01.4IB.60100B
Ground-Gard® High Resistance Grounding Assembly

For Power Systems from 240V to 4160V
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Signal Words

As stated in ANSI Z535.4-2007, the signal word is a word that calls attention to the safety sign and designates a degree or level of hazard seriousness. The signal words for product safety signs are “Danger”, “Warning”, “Caution” and “Notice”. These words are defined as:

- **DANGER** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

- **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

- **CAUTION**, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

- **CAUTION**, used without the safety alert symbol, is used to address practices not related to personal injury.

- **NOTICE** is used to address practices not related to personal injury.

Qualified Person

For the purposes of this manual, a qualified person, as stated in NFPA 70E®, is one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. In addition to the above qualifications, one must also be:

1. trained and authorized to energize, deenergize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
2. trained in the proper care and use of personal protective equipment (PPE) such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
3. trained in rendering first aid if necessary.
Contents

Ch 1 General Information ........................................................................................................ 1
  A. Scope ............................................................................................................................. 2
  B. Purpose .......................................................................................................................... 2
  C. Instruction Bulletins Available Electronically ............................................................... 2

Ch 2 Safety ............................................................................................................................ 3
  A. Safe Work Condition ...................................................................................................... 3
  B. Safety Guidelines .......................................................................................................... 3
  C. General .......................................................................................................................... 4
  D. Specific .......................................................................................................................... 4
  E. Safety Labels .................................................................................................................. 4

Ch 3 Equipment Description ................................................................................................ 5
  A. General .......................................................................................................................... 5
  B. Enclosures ..................................................................................................................... 5
  C. Functional Description .................................................................................................. 6

Ch 4 Installation ..................................................................................................................... 7
  A. General .......................................................................................................................... 7
  B. Receiving ....................................................................................................................... 7
  C. Storage .......................................................................................................................... 7
  D. Handling ......................................................................................................................... 7
  E. Positioning of Enclosure ................................................................................................. 11
  F. Preparation of Floor Anchoring ..................................................................................... 11
    1) Indoor Assembly ........................................................................................................... 11
    2) Outdoor Assembly ....................................................................................................... 14
  G. Grounding ..................................................................................................................... 15
  H. Cleaning Bus Insulation ............................................................................................... 15
  I. Primary Cables ............................................................................................................... 15
  J. Control Cables ................................................................................................................. 16
  K. Adjustments .................................................................................................................... 17
  L. Placing the Ground-Gard® into Service ......................................................................... 17

Ch 5 Operation ....................................................................................................................... 18
  A. Detecting and Locating a Ground Fault ......................................................................... 18
  B. Undervoltage Alarm ...................................................................................................... 18
  C. Operational Testing ....................................................................................................... 18
Contents

Ch 6  Testing for System Capacitive Charging Current ................................................... 19
   A. GENERAL.......................................................................................................................................................... 19
   B. TEST EQUIPMENT ........................................................................................................................................... 19
   C. TEST PROCEDURE ......................................................................................................................................... 19

Ch 7  Maintenance ........................................................................................................... 23
   A. GENERAL.......................................................................................................................................................... 23
   B. PERIODIC MAINTENANCE .............................................................................................................................. 23

Ch 8  Recommended Renewal Parts and Replacement Procedures ............................... 25
   A. ORDERING INSTRUCTIONS .......................................................................................................................... 25
Figures

Figure 1 Typical Free Standing Low Voltage Ground-Gard®, Series P-60048 .............. 8
Figure 2 Typical Wall Mounted Low Voltage Ground-Gard® Control Enclosure .......... 9
Figure 3 Typical Wall Mounted Low Voltage Ground-Gard® Resistor Enclosure ........ 9
Figure 4 Typical Free Standing Medium Voltage Ground-Gard®, Series P-60416 ....... 10
Figure 5 Typical Elementary Diagram of 480V, Wye-Connected Ground-Gard® ....... 12
Figure 6 Typical Elementary Diagram of 480V, Delta-Connected Ground-Gard® .... 12
Figure 7 Typical Elementary Diagram of Medium Voltage, Wye-Connected Ground-Gard® ..................................................................................................... 13
Figure 8 Typical Elementary Diagram of Medium Voltage, Delta-Connected Ground-Gard® .................................................................................................. 13
Figure 9 Recommended Anchoring Method for Outdoor Enclosure ......................... 14
Figure 10 Resistor Connections for 480V Ground-Gard® ............................................. 16
Figure 11 Test Connections for Measuring System Capacitive Charging Current for 480V, Wye-Connected Ground-Gard® ......................................................... 21
Figure 12 Test Connections for Measuring System Capacitive Charging Current for 480V, Delta-Connected Ground-Gard® ......................................................... 21
Figure 13 Test Connections for Measuring System Capacitive Charging Current Medium Voltage, Wye-Connected Ground-Gard® .................................................. 22
Figure 14 Test Connections for Measuring System Capacitive Charging Current Medium Voltage, Delta-Connected Ground-Gard® .................................................. 22

Tables

Table A Capacitive Charging Current Variables ................................................................................................................................. 20
Table B Secondary Resistance Values ..................................................................................................................................................... 20
Ch 1  General Information

⚠️ WARNING

The equipment described in this document may contain high voltages and currents which can cause death or serious injury.

