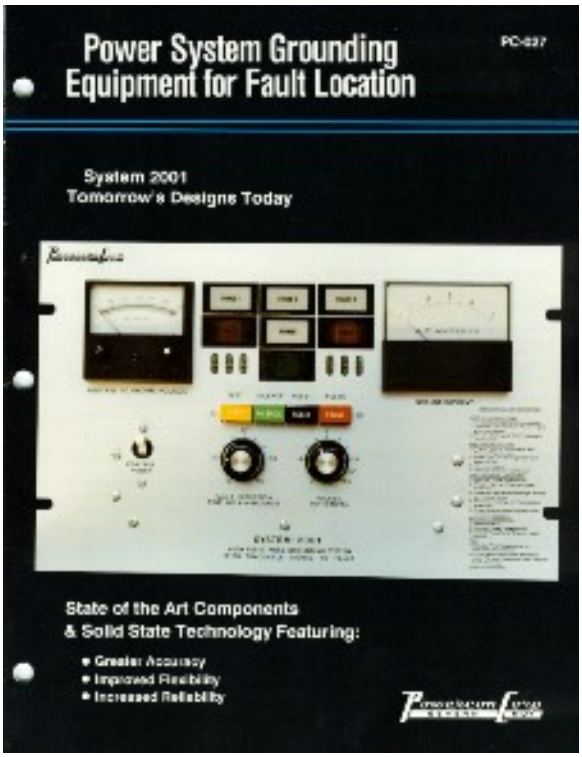
POWERCON CORPORATION



POWER SYSTEM GROUNDING EQUIPMENT FOR FAULT LOCATION

BROCHURE #PC-027

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The High-Resistance Grounded Neutral System with Traceable Signal to Fault

The high-resistance grounded neutral system with traceable signal to fault, is one in which a high-value resistor has been inserted in the neutral connection to ground to limit the resistor current under ground-fault conditions to a value not less than the total system charging current, resulting in a total ground fault current of approximately the square root of 2 times the charging current.

Similar equipments are available for 2400 volts, 4160 volts and other medium voltage applications and both delta and wye systems.

The facility of quickly locating ground faults with the pulsing and tracing equipment on this system tends to lessen the probability of a second ground fault shutting down two circuits simultaneously.

Application

Power System 2001 High Resistance Grounded Neutral Systems with tracing pulses is applied where:

1. Electric Power Service immediate interruption on indicators and a means first phase to ground fault is to be avoided.

   This prevents disorderly shutdowns of equipment which may result in severe financial losses, production delays, or hazards due to immediate loss of electric power.

2. Transient Overvoltage Control on arcing ground faults protection will be obtained.

3. Minimization of Personnel Injuries from arc flash due to accidental line to ground faults.

   The fundamental objectives in the use of the high resistance grounded neutral system with a fault-tracing pulse are several:

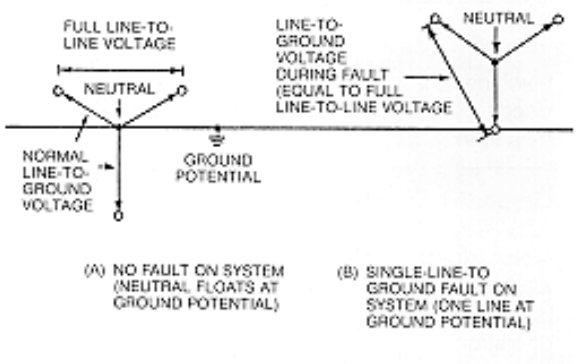
1. The avoidance of an immediate service interruption on the occasion of the first ground fault.

2. The minimizing of flash hazard to personnel arising from accidental ground faults in equipment.

3. A substantial reduction in the risk of equipment burndown arising from ground faults.

4. The ability to quickly trace the location of a ground fault without de-energizing the system.

5. A reduction in voltage dip during ground faults, provided simultaneously ground faults on different phases are not encountered. This system is equipped with ground-fault indicators and a means of pulsing a traceable signal onto a grounded phase to aid in rapid location of system faults to ground while the system is energized.



EFFECT ON LINE-TO-GROUND VOLTAGES OF A SINGLE LINE-TO-GROUND FAULT ON AN UNGROUNDED NEUTRAL SYSTEM.

