F2 Labs
16740 Peters Road
Middlefield, Ohio 44062
United States of America
www.f2labs.com

EMC TEST REPORT

Manufacturer:	**Utility Relay Company** **10100 Queens Way** **Chagrin Falls, Ohio 44023** **United States of America**
Product:	**Masterpact M Direct Replacement Trip Unit**
Models:	**AMP-SAFE-PRO; AC-PRO-MP**
Testing Commenced:	**Nov. 11, 2010**
Testing Ended:	**May 20, 2013**
Summary of Test Results:	**Page 4**
Directive:	**EMC Directive (2004/108/EC)**
Deviations (if applicable):	**N/A**

Standards:

- **EN 60947-2:2006, inc. A1:2009 – Low-voltage switchgear and controlgear – Part 2: Circuit-breakers**
  - **EN 61000-4-2:2009** - Electromagnetic Compatibility-Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test
  - **EN 61000-4-3:2006** - Electromagnetic Compatibility-Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test
  - **EN 61000-4-4:2004** - Electromagnetic Compatibility-Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test
  - **EN 61000-4-5:2006** - Electromagnetic Compatibility-Part 4: Testing and measurement techniques – Section 5: Surge immunity test
  - **EN 61000-4-6:2007** - Electromagnetic Compatibility-Part 4: Testing and measurement techniques – Section 6: Conducted immunity test
- **EN 55011:2007 -** Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment

Evaluation Conducted by: _____

Joe Knepper, EMC Proj. Eng.

Evaluation Conducted by: _____

Michael Toth, Senior EMC Eng.

Evaluation Conducted by: _____

Ken Littell on behalf of Russell Beattie

Report Reviewed by: _____

Ken Littell, EMC Tech. Mgr.

F2 Labs
26501 Ridge Road
Damascus, MD 20872
Ph 301.253.4500
Fax 301.253.5179

F2 Labs
16740 Peters Road
Middlefield, OH 44062
Ph 440.632.5541
Fax 440.632.5542

TABLE OF CONTENTS

GENERAL REPORT SUMMARY

This electromagnetic emission and immunity test report was generated by F2 Labs. The test report is based on testing performed by F2 Labs personnel according to the measurement procedures described in the test specifications given below and in the Test Procedures section of this report.

SECTION	TEST	RESULTS
9	Electrostatic Discharge	Pass
10	Radiated Immunity	Pass
11	Electrical Fast Transient Burst	Pass
12	Power Surge	Pass
13	Conducted Immunity	Pass
14	Radiated Emissions	Pass
15	Conducted Emissions	Pass

Note: Pass/Fail criteria are based upon the following condition: Where the results are compared to published test standard or manufacturer specified limits, the PASS or FAIL opinion is considered without applying the laboratory stated measurement uncertainty.

Reports noted as a revision replace all previously issued reports and/or antecedent report revisions issued under this job number.

1.0 ADMINISTRATIVE DATA

1.1 Management of Test Sample

The test sample was inventoried at the F2 Labs facility and returned to Utility Relay Company, according to the agreement between F2 Labs and the Client.

1.2 Abbreviations and Acronyms

The following abbreviations and acronyms may be used in this document.

AM	Amplitude Modulation
BCI	Bulk Current Injection
CDN	Coupling/Decoupling Network
EFT	Electrical Fast Transients
EMC	Electromagnetic Compatibility
EMIC	Electromagnetic Injection Clamp
EN	European Norm
ESD	Electrostatic Discharge
EUT	Equipment Under Test
GRP	Ground Reference Plane
HCP	Horizontal Coupling Plane
HGP	Horizontal Ground Plane
IEC	International Electrotechnical Commission
KHz	KiloHertz
LISN	Line Impedance Stabilization Network
MHz	MegaHertz
OATS	Open Area Test Site
RF	Radio Frequency
VCP	Vertical Coupling Plane

1.3 Document History

Document Number	Description	Issue Date	Approved By
F2LQ4234A-1A-01E	First Issue	May 28, 2013	K. Littell

2.0 PERFORMANCE CRITERIA

The following Performance Criteria is determined from Section J.2.1 of EN 60947-2:2006, inc. A1:2009.

SPECIFICATION	MINIMUM PERFORMANCE CRITERION
EN 61000-4-2	B
EN 61000-4-3	A
EN 61000-4-4	B
EN 61000-4-5	B
EN 61000-4-6	A

Performance Criterion A: During the test, the resistance against unwanted operation (step1) and functional characteristics (step 2) are verified. Any monitoring function shall correctly indicate the status.

Performance Criterion B: During the test, the resistance against unwanted operation is verified. Monitoring functions may include a false status. After the test the functional characteristics are verified.

3.0 MEASUREMENT OF UNCERTAINTY BUDGETS

The uncertainty in EMC measurements arises from several factors which affect the results, some associated with environmental conditions in the measurement room, the test equipment being used and the measurement techniques adopted.

The measurement uncertainty budgets detailed below are calculated from the test and calibration data.

MEASUREMENT	EXPANDED UNCERTAINTY
Conducted Emissions	3.75dB
Conducted Immunity	CDN 2.91dB BCI 3.77dB
Radiated Immunity	2.12dB
Radiated Emissions	6.93dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

4.0 LISTS OF EUT, ACCESSORIES AND TEST EQUIPMENT

4.1 Equipment Under Test (EUT):

AMP-SAFE-PRO

Device	Manufacturer	Model Number	Serial Number
Masterpact M Direct Replacement Trip Unit	Utility Relay Company	AMP-SAFE-PRO	0100100387

AC-PRO-MP

Device	Manufacturer	Model Number	Serial Number
3 Pole Replacement Trip Unit for Square D/Merlin Gerin Masterpact MP Circuit Breaker	Utility Relay	AC-PRO-MP	0092100000

4.2 Accessories (Support Equipment):

AMP-SAFE-PRO

Device	Manufacturer	Model Number	Serial Number
Current Supply	Valley Communication Engineering	MS-IA	3572
AC/DC Transformer	Utility Relay Company	None Spec.	None Spec.
Switch	Utility Relay Company	None Spec.	None Spec.
Test Box	Utility Relay Company	None Spec.	None Spec.

AC-PRO-MP

Device	Manufacturer	Model Number	Serial Number
Light Bar	F-Squared Laboratories	None Specified	None Specified

4.3 Cables:

AMP-SAFE-PRO

Cable Function	Length	Shielded (Yes/No)
AC Mains	N/A	No
Current Input	<3m	No

AC-PRO-MP

Cable Function	Length	Shielded (Yes/No)
Current Transformer Phase A	<3.0 meters	No
Current Transformer Phase B	<3.0 meters	No
Current Transformer Phase C	<3.0 meters	No
Actuator	<3.0 meters	No
24V DC	<3.0 meters	No
R1	<3.0 meters	No
R2	<3.0 meters	No
ALR 1	<3.0 meters	No
ALR 2	<3.0 meters	No
FV Segregated	<3.0 meters	No
QT Input	<3.0 meters	No
QT Output	<3.0 meters	No

5.0 MODE OF OPERATION

The EUT was set up in a normal testing manner, powered by current running through it.

6.0 METHOD OF MONITORING

The EUT was monitored visually by watching the LED's on the front panel for any unexpected changes.

7.0 IMMUNITY DEGRADATION DEFINITION

The following shall constitute degradation:

- If the EUT changes states unexpectedly, locks up or trips unexpectedly.

8.0 REQUIRED MODIFICATIONS

No modifications were made to the EUT.

9.0 ELECTROSTATIC DISCHARGE TEST

9.1 Electrostatic Discharge Test Procedure

The ESD generator and discharge gun were used to conduct the tests outlined below. The waveform conforms to EN 61000-4-2. The generator was used to simulate electrostatic discharges to the EUT.

A horizontal coupling plane (HCP) conforming to the dimensions of EN 61000-4-2 was placed on a non-conductive table 0.8 meter above the ground reference plane (GRP). The HCP was connected to the GRP via two 470k ohm resistors. The EUT was placed on non-conductive material 0.5 mm above the HCP. The vertical coupling plane (VCP) was connected to the GRP through two 470k ohm resistors and positioned 10 cm from the appropriate face of the EUT, as required.

During the test, three different methods were used to determine if the equipment was susceptible to ESD: direct contact, air discharge and indirect discharge.

The direct contact method was used on all exposed conductive surfaces. Each point was contacted 10 consecutive times in the positive polarity and 10 consecutive times in the negative polarity with an electrostatic discharge from the ESD Gun.

The indirect discharge method was used on one point of the horizontal coupling plane (HCP) and to one point on the vertical coupling plane (VCP) located 10 cm from the edge of the EUT on all four sides of the EUT.

The air discharge method was used on all exposed non-conductive materials. These materials were scanned with the tip of the ESD gun. If the gun discharged at any point, 10 consecutive discharges in both positive and negative polarities were then made to that point.

Test Equipment Used:

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Temp/Hum. Recorder	CL119	Extech	RH520	H005869	Nov. 16, 2011
ESD Immunity Tester	CL076	EMC-Partner	ESD3000	213	June 23, 2011

9.2 Electrostatic Discharge Test Data Sheet

Test Date:	Dec. 10, 2010	**Test Engineer:**	M. Toth
Standard:	EN 60947-2:2006, inc. A1:2009	**Air Temperature:**	17.7° C
Minimum Performance Criteria:	B	**Relative Humidity:**	57%

AC-PRO-MP

Conductive Surfaces:

Discharge Point	Levels (kV)	Method	Achieved Performance Criterion	Pass/Fail
Screws	± 2, 4	Contact	A	Pass
USB Connector	± 2, 4	Contact	A	Pass
Reset Button for Actuator	± 2, 4	Contact	A	Pass

Coupling Planes:

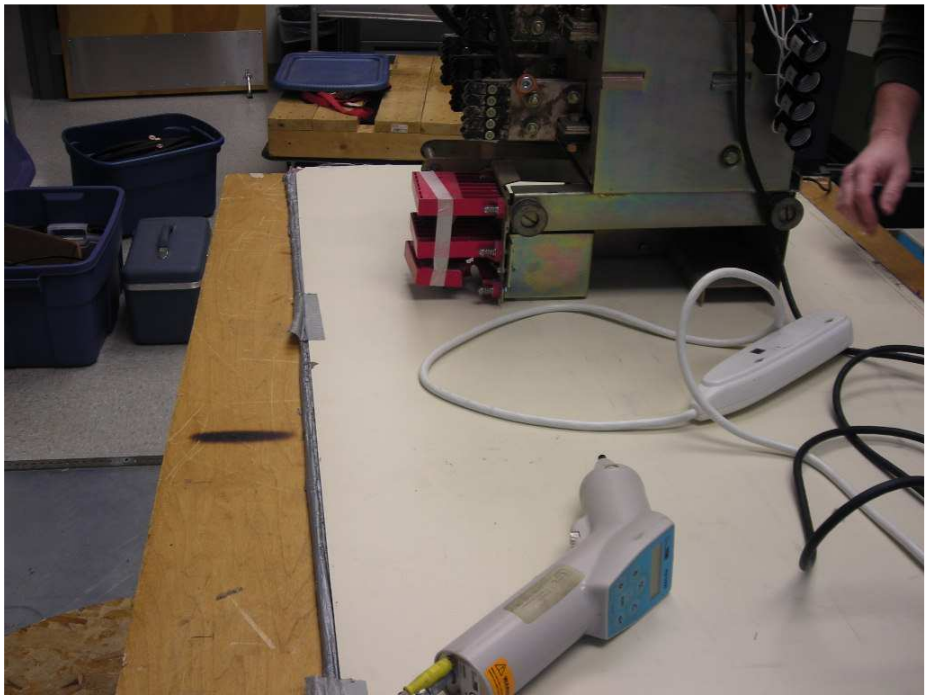
Discharge Point	Levels (kV)	Method	Achieved Performance Criterion	Pass/Fail
Vertical Coupling Plane – Right Side	± 2, 4	Contact	A	Pass
Vertical Coupling Plane – Left Side	± 2, 4	Contact	A	Pass
Vertical Coupling Plane – Front Side	± 2, 4	Contact	A	Pass
Vertical Coupling Plane – Rear	± 2, 4	Contact	A	Pass
Horizontal Coupling Plane – Right Side	± 2, 4	Contact	A	Pass
Horizontal Coupling Plane – Left Side	± 2, 4	Contact	A	Pass
Horizontal Coupling Plane – Front Side	± 2, 4	Contact	A	Pass
Horizontal Coupling Plane – Rear	± 2, 4	Contact	A	Pass

Non-Conductive Surfaces:

Attempted Discharge Point	Levels (kV)	Method	Achieved Performance Criterion	Pass/Fail
Buttons	± 2, 4, 8	Air	No Discharge	Pass
Display	± 2, 4, 8	Air	No Discharge	Pass

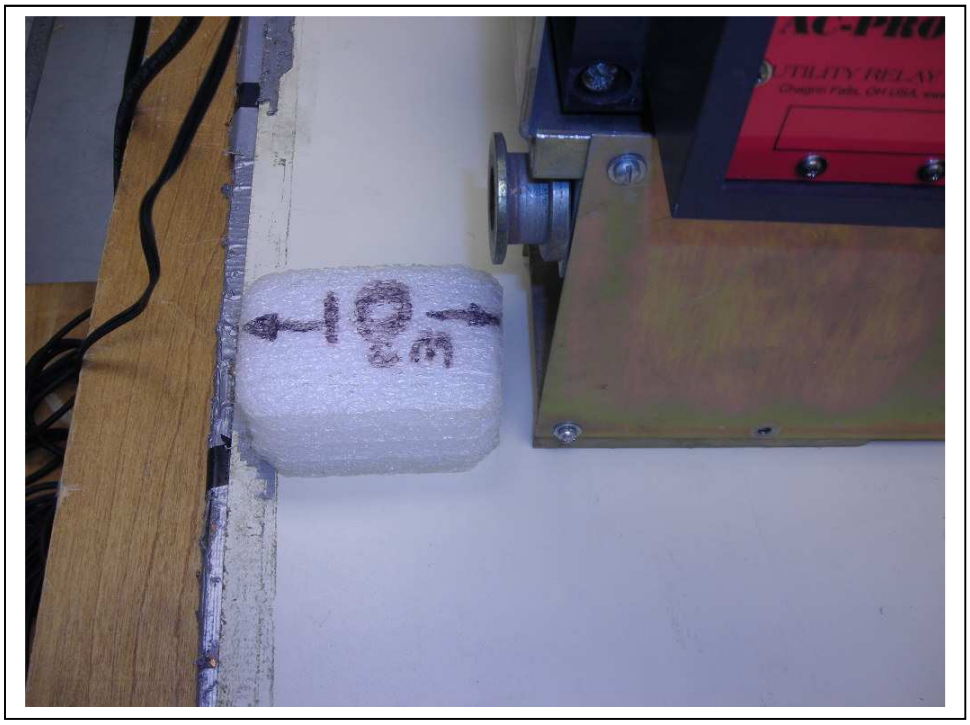
Please refer to the photographs on pages 14-17 for details of actual test points. “C” denotes a contact discharge point. “A” denotes a point where a discharge was observed during a scan of a non-conductive surface. Absence of any Air Discharge points indicates no arc was drawn through the insulated surfaces.