The equipment is designed for use, installation, and maintenance by knowledgeable users of such equipment having experience and training in the field of high voltage electricity. This document and all other documentation shall be fully read, understood, and all warnings and cautions shall be abided by. If there are any discrepancies or questions, the user shall contact Powell immediately at 1.800.480.7273.

⚠️ WARNING

Prior to adjustments, servicing, maintenance, or any act requiring the operator to make physical contact with the equipment, the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.

NOTICE

The information in this instruction bulletin is not intended to explain all details or variations of the Powell equipment, nor to provide for every possible contingency or hazard to be met in connection with installation, testing, operation, and maintenance of the equipment. For additional information and instructions for particular problems, which are not presented sufficiently for the user’s purposes, contact Powell at 1.800.480.7273.

NOTICE

Powell reserves the right to discontinue and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.
A. Scope

The information in this instruction bulletin describes the following Ground-Gard® High Resistance Grounding Assemblies (HRG).

B. Purpose

The information in this instruction bulletin is intended to provide information required to properly operate and maintain the Ground-Gard high resistance grounding assembly described in Ch 1 General Information, A. Scope.

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the Ground-Gard High Resistance Grounding Assembly
3. Instructions for installation and placing the grounding assembly into service
4. Instructions for part replacement
5. Information for ordering renewal parts
6. Illustrations, photographs, and description of the grounding assembly

The illustrations contained in this document may not represent the exact construction details of each particular type of high resistance grounding (HRG) assembly. The illustrations in this document are provided as general information to aid in showing component locations only.

All illustrations and photos are shown using deenergized equipment.

WARNING

Follow the appropriate safety precautions while handling any of the equipment. Failure to do so may result in death or serious injury.

To the extent required, the products described herein meet the applicable ANSI, IEEE, and NEMA Standards; however, no such assurance is given with respect to local codes and ordinances which may vary greatly.

C. Instruction Bulletins Available Electronically

Changes to the instruction bulletin may be implemented at any time and without notice. Go to powellind.com to ensure use of the current instruction bulletin for Powell equipment.

For more information visit powellind.com.
To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, or email info@powellservice.com.

For specific questions or comments pertaining to this instruction bulletin email documents@powellind.com with the IB number in the subject line.


**Ch 2  Safety**

**A. SAFE WORK CONDITION**

The information in Section A is quoted from NFPA 70E 2012 - Article 120, 120.1 Establishing an Electrically Safe Work Condition.

120.1 Process of Achieving an Electrically Safe Work Condition

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

2. After properly interrupting the load current, OPEN the disconnecting device(s) for each source.

3. Wherever possible, visually verify that all blades of the disconnecting devices are fully OPEN or that drawout type circuit breakers are withdrawn to the fully disconnected position.

4. Apply lockout/tagout devices in accordance with a documented and established policy.

5. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. Test each phase conductor or circuit part both phase-to-phase, and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.

Informational Note: See ANSI/ISA-61010-1 (82.02.01)/UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements, for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 V and below.

6. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

**B. SAFETY GUIDELINES**

Study this instruction bulletin and all other associated documentation before uncrating the high resistance grounding assembly (HRG).

Each user has the responsibility to instruct and supervise all personnel associated with usage, installation, operation, and maintenance of this equipment on all safety procedures.

Furthermore, each user has the responsibility of establishing a safety program for each type of equipment encountered.

The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to PowlVac® ARG 63kA vacuum circuit breakers.

**C. GENERAL**

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of high resistance grounding assembly shall be allowed to work on this equipment. It is mandatory that the appropriate instruction bulletins, supplements, and service advisories be studied, understood, and followed.
2. Maintenance programs must be consistent with both customer experience and manufacturer’s recommendations, including service advisories and instruction bulletin(s). A well planned and executed routine maintenance program is essential for circuit breaker’s reliability and safety.

3. Service conditions and circuit breaker applications shall also be considered in the development of safety programs. Variables include ambient temperature; humidity; actual continuous current; thermal cycling; number of operations; interrupting duty; and any adverse local conditions including excessive dust, ash, corrosive atmosphere, vermin and insect infestations.

E. **Safety Labels**

The equipment described in this document has **DANGER**, **WARNING**, **CAUTION**, and instruction labels attached to various locations. All equipment **DANGER**, **WARNING**, **CAUTION**, and instruction labels shall be observed when the circuit breaker is handled, operated, or maintained.

