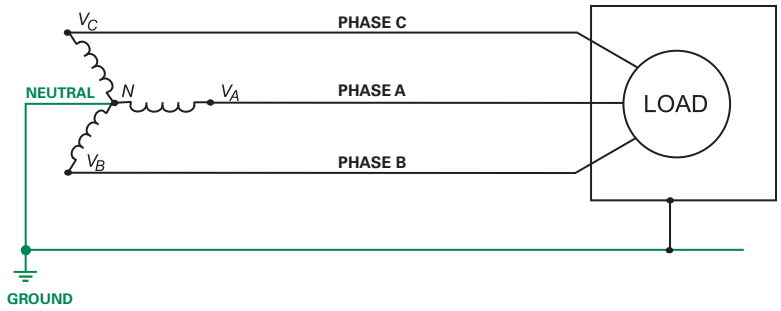
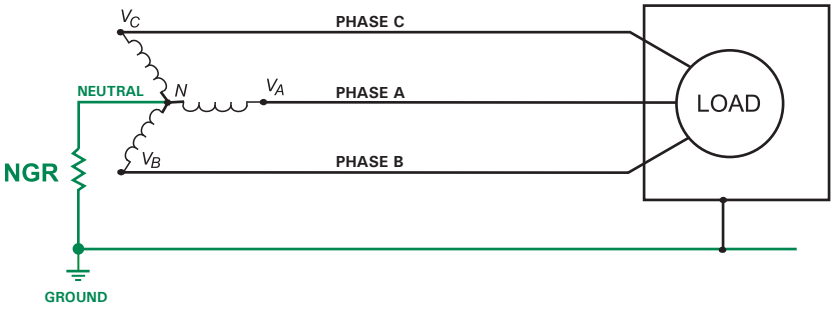
IMPLEMENTING RESISTANCE GROUNDING ON SOLIDLY GROUNDED SYSTEMS

A solidly grounded system is a system in which the transformer secondary neutral Xo, or wye point, is connected directly to ground. This configuration has the advantage of a fixed phase-to-ground voltage; however, a solidly grounded system has several disadvantages. When a ground fault occurs, high point-of-fault damage and an arc flash can result because power available to the fault is limited only by the system impedance. Also, ground-fault voltage, which is equal to the product of the fault current and the ground impedance, can exceed 100 V when a high fault current is available.



In a resistance-grounded system, the neutral point is connected to ground through a neutral-grounding resistor (NGR) used to limit current. The NGR resistance is small enough to provide the stability of a solidly grounded system and large enough to limit ground-fault current. Since the NGR limits current available to the fault, point-of-fault damage is minimized, ground-fault voltage is controlled, and the risk of an arc flash caused by a ground fault is eliminated. In some applications, electrical codes allow a resistance-grounded system to continue to operate with a ground fault until critical processes or batches are completed and maintenance can be scheduled at a convenient time.



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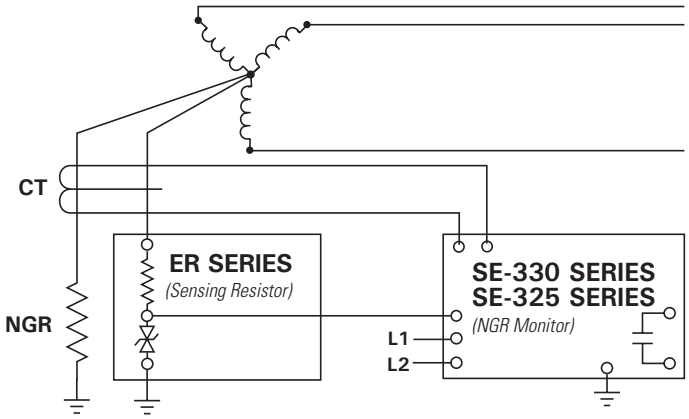
Neutral-Grounding Resistor

The greatly reduced ground-fault current of a resistance-grounded system does not require rapid ground-fault trip times. In tripping systems, the ground-fault relay furthest downstream can be set to operate quickly, on a definite-time basis, and moving closer to the source (upstream), additional delays can be added. The relay closest to a fault will trip first, providing the ability to quickly locate or remove a ground-fault and keep the rest of the system running until the faulted equipment is repaired.

Resistance grounding is typically applied to three-wire systems. If a four-wire system is resistance grounded, the distributed neutral conductor, which is always at zero potential on a solidly grounded system, will rise to line-neutral voltage during a ground fault. To resistance ground a four-wire system, either use a 1:1 isolation transformer where line-neutral loads are used, or convert line-neutral loads to line-line loads. In Canada, the Electrical Code CEC Part 1, 10-1102, allows the use of NGR's on four-wire systems, provided that the neutral conductor is insulated to the system voltage, and a shorted phase-to-ground, a shorted neutral-to-ground, or an open NGR causes the system to deenergize.

In industrial facilities with three-phase three-wire resistance-grounded systems, equipment such as variable-frequency drives and UPSes may have filters at their inputs. These filters must be rated to withstand the elevated line-to-ground voltage that occurs during a ground fault. The filters on many modern VFD's are rated to handle this voltage; however, verification of this is recommended. If transient voltage surge suppressors (TVSS) are used, they must be rated for line-to-line voltage to ground.

A complete resistance-grounded system includes a protective relay to monitor NGR continuity. If the NGR opens from damage, corrosion, faulty connections, or theft of ground wires, the system would be ungrounded and current-based ground-fault protection would not operate as designed, making the system susceptible to transient overvoltages and increasing the likelihood of phase-to-phase failure. A neutral-grounding-resistor monitor will detect this condition and provide an alarm or trip the supply.



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