

C-HRG technical information and adjustment procedure

⚠ DANGER

HAZARDOUS VOLTAGE. WILL CAUSE SEVERE INJURY OR DEATH. DO NOT OPEN SHUTTER IF THE EQUIPMENT IS ENERGIZED.

⚠ WARNING

(1) ONLY QUALIFIED ELECTRICAL PERSONNEL SHOULD BE PERMITTED TO WORK ON THE EQUIPMENT.

(2) DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON THE EQUIPMENT WHILE ENERGIZED. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING.

(3) ALWAYS DE-ENERGIZE PRIMARY AND SECONDARY CIRCUITS BEFORE REMOVING CIRCUIT BREAKER.

FAILURE TO FOLLOW THESE STEPS FOR ALL PROCEDURES DESCRIBED IN THIS INSTRUCTION LEAFLET COULD RESULT IN DEATH, BODILY INJURY, OR PROPERTY DAMAGE.

⚠ CAUTION

SPECIFIC OPERATING PROCEDURES MUST BE DEVELOPED BY THE RESPONSIBLE PARTY, BECAUSE OF THE UNIQUE APPLICATION AND VAST VARIETY OF SYSTEM AND USER REQUIREMENTS. FAILURE TO DEVELOP SPECIFIC PROCEDURES COULD LEAD TO IMPROPER USE OR OTHER MORE SERIOUS CONSEQUENCES.

C-HRG equipment, components, and setup instructions

The following instructions cannot cover all possible installations and all details will not be applicable to all units. When a type C-HRG system is part of a switchboard or switchgear lineup, the instructions furnished with the overall assembly take precedence.



C-HRG freestanding NEMA® 1 unit



C-HRG wall-mounted unit (Separately mounted resistors not shown)



Powering Business Worldwide

Receiving, handling, and storage

⚠ CAUTION

TALL, NARROW STRUCTURE—MAY TIP OVER IF MISHANDLED. MAY CAUSE BODILY INJURY OR EQUIPMENT DAMAGE. DO NOT REMOVE FROM SKID UNTIL READY TO SECURE IN PLACE. READ HANDLING INSTRUCTIONS BELOW BEFORE MOVING.

Configurations

- Freestanding, single enclosure (NEMA Type 1, NEMA Type 3R)
- Wall-mounted control enclosure with separate wall-mounted resistor enclosure (both NEMA Type 1)
- Incorporated into a switchboard or switchgear assembly

Shipping weights:

- Freestanding: 650 lb (294.84 kg)
- Wall-mounted: 250 lb (113.4 kg), control assembly
- 75 lb (34.02 kg), resistor assembly

Packing method:

Plastic overwrapped, suitable for standard truck transportation and indoor storage (all). Freestanding is bolted to fork-liftable skid. Skid adds approximately 4.00 inches (101.6 mm) to overall height.

Lifting

Unit may be lifted by the top-mounted lifting angles or moved into place with a forklift. The unit is a tall, narrow enclosure that can be tipped over if mishandled. For additional stability, keep it on its shipping skid until it is moved into place.

Unit may be rolled by placing pipes under the longitudinal skid members in at least four places, evenly spaced. As one pipe comes free, replace it ahead of the unit. Keep at least three evenly spaced pipes under the unit at all times.

Once the unit is in place, remove and discard the lifting angles. Replace the hardware to plug the exposed holes.

Storage

Choose a location that is suitable for indoor-type electrical equipment. (Note: treat a NEMA 3R unit as if it were indoor-type equipment until it is to be energized.) If the location is unheated, do not allow condensing humidity on or within the equipment. Provide sufficient heat and moving air to prevent condensation. Once the unit is energized, it will provide the required heat internally.

Installation

Unpacking

Remove plastic overwrap. Inspect for shipping damage. Report any damage immediately to the carrier and be sure to save the packing materials until inspected by the carrier. Inspect cover and compartment-mounted devices for blocking or other packing materials. Place all documents in the document pocket.

Equipment location

Observe all the appropriate codes with respect to clearances on all sides. This equipment is front accessible, meaning that side access is not required for installation and maintenance. When choosing the location for a separately mounted resistor assembly, keep in mind that it will give off considerable heat. Do not mount it on a combustible surface or adjacent to heat-sensitive material or equipment.

Walls or floor must be sufficiently level to allow doors and covers to remain properly aligned with the structure. If embedded channel-iron floor sills are used, they must be at or above floor level.

Refer to assembly drawings provided with the unit for bolt-down hole locations. Bolt directly to wall or floor or channel-iron floor sills. Use 1/2-inch or 3/8-inch bolts for freestanding units and 3/8-inch bolts for wall-mounted units. If floor sills are used, unit can be welded to channels. Use sufficient weld bead to approximate the strength of one 3/8-inch SAE grade 5 bolt at each corner.

Seismic

If unit is furnished for suitable use in a seismic zone, refer to seismic installation guidelines referenced on the assembly drawing provided with the unit. Seismic installations supersede all other instructions.

Wiring

SAFETY PRECAUTIONS:

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TURN OFF POWER AT THE SOURCE BEFORE WORKING INSIDE.**

Use the schematic provided with the unit to determine the wiring interconnections required. All wiring must be in conformance with the NEC® and/or local codes. Minimum wire sizes required are indicated on the schematic and must conform to the following minimum guidelines (based on 75 °C copper, per 2011 NEC Table 310.15(B)(16)):

- Neutral: 8 AWG
- Ground: 8 AWG
- Phases: 12 AWG

Terminal block wire ranges:

- Neutral: #8
- Ground: #8 to 500 kcmil
- Phases: #12 to #8
- Control: #22 to #8

Alarm contact ratings:

- 600 Vac (A600) 10 A continuous
7200 VA make / 720 VA break
- 250 Vdc (P300) 5 A continuous
1.1 A at 125 Vdc make/break
0.55 A at 250 Vdc make/break

Final inspection and test log

- Turn all disconnects off. Perform any testing as directed by others
- Inspect for loose or missing connections
- Inspect all compartments for debris, tools, and so on
- Replace all covers removed during installation
- Energize when directed to do so, and make all adjustments (refer to "Adjustment Procedure" section of this instruction manual)

Using the test log provided (**Figure 12**) or a similar format of your choosing, test the unit and make the first entries. A document pocket is provided on the back of the control compartment door. Leave the test log (or a copy of it), a copy of the drawings, and a copy of this instruction manual in the pocket. Store the optional clamp-on ammeter in a clean, dry place. Do not store it in the control or resistor compartment.

Components

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Not all systems will have all components. Check bill of material or schematic for features included in your specific system.

Resistors

⚠ CAUTION

**HIGH TEMPERATURES!
MAY CAUSE SERIOUS BURNS.
ALLOW RESISTOR ASSEMBLY TO COOL DOWN BEFORE SERVICING.**

⚠ CAUTION

**FIRE HAZARD!
MAY CAUSE FIRE OR SEVERE EQUIPMENT DAMAGE.
DO NOT EXCEED RESISTOR CURRENT RATINGS.**

Note the current rating stamped on each resistor's tag. Do not adjust resistance below a level that will allow current in any resistor to exceed that rating.

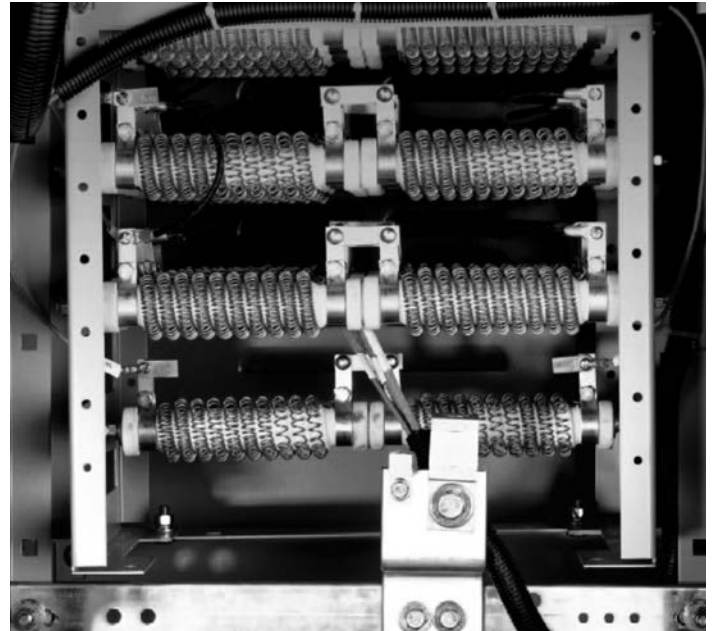
The resistor assembly is shipped ready to use and set at the ohmic value shown on the schematic. User adjustments will not, in general, be required. If, however, minor adjustments are needed, loosen jumper on resistor tap terminal block, and move the position of the jumper to desired tap setting. Beware of parallel paths created after attaching the jumper. The ohmmeter may not show the resistance expected. A simple calculation of parallel impedances will clear this. In order to avoid doing any calculations, check the resistances before attaching the jumper and verify if they conform to expectations.

