



Applied Energy LLC

3011 Mackinaw Meadows Drive

Saginaw, Michigan 48603

Phone: 989-790-1441

www.phaseback.com

PHASEBACK

VOLTAGE STABILIZING GROUND
REFERENCE SYSTEM

PATENT NO. 6,888,709

For Low, Medium & High Voltage Systems





APPLICATIONS

- Industrial Controls & Automation Systems
- Power Stations & Plants
- Water/Wastewater Treatment Facilities
- Oil & Gas Industry
- Onshore & Offshore Platforms
- Solar & Wind Systems
- Communications
- Chemical Companies
- Automotive
- Aerospace
- Work Boats & Cargo Vessels
- LED Surge Protection

OUR CLIENTS

- US Coast Guard
- US Navy
- Automotive Companies
- Papermaking Industries
- Fertilizer Manufacturers
- Plastics Manufacturing
- Fireproofing Manufacturer
- Lighting Manufacturers
- Food & Agriculture Companies

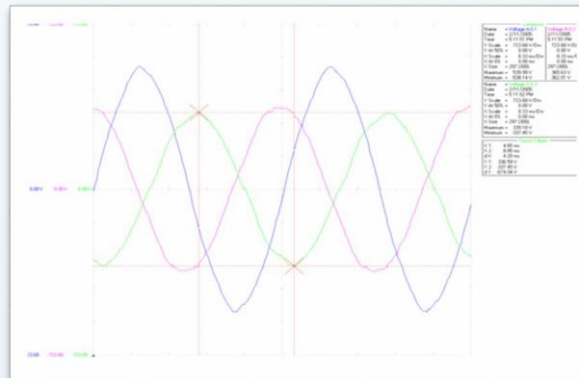
Phaseback EMTVSS

Phaseback is a revolutionary EMTVSS device that serves as a Surge Suppressor, Voltage Regulator and Harmonic filter, without the need for MOVs. The patented **Electromagnetic Transient Voltage Surge Suppressor** makes instant corrections to any phase that is out of balance, and protects against any sized power surge in all power systems **up to 230KV**.

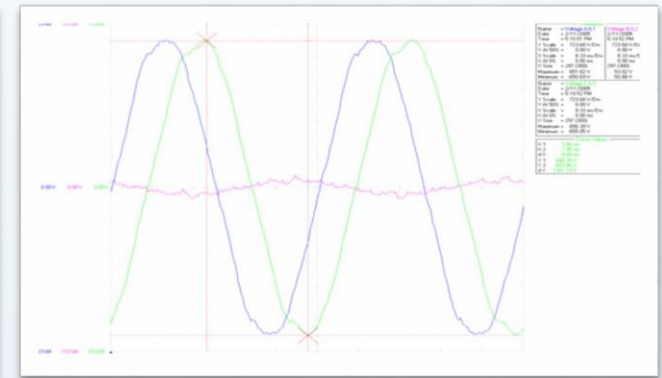
Instantaneous, automatic and reliable

When activated, Phaseback makes an instantaneous correction to any phase voltage that is out of balance. It prevents transient voltages such as those generated by switching transients or phase faults. Additionally, it uses electromagnetic interaction of *mutual induction* to control voltages, protecting the device components and reducing degradation over time or through repeated usage.

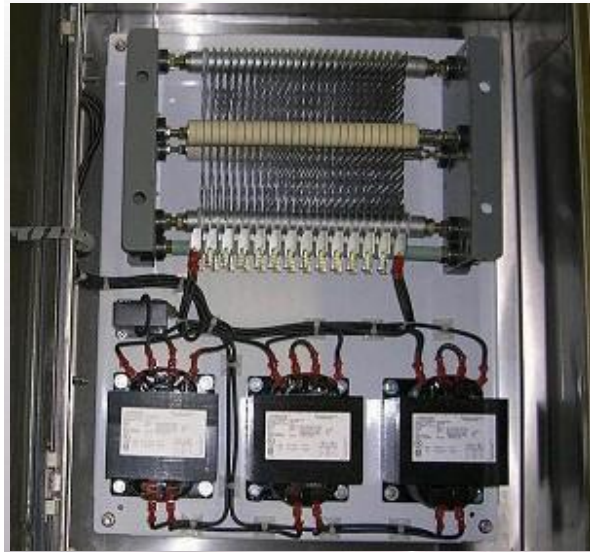
PHASEBACK ON



PHASEBACK OFF



Using **electromagnetism** in lieu of solid-state components, Phaseback reacts at the speed of the current flow at the start of a phase voltage imbalance. Energy is redirected from the phase with the higher voltages and fed back to the low voltage phase. This process uses heavy-duty industrial rated inductive devices closely coupled for maximum efficiency and continuous duty in wet, dirty, or harsh environments as well as being designed for severe shock and vibration.