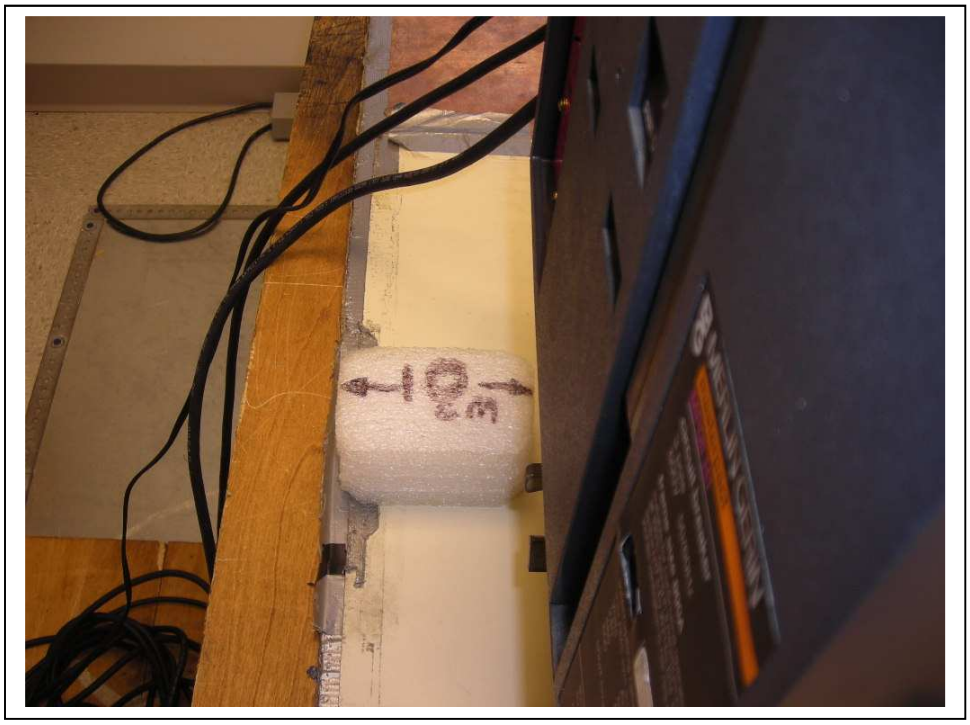
9.3 Photograph(s) of the Electrostatic Discharge Test Setup



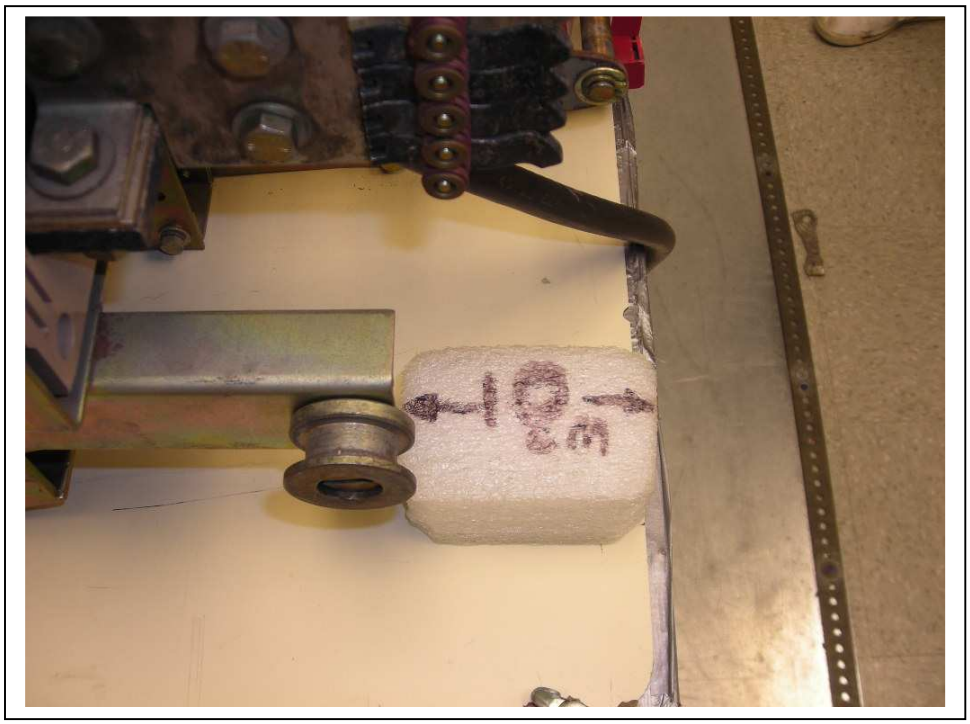
Front View of the EUT During the Electrostatic Discharge Test

HCP

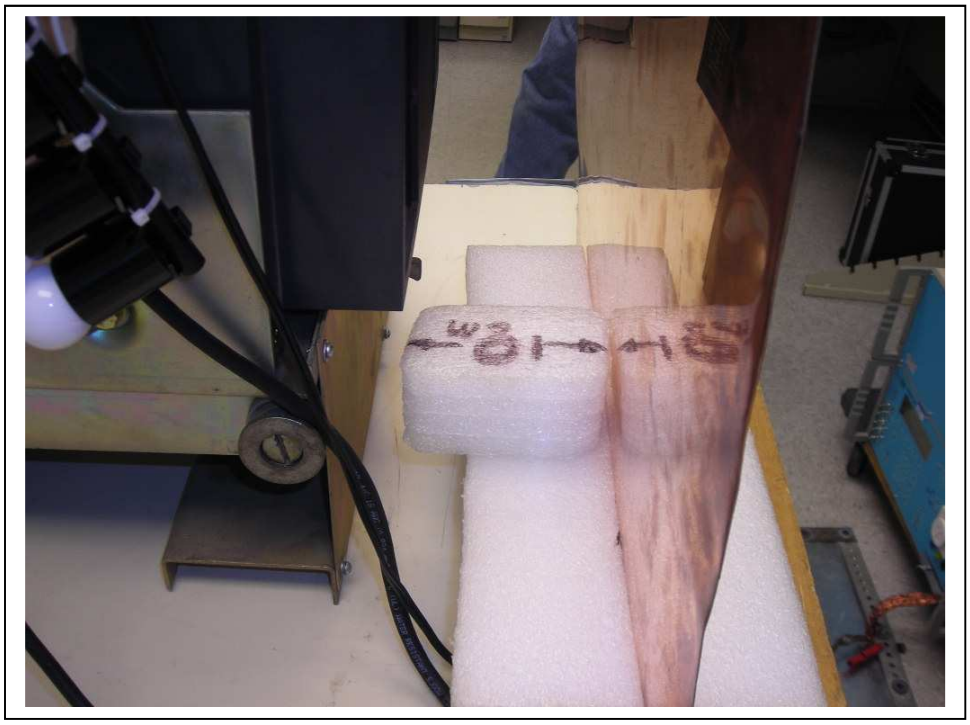




(HCP, cont'd)



VCP



10.0 RADIATED IMMUNITY TEST

10.1 Radiated Immunity Test Procedure

The Equipment Under Test (EUT) was placed in a semi-anechoic chamber on a 0.8-meter high non-conductive table. A broadband antenna was placed 1.8 meters from the EUT and was used to radiate RF energy at the EUT in both horizontal and vertical polarities.

The RF energy consisted of a signal that was stepped at 1% increments through the frequency ranges of 80 MHz to 1000 MHz, and 1400 MHz to 2000 MHz, at a rate slower than the reaction time of the EUT. The signal was 80% AM modulated with a 1 kHz sine wave and had a minimum calibrated field strength of 10.0/10.0 volts/meter at the surface of the EUT, as specified in the following test data sheet. The EUT was exposed to the RF energy on four different surfaces (front, rear, left and right sides).

The test setup conformed to figure 2 of EN 61000-4-3.

Test Equipment Used:

AMP-SAFE-PRO

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shield Room	0175	Ray Proof	N/A	11645	Nov. 13, 2013
Temp/Hum. Recorder	CL137	Extech	RH520	CH16992	Apr. 17, 2014
Antenna, Horn	0138	ARA	DWG-118/A	1109	Verified
Amplifier	0185	Ophir	5151F	1001	Verified
Power Meter; Power Sensor	CL148	Agilent Technologies	E4418B; E9300B	MY41294473; MY41496326	May 2, 2014
Signal Generator	0213	Hewlett Packard	8648C	3623A03444	Nov. 26, 2014
Software:	Tile Version 1.0		Software Verified: May 20, 2013		

AC-PRO-MP

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shield Room	CL014	Shielding Resources	3 Meter	001	Nov. 30, 2010
Temp/Hum. Recorder	CL118	Extech	RH520	H005870	Dec. 11, 2010
Antenna 1-Chamber	0142	ETS/EMCO	3142B	9811-1330	Dec. 31, 2010
Amplifier	0171	Instruments for Industry	SMX 100	2158-1096	Verified
Power Meter and Power Sensor	CL055	Hewlett Packard	436A, 8482H	2512A21615, 2704A05784	June 23, 2011
Signal Generator	0213	Hewlett Packard	8648C	3623A03444	Sept. 29, 2012

10.2 Radiated Immunity Test Data Sheet

Test Date:	May 20, 2013	**Test Engineer:**	J. Knepper
Standard:	EN 60947-2:2006, inc. A1:2009	**Air Temperature:**	22.4° C
Minimum Performance Criteria:	A	**Relative Humidity:**	44%

AMP-SAFE-PRO

Side of EUT Exposed to Antenna	Antenna Polarization	Frequency Range (MHz)	Minimum Calibrated RF Field Strength	Achieved Performance Criterion	Pass/Fail
Front	Horizontal	1400 to 2000	10.0 V/m	A	Pass
Right Side	Horizontal	1400 to 2000	10.0 V/m	A	Pass
Rear	Horizontal	1400 to 2000	10.0 V/m	A	Pass
Left Side	Horizontal	1400 to 2000	10.0 V/m	A	Pass
Front	Vertical	1400 to 2000	10.0 V/m	A	Pass
Right Side	Vertical	1400 to 2000	10.0 V/m	A	Pass
Rear	Vertical	1400 to 2000	10.0 V/m	A	Pass
Left Side	Vertical	1400 to 2000	10.0 V/m	A	Pass

Test Date:	Nov. 11, 2010	**Test Engineer:**	R. Beattie
Standard:	ANSI/IEC C37.90.2-2004	**Air Temperature:**	21.9° C
Minimum Performance Criterion:	Section 6.4.2	**Relative Humidity:**	36%

AC-PRO-MP

AM Modulation

Sides of EUT Exposed to Antenna	Antenna Polarization	Frequency Range (MHz)	Modulation	Minimum Calibrated RF Field Strength	Achieved Performance Criterion
Front	Horizontal	80-1000	AM	20.0 V/m	Pass
Right Side	Horizontal	80-1000	AM	20.0 V/m	Pass
Rear	Horizontal	80-1000	AM	20.0 V/m	Pass
Left Side	Horizontal	80-1000	AM	20.0 V/m	Pass
Front	Vertical	80-1000	AM	20.0 V/m	Pass
Right Side	Vertical	80-1000	AM	20.0 V/m	Pass
Rear	Vertical	80-1000	AM	20.0 V/m	Pass
Left Side	Vertical	80-1000	AM	20.0 V/m	Pass

Note: Spot Frequencies – 80 MHz, 160 MHz, 450 MHz, 900 MHz,
AM Modulation 80% 1kHz.

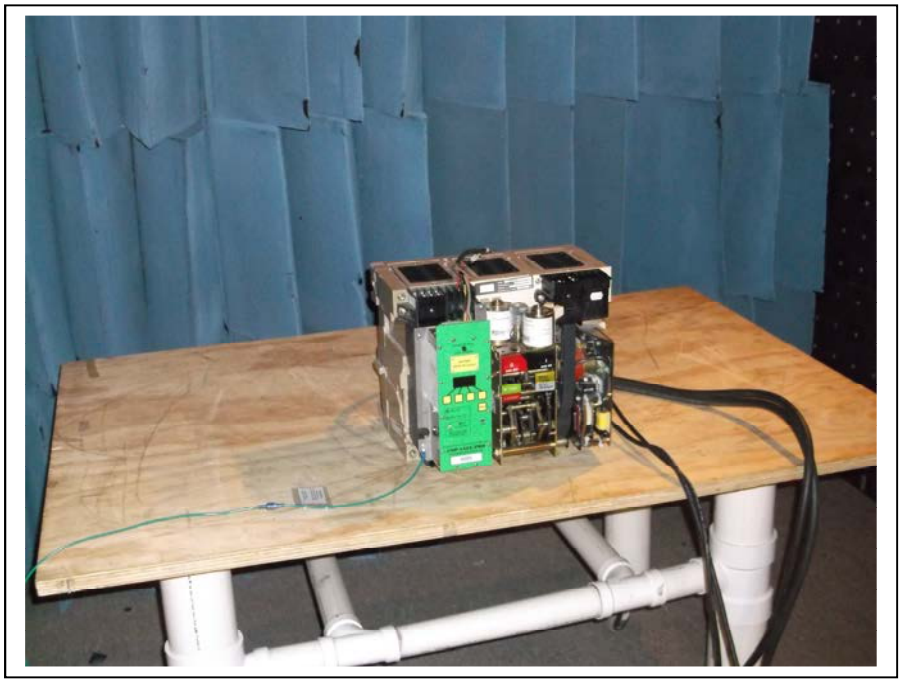
Square Wave Modulation

Sides of EUT Exposed to Antenna	Antenna Polarization	Frequency Range (MHz)	Modulation	Minimum Calibrated RF Field Strength	Achieved Performance Criterion
Front	Horizontal	80-1000	Pulse	20.0 V/m	A
Right Side	Horizontal	80-1000	Pulse	20.0 V/m	A
Rear	Horizontal	80-1000	Pulse	20.0 V/m	A
Left Side	Horizontal	80-1000	Pulse	20.0 V/m	A
Front	Vertical	80-1000	Pulse	20.0 V/m	A
Right Side	Vertical	80-1000	Pulse	20.0 V/m	A
Rear	Vertical	80-1000	Pulse	20.0 V/m	A
Left Side	Vertical	80-1000	Pulse	20.0 V/m	A

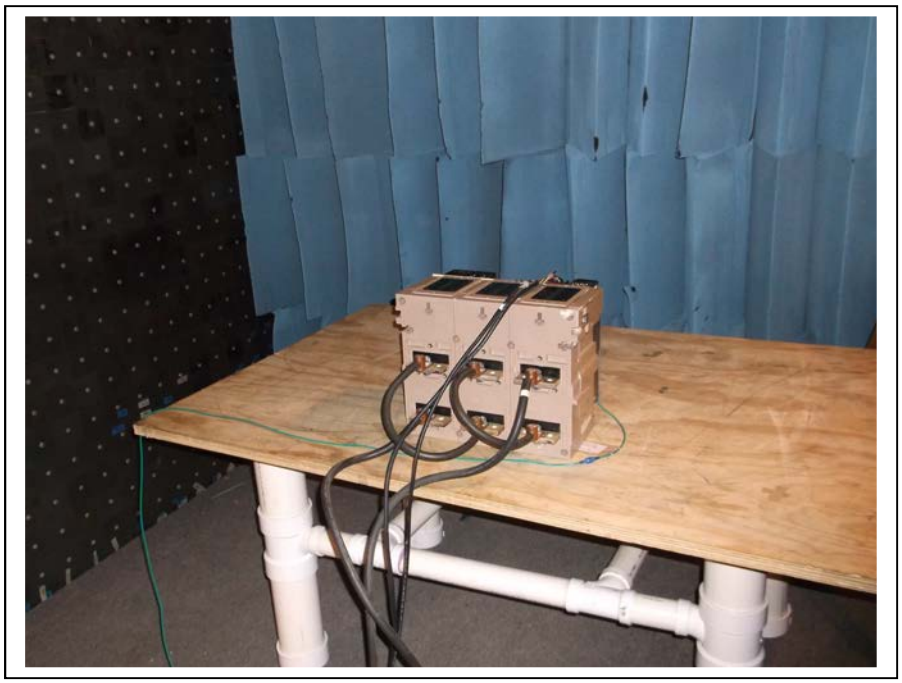
Note: Spot Frequencies – Pulse Modulation, Keying Frequency 200 Hz.

