

Application Note

Basler's DECS-450 and DECS-2100: Two Options for Replacing Aging SILCO Systems

This Application Note addresses various solutions for retrofitting and upgrading General Electric Canada's Silco 5 Digital Static Excitation System with the Basler DECS-450 or DECS-2100 Digital Excitation Control System.

Characteristics of the SILCO 5

In the mid-1980s, GE Canada produced their first generation digital excitation systems, the Silco 5 shown in Figure 1.



Figure 1: General Electric Canada's Silco 5

For synchronous generators, the Silco 5 was used with a variety of prime movers including hydro, gas and steam turbines. The Silco 5 was a highly integrated system with internal data link communications. Common features incorporated into the digital system include Automatic Voltage Regulator, Field Voltage Regulator, and Var and Power Factor Regulators. Excitation limiting functions incorporated in the Silco 5 included Volts/Hz, Minimum Excitation and Generator Current Limiters. A Power System Stabilizer (PSS) was also available as well as a number of other protective and alarm functions. The power rectifier bridges each had 6 thyristor (SCR) controls with positive and negative field forcing capability for optimum control of the generator output. The individual static exciter systems were designed to have one rectifier bridge rated approximately 500 Adc or up to eight bridges in parallel for generator fields requiring thousands of dc amperes. Crowbar circuits triggered by high positive or negative field voltages caused by pole slip or short circuits were used to rapidly discharge the field energy.

Now that the Silco 5 is several generations old, parts and product support has become essentially nonexistent. Owners of this equipment are looking for options for maintaining or upgrading these excitation systems.

The Basler Digital Solutions

Basler Electric has two options for upgrading the Silco 5 static excitation systems using the latest in digital excitation control systems technology. The first option is to replace the "front end" controls of the exciter with the DECS-450 digital controller. Some owners choose to take this option because of the comparatively high cost of a complete excitation system replacement. Additionally, transformers and modern semiconductors have generally proven themselves to be reliable or not difficult to obtain suitable replacements.



Figure 2: Dual DECS-450/dual 2500 Amp bridge system.

The second option is to replace the entire static excitation system with a new DECS-450 control/rectifier bridge(s) system in a NEMA type enclosure as shown in Figure 2 or a DECS-2100 control/rectifier bridge system in a NEMA type enclosure as shown in Figure 3.

At the discretion of the owner, the power stepdown transformer may be reused or replaced.



Figure 3: DECS-2100 Digital Excitation Control System

In the “front end replacement” option, the existing rectifier bridge(s) and power transformer are reused. Because the Silco 5 was highly integrated, the front end replacement solution necessitates the removal of several of the circuit boards mounted in the cabinets and mounting new components and devices in the space obtained. Circuit boards shown in Figures 4, 5 and 6 identified as the AVR, Sequencer, transducer, converter interface (firing circuit), I/O and gate pulse amplifier boards are removed.

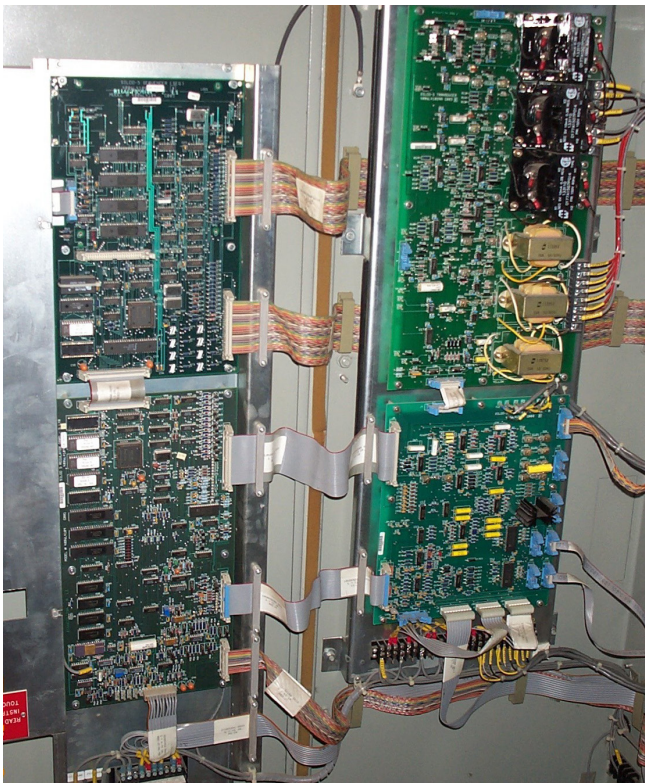


Figure 4: The AVR, sequencer, transducer, and converter interface (firing circuit) are removed.



