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# **Electronic Power Conditioner & TVSS/Filter Testing Report**

**Prepared for  
Smart Power Systems**

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# Electronic Power Conditioner & TVSS/Filter Testing

## Background

Smart Power Systems retained PowerCET Corporation to test and verify the performance of their TBF Copier Guardian electronic power conditioner and of several other filter and TVSS products. Tests performed on the products included:

- Surge voltage testing with ANSI/IEEE C62.41-1991 waveforms -- The surge voltages were generated with a KeyTek model 711 surge generator. Surge voltages were applied normal mode (L/N) and common mode (N/G). All test pulses were category A ringwaves (6kV L/N & 3kV N/G). This test verifies withstand and voltage let-through.
- Momentary over-voltages -- 150% over-voltages were generated with a Power Science line disturbance simulator. Three second over-voltage events were applied to the devices and the output voltages were recorded with a Dranetz 658 power monitor. The monitor simultaneously recorded the voltage at the input and output of various power protection devices.
- Wiring problems -- Open ground and line/neutral reversals were applied to the products. The output electrical conditions were visually checked with light bulbs and multimeters. The wiring problems reflect conditions that are commonly found in residential and commercial facilities:

Products included in the testing:

- Smart Power — Digital Smart TBF — Copier Guardian — model TBF15C-1121TN
- EFI — Transient Voltage Surge Suppressor (TVSS) — model DPF12015NR
- Panamax — MAX ImagePro 15 Amp
- ESP — Digital QC — model D5130NT
- Oneac — FilterOne

## Synopsis of test results

- Surge Voltage Testing: The Smart Power Electronic Power Conditioner kept let-through voltages below 10 volts line/neutral and 0.5 volts neutral/ground. ESP and Oneac products kept let-through voltages below 20 volts. The Panamax product kept neutral/ground let-through below 20 volts, but both the EFI and Panamax products let-through much higher voltages line/neutral.
- Over-voltage Testing: The Smart Power and Panamax products removed output power when applied voltages exceeded preset limits and automatically reset when applied voltage returned to normal levels. The other products passed the over-voltage conditions through to their outputs.
- Wiring Faults: The Smart Power and Panamax products removed power from their outputs with open ground and with line/neutral reversals. The other products maintained output voltages.

## Surge Voltage Tests

### Background

Smart Power Systems electronic power conditioning products along with various filter and TVSS products were tested with standard ANSI/IEEE C62.41-1991 waveforms generated with a KeyTek model 711 surge generator. Surge voltages were applied normal mode (L/N) and common mode (N/G). All test pulses were category A ringwaves (6kV L/N & 3kV N/G).

Products included in the testing are:

- Smart Power Systems – Digital Smart TBF – Copier Guardian
- EFI – Transient Voltage Surge Suppressor (TVSS)
- Panamax – MAX ImagePro 15 Amp
- ESP – Digital QC
- Oneac – FilterOne

Differential let-through voltages were measured with a Tektronix digital storage oscilloscope. L/N measurements were performed with differential Tektronix scope probes and a high pass filter. The high pass filter was used solely to remove the 60 Hz waveform and passes signals above 10kHz. N/G tests were performed with differential 50 Ohm coaxial cables and low pass filter. The low pass filter passes signals up to 4MHz. The EFI N/G measurements did not use a low pass filter for N/G because the voltage differentials exceeded the range of the digital storage oscilloscope. Tektronix 10x probes were used without any filters to measure the N/G differential voltage of the EFI device.

### Numeric test results

**Table 1 - Synopsis of numeric test results.**

<b>6 kV Normal Mode (L/N applied test pulse &amp; L/N measured differential voltage)</b>			
	<b>Volts Peak-to-Peak</b>	<b>Vmax</b>	<b>Vmin</b>
Smart Power Copier Guardian	6	3.2	-2.8
EFI TVSS	94	37	-57
Panamax Max Image Pro	283	124	-159
ESP Digital QC	10.6	5.40	-5.20
Oneac FilterOne	14.6	8.60	-6.00
<b>3 kV Common Mode (N/G applied test pulse &amp; N/G measured differential voltage)</b>			
Smart Power Copier Guardian	0.360	0.680	0.320
EFI TVSS	436	216	-220
Panamax Max Image Pro	10.9	8.80	-2.10
ESP Digital QC	12.9	13.4	0.50
Oneac FilterOne	9.16	6.36	-2.80

## Smart Power – Digital Smart TBF – Copier Guardian



Photo 1 – Smart Power Digital Smart TBF—Copier Guardian.

