Electrical Safety Toolkit

GARD

Unparalleled Protection

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 oil and gas, 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 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 or e-mail us at: support@i-gard.com and don't forget to register for the up-to-date technical library on our website.

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Converting Solidly Grounded Transformers to High Resistance Grounded Systems in a Pulp and Paper Mill

By: Todd Legette, Aaron McPhee, Sergio Panetta and Edmundo Perich

The first step in addressing arc flash is to reduce the probability of exposure at the inception of the arc fault. This can be accomplished utilizing High Resistance Grounding (HRG) systems.

It is well known that up to 70% of all electrical faults begin as single-phase-to-ground faults. Therefore, reducing the energy produced by this type of fault will reduce the likelihood of a single phase to ground fault to propagate to a phase-to-phase or three-phase fault.

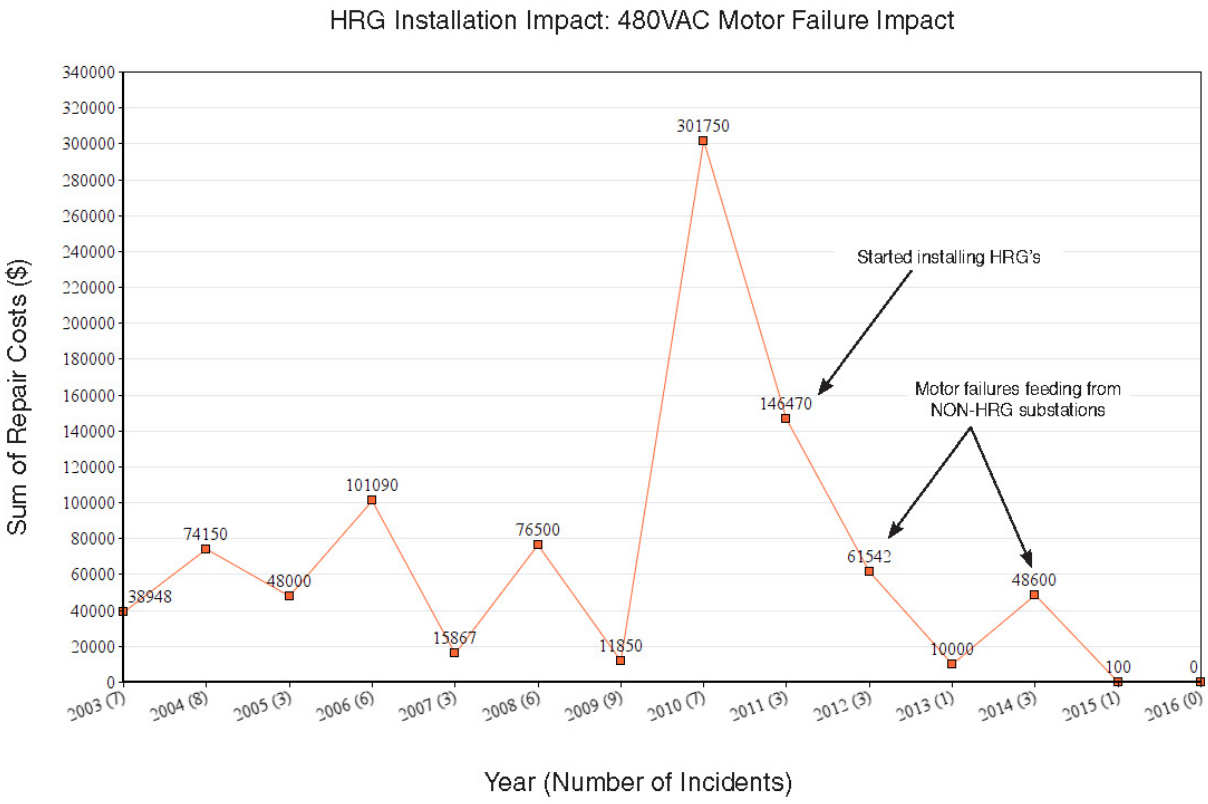
High resistance grounding is the only method to date that will reduce the probability of exposure before a significant phase-to-ground fault arc flash occurs. Other methods will not reduce the probability of an arc flash occurring and begin mitigating the arc flash only after the fault has occurred. That is the reason why NFPA-70E (Z462 in Canada) recognizes high resistance grounding as a mitigation technique for arc flash.

