

## EMC TEST REPORT

Report Number: 102271213DEN-001  
Project Number: G102271213

Report Issue Date: September 14, 2015

Product Designation: DC to DC 1000V String Converter

Standards: EN 61000-6-1:2007  
EN 61000-6-3:2007/A1:2011  
FCC 47 CFR 15B cIB: 2015  
ICES 003: 2012

Tested by:	Client:
Intertek Testing Services NA, Inc. 1795 Dogwood St., Suite 200 Louisville, CO 80027	Ampt 4850 Innovation Drive Fort Collins, CO 80525 USA

Report prepared by	Report reviewed by
 Son La Project Engineer	 Michael Spataro EMC Team Lead

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## 1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 3.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested complies with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

## 2 Test Summary

Section	Test full name	Test date	Result
7	Electrostatic Discharge Immunity Test (IEC 61000-4-2)	9/14/2015	Pass
8	Radiated, Radio-Frequency, Electromagnetic Field Immunity Test (IEC 61000-4-3)	9/10/15 and 9/11/15	Pass
9	EFT/Burst Immunity Test (IEC 61000-4-4)	9/11/2015	Pass
10	Immunity Surge (IEC 61000-4-5)	Not Applicable	NA (5)
11	Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6)	9/11/2015	Pass
12	Power Frequency Magnetic Field Immunity Test (IEC 61000-4-8)	9/11/2015	Pass
13	Voltage Dips / Interruptions Immunity Test (IEC 61000-4-11)	Not Applicable	NA (2)
14	Radiated Emissions (CISPR11)	9/10/2015	Pass
15	Conducted Emissions (CISPR11)	Not Applicable	NA (2)
16	Telecom Port Conducted Emissions (CISPR22)	Not Applicable	NA (1)
17	Harmonics (IEC 61000-3-2)	Not Applicable	NA (2)
18	Flicker (IEC 61000-3-3)	Not Applicable	NA (2)

Notes:

- (1) Product does not provide telecommunications port and/or cables.
- (2) Product is only DC powered. Test not applicable
- (3) Product tested as an unintentional radiator. Highest clock speed is less than 108MHz. Measure to 1GHz.
- (4) DC port treated as signal port not intended for connection to a local DC power network, or a local battery by connecting cable exceeding a length of 30 m per Table 3. Test not applicable
- (5) DC port treated as signal port per Table 3, not (c). Test not applicable.

### 2.1 Test Facility

Intertek Denver's testing facilities are located at 1795 Dogwood St. Suite 200 Louisville, CO 80027. The testing facility is ISO17025:2005 accredited by A2LA, our lab code is 2506.02, our VCCI registration number under Article 15 is A-0160, our FCC registration no. 432519 and our IC lab no. 2042N.

Testing contained in this test report may not be covered under the laboratories scope of accreditation. A note will be placed in the specific test section for testing not covered under the laboratories scope.

**3 Client Information**

This EUT was tested at the request of:

Client: AMPT  
4850 Inno Innovation Drive  
Fort Collins, CO 80525  
USA

Contact: Robin Richardson  
Telephone: (970) 372 -6960  
Fax: (970) 225 - 0483  
Email: [robin.richardson@ampt.com](mailto:robin.richardson@ampt.com)

Manufacturer: AMPT  
4850 Innovation Drive  
Fort Collins, CO 80525  
USA

#### 4 Description of Equipment Under Test

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
DC to DC 1000V String Converter	Ampt, LLC (Sanmina)	31570014-xx	0815K000002

Receive Date:	9/10/2015
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)	
Combines power from two input strings to one output string while ensuring the output string voltage does not exceed the maximum system voltage.	

