENT	Maintained until reset
FIELD OVERVOLTAGE	Maintained until reset
GEN OVERVOLTAGE	Maintained until reset
GEN UNDERVOLTAGE	Maintained until reset
LOST VOLTAGE SENSING	Maintained until reset
OVEREXCITATION LIMIT	Clears 2 s after end of event
SYSTEM BELOW 10HZ	Maintained until reset
UNDEREXCITATION LIMIT	Clears 2 s after end of event
UNDERFREQUENCY	Clears 2 s after end of event

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. 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. However, the metering screen will no longer indicate when a new annunciation occurs because the alarms message would always be present.

Setpoint

The setpoint field displays the setpoint for the active mode of operation. Table 2-6 lists the relationship between the mode of operation and the setpoint field quantity.

Table 2-6. Setpoint Field Operating Mode Cross-Reference

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

Percent of Range

This field displays the setpoint expressed as a percentage of the available adjustment range. The relationship between this field and the setpoint field is linear. For example, a setpoint adjusted to the minimum value would be displayed as 0.0%, a setpoint adjusted to the middle of the adjustment range would be displayed as 50.0%, and a setpoint adjusted to the maximum value would be displayed as 100.0%.

Operating Mode

This line of the metering screen indicates the DECS-200N's current mode of operation. Table 2-5 lists the message displayed for each DECS-200N operating mode.

SECTION 3 • FUNCTIONAL DESCRIPTION

TABLE OF CONTENTS

Tables

SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

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

FUNCTION BLOCK DESCRIPTIONS

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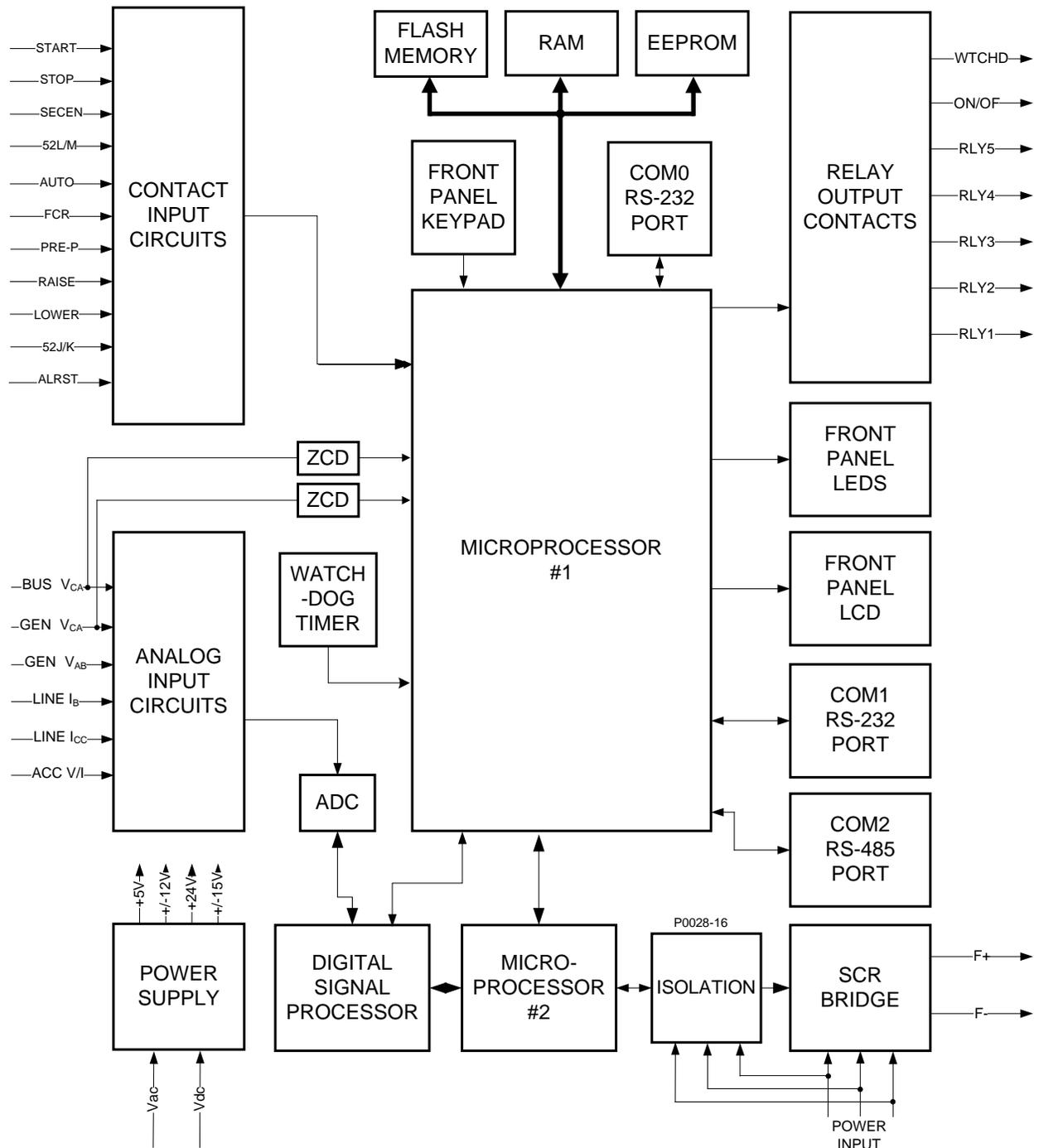

Figure 3-1. DECS-200N Function Block Diagram

Contact Input Circuits

Eleven contact input circuits, powered by isolated 12 Vdc, provide operational input control for the DECS-200N. 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 input requirements are defined in the following paragraphs.

Start

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

Stop

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

AVR (Automatic Voltage Regulation)

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

FCR (Field Current Regulation)

This input accepts a momentary contact closure that places the DECS-200N in the 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 mode 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 and 52J/K

The 52L/M and 52J/K contact inputs can be used to control DECS-200N operation in the following ways:

– Selection of single-generator or paralleled-generator (Droop or Cross-Current Compensation) operation
– Enabling/disabling of var/power factor control
– Selection of on-line overexcitation limiter levels/curves
– Enabling/disabling of secondary PID settings

Six predefined 52 contact options are available to satisfy a variety of applications. Table 3-1 summarizes each 52 contact option. The 52 contact option selected should be coordinated with the contacts selected for disabling voltage matching.

Table 3-1. 52 Contact Options

52 Contact Option	52L/M Contact State		52J/K Contact State	
	Open	Closed	Open	Closed
1	On-Line OEL Droop		On-Line OEL Var/PF	
2	Droop		On-Line OEL Var/PF	
3	On-Line OEL Droop	On-Line OEL	On-Line OEL Var/PF	On-Line OEL
4	On-Line OEL Droop		Var/PF	
5	On-Line OEL Var/PF Droop	On-Line OEL	On-Line OEL	On-Line OEL Secondary PID
6	On-Line OEL Var/PF Droop			Secondary PID

NOTE

When a closed 52 contact input is required to initiate an action, the contact closure must be sustained for as long as the action is desired.

If option 1, 2, 3, or 4 is used and neither var nor power factor correction is desired, connection of a jumper wire across the 52J/K terminals (A38 and A39) is recommended.

SECEN (Secondary Enable)

This input accepts a continuous contact closure and enables the DECS-200N 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)
- B-phase (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-200N 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 set at 85 to 153 Vac. The 240 V range is selected if the generator secondary VT voltage is set at 170 to 300 Vac. The 480 V range is selected if the generator secondary VT voltage is set at 340 to 528 Vac. The 600 V range is selected if the generator VT voltage is set at 540 to 690 Vac.

Generator Voltage (GEN 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. The GEN V$_{CA}$ input is not internally isolated.

Generator Voltage (GEN 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 generator rms voltage across phases B and C.

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.

B-Phase Line Current (LINE I$_B$)

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

Cross Current Loop Input (LINE I$_{CC}$)

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

Accessory Input

The accessory input can be used for either remote setpoint control or limiter scaling. This input is internally isolated and accepts either an analog voltage (–10 to +10 Vdc) or current (4 to 20 mA).

When used for remote setpoint control, the accessory input can be controlled by a power system stabilizer or similar device for the purpose of dampening system oscillations (by modifying the DECS-200N's selected operating mode setpoint).

The accessory input can also be used to scale the OEL and/or SCL functions to limit the amount of heating induced into the generator. In this application, the accessory input signal can be supplied by a current transducer whose output is proportional to either the intake air temperature or hydrogen gas pressure. For more information about limiter scaling, see *Limiter Functions, Limiter Scaling* later in this section.

Accessory input terminals consist of a pair of terminals for voltage and a pair of terminals for current. Only one terminal pair can be used in an application. The voltage terminals accept a control signal over the range of –10 Vdc to +10 Vdc. The current terminals accept a control signal over the range of 4 to 20 mA. When the current terminals of the accessory input are used, the DECS-200N converts the applied current to a –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 (in volts)
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, field overcurrent protection, and control in FCR mode.

Operating Power

The DECS-200N operating (SCR bridge) power input accepts either three-phase or single-phase power over the range of 80 to 277 Vac. To achieve the desired level of excitation, the appropriate operating power input voltage must be applied. Table 3-2 lists the operating power requirements for two typical field voltage applications.

Table 3-2. Operating Power Requirements for Typical Field Voltage Applications

Parameter	For 63 Vdc Continuous Applications		For 125 Vdc Continuous Applications	
Input Power Configuration ∗	1-Phase	3-Phase	1-Phase	3-Phase
Nominal Input Voltage	208 Vac	120 Vac		240 Vac
Minimum Residual Voltage for Buildup	24 Vac	12 Vac		24 Vac
Full-Load Continuous Excitation	63 Vdc	63 Vdc		125 Vdc
Maximum Positive Forcing Voltage †	130 Vac	120 Vac	Not Recommended	240 Vac
Maximum Negative Forcing Voltage †	−105 Vdc	−100 Vdc		−200 Vdc
Maximum Forcing Current	40 Adc	40 Adc		40 Adc
Operating Power Input Burden at 20 Adc Excitation Output	4,160 VA	3,400 VA		6,800 VA
Minimum Field Resistance	3.15 Ω	3.15 Ω		6.25 Ω

∗ Refer to Section 3, *Functional Description, Protection Functions, Exciter Diode Monitor (EDM)* for information about determining the operating power configuration for brushless generators.

† The forcing values listed assume a source impedance of 10%.

Calculations can be made to determine the SCR bridge output level available for different levels of operating power, source impedance, output current, and control angles. These calculations are described in Appendix A, *SCR Bridge Output Calculations*.

Three operating power input frequency ranges, determined by the DECS-200N style number, are available. Units with a style number of X1 have a frequency range of 50 to 160 hertz, units with a style number of X2 have a frequency range of 161 to 420 hertz, and units with a style number of X3 have a frequency range of 421 to 500 hertz.

Control Power

Control power is supplied to an internal power supply that provides +5 Vdc, ±12 Vdc, ±15 Vdc and +24 Vdc to the DECS-200N internal circuitry. Two control power options are available and are determined by the DECS-200N style number.

A unit with a style number of LX accepts a nominal control power input of 24 Vdc, 24 Vac, or 48 Vdc and accepts voltage over the range of 16 to 60 Vdc and 20 to 40 Vac. A unit with a style number of CX accepts nominal control power inputs of 120 Vac and 125 Vdc. Both ac and dc operating power may be applied simultaneously for redundant power supply operation. When dual power sources are used, an isolation transformer is required for the ac input. The ac input accepts voltage over the range of 82 to 132 Vac at 50 or 60 hertz. The dc input accepts voltage over the range of 90 to 150 Vdc.

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 DECS-200N microprocessors perform control, computation, self test and communication functions. Microprocessor #1 generally performs low-speed tasks such as protective functions, frequency measurement, communication, watchdog alarm and other system functions. Microprocessor #2 controls and monitors the firing pulses supplied to the SCR bridge.

Digital Signal Processor

The digital signal processor (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 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 a signal that defines the control angle of the SCR bridge firing pulses.

Operating Settings

Operating settings are stored in nonvolatile memory and 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 operates the SPDT 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-200N will reset the clock.

SCR Bridge

The SCR bridge employs six SCRs to full-wave rectify the three-phase or single-phase operating power input. The ac input power is converted to dc power for application to a machine's field. The output level of the bridge is controlled by six gate pulses controlled by microprocessor #2. The SCR bridge is capable of two-quadrant operation. It can produce negative as well as positive output voltage as long as positive current is flowing in the machine field (in excess of the minimum holding current required for the SCRs).

To achieve the desired level of excitation power from the SCR bridge, the appropriate level of operating power must be applied to the DECS-200N (see *Operating Power*).

Relay Output Circuits

There are seven 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 five are fully programmable via all interfaces and are described in the following paragraphs. Two output relays (one form A and one form B) have predetermined functions and are also described in the following paragraphs.

Programmable Outputs

Output relays RLY1, RLY2, RLY3, RLY4, and RLY5 may be programmed using BESTCOMS software, the front panel HMI, or through the Modbus® protocol using the RS-485 port (COM2).

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-200N has operating power applied. When operating power is removed from the DECS-200N, these contacts will open.

The five output relays labeled RLY1 through RLY5 have the following programmable features.

- Selection of contact functionality: normally open or normally closed
- Selection of output type: momentary, maintained, or latched
  - A momentary type output closes or opens the relay contacts for the duration of the relay's time setting or the duration of the condition triggering the relay's change of state, whichever expires first. Each relay's momentary time setting is adjustable from 0.1 to 5 seconds in 0.05 second increments.
  - A maintained type output closes or opens the relay contacts for the duration of the condition triggering the relay's change of state.
  - A latched type output latches the relay contacts closed or open until the relay is reset by the user.
- Selection of condition(s) to be annunciated, including:

- Buildup active
- Crowbar circuit fired
- Failed to build up
- FCR mode active
- Field overcurrent
- Field overvoltage
- Generator overvoltage
- Generator undervoltage
- Loss of field
- Loss of sensing voltage
- Lower setpoint limit
- Null balance
- Open exciter diode
- Overexcitation limit
- Power input failure: operating (bridge) power below 12 hertz <u>or</u> one of three phases of bridge power lost
- Sensing input below 10 hertz
- Shorted exciter diode
- Stator current limit
- Underexcitation limit
- Underfrequency or volts per hertz limit
- Upper setpoint limit

Watchdog Output

The watchdog output (WTCHD) indicates a software execution problem within the DECS-200N. The SPDT contacts change state under the following circumstances:

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

On/Off Output

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

Communication

Three serial ports provide communication access to the DECS-200N.

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

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

The RS-232 port on the left side of the unit is dedicated for communication in RTU (remote terminal unit) mode using the Modbus® protocol.

COM 1 and COM 2 have a default baud rate of 19200. However, the baud rate for each port can be independently set. Available baud rates are 1200, 2400, 4800, and 19200. COM 0 has a fixed baud rate of 19200. Ports COM 0 and COM 1 use a data format of 8N1 which stands for 8 data bits, no parity, and 1 stop bit. Port COM2 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.

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.

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

Nine protection functions are available in the DECS-200N:

- Field overvoltage
- Field overcurrent
- Generator undervoltage
- Generator overvoltage
- Loss of sensing voltage
- Loss of field
- Exciter diode monitor
- Failure to build up
- Crowbar circuit

Field Overvoltage

When the field voltage increases above the Field Overvoltage Level setting for the duration of the Field Overvoltage Time Delay setting, a field overvoltage condition is annunciated.

A field overvoltage condition is annunciated on the front panel display and may also be assigned to a programmable output for remote annunciation.

The Field Overvoltage Level setting is adjustable from 1 to 325 Vdc in 1 Vdc increments. The Field Overvoltage Time Delay setting is adjustable from 0.2 to 30 seconds in 0.1 second increments. Field overvoltage protection may be disabled without changing the level or time delay settings.

MOV and Crowbar Circuit

Additional protection against field overvoltage is provided by a metal-oxide varistor (MOV) and crowbar circuit. Field overvoltage is normally clamped by the MOV. However, if the field voltage exceeds –800 Vdc for 0.5 milliseconds, the crowbar circuit places a short-circuit across the field and field energy is dissipated through the resistance of the field.

Field Overcurrent

When the field current increases above the Field Overcurrent Level setting for the duration of the Field Overcurrent Time Dial setting, a field overcurrent condition is annunciated. The Field Overcurrent Level and Field Overcurrent Time Dial settings are related by an inverse function. This means that the higher the field current goes above the Field Overcurrent Level setting, the shorter the time to an annunciation. The Field Overcurrent Time Dial setting is a linear multiplier for the time to an annunciation. Figure 3-2 shows a set of typical field overcurrent timing curves. Note that field current levels below 103% of the field overcurrent setpoint 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 cause an annunciation in the same amount of time as the 250% level.

A field overcurrent condition is annunciated on the front panel display and may also be assigned to a programmable output for remote annunciation.

The Field Overcurrent Level setting is adjustable from 01. to 20 Adc in 0.1 Adc increments. The Field Overcurrent Time Dial setting is adjustable from 0.1 to 20 seconds in 0.1 second increments. Field overcurrent protection may be disabled without changing the level or time dial settings.
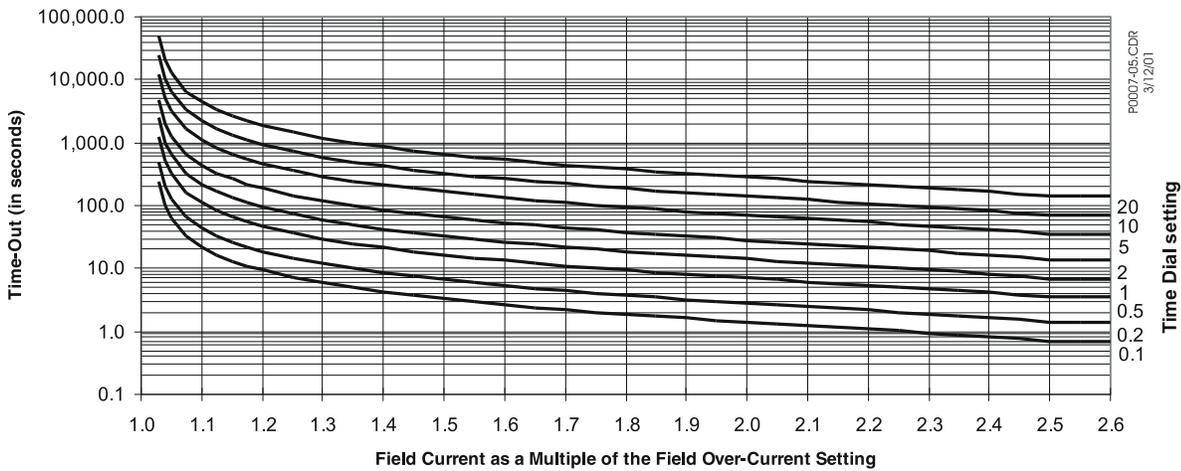
Figure 3-2. Field Overcurrent Timing Curves

Generator Undervoltage

When the generator voltage decreases below the Generator Undervoltage Level setting for the duration of the Generator Undervoltage Time Delay setting, a generator undervoltage condition is annunciated.

A generator undervoltage condition is annunciated on the front panel display and may also be assigned to a programmable output for remote annunciation.

The Generator Undervoltage Level setting is adjustable from 0 to 30,000 Vac in 1 Vac increments. The Generator Undervoltage Time Delay setting is adjustable from 0.5 to 60 seconds in 0.1 second increments. Generator undervoltage protection may be disabled without changing the level or time delay settings.

Generator Overvoltage

When the generator voltage increases above the Generator Overvoltage Level setting for the duration of the Generator Overvoltage Time Delay setting, a generator overvoltage condition is annunciated.

A generator overvoltage condition is annunciated on the front panel display and may also be assigned to a programmable output for remote annunciation.

The Generator Overvoltage Level setting is adjustable from 0 to 30,000 Vac in 1 Vac increments. The Generator Overvoltage Time Delay setting is adjustable from 0.1 to 60 seconds in 0.1 second increments. Generator Overvoltage protection may be disabled without changing the level or time delay settings.

Loss Of Sensing Voltage

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

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

A loss of sensing voltage condition is annunciated on the front panel display and may also be assigned to a programmable output for remote annunciation.

The Loss of Sensing-Balanced Level and Loss of Sensing-Unbalanced Level settings are adjustable from 0 to 100% in 0.1% increments. The Loss of Sensing Time Delay setting is adjustable from 0 to 30 seconds in 0.1 second increments.

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 Time Delay setting, a loss of field condition is annunciated.

A loss of field condition is annunciated on the front panel display and may also be assigned to a programmable output for remote annunciation.

The Loss of Field Level setting is adjustable from 0 to 3,000,000 kvar in 1 kvar increments. The Loss of Field Time Delay setting is adjustable from 0 to 9.9 seconds in 0.1 second increments. Loss of field protection may be disabled without changing the level or time delay settings.

Exciter Diode Monitor (EDM)

The DECS-200N 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. For reliable open diode detection, the exciter-to-generator pole ratio should be 1.5 or higher and the level of field current should be no less than 1.5 Adc.

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 disable all exciter open-diode protection parameters. In this situation, the generator and exciter pole parameters must be set at zero to prevent false tripping.

An open exciter diode may not be detected if the generator frequency and operating power frequency are the same and the DECS-200N operating power is supplied by a single-phase source. Three-phase operating power is recommended for reliable open diode detection. Open diode detection will also be impaired when a permanent magnet generator (PMG) is supplying DECS-200N operating power and the PMG frequency is the same or lower than the generator frequency.

The EDM estimates the fundamental harmonic of the exciter field current using discrete Fourier transforms (DFTs). The harmonic, expressed as a percentage of the field current, is then compared to the trip level for open diode detection (Exciter Open Diode Pickup Level Ripple setting) and shorted diode detection (Exciter Shorted Diode Pickup Level Ripple setting). If the percentage of field current exceeds the Exciter Open Diode Pickup Level Ripple or Exciter Shorted Diode Pickup Level Ripple setting, then

the appropriate time delay will begin. After the programmable time delay for the open diode or shorted diode condition expires and if the percentage of field current still exceeds the open diode ripple setting or shorted diode ripple setting, the condition is annunciated.

An open diode or shorted diode is annunciated on the front panel display and may also be assigned to a programmable output for remote annunciation.

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

- Pole ratio
- Trip level of EDM open diode ripple
- Trip level of EDM shorted diode 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 brushless exciter armature poles to the number of generator rotor poles should be entered to ensure detection of both open and shorted diodes.

Finding the Maximum Field Ripple Current

To set the Exciter Open Diode Pickup Level Ripple and Exciter Shorted Diode Pickup Level Ripple, 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-200N HMI metering screen. Record the highest value for each. See Section 2, *Human-Machine Interface* for more details on displaying metering quantities.

Setting the Trip Level – Number of Generator Poles Known

Multiply the highest EDM OD value, obtained under *Finding the Maximum Field Ripple Current*, by 2. The result is the Exciter Open Diode Pickup Level Ripple setting. The multiplier can be varied between 1.5 and 5 to increase or decrease the trip margin. However, reducing the multiplier could result in nuisance open diode indications.

The Exciter Open Diode Pickup Level Ripple setting is adjustable from 0 to 100% in 0.1% increments. The Exciter Open Diode Time Delay setting is adjustable from 10 to 60 seconds in 0.1 second increments.

Multiply the highest EDM SD value, obtained under *Finding the Maximum Field Ripple Current* by 50. The result is the Exciter Shorted Diode Pickup Level Ripple setting. The multiplier can be varied between 40 and 70 to increase or decrease the trip margin. However, reducing the multiplier could result in nuisance shorted diode indications.

The Exciter Shorted Diode Pickup Level Ripple setting is adjustable from 0 to 100% in 0.1% increments. The Exciter Shorted Diode Time Delay setting is adjustable from 5 to 30 seconds in 0.1 second increments.

The DECS-200N has fixed EDM inhibit levels to prevent nuisance failed diode indications while the generator frequency is less than 45 Hz or 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 1 to 10 with zero used if the ratio is unknown.

Setting the Trip Level – Number of Generator Poles Unknown

The DECS-200N can detect shorted diode conditions when the number of generator poles is not known. To provide this protection, disable EDM OD protection, set the pole ratio to zero, and enable EDM SD protection. Multiply the maximum EDM SD % ripple value, obtained under *Finding the Maximum Field Ripple Current*, by 30. The multiplier can be varied between 20 and 40 to increase or decrease the trip margin. However, reducing the multiplier could result in nuisance shorted diode indications.

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 that no failed diode annunciations occur. All of the EDM setup

guidelines presented here assume that the exciter diodes were not opened or shorted at the time of setup and testing.

Failure to Build Up

During startup, if the generator voltage fails to build up to the Field Flash Dropout Level setting before the Maximum Field Flash Time setting expires, a failure to build up is annunciated.

A failure to build up may be assigned to a programmable output for remote annunciation.

The Field Flash Dropout Level setting is expressed as a percentage of the nominal generator terminal voltage and is adjustable from 0 to 100% in 0.1% increments. The Maximum Field Flash Time setting is adjustable from 0 to 50 seconds in 0.1 second increments.

Crowbar Circuit

An internal crowbar circuit protects against field overvoltage and also discharges the field circuit during generator shutdown.

During a field overvoltage condition, protection is provided by a metal-oxide varistor (MOV) and the crowbar circuit. Field overvoltage is normally clamped by the MOV. However, if the field voltage exceeds –800 Vdc for 0.5 milliseconds, the crowbar places a short-circuit across the field and the field energy is dissipated through the resistance of the field.

During generator shutdown, the DECS-200N field output is disabled and the crowbar places a short-circuit across the field and the field energy is dissipated through the resistance of the field.

SOFT START

DECS-200N 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.

The soft start bias level is adjustable from 0 to 90% of the active mode setpoint in increments of 1%. The default setting is 5%. (Soft start bias is referred to as soft start level in BESTCOMS.)

The soft start time is adjustable from 1 to 7,200 seconds in increments of 1 second. The default setting is 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%.
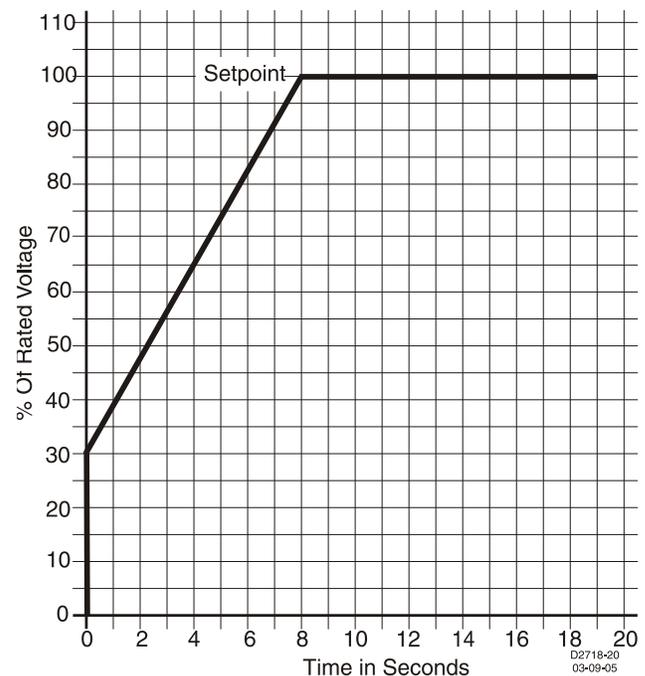
Figure 3-3. Soft Start Voltage Reference

LIMITER FUNCTIONS

DECS-200N limiter functions include an under-frequency limiter, volts-per-hertz ratio limiter, over-excitation limiter, underexcitation limiter, and a stator current limiter.

Underfrequency Limiter

When the generator frequency drops below the corner frequency for the underfrequency slope (see Figure 3-4), an underfrequency annunciation occurs and the voltage setpoint is automatically adjusted by the DECS-200N so that the generator voltage follows the underfrequency slope. The under-frequency 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 allows the DECS-200N to precisely match the operating characteristics of the prime mover and the loads being applied to the generator.

The underfrequency limiter may be effectively disabled by setting the slope to zero. However, if the system frequency is below the corner frequency setting, an underfrequency condition will be annunciated regardless of the slope setting.

A generator underfrequency condition is annunciated on the front panel display and may also be assigned to a programmable output for remote 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-200N 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 system volts per hertz ratio limit. Figure 3-5 is a typical 1.10 PU volts per hertz limiter curve.

Overexcitation Limiter

Overexcitation limiting (OEL) operates in all modes except FCR mode. The DECS-200N senses the field current output and limits the field current to prevent field overheating. In FCR mode, the DECS-200N announces that all conditions for OEL are fulfilled. The DECS-200N 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.
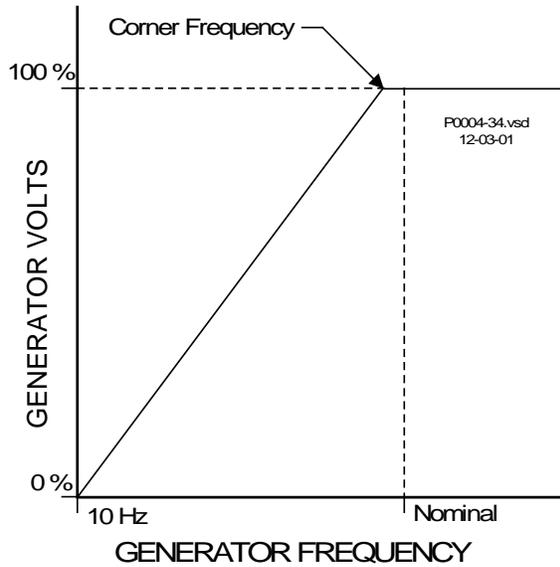

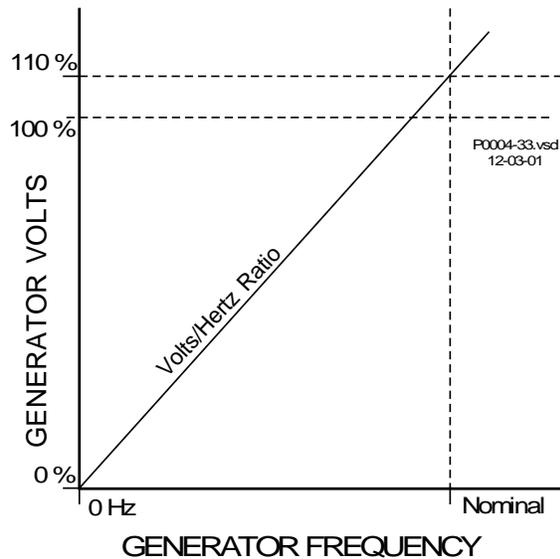Figure 3-4. Typical Underfrequency Compensation Curve

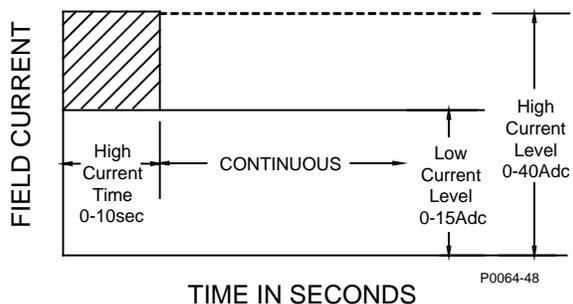Figure 3-5. Typical 1.10 PU V/Hz Limiter Curve

Figure 3-6. Off-Line OEL

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.
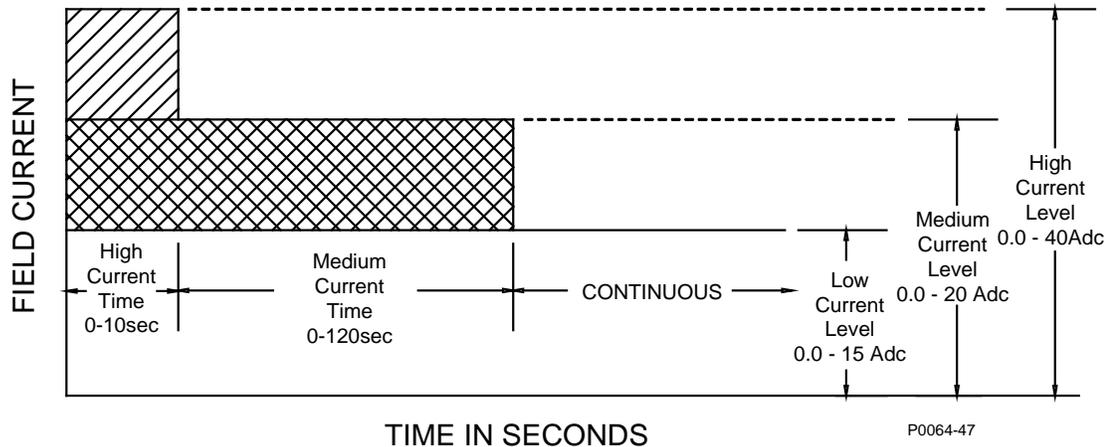

Figure 3-7. On-Line OEL

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. If the 52L/M input is open, the on-Line limiter setting is active.

In addition to the three current levels, the DECS-200N also uses embedded timers to prevent excessive heating of the exciter field that may result from repetitive overexcitation conditions. A duration timer monitors the accumulated time actually spent in an overexcitation condition and a reset timer is used to count backwards 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 0, 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 0 after a previous OEL condition.

When the system operates in OEL, an OEL annunciation occurs. This annunciation occurs via the front panel Metering Screen and may also 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.
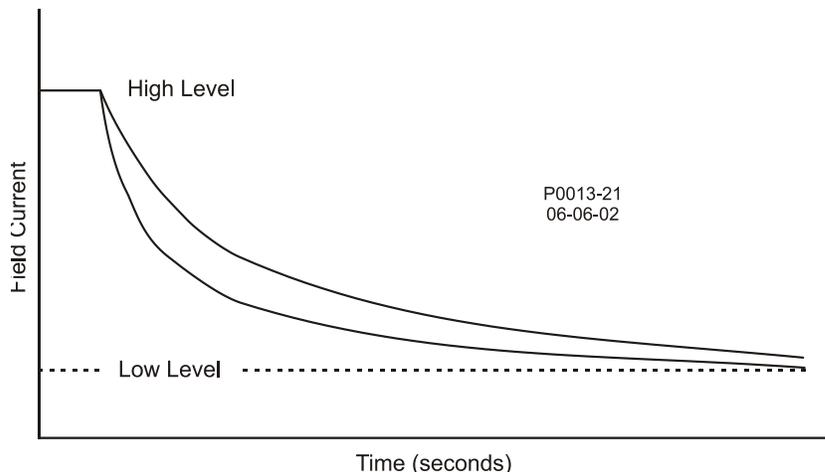

Figure 3-8. Takeover OEL Inverse Time Characteristic

Selection of on-line or off-line OEL levels/curves is determined by the 52 contact option selection:

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. 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-200N 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-200N to operate in Droop mode when applied in a single unit application. Therefore, voltage should not droop as reactive load increases.

Option 4. Option4 allows the 52L/M contact input to define when the off-line and on-line limiters are active. When option 4 is selected, on-line overexcitation limiter settings are active when the 52L/M contact input is open. Off-line OEL settings are active when the 52L/M contact input is closed.

Option 5. When option 5 is selected, on-line overexcitation limiting settings are active at all times.

Option 6. Option 6 allows the 52L/M contact input to define when the on-line overexcitation limiter is active. When option 6 is selected, on-line OEL settings are active only when the 52L/M contact input is open.

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-200N 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 generator voltage and current rating. Typical leading kvar curves and a customer-selected, five-point curve are shown in Figure 3-9.
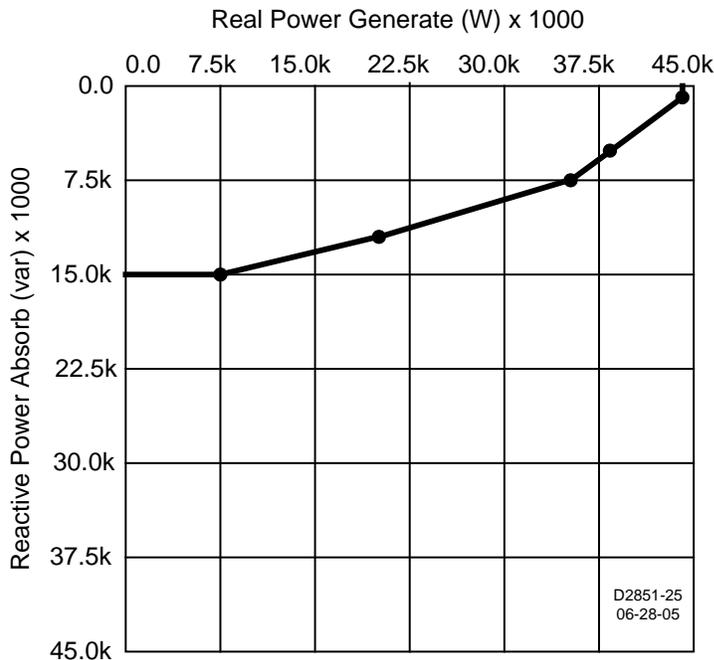

Figure 3-9. Custom Five-Point UEL Curve

When the system operates in UEL, a UEL annunciation occurs. This annunciation occurs via the front panel Metering Screen and may also be assigned to a programmable output relay for external annunciation.

Stator Current Limiter

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-200N 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, but only for a programmed time at the high SCL level.

