

# 869 Advanced Motor Protection – A Comprehensive Protection Solution for Standard and Special Purpose Motor Applications

8 Series Mini Paper



Induction Motor Applications

Synchronous Motor Applications

High Inertia Load Applications

Cyclic/Reciprocating Load Applications

VFD/VSD Motor Applications

## 869

### Thermal Model

The 869 offers a complete overload protection solution with its Thermal Model element to protect the motor from stator and rotor overheating. Proven by over 25 years of use in the GE Multilin 469 motor protection relay, thermal model is now enhanced and able to protect a wide range of motor applications. The main features of the 869 Thermal Model are:

- **Flexibility** – The 869 thermal model is more flexible by selecting the appropriate overload curve that matches the thermal limit of the motor in one of the three available formats: Standard Motor Curves, IEC Curves and Custom Curves (FlexCurves). An example of thermal overload “Standard” curve is shown in the figure below.
- **Simplicity** – The 869 thermal model is simple because it doesn’t require motor equivalent circuit parameters and therefore is easy to configure from the motor nameplate information.
- **Adaptivity** – The Voltage Dependent (VD) overload curve feature in the model is adaptive to overload conditions during starting, acceleration, deceleration, locked rotor and starting input voltage level. The Figure below shows the VD curves for 80% and 100% of rated voltage motor starting.
- **Accuracy** – thermal model has improved accuracy due to enhanced signal processing in calculating RMS, 2-stage filtering and averaging the RMS to eliminate any oscillations. RMS currents are used in the thermal model to calculate extra heating due to harmonics in the motor input signals.
- **Security** – The thermal model biased to ensure secure operation by calculating exact replica of the motor heating in the presence of negative sequence currents, higher harmonics etc. Additionally, the thermal model is biased by the RTD’s temperature that allows the 869 to protect the motor against unusual high ambient temperatures or abnormal heating.

Figure 1: Voltage Dependent Overload Curves

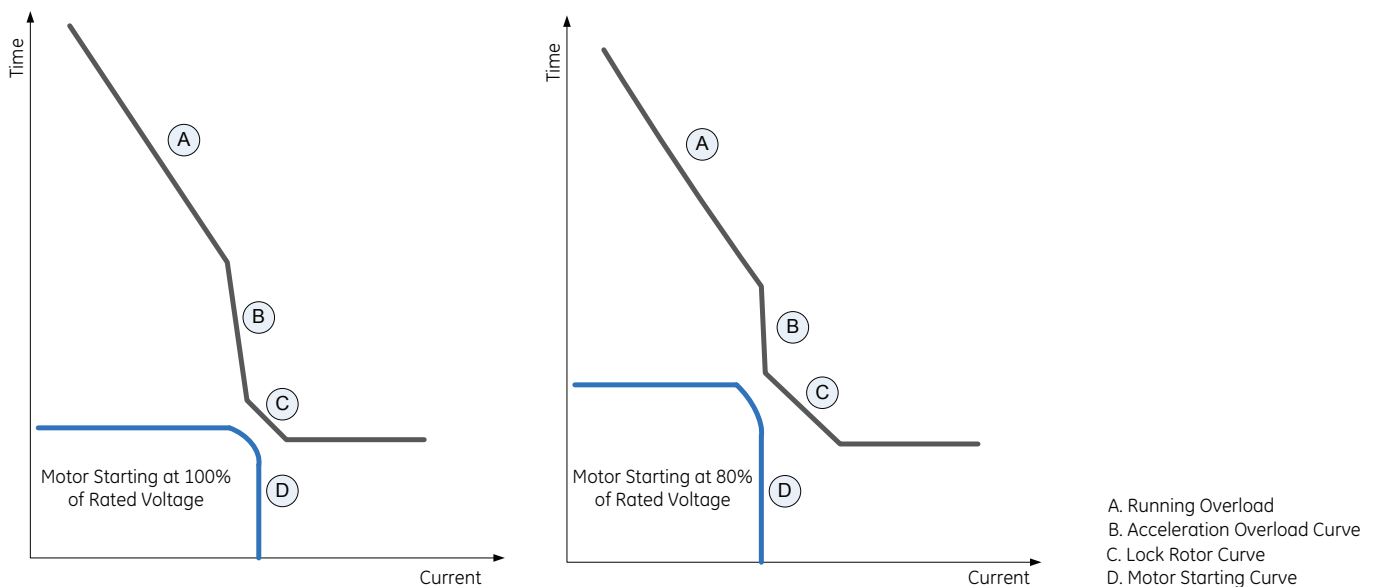


Figure 1 illustrates the automatic switching between the 80% and 100% overload curves when motor is started with 80% and 100% of the rated voltage. This automatic switching between the curves is achieved by using the Voltage Dependent feature in thermal model.

