**MET Laboratories, Inc.** ***Safety Certification - EMI - Telecom Environmental Simulation***
**914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313**
**33439 WESTERN AVENUE • UNION CITY, CALIFORNIA 94587 • PHONE (510) 489-6300 • FAX (510) 489-6372**
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May 10, 2016

Dakota Ultrasonics
1500 Green Hills Road #107
Scotts Valley, CA 95066

Dear William Holt,

Enclosed is the EMC test report for compliance testing of the Dakota Ultrasonics, DFX-8 and Max II, tested to the requirements of EN 61326-1: 2013.

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.

Sofia Cordova
Documentation Department

Reference: (\Dakota Ultrasonics\EMCS88356-EURO)

**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*
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# Electromagnetic Compatibility
# Test Report

for the

## Dakota Ultrasonics
## DFX-8 and Max II

Tested under

**EN 61326-1: 2013**

**MET Report: EMCS88356-EURO**
**May 10, 2016**

**Prepared for:**
**Dakota Ultrasonics**
**1500 Green Hills Road #107**
**Scotts Valley, CA 95066**

ACCREDITED
TESTINGCERT #0591.02

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

# Electromagnetic Compatibility
# Test Report

For the

## Dakota Ultrasonics
## DFX-8 and Max II

Tested under

**EN 61326-1: 2013**

**MET Report: EMCS88356-EURO**

Jeremy Chinn
Project Engineer, Electromagnetic Compatibility Lab

Sofia Cordova
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 applicable limits. 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 per Test Summary (Section 1.0).

Asad Bajwa
Director, Electromagnetic Compatibility Lab

# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| Ø | May 10, 2016 | Initial Issue. |

  

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# List of Terms and Abbreviations

| | | | |
|---|---|---|---|
| **AC** | **A**lternating **C**urrent | **FOKI** | **F**requency **o**f **K**ey **I**nterest |
| **µF** | **microf**arad | **GRP** | **G**round **R**eference **P**lane |
| **µH** | **microh**enry | **H** | Magnetic Field |
| **µs** | **micros**econds | **HCP** | **H**orizontal **C**oupling **P**lane |
| **ACF** | **A**ntenna **C**orrection **F**actor | **Hz** | **H**er**z** |
| **AV** | **Av**erage | **IEC** | **I**nternational **E**lectrotechnical **C**ommission |
| **Cal** | **Cal**ibration | **kHz** | **k**ilo**h**er**z** |
| **CE** | **C**onducted **E**missions | **kPa** | **k**ilo**pa**scal |
| **CI** | **C**onducted **I**mmunity | **kV** | **k**ilo**v**olt |
| **CISPR** | **C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference) | **LISN** | **L**ine **I**mpedance **S**tabilization **N**etwork |
| ***d*** | **M**easurement **D**istance | **MHz** | **M**ega**h**ertz |
| **dB** | **D**eci**b**els | **MI** | **M**agnetic **I**mmunity |
| **dBµA** | **D**eci**b**els above one **micro**amp | **PRF** | **P**ulse **R**epetition **F**requency |
| **dBµA/m** | **D**eci**b**els above one **micro**amp **per m**eter | **QP** | **Q**uasi **P**eak |
| **dBµV** | **D**eci**b**els above one **micro**volt | **RE** | **R**adiated **E**missions |
| **dBµV/m** | **D**eci**b**els above one **micro**volt **per m**eter | **RF** | **R**adio **F**requency |
| **DC** | **D**irect **C**urrent | **RI** | **R**adiated **I**mmunity |
| **E** | **E**lectric Field | **RMS** | **R**oot-**M**ean-**S**quare |
| **EFT/B** | **E**lectrical **F**ast **T**ransient/**B**urst | **V/m** | **V**olts **per m**eter |
| **ESD** | **E**lectro**s**tatic **D**ischarge | **VCP** | **V**ertical **C**oupling **P**lane |
| **EUT** | **E**quipment **U**nder **T**est | **VDI** | **V**oltage **D**ips **I**nterruptions |
| ***f*** | **F**requency | **VF** | **V**oltage **F**luctuations |

# 1.0 Testing Summary

The following tests specified by EN 61326-1 were performed with the following results:

| Test Method | Test Description | Compliance |
|---|---|---|
| EN 55011: 2009 +A1: 2010 | Conducted Emissions - Voltage - Class A | **Compliant** |
| EN 55011: 2009 +A1: 2010 | Radiated Emissions - Class A | **Compliant** |
| EN 61000-3-2: 2006 +A2:2009 | Harmonic Current Emissions | **Not Applicable** for Class A device. |
| EN 61000-3-3: 2008 | Voltage Fluctuations/Flicker | |
| EN 61000-4-2: 2009 | Electrostatic Discharge Immunity | **Compliant** |
| EN 61000-4-3: 2006 +A1:2008 +A2:2010 | Radiated Electromagnetic Field Immunity | **Compliant** |
| EN 61000-4-4: 2012 | Electrical Fast Transient/Burst Immunity | **Compliant** |
| EN 61000-4-5: 2006 | Surge Immunity | **Compliant** |
| EN 61000-4-6: 2009 | Conducted Radio-Frequency Immunity | **Compliant** |
| EN 61000-4-8: 2010 | Magnetic Immunity | **Not Applicable** No Magnetic components |
| EN 61000-4-11: 2004 | Voltage Dips, Interruptions and Variations | **Compliant** |

**Table 1: Executive Summary of EN 61326-1 Compliance Testing**

# 2.0 Equipment Configuration

## 2.1. Overview

MET Laboratories, Inc. was contracted by Dakota Ultrasonics to perform testing on the DFX-8 and Max II, under Dakota Ultrasonics Quote number JT1DAK2210R1.

This document describes the test setups, test methods, required test equipment, and the test limit used to perform compliance testing of the DFX-8 and Max II with the requirements of EN 61326-1: 2013, Electrical Equipment for Measurement, Control and Laboratory Use. .

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

| | |
|---|---|
| **Model(s) Tested:** | DFX-8 and Max II |
| **Model(s) Covered:** | DFX-8 and Max II |
| **Primary Power as Tested:** | 100 – 240 |
| **Equipment Emissions Class:** | A |
| **Evaluated by:** | Jeremy Chinn |
| **Report Date:** | May 10, 2016 |

### 2.1.1. 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.

MET Laboratories is a ISO/IEC 17025 accredited site by A2LA, (Baltimore #0591.01, California #0591.02, Austin #0591.06).

### 2.1.2. Measurement Uncertainty

| Test Method | Typical Expanded Uncertainty (dB) | K | Confidence Level |
|---|---|---|---|
| **Radiated Emissions, (30 MHz – 1 GHz)** | ±3.24 | 2 | 95% |
| **Conducted Emission** | ±3.53 | 2 | 95% |

**Table 2: Uncertainty Calculations Summary**

## 2.2. Detailed EUT Description and Test Setup

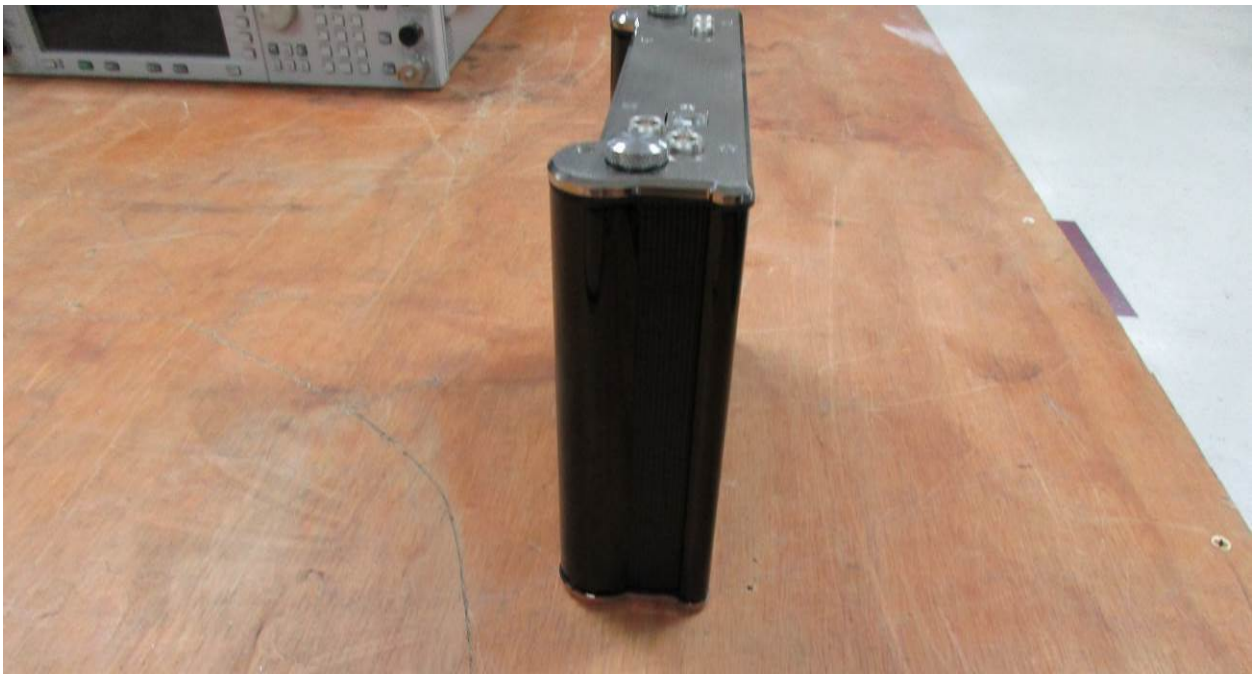
### 2.2.1. Description of Test Sample

The DFX-8 and Max II, Equipment Under Test (EUT), are two products that use the same circuit board and case, the only difference is the type of measurement performed. The DFX-8 flaw detector is typically used to measure the amplitude of echos returned from a weld. A high value of return signal indicates a large flaw or gap in the weld. Since transducers vary in performance, test blocks with known defect sizes are used to calibrate the system. The MAX II bolt gauge, measures the time between the driving pulse and the receipt of the echo. This time, after compensation for temperature, is used in a difference mode to determine the change in length of a bolt. This change is length is proportional to the tightness of the bolt, and is generally much more accurate than torque.

### 2.2.2. Photograph(s) of Test Sample


**Photograph 1. DFX-8 Front**

**Photograph 2. DFX-8 Rear**



**Photograph 3. DFX-8 Right**


**Photograph 4. DFX-8 Left**

**Photograph 5. DFX-8 Top**

**Photograph 6. DFX-8 Bottom**


**Photograph 7. Max II Front**

**Photograph 8. Max II Rear**

**Photograph 9. Max II Right**

**Photograph 10. Max II Left**

**Photograph 11. Max II Top**

**Photograph 12. Max II Bottom**

### 2.2.3. Block Diagram

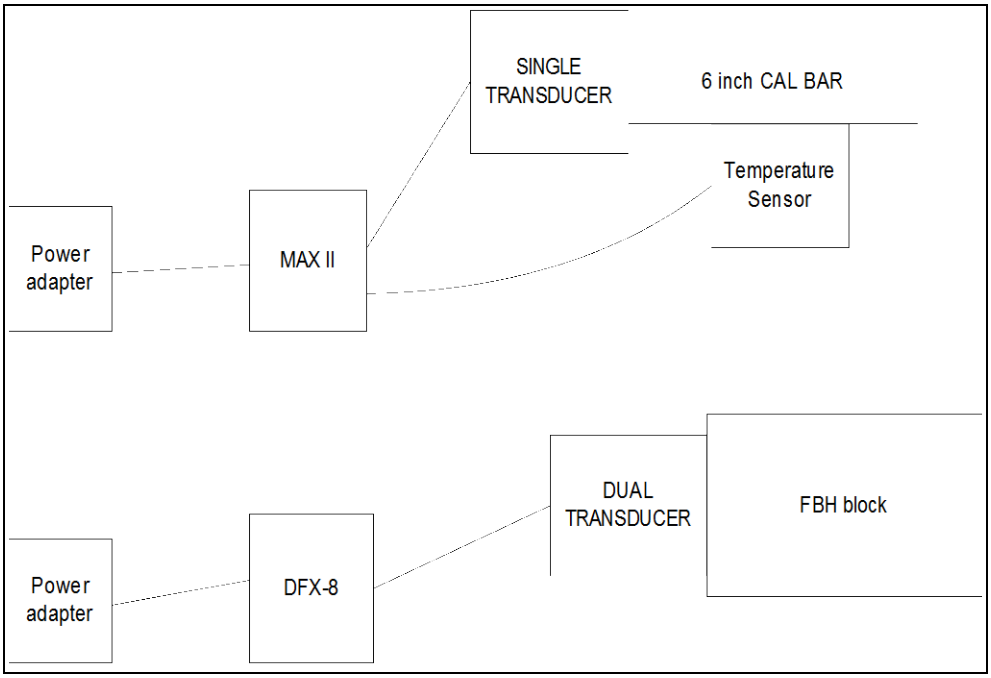



**Figure 1. Block Diagram of Test Configuration**

### 2.2.4. Equipment Configuration

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

| Name / Description | Model Number | Part Number | Serial Number |
|---|---|---|---|
| DFX-8 | Z-251-0001 | -- | -- |
| MAX II | Z-197-0001 | -- | -- |

**Table 3. Equipment Configuration**

### 2.2.5. Support Equipment

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

| Name / Description | Manufacturer | Model Number | Customer Supplied Calibration Data |
|---|---|---|---|
| 5 MHz Dual Transducer | Dakota | T-102-2900 | N/A |
| 5 MHz Single Transducer | Dakota | T-702-2405 | N/A |
| Flat bottom hole Cal block | Dakota | custom | N/A |
| 6 inch Cal Bar | Dakota | X-000-0010 | N/A |
| Temperature sensor | Dakota | A-156-8001 | N/A |

**Table 4. Support Equipment**

### 2.2.6. Ports and Cabling Information

| Port name on EUT | Cable Description or reason for no cable | Qty | Length as tested (m) | Max Length (m) | Shielded (Y/N) | Termination Box ID & Port Name |
|---|---|---|---|---|---|---|
| USB | USB Cable with ferrite | 2 | 1.5 | 2 | no | -- |
| 12 volt input power | 12 volt power supply | 2 | 1.5 | 2 | no | -- |
| AUX | Not normally used | 0 | -- | -- | -- | -- |

**Table 5. Ports and Cabling Information**

## 2.2.7. Mode of Operation & Method of Monitoring EUT Operation

**The EUT was operated in the following manner:**
Flaw detection (DFX8) test: The DFX-8 is connected to a standard 5 MHz Dual Element transducer. The transducer is coupled to a test block with a small defect. The gain is adjusted so 80% screen height is displayed. This amplitude should remain constant + or – 1 dB.

Bolting TOF test: The Max II is connected to a 5 MHz Single Element transducer and temperature sensor. The transducer is coupled to a 6 inch calibration bar and the temperature sensor is placed on the side of the calibration bar. The length of the bar is displayed with resolution of 0.0001 inch. The length of the bar should be remain constant within + or - 0.0003 inch.

**Performance of the EUT was monitored in the following manner:**
1.) DFX-8 should indicate a peak of 80% and a value of 80% on the display. The stability indicator in the upper left of the display (like a cell phone bar graph) should display all bars.

Max II should display a waveform showing the echo from the calibration bar and a thickness reading of approximately 6 inches (the actual value is not important, but is should not change more than 0.0003 inches.) The stability indicator in the upper left of the display (like a cell phone bar graph) should display all bars.

2.) DFX-8 amplitude display height and numeric value changes more than 1 dB (measures outside of 89.8% and 71.3%). No stability is shown, or MEM appears instead of stability (indicating it's displaying a reading from memory.)

MAX II length reading changes more than 0.0003 inch or no stability is shown, or MEM appears instead of stability (indicating it's displaying a reading from memory.)

