Phaseback Arc Flash Prevention

Contained within this document are three case references from customers who found Phaseback to be effective in preventing arc flash incidents.

Customer reference #1

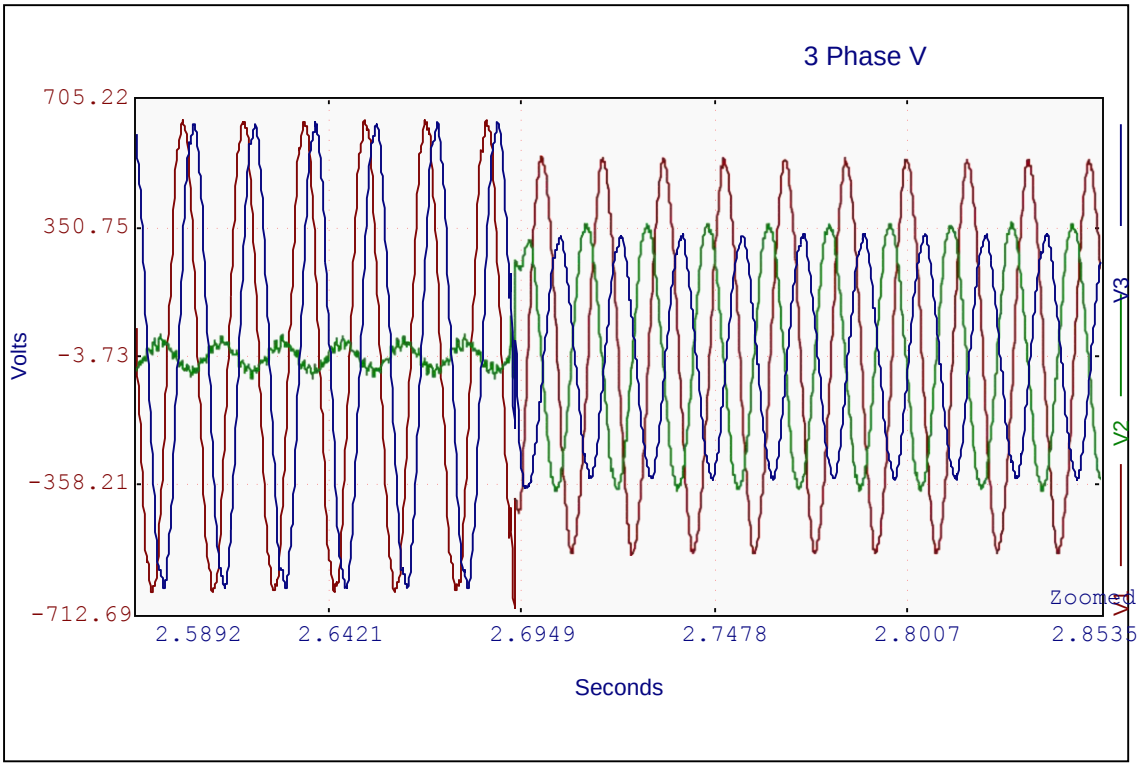
Shows two phases with grounds on the same power system without an arc flash event.

Here is shot 24 from Unit 1, taken on 2/5. I think this is a normal shot showing how Phaseback works.

