**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE ● BALTIMORE, MARYLAND 21230-3432 ● PHONE (410) 354-3300 ● FAX (410) 354-3313
33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587 ● PHONE (510) 489-6300 ● FAX (510) 489-6372
3162 BELICK STREET ● SANTA CLARA, CALIFORNIA 95054 ● PHONE (408 748-3585 ● FAX (510) 489-6372

June 2, 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., NanoStationM2, 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. \ EMC30567-ETS489)

**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE ● BALTIMORE, MARYLAND 21230-3432 ● PHONE (410) 354-3300 ● FAX (410) 354-3313
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# Electromagnetic Compatibility
# Test Report

For the

**Ubiquiti Networks, Inc.**
**NanoStationM2**

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: EMC30567-ETS489**

June 2, 2011

**Prepared For:**

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

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

# Electromagnetic Compatibility
# Test Report

For the

## Ubiquiti Networks, Inc.
## NanoStationM2

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: EMC30567-ETS489

Lionel Gabrillo
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 |
|---|---|---|
| ∅ | June 2, 2011 | Initial Issue. |

# Table of Contents



  

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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**H**enry** |
| **µF** | **micro**F**arad** |
| **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 NanoStationM2, under Ubiquiti Networks, Inc. purchase order number US100132.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the NanoStationM2.

The results obtained relate only to the item(s) tested.

| | |
|---|---|
| **Model(s) Tested:** | NanoStationM2 |
| **Model(s) Covered:** | NanoStationM2 |
| **EUT Specifications:** | Primary Power: 100-240 VAC |
| | 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:** | Lionel Gabrillo |
| **Report Date(s):** | June 2, 2011 |

## 1.2 Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick Street, 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 subclause 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 - EUT is not an Ancillary Equipment. |
| DC Power Input/Output Ports | ETSI EN 301 489-1, Section 8.3 | EN 55022 (2006) | Not Applicable - EUT is AC powered. |
| 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 for fixed installation not vehicular equipment. |
| 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 NanoStationM2, Equipment Under Test (EUT) for the remainder of this document, is a 2.4GHz Hi Power 2x2 MIMO AirMax Station.


**Photograph 1. Ubiquiti Networks NanoStationM2**

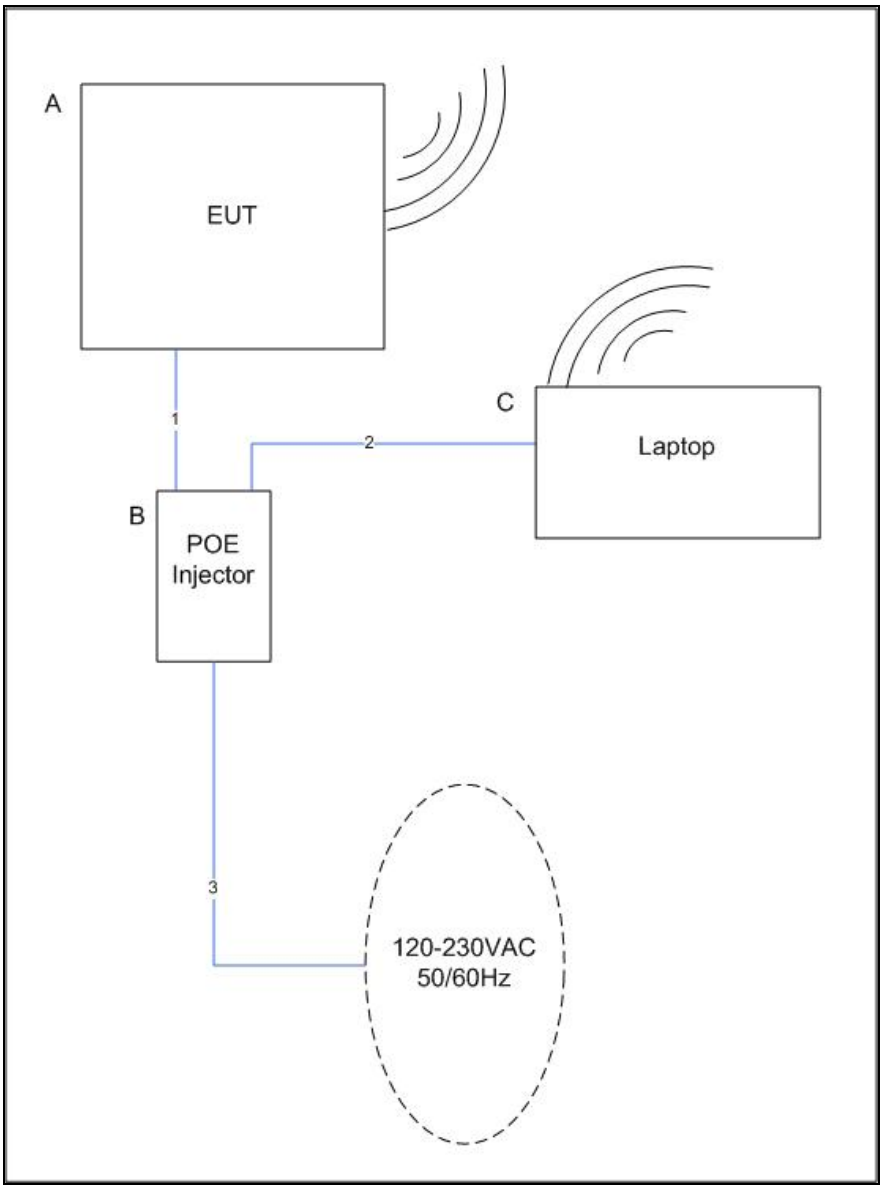



**Figure 1. Block Diagram of Test Configuration**

## 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 | Serial Number |
|---|---|---|---|
| A | NanoStationM2 | NS5 | N/A |
| A | NanoStationM2 | NS5 | N/A |
| A | NanoStationM2 | NS5 | 1O5OL 00156D9ED5C9 |
| B | Power Supply | CPWA240500US | POEZC101126181008 |
| B | Power Supply | UBI-POE-24-5 | 0912-0007163 |

**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 | Serial Number |
|---|---|---|---|---|
| C | Laptop | Dell | Vostro 1510 | 4953929473 |

**Table 4. Support Equipment**

## 2.4 Ports and Cabling Information

| Ref. ID | Port name on EUT | Cable Description or reason for no cable | Qty. | Length (m) | Shielded? (Y/N) | Termination Box ID & Port ID |
|---|---|---|---|---|---|---|
| 1 | NanoM2 - Main | Ethernet | 1 | 10 | Y | PSU – POE port |
| | NanoM2-Secondary | Ethernet | 1 | 10 | Y | Unterminated |
| 1 | PSU - POE | Ethernet | 1 | 10 | Y | NanoM2 - Main |
| 2 | PSU - LAN | Ethernet | 1 | 10 | Y | Laptop |
| 3 | AC port | AC Cable | 1 | 0.5 | Y | 100-240VAC Source |

**Table 5. Ports and Cabling Information**

## 2.5 Mode of Operation

Transmit 1-24Mbps, 36-54Mbps at 802.11b/g modes and MCS0-MCS15 at 802.11n modes @2.4GHz.

## 2.6 Method of Monitoring EUT Operation

IP connectivity is maintained with the EUT. If IP connectivity is lost, EUT connectivity shall be re-established upon power up or re-boot.

## 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. Measured emissions were below applicable limits.

**Test Engineer(s):** Joe Vang and Lionel Gabrillo

**Test Date(s):** 03/11/18 and 03/24/11

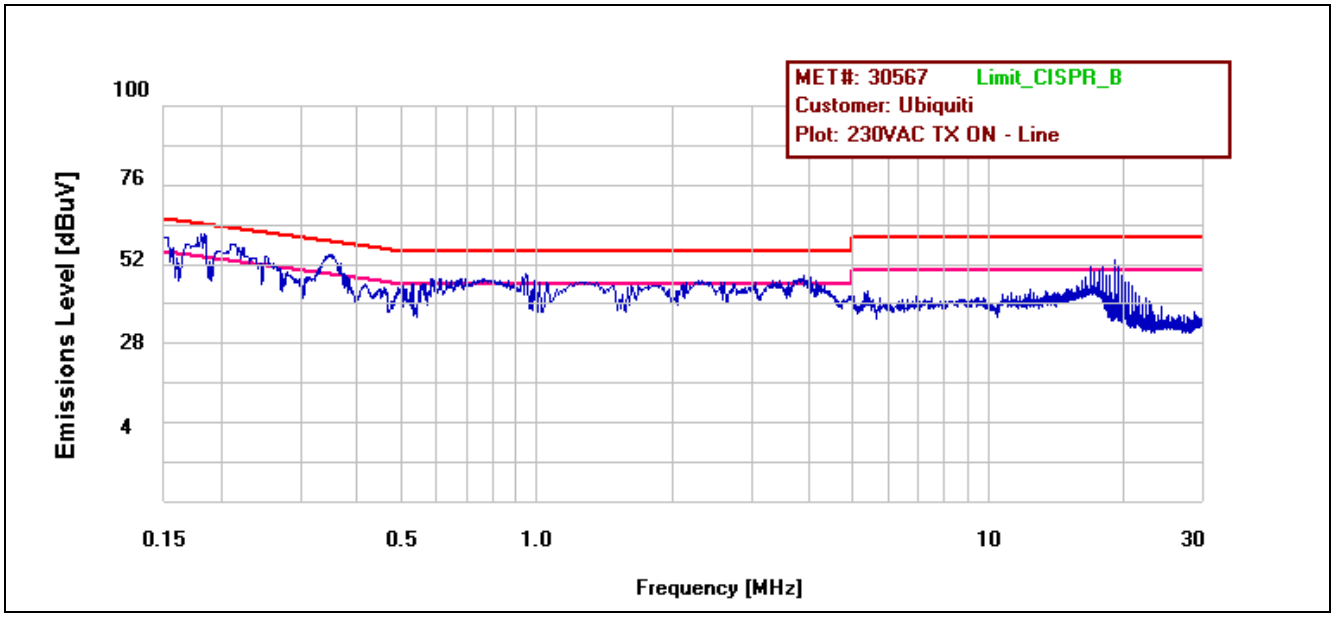
  

## Electromagnetic Compatibility Emission

### 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 TX ON - Line | 0.1684 | 54.01 | 65.042 | -11.032 | Pass | 38.55 | 55.042 | -16.492 | Pass |
| 230VAC TX ON - Line | 0.351 | 52.6 | 58.958 | -6.358 | Pass | 45.44 | 48.958 | -3.518 | Pass |
| 230VAC TX ON - Line | 2.345 | 43.53 | 56 | -12.47 | Pass | 33.88 | 46 | -12.12 | Pass |
| 230VAC TX ON - Line | 17.23 | 47.3 | 60 | -12.7 | Pass | 40.51 | 50 | -9.49 | Pass |
| 230VAC TX ON - Line | 19.44 | 48.41 | 60 | -11.59 | Pass | 42.44 | 50 | -7.56 | Pass |
| 230VAC TX ON - Line | 0.995 | 38.37 | 56 | -17.63 | Pass | 24.061 | 46 | -21.939 | Pass |