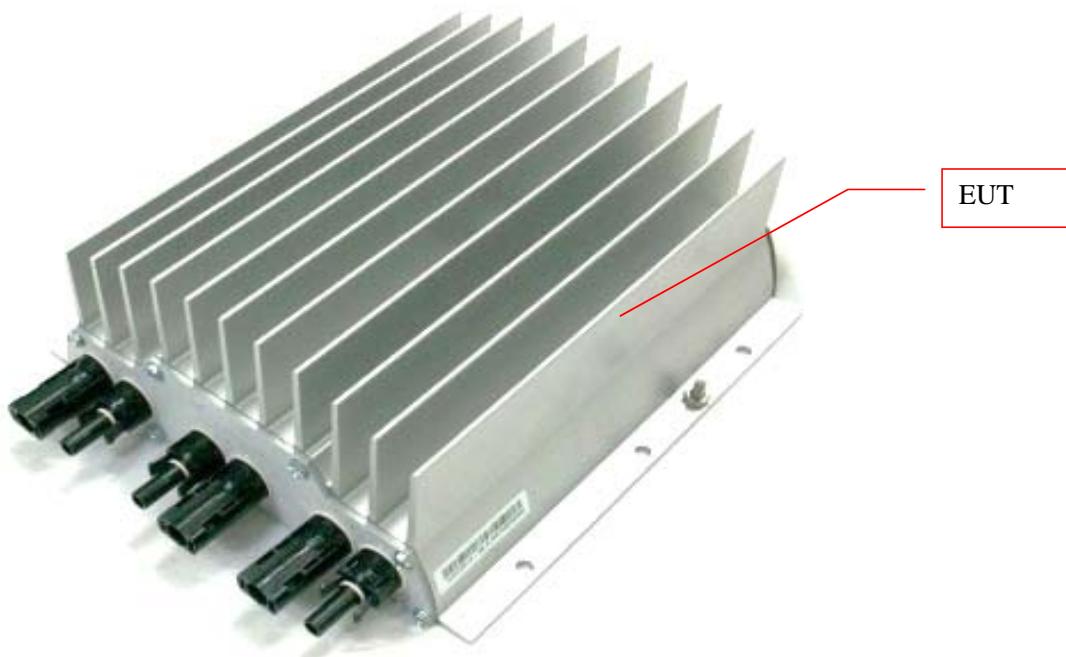
Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
Input: 700Vdc	8.0A x 2 (inputs)		
Output: 1000Vdc	Output: 11.2kWdc	DC	---

Operating modes of the EUT:

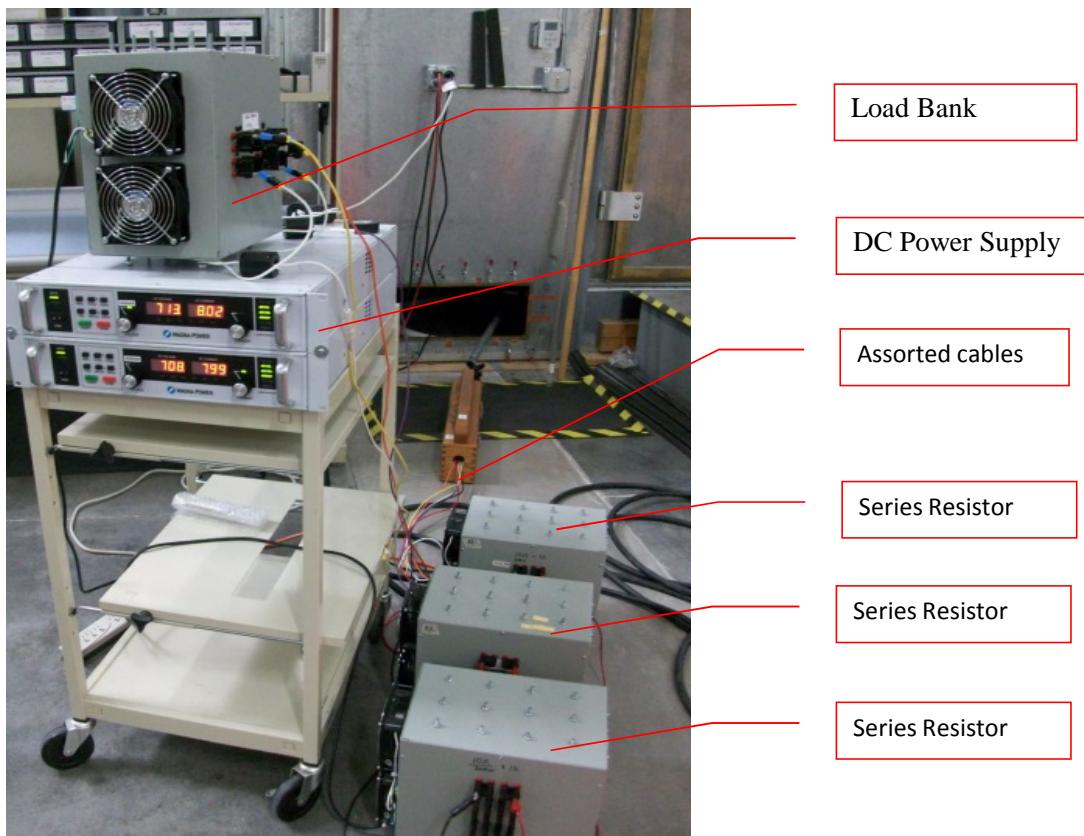
No.	Descriptions of EUT Exercising
1	Mode 1: Input A and B into EUT set for 700Vdc and the current was adjust for 8.0 A and 8.0 A.

