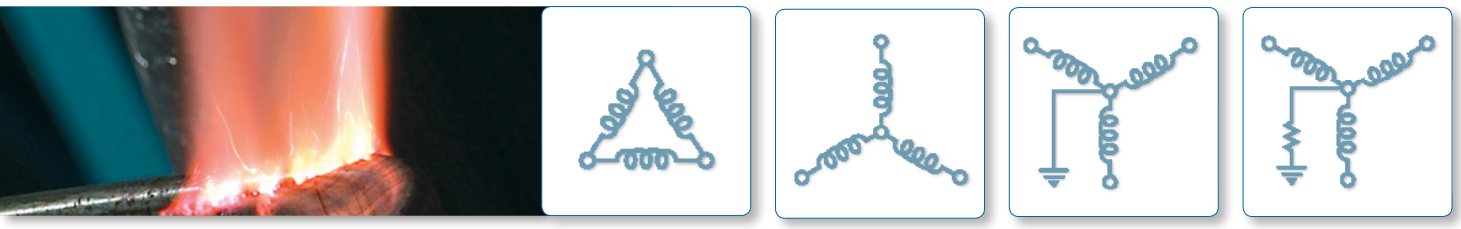
GARD

Unparalleled Protection

FAQ ABOUT HRG TECHNOLOGY

Q&A



Webinar Q&A, July 2020

FAQ ABOUT HRG TECHNOLOGY

Thank you for attending our latest webinar hosted by Sergio Panetta and Aaron McPhee. This webinar was designed to answer the most commonly asked questions about HRG technology and the questions submitted during registration. For those of you who missed it, or would like to watch it again, the webinar recording is available on our website. Please find the link below or visit www.i-gard.com. As always, if you have any further questions, please email support@i-gard.com and one of our team members will gladly assist.

Click here

QUESTIONS & ANSWERS

Q1. How can I quickly and easily identify a fault on the system?

A. Finding a fault on a system depends on the system you have. Is your system ungrounded, solidly grounded, or resistively grounded?

If your system is ungrounded, you can detect a fault by measuring the voltages on your phases. If there is a fault, one of your phases will have a voltage drop and a surge in the other two phases. We have a relay called the VIA which is superior to the traditional 3 light system for detecting ground faults. When there is no fault on the system three green LEDs are on. When there is a single fault on the system the corresponding phase will turn red. It is still difficult to find the fault.

In solidly grounded – it will cause your system to trip/cause service disruptions.
In a resistively grounded system, you can easily identify a fault using our relays. To take it one step further and detect the location of the fault, you can use pulsing, which is a feature on some of I-Gard's products. With pulsing technology this is typically a matter of only a few hours. The more advanced HRG systems include phase and feeder indication, which reduce the time even further.

Q2. Can you explain the second ground fault protection?

A. First ground fault is when there is an unwanted connection between the system conductor and ground. When a second ground fault occurs, a line-to-ground-to-line fault is created which can result in significant damage and a hazard to personnel.

Second ground fault protection is when the relay detects a second ground fault and isolates the lower priority breaker, leaving the facility with the most critical feeders operations.

With the basic or industry standard HRG technology, a second ground fault on a different phase from the first will result in a phase-to-phase fault and the over-current protection on the main circuit will trip and the entire system will isolate.

With advanced HRG technology there is the option to pre-select up to 50 feeders with priority from the lowest to highest (16 different settings are available) so that in the event of a second ground fault the least important feeder will trip within 100ms. This allows process continuity of the more important feeder. With this feature the most important process in your facility will remain operational at all times.

Q3. If there is one ground fault, what happens if there is a second ground fault?

A. The occurrence of a second ground fault on a different phase, means you now have a phase to phase fault, with a current magnitude large enough to do damage, but sometimes too small to activate overcurrent devices in time to minimize damage. This is why it is important to locate and resolve the first ground fault when detected on a resistively grounded system.

Q4. What reasoning can be used to get utilities to sign-off on the idea?

A. Increase in safety and reduction in likelihood of arc-flash is one of the major reasons that can be used to convince utilities to use HRG systems. Refer to CEC and codes/standards. We have had several utilities accept HRG as a superior technology.