Figure 5: Input/output boards are removed.



Figure 6: Gate pulse amplifier boards are also targeted for removal.

The new devices include the DECS-450 digital controller that is mounted in a new cutout of one of the cabinet doors. The DECS-450 incorporates all of the functionality of the voltage regulator, field current regulator, field voltage regulator, VAR/PF regulator, excitation limiters, protection and the optional power system stabilizer. Other devices to be installed are an appropriately sized dc shunt to provide field voltage and current information to a Field Isolation Transducer that provides electrical isolation and ultimately, metering information to the DECS-450. With the Silco 5, a dc current transformer provided field current information to the regulator for current limiting purposes and is no longer used. Other new components are mounted on a pan chassis to be installed in the existing enclosures include the Field Isolation Transducer, SCR firing circuits, a circuit for distributing SCR gate firing pulses to multiple bridges, auxiliary relays and dual source control power interface. A new Gate Pulse Amplifier circuit board for each rectifier bridge interfaces the SCR gate firing pulses to

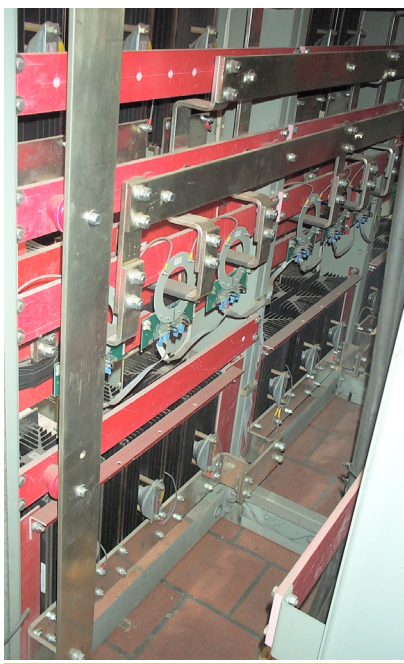


Figure 7: Hall Effect Transducers

DECS-450 Feature Highlights

The DECS-450 Digital Excitation Control System is a microprocessor based controller whose isolated analog output commands the firing control of a six SCR rectifier bridge for control. See Figure 8.

The DECS-450 also monitors generator parameters to protect the generator from operating beyond its designed capability range. An optional Power Systems Stabilizer is an IEEE Type PSS2A, Integral of Accelerating Power that provides positive damping for low frequency power oscillations in the 0.1–5 Hz frequency range. A built-in

the existing bridge(s) is mounted near each rectifier bridge as in Figure 6.

Lastly, the Silco 5 used Hall Effect Transducers (shown in Figure 7) mounted on the three phase voltage inputs to the rectifier bridge for the purpose of bridge conduction monitoring. A new circuit board is provided as an interface between the Hall Effect Transducer and output relays provide indication of failed rectifier(s).

Dynamic System Analyzer and BESTCOMSPUs® software with Bode Plot and Real Time Monitor allow for fast field testing and tuning of the DECS-450 and PSS. Examples of the user friendly, Windows® based BESTCOMSPUs communication software is shown in Figures 9 and 10.

The DECS-450 Feature Table is shown on the next page.