The SCL will not respond until the SCL Initial Delay setting has expired.
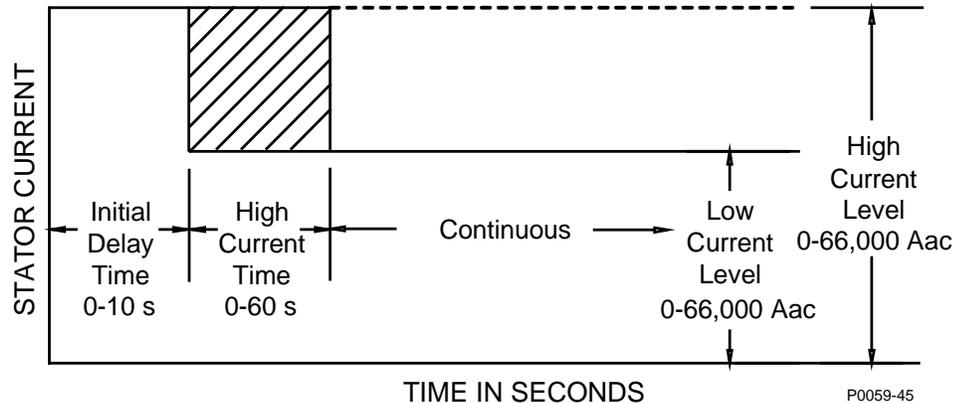
Figure 3-10. Stator Current Limiting

Limiter Scaling

When the accessory input signal is configured for limiter scaling, the stator current limiter (SCL) and overexcitation limiter (OEL) low-level values can be adjusted automatically. Automatic adjustment of the SCL and OEL is based on six parameters: signal and scale for three points. The signal value for each point represents the accessory input voltage and is adjusted from −10 to +10 Vdc in 0.01 Vdc steps.

If a 4–20 mA current transducer is being used in conjunction with the I+ and I− inputs to provide the limiter scaling signal, then the equation $V = 0.625(I − 12)$ must be used to convert the current (I, in milliamperes dc) to volts dc in order to calculate the corresponding value to enter for that setting. Note that the range of the voltage signal is limited to −5 to +5 Vdc when it is derived from a 4–20 mA current signal.

The scale value defines the limiter low level as a percentage of rated field current for the OEL and rated stator current for the SCL. The range of scale values is 0 to 200% with 0.1% increments. For accessory input voltages between two of the three defined points, the low-level limiter setting is linearly adjusted between the two scale values.

DROOP AND LINE-DROP COMPENSATION

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

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

Where: V_{C1} is the compensated output voltage

$\overline{V}_T$ is the measured terminal-voltage vector

$\left(R_c + jX_C \right)$ are the compensation impedance values

$\overline{I}_T$ 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, $\overline{I}_T$.

When the droop percentage is a negative quantity, line-drop compensation (LDC) is performed. 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 zero. For LDC, the above equation becomes:

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

DATA LOGGING AND REPORTING

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

Sequence of Events Reporting

A sequence of events recorder monitors the internal and external status of the DECS-200N. 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 events monitored are listed below.

System Contact Input State Changes

- Alarm reset
- AVR mode enable
- FCR mode enable
- Pre-Position

- Secondary enable
- Start
- Stop

- Unit/Parallel (52L/M) ∗
- VAR/PF enable (52J/K) ∗

∗ The 52 contacts are reported as disabled when the input is jumpered to common and 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

- Relay 4 output
- Relay 5 output
- Watchdog relay output

System Alarm State Changes

- Crowbar fired
- FCR (Manual) mode
- Field overcurrent
- Field overvoltage
- Generator frequency below 10 Hz
- Generator overvoltage
- Generator undervoltage
- Loss of field
- Loss of sensing

- Open exciter diode
- Overexcitation limit
- Setpoint at lower limit
- Setpoint at upper limit
- Shorted exciter diode
- Stator current limit
- Underexcitation limit
- Underfrequency

Changes in State of System Status

- Stop/Start
- Soft-start mode
- Underfrequency mode
- Control mode
- Operating mode

- Load compensation mode
- Limiter mode
- Voltage matching mode
- Auto tracking mode

Oscillography

The data recording function of the DECS-200N can record up to eight oscillographic records. Oscillographic records captured by the DECS-200N 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-200N begins recording the next record over the oldest record. Because all oscillography records are stored in volatile memory, the records will be lost if control 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 4ms to 10s. 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 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-200N monitors a maximum of six, user-selectable, internal variables. All of the available variables are listed as follows:

- 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
- Var/PF controller output

∗ Typically, these variables are used when commissioning or troubleshooting.

Data recording may be triggered manually using either BESTCOMS, logic triggers, or level triggers. Logic triggers initiate data recording when an internal or external DECS-200N status change occurs.

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 it 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 if it falls below its minimum.

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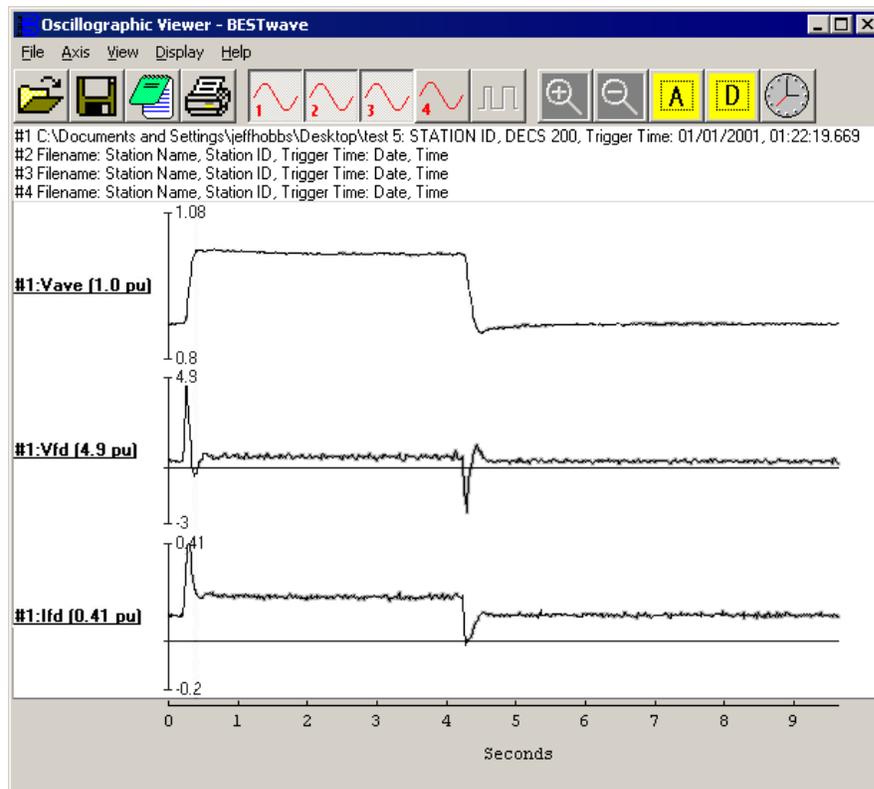

Figure 3-11. Example of Data Record

For more information on how to select triggering types or levels, selecting internal variables for monitoring, or viewing oscillographic records, see Section 5, *BESTCOMS Software*.

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SECTION 4 • INSTALLATION

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SECTION 4 • INSTALLATION

INTRODUCTION

When not shipped as part of assembled equipment, DECS-200N Digital Excitation Control Systems are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a DECS-200N, check the part number with the packing list for agreement. Inspect for damage and, if there is evidence of such, file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric.

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

MOUNTING

Mounting information for the DECS-200N is provided in the following paragraphs.

Overall dimensions are illustrated in Figure 4-1.

Because of the DECS-200N's heat sink orientation, the unit must be mounted vertically. Any other mounting orientation will reduce the heat dissipation capabilities of the unit and possibly lead to premature failure of critical components.

Two DECS-200N mounting configurations are possible: projection mount and panel mount.

The panel drilling diagram for projection mounting of a DECS-200N is shown in Figure 4-2.

Panel mounting of the DECS-200N is possible with the optional escutcheon plate (part number 9388807100). 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-200N. If other screws are used, ensure that the screw length does not exceed 5/16" (0.3125").

A resistor module is supplied with the DECS-200N. Figure 4-5 illustrates the load module (P/N 9388816100) and its overall dimensions. When mounting the resistor module, orient it so that the ventilation holes are located at the top and bottom. Maintain a minimum clearance of 2 inches (5 centimeters) between the resistor module and other objects. For resistor module connections, refer to *Connections, Left-Hand Panel Terminations, Field Output.*
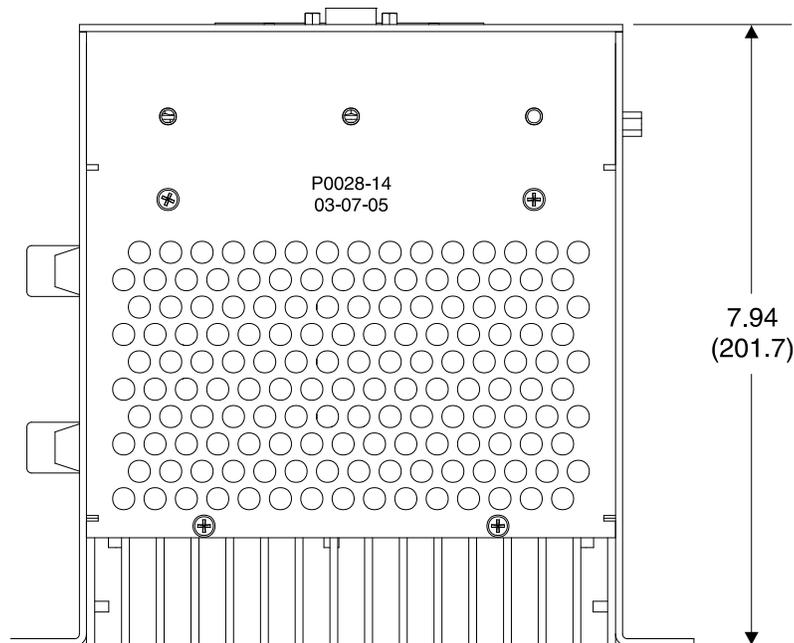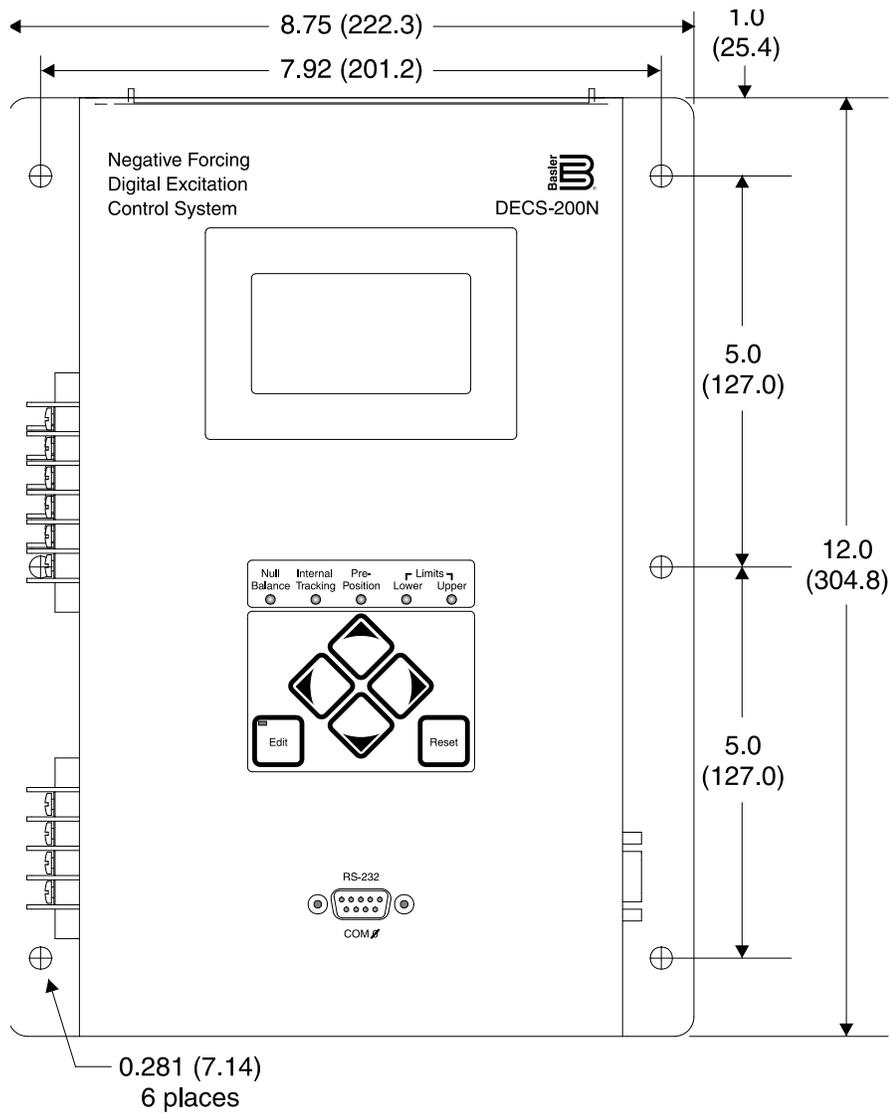
Figure 4-1. Overall Dimensions
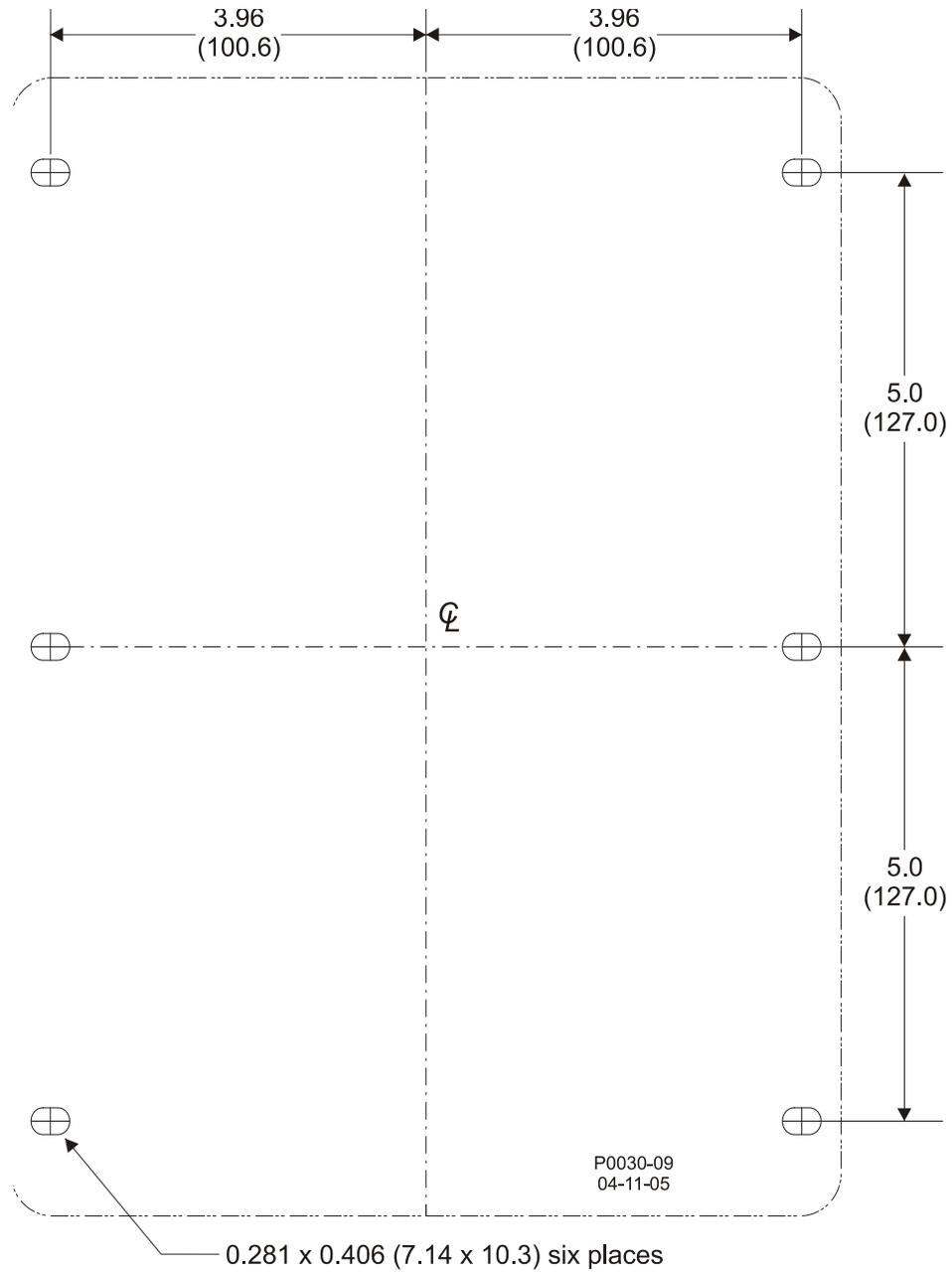
Figure 4-2. Panel Drilling Diagram, Projection Mount
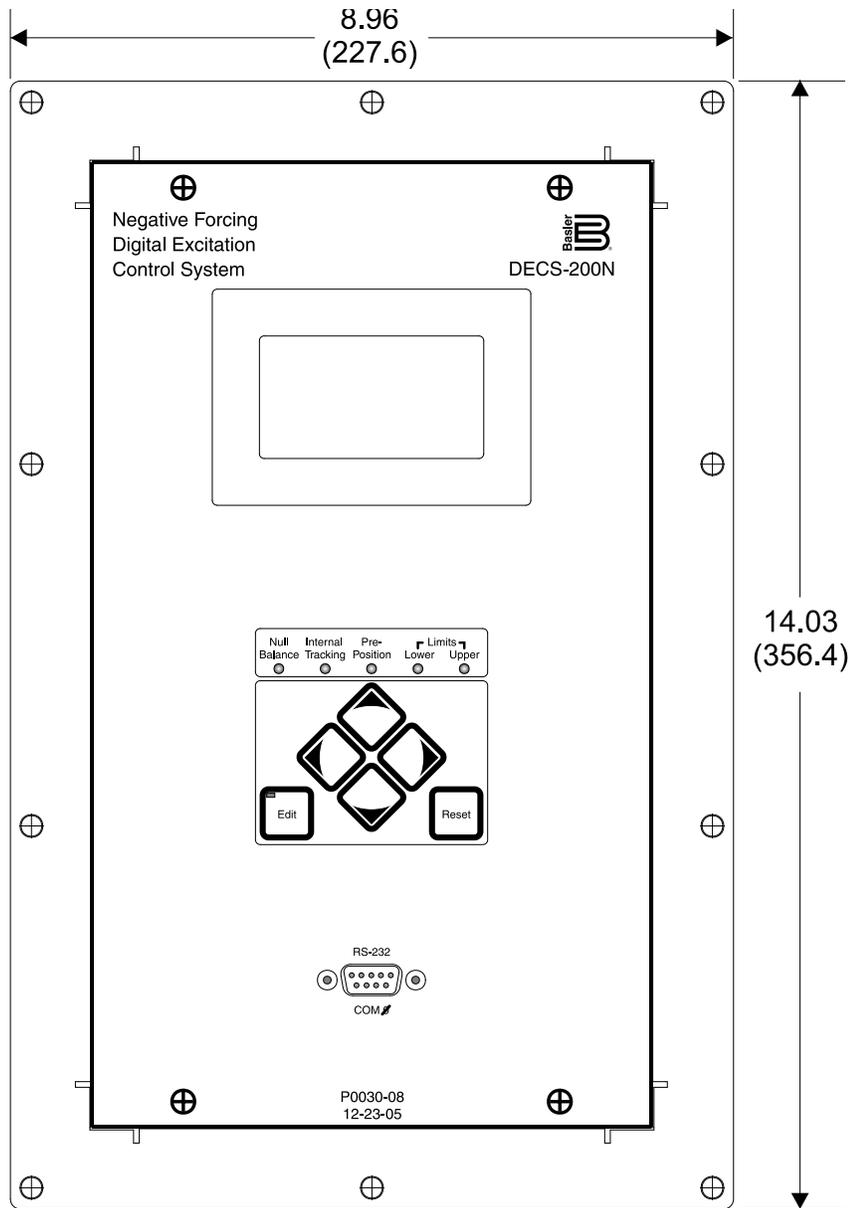
NOTE: Use provided hardware when attaching escutcheon
plate to DECS-200N.

Figure 4-3. Escutcheon Plate Dimensions
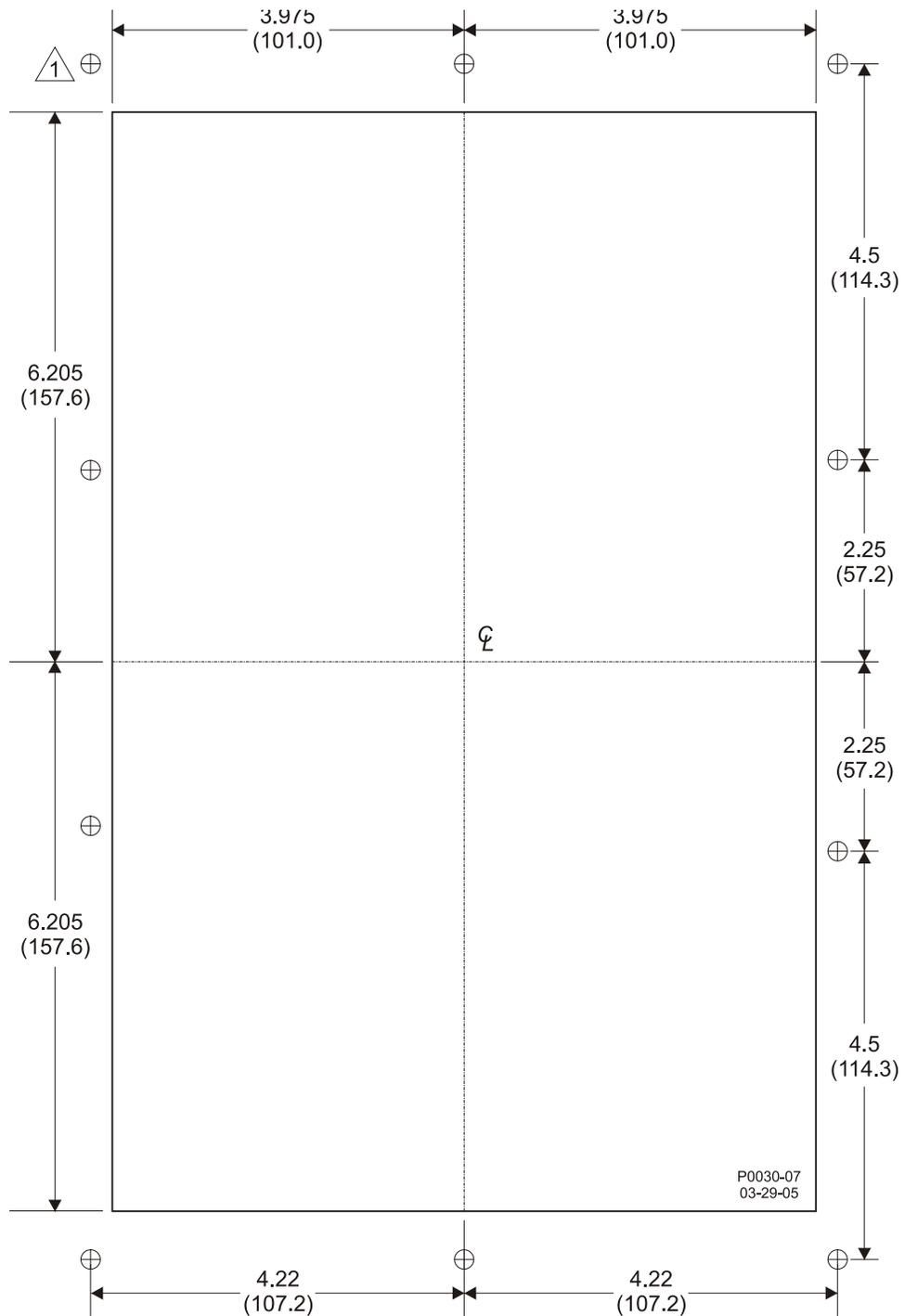
① Mounting holes (10 places) are 0.218 (5.54) diameter.

Figure 4-4. Panel Cutting and Drilling Dimensions, Panel Mount
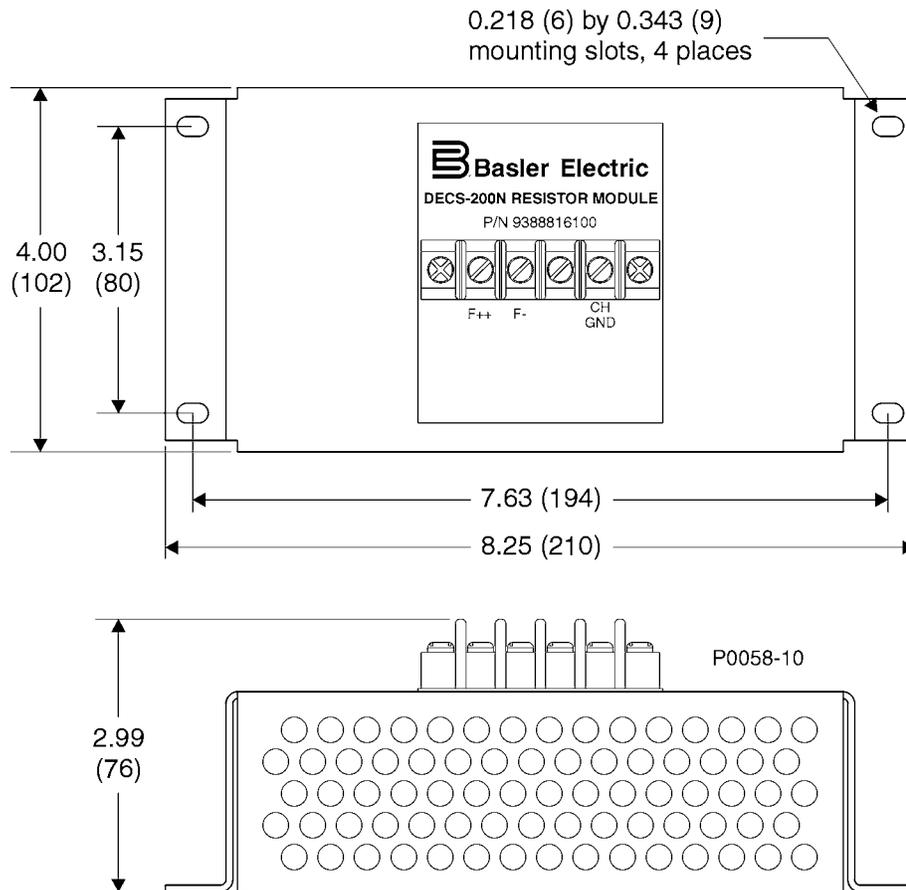
Figure 4-5. Resistor Module and Overall Dimensions

CONNECTIONS

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

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

CAUTION

DECS-200N terminal C4 is reserved for future use. No connections should be made to this terminal.

NOTE

Be sure that the DECS-200N is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal. When the unit is configured in a system with other devices, it is recommended that each unit be grounded with a separate lead.

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

Right-Hand Panel Terminations.

Right-hand panel terminations consist of a nine-pin, female, D-type connector (COM 1) that is used for communication with a second DECS-200N unit when operating in a redundant system. A cable, part number 9310300032, is available for interconnecting two DECS-200N units. Table 4-1 lists the COM 1 pin numbers and functions. Figure 4-6 illustrates the communication connections between two DECS-200N 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-200N
3	RCV	Receive	Receives serial data from DECS-200N
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

NOTE

The RS-232 communication ports are not equipped with Request To Send (RTS) and Clear To Send (CTs) control lines. This makes the DECS-200N incompatible with systems that require hardware handshaking or systems that use self-powered RS-232 to RS-485 converters connected to the RS-232 ports.
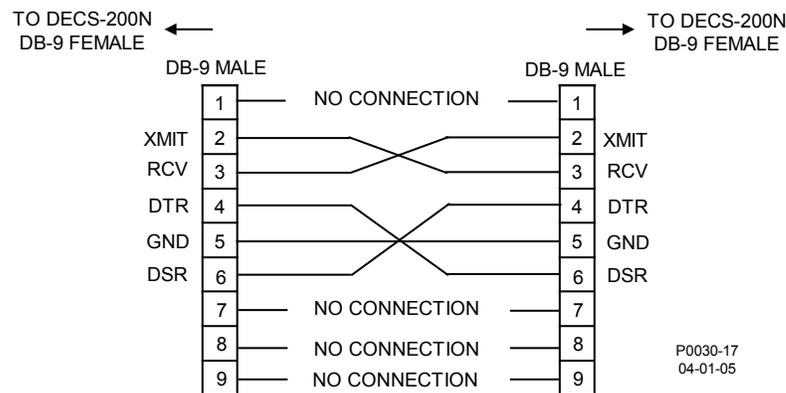
Figure 4-6. DECS-200N to DECS-200N Communication Connections

Front Panel Terminations

Front panel terminations consist of a nine-pin, female, D-type connector 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-200N.

Left-Hand Panel Terminations

Left-hand panel terminations consist of #6 screw terminals and tension clamp terminals. Left-hand panel terminations are illustrated in Table 4-7.

The tension clamp terminals (A1–A46 and B7–B14) are levered open with a small, slotted screwdriver (⅛" blade size). The recommended wire size for all tension clamp terminals is 14 AWG. These terminals accept a maximum wire size of 12 AWG.

All screw terminals accept ring or forked lugs. The recommended wire size for the current sensing terminals (B1–B6) is 12 AWG. The recommended wire size for the field output/load module and operating (bridge) power terminals is 10 AWG.

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

Control Power

DECS-200N units have two sets of control power terminals. One set receives dc control power and the other set receives ac control power. A DECS-200N with a style number of LX accepts nominal dc control power of 24 or 48 Vdc and nominal ac control power of 24 Vac. A DECS-200N with a style number of CX 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 is required for the ac input. Basler part number BE31449001 is a 120 V:120 V isolation transformer and is recommended for DECS-200N units with style number CX. Control power terminals are listed in Table 4-2.

Table 4-2. Control Power Terminals

Terminal	Description
B11 (N)	Return or neutral side of ac input
B12 (L)	Line side of ac input
B13 (BAT–)	Negative side of dc input
B14 (BAT+)	Positive side of dc input

Operating Power

Operating power for the bridge 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. However, the terminals used must be coordinated with the bridge control settings of the BESTCOMS System Configuration screen.

The frequency of the operating power voltage can be between 50 and 160 hertz for units with a style number of X1, between 161 and 420 hertz for units with a style number of X2, or between 421 and 500 hertz for units with a style number of X3. Operating power terminals are listed in Table 4-3.

Table 4-3. Operating Power Terminals

Terminal	Description
C5 (A)	A-phase operating power input
C6 (B)	B-phase operating power input
C7 (C)	C-phase operating power input

Chassis Ground

Terminal C8 (GND) serves as the chassis ground connection.

Generator and Bus Voltage Sensing

The DECS-200N accommodates either three-phase or single-phase generator sensing voltage with four automatically selected ranges: 120, 240, 480, or 600 Vac for 60 hertz systems or 100, 200, 400, or 500 Vac for 50 hertz systems.

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 voltage sensing ranges.

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

Table 4-4. Generator and Bus Voltage Sensing Terminals

Terminal	Description
A1 (E1)	A-phase generator voltage sensing input
A2 (E2)	B-phase generator voltage sensing input
A3 (E3)	C-phase generator voltage sensing input
A4 (B1)	A-phase bus voltage sensing input
A5 (B3)	C-phase bus voltage sensing input
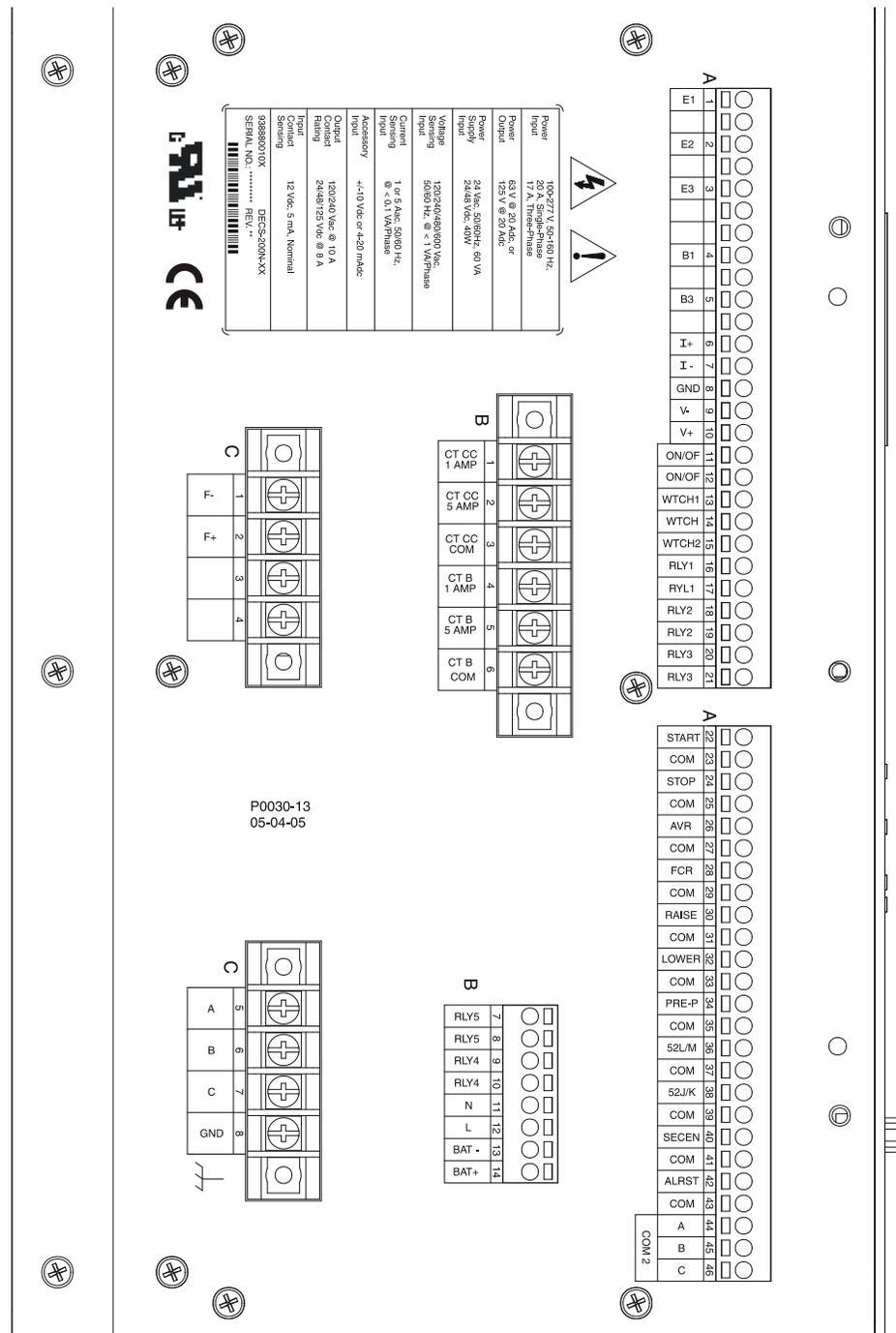
Figure 4-7. Left-Hand Panel Terminals

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 (reactive differential) compensation mode. Figure 4-8 illustrates a typical connection diagram for two paralleled generators using the five ampere sensing range on the DECS-200N 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.
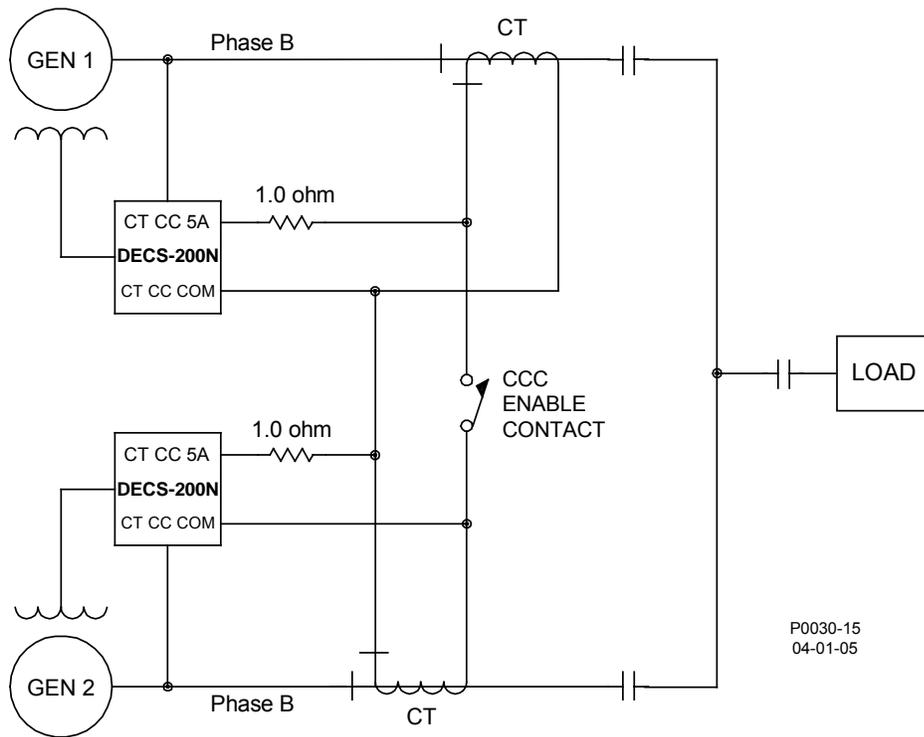
Figure 4-8. Typical Cross-Current Compensation Connections

Generator current sensing terminals are listed in Table 4-5.