Q5. What is the role of LRG?

A. Low resistance grounding of the neutral limits the ground fault current to a high level (typically 50 amps or more] in order to operate protective fault clearing relays and current transformers. These devices are then able to quickly clear the fault, usually within a few seconds. The importance of this fast response time is that it: · Limits damage to equipment, · Prevents additional faults from occurring, · Provides safety for personnel, · Localizes the fault. The limited fault current and fast response time also prevent overheating and mechanical stress on conductors. However, like the solidly grounded neutral system, the circuit must be shut down after the first ground fault. Low resistance grounding resistors are typically rated 400 amps for 10 seconds, and are commonly found on medium and high voltage systems.

Q6. What are the Calculations for the HRG to reduce the Arc Fault Levels below the safe level?

A. HRG does not reduce the Arc Fault Levels, it reduces the likelihood of an Arc Fault to occur. The magnitude of an Arc fault does not change with HRG. To reduce the magnitude of an arc fault, an arc detection relay is required on the system.

Q7. Is there an industry standard for stating breaker tripping priorities (0=never trip vs 0=always trip)?

A. The only standard that specifies tripping or not appears to be in fire pumps. The fire pump circuit seems to be exempt of tripping.

In general both the CEC and NEC provide the rules for tripping when using HRG. Basically you do not have to trip when you have a ground fault.

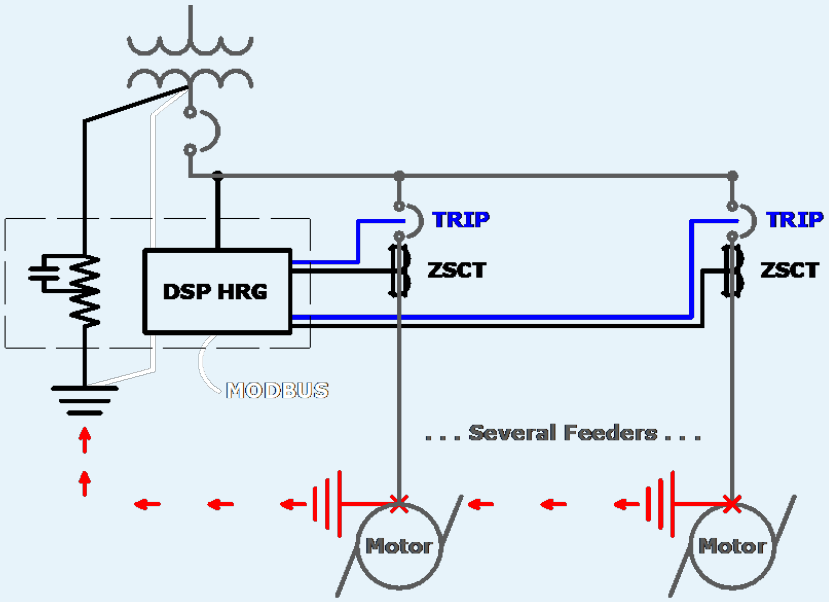
Q8. When replacing old PDC feed cable ground fault monitoring system that uses the 0-5amp secondary CT. Can we use the old CT.?

A. This will depend on the ratio and the sensitivity of the relay. You can imagine that a 100:5 CT will see a primary fault current of 5A. The secondary will be 250 mA. It will be extremely difficult for standard relays to detect this. This is if you are using 1 ground fault CT. Now if you are using three CT's and calculating the residual, 250mA when summing three CTs is very difficult.

Q9. Please discuss the impacts that high resistance grounding has on protective relay settings.

A. As continuity of service is a major advantage of the high resistance grounded systems, they are often operated for long periods of time with a single fault. The protective relays come into picture only when the second fault occurs before the first one is cleared. If the second fault occurs on the same feeder as the first, the phase-to-ground fault changes to phase-to-phase, which cannot be detected by the ZSCT (it is effectively a load current). Thus high current will flow and must be cleared by the overcurrent protection. For the relay settings, one needs to consider all possibilities like paralleling, open or closed ties.

