

Supersedes TD.46F.01.T.E,
pages 1-8 dated August, 1999.

High Voltage High-Resistance Pulsing Ground Systems

Medium Voltage High-Resistance Pulsing Ground Systems (5 kV Max.)

Standard Features

- Current sensing ground fault detection (2-10 amperes pickup/0.5-20 second delay)
- Ground current transformer (10/10 ratio)
- Control circuit pull fuseblock
- Ground current ammeter (0-10 amperes, 1% accuracy)
- Indicating lights
Red (ground fault)
Green (normal)
White (pulse)
- Adjustable pulsing timer (0-10 seconds)
- Tapped resistors (limits primary current to 3-6 amperes)
- 3-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 CT
- UL label
- Wiremarkers

Product Standards

- Tapped resistors supply primary ground current between 3 and 6 amperes in 1 ampere increments.
- Pulse current is an additional 4 amperes. (Pulse currents of a lower magnitude may be difficult to detect.)



C-HRG Free-Standing NEMA 1 Unit

- 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 2 to 10 ampere pickup. Time delay for voltage sensing relay is 1 to 60 seconds.
- "Pull-type" fuse disconnects are supplied for control equipment protection.
- 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 2-1/2-inch. White background with black lettering is standard.

- Top and bottom cable entry areas are standard.
- Phase and neutral terminals accept #4 AWG to 500 kcmil.
- Ground terminal accepts wire sizes from #4 AWG to 500 kcmil. Ground bus is 1/4-inch x 2-inch copper.
- The powder paint is applied to the parts electrostatically. Metal surfaces are prepared by spray cleaning and phosphatizing. The powder paint is a polyester urethane. The standard color is ANSI 61, light gray. The paint is applied to a thickness of 1.5 mil.
- Appropriate current limit drawout type fuses are provided. The chassis is mechanically interlocked with a secondary circuit breaker to prevent its withdrawal under load conditions.
- Resistors are grid type to provide the maximum area for heat dissipation.
- No. 4 AWG wire is used for internal connections from the neutral point to ground. Control connections are a minimum of #14 gauge. All control wires insulation is type SIS.
- UL listed.
- Recommended spare parts list.
- Steel pocket on the inside of the door is provided to hold drawings and manuals.

Note: The C-HRG units can be applied on any 3-wire distribution system, regardless of the manufacturer of the distribution equipment or source power transformer.

A C-HRG High-Resistance Grounding Assembly can be completely described by an 8-digit catalog number: MVRG-_____