Software used by EUT:

No.	Descriptions of EUT Exercising
1	Firmware version: 70000005-1 A

**4.1 Photo – Product Tested:**

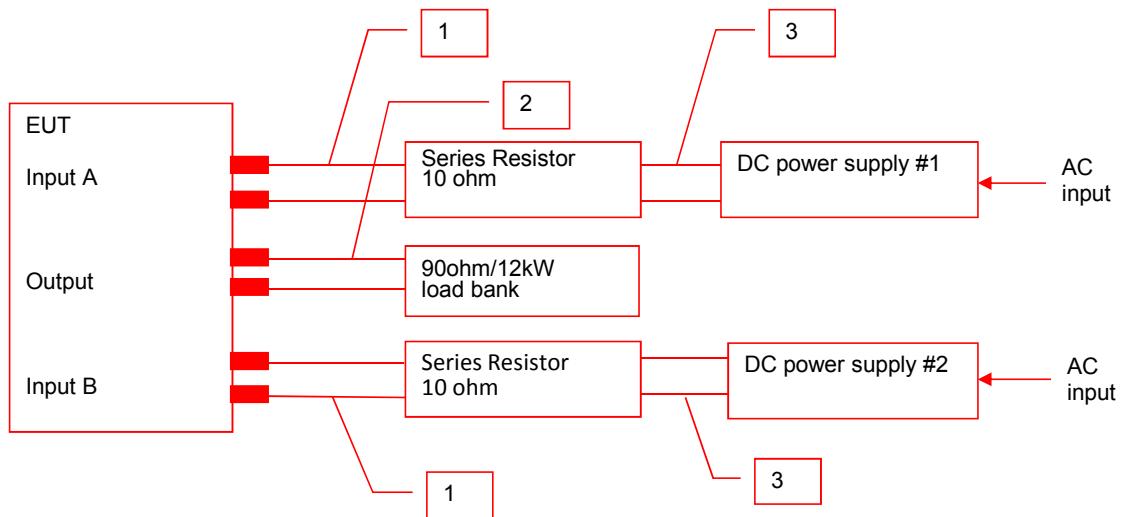
Support equipment shown with products under test.



**5 System setup including cable interconnection details, support equipment and simplified block diagram****5.1 Method:**

Configuration as required by Standard taking Precedence.

Record the details of EUT cabling, document the support equipment, and show the interconnections in a block diagram.

