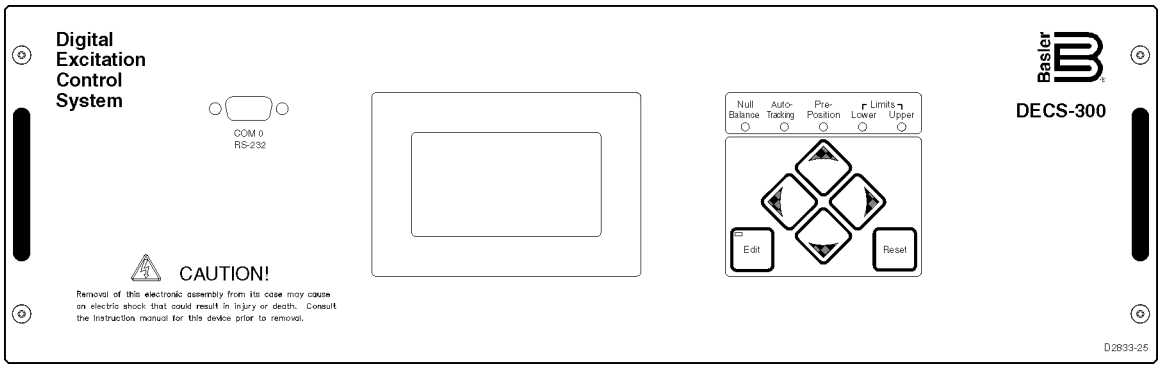
INSTRUCTION MANUAL

FOR

DIGITAL EXCITATION CONTROL SYSTEM

DECS-300



Basler Electric

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INTRODUCTION

This instruction manual provides information about the operation and installation of the DECS-300 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 DECS-300 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the case. When the DECS-300 is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

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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-300 hardware, firmware, and software. The corresponding revisions made to this instruction manual (9310300990) are also summarized. Revisions are listed in chronological order. Revision designations separated by a slash mark (/) indicate the revision level of DECS-300-C before the slash mark and the revision level of DECS-300-L after the slash mark.

Hardware Version and Date	Change
A, 03/99	• Initial release
A1, 04/99	• Released firmware version 2.06.00
A2, 05/99	• Released firmware version 2.06.01
A3, 07/99	• Released new version of FLASH boot code version 2.10.00
B, 07/99	• Released new overlays
B1, 08/99	• Released firmware version 3.00.06
B3, 11/99	• Released firmware version 3.02.01
B5, 12/99	• Released firmware version 3.02.03
B6, 12/99	• Added UL, CSA markings
B7, 02/00	• Released firmware version 3.03.01 and added CE marking
B8, 03/00	• Added noise reduction capacitor CH32
B10, 03/01	• Added serial number label to front panel
C/A, 03/01	• Transformers T3, T4, and T5 upgraded
C1/A1, 06/01	• Released firmware version 3.05.02
C2/A2, 01/02	• Released firmware version 3.05.03
D/B, 05/02	• Released firmware version 4.01.00
E/C, 10/02	• Manufacturing drawings updated
F/D, 01/03	• Front panel LCD updated
G/E, 03/03	• Released firmware version 4.01.03
H/F, 06/03	• Released firmware version 4.01.04
J/G, 08/05	• Released firmware version 4.01.07
K/H, 10/05	• Released new main circuit board with improved isolation between circuit traces
L/J, 12/05	• Released firmware version 4.02.00
M/K, 11/08	• Added paint to aluminum side plates within the DECS-300
N/L, 02/09	• Released firmware version 4.03.00 and BESTCOMS version 2.08.04

Firmware Version and Date	Change
2.4.2, 03/99	• Initial release
2.06.xx, 05/99	• Changed the switch contact input priority so that: – The Stop switch, when closed, has priority of the Start switch input and BESTCOMS – The FCR switch, when closed, has priority of the AVR switch input and BESTCOMS • Changed the maximums for rated generator current and rated CT primary current to 60,000 amperes. • Changed the maximums for rated field current and shunt current rating to 9,999 amperes • Updated frequency display function to indicate zero when the generator or bus voltage decreases below 6 Vac at the sensing terminals
3.00.xx, 08/99	• Added latched annunciation function to the programmable output relays and added reset function for alarm messages and latched programmable relays • Reconfigured the failed-to-buildup relay as programmable • Added: – Loss of sensing enable – Transfer to FCR mode enable – “System <10 Hz” annunciation – Failed to build up alarm message • Changed relay annunciation conditions of “setpoint at low limit” and “setpoint at high limit” to also function when unit is in Stop mode • Removed the auto transfer enable selection from the front panel HMI
3.02.01, 11/99	• Replaced internally defined UEL curve with multipoint programmable UEL curve • Changed AVR mode minimum setpoint from 85% to 80% of the rated voltage
3.02.03, 12/99	• Changed external tracking so that is disabled when the unit is in Stop mode
3.03.xx, 02/00	• Changed var mode setpoint and pre-position minimums in Modbus to permit negative values to be entered • Reversed the raise and lower commands for PF mode setpoint so that a raise command results in increased excitation to be consistent with other modes
3.05.xx, 02/01	• Added: – Field temperature monitor and protection – V/Hz ratio limiting – Autotracking algorithm with accessory input – Off-line definition for Unit mode operation • Revised: – Pre-position function – PID algorithm with Td (derivative time constants) – Minimum AVR setpoint from 80 to 70% – Primary bus sensing range from a maximum of 30 kV to 500 kV • Corrected intermittent alarm indication for <10 Hz and UEL function
4.00.xx, 10/01	• Added dual PID setting groups
4.01.xx, 06/02	• Added the following functions and enhancements: – Data logging and sequence of event recording – Loss of field (40Q) protection – Made <10 Hz alarm self clearing – Stator current limiter – Offline/online OEL limits made user-selectable – Second pre-position setpoint (SWI-2) – Takeover OEL with I^2t characteristic – Line drop compensation
4.02.xx, 12/05	• Added adjustable control voltage output limits
4.03.xx, 02/09	• Improved the contact input response time for power factor and var control

BESTCOMS Version and Date	Change
2.03.xx, 08/99	• Initial Release
2.04.xx, 11/99	• Added UEL as a separate screen under Settings Adjustments • Added five-point UEL feature and associated functions
2.05.xx, 02/00	• Added a button to the five-point UEL screen to switch between the five-point UEL and the internal UEL curve • Changed the: – AVR minimum setting range to 80-100% – AVR maximum setting range to 100-110% – OEL level settings resolution from integer to 0.1 – Five-point UEL function to update all settings when GetFromDECS button is selected. Settings are updated when a different screen is displayed and settings have been changed from front panel interface or other serial link. This includes the pre-position status for AVR, FCR, var, and PF modes.
2.06.xx, 02/01	• Enabled BESTCOMS to run without a DECS-300 unit • Added the following features/functions: – Field temperature – Brush voltage drop – Exciter field resistance – V/Hz or underfrequency limiting – Time delay settings in AVR/FCR derivative gain – Field overtemperature alarm – Save settings to a text file – Primary bus sensing range changed from a maximum of 30 kV to 500 kV • Changed the following features/functions: • AVR minimum setpoint • Curve graphics review of customized UEL curve • UEL curve scale from kvar to var x 1000 and kW to W x 1000 • Enhanced the following operations/features: – Saving, opening, and downloading LOS files – Five-point UEL curve to prevent loss of values when changing curves
2.07.xx, 10/01	• Added dual PID setting groups
2.08.xx, 06/02	• Added the following functions and enhancements: • Data logging and sequence of event recording • Loss of field (40Q) protection • Stator current limiting • Offline/online OEL limits made user-selectable • Second pre-position setpoint • Takeover OEL with I^2t characteristic • Balanced and unbalanced level in LOS
2.08.04, 02/09	• Implemented changes for compatibility with Microsoft™ Vista operating system

Manual Revision and Date	Change
—, 09/99	• Initial release
A, 02/00	• Added: – *Revision History* to the manual *Introduction* section – UL recognition and CSA certification – Five-point UEL feature descriptions – Soft-start descriptions and diagrams – Section 5, *Operation* (moved BESTCOMS to Section 6) – Section 7, *Maintenance* – Section 8, *Modbus™ Communication* • Changed: – Figure 4-2 to show mounting studs – Figure 4-5 to show UL, CSA labels
B, 02/01	• Added Table 4-7 • Changed: – Specifications for Remote Setpoint Control and Control Options – Section 2 to reflect changes in the DECS-300 front panel parameters and menu tree – Section 5 and Section 6 to reflect changes in BESTCOMS and the DECS-300 – Section 8 to reflect changes in the DECS-300 – Section 3 by adding text and two illustrations and removing an illustration – Figure 4-7 and 4-8 by adding bus sensing transformer and changing the title of the 52G breaker • Corrected Figure 4-11
C, 12/01	• Documented addition of second PID setting group • All references to the EXTRE contact input circuit were changed to Switch Input 1 (SWI-1). • All references to the INTRE contact input circuit were changed to Switch Input 2 (SWI-2).
D, 06/02	• Documented added functionality: – Data logging and sequence of events recording – Stator current limiting – Second pre-position setpoint – Takeover-style overexcitation limiting – Field overtemperature protection – Loss of field protection – Offline/online OEL limits made user-selectable – Line drop compensation • Modified Section 2 menu tree and Section 8 Modbus register tables to reflect added functions
E, 02/09	• Updated list of Windows operating systems compatible with BESTCOMS: removed Windows NT®, Windows® 95, 98, and Me, added Windows® 2000, XP, and Vista • Updated BESTCOMS installation instructions to reflect change of installation file media to CD-ROM • Removed expired patent information • Added publication number and revision letter to footers • Corrected SWI-2 labeling in Table 4-6 and Figure 4-7

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SECTION 1 • GENERAL INFORMATION

GENERAL

Digital Excitation Control Systems (DECS-300) are microprocessor based devices intended for generator power management. These devices provide analog control signals for SCR bridges manufactured by Basler Electric and other manufacturers. Programmability of system parameters and regulation settings allows the DECS-300 to be used in a wide range of applications and provides greater flexibility in excitation system optimization. DECS-300 units are designed to provide control for generators of any size, and can be used for both exciter field and main field applications.

FEATURES

DECS-300 units have the following features and capabilities.

- Four control modes automatic voltage regulation (AVR), manual or field current regulation (FCR), power factor (PF) regulation, and reactive power (var) regulation).
- Two programmable stability setting (PID) groups.
- Two pre-position setpoint for each mode.
- Soft start and voltage buildup control with an adjustable ramp in AVR and FCR control modes.
- Takeover-style (on-line and off-line) overexcitation limiting (OEL), underexcitation limiting (UEL), and stator current limiting (SCL) in AVR, var, and PF control modes.
- Underfrequency or volts/hertz ratio limiting.
- Three-phase or single-phase generator voltage (rms) sensing/regulation in AVR mode.
- Single-phase bus voltage (rms) sensing.
- Single-phase generator current sensing for metering and regulation purposes.
- Field current and field voltage sensing.
- Fine voltage point regulation in AVR (–30 to +10%) over the voltage range.
- One analog input for proportional remote control of the setpoint.
- Programmable analog control output: 4 to 20 milliamperes, 0 to +10 Vdc, or –10 to +10 Vdc.
- Autotracking between modes within the DECS-300 (internal tracking).
- Autotracking between two DECS-300 units (external tracking).
- Autotransfer (bumpless) between modes and between units.
- Thirteen contact sensing inputs for system interface.
- Eight output relays for system control and/or annunciation with four of the eight outputs being programmable.
- Seven protection functions (field overvoltage, field overcurrent, generator overvoltage, generator undervoltage, loss of sensing, field overtemperature, and loss of field).
- Real-time metering.
- Data logging and event recording.
- Generator paralleling with reactive droop compensation and reactive differential compensation.
- Front RS-232 communication port for personal computer communication using BESTCOMS Windows®-based software for fast, user-friendly, accurate setup, and control.
- Rear RS-232 port for dedicated communication with a redundant DECS-300.
- Rear RS-485 port supporting the Modbus™ communication protocol.
- Operates from redundant power sources (ac and/or dc).

APPLICATIONS

Introduction

In this typical SSE-N application (Figure 1-1), the DECS-300 controls the exciter field in a synchronous generator. Front panel operation and serial communication links using PC software makes the system user friendly and easy to operate from local or remote locations. The user should study the operation,

setting, and safety setup procedures in this manual before attempting to operate a similar application. For detailed application assistance, please contact Basler Electric or your local sales representative.

Description

Input power from either the ac or dc station power provides operating voltage for the DECS-300. The DECS-300 senses generator voltage and current through voltage and current transformers. Field voltage and current are sensed by the Isolation Module and converted to analog voltage signals for the DECS-300.

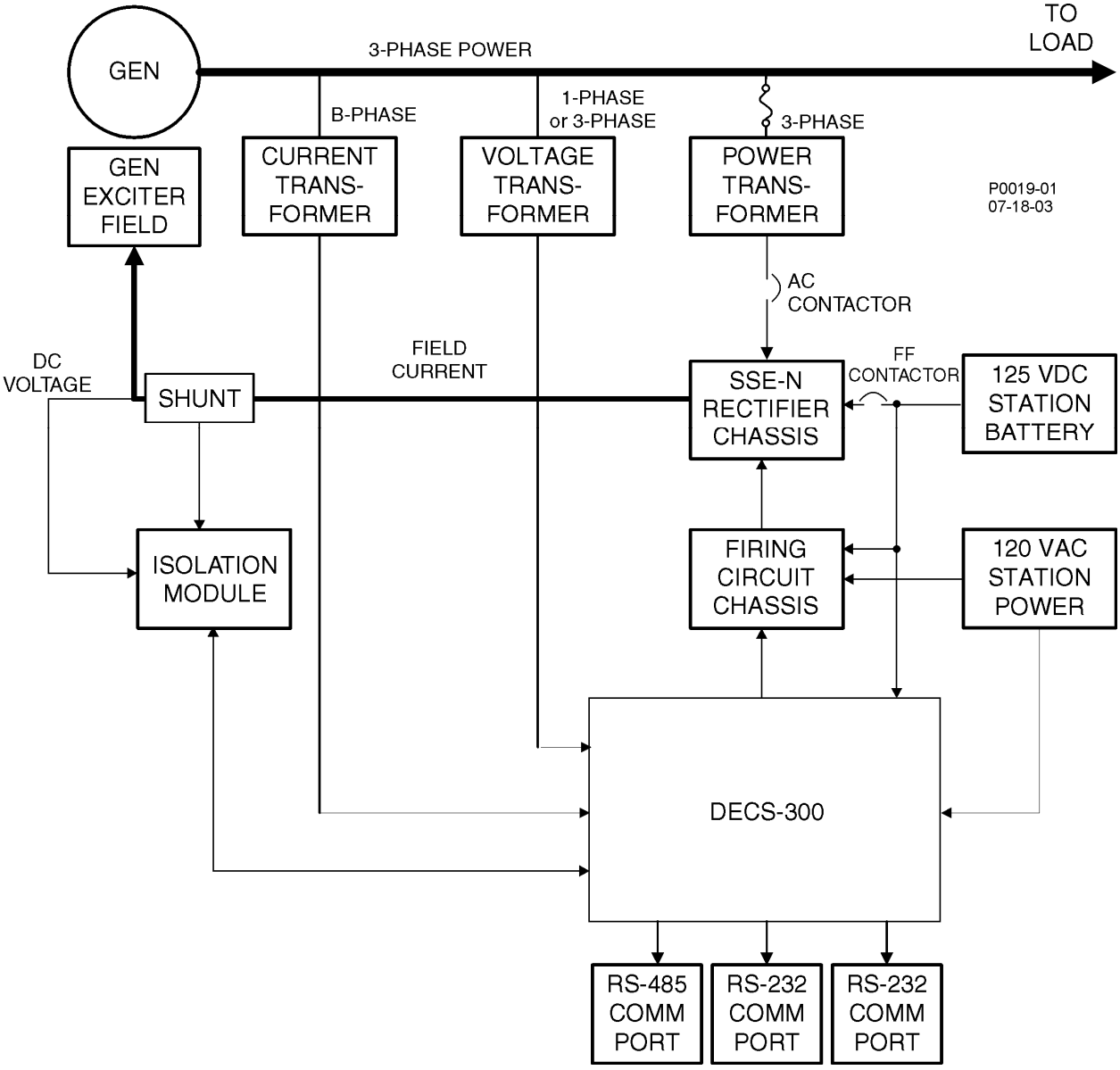

Figure 1-1. Typical DECS-300/SSE-N Block Diagram

Based on the system operating state, the DECS-300 provides an analog control signal to the firing circuit chassis. This analog control signal (4 to 20 milliamperes, 0 to 10 Vdc, or ±10 Vdc) controls the phase angle of the SCR firing pulses generated in the firing circuit chassis.

DECS-300 can control power bridges that have various output current capabilities ranging from 20 to 5,000 amperes dc at nominal voltage levels of 32 to 375 Vdc. These power bridges may be semicontrolled or fully controlled. Full controlled bridges provide faster de-excitation of the generator or exciter field to obtain faster, load off, transient recovery.

The isolation module (transducer) senses the field voltage and current and develops analog voltages for the DECS-300. It also isolates the DECS-300 from the field. These analog voltage signals are applied to

the DECS-300 through the cable connected between the two connectors (P1 on the DECS-300 and J1 on the isolation module). Operating voltage for the sensing circuits in the isolation module comes from the DECS-300 through the same cable.

Each DECS-300 has integrated over/underexcitation limiters. Overexcitation limiters are present for both on-line and off-line excitation levels. This feature provides maximum overexcitation protection by having different settings for off-line operation. During off-line operation, lower limiter settings are required to properly protect the generator.

The DECS-300 has many customizing features to meet the various power generation system operating requirements. Var/power factor controllers are available for operating the generator in parallel with a utility. Another feature is the user selectable, 20 standard pre-programmed stability settings for exciter field applications, 20 standard stability settings for main field applications, and one user programmable stability setting. It has programmable output contacts for annunciating the various DECS-300 operating and protection features. DECS-300 can be programmed to operate safely in the event of loss of sensing.

For critical applications where the failure of the excitation system keeps the generator from operating, a redundant DECS-300 can be used to provide back-up excitation control. Redundant excitation systems need to be properly designed to allow for proper removal of the failed system and also for the proper enabling of the back-up system. Provisions also have to be made for the periodic checkout of the back-up system to insure it is operational and can be put into service without warning. DECS-300 allows for excitation system redundancy by providing automatic tracking and transfer between control modules. In a single DECS-300 application, the DECS-300 can be selected to allow the inactive operating modes of the DECS-300 to track the active operating mode. If the excitation system is normally operating on-line in the automatic mode and a loss of sensing occurs, the unit could be changed to the manual mode of operation where the loss of sensing has no impact on the exciters ability to provide proper levels of excitation. While performing a routine maintenance checkout of the DECS-300 in back-up mode, the internal tracking feature allows a transfer to an inactive mode that will result in no disturbance to the system. DECS-300 also provides for tracking between DECS-300 units. The back up DECS-300 unit can be programmed to designate any of the operating modes to track the primary DECS-300 operating mode.

DECS-300 is Modbus™ compatible via the RS-485 port. For more information about Modbus™, see Section 7 in this manual. The front panel RS-232 communications port supports the BESTCOMS PC software. BESTCOMS allows for user-friendly programming of setpoints and ranges, and allows for step changes to facilitate proper stability programming. BESTCOMS provides easy start/stop control and operator adjustment of the excitation system with real-time metering. The software catalog number is BESTCOMS-DECS300-32. BESTCOMS is provided with the DECS-300 as part of the software/manual package.

MODEL NUMBERS

The DECS-300 is available in one of two power supply ranges. Model number designations are shown in Table 1-1.

Table 1-1. DECS-300 Model Numbers

Model	Power Supply
DECS-300-L	24/48 Vdc
DECS-300-C	120 Vac/125 Vdc

SPECIFICATIONS

Tables 1-2 and 1-3 list the DECS-300 electrical and physical specifications. Tables 1-4 and 1-5 list the Isolation Module electrical and physical specifications.

Table 1-2. DECS-300 Electrical Specifications

Regulation Accuracy	
AVR Mode	Voltage regulation: ±0.25% over the load range at rated power factor and constant generator frequency. Steady state stability: ±0.1% at a constant load and generator frequency. Temperature drift: ±0.5% for 0 to 50°C temperature change. Underfrequency (volts/hertz) characteristic slope from 0 P.U. to 3.0 P.U. is adjustable in 0.1 P.U. increments. Voltage regulation error is within ±2.0% of the nominal voltage. Response time: <1 cycle.
FCR Mode	Field current regulation: ±1.0% of the nominal value for 10% of the bridge input voltage change or 20% of the field resistance change. Otherwise, ±5.0%.
VAR Mode	±2.0% of the nominal VA rating at the rated frequency.
PF Mode	±0.02 PF of the setpoint PF for the real power between 10 and 100% at the rated frequency. (e.g., setpoint PF = 0.80, PF regulation is from 0.78 to 0.82 PF.)
Internal Tracking	±0.5% of the nominal field voltage change when transferring.
Metering Accuracy	Line voltage <0.5% at 25 to 50°C (50/60 Hz) Bus voltage <0.5% at 25 to 50°C (50/60 Hz) Line current(s) <0.2% at 25 to 50°C (50/60 Hz) Field voltage = ±1.0% of the nominal value or measured value whichever is greater Field current 0.5% at 25 to 50°C Phase angle = ±1.0° Power factor <0.01 PF at 25 to 50°C Active power (watts) <1.0% at 25 to 50°C Reactive power (vars) <1.0% at 25 to 50°C Generator frequency = ±0.1 hertz. Bus frequency = ±0.1 hertz.
Generator Voltage Sensing:	Single-phase or three-phase line voltage, two ranges 1. 100 volts/50 hertz nominal (85 to 127 volts) 120 volts/60 hertz nominal (94 to 153 volts) 2. 200 volts/50 hertz nominal (170 to 254 volts) 240 volts/60 hertz nominal (187 to 305 volts). Burden = less than 1 VA per phase

Table 1-2. DECS-300 Electrical Specifications - Continued

Bus Voltage Sensing:	Single -phase line voltage, two ranges 1. 100 volts/50 hertz nominal (85 to 127 volts) 120 volts/60 hertz nominal (94 to 153 volts) 2. 200 volts/50 hertz nominal (170 to 254 volts) 240 volts/60 hertz nominal (187 to 305 volts). Burden = less than 1 VA
Generator Current Sensing:	Two ac current sensing ranges and two channel (phase) inputs 1. 1 ampere, phase B 1 ampere, phases A or C 2. 5 ampere, phase B 5 ampere, phases A or C. Burden = less than 0.1 VA per phase
Power Input:	120 Vac nominal (85 to 132 Vac, 50 or 60 hertz), Burden = 50 VA. 125 Vdc nominal (90 to 150 Vdc), Burden = 30 W. 24/48 Vdc nominal (16 to 60 Vdc) Burden = 30 W.
Contact Input Circuits:	Thirteen contact input circuits are internally supplied with 24 Vdc to accommodate dry contacts. Contacts are as follows: • Start • Stop • Secondary Enable (SECEN) • Unit/Parallel Operation (52L/M) • Auto (AVR) Mode • FCR Mode • VAR/PF Enable (52J/K) • Pre-position 1 (PRE-P) • Pre-position 2 (SWI-2) • Raise • Lower • PID Setting Group Selection (SWI-1) • Alarm Reset (ALRST)
Remote Setpoint Control: (Accessory Input)	Two analog inputs for remote setpoint control (select one from the configuration menu). This input is typically a control signal input from a Power System Stabilizer. 1. +10 to –10 Vdc. 2. 4 to 20 milliamperes.
Control Outputs:	There are two analog outputs for setpoint control. A voltage output in one of two ranges and a current output. This output is intended to drive an external firing circuit/rectifier bridge. The ranges are as follows: 1. ±10 Vdc or 0 to +10 Vdc. 2. 4 to 20 milliamperes.

Table 1-2. DECS-300 Electrical Specifications - Continued

Contact Outputs:	
Make and carry for tripping duty	30 amperes for 0.2 seconds per IEEE C37.90; 7 amperes continuous.
Break resistive or inductive.	0.3 amperes at 125 or 250 Vdc (L/R = 0.04 maximum). Eight output contacts rated as described with 300 volt surge suppressors installed across contacts to prevent arcing from inductive loads. Contacts are as follows: • Buildup (BLDUP) • Fail-To-Build-Up (FTBUP) • Watchdog (WTCHD) • Start/Stop (ON/OF) • Relay # 4 (RLY4) • Relay # 3 (RLY3) • Relay # 2 (RLY2) • Relay # 1 (RLY1)
Isolation Module:	Operating voltage: +12 and -12 Vdc from DECS-300. Five field voltage sensing ranges: 32, 63, 125, 250, and 375 volts. Field analog output signal: 0.9 to 9.1 Vdc (5.0 Vdc = 0 field voltage) Two field current sensing ranges: 50 and 100 millivolts. Field analog output signal: 2.0 to 9.5 Vdc (2.0 Vdc = 0 field current)
Communication:	There are three communication ports, two RS-232 and one RS-485. COM0 - RS-232, nine pin, sub-D connector located on the front panel and used to communicate with local computers. COM1 - RS-232, 9 pin, sub-D connector located on the rear panel and used to connect primary and back-up DECS-300 units. COM2 - RS-485, located on the rear panel and used to communicate with local or remote computers or other devices.
COM0, Front RS-232	1200 to 19200 baud, 8N1 full duplex, ASCII commands
COM1, Rear RS-232	1200 to 19200 baud, 8N1 full duplex, unique ASCII commands, only used for internal tracking between two DECS-300 units.
COM2 Rear RS-485	1200 to 19200 baud, 8N2 half duplex, Modbus™ protocol
Parallel Compensation:	Can use either reactive droop or reactive differential (cross-current) compensation. Adjustable 30% of the rated generator voltage droop with optional 1 ampere or less or 5 amperes or less input. For parallel reactive differentiation compensation, burden may be greater than 1 VA if external resistors are added to the CT circuit.
Line Drop Compensation:	Active when the droop setting is set as a negative value. Adjustable from –30% to +30% in 0.1% increments.
Field Overvoltage Protection:	Adjustable in increments of 1.0 Vdc from 1.0 to 900 Vdc output voltage with a 0.2 to 30 second time delay settable in increments of 0.1 second.
Field Overcurrent Protection:	Adjustable in increments of 0.1 Adc from 0.1 to 9999 Adc with an inverse time delay (ANSI C50.13).

Table 1-2. DECS-300 Electrical Specifications - Continued

Field Overtemperature	Adjustable from 0 to 572° in 1° increments and the scale is selectable for either Celsius or Fahrenheit.
Generator Undervoltage Protection:	Adjustable in increments of 1 from 1 to 30 kV sensing voltage setting with a 0.5 to 60 second time delay settable in increments of 0.1 second.
Generator Overvoltage Protection:	Adjustable in increments of 1 from 1 to 30 kV sensing voltage with a 0.1 to 60 second time delay settable in increments of 0.1 second.
Loss of Field Protection	Adjustable in increments of 1 kvar from 0 to 3,000 Mvar with a 0.1 to 9.9 second delay settable in increments of 0.1 second.
Soft-Start:	Functional in AVR and FCR with two variables: level and time. Level is adjustable from 0 to 90% of rated voltage in 1% increments. Time is adjustable from 1 to 7200 seconds in 1 second increments.
Summing Point OEL: **On-Line** **Off-Line**	Limiter response time is less than three cycles. High Level - Highest current level (instantaneous) setpoint adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Limiting occurs for a time period ranging from 0 to 60 seconds, settable in 1 second increments. Medium Level - Medium current level setpoint adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Limiting occurs for a time period ranging from 0 to 120 seconds, settable in 1 second increments. Low Level - Lowest current level setpoint adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Limiting occurs indefinitely. High Level - Highest current level setpoint adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Limiting occurs for a time period ranging from 0 to 60 seconds, settable in 1 second increments. Low Level - Lowest current level setpoint adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Limiting occurs indefinitely.
Takeover OEL: **On-Line** **Off-Line**	The Takeover OEL uses an I^2t characteristic. Limiter response time is less than three cycles. High Level – High current level (instantaneous) setpoint is adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Low Level – Low current setpoint is adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Limiting occurs indefinitely. Time Dial – This setting determines the inverse time curve selected. High Level – High current level (instantaneous) setpoint is adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Low Level – Low current setpoint is adjustable from 0 to 9,999 Adc in 0.1 Adc increments. Limiting occurs indefinitely. Time Dial – This setting determines the inverse time curve selected.
Underexcitation Limiting:	Adjustable from zero to rated generator rated apparent power (kvar) at 0 kW real power for internally generated curve. Customizable five point curve is adjustable from zero to rated generator apparent power (kvar) with respect to real power (kW) ranging from zero to rated generator kW.

Table 1-2. DECS-300 Electrical Specifications - Continued

Stator Current Limiting	High Level – Highest current level setpoint adjustable from 0 to 60,000 Aac in 0.1 Aac increments. Limiting occurs for a time period ranging from 0 to 60 seconds, settable in 0.1 second increments. Low Level – Lowest current level setpoint adjustable from 0 to 60,000 Aac in 0.1 Aac increments. Limiting occurs indefinitely.
Manual Excitation Control: (FCR Mode)	Regulates field current from 0 to 9999 amperes in increments of 0.1% of the rated field current.
Voltage Matching:	Matches utility bus RMS voltage with generator output RMS voltage within ±0.5% of the generator voltage.
UL Recognition	UL Recognized per Standard 508, UL File No. E97035.
CSA Certification	CSA Certified per Standard CAN/CSA-C22.2 No. 14-95, CSA File No. LR 23131.
CE Compliance	This product meets or exceeds the standards required for distribution in the European Community.
Radiated Emissions	Qualified to EN 50081-2, *Generic emission standard, Industrial environment.*
Conducted Emissions	Qualified to EN 50081-2, *Generic emission standard, Industrial environment.*
Radio Frequency Interference (RFI)	Qualified to EN 61000-4-3, *Radiated, radio-frequency, electromagnetic field immunity test*, and EN 61000-4-6, *Immunity to conducted disturbances, induced by radio-frequency fields.*
Electrostatic Discharge	Qualified to EN 61000-4-2, *Electrostatic Discharge Immunity Test.*
Surge Withstand Capability Fast Transient	Qualified to EN 61000-4-4, *Electrical Fast Transient/Burst Immunity Test.*
Electrostatic Discharge	Qualified to EN 61000-4-8, *Power Frequency Magnetic Field Immunity Test.*

Table 1-3. DECS-300 Physical Specifications

Operating Temperature:	–40 to +60°C (–40 to +140°F). Front panel display is inoperative below -20°C (-4°F).
Storage Temperature:	–40 to +85°C (–40° to +185°F).
Shock:	15 G in each of three mutually perpendicular planes.
Vibration:	In standard tests, the DECS-300 has withstood 2 G in each of three mutually perpendicular axes swept over the range of 94 to 220 hertz without structural damage or degradation of performance.
Size:	19 inch rack mount, 3 rack units high.
Weight:	13.5 lb (6.12 kg) net, 17 lb (7.71 kg) shipping.

Table 1-4. Isolation Module Electrical Specifications

Input Power:	±12 Vdc from DECS-300.
Field Voltage Sensing Ranges:	Minus 300 to plus 300 % of the five nominal ranges: 32 V, 63 V, 125 V, 250 V, and 375 V.
Field Current Sensing Ranges:	0 to 300 % of the two nominal shunt ranges: 50 millivolts and 100 millivolts.
Power Output:	
Field Voltage Signal	0.9 to 9.1 Vdc with 5.0 Vdc = zero field voltage.
Field Current Signal	2.0 to 9.5 Vdc with 2.0 Vdc = zero field current.

Table 1-5. Isolation Module Physical Specifications

Operating Temperature:	-40°C (-40°F) to +60°C (+140°F).
Storage Temperature:	-40°C (-40°F) to +85°C (+185°F).
Shock:	15 G in each of three mutually perpendicular planes.
Vibration:	1 G at 5 to 26 Hz. 0.036" (0.914 mm) double amplitude at 27 to 52 Hz. 5 G at 53 to 500 Hz.
Size:	See Section 4, *Installation*, for overall dimensions.
Weight:	1.5 lb (680 g)

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SECTION 2 • HUMAN-MACHINE INTERFACE

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SECTION 2 • HUMAN-MACHINE INTERFACE

GENERAL

This section provides a description of the DECS-300 human-machine interface (HMI) and illustrates the menu tree.

FRONT PANEL DISPLAY

Figure 2-1 shows the front panel human-machine interface (HMI) for the DECS-300. This unit has a 19 inch rack mount case that is three rack units high (5.25 inches) and is designed for rack mounting or surface mounting in a cabinet door using the optional escutcheon plate.

The front panel HMI is composed of several elements, including a backlit LCD screen, six pushbuttons, and six LEDs. The LCD is the primary interface because it conveys the majority of the information between the DECS-300 and the user/operator. Front panel pushbuttons allow the user to view menu screens and modify the various screen settings and operating conditions. The LEDs annunciate their respective states.

Table 2-1 describes the call-outs shown in Figure 2-1.

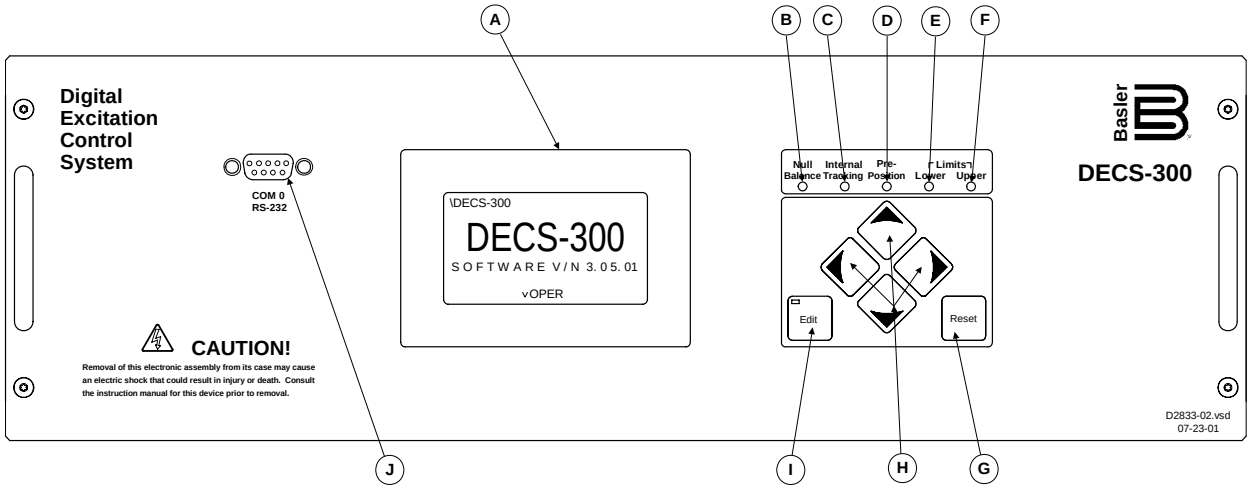

Figure 2-1. DECS-300 Front Panel

Table 2-1. DECS-300 Human-Machine Interface

Call-Out	Description
A)	64 x 128 pixel graphic LCD with backlighting. Primary source for receiving information from the DECS or when locally programming settings. Displays operations, setpoints, loop gains, metering, protection functions, system parameters and general settings.
B)	Null Balance LED - Lights when the inactive modes (AVR, FCR, VAR, or PF) match the active mode.
C)	Internal tracking LED - All inactive modes (AVR, FCR, VAR, or PF) track the active mode to accomplish a bumpless transfer when changing active modes.
D)	Pre-Position LED - Lights at the pre-defined setting (within the limits of the setpoints) of the active mode.
E)	Lower Limit LED - Lights at the minimum setpoint value of the active mode.
F)	Upper Limit LED - Lights at the maximum setpoint value of the active mode.

Table 2-1. DECS-300 Human-Machine Interface - Continued

Call-Out	Description

G) Reset Pushbutton. Cancels editing sessions, resets alarm relays when latched and alarm annunciations, and can be used as a quick-access to the metering screen (see following paragraph on menu navigation).

H) Scrolling Pushbuttons. Scrolls UP/DOWN/LEFT/RIGHT through the menu tree or when in the EDIT mode, the LEFT/RIGHT scrolling pushbuttons select the variable to change and the UP/DOWN scrolling pushbuttons change the variable value.

I) Edit Pushbutton. Enables settings changes. When the EDIT pushbutton is first pushed, an LED on the pushbutton turns ON to indicate the edit mode is active. When changes are complete (using the scrolling pushbuttons) and the EDIT pushbutton is pushed again, the LED turns OFF indicating that the changes are saved.

J) Serial Port COM0: D-type 9 pin connector. This port is dedicated to RS-232 (ASCII commands) communication with a computer terminal or PC running a terminal emulation program such as BESTCOMS. See Section 3 or refer to Section 1 for additional information on the serial ports.

Menu Navigation

Movement through the front panel menu system is achieved through the use of the arrow pushbuttons on the front panel. A short-cut to the metering screen is achieved by pressing the Reset pushbutton once when an edit session is not in progress. If the user wishes to jump to the metering screen during an edit session, the edit session must first be terminated before proceeding. See the following paragraph on *Edit Sessions* for more information.

Navigation Aids

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

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

The bottom line displays which menu screens may be accessed from the current screen with left-arrow, down-arrow, and right-arrow pushbuttons on the front panel. The left-arrow listing consists of a <, followed by an abbreviated menu name. The down-arrow listing consists of a lower-case v, followed by an abbreviated menu name. The right-arrow listing consists of a >, followed by an abbreviated menu name.

If the left-arrow and right-arrow listings are blank, then the current screen is the only one on this level. If the down-arrow listing is blank, then there are no screens below the current screen.

Edit Sessions

Operators may edit settings from the front panel, but password access is required. To initiate an edit session, press the Edit pushbutton. A red LED in the Edit pushbutton turns ON indicating that the front panel is in edit mode. If the appropriate access level is not active, then a prompt to enter a password appears. (See the following paragraphs on *Password Protection* in this section for additional information.)

Editing Settings

Once the password is entered and security access is obtained, the first editable field on the current screen is underlined. The setting in this field may now be modified by pressing the up-arrow or down-arrow pushbuttons to increase or decrease the setting, respectively. If the operator wishes to edit another setting on the current screen, then the left-arrow or right-arrow pushbuttons are used to advance the underline upward or downward (respectively) to the other editable fields.

NOTE

On most screens, changes made to a setting are immediately used by the DECS-300, but these changes are not saved in non-volatile memory until the Edit pushbutton is pressed to terminate the edit session.

After all desired editing on the current screen is completed, the operator can either save the changes or restore the previous values that were in use prior to this edit session. Changes are saved by pressing the Edit button which terminates the current edit session and saves the changes in non-volatile memory. Changes are aborted by pressing the Reset pushbutton which also terminates the current edit session. The previous values are then restored by reading them from non-volatile memory. In both cases, the red LED in the Edit pushbutton turns off to indicate that the edit session is terminated.

Security (password) access is not immediately lost when an edit session is terminated. Security access terminates after ten minutes of button inactivity at the front pane. (Security access time out is different from edit session time out. See the following paragraph on edit session time out.) If this period of inactivity should occur during an edit session, any changes that were made will be saved in non-volatile memory and will be used or continue to be used by the DECS-300. At this time, both edit access and security access are terminated.

CAUTION

Pressing the Reset pushbutton while in the edit mode after changing the current operating setpoint will cause a step change in the operating setpoint.

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

Edit Session Time Out

Another feature associated with editing settings from the front panel is the edit session time out. If the front panel is left in the edit mode after any setting changes are made, the changes will be saved and the edit session terminated after ten minutes of button inactivity.

Changing Settings

All settings that are viewable from the front panel are password protected. Global access grants the user the right to change any setting that is viewable from the front panel. Setpoint access grants the user the right to change only a few settings. These include the basic operational settings, like Start/Stop, AVR/FCR, PF/VAR, control setpoints and pre-positions. For a complete listing, showing the range, increments, and the default settings, see Table 2-2. In Table 2-2, notice that the **Ref.** Column refers to numbers associated with the menu screens shown later in this section. These numbers should help you to quickly find the specific screen that contains the setpoint or parameter that you want to change. For a listing of settings that are accessible with the Setpoint Access Level, see Table 2-3. All editable settings on a single menu screen are at the same access level. (See the following paragraphs on *Password Protection* in this section for additional information.)

Table 2-2. Front Panel Setting Parameters

Ref.	Parameter	Minimum	Maximum	Increment	Default
1.1	Start/Stop Selection	Stop, Start		N/A	Stop
	AVR/FCR Selection	AVR, FCR		N/A	AVR
	PF/VAR Control Enable	Off, PF Control, VAR Control		N/A	Off
	Load Comp. Selection	Off, Droop, Line Drop		N/A	Droop
	Pre-position 1 Enable	Off, On		N/A	On
	Pre-position 2 Enable	Off, On		N/A	Off
1.2	Voltage Matching	Off, On		N/A	Off
	Internal Tracking Enable	Off, On		N/A	Off
	External Tracking Enable	Off, On		N/A	Off
	UF or V/HZ	UF, V/HZ		N/A	UF

Table 2-2. Front Panel Setting Parameters - Continued

Ref.	Parameter	Minimum	Maximum	Increment	Default
2.1	AVR setpoint	AVR min. setpoint	AVR max. setpoint	0.1V	120V
	FCR setpoint	FCR min. setpoint	FCR max. setpoint	0.1A	0.1A
	Droop compensation	-30% nom.	30% nom.	0.1% nom.	5% nom.
	VAR setpoint	VAR min. setpoint	VAR max. setpoint	1%	0%
	PF setpoint	PF min. setpoint	PF max. setpoint	0.005	1.00
2.1.1	Fine voltage band	0% (nom.)	30% (nom.)	0.01% (nom.)	20% (nom.)
	AVR min. setpoint	70% (nom.)	100% (nom.)	0.1% (nom.)	70% (nom.)
	AVR max. setpoint	100% (nom.)	110% (nom.)	0.1% (nom.)	110% (nom.)
	FCR min. setpoint	0% (nom.)	100% (nom.)	0.1% (nom.)	0% (nom.)
	FCR max. setpoint	0% (nom.)	120% (nom.)	0.1% (nom.)	120% (nom.)
2.1.2	VAR min. setpoint	-100% (of rated VA)	100% (of rated VA)	1% (of rated VA)	0%
	VAR max. setpoint	-100% (of rated VA)	100% (of rated VA)	1% (of rated VA)	0%
	PF min. setpoint	0.5	1.0	0.005	0.8
	PF max. setpoint	1.0	-0.5	0.005	-0.8
	Voltage Matching band	0% (nom.)	20% (nom.)	0.01% (nom.)	0.5% (nom.)
	Volt. Matching ref.	90.0%	120.0%	0.1%	1.0%
2.2	AVR prep. setpoint 1	AVR min. setpoint	AVR max. setpoint	0.1 V	120.0 V
	FCR prep. setpoint 1	FCR min. setpoint	FCR max. setpoint	0.1 A	0.1 A
	VAR prep. setpoint 1	VAR min. setpoint	VAR max. setpoint	1%	0%
	PF prep. setpoint 1	PF min. setpoint	PF max. setpoint	0.005	1.000
2.3	AVR prep. setpoint 2	AVR min. setpoint	AVR max. setpoint	0.1 V	120.0 V
	FCR prep. setpoint 2	FCR min. setpoint	FCR max. setpoint	0.1 A	0.2 A
	VAR prep. setpoint 2	VAR min. setpoint	Var max setpoint	1%	0%
	PF prep. setpoint 2	PF min. setpoint	PF max. setpoint	0.005	0.800
3.0	Active Gain Group	Primary/Secondary		N/A	Primary
3.1	Prim. Gain Table Index	1	21	1	21
	Primary AVR/FCR Kp	0.0	1000.0	0.1	30.0
	Primary AVR/FCR Ki	0.0	1000.0	0.1	150.0
	Primary AVR/FCR Kd	0.0	1000.0	0.1	2.0
	Primary AVR/FCR Td	0.0	1.0	0.01	0.08
	Primary AVR Kg	0.0	1000.0	0.1	1.0
3.1.1	Secon. Gain Table Index	1	21	1	21
	Secondary AVR/FCR Kp	0.0	1000.0	0.1	30.0
	Secondary AVR/FCR Ki	0.0	1000.0	0.1	150.0
	Secondary AVR/FCR Kd	0.0	1000.0	0.1	2.0
	Secondary AVR/FCR Td	0.0	1.0	0.01	0.08
	Secondary AVR Kg	0.0	1000.0	0.1	1.0
3.2	FCR Kg	0.0	1000.0	0.1	25.0
3.3	OEL Ki	0.0	1000.0	0.1	10.0
	OEL Kg	0.0	1000.0	0.1	1.0
	UEL Ki	0.0	1000.0	0.1	10.0
	UEL Kg	0.0	1000.0	0.1	2.0
	SCL Ki	0.0	1000.0	0.1	10.0
	SCL Kg	0.0	1000.0	0.1	1.0

Table 2-2. Front Panel Setting Parameters - Continued

Ref.	Parameter	Minimum	Maximum	Increment	Default
3.4	PF Ki	0.0	1000.0	0.1	120.0
	PF Kg	0.0	1000.0	0.1	1.0
	VAR Ki	0.0	1000.0	0.01	120.00
	VAR Kg	0.0	1000.0	0.01	1.00
	Voltage Matching Kg	0.0	1000.0	0.1	1.0
4.0	1st Metering Field	V a-b, V b-c, V c-a, V Avg, Line I,			V Avg
	2nd Metering Field	VA, Watts, VAR, PF, Gen Hz,			V c-a
	3rd Metering Field	Bus Hz, Bus V, Fld V, Fld I, V Aux, F Temp			Fld I
5.1	UF Corner Frequency	15.0HZ	90.0HZ	0.1HZ	57.0HZ
	UF Slope	0 x V/HZ	3.0 x V/HZ	0.1 x V/HZ	1.0 x V/HZ
5.2	Field OV Enable	OFF, ON		N/A	OFF
	Field OC Enable	OFF, ON		N/A	OFF
	Stator OV Enable	OFF, ON		N/A	OFF
	Stator UV Enable	OFF, ON		N/A	OFF
	Loss of Sensing Enable	OFF, ON		N/A	OFF
	Loss of Sensing Xfr to FCR Enable	OFF, ON		N/A	OFF
5.3	Field OT Enable	OFF, ON		N/A	OFF
	Loss of Field	OFF, ON		N/A	OFF
5.4	Field OV Threshold	1V	900V	1V	50V
	Field OC Base Value	0.1A	9999.0A	0.1A	0.1A
	Stator OV Threshold	0V	30,000V	1V	150V
	Stator UV Threshold	0V	30,000V	1V	90V
	Field OT Threshold	0°	572°	1°	150°
	LOS Bal. Threshold	0%	100%	0.1%	50%
5.5	LOS Unbal. Threshold	0%	100%	0.1%	20%
	Loss of Field Threshold	0 var	3,000 Mvar	1 kvar	50 kvar
5.6	Field OV Delay	0.2 s	30.0 s	0.1 s	5.0 s
	Exc OC Time Dial Mult.	0.1	20.0	0.1	1.0
	Stator OV Delay	0.1 s	60.0 s	0.1 s	5.0 s
	Stator UV Delay	0.5 s	60.0 s	0.1 s	5.0 s
	Loss of Voltage Sensing	0.0 s	30.0 s	0.1 s	2.0 s
	Field OT Delay	0.1 s	60.0 s	0.1 s	5.0 s
5.7	Loss of Field Delay	0.0 s	9.9 s	0.1 s	9.9 s
6.0	Limiter selection	None, UEL, OEL, OEL/UEL, SCL, SCL/UEL, SCL/OEL, SCL/OEL/UEL		N/A	OEL/UEL
6.1	OEL Style	SUM PT/TAKEOVER		N/A	SUM PT
	OEL Option	OPT1/OPT2/OPT3		N/A	OPT1
6.2	OEL on-line hi level	0.0 A	9999.0 A	0.1 A	0.0 A
	OEL on-line hi time	0 s	60 s	1 s	0 s
	OEL on-line med. level	0.0 A	9999.0 A	0.1 A	0.0 A
	OEL on-line med. time	0 s	120 s	1 s	0 s
	OEL on-line low level	0.0 A	9999.0 A	0.1 A	0.0 A

Table 2-2. Front Panel Setting Parameters - Continued

Ref.	Parameter	Minimum	Maximum	Increment	Default
6.3	OEL off-line hi level	0.0A	9999.0A	0.1A	0.0A
	OEL off-line hi time	0s	10s	1s	0.s
	OEL off-line low level	0.1A	9999.0A	0.1A	0.0A
6.4	OEL off-line takeover high level	0.0 A	9999.0 A	0.1 A	0.0 A
	OEL off-line takeover low level	0.0 A	9999.0 A	0.1 A	0.0 A
	OEL offline takeover time dial	0.1	20	0.1	0.1
6.5	OEL on-line takeover high level	0.0 A	9999.0 A	0.1 A	0.0 A
	OEL on-line takeover low level	0.0 A	9999.0	0.1 A	0.0 A
	OEL on-line takeover time dial	0.1	20	0.1	0.1
6.6	UEL curve, pt. 1 Watts	0 W	1,000 MW	1 kW	0 W
	UEL curve, pt. 2 Watts	0 W	1,000 MW	1 kW	0 W
	UEL curve, pt. 3 Watts	0 W	1,000 MW	1 kW	0 W
	UEL curve, pt. 4 Watts	0 W	1,000 MW	1 kW	0 W
	UEL curve, pt. 5 Watts	0 W	1,000 MW	1 kW	0 W
6.7	UEL curve, pt. 1 Vars	0 vars	1,000 Mvar	1 kvar	0 var
	UEL curve, pt. 2 Vars	0 vars	1,000 Mvar	1 kvar	0 var
	UEL curve, pt. 3 Vars	0 vars	1,000 Mvar	1 kvar	0 var
	UEL curve, pt. 4 Vars	0 vars	1,000 Mvar	1 kvar	0 var
	UEL curve, pt. 5 Vars	0 vars	1,000 Mvar	1 kvar	0 var
6.8	SCL hi level	0.0 A	66000.0 A	0.1 A	0.0 A
	SCL hi time	0 s	60 s	0.1 s	0 s
	SCL low level	0.0 A	66000.0 A	0.1 A	0.0 A
7.1.1	Gen. rated output V	85 V	30,000 V	1 V	120 V
	Gen. rated output I	10.0 A	60,000 A	0.1 A	200.0 A
	Gen. rated frequency	50 Hz	60 Hz	10 Hz	60 Hz
7.2.1	Rated field voltage	1.0 V	400.0 V	0.1 V	50.0 V
	Rated field current	0.1 A	9999 A	0.1 A	10.0 A
	Field I shunt rating	1.0 A	9999 A	0.1 A	10.0 A
	Isol. box field V conn.	32, 63, 125, 250, 375 V		N/A	63 V
	Field resistance	0.0 Ω	99.999 Ω	0.001 Ω	25.0 Ω
	Ambient temperature	–40.0°	572°	1°	25.0°
	Brush V drop	0.0 V	99.99 V	0.01 V	1.5 V
7.3.1	Gen. sensing PT pri.	1 V	30,000 V	1 V	120 V
	Gen. sensing. PT sec.	1 V	240 V	1 V	120 V
	Bus sensing PT pri.	1 V	500,000 V	1 V	120 V
	Bus sensing. PT sec.	1 V	240 V	1 V	120 V
	Gen. CT pri.	1 A	60,000 A	1 A	200 A
	Gen. CT sec.	1 A	5 A	4 A	5 A

Table 2-2. Front Panel Setting Parameters - Continued

Ref.	Parameter	Minimum	Maximum	Increment	Default
7.4.1	Field type	Exciter, Main		N/A	Exciter
	Sensing configuration	1-ph A-C, 3-phase		N/A	1-ph A-C
	Bridge control signal	0+10V, –10+10V, 4-20mA		N/A	–10+10V
	Auxiliary input type	Voltage, Current		N/A	Voltage
	Cross current gain	-30.00	30.00	0.01	0.00
	Temperature mode	Degree C, Degree F		N/A	Degree C
7.4.2	AVR mode aux. gain	–99.00	99.00	0.01	1.00
	AVR mode aux. gain	–99.00	99.00	0.01	1.00
	AVR mode aux. gain	–99.00	99.00	0.01	1.00
	AVR mode aux. gain	–99.00	99.00	0.01	1.00
	Inner or outer loop	Inner, Outer		N/A	Inner
7.5.1	Relay 1 contact sense	NC, NO	N/A	NO	
	Relay 1 annunciation type	Momentary, Maintained, Latched	N/A	Maintained	
	Relay 1 moment. time	0.10 s	5.00 s	50 ms	0.10 s
	Field Overvoltage	ON, OFF		N/A	OFF
	Field Overcurrent	ON, OFF		N/A	OFF
	Stator Undervoltage	ON, OFF		N/A	OFF
7.5.2	Stator Overvoltage	ON, OFF		N/A	OFF
	Underfrequency	ON, OFF		N/A	OFF
	Overexcitation Limit	ON, OFF		N/A	OFF
	Underexcitation Limit	ON, OFF		N/A	OFF
	FCR Mode	ON, OFF		N/A	OFF
	No Voltage Sensing	ON, OFF		N/A	OFF
7.5.3	Setpoint at Low Limit	ON, OFF		N/A	OFF
	Setpoint at High Limit	ON, OFF		N/A	OFF
	System below 10 Hz	ON, OFF		N/A	OFF
	Field overtemperature	ON, OFF		N/A	OFF
	Loss of Field	ON, OFF		N/A	OFF
	Stator current limit	ON, OFF		N/A	OFF
7.5.4	Relay 2 contact sense	NC, NO		N/A	NO
	Relay 2 annunc. type	Momentary, Maintained, Latched		N/A	Maintained
	Relay 2 moment. time	0.10 s	5.00 s	50 ms	0.10 s
	Field Overvoltage	ON, OFF		N/A	OFF
	Field Overcurrent	ON, OFF		N/A	OFF
	Stator Undervoltage	ON, OFF		N/A	OFF
7.5.5	Stator Overvoltage	ON, OFF		N/A	OFF
	Underfrequency	ON, OFF		N/A	OFF
	Overexcitation Limit	ON, OFF		N/A	OFF
	Underexcitation Limit	ON, OFF		N/A	OFF
	FCR Mode	ON, OFF		N/A	OFF
	No Voltage Sensing	ON, OFF		N/A	OFF
7.5.6	Setpoint at Low Limit	ON, OFF		N/A	OFF
	Setpoint at High Limit	ON, OFF		N/A	OFF
	System below 10 Hz	ON, OFF		N/A	OFF
	Field overtemperature	ON, OFF		N/A	OFF
	Loss of Field	ON, OFF		N/A	OFF
	Stator current limit	ON, OFF		N/A	OFF

Table 2-2. Front Panel Setting Parameters - Continued

Ref.	Parameter	Minimum	Maximum	Increment	Default
7.5.7	Relay 3 contact sense	NC, NO		N/A	NO
	Relay 3 annunc. type	Momentary, Maintained, Latched		N/A	Maintained
	Relay 3 moment. time	0.10 s	5.00 s	50 ms	0.10 s
	Field Overvoltage	ON, OFF		N/A	OFF
	Field Overcurrent	ON, OFF		N/A	OFF
	Stator Undervoltage	ON, OFF		N/A	NONE
7.5.8	Stator Overvoltage	ON, OFF		N/A	OFF
	Underfrequency	ON, OFF		N/A	OFF
	Overexcitation Limit	ON, OFF		N/A	OFF
	Underexcitation Limit	ON, OFF		N/A	OFF
	FCR Mode	ON, OFF		N/A	OFF
	No Voltage Sensing	ON, OFF		N/A	OFF
7.5.9	Setpoint at Low Limit	ON, OFF		N/A	OFF
	Setpoint at High Limit	ON, OFF		N/A	OFF
	System below 10 Hz	ON, OFF		N/A	OFF
	Field overtemperature	ON, OFF		N/A	OFF
	Loss of Field	ON, OFF		N/A	OFF
	Stator current limit	ON, OFF		N/A	OFF
7.5.10	Relay 4 contact sense	NC, NO		N/A	NO
	Relay 4 annunc. type	Momentary, Maintained, Latched		N/A	Maintained
	Relay 4 moment. time	0.10 s	5.00 s	50 ms	0.10 s
	Field Overvoltage	ON, OFF		N/A	OFF
	Field Overcurrent	ON, OFF		N/A	OFF
	Stator Undervoltage	ON, OFF		N/A	OFF
7.5.11	Stator Overvoltage	ON, OFF		N/A	OFF
	Underfrequency	ON, OFF		N/A	OFF
	Overexcitation Limit	ON, OFF		N/A	OFF
	Underexcitation Limit	ON, OFF		N/A	OFF
	FCR Mode	ON, OFF		N/A	OFF
	No Voltage Sensing	ON, OFF		N/A	OFF
7.5.12	Setpoint at Low Limit	ON, OFF		N/A	OFF
	Setpoint at High Limit	ON, OFF		N/A	OFF
	System below 10 Hz	ON, OFF		N/A	OFF
	Field overtemperature	ON, OFF		N/A	OFF
	Loss of field	ON, OFF		N/A	OFF
	Stator current limit	ON, OFF		N/A	OFF
7.5.13	Failed-to-build-up Relay annunc. type	Momentary, Latched		N/A	Momentary
	Failed-to-build-up Relay annunc. time	0.10 s	5.00 s	50 ms	0.10 s
7.6.1	AVR Traverse Rate	10 s	200 s	1 s	20 s
	FCR Traverse Rate	10 s	200 s	1 s	20 s
	Var Traverse Rate	10 s	200 s	1 s	20 s
	PF Traverse Rate	10 s	200 s	1 s	20 s

Table 2-2. Front Panel Setting Parameters - Continued

Ref.	Parameter	Minimum	Maximum	Increment	Default
7.7.1	AVR prep. mode 1	Maintain, Release		N/A	Release
	FCR prep. mode 1	Maintain, Release		N/A	Release
	VAR prep. mode 1	Maintain, Release		N/A	Release
	PF prep. mode 1	Maintain, Release		N/A	Release
7.7.2	AVR prep. mode 2	Maintain, Release		N/A	Release
	FCR prep. mode 2	Maintain, Release		N/A	Release
	VAR prep. mode 2	Maintain, Release		N/A	Release
	PF prep. mode 2	Maintain, Release		N/A	Release
7.8.1	Soft Start Level	0%	90%	1%	5%
	Soft Start Time	1 s	7200 s	1 s	5 s
	Field Flashing Time	1 s	50 s	1 s	10 s
	Field Flashing Level	0%	100%	1%	50%
7.9.1	Internal Track Rate	1.0 s	80 s	0.1 s	20.0 s
	Internal Track Delay	0.0 s	8 s	0.1 s	0.1 s
	External Track Rate	1.0 s	80 s	0.1 s	20.0 s
	External Track Delay	0.0 s	8 s	0.1 s	0.1 s
8.1.1	Com0 RS232 baud rate	1200 bps	19,200 bps	↑ by x2, ↓ by x1/2	9600 bps
	Com1 RS232 baud rate	1200 bps	19,200 bps	↑ by x2, ↓ by x1/2	9600 bps
	Com2 RS485 baud rate	1200 bps	19,200 bps	↑ by x2, ↓ by x1/2	9600 bps
8.1.2	Com2 Address	0	247	1	247
	Com2 Delay	0ms	200ms	10ms	10ms
	Parity	NONE, ODD, EVEN		N/A	NONE
	Stop Bits	1	2	1	2
8.2	LCD Contrast	40	80	1	60
8.3	Real-Time Clock Setting	N/A		1	N/A
	Real-Time Clock Date Setting	N/A		1	01-01-01
8.3.1	Time Format	12 hour, 24 hour		N/A	12 hour
	Daylight Saving Time	DS ON, DS OFF		N/A	DS OFF
	Date Format	d-m-y, m/d/y		N/A	M/d/y

PASSWORD PROTECTION

All settings that are editable from the front panel are password protected. There are two levels of access: **global** and **setpoint**. Global access grants the user the right to change any setting that is editable from the front panel. Setpoint access grants the user the right to change only a few settings. These settings include the basic operational settings like Start, Stop, AVR/FCR, PF/VAR, control setpoints, and pre-position. For a complete list, refer to Table 2-3. All editable settings on a single menu screen are at the same access level.