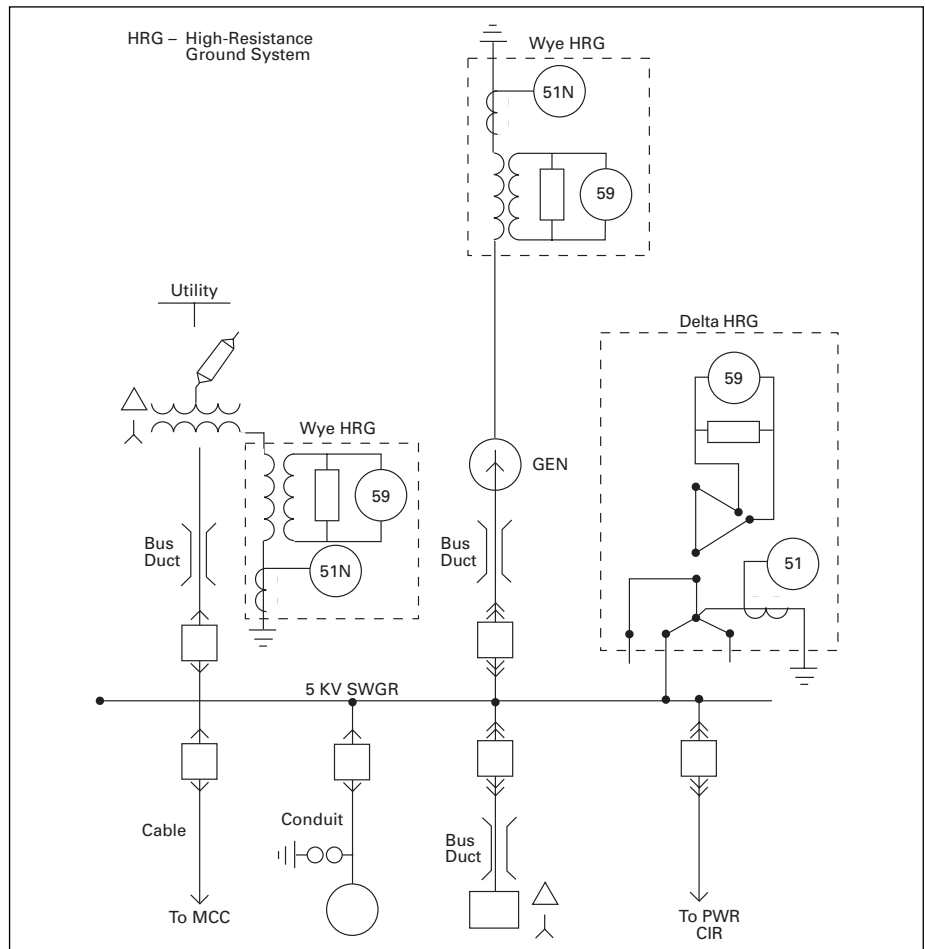
Catalog Digit	Feature	Feature Description	Option Code	Option Description
1	Enclosure Type	Free-standing enclosure for mounting ground TFMRs and resistors internally	F R	Free-standing NEMA1 Free-standing NEMA 3R outdoor
2	Distribution System Voltage	Voltage of Distribution System	W X Y	4200 V 60 Hz 2400 V 60 Hz 3300 V 60 Hz
3	System Neutral Point	Choose Wye when the neutral point of the power source is accessible for direct connection to grounding TFMR. Choose Delta when there is no neutral or when neutral is not accessible.	W D	Wye D (Wye broken Delta grounding TFMRs)
4	Fault Sensing	Current Sensing Voltage Sensing Voltage Sensing	C V D	Overcurrent relay Single set-point voltmeter relay Indicating voltmeter only
5	Audible Alarm	Alarm contacts are standard on all assemblies.	N L	No audible alarm Alarm horn with re-alarm timer
6	Loss of Control Power Alarm	A relay is connected across the customer's 120 volt AC supply.	N L	No relay Alarm relay with 1 NO and 1 NC
7	Indicating Lamps	Standard lights are industrial, oil-tight, transformer type. Optional are the same type lights except with a push-to-test feature.	T X	Transformer type incandescent lamps Push-to-test TFMR type
8	Wiremarkers	Marks all internal wiring for ease of maintenance.	S T	Standard wrap-on Tube/heat shrink type

Example: MVRG-FWWCLLTS defines a free-standing NEMA 1 enclosure, 4200V/60 Hz, Wye-connected system, current-sensing control scheme, alarm horn with re-alarm timer, alarm relay with 1 NO and 1 NC, transformer type incandescent lights, wrap-on wiremarkers.

High-Resistance Grounding

Where continuity of service is a high priority, high-resistance grounding can add the safety of a grounded system while minimizing the risk of service interruptions due to grounds. The concept is a simple one: provide a path for ground current via a grounding transformer (with adjustable resistance across its secondary) that limits the current magnitude and a monitor to determine when an abnormal condition exists.

The ground current path is provided at the point where the service begins, by placing a predominantly resistive impedance 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. A 120-volt AC supply (remote) is required for control power for the system.



4200V (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 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 6 amperes.

Application 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. This method is shown in the illustration to the left. One delta high-resistance grounding would ground the 5 kV system.