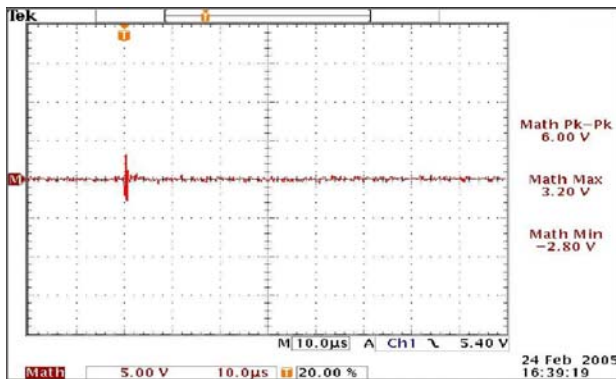


Figure 1: Smart Power Copier Guardian  
Line/Neutral Let-through

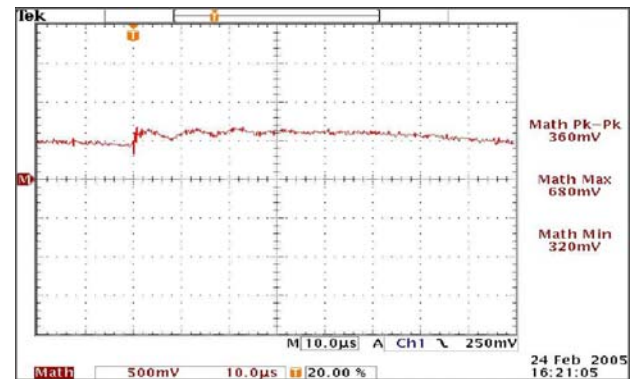


Figure 2: Smart Power Copier Guardian  
Neutral/Ground Let-through

## EFI – Transient Voltage Surge Suppressor



Photo 2 – EFI Transient Voltage Surge Suppressor.

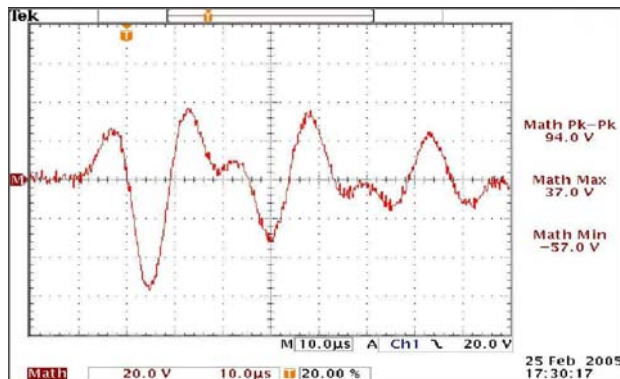


Figure 3: EFI TVSS Isolated output  
Line/Neutral Let-through

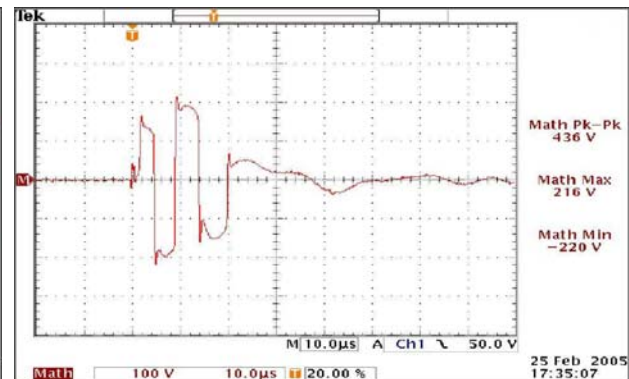


Figure 4: EFI TVSS Isolated output  
Neutral/Ground Let-through



## Panamax – MAX ImagePRO 15-Amp



Photo 3 – Panamax MAX ImagePRO 15-Amp.

