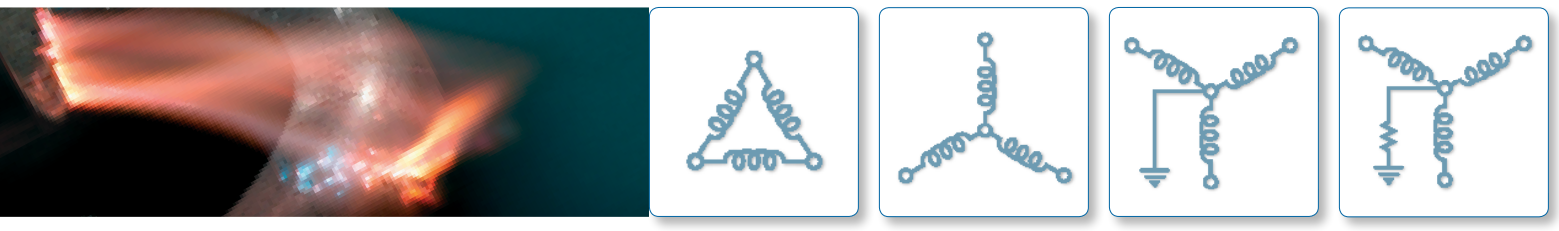
GARD

Unparalleled Protection

A DUMMIES GUIDE TO GROUND FAULT PROTECTION



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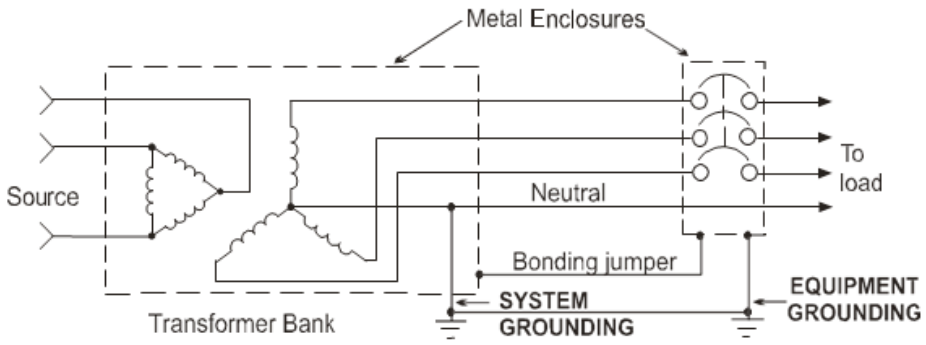
What is Grounding?

The term grounding is commonly used in the electrical industry to mean both "equipment grounding" and "system grounding". "Equipment grounding" means the connection of earth ground to non current carrying conductive materials such as conduit, cable trays, junction boxes, enclosures and motor frames. "System grounding" means the connection of earth ground to the neutral points of current carrying conductors such as the neutral point of a circuit, a transformer, rotating machinery, or a system, either solidly or with a current limiting device. Figure 1 illustrates the two types of grounding.

Figure 1



What is a Grounded System?

Grounded System – a system in which at least one conductor or point (usually the middle wire or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through an impedance.

IEEE Standard 142-1991 1.2.

Are there different types of System Grounding?

The types of system grounding normally used in industrial and commercial power systems are:
Solid grounding
Low-resistance grounding High-resistance grounding Ungrounded
IEEE Std 242-1986 7.2.1

What is the purpose of System Grounding?

System grounding, or the intentional connection of a phase or neutral conductor to earth, is for the purpose of controlling the voltage to earth, or ground, within predictable limits. It also provides for a flow of current that will allow detection of an unwanted connection between system conductors and ground [a ground fault].

What is a Ground Fault?

A Ground Fault is an unwanted connection between the system conductors and ground.

Why are Ground Faults concern?

Ground faults often go unnoticed and cause havoc on plant production processes. Shutting down power and damaging equipment, ground faults disrupt the flow of products leading to hours or even days of lost productivity Undetected ground faults pose potential health and safety risks to personnel. Ground faults can lead to safety hazards such as equipment malfunctions, fire and electric shock.
Ground faults cause serious damage to equipment and to your processes. During a fault condition, equipment can be damaged and processes shut down, seriously affecting your bottom line.

I have Over-current protection. Do I need additional Ground Fault Protection?

The over-current protection will act to interrupt a circuit for currents for which it was designed and set to operate. However, some ground faults, particularly low level arcing faults, will produce significant damage and create a fire- ignition source without ever reaching the level necessary to activate the over- current protective device.

What is an ungrounded system?

Electrical power systems which are operated with no intentional ground connection to the system conductors are generally described as ungrounded. In reality, these systems are grounded through the system capacitance to ground.

Why do people choose to operate an ungrounded system? Two principal advantages are attributed to ungrounded systems. The first is operational: The first ground fault on a system causes only a small ground current to flow, so the system may be operated with a ground fault present, improving system continuity. The second is economic: No expenditures are required for grounding equipment

What does IEEE say about ungrounded systems?

Ungrounded systems employ ground detectors to indicate a ground fault. These detectors show the existence of a ground on the system and identify the faulted phase, but do not locate the ground, which could be anywhere on the entire system. If this ground fault is intermittent or allowed to continue, the system could be subjected to possible severe over-voltages to ground, which can be as high as six or eight times phase voltage. This can puncture insulation and result in additional ground faults.

A second ground fault occurring before the first fault is cleared will result in a phase-to-ground-to-phase fault, usually arcing, with current magnitude large enough to do damage, but sometimes too small to activate over-current devices in time to prevent or minimize damage.