When the DECS-300 unit leaves the factory, the global and setpoint access passwords are set to the default values. The default value for both passwords is DECS3. When a password is entered, software first checks for a match between the entered password and the global password. Because the two passwords are the same, global access is always granted. This means that in order to allow setpoint

access only, the global and setpoint passwords must be changed so that they are not the same. Passwords may be changed using the BESTCOMS-DECS300 software. It is suggested that the user change the passwords in order to provide security against unauthorized parameter changes. A password can contain a maximum of six alphanumeric characters. Once changed, the passwords should be stored in a secure location.

Table 2-3. Settings Accessible With Setpoint Access Level

Screen	Setting
OPERATE_1 (1.1)	Start/Stop control
OPERATE_1 (1.1)	AVR/FCR mode
OPERATE_1 (1.1)	PF/VAR mode
OPERATE_1 (1.1)	Load compensation type
OPERATE_1 (1.1)	Pre-position enable
OPERATE_2 (1.2)	Voltage matching enable
OPERATE_2 (1.2)	Autotracking enable
OPERATE_2 (1.2)	Autotransfer enable
MODE_SET (2.1)	AVR mode setpoint
MODE_SET (2.1)	FCR mode setpoint
MODE_SET (2.1)	VAR mode setpoint
MODE_SET (2.1)	PF mode setpoint
MODE_SET (2.1)	Droop setting
PREP_SET 1 (2.2)	AVR mode setpoint preposition 1
PREP_SET 1 (2.2)	FCR mode setpoint preposition 1
PREP_SET 1 (2.2)	VAR mode setpoint preposition 1
PREP_SET 1 (2.2)	PF mode setpoint preposition 1
PREP_SET 2 (2.2)	AVR mode setpoint preposition 2
PREP_SET 2 (2.2)	FCR mode setpoint preposition 2
PREP_SET 2 (2.2)	VAR mode setpoint preposition 2
PREP_SET 2 (2.2)	PF mode setpoint preposition 2
ADJUST (4.1)	1st Metering field display quantity
ADJUST (4.1)	2nd Metering field display quantity
ADJUST (4.1)	3rd Metering field display quantity
ADJUST (4.1)	Active setpoint
CONTRAST (8.2)	LCD contrast

In the event the user-defined passwords are lost or forgotten, the default passwords may be restored by pressing the Edit and Reset buttons during power-up of the DECS-300.

CAUTION

Pressing the Edit and Reset buttons during power-up of the DECS-300 will cause all user-programmed settings to be replaced with the default settings.

This procedure changes the password to the default value. However, this also changes all settings previously programmed by the user to the default values. It is recommended that the user save (download) all settings to a file using BESTCOMS-DECS300 software prior to restoring the defaults. After the defaults are reloaded, the user-defined settings may be uploaded from the saved file. The user may also reprogram the passwords.

A password is required the first time any settings in the DECS-300 are changed; or, when the password access expires (after ten minutes with no additional entries). If the user attempts to begin an edit session on a screen requiring global access while only settings access is granted, the settings access is revoked and the user is prompted to enter a password to gain global access.

METERING SCREEN

The metering screen has several unique features designed to enhance the presentation of information on the current state of the system.

Metering Fields

First, there are three separate metering fields for displaying up to three different metering quantities at any time. These metering fields are user-programmable. See Table 2-4 for the list of user-selectable metering quantities.

Table 2-4. User-Selectable Metering Quantities

Metering Labels	Metering Quantities
V a-b	Gen. A-B (L-L) rms voltage
V b-c	Gen. B-C (L-L) rms voltage
V c-a	Gen. C-A (L-L) rms voltage
V Avg	Avg. of 3 gen. L-L voltages
Line I	Generator line current
VA	Generator load VA
Watts	Generator load watts
VAr	Generator load var
PF	Generator load power factor
Gen Hz	Generator frequency
Bus Hz	Bus frequency
Bus V	Bus rms L-L voltage
Fld V	Field voltage
Fld I	Field current
V Aux	Voltage proportional to aux. Input
F Temp	Field temperature

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

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

Table 2-5. Metering Screen Fields as a Function of Operating Mode

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

Third, the percent-of-range field displays the setpoint expressed as a percent of the available adjustment range. This relationship is linear. As an example, a setpoint that is at the minimum would be displayed as 0.0%. A setpoint that is half way between the minimum and maximum would be displayed as 50.0%. A setpoint that is at the maximum would be displayed as 100.0%.

Fourth, the mode message field displays a message indicating the present mode of operation in the DECS-300. This field is at the bottom of the metering screen which is where navigation aids are displayed for the other menu screens.

Finally, there is a blank line below the three metering fields that has a special function. Under normal operating conditions, this remains blank. However, if an annunciable condition should occur, ALARMS (PRESS < OR >) appears as an inverse display. This message indicates that an annunciable condition has occurred. See the following paragraphs, *Alarm Message Screen,* for information on how to identify which condition was annunciated.

Alarm Message Screen

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

Table 2-6. Annunciation Messages

Annunciation Message	Duration of Message
FIELD OVERVOLTAGE	Maintained until reset
FIELD OVERCURRENT	Maintained until reset
GEN. UNDERVOLTAGE	Maintained until reset
GEN. OVERVOLTAGE	Maintained until reset
UNDERFREQUENCY	Clears 2 s after end of event
OVEREXCITATION LIMIT	Clears 2 s after end of event
UNDEREXCITATION LIMIT	Clears 2 s after end of event
LOST VOLTAGE SENSING	Maintained until reset
FAILED TO BUILD UP	Maintained until reset
SYSTEM BELOW 10HZ	Clears 2 s after end of event
FIELD OVERTEMPERATURE	Maintained until reset
LOSS OF FIELD	Maintained until reset
STATOR CURRENT LIMIT	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. Furthermore, the alarms message on the metering screen will also be cleared. However, if the user leaves the alarm message screen by pressing the left-arrow, right-arrow, or up-arrow pushbuttons, then the annunciation messages list remains intact. This allows the user to maintain a short history of annunciations. In addition, the alarms message on the metering screen will also remain. The disadvantage of this is that the metering screen would no longer indicate that a new annunciation occurred because the alarms message would always be present.

Screens With Special Editing Modes

There are a several screens that operate differently while in the edit mode. OPERATE_1 (1.1), BAUD_RATE (8.1.1), and MODBUS (8.1.2) are examples of such screens. In each case, any changes made to a setting are not used by the system (nor saved in non-volatile memory) until the Edit pushbutton is pressed again. The programmable inputs for output relays 1 through 4 work in the same manner. These are on screens RELAY_1 (7.5.1) through RELAY_4B (7.5.12).

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

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

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

If the DECS-300 is using the user-defined values previously set at STAB SET # 21 and a STAB SET # of 1 to 20 is saved, the user-defined values are lost. The next time that user-defined values for STAB SET # 21 are required, they must be manually entered and then saved. It is assumed that the table entries for STAB SET # 1 to 20 will be used as starting points from which users will arrive at their own customized values after the selected starting point has been saved (and thus copied into STAB SET # 21).

Menu Tree

The menu tree has eight branches. These branches are:

1. OPERATIONS. Displays mode status and ON or OFF status (e.g. - AVR, FCR, VAR, PF, etc.).
2. SETPOINTS. Display and setting of mode values (e.g. - AVR, FCR, VAR, PF, etc.).
3. LOOP GAINS. Loop gains for each element are set here (e.g. - Kp, Ki, Kd, Kg).
4. METERING. Real-time metering of user-selected values and alarm messages.
5. PROTECTION. Display and setting of protective function setting parameters such as pickups.
6. LIMITERS. Display and setting of system limiters (e.g. - overexcitation limit (OEL), under-excitation limit (UEL), etc).
7. SYSTEM PARAMETERS. Display and setting of system parameters. This menu item consists of nine additional branches:
   - Generator Data
   - Field Data
   - Transformers
   - Configuration
   - Output Contacts

- Traverse Rates
- Pre-position Modes
- Start Up
- Tracking

8. GENERAL SETTINGS. Display and setting of communication setting parameters and LCD contrast.

Figures 2-2 through 2-7 illustrate all branches of the menu tree. In Figures 2-2 through 2-6, notice that the upper left corner of each screen displays a one, two, or three digit number with decimal points between each digit. These numbers are reference numbers to the screens in the menu tree. The letter at the upper right corner (G, S, and N) indicates the security access level (Global, Setpoint, and Not applicable) required to edit that screen.

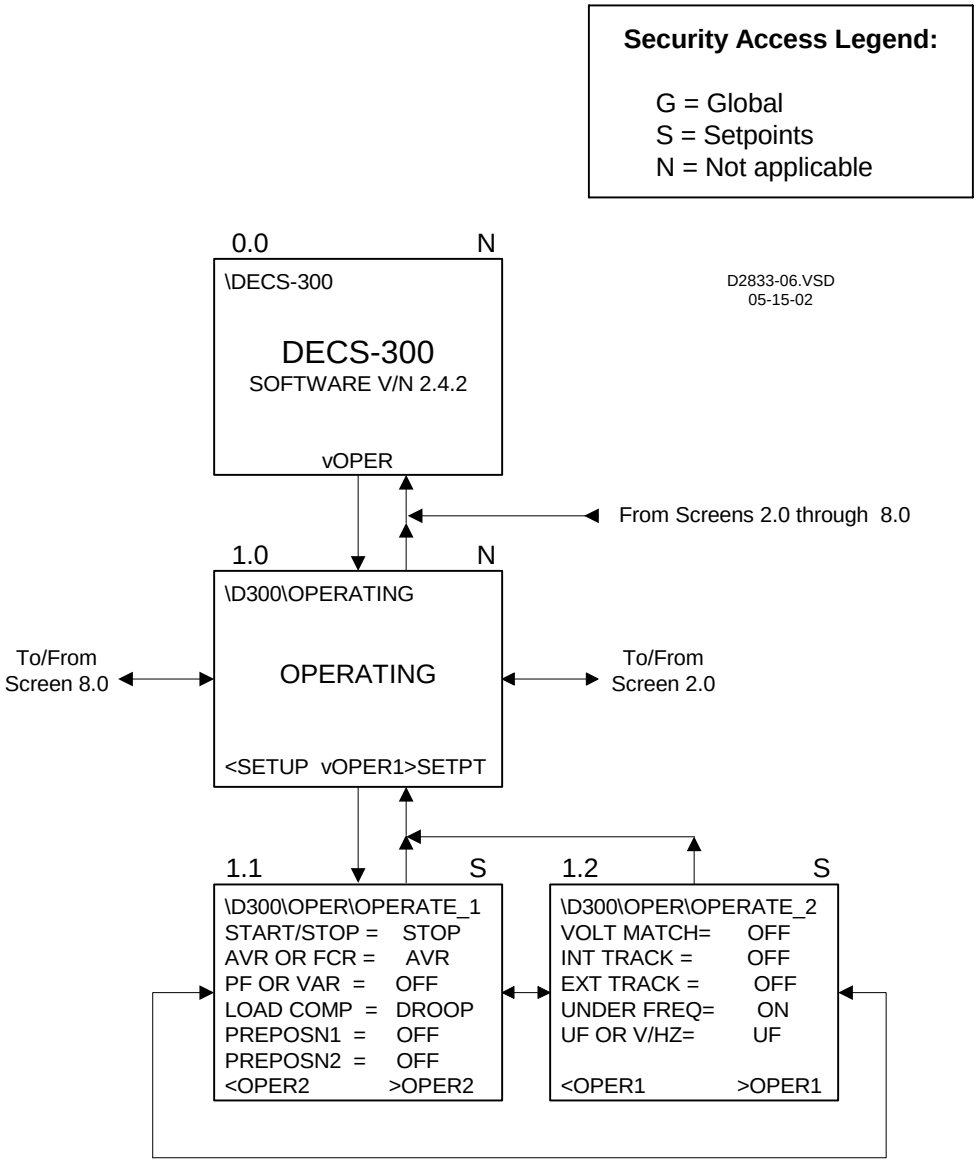

Figure 2-2. Menu Tree (Sheet 1 of 7)

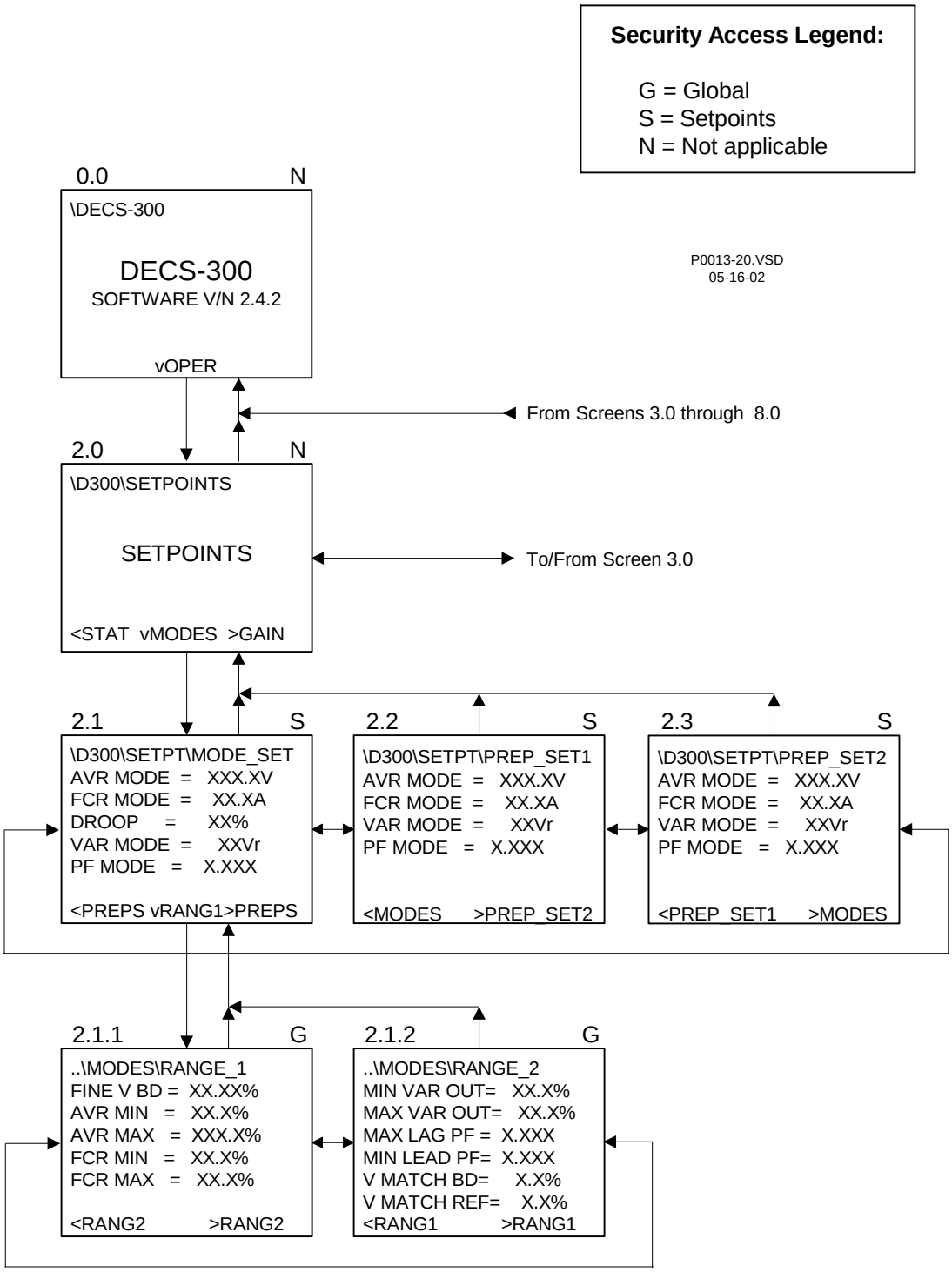

Figure 2-3. Menu Tree (Sheet 2 of 7)

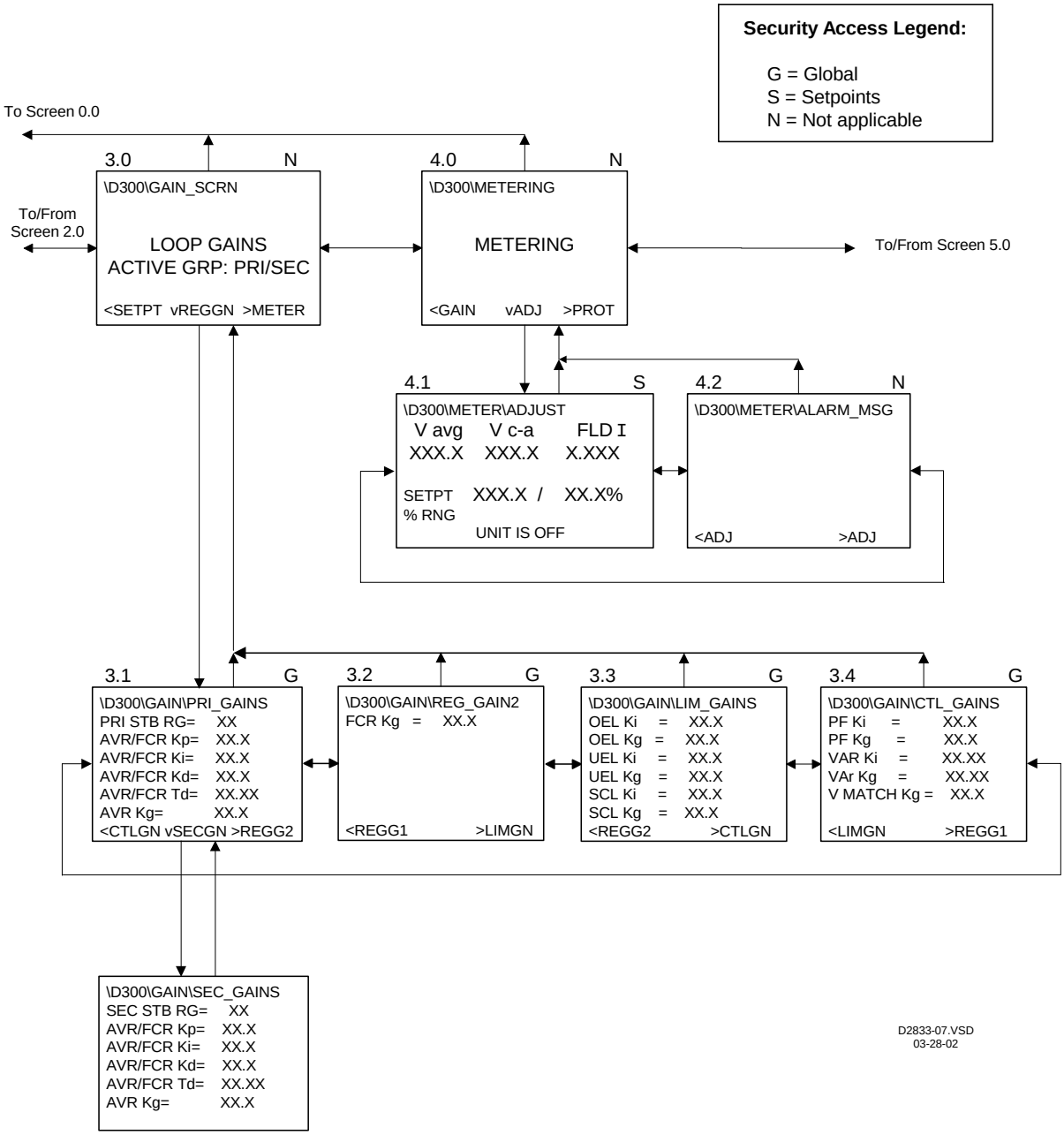

Figure 2-4. Menu Tree (Sheet 3 of 7)

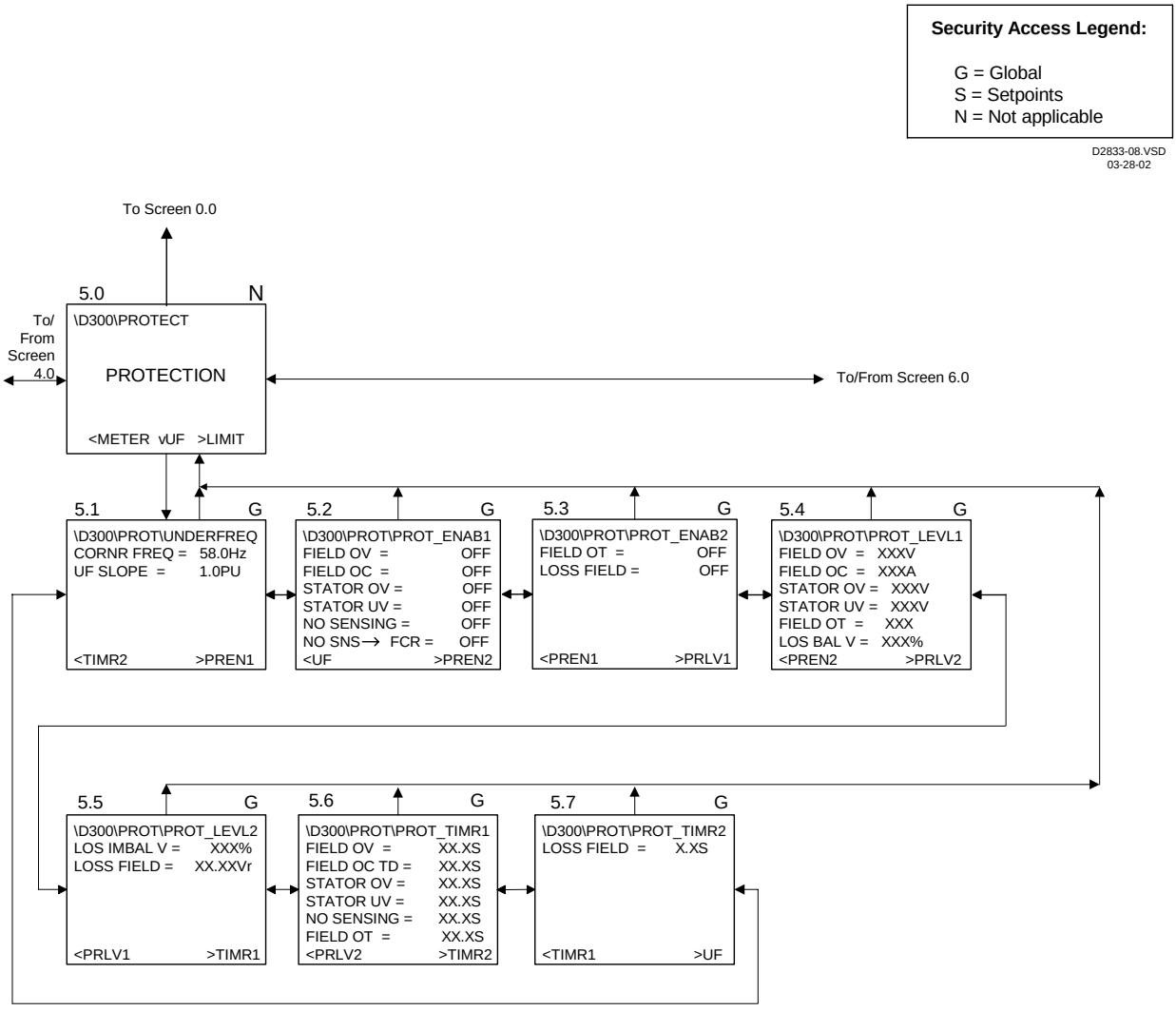

Figure 2-5. Menu Tree (Sheet 4 of 7)

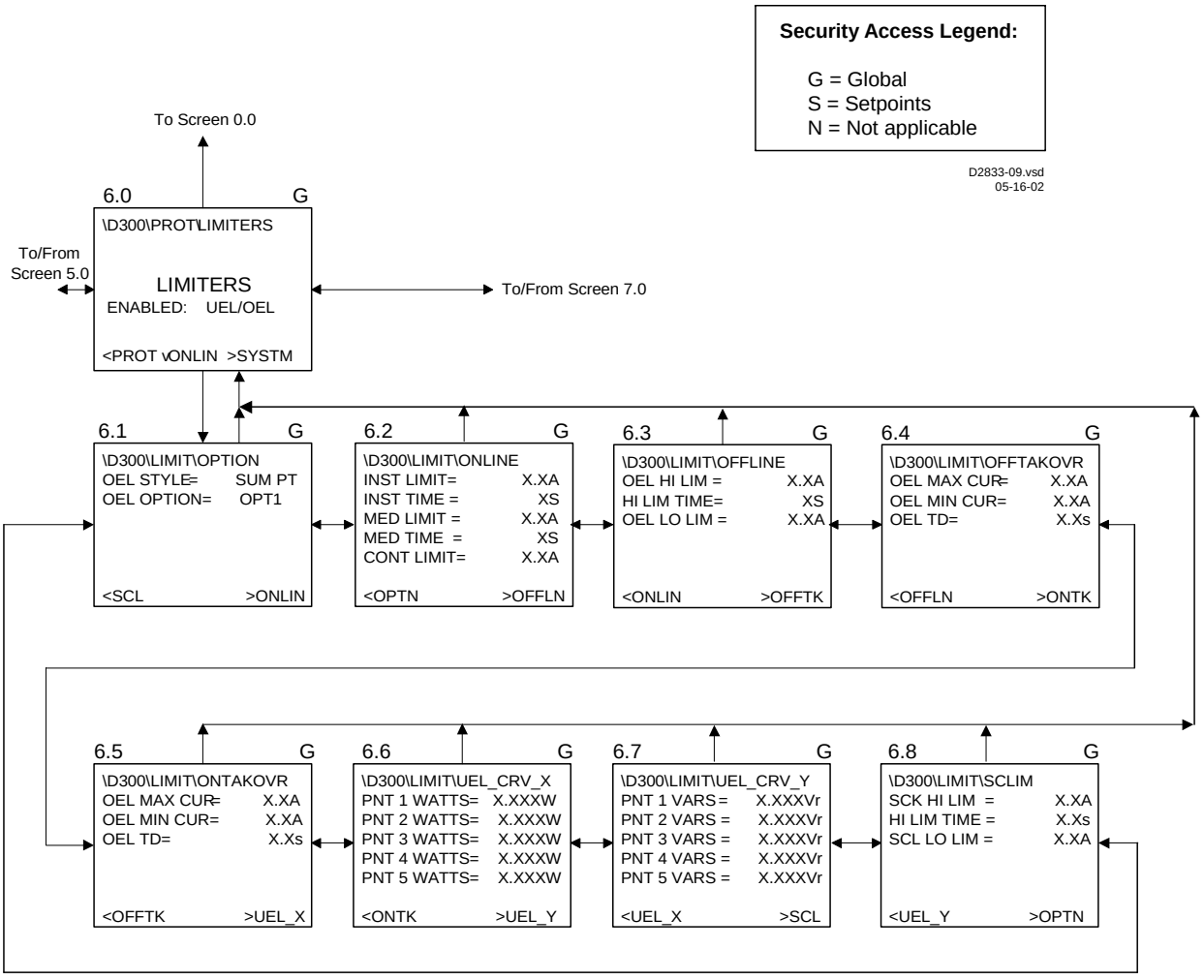

Figure 2-6. Menu Tree (Sheet 5 of 7)

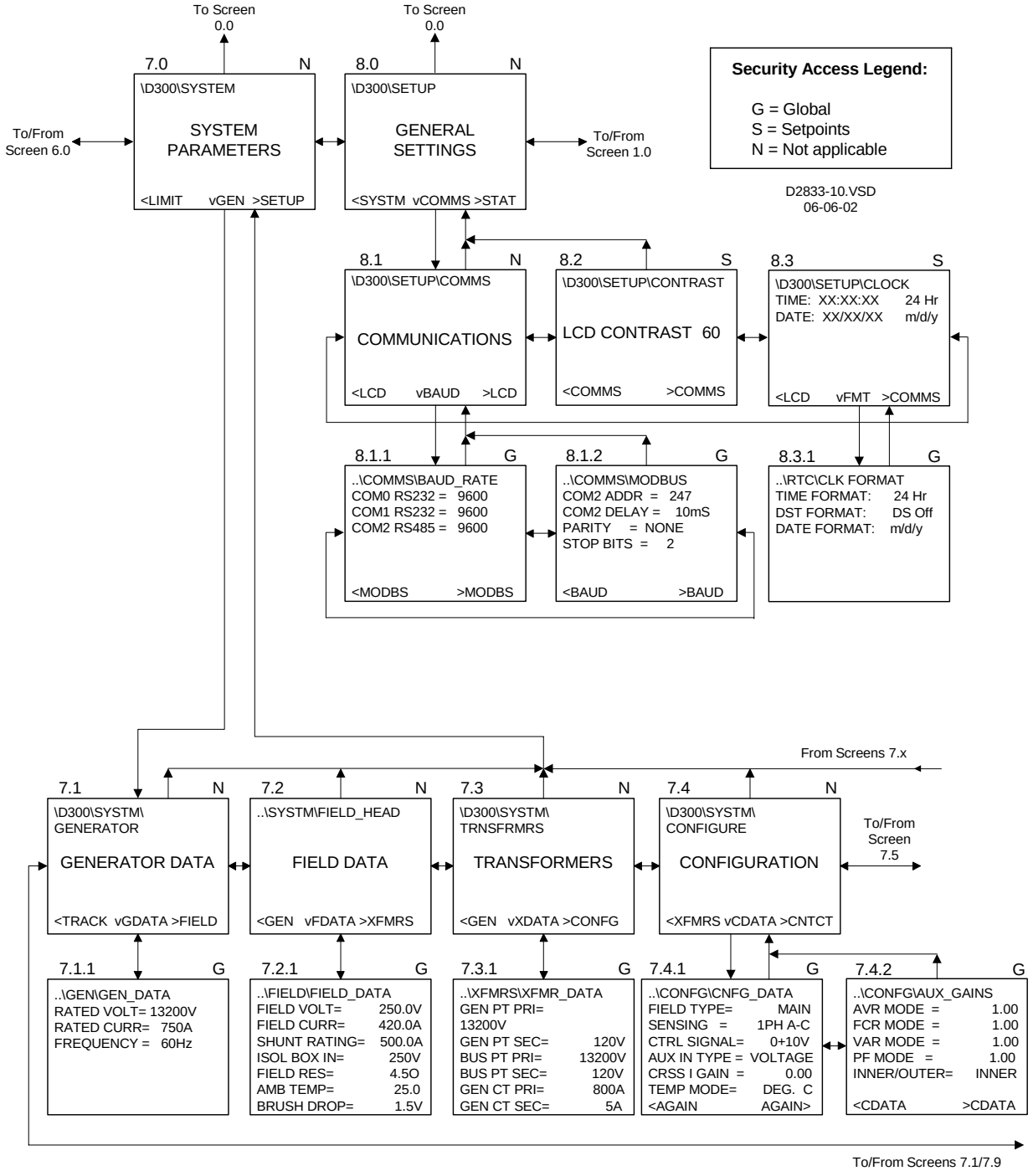

Figure 2-7. Menu Screen (Sheet 6 of 7)

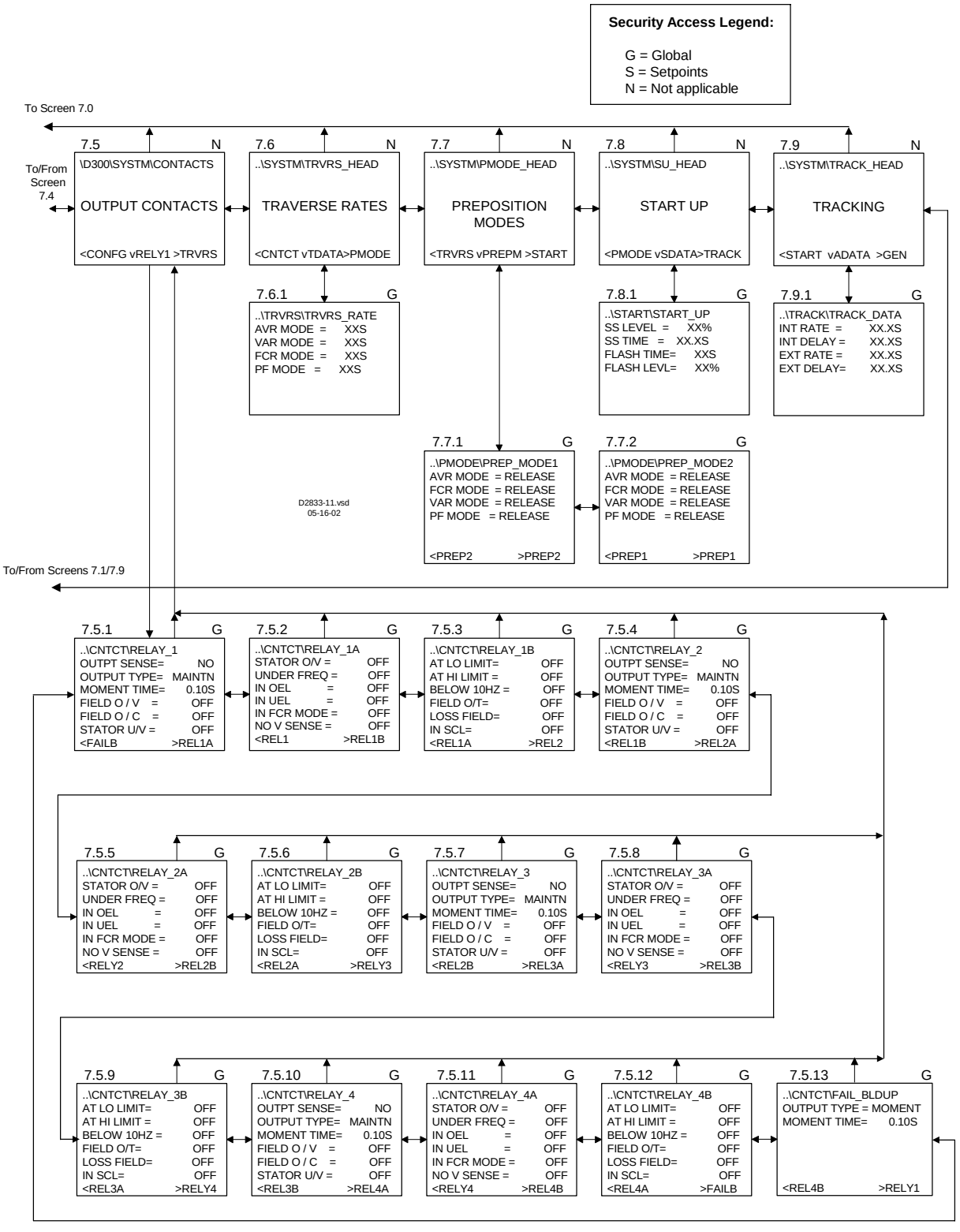

Figure 2-8. Menu Tree (Sheet 7 of 7)

FRONT PANEL OPERATION

The following paragraphs describe the settings and adjustments that are available via the DECS-300 front panel. They are grouped into eight main categories. The categories include: operating modes, setpoints, loop gains, metering, protection, limiters, system parameters, and general settings.

Following is a list and description of the settings and adjustments. The list is organized by category and by screen. Screens that are not listed contain no adjustable parameters.

Operating Modes

Screen: \OPER\OPERATE_1 (1.1)

START/STOP - starts and stops the regulator

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

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

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

PRE-POSITION 1 – enables the pre-position 1 function: ON to enable

PRE-POSITION 2 – enables the pre-position 2 function: ON to enable

Screen: \OPER\OPERATE_2 (1.2)

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

INT TRACK - turns the internal tracking function on and off

EXT TRACK - turns the external tracking function on and off

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

Setpoints

Screen: \SETPT\MODE_SET (2.1)

AVR MODE - the automatic voltage regulator setpoint in Volts

FCR MODE - the field current regulator setpoint in Amps

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

VAR MODE - the var controller setpoint in var

PF MODE - the power factor controller setpoint

Screen: \SETPT\MODES\RANGE_1 (2.1.1)

FINE V BD - the adjustable voltage band around the generator's output voltage as a % of rated generator voltage

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

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

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

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

Screen: \SETPT\MODES\RANGE_2 (2.1.2)

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

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

MAX LAG PF - maximum lagging power factor setpoint

MAX LEAD PF - maximum leading power factor setpoint

V MATCH BD - the adjustable voltage band to allow the voltage matching function as a numerical % of rated generator voltage

V MATCH REF - the bus voltage setpoint for the voltage matching function as a numerical % of bus voltage

Screen: \SETPT\PREP_SET1 (2.2)

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

AVR MODE - the automatic voltage regulator setpoint pre-position value 1

FCR MODE - the field current regulator setpoint pre-position value 1

VAR MODE - the var controller setpoint pre-position value 1

PF MODE - the power factor setpoint pre-position value 1

Screen: \SETPT\PREP SET2 (2.3)

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

AVR MODE - the automatic voltage regulator setpoint pre-position value 2

FCR MODE - the field current regulator setpoint pre-position value 2

VAR MODE - the var controller setpoint pre-position value 2

PF MODE - the power factor setpoint pre-position value 2

Loop Gains

These screens are used to view and adjust the primary and secondary loop gains for the active group. The active group is the active set of primary or secondary AVR gains.

Screen: \GAIN\PRI_GAINS (3.1)

PRI STB RG - the index into the internally defined P-I-D table for the primary setting group AVR/FCR gains. Table 2-7 lists the automatic pre-defined stability gain settings for both excitation modes (main field and exciter field) and the 20 stability settings.

AVR/FCR Kp - proportional gain coefficient used in the AVR/FCR loop when the primary setting group is active

AVR/FCR Ki - integral gain coefficient used in the AVR/FCR loop when the primary setting group is active

AVR/FCR Kd - derivative gain coefficient used in the AVR/FCR loop when the primary setting group is active

AVR/FCR Td - derivative time constant used in the AVR/FCR loop when the primary setting group is active

AVR Kg – loop gain used in AVR mode when the primary setting group is active

Screen: \GAIN\PRI_GAINS (3.1.1)

PRI STB RG - the index into the internally defined P-I-D table for the secondary setting group AVR/FCR gains. Table 2-7 lists the automatic pre-defined stability gain settings for both excitation modes (main field and exciter field) and the 20 stability settings.

AVR/FCR Kp - proportional gain coefficient used in the AVR/FCR loop when the secondary setting group is active

AVR/FCR Ki - integral gain coefficient used in the AVR/FCR loop when the secondary setting group is active

AVR/FCR Kd - derivative gain coefficient used in the AVR/FCR loop when the secondary setting group is active

AVR/FCR Td - derivative time constant used in the AVR/FCR loop when the secondary setting group is active

AVR Kg – loop gain used in AVR mode when the secondary setting group is active

Screen: \GAIN\REG_GAIN2 (3.2)

FCR Kg - loop gain used in FCR mode

Screen: \GAIN\LIM_GAINS (3.3)

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

OEL Kg - loop gain used in the overexcitation limiter

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

UEL Kg - loop gain used in the underexcitation limiter

SCL Ki – integral gain coefficient used in the stator current limiter loop

SCL Kg – loop gain used in the stator current limiter

Screen: \GAIN\CTL_GAINS (3.4) - controller 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

Table 2-7. 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	42.20	115.2	4.433
	2	1.5	0.25	66.50	150.0	8.750
	3	2.0	0.33	87.16	167.9	13.67
	4	2.5	0.42	104.5	175.8	18.96
	5	3.0	0.50	119.0	177.8	24.50
	6	3.5	0.58	131.3	176.4	30.22
	7	4.0	0.67	141.8	173.1	36.06
	8	4.5	0.75	150.9	168.8	42.00
	9	5.0	0.83	158.8	163.9	48.01
	10	5.5	0.92	165.7	158.7	54.08
	11	6.0	1.00	171.8	153.6	60.20
	12	6.5	1.08	177.2	148.5	66.35
	13	7.0	1.17	182.1	143.6	72.54
	14	7.5	1.25	186.5	138.9	78.75
	15	8.0	1.33	190.5	134.4	84.98
	16	8.5	1.42	194.1	130.1	91.23
	17	9.0	1.50	197.4	125.9	97.50
	18	9.5	1.58	200.4	122.1	103.8
	19	10.0	1.67	203.2	118.4	110.1
	20	10.5	1.75	205.7	114.8	116.4

Table 2-7. Automatic Stability Range Gain Settings Index - continued

Excitation Mode	Setting	Generator Open Circuit Time Constant (T'_{do})	Generator Exciter Time Constant (T_{exc})	Kp	Ki	Kd
Main Field	1	1.0	N/A	11.80	42.60	0.0
	2	1.5	N/A	16.45	52.81	0.0
	3	2.0	N/A	20.33	59.16	0.0
	4	2.5	N/A	23.62	63.02	0.0
	5	3.0	N/A	26.43	65.20	0.0
	6	3.5	N/A	28.87	66.26	0.0
	7	4.0	N/A	31.00	66.56	0.0
	8	4.5	N/A	32.88	66.33	0.0
	9	5.0	N/A	34.56	65.74	0.0
	10	5.5	N/A	36.06	64.90	0.0
	11	6.0	N/A	37.40	63.90	0.0
	12	6.5	N/A	38.62	62.79	0.0
	13	7.0	N/A	39.73	61.61	0.0
	14	7.5	N/A	40.74	60.39	0.0
	15	8.0	N/A	41.67	59.16	0.0
	16	8.5	N/A	42.52	57.93	0.0
	17	9.0	N/A	43.31	56.71	0.0
	18	9.5	N/A	44.04	55.51	0.0
	19	10.0	N/A	44.71	54.33	0.0
	20	10.5	N/A	45.34	53.18	0.0

Metering

Screen: \METER\ADJUST (4.1)

1st Metering Field - displays any one of several metering quantities

2nd Metering Field - displays any one of several metering quantities

3rd Metering Field - displays any one of several metering quantities

SETPT - the present control mode operating setpoint

Screen: \METER\ALARM_MSG (4.2)

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

Protection

Screen: \PROT\UNDERFREQ (5.1)

CORNR FREQ - the corner frequency for the underfrequency curve

UF SLOPE - the slope of the underfrequency curve

Screen: \PROT\PROT_ENAB1(5.2)

FIELD OV - field overvoltage detection enable

FIELD OC - field overcurrent detection enable

STATOR OV - generator output overvoltage detection enable

STATOR UV - generator output undervoltage detection enable

NO SENSING – loss of voltage sensing detection enable

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

Screen: \PROT\PROT_ENAB2 (5.3)

FIELD OT – field overtemperature detection enable

LOSS FIELD – loss of field detection enable

Screen: \PROT\PROT_LEVEL (5.4)

FIELD OV - field overvoltage threshold

FIELD OC - field overcurrent base value (100%)

STATOR OV - generator output overvoltage threshold

STATOR UV - generator output undervoltage threshold

FIELD OT – field overtemperature threshold

LOS BAL V – loss of balanced sensing voltage threshold

Screen: \PROT\PROT_TIMER (5.5)

LOS IMBAL V – loss of unbalanced sensing voltage threshold

LOSS FIELD – loss of field threshold

Screen: \PROT\PROT TIMER1 (5.6)

FIELD OV – field overvoltage time delay

FIELD OC TD – field overcurrent time dial multiplier

STATOR OV – generator output overvoltage time delay

STATOR UV – generator output undervoltage time delay

NO SENSING – lost sensing voltage time delay

FIELD OT – field overtemperature time delay

Screen: \PROT\PROT TIMR2 (5.7)

LOSS FIELD – loss of field time delay

Limiters

Screen: LIMITERS (6.0)

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

Screen: \LIMIT\OPTION (6.1)

OEL STYLE – summing point or takeover style OEL limiter

OEL OPTION – option 1/option 3/option 4. See description in Section 3, *Functional Description*

Screen: \LIMIT\ONLINE (6.2)

Online (paralleled) overexcitation limiter settings.

INST LIMIT - overexcitation limiter high current threshold

INST TIME - overexcitation limiter high current delay

MED LIMIT - overexcitation limiter medium current threshold

MED TIME - overexcitation limiter medium current delay

CONT LIMIT - overexcitation limiter continuous (low) current threshold

Screen: \LIMIT\OFFLINE (6.3)

Offline (stand-alone) overexcitation limiter settings

OEL HI LIMIT - overexcitation limiter high current threshold

HI LIM TIME - overexcitation limiter high current threshold

OEL LO LIM - -excitation limiter low current threshold

Screen: \LIMIT\OFFTAKOVR (6.4)

Takeover OEL off-line settings.

OEL MAX CUR – OEL off-line high level

OEL MIN CUR – OEL off-line low level

OEL TD – OEL off-line time dial

Screen: \LIMIT/ONTAKOVER (6.5)

Takeover OEL on-line settings.

OEL MAX CUR – OEL on-line high level

OEL MIN CUR – OEL on-line low level

OEL TD – OEL on-line time dial

Screen: \LIMIT\UEL_CURVE (6.6)

Underexcitation limiter settings.

PNT 1 WATTS - the real power coordinate for the 1st point of the programmable UEL curve

PNT 2 WATTS - the real power coordinate for the 2nd point of the programmable UEL curve

PNT 3 WATTS - the real power coordinate for the 3rd point of the programmable UEL curve

PNT 4 WATTS - the real power coordinate for the 4th point of the programmable UEL curve

PNT 5 WATTS - the real power coordinate for the 5th point of the programmable UEL curve

Screen: \LIMIT\UEL_CRV_X (6.7)

Underexcitation limiter settings.

PNT 1 VARS - the reactive power coordinate for the 1st point of the programmable UEL curve

PNT 2 VARS - the reactive power coordinate for the 2nd point of the programmable UEL curve

PNT 3 VARS - the reactive power coordinate for the 3rd point of the programmable UEL curve

PNT 4 VARS - the reactive power coordinate for the 4th point of the programmable UEL curve

PNT 5 VARS - the reactive power coordinate for the 5th point of the programmable UEL curve

Screen: \LIMIT\OFFLINE (6.8)

Stator current limiter settings

SCL HI LIMIT – stator current limiter high current threshold

HI LIM TIME – stator current limiter high current time

SCL LO LIM – stator current limiter low current threshold

System Parameters

Screen: \GEN\GEN_DATA (7.1.1)

RATED VOLT - generator rated output voltage

RATED CURR - generator rated output current

FREQUENCY - generator rated frequency

Screen: \FIELD\FIELD_DATA (7.2.1)

FIELD VOLT - rated field voltage

FIELD CURR - rated field current

SHUNT RATING - current rating of field current sensing shunt resistor

ISOL BOX IN - field voltage connections used on the field isolation module

FIELD RES – field resistance in ohms at ambient temperature

AMB TEMP – ambient temperature at which field resistance is measured

BRUSH DROP – brush voltage drop

Screen: \XFMRS\XFMR_DATA (7.3.1)

GEN PT PRI - generator sensing transformer primary voltage rating

GEN PT SEC - generator sensing transformer secondary voltage rating

BUS PT PRI - bus sensing transformer primary voltage rating

BUS PT SEC - bus sensing transformer secondary voltage rating

GEN CT PRI - generator sensing transformer primary current rating

GEN CT SEC - generator sensing transformer secondary current rating

Screen: \CONFG\CNFG_DATA (7.4.1)

FIELD TYPE - rotary EXCITER field, or static MAIN field

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

CTRL SIGNAL - bridge control signal range: 0 to +10 Vdc, -10 to +10 Vdc, 4 to 20 mA dc source

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

CRSS I GAIN - cross current compensation input gain

TEMP MODE – temperature measurement units -degrees Celsius or degrees Fahrenheit

Screen: \CNFG AUX GAINS (7.4.2)

The auxiliary input allows an analog signal to be externally applied to the DECS-300 to modify the operating setpoint. The amount of change that may be induced is proportional to the magnitude of the signal and the input gain.

AVR MODE – auxiliary input gain in AVR mode

FCR MODE – auxiliary input gain in FCR mode

VAR MODE – auxiliary input gain in VAR mode

PR MODE – auxiliary input gain in PF mode

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

Screen: \CNTCT\RELAY_1 (7.5.1)

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

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

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

MOMENT TIME - the duration of a momentary annunciation

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

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

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

Screen: \CNTCT\RELAY_1A (7.5.2)

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

UNDER FREQ - assignment of underfrequency annunciation to output relay 1

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

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

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

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

Screen: \CNTCT\RELAY_1B (7.5.3)

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

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

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

FIELD O/T – assignment of field overtemperature limit annunciation to output relay 1

LOSS FIELD – assignment of loss of field annunciation to output relay 1

IN SCL – assignment of stator current limit annunciation to output relay 1

Screen: \CNTCT\RELAY_2 (7.5.4)

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

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

MOMENT TIME - the duration of a momentary annunciation

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

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

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

Screen: \CNTCT\RELAY_2A (7.5.5)

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

UNDER FREQ - assignment of underfrequency annunciation to output relay 2

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

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

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

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

FIELD O/T – assignment of field overtemperature limit annunciation to output relay 1

Screen: \CNTCT\4RELAY_2B (7.5.6)

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

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

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

FIELD O/T – assignment of field overtemperature limit annunciation to output relay 2

LOSS FIELD – assignment of loss of field annunciation to output relay 2

IN SCL – assignment of stator current limit annunciation to output relay 2

Screen: \CNTCT\RELAY_3 (7.5.7)

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

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

MOMENT TIME - the duration of a momentary annunciation

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

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

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

Screen: \CNTCT\RELAY_3A (7.5.8)

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

UNDER FREQ - assignment of underfrequency annunciation to output relay 3

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

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

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

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

Screen: \CNTCT\RELAY_3B (7.5.9)

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

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

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

FIELD O/T – assignment of field overtemperature limit annunciation to output relay 3

LOSS FIELD – assignment of loss of field annunciation to output relay 3

IN SCL – assignment of stator current limit annunciation to output relay 3

Screen: \CNTCT\RELAY_4 (7.5.10)

OUTPUT SENSE - relay 4 contact normal state: NO for normally open, NC for normally closed

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

MOMENT TIME - the duration of a momentary annunciation

FIELD O/V - assignment of field overvoltage annunciation to output relay 4

FIELD O/C - assignment of field overcurrent annunciation to output relay 4

STATOR U/V - assignment of stator undervoltage annunciation to output relay 4

Screen: \CNTCT\RELAY_4A (7.5.11)

STATOR O/V - assignment of stator overvoltage annunciation to output relay 4

UNDER FREQ - assignment of underfrequency annunciation to output relay 4

IN OEL - assignment of overexcitation limit annunciation to output relay 4

IN UEL - assignment of underexcitation limit annunciation to output relay 4

IN FCR MODE - assignment of FCR mode (Manual) annunciation to output relay 4

NO V SENSE - assignment of lost voltage sensing annunciation to output relay 4

Screen: \CNTCT\RELAY_4B (7.5.12)

AT LO LIMIT - assignment of setpoint at low limit annunciation to output relay 4

AT HI LIMIT - assignment of setpoint at high limit annunciation to output relay 4

BELOW 10 HZ – assignment of generator frequency below 10 hertz annunciation to output relay 4

FIELD O/T – assignment of field overtemperature limit annunciation to output relay 4

LOSS FIELD – assignment of loss of field annunciation to output relay 4

IN SCL – assignment of stator current limit annunciation to output relay 4

Screen: \CNTCT\FAIL BLDUP (7.5.13)

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

MOMENT TIME - the duration of a momentary annunciation

Screen: \TRVRS\TRVRS_RATE (7.6.1)

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

AVR MODE - the automatic voltage regulator mode traverse rate

FCR MODE - the field current regulator mode traverse rate

VAR MODE - the var control mode traverse rate

PF MODE - the power factor control mode traverse rate

Screen: \PMODE\PREP_MODE (7.7.1)

The pre-position mode for the present control mode determines whether or not the unit will respond to further setpoint change commands once the operating setpoint is driven to the pre-position 1 value. If the pre-position mode is set for MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is set for RELEASE, then subsequent setpoint change commands are followed.

AVR MODE - automatic voltage regulator pre-position 1 mode

FCR MODE - field current regulator pre-position 1 mode

VAR MODE - var controller pre-position 1 mode

PF MODE - power factor controller pre-position 1 mode

Screen: \PMODE\PREP_MODE (7.7.2)

The pre-position mode for the present control mode determines whether or not the unit will respond to further setpoint change commands once the operating setpoint is driven to the pre-position 2 value. If the pre-position mode is set for MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is set for RELEASE, then subsequent setpoint change commands are followed.

AVR MODE - automatic voltage regulator pre-position 2 mode

FCR MODE - field current regulator pre-position 2 mode

VAR MODE - var controller pre-position 2 mode

PF MODE - power factor controller pre-position 2 mode

Screen: \START\START_UP (7.8.1)

SS LEVEL - soft start level

SS TIME - soft start time

FLASH TIME - the time allowed for field flashing before the overflash relay annunciates

FLASH LEVEL - the level of generator output voltage (as a % of rated) at which field flashing is discontinued

Screen: \TRACK\TRACK_DATA (7.9.1)

Internal tracking (autotracking) and external tracking (autotransfer)

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

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

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

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

General Settings

Screen: \COMMS\BAUD_RATE (8.1.1)

COM0 RS232 - the front panel RS232 ASCII communications port baud rate

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

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

Screen: \COMMS\MODBUS (8.1.2)

Settings for the rear panel RS485 Modbus™ communications port

COM2 ADDR - device address

COM2 DELAY - response delay time

PARITY - parity: NONE, ODD, or EVEN

STOP BITS - number of stop bits: 1 or 2

Screen: \SETUP\CONTRAST (8.2)

Front panel LCD contrast setting

Screen: \D300\SETUP\CLOCK (8.3)

TIME – displays and sets the current time

DATE – displays and sets the current date

Screen: \RTC\CLK FORMAT (8.3.1)

TIME FORMAT – selects the format for displaying time on screen 8.3

DST FORMAT – selects the DECS-300 RTC for daylight saving time

DATE FORMAT – selects the format for displaying the date on screen 8.3

SECTION 3 • FUNCTIONAL DESCRIPTION

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SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

This section provides a functional description of the DECS-300. While the microprocessors are the heart of this system, the input and output circuits do have active circuitry for isolation and scaling. Figure 3-1 provides a functional block diagram for the DECS-300. For a description of the Isolation Module, see the paragraphs later in this section.

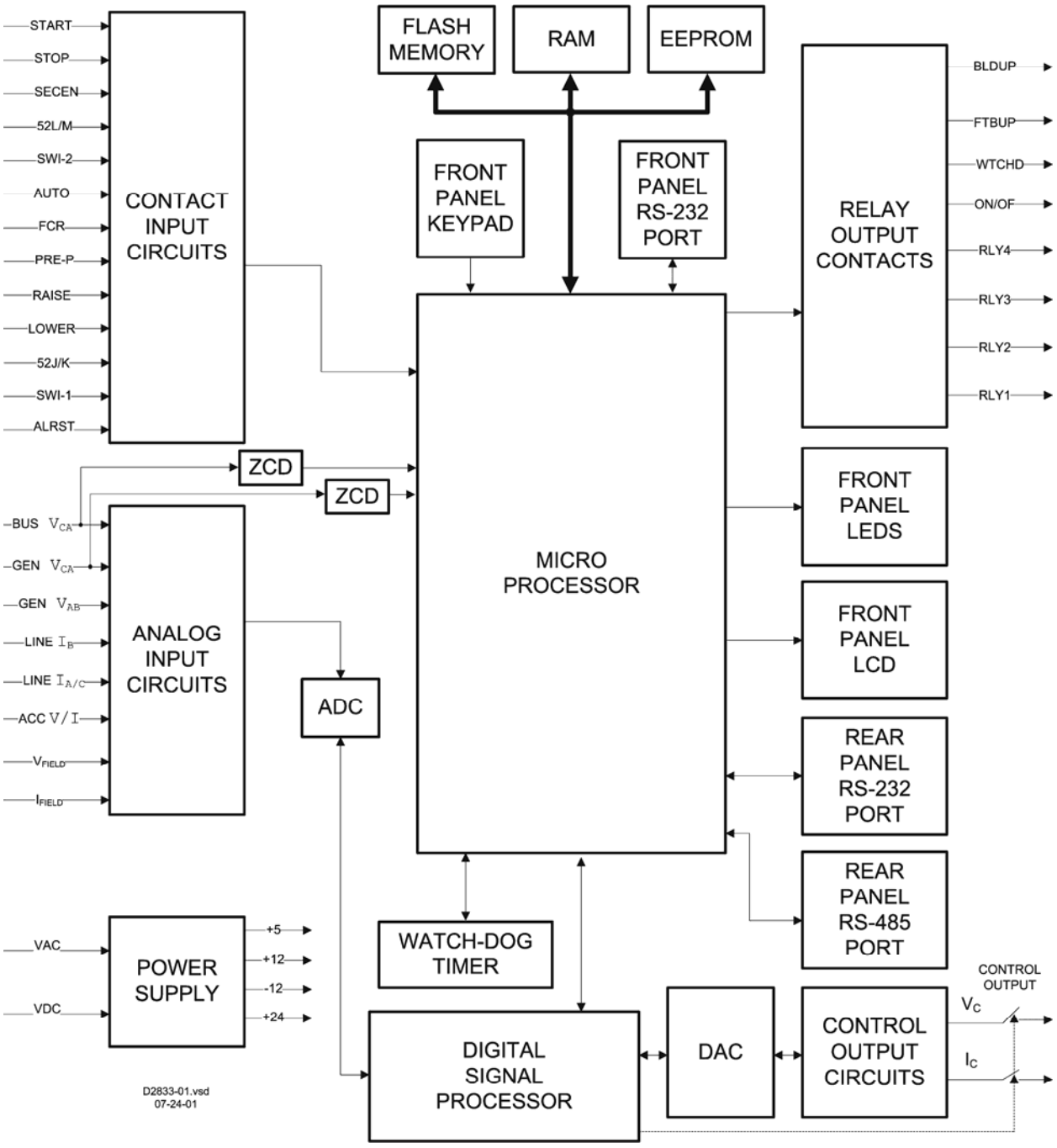

Figure 3-1. Simplified Block Diagram

CONTACT INPUT CIRCUITS

Thirteen contact input circuits powered by isolated 24 volts dc provide operational input control for the DECS-300. 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 thirteen inputs, their functions, and types of input required are defined in the following paragraphs which are grouped in the order that the terminals appear on the DECS-300 rear panel.

