

**“Phantom” Earth Grounds
On Some UPS Installations”**

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"PHANTOM" EARTH GROUNDS ON CERTAIN UPS BATTERY INSTALLATIONS

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Background

Maintenance personnel have become accustomed to working around battery terminals that are floating with respect to the earth grounded racks and switchgear. When a battery terminal connection or path to ground cannot be found by visibly tracing the cables from the battery to the switchgear and is not indicated on any diagram, a technician can become complacent during maintenance and testing. This paper will show that a path to ground through a UPS can result in extremely hazardous voltages being present between the battery terminals and the earth grounded racks and switchgear enclosures. This condition can result in electrical shocks to experienced battery technicians as well as possible hardware damage and improper indications from grounded battery test equipment that is connected to the battery terminals.

UPS Input Power

Pressure to reduce the initial installed costs and improve UPS ongoing operating efficiency has resulted in designers finding a way to eliminate the input isolation transformer. (Figure 1) Advancements in precision digital electronic control circuits and new solid state power devices used within the UPS have made it possible to connect the UPS input power terminals directly to the three phase utility line. Transformers have been used in the past to isolate the UPS from the utility power and earth ground. The three phase Thyristor (SCR) phase control rectifiers in the past were prone to commutation faults (when one or more of the thyristors fail to turn off) that can instantly draw extremely high levels of phase to phase fault current directly from the utility line input. New digital thyristor electronic control circuits now provide the kind of reliable and precise operation that can make the elimination of the input isolation transformer a cost saving and viable option.

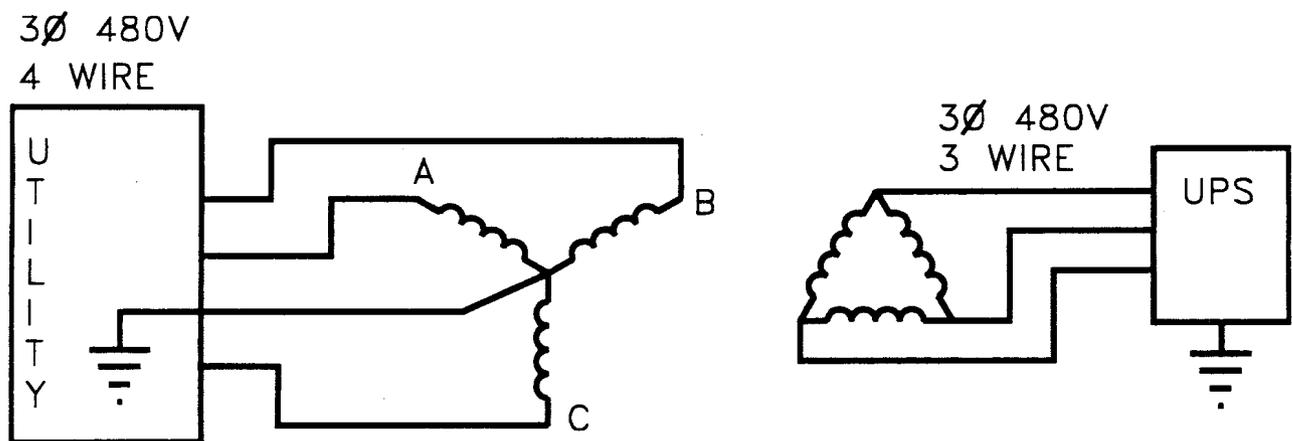


Figure 1
Input Isolation Transformer

How this affects the battery

When the Wye/Delta isolation transformer is eliminated, the three phase four wire, grounded neutral Wye input is connected directly to three pairs of thyristors in the phase control rectifier in the UPS. The thyristors fire in pairs at a point on the sine wave to produce a regulated and rectified DC voltage conversion. (Figure 2) This DC voltage is connected directly to the positive and negative battery terminals that are in parallel support of the input to the UPS inverter where it is reconverted to AC.

When the first two thyristors fire, there is a path made through the device pair and to the earth grounded input power utility power transformer winding.

Relative to safety earth ground, the positive battery terminal now has half of the total DC voltage (+270 VDC for a 480 Volt UPS) as a positive potential and the negative battery terminal has the other half of the total DC voltage (-270 VDC for a 480 Volt UPS) as a negative potential. The center point of the battery bank will reflect zero volts DC to ground and an AC waveform with a peak to peak value that changes shape and amplitude with the UPS load.