Ungrounded systems offer no advantage over high-resistance grounded systems in terms of continuity of service and have the disadvantages of transient over-voltages, locating the first fault and burn downs from a second ground fault.

IEEE 242-1986 7.2.5

Why Consider Grounding your System?

The intentional connection of the neutral points of transformers, generators and rotating machinery to the earth ground network provides a reference point of zero volts. This protective measure offers many advantages over an ungrounded system, including:

- Reduced magnitude of transient over-voltages
- Simplified ground fault location
- Improved system and equipment fault protection
- Reduced maintenance time and expense
- Greater safety for personnel
- Improved lightning protection
- Reduction in frequency of faults.

What is a Solidly Grounded System?

A solidly grounded system is one in which the neutral points have been intentionally connected to earth ground with a conductor having no intentional impedance. This partially reduces the problem of transient over- voltages found on the ungrounded system, provided the ground fault current is in the range of 25 to 100% of the system three phase fault current.

However; if the reactance of the generator or transformer is too great, the problem of transient over-voltages will not be solved.

Is Solidly Grounded Safer than Ungrounded?

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 and are caused by the energy dissipated in the fault.

What does IEEE say about solidly grounded systems?

The solidly grounded system has the highest probability of escalating into a phase-to-phase or three-phase arcing fault, particularly for the 480 and 600V systems. A safety hazard exists for solidly grounded systems from the severe flash, arc burning and blast hazard from any phase-to-ground fault.

IEEE Standard 141-1993

What is a Resistance Grounded System?

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.

How do I determine what size of Neutral grounding Resistor I require?

The resistor must be sized to ensure that the ground fault current limit is greater than the system's total capacitance-to-ground charging current. If not, then transient over-voltages can occur .

What is Low Resistance Grounding?

Low resistance grounding of the neutral limits the ground fault current to a high level (typically 50 amps or more] in order to operate protective fault clearing relays and current transformers. These devices are then able to quickly clear the fault, usually within a few seconds. The importance of this fast response time is that it:

- Limits damage to equipment,
- Prevents additional faults from occurring,
- Provides safety for personnel,
- Localizes the fault.

The limited fault current and fast response time also prevent overheating and mechanical stress on conductors. However, like the solidly grounded neutral system, the circuit must be shut down after the first ground fault.

Low resistance grounding resistors are typically rated 400 amps for 10 seconds, and are commonly found on medium and high voltage systems.

What is High Resistance Grounding?

High resistance grounding of the neutral limits the ground fault current to a very low level (typically under 25 amps). It is used on low voltage systems of 600 volts or less, under 3000 amps.

Why Consider Resistance Grounding?

Resistance grounding is by far the most effective and preferred method. It solves the problem of transient over-voltages, thereby reducing equipment damage. It accomplishes this by allowing the magnitude of the fault current to be predetermined by a simple ohms law calculation. Thus the fault current can be limited, in order to prevent equipment damage.

In addition, limiting fault currents to predetermined maximum values permits the designer to selectively co-ordinate the operation of protective devices, which minimizes system disruption and allows for quick location of the fault.

What does IEEE say about High Resistance Grounded systems?

High-resistance grounding helps insure a ground-fault current of known magnitude, helpful for relaying purposes. This makes it possible to identify the faulted feeder with sensitive ground-fault relays. IEEE Std 242-1986 7.2.4 High-resistance grounding provides the same advantages as ungrounded systems yet limits the steady state and severe transient over-voltages associated with ungrounded systems. There is no arc flash hazard, as there is with a solidly grounded system, since the fault current is limited to approximately 5A. IEEE Std 141-1993 7.2.2

Why limit the current through Resistance Grounding?

1) to reduce burning and melting effects in faulted electric equipment, such as switchgear, transformers, cables and rotating machines.

2) to reduce mechanical stresses in circuits and apparatus carrying fault currents

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

4) 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

5) to reduce the momentary line-voltage dip occasioned by the occurrence and clearing of a ground fault

6) to secure control of transient over voltages while at the same time avoiding the shutdown of a faulty circuit on the occurrence of the first ground fault

Do I have to shutdown my system to look for a fault?

By limiting the ground fault current, the fault can be tolerated on the system until it can be located, and then isolated or removed at a convenient time. This permits continued production, providing a second ground fault does not occur

If I have a fault and a second fault appears, what happens? Should a second ground fault occur on another phase before the first ground fault is removed, a line-to-line fault is created which can result in significant damage and a hazard to personnel.

Is there any protection against second fault damage?

The DSP relay system is designed to provide an alarm but not trip when one ground fault occurs on the system thus retaining system continuity. The relay does provide

phase and feeder indication as well as fault magnitude.

The DSP is the only relay to offer second fault protection through the SIFT system

(Selective Instantaneous Feeder Trip). This enables the user to prioritise the feeders and upon the occurrence of a second fault on a different phase to select which feeder will instantaneously trip.

I have heard that pulsing makes fault finding faster, what is pulsing?

Through the use of a specially designed resistor, the fault current is changed to provide a distinct signal that can be traced by qualified personnel to facilitate fault finding. This can often reduce the time required from hours to minutes.

What if I do not have qualified personnel who can locate or clear the fault?

I-GARD has partnered up with service organizations who have received specialized training and as qualified I-GARD Integrators have the necessary experience, training and products to assist you with fault location and clearing. Contact I-GARD to find the Integrator nearest you.

How can I learn more before making a decision on what I need?

Technical Seminars on Ground Fault Protection are offered by I-GARD, contact us!