In the studied facility, a significant decision making process was conducted to determine the best approach to give the facility the most protection for their employees. To do this, the owners chose to implement arc flash reduction in a two-pronged attack; first, limit the probability of an arc flash occurring and second, reduce the arc flash incident energy if more than a phase to ground fault occurs. Arc flash mitigation was accomplished through a number of strategies:

1. Application of high resistance grounding on all the low voltage transformers to reduce the probability of occurrence;
2. Installation of low voltage power circuit breakers digital relays on most low voltage breakers for tighter tripping control;
3. Installation of electronic protection relays on low voltage substations which incorporated Maintenance Mode switches programmed into the relays; and
4. Installation of 15kV primary fuses which have faster trip curves

The facility also recognized the disadvantage of not having the neutral available to service line-to-neutral loads. This necessitated the installation of isolation transformers to service these loads. This also made the system safer by exposing the single phase loads to much lower bolted fault current.

Even with the added cost to the project, there were overwhelming advantages observed by utilizing a high resistance grounding system and the facility felt it was well worth it since they wanted to not only reduce the probability of an arc flash occurrence, but also reduce the incident energy to protect their employees.



PULP AND PAPER CUSTOMERS

I-Gard values it's long standing relationships with hundreds of industry leaders and widely recognized institutions, many of which are in the food and beverage industry. Please see a small portion of our pulp and paper clients outlined below.

Customer	Product	Location	Year
International Paper	Sleuth	Oregon, USA	2021
International Paper	DSP OHMNI	Alberta, Canada	2021
Rhona	NGR	Chile	2021
Georgia-Pacific Consumer Operations LLC	Sleuth	Oklahoma, USA	2018-2020
Western Forest Products - Saltair	DSP-223	British Columbia, Canada	2019
Foley Cellulose	DSP Upgrade	Georgia, USA	2019
Verso Paper	Sentinel	Michigan	2019
Tolko	DSP OHMNI	British Columbia, Canada	2019
Tolko	DSP OHMNI	Alberta, Canada	2019
Harmac Pacific	DSP OHMNI	British Columbia, Canada	2019
Georgia-Pacific Consumer Operations LLC	Sleuth	Florida, USA	2019
Weyerhauser	DSP-223	British Columbia, Canada	2018
Weyerhauser	DSP system	Montana, USA	2018
Georgia-Pacific Consumer Operations LLC	Sleuth (PS-277-5-HORN)	Oklahoma, USA	2018
Northland Forest Products	Sleuth + ZZ transformer (PS-277-5-ZZ)	Alberta, Canada	2018

Vaagen Fibre	Sleuth, VIA (Voltage Indication Alarm)	British Columbia, Canada	2018
International Paper	Sleuth + ZZ transformer (PS-277-5-ZZ)	Mississippi, USA	2018
Canfor	DSP OHMNI	British Columbia, Canada	
Graphic Packaging International	Sleuth (PS-2400-10)	Georgia, USA	2018
Graphic Packaging International	Sleuth + ZZ transformer (PS-277-5-ZZ)	Georgia, USA	2018
Pinnacle Point	DSP OHMNI	British Columbia, Canada	
Millport Lumber	DSP system	Alabama, USA	2017
Interfor	DSP OHMNI	British Columbia	2017
Alberta Pacific Forest Industries (ALPAC)	DSP OHMNI	Alberta, Canada	2017
Weyerhauser	DSP system	Georgia, USA	2015
Weyerhauser	DSP system	Alberta, Canada	2015
Weyerhauser	DSP system	North Carolina, USA	2015
CMPC	DSP-OHMNI	Concepcion, Chile	2015
Mercer (Zellstoff Celgar)	DSP OHMNI	British Columbia, Canada	2015
SFK	DSP MK lll System	Quebec, Canada	2006
Arauco	DSP MK lll System	Valdivia, Chile	2006
CMPC	DSP MK lll System	Santiago, Chile	2006
Eaton Laprairie	Sleuth	Ontario, Canada	2007

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1

fact

The US Labor Department's Bureau of Labor Statistics compiles the Census of Occupational Injuries from death certificates and other information for US workers killed on the job. The 1992-1998 database shows that 2,287 workers died and 32,807 workers sustained days away from work due to electrical shock or electrical burn injuries.

