MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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December 9, 2011

Ubiquiti Networks, Inc.
91 E. Tasman
San Jose, CA 95134

Dear Jennifer Sanchez,

Enclosed is the EMC test report for compliance testing of the Ubiquiti Networks, Inc., AirRouterHP, tested to the requirements of ETSI EN 301 489-1 with ETSI EN 301 489-17 (Article 3.1(b) of R&TTE Directive).

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\ Ubiquiti Networks, Inc. \ EMCS32997-ETS489)

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Electromagnetic Compatibility
Test Report

For the

Ubiquiti Networks, Inc.
AirRouterHP

Tested for Compliance with

ETSI EN 301 489-1
With ETSI EN 301 489-17 (Article 3.1(b) of R&TTE Directive)

MET Report: EMCS32997-ETS489

December 9, 2011

Prepared For:

Ubiquiti Networks, Inc.
91 E. Tasman
San Jose, CA 95134

Prepared By:
MET Laboratories, Inc.
3162 Belick St.
Santa Clara, CA 95054

Electromagnetic Compatibility
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ETSI EN 301 489-1
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MET Report: EMCS32997-ETS489

Lionel Gabrillo, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of ETSI EN 301 489-1 with ETSI EN 301 489-17 under normal use and maintenance.

Shawn McMillen,
Wireless Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	December 9, 2011	Initial Issue.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
CISPR	**C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference)
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**H**ert**z**
kPa	**k**ilo**Pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**H**ertz
µH	**micro**Henry
µF	**micro**Farad
µs	**micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

1.0 Introduction

1.1 Overview

MET Laboratories, Inc. was contracted by Ubiquiti Networks, Inc. to perform testing on the AirRouterHP, under Ubiquiti Networks, Inc. purchase order number US100230.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the AirRouterHP.

Model(s) Tested:	AirRouterHP
Model(s) Covered:	AirRouterHP
EUT Specifications:	Primary Power: 230 VAC, 50 Hz
	Secondary Power: N/A
	Equipment Emissions Class: The radio equipment and/or associated ancillary equipment under test are classified as equipment for fixed use
Lab Ambient Test Conditions:	Temperature: 15-35º C
	Relative Humidity: 30-60%
	Atmospheric Pressure: 860-1060 mbar
Evaluated by:	Anderson Soungpanya
Report Date(s):	December 9, 2011

1.2 Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick St., Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

1.3 General Performance Criteria

The performance criteria cited in EN 301 489-17:

- performance criteria A for immunity tests with phenomena of a continuous nature;
- performance criteria B for immunity tests with phenomena of a transient nature;
- performance criteria C for immunity tests with power interruptions exceeding a certain time.

Note: For specific details on performance criteria, see sub-clause 6.2 of EN 301 489-17.

1.4 Testing Summary

Emissions

Descriptive Name	Requirement	Test Method	Result
Enclosure of Ancillary Equipment Measured on a Stand Alone Basis	ETSI EN 301 489-1, Section 8.2	EN 55016-2-3 (2006)	Not Applicable – No ancillary equipment associated with EUT.
DC Power Input/Output Ports	ETSI EN 301 489-1, Section 8.3	EN 55022 (2006)	Not Applicable – EUT uses AC Power.
AC Mains Power Input/Output Ports	ETSI EN 301 489-1, Section 8.4	EN 55022 (2006)	Compliant
Harmonic Current Emissions (AC Mains Input Port)	ETSI EN 301 489-1, Section 8.5	EN 61000-3-2 +A1 (2006)	Compliant
Voltage Fluctuations and Flicker (AC Mains Input Port)	ETSI EN 301 489-1, Section 8.6	EN 61000-3-3 (1995)	Compliant
Telecommunication Ports	ETSI EN 301 489-1, Section 8.7	EN 55022 (2006)	Compliant

Immunity

Descriptive Name	Requirement	Test Method	Result
Radio Frequency Electromagnetic Field (80 MHz – 1000 MHz and 1400 MHz to 2700 MHz)	ETSI EN 301 489-1, Section 9.2	EN 61000-4-3 (2006)	Compliant
Electrostatic Discharge (ESD)	ETSI EN 301 489-1, Section 9.3	EN 61000-4-2 (2001)	Compliant
Fast Transient, Common Mode	ETSI EN 301 489-1, Section 9.4	EN 61000-4-4 (2004)	Compliant
Radio Frequency, Common Mode	ETSI EN 301 489-1, Section 9.5	EN 61000-4-6 (2005)	Compliant
Transient & Surges in the Vehicular Environment	ETSI EN 301 489-1, Section 9.6	ISO 7637-2 (2004) (12/24 VDC)	Not Applicable – EUT is not intended for Vehicular use.
Voltage Dips and Interruptions	ETSI EN 301 489-1, Section 9.7	EN 61000-4-11 (2004)	Compliant
Surges	ETSI EN 301 489-1, Section 9.8	EN 61000-4-5 (2006)	Compliant

Table 1. Summary of Compliance Testing

1.5 Modifications to the Test Standard

No modifications were made to the test standard.

1.6 References

ETSI EN 301 489-1 V1.8.1 (2008-04)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
ETSI EN301 489-17 V2.1.1(2009-05)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Wideband data and HIPERLAN equipment
EN 55022	Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement, 2006
EN 61000-3-3	Electromagnetic Compatibility (EMC) Part 3-3: Limits – Limitation of Voltage Changes, Voltage Fluctuations and Flicker in Public Low-Voltage Supply Systems, for Equipment with Rated Current ≤ 16 A per Phase and Not Subject to Conditional Connection, 1995
EN 61000-4-2	Electromagnetic Compatibility (EMC) Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test, 2001
EN 61000-4-3	Electromagnetic compatibility (EMC) Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test, 2006
EN 55016-2-3	Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods – Part 2-3: Methods of Measurement of Disturbances and Immunity – Radiated Disturbance Measurements, 2006
EN 61000-4-4	Electromagnetic Compatibility (EMC) Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test, 2004
EN 61000-4-5	Electromagnetic Compatibility (EMC) Part 4-5: Testing and Measurement Techniques – Surge Immunity Test, 2006
EN 61000-4-6	Electromagnetic Compatibility - Part 4-6: Testing and Measurement Techniques Section – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields, 2005
EN 61000-4-11	Electromagnetic Compatibility - Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests, 2004
ISO 7637-2	Road Vehicles – Electrical Disturbances from Conduction and Coupling – Part 2: Electrical Transient Conduction Along Supply Lines Only, 2004
EN 61000-3-2/Amendment 1	Electromagnetic Compatibility (EMC) – Part 3-2: Limits – Limits for Harmonic Current Emissions (Equipment Input Current Up to and Including 16 A per Phase, 2006

Table 2. Test References

2.0 Equipment Under Test

2.1 Description of Test Sample

The Ubiquiti Networks, Inc. AirRouterHP, Equipment Under Test (EUT), is a 2400MHz 802. 11b/g/n Radio.

Photograph 1. Ubiquiti Networks, Inc. AirRouterHP

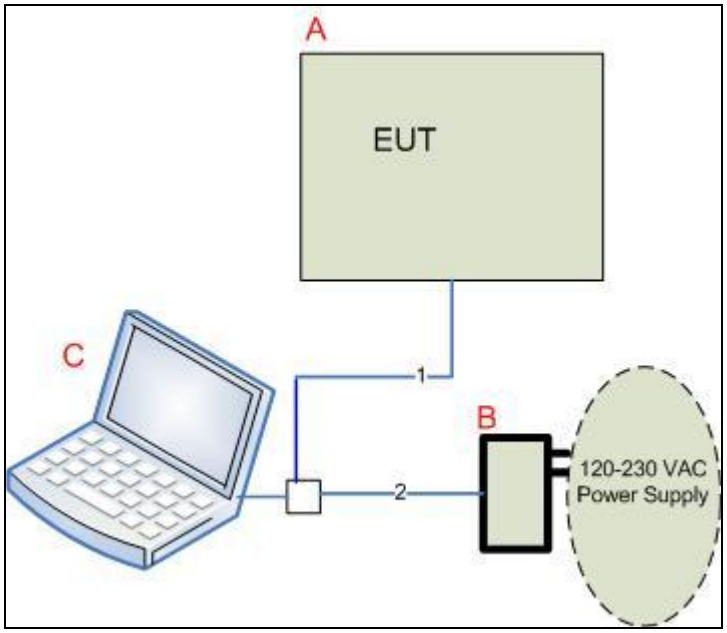


Figure 1. Block Diagram of Test Configuration

2.2 Equipment Configuration

The EUT was set up as outlined in Figure 1. All equipment incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Part Number	Serial Number
A	2400MHz Radio	AirRouterHP	NA	1129C00272222A234
B	Poe Adapter	GFP121T-050200-1	NA	1002-0010465

Table 3. Equipment Configuration

2.3 Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number
C	Laptop	Dell	Vostro 1000

Table 4. Support Equipment

2.4 Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
1	A, Ethernet	Ethernet	1	2	Y	C
2	A, Power Input	2 Conductor DC Cable	1	1	N	B, 100-240VAC 50/60Hz

Table 5. Ports and Cabling Information

2.5 Mode of Operation

Using Atheros Radio Test Software.

2.6 Method of Monitoring EUT Operation

Ping Times out and doesn't return. Unit locks up requires power down is a fail.

2.7 Modifications to the EUT

No modifications were made to the EUT.

2.8 Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Ubiquiti Networks, Inc. upon completion of testing.

3.0 Electromagnetic Compatibility Emission Criteria

3.1 AC Mains Power Input/Output Ports: Limits for Conducted Emissions

Test Requirement(s): **ETSI EN 301 489-1, Clause 8.4:**

In accordance with *EN 55022 Clause 5.1*, the EUT shall meet the Class B limits shown in Table 6:

Limits for Conducted Emissions of Equipment				
Frequency Range (MHz)	**intended for use in telecommunication centres only [EN 55022Class A Limits] (dBµV)**		**[EN 55022 Class B Limits] (dBµV)**	
	Quasi-Peak	**Average**	**Quasi- Peak**	**Average**
0.15 - 0.5	79	66	66 to 56	56 to 46
0.5 - 5	73	60	56	46
5 - 30	73	60	60	50

Table 6. Limits of Conducted Disturbance at AC Mains Power Input/Output Ports

Note: The lower limit shall apply at the transition frequencies. The limits decrease linearly with the logarithm of the frequency in the range of 0.15 MHz to 0.5 MHz.

Test Procedure: The EUT was placed on a non-metallic table located in a shielded enclosure (See Photograph 2). The measurement was performed using normal operation of the equipment. The method of testing, test conditions, and test procedures of *Clause 9* of *EN 55022* were used. The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω / 50 µH as the input transducer to an EMC field intensity meter. The tests were conducted in a RF-shielded enclosure.

Test Results: The EUT was compliant with the specified requirements of Clause 8.4.

