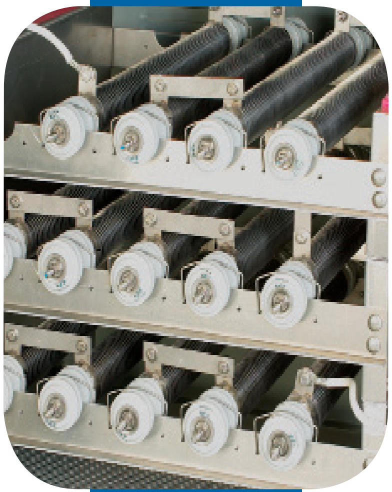
I GARD

NEUTRAL GROUNDING RESISTORS



NGR

I-Gard offers a complete range of Neutral Grounding Resistors from 480V to 69,000 volts and utility for resistance grounding of industrial power systems and are connected between earth ground and the neutral of power transformers, power generators or artificial neutral transformers.

Neutral Grounding Resistors are similar to fuses in that they do nothing until something in the system goes wrong. Then, like fuses, they protect personnel and equipment from damage. Damage comes from two factors, how long the fault lasts and the fault magnitude. Ground fault relays trip breakers and limit how long a fault lasts based on current. Neutral grounding resistors limit the fault magnitude.

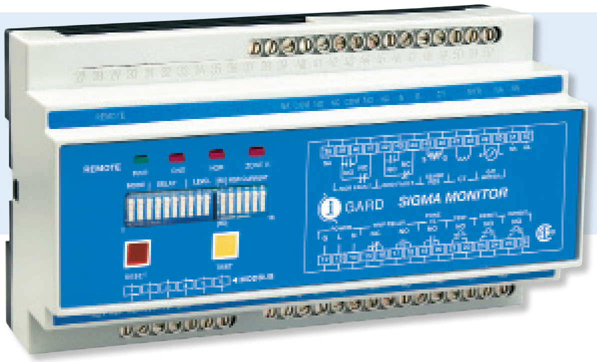
The I-Gard Neutral Grounding Resistor with integral Sigma Relay is the only NGR that controls both factors.

unparalleled protection

Neutral grounding resistors limit the maximum fault current to a value which will not damage generating, distribution or other associated equipment in the power system, yet allow sufficient flow of fault current to operate protective relays to clear the fault.

The I-Gard SIGMA MONITOR RELAY is a combination neutral grounding resistor (NGR) monitor and ground fault relay. In distribution systems employing resistance grounding the SIGMA MONITOR RELAY protects against ground faults and abnormal conditions in the path between system neutral and ground possibly caused by loose or improper connections, corrosion, foreign objects or missing or compromised copper ground wires.

The SIGMA MONITOR RELAY measures the current through the NGR, the transformer neutral-to-ground voltage and the NGR resistance. The relay compares the measured values against the field settings of the relay and provides relay outputs and LED indications when an abnormal condition is detected.



Why choose an NGR from I-Gard:

- The only NGR with integral monitoring of grounding circuit (2400v and above models)
- The only NGR with integral ground fault relay(2400v and above models)
- Designed with special element material with low temperature coefficient of resistivity for consistent fault current levels
- Edgewound element design eliminates hot-spots
- CSA certified and UL approved

Why consider Low-Resistance Grounded over Solidly Grounded?

While solidly grounded systems are an improvement over ungrounded systems, and speed the location of faults, they lack the current limiting ability of resistance grounding and the extra protection this provides. The destructive nature of arcing ground faults in solidly grounded systems is well known and documented by IEEE and are caused by the energy dissipated in the fault.

A measure of this energy can be obtained from the estimate of Kilowatt-cycles dissipated in the arc: Kilowatt cycles = V x I x Time (cycles) /1000.