Readjust as required and replace the wire connection. Each resistor tube has a metal tag showing the part number, ohmic value, and maximum rating; do not adjust any resistor to an ohmic value that will allow current in excess of the current rating.

Note: During initial usage, the resistors may "smoke" for the first hour or so, depending on the current. This is normal and comes from residual process oils and the curing of the resistor tube insulation. Lower current levels may allow the initial burn-off to occur gradually with little or no visible smoking. Smoking may reoccur after the initial burn-off if dust or other contamination is allowed to accumulate. Refer to maintenance procedures outlined in this manual.

Current relay, device 51N

- The relay has two adjustment potentiometers—one for pickup and one for time delay
- If relay has plugs over the adjustments pots, replace them when adjustments are completed



Resistor assembly

Voltmeter relay, device 59N

- This meter/controller has user-programmable parameters all set from the front panel
- Four LED indicators for up to four independent set points

Delay timer, device 2 (systems with voltmeter relays)

The voltmeter relay does not have a built-in time relay, therefore relay 2 is provided for that purpose. The knob on the top of the relay will allow selection of the desired time delay.

Recycle timer, device 95

This relay has two adjustment knobs, one for on-delay and one for off-delay. The output of the relay drives the pulser contactor (relay 4). In most systems, a pulsing rate of 30 pulses per minute (1 second on, 1 second off) will be satisfactory.

Alarm horn (optional)

The horn has a small setscrew on its front face, for which a setscrew wrench is furnished. Turn the setscrew clockwise to soften the tone and counterclockwise for a louder tone.

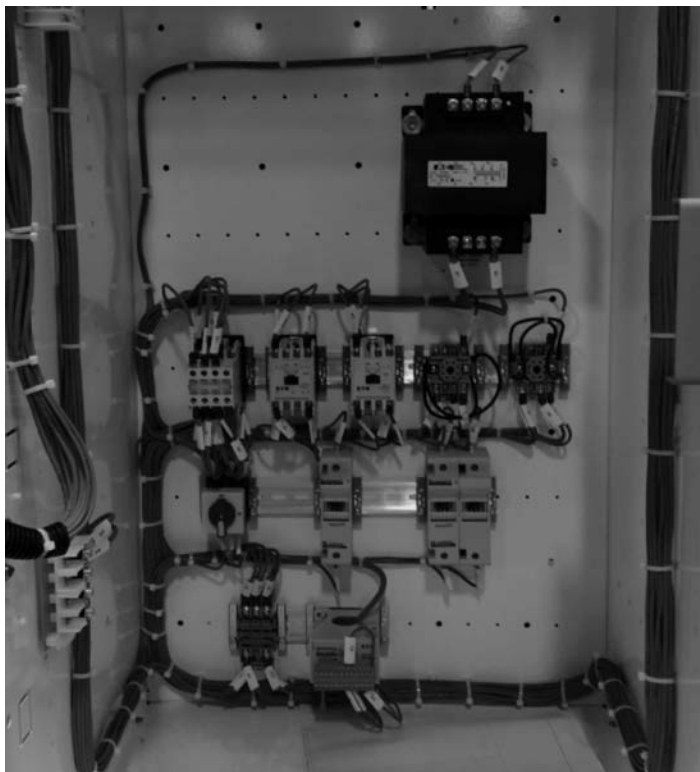
Re-alarm timer, device 74 (furnished with optional alarm horn)

If the system detects a ground and sounds the alarm horn, and an operator then silences the horn, this relay will cause the horn to resound in a certain amount of time if the fault is still present. The timer is typically set for 24 hours, and is knob-adjustable for 2–48 hours.

Loss of control power relay, device 27 (optional)

If the control power voltage falls below the relay's setting, the relay contacts will transfer. The contacts are wired to terminal block points for customer use. Dropout (marked "setting") is adjustable from 75 to 100%. Differential (marked "reset") is adjustable from 1 to 15%. Both potentiometers are screwdriver-adjustable, and are mounted on the front of the relay. The percentages are in reference to 120 Vac.

Operation



Indication and alarm circuits

Indication and alarm circuits

When a fault is detected by means of either current or voltage, an adjustable time relay is provided in order to override transients. There may be an extra timer in the control circuit. 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 on "auto," the lights will return to "normal" on, "ground fault" off. 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 will then return to "normal" on, "ground fault" off. The system can be reset only if 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 resound 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 runs down, the horn will resound, 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 and 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 and mode selector switch. (The selector will spring-return to "normal" when released.) The relay's contact grounds phase B through the resistor, causing ground current to flow. The system then reacts as it would under actual system ground conditions. The lights turn on, alarm contacts transfer, and the (optional) alarm horn sounds. Because periodic testing is the only assurance of continuing reliability, a program of regular testing and maintenance is strongly recommended.

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 (in "test" mode, the pulser turns on automatically). Turn the mode selector switch from "normal" to "pulse" to activate the pulser circuit. The pulse intervals are controlled by a recycle timer, which has a range of 1–10 seconds "on" and 1–10 seconds "off." (The recommended setting is 30 pulses/minute—1 sec on, 1 sec off.) The white "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 5 A current pulse above the ground current).

Short circuiting terminal block

⚠ DANGER

**HIGH VOLTAGE!
WILL CAUSE DEATH, BODILY INJURY, OR EQUIPMENT DAMAGE.
DO NOT OPEN-CIRCUIT A CURRENT TRANSFORMER UNDER LOAD.**

If the current transformer has primary current passing through it, do not disconnect any devices on its secondary side without first shorting across the transformer's secondary terminals. If open-circuited under load, a very high voltage will develop instantaneously across the disconnection point, placing the operator and equipment in danger.

This is the first device in the current circuit on the secondary side of the current transformer and is provided to allow a convenient means for short circuiting the current transformer's secondary side when testing, calibration, or repairs are required. To short the current transformer secondary, move the shorting pins from storage positions at the corners of the terminal block to both current connections. Devices in the current circuit may be safely disconnected only after the current transformer secondary is properly shorted.

Ground fault

Ground fault detection

Any time a system is energized, a very small ground current will be observed. When one phase becomes grounded, much more current will flow to ground. The maximum amount of current that will flow to ground during a ground fault is predetermined by the resistor taps in a high resistance grounding system.

A small current called “the charging current” will flow toward the unfaulted phases. Most of the ground current, however, must flow through the grounding resistor, and an ammeter in this circuit will read the amount of current.

By placing a current-sensing relay in series with the ammeter, the current relay can be adjusted to pick up at a preset level, thus indicating an abnormal condition.

An alternative detection scheme employs a voltmeter-relay connected across grounding resistors. The voltage across the resistors is proportional to the amount of ground current. The voltmeter-relay’s pickup adjustment is preset to a desired level to avoid nuisance tripping.

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.

Ground fault location

The current pulses can be noted with a clamp-on ammeter when the ammeter is placed around the cables or the conduit feeding the fault. See **Figure 16**.

Note: When tracing along cables or conduits that are carrying a load, all three phases must be within the ammeter’s jaws. If not, the pulsing current may not be noticeable above the load, or the ammeter may be “pegged” by the magnitude of the load current.

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. See **Figure 17** and **Figure 18**.

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 with the pulser or may take a path that the ammeter cannot trace.

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.

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 (megger, high-potential, and so on) may be needed.

Maintenance

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DANGER

**HIGH VOLTAGE!
WILL CAUSE DEATH, BODILY INJURY, OR EQUIPMENT DAMAGE.
TURN OFF POWER AT THE SOURCE BEFORE WORKING INSIDE.**

Before attempting any inspection or maintenance, open, tag, and lock out the primary devices supplying this equipment. Verify that no voltage is present in this equipment using calibrated testers that are known to be operating correctly.

CAUTION

**HIGH TEMPERATURES!
MAY CAUSE SERIOUS BURNS.
ALLOW RESISTOR ASSEMBLY TO COOL DOWN BEFORE SERVICING.**

The resistor assembly is rated at up to 375 °C at full load. Approach it with due caution, especially if a fault condition has occurred recently. Even when it is hot enough to cause serious burn, the resistor assembly may not appear hot!