BENEFITS

- Voltage Stabilization & Balancing
- Transient & Arc Fault Damage Elimination
- Arc Flash Mitigation
- Harmonic Reduction
- Harmonic Cancellation
- Reduction in Energy Consumption
- Extended Motor Life
- Extended Distance between Drive and Motor
- Transient elimination from the Drive

WHAT PHASEBACK DOES

VOLTAGE STABILIZATION & BALANCING

Phaseback balances and stabilizes phase voltages with respect to ground. This phase correction allows motors, drives and control systems to operate more reliably. This voltage stabilization also maintains the **ground reference** in the event of a power failure or scheduled shutdown, preventing damage to sensitive equipment.

ELIMINATE TRANSIENT & ARC FAULT DAMAGE

Transient voltages and arcing ground faults cause high frequency noise, insulation breakdown, control lockups and premature equipment failure. Most solid grounds, which can cause an arc-flash hazard, start as arcing ground faults.

Phaseback prevents arcing ground faults, reducing the potential for arc flash **by over 85%** and even in a scheduled or unscheduled power outage, Phaseback discharges the stored energy from the power distribution, reducing the arc-flash danger. Phaseback has been used in ungrounded and grounded systems **up to 230KV**, and has been unaffected by any sized power surge or noise outside its operational parameters.

HARMONIC REDUCTION & CANCELLATION

Phase voltage harmonics cause eddy currents which cause heat in motors, transformers and all other inductive devices. Phaseback reduces all harmonics, including zero, even, odd and inter-harmonics, by 85% instantly.

Phaseback reduces harmonic frequencies by the **square law factor**. The 3rd harmonic is filtered 9 times, the 5th harmonic is filtered 25 times and the 7th harmonic is filtered 49 times the typical loss of 60Hz noise. This typically reduces all harmonics **50% to 85%** from the 2nd harmonic through the 56,000,000th harmonic of 60Hz. Unlike other types of inline filters designed for smoothing the current in 1 or 2 harmonics, Phaseback reduces harmonic noise by beating it against itself so it reduces **all** harmonics.

In the field, Phaseback has eliminated harmonic frequencies exceeding 3.6GHZ, the equivalent of an EMP.

Phaseback reduces power consumption, extends motor life and protects against transients and damaging harmonics unlike anything else on the market.

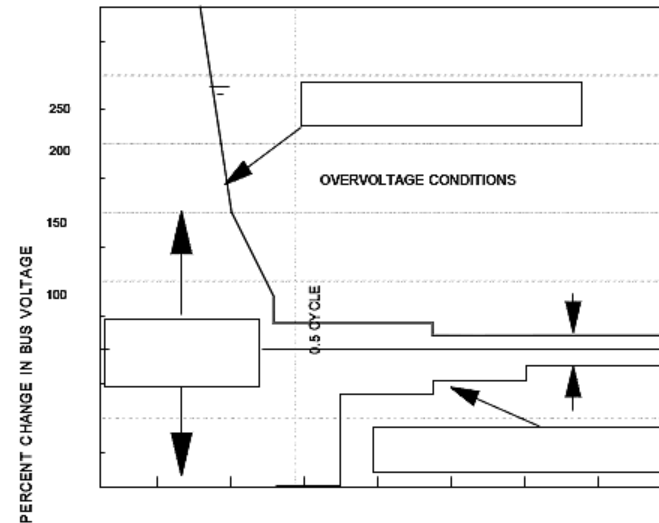
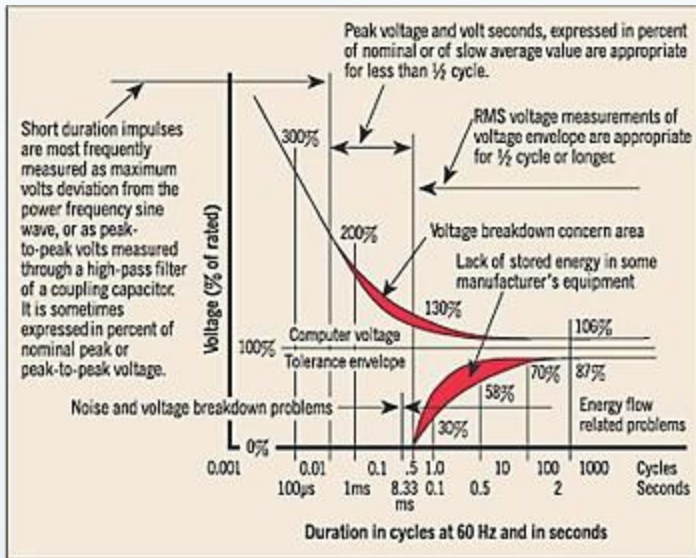
HOW PHASEBACK WORKS



