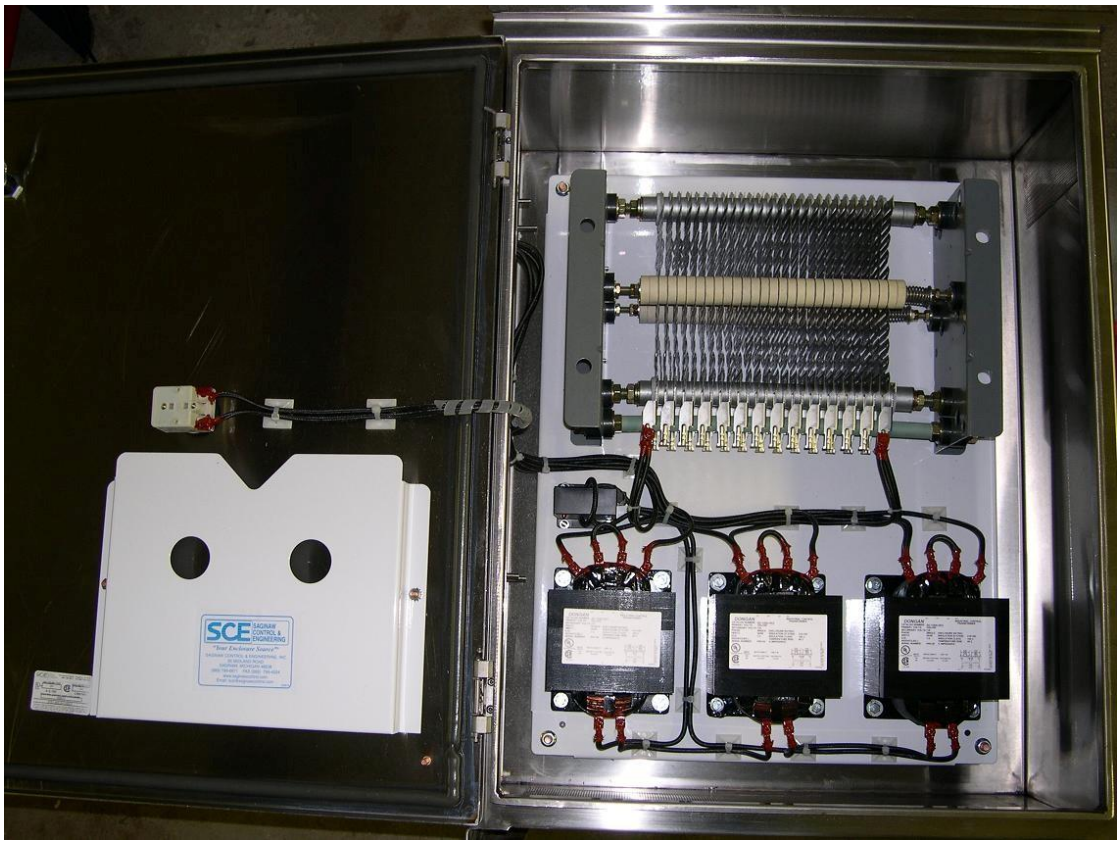
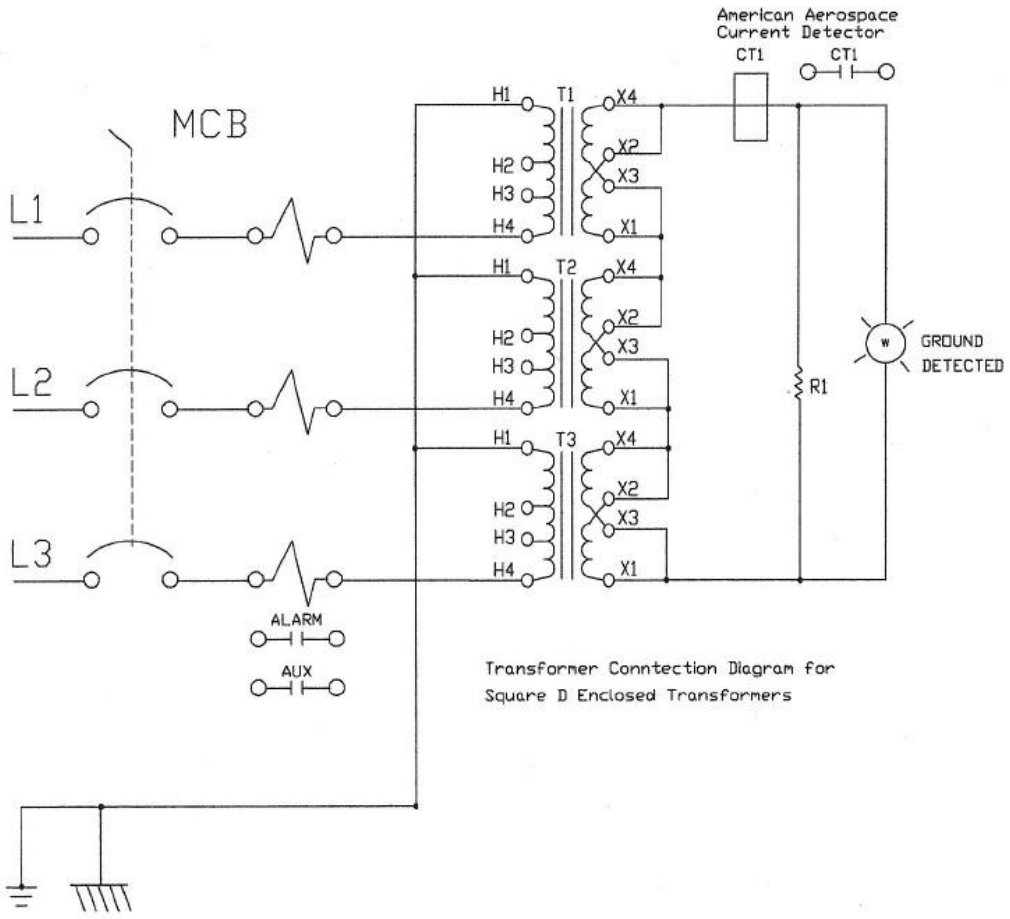
Eliminate TVSS with Phaseback