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**NOTICE**

*Warning and Caution labels are located in various places. Do not remove or deface any of these warning/caution labels.*

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D. **Specific**

1. **DO NOT WORK ON AN ENERGIZED HRG.**

2. **DO NOT WORK ON AN HRG WITH THE CONTROL CIRCUIT ENERGIZED.**

3. **ALL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE HRG.**

4. Interlocks may be provided to ensure the proper operating sequences of the HRG and for the safety of the user. If for any reason an interlock does not function as described, do not make any adjustments, modification, or deform the parts. **DO NOT FORCE THE PARTS INTO POSITION. CONTACT POWELL FOR INSTRUCTIONS.**
A. General

Ground-Gard® high resistance grounding assembly provides a high resistance grounded neutral system, gives an immediate alarm when the first ground fault occurs and provides a simple method for locating the fault quickly. This assembly is designed for use on low voltage and medium voltage electrical power systems with phase-to-phase voltages of 4160V or less.

The information in this instruction bulletin is generally applicable to all Ground-Gard high resistance grounding assembly. Each assembly, however, is designed for its particular application. Detailed drawings are provided for each assembly. This instruction bulletin is a supplement to these drawings, and the drawings for a particular assembly take precedence over this instruction bulletin.

Ground-Gard high resistance grounding assembly consists of a group of devices coordinated and connected to provide a high resistance ground for a power system. The major components of the system are:

- A bank of three grounding transformers (for delta-connected power systems only)
- A single grounding transformer (for wye-connected medium voltage power systems only)
- A grounding resistor
- A disconnecting device to disconnect the Ground-Gard from the power system
- Metering and control devices to detect and alarm a ground fault condition
- A pulsing system to aid in the location of ground faults
- An enclosure, or inclosures, for these items

B. Enclosures

Ground-Gard assembly is packaged in many kinds of enclosures. A typical free-standing enclosure for low voltage (≤600V) assembly is shown in Figure 1. An alternate design for low voltage assemblies consists of a wall mounted control enclosure and a separate resistor enclosure, which can be mounted on top of the control cabinet or in a separate location (Figure 2). A typical free standing enclosure for a medium voltage assembly is shown in Figure 4.

Frequently, when Ground-Gard is furnished as part of a substation or other larger switchgear assemblies, the components of the Ground-Gard system are built into the larger assembly. In such cases, the electrical and physical drawings for the Ground-Gard system are incorporated into the drawings for the larger assemblies.
C. Functional Description

Refer to the Elementary Diagram supplied with the assembly. Typical elementary diagrams for various systems are also shown in Figures 5-8. During normal conditions, with no ground fault on the power systems, no current flows through the resistor. If the Ground-Gard assembly is connected to the system and control power is present, a green “NORMAL” lamp on the panel will be illuminated and the undervoltage alarm relay (UV) will be engaged.

When a ground fault occurs, the impedance of the resistor limits the ground current. The voltage appearing across the grounding resistor will be sensed by the meter relay (MR). After a 5 second time delay to prevent unnecessary operation on system transients, this relay closes its contact to energize the hand reset relay (HR) and the red “GROUND FAULT” light illuminates. The hand reset relay seals the circuit in, deenergizing the green “NORMAL” light. A normally open and a normally closed contact of the hand reset relay are available to the user for use in an alarm circuit.

To locate the ground fault, turn the selector switch to the “PULSE” position. This energizes the pulsing control relay (PCR), which initiates the pulsing, alternately energizing and deenergizing a pulsing contactor (PC). The contact of the pulsing contactor shorts out part of the secondary resistor, producing a rhythmic fluctuation in the magnitude of the ground current at a rate of approximately 40 pulses per minute.

The current transformer and ammeter on the panel will allow the operator to determine the current fluctuation on the system. Using the portable hook on ammeter, trace the fluctuation of the ground current through the system to the point of fault by clamping around the cable or conduit. Rhythmic fluctuations on the scale indicate the faulted circuit. Pulsing will disappear when the location of the ground fault is reached. Once the ground fault is located, the selector switch should be returned to the “NORMAL” position, deenergizing the pulsing circuit. When the ground fault has been removed from the power system, press the “RESET” push button to return the system to its normal operating condition.

Pressing the “TEST” button tests the control circuits and allows a test of the pulsing circuit. It does not test the operation of the meter relay. For low voltage Ground-Gard assemblies, an optional test circuit which applies a test ground to one phase of the power system through a current limiting resistor is available.

Disconnecting the Ground-Gard assembly from the power system, or failure of the external control power source (if one is used), will deenergize both the “NORMAL” light and undervoltage alarm relay. A normally open and a normally closed contact of the undervoltage relay are available to the user for use in an alarm circuit.
Ch 4 Installation

A. GENERAL

This section contains information on receiving, handling, positioning, power cable termination, grounding, and check to make the assembly ready for operation.