2

fact

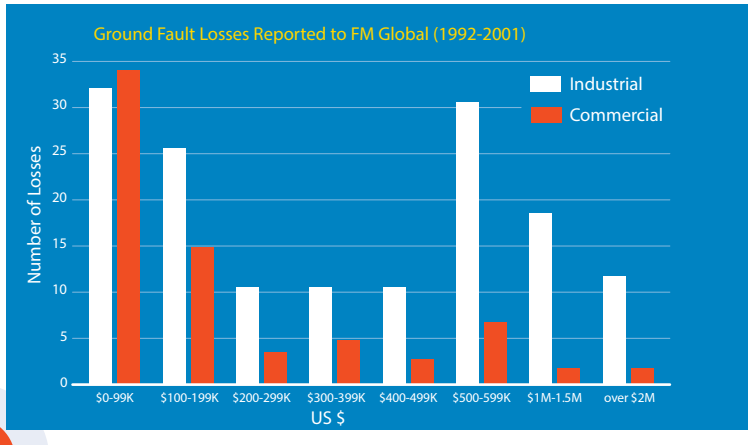
One leading US-based insurance company notes that over a 7-year period, its clients reported 228 losses that were attributed to ground faults resulting in payments of $180 million.

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.

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 US 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 (impact), and so 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.

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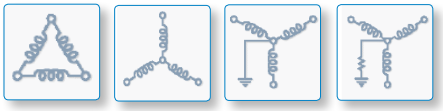

Ungrounded Electrical Distribution System

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

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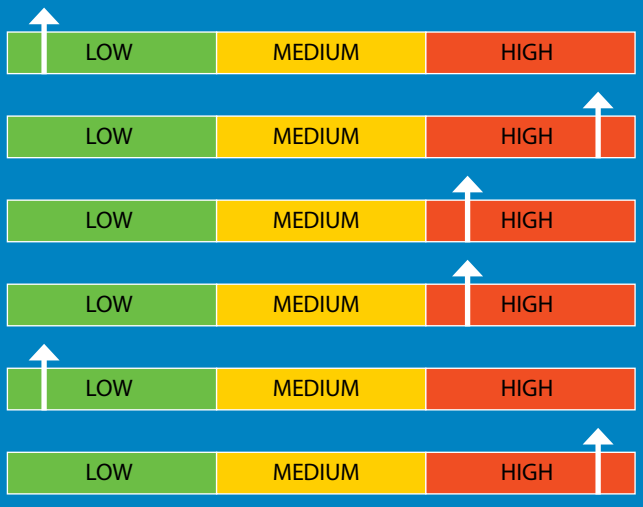
risk overview



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

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

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

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.”

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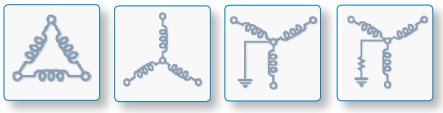

High-Resistance Grounding Overview

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.

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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 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

PLATINUM

SENTINEL – SMART HRG

Includes all features of Gold, Silver and Bronze plus

- Selective instantaneous feeder isolation on 2nd phase to ground fault
- Mitigate 95-98% of arc flash incidents on 1st phase to ground fault
- Assisted fault location – identify faulted feeder and phase
- Resistor monitoring relay and fail-safe grounding circuit
- Time and date data logging

GOLD

GEMINI – FAIL-SAFE

Includes all features of Silver and Bronze plus

- Ground circuit monitoring relay
- Patented fail-safe grounding circuit (unique to I-Gard)

SILVER

SLEUTH – PULSING Includes

all features of Bronze plus

- Ground fault pulsing
- Touchscreen display

BRONZE

STOPLIGHT – BASIC HRG

- Ground fault alarm
- Reduce frequency of arc flash hazards
- Limit magnitude of ground fault current
- Ground neutral of a three phase power system