Figure 8: DECS-450 Digital Excitation Control System

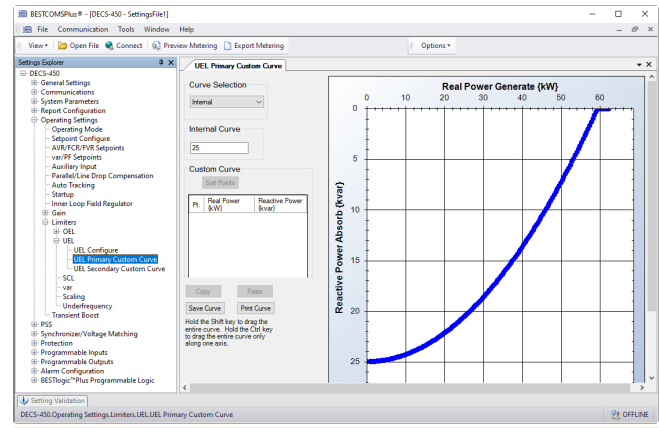


Figure 9: Custom 5 Point UEL Limiting via BESTCOMSPUs®

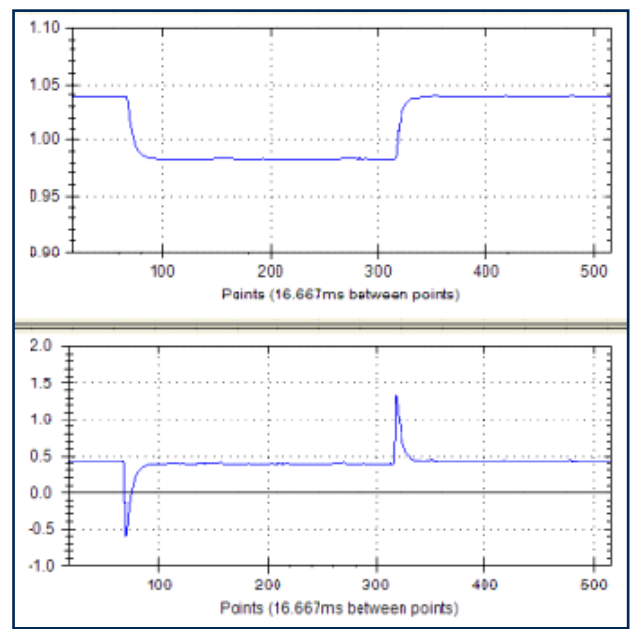


Figure 10: Real Time Monitoring

DECS-450 Features

- UL Recognized, CSA Qualified, CE Compliant
- Oscillography - 1,200 points, 6 programmable parameters, holds up to 6 records
- Meets ANSI C37.90.1 for Surge Withstand and Fast Transient
- Meets RFI (Radio Frequency Interference)
- Meets Conducted and Radiated Noise per IEC 60255-22-6 (Conducted) & 60255-22-3 (Radiated)
- Field current or field voltage regulator for standby mode and NERC testing
- Operating Temperature Range -40° to 60°C
- Voltage Regulation - 0.1% Accuracy
- Var/Power Factor Controller
- Automatic Nulling - Nulling between operating modes and redundant DECS
- Selectable Underfrequency or Volts/Hertz Ratio Limiter
- Minimum Excitation Limiter - Flexible 5 point map on real/ reactive power axis or Internal generated UEL curve
- Maximum Excitation Limiter
- Var Limiter
- Stator Current Limiter
- Dual PID Setting Groups - Allows for programmed changes in PID gain settings for use with Power System Stabilizer or alternate transmission systems
- Auto Tuning of the Voltage Regulator PID gains
- Auto Voltage Matching - Automatically matches generator voltage to bus voltage
- Auto Synchronizing (Device 25A) option
- Autotracking for bumpless transfer between Automatic Voltage Regulator (AVR), manual control, and redundant controller where applicable
- 3 Preposition Set points - Programmable for AVR, Manual, Var/PF Controller
- Reactive Droop or Line Drop Compensation, Network Reactive line sharing via Ethernet communications for multiple machine on a single bus
- Loss of Voltage Sensing - Transfers to manual control automatically due to loss of voltage sensing at the voltage regulator
- Sequence of events - stores 2,047 records
- Real time chart recorder, data logging including oscillography and sequence of event information for data capture up to six channels
- Built-in Dynamic Analyzer for measuring frequency response of generator and excitation system using Signal Generator
- Protection
 - Generator Overvoltage
 - Generator Undervoltage
 - Loss of Voltage Sensing
 - Field Overvoltage with Dual Settings Groups
 - Field Overcurrent with Dual Settings
 - Generator Overfrequency
 - Generator Underfrequency
 - Generator Reverse Power
 - Generator Loss of Excitation
 - Synch Check when 25A is disabled
- Exciter Diode Monitor
- Generator Below 10Hz
- Volts per Hertz: coordinates with the V/Hz limiter function
- Loss of Field Isolation Transducer
- Control Power Input Failure
- Crowbar Activated
- Field Over Temperature
- Watchdog Timer: monitors the microprocessors and provides a trip contact if a microprocessor fault occurs
- Field overvoltage, generator over/undervoltage, field overcurrent, and loss of field protections have dual set points selectable via programmable logic
- HMI Metering, Operating Screen - Metering, Control, Annunciation
- IRIG-B Time Synchronization stamp
- Generator Field Temperature Monitoring (Static Exciter)
- 5 Analog Transducers Outputs
- Optional Built-in Power System Stabilizer, Type 2A/2B/2C, Integral of Accelerating Power
- Phase Plot Compensator for Power System Stabilizer assisted tuning
- 6 SCR Bridge Rectifier
- RS-485
- Ethernet over Modbus® TCP
- BESTCOMSPPlus® common operating software to Basler Electric product family
- BESTlogic™Plus programmable logic
- Expandable Inputs and Outputs via remote modules