Pat. No. 6,888,709

Stainless Steel Version



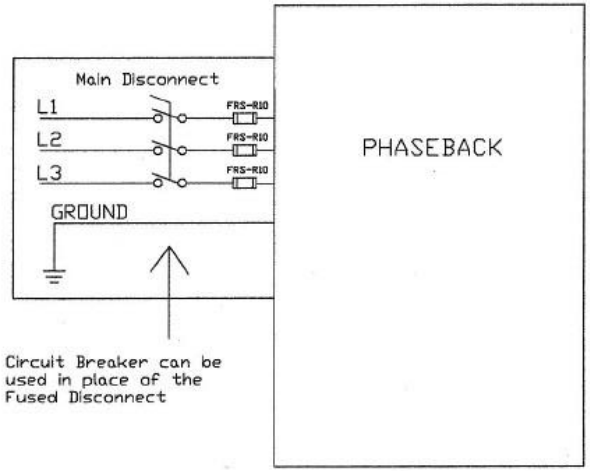
WIRING DIAGRAM



Transformer Conntection Diagram for
Square D Enclosed Transformers

Installation Instructions: Feed the MAIN DISCONNECT
with (3) #10 AWG phase conductors
plus (1) #10 AWG ground wire

NOTE: This unit is wired for 690 volts. All installation wiring to be installed into the Main Disconnect. Fuses to be Bussman FRS-R10, do not substitute



Circuit Breaker can be
used in place of the
Fused Disconnect

Use on 690 Volt Power Systems

APPLIED ENERGY LLC
Saginaw, Michigan

Patent Pending

PHASEBACK 9kVA 690 VOLT CLASS

690 VOLT 60Hz 3-Phase

Vented NEMA 3R Enclosure

Part Number PB-690D-3000-M

Date 03/09/2012 Drawing No. PB-690D-3000-M

Phaseback is a phase voltage stabilization system.

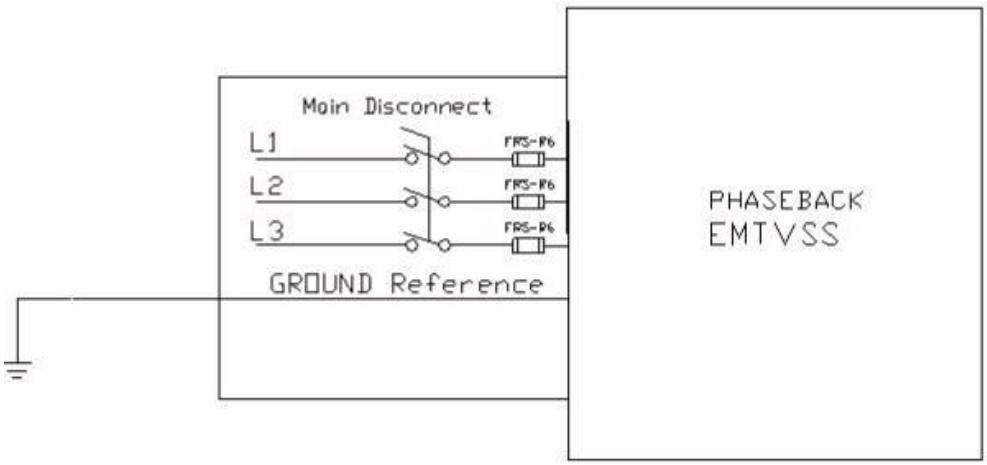
To be effective, a voltage stabilization system must address the following issues:

1) Arc-Flash Prevention and Mitigation
2) Voltage spikes from internal or external sources
3) Phase voltage imbalance
4) Phase Loss due to high-impedance grounds
5) Phase angle differential
6) Phase voltage instability
7) Phase voltage harmonics
8) Waveform distortion
9) Noisy ground reference and frequency instability
10) Arcing ground-faults
11) Operational efficiency increases

INSTALLATION

Phaseback connects parallel with the power system.

To install Phaseback, connect like any 3-phase load to a power system. Phaseback connects to any 30 amp, 3phase disconnect (Circuit Breakers are used in Marine applications) with (3) #10 phase conductors and a #10 ground.



Phaseback does not carry or handle load current. It provides voltage stabilization, causing the phase voltages to be equal with respect to ground. Phaseback operates at the speed of the current flow.

Phaseback has been used in land and recently in marine applications to prevent arc-flash, balance phase voltages, provide phase voltage stability to ungrounded Wye or Delta power systems, and to reduce phase voltage harmonics. Additionally, Phaseback provides an increase in power factor and efficiency, resulting in lower electrical usage.

COMPONENT RATINGS

The components used in Phaseback are industrially hardened NEMA and IEC rated. In designing Phaseback, Applied Energy LLC calculated the projected component lifetime in order that under worst case scenario, no component would be stressed beyond fifty percent of its NEMA and or IEC rating for continuous operation of 35 years. Phaseback will maintain power system stability even during a direct short to ground within the power system.

Phaseback enclosures are available in vented NEMA 3R powder coated steel with optional stainless steel and NEMA 4X.

Each voltage class has a basic impulse level rating six times operational system voltage, for example:
The standard 600 volt class 480 volt Phaseback has been tested continuously with 2,500 volts and intermittently tested to withstand 200,000 volt transient voltage spikes directly to the phase conductors for 30 hours without damage.

INTERRUPTING RATING

Phasebacks for land based operation are provided with a fused disconnect rated 200,000 amps Phasebacks for marine operation are provided with a circuit breaker rated 65,000 amps

SIZING PHASEBACK

Phasebacks are sized by power transformer or generator KVA. The standard size Phaseback is for power systems up to 3,000 KVA and the next size up is for power systems through 6,000 kVA.

Phasebacks are available in various voltage classes (NEMA and IEC):
600 volt class with taps for nominal 120-240/480 volt 3-phase power systems
690 volt class for 690 volt 3-phase power systems
5kV class for 4160 – 4800 volt 3-phase power systems - Multiple voltage taps available
7,200 volt class for 6,600 volt 3-phase power systems - Multiple voltage taps available 15kV class for 13,800 volt 3-phase power systems - Multiple voltage taps available

THE OPERATION OF PHASEBACK

The Phaseback voltage stabilization system does many things in a power system that may be difficult to understand.

First, **Ohm's Law for AC circuits** states that Voltage equals Current multiplied by Ohms of Impedance. Second, circuits have the same current through the entire circuit, which means circuits with equal Ohms of Impedance with equal Current will have equal Voltage.

It is important to understand that transformers couple (2) circuits with magnetic lines of force; the secondary current of a transformer controls the primary current of that transformer. This means the voltage ratio is equal to the ratio of turns in a transformer. The current ratio is at the inverse of the voltage ratio in a transformer.

With a three-phase Wye transformer, connections can be made from (3) single-phase transformers. The centertap or neutral of a Wye connected transformer can be connected to ground.