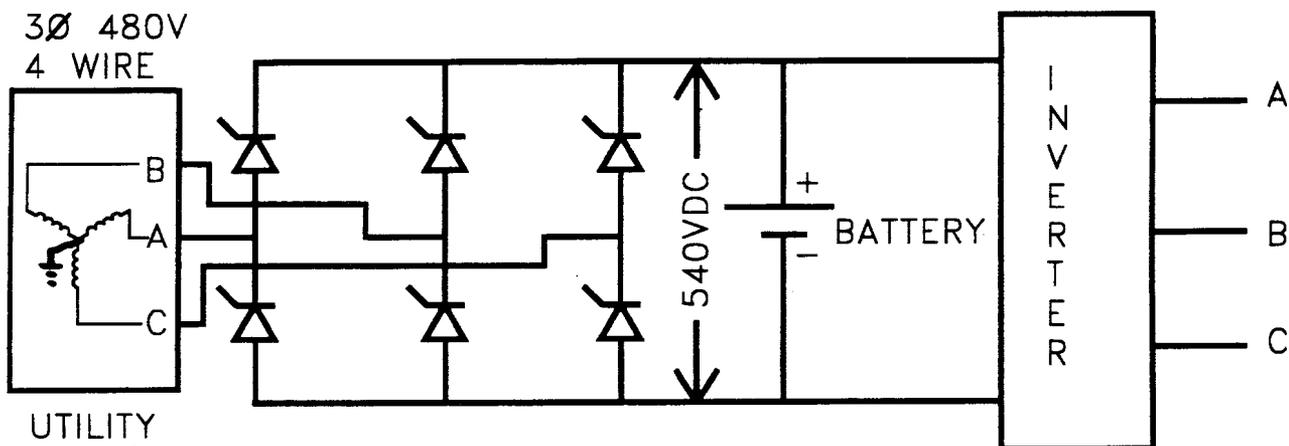


Figure 2
UPS Schematic

Ground Fault Detection

When this condition is present it is not possible to provide normal ground fault detection sensing.

How to test for this condition

If the battery is truly "floating" above ground, there will be little or no DC voltage measure between the battery terminals and the grounded battery rack or switchgear cabinet. If the battery has the "phantom" ground as described here, the DC voltage will appear as described above. Use a Voltmeter to measure from each battery output lead to earth ground. (Figure 3)

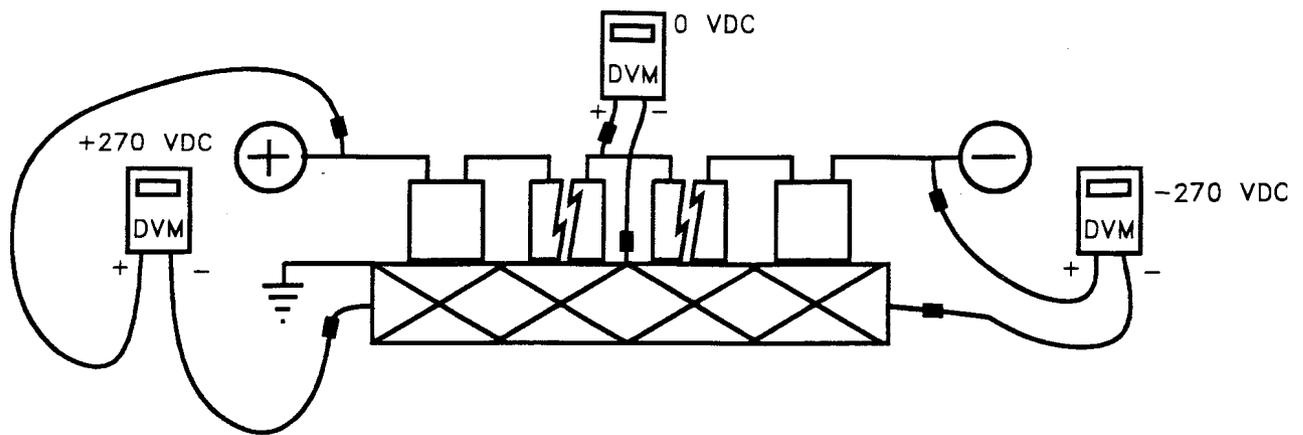


Figure 3
Test Connection Points

What to do if this condition is found

1. Personnel who work around the battery should be notified of this condition.
2. Signs should be posted near the battery indicating that dangerous voltage exists between the battery terminals and ground.
3. Test equipment that is grounded must have totally floating inputs that have at least a 1000 V insulation strength rating.

Summary

It is not sufficient to depend upon diagrams or visual tracing of the DC cabling from the installed battery to determine that no hazardous voltage is present with reference to the earth grounded racks and cabinets.