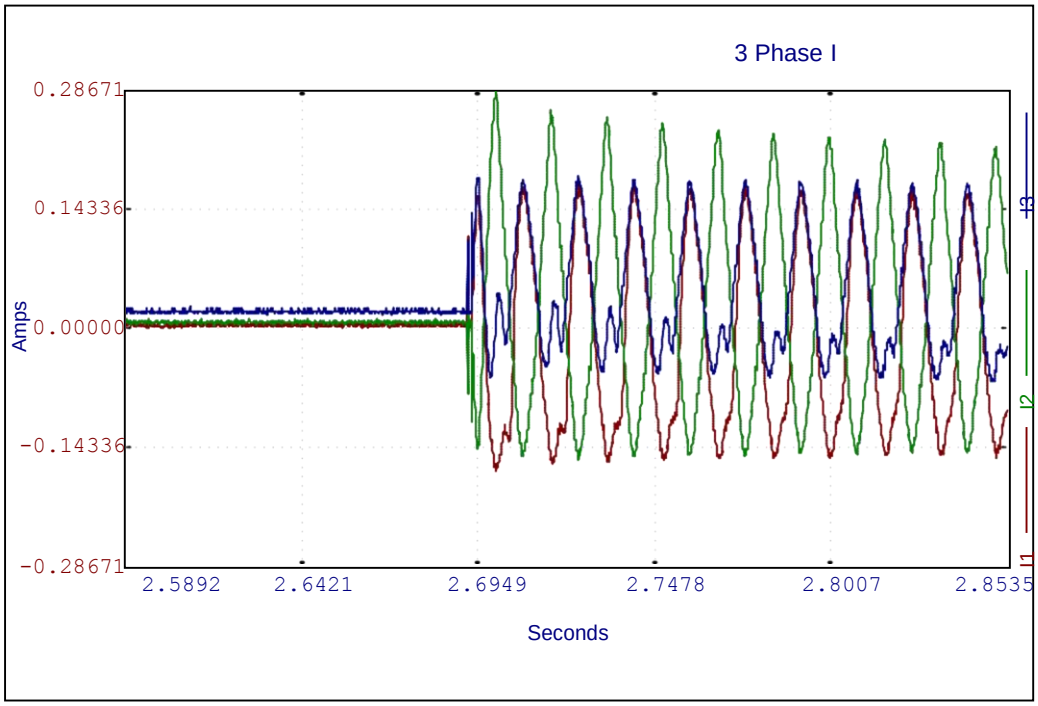
```
; Delphi
; Substation
; Unit 1
; Description 2
; c:\my documents\delphi\unit 1.dem

; Shot:                 24
; Time:          09:39:07
; Date:          02/05/03

; Delphi
; Substation
; Unit                  1
; Description           2
;
; Event         Time:           9:39:07
; Event         Date:           2/5/03
;
; Total         Cycles:           226
;
; Event         Extreme     Values
; Item          Peak        MinRMS     MaxRms
; V1             699.04       370.4     463.65 V
; V2             373.19       28.54      259.3 V
; V3             650.79       227.3     453.75 V
; Vr              135.8        0.52      74.86 V
; I4             0.1741      0.0037     0.1211 A
; I5             0.2867      0.0076     0.1417 A
; I6             0.1863      0.0215     0.0951 A
; IN              0.235       0.033       0.11 A
; E1            0.09354     0.03277    0.03438 Volts
```

The MinRMS (28.54v RMS) is the grounded phase B before Phaseback is energized. Phaseback recovers the phase to 259.3v, (MaxRMS).

Here is the waveform showing the B phase smooth transition to recovery.



Here is the current waveform showing the start of Phaseback action.



Now, here is the waveform in question.

; Delphi
; Substation
; Unit 1
; Description 2
; c:\my documents\delphi\unit 1.dem