Test Engineer(s): Lionel Gabrillo

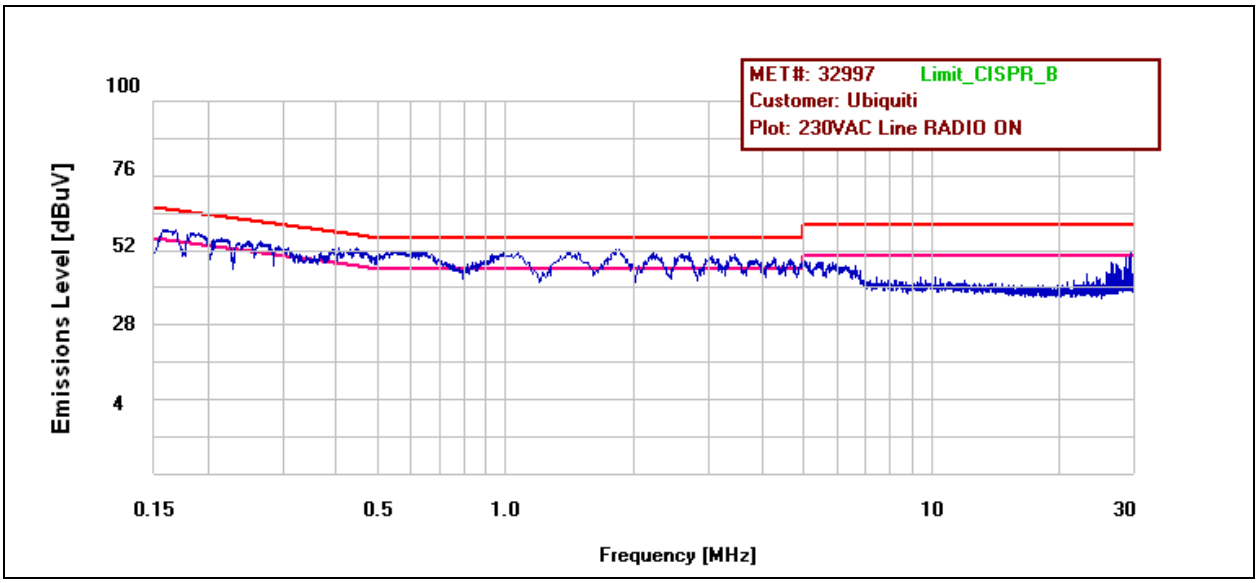
Test Date(s): 09/30/11

Electromagnetic Compatibility Emission

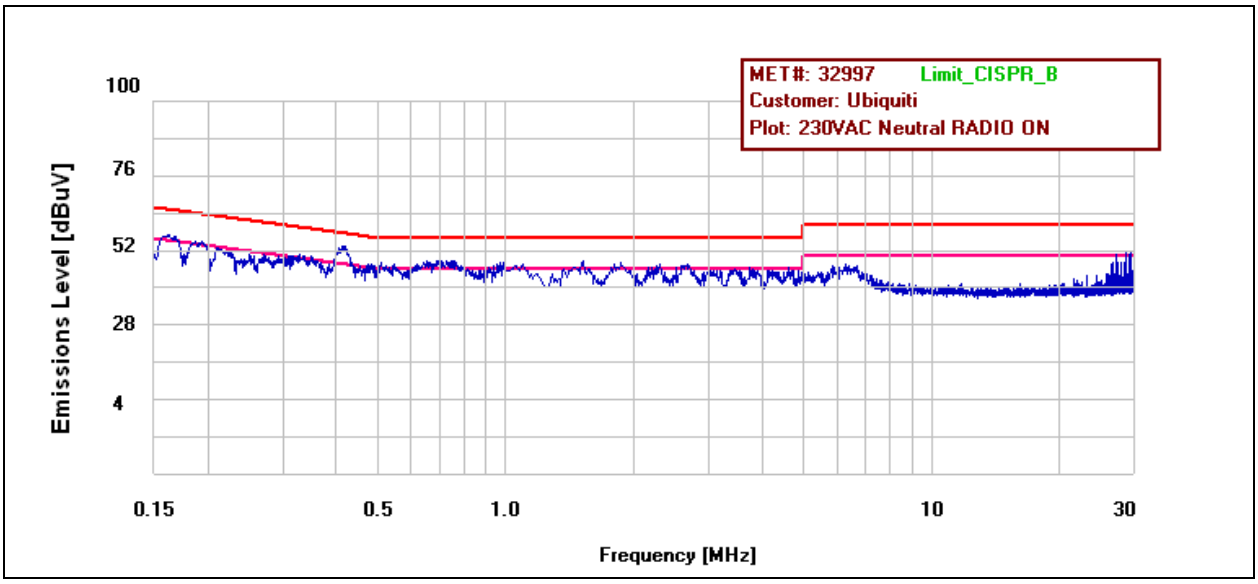
AC Mains Power Input/Output Ports: Limits for Conducted Emissions

Line	Freq. (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
230VAC Line RADIO ON	0.1609	55.27	65.419	-10.149	Pass	43.65	55.419	-11.769	Pass
230VAC Line RADIO ON	0.213	51.4	63.095	-11.695	Pass	38.2	53.095	-14.895	Pass
230VAC Line RADIO ON	0.4395	46.94	57.096	-10.156	Pass	36.82	47.096	-10.276	Pass
230VAC Line RADIO ON	0.5512	48.06	56	-7.94	Pass	37.96	46	-8.04	Pass
230VAC Line RADIO ON	0.4905	44.26	56.164	-11.904	Pass	32.72	46.164	-13.444	Pass
230VAC Line RADIO ON	2.21	45.61	56	-10.39	Pass	35.8	46	-10.2	Pass
230VAC Line RADIO ON	29.25	48.88	60	-11.12	Pass	45.4	50	-4.6	Pass
230VAC Line RADIO ON	29.23	49.53	60	-10.47	Pass	43.88	50	-6.12	Pass
230VAC Line RADIO ON	27.95	42.9	60	-17.1	Pass	35.48	50	-14.52	Pass
230VAC Line RADIO ON	2.71	41.52	56	-14.48	Pass	31.11	46	-14.89	Pass
230VAC Line RADIO ON	0.1631	53.49	65.306	-11.816	Pass	41.51	55.306	-13.796	Pass
230VAC Line RADIO ON	0.4205	49.56	57.462	-7.902	Pass	34.94	47.462	-12.522	Pass
230VAC Line RADIO ON	0.6625	43.32	56	-12.68	Pass	31.74	46	-14.26	Pass

Table 7. Conducted Emissions - Voltage, Worst Case Emissions, AC Power



Plot 1. Conducted Emission Limits, Phase Line Plot



Plot 2. Conducted Emission Limits, Neutral Line Plot

Electromagnetic Compatibility Emission

AC Mains Power Input/Output Ports: Limits for Conducted Emissions

Photograph 2. AC Mains Power Input/output Ports, Conducted Disturbance, Test Setup

Electromagnetic Compatibility Emission

3.2 Harmonic Current Emissions

Test Requirement(s): **ETSI EN 301 489-1, Clause 8.5:**

Per *EN 61000-3-2+A1, Clause 7*, the EUT must not produce harmonic currents, which exceed the limits expressed in Table 8.

Harmonic Order	Maximum Permissible Harmonic Current (in Amperes)
Odd Harmonics	
3	2.30
5	1.14
7	0.77
9	0.40
11	0.33
13	0.21
15 < n < 39	0.15 - 15/n
Harmonic Order	**Maximum Permissible Harmonic Current (in Amperes)**
Even Harmonics	
2	1.08
4	0.43
6	0.30
8< n <40	0.23 - 8/n

Table 8. Harmonic Current Emission Limits from Section 7 of EN 61000-3-2

Test Procedure: The EUT was placed on a non-metallic table located in a shielded enclosure (See Photograph 3). The measurement was performed using normal operation of the equipment. The method of testing, test conditions, and test procedures of *EN 61000-3-2+A1*.

Electromagnetic Compatibility Emission

Harmonic Current Emissions

Test Procedure (Con't): ITE is tested with the equipment configured to its rated current. In this case, the equipment, if necessary, may be configured with its power supplies loaded with additional load (resistive) boards to simulate rated current conditions. For ITE systems designed for use with a manufacturer-supplied power distribution system, e.g. transformers, UPS, power conditioner, etc., compliance with the limits of this standard shall be met at the input to the power distribution system.

Test Results: The EUT was found compliant with the specified requirements of Clause 8.5.

Test Engineer(s): Junwei Zhang

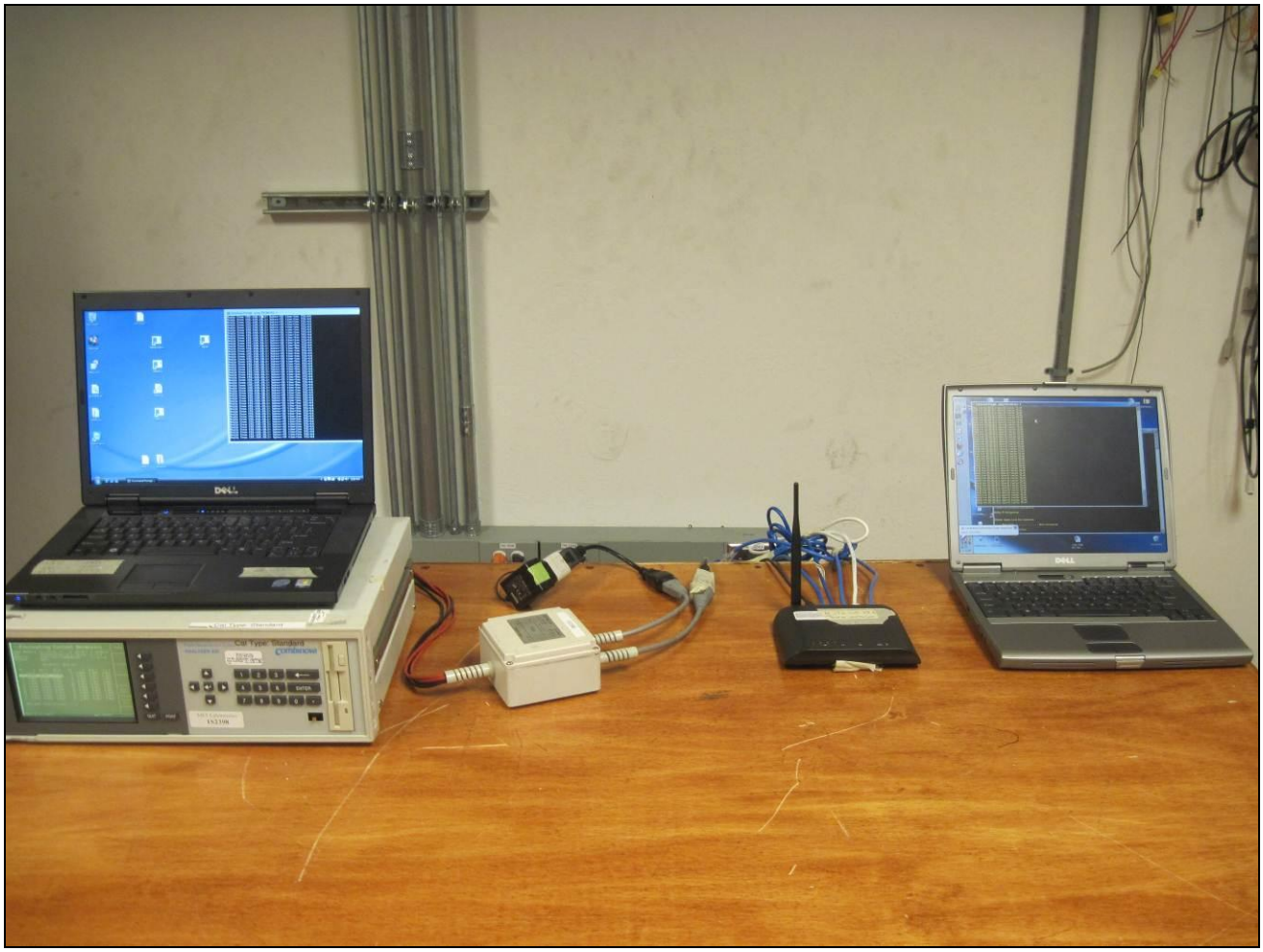
Test Date(s): 11/18/11

Class (A, B, C, D)	Voltage (V)	Current (A)	Frequency (Hz)	Total Harmonic Distortion (%)
A	242.06	0.0498	50	280.2
Harmonic #	**Measured (A)**	**Limit(A)✧**	**Results**	**Notes**
3	0.0172	2.300	Pass	No Anomalies
5	0.0168	1.140	Pass	No Anomalies
7	0.0163	0.770	Pass	No Anomalies
9	0.0156	0.400	Pass	No Anomalies
11	0.0148	0.330	Pass	No Anomalies
13	0.0139	0.21	Pass	No Anomalies
15-39	0.0128-0.0023	0.150- 0.058	Pass	No Anomalies
2	0.0025	1.080	Pass	No Anomalies
4	0.0025	0.430	Pass	No Anomalies
6	0.0025	0.300	Pass	No Anomalies
8-40	0.0024-0.0006	0.230- 0.046	Pass	No Anomalies