9.3 Photograph(s) of the Radiated Immunity Test Setup

AMP-SAFE-PRO Front View

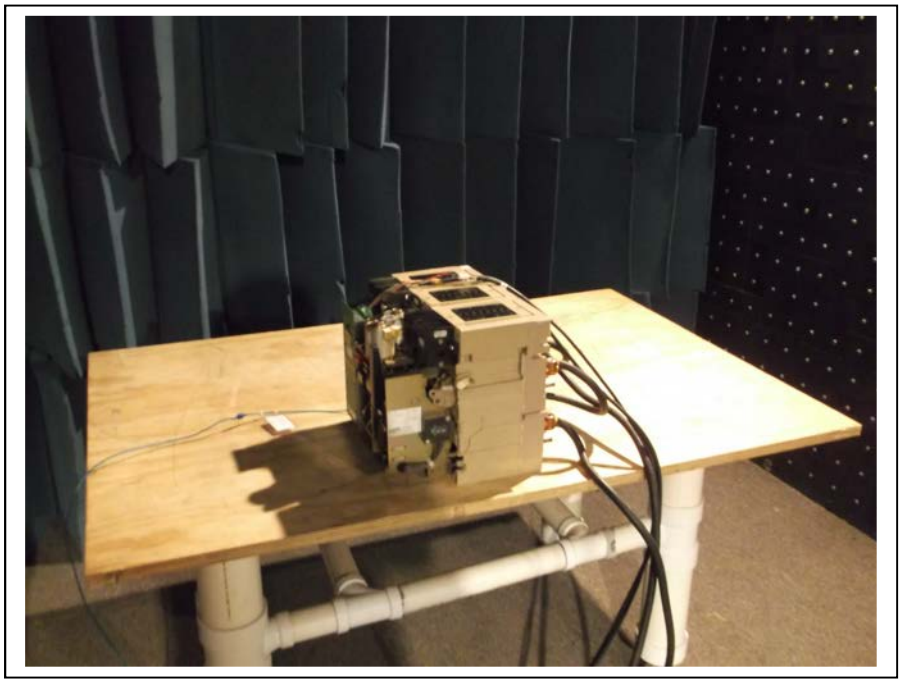


AMP-SAFE-PRO Rear View

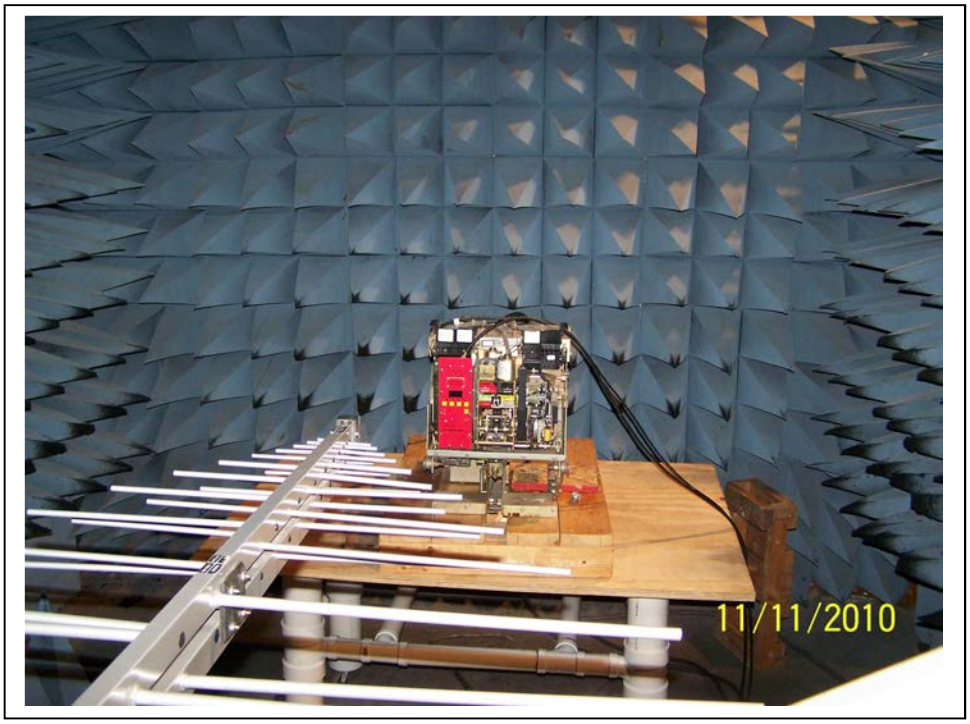


AMP-SAFE-PRO Right Side View

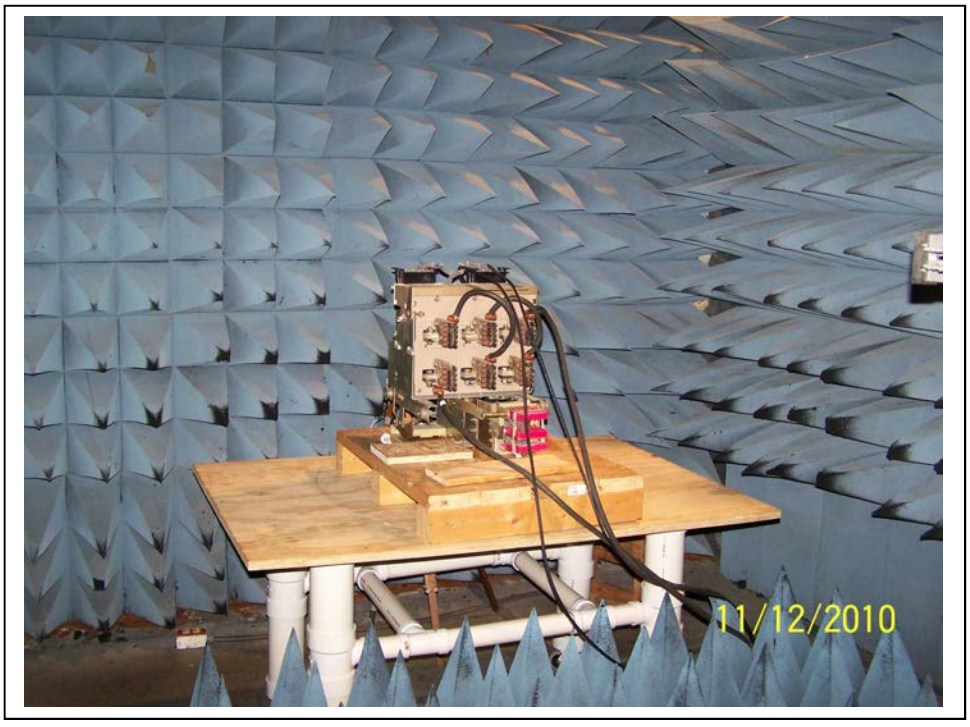
AMP-SAFE-PRO Left Side View



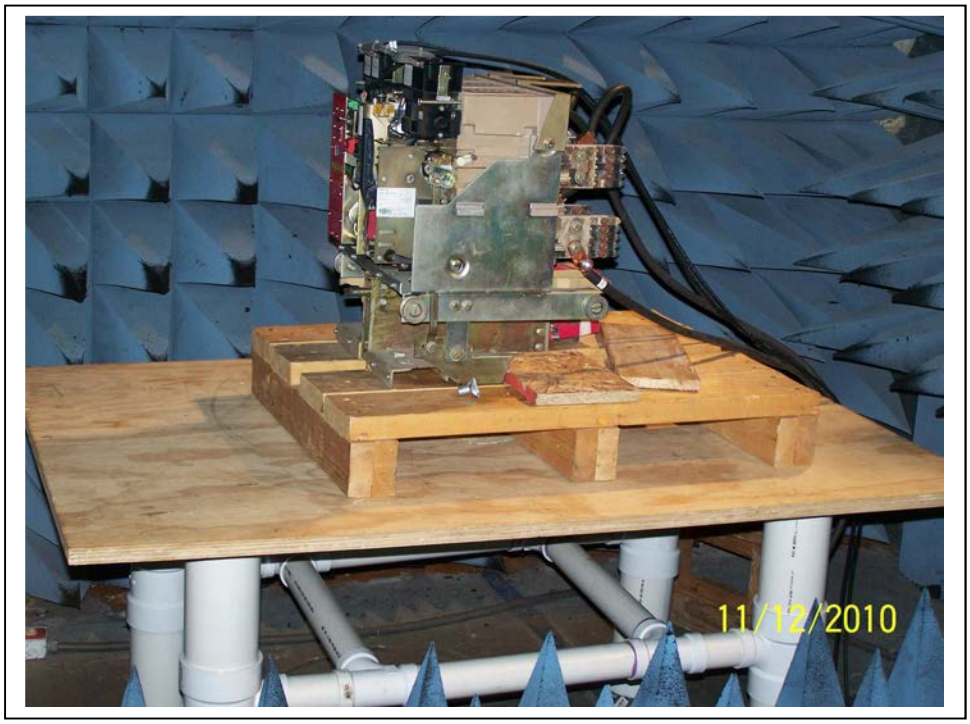
AC-PRO-MP: Front View



AC-PRO-MP: Rear View



AC-PRO-MP: Right Side View



10.0 ELECTRICAL FAST TRANSIENT/BURST TEST

10.1 Electrical Fast Transient/Burst Test Procedure

The Electrical Fast Transient Burst generator was used to conduct the tests outlined below. The waveform conforms to EN 61000-4-4. This generator was used to simulate RF energy coupled onto power and data cables from switches, relays, motors, and any other device that could produce a voltage "spike."

During the testing, the product was placed above a ground plane on a 0.1-meter high non-conductive platform. The setup conformed to EN 61000-4-4, figure 7. The transient energy (as defined in EN 61000-4-4) was coupled to the cables under test at various levels and polarities as defined by the standard. (Refer to the test data sheet for the details of this test.)

During the test, all data cables that may have a practical length greater than 3.0 meters, and all power mains cables were tested as outlined below.

AC Mains

The transient energy was coupled through the EFT generator coupling/decoupling network to each conductor of the power mains cable with respect to ground.

Test Equipment Used:

AMP-SAFE-PRO

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Temp/Hum. Recorder	CL119	Extech	RH520	H005869	Jan. 2, 2014
EMC Immunity Tester	CL077	EMC-Partner	TRA2000IN6	780	Jan. 23, 2014
Software:	Genecs Generator Controlling Software Version 2.58		Software Verified: May 20, 2013		

AC-PRO-MP

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Temp/Hum. Recorder	CL119	Extech	RH520	H005869	Nov. 16, 2011
EMC Immunity Tester	CL077	EMC-Partner	TRA2000IN6	780	June 24, 2011

10.2 EFT Test Data Sheet

Test Date:	May 20, 2013	**Test Engineer:**	J. Knepper
Standard:	EN 60947-2:2006, inc. A1:2009	**Air Temperature:**	23.1° C
Minimum Performance Criterion:	B	**Relative Humidity:**	46%

AMP-SAFE-PRO

AC Power Lines:

Description of Power Line Conductor	Test Level	Polarity	Test Duration	Achieved Performance Criterion	Pass/Fail
Line 1	1.0 kV	+ / -	1 minute	A	Pass
Line 2	1.0 kV	+ / -	1 minute	A	Pass
Line 3	1.0 kV	+ / -	1 minute	A	Pass
Ground	1.0 kV	+ / -	1 minute	A	Pass

Test Date:	Nov. 22, 2010	**Test Engineer:**	R. Beattie
Standard:	C37.90.1:2002	**Air Temperature:**	20.5° C
Minimum Performance Criterion:	Section 9.2	**Relative Humidity:**	57%

AC-PRO-MP

Current Circuit:

Description of Line	Coupling	Test Level	Polarity	Test Duration	Pass/Fail
Current Transfomer, Phase A (blue/white)	Common	4.0 kV	+ / -	1 minute	Pass
Current Transfomer, Phase B (yellow/white)	Common	4.0 kV	+ / -	1 minute	Pass
Current Transfomer, Phase C (brown/white)	Common	4.0 kV	+ / -	1 minute	Pass

Power Supply:

Description of DC Line	Coupling	Test Level	Polarity	Test Duration	Pass/Fail
24V DC (red/black)	Common	4.0 kV	+ / -	1 minute	Pass
24V DC (red/black)	Traverse	4.0 kV	+ / -	1 minute	Pass

Output – AC PRO:

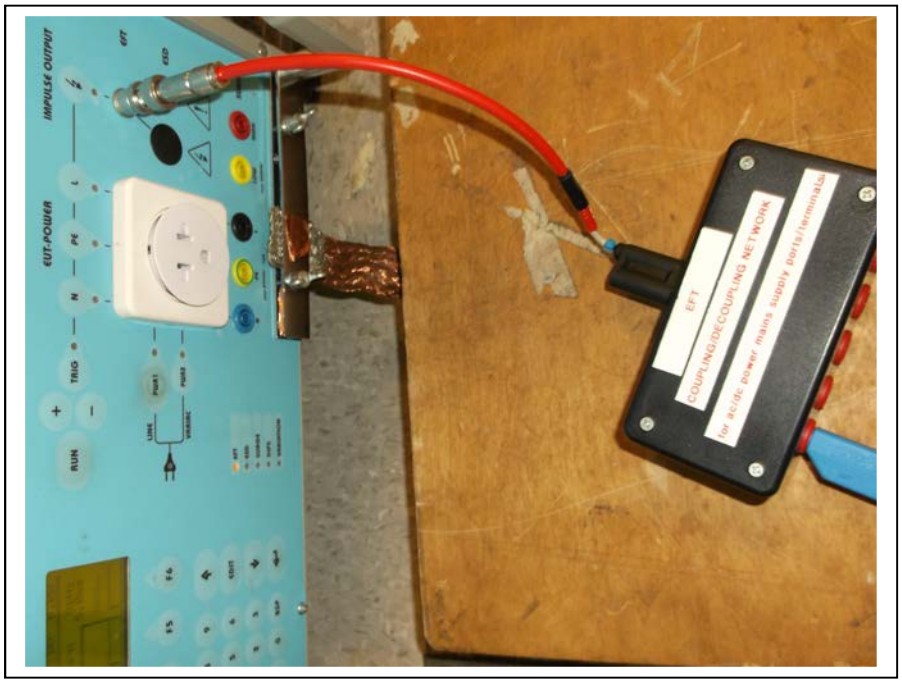
Description of Data Line	Coupling	Test Level	Polarity	Test Duration	Pass/Fail
Actuator (red/black)	Common	4.0 kV	+ / -	1 minute	Pass
Actuator (red/black)	Traverse	4.0 kV	+ / -	1 minute	Pass

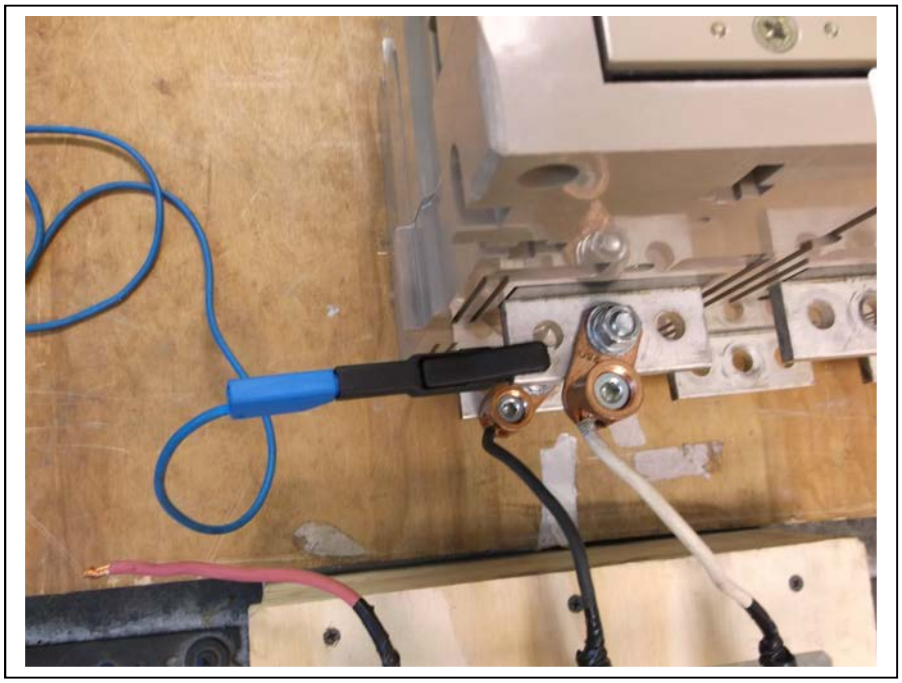
I/O:

Description of Data Line	Coupling	Test Level	Polarity	Test Duration	Pass/Fail
R1	Common	4.0 kV	+ / -	1 minute	Pass
R1	Traverse	4.0 kV	+ / -	1 minute	Pass
R2	Common	4.0 kV	+ / -	1 minute	Pass
R2	Traverse	4.0 kV	+ / -	1 minute	Pass
ALR 1	Common	4.0 kV	+ / -	1 minute	Pass
ALR 1	Traverse	4.0 kV	+ / -	1 minute	Pass
ALR 2	Common	4.0 kV	+ / -	1 minute	Pass
ALR 2	Traverse	4.0 kV	+ / -	1 minute	Pass
FV Segregated Trip	Common	4.0 kV	+ / -	1 minute	Pass
FV Segregated Trip	Traverse	4.0 kV	+ / -	1 minute	Pass
Quick Trip Input (black & white)	Common	4.0 kV	+ / -	1 minute	Pass
Quick Trip Input (black & white)	Traverse	4.0 kV	+ / -	1 minute	Pass
Quick Trip Output (red & green)	Common	4.0 kV	+ / -	1 minute	Pass
Quick Trip Output (red & green)	Traverse	4.0 kV	+ / -	1 minute	Pass

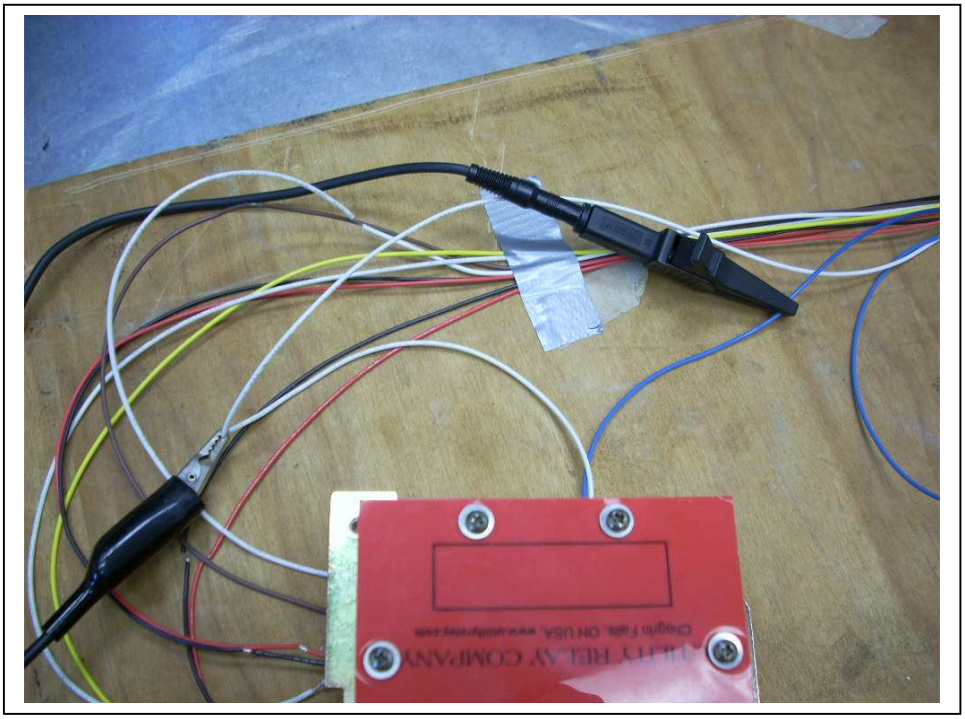
10.3 Photograph(s) of the Electrical Fast Transient Test Setup

AMP-SAFE-PRO

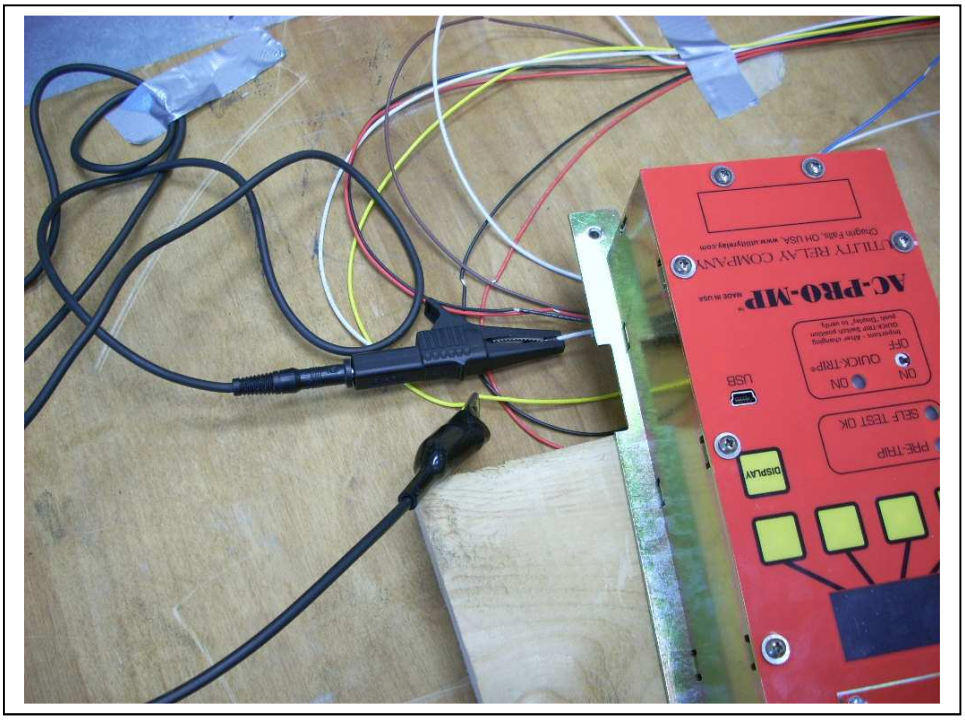




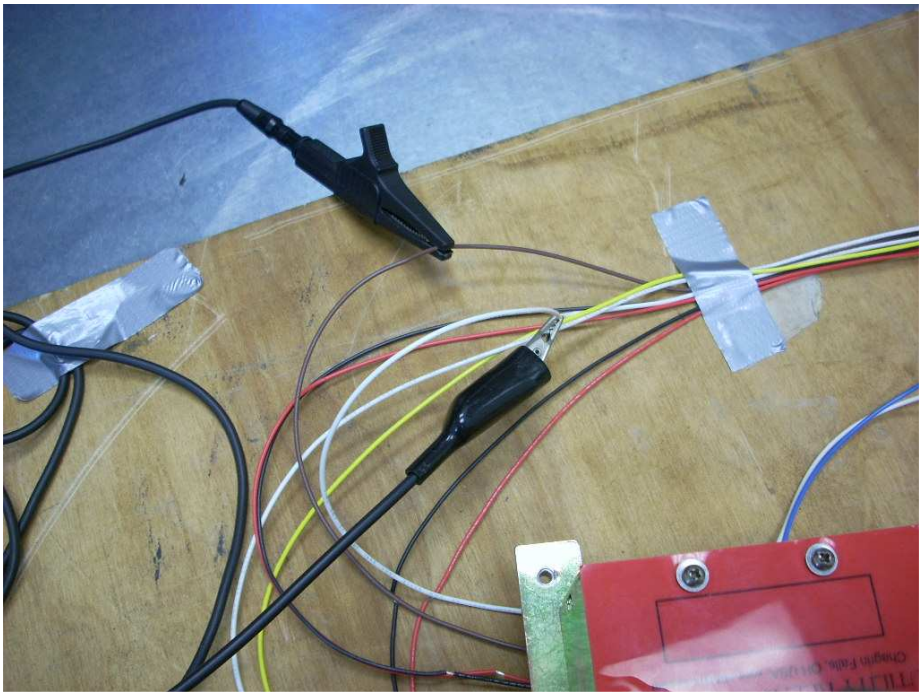
AC-PRO-MP: Current Transformer – Phase A



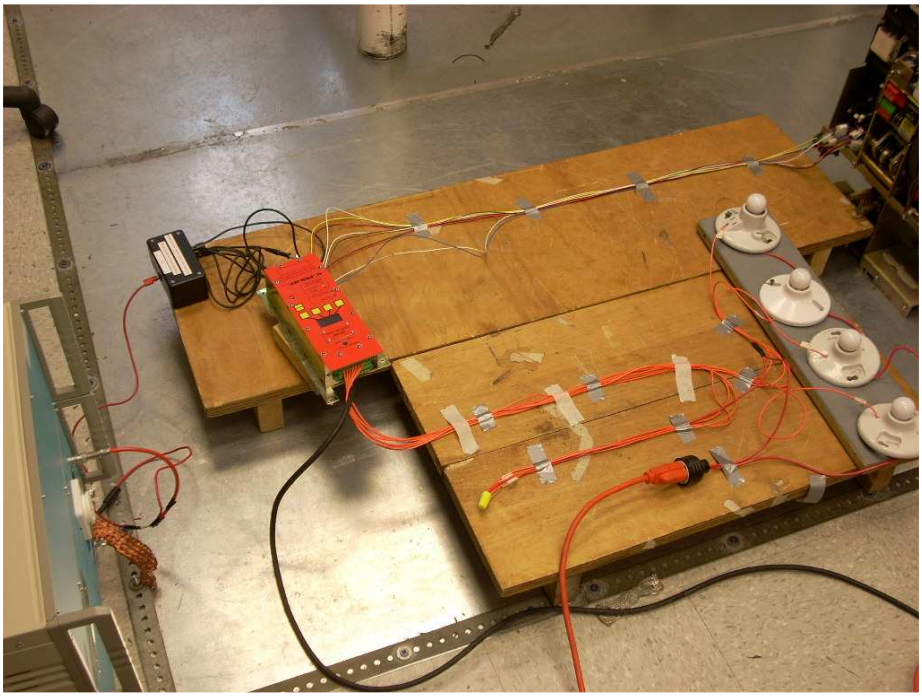
AC-PRO-MP: Current Transformer – Phase B



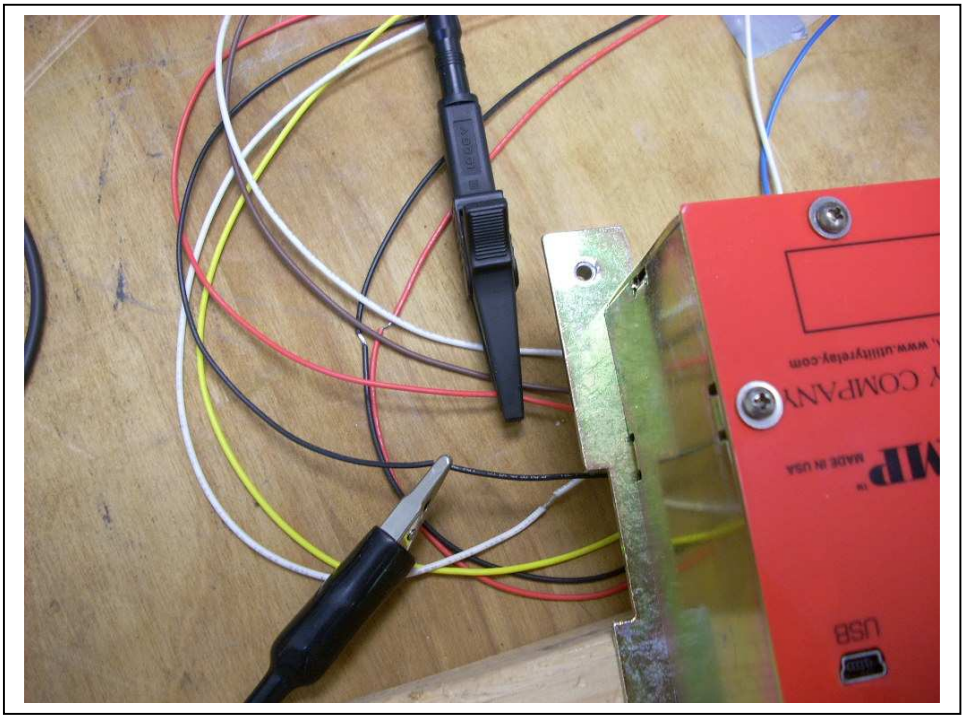
AC-PRO-MP: Current Transformer – Phase C



