

Application Note

Basler ES-55 Power Factor Relay Protects Synchronous Motor Applications against Damage from Low Power Factor Operation

A synchronous motor is designed to operate at a speed equal to the system frequency. To accomplish this, a synchronous motor field is derived from an external dc excitation source. While this complicates the motor, it increases the capabilities of the motor. If the excitation system is sufficiently sized, the motor can operate at a synchronous speed when the voltage is in phase with the current. When this occurs, power is equal to the VA supplied to the motor and vars are equal to zero. This condition is defined as operating at a power factor of one.

The power factor will decrease if the excitation fails to provide the necessary field voltage. The power factor will also decrease if the load on the motor increases beyond the capability of the motor. When the power factor decreases, the stator current increases to support the motor load. This results in increased motor temperature and possible damage to the motor. If the power factor decreases enough, the motor can pull out of synchronization and slip a pole resulting in large increases in current and damage to the motor. The ES-55 Power Factor Relay measures power factor. When the power factor drops below the setpoint, the relay will pick up and start timing towards a trip. The pickup is adjustable between 0.45 and 0.95. The time delay until trip is adjustable between 0 and 10 seconds.

The ES-55 measures the power factor by monitoring the V_{CA} (C to A voltage) and I_B (phase B current). Connections are shown in Figure 1.

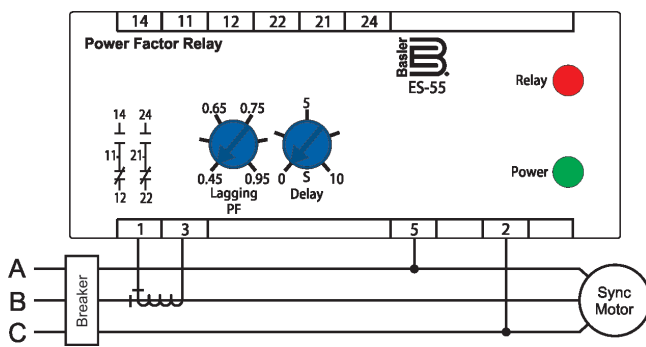


Figure 1 - ES-55 Connections

When I_B is either plus or minus 90 degrees from V_{CA} , the power factor is equal to 1.

When I_B is less than 90 degrees from V_{CA} , the power factor is calculated with the following equation:

$$PF = \sin(|\angle V_{CA} - \angle I_B|)$$

The power factor angle is 90 degrees minus the angle between V_{CA} and I_B as shown in the equation below:

$$PF \text{ Angle} = 90 - |\angle V_{CA} - \angle I_B|$$

Figure 2 illustrates the ES-55 trip region. In this figure, Lagging PF is set at approximately 0.86 and the power factor angle is 30 degrees. The relay will start timing towards a trip when the I_B current is within 60 degrees of V_{CA} . The relay will trip when the pickup condition is met for a time equal to the Delay setting.

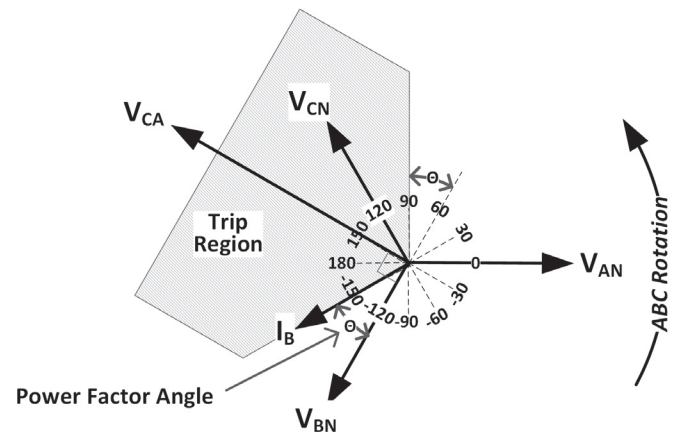


Figure 2 - ES-55 Trip Region

The ES-55 can be used for new applications or as a viable replacement for the PRP 320 and PRP 340 relays. The ES-55 operates on nominal voltages of 120, 208, 240, 380, 415 or 480 Vac as shown in the Style Chart (Figure 4). Special voltage ranges are also available by contacting Basler Electric. The ES-55 can operate on 50 or 60 Hz systems. It provides wider pickup and timing adjustment ranges than the PRP relays and operates