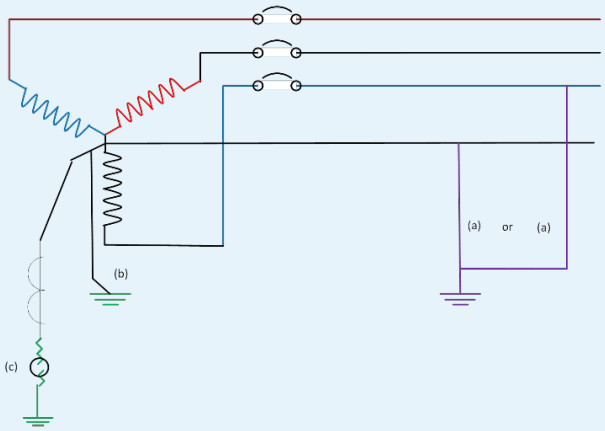
On the other hand, if the second fault occurs on a different feeder some distance away, or the fault develops into an arcing fault, the ground impedance between the two faults will limit the fault, which cannot be cleared quickly by the overcurrent devices and can cause severe damage. With the SMART HRG systems like DSP, one can assign priorities to the feeders. The protecting feeder breakers can be tripped when the fault current exceeds a predetermined level so that the feeder with the lowest priority will open first.



Q10. Would a failure in the NGR - neutral cable be detected as a resistor failure in a system with a sensing resistor?

A. A failure in NGR-neutral cable is an open circuit and will be detected as NGR failure. Resistor monitoring can be can be achieved using I-GARD current sensors, sensing resistors and SIGMA relay. The monitor must be able to detect the faults as described below

a) A grounded neutral of grounded phase
b) A grounded neutral from the X0 bushing to the resistor
c) An open path anywhere along the X0 bushing to ground. This will include the resistor.



Q11. Can High Pass Filters be used with elevated ground potential on non-sinusoidal loads such as large coordinated VFD?

A. Our relays often employ a filter like this.

Q12. Advantages/Disadvantages of Resistor versus Reactor grounding system and special design considerations for each.

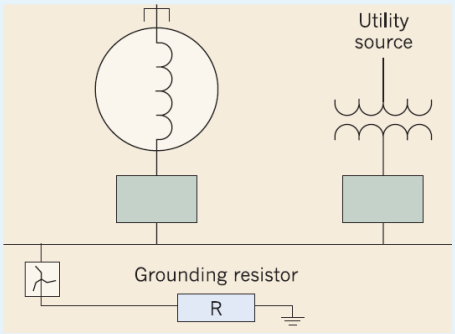
A. This is hard to answer and it is not correct to state that an advantage for one is a disadvantage for the other. Both are valid grounding schemes and both bring their own advantages. This answer may require a webinar of its own if you are interested.

Q13. Can you discuss the application of HRG on the 480V secondary of a wye-delta transformer?

A. For Wye-Delta connected systems, an artificial neutral needs to be created. Grounding transformers is used to create a neutral and connected through the HRG. These Grounding transformers may be either Zigzag or Wye-Delta type. Once the neutral is created in the delta, it is a straightforward HRG installation from that point on.

Q14. Are single UPS and parallel UPS compatible with HRG? Is it OK to use the same resistor for Utility & Generators sharing Neutral?

A. HRG can be used with single and parallel UPS but ensure to check with the UPS manufacturer on the compatibility. When there are parallel power sources that share a common neutral, instead of directly connecting an NGR to a common neutral terminal, an artificial neutral zigzag grounding transformer is connected to the three-phase paralleling bus. The neutral point of the grounding transformer is then grounded through the NGR, this prevents excessive circulating neutral currents and limits ground-fault current to a safe value. I-Gard has had a great deal of experience working with UPSs and UPS manufacturers to find the optimal solution.



Q15. We installed SEL relays for NGR monitoring but didn't annunciate the faults to a maned area, is that something we should be doing?

A. In Canada, section 10-302 of the Canadian electrical code mandates that the integrity of an impedance grounded system must have an audio or visual alarm. This alarm should clearly annunciate the status of the system to the persons monitoring it, and continue signaling until the condition is corrected. This is not mandatory in US.