**Table 7. Conducted Emissions, AC Power, Phase Line, CETUS Power Supply**



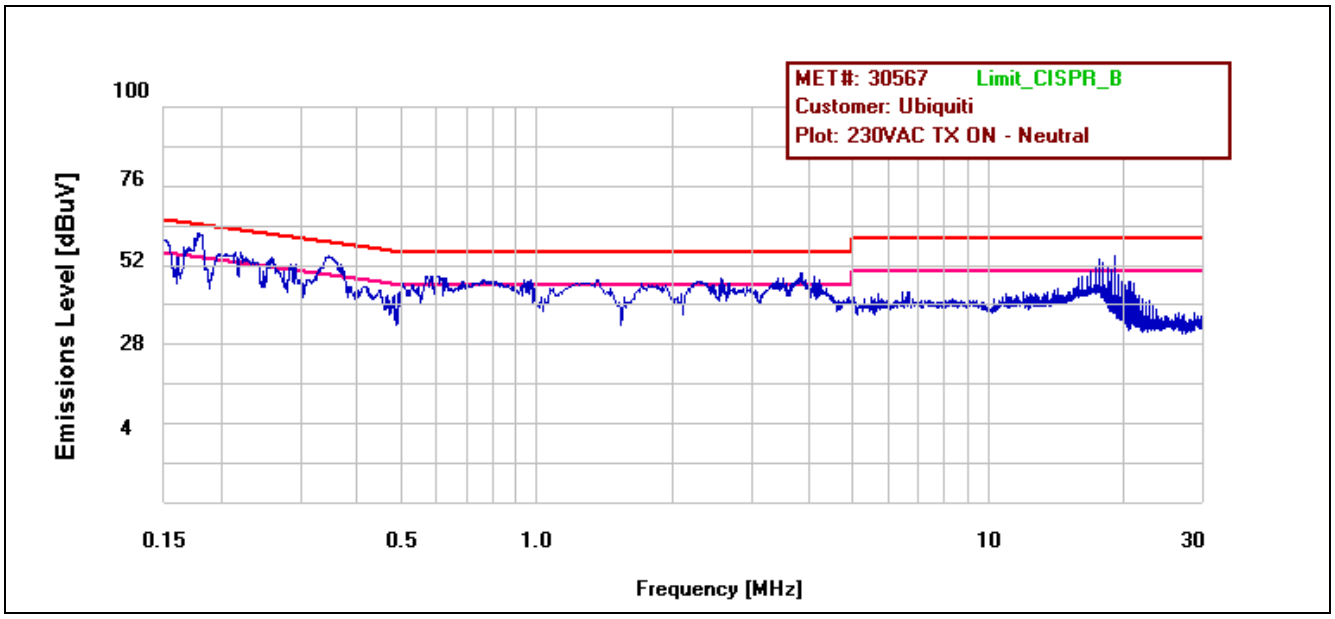

**Plot 1. Conducted Emission Limits, Phase Line Plot, CETUS Power Supply**

## 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 TX ON - Neutral | 0.1768 | 54.06 | 64.638 | -10.578 | Pass | 41.42 | 54.638 | -13.218 | Pass |
| 230VAC TX ON - Neutral | 0.3458 | 52.77 | 59.082 | -6.312 | Pass | 45.89 | 49.082 | -3.192 | Pass |
| 230VAC TX ON - Neutral | 0.7738 | 44.56 | 56 | -11.44 | Pass | 35.43 | 46 | -10.57 | Pass |
| 230VAC TX ON - Neutral | 1.28 | 43.7 | 56 | -12.3 | Pass | 34.66 | 46 | -11.34 | Pass |
| 230VAC TX ON - Neutral | 19.1 | 49.29 | 60 | -10.71 | Pass | 42.26 | 50 | -7.74 | Pass |
| 230VAC TX ON - Neutral | 17.64 | 49.94 | 60 | -10.06 | Pass | 42.82 | 50 | -7.18 | Pass |

**Table 8. Conducted Emissions, AC Power, Neutral Line, CETUS Power Supply**



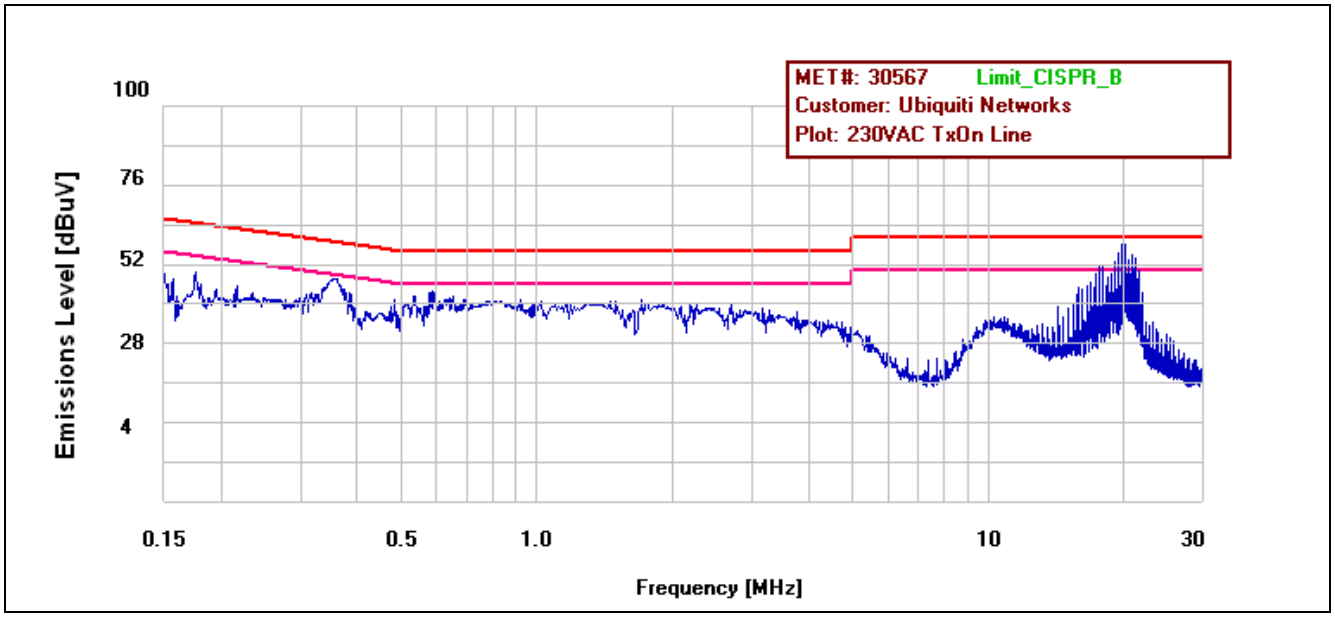

**Plot 2. Conducted Emission Limits, Neutral Line Plot, CETUS Power Supply**

## 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 TxOn Line | 19.82 | 54.39 | 60 | -5.61 | Pass | 49.25 | 50 | -0.75 | Pass |
| 230VAC TxOn Line | .167 | 39.23 | 65.111 | -25.881 | Pass | 27.88 | 55.111 | -27.231 | Pass |
| 230VAC TxOn Line | .357 | 46.38 | 58.818 | -12.438 | Pass | 37.68 | 48.818 | -11.138 | Pass |

**Table 9. Conducted Emissions, AC Power, Phase Line, GME Power Supply**



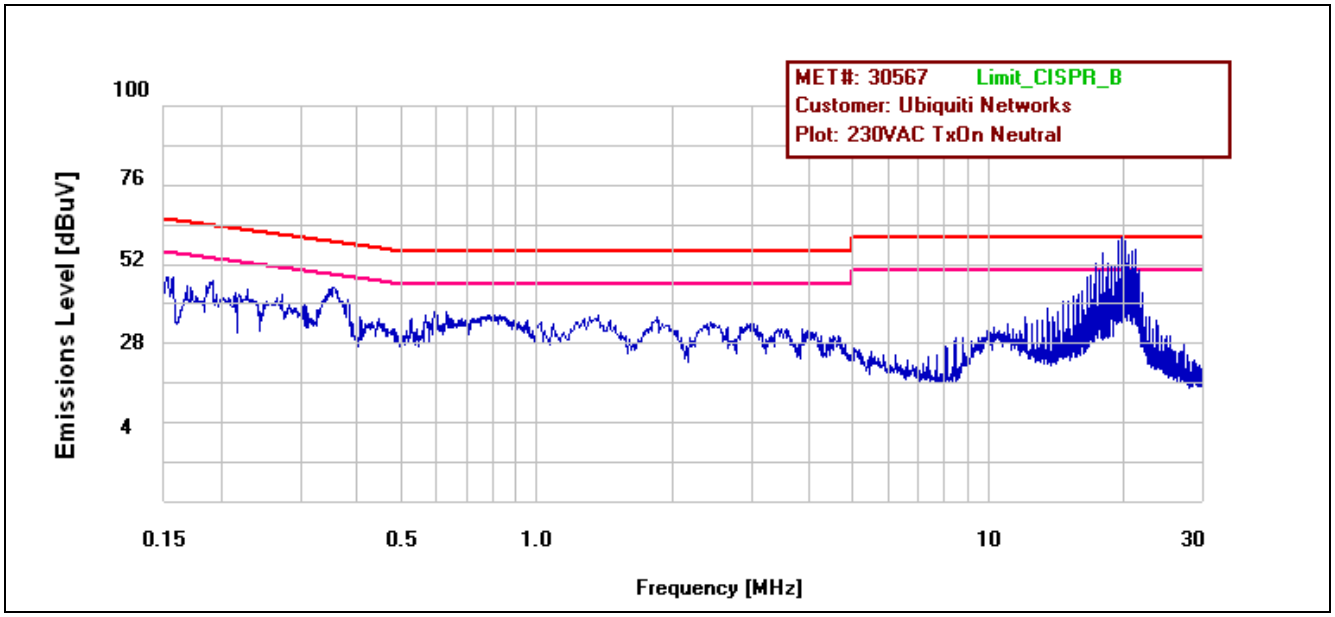

**Plot 3. Conducted Emission Limits, Phase Line Plot, GME Power Supply**

## 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 TxOn Neutral | 19.82 | 55.03 | 60 | -4.97 | Pass | 49.73 | 50 | -0.27 | Pass |
| 230VAC TxOn Neutral | .347 | 44.37 | 59.053 | -14.683 | Pass | 34.32 | 49.053 | -14.733 | Pass |
| 230VAC TxOn Neutral | .171 | 38.83 | 64.915 | -26.085 | Pass | 25.54 | 54.915 | -29.375 | Pass |

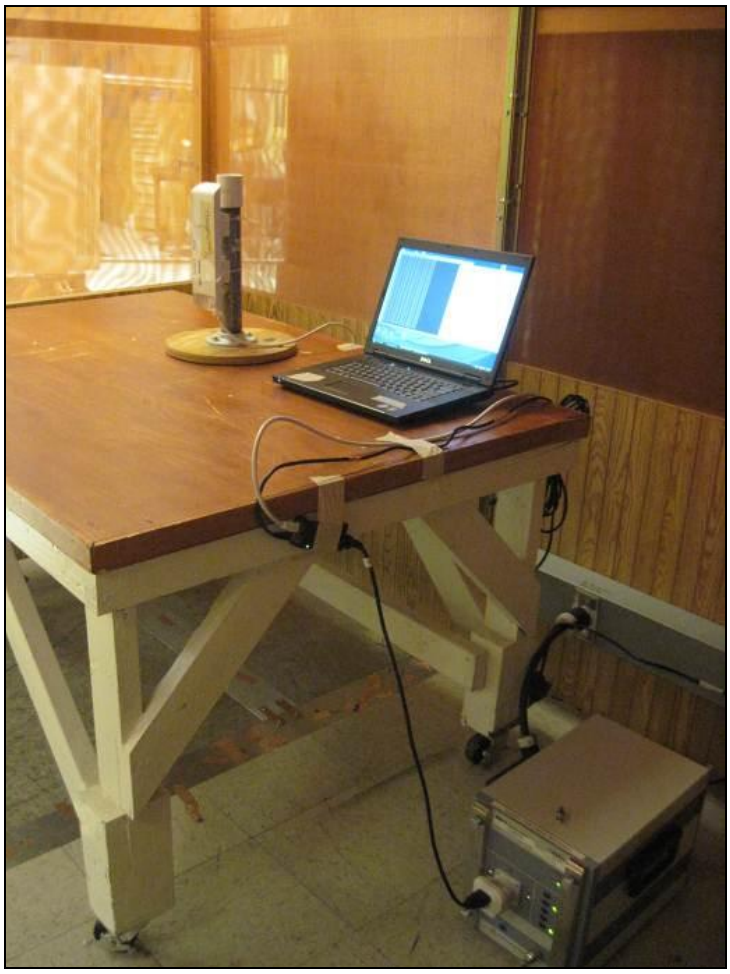
**Table 10. Conducted Emissions, AC Power, Neutral Line, GME Power Supply**




**Plot 4. Conducted Emission Limits, Neutral Line Plot, GME Power Supply**

## Electromagnetic Compatibility Emission

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



**Photograph 2. AC Mains Power 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 11.

| 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 11. 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. Measured emissions were below applicable limits.