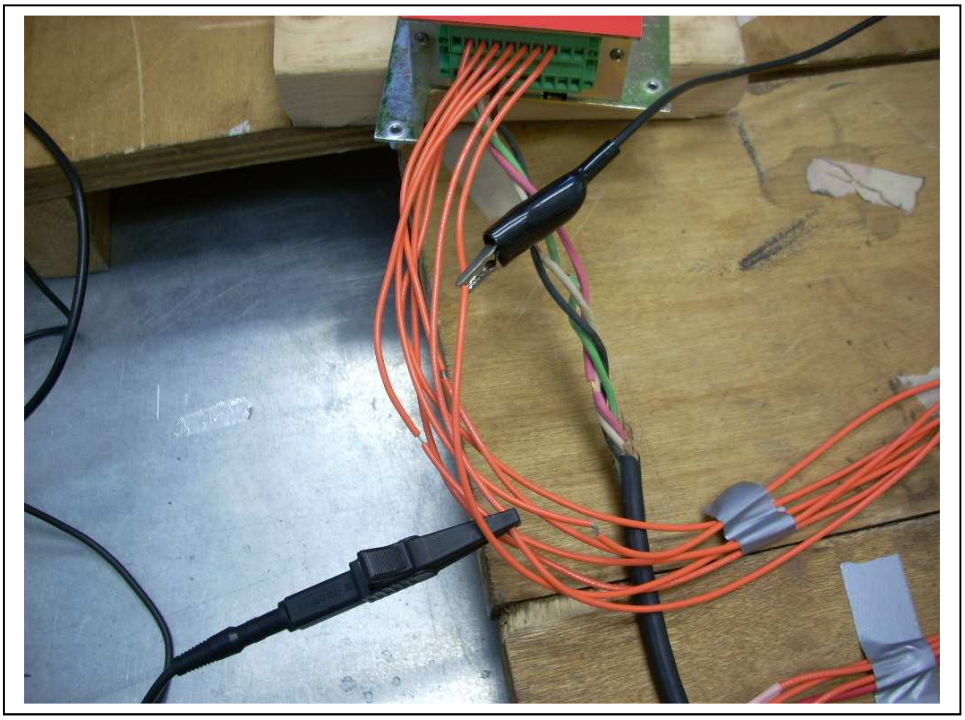
AC-PRO-MP: Actuator



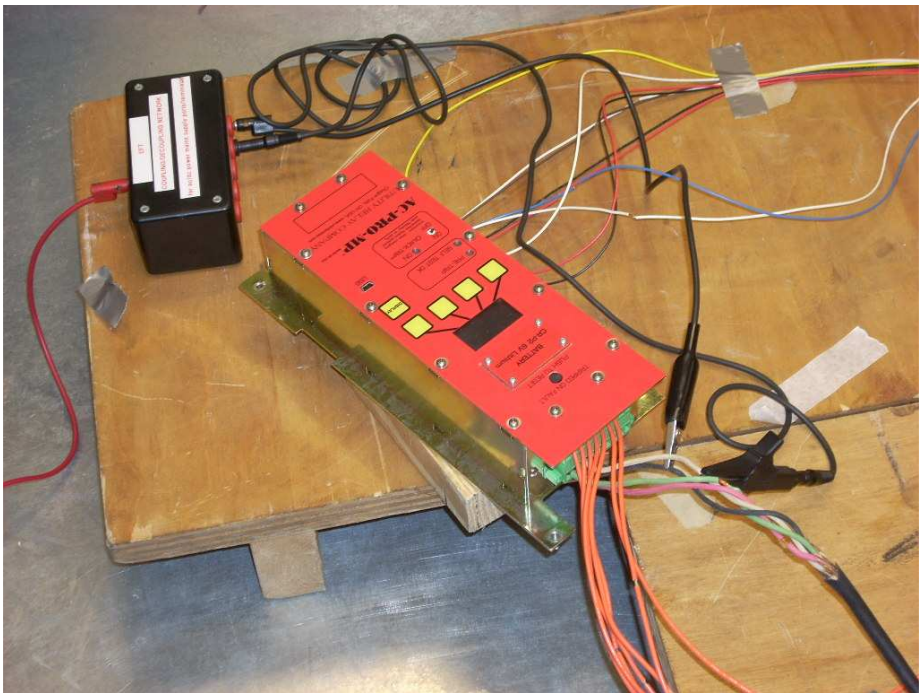
AC-PRO-MP: 24V DC



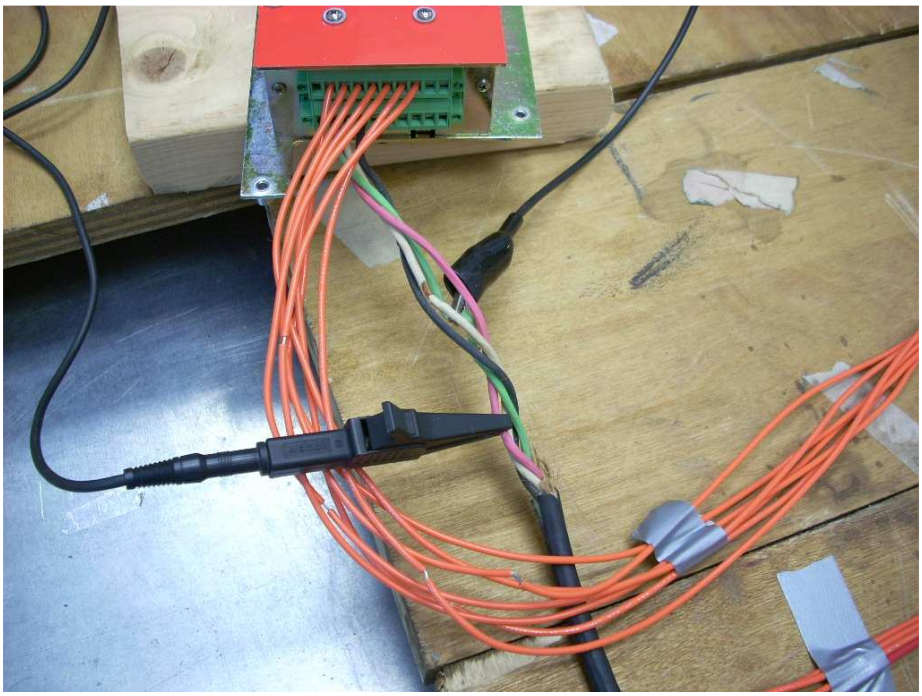
AC-PRO-MP: I/O



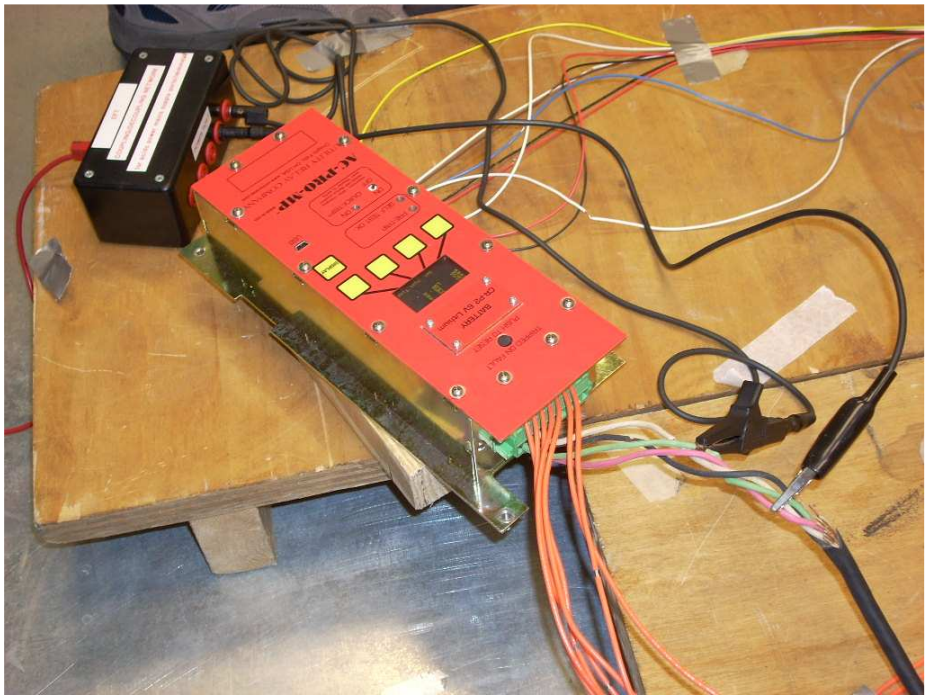
AC-PRO-MP: Quick Trip Input



AC-PRO-MP: Quick Trip Output



AC-PRO-MP: Quick Trip Output



11.0 SURGE IMMUNITY TEST

11.1 Surge Immunity Test Procedure

The test was performed on the unit as per EN 60947-2 and C37.90.1. The surge pulse duration from the combination wave generator was 1.2/50 µs voltage into an open circuit as high as 2.5 kV and an 8/20 µs current pulse into a short circuit. Each pulse was injected 5 times in each polarity with a minimum of 10 seconds interval between each pulse.

AC Mains

The AC Mains lines were coupled to the surge generator through a capacitor/resistor coupling network as described in paragraph 7, figure 10. Surges were applied to each AC line and protective earth in both line-to-line and line-to-earth modes.

Test Equipment Used:

AMP-SAFE-PRO

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Temp/Hum. Recorder	CL119	Extech	RH520	H005869	Jan. 2, 2014
EMC Immunity Tester	CL077	EMC-Partner	TRA2000IN6	780	Jan. 23, 2014
Software:	Genecs Generator Controlling Software Version 2.58		Software Verified: May 20, 2013		

AC-PRO-MP

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Temp/Hum. Recorder	CL119	Extech	RH520	H005869	Nov. 16, 2011
Oscillating Wave Module w/integrated 3phase CDN	N/A	Haefely	8000 W PIM 150	149818/152775	Nov. 22, 2011
Surge Platform Test System	N/A	Haefely	PSURGE 8000		

11.2 Surge Immunity Test Data Sheet

Test Date:	May 20, 2013	**Test Engineer:**	J. Knepper
Standard:	EN 60947-2:2006, inc. A1:2009	**Air Temperature:**	22.8° C
Minimum Performance Criterion:	B	**Relative Humidity:**	47%

AMP-SAFE-PRO

Cable Designation AC Port Testing	Level (kV)	Phase (Degrees)	Achieved Performance Criterion	Pass/Fail
Line 1	+0.5	Asynchronous	A	Pass
Line 1	-0.5	Asynchronous	A	Pass
Line 2	+0.5	Asynchronous	A	Pass
Line 2	-0.5	Asynchronous	A	Pass
Line 3	+0.5	Asynchronous	A	Pass
Line 3	-0.5	Asynchronous	A	Pass

Cable Designation AC Port Testing	Level (kV)	Phase (Degrees)	Achieved Performance Criterion	Pass/Fail
Line 1	+1.0	Asynchronous	A	Pass
Line 1	-1.0	Asynchronous	A	Pass
Line 2	+1.0	Asynchronous	A	Pass
Line 2	-1.0	Asynchronous	A	Pass
Line 3	+1.0	Asynchronous	A	Pass
Line 3	-1.0	Asynchronous	A	Pass

Cable Designation AC Port Testing	Level (kV)	Phase (Degrees)	Achieved Performance Criterion	Pass/Fail
Line 1 to Earth	+0.5	Asynchronous	A	Pass
Line 1 to Earth	-0.5	Asynchronous	A	Pass
Line 2 to Earth	+0.5	Asynchronous	A	Pass
Line 2 to Earth	-0.5	Asynchronous	A	Pass
Line 3 to Earth	+0.5	Asynchronous	A	Pass
Line 3 to Earth	-0.5	Asynchronous	A	Pass
Ground to Earth	+0.5	Asynchronous	A	Pass
Ground to Earth	-0.5	Asynchronous	A	Pass

Cable Designation AC Port Testing	Level (kV)	Phase (Degrees)	Achieved Performance Criterion	Pass/Fail
Line 1 to Earth	+1.0	Asynchronous	A	Pass
Line 1 to Earth	-1.0	Asynchronous	A	Pass
Line 2 to Earth	+1.0	Asynchronous	A	Pass
Line 2 to Earth	-1.0	Asynchronous	A	Pass
Line 3 to Earth	+1.0	Asynchronous	A	Pass
Line 3 to Earth	-1.0	Asynchronous	A	Pass
Ground to Earth	+1.0	Asynchronous	A	Pass
Ground to Earth	-1.0	Asynchronous	A	Pass

Cable Designation AC Port Testing	Level (kV)	Phase (Degrees)	Achieved Performance Criterion	Pass/Fail
Line 1 to Earth	+2.0	Asynchronous	A	Pass
Line 1 to Earth	-2.0	Asynchronous	A	Pass
Line 2 to Earth	+2.0	Asynchronous	A	Pass
Line 2 to Earth	-2.0	Asynchronous	A	Pass
Line 3 to Earth	+2.0	Asynchronous	A	Pass
Line 3 to Earth	-2.0	Asynchronous	A	Pass
Ground to Earth	+2.0	Asynchronous	A	Pass
Ground to Earth	-2.0	Asynchronous	A	Pass

Test Date:	Nov. 24, 2010	**Test Engineer:**	M. Toth
Standard:	C37.90.1-2002	**Air Temperature:**	19.6° C
Minimum Performance Criterion:	Section 9.2	**Relative Humidity:**	55%

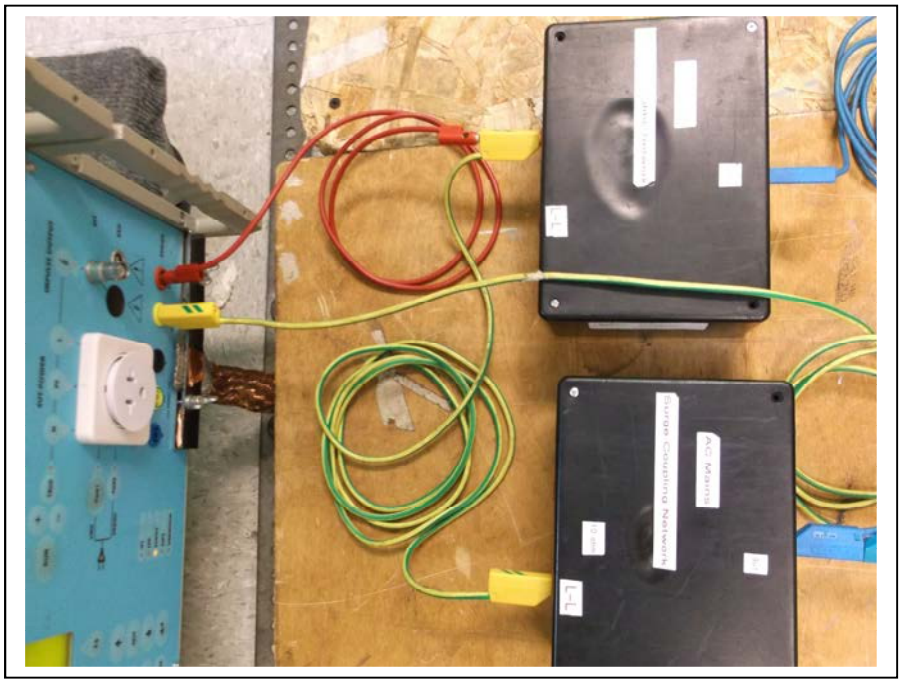
AC-PRO-MP

Cable Designation	Level (kV)	Phase (Degrees)	Mode	Results
Current Transformer, Phase C (brown & white)	+ / - 2.5	Ringwave	Common	Pass
Current Transformer, Phase C (brown & white)	+ / - 2.5	Ringwave	Transverse	Pass
Current Transformer, Phase B (yellow & white)	+ / - 2.5	Ringwave	Common	Pass
Current Transformer, Phase B (yellow & white)	+ / - 2.5	Ringwave	Transverse	Pass
Current Transformer, Phase A (white & blue)	+ / - 2.5	Ringwave	Common	Pass
Current Transformer, Phase A (white & blue)	+ / - 2.5	Ringwave	Transverse	Pass
24V DC (red & black)	+ / - 2.5	Ringwave	Common	Pass
24V DC (red & black)	+ / - 2.5	Ringwave	Transverse	Pass
Actuator	+ / - 2.5	Ringwave	Common	Pass
Actuator	+ / - 2.5	Ringwave	Transverse	Pass
R1 (1 & 3)	+ / - 2.5	Ringwave	Common	Pass
R1 (1 & 3)	+ / - 2.5	Ringwave	Transverse	Pass
R2 (2 & 3)	+ / - 2.5	Ringwave	Common	Pass
R2 (2 & 3)	+ / - 2.5	Ringwave	Transverse	Pass
I/O ALR 1 & 2 (4 & 5)	+ / - 2.5	Ringwave	Common	Pass
I/O ALR 1 & 2 (4 & 5)	+ / - 2.5	Ringwave	Transverse	Pass
I/O FV Segreated Trip (6 & 7)	+ / - 2.5	Ringwave	Common	Pass
I/O FV Segreated Trip (6 & 7)	+ / - 2.5	Ringwave	Transverse	Pass

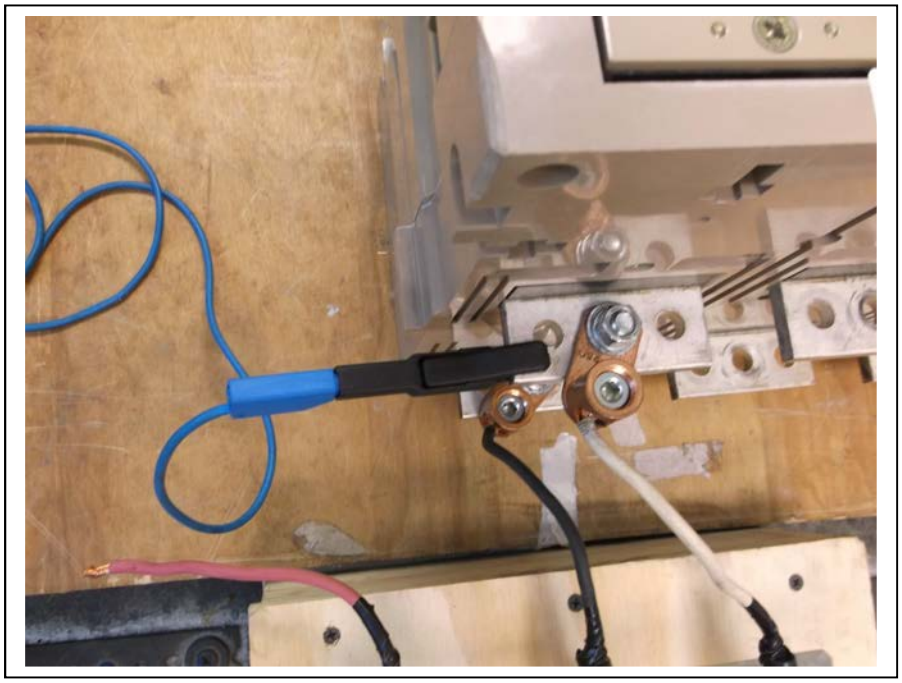
Cable Designation	Level (kV)	Phase (Degrees)	Mode	Results
Quick Trip Input (black & white)	+ / - 2.5	Ringwave	Common	Pass
Quick Trip Input (black & white)	+ / - 2.5	Ringwave	Transverse	Pass
Quick Trip Output (red & green)	+ / - 2.5	Ringwave	Common	Pass
Quick Trip Output (red & green)	+ / - 2.5	Ringwave	Transverse	Pass