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Arc Flash Protection Overview

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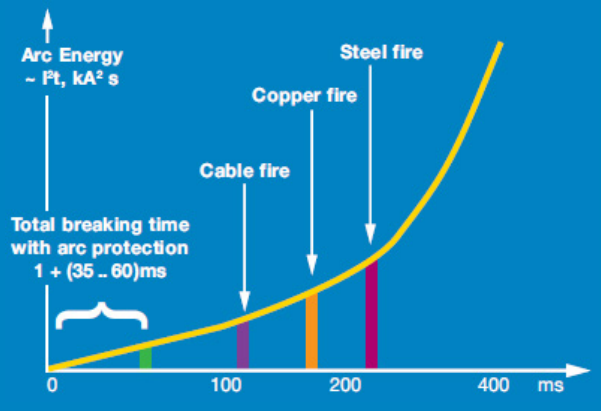
While infrequent, the impact of an arc flash is devastating and often deadly. It is estimated that there are 5-10 arc flash incidents per day that require hospital treatment and the financial impact is staggering.

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 and 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 mili-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.

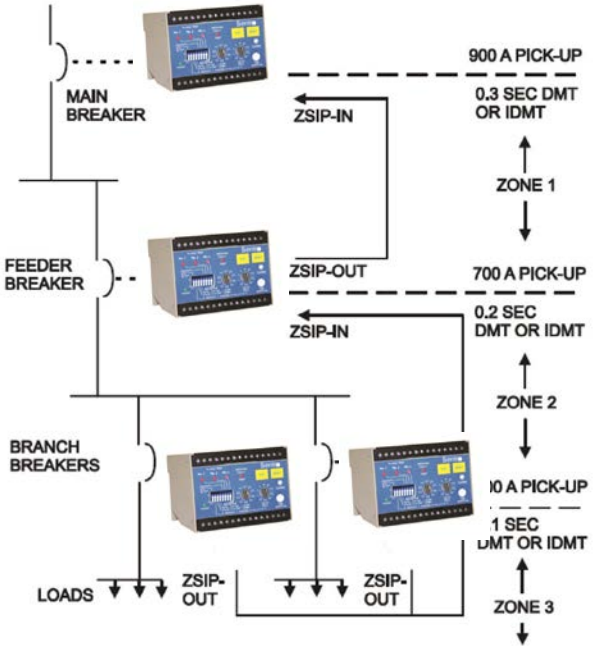
TOTAL CLEARING TIME IS CRITICAL		
REDUCE THE TIME	REDUCE THE DAMAGE	REDUCE THE INCIDENT ENERGY
35ms	no significant damage to persons or switchgear, which can often be returned to use after checking the insulation resistances	1.27 Cal/cm^2
100ms	small damage, requires cleaning and possibly some minor 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 Sentri 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 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.

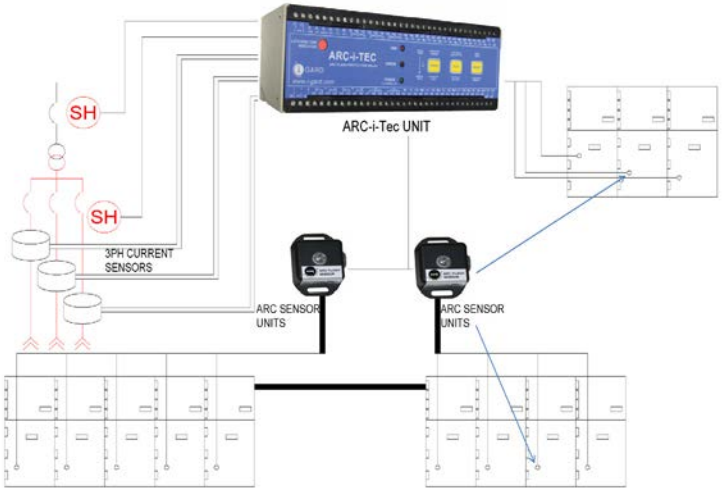


What is Arc Detection and how is it safer?

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.



