

Low voltage high resistance grounding systems



C-HRG Freestanding NEMA® 1 Unit



C-HRG Walmounted Unit
(Separately Mounted Resistors Not Shown)

Low voltage high resistance grounding

Where continuity of service is a high priority, high resistance grounding can provide the safety of a grounded system and also minimize the risk of service interruptions due to grounds. The concept is a simple one: provide a path for ground current via a resistance that limits the current magnitude, and monitor to determine when an abnormal condition exists. This provides maximum continuity of service because no tripping occurs for the resistance-limited ground fault.

The ground current path is provided at the point where the service begins by placing resistance in the connection from system neutral to ground. Control equipment continuously measures ground current; a relay detects when the current exceeds a predetermined level. An alarm alerts building personnel that a ground exists. The system has built-in fault tracing means to assist in finding the source of the ground. An integral transformer provides control power from the primary source.

Standard features

- Current sensing ground fault detection (1–5A pickup/0.5–20 sec delay)
- Ground current transformer (10/10 ratio)
- Control circuit disconnect switch (fused)
- Lockable door handle
- Ground current ammeter (0–10A, 1% accuracy)
- Indicating lights
 - Red (ground fault)
 - Green (normal)
 - White (pulse)
- Adjustable pulsing timer (0–10 sec)
- Tapped resistors (1–5A)
- Three-position selector switch (normal, pulse, test)
- Control switch for manual or automatic reset
- Ground fault contacts (1-NO/1-NC)
- Shorting terminal block for ground current transformer
- UL® Label
- Rated for use up to 200 kA fault current system
- Front accessible
- Sleeve type wire markers
- Three “zig-zag” or “wye-broken delta” grounding transformers for systems without a neutral point

EATON

Powering Business Worldwide

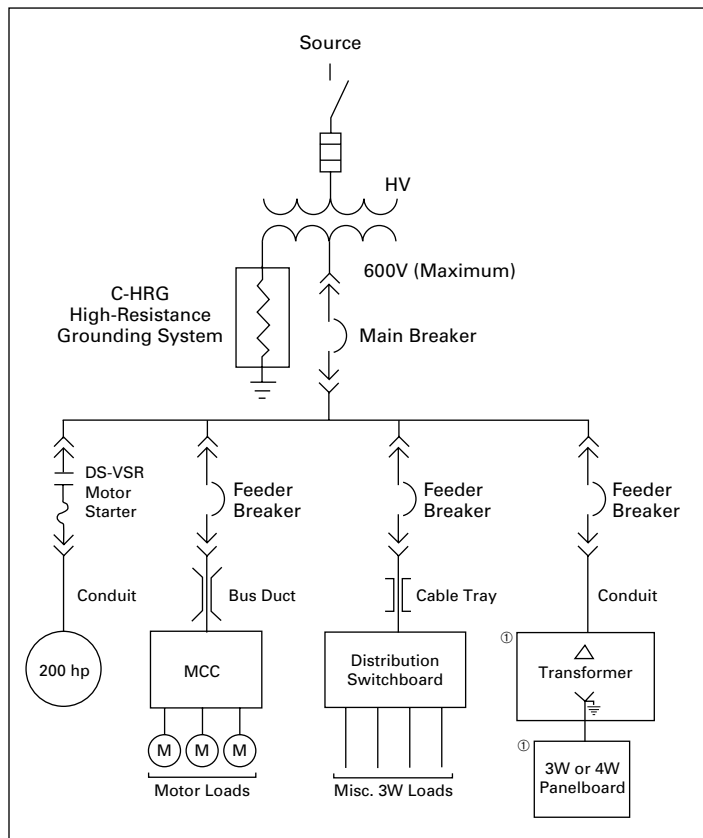


Figure 1. Typical Distribution System

① Phase-to-neutral loads require a delta-wye distribution transformer. The neutral on the secondary side of this transformer must be solidly grounded.

600/347V (maximum) wye systems

To add high resistance grounding to a wye-connected system, resistors are placed in series with the neutral-to-ground connection of the power source. The resistors are chosen to limit the current to a maximum value of 5A.

Note: Per 1993 NEC® 250.5b, exception No. 5, line-to-neutral loads may not be connected to a system if it is resistance grounded.

600V (maximum) delta systems

To add high resistance grounding to an ungrounded delta-connected system, a neutral point must be created. Three single-phase transformers can be interconnected in a zig-zag or wye-broken delta configuration to provide such a neutral point. The transformers and grounding resistors are chosen to limit the ground current to a maximum value of 5A.

