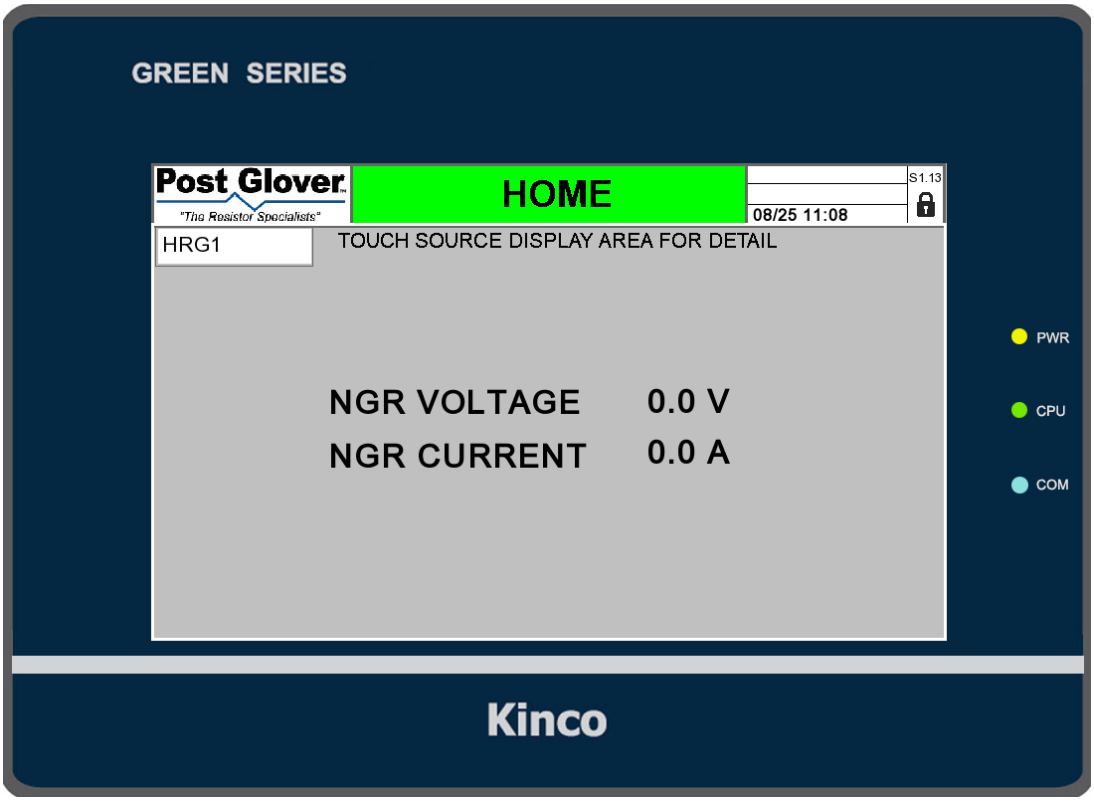
SmartPulse™
Low Voltage High Resistance Grounding System

Installation, Operation and Maintenance Instructions



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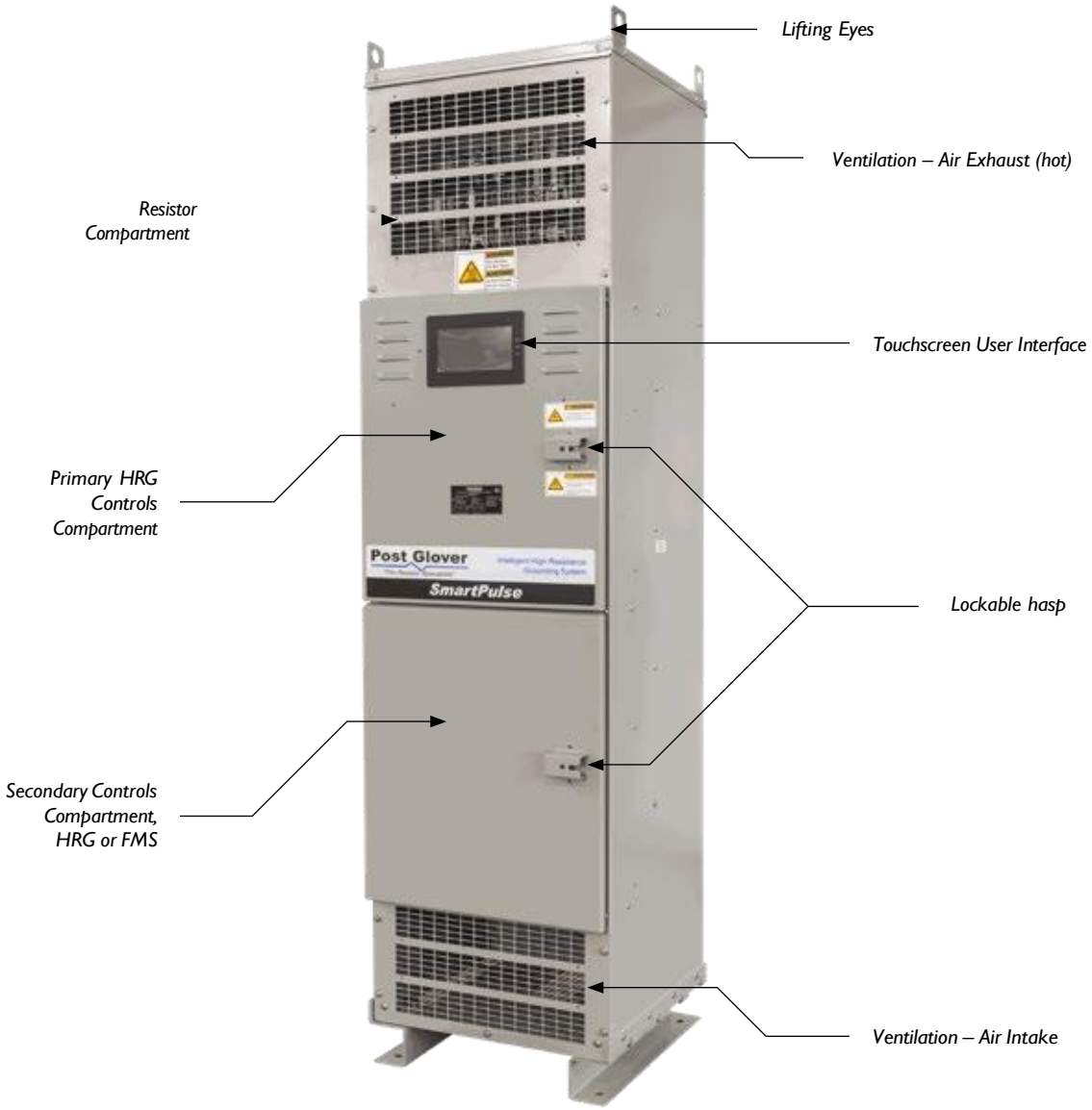
Section 1 – Equipment Overview

1.1 Exterior View – Standard Single HRG Cabinet



Acronyms			
NGR	Neutral Grounding Resistor	**LDEM**	Low-Voltage Digital Electronics Module
HRG	High Resistance Grounding	**SRE**	Smart Relay
HMI	Human Machine Interface	**FMS**	Feeder Monitoring System

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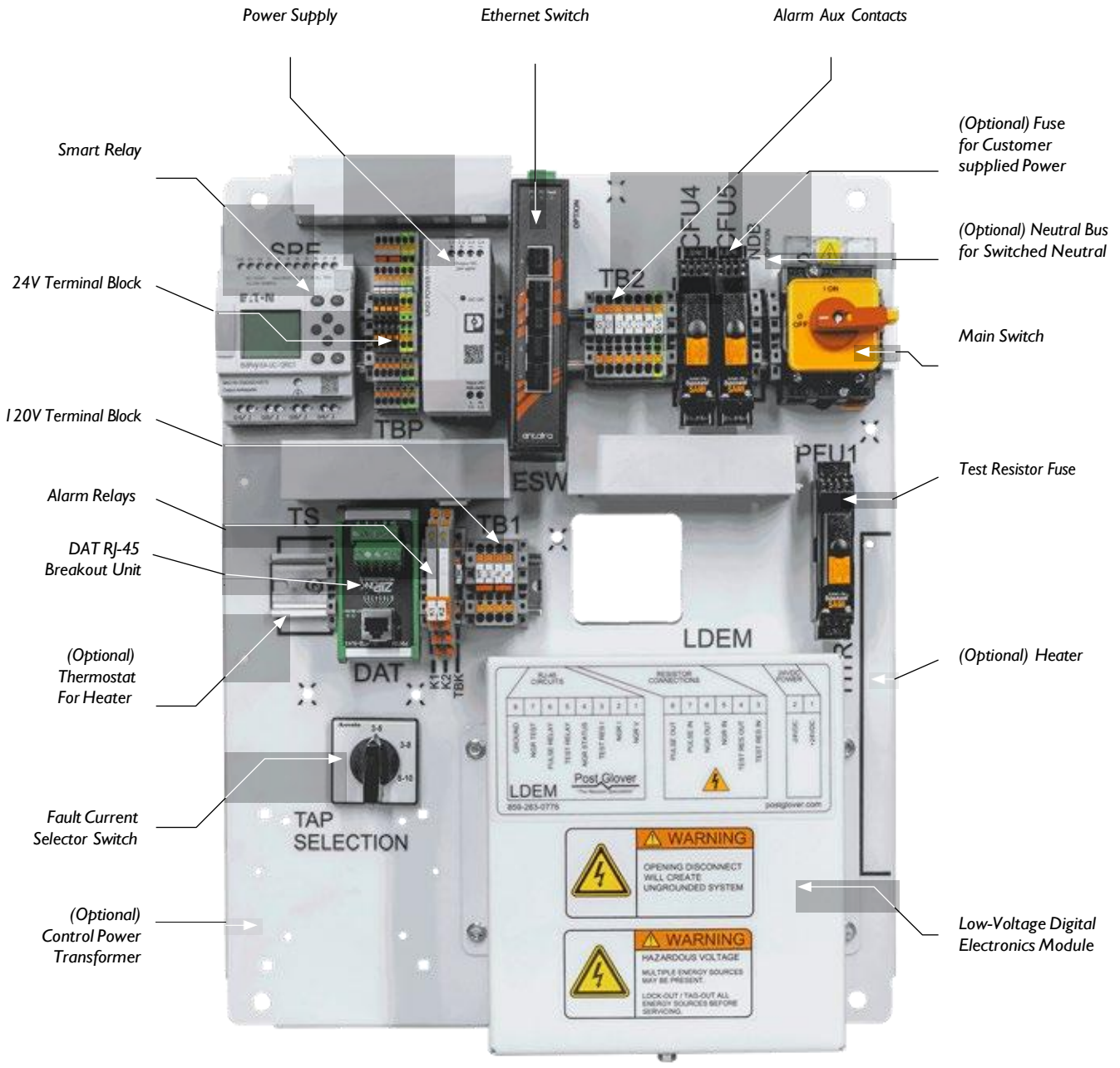
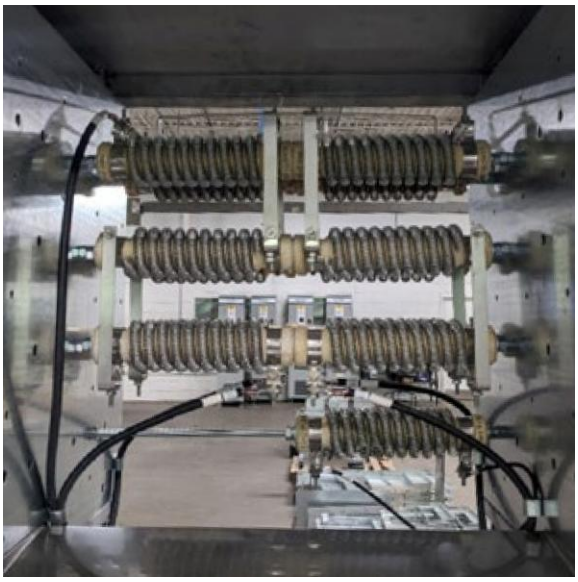
1.2 Interior View – Standard Control Panel