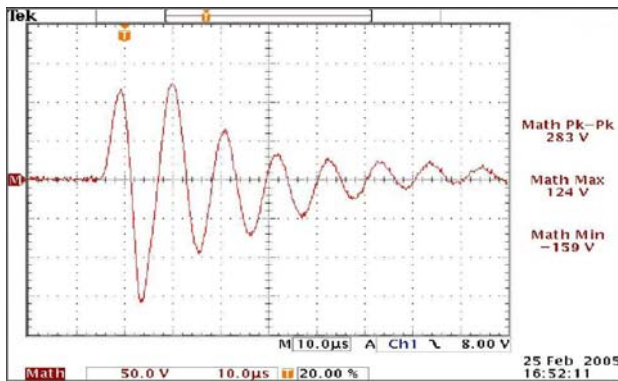


Figure 5: Panamax MAX Image Pro 15 Amp -  
Line/Neutral Let-through

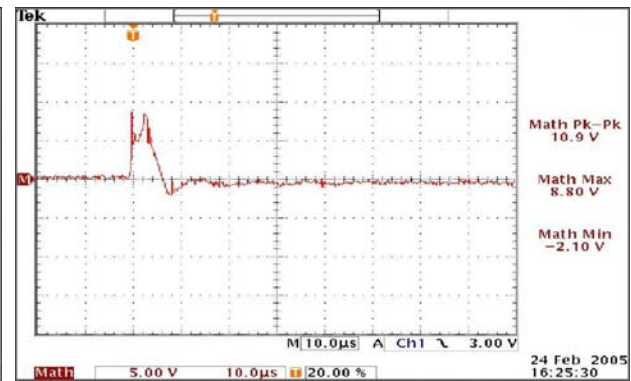


Figure 6: Panamax MAX Image Pro 15 Amp  
Neutral/Ground Let-through

## Electronic System Protection — Digital QC



Photo 4 – Electronic System Protection Digital QC.

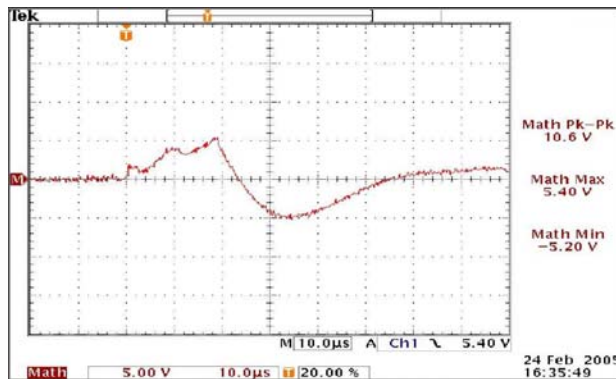


Figure 7: ESP Digital QC Line/Neutral Let-through

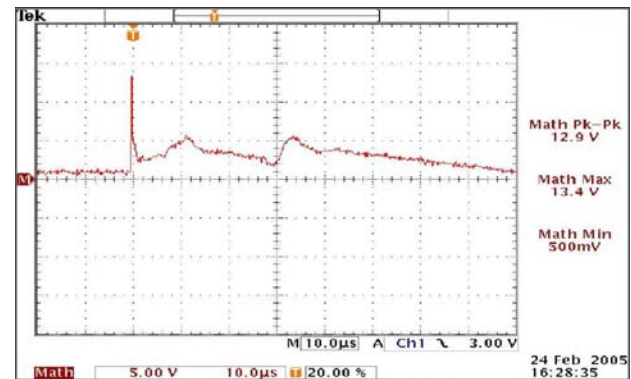


Figure 8: ESP Digital QC Neutral/Ground Let-through



## Oneac — FilterOne



Photo 5 – Oneac FilterOne.

