Ground Fault Location

Turbo Sleuth

Instruction Manual

THE POWER TO PROTECT

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⚠ DANGER
ELECTRICAL SHOCK, FIRE OR EXPLOSION HAZARD
All installation, servicing and testing referred to in this manual must be performed by qualified personnel. All power should be disconnected prior to removing covers or enclosures and where live conductors may otherwise be exposed.
Failure to observe these precautions will result in death or severe personal injury.

INSTRUCTION MANUAL

C-103EM

Turbo Sleuth Ground Fault Locator

9 September 2002

1. Introduction

1.1. Turbo Sleuth is 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.

1.2. Turbo Sleuth is the 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 120V ac.

1.3. For delta systems an optional artificial neutral may be attached to the unit with clasp type fasteners. This unit is required to provide an artificial star-point for the pulsing grounding resistor. If all systems to be tested are wye connected with available star-points, then this artificial neutral device is not required.

1.4. 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.

1.5. Turbo Sleuth is available in either 480V or 600V types and provides pulsing currents in three incremental levels of 5A, 3.75 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, that the currents will add to the continuous ground current. See Section 4.5.

1.6. The 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 can modify 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.

2. High-Resistance Grounding

2.1. Both the Canadian Electrical Code, Part 1, C22.1-98 and the National Electrical Code, NFPA 70 1999, approve the use of high-impedance grounding neutral systems up to 1000 V. A.C. where the ground fault current is limited to 5 amperes or less. These new changes to the electrical code allow users of the Turbo Sleuth to maintain a ground fault current of 5 amperes or less on their electrical distribution system

without shutting down because of a single ground fault, thereby avoiding unscheduled down times. Turbo Sleuth users can locate, isolate and repair faulty equipment at a more convenient time.

3. Inspection

Upon receipt, carefully open the protective shipping carton, remove all packing material and visually inspect all parts. If any part is damaged, contact IPC Resistors at the numbers listed on the final page of this document for authorization of return for any replacement or repair. Note: Be sure to quote the serial number on the rating plate.

The following parts should be included: -

Qty.	Cat No.	Description
1	TS-PPS	Main unit
1	TS-NG	Cable Neutral Grounding Cable Twist-Loc – Test Clips
1	TS-120V	Cable Control Power Cable 120V, 15A U-Ground receptacle
1	C-103EM	Instruction Manual

Options

Qty.	Cat No.	Description
1	TS-ZZ	Zig-Zag Transformer
1	TS-SV	6 foot, Cable for System Voltage (for Zig-Zag)
1	TS-NGZZ	3 foot, jumper cable for X_0 cable from TS-ZZ to TS-PPS
1	TS-SENSOR	Flexible core ac current probe
1	TS-XLC	20 foot Cable Set 120V and Neutral Grounding Cables
1	TS-AH	Outdoor Alarm Horn

Quantities noted are the minimum required by one system only.

4. Connections

4.1. Turbo Sleuth requires a 120 VAC supply. A 120V cord is supplied for connection to standard North American duplex receptacles. Install this cord in the lower right hand socket of TS-PPS, looking at the rear of the enclosure. The standard Turbo Sleuth is supplied with two cables one for 120V ac control power and the other is for connection of the neutral and ground system connections. If an artificial neutral is option was supplied then two more cables are provided for connection of the X_0 point (Neutral) on the zig-zag transformer (upper unit) to the lower section of the Turbo Sleuth and a three phase, three wire cable with welding type plug, for typical system connection to a receptacle. The following is supplied: -

Cable 1: TS-120V, 120V ac to duplex receptacle North American type

Cable 2: TS-NG, Two-wire cable with un-terminated end for connection to system neutral and Ground (for standard Turbo Sleuth version)

Cable 3: TS-NGZZ, Two-wire cable with plugs on both ends for jumper from artificial neutral star-point to lower section of Turbo Sleuth (for optional artificial neutral version)
Cable 4: TS-SV, Three wire +ground cable terminated with welding plug at customer's connection.

4.2. All connections to Turbo sleuth are with standard outdoor connectors and plug in to rear mounted receptacles on the unit as shown in Figure 1.