**5.2 EUT Block Diagram:**

**5.3 Support Data:**

ID	Description	Length	Shielding	Ferrites
1	Load wires from controller	15 feet	None	None
2	Load bank wires	10 feet	None	None
3	DC power supply output wires	5 feet	None	None

Support Equipment				
Description	Manufacturer	Model Number	Serial Number	
DC power supply	MAGA-POWER	XR1000-10/208+HS	1162-6476	
DC power supply	MAGA-POWER	XR1000-10/208+HS	1162-6477	
Load bank	Ampt	N/A	N/A	
Series Resistor	Ampt	N/A	N/A	

## 6 Performance Criterion of the Equipment when tested against the immunity requirements for the European CE Mark

### 6.1 Method:

Performance as required by Standard taking Precedence.

The equipment under test (EUT) is to be installed in accordance with the manufacturer's instructions. The installation process includes, product assembly, connecting any support equipment, connecting power and configuration of the equipment under test. All unused ports should be terminated as instructed by the test standard. The EUT should indicate normal operation in accordance with the Operation Manual.

If, as a result of the application of the tests defined in this standard, the apparatus becomes dangerous or unsafe, the apparatus shall be deemed to have failed the test.

A functional description and a definition of performance criteria, during or as a consequence of the EMC testing, shall be provided by the manufacturer.

**Performance criterion A:** The apparatus 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 apparatus 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 apparatus if used as intended.

**Performance criterion B:** The apparatus 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 apparatus 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 apparatus if used as intended.

**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.

**Performance criterion D:** EUT is physically damaged.

Product Specific Performance Criterion:

No.	Descriptions
1	EN61000-6-1, Table 1, Performance criterion "A" : 61000-4-3, 61000-4-8
2	EN61000-6-1, Table 2 & 4, Performance criterion "A" : 61000-4-6
3	EN61000-6-1, Table 1, Performance criterion "B": 61000-4-2
4	EN61000-6-1, Table 2 & 4, Performance criterion "B": 61000-4-4, (dc ports)

Description of how performance was observed during testing:

No.	Descriptions
1	Mode 1: Monitoring the current output of the power supplies.

General notes:

**Product inputs and outputs only Vdc.**

**7        Electrostatic Discharge Immunity Test****7.1      Method:**

Unless otherwise stated no deviations from IEC/EN 61000-4-2 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**7.2      Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
DEN-034	ESD Simulator and Gun	NOISEKEN	ESS-2002	ESS0838103		06/21/15	06/21/16
DEN-077	Oscilloscope	TEKTRONIX	TDS 520	B022197	--	02/20/15	02/20/16
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	--	09/04/15	09/04/16

Software Utilized:

Name	Manufacturer	Version
None.		

**7.3      Results:**

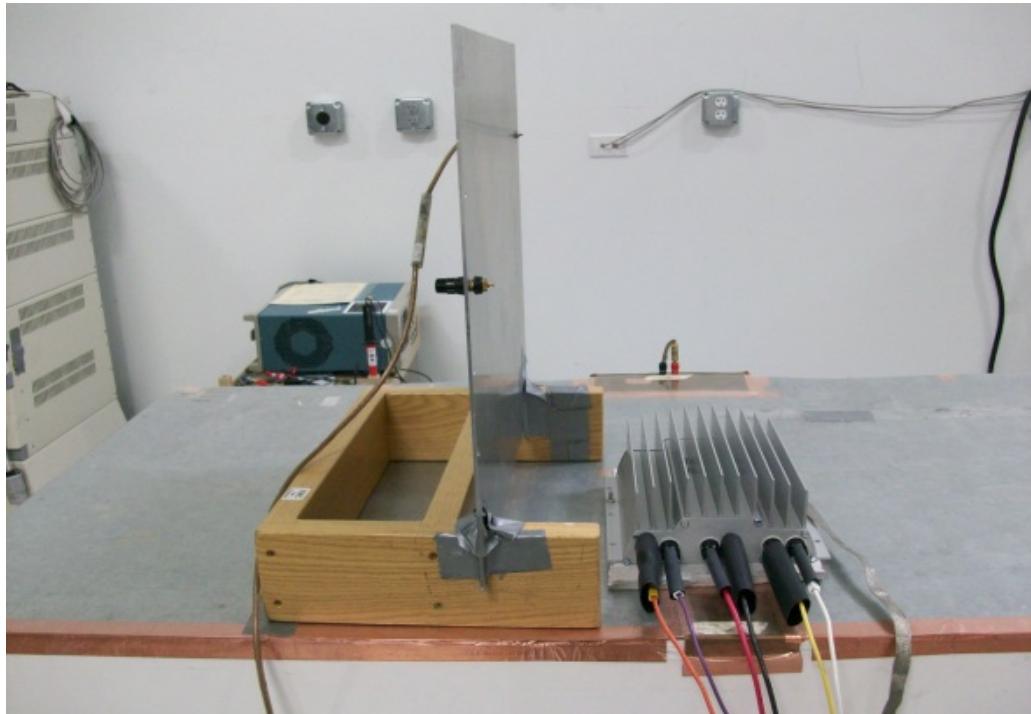
The sample tested was found to Comply.