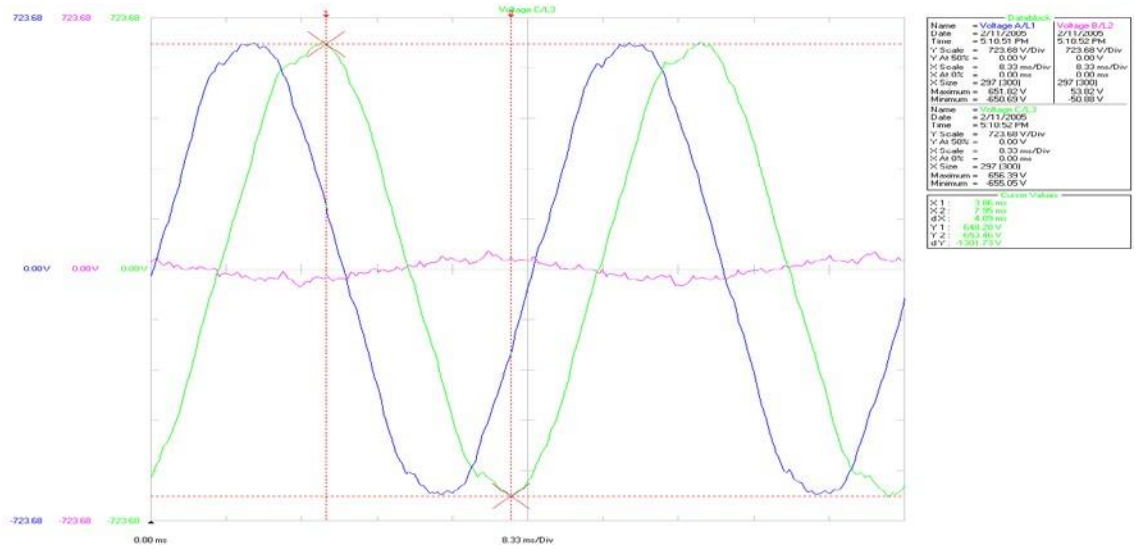
Phasebacks have (3) single-phase transformers with the primary connected Wye and have the (3) ungrounded single-phase secondary coils connected in series with a large power resistor. The large power resistor limits current to protect the transformers from overload. The current through and voltage across the resistor are inphase, causing it to be 100% power factor corrected.

Harmonics are reduced and filtered as current circulates in the secondary, using identical transformers with equal secondary voltages having equal primary voltages.

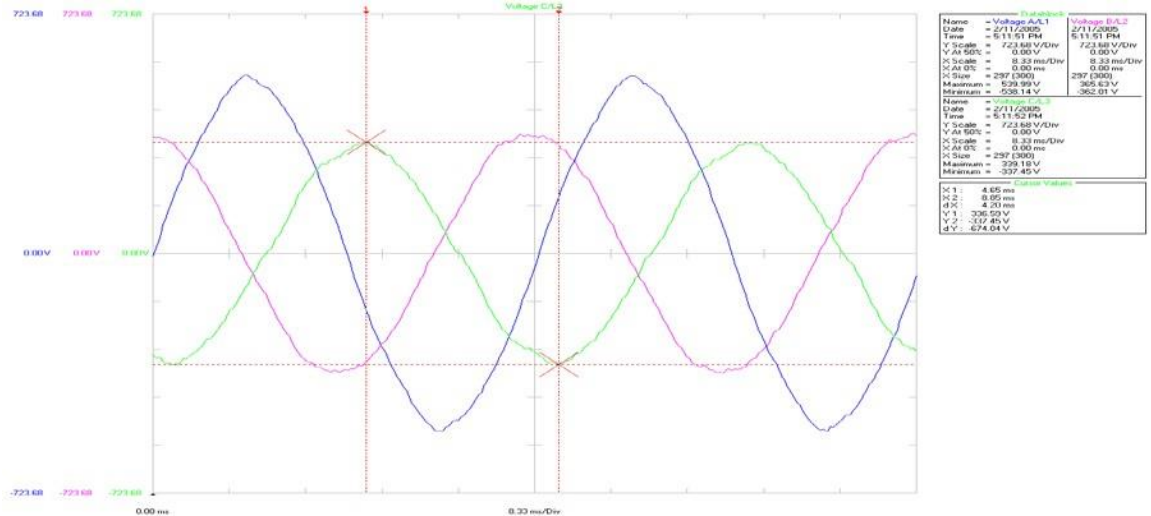
The reader should know that transformers are bi-directional. Step-down and step-up and phase voltages across each primary coil are equal in a balanced power system. Equal primary voltages cause equal secondary voltages in Phaseback.