Figure 1. Connections for direct connection to system star-point

4.3. The Turbo Sleuth with artificial neutral TS-ZZ, is connected differently. Three cables are required, three (3) phase connections and one ground connection as shown in Figure 2. Test cable 1 is still required for 120Vac. Test cable 3 (TS-NGZZ) connects the star-point of the Zig-zag transformer from the artificial neutral to the grounding resistor located in the main unit. No connection is therefore, required to the system neutral. Instead, three phase system voltage is required using cable 4, which is terminated either with a rated welding plug connector or un-terminated leads or clips as specified by the user. The standard cable length of cable 4 as supplied is 6 feet. A Longer cable TS-XLC (20ft) can be ordered if necessary

Figure 2. Zig-zag Connections - where system neutral is not available

4.4. If no artificial neutral is required, it may only be necessary to connect the Turbo Sleuth Cable (TS-NG) to the existing star-point of the system. To do this, connect the X_0 (black) to the system X_0 and the ground to system ground (green wire). This can be done by connection across any existing Grounding Resistor. It is recommended that a suitable receptacle be installed to allow such connection to be done safely and quickly. The use of test clips is not recommended due to the risks involved with connection to live circuits.

4.5. Note that if the system already has a Neutral Grounding Resistor (with or without an artificial neutral device), the Turbo Sleuth can still be connected to the system. In this case the currents will add to the existing ground current arithmetically but since we are interested only in the difference current due to the pulsing to locate the fault, it does not detract from the fault location technique in any way. For example if the existing NGR is 5A and the Turbo Sleuth currents during pulsing are 5, 3.75 and 2.5A then the actual currents detected by the TS-SENSOR probe will be 10, 8.75 and 7.5A. The modulation will still be clearly visible on the meter. If it is desired to limit the current to maximum of 5A as in the previous example, then a fully rated switch could be installed to remove the fixed NGR during the Turbo Sleuth fault detection process.

4.6. Connection of cable 4 (TS-SV) to the system voltage similarly, should be made through a fully rated disconnect, and receptacle, ideally. The disconnect should be as close to the source as possible to reduce the back-tracking required during fault location when connected at a downstream location. It is recommended that a dedicated receptacle and switch be installed at the main service for each system of the plant.

Figure 3. Turbo Sleuth Control Panel

5. Operation.

5.1. See Figure 3. Turning the rotary “POWER” switch to the ON position energizes Turbo Sleuth. The “POWER” switch is located on the panel door. Upon energizing the control panel the “SYSTEM NORMAL”, green light turns on signifying that no ground faults are on the system and the Turbo Sleuth is receiving control voltage. System connection will require operation of the disconnect switch used at the point of insertion of the Turbo Sleuth in the plant power network.

5.2. Verify the Turbo Sleuth functionality by pushing the “TEST” button, and holding for the delay time set on the DGF-CT-A Fault detector module. This causes the DGF-CT-A to trip. The green light will turn OFF, the red “GROUND FAULT ACTIVE” light will turn on and the fans will activate. This will confirm that control voltage is available, the DGF-CT-A is functioning and the fans are operational.

5.3. Push the “RESET” button to reset the system to normal operational status. The red “GROUND FAULT ACTIVE” light will go OFF, the green “SYSTEM NORMAL” light will turns ON, and the fans will STOP. The Turbo Sleuth is now ready to monitor or Locate faults on the distribution system. Close the system disconnect or breaker to begin the system testing.

5.4. When a ground fault occurs the potential between the system neutral and ground elevates to the line to neutral voltage. This is reflected by the deflection of the voltmeter pointer on the Turbo Sleuth panel. In addition to the voltage, the current is also being monitored. A deflection of the ammeter pointer will indicate the magnitude of the fault current on the system. If the fault

current magnitude is greater than the pick up setting of the DGF-CT-A and the duration is greater than the time delay setting on the DGF-CT-A, the DGF-CT-A will trip changing the state of the "TRIP" contacts. The green light will turn off, the red light will turn on, and the fans will activate.

5.5. The "GROUND FAULT ACTIVE" red light indicates the presence of a ground fault. Deflection on the voltmeter and ammeter on the Turbo Sleuth indicate the magnitude of the neutral to ground voltage and the ground fault current available.

5.6. The ground fault pickup level can be set from 5% to 100% of the Turbo Sleuth let through current. The time delay can be adjusted from 0.7s to 10 s. this allows the user to adjust the Turbo Sleuth settings to the unique requirements of his system in order to avoid nuisance tripping.