**7.4      Setup Photographs:**

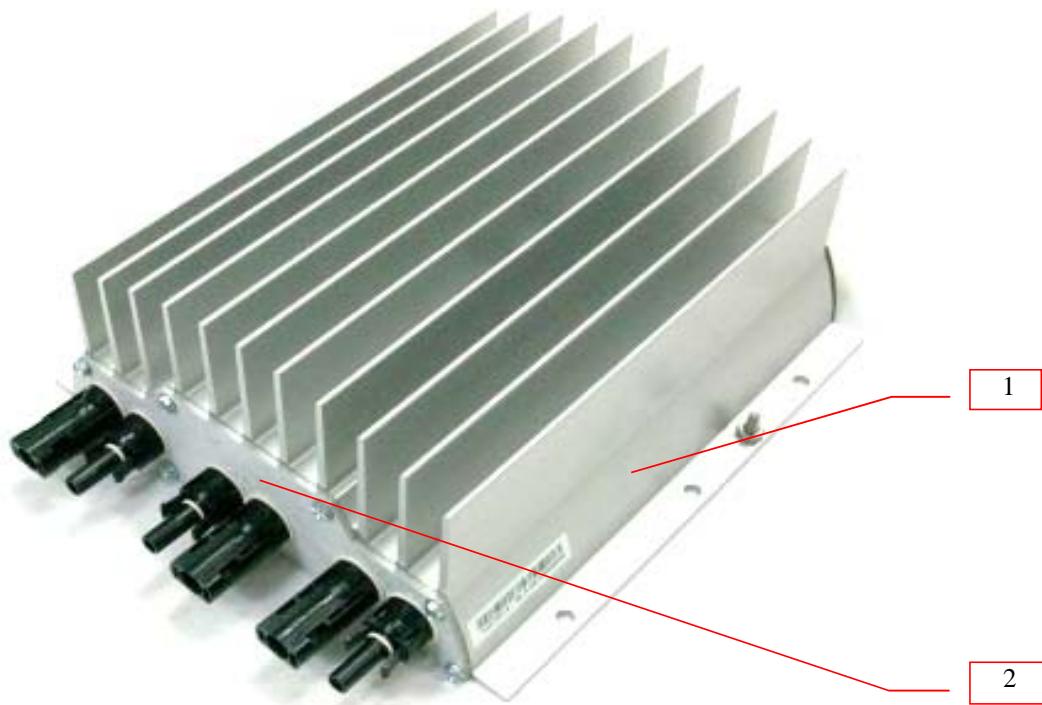
Test Setup - Front



Test Setup - Rear



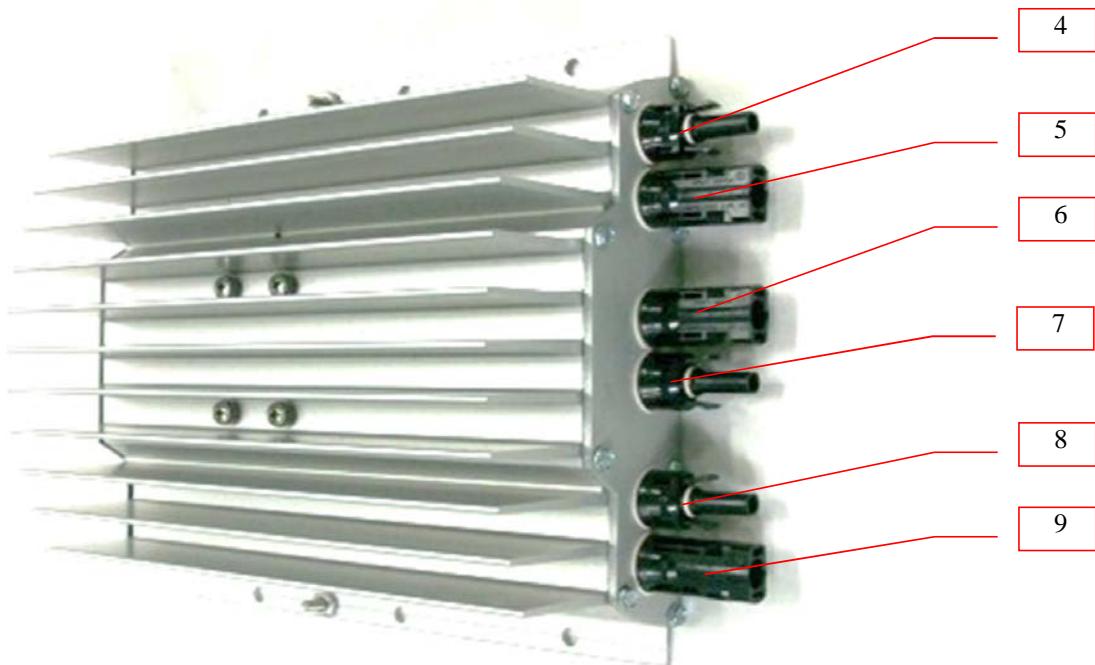