6. Avoids requirement of expensive coordinated ground fault relay system.

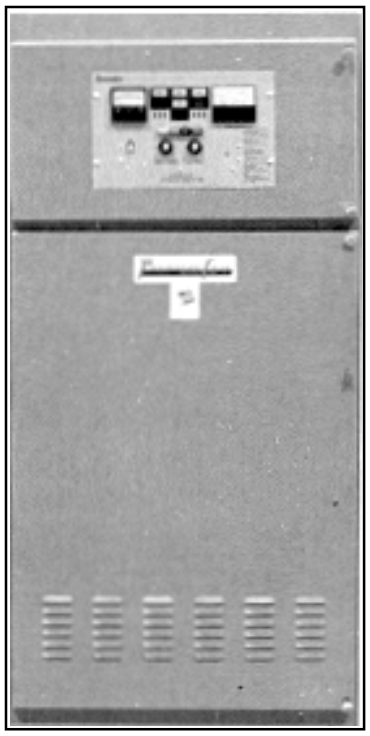
7. Provides a more flexible transformer primary relaying coordination.

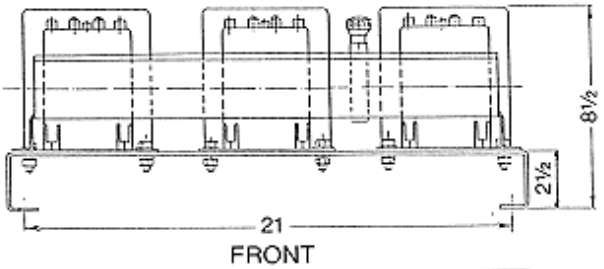
Comparison Between the System 2001 and Twenty Year Old Mechanical Control Systems

Mechanical Control	System 2001
Voltage Instrumentation and Adjustment for High and Low Settings of Voltage	
Uses Voltmeter Relay	Uses Voltmeter Relay
Control Power Control	
Fuse mounted on the back of the panel.	Circuit breaker with front of panel mounting and indication of power available.
Indicating Lights	
Uses Regular Indicating Lights.	Annunciation type with engraved lenses provide easy identification of illuminated function.
Pulsing Signal Relay	
Mechanical motor driven cam operated switches. Subject to wear and contact erosion. Once number of pulses per minute is set no further adjustment. Definite life subject to maintenance.	Static device. No moving parts. Capable of adjusting number of pulses per minute. Indefinite life not subject to mechanical wear. Encapsulated - not subject to dirt, dust, moisture, etc.
Pulsing Relay	
Machine tool relay. 1 0 Ampere Contacts must be serviced every year. Subject to dirt, dust, and contaminants.	Solid state relay. 20 Ampere Contacts, 400 Volts AC. Encapsulated needs no service or inspection. Not subject to contact pitting or mechanical wear.
Ground Fault Time Relay	
Motor driven. Mechanical timer. Adjustable by anyone from front of panel. Subject to wear and contact erosion. Also dirt, dust, moisture will effect operation.	Solid State Timer. Adjustable from front. Knob lock system to prevent inadvertent changes.
Pulse Normal Switch	
Selector Switch. 2-Pole Double-Throw can be left in pulse position - no signal.	Push-to-Pulse. Internal light pulses with pulse relay. Push-To-Normal light goes out.
Grounded Phase Indication	
None	Phase Indicating Lights Provided.

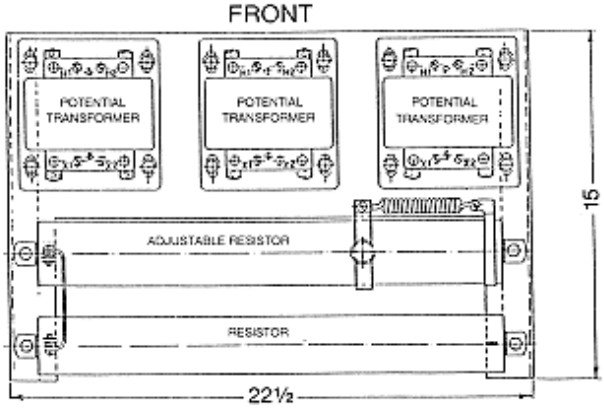
Arrangement -
Solid State System 2001

Dead front self-contained High Resistance Ground System
for utilization with new or existing power system.