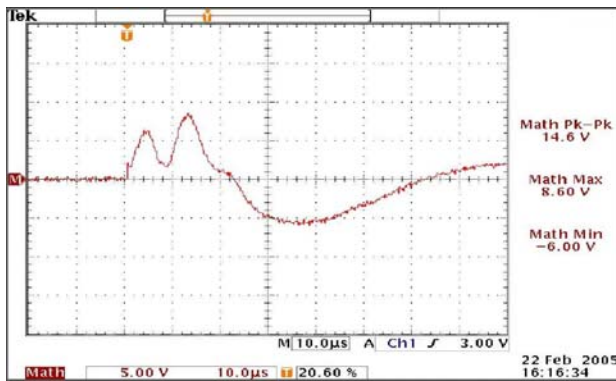


Figure 9: Oneac FilterOne Line/Neutral Let-through

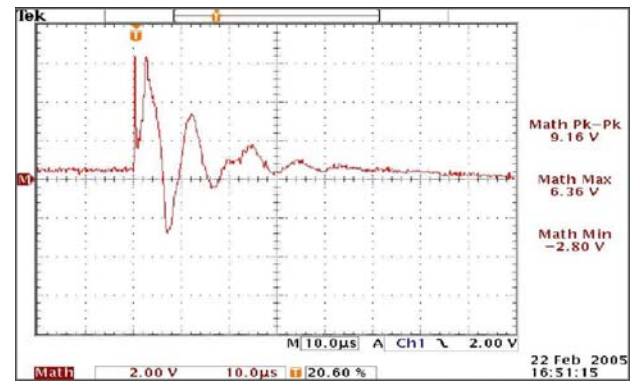


Figure 10: Oneac FilterOne Neutral/Ground Let-through



## Over-Voltage Tests

### Background

The power conditioning and filter/TVSS products were tested with momentary over-voltage. A Power Science line disturbance simulator generated three second over-voltage events. A Dranetz 658 power monitor recorded the voltage at the input and output of various power protection devices.

Products included in the testing are:

- Smart Power — Digital Smart TBF — Copier Guardian
- EFI — Transient Voltage Surge Suppressor (TVSS)
- Panamax — MAX ImagePro 15 Amp
- ESP — Digital QC
- Oneac — FilterOne

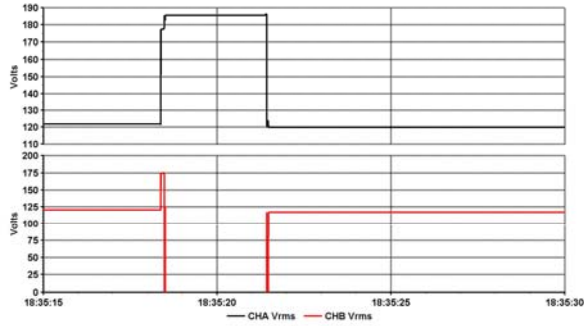
### Monitor Setup

- ChA = voltage input to protection device
- ChB = voltage output from protection device

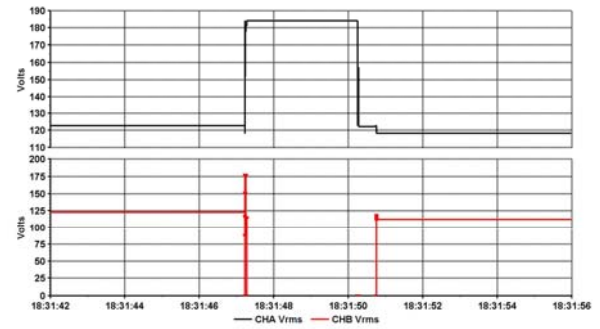
### Test results

- Smart Power – Digital Smart TBF – Copier Guardian: Removes over-voltage condition from output 100mS after voltage reaches high limits and returns voltage automatically when voltage returns to normal levels.
- Panamax: Removes over-voltage condition from output 50mS after voltage reaches high limits and returns voltage automatically when voltage returns to normal levels.
- EFI TVSS: Passes over-voltage event through to output. <sup>[1]</sup>
- Digital QC: Passes over-voltage event through to output. <sup>[1]</sup>
- Oneac — FilterOne: Passes over-voltage event through to output. <sup>[1]</sup>

