

Electrical Safety Toolkit

TEST



RESET



GARD

Unparalleled Protection

GROUND
FAULT
ACTIVE



GROUND
FAULT
OCCURRED



SYSTEM
NORMAL



I-Gard's commitment to electrical safety provides both industrial and commercial customers with the products needed to protect their electrical equipment and the people that operate them.

As the only electrical-safety focused company whose product portfolio includes neutral grounding resistors, high-resistance grounding systems and optical arc mitigation, we take pride in our technologies that reduce the frequency and impact of electrical hazards, such as arc flash and ground faults.

For those customers who have purchased from us over the last 30 years, you know us for the quality and robustness of our product, our focus on quality, customer service and technical leadership. We build on this foundation by investing in developing new products in electrical safety education – including the EFC scholarship program – by actively participating in the IEEE community programs on technical and electrical safety standards, and working with local universities at uncovering new technologies. We remain unrelenting in our goal of improving electrical safety in the workplace.

Our commitment to excellence is validated by long-standing relationships with industry leaders in fields as diverse as petroleum and chemical; hospitals; automotive; data centres; food processing; aerospace; water and waste water; and telecommunications.

We provide them with the product and application support required to ensure that their electrical distribution system is safe and reliable.

3 SOLUTIONS & FACTS ABOUT I-GARD

I-Gard offers more HRG products at more price points than any other competitor in the industry, with customizable solutions for your specific application.

I-Gard is the exclusive supplier of FAIL-SAFE and SMART HRG systems with 2nd ground fault protection to better match your need for electrical reliability and safety.

We are the only HRG supplier that also offers optical arc mitigation for Total Protection against ground faults and arc flash incidences.



With global application and local representation, we can provide you with the technical support, application experience and product range needed to make your workplace safer.

Please feel free to give us a call at 1-888-737-4787 and don't forget to register for the up-to-date technical library on our website.



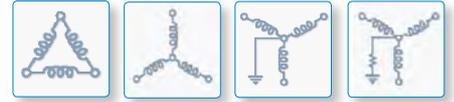


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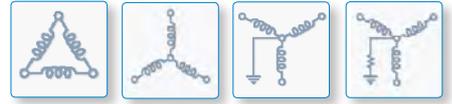
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4 Facts – The Problem Defined

unparalleled protection

1 fact

Electrical hazards have been identified in the Ministry of Labour's *Safe At Work Ontario* strategy as one of the hazards requiring attention to reduce injuries and create safer workplaces. Roughly half of electrical incidents causing injury were caused by working directly on energized electrical equipment. This includes deaths and serious burn injuries from arc-flash.



2 fact

One leading US-based insurance company notes that over a seven-year period, its clients reported 228 losses that were attributed to ground faults resulting in payments of \$180 million.

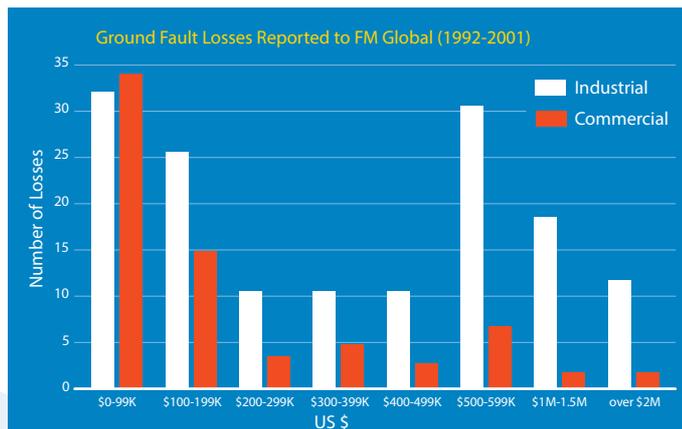
A review of the costs shows the impact of both direct and indirect costs. On the direct side are the costs associated with equipment repair and replacement, as well as the direct medical costs associated with injuries. On the indirect side, we see the cost of business interruption in terms of unscheduled delays, employee training and redeployment, accident investigation, legal costs and possible fines.

Why is *Safe At Work Ontario* important?

- Over 250,000 people are injured in Ontario workplaces each year,
- Direct cost (WSIB premiums) of a new lost time injury (LTI) in 2007 averages around \$21,300
- Indirect cost of each LTI in 2007, including re-hiring, re-training, lost productivity, etc., was \$85,000.

3 fact

According to statistics compiled by CapSchell Inc., a Chicago-based research and consulting firm that specializes in preventing workplace injuries and deaths, there are five to ten arc-flash explosions that occur in electric equipment every day in the U.S. resulting in hospitalization of workers.



4 fact

The US National Fire Prevention Association notes, "During the five-year period from 1994 through 1998, an estimated average of 16,900 reported industrial and manufacturing structure fires caused 18 civilian deaths, 556 civilian injuries, and \$789.6 million in direct property damage per year."

structured approach to electrical safety



RISK: the likelihood that an event will occur and result in damages.

HAZARD: something with the potential to cause harm and damages.

To be safe, we must reduce both the **RISK** (frequency) and the **HAZARD** (magnitude), the American Society of Safety Engineers has developed a structured approach using a Hierarchy of Hazard Control Measures.

The first choice is to “eliminate the hazard during design.” This is the most effective control measure and must always be considered first.

If the hazard cannot be eliminated completely, then there are a number of control options that can be used to prevent or minimize exposure to the risk:

- ▶ Substituting the risk for a lesser one
- ▶ Redesigning the equipment
- ▶ Isolating the hazard
- ▶ Establishing safe work practices
- ▶ Using personal protective equipment

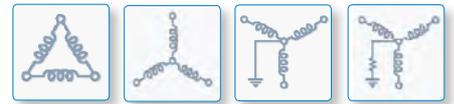
Administration controls and the use of personal protective equipment are the lowest priority on the list of control measures and should never be relied on as a primary means of risk control.

Personal protective equipment should be used as a last resort when exposure to risk is not or cannot be, minimized by other measures. I-Gard provides yearly seminars on educating and raising awareness on the lasting benefits of high-resistance grounding and innovations to reducing arc flash hazards.





GARD



Ungrounded Electrical Distribution System

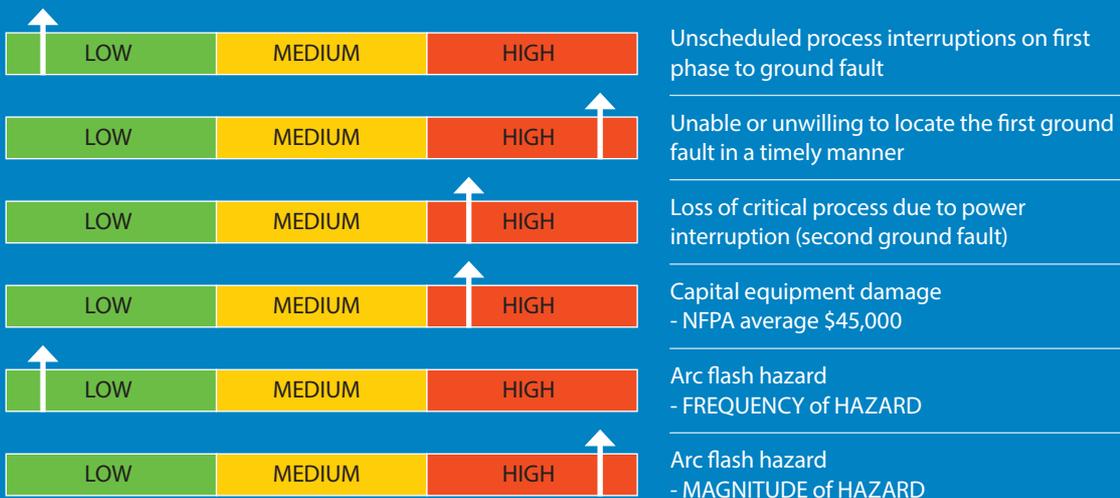
definition

Electrical power systems, which are operated with no intentional ground connection to the system conductors, are generally described as ungrounded.

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. *IEEE Standard 142-1991 1.4.2*

unparalleled protection

risk overview



recommendation

Consider the simple, economical and effective conversion upgrade from ungrounded to high-resistance grounded.

justification for recommendation

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.