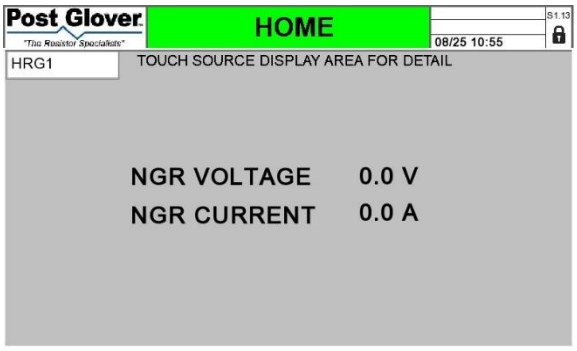
1.3 Interior View – Resistors

- Stepped Neutral Ground Resistor (NGR).
- Included test resistor and resistors for Pulsing.
- Desired fault and pulsing current can be set using the tap selector switch or NGR terminal block for units without a tap switch. *See section 5.2 for further detail.*



1.4 HMI Home Screen

See section 4 for more detail on operating the unit through the HMI.



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Section 2 – Installation

This instruction booklet is intended as a general guidance tool for personnel installing Post Glover Resistors High Resistance Grounding Systems. However, each unit is designed for a specific application/installation.

Please refer to the drawings supplied with your unit for ratings and other information. Appendix A contains dimension drawings with information for standard low voltage systems. Consult all specific equipment drawings furnished by Post Glover Resistors, Inc., for your particular installation.

***WARNING**: Install only in access restricted locations.*

***AVERTISSEMENT**: Installer seulement dans des endroits auxquels l'accès est limité.*

2.1 Receiving

A preliminary inspection of the crate (or enclosure) should be made at this point to ensure that the unit was handled properly during shipment. If damage is detected, contact the carrier immediately to file a claim.

2.2 Handling

Once received, the high resistance grounding unit should be unloaded and carefully moved by overhead crane. Free-standing units have lifting angles for an overhead crane to use when moving the unit. Do not attempt to move or lift the unit at points other than the lifting angles. Always store the unit upright to avoid damaging the enclosure and/or controls. Do not stack the units.

2.3 Inspection

Inspect the enclosure for any signs of shipping damage such as dents, scratches or chips. Inspect the inside of the enclosure for any loose wiring or bolts. Check the resistor for any signs of broken insulators or elements.

2.4 Storage

If the unit will be stored for some length of time, take the following precautions:

1. Remove the crate and thoroughly inspect the unit.
2. Store the unit in an area that is clean and dry and has moderate temperatures. Cover it with a heavy-duty plastic cover or cloth.
3. To prevent condensation in units stored in damp areas, provide 120-200 watts of heat for the duration of the storage period.

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2.5 Floor Preparation

The equipment foundation must be designed with suitable strength and levelness. A 1 inch clearance gap must be provided to the sides and back of the unit. The purchaser is responsible for anchoring the unit to the floor with anchors of suitable strength.

***WARNING**: When mounting on or over a combustible surface, a floor plate of at least 1.43 mm galvanized steel or 1.6 mm uncoated steel extending at least 150 mm beyond the equipment on all sides shall be installed.*

***AVERTISSEMENT**: Lorsque l'appareil est installé sur ou au-dessus d'une surface combustible, on doit prévoir une plaque d'acier galvanisé d'au moins 1.43 mm ou une plaque d'acier sans revêtement de 1.6 mm se prolongeant sur au moins 150 mm tout autour de l'appareil.*

2.6 Physical Installation

Once removed from the shipping pallet and packaging, secure the unit to the floor using the provisions in the base. It is the responsibility of the user to utilize adequate mounting hardware. Post Glover freestanding HRG units should be mounted on a concrete pad.

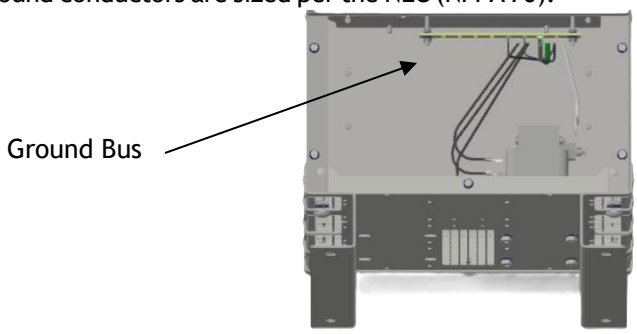
Seismic / Wind rated units should be bolted to the mounting surface using the holes provided in the feet at the bottom of each enclosure using four (4) Grade A325 bolts, A563-DH nuts, and special washers provided by Post Glover. Expansion-type anchors are recommended for concrete pad mounting.

In one of the conduit entry areas noted on the delivered unit enclosure drawings, cut an appropriate access hole to bring in the required connection. See page two of the included wiring schematic for detail on the required connections. The ground connection can be routed through the same opening or if more convenient, a second entrance can be added in another location.

***NOTE**: Any work performed on this unit should be done by qualified persons and must be done in compliance with national, regional, local and site-specific safety procedures. It is the responsibility of the owner to comply with all applicable electrical codes.*

2.7 Grounding... CAUTION!

To reduce the possibility of electric shock, the unit must be properly grounded before making any system power connections. Connect the system ground to the ground bus located in the lower portion of the free-standing units. For the wall-mount units refer to the unit specific drawings to find the ground connection locations. Make sure that all ground conductors are sized per the NEC (NFPA 70).



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2.8 Line and Control Connections

Refer to application specific drawings that accompany the Post Glover Resistors system. The free-standing enclosure is designed to accommodate the line cables through the sides of the enclosure without unnecessary cable bends. The control power connections made to the terminal blocks are rated for 20 amperes, 600 volts. The auxiliary device connections made to the terminal blocks are rated for 3 amperes at 120/230 VAC, 2 amperes at 24 VDC, and 100mA at 220 VDC.

Refer to the specific diagrams furnished with the equipment for location detail.

As a final check, inspect all wiring to verify that connections are made properly and that they are clean and tight. Make sure there is adequate clearance between the external connections and all devices.

***NOTE**: It is possible for the electrical connections to loosen during transit. Check all electrical connections to ensure they are firmly tightened.*

***NOTE**: Consult local NEC codes for proper cable sizing.*

2.9 Setting Ground Fault/Pulsing Levels

The ground fault and pulsing current levels can be chosen using the selector switch. Turn the dial to the desired setting. The first value on the switch setting is the value for the ground fault current, the second value is the current that will occur during a pulse operation. On some models, a terminal block is provided. Wire to the appropriate terminal for the current setting required. Change the pulse jumper to a higher current setting.

***NOTE**: For user safety do not turn the selector switch with an active ground fault.*

***NOTE**: Do not connect the neutral connection (N) directly to ground. This results in a solidly grounded system and disables any benefits and protections of the HRG system.*

2.10 General

When the installation is complete and all incoming wiring has been terminated, clean the inside of the unit with a soft cloth or vacuum cleaner. Do not blow out with compressed air. Make sure any dirt or debris, such as packing material, is removed so it does not interfere with the operation of the unit. Before connecting power to the control panel, check all components to make sure all shipping devices, such as blocking or tying of relays, have been removed.

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Section 3 – Start-up Guide

This quick start guide provides a brief overview of the steps required to use this High Resistance Grounding Equipment, but **is not meant to be a substitute for reading the entire manual.**
Please refer to section 4 for setting suggestions or reasons to change from default.

3.1 Pre-energization Checks

Perform the following checks before energizing the HRG unit:

- Inspect the enclosure interior for connections that may have come loose in shipping.
- Check continuity of all fuses.
- Open SW1
  - For units on a wye system ensure that the transformer X0 is only connected to the HRG unit. SW1 Terminal 1 to the ground bus should produce ∞, OL, resistance. Also check the resistance from terminal 2 of the disconnect switch to ground. This should match the drawing value for the default resistor tap. **Default value is 55Ω for 5A ground fault for 480V_{L-L}/277V_{L-N} systems.**
  - For units on a delta system check the resistance from LDEM terminal 5 to ground. This should match the drawing value for the default resistor tap. **Default value is 55Ω for 5A ground fault for 480V_{L-L}/277V_{L-N} systems.**
- If the unit is equipped with an anti-condensation heater, verify the thermostat is set correctly for your environment.

3.2 Electrical Connection and Start-up

Connect the required phases (2 for wye units with control power transformer, one for wye units with customer supplied power, and three for delta units) to the appropriate points on the disconnect switch. Connect the internal ground bus to the system ground. *See Appendix B for recommended wire sizes.*

> ***NOTE**: Opening the disconnect switch may remove power to the unit and/or the grounding resistor from the circuit. The system is ungrounded while the disconnect switch is open.*

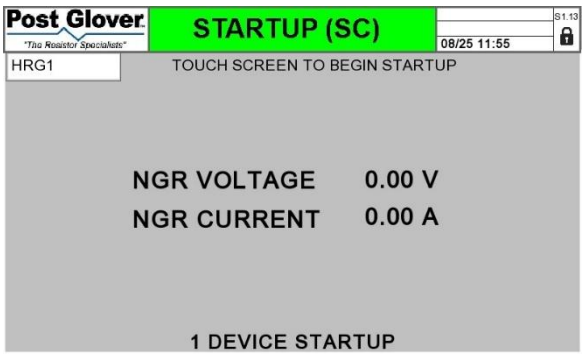
After the mechanical installation and all wiring is completed per specific equipment drawings furnished by Post Glover Resistors, Inc., place the system in service by following these steps:

3.2.1 Power the system

Close SW1 and control power if it is separately derived. The first Startup screen will be displayed.

3.2.2 Note initial NGR Voltage and Current.

When systems are first installed, any parasitic capacitance, system insulator breakdown, or fault will be evident by the NGR Voltage and Current. Typically, significantly high Voltage or Current values indicate insulation breakdown, wet conductors, or a phase being grounded. The lower the voltage, the higher the resistance of the ground connection.



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***NOTE**: Default NGR Voltage alarm value, OVERVOLTAGE ALARM, is 60V, and the default NGR Current Alarm value, OVERCURRENT ALARM, is 4A. NGR Voltage or Current above these values will produce an alarm. If there is an active fault upon power up, the alarm screen will display and the alarm horn will sound. See section 9 for a full list of alarms.*

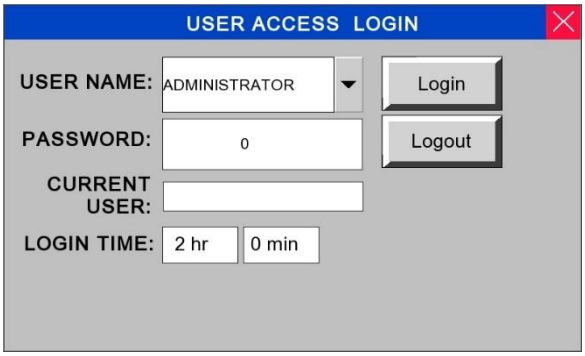
3.2.3 Disable the password by first touching the lock icon in the top right corner.