A phase voltage imbalance anywhere on the system bus will cause positive feedback of current to flow back into the low-voltage phase, thus stabilizing phase voltages as shown in the graph. The positive feedback keeps the capacitive charge equal maintaining equal phase voltages.

Phaseback is <u>not</u> a high-resistance grounding circuit, which drains off the capacitive charge energy (current). Just the opposite, Phaseback sends energy (current) back into the low-voltage phase to reestablish the phase voltage balance. (See the Graphs below)



Voltages Phase to Ground without Phaseback connected



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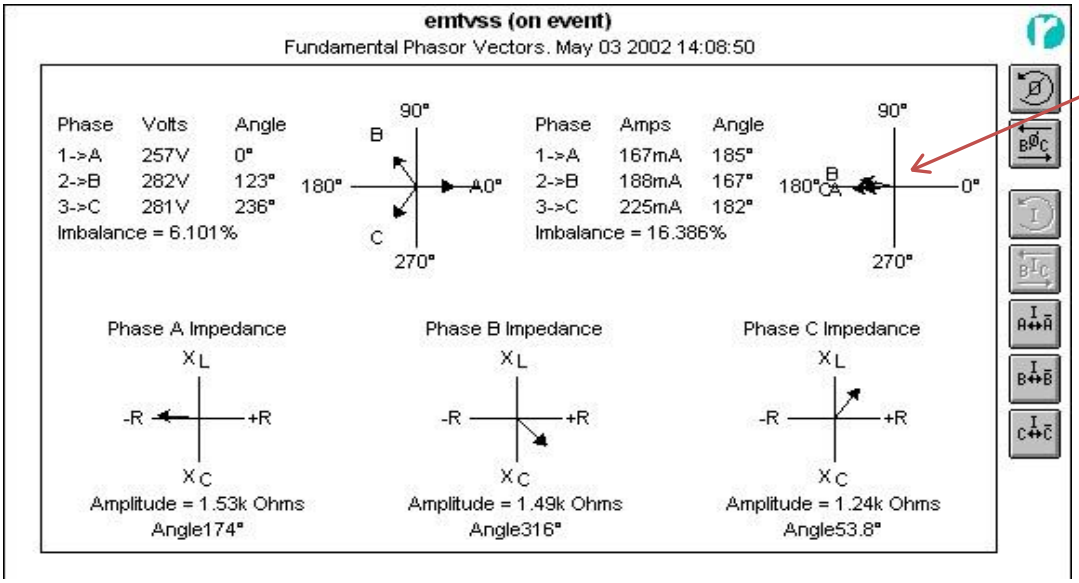


Vectors of current flowing from the secondary of Phaseback to the primary onto the low phase re-establishing the stabilization

Phaseback does not handle load current. Rather, it provides a voltage correction to counteract the negative effects of electrical noise including harmonics. Any event or type of electrical noise causing waveform distortion is corrected by Phaseback. Phaseback uses the energy from the event to counteract the event by beating the noise against itself to cancel it. The greater the voltage imbalance, the more energy Phaseback uses to counteract it.

APPLICATIONS

Phaseback has been used in many land-based industrial applications over the last 18 years and marine applications over the last 5 years.

Phasebacks are used to balance phase voltages, stabilize system voltages, prevent voltage spikes, and reduce harmonics. These are the main causes in capacitor failure. The dielectric (insulation) will fail from voltage spikes exceeding 115% of their rating and high current due to various harmonics of the fundamental frequency. Capacitor failure stops when a Phaseback is installed.

