EX-D250N • February, 2024
Published for the Basler Electric Power Systems Group

Application Note

DECS-250N Negative Field Forcing Capability Offers Tuning Advantages for Rotating Exciter Systems

Voltage regulators of various types have been designed over the years. On many machines, one quadrant voltage regulators provide positive field control but no negative field forcing into the exciter field in response to system disturbances.

For generators having small machine time constants, the lack of negative field forcing generally is not an issue. However, as the size of the generator becomes larger, performance expectations increase. A non-negative field forcing voltage regulator has limitations when asked to provide corrective generator voltage change in response to system disturbances. The lack of negative field forcing creates nonlinearity in the system when fast response is desired, such as during system transients, because it limits the exciter field decay. For hydros, which are slow speed spinning machines with large time constants, tuning the digital excitation system can be a challenge when negative field forcing is not available.

Yet, for machines that are brush or brushless, up to 30-40 MVA, cost may be a concern to purchase extra performance capabilities.

Figure 1. Standalone DECS-250N

Figure 2. At facilities with slow speed hydros, like the one above, there can be tuning challenges without negative field forcing voltage regulators.

Figure 3. Facilities with gas turbines requiring power system stabilizers benefit from negative field forcing voltage regulators.

Today, Basler offers a solution to address the need for improved performance: the DECS-250N (Figure 1). The DECS-250N has similar features and functionality of the Basler DECS-250 except instead of having a pulse width modulated bridge for field control, it uses an SCR bridge with the ability to provide both positive and negative field forcing. Table 1 offers a summary of DECS-250N features and functions.

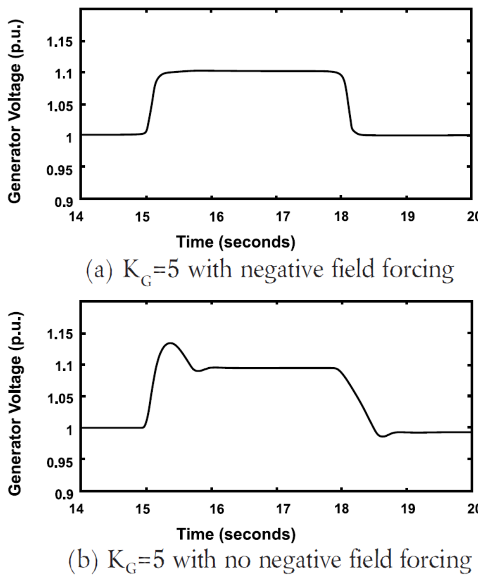

Figure 4. Performance differences with negative forcing

Voltage regulators with negative forcing can improve the generator voltage response time during load disturbances. Figure 4 represents a typical response characteristic for a voltage step change on a generator that utilizes a negative forcing voltage regulator, compare the lower diagram with the same voltage step change. Note the generator being controlled by a Non-Negative Forcing Voltage Regulator has a much more sluggish response with voltage steps up and even slower for voltage steps down. The voltage overshoot can be minimized by lowering the gain to make the system produce less voltage overshoot, but this affects the overall system response by making it even more sluggish.

Yet another concern exists where higher performance is needed, with increasing demand for reliable power. Today, more and more excitation systems are being equipped with power system stabilizers to improve the collected response of machines connected to the transmission system.

In Western North America, machines 30 MVA and higher, and plants having 75 MVA of generation or greater, must have a power system stabilizer. In the past, power system stabilizers have been added to various types of voltage regulator systems working directly into the shunt field of the rotating exciter. The stabilizer often was added to a system to meet a regulatory requirement without review of the excitation system to determine if it had the performance capabilities to respond favorably to system disturbances.

For a power system stabilizer to be fully beneficial for generators having rotating exciters, the voltage regulator should have fast response and a wide frequency bandwidth, ideally in the range of 135 degrees phase lag at 1 Hertz. Where many excitation systems used on turbine generators in the 30 MVA range have only positive field forcing to drive the exciter shunt, field performance is limited.