11.3 Photograph(s) of Surge Immunity Test Setup

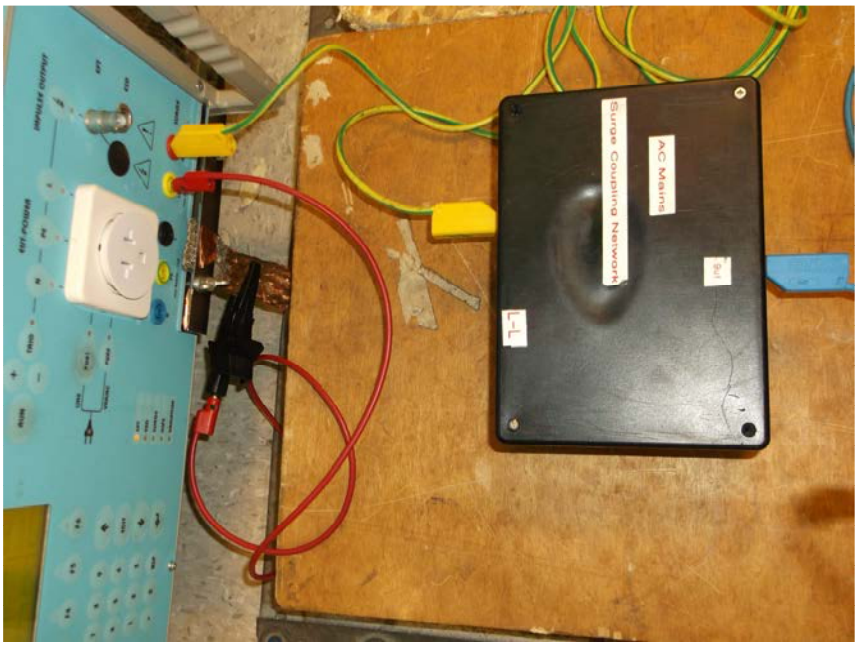
AMP-SAFE-PRO: Box, Line to Line



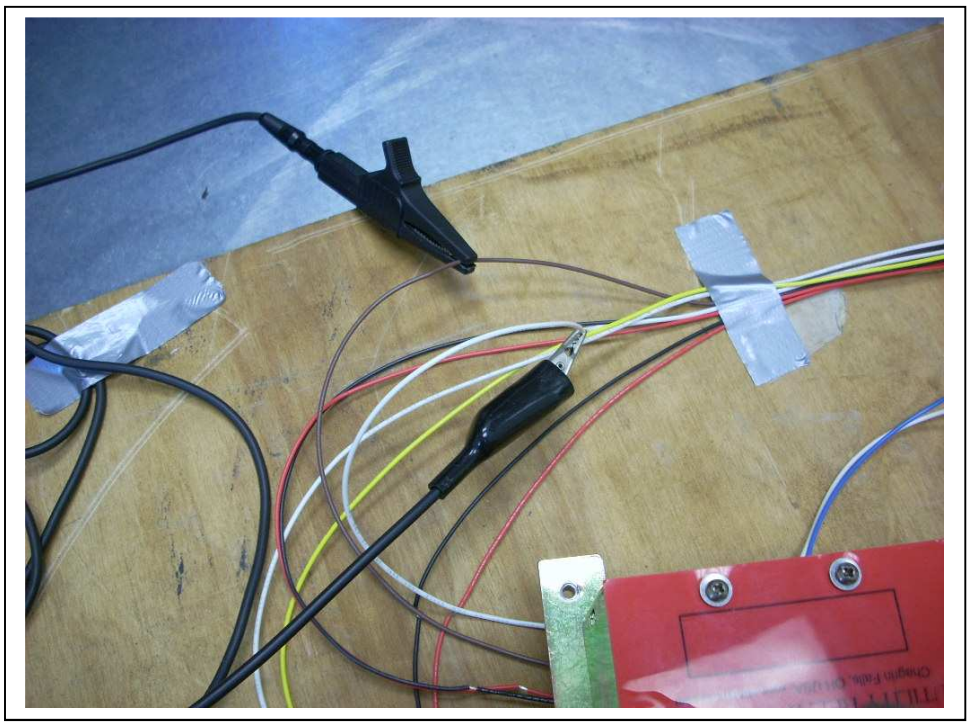
AMP-SAFE-PRO: EUT



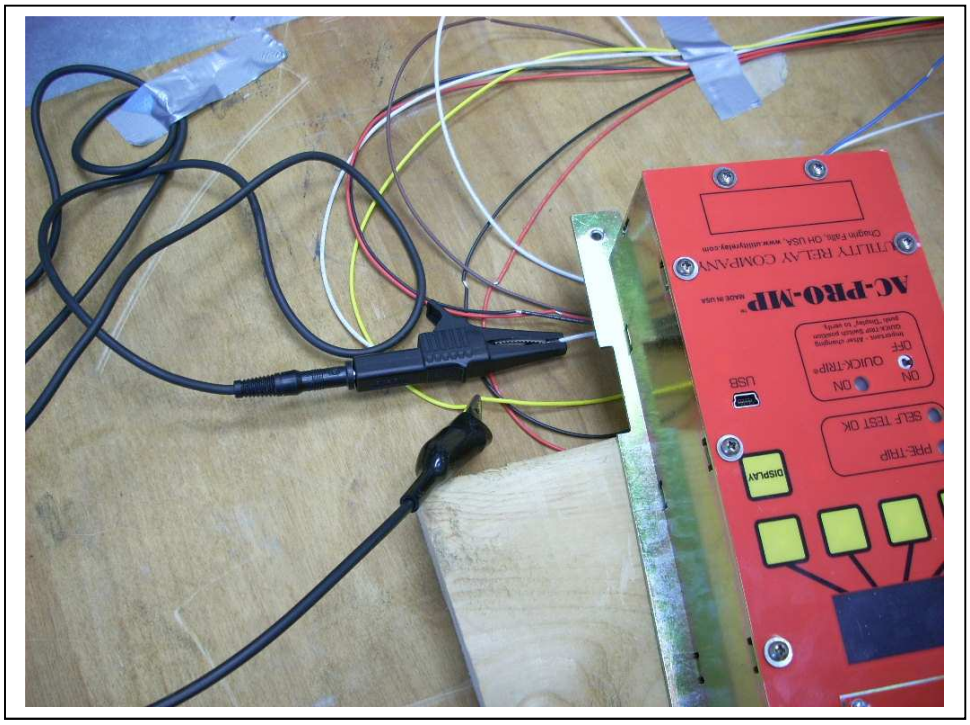
AMP-SAFE-PRO: Box Line to PE



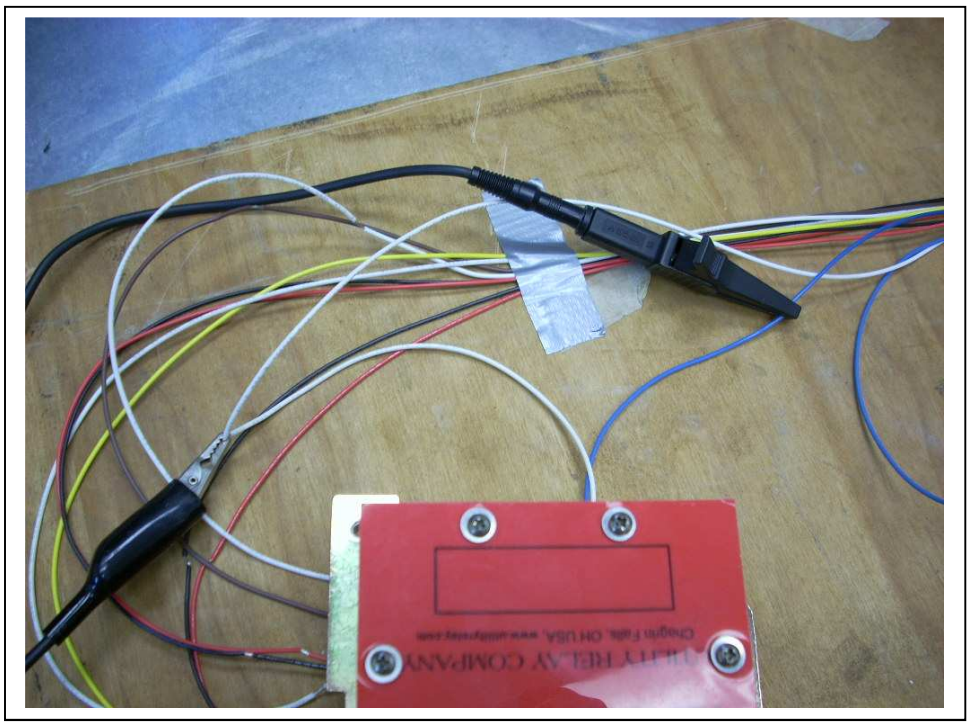
AC-PRO-MP: Current Transformer, Phase C



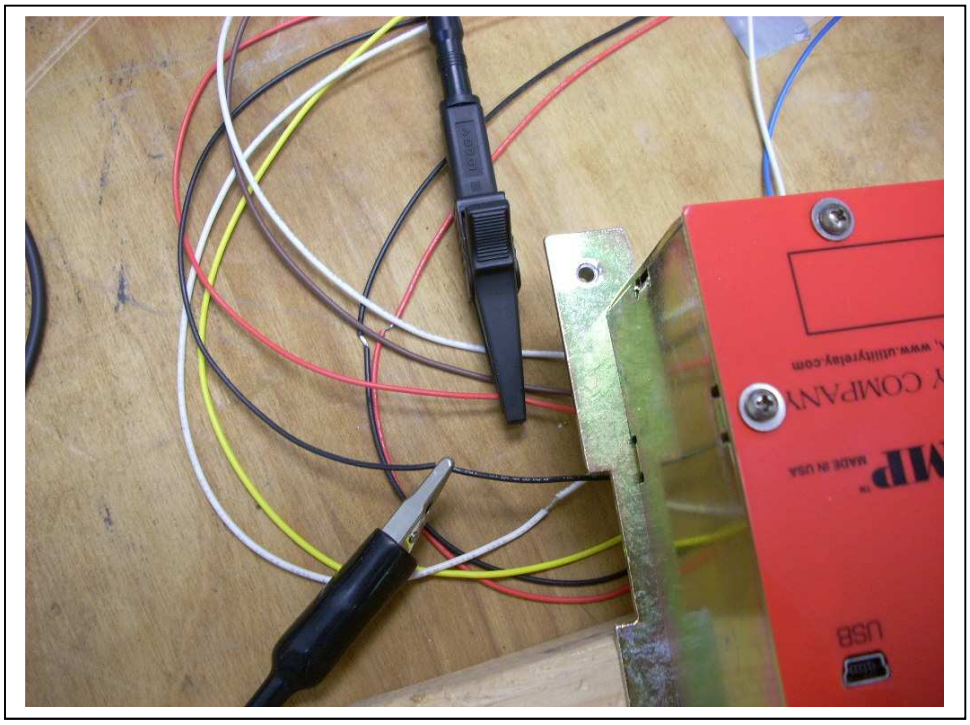
AC-PRO-MP: Current Transformer, Phase B



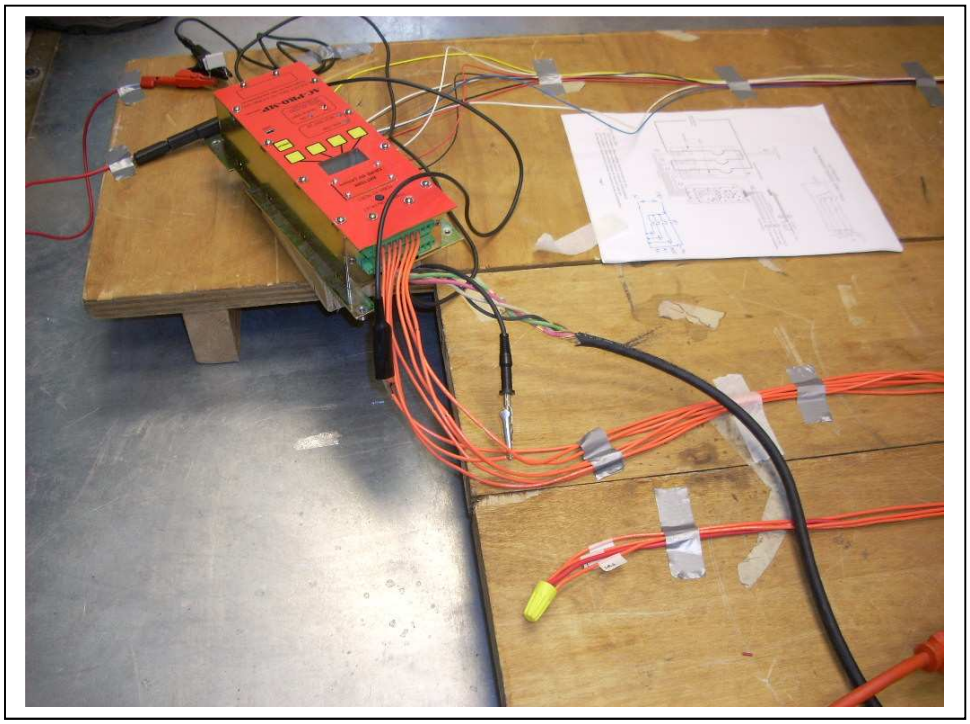
AC-PRO-MP: Current Transformer, Phase A



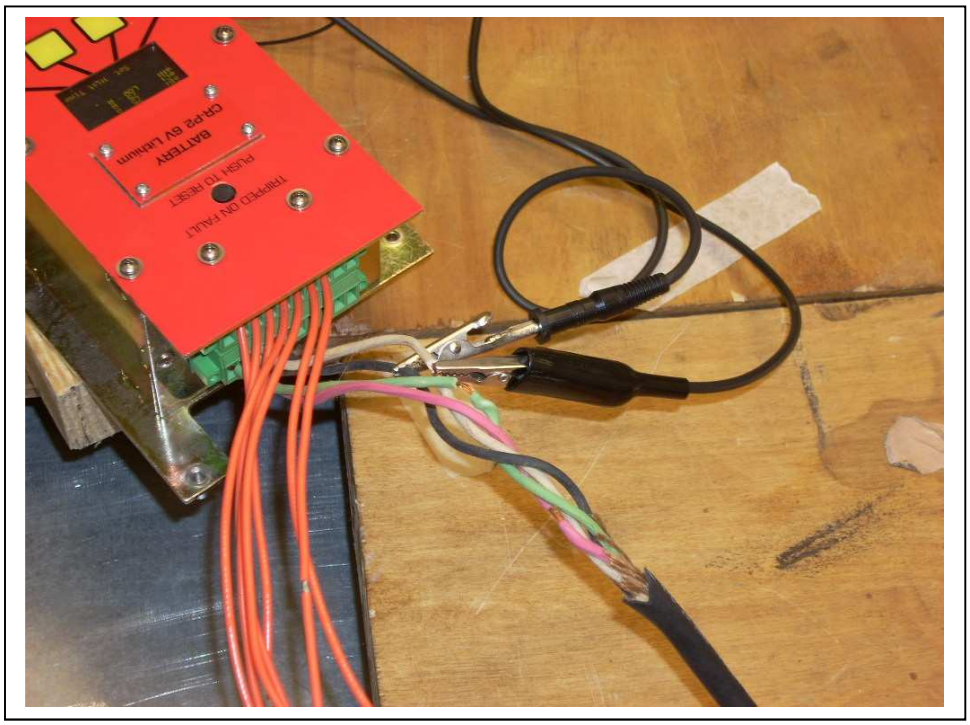
AC-PRO-MP: 24V DC, Actuator



AC-PRO-MP: R1, R2, I/O ALR 1 & 2, I/O FV Segregated



AC-PRO-MP: Quick Trip Input



12.0 CONDUCTED IMMUNITY TEST

12.1 Conducted Immunity Test Procedure

The Equipment Under Test (EUT) was placed 0.1 meter above a ground reference. A bulk current injection probe (BCI), EM Injection Clamp (EMIC) or Coupling/Decoupling Network (CDN) was connected to the EUT's power cord and was used to couple RF energy onto all lines of the power to the EUT. A Bulk Current Injection Clamp (BCI) or EM Injection Clamp (EMIC) was used to couple RF energy onto all data, control and I/O lines if an appropriate coupling/decoupling network (CDN) was not available.