Note: The neutral point may not be used to serve phase-to-neutral loads. Also, this technique may be applied on wye-connected sources when the neutral point is not conveniently accessible from the service entrance location.

Ground current detection

Any time a system is energized, a small ground current called the “capacitive charging current” will be observed. For low voltage (600V and below) systems, this naturally occurring current is typically 1A or less.

When one phase becomes grounded, additional current above the charging level will flow. As all ground current must flow through the grounding resistor/transformer assembly, an ammeter in this circuit will read the total amount of ground current. By placing a current-sensing relay in series with the ammeter, the current relay can be adjusted to pick up at a level in excess of the capacitive charging current, therefore indicating the abnormal condition.

Alternatively, an optional voltmeter relay can be connected across the grounding resistors. The voltage across the resistors is proportional to the amount of ground current. The voltmeter relay’s pickup adjustment is set above the capacitive charging current to the desired detection level.

In both current and voltage detection methods, the ground current ammeter provides a direct reading of the total actual ground current present in the system at that time. It will be helpful to periodically note the ammeter’s reading; a trend toward higher values may indicate the need for equipment maintenance and consequently reduce the occurrence of unplanned shutdowns.

Indication and alarm circuits

When a fault is detected, an adjustable time delay is provided to override transients. When the time delay has been exceeded, the green “normal” light will turn off, the red “ground fault” light will turn on, and the ground alarm contacts will transfer. If equipped with the optional alarm horn, it will sound.

When the fault is cleared, the current/voltage relay will reset. If the reset control is set to “auto”, the lights will return to “normal” on, “ground fault” off, and the ground alarm contacts will re-transfer. If the reset control is set to “manual”, the lights and relay will remain latched until the operator turns the reset control to “reset”. The lights and ground alarm contacts will then return to normal. The system can be reset only if the fault has been cleared.

During a fault, the optional alarm horn can be silenced at any time by using the “alarm silence” pushbutton. It will not sound again until either the system is reset or the re-alarm timer expires. The re-alarm timer is activated by the “alarm silence” control. If the horn has been silenced but the fault has not been cleared, the timer will run. It has a range of 2–48 hours. When the timer times out, the horn will sound again, alerting maintenance personnel that the fault has not been cleared.

Test circuit

A test circuit is provided to allow the user to quickly determine that the system is working properly. The test circuit will operate only under normal conditions—it will not allow testing if the system is sensing a fault. A separate grounding resistor is provided, and is connected to a relay operated by the “test” position of the mode selector switch. The relay’s contact grounds phase B through the test resistor, causing ground current to flow. The system then reacts as it would under actual system ground conditions—lights transfer, alarm contacts transfer, and the (optional) horn sounds.

Pulser circuit

The pulser circuit offers a convenient means to locate the faulted feeder and trace the fault to its origin. The pulser is available any time a fault has been detected. The pulse intervals are controlled by an adjustable recycle timer. The "pulse" light flashes on and off, corresponding to the on/off cycles of the pulser contactor. The pulser contactor switches a bank of resistors on and off, allowing a momentary increase in the ground current (approximately a 5A current pulse above the ground current).

Locating a ground fault

The current pulses can be noted with a clamp-on ammeter when the ammeter is placed around the cables or conduit feeding the fault. The operator tests each conduit or set of cables until the pulsing current is noted. By moving the ammeter along the conduit or checking the conduit periodically along its length, the fault can be traced to its origin. The fault may be located at the point where the pulsing current drops off or stops.

If little or no change in the pulsing current is noted along the entire length of a conduit, then the fault may be in the connected load. If the load is a panelboard, distribution switchboard, or motor control center, repeat the process of checking all outgoing cable groups and conduits to find the faulted feeder. If the fault is not found in an outgoing feeder, the fault may be internal to that equipment.

Note: It may not be possible to precisely locate faults within a conduit. The ground current may divide into many components, depending on the number of cables per phase, number of conduits per feeder, and the number and resistance of each ground point along the conduits. The resulting currents may be too small to allow detection or may take a path that the ammeter cannot trace. An important note to keep in mind is that although the pulser can greatly aid in locating a fault, there may be certain conditions under which the pulses cannot be readily traced, and other test procedures (megohm, high-potential, and so on) may be needed.

