

Application Note

Prepackaged Dual SGC-250 Synchronous Generator Controller Reduces Engineering and Installation Time and Increases Reliability

The flexibility of digital control provides solutions for obsolete excitation systems by providing increased machine capability range at reasonable cost. In this application note, the redundant SGC-250 prepackaged retrofit solution is discussed for use on small to medium size synchronous machines having either brush or brushless type rotating exciters. The redundant SGC-250 offers the advantage of two digital controllers that communicate via parallel ports to maintain the generator output voltage via the field of the exciter. The redundant controllers offer the means to use the second controller as a voltage regulator or an independent manual control. The prepackaged system can be supplied as panels for installation into an existing excitation cabinet or the panel can be supplied in its own NEMA 1 enclosure.

The redundant SGC-250 package is intended for those applications where an independent manual control may have otherwise been required, or where there is a need to have increased reliability in the excitation system at an affordable cost. The SGC-250 offers the ability to automate plant controls and meet the directives from various agencies for performance, model simulations/testing and functions dictated by such agencies as NERC and MAPP that require certification for generators connected to the public power grid.

Offers Effective Features to Meet Agency Requirements

Ease and convenience are key words when replacement of the original excitation package becomes necessary. The SGC-250 system meets the requirement of a full featured excitation system equipped with all functions needed to provide reliable operation of the generator but where exceptional performance, typical of a two-quadrant control excitation system, is not required. The SGC-250 is the system of choice for smaller, less than 40 MVA machines, where fast dynamic performance is a lesser issue, but full excitation capability is needed to safeguard the generator, offering an efficient and economical solution for equipment upgrade.

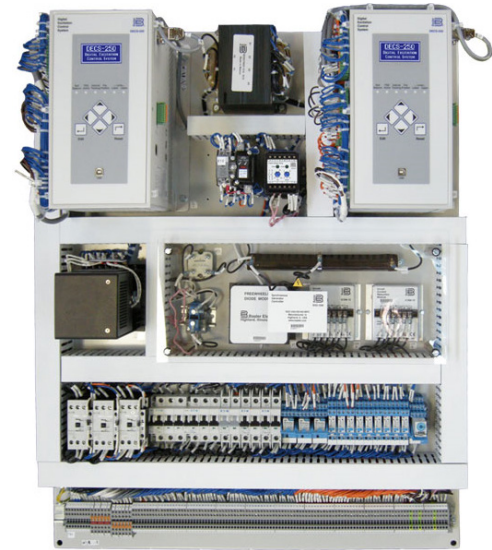


Figure 1: Packaged excitation system with a redundant SGC-250 Synchronous Generator Controller

Today's demands are much different than in the past when the minimum requirement was to regulate generator voltage. Today, it is not so simple because regulatory agencies are requiring model information of the excitation system and performance data of the generator and excitation system. Such data will include voltage step responses and dynamic performance of the excitation limiters both open circuited and when parallel to the electric power system. Additionally, performance testing may need to be repeated every two to three years.

The power system has become very complex and the need to understand the behavior of the generator and excitation system has become important to predict its performance. At the same time, unscheduled shutdown is unacceptable; therefore, increased reliability becomes vital.

Basler Electric offers a retrofit solution that, through commissioning software tools, aid the end user to address the various concerns of connecting to the utility to safeguard the generator, replacing the obsolete excitation system, and having the capabilities to streamline test and capture data for diagnostics.

The Packaged Excitation System

Basler Electric has engineered a prepackaged excitation system with redundant DECS-250 controllers and control relays mounted on a pan chassis capable of being installed in an existing enclosure (see Figures 2 and 5). It is also possible to order the dual excitation system mounted in a freestanding NEMA 1 type enclosure. The prepackaged design reduces engineering and installation time and is tested as a complete system at the factory to eliminate problems associated with individual components that are installed and wired at the job site. This also can reduce commissioning time by eliminating the need to troubleshoot and identify wiring errors.

Input Voltage Range / Field Output Capacity

The DECS-250 has a wide range of input voltages and frequencies and a robust internal power stage capable of delivering 15 Adc continuously to the shunt field of the rotary exciter. This diversity allows a single model of the DECS-250 to be applied to a vast array of generators, including those that have a permanent magnet generator as the AC input power source as well as those being shunt fed from the generator output terminals. Applying either a single or three-phase AC input voltage between the ranges of 56–277 Vac and 50–400 Hz determines the DC nominal output voltage of the SGC-250 that is rated 32, 63 and 125 Vdc with single quadrant field power control.