4200V (Maximum) Wye Systems

To add high-resistance grounding to a wye-connected system, resistors are placed across the secondary of a grounding transformer whose primary is 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 6 amperes.

Application Note: Per 1993 NEC 250-5b, exception No. 5, line-to-neutral loads may not be connected to a system in which the neutral is resistance-grounded. Refer to the illustration on page M3-10. Because the system shown has two switchable sources not permanently connected to the bus, two wye-type grounding systems are required.

Ground Current Detection

Any time a system is energized, a small ground current called the "capacitive charging current" will be observed. For medium voltage (4200V and below) systems, this naturally occurring current is typically 3A 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/grounding 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, thus 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 hence 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.

The grounding transformer secondary breaker must be closed for the system to be operational. Should this breaker be opened at any time, the system will signal a ground fault condition as a fail-safe feature. The breaker must be closed to clear the alarm signal.

When the fault is cleared, the current/voltage relay will reset. If the reset control is set on "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 on "manual," the lights and relay contacts 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 re-sound 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 re-sound, 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. The test operation does not simulate an actual system ground fault. It does, however, test the complete controls of the fault indication and pulsing circuitry. 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, thus allowing a momentary increase in the ground current (approximately a 4A 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.

Application 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 while 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, etc.) 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

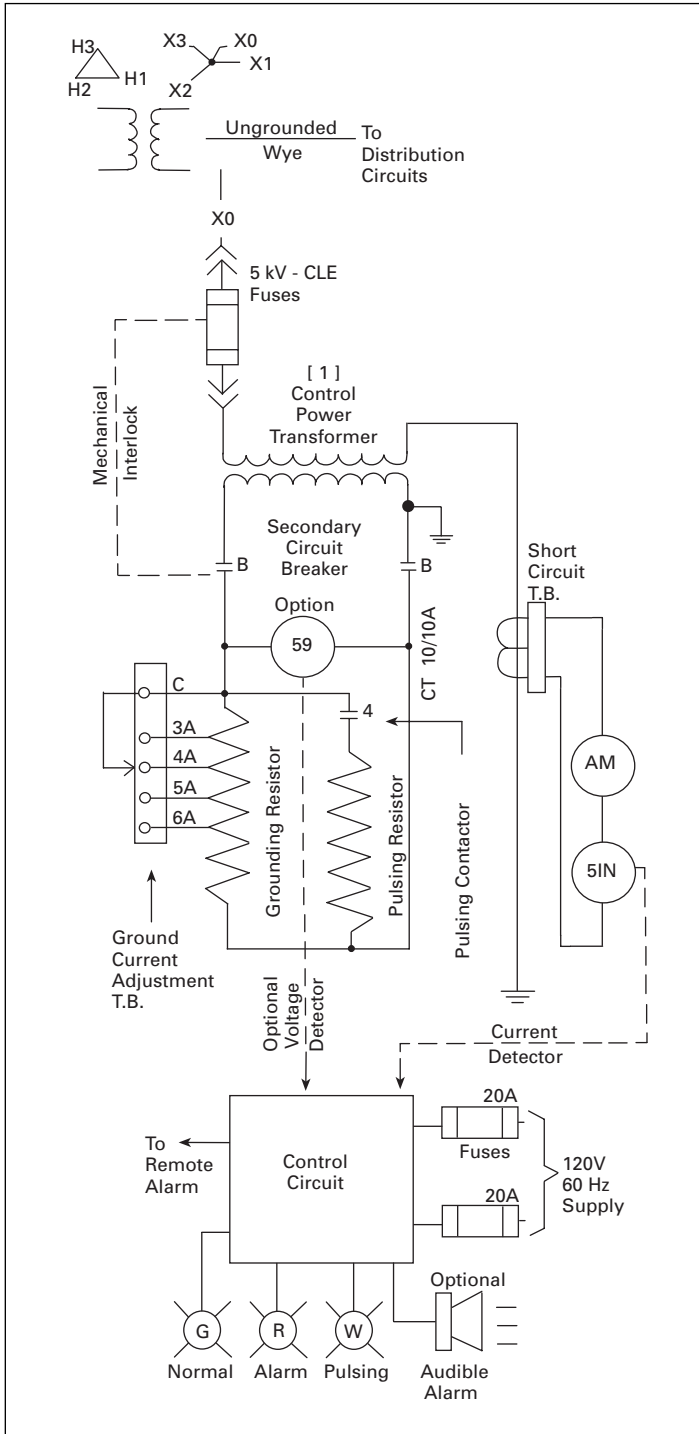
Turn and hold the system control switch in the "test" position. This mode will test the control circuitry only. It will by-pass the sensing circuit and cause the green "normal" light to turn off and the red "ground fault" light to turn on. The pulser will be activated as well. The white "pulse" light will turn on and off as the pulser contactor closes and opens. However, the ground current ammeter will not 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.