DECS-2100 Feature Highlights

The DECS-2100 is a multi-microprocessor excitation control system that provides advanced technology to precisely control, protect, and monitor synchronous generators, including new and existing applications that are driven by all types of prime movers, such as steam, gas, and hydro. Its multifunctional design allows the DECS-2100 to operate as a voltage regulator or as a static exciter, providing excitation currents up to 10,000 Adc.

Features include:

- +0.1% Voltage Regulation Accuracy
- Auto Synchronizing (Device 25A) option
- Performance response <20 ms
- Multiple PID Setting Groups for PSS tuning
- Redundant Controllers with Independent Supervisory
- Channel (options)
- Six-SCR Power Rectifier Bridges Fixed or Power Drawer
- Medium- and High-Voltage Drawer types depending upon field forcing levels required
- Patented Active Current and Temperature Balance Algorithm for rectifier bridge sharing
- Multiple Excitation Limiters with online and offline settings and dual setpoints
- Generator optimization by real-time limiter setpoint recalibration
- Optional Integrated Power System Stabilizer
- IEEE Type PSS2A/2B with dual settings groups
- Negative Field Forcing for highest performance
- Multiple Operating Modes with Auto-following and multiple protection functions with online and offline settings and dual settings groups
- Programmable input/output terminations and sequencing provisions
- Frequency Response Analysis Tools
- PID Autotuning
- Built-in Field Ground Protection (64F)
- High Initial Response Per IEEE 421.2
- RS-232, RS-485, Ethernet and USB ports for communications and data acquisition
- BESTCOMS™Pro, a sophisticated software configuration program for setup and testing
- Continuous self diagnostic capabilities
- Transient event recording and data logging
- Incorporates fiber optics for critical signals
- Provisions for Field Flashing from Station Service

Controller Configuration Tool: BESTCOMS™Pro

BESTCOMSPro is an easy-to-use software tool for configuring, monitoring, and maintaining the DECS-2100

Digital Excitation Control System purchased. It provides operators and maintenance personnel with password access to the operational parameters and optional configuration management of the DECS-2100 Digital Excitation System through a laptop or desktop PC. Request bulletin ECB to find out more about the DECS-2100.

DECS-2100 and DECS-450 Auto Tuning

PID auto tuning via BESTCOMS™Pro (DECS-2100) and BESTCOMSPlus® (DECS-450) operating software is used during commissioning with the generator spinning. After initiation, the auto tuning feature is performed in less than a minute that will determine the PID gains for the generator. It accomplishes this with the spinning machine open circuited by performing number of voltage step changes to the generator output resulting in suggested gains. Additionally, the auto tuning will determine the machine Time Constants of the Exciter (t_e) (where applicable) and Generator (T'_{do}), which is required data for generator modeling. The PID auto tuning process speeds commissioning to enable the generator to become fully operational sooner to the system.

DECS-2100 and DECS-450 Phase Plot Compensator

Additionally, a Phase Plot Compensators is provided with the Dynamic Frequency Analyzer to assist in evaluating the Power System Stabilizer Lead/Lag time filters selected that are derived from the Frequency Response of the generator system. Proper compensation is required for all systems that require a Power System Stabilizer. See Figure 11. When the red and blue curves align in the Phase Lag plot, proper compensation has been achieved and test validation is then required.