Monthly

- Ammeter readings: note ground current reading on ammeter and record in test log. Compare with previous month’s reading (Take readings at a time when most equipment is online. More importantly, take readings when loads are similar in nature, and environmental conditions are similar as well)
- Test system: turn mode selector to “test” and hold long enough for pulser to begin operating. Note pulse amplitude on test log and compare to previous month’s readings
- When under test mode, the ground fault relay should pick up and the ground fault alarm should activate. Make sure the ground fault relay is working properly
- Inspect compartments: open control compartment door and inspect for dirt accumulation, or any sign of component/wiring degradation or overheating
- Inspect vents: check that all vents are clean and unobstructed
- Check lamps: note that all lamps are working and replace bulb as required
- Record findings: record any findings in test log (**Figure 12**) and arrange for further maintenance if required

Yearly (or more if significant dirt accumulation is noted)

- Clean equipment: in addition to monthly checks, after first de-energizing the equipment, remove the cover over the resistor compartment. Check for heat and note dirt accumulation. Compare to last observations. Using a good quality industrial vacuum cleaner with a soft brush attachment, clean dirt from resistors, vents, and the cabinet
- Inspect for contamination: inspect assembly for contamination from airborne pollutants (oil mist, lint, and so on). The accumulation of significant amounts may indicate the need for specialized cleaning procedures, and/or the need to take measures to keep the contaminants away from the grounding assembly
- Inspect for overheating: darkening of copper ground bus and moderate discoloration of resistor tubes and terminal bands is normal. Painted surfaces adjacent to the resistors will darken somewhat over time, but should not appear blackened or burnt. Check that all wiring is routed away from resistors and that no wiring passes over resistors
- Check wiring: check that all wiring connections to resistors and ground bus are secure
- Clean control compartment: use vacuum cleaner to clean dirt accumulation from control compartment. Be very careful not to dislodge wiring
- Replace covers: replace all covers and all cover hardware. Return to service as directed

Fuse replacement

⚠ DANGER

FIRE AND SHOCK HAZARD!
MAY CAUSE DEATH, BODILY INJURY, OR EQUIPMENT DAMAGE.
TURN CONTROL DISCONNECT OFF BEFORE SERVICING FUSES.
ANY REPLACEMENT FUSE MUST BE THE SAME RATING AS ORIGINAL.

A control disconnect switch is provided on the line side of all fuses. Turn disconnect off before servicing fuses.

All primary fuses are selected to allow application on power systems with an available fault current of 200 kA rms at 600 Vac, maximum. If any fuse must be replaced, be certain that only an identically-rated, UL® listed fuse is installed. If a substandard or underrated fuse is used, it may rupture violently, causing burns, electrical shock, and/or substantial equipment damage. If the original fuse is not available or its markings not legible, refer to label adjacent to fuseblock or to the schematic for this unit.

Adjustment procedure

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Before attempting any maintenance, open, tag, and lock out the primary devices supplying this equipment. Verify that no voltage is present in this equipment using calibrated testers that are known to be operating correctly.

The resistor assembly is rated to operate at 375 °C at full load. Approach it with due caution, especially if a fault condition has recently occurred. Even when it is hot enough to cause a serious burn, the resistor assembly may not appear hot!

Resistor taps

⚠ CAUTION

HIGH TEMPERATURES!
MAY CAUSE SERIOUS BURNS.
ALLOW RESISTOR ASSEMBLY TO COOL DOWN BEFORE SERVICING.

THE RESISTOR TAP SETTING WILL DETERMINE THE AMOUNT OF GROUND RETURN CURRENT THAT A SYSTEM WILL ALLOW AND/OR WHETHER THE C-HRG WILL FUNCTION PROPERLY. IMPROPER RESISTOR TAP SETTING MAY RESULT IN EQUIPMENT DAMAGE/MALFUNCTION.

The tap points are brought to a terminal block in the control section. If the tap jumper is omitted, the resistor assembly will be at its lowest current rating (1 A for a 1 A to 5 A assembly, for example). For higher current levels, connect the jumper from its base point to the tap terminal marked with the required current level. Refer to the schematic for tap values and corresponding terminal numbers.

The C-HRG typically comes with five resistor settings:

- 5 A tap—57 Ω
- 4 A tap—69.5 Ω
- 3 A tap—89.5 Ω
- 2 A tap—139.5 Ω
- 1 A tap—264.5 Ω

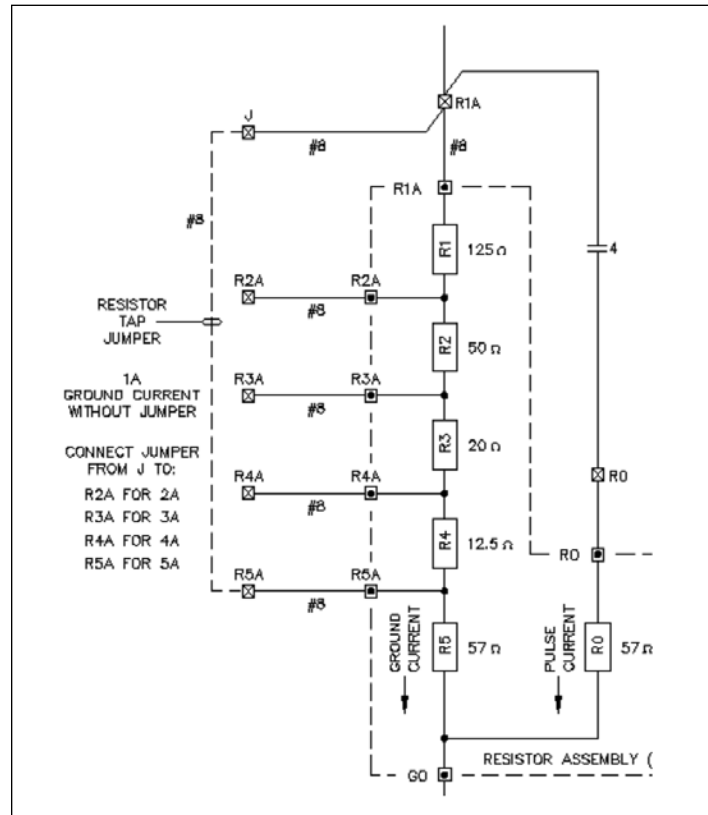


Figure 1. Schematic for tap value and corresponding terminal numbers

There are two important factors that should be considered when choosing which resistor setting to use in a system:

1. The charging current of a system.
2. The amount of ground return current through the neutral resistor that should be allowed on the system.

It is rather important to consider these factors in this order because the capacitive charging current will provide the minimum amount of ground return current that should be let on the system to make the C-HRG effective. That, in turn, relates to the maximum grounding resistance that can be chosen.

Note: The ground return current to be allowed on the system should be higher than the charging current of a system. In other words, the grounding resistor value to be chosen should be lower than the capacitive coupling to ground.

The reason behind choosing a grounding resistor value that is lower than the charging capacitive coupling is so that in case of a ground fault, the return path of the ground current will be assured to flow through the grounding resistor and not through the alternate capacitive path.

Note: For most systems, a resistor tap setting of 5 A will exceed the capacitive charging current of the system yet still prevent equipment damage.

Determining the charging current

WARNING

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There are different methods to determine the capacitive charging current of a system, but they all prove to be tedious and/or impractical. **It is advisable to use the industry accepted method of estimating the charging current instead of calculating and/or measuring it.** It is important to note that the capacitive charging current of a system is the current that flows toward the unfaulted phases during a ground fault.

This current is different from the leakage current that flows to ground from the phases during normal operations. The leakage current, typically of very small magnitudes, will continually flow through insulation.

Estimating the charging current

THIS IS THE PREFERRED METHOD FOR DETERMINING THE CHARGING CURRENT OF A SYSTEM.

IEEE® Standard 141 (IEEE "Recommended Practice for Electrical Power Distribution for Industrial Plants") recommends a resistance value that limits the maximum ground current between 5 A and 10 A for high resistance ground systems.

It also recommends for high resistance grounding to be used only in systems of 5 kV or lower, charging currents of 5.5 A or lower, and never in 15 kV systems.

A way to estimate the capacitive charging current for low-voltage systems is as follows:

480 V systems:

- 0.5 A per 1000 kVA
- 0.5 A per set of surge capacitor used

Calculating the charging current

Both of the methods described below are either tedious or impractical for industrial applications.

To calculate the capacitive charging current of a system:

1. De-energize the system completely.
2. Allow enough time for all the components to cool down to room temperature.
3. Develop an impedance model by either measuring cable lengths, field data collection, information on one-lines, and so on.
4. Calculate the Thévenin equivalent of the entire system.
5. Using Ohm's law and with the aid of a power system software, calculate the capacitive charging current.

Measuring the charging current [1]

DANGER

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THE METHOD BELOW IS FOR INFORMATIONAL PURPOSES. IT IS RECOMMENDED TO ESTIMATE THE CHARGING CURRENT AS SUGGESTED ABOVE WHEN DETERMINING THE CHARGING CURRENT.

Only qualified personnel should attempt to measure the capacitive charging current of a system.

The system needs to be **ungrounded** and the equipment **rated properly for the system voltage**.

If system is grounded, disconnect all grounding equipment by opening the appropriate disconnect switch or breaker. Make sure no other ground is connected to the system.

1. De-energize the system or part of the system under test.
2. Take one phase to ground in the de-energized part of the system using a 6 A current-limiting fast acting fuse, a circuit breaker, a variable resistor, and an ammeter, all in series.
3. Make sure the circuit breaker is open and the resistance is set to maximum.
4. Re-energize the system and make sure that the entire system is energized and under maximum load conditions.
5. Close said breaker protecting the circuit under test and slowly reduce the resistance to zero.
6. The reading on the ammeter should be showing the capacitive charging current at this time.
7. Take the resistance back to the maximum and open the breaker.