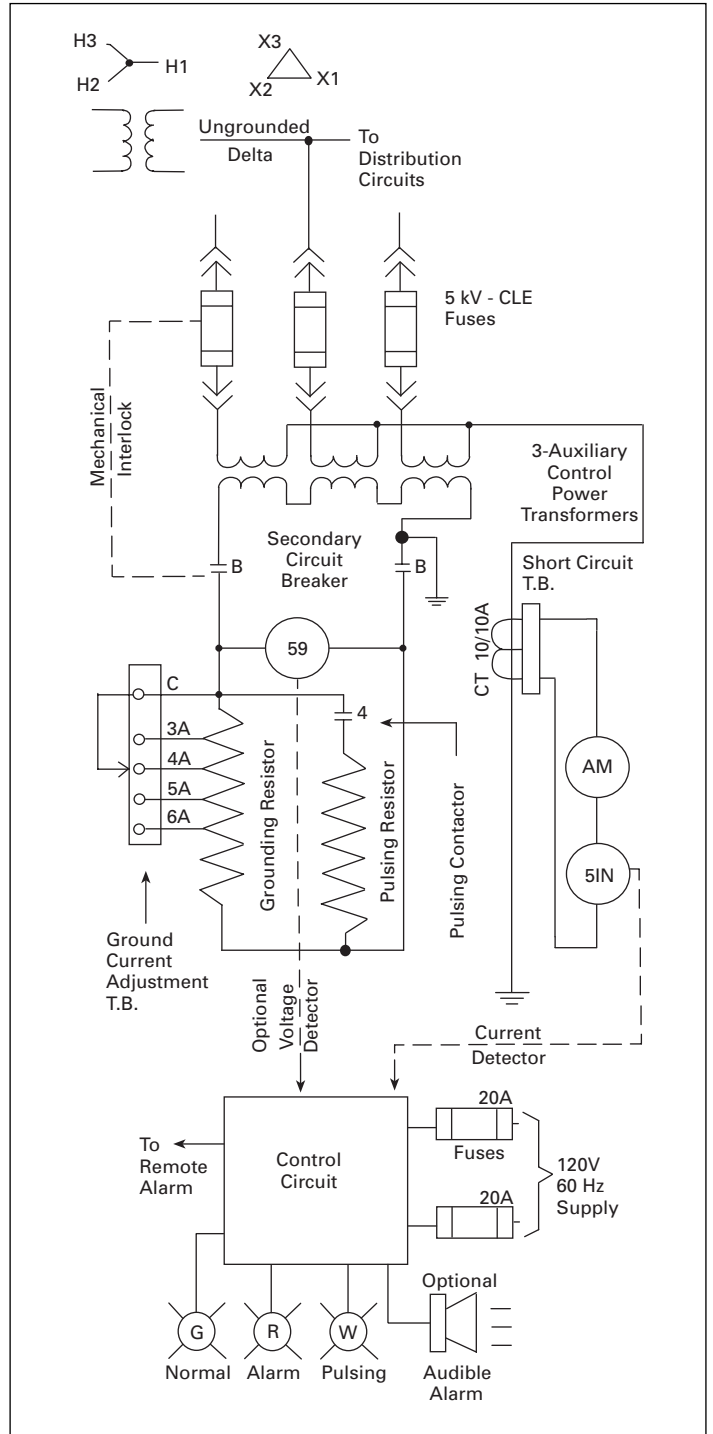
Ground Fault

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."