Table 4-5. Generator Current Sensing Terminals

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

Accessory Input

DECS-200N units accept accessory (analog) signals from other controllers (e.g., power system stabilizers (PSS)) for remote control of the setpoint. Two types of accessory inputs are provided: voltage and current. Only one accessory input (either 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. The accessory input terminals are listed in Table 4-6.

Table 4-6. 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–)	Negative side of voltage accessory input
A10 (V+)	Positive side of voltage accessory input

Contact Inputs

The DECS-200N 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 4-7 lists the contact input terminals.

Table 4-7. Contact Input Terminals

Function	Terminal	Common Terminal	Input Type
Start	A22 (START)	A23 (COM)	Momentary
Stop	A24 (STOP)	A25 (COM)	Momentary
AVR Mode Enable	A26 (AVR)	A27 (COM)	Momentary
FCR Mode Enable	A28 (FCR)	A29 (COM)	Momentary
Raise Command	A30 (RAISE)	A31 (COM)	Momentary
Lower Command	A32 (LOWER)	A33 (COM)	Momentary
Pre-Position	A34 (PREP)	A35 (COM)	Continuous
Unit/Parallel	A36 (52L/M)	A37 (COM)	Continuous
Var/PF Enable	A38 (52J/K)	A39 (COM)	Continuous
Secondary Enable	A40 (SECEN)	A41 (COM)	Continuous
Alarm Reset	A42 (ALRST)	A43 (COM)	Momentary

Output Contacts

The DECS-200N has two dedicated contact outputs and five programmable contact outputs. All outputs are Form A (SPST) except for the Watchdog output which is a Form C (SPDT) output. Annunciation options for the programmable outputs are described in Section 3, *Functional Description*. Contact output ratings are listed in Section 1, *General Information, Specifications*. Table 4-8 lists the contact output terminals.

Table 4-8. Output Contact Terminals

Terminal	Description
A11 (ON/OF)	On/Off contact terminals
A12 (ON/OF)	
A13 (WTCH1)	Watchdog normally-closed (NC) contact terminal
A14 (WTCH)	Watchdog common contact terminal
A15 (WTCH2)	Watchdog normally-open (NO) contact terminal
A16 (RLY1)	Programmable relay #1 terminals
A17 (RLY1)	
A18 (RLY2)	Programmable relay #2 terminals
A19 (RLY2)	
A20 (RLY3)	Programmable relay #3 terminals
A21 (RLY3)	
B7 (RLY5)	Programmable relay #5 terminals
B8 (RLY5)	
B9 (RLY4)	Programmable relay #4 terminals
B10 (RLY4)	

Field Output

The DECS-200N output is capable of supplying 20 Adc of continuous excitation current to a field with no less than 3.15 ohms of resistance (at 63 Vdc) or 6.25 ohms of resistance (at 125 Vdc).

Field output terminals are listed in Table 4-9.

Table 4-9. Field Output Terminals

Terminal	Description
C1 (F–)	Field output negative terminal
C2 (F+)	Field output positive terminal

The DECS-200N load module (P/N 9388816100) connects across terminals C1 and C3 of the DECS-200N. Figure 4-9 and 4-11 illustrate the connections. A minimum wire size of 10 AWG should be used to connect the load module to the field circuit.
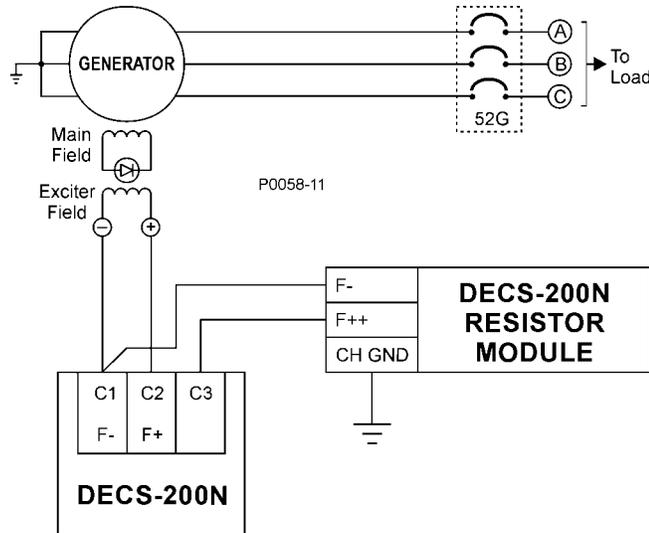
Figure 4-9. Resistor Module Connections

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 4-10. Figure 4-10 illustrates the COM 2 connections used for multiple DECS-200N units communicating over a Modbus network.

Table 4-10. COM 2 Terminals

Terminal	Description
A44 (A)	RS-485 send/receive A terminal
A45 (B)	RS-485 send/receive B terminal
A46 (C)	RS-485 signal ground terminal
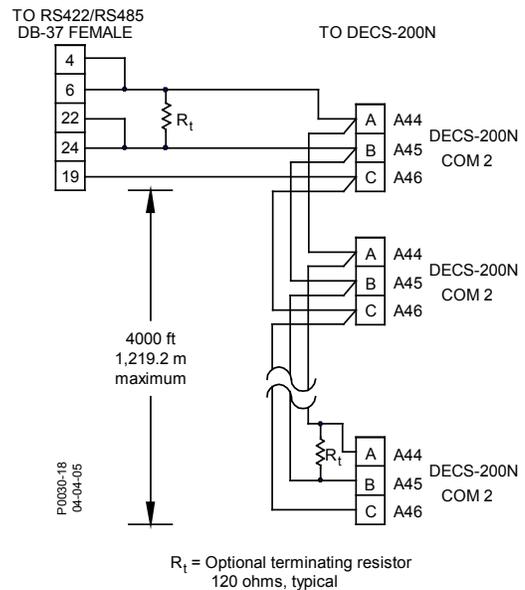
Figure 4-10. Typical COM 2 Connections

Typical AC Connections

Typical ac connections for the DECS-200N are illustrated in Figure 4-11.
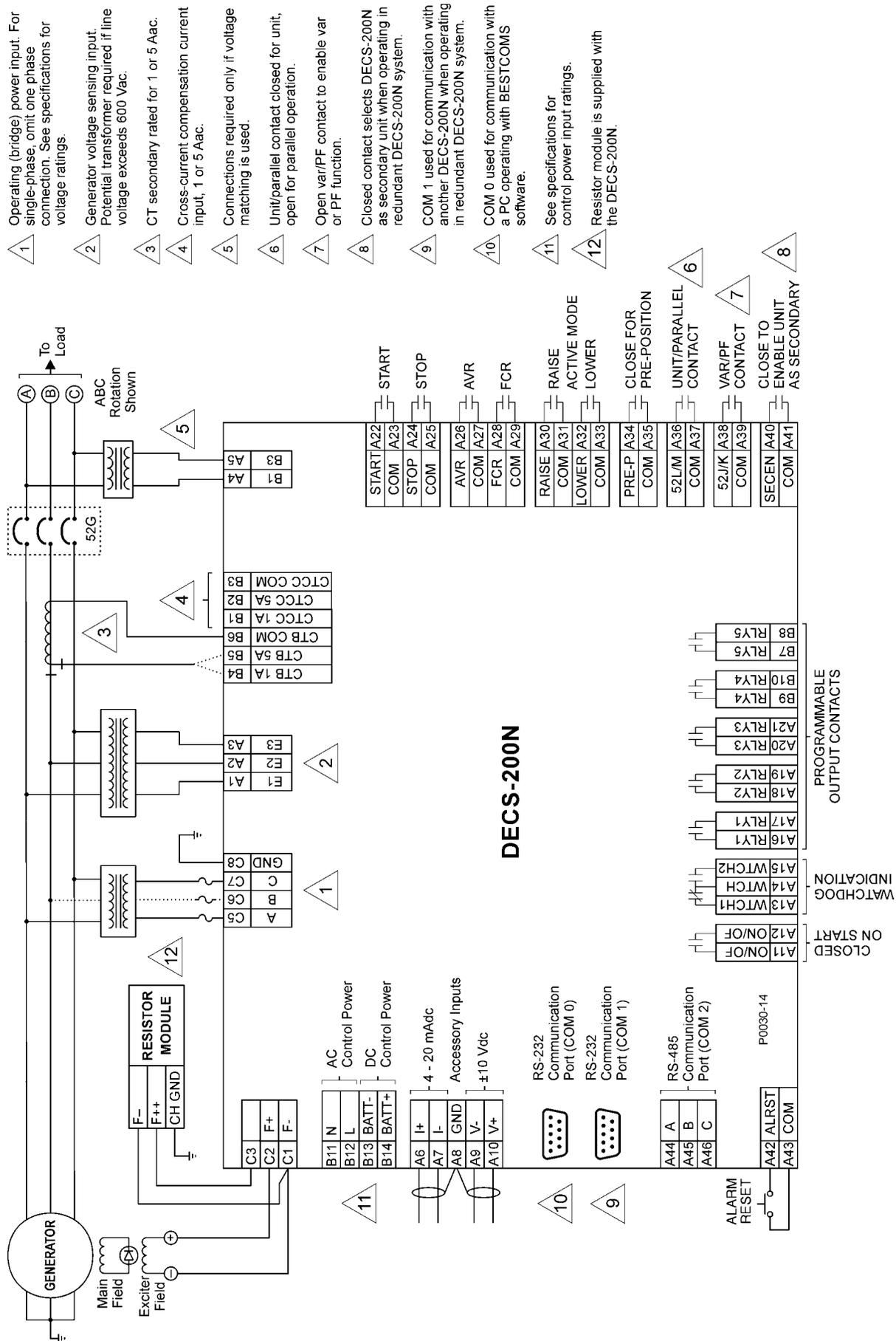
Figure 4-11. Typical AC Connections

Notes (numbered callouts):

1. Operating (bridge) power input. For single-phase, omit one phase connection. See specifications for voltage ratings.
2. Generator voltage sensing input. Potential transformer required if line voltage exceeds 600 Vac.
3. CT secondary rated for 1 or 5 Aac.
4. Cross-current compensation current input, 1 or 5 Aac.
5. Connections required only if voltage matching is used.
6. Unit/parallel contact closed for unit, open for parallel operation.
7. Open var/PF contact to enable var or PF function.
8. Closed contact selects DECS-200N as secondary unit when operating in redundant DECS-200N system.
9. COM 1 used for communication with another DECS-200N when operating in redundant DECS-200N system.
10. COM 0 used for communication with a PC operating with BESTCOMS software.
11. See specifications for control power input ratings.
12. Resistor module is supplied with the DECS-200N.

SECTION 5 • BESTCOMS™ SOFTWARE

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SECTION 5 • BESTCOMS™ SOFTWARE

INTRODUCTION

BESTCOMS-DECS200N is a Windows®-based application that provides a user-friendly environment for programming and customizing the DECS-200N. In addition to screens for configuring DECS-200N 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 makes the selection of stability settings fast and easy.

CAUTION
This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

INSTALLATION

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

- IBM compatible PC, 486 DX2 or faster (100 MHz or higher speed microprocessor recommended), with a minimum 20 MB of RAM
- Windows® XP (32-bit SP2/SP3), Vista (32-bit all editions), 7 (32/64-bit all editions), 8 (32/64-bit all editions)
- CD-ROM drive
- One available serial port (19200 baud) or USB port with a USB to serial converter

BESTCOMS is installed on a PC by performing the following steps:

1. Insert the DECS-200N CD-ROM into the PC CD-ROM drive
2. When the DECS-200N setup and documentation CD menu appears, click the Install button for BESTCOMS-DECS200N. 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 Windows Start button and pointing to Programs. The Basler Electric folder contains an icon for BESTCOMS-DECS200N.

Connecting the DECS-200N and PC

Connect a communication cable between the DECS-200N 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-DECS200N 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 5-6).

Establishing Communication

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

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

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

Figure 5-1. Wait Dialog Box

Configuring the Communication Ports

DECS-200N communication settings are changed through the Communication Port Settings screen. To access the Communication Port Settings screen, click **Communication** 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. The settings of the front-panel port are adjusted by selecting COM0 RS-232. The settings of the port on the right-hand panel are adjusted by selecting COM1 RS-232. The settings of the port on the left-hand panel are adjusted by selecting COM2 RS-485.

Baud Rate. The baud rate can be adjusted only for ports Com 1 and Com 2. A baud rate of 1200, 2400, 4800, 9600, or 19200 may be selected.

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.

Figure 5-2. Communication Port Settings

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 0 to 200 milliseconds may be entered in 10 millisecond increments.

Communication port settings changes are enabled by clicking the OK button and discarded by clicking the Cancel button.

Configuring the Real-Time Clock

DECS-200N timekeeping is set and configured through the Set Real Time Clock screen (Figure 5-3). To access the Set Real Time Clock screen, click **Configure** on the menu bar and click **Real Time Clock**. The DECS-200N 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-200N. 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.
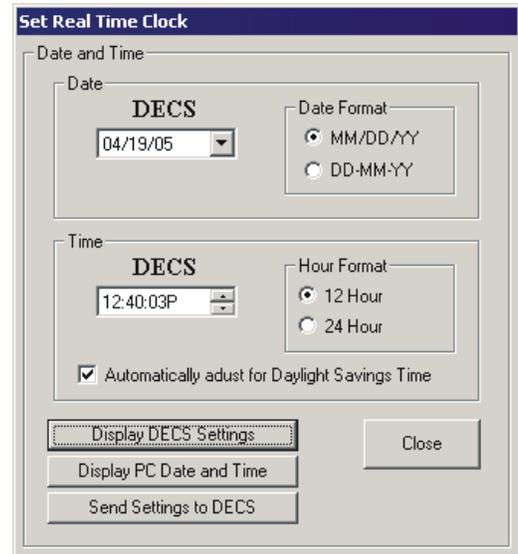
Figure 5-3. Set Real Time Clock Screen

Assigning Identification Labels

Identification labels can be assigned to the DECS-200N through the Device ID screen (Figure 5-4). The information entered on the Device ID screen identifies the DECS-200N 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.
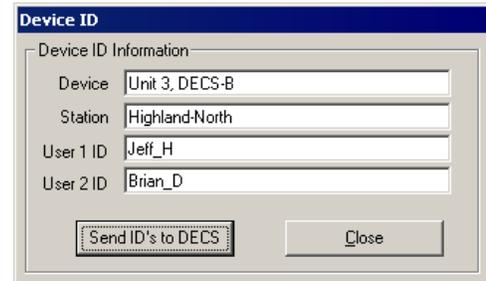
Figure 5-4. Device ID Screen

Creating a Password

Password protection guards against unauthorized changing or viewing of DECS-200N settings. A single password protects all DECS-200N settings. The DECS-200N is delivered with a default password of *decs2*. The password can be changed only after communication between BESTCOMS and the DECS-200N 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 5-5, 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 5-5. 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 increment 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 selected setting.

Sending Settings to the DECS-200N

Once all desired setting changes have been made on a setting group screen, the settings must be sent to the DECS-200N before viewing other screens. Otherwise, the setting changes will be lost. Setting changes can be sent to the DECS-200N 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-200N by pressing the Enter key. Functions controlled by option buttons or checkboxes are immediately sent to the DECS-200N when the option button or checkbox is selected.

Retrieving DECS-200N Settings

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

Saving Settings in DECS-200N Memory

DECS-200N 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-200N, 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.

SETTINGS, METERING VALUES, AND DATA RECORDS

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

- 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 screens and tabs.

System Configuration

The System Configuration screen consists of six tabs labeled Sys Options, Sys Data, Rated Data, 52 Contacts, Aux Input, and Bridge. To view the System Configuration screen, click the **Configure** button on the tool bar or click **Screens** on the menu bar and click **System Configuration**.

Only five tabs are displayed when BESTCOMS is communicating with a DECS-200N equipped with firmware older than version 1.03.00. In this case, the 52 Contacts tab is not displayed.

System Options

System Options tab functions are shown in Figure 5-6 and described in the following paragraphs.

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, 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.
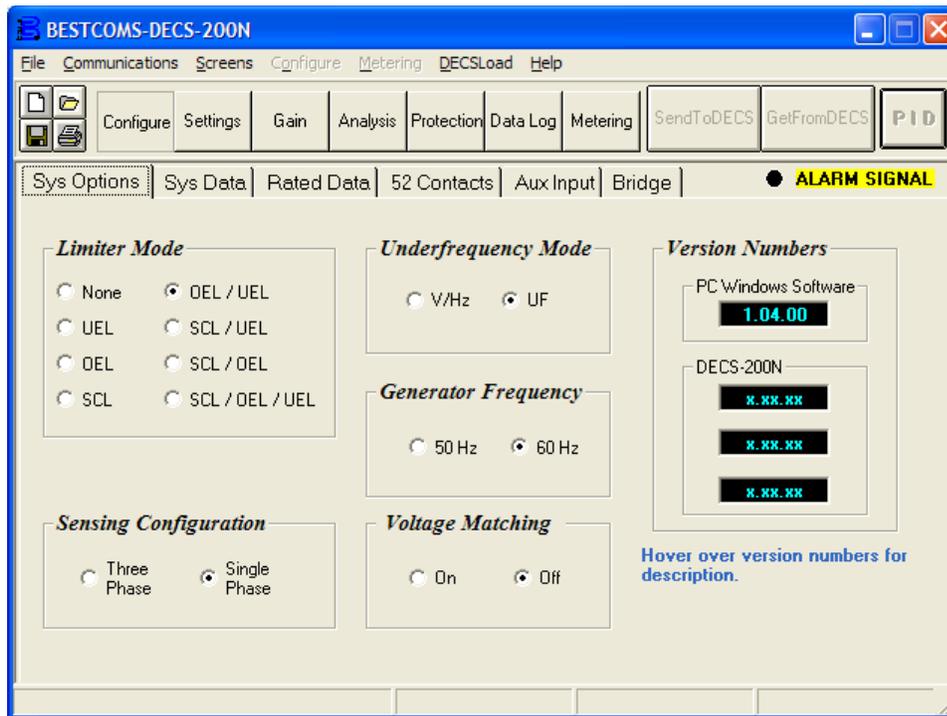
Figure 5-6. System Configuration Screen, System Options Tab

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

Version Numbers. These four read-only fields display the version of BESTCOMS (PC Windows software) and the versions of DECS-200N firmware. DECS-200N firmware consists of the main processor firmware, digital signal processor (DSP) firmware, and the bridge processor firmware. In order for the DECS-200N firmware versions to be displayed, communication must be established between BESTCOMS and the DECS-200N.

System Data

System Data tab functions are shown in Figure 5-7 and described in the following paragraphs.
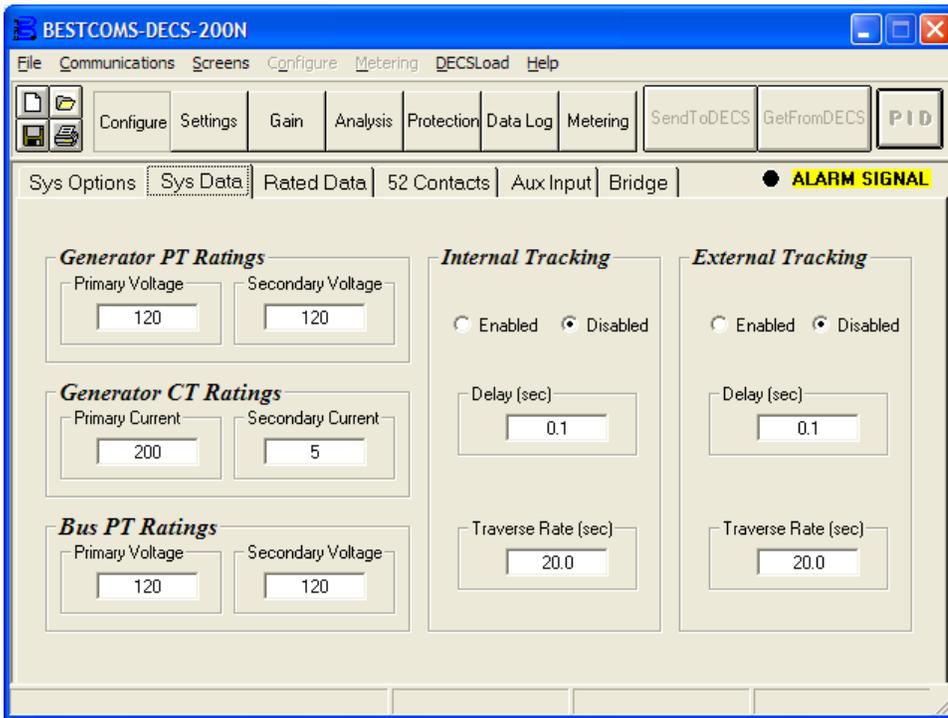
Figure 5-7. System Configuration Screen, System Data Tab

Generator PT Ratings–Primary Voltage. Sets the rated primary voltage of the generator potential transformer (PT). 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 (PT). 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). 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). 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–Enabled/Disabled. Enables or disables tracking of a second DECS-200N's setpoint.

External Tracking–Delay. Determines the time delay between a transfer to a second DECS-200N and the start of tracking of the second DECS-200N setpoint. A setting of 0 to 8.0 seconds may be entered in 0.1 second increments.

External Tracking–Traverse Rate. Determines the amount of time required for the DECS-200N to traverse (cross) the full setting range of a second, active DECS-200N. 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 5-8 and described in the following paragraphs.
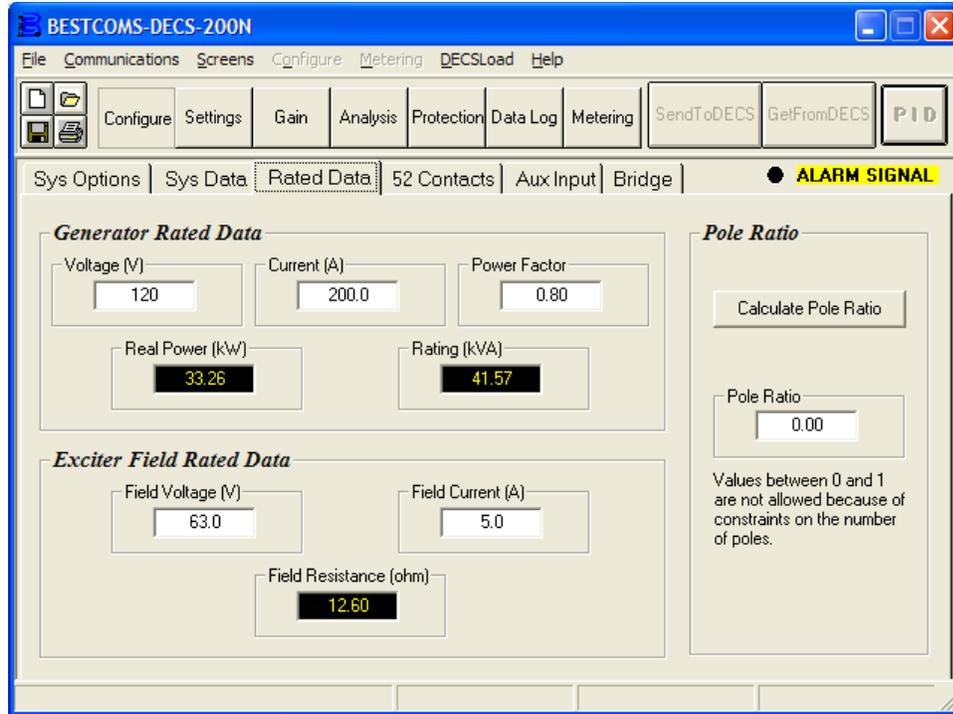
Figure 5-8. System Configuration Screen, Rated Data Tab

Generator Rated Data–Voltage. Sets the rated line-to-line 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 5-9). 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.
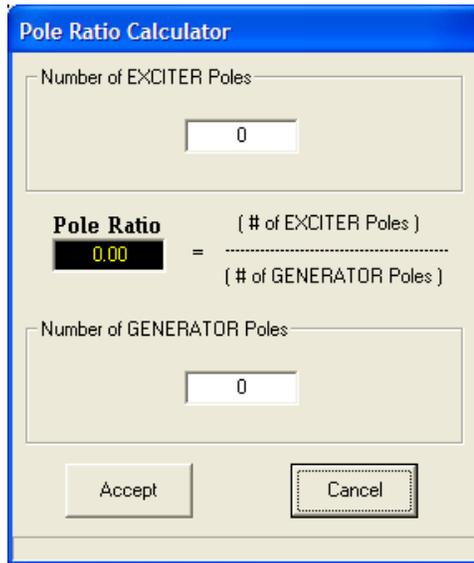
Figure 5-9. Pole Ratio Calculator

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. A pole ratio between 1.5 and 10 is recommended for proper exciter diode monitor (EDM) operation. This value can be automatically calculated using the pole ratio calculator, accessed by clicking the Calculate Pole Ratio button.

<u>52 Contacts</u>

The 52 Contacts tab settings are illustrated in Figure 5-10 and described in the following paragraphs. The 52 contacts option selected should be coordinated with the voltage matching disable contact selection made on the Startup tab of the Settings page.
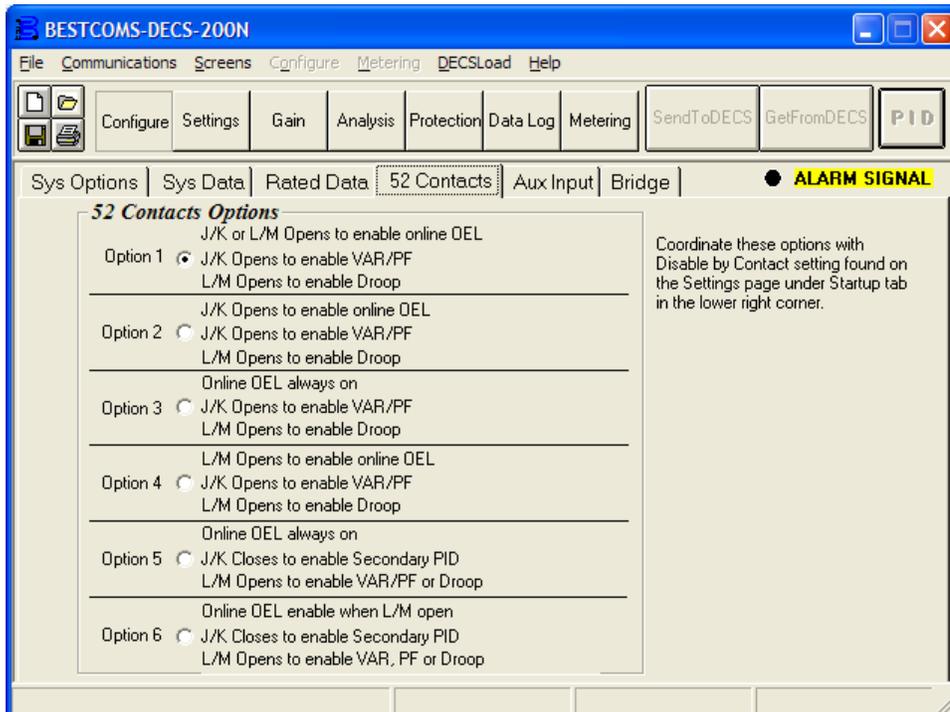
Figure 5-10. System Configuration Screen, 52 Contacts Tab

Option 1. Open 52J/K contacts enable var/power factor control; otherwise, var/power factor control is disabled. Open 52L/M contacts enable droop; otherwise, droop is disabled. Open 52J/K or open 52L/M contacts enable the on-line OEL; otherwise, the off-line OEL is used.

Option 2. Open 52J/K contacts enable var/power factor control and the on-line OEL; otherwise, var/power factor control is disabled and the off-line OEL is used. Open 52L/M contacts enable droop; otherwise, droop is disabled.

Option 3. Open 52J/K contacts enable var/power factor control; otherwise, var/power factor control is disabled. Open 52L/M contacts enable droop; otherwise, droop is disabled. The on-line OEL is always enabled.

Option 4. Open 52J/K contacts enable var/power factor control; otherwise, var/power factor control is disabled. Open 52L/M contacts enable droop and the on-line OEL; otherwise, droop is disabled and the off-line OEL is used.

Option 5. Closed 52J/K contacts enable the secondary PID settings; otherwise, the primary PID settings are used. Open 52L/M contacts enable var/power factor control or droop; otherwise, var/power factor control and droop are disabled. The on-line OEL is always enabled.

Option 6. Closed 52J/K contacts enable the secondary PID settings; otherwise, the primary PID settings are used. Open 52L/M contacts enable var/power factor control or droop; otherwise, var/power factor control and droop are disabled. Open 52L/M contacts enable the on-line OEL; otherwise, the off-line OEL is used.

Because units with firmware older than version 1.03.00 do not have all of the options contained on the 52 Contacts tab, this tab is not visible when BESTCOMS is communicating with these units. The 52 contact options provided with these units are configured on the OEL Type tab of the Setting Adjustments screen. The OEL Type tab is visible only when BESTCOMS is communicating with a DECS-200N equipped with firmware older than version 1.03.00.

Auxiliary Input

Auxiliary Input tab functions are shown in Figure 5-11 and described in the following paragraphs.
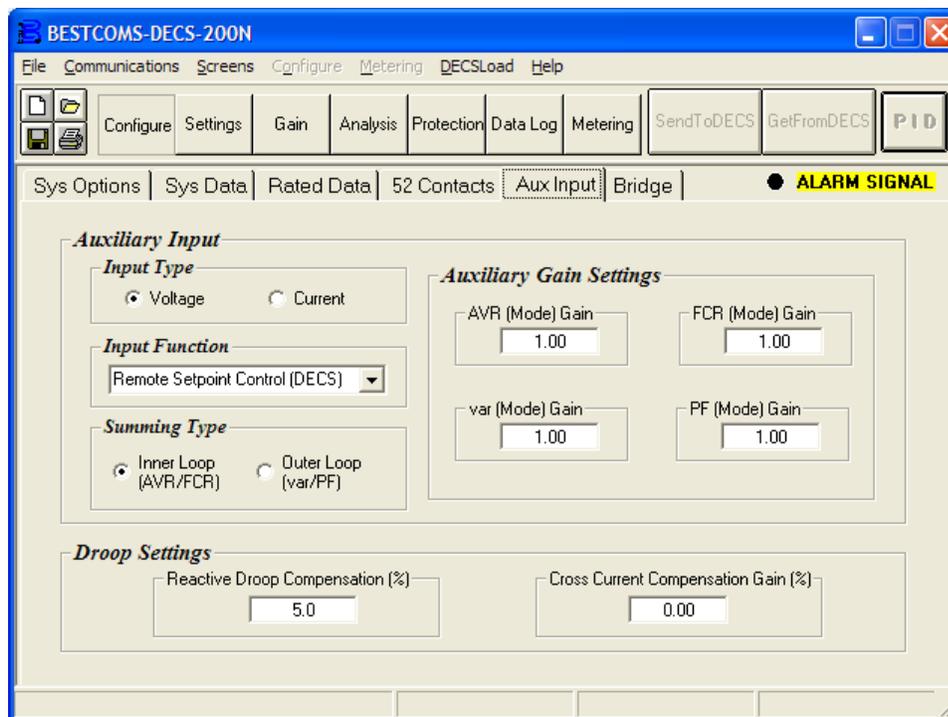
Figure 5-11. System Configuration Screen, Auxiliary Input Tab

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

Auxiliary Input–Input Function. Determines how the auxiliary input signal is used. Selecting Remote Setpoint Control (DECS) configures the auxiliary input signal to control the DECS-200N active operating mode setpoint. Selecting Limiter Scaling configures the auxiliary input signal to scale the OEL or SCL limiter functions.

This setting is not visible when BESTCOMS is communicating with a unit that has firmware older than version 1.03.00.

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 or 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. A setting of zero disables the accessory input for that operating mode.

Droop Settings–Reactive Droop Compensation. Sets the level of droop compensation for paralleled generators or line-drop compensation. A setting of –30 to +30 may be entered in 0.01 increments.

Droop Settings–Cross Current Compensation Gain. Sets the level of cross-current compensation (reactive differential) gain for paralleled generators. A setting of –30 to +30 may be entered in 0.01 increments.

Bridge Control

Bridge Control tab functions are illustrated in Figure 5-12 and described in the following paragraphs.
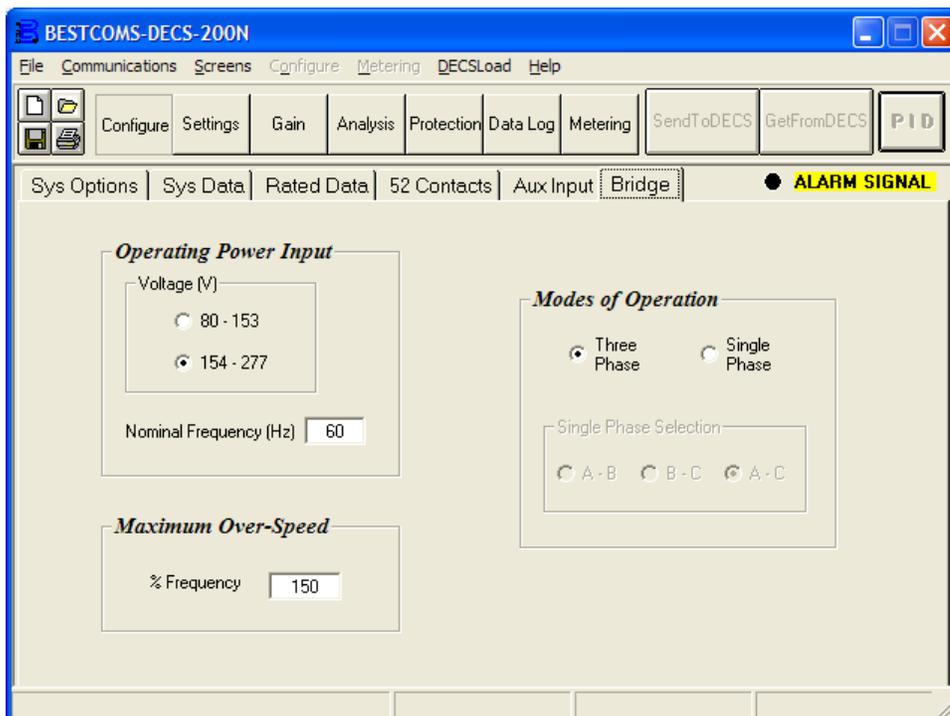
Figure 5-12. System Configuration Screen, Bridge Control Tab

Power Input–Voltage. Selects the input power range for the bridge. A range of 80 to 153 Vac or 154 to 277 Vac can be selected.

Power Input–Nominal Frequency. Sets the frequency of the bridge power voltage. A setting of 50 to 500 Hz may be entered in 1 Hz increments. Note that DECS-200N units with style number X1 have a bridge power frequency range of 50 to 160 Hz, units with style number X2 have a bridge power frequency range of 161 to 420 Hz, and units with style number X3 have a bridge power frequency range of 421 to 500 Hz.

Maximum Overspeed–% Frequency. Sets the maximum overspeed frequency, expressed as a percentage of the nominal bridge power frequency. A setting of 50 to 320% may be entered in 1% increments.

Modes of Operation–Three-Phase/Single-Phase. Selects either three-phase or single-phase bridge operating power.

Modes of Operation-Single-Phase Selection. When single-phase bridge operating power is used, this setting selects the two phases that will supply bridge operating power. Setting selections are A-B, B-C, and A-C. This setting is disabled when three-phase bridge power is selected.

Setting Adjustments

The Setting Adjustments screen consists of nine tabs labeled AVR/FCR, var/PF, Startup, OEL (Sum.), OEL (Take.), UEL, SCL, and SCL. To view the Setting Adjustments 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 5-13 and described in the following paragraphs.
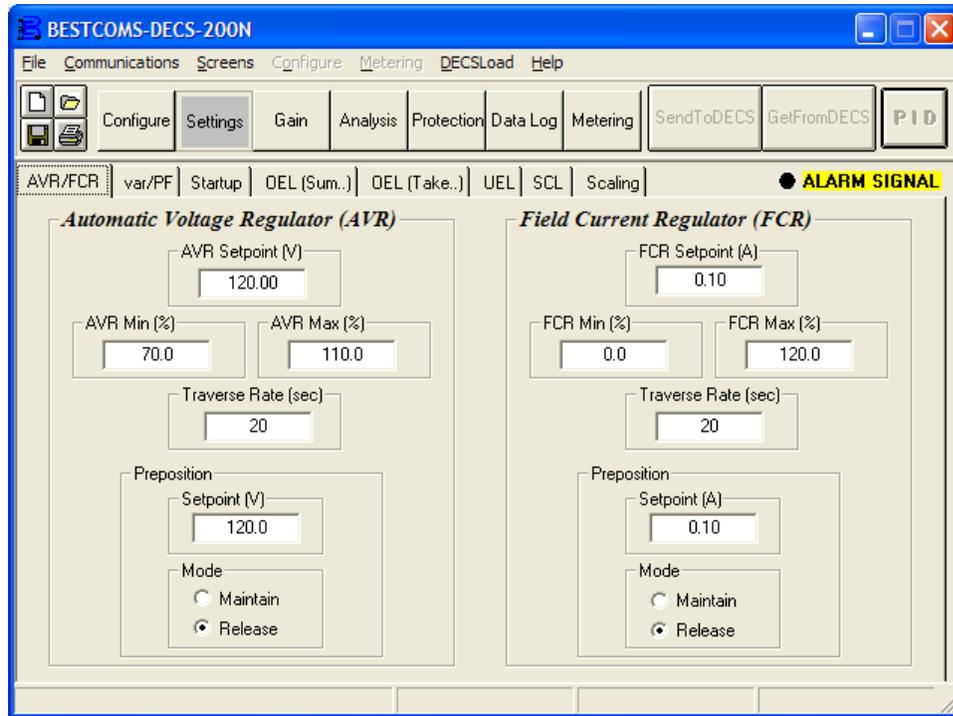
Figure 5-13. Setting Adjustments Screen, AVR/FCR Tab

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 field.