Adding negative field forcing into the excitation systems with exciter shunt fields restores the linearity and optimizes the unit response.

Figure 5 is a simulation of an external fault. The first half of the record is for a full-controlled bidirectional bridge; at time equals 3 seconds, a single directional bridge is implemented. The single directional bridge produces a generator terminal voltage increase of over 10% . See

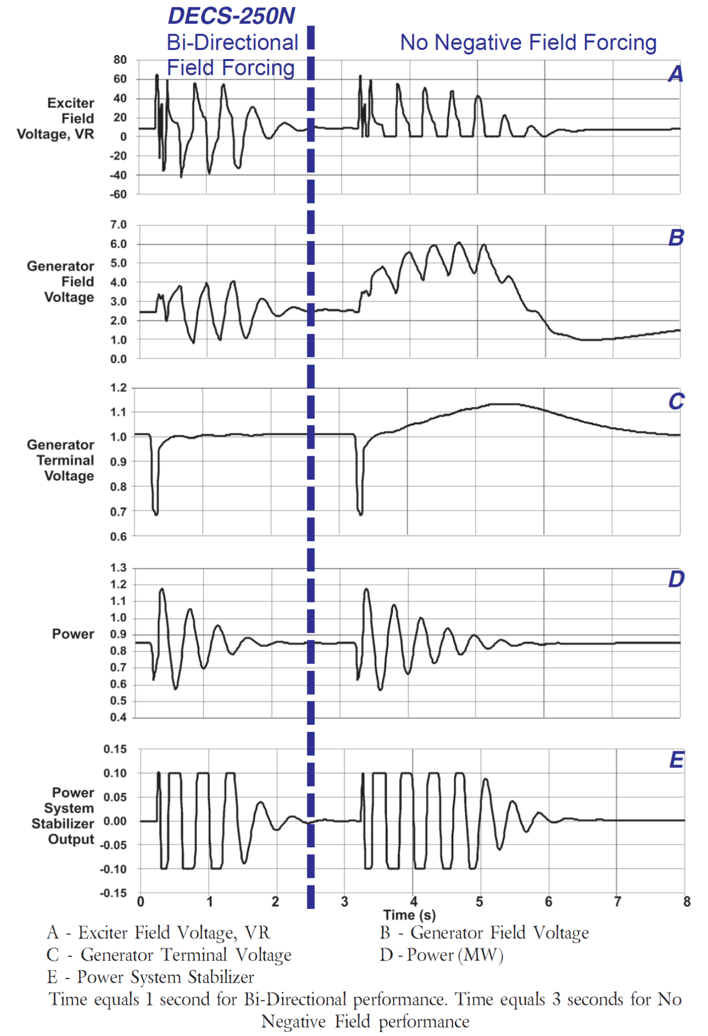

Figure 5. Simulation of an external disturbance

Figure 5C. The settings for the PSS on these systems must consider this effect. Notice power swings dampen much faster when the bi-directional field control is utilized. See Figure 5D.

Where a high end excitation system like the DECS-400 may not be the most economical solution for these smaller machines, the DECS-250N may be the more favorable selection.

Power for the bridge can be single phase and for high field forcing, three-phase voltage input is suggested. For generators having permanent magnet generators, the DECS-250N is compatible with PMG frequencies ranging from 50 to 420 Hertz. The DECS-250N has a 20 ampere continuous current capacity and is compatible with field voltages of 63 and 125 Vdc (250 Vdc option available at 50/60Hz).

Basler Electric offers the Redundant Controller package in a fixed mounted configuration or a disconnectable DECS-250N version allowing on-line maintenance of the DECS-250N while the machine is running.

While Table 2 offers various solutions pre-engineered for end users to address performance expectations, Basler Electric can custom engineer virtually any chassis or cabinet design requested to include all the tools needed for a successful excitation upgrade. For redundant controller applications, the two DECS-250Ns can be provided on a panel or in a cubicle with sequencing control relays and automatic transfer capability to the backup controller, with wire out terminal blocks for easy customer interconnection. See Figures 6 and 7.

