

RG-11 : VOLTAGE METERING IN RESISTANCE-GROUNDED SYSTEMS

Background

A high-resistance-grounded system is similar to an ungrounded system in that it is not capable of supplying line-to-ground loads. Protection and monitoring equipment connected from line to ground must not jeopardize the protection system and should have little or no impact on system performance.

If line-to-ground potential transformers (PT's) are used to measure line-to-ground voltages, the PT's create a Y-Y transformer connection:

- 1) Any unbalance in PT-secondary loading will cause neutral-grounding-resistor (NGR) current to flow even though the system is not faulted. In most cases the current will be below ground-fault relay pick-up levels; however, this system ramification should be considered if line-to-ground PT's are used in a high-resistance-grounded system.
- 2) An open NGR will result in the system being grounded through the PT's. Although not well documented for 3-phase PT connections, the possibility exists for high voltages caused by the interaction of the PT magnetizing inductance and system capacitance.

NGR Monitoring with Grounded PT'S

Littelfuse Startco NGR monitors (SE-325 and SE-330) continuously measure NGR resistance by injecting a sensing signal through the NGR. Neutral voltage and current are also measured to allow detection of resistor failure during a ground fault.

Primary-grounded PTs provide an alternate path for the NGR-monitor sensing signal. The result is that the monitor will not trip when an NGR opens, unless a ground fault is present.

SE-325 NGR Monitoring with Grounded PT's

The continuity circuit of the SE-325 is not compatible with grounded-PT connections and an SE-325 will not detect an open NGR unless neutral voltage exceeds the RES TRIP LEVEL setting as a result of a ground fault.

SE-330 NGR Monitoring with Grounded PT's

20K Sensing Resistors (ER-600VC, ER-5KV)

In some applications, an additional neutral-grounding resistor can be used to ground the PT-primary "Y" point. The PT's NGR value must be greater than the sum of the SE-330 trip resistance (500 ohms) plus the resistance of the system NGR. In the case where multiple PT installations are used on the same system, the PT NGR-resistance values must be increased so that when the system NGR opens there is at least a 500-ohm increase in neutral-to-ground resistance.

The resistance of the PT NGR has little impact on voltage-measurement accuracy during normal operation but will affect accuracy during a ground fault. Expect a voltage-measurement error in the range of a few percent in the presence of a ground fault.

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100K and 200K Sensing Resistors (ER-15KV, ER-25KV, ER-35KV, ER-72KV)

The continuity circuit of the SE-330 is not compatible with grounded transformer-type PT connections and an SE-330 will not detect an open NGR unless neutral voltage exceeds the VN TRIP LEVEL setting as a result of a ground fault. If neutral voltage persists after a Resistor-Fault trip, a Ground-Fault trip will also occur.

Capacitor-voltage transformers (CVT) are recommended for high-voltage applications.

THE CVT Solution

A CVT is an ideal solution for voltage measurement in resistance-grounded systems. Since the CVT uses a coupling capacitor, the DC sensing signal used for NGR monitoring is blocked by the CVT and its presence has no impact on the NGR monitor's continuity circuit. Unfortunately, CVTs are not readily available in the 4160-V to 25-kV range. Startco will continue to investigate the availability of a CVT for medium-voltage NGR applications.