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 100 to 110% may be entered in 0.1% increments.

Automatic Voltage Regulator–Traverse Rate. 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 used, primary voltage should be entered.

Automatic Voltage Regulator–Pre-Position Mode. Determines whether or not the DECS-200N 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 0 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–Pre-Position 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-200N 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 5-14 and described in the following paragraphs.
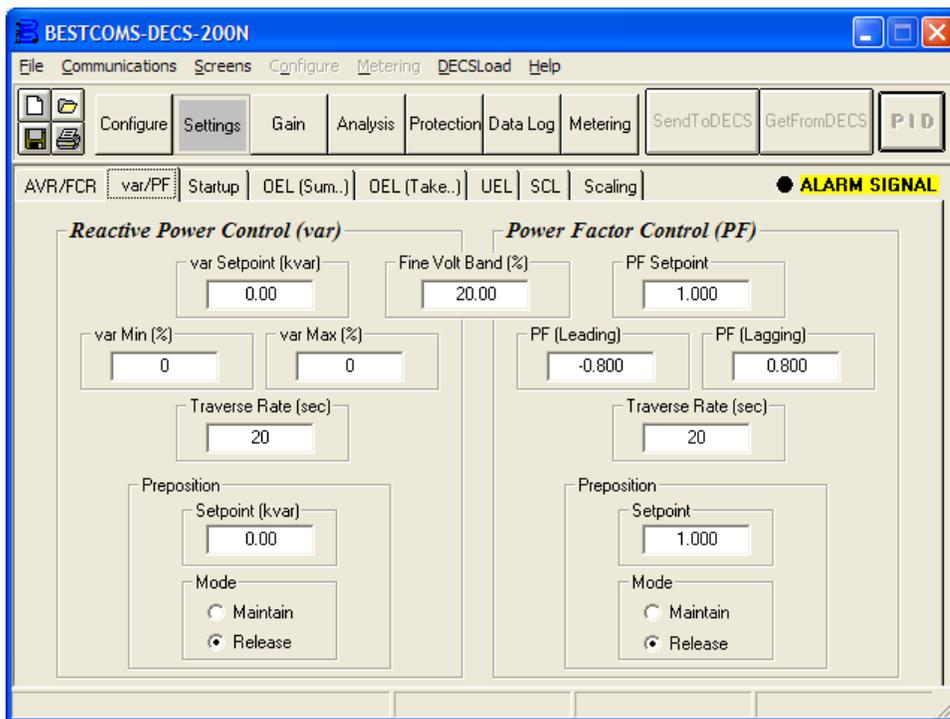
Figure 5-14. Setting Adjustments Screen, var/PF Tab

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–Pre-Position 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–Pre-Position Mode. Determines whether or not the DECS-200N 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/Power Factor–Fine Volt Band. Sets the upper and lower boundaries of voltage correction when operating in var or PF mode. The fine voltage adjustment band setting is expressed as a percentage of the nominal generator voltage. A setting of 0 to 30% may be entered in 0.01% increments.

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. 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–Pre-Position 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–Pre-Position Mode. Determines whether or not the DECS-200N 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.

<u>Startup</u>

Startup tab settings are illustrated in Figure 5-15 and described in the following paragraphs.
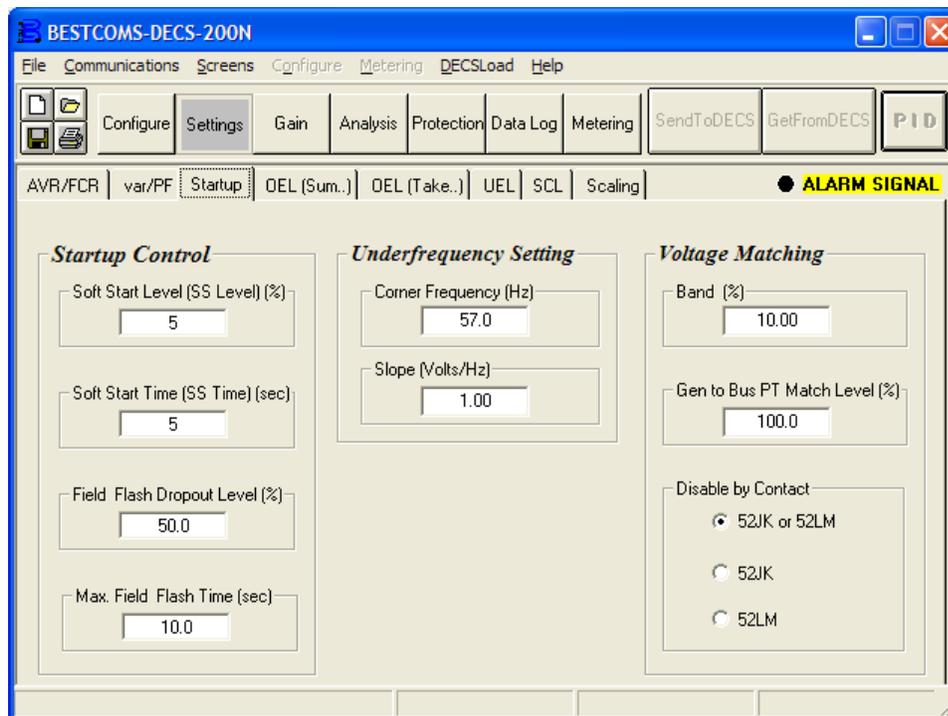
Figure 5-15. Setting Adjustments Screen, Startup Tab

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.

Startup Control–Field Flash Dropout Level. Establishes the level of generator voltage where field flashing is withdrawn. This setting is expressed as a percentage of the nominal generator terminal voltage. A setting of 0 to 100% may be entered in 0.1% increments.

Startup Control–Max. Field Flash Time. Dictates the maximum length of time that field flashing may be applied during startup. A setting of 0 to 50 seconds may be entered in 0.1 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 compensating 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.

Voltage Matching–Disable by Contact. Selects the DECS-200N contact inputs that will disable voltage matching. Options include 52J/K, 52L/M, or either 52J/K or 52L/M. When voltage matching is enabled, the DECS-200N automatically adjusts the field current to match the generator output voltage with the bus voltage prior to synchronizing.

<u>OEL (Sum.)</u>

Summing-Point Overexcitation Limiter tab settings are illustrated in Figure 5-16 and described in the following paragraphs.
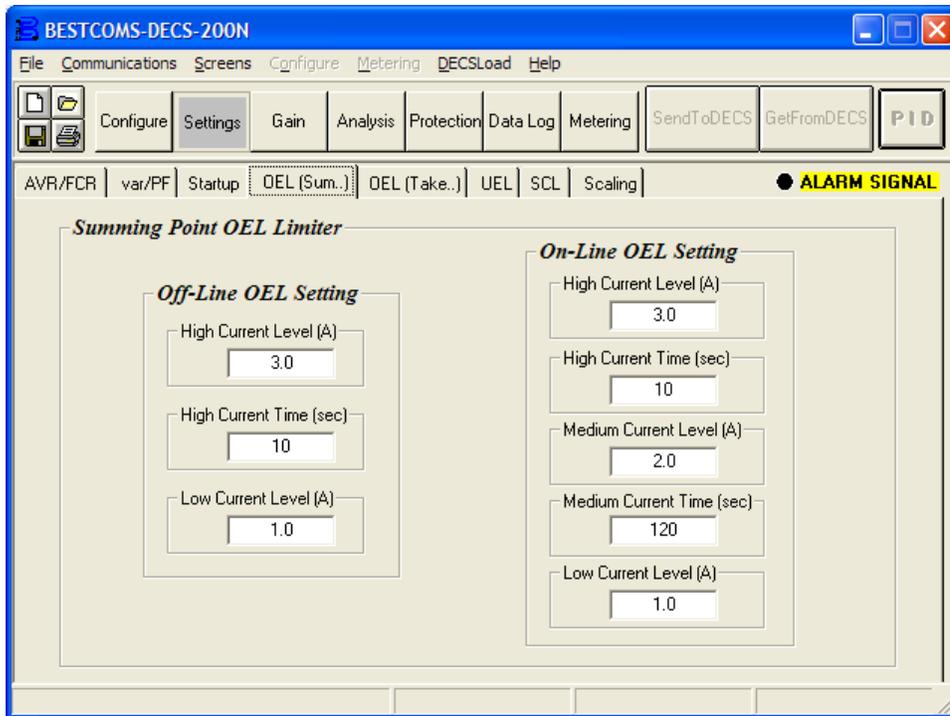
Figure 5-16. Setting Adjustments Screen, OEL (Summing) Tab

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 40 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 20 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 40 Adc may be entered in 0.1 Adc increments.

On-Line OEL Setting–High Current Time. Sets the duration for the high current setpoint of the on-line, summing-point , overexcitation limiter. A setting of 0 to 10 seconds may be entered in 1 second 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 30 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 20 Adc may be entered in 0.1 Adc increments.

OEL (Take.)

Takeover Overexcitation Limiter tab functions are illustrated in Figure 5-17 and described in the following paragraphs.
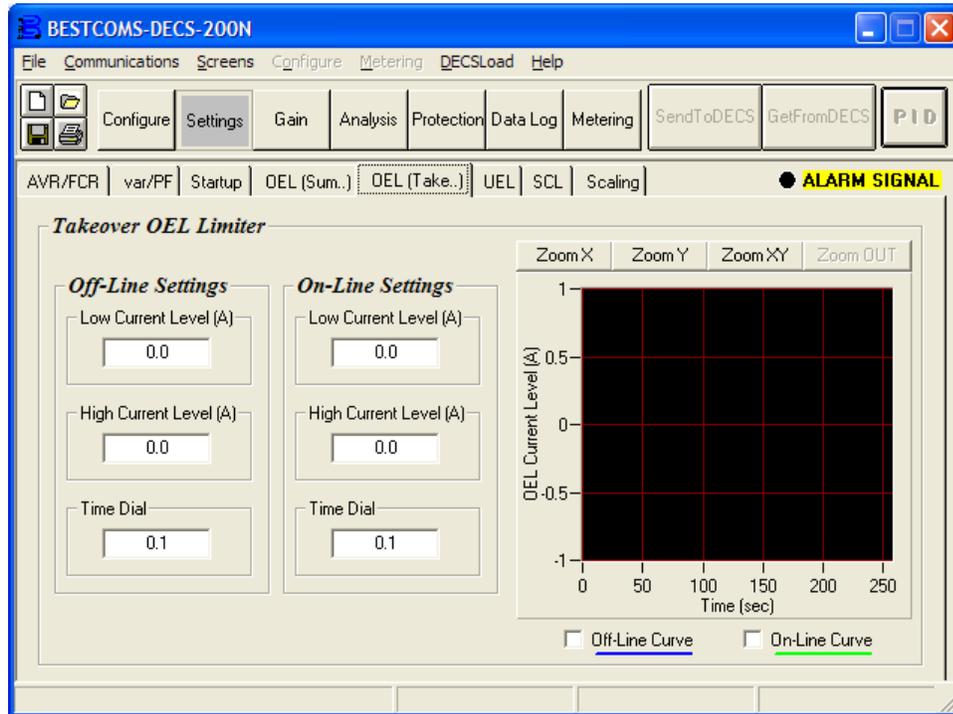
Figure 5-17. Setting Adjustments Screen, OEL (Takeover) Tab

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 40 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.

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 20 Adc may be entered in 0.1 Adc increments.

On-Line Settings–High Current Level. Establishes the high-level current setpoint for the on-line, takeover-style, overexcitation limiter. A setting of 0 to 40 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 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 under-excitation limiting curve. Selecting "3 point", "4 point", or "5 point" enables the user to create a custom UEL curve that matches specific generator characteristics. When "Internal" is selected, the DECS-200N 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.
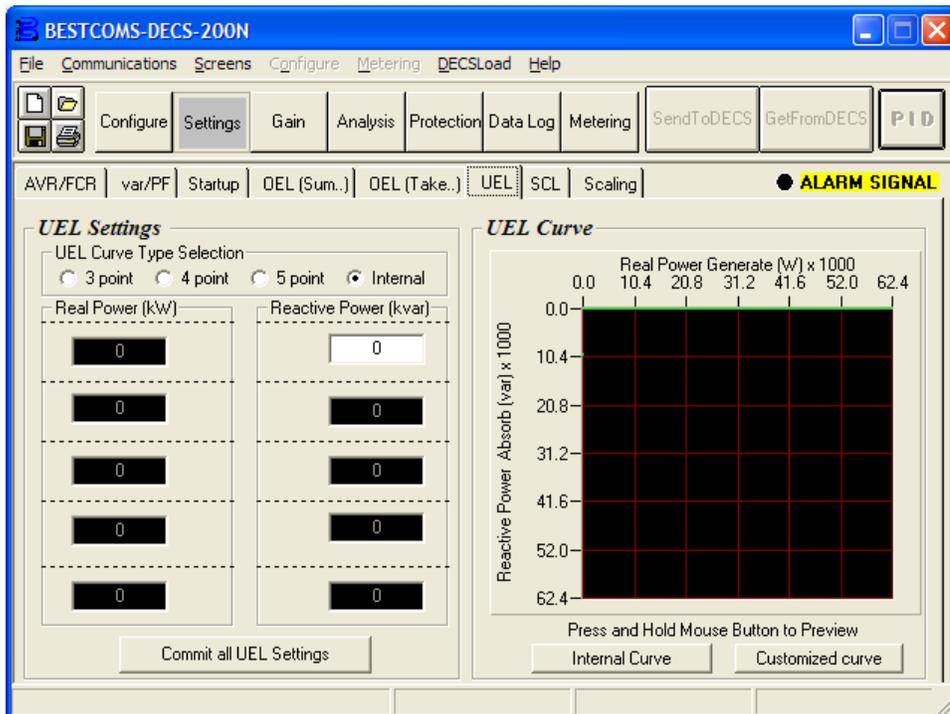
Figure 5-18. Setting Adjustments Screen, UEL Tab

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 two 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 on 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.

<u>SCL</u>

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

Stator Current Limiter, Initial Delay. The SCL does not respond until the Initial Delay has expired. A setting of 0 to 10 may be entered in 0.1 second increments.

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.
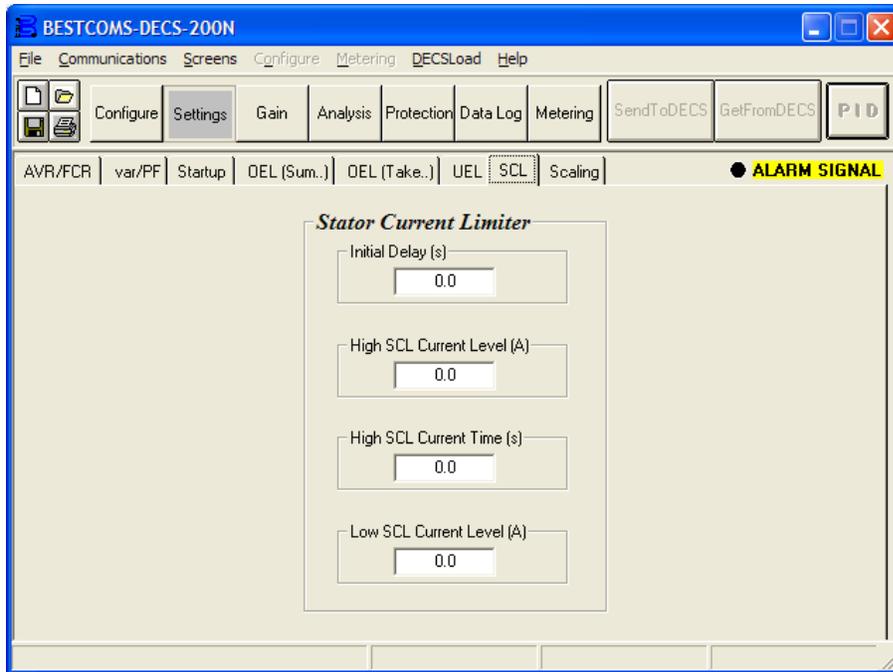
Figure 5-19. Setting Adjustments Screen, SCL Tab

<u>Scaling</u>

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

Because units with firmware older than version 1.03.00 do not have all of the options contained on the Scaling tab, this tab is not visible when BESTCOMS is communicating with these units. The OEL limiter style of units with firmware older than version 1.03.00 is selected on the OEL Type tab of the Setting Adjustments screen. The OEL Type tab is visible only when BESTCOMS is communicating with a DECS-200N equipped with firmware older than version 1.03.00. See Appendix C for information about configuring OEL Type tab settings.
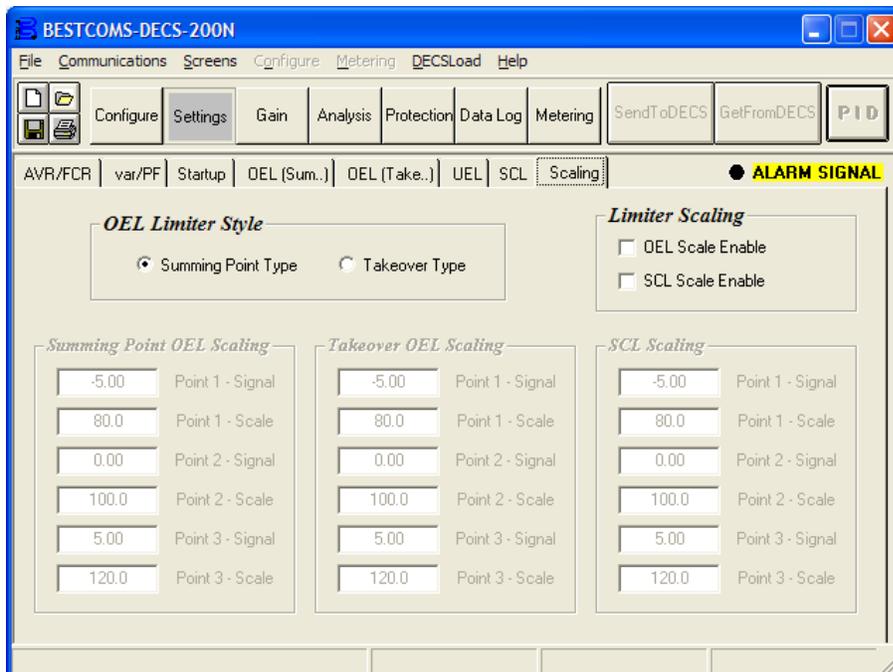
Figure 5-20. Setting Adjustments Screen, Scaling Tab

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

Limiter Scaling. When enabled, limiter scaling is controlled by the auxiliary input signal applied to the DECS-200N and is user-defined by a three-point, piece-wise linear function for each limiter.

Enabling OEL scaling allows the overexcitation limiter to compensate for the level of field current. Enabling SCL scaling allows the stator current limiter to compensate for the level of stator current.

To enable the auxiliary input to control limiter scaling, the Input Function type (Aux Input tab of System Configuration screen) must be set for Limiter Scaling.

Summing Point OEL Scaling. Scaling of summing-point overexcitation limiting is provided for three levels (or points) of field current. Each level, or point, has a Signal setting to adjust the scaling level and a Scale setting to establish the level of field current where the scaling occurs. Each of the three Signal settings has a setting range of −10 to +10 Vdc with increments of 0.01 Vdc. Each of the three Scale settings is expressed as a percentage of the rated field current and has a setting range of 0 to 200% with increments of 0.1%. These settings are enabled only when summing point overexcitation limiting is enabled on the Configuration tab of the Limiters screen.

Takeover OEL Scaling. Scaling of takeover-style overexcitation limiting is provided for three levels (or points) of field current. Each level, or point, has a Signal setting to adjust the scaling level and a Scale setting to establish the level of field current where the scaling occurs. Each of the three Signal settings has a setting range of −10 to +10 Vdc with increments of 0.01 Vdc. Each of the three Scale settings is expressed as a percentage of the rated field current and has a setting range of 0 to 200% with increments of 0.1%. These settings are enabled only when takeover overexcitation limiting is enabled on the Configuration tab of the Limiters screen.

SCL Scaling. Scaling of stator current limiting is provided for three levels (or points) of stator current. Each level, or point, has a Signal setting to adjust the scaling level and a Scale setting to establish the level of stator current when the scaling occurs. Each of the three Signal settings has a setting range of −10 to +10 Vdc with increments of 0.01 Vdc. Each of the three Scale settings is expressed as a percentage of the rated stator current and has a setting range of 0 to 200% with increments of 0.1%.

NOTE

Scaling Signal settings must be entered in volts, dc. If the limiter scaling signal is supplied from a 4 to 20 mA current transducer to the I+ and I− terminals of the DECS-200N accessory input, a calculation must be performed to convert the applied current to a voltage that can be entered as the scaling signal setting. Use the equation $V = 0.625 (I{-}12)$, where I is milliamperes, dc to calculate the corresponding voltage value for a scaling signal setting.

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

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

Gain Settings. Two buttons select between the primary and secondary control gain settings. Clicking the Primary button selects the primary control gain settings and highlights all of the associated gain setting fields with the color green. Clicking the Secondary button selects the secondary control gain settings and highlights all of the associated gain setting fields with the color yellow. The active group of control gain settings are indicated by the word "Active" below the Primary or Secondary button.

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.
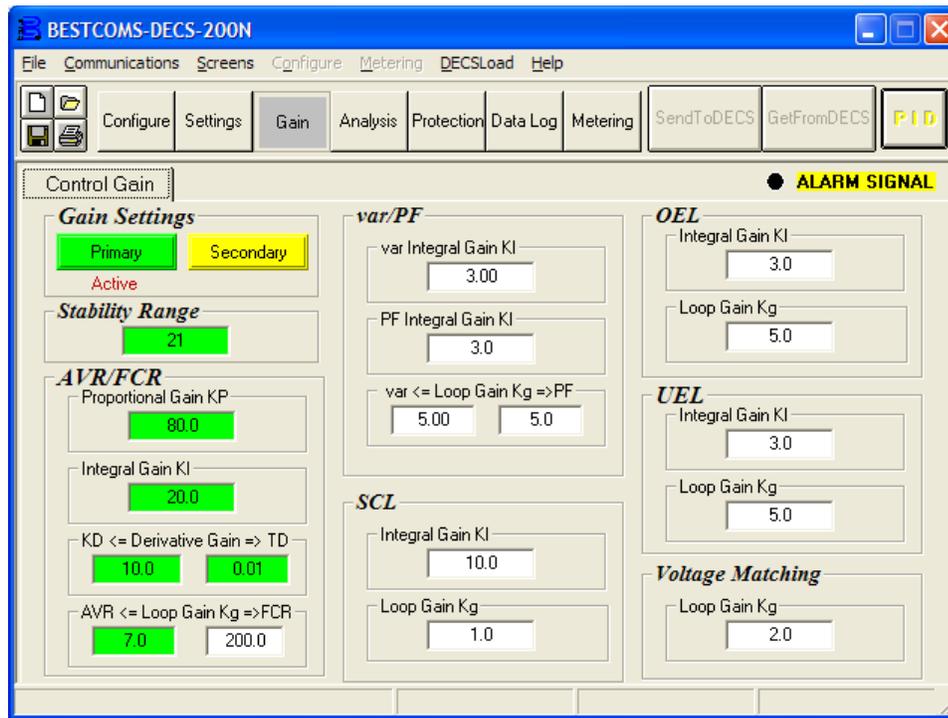
Figure 5-21. Control Gain Screen, Control Gain Tab

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-200N 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-200N provides an output value that is equivalent to KI multiplied by the integral of the error between the voltage setpoint and the actual generator output voltage. Generally, if the time to reach steady state is deemed too long, increase 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-200N 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-200N 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-200N 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-200N 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-200N 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-200N responds during an underexcitation condition. A setting of 0 to 1,000 may be entered in 0.1 increments.

UEL–Loop Gain Kg. Adjusts 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 <u>Screens</u> 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.

<u>AVR</u>

AVR tab settings are illustrated in Figure 5-22 and described in the following paragraphs.
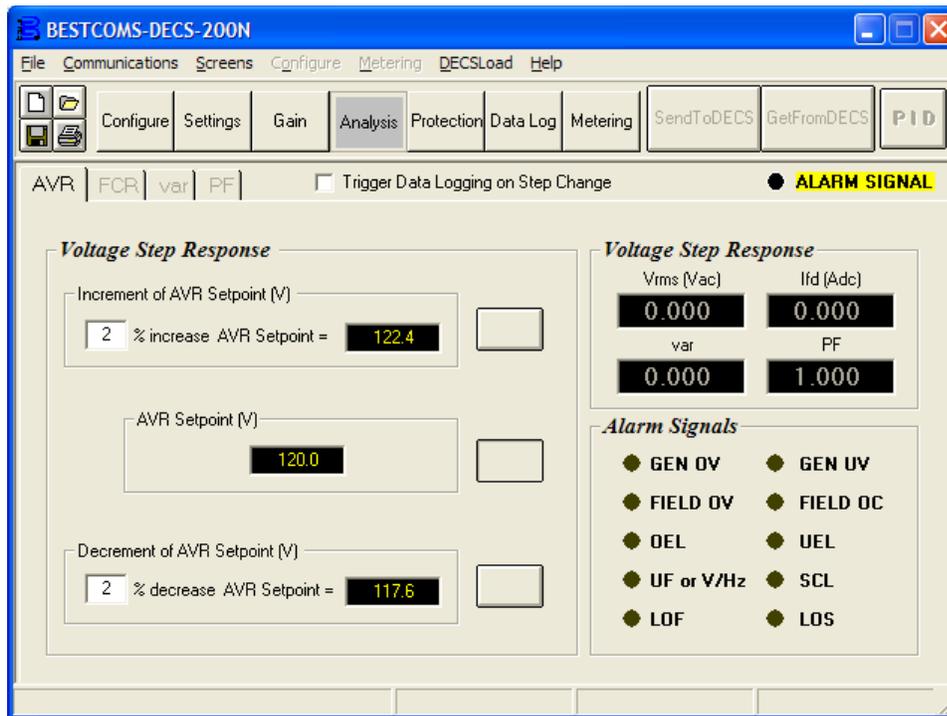
Figure 5-22. Analysis Screen, AVR Tab

Voltage Step Response–Increment of AVR Setpoint. Sets the voltage step size that the DECS-200N 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 set-point 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-200N 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, 10 alarm indicators are available to indicate system alarms. The indicators annunciate the following conditions:

- Field overcurrent
- Field overvoltage
- Generator overvoltage
- Generator undervoltage
- Loss of field

- Loss of sensing
- Overexcitation limiting
- Stator current limiting
- Underexcitation limiting
- Underfrequency or volts per hertz

Alarm annunciations are updated approximately once every second.

FCR

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

Field Current Step Response–Increment of FCR Setpoint. Sets the current step size that the DECS-200N 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.
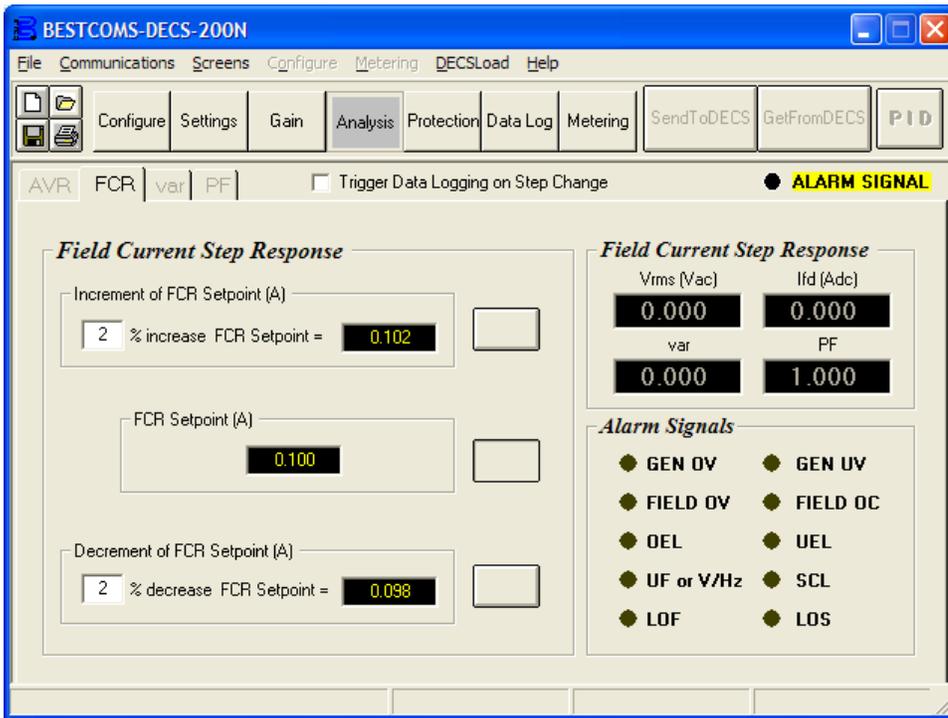
Figure 5-23. Analysis Screen, FCR Tab

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-200N 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.

<u>*Var*</u>

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

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-200N 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-200N 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.
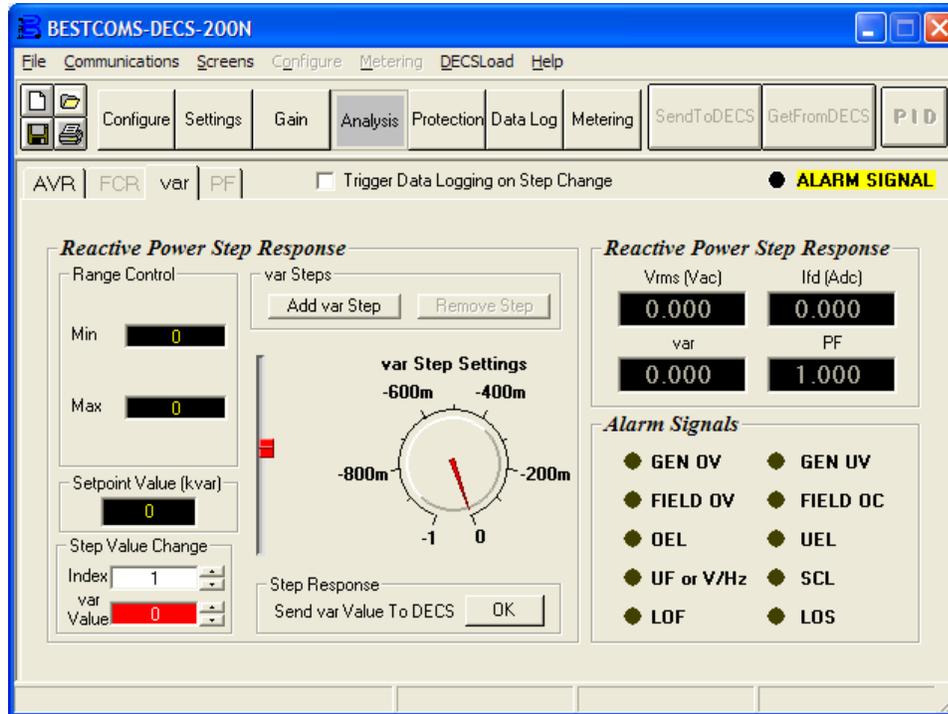
Figure 5-24. Analysis Screen, var Tab

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 in 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 about adding setpoint indexes (var steps).

Reactive Power Step Response–var Steps-Remove Step. Removes the last setpoint index created.

Reactive Power Step Response–var. 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, 10 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.

<u>PF</u>

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

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 Step. 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.
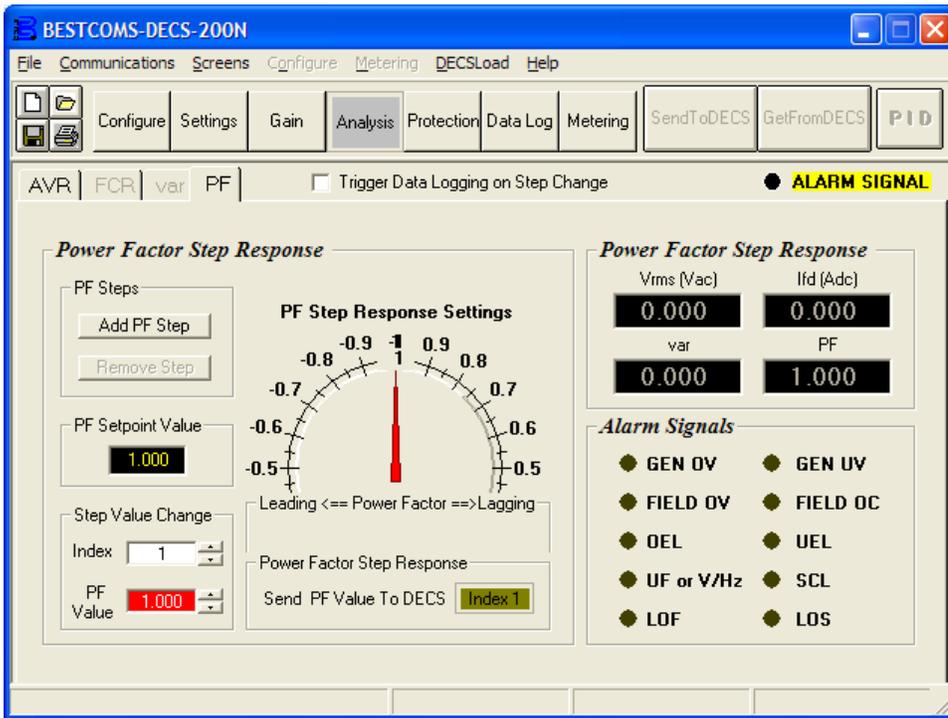
Figure 5-25. Analysis Screen, PF Tab

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-200N 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-200N 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 cooler 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, 10 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 four tabs labeled Options, Settings, Relay Logic, and Relay Settings. The Relay Logic and Relay Settings tabs each have five sub-tabs labeled Relay 1, Relay 2, Relay 3, Relay 4, and Relay 5. 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 5-26 and described in the following paragraphs.
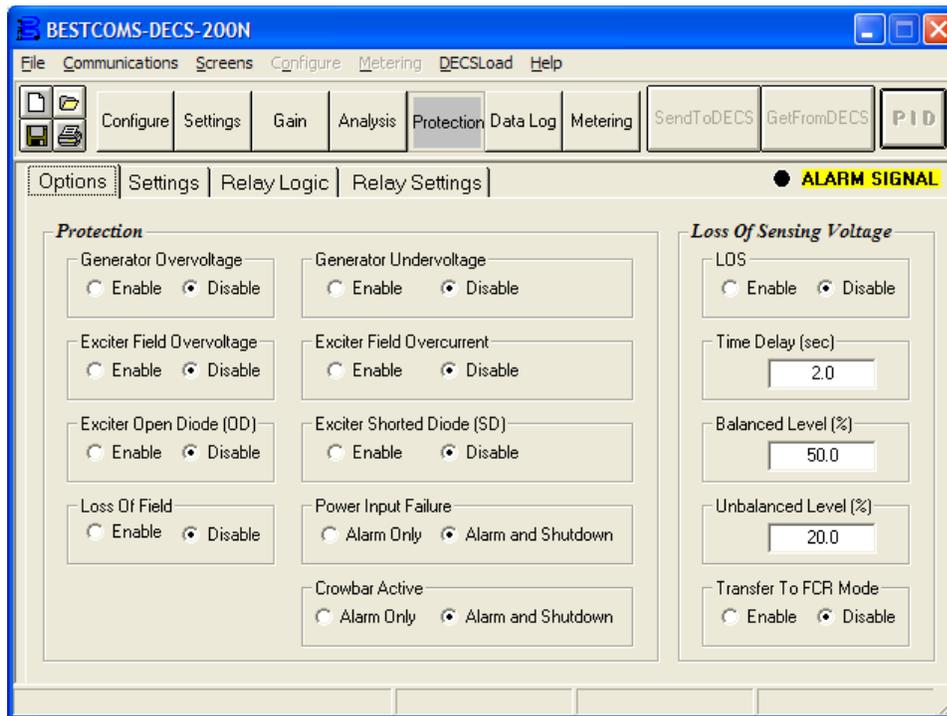
Figure 5-26. Protection/Relay Screen, Options Tab

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

CAUTION

For power input failure protection, Alarm and Shutdown is the recommended selection for most applications. If Alarm Only is selected and operating power is lost and then restored, the DECS-200N may resume field excitation in a full-on state.