For these reasons, they are being used less frequently today than high-resistance grounded systems, and existing ungrounded systems are often converted to high-resistance grounded systems by resistance grounding the neutral. *IEEE Standard 242-1986 7.2.5*

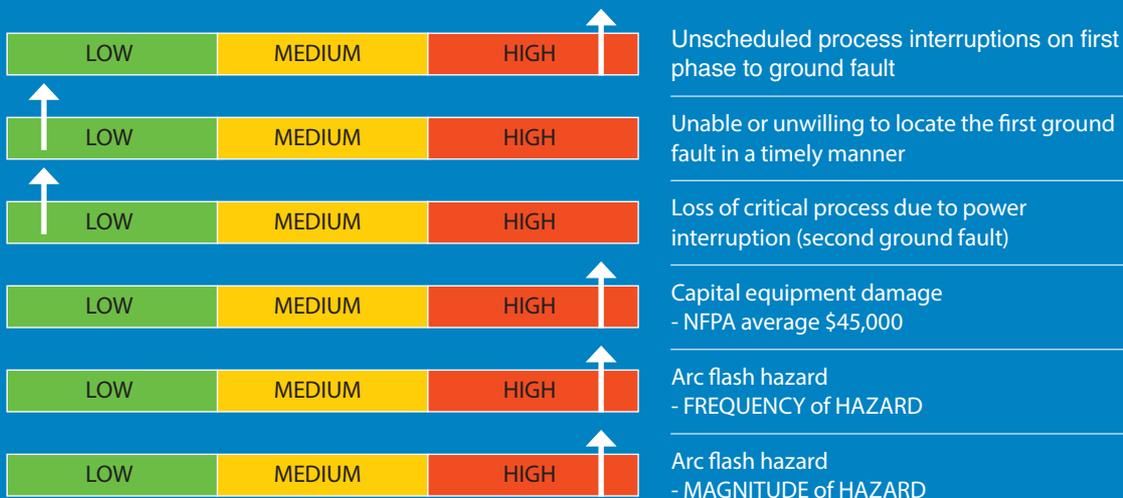
Solidly Grounded Electrical Distribution System

definition

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.

unparalleled protection

risk overview



recommendation

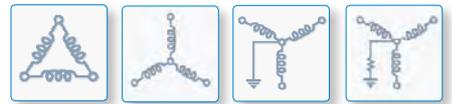
Converting to resistance grounded (low or high to control fault current) and/or adding optical arc flash mitigation to lower incident energy and hazard levels.

justification for recommendation

The solidly grounded system has the highest probability of escalating into a phase-to-phase or three-phase arcing fault, particularly for the 480V 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*

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 Standard 141-1993 7.2.2*

NFPA 70E section 130.2 FPN No. 3 states "Proven designs such as arc-resistant switchgear... high-resistance grounding and current limitation... are techniques available to reduce the hazard of the system."



High-Resistance Grounding Overview

I-Gard has the widest range of HRG products available today and with products at every price point and for every level of application we can improve the reliability and safety of your electrical process.

unparalleled protection

What is high-resistance grounding?

High-resistance grounding of the neutral limits the ground fault current to a very low level (typically under 25A). It is used on low and medium voltage systems under 5kV.

What does IEEE say about high-resistance grounded systems?

High-resistance grounding helps ensure 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 Standard 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 Standard 141-1993 7.2.2*

Taking Control of Electrical Safety

Electrical hazards have been identified in the Ministry of Labour's Safe At Work Ontario strategy as one of the hazards requiring attention to reduce injuries and create safer workplaces. Roughly half of electrical incidents causing injury were caused by working directly on energized electrical equipment. This includes deaths and serious burn injuries from arc-flash.

CSA Z462 Annex 0 General Design Requirements 0.2 Design option decision should facilitate the ability to eliminate hazards or reduce risk by the following:

1. Reducing the likelihood of exposure
2. Reducing the magnitude or severity of exposure

A safer workplace can easily be achieved if we simply change the approach and follow the steps recommended of reducing the likelihood of exposure and then reducing the magnitude of exposure by applying available technology. High Resistance Grounding eliminates 95% of electrical hazards from ever occurring, arc mitigation relays lower the impact significantly - we can take control and make the workplace safer today. For more details contact I-Gard Corporation at sales@i-gard.com – we offer Unparalleled Protection against arc flash.

Hierarchy of Hazard Control Measures from ANSI Z10

Control effectiveness					
ELIMINATION	SUBSTITUTION	ENGINEERING CONTROLS	WARNINGS	ADMINISTRATIVE CONTROLS	PERSONAL PROTECTIVE EQUIPMENT
Eliminate the hazard during the design phase	Substitute for a lower energy level.	Design options that automatically reduce risk.	Automatic or manual, permanent or temporary, visible or audible warning systems, signs, barriers and lubebs.	Planning processes, training permits, safe work practices, maintenance systems, communications and work management	Available, effective, easy to use.
Design or redesign the systems to use High Resistance Grounding	Reduce the impact of the hazard.	Increase distance away from hazard.			
Reduces likelihood of arc flash by 95%.	Lowers the HRC to category 0 or 1- safer levels.				

Life Cycle Value



Please visit our website at www.i-gard.com

I-Gard is pleased to offer nine levels of high-resistance grounding protection to meet your specific requirements. If your specific requirements are not covered by one of the solutions below, then our in-house team will customize a solution that matches your specific needs and budget.

STANDARD
HRG Offerings

PULSING

SMART

**Level 1
STOPLIGHT**

Inexpensive, simple HRG that provides visual indication of ground fault.



**Level 3
SLEUTH**

Self-contained HRG system with integral pulsing circuit to aid in locating fault.



**Level 7
SENTINEL**

Advanced HRG system that protects up to 50 feeders with critical process protection even under second ground fault.



**Level 2
STOPLIGHT – M**

Stoptlight with an integral monitoring relay that continuously monitors the integrity of the grounding circuit.



**Level 4
SLEUTH – M**

Sleuth that provides all process continuity and fault location properties with the added monitoring relay that continuously monitors the integrity of the grounding circuit.



**LEVEL 8
SENTINEL – M**

Sentinel with an integral relay that continuously monitors the integrity of the grounding circuit.



MONITORING

**LEVEL 5
GEMINI**

Fail-safe HRG with redundant resistor path and full-time monitoring relay.



**LEVEL 6
GEMINI – PS**

Fail-safe HRG with integral pulsing, redundant resistor path and full-time monitoring.



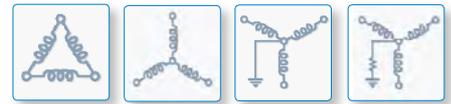
**LEVEL 9
GARDIAN**

Combines the recognized safety and reliability benefits of HRG with the incident energy reduction capabilities of arc mitigation.



FAIL-SAFE

PREMIUM
Exclusive to I-Gard



Arc Flash Protection Overview

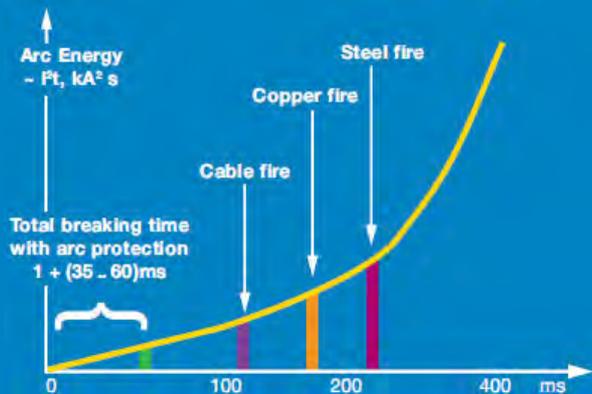
unparalleled protection

While infrequent, the impact of an arc flash is devastating and often deadly. It is estimated that there are five to ten arc flash incidents per day that require hospital treatment and the financial impact is staggering.

To minimize the impact, you need to first reduce the frequency of the hazard and HRG technology is proven in this regard.

The next task is to lower the impact. By reacting quickly to interrupt the flow of current, this can be achieved.

The arc detection relays from I-Gard detect the light signature from an arc in less than 1ms and send an interruption signal.



An arc is developed within milli-seconds and leads to the discharge of enormous amounts of destructive energy. The energy in the arc is directly proportional to the square of the short-circuit current and the time the arc takes to develop.

TOTAL CLEARING TIME IS CRITICAL

REDUCE THE TIME	REDUCE THE DAMAGE	REDUCE THE INCIDENT ENERGY
35ms	no significant damage to persons or switchgear, which can often be returned to use after checking the insulation resistances	1.27 Cal/cm ²
100ms	small damage, requires cleaning and possibly some minor repair likely	3.23 Cal/cm ²
500ms	large damage both for persons and the switchgear, which must be partly replaced	18.1 Cal/cm ²

The arc burning time is the sum of the time to detect the arc and the time to open the correct breaker.

The Senti relay is designed for application on all forms of resistance-grounded and solidly-grounded systems and can detect ground faults from as low as 10mA up to 1200 amps. It is the only relay with built-in Zone Selective Interlocking (ZSI) and optical arc detection capability.

How can Zone Selective Interlocking reduce the arc flash hazard from ground faults?