ELECTRO-MAGNETIC TRANSIENT VOLTAGE SURGE SUPPRESSION

Applied Energy LLC has developed an EMTVSS device using **electromagnetism** in lieu of solid-state components. This allows Phaseback to react at the *speed of the current flow* at the start of a phase voltage imbalance. Energy is redirected from the phase with the higher voltages and fed back to the low voltage phase. This process uses heavy-duty industrial rated inductive devices closely coupled for maximum efficiency and continuous duty in wet, dirty, or harsh environments as well as being designed for severe shock and vibration.

Though originally created based on mainframe computer operation, today's control systems being smaller and faster have made adherence to the magnitude and duration of power disturbance considerations of the CBEMA Curve and its successor, the ITIC Curve, even more critical

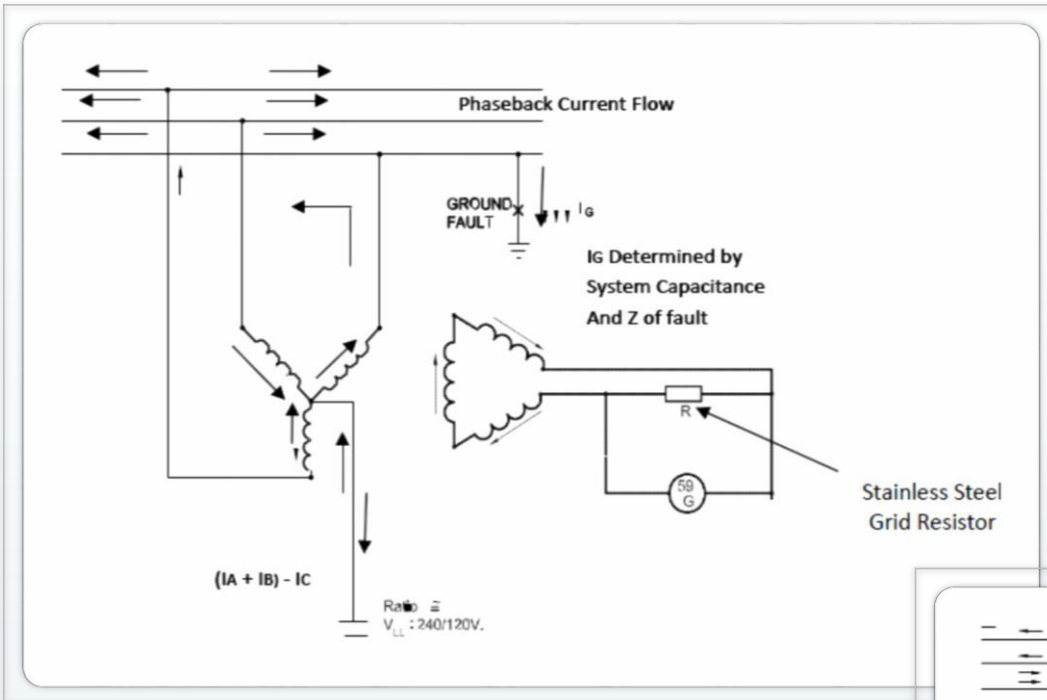


Ungrounded power system applications require special consideration due to the fact that there is no safe way to ground the system without inducing current, thus violating the National Electric Code (NEC) which states "ground is not to be an intentional current-carrying conductor". It is dangerous to allow current to flow to ground when intermittent faults, transient overvoltage occurrences, and short circuit problems can possibly create a dangerous condition for personnel.