If administrator is not listed as **USER NAME** click the drop-down arrow and select "ADMINISTRATOR".

Click the password box currently displaying "0". Enter "3000" followed by enter.

Click **Login**.

The lock icon in the top right corner should now be open.



3.2.4 Name device and verify factory settings.

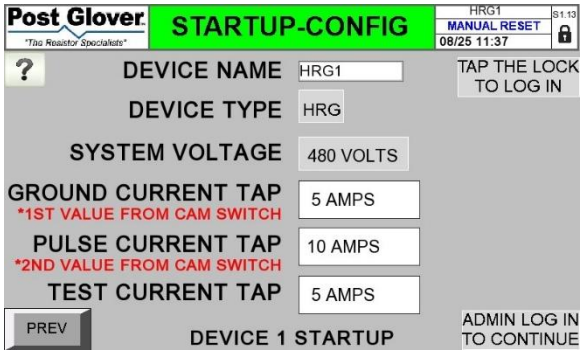
If desired changed the device name by press the white box with the default "HRG1" title.

Confirm that the System Voltage matches the Line- to-Line voltage of the system being grounded.

Confirm that the Ground Current Tap and The Pulse Current Tap settings match the selected values on the cam switch.

Confirm the Test Current Tap matches the specified test current for the unit.

If any of these settings need to be changed simply click the numerical value to bring up the touchpad to adjust the setting.



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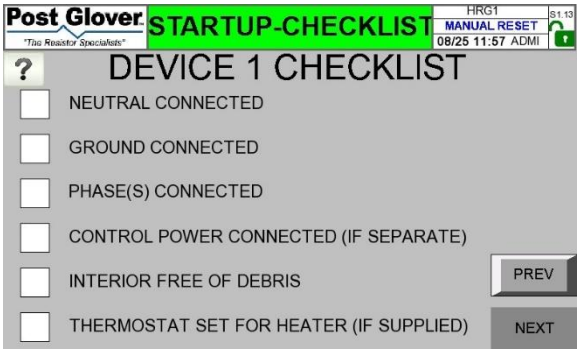
3.2.5 Perform the Device Checklist and verify the desired settings.

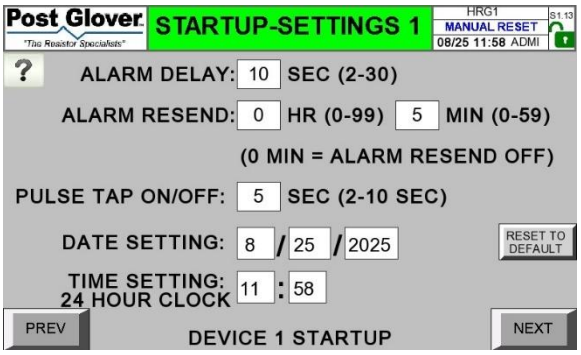
Check the various items on the device checklist.

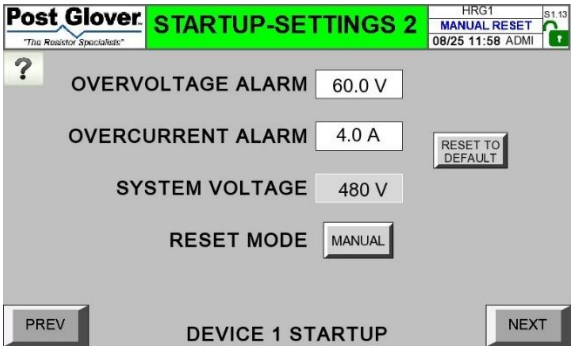
Once the item is deemed acceptable touch the white box next to the item to check it off. Check all the listed items and touch the **NEXT** button.



The next two screens consist of the time, alarm, and sensing settings. To change a setting simply press on the numerical value and enter the desired value. *These settings will be covered in detail in section 4.*

Press the **NEXT** button to continue the start-up process.

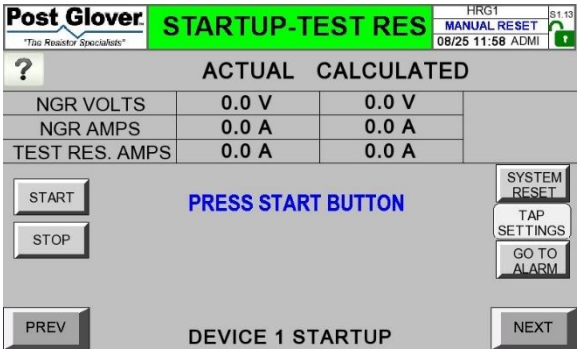




3.2.6 Perform a Ground Fault Test and a Ground Fault Pulse Test.

To begin a ground fault test press the **START** button.

The unit will short the connected phase to ground through the test resistor. This should produce a voltage and amperage on the NGR. There should also be an amperage on the Test Resistor. These values should be within 20% of the calculated values.



After 10 seconds the unit should alarm, this is the sign of a passed test. If the unit does not alarm or an error screen is produced *see section 11 Troubleshooting.*

After running a successful ground fault test press the **NEXT** button to proceed to the ground fault pulse test.

Now press the **START** button ground fault and pulse test. This test will be exactly as the previous test except after 10 seconds the unit will begin to pulse. During the pulse cycle you should see the amperage on the unit increase and decrease on 2 second increments. Upon completion of the Ground Faults Tests press next.

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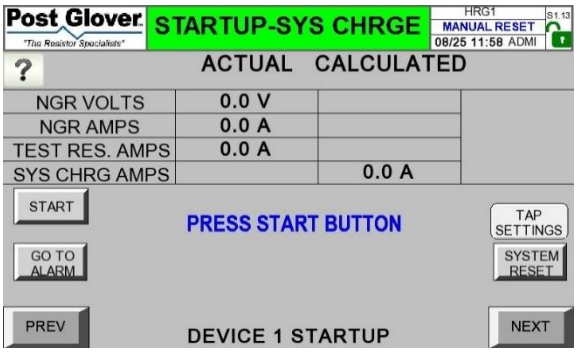
3.2.7 Perform a System Charging Current Test.



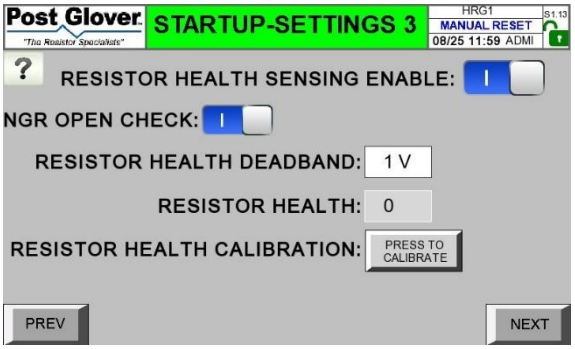
Press the **START** button to begin the System Charging Current Test.

Similar to the earlier test a phase will be faulted through the test resistor.

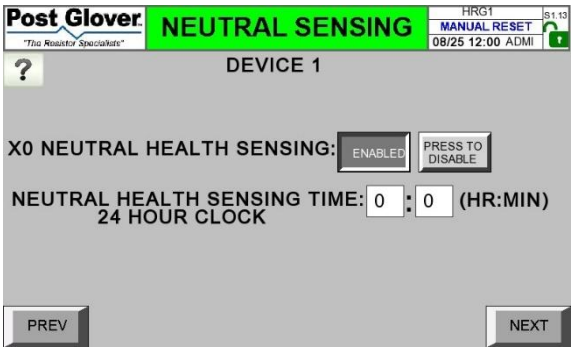
After 10 seconds the unit will return a calculated system charging current value.

The Ground Fault tap must be set to a value higher than this value for proper operation.

> ***NOTE**: The System Charging Current is a critical test and is used to determine the NGR Tap Setting as well as the minimum OVERCURRENT ALARM setting. See section 5.1 and section 5.2 for more information.*



3.2.8 Calibrate Neutral Health Sensing. This screen offers the opportunity to calibrate the NGR after the system is running, as well as modify settings. Follow complete instructions in 4.4.3.



3.2.9 Enable Daily Neutral Health Sensing (if desired). This screen allows the daily NHS test to be enabled. If the test is enabled, also enter the time in 24-hour format (HH:MM) that the test should be run every day.

3.2.10 Commissioning is now complete. Press complete to enter normal operation.

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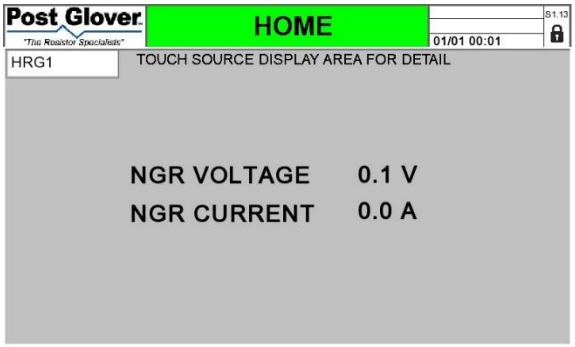
Section 4 – Operational Description

4.1 HRG Functions

The Post Glover Resistors SmartPulse High Resistance Grounding System Equipment (HRG) coordinates the use of resistors and monitoring devices to create a high resistance ground for a power system. When a phase to ground fault occurs, the Neutral Grounding Resistor (NGR) limits the fault current. The mon- itoring components display, log, and can communicate information pertaining to the fault and system events. The information can be viewed on the local User Interface or over the facility network.

4.2 Home Screen

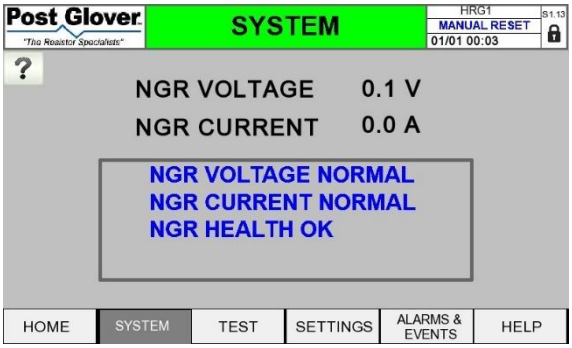


The HMI is used to monitor, set up, test, communicate, and provide diagnostic tools for the SmartPulse HRG.

4.2.1 The Center of the Home Screen displays the NGR Voltage and NGR Current.

4.2.2 The unit device name will be displayed in the top left corner.

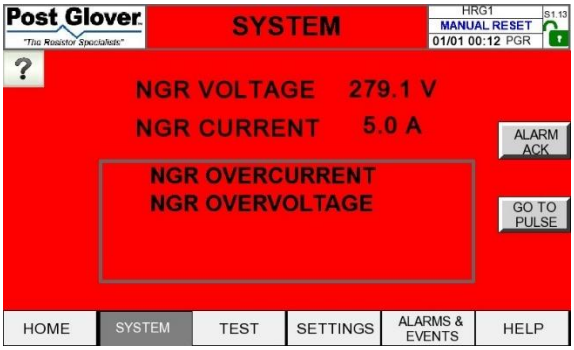
4.2.3 The password status is displayed in the top right corner. A black closed lock indicates that the unit is currently password protected. A green open lock indicates that the password has been entered and the unit is unlocked for changes and tests. Press the lock to access the login screen. If the unit is unlocked a timer will also be displayed. When this timer reaches 0 the unit will lock itself.



