QUANTUM DIGITAL LABORATORIES Pty Ltd

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3 July 2007

ENGINEERING NOTE QDL070605.E

A Surge Protection Device, Model: TLP-SF20SL-240 (Equipment Under Test =EUT), was subjected to a combination wave surge (as per EN 61000-4-5, 1.2/50µs voltage waveshape and 8/20µs current waveshape) at a variety of different voltages using a Keytek EMCPro Advanced EMC Immunity Test System.

Pre-compliance testing was performed according to the methodology and procedures of IEC 61643-1:2005 Clause 7/7.1, Clause 7.5.2, Clause 7.6.5/7.6.6 and AS/NZS 1768(Int):2003 Appendix D.

The let through voltage was monitored with a floating oscilloscope (battery powered Agilent U1604A Handheld Oscilloscope (Serial: KR46000085) with Certificate of Calibration No: U1604AKR46000085.

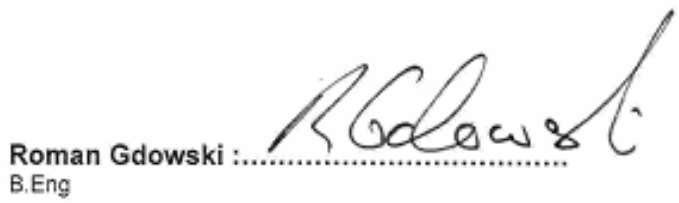
The system passed testing to IEC 61643-1:2005 Clause 7.5.2 and Clause 7.6.5/7.6.6 for a Category II device. The Residual Voltage Level Rating was calculated (as per Clause 7.5.2) to be = 840V.

According to AS/NZS 1768(Int):2003 Appendix D, the Residual Voltage Level Rating = 900 V (Category B, 6kV/3000A)

RECOMMENDATIONS

The unit as tested has passed IEC 61643-1:2005 Clause 7.5.2 and Clause 7.6.5/7.6.6 and AS/NZS 1768(Int):2003 Appendix D for a Category B device.

Roman Gdowski :……
B.Eng



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IEC 61643-1:2005 Clause 7 – Type Test

The EUT was tested in accordance with Clause 7 – Type Test.

IEC 61643-1:2005 Clause 7.1 – General Testing Procedures

The EUT was tested in accordance with Clause 7.1 – General Testing Procedures.

IEC 61643-1:2005 Clause 7.5.2 – Residual Voltage with 8/20 current impulses

The EUT was tested in accordance with the methodology and procedures of Clause 7.5.2 – Test procedure to measure the residual voltage with 8/20 current impulses, for a Class II (Category B) device.

The SPD contains only voltage-limiting components, hence the test was performed at $I_n = \pm 6kV$ only

Results:

Sample 1	Active to Earth	Neutral to Earth	Active to Neutral
+6kV, 3kA	+780V	+840V	+720V
-6kV, 3kA	+680V	-800V	-760V

Plate 1: Surge Residual Voltage Reference Data – Sample 1.

Sample 2	Active to Earth	Neutral to Earth	Active to Neutral
+6kV, 3kA	+820V	+800V	+660V
-6kV, 3kA	+720V	-760V	-700V

Plate 2: Surge Residual Voltage Reference Data – Sample 2.

Sample 3	Active to Earth	Neutral to Earth	Active to Neutral
+6kV, 3kA	-700V	+780V	-680V
-6kV, 3kA	-700V	-780V	-740V

Plate 3: Surge Residual Voltage Reference Data – Sample 3.

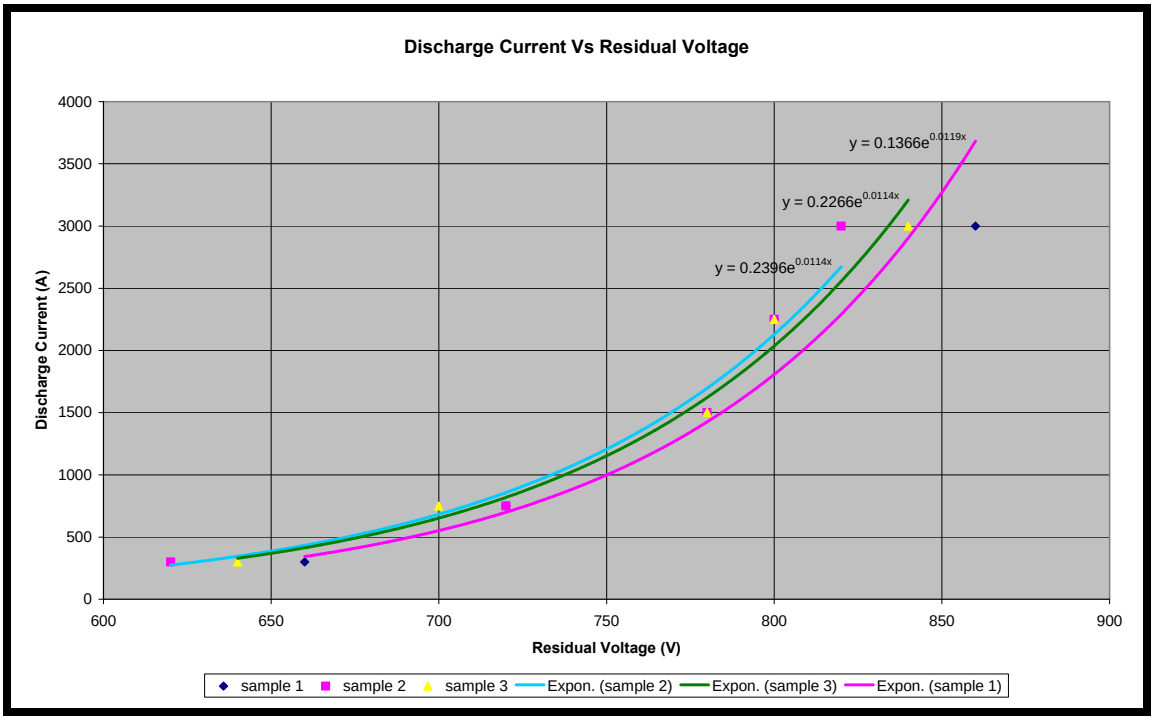

Plate 4: Discharge Current Vs Residual Voltage graph.

The residual voltage used for determining the measured limiting voltage is given by definition as the highest voltage on this curve corresponding in the range of currents for class II: up to I_n (3000Amps).

Hence the residual voltage, calculated from the line of best fit on the worst case sample data ($Y = 0.1366e^{0.0119x}$) is = 840V

Note:

The interval between the individual impulses was 0.5 hrs. The EUT remained thermally stable after each impulse. The maximum external case temperature rise was 3 degrees C above ambient.

All voltage waveform oscillographs were taken with a 500V/DIV voltage axis and a 1ms/Div time axis.

All current waveform oscillographs were taken with a 5V/DIV voltage axis and a 10µs/DIV time axis where the current monitor supplies 1V per 200Amps.

All positive surges were coupled to lines with a 2Ω source impedance at a 90º phase angle reference and likewise, all negative surges were coupled to lines with a 2Ω source impedance at a 270º phase angle reference to maximise the severity of the impulse.

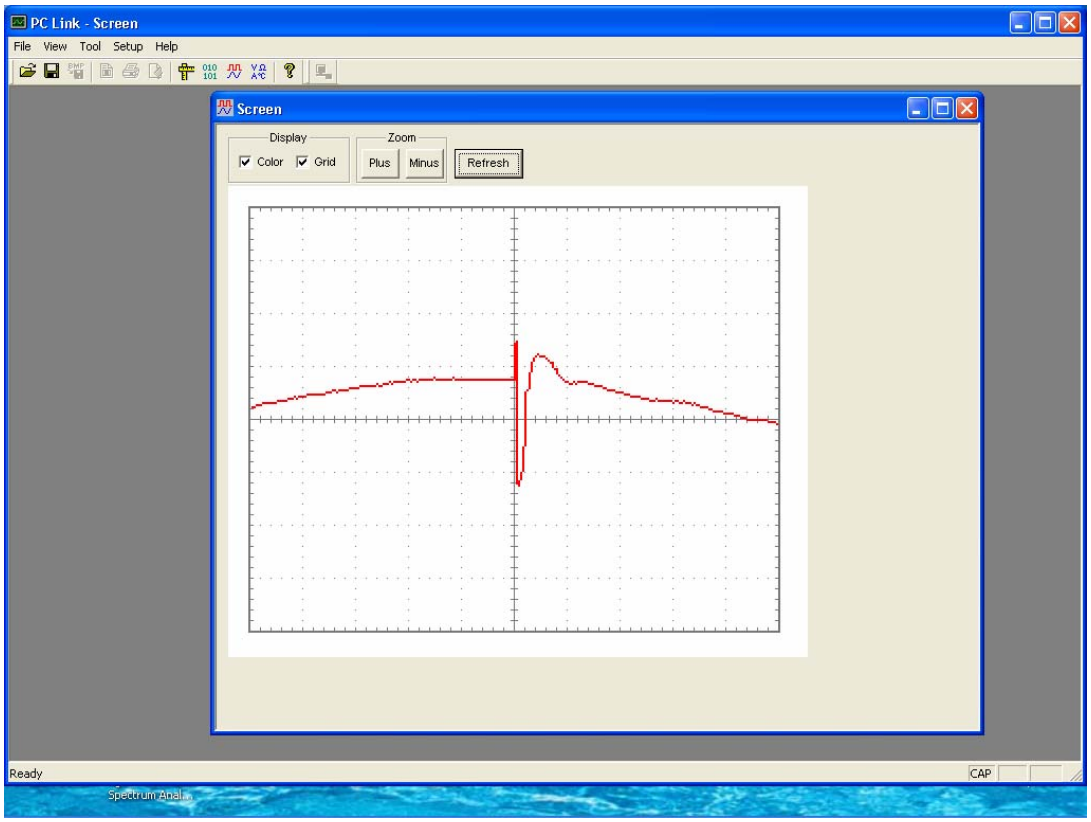

Plate 5: Voltage waveform at +6000V, 3000A active line to protective earth.

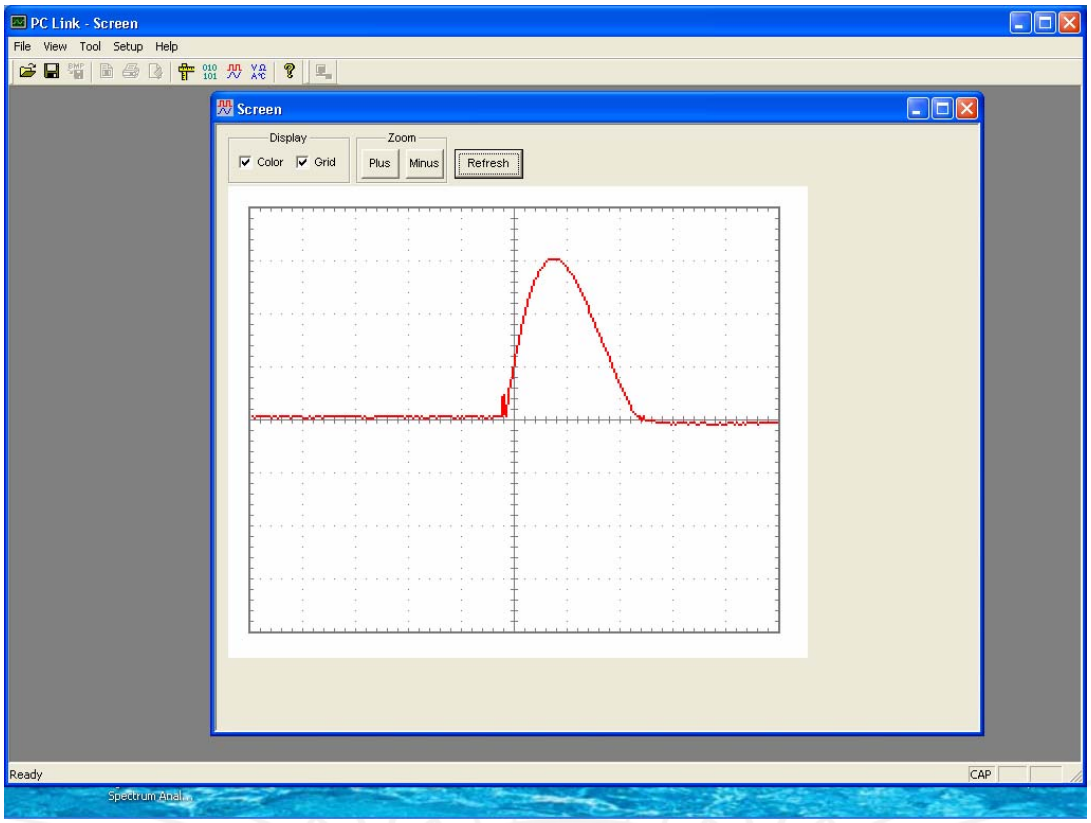

Plate 6: Current waveform at +6000V, 3000A active line to protective earth.

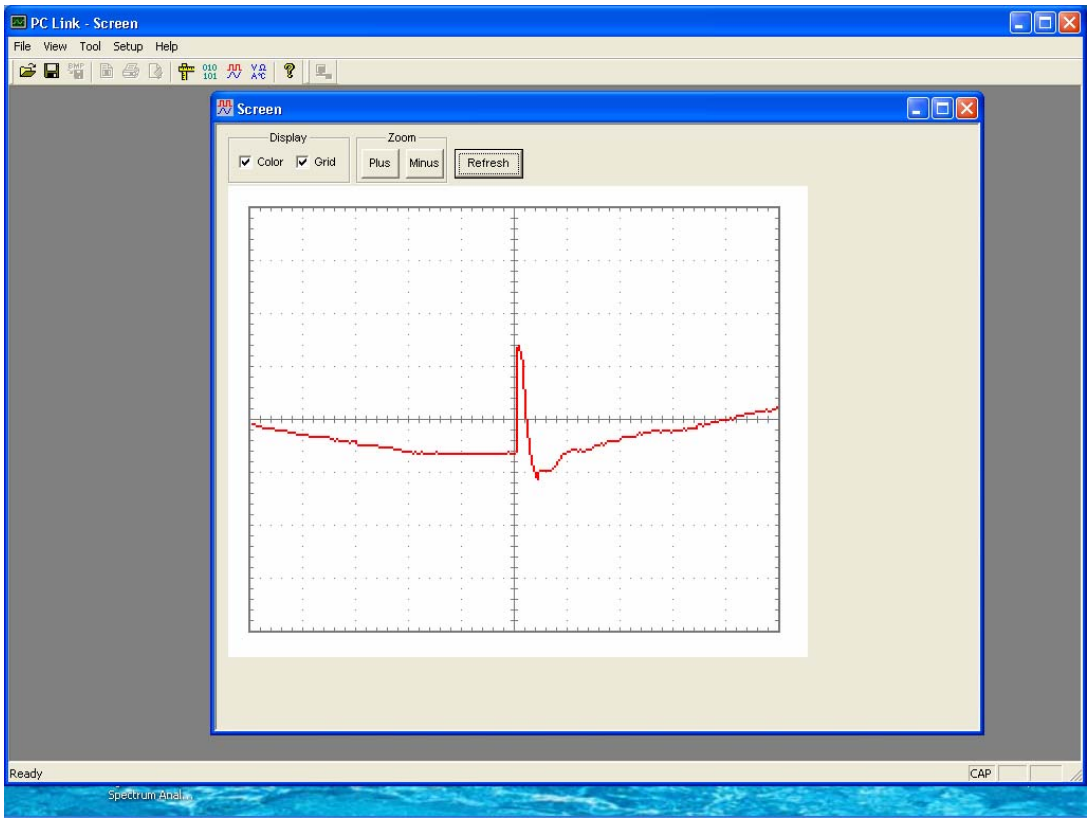

Plate 7: Voltage waveform at -6000V, 3000A active line to protective earth.

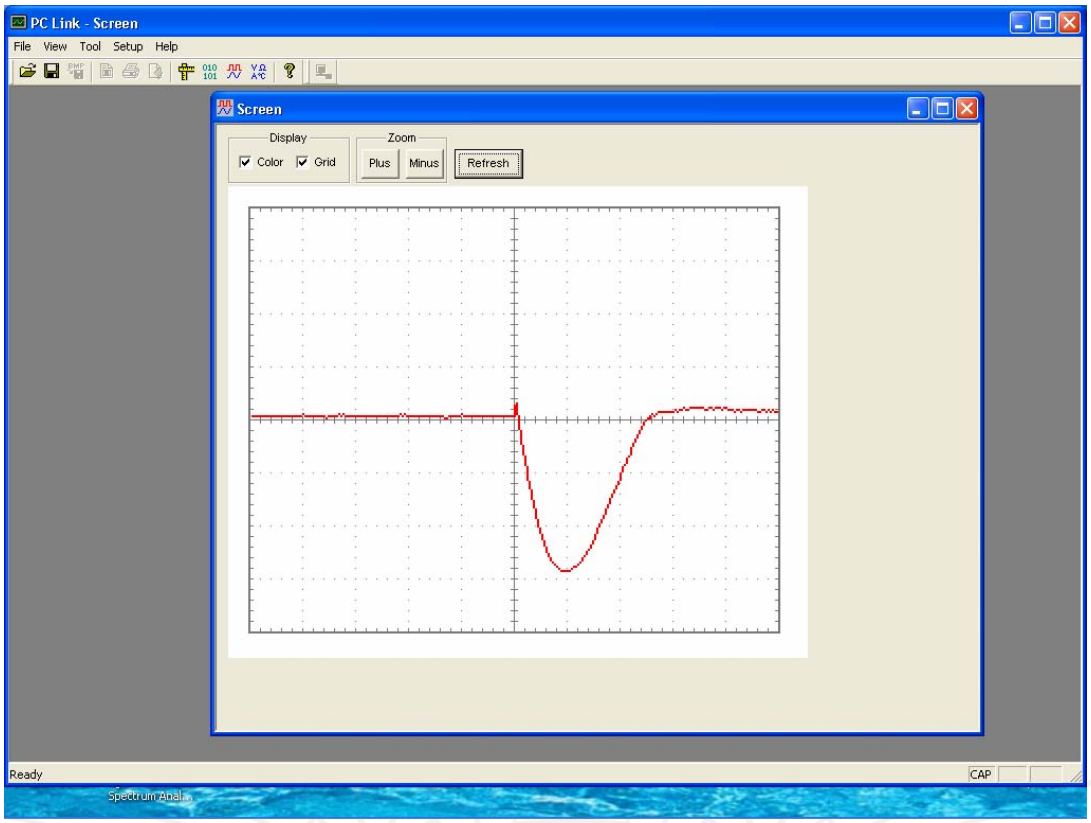

Plate 8: Current waveform at -6000V, 3000A active line to protective earth.

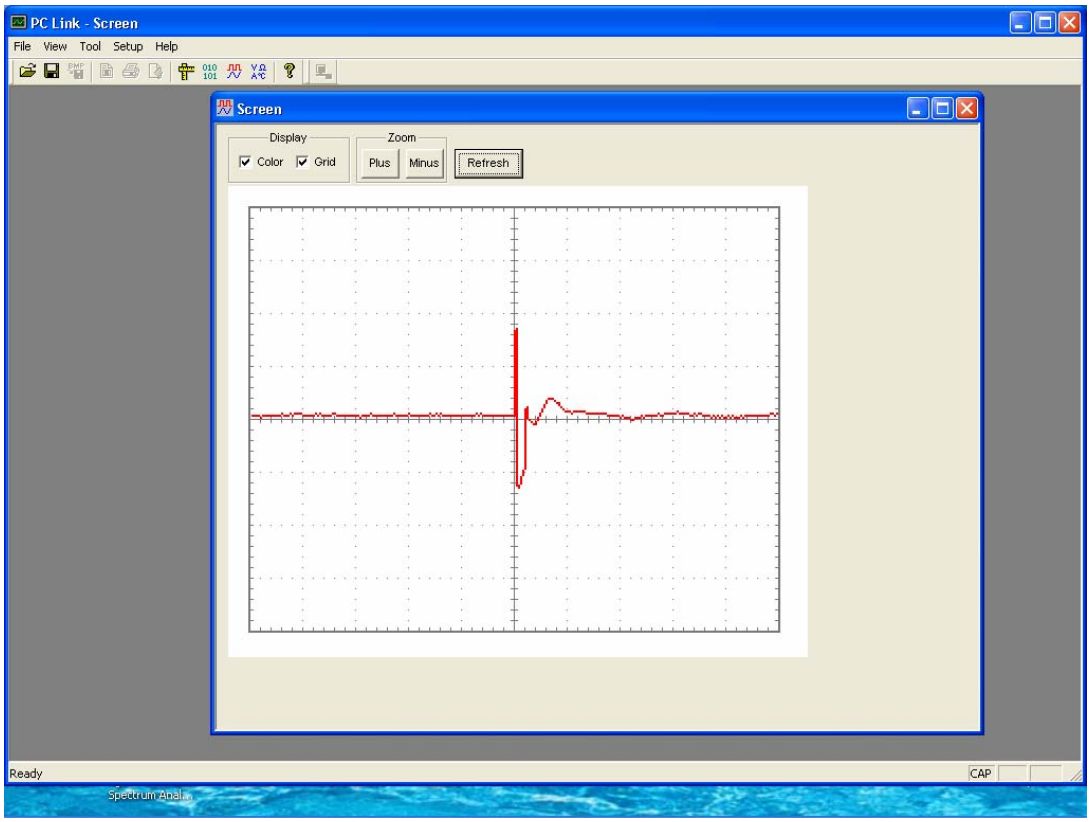

Plate 9: Voltage waveform at +6000V, 3000A neutral line to protective earth.