Sequence of operations

Normal

- Green "normal" light on
- Red "ground fault" light off
- White "pulse" light off
- System control switch in "normal" position
- Reset control switch in either "auto" or "manual"

Test

Turn and hold the system control switch in the "test position". Phase B will be grounded via the test resistor. The ground current will activate the sensing circuit, causing the green "normal" light to turn off and the red "ground fault" light to turn on. The pulser will be activated as well. The white "pulse" light will turn on and off as the pulser contactor closes and opens. The ground current ammeter will display the total ground current, including the incremental pulse current. When ready, return the system control switch to "normal". The pulser will stop. If the reset control is in the "manual" position, turn it to "reset" to reset the fault-sensing circuit. The red "ground fault" light will turn off, and the green "normal" light will turn on. Test mode is not available if the system is detecting a ground. The sensing circuit will disable the test circuit.

Ground fault

When the sensing circuit detects a fault, the green "normal" light will turn off and the red "ground fault" light will turn on. The ground current ammeter will indicate the total ground current. To use the pulser, turn the system control switch to "pulse". The pulser contactor will cycle on and off as controlled by the recycle timer relay. Use the clamp-on ammeter to locate the faulted feeder. Open the feeder and clear the fault. If the reset control switch is in the "manual" position, turn it to "reset" to reset the sensing circuit (if reset control is in "auto", it will reset itself). When ready to restore service to the load, close the feeder. Return the system control to "normal."

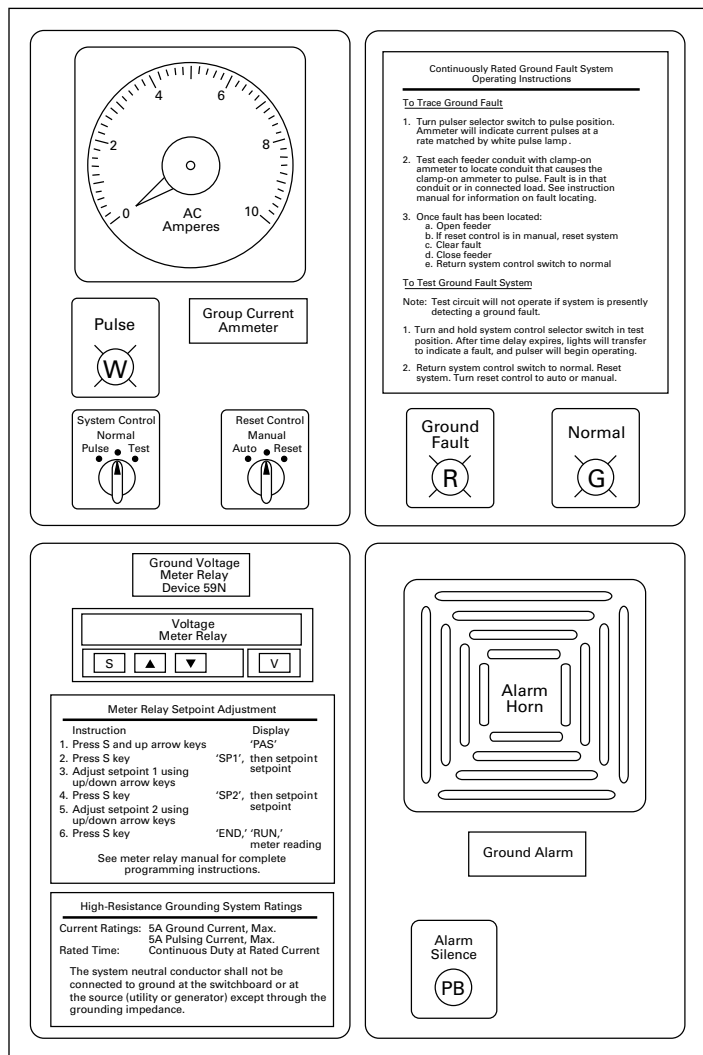


Figure 2. Ground Fault System

Construction features

- Tapped resistors supply ground current between 1A and 5A in 1A increments
- Pulse current is an additional 5A (pulse currents of a lower magnitude may be difficult to detect)
- Pulse timer is adjustable from 3 to 60 pulses per minute
- Time delay for current sensing relay is 0.5 to 20 seconds with a 1A to 5A pickup (time delay for voltage sensing relay is 1 to 60 seconds)
- Fused disconnects are supplied for control and ground transformers
- All door-mounted equipment is guarded against accidental contact
- All exterior nameplates are fastened with stainless steel screws
- Nameplates are 2-ply with 3/16-inch lettering; the nameplate size is 1-inch x 2.5 inches; white background with black lettering is standard
- Top and bottom cable entry areas are standard
- Phase and neutral terminals accept No. 8 AWG to No. 12 AWG
- Ground terminal accepts wire sizes from No. 8 AWG to 500 kcmil; ground bus is 1/4-inch x 2 inches copper
- The paint is applied using an electrostatic powder coating system; the standard color is ANSI 61, light gray
- Line side fuses are rated for use up to 200 kA fault current systems; all other fuses are rated to protect each circuit as required
- The resistors are wire wound on a steel tube, insulated by Micarta®; resistors are mounted on a steel rack with ceramic insulators
- No. 8 AWG wire is used for internal connections from the neutral point to ground; control connections are a minimum of No. 14 gauge; all control wires' insulation is type SIS
- UL® Listed
- A list of recommended spare parts can be provided after the final engineering is complete
- Steel pocket on the inside of the door is provided to hold drawings and manuals