## 2.2.8. Overall Immunity Performance Criteria

In accordance with EN 61326-1, the EUT was evaluated according to the following performance criteria where specified:

**EN 61326-1 Sub-clause**
**6.4.1 General**

The general principles (performance criteria) for the evaluation of the immunity test results are the following.

**6.4.2 Performance Criterion A**

The equipment shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.

**6.4.3 Performance Criterion B**

The equipment shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.

**6.4.4 Performance Criterion C**

Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

| Reference | Descriptive Name | EN 61326-1: 2013, Table 1 Performance Criteria Required | EN 61326-1: 2013, Table 1 Performance Criteria Achieved |
|---|---|---|---|
| EN 61000-4-2: 2009 | Electrostatic Discharge Immunity | B | A |
| EN 61000-4-3: 2006 +A1:2008 +A2:2010 | Radiated Electromagnetic Field Immunity | A | A |
| EN 61000-4-4: 2012 | Electrical Fast Transient/Burst Immunity | B | A |
| EN 61000-4-5: 2006 | Surge Immunity | B | A |
| EN 61000-4-6: 2009 | Conducted Radio-Frequency Immunity | A | A |
| EN 61000-4-11: 2004 | Voltage Dips, Interruptions and Variations | B, B, C, C | A, A, A and A |

**Table 6. Performance Criteria Summary**

### 2.2.9. Modifications to EUT

The following modification was made to comply with Radiated Immunity:
Ferrite added to temperature sensor cable.

### 2.2.10. Disposition of EUT

The test sample including all support equipment (if any), submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Dakota Ultrasonics upon completion of testing.

# 3.0 Electromagnetic Compatibility Emission Criteria

## 3.1. Conducted Emission: Limits of Mains Terminal Disturbance Voltage

### 3.1.1. Test Method, Test Requirements, and Test Procedures

#### 3.1.1.1. Test Method

**EN 55011: 2009 +A1: 2010**
Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and Methods of Measurement

#### 3.1.1.2. Test Requirements

In accordance with EN 61326-1, Section 7.2 Emission Limits, the EUT shall meet the Class A limits shown in Table 7:

| Class A Equipment Limits (dBµV) | | |
|---|---|---|
| **Frequency Range (MHz)** | **Quasi- Peak** | **Average** |
| 0.15 - 0.5 | 79 | 66 |
| 0.5 - 5 | 73 | 60 |
| 5 - 30 | 73 | 60 |

**Table 7. Conducted Emission Limits for Class A Equipment from EN 61326-1**

#### 3.1.1.3. Test Procedure

The EUT was placed on a wooden table top located in a screen room. The method of testing, test conditions, and test procedures of CISPR 11: 2009 were used. The EUT was powered through a 50Ω/50µH LISN. An EMI receiver, connected to the measurement port of the LISN, scanned the frequency range from 150 kHz to 30 MHz in order to find the peak conducted emissions. All peak emissions within 6 dB of the limit were re-measured using a quasi-peak and/or average detector as appropriate.

## 3.1.2. Test Results, Test Data, and Test Setup

### 3.1.2.1. Test Results

The EUT was **compliant** with the Class A requirement(s) of this section. Measured emissions were below applicable limits.

| Environmental Conditions for Conducted Emissions (Mains) | |
|---|---|
| **Ambient Temperature:** | 22 °C |
| **Relative Humidity:** | 43 % |
| **Atmospheric Pressure:** | 100 kPa |

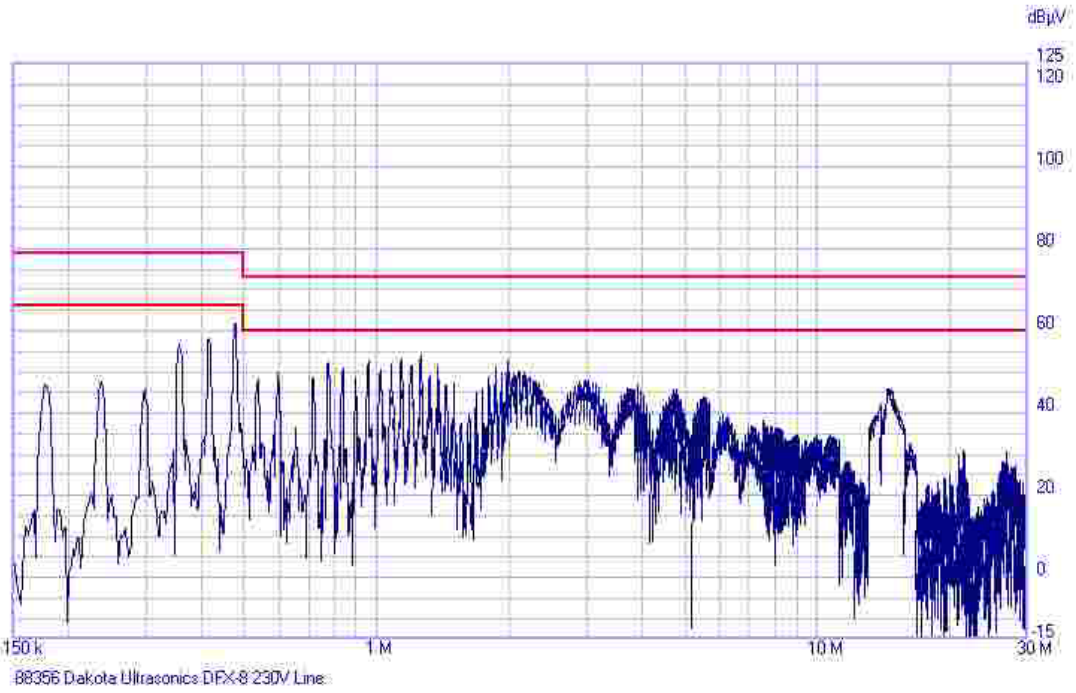
**Test Engineer(s):** Danny Alvendia

**Test Date(s):** 03/07/2016

### 3.1.2.2. Test Data

| Freq (MHz) | QP Amplitude | QP Limit | Delta | Results | Average Amplitude | Average Limit | Delta | Results |
|---|---|---|---|---|---|---|---|---|
| 0.387 | 53.26 | 79 | -25.74 | Pass | 34.63 | 66 | -31.37 | Pass |
| 0.422 | 45.92 | 79 | -33.08 | Pass | 32.56 | 66 | -33.44 | Pass |
| 0.489 | 56.77 | 79 | -22.23 | Pass | 42.71 | 66 | -23.29 | Pass |
| 0.575 | 52.41 | 73 | -20.59 | Pass | 37.33 | 60 | -22.67 | Pass |
| 1.248 | 47.17 | 73 | -25.83 | Pass | 32.82 | 60 | -27.18 | Pass |
| 1.346 | 51.79 | 73 | -21.21 | Pass | 39.64 | 60 | -20.36 | Pass |

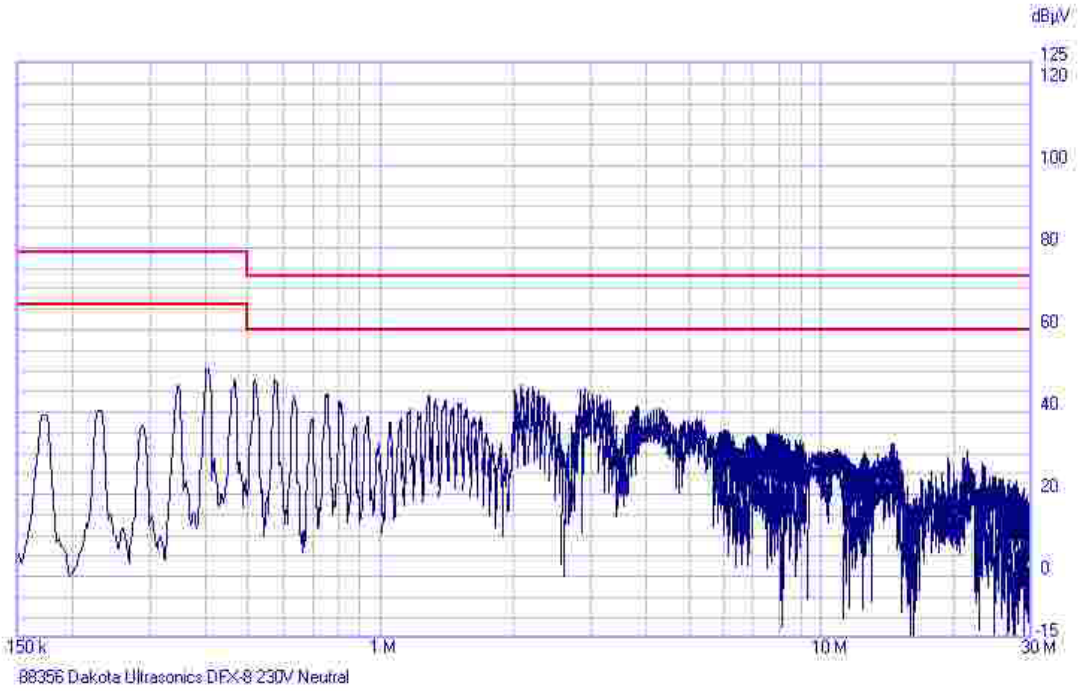
**Table 8. CE Voltage - (230 VAC, 50 Hz), Phase Line Test Results (DFX-8)**




**Plot 1. CE Voltage, Phase Line Plot (DFX-8)**

| Freq (MHz) | QP Amplitude | QP Limit | Delta | Results | Average Amplitude | Average Limit | Delta | Results |
|---|---|---|---|---|---|---|---|---|
| 0.152 | 34.07 | 79 | -44.93 | Pass | 7.25 | 66 | -58.75 | Pass |
| 0.387 | 51.45 | 79 | -27.55 | Pass | 33.27 | 66 | -32.73 | Pass |
| 0.422 | 53.91 | 79 | -25.09 | Pass | 40.92 | 66 | -25.08 | Pass |
| 0.489 | 54.47 | 79 | -24.53 | Pass | 41.07 | 66 | -24.93 | Pass |
| 0.575 | 49.97 | 73 | -23.03 | Pass | 35.8 | 60 | -24.2 | Pass |
| 1.332 | 45.42 | 73 | -27.58 | Pass | 34.66 | 60 | -25.34 | Pass |

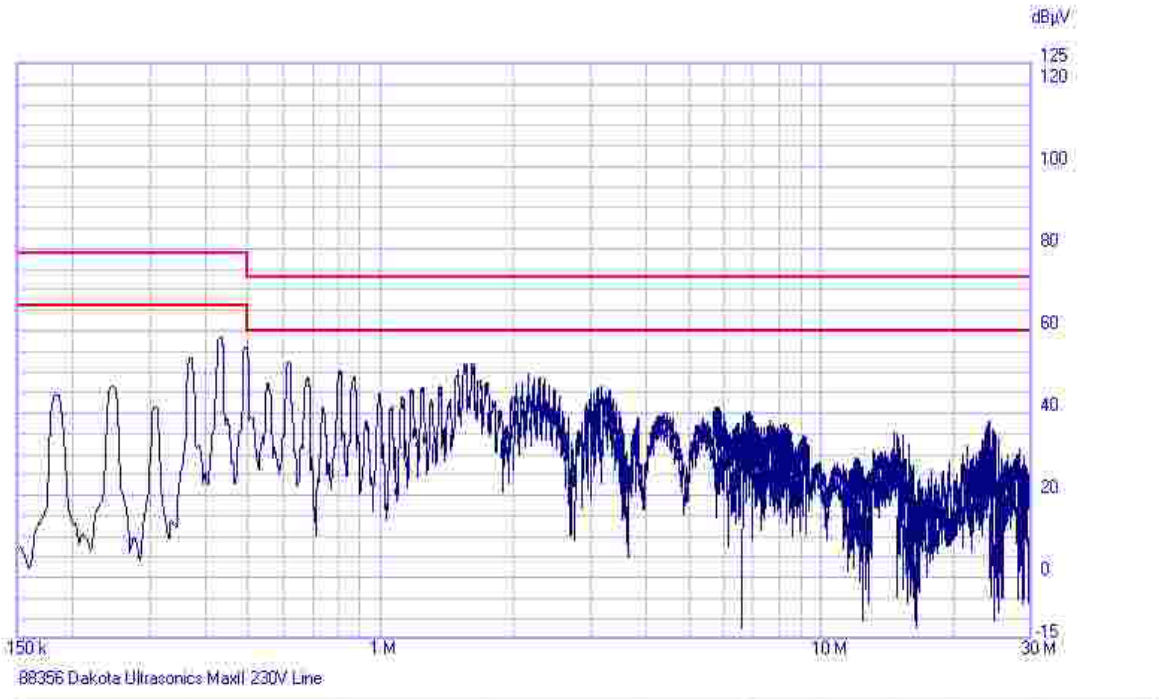
**Table 9. CE Voltage - (230 VAC, 50 Hz), Neutral Line Test Results (DFX-8)**




**Plot 2. CE Voltage, Neutral Line Plot (DFX-8)**

| Freq (MHz) | QP Amplitude | QP Limit | Delta | Results | Average Amplitude | Average Limit | Delta | Results |
|---|---|---|---|---|---|---|---|---|
| 0.371 | 51.69 | 79 | -27.31 | Pass | 40.02 | 66 | -25.98 | Pass |
| 0.434 | 56.24 | 79 | -22.76 | Pass | 43.89 | 66 | -22.11 | Pass |
| 0.494 | 54.06 | 79 | -24.94 | Pass | 40.32 | 66 | -25.68 | Pass |
| 0.618 | 49.96 | 73 | -23.04 | Pass | 35.33 | 60 | -24.67 | Pass |
| 1.559 | 51.25 | 73 | -21.75 | Pass | 43.52 | 60 | -16.48 | Pass |
| 1.622 | 49.77 | 73 | -23.23 | Pass | 41.36 | 60 | -18.64 | Pass |

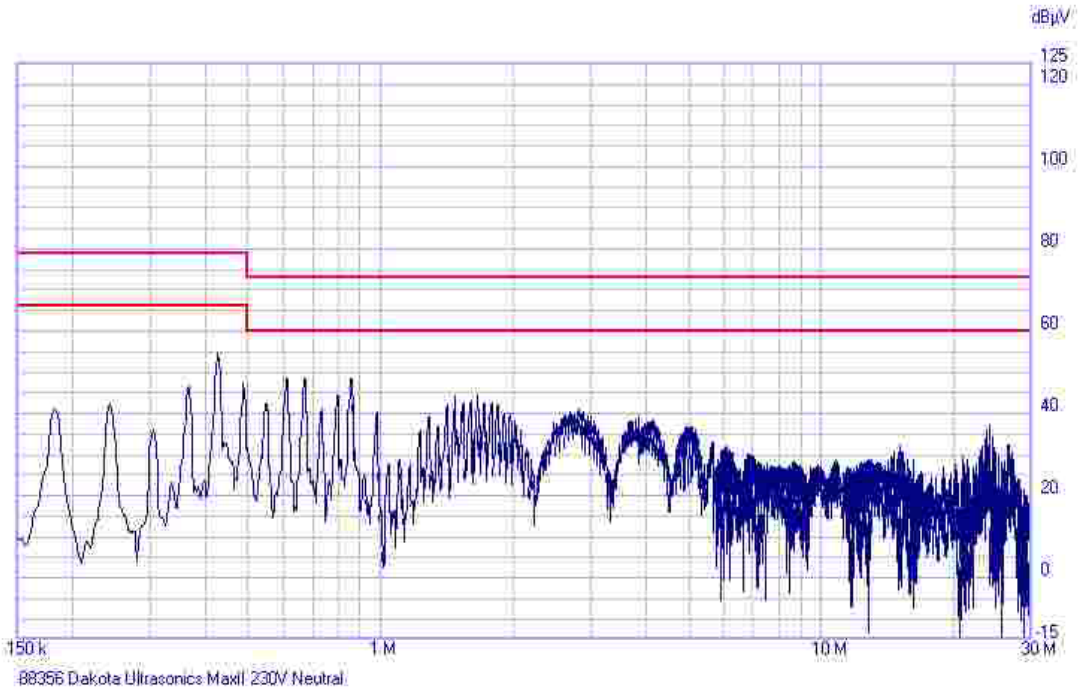
**Table 10. CE Voltage - (230 VAC, 50 Hz), Phase Line Test Results (Max II)**