The Power Input Failure protection function has two annunciation/protection modes. Selecting Alarm Only will trigger annunciation of the condition during a loss of operating (bridge) power. Selecting Alarm and Shutdown triggers an annunciation and disables the DECS-200N excitation output until operating power is restored and the Power Input Failure alarm is reset. Alarm and Shutdown is the default and recommended selection for most applications. If Alarm Only is selected and operating power is lost and then restored, the DECS-200N may resume field excitation in a full-on state. This condition could result in a generator overvoltage condition which may damage the generator.

CAUTION

For crowbar active protection, Alarm and Shutdown is the recommended selection for most applications. If Alarm Only is selected and the crowbar is activated, the DECS-200N may apply full excitation power following removal of the crowbar.

The Crowbar Active protection function also has two annunciation/protection modes: Alarm Only and Alarm and Shutdown. Selecting Alarm Only will trigger annunciation of the condition if the field voltage exceeds –800 Vdc for 0.5 milliseconds and the crowbar places a short-circuit across the field. Selecting Alarm and Shutdown triggers an annunciation and disables the DECS-200N excitation output until the

Crowbar Active alarm is reset. Alarm and Shutdown is the default and recommended selection for most applications. If Alarm Only is selected and the crowbar circuit is activated, the DECS-200N may apply full excitation power following removal of the crowbar.

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

Loss of Sensing Voltage–Time Delay. Sets the time delay between when the DECS-200N detects a loss of sensing voltage and when the alarm annunciates and if programmed, the output relay actuates. 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.

Settings

Settings tab settings are illustrated in Figure 5-27 and described in the following paragraphs.

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. 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. 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.
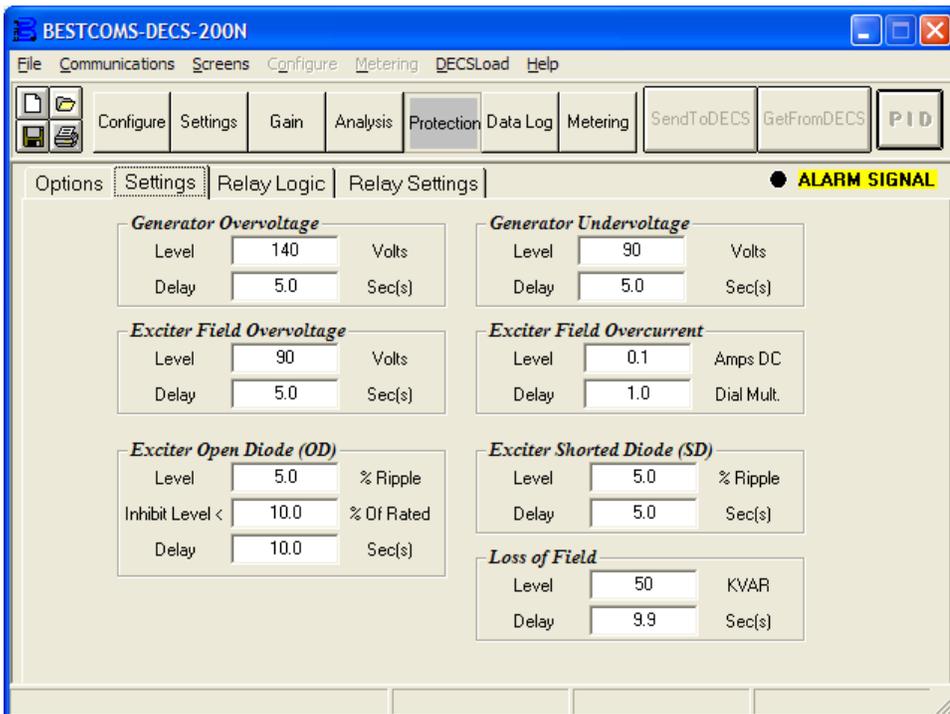
Figure 5-27. Protection/Relay Screen, Settings Tab

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 <u>both</u> 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. 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. A setting of 0.1 to 20 Adc may be entered in 0.1 Adc increments.

Exciter Field Overcurrent–Delay. Sets the time delay for the exciter field overcurrent protection function. This setting is active only when field overcurrent 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. A setting of 0 to 3,000,000 kvar may be entered in 1 kvar increments.

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

<u>Relay Logic</u>

The Relay Logic tab has five sub-tabs labeled Relay 1, Relay 2, Relay 3, Relay 4, and Relay 5. The settings of each sub-tab control the corresponding programmable output relay. Because the settings of each tab are identical, only the settings of the Relay 1 sub-tab are illustrated here (Figure 5-28). The settings described here apply to all five sub-tabs.

Protection. A programmable relay output can be configured to annunciate any of 13 active protection functions. These protection functions include:

- Buildup
- Crowbar Fired
- Failed to Buildup
- Field Overcurrent
- Field Overvoltage

- Generator Overvoltage
- Generator Undervoltage
- Loss of Field
- Loss of Sensing Voltage

- Open Exciter Diode
- Power Input Failure ∗
- Shorted Exciter Diode
- Sensing Input Below 10 Hz

∗   Power input failure can indicate bridge power frequency below 12 Hz or one of three phases of bridge power lost.

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

Null Balance. Selecting this annunciation causes the corresponding relay output to activate when a null balance condition is achieved.

Setpoint Limit. A programmable output can be configured to close when the active setpoint reaches the upper limit or lower limit.
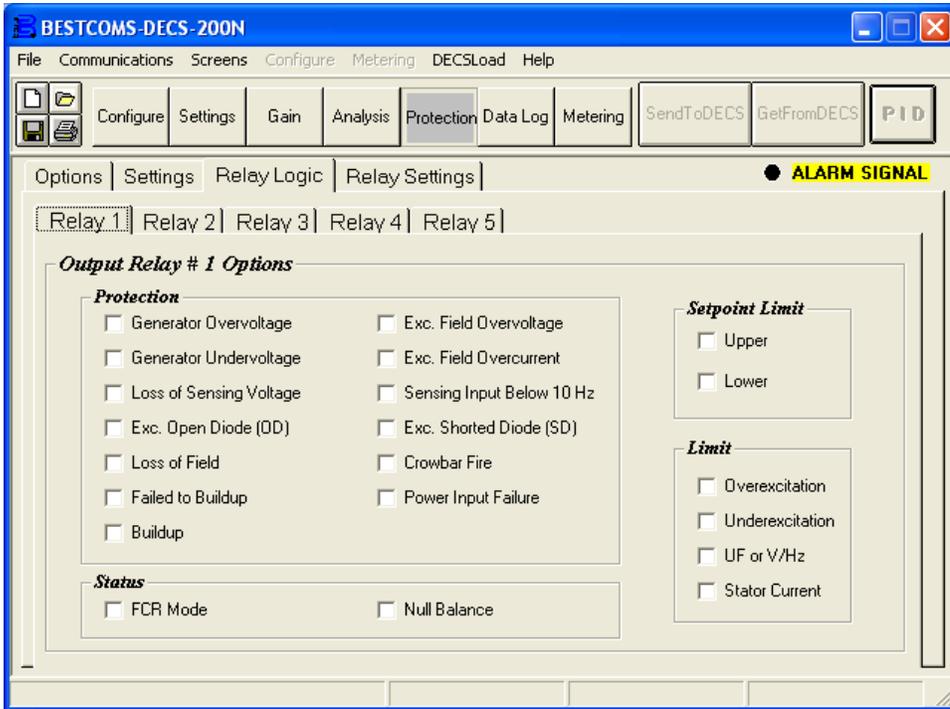
Figure 5-28. Protection/Relay Screen, Relay Logic Tab

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

Relay Settings

The Relay Settings tab has five sub-tabs labeled Relay 1, Relay 2, Relay 3, Relay 4, and Relay 5. The settings of each sub-tab control the corresponding programmable output relay. Because the settings of each tab are identical, only the settings of the Relay 1 sub-tab are illustrated here (Figure 5-29). The settings described here apply to all five sub-tabs.

Contact Status. Configures the output contacts as normally open (NO) or normally closed (NC).

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 contacts 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.

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-200N has operating power applied. When operating power is removed from the DECS-200N, these contacts will open.

Momentary Time. When Momentary is selected as the contact type, this setting controls the duration 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.
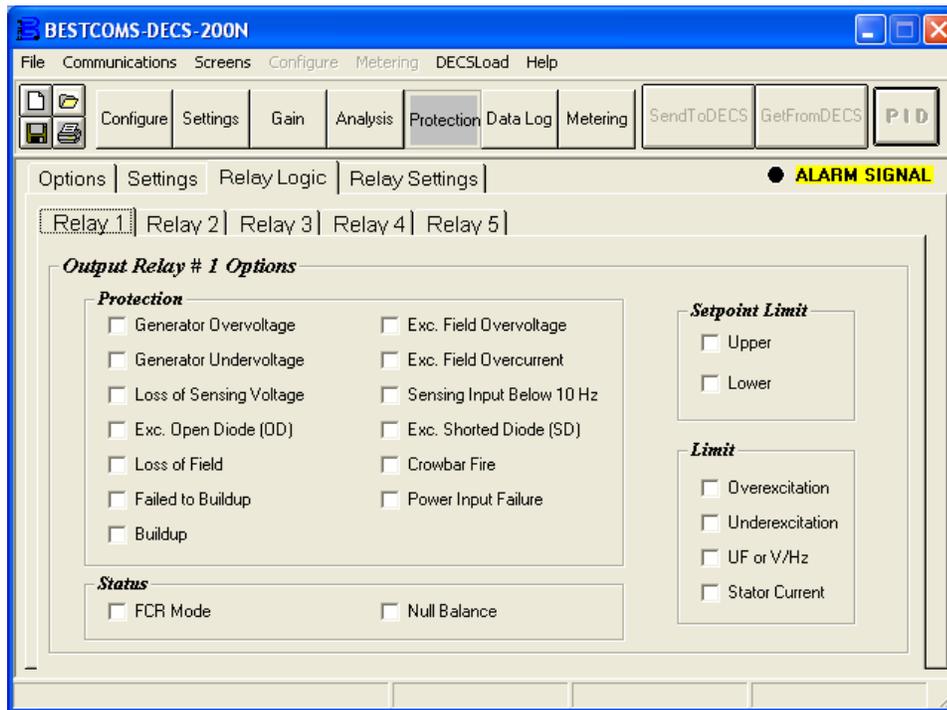
Figure 5-29. Protection/Relay Screen, Relay Settings Tab

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 5-30 and described in the following paragraphs.
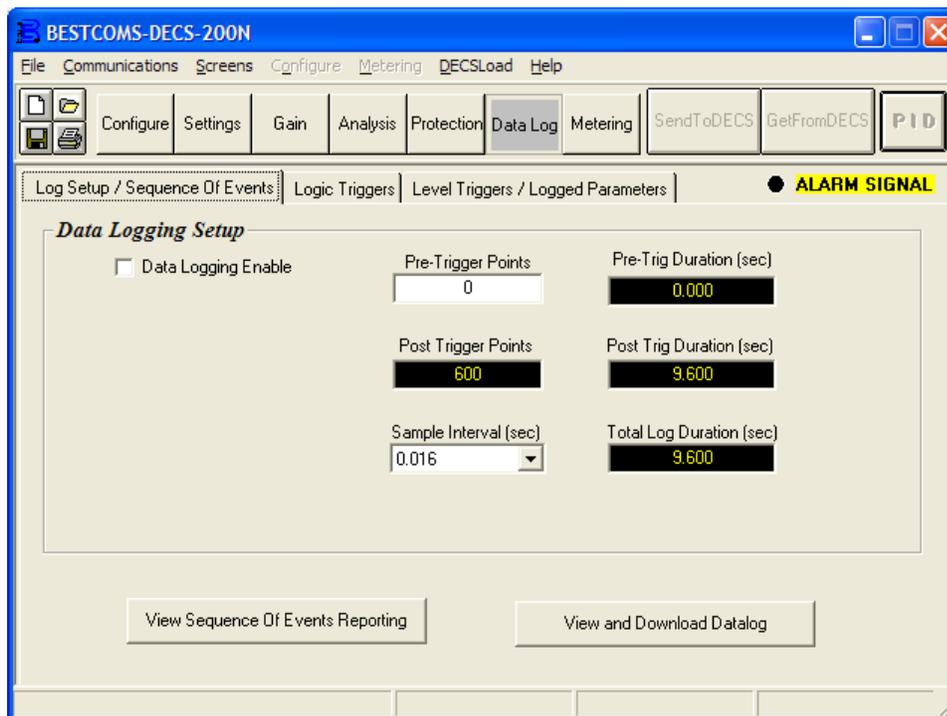
Figure 5-30. Data Log Screen, Log Setup/Sequence of Events Tab

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 5-31). Sequence of Events Reporting screen displays and controls are described in the following paragraphs.
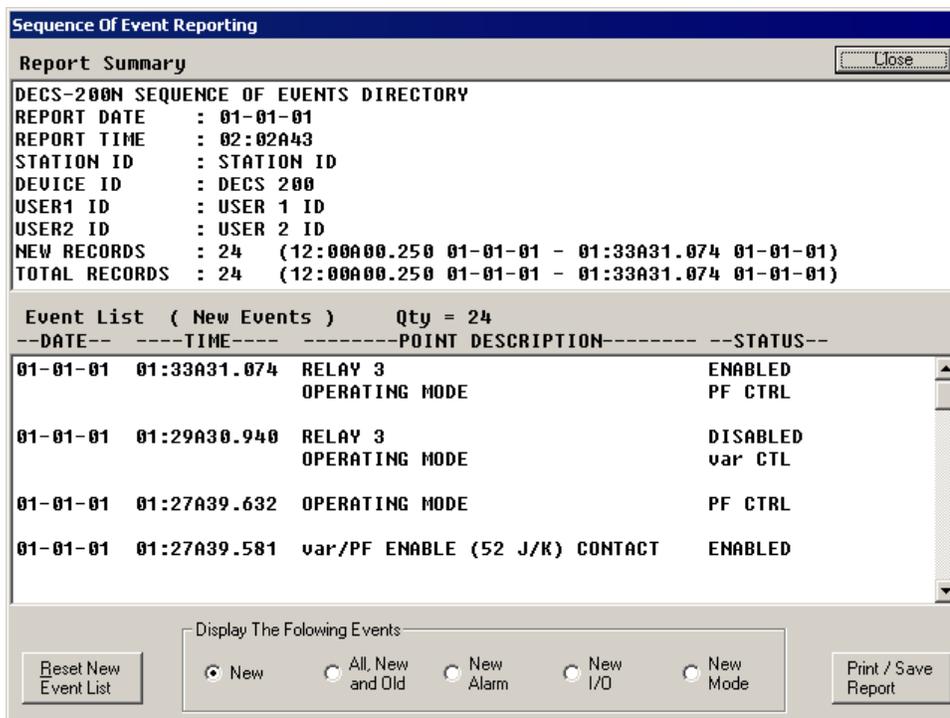
Figure 5-31. Sequence of Events Reporting Screen

Report Summary. This area of the Sequence of Event Recording screen provides 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.

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 Datalog. Clicking this button displays the Data Logging screen of Figure 5-32. Data Logging screen displays and controls are described in the following paragraphs.

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.

Record List. This area of the Data Logging screen displays the list of available data log records. Individual records can be selected from the list and printed, saved as a text file, or downloaded in the ASCII, ASCII COMTRADE, or binary COMTRADE formats.

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.
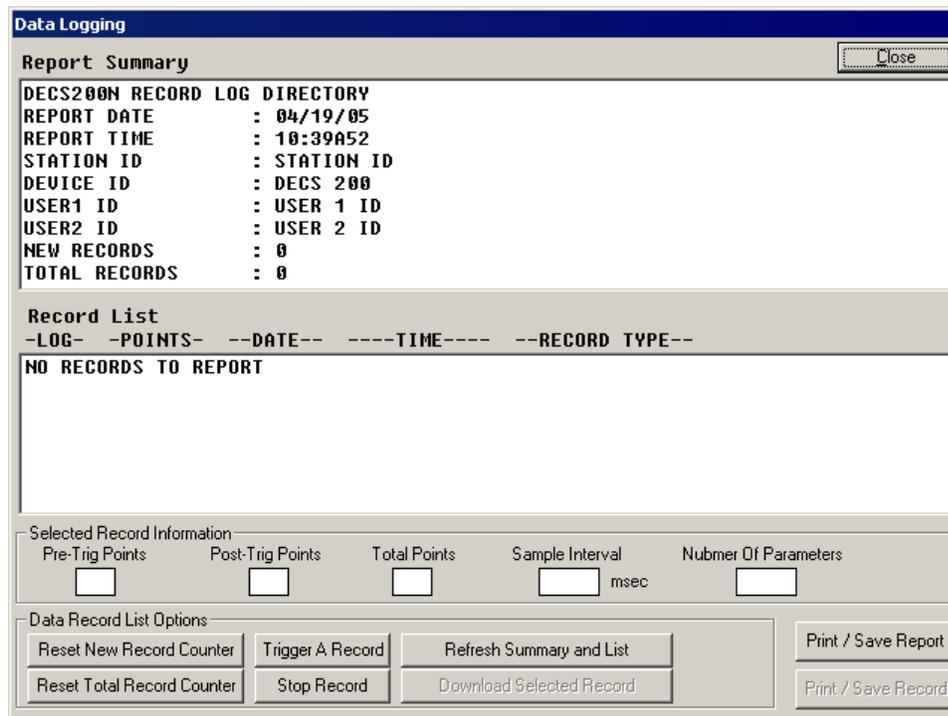
Figure 5-32. Data Logging Screen

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 tab settings are illustrated in Figure 5-33 and described in the following paragraphs.
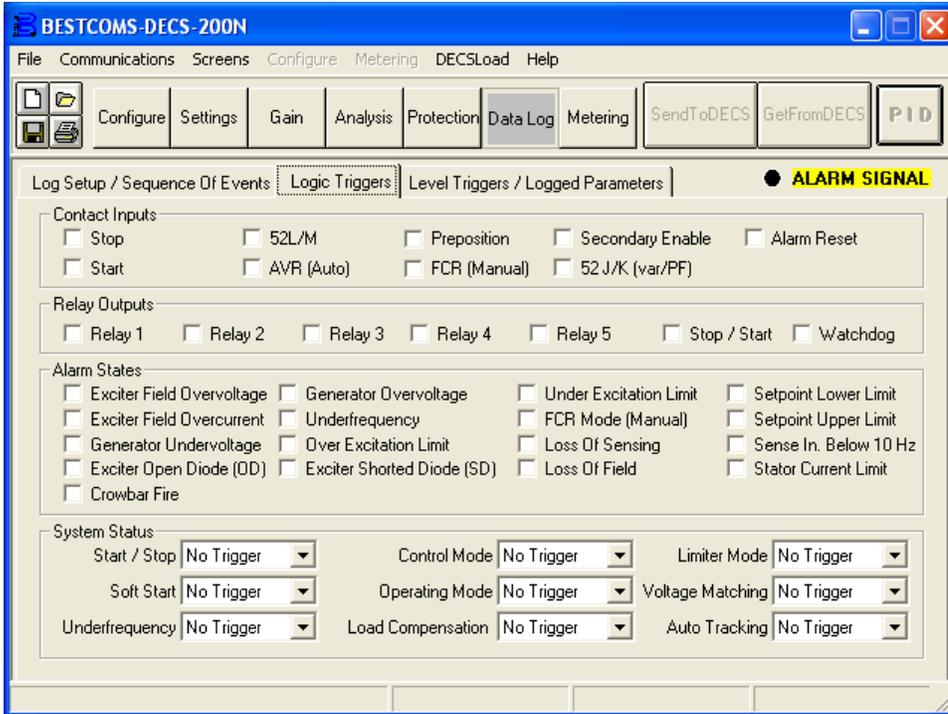
Figure 5-33. Data Log Screen, Logic Triggers Tab

Contact Inputs. This area of the Logic Triggers tab lists the available DECS-200N 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-200N 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

- Relay 4
- Relay 5
- 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:

- Crowbar Fired
- FCR Mode
- Field Overcurrent
- Field Overvoltage
- Generator Overvoltage

- Generator Sensing <10 Hz
- Generator Undervoltage
- Loss of Field
- Loss of Sensing
- Open Exciter Diode
- 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 Soft Start mode is active or inactive. Selecting NO TRIGGER disables a Soft Start trigger.

System Status–Underfrequency. Enables a data log report to be triggered when Underfrequency protection is active or inactive. 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)
- Off (no limiters active)
- OEL (overexcitation limiter active)
- SCL (stator current limiter active)
- SCL, OEL (stator current limiter and overexcitation limiter active)
- SCL, OEL, UEL (stator current limiter, overexcitation limiter, and underexcitation 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-200N is functioning as the primary controller or the secondary controller in a redundant DECS-200N system. Selecting NO TRIGGER disables an auto-tracking trigger.

Level Triggers/Logged Parameters

The Level Triggers/Logged Parameters tab (Figure 5-34) 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 or decreases below the lower threshold setting. The available parameters that can be selected to trigger a data log report are listed in Table 5-2.
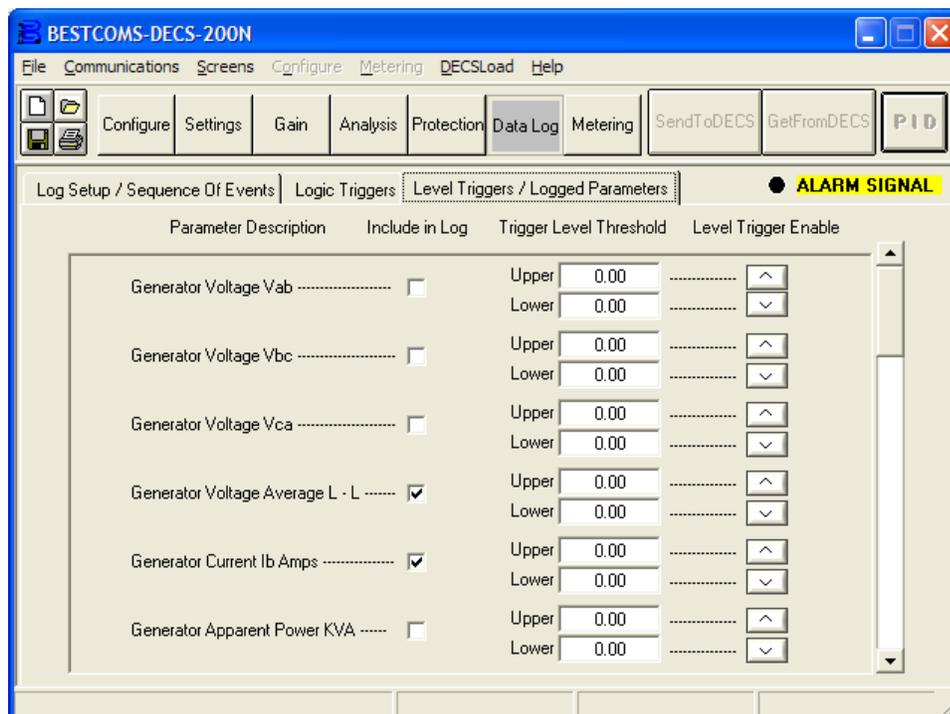
Figure 5-34. Data Log Screen, Level Triggers/Logged Parameters Tab

Table 5-2. Data Log Report Parameter Triggers

Parameter	Unit of Measure	Threshold Lower	Threshold Upper	Increment
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 5-35 and described in the following paragraphs.

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.

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.
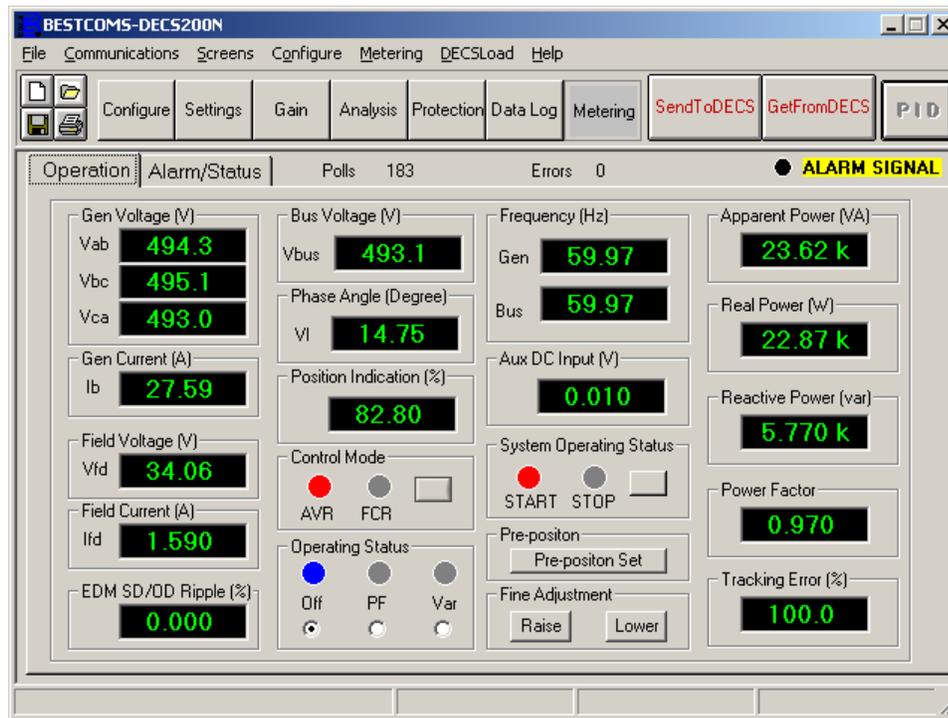
Figure 5-35. Metering Screen, Operation Tab

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-200N 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.

System Operating Status. Two indicators show the start/stop mode status of the DECS-200N. 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 to toggle between Start and Stop modes.

Pre-position. 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 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 5-36 and described in the following paragraphs.

System Status. When any of the 18 conditions listed in Figure 5-36 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.
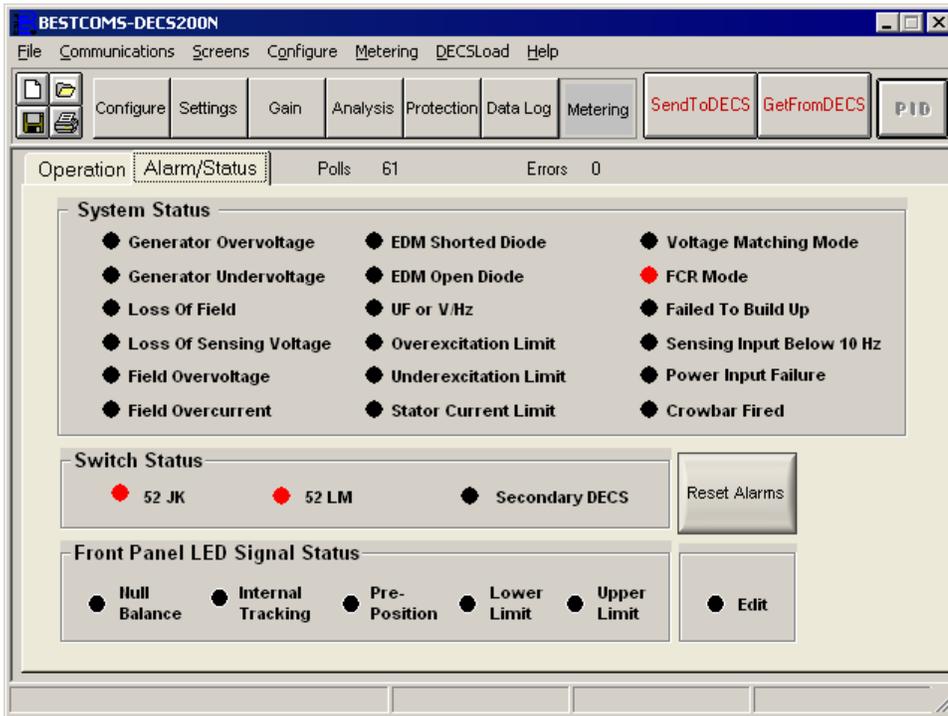
Figure 5-36. Metering Screen, Alarm/Status Tab

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 52 L/M contact input is open. The Secondary DECS indicator turns on when the SECEN (secondary DECS 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-200N 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-200N 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-200N settings file. DECS-200N setting files are saved with a *.d2n* extension.

Printing Files

A printed copy of DECS-200N 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-200N firmware version, and the time and date are printed along with the settings.

Opening/Uploading Files

DECS-200N settings files can be opened by BESTCOMS and uploaded to a DECS-200N communicating with the PC running BESTCOMS. A DECS-200N 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-200N or retrieved into BESTCOMS without uploading to the DECS-200N. When the Open dialog box Open button is clicked, the dialog box of Figure 5-37 appears.
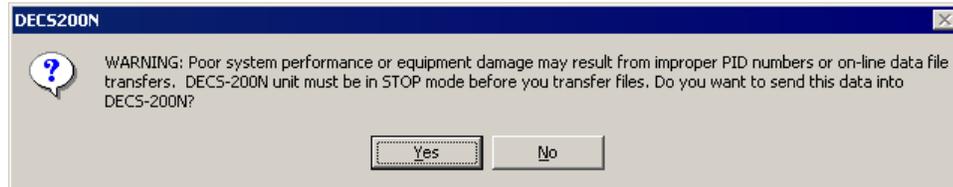
Figure 5-37. Settings Upload Dialog Box

Clicking the Yes button retrieves the settings into BESTCOMS and uploads the settings to the DECS-200N. Clicking the No button retrieves the settings into BESTCOMS without uploading the 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 set at 21.

PID window functions are shown in Figure 5-38 and described in the following paragraphs.
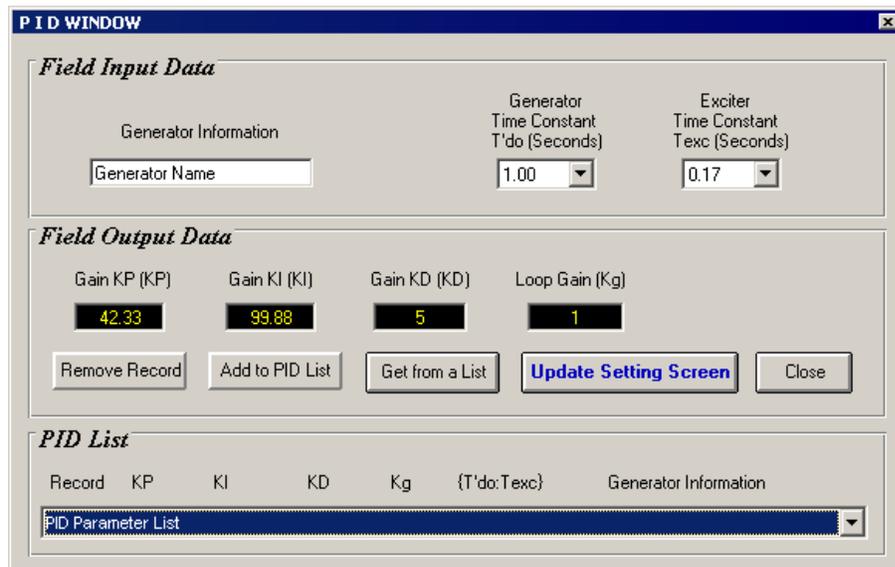
Figure 5-38. PID Window

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).

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.

TERMINATING COMMUNICATION

Communication between BESTCOMS and the DECS-200N is terminated by clicking **Communications** on the menu bar and clicking **Close Comm Port**.

EMBEDDED FIRMWARE

Embedded firmware is the operating program that controls the actions of the DECS-200N. The DECS-200N stores firmware in nonvolatile flash memory that can be programmed through the RS-232 communication port. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

Future enhancements to DECS-200N functionality may make a firmware update desirable.

Updating DECS-200N Firmware

DECS-200N embedded firmware can be updated by performing the following steps.

CAUTION

If control power is lost or communication is interrupted during file transfer, the DECS-200N will not recover and will cease to be operational.

NOTE

Communication must be closed prior to uploading embedded firmware to the DECS-200N. Refer to *Terminating Communication* for information about closing DECS-200N communication.

It is recommended to save the DECS-200N settings in a file before proceeding with firmware uploading. Firmware uploading will replace user-adjusted settings with factory-default settings.

---

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

2. Click **DECSLoad** on the BESTCOMS menu bar and click **Upload Embedded Software**. If this menu selection is grayed out, you'll need to close DECS-200N communication (refer to *Terminating Communication*). When **Upload Embedded Software** is clicked, a dialog box is displayed that

advises you to disconnect the DECS-200N generator and bus connections and save the DECS-200N settings in a file before proceeding with firmware uploading. Firmware uploading will replace user-adjusted settings with factory-default settings.

3. Click **Yes** to continue with firmware uploading. When Yes is clicked, the Embedded Program Loader screen (Figure 5-39) appears.

4. Click the **Get File** button. An Open dialog box will appear and enable you to locate and select the appropriate file for uploading to the DECS-200N. Only files with an S19 or HEX extension are displayed in the Open dialog box.

5. Select the appropriate file for uploading and click the **Open** button. The file is selected and the Embedded Program Loader screen is displayed again. Either the Get Device Information button or the Start Transfer Data button may be clicked.

6. Click the **Get Device Information** button to retrieve and display DECS-200N information (including the current firmware version) in the left-hand information pane.

7. Click the **Start Transfer Data** button to initiate file transfer. A dialog box will prompt you for the global access password. Once the correct password is entered, the transfer begins and the new firmware is uploaded to the DECS-200N. During firmware uploading, a dialog box will indicate the file transfer progress.

8. Close the Embedded Program Loader. BESTCOMS loads the default settings, loads the saved settings, and checks the settings.
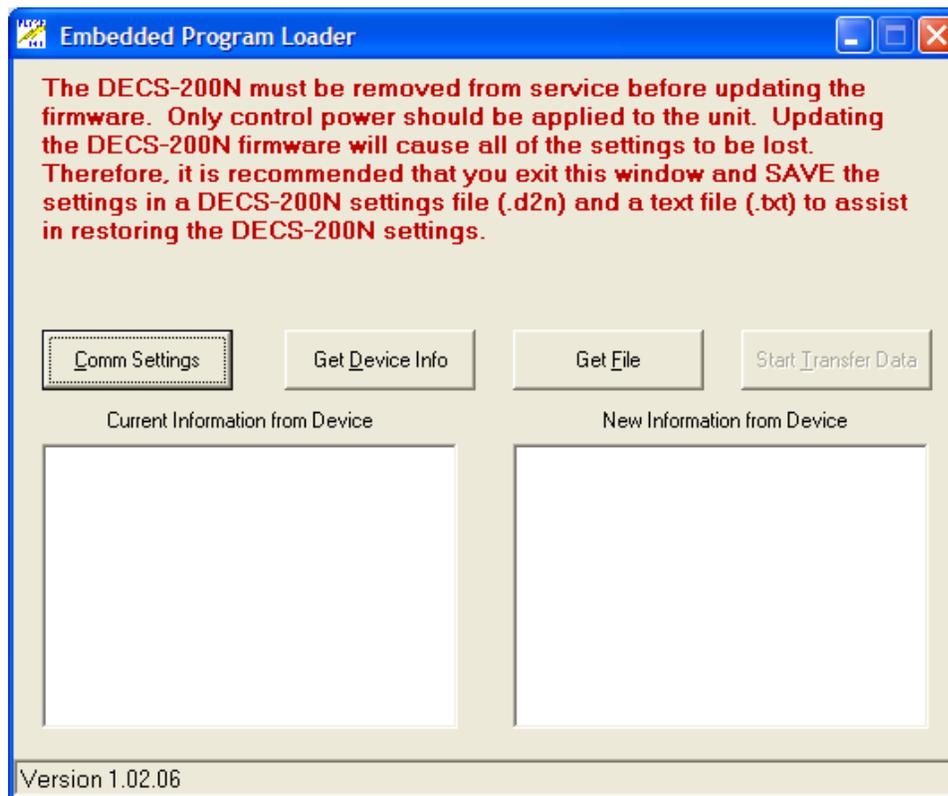
Figure 5-39. Embedded Program Loader Screen

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SECTION 6 • SETUP

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SECTION 6 • SETUP

INTRODUCTION

This section provides generic setup and operation procedures for excitation systems using the DECS-200N. 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-200N settings are entered through the BESTCOMS interface. Therefore, a PC operating with BESTCOMS software will need to be connected to the DECS-200N 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-200N's oscillography. First channel measures the generator voltage at DECS-200N terminals A1 (E1) and A3 (E3). Second channel measures the field voltage at DECS-200N terminals C1 (F–) and C2 (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-200N to the PC.

Basler Electric Application Note 126 is not required, but provides helpful information about paralleling circuits. This application note is available for downloading (in PDF format) from the Basler Electric website at http://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-200N 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

Enter the desired settings and enable the desired functions on each tab of the BESTCOMS System Configuration screen. Figures 6-1 through 6-5 illustrate the settings of each System Configuration screen tab.

System Options Tab

Select the desired system options illustrated in Figure 6-1.