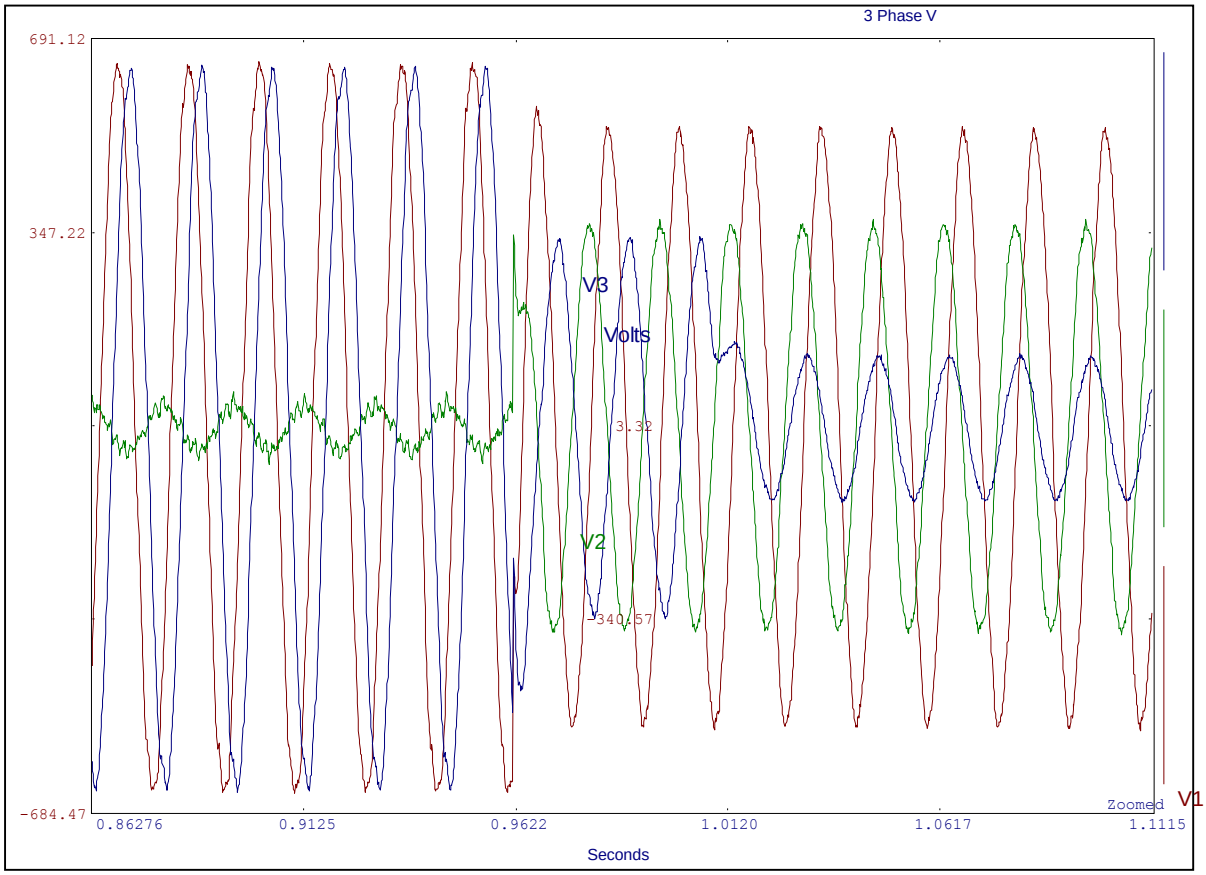
; Shot: 18
; Time: 09:37:35
; Date: 02/05/03

; Delphi
; Substation

; Unit 1
; Description 2
;
; Event Time: 9:37:35
; Event Date: 2/5/03
; Total Cycles: 226
; Event Extreme Values
; Item Peak MinRMS MaxRms
; V1 657.35 370.61 463.37 V
; V2 375.02 29.24 257.96 V
; V3 652.05 87.59 453.58 V

; Vr	129.05	0.54	73.47 V
; I4	0.1863	0.0034	0.1097 A
; I5	0.2107	0.0077	0.1124 A
; I6	0.1936	0.0216	0.1002 A
; IN	0.213	0.033	0.104 A
; E1	0.09354	0.03275	0.03412 Volts

Both B and C phases are shown to be grounded in the text of MinRMS.



At time 0.9125, A phase is 450v RMS, B phase is 26v, and C phase is 442v RMS.

At time 0.9622, Phaseback is energized.

A phase recovers to 369v RMS.
B phase recovers to 257v RMS.
C phase recovers to 232v RMS.

Then, the mystery!! Three and one-half cycles later, at time 1.0120, C phase grounds, with no further change in the recovered voltages of phases A and B!

The phases now read; A=371v RMS, B=252v RMS, and C phase 87v RMS.!!!!

"Here is what I think at this point. Although there was no further change in Phaseback primary current after the first recovery, I think that Phase C grounded at the second transition. This means that two phases were grounded! I believe this for one reason. Look at the phase angles at the different transitions. Initially, you see the severe phase error due to the initial grounding of phase B. Then note the phase angle correction that occurs when Phaseback is applied to the circuit.

Then at the second transition, the phase error re-appears. In my mind this can only occur with a second grounded phase. (OK, so it's the first time I have ever seen this!) What do you guys think? This is something that can be verified. Find a unit with a ground, and add a second ground. Carefully!

Measure the voltages. Yikes! If this proves out, a lot of books will have to be re-written!"

- Mike McClelland

  MEM Power Solutions, LLC.

Customer Reference #2

Describes an oil platform workboat with intermittent arcing grounds, which caused multiple catastrophic arc flash damage and injuries. Once the Phaseback VSGR was installed, these problems ceased entirely.

"Here is a quick synopsis of my recent job using Phaseback solutions to restore system balance and provide arc flash prevention.