4.2.4 If the screen is solid red or flashing red the unit currently has an alarm. Press anywhere to get to the system screen for more detail.

4.2.5 The software version is displayed in the upper right corner of the Home Screen.

4.3 System Screen



4.3.1 From the Home Screen, pressing anywhere on the screen accesses the System Screen.

The System Screen displays the voltage and current actively on the unit and the status of any alarms on the unit.

If an alarm is present on the unit the screen will be red and show details about the alarm. If applicable the options for pulsing and system reset will displayed.

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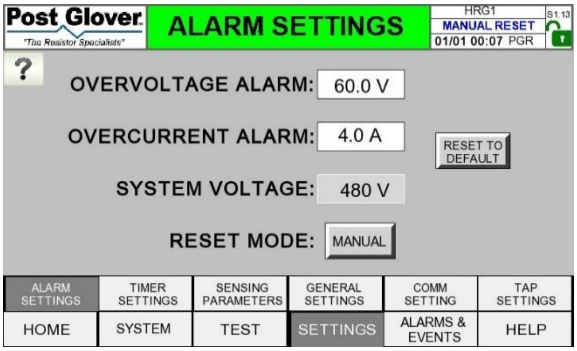
4.4 Settings

4.4.1 Alarm Settings

From the System Screen, pressing the Settings button at the bottom of the screen allows parameters to be viewed or set through the setup menu. The following parameters have default values to allow for ease of setup. Password protected parameters can be modified to customize the system monitoring.



> ***NOTE**: Before any settings can be changed the password must be disabled. See more information on section 8.*

The Alarm settings are used to determine if a ground fault has occurred, or a circuit has opened. Any conductive path from the power system phase to ground will conduct zero sequence current back to the system transformer X0 through the NGR. The voltage across the NGR and the current through the NGR will be dependent upon the resistance of the phase to ground path. A direct bolted fault to ground on a 480 VAC system will produce approximately 277 VAC across the NGR. The current flowing through the NGR will be dependent upon the tap setting of the resistor bank. The default Tap N5 will allow approximately 5A of current to flow.

4.4.1.1 Overvoltage Alarm

The NGR Over-voltage setting (OVERVOLTAGE ALARM) is used to alarm when Ground Faults exist. The alarm **"NGR OVERVOLTAGE"** will be triggered if the voltage on the neutral exceeds this value.

A Ground Fault Test with typically installed test resistors and the default NGR tap will produce more than the default setting of 60 Volts. Performing a ground fault test will display the NGR voltage present during the test. Expected Ground Fault test voltage can be calculated with the following formula.

$V_{TEST} = (V_{L\text{-}N} / (R_{GF} + R_{T\text{-}G})) R_{GF}$

Where: V_{TEST} is the test voltage to be temporarily entered for the Over-voltage setting

$V_{L\text{-}N}$ is the line-to-neutral system voltage

R_{GF} is the resistance of the neutral grounding resistor at the chosen tap. N5 typically = 55.7 Ω for $480V_{L\text{-}L}/277V_{L\text{-}N}$ systems

$R_{T\text{-}G}$ is the test-to-ground resistance – *see resistor drawing.* Typical Test Resistor = 55.7 Ω for $480V_{L\text{-}L}/277V_{L\text{-}N}$ systems

4.4.1.2 Overcurrent Alarm

The NGR Over-Current setting (OVERCURRENT ALARM) is used to alarm when Ground Faults exist. The alarm **"NGR OVERCURRENT"** will be triggered if the current on the neutral exceeds this value.

> ***NOTE**: The value needs to be below the maximum current permitted to flow with a direct bolted phase to ground fault, as determined by system voltage and the resistor tap setting, and above the charging current test result.*

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4.4.1.3 System Voltage

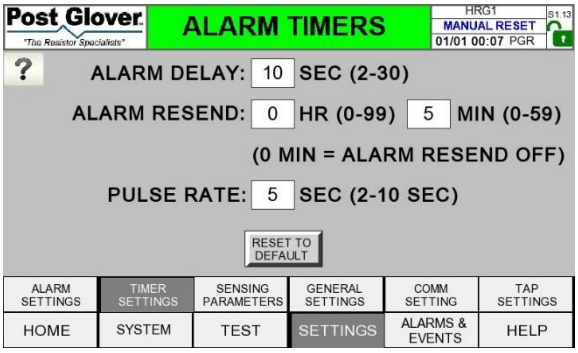
This setting is set during start-up and should match the system's L-L voltage. SYSTEM VOLTAGE is used for the system charging current algorithm.

4.4.1.4 Reset Mode

When in Manual Mode, if an alarm occurs, the horn will sound and the System Screen will flash until acknowledged. Pressing the **ALARM ACK** button will silence the horn and cause the System Screen to stop flashing. Once the alarm clears and after the Ground Fault Test Timer times out, the System Screen can be cleared and the system reset by pressing the **SYSTEM RESET** button. To reset the system, the alarm must not be active, and the Ground Fault Test Timer must time out. There will be no active fault on the home screen.

When in Automatic Mode, any alarm that is triggered will be reset when the alarm conditions go away and after the Ground Fault Test Timer times out. The System Screen will clear and show no active alarms.

4.4.2 Alarm Timers



4.4.2.1 GF Alarm Delay

The Ground Fault Alarm Delay will determine how long a fault condition exists prior to an alarm being generated. The default is 10 seconds to avoid any short-term intermittent faults.

4.4.2.2 GF Alarm Resend

The Ground Fault Alarm Resend Timer will recycle the auxiliary alarm contacts for the "System Fault", and the "Ground Fault", each time this timer times out.

4.4.2.3 Pulse Tap ON/OFF

The Pulse Tap On/Off timer will determine the length of time the pulse relay is engaged. The pulse relay is used to vary the NGR resistance making it easier to find a ground fault. *See section 6 Finding a Ground Fault for details.* The relay will be off for the same period of time it is on.

> ***NOTE**: Pulsing automatically turns off after 4 hours to keep the contactor from fusing. Pulsing can be restarted by simply pressing the **PULSE** button.*

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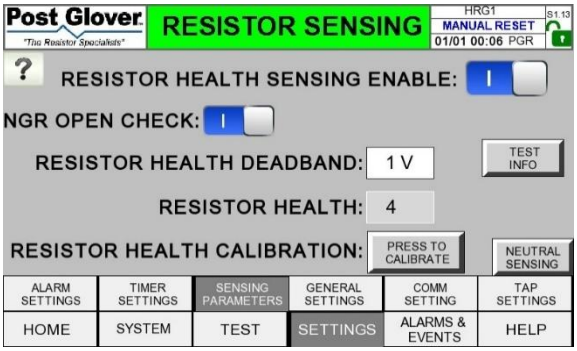
4.4.3 Resistor/Neutral Health Sensing



The Sensing values menu features all the settings for the resistor and neutral sensing features.
For more details on the sensing methods used by the SmartPulse see section 7.

4.4.3.1 Resistor Health Sensing Enable

Use the touch button slider to turn on or off Resistor Health Sensing.
For more details on Resistor Health Sensing see section 7.1

4.4.3.2 NGR Open Check

Use the touch button slider to turn off NGR Open alarm checks. This check also utilizes Resistor Health Sensing, which must be enabled first.
For more details on Resistor Health Sensing see section 7.1

4.4.3.3 Resistor Health Deadband

The Resistor Health Deadband determines the sensitivity of the NGR Open alarm. The lower this value is set, the more the system will need to vary from the calibration point for an alarm to occur.

4.4.3.4 Resistor Health

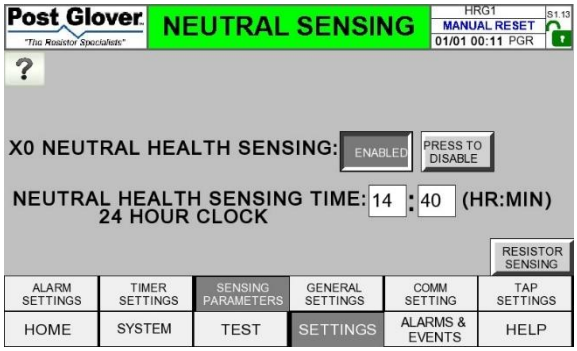
The Resistor Health field is a calculated value that cannot be changed. This value along with the deadband are used to determine the health of the resistor using resistor sensing.

4.4.3.5 Resistor Calibration

The Resistor Calibration should be completed after initial installation and anytime the resistor is disconnected for maintenance. It is an internal calculation that views the resistance of the resistor circuit and is used for the resistor health calculation.

4.4.3.6 Neutral Sensing

From the Neutral Sensing menu, this feature can be enabled or disabled and the neutral sensing start time can be set. The neutral sensing start time should be
entered in 24 hour format.
For more details on Neutral Health Sensing see section 7.2.



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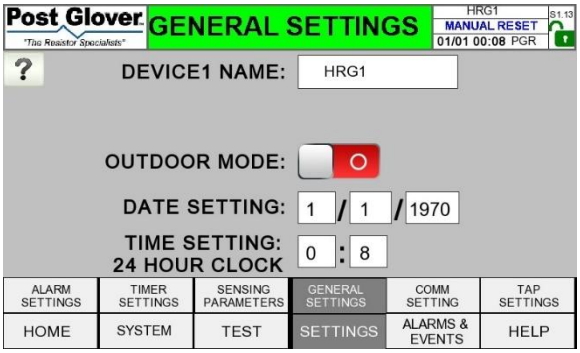
4.4.4 General Settings

4.4.4.1 DEVICE1 Name



Device name is a field that can be used to more accurately label the circuit that the HRG is connected to. This can be particularly helpful on Generator and Utility mix circuits that use multiple HRGs.

4.4.4.2 Outdoor Mode

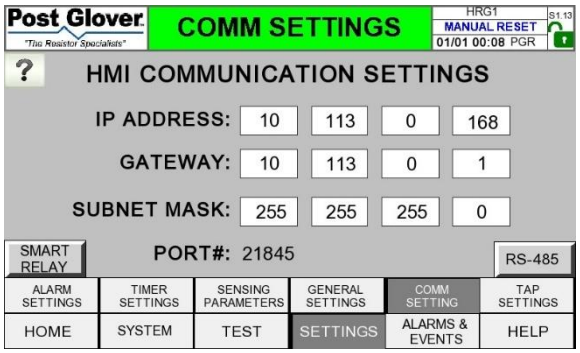
Outdoor Mode is a toggle that be used to change the background color of the main display in a bright environment. Outdoor mode is not required for outdoor applications.

4.4.4.3 Date and Time Settings

Use these fields to enter the Date and local Time for the unit. These settings are often set during original commissioning.

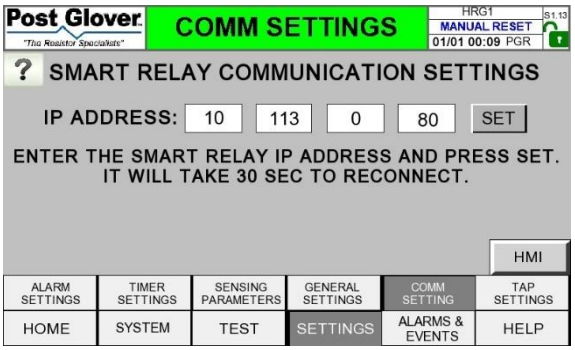
4.4.5 COMM Settings

Use these fields to enter the desired Ethernet communication settings if applicable.



