

GF-11 : GROUND-FAULT MONITORING IN ADJUSTABLE-SPEED DRIVE APPLICATIONS

Issues with variable frequency drives:

The built-in ground-fault-trip level of many drives is not adjustable, and is set to function at a ground-fault current that is a proportion, such as 50%, of rated drive current. As a result, variable-frequency drives used on resistance-grounded power-distribution systems may not trip when a ground fault is present. Because the trip level of the drive is higher than the maximum ground-fault current, the drive will continue to operate with a fault present. An SE-701 Ground-Fault Monitor or SE-703/SE-704 Earth Leakage Monitor can be used to add ground-fault protection to these systems.

Many VFD's have EMI-reduction capacitors connected phase-to-ground at their input. The capacitors are often rated for line-to-neutral voltage, with the assumption that the power system will be solidly grounded. However, during a ground-fault on a resistance-grounded system, the voltage on the two non-faulted phases rises to line-to-line voltage to ground, possibly destroying the EMI capacitors. It is prudent to remove these capacitors before this occurs. For more information, review the VFD documentation or contact the drive manufacturer.

Filtering, filter selection, and recommended set point:

When an SE-700 Series Ground-Fault/Earth-Leakage Monitor is used in a variable-frequency application for ground-fault detection across a wide frequency range, select the Variable-Frequency (peak-detection) filter. This filter has a wider pass band and less attenuation of frequencies below 60 Hz than the Fixed-Frequency (DFT) filter.

When used to detect a low-frequency fault, a lower trip setting can be required due to the SE-700 Series frequency response. Use the normalized response value from the chart in Fig. 1 to calculate the appropriate trip-level setting, considering the lowest expected operating frequency. To calculate the setting, multiply the desired trip level by the normalized response value at the lowest-expected operational frequency.

Recommended setting = (desired trip level) x (normalized response at lowest frequency)

For instance, if a 625-mA RMS trip level is desired and the VFD will often be operating at 40 Hz, the recommended setting is $625 \text{ mA} \times 0.8 = 500 \text{ mA}$.

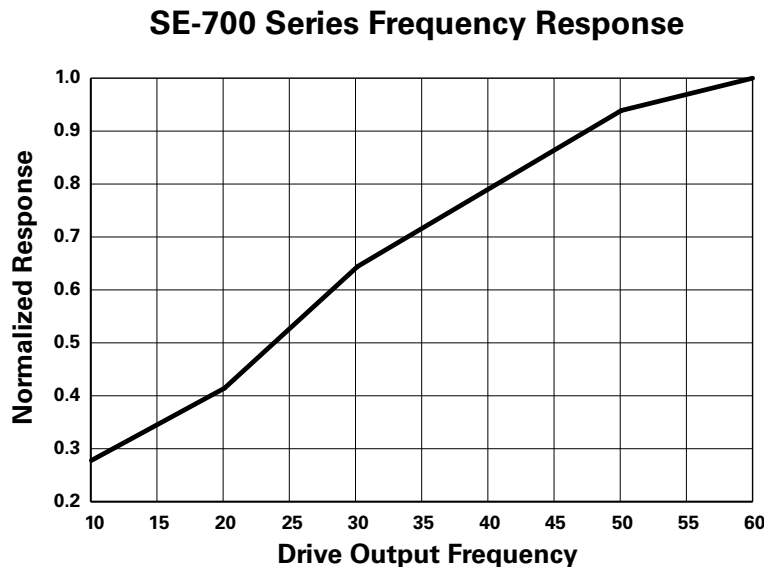


Figure 1: SE-700 Series Frequency Response, Variable-Frequency Filter

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Ground-fault current transformer location:

Install the zero-sequence current transformer on the line side of the drive. Without an isolation transformer, a VFD does not isolate downstream fault current; a ground-fault located on a VFD-supplied load will be detected equally by ground-fault monitors upstream and downstream of the drive. In the resistance-grounded system shown in Fig. 2 with a ground fault in the load, the measured ground-fault current is the same at each SE-700 Series.

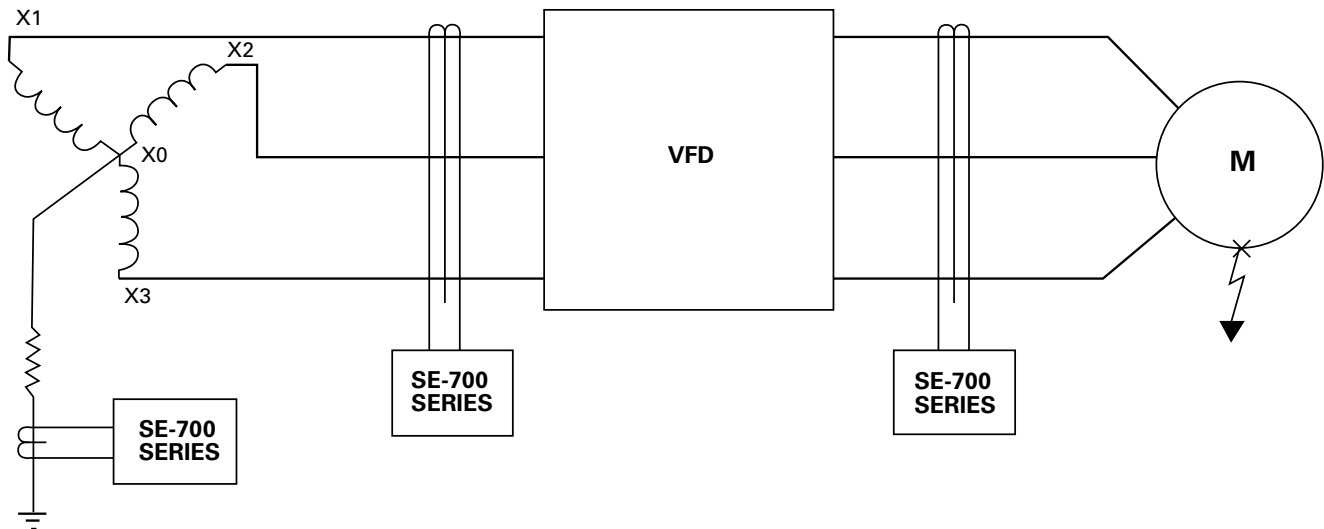


Figure 2: VFD Resistance-Grounded System

Installing the ground-fault CT upstream of the drive is beneficial because it can detect a fault in the cable to the drive, in the drive, and downstream of the drive. For detailed information on ground-fault currents in VFD systems see "SE-701 with VFD Test Report" located at www.startco.ca/library/pdf/SE-701_VFD_TestReport.pdf

DC bus ground-fault:

When an SE-700 Series is installed on the line side of a VFD it is possible for it to detect a ground fault on the DC bus of the drive, and to detect a low-frequency fault elsewhere. With the peak-detection filter, the 180 Hz ripple current (150 Hz on a 50-Hz supply) that is always present can be detected. This ripple current is typically of a much smaller magnitude than the total fault-current and requires a low trip-level setting, which should be verified by testing. The expected value of the 180 Hz component is 10 to 15% of the prospective fault current on a resistance-grounded system, requiring a trip-level setting that is a maximum 10% of NGR let-through current.