Visit www.basler.com for more information on the DECS-250N.

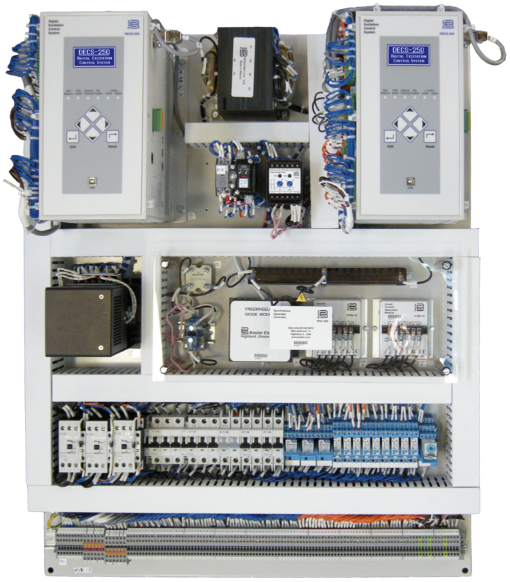

Figure 6. Typical Dual SGC-250N

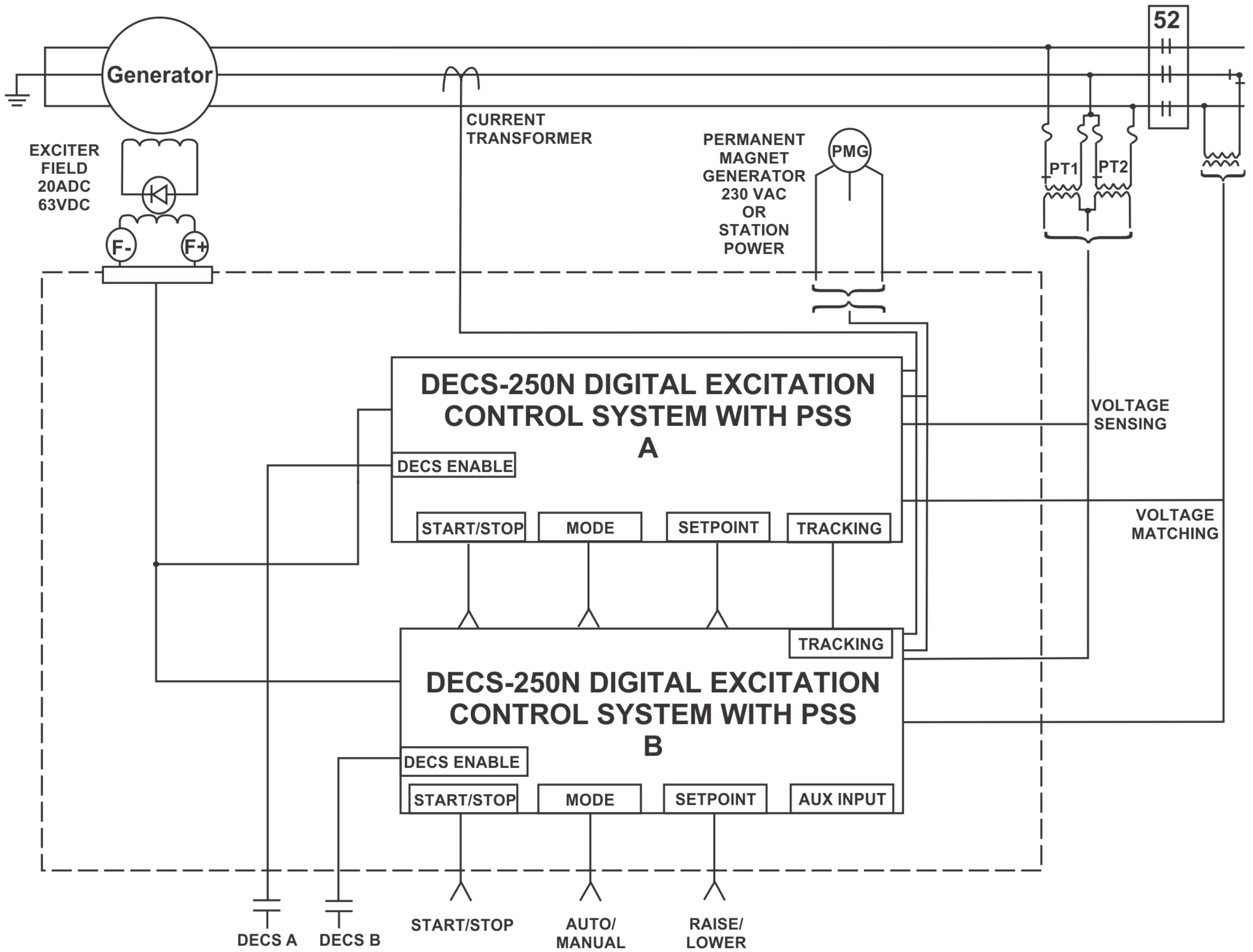

Figure 7. Simplified Interconnection of a Dual DECS-250N System with Integrated Power System Stabilizer

Basler DECS-250N Digital Excitation Control System Features and Functions

- 0.25% Voltage Regulation
- Field Current Regulation (manual)
- Var or Power Factor Control
- Overexcitation limiter (off-line and on-line)
- Underexcitation limiter (custom 5 point or standard curve)
- Dual PID settings groups optimize system response when the integrated Power System Stabilizer (PSS) is active or inactive
- Auto Tuning Feature
- Internal and External Tracking for Bumpless Transfer
- Underfrequency Voltage Limited Compensation or Selectable Volts/Hertz Ratio Limiter
- Automatic Voltage Matching and Synchronization
- Generator Voltage Softstart
- Oscillography (1,200 data points)
- Sequence of Events Recording (1,023 events)
- HMI Metering, Operating Screen Communications
- Protection:
  - Field Overvoltage
  - Generator Over/Under Voltage
  - Field Overcurrent
  - Loss of Voltage Sensing Detection/ Transfer to Manual
- Control
  - Brushless Exciter Diode Monitoring