The site is a commercial maritime vessel used in the off-shore industry. It is heavily dependent on ungrounded voltage systems for service continuity. You can consider this a true, "No-Break" system, which means these voltage systems MUST tolerate phase grounds without danger to personnel, AND WITHOUT allowing loss of control system authority due to the inherent danger to operating equipment and operating personnel. Two arc flash events occurred recently while electrical workers were in the process of operating large circuit breakers. In each incident, the same breaker failed explosively, initiation the events. Several workers were injured, one seriously.

A total of four Phaseback units were purchased and installed; two on 690v systems and two on 480v systems. The Principle project electrical engineer (from Europe) enthusiastically endorsed my selection, agreeing that if the unit will stabilize the system voltages, then arc flash events cannot occur. We proved this by installing one 690v unit, and then forcing a ground on one phase. The grounded phase voltage only dropped 2 volts! At this point, four more Phaseback units were purchased for a second vessel of the same design.

A large part of this task was to demonstrate to the ship crew that it was now safe to operate the equipment. The demonstration of Phaseback capabilities did this.

During the remainder of this job, Phaseback saved us two additional times. A large, 2.5MVA VSD system twice suffered catastrophic failure and subsequent grounding of a DC link snubber resistor (375kW). When this happened, since the VSD is powered from the 690v system, the DC went to the ship's hull and we believe this was the cause of the earlier arc flashes. The Phaseback was credited with preventing possibly major damage to the equipment and injury to personnel.

Thanks, and you have a great product!"

- Mike McClelland

  MEM Power Solutions, LLC.