**Test Engineer(s):** Lionel Gabrillo

**Test Date(s):** 02/15/11 and 03/24/11

| Class (A, B, C, D) | Voltage (V) | Current (A) | Frequency (Hz) | Total Harmonic Distortion (%) |
|---|---|---|---|---|
| A | 237.72 | 0.03948 | 49.997 | 184.53 |
| **Harmonic Odd #** | **Measured (A)** | **Class A Limit (A)** | **Results** | **Notes** |
| 3 | 0.01737 | 2.300 | Pass | No Anomalies Observed |
| 5 | 0.01598 | 1.140 | Pass | No Anomalies Observed |
| 7 | 0.01497 | 0.770 | Pass | No Anomalies Observed |
| 9 | 0.01271 | 0.400 | Pass | No Anomalies Observed |
| 11 | 0.01116 | 0.330 | Pass | No Anomalies Observed |
| 13 | 0.0097 | 0.21 | Pass | No Anomalies Observed |
| 15-39 | 0.00683 – 0.0006 | 0.150- 0.058 | Pass | No Anomalies Observed |
| **Harmonic Even #** | **Measured (A)** | **Class A Limit (A)** | **Results** | **Notes** |
| 2 | 0.00281 | 1.080 | Pass | No Anomalies Observed |
| 4 | 0.00269 | 0.430 | Pass | No Anomalies Observed |
| 6 | 0.00251 | 0.300 | Pass | No Anomalies Observed |
| 8-40 | 0.00230 – 0.00026 | 0.230- 0.046 | Pass | No Anomalies Observed |

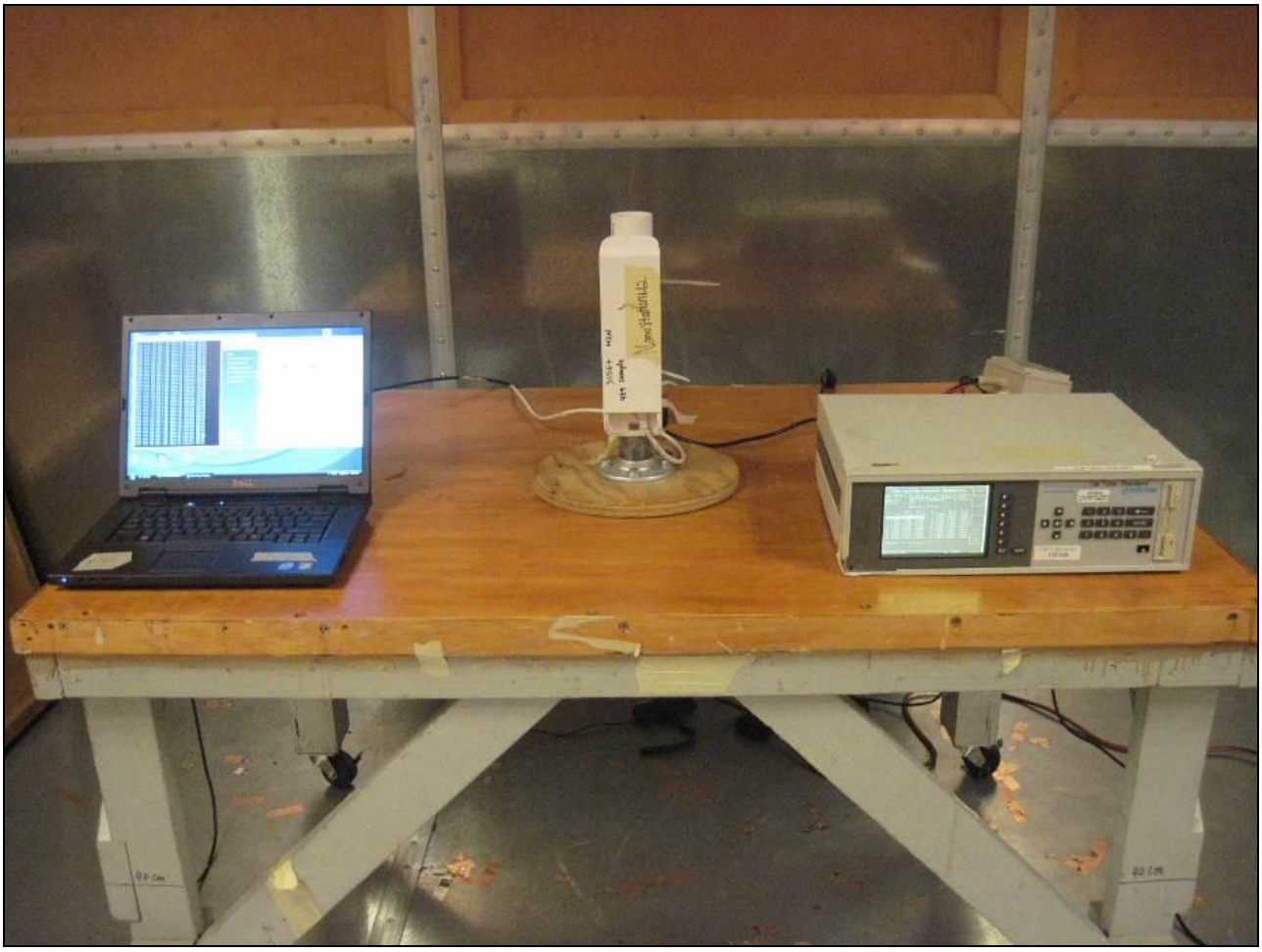
**Table 12. Harmonics, Test Results, CETUS Power Supply**

| Class (A, B, C, D) | Voltage (V) | Current (A) | Frequency (Hz) | Total Harmonic Distortion (%) |
|---|---|---|---|---|
| A | 240.60 | 0.0566 | 50.000 | 282.46 |
| **Harmonic Odd #** | **Measured (A)** | **Class A Limit (A)** | **Results** | **Notes** |
| 3 | 0.0161 | 2.300 | PASS | No Anomalies Observed |
| 5 | 0.0153 | 1.140 | PASS | No Anomalies Observed |
| 7 | 0.0155 | 0.770 | PASS | No Anomalies Observed |
| 9 | 0.0148 | 0.400 | PASS | No Anomalies Observed |
| 11 | 0.0144 | 0.330 | PASS | No Anomalies Observed |
| 13 | 0.0140 | 0.21 | PASS | No Anomalies Observed |
| 15-39 | 0.0137 – 0.0054 | 0.150- 0.058 | PASS | No Anomalies Observed |
| **Harmonic Even #** | **Measured (A)** | **Class A Limit (A)** | **Results** | **Notes** |
| 2 | 0.0027 | 1.080 | PASS | No Anomalies Observed |
| 4 | 0.0027 | 0.430 | PASS | No Anomalies Observed |
| 6 | 0.0026 | 0.300 | PASS | No Anomalies Observed |
| 8-40 | 0.0025 – 0.0009 | 0.230- 0.046 | PASS | No Anomalies Observed |

**Table 13. Harmonics, Test Results, GME Power Supply**

# Electromagnetic Compatibility Emission

## Harmonic Current Emissions



**Photograph 3. Harmonic Current Emissions, Test Setup**

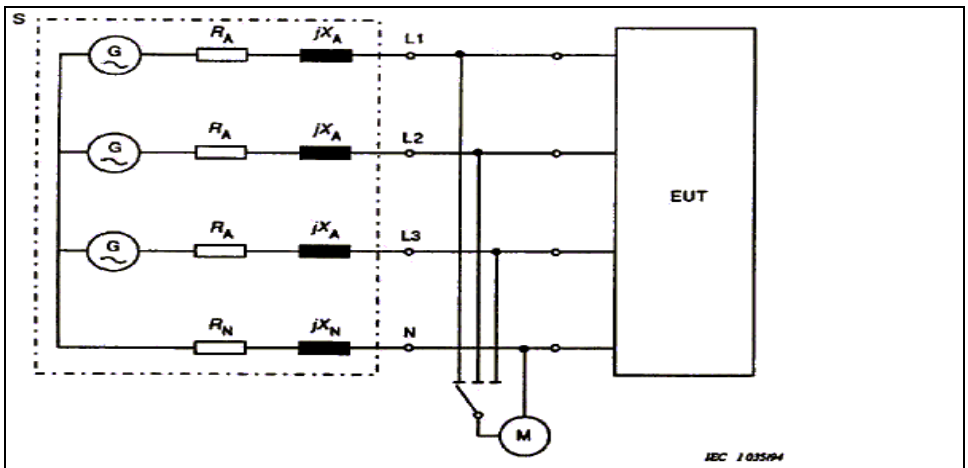
## Electromagnetic Compatibility Emission

### 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. Measured emissions were below applicable limits.

**Test Engineer(s):** Lionel Gabrillo

**Test Date(s):** 02/15/11 and 03/24/11

| Voltage (V) | Current (A) | Frequency (Hz) | Power Factor |
|---|---|---|---|
| 240.6 | 0.0561 | 50.003 | 0.279 |

| | | | |
|---|---|---|---|
| **Average (Is) relative voltage Drop** | | **d(t)** | 0.002 % |
| **Relative voltage fluctuation (3s)** | | **Dpp** | 0.002 % |
| **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 | 0 | 4 |
| **Max rel. steady-state voltage change** | **dc** | 0 | 0 | 3 |
| **Duration of d(t) > 3 %** | **t** | 0 | 0 | 0.2 |
| **Short term flicker severity** | **Pst** | 0 | 0 | 1.0 |
| **Long term flicker severity** | **Plt** | NA | 0 | 0.65 |

**Table 14. Flicker, Test Results, CETUS Power Supply**

| Voltage (V) | Current (A) | Frequency (Hz) | Power Factor |
|---|---|---|---|
| 239.0 | 0.0522 | 49.997 | 0.0281 |

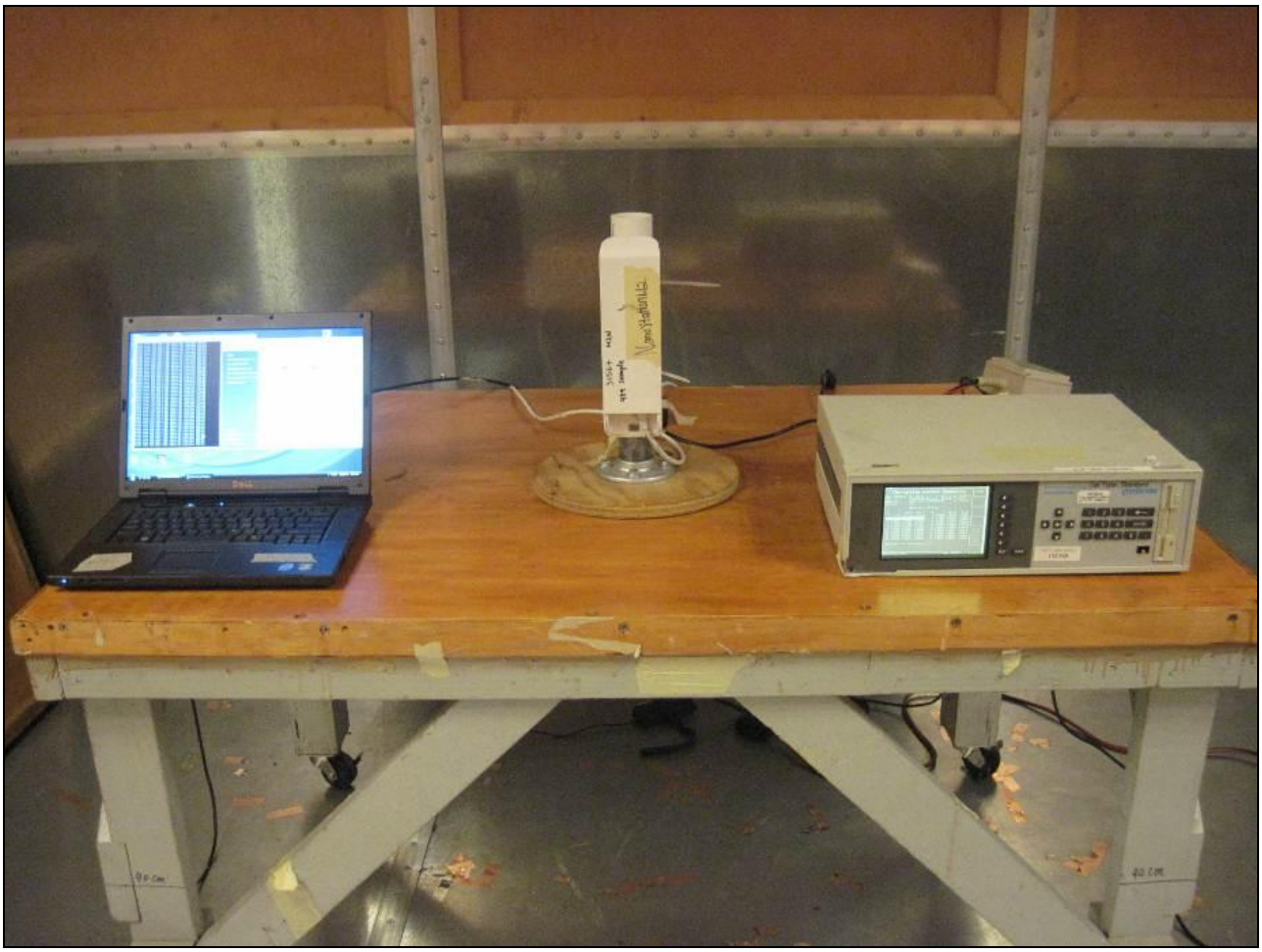
| | | | |
|---|---|---|---|
| **Average (Is) relative voltage Drop** | | **d(t)** | 0.002 % |
| **Relative voltage fluctuation (3s)** | | **Dpp** | 0.002 % |
| **d(t) at steady - state level** | | **YES /NO** | YES |
| **Last relative steady - state level change** | | **Dc** | 0.000 % |
| **Last transition 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 | 0 | 4 |
| **Max rel. steady-state voltage change** | **dc** | 0 | 0 | 3 |
| **Duration of d(t) > 3 %** | **t** | 0 | 0 | 0.2 |
| **Short term flicker severity** | **Pst** | 0 | 0 | 1.0 |
| **Long term flicker severity** | **Plt** | NA | 0 | 0.65 |

**Table 15. Flicker, Test Results, GME Power Supply**

# 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 16:

| 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 16. 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°C |
| **Relative Humidity:** | 32 % |

**Test Results:** The EUT was found compliant with the requirement(s) of this section. Measured emissions were below applicable limits.