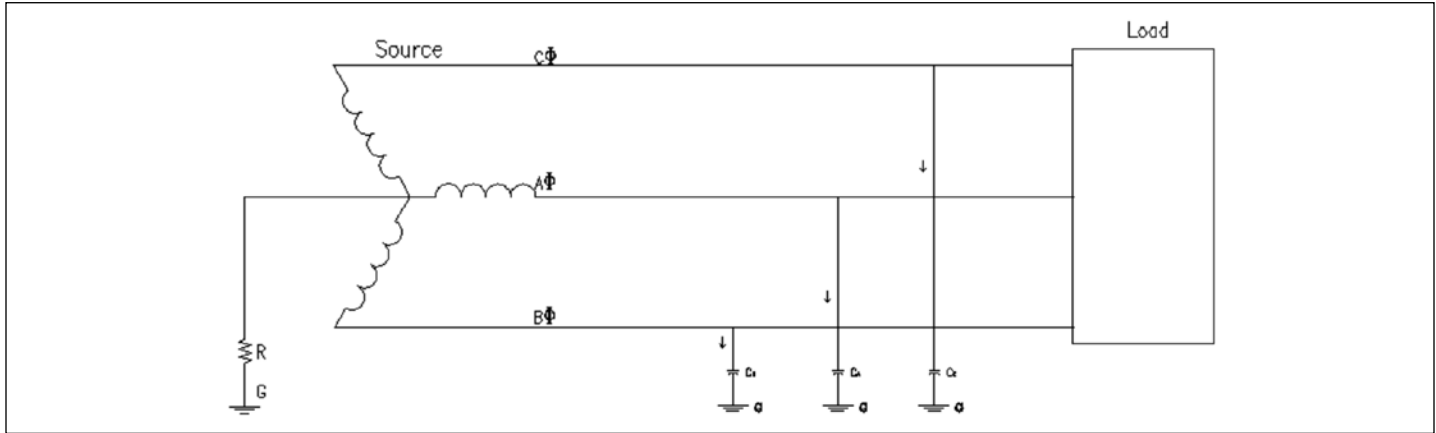


Figure 2. Illustration of the leakage current in a system

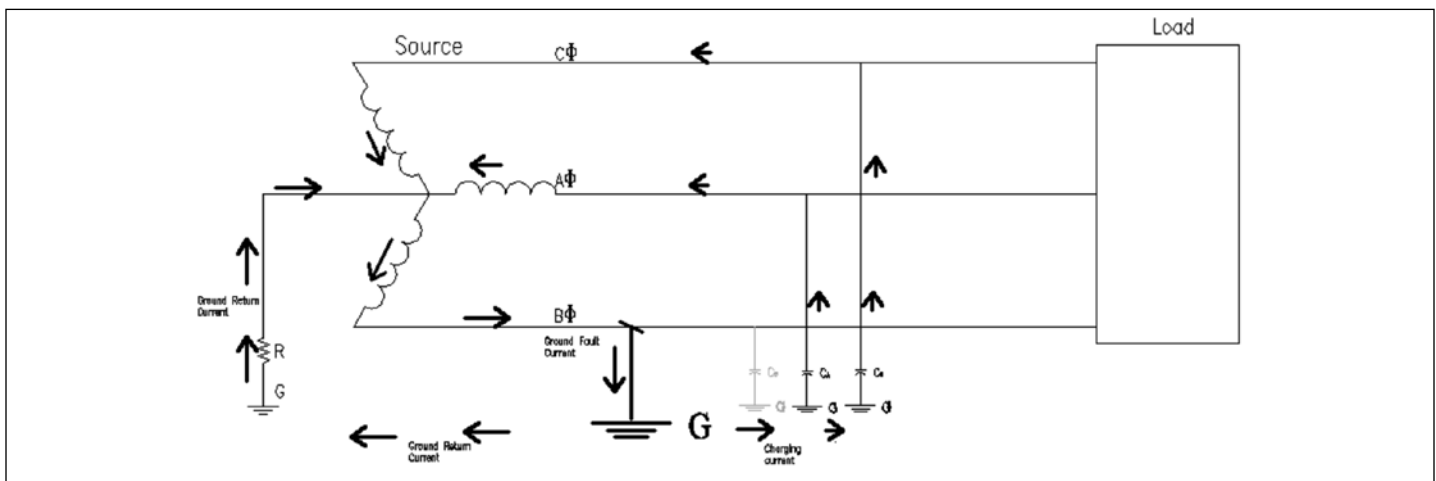


Figure 3. Capacitive charging current and ground return current

This method follows Baldwin Bridger's paper on determining the charging current of a system [1].

Setting the current relay and voltage relay

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Only qualified personnel should attempt to service energized equipment.

1. De-energize the C-HRG equipment.
2. Set the time delay to minimum. There may be an additional timer in the control circuits, and for voltage relays the control circuit timer is the only timer.
3. Set the current one setting above the expected ground return current that was established using resistor taps—each tap corresponds to a current value (as shown in "Resistor taps" section). For a voltage relay, use the corresponding voltage, which is the current to be allowed on the circuit \times the resistance previously set with resistor taps (see note). Example: if the allowed ground return current on the system is 3 A, set the current relay to 4 A.
4. Re-energize the equipment.
5. Put the C-HRG in "test" mode.

6. Make sure the selector switch is held in "test" position. The switch has a spring-return to normal position and must be held in "test" position.
7. The relay should not pick up the test current.
8. De-energize the equipment.
9. Set the relay to one setting below the allowed ground return current.
10. Re-energize the equipment.
11. Put the C-HRG in "test" mode and hold the switch in "test" position.
12. The relay should pick up the test current, the alarm lights will go on, and the optional horn will sound.
13. Reset the alarm using the reset switch.
14. This proves that the relay works.
15. De-energize the equipment.
16. Choose a desirable pickup point below the allowed ground return current and set the time relay to a desirable level to avoid nuisance trips.

Note: There is an additional resistance of 10 Ω in the test circuit. When calculating the voltage **in TEST MODE** using the voltage relay, it should be taken into consideration. For example, at step 3, a 3 A ground return current and 4 A setting on the current relay **ONLY IN TEST MODE** has a corresponding voltage of $4 \text{ A} \times (89.5 \Omega - 10 \Omega) = 318 \text{ V}$. The 89.5 Ω resistance is associated with 3 A ground return current. The relay should not pick up as that was the purpose of step 3. **The calculations in TEST MODE should always take that resistance into consideration for accuracy.** To set the voltage relay **in NORMAL MODE**, the test resistance of 10 Ω should no longer affect the circuit.