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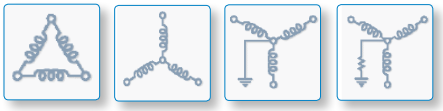
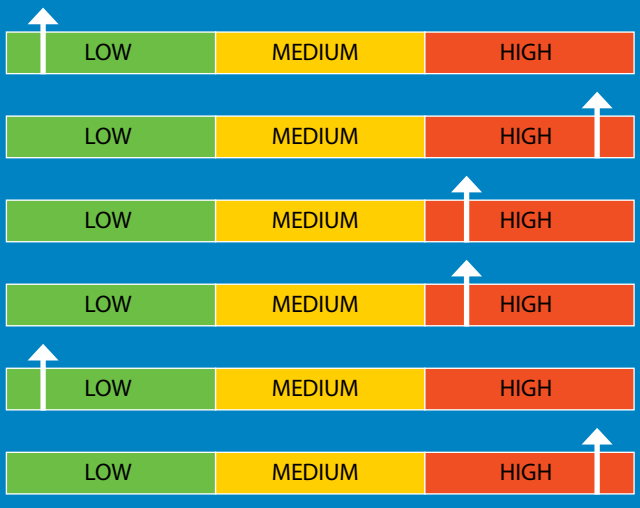


Risk Meter Overview

unparalleled protection

ungrounded distribution system



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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

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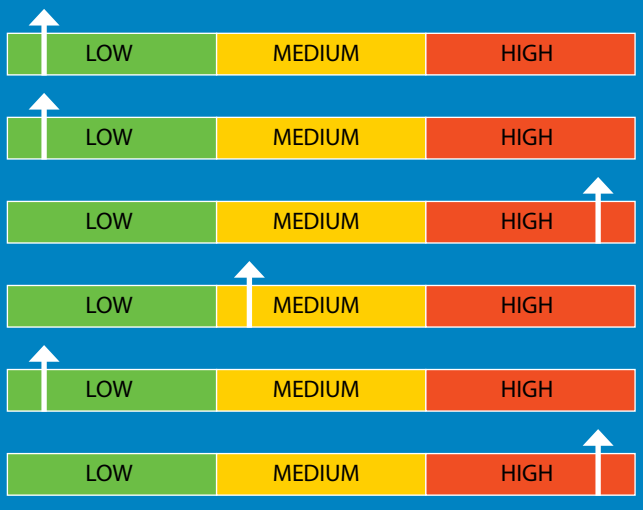
unparalleled protection

standard high-resistance grounded distribution system



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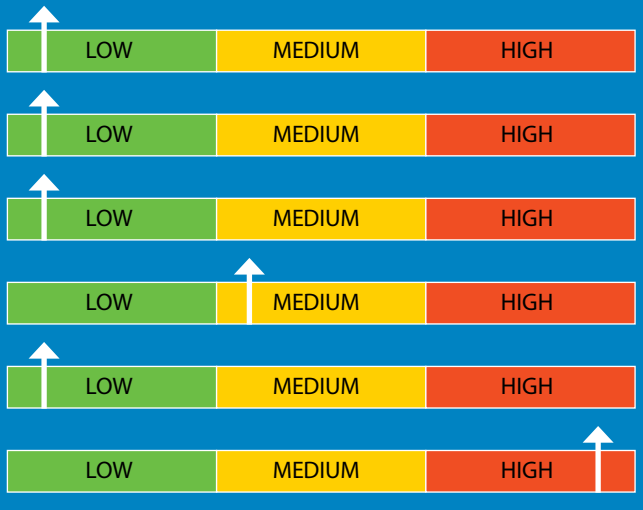
SMART high-resistance grounded distribution system