Digital Control

Digital control makes setting up DECS-250 and commissioning the system fast and convenient with the BESTCOMSPPlus® software that is included (See Figure 3). Because of digital settings, there are no potentiometers to calibrate set points, no set point drifting and no potentiometers to get dirty and fail. Functions of the digital control include:

- 0.25% Regulation Accuracy for precise control
- PID stability network for optimizing system response
- Underfrequency or V/Hz Ratio Limiter
- Softstart Voltage Buildup to prevent generator overshoot
- Paralleling provisions for reactive droop or line drop compensation
- Set Point Preposition for all 4 operating modes
- VAR/PF Control
- Minimum Excitation Limiter to prevent pole slip
- Maximum Excitation Limiter (online and offline settings) to prevent rotor overheating
- Voltage Matching to match generator voltage to bus voltage before synchronizing
- Field Current Regulator
- Internal Tracking for bumpless transfer between operating modes

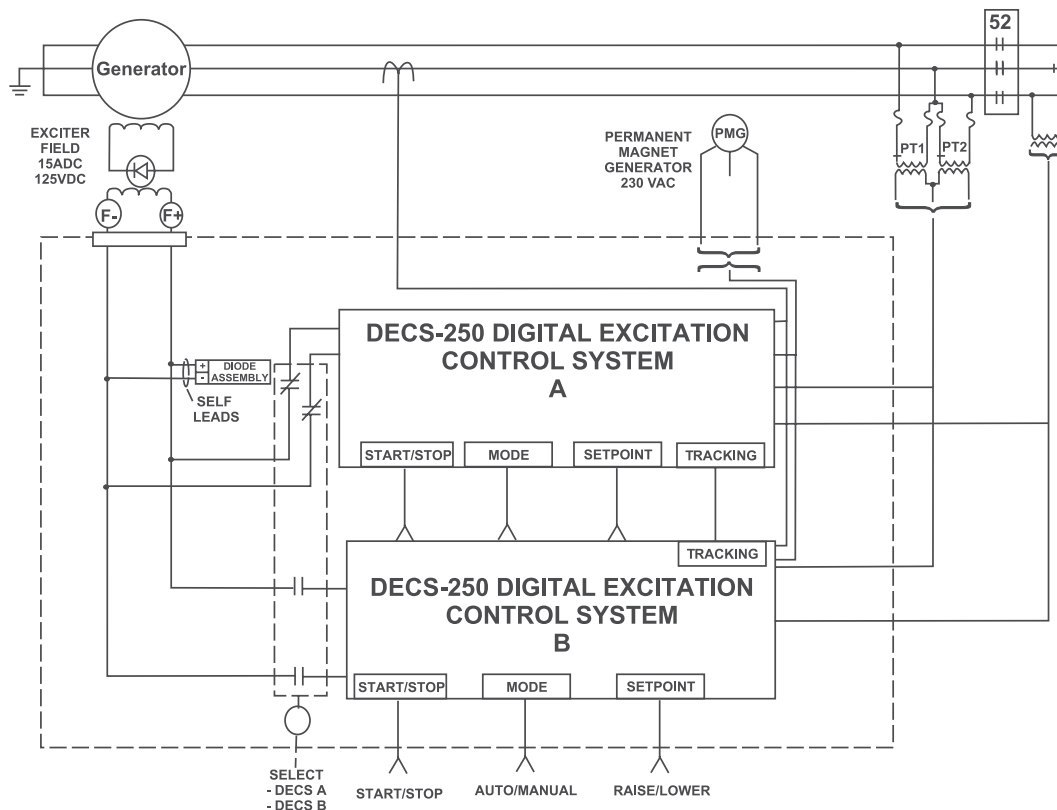


Figure 2: Simplified system interconnection drawing for the redundant SGC-250

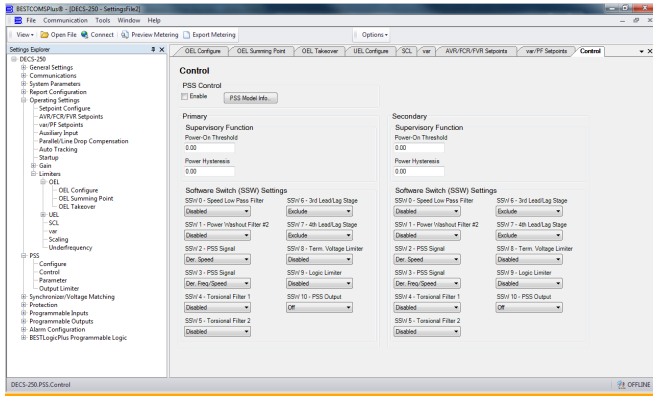


Figure 3: BESTCOMSPiUS settings screens allow the user to type in settings values for fast and easy commissioning.