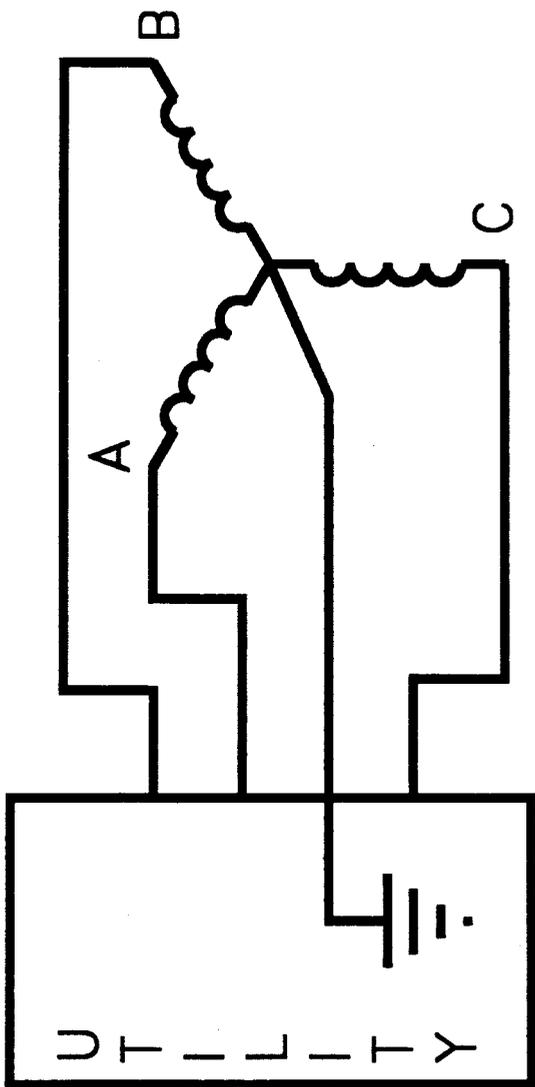
Background

- * UPS Cost**
- * UPS Efficiency**
- * UPS Footprint**
- * UPS Reliability**
- * Technology**

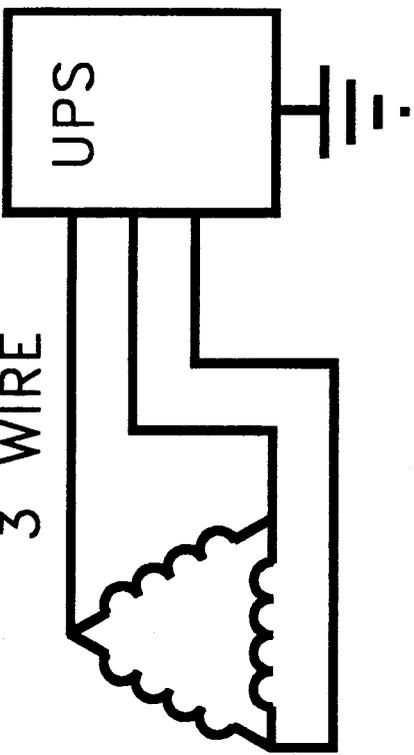
UPS Power Input

- * 3 Phase Delta (3 Wire)**
- * 3 Phase Wye (4 Wire)**
- * Isolation Transformers**