100 Kilowatt Cycles	Fault location identifiable at close inspection-spit marks on metal and some smoke marks
2000 Kilowatt Cycles	Equipment can usually be restored by painting smoke marks and repairing punctures in insulation
6000 Kilowatt Cycles	Minimal amount of damage, but fault more easily located
10,000 Kilowatt Cycles	Fault probably contained by the metal enclosure
20,000 Kilowatt Cycles	Fault probably burns through single thickness enclosure and spreads to other sections
Over 20,000 Kilowatt Cycles	Considerable destruction

There are two broad categories of resistance grounding: low-resistance and high-resistance. In both types of grounding, the resistor is connected between the neutral of the transformer secondary and the earth ground. It is sized to ensure that the ground fault current limit is greater than the system's total capacitance-to-ground charging current.

Low-resistance grounding of the neutral limits the fault current to a high level (typically 50 amps or more) in order to operate protective fault clearing relays. These devices are then able to quickly clear the fault, usually within a few seconds.

What does IEEE say about Low-Resistance Grounding?

IEEE Std 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems

Clause 1.4.3 Resistance Grounding

The low-resistance method has the advantage of immediate and selective clearing of the grounded circuit, but requires that the minimum ground-fault current be large enough to positively actuate the applied ground-fault relay

IEEE Std 242-1986 Recommended Practice for the Protection and Coordination of Industrial and Commercial Power Systems

Clause 7.2.3 Low-Resistance Grounding

The magnitude of the grounding resistance is selected to allow sufficient current for ground-fault relays to detect and clear the faulted circuit

Comparison of Damage

2000 kvA, 480 Volt system, single phase fault current available	30,000 amps.
Solidly Grounded Assumes breaker opens in 10 cycles or 0.16 seconds	100 x 30,000 x 10 / 1000 = 30,000 KWC
Low Resistance Grounded, 50 Amps 1 second	100 x 50 x 60 / 1000 = 300 KWC

The key reasons for limiting the fault current through resistance grounding are:

To reduce burning / melting effects in faulted electrical equipment, such as switchgear, transformers, cables and rotating machines

To reduce mechanical stresses in circuits and apparatus carrying fault currents

To reduce electric shock hazards to personnel caused by stray ground fault currents in the ground return path

To reduce arc blast or flash hazard to personnel who may have accidentally caused or who happen to be in close proximity to the fault current

To secure control of transient over voltages

All I-Gard's low-resistance grounding products are standardized on the edgewound element design. Because of the rapid heating and very high temperatures encountered, this design has been proven superior for the NGR application.

The edgewound element material is mounted on porcelain supports, which are not affected by the high temperature or high voltages. The sturdy, helically coiled element is free to expand and does not deform when heated and offers consistent current density.

The element material is critical in ensuring high operating performance of the neutral grounding resistor. The element material is a special grade of electrical alloy with a low temperature coefficient of resistance. This prevents the resistance value from increasing significantly as the resistor operates through a wide temperature range. It also ensures a stable value of the fault current for proper metering and relaying.

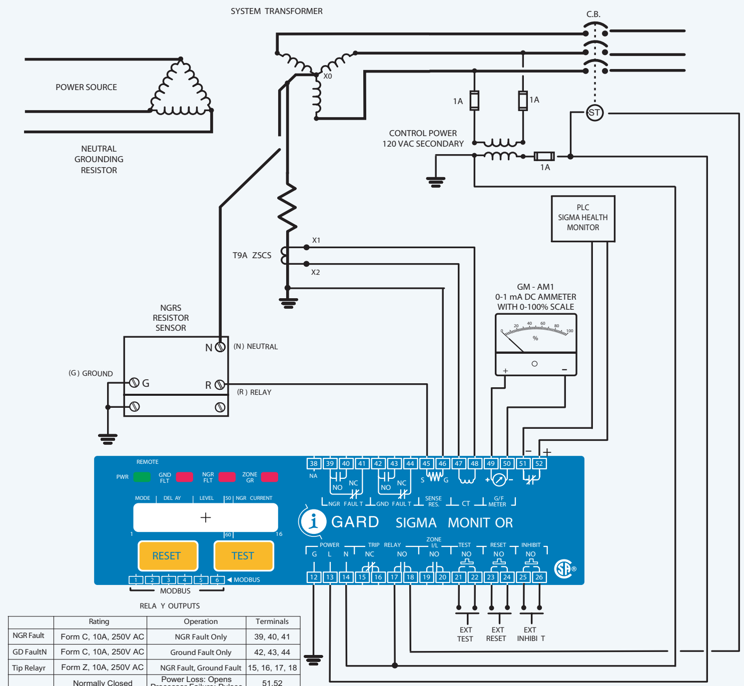
Some manufacturers offer stamped and cast alloy grids resistors for low-resistance grounding applications but the mica paper insulation they incorporate limits the temperature at which they can operate. The mica paper insulation can also absorb moisture and fail while the flat grid stampings may severely warp when rapidly heated. Also, the grids have hot spots which may burn when overloaded by the fault.