5.7. Both ground fault pickup level and time delay are adjusted using the knobs located on the front plate of the DGF-CT-A. (See Figure 5) The DGF-CT-A is located inside the Turbo Sleuth enclosure. Rotating the controls in the clockwise direction increases the time delay or pick up level; counter-clockwise reduces these parameters. (Note Figure 5 shows an equivalent relay)

5.8. IMPORTANT NOTE: Although the ground fault pickup level can be adjusted up to 100% of the let through current, this it is not recommended. Adjusting to a setting higher than 50% of the let through current may prevent the DGF-CT-A from detecting a fault.

6. Tracing

6.1. Connect the Turbo Sleuth as close to the source as possible. Ideally it should be connected at the neutral point of the Main power transformer. It is a good idea to install a dedicated receptacle at the system neutral for this purpose. If necessary the Turbo Sleuth can be connected at a feeder branch or downstream disconnect, however this will involve tracing back upstream with the TS-SENSOR probe, to identify the location of the fault, if for example the fault is on the main bus or transformer. If it is reasonably certain that the fault does not exist in the substation then the probe can be moved to the feeders directly to locate which one has the fault.

6.2. Turbo Sleuth can only pulse when tripped by an active ground fault. If ground fault current is present, pulses will be visible on the FAULT CURRENT ammeter.

6.3. To initiate pulsing, rotate the "PULSING" switch to the "ON" position. The "PULSING ACTIVE" light turns on and the ground fault current changes from 100% to75% and 50% of available ground fault current.

6.4. SAFETY NOTE: Tracing the ground fault signal involves working with live circuits. Additional care must be exercised whenever working in the proximity of live conductors.

6.5. Turbo Sleuth creates a pattern of step pulses in the ground fault current. The pulses only appear in the faulted circuit. Use the TS-SENSOR current sensor and voltmeter to follow the pulse trail directly to the fault site.

6.5.1. Check for the presence of pulses by viewing the panel ammeter pointer deflection. The pointer will cycle between 100%, 75% and 50% of the available ground fault current. (Plus any existing NGR current see 4.5 above) After confirming that the pulses are active, trace the source of the ground fault as follows: -

6.5.2. Attach the TS-SENSOR current sensor to a standard voltmeter as described in section 7.

6.5.3. Locate the pulsing ground fault current by wrapping the TS-SENSOR around the X0 or ground cable connection (or system voltage cable if using TS-ZZ) a pulse should be noticeable on the TS-SENSOR voltmeter. Familiarize yourself with the values of the pulses on the hand held meter. Use a single line diagram for the electrical distribution protected by the Turbo Sleuth. Identify the location of the Turbo Sleuth on the diagram.

6.5.4. Comparing readings of the front panel ammeter and the remote meter. Both meters should display the same step time pattern.

6.5.5. Check for the presence of pulses at the closest branch point. Place the current sensor around the 3 phase conductors of each outgoing circuit. If you see no pulses this is not the faulted circuit. Move on to the next circuit

6.5.6. If current pulses are found, move down the circuit to the next branch point and repeat the procedure.

6.5.7. Follow the pulses. The pulsing ground fault signal will lead to the equipment or to the section of conductor containing the ground fault

6.5.8. Isolate the equipment or conductor from the circuit. Check the Turbo Sleuth ammeter and voltmeter. If the voltage and current reads zero on these meters, the ground fault has been removed.

6.5.9. At this point the Turbo Sleuth may be reset. Rotate the “PULSING ACTIVE” switch to the “OFF” position and push the “RESET” button.

6.5.10. Repair or replace the equipment or conductor that was the source of the ground fault. The equipment or conductor may now be reconnected to the circuit.

6.5.11. Confirm that the ground fault has not returned by viewing the Turbo Sleuth front panel.

Figure 4 TS-SENSOR with typical meter

7. Operation of the TS-SENSOR probe

7.1. Turbo Sleuth comes complete with a TS-SENSOR current sensor loop. The TS-SENSOR loop is supplied with a dual banana to BNC adapter for easy connection to most standard meters. The TS-SENSOR will pick up and facilitate the display of the ground fault current pulses. Ideally an analog meter is preferred which has a pointer which is easily observed, but if a digital meter is used make sure it has an analog bar-graph display so that the pulse current can be seen clearly.