If the components of a Ground-Gard® assembly are built into another, larger switchgear assembly, follow the installation instructions furnished with that assembly.

B. RECEIVING

Free standing Ground-Gard assembly are fabricated in rigid, floor mounted self supporting steel sections. Indoor assemblies are enclosed in a covering to protect them from the weather. Sections are shipped in an upright position and when received should be kept upright. Smaller, wall mounted assemblies may be shipped and stored in any convenient position.

When the grounding assembly is received check for any sign of damage. If damage is found or suspected, file all claims immediately with the transportation company and notify the nearest Powell representative.

C. STORAGE

If it is necessary to store the assembly for any length of time, the following precautions should be taken to prevent corrosion:

- Uncrate equipment and check shipment for condition and completeness.
- Store in a clean, dry (maximum 50% humidity) place with a moderate temperature (15°C/59°F) and cover with a suitable canvas to prevent deposit of dirt or other foreign substances upon movable parts and electrical contact surfaces.
- If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 150 to 200 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside units before energizing any heaters.
- Indoor equipment should not be stored outdoors, even if completely covered with tarpaulin or plastic sheet.

D. HANDLING

It is always preferable to handle free standing Ground-Gard assemblies with overhead cranes, by lifting points provided.

For outdoor enclosures, lifting channels are provided at the base of the assembly, and spreaders should be used in the slings above the enclosure to prevent damage to the top edges. Do not attempt to lift the assembly by using the angles installed on the sides, as these angles are provided only to tie the assembly down during shipment to ensure that it will not tip if top heavy, and are not intended to be used for lifting purposes. Slings should be tied to referenced angles to prevent tipping.

The use of fork lift trucks is not recommended, since the forks may damage the enclosure or interior parts of the assembly. If no other method of handling is available, the forks must go under the base bottom to avoid damage to the assembly.
Figure 1  Typical Free Standing Low Voltage Ground-Gard®, Series P-60048
Figure 2  Typical Wall Mounted Low Voltage Ground-Gard® Control Enclosure

Figure 3  Typical Wall Mounted Low Voltage Ground-Gard® Resistor Enclosure
Figure 4  Typical Free Standing Medium Voltage Ground-Gard®, Series P-60416

SPACE AVAILABLE FOR CABLES ABOVE & BELOW

BOLTED REMOVABLE COVER

2" MIN CLEARANCE TO REAR WALL

BASE PLAN
E. **Positioning of Enclosure**

Before any installation work is done, consult and study all drawings furnished by Powell for the particular order. These drawings include arrangement drawings, wiring and schematic diagrams, and a bill of material.

Mats, screens, railings, etc., which are external to the assembly, but which may be required to meet any local codes, must be furnished by the purchaser.

The recommended aisle space required at the front and the rear of the assembly is shown on the floor plan drawing furnished for the particular order.

F. **Preparation of Floor Anchoring**

1) **Indoor Assembly**

The station floor must be strong enough to prevent sagging due to the weight of the assembly.

Suitable means must be provided by the purchaser for anchoring the assembly to the floor. It is essential that the floor be level to avoid distortion of the assembly structure, and that the assembly be completely aligned prior to final anchoring.

Floor channels are not required for installation on a well prepared, level floor. If the floor is very irregular, installing floor channels may be the preferred way of obtaining a level surface for installing the assembly. Floor channels, when used, must be level and straight with respect to each other. Steel shims should be used for final leveling of the assembly floor channels if necessary.

When installing this assembly on existing floors, it will usually be desirable to pour a new finish floor with embedded channels, or to cut slots in the floor for embedding and leveling the support channels.

If floor channels are used, the recommended practice is to weld the assembly structure to the floor channels, using a tack weld at points along the assembly base channel. After welding, any damaged paint should be removed, and the weld and surrounding metal painted to deter corrosion. If welding facilities are not available, the gear should be bolted to the floor channels. If floor channels are not used, the gear should be bolted directly to the floor.

Provisions should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular order. If desired, the conduits may be installed before the assembly. Positioning rollers, if used, should be high enough to allow the assembly to pass over the conduits which might be required for future connections.
Figure 5  Typical Elementary Diagram of 480V, Wye-Connected Ground-Gard®

Figure 6  Typical Elementary Diagram of 480V, Delta-Connected Ground-Gard®
**Figure 7**  Typical Elementary Diagram of Medium Voltage, Wye-Connected Ground-Gard®

TO 2400V OR 4160V SYSTEM NEUTRAL

GROUNDING TRANSFORMER
2400V - 120/240V

GROUND RESISTOR

120VAC BY OTHERS

**Figure 8**  Typical Elementary Diagram of Medium Voltage, Delta-Connected Ground-Gard®

TO 2400V OR 4160V SYSTEM BUS

GROUNDING TRANSFORMERS
2400V - 120/240V

GROUND RESISTOR
2) **Outdoor Assembly**

Outdoor assemblies are provided with a channel base, usually 6” high. The assembly may be installed on a flat concrete pad or on piers.