**Test Engineer(s):** Joe Vang and Lionel Gabrillo

**Test Date(s):** 03/18/11 and 03/24/11

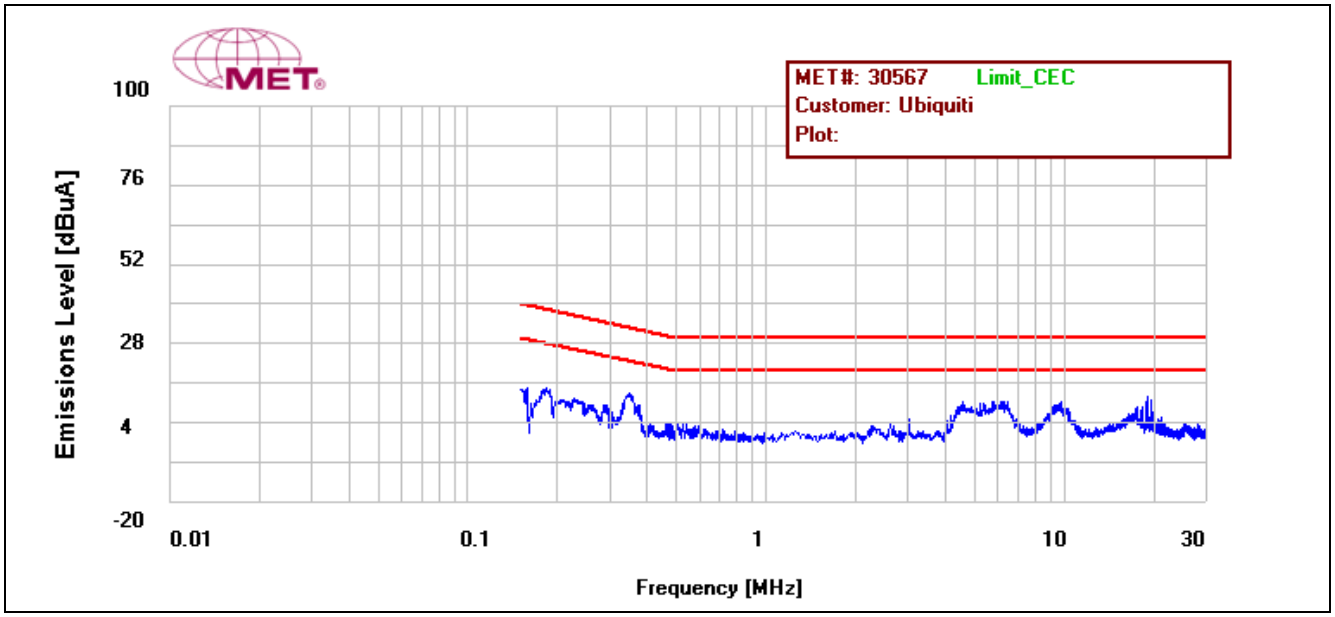
  

## Limits for Conducted Disturbance at Telecommunication Ports

### Conducted Emissions - Voltage for Telecommunication Ports, Worst Case Emissions, LAN Line

| Line | Frequency (MHz) | Raw | QP Amplitude | QP Limit | Delta | Pass/Fail | Raw | Average Amplitude | Average Limit | Delta | Pass/Fail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LAN Port | 0.350 | 28.81 | 6.81 | 32.962 | -26.152 | Pass | 22.25 | 0.25 | 22.962 | -22.712 | Pass |
| LAN Port | 0.1768 | 30.11 | 8.11 | 38.635 | -30.525 | Pass | 22.98 | 0.98 | 28.635 | -27.655 | Pass |
| LAN Port | 6.07 | 24.22 | 2.22 | 30 | -27.78 | Pass | 18.23 | -3.77 | 20 | -23.77 | Pass |
| LAN Port | 9.64 | 23.67 | 1.67 | 30 | -28.33 | Pass | 18.0 | -4 | 20 | -24 | Pass |
| LAN Port | 17.04 | 23.01 | 1.01 | 30 | -28.99 | Pass | 13.43 | -8.57 | 20 | -28.57 | Pass |
| LAN Port | 18.74 | 17.17 | -4.83 | 30 | -34.83 | Pass | 9.98 | -12.02 | 20 | -32.02 | Pass |

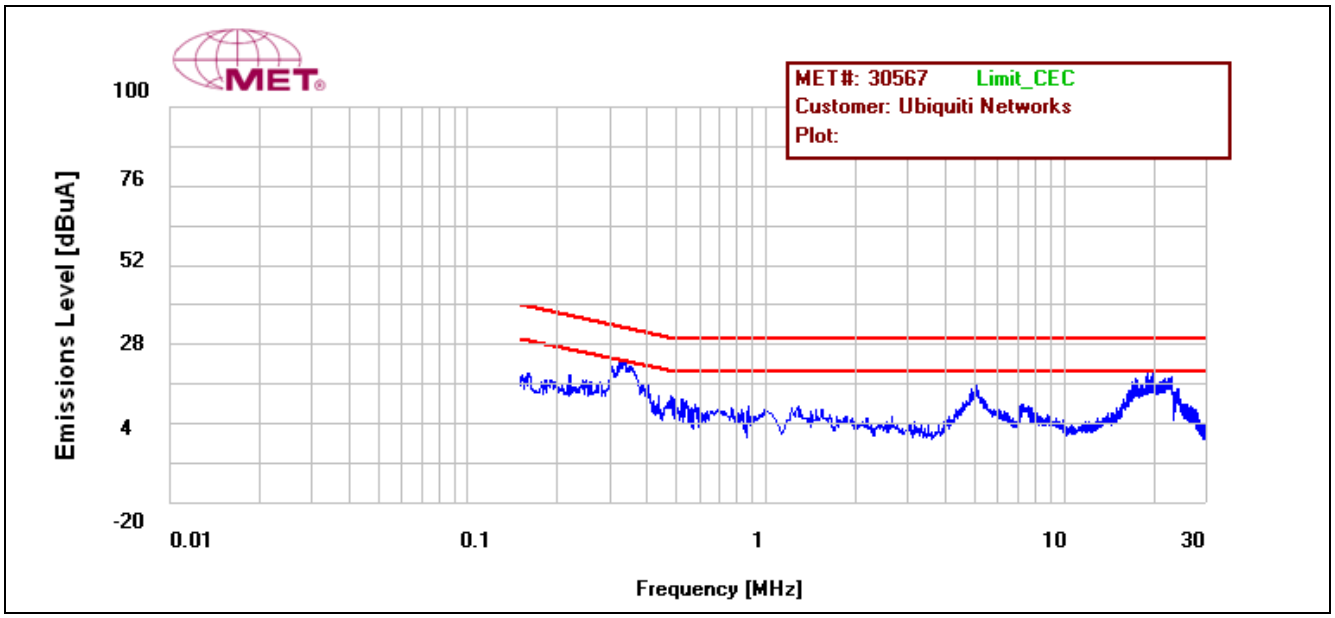
**Table 17. Conducted Disturbance at Telecommunication Ports Test Results, LAN, CETUS Power Supply**




**Plot 5. Conducted Emission Limits for Telecommunications Ports, LAN Plot, CETUS Power Supply**

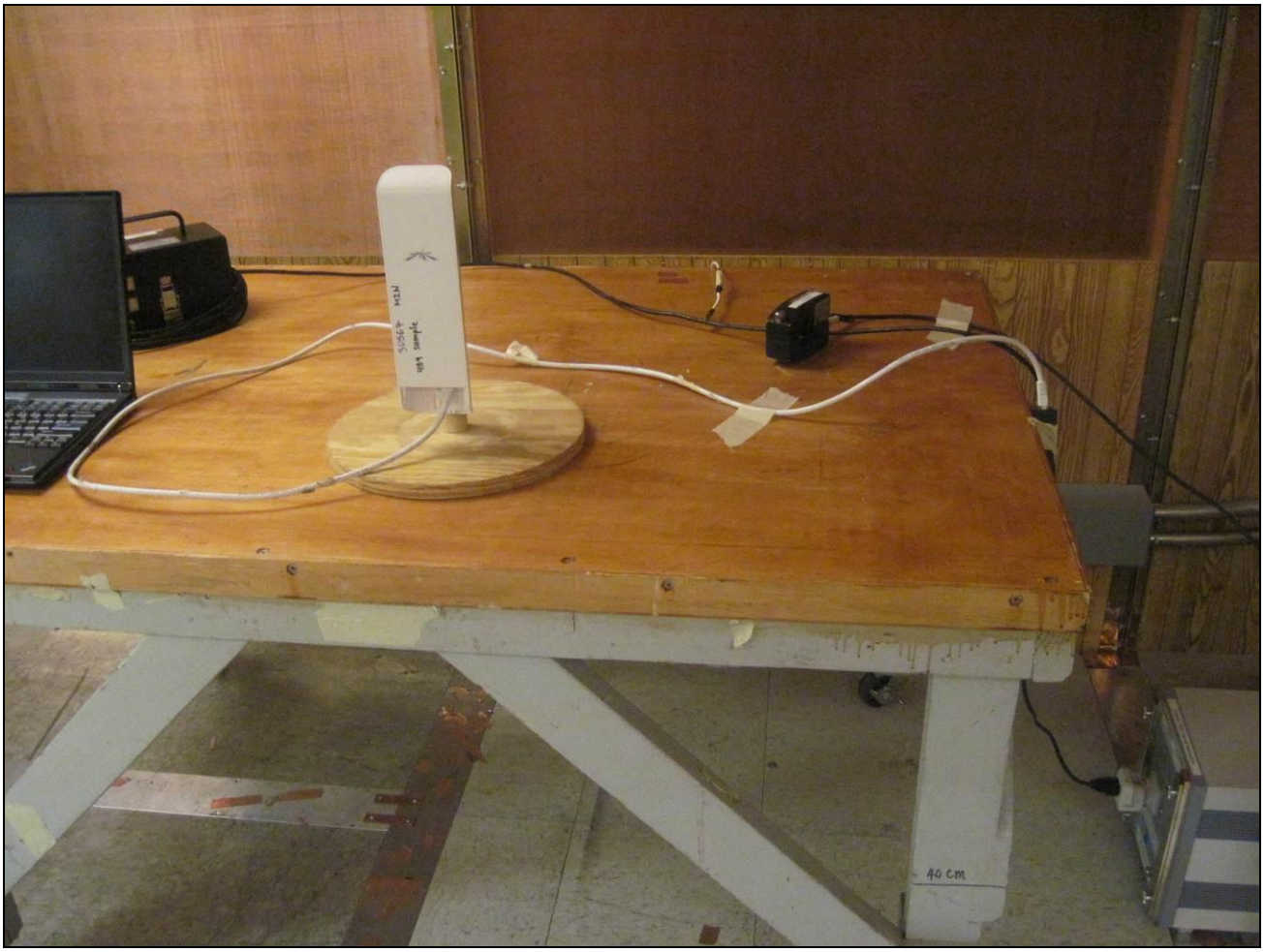
| Line | Frequency (MHz) | Raw | QP Amplitude | QP Limit | Delta | Pass/Fail | Raw | Average Amplitude | Average Limit | Delta | Pass/Fail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LAN | .336 | 47.2 | 15.2 | 33.302 | -18.102 | Pass | 41.13 | 9.13 | 23.302 | -14.172 | Pass |
| LAN | 4.99 | 38.3 | 6.3 | 30 | -23.7 | Pass | 30.9 | -1.1 | 20 | -21.1 | Pass |
| LAN | 19.44 | 47.9 | 15.9 | 30 | -14.1 | Pass | 43.3 | 11.3 | 20 | -8.7 | Pass |
| LAN | 24.25 | 33.7 | 1.7 | 30 | -28.3 | Pass | 26.51 | -5.49 | 20 | -25.49 | Pass |
| LAN | 4.88 | 37.25 | 5.25 | 30 | -24.75 | Pass | 29.75 | -2.25 | 20 | -22.25 | Pass |
| LAN | .156 | 48.3 | 16.3 | 39.674 | -23.374 | Pass | 42.19 | 10.19 | 29.674 | -19.484 | Pass |

**Table 18. Conducted Disturbance at Telecommunication Ports Test Results, LAN, GME Power Supply**




**Plot 6. Conducted Emission Limits for Telecommunications Ports, LAN Plot, GME Power Supply**

## 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 – 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 MHz 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. Measured emissions were below applicable limits.