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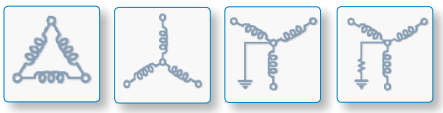
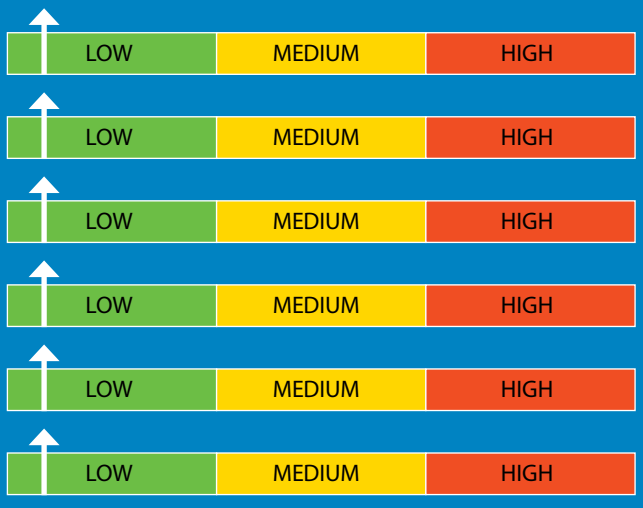


The I-Gard Total System Protection

unparalleled protection

SMART high-resistance grounded distribution system
+ optical arc mitigation



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Arc flash hazard
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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

hierarchy of hazard control measures from ANSI Z10

control effectiveness

life cycle value

Elimination Eliminate the hazard during design	De-energize before working on equipment OR install HRG which reduces the frequency of arc flash incidents
Substitution Substitution of less hazardous equipment system or energy	Reduce Current or Time to reduce hazard level. Current Limiting Fuses, Maintenance Switch, Relay with ZSIP or Optical Arc Detection
Engineering Controls Design options that automatically reduce risk	Redirect the blast or remove employee from blast area Arc Resistant Switchgear, Remote Racking, Chicken Switch
Warnings Automatic or manual, permanent or temporary, visible or audible warning systems, signs, barriers and labels	Electrical Safety Training Warning Labels, Barriers
Administrative Controls Planning processes, training, permits, safe work practices, maintenance systems, communications, and work management	
Personal Protective Equipment Available, effective, easy to use	Appropriate PPE based on study results

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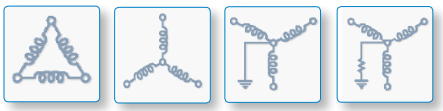


Why I-Gard?

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 Sentri 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 1ms (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 DSP Ohmni system + ADM Arc Flash Detection module.

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.

Sleuth

SLEUTH

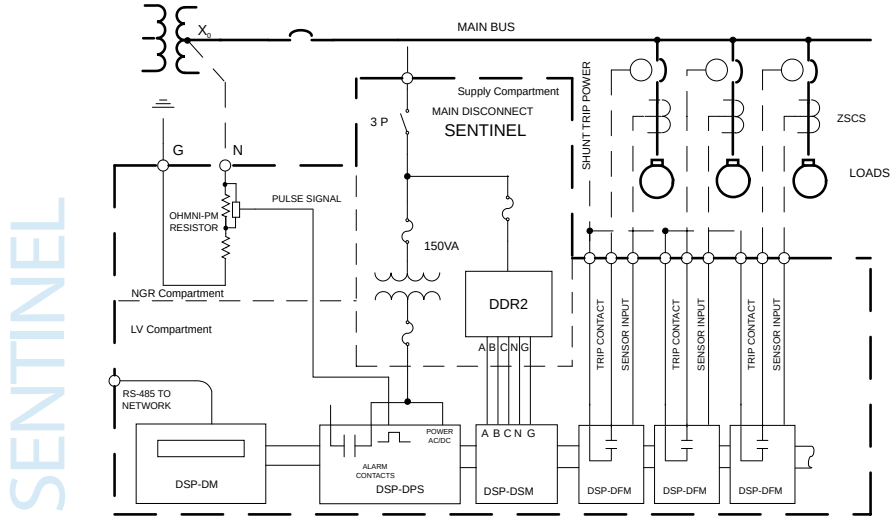
- NEMA 2R enclosure containing current limiting resistor and ground fault relay
- Available with artificial neutral for use on delta systems
- Visual indication of system normal, active ground fault and pulsing active
- Available for 480V, 600V and 4160V distribution systems

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 Relay and Touchscreen Display	The ground fault relay measures the current through the resistor, compares the values with the fields settings of the relay and provides the indication means when an abnormal condition is detected. The ground fault relay can be used with the touchscreen display module to provide an advanced HMI.