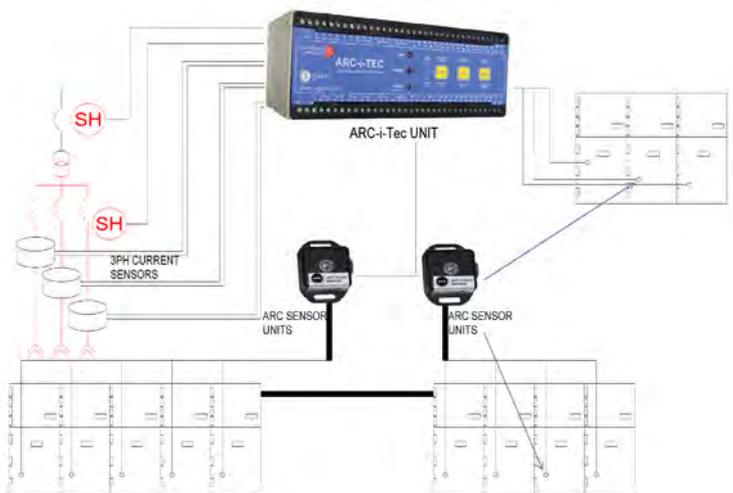
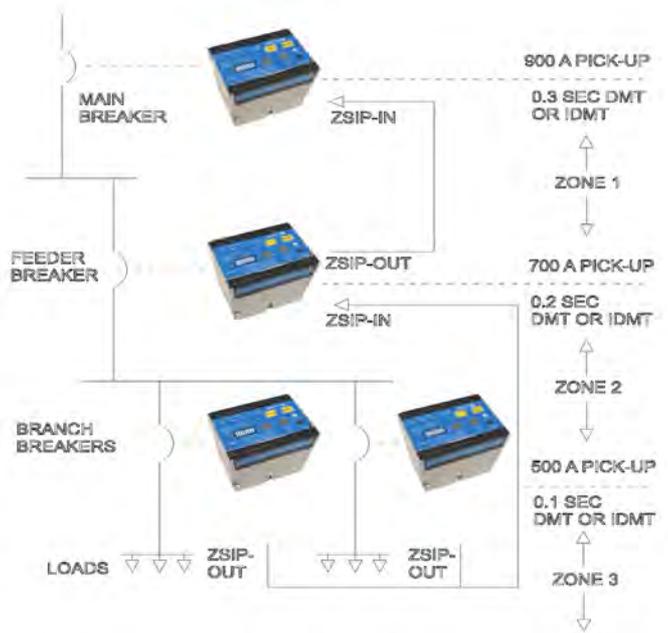
Arc flash hazard is the energy released in an arc flash and is proportional to the duration of the arcing fault; hence, arc flash hazard can be reduced by lowering time-delay settings of the ground fault over-current protective devices. Continuity of service is very important, and is maximized by time-current coordination of the ground fault devices. The drawback of time-current coordination is that an extra time delay is required on upstream protection devices. Zone Selective Instantaneous Protection (ZSIP) improves arc flash safety upstream in the distribution system without affecting service continuity.

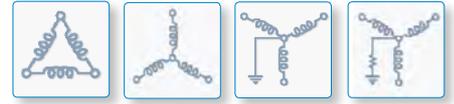
What is Arc Detection and how is it safer?

An arc is accompanied by radiation in the form of light, sound, heat and as such, the presence of an arc can be detected by analyzing visible light, sound waves, and temperature change.

To avoid erroneous trips, it is normal to use a short-circuit current detector along with one of the aforementioned arc indicators, and the most common pairing in North America is current and light. By controlling the time that a fault is present on the system, the I-Gard Arc-i-tec reduces significantly the fault energy and the damage to equipment and the safety hazard to personnel.

The Arc-i-tec system is scalable and configurable to your specific application and provides protection at the speed of light.

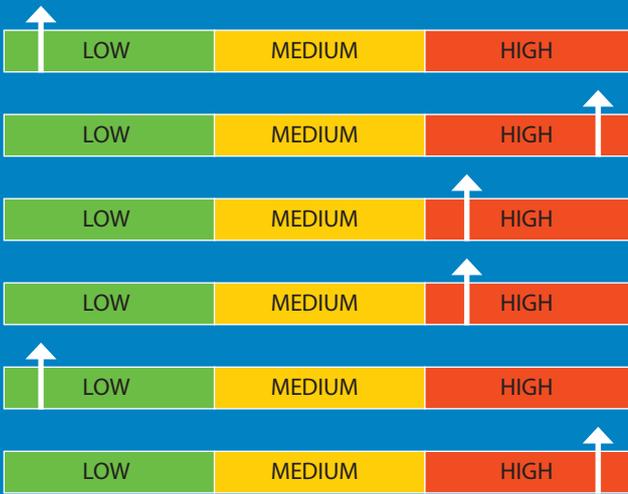




Risk Meter Overview

unparalleled protection

ungrounded distribution system



Unscheduled process interruptions on first phase to ground fault

Unable or unwilling to locate the first ground fault in a timely manner

Loss of critical process due to power interruption (second ground fault)

Capital equipment damage
- NFPA average \$45,000

Arc flash hazard
- FREQUENCY of HAZARD

Arc flash hazard
- MAGNITUDE of HAZARD

solidly-grounded distribution system



Unscheduled process interruptions on first phase to ground fault

Unable or unwilling to locate the first ground fault in a timely manner

Loss of critical process due to power interruption (second ground fault)

Capital equipment damage
- NFPA average \$45,000

Arc flash hazard
- FREQUENCY of HAZARD

Arc flash hazard
- MAGNITUDE of HAZARD

unparalleled protection

standard high-resistance grounded distribution system



Unscheduled process interruptions on first phase to ground fault



Unable or unwilling to locate the first ground fault in a timely manner



Loss of critical process due to power interruption (second ground fault)



Capital equipment damage
- NFPA average \$45,000



Arc flash hazard
- FREQUENCY of HAZARD



Arc flash hazard
- MAGNITUDE of HAZARD

SMART high-resistance grounded distribution system



Unscheduled process interruptions on first phase to ground fault



Unable or unwilling to locate the first ground fault in a timely manner



Loss of critical process due to power interruption (second ground fault)



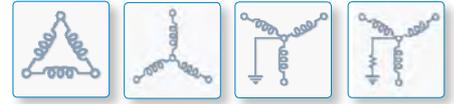
Capital equipment damage
- NFPA average \$45,000



Arc flash hazard
- FREQUENCY of HAZARD



Arc flash hazard
- MAGNITUDE of HAZARD



The I-Gard Total System Protection

unparalleled protection

SMART high-resistance grounded distribution system
+ optical arc mitigation

↑	LOW	MEDIUM	HIGH	Unscheduled process interruptions on first phase to ground fault
↑	LOW	MEDIUM	HIGH	Unable or unwilling to locate the first ground fault in a timely manner
↑	LOW	MEDIUM	HIGH	Loss of critical process due to power interruption (second ground fault)
↑	LOW	MEDIUM	HIGH	Capital equipment damage - NFPA average \$45,000
↑	LOW	MEDIUM	HIGH	Arc flash hazard - FREQUENCY of HAZARD
↑	LOW	MEDIUM	HIGH	Arc flash hazard - MAGNITUDE of HAZARD