Test Setup - Front Closeup - VP and HP all four sides



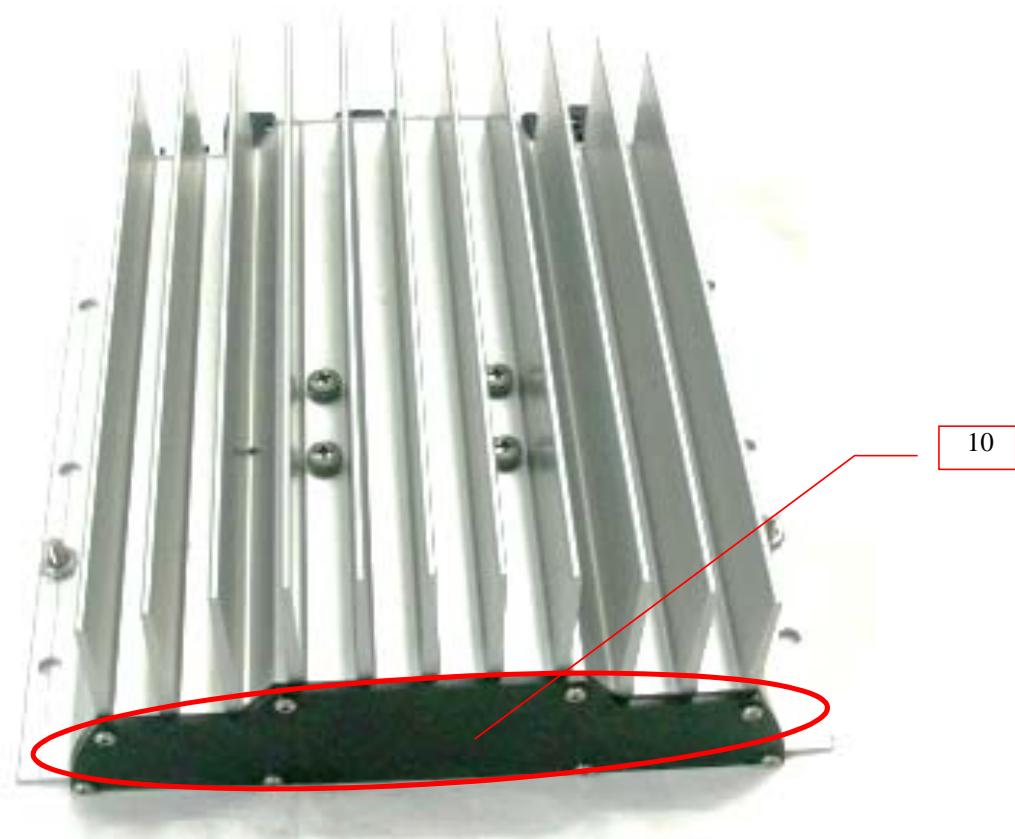
ESD Locations - Photo #1 (Contact Discharge)