The RF energy consisted of a signal that was stepped at 1% increments through the frequency range of 0.15 MHz to 80 MHz at a rate slower than the reaction time of the EUT. The signal was 80% AM modulated with a 1 kHz sine wave and had a minimum calibrated level of 10.0 Volts rms.

The test setup conformed to figure 2 of EN 61000-4-6.

Test Equipment Used:

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Temp/Hum. Recorder	CL119	Extech	RH520	H005869	Jan. 2, 2014
Amplifier	0208	Amplifier Research	25A250A #1	301006	N/A
Bulk Current Injection Probe	0198	Fischer Custom Communications	F-120-9A	111	Jan. 21, 2014
Signal Generator	CL126	Hewlett Packard	8648A	3619U00447	Sept. 13, 2013
Software:	Tile Version 1.0		Software Verified: May 20, 2013		

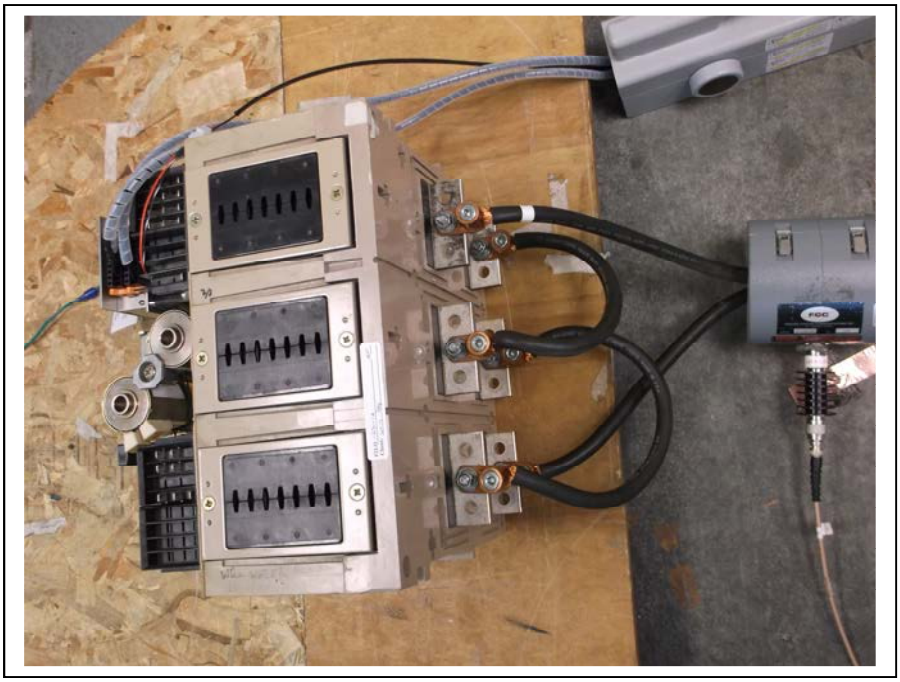
12.2 Conducted Immunity Test Data Sheet

Test Date:	May 20, 2013	**Test Engineer:**	J. Knepper
Standard:	EN 60947-2:2006, inc. A1:2009	**Air Temperature:**	23.4° C
Minimum Performance Criterion:	A	**Relative Humidity:**	49%

AMP-SAFE-PRO

Line Tested	Coupling	Frequency Range	Minimum Calibrated RF Level	Achieved Performance Criterion	Pass/Fail
Current Input	BCI	0.15 MHz to 80 MHz	10.0 volts rms	A	Pass

12.3 Photograph(s) of the Conducted Immunity Test Setup



13.0 RADIATED EMISSIONS TEST

13.1 Radiated Emissions Test Procedure

The EUT was initially placed in a semi-anechoic chamber, and wide band characterization measurements were performed to determine the frequencies at which significant emissions occurred.

The equipment was installed on a 0.8-meter high non-conductive turntable on an Open Area Test Site (OATS) as described in EN 55011. A receiving antenna was located 10.0 meters from the edge of the Equipment under Test (EUT). The antenna was attached to an antenna mast that allowed the antenna height to be adjusted from 1.0 to 4.0 meters above the ground plane.

The equipment was then fully exercised with all cabling attached to the EUT. While the equipment was energized, the receiving antenna was scanned from 1.0 meter to 4.0 meters in both vertical and horizontal polarities while the turntable was adjusted 360 degrees to determine the maximum field strength. During the test, frequencies identified as being generated by the EUT in the frequency range of 30 MHz to 1000 MHz were measured. The highest levels were recorded along with antenna polarity. These levels were then compared to the Class A limits specified in EN 55011.

Test Equipment Used:

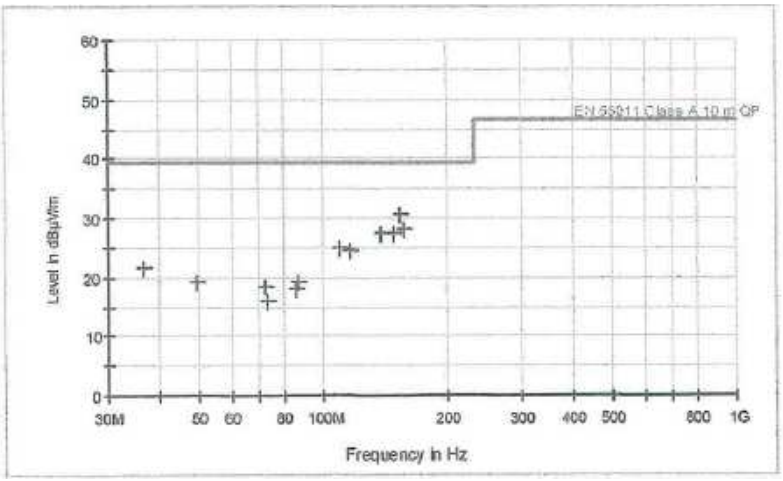
Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shield Room	CL014	Shielding Resources	3 Meter	001	May 19, 2013
Temp/Hum. Recorder	CL137	Extech	RH520	CH16992	Apr. 17, 2014
OATS-10m	CL017	Compliance Labs	N/A	001	Sept. 19, 2013
Spectrum Analyzer	CL138	Agilent Technologies	E4407B	US41192779	Sept. 14, 2013
Receiver	CL151	Rohde & Schwarz	ESU40	100319	Nov. 8, 2013
Antenna 1-Chamber	0142	ETS/EMCO	3142B	9811-1330	Verified
Antenna 2-OATS	0105	Sunol Sciences	JB1	A101101	May 17, 2013
Pre-Amplifier	CL136	Hewlett Packard	8447E	1937A01894	Apr. 16, 2014
Software:	Tile Version 1.0		Software Verified: May 20, 2013		
Software:	EMC 32, Version 5.20.2		Software Verified: May 20, 2013		

13.2 Radiated Emissions Test Data Sheet

Test Date:	May 20, 2013	**Test Engineer:**	J. Knepper
Standard:	EN 55011:2007	**Air Temperature:**	31.2°C
Limit:	Class A	**Relative Humidity:**	51%
Distance:	10.0 meters		

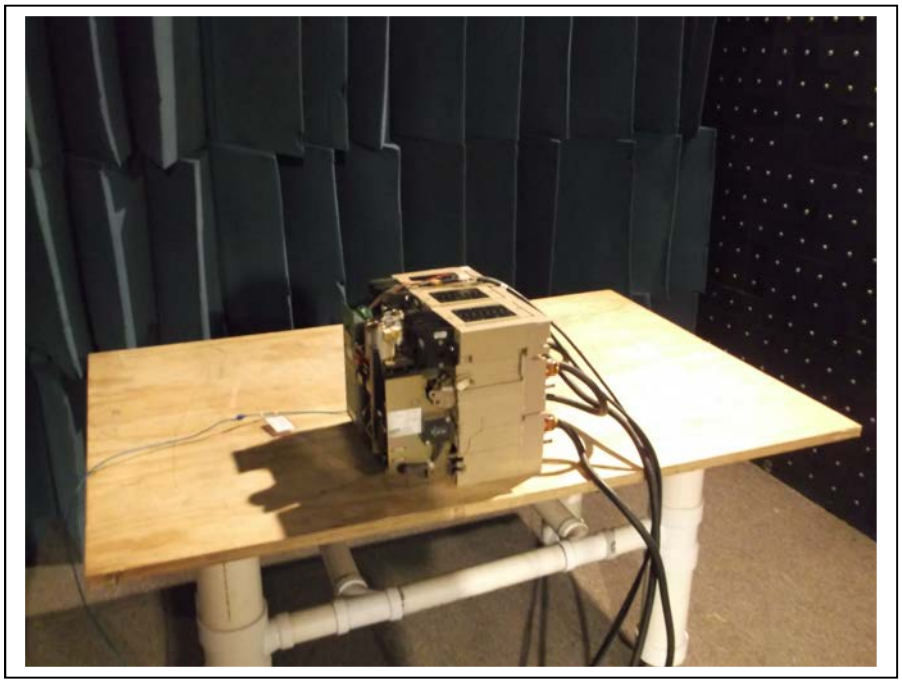
AMP-SAFE-PRO

Frequency (MHz)	Antenna Polarization	Reading (dBµV)	Cable Loss & Antenna Factor (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
36.630000	V	6.2	15.6	21.8	40.0	-18.2
49.460000	V	8.8	10.2	19.0	40.0	-21.0
71.990000	H	9.8	8.7	18.5	40.0	-21.5
72.910000	V	7.0	8.9	15.9	40.0	-24.1
85.920000	H	6.5	11.7	18.2	40.0	-21.8
86.340000	V	7.3	11.8	19.1	40.0	-20.9
108.690000	H	7.7	17.2	24.9	40.0	-15.1
115.420000	V	6.2	18.4	24.6	40.0	-15.4
137.960000	H	6.2	21.2	27.4	40.0	-12.6
147.040000	H	6.2	21.4	27.6	40.0	-12.4
152.200000	H	9.7	21.1	30.8	40.0	-9.2
155.560000	V	7.5	20.7	28.2	40.0	-11.8



13.3 Photograph(s) of the Radiated Emissions Test Setup

Pre-scan



OATS

14.0 CONDUCTED EMISSIONS TEST

14.1 Conducted Emissions Test Procedure

The equipment was installed on a 0.8-meter high non-conductive table as described in EN 55011. Power was provided to the Equipment under Test (EUT) through a Line Impedance Stabilization Network (LISN). An EMI receiver was also connected to the LISN to measure the RF emissions on the power lines of the EUT. The EUT was fully exercised with all cabling attached. The setup conforms to EN 55011. During the test, each conductor of the power mains was tested and emissions were measured over the frequency range of 0.15 MHz to 30 MHz. The highest levels were recorded and plots were taken showing the emissions on each conductor. These levels were compared to the Class A limits specified in EN 55011.

Test Equipment Used:

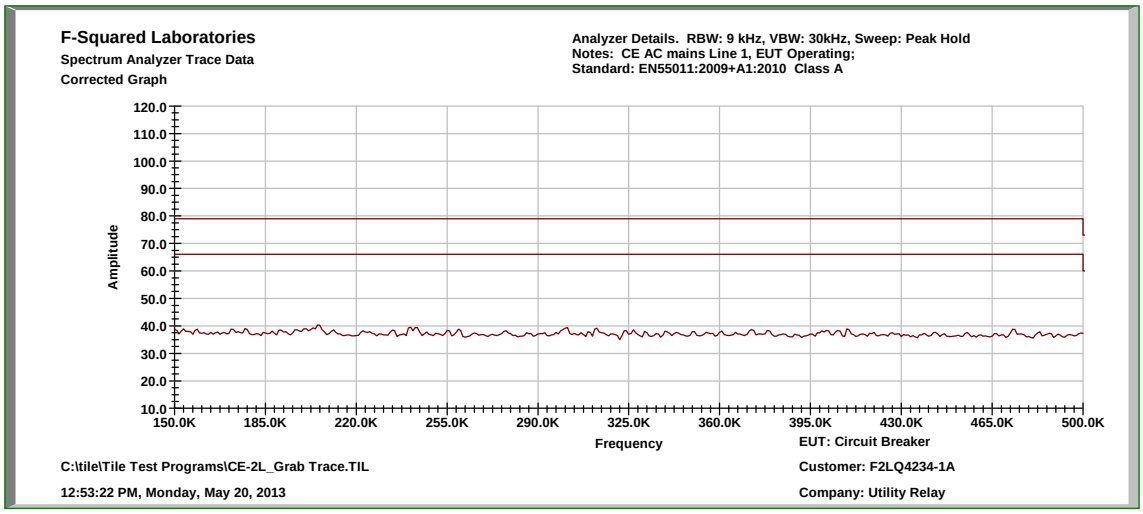
Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Temp/Hum. Rec.	CL119	Extech	RH520	H005869	Jan. 2, 2014
Software:	Tile Version 1.0		Software Verified: May 20, 2013		
Digital Thermometer with Humidity	CL075	ACU-Rite	00891	None Specified	Verified
Voltage Probe	CL145	Solar	9533-1	1111501	Jan. 13, 2013
Spectrum Analyzer	CL147	Agilent	E7402A	MY45101241	Oct. 8, 2013

14.2 Conducted Emissions Test Data Sheet

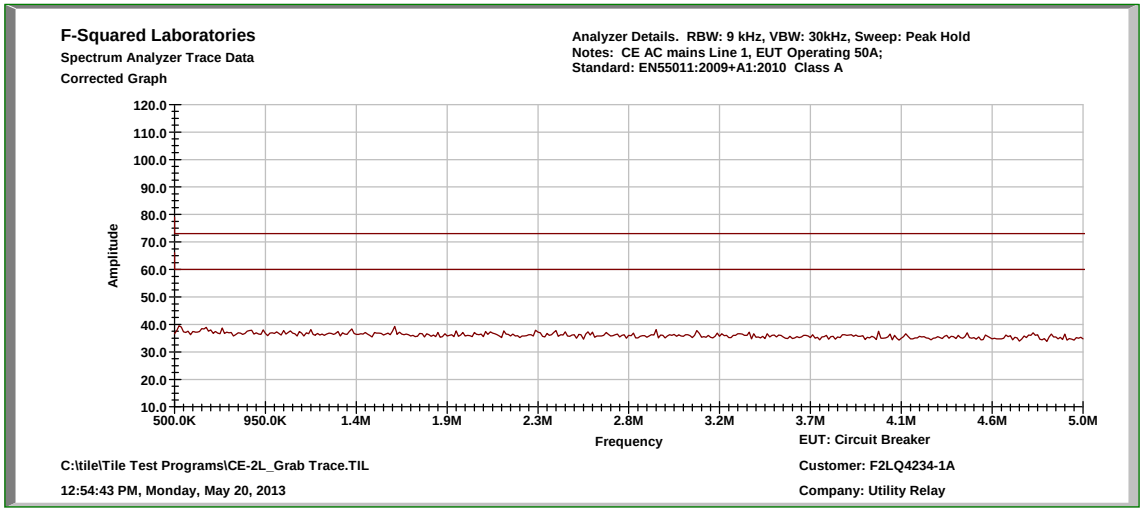
Test Date:	May 20, 2013	**Test Engineer:**	J. Knepper
Standard:	EN 55011:2007	**Air Temperature:**	23.3° C
Limit:	Class A	**Relative Humidity:**	46%
Pass/Fail:	Pass		