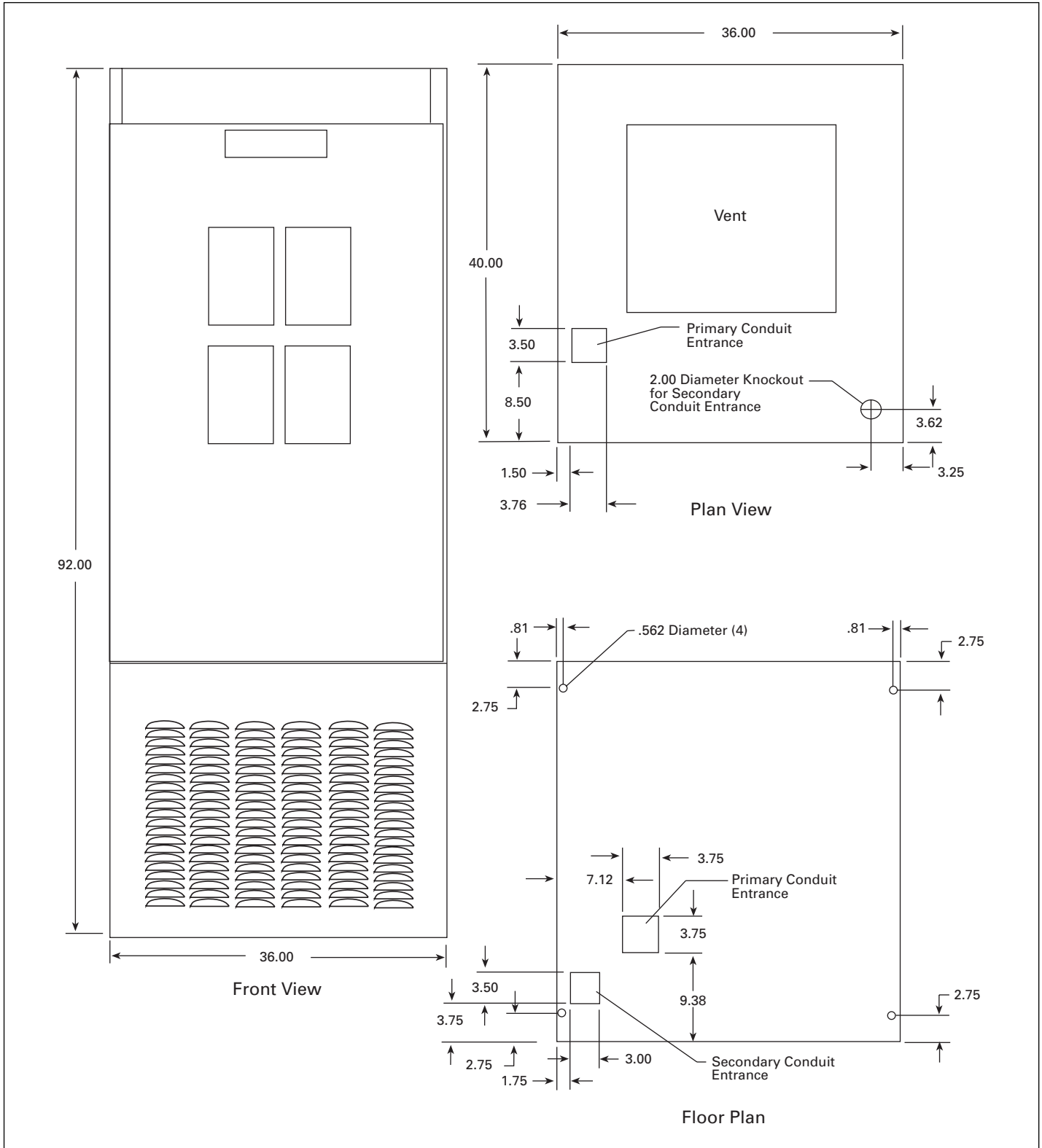
Ungrounded Wye System (with standard current and optional voltage relay fault detectors)