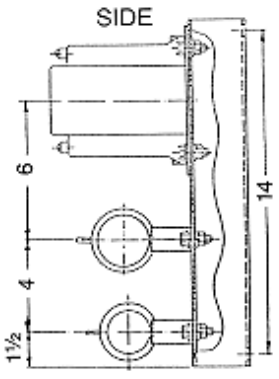
FRONT

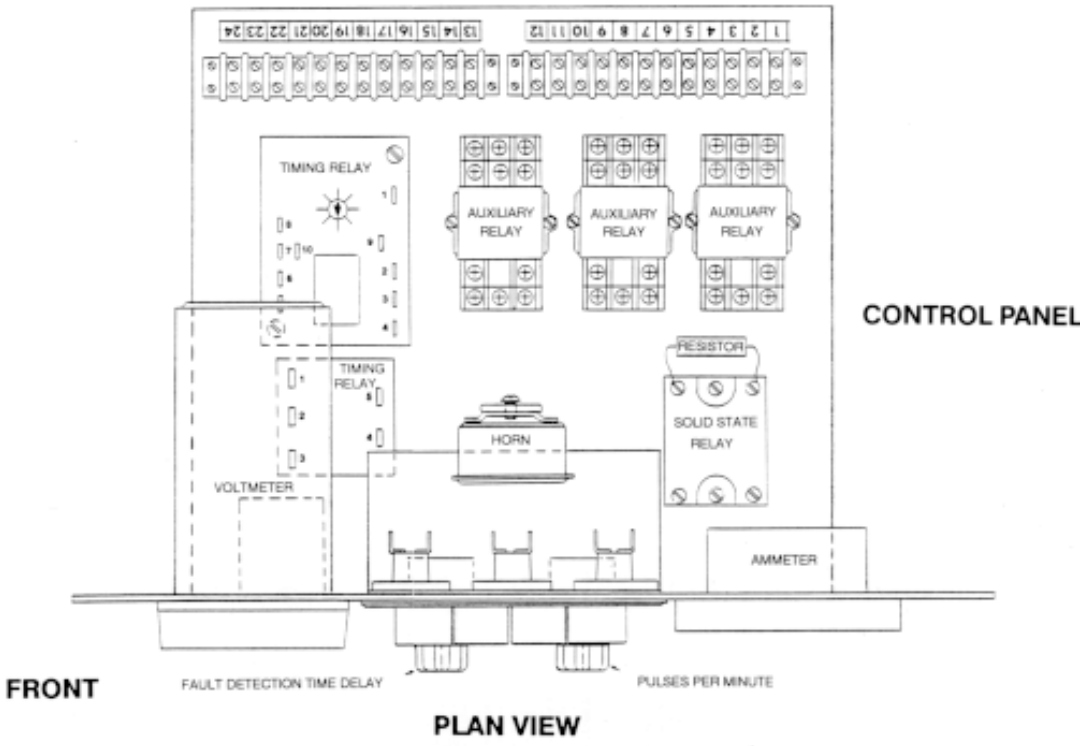


PLAN VIEW

TRANSFORMER AND RESISTOR PAN

SIDE





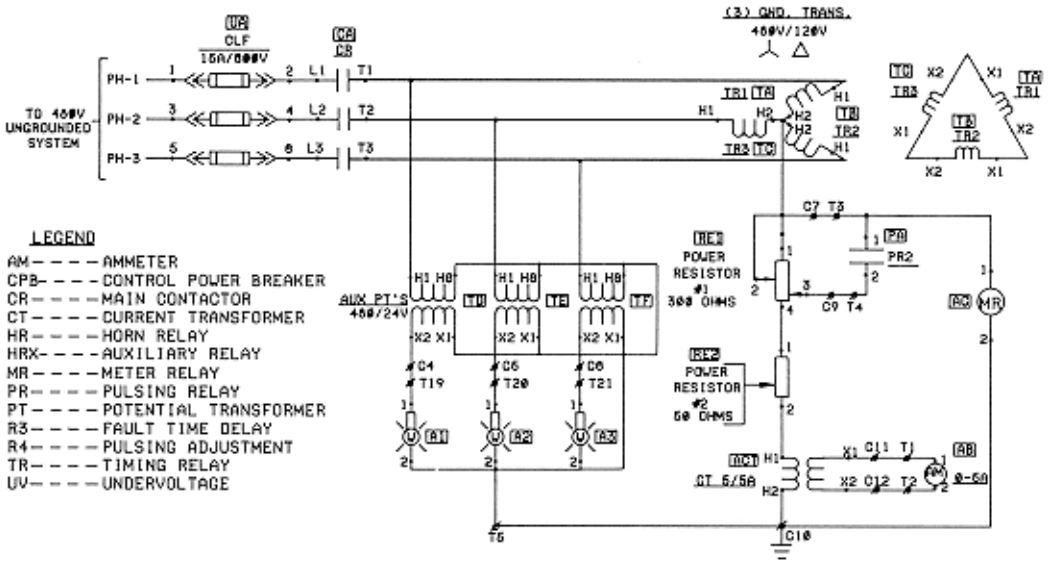
Free standing self-contained High Resistance Grounding System 2001 used at existing various plant wide unit substations secondaries.

Operation of System 2001

Description of Basic Equipment for 480 Volt Systems

The grounding transformer for Delta systems will consist of three single phase transformers connected wye-delta.*

*For Wye systems where system neutral is available, these grounding transformers are not needed.



SCHEMATIC DIAGRAM

During normal conditions, with no ground fault on the system, only a small magnetizing current flows in the grounding transformers and no voltage appears across the resistor.