AMP-SAFE-PRO

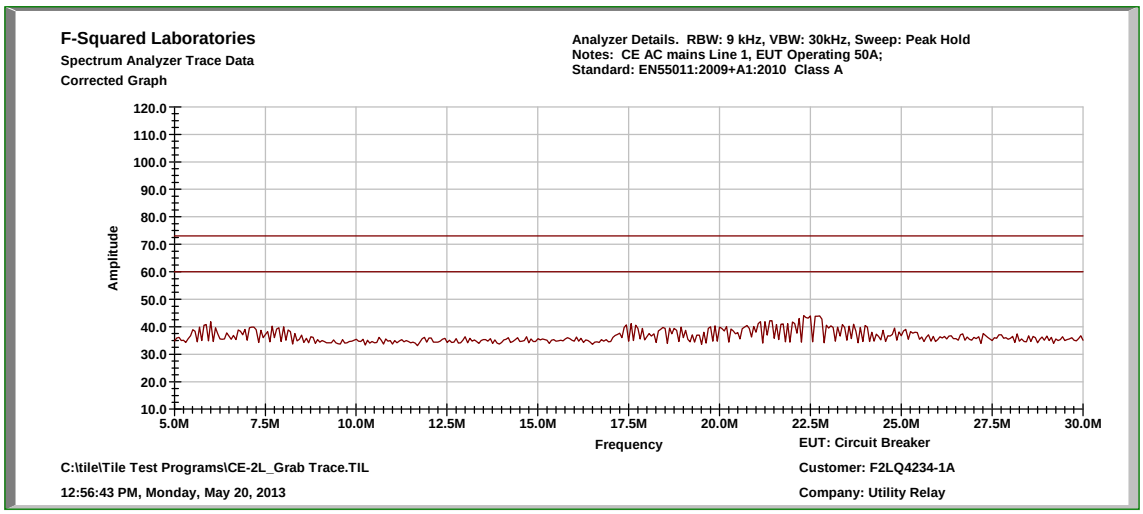
Conducted Test – Line 1: 0.15 MHz to 0.5 MHz



Conducted Test – Line 1: 0.5 MHz to 5.0 MHz

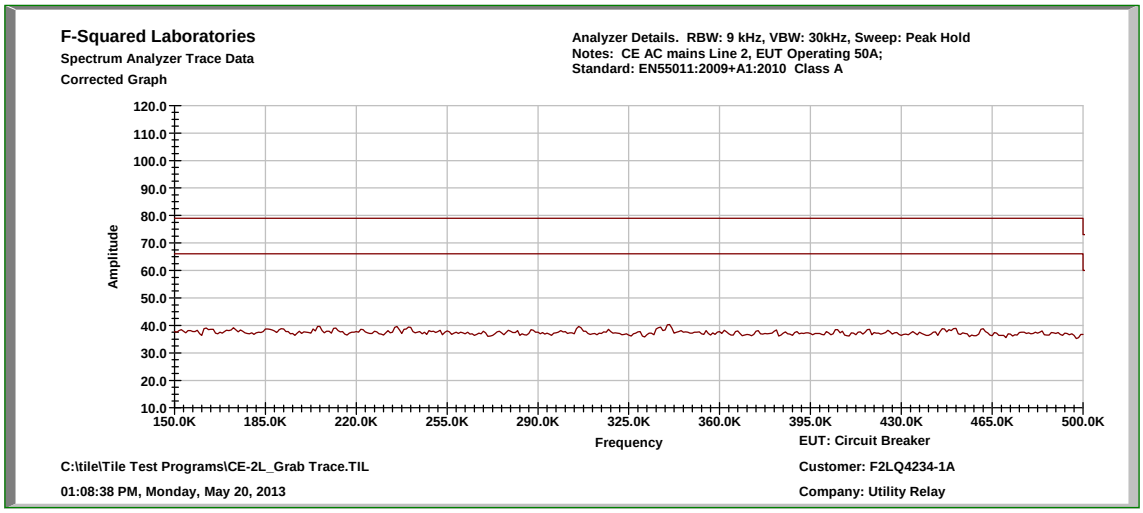


Conducted Test – Line 1: 5.0 MHz to 30.0 MHz

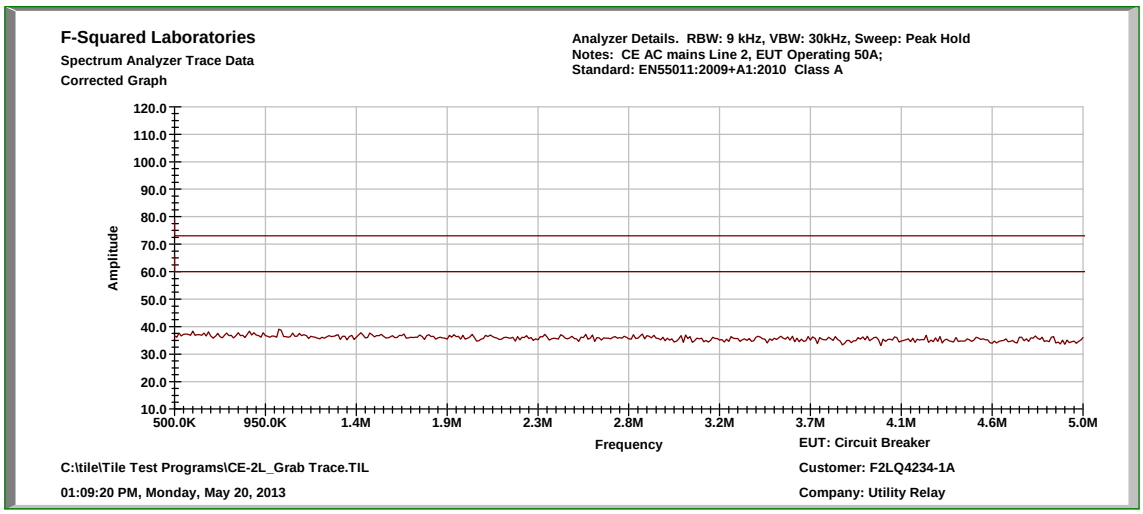


Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Line 1	6.0	Quasi-Peak	15.55	24.0	39.55	73.0	-33.5
			Average	11.65	24.0	35.65	60.0	-24.4
2	Line 1	17.56	Quasi-Peak	13.78	24.0	37.78	73.0	-35.2
			Average	10.52	24.0	34.52	60.0	-25.5
3	Line 1	22.5	Quasi-Peak	18.39	24.0	42.39	73.0	-30.6
			Average	14.68	24.0	38.68	60.0	-21.3
4	Line 1	22.75	Quasi-Peak	18.36	24.0	42.36	73.0	-30.6
			Average	13.75	24.0	37.75	60.0	-22.3

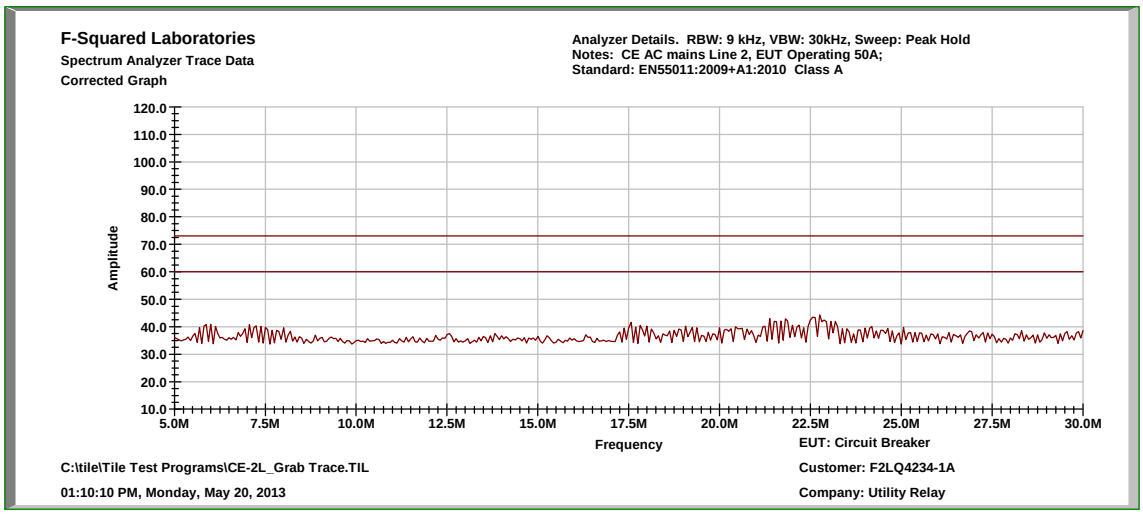
Conducted Test – Line 2: 0.15 MHz to 0.5 MHz



Conducted Test – Line 2: 0.5 MHz to 5.0 MHz

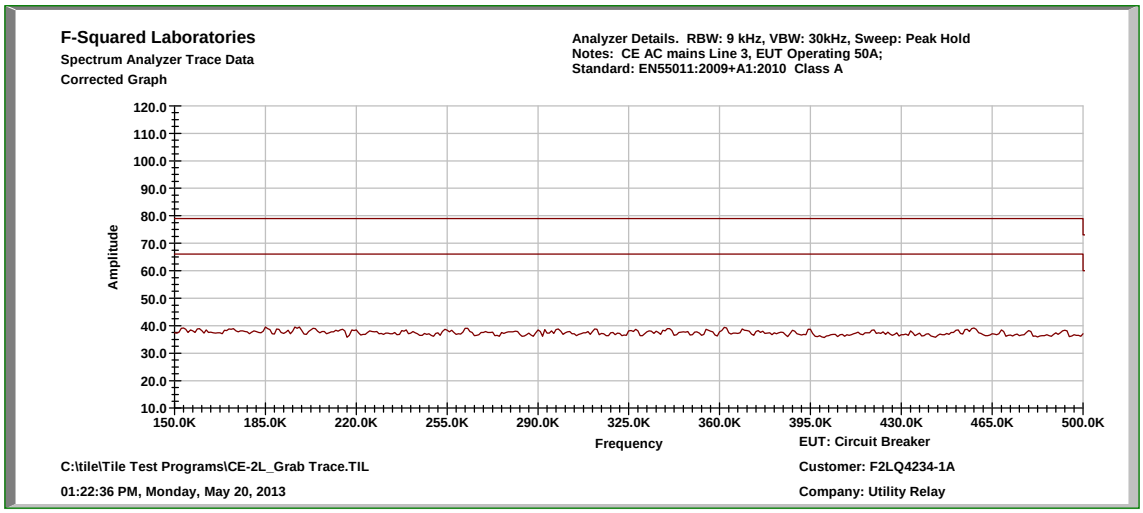


Conducted Test – Line 2: 5.0 MHz to 30.0 MHz

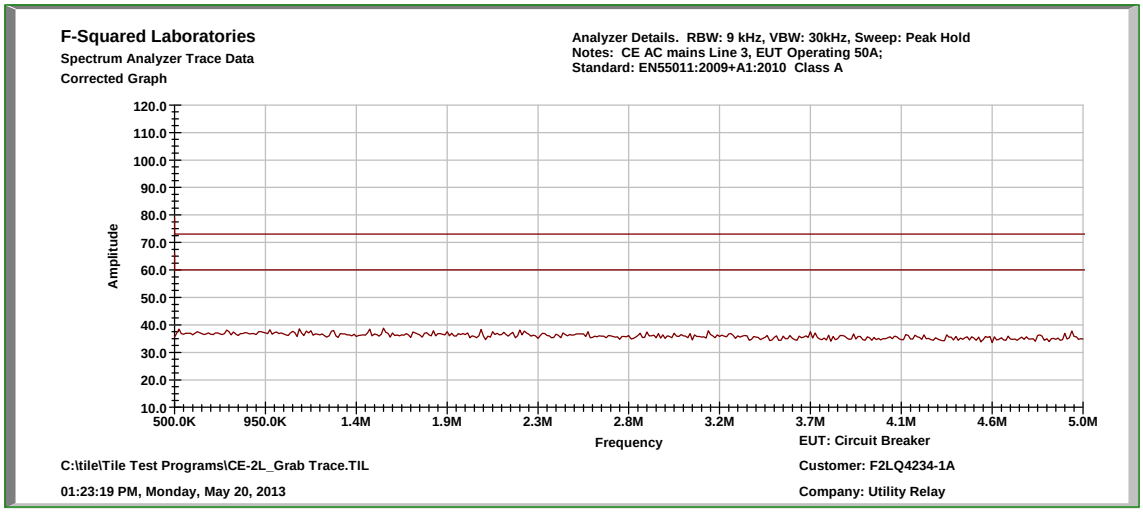


Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Line 2	21.375	Quasi-Peak	14.83	24.0	38.83	73.0	-34.2
			Average	18.74	24.0	42.74	60.0	-17.3
2	Line 2	21.81	Quasi-Peak	16.44	24.0	40.44	73.0	-32.6
			Average	4.77	24.0	28.77	60.0	-31.2
3	Line 2	22.75	Quasi-Peak	16.91	24.0	40.91	73.0	-32.1
			Average	12.39	24.0	36.39	60.0	-23.6

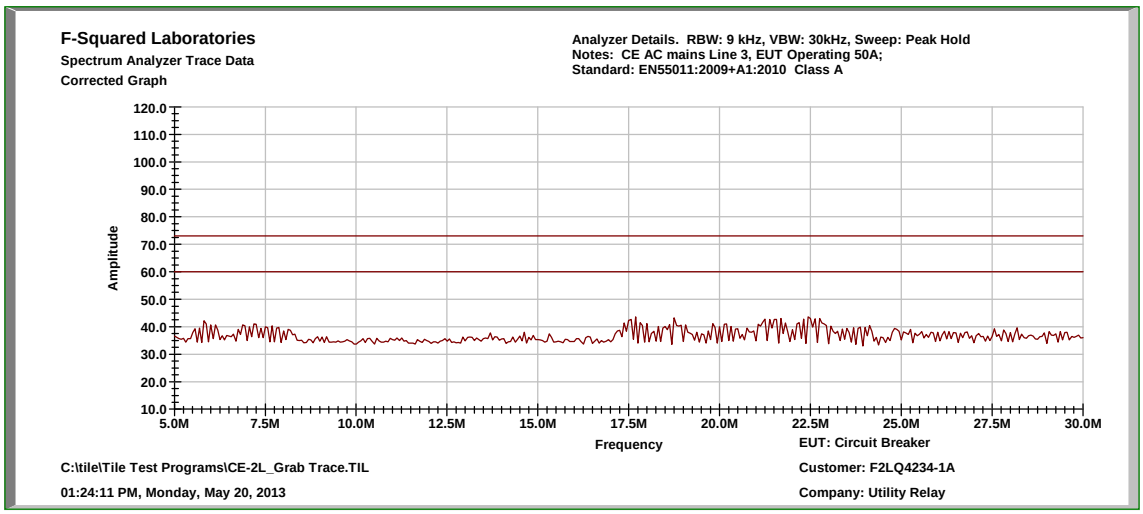
Conducted Test – Line 3: 0.15 MHz to 0.5 MHz



Conducted Test – Line 3: 0.5 MHz to 5.0 MHz



Conducted Test – Line 3: 5.0 MHz to 30.0 MHz



Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Line 1	5.81	Quasi-Peak	16.85	24.0	40.85	73.0	-32.2
			Average	13.88	24.0	37.88	60.0	-22.1
2	Line 1	7.375	Quasi-Peak	16.53	24.0	40.53	73.0	-32.5
			Average	9.88	24.0	33.88	60.0	-26.1
3	Line 1	7.81	Quasi-Peak	14.16	24.0	38.16	73.0	-34.8
			Average	10.17	24.0	34.17	60.0	-25.8
4	Line 1	17.69	Quasi-Peak	16.89	24.0	40.89	73.0	-32.1
			Average	13.89	24.0	37.89	60.0	-22.1

14.3 Photograph(s) of the Conducted Emissions Test Setup