7.2. SAFETY NOTE: Read all safety and use information packaged with the TS-SENSOR before use.

7.3. Set the selector switch on the TS-SENSOR transducer to 10mV/A. The “POWER ON” light will flash on and off. A deflection of 0.25mV on the voltmeter with the transducer set to 10mV/A translates into a ground fault current of 2.5 Amps.

7.4. The TS-SENSOR requires a 9 Volt battery. Ensure that a fully charged battery is in place. The unit incorporates a flashing “Battery Low” light to indicate the battery is too low for correct measurement results.

7.5. Wrap the TS-SENSOR loop around all three phases conductors of the circuit. Any imbalance will be evident in meter deflection when the range is set to the appropriate setting. The ground fault current pulses will be visible in the meter deflection. Analog meters provide easier reading during rapid pulsing. The pulse rate may be programmed to facilitate easier readings on digital meters.

7.6. When placing the sensor around the three phase conductors make sure that the arrow moulded into the sensor loop points downstream (toward the load) in order to provide proper readings.

7.7. Ensure that the junction point of the loop is held a minimum of 1" away from the conductors in order to minimize interference.

7.8. Additional information on the TS-SENSOR is available on the TS-SENSOR data sheet and at the address located at the end of this manual.

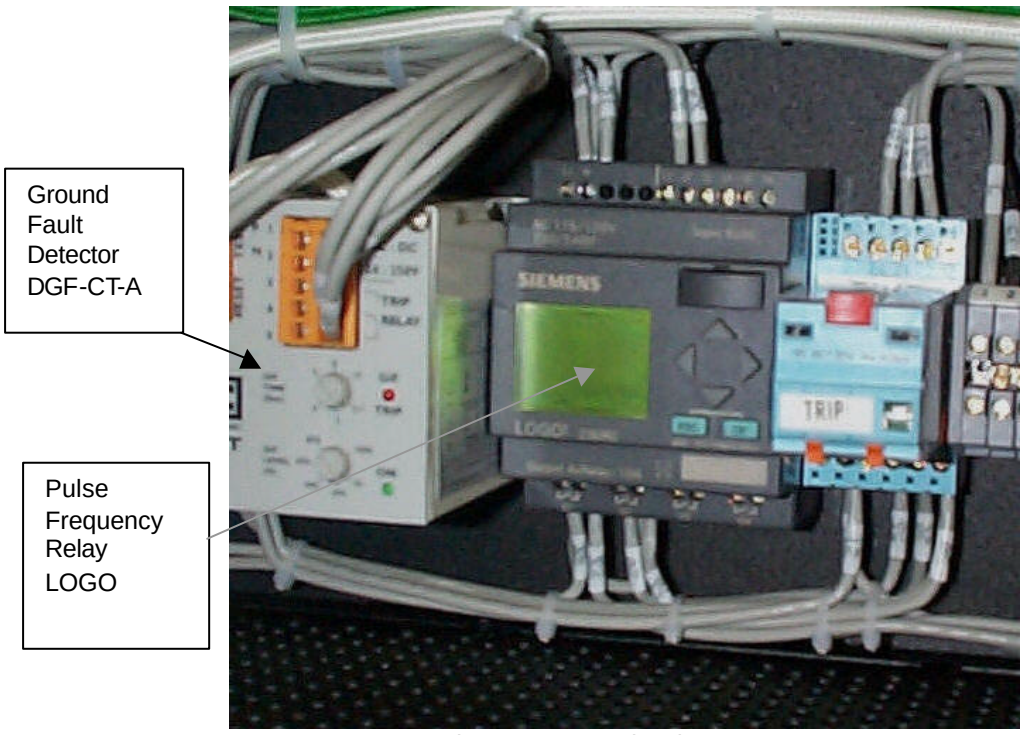

Figure 5 : Control Relays

8. Pulse Duration

8.1. Pulse time duration may be varied by programming the LOGO logic controller. This is located beside the DGF-CT-A. See Figure 5. On the front of the LOGO are four arrow shaped buttons and two square buttons labelled "ESC" and "OK". Modify the pulse time settings by following this procedure.

8.2. Simultaneously press both the “ESC” and “OK” buttons

8.3. The display shows two choices “SET CLOCK” and “SET PARAM”. Press the bottom arrow key to highlight “SET PARAM”.

8.4. Confirm your choice by pressing the “OK” button twice.

8.5. The display will now show a cursor between available pulse delay settings. Determine which direction you wish the cursor to move in order to set the parameters of your choice.