Table 9. Harmonics, Test Results

Electromagnetic Compatibility Emission

Harmonic Current Emissions



Photograph 3. Harmonic Current Emissions, Test Setup

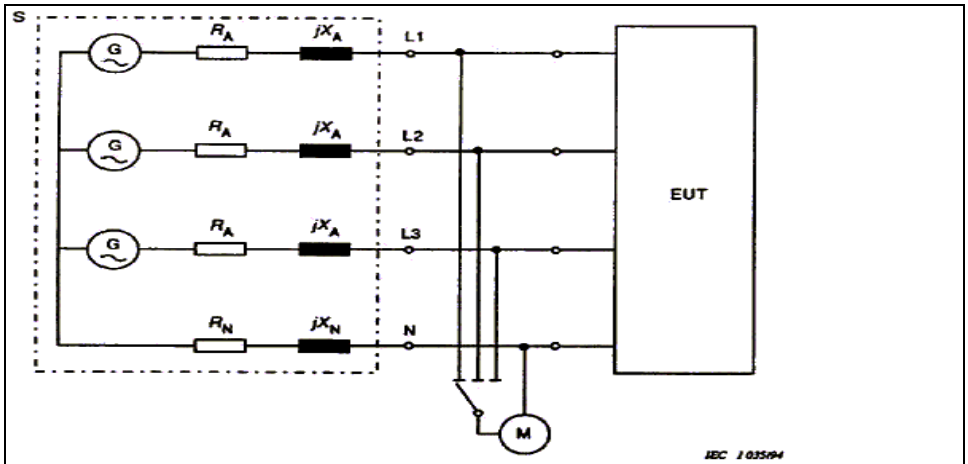
Electromagnetic Compatibility Emission

3.3 Voltage Fluctuations (Flicker)

Test Requirement(s): **ETSI EN 301 489-1, Clause 8.6:**

The EUT must not produce voltage fluctuations and/or flicker at the supply terminals as measured or calculated according to clause 4, according to limits expressed in *Clause 5*, under test conditions described in *Clause 6* and *Annex A* of *EN 61000-3-3.*

Test Procedure: The EUT was placed on a non-metallic table inside a shielded enclosure (See Photograph 4). The EUT was situated such that the sides of the EUT were no closer than 2.0 m from the walls of the shielded enclosure. The EUT was operated with an AC main source at 220 V. Tests to prove the compliance of the EUT with the limits of *EN 61000-3-3, Section 5* were made using the test circuit provided in Figure 2 of *EN 61000-3-3*. The test circuit consisted of the test power supply, the reference impedance, the EUT, and a flickermeter. The test supply voltage (open-circuit voltage) was the rated voltage of the equipment. The test voltage was maintained within 2% of the nominal value. The frequency was 50 Hz 0.5%. The total harmonic distortion of the supply voltage was less than 3%. The limits applicable to voltage fluctuations and flicker at the supply terminals of the EUT were automatically measured with the analyzer.



EUT equipment under test

M measuring equipment

S supply source consisting of the supply voltage generator G and reference impedance Z with the elements:

R_A = 0,24 Ω; jX_A = 0,15 Ω at 50 Hz;

R_N = 0,16 Ω; jX_N = 0,10 Ω at 50 Hz.

The elements include the actual generator impedance.

When the source impedance is not well defined, see 6.2.

G voltage source in accordance with 6.3.

NOTE – In general, three-phase loads are balanced, and R_N and X_N can be neglected, as there is no current in the neutral wire.

Figure 2. Test Circuit for EN 61000-3-3

Electromagnetic Compatibility Emission

Voltage Fluctuations (Flicker)

Test Results: The EUT was found compliant with the specified requirements of Clause 8.6.

Test Engineer(s): Junwei Zhang

Test Date(s): 11/18/11

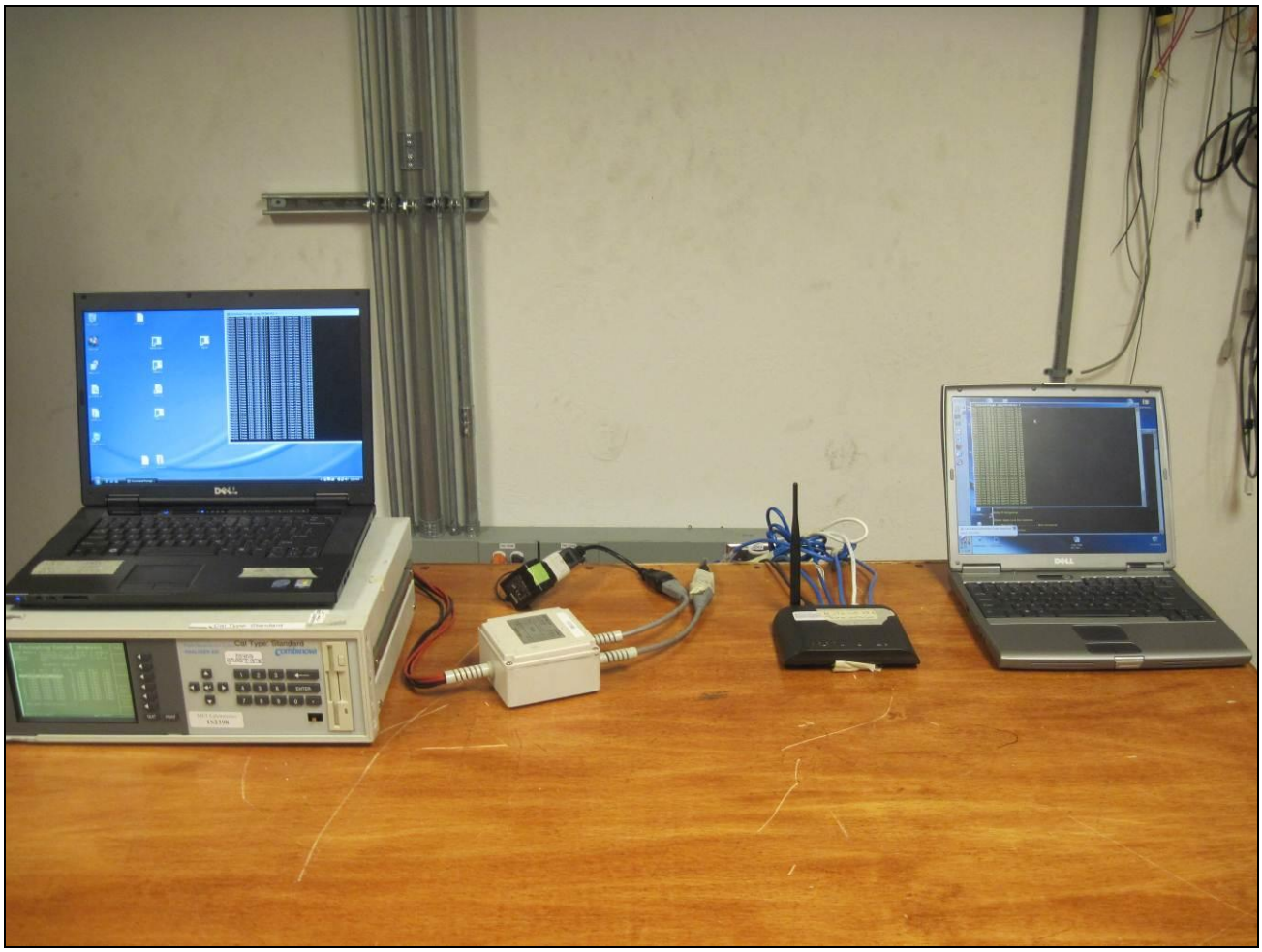
Voltage (V)	Current (A)	Frequency (Hz)	Power Factor
242.0	0.0496	50.01	0.323

Average (Is) relative voltage Drop		**d(t)**	0.003	
Relative voltage fluctuation (3s)		**Dpp**	0.003	
d(t) at steady - state level		**YES /NO**	Yes	
Last relative steady - state level change		**Dc**	0.000	
Last transition swing		**Dmax**	--	
Normalized peak flicker (3s)		**Pp**	0.00	
Parameter		**Observation Period**	Limit	
		Short	**Long**	
Observation Time	**Tp**	10 min	120 min	
Maximum relative voltage change	**dmax**	0.00	0.00	4
Max rel. steady-state voltage change	**dc**	0.00	0.00	3
Duration of d(t) > 3 %	**t**	0.00	0.00	0.2
Short term flicker severity	**Pst**	0.00	0.00	1.0
Long term flicker severity	**Plt**	NA	0.00	0.65

Table 10. Flicker, Test Results

Electromagnetic Compatibility Emission

Voltage Fluctuations (Flicker)



Photograph 4. Voltage Fluctuations (Flicker), Test Setup

Electromagnetic Compatibility Emission

3.4 Telecommunications Ports

Test Requirement(s): **ETSI EN 301 489-1, Clause 8.7:**

The EUT must be in accordance with EN 55022 (2006), Section 5.2.

The EUT shall meet the Conducted Common Mode limits shown in Table 11:

Frequency Range (MHz)	Voltage Limits (dBµV)		Current Limits (dBµA)	
	Quasi-Peak	Average	Quasi- Peak	Average
0.15 - 0.5	84 to 74	74 to 64	40 to 30	30 to 20
0.5 - 30	74	64	30	20
Note: The limits decrease linearly with the logarithm of the frequency in the range of 0.15 MHz to 0.5 MHz. The current and voltage disturbnace limits are derived for use with an ISN which presents a common mode (asymetric mode) impedance of 150 Ω to the telecommunication port under test (conversion factor is 20 Log_{10} 150/1 = 44 dB).				

Table 11. Limits of Conducted Common Mode (Asymmetric Mode) Disturbance at Telecommunication Ports from Clause 5.2 of EN 55022 Class B

Test Procedure: The EUT was placed on a non-metallic table located in a shielded enclosure (See Photograph 5). The measurements were performed using normal operation of the equipment. The method of testing, test conditions, and test procedures of *Clause 9* of *EN 55022* were used. The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using an ISN, Current Probe or Capacitive Voltage Probe as the input transducer to an EMC field intensity meter.

Environmental Conditions for Conducted Emission	
Ambient Temperature:	22.5°C
Relative Humidity:	34%

Test Results: The EUT was found compliant with the requirement(s) of this section.