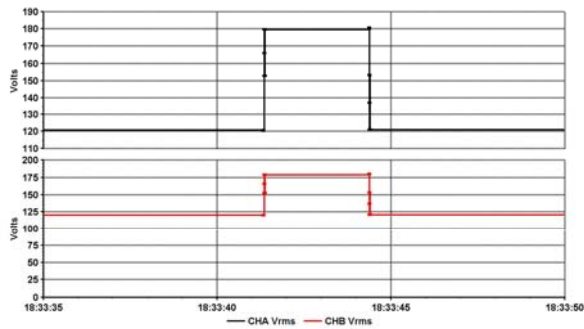
<sup>[1]</sup> Sustained over-voltage conditions can cause failure of components in the protection device as well as the connected load.



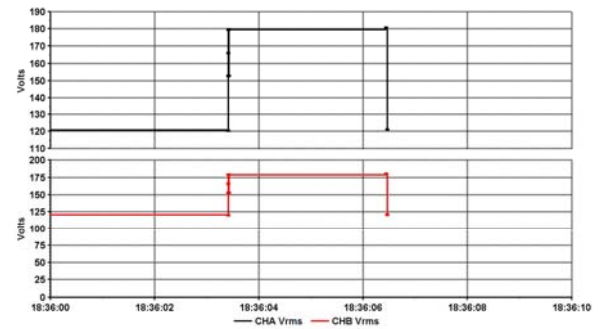
**Figure 11: Smart Power Copier Guardian over-voltage test**



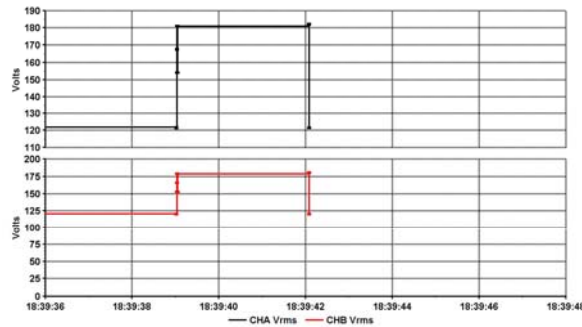
**Figure 12: Panamax Max Image Pro over-voltage test**



**Figure 13: EFI TVSS over-voltage test**



**Figure 14: ESP Digital QC over-voltage test**



**Figure 15: Oneac FilterOne over-voltage test**

## Wiring Fault Tests

### Background

The various power conditioning and filter/TVSS products were tested with two types of wiring problems commonly found in residential and commercial facilities: Open ground and line/neutral reversal. Ideally, a protection device should disable the output if severe wiring problems are present.

### Products included in the testing are:

- Smart Power — Digital Smart TBF — Copier Guardian
- EFI — Transient Voltage Surge Suppressor (TVSS)
- Panamax Power Filter — MAX ImagePro 15 Amp
- ESP Power Filter — Digital QC
- Oneac Power Filter — FilterOne

**Table 2 - Wiring fault tests**

<b>Wiring Problem: Open Ground</b>		
	<b>Indicator Status</b>	<b>Output</b>
Smart Power Copier Guardian	Red light	Disabled
EFI TVSS	Green light	Voltage Present
Panamax Max Image Pro	Red lights – line fault unsafe power	Disabled
ESP Digital QC	No light	Voltage Present
Oneac FilterOne	Red light – wiring fault	Voltage Present
<b>Wiring Problem: Line/neutral Reversed</b>		
Smart Power Copier Guardian	Red light	Disabled
EFI TVSS	Green light	Voltage Present
Panamax Max Image Pro	Red lights – line fault unsafe power	Disabled
ESP Digital QC	No light	Voltage Present
Oneac FilterOne	Red light – wiring fault	Voltage Present