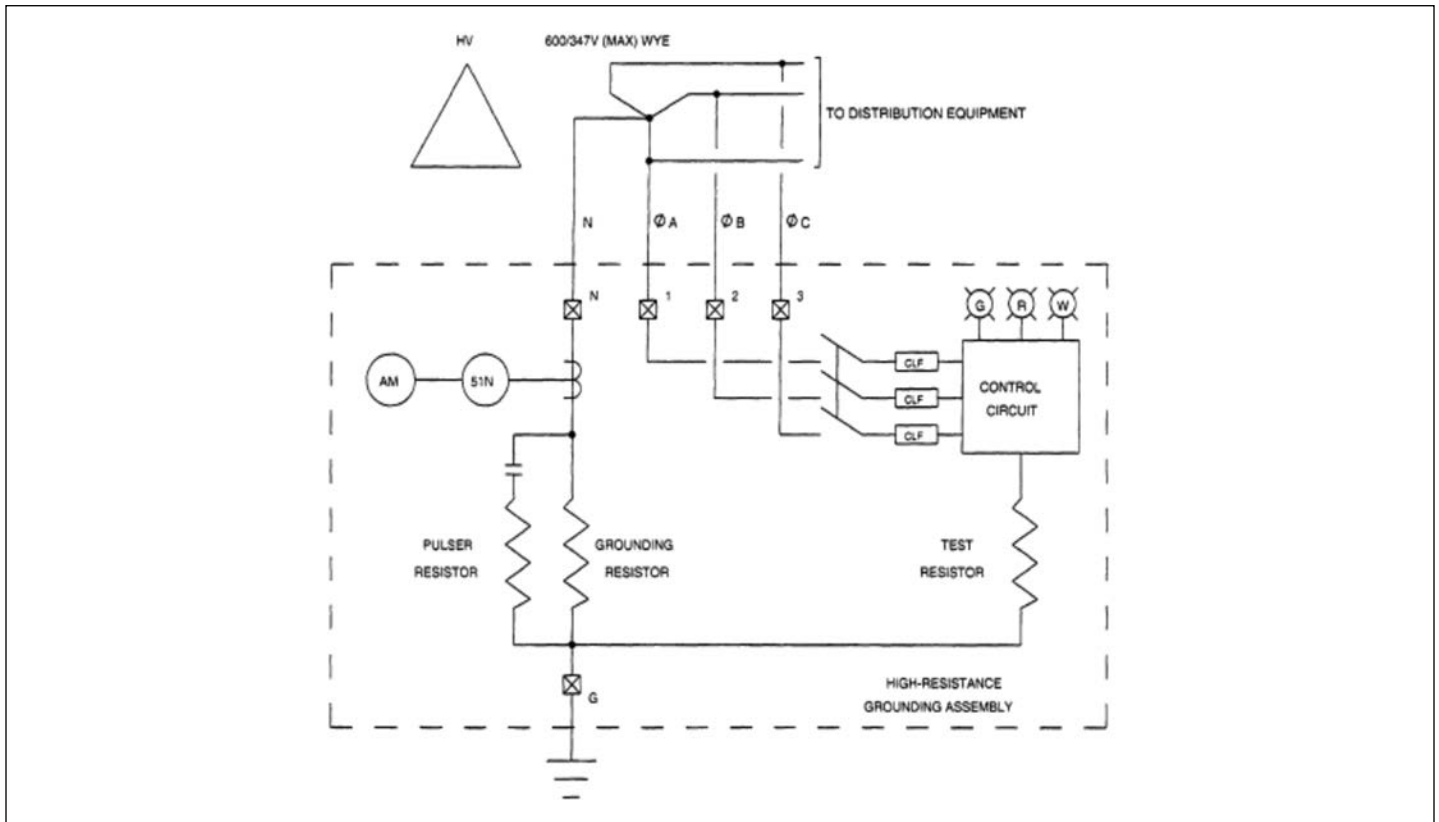


Figure 4. Four-wire system—fault detection via current relay

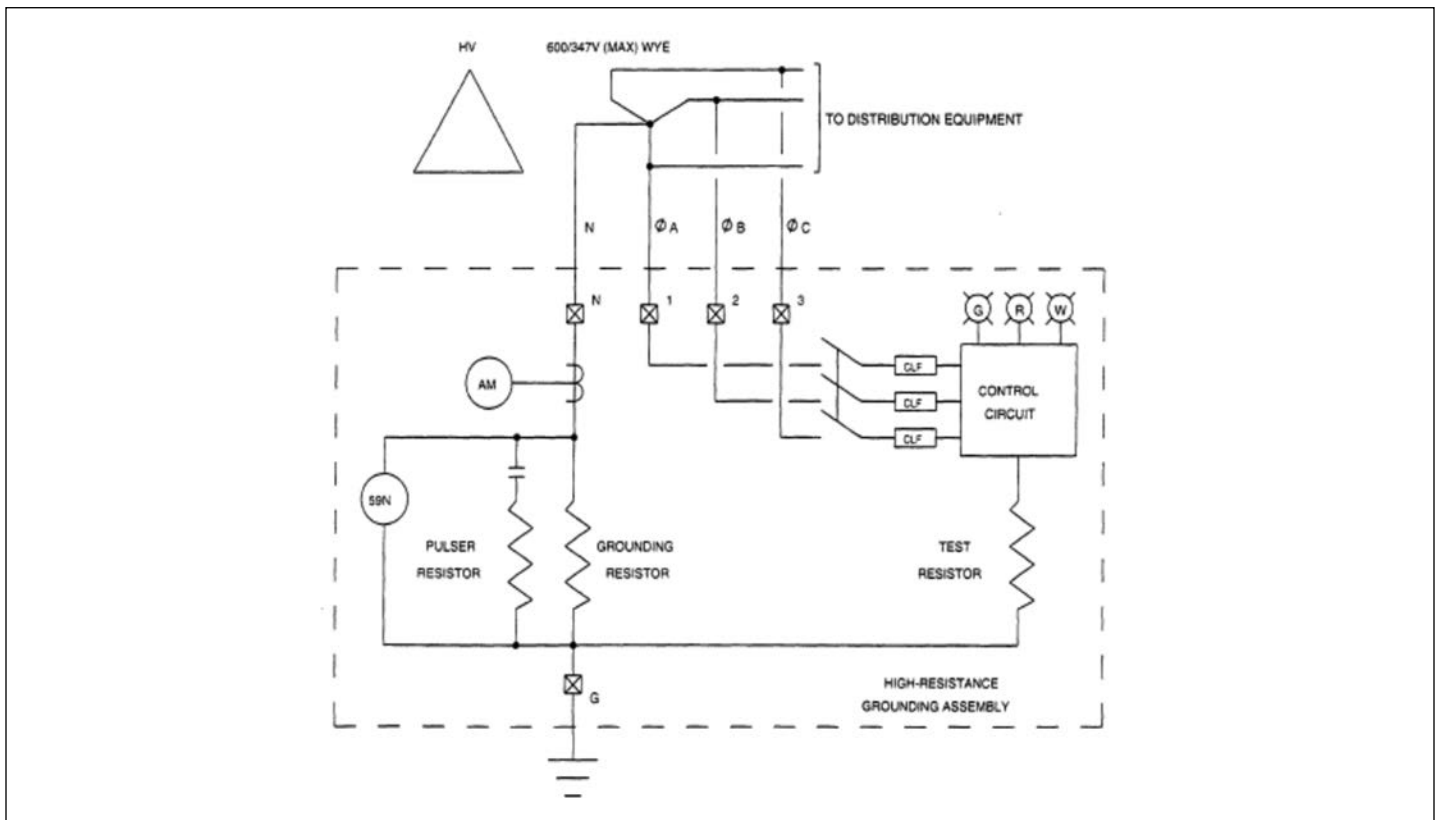


Figure 5. Four-wire system—fault detection via voltmeter relay

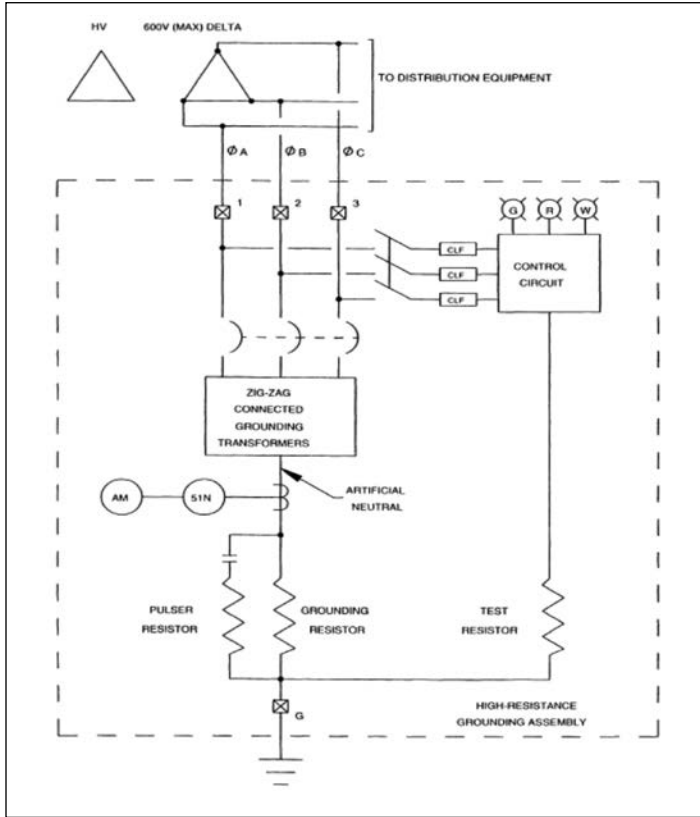


Figure 6. Three-wire system—zig-zag grounding transformers, fault detection via current relay

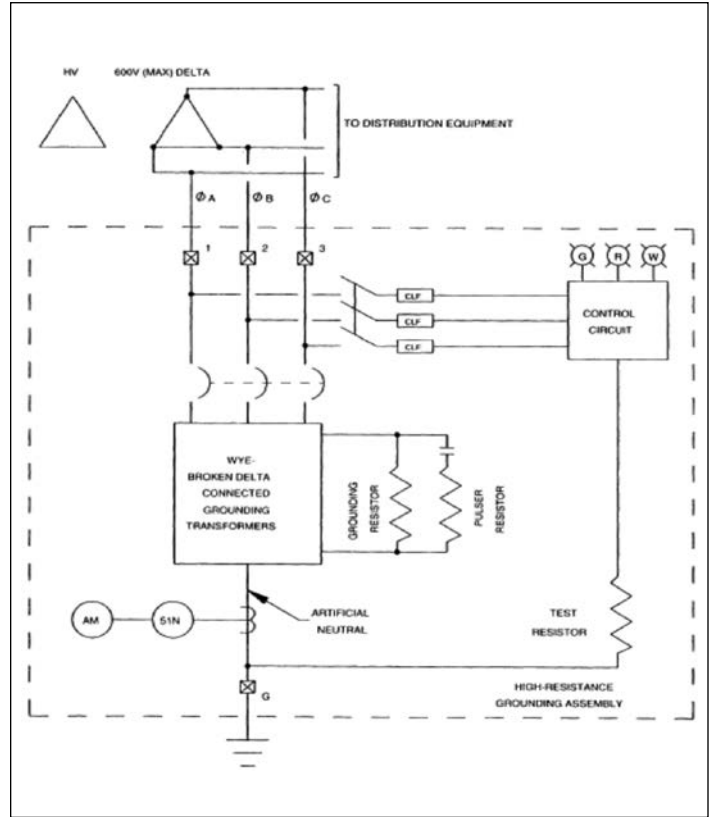


Figure 8. Three-wire system—wye-broken delta grounding transformers, fault detection via current relay