Test Engineer(s): Junwei Zhang

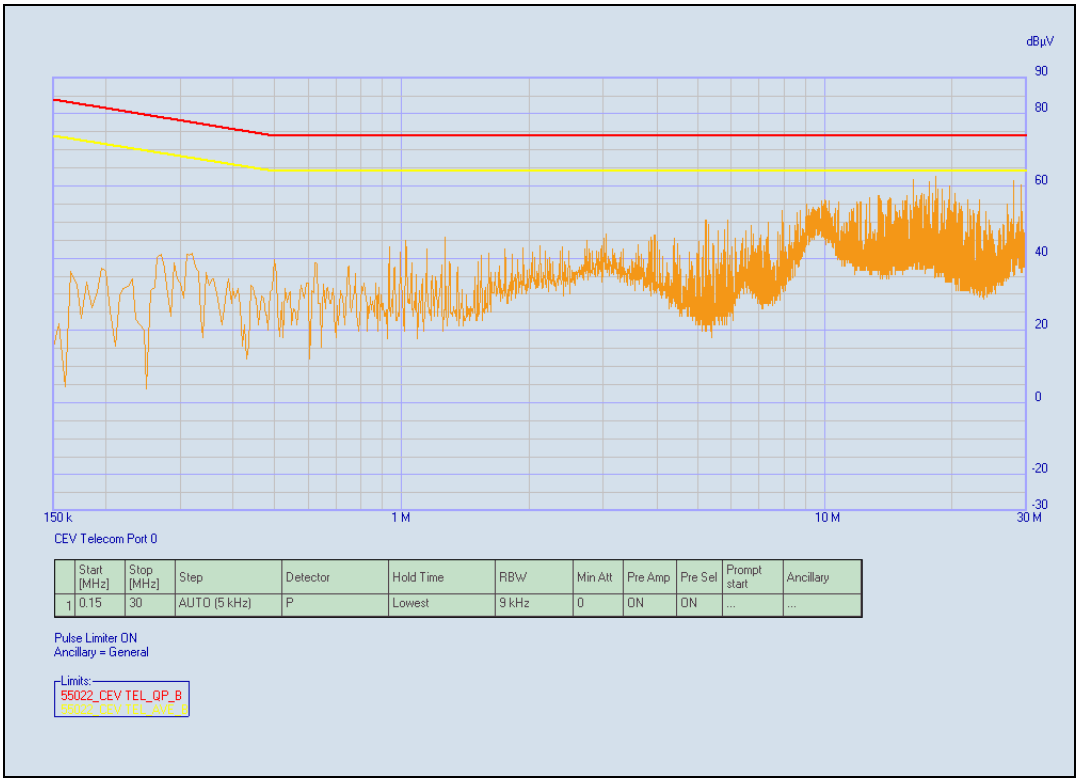
Test Date(s): 11/23/11

Limits for Conducted Disturbance at Telecommunication Ports

Conducted Emissions - Voltage for Telecommunication Ports, Worst Case Emissions, Port 0 Line

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
CEV Telecom Port 0	16.225	60.85	74	-13.15	Pass	58.02	64	-5.98	Pass
CEV Telecom Port 0	17.695	60.43	74	-13.57	Pass	59.02	64	-4.98	Pass
CEV Telecom Port 0	18.245	61.96	74	-12.04	Pass	59.76	64	-4.24	Pass
CEV Telecom Port 0	19.71	58.8	74	-15.2	Pass	56.24	64	-7.76	Pass
CEV Telecom Port 0	28.05	60.01	74	-13.99	Pass	57.52	64	-6.48	Pass
CEV Telecom Port 0	29.055	55.02	74	-18.98	Pass	46.39	64	-17.61	Pass

Table 12. Limits for Conducted Disturbance at Telecommunication Ports Test Results, Port 0



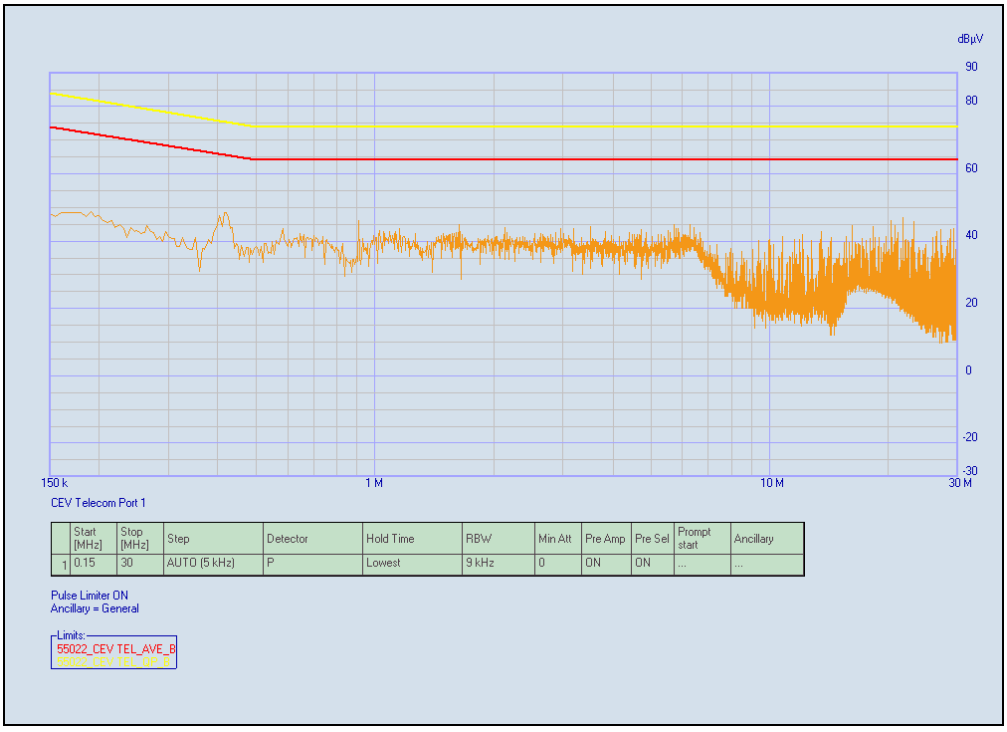
Plot 3. Conducted Emission Limits for Telecommunications Ports, Port 0 Plot

Limits for Conducted Disturbance at Telecommunication Ports

Conducted Emissions - Voltage for Telecommunication Ports, Worst Case Emissions, Port 1 Line

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
CEV Telecom Port 1	0.155	59.2	83.728	-24.528	Pass	53.8	73.728	-19.928	Pass
CEV Telecom Port 1	0.235	73.95	80.271	-6.321	Pass	47.3	70.271	-22.971	Pass
CEV Telecom Port 1	0.425	55.32	75.35	-20.03	Pass	48.58	65.35	-16.77	Pass
CEV Telecom Port 1	1.36	47.43	74	-26.57	Pass	39.32	64	-24.68	Pass
CEV Telecom Port 1	3.955	48.79	74	-25.21	Pass	42.18	64	-21.82	Pass
CEV Telecom Port 1	23.13	58.28	74	-15.72	Pass	55.42	64	-8.58	Pass

Table 13. Limits for Conducted Disturbance at Telecommunication Ports Test Results, Port 1



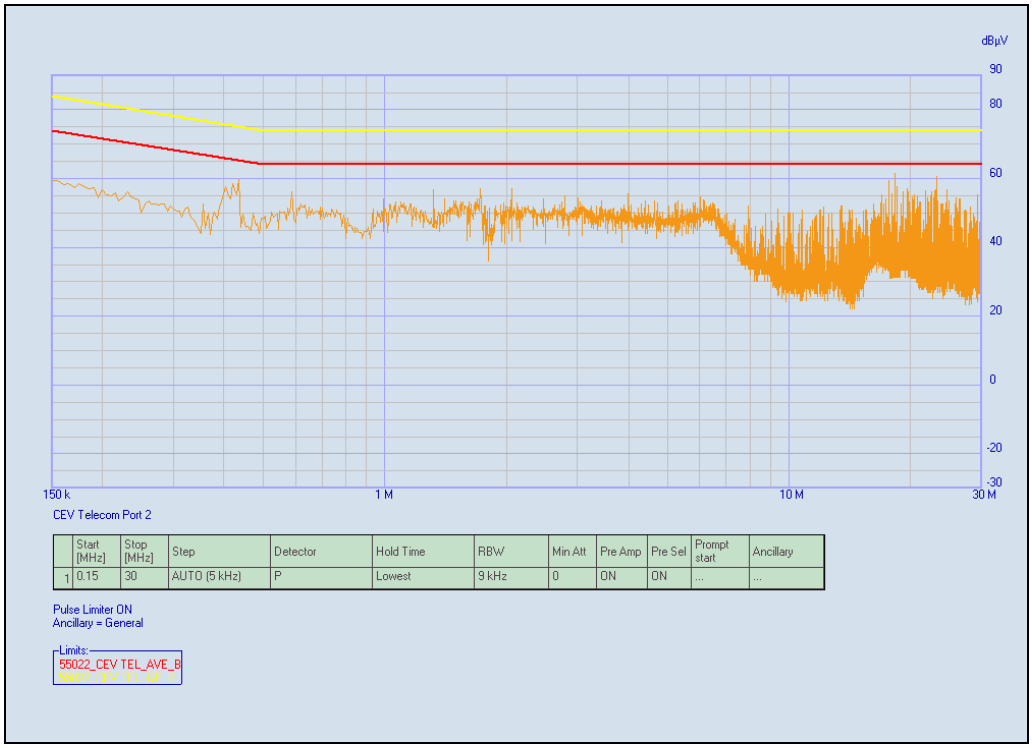
Plot 4. Conducted Emission Limits for Telecommunications Ports, Port 1 Plot

Limits for Conducted Disturbance at Telecommunication Ports

Conducted Emissions - Voltage for Telecommunication Ports, Worst Case Emissions, Port 2 Line

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
CEV Telecom Port 2	0.155	57.64	83.728	-26.088	Pass	53.42	73.728	-20.308	Pass
CEV Telecom Port 2	0.435	62.39	75.157	-12.767	Pass	54.95	65.157	-10.207	Pass
CEV Telecom Port 2	17.695	59.4	74	-14.6	Pass	57.87	64	-6.13	Pass
CEV Telecom Port 2	18.24	60.45	74	-13.55	Pass	60.39	64	-3.61	Pass
CEV Telecom Port 2	18.49	54.68	74	-19.32	Pass	56.33	64	-7.67	Pass
CEV Telecom Port 2	23.13	59.5	74	-14.5	Pass	56.29	64	-7.71	Pass

Table 14. Limits for Conducted Disturbance at Telecommunication Ports Test Results, Port 2



Plot 5. Conducted Emission Limits for Telecommunications Ports, Port 2 Plot

Limits for Conducted Disturbance at Telecommunication Ports

Photograph 5. Limits for Conducted Disturbance at Telecommunication Ports

4.0 Electromagnetic Compatibility Immunity Criteria

4.1 Radio Frequency Electromagnetic Field

Test Requirement(s): **ETSI EN 301 489-1, Clause 9.2:**

Per *EN 61000-4-3*, the EUT must not be susceptible to a radiated electromagnetic field of 3 V/m, 80% amplitude modulated, in the frequency range 80 MHz to 1000 MHz and 1400 MHz to 2700 MHz (EN 61000-4-3). Performance criterion A applies.

The EUT was placed on a non-metallic table in the center of a 20' x 12' x 8' enclosure, and the radiating antenna was placed 3 m in front of the EUT (See Photograph 7). Support equipment for the EUT was located outside of the test room. The EUT was exposed to the required immunity fields. The amplitude and frequency of the radiated interference was set by an automated, computer-controlled system.

The chamber and signal generation/amplification system is calibrated to insure a uniform RF field with no EUT present. The recorded signal is played back by the controlling computer with the EUT placed in the area of uniform field. The signal source was stepped through the applicable frequency range at a rate no faster than 1% of the fundamental, as recommended in EN 61000- 4-3. The signal was amplitude modulated 80% over the frequency range 80 MHz to 1000 MHz and 1400 MH to 2700 MHz at a level of 3 V/m. Field presence was monitored during testing via a field probe placed in close proximity to the EUT. Throughout testing, the EUT was closely monitored for signs of susceptibility. The test was performed with the antennae oriented in both a horizontal and vertical polarization. Testing was performed in a semi-anechoic chamber.

Test Results: The EUT as tested was compliant with the requirements of Clause 9.2.