Ungrounded Delta System (with standard current and optional voltage relay fault detectors)



NEMA 1 Free-standing



General

Provide a high-resistance grounding system as a means to provide a path for ground current via a resistance that limits the current magnitude. While monitoring the ground current, the system must be able to determine when an abnormal condition exists. Once the abnormality is detected, the system shall alert building personnel that a ground exists. The system shall be suitable for 5000 Volt maximum service, and designed and tested for that voltage class in accordance with the latest standards of NEMA and UL.

System Ratings and Features

Provide a UL-labeled high-resistance grounding system equal to Cutler-Hammer catalog number _____ for use on a system with a short circuit capacity of ___kA at ___ Volts. The structure shall be a [free-standing NEMA 1] [free-standing NEMA 3R]. The system neutral point shall be provided by [the power transformer's wye neutral point] [wye-broken delta grounding transformers]. The ground current shall be detected with [an overcurrent relay] [a single-setpoint voltmeter relay]. [An alarm horn with re-alarm timer is required.] [An alarm to indicate the loss of control power is required.] The indicating lights shall be [transformer-type incandescent lamps] [push-to-test transformer type lamps]. Control wiring shall be marked using [wrap-on type] [heat-shrink sleeve type] wiremarkers.

[A portable clamp on detector with 1/2/5/10/20 ampere scales, a shorting switch and a storage case is required].

In addition to the components specified above, the following shall be supplied with each system:

- Ground current transformer (10/10 ratio)
- Control circuit disconnect switch (fused)
- Ground current ammeter (0-10 amperes, 1% accuracy)
- Control switch for manual or automatic reset
- Ground fault contacts (1-NO/1-NC) for customer use
- Shorting terminal block for ground current CT
- Adjustable pulsing timer (0-10 seconds)
- Tapped resistors (across neutral forming transformer secondary, limiting primary current to 3-6 amperes)
- 3-position selector switch (normal, pulse, test)
- Indicating lights
Red (ground fault)
Green (normal)
White (pulse)

Components and Connections

Phase and neutral terminals shall accept #4 AWG to 500 kcmil wire. Ground terminals shall accept wire sizes from #8 AWG to 500 kcmil. Ground bus shall be 1/4-inch x 2-inch copper. #4 AWG wire shall be used for all internal connections

from the neutral point to ground. Control connections shall be a minimum of #14 gauge. All control wire insulation shall be type SIS. All control wiring shall be labeled at each end. Wiring within the resistor assembly shall be rated for 200°C service.

Structure

The unit shall be free-standing and house the resistor bank within an isolated section of the structure. Access to the resistor shall be via a bolted-on cover. The rear cover shall be removable. The structure shall provide top and bottom cable entry points. Lifting angles shall be provided to facilitate the installation of the unit. The structure shall be suitable for moving on rollers and shall be skidded for shipment in a manner suitable for handling by a forklift.

All steel parts (except for plated parts) shall be thoroughly cleaned and phosphatized prior to the application of the light gray ANSI No. 61 finish. A pocket is required on the inside of the control compartment door to store drawings and manuals.

Factory Assembly and Tests

The system shall be completely assembled, wired, and tested at the factory in accordance with NEMA and UL requirements. A certified production test report shall be shipped with the unit.

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