**Test Engineer(s):** Lionel Gabrillo

**Test Date(s):** 02/21/11 and 04/27/11

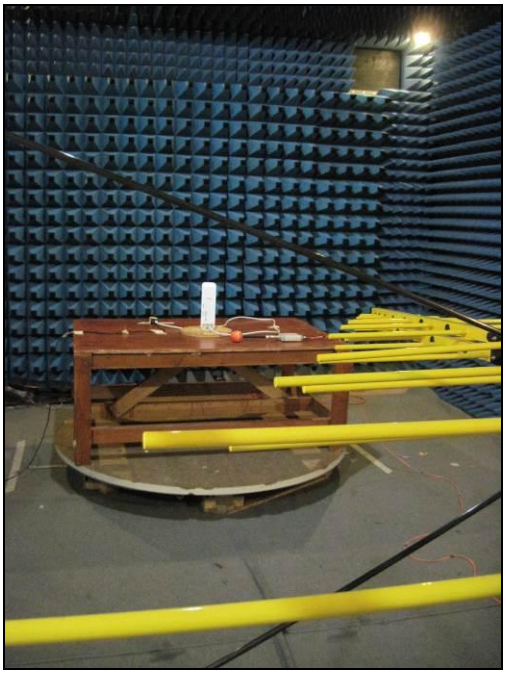
| Start Frequency (MHz) | Stop Frequency (MHz) | Severity (V/m) | Polarity (H/V) | Modulation (Freq. & Type) | Results | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Front | Back | Left | Right |
| 80 | 1000 | 3 | V | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 80 | 1000 | 3 | H | 1 kHz, 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 19. Radiated Immunity, Test Results, CETUS Power Supply**

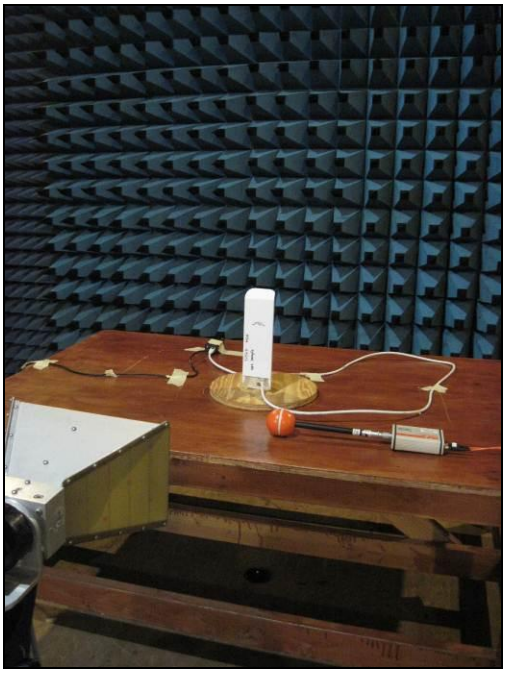
| Start Frequency (MHz) | Stop Frequency (MHz) | Severity (V/m) | Polarity (H/V) | Modulation (Freq. & Type) | Results | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Front | Back | Left | Right |
| 80 | 1000 | 3 | V | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 80 | 1000 | 3 | H | 1 kHz, 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 20. Radiated Immunity, Test Results, GME Power Supply**

## Radio Frequency Electromagnetic Field



**Photograph 6. Radiated Immunity, Test Setup, 80 MHz – 1 GHz**



**Photograph 7. Radiated Immunity, 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, the HCP 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 17), 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:** | 24°C |
| **Relative Humidity:** | 34% |
| **Atmospheric Pressure:** | 101.3 kPa |

**Environmental Conditions during EN 61000-4-2 Testing, CETUS Power Supply**

| | |
|---|---|
| **Ambient Temperature:** | 20.6°C |
| **Relative Humidity:** | 30% |
| **Atmospheric Pressure:** | 101.9 kPa |

**Environmental Conditions during EN 61000-4-2 Testing, GME Power Supply**

# 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 B

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

**Test Engineer(s):** Anderson Soungpanya

**Test Date(s):** 03/25/11

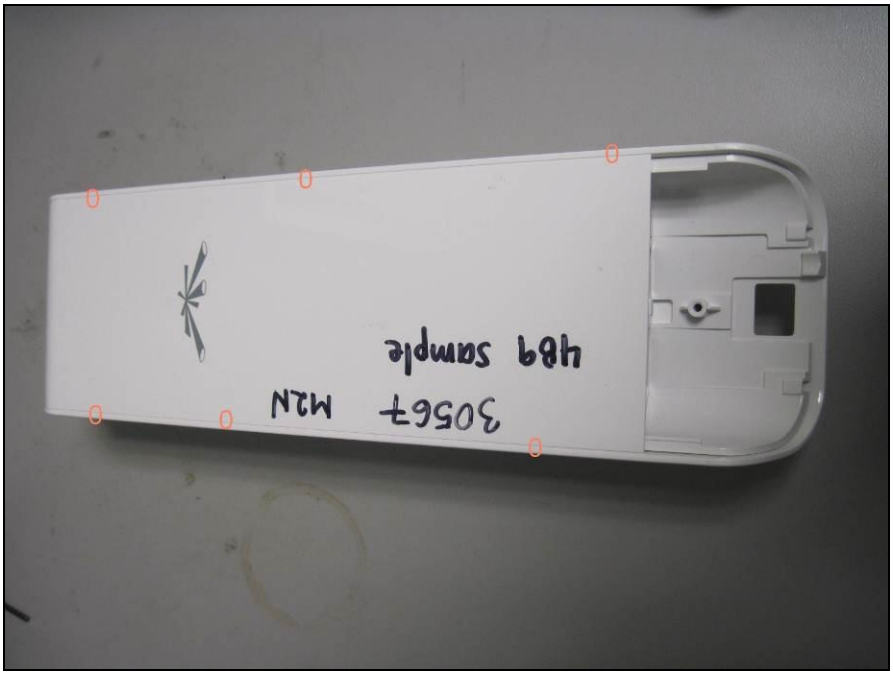
| Discharge Type | Test Voltage (±kV) | Results | | | | Anomalies |
|---|---|---|---|---|---|---|
| | | Front | Back | Left | Right | |
| VCP | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | Random drop packets on LAN Line None |
| HCP | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | Random drop packets on LAN Line None |
| Contact Discharge | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | Random drop packets on LAN Line None |
| Air Discharge | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | Random drop packets on LAN Line |
| | 6 | PASS | PASS | PASS | PASS | Random drop packets on LAN Line |
| | 8 | PASS | PASS | PASS | PASS | Random drop packets on LAN Line |

**Table 21. Electrostatic Discharge, Test Results, CETUS Power Supply**

| Discharge Type | Test Voltage (±kV) | Results | | | | Anomalies |
|---|---|---|---|---|---|---|
| | | Front | Back | Left | Right | |
| VCP | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | None |
| HCP | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | None |
| Contact Discharge | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | None |
| Air Discharge | 2 | PASS | PASS | PASS | PASS | None |
| | 4 | PASS | PASS | PASS | PASS | None |
| | 6 | PASS | PASS | PASS | PASS | None |
| | 8 | PASS | PASS | PASS | PASS | None |