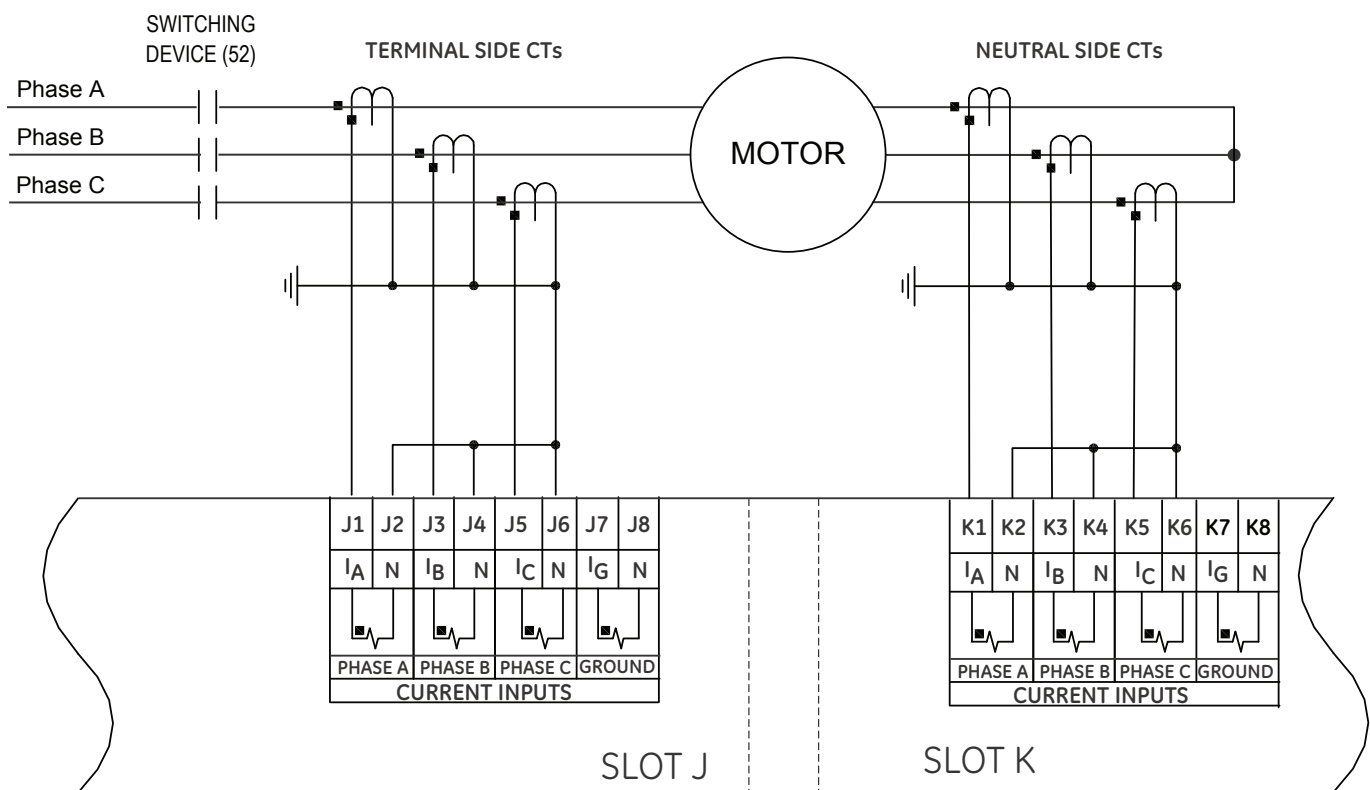
A Voltage Dependent overload curve consists of three distinct segments, which are based on the three running conditions of the motor: the locked rotor or stall condition, motor acceleration and motor running in overload. A trip occurs when the thermal capacity (TCU) reaches 100%. When stopped, the motor can be started, if TCU decays to the allowable starting TCU level or an emergency restart is activated via an input.

## Stator Differential Advancements

Differential protection may be considered as the first line of protection for internal stator phase to phase or phase to ground faults in induction and synchronous motors.

