

Application Note

DECS-250E Synchronous Motor Applications

A synchronous motor (Figure 1) has a fixed stator winding that is electrically connected to the ac supply of the motor with a separate source of excitation for the motor field (rotor). The motor consists of a rotor (field winding) and a stator winding. When a synchronous motor is started, it starts as an induction motor, needing only the ac power applied from the bus with the help of a starting resistor across the rotor. When the motor reaches synchronous speed, the rotor poles lock into synchronism and an excitation source is supplied to the field.

Synchronous motors offer many advantages, primarily their ability to change power factor by adjusting excitation for lagging (unfavorable) to leading (favorable) operation. Many industrial facilities contain motor loads requiring substantial var support from the local utility system. By operating a synchronous motor with a leading power factor, the overall system power factor can be shifted toward unity. The power factor of a synchronous motor can be controlled by varying the amount of excitation



Figure 1. Synchronous Motor

current delivered to the motor field during operation. As the dc field excitation increases, the synchronous motor begins to operate in leading power factor, exporting vars. As the dc field excitation decreases, the synchronous motor operates in lagging power factor, importing vars and less favorable power factor.

When a synchronous motor operates in lagging power factor, the system interconnect must carry a larger kVA load than when it operates at unity power factor. Plant utility costs rise as the kVA burden increases at lagging power factor.

Basler Electric's DECS-250E Digital Excitation Control System provides the necessary excitation for field control. The DECS-250E provides accurate and reliable regulation, control, and field protection

for synchronous motor applications. For slip-ring applications, the DECS-250E is available in three different models: 50 Adc, 100 Adc, and 200 Adc. It can be shipped loose (Figure 2) or housed in a compact enclosure built by Basler Electric as a complete, ready-to-install package.



Figure 2. DECS-250E, Static Exciter Package

The DECS-250E offers enhanced control features including Field Voltage Regulation (FVR) and Power Factor (PF) control. These features offer flexibility of operation of the synchronous motor.

The power factor controller regulates the power factor setpoint that maintains the cosine angle power factor by measuring real power into the motor versus var and automatically adjusts excitation into the field to provide the correct amount of kvars to maintain the cosine angle. Figure 3 shows the constant angle as a function of kW into the machine versus kvars out of the machine. Load variations that occur in the plant are compensated by the excitation system to maintain the desired power factor, which saves utility costs.

With automatic power factor control, a fluctuating ac supply variation is compensated by field-forcing margins built into the excitation system. Without this feature, field poles would slip causing motor pull out as a result of too little excitation for the motor field.

When the motor starts, the excitation system is in FVR control mode. A separate field application device determines when to apply excitation to the field of the

motor. A field-voltage regulator's output mode remains active until a field application relay causes the dc contactor to close which applies excitation to the motor field and initiates a transfer to Power Factor control mode. Basler Electric's BESTCOMSPPlus® PC software is used to set the control mode.