Q16. How exactly does the HRG technology affect the control section of double conversion UPS systems and how do we mitigate them?

A. a) We have had some experiences with some UPS manufacturers that had standard control sections in their UPS. When the UPS switched due to a power outage, it would not switch back to normal power when it returned. Obviously, this depleted the battery source.

b) In communication with the UPS manufacturer, they implemented a different monitoring system and everything was resolved. It is more a lack of communication which causes these issues that an incompatibility. If the grounding means are discussed at the beginning of a project, there are fewer surprises at the end.

Q17. What is the standard installation in underground mines in the USA and in Canada? Solidly grounded or HRG?

A. Standard installation in underground mines recommends the use of HRG. This allows for tripping on the first fault at a low current value, which is the safest method for such applications. One issue when using HRG for mobile loads in mines is the possibility of a disconnection at the trailing cable, removing the return bath from ground. Industry standards look to use an NGR that trips on the first fault in combination with I-Gard's GCHK-100 relay, which uses a terminating diode to determine an open/short at the ground loop. In Canada, CSA standard C421 focuses on mining industry requirements, while the US uses both CFR and MSHA standards

Q18. Does HRG or LRG more effectively mitigate arc flash hazards?

A. Arc faults occur when a single phase ground fault propagates into a phase-ground-phase fault, where two of the circuit conductors come into contact with each other. Although HRG/LRG does not lower the incident energy seen when a fault occurs, the resistors limit the ground fault current during the initial single phase ground fault. This decreases the likelihood of a phase-ground fault from converting over to a phase-ground-phase fault. HRG is stated to be an arc flash mitigation technique when the voltage is 4160 V or less and the current is limited to 10A as per CSA Z 462 and NFPA 70E.

Q19. What ground current threshold do you use to determine whether LR or HR grounding is appropriate & what is the Standard for that?

A. The grounding method used varies by application - Many factors play a key role in determining the parameters needed to size a neutral grounding resistor. Transformer specifications, Generator specifications, charging current, and overall system parameters play a key role in this process. I-Gard uses CSA and IEEE requirements to determine a suitable let through current that will not cause nuisance trips.

HRG is an option when the system voltage is less than 15kV or if the charging current is less than 10A. LRG becomes a standard when charging currents range anywhere from 10A to 1000A.

Q20. Who typically calculates the resistor size and is it based on a specification provided by the design engineer?

A. The resistor size is calculated based on the required let through current seen at the neutral point. Then, based on the system voltage and let-through current, we use ohm's law to identify the appropriate resistance needed to provide resistance grounding to limit the current to the required parameter. I-Gard is able to calculate the resistor size for a specific application if given enough information (ie. SLD, nameplates, data sheets).

Q21. How does HRG affect generator hook-up?

A. HRG installation does not affect generator hook-up unless the generator is mobile. For standard generators, HRG installation simply involves extending the neutral connection of the generator to the NGR.

Q22. Is there a trend to higher continuous currents? Seeing 5-7A, sometimes 10A for HRG bank requirements by customers.

A. Higher continuous currents are calculated based on the charging current of the system. Providing a let through rating of 10A in such situations ensures that no nuisance tripping will occur.

Q23. How do you size a zig-zag xfmr?

A. A zigzag transformer is typically sized to match the current rating and duty cycle of the NGR connected to it, based on charging current calculations done on the system. For example, an NGR rated for 347V L/N, 5 Amps continuous duty cycle will be connected to the neutral point of 1735 VA continuously rated zz transformer. It is more difficult when you have a system which is 4160V and you want to use a 400A 10s resistor. During a fault the rating of the transformer is 960kVA, this can be reduced to the low duty cycle

Q24. Personnel Safety concerns operating short term with one leg grounded?

A. This is a common occurrence and does not pose any additional hazard. Many HRG and ungrounded systems can operate without any adverse effects or increased hazard to personnel under faulted conditions. In fact, some industries use a corner grounded delta system as their grounding means. This is treated like a solidly grounded system.