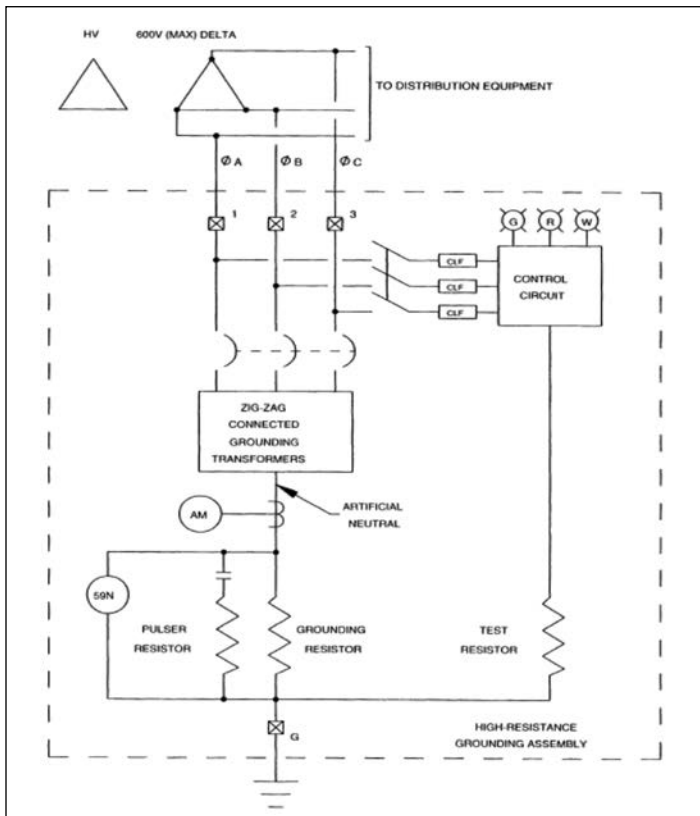


Figure 7. Three-wire system—zig-zag grounding transformers, fault detection via voltmeter relay

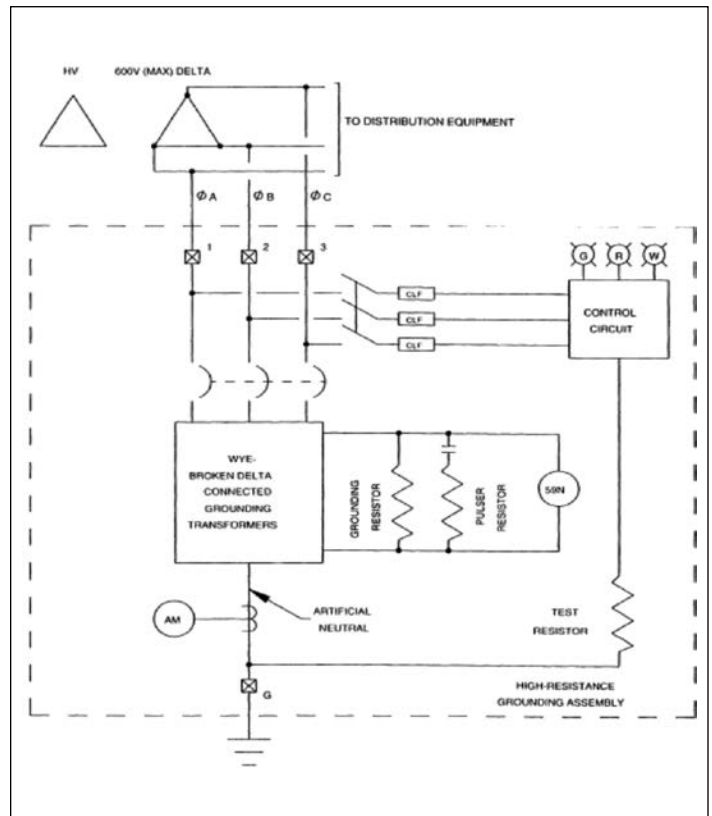


Figure 9. Three-wire system—wye-broken delta grounding transformers, fault detection via voltmeter relay

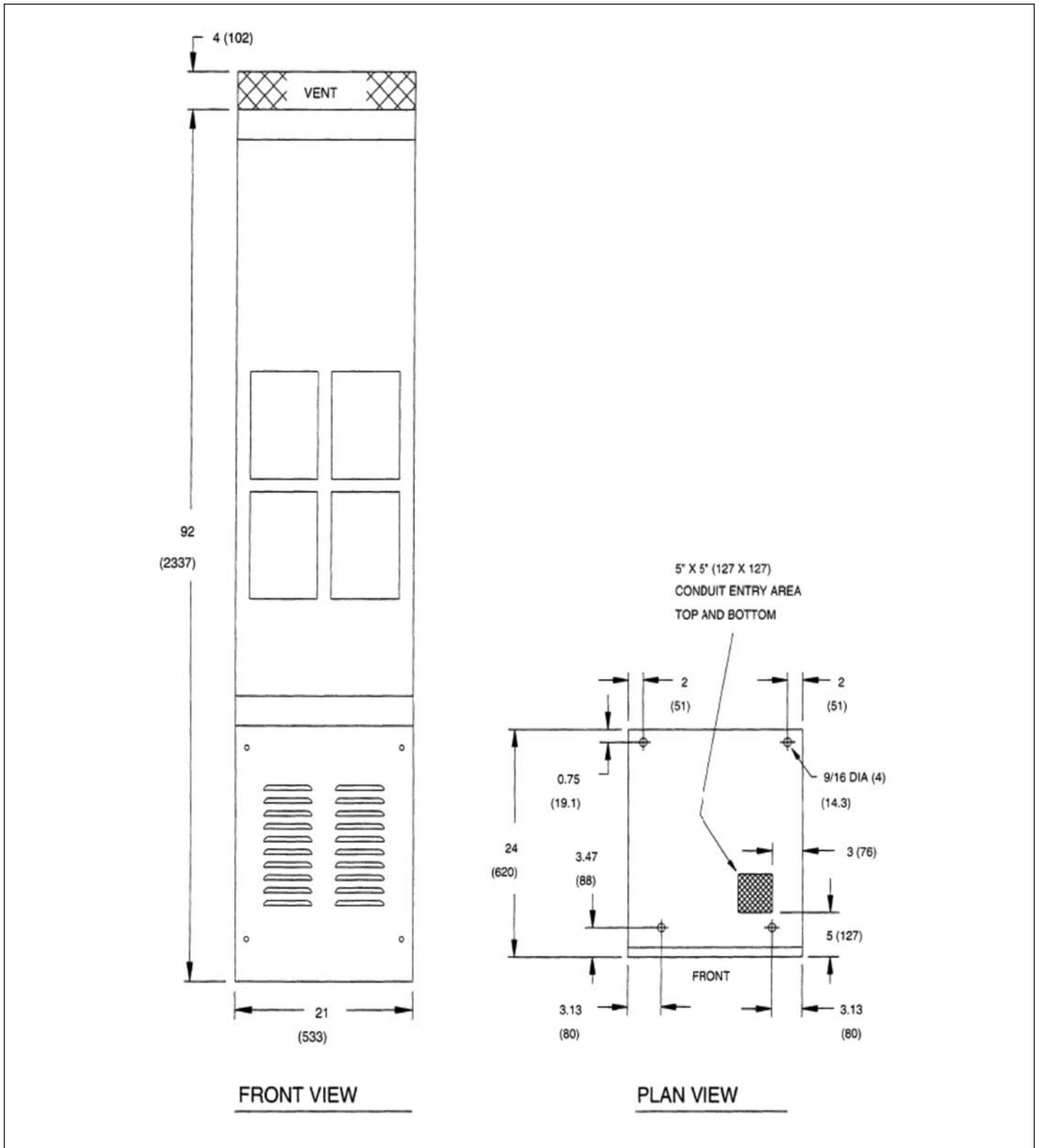


Figure 10. Typical enclosure dimensions for NEMA 1 free-standing system—dimensions in inches (mm)