**Plot 3. CE Voltage, Phase Line Plot (Max II)**

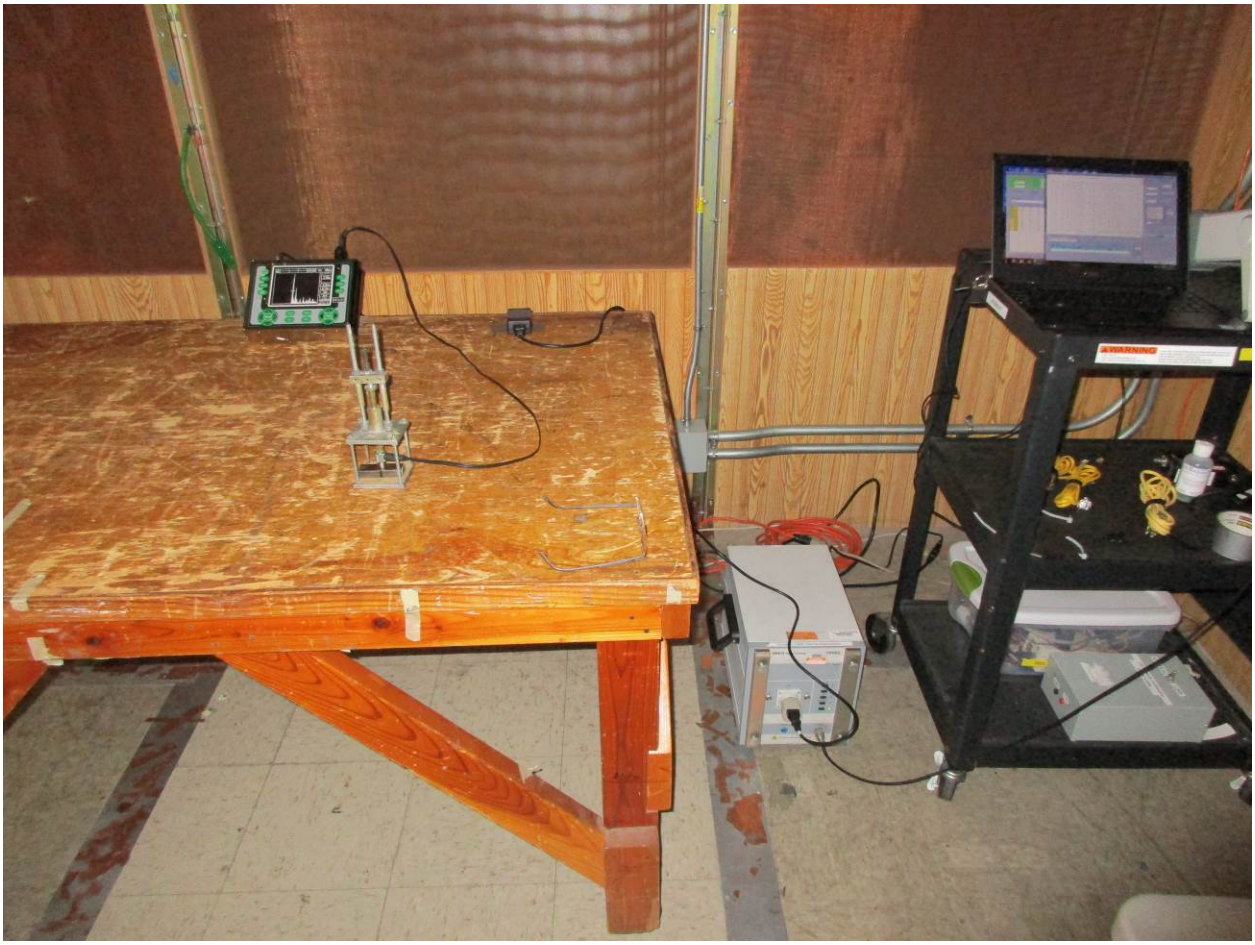
| Freq (MHz) | QP Amplitude | QP Limit | Delta | Results | Average Amplitude | Average Limit | Delta | Results |
|---|---|---|---|---|---|---|---|---|
| 0.367 | 47.32 | 79 | -31.68 | Pass | 35.79 | 66 | -30.21 | Pass |
| 0.428 | 51.73 | 79 | -27.27 | Pass | 39.49 | 66 | -26.51 | Pass |
| 0.489 | 48.87 | 79 | -30.13 | Pass | 36.07 | 66 | -29.93 | Pass |
| 0.612 | 45.01 | 73 | -27.99 | Pass | 31.22 | 60 | -28.78 | Pass |
| 0.673 | 41.68 | 73 | -31.32 | Pass | 27.12 | 60 | -32.88 | Pass |
| 0.857 | 41.44 | 73 | -31.56 | Pass | 27.15 | 60 | -32.85 | Pass |

**Table 11. CE Voltage - (230 VAC, 50 Hz), Neutral Line Test Results (Max II)**

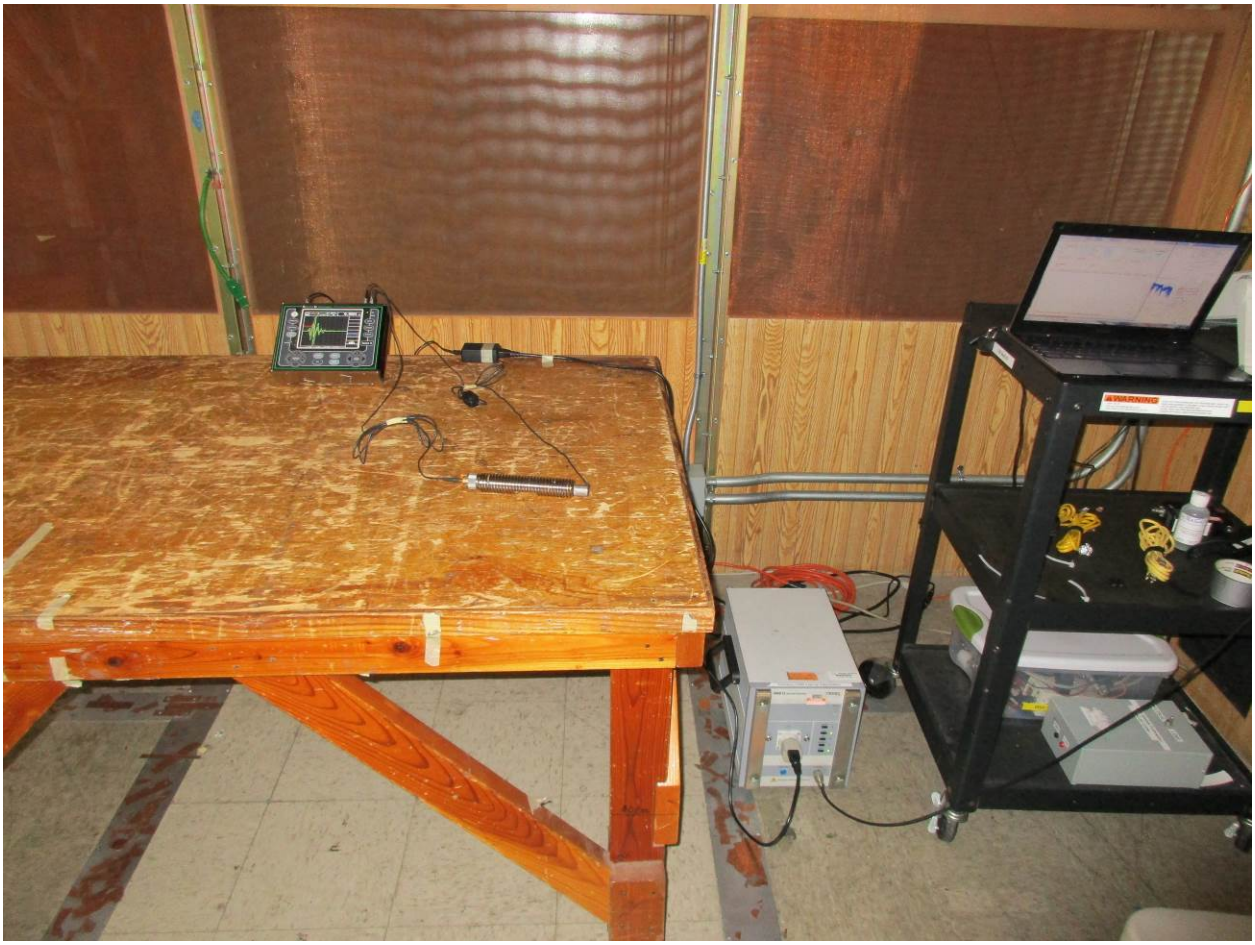



**Plot 4. CE Voltage, Neutral Line Plot (Max II)**

### 3.1.2.3. Test Setup Photograph



**Photograph 13. CE Voltage Test Setup (DFX-8)**



**Photograph 14. CE Voltage Test Setup (Max II)**

### 3.1.2.4. Test Setup Photograph

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Conducted Emission: Limits of Mains Terminal Disturbance Voltage | | | **Test Date(s):** 03/07/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2657 | Screen Room | ETS Lindgren | 14w-2/2-0 | See Note | |
| 1S2678 | LISN, Dual-Line V-Network | Teseq | NNB 51 | 03/03/2015 | 04/03/2016 |
| 1S3809 | EMI Receiver | Narda Safety Test Solutions | PMM 9010F | 02/01/2016 | 02/01/2017 |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 12. CE Voltage Test Equipment List**

## 3.2. Radiated Emission: Limits of Electromagnetic Radiation Disturbance

### 3.2.1. Test Method, Test Requirements, and Test Procedures

#### 3.2.1.1. Test Method

**EN 55011: 2009 +A1: 2010**
Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and Methods of Measurement

#### 3.2.1.2. Test Requirements

In accordance with EN 61326-1, Section 7.2 Emission Limits, the EUT shall meet the Class A radiated emission limits shown in Table 13.

| Frequency Band (MHz) | Class A Quasi-Peak limits 10 m measurement distance (dBµV/m) |
|---|---|
| 30 to 230 | 40 |
| 230 to 1000 | 47 |

**Table 13. Radiated Emission Limits for Class A Equipment from EN 61326-1**

#### 3.2.1.3. Test Procedure

The EUT was placed on a non metallic table top located inside a semi-anechoic chamber. The method of testing, test conditions, and test procedures of CISPR 11: 2009 were used. An antenna was located 5 m from the EUT on an adjustable mast. A pre-scan was first performed in order to find prominent radiated emissions. For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. Unless otherwise specified, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

Emissions measured at 5 m were normalized using an inverse proportionality factor of 20dB per decade for comparison to the 10 m limit. The physical size of the EUT was taken into account as to avoid near-field effects, which could occur near 30 MHz.

## 3.2.2. Test Results, Test Data, and Test Setup

### 3.2.2.1. Test Result

The EUT was **compliant** with the Class A requirement(s) of this section. Measured emissions were below applicable limits.

| Environmental Conditions for Radiated Emission | |
|---|---|
| **Ambient Temperature:** | 20.9 °C |
| **Relative Humidity:** | 28 % |
| **Atmospheric Pressure:** | 101.9 kPa |

**Test Engineer(s):** Mario Garcia

**Test Date(s):** 02/02/2016

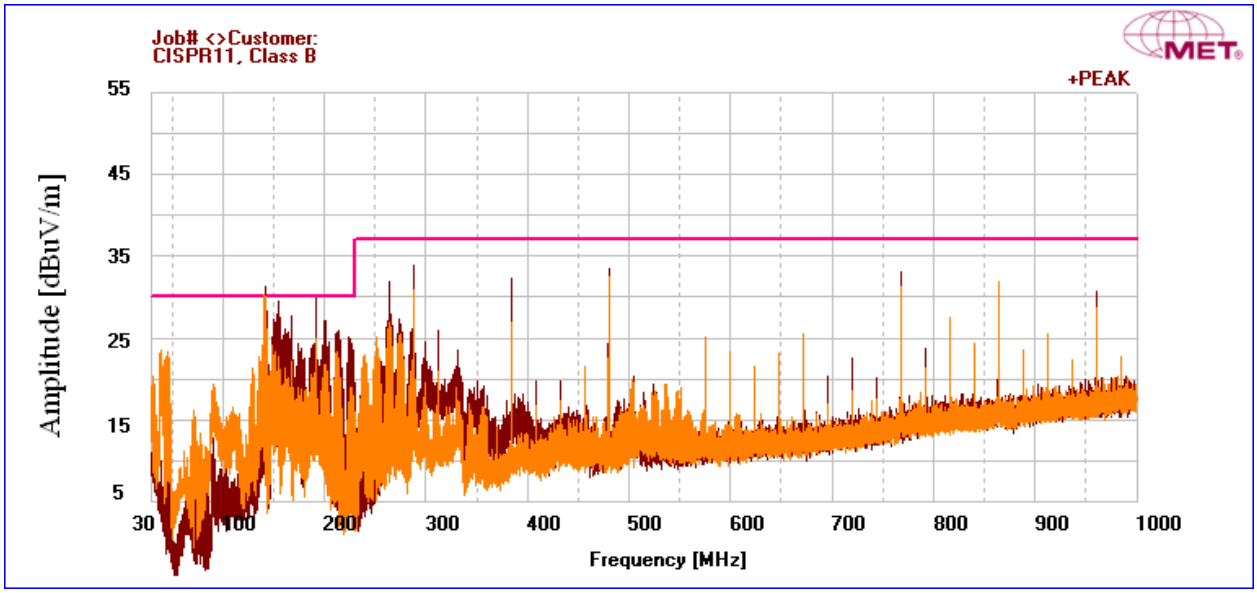
### 3.2.2.2. Test Data

| Frequency (MHz) | Antenna Polarity | EUT Azimuth (Degrees) | Antenna Height (cm) | Uncorrected Amplitude (dBuV) | ACF (dB/m) | Pre Amp Gain (dB) | CBL (dB) | DCF (dB) | Corrected Amplitude (dBuV) | Limit (dBuV) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***142.08** | **H** | **105** | **208.58** | **22.09** | **13.292** | **0** | **2.122** | **-10.46** | **27.044** | **30** | **-2.956** |
| ***142.08** | **V** | **70** | **100** | **22.15** | **13.192** | **0** | **2.122** | **-10.46** | **27.004** | **30** | **-2.996** |
| 155.08 | H | 88 | 212.82 | 21.79 | 12.9 | 0 | 2.228 | -10.46 | 26.458 | 30 | -3.542 |
| ***191.98** | **V** | **78** | **127.41** | **25.23** | **11.698** | **0** | **2.461** | **-10.46** | **28.929** | **30** | **-1.071** |
| ***287.98** | **H** | **311** | **100** | **28.64** | **13.8** | **0** | **3.081** | **-10.46** | **35.061** | **37** | **-1.939** |
| 479.98 | H | 181 | 100 | 17.36 | 18 | 0 | 3.928 | -10.46 | 28.828 | 37 | -8.172 |

**Table 14. RE - (30 MHz – 1 GHz) Test Results (DFX-8)**

Note: * - At this frequency, the measured electric-field strength exhibits a margin of compliance that is less than 3 dB below the specification limit. We recommend that every emission measured, have at least a 3 dB margin to allow for deviations in the emission characteristics that may occur during the production process.

The EUT was tested at 3 m. The data has been corrected for comparison with the 10 m limit using the formula: 20log (3 m/10 m) as expressed in the 'Distance Correction' column.