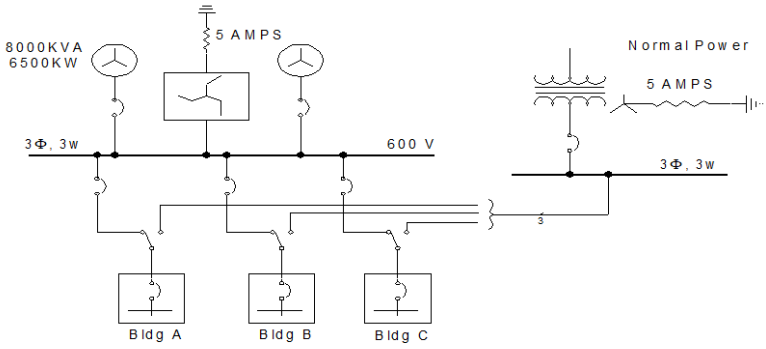
Q25. When is HRG required?

A. High resistance grounding is generally required on low and medium voltage systems, where ground fault current can be limited to 10 Amps or less, based on the charging current of the system. HRG provides numerous benefits, including

reducing the likelihood of an arc-flash occurrence on the first ground fault, and enabling the customer to run the system continuously.

Q26. Please discuss HRG configuration of standby power systems and their transfer switches.

A. An ideal configuration of HRG for a standby setup would utilize a 3 phase , 3 wire system, this enables the use of three-pole transfer switches, and the emergency power system to be resistive grounded with its own separate HRG unit from the utility, as shown below.



3 Pole Transfer Switches and 3 phase, 3w Distribution

Q27. What is the latest technology for High Resistance Grounding?

A. Although HRG technology is not new, new methods of monitoring HRG are continuously being upgraded.

Resistor monitoring is place of advancement – DRM3 and SIGMA3 have the ability to monitor integrity of resistor in accordance to CEC 2018 update.

One I-Gard product that includes the latest technology in monitoring would be the DSP-OHMNI. It includes many different modules that are beneficial for your system. The DRM module monitors the integrity of your resistor. The DFM module monitors the feeders to detect which feeder the fault is located and on second fault, trips the one with lower priority. You also have the option of including the ADM module which reduces the severity of the arc flash.

Q28. Why and when should reactance grounding be considered?

A. Reactance grounding is used for grounding the neutral of circuits where high charging currents are involved such as transmission lines, underground cables, synchronous motor and synchronous capacitors. An inductive reactance limits the ground fault current and still keeps the over voltages within limits.

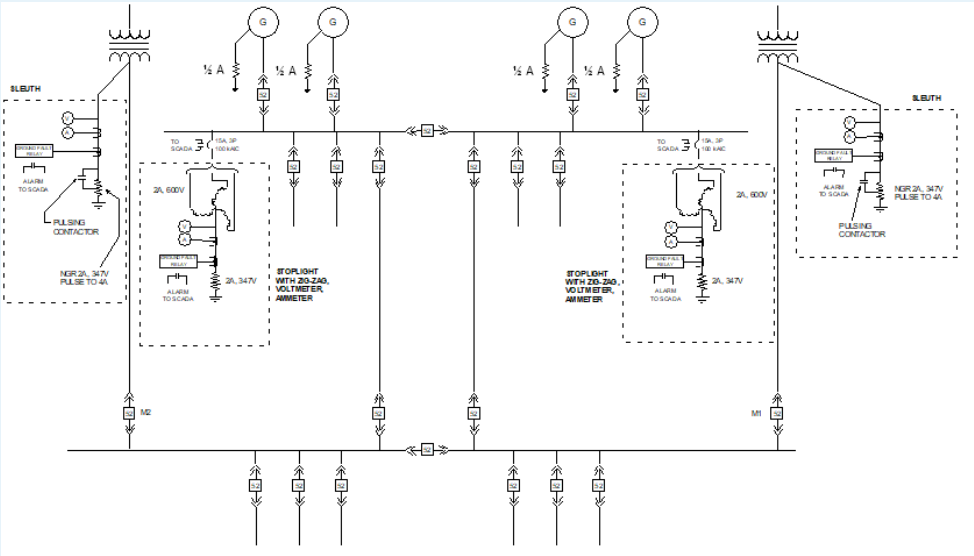
Q29. What is the recommended surge arrestor for solid ground and resistive ground?