SLEUTH

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



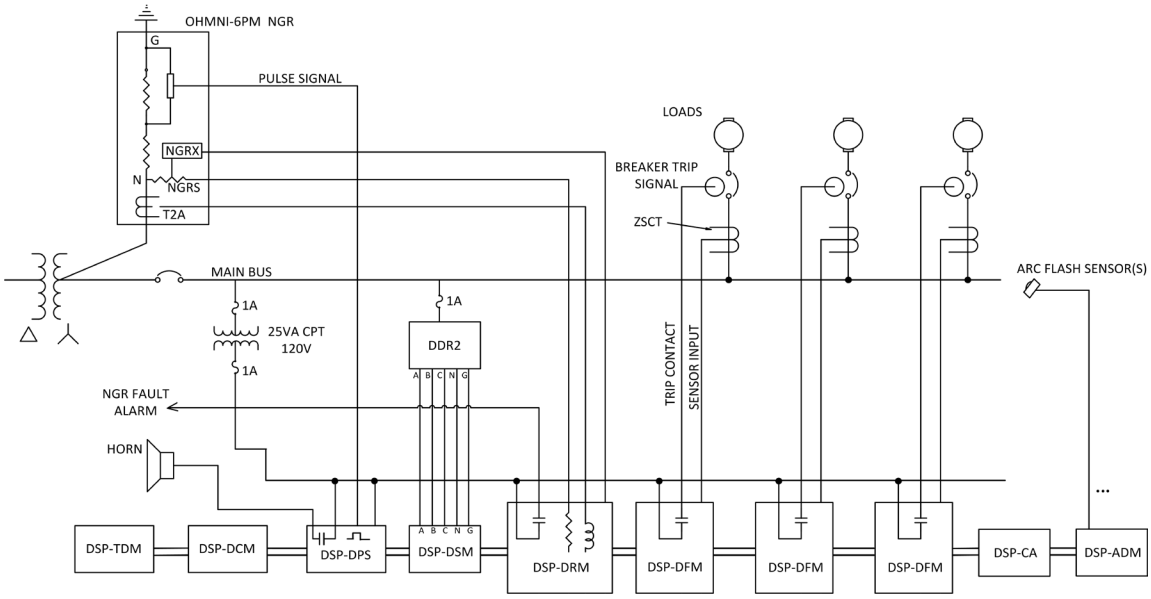
TECHNICAL SPECIFICATIONS

Power Requirements	100-240V, 50/60 Hz or DC, 25 V A
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 ±10% of system let-through current Trip Level Accuracy ±10A DSP-DSM Alarm Level Accuracy ±10% of IG
Temperature Range	Operating temperature 0°C - 50°C

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
- Reduces the risk of an arc flash from ocurring and minimizing the impact if one does

DSP-OHMNI

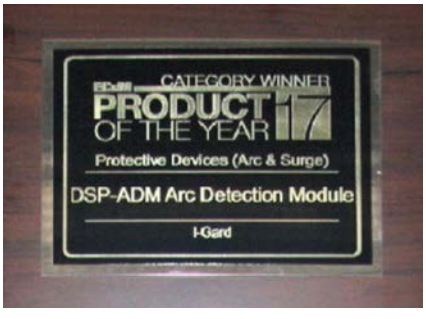


DSP-ADM Arc Detection Module

The DSP-ADM module monitors the area to be protected for flashes of light and for air pressure waves caused by arc flashes. When any of the sensors identifies such an incident, the internal Form C contact transfers. This signal is then use to trip the breaker interrupting energy to the circuit.

The I-Gard DSP-ADM is an ARC detection module that uses air pressure and/or light sensing transducers to continuously monitor up to 21 sensors through up to seven channels. It offers a first line of defense in the arc detection feature of the DSP-OHMNI system.

The DSP-ADM is used to provide protection against arc flash hazards in lowering the incident energy level to safer values protecting both personnel and equipment from severe damages.