total system protection

High-resistance grounding reduces the frequency of the ground fault hazard

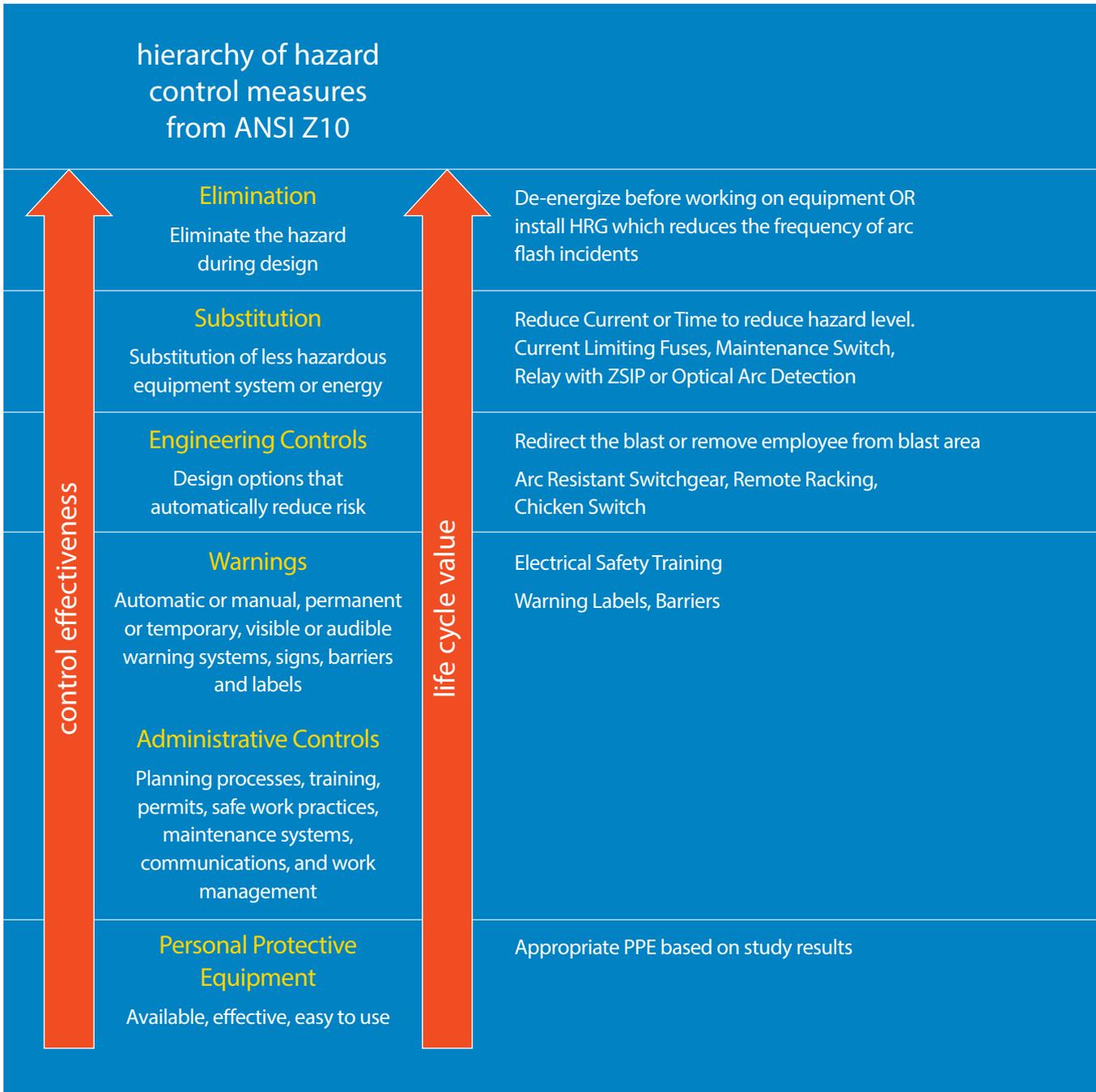
By limiting the fault current to 5 amps or less, there is insufficient energy for an arc flash to re-strike and it self-extinguishes

SMART HRG allows for continuous operation of critical processes even under second ground fault conditions

Optical arc mitigation reacts at the speed of light to interrupt the fault, lower the hazard level and protect personnel and equipment

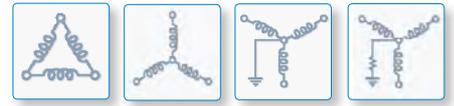
The combination of SMART HRG and Optical Arc Detection provides Total System Protection

unparalleled protection





I-GARD



Why I-Gard?

I-Gard has the broadest range of high-resistance grounding systems (a technology that the NFPA recognizes as reducing the arc flash hazard) in the marketplace. From our simple and budget friendly Stoplight product to the industry's only fail-safe HRG system, to the only SMART HRG system that selectively protects against second faults without interrupting the entire process.

unparalleled protection

80%

PREVENT HAZARD

HRG enhances the reliability and uptime of power distribution equipment by limiting the fault current so the fault energy is insufficient to allow the arc to re-strike. The hazard is prevented since the arc self-extinguishes.

15%

CRITICAL PROCESS PROTECTION

Smart HRG incorporates current sensor and relays capable of dropping the lowest priority feeder when a second ground fault on the system occurs. This ensures that your process continuity will not be affected and avoids the risk of two simultaneous ground faults tripping the entire system.

5%

EQUIPMENT AND PERSONAL PROTECTION

The special optical sensors in Arc Detection Relays detect the high flux value of the arc and operate in 1ms, resulting in quick isolation of the fault. (It takes 300ms to blink.)

We are the only electrical safety-focused company whose product portfolio includes both standard HRG systems, SMART HRG systems and optical arc flash mitigation – technologies that reduce the frequency of the arc flash (HRG) and the impact of the arc flash (optical arc detection).

Our products include the innovative Senti relay that protects against both ground faults and arc flash and the brand new Arc-i-tec, both of which react to an arc flash in less than 1 ms (it takes you 300ms to blink).

For customers who have purchased from us over the last 30 years, you know us for the quality and robustness of our product, our focus on quality, customer service and technical leadership. We look to build on these foundations by investing in developing new products, in electrical safety education including the EFC scholarship program, by actively participating within the IEEE community on technical and electrical safety standards and to working with local universities at uncovering new technologies as we remain unrelenting in our goal of improving electrical safety in the workplace.

safety through innovation

Our commitment to excellence is validated through our long-standing relationship with industry leaders in fields as diverse as oil and gas, hospitals, automotive, data centres, food processing, aerospace, telecommunications (see Case Studies) at providing them the product and application support they require to ensure reliability and safety of their electrical distribution system.

- ▶ The first power resistor company in North America to be ISO 9001 certified
- ▶ The only resistor manufacturer with a CSA-approved testing facility in-house
- ▶ The only resistor manufacturer with UL listing of our complete NGR product offering
- ▶ Approved by the Government of Canada in its Controlled Goods Program for Defense applications

High-resistance grounding is a proven technology that provides process continuity even under a single ground fault condition. The SMART HRG from I-Gard is the only HRG system that ensures process continuity of your most critical processes even under second ground fault conditions.



total system protection

High-resistance grounding is also a proven technology that reduces the frequency of the arc flash hazard as the fault current is limited to a low level and there is insufficient fault current for the arc to re-strike and it self-extinguishes.

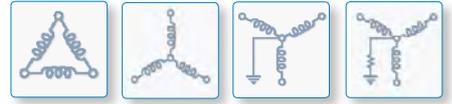
Optical arc flash detection reduces the time the fault is active and this directly lowers the incident energy level and significantly reduces the destructive impact of the arc.

The combination of HRG technology, which reduces the frequency of the arc flash hazard, and optical arc flash detection, which reduces the impact of the hazard, provides total system protection only with the Gardian.



DSP Ohmni system

The DSP Ohmni is the industry's most advanced high-resistance grounding system. It is designed to protect your continuous process or critical power system from unnecessary outage of electrical power. It detects the event of a single ground fault, signals an alarm, and points to the affected branch or feeder. Thus maintenance can be immediately alerted to the problem and an operator dispatched to locate the fault in order to promptly isolate the fault. The DSP Ohmni relay is the brains behind the SMART HRG system and is the only relay that ensures process continuity of your most critical processes even under second ground fault conditions.



case
study

High-Resistance Grounded System Should Become Industry Standard

Process reliability has always been an important aspect in the design and operation of a low-voltage power system, particularly in the petroleum and chemical industry.

unparalleled protection

Industry

Petroleum and Chemical

Focus

Reliability



Sample applications

- ▶ Albian Sands Energy – SHELL AOSP US Project
- ▶ Albian Sands Energy – Bowmanville Compressor Station
- ▶ Northern Transformer – ESSO Sarnia
- ▶ Rumsey Electric – SUNOCO Eagle Point
- ▶ Ace Electric – OHS Refinery
- ▶ Wholesale Electric – SHELL PIP ELSFS01
- ▶ Celanese Diversified – Nanjing
- ▶ Siemens – Petro Canada Bantrel Project
- ▶ PEMEX Oil Company
- ▶ Coastal Aruba Refinery

About I-Gard

I-Gard provides both industrial and commercial customers with the products and application support they need to protect their electrical equipment and the people that use them. Since 1982, I-Gard is committed to electrical safety and reliability.

While process interruptions can have an impact in any industry, the loss of low-voltage power can be especially disruptive and can cause a complete upset. This scenario can cause a plant to close, create personnel and equipment safety problems, have an adverse environmental impact, and can result in substantial economic losses. As such, the need for a safe, reliable, low-voltage power source is essential.

While in the past ungrounded distribution systems were applied under the assumption of reliability, experience with multiple failures due to arcing ground faults has resulted in the adoption of high-resistance grounding as the preferred method for this critical industry.

In the 1999 IEEE paper on high-resistance grounding of low-voltage systems, A Standard for the Petroleum and Chemical Industry, John Nelson and Pankaj Sen note “When reliability and limitation of ground fault current is essential, a high-resistance grounded system is recommended. With the proper design and testing, a high-resistance grounded system provides the safety and reliability necessary for a petrochemical or other heavy industry. As such, the high-resistance grounded system should become a standard of the industry, and the solidly grounded system should only be used where the high-resistance grounded system cannot be used for a three-phase, four-wire system.”

With ungrounded systems prone to transient over-voltages and burn down from second ground faults, and solidly grounded systems susceptible to arcing ground faults, the application and acceptance of high-resistance grounding continues to increase.