**Table 22. Electrostatic Discharge, Test Results, GME Power Supply**

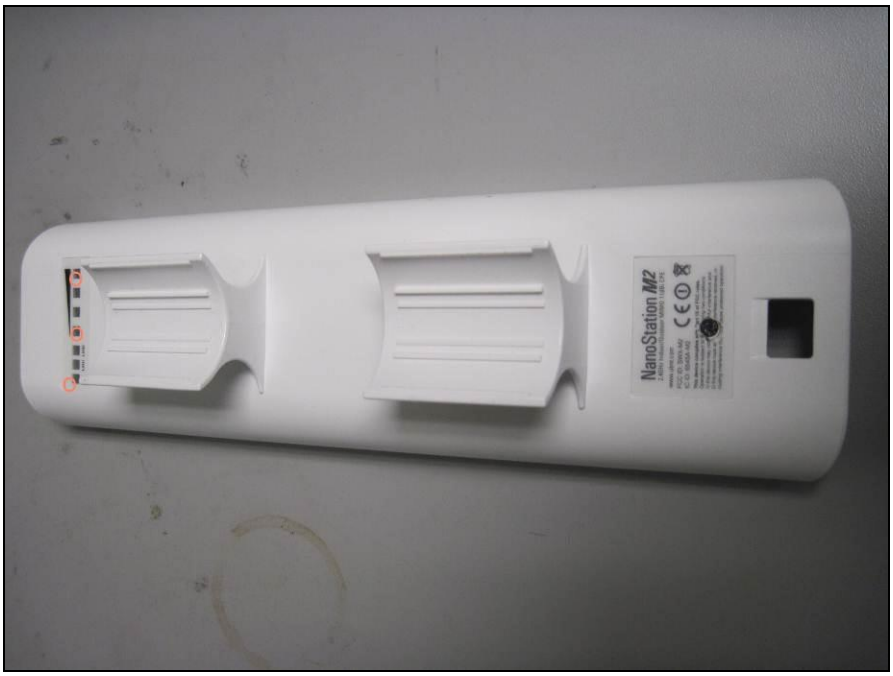
## Electrostatic Discharge, Test Points




**Photograph 8. ESD, Test Points, Top View 1, CETUS Power Supply**


**Photograph 9. ESD, Test Points, Top View 2, CETUS Power Supply**

O = Air Discharge
X = Contact Discharge




**Photograph 10. ESD, Test Points, Rear View, CETUS Power Supply**


**Photograph 11. ESD, Test Points, CETUS Power Supply**

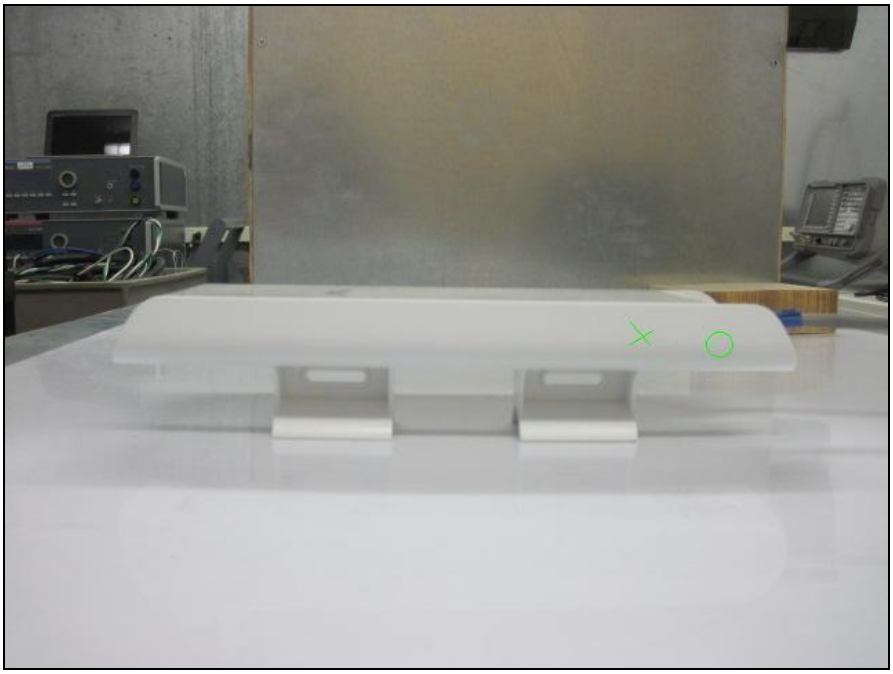
O = Air Discharge
X = Contact Discharge


**Photograph 12. ESD, Test Points, Top View, GME Power Supply**


**Photograph 13. ESD, Test Points, Bottom View, GME Power Supply**

O = Air Discharge
X = Contact Discharge

**Photograph 14. ESD, Test Points, Front View, GME Power Supply**

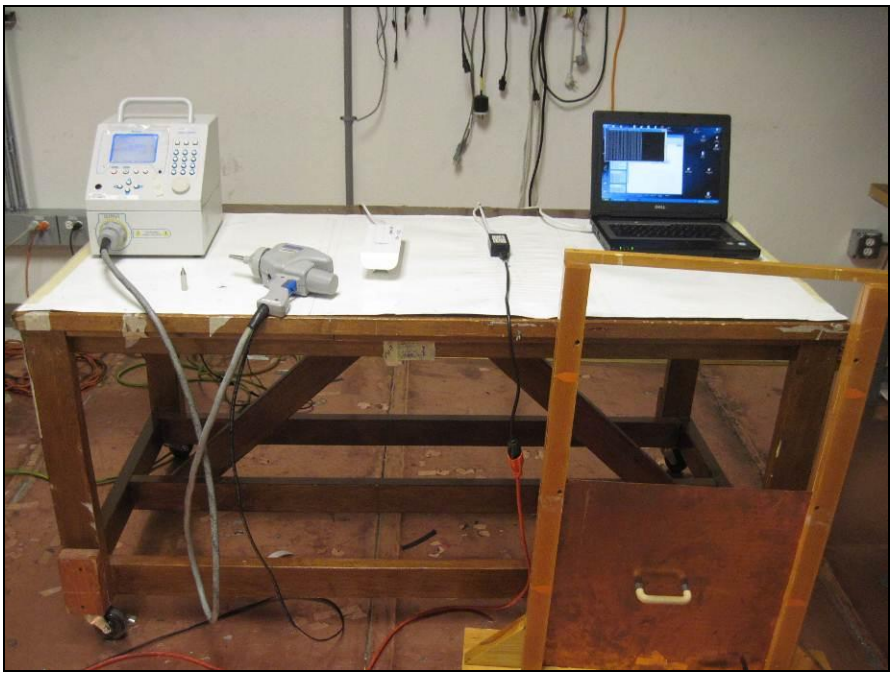


**Photograph 15. ESD, Test Points, Left Side View, GME Power Supply**

O = Air Discharge
X = Contact Discharge


**Photograph 16. ESD, Test Points, Rear Side View, GME Power Supply**

O = Air Discharge
X = Contact Discharge



**Photograph 17. Electrostatic Discharge, Test Setup, CETUS Power Supply**

**Photograph 18. Electrostatic Discharge, Test Setup, GME Power Supply**

# 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 19). 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

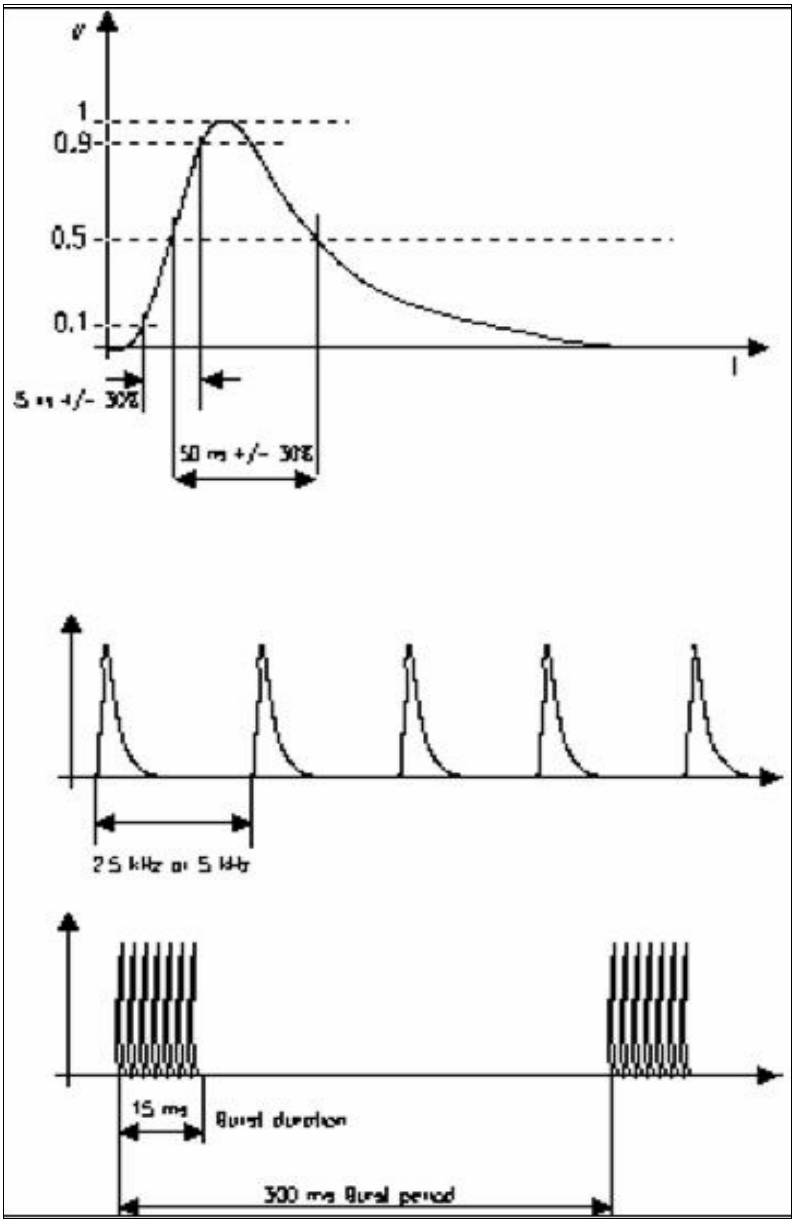



**Figure 3. EN 61000-4-4 Test Waveform**

# 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):** Joe Vang and Lionel Gabrillo

**Test Date(s):** 03/11/11 and 04/05/11

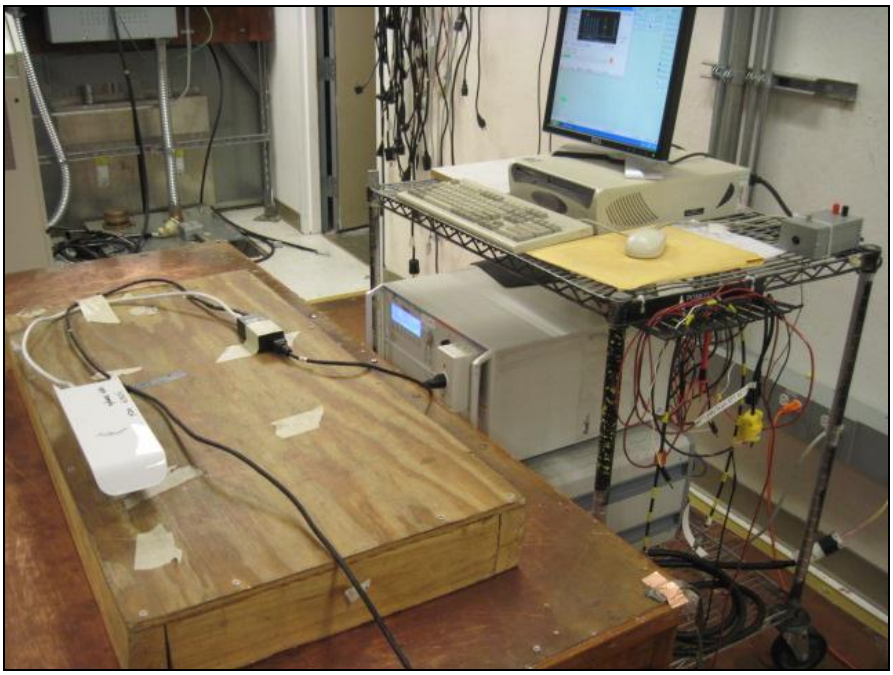
| Port Name | Slot/EUT Side | Test Level | Result | Anomalies |
|---|---|---|---|---|
| **AC Power** | | | | |
| Phase | Bottom | ±1 kV | Pass | Pinging stopped but came back to normal after the test. |
| Neutral | Bottom | ±1 kV | Pass | Pinging stopped but came back to normal after the test. |
| Ground | Bottom | ±1 kV | Pass | Pinging stopped but came back to normal after the test. |
| **Port Name** | **Slot/EUT Side** | **Test Level** | **Result** | **Anomalies** |
| **I/O Cables** | | | | |
| LAN Port | Bottom | ±0.5 kV | Pass | No Anomalies |

**Table 23. Fast Transient, Test Results, CETUS Power Supply**

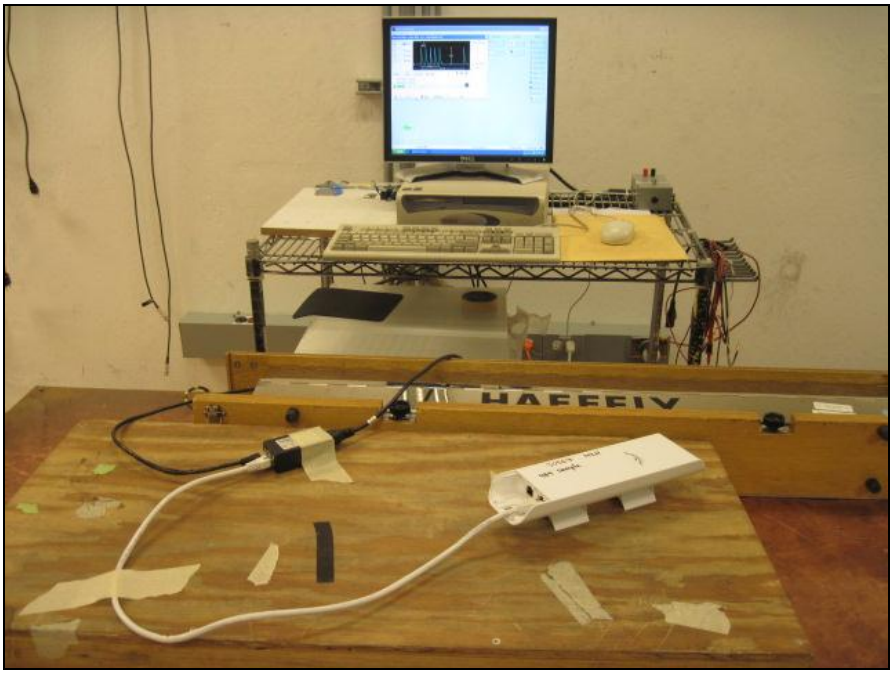
| Port Name | Slot/EUT Side | Test Level | Result | Anomalies |
|---|---|---|---|---|
| **AC Power** | | | | |
| Phase | Bottom | ±1 kV | Pass | No Anomalies |
| Neutral | Bottom | ±1 kV | Pass | No Anomalies |
| Ground | Bottom | ±1 kV | Pass | No Anomalies |
| **Port Name** | **Slot/EUT Side** | **Test Level** | **Result** | **Anomalies** |
| **I/O Cables** | | | | |
| LAN Port | Bottom | ±0.5 kV | Pass | No Anomalies |

**Table 24. Fast Transient, Test Results, GME Power Supply**

## Fast Transient, Common Mode



**Photograph 19. Fast Transient, Common Mode, Test Setup, AC Mode**



**Photograph 20. Fast Transient, Common Mode, Test Setup, I/O Cables**

# 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 21). 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.

## Electromagnetic Compatibility Immunity

### Radio Frequency, Common Mode

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

**Test Engineer(s):** Joe Vang

**Test Date(s):** 03/14/11 and 04/20/11

| Cable Ref. ID | Port Name On EUT | Severity (Vrms) | Modulation (Freq. & Type) | Results | Anomalies |
|---|---|---|---|---|---|
| | AC Port | 3 | 1 kHz, 80%AM | Pass | No Anomalies |
| | PSU-LAN | 3 | 1 kHz, 80%AM | Pass | No Anomalies |