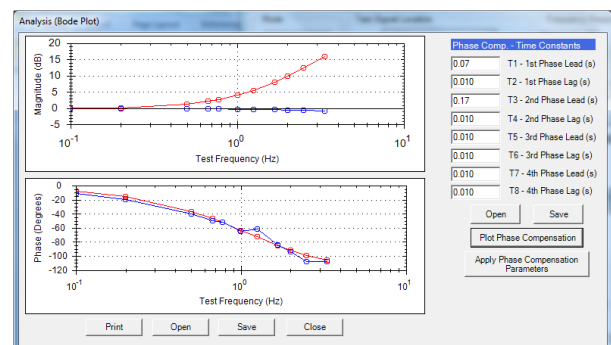


Figure 11: Frequency Response Results using Built-in Dynamic Analyzer

BESTspace™

The DECS-450 and DECS-2100 offer a setup commissioning tool in BESTCOMSPPlus and BESTCOMSPPro operating software that allows one to set up preferred monitoring screens from the Metering Explorer. BESTspace allows one to save the file as a “default” and it will come up on the preferred screen every time BESTCOMS is opened. Valuable time saved during setup speeds the commissioning preparation time for startup. See Figure 12.

For More Information

For more, detailed information or to discuss your application, please contact a Basler Electric Excitation System Application Specialist at +1 618.654.2341 or info@basler.com.

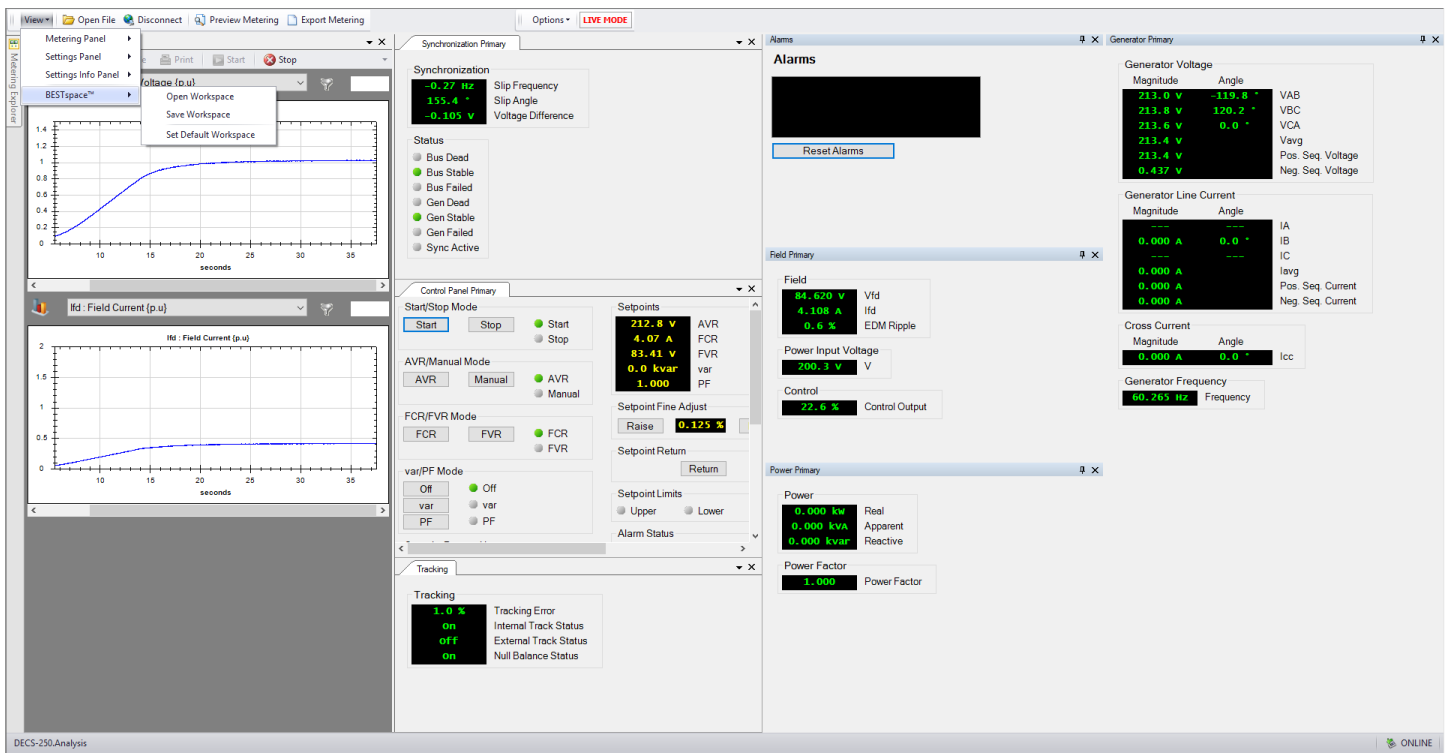


Figure 12: BESTspace