SLEUTH

SLEUTH



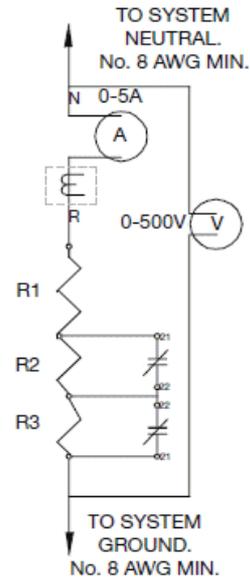
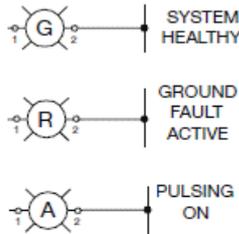
NEMA 2R enclosure containing current limiting resistor and ground fault relay

Available with artificial neutral for use on delta systems

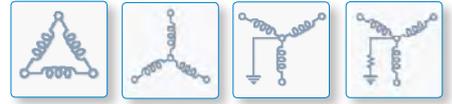
Visual indication of system normal, active ground fault and pulsing active

Available for 480V, 600V and 4160V distribution systems

SLEUTH



FEATURES	BENEFITS
High-Resistance Grounding Resistor	This resistor is connected to the wye point of the transformer or generator supplying the facility. Its function is to limit ground fault currents to non-damaging levels under a single line-to-ground fault condition. This provides the user an opportunity to retain process continuity and to detect and clear the fault.
Hand Held Pulse Tracing Sensor	This device, similar to a clamp-on ammeter, allows the user to follow the pulses from their source at the Sleuth unit through to the specific location of the line-to-ground fault.
Automatic Pulsing System	Once the pulsing feature on the Sleuth system is selected and activated, the system will cyclically limit the fault to 100%, 75% and 50% of the available ground fault current. The cyclical pulsing combined with the hand held pulse tracing sensor empowers the user to trace the fault circuit to the point of the fault in even complex distributions systems without de-energizing the load.
Ground Fault Sensing Transformer and Relay	This microprocessor based digital relay measures ground fault current using a 1:1 zero sequence current transformer. It maintains accuracy over a range of 45Hz to 65Hz and filters out harmonics to eliminate nuisance tripping.



I-Gard Helps a World-Leading Communications Provider Protect its Employees

case study

One of the major customers for Conestogo Electric Inc. is a leading designer and manufacturer of the award-winning mobile device used by millions of people from around the world. With over 20 years of experience, the company also creates innovative solutions for the worldwide mobile communications market. With reliability critical at their assembly and development facilities, they operate both a main electrical distribution system and have multiple generators on hand for emergency use.

unparalleled protection

Industry
Communications

Focus
Reliability



About Communications Industry Client

Conestogo Electric Inc.'s client is a leader in designing and manufacturing an award-winning universal mobile device. Its products and services are used by millions of customers around the world daily. Since 1984, the communications industry has grown extensively because of the developments from this innovative leader.

About I-Gard

I-Gard provides both industrial and commercial customers with the products and application support they need to protect their electrical equipment and the people that use them. Since 1982, I-Gard is committed to electrical safety and reliability.

The traditional approach to protecting each generator from the damaging effects of a ground fault is to ground each generator through a resistor which limits the fault and isolates the damaged generator in a timely manner. However, with multiple generators in use at any one time, circulating third harmonic currents through the connected neutrals can lead to equipment damage.

In addition, a ground fault anywhere in the system will elevate the potential of the neutral — whether the generator is connected to the system or not and this can result in a safety hazard for any personnel working on the generators. In order to ensure process reliability for their client as well as avoiding unnecessary equipment damage and unsafe operating conditions, Conestogo Electric Inc. employed I-Gard to custom design an effective grounding solution.

The answer was to treat each generator as its own feeder circuit and to apply the industry leading Sentinel HRG system from I-Gard to provide individual circuit protection for up to 50 feeders. The Sentinel is the only HRG system that provides critical feeder protection in the event of a second ground fault.

SENTINEL

SENTINEL

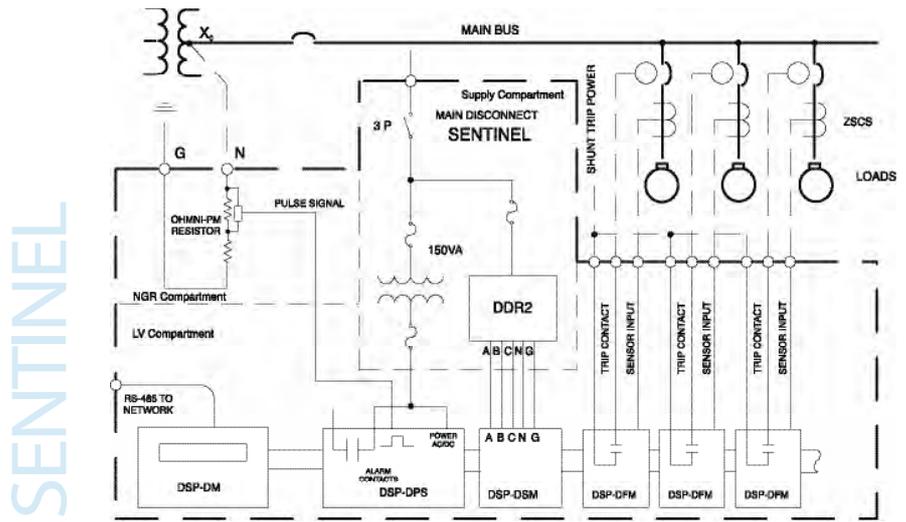


Nema 3R enclosure contains current limiting resistor, ground fault relay and isolation switch

Multi-feeder ground alarm indication with double ground fault protection

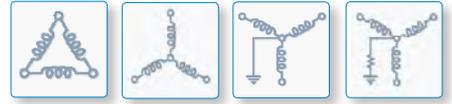
Integral resistance pulsing and MODBUS communication for remote monitoring

Inrush detection restraint prevents nuisance tripping on high inrush loads



TECHNICAL SPECIFICATIONS

Power Requirements	100-240V, 50/60 Hz or DC, 25 V AC
Dielectric	Relay contacts to chassis 1500V rms. for 1 minute alarm level Control terminals to chassis 1500V rms. for 1 minute alarm level EC-60255-5
Trip Level Inhibit	25% of systems ground current
Contact Ratings	DSP-DFM Trip contacts-form C SPDT 10 Amp, 240V AC resistive DSP-DPS Alarm contacts-form C SPDT 8 Amp, 240 V AC resistive Insulation voltage withstand/lighting impulse withstand in accordance to IEC-60950
Performance	DSP-DFM Pickup accuracy $\pm 10\%$ of system let-through current Trip Level Accuracy $\pm 10\%$ DSP-DSM Alarm Level Accuracy $\pm 10\%$ of IG
Temperature Range	Operating temperature $0^{\circ}\text{C} - 50^{\circ}\text{C}$



case study

I-Gard Provides Electrical Reliability for Data Centres

One of the largest infrastructure growth sectors in North America are data centres. In order for a data centre investment to last the 10 to 15 years for which they are designed, the designs need to either be specifically tailored to the business' needs or they need to have the inherent flexibility to adapt as their needs change.

unparalleled protection

Industry
Data Centre

Focus
Reliability



Sample installations

- ▶ TD Canada Trust, Ontario
- ▶ Ontario Provincial Police, Ontario
- ▶ Telus Communications, BC
- ▶ Bank of America, Delaware, USA
- ▶ Rogers Communications, Ontario
- ▶ Bank of Montreal, Ontario

About I-Gard

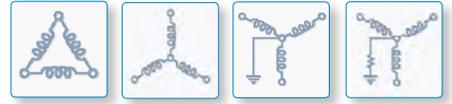
I-Gard provides both industrial and commercial customers with the products and application support they need to protect their electrical equipment and the people that use them. Since 1982, I-Gard is committed to electrical safety and reliability.

A constant issue facing data centres is electrical reliability. Significant focus, attention and capital are applied to back up power systems, which include generators, batteries and UPS systems. These systems protect critical processes and power factor correction equipment but an often-overlooked issue remains electrical ground faults. It has become standard for data centres to utilize high-resistance grounding as the method of choice.

While high-resistance grounding as a technology was originally applied to process industries as diverse as food processing, mining, petrochemical in the last 10 years, it has been increasingly applied to commercial installations such as airports, data centres and hospitals to enhance the reliability and uptime of power distribution equipment.

However, standard high-resistance grounding has several inherent application issues that can still negatively impact electrical reliability. This impact includes the loss of the neutral path due to poor connection, broken wires, corrosion, etc. Even the occurrence of a second ground fault can cause serious damage and process interruptions. Both of these concerns are addressed by applying the I-Gard DSP relay system, the industry's most advanced and complete HRG relay.