To ensure sufficient fault current is available to positively actuate the over-current relay and that the fault current does not decrease by more than 20% between ambient and the full operating temperature, it is recommended that the NGR element material to be specified to have a temperature coefficient not greater than 0.0002 ohms / °C.

Typical NGR 8000 Volts, 1000 Amps 10 seconds, 760 °C temperature rise as per IEEE 32.

	Material 1 AISI 304 Nickel Chrome Competitor 1	Material 2 AISI 430 Competitor 2	Material 3 Aluminum Chrome Steel 1JR (Ohmalloy)
Temp Coefficient of Resistance	0.001 ohms / °C	0.00135 ohms / °C	0.00012 ohms / °C
Ohms at Ambient	8000 / 1000 = 8 ohms	8000 / 1000 = 8 ohms	8000 / 1000 = 8 ohms
After 10 Seconds	8 * (1+0.001 * 760) = 14.08 ohms	8 * (1+0.00135 * 760) = 16.21 ohms	8 * (1+0.00012*760) = 8.7 ohms
Operating Fault Current	8000 / 14.08 = 568 amps	8000 / 16.21 = 493 amps	8000 / 8.7 = 919 amps
Change	43.2%	50.7%	8.1%

SIGMA



	Rating	Operation	Terminals
NGR Fault	Form C, 10A, 250V AC	NGR Fault Only	39, 40, 41
GD FaultN	Form C, 10A, 250V AC	Ground Fault Only	42, 43, 44
Tip Relayr	Form Z, 10A, 250V AC	NGR Fault, Ground Fault	15, 16, 17, 18
Monitor	Normally Closed 1A, 129V DC	Power Loss: Opens Processor Failure: Pulses Healthy. Close	51,52
Control Power	110-240V AC/DC 5VA AC/5W DC		

Technical Specifications

Electrical Ratings

Control Power: 110-240V AC/DC 50/60Hz 5Vac or 5Wdc

Maximum: -45% to +10% (60-264V AC/DC)

Output Relay Contacts

Main Trip Relay: **Type:** Form Z (NO and NC pair)
Rating: 10A@240Vac, 10A@30Vdc, 1/2HP@240Vac

Auxiliary Ground Fault Relay: **Type:** 1 Form C (NO/NC)
Rating: 10A@240Vac, 8A@24Vdc,

Auxiliary NGR Fault Relay: **Type:** 1 Form C (NO/NC)
Rating: 10A@240Vac, 8A@24Vac,

Electrical Tests

Surge test: @ 3kV **Dielectric test:** @ 2kV for 1 minute

Temperature Range

Operating: -40˚C to +60˚C **Storage:** -50˚C to +70˚C

Physical

Dimensions: **Length:** 157 mm (6.18 in.) **Width:** 86mm (3.39 in.)
Height: 58 mm (2.28 in.) **Weight:** 344 g

Ground Fault Circuit

CT Input: Non-Isolated. One side of the CT input, terminal 22, is internally grounded.

CT Ratio: T2A, T3A or equivalent

DIP Switch Settings

Trip Level: 8 settings: 5%, 10%, 15%, 20%, 25%, 30%, 40%, and 50% of the set

NGR Current Setting

Trip Time: 32 settings, 0-60 msec.,
150 msec. to 3.15 sec. in 100 msec. steps

Accuracy: **Repeatability:** ±1% **Trip Time:** ±10%, ±10 msec.

Trip Current: ±10% **Meter Output:** ±2% at full scale.

Thermal Characteristics: Short Time Withstand 400A for 1 sec.

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