Select the limiter mode .... _____

Select the sensing configuration... _____

Select the underfrequency mode... _____

Select the generator frequency .... _____

Enable or disable voltage matching... _____
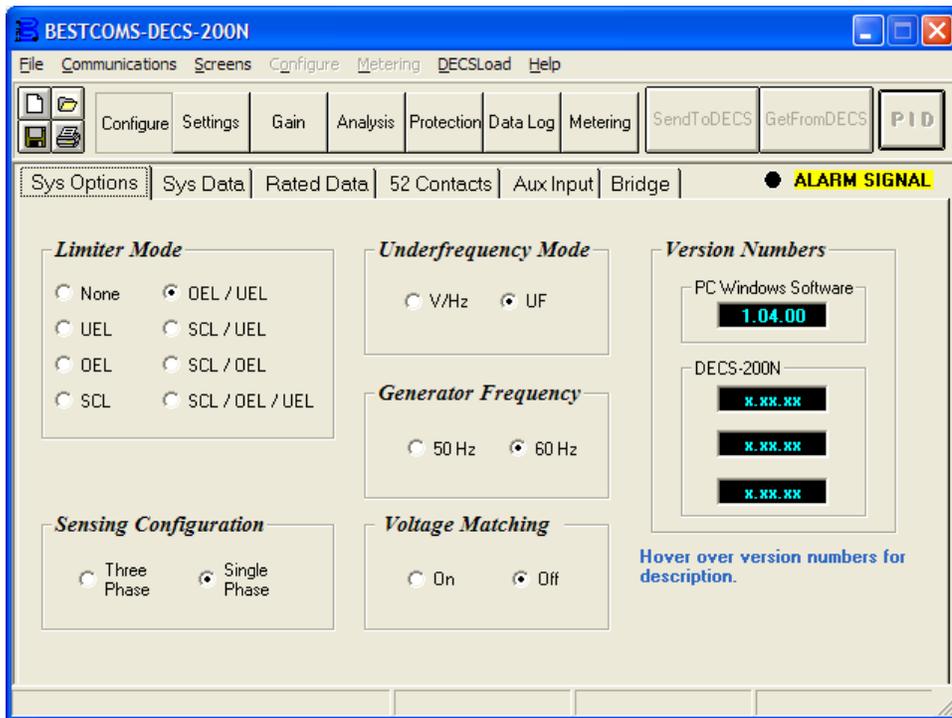
Figure 6-1. System Configuration Screen, System Options Tab

<u>System Data Tab</u>

Enter the system PT and CT ratings and configure the internal and external tracking settings illustrated in Figure 6-2.
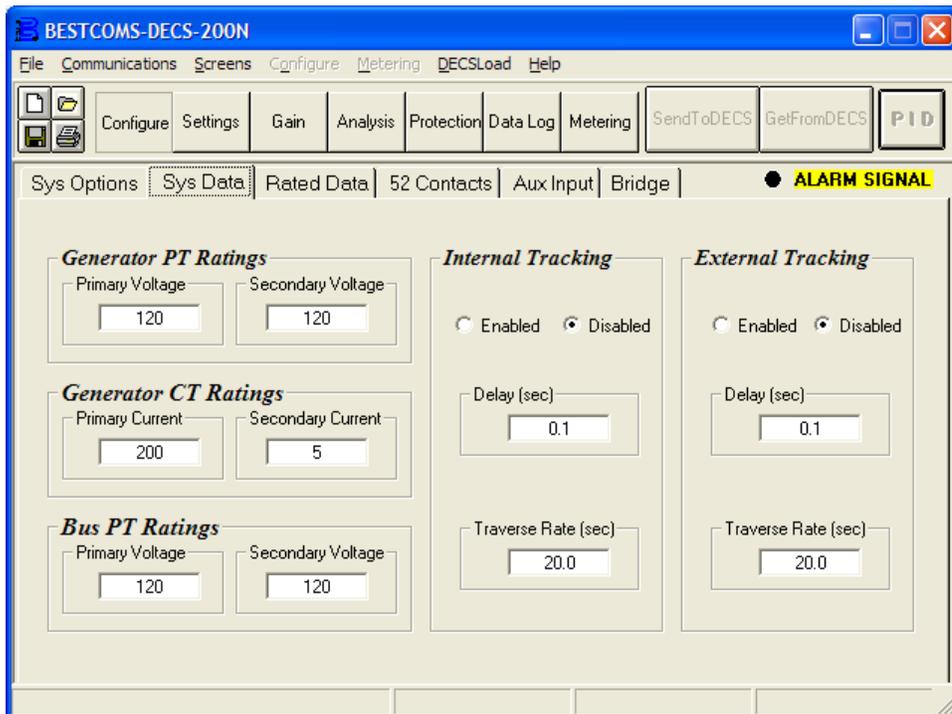
Figure 6-2. System Configuration Screen, System Data Tab

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-200N systems) ..... _____

Set the external tracking delay (applies only to redundant DECS-200N systems) .... _____

Set the external tracking traverse rate (applies only to redundant DECS-200N systems) _____

Rated Data Tab

Enter the generator and exciter field ratings and exciter-to-generator pole ratio settings illustrated in Figure 6-3.
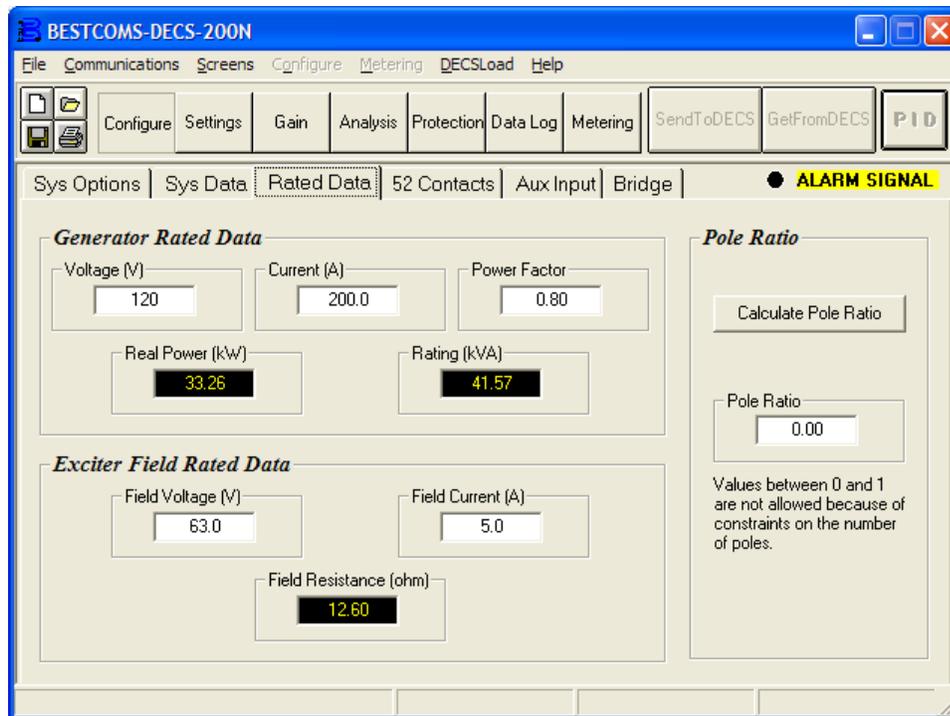
Figure 6-3. System Configuration Screen, Rated Data Tab

Enter the rated generator terminal voltage.. _____

Enter the rated generator current .... _____

Enter the rated generator power factor .... _____

Enter the rated field voltage.. _____

Enter the rated field current .... _____

Enter the exciter-to-generator pole ratio.. _____

Auxiliary Input Tab

Configure the accessory input selections and settings illustrated in Figure 6-4.

Select either voltage or current as the accessory input type.. _____

Select either Remote Setpoint Control or Limiter Scaling for the input function .... _____

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..................................... _____

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 _____
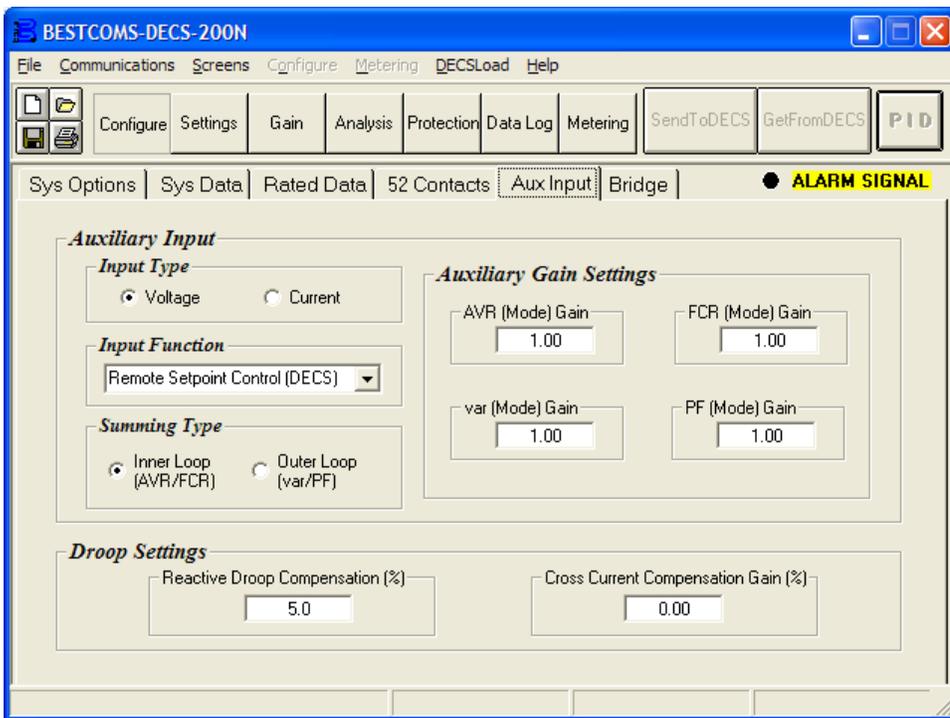
Figure 6-4. System Configuration Screen, Auxiliary Input Tab

Bridge Control Tab

Configure the bridge power input settings illustrated in Figure 6-5.

Select the bridge operating power range.. _____

Enter the nominal frequency of the bridge input power... _____

Enter the maximum overspeed frequency (percent of nominal) for the bridge power input _____

Select either three-phase or single-phase bridge operating power..................................... _____

If single-phase operating power is used, select the two phases used for bridge power .... _____
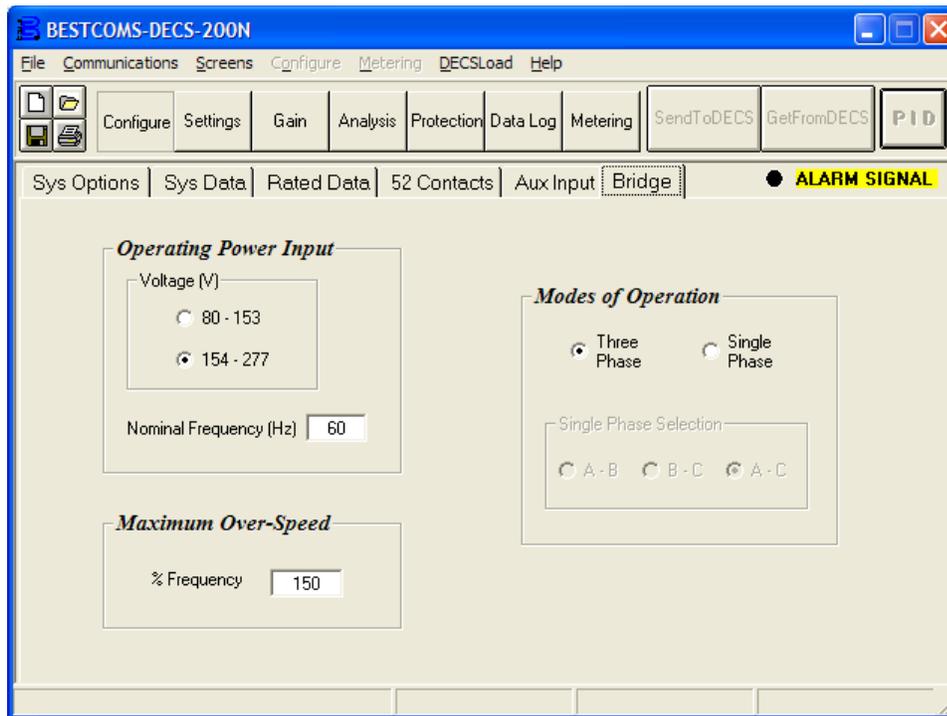
Figure 6-5. System Configuration Screen, Bridge Control Tab

Setting Adjustments Screen

Enter the desired settings and enable the desired functions on each tab of the BESTCOMS Setting Adjustments screen. Figures 6-6 through 6-13 illustrate the settings of each System Configuration screen tab.

AVR/FCR Tab

Configure the AVR mode and FCR mode settings illustrated in Figure 6-6.
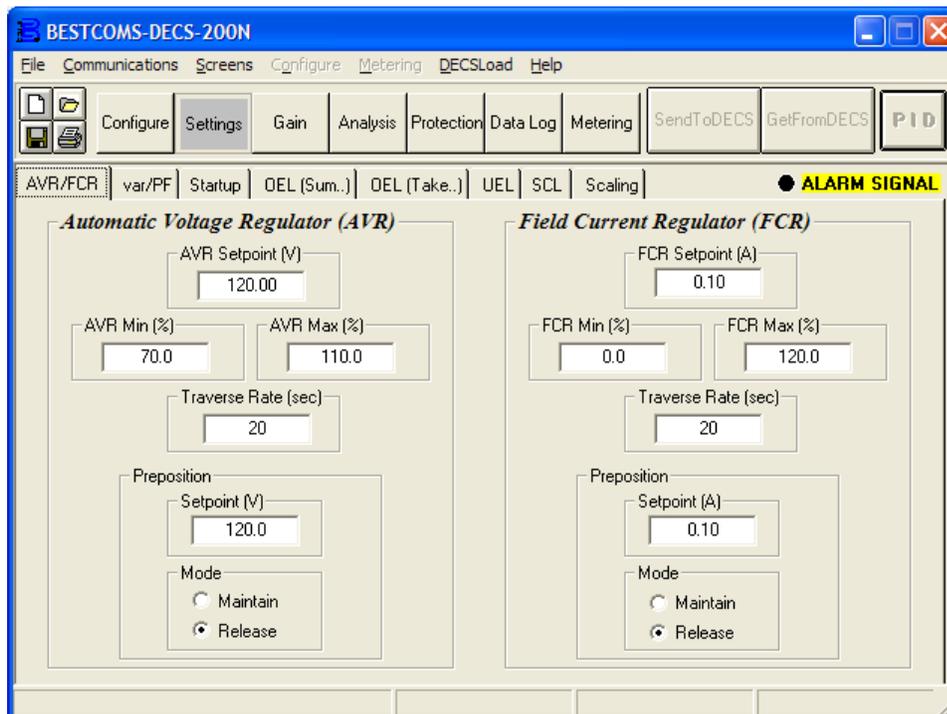
Figure 6-6. Setting Adjustments Screen, AVR/FCR Tab

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 .... _____

Enter the FCR mode pre-position setpoint .... _____

Select either maintain or release as the FCR pre-position mode.. _____

var/PF Tab

Configure the var mode and power factor mode settings illustrated in Figure 6-7.
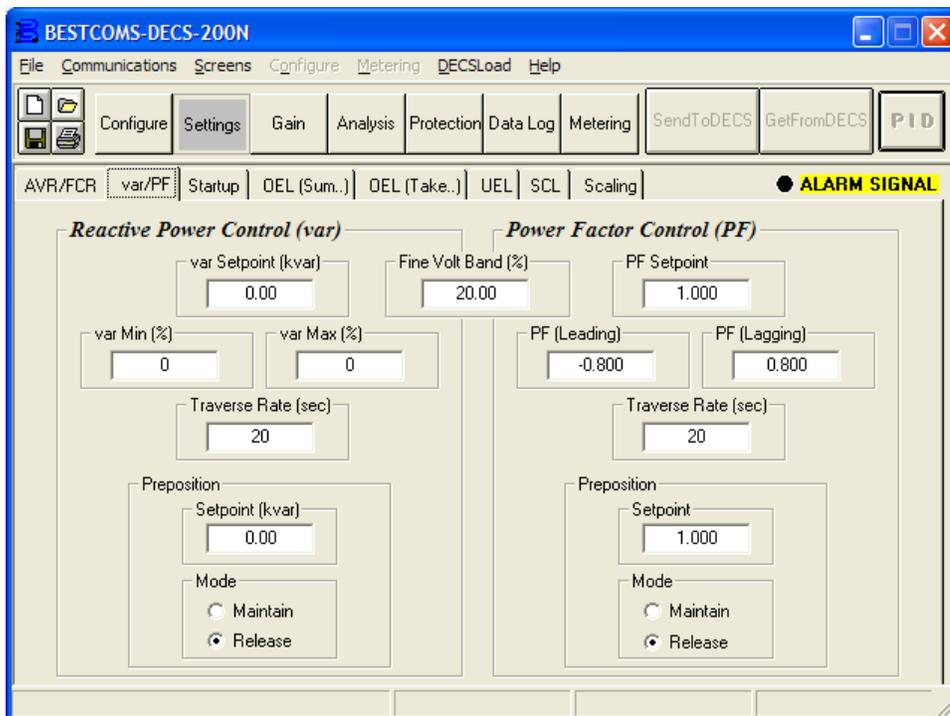
Figure 6-7. Setting Adjustments Screen, var/PF Tab

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 pre-position mode .... _____

Enter the fine voltage band for var/PF mode, expressed as a percent of nominal .... _____

Enter the power factor setpoint... _____

Enter the maximum desired leading PF mode setpoint... _____

Enter the maximum desired lagging PF mode setpoint... _____

Enter the power factor traverse rate .... _____

Enter the PF pre-position setpoint .... _____

Select either maintain or release as the pre-position mode .... _____

Startup Tab

Configure the startup control, underfrequency, and voltage matching settings illustrated in Figure 6-8.
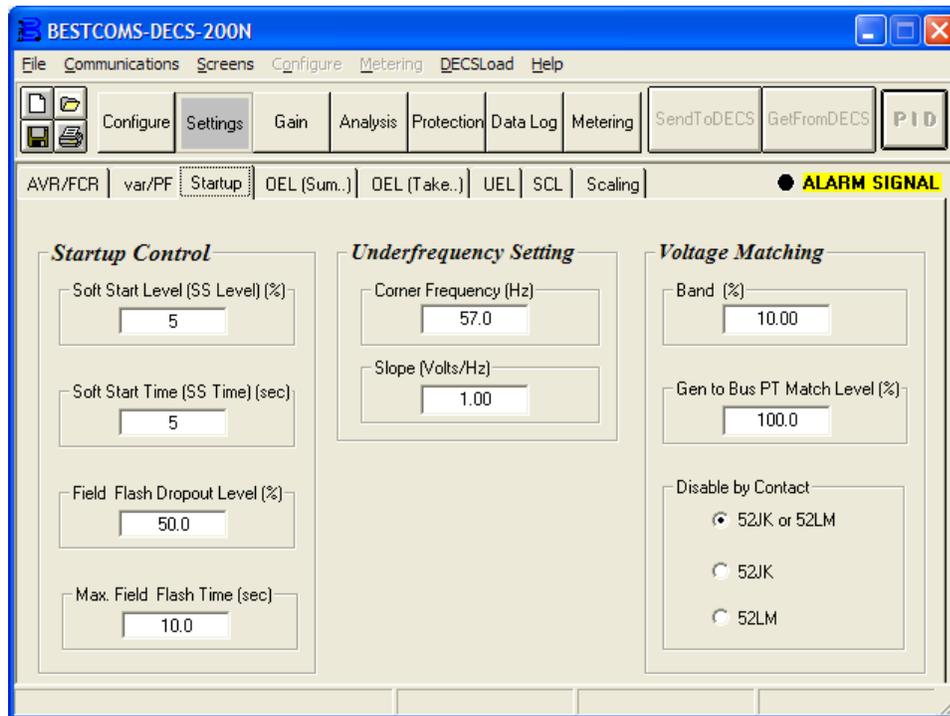
Figure 6-8. Setting Adjustments Screen, Startup Tab

Enter the soft-start voltage offset used during startup.. _____

Enter the soft-start time limit used during startup.. _____

Enter the desired generator voltage level where field flashing will be withdrawn .... _____

Enter the desired maximum length of time that flashing is applied to the field .... _____

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................... _____

Select the 52 contact inputs that will disable voltage matching .... _____

Scaling Tab

Select either Summing Point or Takeover as the overexcitation limiter style. Select the desired OEL setting selection option. Scaling tab selections are illustrated in Figure 6-9.
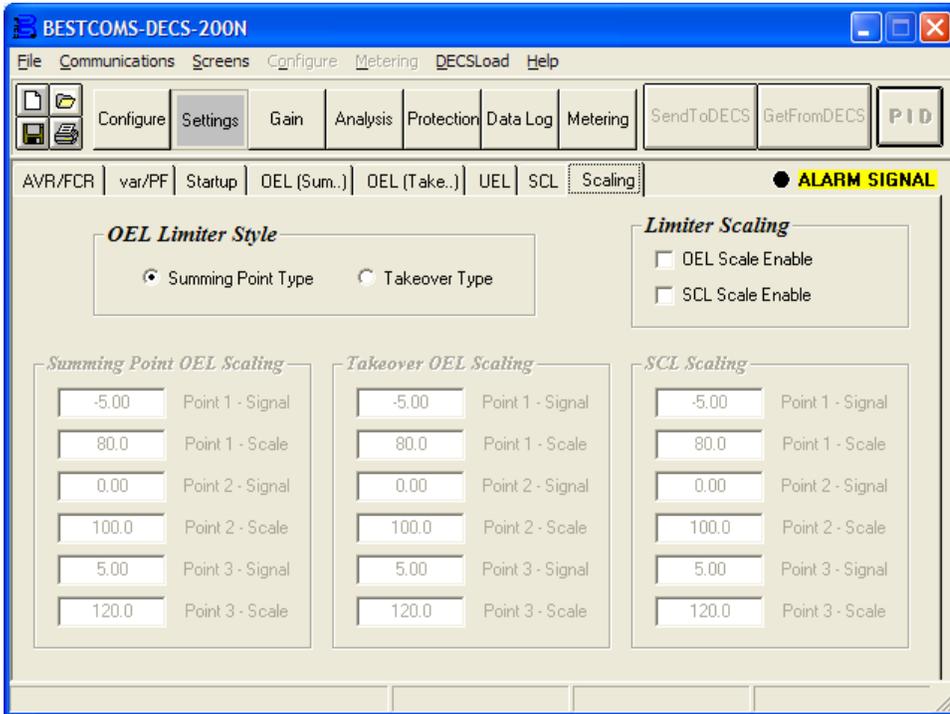
Figure 6-9. Setting Adjustments Screen, Scaling Tab

Summing OEL Tab

If summing-point overexcitation limiting is enabled, configure the off- and on-line OEL settings illustrated in Figure 6-10.
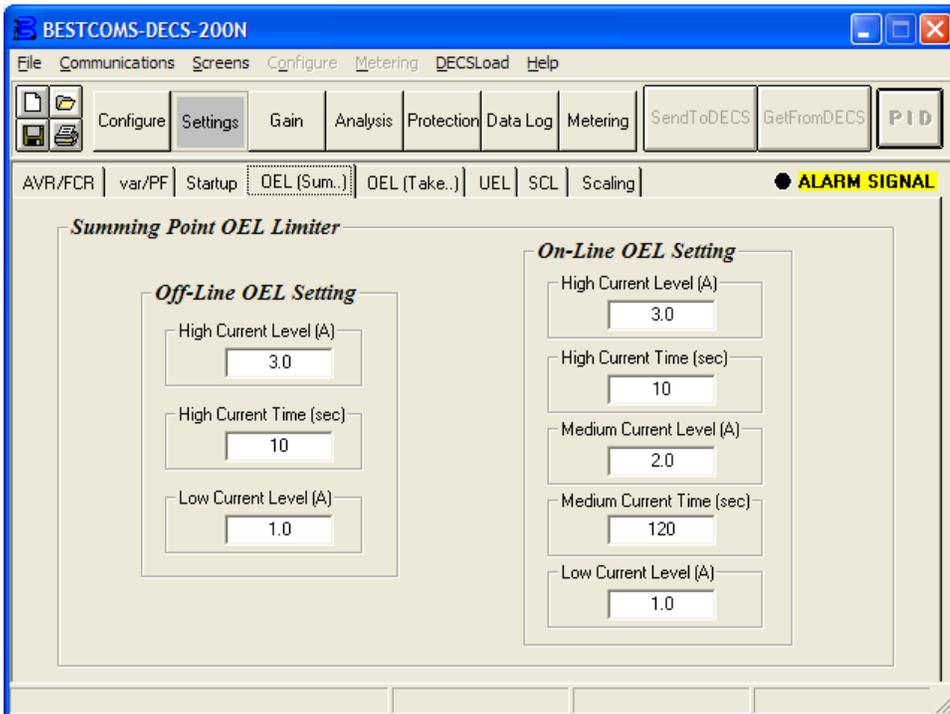
Figure 6-10. Setting Adjustments Screen, OEL (Summing) Tab

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 Tab

If takeover style overexcitation limiting is enabled, configure the off- and on-line OEL settings illustrated in Figure 6-11.
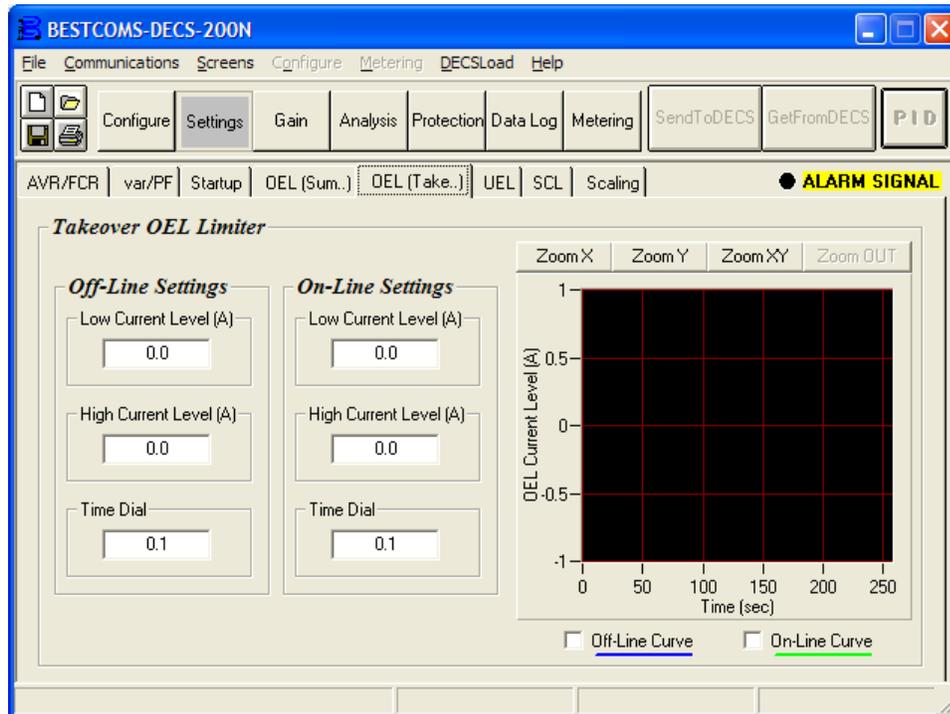
Figure 6-11. Setting Adjustments Screen, OEL (Takeover) Tab

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 Tab

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 6-12 illustrates the settings of the UEL tab.
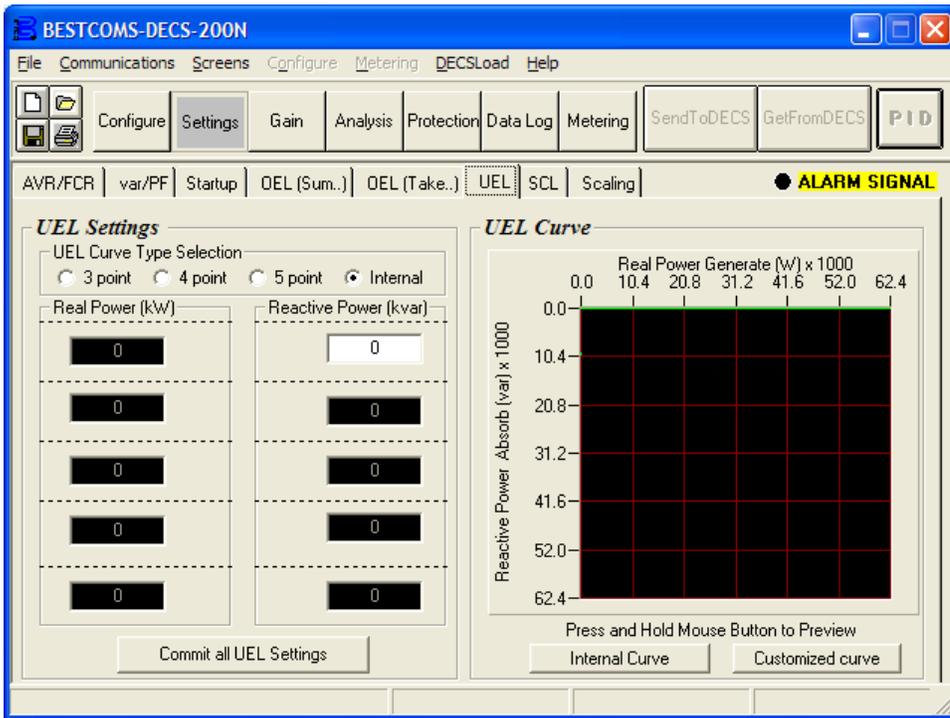
Figure 6-12. Setting Adjustments Screen, UEL Tab

SCL Tab

Configure the stator current limiter settings illustrated in Figure 6-13.
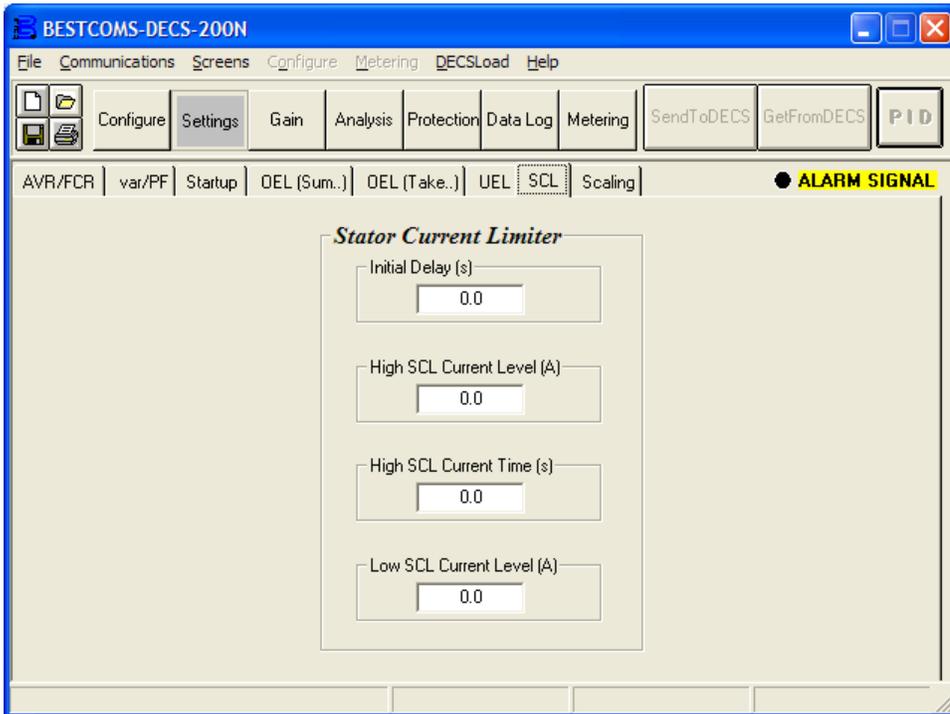
Figure 6-13. Setting Adjustments Screen, SCL Tab

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 6-14 through 6-17 illustrate the settings of each Protection/Relay screen tab.