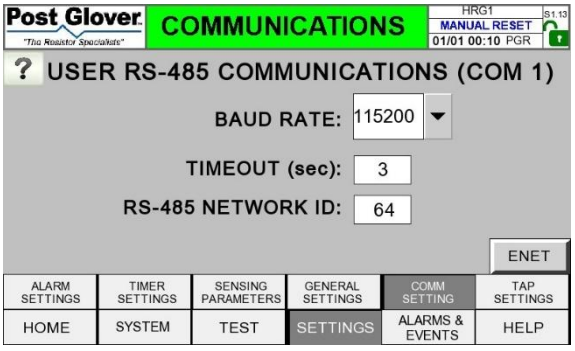
Press the SMART RELAY button to access the screen for the Smart Relay IP address settings.

> ***NOTE**: IP address must also be changed in the Smart Relay itself. This setting must match the Smart Relay IP address.*



Press the **RS-485** button to access the screen for the RS-485 network settings.

> ***NOTE**: See the communications manual for more information on Ethernet and Modbus communications.*



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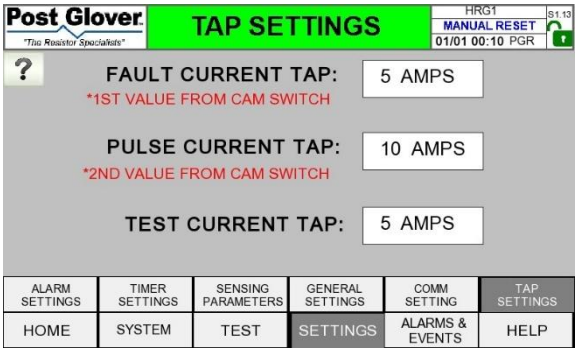
4.4.6 Tap Settings

The tap settings for the HRG are physically set with the cam switch internal the unit. The settings in the Tap Settings menu should match those set by the switch.



4.4.6.1 Fault Current Tap

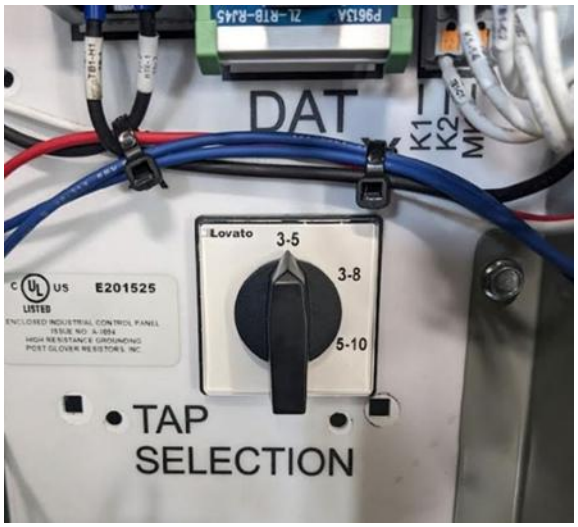
From the drop down select the ground fault setting on the unit. This should be the desired fault current during a fault. This value must match the first number on the cam switch setting or the NGR fault terminal tap for models without a cam switch.

4.4.6.2 Pulse Current Tap

From the drop down select the pulse fault setting on the unit. This should be the desired pulse amperage during a ground fault with the pulse feature activated. This value must match the second number on the cam switch setting or the NGR pulse terminal tap for models without a cam switch.

4.4.6.3 Test Current Tap

Press the amp value box to set the test current setting on the unit. This should be the desired amperage on the test resistor based on a solidly grounded system. This value will be 5 amps for most units. The unit schematic will show the factory installed test resistor value.



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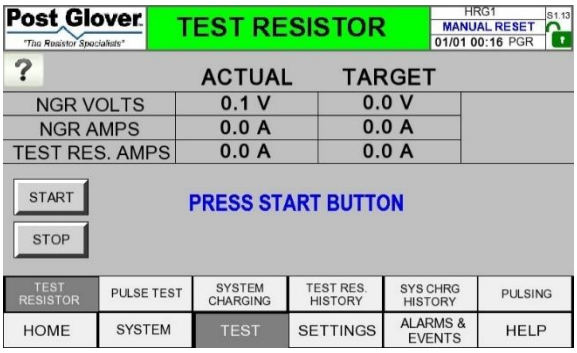
4.5 System Tests

The password must be disabled to perform tests. Only qualified persons should perform testing. **Abide by all Electrical Safe Work Practices to perform System Tests.**

***NOTE**: A user with testing permissions must be logged in for completing test. See section 8.3 for details on logging in/disabling the password.*

4.5.1 Test Resistor

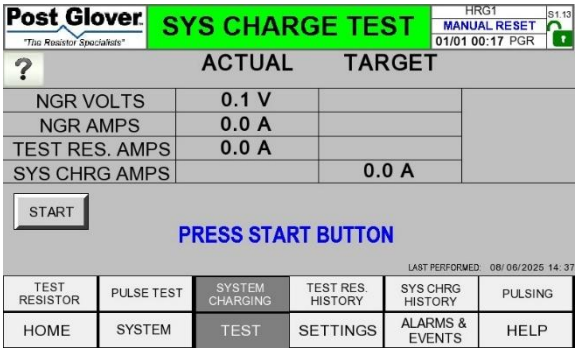


The Ground Fault Test places a ground fault on the system using the supplied system voltage at SW1. The test relay in the LDEM will close and current will flow through the test resistor bank to ground and from ground to the NGR bank back to the system neutral. The unit should alarm during this test to signify a passing result.
See section 3.2.6 for more information.

4.5.2 Pulse Test

The Pulse Test begins the same way as the Test Resistor test. After 10 seconds, when the Test Resistor Test would alarm, the unit should begin pulsing. During this pulsing process the NGR amps should oscillate up and down every 2 seconds.

4.5.3 System Charging

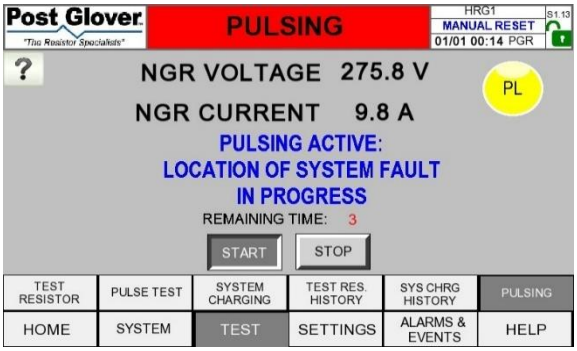


The System Charging current test initiates the test circuit described above to calculate the system charging current. The maximum charging current on the system will only be detected and displayed if all available circuits on the system are connected to the system. Each branch circuit must have all disconnects, breakers, or other connecting means closed. *See section 3.2.7 and section 5.1 for more information.*

4.5.4 Test RES History and SYS CHRG History

The Test Resistor history and System Charging History can be viewed to see the historical data of past tests on the unit. This can be used as a way to view the changes to a system over time.

4.5.5 Pulsing



During a ground fault navigate to the Pulsing tab to initiate pulsing. After pressing the **START** button the unit will pulse for 4 hours or until the **STOP** button is pressed.
See section 6 for more information on pulsing.

4.6 Alarm Notification

4.6.1 Normal

- When the top center background of the display is green, the system does not detect any of the Alarms being monitored.

4.6.2 Fault

- Alarm Mode in manual
  - When the top center background of the display is red, one of the alarms *listed in section 9.2* has occurred and not yet cleared or is still active. The password will need to be entered and the system reset to return to normal after the fault condition has cleared.
- Alarm Mode in automatic
  - When the top center background of the display is red, one of the alarms *listed in section 9.2* has occurred and not yet cleared or is still active. The unit will return to normal after the fault condition has cleared.

4.7 Alarm Horn

The alarm horn sounds when a fault occurs. Press the **ALARM ACK** button from the System Screen to silence the horn.

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Section 5 – Charging Current & Resistor Tap Setting

5.1 System Charging Current

5.1.1 General

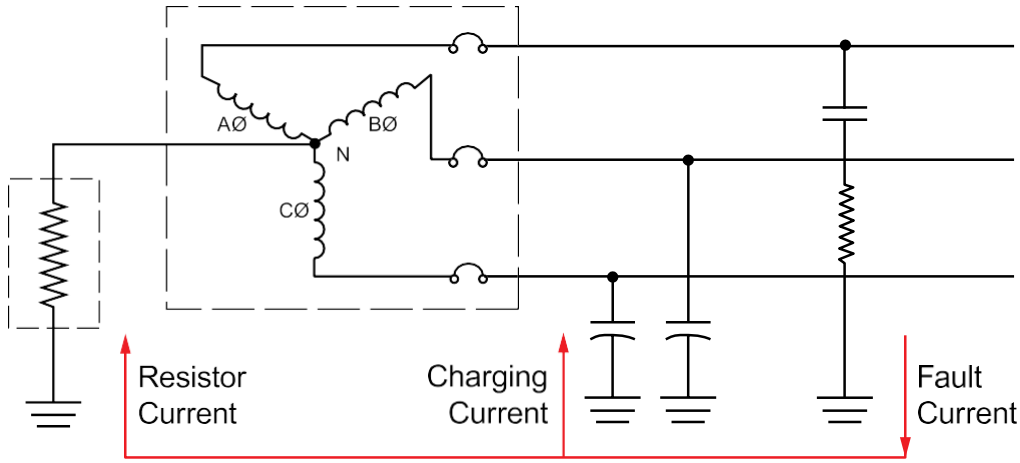
In ungrounded systems, a voltage is held on the system capacitance after a fault. In an arcing or intermittent fault, this can lead to a significant voltage build-up. In a high resistance grounded system, the resistance must be low enough to allow the system capacitance to discharge, thereby preventing significant voltage build-up.

The magnitude of zero-sequence charging current is determined by the line-to-ground capacitance associated with system components. The value of this current must be known to properly coordinate the Post Glover Resistors High Resistance Grounding System. In an industrial power system where the design and components are known, the charging current can be estimated with reasonable accuracy.