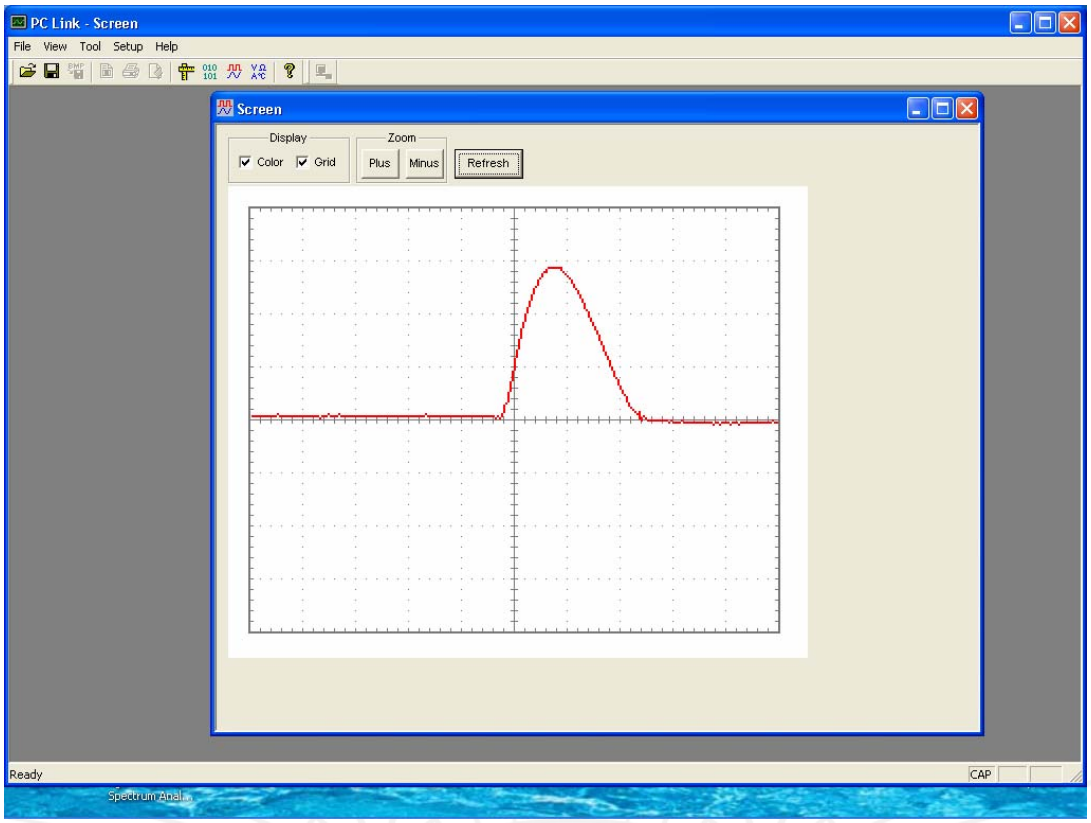

Plate 10: Current waveform at +6000V, 3000A neutral line to protective earth.

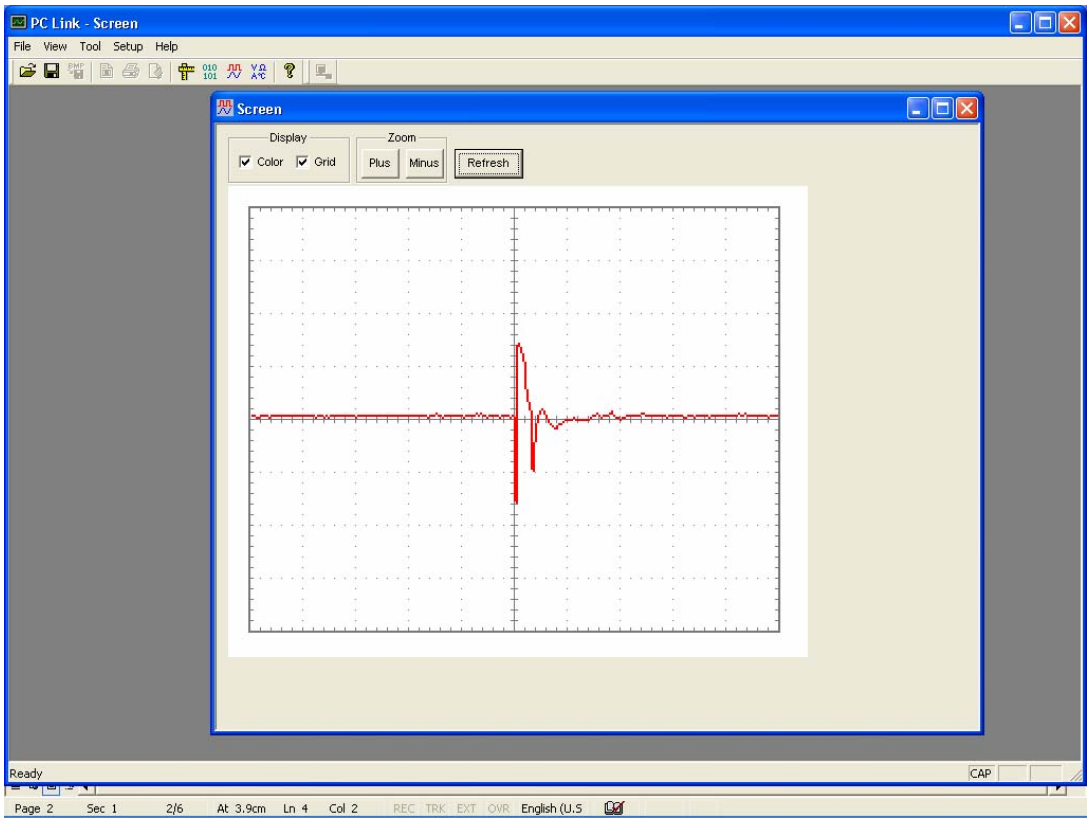

Plate 11: Voltage waveform at -6000V, 3000A neutral line to protective earth.

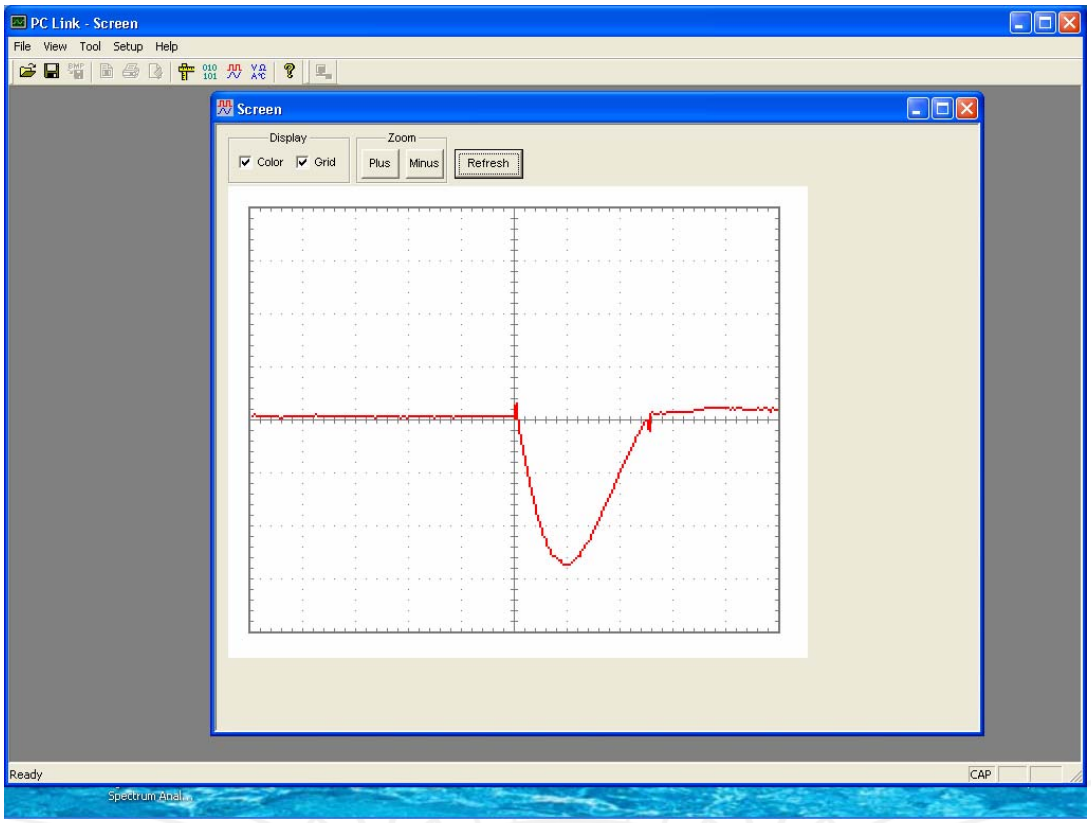

Plate 12: Current waveform at -6000V, 3000A neutral line to protective earth.

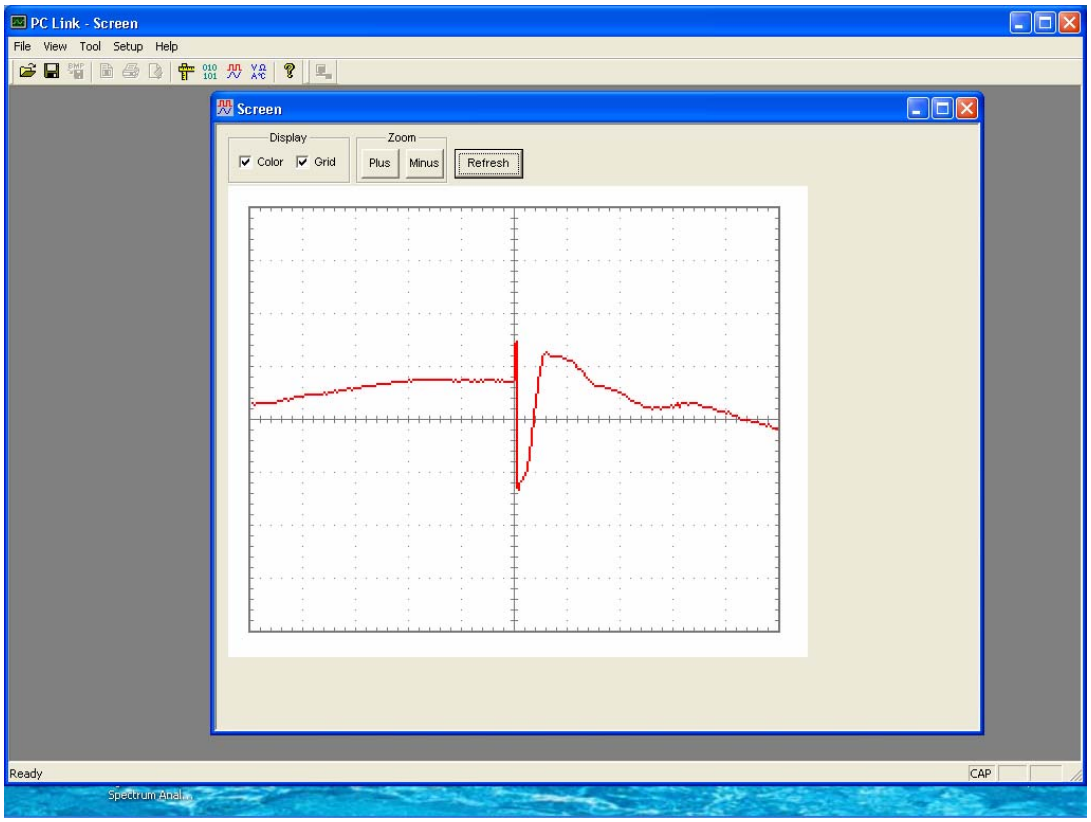

Plate 13: Voltage waveform at +6000V, 3000A active line to neutral line.

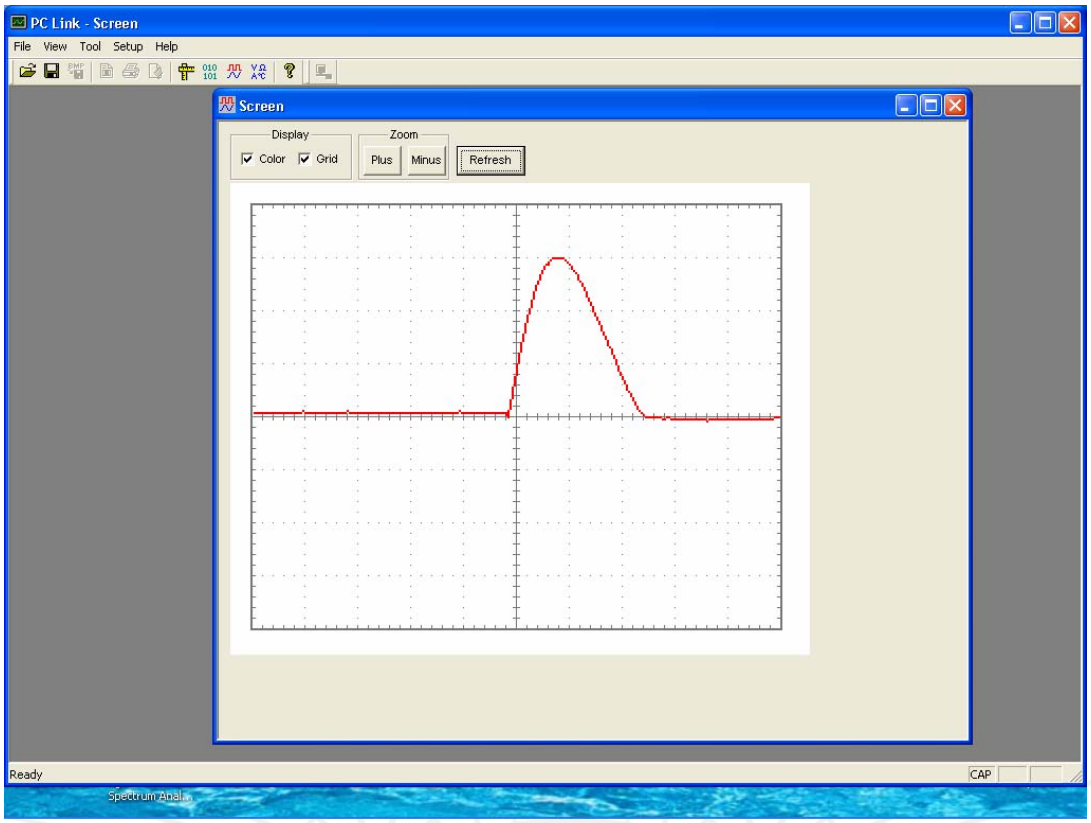

Plate 14: Current waveform at +6000V, 3000A active line to neutral line.

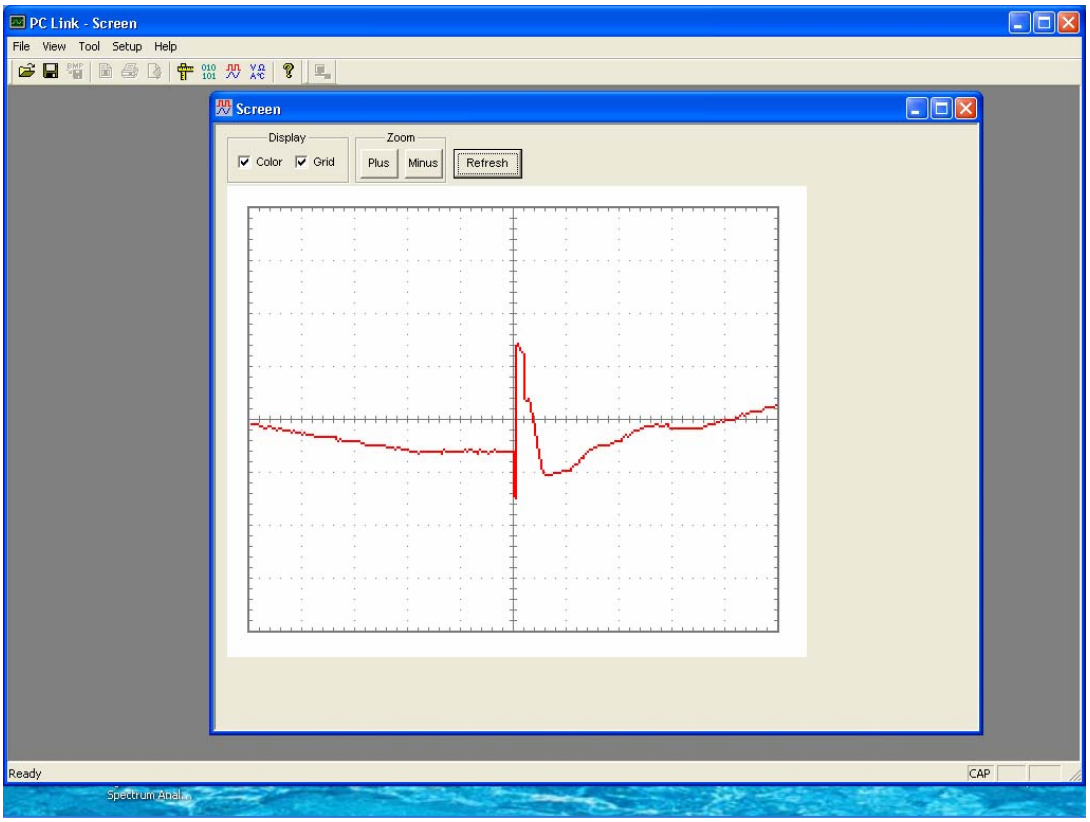

Plate 15: Voltage waveform at -6000V, 3000A active line to neutral line.

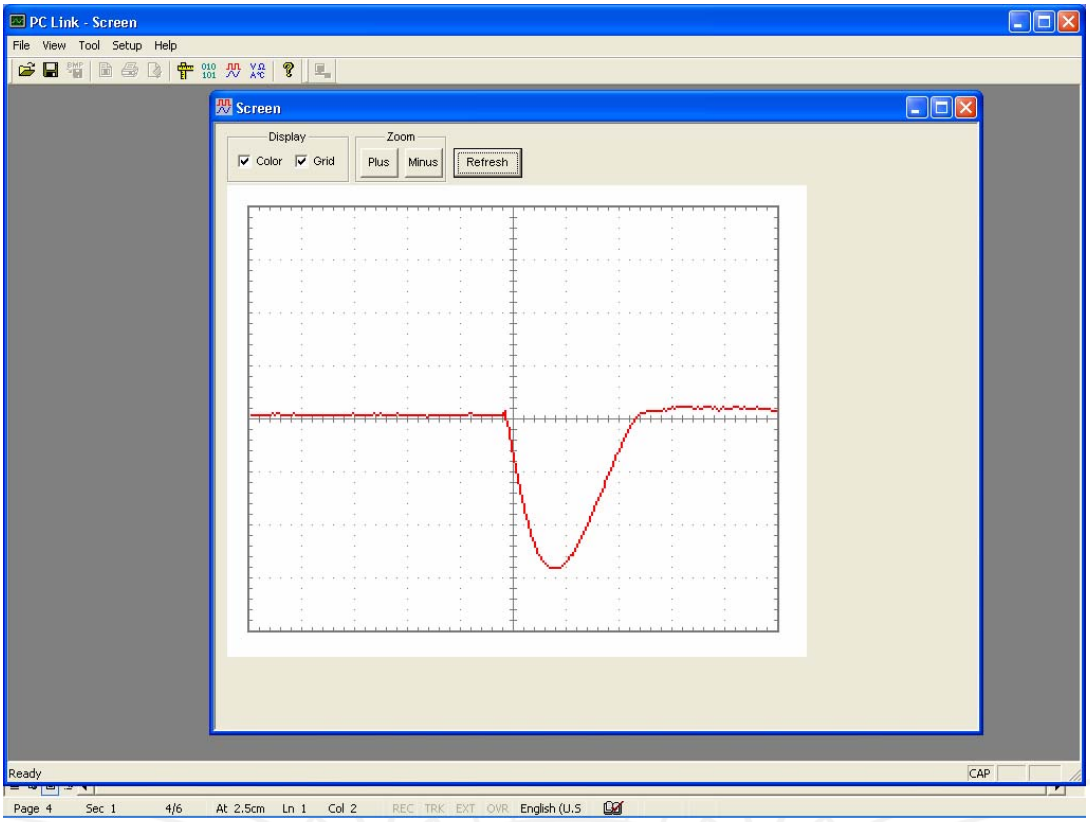

Plate 16: Current waveform at -6000V, 3000A active line to neutral line.

IEC 61643-1:2005 Clause 7.6.5/7.6.6 – Class II Operating Duty Test

The EUT was tested in accordance with the methodology and procedures of Clause 7.6.5 for a Class II (Category B) device and has passed the performance criteria outlined in Clause 7.6.6.

Results:

Sample 1	Active to Earth	Neutral to Earth	Active to Neutral
1.00 x Imax = 3.00 kA	+780V	+860V	+820V
0.75 x Imax = 2.25 kA	+620V	+800V	+620V
0.50 x Imax = 1.50 kA	+700V	+780V	+580V
0.25 x Imax = 0.75 kA	+700V	+640V	+720V
0.10 x Imax = 0.30 kA	+640V	+600V	+660V

Plate 17: Surge Residual Voltage Reference Data – Sample 1.

Sample 2	Active to Earth	Neutral to Earth	Active to Neutral
1.00 x Imax = 3.00 kA	+820V	+820V	+800V
0.75 x Imax = 2.25 kA	+800V	+740V	+780V
0.50 x Imax = 1.50 kA	+700V	+760V	+780V
0.25 x Imax = 0.75 kA	+720V	+700V	+700V
0.10 x Imax = 0.30 kA	+620V	+620V	+620V

Plate 18: Surge Residual Voltage Reference Data – Sample 2.

Sample 3	Active to Earth	Neutral to Earth	Active to Neutral
1.00 x Imax = 3.00 kA	+740V	+840V	+780V
0.75 x Imax = 2.25 kA	+620V	+800V	+600V
0.50 x Imax = 1.50 kA	+460V	+780V	+720V
0.25 x Imax = 0.75 kA	+700V	+700V	+420V
0.10 x Imax = 0.30 kA	+580V	+600V	+640V

Plate 19: Surge Residual Voltage Reference Data – Sample 3.

All follow current was self-extinguished and thermal stability was achieved after each impulse of the operating duty test. Once thermal stability was achieved, the post surge leakage current was measured as ~3μA (which meets the requirements of < 1 mA).

Following the complete test sequence and after the sample had cooled down to near ambient temperature, the measured limiting voltage test, which was made at the beginning of the test sequence, was repeated. The values measured before and after the test are below that of the voltage protection level, U_p = 0.9kV. The EUT, therefore, is deemed to have passed the test requirements of Clause 7.6.5/7.6.6.