With the I-Gard DSP relay, the neutral path is continually monitored and an alarm is given should the system deviate from normal conditions. There is also the option to install a second redundant resistor circuit for fail-safe operation. In addition, only the I-Gard DSP relay offers critical process protection where a second ground fault will be detected and a single low priority feeder will be isolated rather than the whole system being compromised.



case study

unparalleled protection

World-Class Automotive Supplier Turns to I-Gard

World-class global parts supplier to the automotive industry recognizes the importance of high-resistance grounding. To remain ahead of the game, process continuity is an absolute must when your customers operate on a “Just-In-Time” inventory. Lean processes and any unscheduled outage can negatively affect all processes.

Industry
Automotive
Focus
Reliability



About Automotive Supplier

Most diversified automotive supplier in the world. Design, develop and manufacture automotive systems, assemblies, modules and components, and engineer and assemble complete vehicles. There are 256 manufacturing operations and 82 product development, engineering and sales centres in 26 countries on five continents as of December 2010.

About I-Gard

I-Gard provides both industrial and commercial customers with the products and application support they need to protect their electrical equipment and the people that use them. Since 1982, I-Gard is committed to electrical safety and reliability.

To optimize the continuity of their manufacturing process, this automotive supplier standardized on high-resistance grounding for their electrical distribution systems, first across North America and then across all global operations.

An independent electrical consultant who counts this world-class automotive supplier among his clients, notes “all HRG products offer process continuity under first ground fault conditions but only the DSP Relay system from I-Gard provides process continuity for your most critical process under second ground fault condition. With all other HRG systems, the second ground fault results in the entire system being interrupted. With the DSP from I-Gard, you only isolate a low priority feeder and your most important processes just keep running.”

The majority of automotive facilities in North America operate on an ungrounded system. The reasoning behind the prevalence of ungrounded systems in automotive industrial facilities appears to be historical. Prior to the emergence of high-resistance grounding in the late 1980s, the only choice when process continuity was required was an ungrounded system.

However, ungrounded systems offer no advantage over high-resistance grounded systems in terms of continuity of service. Their disadvantage is the inability to locate the first ground fault without shutting down the entire system and excessive over voltages. The over voltages can cause insulation failure and equipment damage, as well as the potential for a second fault to occur before the first one is removed leading to severe burn downs. (See IEEE Standard 242 - 1986 7.2.4.)

DSP-OHMNI



Phase and feeder indication resulting in quicker fault location

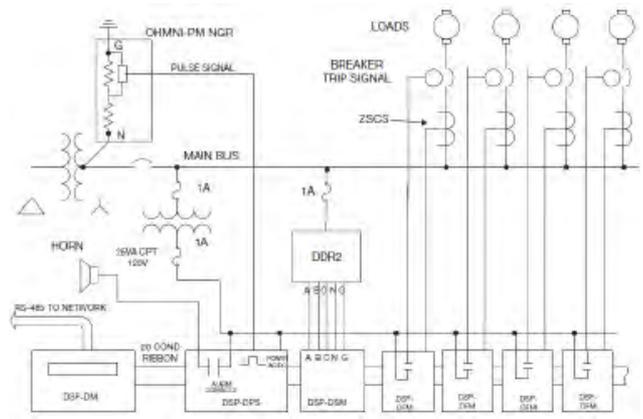
Monitors and protects up to 50 feeders on one relay

Available 1st fault alarm, 1st fault trip or 1st fault delay trip

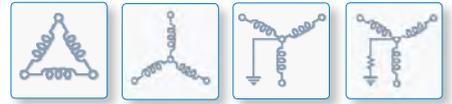
Integral resistor monitoring module eliminates requirement for separate monitoring relay

Unique selective instantaneous feeder trip (sift) on occurrence of 2nd ground fault

DSP-OHMNI



FEATURES	BENEFITS
DIN-rail parts	Compact mounting reduces space requirements
Compact Feeder Modules DSP-DFM	Large systems up to 50 circuits / DSP-OHMNI can be accommodated
Selectable MUTE ON/OFF function	Allows alarm contact to be used for other applications
Selectable trip on 1st fault or 2nd fault operation	Provides user the option of maximizing continuity of service (2nd fault trip) or minimizing fire/damage risk (1st fault trip). Both can be used on the same system.
0-99min delay setting on 1st fault trip	Allows time to locate fault and/or orderly shutdown of equipment
10-90% Alarm Level setting	User selected sensitivity in 10% increments, allows maximum sensitivity to be used while preventing nuisance alarms.
Switching Modules DSP-CAS	Provides co-ordination between systems either vertically (between zones) or horizontally (same zone) on multi-zone or main-tie-main systems
NGR monitor DSP-DRM	Monitors the status of grounding resistor in one DSP-OHMNI compatible unit.
Password Protected Setup	Four digit codes selectable by user prevent unauthorized setup changes while still allowing self-test and read-only data.
Self-Test of Modules	Internal self-test of DSP-DFM, DSP-DSM verifies connections to provide assurance of functionality
MODBUS Communications	Allows the operator to remotely monitor which feeder has faulted as well as the leakage currents of all feeders for trending purposes.



case study

I-Gard Provides Innovative Solutions

The Narmco Group is an automotive parts manufacturer with many operations of which five are clustered in Southwestern Ontario. The electrical maintenance for all five of the facilities is undertaken by Collins Electrical Company, Inc (CECI). Narmco, like the majority of automotive industrial facilities, operates on an ungrounded electrical system.

unparalleled protection

Industry
Automotive

Focus
Reliability

About Collins Electrical Company, Inc.

Collins Electrical Company, Inc. (CECI) is one of the leading electrical construction and engineering firms in Northern California with approximately \$80 million in annual revenues. As an IBEW Union contractor, CECI has maintained a long-term reputation for unmatched quality and excellence in design, construction, and project management since 1928.

About I-Gard

I-Gard provides both industrial and commercial customers with the products and application support they need to protect their electrical equipment and the people that use them. Since 1982, I-Gard is committed to electrical safety and reliability.

The answer lies with the Turbo Sleuth from I-Gard. The Turbo Sleuth is an industry first – a robust portable unit that temporarily and easily connects to an existing electrical system. It converts the faulted system to high-resistance grounding and utilizes an integral pulsing circuit to facilitate fault finding where and when required, while ensuring system continuity. The Turbo Sleuth contains the fault-limiting resistor, the pulsing circuitry and, if required, an artificial neutral in a wheeled enclosure that can be readily moved throughout any manufacturing facility.

“One of the reasons behind choosing this product,” states Vic Galamb of CECI, “was the ease of installation; we simply installed welding plugs at convenient locations throughout the five facilities. Once we knew from the ground detectors that we had a fault, we moved the portable unit to the closest available outlet, connected the unit, converted the system without de-energizing and impacting production and then started the pulse. We then used the current sensor loop provided with the unit to trace and follow the fault, dividing the plant into sections to enable us to quickly zero in on the fault. With five separate facilities, we were also able to use one Turbo Sleuth by throwing the unit in the back of the pickup and transporting it wherever we need it.”

With full understanding of the possible consequences of a second ground fault on an ungrounded system, the maintenance personnel at CECI committed to removing faults as quickly as possible but were faced with two vital roadblocks. The first issue was the lack of time required to locate a fault in an ungrounded system. The second issue was that full-scale conversion to high-resistance grounding would take capital, time and resources at such a large facility. While this was being reviewed and a budgetary request was submitted, the situation of equipment damage and time-consuming fault finding continued.

“We needed to temporarily convert to a high-resistance system,” says Galamb. “I-Gard had the solution where we were able to locate the fault quickly without taking down the system or disrupting production.”



TURBO SLEUTH

NEMA 2R enclosure containing current limiting resistor

Available with artificial neutral for use on delta systems

Visual indication of system normal, active ground fault and pulsing active

Available for 480V, 600V and 4160V distribution system

A portable neutral grounding device used for fault detection in ungrounded or high-resistance grounded, wye or delta power systems. The portability of the Turbo Sleuth allows one unit to be moved from system to system for the purpose of locating faults, thus eliminating the cost of installation of pulsing units on all systems. Operations can continue with the faulted system while the Turbo Sleuth is connected, maximizing productivity and preventing unwanted downtime.

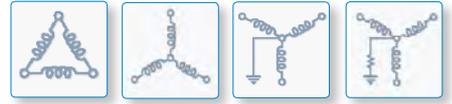
An ideal tool for sensing and locating ground faults quickly and easily. Ground faults are the most common form of electrical fault, accounting for a minimum of 85% of all electrical faults in a distribution system. When a ground fault occurs: Turbo Sleuth is connected to the system at a convenient location and plant electrical personnel may then follow a simple sequence to locate and isolate the fault without interrupting or opening circuit breakers. Connection is made by cables supplied with the unit, which are provided with rugged, outdoor plugs and/or un-terminated conductors. Control power requirements are 120VAC.