Start

This input accepts a momentary contact closure and turns the DECS-300 on. Once the unit is turned on, this input has no effect.

Stop

This input accepts a momentary contact closure and turns the DECS-300 off. Once the unit is turned off, this input has no effect. This input also takes precedence over the start input.

SECEN (Secondary Enable)

This input accepts a continuous contact closure and configures the DECS-300 as a secondary unit to another excitation control system. A closed input configures the DECS-300 as a secondary unit and an open input configures the DECS-300 as the primary unit.

52L/M (Unit Parallel)

This input informs the DECS-300 that the system is operating in single unit operation or paralleled to another generator or power grid in droop mode. It also switches between which overexcitation limiter (off-line limiter or on-line limiter) is activated when excitation levels exceed the OEL settings. This input is typically connected to a 52b auxiliary contact of the generator breaker and requires a continuous contact closure to switch modes. Reference 52J/K (VAR/PF Enable) input for more information.

If both the 52L/M and 52J/K are closed, AVR mode is active while the off-line overexcitation limiter is enabled and will limit if the settings are exceeded.

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

If 52L/M is open and 52J/K is open, var/power factor mode is active while the on-line overexcitation limiter is enabled and will limit if the settings are exceeded.

Table 3-1. 52L/M And 52J/K Truth Table

Operation Mode	52L/M	52J/K
AVR Mode Active, Off-Line OEL Enabled, No Droop, No VAR/PF	Closed	Closed
Droop Mode Active, On-Line OEL Enabled, No VAR/PF	Open	Closed
VAR/PF Mode Active, On-Line OEL Enabled	Open	Open

SWI-2 (Switch Input 2)

A continuous contact closure at this input causes all setpoints to change to the second 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 second 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 second 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 second 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 second pre-position value and respond to the tracking function.

AVR (Automatic Voltage Regulation)

This input accepts a momentary contact closure that places the DECS-300 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-300 in the FCR mode. Once the unit is in FCR mode, this input has no effect.

PRE-P (Pre-Position 1)

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

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

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.

52J/K (Var/PF Enable)

This input accepts a continuous contact closure that disables var/power factor operation. An open contact enables the DECS-300 to control the generator reactive power in either the var or power factor modes. These functions must be enabled via HMI, BESTCOMS or the Modbus™ before use. For more information, refer to the 52L/M input. If neither var nor power factor mode is desired, it is recommended that a jumper wire be placed across the 52J/K and common terminals, and switch the 52L/M input with the generator breaker, 52b, auxiliary contact.

SWI-1 (Switch Input 1)

This programmable input accepts a continuous contact closure that selects the primary or secondary stability (PID) group settings. An open contact selects the primary stability group settings. Transitions from one group setting to the other are bumpless when the generation system is in steady state operation.

ALRST (Alarm Reset)

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

ANALOG INPUTS

Eight analog voltage or current inputs may be sensed and brought to the DECS-300 input. The generator and bus voltages are sensed by external isolation transformers which bring the signal levels within the operating range of the analog input circuits voltage capabilities. The ac voltage sensing range of the DECS-300 is split into two operating ranges: 120 volts nominal (200 volts maximum) and 240 volts nominal (400 volts maximum). 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 V range is selected if the generator secondary VT voltage is set to 160 V or less, otherwise the 240 V range is selected. The 120 volt range is selected if the generator secondary VT voltage is set to 160 volts or less. If it is greater than 160 volts, the 240 volt range is selected. Five analog input signals to the DECS-300 are isolated and filtered by low pass filters in the analog input circuits. The remaining three input signals are filtered but do not require isolation. All analog input signals are brought to the input of the twelve bit analog-to-digital converter (ADC).

Bus Voltage (BUS V_{CA})

This sensed input, bus voltage phase C to phase A (BUS V_{CA}), is used to calculate the bus rms voltage and is compared with the generator sensed voltage magnitude for voltage matching. This input is not phase sensitive. Therefore, other phase combinations are acceptable.

Generator Voltage (V_{CA})

This sensed input, generator voltage, phase C to phase A (GEN V_{CA}), is used to calculate the generator frequency and also two of the three-phase generator rms voltages. Sensed voltage is filtered to eliminate multiple zero crossings during one fundamental period. The signal from the zero crossing detector (ZCD) is used to calculate the generator ac. The generator voltage, phase C to phase A signal is used to calculate the generator phase C to phase A rms voltage. Generator phase B to phase C voltage is calculated by the microprocessor from the phase C to phase A signal and the phase A to phase B signal.

Generator Voltage (V_{AB})

This sensed input, generator voltage, phase A to phase B (GEN V_{AB}) is used to calculate two of the three-phase generator rms voltages. The generator phase A to phase B voltage signal is used to calculate the generator phase A to phase B rms voltage. Generator phase B to phase C voltage is calculated by the microprocessor from the phase A to phase B signal and the phase C to phase A signal.

Phase B Line Current

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

Phase A or C Generator Line Current

This input, phase A or C generator line current, is developed from a current transformer and used to calculate the phase A or C generator line current. It is only used during cross-current compensation applications.

Accessory Input (Remote Setpoint Control)

This input may be either an analog voltage (-10 to +10 Vdc) or current (4 to 20 milliamperes). Separate terminals provide convenient terminations but only one input may be used in any application. This input is typically from the Power System Stabilizer or a similar device.

The accessory voltage input signal changes the setpoint of the selected operating mode. This input may be in the range of -10 to +10 Vdc or 4 to 20 milliamperes. The input signal is named a voltage signal even though one input mode may be 4 to 20 milliamperes. When the current input mode is selected, the input current (4 to 20 milliamperes) is converted by the DECS-300 to –5 to +5 Vdc voltage signal. Refer to the following formula for converting current signals to voltage signals.

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

Where:

V_{aux} = the voltage signal and
I = 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 Voltage

This input is developed in the Isolation Module or similar device and is an analog voltage in the range of 0.9 to 9.1 volts, with 5.0 volts equal to zero field voltage. Five pair of input terminals on the Isolation Module provide voltage matching for the input field voltage. The input signal may be ±300% of the nominal signal. On this system, the input signal is conducted on a specific cable and is connected to a 15 pin connector, P1 on the DECS-300.

Field Current

This input is developed in the Isolation Module and is an analog voltage in the range of 2.0 to 9.5 volts, with 2.0 volts equal to zero field current. Two pair of input terminals on the Isolation Module provide voltage matching (50 and 100 millivolt) for the input field current signal. The input signal to the DECS-300 may be +300% of the nominal signal. On this system, the input signal is conducted on a specific cable and is connected to a 15 pin connector, P1 on the DECS-300.

INPUT POWER

Input power may be either of two types. A nominal 24/48 Vdc or a nominal 120 Vac/125 Vdc. For the 120 Vac/125 Vdc type, both input power voltages may be applied at the same time for redundant power supply operation. Refer to Section 1, *Specifications*, for voltage ranges. The power supply provides operating voltages (+5 Vdc, ±12 Vdc, and +24 Vdc) for the rest of the DECS-300 circuitry and ±12 Vdc for the Isolation Module.

ANALOG-TO-DIGITAL CONVERTER

All analog input signals are brought to the input of the twelve bit ADC. Each input signal is sampled in the ADC, 96 times per generator frequency period. This sampling rate is controlled by the digital signal processor.

MICROPROCESSOR

The microprocessor is the heart of the DECS-300 and performs control, computation, self test, and communication functions. The main processor (labeled microprocessor in Figure 3-1) generally performs low speed tasks such as protective functions, frequency measurements, communications, watchdog alarm, or other system functions.

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 also filtered by the Infinite Impulse Response (IIR) filters, and dc signals (field voltage and current) are filtered by averaging filters. Output data to the DAC are used to generate the control output signals.

OPERATIONAL SETTINGS

Operational settings that affect the system are stored in nonvolatile memory. These settings may be changed by the customer. You must have password access to change settings. No password access is required to view settings from the front panel HMI display or through BESTCOMS communication software.

WATCHDOG TIMER

If the microprocessor fails for any reason, output pulses to the watch-dog timer stop. After a short duration of time, the watch-dog timer takes the system off-line.

REAL-TIME CLOCK

The real-time clock is used by the event and data logging functions to timestamp events. Time is displayed in either the 12 hour or 24 hour format. Correction for daylight saving time can be enabled or disabled. The date is displayed in either the d-m-y format or m/d/y format. Time and date format changes are made at the front-panel HMI or through BESTCOMS.

Interruption of DECS-300 operating power will reset the clock time and date values.

DIGITAL-TO-ANALOG CONVERTER

Digital input data from the DSP is converted to analog signals for controlling the generator system excitation. Output data from the DAC may be either a voltage signal or current signal. This selection may be made from the front panel HMI or through the serial communications link.

CONTROL OUTPUT CIRCUITS

Analog signals from the DAC are output to switches controlled by the DSP. There are three control signal options. They are two voltage signal ranges (0 to 10 Vdc and ±10 Vdc) and one current signal (4 to 20 milliamperes). This selection may be made from the front panel HMI or through the serial communications link.

RELAY OUTPUT CIRCUITS

There are eight output relays. These relay outputs are controlled by the microprocessor and sustain seven amperes at 250 Vac. Each output relay has 300 volt surge protectors across the contacts to protect against arcing from inductive loads. Refer to Section 1, *Specifications* for details. Relay outputs one through four are fully programmable via all interfaces and are described in the following paragraphs. Four output relays (three Form A and one Form B) have predetermined functions and are also described in the following paragraphs.

RLY1 To RLY4

Output relays RLY1 through RLY4 may be programmed using the front panel HMI, through BESTCOMS software using the front RS-232 port (COM0), and through the Modbus™ protocol using the rear RS-485 port (COM2).

NOTE

If the contact functionality for a programmable output relay is chosen to be normally closed, then this functionality is maintained only while the DECS-300 has power applied. When power is removed from the DECS-300, the contacts open.

The four output relays labeled RLY1, RLY2, RLY3, and RLY4 have the following programmable features.

- Selection of contact functionality (normally open or normally closed)
- Selection of output type (momentary, maintained for as long as condition is present, or latched until reset)

- Program duration of momentary annunciation from 0.1 to 5 seconds in 50 millisecond steps
- Selection of condition(s) to be annunciated, including:
  1) Field overvoltage
  2) Field overcurrent
  3) Field overtemperature
  4) Generator undervoltage
  5) Generator overvoltage
  6) Underfrequency or Volts-per-hertz limit
  7) Overexcitation limit
  8) Underexcitation limit
  9) FCR mode
  10) Loss of sensing (LOS) voltage
  11) Active setpoint at low limit
  12) Active setpoint at high limit
  13) System frequency is below 10 hertz

BLDUP

BLDUP is the build-up relay which is used to initiate generator voltage build-up. Typically this occurs by enabling external field flashing circuitry with a closure of the BLDUP contacts. The contacts open when field flashing is to be terminated.

FTBUP

FTBUP is the failed-to-build-up relay which is used to indicate that generator voltage failed to build up. The contacts close after the build-up process if the generator voltage fails to reach the field flashing level by the end of the field flashing time interval. The output type is selectable as momentary or latched until reset. The duration of momentary closure is programmable from 0.1 to 5 seconds in 50 millisecond steps.

WTCHD

WTCHD is the watchdog relay which is used to indicate that there is a software execution problem within the DECS-300. The contact closes under the following circumstances:

- No power is applied to the DECS-300.
- After application of power for approximately eight seconds.
- Software in the DECS-300 stops executing normally.

ON/OF

ON/OF is the unit on/off relay which indicates that the unit is operating by closing the output contact when the unit is started. When the unit is stopped, the contact opens.

COMMUNICATION

Three serial communications ports provide access to the DECS-300. The front RS-232 port (COM0) is dedicated to communications with BESTCOMS DECS300-32 software. The rear RS-232 port (COM1) is dedicated for communications with another DECS-300 in support of tracking between units with a redundant DECS-300. The rear RS-485 port (COM2) is dedicated to communications using Modbus™ protocol in RTU (remote terminal unit) mode only.

NOTE

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

All three ports have default baud rate of 9600. However, each baud rate can be independently set. The selection of baud rates includes 1200, 2400, 4800, 9600, and 19200. Ports COM0 and COM1 both 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.

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 is temporary storage for data. EEPROM is nonvolatile and stores the settings and configuration.

PROTECTION FUNCTIONS

There are seven protection functions available in the DECS-300 for annunciating that specific conditions have occurred. Each of the seven protection functions can be indicated via the front panel HMI display, remotely via communications using the front panel RS-232 (COM0) port or the Modbus™ protocol using the RS-485 (COM2) port, and/or assigned to any of the four programmable output relays.

Field Overvoltage

When the field voltage rises above a specific level for more than a definite amount of time, a field overvoltage annunciation will occur. The annunciation occurs via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation. The field overvoltage threshold is adjustable from 1 to 900 Vdc in 1 Vdc increments, and the time delay is adjustable from 0.2 to 30.0 seconds in 0.1 second increments. Once the field voltage drops below the threshold, the field overvoltage timer is reset. The field overvoltage function may be disabled without changing the threshold or time delay settings.

Field Overcurrent

When the field current rises above a specific level for more than a definite amount of time, a field overcurrent annunciation occurs. The annunciation occurs via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation. The field overcurrent threshold and the time delay are related by an inverse function. This means that the higher the field current goes above the threshold, the shorter the time to an annunciation. The time dial setting is a linear multiplier for the time to an annunciation. The overcurrent threshold is adjustable from 0.1 to 9999.0 Adc in 0.1 Adc increments. The time dial setting is adjustable from 0.1 to 20.0 in increments of 0.1. The field overcurrent function may be disabled without changing the threshold or time dial settings. Figure 3-2 shows a set of typical field overcurrent timing curves. Notice that field current levels below 103% of the field overcurrent setpoint value do not cause an annunciation. Also, field current levels greater than 250% (field current multiple of 2.5 in Figure 3-2) of the setpoint value cause an annunciation in the same amount of time as the 250% level.

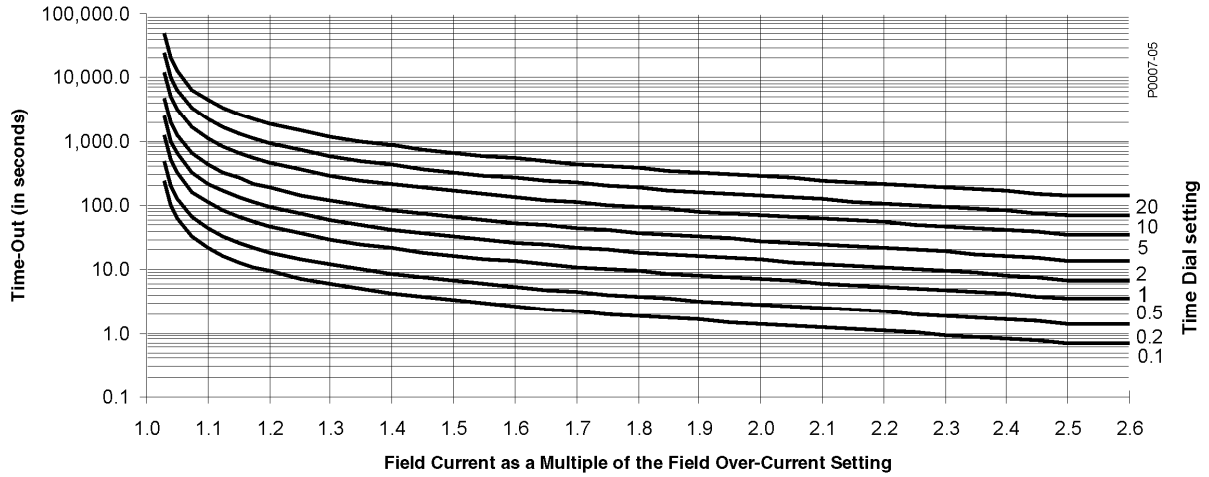

Figure 3-2. Field Overcurrent Timing Curves

Field Overtemperature

The DECS-300 calculates field temperature based on the generator main field resistance, the field ambient temperature, and the voltage drop across the generator main field brushes. With this information, the DECS-300 can display the calculated field temperature and also provide protection against field overtemperature conditions. The field overtemperature adjustment range is from 0 to 572 degrees in 1 degree steps. This range is selectable for Celsius or Fahrenheit scales and each scale has the same range. This feature is intended for static exciter applications working into the generators main field and not rotary exciter type applications.

When an overtemperature condition exists and the overtemperature time delay expires, the DECS-300 annunciates via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation. The overtemperature time delay is adjustable from 0.1 to 60.0 seconds in 0.1 second increments.

Generator Undervoltage

When the generator voltage falls below a specific level for more than a definite amount of time, a generator undervoltage annunciation occurs. The annunciation occurs via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation. The generator undervoltage threshold is adjustable from 0 to 30,000 Vac in 1 Vac increments, and the time delay is adjustable from 0.5 to 60.0 seconds in 0.1 second increments. Once the generator voltage rises above the threshold, the generator undervoltage timer is reset. The generator undervoltage function may be disabled without changing the threshold or time delay settings.

Generator Overvoltage

When the generator voltage rises above a specific level for more than a definite amount of time, a generator overvoltage annunciation occurs. The annunciation occurs via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation. The generator overvoltage threshold is adjustable from 0 to 30,000 Vac in 1 Vac increments, and the time delay is adjustable from 0.1 to 60.0 seconds in 0.1 second increments. Once the generator voltage drops below the threshold, the generator overvoltage timer is reset. The generator overvoltage function may be disabled without changing the threshold or time delay settings.

Loss Of Sensing

When the generator voltage falls below a fixed percentage of the rated value for more than a definite amount of time, a loss of voltage sensing annunciation occurs. The annunciation occurs via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation. The loss of voltage sensing threshold is fixed at 50 percent of the generator rated voltage, but the time delay is adjustable from 0.0 to 30.0 seconds in 0.1 second increments. You can also program the DECS-300 to transfer to FCR mode when loss of sensing occurs.

Below 10 Hertz

A below 10 hertz condition occurs when the generator frequency falls below ten hertz. A below ten hertz condition is annunciated as *SYSTEM BELOW 10 HZ*. Output relays RLY1 through RLY4 may be programmed to initiate additional annunciation or actions. When the generator frequency increases above the 10 hertz threshold, the below 10 hertz annunciation resets automatically. Refer to the paragraphs *RLY1 To RLY4* previously in this section.

Soft Start

DECS-300 soft start capability provides for an orderly build-up of terminal voltage from residual to the voltage setpoint in the desired time with minimal overshoot. When the system is in start up, the voltage reference is adjusted by the amount calculated based on two parameters. These parameters are level and time. Level is adjustable from 0 to 90 percent in increments of 1 percent with a default setting of 5 percent. Soft start time is adjustable from 1 to 7,200 seconds in increments of 1 second with a default setting of 5 seconds. Figure 3-3 is a graph for the voltage reference showing soft start bias at 30 percent, soft start time at 8 seconds, and a voltage setpoint of 100 percent. Soft start level is the same parameter as soft start bias when interfaced from the BESTCOMS, *Setting Adjustments, Startup* screen.

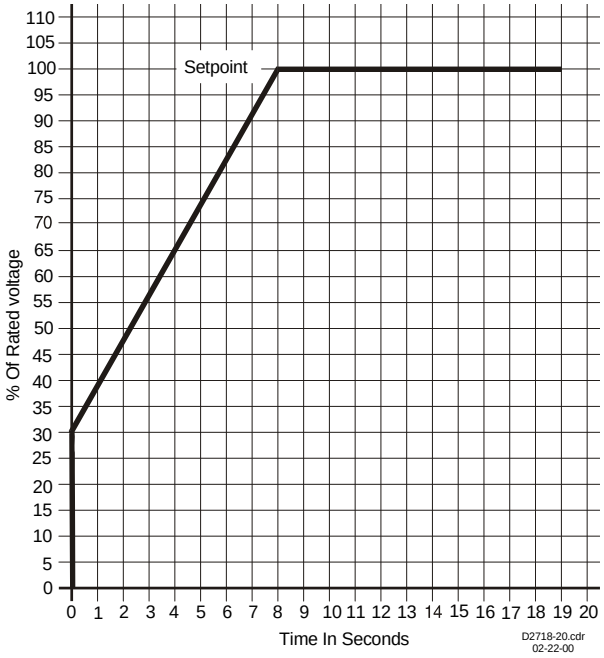

Figure 3-3. Soft Start Voltage Reference

Loss of Field

When the reactive power absorbed by the generator exceeds the loss of field threshold for the duration of the loss of field time delay, a loss of field annunciation occurs. A loss of field condition is annunciated on the front-panel metering screen and can also be assigned to a programmable output relay for external annunciation. The loss of field threshold is adjustable from 0 to 3,000 Mvar in 1 kvar increments. The loss of field time delay is adjustable from 0 to 9.9 seconds in 0.1 second increments. Once the absorbed reactive power decreases below the threshold, the loss of field timer is reset. The loss of field function may be disabled without changing the threshold or time delay settings.

LIMITING

There are four limiting functions in the DECS-300. Overexcitation, underexcitation, underfrequency, and volts/hertz. For excitation limiting, you may select overexcitation limiting, underexcitation limiting, stator current limiting, or any combination. For underfrequency limiting, you may select either underfrequency compensation or volts-per-hertz limiting. See the following paragraphs for a description of these functions.

Overexcitation Limiter

Overexcitation limiting (OEL) operates in all modes except FCR mode. OEL senses the field current output of the voltage regulator or static exciter and limits the field current to prevent field overheating . In FCR mode, the DECS-300 only announces that all conditions for OEL are fulfilled and does not provide limiting. The DECS-300 provides two types of over-excitation limiting: Summing Point and Takeover.

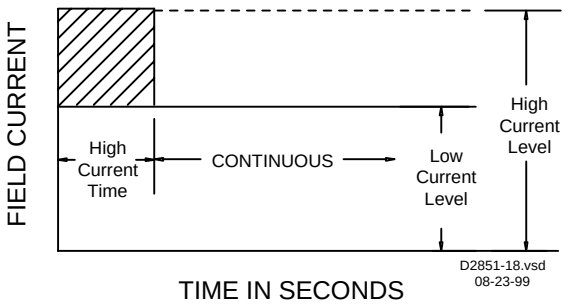

Figure 3-4. Off-Line Overexcitation Limiting

Summing Point OEL

Two OEL current levels are defined for off-line operation. They are high and low (see Figure 3-4). The generator can operate continuously at the low OEL current level and for a programmed time at the high OEL current level.

Three OEL current levels are defined for on-line operation. They are high, medium, and low (see Figure 3-5). The generator can operate continuously at the low OEL current level and for programmed times at the high and medium OEL current levels.

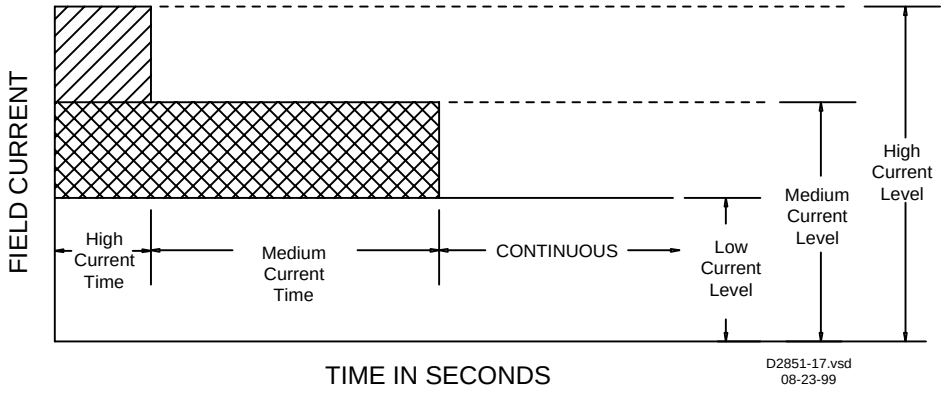

Figure 3-5. On-Line Overexcitation Limiting

In addition to the three current levels, the DECS-300 also uses embedded timers to prevent excessive heating of the exciter field that may result from repetitive overexcitation. A duration timer monitors the accumulated time spent in an overexcitation condition and reset timer is used to count backward from either the high OEL time setting or the sum of the high plus the medium OEL time setting (depending on the duration timer value). The reset timer countdown begins when the excitation current decreases below the low OEL limit level. In the event that a subsequent overexcitation condition occurs before the reset timer reaches zero, the OEL limiter will resume from its state prior to the excitation decreasing below the low OEL limit level. A full OEL cycle cannot occur until the reset timer has counted down to zero after a previous OEL condition.

Takeover OEL

In addition to the Summing Point OEL described above, the DECS-300 has a Takeover-style over-excitation limiter. The field current level at which limiting occurs is determined by an inverse time characteristic similar to that shown in Figure 3-6. Two current levels and a time dial setting are defined for the takeover-style OEL limiter. Separate curves may be selected for on-line and off-line operation. If the system enters an overexcitation condition, the field current is limited and made to follow the selected curve.

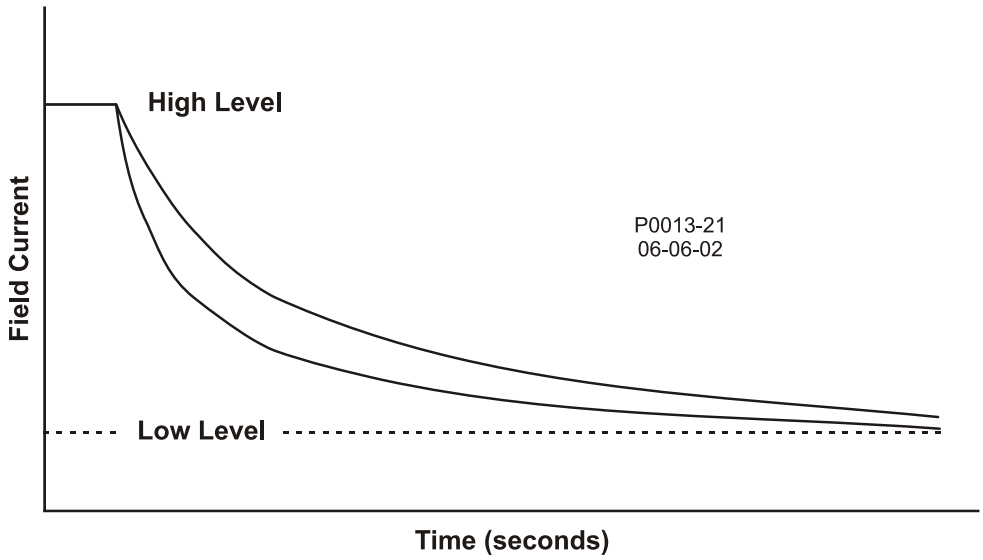

Figure 3-6. Inverse Time Characteristic for Takeover-Style OEL

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

Option 1. This selection provides the default functionality described in the previous paragraphs labeled *52L/M (Unit Parallel)* and *52J/K (Var/PF Enable)*. Note that the 52J/K input can also switch between on-line and off-line OEL when the 52L/M input is jumpered. Also, if var/PF modes are disabled, Droop will be active when the 52J/K input is open and closed. AVR mode will be active.

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

Option 3. In this mode, on-line settings are activated at all times. This selection allows the DECS-300 to operate in AVR mode (stand-alone application) and is not restricted by the off-line OEL settings. In this case, the on-line OEL setting would be active to limit excessive excitation current. This choice also eliminates the need for the DECS-300 to operate in Droop mode when applied in a single unit application. Therefore, voltage should not droop as reactive load increases.

Underexcitation Limiter

Underexcitation limiting (UEL) operates in all modes except FCR mode. UEL senses the leading var level 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-300 only annunciates for UEL conditions and does not limit.

The DECS-300 provides the ability to select an internally generated UEL curve or a customizable UEL curve. The internally generated curve is based on the desired reactive power limit level at zero real power with respect to the generator voltage and current rating. The customizable UEL curve is selectable for up to five points. This curve will allow the user to match a specific generator characteristic specifying coordinates of the intended leading reactive power (kvar) limit at the appropriate real power (kW) level. A typical customer selected five-point curve is shown in Figure 3-7.

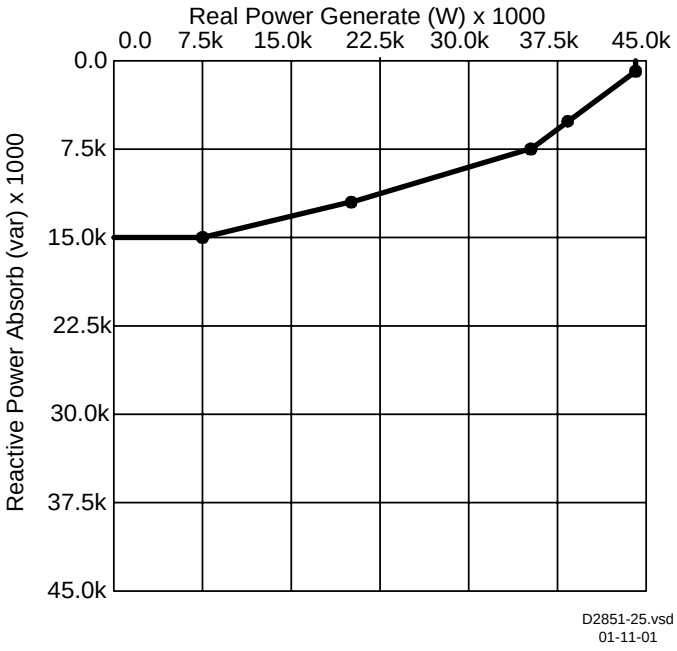

Figure 3-7. Custom Five-Point Curve

In an underexcited condition, the DECS-300 will limit and annunciate via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation.

Underfrequency Limiter

When the generator frequency drops below the corner frequency for the underfrequency slope (see Figure 3-8), the voltage setpoint is automatically adjusted by the DECS-300 so that generator voltage will follow the underfrequency slope and an underfrequency annunciation occurs. The under-frequency slope can be tuned to have zero to three times the volts/hertz slope, in 0.1 increments and the corner frequency can be set across a range of 45 to 65 hertz in 0.1 hertz increments. This adjustability allows the DECS-300 to precisely match the operating characteristics of the prime mover and the loads being applied to the generator. The generator underfrequency function may be effectively disabled by setting the slope to zero.

When the underfrequency function is active, an underfrequency annunciation occurs. The annunciation occurs via the front panel metering screen and may also be assigned to a programmable output relay for external annunciation.

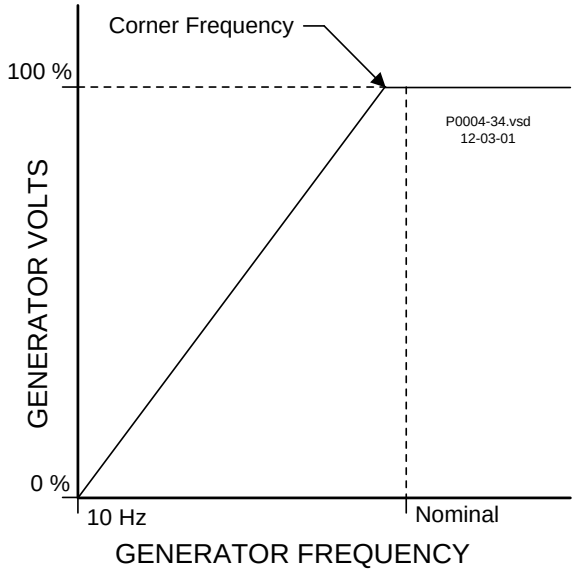

Figure 3-8. Typical Underfrequency Compensation Curve

Volts Per Hertz Ratio Limiter

The volts per hertz ratio limiter will prevent the regulation setpoint from exceeding the volts per hertz ratio that is prescribed by the slope setting of the DECS-300. (Refer to the previous paragraphs on *Underfrequency Limiter*.) This feature is also useful for other potentially damaging system conditions such as a change in system voltage and reduced frequency situations that could exceed the systems volts per hertz ratio limit. Figure 3-9 is a typical 1.1 PU volts per hertz limiter curve.

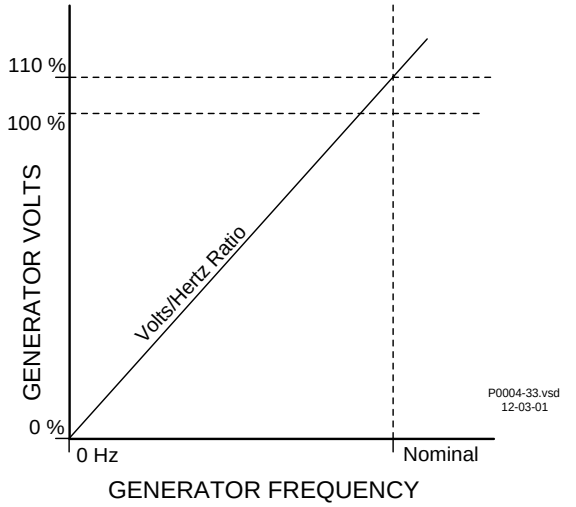

Figure 3-9. Typical 1.1 PU Volts/Hertz Limiter Curve

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-300 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.

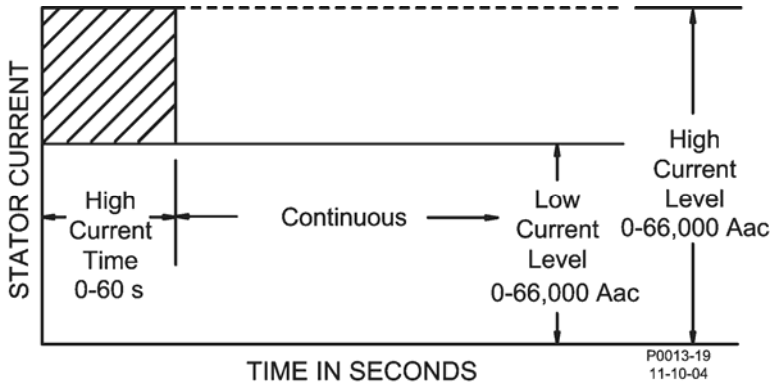

Figure 3-10. Stator Current Limiting

DATALOGGING AND REPORTING

Sequence of Events Reporting

A sequence of events recorder monitors the internal and external status of the DECS-300. 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 of the possible monitored state changes are listed below.

Contact Input State Changes

- Start
- Stop
- Secondary enable
- Unit/Parallel (52L/M)
- AVR mode enable
- FCR mode enable
- Var/PF enable (52 J/K) ∗
- Alarm reset
- PID select (SW1)
- Pre-position 1
- Pre-position 2 (SW2) ∗

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

Output State Changes

- Relay 1 output
- Relay 2 output
- Relay 3 output
- Relay 4 output
- Watchdog relay output
- On/Off relay output
- Buildup relay output
- Fail to buildup relay output

System Alarm State Changes

- Field overvoltage
- Field overcurrent
- Generator undervoltage
- Generator overvoltage
- Underfrequency
- Overexcitation limit
- Underexcitation limit
- Lost voltage sensing
- Field overtemperature
- Failed to build up
- System below 10 Hz
- Loss of field
- Stator current limit

System Status State Changes

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

Oscillography

The data recording function of the DECS-300 can record up to eight oscillography records. DECS-300 oscillography records 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-300 begins recording the next record over the oldest record. Because all oscillography records are stored in volatile memory, all records are lost if DECS-300 operating power is interrupted.

Each oscillography record consists of six user-selectable variables with 600 data points recorded for each variable. The sample rate, or time between data point samples, is user-selectable from 4 milliseconds to 10 milliseconds. 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-300 monitors six user-selectable internal variables. Any six variables from the following list may be selected.

- Generator Vab
- Generator Vbc
- Generator Vca
- Generator ave L-L voltage
- Generator Ib in amps
- Generator kVA
- Generator kW
- Generator kvar
- Generator power factor
- Generator frequency
- Bus frequency
- Bus voltage
- Exciter field voltage Vfd
- Exciter field current Ifd
- Var/PF controller output value *
- Generator V-I phase angle *
- Auxiliary input voltage *
- Cross-current input *
- Control output *
- Internal integrator state *
- Tracking error signal (not used)
- Voltage regulator error signal *

* These variables are typically used when commissioning or troubleshooting.

Data recording may be triggered manually by using BESTCOMS, logic triggers, or level triggers. Logic triggers allow data recording to occur as a result of an internal or external status change of the DECS-300.

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 rises above its maximum or it decreases below its minimum.

Figure 3-11 shows an example of a data record as it would look when viewed with BESTwave software. The example illustrates a serial-triggered record monitoring average voltage, generator frequency, field voltage, and field current over a time period of 2.4 seconds. For more information about selecting triggering types or levels, selecting internal variables for monitoring, or viewing oscillography records, see Section 6, *BESTCOMS Software*.

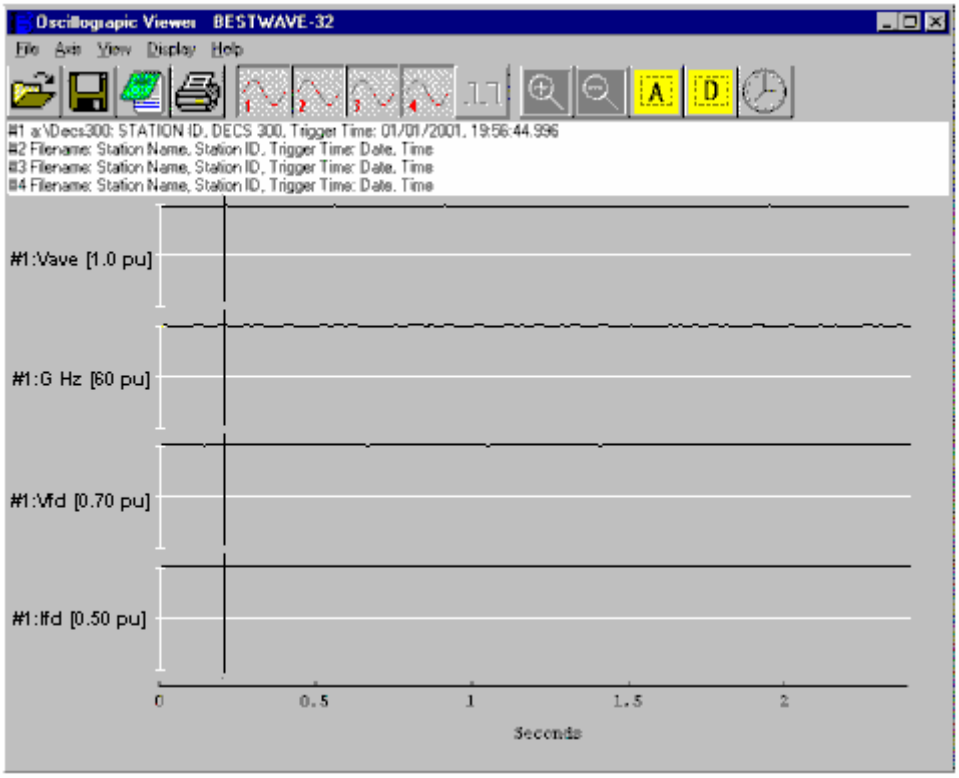

Figure 3-11. Data Record Example

ISOLATION MODULE

Isolation module 9 3229 00 102 and interconnection cable 9 3229 00 006 are components in all DECS-300 units and are provided with each unit. See Section 4, *Installation* for additional information on cable pin-outs. The following paragraphs describe the functions of the circuits shown in the block diagram, Figure 3-12.

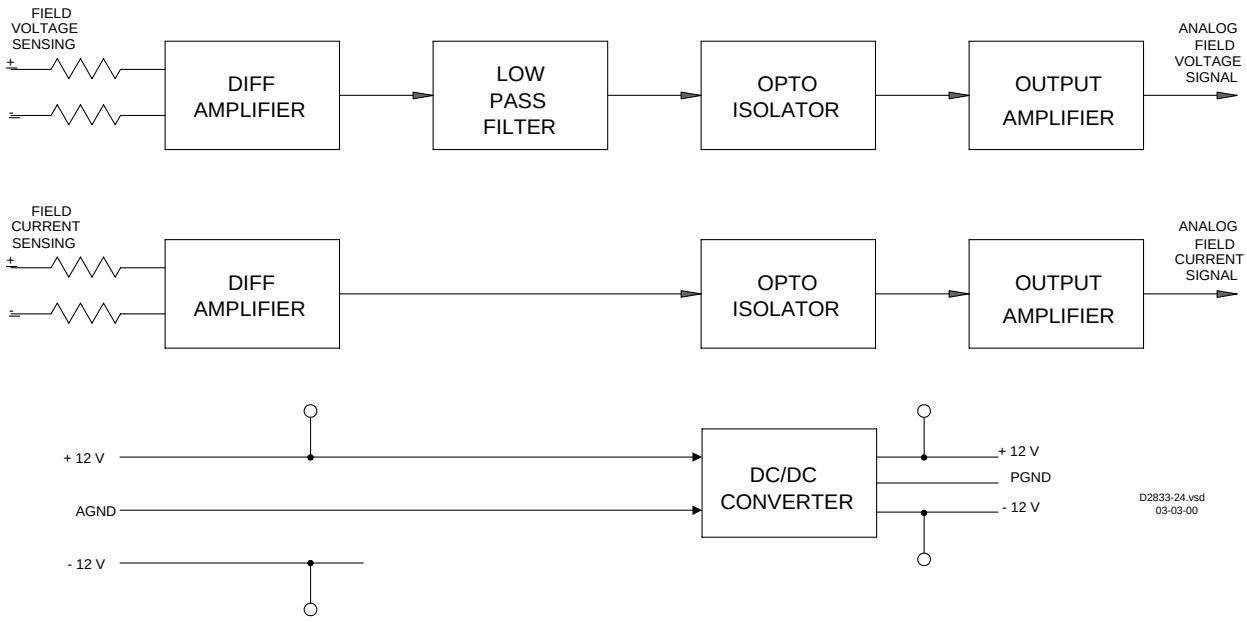

Figure 3-12. DECS-300 Isolation Module Functional Block Diagram

Operating Power

Operating voltage, +12 and -12 Vdc from the DECS-300 (signal port P1 on the rear panel) is applied to the isolation module at signal port J1 on the front panel. J1 is a 15-pin, D-sub connector. Input power is isolated from the internal isolation module operating power through the dc-to-dc converter.

Field Voltage Sensing

There are five field voltage sensing ranges: 32, 63, 125, 250, and 375 volts. Each range has a positive and negative terminal located on the isolation module front panel, and is designed to sense plus or minus 300% of the nominal voltage. The sensed field voltage is applied to a differential amplifier. Output voltage from the differential amplifier is low-pass filtered and optically coupled to the output amplifier. From the output amplifier, the analog output field voltage signal is connected to the 15-pin D-sub connector and the DECS-300. The analog output field voltage signal is a positive dc voltage in the range of 0.9 to 9.1 volts with 5.0 volts equal to zero field voltage.

Field Current Sensing

There are two field current sensing ranges: 50 and 100 millivolts. Each range has a positive and negative terminal located on the isolation module front panel, and accepts voltage outputs from current shunts or current transducers. The field current sensing circuits are designed to accept up to 300 percent of the nominal current range. The field current signal is applied to a differential amplifier with the output optically coupled to the output amplifier. From the output amplifier, the analog output field current signal is connected to the 15-pin D-sub connector and the DECS-300. The analog output field current signal is a positive dc voltage in the range of 2.0 to 9.5 volts with 2.0 volts equal to zero field current.

SECTION 4 • INSTALLATION

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Figures

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SECTION 4 • INSTALLATION

GENERAL

DECS-300 Digital Excitation Control Systems are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a system, check the Part Number against the requisition and packaging list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative or a sales representative at Basler Electric, Highland, Illinois.

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

WARNING!

Removal of the electronic assembly from the case opens the input current transformer (CT) circuit(s). If the case is connected to an active system and the CT circuits are not shorted, high voltage is present. This high voltage may cause electrical shock that could result in injury or death.

MOUNTING

Because the units are of solid-state design, they do not have to be mounted vertically. Any convenient mounting angle may be chosen. Standard DECS-300 units are available in 19 inch rack mount case styles. An optional escutcheon plate (part number 9310304100) is available to allow mounting the unit in a panel or exciter cabinet door. Overall dimensions for the 19 inch rack mount unit is shown in Figure 4-1. In Figure 4-1 and other drawings showing dimensions, the dimensions are in inches and the numbers in parentheses are the metric equivalent. Figure 4-2 shows the escutcheon plate and dimensions. Cutout dimensions and the hole drilling diagram for the panel mount escutcheon plate is shown in Figure 4-3. Figure 4-4 shows the Isolation Module overall dimensions. DECS-300 Isolation Modules may be mounted vertically or horizontally. The unit may be mounted anywhere that the ambient temperature does not exceed the environmental conditions (refer to Section 1 for the environmental conditions). The Isolation Module may be surface mounted and no panel cutout is required. Figure 4-4 also shows the hole drilling locations for mounting the Isolation Module.

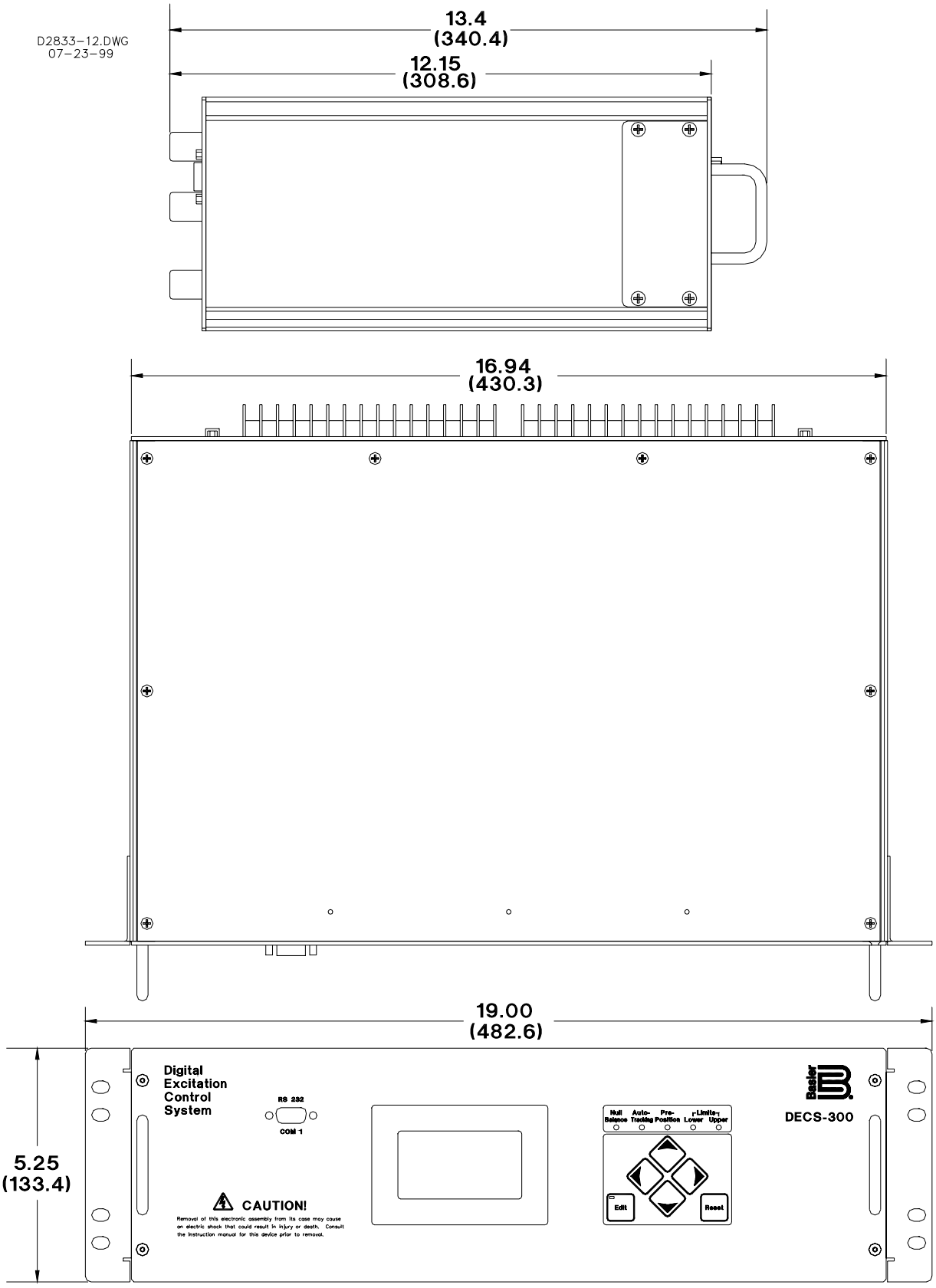

Figure 4-1. DECS-300, 19 Inch Rack Mount Case, Overall Dimensions

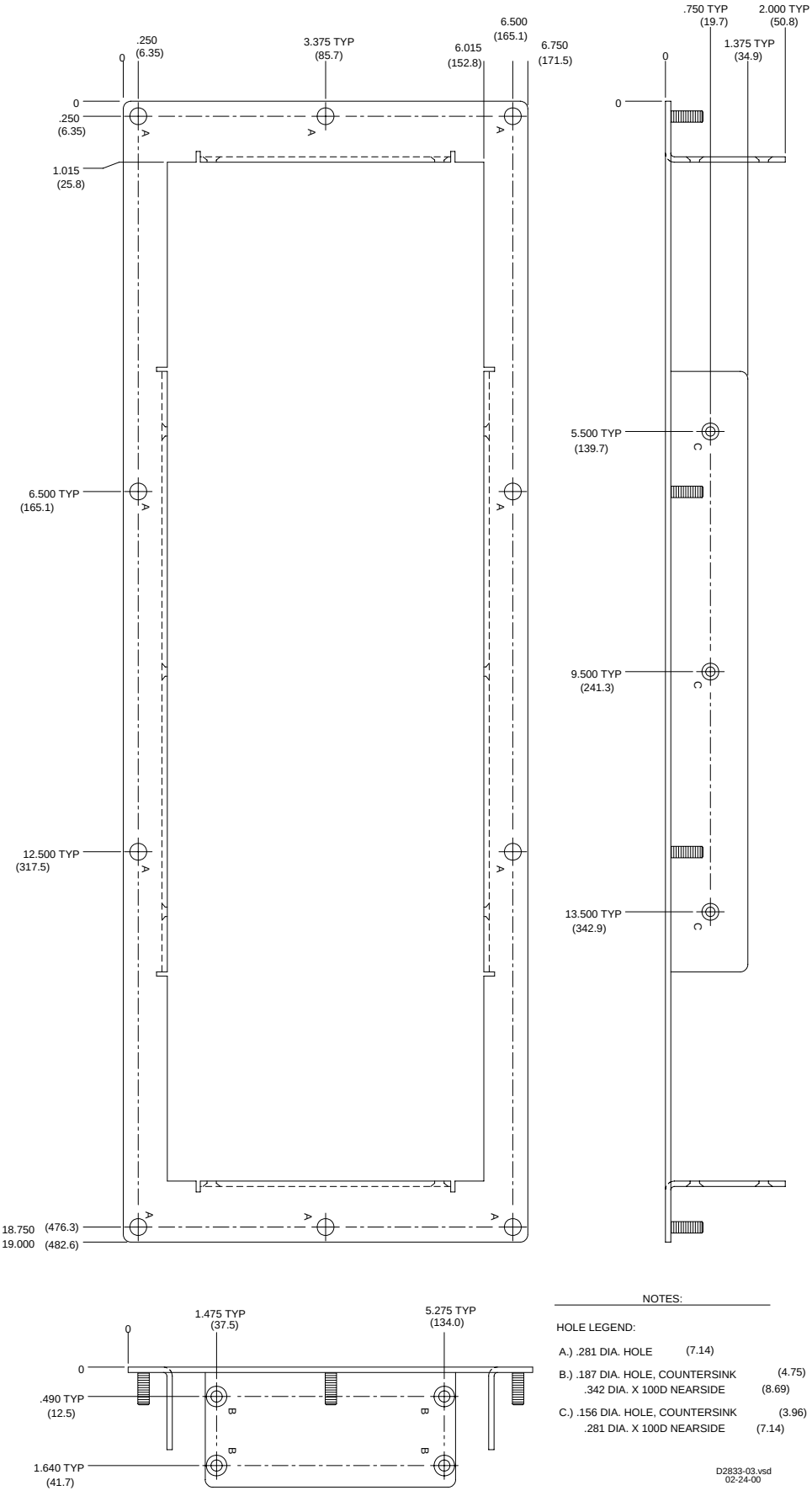

Figure 4-2. DECS-300, Panel-Mount Escutcheon Plate (Part Number 9310304100)

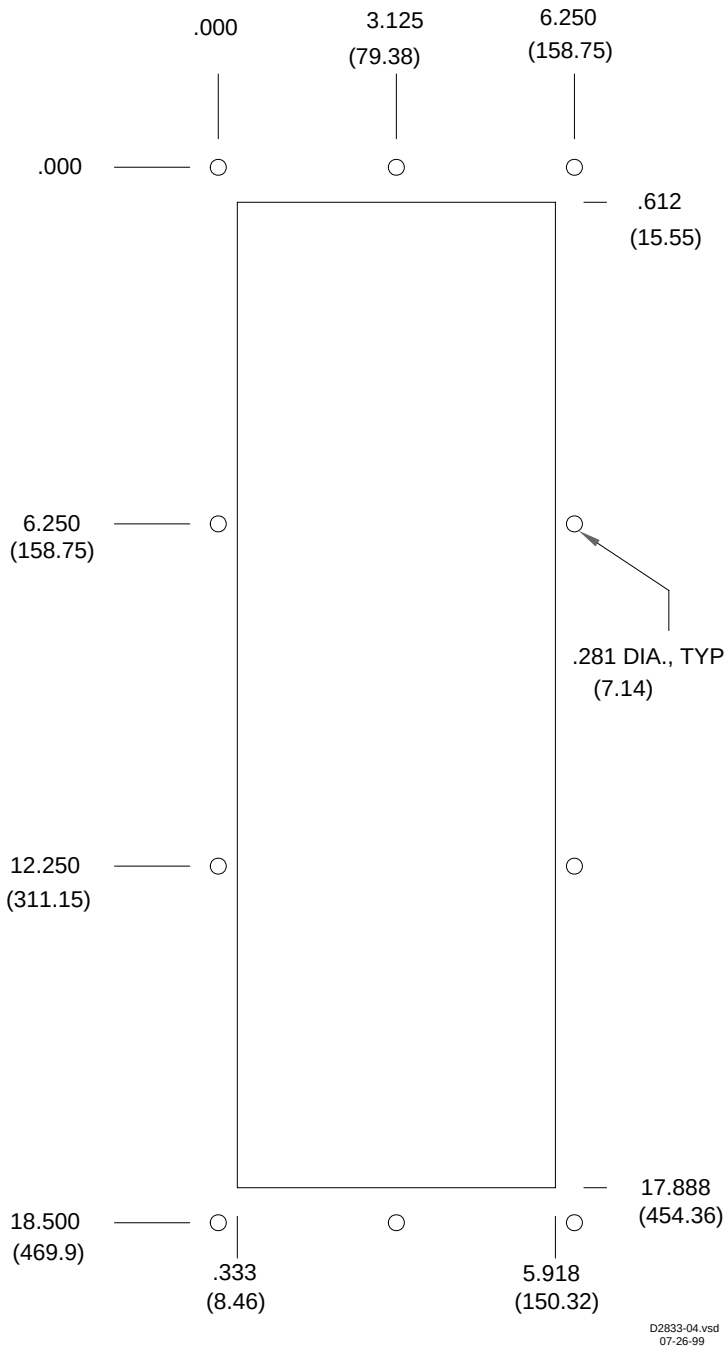

Figure 4-3. DECS-300, Panel Mount Drilling Diagram (illustration is rotated 90°)

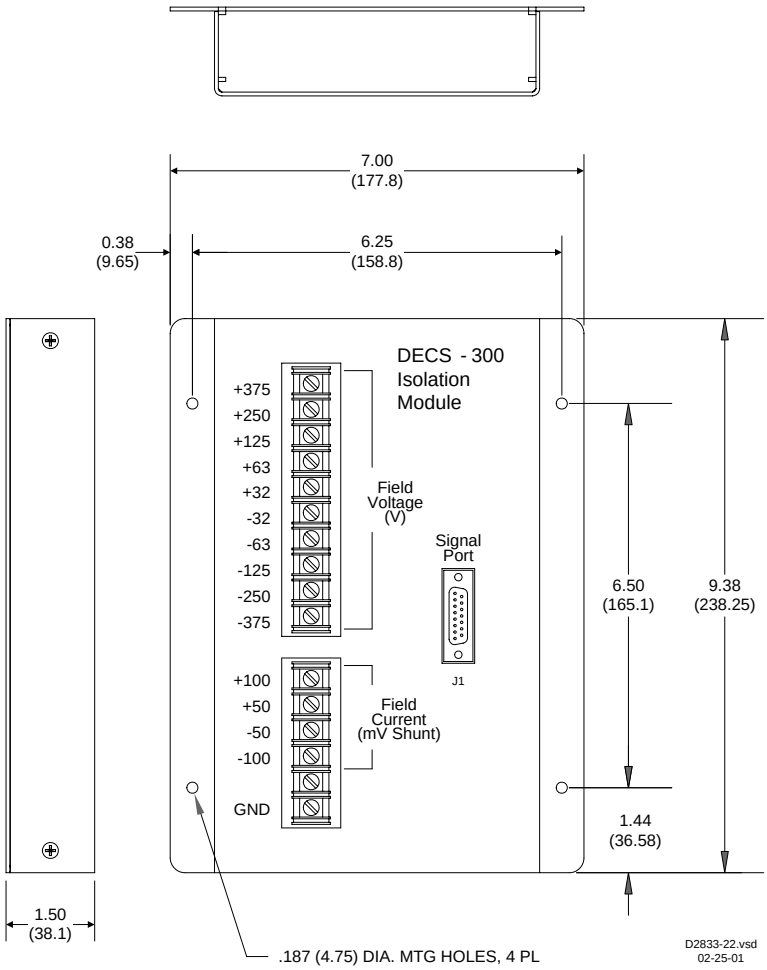

Figure 4-4. Isolation Module Overall Dimensions And Hole Drilling Locations

CONNECTIONS

DECS-300 connections are dependent on the application and excitation scheme. All inputs or outputs may not be used in a given installation. Incorrect wiring may result in damage to the unit. Check the part number to insure that you have the correct unit before connecting and applying power.