**Plot 5. RE - (30 MHz – 1 GHz), Plot (DFX-8)**

= Vertical Polarization
= Horizontal Polarization

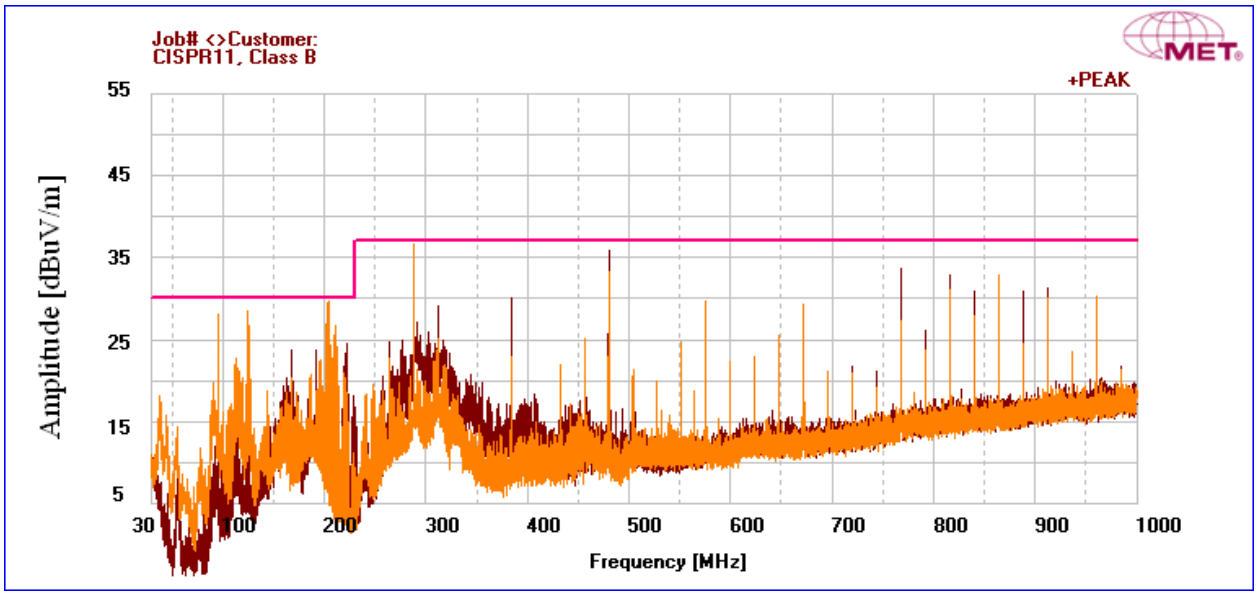
  

| Frequency (MHz) | Antenna Polarity | EUT Azimuth (Degrees) | Antenna Height (cm) | Uncorrected Amplitude (dBuV) | ACF (dB/m) | Pre Amp Gain (dB) | CBL (dB) | DCF (dB) | Corrected Amplitude (dBuV) | Limit (dBuV) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***95.98** | **V** | **159** | **100** | **26.28** | **10.298** | **0** | **1.724** | **-10.46** | **27.842** | **30** | **-2.158** |
| 124.44 | V | 112 | 108.70 | 15.33 | 14.9 | 0 | 1.958 | -10.46 | 21.728 | 30 | -8.272 |
| 203.56 | V | 42 | 100 | 18.19 | 12.43 | 0 | 2.538 | -10.46 | 22.698 | 30 | -7.302 |
| 287.97 | V | 230 | 197.76 | 23.67 | 13.381 | 0 | 3.081 | -10.46 | 29.672 | 37 | -7.328 |
| 479.98 | H | 192 | 100 | 20.92 | 18 | 0 | 3.928 | -10.46 | 32.388 | 37 | -4.612 |
| ***767.979** | **H** | **36** | **100** | **18.16** | **21.4** | **0** | **5.06** | **-10.46** | **34.16** | **37** | **-2.84** |

**Table 15. RE - (30 MHz – 1 GHz) Test Results (Max II)**

Note: * - At this frequency, the measured electric-field strength exhibits a margin of compliance that is less than 3 dB below the specification limit. We recommend that every emission measured, have at least a 3 dB margin to allow for deviations in the emission characteristics that may occur during the production process.

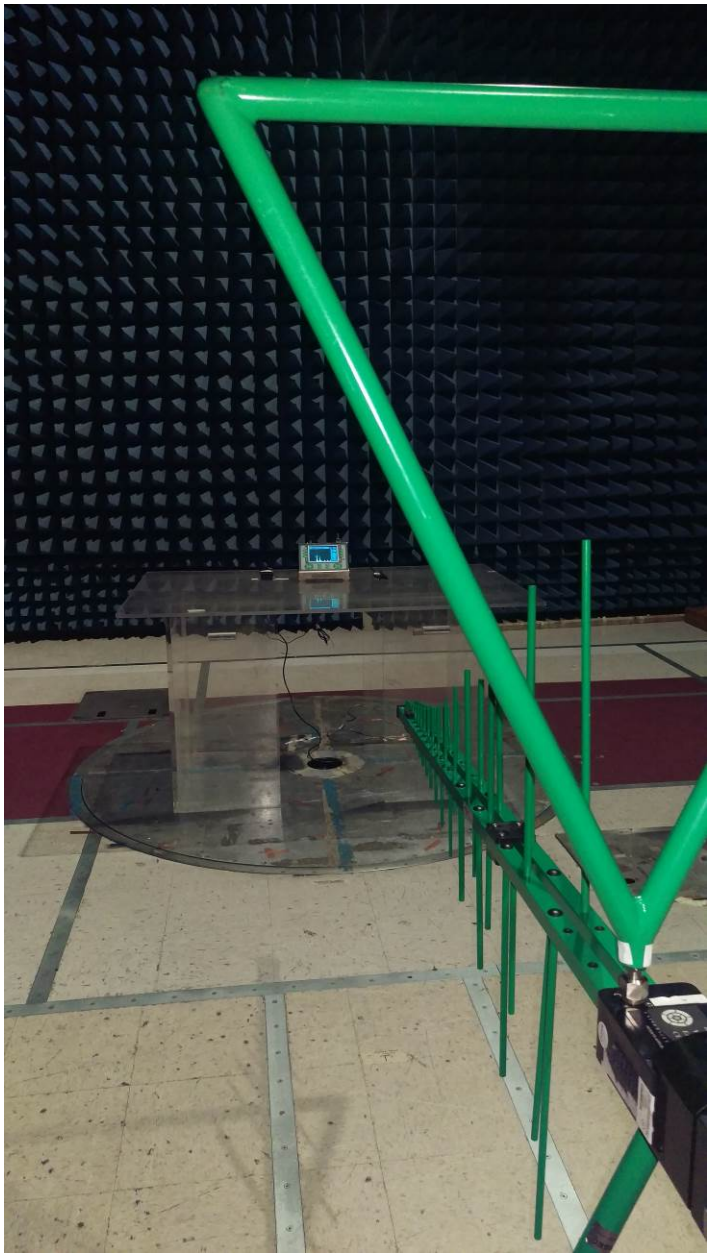
The EUT was tested at 3 m. The data has been corrected for comparison with the 10 m limit using the formula: 20log (3 m/10 m) as expressed in the 'Distance Correction' column.




**Plot 6. RE - (30 MHz – 1 GHz), Plot (Max II)**

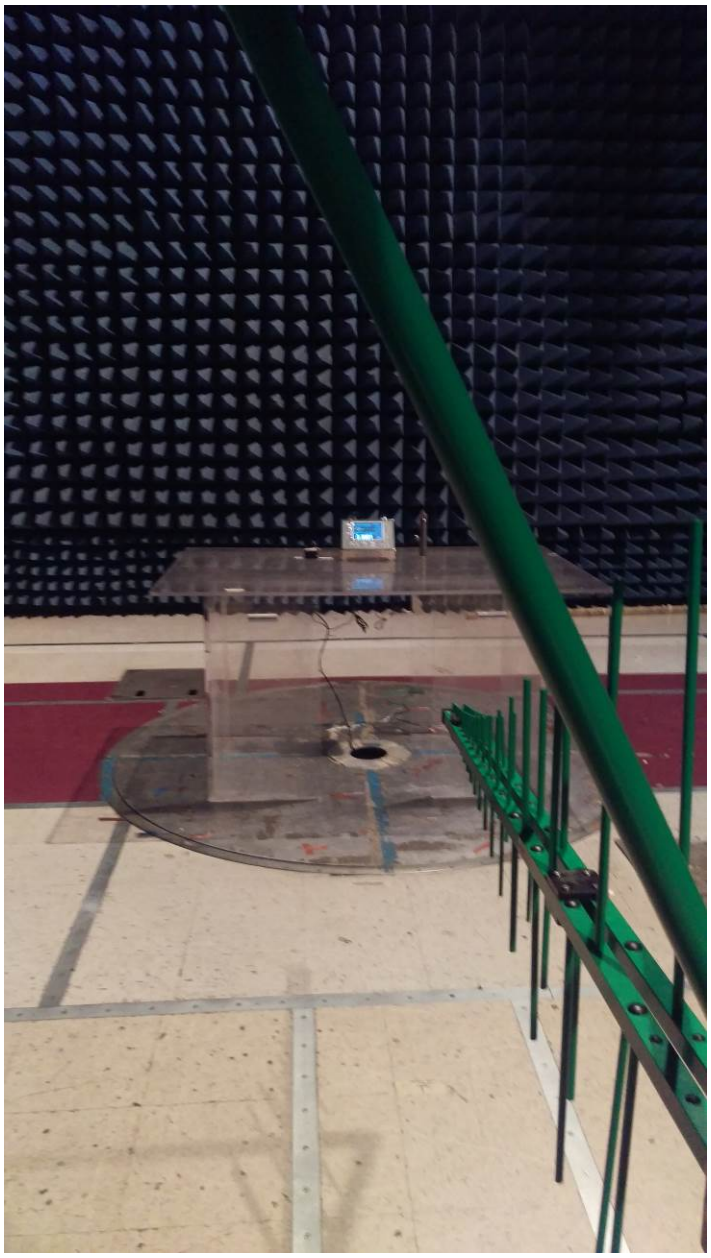
= Vertical Polarization
= Horizontal Polarization

### 3.2.2.3. Test Setup Photograph



**Photograph 15. RE Test Setup (DFX-8)**



**Photograph 16. RE Test Setup (Max II)**

### 3.2.2.4. Test Setup Photograph

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Radiated Emissions Electric Field | | | **Test Date(s):** 02/02/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2482 | 5 Meter Chamber (NSA) | Panashield | 5 Meter Semi-Anechoic Chamber | 03/12/2015 | 09/12/2016 |
| 1S2600 | Bilog Antenna | Teseq | CBL6112D | 10/05/2015 | 10/05/2016 |
| 1S3826 | DRG Horn Antenna | ETS-Lindgren | 3117 | 04/22/2015 | 04/22/2017 |
| 1S2587 | Preamplifier | AML Communications | AML0126L3801 | See Note | |
| 1S3835 | PSA Spectrum Analyzer | Agilent Technologies | E4448A | 11/20/2015 | 11/20/2017 |
| 1S2421 | EMI Test Receiver | Rohde & Schwarz | ESIB7 | 12/31/2015 | 12/31/2016 |
| 1S2399 | Turntable Controller | SUNOL SCIENCE | SC99V | See Note | |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 16. RE Test Equipment List**

# 4.0 Electromagnetic Compatibility Immunity Criteria

## 4.1. Electrostatic Discharge

### 4.1.1. Test Method, Test Requirements, and Test Procedures

#### 4.1.1.1. Test Method

**EN 61000-4-2: 2009**
Electromagnetic Discharge Immunity Test

#### 4.1.1.2. Test Requirements

**EN 61326-1, Section 6.2, Immunity Requirements**
Per EN 61000-4-2, the EUT shall be 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, HCP and the VCP.

#### 4.1.1.3. Test Procedure

The EUT and cables were isolated from the ground reference plane by an insulating support approximately **0.5 mm** thick. Air discharges of up to ±8 kV were applied to non-conductive surfaces. Contact discharges of up to ±4 kV were applied to conductive surfaces of the EUT and the HCP and VCP. Discharges were applied at least ten times to each selected discharge point at each polarity with a minimum time between discharges of 1s. The functionality of the EUT was determined during and after each discharge.

### 4.1.2. Test Results, Test Data, and Test Setup

#### 4.1.2.1. Test Results

The EUT was **compliant** with the requirement(s) of this section. No anomalies observed.

| Environmental Conditions for Electrostatic Discharge | |
|---|---|
| **Ambient Temperature:** | 21.7 °C |
| **Relative Humidity:** | 57 % |
| **Atmospheric Pressure:** | 101.9 kPa |

**Test Engineer(s):** Bobak Beheshti

**Test Date(s):** 03/04/2016

### 4.1.2.2. Test Data

| Discharge Type | Test Voltage (±kV) | Results | | | | | | Anomalies |
|---|---|---|---|---|---|---|---|---|
| | | Front | Back | Left | Right | Top | Bottom | |
| VCP | 2 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| | 4 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| HCP (Tabletop EUT only) | 2 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| | 4 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| Contact Discharge | 2 | N/A | N/A | N/A | N/A | Pass | Pass | No anomalies observed. |
| | 4 | N/A | N/A | N/A | N/A | Pass | Pass | No anomalies observed. |
| Air Discharge | 2 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |
| | 4 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |
| | 6 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |
| | 8 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |

**Table 17. ESD Test Results (DFX-8)**

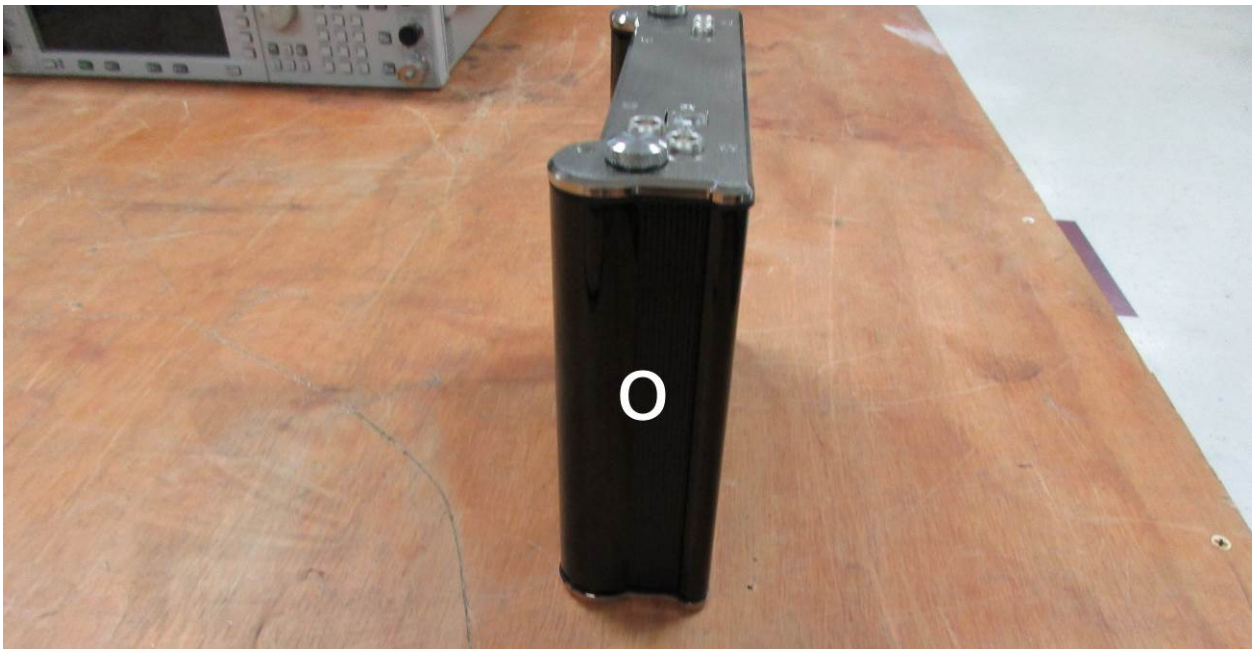
| Discharge Type | Test Voltage (±kV) | Results | | | | | | Anomalies |
|---|---|---|---|---|---|---|---|---|
| | | Front | Back | Left | Right | Top | Bottom | |
| VCP | 2 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| | 4 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| HCP (Tabletop EUT only) | 2 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| | 4 | Pass | Pass | Pass | Pass | Pass | Pass | No anomalies observed. |
| Contact Discharge | 2 | N/A | N/A | N/A | N/A | Pass | Pass | No anomalies observed. |
| | 4 | N/A | N/A | N/A | N/A | Pass | Pass | No anomalies observed. |
| Air Discharge | 2 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |
| | 4 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |
| | 6 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |
| | 8 | Pass | N/A | Pass | Pass | N/A | N/A | No anomalies observed. |