Functional Operation

Each of the two DECS–250s in the dual excitation system has four control modes that include automatic voltage regulator, field current regulator (manual), VAR control and Power Factor control. The three inactive operating modes automatically track the output level of the active mode for bumpless transfer between operating modes. The backup regulator of the dual system is designed to track the output level of the primary regulator. In the unlikely event of a primary regulator failure, the system is designed to automatically transfer to the backup unit, thereby providing maximum assurance that the generator will stay on line. Transfer is executed via a watchdog circuit that monitors the microprocessor and power supply.

External automatic tracking between DECS (A) and DECS (B) and vice versa is provided, allowing bumpless manual transfer to either controller. Normal operating mode of the primary DECS–250 is AVR mode. Should a loss of voltage sensing occur, the system transfers to FCR–manual mode and raise/lower control affects manual mode set point only until the problem has been resolved.

Voltage matching is provided to allow automatic adjustment of the AVR mode set point to match the sensed bus voltage with the generator. Voltage matching is enabled in AVR mode only.

Contact status is provided for:

- DECS (A) or DECS (B) operating
- FCR mode active
- Limiting Active
- Protection Active
- On/Off Status
- Extended field overcurrent for machine trip
- Watchdog failure alarm

External Switch Interface is provided for:

- DECS (A) to DECS (B) Transfer
- On/Off
- FCR Reset to AVR mode
- Alarm/Fault reset
- Raise/Lower Control

Local/Remote Control and Communications

Digital technology simplifies local and remote control capability and communication. Local control, setup and monitoring can be accomplished by two means:

1. Using the backlit LCD and advanced menu driven, password protected, HMI keypad; or
2. Using Basler’s free Windows®-based, password protected, BESTCOMSPiUS® software with capability to connect to Ethernet or USB.

Remote control is accomplished by using:

1. Control room switches and breaker contact inputs; or
2. Remote control and data acquisition through a RS-485 COM port that supports the open Modbus® protocol so all data registers and operating instructions can be accessed.

Protective Functions

The inherent protective functions of the DECS–250 provide supplemental fault protection and may be used as backup to primary protection relays:

- Generator Overvoltage and Undervoltage
- Field Overvoltage and Overcurrent
- Watchdog Timer (DECS failed)
- Loss of Voltage Sensing (can be programmed to automatically transfer to FCR mode (manual))
- Extended Overexcitation Relay for alarm or tripping generator (external to DECS-250 and incorporated into system assembly)

Auto-Tuning Offers Reliable Gain Settings for PID Controller

When commissioning the SGC–250, the auto-tune feature can be used to generate a set of gains. This feature uses a well developed and tested algorithm which tests the settings of the generator and produces the Kp, Ki and Kd gains.

Power System Diagnostic Tools

Digital technology also makes troubleshooting events or disturbances “after the fact” simpler with the SGC–250 by reconstructing the exact timing of contact input/output changes of state, system operation changes and alarm conditions. An example of an event record is shown in Figure 4. In this event, there was an abrupt increase in the system bus voltage noted by Vave and Vbus. The DECS–250 responds appropriately by decreasing field voltage and current (Vfd and Ifd). When

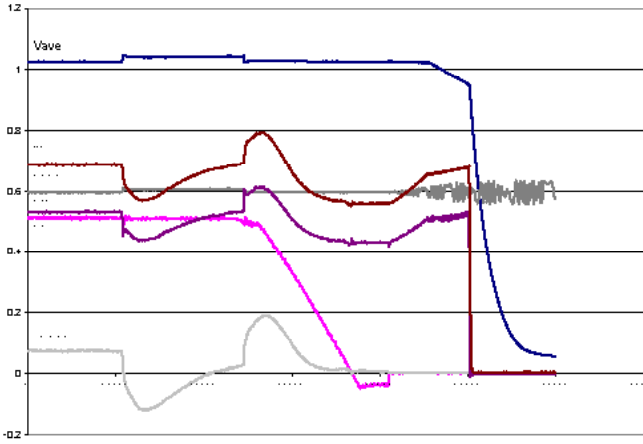


Figure 4: Oscillographic records like those shown above aid in troubleshooting system disturbances.