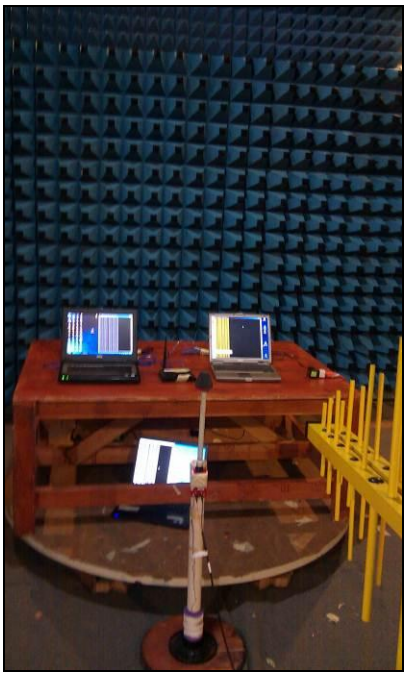
Test Engineer(s): Junwei Zhang

Test Date(s): 11/29/11

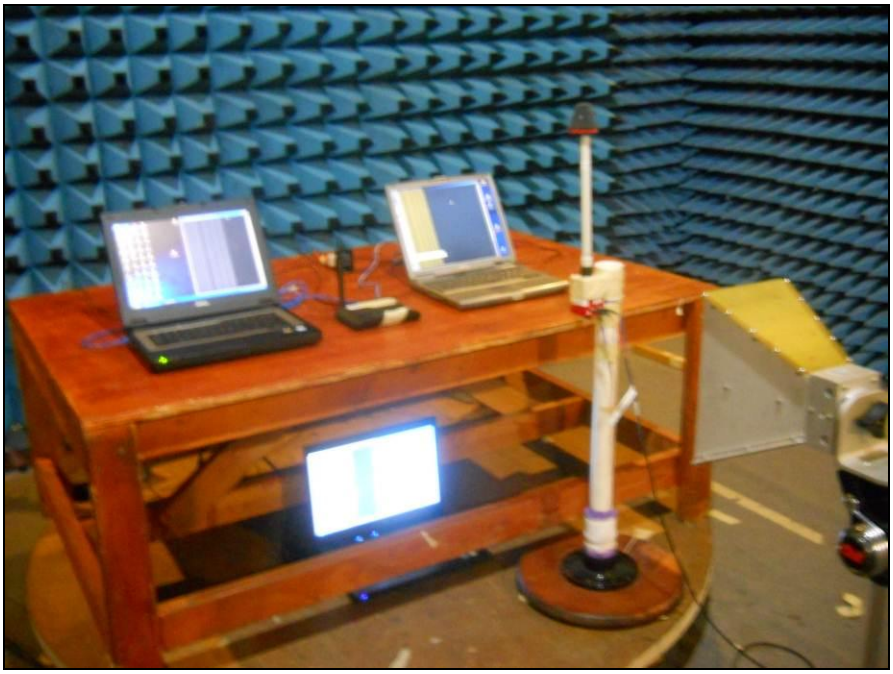
Start Frequency (MHz)	Stop Frequency (MHz)	Severity (V/m)	Polarity (H/V)	Modulation (Freq & Type)	Results			
					Front	Back	Left	Right
80	1000	3	V	1 kHz, 80%AM	Pass	Pass	Pass	Pass
80	1000	3	H	1 kHz, 80%AM	Pass	Pass	Pass	Pass
1400	2700	3	V	1 kHz, 80%AM	Pass	Pass	Pass	Pass
1400	2700	3	H	1 kHz, 80%AM	Pass	Pass	Pass	Pass

Table 15. Radiated Immunity, Test Results

Radio Frequency Electromagnetic Field



Photograph 6. Radio Frequency Electromagnetic Field, Test Setup, 80 MHz – 1 GHz



Photograph 7. Radio Frequency Electromagnetic Field, Test Setup, 1.4 GHz – 2.7 GHz

Electromagnetic Compatibility Immunity

4.2 Electrostatic Discharge

Test Requirement(s): **ETSI EN 300 489-1 Clause 9.3:**

Per *EN 61000-4-2*, the EUT was tested with air discharges of up to ± 8 kV, applied to non-conductive surfaces, and to contact discharges of up to ± 4 kV, applied to conductive surfaces of the EUT and the VCP. Performance Criterion B applies.

The EUT was placed on a non-metallic table located above a ground reference plane (GRP) (See Photograph 15), with a thickness of at least 0.25 mm, thus satisfying the requirements of *IEC 61000-4-2*:

> It [the GRP] shall be a metallic sheet (copper or aluminum) of 0.25 mm minimum thickness.... The minimum size of the reference plane is 1 m2, the exact size depending on the dimensions of the EUT. It shall project beyond the EUT or coupling plane by at least 0.5 m on all sides....

A horizontal coupling plane (HCP), 1.6 m x 0.8 m, shall be placed on the table. The EUT and cables shall be isolated from the coupling plane by an insulating support 0.5 mm thick.

A copper vertical coupling plane (VCP) measuring 0.5 m X 0.5 m was placed 0.1 m from the EUT. The VCP was connected to the GRP through two series 470 k Ω resistors. The GRP was connected to safety ground. The EUT was connected to the grounding system through its power cable only, in accordance with *EN 61000-4-2, Section 7.1, paragraph 4*:

> The EUT shall be connected to the grounding system in accordance with its installation specifications. No additional grounding connections are allowed.

Ambient Temperature:	21.2°C
Relative Humidity:	23%
Atmospheric Pressure:	101.9 kPa

Environmental Conditions during EN 61000-4-2 Testing

Electromagnetic Compatibility Immunity

Electrostatic Discharge

Test Procedure: Air discharges of up to ± 8kV were applied to non-conductive surfaces. Contact discharges of up to ± 4 kV were applied to conductive surfaces of the EUT. Contact discharges of ± 4 kV were applied to the VCP. Negative and positive discharges were applied at least ten times to each selected discharge point. The functionality of the EUT was determined during and after each discharge in accordance with Performance Criterion %%ESDC%%.

Test Results: The EUT as tested was compliant with the requirements of Clause 9.3.

Test Engineer(s): Junwei Zhang

Test Date(s): 12/01/11

Discharge Type	Test Voltage (±kV)	Results					Anomalies
		Front	Back	Left	Right	Top	
HCP	2	Pass	Pass	Pass	Pass	N/A	None
	4	Pass	Pass	Pass	Pass	N/A	None
VCP	2	Pass	Pass	Pass	Pass	N/A	None
	4	Pass	Pass	Pass	Pass	N/A	None
Contact Discharge	2	N/A	*Pass	N/A	N/A	N/A	*see anomaly list
	4	N/A	*Pass	N/A	N/A	N/A	*see anomaly list
Air Discharge	2	Pass	Pass	Pass	Pass	Pass	None
	4	Pass	Pass	Pass	Pass	Pass	None
	6	Pass	Pass	Pass	Pass	Pass	None
	8	Pass	Pass	Pass	Pass	Pass	None

Table 16. Electrostatic Discharge, Test Results

Anomalies:
+/-2kV back side: Discharge was applied on USB port. Time out occurred during duration of discharge, unit recovered without manual intervention.

+/-4kV back side: Discharge was applied on USB port. Time out occurred during duration of discharge, unit recovered without manual intervention.

Electrostatic Discharge, Test Points

Photograph 8. ESD Test Points, Top View

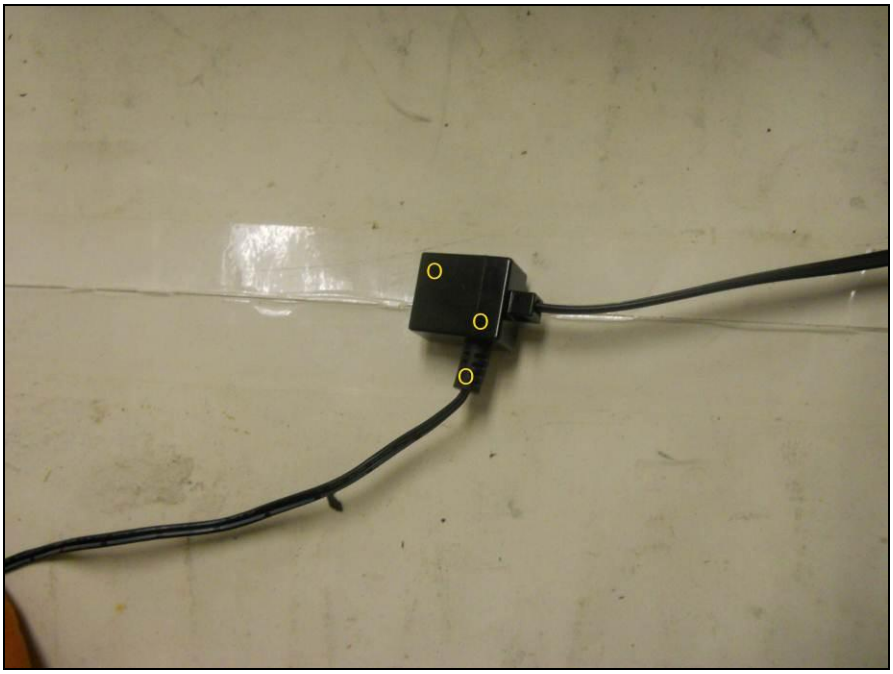
Photograph 9. ESD Test Points, Rear View

O = Air Discharge

Photograph 10. ESD Test Points, Front View

Photograph 11. ESD Test Points, Left View

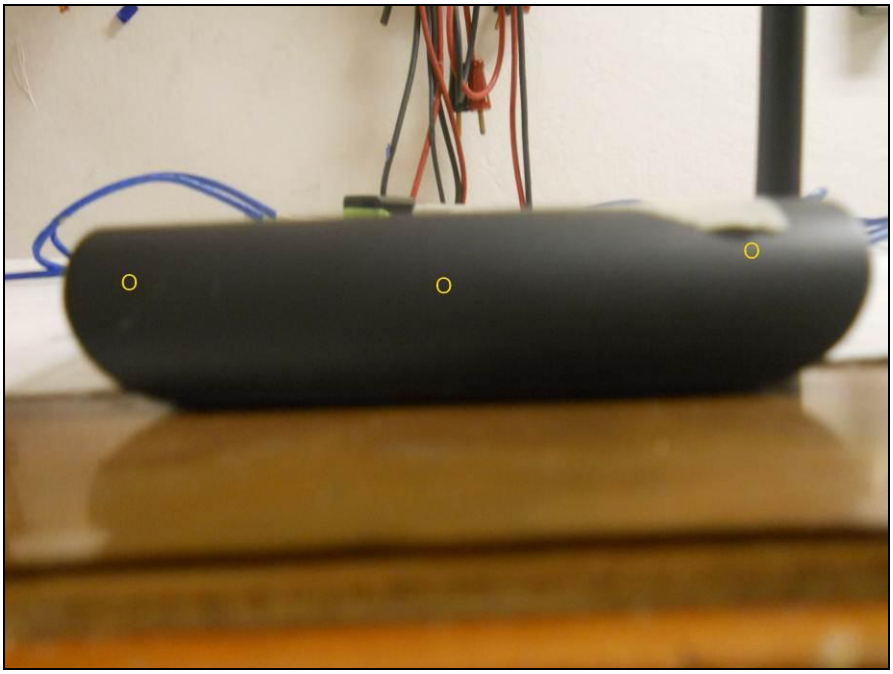
O = Air Discharge



Photograph 12. ESD Test Points, POE

Photograph 13. ESD Test Points, Power Adapter

O = Air Discharge



Photograph 14. ESD Test Points, Right View

O = Air Discharge

Photograph 15. Electrostatic Discharge, Test Setup

Electromagnetic Compatibility Immunity

4.3 Fast Transient, Common Mode

Test Requirement(s): **ETSI EN 300 489-1, Clause 9.4:**

Per *EN 61000-4-4*, The EUT was tested with the electrical fast transients shown in Figure 3, having an amplitude of ± 1 kV applied to the AC power cables (plug type); ± 0.5 kV applied to I/O and data lines. Only cables that could potentially exceed 3 m in length in real-world application of the EUT need be tested. Performance criterion B applies for all tests.

Test Procedure: The EUT was placed on a non-metallic table above a GRP extending at least 1 m beyond all sides of the EUT (See Photograph 16). The Electrical Fast Transient/Burst (EFT/B) generator and the coupling clamp were mounted to the ground plane. For application of the fast transients to the power lines, power was supplied to the EUT through the EFT/B generator. For application of the fast transients to I/O, data and control lines, the cables were individually placed in the coupling clamp, which was also connected to the EFT/B generator.

The EFT/B generator was operated to couple the required transient bursts to each line of the power input in common mode. Transient bursts were applied for a period not less than one minute with both positive transients and negative transients.

The EUT was then powered from an isolated circuit, and selected I/O, data and control cables were placed one at a time in the capacitive coupling clamp. The EFT/B generator was operated to inject the required bursts onto each selected cable via the coupling clamp.

Throughout testing, the EUT was monitored closely for signs of susceptibility.