**Table 18. ESD Test Results (Max II)**

### 4.1.2.3. ESD Test Point Photographs


**Photograph 17. ESD Test Points – Front of EUT (DFX-8)**

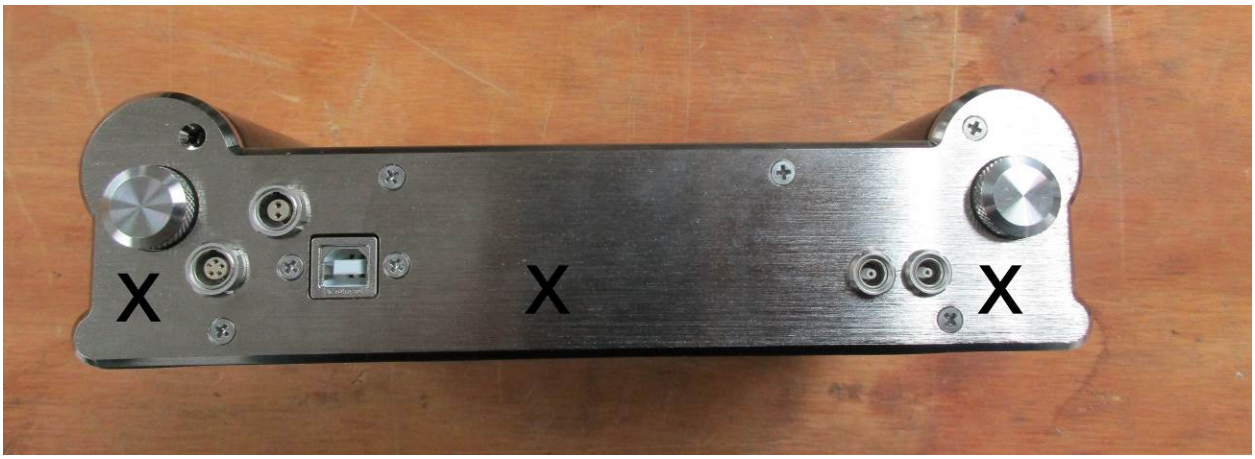
O = Air Discharge Test Points




**Photograph 18. ESD Test Points – Right of EUT (DFX-8)**


**Photograph 19. ESD Test Points – Left of EUT (DFX-8)**

O = Air Discharge Test Points




**Photograph 20. ESD Test Points – Top of EUT (DFX-8)**


**Photograph 21. ESD Test Points – Bottom of EUT (DFX-8)**

X = Contact Discharge Test Points


**Photograph 22. ESD Test Points – Front of EUT (Max II)**

**Photograph 23. ESD Test Points – Right of EUT (Max II)**

O = Air Discharge Test Points


**Photograph 24. ESD Test Points – Left of EUT (Max II)**

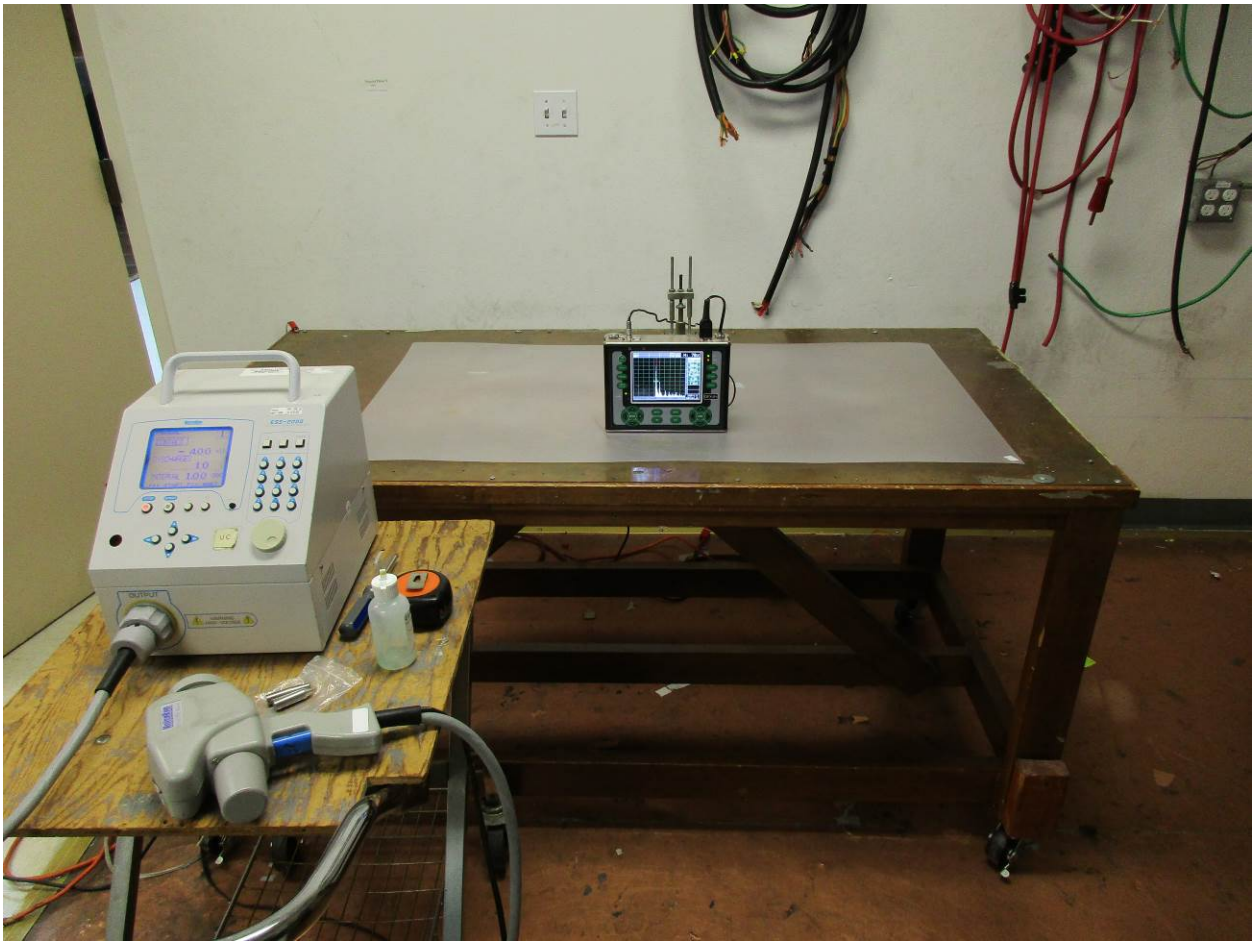
O = Air Discharge Test Points


**Photograph 25. ESD Test Points – Top of EUT (Max II)**


**Photograph 26. ESD Test Points – Bottom of EUT (Max II)**

X = Contact Discharge Test Points

### 4.1.2.4. Test Setup Photograph



**Photograph 27. ESD Test Setup (DFX-8)**

**Photograph 28. ESD Test Setup (Max II)**

### 4.1.2.5. Test Equipment List

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Electrostatic Discharge | | | **Test Date(s):** 03/04/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2654 | Ground Plane 5 | MET LABS | N/A | See Note | |
| 1U0175 | Electrostatic Discharge Simulator | NoiseKen | ESS-2000 | 10/13/2015 | 10/13/2016 |
| 1U0176 | Discharge Gun | NoiseKen | TC-815R | 10/13/2015 | 04/13/2017 |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 19. ESD Test Equipment List**

## 4.2. Radio Frequency Electromagnetic Field

### 4.2.1. Test Method, Test Requirements, and Test Procedures

#### 4.2.1.1. Test Method

**EN 61000-4-3: 2006 +A1:2008 +A2:2010**
Radiated, Radio-Frequency, Electromagnetic Field Immunity Test

#### 4.2.1.2. Test Requirements

**EN 61326-1, Section 6.2, Immunity Requirements**
The EUT must not be susceptible to a radiated electromagnetic field of 10 V/m, 80% amplitude modulated 1 kHz, in the frequency range 80 MHz to 2.7 GHz.

#### 4.2.1.3. Test Procedure

Testing was performed in a semi-anechoic chamber as recommended by IEC 61000-4-3. The radiating antenna was placed 2 m in front of the EUT Support equipment for the EUT was located outside of the test room. The amplitude, frequency, and dwell time of the radiated interference was controlled by an automated, computer-controlled system.

The signal source was stepped through the applicable frequency range at a rate no faster than 1% of the fundamental. The signal was amplitude modulated 80% over the frequency range 80 MHz to 2.7 GHz at a level of 10. The dwell time was set at 1 s. 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.

### 4.2.2. Test Results, Test Data, and Test Setup

#### 4.2.2.1. Test Result

The EUT was **compliant** with the requirement(s) of this section. No anomalies observed.

| Environmental Conditions for Radio Frequency Electromagnetic Field | |
|---|---|
| **Ambient Temperature:** | 23.5 °C |
| **Relative Humidity:** | 47 % |
| **Atmospheric Pressure:** | 100 kPa |

**Test Engineer(s):** Jeremy Chinn

**Test Date(s):** 05/02/2016

### 4.2.2.2. Test Data

| DFX-8 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start Frequency (MHz) | Stop Frequency (MHz) | Severity (V/m) | Polarity (H/V) | Modulation (Freq & Type) | Results | | | |
| | | | | | Front | Back | Left | Right |
| 80 | 1000 | 10 | V | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 80 | 1000 | 10 | H | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 1000 | 2700 | 10 | V | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 1000 | 2700 | 10 | H | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |

| Max II | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start Frequency (MHz) | Stop Frequency (MHz) | Severity (V/m) | Polarity (H/V) | Modulation (Freq & Type) | Results | | | |
| | | | | | Front | Back | Left | Right |
| 80 | 1000 | 10 | V | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 80 | 1000 | 10 | H | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 1000 | 2700 | 10 | V | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |
| 1000 | 2700 | 10 | H | 1 kHz, 80%AM | Pass | Pass | Pass | Pass |

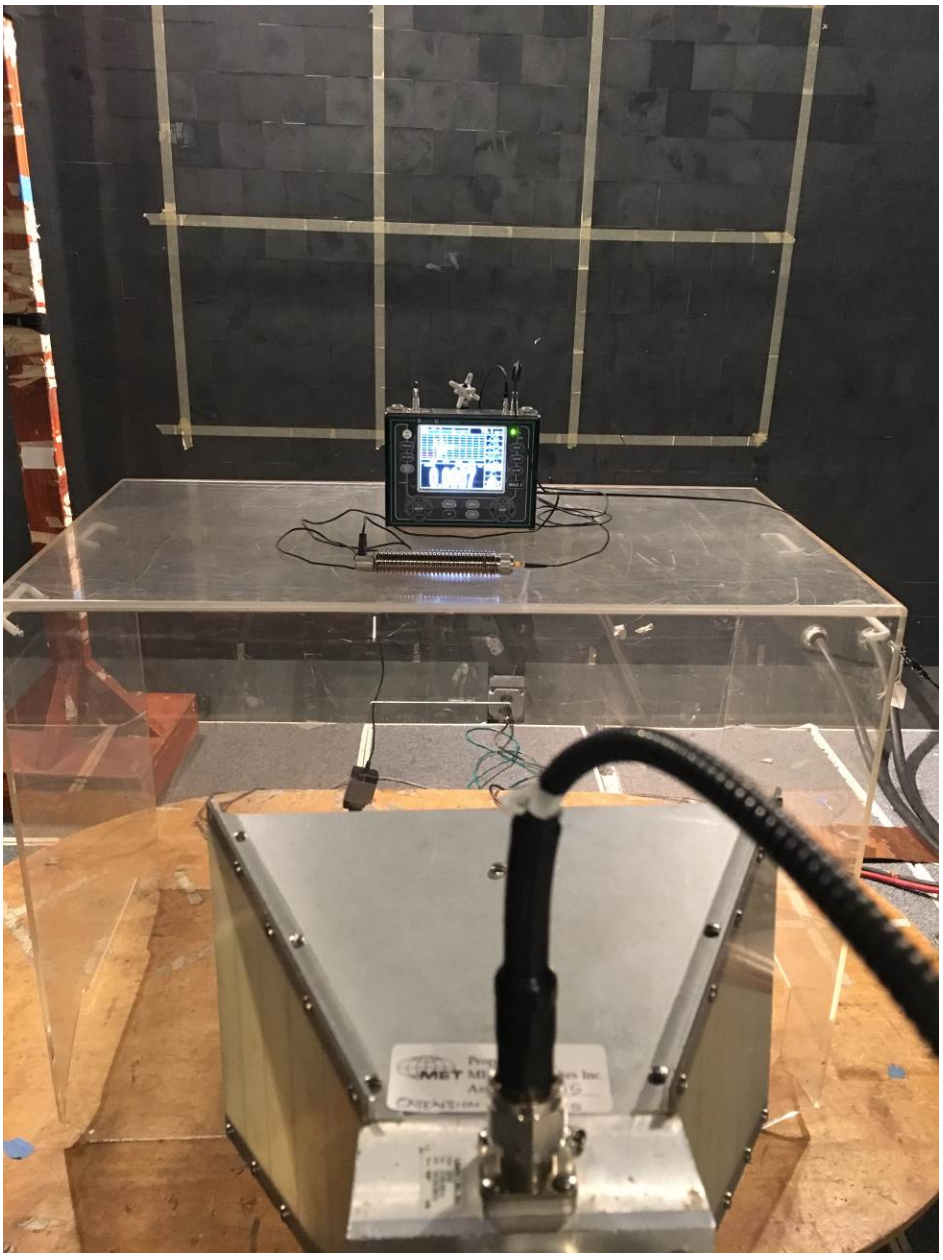
**Table 20. RI Test Results**

### 4.2.2.3. Test Setup Photograph

**Photograph 29. RI (80 MHz – 1 GHz) Test Setup (DFX-8)**


**Photograph 30. RI (1 – 2.7 GHz) Test Setup (DFX-8)**

**Photograph 31. RI (80 MHz – 1 GHz) Test Setup (Max II)**



**Photograph 32. RI (1 – 2.7 GHz) Test Setup (Max II)**

### 4.2.2.4. Test Equipment List

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Radio Frequency Electromagnetic Field | | | **Test Date(s):** 05/02/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S3927 | Microwave Signal Generator | Rohde & Schwarz | SMF100A | 10/22/2015 | 10/22/2016 |
| 1U0025 | Wideband System Amplifier | IFI | CMX5001 | See Note | |
| 1U0109 | Wide Band Amp | IFI | SMX201 | See Note | |
| 1U0257 | Amplifier | Amplifier Research | 25S1G4A | See Note | |
| 1U0033 | Immunity Chamber | Lindgren Enclosures | FACT 3 | See Note | |
| 1U0040 | Antenna, Biconilog | Schaffner | CBL6140A | See Note | |
| 1U0115 | Antenna, Horn | EMCO | 3115 | See Note | |
| 1U0303 | E-field Probe | Narda | PMM EP601 | 01/21/2016 | 07/21/2017 |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 21. RI Test Equipment List**

## 4.3. Electrical Fast Transient/Burst

### 4.3.1. Test Method, Test Requirements, and Test Procedures

#### 4.3.1.1. Test Method

**EN 61000-4-4: 2012** - Electrical Fast Transient/Burst Immunity Test

#### 4.3.1.2. Test Requirements

**EN 61326-1, Section 6.2, Immunity Requirements**
EUT shall be tested with the electrical fast transients shown in Figure 2, having amplitude of up to ±2 kV applied to AC a power ports. AC power lines connected directly to mains supply, and I/O Signal/Control lines, which are greater than 3 m, shall be tested.