> **NOTE**
>
> Be sure the DECS-300 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 unit is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

DECS-300 Terminations

Except as noted above, connections should be made with minimum wire size of 14 AWG. Be sure to use the correct input power for the redundant power supplies.

DECS-300 units have two types of interface terminals (Figure 4-5). One type is terminal blocks and the other is D-type subminiatures.

Located on the rear panel are seven terminal block groups. They are placed in three rows with the upper row label A, the middle row B, and the bottom row labeled C. Terminals are numbered from the left side, starting with 1. Row A, terminal 1 is referenced as A1. Terminals can accommodate wire up to 10 AWG. Wires performing common functions (e.g., battery (+) and battery (–) and wires belonging to the same relay contact) should be grouped together. When control signals are transferred between the excitation system units, corresponding wire pairs should be twisted (e.g., wires to terminals A1 and A2).

There are three D-type connectors. Two are 9 pin (one on the front panel and one on the rear panel) and are used as RS-232 serial communication ports. One connector is a 15 pin and is used for interface with the Isolation Module or the Power Module.

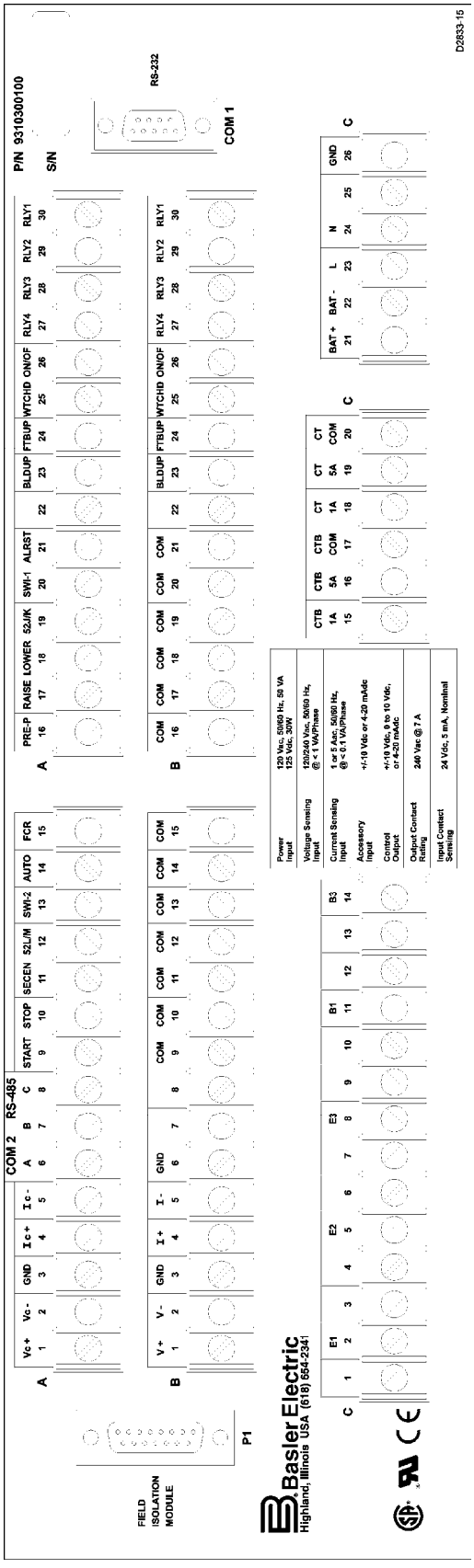

Figure 4-5. DECS-300 Rear Panel

Power Supply Inputs

DECS-300 units are designed to accept a nominal 24/48 Vdc or both 125 Vdc and 120 Vac as energy sources. For the 125 Vdc and 120 Vac, one source is sufficient for operation, but both sources can be used for redundant operation and additional protection. The dc input has internal protection against reversed polarity connection. If redundant power sources (ac and dc) are used, connect the ac power through an isolation transformer to prevent damage to the DECS-300. Connect the power supply inputs to the following terminals.

Table 4-1. Power Supply Inputs

Description	Terminal
DC +	C21 (BAT+)
DC -	C22 (BAT-)
AC Line	C23 (L)
AC Return	C24 (N)
GND CHASSIS	C26 (GND)

Ground Chassis

Terminal C26 (GND) is the chassis ground.

AC Voltage Sensing

DECS-300 units have one bus voltage sensing input (phase A to phase C), and single-phase or three-phase generator voltage sensing with two ac voltage sensing ranges: 120 and 240 volts. Connect the ac inputs to the following terminals.

Table 4-2. AC Voltage Sensing Terminals

Phase	Terminal
Gen. A	C2 (E1)
Gen. B	C5 (E2)
Gen. C	C8 (E3)
Bus A	C11 (B1)
Bus C	C14 (B3)

AC Current Sensing

DECS-300 units have two channels for ac current sensing. They are for the generator phase-B current, and generator phase-A or -C current. The phase-A or -C current sensing is intended for sensing the current in a cross-compensation loop. There are also two ac current sensing ranges: 1 ampere and 5 amperes. Connect the ac current sensing to the following terminals.

Table 4-3. AC Current Sensing Terminals

Phase	1 Ampere Terminals	5 Ampere Terminals
Generator Phase B	C15 (CTB1)	C16 (CTB5)
	C17 (CTBCOM)	C17 (CTBCOM)
Generator Phase A or C	C18 (CT 1A)	C19 (CT 5A)
	C20 (CT COM)	C20 (CT COM)

Accessory Input

DECS-300 units can accept accessory (analog) signals from other controllers (e.g., power system stabilizer (PSS)). They can accommodate two types of accessory signals: voltage signals (range –10 to +10 Vdc) and current signals (4 to 20 mA). Only one signal (voltage or current) may be used at one time. Connect the accessory signals to the following terminals. If shielded cables are used, terminal B3 (GND) may be used for the shield connection.

Table 4-4. Accessory Input Terminals

Signal	Terminal
Voltage	B1 (V+)
	B2 (V–)
Current	B4 (I+)
	B5 (I–)

Control Output Signals

DECS-300 units provide two types of analog control output signals: voltage and current. The control output voltage signal can be either 0 to +10 Vdc or ±10 Vdc and the control output current signal is 4 to 20 milliamperes. Only one control signal is available at a time. Connect the control output signals to the following DECS-300 terminals and select the control signal type through the human-machine interface. If shielded cables are used, terminal A3 (GND) may be used for the shield connection.

Table 4-5. Control Output Terminals

Control Signal	Terminal
Voltage	A1 (Vc+)
	A2 (Vc–)
Current	A4 (Ic+)
	A5 (Ic–)

Contact Input Circuits

DECS-300 units have 13 contact input circuits. Terminals B9 to B21 (all marked COM) are shorted and connected to the positive side (+) of the 24 Vdc power supply. This provides flexibility to the customer when wiring switching inputs. Connect the following terminals to the contact switching inputs.

Table 4-6. Contact Switching Input Terminals

Function	Terminal	Suggested Common	Input Type
Start	A9 (START)	B9 (COM)	Momentary
Stop	A10 (STOP)	B10 (COM)	Momentary
Secondary DECS Enable	A11 (SECEN)	B11 (COM)	Continuous
Unit / Parallel	A12 (52L/M)	B12 (COM)	Continuous
Pre-Position 2	A13 (SWI-2)	B13 (COM)	Continuous
AVR Mode Enable	A14 (AUTO)	B14 (COM)	Momentary
FCR Mode Enable	A15 (FCR)	B15 (COM)	Momentary
Pre-Position	A16 (PRE-P)	B16 (COM)	Continuous
Raise Command	A17 (RAISE)	B17 (COM)	Momentary
Lower Command	A18 (LOWER)	B18 (COM)	Momentary
VAR / PF Enable	A19 (52J/K)	B19 (COM)	Continuous
AVR PID Group Selection	A20 (SWI-1)	B20 (COM)	Continuous
Alarm Reset	A21 (ALRST)	B21 (COM)	Momentary

Table 4-7 lists the 52L/M and 52J/K contact input requirements for specific operating modes. Use this table to assist in determining your system wiring connections.

Table 4-7. 52L/M And 52J/K Contact Input Requirements

Operating Mode	Input A12 (52L/M)	Input A19 (52J/K)
AVR Mode Active, Off-line OEL Enabled, No Droop, No VAR/PF	Closed	Closed
Droop Mode Active, On-line OEL Enabled, No VAR/PF	Open	Closed
VAR/PF Active, On-line OEL Enabled	Open	Open

Output Contacts

DECS-300 units have eight output relays for control and annunciation. Table 4-8 lists the output functions and terminal numbers. Four output relays (three have Form A contacts and one has Form B contacts) have predetermined functions. Relay outputs one through four are fully programmable via all interfaces. Connect the following terminals to the DECS-300 output relay contacts. For additional information on relay specifications, refer to Section 1. For additional information on programming relays, refer to Section 3.

Table 4-8. Output Contact Terminals

Function	Terminal #1	Terminal #2
Buildup Relay	A23 (BLDUP)	B23 (BLDUP)
Fail-to-Build-Up	A24 (FTBUP)	B24 (FTBUP
Watchdog Relay	A25 (WTCHD)	B25 (WTCHD)
Start / Stop Relay	A26 (ON/OF)	B26 (ON/OF)
Relay #4	A27 (RLY4)	B27 (RLY4)
Relay #3	A28 (RLY3)	B28 (RLY3)
Relay #2	A29 (RLY2)	B29 (RLY2)
Relay #1	A30 (RLY1)	B30 (RLY1)

Field Voltage And Current Signals

P1 (15 pin, D-type connector) on the DECS-300 rear panel supplies operating voltage to the Isolation Module. It receives field voltage and current signals on the same cable. J1 (15 pin, D-type connector) on the Isolation module is pin-to-pin compatible with P1 on DECS-300. Connect the field voltage and current signals to the terminals as listed in Table 4-9.

Table 4-9. Field Voltage And Current Signal Terminals

Terminal	Function	Isolation Module
1	+12 Vdc	yes
2	Signal Common	yes
3	–12 Vdc	yes
4	Field current	yes
5	Field current return	yes
6	Field voltage	yes
7	Field voltage return	yes
8	N/A	N/A
9	N/A	N/A
10	N/A	N/A
11	N/A	N/A
12	N/A	N/A
13	Unit yes or no	yes
14	not used	
15	not used	

Droop And Line-Drop Compensation

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

$$V_{c1} = |\overline{V}_T + (R_c + jX_c)\overline{I}_T|.$$

where V_{c1} is the compensated output voltage

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

$(R_c + jX_c)$ are the compensation impedance values

$\overline{I}_T$ is the measure terminal current vector

When the droop percentage is a positive quantity, reactive droop compensation is performed. Droop is equal to the output voltage magnitude times the kvar the generator is exporting. This is equivalent to the above compensation equation with $R_c = 0$ 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 which takes into account the real part of the vector $\overline{I}_T$. Since LDC is typically used to compensate for reactive impedance losses of transformers, R_c is assumed to be zero. For LDC, the above equation becomes:

$$V_{c1} = |\overline{V}_T + (jX_C)\overline{I}_T|.$$

Cross-Current Compensation

Two or more paralleled generators can operate in cross-current compensation (reactive differential) mode. Figure 4-6 shows a typical connection diagram for two paralleled generators using the five ampere sensing input range on the ac current input. The two ohm resistor is a typical value that can be used to set the burden. (Ensure that the resistor power rating is adequate for the installation.)

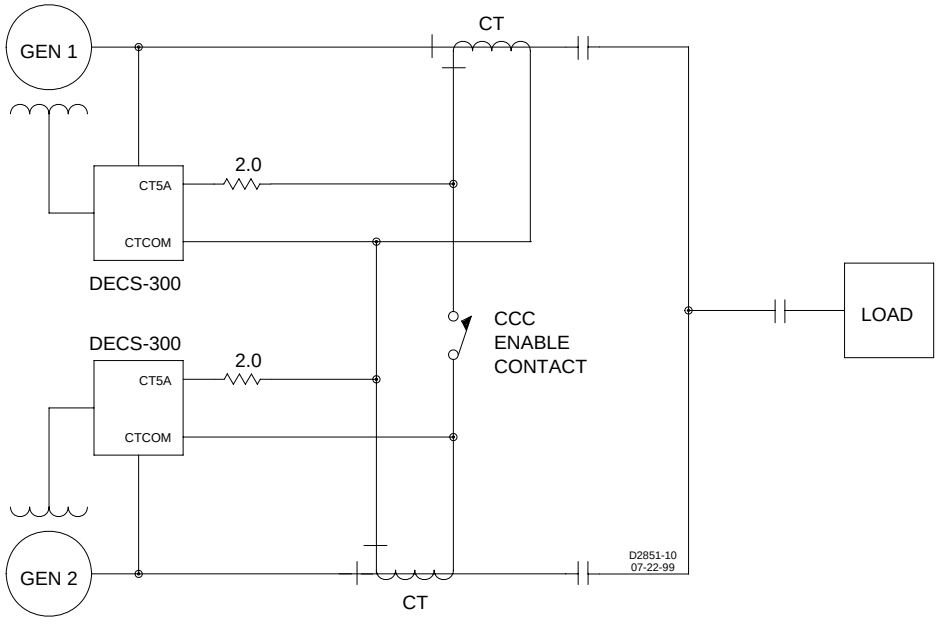

Figure 4-6. Cross-Current (Reactive Differential) Compensation Interconnection

Typical SSE-N And SSE Interconnection Diagrams

Figure 4-7 is a typical SSE-N interconnection diagram. Figure 4-8 is a typical SSE interconnection diagram.

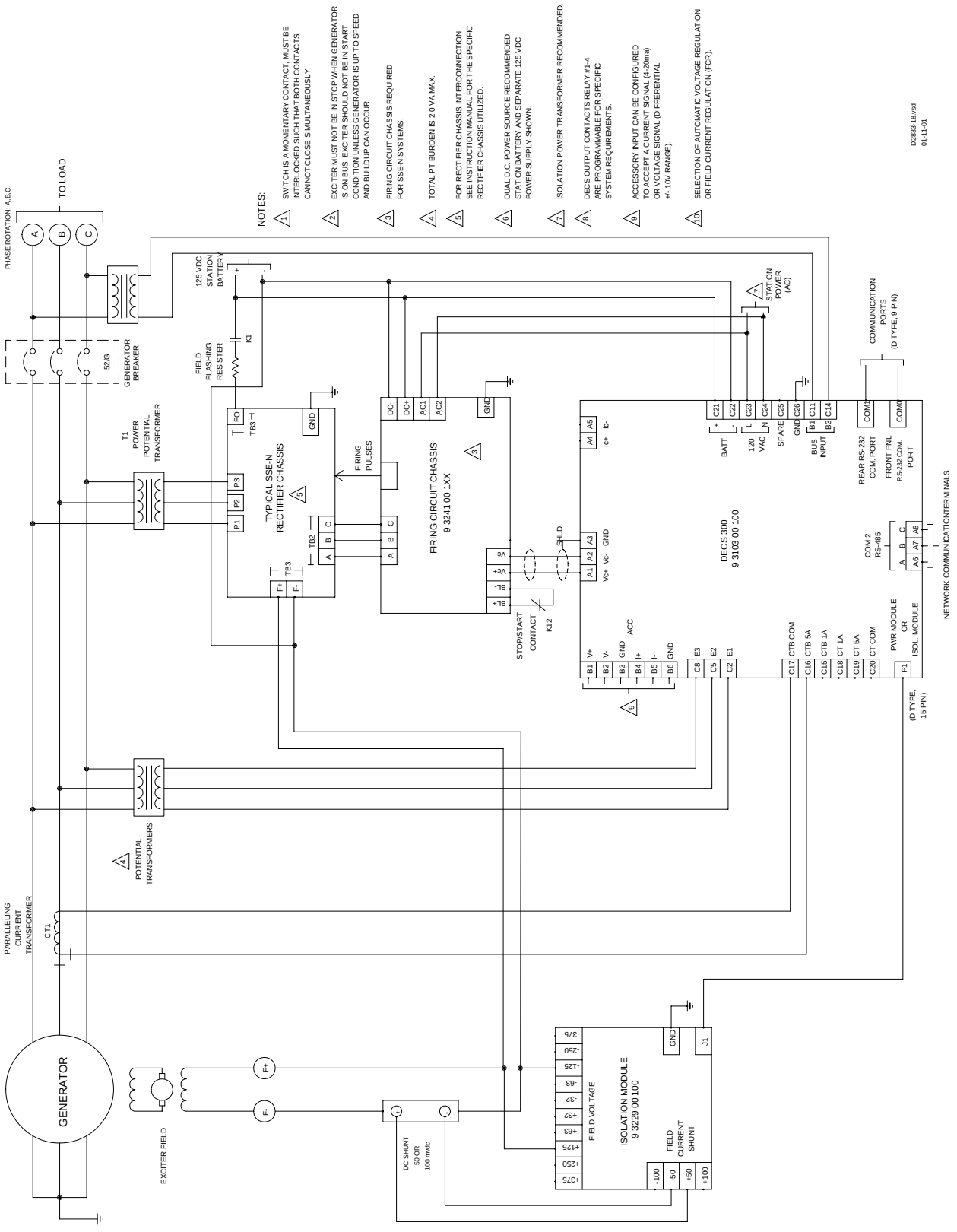

Figure 4-7. Typical AC Connection Diagram For SSE-N System (Sheet 1 of 2)

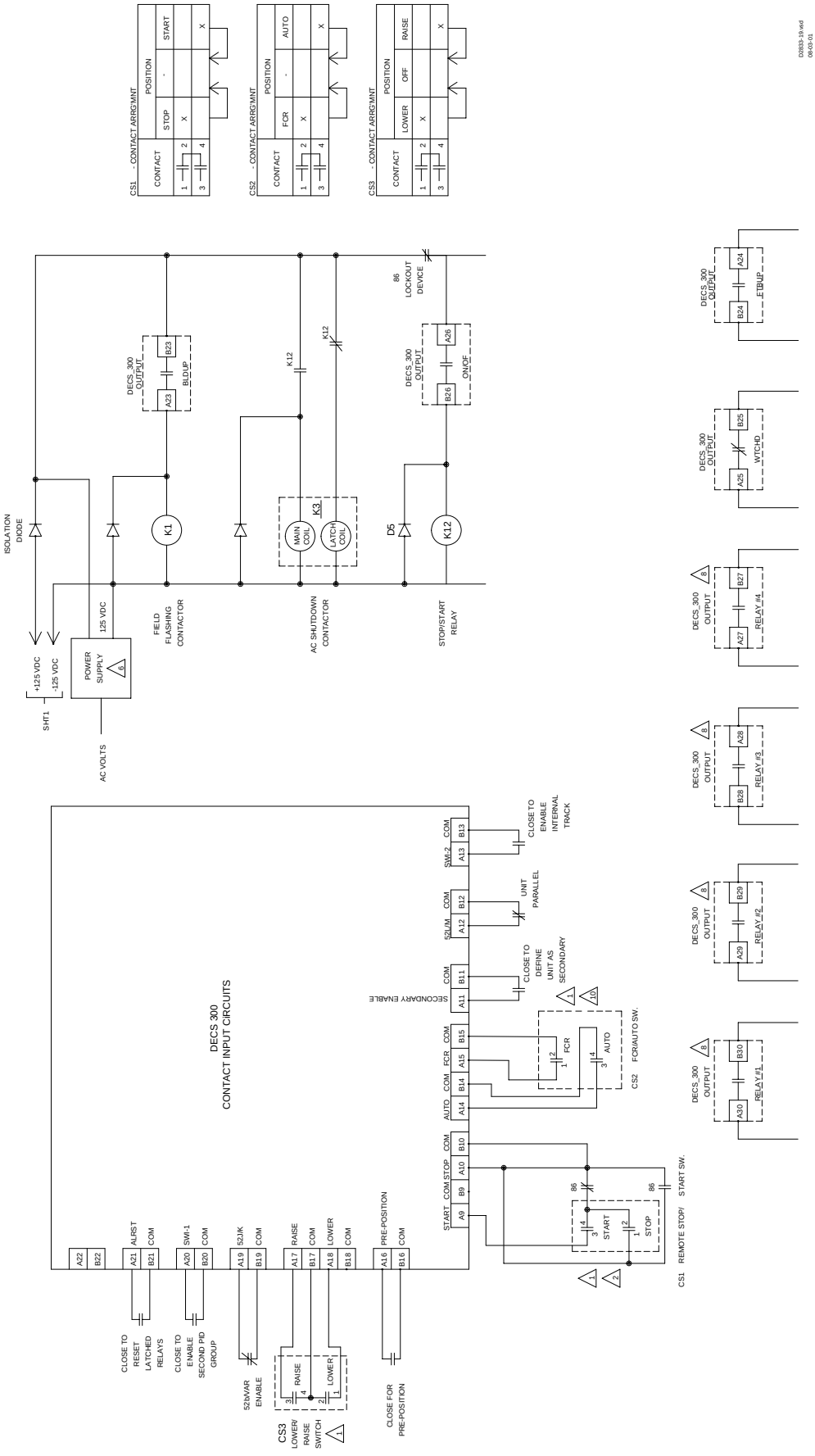

Figure 4-7. Typical AC Connection Diagram For SSE-N System (Sheet 2 of 2)

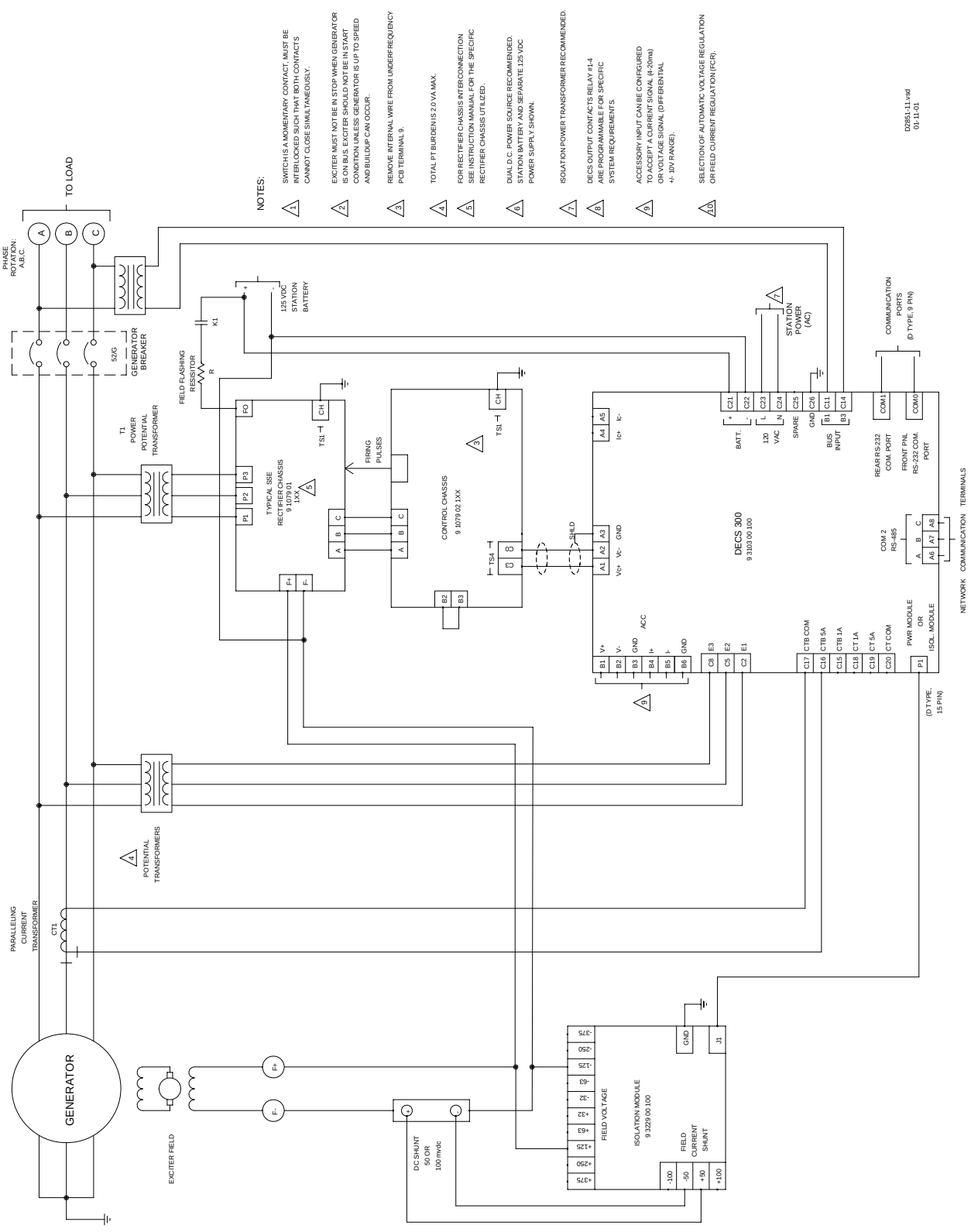

Figure 4-8. Typical AC Connection Diagram For SSE System (Sheet 1 of 2)

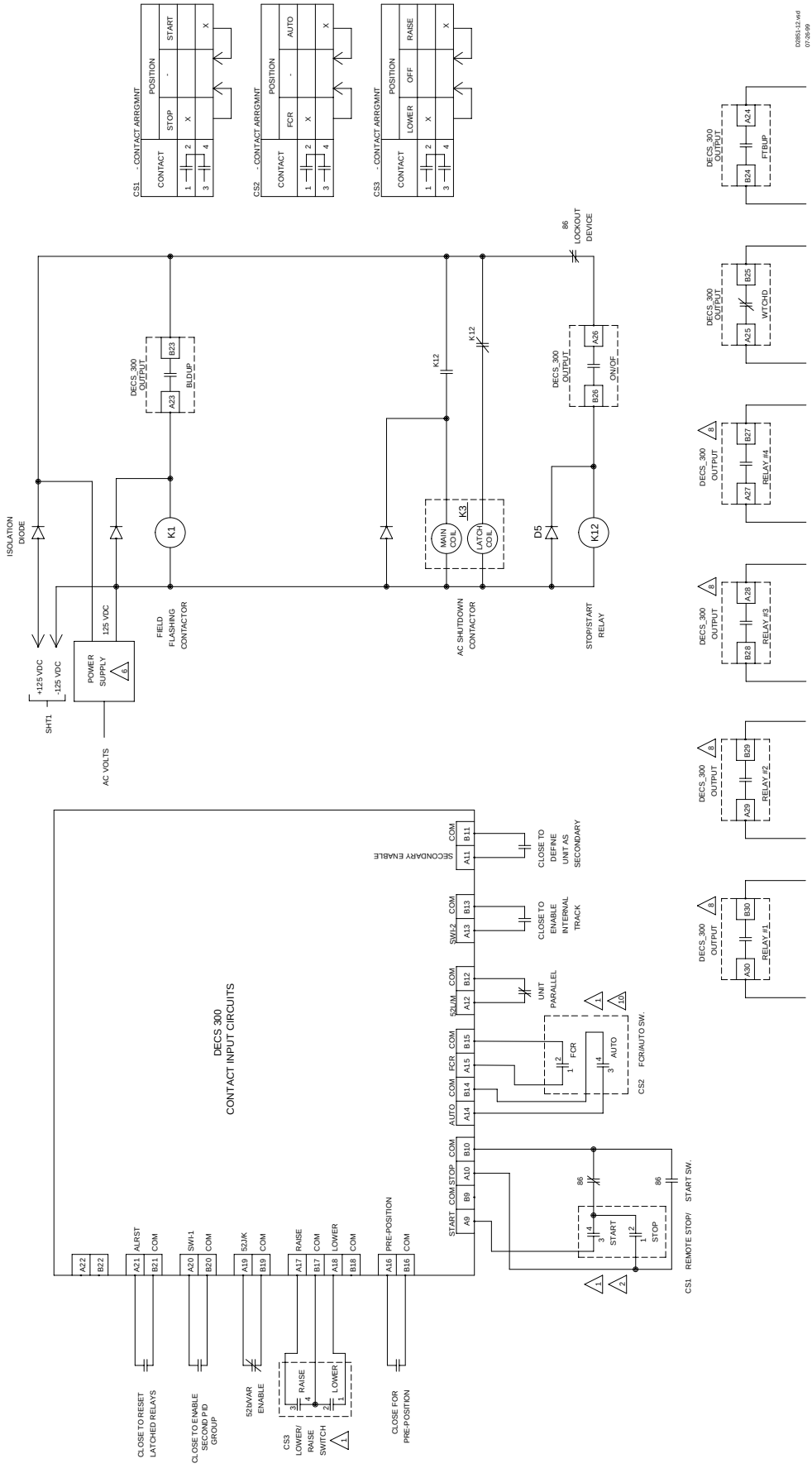

Figure 4-8. Typical AC Connection Diagram For SSE System (Sheet 2 of 2)

Isolation Module Terminations

DECS-300 Isolation Module connections are dependent on the application and excitation scheme. All inputs and outputs may not be used in a given installation. Incorrect wiring may result in damage to the unit.

Refer to Figures 4-7 and 4-8 for typical DECS-300 Isolation Module interconnection diagrams. These diagrams show the 50 millivolt shunt for field current sensing and the field voltage connected to the 125 volt input terminals. Operating voltage for the Isolation Module and analog signals for the field voltage and current are conducted by the cable connected to the 15-pin D-sub connector on the Isolation Module front panel. Refer to Table 4-9 for pin numbers and functions.

COMMUNICATION CONNECTORS AND SETTINGS

Front RS-232 Connector (COM0)

The front RS-232 connector is a DB-9 female connector, and is used for communication with a personal computer. Connector pin numbers, functions, names, and signal directions are shown in Table 4-10. Figure 4-9 provides an RS-232 cable connection diagram.

Table 4-10. RS-232 Pinouts (COM0 And COM1)

Pin	Function	Name	Direction
1	Shield	----	N/A
2	Transmit Data	(TXD)	From DECS
3	Receive Data	(RXD)	Into DECS
4	N/C	----	N/A
5	Signal Ground	(GND)	N/A
6	N/C	----	N/A
7	N/C	----	N/A
8	N/C	----	N/A
9	N/C	----	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-300 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.

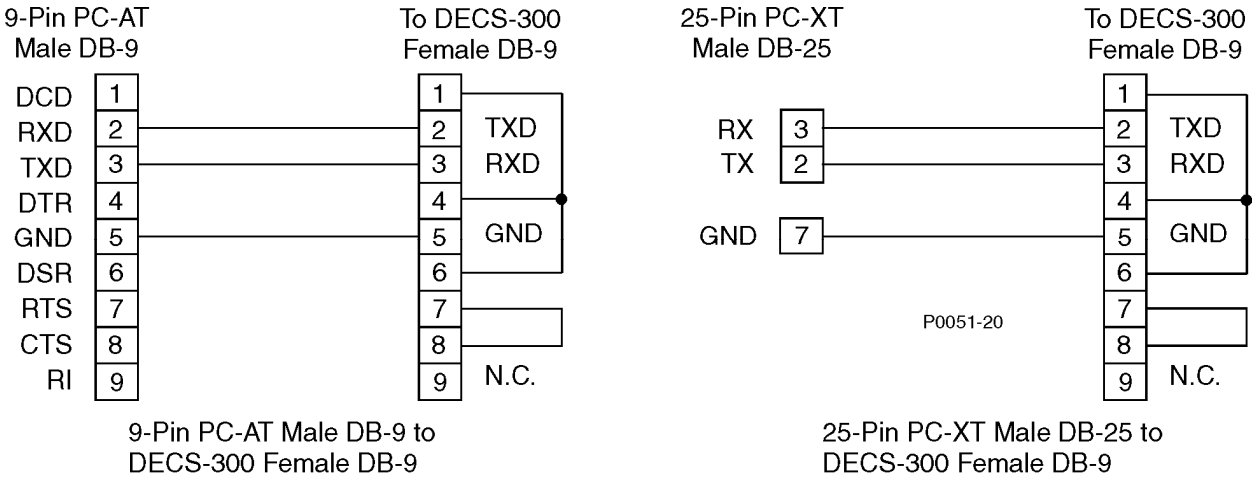

Figure 4-9. Personal Computer To DECS-300

Rear RS-232 Connector (COM1)

The rear RS-232 connector is a DB-9 female connector, and is used for communication with another DECS-300 unit when operating in the redundant system configuration. See Table 4-11 and Figure 4-10 for connector pin numbers, functions, names, and signal directions. A cable, part number 9 3103 00 032, for interconnecting two DECS-300 units is available.

Table 4-11. DECS-300 Interconnection Cable

Pin	Name	Description	Function
1		Not Used	
2	XMIT	Transmit	Sends serial data from DECS-300
3	RCV	Receive	Receives serial data from DECS-300
4	DTR	Data Terminal Ready	Receives a signal that the sending unit is operational
5	GND	Ground	Provides the ground signal
6	DSR	Data Set Ready	Sends a signal that the DECS-300 is operational
7, 8, 9		Not Used	

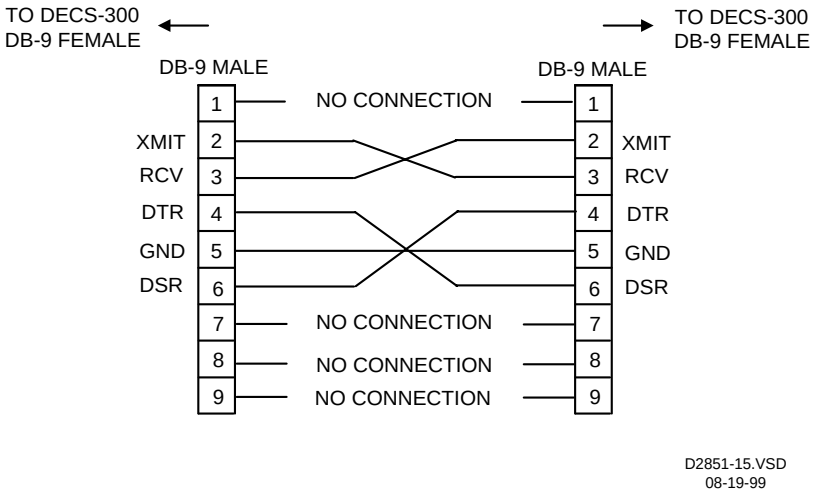

Figure 4-10. DECS-300 Interconnection Cable Diagram

RS-485 Connector (COM2)

The RS-485 connector is a three position terminal block connector designed to interface with local or remote personal computers or other devices. A twisted-pair cable is recommended. Connector pin numbers, functions, names, and signal directions are shown in Table 4-12. A cable connection diagram is provided in Figure 4-11.

Table 4-12. RS-485 Pinouts (COM2)

Terminal	Function	Name	Direction
A6 (A)	Send/Receive A	(SDA/RDA)	In/Out
A7 (B)	Send/Receive B	(SDB/RDB)	In/Out
A8 (C)	Signal Ground	(GND)	N/A

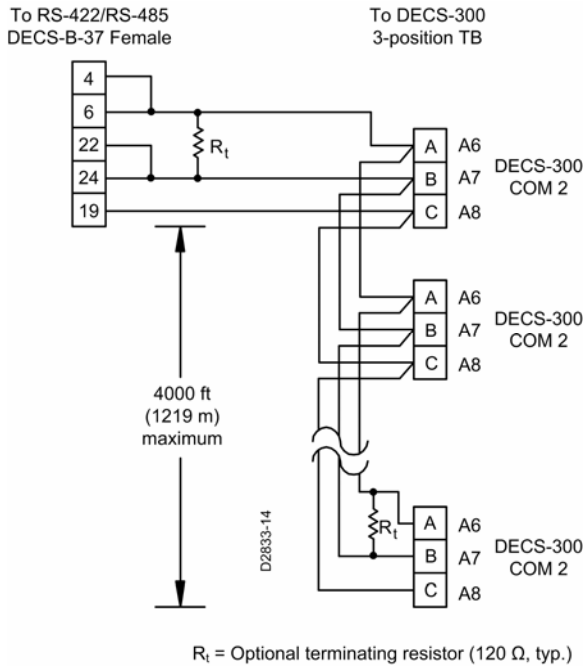

Figure 4-11. RS-485 DB-37 To DECS-300

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SECTION 5 • OPERATION

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SECTION 5 • OPERATION

INTRODUCTION

This section provides a generic setup and operation procedure for excitation systems using the DECS-300 and BESTCOMS-DECS300-32 installed on a personal computer. As such and because we cannot know the specific operating parameters of your system, it is provided only as a guide. For additional information on BESTCOMS, see Section 6, *BESTCOMS Software*.

PREPARATION

You may photocopy these pages as a record and retain them for your files.

Equipment Required

Two channel chart recorder. First channel to measure the generator voltage connected to E1 and E3 on the DECS-300. Second channel to measure field voltage.

Personal computer (PC) and BESTCOMS. For information on complete computer requirements and initializing BESTCOMS communication between the DECS-300 and a PC, see Section 6, *BESTCOMS Software*.

Basler Electric application note #126 is not required, but provides helpful information on paralleling circuits. This application note can be downloaded from the Basler Electric website at www.basler.com. You may also request this application note by contacting the Customer Service department at Basler Electric.

Record System Parameters

Record the specific information for your system in the following spaces.

Generator: _____Vac,_____Hz,_____MW,_____Mvar,_____rpm_____

Full load field voltage main/exciter (as applicable) _____Vdc

Full load field current main/exciter (as applicable) _____Adc

INITIAL TEST SETUP

Each of the menu screens should be evaluated to determine the setup for the unit application before commissioning. **Press enter after each change.**

NOTE

Some screens shown in this document may vary slightly from the BESTCOMS software that is currently provided. Please review each screen carefully.

Configuration Screens

Input the initial settings (parameters) to match your system applications for each of the Configuration screen tabs as shown in the following paragraphs. Review those settings and enable the functions that apply.

System Options

Select the system parameters as applicable. See Figure 5-1 for the first Configuration screen tab, the System Options tab.

- Select Limiter Mode(s)..... _____
- Select Sensing Voltage ..... _____
- Select Field Type..... _____
- Select Bridge Control Signal..... _____
- Enable Internal Tracking ..... _____
- Enable External Tracking ..... _____
- Select Temperature Mode..... _____
- Select Generator Frequency ..... _____
- Select Pre-Position On or Off ..... _____

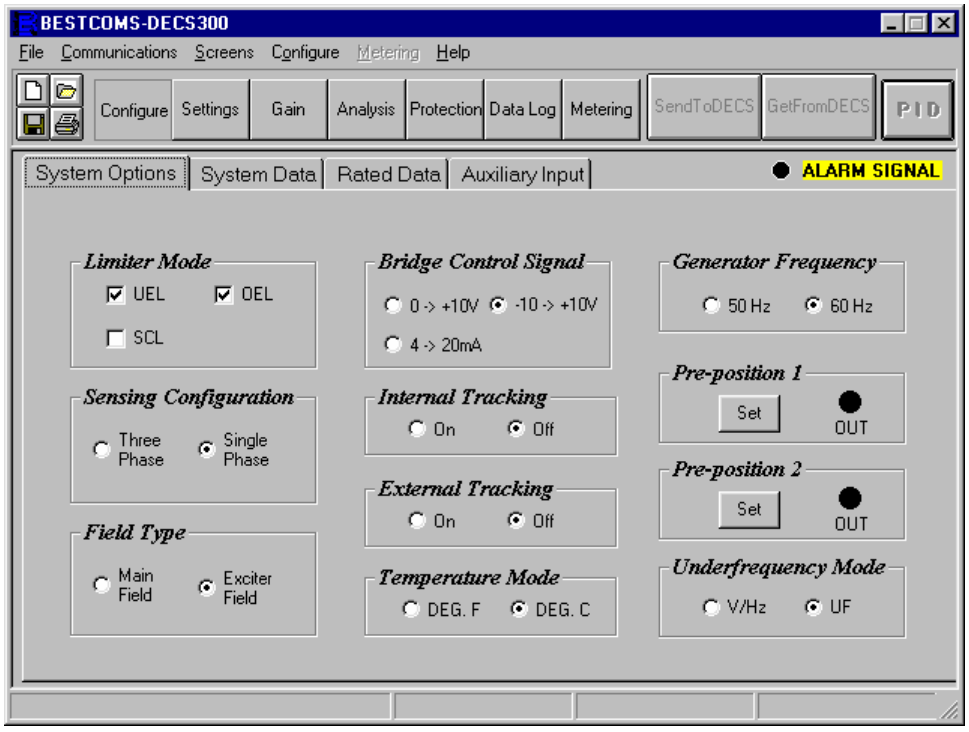

Figure 5-1. Configuration Screen, System Options Tab

Rated Data

Refer to Figure 5-2 for the Rated Data tab. Select the machine rating information as it applies in actual values in all the white fields of the Rated Data tab.

- Generator Power Factor ..... _____
- Generator Voltage ..... _____
- Generator Current ..... _____
- Generator Field Ambient Temperature..... _____
- Generator Brush Voltage Drop..... _____
- Exciter Field Voltage ..... _____
- Exciter Field Current..... _____
- Exciter Field Resistance (ohms)..... _____

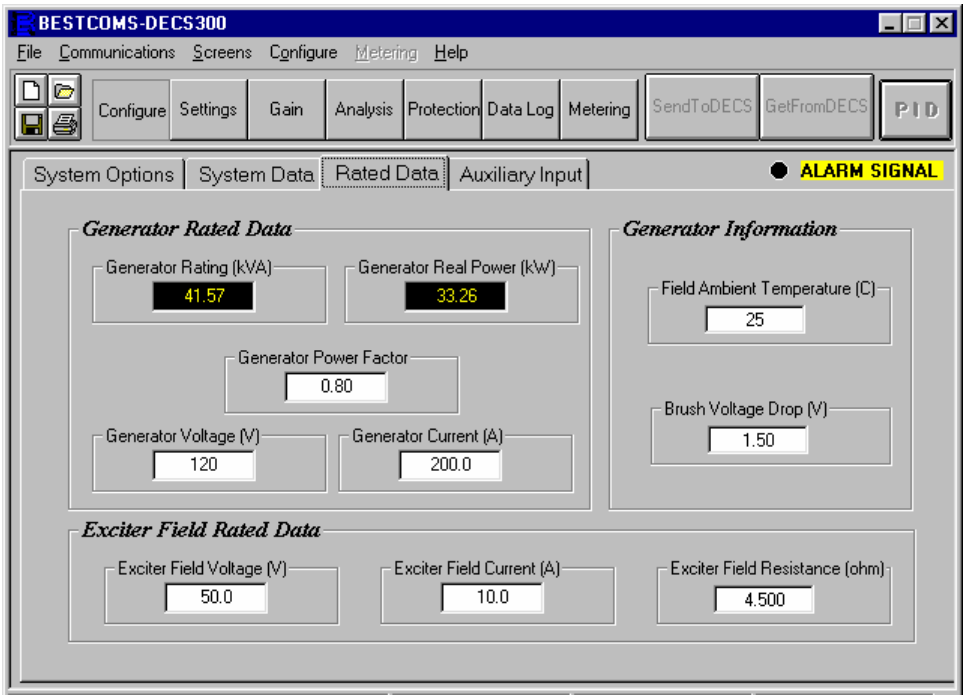

Figure 5-2. Configuration Screen, Rated Data Tab

System Data

Verify that the System Data was entered as shown in the following paragraphs. See Figure 5-3 for the System Data tab.

- Select Generator PT and CT ratios. ..... _____
- Verify if the Bus PT input applies and define the ratio. ..... _____
- Field Voltage Isolation Box Input selection is based upon rectifier bridge voltage. Verify that the appropriate voltage is selected. ..... _____
- A suggested value for the Internal Tracking Delay is one second ..... _____
- A suggested value for the Internal Tracking Traverse Rate is ten seconds ..... _____
- Only redundant DECS units require External Tracking ..... _____

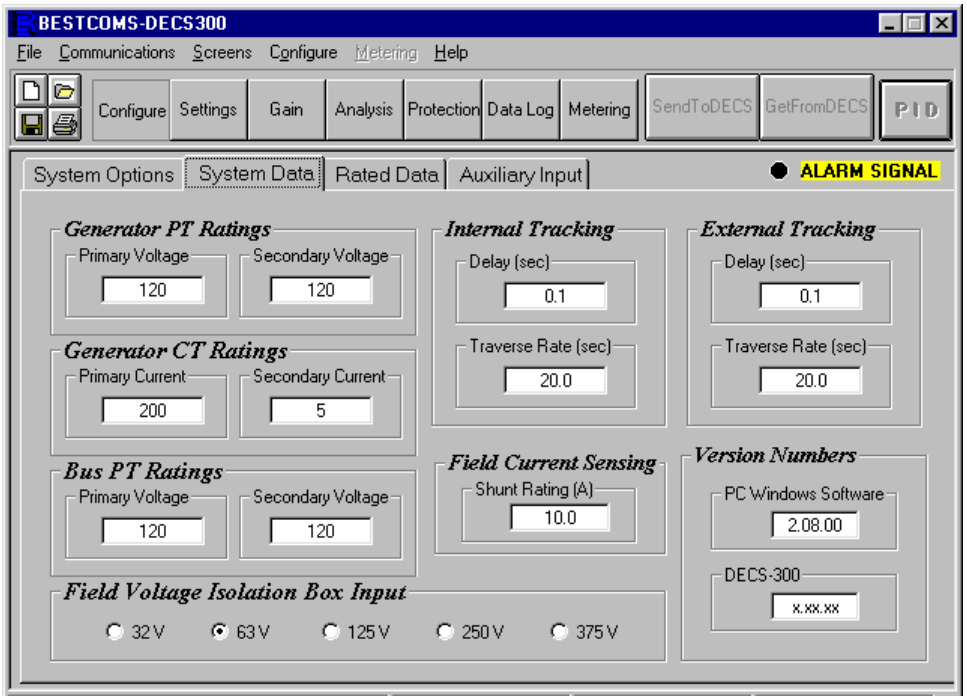

Figure 5-3. Configuration Screen, System Data Tab

Auxiliary Input

Verify that the Auxiliary Input data is entered correctly. See Figure 5-4 for the Auxiliary Input tab.

- Auxiliary Voltage Input Mode..... _____
- Auxiliary Voltage Input Summing Mode. ..... _____
- Auxiliary Voltage Gain ..... _____
- Auxiliary Current Gain ..... _____
- Auxiliary Var Gain..... _____
- Auxiliary Power Factor Gain..... _____
- Reactive Droop..... _____
- Cross Current Compensation Gain ..... _____

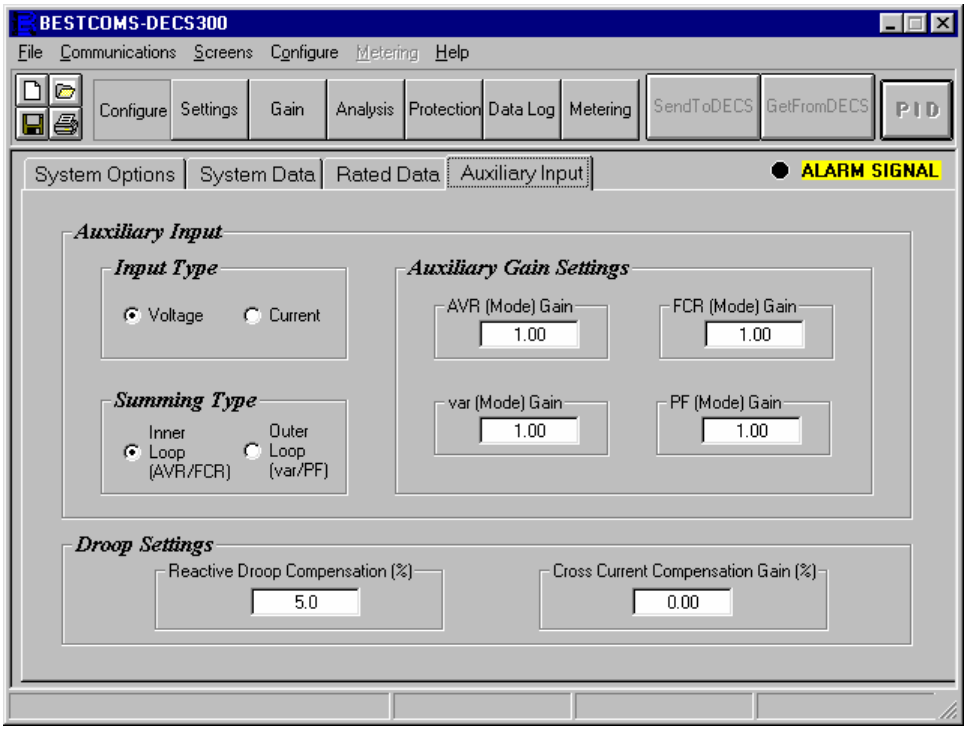

Figure 5-4. Configuration Screen, Auxiliary Input Tab

Settings Screens

Input the initial settings (parameters) to match your system application for each of the Settings screen tabs as shown in the following paragraphs. Review those settings and enable the functions that apply.

AVR/FCR

Identify the setpoints and data required for AVR and FCR and enter the values in the white fields of the AVR/FCR tab. See Figure 5-5 for the AVR/FCR tab. During commissioning, review setpoints unique to starting; especially review those for the FCR (manual) mode where the system would be started at the no-load excitation value or less. If pre-position is used, set the pre-position values as required.

- AVR Setpoint (V). ..... _____
- AVR Min (%). ..... _____
- AVR Max (%). ..... _____
- Pre-position (V). ..... _____
- Traverse Rate (sec) ..... _____
- AVR Pre-position Mode, Maintain or Release ..... _____

- FCR Setpoint (A). ..... _____
- FCR Min (%). ..... _____
- FCR Max (%). ..... _____
- Pre-position (A). ..... _____
- Traverse Rate (sec) ..... _____
- FCR Pre-position Mode, Maintain or Release ..... _____

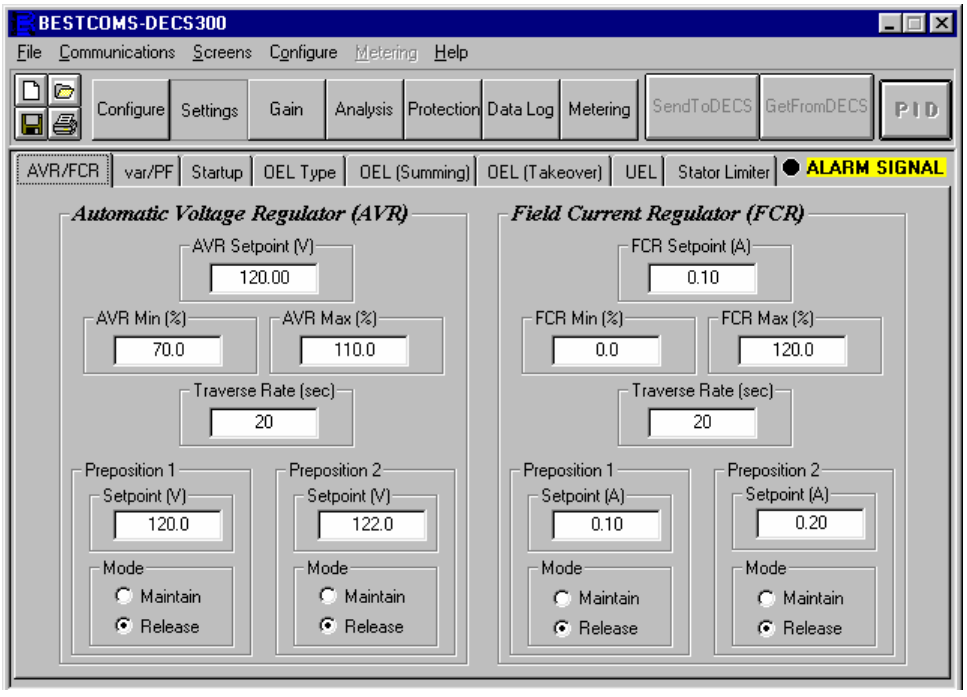

Figure 5-5. Settings Screen, AVR/FCR Tab

Var/PF

Identify the setpoints and data required for var and power factor correction and enter the values in the white fields of the Var/PF tab. See Figure 5-6 for the Var/PF tab. If Var or PF mode is enabled, the setpoint will be active only after transfer occurs into the specific mode because autotracking always forces a null condition to any operating mode.

- VAR Setpoint (kvar)..... _____
- VAR Min (%)..... _____
- VAR Max (%)..... _____
- Pre-position (kvar)..... _____
- Traverse Rate (sec)..... _____
- VAR Pre-position Mode, Maintain or Release..... _____

- PF Setpoint ..... _____
- PF (Leading)..... _____
- PF (Lagging)..... _____
- Pre-position Setpoint ..... _____
- Traverse Rate (sec)..... _____
- PF Pre-position Mode, Maintain or Release ..... _____

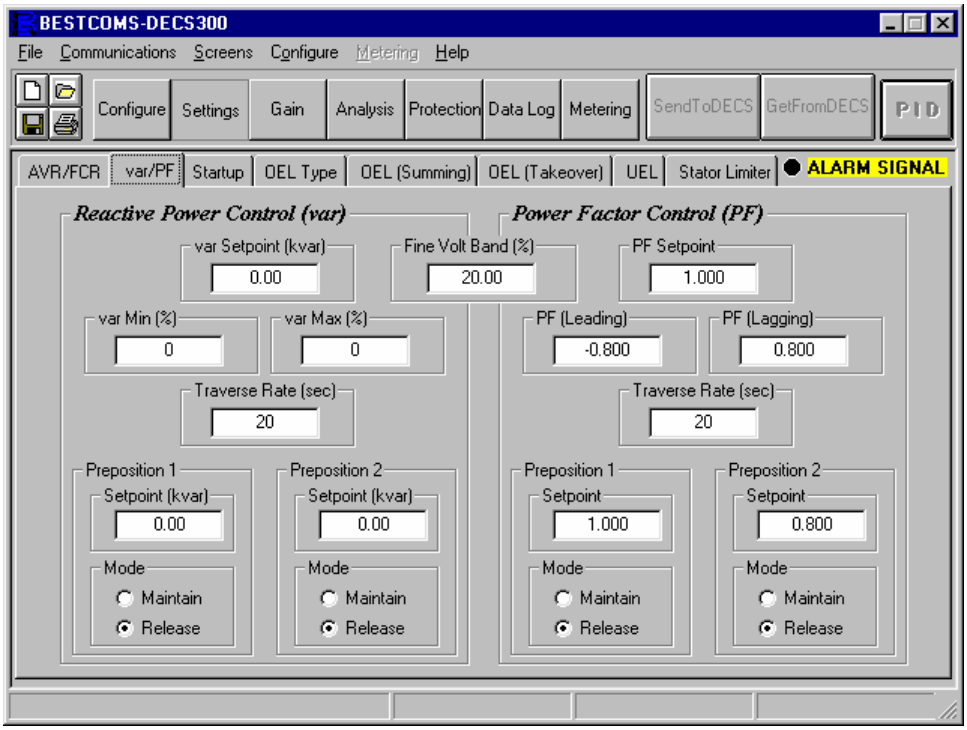

Figure 5-6. Settings Screen, var/PF Tab

Startup

Identify the setpoints and data required for startup and enter the values in the white fields of the Startup tab. See Figure 5-7 for the Startup tab. The following values are only suggested values. If power for the rectifier bridge is derived from a station power source, set the field flash dropout to zero. If voltage matching is utilized, review voltage matching band and PT matching ratio.

- Gen Voltage Soft Start Level (%), 10%. ..... _____
- Gen volt Soft Start Time (sec), 10 seconds..... _____
- Field Flash Dropout Level (%), 50% (See *station power source* reference in the preceding paragraph.). ..... _____
- Max. field flash Time (sec), 10 seconds. ..... _____

- Corner Frequency (Hz), 58 Hz ..... _____
- Slope (Volts/Hz)..... _____

- Fail To Build Up Relay, Momentary or Latched. ..... _____
- Momentary Time (sec)..... _____

- Band (%) ..... _____
- Gen to Bus PT Match Level (%)..... _____

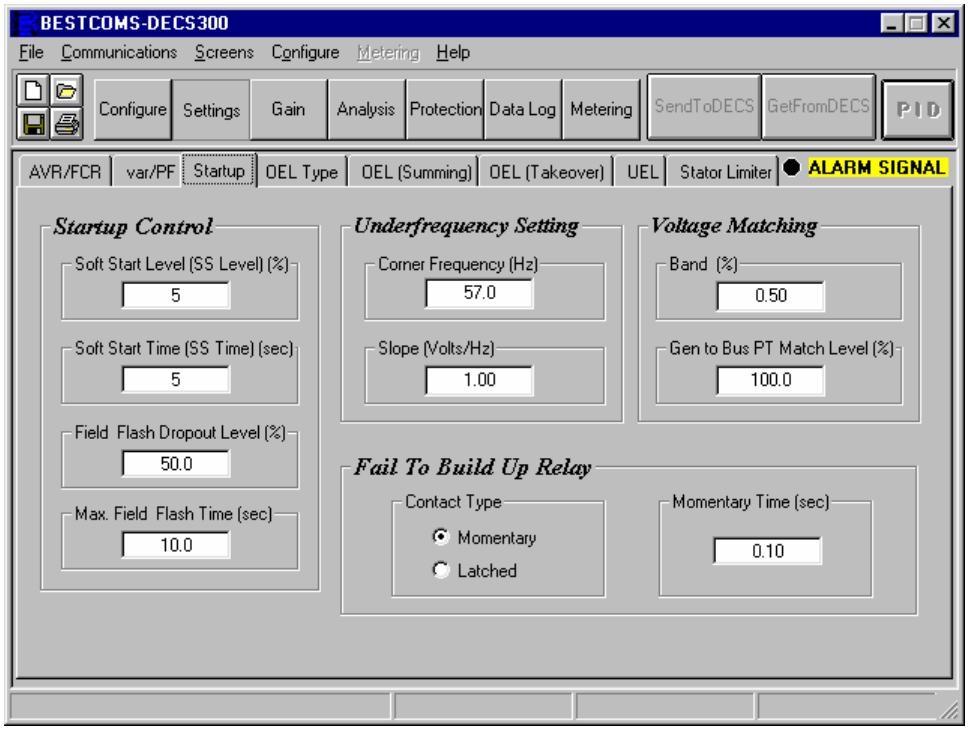

Figure 5-7. Settings Screen, Startup Tab

OEL

Identify the setpoints and data required for Off-Line, OEL and enter the values in the white fields on the OEL (Summing) tab. See Figure 5-8 for the OEL (Summing) tab. Suggested settings for the off-line, no-load field current are: high current - 105% of rated, low current - 105% of rated, and time delay - zero.