The foundation must be level in order to prevent distortion of the assembly. Poor outdoor foundation leveling may be corrected by inserting shims at the points where the integral base frame is fastened to the concrete foundation. Level foundations are desirable since they automatically produce true, level, and plumb assembly installations. However, Ground-Gard® assemblies will operate satisfactorily on a true and flat foundation which has a uniform slope of no more than 1/8” in three feet. When installing assembly housing on a foundation with a uniform slope, the floor of the housings should be parallel to the foundation and the vertical center line of the housings should be perpendicular to the floor instead of level and plumb.

For pad mounted assemblies, power and control conduits should be installed prior to placement of the gear. For pier mounted assemblies, the conduits may be installed either before or after the assembly is placed.

![Recommended Anchoring Method for Outdoor Enclosure](image-url)

The recommended method of anchoring outdoor assemblies is shown in Figure 8. An alternate method is to tack weld the channel base to leveling steel embedded in the concrete. It is not recommended that users attempt to embed anchor bolts in the concrete to penetrate pre-drilled holes in the channel base, as the accuracy required for this method is very difficult to achieve under field conditions.
G. Grounding

The enclosure must be grounded before making any power connections. A ground bus is furnished with a lug for connection to the grounding system.

Ground bus connections are made in the lower portion of the primary enclosure. The assembly ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the assembly ground bus.

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CAUTION

It is very important that the assembly be adequately grounded to protect the operator from injury when ground faults or other abnormal occurrences take place and to ensure that all parts of the assembly, other than live parts, are at ground potential.

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H. Cleaning Bus Insulation

Main bus bars are insulated with a high temperature thermoplastic material having excellent dielectric and mechanical properties. When cleaning is necessary, only denatured alcohol or isopropyl alcohol should be used to remove any foreign materials from the insulation surface.

Do not use carbon tetrachloride. Use only OSHA approved solvents. Avoid prolonged exposure to solvent vapors. Use solvents in a well ventilated area.

I. Primary Cables

The location of the primary cable termination point in Ground-Gard® assemblies is indicated on the drawings furnished with the assembly. If conduit or armored cable is used for cables entering from above, the conduit or armor should be terminated at the top cover of the enclosure.

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the assembly connections. This is necessary to ensure that the phase rotation is the same when interconnecting two different sources of power. For Ground-Gard assemblies used on wye-connected power systems with the neutral point available, the primary cable brought to the Ground-Gard assembly will be connected to this system neutral point. This connection must be considered as a primary circuit, since it will have full phase-to-neutral voltage impressed on it during a solid ground fault on the power system.

Compression terminals are normally used for cable terminations in Ground-Gard assemblies. Insulation of the connection point is not normally required in this class of assembly.
Cable shields, assembly bonding wires, and other ground leads associated with primary cables should be connected to the assembly ground bus.

In all cases, carefully follow the cable manufacturer’s recommendations for installation of the type of cable being used.

J. Control Cables

When control conduits enter the unit from below, the conduit should not extend more than 1” above the floor. The control cables may be pulled through the conduits before or after the assembly is installed, whichever is more convenient.

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the specific job.

If the control conduits enter from above, drill the top cover of the secondary enclosure to sit the conduits, being careful not to damage existing wire bundles. Fasten the conduits to the cover with lock nuts.

When an external control power source is used, the cables from the control power source to the assembly should be large enough to avoid excessive voltage drop when the assembly is operated.

Ground-Gard® assemblies are provided with alarm contacts to indicate the presence of a ground fault, the loss of control power or the loss of connection to the power system. Although indicating lamps on the Ground-Gard assembly give a visual indication of these conditions, it is recommended that the alarm contacts be connected to the power system’s alarm and annunciation system to ensure that abnormal operating conditions are noted promptly by the power system operator.
K. Adjustments

Adjust the resistor at installation so that the ground current with a solid ground fault is equal to or greater than the system capacitive charging current. An exact setting is not critical. The setting may be any value up to twice the system capacitive charging current, or the minimum setting of the Ground-Gard assembly, whichever is greater. A method for measuring the capacitive charging current is described in Ch 6 Testing for System Capacitive Charging Current, C. Test Procedure. Refer to the table on the elementary diagram for the proper resistor jumper connection. Refer to Figure 10 for typical connections for resistors used in 480V Ground-Gard assemblies.

The assembly is normally supplied connected for systems with minimum charging current. When reconnecting the resistor for higher charging currents, never place a jumper where it will completely short out the resistor when the pulsing contactor contact is closed. This connection would convert the power system into a solidly grounded system while in the pulsing mode, possibly resulting in very high ground fault currents and severe damage to both the Ground-Gard assembly and other parts of the power system.