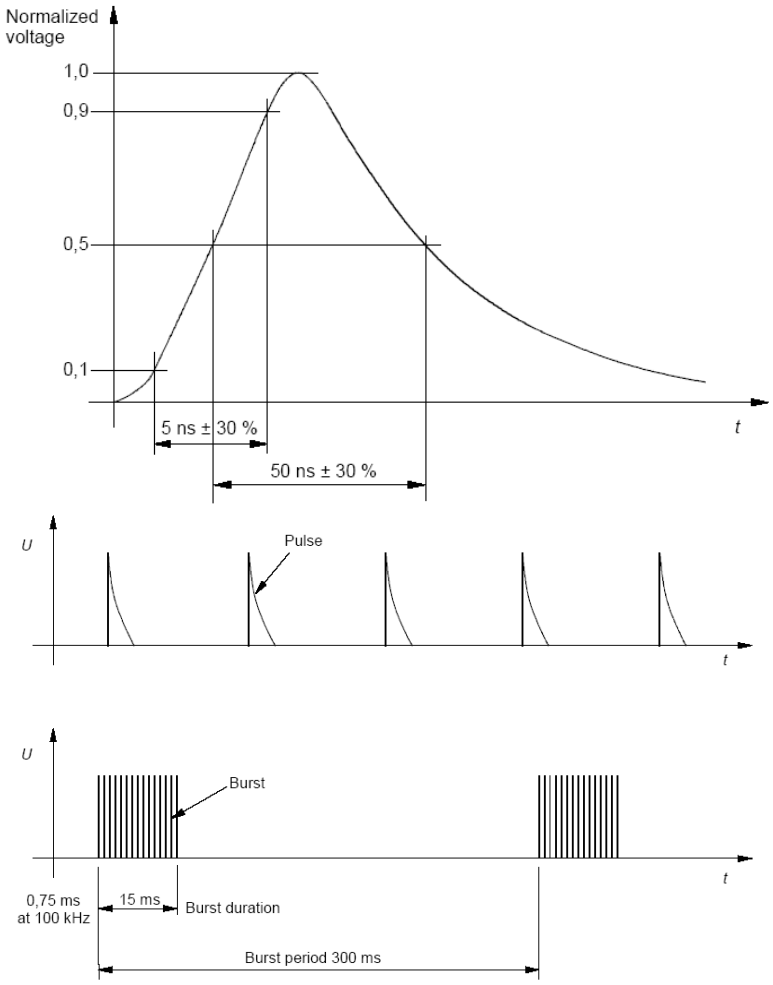



**Figure 2. Fast Transient Test Waveform from EN 61000-4-4**

#### 4.3.1.3. Test Procedure

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.

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

### 4.3.2. Test Results, Test Data, and Test Setup

#### 4.3.2.1. Test Result

The EUT was **compliant** with the requirement(s) of this section. No anomalies observed.

| Environmental Conditions for Fast Transients | |
|---|---|
| **Ambient Temperature:** | 19.3 °C |
| **Relative Humidity:** | 56 % |
| **Atmospheric Pressure:** | 100 kPa |

**Test Engineer(s):** Jeremy Chinn

**Test Date(s):** 02/29/2016

#### 4.3.2.2. Test Data

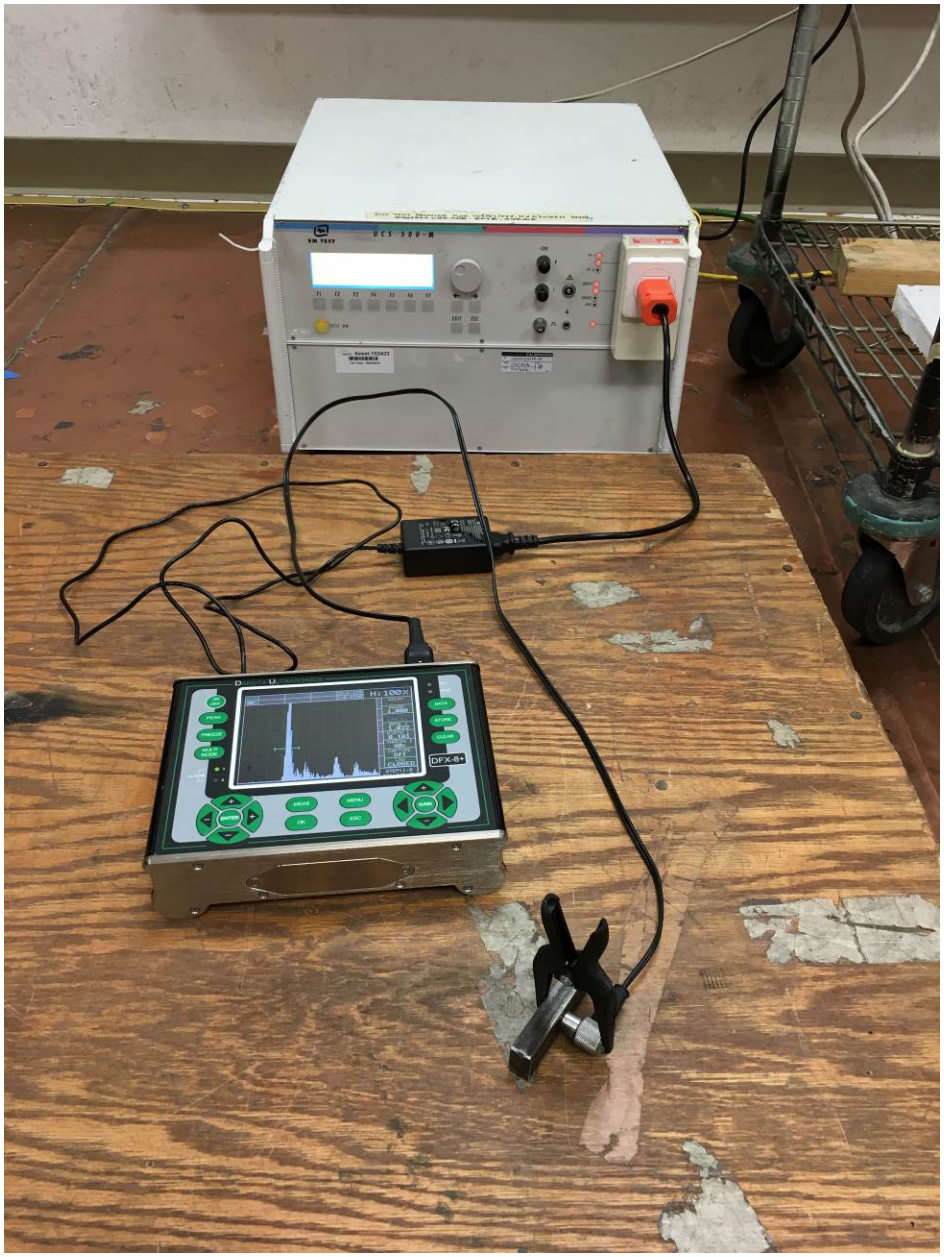
| DFX-8 | | | | |
|---|---|---|---|---|
| **Port Name** | **Test Level** | **Coupling Method** | **Results** | **Anomalies** |
| AC Power | ±2 kV | CDN | Pass | No anomalies observed. |

| Max II | | | | |
|---|---|---|---|---|
| **Port Name** | **Test Level** | **Coupling Method** | **Results** | **Anomalies** |
| AC Power | ±2 kV | CDN | Pass | No anomalies observed. |

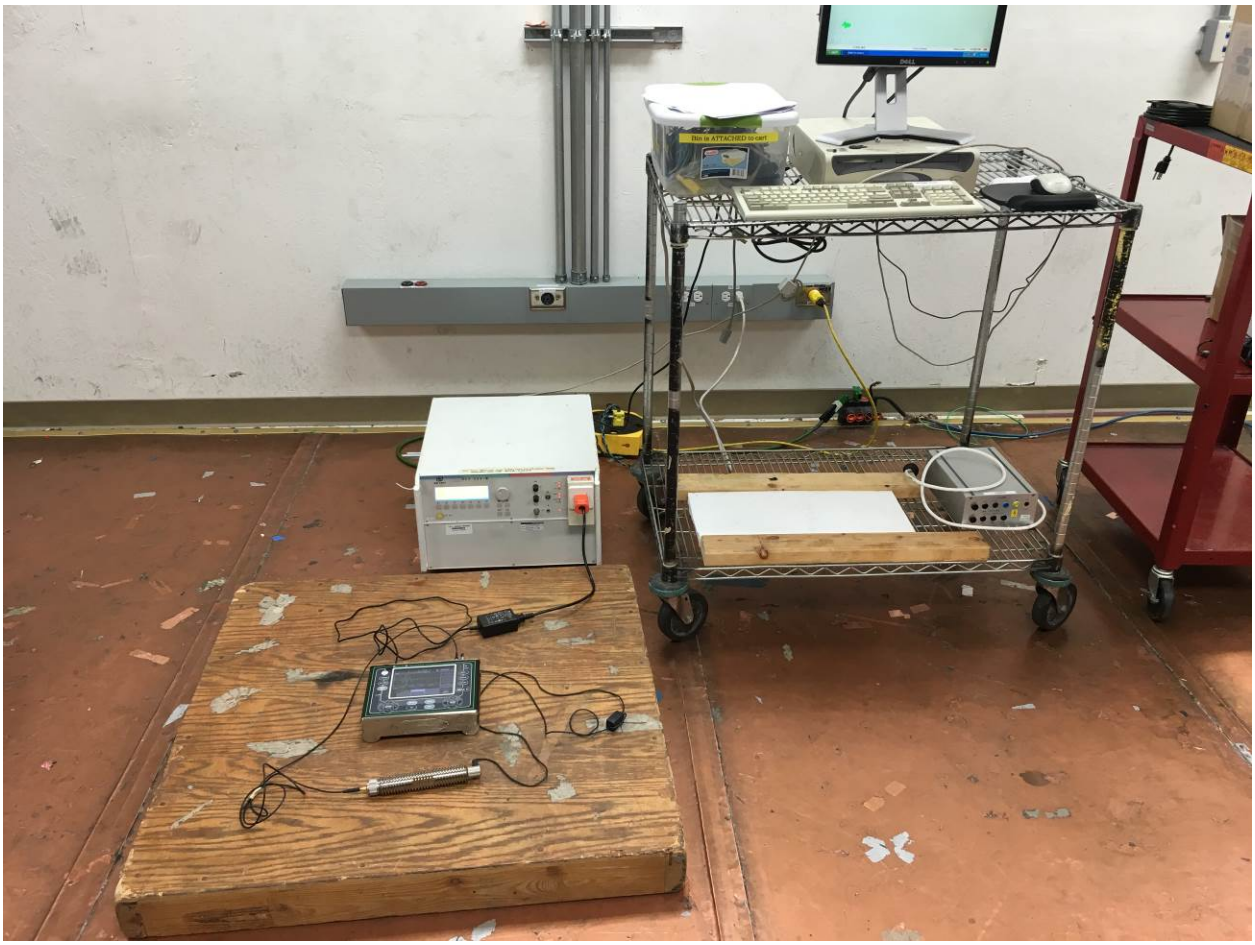
**Table 22. EFT/B Test Results**

### 4.3.2.3. Test Setup Photograph




**Photograph 33. EFT/B Test Setup (DFX-8)**



**Photograph 34. EFT/B Test Setup (Max II)**

### 4.3.2.4. Test Equipment List

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Electrical Fast Transients/Bursts | | | **Test Date(s):** 02/29/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2490 | Ground Plane 2 | MET LABS | N/A | See Note | |
| 1S2423 | Ultra Compact Simulator | EM Test | UCS-500M-6A | See Note | |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 23. EFT/B Test Equipment List**

## 4.4. Surge

### 4.4.1. Test Method, Test Requirements, and Test Procedures

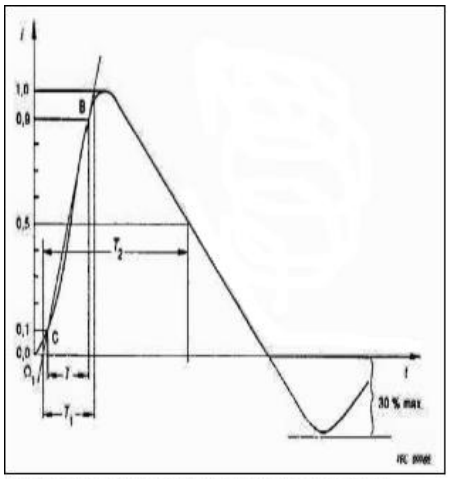
#### 4.4.1.1. Test Method

**EN 61000-4-5: 2006**
Surge Immunity Test

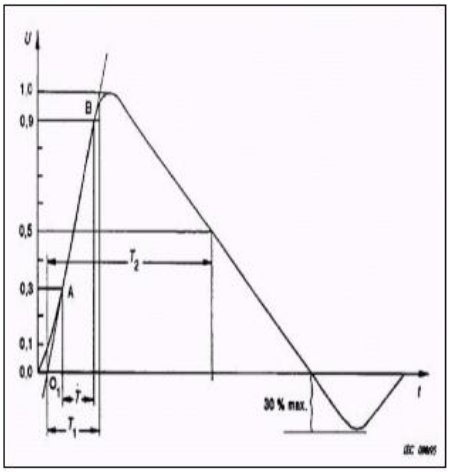
#### 4.4.1.2. Test Requirements

**EN 61326-1, Section 6.2, Immunity Requirements**
The EUT shall be tested with the surge test waveforms shown in Figure 2. AC Power Ports shall be tested to surges having an open circuit amplitude of ±0.5 kV - 1 kV (differential mode) and ±1 kV – 2 kV (common mode). This is applicable to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 30 m within the building or cables that leave the building. The test setup, test methods, required test equipment, and the test limits of EN 61000-4-5 shall be used.

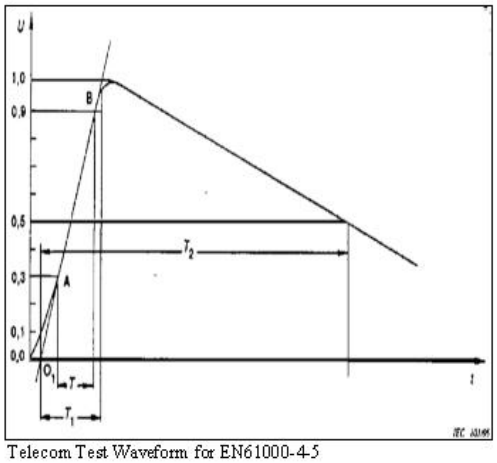
  




Short Circuit Current Waveform for EN 61000-4-5




Open Circuit Voltage Waveform for EN 61000-4-5




Telecom Test Waveform for EN61000-4-5

**Figure 3. Surge Test Waveforms from EN 61000-4-5**

#### 4.4.1.3. Test Procedure

The EUT was placed on a wooden pallet above a GRP. For application of the surge to the AC power lines of the EUT, power was supplied to the EUT through the coupling/decoupling section of the surge generator.

Each AC power line under test was subjected to at least five positive and five negative surges at the appropriate voltage and phase angle, at a maximum repetition rate of 1/min. Throughout testing, the EUT was monitored for signs of susceptibility.

For I/O Signal/Control lines, a coupling de-coupling network [CDN] was required in order to avoid possible adverse effects on equipment not under test and to provide sufficient decoupling impedance to the surge wave so that the specified wave could be developed on the lines under test. The length of the interconnection line between the CDN and the EUT was no longer than 2 m.