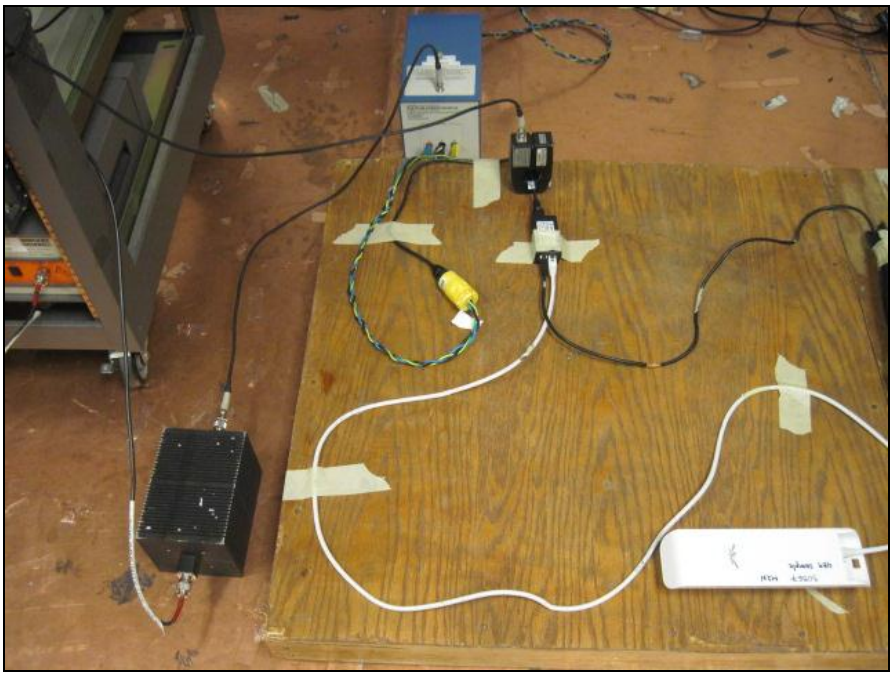
**Table 25. Conducted Immunity, Test Results, CETUS Power Supply**

| Port Name On EUT | Severity (Vrms) | Modulation (Freq. & Type) | Results | Anomalies |
|---|---|---|---|---|
| AC Port | 3 | 1 kHz, 80%AM | Pass | No Anomalies |
| PSU-LAN | 3 | 1 kHz, 80%AM | Pass | No Anomalies |

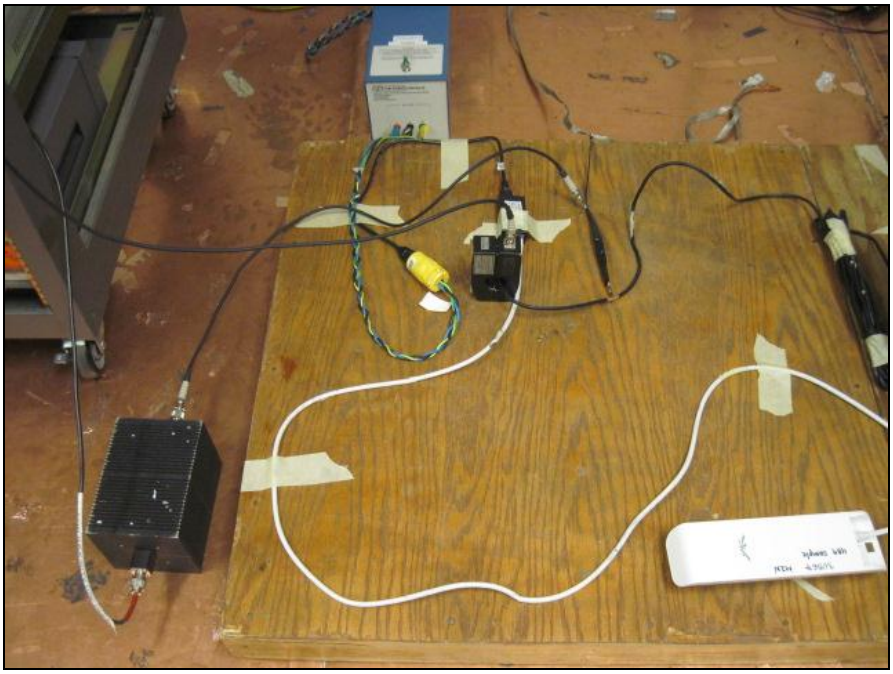
**Table 26. Conducted Immunity, Test Results, GME Power Supply**

# Electromagnetic Compatibility Immunity

## Radio Frequency, Common Mode



**Photograph 21. Radio Frequency, Common Mode, Test Setup, AC Mode**



**Photograph 22. Radio Frequency, Common Mode, Test Setup, I/O 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 %<br>Duration ms | >95<br>10 | B |
| Voltage reduction %<br>Duration ms | >95<br>20 | B |
| Voltage reduction %<br>Duration ms | 30<br>500 | C |
| Voltage reduction %<br>Duration ms | >95<br>5000 | C |

**Table 27. 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 23). 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:** Joe Vang and Lionel Gabrillo

**Test Date:** 03/11/11 and 04/05/11

| 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 | EUT turns off, but recovers with no intervention. |

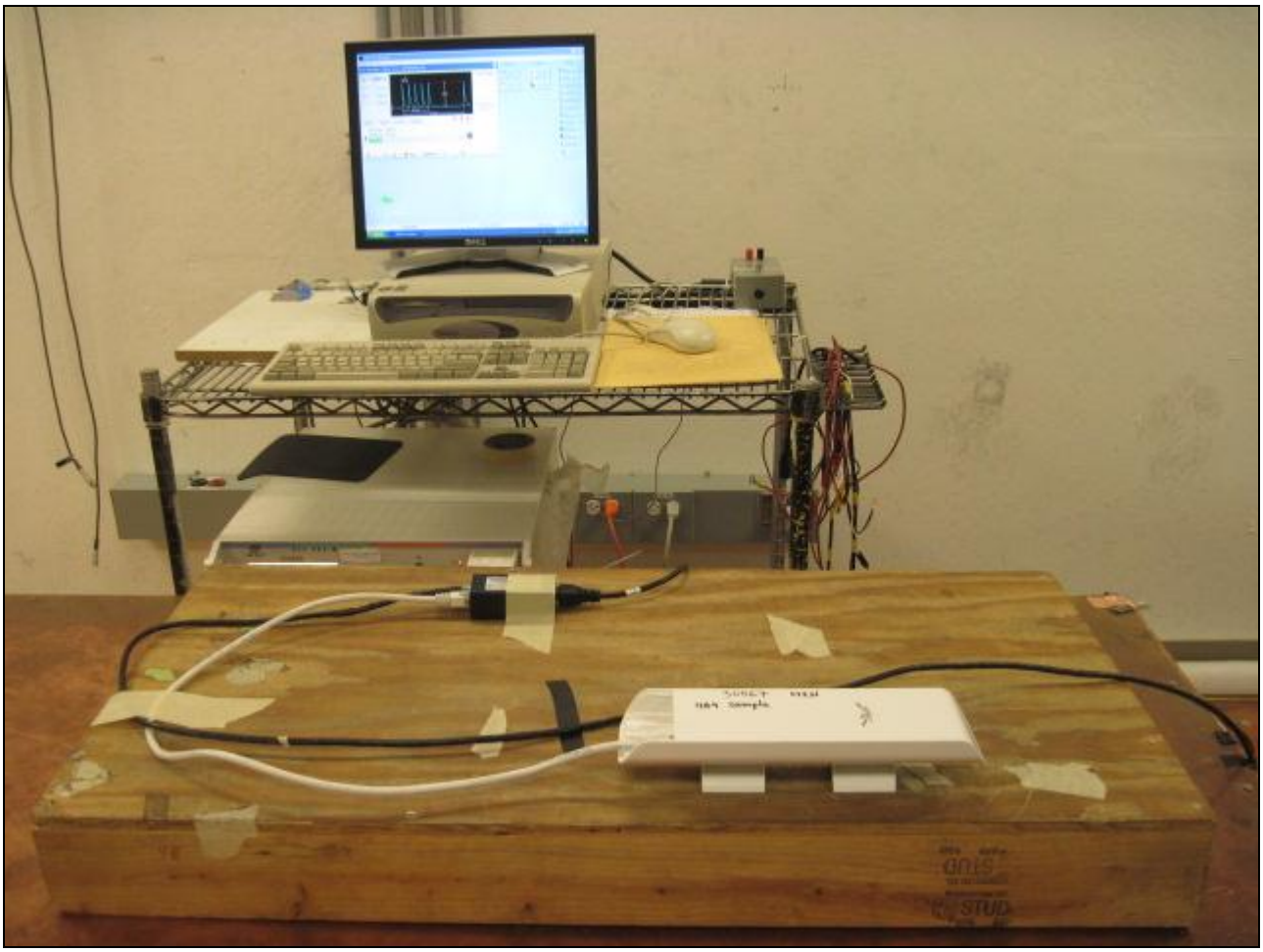
**Table 28. Voltage Dips and Interruptions, Test Results, CETUS Power Supply**

| 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 | B | Pass | EUT turns off, but recovers with no intervention. |
| Short Interrupts | 0% drop for 5000 ms or 250 cycles | 3 | C | B | Pass | EUT turns off, but recovers with no intervention. |

**Table 29. Voltage Dips and Interruptions, Test Results, GME Power Supply**

# Electromagnetic Compatibility Immunity

## Voltage Dips and Short Interruptions



**Photograph 23. 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 ± 1.0 kV applied to the I/O interconnection cables. Performance criterion A applies for I/O cables.

The EUT was tested with the surge waveforms shown on the following page, having an open circuit amplitude of ± 2 kV (differential mode), and ±2 kV (common mode) applied to the AC power cables. Performance Criterion A 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 24). 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 $\mu$s<br>Time to Half = 50 $\mu$s |
| Short Circuit Current: | Front Time = 8 $\mu$s<br>Time to Half = 20 $\mu$s |
| Telecom wave parameters: | Front Time = 10 $\mu$s<br>Time to Half = 700 $\mu$s |

**Table 30. Combination Wave Generator Test Parameters for EN 61000-4-5**

# Electromagnetic Compatibility Immunity

## Surges

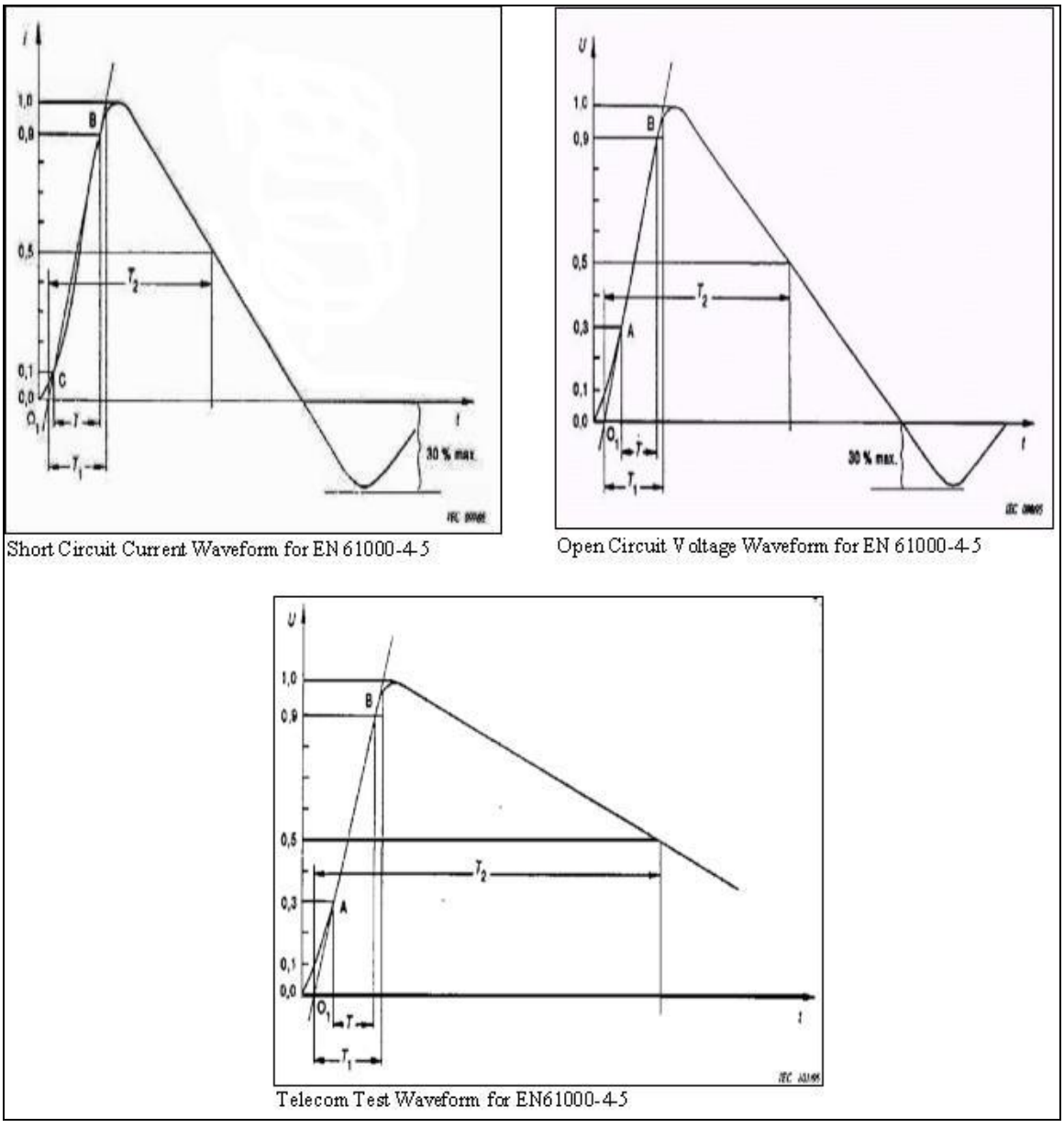



**Figure 4. EN 61000-4-5 Surge Test Waveforms**

# 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°, 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):** Joe Vang