the bus voltage abruptly returns to a nominal value, the DECS again responds appropriately to increase field voltage and current to maintain appropriate Kvar levels. The graph also shows that the turbine/generator was tripped off as seen by KW, Vave, Vfd and Ifd collapsing to zero. This investigation led to the discovery of incorrect settings of a protective relay that tripped the generator. Volatile memory can store 1,023 event sequences that can be retrieved using the BESTCOMSPi.us software. The DECS-250 can store up to 6 oscillographic records of up to 6 monitored parameters. Oscillographic records are viewable using standard COMTRADE software or Basler BESTview™.

Where agency requirements dictate the need to provide data of unit performance such as excitation limiters operation and voltage step responses, the oscillography offers a convenient tool to record and store records of performance testing at time of commissioning and offering comparison of data later when unit performance needs to be verified based upon an agency's requirement to periodically recheck data. The data can be set to trigger from a mode trigger, level trigger or logic trigger.

Dual Control Power Input Sources

The redundant SGC-250 modules accept simultaneous control power input voltages of 120 Vac and 125 Vdc or 120 Vac and 24 Vdc from plant power sources so that loss of one source will not cause the regulator to lose control.

If both control power sources are lost, the dedicated watchdog circuit output of the backup DECS-250 is designated to trip an 86 generator lockout relay. There are provisions to convert the 120 Vac control power to dc in parallel with the 125 Vdc or 24 Vdc control power for redundant control power to the onboard sequencing relays.

Installation and Commissioning

The prepackaged excitation system provides faster factory lead time, installation and commissioning time. For further information on this product, visit www.basler.com to access product documentation. To discuss your specific application or turnkey installation, contact Basler's experienced Application Specialists at +1 618.654.2341.

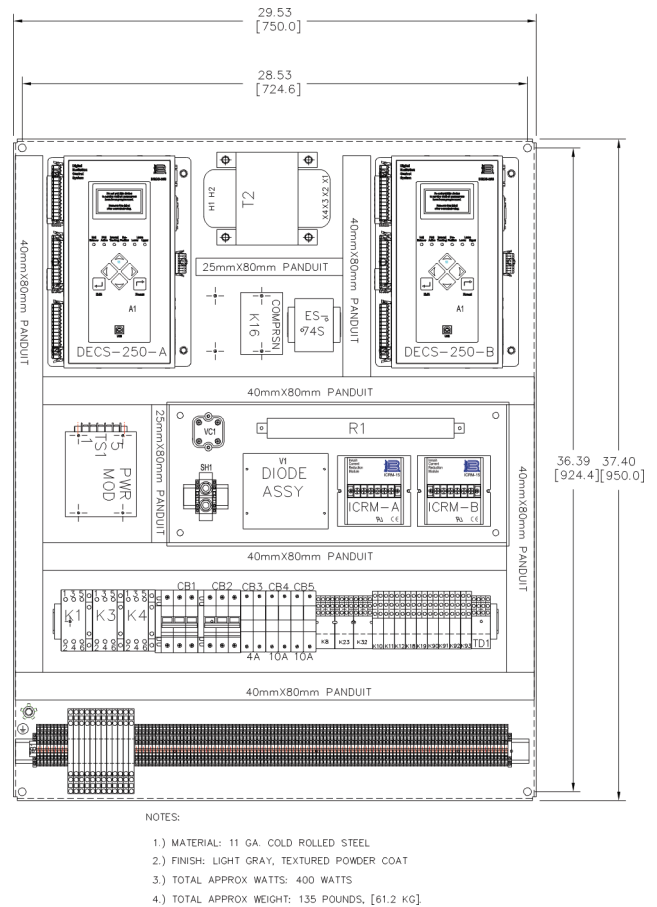


Figure 5: Outline drawing of a redundant SGC-250, a retrofit solution that features redundant regulators and control relays mounted on a pan chassis capable of being installed in an existing enclosure.