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

**Table 24. Combination Wave Generator Test Parameters for Surge Immunity Testing**

### 4.4.2. Test Results, Test Data, and Test Setup

#### 4.4.2.1. Test Result

The EUT was **compliant** with the requirement(s) of this section. No anomalies observed.

| Environmental Conditions for Surge | |
|---|---|
| **Ambient Temperature:** | 19.9 °C |
| **Relative Humidity:** | 56 % |
| **Atmospheric Pressure:** | 101 kPa |

**Test Engineer(s):** Jeremy Chinn

**Test Date(s):** 02/29/2016

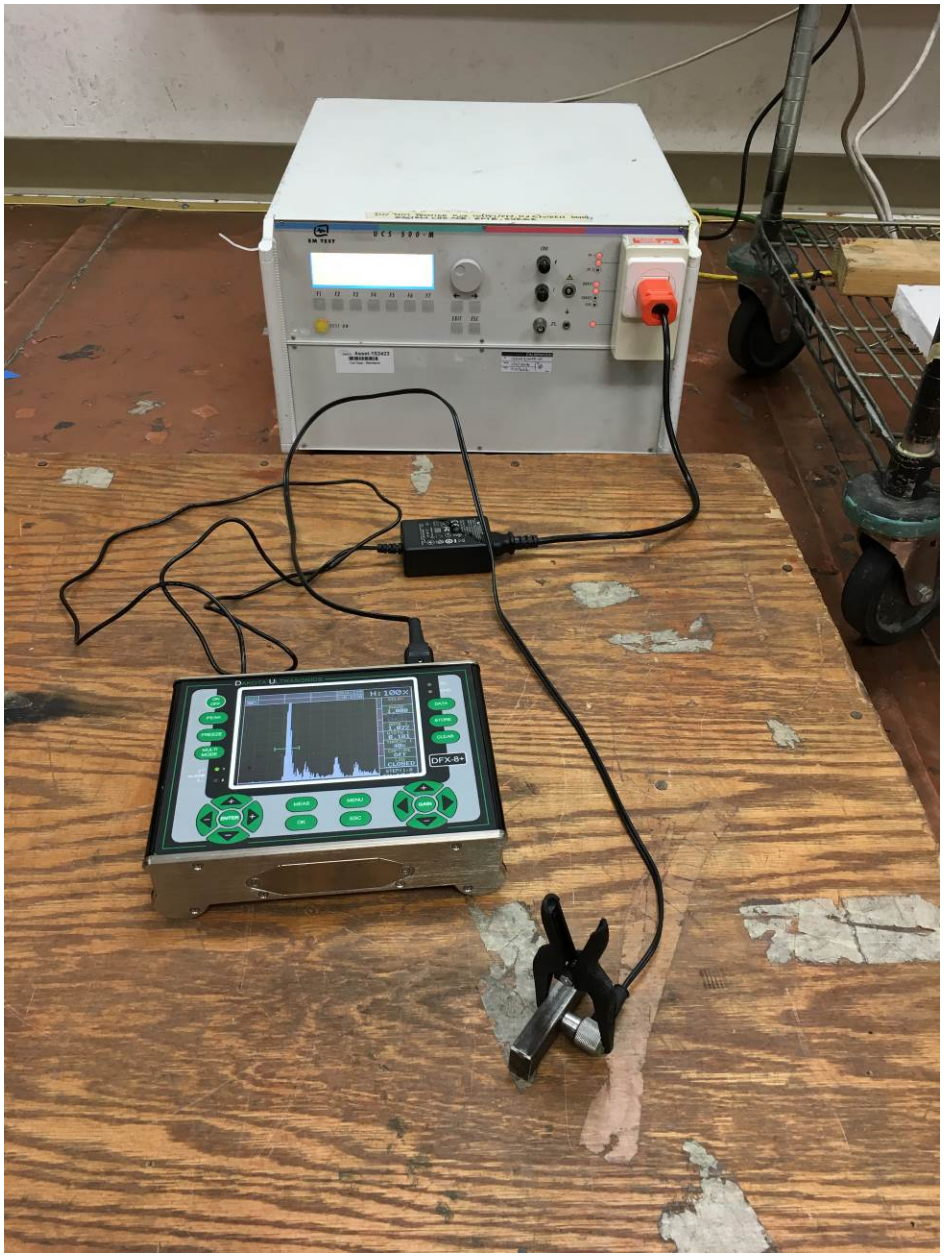
### 4.4.2.2. Test Data

| DFX-8 | | | | | |
|---|---|---|---|---|---|
| **Coupling** | **Phase** | **Test Level** | **Results** | **Coupling Method** | **Anomalies** |
| **AC, Differential Mode** | | | | | |
| **Line to Neutral** | 0 | ±1.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 90 | ±1.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 180 | ±1.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 270 | ±1.0 kV | Pass | Internal CDN | No anomalies observed. |
| **AC, Common Mode** | | | | | |
| **Neutral to Ground** | 0 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 90 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 180 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 270 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |
| **Line to Ground** | 0 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 90 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 180 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |
| | 270 | ±2.0 kV | Pass | Internal CDN | No anomalies observed. |

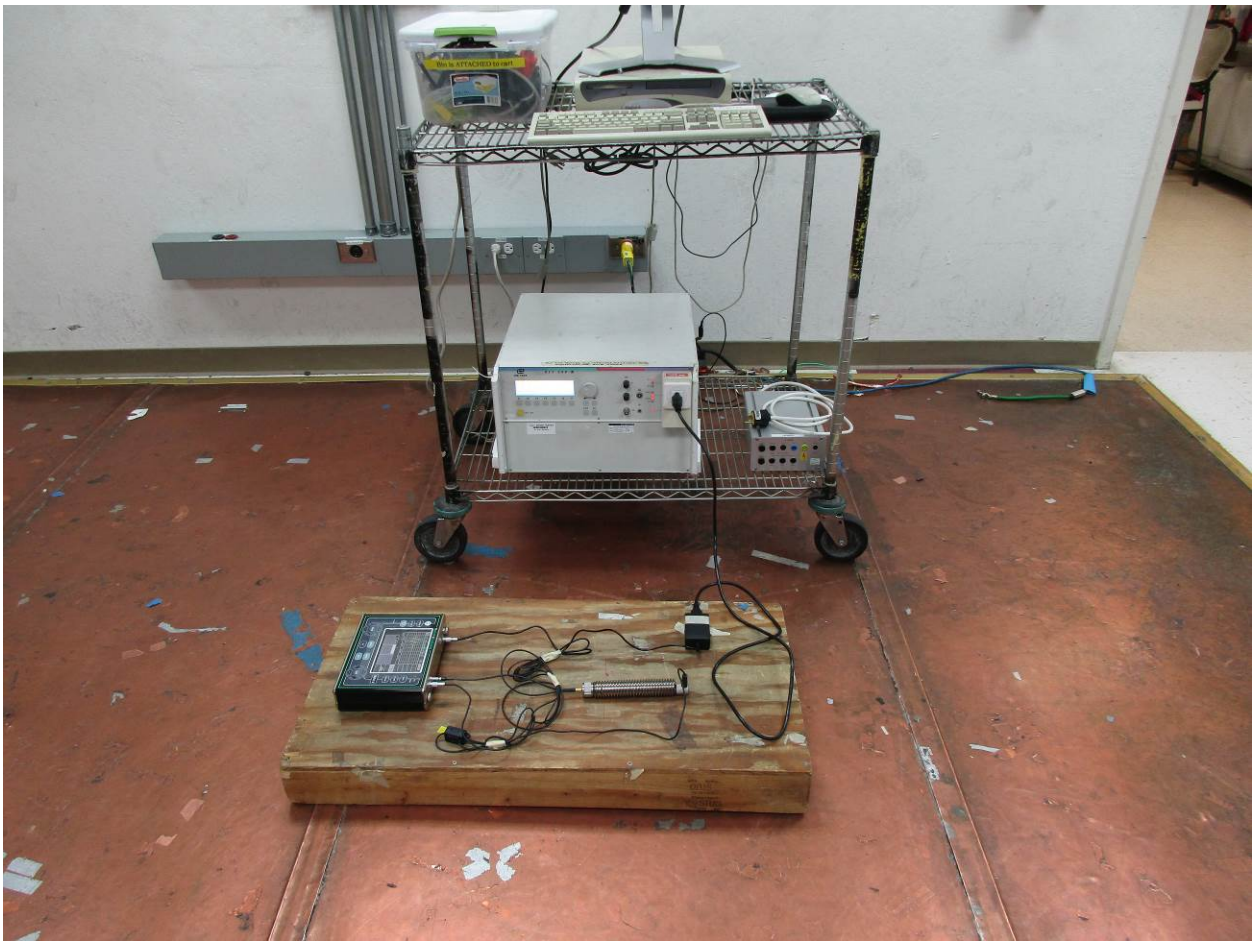
| Max II | | | | | |
|---|---|---|---|---|---|
| **Coupling** | **Phase** | **Test Level** | **Results** | **Coupling Method** | **Anomalies** |
| **AC, Differential Mode** | | | | | |
| **Line to Neutral** | 0 | ±1.0 kV | Pass | Internal CDN | No anomalies observed |
| | 90 | ±1.0 kV | Pass | Internal CDN | No anomalies observed |
| | 180 | ±1.0 kV | Pass | Internal CDN | No anomalies observed |
| | 270 | ±1.0 kV | Pass | Internal CDN | No anomalies observed |
| **AC, Common Mode** | | | | | |
| **Neutral to Ground** | 0 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |
| | 90 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |
| | 180 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |
| | 270 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |
| **Line to Ground** | 0 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |
| | 90 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |
| | 180 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |
| | 270 | ±2.0 kV | Pass | Internal CDN | No anomalies observed |

**Table 25. Surge Test Results**

### 4.4.2.3. Test Setup Photograph




**Photograph 35. Surge Test Setup (DFX-8)**



**Photograph 36. Surge Test Setup (Max II)**

### 4.4.2.4. Test Equipment List

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Surge | | | **Test Date(s):** 02/29/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2490 | Ground Plane 2 | MET LABS | N/A | See Note | |
| 1S2423 | Ultra Compact Simulator | EM Test | UCS-500M-6A | See Note | |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 26. Surge Test Equipment List**

## 4.5. Radio Frequency, Conducted Continuous

### 4.5.1. Test Method, Test Requirements, and Test Procedures

#### 4.5.1.1. Test Method

**EN 61000-4-6: 2009**
Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields

#### 4.5.1.2. Test Requirements

**EN 61326-1, Section 6.2, Immunity Requirements**
AC and DC power lines connected directly to mains supply, and I/O Signal/Control lines, which are greater than 3 m, shall be tested. For input/output circuits where the manufacturer specifies that shielded cables must be used, or that the cables must be located on conductive cable trays or in conduits, the conducted immunity requirements can be omitted within the frequency range of 150 kHz to 80 MHz.

AC and DC power lines and applicable I/O Signal/Control lines shall be tested to an injected level of 3 Vrms. The injection voltage shall be amplitude modulated 80% by a 1 kHz tone.

#### 4.5.1.3. Test Procedures

The EUT was placed on a wooden pallet above a GRP.

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 a 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 power line in the frequency range 0.15 MHz - 80 MHz, a BCI probe 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 a 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.

## 4.5.2. Test Results, Test Data, and Test Setup

### 4.5.2.1. Test Result

The EUT was **compliant** with the requirement(s) of this section. No anomalies observed.

| Environmental Conditions for Radio Frequency, Conducted Continuous | |
|---|---|
| **Ambient Temperature:** | 20 °C |
| **Relative Humidity:** | 38 % |
| **Atmospheric Pressure:** | 101 kPa |

**Test Engineer(s):** Danny Alvendia

**Test Date(s):** 03/02/2016

### 4.5.2.2. Test Data

| DFX-8 | | | | | | |
|---|---|---|---|---|---|---|
| **Cable Ref. ID** | **Port Name On EUT** | **Severity (Vrms)** | **Modulation (Freq & Type)** | **Coupling Method** | **Results** | **Anomalies** |
| **Power Cables** | | | | | | |
| AC | AC | 3 | 1 kHz, 80%AM | CDN | Pass | No anomalies observed. |

| FOKI (MHz) | Results | Anomalies |
|---|---|---|
| 0.2 | Pass | No anomalies observed. |
| 1 | Pass | No anomalies observed. |
| 7.1 | Pass | No anomalies observed. |
| 13.56 | Pass | No anomalies observed. |
| 21 | Pass | No anomalies observed. |
| 27.12 | Pass | No anomalies observed. |
| 40.68 | Pass | No anomalies observed. |
| 52 | Pass | No anomalies observed. |

| Max II | | | | | | |
|---|---|---|---|---|---|---|
| **Cable Ref. ID** | **Port Name On EUT** | **Severity (Vrms)** | **Modulation (Freq & Type)** | **Coupling Method** | **Results** | **Anomalies** |
| **Power Cables** | | | | | | |
| AC | AC | 3 | 1 kHz, 80%AM | CDN | Pass | No anomalies observed. |

| FOKI (MHz) | Results | Anomalies |
|---|---|---|
| 0.2 | Pass | No anomalies observed. |
| 1 | Pass | No anomalies observed. |
| 7.1 | Pass | No anomalies observed. |
| 13.56 | Pass | No anomalies observed. |
| 21 | Pass | No anomalies observed. |
| 27.12 | Pass | No anomalies observed. |
| 40.68 | Pass | No anomalies observed. |
| 52 | Pass | No anomalies observed. |

**Table 27. CI Test Results (Max II)**

### 4.5.2.3. Test Setup Photograph

**Photograph 37. CI Test Setup (DFX-8)**

**Photograph 38. CI Test Setup (Max II)**

### 4.5.2.4. Test Equipment List

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Radio Frequency, Conducted Continuous | | | **Test Date(s):** 03/02/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2649 | Spectrum Analyzer 9 kHz-1.5 GHz | Agilent Technologies | E4401B | See Note | |
| 1S2390 | Synthesized Signal Generator | Gigatronics | 6061A | 10/16/2015 | 10/16/2016 |
| 1S2578 | Amplifier (10 K-250 MHz) | Amplifier Research | 75A250A | See Note | |
| 1S2271 | Attenuator, High Power (6 dB) | JFW | 50FH-006-300 | See Note | |
| 1S2487 | RF Current Probe | Solar Electronics Company | 6741-1 | 02/12/2015 | 03/12/2016 |
| 1S2586 | Coupling Decoupling Network | COM-POWER | CDN-M325 | 06/17/2015 | 12/17/2016 |
| 1S2490 | Ground Plane 2 | MET LABS | N/A | Not Required | |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 28. CI Test Equipment List**

## 4.6. Voltage Dips and Short Interruptions

### 4.6.1. Test Method, Test Requirements, and Test Procedures

#### 4.6.1.1. Test Method

**EN 61000-4-11: 2004**
Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests

#### 4.6.1.2. Test Requirements

**EN 61326-1, Section 6.2, Immunity Requirements**
The EUT shall be tested for the following voltage dip/short interruption:

| Voltage Dips and Short Interruptions | | |
|---|---|---|
| **Unit** | **Test level and Characteristic** | **Performance Criteria Required** |
| Voltage Dips | 0%, ½ Cycle | B |
| | 0%, 1 Cycle | B |
| | 70%, 25/30 Cycles | C |
| Short Interruptions | 0%, 250/300 Cycles | C |

**Table 29. Voltage Dips and Short Interruptions Limits**

#### 4.6.1.3. Test Procedures

The EUT was provided with AC power via the programmable power supply. The power supply was programmed to perform the applicable set of voltage dips, interruptions and variations. Each sequence was repeated a minimum of three times to verify the results.