Electromagnetic Compatibility Immunity

Fast Transient, Common Mode

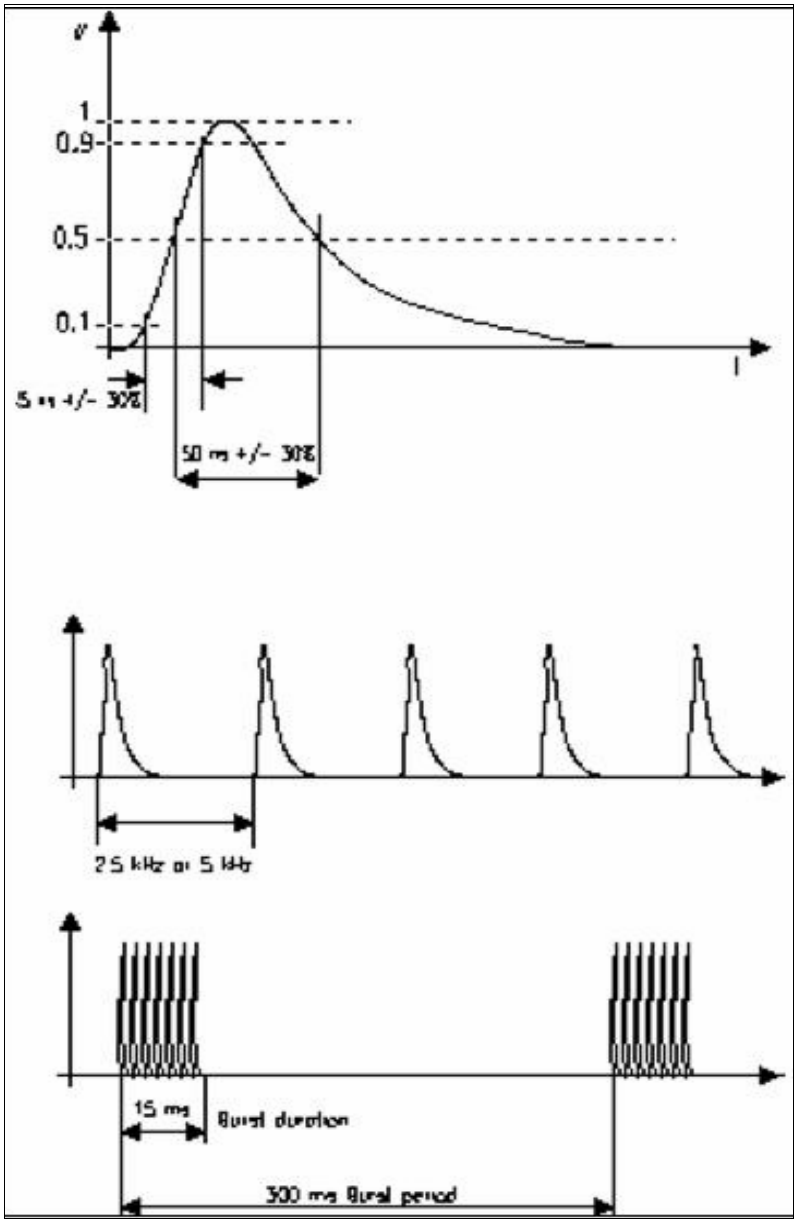


Figure 3. EN 61000-4-4 Test Waveform

Electromagnetic Compatibility Immunity

Fast Transient, Common Mode

Test Results: The EUT as tested was found compliant with the requirements of Clause 9.4.

Test Engineer(s): Anderson Soungpanya

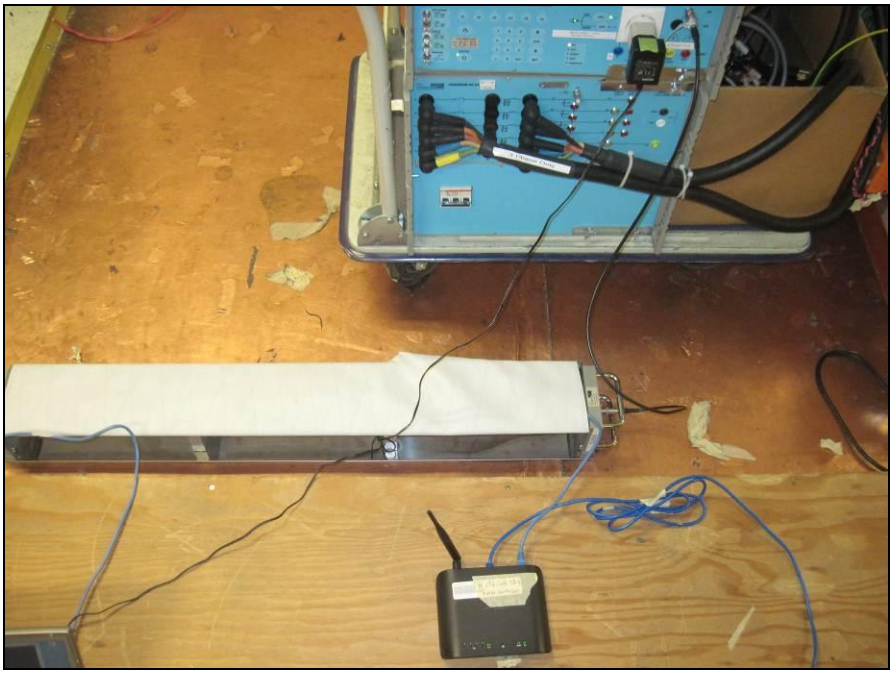
Test Date(s): 11/30/11

Port Name	Slot/EUT Side	Test Level	PASS	Anomalies
AC Power				
Phase	Back	±1 kV	Pass	Time out occurred during duration of discharge, unit recovered without manual intervention.
Neutral	Back	±1 kV	Pass	Time out occurred during duration of discharge, unit recovered without manual intervention.
Port Name	**Slot/EUT Side**	**Test Level**	**PASS**	**Anomalies**
I/O Cables				
LAN POE	Back	±0.5 kV	Pass	Time out occurred during duration of discharge, unit recovered without manual intervention.
LAN IO	Back	±0.5 kV	Pass	Time out occurred during duration of discharge, unit recovered without manual intervention.

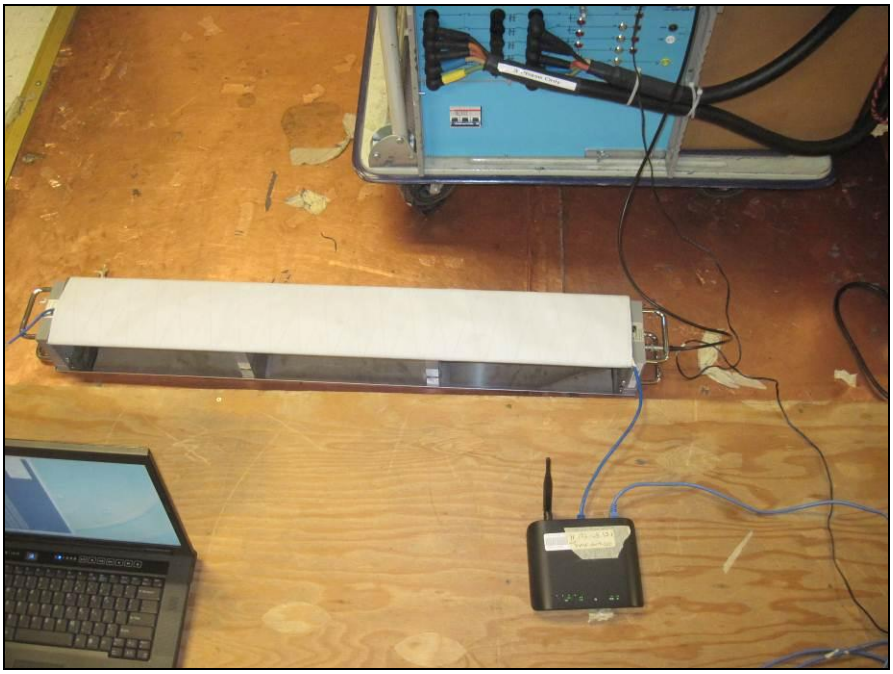
Table 17. Fast Transient, Test Results

Fast Transient, Common Mode

Photograph 16. Fast Transient, Common Mode, Test Setup, AC Mode



Photograph 17. Fast Transient, Common Mode, Test Setup, I/O Mode (1)



Photograph 18. Fast Transient, Common Mode, Test Setup, I/O Mode (2)

Electromagnetic Compatibility Immunity

4.4 Radio Frequency, Common Mode

Test Requirement(s): **ETSI EN 300 489-1, Clause 9.5:**

Per *EN 61000-4-6*, all interconnecting cables on the EUT including AC power lines, data and control lines shall be tested for immunity to conducted radio frequencies in the range 0.15 MHz - 80 MHz. Using the bulk current injection method, I/O and data cables must be tested to a level of 3 Vrms. The injection voltage shall be amplitude modulated at 80% by a 1 kHz tone. Performance Criterion A applies for all tests.

Test Procedure: The EUT was placed on a non-metallic table above a GRP extending at least 1 m beyond all sides of the EUT (See Photograph 19). For power line cables, a Coupling Decoupling Network (CDN) was used. The CDN was initially calibrated in a calibration jig with a 50 Ω RF load and a 100 Ω matching resistor on one side, and a 100 Ω matching resistor and the receiver (spectrum analyzer) on the other. The injection voltage level was adjusted to maintain a monitored voltage of 3 Vrms across the frequency range (0.15 MHz to 80 MHz).

For cables other than the power line in the frequency range 0.15 MHz - 80 MHz, the BCI was initially calibrated in a calibration jig with a 50 Ω RF load and a 100 Ω matching resistor on one side, and a 100 Ω matching resistor and the receiver (spectrum analyzer) on the other. The injection voltage level was adjusted to maintain a monitored voltage of 3 Vrms across the frequency range (0.15 MHz to 80 MHz). The BCI was clamped around the cable under test at a distance of 0.1 to 0.3 m from the EUT.

Test Results: The EUT as tested was found compliant with the requirements of Clause 9.5.

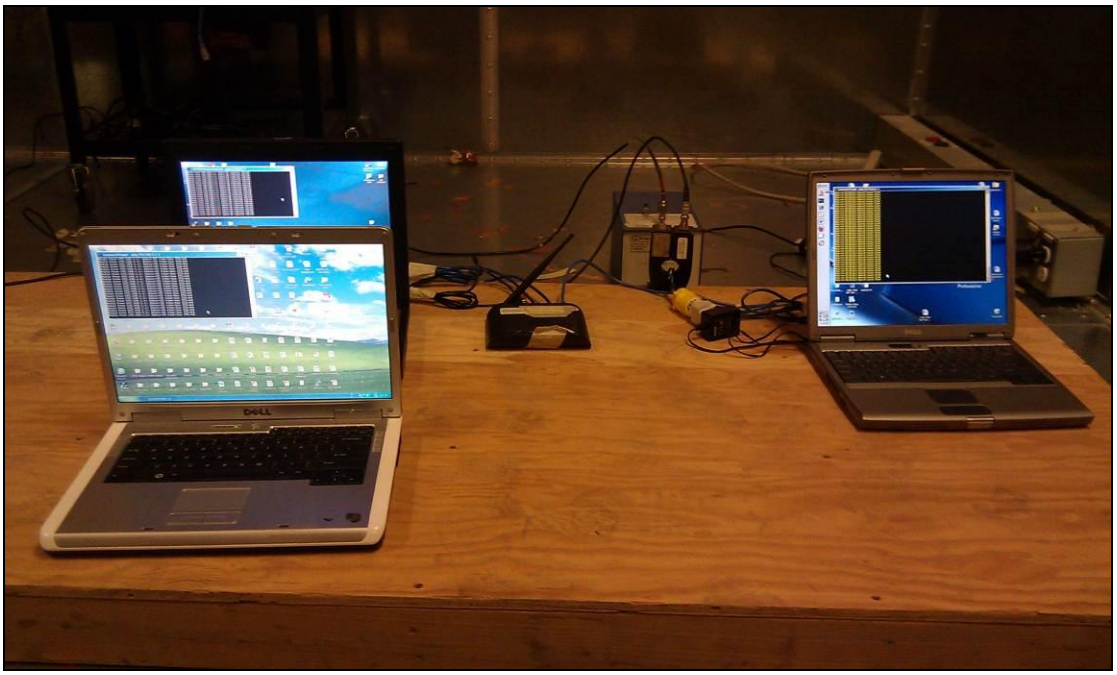
Test Engineer(s): Junwei Zhang and Daniel Salinas