Turbo Sleuth confirms the ground fault by means of lights on the panel front. In addition, it provides auxiliary relay contacts, which may be wired to alarm or annunciation devices, such as the optional TS-AH horn.

TURBO SLEUTH
Turbo Sleuth is available in either 480V or 600V types and provides pulsing currents in three incremental levels of 5A, 3.75A and 2.5A when in operation. This 3-stage current pulse maximizes visibility of the detection system eliminating false indications. The Turbo Sleuth is enclosed in a NEMA 3 outdoor enclosure with caster wheels providing mobility. The unit can be left connected outside at a substation if necessary. Note that if high-resistance grounding is already used, the currents will add to the continuous ground current.

Turbo Sleuth pulsing system, when activated, will cyclically limit the ground fault current to 100%, 75%, and, 50% of the available ground fault current. The user modifies the duration of this pulse to suit the requirements of his sensing device.

The cyclic pulsing, combined with the hand-held current sensor and a single-line diagram, can be used to rapidly locate a ground fault even in a very complex power distribution system.



Why High-Resistance Grounding Systems Should Become an Industry Standard

case study

One of the major customers for Resource Engineering in Oregon, USA is a world leader in silicon innovation. This company develops technologies, products and initiatives that continually advance how people work and live. Founded in 1968 to build semiconductor memory products, this company introduced the world's first microprocessor in 1971.

unparalleled protection

Industry

Hi-Tech

Focus

Electrical Reliability



Electrical Injuries

Electric Shock - Voltage as low as 50V between two body parts blocking electrical signals from the brain and the muscles.

Electric Burn - Current passes through the human body heating the tissue along the way.

Loss of Muscle Control - Shock causing muscle spasms that dislocate joints and even break bones.

Thermal Burns - Faulty electrical equipment when heated explodes causing serious fires and burns.

About I-Gard

I-Gard provides both industrial and commercial customers with the products and application support they need to protect their electrical equipment and the people that use them. Since 1982, I-Gard is committed to electrical safety and reliability.

One of the constant issues facing all industry manufacturers and developers is electrical reliability. While significant focus, attention and capital are applied to back up power systems including generators, battery and UPS systems to protect critical processes and power factor correction equipment, an often-overlooked issue is electrical ground faults. A single electrical accident can cost the company up to \$1 million or more in lost productivity, equipment damage, lost time, medical expenses, as well as liability exposure.

To assist its clients in ensuring process continuity, even under single ground fault conditions, Resource Engineering partnered with I-Gard to provide the Sleuth high-resistance grounding system. Not only does the I-Gard Sleuth provide resistance grounding, ensuring that the process remains protected under a single ground fault and does not require to be isolated, but the integral pulsing feature allows for the fault to be quickly located and corrective action to be taken.

SLEUTH

SLEUTH



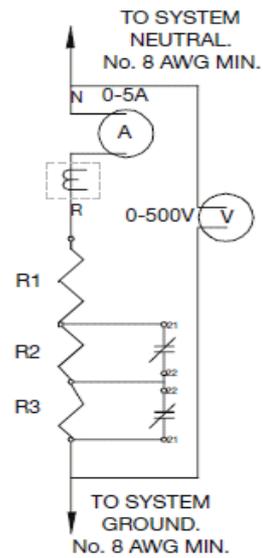
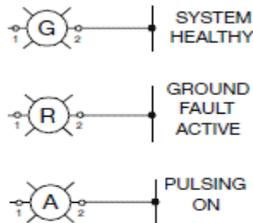
NEMA 2R enclosure containing current limiting resistor and ground fault relay

Available with artificial neutral for use on delta systems

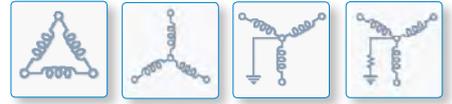
Visual indication of system normal, active ground fault and pulsing active

Available for 480V, 600V and 4160V distribution systems

SLEUTH



FEATURES	BENEFITS
High-Resistance Grounding Resistor	This resistor is connected to the wye point of the transformer or generator supplying the facility. Its function is to limit ground fault currents to non-damaging levels under a single line-to-ground fault condition. This provides the user an opportunity to retain process continuity and to detect and clear the fault.
Hand Held Pulse Tracing Sensor	This device, similar to a clamp-on ammeter, allows the user to follow the pulses from their source at the Sleuth unit through to the specific location of the line-to-ground fault.
Automatic Pulsing System	Once the pulsing feature on the Sleuth system is selected and activated, the system will cyclically limit the fault to 100%, 75% and 50% of the available ground fault current. The cyclical pulsing combined with the hand held pulse tracing sensor empowers the user to trace the fault circuit to the point of the fault in even complex distributions systems without de-energizing the load.
Ground Fault Sensing Transformer and Relay	This microprocessor based digital relay measures ground fault current using a 1:1 zero sequence current transformer. It maintains accuracy over a range of 45Hz to 65Hz and filters out harmonics to eliminate nuisance tripping.



Hospitals Rely on I-Gard for Electrical Safety

case study

One of the constant issues facing hospitals is electrical reliability. While significant focus, attention and capital are applied to back up power systems including generators, battery and UPS systems to protect critical processes and power factor correction equipment, an often-overlooked issue is electrical ground faults. According to the authors J.R. Dunki-Jacobs, F.J. Shields and Conrad St. Pierre of "Industrial Power Systems Grounding Design Book," 95% of all electrical outages are caused by ground faults.

unparalleled protection

Industry
Hospital
Focus
Reliability



Sample installations

- ▶ Hospital Sacre Coeur
- ▶ Hospital For Sick Children
- ▶ Listowel Memorial Hospital
- ▶ North Bay Psychiatric Hospital
- ▶ North Bay Regional Health Centre
- ▶ Peterborough Regional Health Centre
- ▶ Scarborough General Hospital
- ▶ Sherbourne Health Centre
- ▶ St. Michaels Hospital
- ▶ Sunnybrook Health Centre
- ▶ Tillsonberg District Hospital
- ▶ William Osler Health Centre
- ▶ York Central Hospital
- ▶ San Diego Hospital

Many hospitals, whether in their main electrical distribution or for application on their emergency generators, are choosing high-resistance grounding as their method of choice. While high-resistance grounding as a technology was originally applied to process industries as diverse as food processing, mining, petrochemical in the last 10 years, it has been increasingly applied to commercial installations such as airports, data centres and hospitals to enhance the reliability and uptime of power distribution equipment.

High-resistance grounding (HRG) allows continuity of service in the event of a ground fault that would cause an outage on a solidly-grounded system.

With respect to emergency generators, resistance grounding not only ensures reliability but lessens stator damage and repairs due to ground faults.

Standard concerns with high-resistance grounding, such as risk of the loss of the neutral path due to poor connection, broken wires, corrosion, etc., are addressed by applying the I-Gard DSP relay system, the industry's only SMART HRG relay.

With the I-Gard DSP OHMNI, the neutral path is continually monitored and an alarm is given should the system deviate from normal conditions. There is also the option to install a second redundant resistor circuit for fail-safe operation. In addition, only the I-Gard DSP OHMNI not only allows continuity of service in the event of a ground fault, but it offers additional critical process protection where a second ground fault can be detected and a lower priority feeder can be isolated rather than the whole system being compromised.

DSP-OHMNI

DSP-OHMNI



Phase and feeder indication resulting in quicker fault location

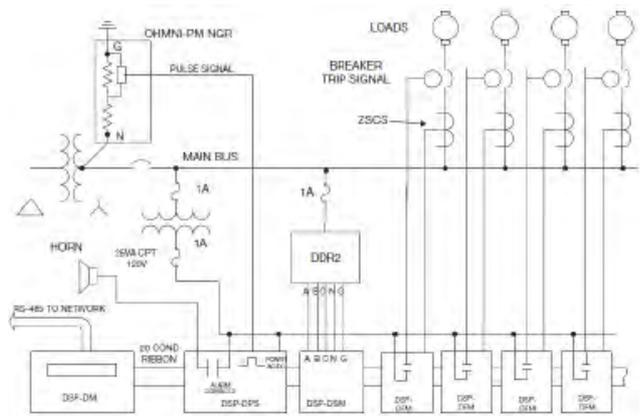
Monitors and protects up to 50 feeders on one relay

Available 1st fault alarm, 1st fault trip or 1st fault delay trip

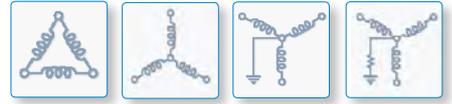
Integral resistor monitoring module eliminates requirement for separate monitoring relay

Unique selective instantaneous feeder trip (sift) on occurrence of 2nd ground fault

DSP-OHMNI



FEATURES	BENEFITS
DIN-rail parts	Compact mounting reduces space requirements
Compact Feeder Modules DSP-DFM	Large systems up to 50 circuits / DSP-OHMNI can be accommodated
Selectable MUTE ON/OFF function	Allows alarm contact to be used for other applications
Selectable trip on 1st fault or 2nd fault operation	Provides user the option of maximizing continuity of service (2nd fault trip) or minimizing fire/damage risk (1st fault trip). Both can be used on the same system.
0-99min delay setting on 1st fault trip	Allows time to locate fault and/or orderly shutdown of equipment
10-90% Alarm Level setting	User selected sensitivity in 10% increments, allows maximum sensitivity to be used while preventing nuisance alarms.
Switching Modules DSP-CAS	Provides co-ordination between systems either vertically (between zones) or horizontally (same zone) on multi-zone or main-tie-main systems
NGR monitor DSP-DRM	Monitors the status of grounding resistor in one DSP-OHMNI compatible unit.
Password Protected Setup	Four digit codes selectable by user prevent unauthorized setup changes while still allowing self-test and read-only data.
Self-Test of Modules	Internal self-test of DSP-DFM, DSP-DSM verifies connections to provide assurance of functionality
MODBUS Communications	Allows the operator to remotely monitor which feeder has faulted as well as the leakage currents of all feeders for trending purposes.