at about 20% of the burden. The ES-55 can be used in applications where temperatures range from -40 to 70°C (-40 to 158°F), while the PRP has a -20 to 50°C (-4 to 122°F) operating range. Unlike the PRP, the ES-55 does not include a latching output. If a latching output is desired, an auxiliary double-pole, single-throw relay can be used as shown in Figure 3. One contact from the auxiliary relay is connected to the motor contactor. The other contact is used with a momentary-open switch to provide the seal-in function.

For More Information

For further assistance with product orders or questions, contact Basler Electric Technical Support at 618-654-2341.

For additional information on ES Series Relays, including more application notes, product bulletins and instruction manuals, go to www.basler.com, contact your Application Engineer, or contact Technical Support at 618-654-2341.

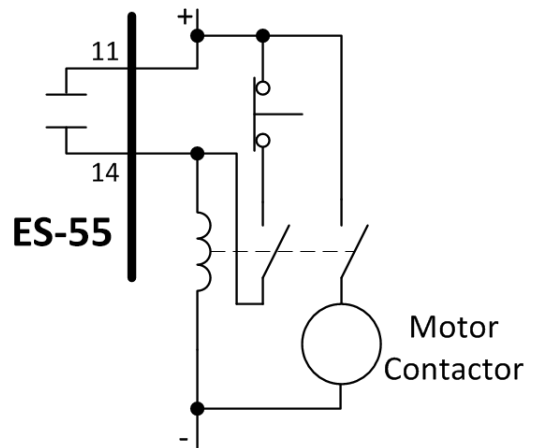


Figure 3 - ES-55 Latching Output

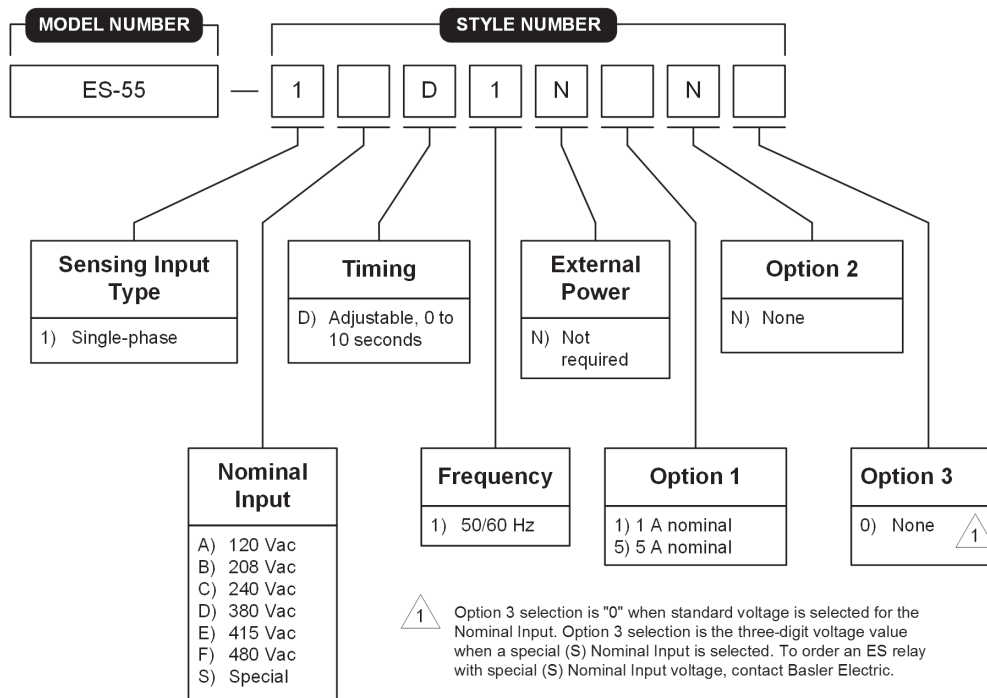


Figure 4 - ES-55 Style Chart