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Digital Energy

# 869 Synchronous Motor Protection

8 Series Mini Paper



imagination at work

# Synchronous Motor Excitation, Protection, and Control

A typical fixed speed brushless synchronous motor single line diagram is shown below in Fig. 1. The field excitation panel receives dedicated speed signals and rotor monitoring signals for enhanced excitation control. The 869 receives protection and monitoring related signals from RTDs, CTs, and PTs. The Exciter Panel's control and 869's Protection and Monitoring together form a full motor management system.

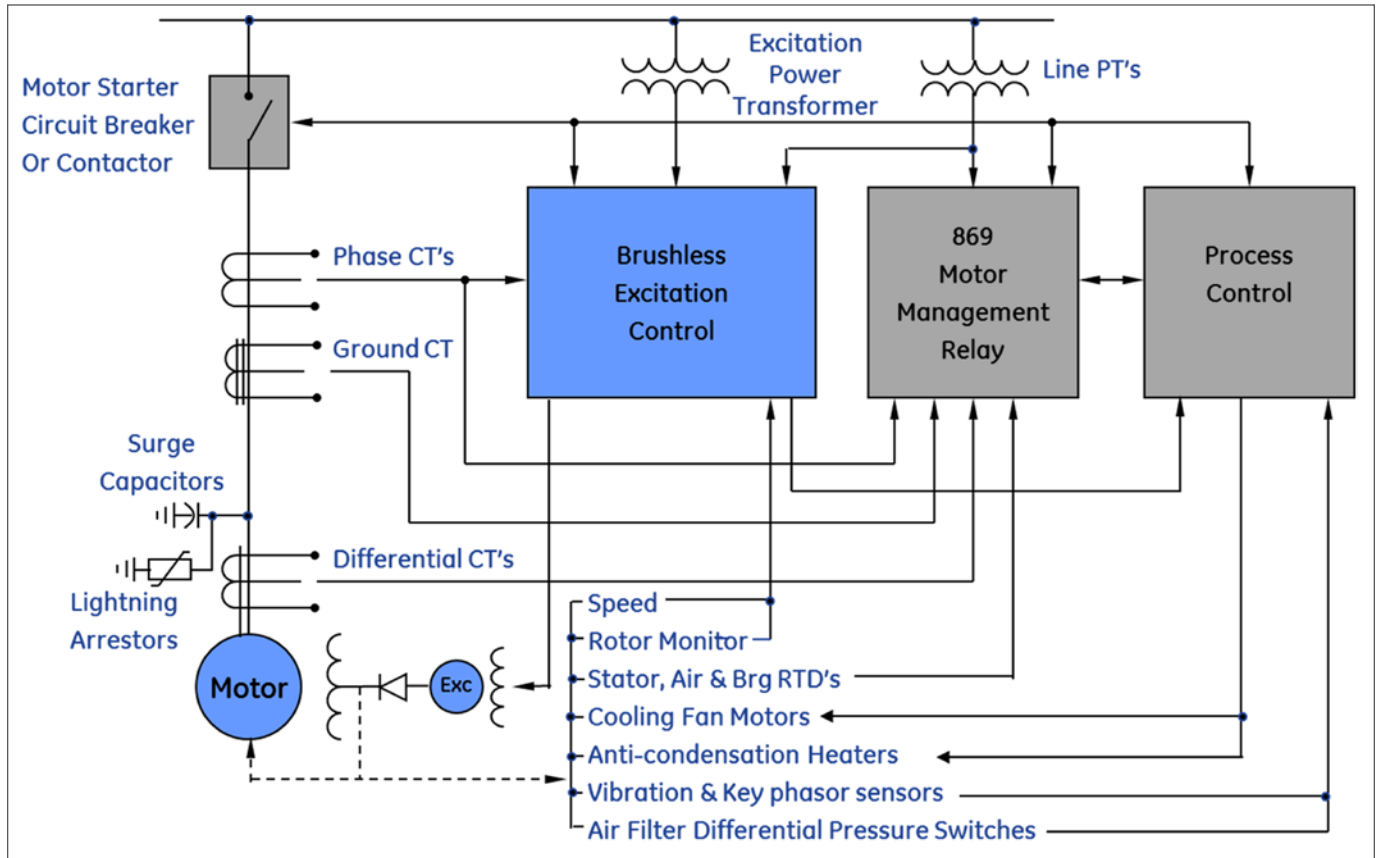


Figure 1. Synchronous Motor Brushless Excitation Typical SLD

# Comparison of Synchronous Motor Excitation panel vs The 869 functionality

A typical excitation panel has smart motor starting controls and advanced reliability controls while the motor is running. Diagnostics are also very common with excitation panels for operating personnel's use. Excitation panels make optimum use of the motor's available torque by having robust excitation control for synchronizing and pullout protection. In summary, the excitation panel provides basic start/stop protection, excitation protection, diagnostics, and rotor (or field) protection.