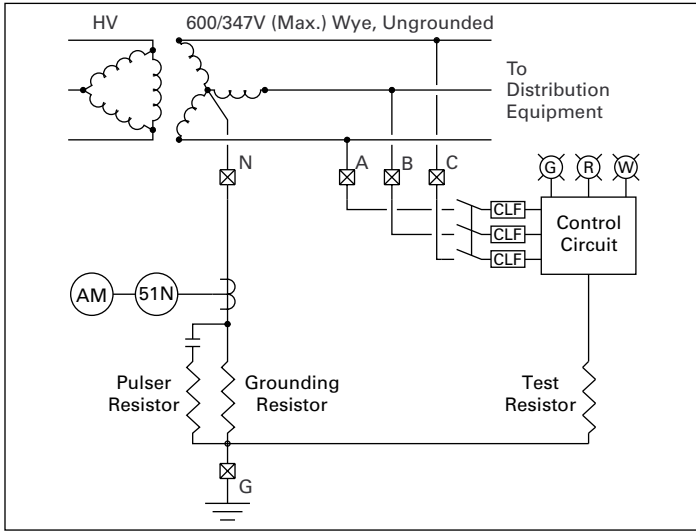


Figure 3. Four-Wire Source—Fault Detection via Current Relay

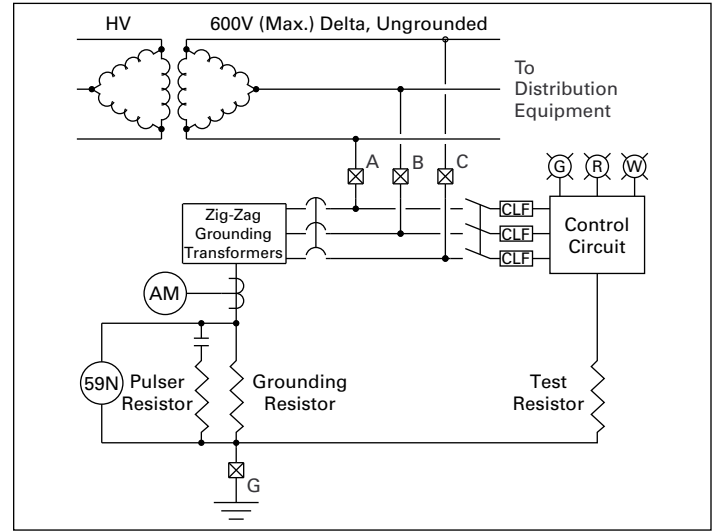


Figure 6. Three-Wire Source—Fault detection via Current Relay

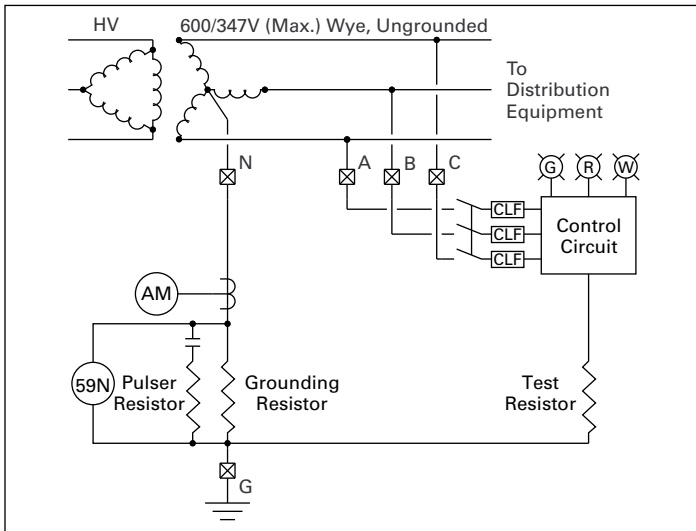


Figure 4. Four-Wire Source—Fault Detection via Voltmeter Relay