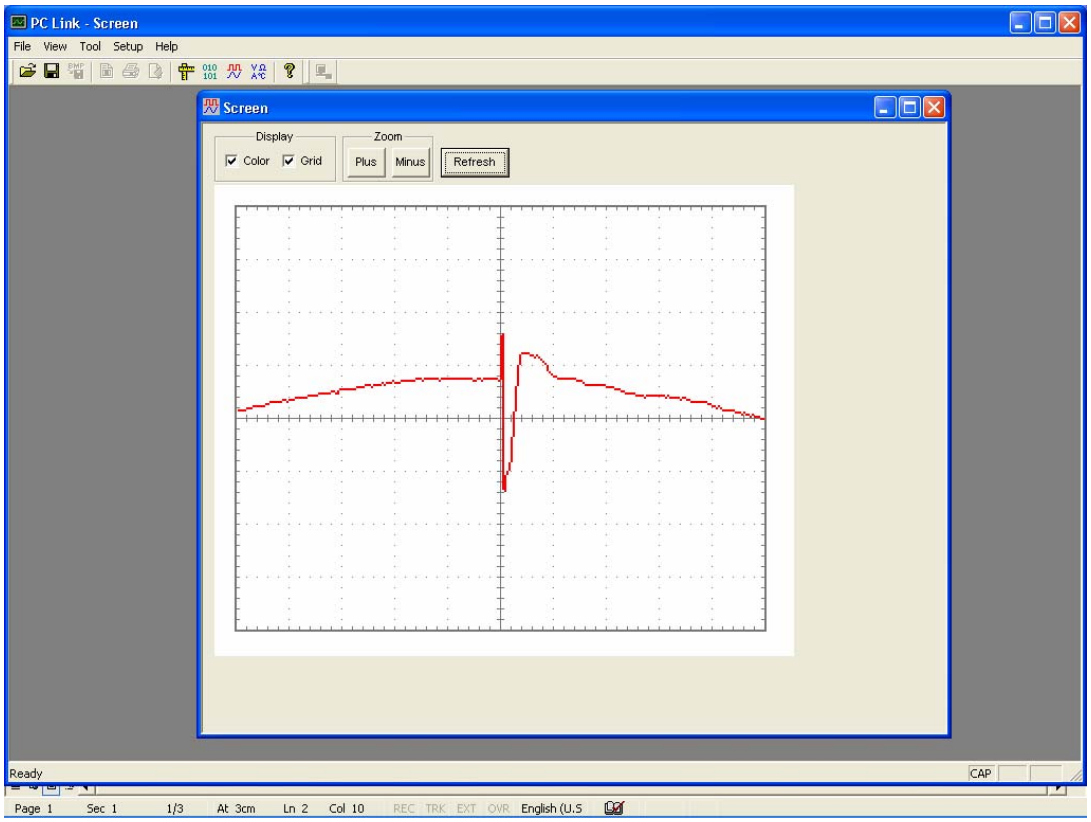

Plate 20: Voltage waveform at +6000V, 3000A active line to protective earth.

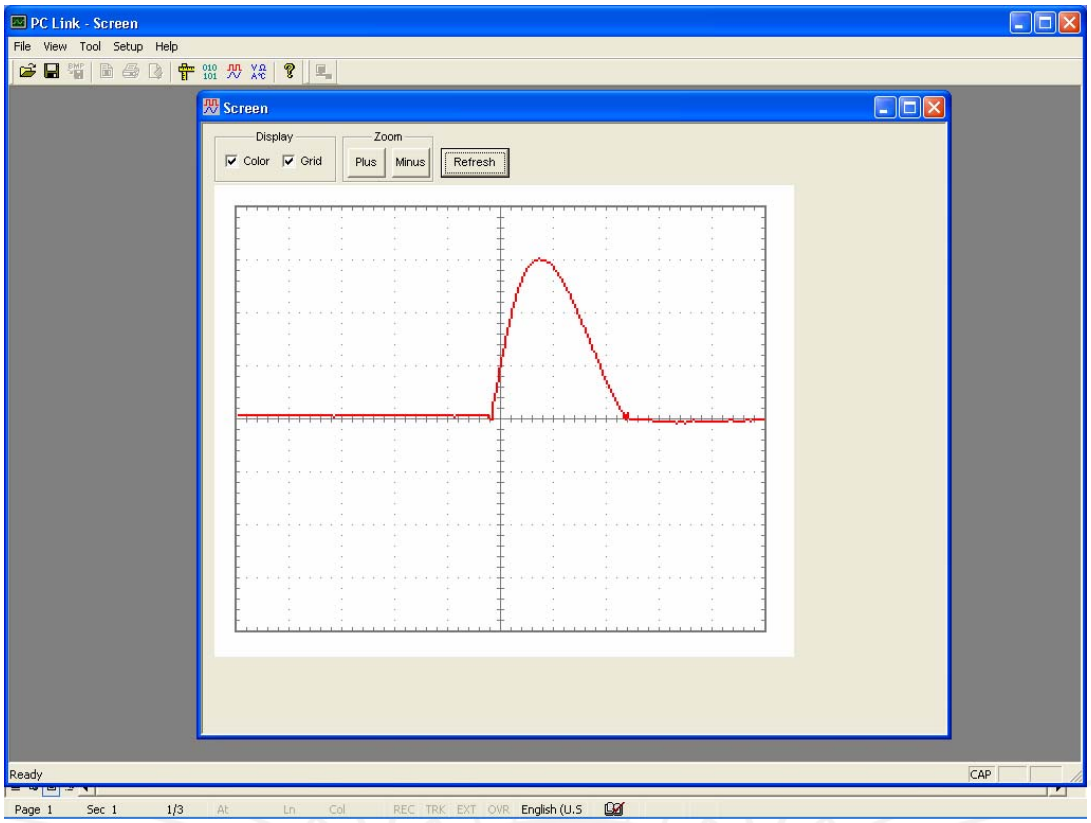

Plate 21: Current waveform at +6000V, 3000A active line to protective earth.

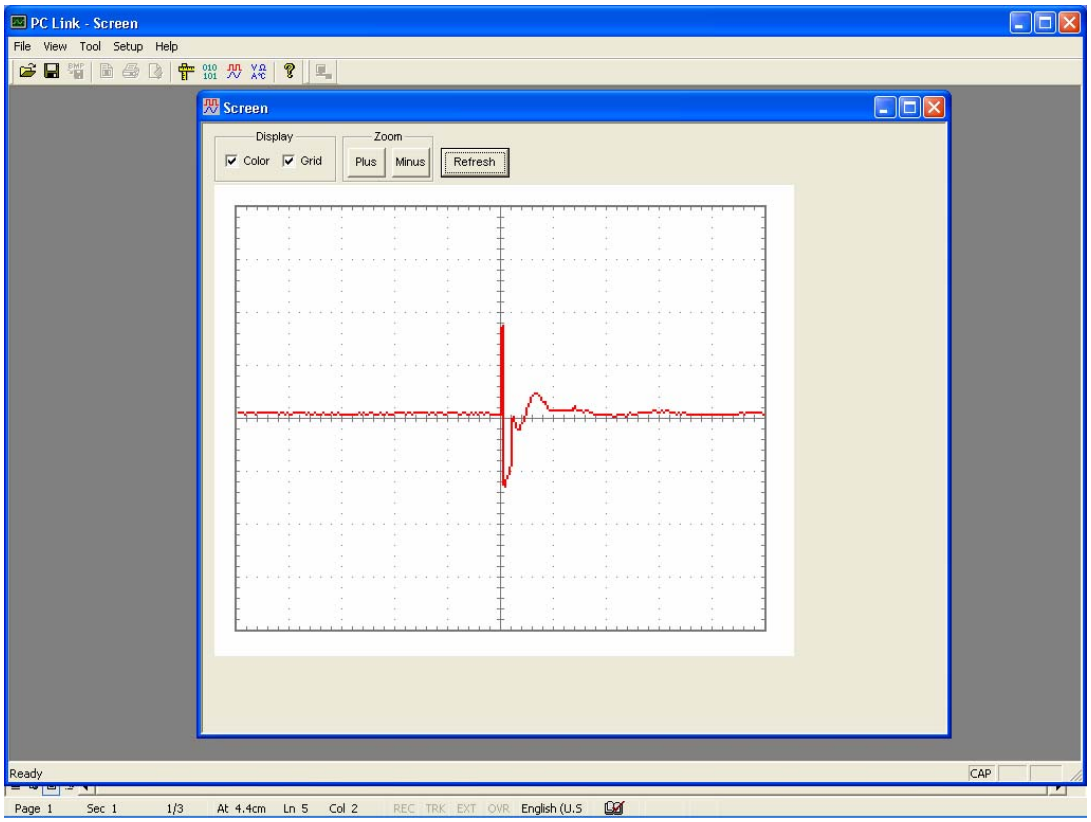

Plate 22: Voltage waveform at +6000V, 3000A neutral line to protective earth.

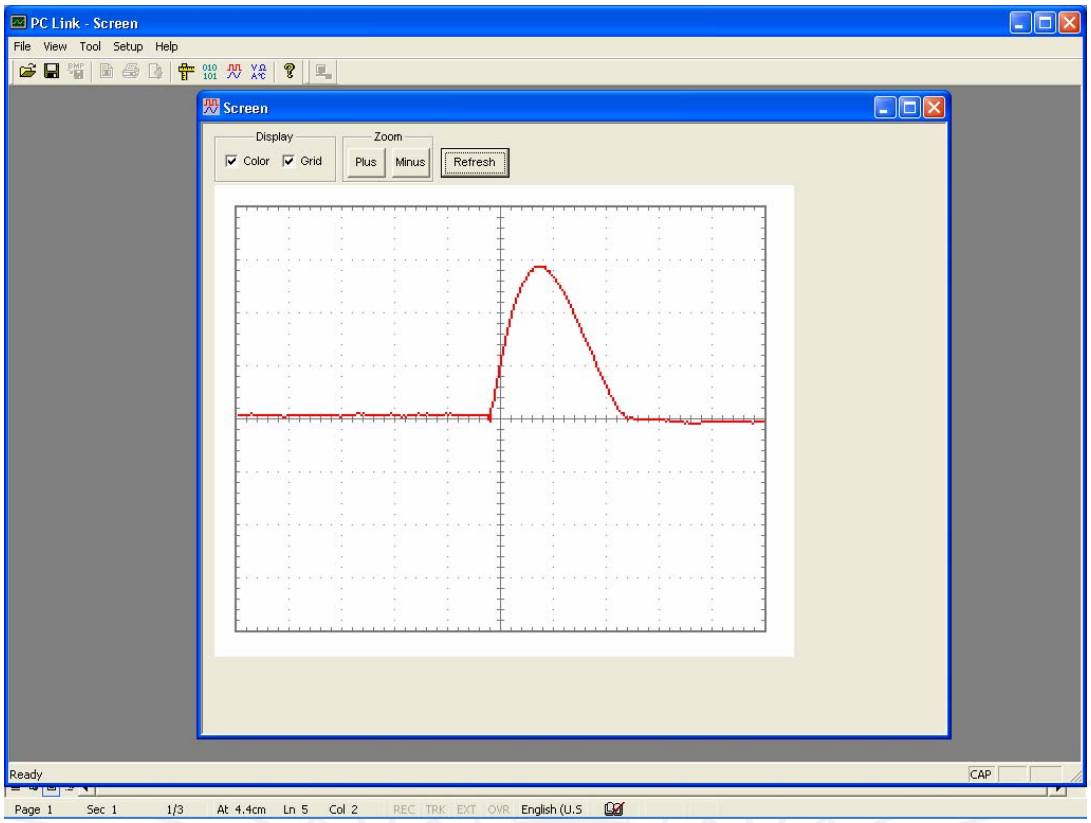

Plate 23: Current waveform at +6000V, 3000A neutral line to protective earth.

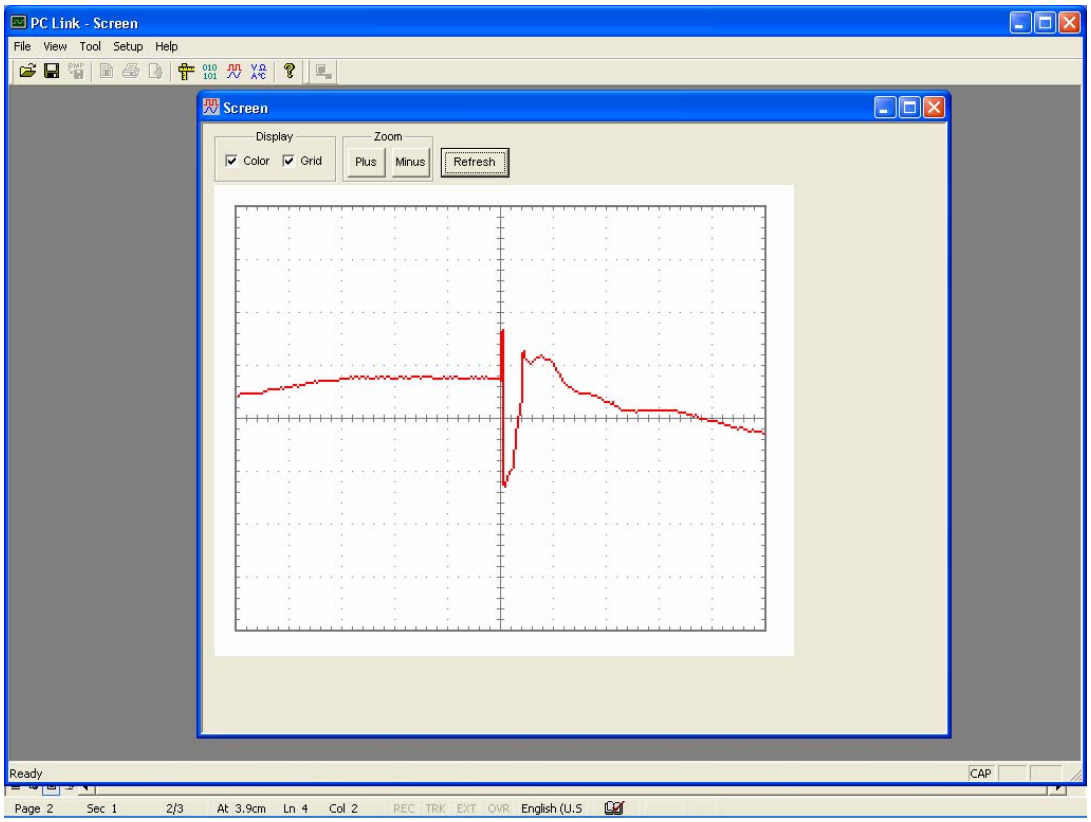

Plate 24: Voltage waveform at +6000V, 3000A active line to neutral line.

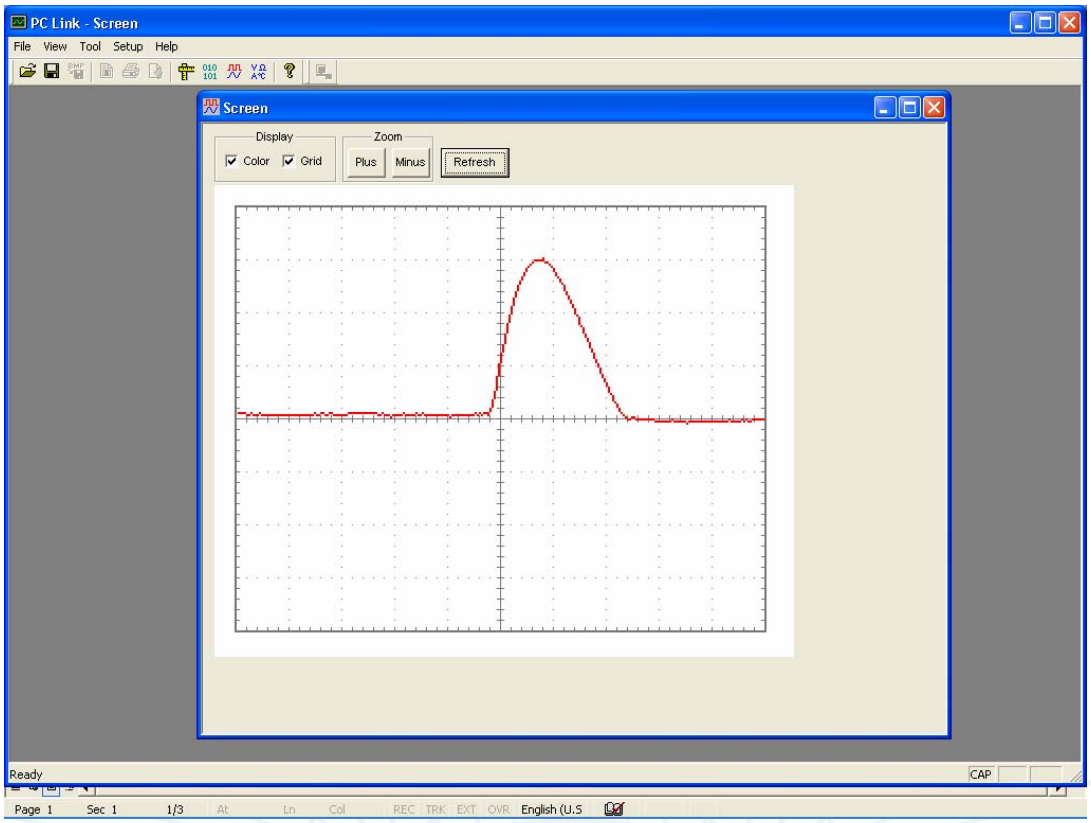

Plate 25: Current waveform at +6000V, 3000A active line to neutral line.

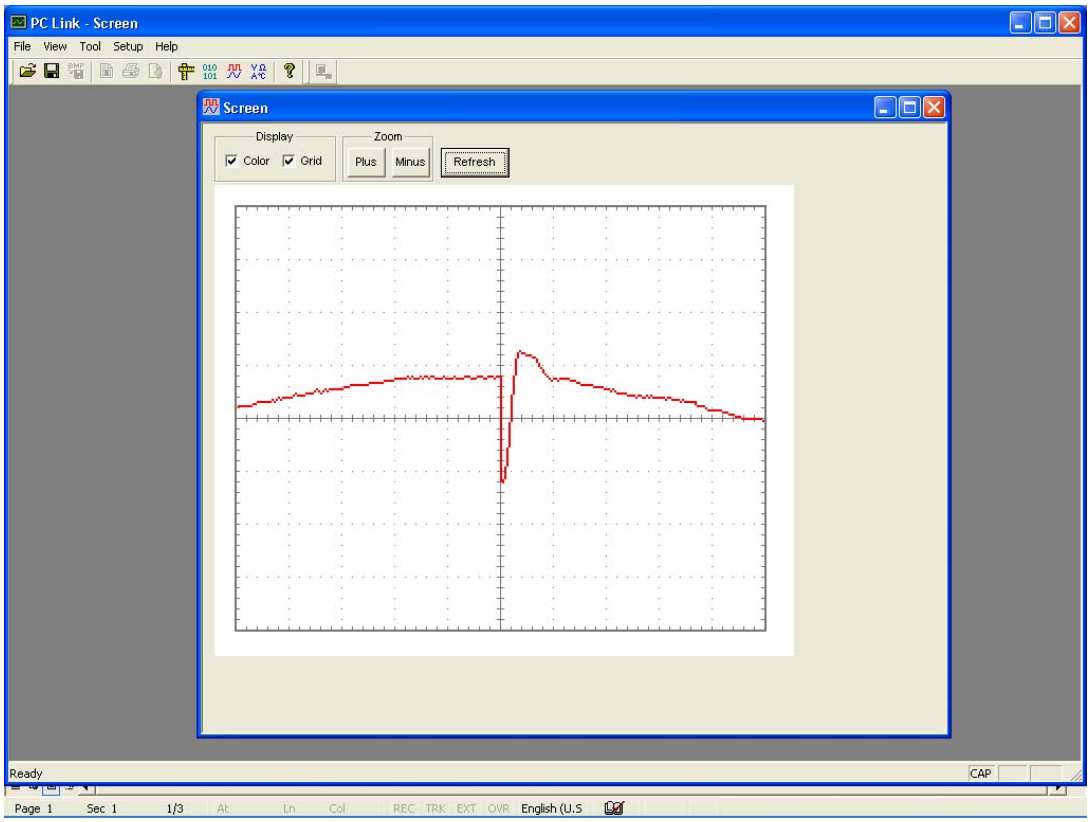

Plate 26: Voltage waveform at +4500V, 2250A active line to protective earth.

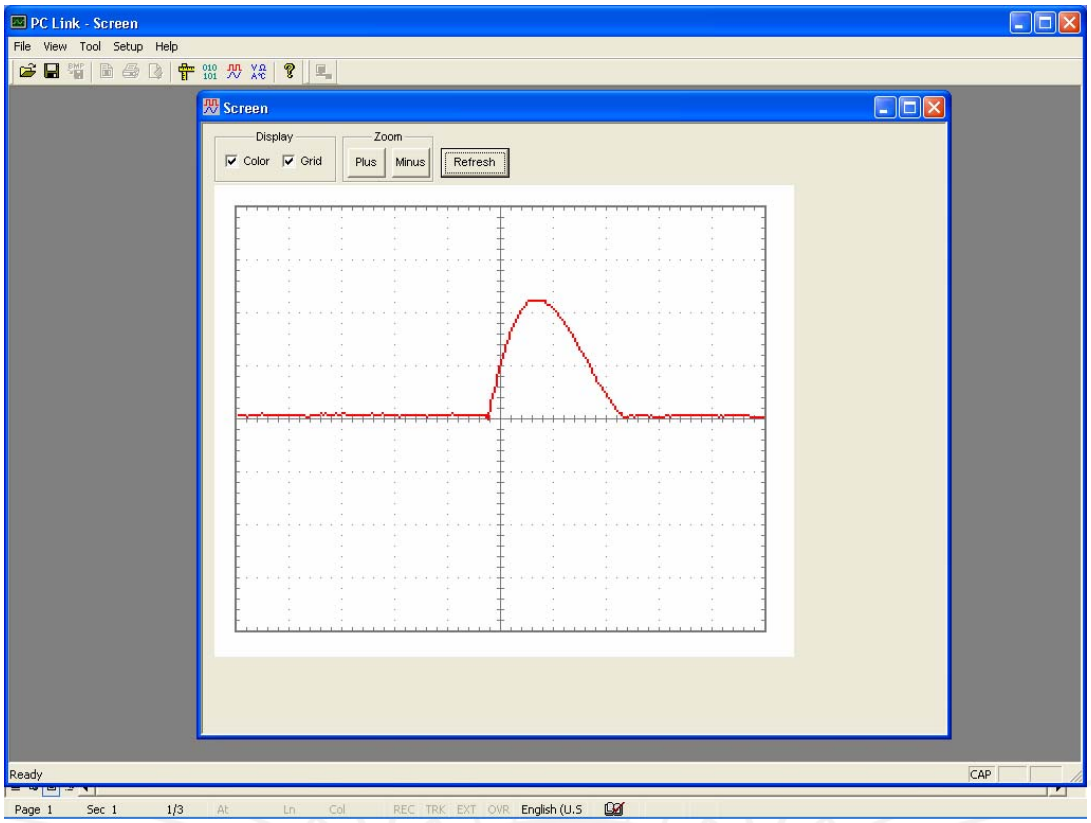

Plate 27: Current waveform at +4500V, 2250A active line to protective earth.