With a complex array of machines and cables, this may be tedious and yield less-than-accurate results. During the startup procedure, a System Charging Current Test will be performed. The system charging current will be used to determine the NGR tap setting, which in turn determines current permitted to flow during a ground fault. *See section 5.2 for details.*

5.1.2 System Charging Current Test

The most accurate way to determine the maximum value of the charging current is by test since extreme variations can exist. The charging current per phase is represented by I_{CA}, I_{CB} or I_{CC}, while I_C corresponds to the total line-to-ground charging current. To obtain the zero-sequence charging current, one phase conductor is intentionally grounded as shown in the schematic below. ***The test should be performed with all system equipment connected and in the circuit.*** Repeating the charging current test is necessary with a significant system change.



$$I_C = \frac{V_{RATED}}{\sqrt{3}V_R}\sqrt{I_F^2 - I_R^2}$$

V_{RATED} = System Voltage taken from System Values Screen
V_R = Measured Resistor Voltage
I_F = Fault current measured at test resistor
I_R = Measured Grounding Resistor Current

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5.1.3 Test Results

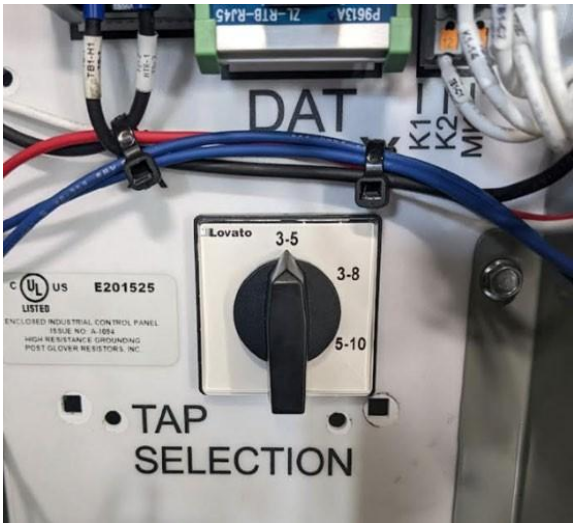
The resulting value is to be used to determine the minimum current for the ground fault current tap, and correspondingly the ground fault alarming current (OVERCURRENT ALARM) setting on the Alarm Settings Screen. The ground fault current tap should be greater or equal to the charging current value, and the OVERCURRENT ALARM setting should be less than the ground fault current tap selected.

5.2 Resistor Tap Connection

Using the cam switch, the resistor taps should be set at installation so that ground current with a ground fault is greater than or equal to the system capacitive-charging current.

The first number on the switch represents the pre-determined amperes that will be allowed to flow during a bolted fault. The second value is the current that will flow when the pulse is active during a fault. In the example below the unit is set to have a 3-amp ground fault with a 5-amp pulse.

For models without a cam switch, taps are selected via terminals on the NGR terminal block. See the unit schematics for information on which terminals to use for the desired ground fault and pulse currents.



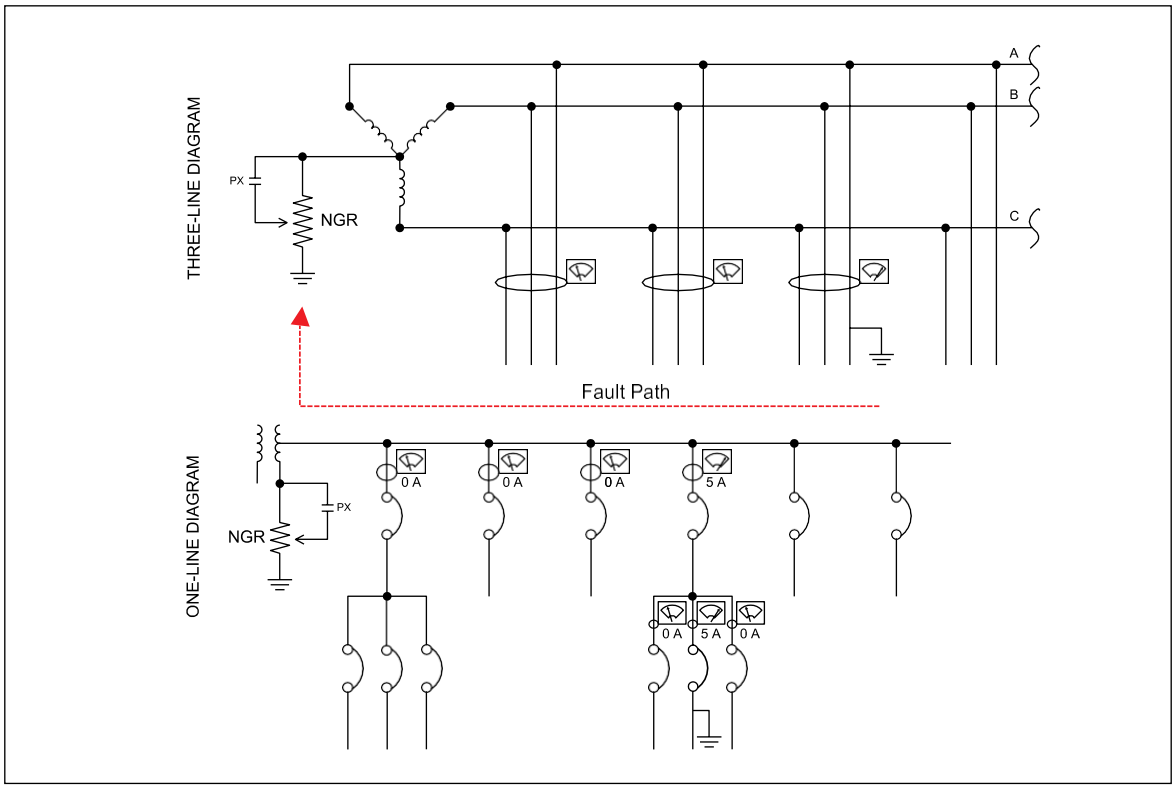
Section 6 – Locating a Ground Fault/Using Pulse

To locate a ground fault, activate the pulsing circuit by pressing the **PULSE** button on the Pulsing Screen on the HMI. The pulsing circuit cannot be enabled unless there is a ground fault detected by the SmartPulse. After pressing the button, the controller will display "PULSER ACTIVE" on the screen. This screen shows the pulse rate in seconds as well as the neutral voltage and current. This activates a control circuit which causes a cyclic switching sequence. The switching sequence consists of the cycle timing of an integral pulsing relay (PX). The pulsing relay (PX) shorts out a portion of the grounding resistor (NGR) each time the relay is energized, producing a tracer signal.

The optional portable hook-on detector is then used to follow the tracer signal through the system to the point of the fault. The detector is clamped around all three phases of each individual feeder (*see the schematic below*). The feeder with the fault will show rhythmic fluctuations on the detector's readout. The fault can be traced to the sub-feeder and eventually to the faulted device. Once this location is determined, the pulsing circuit should be deactivated by pressing **PULSE** on the operator's panel. This will return the user to the System status screen.

After clearing the fault, place the system in its normal operation mode by pressing the **SYSTEM RESET** button.

***NOTE**: A portable ammeter can be included as an option with the SmartPulse.*



How to Locate a Ground Fault

Section 7 – Neutral Health Monitoring

For all high resistance grounding systems, it is required for the neutral to be monitored. Outside of the standard fault monitoring via current and voltage actively on the neutral of the system, the SmartPulse uses additional methods for monitoring the health of the neutral grounding resistor. The methods used are **Resistor Health Sensing** and **Neutral Health Sensing**.

7.1 Resistor Health Sensing

Resistor Health Sensing is a method used to verify the health of the actual resistor circuit. When resistor sensing is enabled the LDEM will continuously verify the state of the resistor circuit compared to the last calibrated state of the resistor. For this reason, it is important to recalibrate the resistor health once major system changes have occurred. The resistor health deadband can be used to control the sensitivity of this check. Resistor Health Sensing is enabled by default. *See Section 9.2 for more details on specific alarms that can be generated by grounding resistor faults.*

7.2 Neutral Health Sensing

Neutral Health Sensing is a method used to verify the complete connection of the SmartPulse system from the neutral (X0) connection point through the resistor to ground. This test runs automatically once per day at the NEUTRAL HEALTH SENSING TIME set on the Neutral Sensing settings screen. Neutral Health Sensing is disabled by default for the reason noted below.

***NOTE**: This setting can cause nuisance alarms for units that do not have continuous transmission power. It is recommended to be disabled for all units on intermittent generator power. For units in initial commissioning, it should remain disabled until continuous power is provided.*

***NOTE**: During the daily Neutral Health Sensing test the grounding and test resistors will see phase voltage for a few seconds during the test. This may produce incidental heat.*

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Section 8 – Password Protection and User Permissions

The SmartPulse High Resistance Grounding System offers multiple Users that have varying levels of clearance to change settings or perform system tests. An administrator level user has full access to the settings and tests available to an end user. A maintenance level user has access to the features needed for normal operation of the HRG. Reviewing settings, silencing alarms, and activating the pulse feature do not require a user login. *Refer to table below for more details.*

8.1 User Permission Table

Action	User Level		
	Login Not Required	Maintenance	Administrator
Acknowledge Alarm	X	X	X
Acknowledge Event in Event Table	X	X	X
Startup Acknowledge Alarm	X	X	X
Toggle Outdoor Mode	X	X	X
Start/Stop Pulse	X	X	X
Alarm Settings		X	X
Alarm Timers		X	X
Begin Startup Process		X	X
Change NGR Health Settings		X	X
Change Resistor Sensing Settings		X	X
Change System Settings		X	X
Change Tap Settings		X	X
Clear Alarm and Events Tables		X	X
Clear Sys Charging Table		X	X
Enable/Change X0 Neutral Sensing		X	X
Startup Device Settings		X	X
Restart HMI		X	X
Start / Stop Test Resistor Test		X	X
Start/Stop Pulse Test		X	X
Startup Device Configuration		X	X
System Charging Test		X	X
Toggle Startup Complete		X	X
Add/Delete Users			X
Change HMI Communication Settings			X
Change RS-485 Comm Settings			X
Change Smart Relay IP Address			X
Download Software			X
Manage Users			X
System Reset			X

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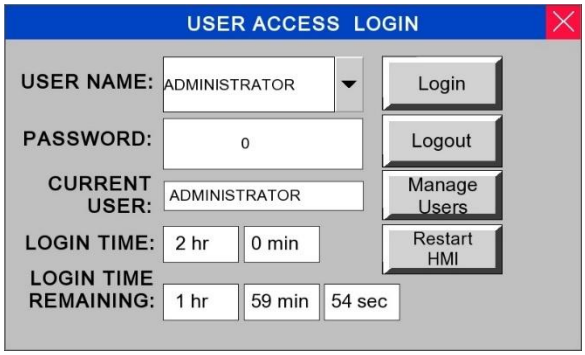
8.2 Default Passwords

USER LEVEL		
Login Not Required	**Maintenance**	**Administrator**
N/A	2000	3000

8.3 Disabling the Password Protection/ Logging into a User Profile



To disable the password protection, you must log into a user profile. To login do the following steps:

- Press the lock icon in the top right corner of the screen.
- Press the **USER NAME** box and select the desired user profile.
- Press the **PASSWORD** box currently displaying "0"
- Input the correct password for the user followed by ENTER.
- Default passwords can be found in the table above
- Press **Login**.
- The lock icon in the top right corner should now be open.

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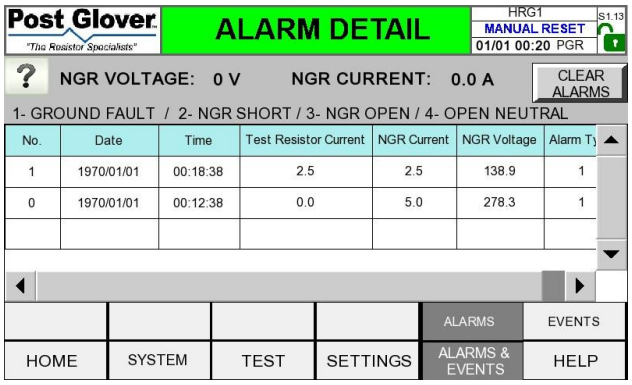
Section 9 – Troubleshooting Alarms and Events

The Alarm and Event tables will log which alarms or events have occurred, when it occurred, what the values detected were at the time, and when the system returned to a normal state. Any active alarm states will be displayed on the home screen with additional information.