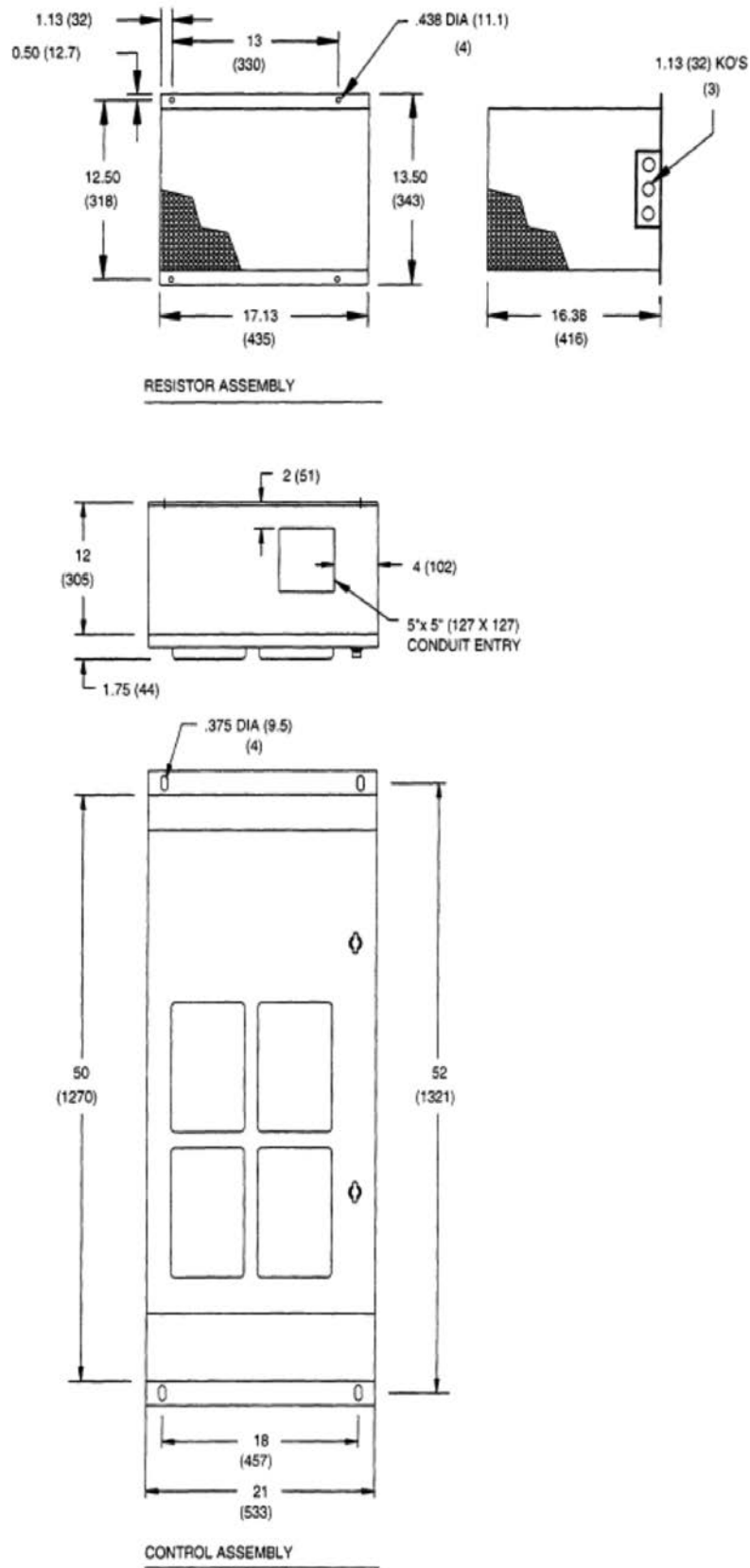


Figure 11. Typical enclosure dimensions for NEMA 1 wall-mounted system—dimensions in inches (mm)

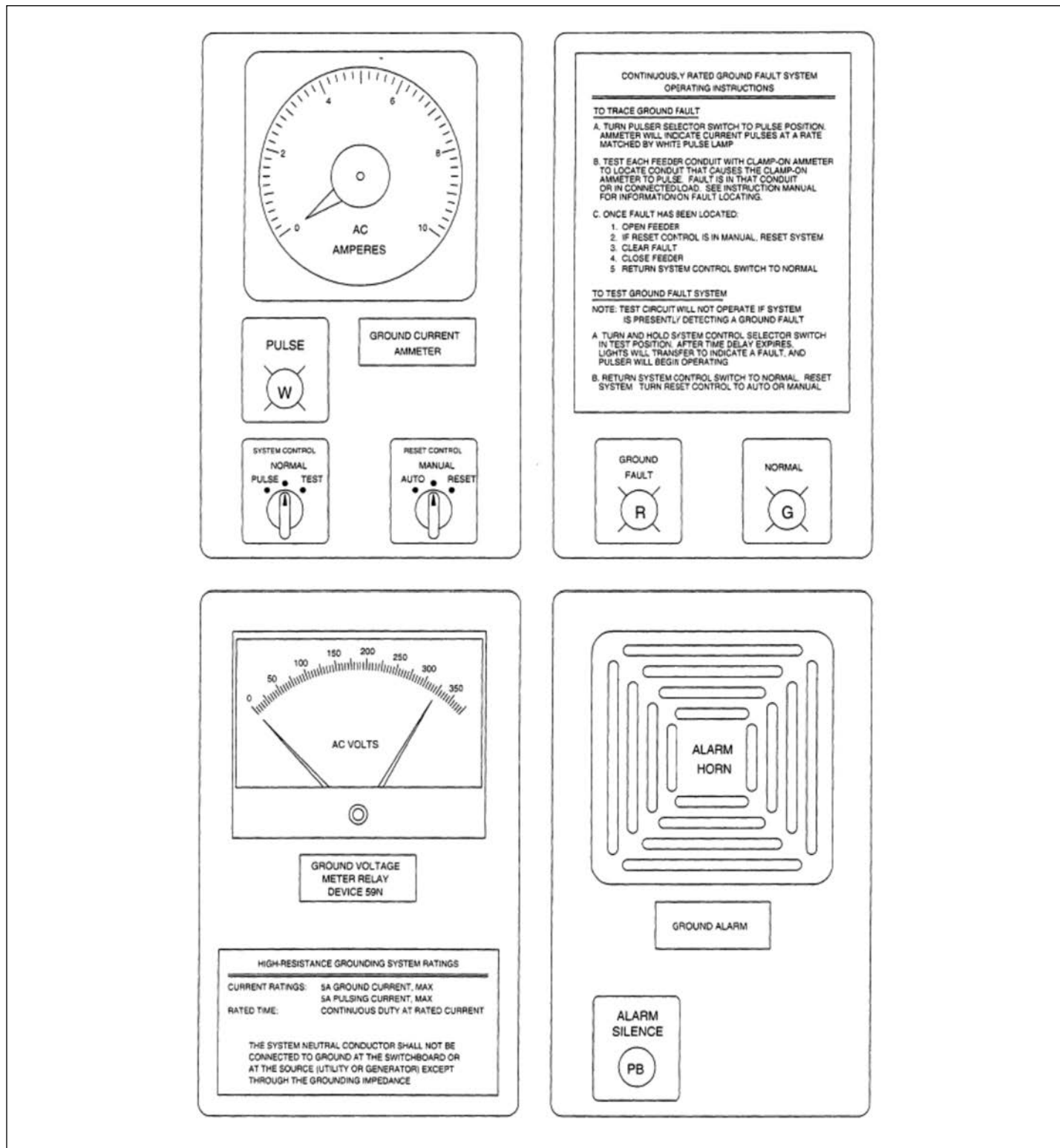


Figure 13. Standard front control panel detail (voltmeter relay and alarm horn options shown)