Options Tab

Enable/disable the protection functions and configure the loss of sensing voltage settings illustrated in Figure 6-14.
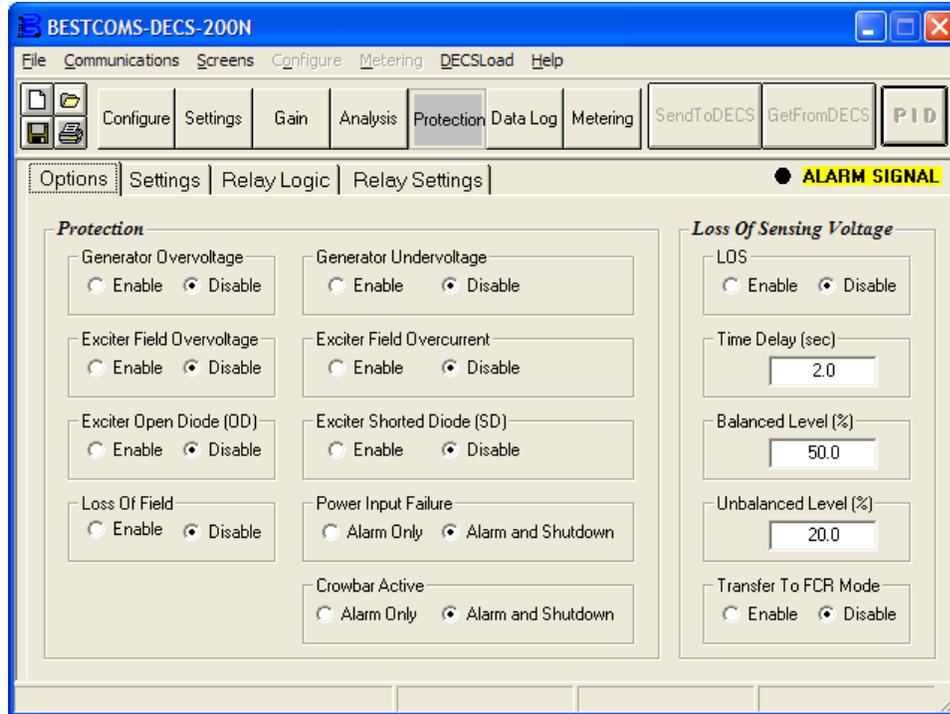
Figure 6-14. Protection/Relay Screen, Options Tab

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 .... _____

Configure an operating power failure to trigger only an alarm or both an alarm and excitation shutdown .... _____

Configure the activation of the crowbar to trigger only an alarm or both an alarm and excitation shutdown .... _____

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 .... _____

Enter the protection settings illustrated in Figure 6-15. Only protection functions enabled on the Options tab need to be configured here.
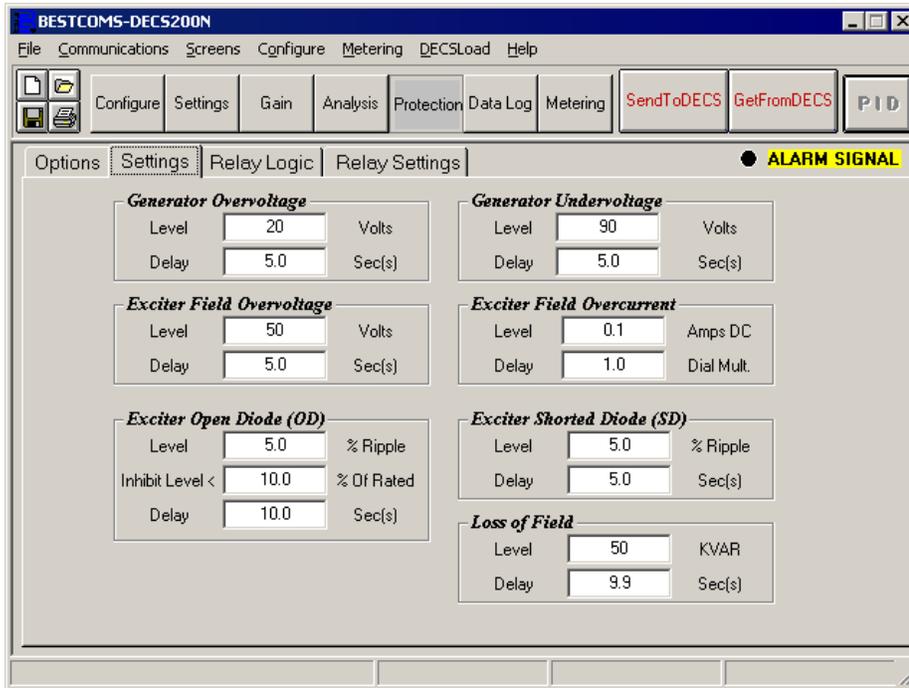
Figure 6-15. Protection/Relay Screen, Settings Tab

Enter the threshold for generator overvoltage protection.. _____

Enter the time delay for generator overvoltage protection .... _____

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 Tab

Review the excitation system interconnection drawings and verify the relay configurations. Relay logic settings for each of the five DECS-200N programmable outputs are contained on five sub-tabs with identical configuration options. Only the sub-tab for Relay 1 is illustrated here (Figure 6-16). 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.
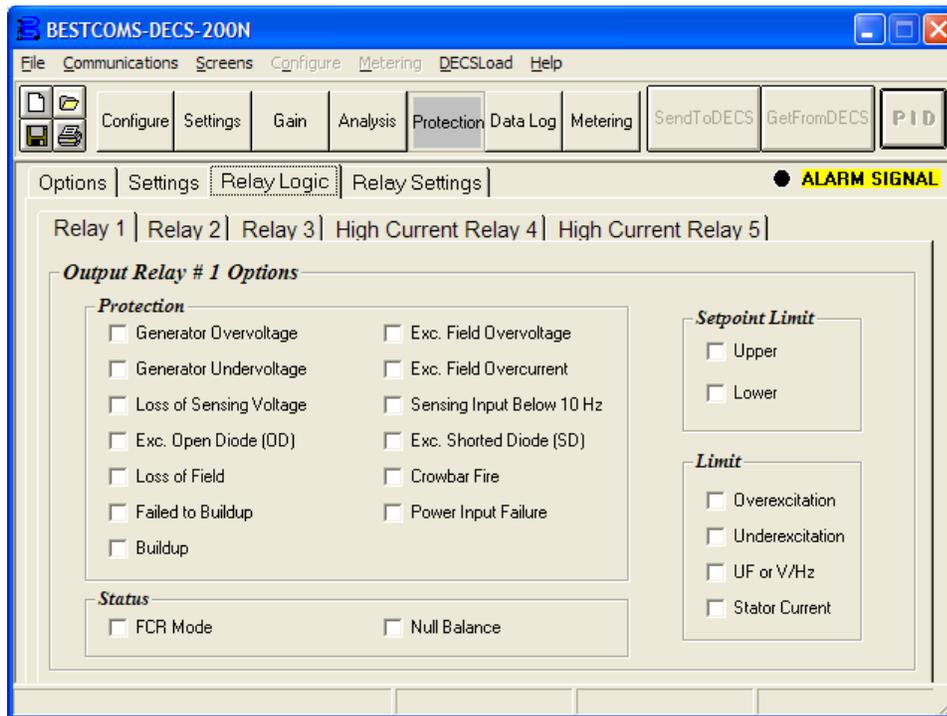
Figure 6-16. Protection/Relay Screen, Relay Logic Tab, Relay 1 Sub-Tab

Table 6-2. Programmable Output Function Assignments

	Relay				
Function	**1**	**2**	**3**	**4**	**5**
Generator overvoltage					
Generator undervoltage					
Loss of sensing voltage					
Open exciter diode					
Loss of field					
Failed to build up					
Buildup					
Field overvoltage					
Field overcurrent					
Sensing input below 10 Hz					
Shorted exciter diode					
Crowbar fired					
Power input failure					
FCR mode					
Null balance					
Upper setpoint limit					
Lower setpoint limit					
Overexcitation limit					
Underexcitation limit					
Underfrequency or V/Hz limit					
Stator current limit					

Relay Settings Tab

Relay settings for each of the five DECS-200N programmable outputs are contained on five sub-tabs with identical configuration options. Only the sub-tab for Relay 1 is illustrated here. Configure the contact status and type settings illustrated in Figure 6-17.
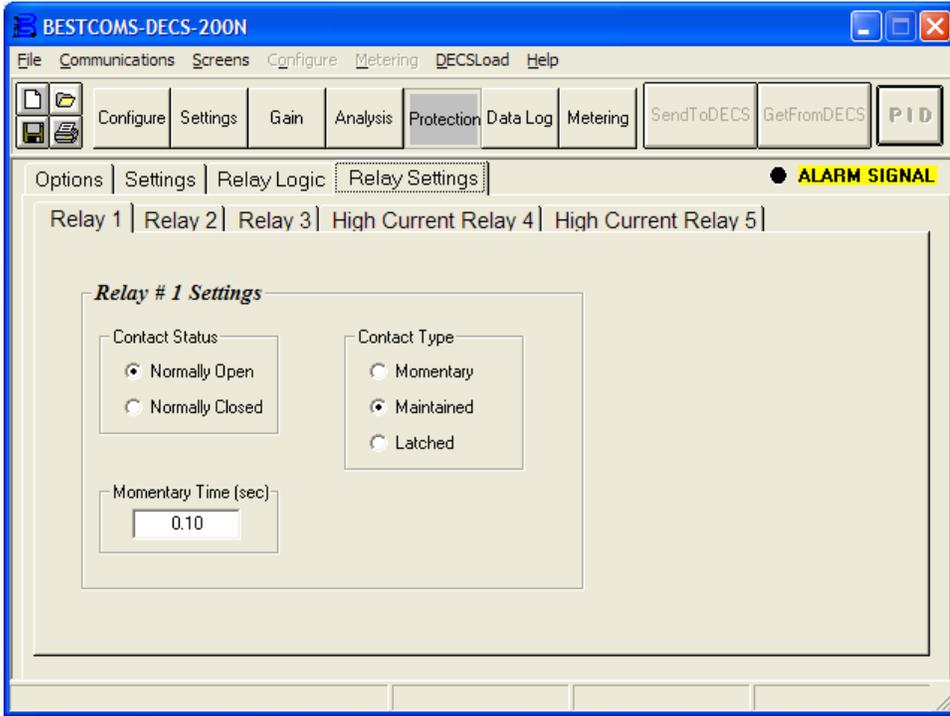
Figure 6-17. Protection/Relay Screen, Relay Settings Tab, Relay 1 Sub-Tab

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 1 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 3 contact status as normally open (NO) or normally closed (NC)........... _____

Configure the Relay 3 contact type as momentary, maintained, or latched....................... _____

If the Relay 3 contact type is momentary, enter the open/closed contact duration............ _____

Select the Relay 4 contact status as normally open (NO) or normally closed (NC)........... _____

Configure the Relay 4 contact type as momentary, maintained, or latched....................... _____

If the Relay 4 contact type is momentary, enter the open/closed contact duration............ _____

Select the Relay 5 contact status as normally open (NO) or normally closed (NC)........... _____

Configure the Relay 5 contact type as momentary, maintained, or latched....................... _____

If the Relay 5 contact type is momentary, enter the open/closed contact duration............ _____

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-200N front panel.. _____

Remote switches .... _____

With excitation off, check AVR/FCR transfer from 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 the 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*.

The following suggested settings may be used for AVR and FCR modes when the generator and exciter time constants are unknown.

> **NOTE**
>
> If proper startup is not achieved, increase the value of loop gain (Kg) for AVR and FCR modes..

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

During off-line tests with the turbine spinning, the generator circuit breaker is open.

FCR Mode

Initial testing should be conducted in FCR (manual) mode with minimum generated voltage.

Place the DECS-200N 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. Figure 6-18 illustrates a
field voltage waveform with three-phase bridge power applied to the DECS-200N and
Figure 6-19 illustrates a field voltage waveform with single-phase bridge power applied
to the DECS-200N. .... _____
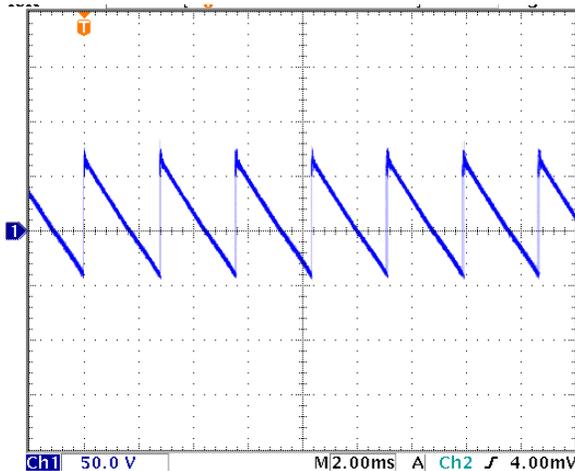
Figure 6-18. Field Voltage Output,
3-Phase Bridge Power
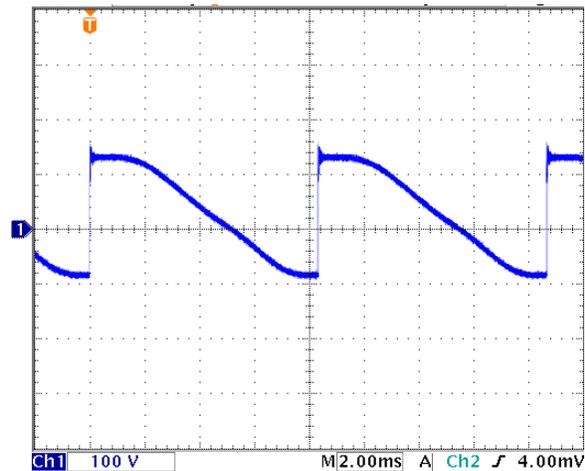
Figure 6-19. Field Voltage Output,
1-Phase Bridge Power

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 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 the full, rated output.................... _____

Using the BESTCOMS Analysis screen, perform a 5% step change in FCR mode .... _____

Decrease the value, then increase the value. Observe stable performance with a 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 BESTCOMS Metering screen to ensure that tracking is stable before transferring..... _____

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 and perform a step response in AVR _____

Review the PID values .... _____

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 6-20.
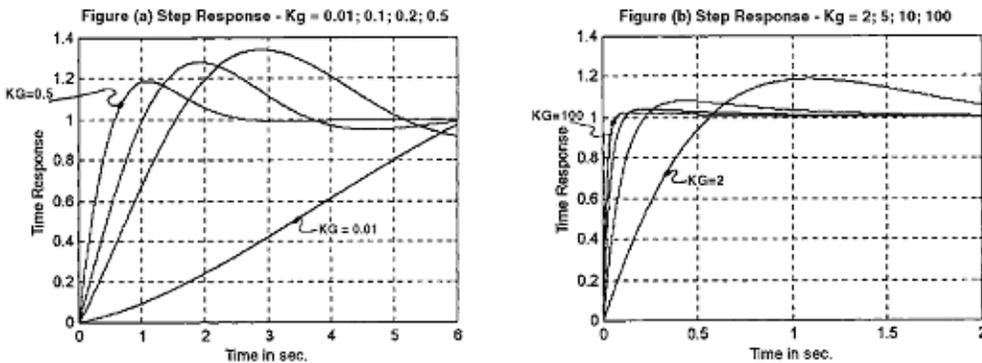
Figure 6-20. Kg Gain Effect on Generator Performance

When individual adjustment is needed to further refine performance, Figures 6-21 through 6-24 demonstrate the effect that PID changes have for additional control. All figures have a one second major division.

In Figure 6-21, the generator voltage exhibits one under-damp (overshoot) and one over-damp (undershoot) before settling. The total time (five seconds) is too long. Here, the KP (proportional gain) needs to be increased.
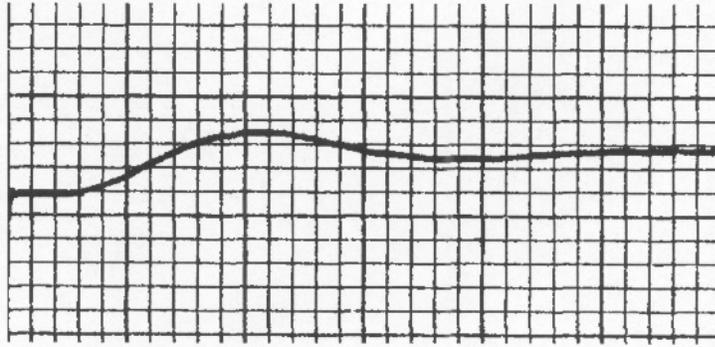
Figure 6-21. Insufficient Proportional Gain

Figure 6-22 demonstrates that the terminal voltage has prolonged instability after a voltage step change because there is too much integral gain (I). The integral gain needs to be decreased.
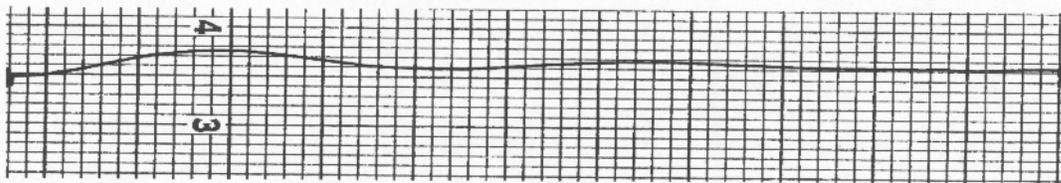
Figure 6-22. Prolonged Instability

In Figure 6-23, less overshoot is desired, KD (derivative gain) is increased.
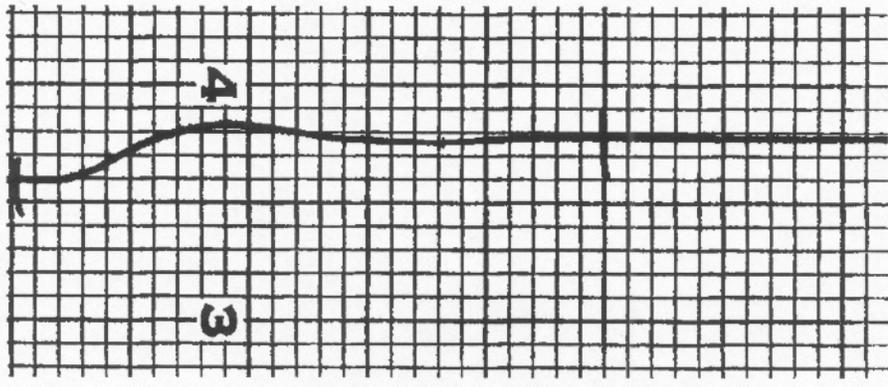
Figure 6-23. Insufficient Derivative Gain

Figure 6-24 illustrates the final solution. Increased KD (derivative gain) decreases voltage overshoot.
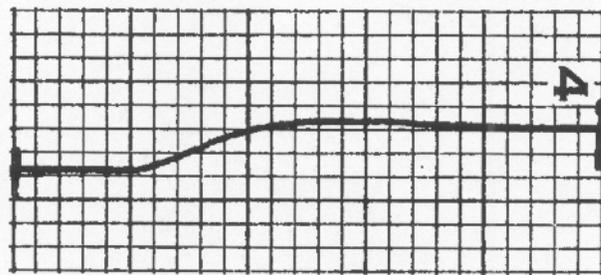
Figure 6-24. Step Response—Final Solution

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, temporary settings will be used to enable the testing of excitation performance without stressing the machine or exceeding ancillary protection devices. Procedures are provided that 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 annunciated, 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 generator overvoltage protection settings in BESTCOMS ....   _____

Reduce the Generator Overvoltage Level setting to the alarm threshold ....   _____

Verify that all alarms and annunciations 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.....................................   _____

Reset the Exciter Field Overvoltage Level setting to the desired value ....   _____

Reduce the Exciter Field Overcurrent Level setting to the alarm threshold ....   _____

Verify that 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 the 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 http://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-200N. 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 mode .... _____

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 the 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 point 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 mode 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 a 5% step-response stability test.. _____

If necessary, increase the var gain (KI and Kg) 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 the PF Pre-Position mode is disabled or the 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 mode... _____

Adjust PF to 0.9, lagging .... _____

Perform a step response by changing the 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.

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SECTION 7 • MAINTENANCE

PREVENTIVE MAINTENANCE

Periodically check the DECS-200N connections to ensure that they are clean and tight and remove any accumulation of dust.

The DECS-200N contains long-life, aluminum electrolytic capacitors. For a DECS-200N kept in storage as a spare, the life of these capacitors can be maximized by energizing the control power input for 30 minutes once per year. For style LX, apply 24 Vdc or 48 Vdc (18 to 60 Vdc). For style CX, apply 125 Vdc (90 to 150 Vdc). It is not necessary to apply operating power since the bridge circuitry contains no capacitors.

WARRANTY AND REPAIR SERVICE

DECS-200N 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-200N 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-200N, first check the programmable settings for the appropriate function.

DECS-200N Appears Inoperative

If the DECS-200N 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 LX have an input voltage range of 16 to 60 Vdc or 20 to 40 Vac (50/60 Hz) Units with style number CX 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-200N.

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-200N 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-200N operating (bridge) power terminals (C5 (A), C6 (B), and C7 (C))

Check the DECS-200N 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-200N 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-200N 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-200N drive voltage. If the problem is caused by the DECS-200N, 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-200N is connected to a CT on phase B and not phases A or C.

No Communication

If communication with the DECS-200N cannot be initiated, check the connections at the communication ports, the baud rate, and supporting software.

DECS-200N Reboots Frequently

If a single DECS-200N 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-200N will reboot. Increase the control power source voltage so that it is within the specified operating range. Units with style number LX have an input voltage range of 16 to 60 Vdc or 20 to 40 Vac (50/60 Hz) Units with style number CX have an input voltage range of 90 to 150 Vdc or 82 to 132 Vac (50/60 Hz).

APPENDIX A • SCR BRIDGE OUTPUT CALCULATIONS

INTRODUCTION

The output voltage of the DECS-200N's fully phase-controlled SCR bridge output can be calculated for various operating conditions such as operating power voltage, source impedance, output current, and control angle. This appendix provides equations for output voltage calculation in the case of highly inductive loads (which are typical in excitation systems) and three- and single-phase operating power applications.

PARAMETER DEFINITIONS

The following parameter definitions apply to the equations used throughout this appendix:

V_{LN} rated, line-to-neutral source voltage

V_{LL} rated, line-to-line source voltage ($V_{LL} = \sqrt{3} \bullet V_{LN}$)

z total short-circuit impedance. If z is not known, use 10% (0.1).

r resistive component of the short-circuit impedance. (Compared to x, r is negligible. Therefore, for rough calculations, r can be omitted ($z = x$).

x inductive component of the short-circuit impedance, as related in the equation $z = \sqrt{r^2 + x^2}$

I_L rated source current for powering the DECS-200N

I_{FL} rated, full-load exciter field current

$I_F *$ current supplied to the exciter field by the DECS-200N to achieve the desired operating setpoint

R_{DC} resistance of the cables connecting the DECS-200N output to the field

V_F exciter field voltage

$V_L *$ secondary voltage of the transformer or PMG used as the power source for the SCR bridge

S_T SCR bridge power transformer VA rating

I_{FF} minimum required forcing current

α control phase angle at the operating point (30 to 135° for the DECS-200N at nominal frequency, where 30° gives maximum, positive forcing and 135° gives maximum, negative forcing)

*   These parameters are used to assist in determining the dynamic effect on the value being calculated. Varying VL and IF through their anticipated voltage and current ranges will assist in the proper selection of a power transformer and determine if adequate forcing voltage is available to meet desired expectations.

THREE-PHASE OPERATING POWER

The phase voltage drop, scaled to the transformer secondary side, is equal to $z \bullet V_{LN}$ when the source terminals are shorted and the output current equals I_L.

The rated, full-load, exciter field current (I_{FL}) that corresponds to the rated source current (I_L) is calculated as shown in Equation A-1.

$$I_L = \sqrt{2/3} \bullet I_{FL} = 0.816 \bullet I_{FL}$$
Equation A-1

The output voltage of an "ideal" diode bridge (used to simplify explanation) for a given source voltage is calculated using Equation A-3.

$$V_{DI0} = 1.35 \bullet V_{LL}$$
Equation A-2

The voltage drop across simultaneously conducting SCRs (typically, two SCRs conduct at any given time (the voltage drop across one conducting SCR is $V_T = 1V$)) can be taken into account.

The voltage drop across the wires connecting the DECS-200N to the field terminals is calculated using Equation A-4.

$$V_{DC} = R_{DC} \bullet I_F$$

Equation A-3

In Equation A-4, R_{DC} is the wire resistance between the DECS-200N and the field terminals and I_F is the field current actually applied at the operating point under consideration.

Finally, if the output of the voltage source is V_L (it may differ from the rated value), the field voltage is calculated as:

A   B   C

$$V_F = V_{DI0}\left(\cos\alpha - \frac{0.5 \bullet x \bullet I_F \bullet V_{LL}}{I_{FL} \bullet V_L} - \frac{r \bullet I_F}{I_{FL}} \right) - 2 \bullet V_T - R_{DC} \bullet I_F$$

Equation A-4

In Equation A-4, α is the control angle at the operating point (30 to 135° for the DECS-200N at nominal frequency). The portion of Equation A-4 marked by callout A calculates the voltage drop across the input power wires. The portion marked by callout B calculates the SCR voltage drop. The portion marked by callout C calculates the voltage drop across the wires connecting the DECS-200N output to the field.

Equation A-5 simplifies Equation A-4 by ignoring the insignificant voltage drops across the input power wires, SCRs, and field wiring.

$$V_F = V_{DI0}\left(\cos\alpha - \frac{0.5 \bullet x \bullet I_F \bullet V_{LL}}{I_{FL} \bullet V_L} \right)$$

Equation A-5

Very often, a power transformer is used as a source for the field energy—as an interface between the energy source (generator or mains) and the SCR bridge. For the nominal field current, I_F (generally, maximum continuous field current) and the selected maximum transformer secondary voltage, V_L, the type power of the transformer is calculated as follows.

First, the ideal diode rectifier voltage output is calculated using Equation A-3 ($V_{DI0} = 1.35 \bullet V_L$). Once the rectifier output voltage is found, the transformer VA is calculated using Equation A-6.

$$S_T = 1.05 \bullet V_{DI0} \bullet I_F$$

Equation A-6

Example 1

DECS-200N operating power will be supplied by a three-phase transformer connected to the mains. The mains voltage can vary by ±10%. Define the type power of the transformer if the nominal field current (I_{FN}) is 15 Adc and the nominal field voltage (V_F) is 100 Vdc.

In a typical application, for 100 Vdc nominal field voltage, the nominal secondary voltage of the transformer (V_{LL}) will be 240 Vac. The maximum line voltage at the transformer secondary is then $V_L = 1.1 \bullet V_{LL} = 1.1 \bullet 240\ V = 264\ V$. From Equation A-3, $V_{DI0} = 356.4\ V$. The type power of the transformer (S_T) can be calculated using Equation A-6 and is 5,613.3 VA or 5.6 kVA.

Example 2

The transformer from Example 1 has a total short-circuit impedance (x) of 0.09. The resistive component of the short-circuit impedance (r) is 0.02. Determine if minimum forcing of 200% for the specified field is possible under all conditions. The field terminals are connected with two 10 AWG wires and each wire is 50 feet in length.

Minimum forcing will occur when the input voltage is at its minimum value—10% below the nominal value. Under these conditions, the required forcing current is $I_{FF} = 2 \bullet I_F = 30\ Adc$. The secondary voltage of the transformer during this condition is at its minimum—$V_{Lmin} = 0.9 \bullet V_{LL} = 216\ Vac$. The maximum voltage that the DECS-200N output can provide is at the minimum control angle, which is 30° (α_{min}).

Specifications for the 10 AWG wire used in this example list a dc resistance of 1.08 Ω per 1,000 feet at 25°C. Assuming that the wire temperature is about 50°C (based on the ambient temperature and internal heating), the dc resistance of 100 feet of wire can be estimated at about 0.12 Ω (R_{DC}).

Using Equation A-5, the field voltage can be calculated for a given condition such as $V_X = 206.1\ V$. Because the calculated field voltage is higher than the required 200 Vdc for 200% forcing at 30 Adc of field current, the minimum forcing of 200% is possible for all conditions specified in the example. It is worth noting that the specified level of forcing would not be possible if the input voltage decreased by an additional 5%.

SINGLE-PHASE OPERATING POWER

The phase voltage drop, scaled to the transformer secondary side, is equal to $z \bullet V_{LN}$ when the source terminals are shorted and the output current equals I_L.

The rated, full-load exciter field current (I_F) that the source can provide (at the rated source current) and the rated source current (I_L) are equal to each other ($I_L = I_F$).

The output voltage of an "ideal" diode bridge (used to simplify explanation) for a given source voltage is calculated using Equation A-7.

$$V_{DI0} = \frac{2 \bullet \sqrt{2}}{\pi} \bullet V_{LL} = 0.9 \bullet V_{LL}$$

Equation A-7

The voltage drop across simultaneously conducting SCRs (typically, two SCRs conduct at any given time (the voltage drop across one conducting SCR is $V_T = 1V$)) can be taken into account.

The voltage drop across the wires connecting the DECS-200N to the field terminals is calculated using Equation A-3 ($V_{DC} = R_{DC} \bullet I_F$).

In Equation A-3, R_{DC} is the wire resistance between the DECS-200N and the field terminals and I_F is the field current actually applied at the operating point under consideration.

Finally, if the actual, applied output of the voltage source is V_L (it may differ from the rated value), the field voltage is calculated as:

$$
\begin{array}{ccc}
A & B & C
\end{array}
$$

$$V_F = V_{DI0}\left(\cos\alpha - \frac{x \bullet I_F \bullet V_{PR}}{\sqrt{2} \bullet I_{FR} \bullet V_P} - \frac{r \bullet I_F}{I_{FR}} \right) - 2 \bullet V_T - r_{DC} \bullet I_F$$

Equation A-8

In Equation A-8, α is the control angle at the operating point (30 to 135° for the DECS-200N at nominal frequency). The portion of Equation A-4 marked by callout A calculates the SCR voltage drop. The portion marked by callout B calculates the SCR voltage drop. The portion marked by callout C calculates the voltage drop across the wires connecting the DECS-200N output to the field.

Equation A-9 simplifies Equation A-8 by ignoring the insignificant voltage drops across the input power wires, SCRs, and field wiring.

$$V_F = V_{DI0}\left(\cos\alpha - \frac{x \bullet I_F \bullet V_{LN}}{\sqrt{2} \bullet I_{FR} \bullet V_P} \right)$$

Equation A-9

Very often, a power transformer is used as a source for the field energy—as an interface between the energy source (generator or mains) and the SCR bridge. For the nominal field current, I_F (generally, maximum continuous field current) and the selected maximum transformer secondary voltage, V_L, the type power of the transformer is calculated as follows.

First, the ideal diode rectifier voltage output is calculated using Equation A-10:

$$V_{DI0} = 0.9 \bullet V_{LL}$$

Equation A-10

Once the rectifier output voltage is found, the transformer VA is calculated using Equation A-11.

$$S_T = 1.11 \bullet V_{DI0} \bullet I_F$$

Equation A-11

APPENDIX B • MODBUS® COMMUNICATION

TABLE OF CONTENTS

APPENDIX B • MODBUS® COMMUNICATION

INTRODUCTION

This section describes the Modbus communication protocol employed by the DECS-200N and how to exchange information with the DECS-200N over a Modbus network. The DECS-200N communicates by emulating a subset of the Modicon™ 984 Programmable Controller.

<table>
<tr><td align="center">CAUTION</td></tr>
<tr><td>This product contains one or more nonvolatile memory devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.</td></tr>
</table>

DECS-200N MODBUS® PROTOCOL

Modbus communications use a master-slave technique in which only the master can initiate a trans-action called a query. When appropriate, a slave (DECS-200N) 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-200N is grouped characteristically in categories. The following information categories are maintained by the DECS-200N:

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-200N 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-200N (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 1 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-200N 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-200N Modbus performs all of the above functions when a Modbus message has its unique address which is numbered from 1 to 247. DECS-200N also recognizes a broadcast (group) address of 0. Only functions 16 and 8 are recognized as valid for broadcast. The DECS-200N 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 their 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-200N supports only the RTU mode via rear RS-485 serial interface.

Communication settings for the DECS-200N Rear RS-485 port are listed in Table B-1.

Table B-1. DECS-200N Communication Settings

Setting	Programable Y(Yes) / N(No)	Default Value	Value Range
Baud Rate	Y	9600	1,200 / 2,400 / 4,800 / 9,600 / 19,200

Setting	Programable Y(Yes) / N(No)	Default Value	Value Range
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-200N requires an inter-byte latency of 3.5 character times before considering the message complete.

Once a valid query is received, the DECS-200N 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 B-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 B-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-200N 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-200N) 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-200N are provided in Table B-3.

Table B-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-200N 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-200N 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-200N 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-200N will perform the write when the device address is the same as the DECS-200N 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* for more information).

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-200N 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 (FC=6)

A Preset Single Register query message requests a single register to be written. The DECS-200N will perform the write when the device address is the same as the DECS-200N'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.

Normal Response

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 a disallowed value (out of range) 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-200N 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-200N 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-200N 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-200N 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-200N 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-200N data does not need to be converted into any special format for transmission over a Modbus network.

Modbus Registers hold original DECS-200N data of the generic (built-in) data types listed in Table B-4.

Table B-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-200N 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-200N 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 B-5.

Table B-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-200N UINT16 or INT16 type data value of 0xF067 is mapped to HR 47003. Data is copied to HR 47003 as shown in Table B-6.

Table B-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 B-7.

Table B-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 MMM MMMM	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 B-8 shows the floating-point format.

Table B-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 B-9.

Table B-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-200N 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-200N 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-200N MODBUS REGISTER SPACE

Modbus Address space from 40000 to 49999 refers to Functions Code 3, 6 and 16. The DECS-200N uses address space from 47001 to 48550 (1,250 registers). This address space is divided into 14 areas referred to as information categories. Table B-10 provides a statistical summary for each information category.

Table B-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	57	R	FLOAT: 24 UINT16: 9
C3	Reporting (Status)	125	47376 to 47499	None	R	None (for future use)
C4	Control System Configuration Parameters Group 1	60	47500 to 47560	61	60 RW 1 R	FLOAT: 26 UINT16: 9
C5	Operating Modes	60	47561 to 47620	29	20 RW 9 R	UINT16: 29
C6	Setpoints	120	47621 to 47740	94	48 R 46 RW	FLOAT: 45 UINT16: 4
C7	Startup Parameters	60	47741 to 47800	20	RW	FLOAT: 10
C8	Limiter Parameters	60	47801 to 47860	56	RW	FLOAT: 28
C9	Control Loop Gains	60	47861 to 47920	51	RW	FLOAT: 25 UINT16: 1
C10	Protective Functions	60	47921 to 47980	42	RW	FLOAT: 17 UINT16: 84
C11	Calibration Rated Parameters	60	47981 to 48040	None (for future use)	RW	None (for future use)
C12	Relay Parameters	120	48041 to 48160	83	RW	UINT16: 83
C13	General System Parameters	60	48161 to 48220	8	2 R 6 RW	UINT16: 6 UCHAR: 2
C14	FP Metering Configuration Parameters	30	48221 to 48250	3	3 RW	UINT16: 3
C15	Control System Configuration Parameters Group	50	48501 to 48550	10	RW	FLOAT: 4 UINT16: 2

DECS-200N 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-200N. There is a separate table for each information category.

Holding Registers for Information Category C1

Table B-11. Information Category C1 (Product Information)

Holding Register	Data ID	Description	Access	Data Format
47001	1001	First character of the ASCII string of model information	R-	UI8
47002	1002	2nd character of the ASCII string of model information	R-	UI8
47003	1003	3rd character of the ASCII string of model information	R-	UI8
47004	1004	4th character of the ASCII string of model information	R-	UI8
47005	1005	5th character of the ASCII string of model information	R-	UI8
47006	1006	6th character of the ASCII string of model information	R-	UI8
47007	1007	7th character of the ASCII string of model information	R-	UI8
47008	1008	8th character of the ASCII string of model information	R-	UI8
47009	1009	9th (the last) character of the ASCII string of model information	R-	UI8
47010	1010	1st character of the ASCII string of application program version info.	R-	UI8
47011	1011	2nd character of the ASCII string of application program version info.	R-	UI8
47012	1012	3rd character of the ASCII string of application program version info.	R-	UI8
47013	1013	4th character of the ASCII string of application program version info.	R-	UI8
47014	1014	5th character of the ASCII string of application program version info.	R-	UI8
47015	1015	6th character of the ASCII string of application program version info.	R-	UI8
47016	1016	7th character of the ASCII string of application program version info.	R-	UI8
47017	1017	8th (the last) character of the ASCII string of application program version information	R-	UI8
47018	1018	1st character of the ASCII string of date of the application program version	R-	UI8
47019	1019	2nd character of the ASCII string of date of the application program version	R-	UI8
47020	1020	3rd character of the ASCII string of date of the application program version	R-	UI8
47021	1021	4th character of the ASCII string of date of the application program version	R-	UI8
47022	1022	5th character of the ASCII string of date of the application	R-	UI8

Holding Register	Data ID	Description	Access	Data Format
		program version		
47023	1023	6th character of the ASCII string of date of the application program version	R-	UI8
47024	1024	7th character of the ASCII string of date of the application program version	R-	UI8
47025	1025	8th character of the ASCII string of date of the application program version	R-	UI8
47026	1026	9th (the last) character of the ASCII string of date of the application program version	R-	UI8
47027	1027	1st character of the ASCII string of DSP program version information	R-	UI8
47028	1028	2nd character of the ASCII string of DSP program version information	R-	UI8
47029	1029	3rd character of the ASCII string of DSP program version information	R-	UI8
47030	1030	4th character of the ASCII string of DSP program version information	R-	UI8
47031	1031	5th character of the ASCII string of DSP program version information	R-	UI8
47032	1032	6th character of the ASCII string of DSP program version information	R-	UI8
47033	1033	7th character of the ASCII string of DSP program version information	R-	UI8
47034	1034	8th (the last) character of the ASCII string of DSP program version information	R-	UI8
47035	1035	1st character of the ASCII string of date of the DSP program version	R-	UI8
47036	1036	2nd character of the ASCII string of date of the DSP program version	R-	UI8
47037	1037	3rd character of the ASCII string of date of the DSP program version	R-	UI8
47038	1038	4th character of the ASCII string of date of the DSP program version	R-	UI8
47039	1039	5th character of the ASCII string of date of the DSP program version	R-	UI8
47040	1040	6th character of the ASCII string of date of the DSP program version	R-	UI8
47041	1041	7th character of the ASCII string of date of the DSP program version	R-	UI8
47042	1042	8th character of the ASCII string of date of the DSP program version	R-	UI8
47043	1043	9th (the last) character of the ASCII string of date of the DSP program version	R-	UI8
47044	1044	1st character of the ASCII string of Boot program version information	R-	UI8

Holding Register	Data ID	Description	Access	Data Format
47045	1045	2nd character of the ASCII string of Boot program version information	R-	UI8
47046	1046	3rd character of the ASCII string of Boot program version information	R-	UI8
47047	1047	4th character of the ASCII string of Boot Program version information	R-	UI8
47048	1048	5th character of the ASCII string of Boot program version information	R-	UI8
47049	1049	6th character of the ASCII string of Boot program version information	R-	UI8
47050	1050	7th character of the ASCII string of Boot program version information	R-	UI8
47051	1051	8th (the last) character of the ASCII string of Boot program version information	R-	UI8
47052	1052	1st character of the ASCII string of date of the Boot program version	R-	UI8
47053	1053	2nd character of the ASCII string of date of the Boot program version	R-	UI8
47054	1054	3rd character of the ASCII string of date of the Boot program version	R-	UI8
47055	1055	4th character of the ASCII string of date of the Boot program version	R-	UI8
47056	1056	5th character of the ASCII string of date of the Boot program version	R-	UI8
47057	1057	6th character of the ASCII string of date of the Boot program version	R-	UI8
47058	1058	7th character of the ASCII string of date of the Boot program version	R-	UI8
47059	1059	8th character of the ASCII string of date of the Boot program version	R-	UI8
47060	1060	9th (the last) character of the ASCII string of date of the Boot program version	R-	UI8
47061	1061	1st character of the ASCII string of style number information	R-	UI8
47062	1062	2nd character of the ASCII string of style number information	R-	UI8
47063	1063	3rd 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 B-12. Information Category C2 (Metering)

Holding Register	Data ID	Description	Access	Data Format
47251	2001	RMS generator voltage phase A to B	R-	R32_23

Holding Register	Data ID	Description	Access	Data Format
47252	2001		R-	
47253	2002	RMS generator Voltage phase B to C	R-	R32_23
47254	2002		R-	
47255	2003	RMS generator voltage phase C to A	R-	R32_23
47256	2003		R-	
47257	2004	Average of the three rms line-to-line voltages	R-	R32_23
47258	2004		R-	
47259	2005	Generator current Ib in amps	R-	R32_23
47260	2005		R-	
47261	2006	Generator apparent power in kVA	R-	R32_23
47262	2006		R-	
47263	2007	Generator real power in kW	R-	R32_23
47264	2007		R-	
47265	2008	Generator reactive power in kvar	R-	R32_23
47266	2008		R-	
47267	2009	Power factor	R-	R32_23
47268	2009		R-	
47269	2010	Generator frequency in hertz	R-	R32_23
47270	2010		R-	
47271	2011	Bus frequency in hertz	R-	R32_23
47272	2011		R-	
47273	2012	RMS bus voltage in volts	R-	R32_23
47274	2012		R-	
47275	2013	Field voltage in volts	R-	R32_23
47276	2013		R-	
47277	2014	Field current in amps	R-	R32_23
47278	2014		R-	
47279	2015	Var/PF controller output in volts	R-	R32_23
47280	2015		R-	
47281	2016	Phase angle between phase B voltage and current in degrees	R-	R32_23
47282	2016		R-	
47283	2017	Auxiliary input in volts (PSS input)	R-	R32_23
47284	2017		R-	
47285	2018	Current input for load compensation	R-	R32_23