Combining with the 869's full range of protection functions; complete control, protection, and monitoring can be achieved for large synchronous motors.

Table 1 below shows the typical protection functions provided by the Excitation Panels compared to the 869 Motor Protection Relay.

**Table 1. Typical Functions of an Excitation Panel versus 869 Motor Protection Relay**

ANSI	EXCITATION PANEL FUNCTIONS	ANSI	869 FUNCTIONS
40	Field Loss Trip	27P	Phase Undervoltage
40	Field Overcurrent/Undercurrent Trip	32	Directional Power
76	DC Overcurrent	37	Undercurrent
48	Incomplete Sequence Trip	37P	Underpower
59	Overvoltage	46	Current Unbalance
	Locked rotor protection	47	Voltage Reversal
	Excitation Panel Self Diagnostic Test Trip & Fault Identification	49	Thermal Model
	Field Ground Resistance Alarm/Trip	50BF	Breaker Failure
	Field Overtemperature Alarm/Trip	50P/N/G/SG/_2	Instantaneous Overcurrent
	Field Temperature Based Start Block	51P/N/G	Time Overcurrent
	Time Between Starts Block	52	AC Circuit Breaker
	Start Inhibit	55	Power Factor
	Start/Stall Protection	59P/N/X/_2	Overvoltage
	Motor Pull-out-of-sync protection	67P/N	Directional Element
	Basic Transient Recorder	81U/O	Under/Over Frequency
	Excitation, Power Factor, and Reactive Power control	86	Start Inhibit
	Basic Event Logger with timestamp	87S	Stator Differential
		VTFF	Voltage Transformer Fuse Failure

## Additional Functions provided by 869 Motor Protection Relay

The excitation panels also have additional monitoring and recording functions but are bare minimum and cannot fully monitor a motor's status. The 869 offers advanced diagnostics through features like Broken Rotor Bar Detection, Turn-Turn Fault Detection, and Reduced Voltage Starting. It also offers superior monitoring by collecting motor start records, health reports, and overall motor statistics.

The 869's additional device functions in addition to exciter panel functions, creates a complete motor management system. Table 2 below shows the additional functions provided by the 869 Relay.

**Table 2. Additional 869 Features**

DIAGNOSTICS / ALARMS	ADVANCED MONITORING	ADVANCED COMMUNICATIONS
Mechanical Jam	Motor Start Records	IEC61850 Communications
Overload Alarm	Motor Start Statistics	Wi-Fi
Acceleration Time	Motor Learned Data	PTP and SNTP Clocks
Phase Reversal	Motor Health Report	Advanced Security CyberSentry Level1
Broken Rotor Bar	Advanced Breaker Health	Modbus RTU/TCP, IEC60870-5-103/104, PRP
Reduced Voltage Starting	Data Logger	
RTD Temperature	Transient Recorder (Oscillography)	
	Fault Report	
	Digital Counters	
	Event Recorder	
	Metering: current, voltage, power, PF, energy, frequency, harmonics, THD	

Synchronous motors are manufactured specifically for each application. Their efficiency and flexibility allow applications in a broad range of industries. Table 3 shows all the different applications for synchronous motors. The 869 relays is suitable for all these applications and can be deployed and customized depending on its protection and monitoring requirements.

It optimizes the capability of the motor through accurate protection while maximizing the usage life through informed decisions based on motor statistics and advanced diagnostics.

**Table 3. Synchronous Motors Industry Application**

INDUSTRY	APPLICATION
Mining	Crushers, Grinding Mills, Belt Conveyors and others
Metals	Rolling Mills, Fans, Pumps, Compressors
Pulp and Paper	Extruders, Chippers, Shredders, Compressors, Peelers, Refiners
Water/Wastewater	Pumps
Chemical and Petrochemical	Compressors, Fans, Exhausters, Pumps
Cement	Crushers, Mills, Conveyor Belts
Rubber	Extruders, Mills, Mixers