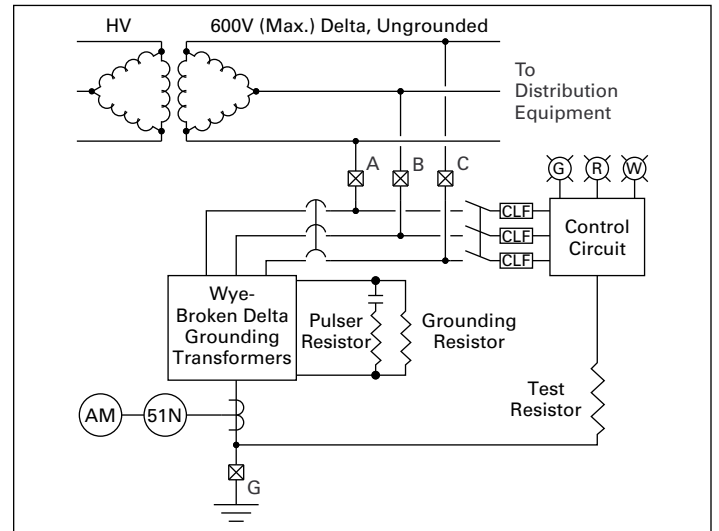


Figure 7. Three-Wire Source—Fault Detection via Voltmeter Relay

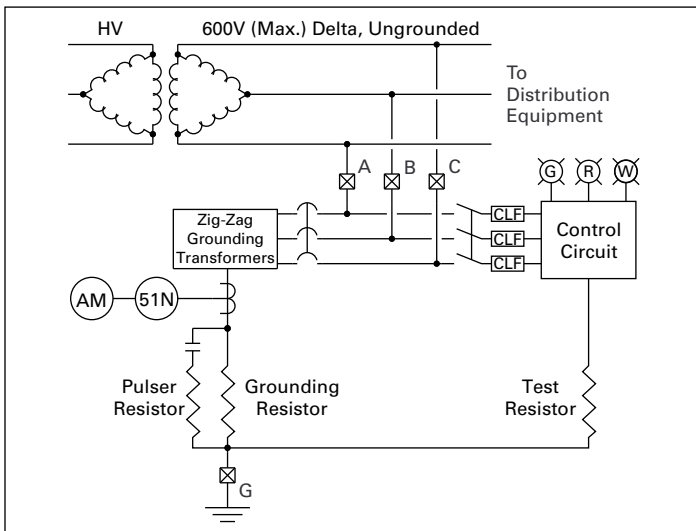


Figure 5. Three-Wire Source—Fault Detection via Current Relay

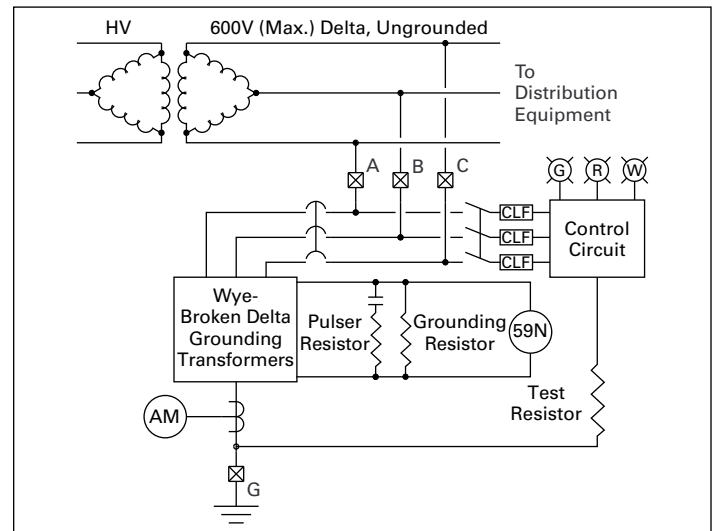


Figure 8. Three-Wire Source—Fault Detection via Voltmeter Relay

Dimensions in inches (mm)