The issue becomes how to provide a ground reference necessary for control systems to properly operate without installing products that allow current to flow to ground, which could cause safety concerns and, should two phases connect to ground, a possible Arc Flash.

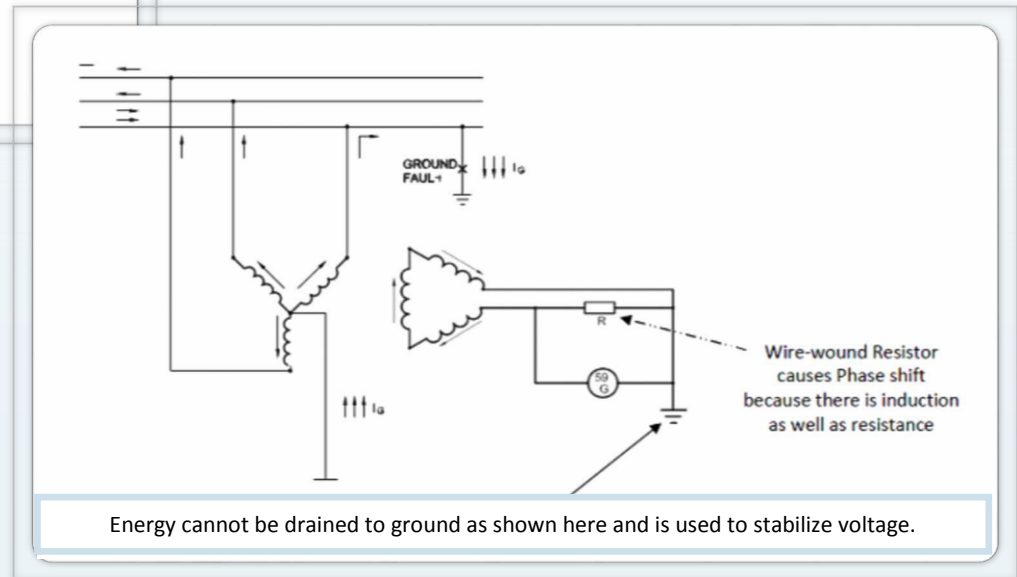
HOW PHASEBACK WORKS

ELECTRO-MAGNETIC TRANSIENT VOLTAGE SURGE SUPPRESSION



Phaseback, the trade name of a product created by Applied Energy LLC, provides a Stabilizing Ground Reference by monitoring the voltage on each phase with respect to ground and electromagnetically reacting at the instant an imbalance begins, thus maintaining proper power quality and a stable ground reference to ensure proper operation of control systems without interruption.

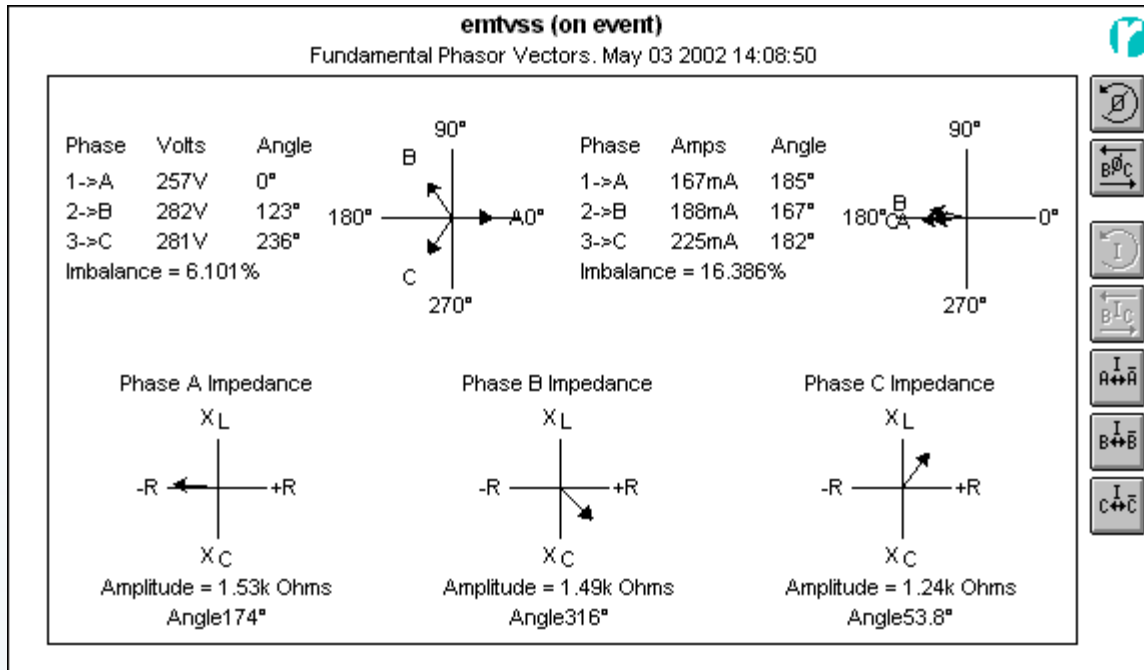
High Resistance Grounding IEEE 142 Current Flow