Test Date(s): 11/28/11

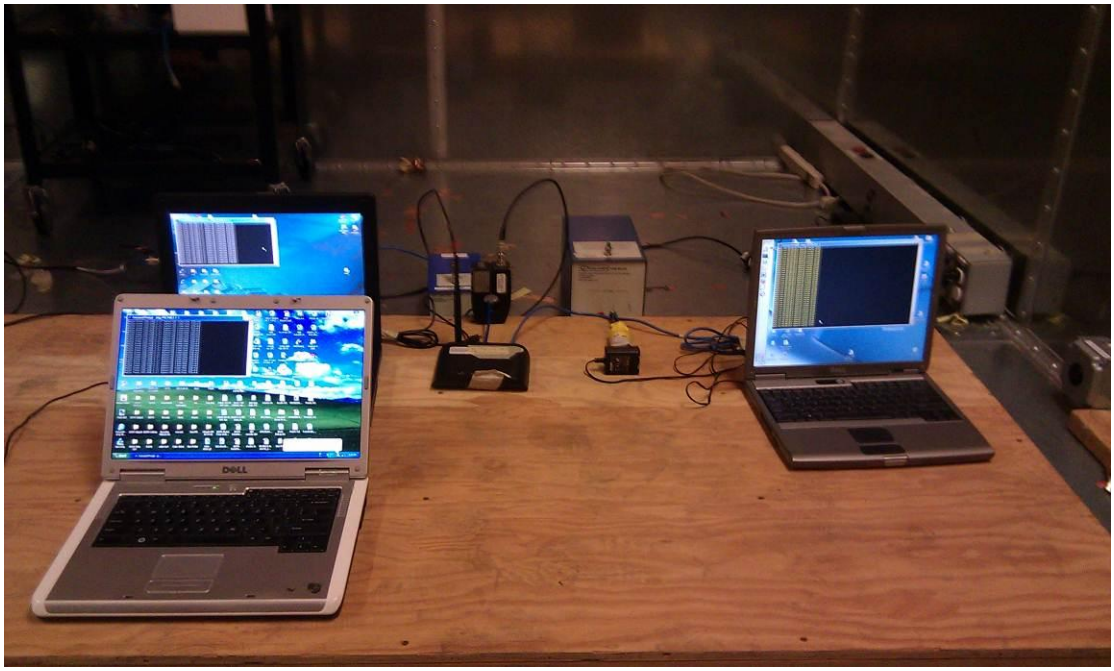
Slot/EUT Side	Port Name	Results / Anomalies
PSU	AC power input	Pass: No Anomalies
Rear	IO	Pass: No Anomalies
Rear	POE	Pass: No Anomalies

Table 18. Conducted Immunity, Test Results

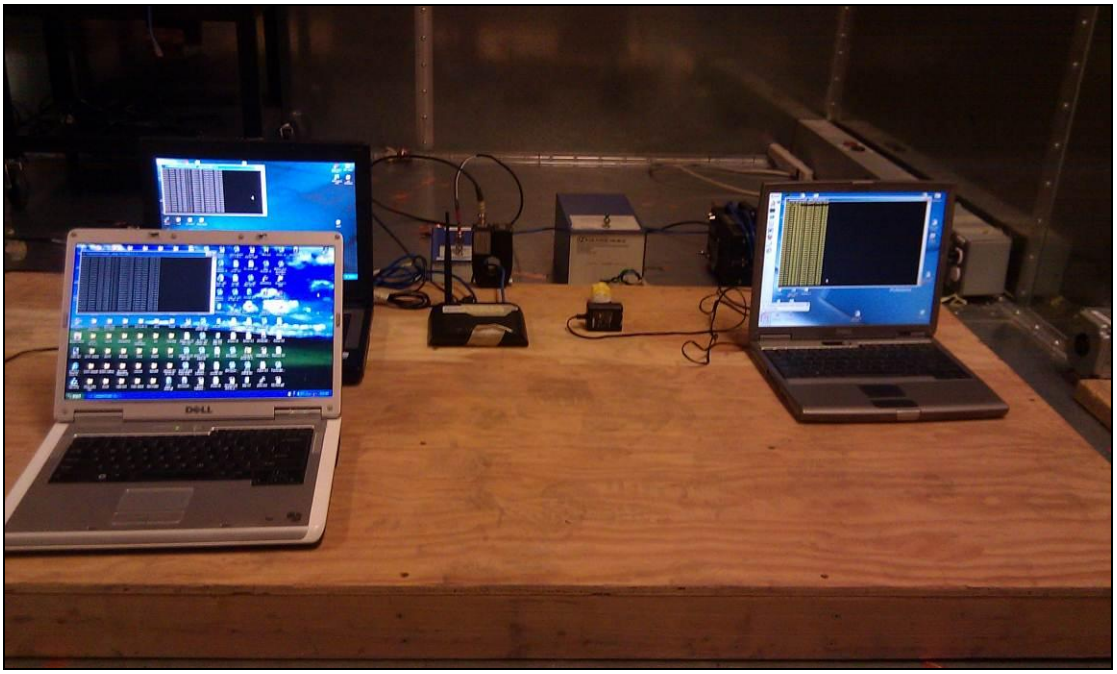
Radio Frequency, Common Mode



Photograph 19. Radio Frequency, Common Mode, Test Setup, AC Mode



Photograph 20. Radio Frequency, Common Mode, Test Setup, I/O Mode



Photograph 21. Radio Frequency, Common Mode, Test Setup, POE Mode

Electromagnetic Compatibility Immunity

4.5 Voltage Dips and Short Interruptions

Test Requirement(s): **ETSI EN 300 489-1, Clause 9.7:**

Per *EN 61000-4-11*, the EUT shall be tested for the following voltage dips, interruptions and variations:

5.2.4.4 Voltage Dips and Short Interruptions		
Unit	**Test level and Characteristic**	**Performance Criterion**
Voltage reduction % Duration ms	>95 10	B
Voltage reduction % Duration ms	30 500	C
Voltage reduction % Duration ms	>95 5000	C

Table 19. Voltage Dips and Short Interruptions Limits

Test Procedure: The EUT was placed on a non-metallic table and situated in the center of a GRP. The EUT was provided with AC power via the programmable power supply (See Photograph 22). The power supply was programmed to perform the applicable set of voltage dips, interruptions and variations. Each sequence was repeated three times to verify the results.

Results: The EUT as tested was found compliant with the requirements of Clause 9.7.

Test Engineer: Anderson Soungpanya

Test Date: 11/30/11

Test Type	Parameters	No of Rep.	Criterion Required	Criterion Achieved	Results	Anomalies
Voltage Dips	0% drop for 10 ms or 1/2 cycle	3	B	A	Pass	No Anomalies
Voltage Dips	0% drop for 20 ms or 1 cycle	3	B	A	Pass	No Anomalies
Voltage Dips	70% drop for 500 ms or 25 cycles	3	C	A	Pass	No Anomalies
Short Interrupts	0% drop for 5000 ms or 250 cycles	3	C	B	Pass	No Anomalies

Table 20. Voltage Dips and Interruptions, Test Results

Electromagnetic Compatibility Immunity

Voltage Dips and Short Interruptions

Photograph 22. Voltage Dips and Interruptions, Test Setup

Electromagnetic Compatibility Immunity

4.6 Surges

Test Requirement(s): **ETSI EN 301 489-1, Clause 9.8:**

The EUT was tested with the surge waveforms shown on the following page, having an open circuit amplitude of ± 0.5 kV applied to the I/O interconnection cables. Performance criterion B applies for I/O cables.

The EUT was tested with the surge waveforms shown on the following page, having an open circuit amplitude of ± 1 kV (differential mode), and ±2 kV (common mode) applied to the AC power cables. Performance Criterion B applies for AC power cables.

Test Procedure: The EUT was placed on a non-metallic table above a GRP extending at least 1 m beyond all sides of the EUT (See Photograph 23). For I/O port surges, For application of the fast transients to I/O, data and control lines, the cables were individually placed in the coupling clamp, which was also connected to the EFT/B generator. These three tests were performed with positive surges and negative surges.

AC power [where applicable] was supplied to the EUT through the Combination Wave Generator. The combination wave generator was configured to produce the following output:

Open Circuit Voltage:	Front Time = 1.2 μs Time to Half = 50 μs
Short Circuit Current:	Front Time = 8 μs Time to Half = 20 μs
Telecom wave parameters:	Front Time = 10 μs Time to Half = 700 μs

Table 21. Combination Wave Generator Test Parameters for EN 61000-4-5

Electromagnetic Compatibility Immunity

Surges

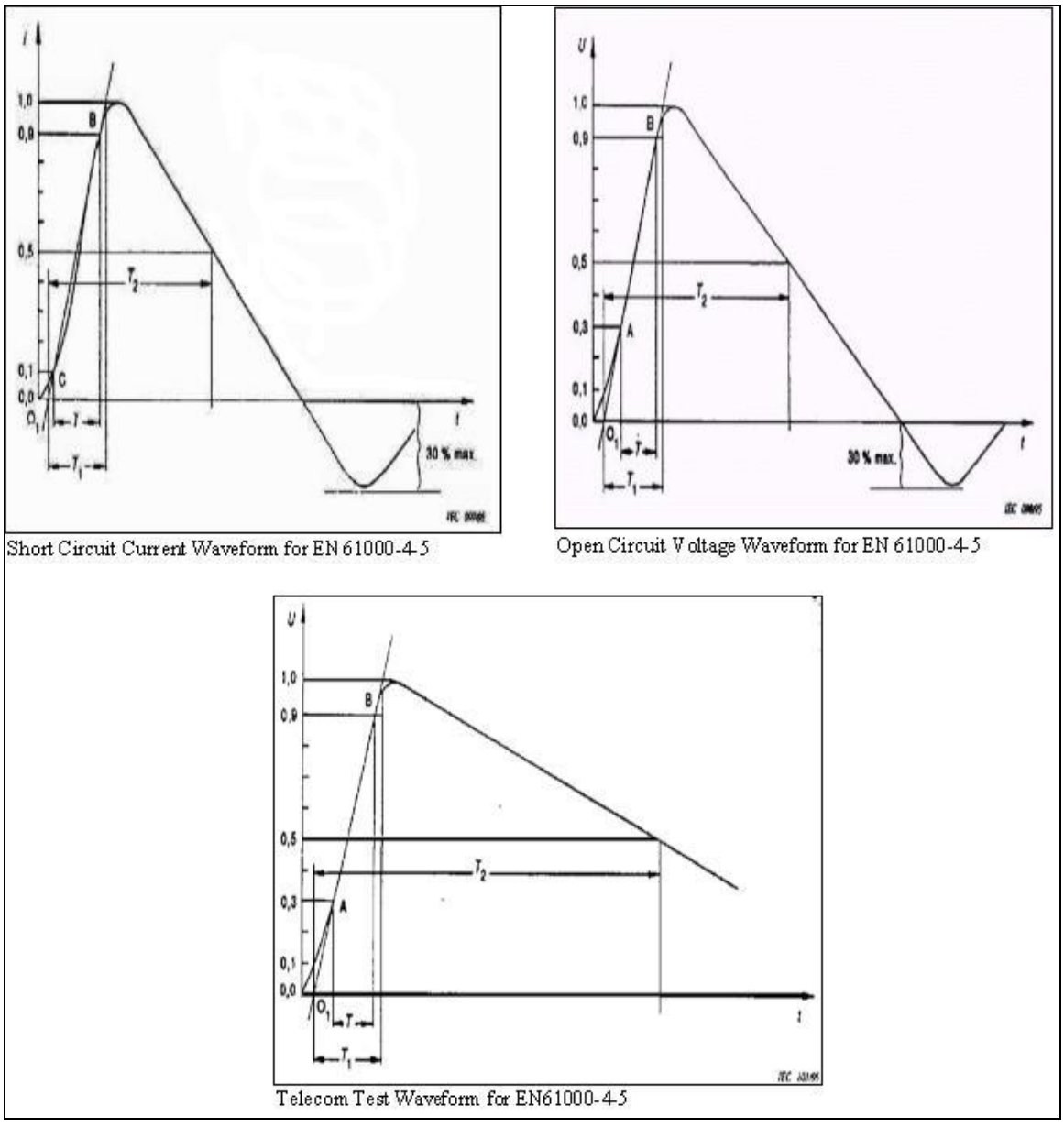


Figure 4. EN 61000-4-5 Surge Test Waveforms

Electromagnetic Compatibility Immunity

Surges

Test Procedure (Continued): For AC power lines, the Combination Wave Generator was operated to couple the required surges between each EUT input power phase and ground, and from line to line. These three tests were performed with positive surges and negative surges, synchronized with the power input phase at 0°, 90°, 180° and 270°. Throughout testing, the EUT was monitored closely for signs of susceptibility. For I/O port surges, surge waveforms were applied via a CDN, in accordance with *Section 7 of EN 61000-4-5*.