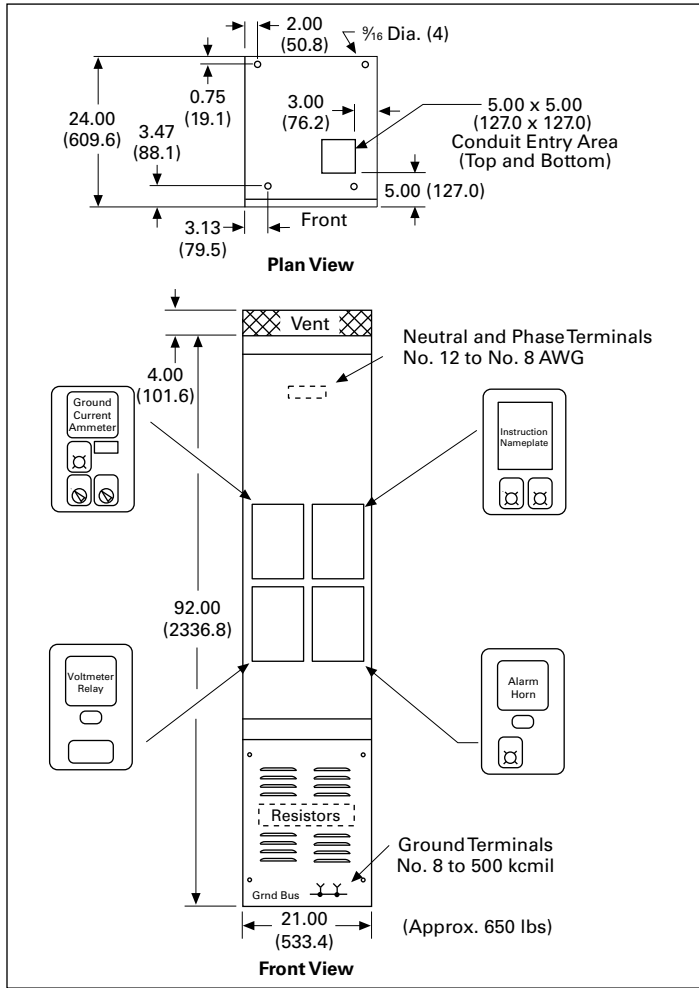


Figure 9. NEMA 1 Freestanding

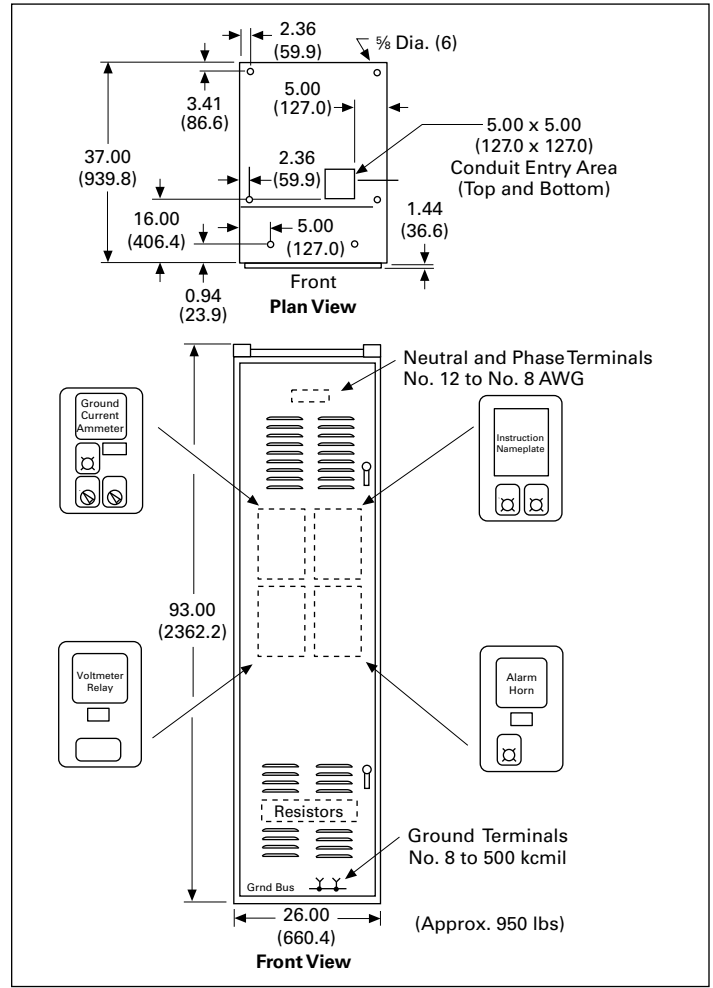


Figure 10. NEMA 3R Outdoor

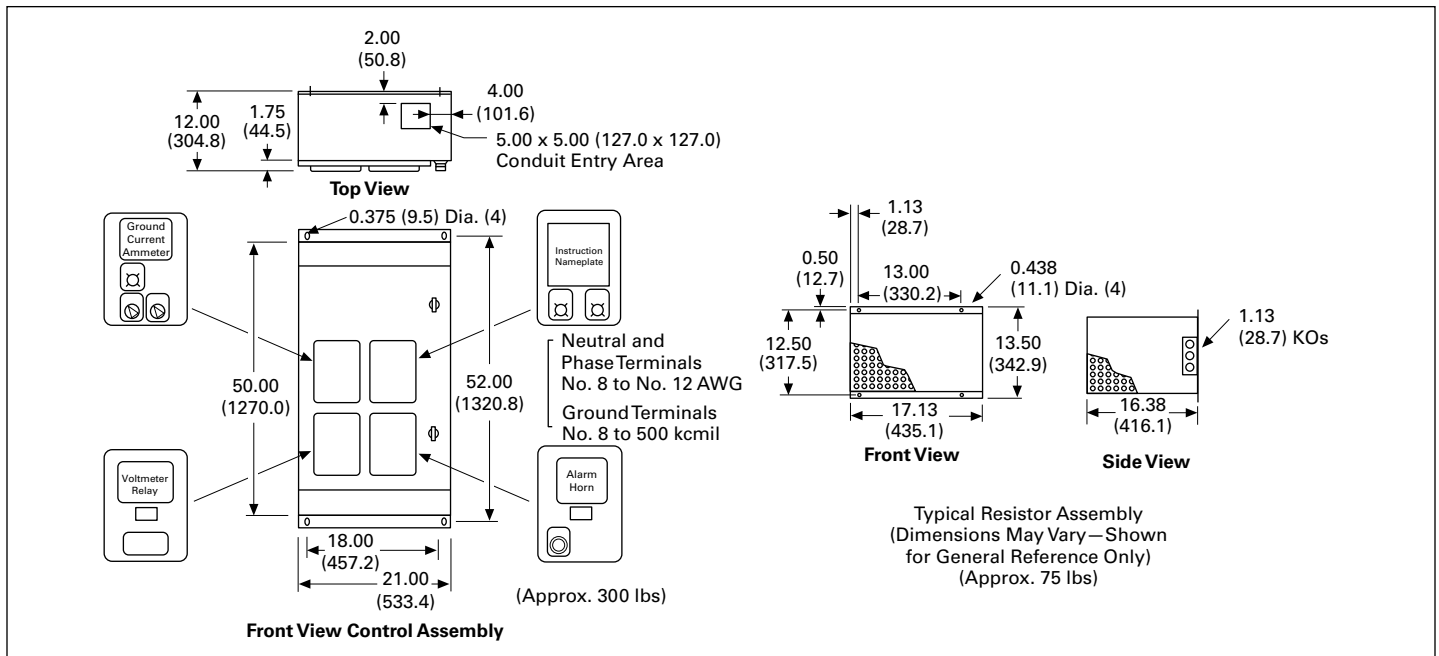


Figure 11. NEMA 1 Wallmounted

Typical specifications

Ratings

- Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 Vac maximum service
- The assembly shall be rated to withstand mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current (of 30,000A, 42,000A, 50,000A, 65,000A, 85,000A, 100,000A, or 200,000A symmetrical at rated voltage) as shown on the drawings
- All ratings shall be tested to the requirements of ANSI C37.20.1 and UL witnessed and approved

Construction

- The assembly shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the roof of the switchgear to ensure adequate ventilation within the enclosure
- The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills provided the floor is level to 1/8-inch per 3-foot distance in any direction (contractor supplied floor sills to be set level in concrete per manufacturer's recommendations). Base of assembly shall be suitable for rolling directly on pipes without skids
- The assembly shall be Eaton C-HRG high resistance grounding equipment using Eaton grounding resistors and/or grounding transformers as herein specified or approved equal
- Each vertical steel unit forming part of the assembly shall be a self-contained housing with an instrument compartment and a resistor compartment. The control compartment shall be segregated from the resistor compartment by means of steel barriers or, if indicated on the drawings, the resistor assembly shall be a separately mounted component furnished in its own ventilated enclosure
- The assembly shall be fully front accessible. Rear or side access shall not be required for installation or maintenance

Bus

- A copper ground bus shall be firmly secured to the assembly. It shall be silver-plated copper or tin-plated copper. Provide terminals for connection of the system grounding conductor, suitable for No. 8 AWG to 500 kcmil, copper or aluminum

Wiring/terminations

- Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required
- All control wire insulation shall be type SIS. Wire bundles shall be secured with nylon ties and anchored to the assembly without the use of adhesive-only wire anchors. All current transformer secondary leads shall first be connected to front accessible short-circuiting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires shall be provided with terminal blocks with suitably numbered strips. Provide wire markers at each end of all control wiring