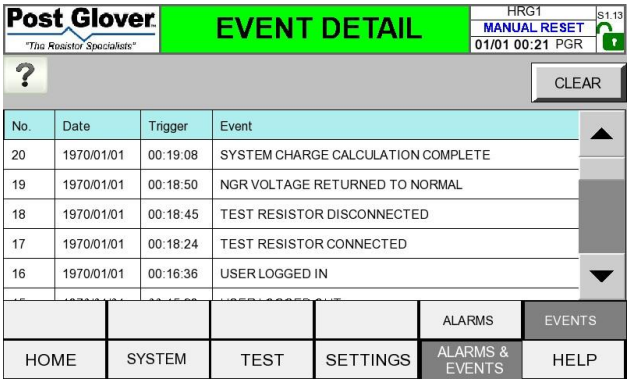
9.1 Alarm and Event Tables

9.1.1 Alarm Detail



This table displays the historical data of alarms on the system. It is capable of recording 200 alarms with FIFO event management. They are arranged chronologically with the most recent alarm appearing on top. *See section 9.2 for detail on the specific alarm types.* Once alarm conditions have been clear from a unit the data tabled can be cleared by pressing the **CLEAR ALARMS** button. An administrator level login is required.

9.1.2 Event Detail



This table displays the historical data of events that have occurred in the SmartPulse system. It is capable of recording 200 events with FIFO event management. They are arranged chronologically with the most recent event appearing on top. The events table can be cleared by pressing the **CLEAR** button. An administrator level login is required.

9.2 Alarm Types

9.2.1 Alarm Type 1 – Ground Fault

This alarm indicates the unit has experienced a phase to ground fault. The unit identifies a ground fault as any time the voltage or current exceed the values set at the alarm settings for Overvoltage, or Over- current. *See section 4.4.1 for more information.* This alarm will stay active until the ground fault clears. The pulse function may be used to help locate for the fault. *See section 6 for details on fault detection.*

9.2.2 Alarm Type 3 – NGR Open

This alarm indicates the electronics module has detected an open circuit between neutral and ground in the SmartPulse unit. The unit identifies an NGR Open alarm using the Resistor Health Sensing settings *see section 4.4.3 and section 7 for more information.* To troubleshoot this alarm, verify the connection from the unit's neutral to ground through the resistor is not Open.

9.2.3 Alarm Type 4 – Open Neutral

This alarm indicates the unit has detected an open circuit between neutral and ground in the connection from neutral(X0) to ground. The unit identifies an Open Neutral alarm using the Neutral Sensing settings *see section 4.4.3 and section 7 for more information.* To troubleshoot this alarm, verify the connection from X0 to ground through the resistor is not Open. Once the cause of the alarm has been fixed, the alarm can be cleared by running a Ground Fault Test *see section 4.5.1 for more information.*

Alarm Type	System Condition	Alarm If
1 – Ground Fault	Ground fault in distribution system	Neutral Voltage exceeds Overvoltage Alarm Neutral Current exceeds Overcurrent Alarm
2 – Unused (Reserved)	N/A	N/A
3 – NGR Open	Open circuit in resistor path within HRG cabinet	Resistor Health value exceeds 10 minus the Resistor Health Deadband for 10 seconds
4 – Open Neutral	Open circuit in resistor path between source neutral connection and ground	NGR Current and Test Resistor Current < 0.5A for 7 seconds. This check is only performed during a Ground Fault Test, Pulse Test, or the 24Hr Neutral Sensing test (if enabled).

9.3 Events

The SmartPulse High Resistance Grounding system considers all noncritical system changes events. These include user login/logouts, system test, alarm states clearing, operator mode changes, and pulsing activation. Events can be used in conjunction with alarms to track exactly when intermittent faults occur and clear to provide additional information for fault troubleshooting.

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Section 10 – Maintenance

Normally, no maintenance is necessary for the SmartPulse high resistance grounding system. However, periodic inspections are needed to ensure that the controller is functioning correctly and the resistor is still capable of protecting the system. Post Glover Resistors recommends that the periodic inspections coincide with a normal system Preventative Maintenance schedule.

The following procedure is recommended for periodic field inspections:

1. De-energize the system being grounded. Open the front panel and open/turn OFF the disconnect switch (SW1) on the SmartPulse, which will de-energize the control circuits (for units with a CPT) and isolate the connection between the system neutral and ground. For units with externally provided control power, turn off the power on the external disconnect. For units with an unswitched neutral, the protected transformer must be deenergized. Always use proper lock-out/tag-out procedures when working on electrical equipment.

> ***WARNING***: *Danger: High Voltage*
>
> ***AVERTISSEMENT***: *Danger: Haute Tension*

2. Remove the back panel of the free-standing enclosure. This will allow for a visual inspection of all internal components.

3. Check the enclosure for signs of damage from weather or rodents. Remove any dirt or debris from the inside of the enclosure using a vacuum cleaner.

4. Carefully check for cracked insulators and resistor cores. A MEGGER or Hi-Pot test is the most reliable method of ensuring that the insulation is still providing the necessary electrical isolation. Remove any connections from the resistor elements to ground and the controller before performing one of these tests.

5. With SW1 open/OFF, measure the resistance between the neutral (at the bottom of SW1) and ground (green terminal block on the DIN rail). Compare this measurement with the ideal resistance, which is calculated by dividing the system L-N voltage by the fault value chosen on the tap selection switch or terminal block. If the measurement is more than 15% different from the ideal resistance, connections should be checked and/or resistors replaced.

6. Check all internal connections for tightness. Check wiring for signs of damage from heat or overloads.

7. Replace all side covers removed during inspection and check the mounting bolts for tightness. Close/turn ON SW1. Close the front door of the control enclosure.

8. After re-energizing the system, perform a Ground Fault Test *see section 4.5.1* to verify system operation. If significant changes to the protected system were made, also perform a System Charging current test *see section 4.5.3.*

9. FOR REPLACEMENT PARTS OR ASSISTANCE, CALL 1-800-537-6144 (or from outside the USA, +1-859-283-0778) or e-mail sales@postglover.com. Please have the resistor nameplate information readily available when you call.

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Section 11 – Troubleshooting by Symptom

11.1 Alarm active/Home Screen is red:

1. Active alarms are displayed in the middle of the Home Screen. Determine if the fault is still active.
2. If the alarm is not active, an event will be recorded in the Event table *see section 9.1*, indicating when the fault condition returned to normal.
3. The Alarm table identifies voltage and current readings at alarm time, as well as alarm type *see section 9.1*.
4. Many ground faults will have two alarms associated with the fault: Overvoltage, and/or Overcurrent. For active Ground Faults, *refer to section 6: Locating a Ground Fault/Using Pulse.*

11.2 No information on display:

1. Is 24VDC power available? Check the voltage at the power supply output terminals with the disconnect switch (SW1) in the ON position. If there is no voltage present, check the fuses and the source 120VAC power.
2. Is the HMI power cable secure? Verify that the wires between the HMI and base panel are firmly connected.
3. If both of the above check out OK, consider replacing the HMI.

11.3 Ground Fault Test does not seem to function properly (no alarm):

1. Verify that the HMI is logged in as Maintenance or Administrator.
2. Do the voltage and current readings on the display increase during the test?
   a) If so, the **OVERVOLTAGE ALARM** and **OVERCURRENT ALARM** settings may need to be lowered for the fault to register.
   b) If not, there may be an installation issue, such as the Neutral wire for the HRG not connected to the system neutral.
3. Is there heat coming from the test resistor? Check by feeling for warm air from the exhaust vent of the resistor enclosure. If there is heat and there is no voltage and current reading on the NGR, this condition is indicative of a solidly-grounded neutral. Check the transformer/generator X0 bushing and the switchgear to make sure that all connections between neutral and ground are removed.

For further assistance, navigate to the HELP screen and use the contact information provided to contact Post Glover Resistors. When contacting Post Glover Resistors, please provide the following:

1. The name/type of alarm
2. The SO Number for the equipment, which can be found on the black nameplate on each Post Glover Resistors Unit
3. Any details which may be pertinent.

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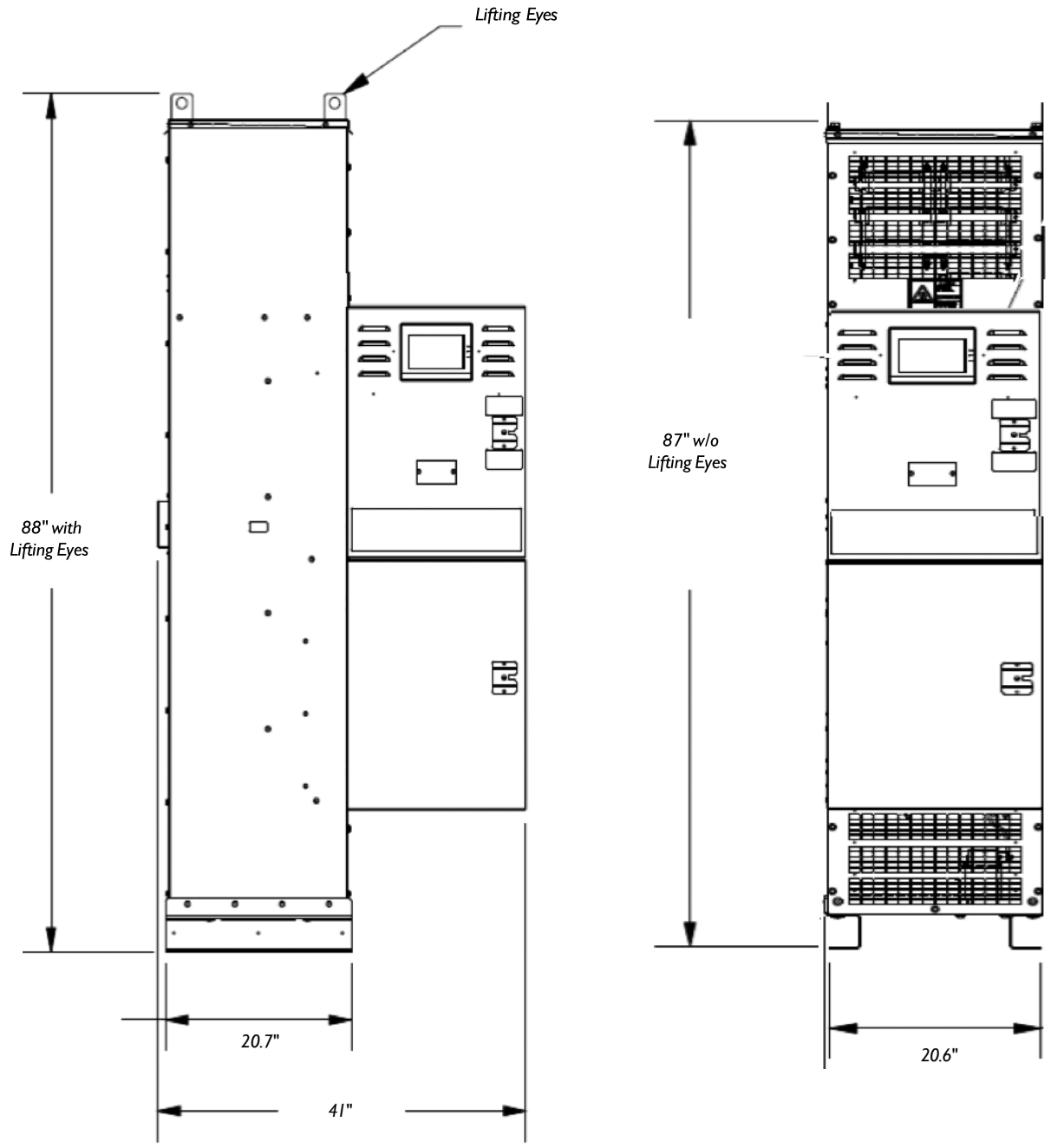
Appendix A – Dimension Drawings, Low Voltage Enclosure

Refer to the specific order drawings for the SmartPulse for connections and more detailed dimensions.