3Ø 480V
4 WIRE



3Ø 480V
3 WIRE



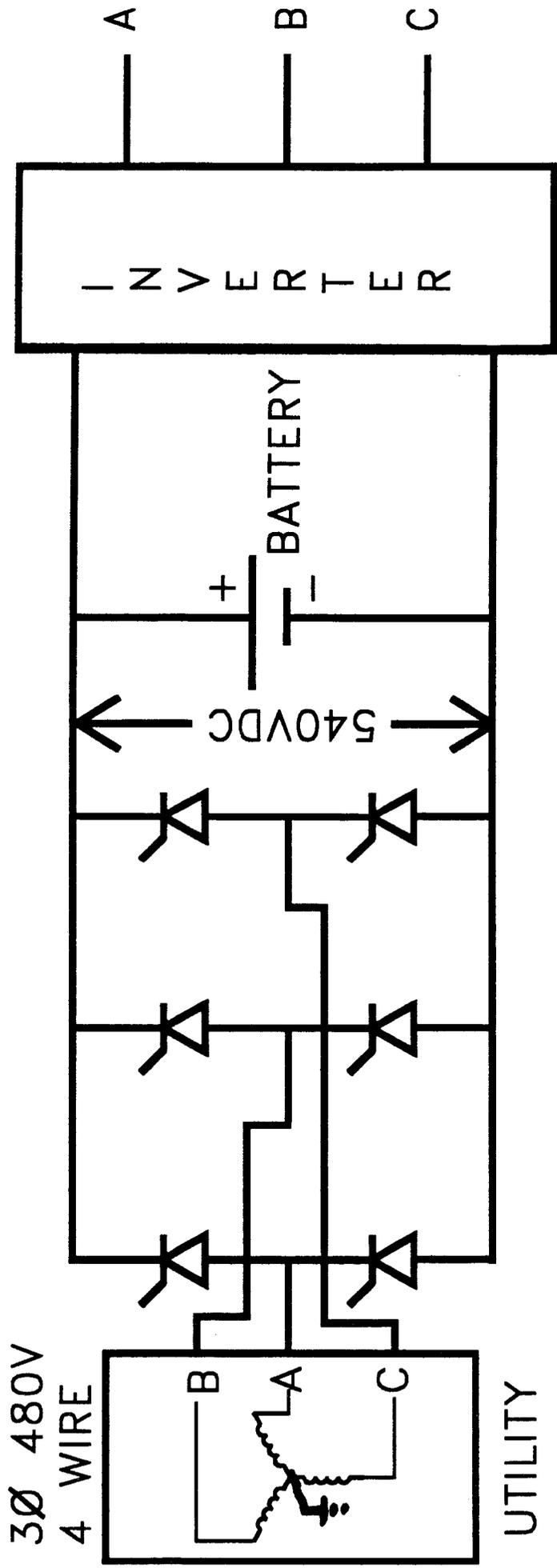
Converter/Rectifier

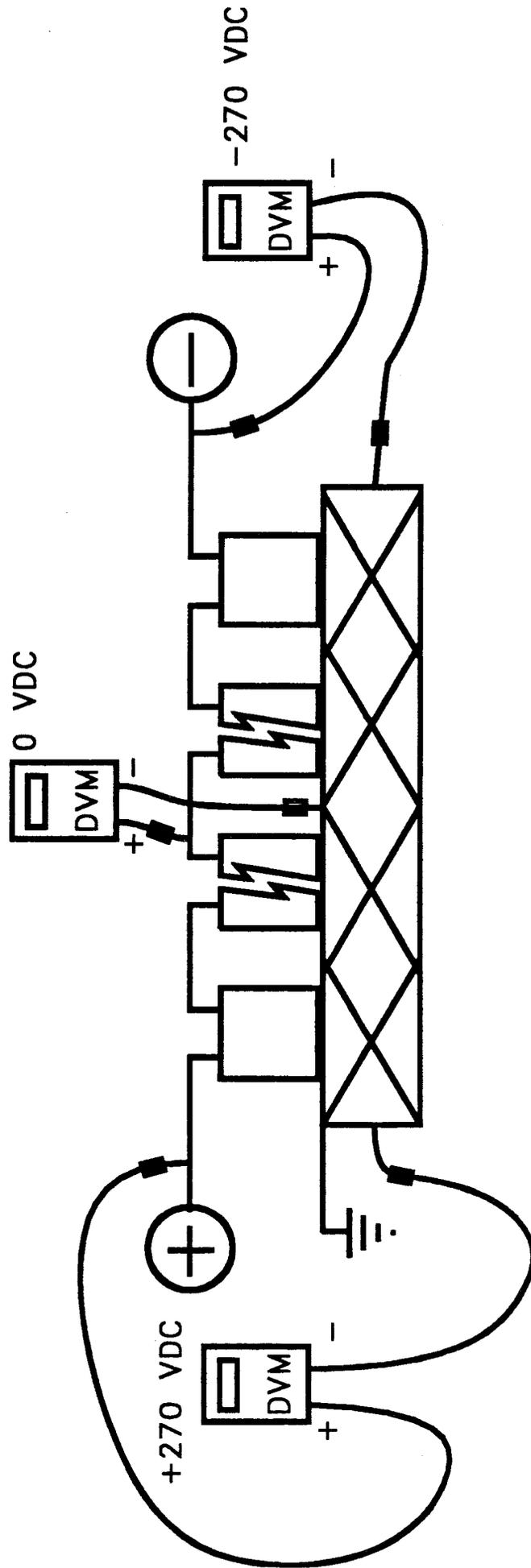
- * Thyristors (SCR)**

 - * Commutation**

- * Phase Control Rectifier**

 - * Commutation Faults**





Summary

- * Visual Tracing**
- * Job Drawings**
- * Use a Voltmeter**
- * Isolate Equipment**