- High Current Level (A)..... _____
- High Current time (sec). ..... _____
- Low Current Level (A)..... _____

Review the On-Line, OEL generator field acceptable recommended values. As an alternative, use the following suggested levels and time delays.

- High Current Level (A), 150% of rated field,. ..... _____
- High Current time (sec), three seconds. ..... _____
- Medium Current Level (A), 130% of rated field,. ..... _____
- Medium Current time (sec), ten seconds. ..... _____
- Low Current Level (A), 105% of rated field,.. ..... _____

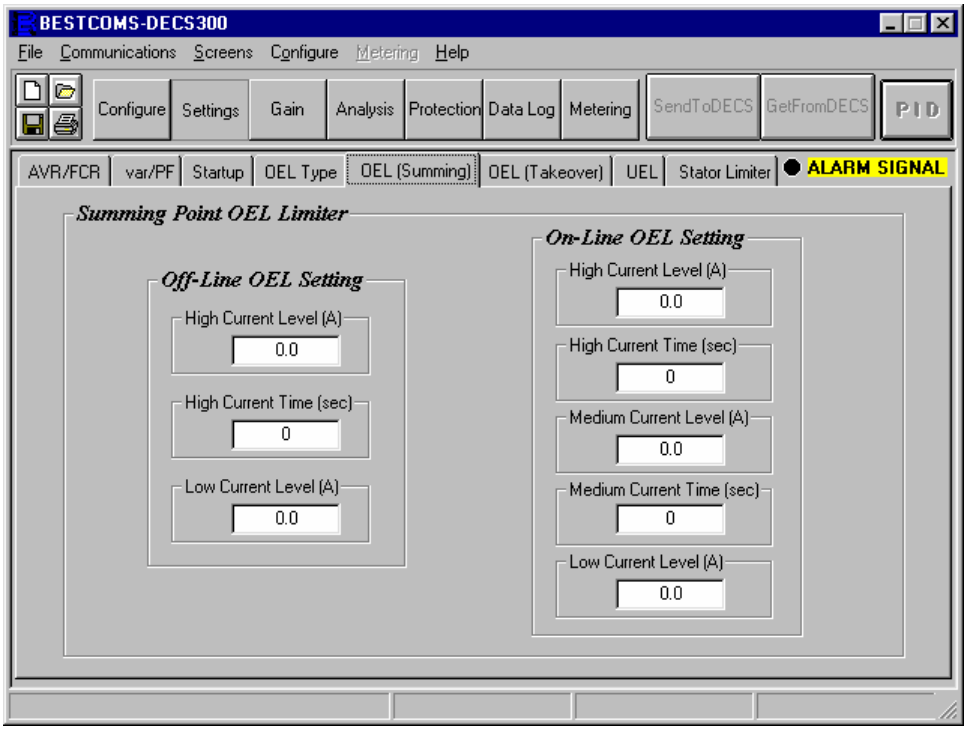

Figure 5-8. Settings Screen, OEL (Summing) Tab

If takeover OEL is being used, identify the high level, low level and time dial setting required for offline OEL. See Figure 5-9 for the OEL (Takeover) tab. Suggested settings are: high level – 105% of rated, low level – 105% of rated, and time dial – 0.1.

- High Current Level (A)..... _____
- Low Current Level (A)..... _____
- Time Dial Setting ..... _____

Review the on-line, OEL generator field acceptable recommended values.

- High Current Level (A)..... _____
- Low Current Level (A)..... _____
- Time Dial Setting ..... _____

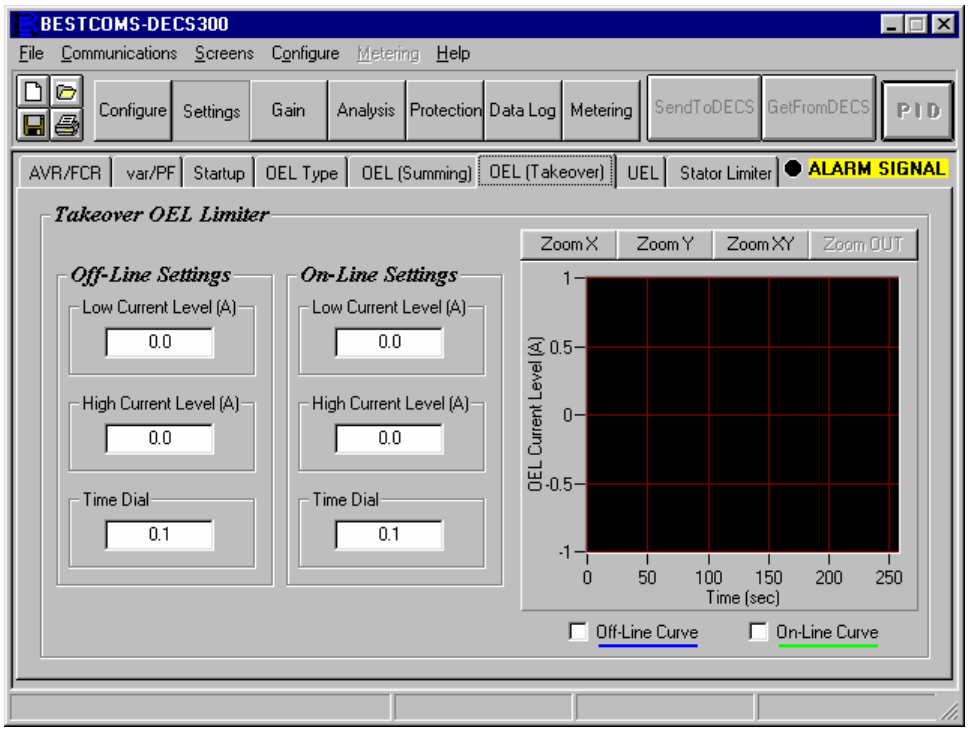

Figure 5-9. Settings Screen, OEL (Takeover) Tab

UEL

Set the UEL value based upon the generator capability curve. If data is not available, select the **Internal** UEL Curve Type Selection. For the Plot 1st Point, it is recommended that you enter a reactive power (kvar) that is approximately 20% less than the generator rating.

Stator Current Limiter

Identify the setpoints and data required for stator current limit and enter the values in the white fields on the Stator Limiter tab. See Figure 5-10 for the Stator Limiter tab.

- High SCL Current Level (A)..... _____
- High SCL Current Time (sec)..... _____
- Low SCL Current Level (A) ..... _____

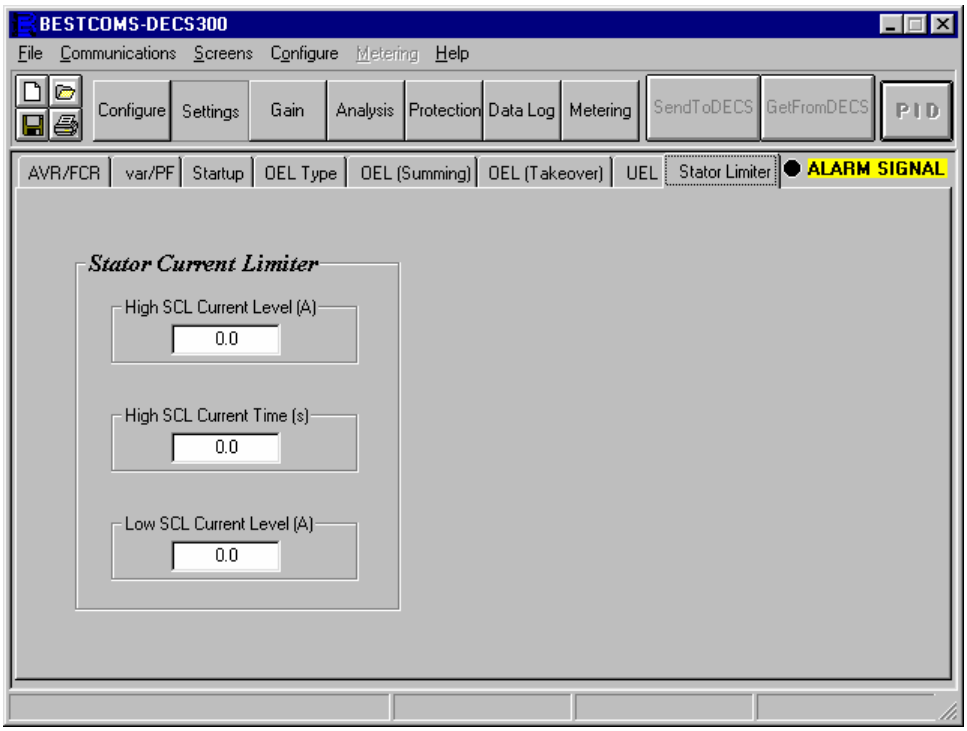

Figure 5-10. Settings Screen, Stator Current Limiter Tab

Protection Options

Determine the functions that apply to the excitation system. Some of the devices may be discrete modules in the excitation cabinet. Review carefully. See Figure 5-11 for the Protection Options tab.

- Generator Overvoltage, Enable or Disable ..... _____
- Generator Undervoltage, Enable or Disable. ..... _____
- Field Overvoltage, Enable or Disable ..... _____
- Field Overcurrent, Enable or Disable ..... _____
- Field Overtemperature, Enable or Disable ..... _____
- Loss of Field, Enable or Disable ..... _____
- Loss of Sensing Voltage, Enable or Disable ..... _____
- Loss of Sensing, Time Delay (sec) ..... _____
- Loss of Sensing, Balance Level (%) ..... _____
- Loss of Sensing, Unbalance Level (%) ..... _____
- Transfer To FCR Mode, Enable or Disable ..... _____

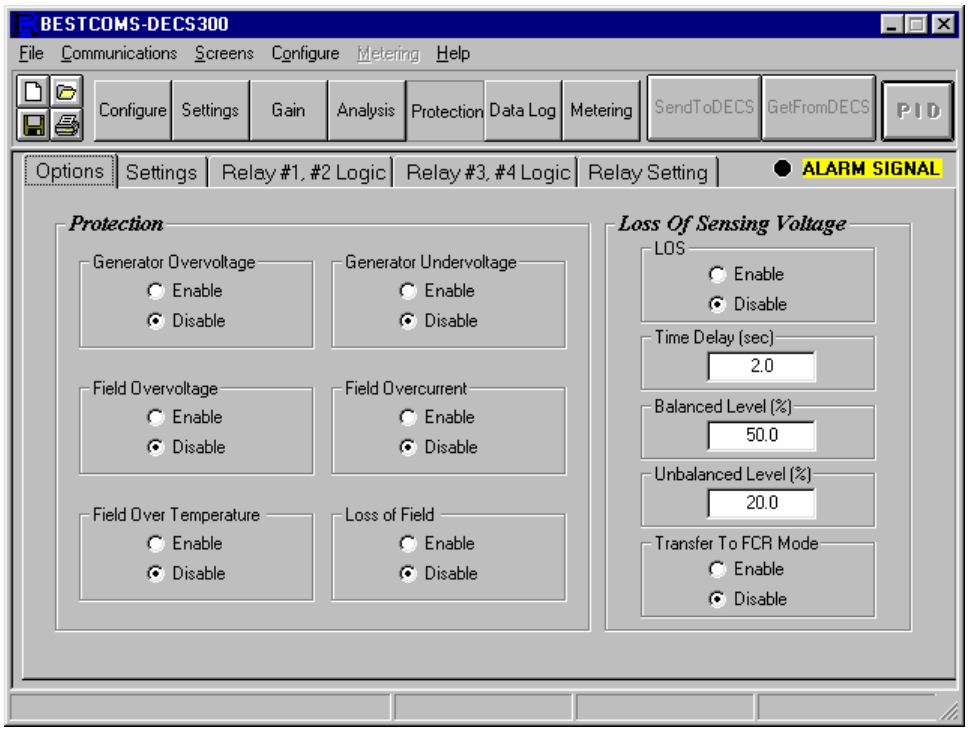

Figure 5-11. Protection Screen, Options Tab

Protection Settings

Determine protective level settings as needed and applicable for your system. Some of the devices may be discrete modules in the excitation cabinet, e.g., loss of voltage sensing relay. Review carefully. See Figure 5-12 for the Protection Settings tab.

- Generator Overvoltage (V) ..... _____
- Generator Undervoltage (V). ..... _____
- Field Overvoltage (V) ..... _____
- Field Overcurrent (A) ..... _____
- Field Overtemperature setpoint (degrees) ..... _____
- Field Overtemperature Time Delay (sec) ..... _____
- Loss of Field (kvar) ..... _____
- Generator Overvoltage (sec) ..... _____
- Generator Undervoltage (sec). ..... _____
- Field Overvoltage (sec) ..... _____
- Field Overcurrent Time Dial ..... _____
- Loss of Field Time Delay (sec) ..... _____

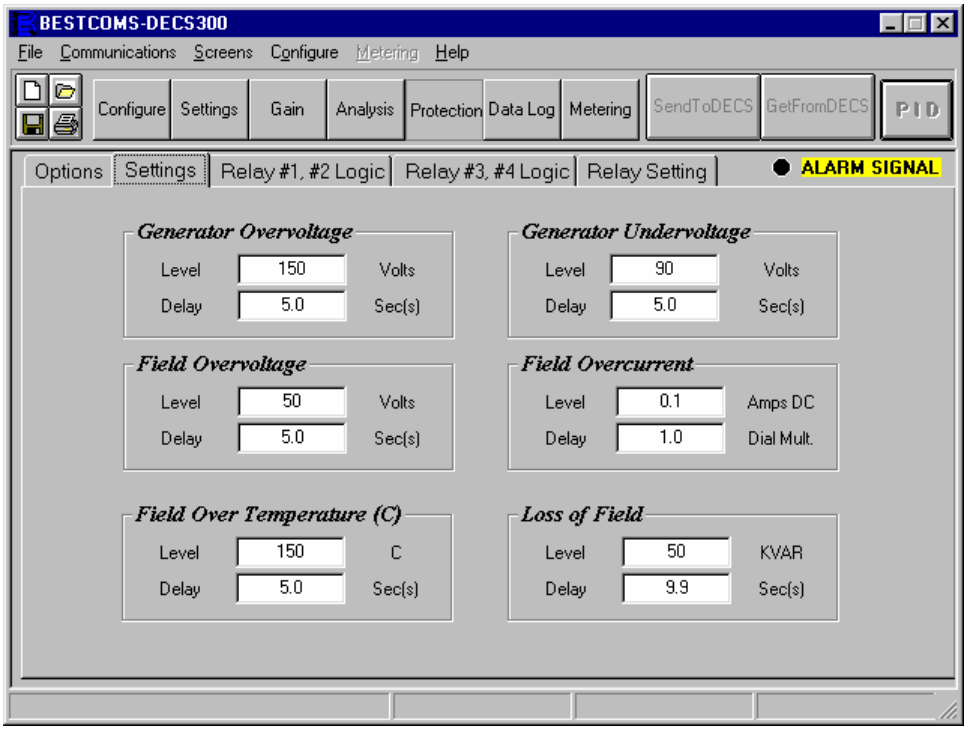

Figure 5-12. Protection Screen, Settings Tab

Relay Logic

Review the interconnection drawing and verify relay format setup. See Figure 5-13 for the Relay Logic #1, #2 tab. Relay #3, #4 Logic tab is identical to the Relay #1, #2 Logic tab and is not shown.

Output Relay # 1 Options

- Generator Overvoltage ..... _____
- Generator Undervoltage ..... _____
- Loss Of Sensing Voltage ..... _____
- Field Overvoltage ..... _____
- Field Overcurrent ..... _____
- Field Overtemperature ..... _____
- System Below 10 Hz ..... _____
- Setpoint Limit, Upper ..... _____
- Setpoint Limit, Lower ..... _____
- FCR Mode ..... _____
- Limit, Overexcitation ..... _____
- Limit, Underexcitation ..... _____
- Limit, UF or V/Hz ..... _____
- Limit, Stator Current ..... _____
- Loss of Field ..... _____

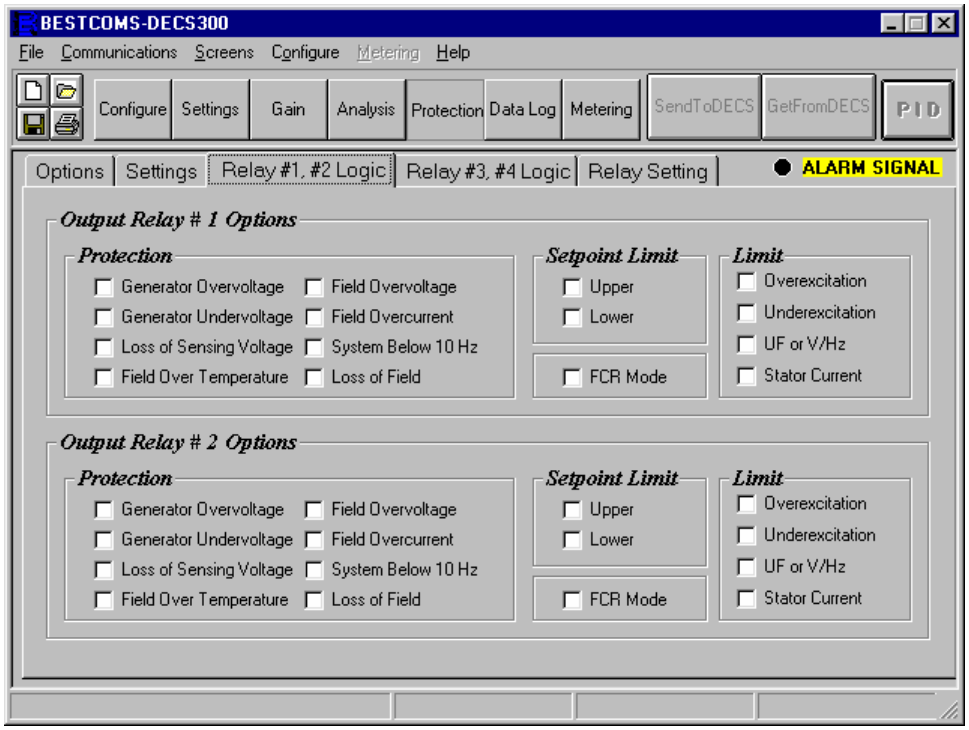

Figure 5-13. Protection Screen, Relay #1, #2 Logic Tab

Output Relay # 2 Options

- Generator Overvoltage ..... _____
- Generator Undervoltage ..... _____
- Loss Of Sensing Voltage ..... _____
- Field Overvoltage ..... _____

- Field Overcurrent ..... _____
- Field Overtemperature ..... _____
- System Below 10 Hz ..... _____
- Setpoint Limit, Upper ..... _____
- Setpoint Limit, Lower ..... _____
- FCR Mode ..... _____
- Limit, Overexcitation ..... _____
- Limit, Underexcitation ..... _____
- Limit, UF or V/Hz ..... _____
- Limit, Stator Current ..... _____
- Loss of Field ..... _____

Output Relay # 3 Options

- Generator Overvoltage ..... _____
- Generator Undervoltage ..... _____
- Loss Of Sensing Voltage ..... _____
- Field Overvoltage ..... _____
- Field Overcurrent ..... _____
- Field Overtemperature ..... _____
- System Below 10 Hz ..... _____
- Setpoint Limit, Upper ..... _____
- Setpoint Limit, Lower ..... _____
- FCR Mode ..... _____
- Limit, Overexcitation ..... _____
- Limit, Underexcitation ..... _____
- Limit, UF or V/Hz ..... _____
- Limit, Stator Current ..... _____
- Loss of Field ..... _____

Output Relay # 4 Options

- Generator Overvoltage ..... _____
- Generator Undervoltage ..... _____
- Loss Of Sensing Voltage ..... _____
- Field Overvoltage ..... _____
- Field Overcurrent ..... _____
- Field Overtemperature ..... _____
- System Below 10 Hz ..... _____
- Setpoint Limit, Upper ..... _____
- Setpoint Limit, Lower ..... _____
- FCR Mode ..... _____
- Limit, Overexcitation ..... _____
- Limit, Underexcitation ..... _____
- Limit, UF or V/Hz ..... _____
- Limit, Stator Current ..... _____
- Loss of Field ..... _____

Relay Settings

Review the relay contact configuration and select relay settings. See Figure 5-14 for the Relay Setting tab.

Relay # 1 Settings

- Contact Status, Normally Open or Normally Closed ..... _____
- Contact Type, Momentary, Maintained, or Latched . ..... _____
- Momentary Time (sec)..... _____

Relay # 2 Settings

- Contact Status, Normally Open or Normally Closed ..... _____
- Contact Type, Momentary, Maintained, or Latched . ..... _____
- Momentary Time (sec)..... _____

Relay # 3 Settings

- Contact Status, Normally Open or Normally Closed ..... _____
- Contact Type, Momentary, Maintained, or Latched . ..... _____
- Momentary Time (sec)..... _____

Relay # 4 Settings

- Contact Status, Normally Open or Normally Closed ..... _____
- Contact Type, Momentary, Maintained, or Latched . ..... _____
- Momentary Time (sec)..... _____

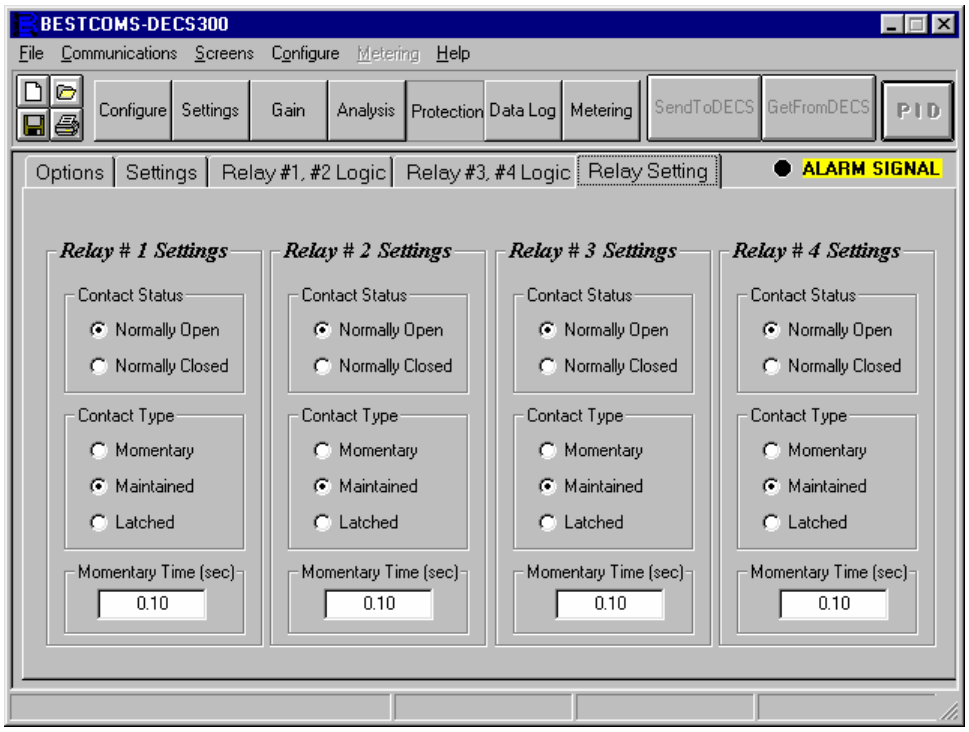

Figure 5-14. Protection Screen, Relay Setting Tab

This concludes the DECS-300, Initial Test Setup using the BESTCOMS-DECS300-32 software. Save the information into the non-volatile memory by clicking the SendToDECS button.

OFF-LINE TESTS, TURBINE NOT SPINNING

For these tests, control of the machine is to be demonstrated via the PC, front panel human-machine interface (HMI) display, and customer remote switches. These tests are to ensure that the machine is not stressed because of incorrect wiring or faulty components. Recommended settings are only temporary, initial settings.

Start/Stop Tests

Check the operation of the following start and stop switches.

- Start/Stop from the BESTCOMS, Metering screen Operation tab (see Figure 5-15 for the Operation tab)..... _____
- Start/Stop from DECS front panel HMI ..... _____
- Start/Stop from remote switches ..... _____

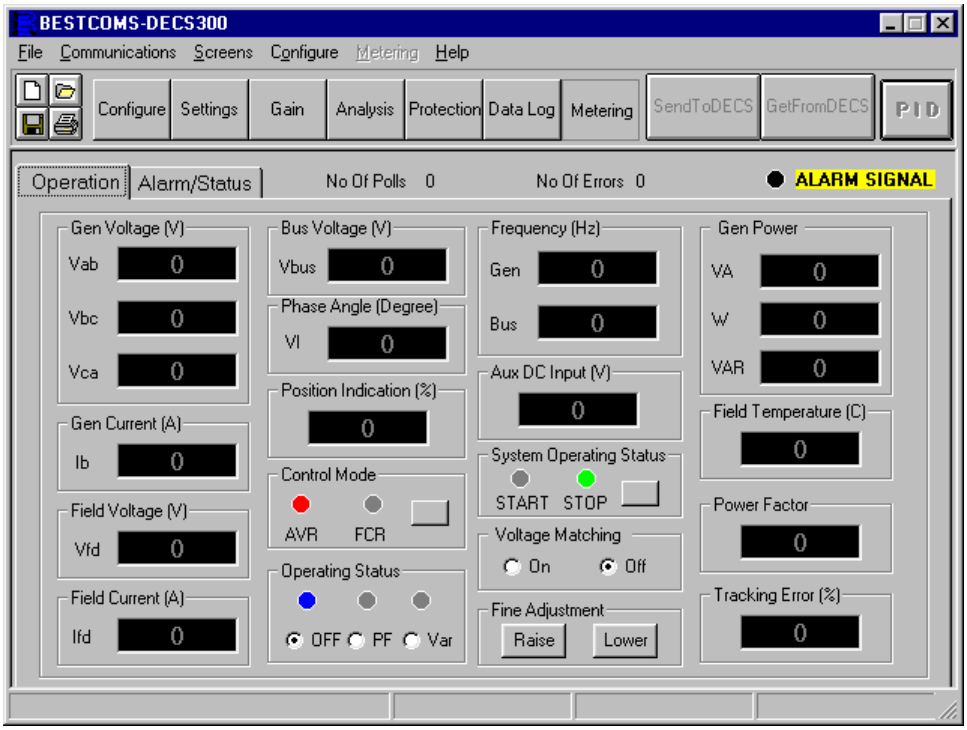

Figure 5-15. Metering Screen, Operation Tab

WARNING!

Field flash current is used in the following steps. Even though the turbine is not moving, serious injury from stator induced high voltages could result during the field start/stop test. Verify that all personnel are clear of the machine before testing the start procedure. To insure personnel safety, the field flash fuses may be removed and only the unit start/stop capabilities checked.

- Verify field flash and shutdown occurs with the start and stop functions..... _____
- Verify Alarms for fail to build voltage if field flashing is used . ..... _____
- Verify remote status, front panel HMI, and BESTCOMS as appropriate for alarms..... _____
- With the excitation OFF, check AVR/FCR transfer from the front panel HMI, remote switches, and BESTCOMS if applicable ..... _____
- Verify transfer indications from the remote status, front panel HMI, and BESTCOMS..... _____
- Check raise/lower limits..... _____
- Verify raise/lower limit indications from the remote status, front panel HMI, and BESTCOMS as appropriate. ..... _____

NOTE

For station powered systems, field flash is not used. When the system is energized with the field connected, the field current will build to the value specified on the FCR setting screen. During this test, the suggested setting for the no load field current is 20% and the FCR K_G gain is 1,000. Verify that the system is stable.

Control Gain Settings

Perform Active Settings Group (green background fields) gain settings.

- Set generator no-load setpoint in FCR mode (use the AVR/FCR tab of the Settings screen), recommend 20% of exciter rated current ..... _____

For the following settings, click the *Gain* button to view the Control Gain tab (Figure 5-16). Table 5-1 lists the recommended PID settings for exciter and static exciter installations.

Table 5-1. Recommended Settings for Exciter And Static Exciter Installations

PID Setting	Static Exciter		Exciter	
	AVR	FCR	AVR	FCR
KP	80		80	
KI	20		15	
KD			40	
KG	15	1000	15	1000
TD	0.01	0.01	0.01	0.01

Find the Proportional Gain KP green background window on the screen.

- Set Proportional Gain KP setting ..... _____

Find the KD <= Derivative Gain => TD green background windows on the screen.

- Set TD filter setting ..... _____

Find the AVR <= Loop Gain Kg => FCR green background windows on the screen.

- Set FCR, Loop Gain K_g setting ..... _____

Recommended settings for OEL

- Set $K_I = 3$ ..... _____
- Set $K_G = 1$ ..... _____

Recommended settings for UEL

- Set $K_I = 10$ ..... _____
- Set $K_G = 1$ ..... _____

Recommended settings for var/PF

- Set $K_I = 10$ ..... _____
- Set $K_G = 1$ ..... _____

Recommended settings for SCL

- Set $K_I = 10$ ..... _____
- Set $K_G = 1$ ..... _____

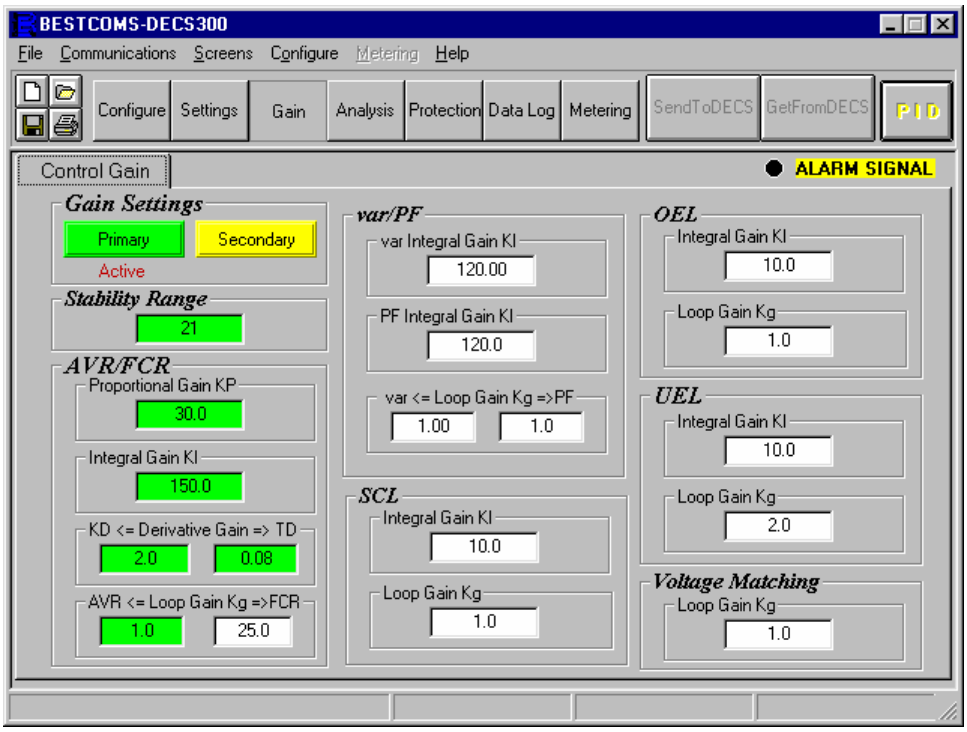

Figure 5-16. Gain Screen, Control Gain Tab

PID Settings

From the Control Gain screen, click the PID button on the menu tool bar to view the PID window. Use the PID window to select the correct PID values based upon generator time constant, T'_{do}, and exciter time constant T_e as applicable. See Figure 5-17 for the PID window and Section 6, *BESTCOMS Software, PID Window*, for more information on PID settings.

- Verify transfer indications from the remote status, front panel HMI, and BESTCOMS..... _____

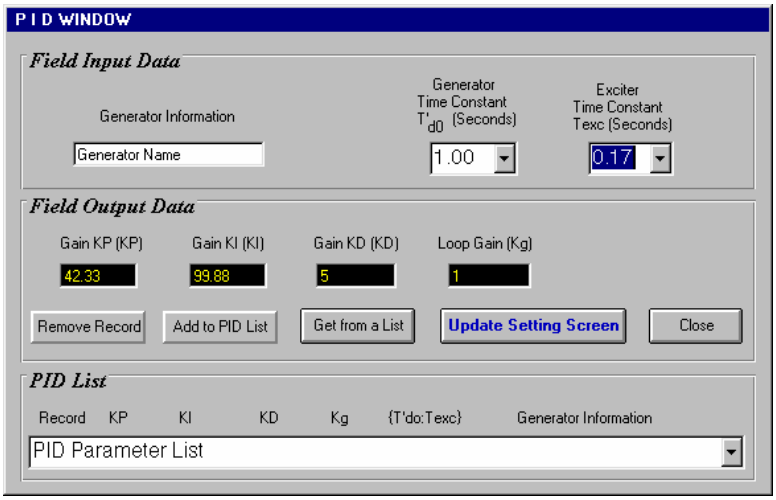

Figure 5-17. PID Window

OFF-LINE TESTS,-TURBINE SPINNING

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

WARNING!

Field flash current is used in the following steps. Even though the turbine is not moving, serious injury from stator induced high voltages could result during the field start/stop test. Verify that all personnel are clear of the machine before testing the start procedure. To insure personnel safety, the field flash fuses may be removed and only the unit start/stop capabilities checked.

FCR Mode

Initial testing should begin in the manual (FCR) mode and minimum generated voltage.

- Place DECS-300 in FCR mode ..... _____
- Position the start/stop switch to start position ..... _____
- Generator voltage should build to a percentage of rated voltage ..... _____
  (FCR setpoint was set to 20% of the exciter field rated current in a previous step.)
- Increase the exciter field rated current to 75% of rated ..... _____
- Generator voltage should build to a percentage of rated voltage ..... _____
- Check field voltage with scope for proper output, (2.8 ms) ..... _____
  (See current balance firing circuit waveform in Figure 5-18.)

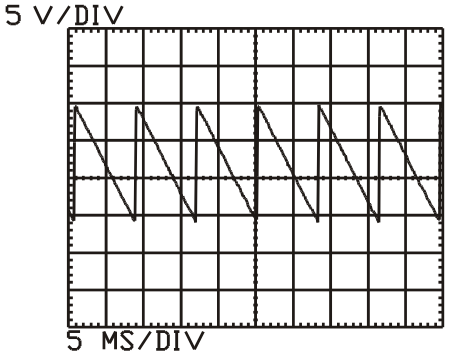

Figure 5-18. Field Voltage Output Waveform

- Meter for correct voltages at input to voltage sensing (E1, E2, E3) ..... _____
- Measure for PPT (P1, P2, P3) secondary voltages ..... _____
  (See Table 5-2 for correct secondary voltages at transformer output.)

Table 5-2. PPT Secondary Voltages

Rectifier DC Voltage	PPT AC Secondary Voltage
63	80
125	160
250	360
375	480

- Using the raise/lower control, raise terminal voltage incrementally to rated voltage ..... _____
- Position the excitation switch to Stop ..... _____
- Position the excitation switch to Start to start the generator again in **FCR** mode ..... _____
- Record the voltage buildup characteristic on the system as it reaches full rated output ..... _____
- Perform step response in FCR mode ..... _____
- Using the Analysis Screen, perform a 5% step change in FCR mode ..... _____
- Decrease value first, then increase ..... _____
  (Observe stable performance with chart recorder.)
- Note the overshoot and settling time ..... _____
  (The FCR output should be very stable.)

In the following test, be ready to transfer back to FCR if there is a problem.

- Check that autotracking AVR follows FCR, then transfer ..... _____
  (Monitor the tracking meter during this test on the PC Metering Screen and note that the tracking meter is stable before transferring. The green LED on the DECS-300 should be ON continuous. If the Pre-position is enabled, the setpoint will first go to the assigned value. The Pre-position may need to be disabled for this test.)

NOTE

In the following check, if the Pre-position is enabled, the setpoint will go to the assigned value first.

- Check that autotracking FCR follows AVR, then transfer ..... _____
- Use a chart recorder, and perform step response in AVR mode ..... _____
- Review the PID numbers ..... _____
- On Configuration screen, turn limiters OFF ..... _____
- Perform a 2% voltage step response and record performance to verify stability ..... _____
- Adjust the PID on the controller until performance is achieved. If performance appears stable, repeat with 5% step changes ..... _____

Tuning Suggestion

Assuming the T'_{do} (main field) and T_e (exciter field) is known (as applicable for main field static exciter or exciter field voltage regulator application), increasing K_G will speed the response time of the generator. See Figure 5-19.

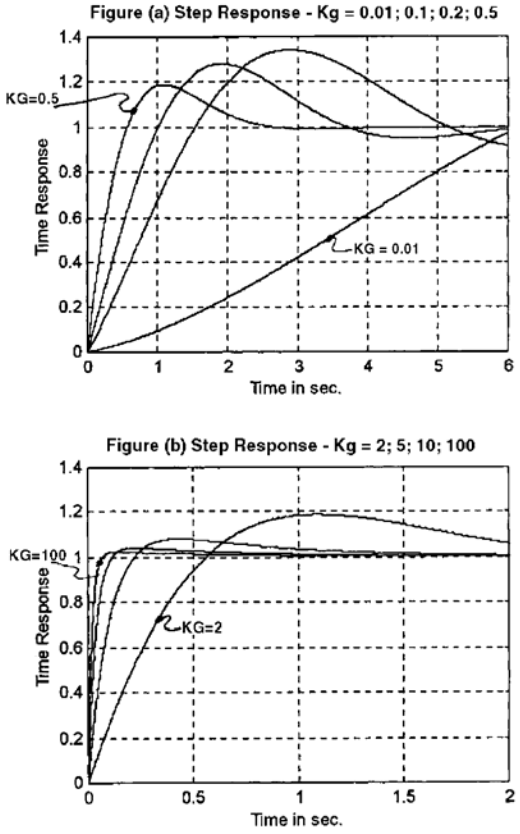

Figure 5-19. K_G Gain Effect on Generator Performance

- Save settings to EEPROM ..... _____

When individual adjustment is needed to further refine performance, Figures 5-20, 5-21, and 5-22 demonstrate the effect that the PID changes have for additional control. These figures all have a one second major division.

In Figure 5-21, the generator voltage exhibits one underdamp (overshoot) and one underdamp (undershoot) before settling. The total time is too long (five seconds). Here the K_P (Proportional Gain) needs to be increased.

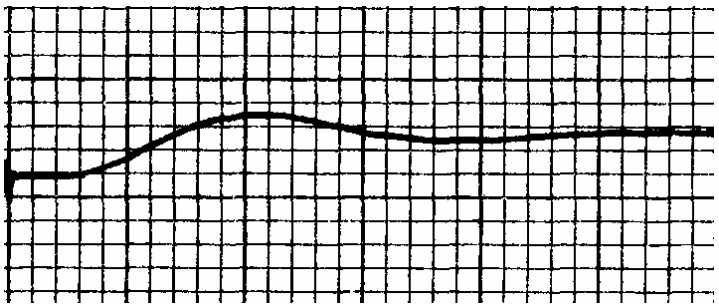

Figure 5-20. Insufficient Proportional Gain

Figure 5-21 demonstrates that the terminal voltage has prolonged instability after a voltage step change because there is too much integral gain (I). Integral gain value needs to be decreased.

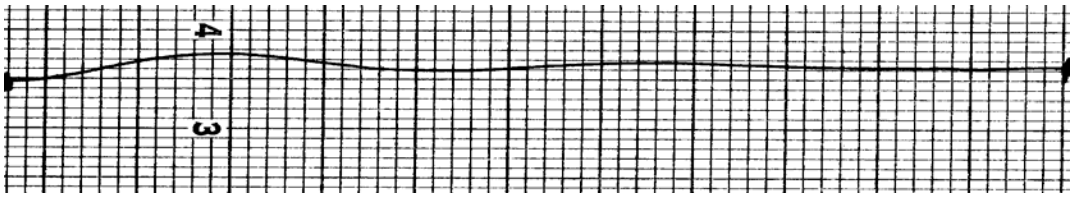

Figure 5-21. Prolonged Instability

Less voltage overshoot is desired, K_D (Derivative gain is increased). See Figure 5-22.

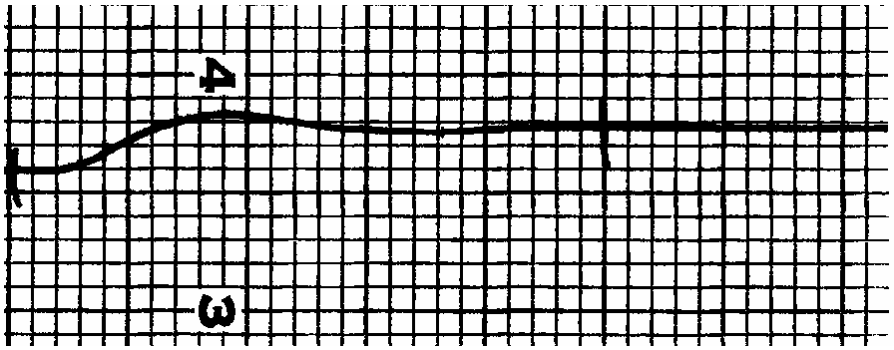

Figure 5-22. Insufficient Derivative Gain

See Figure 5-23 for the final solution. Increased K_D (Derivative gain), decreases voltage overshoot

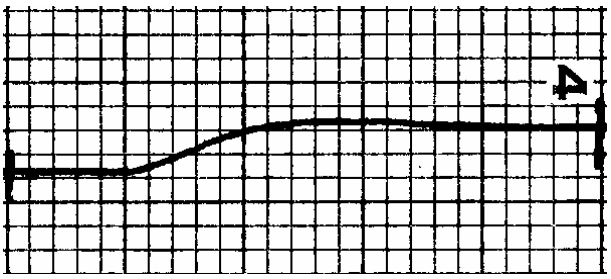

Figure 5-23. Final Solution Step Response

- Position the Start/Stop Switch to stop ..... _____
- Set system to AVR mode ..... _____
- Monitor generator voltage soft start time..... _____
- Position the Start/Stop Switch to Start ..... _____
- Raise terminal voltage to setpoint ..... _____

EXCITATION PERFORMANCE EVALUATION

In this performance evaluation, we are going to temporarily set values that will enable us to test the excitation performance without stressing the machine or exceeding ancillary protection devices. Procedures are provided that will allow you to set your final operating values. This evaluation is a continuation of the previous tests.

Off-Line Excitation Limiter Operation

In this test, with the generator set below the rated voltage output, you will set the AVR setpoint above the maximum setting and the system should alarm. If the system does not alarm, the OEL gain, (K_I and K_G) may be set too low. If the system does alarm and oscillates, the OEL gain, (K_I and K_G) may be set too high.

- Enable off-line OEL (overexcitation limiter)..... _____
- Determine the field current required to reach 105% of the rated generator voltage..... _____
- Set off-line OEL for a value equal to the no load field current ..... _____
- Lower terminal voltage to 10% below rated ..... _____

To speed performance in the following test, you may increase the OEL gain, K_I and K_G terms.

- Using the BESTCOMS, Settings screen for AVR, set the AVR setpoint to 110% of the rated output. (AVR Max should remain at 105%.)..... _____
- If an output relay is programmed to alarm, the alarm, BESTCOMS, the front panel HMI, and any remote devices should indicate the alarm status. ..... _____
- Return (set) the AVR setpoint to the rated output. ..... _____

Limit and Protection Check

In this test, you will exercise the generator over and undervoltage protection and the field overvoltage and overcurrent protection.

- Review the overvoltage protection settings in the BESTCOMS, Protection screens ..... _____
- Reduce the Generator Overvoltage Level setpoint to the alarm threshold..... _____
- Verify all alarms and annunciation function as programmed ..... _____
- Reset Generator Overvoltage Level setpoint back to final value..... _____

- Raise the Generator Undervoltage Level setpoint to the alarm threshold..... _____
- Verify all alarms and annunciation function as programmed ..... _____
- Reset Generator Undervoltage Level setpoint back to final value..... _____

- Reduce the Field Overvoltage Level setpoint to the alarm threshold ..... _____
- Verify all alarms and annunciation function as programmed ..... _____
- Reset Field Overvoltage Level setpoint back to final value ..... _____

- Reduce the Field Overcurrent Level setpoint to the alarm threshold..... _____
- Verify all alarms and annunciation function as programmed ..... _____
- Reset Field Overcurrent Level setpoint back to final value..... _____

Parallel Operation, Generator On Line

In this test, we will connect the generator to the bus and check for phase relationship between the current and the sensed voltage. If the CT has the wrong polarity, a shorting terminal block can be used to reverse the CT polarity. If sensed voltage has the wrong phasing, the generator breaker must be opened and the generator must be shutdown in order to reverse the voltage sensing polarity. After the phase relationship is verified as correct, we will exercise the over and underexcitation limit protection, plus var and power factor performance evaluations at values that will not stress the machine, but still verify their functioning.

For more information on paralleling circuits, contact Basler Electric, Customer Service personnel at the Highland, Illinois facility, and ask for Application Note #126, dated October 1997.

Phase Relationship Test

- Transfer to FCR mode ..... _____
- Parallel the generator to bus ..... _____
- Set machine kilowatts for approximately 25% of machine rating at zero vars ..... _____
- Check for phase shift at input to DECS-300 between voltage sensing and B-phase current. B-phase current should lag the sensed voltage between E1 and E3 by 90° ..... _____
- If phase relationship is correct, proceed with testing. If phase relationship is not correct, troubleshoot the system, resolve the problem and retest as appropriate before transferring to AVR mode. ..... _____
- Verify that AVR is nulled to FCR ..... _____
- Verify that all null status indicators provide the null indication ..... _____
- Verify that AVR Pre-Position Mode is disabled or external pre-position contacts are open. _____

In the following step, be prepared to transfer back to manual if the excitation voltage increases suddenly.

- Transfer to AVR ..... _____

OEL Test

- Disable OEL using the BESTCOMS Configuration screen ..... _____
- Set the On-Line, OEL three current limits for 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, K_I and K_G terms and run the test again.

- Increase field excitation until the field current reaches 125 percent of the no load field current setting ..... _____
- Enable OEL using the BESTCOMS Configuration screen ..... _____
- Verify that the response time is within specified limits ..... _____
- Enter final OEL values ..... _____

UEL Test

- Disable UEL using the BESTCOMS Configuration screen ..... _____
- Using BESTCOMS, set the UEL var limit for 5% vars into the generator ..... _____
- Adjust vars into the generator for 15% at 25% load ..... _____
- Perform step response into the UEL limit by enabling UEL using the BESTCOMS Configuration screen ..... _____
- Verify stable performance and speed of response ..... _____

If the response time is too slow, increase the UEL gain, K_I and K_G terms and run the test again.

- Verify stability performance of UEL by testing machine from 25% through 100% real power loading, underexcited ..... _____
- Increase the excitation above the UEL limit ..... _____
- Enter final UEL values ..... _____

SCL Test (If Applicable)

- Disable SCL using the BESTCOMS Configuration screen ..... _____
- Operate the unit at approximately 30 % load at 0.8 lagging power factor in Droop mode ... _____
- Using BESTCOMS, set the SCL low limit to 5% greater than the metered current ..... _____
- Using BESTCOMS, set the SCL high limit to 50% greater than the metered current ..... _____
- Using BESTCOMS, set the SCL high limit time delay at 5 seconds ..... _____
- Enable SCL using the BESTCOMS Configuration screen ..... _____
- Perform step response into the SCL limit ..... _____
- Verify stable performance and speed of response ..... _____
- Repeat with unit supplying 30% load at 0.8 leading power factor in Droop mode ..... _____

If the response time is too slow, increase the SCL gain, K_I term, and K_G term, and rerun the test.

- Verify stability performance of SCL by testing machine from 25% through 100% real-

power loading, underexcited ..... _____
- Increase the excitation above the UEL limit ..... _____
- Enter the final UEL values ..... _____

Var Test (If Applicable)

- Verify that VAR mode is nulled to AVR ..... _____
- Verify that all null status indicators provide the null indication ..... _____
- Verify that VAR Pre-Position Mode is disabled or external pre-position contacts are open . _____

In the following step, be prepared to transfer back to AVR if the excitation voltage increases suddenly.

- Transfer to VAR ..... _____
- Set kW for 25% output ..... _____
- Adjust vars to 30% of rated ..... _____

Monitor the field voltage to determine performance of the following step.

- Using BESTCOMS, perform 5% step response stability test ..... _____
- If necessary, increase the VAR gain, K_I and K_G terms to speed up the response, and run the test again ..... _____

PF Performance Test (If Applicable)

- Verify that PF mode is nulled to VAR mode ..... _____
- Verify that all null status indicators provide the null indication ..... _____
- Verify that PF Pre-Position Mode is disabled or external pre-position contacts are open .... _____

In the following step, be prepared to transfer back to PF if the excitation voltage increases suddenly.

- Transfer to PF ..... _____
- Adjust PF for 0.9 lagging ..... _____
- Perform step response by changing PF setpoint to 0.85 PF lag to determine stability ..... _____
- If necessary, increase the PF gain, K_I and K_G terms to speed up the response, and run the test again ..... _____

End Of Testing

This concludes the parallel operation, generator on-line tests. Configure the excitation system to the required parameters. Once satisfactory performance is achieved, save all information to EEPROM.

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SECTION 6 • BESTCOMS SOFTWARE

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SECTION 6 • BESTCOMS SOFTWARE

INTRODUCTION

BESTCOMS-DECS300-32, Windows® based software is an application that enhances communication between the personal computer (PC) user and the DECS-300 unit. This software serves four main purposes. First, it provides a user-friendly environment for changing DECS-300 settings. Second, it provides on-screen, real-time metering that is updated approximately every second. Third, it provides PID (Proportional-Integral-Derivative) software that allows the users to establish the right PID parameters based on the user specified generators and/or exciter time constants. Fourth, it provides the operational performance analysis tools for the step response of automatic voltage control (AVR), field current regulation (FCR), var, or power factor (PF). Also, users can save DECS-300 settings in a PC file which saves setup time when configuring multiple units to the same settings.

INSTALLATION

BESTCOMS-DECS300-32 software contains a setup utility that installs the program on your PC. When it installs the program, an uninstall icon is created that you may use to uninstall (remove) the program from your PC. The minimum recommended operating requirements are listed in the following paragraph.

Operating Requirements

- IBM compatible PC, 486DX2 or faster (100 MHz or higher speed microprocessor recommended), with a minimum of twenty megabytes of RAM
- Microsoft® Windows® 2000, XP, or Vista operating system
- CD-ROM drive
- One available serial port

Installing The Program On Your PC Using Microsoft Windows

1. Insert the DECS-300 CD-ROM into the PC CD-ROM drive.
2. When the DECS-300 setup and documentation CD menu appears, click the Install button for BESTCOMS-DECS-300-32. The BESTCOMS setup utility automatically installs BESTCOMS.

Configuring The System

Verify that the DECS-300 communication interface cable is connected correctly between the DECS-300 unit and the PC. If not, connect the cable to the front RS-232 port (Com 0) on the DECS-300 and the appropriate communication port on the PC. Once communication is initialized, the BESTCOMS-DECS300-32 software automatically retrieves configuration settings from the DECS-300 unit.

HELP INSTRUCTIONS

From the main menu, clicking Help, Instructions provides general instructions for using the BESTCOMS-DECS300-32 software.

STARTING BESTCOMS

BESTCOMS is started by clicking the Windows® Start button, pointing to Programs, the Basler Electric folder, and then clicking the BESTCOMS-DECS300-32 icon. At startup, a dialog box with the program title and version number is displayed briefly (Figure 6-1) This information is also provided in the Help/About screen. After this dialog box is displayed, the System Configuration screen appears (Figure 6-2).

Figure 6-1. BESTCOMS-DECS300-32 Title and Version

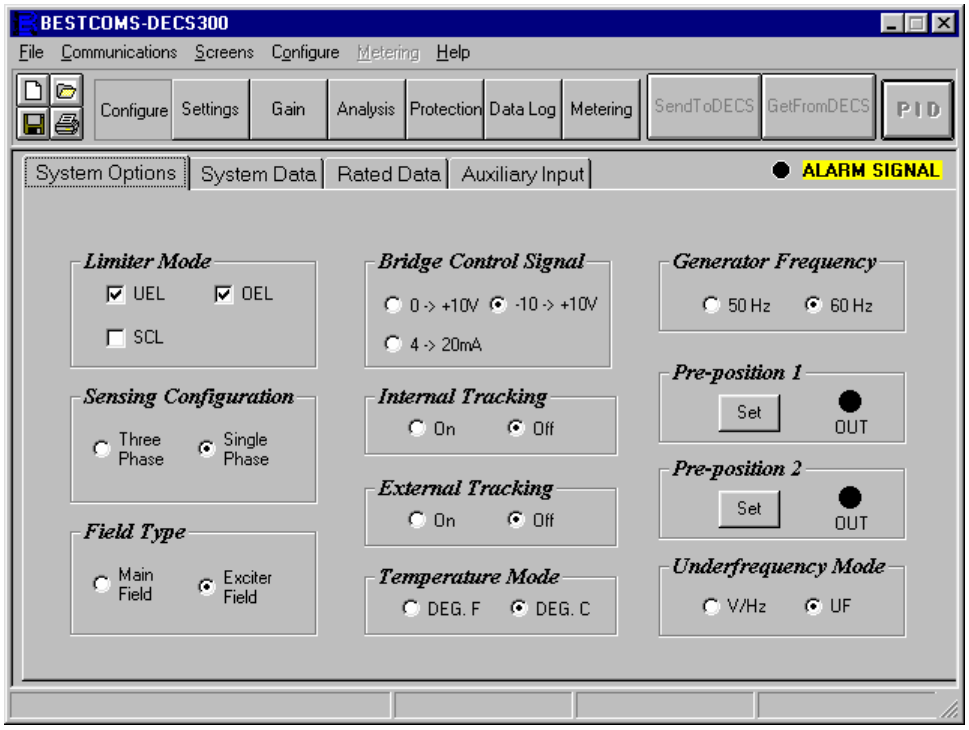

Figure 6-2. System Configuration Screen

Establishing Communication

Communication between BESTCOMS and the DECS-300 must be established before viewing metering values or reading or changing settings.

Pull down the **Communications** menu and select **Open Comm Port** (Figure 6-3). This opens the Comm Port screen shown in Figure 6-4.

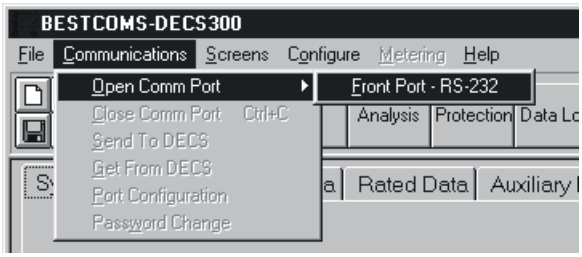

Figure 6-3. Communication Port Selection

Select the active communication port on your PC (like Comm 1 in Figure 6-4) and click the **Initialize** button. BESTCOMS initiates communication by obtaining the configuration settings from the DECS-300.

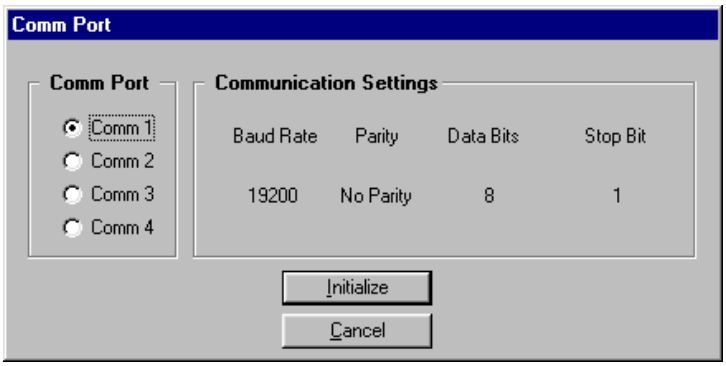

Figure 6-4. Comm Port Screen

NOTE

BESTCOMS screen settings are updated only after communication is opened or a setting has been changed. Changing screen displays from one screen to another will automatically update the target screen settings. When initiating communication, obtaining DECS-300 configuration settings, or performing other tasks, BESTCOMS may display the dialog box of Figure 6-5. It's important to wait until the box disappears. Issuing commands while the Wait dialog box is present may disrupt communication between BESTCOMS and the DECS-300.

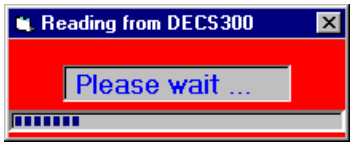

Figure 6-5. Wait Dialog Box

Changing Communication Settings

A password (Figure 6-6) is required for any setting changes. This includes communication settings. The default pass-word is **decs3**. A password change is made by opening the COMMUNICATIONS\PASSWORD CHANGE option on the main menu toolbar (Figure 6-7). The DECS-300 password is limited to six alphanumeric characters. For more information on changing passwords, see Section 2, *HMI, Password Protection*.

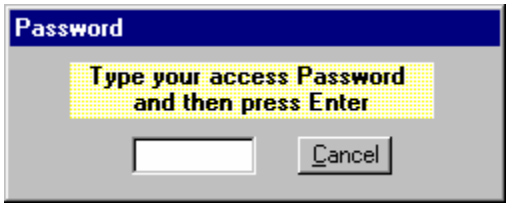

Figure 6-6. Password Entry

Reading the settings from the DECS-300 and/or real-time metering does not require a password. You can download the settings from the DECS-300 unit and save it to a file as long as communications was successfully opened or initialized.

The DECS-300 communication settings for RS-232 (COM0 and COM1) and RS-485 (COM2) can be made at any time by opening the COMMUNICATIONS\PORT CONFIGURATION option on the main menu bar (Figure 6-8).

Figure 6-7. Changing DECS Password

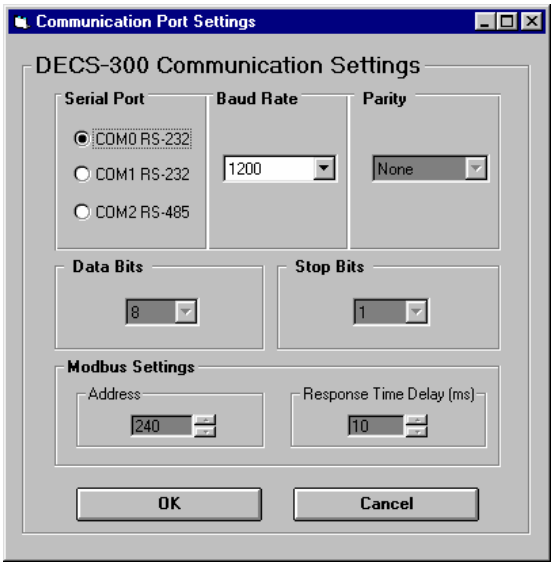

Figure 6-8. Communication Port Settings

CHANGING SYSTEM SETTINGS

Settings are arranged in seven groups.