Test Results: The EUT as tested was found compliant with the requirements of Clause 9.8.

Test Engineer(s): Anderson Soungpanya

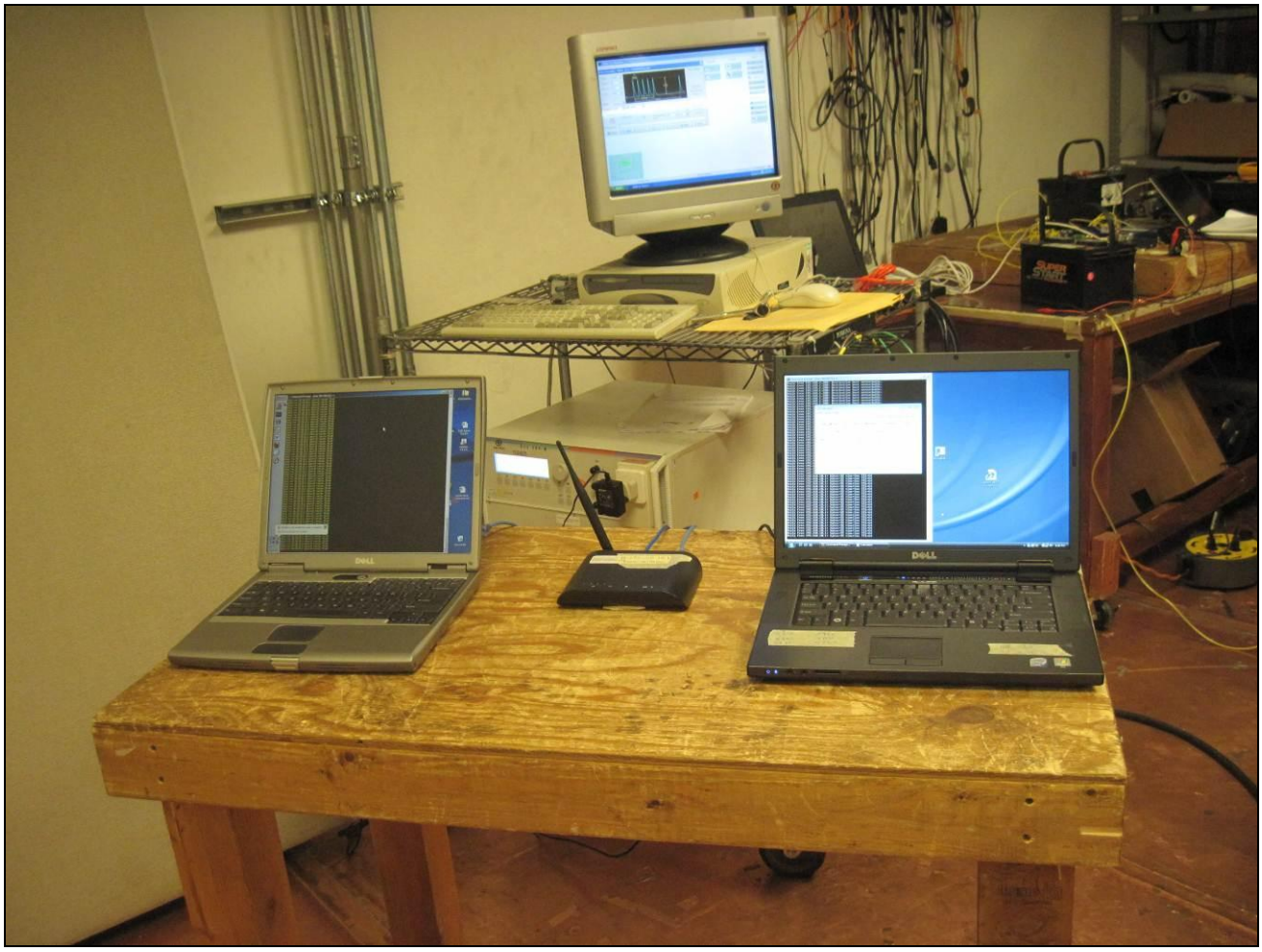
Test Date(s): 11/30/11

Port Name / Coupling	Phase	Test Level	Results	Anomalies
AC, Differential Mode				
Phase to Neutral	0, 90, 180, 270	±1.0 kV	Pass	None
Port Name / Coupling	**Phase**	**Test Level**	**Results**	**Anomalies**
IO, Differential Mode				
Phase to Neutral	N/A	±1.0 kV	N/A	EUT does not pass traffic. CDN has impact on traffic

Table 22. Surges, Test Results

Electromagnetic Compatibility Immunity

Surges



Photograph 23. Surges, Test Setup

5.0 Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

Test Name: AC Conducted Emissions Voltage Clause 8.4					Test Date(s): 09/30/11
MET Asset #	**Nomenclature**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2482	5 METER CHAMBER	PANASHIELD	5 METER SEMI-ANECHOIC CHAMBER	11/17/2010	11/17/2011
1S2607	SPECTRUM ANALYZER ESA-E	AGILENT/HP	E4407B	8/9/2011	8/9/2012
1S2633	TRANSIENT LIMITER	FISCHER CUSTOM COMMUNICATIONS INC.	FCC-450B-2.4-N	2/18/2011	2/18/2012
1S2691	DUAL-LINE V-LISN	TESEQ	NNB-51	3/31/2011	3/31/2012
Test Name: Harmonic Current Emissions Clause 8.5					**Test Date(s): 11/18/11**
MET Asset #	**Nomenclature**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2398	POWER MEASUREMENT SYSTEM	COMBINOVA	ANALYZER 300	04/19/11	04/19/12
1S2491	GROUND PLANE 3	METLABS	N/A	NOT REQUIRED	
Test Name: Voltage Fluctuations (Flicker) Clause 8.6					**Test Date(s): 11/18/11**
MET Asset #	**Nomenclature**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2398	POWER MEASUREMENT SYSTEM	COMBINOVA	ANALYZER 300	04/19/11	04/19/12
1S2491	GROUND PLANE 3	METLABS	N/A	NOT REQUIRED	
Test Name: Telecom Line Conducted Emissions Clause 8.7					**Test Date(s): 11/23/11**
MET Asset #	**Nomenclature**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2676	EMI CISPR RECEIVER	NARDA SAFETY TEST SOLUTIONS	PMM9010	2/24/2011	2/24/2012
1S2488	SCREEN ROOM	UNIVERSAL	CUSTOM MADE	SEE NOTE	
1S2659	IMPEDANCE STABILIZATION NETWORK(ISN)	FISCHER CUSTOM COMMUNICATIONS INC	F-071115-1057-1-09	9/20/2011	9/20/2012
1S2677	LISN, DUAL-LINE V-NETWORK	TESEQ	NNB 51	12/1/2010	12/1/2011
Test Name: Radiated Electromagnetic Field Clause 9.2					**Test Date(s): 11/29/11**
MET Asset #	**Equipment**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2208	HORN ANTENNA	EMCO	3115	8/23/2011	8/23/2012
1S2264	RADIATED IMMUNITY CHAMBER	LINDGREN	N/A	8/23/2011	8/23/2012
1S2401	BILOG ANTENNA	SCHAFFNER	CBL6140A	8/23/2011	8/23/2012
1S2473	AMPLIFIER	HUGHES	1277H01F000	SEE NOTE	
1S2478	TWT AMPLIFIER	COMMUNICATIONS & POWER INDUSTRIES	VZL6943J2	SEE NOTE	
1S2576	AMPLIFIER (80-1000MHZ)	AMPLIFIER RESEARCH	500W1000A	SEE NOTE	
1S2643	SIGNAL GENERATOR 40GHZ	ANRITSU	MG3694B	2/11/2011	2/11/2012
1S2702	ISOTROPIC ELECTRIC FIELD PROBE	HI-6053	HI-6053	7/27/2011	1/27/2013

Test Name: Electrostatic Discharge Immunity Clause 9.3					Test Date(s): 12/01/11
MET Asset #	**Equipment**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2470	ELECTROSTATIC DISCHARGE GUN & SIMULATOR	NOISEKEN NOISE LABORATORY CO., LTD.	TC-815R & ESS-2000	5/19/2011	5/19/2012
1S2490	GROUND PLANE 2	MET LABS	N/A	NOT REQUIRED	
1S2521	DIGITAL THERMO/HYGROMETER	CONTROL COMPANY	11-661-7D	12/2/2009	12/2/2011
Test Name: Fast Transients Clause 9.4					**Test Date(s): 11/30/11**
MET Asset #	**Equipment**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2656	TRANSIENT 2000	EMC-PARTNER	TR2000: 2000; CDN: 2000A-06-63; CN: EFT 1000	SEE NOTE	
1S2490	GROUND PLANE 2	MET LABS	N/A	NOT REQUIRED	
Test Name: Radio Frequency, Conducted Continuous Clause 9.5					**Test Date(s): 11/28/11**
MET Asset #	**Equipment**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2490	GROUND PLANE 2	MET LABS	N/A	NOT REQUIRED	
1S2400	RF CURRENT PROBE	SOLAR	6741-1	10/17/2011	4/17/2013
1S2586	COUPLING DECOUPLING NETWORK	COM-POWER	CDN-M325	SEE NOTE	
1S2621	CI FIXTURE	MET LABS	N/A	11/22/2010	12/22/2011
1S2649	SPECTRUM ANALYZER 9KHZ-1.5GHZ	AGILENT	E4401B	SEE NOTE	
Test Name: Voltage Dips and Short Interruptions Clause 9.7					**Test Date(s): 11/30/11**
MET Asset #	**Equipment**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2490	GROUND PLANE 2	MET LABS	N/A	NOT REQUIRED	
1S2634	VARIABLE POWER SUPPLY	AMETEK	MX30-480-160-704-A350-ABD-AMD-HF	SEE NOTE	
Test Name: Surges Clause 9.8					**Test Date(s): 11/30/11**
MET Asset #	**Equipment**	**Manufacturer**	**Model**	**Last Cal Date**	**Cal Due Date**
1S2423	ULTRA COMPACT SIMLULATOR	EM TEST	UCS-500M-6A	SEE NOTE	
1U0156	OSCILLISCOPE (1 GHZ, 4 CH)	TEKTRONIX	TDS5104	9/30/2011	9/30/2012
1S2490	GROUND PLANE 2	MET LABS	N/A	1/22/2011	1/22/2012

Note: Functionally verified test equipment is verified using calibrated instrumentation at the time of testing.