

# Neutral Grounding Resistors

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This information is general in nature and intended to give the reader an overview of the issues involved.

Specific recommendations can only be made after a review of the equipment involved, installation parameters, applicable codes and national standards by competent personnel. Please consult Avtron Manufacturing, Inc. with comments or questions about the information contained herein.



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**Neutral Grounding Resistors** are an effective way to limit fault current in industrial power distribution systems. The proper application of a neutral grounding resistor is the result of a complete evaluation of the system design and capabilities and an evaluation of fault current coordination. It is the responsibility of the specifying engineer to properly evaluate the system parameters and determine the best equipment to meet the system design requirements. It is beyond the scope of this article to provide specific recommendations for the application of neutral grounding resistors.

**SYSTEM GROUNDING** is an basic design issue to be resolved when laying out an industrial power system. It is important to understand that “System Grounding” refers to the grounding arrangement of the current carrying conductor system and not “Equipment Grounding” which is provided for personnel and equipment safety. Industrial power systems can be either “Ungrounded” or “Grounded”.

**UNGROUNDING SYSTEMS** do not have a direct electrical connection between the generator or transformer secondary but are in fact capacitively grounded. This means that the system neutral will be close to ground potential if there are no ground faults on any phases of the system. Ungrounded systems have the ability to continue to operate with a single ground fault on any phase. This will allow for the repair of the ground fault while normal operations continue. A single ground fault will raise the potential to ground of the remaining two ungrounded phases to their full line to line value. The shift of phase to ground potential will place additional stresses on the insulation systems and equipment connected to the system.

The ability of the ungrounded system to continue to operate with a single ground fault may be considered an advantage for certain operations where a unplanned shut down of any part of the system may create an unsafe condition. While the operation of the system may continue, any ground fault condition should be investigated and repaired as soon as possible.

**GROUNDING SYSTEMS** will have a solid connection between the power system and a ground. The grounding connection may made with no impedance inserted in the connection or it may have an impedance of resistance or reactance intended to limit the ground fault current and

reduce damage. The grounded system will clear a ground fault in the affected circuit by opening the over current protective device (circuit breaker or fuses).

Arcing ground faults can produce significant damage caused by the energy dissipated into the fault. This may burn the insulation and may actually vaporize the conductors. At lower current levels the fault can continue to burn but not be at a high enough level to operate the overcurrent protection. This is especially possible with an ungrounded system. With a grounded system the phase to ground fault would trip the over current protection and clear the fault. Again with the proper application of a neutral grounding resistor the ground fault current and resultant damage can be limited.

An additional concern is the possibility of resonant conditions creating a serious over voltage condition when a ground fault occurs. The capacitance of the power distribution system and the inductance of the source (transformer or generator) winding can, under certain conditions, allow voltages to be generated in excess of the nominal system voltage and cause additional damage. A similar condition can occur due to a restriking ground fault which can raise the voltage to as much as six times the normal system voltage. A grounded neutral system would prevent this voltage build up by controlling the system phase to ground voltage to their nominal phase to neutral values.

**NEUTRAL GROUNDING RESISTORS** are installed in series with the power system neutral grounding connection. By inserting the impedance we can limit the ground fault current and the damage which may result from a system phase to ground fault. The neutral grounding resistor is provided with a termination for the power system neutral and the opposite side is connected directly to a suitable ground. In some cases the resistor may actually be wired to the secondary of a single phase transformer which has its primary wired in series with the power system neutral to ground connection. The ratio of the transformer will “reflect” the resistor’s impedance into the power system neutral bonding connection.

The location of the neutral grounding resistor also provides a convenient point to monitor the ground fault current. A current transformer is often placed in the neutral connection at this point

to operate protective relaying systems. In most cases the current transformer ratio primary will be the same rating as the resistor, ie: a 400 amp resistor will have a 400:5 current transformer.

The resistor will be rated with two key parameters, current in amps and time. IEEE standards specify 10 second, 760 degree temperature rise; extended time, 610 degree temperature rise and continuous, 385 degree temperature rise.

**INSTALLATION** The installation of the neutral grounding resistor may be on a suitable concrete pad or as a part of the transformer/switchgear structure. The enclosures are rated for outdoor installation and may include internal neutral and ground connections within the enclosure.

**RATINGS** It is beyond the scope of this paper to specify ratings for the neutral grounding resistor. It is the responsibility of the specifying engineer to coordinate the neutral grounding resistor with the overall design on the electrical distribution system and its specific characteristics. The selection of the ampere rating of the neutral grounding resistor current and time parameters must be selected to operate safely with the available fault current and overcurrent protective system



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