Set the meter relay such that the pointer is at about 15% of the voltage that will be measured for a solid ground fault on the power system. This will be about 40V for a 480V power system, 21V for a 2400V system, and 36V for a 4160V system. With this setting, the Ground-Gard system will indicate any ground fault with a resistance of up to several hundred ohms, depending on the setting of the resistor.

L. Placing the Ground-Gard® into Service

Close the disconnect switch on the front panel of the Ground-Gard® assembly. On a medium voltage assembly, also close the fuse tiltout tray. These actions will connect the Ground-Gard assembly to the power system. If the particular assembly is designed to use an external control power source, the Ground-Gard assembly will also be connected to the control power source.

With a 120V, 60HZ control power source available, turn the selector switch to the “NORMAL” position and leave it there. The green “NORMAL” indicating light should be lit, and the undervoltage relay energized to give remote indication (if used) that control power is on and panel is operating correctly.
### Ch 5 Operation

**A. Detecting and Locating a Ground Fault**

Should a ground fault occur, the red “GROUND FAULT” indicating lamp will be lit and the green “NORMAL” lamp will go out. The hand reset relay will be energized, and if contacts of this relay have been connected to a remote alarm circuit, that alarm will also be energized. The ammeter will read the ground fault current, and the meter relay will show the voltage across the resistor generated by the fault current.

After a ground fault has been detected, turn the selector switch to the “PULSE” position and trace the pulsing ground current with the portable detector (Cat. #176A2823P1- not supplied unless ordered separately). This detector will show the pulses of ground fault current in the cable or conduit around which it is clamped until the location of the ground fault is reached. At that point, the pulses will disappear.

Some models of low voltage Ground-Gard® assemblies are supplied with a portable pulsing device, rather than having a pulsing circuit in each Ground-Gard assembly. The portable pulsing device is mounted in a small metal box with a carrying handle, and is equipped with a multi-conductor cord and plug assembly to connect it to a receptacle in the front panel of the Ground-Gard assembly. If this model of Ground-Gard assembly is in use, the portable pulsing device must be plugged into the Ground-Gard assembly before starting the pulsing and fault tracing process.

When the ground fault has been located and removed from the power system, return the selector switch to the “NORMAL” position. Press the “RESET” button to remove fault indication. This returns the system to normal, the green light will be on, and the remote alarm off.

**B. Undervoltage Alarm**

If the control power source is interrupted, or if the Ground-Gard assembly is disconnected from the power system, both the green indicating lamp and undervoltage relay will be deenergized. In this condition, neither indicating lamp on the Ground-Gard assembly will be lit, and the remote undervoltage alarm, if used, will be activated. Since the Ground-Gard assembly has been effectively removed from service, the cause of this alarm should be located and corrected and the assembly returned to service.

**C. Operational Testing**

Each Ground-Gard assembly is furnished with a “TEST” push button on the front panel. For most Ground-Gard assemblies, pressing this button will simulate operation of the meter relay, and will check the operation of the indicating lamps and the hand reset relay. If the selector switch is turned to “PULSE”, the pulsing circuit may also be checked. When the test is complete, the selector switch must be returned to the “NORMAL” position and the “RESET” button must be pressed to return the Ground-Gard assembly to normal operation.

Some low voltage Ground-Gard assemblies are furnished with an optional test circuit which actually places a ground fault on one phase of the power system. A resistor is placed in series with the “TEST” push button to limit the ground fault current even further than it is limited by the normal resistor in the Ground-Gard assembly. This optional test circuit provides facilities for testing the entire Ground-Gard assembly, including the voltmeter relay and the ammeter circuit.
Ch 6  Testing for System Capacitive Charging Current

A. General

If the design of a power system and the rating of all its components are known, the system capacitive charging current may be estimated with reasonable accuracy. However, Powell recommends that each system on which Ground-Gard® is installed be tested for the actual capacitive charging current before setting the grounding resistor. A procedure for this testing follows.

Figures 11 through 14 show the test connections for low voltage wye-connected, low voltage delta-connected, medium voltage wye-connected, and medium voltage delta-connected systems, respectively. The circled numbers in these figures correspond to the numbered steps in the following procedure. Although very similar, the procedure differs slightly for different models of Ground-Gard. The differences are detailed in each step.

B. Test Equipment

To test for system capacitive charging current, the following test apparatus is needed:

1. An ungrounded 120V, 60Hz power source. If only a grounded power source is available, a 1:1 isolating transformer is needed to isolate the power source from ground.
2. A variable voltage autotransformer, rated 0-120V, 20 amps minimum, with supply fuses and switch.
3. An AC voltmeter rated 0-150V.
4. An AC ammeter rated 0-0.5 amp or 0-1 amp.
5. A current limiting fuse, rated 6 amps, 600V for low voltage Ground-Gard assembly or 5 amps, 5000V for medium voltage Ground-Gard assembly.
6. For medium voltage delta-connected Ground-Gard assembly only, a 2400-120/240V isolation transformer, 1kVA or greater.