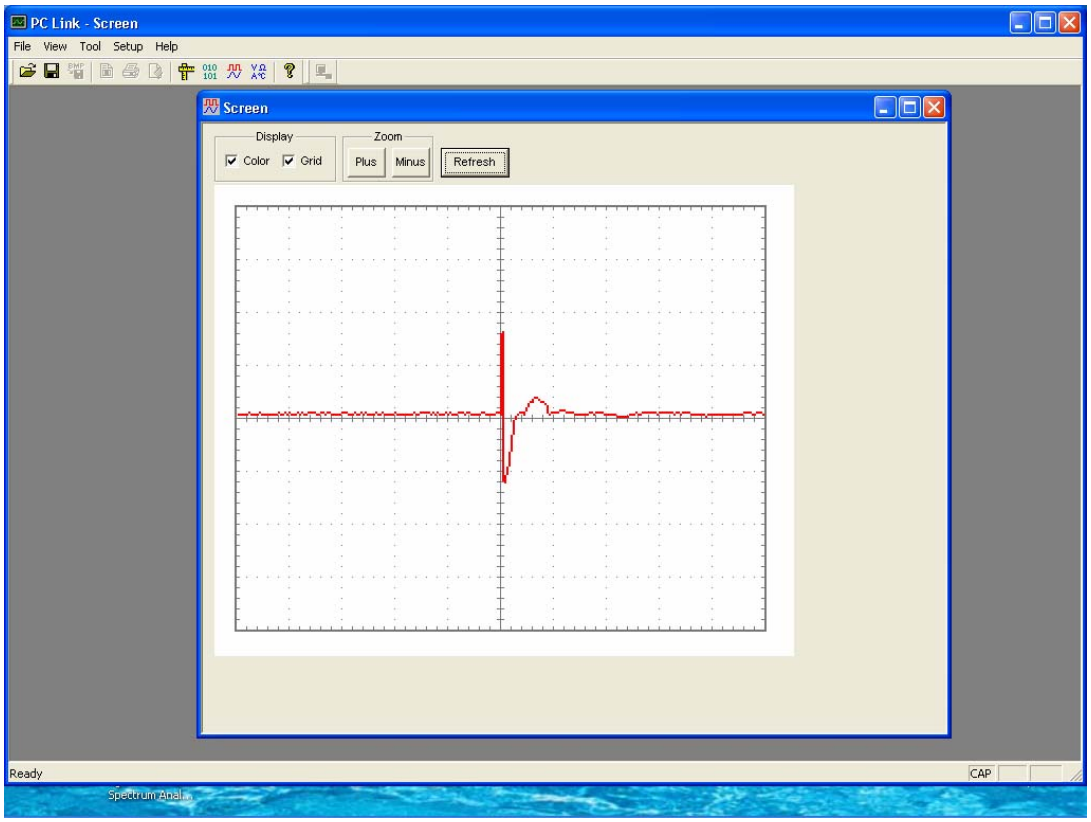

Plate 28: Voltage waveform at +4500V, 2250A neutral line to protective earth.

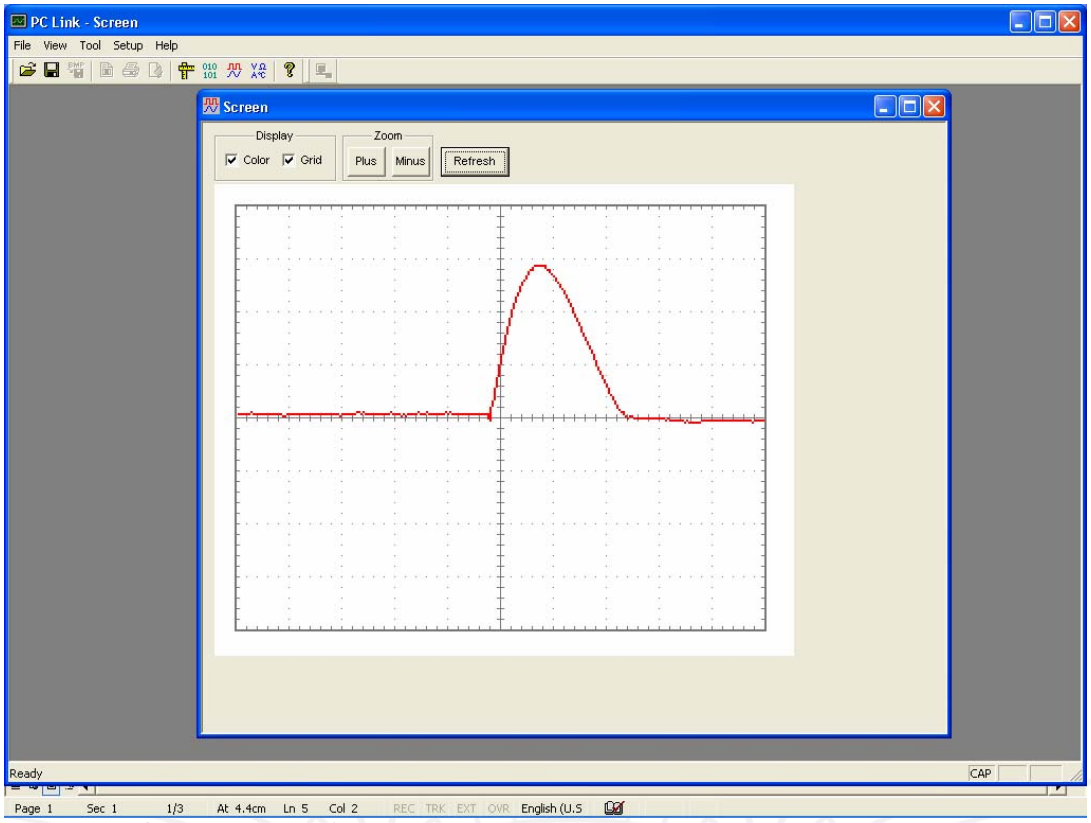

Plate 29: Current waveform at +4500V, 2250A neutral line to protective earth.

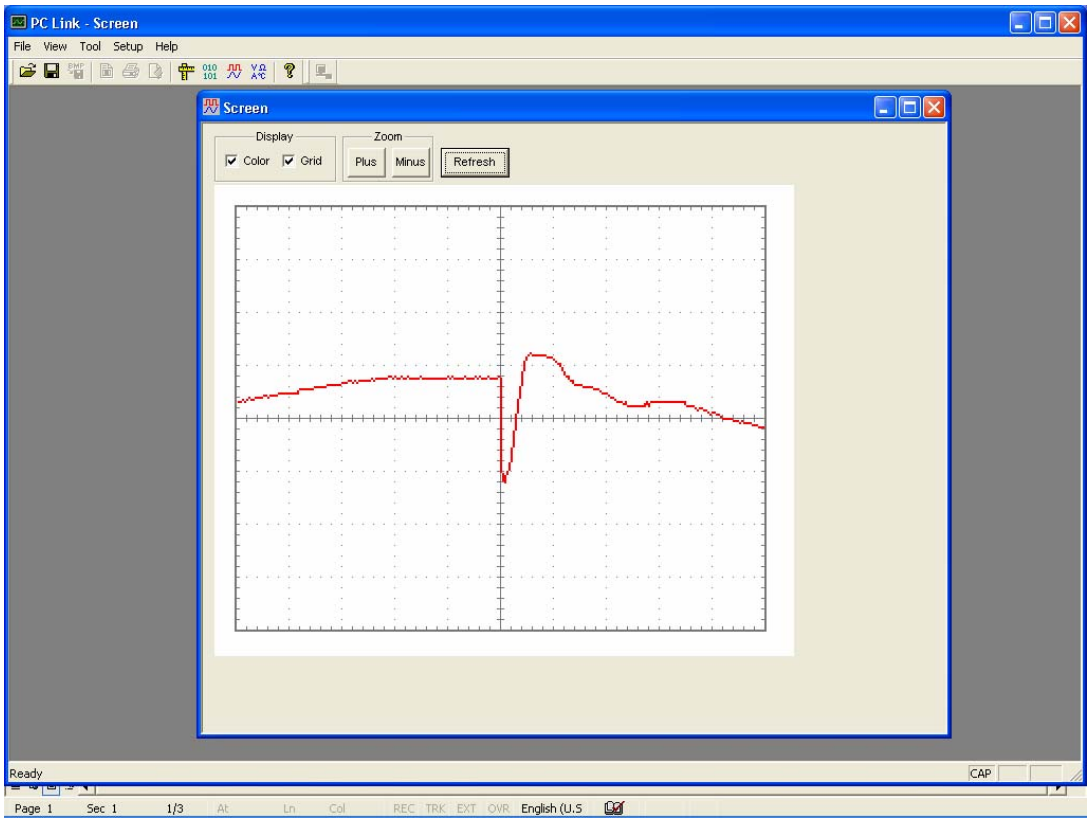

Plate 30: Voltage waveform at +6000V, 2250A active line to neutral line.

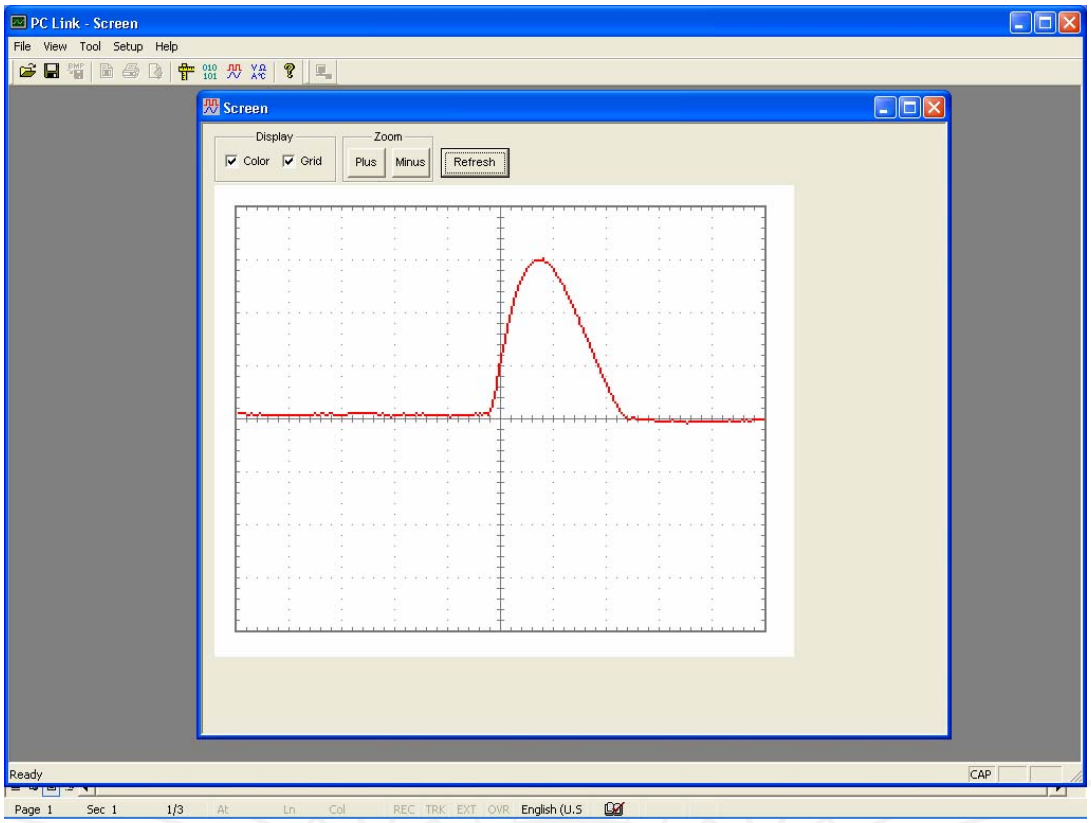

Plate 31: Current waveform at +6000V, 2250A active line to neutral line.

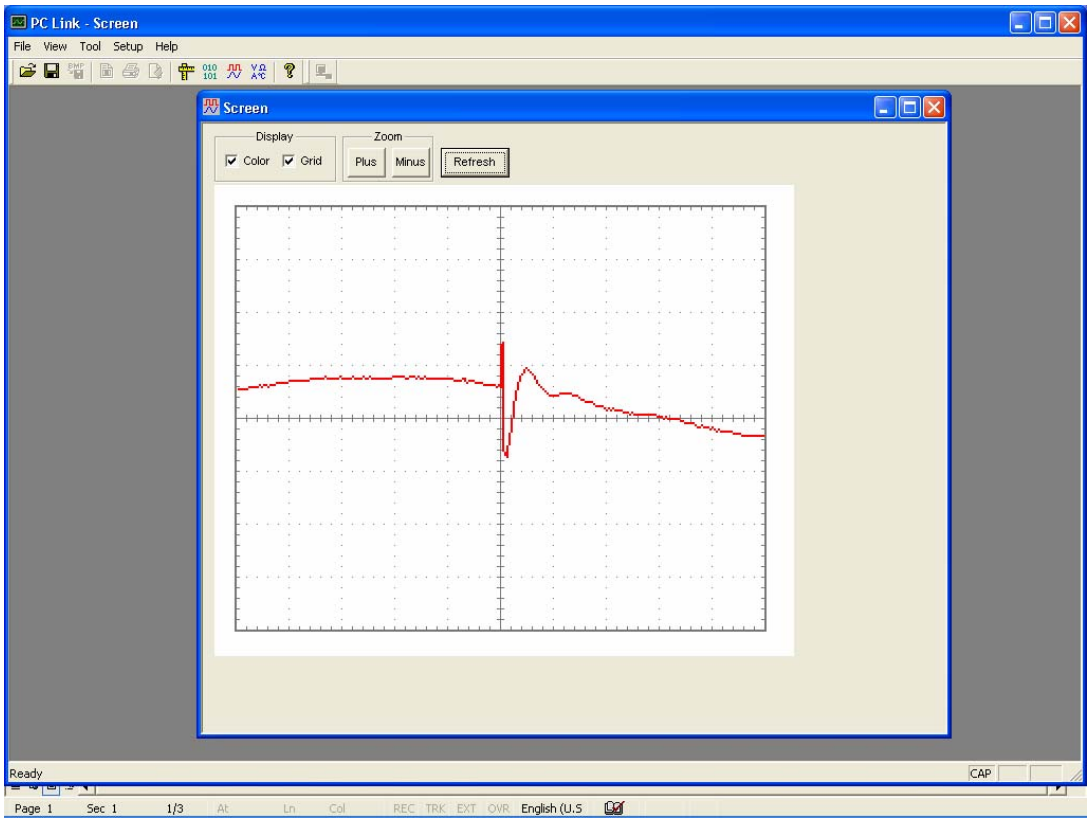

Plate 32: Voltage waveform at +3000V, 1500A active line to protective earth.

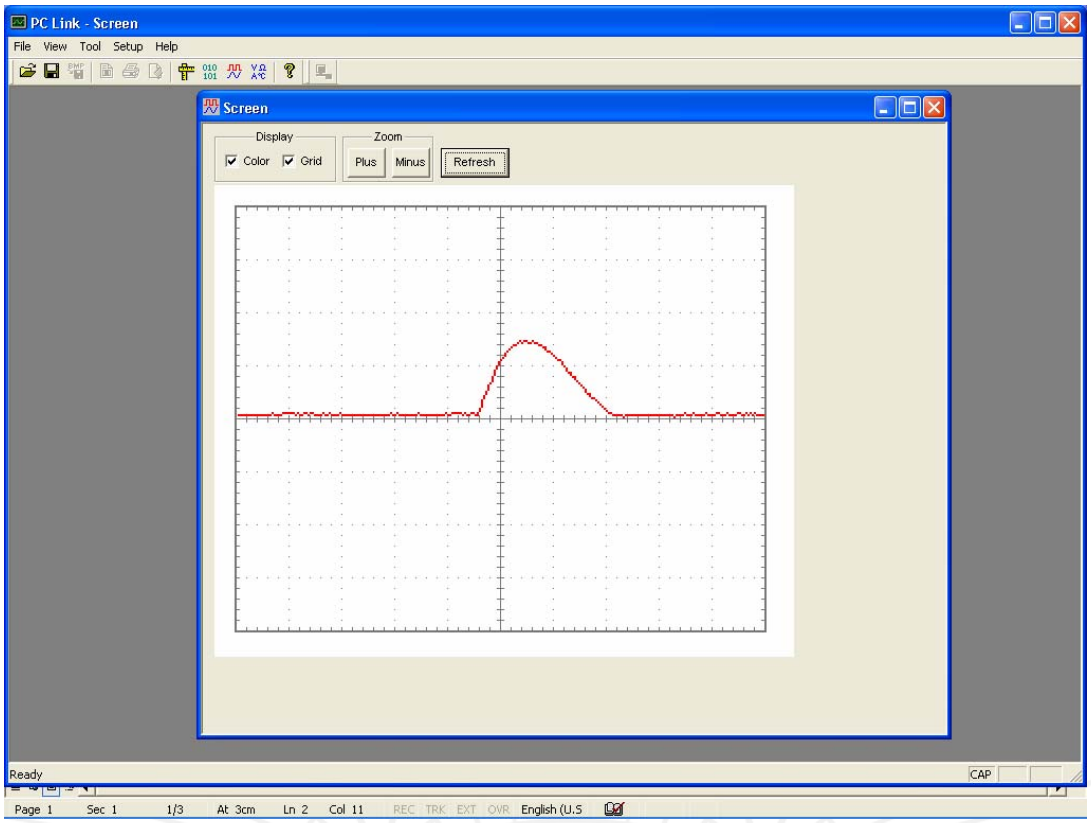

Plate 33: Current waveform at +3000V, 1500A active line to protective earth.

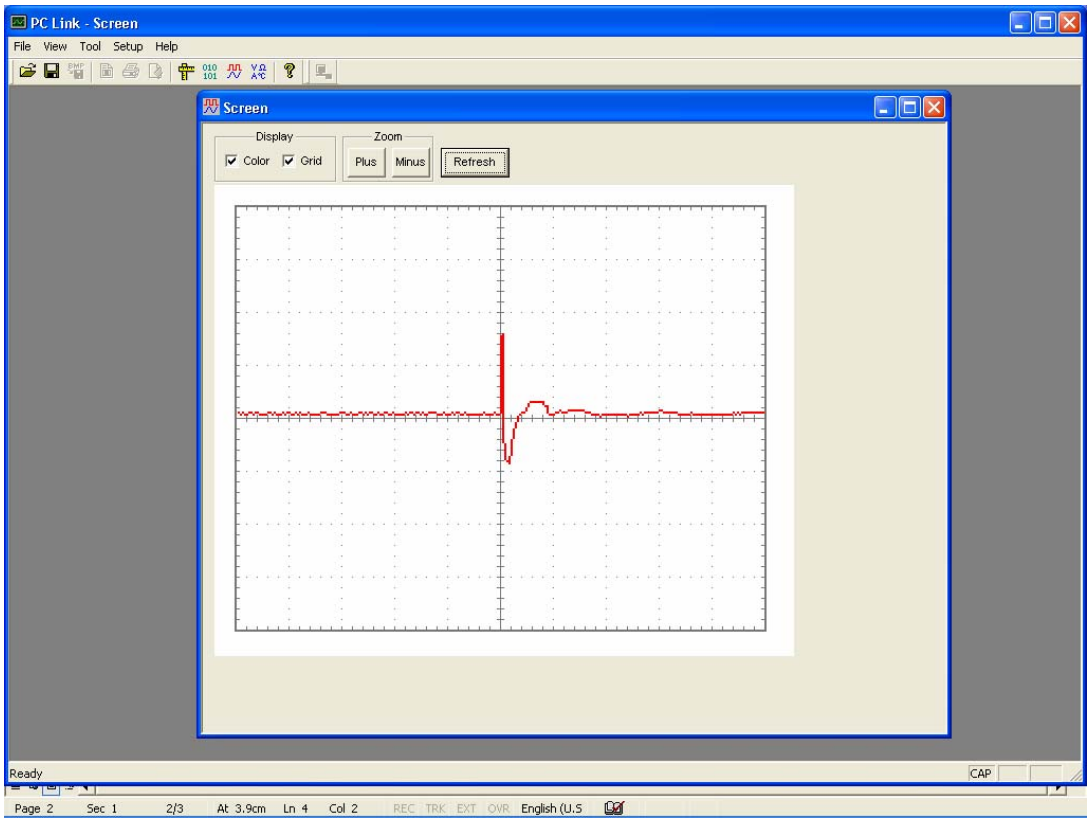

Plate 34: Voltage waveform at +3000V, 1500A neutral line to protective earth.

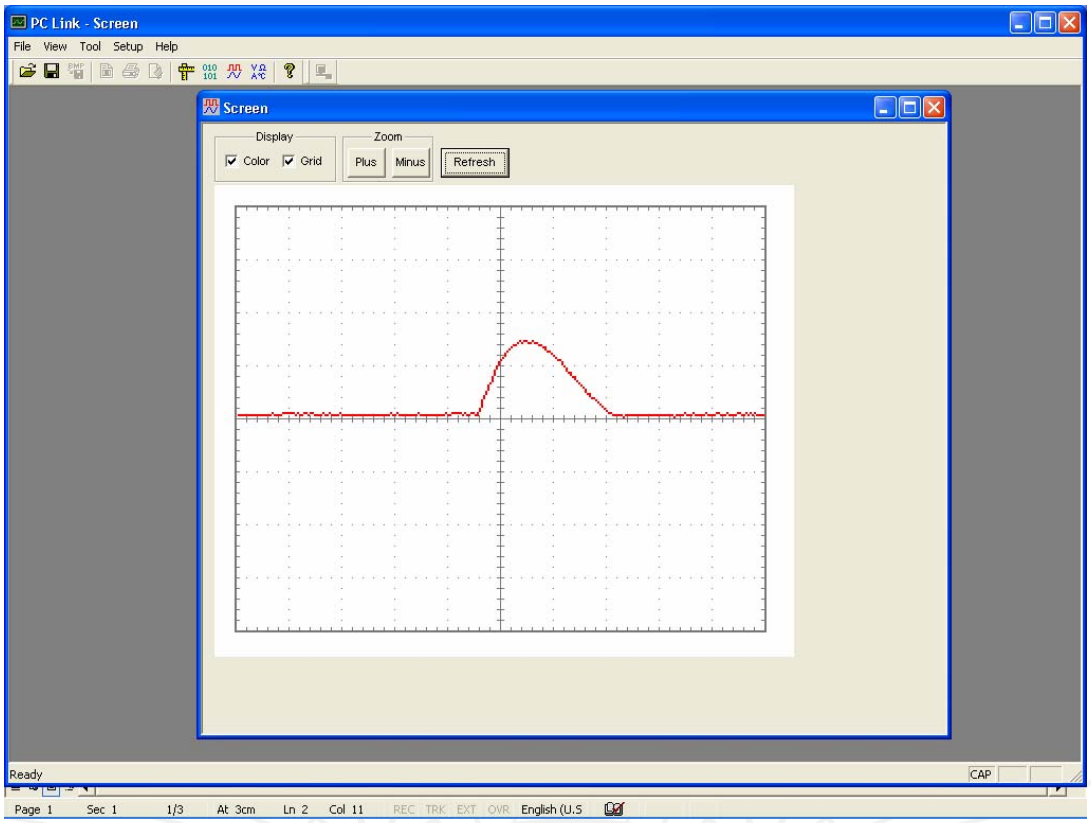

Plate 35: Current waveform at +3000V, 1500A neutral line to protective earth.