- System Configuration
- Setting Adjustments
- Control Gain
- Analysis
- Protection/Relay
- Data Log
- Metering/Operation / Alarm Status (includes detailed alarm signals, hardware switch status and front panel LED display)

To change settings, you must first select the group by selecting the button associated with that group or by the **Screens** pull-down menu (Figure 6-9). Double click any white rectangular setting box and it will show you the setting limits for this setting. To change the settings, select (click on and highlight) the setting to be changed. Enter the new setting; the new setting can be sent to the DECS-300 unit by pressing the <Enter> key or selecting <**SendToDECS>** to execute the communications command. The following paragraphs describe these functions.

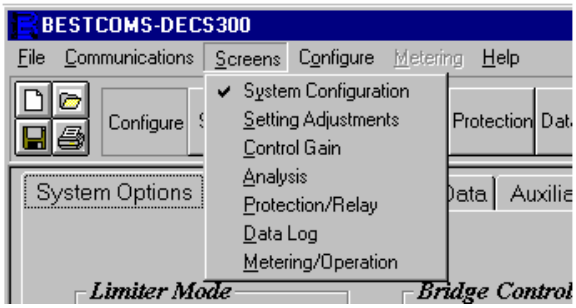

Figure 6-9. Changing Settings

SENDING AND RECEIVING SETTINGS

When communications is in progress, the user may send settings to or receive settings from the DECS unit.

Send To DECS

To send data to the DECS-300 unit (update any white rectangular box), pull down the **Communications** menu and select **SendToDECS** or press the <Enter> key. Settings displayed on the current setting screen become the DECS-300 unit settings. Selecting (clicking on) the <**SendToDECS>** button on the menu toolbar also sends the data to the DECS-300 unit. If a Radio Button, Check Box, or Toggle Switch is selected, that setting is sent immediately to the DECS-300. If you enter a value that is out of range and attempt to send that setting to the DECS, an input error message dialog box, similar to the one shown in

Figure 6-10, appears. If you click <OK>, the previous out-of-range setting value is displayed. This indicates that the new setting was not accepted by the DECS-300 unit.

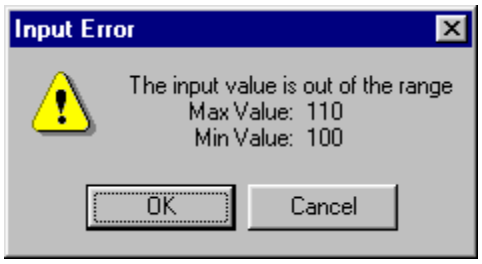

Figure 6-10. Input Error

Get From DECS

To retrieve data from the DECS-300 unit (get settings), you can pull down the **Communications** menu and select **GetFromDECS**. Settings previously saved to the DECS-300 unit are displayed on the setting screens. Selecting (clicking on) the <**GetFromDECS>** button on the menu toolbar also gets the data from the DECS-300 unit. Any black rectangular box contains read-only data received from the DECS-300 unit. The settings are also updated when the screens change or by executing **GetFromDECS.** If the **ALARM SIGNAL** LED (on the upper, right hand corner of each setting screen) is RED, it indicates at least one of the alarm signals is ON. You may see the details by selecting either the *Metering, Alarm/Status* or *Analysis* screen. The ALARM SIGNAL is not an actual LED. In this section of the manual, the term LED means a simulated LED.

EEPROM

Default settings are saved in nonvolatile memory (EEPROM). In the event of a power loss, these are the settings that are active at power up. If you change settings and send them to the DECS-300, they are saved to EEPROM also. When you exit the communications program or close communications, the settings are saved to EEPROM again.

SETTINGS DEFINITIONS

Definitions for all the available settings are provided in the following paragraphs. These definitions are also arranged in seven groups according to the screen displays.

System Configuration

There are four tabs in the System Configuration (Configure) screen: *System Options, System Data, Rated Data,* and *Auxiliary Input*. Each tab has parameters as described in the following paragraphs.

System Options (Figure 6-11)

Limiter Mode. This setting allows the user to select overexcitation limiter (OEL), underexcitation limiter (UEL), and stator current limiter (SCL).

Sensing Voltage. This setting selects either single-phase or three-phase sensing voltages.

Field Type. This setting allows the user to select excitation control for either the generator main field or the exciter field. The mode selection determines corresponding rated data and PID parameters for either the main field or exciter field.

Bridge Control Signal. This setting allows the user to select the DECS-300 bridge rectifier analog control signal. The signal may be in the range of 0 to +10 Vdc, –10 to +10 Vdc, or 4 to 20 milliamperes.

Internal Tracking. This setting allows the user to enable internal tracking. (Hardwired input SWI-2, if closed, overrides the software input. If Internal Tracking, Off is selected here, but the DECS-300 unit does not accept the input, then the SWI-2 input contacts are closed.) When transferring between control modules or redundant DECS-300 units, internal tracking provides a nominal field voltage change of ±0.5%.

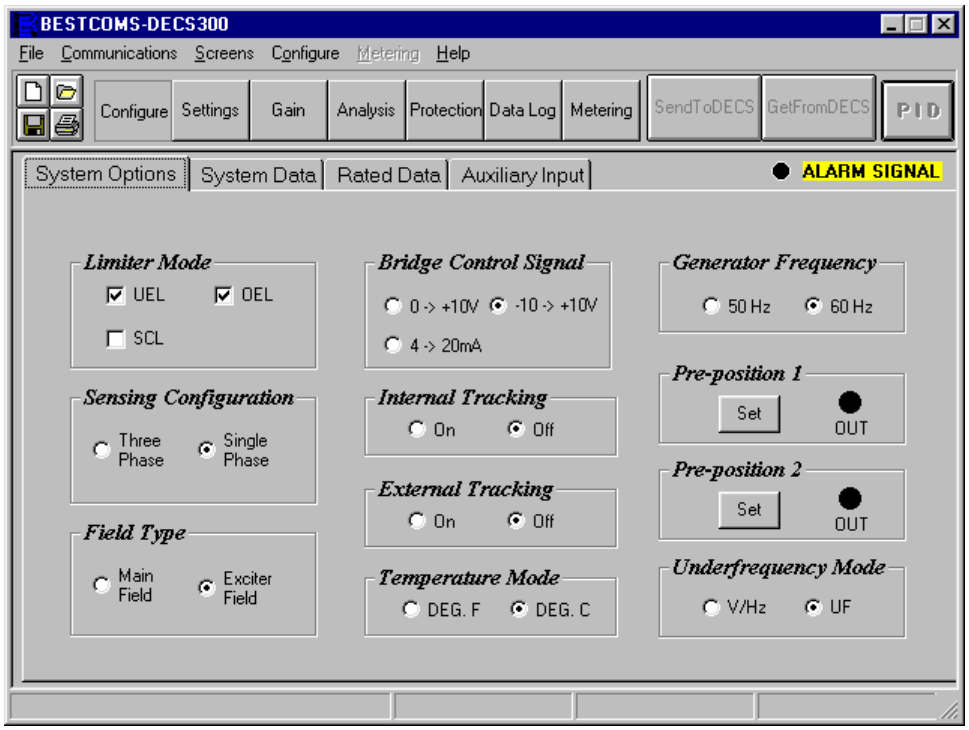

Figure 6-11. System Configuration Screen, System Options Tab

External Tracking. This setting allows the user to enable external tracking. When transferring between redundant DECS-300 units, external tracking provides a nominal field voltage change of ±0.5%.

Temperature Mode. This setting allows the user to select the temperature scale: either degrees Fahrenheit or degrees Celsius. It is associated with the field overtemperature protection and monitoring. This selection determines the scale that the DECS-300 front panel HMI or BESTCOMS uses to display the field temperature and the overtemperature alarm level.

Generator Frequency. This setting allows the user to select the nominal system operating frequency: either 50 or 60 hertz.

Underfrequency Mode. This setting allows the user to select either volts-per-hertz mode or underfrequency mode limiting.

Pre-position 1. The Set button allows the excitation system to be preset to a repeatable value (pre-position value 1) within the limits of the setpoints. (Hard-wired input PRE-P, if closed, overrides the software input.) An indicator annunciates when pre-position mode is active or inactive.

Pre-position 2. The Set button allows the excitation system to be preset to a repeatable value (pre-position value 2) within the limits of the setpoints. (Hard-wired input SWI-2, if closed, overrides the software input.) An indicator annunciates when pre-position mode is active or inactive.

System Data (Figure 6-12)

Generator and bus PT ratings must be specified in the same sensing range.

Generator PT Ratings. These two settings allow the user to input the rated generator potential transformer (PT) primary voltage (1 to 30,000) and secondary voltage (1 to 240).

Generator CT Ratings. These two settings allow the user to input the rated generator current transformer (CT) primary current (1 to 5,000) and secondary current (1 or 5).

Bus PT Ratings. These two settings allow the user to input the rated bus PT primary voltage (1 to 500,000) and secondary voltage (1 to 240).

Field Voltage Isolation Box Input. This setting (32V, 63V, 125V, 250V, or 375V) allows the user to input the shunt voltage rating into the DECS-300 memory. The sensing range is three times nominal for both negative and positive voltages. A signal from the shunt is converted into field current for the specified

generator. The setting value on this box can be changed by clicking on the selection. If the DECS-300 is in the read-only mode, a password is requested when you change the selection.

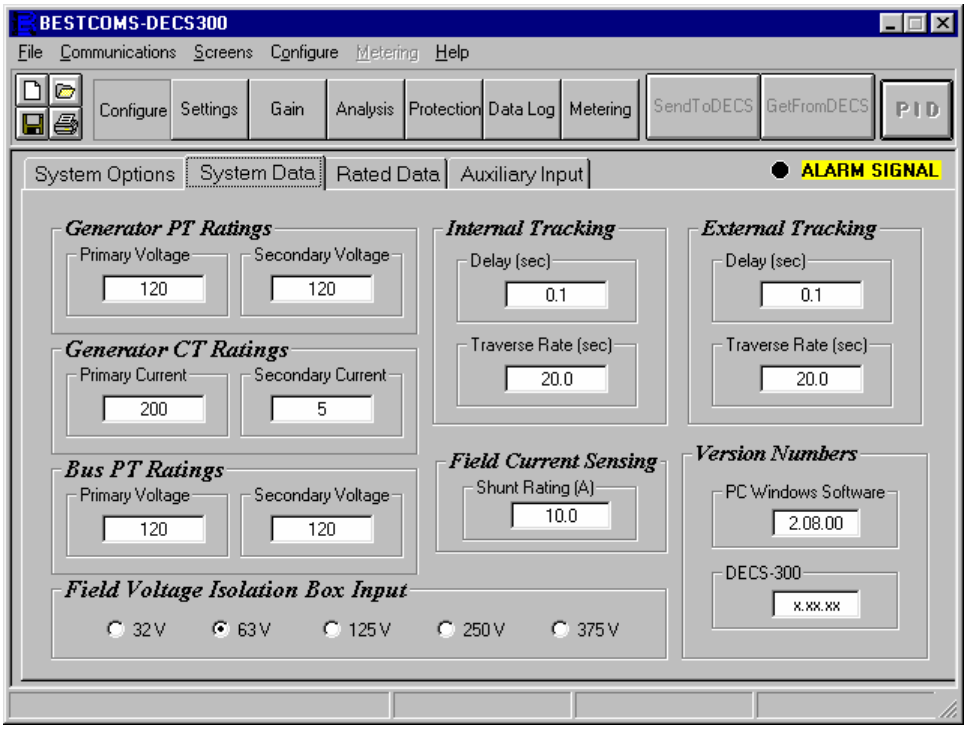

Figure 6-12. System Configuration Screen, System Data Tab

Internal Tracking. These two settings allow the user to input the primary DECS-300 tracking time delay (0 to 8 seconds) and tracking traverse rate (0 to 80 seconds).

Field Current Sensing. This setting (0.1 to 5,000) allows the user to set the shunt rating into the DECS-300 memory. The signal from the shunt is converted into field current for the specified generator.

External Tracking. These two settings allow the user to input the secondary DECS-300 tracking time delay (0 to 8 seconds) and tracking traverse rate (0 to 80 seconds).

Version Numbers. These two version numbers are read-only. They indicate which software versions (BESTCOMS and DECS embedded) are currently installed. If no version numbers show in the DECS-300 window, then the PC (BESTCOMS software) did not communicate with the DECS-300 unit. If communication did occur, the DECS-300 window shows the embedded software version number.

Rated Data (Figure 6-13)

Generator Rated Data, Generator Rating (kVA). This read-only value is calculated based on the generator voltage and generator current settings.

Generator Rated Data, Generator Real Power (kW). This read-only value is calculated based on the Generator Voltage, Current, and Power Factor.

Generator Rated Data, Generator Power Factor. This setting allows the user to input the generator power factor value which is used to calculate the generator real power. The BESTCOMS software performs the calculations.

Generator Rated Data, Generator Voltage (V). This setting allows the user to input the rated generator line-to-line ac voltage (85 to 30,000).

Generator Rated Data, Generator Current (A). This setting allows the user to input the rated generator ac line current (1 to 60,000).

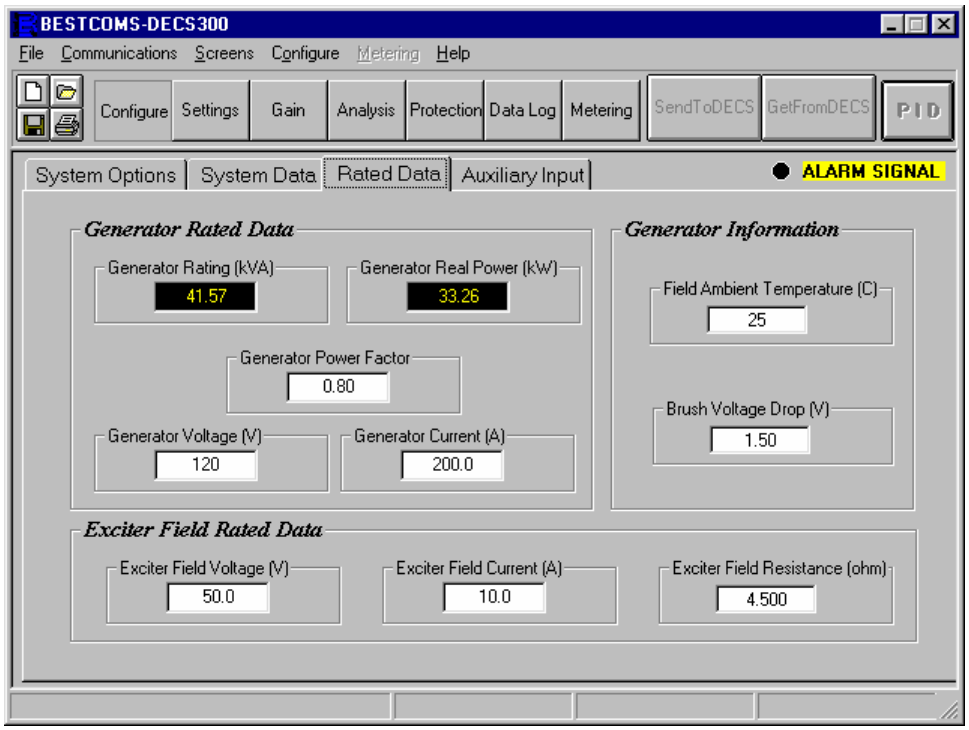

Figure 6-13. System Configuration Screen, Rated Data Tab

Exciter/Main Field Rated Data, Field Voltage (V). This setting allows the user to input the rated main field or exciter field voltage (1.0 to 400). The value in this window is applied to either the main field or exciter field rating depending on the selection of the Field Type in the System Options screen.

Exciter/Main Field Rated Data, Field Current (A). This setting allows the user to input the rated main field or exciter field current (1.0 to 9,999). The value in this window is applied to either the main field or exciter field rating depending on the selection of the Field Type in the System Options.

Exciter/Main Field Rated Data, Exciter Field Resistance (ohm). This read-only value is calculated based on the main field or exciter field rated dc voltage and current.

Generator Information, Field Ambient Temperature (C). This setting allows the user to input the ambient generator temperature. This setting is used to calculate the generator main field temperature.

Generator Information, Brush Voltage Drop (V). This setting allows the user to input the brush voltage drop at ambient generator temperature. This setting is used to calculate the generator main field temperature.

Auxiliary Input (Figure 6-14)

The auxiliary voltage input signal changes the setpoint of the selected operating mode. For more information on the auxiliary voltage input, refer to Section 3, F*unctional Description*.

Auxiliary Voltage Input, Input Mode. This setting allows the user to select the DECS-300 auxiliary input mode (Voltage or Current) for remote setpoint control (typically an input from the Power System Stabilizer).

Auxiliary Voltage Input, Summing Mode. This setting allows the user to select the summing mode. When the Inner Loop is selected, the operational mode is either AVR or FCR. When the Outer Loop is selected, the operational mode is either var or power factor.

Auxiliary Voltage Input, Auxiliary Gain Settings. These four settings select the gain which affects the setpoint of the selected operating mode. The auxiliary voltage input signal is multiplied by the auxiliary gain setting. The gain setting is in the range of –99 to +99. If the gain is set to zero, the auxiliary voltage input signal is made inactive. For more information on the auxiliary gain settings, refer to Section 3, F*unctional Description*.

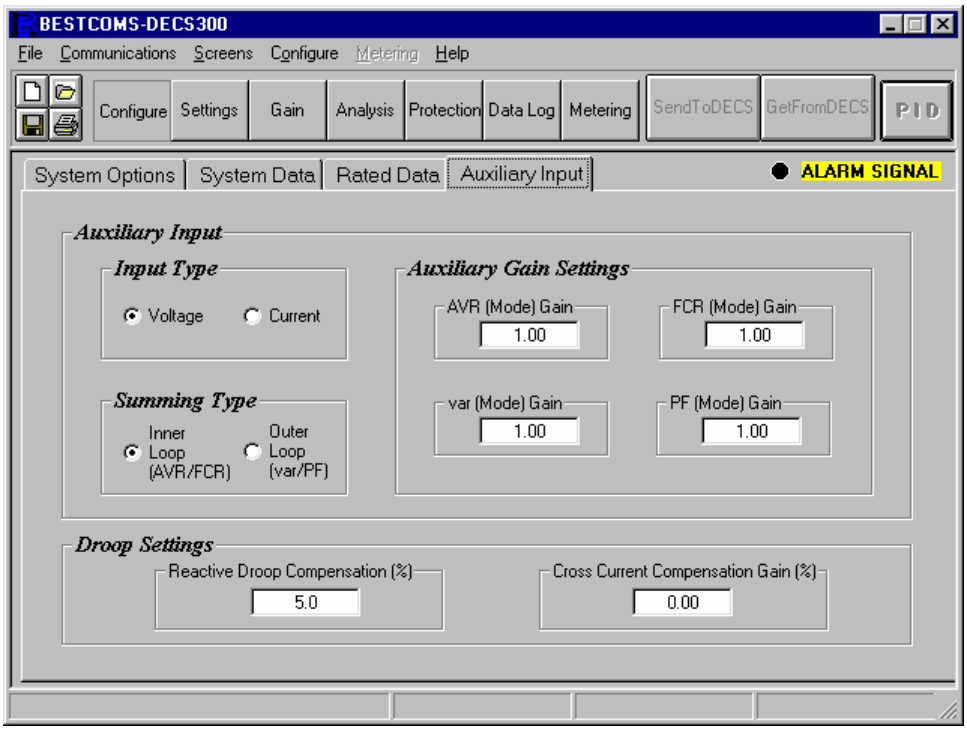

Figure 6-14. System Configuration Screen, Auxiliary Input Tab

Auxiliary Voltage Input, Droop Settings. When enabled, this setting allows the excitation system to provide droop compensation for paralleling generators. Droop compensation is adjustable from –30 to +30% of the generator nominal terminal voltage in 0.1% steps.

Auxiliary Voltage Input, Cross Current Compensation Gain. When enabled, this setting allows the excitation system to provide cross current compensation (reactive differential) gain for parallel generators. Cross current compensation gain is adjustable from -30 to +30% of the rated CTs in 0.01% steps. Refer to Section 4, *Installation*, for more information on cross current compensation gain.

Setting Adjustments

To access the setting adjustment screens, pull down the **Screens**, menu and select **Setting Adjustments**. There are eight tabs in the Setting Adjustments screen: *AVR/FCR, VAR/PF, Startup, OEL Type, OEL (Summing), OEL (Takeover), UEL,* and *Stator Limiter*. Each tab has additional parameters as described in the following paragraphs.

AVR/FCR, Automatic Voltage Regulator (AVR) (Figure 6-15)

AVR Setpoint (V). This setting allows the user to set the desired generator output terminal voltage. The range of this setting depends on the settings of the AVR Min/Max setting values. Enter the desired AVR setpoint value using the primary generator voltage level intended to be maintained at the generator output.

AVR Min (%). This setting allows the user to set the generator minimum voltage setpoint as a percentage (70 to 100%) of generator rated voltage.

AVR Max (%). This setting allows the user to set the generator maximum voltage setpoint as a percentage (100 to 110%) of generator rated voltage.

Traverse Rate (sec). This setting allows the user to set the setpoint traverse rate (10 to 200 seconds). This setting determines the time required to adjust the AVR setpoint from the minimum value to the maximum value of the adjustment range.

Pre-position 1 and 2, Pre-position (V). This setting allows the user to set the generator output terminal voltage to a pre-position voltage during AVR mode. The setting range is the same as the AVR Setpoint.

The pre-position setting value replaces the AVR Setpoint value if pre-position is selected and the AVR Pre-position Mode is set to Maintain.

Pre-position 1 and 2, AVR Pre-position Mode. The AVR pre-position mode determines whether or not the unit will respond to further setpoint change commands once the operating setpoint is driven to the pre-position value. If the pre-position mode is set for MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is set for RELEASE, then subsequent setpoint change commands are possible by using the raise and lower switches.

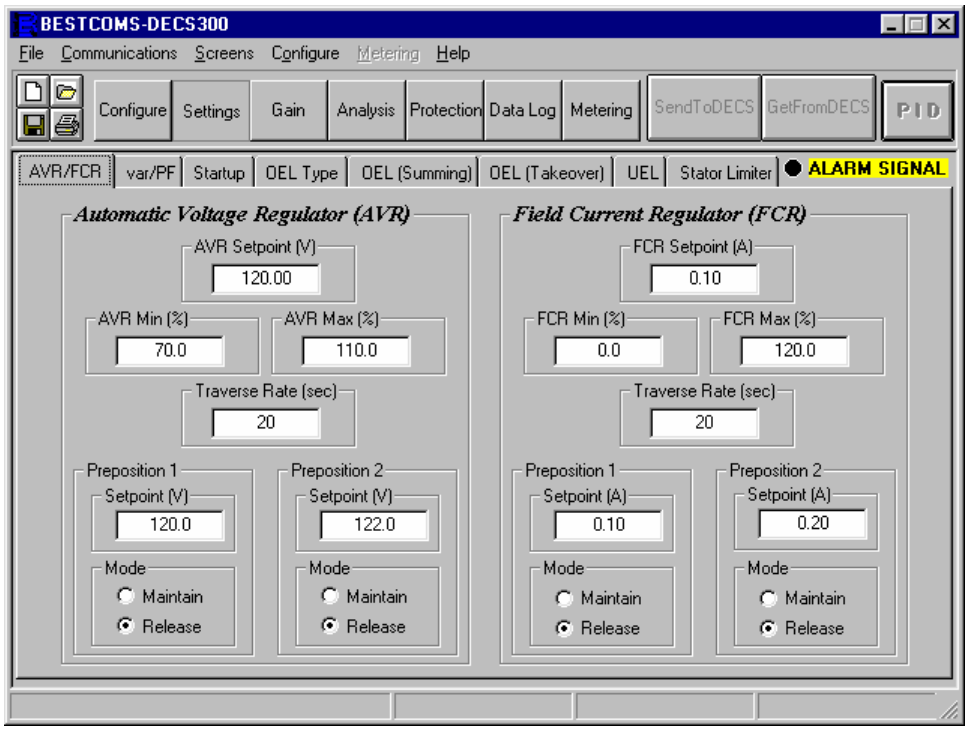

Figure 6-15. Setting Adjustments Screen, AVR/FCR Tab

AVR/FCR, Field Current Regulator (FCR) (Figure 6-15)

FCR Setpoint (A). In manual (FCR) mode, this setting allows the user to set the field dc current setpoint. The range of this setting depends on which Excitation Mode (generator main field or exciter field) and the ratings associated with each device.

FCR Min (%). This setting allows the user to set the minimum field current setpoint as a percentage (0 to 100%) of rated field current.

FCR Max (%). This setting allows the user to set the maximum field current as a percentage (0 to 120%) of rated field current.

Traverse Rate (sec). This setting allows the user to set the setpoint traverse rate (10 to 200 seconds). This setting determines the time required to adjust the FCR setpoint from the minimum value to the maximum value of the adjustment range.

Pre-position 1 and 2, Pre-position (A). This setting allows the user to set the field current to a pre-position current level during FCR mode. The setting range is the same as the FCR Setpoint. The pre-position setting value replaces the FCR Setpoint value if pre-position is selected and the FCR Pre-position Mode is set to Maintain.

Pre-position 1 and 2, FCR Pre-position Mode. The FCR pre-position mode determines whether or not the unit will respond to further setpoint change commands once the operating setpoint is driven to the pre-position value. If the pre-position mode is set for MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is set for RELEASE, then subsequent setpoint change commands are possible by using the raise and lower switches.

VAR/PF, Reactive Power Control (VAR) (Figure 6-16)

VAR Setpoint (kvar). This setting allows the user to set the reactive power set-point in the VAR mode. The range of this setting depends on the generator settings and the VAR Min/Max values.

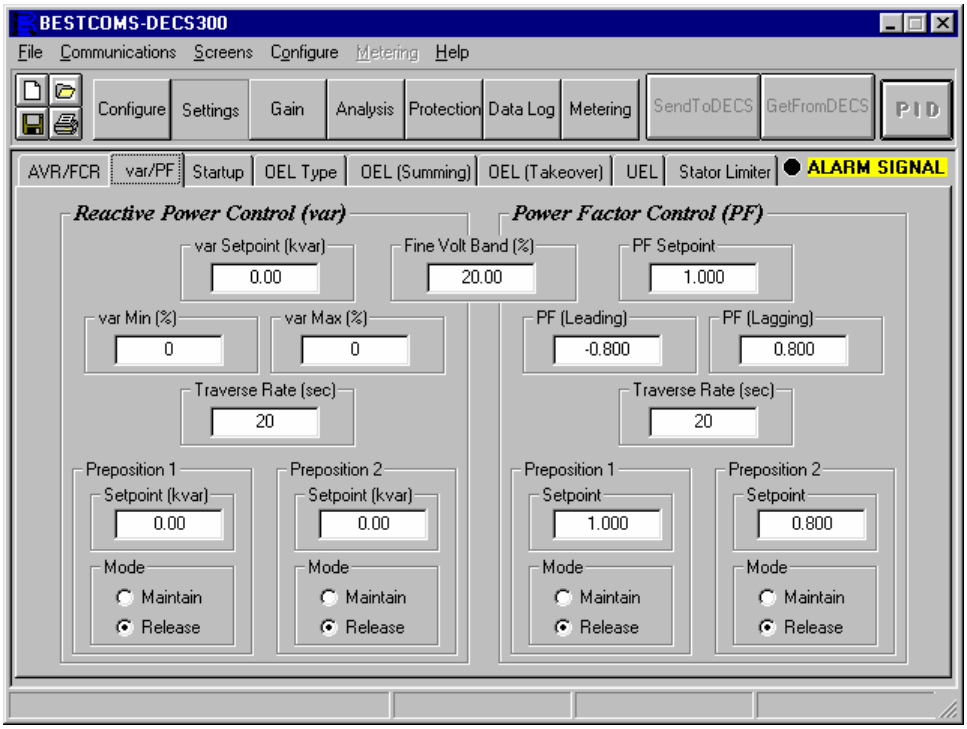

Figure 6-16. Setting Adjustments Screen, VAR/PF Tab

VAR/PF Volt Band (%). This setting (fine voltage adjustment band) allows the user to set the upper and lower boundaries of the voltage correction during var or power factor control modes as a percentage of the generator nominal voltage (0 to 30).

VA*R Min (%)*. This setting allows the user to set the generator minimum var setpoint as a percentage (–100 to +100%) of the generator rated var output.

VAR Max (%). This setting allows the user to set the generator maximum var setpoint as a percentage (–100 to +110%) of the generator rated var output.

Traverse Rate (sec). This setting allows the user to set the setpoint traverse rate (10 to 200 seconds). This setting determines the time required to adjust the var setpoint from the minimum value to the maximum value of the adjustment range.

Pre-position 1 and 2, Pre-position (kvar). This setting allows the user to set the var setpoint to a pre-position level during var mode. The setting range is the same as the var Setpoint. The pre-position setting value replaces the VAR Setpoint value if pre-position is selected and the VAR Pre-position Mode is set to Maintain.

Pre-position 1 and 2, VAR Pre-position Mode. The var pre-position mode determines whether or not the unit will respond to further setpoint change commands once the operating setpoint is driven to the pre-position value. If the pre-position mode is set for MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is set for RELEASE, then subsequent setpoint change commands are possible by using the raise and lower switches.

VAR/PF, Power Factor (PF) (Figure 6-16)

PF Setpoint. This setting allows the user to set the generator operating power factor. The range of this setting depends on the PF (Leading) and PF (Lagging) settings.

PF *(Leading).* This setting allows the user to set the generator leading power factor (–0.500 to –0.999).

PF *(Lagging).* This setting allows the user to set the generator lagging power factor (+0.500 to +1.000).

Traverse Rate (sec). This setting allows the user to set the setpoint traverse rate (10 to 200 seconds). This setting determines the time required to adjust the PF setpoint from the minimum value to the maximum value of the adjustment range.

Pre-position 1 and 2, Pre-position Setpoint. This setting allows the user to set the PF setpoint to a pre-position level during PF mode. The setting range is the same as the PF Setpoint. The pre-position setting value replaces the PF Setpoint value if pre-position is selected and the PF Pre-position Mode is set to Maintain.

Pre-position 1 and 2, PF Pre-position Mode. The PF pre-position mode determines whether or not the unit will respond to further setpoint change commands once the operating setpoint is driven to the pre-position value. If the pre-position mode is set for MAINTAIN, then further setpoint change commands are ignored. If the pre-position mode is set for RELEASE, then subsequent setpoint change commands are possible by using the raise and lower switches.

Startup, Startup Control (Figure 6-17)

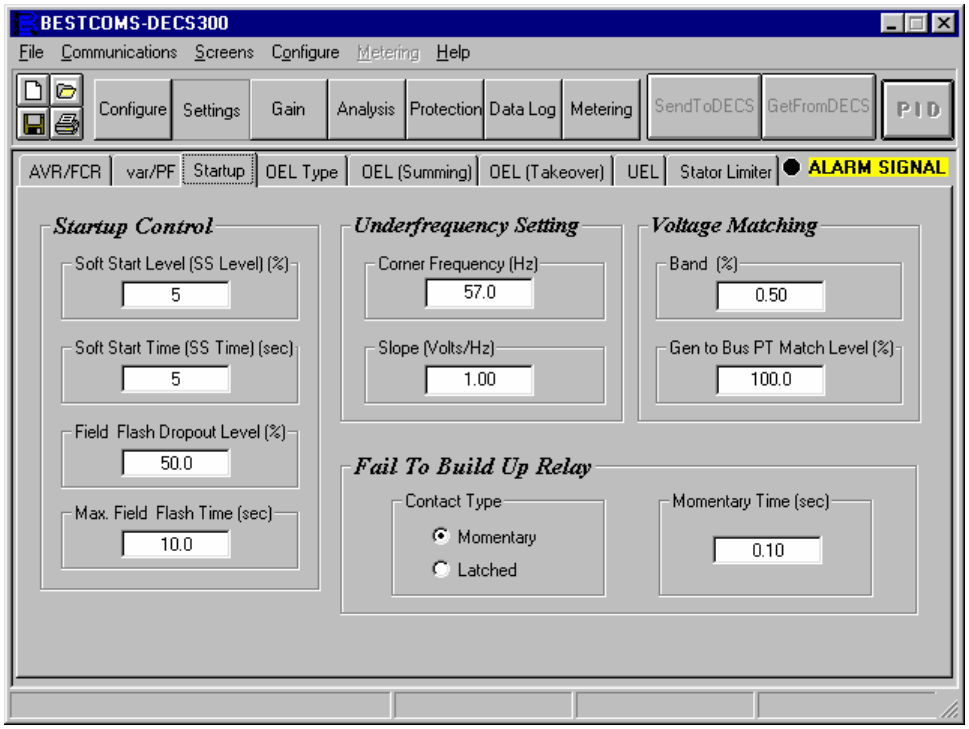

Figure 6-17. Setting Adjustments Screen, Startup Tab

Soft Start Level (SS Level) (%). This setting allows the user to set the generator soft start voltage offset (0 to 90) during startup. This parameter is the same as Soft Start Level when accessed at the front panel HMI.

Soft Start Time (SS Time) (sec). This setting allows the user to set the generator soft start time limit (1.0 to 7,200) during startup.

Field Flash Dropout Level (%). During startup, this setting controls the level of generator voltage where field flashing is withdrawn.

Max Field Flash Time (sec). This setting allows the user to set the generator maximum field flash time (1 to 50 seconds) during startup. If this timer expires, the Fail To Build Up Relay will operate.

Underfrequency Setting

Corner Frequency (Hz). This setting allows the user to set the generator corner frequency (15 to 90) for generator underfrequency and volts per hertz protection.

Slope (Volts/Hz). This setting allows the user to set the generator frequency slope (0 to 3.00) for generator underfrequency and volts per hertz protection.

Voltage Matching

Band (%). This setting configures the generator voltage matching band as a percentage (0 to 20) of the generator rated voltage. If the bus input voltage is outside this band, no voltage matching will occur.

Gen to Bus PT Match Level (%). This setting allows the user to compensate for the voltage transformer error of the voltage matching function as a percentage (0.9 to 120%) of the bus voltage.

Fail To Build Up Relay

Contact Type. This setting allows the user to select the fail-to-build-up relay output type as momentary or latched until reset.

Momentary Time (sec). This setting allows the user to select the duration of momentary closure for the FTBUP output contacts. This setting is from 0.1 to 5 seconds in 50 millisecond steps.

OEL Type (Figure 6-18)

OEL Limiter Style. This setting selects between the summing point type OEL and the takeover type OEL.

OEL Setting Selection Option. This setting selects the on-line and off-line OEL settings for various 52JK and 52LM contact statuses. The details of each option are viewed by pressing the corresponding Details button.

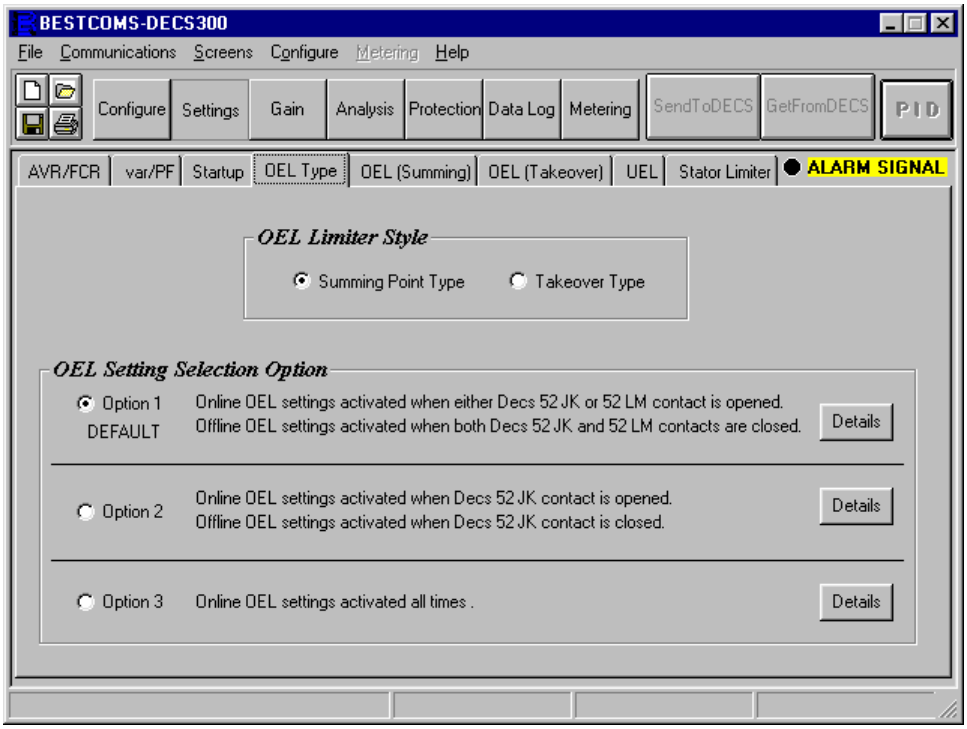

Figure 6-18. Setting Adjustments Screen, OEL Type Tab

OEL (Summing), Off-Line OEL Setting (Figure 6-19)

High Current Level (A). This setting allows the user to set the high current level setpoint (0 to 9,999) for the off-line overexcitation limiter (off-line OEL).

High Current Time (sec). This setting allows the user to set the time limit (0 to 10.0) for high current limiting for the off-line overexcitation limiter.

Low Current Level (A). This setting allows the user to set the low current level setpoint (0 to 9,999) for the off-line overexcitation limiter.

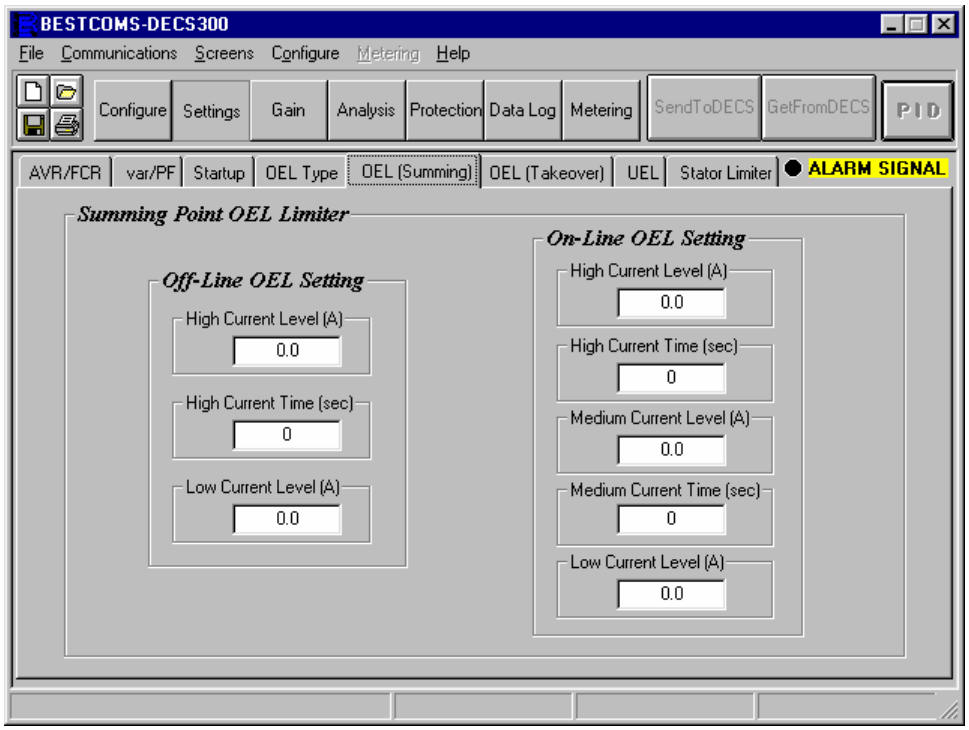

Figure 6-19. Setting Adjustments Screen, OEL Summing Tab

OEL (Summing), On-line OEL Setting

High Current Level (A). This setting allows the user to set the high current level setpoint (0 to 9,999) for the on-line overexcitation limiter (on-line OEL).

High Current Time (sec). This setting allows the user to set the time limit (0 to 60) for the on-line overexcitation limiter.

Medium Current Level (A). This setting allows the user to set the medium current level setpoint (0 to 9,999) for the on-line overexcitation limiter.

Medium Current Time (sec). This setting allows the user to set the time limit (0 to 120) for the on-line overexcitation limiter.

Low Current Level (A). This setting allows the user to set the low current level setpoint (0 to 9,999) for the on-line overexcitation limiter.

OEL (Takeover), Takeover OEL Limiter, Off-Line Settings (Figure 6-20)

Low Current Level (A). This setting allows the user to set the low-level current setpoint (0 to 9,999) for the off-line overexcitation limiter.

High Current Level (A). This setting allows the user to set the high-level current setpoint (0 to 9,999) for the off-line overexcitation limiter.

Time Dial. This setting configures the time delay (0.1 to 20) for the off-line overexcitation limiter.

OEL (Takeover), Takeover OEL Limiter, On-Line Settings

Low Current Level (A). This setting allows the user to set the low-level current setpoint (0 to 9,999) for the on-line overexcitation limiter.

High Current Level (A). This setting allows the user to set the high-level current setpoint (0 to 9,999) for the on-line overexcitation limiter.

Time Dial. This setting configures the time delay (0.1 to 20) for the on-line overexcitation limiter.

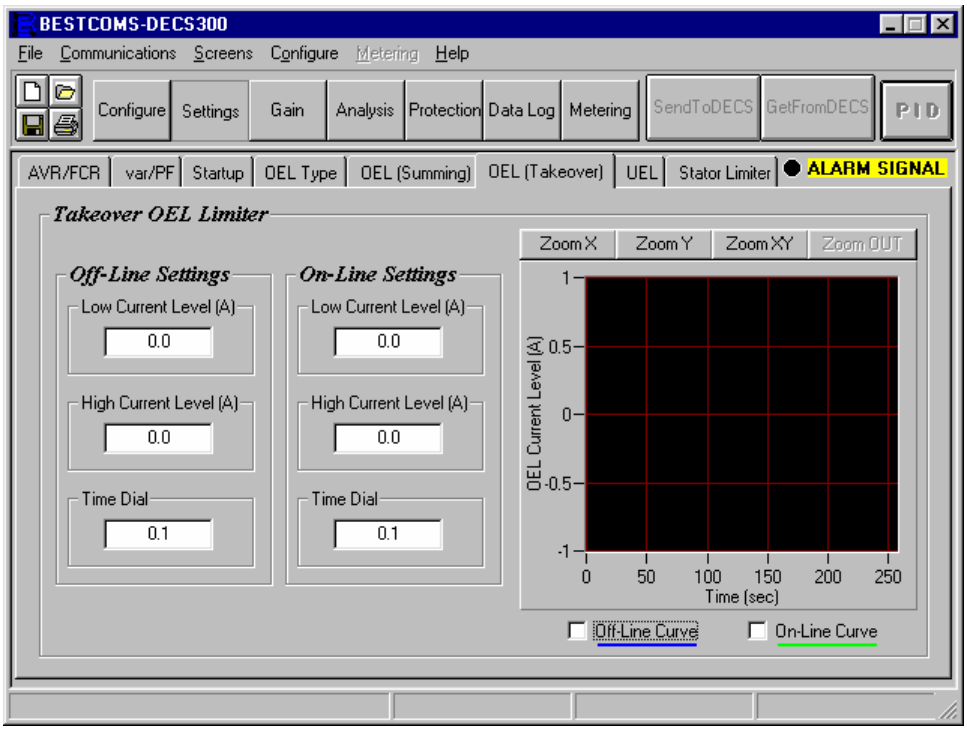

Figure 6-20. Setting Adjustments Screen, OEL (Takeover) Tab

Off-line Curve and On-line Curve Check Boxes. The appropriate box is checked to view the OEL curves. Magnification functions are provided by the Zoom X, Zoom Y, and Zoom XY buttons.

UEL, UEL Settings

UEL Curve Type Selection, Customized or *Internal (Figure 6-21).* This setting allows the user to select either a customized, one-to-five-point UEL curve to match specific generator characteristics or an internal curve based on the first point setting of absorbed reactive power level. When either curve type is selected, a command is sent to the DECS-300 to initiate the curve selection. This function is operational in all modes except FCR mode.

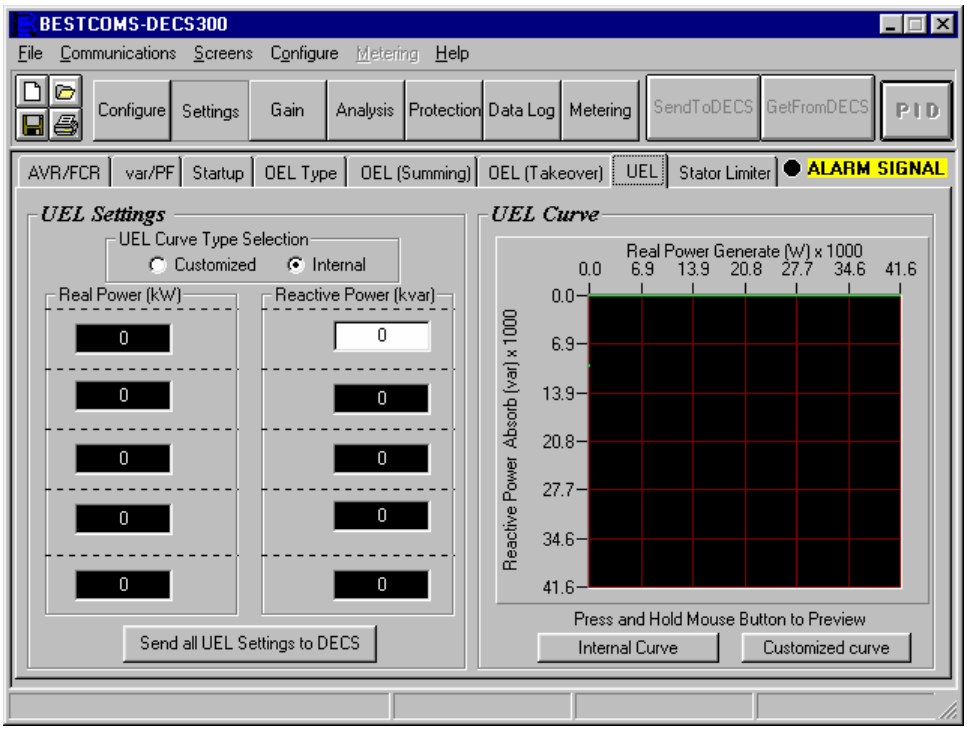

Figure 6-21. Setting Adjustments Screen, UEL Tab

Real Power (kW). This setting allows the user to set the real power (kW) setpoint for the under excitation limiter. The range for each point of this setting is based on the generator capabilities. If the second point setting is zero, then an internal curve is active. If the first two points are nonzero values and the third point setting is zero, then a customized two-point curve is active. If the fourth point setting is zero, then a customized three-point curve is active. If all five point settings are nonzero values, then a customized five-point curve is active.

Reactive Power (kvar). This setting allows the user to set the reactive power (kvar) setpoint for the under excitation limiter. The range for each point of this setting is based on the generator capabilities. If the second point setting is zero, then an internal curve is active. If the first two points are nonzero values and the third point setting is zero, then a customized two-point curve is active. If the fourth point setting is zero, then a customized three-point curve is active. If all five point settings are nonzero values, then a customized five-point curve is active.

Points are plotted in the UEL curve 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.

UEL, UEL Curve

The Internal Curve and Customized Curve buttons can be used to view the curves for the settings entered in the Real Power and Reactive Power text boxes. Values can be entered in the text boxes and the curve can be previewed before sending the setting to the unit. To preview a selected curve, the corresponding button must be pressed and held. When released, BESTCOMS plots the curve for the values stored in the unit.

Stator Limiter, Stator Current Limiter (Figure 6-22)

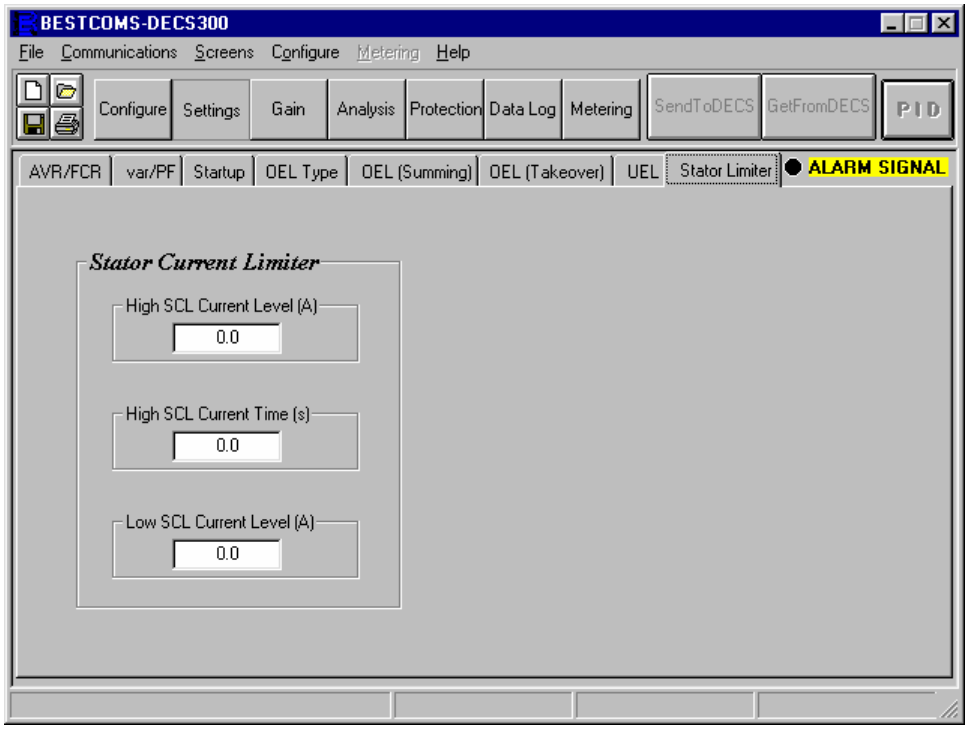

Figure 6-22. Setting Adjustments Screen, Stator Limiter Tab

High SCL Current Level (A). This setting allows the user to set the high-level current setpoint (0 to 66,000) for the stator current limiter.

High SCL Current Time (sec). This setting allows the user to set the time limit (0 to 60) for high current limiting for the stator current limiter.

Low SCL Current Level (A). This setting allows the user to set the low current level setpoint (0 to 66,000) for the stator current limiter.

Control Gain

To access the Control Gain screen, pull down the **Screens** menu and select **Control Gain**. Screen parameters are contained on a single *Control Gain* tab (Figure 6-23).

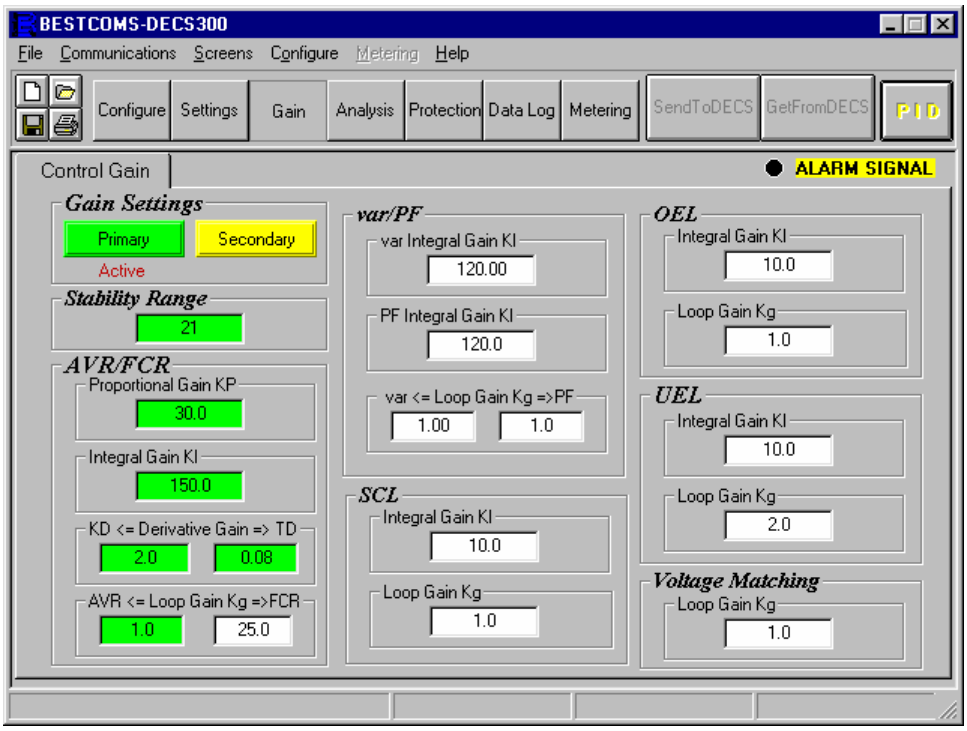

Figure 6-23. Control Gain Screen and Tab

Gain Settings

There are two gain setting groups: Primary and Secondary. Only one gain setting group can be active and is selected by the open or closed input to SW1-1 terminals on the back of the DECS-300 unit. The active setting group has a green colored back-ground in all applicable windows. Inactive settings have a yellow colored back-ground. Primary and secondary setting group parameters can be viewed and edited by clicking the Primary and Secondary button respectively.

Stability Range

There are 40 predefined stability settings. Twenty for the exciter field and twenty for the main field. This setting allows the user to select 1 of 20 automatic predefined stability settings for the DECS-300 unit. Refer to Section 2, *HMI, Loop Gains* for more information and the gain settings table.

The PID button on the menu bar is disabled with a stability range of 1 to 20. Setting the stability range to 21 activates the PID function and allows the user to optimize the stability settings. The PID function provides reference gain settings for user specified generator time constants and/or exciter time constants.

AVR/FCR

AVR/FCR Proportional Gain KP. This setting allows the user to select the proportional constant (KP) stability parameter. The DECS-300 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 1 to 1000. The general guidelines for tuning the value of KP are as follows: If the transient response has too much overshoot, then de-crease KP. If the transient response is too slow, with little or no overshoot, then increase KP.

AVR/FCR Integral Gain KI. This setting configures the integral constant (KI) stability parameter. The DECS-300 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. Typical values of KI range from 1 to 1,000. Generally, if the time to reach steady state is deemed too long, then increase the value of KI.

AVR/FCR KD <=Derivative Gain=> TD. These settings allow the user to select the derivative constant (KD) stability parameter and filter time constant (TD). The DECS-300 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. KD range is 0 to 1,000 in 0.1 increments. Typical values of KD range from 1 to 10. Generally, if the transient response has too much ringing, increase the value of KD. The filter time constant (TD) is used to remove the noise effect on numerical differentiation. The filter time constant ranges from 0.0 to 1.0 in 0.01 increments. Typical values of TD range from 0.01 to 0.03.

AVR/FCR AVR <=Loop Gain Kg=>FCR. This AVR/FCR variable is adjustable from 0 to 1,000 in 0.1 increments and allows the user to adjust the coarse loop-gain level of the PID algorithm.

VAR/PF

VAR/PF PF Integral Gain KI. This feature allows the user to adjust the integral gain, which determines the characteristic of the DECS-300 dynamic response to a changed PF setting. This setting range is from 0 to 1000 with single integer steps.

VAR/PF VAR Integral Gain KI. This feature allows the user to adjust the integral gain, which determines the characteristic of the DECS-300 dynamic response to a changed VAR setting. This setting range is from 0 to 1000 with single integer steps.

VAR <=Loop Gain Kg=>PF. This variable is adjustable from 0 to 1,000 and allows the user to adjust the coarse loop-gain level of the PI algorithm for VAR or PF control.

Voltage Matching, Loop Gain Kg.

This variable is adjustable from 0 to 1000 and allows the user to adjust the coarse loop-gain level of the PID algorithm for Voltage matching between the Bus and Generator voltage.

OEL (Overexcitation Limiter)

Integral Gain KI. This feature allows the user to adjust the rate (integral gain) at which the DECS-300 responds during an over excitation event. This setting range is from 0 to 1,000 with single integer steps.

Loop Gain Kg. This variable is adjustable from 0 to 1,000 and allows the user to adjust the coarse loop-gain level of the PID algorithm for OEL function.

UEL (Underexcitation Limiter)

Integral Gain KI. This feature allows the user to adjust the rate (integral gain) at which the DECS-300 responds during an under excitation event. This setting range is from 0 to 1,000 with single integer steps.

Loop Gain Kg. This variable is adjustable from 0 to 1,000 and allows the user to adjust the coarse loop-gain level of the PID algorithm for UEL function.

SCL (Stator Current Limiter)

Integral Gain KI. This feature allows the user to adjust the rate (integral gain) at which the DECS-300 responds during a stator current limiting event. The KI setting range is 0 to 1,000.

Loop Gain Kg. This variable is adjustable from 0 to 1,000 and allows the user to adjust the coarse loop-gain level of the PID algorithm for SCL function.

Analysis

There are four tabs in the Analysis screen: *AVR* (*Voltage Step Response), FCR (Field Current Step Response), VAR (Reactive Power Step Response),* and *PF (Power Factor Step Response).* For each type of step response screens, there are four sensing values: Vrms (RMS voltage), Ifd (field dc current), reactive power (VAR), and power factor (PF).

Alarm Signals. Alarm signals on this screen are updated approximately once every second. They indicate the changes or alarms signal status when you run the step response analysis.