Metering and controls

- Provide a separate control compartment with front hinged door that includes the following:
 - A switchboard type ground current ammeter, 1% accuracy, 250 degree scale, 0 to 10A AC
 - System control selector switch with pulse/normal/test positions. Switch shall spring-return from the test position
 - Reset control selector switch with auto/manual/reset positions. Switch shall spring-return from reset position. The auto position shall cause the ground fault relay to automatically reset when a ground is no longer detected. The manual position shall cause the ground alarm relay to latch and remain latched until the selector is moved to the reset position by the operator
 - A green lamp to indicate that the system is in normal condition, a red lamp to indicate that a ground fault has been detected and a white lamp that flashes at the same rate and at the same time as the pulsing contactor
 - An instruction nameplate that provides the operator with a step-by-step procedure for operating the controls
 - A rating nameplate that states the maximum ground current, maximum pulse current, and duty rating of the equipment at maximum current levels
 - A ground voltage meter-relay, 3% accuracy, 90 degree scale, 4.5-inch panel type, AC voltage-scaled to coordinate with system voltage, UL component-recognized (setpoint adjustment shall be via a front-mounted knob). Meter relay to be equipped with dual setpoints. One setpoint output contact set shall be wired to terminal blocks for field connection as shown on the drawings. Setpoint adjustments shall be via front-mounted knobs
 - An alarm horn with an alarm silence pushbutton and re-alarm timer. The horn shall be a heavy-duty, high-decibel type, adjustable from 78 dB to 103 dB. Alarm silence control shall reset when ground relay is reset. Alarm shall automatically re-sound at the end of a 2- to 48-hour field-settable time interval if alarm has been silenced but ground fault still exists. Re-alarm timer shall not be defeatable via any control device

- Provide the following control devices and features:
 - One normally open and one normally closed ground fault alarm contact each rated 10A at 240 Vac
 - Test loops (for convenient attachment of a snap-on hand-held ammeter) in the ground current and test current circuits
 - A test circuit protected by a current limiting fuse rated 200,000A and operated by the system control switch via a panel-mounted test circuit relay. The test circuit shall connect phase B to ground through a current-limiting resistor. The test circuit shall not be direct-wired to the door-mounted test switch. The test circuit relay shall be constrained from operating if a ground fault is presently being detected
 - A pulsing contactor, controlled by an adjustable timer. The timer shall allow an adjustment range of 0 to 10 seconds
 - 120 Vac control power transformer for self-contained operation. The control power transformer shall have current limiting primary fuses rated 200,000 AIC at the system voltage
 - Primary disconnect switch-mounted ahead of test and control power fuses
 - Tapped resistors with taps wired out to a convenient front accessible terminal block. Taps shall provide 1A to 5A of ground current in 1A increments. Resistors shall be heavy-duty industrial type, edge wound or wire wound design. Each resistor tube shall have a stamped steel rating nameplate. The resistor assembly shall be interconnected with 200°C rated No. 8 AWG wire. All connections to the resistor assembly shall be No. 8 AWG SIS wire
 - All wiring in the grounding circuit from the neutral point to the system ground terminal shall be No. 8 AWG type SIS minimum. All control wiring shall be No. 14 AWG type SIS minimum
 - A detailed schematic shall be furnished that accurately and completely describes the control and grounding circuits. All wire designations, terminal points, control device, and selector switch contact developments shall be shown. The schematic and the accompanying wiring diagrams shall be amended as required after final testing at the factory. An as-built copy of the schematic, wiring diagrams, and material list shall be packed with the unit prior to shipment. Provide a drawing pocket secured by screws or weldment for drawing storage within the assembly
 - When the power system source has a neutral terminal, as indicated on the contract drawings, the grounding resistors shall be connected to that neutral. When the power system source has no neutral point, zig-zag or wye-broken delta transformers shall be furnished in the assembly to provide a neutral point

Enclosures

- NEMA 1 freestanding enclosure
- Outdoor non walk-in enclosure
 - Assembly shall be enclosed in an outdoor NEMA 3R enclosure conforming to all applicable requirements of UL. The enclosure shall have a roof sloping toward the rear
 - The enclosure shall be provided with a front hinged door with provisions for padlocking. Ventilating openings shall be provided complete with removable air filters
- NEMA 1 wallmounted enclosure
- OEM panel-mounted, no enclosure

Nameplates

- Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum
- Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, and switches, shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams

Finish

- All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the assembly shall be the manufacturer's standard

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

© 2013 Eaton
All Rights Reserved
Printed in USA
Publication No. TD019001EN / Z14619
December 2013