C. Test Procedure

![WARNING]

Testing for capacitive charging current requires that the entire system be energized. Take great care while making this test. Follow all the applicable safety codes and practices. Failure to do so may result in death or serious injury.

To perform the capacitive charge procedure follow these steps.

1. Deenergize the Ground-Gard assembly by opening the main neutral disconnect, the control power disconnect (if present), and all other sources of power. Be sure no other ground is connected to system.
2. Disconnect or open circuit secondary resistor during test. For medium voltage delta-connected Ground-Gard assemblies only, short circuit the open corner of the delta-connected secondary windings of the grounding transformers. Insert the current limiting fuse in the neutral circuit.
3. Connect the sensitive (0.5 amp or 1 amp full scale) ammeter in place of the 10 amp panel ammeter during the test. For medium voltage delta-connected Ground-Gard® assembly only, connect the 2400-120/240V isolation transformer in the neutral lead as shown in Figure 14. For low voltage assembly, connect the 0-150V voltmeter in the neutral circuit as shown in Figure 11 or 12. For medium voltage assembly, connect the 1-150V voltmeter across the secondary of the neutral transformer as shown in Figure 13 or 14.
4. Connect the variable voltage autotransformer in parallel with the voltmeter. Energize this circuit with the variable voltage transformer, initially set at zero voltage. Energize the variable voltage autotransformer from an ungrounded 120V, 60Hz source.

5. Reenergize the Ground-Gard® assembly by closing the main neutral disconnect.

6. With maximum operating load equipment connected on the power system, gradually increase the output voltage of the autotransformer from 0-50V maximum, recording neutral displacement voltage and current at selected test points. Plot various test values to verify that linear relationship of current to voltage is being attained as system neutral is gradually displaced from ground potential.

7. Once this linear relationship is verified, reduce the output voltage of the autotransformer to zero, disconnect the Ground-Gard assembly from the power system, remove all test equipment, and reconnect the Ground-Gard assembly in its original configuration.

8. Calculate system capacitive charging current, \( I_c \), at rated voltage by extrapolation as follows:

\[
I_c = \frac{E}{\sqrt{3}} \times \frac{I_a}{N} = \text{Amps system charging current}
\]

**Note:** Refer to Table A for definition of terms in formula above.

9. With the Ground-Gard assembly disconnected from the power system, set the resistor to produce proper value of steady ground current during first ground fault. This current should be equal to or slightly greater than \( I_c \), as calculated above. Proper values of secondary resistance for typical systems are as follows:

**Table B Secondary Resistance Values**

<table>
<thead>
<tr>
<th>Rating (Volts)</th>
<th>Wye-Connected</th>
<th>Delta-Connected</th>
</tr>
</thead>
<tbody>
<tr>
<td>480V</td>
<td>( \leq 277/I_c )</td>
<td>( \leq 277/I_c )</td>
</tr>
<tr>
<td>2400V</td>
<td>( \leq 13.85/I_c )</td>
<td>( \leq 31.2/I_c )</td>
</tr>
<tr>
<td>4160V</td>
<td>( \leq 24/I_c )</td>
<td>( \leq 18/I_c )</td>
</tr>
</tbody>
</table>

For low voltage assemblies, several recommended combinations of ground fault current and pulsing current are shown in Figure 10. For medium voltage assemblies, set pulsing current 2 or 3 amps more than steady current.

10. Reconnect Ground-Gard assembly to the power system.
**Figure 11** Test Connections for Measuring System Capacitive Charging Current for 480V, Wye-Connected Ground-Gard®

![Diagram](image1)

**Figure 12** Test Connections for Measuring System Capacitive Charging Current for 480V, Delta-Connected Ground-Gard®

![Diagram](image2)
Figure 13  Test Connections for Measuring System Capacitive Charging Current Medium Voltage, Wye-Connected Ground-Gard®

Figure 14  Test Connections for Measuring System Capacitive Charging Current Medium Voltage, Delta-Connected Ground-Gard®
Ch 7 Maintenance

A. General

A regular maintenance schedule should be established to obtain the best service and reliability from the Ground-Gard® assembly. Plant operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, such as contactors, switches, relays, meters, etc., refer to the separate instruction bulletin furnished for each device. Under normal conditions, the relays which indicate a ground fault do not operate. Therefore, it is important to check the operation of these devices regularly. See Ch 5 Operation. C. Operational Testing of this instruction bulletin for information concerning the built in test features of Ground-Gard assemblies.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. The record will be a valuable reference for subsequent maintenance work and for station operation. It is also recommended that the record include reports of tests performed, the condition of the assembly and any repairs or adjustments that were performed. This record should begin with tests performed at the time of installation and energization, and all data should be graphed as a function of time to ensure a proper maintenance cycle is being scheduled.