A. Surge arresters that have been listed and approved for use on a resistively grounded system should be employed. It

is important that the type of grounding to be used on the system is specified to the manufacturer. Typically using surge arrestors suitable for Delta systems will work.

Q30. Planning an HRG for a 480V bus with a gen PL bus. On until only or 1, 2, 3, 4 gens or both or any. Switch resistors in/out?

A. HRG can be placed on both the main bus and the gen bus. However, it is important to keep the sum of NGR let through currents on both buses at 10A or less, as this is the limit allowed by the electrical code, for the system to run continuously in the event of a ground fault. An example of an HRG system with multiple sources is shown below



Q31. Is the use of residual current CB relays (trip for 30 mA) necessary to complement the HGR protection?

A. In North America we do not use RCCBs , we use GFCIs and specifically class A GFCI where any leakage current above 5 mA will isolate the device. These types of devices as well as RCCB for outside North America can complement the HRG system. If you wish to isolate at 480V of 600 V at 5 mA the is not a Class A GFCI. I-Gard has products that can act like a Class A GFCI at higher voltage .

Q32. What are the required changes to be made on solidly grounded system when converting to HRG?

A. Here following points to consider:

a. Cable should be rated for Line-to-Line Voltage. This is not an issue for LV system.
b. VFDs, SPDs and UPS should be compatible with HRG application.
c. Single Phase loads that include the neutral should be isolated using an isolation transformer.
d. Do not recommend distributed neutral in Canada. NEC do not allow distributed neutral for system with HRG.

Q33. What are commonly overlooked items when retrofitting into 480-V Solid Ground system or Un-Grounded Delta Systems?

A. The following are commonly overlooked items:

Solidly Grounded System:

a. SPDs, MOVs should be change to line to line voltage.

b. VFDs

c. UPS

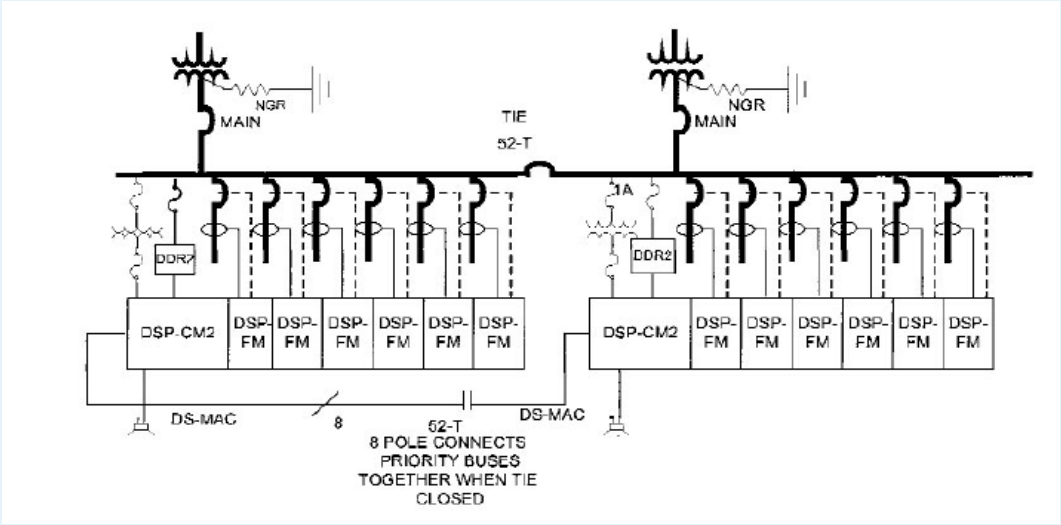
d. Isolation 1 Phase Load/s

Ungrounded System:

a. If a system is compatible with an ungrounded system, there will be no issues converting to HRG

Q34. How many HRGs do we need on a Main-Main (delta secondary transformer (Main 1) and wye secondary transformer (Main 2)?