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Appendix B – Customer Connection Details

B.1 Freestanding Unit

The tables below indicate the wiring requirements to connect the SmartPulse to the customer equipment. For each wire, the ending termination locations at the SmartPulse are given along with the wire temperature rating, size, color and termination requirements.

Wye unit without control power transformer:

Terminal 1	Termination Type	Terminal 2	Termination Type	Wire Temp	Wire Size	Wire Color
SW1-1	0.625” stripped wire	Xfmr/Gen X0	By customer	60/75C	#8	White
SW1-5	0.5” stripped wire	Swgr. L3	By customer	60/75C	#14	Black*
CFU5-1	0.5” stripped wire	Cust 120VAC Line**	By customer	60/75C	#18 to #14	Red
TB1-N	0.5” stripped wire	Cust 120VAC Neutral**	By customer	60/75C	#18 to #14	White
GNDB#	ILSCO CSWS-8-8	Customer Ground	By customer	60/75C	#8	Green

Wye unit with control power transformer:

Terminal 1	Termination Type	Terminal 2	Termination Type	Wire Temp	Wire Size	Wire Color
SW1-1	0.625” stripped wire	Xfmr/Gen X0	By customer	60/75C	#8	White
SW1-3	0.5” stripped wire	Swgr. L2	By customer	60/75C	#14	Black*
SW1-5	0.5” stripped wire	Swgr. L3	By customer	60/75C	#14	Black*
GNDB#	ILSCO CSWS-8-8	**Customer Ground**	**By customer**	**60/75C**	**#8**	**Green**

Delta unit without control power transformer:

Terminal 1	Termination Type	Terminal 2	Termination Type	Wire Temp	Wire Size	Wire Color
SW1-1	0.5” stripped wire	Swgr. L1	By customer	60/75C	#14	Black*
SW1-3	0.5” stripped wire	Swgr. L2	By customer	60/75C	#14	Black*
SW1-5	0.5” stripped wire	Swgr. L3	By customer	60/75C	#14	Black*
CFU5-1	0.5” stripped wire	Cust 120VAC Line**	By customer	60/75C	#18 to #14	Red
TB1-N	0.5” stripped wire	Cust 120VAC Neutral**	By customer	60/75C	#18 to #14	White
GNDB#	ILSCO CSWS-8-8		By customer	60/75C	#8	Green

Delta unit with control power transformer:

Terminal 1	Termination Type	Terminal 2	Termination Type	Wire Temp	Wire Size	Wire Color
SW1-1	0.5" stripped wire	Swgr. L1	By customer	60/75C	#14	Black*
SW1-3	0.5" stripped wire	Swgr. L2	By customer	60/75C	#14	Black*
SW1-5	0.5" stripped wire	Swgr. L3	By customer	60/75C	#14	Black*
GNDB#	ILSCO CSWS-8-8	**Customer Ground**	**By customer**	**60/75C**	**#8**	**Green**

*The three-phase wire color can be the customer's standard colors, such as Brown, Orange, Yellow, etc.

**Customer must provide remote disconnecting means for 120VAC control power circuit.

B.2 Wall-Mounted Unit

In addition to the connections above, the wall-mounted unit requires connections between the wall-mounted control unit and the freestanding resistor unit. These additional connections are in the following table:

Terminal 1	Termination Type	Terminal 2	Termination Type	Wire Temp	Wire Size	Wire Color
LDEM-4	Panduit FSD80-8-D	TBR-T	Burndy YAV14	60/75C	#14	Black
LDEM-6	Panduit FSD83-18-C	TBR-N	ILSCO CSWS-8-8	60/75C	#8	White
LDEM-7	Panduit FSD83-18-C	TBR-P	ILSCO CSWS-8-8	60/75C	#8	White
LDEM-8	Panduit FSD83-18-C	GNDB#	By customer	60/75C	#8	Green
TBR-F	ILSCO CSWS-8-8	GNDB#	By customer	60/75C	#8	Green
TB2-G	Panduit FDS76-8-D	GNDB#	By customer	60/75C	#18	Green

Terminal block TBR is located in the resistor cabinet.

#Customer ground bus GNDB provided as per applicable codes and standards.

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B.3 Torque Recommendations for Customer Connections

The following table provides the torque required when tightening customer connection hardware unless superseded by documentation provided with the sales order:

SAE				
304, 316, or 18/8 Stainless Steel, Lubricated	Size-Pitch	Torque Value Inch-Lbs.	Torque Value Foot-Lbs.	Torque Value N-m
	#8-32	14.4	1.2	1.6
	#10-32	24	2.0	2.7
	¼”-20	72	6	8
	5/16”-20	120	10	14
	3/8”-16	240	20	27
	½”-13	540	45	61
Zinc Plated #2 Grade Higher, Dry	Size-Pitch	Torque Value Inch-Lbs.	Torque Value Foot-Lbs.	Torque Value N-m
	#8-32	18	1.5	1.6
	#10-32	24	2.0	2.7
	¼”-20	72	6	8
	5/16”-20	120	10	14
	3/8”-16	240	20	27
	½”-13	540	45	61
METRIC				
304, 316, or 18/8 Stainless Steel, Lubricated	Size-Pitch	Torque Value Inch-Lbs.	Torque Value Foot-Lbs.	Torque Value N-m
	M4-0.7	24	2.0	2.7
	M5-0.8	48	4.0	5.4
	M6-1	72	6	8
	M8-1.25	120	10	14
	M10-1.5	240	20	27
	M12-1.75	540	45	61
	M14-2	-	75	102
	M16-2	-	120	163

Appendix C – Control Specifications

C.1 Ground Circuits:

1. Low Voltage HRG Digital Electronics Module (LDEM)
   a) Voltage Limit: 600VAC
   b) Current Limit: 30A

C.2 Controller Output Relays:

1. System Fault: 3A @ 120/230VAC, 2A @ 24VDC, 200mA @ 110VDC, 100mA @ 220VDC, refer to drawings for contact logic
2. Ground Fault: 3A @ 120/230VAC, 2A @ 24VDC, 200mA @ 110VDC, 100mA @ 220VDC, refer to drawings for contact logic

C.3 Communication Ports:

1. HMI Com1: 1 channel, RS-485
   a) D-SUB, 9 pin male connector, refer to drawings for connector pin-out
   b) Baud Rate: 1200 to 187500 bps
   c) RS-485
      i. Cable type: Shielded twisted pair
      ii. Cable length: 1200m/4000ft maximum
      iii. Nodes: Up to 255
2. Ethernet switch ESW:
   a) 5-port 10/100Tx RJ45 Fast Ethernet
   b) Auto MDI/MDI-X Function
   c) Full/Half Duplex Mode
   d) Cable length: 100m/328ft (Fast Ethernet)
3. Door mount Ethernet interface:
   a) 22mm chromed plastic with polyamide boot
   b) RJ45 Ethenet interface, minimum CAT 5E
   c) IP65 degree of protection
   d) UL 1, 3R, 4 degrees of protection

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C.4 SD Card

1. HMI:
   a) Type of Port: Micro SD adapter connected to USB Host port
   b) Maximum Card size: 32GB
2. Smart Relay:
   a) Type of Port: Micro SD slot with cover
   b) Maximum Card size: 32GB

C.5 Miscellaneous

1. HMI Battery back-up: 3 years typical at 25°C
2. HMI Battery: Coin-type 3V, lithium ion manganese oxide (LMO) battery, CR2032
3. Maximum torque on connection screws, main disconnect switch: 2 N-m (17.7 in-lb).

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Appendix D – Setup Report Form

These pages are intended as means of recording the parameters and settings used when commissioning the Post Glover Resistors SmartPulse. This is not a "how-to" guide, nor is it intended as a substitute for reading the manual.

INSTALLATION INFORMATION					
Unit ID:		Date:			
Customer:		NGR Tap:	N		Amps
System Voltage:		Pulsing Tap:	N		Amps
Part Number:		Maximum Time On:		Continuous	
Serial No.:		Temp. Rise:			° Celsius

ROUTINE INSPECTION	
ENCLOSURE FINISH FREE OF DEBRIS?	Y / N
PHYSICAL INSTALLATION CORRECT?	Y / N
NEUTRAL AND GROUND TERMINATIONS PROPERLY CONNECTED?	Y / N
INTERNAL INSPECTION COMPLETED?	Y / N
CONTROL POWER CORRECTLY CONNECTED (CUSTOMER SOURCE OR CPT)?	Y / N
FIRMWARE VERSION INSTALLED:	
TIME AND DATE SET?	Y / N
CONTROL CIRCUIT OPERATIONAL TEST SUCCESSFUL?	Y / N
PARAMETERS SET AND EXPLAINED TO CUSTOMER?	Y / N
GROUND FAULT AND PULSING TAP SET TO CUSTOMER SPEC?	Y / N
GROUND FAULT AND PULSING TAP SET BASED ON TEST?	Y / N

NOTES

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PARAMETER SETTINGS								
Setup Menu	**Parameter**		**Default**	**Range**		**Setting**		**Section**
Alarm Settings	OVERVOLTAGE ALARM		60 V	0.0 - 9999.0				
	OVERCURRENT ALARM		4.0 A	0.0 - 9999.0				
	RESET MODE		MANUAL	AU / MN				
Alarm Timers	ALARM DELAY		10 SEC	2 - 30				
	ALARM RESEND		0 HR, 5 MIN	0 - 99 HR 0-59 MIN				
	PULSE RATE		5 SEC	2 - 10				
Sensing Param-eters	RESISTOR HEALTH SENSING ENABLED		OFF	ON/OFF				
	RESISTOR HEALTH DEADBAND		1 V	1 - 4				
	RESISTOR CALIBRATION PERFORMED			Y / N				
	X0 NEUTRAL SENSING		DISABLED	EN / DIS				
	NEUTRAL SENSING TIME		-	24 HR CLK				
General Settings	DEVICE NAME		HRG1	-				
	OUTDOOR MODE		OFF	ON/OFF				
	DATE SETTING		-					
	TIME SETTING		-					
Comm Settings	SMART RELAY	IP ADDRESS	10.113.0.80					
	ETHERNET SETTINGS	IP ADDRESS	10.113.0.168					
		GATEWAY	10.113.0.1					
		SUBNET MASK	255.255.255.0					
	RS-485 SETTINGS	BAUD RATE	115200	Drop-down				
		TIMEOUT	3	0-9999				
		NETWORK ID	64	0-9999				
Tap Settings	FAULT CURRENT TAP		Depends on specific ratings ordered					
	PULSE CURRENT TAP							
	TEST CURRENT TAP							

Customer Signature: _____ Date: _____

Technician Signature: _____ Date: _____

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