I-Gard Helps Packaging Corporation of America Protect its Employees

case
study

unparalleled protection

Industry

Pulp and Paper

Focus

Electrical Reliability



About Packaging Corporation of America

Packaging Corporation of America (PCA) annually produces over 2.4 million tons of kraft linerboard for domestic and international customers. One of their facilities is located in Valdosta, Georgia. The Valdosta mill produced over 457 thousand tons of 100% virgin, high-quality linerboard annually. PCA is the fifth largest producer of containerboard and corrugated packaging products in the U.S. PCA operates four paper mills and 68 corrugated product plants in 26 states.

About I-Gard

I-Gard provides both industrial and commercial customers with the products and application support they need to protect their electrical equipment and the people that use them. Since 1982, I-Gard is committed to electrical safety and reliability.

According to the authors J.R. Dunki-Jacobs, F.J. Shields and Conrad St. Pierre of "Industrial Power Systems Grounding Design Book," 95% of all electrical outages are caused by ground faults. A single electrical accident can cost the company up to \$1 million or more in lost productivity, equipment damage, lost time, medical expenses, as well as liability exposure.

Packaging Corporation of America experienced a ground fault at its Valdosta facility but with the foresight of selecting and deploying a high-resistance grounding system, it avoided a costly outage. The challenge was to locate and clear the fault before a second fault occurred. This could have led to unwanted process interruptions and a possible arc fault.

With training from I-Gard on the application of I-Gard's industry leading DSP relay, which features assisted fault finding and pulsing capability, fault location is reduced from several shifts to a few hours.

As part of a further upgrade in electrical reliability, George Lavender, Senior Project Electrical Engineer at PCA, in consultation with Sergio Panetta, Vice President of Engineering at I-Gard, selected the I-Gard Gemini, the only fail-safe HRG system available.

"High-resistance grounding as a technology can be applied to industrial as well as commercial sectors in order to enhance its reliability and uptime of power distribution equipment. HRG significantly reduces the frequency and severity of arc flash accidents," says Mr. Lavender. "We have a responsibility to our employees and our employer to operate a safe and reliable electrical distribution system. The fail-safe HRG system from I-Gard ensures peace of mind."

GEMINI

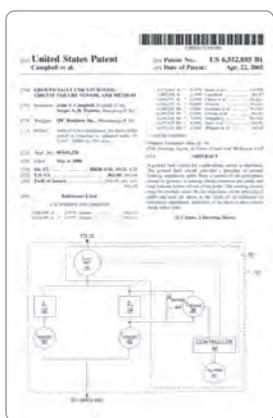


Patented fail-safe high-resistance grounding system with twin resistance paths

Only monitoring relay capable of discriminating between ground faults, resistor failure and open and short circuits

Eliminates nuisance tripping through adjustable time delay settings 60 milliseconds up

Self diagnosis through built-in test circuitry



High-Resistance Grounding Resistor

This resistor is connected to the wye point of the transformer or generator supplying the facility. Its function is to limit ground fault currents to non-damaging levels under a single line-to-ground fault condition. In the case of the Gemini system there is a parallel resistance circuit comprised of two identical resistor paths connected from the neutral to the ground. The parallel resistance circuit is sized to limit any ground fault to predetermined levels. In the unlikely event that one resistor path fails, the second resistor path continues to limit the ground fault to half of the predetermined levels and still provides full ground fault protection and an alarm indicating resistor failure.

Ground Fault and Resistor Integrity Relay (GFR-RM)

In conjunction with a sensing resistor and a series current transformer, the GFR-RM measures current through the neutral grounding resistor, transformer neutral to ground voltage and NGR resistance for continuity. The GFR-RM compares the measured values against the field settings of relay and provides relay outputs and lighted signal when an abnormal condition is detected.

Automatic Pulsing System (optional)

Once the pulsing feature on the Gemini system is selected and activated, the system will cyclically limit the fault to 100%, 75% and 50% of the available ground fault current. The cyclical pulsing combined with the hand held pulse tracing sensor empowers the user to trace the fault circuit to the point of the fault in even in complex distribution systems without de-energizing the load.

Ground Fault Sensing Transformer and Relay

This microprocessor based digital relay measures ground fault current using a 1:1 zero sequence current transformer. It maintains accuracy over a range of 45Hz to 65Hz and filters out harmonics to eliminate nuisance tripping.

GEMINI



GARDIAN



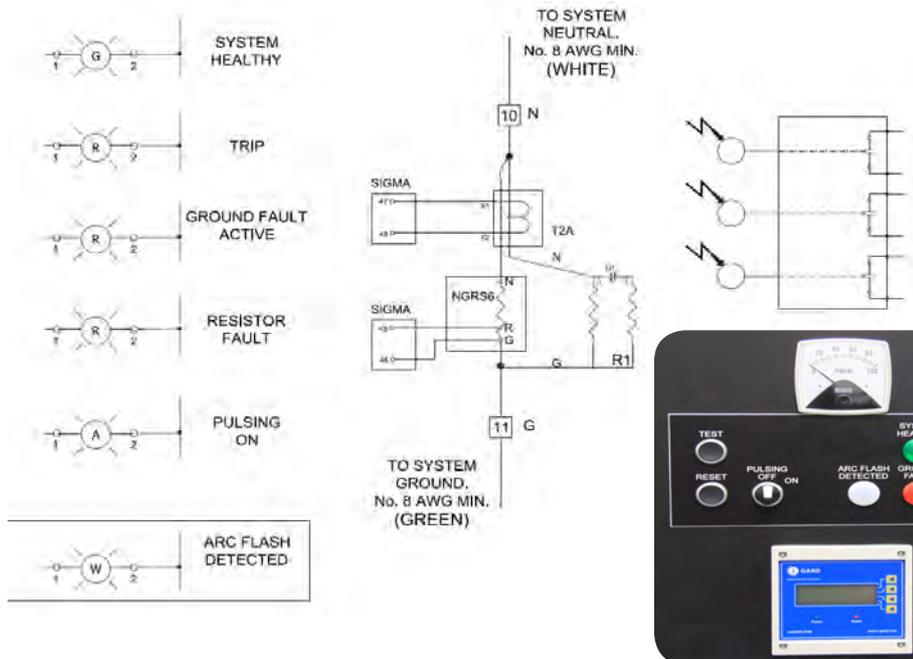
NEMA 3R enclosure containing current limiting resistor and ground fault relay and optical arc detection sensor

Available with artificial neutral for use on ungrounded systems

Visual indication of system normal, active ground fault, pulsing active and arc flash

Available for 480V, 600V and 4160V distribution systems

GARDIAN



BENEFITS OF HAVING A GARDIAN

NFPA Clause: 120.3FPN No.3	"High resistance grounding of low voltage and 5 kV (nominal) (systems),... are techniques available to reduce the hazard of the system."		
IEEE Standard 242-1986 7.2.5	Ungrounded systems offer no advantage over high-resistance grounded systems in terms of continuity of service and have the disadvantages of transient overvoltages, locating the first fault and burn downs from a second ground fault. For these reasons, they are being used less frequently today than high-resistance grounded systems, and existing ungrounded systems are often converted to high-resistance grounded systems by resistance grounding the neutral.		
Reduces PPE with optical arc detection	Protection Type	Clearing Time (seconds)	Incident Energy (Cal/cm2)
	51 Overcurrent 50 Instantaneous I-Gard Gardian System	2.000 0.450 0.084	211 47 9

- Assume breaker clearing time of 5 cycles
- 480V and 65kA bolted fault current, 18 inches



Unparalleled Protection

designed &
manufactured



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sales@i-gard.com



www.i-gard.com