**Test Date(s):** 03/09/11 and 04/22/11

| Port Name / Coupling | Phase | Test Level | Results | Anomalies |
|---|---|---|---|---|
| **AC, Differential Mode** | | | | |
| **Phase to Neutral** | 0, 90, 180, 270 | ±1.0 kV | pass | None |
| **AC, Common Mode** | | | | |
| **Phase to Ground** | 0, 90, 180, 270 | ±2.0 kV | pass | None |
| **Neutral to Ground** | 0, 90, 180, 270 | ±2.0 kV | pass | None |
| **Port Name / Coupling** | Phase | Test Level | Results | Anomalies |
| **IO, Differential Mode** | | | | |
| **Phase to Neutral** | n/a | ±1.0 kV | pass | None |

**Table 31. Surges, Test Results, CETUS Power Supply**

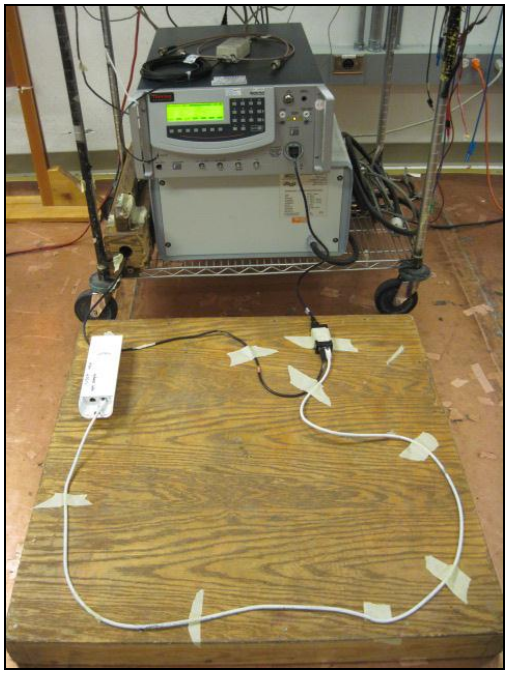
| Port Name | Cable Ref. ID | Coupling | Phase | Test Level | Results | Anomalies |
|---|---|---|---|---|---|---|
| **AC, Differential Mode** | | | | | | |
| Phase to Neutral | POE | Phase to Neutral | 0 | ±1.0 kV | Pass | No Anomalies |
| | | | 90 | ±1.0 kV | Pass | No Anomalies |
| | | | 180 | ±1.0 kV | Pass | No Anomalies |
| | | | 270 | ±1.0 kV | Pass | No Anomalies |
| **AC, Common Mode** | | | | | | |
| Phase to Ground | POE | Phase to Ground | 0 | ±2.0 kV | Pass | No Anomalies |
| | | | 90 | ±2.0 kV | Pass | No Anomalies |
| | | | 180 | ±2.0 kV | Pass | No Anomalies |
| | | | 270 | ±2.0 kV | Pass | No Anomalies |
| Neutral to Ground | POE | Neutral to Ground | 0 | ±2.0 kV | Pass | No Anomalies |
| | | | 90 | ±2.0 kV | Pass | No Anomalies |
| | | | 180 | ±2.0 kV | Pass | No Anomalies |
| | | | 270 | ±2.0 kV | Pass | No Anomalies |
| **I/O Cables** | | | | | | |
| **Port Name** | **Phase** | **Test Level** | | | **Results** | **Anomalies** |
| LAN Port | Phase to Neutral | ±1 kV | | | Pass | No Anomalies |

**Table 32. Surges, Test Results, GME Power Supply**

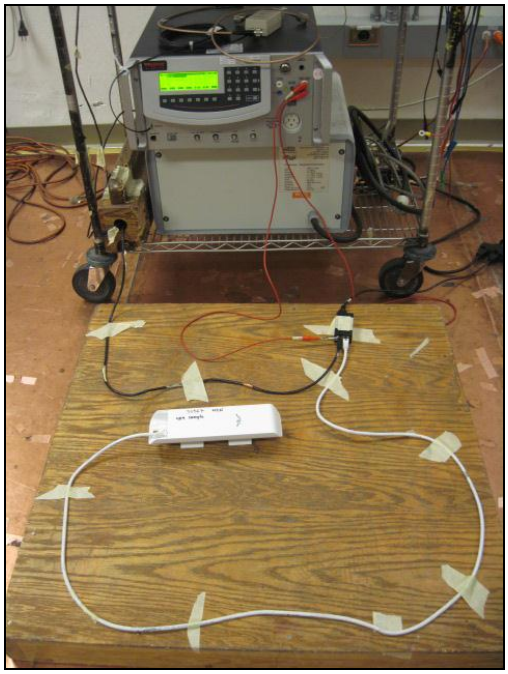
  

# Electromagnetic Compatibility Immunity

## Surges



**Photograph 24. Surges, Test Setup, AC Mode**



**Photograph 25. Surges, Test Setup, I/O Mode**

## 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): 03/23/11** |
|---|---|---|---|---|---|
| **MET Asset #** | **Nomenclature** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2671 | TRANSIENT LIMITER | AGILENT TECHNOLOGIES | 11947A | SEE NOTE | |
| 1S2460 | 1-26GHZ SPECTRUM ANALYZER | AGILENT | E4407B | 07/13/2010 | 07/13/2011 |
| 1S2668 | AMPLIFIER | SONOMA INSTRUMENTS | 310 N | SEE NOTE | |
| 1S2657 | SCREEN ROOM | ETS LINDGREN | 14W-2/2-0 | SEE NOTE | |
| 1S2507 | LISN | SOLAR ELECTRONICS COMPANY | 9252-50-R-24-BNC | 02/17/2011 | 02/17/2012 |
| **Test Name: Harmonic Current Emissions Clause 8.5** | | | | | **Test Date(s): 03/22/11** |
| **MET Asset #** | **Nomenclature** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2398 | POWER MEASUREMENT UNIT | COMBINOVA | A300 | 03/31/2010 | 03/31/2011 |
| **Test Name: Voltage Fluctuations (Flicker) Clause 8.6** | | | | | **Test Date(s): 03/22/11** |
| **MET Asset #** | **Nomenclature** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2398 | POWER MEASUREMENT UNIT | COMBINOVA | A300 | 03/31/2010 | 03/31/2011 |
| **Test Name: Telecom Line Conducted Emissions Clause 8.7** | | | | | **Test Date(s): 03/24/11** |
| **MET Asset #** | **Nomenclature** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2671 | TRANSIENT LIMITER | AGILENT TECHNOLOGIES | 11947A | SEE NOTE | |
| 1S2460 | 1-26GHZ SPECTRUM ANALYZER | AGILENT | E4407B | 07/13/2010 | 07/13/2011 |
| 1S2668 | AMPLIFIER | SONOMA INSTRUMENTS | 310 N | SEE NOTE | |
| 1S2657 | SCREEN ROOM | ETS LINDGREN | 14W-2/2-0 | SEE NOTE | |
| 1S2507 | LISN | SOLAR ELECTRONICS COMPANY | 9252-50-R-24-BNC | 02/17/2011 | 02/17/2012 |
| **Test Name: Radiated Electromagnetic Field Clause 9.2** | | | | | **Test Date(s): 04/27/11** |
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2576 | AMPLIFIER (80M-1GHZ) | AMPLIFIER RESEARCH | 500W1000A | SEE NOTE | |
| 1S2264 | CHAMBER 3 | LINDGREN RF ENCLOSURES | IMMUNITY CHAMBER | 07/29/2010 | 07/29/2011 |
| 1U0200 | FIELD MONITOR | AR WORLDWIDE | FM 7004 | SEE NOTE | |
| 1S2674 | FIELD PROBE | AMPLIFIER RESEARCH | FP7060 | 03/30/2011 | 03/30/2012 |
| 1S2401 | BILOG ANTENNA | SCHAFFNER | CBL6140A | SEE NOTE | |
| 1S2208 | HORN ANTENNA | EMCO | 3115 | SEE NOTE | |
| 1S2643 | SIGNAL GENERATOR 40GHZ | ANRITSU | MG3694B | 06/09/2010 | 06/09/2011 |
| 1S2478 | TWT AMPLIFIER | COMM POWER INDUSTRIES | VZL6343J2 | SEE NOTE | |

| Test Name: Electrostatic Discharge Immunity Clause 9.3 | | | | | Test Date(s): 03/25/11 |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2470 | ESD DISCHARGE MODULE | NOISEKEN | ESS-2000 | 04/26/2010 | 04/26/2011 |
| 1S2491 | GROUND PLANE #3 | N/A | GROUND PLANE | SEE NOTE | |
| **Test Name: Fast Transients Clause 9.4** | | | | | **Test Date(s): 04/05/11** |
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2423 | ULTRA COMPACT SIMLULATOR | EM TEST | UCS-500M-6A | SEE NOTE | |
| 1S2490 | GROUND PLANE 2 | MET LABS | N/A | SEE NOTE | |
| 1S2104 | CLAMP, COUPLING, CAPACITIVE | HEAFELY | N/A | SEE NOTE | |
| **Test Name: Radio Frequency, Conducted Continuous Clause 9.5** | | | | | **Test Date(s): 04/20/11** |
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2491 | GROUND PLANE 3 | GROUND PLANE 3 | GROUND PLANE 3 | SEE NOTE | |
| 1S2624 | POWER LINE COUPLING DECOUPLING NETWORK | COM-POWER CORP. | CDN M3-25 | SEE NOTE | |
| 1S2514 | 3DB ATTENUATOR | JFW | 50FH-003-300 | SEE NOTE | |
| 1S2390 | SYNTHESIZED SIGNAL GENERATOR | GIGATRONICS | 6061A | 06/24/2010 | 06/24/2011 |
| 1S2578 | AMPLIFER (10K-250MHZ) | AMPLIFIER RESEARCH | 75A250A | SEE NOTE | |
| 1S2394 | CURRENT PROBLE | FCC | F-120-9A | 11/22/2010 | 11/22/2011 |
| 1S2671 | TRANSIENT LIMITER | AGILENT TECHNOLOGIES | 11947A | SEE NOTE | |
| 1S2649 | SPECTRUM ANALYZER 9KHZ-1.5GHZ | AGILENT | E4401B | SEE NOTE | |
| 1S2621 | CI FIXTURE | MET LABS | N/A | 11/22/2010 | 11/22/2011 |
| **Test Name: Voltage Dips and Short Interruptions Clause 9.7** | | | | | **Test Date(s): 04/05/11** |
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2423 | ULTRA COMPACT SIMLULATOR | EM TEST | UCS-500M-6A | SEE NOTE | |
| 1S2490 | GROUND PLANE 2 | MET LABS | N/A | SEE NOTE | |
| **Test Name: Surges Clause 9.8** | | | | | **Test Date(s): 04/22/11** |
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| RENTAL | SURGE GENERATOR | THERMO SCIENTIFIC | EMC PRO PLUS GENERATOR | 06/29/2010 | 06/29/2011 |
| 1S2604 | OSCILLOSCOPE | TEKTRONIX | TDS7104 | 05/21/2010 | 05/21/2011 |
| 1S2490 | GROUND PLANE 2 | MET LABS | N/A | SEE NOTE | |

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