  - Loss of Field
- Communications (ModBus® protocol)
- PC Setup Software (BESTCOMS*Plus*®/ BESTlogic™*Plus*)
- Preposition Set point
- Reactive Droop or Line Drop Compensation
- Reactive Load Sharing over Communication
- Ethernet (RJ45 Modbus)
- RS-485 (Modbus)
- USB

SGC-250N Kit Options	Style Number	Description
Single DECS-250N	SD1*1*5**	125 Vdc Control Power, 50/60 Hz, No PSS
	SD2*1*5**	125 Vdc Control Power, 50/60 Hz, With PSS
	SD1*2*5**	24 Vdc Control Power, 50/60 Hz, No PSS
	SD2*2*5**	24 Vdc Control Power, 50/60 Hz, With PSS
	SD1*1*6**	125 Vdc Control Power, 61 to 420 Hz, No PSS
	SD2*1*6**	125 Vdc Control Power, 61 to 420 Hz, With PSS
	SD1*2*6**	24 Vdc Control Power, 61 to 420 Hz, No PSS
	SD2*2*6**	24 Vdc Control Power, 61 to 420 Hz, With PSS
Redundant DECS-250N	DD1*1*5**	125 Vdc Control Power, 50/60 Hz, No PSS
	DD2*1*5**	125 Vdc Control Power, 50/60 Hz, With PSS
	DD1*2*5**	24 Vdc Control Power, 50/60 Hz, No PSS
	DD2*2*5**	24 Vdc Control Power, 50/60 Hz, With PSS
	DD1*1*6**	125 Vdc Control Power, 61 to 420 Hz, No PSS
	DD2*1*6**	125 Vdc Control Power, 61 to 420 Hz, With PSS
	DD1*2*6**	24 Vdc Control Power, 61 to 420 Hz, No PSS
	DD2*2*6**	24 Vdc Control Power, 61 to 420 Hz, With PSS

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