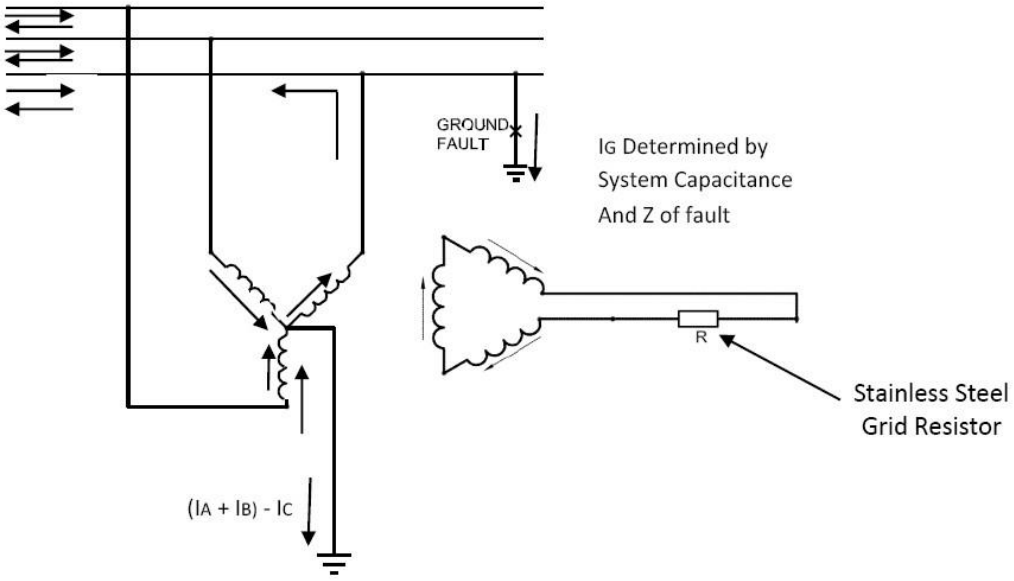
There are other considerations for high-voltage and high-frequency noise protection and mitigation, such as lightning and electromagnetic pulse issues. They can cause similar issues in the power system, but the voltages on the secondary of a power transformer or output from a generator will typically not exceed 50,000 volts and the noise can be from 10KHz through the mid gigahertz range. 600 volt class Phasebacks can withstand and

protect a power system with voltages of 200,000 volts and we have filtered electrical noise through the midgigahertz range.

There are many testimonials at **www.Phaseback.com** explaining the applications and the results.

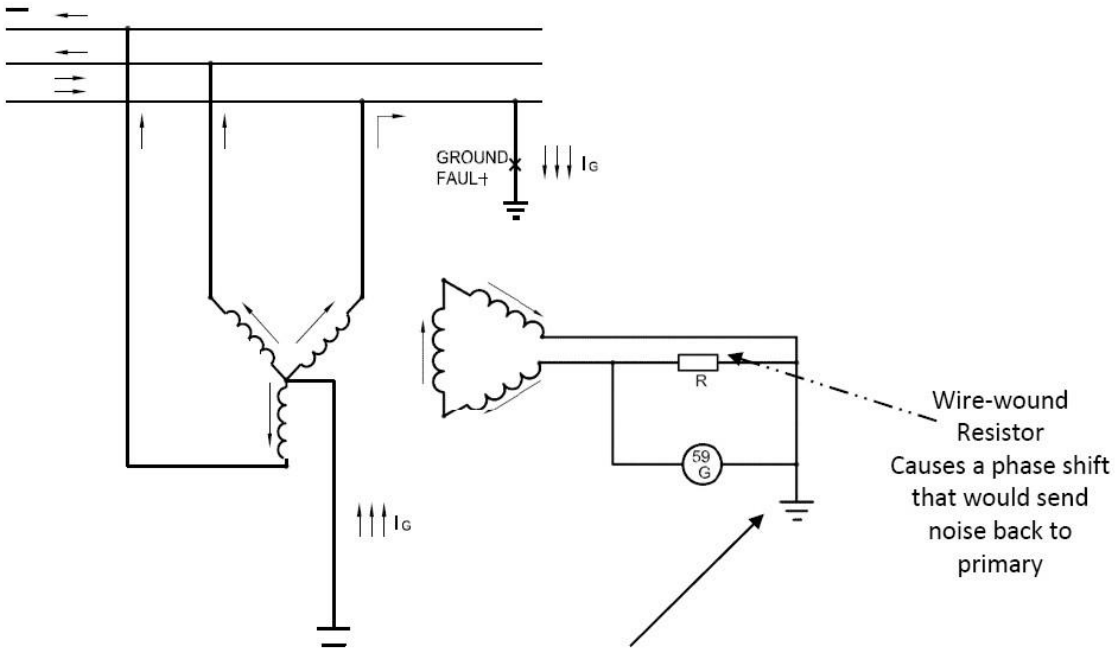
Unlike other high-resistance grounding circuits, Phaseback does not drain off the capacitive charge energy (current). Instead, Phaseback sends energy (current) back into the low voltage phase to reestablish the phase voltage balance.

Phaseback Current Flow



Current is returned from the secondary to the primary to stabilize the voltage on the faulting phase . No secondary ground connection

High Resistance Grounding IEEE 142 page 26 Current Flow



Energy cannot be drained to ground as shown here and used to stabilize voltage

More data is available from Applied Energy LLC.
Contact us at 989-790-1441 or 989-233-4215.