AVR (Figure 6-24)

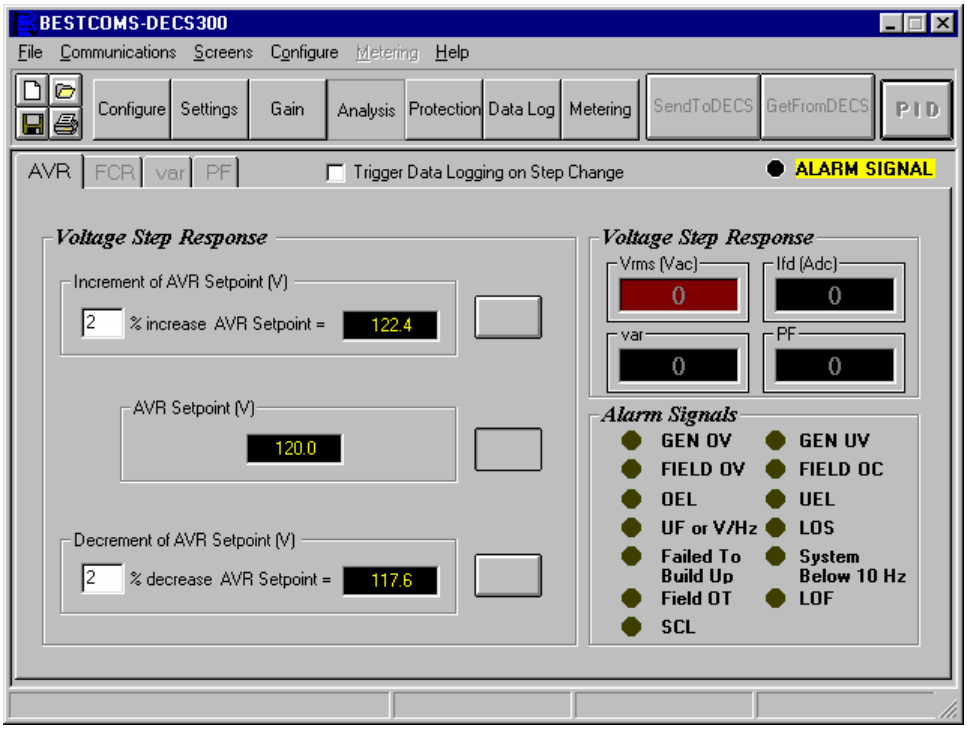

Figure 6-24. Analysis Screen, AVR Tab

Voltage Step Response, Increment Of AVR Setpoint (V). This setting lets the user set the voltage step size that the DECS-300 unit will use when step changing the generator terminal voltage setpoint. The range of this setting is from 0 to 10% in integer steps. If you choose a 10% step size, the generator terminal setpoint voltage plus the 10% of that setpoint voltage is shown in the adjacent window. To send this setpoint voltage value to the DECS-300, select the button adjacent to the indication window. If the specified percentage step size is out of the setpoint limit, a warning message will appear.

Voltage Step Response, AVR Setpoint (V). This voltage setting description is a read-only indication of the generator terminal voltage setpoint that was set in AVR Setpoint in the *Setting Adjustments* screen. If you want the indicated voltage to be the generator output voltage, select the button adjacent to the indication window. When the button is selected, the voltage level indicated is sent to the DECS-300 to be the AVR Setpoint voltage.

Voltage Step Response, Decrement Of AVR Setpoint (V). This setting lets the user set the voltage step size that the DECS-300 unit will use when decrementing the generator voltage setpoint. The range of this setting is from 0 to 10% in integer steps. If you choose a 10% step size, the generator terminal setpoint voltage minus the 10% of that setpoint voltage is shown in the adjacent window. To send this setpoint voltage level to the DECS-300, select the button adjacent to the indication window.

Voltage Step Response, Vrms (Vac). This voltage is a read-only indication of the generator terminal voltage. As shown in Figure 6-21, the button adjacent to the Increment window was selected (clicked) and the terminal voltage was increased by the step amount.

Alarm Signals. Alarm signals on this screen are updated approximate once every second. They indicate the changes or alarms signal status when you run the step response analysis.

FCR (Figure 6-25)

FCR, Increment Of FCR Setpoint (A). This setting lets the user set the current step size that the DECS-300 unit will use when step changing the field current. The range of this setting is from 0 to 10% in integer steps. If you choose a 10% step size, the field current setpoint plus the 10% of that current is shown in the adjacent window. To send this current level setpoint to the DECS-300, select the button adjacent to the indication window. If the specified percent-age step size is out of the setpoint limit, a warning message will appear.

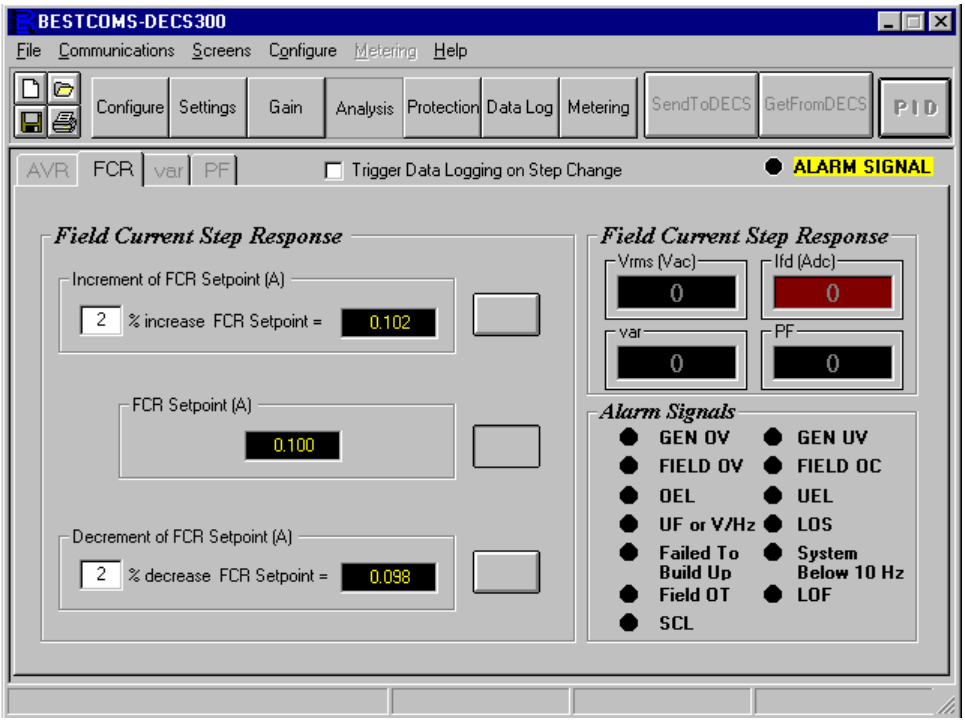

Figure 6-25. Analysis Screen, FCR Tab

FCR, FCR Setpoint (A). This setting is a read-only indication of the field dc current that was set in the FCR, *Setting Adjustments* screen. The type of field current (generator main field or exciter field current) depends on the Excitation Mode which was selected at the System Options screen. If you want the indicated field current to be the field current setpoint, select the button adjacent to the indication window. When the button is selected, the field current indicated is sent to the DECS-300 as the field dc current setpoint.

FCR, Decrement Of FCR Setpoint (A). This setting lets the user set the field current step size that the DECS-300 unit will use when step changing the field current. The range of this setting is from 0 to 10% in integer steps. If you choose a 10% step size, the field setpoint current minus the 10% of that setpoint is shown in the adjacent window. To send this current level setpoint to the DECS-300, select the button adjacent to the indication window.

FCR, Field Current Step Response, Ifd (Adc). This current is a read-only indication of the selected field current.

Var (Figure 6-26)

VAR, Reactive Power Step Response, Range Control, Min. This setting allows you to change the range indicated by the dial (VAR Step Settings) and the minimum allowable var settings for the generator. If you select the existing value (double click on the value), enter the new minimum limit (e.g. –25000), and press <Enter>, the minimum range on the dial changes to –25k. To reset the minimum to the rated limit based on the system configuration and settings, select (click) the **Reset Rated Limit** button.

VAR, Reactive Power Step Response, Range Control, Max. This setting allows you to change the range indicated by the dial (VAR Step Settings) and the maximum allowable var settings for the generator. If you select the existing value (double click on the value), enter the new minimum limit (e.g. 25000), and press <Enter>, the maximum range on the dial changes to 25k. To reset the maximum to the rated limit based on the system configuration and settings, select (click) the **Reset Rated Limit** button.

VAR, Reactive Power Step Response, Setpoint Value (kvar). This kvar setting is a read-only indication of the setpoint of reactive power from the *Setting Adjustments, VAR/PF* screen. If a step response setpoint change has been made from this screen, the actual setpoint value for the regulator will be different from this read-only indication.

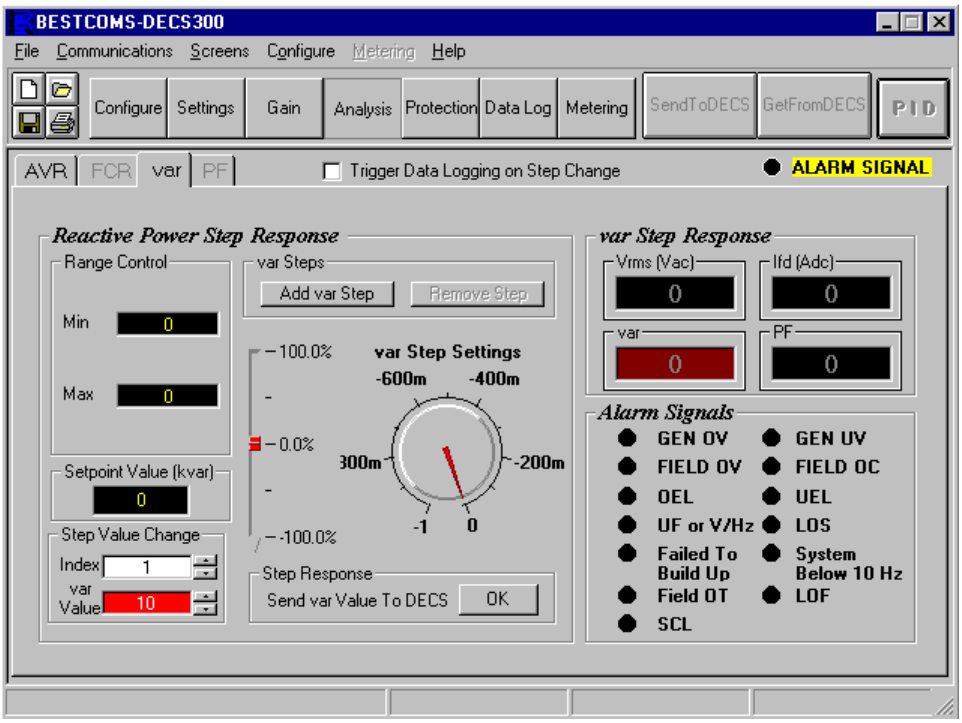

Figure 6-26. Analysis Screen, Var Tab

VAR, Reactive Power Step Response, Step Value Change. Changes to the kvar setpoint can be made using one of the three options: VAR Step Settings (dial), slide bar, or var Value window. For example, you want a setpoint value of –12 kvar. Select (double click) the var Value window, and enter a 1. Use the adjacent down arrow to decrease the setting to –12, and select (click and hold) the **Step Response, Send var Value To DECS** button. When the button is clicked, the button changes to **Index 1** (red in color). When the button is released, this var value setting is sent to the DECS-300 to be the reactive power setpoint for the var regulator. If the specified var value is out of the range limit, a dialog box will show you the accepted values for this step response. Changing the var setpoint through the var Value window does not change the dial or slide indicators. You can also use the mouse to point to the pointer (red pointer on the computer screen) select (click) and drag the pointer to the approximate setting that you want. As the pointer moves, the percent indicator (slide) changes to show the relative percent of minimum or maximum var setting. You can then fine tune the setpoint using the up/down scrolling keys of the var Value window.

VAR, Reactive Power Step Response, Step Value Change, Index. With this BESTCOMS software, you may select one, two, or three var step response setpoints (indexes), and make them active from this screen. In the previous paragraph, changing the setpoint value to a –12 created index 1. Create index 2 by clicking on the **Add VAR Step** button. (It may be necessary to drag the red pointer out of the way to allow you access to the yellow line pointer.) When you clicked to create index 2, the yellow line pointer and a yellow slide appear-ed on the screen. Drag the yellow line pointer to the index 2 setpoint value. As the index 2 pointer (yellow) moved, the percent value changed for the index 2 slide. You may also change the setpoint by selecting and dragging the handle on the slide. As the slide moves, the pointer moves and the var Value window display changes. Select (click and hold) the **Step Response, Send var Value To DECS** button, and a yellow Index 2 appears. When the button is released, this var value setting is sent to the DECS-300 to be the reactive power setpoint for the var regulator. A third index can be added in the same manner as index 2, but the third index color is blue.

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

VAR, Reactive Power Step Response, VAR Steps, Remove Step. This button removes a setpoint index. If three indexes are created and this button is clicked, the third step (Index 3) is removed. If two indexes

are created and this button is clicked, the second index is removed. If one index is created and this button is clicked, that index is removed.

VAR, VAR Step Response. This VAR indication is a read-only indication of the regulator var.

PF (Figure 6-27)

PF, Power Factor Step Response, Add PF Step. This button adds a setpoint index. A maximum of three setpoint indexes may be created. See the following paragraph *Power Factor Step Response, Step Value Change* for additional information on adding setpoint indexes (PF Steps).

PF, Power Factor Step Response, Remove Steps. This button removes a setpoint index. If three indexes are created and this button is clicked, the third step (Index 3) is removed. If two indexes are created and this button is clicked, the second index is removed. If one index is created and this button is clicked, that index is removed.

PF, Power Factor Step Response, PF Setpoint Value. This PF setting is a read-only indication of the PF setpoint from the *Setting Adjustments, VAR/PF* screen. If a step response setpoint change has been made from this screen, the actual setpoint value for the regulator will be different from this read-only indication.

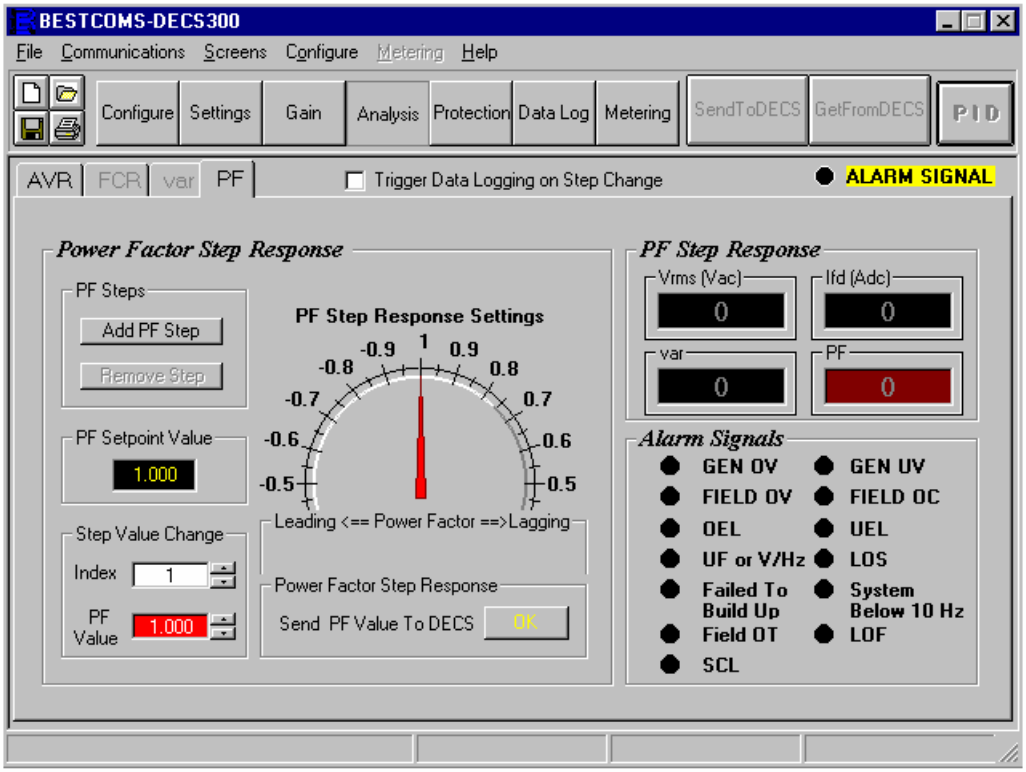

Figure 6-27. Analysis Screen, PF Tab

PF, Power Factor Step Response, Step Value Change. Changes to the power factor setpoint can be made using one of two options: PF Step Response Settings (dial) or PF Value window. For example, you want a leading PF setpoint value of –0.9. Select (double click) the PF Value window, and enter a -.9 and press the <Enter> key. At this time, the red pointer on the dial indicator should move to –0.9. Select (click and hold) the **Step Response, Send PF Value To DECS** button. When the button is clicked, the button changes to **Index 1** (red in color). When the button is released, this PF value setting is sent to the DECS-300 to be the power factor setpoint for the PF regulator. If the specified PF value is out of the range limit, a dialog box will show you the accepted values for this step response. Changing the PF setpoint through the PF Value window changes the dial indicator. You can also use the mouse to point to the pointer, select (click) and drag the pointer to the approximate setting that you want. You can fine tune the setpoint using the up/down scrolling keys of the PF Value window.

PF, Power Factor Step Response, Step Value Change, Index. With this BESTCOMS software, you may select one, two, or three PF step response setpoints (indexes), and make them active from this screen. In

the previous paragraph, changing the setpoint value to a –0.9 created index 1. Create index 2 by clicking on the **Add PF Step** button. (It may be necessary to drag the red pointer out of the way to allow you access the yellow line pointer.) When you clicked to create index 2, the yellow line pointer appeared on the screen. Drag the yellow line pointer to the index 2 setpoint value. Select (click and hold) the **Step Response, Send PF Value To DECS** button, and a yellow Index 2 appears. When the button is released, this PF value setting is sent to the DECS-300 to be the reactive power setpoint for the PF regulator. A third index can be added in the same manner as index 2, but the third index color is blue.

PF, Power Factor Step Response. This PF indication is a read-only indication of the regulator PF.

The **Trigger Data Logging on Step Change** check box is present on all tabs of the Analysis screen and can be used to create a serial-triggered data log for any step changes performed through the Analysis screen.

Protection

There are five tabs in the *Protection/Relay* screen: *Protection Options, Protection Settings, Relay #1, #2 Logic*, *Relay #3, #4 Logic*, and *Relay Settings*. Each tab has additional parameters as described in the following paragraphs.

Protection Options (Figure 6-28)

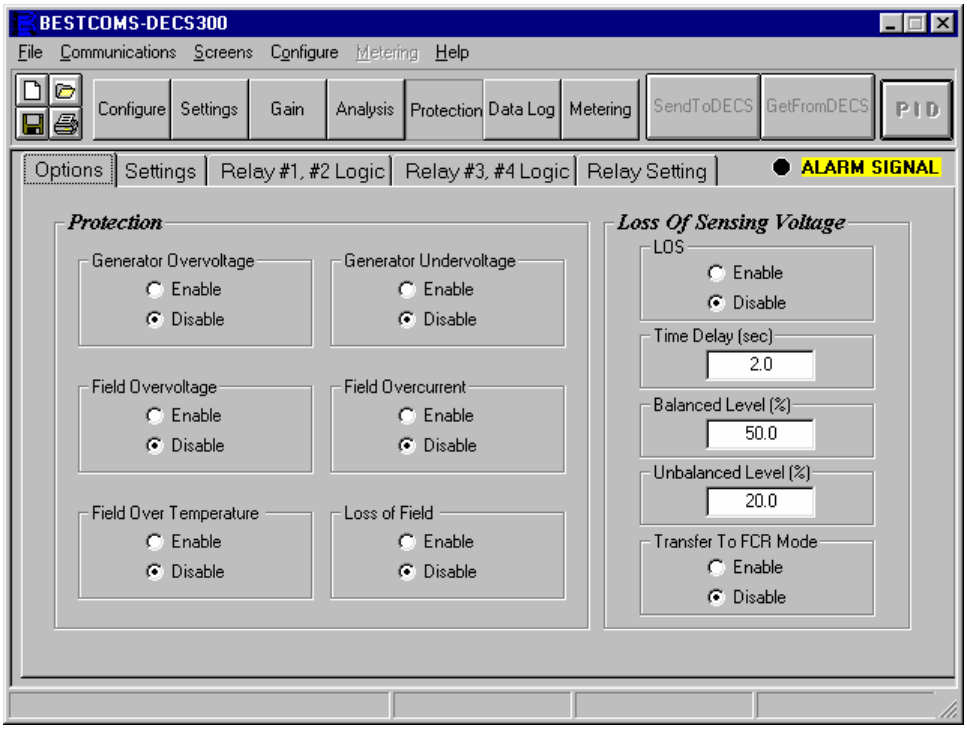

Figure 6-28. Protection/Relay Screen, Options Tab

Protection. To enable the protection options, select (click) on the **Enable** button for the protection function de-sired. To disable the function, select (click) on the **Disable** button. When these options are selected (Either enable or Disable) the change is immediately sent to DECS.

Loss Of Sensing Voltage, LOS. This setting allows the user to enable or disable the LOS function.

Loss Of Sensing Voltage, Time Delay, (sec). This setting allows the user to set the time delay between when the DECS-300 senses loss of voltage and when the alarm annunciates and if programmed, the output relay(s) actuates. When the time delay expires, the corresponding protection alarm LED will light (see *Alarm/Status* or *Analysis* screens for the detailed alarm LED signals). If programmed for the loss of sensing protection function, one or more of the four programmable output relays are actuated.

Loss of Sensing Voltage, Balance Level (%). This setting allows the user to set the LOS balance level in percent.

Loss of Sensing Voltage, Unbalance Level (%). This setting allows the user to set the LOS unbalance level in percent.

Protection Settings (Figure 6-29)

When new protection settings are typed in and entered, the new settings are immediately sent to the DECS.-300.

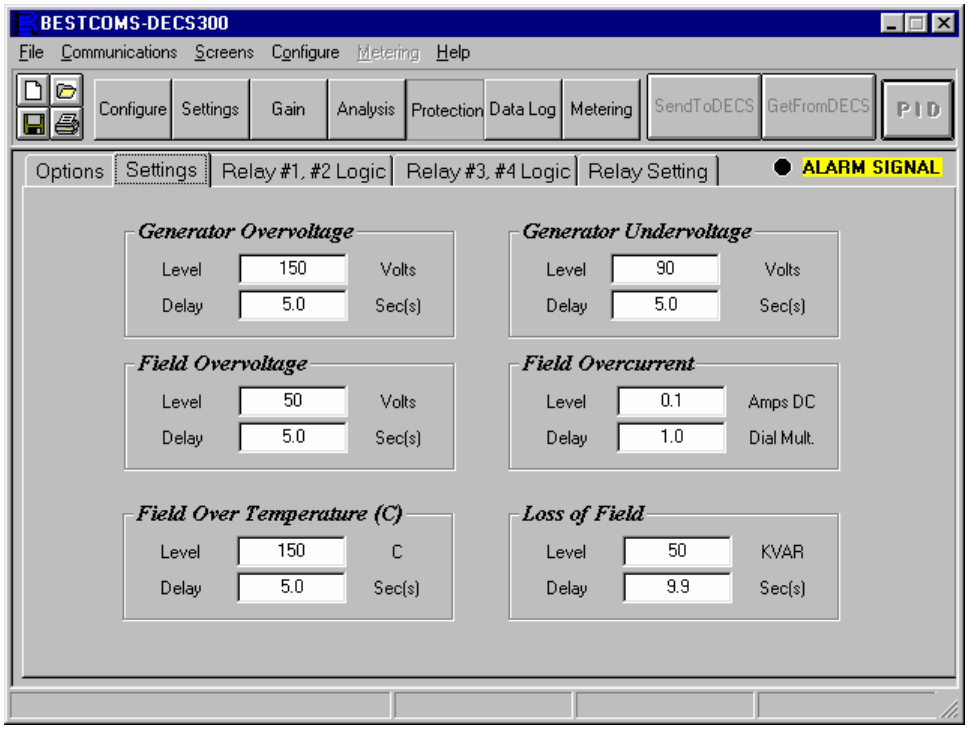

Figure 6-29. Protection/Relay Screen, Settings Tab

Level, Generator Overvoltage (V). This setting allows the user to set the generator primary voltage set-point for the over-voltage protection function. This setting is active if the generator overvoltage protection option is enabled. When the generator terminal voltage reaches this setting, and the specified time delay expires, the corresponding protection alarm LED lights (see the *Alarm/Status* or *Analysis* screens for the location of the specific alarm signal LEDs). If programmed for the overvoltage function, one or more of the four programmable output relays are actuated.

Level, Generator Undervoltage (V). This setting allows the user to set the generator primary voltage undervoltage setpoint for the undervoltage protection function. This setting is active if the generator undervoltage protection option is enabled. When the generator terminal voltage reaches this setting, after the time out of the specified time delay, the corresponding protection alarm LED will light (see *Alarm/Status* or *Analysis* screen for the detailed alarm LED signals). If programmed for the undervoltage function, one or more of the four programmable output relays are actuated.

Level, Field Overvoltage (V). This setting allows the user to set the field dc overvoltage setpoint for the field overvoltage protection function. This setting is active if the field overvoltage protection option is enabled. When the field voltage reaches this setting, after the time out of the specified time delay, the corresponding protection alarm LED will light (see *Alarm/Status* or *Analysis* screen for the detailed alarm LED signals). If programmed for the field overvoltage function, one or more of the four programmable output relays are actuated.

Level, Field Overcurrent (A). This setting allows the user to set the field dc overcurrent setpoint for the overcurrent protection function. This setting is active if the field overcurrent protection option is enabled. When the field current exceeds this setting, and remains there until after the time out of the specified time delay, the corresponding protection alarm LED will light (see *Alarm/Status* or *Analysis* screen for the detailed alarm LED signals). If programmed for the field overcurrent function, one or more of the four programmable output relays are actuated.

Level, Field Overtemperature (C/F). This setting allows the user to set the field overtemperature setpoint for the overtemperature protection function. The setpoint scale, Celsius or Fahrenheit, is selected in the *Configure* screen, *System Options*. This setting is active if the field overtemperature protection option is enabled. When the field temperature exceeds this setting, and remains there until after the time out of the specified time delay, the corresponding protection alarm LED will light (see *Alarm/Status* or *Analysis* screen for the detailed alarm LED signals). If programmed for the field overtemperature function, one or more of the four programmable output relays are actuated.

Level, Loss of Field (KVAR). This setting configures the setpoint for the loss of field protection function. This setting is active if the loss of field protection option is enabled. When the kvar value decreases below the negative value of this setting for the duration of the specified time delay, the corresponding protection alarm LED lights. (See the Alarm/Status or Analysis screen for the detailed alarm LED signals.) If programmed for the loss of field function, one or more of the four programmable output relays are actuated.

Time Delay, Generator Overvoltage (sec). This setting allows the user to set the time delay between when the generator voltage reaches the overvoltage setpoint and when the alarm annunciates and, if programmed, the output relay(s) actuates. This setting is active if the generator overvoltage protection option is enabled.

Time Delay, Generator Undervoltage (sec). This setting allows the user to set the time delay between when the generator voltage reaches the undervoltage setpoint and when the alarm annunciates and, if programmed, the output relay(s) actuates. This setting is active if the generator undervoltage protection option is enabled.

Time Delay, Field Overvoltage (sec). This setting allows the user to set the time delay between when the field voltage reaches the overvoltage setpoint and when the alarm annunciates and, if programmed, the output relay(s) actuates. This setting is active if the field overvoltage protection option is enabled.

Time Delay, Field Overcurrent Time Dial. This setting allows the user to select the time delay between when the field current reaches the overcurrent setpoint and when the alarm annunciates and, if programmed, the output relay(s) actuates. Time delay is initiated when the sensed current exceeds the overcurrent setpoint, and is inversely proportional to the overcurrent level. The higher the current level, the less time delay before alarm annunciation. This setting is active if the field overcurrent protection option is enabled.

Time Delay, Field Overtemperature (sec). This setting allows the user to set the time delay between when the field temperature reaches the overtemperature setpoint and when the alarm annunciates and, if programmed, the output relay(s) actuates. This setting is active if the field overtemperature protection option is enabled.

Time Delay, Loss of Field (sec). This setting allows the user to set the time delay between when the kvar level crosses the loss of field setpoint and when the alarm annunciates, and, if programmed, the output relay(s) actuate(s). This setting is active when the loss of field protection option is enabled.

Relay #1, #2, #3, And #4 Logic

There are four programmable output relays. Each of these relays may be programmed to actuate or operate when the required conditions are met for any of the seven protection functions, the upper and lower programmable setting limits, the stator current, over and underexcitation limits, loss of field, or underfrequency limit. The required conditions include exceeding the setpoint and time delay. If the DECS-300 is in the manual (FCR) mode and any of the four relays are programmed for the FCR Mode as shown in Figure 6-30, Output Relay #2 Options, then that relay will operate and announce the FCR (manual) condition. Figure 6-30 shows the programming for relays one and two. Relay logic for relays three and four are identical in programmability and are not illustrated. Changes in these settings are immediately sent to DECS-300.

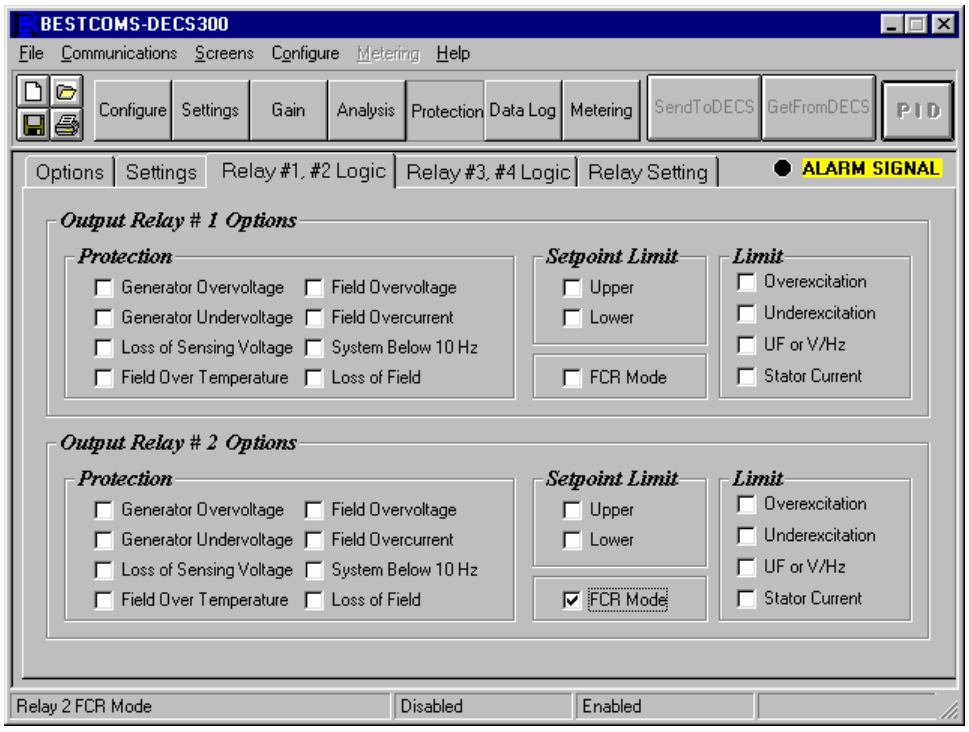

Figure 6-30. Protection/Relay Screen, Relay #1, #2 Tab

Relay Settings (Figure 6-31)

Each of the four programmable output relays are also programmable for Form (A is normally open and B is normally closed) and for momentary, maintained, or latched contacts. The momentary contact time is programmable from 0.1 to 5 seconds in 0.05-second increments. Maintained contacts are held for as long as the condition exists. Latched contacts re-main latched until reset. Normally-closed relays do **not** remain closed when power is removed from the DECS-300 unit. Normally-closed relay contacts open when power is removed. Changes in these settings are immediately sent to DECS-300.

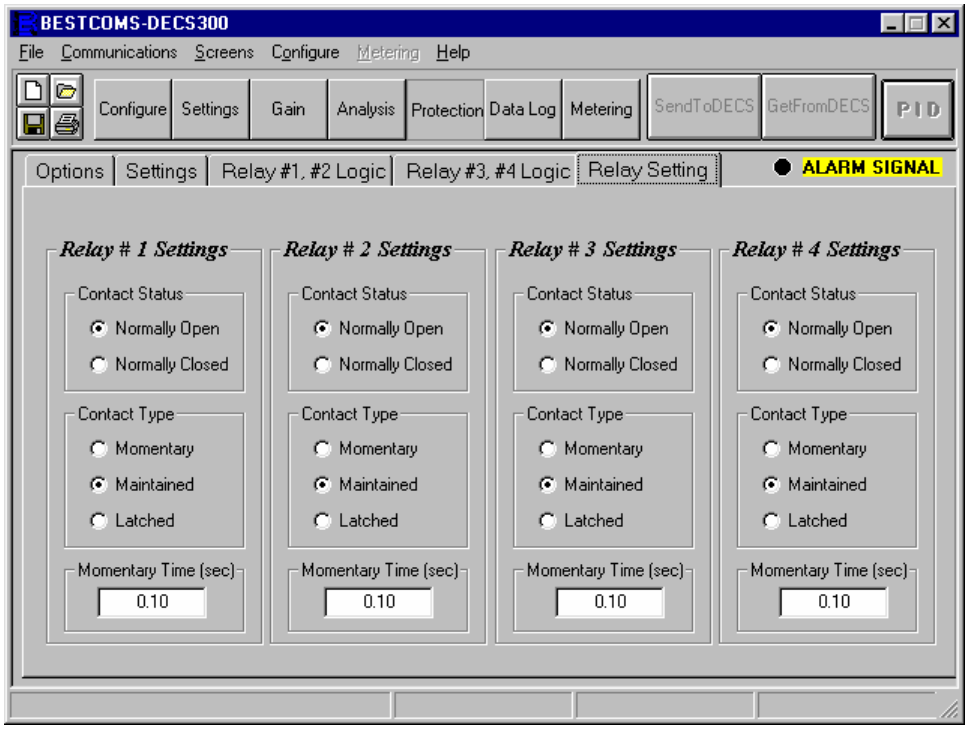

Figure 6-31. Protection/Relay Screen, Relay Setting Tab

Data Logging/Sequence of Events

Log Setup/Sequence of Events (Figure 6-32)

Data Logging Setup, Data Logging Enable. Data logging is enabled by clicking the check box.

Data Logging Setup, Pre-trigger Points. This setting is used to select the number of pre-trigger data points. A value of 0 to 599 may be selected.

Data Logging Setup, Sample Interval. This setting selects the sample rate of the data points. A sample interval of 4 milliseconds to 10 seconds may be entered.

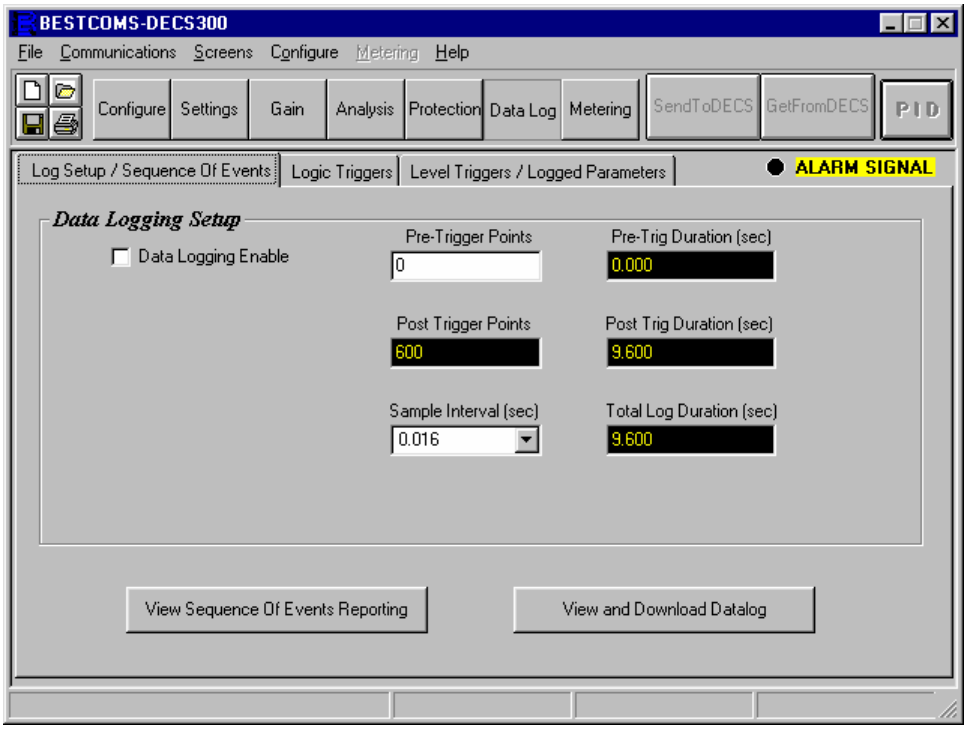

Figure 6-32. Data Log Screen, Log Setup/Sequence of Events Tab

View Sequence of Events Reporting. This button is pressed to display the sequence of events report. Figure 6-33 illustrates an example of a sequence of events report.

View and Download Data Log. Pressing this button accesses the Data Logging screen and its functions. Figure 6-34 illustrates the Data Logging screen.

Reset New Event List. Pressing this button refreshes the event list displayed in the bottom portion of the Sequence of Events Reporting screen.

Print/Save Report. Pressing this button allows the sequence of events report to be printed or saved as a text file.

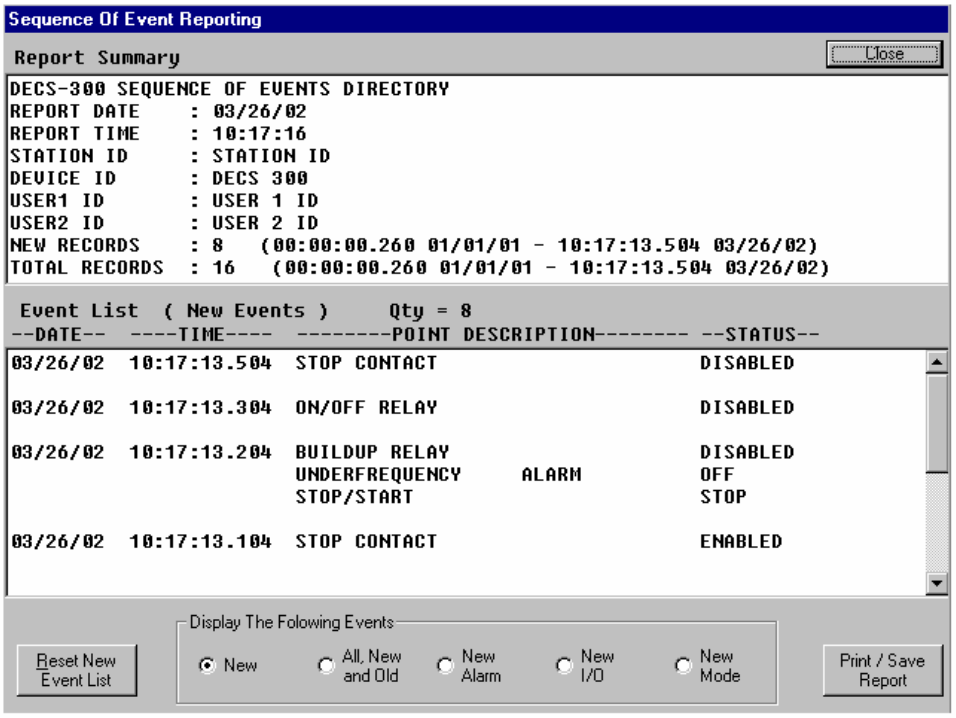

Figure 6-33. Sequence of Events Reporting Screen

Data Logging (Figure 6-34)

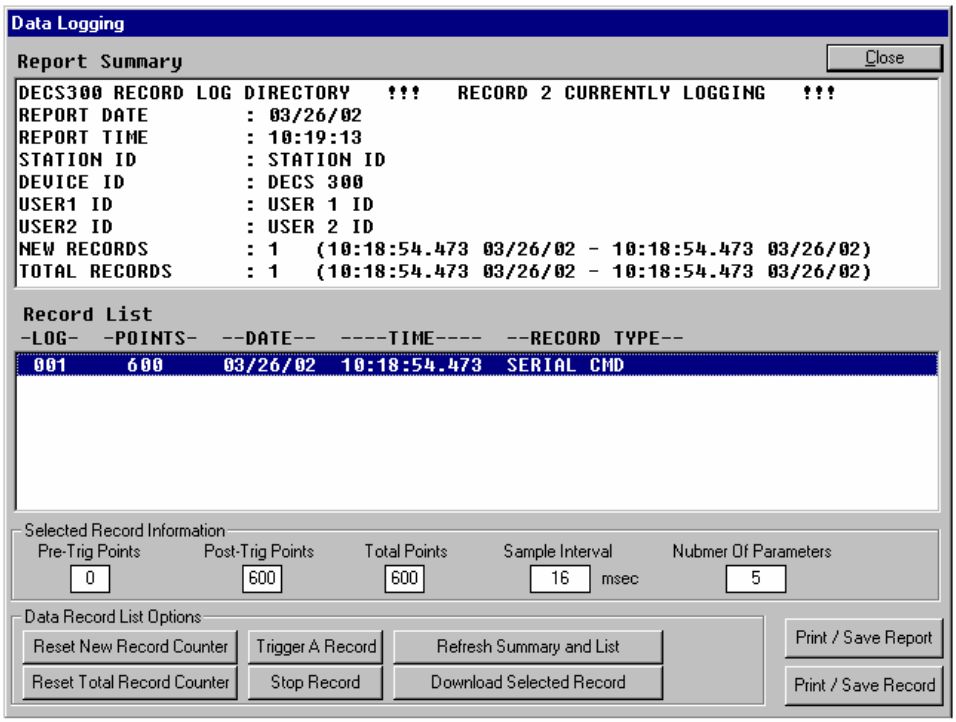

Figure 6-34. Data Logging Screen

Data Record List Options, Reset New Record Counter and Reset Total Record Counter. These buttons allow remote access to the data logging features. The new record counter and total record counter can be reset to zero by selecting either button.

Data Record List Options, Trigger A Record and Stop Record. A record can be software-triggered by pressing the Trigger A Record button. Pressing the Stop Record button ends the record.

Data Record List Options, Refresh Summary and List. Pressing this button updates the summary report and list with the latest information.

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

Data Record List Options, Print/Save Report and Print/Save Record. These two buttons allow for a report or record to be printed or saved as a text file.

Logic Triggers (Figure 6-34)

The Logic Triggers screen is used to set the conditions that will trigger a data logging report. Any combination of conditions can be selected.

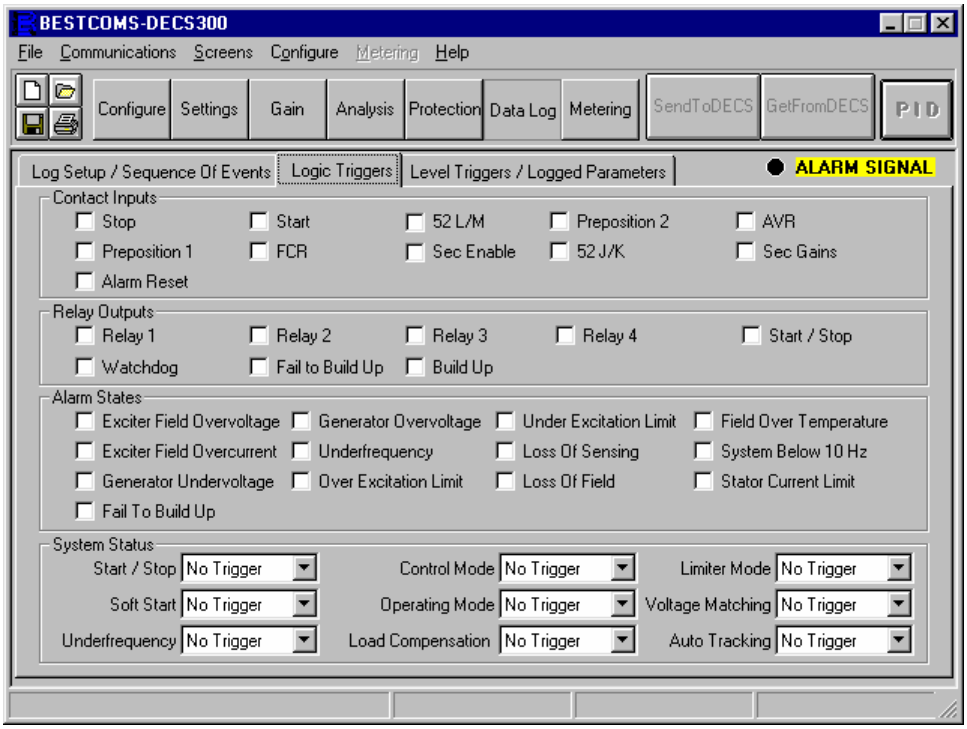

Figure 6-34. Data Log Screen, Logic Triggers Tab

Level Triggers/Logged Parameters (Figure 6-35)

This screen is used to set up the parameters monitored by the oscillography function and the levels at which they will trip. Up to six parameters may be selected for monitoring. Parameters are selected by checking the respective box. The Trigger Level Threshold fields provide for the selection of the upper and lower trigger levels for the monitored parameters. The upper and/or lower Trigger Level Threshold can be enabled for a parameter by entering a non-zero value in the appropriate field.

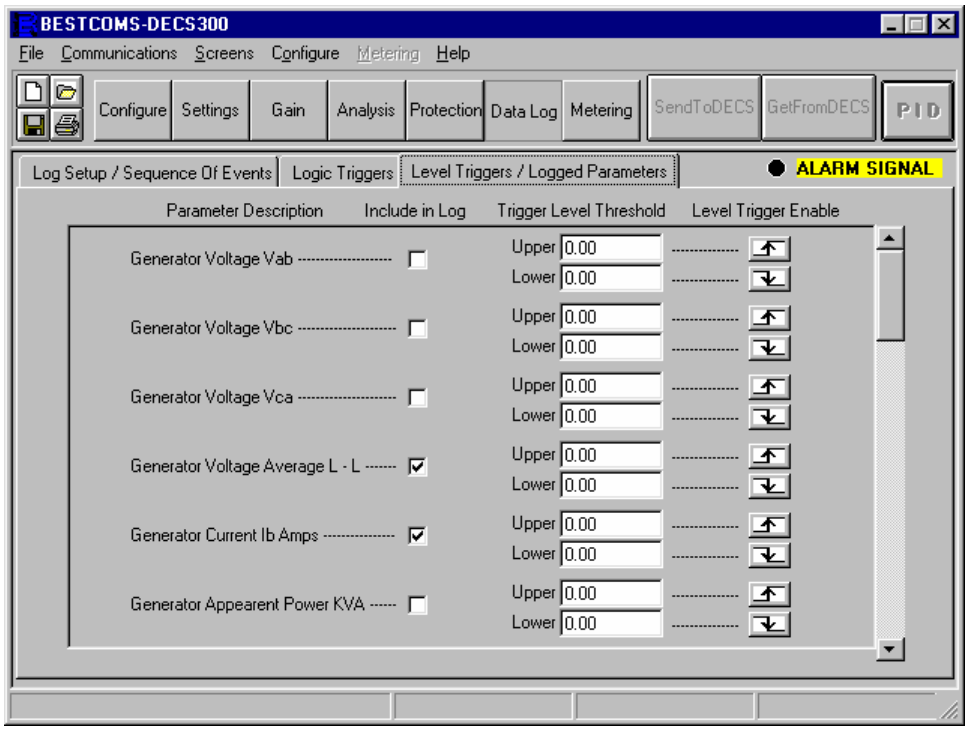

Figure 6-35. Data Log Screen, Level Triggers/Logged Parameters Tab

Metering

Operation

DECS-300 BESTCOMS software provides real time monitoring of the following data. This data is refreshed approximately once every second. Metering is enabled or disabled through the pull-down menu or by clicking the <Metering> button.

- Generator voltage and current
- Field voltage and current
- Bus voltage
- Phase angle (between phase voltage and phase current)
- Position Indication (Each mode of operation has programmable upper and lower setpoints. This percent indication is the relative position from current setpoint value to the minimum or maximum.)
- Generator frequency
- Bus frequency
- Auxiliary dc input voltage (This voltage is relative to the auxiliary input voltage or auxiliary input current depending on the mode selected. If the auxiliary input signal is 4 to 20 milliamperes, the current signal is converted to a voltage signal.)
- Generator apparent power (VA)
- Generator real power (kW)
- Generator reactive power (kvar)
- Field temperature
- Power factor
- Tracking error (this value is a percentage of the nominal value of the tracking mode to the mode being tracked. If you were in AVR mode and a generator nominal value of 100 volts and internal tracking with an indication of –0.5%, a transfer to another mode of operation would cause the generator output voltage to change to 99.5 volts.)

Included in the Operation tab of the Metering/Operation screen (Figure 6-36), are several important control functions. You may start or stop the system, select the mode of operation, choose voltage matching, and raise or lower the operating setpoint.

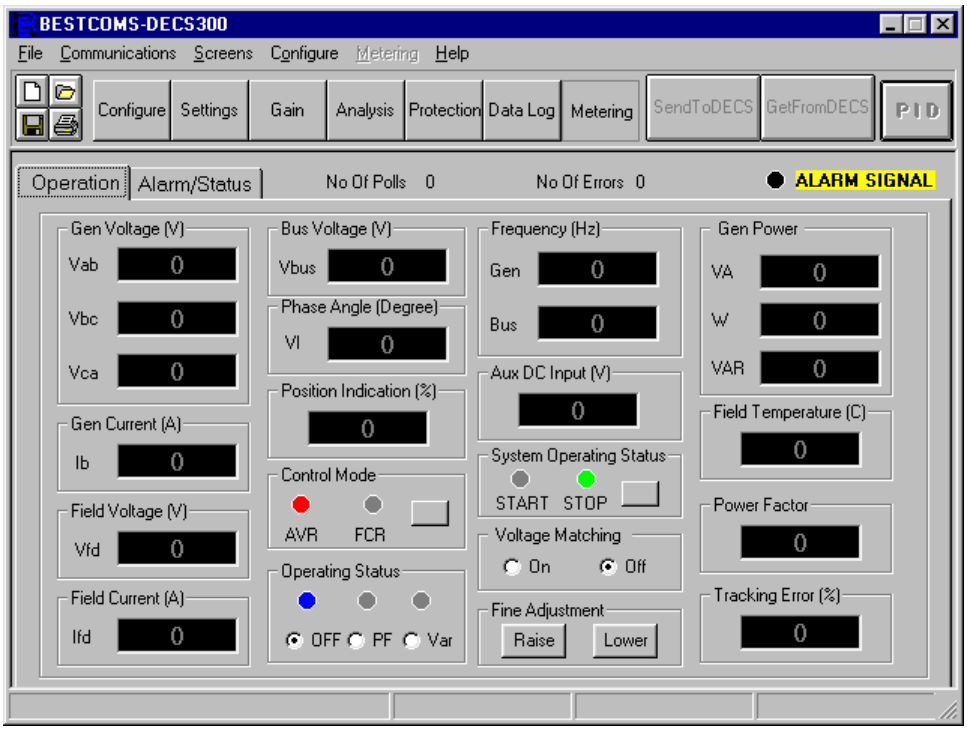

Figure 6-36. Metering/Operation Screen, Operation Tab

You must have either AVR or FCR for the control mode. To choose a control mode different than the one selected, select (click on) the Control Mode button. If you have password access, the new mode is sent to the DECS-300 unit. If you select the control Mode button again, the control mode switches back to the previous mode.

The Operating Status functions differently. To select var operation, select (click on) the VAR button. After the command is sent to DECS-300 and var mode is operational, the green LED above the VAR button turns ON. If the power factor mode is operational, the red LED above the PF button turns ON. If neither var or power factor mode is operational, the blue LED above OFF turns ON. You may select var or power factor mode if the control mode is FCR, but the var/power factor selection is ignored. In order for the var or power factor mode to be operational, the 52JK input (a terminal on the back of the DECS-300 unit) must also be open. See Table 6-1 for additional information on switch logic ignored. In previous DECS-300 versions, even though the VAR or PF LED was ON, the system may not have been in that mode. Effective with Revision C of this manual, the VAR or PF LED will follow the mode status.

Table 6-1. Switch 52JK And 52LM Input Logic

52JK Switch Input	52 LM Switch Input	Operational Mode
Open	Open	Var or Power Factor*
Closed	Open	Droop
Closed	Closed	**NOT** Var, Power Factor, or Droop

Note: * If neither var or power factor are selected via operator interfaces, then the operational mode is droop.

System Operating Status (START and STOP) function in a manner similar to the AVR and FCR control mode. You select (click on) the System Operating Status button to change from stop to start or start to stop. When the system is in stop, the green LED above STOP turns ON. When the system is in start, the red LED above START turns ON.

For the voltage matching function to be operational, the DECS-300 must be in AVR mode with the operating status (var/power factor) in OFF and the system **not** on line. To bring voltage matching into operation, select (click on) the On button (white circle by the On label), and if the DECS-300 is not in voltage matching, there is a slight pause while the information is sent to the DECS-300. The On button then gets a black dot in the middle of the circle. If voltage matching is already in operation and the black

dot is in the middle of the On circle, the system does not change. Switching voltage matching Off works the same way.

To raise or lower the operating setpoint, select the Fine Adjustment Raise or Lower button. The system responds with a change in setpoint the same as if you sent a remote signal into the raise or lower terminals on the back of the DECS unit.

Alarm/Status

Real-time monitoring provides critical generator data for evaluating the system performance. System status, switch status, and front panel LED signal status are displayed on the computer screen and refreshed approximately once every second.

System Status. Fifteen LEDs (Figure 6-37), provide system status information. If a system status condition (e.g., overvoltage or overcurrent) exists, the corresponding LED lights. Selecting (clicking) the Alarm Reset button resets the system status alarms and any condition that remains in alarm has the associated LED turned on again.

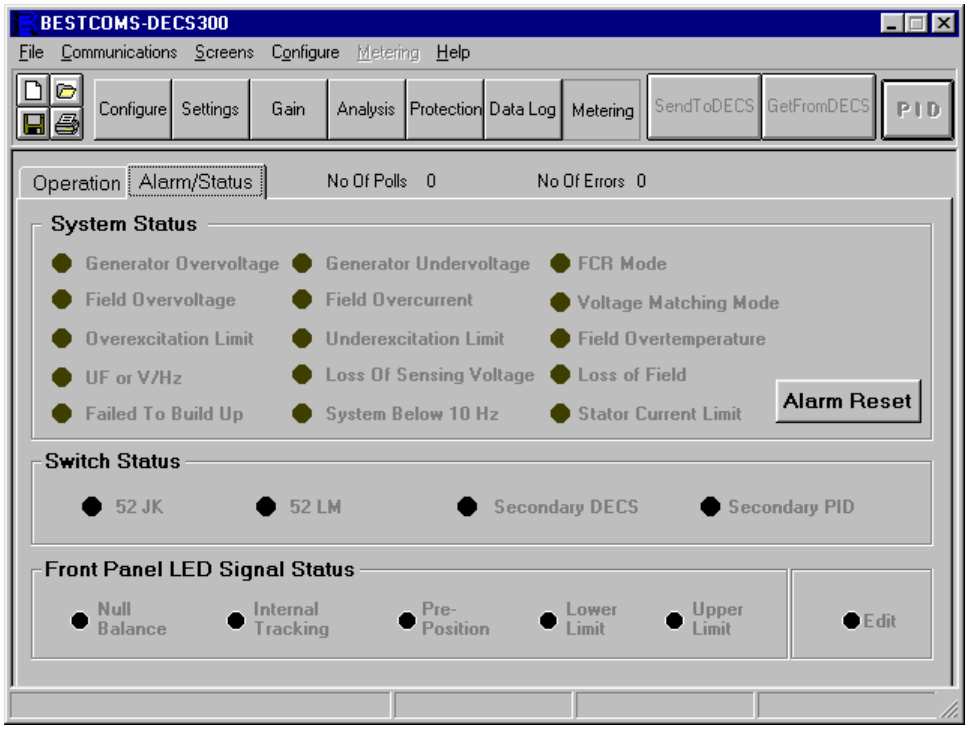

Figure 6-37. Metering/Operation Screen, Alarm/Status Tab

Switch Status. Four LEDs provide input switch status information. The LED for the 52 JK switch input turns on when the switch input is open. The LED for the 52 LM switch input turns on when the switch input is open. Refer to Table 6-1 for additional information on switch logic. The LED for Secondary DECS-300 lights when the contact input to SECEN (secondary enable) terminal is closed. The LED for Secondary PID lights when contact closure occurs at the DECS-300 Secondary PID Enable contact input terminals.

Front Panel LED Signal Status. Six LEDs provide a remote indication for the front panel LEDs. Refer to Section 2, *HMI* for additional information on the function or indication provided by these LEDs.

Number Of Polls and Number of Errors. These counters display the numbered of meter values and any errors polled from the unit. If five errors occur, an error message is displayed.

SAVING, PRINTING, AND OPENING FILES

BESTCOMS-DECS300-32 software also allows the user to save setup configurations to a computer file. This allows a user to save setups for history purposes and saves setup time when configuring multiple units to the same configuration. These files may be opened and edited using several different computer applications and printed from the DECS300-32 software print option for a hard copy reference.

Saving Files

If you have changed the settings on a specific DECS-300 unit, you may want to save those settings for reference or future use. You may save those settings as either a text file or data file.

Saving Data Files

To save DECS-300 settings in a data file, open the pull-down **File** menu and select **Save** or click the <Save File> icon. A Save As dialog box appears (Figure 6-38) with the default extension *.de3 for a DECS-300 data file. Use normal Windows® techniques and name the path and file with a file extension of .de3. When the path and file are named and you select **Save**, the dialog box disappears and the data file is saved.

Figure 6-38. Save As Dialog Box

Printing/Saving Text Files

A list of DECS-300 settings can be printed for use as a file reference. To do this, open the **File** pull-down menu and select **Print** or click the <Print> icon. When you select the Print command, a printer dialog box appears so that you can select the desired printer. Next, a dialog box will prompt you to type user information, the DECS-300 serial number, and comments to be printed at the top of the printout. Each of the three user entries are limited to a maximum of 54 characters. After you have entered the specific user information, Ok the Print command. A settings file dialog box appears with all of the settings. A text file can be saved by pressing the Save button. The file can be printed by pressing the Print icon. The BESTCOMS software version, current date and time, user specified information, and DECS-300 internal software version are provided, and the DECS-300 internal software version is provided if BESTCOMS is communicating with the unit.

Uploading Files

Only a DECS-300 file *(*.de3*) can be loaded into a DECS-300 unit. To upload this new file (or the factory settings) into the DECS-300 unit, initiate communications with the DECS-300 unit if you have not previously done so. Now open the **File** pull-down menu and select **Open** or click the <Open> icon. Use normal Windows techniques to select the new file. When you execute the **Open** command, a WARNING dialog box appears. This dialog box warns you that equipment damage may occur as a result of the changes that were made in the computer file. If you have confidence that no damage will occur, you may send the data to the DECS-300.

CAUTION

A file data transfer while the DECS-300 is on-line may result in poor system performance or equipment damage. Make sure that the new settings are safe to upload before you transfer the data file.

If you select <Yes>, then DECS-300 setting data is sent to the DECS-300 block by block. Please wait until all data has been transferred. After the data has been uploaded, a dialog box asks if you want to save the data into EEPROM. If you select No and later remove power from the DECS-300, all of the uploaded settings are lost. When power is next applied to the DECS-300 unit, the previous settings that were loaded in EEPROM will be the current settings.