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. Provides communications by Ethernet connection and RS-485 serial network connection supporting Modbus TCP and Modbus RTU communication protocols.
Arc Detection Module DSP-ADM	Optical sensing Arc Detection Module . The DSP-ADM is used to provide protection against arc flash hazards in lowering the incident energy level to safer values.
Touchscreen Display DSP-TDM	Provides a simple yet intuitive interface that creates a seamless user-experience by guiding users through its advanced features. Direct access to set-up and controls.

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

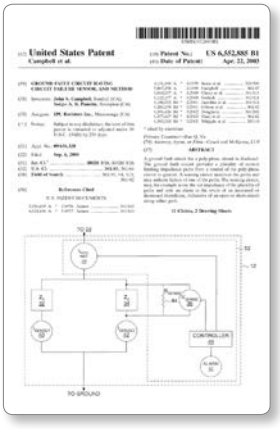
Turbo Sleuth is available in either 480V or 600V types and provides pulsing currents in three incremental levels of 5A, 3.75A and 2.5A when in operation. This 3-stage current pulse maximizes visibility of the detection system eliminating false indications. The Turbo Sleuth is enclosed in a NEMA 3 outdoor 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.

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

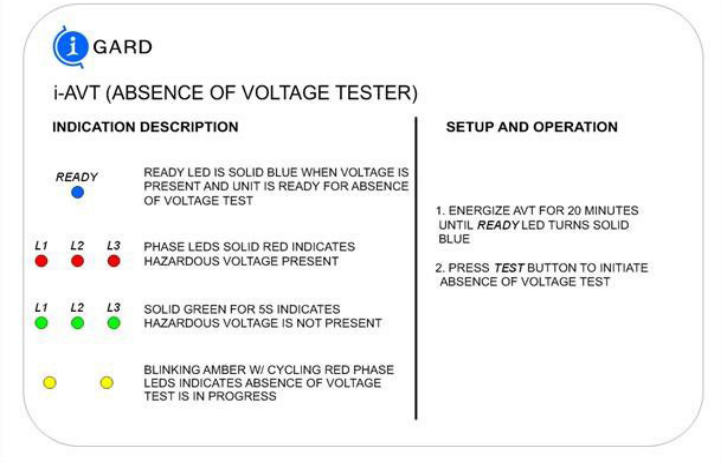
I-AVT ABSENCE OFF VOLTAGE TESTER

I-AVT

DISPLAY

- Indication before entering the panel reducing risk of electrical shock
- Solid GREEN LED indication (positive indication) for 5 seconds indicates the Absence of voltage
- Solid RED LED indication in presence of hazardous voltage
- Easy installation and operation

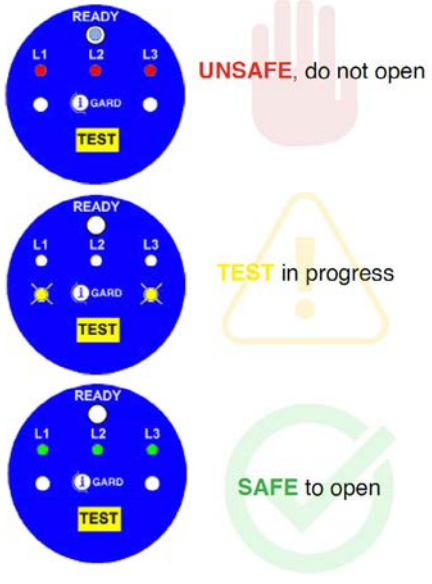
CONTROL UNIT



INSTRUCTION STICKER

i-AVT

Simple, intuitive, better.



i-AVT Absence of Voltage Tester

The i-AVT allows for the Absence of Voltage test to be initiated via the press of a button and completes the test in 10 seconds and allows the test to be conducted prior to opening an electrical enclosure, thereby reducing the risk of exposure to shock or electrocution hazards.

The i-AVT provides visual indication of the presence of voltage via three-phase voltage red lights connected directly to the circuit conductors, thereby indicating that hazardous voltage is present.

- The i-AVT provides positive indication of the Absence of Voltage via 3 Green LED lights.
- The i-AVT provides a continuity check to ensure that all leads are properly connected.
- The i-AVT is maintenance free with secondary power source built-in to the control module.
- The i-AVT is SIL-3 rated ensuring that it will not provide a false positive.

Unparalleled Protection

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