The 869 differential element offers the following distinguished features:

- Sensitivity to phase to phase and phase to ground faults
- High speed fault detection
- Biased differential, allowing different ratios of terminals and neutral CT nominal.
- Dual slop characteristic to prevent a misoperation, caused by spurious differential current during external faults with a possible CT saturation.
- Supports 3 and 6 CTs configurations: core balance with 3 CTs and true percentage differential configurations with 6 CTs



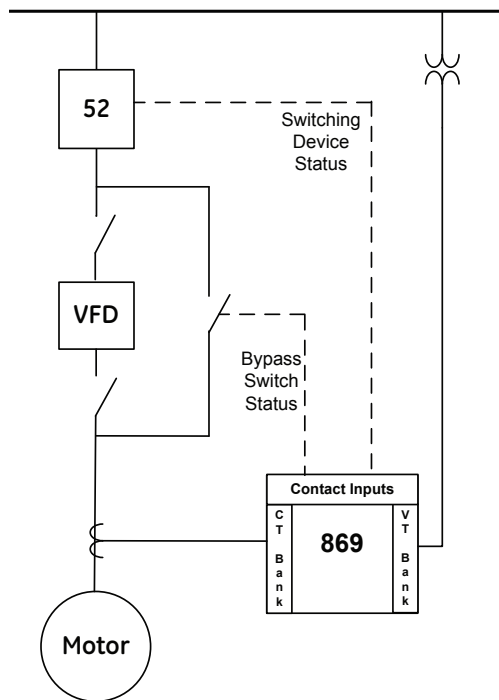
# Variable Frequency Drive Motor Applications

Variable frequency drives (VFD) generate a significant distortion in motor input signals.

The 869 protection relay is enhanced to ensure secure operation of the relay due to distorted motor ac signals and online switching to/from the VFD using a bypass switch while maintaining the high sensitivity to the abnormal system/motor conditions.

Main features of the 869 VFD function are:

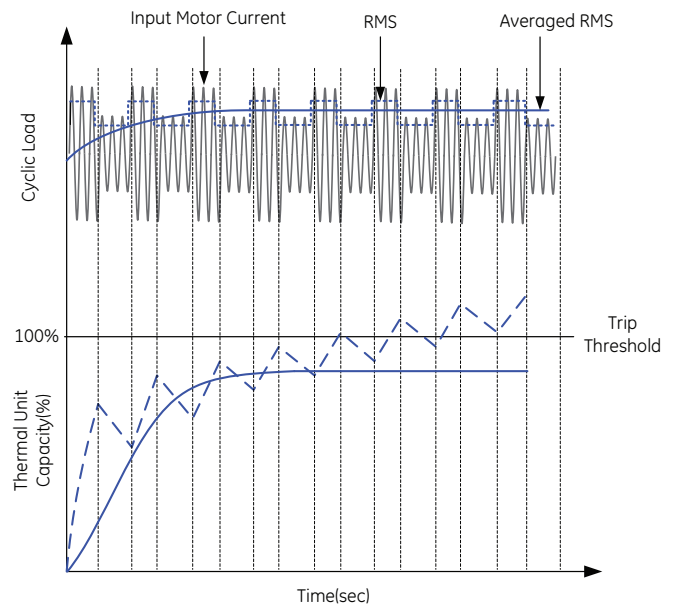
- Accurate tracking of the system frequency in the range of 3-72Hz and accurate phasor estimation over this range
- Additional filtering of the distorted input signals to achieve secure operation of the relay, while maintain the sensitivity to phase-phase and ground faults using short circuit, ground fault and differential protection.
- Ensuring thermal model accuracy by taking into account the extra heating generated by the higher harmonics due to VFD in order to achieve accurate response to the actual motor heating
- Making motor protection functions adaptive to the starting frequency on motor start and keep accurate tracking of the varying frequency during motor acceleration and deceleration



# Cyclic or Reciprocating Load Applications

The Input currents of a motor driving a cyclic load can vary from very low to above the maximum allowable current during a duty load cycle. To cope with this the 869 is adaptive to adjust to such continuously changing load current in order to get proper operation of the protection functions including thermal protection.

To better illustrate the behavior of thermal model for a cyclic load motor application, the following figure shows the calculation of thermal capacity based on the typical approach and 869 thermal overload method. The advanced 869 thermal model ensures more secure relay operation for the reciprocating or cyclic load motor applications with a number of poles between 2 to 64 poles.



Calculation of thermal capacity using:

- Conventional thermal overload protection: Wrong Operation
- GE 869 thermal model: Desired Operation