The primary circuits of Ground-Gard assemblies are insulated in some areas in order to reduce the size of the assembly. However, this insulation, in most instances, requires a certain amount of air gap between phases and to ground to complete the insulation.

![CAUTION]

To avoid serious damage or injury to the assembly or personnel it is very important to avoid inserting any object in to the air gap when the assembly is energized. Doing so under certain conditions will short circuit the air gap and cause a breakdown in the primary circuit to ground.

Care should be exercised in the maintenance and checking procedures to ensure that accidental operation is not initiated.

B. Periodic Maintenance

The assembly structure and connections should be given the following overall maintenance at least annually.

1. Thoroughly clean the assembly, removing all dust and other accumulations. Wipe clean the buses and supports. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2. Clean mechanisms and lubricate wear points. The application of lubricants should be held to a minimum to reduce the accumulation of dust and dirt.

3. Control Contacts: Contacts should be inspected and dressed or replaced when the surface becomes seriously pitted. Unless repetitive duty has been experienced, little attention should be required.

4. Secondary Wiring: Check all wiring connections for tightness, including those at the current and potential transformers and at the terminal blocks where circuits leave the assembly. Make sure that all secondary wiring connections are properly connected to the assembly ground bus where so indicated.
5. Mechanical Parts: Visually check and manually operate mechanical moving parts such as the disconnecting switch, the interlocks, and the hinged doors.

6. Ventilation: Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt. The air space under outdoor assemblies is necessary for the entrance of ventilating air. It should be cleaned of leaves and other debris. Replace or clean dirty filters.

7. Check to see that all anchor bolts and bolts in the structure are tight.

8. If the assembly is equipped with heaters, check to see that all heaters are energized and operating.

9. Records: The condition of each assembly at the time of inspection should be listed in a permanent record to become a guide for anticipating the need for replacements or for special attention between the regular maintenance periods. Insulation resistance tests are suggested for checking the insulation. A series of these tests will indicate any tendency toward a reduction in dielectric strength of the insulation. Insulation resistance readings should be taken before and after cleaning the assembly and, insofar as possible, under similar conditions at successive periods. Records should include the insulation resistance reading, the temperature and the humidity (either by definite reading or description). Acceptable limits will vary with the extent and design of the bus structure. In contrast to a small installation, the longer assemblies will have a more extensive bus structure with a greater number of parallel insulation resistance paths to ground, which will tend to decrease insulation resistance readings. This variation in insulation resistance between different assemblies emphasizes the value of a series of reading which can be charted to establish a normal insulation level so that progressive weakening of the insulation can be recognized.

10. Abnormal Conditions: Local conditions such as high humidity, salt laden atmosphere, corrosive gases, heavy dust, or severe circuit operating conditions, are considered to be abnormal, and will require more frequent inspections.

It should be emphasized that a series of inspections should be made at quarterly intervals until the progressive facts of the local conditions can be analyzed to determine a schedule which will maintain the assembly in satisfactory condition.

In some locations, local conditions may be so bad that the frequency of maintenance will interfere with operating and production schedules. In such cases, consideration should be given to the possibility of enclosing the assembly in a relatively tight room and to supplying a sufficient quantity of clean air so as to maintaining a positive pressure in the room. Under such conditions, maintenance schedules may then be established on a more normal basis. Such an arrangement might also provide for cooling the air where the ambient temperature is relatively high, thus further improving operating conditions.
Ch 8  Recommended Renewal Parts and Replacement Procedures

A. Ordering Instructions

Ground-Gard® assemblies do not normally include any consumable parts, so no recommendation is made for stocking spare or renewal parts. If renewal parts should be required, follow these ordering instructions.

1. Order renewal parts from Powell at powellind.com or call 1.800.480.7273.

2. Always specify the work order number on which the assembly was originally furnished. This number may be found engraved on the lower right hand corner of the large Powell nameplate on the front of the Ground-Gard assembly.

3. Specify the quantity and description of the part and the instruction bulletin number. For parts not easily identified, a description should be accompanied by a marked illustration from this instruction bulletin, a photo or simply submit a sketch showing the part needed.

4. Standard hardware, such as screws, bolts, nuts, washers, etc., should be purchased locally. Hardware used in bolted joints of conductors must be SAE Grade 5 or better in order to ensure proper clamping torque and prevent overheating of the joints. Steel hardware should have a protective coating to inhibit rust.
01.4IB.60100B
Ground-Gard® High Resistance Grounding Assembly

For Power Systems from 240V to 4160V

September 2015