PID WINDOW

BESTCOMS-DECS300-32 software provides the capability to increase the generator stability by changing the PID (Proportional-Integral-Derivative) parameters. This capability calculates PID parameters automatically after the user selects generator time constant (**T'_{do}**), and/or exciter time constant (**T_{exc}**). You may generate new PID numbers, add to a PID list file, and update the AVR gain settings in the Control Gain screen. The <PID> button allows you to access the PID Window. It is available only when the Control Gain, Stability Range is set to 21 (which is the default setting).

When you select the PID button, the PID Window (Figure 6-39) allows you to modify the PID numbers. After the PID numbers are calculated and up-dated, you can close this window by clicking the <Update setting Screen> button. Modified PID numbers are shown in the current screen. When complete, you may use the <SendToDECS> command or click the changed setting and press the <Enter> key to update the DECS-300 PID AVR gain settings. If this command is not executed, the changes will not be saved.

Figure 6-39 shows the PID Window with the Main Field screen. If the excitation mode in the System Options screen is set to Exciter Field, the Exciter Field Input Data screen appears.

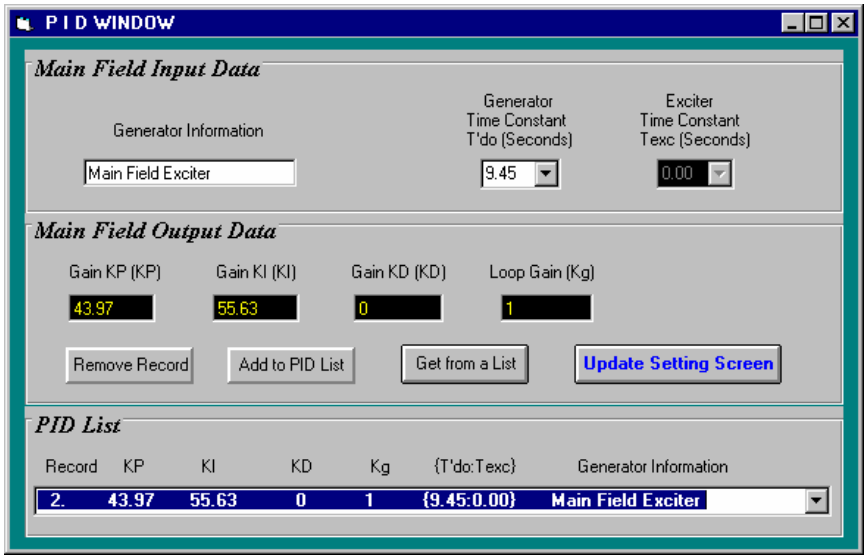

Figure 6-39. PID WINDOW With Generator Main Field Input Data

PID Calculations Based On Input Values

The exciter time constant available range is determined by the generator time constant input value. (The default value for the exciter time constant is the generator time constant divided by six.) The generator time constant input value must be in the range of 1.00 to 15.00 seconds and in 0.05 second increments. When the generator time constant value is 1.00, the available exciter time constant range is 0.03 to 0.50 in 0.01 second increments. When the generator time constant value is 15.00, the available exciter time constant range is 0.30 to 3.00 in 0.01 second increments.

For example, when you set $\mathbf{T'_{do}}$=2.0 seconds, $\mathbf{T_{exc}}$ is 0.33. After specifying the input values, a set of PID parameters (Output Data) is generated automatically. If you set $\mathbf{T'_{do}}$=5.00 seconds, then $\mathbf{T_{exc}}$ will be 0.83 seconds. The calculated KP is 155.47, KI is 138.72, KD is 48, and Kg is 1.

PID parameters can be directly removed from, added to, or modified in the PID List Data. PID parameters may also be saved into a file (*pidlist.dat*).

Adding To PID List

CAUTION

Improper PID numbers will result in poor system performance or equipment damage!

ID parameters can be added to a list and recalled for operational use and comparison. To add to the list, type the name for the generator (or other appropriate information) in the generator information box. Choose the generator time constant and if appropriate, the exciter time constant. Observe the PID gain parameters in the Field Output Data boxes. If these gain parameters are appropriate, select (click on) the **Add to PID List** button. To check for the new parameters, pull down the **PID Parameters List** (click on the down arrow). The new gain and time constant parameters should be displayed.

Removing A PID List Record

PID parameters can also be removed from the list. To remove a list (record), pull down the **PID Parameters List** and select the record or list so that the gain and time constant parameters are displayed. Select (click on) the **Remove Record** button and the listed record is deleted.

Retrieving Existing Data From PID List

CAUTION

Improper PID numbers will result in poor system performance or equipment damage!

To retrieve existing data, pull down the **PID Parameters List** and select the record or list so that the gain and time constant parameters are displayed and highlighted. Select (click on) the **Get from a list** button and the listed record input and output data displays in the boxes.

TERMINATING COMMUNICATIONS

To terminate DECS300-32 communications, pull down the **Communications** menu and select **Close**. When you execute the Close command, communications are terminated. Pull down the **File** menu, choose **Exit,** and the DECS300-32 software is terminated.

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SECTION 7 • MAINTENANCE

TABLE OF CONTENTS

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SECTION 7 • MAINTENANCE

PREVENTIVE MAINTENANCE

The only preventive maintenance required on the DECS-300 is to periodically check that the connections between the DECS-300 and the system are clean and tight. DECS-300 units are manufactured using state-of-the-art, surface mount technology. As such, Basler Electric recommends that no maintenance procedures be attempted by anyone other than Basler Electric personnel.

WARNING!

Removal of the electronic assembly from the case opens the input current transformer (CT) circuit(s). If the case is connected to an active system and the CT circuits are not shorted, high voltage is present. This high voltage may cause electrical shock that could result in injury or death.

WARRANTY AND REPAIR SERVICE

The Basler DECS-300 is warranted against defective material and workmanship for 18 months from the date of shipment from our factory. Units submitted for warranty repair should be returned to the factory in Highland, Illinois, freight pre-paid, with a complete description of the installation and the reported problem. Prearrangement with either the nearest Basler Electric sales office or with the Customer Service Department at the factory will assure the fastest possible turn-around time.

TROUBLESHOOTING

These troubleshooting procedures assume that the excitation system components are selected correctly, fully operational, and connected correctly. If you do not get the results that you expect from the DECS-300, first check the programmable settings for the appropriate function.

DECS-300 Appears Inoperative

If the DECS-300 unit does not power-up (no backlighting on front panel display), ensure that the input power to the unit is present, the correct voltage, and if dc, the correct polarity. The input voltage range is 90 to 150 Vdc if the battery input is used, and 82 to 132 Vac if the ac input is used. If the input power is okay, return the unit to the factory as described in the preceding paragraphs.

Display Blank Or Frozen

If the front panel display (LCD) is blank or frozen (does not scroll), remove input power and then reapply input power after approximately 60 seconds. 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 the factory as described in the preceding paragraphs.

Generator Voltage Does Not Build

Check the DECS-300 settings for the following system configurations.

a) Generator potential transformer (PT) primary voltage.
b) Generator PT secondary voltage.
c) Analog control output signal type.

Check the DECS-300 soft start settings.

d) Maximum field flash dropout time
e) Field flash dropout level.
f) Generator soft start bias.
g) Generator soft start time.

If the generator voltage still does not build, increase the soft start setting values in paragraphs d through f, and decrease the setting for paragraph g.

Temporarily turn off the overexcitation limiter.

Generator Voltage Builds But DECS-300 Fails To Flash

Check the DECS-300 settings for the following system configurations.

a) Generator potential transformer (PT) primary voltage.
b) Generator PT secondary voltage.
c) Analog control output signal type.

Check the DECS-300 soft start settings.

d) Maximum field flash dropout time
e) Field flash dropout level.
f) Generator soft start bias.
g) Generator soft start time.

If the generator voltage still does not build, increase the soft start setting values in paragraphs d through f, and decrease the setting for paragraph g.

Temporarily turn off the overexcitation limiter.

Check the exciter power circuitry.

If the problem persists, return the unit to the factory as described in the preceding paragraphs.

Field Voltage Reading or Current Reading on LCD Does Not Change

Check the connections between the isolation module and the DECS-300.

Check the connections between the isolation module and shunt (field current sensing); and between the isolation module and the output of the exciter (field voltage sensing).

If the problem persists, apply a field current or voltage input signal to the DECS-300 at connector P1. (You are simulating the output from the isolation module.) The field current signal should be applied to P1, pin 4, and return to P1, pin 5. The field current signal should be 2.0 to 9.5 volts dc with 2.0 volts dc equal to zero field current.) The field voltage signal should be applied to P1, pin 6, and return to P1, pin 7. The field voltage signal should be 0.9 to 9.1 volts dc with 5.0 volts dc equal to zero field voltage. If necessary refer to Section 4, *Installing, Connections*, for P1 terminations. If the LCD reading does not change, return the unit to the factory as described in the preceding paragraphs. If the reading does change, the isolation module is defective.

Low Generator Voltage (In AVR Mode)

Check the DECS-300 for the following settings.

a) AVR voltage setpoint.
b) Generator potential transformer (PT) primary voltage.
c) Generator PT secondary voltage.
d) OEL is not activated.
e) Accessory inputs (should be zero).
f) VAR/PF and droop should be disabled.
g) Cut-in underfrequency setting is below the generator operating frequency.

If the problem persists, contact Basler Electric, Customer Service for advice.

High Generator Voltage (In AVR Mode)

Check the DECS-300 for the following settings.

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 Basler Electric, Customer Service 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-300 drive voltage. If the problem is caused by the DECS-300, check the gain settings for the specific mode of operation selected.

If the problem persists, contact Basler Electric, Customer Service 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 Basler Electric, Customer Service for advice.

Metering Readings Incorrect

If your PF, VAR, or watt readings are significantly different from the expected readings for a know load, verify that the CT for phase B is actually placed on the phase B input to the DECS-300 and not or phase A or C

No Communications

If communications can not be initialized, check the serial cables to the port connections, the transmission speed (baud rate), and supporting software.

DECS-300 Reboots Frequently

If a single input power source is used and the input power is less than the minimum as specified or fluctuates below the minimum, the DECS-300 will reboot. Increase input power to meet or exceed the specified requirements.

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SECTION 8 • MODBUS COMMUNICATIONS

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SECTION 8 • MODBUS™ COMMUNICATIONS

INTRODUCTION

This section describes the Modbus™ communications protocol employed by the DECS-300, and how to exchange information with DECS-300 over a Modbus™ network. The DECS-300 communicates by emulating a subset of the Modicon 984 Programmable Controller.

DECS-300 MODBUS™ PROTOCOL

Modbus™ communications use a master-slave technique in which only the master can initiate a transaction. This transaction is called a query. When appropriate, a slave (DECS-300) 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-300 is grouped characteristically in categories. The following information categories are maintained by the DECS-300:
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 can not 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™, and will always generate a response to the query unless certain error conditions occur. The DECS-300 is designed to communicate on the Modbus™ 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-300 (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-300 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 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-300 Modbus™ performs all of the above functions when a Modbus™ message has its unique address which is numbered from 1 to 247. DECS-300 also recognizes a broadcast (group) address of 0. Only functions 16 and 8 are recognized as valid for broadcast. DECS-300 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 the validity of response message contents. 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-300 supports only the RTU mode via rear RS-485 serial interface.

Communication settings for DECS-300 Rear RS-485 port are listed in Table 8-1.

Table 8-1. DECS-300 Communication Settings

Setting	Programmable Y(Yes) / N(No)	Default Value	Value Range
Baud rate	Y	9600	1200/2400/4800/9600/19200
Data Size in bits	N	8	N/A
Parity	Y	None	'N'=None, 'O'=ODD, 'E'=EVEN
Stop Bits	Y	2	1 or 2
Modbus™ Slave Address	Y	247	0 for broadcast, 1 to 247 for Slave
Modbus™ Response Delay Time in ms	Y	10 ms	From 0 to 200 ms in increments of 10 ms

Communication settings are user-selectable and can be set at installation and altered during real-time operation.

Message Framing and Timing Considerations

When receiving a message, the DECS-300 requires an inter-byte latency of 3.5 character times before considering the message complete.

Once a valid query is received, the DECS-300 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 8-2 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 8-2. Timing Considerations For 10 Character Bits (8 Data Bits + 1 Start Bit + 1 Stop Bit)

Baud Rate	1 character Time (msec)	3.5 characters Time (msec)	Max. Read Register Response Message (255 characters) Transmission Time (msec)
1200	8.33	29.17	2,124.15
2400	4.17	14.58	1,063.35
4800	2.083	7.292	531.165
9600	1.0417	3.645	265.6335
19200	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-300 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-300) 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-300 are provided in Table 8-3.

Table 8-3. 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-300 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-300 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-300 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 can not 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 which 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.

NOTE

Variables changed by this function will not be directly saved to non-volatile 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.

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-300 will perform the write when the device address is the same as the DECS-300 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 section 7.2.8 Data Format).

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 results 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-300 Modbus™ address space, but is not referenced to the lower order 16 bits of the assigned application data. (See explanation in section 7.2.8 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 section 7.2.8 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: Max. length of Preset Multiple Registers Query is 9 + (100 x 2) = 209 bytes.

Response

The response message echoes the starting address and the number of registers. There is no response message when the query is a broadcast (device address of 0).

Device Address	Function Code = 10 (hex)	Starting Address High	Starting Address Low	Number of Registers High	Number of Registers Low	CRC Low	CRC High

Preset Single Register (Write Single Holding Register)

A Preset Single Register query message requests a single register to be written. The DECS-300 will perform the write when the device address is the same as the DECS-300 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

Response

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 the Read Only registers result in an error response with Exception Code of "Illegal Data Address".
- A query to write an illegal 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-300 data value (e.g. - 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".

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-300 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-300 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-300 to the listen only mode for Modbus™ communications, isolating it from other devices on the network.

While in Listen 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-300 receives the restart communications query, the listen only mode is removed.

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-300 data does not need to be converted into any special format for transmission over a Modbus™ network.

Modbus™ Registers hold original DECS-300 data of the generic (built-in) data types listed in Table 8-4.

Table 8-4. 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-300 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-300 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 contains always 0, and second (low) HR byte contains the data.

Example:

Assume that 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 8-5.

Table 8-5. 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 DECS-300 UINT16 or INT16 type data which value is 0xF067 is mapped to HR 47003. Data is copied to HR 47003 as shown in Table 8-6.

Table 8-6. 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:

UI32 data type, which value is 0xE0234567 is mapped to two Holding registers (such as 45003 and 45004) as shown in Table 8-7.

Table 8-7. 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, (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 8-8 shows the floating-point format.

Table 8-8. 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 8-9.

Table 8-9. Number 123 In Floating Point Format

Register	45005	45006
Hexadecimal	0000	42F6

CAUTION

For DECS-300 Modbus, two consecutive holding registers, which are mapped to any of the four-byte data types, are considered to be linked together as one atomic, indivisible unit of information that can be read or written by Modbus message only as one entity (that is, one cannot be read or written without the other.

Binary	0000 0000 0000 0000	0100 0010 1111 0110

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-300 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. If no transmission error has occurred, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

The CRC calculation is performed using all bytes of the device address, function code and data block fields. A 16-bit CRC-register is initialized to all 1's. Then each eight-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted eight times. The CRC-register MSB is zero-filled with each shift. After each shift, the CRC-register LSB is examined. If the LSB IS a 1, the CRC-register is 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-300 MODBUS™ REGISTER SPACE

Modbus™ Address space from 40000 to 49999 refers to Functions code 3, 6 and 16. DECS-300 uses address space from 47001 to 48250 (1250 registers). This address space is divided into fourteen areas, referred to as information categories. Table 8-10 provides a statistical summary for each information category.

Table 8-10. 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	60	R	UCHAR: 60
C2	Metering	125	47251 to 47375	57	R	FLOAT: 24 UINT16: 9
C3	Reporting (Status)	125	47376 to 47500	None	R	None (for future use)
C4	Control System Configuration Group 1	60	47501 to 47560	60	59 RW 1 R	FLOAT: 26 UINT16: 8
C5	Operating Modes	60	47561 to 47620	27	19 RW 8 R	UINT16: 27
C6	Setpoints	120	47621 to 47740	106	48 R 58 RW	FLOAT: 49 UINT16: 84
C7	Start-up	60	47741 to 47800	20	RW	FLOAT: 10
C8	Limiters	60	47801 to 47860	56	RW	FLOAT: 28
C9	Control Loop Gains	60	47861 to 47920	49	RW	FLOAT: 24 UNIT16: 1
C10	Protective Functions	60	47921 to 47980	30	RW	FLOAT: 12 UNIT16: 64
C11	Calibration	60	47981 to 48040	None (for future use)	RW	None (for future use)
C12	Relays	120	48041 to 48160	83	RW	UINT16: 83
C13	General System	60	48161 to 48220	8	2 R 6 RW	UINT16: 6 UCHAR: 2
C14	FP Metering Configuration	30	48221 to 48250	3	3 RW	UINT16: 3
C15	Control System Configuration Group II	50	48501 to 48550	6	RW	FLOAT: 3

DECS-300 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-300. There is a separate table for each information category.

Holding Registers for Information Category C1

Table 8-11. Information Category C1 (Product Information)

Registers	Data Description	Access	Data Format
47001	1st character of the ASCII string of model information	R-	UI8
47002	2nd character of the ASCII string of model information	R-	UI8
47003	3rd character of the ASCII string of model information	R-	UI8
47004	4th character of the ASCII string of model information	R-	UI8
47005	5th character of the ASCII string of model information	R-	UI8
47006	6th character of the ASCII string of model information	R-	UI8
47007	7th character of the ASCII string of model information	R-	UI8
47008	8th character of the ASCII string of model information	R-	UI8
47009	Last character of the ASCII string of model information	R-	UI8
47010	1st character of the ASCII string of application program version number	R-	UI8
47011	2nd character of the ASCII string of application program version number	R-	UI8
47012	3rd character of the ASCII string of application program version number	R-	UI8
47013	4th character of the ASCII string of application program version number	R-	UI8
47014	5th character of the ASCII string of application program version number	R-	UI8
47015	6th character of the ASCII string of application program version number	R-	UI8
47016	7th character of the ASCII string of application program version number	R-	UI8
47017	Last character of the ASCII string of application program version number	R-	UI8
47018	1st character of the ASCII string of date of the application program	R-	UI8
47019	2nd character of the ASCII string of date of the application program	R-	UI8
47020	3rd character of the ASCII string of date of the application program	R-	UI8
47021	4th character of the ASCII string of date of the application program	R-	UI8
47022	5th character of the ASCII string of date of the application program	R-	UI8
47023	6th character of the ASCII string of date of the application program	R-	UI8
47024	7th character of the ASCII string of date of the application program	R-	UI8
47025	8th character of the ASCII string of date of the application program	R-	UI8
47026	Last character of the ASCII string of date of the application program	R-	UI8
47027	1st character of the ASCII string of DSP program version number	R-	UI8
47028	2nd character of the ASCII string of DSP program version number	R-	UI8
47029	3rd character of the ASCII string of DSP program version number	R-	UI8
47030	4th character of the ASCII string of DSP program version number	R-	UI8
47031	5th character of the ASCII string of DSP program version number	R-	UI8
47032	6th character of the ASCII string of DSP program version number	R-	UI8
47033	7th character of the ASCII string of DSP program version number	R-	UI8
47034	Last character of the ASCII string of DSP program version number	R-	UI8
47035	1st character of the ASCII string of date of the DSP program	R-	UI8
47036	2nd character of the ASCII string of date of the DSP program	R-	UI8
47037	3rd character of the ASCII string of date of the DSP program	R-	UI8

Table 8-11. Information Category C1 (Product Information)

Registers	Data Description	Access	Data Format
47038	4th character of the ASCII string of date of the DSP program	R-	UI8
47039	5th character of the ASCII string of date of the DSP program	R-	UI8
47040	6th character of the ASCII string of date of the DSP program	R-	UI8
47041	7th character of the ASCII string of date of the DSP program	R-	UI8
47042	8th character of the ASCII string of date of the DSP program	R-	UI8
47043	Last character of the ASCII string of date of the DSP program	R-	UI8
47044	1st character of the ASCII string of Boot program version number	R-	UI8
47045	2nd character of the ASCII string of Boot program version number	R-	UI8
47046	3rd character of the ASCII string of Boot program version number	R-	UI8
47047	4th character of the ASCII string of Boot Program version number	R-	UI8
47048	5th character of the ASCII string of Boot program version number	R-	UI8
47049	6th character of the ASCII string of Boot program version number	R-	UI8
47050	7th character of the ASCII string of Boot program version number	R-	UI8
47051	Last character of the ASCII string of Boot program version number	R-	UI8
47052	1st character of the ASCII string of date of the Boot program	R-	UI8
47053	2nd character of the ASCII string of date of the Boot program	R-	UI8
47054	3rd character of the ASCII string of date of the Boot program	R-	UI8
47055	4th character of the ASCII string of date of the Boot program	R-	UI8
47056	5th character of the ASCII string of date of the Boot program	R-	UI8
47057	6th character of the ASCII string of date of the Boot program	R-	UI8
47058	7th character of the ASCII string of date of the Boot program	R-	UI8
47059	8th character of the ASCII string of date of the Boot program	R-	UI8
47060	Last character of the ASCII string of date of the Boot program	R-	UI8
47061 to 47250	Reserved for future C1 data	Not supported	Not defined

Holding Registers for Information Category C2

Table 8-12. Information Category C2 (Metering)

Registers	Data Description	Access	Data Format
47251-52	Phase A to B rms generator voltage	R -	R32_23
47253-54	Phase B to C rms generator voltage	R-	R32_23
47255-56	Phase C to A rms generator voltage	R-	R32_23
47257-58	Average of the 3 rms line-to-line voltages	R-	R32_23
47259-60	Phase B generator current in amps	R-	R32_23
47261-62	Generator apparent power in kVA	R-	R32_23
47263-64	Generator real power in kW	R-	R32_23
47265-66	Generator reactive power in kVAR	R-	R32_23
47267-68	Power factor	R-	R32_23
47269-70	Generator frequency in Hertz	R-	R32_23
47271-72	Bus frequency in Hz	R-	R32_23
47273-74	RMS bus voltage in Volts	R-	R32_23
47275-76	Field voltage in Volts	R-	R32_23
47277-78	Field current in Amps	R-	R32_23
47279-80	VAR/PF controller output in Volts	R-	R32_23
47281-82	Phase angle between phase B voltage and current in degrees	R-	R32_23
47283-84	Auxiliary input in volts (PSS input)	R-	R32_23
47285-86	Current input for load compensation	R-	R32_23
47287-88	Null balance (tracking error) in percent	R-	R32_23
47289-90	Error signal to autotracking loop	R-	R32_23
47291-92	Active controller output	R-	R32_23

Table 8-12. Information Category C2 (Metering)

Registers	Data Description	Access	Data Format
47293	PF state: 0 = leading / 1 = lagging	R-	UI16
47294	Generator state: 0 = generating / 1 = motoring	R-	UI16
47295	Status of the Front panel LEDs (bit flags, where 0=off, 1=on): b0 = Null Balance, b1 = Tracking, b2 = Pre-position, b3 = Upper Limit, b4 = Lower Limit, b5 = Edit, b6-b15 = unassigned	R-	UI16
47296	Voltage matching status: 0=off / 1=on	R-	UI16
47297	Protection status bit flags (0=clear, 1=condition present): b0 = field over-voltage, b1 = field over-current, b2 = gen. under-voltage, b3 = gen. 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 = gen. failed to build up, b12 = gen. below 10Hz, b13 = field overtemperature, b14-b15 are unassigned.	R-	UI16
47298-99	Reserved for future C2 data	R-	R32_23
47300-01	The active operating setpoint expressed as a percent of its present adjustment range.	R-	R32_23
47302	The state of some contact inputs: b0 = 52JK, b1 = 52LM, b2 = Automatic transfer, b3 = Switch Input 1 (SWI-1)	R-	UI16
47303	Annunciation status bit flags (0=clear, 1=annunciation present): b0 = field over-voltage, b1 = field over-current, b2 = gen. under-voltage, b3 = gen. 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 = gen. failed to build up, b12 = gen. below 10Hz, b13 = field overtemperature, b14-b15 are unassigned.	R-	UI16
47304-05	Field Temperature	R-	R32_23
47306	Protection status bit flags (0 = clear, 1 = condition present) b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	R-	UI16
47307	Annunciation status bit flags (0 = clear, 1 = condition present) b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	R-	UI16
47308 to 47375	Reserved for C2 data		

Holding Registers for Information Category C3

Table 8-13. Information Category C3 (Reporting)

Registers	Data Description	Access	Data Format
47376 to 47500	Reserved for future C3 data	Not supported	Not defined

Holding Registers for Information Category C4

Table 8-14. Information Category C4 (Control System Configuration Parameters)

Registers	Data Description	Access	Data Format
47501-02	Generator rated frequency, selectable to be 50 or 60 Hz	RW	R32_23
47503-04	Generator PT primary voltage rating, adjustable from 1 to 30,000 Vac, in 1-volt increments	RW	R32_23
47505-06	Generator PT secondary voltage rating, adjustable from 1 to 240 Vac, in 1-volt increments	RW	R32_23
47507-08	Generator CT primary current rating, adjustable from 1 to 60,000 Aac, in 1-amp increments	RW	R32_23
47509-10	Generator CT secondary current rating, selectable to be 1 or 5 Aac	RW	R32_23
47511-12	Field current shunt resistor rating, adjustable from 1 to 9999 Adc, in 0.1-amp increments	RW	R32_23
47513-14	Field voltage connections to isolation box, selectable to be 32V, 63V, 125V, 250V, or 375V	RW	R32_23
47515-16	Bus sensing PT primary rating, adjustable from 1 to 500,000 Vac, in 1-volt increments	RW	R32_23
47517-18	Bus sensing PT secondary rating, adjustable from 1 to 240 Vac, in 1-volt increments	RW	R32_23
47519-20	Time allowed for field flashing, adjustable from 1 to 50 seconds, in 1-second increments	RW	R32_23
47521-22	Level of generator voltage (as a % of nominal) at which field flashing is discontinued, adjustable from 0 to 100%, in 1% increments	RW	R32_23
47523-24	Generator rated voltage, adjustable from 85 to 30,000 Vac, in 1-volt increments	RW	R32_23
47525-26	Generator rated output current, adjustable from 10 to 60,000 Aac, in 0.1-amp increments	RW	R32_23
47527-28	Generator rated field voltage, adjustable from 1 to 400 Vdc, in 1-volt increments	RW	R32_23
47529-30	Generator rated field current, adjustable from 0.1 to 9999.0 Adc, in 0.1-amp increments	RW	R32_23
47531-32	Nominal bus voltage, adjustable from 85 to 500,000 Vac, in 1-volt increments	RW	R32_23
47533-34	Auxiliary input gain for AVR mode, adjustable from 0 to 99, in 0.01 increments	RW	R32_23
47535-36	Internal tracking time delay, adjustable from 0 to 8 seconds, in 0.1-second increments	RW	R32_23
47537-38	Internal tracking traverse rate, adjustable from 1 to 80 seconds, in 0.1-second increments	RW	R32_23
47539-40	Null balance level, adjustable from 0 to 9999, in 0.01 increments	RW	R32_23
47541-42	Gain for cross current compensation, adjustable from 0 to 30, in 0.01 increments	RW	R32_23
47543	Voltage sensing configuration: 0 = 1-phase (A-C) / 1 = 3-phase	RW	UI16
47544	Auxiliary input summing mode: 0 = Inner Loop for AVR and FCR modes / 1 = Outer Loop for VAR and PF modes	RW	UI16
47545	Control signal output range: 0 or 1 = 0+10V / 2 = -10+10V / 3 = 4-20mA	RW	UI16
47546	Generator field type: 0 = exciter field / 1 = main field	RW	UI16
47547	Auxiliary input selection: 0 = voltage input / 1 = current input	RW	UI16
47548	PSS input mode -- Reserved for future C4 data	RW	UI16
47549-50	External tracking time delay, adjustable from 0 to 8 seconds, in 0.1-second increments	RW	R32_23
47551-52	External tracking traverse rate, adjustable from 1 to 80 seconds, in 0.1-second increments	RW	R32_23
47553	Voltage sensing hardware gain control signal: 0 = gen. PT 2ndary	R-	UI16

Table 8-14. Information Category C4 (Control System Configuration Parameters)

Registers	Data Description	Access	Data Format
	<= 160 Vac / 1 = gen. PT 2ndary > 160 Vac		
47554-55	Auxiliary input gain for FCR mode, adjustable from -99 to 99, in 0.01 increments	RW	R32_23
47556-57	Auxiliary input gain for VAR mode, adjustable from -99 to 99, in 0.01 increments	RW	R32_23
47558-59	Auxiliary input gain for PF mode, adjustable from -99 to 99, in 0.01 increments	RW	R32_23
47560	Field Temperature Measure Mode: 0 = degrees C / 1 = degrees F	RW	UI16

Holding Registers for Information Category C5

Table 8-15. Information Category C5 (Operating Mode Parameters)

Registers	Data Description	Access	Data Format
47561	Virtual toggle switch for Start or Stop: 0 = no change / 1 = change state. Holding register 47572 contains Unit mode status. Note: Read value of register 47561 is always 0.	RW	UI16
47562	Virtual toggle switch for changing control mode from comm. port between AVR and FCR: 0 = no change / 1 = change state. Holding register 47573 contains Control mode status. Note: Read value of register 47562 is always 0.	RW	UI16
47563	Switch for changing operating mode via comm. port, to one of three modes, 0=OFF / 1=PF / 2=VAR. Holding register 47571 contains Operating mode status. Note: Read value of register 47563 is always 4.	RW	UI16
47564	Internal tracking status from comm. port: 0 = Off / 1 = On	RW	UI16
47565	Preposition enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47566	Raise input enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47567	Lower input enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47568	External tracking enable status from comm. port: 0 = Off / 1 = On	RW	UI16
47569	Limiter Mode options: 0 = both off / 1 = UEL on / 2 = OEL on / 3 = both on	RW	UI16
47570	Voltage matching mode: 0 = Off / 1 = On	RW	UI16
47571	Operating mode: 0 = Off / 1 = PF Control / 2 = VAR Control	R-	UI16
47572	Unit mode status: 0 = Stop / 1 = Start	R-	UI16
47573	Control mode status: 1 = FCR / 2 = AVR	R-	UI16
47574	Internal (mode-to-mode) tracking status: 0 = Off / 1 = On	R-	UI16
47575	Reserved for future C5 data	R-	UI16
47576	Secondary unit enable status: 0 = primary unit / 1 = secondary unit	R-	UI16
47577	Load compensation mode status: 0 = Off / 1 = Droop / 2 = Line Drop	R-	UI16
47578	Load compensation mode selection via comm. ports: 0 = Off / 1 = Droop / 2 = Line Drop. Holding register 47577 contains Load compensation mode status. Note: Read value of register 47578 is always 0.	RW	UI16
47579	Input for resetting front panel annunciations and latched relay annunciations: 0 = no change / 1 = reset. Note: Read value of register 47579 is always 0.	RW	UI16
47580	Loss-of-sensing detection enable: 0 = disable / 1 = enable	RW	UI16
47581	Loss of sensing triggered transfer-to-FCR-mode enable.	RW	UI16
47582	Underfrequency or volts per hertz mode enable.	RW	UI16
47583	Virtual toggle switch for external tracking enable: 0 = no change, 1 = change. When read back, this register will indicate 0 if external	RW	UI16

Table 8-15. Information Category C5 (Operating Mode Parameters)

Registers	Data Description	Access	Data Format
	tracking is disabled, 1 if external tracking is enabled.		
47584	Virtual toggle switch for OEL style: 0 = no change, 1 = change. Read back: 0 = summing point, 1 = takeover	RW	UI16
47585	OEL option: 0 = Option 1, 1 = Option 2, 3 = Option 3	RW	UI16
47586	PF/var option status: 0 = Off, 1 = PF, 2 = var	R-	UI16
47587	Virtual toggle switch for second pre-position enable: 0 = no change, 1 = change. When read back, this register will indicate 0 if the active mode setpoint does not match either pre-position value, 1 if it matches pre-position 1 and 2 if matches pre-position 2.	RW	UI16
47588 to 47620	Reserved for future C5 data	Not supported	Not defined

Holding Registers for Information Category C6

Table 8-16. Information Category C6 (Setpoint Parameters)

Registers	Data Description	Access	Data Format
47621-22	FCR (field current regulator) mode setpoint; adjustment range is determined by registers (47699-700) and (47707-08)	RW	R32_23
47623-24	AVR (automatic voltage regulator) mode setpoint; adjustment range is determined by registers (47701-02) and (47709-10)	RW	R32_23
47625-26	VAR mode setpoint (in kvars); adjustment range is determined by registers (47703-04) and (47711-12)	RW	R32_23
47627-28	PF mode setpoint; adjustment range is determined by registers (47705-06) and (47713-14)	RW	R32_23
47629-30	Droop setting in percent (of rated generator voltage), adjustable from -30 to 30% in 0.1% increments	RW	R32_23
47631-32	FCR mode traverse rate, adjustable from 10 to 200 seconds, in 1-second increments	RW	R32_23
47633-34	AVR mode traverse rate, adjustable from 10 to 200 seconds, in 1-second increments	RW	R32_23
47635-36	VAR mode traverse rate, adjustable from 10 to 200 seconds, in 1-second increments	RW	R32_23
47637-38	PF mode traverse rate, adjustable from 10 to 200 seconds, in 1-second increments	RW	R32_23
47639-40	FCR mode setpoint preposition; adjustment range is determined by registers (47699-700) and (47707-08)	RW	R32_23
47641-42	AVR mode setpoint preposition; adjustment range is determined by registers (47701-02) and (47709-10)	RW	R32_23
47643-44	VAR mode setpoint preposition (in kvars); adjustment range is determined by registers (47703-04) and (47711-12)	RW	R32_23
47645-46	PF mode setpoint preposition; adjustment range is determined by registers (47705-06) and (47713-14)	RW	R32_23
47647-48	FCR mode setpoint step size = setpoint range / (traverse rate x 10):[(regs. 47707-08) - (regs. 47699-700)] / [(regs. 47631-32) x 10]	R	R32_23
47649-50	AVR mode setpoint step size = setpoint range / (traverse rate x 10):[(regs. 47709-10) - (regs. 47701-02)] / [(regs. 47633-34) x 10]	R	R32_23
47651-52	VAR mode setpoint step size (in kvars) = setpoint range / (traverse rate x 10): [(regs. 47711-12) - (regs. 47703-04)] / [(regs. 47635-36) x 10]	R	R32_23
47653-54	PF mode setpoint step size = setpoint range / (traverse rate x 10):[2 + (regs.47713-14) - (regs.47705-06)] / [(regs.47635-36) x 10]	R	R32_23
47655-56	FCR mode setpoint's minimum (in % of rated field current),	RW	R32_23

Table 8-16. Information Category C6 (Setpoint Parameters)

Registers	Data Description	Access	Data Format
	adjustable from 0 to 100%, in 0.1% increments		
47657-58	AVR mode setpoint's minimum (in % of rated generator output voltage), adjustable from 70 to 100%, in 0.1% increments	RW	R32_23
47659-60	VAR mode setpoint's minimum (in % of rated generator VA), adjustable from -100 to 100%, in 0.1% increments	RW	R32_23
47661-62	PF mode setpoint's adjustable minimum, adjustable from 0.5 to 1.0, in 0.005 increments	RW	R32_23
47663-64	FCR mode setpoint's maximum (in % of rated field current), adjustable from 100 to 120%, in 0.1% increments	RW	R32_23
47665-66	AVR mode setpoint's maximum (in % of rated generator output voltage), adjustable from 100 to 110%, in 0.1% increments	RW	R32_23
47667-68	VAR mode setpoint's maximum (in % of rated generator VA), adjustable from -100 to 100%, in 0.1% increments	RW	R32_23
47669-70	PF mode setpoint's adjustable maximum, adjustable from -1.0 to -0.5, in 0.005 increments	RW	R32_23
47671-72	Minimum value for FCR mode setpoint's adjustable minimum (in % of rated field current) = 0%	R	R32_23
47673-74	Minimum value for AVR mode setpoint's adjustable minimum (in % of rated generator output voltage) = 80%	R	R32_23
47675-76	Minimum value for VAR mode setpoint's adjustable minimum (in % of rated generator VA) = -100%	R	R32_23
47677-78	Minimum value for PF mode setpoint's adjustable minimum	R	R32_23
47679-80	Maximum value for FCR mode setpoint's adjustable maximum (in % of rated field current) = 120%	R	R32_23
47681-82	Maximum value for AVR mode setpoint's adjustable maximum in (in % of rated generator output voltage) = 110%	R	R32_23
47683-84	Maximum value for VAR mode setpoint's adjustable maximum (in % of rated generator VA) = 100%	R	R32_23
47685-86	Maximum value for PF mode setpoint's adjustable maximum	R	R32_23
47687-88	Step size for FCR mode setpoint's adjustable maximum (in % of rated field current) = 0.1%	R	R32_23
47689-90	Step size for AVR mode setpoint's adjustable maximum (in % of rated generator output voltage) = 0.1%	R	R32_23
47691-92	Step size for VAR mode setpoint's adjustable maximum in % of rated generator VA) = 0.1%	R	R32_23
47693-94	Step size for PF mode setpoint's adjustable maximum = 0.005	R	R32_23
47695	FCR preposition mode: 0 = maintained / 1 = release	RW	UI16
47696	AVR preposition mode: 0 = maintained / 1 = release	RW	UI16
47697	VAR preposition mode: 0 = maintained / 1 = release	RW	UI16
47698	PF preposition mode: 0 = maintained / 1 = release	RW	UI16
47699-700	FCR minimum setpoint (in amps) = % of nominal x rated field current:(regs. 47655-56) x (regs. 47529-30) / 100	R-	R32_23
47701-02	AVR minimum setpoint (in volts) = % of nominal x rated gen. voltage:(regs. 47657-58) x (regs. 47525-26) / 100	R-	R32_23
47703-04	VAR minimum setpoint (in kvars) = % of nominal x rated generator VA:(regs. 47659-60) x rated VA / 100	R-	R32_23
47705-06	PF minimum setpoint = registers 47661-62	R-	R32_23
47707-08	FCR maximum setpoint (in amps) = % of nominal x rated field current:(regs. 47663-64) x (regs. 47529-30) / 100	R-	R32_23
47709-10	AVR maximum setpoint (in volts) = % of nominal x rated gen. voltage:(regs. 47665-66) x (regs. 47525-26) / 100	R-	R32_23
47711-12	VAR maximum setpoint (in kvars) = % of nominal x rated gen. VA:(regs. 47667-68) x rated VA / 100	R-	R32_23

Table 8-16. Information Category C6 (Setpoint Parameters)

Registers	Data Description	Access	Data Format
47713-14	PF maximum setpoint = registers 47669-70	R-	R32_23
47715	FCR pre-position mode 2: 0 = maintained, 1 = release	RW	UI16
47716	AVR pre-position mode 2: 0 = maintained, 1 = release	RW	UI16
47717	Var pre-position mode 2: 0 = maintained, 1 = release	RW	UI16
47718	PF pre-position mode 2: 0 = maintained, 1 = release	RW	UI16
47719 to 47720	FCR mode setpoint pre-position 2: adjustment range is determined by registers (47699-47700) and (47709-47710)	RW	R32_23
47721 to 47722	AVR mode setpoint pre-position 2: adjustment range is determined by registers (47701-47702) and (47711-47712)	RW	R32_23
47723 to 47724	Var mode setpoint pre-position 2 (in kvars): adjustment range is determined by registers (47703-47704) and (47711-47712)	RW	R32_23
47725 to 47726	PF mode setpoint pre-position 2: adjustment range is determined by registers (47705-47706) and (47713-47714)	RW	R32_23
47727 to 47740	Reserved for future C6 data	Not supported	Not defined

Holding Registers for Information Category C7

Table 8-17. Information Category C7 (Start-up Parameters)

Registers	Data Description	Access	Data Format
47741-42	Soft start level, adjustable from 0 to 90 % (of rated generator voltage), in 1% increments	RW	R32_23
47743-44	Soft start duration, adjustable from 1 to 7,200 seconds, in 1-second increments	RW	R32_23
47745-46	Underfrequency corner frequency, adjustable from 15 to 90 Hz, in 0.1 Hz increments	RW	R32_23
47747-48	Slope of underfrequency curve, adjustable from 0 to 3 V/Hz, in 0.1 V/Hz increments	RW	R32_23
47749-50	Width of voltage matching window, adjustable from 0 to 20 % (of rated generator voltage), in 0.01 % increments	RW	R32_23
47751-52	Voltage matching reference, adjustable from 90 to 120 % (of rated generator voltage), in 0.01 % increments	RW	R32_23
47753-54	Fine voltage adjust band, adjustable from 0 to 30 % (of rated generator voltage), in 0.1 % increments	RW	R32_23
47755-56	Time delay for loss of sensing, adjustable from 0 to 3 seconds, in 0.1-second increments	RW	R32_23
47757-58	Loss of Sensing balanced voltage level, adjustable from 0% to 100% in 0.1% increments.	RW	R32_23
47759-60	Loss of Sensing unbalance voltage level, adjustable from 0% to 100% in 0.1% increments.	RW	R32_23
47761 to 47800	Reserved for future C7 data	Not supported	Not defined

Holding Registers for Information Category C8

Table 8-18. Information Category C8 (Limiter Parameters)

Registers	Data Description	Access	Data Format
47801-02	On-line OEL high limit level, adjustable from 0.1 to 9999 Adc, in 0.1-amp increments	RW	R32_23
47803-04	Time allowed at on-line OEL high limit level, adjustable from 0 to 60 seconds, in 1-second increments	RW	R32_23
47805-06	On-line OEL medium limit level, adjustable from 0.1 to 9999 Adc, in 0.1-amp increments	RW	R32_23
47807-08	Time allowed at on-line OEL medium limit level, adjustable from 0 to 120 seconds, in 1-second increments	RW	R32_23
47809-10	On-line low OEL low limit level, adjustable from 0.1 to 9999 Adc, in 0.1-amp increments	RW	R32_23
47811-12	Internal UEL curve's starting point (reactive power level at 0 kW). This should be 0 to allow the programmable UEL curve to be used.	RW	R32_23
47813-14	Time allowed at off-line OEL high limit level, adjustable from 0 to 10 seconds, in 1-second increments	RW	R32_23
47815-16	Off-line OEL high limit level, adjustable from 0 to 9999 Adc, in 0.1-amp increments	RW	R32_23
47817-18	Off-line OEL low limit level, adjustable from 0 to 9999 Adc, in 0.1-amp increments	RW	R32_23
47819-20	1st UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47821-22	2nd UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47823-24	3rd UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47825-26	4th UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47827-28	5th UEL point real power value, adjustable from 0 to generator's full rating (in kW)	RW	R32_23
47829-30	1st UEL point reactive power value, adjustable from 0 to generator's full rating (in kvars)	RW	R32_23
47831-32	2nd UEL point reactive power value, adjustable from 0 to generator's full rating (in kvars)	RW	R32_23
47833-34	3rd UEL point reactive power value, adjustable from 0 to generator's full rating (in kvars)	RW	R32_23
47835-36	4th UEL point reactive power value, adjustable from 0 to generator's full rating (in kvars)	RW	R32_23
47837-38	5th UEL point reactive power value, adjustable from 0 to generator's full rating (in kvars)	RW	R32_23
47839-40	SCL high limit level, adjustable from 0 to 66,000 A in 0.1 A increments.	RW	R32_23
47841-42	Time allowed at SCL high limit level, adjustable from 0 to 60 seconds in 0.1 second increments.	RW	R32_23
47843-44	SCL low limit level, adjustable from 0 to 66,000 A, in 0.1 A increments.	RW	R32_23
47845-46	Takeover OEL offline high limit level, adjustable from 0 to 9,999 A in 0.1 A increments.	RW	R32_23
47847-48	Takeover OEL offline low limit level, adjustable from 0 to 9,999 A in 0.1 A increments.	RW	R32_23
47849-50	Takeover OEL offline time dial, adjustable from 0.1 to 20, in 0.1 increments.	RW	R32_23
47851-52	Takeover OEL online high limit level, adjustable from 0 to 9,999 A in 0.1 A increments.	RW	R32_23

Table 8-18. Information Category C8 (Limiter Parameters)

Registers	Data Description	Access	Data Format
47853-54	Takeover OEL online low limit level, adjustable from 0 to 9,999 A in 0.1 A increments.	RW	R32_23
47855-56	Takeover OEL online time dial, adjustable from 0.1 to 20 in 0.1 increments	RW	R32_23
47857 to 47860	Reserved for future C8 data	Not supported	Not defined

Holding Registers for Information Category C9

Table 8-19. Information Category C9 (Control Loop Gain Parameters)

Registers	Data Description	Access	Data Format
47861-62	Primary stability setting group number: 1 to 21, where groups 1 to 20 are preprogrammed values and group 21 is user programmable	RW	R32_23
47863-64	Primary AVR/FCR mode proportional gain (Kp), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47865-66	Primary AVR/FCR mode integral gain (Ki), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47867-68	Primary AVR/FCR mode derivative gain (Kd), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47869-70	OEL integral gain (Ki), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47871-72	PF mode integral gain (Ki), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47873-74	VAR mode integral gain (Ki), adjustable from 0 to 1000, in 0.01 increments	RW	R32_23
47875-76	FCR mode loop gain (Kg), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47877-78	Primary AVR mode loop gain (Kg), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47879-80	VAR mode loop gain (Kg), adjustable from 0 to 1000, in 0.01 increments	RW	R32_23
47881-82	PF mode loop gain (Kg), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47883-84	OEL loop gain (Kg), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47885-86	UEL loop gain (Kg), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47887-88	UEL integral gain (Ki), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47889-90	Voltage matching loop gain (Kg), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47891-92	Primary AVR mode derivative time constant, adjustable from 0 to 1, in 0.01 increments	RW	R32_23
47893 -94	Secondary stability setting group number: 1 to 21, where groups 1 to 20 are preprogrammed values and group 21 is user programmable	RW	R32_23
47895-96	Secondary AVR/FCR mode proportional gain (Kp), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47897-98	Secondary AVR/FCR mode integral (Ki), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47899-900	Secondary AVR/FCR mode derivative gain (Kd), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47901-02	Secondary AVR mode loop gain (Kg), adjustable from 0 to 1000, in 0.1 increments	RW	R32_23
47903-04	Secondary AVR mode derivative time constant, adjustable from 0 to 1, in 0.01 increments	RW	R32_23
47905	AVR/FCR Gain Setting group currently active, 0 = Primary, 1 = Secondary	R	UI16

Registers	Data Description	Access	Data Format
47906-07	SCL loop gain (Kg), adjustable from 0 to 1,000 in 0.1 increments	RW	R32-23
47908-09	SCL loop gain (Ki), adjustable from 0 to 1,000 in 0.1 increments	RW	R32_23
47910 to 47920	Reserved for future C9 data	Not supported	Not defined

Holding Registers for Information Category C10

Table 8-20. Information Category C10 (Protective Functions Parameters)

Registers	Data Description	Access	Data Format
47921-22	Field overvoltage level, adjustable from 1 to 900 Vdc, in 1-volt increments	RW	R32_23
47923-24	Field overcurrent base level, adjustable from 0.1 to 9999 Adc, in 0.1-amp increments	RW	R32_23
47925-26	Stator undervoltage level, adjustable from 0 to 30,000 Vac, in 1-volt increments	RW	R32_23
47927-28	Stator overvoltage level, adjustable from 0 to 30,000 Vac, in 1-volt increments	RW	R32_23
47929-30	Field overvoltage time delay, adjustable from 0.2 to 30 seconds, in 0.1-second increments	RW	R32_23
47931-32	Field overcurrent time dial multiplier, adjustable from 0.1 to 20, in 0.1 increments	RW	R32_23
47933-34	Stator undervoltage time delay, adjustable from 0.5 to 60 seconds, in 0.1-second increments	RW	R32_23
47935-36	Stator overvoltage time delay, adjustable from 0.1 to 60 seconds, in 0.1-second increments	RW	R32_23
47937	Field overvoltage alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47938	Field overcurrent alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47939	Stator undervoltage alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47940	Stator overvoltage alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47941-42	Field Over-temperature set level (in degrees): adjustable from 0 to 572 in I degree increments	RW	R32_23
47943-44	Field Over-temperature delay (in secs.): adjustable from 0.1 to 60 seconds in 0.1 second increments	RW	R32_23
47945	Field Over-temperature alarm enable: 0 = disabled / 1 = enabled	RW	UI16
47946	Loss of field alarm enable: 0 = disabled, 1 = enabled	RW	UI16
47947-48	Loss of field level, adjustable from 0 to 3,000 Mvar in 1 kvar increments	RW	R32_23
47949-50	Loss of field delay (in seconds): adjustable from 0.1 to 9.9 seconds in 0.1 second increments	RW	R32_23
47951 to 47980	Reserved for future C10 data	Not supported	Not defined

Holding Registers for Information Category C11

Table 8-21. Information Category C11 (Calibration related Parameters)

Registers	Data Description	Access	Data Format
47981 to 48040	Reserved for future C11 data	Not supported	Not defined

Holding Registers for Information Category C12

Table 8-22. Information Category C12 (Relay Parameters)

Registers	Data Description	Access	Data Format
48041	Annunciation enable for Relay 1: 0 = disabled, 1 = enabled b0 = field overvoltage, b1 = field overcurrent, b2 = gen. undervoltage, b3 = gen. overvoltage, b4 = underfrequency, b5 = in OEL, b6 = in UEL, b7 = in FCR mode, b8 = loss of sensing voltage, b9 = setpoint at lower limit, b10 = setpoint at upper limit, b11 = unassigned, b12 = gen. below 10 Hz, b13 = field overtemperature, b14, b15 are unassigned.	RW	UI16
48042	Annunciation enable for Relay 1: 0 = disabled, 1 = enabled b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	RW	UI16
48043	Reserved	RW	UI16
48044	Reserved	RW	UI16
48045	Reserved	RW	UI16
48046	Reserved	RW	UI16
48047	Reserved	RW	UI16
48048	Reserved	RW	UI16
48049	Reserved	RW	UI16
48050	Reserved	RW	UI16
48051	Reserved	RW	UI16
48052	Reserved	RW	UI16
48053	Reserved	RW	UI16
48054	Reserved	RW	UI16
48055	Reserved	RW	UI16
48056	Reserved	RW	UI16
48057	Output for Relay 1: 0 = contact open / 1 = contact closed	RW	UI16
48058	Relay 1 annunciation type: 0 = momentary / 1 = maintained / 2 = latched	RW	UI16
48059	Relay 1 contact sense: 0 = closed for normal operation, open for annunciation; 1 = open for normal operation, closed for annunciation	RW	UI16
48060	Relay 1 output duration for momentary type, adjustable from 2 to 100, in unity increments (which is 0.1 to 5 seconds, in 0.05-second increments)	RW	UI16
48061	b0 = field overvoltage, b1 = field overcurrent, b2 = gen. undervoltage, b3 = gen overvoltage, b4 = underfrequency, b5 = in OEL, b6 = in UEL, b7 = in FCR mode, b8 = loss of sensing voltage, b9 = setpoint at lower limit, b10 = setpoint at upper limit, b11 = unassigned, b12 = gen. below 10 Hz, b13 = field overtemperature, b14-b15 are unassigned.	RW	UI16
48062	b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	RW	UI16
48063	Reserved	RW	UI16
48064	Reserved	RW	UI16
48065	Reserved	RW	UI16
48066	Reserved	RW	UI16
48067	Reserved	RW	UI16
48068	Reserved	RW	UI16
48069	Reserved	RW	UI16
48070	Reserved	RW	UI16
48071	Reserved	RW	UI16
48072	Reserved	RW	UI16
48073	Reserved	RW	UI16
48074	Reserved	RW	UI16
48075	Reserved	RW	UI16

Table 8-22. Information Category C12 (Relay Parameters)

Registers	Data Description	Access	Data Format
48076	Reserved	RW	UI16
48077	Output for Relay 2: 0 = contact open / 1 = contact closed	RW	UI16
48078	Relay 2 annunciation type: 0 = momentary / 1 = maintained / 2 = latched	RW	UI16
48079	Relay 2 contact sense: 0 = closed for normal operation, open for annunciation; 1 = open for normal operation, closed for annunciation	RW	UI16
48080	Relay 2 output duration for momentary type, adjustable from 2 to 100, in unity increments (which is 0.1 to 5 seconds, in 0.05-second increments)	RW	UI16
48081	b0 = field overvoltage, b1 = field overcurrent, b2 = gen. undervoltage, b3 = gen. overvoltage, b4 = underfrequency, b5 = in OEL, b6 = in UEL, b7 = in FCR mode, b8 = loss of sensing voltage, b9 = setpoint at lower limit, b10 = setpoint at upper limit, b11 = unassigned, b12 = gen. below 10 Hz, b13 = field overtemperature, b14-b15 are unassigned.	RW	UI16
48082	b0 = loss of field, b1 = SCL, b2-b15 are unassigned	RW	UI16
48083	Reserved	RW	UI16
48084	Reserved	RW	UI16
48085	Reserved	RW	UI16
48086	Reserved	RW	UI16
48087	Reserved	RW	UI16
48088	Reserved	RW	UI16
48089	Reserved	RW	UI16
48090	Reserved	RW	UI16
48091	Reserved	RW	UI16
48092	Reserved	RW	UI16
48093	Reserved	RW	UI16
48094	Reserved	RW	UI16
48095	Reserved	RW	UI16
48096	Reserved	RW	UI16
48097	Output for Relay 3: 0 = contact open / 1 = contact closed	RW	UI16
48098	Relay 3 annunciation type: 0 = momentary / 1 = maintained / 2 = latched	RW	UI16
48099	Relay 3 contact sense: 0 = closed for normal operation, open for annunciation; 1 = open for normal operation, closed for annunciation	RW	UI16
48100	Relay 3 output duration for momentary type, adjustable from 2 to 100, in unity increments (which is 0.1 to 5 seconds, in 0.05-second increments)	RW	UI16
48101	b0 = field overvoltage, b1 = field overcurrent, b2 = gen. undervoltage, b3 = gen. overvoltage, b4 = underfrequency, b5 = in OEL, b6 = in UEL, b7 = in FCR mode, b8 = loss of sensing voltage, b9 = setpoint at lower limit, b10 = setpoint at upper limit, b11 = unassigned, b12 = gen. below 10 Hz, b13 = field overtemperature, b14-b15 are unassigned	RW	UI16
48102	b0 = loss of field, b1 = in SCL, b2-b15 are unassigned	RW	UI16
48103	Reserved	RW	UI16
48104	Reserved	RW	UI16
48105	Reserved	RW	UI16
48106	Reserved	RW	UI16
48107	Reserved	RW	UI16
48108	Reserved	RW	UI16
48109	Reserved	RW	UI16
48110	Reserved	RW	UI16

Table 8-22. Information Category C12 (Relay Parameters)

Registers	Data Description	Access	Data Format
48111	Reserved	RW	UI16
48112	Reserved	RW	UI16
48113	Reserved	RW	UI16
48114	Reserved	RW	UI16
48115	Reserved	RW	UI16
48116	Reserved	RW	UI16
48117	Output for Relay 4: 0 = contact open / 1 = contact closed	RW	UI16
48118	Relay 4 annunciation type: 0 = momentary / 1 = maintained / 2 = latched	RW	UI16
48119	Relay 4 contact sense: 0 = closed for normal operation, open for annunciation; 1 = open for normal operation, closed for annunciation	RW	UI16
48120	Relay 4 output duration for momentary type, adjustable from 2 to 100, in unity increments (which is 0.1 to 5 seconds, in 0.05-second increments)	RW	UI16
48121	Fail-to-build-up relay output: 0 = contact open / 1 = contact closed	RW	UI16
48122	Fail-to-build-up relay annunciation type: 0 = momentary / 2 = latched	RW	UI16
48123	Fail-to-build-up relay output duration for momentary type, adjustable from 2 to 100, in unity increments (which is 0.1 to 5 seconds, in 0.05-second increments)	RW	UI16
48124 to 48160	Reserved for future C12 data	Not supported	Not defined

Holding Registers for Information Category C13

Table 8-23. Information Category C13 (Communications Parameters)

Registers	Data Description	Access	Data Format
48161	Save data to EEPROM flags: 0x0001 saves C4 and C6; 0x0002 saves C5 and C7; 0x0004 saves C6; 0x0008 saves C5 and C7; 0x0010 saves C8; 0x0020 saves C9; 0x0040 saves C10; 0x0080 saves C11; 0x0100 saves C12; 0x0800 saves C14. (Changes in C13 are automatically saved.)	RW	UI16
48162	Comm. port 0, front RS-232, baud rate, selectable to be 1200, 2400, 4800, 9600, or 19200	R	UI16
48163	Comm. port 1, rear RS-232, baud rate, selectable to be 1200, 2400, 4800, 9600, or 19200	R	UI16
48164	Comm. port 2, rear RS-485, baud rate, selectable to be 1200, 2400, 4800, 9600, or 19200	RW	UI16
48165	Comm. port 2, Rear RS-485, Parity: ‘O’ = 79 = 0x4F for Odd Parity,‘E’ = 69 = 0x45 for Even Parity, and ‘N’ = 78 = 0x4E for No Parity	RW	UI8
48166	Comm. port 2, Rear RS-485, stop bits, selectable to be 1 or 2	RW	UI8
48167	DECS-300 polling address (Modbus™ slave address), selectable from 1 to 247 (slave address)	RW	UI16
48168	Modbus™ Response Time Delay, adjustable from 10 to 200 milliseconds, in 10-millisecond increments	RW	UI16
48169 to 48220	Reserved for future C13	Not supported	Not defined

Holding Registers for Information Category C14

Table 8-24. Information Category C14 (Front Panel Metering Configuration Parameters)

Registers	Data Description	Access	Data Format
48221	1st metering display field on the front panel metering screen: 0 to 14	RW	UI16
48222	2nd metering display field on the front panel metering screen: 0 to 14	RW	UI16
48223	3rd metering display field on the front panel metering screen: 0 to 14	RW	UI16
48224 to 48250	Reserved for future C14 data	Not supported	Not defined

Holding Registers for Information Category C15

Table 8-25. Information Category C15 (Control System Configuration Parameters Group II)

Registers	Data Description	Access	Data Format
48501-02	Field resistance value at ambient temperature: adjustable from 0 to 99.999 ohms in 0.001 increments	RW	R32_23
48503-04	Ambient Temperature: adjustable from 0 to 572 degrees in 1 degree increments	RW	R32_23
48505-06	Brush Voltage Drop: adjustable from 0 to 99.99 volts in 0.01 volt increments	RW	R32_23

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