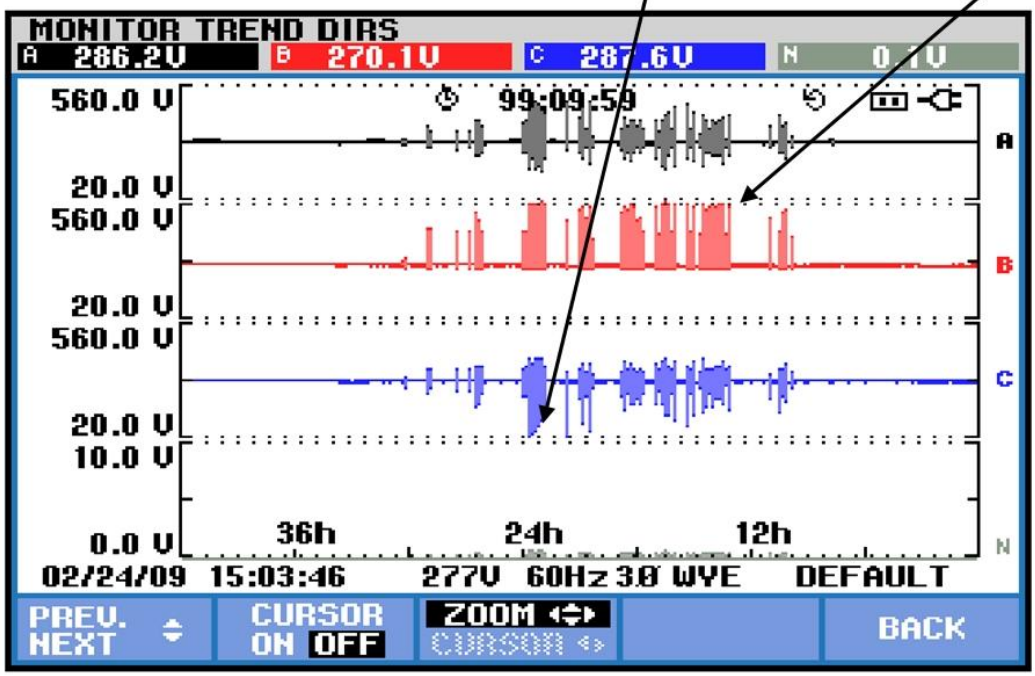
  619-602-3374

  3/16/2012

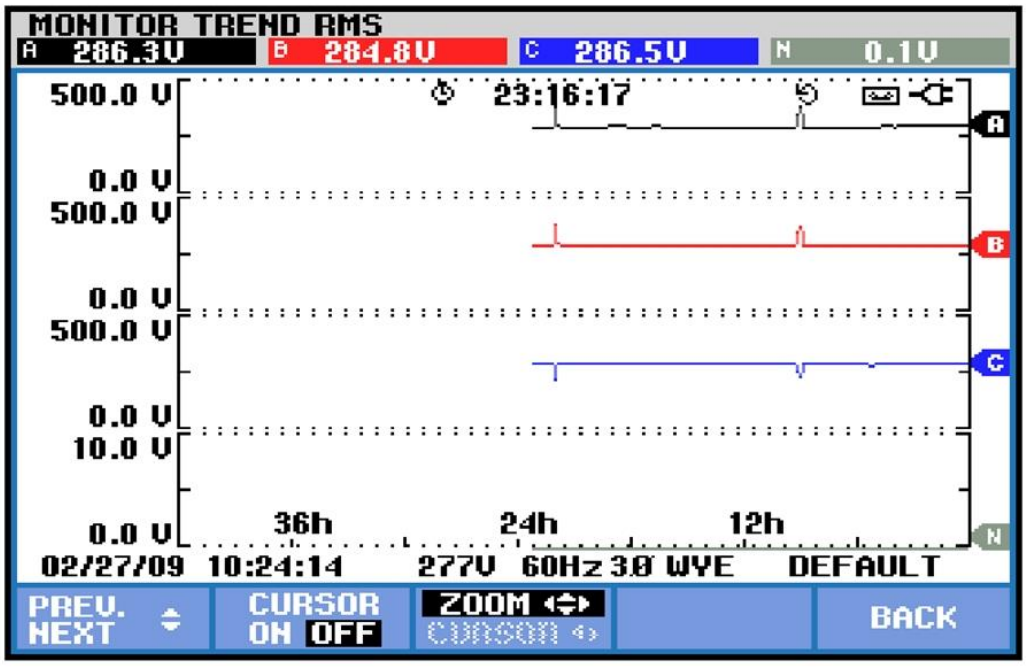
Customer Reference #3

Shows hundreds of voltage spikes on phase B, and arcing ground faults on phase C.

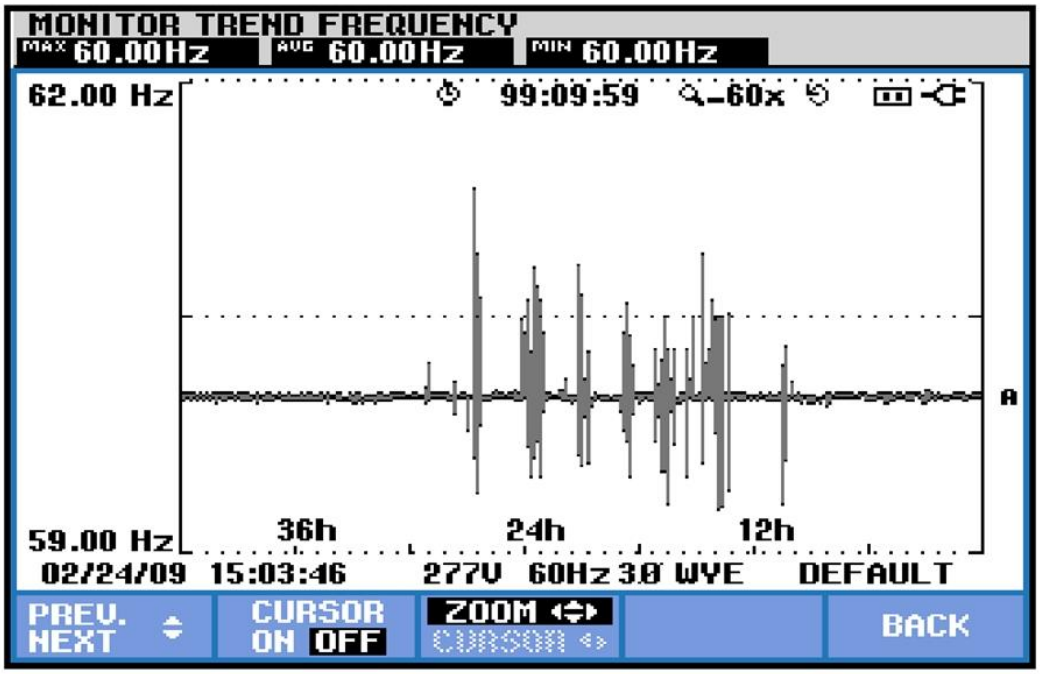
Voltages unstable and noisy from transient voltage spikes exceeding 560 volts stressing the insulation system and arcing ground-faults on the phases



Phase Voltages balanced and stabilized with Phaseback



Frequency unstable and noisy from the voltage spikes and arcing ground-faults



Frequency stabilized with Phaseback