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

HOW PHASEBACK WORKS

ELECTRO-MAGNETIC TRANSIENT VOLTAGE SURGE SUPPRESSION



Phaseback's voltage stabilizing ground reference addresses the following:

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

To understand the operation of the Voltage Stabilizing Ground Reference the following explanation is necessary:

Ohms Law for AC circuits is Voltage equals Current multiplied by Ohms of Impedance, and, as the leading event, the voltage change offers the fastest reaction time when detected.

Phaseback operates very similar to a braking resistor, dissipating the charge current in the power system through the resistor in the series secondary circuit to lower the capacitive energy to a non-damaging level, thus mitigating the arc flash potential.

The series circuits in Phaseback have the same current through the entire circuit; circuits with equal ohms of impedance and equal current will maintain equal voltage. The transformers couple the primary and secondary circuits with magnetic lines of force. The secondary current of each transformer controls the primary current of that transformer and the voltage ratio is equal to the turn's ratio in the transformer; the current ratio is at the inverse of the voltage ratio in the transformer.

Phaseback makes a three-phase wye connected transformer from (3) single-phase transformers. The center-tap or neutral of a wye-connected primary is connected to ground and the ungrounded single-phase secondary coils are connected in series with a large power resistor connected in series with those secondary coils.

HOW PHASEBACK WORKS

ELECTRO-MAGNETIC TRANSIENT VOLTAGE SURGE SUPPRESSION



The large power resistor limits current to protect the transformers from overload and the current through and voltage across the resistor are in-phase. (100% power factor). Harmonics are reduced and filtered through the resistor in the secondary as current circulates.

The transformers are identical with equal secondary voltages and equal primary voltages. They are bi-directional, step-down and step-up and the phase voltages across each primary coil are equal when the power system is balanced and cause the secondary voltages in Phaseback to be equal.

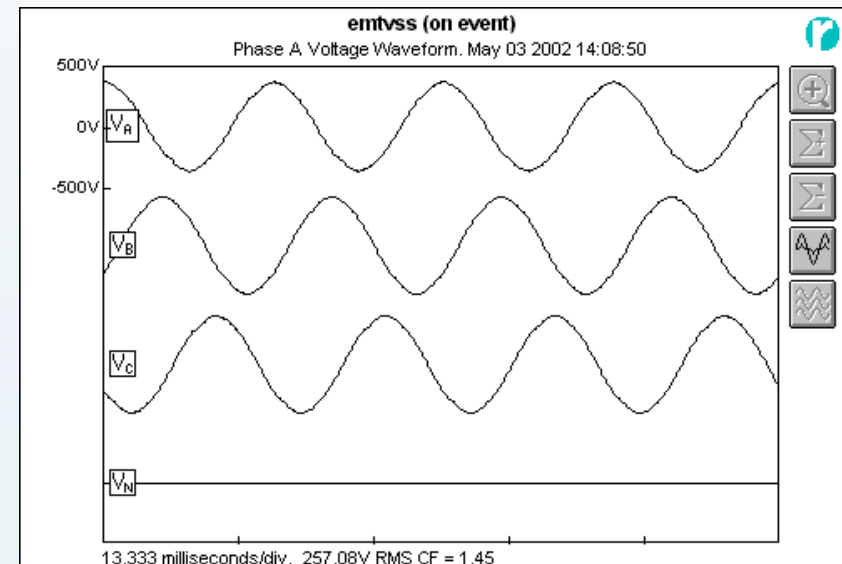
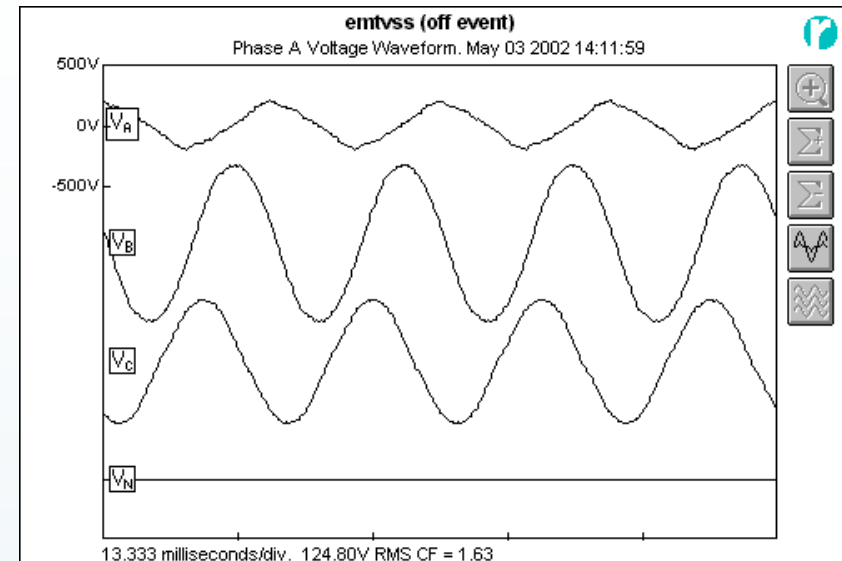
During an imbalance on the Power Distribution system, energy from the secondary is sent back to the low voltage primary phase, and the positive feedback keeps the capacitive charge equal, causing the phase voltages on the power system to become stable.