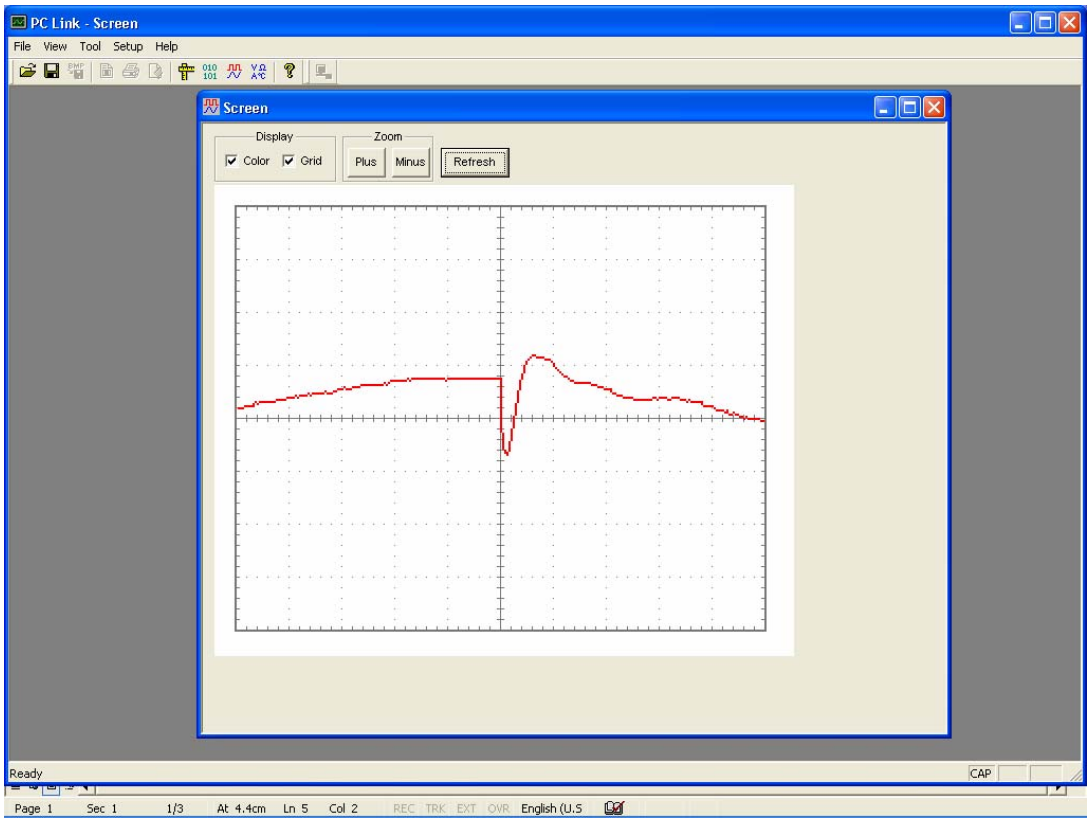

Plate 36: Voltage waveform at +3000V, 1500A active line to neutral line.

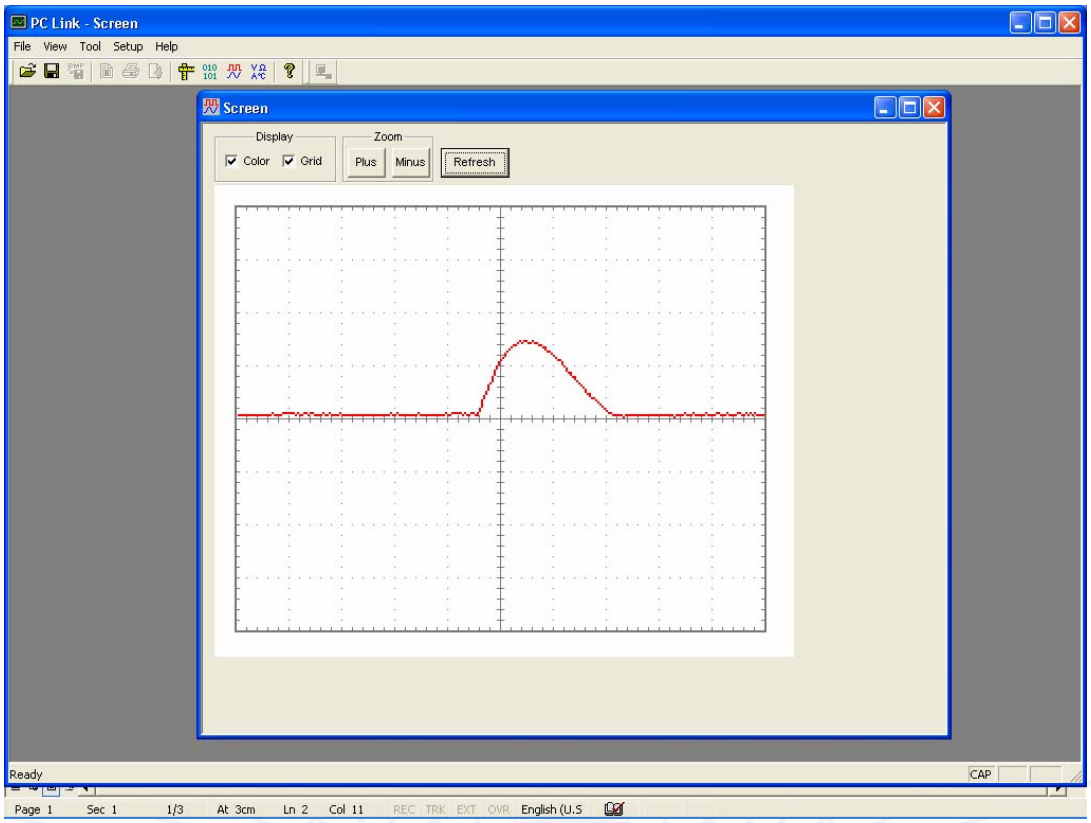

Plate 37: Current waveform at +3000V, 1500A active line to neutral line.

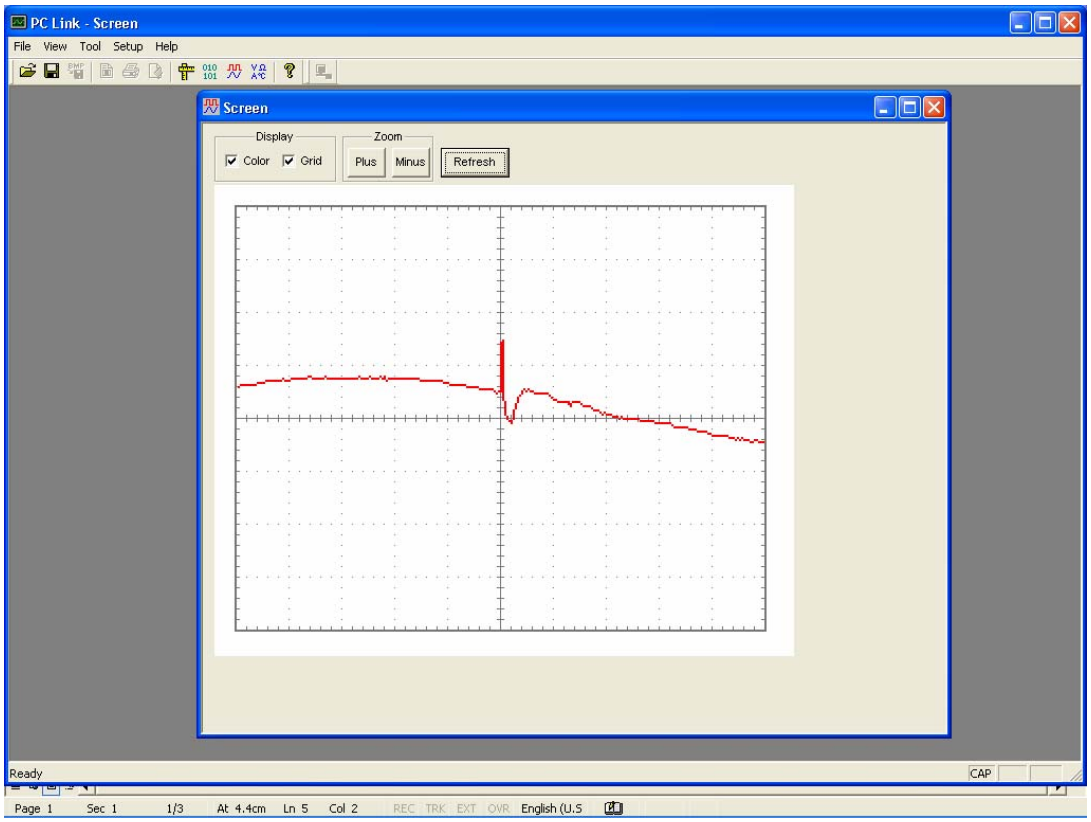

Plate 38: Voltage waveform at +1500V, 750A active line to protective earth.

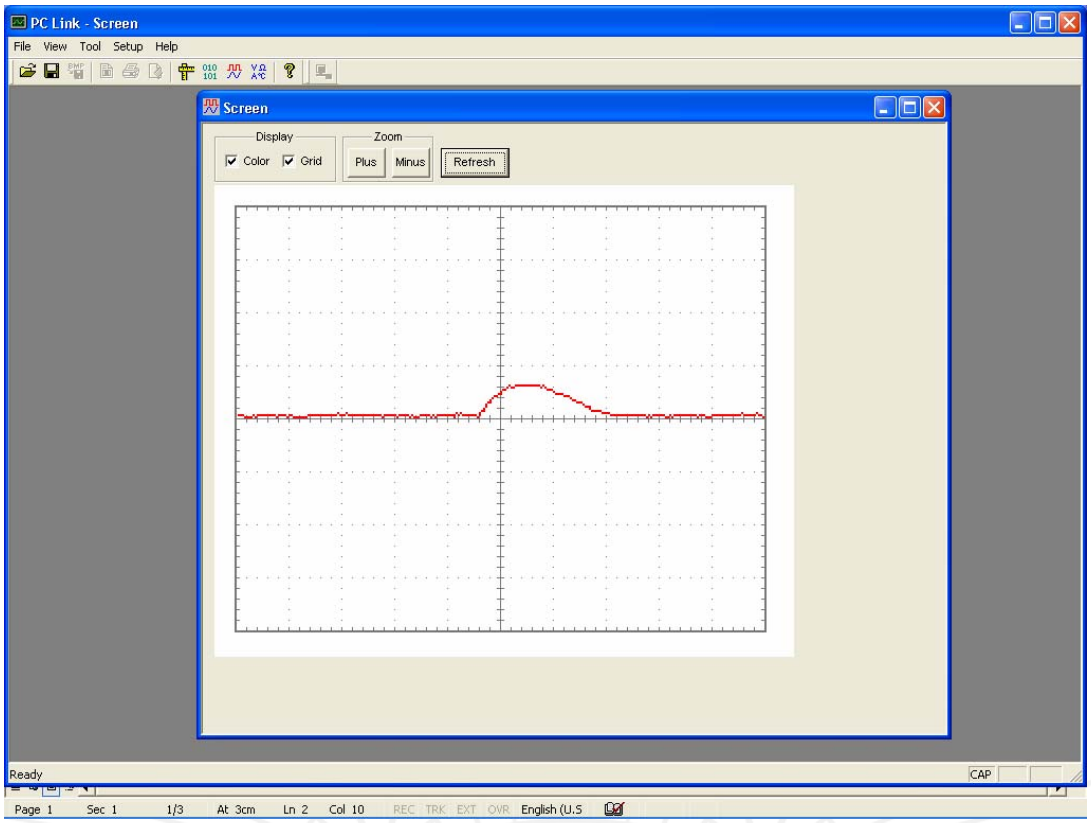

Plate 39: Current waveform at +1500V, 750A active line to protective earth.

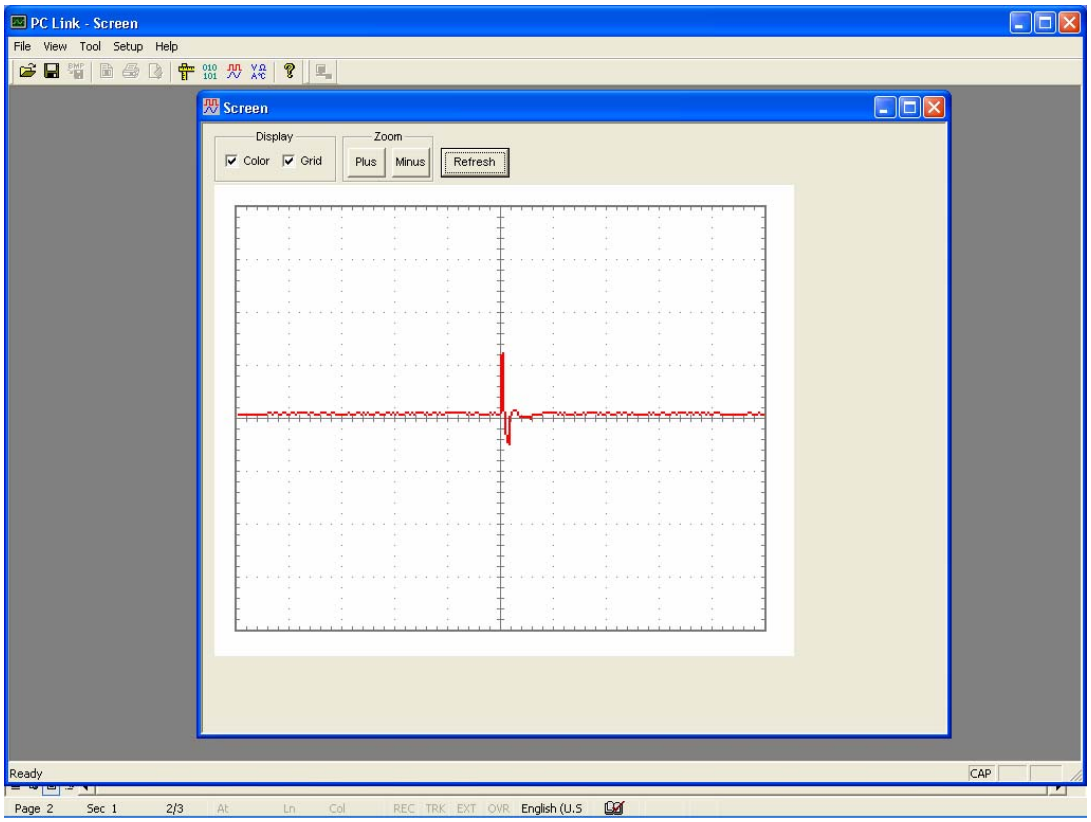

Plate 40: Voltage waveform at +1500V, 750A neutral line to protective earth.

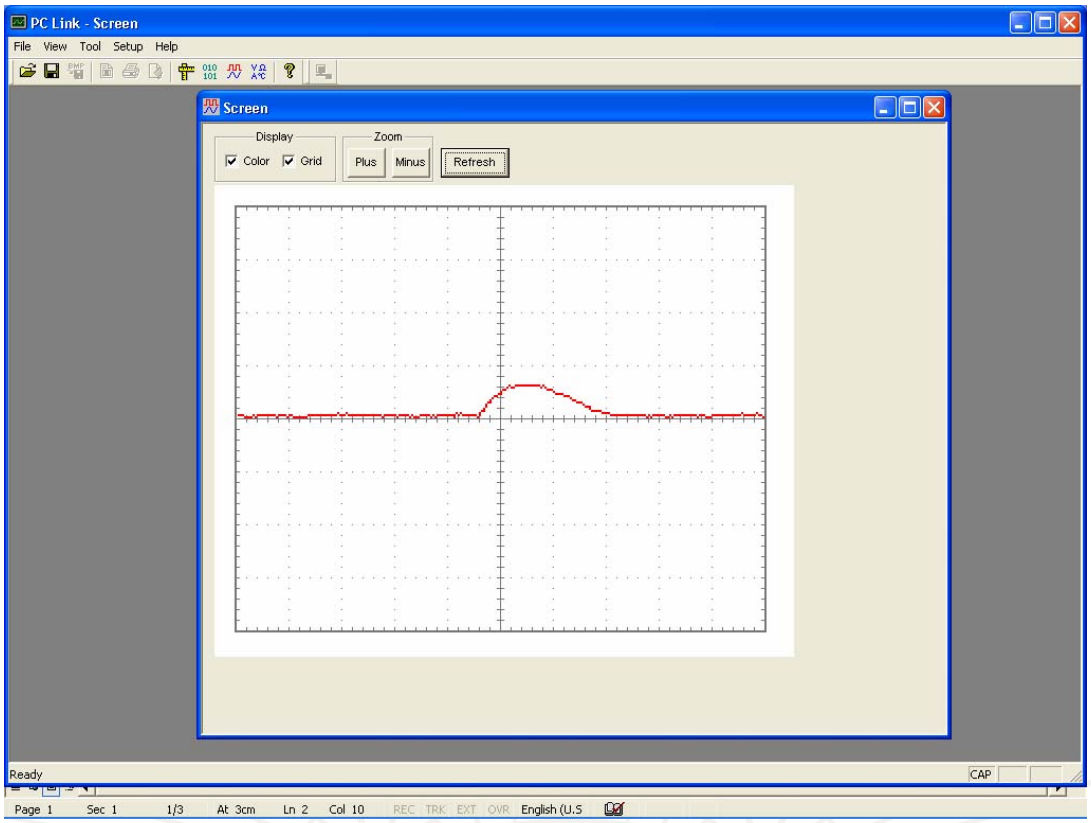

Plate 41: Current waveform at +1500V, 750A neutral line to protective earth.

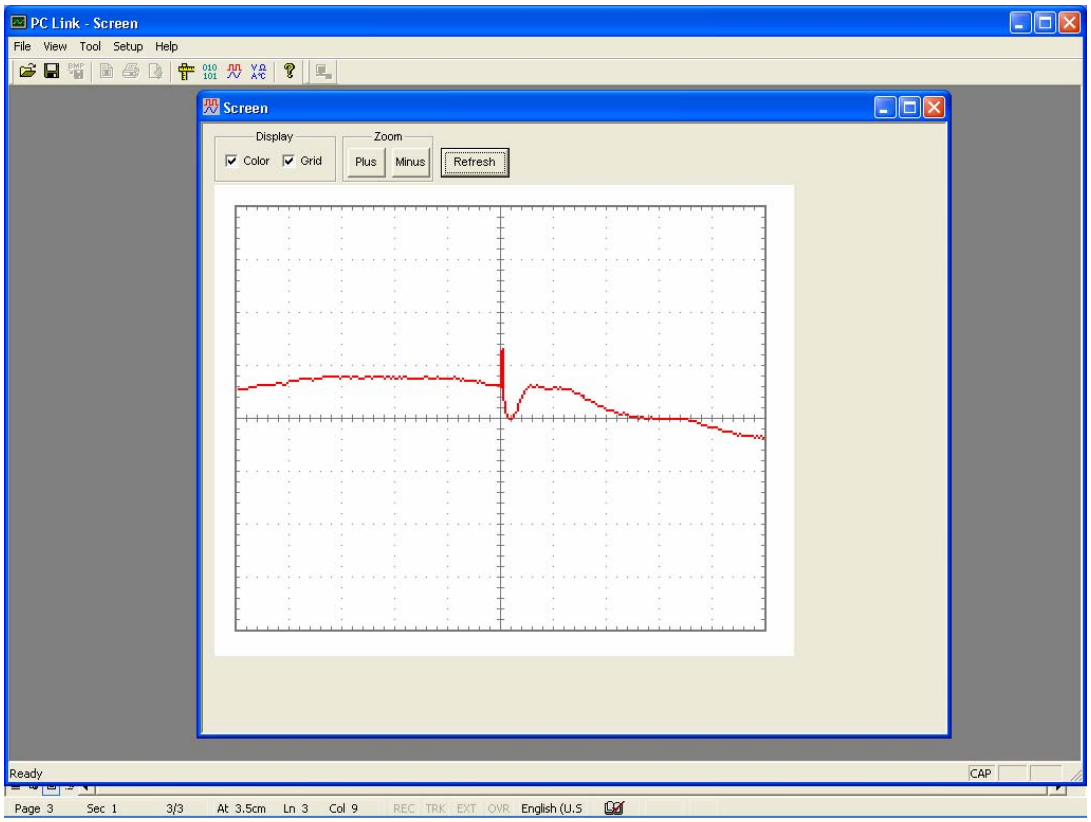

Plate 42: Voltage waveform at +1500V, 750A active line to neutral line.

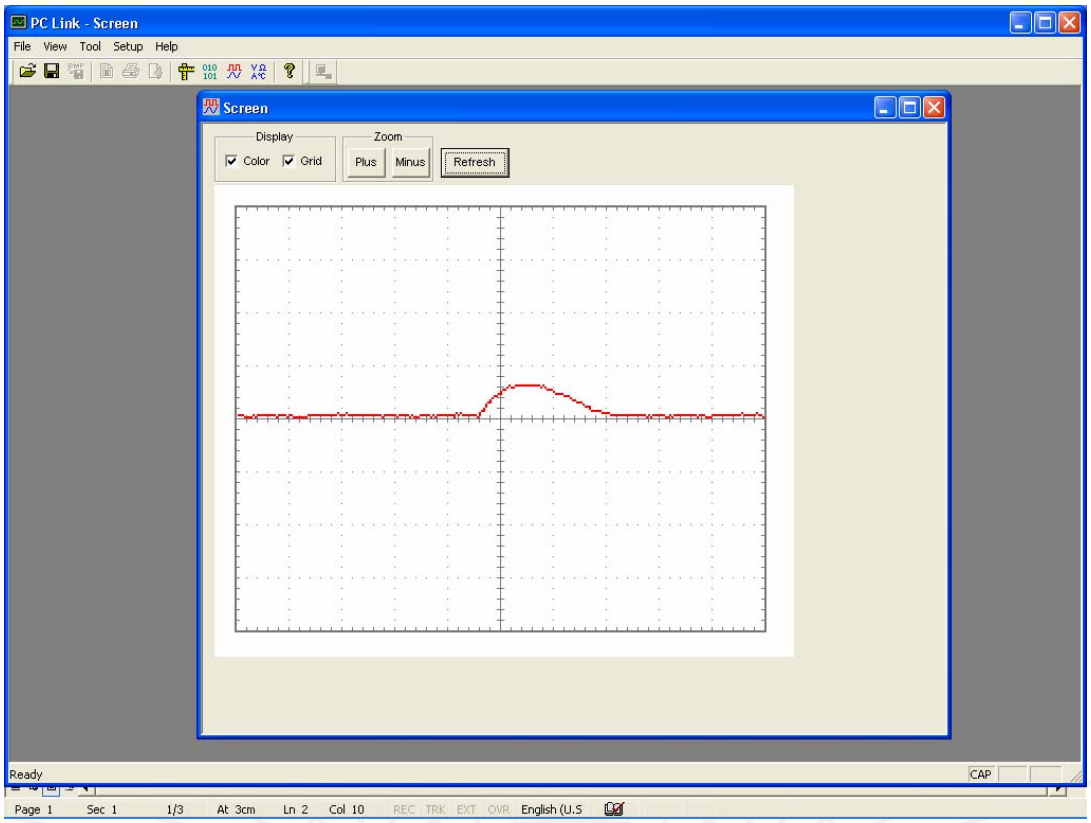

Plate 43: Current waveform at +1500V, 750A active line to neutral line.