8.6. There are three steps in one pulsing cycle. The entire cycle will take six times the number you program in seconds. If you program .5, the cycle will consist of three steps each 1 second long for a total of 3 seconds.

8.7. Push the UP and DOWN arrow buttons to move the cursor. Continue to press the arrow buttons until you chosen parameter is reached.

8.8. Confirm your choice by pushing the “OK” key. The cursor disappears and Turbo Sleuth will pulse using the newly set time duration.

8.9. Leave the programming mode by pushing the “ESC” button twice. Turbo Sleuth will now return to normal operation.

Turbo Sleuth will now remember and use the newly set pulsing times. The settings are non-volatile and will be retained even when the control power is interrupted.

9. Dimensions

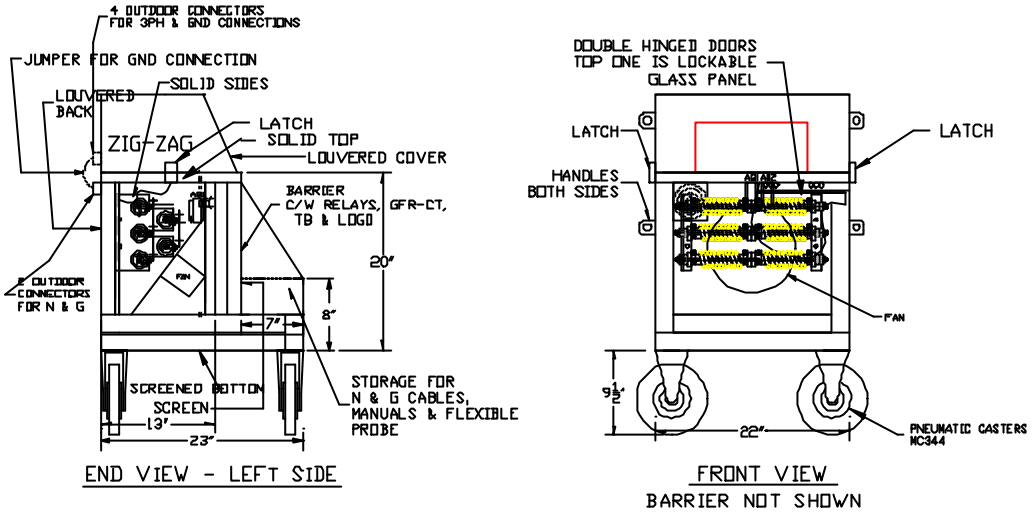

Figure 6 Turbo Sleuth Dimensions

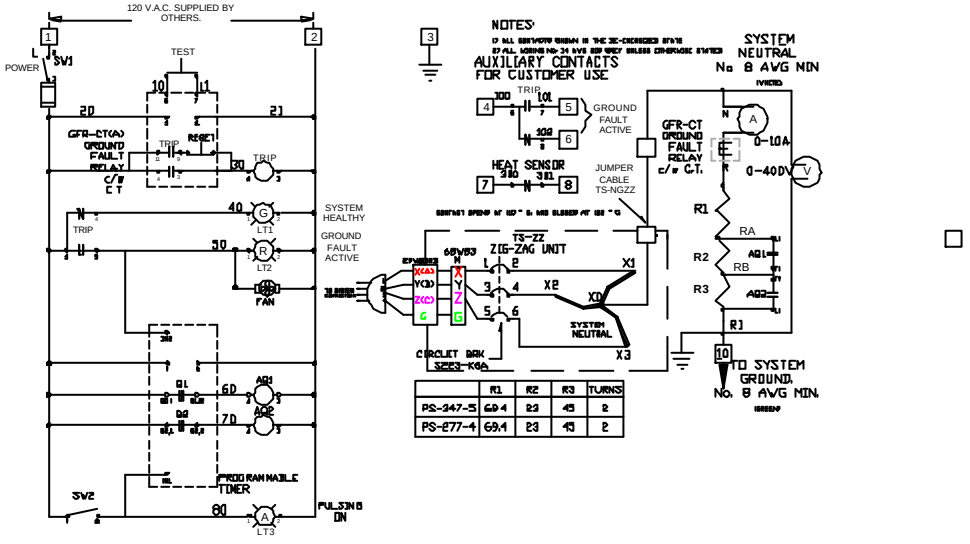

Figure 7. Turbo Sleuth Wiring Diagram

10. Maintenance

10.1. Testing

Turbo Sleuth is designed and constructed to reduce maintenance needs to a minimum. Test your Turbo Sleuth every time it is used.