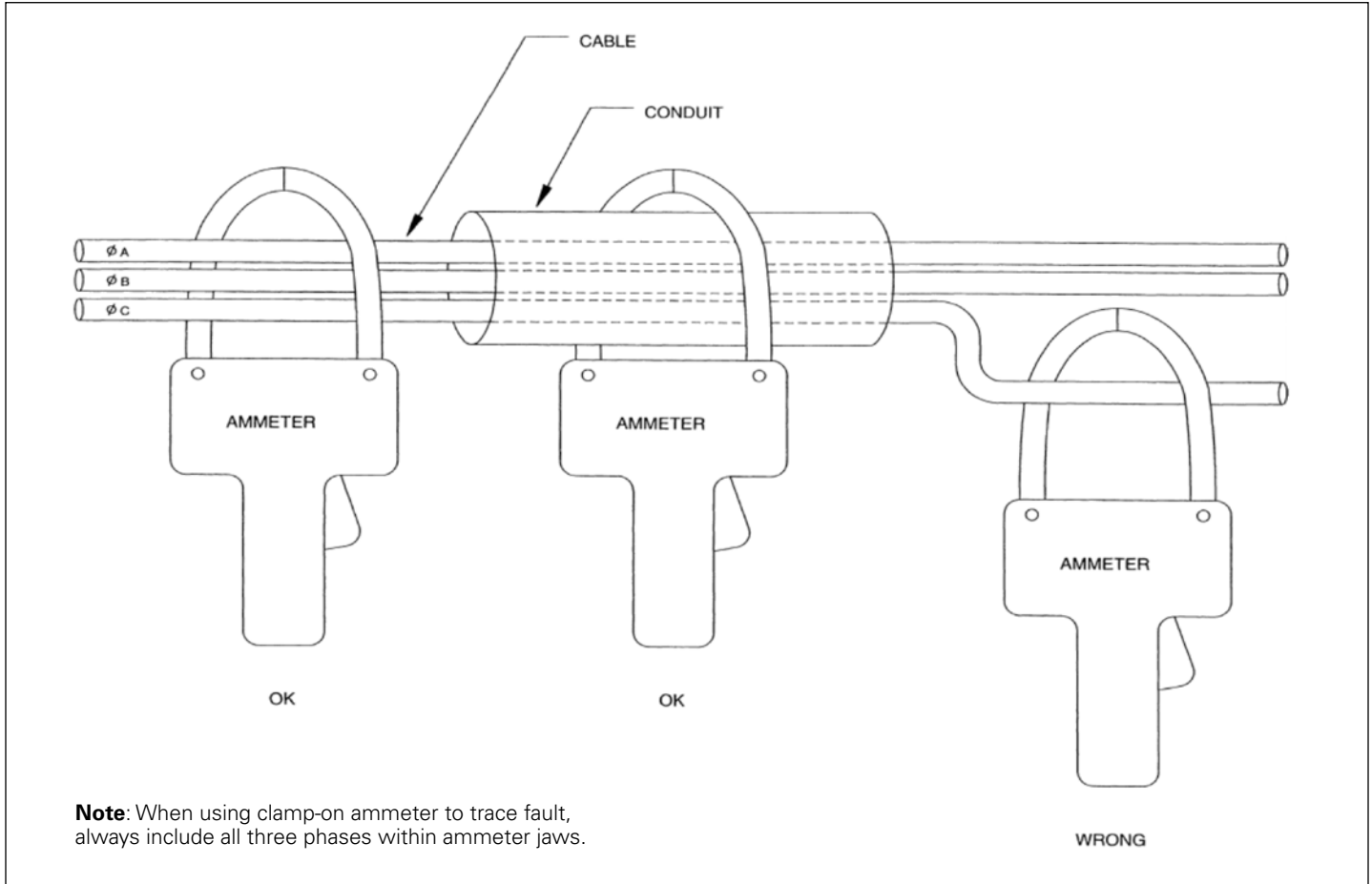


Figure 16. Clamp-on ammeter

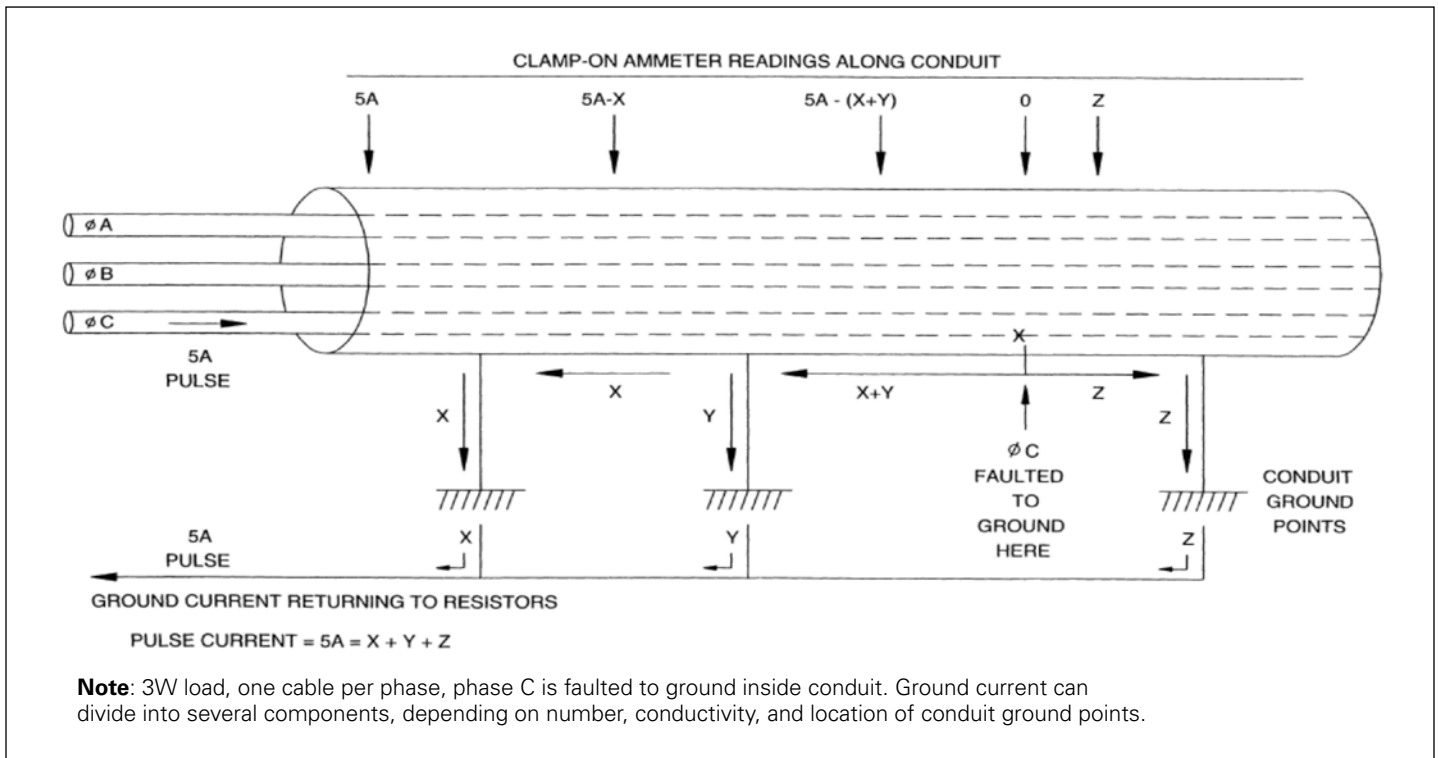


Figure 17. Example of a typical fault

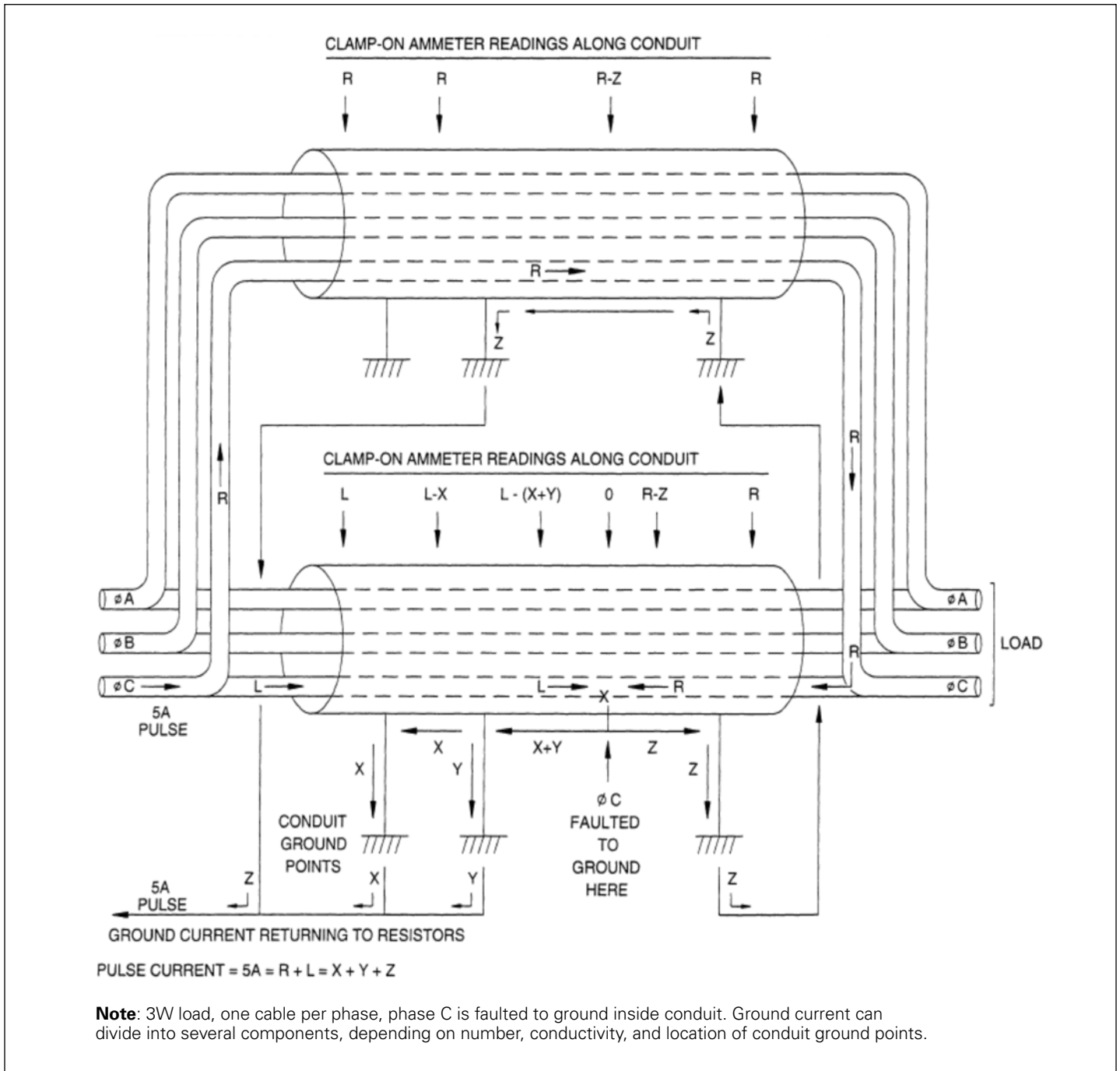


Figure 18. Example of a typical fault

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