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

### 4.6.2. Test Results, Test Data, and Test Setup

#### 4.6.2.1. Test Result

The EUT was **compliant** with the requirement(s) of this section. No anomalies observed.

| Environmental Conditions for Voltage Dips & Short Interruption | |
|---|---|
| **Ambient Temperature:** | 19.6 °C |
| **Relative Humidity:** | 56 % |
| **Atmospheric Pressure:** | 101 kPa |

**Test Engineer:** Jeremy Chinn

**Test Date(s):** 02/29/2016

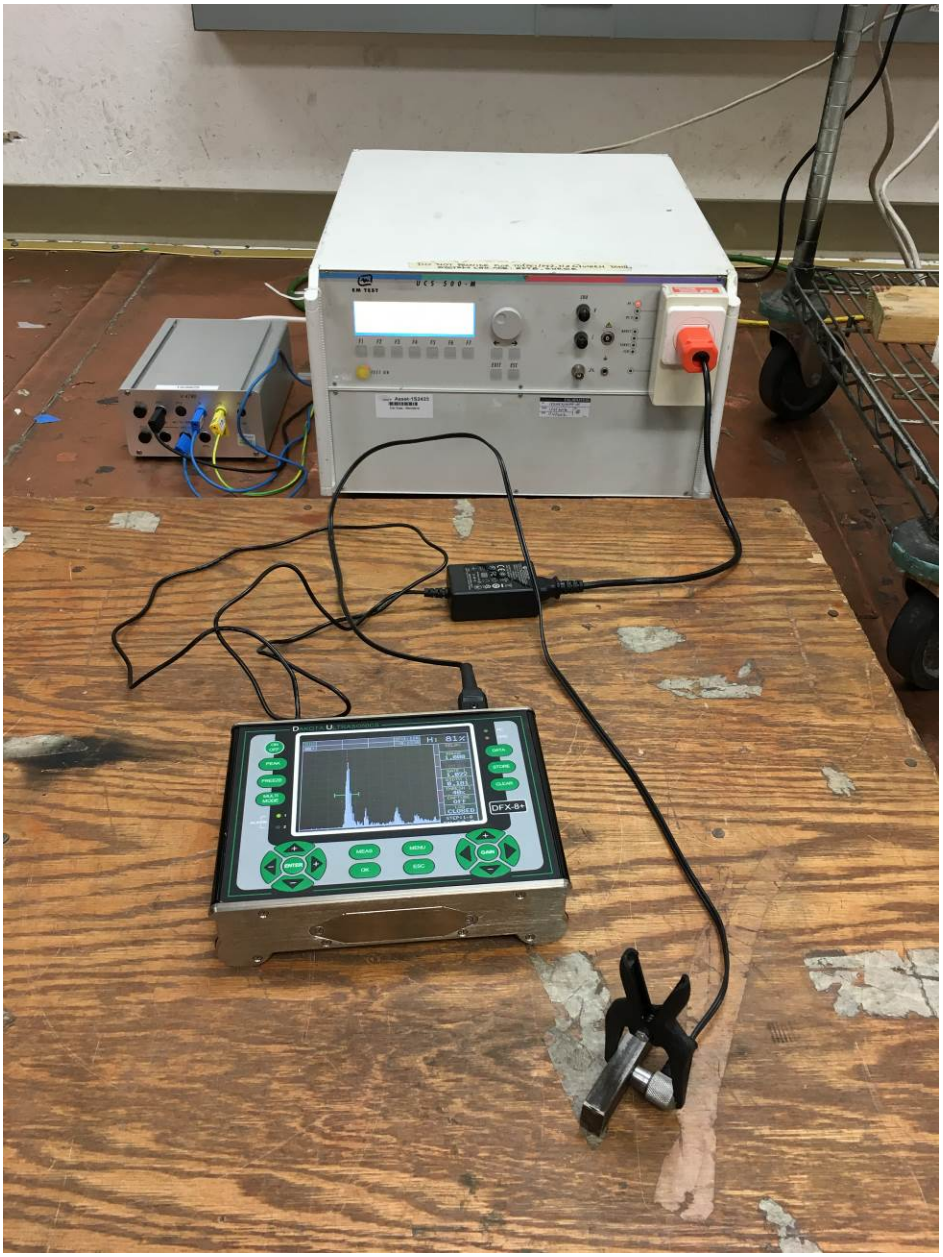
### 4.6.2.2. Test Data

| DFX-8 | | | | | | |
|---|---|---|---|---|---|---|
| **Test Type** | **Parameters** | **No of Rep.** | **Criterion Required** | **Criterion Achieved** | **Results** | **Anomalies** |
| Voltage Dips | 100% reduction 1/2 period 10 ms | 1 | B | A | Pass | No anomalies observed. |
| Voltage Dips | 60% reduction 10 periods 200 ms | 10 | C | A | Pass | No anomalies observed. |
| Voltage Dips | 30% reduction 25 periods 500 ms | 30 | C | A | Pass | No anomalies observed. |
| Short Interrupts | 100% reduction 250 period 5000 ms | 250 | C | A | Pass | No anomalies observed. |

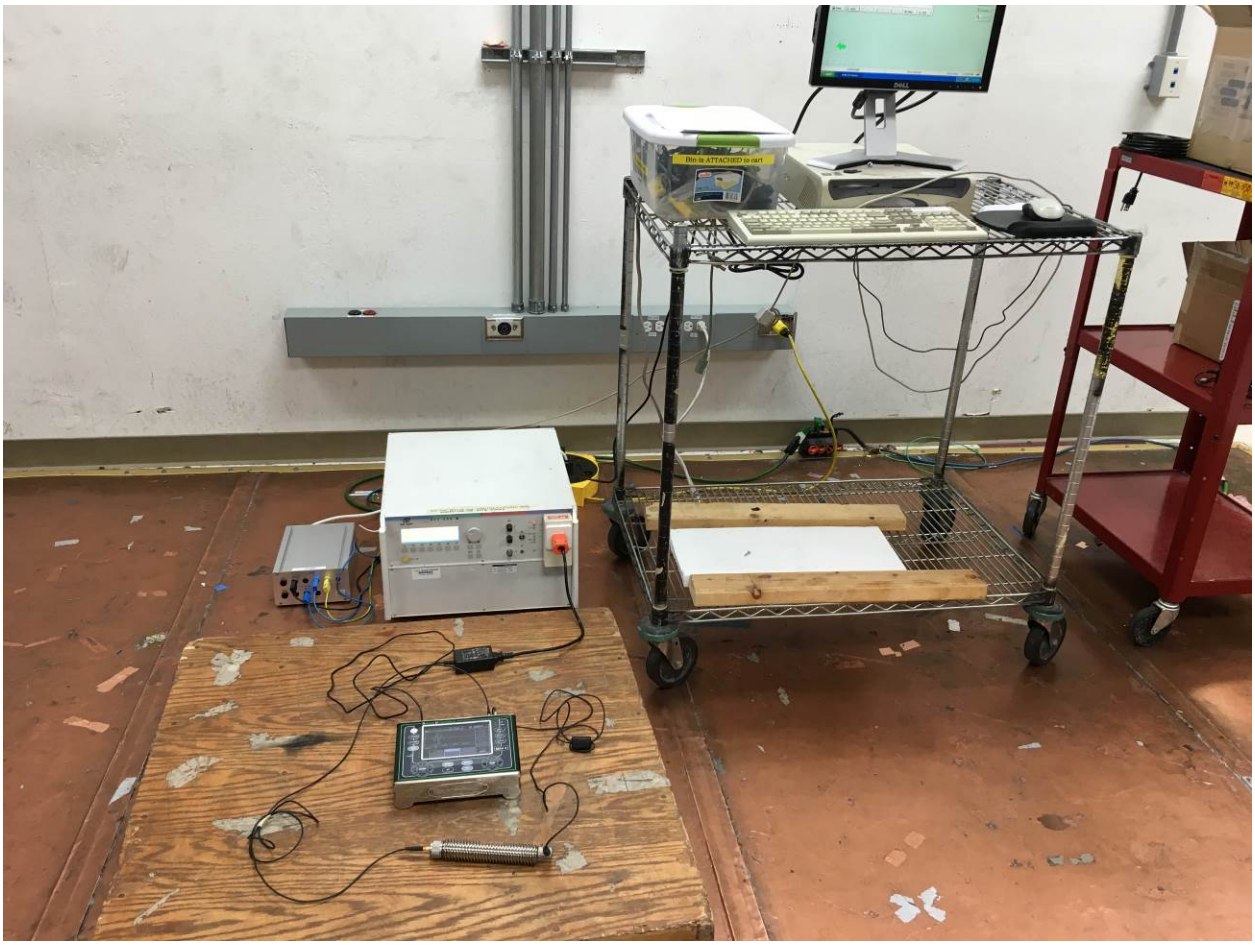
| Max II | | | | | | |
|---|---|---|---|---|---|---|
| **Test Type** | **Parameters** | **No of Rep.** | **Criterion Required** | **Criterion Achieved** | **Results** | **Anomalies** |
| Voltage Dips | 100% reduction 1/2 period 10 ms | 1 | B | A | Pass | No anomalies observed. |
| Voltage Dips | 60% reduction 10 periods 200 ms | 10 | C | A | Pass | No anomalies observed. |
| Voltage Dips | 30% reduction 25 periods 500 ms | 30 | C | A | Pass | No anomalies observed. |
| Short Interrupts | 100% reduction 250 period 5000 ms | 250 | C | A | Pass | No anomalies observed. |

**Table 30. VDI Test Results**

### 4.6.2.3. Test Setup Photograph



**Photograph 39. VDI Test Setup (DFX-8)**



**Photograph 40. VDI Test Setup (Max II)**

### 4.6.2.4. Test Equipment List

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| **Test Name:** Voltage Dips and Short Interruptions | | | **Test Date(s):** 02/29/2016 | | |
|---|---|---|---|---|---|
| **MET Asset #** | **Equipment** | **Manufacturer** | **Model** | **Last Cal Date** | **Cal Due Date** |
| 1S2490 | Ground Plane 2 | MET LABS | N/A | See Note | |
| 1S3925 | Transformer | EM Test | V4780 | See Note | |
| 1S2423 | Ultra Compact Simulator | EM Test | UCS-500M-6A | See Note | |
| Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing. | | | | | |

**Table 31. VDI Test Equipment List**

# 5.0 CE Conformity Marketing

In order to place the CE marking on your product, it must meet all the requirements of all applicable directives.

**The CE conformity marking shall consist of the initial "CE" taking the following form:**

If the CE marking is reduced or enlarged, the proportions given in the above graduated drawing must be respected. The various components of the CE marking must have substantially the same vertical dimension, which may not be less than 5 mm.

Declaration of Conformity -

The Declaration must identify the manufacturer or its authorized representative established within the 15 nation European Union (EU). The Declaration must be signed by the party empowered to enter into commitments on behalf of the manufacturer or its authorized representative established within the EU.

User's Manual -

The User's Manual which accompanies the equipment must indicate the Directive(s) to which the CE Mark indicates compliance.

Disposition of Documents -

The technical documentation package and the Declaration of Conformity must be kept within the EU at the disposal of relevant national authorities for inspection. The information must be maintained for a period ending at least 10 years after the last product has been manufactured.

Internal Production Control -

The manufacturer shall take all measures necessary in order that the manufacturing process shall ensure compliance of the manufactured products with the technical documentation and with the requirements of the Directives that apply to them.

**Example of a DoC:**

# DECLARATION OF CONFORMITY

Application of Council Directive(s)**: EU/EMC Directive 2014/30/EU**

Standards to which Conformity is Declared: **EN 61326-1: 2013**

**Class A/B**

Declarer's Name: **Dakota Ultrasonics**

Declarer's Address: **1500 Green Hills Road #107, Scotts Valley, CA 95066**

Type of Equipment: **DFX-8 and Max II**

*I the undersigned, hereby declare under my sole responsibility that the equipment specified above conforms to the above Directive(s) and Standard(s).*

(Signature) (Date)

(Printed name) (Title)

To be completed by Dakota Ultrasonics personnel.

# 6.0 Test Plan

## EMC Test Plan for the Dakota Ultrasonics, DFX-8 and Max II

(Please refer to the following section numbers of EN 61326-1 for more detailed information)

**EN 61326**
**Subclause:**
**5.2.2 COMPOSITION OF EUT**

| | |
|---|---|
| Manufacturer: | Dakota Ultrasonics |
| Model: | DFX-8 and Max II |
| Serial Number: | N/A |
| Size (inches): | Height – 6.5 |
| | Width – 8.5 |
| | Length – 2.5 |
| Electrical Ratings: | 100 - 240 |
| Installation: | Table Top |
| Description: | There are two products that use the same circuit board and case, the only difference is the type of measurement performed. The DFX-8 flaw detector is typically used to measure the amplitude of echos returned from a weld. A high value of return signal indicates a large flaw or gap in the weld. Since transducers vary in performance, test blocks with known defect sizes are used to calibrate the system. The MAX II bolt gauge, measures the time between the driving pulse and the receipt of the echo. This time, after compensation for temperature, is used in a difference mode to determine the change in length of a bolt. This change is length is proportional to the tightness of the bolt, and is generally much more accurate than torque. |

**5.2.3 ASSEMBLY of EUT**

| Name / Description | Model Number | Part Number | Serial Number |
|---|---|---|---|
| DFX-8 | Z-251-0001 | -- | -- |
| MAX II | Z-197-0001 | -- | -- |

### 5.2.4 I/O PORTS

| Port name on EUT | Cable Description or reason for no cable | Qty | Length as tested (m) | Max Length (m) | Shielded (Y/N) | Termination Box ID & Port Name |
|---|---|---|---|---|---|---|
| b | USB Cable with ferrite | 2 | 1.5 | 2 | no | -- |
| 12 volt input power | 12 volt power supply | 2 | 1.5 | 2 | no | -- |
| AUX | Not normally used | 0 | -- | -- | -- | -- |

### 5.2.5 AUXILLARY EQUIPMENT

| Name / Description | Manufacturer | Model Number | Customer Supplied Calibration Data |
|---|---|---|---|
| 5 MHz Dual Transducer | Dakota | T-102-2900 | N/A |
| 5 MHz Single Transducer | Dakota | T-702-2405 | N/A |
| Flat bottom hole Cal block | Dakota | custom | N/A |
| 6 inch Cal Bar | Dakota | X-000-0010 | N/A |
| Temperature sensor | Dakota | A-156-8001 | N/A |

### 5.2.6 CABLING AND EARTHING

Earthing was achieved through the ground pin of the power supply cord in the case of the AC powered configurations.

### 5.3.1 OPERATION MODES

Flaw detection (DFX8) test: The DFX-8 is connected to a standard 5 MHz Dual Element transducer. The transducer is coupled to a test block with a small defect. The gain is adjusted so 80% screen height is displayed. This amplitude should remain constant + or – 1 dB.

Bolting TOF test: The Max II is connected to a 5 MHz Single Element transducer and temperature sensor. The transducer is coupled to a 6 inch calibration bar and the temperature sensor is placed on the side of the calibration bar. The length of the bar is displayed with resolution of 0.0001 inch. The length of the bar should be remain constant within + or - 0.0003 inch.

### 5.3.2 ENVIRONMENTAL CONDITIONS

**Temperature Range:** 0c - 100c
**Humidity Range:** 15% - 80% RH
**Atmospheric pressure:** 90-110 kPa

### 5.3.3 EUT SOFTWARE DURING TEST

REL 3.0

## 5.4 TEST DESCRIPTION

Tests shall be performed as per EN 61326-1, Table 1

Is the product Class A or Class B in nature (Commercial or Residential)? Class A

Is the product used in Industrial locations? Yes

Is the product used in Controlled Electromagnetic environments (i.e. MRI areas)? No

Is the product battery operated Portable T&M equipment? Yes

Emissions tests shall be performed as per:

**1) Class A (commercial equipment)**
2) Class B (residential equipment)

Immunity tests shall be performed as per:

**1) EN 61326-1: 2013, Table 1 – Basic immunity test requirements**
2) EN 61326-1: 2013, Table 2 – Immunity test requirements for equipment intended for use in industrial locations
3) EN 61326-1: 2013, Table 3 – Immunity test requirements for equipment used in controlled EM environments
4) EN 61326-1: 2013, Table A.1 – Immunity test requirements for portable test and measurement equipment
5) EN 61326-2-X (specify specific standard if applicable)