Test Procedure:

10.1.1. Push the "TEST" button located on the front of the panel. The following changes take place.
10.1.2. The red "GROUND FAULT ACTIVE" light turns on.
10.1.3. The green "SYSTEM NORMAL" light turns off.
10.1.4. The internal fans turn on.
10.1.5. Auxiliary contacts change state.
10.1.6. This change confirms that your Turbo Sleuth is functioning normally. Return the Turbo Sleuth to normal operating mode by pushing the "RESET" button.

10.2. If a lamp fails to function, check the bulb with an ohmmeter and replace it if necessary.

10.3. If the fans fail to start, remove power and check the electrical connections.

10.4. If all power fails, check the internal fuse and replace it if necessary.

10.5. To clean the Turbo Sleuth, first disconnect the electrical power. Using compressed air, blow away any accumulated dust and foreign material. The exterior may be cleaned using a slightly damp cloth. Ensure that the Turbo Sleuth is completely dry before energizing. Close the front door and reconnect electrical power. Test the unit again before returning to normal service.

10.6. For your convenience, schematic and dimensional information are included for reference. See Figures 6 and 7.

11. Definitions and applicable Standards.

11.1. Grounding means a permanent and continuous conductive path to the earth with sufficient ampacity to carry any fault current liable to be imposed on it, and of a sufficiently low impedance to limit the voltage rise above ground and to facilitate the operation of protective devices in the circuit;

11.2. Bonding means a low impedance path obtained by permanently joining all non-current-carrying metal parts to assure electrical continuity and having the capacity to conduct safely any current likely to be imposed on it;

12. NEC 2002 pg. 70-87-88

12.1. High-Impedance Grounded Neutral Systems.

High-impedance grounded neutral systems in which a grounding impedance, usually a resistor, limits the ground-fault current to a low value shall be permitted for 3-phase ac systems of 480 volts to 1000 volts where all of the following conditions are met:-

12.1.1. The conditions of maintenance and supervision ensure that only qualified persons will service the installation.
12.1.2. Continuity of power is required.
12.1.3. Ground detectors are installed on the system.
12.1.4. Line-to neutral loads are not served.

12.2. **High-impedance grounded neutral systems** shall comply with provisions (a) through (f).

12.3. **Grounding Impedance Location.** The grounding impedance shall be installed between the grounding electrode conductor and the system neutral. Where a neutral is not available, the grounding impedance shall be installed between the grounding electrode conductor and the neutral derived from a grounding transformer.

12.4. **Neutral Conductor.** The neutral conductor from the neutral point of the transformer or generator to its connection point to the grounding impedance shall be fully insulated.

12.5. The neutral conductor shall have an ampacity of not less than the maximum current rating of the grounding impedance. In no case shall the neutral conductor be smaller than No. 8 copper or No. 6 aluminum or copper-clad aluminum.

12.6. **System Neutral Connection.** The system neutral connection shall not be connected to ground except through the grounding impedance.

12.7. **Neutral Conductor Routing.** The conductor connecting the neutral point of the transformer or generator to the grounding impedance shall be permitted to be installed in a separate raceway. It shall not be required to run this conductor with the phase conductors to the first system disconnecting means or overcurrent device.

12.8. **Equipment Bonding Jumper.** The Equipment bonding jumper (the connection between the equipment grounding conductors and the grounding impedance) shall be an unspliced conductor run from the first system disconnecting means or overcurrent device to the grounded side of the grounding impedance.

12.9. **Grounding Electrode Conductor Location.** The grounding electrode conductor shall be attached at any point from the grounded side of the grounding impedance to the equipment grounding connection at the service equipment or first system disconnecting means.

13. CSA Canadian Electrical Code Part 1, C22.1-2002

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10-1100 Scope.
Rules 10-1102 to 10-1108 apply to the use of neutral grounding devices used for the purpose of controlling the ground fault current or the voltage to ground of an alternating-current system.