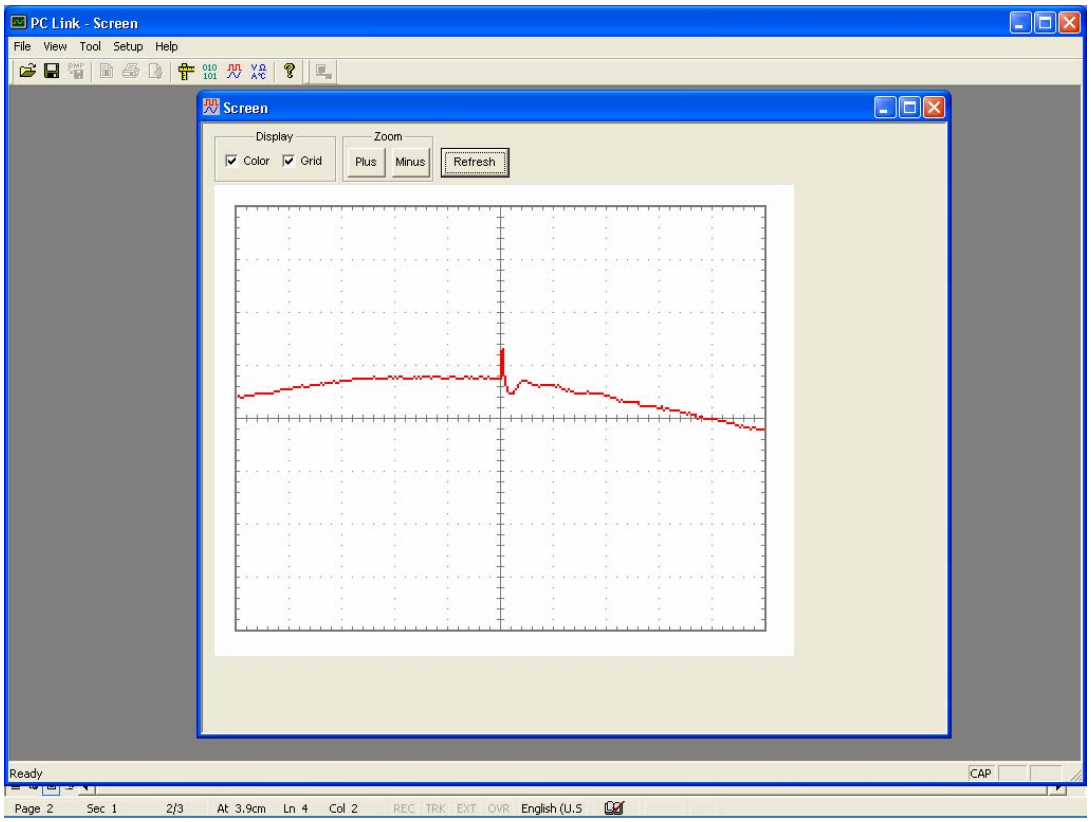

Plate 44: Voltage waveform at +600V, 300A active line to protective earth.

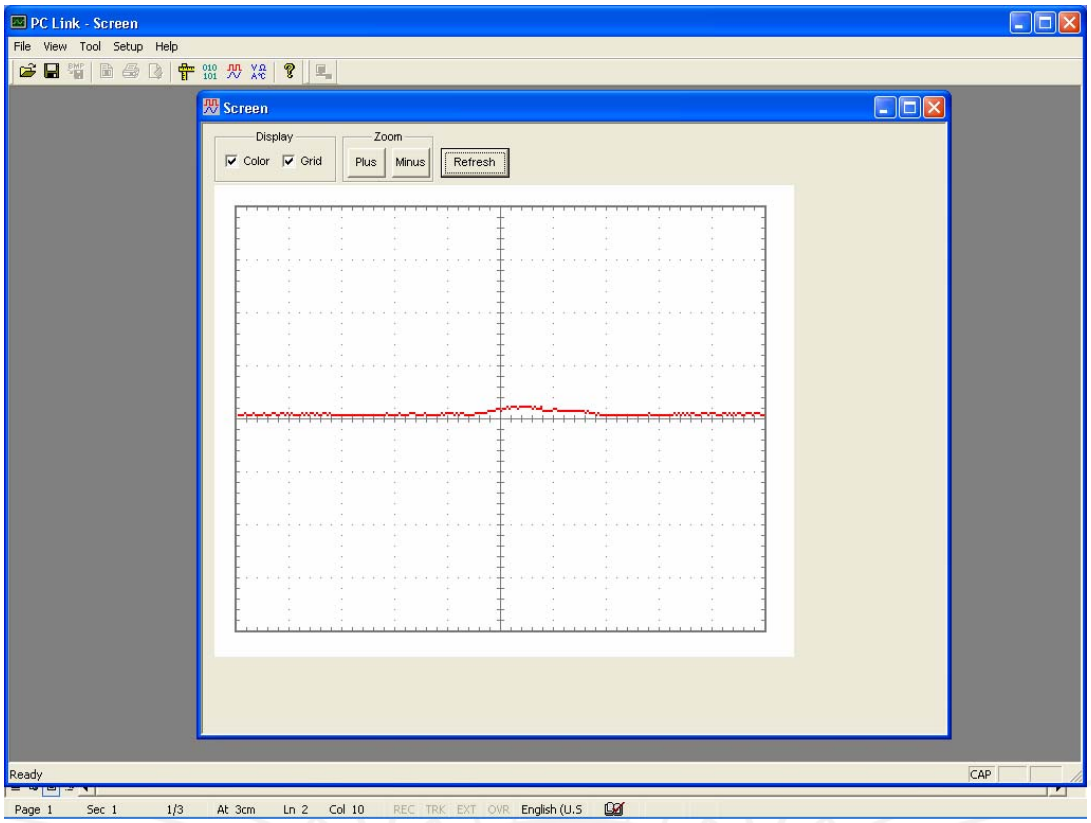

Plate 45: Current waveform at +600V, 300A active line to protective earth.

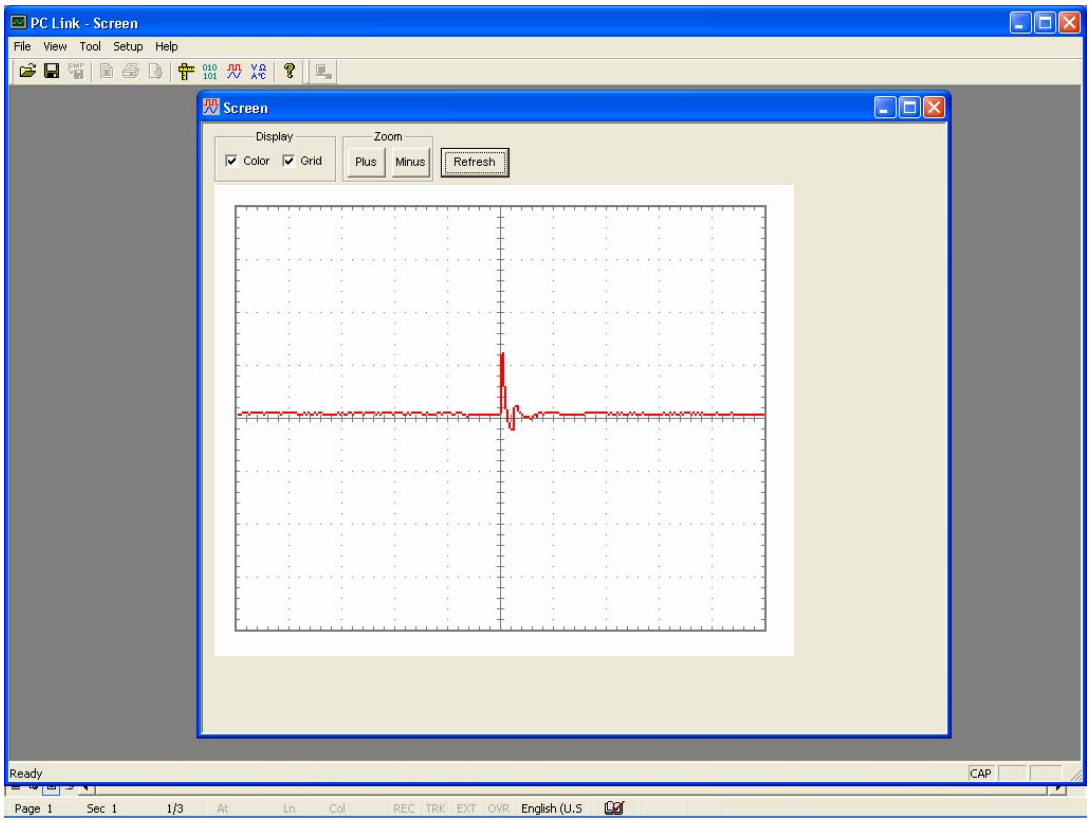

Plate 46: Voltage waveform at +600V, 300A neutral line to protective earth.

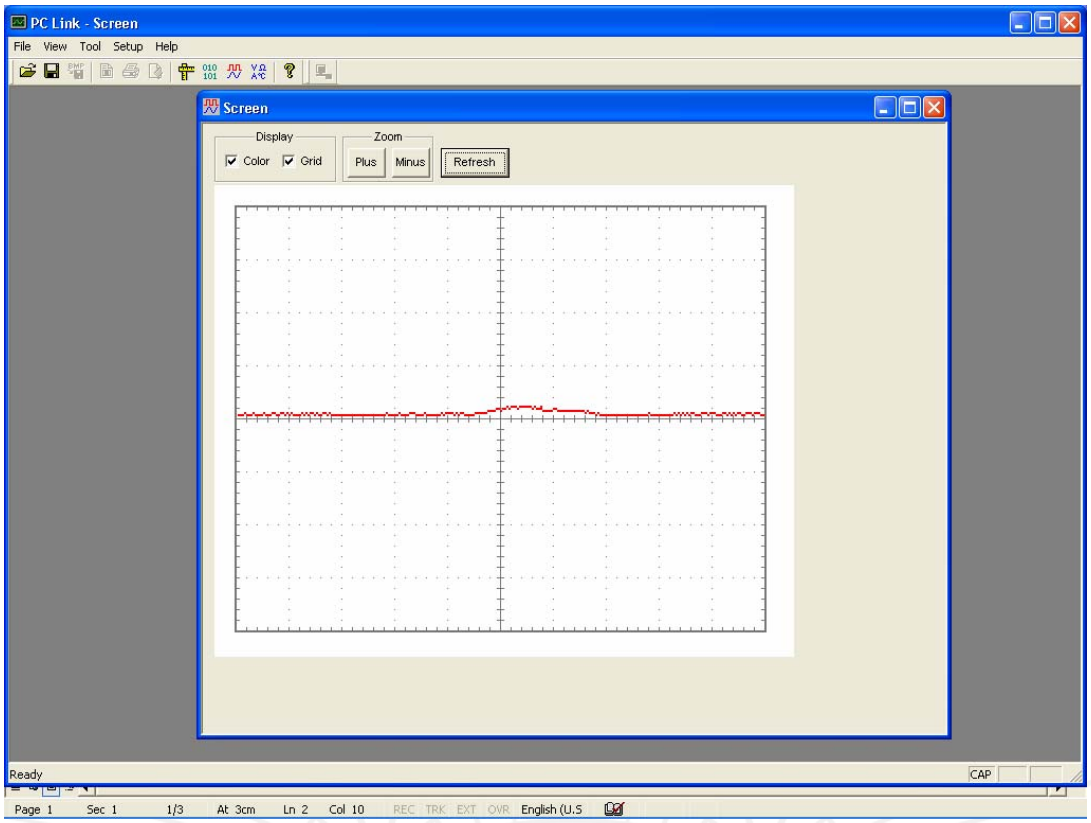

Plate 47: Current waveform at +600V, 300A neutral line to protective earth.

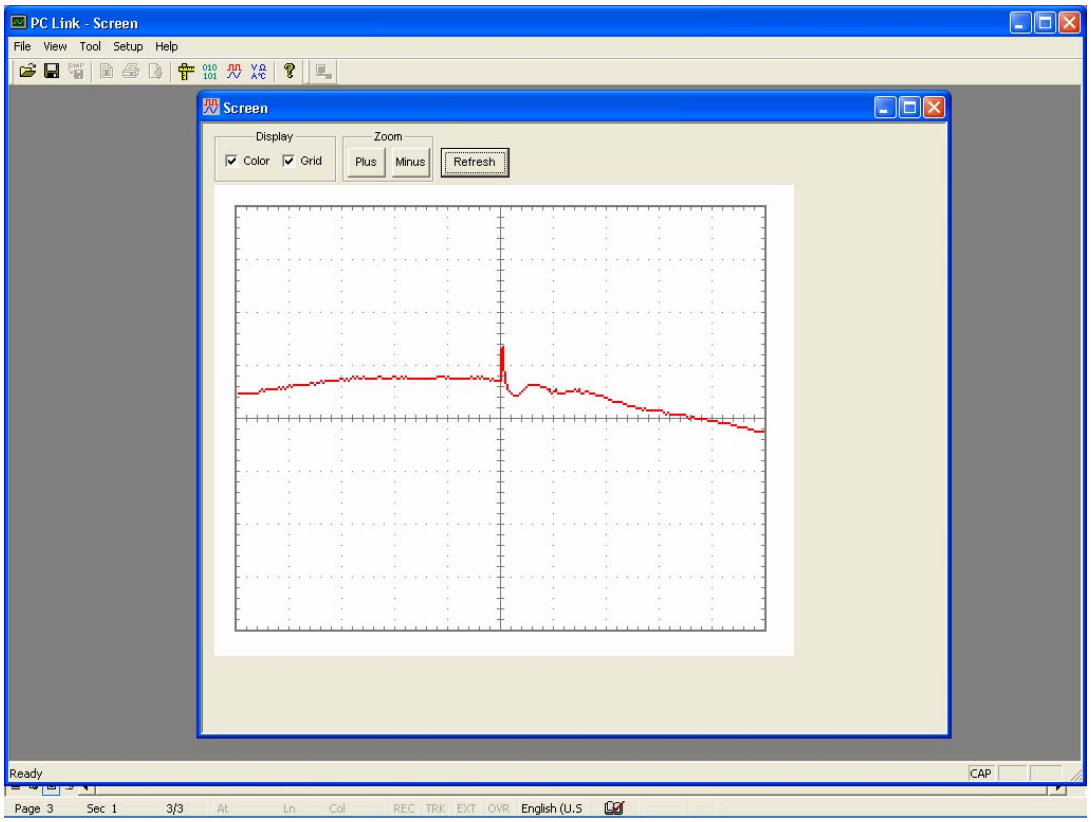

Plate 48: Voltage waveform at +600V, 300A active line to neutral line.

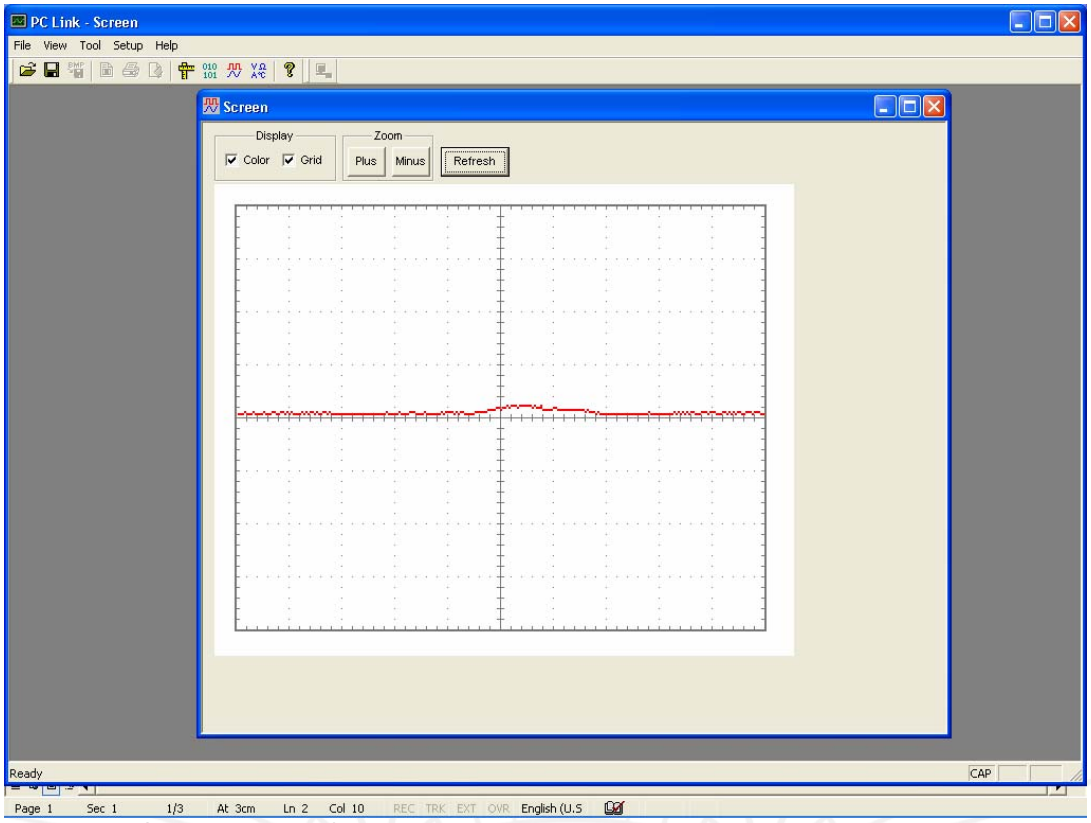

Plate 49: Current waveform at +600V, 300A active line to neutral line.

AS/NZS 1768(Int):2003 – Appendix D

The EUT was tested in accordance with the methodology and procedures of AS/NZS 1768(Int):2003 – Appendix D for a Class II (Category B) device.

Results:

Sample 1	Active to Earth	Neutral to Earth	Active to Neutral
+6kV, 3kA	+780V	+840V	+720V
-6kV, 3kA	+680V	-800V	-760V

Plate 50: Surge Residual Voltage Reference Data – Sample 1.

Sample 2	Active to Earth	Neutral to Earth	Active to Neutral
+6kV, 3kA	+820V	+800V	+660V
-6kV, 3kA	+720V	-760V	-700V

Plate 51: Surge Residual Voltage Reference Data – Sample 2.

Sample 3	Active to Earth	Neutral to Earth	Active to Neutral
+6kV, 3kA	-700V	+780V	-680V
-6kV, 3kA	-700V	-780V	-740V

Plate 52: Surge Residual Voltage Reference Data – Sample 3.

The Residual Voltage Level Rating = 900 V (Category B, 6kV/3000A) as per AS/NZS 1768(Int):2003 – Appendix D

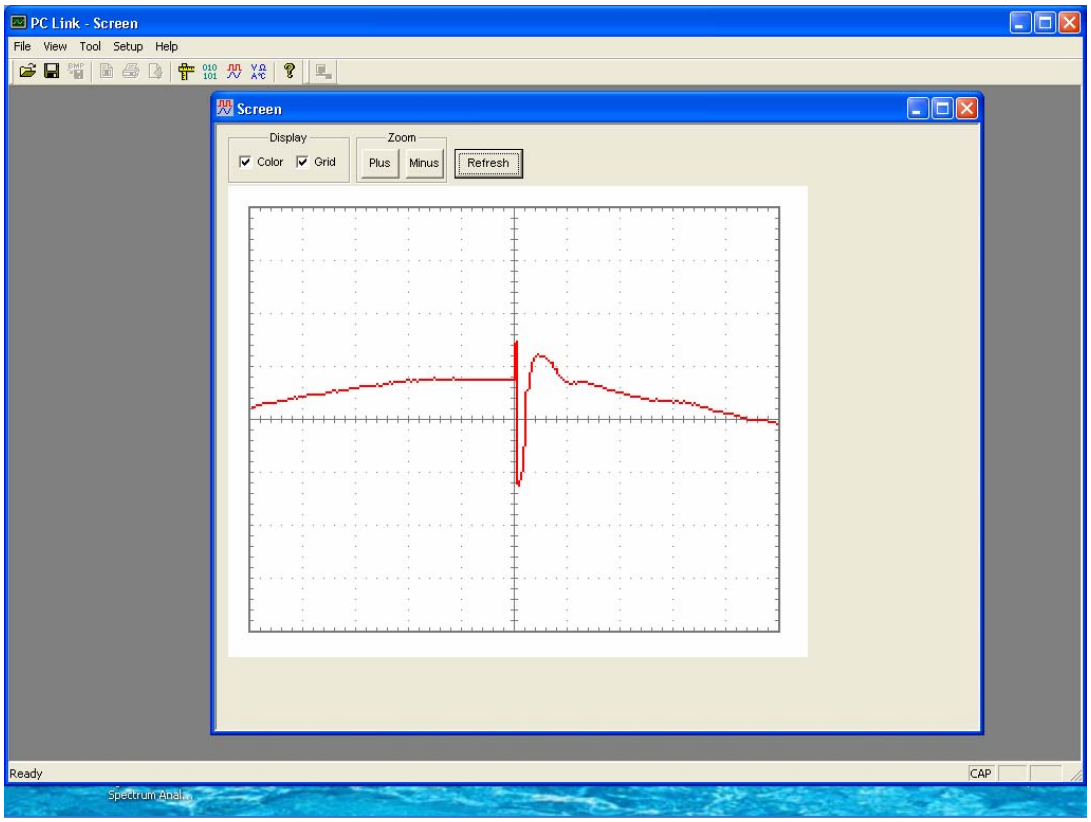

Plate 53: Voltage waveform at +6000V, 3000A active line to protective earth.