Included in the Phaseback Voltage Stabilizing Ground Reference are two alarm points. The first point is located on the front of the panel; it is a ground fault indicating light. The second point is a secondary series circuit current detector with solid state (normally open) contacts that is factory set to alarm when 500 milliamps flow through the resistor. The early warning of the current detector provides maintenance the ability to correct the problem before a second fault forms, which can prevent multiple phases faulting through ground. This is a prime cause of arc flash.

For marine applications, we also recommend connecting a second current detector on the ground connection. This current detector is connected to the neutral point of the primary connection in the unit for protection in the event that the ground cable is cut or otherwise disconnected.

Spare part recommendations for the unit are minimal, with the only recommendation being a couple of additional GE755 light bulbs and an additional current detector.

Based on MTBF calculations shown below, the Voltage Stabilizing Ground Reference should operate for years without problems.



INSULATION “HALF LIFE”



“Half-life” is a new word in our vocabulary and relates to the fact that for every 8 to 10 degree C increase in insulation temperature, its useful life will be cut in two. The original rule of thumb was 8 degrees, but in recent years technical writing generally refer to 10 degrees.

Insulation temperature rating of the transformers used in Phaseback is 180 degrees Celsius.

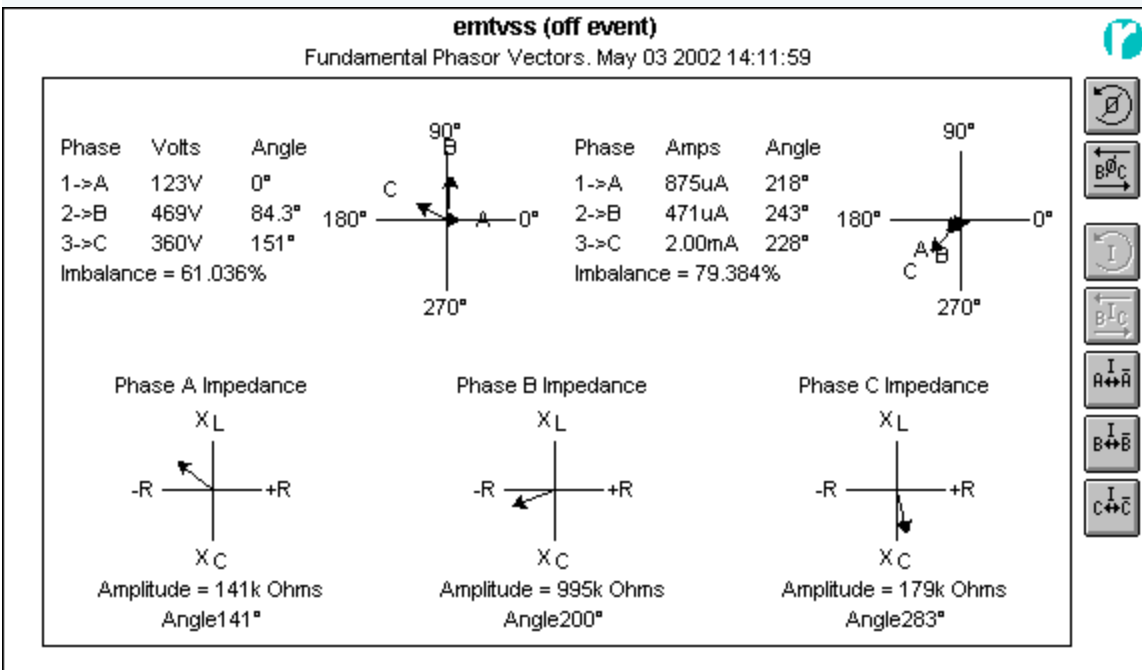
Typical operating temperature under 100 degrees Celsius extends the operational life to over 294 years.