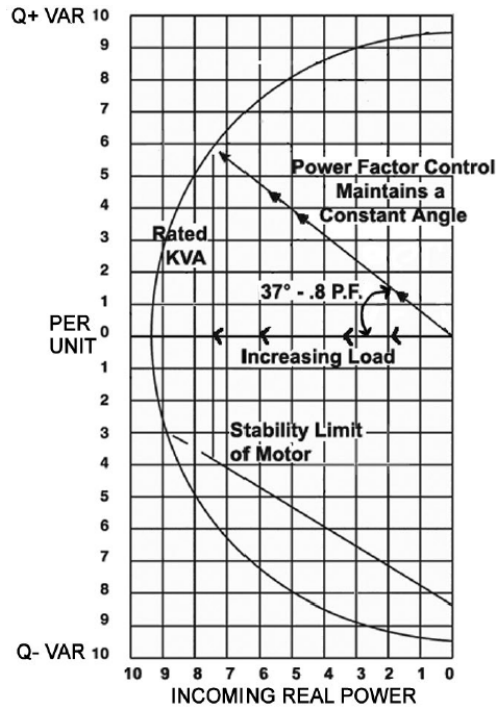


Figure 3. kW In versus kvar Out

AVR Control- First Action

One benefit of the new DECS package is its ability to provide voltage boost to the system when there is a voltage sag in the connected network. A lightning strike in the distribution network or other motors starting in a paper or ball mill can result in a significant voltage sag in the system. The voltage sag can comprise the running motors' ability to remain synchronous. The DECS system's first priority control loop is voltage support. The DECS has an automatic voltage regulator and a power factor/var controller for auto control. However, for any network disturbance, the voltage regulator reacts first to the voltage sag and immediately increases the field excitation to return the system voltage back to normal. After a short time delay, the system voltage normalizes and the power factor controller integrates its control signal back into the controller as a supplementary control loop to bring the system back to the desired operating power factor of the motor. Additionally, the maximum voltage deviation limits (voltage band) can be set within the DECS-250E to establish when voltage regulation should take priority over power factor control.

Field Application Device

For applications involving the dc contactor, Basler Electric offers a complete package that includes a dc Field Application Relay that measures the rotor slip frequency across the discharge resistor as compared to the ac induced frequency from the stator to determine the minimum slip to close the dc contactor to ensure proper synchronization.

Once the slip frequency from the motor is less than 2 Hertz, the dc field application relay signals the dc contactor to close across the field and open the dc contactor across the discharge pole that removes the starting resistor.

Figure 4a shows a typical system.

Features and Functions

In addition to FVR and PF control modes, the DECS-250E is equipped with the following integrated features and functions that facilitate efficient motor operation:

- Automatic setpoint tracking in all regulation modes to ensure "bumpless" transfers
- External setpoint tracking for a redundant application
- Integrated dynamic system analyzer for motor, excitation, and system frequency response testing
- Real-time monitoring by means of a chart recorder
- Oscillography data
- Sequence of events recording
- Trending
- Overexcitation protection and limiting
- Motor overvoltage protection
- Motor undervoltage protection
- Loss of sensing protection
- Field overvoltage protection
- Rectifier bridge overtemperature/pole slip protection

Communication

- RS-232 for external setpoint tracking
- CAN Bus
- RS-485 with Modbus RTU
- Ethernet 100Base-T
- USB for BESTCOMSPPlus communication
- Optional PROFIBUS

BESTCOMSPPlus® and BESTlogic™Plus

BESTCOMSPPlus PC software connects with the DECS-250E and enables access to all settings as well as features such as oscillography, real-time monitoring, and BESTlogicPlus programmable logic.