A green indicating light on the equipment indicates that the system is normal. A white indicating lamp indicates the control voltage is available

When a ground fault occurs current flows through the resistor limiting the ground current to a low value adjustable between 0.9 and 3.6 amperes.

A Voltage appears across the resistor and will be sensed by a contact making voltmeter with a set of adjustable high/low contacts. Auxiliary sensors in the control system are provided for remote indication and annunciation when required.

The ground fault causes the red light to illuminate and an internal horn to be energized. Pushing the green SILENCE button silences the horn but leaves the red light illuminated. Contacts are provided for a remote alarm horn that must be silenced remotely or await resetting at the control panel.

To trace the ground fault the operator, push the selector switch to the PULSE position. This sends a pulse of current into the indicated faulted conductor whose phase is determined by the extinguished phase indicating light. Cyclic timing, alternating energizing and de-energizing by a shorting contactor at the secondary resistor, results in a rhythmic fluctuation in the magnitude of the current in that conductor.

The current transformer and ammeter at the panel will allow the operator along with the amber indicating light to determine the current fluctuations on the system. A portable hook-on detector is then used to trace the fluctuations and ground current to feed the system to the point of fault. After the ground fault has been located and removed from the system the operator then pulls the PULSE selector switch to de-energize the pulse timing circuits and presses a RESET button to reset indicating lights and annunciators.

Taps are provided on the resistor to adjust the magnitude of the ground current in the range from 0.9 to 7.3 amperes. Depending on the size of the system, the current supplied by the resistor to a ground fault will be slightly greater than the system's natural capacitance charging current.

Advantages of System 2001

ITEM	SYSTEM 2001 ADVANTAGE
Control of transient and steady-state overvoltages from neutral to ground.	The high-resistance grounded neutral system effectively controls to safe levels the overvoltages generated in the power system by resonant capacitative-inductive circuits, static charges, and restriking ground faults. It does not control certain steady-state overvoltages such as those arising from the physical contact with a higher voltage system, from autotransformer extended wiring failures, or from faulty series r-capacitor-welder circuits.
Probability of sustained arcing for line-to-ground fault on single phase circuit extension.	Extremely low probability, near zero. Arcing line-to ground fault would be difficult to initiate and would very likely be self-extinguishing.
Rms current value for sustained single-phase line-to ground arcing fault.	Very low current value, if fault could be sustained. Single-phase line-to-ground arcing fault in high-resistance grounded neutral system would likely be self-extinguishing.
Probability of escalation of single-phase line-to ground arcing fault into line-to-line or three-phase arcing fault, in bare bus system.	Very small probability. Escalation probability would be prominently influenced by closeness of phase conductors.
Automatic tripping by phase overcurrent devices for the first ground fault.	No automatic tripping for the first ground fault occurs provided a second line-to-ground fault on another phase does not occur before the first one is removed. The fault circuit continues in operation. In certain process industries and conditions of service this procedure is considered necessary and advantageous.
Safety hazard for ground faults in directly connected control circuits using line-to-line rated voltage contactor coils.	Less than line-to-neutral voltage appears on the contactor coil. Motor will not start.
Shock hazard, from neutral-to-ground, during line-to ground fault.	Essentially zero shock hazard since the neutral is not run with the phase conductors.
Flash hazard to personnel arising from accidental line-to-ground fault.	Basically no flash hazard exists, unless the system has an unremoved ground fault on another phase. This could result in a double line-to-ground fault with serious flash hazard.
Difficulty of locating the first line-to-ground fault.	Very little difficulty. Pulsed signal aids in locating fault with system energized, but some skill in use of tracing equipment is required.
Cost of system maintenance	Slightly more than the same as solid grounding. Tracing ground faults adds cost, and insulation life is reduced by unremoved ground faults, but fault damage arising from ground faults is reduced, with solid state controls maintenance costs are the same as solid grounding.

Portable Detector

The ground current detector is a portable hook-on and includes the following special features:

- Multi-range switch
- Large window suitable for conduits up to 3 inches nominal diameter. 5" available as an option.
- Removable arm to facilitate use in limited spaces where conduits are closely adjacent.
- Shorting switch to provide transient protection while detector is being positioned around conductors.
- Closed magnetic core to minimze effects of stray fields.

For use on systems rated up to 4160 volts nominal. The handle is insulated making it suitable for use where valves are not in conduit. The instrument is given a dielectric test of 12,000 volts, between metal core and handle, during manufacturing.

Portable Detector

Since ground current is limited by the resistor, the last section must never be shorted out by the shorting contactor during pulsing.

The resistor must be adjusted at installation so that the ground current with one ground fault is equal to or slightly greater than the maximum system capacitance charging current. (The value obtained with maximum connected load on the system). If maximum system capacitance charging current is not know, instructions will be furnished for measuring the actual value before placing the equipment in operation.