10-1102 Use.
(1) Neutral grounding devices shall be permitted to be used only on a system involving a true neutral or an artificial neutral, where the line to neutral loads are not served.
(2) Where a neutral grounding device is used on an electrical system operating above 5 kV, provision shall be made to automatically de-energize the system on the detection of ground fault.
(3) Where a neutral grounding device is used on an electrical system operating at 5 kV or less, provision shall be made to automatically de-energize the system on the detection of ground fault, unless
  (a) The ground fault current is controlled at 5 A or less; and
  (b) A visual or audible alarm, or both, clearly identified to indicate the presence of a ground fault is provided.

10-1104 Neutral Grounding Devices.
(1) Neutral grounding devices shall be specifically approved for the application.
(2) Only neutral grounding devices with a continuous rating shall be permitted where provision is not made to de-energize the system on the detection of a ground fault.
(3) Neutral grounding devices not having a continuous rating shall be permitted where:
  (a) Provision is made to automatically de-energize the system on the detection of a ground fault; and
  (b) The time rating of the device is coordinated with the time/current rating of the protective device on the system.

(4) Neutral grounding devices shall have insulation voltages at least equal to the line-to-neutral voltage.

10-1106 Location of Neutral Grounding Devices and Warning Signs.

(1) All live parts of neutral grounding devices shall be enclosed or guarded in compliance with Rule 2-202.

(2) Neutral grounding devices shall be placed in a location that is accessible only to qualified persons to perform inspection, testing, and maintenance of the neutral grounding device.
(3) Neutral grounding devices shall be placed in a location so that heat dissipation from the device under ground fault conditions will not damage or adversely affect the operation of the device or other equipment.
(4) Where neutral grounding devices are used, warning signs indicating that the system is impedance grounded and the and the maximum voltage at which the neutral may be operating relative to ground shall be placed at the:
(a) Transformer or generator, or both; and
(b) Consumer's service switchgear or equivalent; and
(c) Supply authority's metering equipment.

10-1108 Conductors Used with Neutral Grounding Devices.

(1) The conductor connecting the neutral grounding device to the neutral point of the transformer, generator, or grounding transformer shall be:
(a) Insulated for the nominal system voltage; and
(b) Identified white or natural grey; and
(c) Sized to conduct the rated current of the neutral grounding device, and in no case less than No. 8 AWG; and
(d) Installed in accordance with other appropriate Rules of this Code.

(2) The conductor connecting the neutral grounding device to the neutral point of the transformer, generator, or grounding transformer shall not be grounded.
(3) The conductor connecting the neutral grounding device to the system grounding electrode shall be:
(a) A copper conductor which shall be permitted to be insulated or bare; and
(b) Identified green if insulated; and
(c) Sized to conduct the rated current of the neutral grounding device, and in no case less than No. 8 AWG in size; and
(d) Installed in accordance with other appropriate Rules in this Code.

CAN/CSA M421-93 Use of Electricity in Mines

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4.5.2 Neutral-grounding Devices
The neutral grounding device shall be continuously monitored by a device that will trip the supply if an open circuit in the neutral grounding device occurs.

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4.7.3.4.1 Resistance Grounding
Where on-board three-phase, isolation power transformers larger than 20 kVA and operating at voltages in excess of 300 V are used, the following requirements shall apply:
(a) Except as permitted by item (g), either a direct or derived neutral shall be grounded through a resistor at the power source to limit the prospective ground-fault current to 25 A or less.
(b) A grounding circuit shall originate at the grounded side of the resistor and extend along with the power conductors to ground the frames of all electrical apparatus supplied from the circuit, except where the steel structure provides the ground-return path as permitted by clause 4.7.5 (b).
(c) The size of the grounding conductors may be reduced provided the ampacity exceeds the prospective ground-fault current.

(d) Neutral-grounding resistors shall be isolated by elevation or guarded in accordance with Clause 4.7.4.1.
(e) Neutral-grounding resistors shall be rated and protected in accordance with Clause 3.6.2.
(f) Ground-fault protection with a minimum tripping ratio of 5 shall be provided, except as permitted by items (g) and (h).
(g) Acceptable ungrounded systems with ground-fault detection may be used for specialized drive circuits.
(h) Ground-fault detection, which alerts the operator to the ground fault, may be used instead of ground-fault protection where de-energizing a circuit can create a machine-operation hazard.

ADDITIONAL INFORMATION

If you require more information or experience problems with your equipment that persist after taking the steps identified in this manual, contact IPC Resistors Customer Service at the number below.

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