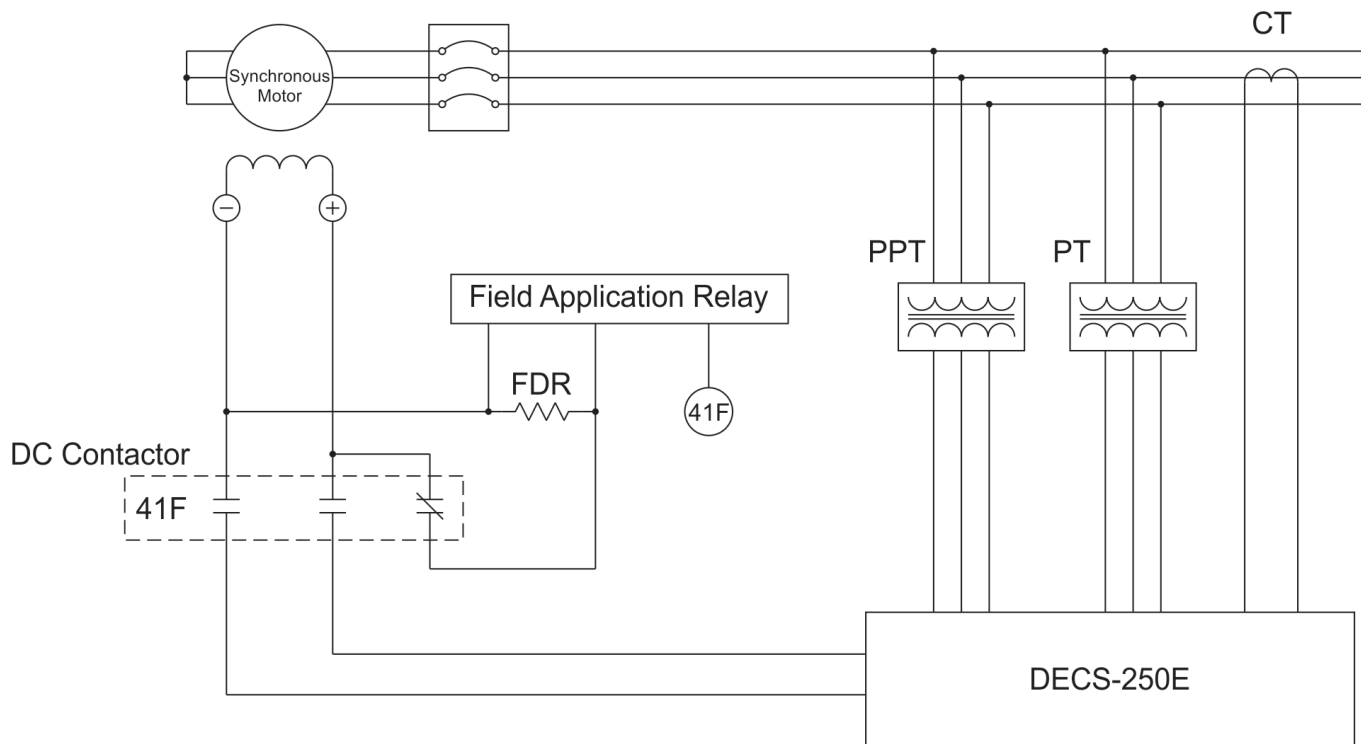


Figure 4a. Typical System

An integrated oscillography function records up to six parameters using the COMTRADE file format. Oscillography records are stored in nonvolatile memory and retained when DECS-250E control power is lost.

The real-time monitor (Figure 5) records live system data without the need for external recording equipment. The DECS-250E performs simultaneous measurements having up to six variables for monitoring with the ability to adjust the resolution.

BESTlogicPlus (Figure 6) is used to set DECS-250E contact inputs and outputs. Intuitive logic schemes provide simple and flexible programming of DECS-250E functions.

Conclusion

The DECS-250E is the best solution for regulation and control in field applications and excitation. It automatically regulates the power factor setpoint which improves operation of a synchronous motor. When synchronization occurs, an available accessory device provides excitation to the motor to prevent poles from slipping.



Figure 4b. DECS-250E with Field Application Device

For more information

For further assistance with product orders or questions, contact Basler Electric Technical Support at 618.654.2341.

For additional information on BESTCOMSPiUs software, including more application notes, product bulletins and instruction manuals, visit to www.basler.com, contact your Application Engineer, or contact Technical Support at 618.654.2341.

Critical information required for a system retrofit.

- Motor starting resistor value (resistance value for motor starting torques obtained from the motor manufacturer or the existing resistor nameplate)
- Motor starting time (how long it takes for the motor to reach synchronous speed)
- AC induced current into the discharge resistor at time of starting

Other devices included with the excitation package:

- Field Under and Over Current Protective Relay
- Motor Power Factor trip

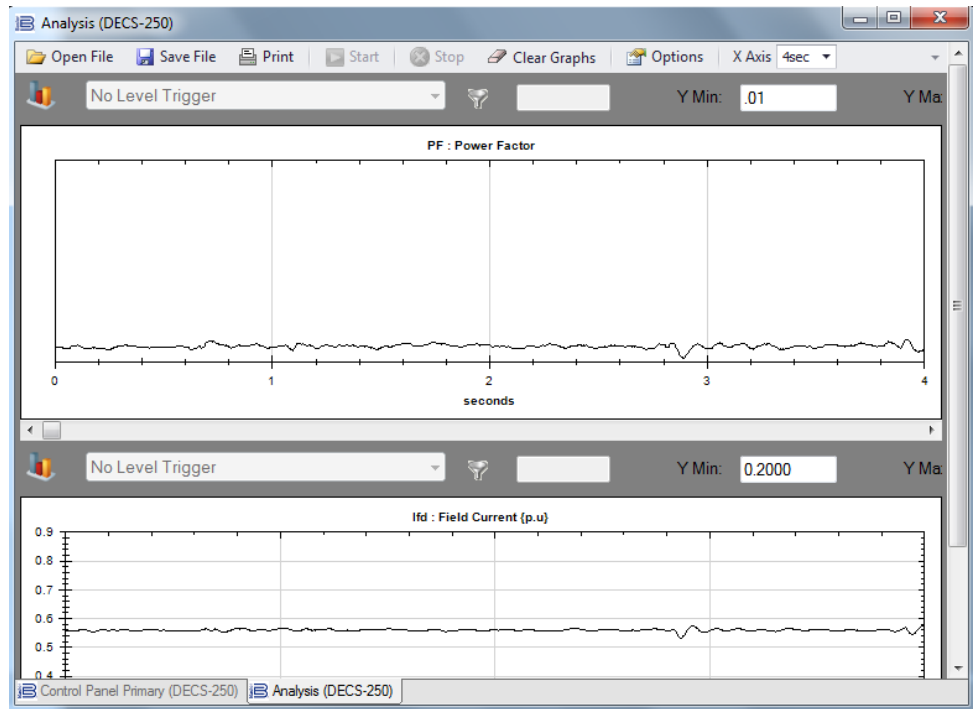


Figure 5. Real-Time Monitoring of Power Factor Control

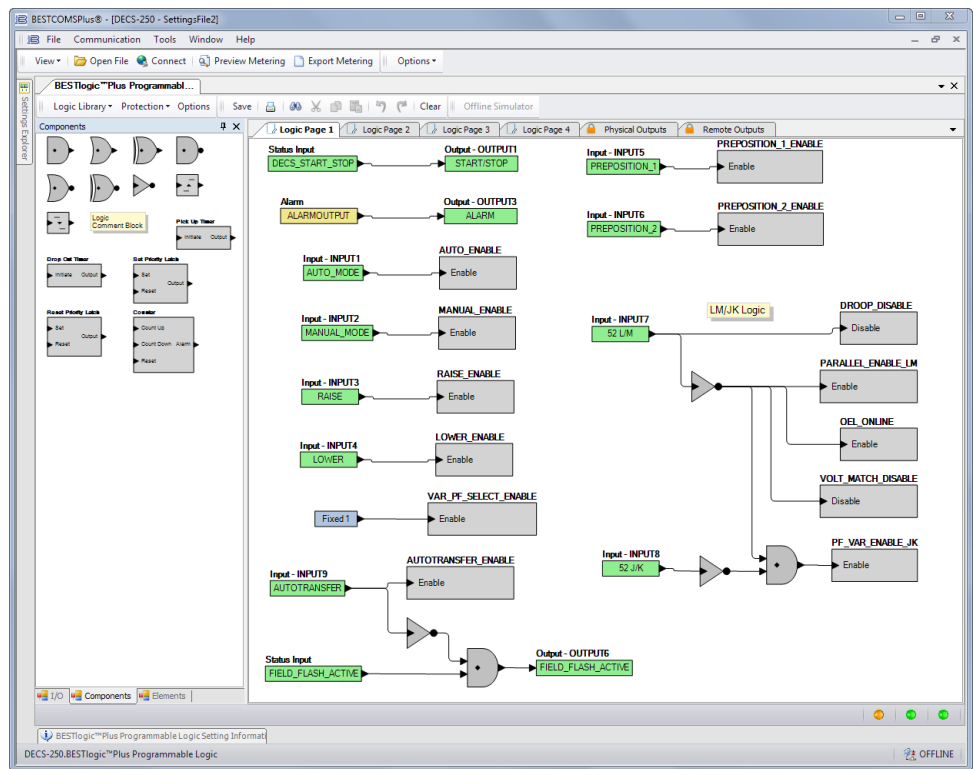


Figure 6. BESTlogicPlus