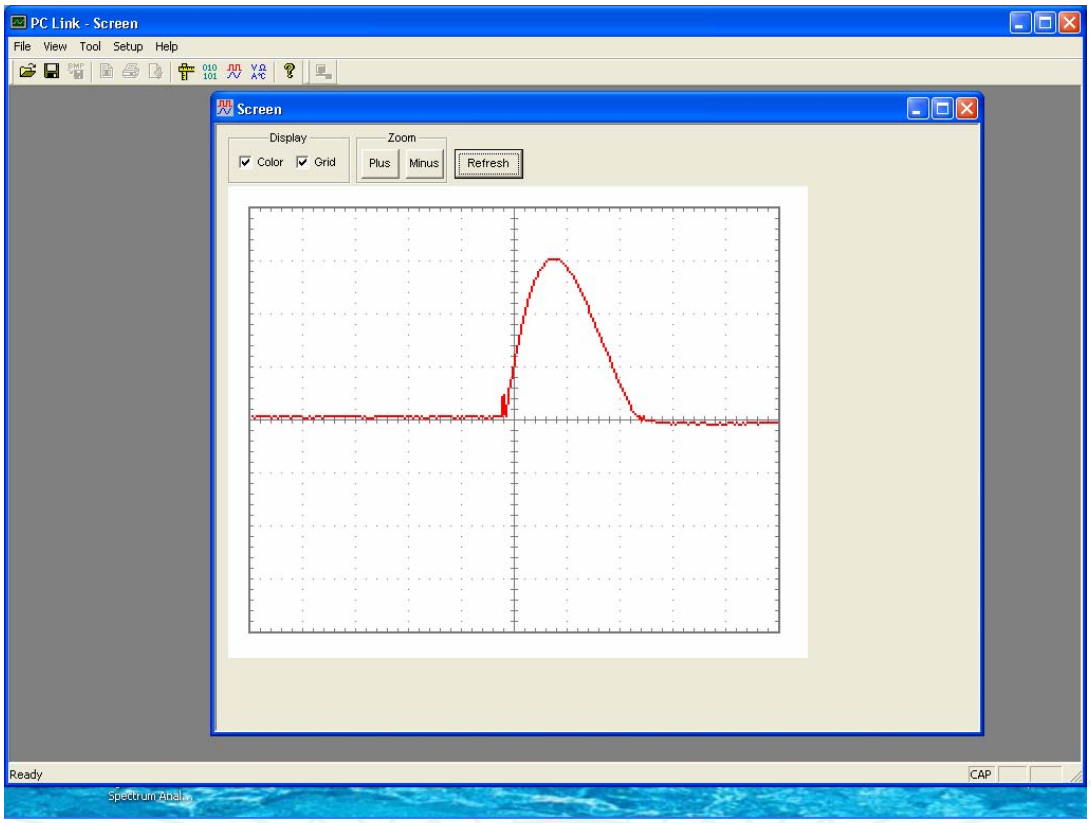

Plate 54: Current waveform at +6000V, 3000A active line to protective earth.

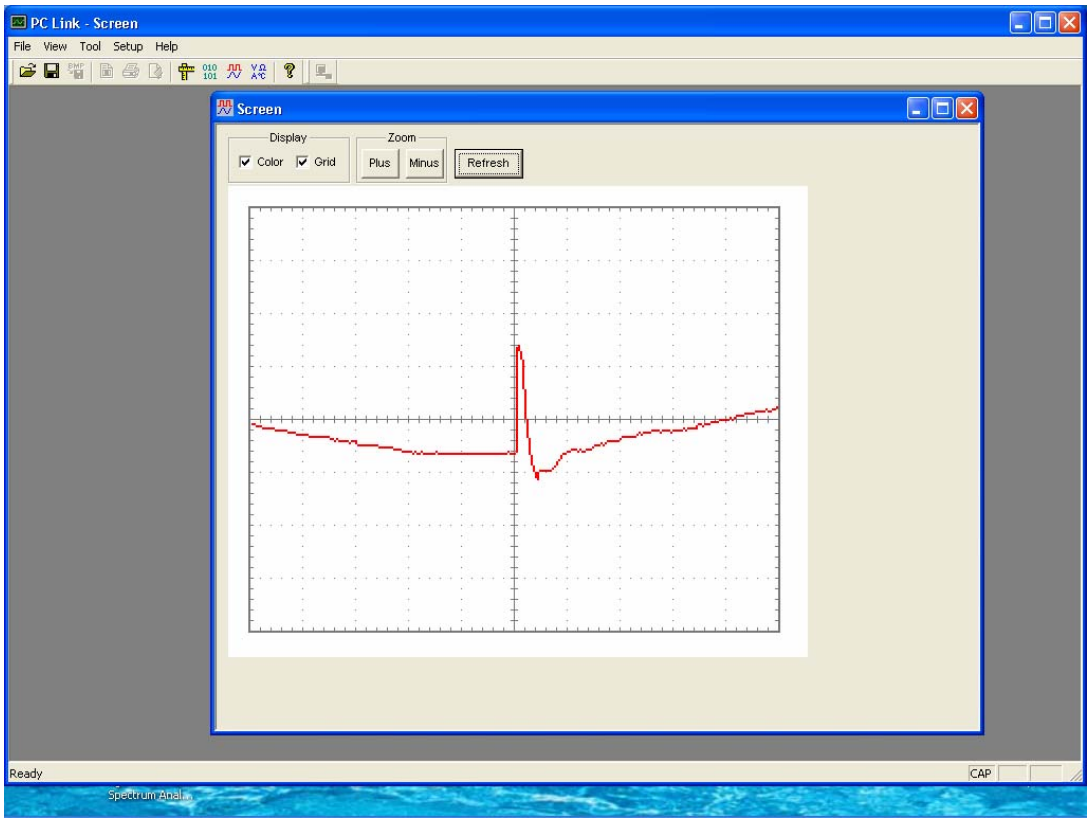

Plate 55: Voltage waveform at -6000V, 3000A active line to protective earth.

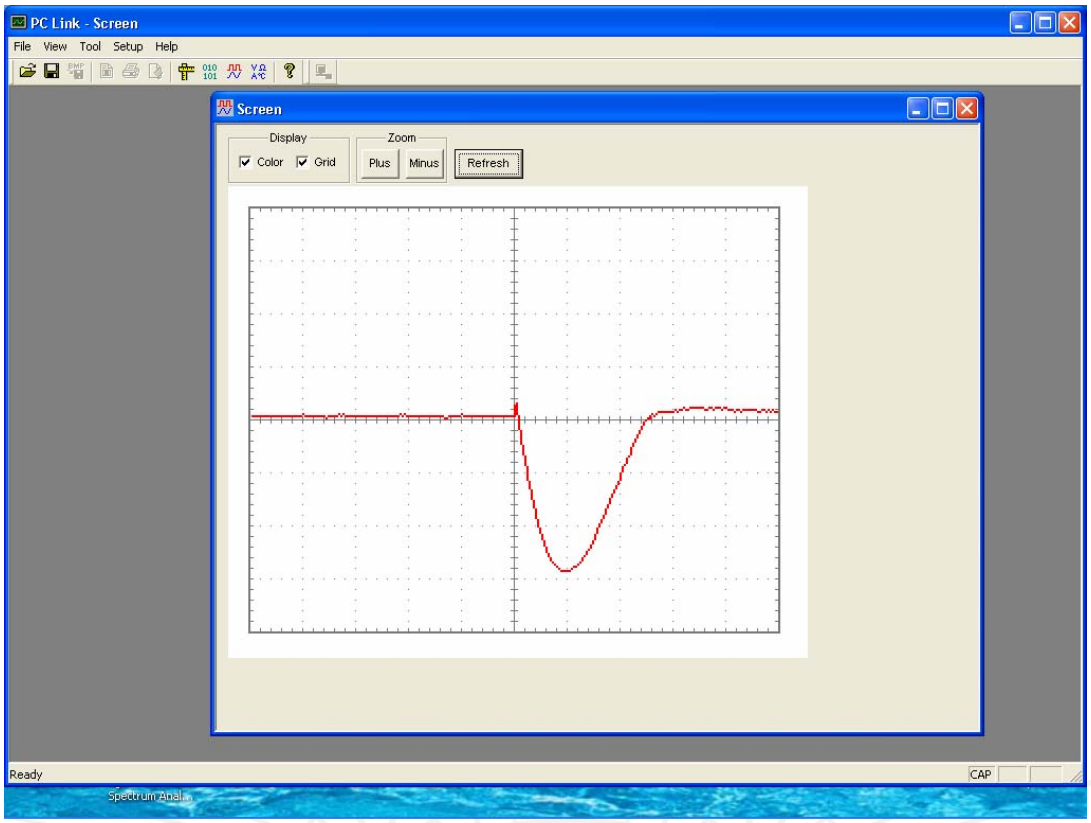

Plate 56: Current waveform at -6000V, 3000A active line to protective earth.

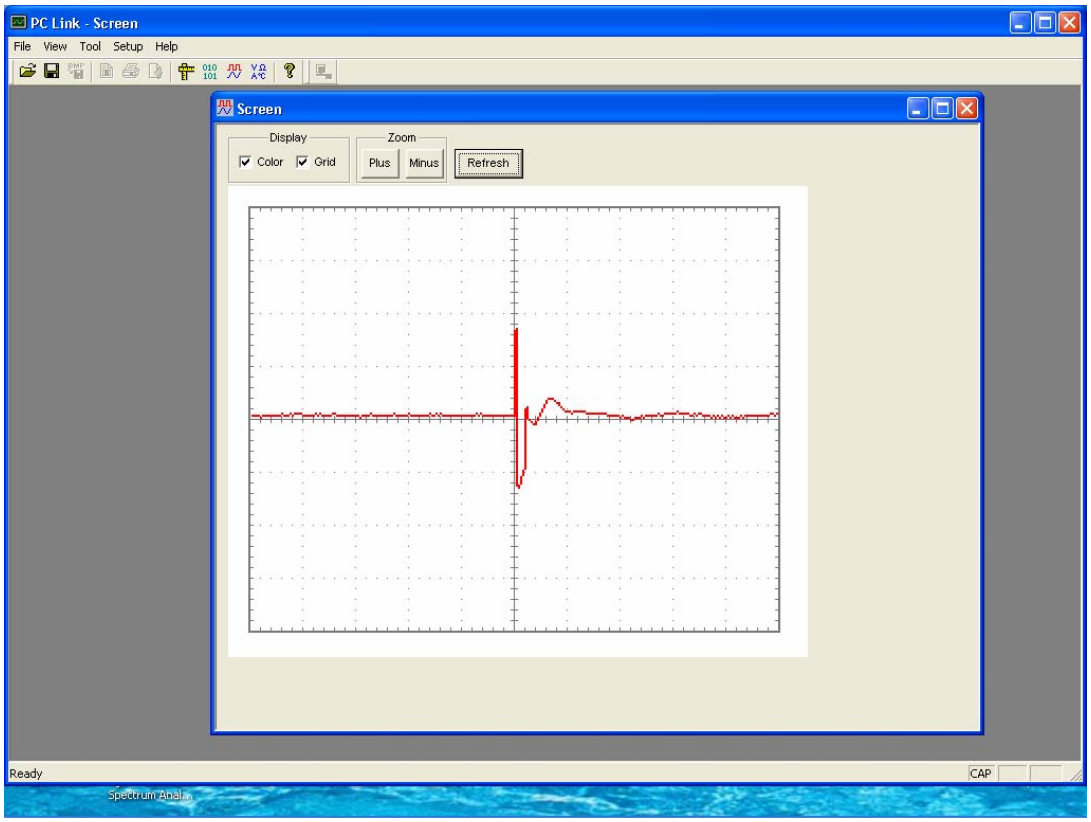

Plate 57: Voltage waveform at +6000V, 3000A neutral line to protective earth.

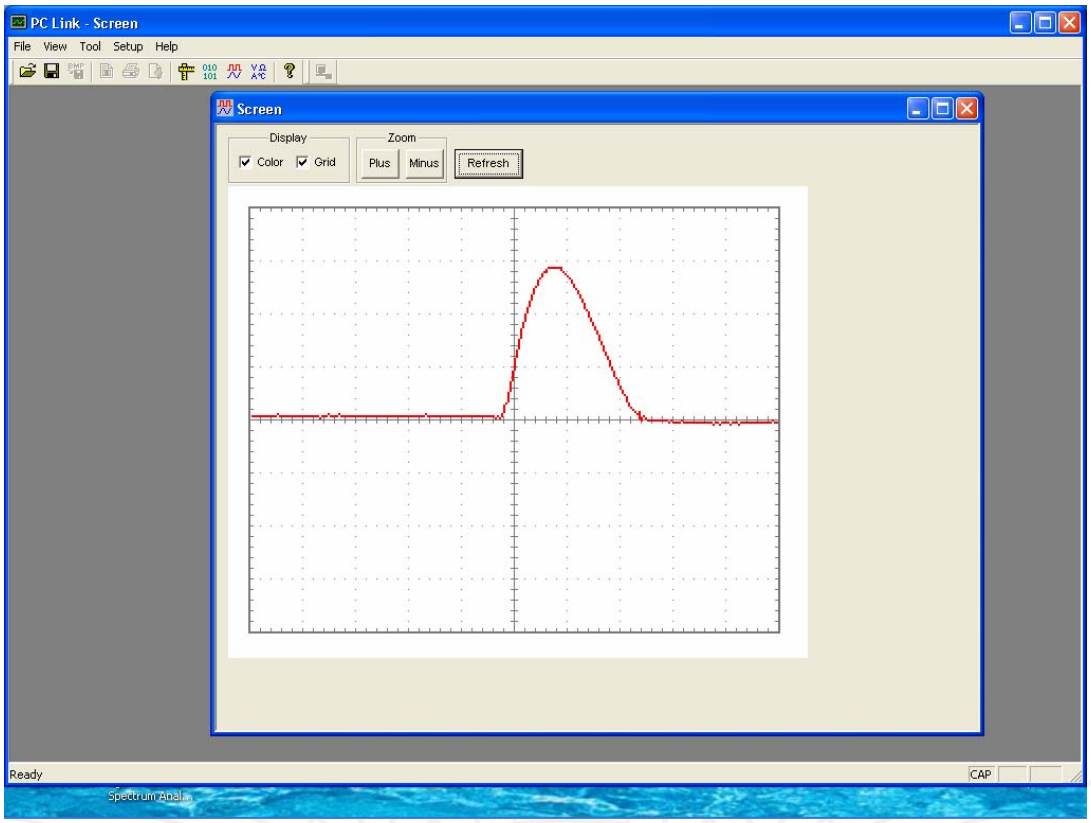

Plate 58: Current waveform at +6000V, 3000A neutral line to protective earth.

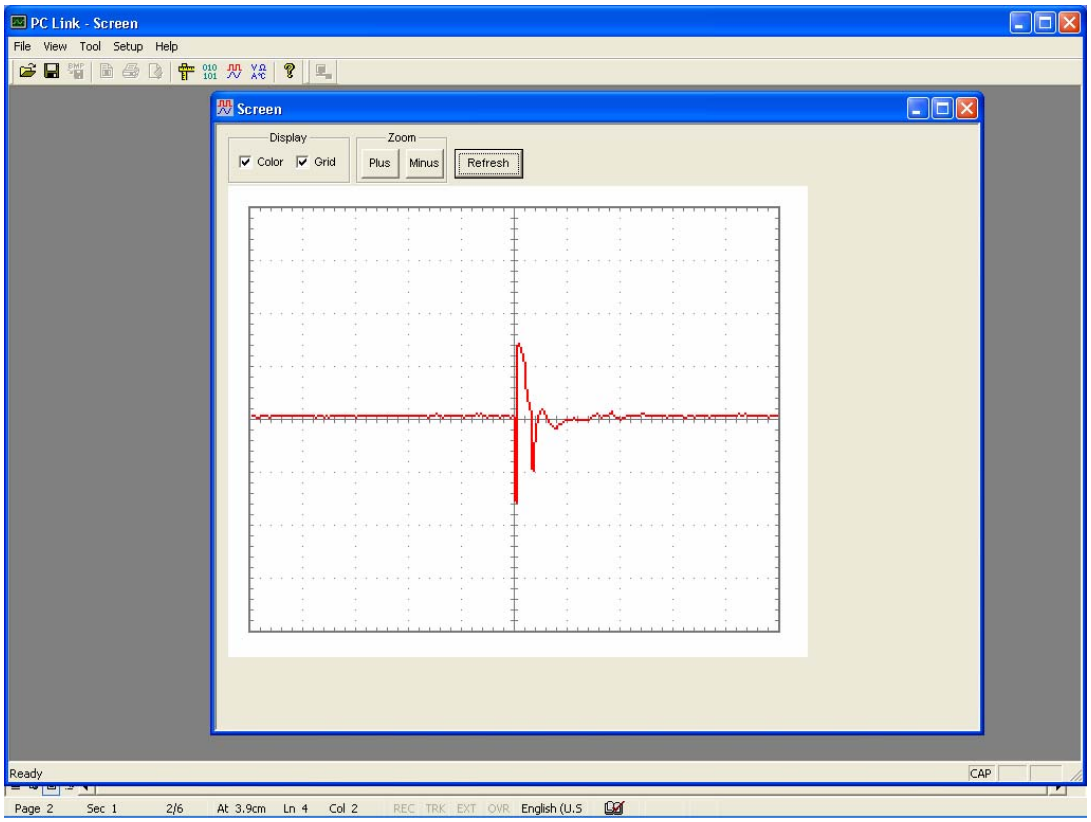

Plate 59: Voltage waveform at -6000V, 3000A neutral line to protective earth.

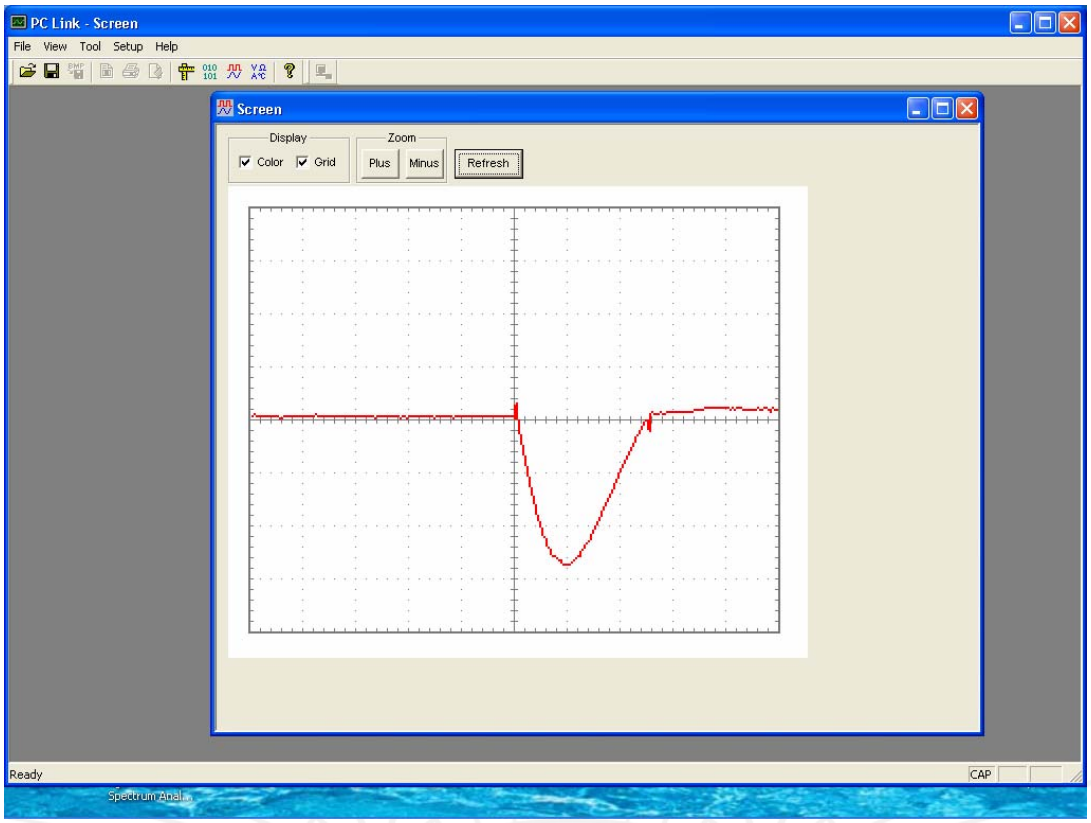

Plate 60: Current waveform at -6000V, 3000A neutral line to protective earth.

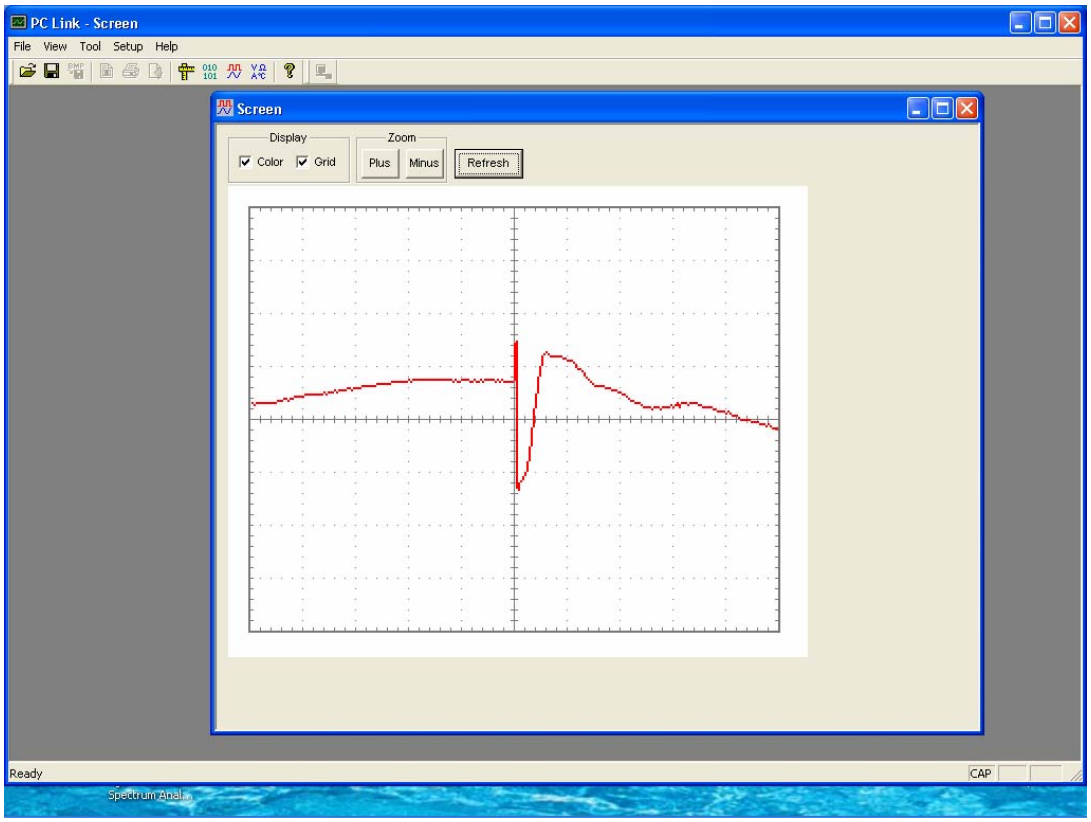

Plate 61: Voltage waveform at +6000V, 3000A active line to neutral line.