Holding Register	Data ID	Description	Access	Data Format
47286	2018		R-	
47287	2019	Null balance (tracking error) in percent	R-	R32_23
47288	2019		R-	
47289	2020	Error signal to autotracking loop	R-	R32_23
47290	2020		R-	
47291	2021	Active controller output	R-	R32_23
47292	2021		R-	
47293	2022	PF state: 0=leading/1=lagging	R-	UI16
47294	2023	Generator state: 0=generating /1=motoring	R-	UI16
47295	2024	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=Internal Tracking, b2=Pre-Position, b3=Upper Limit, b4=Lower Limit, b5=Edit Button	R-	UI16
47296	2025	Voltage matching status: 0=off/1=on	R-	UI16
47297	2026	Protection status bit flags (0=clear, 1=condition present): b0=field over-voltage, b1=field over-current, b2=generator under-voltage, b3=generator over-voltage, b4=under-frequency, 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= generator below 10Hz, b12=exciter diode open, b13=exciter diode shorted, b14=loss of field, b15=in stator current limiting.	R-	UI16
47298	2027	For future use	R-	R32_23
47299	2027		R-	
47300	2028	The active operating setpoint expressed as a percent of its adjustment range.	R-	R32_23
47301	2028		R-	
47302	2029	The state of some contact inputs: b0=52JK, b1=52LM, b2=Auto Transfer, b3=Ext. Tracking Enable	R-	UI16
47303	2030	Annunciation status bit flags (0=clear, 1=annunciation present): b0=field over-voltage, b1=field over-current, b2=generator under-voltage, b3=generator over-voltage, b4=under-frequency, 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= generator below 10 Hz, b12=exciter diode open, b13=exciter diode shorted, b14=loss of field, b15=in stator current limiting.	R-	UI16
47304	2031	Reserved	R-	R32_23
47305	2031		R-	
47306	2032	Protection status bit flags (0 = clear, 1 = condition present): b0=failed to build up, b1=build-up activated, b2= power input failure, b3 = crowbar activated, b4 - b15 are unassigned.	R-	UI16

Holding Register	Data ID	Description	Access	Data Format
47307	2033	Annunciation status bit flags (0 = clear, 1 = condition present) b0=failed to build up, b1=build-up activated, b2= power input failure, b3 = crowbar activated, b4– b15 are unassigned.	R-	UI16
47308 to 47375		Reserved for C2 data	Not Supported	Not Defined

Holding Registers for Information Category C3

Table B-13. Information Category C3 (Reporting)

Holding Register	Data ID	Description	Access	Data Format
47376 to 47499		Reserved for C3 data	Not Supported	Not Defined

Holding Registers for Information Category C4

Table B-14. Information Category C4 (Control System Configuration Parameters)

Holding Register	Data ID	Description	Access	Data Format
47500	4009	Auxiliary input function	RW	UI16
47501	4011	Generator rated frequency	RW	R32_23
47502	4011		RW	
47503	4012	Generator PT primary voltage rating	RW	R32_23
47504	4012		RW	
47505	4013	Generator PT secondary voltage rating	RW	R32_23
47506	4013		RW	
47507	4014	Generator CT primary current rating	RW	R32_23
47508	4014		RW	
47509	4015	Generator CT secondary current rating	RW	R32_23
47510	4015		RW	
47511	4016	Field current shunt res. rating (in amps)	RW	R32_23
47512	4016		RW	
47513	4017	Field voltage connections to isolation box	RW	R32_23
47514	4017		RW	
47515	4018	Bus sensing PT primary rating	RW	R32_23
47516	4018		RW	
47517	4019	Bus sensing PT secondary rating	RW	R32_23
47518	4019		RW	
47519	4020	Reserved	RW	R32_23
47520	4020		RW	
47521	4021	Reserved	RW	R32_23
47522	4021		RW	
47523	4022	Generator rated voltage	RW	R32_23
47524	4022		RW	
47525	4023	Generator rated current	RW	R32_23
47526	4023		RW	
47527	4024	Generator rated field voltage	RW	R32_23
47528	4024		RW	
47529	4025	Generator rated field current	RW	R32_23
47530	4025		RW	
47531	4026	Nominal bus voltage	RW	R32_23
47532	4026		RW	

Holding Register	Data ID	Description	Access	Data Format
47533	4027	Auxiliary input gain for AVR mode	RW	R32_23
47534	4027		RW	
47535	4028	Time delay before autotracking	RW	R32_23
47536	4028		RW	
47537	4029	Traverse rate of autotracking	RW	R32_23
47538	4029		RW	
47539	4030	Null balance level	RW	R32_23
47540	4030		RW	
47541	4031	Gain for cross current compensation	RW	R32_23
47542	4031		RW	
47543	4001	Sensing Mode 1-phase/3-phase	RW	UI16
47544	4002	Auxiliary input summing mode (Inner Loop or Outer Loop)	RW	UI16
47545	4003	Power Output Mode: 0 to +10V /–10 to +10V / 4 to 20mA	RW	UI16
47546	4004	Reserved	RW	UI16
47547	4006	Auxiliary input mode (voltage or current input)	RW	UI16
47548	4007	For future use	RW	UI16
47549	4032	External tracking time delay	RW	R32_23
47550	4032		RW	
47551	4033	External tracking traverse rate	RW	R32_23
47552	4033		RW	
47553	4005	Voltage sensing hardware gain control signal	R	UI16
47554	4034	Auxiliary input gain for FCR mode	RW	R32_23
47555	4034		RW	
47556	4035	Auxiliary input gain for VAR mode	RW	R32_23
47557	4035		RW	
47558	4036	Auxiliary input gain for PF mode	RW	R32_23
47559	4036		RW	
47560	4008	Reserved	RW	UI16

Holding Registers for Information Category C5

Table B-15. Information Category C5 (Operating Mode Parameters)

Holding Register	Data ID	Description	Access	Data Format
47561	5001	Virtual toggle switch for changing Unit mode from comm. port from START to STOP or from STOP to START. Value 1 is only valid to apply. Data Id 5013 in holding register 47572 contains Unit mode status. Note: Read value of register 47561 is always 0.	RW	UI16
47562	5002	Virtual toggle switch for changing Control mode from comm. port from AVR to FCR or from FCR to AVR. Value 1 is only valid to apply. Data Id 5014 in holding register 47573 contains Control mode status. Note: Read value of register 47562 is always 0.	RW	UI16
47563	5004	Switch for changing Operating mode via comm. port, one of three modes, 0=OFF/ 1=PF/ 2=VAR. Data Id 5012 in holding register 47571 contains Operating mode status. Note: Read value of register 47563 is always 4.	RW	UI16
47564	5005	Virtual toggle switch for changing Auto Track mode from comm. port from ENABLED to DISABLED or from DISABLED to ENABLED. Value 1 is only valid to apply. Data Id 5015 in holding register 47574 contains Auto Track mode status. Note: Read value of register 47564 is always 0.	RW	UI16
47565	5006	Pre-position enable status from comm. port (0=off/ 1=on)	RW	UI16
47566	5007	Raise Enabled status from comm. port (0=off/ 1=on)	RW	UI16
47567	5008	Lower Enabled status from comm. port (0=off/ 1=on)	RW	UI16

Holding Register	Data ID	Description	Access	Data Format
47568	5009	Autotransfer Enable status from comm. port (0=off/ 1=on)	RW	UI16
47569	5010	Limiter Mode options (0=OFF/ 1=UEL/ 2=OEL/ 3=BOTH)	RW	UI16
47570	5011	volt match mode; (0=OFF/1= ON)	RW	UI16
47571	5012	Operating mode (0=OFF/ 1=PF/ 2=VAR)	R	UI16
47572	5013	Unit mode status (1=START, 0=STOP)	R	UI16
47573	5014	Control mode status (1=FCR, 2=AVR)	R	UI16
47574	5015	AutoTrack status	R	UI16
47575	5016	Pre-position Enable status	R	UI16
47576	5017	Autotransfer status	R	UI16
47577	5018	Load compensation mode (0=OFF, 1=Droop, 2=Line Drop)	R	UI16
47578	5003	Comm. port input to select Load compensation mode	RW	UI16
47579	5019	Alarm reset enable	RW	UI16
47580	5020	Loss-of-sensing detection enable	RW	UI16
47581	5021	Loss of sensing triggered transfer-to-FCR-mode enable	RW	UI16
47582	5023	Under frequency or V/Hz mode enable	RW	UI16
47583	5022	External Tracking enabled: 0 = disabled /1 = enabled	RW	UI16
47584	5024	Virtual toggle switch for OEL style: 0 = no change, 1 = change Read back: 0 = summing point, 1 = takeover	RW	UI16
47585	5025	52 contacts option: 0 = Option 1, 1 = Option 2, 2 = Option 3, 3 = Option 4, 4 = Option 5, 5 = Option 6	RW	UI16
47586	5026	PF/var option status: 0 = Off, 1 = PF, 2 = var	R-	UI16
47587	5027	Power input failure status	R-	UI16
47588	5029	Power input failure mode: 0 = alarm and shutdown, 1 = alarm only	RW	UI16
47589	5030	Crowbar active mode: 0 = alarm and shutdown, 1 = alarm only	RW	UI16
47590 to 47620		Reserved for C5 data		

Holding Registers for Information Category C6

Table B-16. Information Category C6 (Setpoint Parameters)

Holding Register	Data ID	Description	Access	Data Format
47621	6001	FCR mode (field current) setpoint	RW	R32_23
47622	6001		RW	
47623	6002	AVR mode (generator voltage) setpoint	RW	R32_23
47624	6002		RW	
47625	6003	Var mode setpoint in kvar	RW	R32_23
47626	6003		RW	
47627	6004	PF mode setpoint	RW	R32_23
47628	6004		RW	
47629	6005	Droop setting in per-cent (of rated generator voltage)	RW	R32_23
47630	6005		RW	
47631	6014	FCR mode traverse rate	RW	R32_23
47632	6014		RW	
47633	6015	AVR mode traverse rate	RW	R32_23
47634	6015		RW	
47635	6016	Var mode traverse rate	RW	R32_23
47636	6016		RW	
47637	6017	PF mode traverse rate	RW	R32_23
47638	6017		RW	
47639	6018	FCR mode setpoint pre-position	RW	R32_23
47640	6018		RW	

Holding Register	Data ID	Description	Access	Data Format
47641	6019	AVR mode setpoint pre-position	RW	R32_23
47642	6019		RW	
47643	6020	Var mode setpoint pre-position in kvar	RW	R32_23
47644	6020		RW	
47645	6021	PF mode setpoint pre-position	RW	R32_23
47646	6021		RW	
47647	6022	FCR mode setpoint step size	R	R32_23
47648	6022		R	
47649	6023	AVR mode setpoint step size	R	R32_23
47650	6023		R	
47651	6024	Var mode setpoint step size in kvar	R	R32_23
47652	6024		R	
47653	6025	PF mode setpoint step size	R	R32_23
47654	6025		R	
47655	6026	FCR mode setpoint's adjustable minimum in %	RW	R32_23
47656	6026		RW	
47657	6027	AVR mode setpoint's adjustable minimum in %	RW	R32_23
47658	6027		RW	
47659	6028	Var mode setpoint's adjustable minimum in %	RW	R32_23
47660	6028		RW	
47661	6029	PF mode setpoint's adjustable minimum	RW	R32_23
47662	6029		RW	
47663	6030	FCR mode setpoint's adjustable maximum in %	RW	R32_23
47664	6030		RW	
47665	6031	AVR mode setpoint's adjustable maximum in %	RW	R32_23
47666	6031		RW	
47667	6032	Var mode setpoint's adjustable maximum in %	RW	R32_23
47668	6032		RW	
47669	6033	PF mode setpoint's adjustable maximum	RW	R32_23
47670	6033		RW	
47671	6034	Minimum value for FCR mode setpoint's adjustable maximum in percent	R-	R32_23
47672	6034		R-	
47673	6035	Minimum value for AVR mode setpoint's adjustable maximum in percent	R-	R32_23
47674	6035		R-	
47675	6036	Minimum value for var mode setpoint's adjustable maximum in percent	R-	R32_23
47676	6036		R-	
47677	6037	Minimum value for PF mode setpoint's adjustable maximum	R-	R32_23
47678	6037		R-	
47679	6038	Maximum value for FCR mode setpoint's adjustable maximum in percent	R-	R32_23
47680	6038		R-	
47681	6039	Maximum value for AVR mode setpoint's adjustable maximum in percent	R-	R32_23
47682	6039		R-	
47683	6040	Maximum value for var mode setpoint's adjustable maximum in percent	R	R32_23
47684	6040		R-	
47685	6041	Maximum value for PF mode setpoint's adjustable maximum	R-	R32_23
47686	6041		R-	
47687	6042	Step size for FCR mode setpoint's adjustable maximum in	R-	R32_23

Holding Register	Data ID	Description	Access	Data Format
		percent		
47688	6042		R-	
47689	6043	Step size for AVR mode setpoint's adjustable maximum in percent	R-	R32_23
47690	6043		R-	
47691	6044	Step size for var mode setpoint's adjustable maximum in %	R-	R32_23
47692	6044		R-	
47693	6045	Step size for PF mode setpoint's adjustable maximum in %	R-	R32_23
47694	6045		R-	
47695	6046	FCR pre-position mode (0=maint./1=release)	RW	UI16
47696	6047	AVR pre-position mode (0=maint./1=release)	RW	UI16
47697	6048	Var pre-position mode (0=maint./1=release)	RW	UI16
47698	6049	PF pre-position mode (0=maint./1=release)	RW	UI16
47699	6006	FCR minimum setpoint	R-	R32_23
47700	6006		R-	
47701	6007	AVR minimum setpoint	R-	R32_23
47702	6007		R-	
47703	6008	Var minimum setpoint in kvar	R-	R32_23
47704	6008		R-	
47705	6009	PF minimum setpoint	R-	R32_23
47706	6009		R-	
47707	6010	FCR maximum setpoint	R-	R32_23
47708	6010		R-	
47709	6011	AVR maximum setpoint	R-	R32_23
47710	6011		R-	
47711	6012	Var maximum setpoint in kvar	R-	R32_23
47712	6012		R-	
47713	6013	PF maximum setpoint	R-	R32_23
47714	6013		R-	
47715 to 47740		Reserved for C6 data		

Holding Registers for Information Category C7

Table B-17. Information Category C7 (Startup Parameters)

Holding Register	Data ID	Description	Access	Data Format
47741	7001	Soft start threshold	RW	R32_23
47742	7001		RW	
47743	7002	Soft start duration in seconds	RW	R32_23
47744	7002		RW	
47745	7003	Underfrequency corner frequency in hertz	RW	R32_23
47746	7003		RW	
47747	7004	Slope of underfrequency curve in V/Hz	RW	R32_23
47748	7004		RW	
47749	7005	Width of voltage matching window in % of nominal voltage	RW	R32_23
47750	7005		RW	
47751	7006	Voltage matching reference in % of nominal voltage	RW	R32_23
47752	7006		RW	
47753	7007	Fine voltage adjust band in % of nominal voltage	RW	R32_23
47754	7007		RW	
47755	7008	Time required for Loss of Sensing in seconds	RW	R32_23
47756	7008		RW	

Holding Register	Data ID	Description	Access	Data Format
47757	7010	Loss of sensing level under balanced conditions, adjustable from 0 to 100% of rated generator voltage in 0.1% increments	RW	R32_23
47758	7010		RW	
47759	7011	Loss of sensing level under unbalanced conditions, adjustable from 0 to 100% of rated generator voltage in 0.1% increments	RW	R32_23
47760	7011		RW	
47761 to 47800		Reserved for C7 data		

Holding Registers for Information Category C8

Table B-18. Information Category C8 (Limiter Parameters)

Holding Register	Data ID	Description	Access	Data Format
47801	8001	On-line high OEL level (in amps)	RW	R32_23
47802	8001		RW	
47803	8002	Time allowed for On-line high OEL level in seconds	RW	R32_23
47804	8002		RW	
47805	8003	On-line medium OEL level in amps	RW	R32_23
47806	8003		RW	
47807	8004	time allowed for On-line medium OEL level in seconds	RW	R32_23
47808	8004		RW	
47809	8005	On-line low OEL level in amps	RW	R32_23
47810	8005		RW	
47811	8006	UEL level in kvar	RW	R32_23
47812	8006		RW	
47813	8008	Time allowed for off-line, high OEL level in seconds	RW	R32_23
47814	8008		RW	
47815	8009	Off-line high OEL level in amps	RW	R32_23
47816	8009		RW	
47817	8010	Off-line low OEL level in amps	RW	R32_23
47818	8010		RW	
47819	8011	1st UEL point kW value	RW	R32_23
47820	8011		RW	
47821	8012	2nd UEL point kW value	RW	R32_23
47822	8012		RW	
47823	8013	3rd UEL point kW value	RW	R32_23
47824	8013		RW	
47825	8014	4th UEL point kW value	RW	R32_23
47826	8014		RW	
47827	8015	5th UEL point kW value	RW	R32_23
47828	8015		RW	
47829	8016	1st UEL point kvar value	RW	R32_23
47830	8016		RW	
47831	8017	2nd UEL point kvar value	RW	R32_23
47832	8017		RW	
47833	8018	3rd UEL point kvar value	RW	R32_23
47834	8018		RW	
47835	8019	4th UEL point kvar value	RW	R32_23
47836	8019		RW	
47837	8020	5th UEL point kvar value	RW	R32_23
47838	8020		RW	
47839	8021	SCL high limit level, adjustable from 0 to 66,000 A in 0.1 A	RW	R32_23

Holding Register	Data ID	Description	Access	Data Format
		Increments.		
47840	8021		RW	
47841	8022	Time allowed at SCL high limit level, adjustable from 0 to 60 seconds in 0.1 second increments.	RW	R32_23
47842	8022		RW	
47843	8023	SCL low limit level, adjustable from 0 to 66,000 A, in 0.1 A Increments.	RW	R32_23
47844	8023		RW	
47845	8024	Takeover OEL offline high limit level, adjustable from 0.1 to 30 A in 0.1 A increments.	RW	R32_23
47846	8024		RW	
47847	8025	Takeover OEL offline low limit level, adjustable from 0.1 to 15 A in 0.1 A increments.	RW	R32_23
47848	8025		RW	
47849	8026	Takeover OEL offline time dial, adjustable from 0.1 to 20 A, in 0.1 Increments.	RW	R32_23
47850	8026		RW	
47851	8027	Takeover OEL online high limit level, adjustable from 0.1 to 30 A in 0.1 A increments.	RW	R32_23
47852	8027		RW	
47853	8028	Takeover OEL online low limit level, adjustable from 0.1 to 15 A in 0.1 A increments.	RW	R32_23
47854	8028		RW	
47855	8029	Takeover OEL online time dial, adjustable from 0.1 to 20 in 0.1 Increments.	RW	R32_23
47856	8029		RW	
47857 to 47860		Reserved for C8 data		

Holding Registers for Information Category C9

Table B-19. Information Category C9 (Control Loop Gain Parameters)

Holding Register	Data ID	Description	Access	Data Format
47861	9001	Index into table of programmed gain constants. 1 – 20 gives predefined gain, 21 allows gain to be user-programmed	RW	R32_23
47862	9001		RW	
47863	9002	Primary AVR/FCR mode proportional gain, Kp	RW	R32_23
47864	9002		RW	
47865	9003	Primary AVR/FCR mode integral gain	RW	R32_23
47866	9003		RW	
47867	9004	Primary AVR/FCR mode derivative gain	RW	R32_23
47868	9004		RW	
47869	9006	OEL integral gain, Ki	RW	R32_23
47870	9006		RW	
47871	9007	PF mode integral gain, Ki	RW	R32_23
47872	9007		RW	
47873	9008	Var mode integral gain, Ki	RW	R32_23
47874	9008		RW	
47875	9009	FCR mode loop gain, Kg	RW	R32_23
47876	9009		RW	
47877	9010	Primary AVR mode loop gain, Kg	RW	R32_23
47878	9010		RW	
47879	9011	Var mode loop gain, Kg	RW	R32_23
47880	9011		RW	

Holding Register	Data ID	Description	Access	Data Format
47881	9012	PF mode loop gain, Kg	RW	R32_23
47882	9012		RW	
47883	9013	OEL loop gain, Kg	RW	R32_23
47884	9013		RW	
47885	9014	UEL loop gain, Kg	RW	R32_23
47886	9014		RW	
47887	9022	UEL integral gain, Ki	RW	R32_23
47888	9022		RW	
47889	9015	Voltage matching loop gain, Kg	RW	R32_23
47890	9015		RW	
47891	9023	Primary AVR mode derivative time constant, Td	RW	R32_23
47892	9023		RW	
47893	9024	Secondary gain option (index into table)	RW	R32_23
47894				
47895	9025	Secondary AVR mode proportional gain, Kp	RW	R32_23
47896				
47897	9026	Secondary AVR mode integral gain, Ki	RW	R32_23
47898				
47899	9027	Secondary AVR mode derivative gain, Kd	RW	R32_23
47900				
47901	9028	Secondary AVR mode loop gain, Kg	RW	R32_23
47902				
47903	9029	Secondary AVR derivative time constant, Td	RW	R32_23
47904				
47905	9030	Active gain setting group (status indicator)	R	UI16
47906	9031	SCL loop gain (Kg), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47907	9031		RW	
47908	9033	SCL integral gain (Ki), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47909	9033		RW	
47910 to 47920		Reserved for C9 data		

Holding Registers for Information Category C10

Table B-20. Information Category C10 (Protective Functions Parameters)

Holding Register	Data ID	Description	Access	Data Format
47921	10001	Field overvoltage level (in volts)	RW	R32_23
47922	10001		RW	
47923	10002	Field overcurrent base level (in amps)	RW	R32_23
47924	10002		RW	
47925	10003	Stator undervoltage level (in volts)	RW	R32_23
47926	10003		RW	
47927	10004	Stator overvoltage level (in volts)	RW	R32_23
47928	10004		RW	
47929	10005	Field overvoltage delay (in seconds)	RW	R32_23
47930	10005		RW	
47931	10006	Field overcurrent time dial	RW	R32_23
47932	10006		RW	
47933	10007	Stator undervoltage delay (in seconds)	RW	R32_23
47934	10007		RW	

Holding Register	Data ID	Description	Access	Data Format
47935	10008	Stator overvoltage delay (in seconds)	RW	R32_23
47936	10008		RW	
47937	10009	Field overvoltage alarm enable	RW	UI16
47938	10010	Field overcurrent alarm enable	RW	UI16
47939	10011	Stator undervoltage alarm enable	RW	UI16
47940	10012	Stator overvoltage alarm enable	RW	UI16
47941	10013	Reserved	RW	R32_23
47942	10013		RW	
47943	10014	Reserved	RW	R32_23
47944	10014		RW	
47945	10015	Reserved	RW	UI16
47946	10016	Exciter open diode ripple pickup level, adjustable from 0% to 100% in 0.1% increments.	RW	R32_23
47947	10016		RW	
47948	10017	Exciter open diode time delay, adjustable from 10 s. to 60s. in 0.1s. increments.	RW	R32_23
47949	10017		RW	
47950	10018	Exciter open diode protection enable: 0 = disabled, 1 = enabled	RW	UI16
47951	10019	Exciter shorted diode ripple pickup level, adjustable from 0% to 100% in 0.1% increments.	RW	R32_23
47952	10019		RW	
47953	10020	Exciter shorted diode time delay, adjustable from 5 s to 30 s in 0.1 s. increments.	RW	R32_23
47954	10020	EDM protection disable level in % of rated field current	RW	
47955	10021	Exciter shorted diode protection enable: 0 = disabled, 1 = enabled	RW	UI16
47956	10022	Exciter diode protection disable level, adjustable from 0% to 100% of rated exciter field current in 0.1% increments.	RW	R32_23
47957	10022		RW	
47958	10023	Loss of field alarm enable: 0 = disabled, 1 = enabled	RW	UI16
47959	10024	Loss of field level, adjustable from 0 to 3,000 Mvar in 1 kvar increments	RW	R32_23
47960	10024		RW	
47961	10025	Loss of field delay (in seconds): adjustable from 0.1 to 9.9 seconds	RW	R32_23
47962	10025			
47963 to 47980		Reserved for C10 data		

Holding Registers for Information Category C11

Table B-21. Information Category C11 (Calibration Related Parameters)

Holding Register	Data ID	Description	Access	Data Format
47981 to 48040		Reserved for C11 data		

Holding Registers for Information Category C12

Table B-22. Information Category C12 (Relay Parameters)

Holding Register	Data ID	Description	Access	Data Format
48041	12001	Annunciation enables for Relay 1 (0=disable, 1=enable): b0=field over-voltage, b1=field over-current, b2=generator under-voltage, b3=generator over-voltage, b4=under-frequency, b5=in over-excitation limit, b6=in under-excitation limit, b7=in FCR mode, b8=loss of sensing voltage, b9=setpoint at lower limit, b10=setpoint at upper limit, b11=generator below 10Hz, b12=exciter diode open, b13=exciter diode shorted, b14=loss of field, b15=in stator current limiting.	RW	UI16
48042	12002	Annunciation enables for Relay 1 (0=disable, 1=enable): b0=failed to build up, b1=build-up activated, b2=safe mode activated, b3=crowbar activated, b4-b15 not assigned	RW	UI16
48043	12003	Reserved	RW	UI16
48044	12004	Reserved	RW	UI16
48045	12005	Reserved	RW	UI16
48046	12006	Reserved	RW	UI16
48047	12007	Reserved	RW	UI16
48048	12008	Reserved	RW	UI16
48049	12009	Reserved	RW	UI16
48050	12010	Reserved	RW	UI16
48051	12011	Reserved	RW	UI16
48052	12012	Reserved	RW	UI16
48053	12013	Reserved	RW	UI16
48054	12014	Reserved	RW	UI16
48055	12015	Reserved	RW	UI16
48056	12016	Reserved	RW	UI16
48057	12017	Output for Relay 1	R	UI16
48058	12018	Relay 1 annunciation type (0=moment., 1=maint., 2=latched)	RW	UI16
48059	12019	Relay 1 contact sense (0=NC/1=NO)	RW	UI16
48060	12020	Relay 1 output duration for momentary type (multiples of 50 milliseconds)	RW	UI16
48061	12021	Annunciation enables for Relay 2 (0=disable, 1=enable): b0=field over-voltage, b1=field over-current, b2=generator under-voltage, b3=generator over-voltage, b4=under-frequency, b5=in over-excitation limit, b6=in under-excitation limit, b7=in FCR mode, b8=loss of sensing voltage, b9=setpoint at lower limit, b10=setpoint at upper limit, b11=generator below 10Hz, b12=exciter diode open, b13=exciter diode shorted, b14=loss of field, b15=in stator current limiting.	RW	UI16
48062	12022	Annunciation enables for Relay 2 (0=disable, 1=enable): b0=failed to build up, b1=build-up activated, b2=safe mode activated, b3=crowbar activated, b4-b15 unassigned.	RW	UI16
48063	12023	Reserved	RW	UI16
48064	12024	Reserved	RW	UI16
48065	12025	Reserved	RW	UI16
48066	12026	Reserved	RW	UI16
48067	12027	Reserved	RW	UI16
48068	12028	Reserved	RW	UI16
48069	12029	Reserved	RW	UI16
48070	12030	Reserved	RW	UI16
48071	12031	Reserved	RW	UI16
48072	12032	Reserved	RW	UI16
48073	12033	Reserved	RW	UI16
48074	12034	Reserved	RW	UI16

Holding Register	Data ID	Description	Access	Data Format
48075	12035	Reserved	RW	UI16
48076	12036	Reserved	RW	UI16
48077	12037	Output for Relay 2	R	UI16
48078	12038	Relay 2 annunciation type (0=moment./1=maint./2=latched)	RW	UI16
48079	12039	Relay 2 contact sense (0=NC/1=NO)	RW	UI16
48080	12040	Relay 2 output duration for momentary type (multiples of 50 milliseconds)	RW	UI16
48081	12041	Annunciation enables for Relay 3 (0=disable, 1=enable): b0=field overvoltage, b1=field overcurrent, b2=generator undervoltage, b3=generator overvoltage, b4=underfrequency, b5=in overexcitation limit, b6=in underexcitation limit, b7=in FCR mode, b8=loss of sensing voltage, b9=setpoint at lower limit, b10=setpoint at upper limit, b11= generator below 10 Hz, b12=exciter diode open, b13=exciter diode shorted, b14=loss of field, b15=in stator current limiting.	RW	UI16
48082	12042	Annunciation enables for Relay 3 (0=disable, 1=enable): b0=failed to build up, b1=build-up activated, b2=safe mode activated, b3=crowbar activated, b4-b15 unassigned.	RW	UI16
48083	12043	Reserved	RW	UI16
48084	12044	Reserved	RW	UI16
48085	12045	Reserved	RW	UI16
48086	12046	Reserved	RW	UI16
48087	12047	Reserved	RW	UI16
48088	12048	Reserved	RW	UI16
48089	12049	Reserved	RW	UI16
48090	12050	Reserved	RW	UI16
48091	12051	Reserved	RW	UI16
48092	12052	Reserved	RW	UI16
48093	12053	Reserved	RW	UI16
48094	12054	Reserved	RW	UI16
48095	12055	Reserved	RW	UI16
48096	12056	Reserved	RW	UI16
48097	12057	Output for Relay 3	R	UI16
48098	12058	Relay 3 annunciation type (0=moment./1=maint./2=latched)	RW	UI16
48099	12059	Relay 3 contact sense (0=NC/1=NO)	RW	UI16
48100	12060	Relay 3 output duration for momentary type (multiples of 50 milliseconds)	RW	UI16
48101	12061	Annunciation enables for Relay 4 (0=disable, 1=enable): b0=field overvoltage, b1=field overcurrent, b2=generator undervoltage, b3=generator overvoltage, b4=underfrequency, b5=in overexcitation limit, b6=in underexcitation limit, b7=in FCR mode, b8=loss of sensing voltage, b9=setpoint at lower limit, b10=setpoint at upper limit, b11= generator below 10Hz, b12=exciter diode open, b13=exciter diode shorted, b14=loss of field, b15=in stator current limiting.	RW	UI16
48102	12062	Annunciation enables for Relay 4 (0=disable, 1=enable): b0=failed to build up, b1=build-up activated, b2=safe mode activated, b3=crowbar activated, b4-b15 unassigned.	RW	UI16
48103	12063	Reserved	RW	UI16
48104	12064	Reserved	RW	UI16
48105	12065	Reserved	RW	UI16
48106	12066	Reserved	RW	UI16
48107	12067	Reserved	RW	UI16
48108	12068	Reserved	RW	UI16
48109	12069	Reserved	RW	UI16
48110	12070	Reserved	RW	UI16

Holding Register	Data ID	Description	Access	Data Format
48111	12071	Reserved	RW	UI16
48112	12072	Reserved	RW	UI16
48113	12073	Reserved	RW	UI16
48114	12074	Reserved	RW	UI16
48115	12075	Reserved	RW	UI16
48116	12076	Reserved	RW	UI16
48117	12077	Output for Relay 4	R	UI16
48118	12078	Relay 4 annunciation type (0=moment./1=maint./2=latched)	RW	UI16
48119	12079	Relay 4 contact sense (0=NC/1=NO)	RW	UI16
48120	12080	Relay 4 output duration for momentary type (multiples of 50 milliseconds)	RW	UI16
48121	12081	Annunciation enables for Relay 5 (0=disable, 1=enable): b0=field overvoltage, b1=field overcurrent, b2=generator undervoltage, b3=generator overvoltage, b4=underfrequency, b5=in overexcitation limit, b6=in underexcitation limit, b7=in FCR mode, b8=loss of sensing voltage, b9=setpoint at lower limit, b10=setpoint at upper limit, b11= generator below 10Hz, b12=exciter diode open, b13=exciter diode shorted, b14=loss of field, b15=in stator current limiting.	RW	UI16
48122	12082	Annunciation enables for Relay 5 (0=disable, 1=enable): b0=failed to build up, b1=build-up activated, b2=safe mode activated, b3=crowbar activated, b4=field over-temperature, b5-b15 unassigned.	RW	UI16
48123	12083	Reserved	RW	UI16
48124	12084	Reserved	RW	UI16
48125	12085	Reserved	RW	UI16
48126	12086	Reserved	RW	UI16
48127	12087	Reserved	RW	UI16
48128	12088	Reserved	RW	UI16
48129	12089	Reserved	RW	UI16
48130	12090	Reserved	RW	UI16
48131	12091	Reserved	RW	UI16
48132	12092	Reserved	RW	UI16
48133	12093	Reserved	RW	UI16
48134	12094	Reserved	RW	UI16
48135	12095	Reserved	RW	UI16
48136	12096	Reserved	RW	UI16
48137	12097	Output for Relay 5	R	UI16
48138	12098	Relay 5 annunciation type (0=moment./1=maint./2=latched)	RW	UI16
48139	12099	Relay 5 contact sense (0=NC/1=NO)	RW	UI16
48140	12100	Relay 5 output duration for momentary type (multiples of 50 milliseconds)	RW	UI16
48141 to 48160		Reserved for C12 data		

Holding Registers for Information Category C13

Table B-23. Information Category C13 (Communication Parameters)

Holding Register	Data ID	Description	Access	Data Format
48161	13001	Storage for Modbus "SAVE data to EEPROM" command	RW	UI16
48162	13002	Comm. port 0, Front RS-232, baud Rate	R	UI16
48163	13003	Comm. port 1, Rear RS-232, Baud Rate	R	UI16
48164	13004	Comm. port 2, Rear RS-485, Baud Rate	RW	UI16
48165	13005	Comm. port 2, Rear RS-485, Parity	RW	UI8

Holding Register	Data ID	Description	Access	Data Format
48166	13006	Comm. port 2, Rear RS-485, Stop Bits	RW	UI8
48167	13007	DECS-200N pooling address (Modbus slave address)	RW	UI16
48168	13008	Modbus Response Time Delay	RW	UI16
48169 to 48220		Reserved for C13		

Holding Registers for Information Category C14

Table B-24. Information Category C14 (Front Panel Metering Configuration Parameters)

Holding Register	Data ID	Description	Access	Data Format
48221	14001	1st metering display field on the front panel metering screen	RW	UI16
48222	14002	2nd metering display field on the front panel metering screen	RW	UI16
48223	14003	3rd metering display field on the front panel metering screen	RW	UI16
48224 to 48250		Reserved for C14		

Holding Registers for Information Category C15

Table B-25. Information Category C15 (Control System Configuration Parameters Group II)

Holding Register	Data ID	Description	Access	Data Format
48501	15001	Reserved	RW	R32_23
48502	15001		RW	
48503	15002	Reserved	RW	R32_23
48504	15002		RW	
48505	15003	Reserved	RW	R32_23
48506	15003		RW	
48507	15004	Number of generator poles	RW	UI16
48508	15005	Number of exciter poles	RW	UI16
48509	15006	Pole Ration = # of exciter poles / # of generator poles	RW	R32_23
48510	15006		RW	
48511 to 48550		Reserved for C15	RW	

APPENDIX C • OEL TYPE TAB SETTINGS

FOR DECS-200N UNITS WITH FIRMWARE OLDER THAN VERSION 1.03.00

This appendix applies only to DECS-200N units with firmware older than version 1.03.00. The OEL Type tab of the Setting Adjustments screen is visible when BESTCOMS is communicating with a DECS-200N that has firmware older than 1.03.00. In this case, because of additional features available in later versions of firmware, the 52 Contacts tab (of the System Configuration screen) and the Scaling tab (of the Setting Adjustments screen) are not visible.

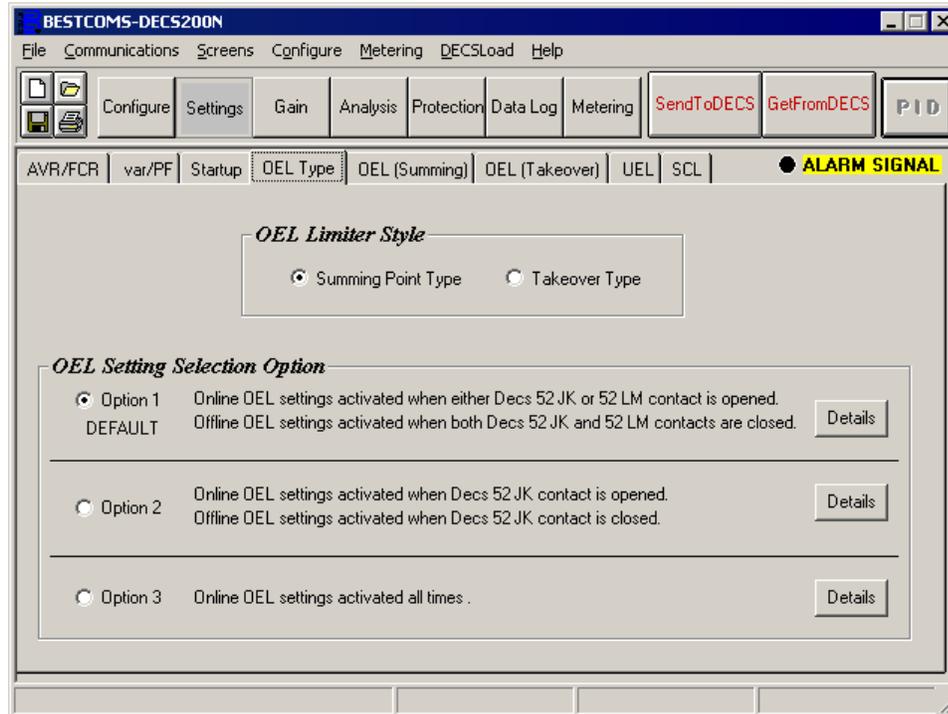OEL Type tab settings are illustrated in Figure C-1 and described in the following paragraphs.

Figure C-1. Setting Adjustments 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-200N 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-200N to operate in Droop mode when applied in a single-unit application. Therefore, generator voltage should not droop as reactive load increases.

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