A. You need two HRG systems to cover both sides of your switchboard/switchgear. For transformer with Delta secondary you need to add a zig-zag transformer to create an artificial neutral. See diagram below for M-T-M arrangement for details. I-Gard's SMART HRG DSP system can work independently when the tie breaker is open and can work together as one when tie breaker is closed. For more details on the DSP system, please visit our website at www.i-gard.com.



Q35. We use HRG on all LV 480V MCCs. We also have small 480V 3 phase power panels, fed be 45kVA transformers; How can we apply HRG?

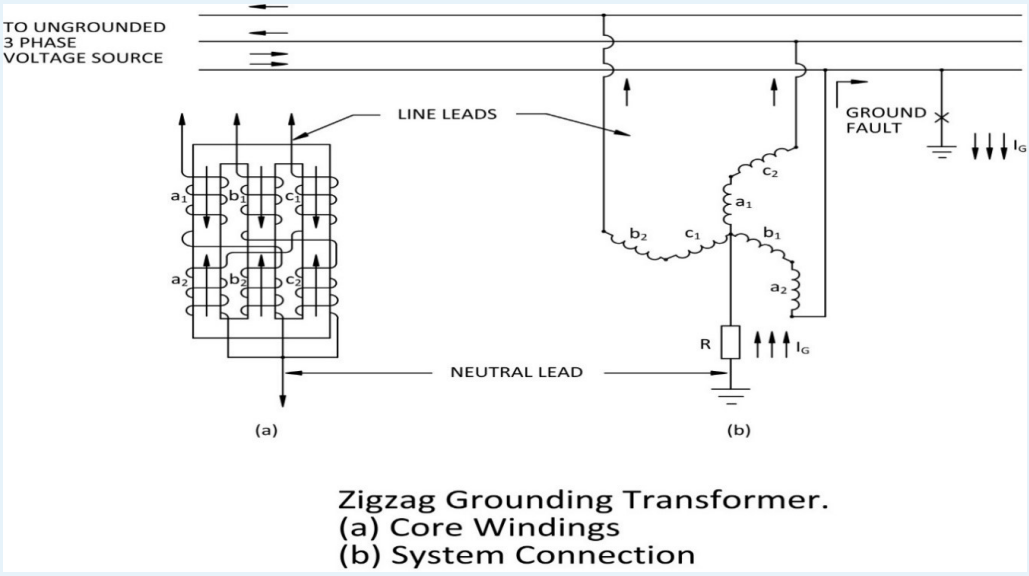
A. If this transformer does not have single phase loads, then you can apply HRG normally. However if there is a single phase load, you may not be able to apply HRG. In the US as per NEC, you cannot apply HRG when your neutral is distributed. However if you are in Canada, you can but you have to trip when you have a ground fault.

Q36. Please discuss the use/advantage of HRG on 3 phase LV generating set with distributed neutral.

A. The main advantage of having HRG connected at the Xo point of the generator is the magnitude of the ground fault current going back to the source. HRG will limit the ground fault current to 10A and below thus provide protection on the alternator windings against electrical and mechanical damage. Especially when the fault occurred inside the alternator windings.

Q37. Please discuss the use of zig zag transformers on solidly grounded systems to implement HRG

A. When your system is solidly grounded, it means that the Xo point of your source is intentionally connected to the ground, therefore HRG is of no use. Typically a zig-zag transformer is installed to create artificial neutral as a return path of ground fault current. This is usually used when your transformer secondary windings is “Delta” or when you float the Xo of your source and install the HRG on the switchboard (see diagram below). Please feel free to contact us at support@i-gard.com if you further assistance on this application.



Zigzag Grounding Transformer.
(a) Core Windings
(b) System Connection

Q38. If older existing system and primary transformers are solidly grounded what are the Dangers of installing HRG on downstream 12kv gens?

A. I do not see any danger if genset neutral will be connected to HRG or LRG rather I can see benefits on your genset. The HRG/LRG will protect the alternator windings when you have ground fault especially when the fault occurred inside the alternator windings. HRG may not be possible depending on the capacitance to ground of your alternator and I am not sure how many generators will be working in parallel. Please contact us at support@i-gard.com if you want to discuss your concerns further and we would be happy to provide more assistance.