For every 10 degrees Celsius below rated temperature electrical equipment operates at, its projected lifespan doubles.

This is a realistic life expectancy of the transformers used in each Marine Phaseback. The resistor is rated for a continuous operating temperature of 375 degrees Celsius. Operating below 100 degrees Celsius extends its life to excess of 275 years.

TABLE 2. RELATIVE LIFE USING A 220°C. INSULATION SYSTEM

Design average conductor temperature rise	Equivalent hot-spot temperature	Minimum theoretical life (years)
150C	220C	2.3
140C	210C	4.6
130C	200C	9.2
120C	190C	18.4
110C	180C	36.8
100C	170C	73.6
90C	160C	147.2
80C	150C	294.4



Taken from Square-D Dry Type Transformer Study Course (Bulletin I-1 (R1) 10M BP 4/91) Page 26.



CONTACT INFORMATION

Applied Energy LLC
3011 Mackinaw Meadows
Drive Saginaw, Michigan
48602 Phone: 989-790-1441
www.phaseback.com

REQUEST A QUOTE

Phaseback is built to order, and is designed for your specific need.
For a quote, go to our website and fill out our form, or call our offices to speak to an engineer about your issues.

WHAT PHASEBACK HAS DONE FOR OUR CLIENTS

Phaseback is the only TVSS that can withstand the most powerful surges without damage to itself or anything it protects. The laws of physics do not change, but our understanding of them does; Phaseback works on a fundamental electromagnetic principle that reacts at the speed of current flow, is shock proof, vibration proof and works in the harshest conditions.



Phaseback has a Lifetime Warranty and has proved itself in the market for the past 12 years. Used by industries, factories, and the military, Phaseback has saved billions of dollars worth of equipment, and has even saved lives.

“ *A leaky roof and a Buss Plug do not mix.*

Usually when this would happen it would take days to identify the damaged components and replace them if the parts were available. No more, with Phaseback the Buss Plug was replaced, the breaker closed and every machine started back up. No scrambled programs and not one circuit board damaged.”

-Mid Michigan Automotive Manufacturing Plant, Michigan

“ *Being the active regulating device that it is [for true Delta configured power supplies], gives cause for the reason Phaseback is able to control hundreds of amperes of fault and imbalanced current [within the Delta connected Phase windings].*

The end result of Phaseback being able to control these high currents within the Delta connected Phase windings has the net effect of controlling damaging voltage transients being applied to both equipment and ground. At Kodiak, we've had one such Delta-Delta/ Phaseback system set up as an isolated power supply. It's been in use for approximately one year at one of transmitter/ communication facilities with flawless results.”

-ALB , Kodiak Alaska

See more testimonials, information and whitepapers on our website

www.phaseback.com

KEMA ARC FLASH TEST

On January 13th 2017, the resilience of the Phaseback VSGR against arc flash events was put to the test at the KEMA high-voltage laboratory in Pennsylvania. A battery of arc flash tests were performed against the VSGR.

The result: no damaged equipment, no arc flash, and no hazardous rise in voltage.

Depicted in the graph at right, the VSGR mitigated a voltage charge of 6,000V to a spike of only 12V. In doing so, the VSGR consumed 0.25 amperes of current.

See our website to see the [full KEMA Arc Flash Test Report \(PDF\)](#), as well as the [KEMA Arc Flash Test with Phaseback VSGR Video \(YouTube\)](#).