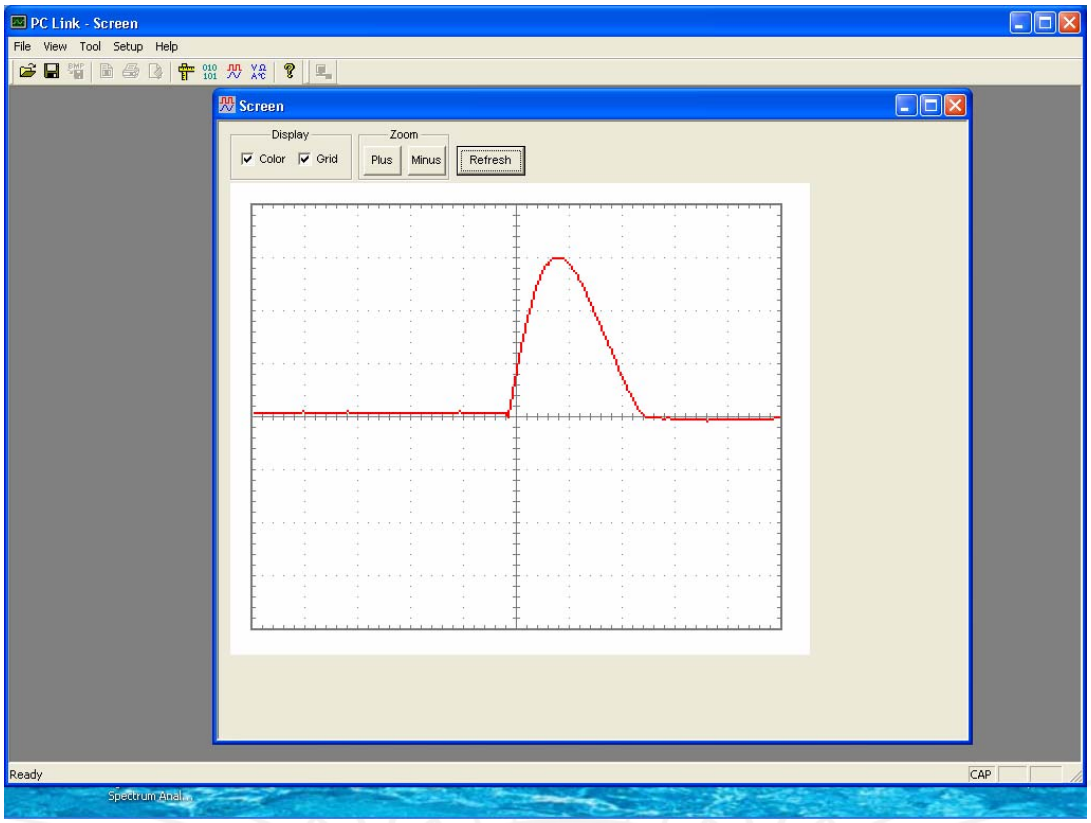

Plate 62: Current waveform at +6000V, 3000A active line to neutral line.

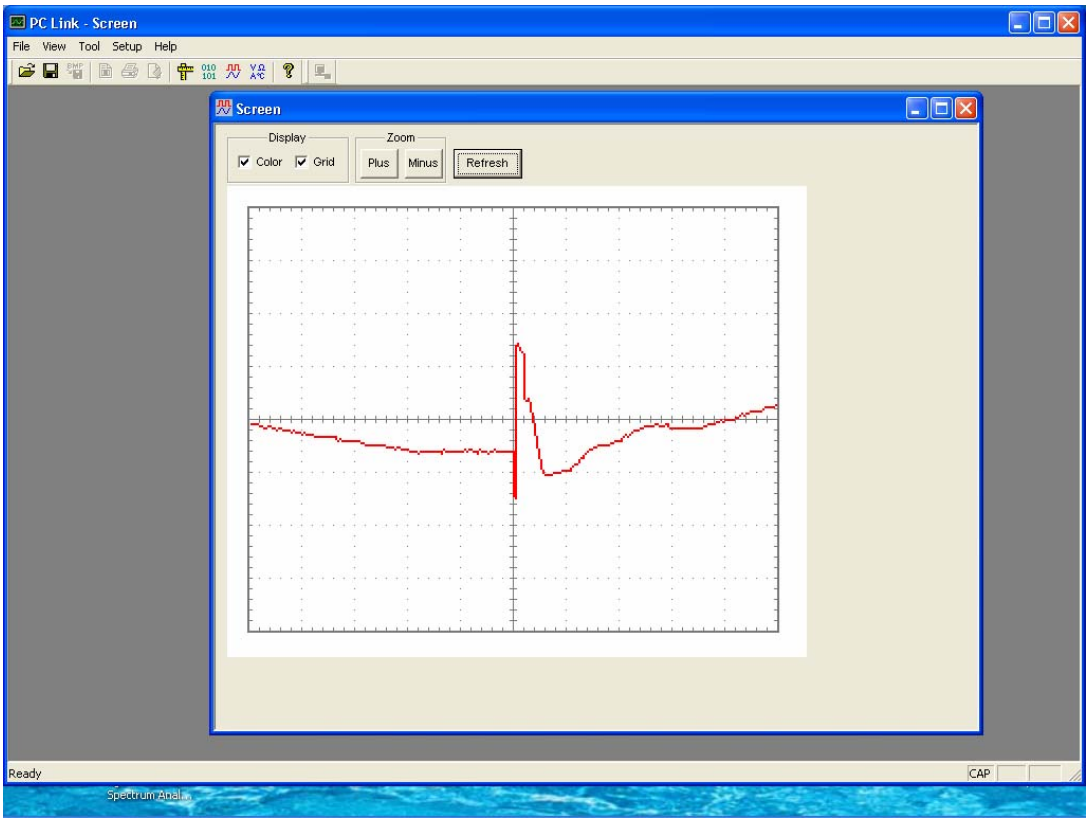

Plate 63: Voltage waveform at -6000V, 3000A active line to neutral line.

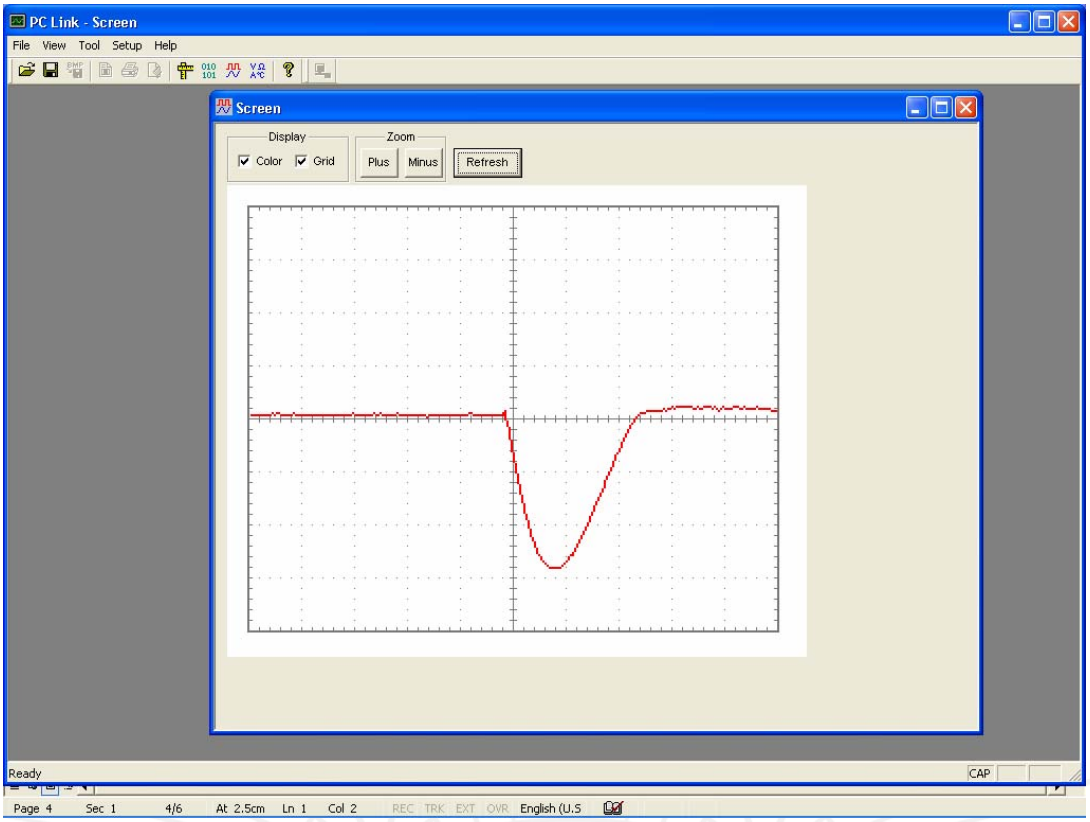

Plate 64: Current waveform at -6000V, 3000A active line to neutral line.

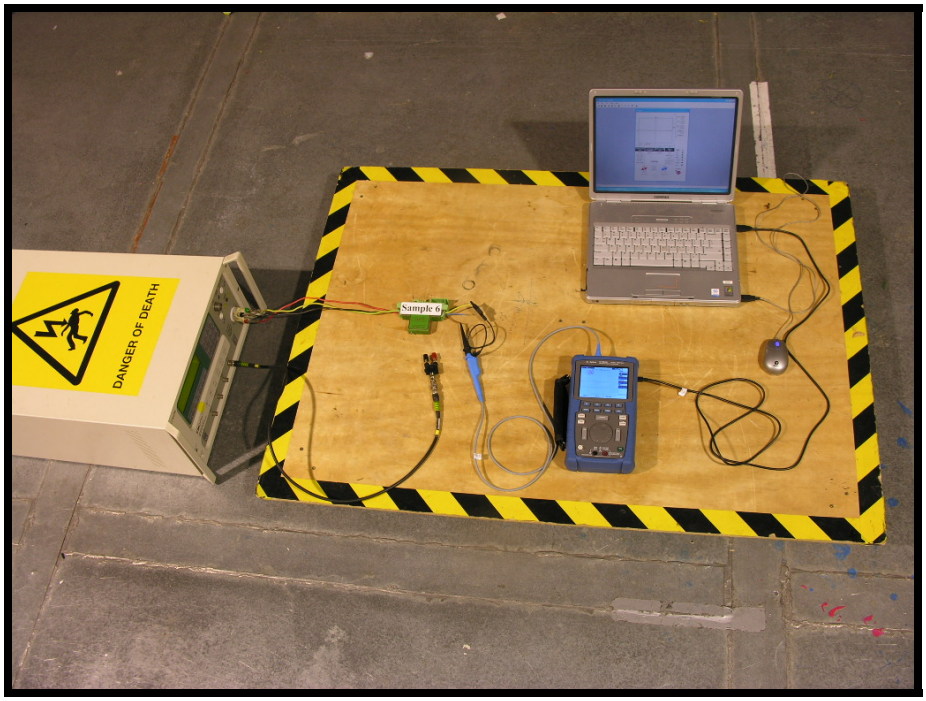

Plate 65: EUT Setup for Surge Testing, monitoring voltage waveform.

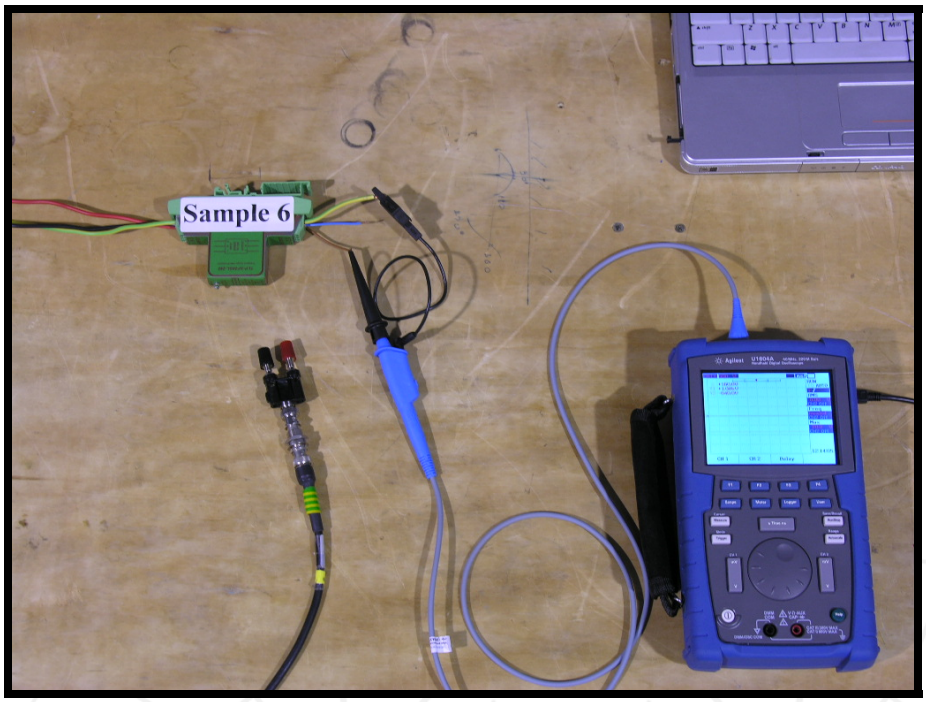

Plate 66: EUT Setup for Surge Testing, monitoring voltage waveform.

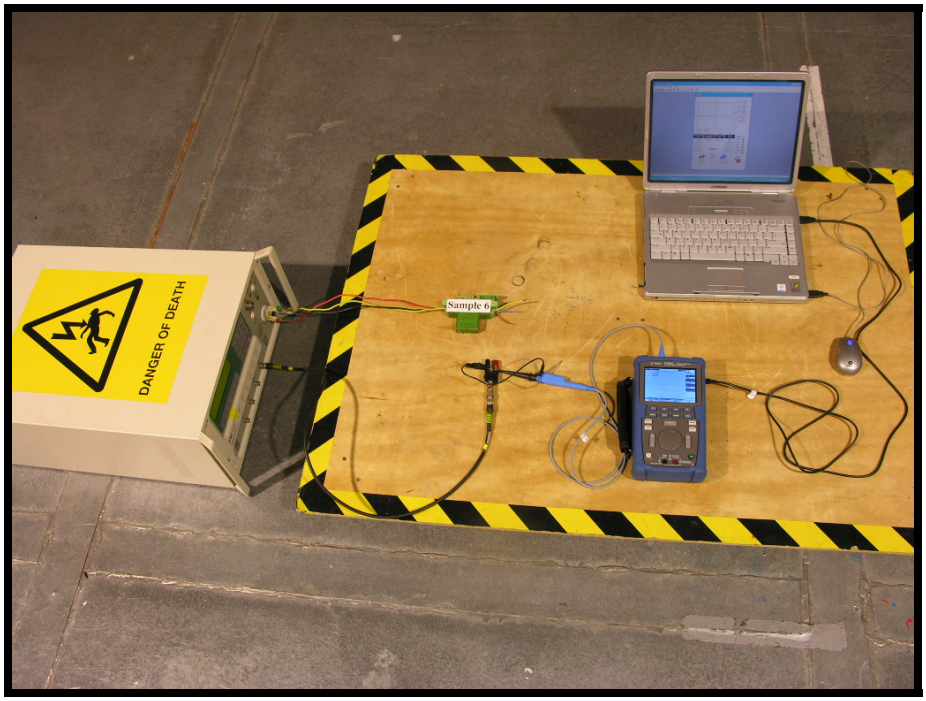

Plate 67: EUT Setup for Surge Testing, monitoring current waveform.

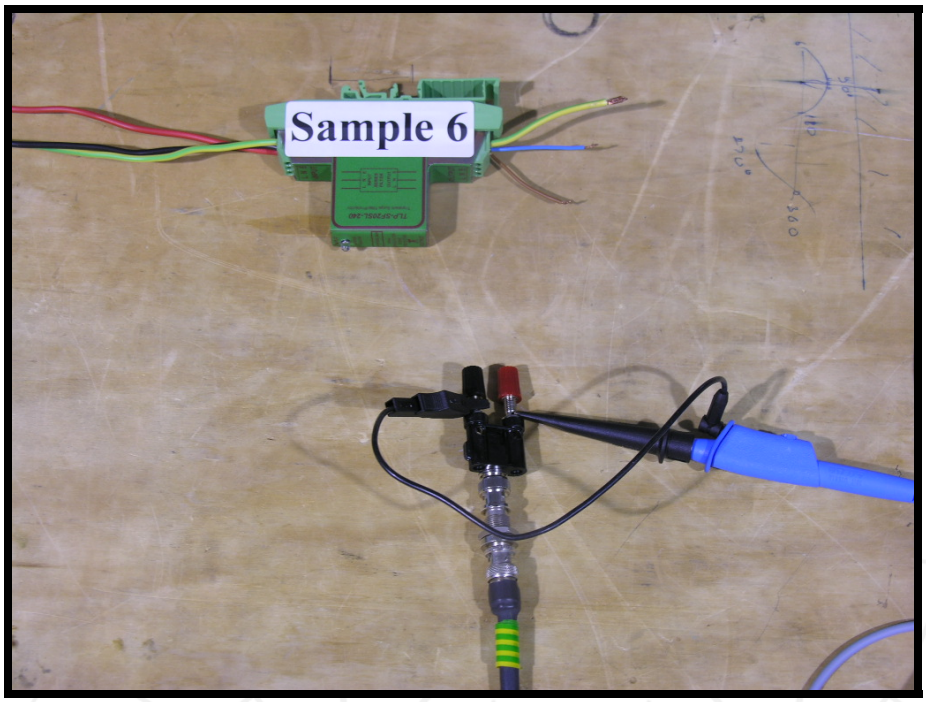

Plate 68: EUT Setup for Surge Testing, monitoring current waveform.

Plate 69: EUT Identification.

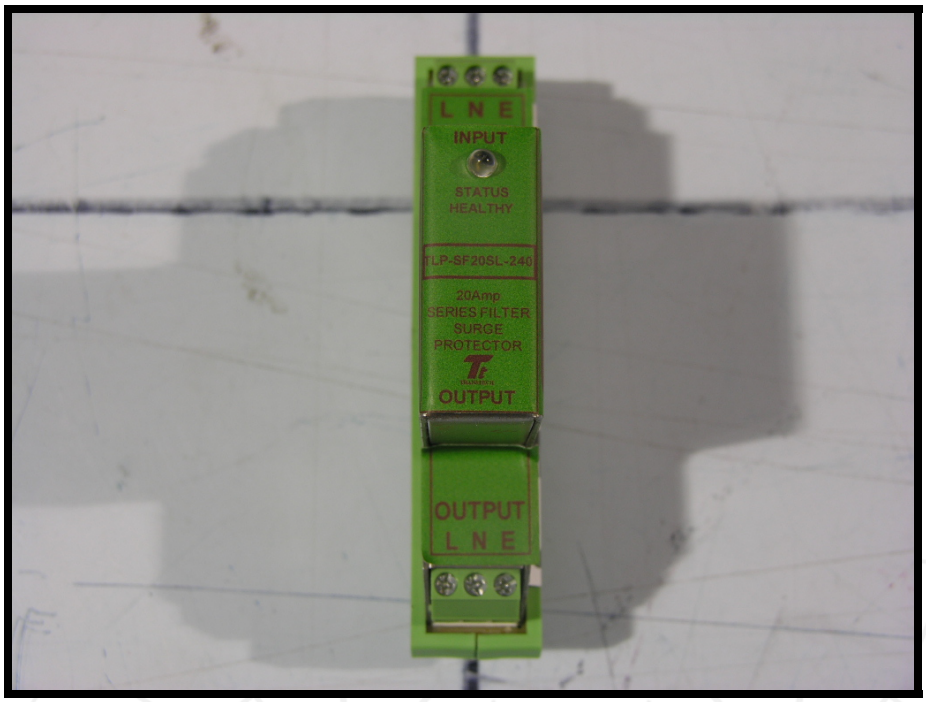

Plate 70: EUT Identification.

Plate 71: Ancillary Equipment Identification – Agilent U1604A Handheld Oscilloscope.

Agilent Technologies

Agilent Technologies (M) Sdn Bhd (012767-W)
Bayan Lepas Free Industrial Zone
11900 Penang
Malaysia.

5962-0476

Certificate Of Calibration

Certificate No: U1604AKR46000085

Manufacturer: Agilent Technologies
Model No: U1604A
Option Installed With Specification: 001

Description: U1600A Series Handheld Oscilloscope
Serial No: KR46000085

Date of Calibration: 19-DEC-2006
Temperature: (23 +/-5) C
Procedure: QI-A101

Humidity: 30 to 70% RH

This certifies that the above product was calibrated in compliance with a quality system registered to ISO 9001:2000, using applicable Agilent Technologies' procedures.

As Received Condition: Factory tested - No incoming data available.

As Shipped Conditions: At the completion of the calibration, measured values were IN-SPECIFICATION at the points tested.

These calibration procedures and test points are those recommended in a procedure developed by Agilent.

Remarks or special requirements:

Traceability Information: Traceability is to national standards administered by the U. S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment. This report shall not be reproduced, except in full, without prior written approval of the calibration facility.

Calibration Equipment Used: *Date used: Date equipment used in this calibration.*

Model Number	Model Description	Trace Number	Date Used	Cal Due Date
Fluke 5820A	Oscilloscope Calibrator	9235030	19-DEC-2006	23-AUG-2007
Fluke 5520A	Multi-Product Calibrator	9225004	19-DEC-2006	15-AUG-2007

Print Date: 19-DEC-2006

Mack Soh
Quality Manager

Agilent Technologies

	DD	MM	YY	BY
CAL	19	12	06	DI
DUE				

cert form rev d

Page 1 of 1

Plate 72: Calibration Certificate – Agilent U1604A Handheld Oscilloscope.