ESD Locations - Photo #2 (Contact Discharge)



ESD Locations - Photo #3 (Air Discharge)



ESD Locations - Photo #4 (Air Discharge)

## 7.5 Test Data

Test Personnel:	Duan Wei Lin		Test Date:	9/14/215
Supervising/Reviewing Engineer:	Michael Spataro		Required Performance:	B
Standard:	EN 61000-4-2		Test Levels:	+/- 4kV contact, +/- 8kV air
Input Voltage:	700Vdc (2 PSU), 16A dc			10 pulses per voltage per polarity
Waveform Verified on Oscilloscope:	Yes		Ambient	23.5 °C
470k x 2 Strap(s) Verified:	Yes		Relative Humidity:	19.2 %

### Notes:

- (1) Discharged to Horizontal Coupling Plane, 4 locations.
- (2) Discharged to Vertical Coupling Plane, 4 locations
- (3) Performance criteria requirement: B, (product meets A as indicated in above matrix).
- (4) No discharge to the test point of interest. Discharges to nearest adjacent metal
- (5) The EUT met the requirements without any degradation of performance.

Deviations, Additions, or Exclusions: None

## 8 Radiated, radio-frequency, electromagnetic field immunity test

### 8.1 Method:

Unless otherwise stated no deviations from IEC 61000-4-3:2010 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

### 8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
18739	Power Meter (set 3)	Hewlett Packard	436A	2446A21023		02/18/2015	02/18/2016
18707	Sensor	Amplifier Research	FP5000	20134	--	08/03/15	08/03/16
18740	Power Sensor Set 3	Hewlett-Packard	8482A	2349A14570	--	02/19/2015	02/19/2016
18763	30DB Directional Coupler	WERLATONE	C5091	5768	--	05/16/2015	05/16/2016
18764	Antenna	EMCO	3142	9706-1190	--	VBU	VBU
18769	Directional Coupler (1.7-12.4 GHz)	Hewlett-Packard	779D	1144A05973	--	06/05/15	06/05/16
18779	Broadband amplifier ( 80MHz - 1GHz)	Amplifier Research	200W1000M7 A	16049	--	VBU	VBU
18781	Signal Generator	MARCONI INSTRUMENTS	2031	119537	Firmware ver. 7.001	04/24/15	04/24/16
18796	High-gain Horn Antenna	Amplifier Research	AT4510	27653	--	VBU	VBU
18871	10dB Attenuator	WIENSCEL	2	AC1932	--	05/14/2015	05/14/2016
DEN-003	10W .8-4.2GHz amplifier	Amplifier Research	10S1G4A	0327889	--	VBU	VBU
18777	40 dB Directional Coupler	WERLATONE	C3736	4153	--	05/14/2015	05/14/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	--	09/04/15	09/04/16

Software Utilized:

Name	Manufacturer	Version
SW-7: Software application for Radiated and Conducted Immunity.	CKC	EMITest V.3.15.1

### 8.3 Results:

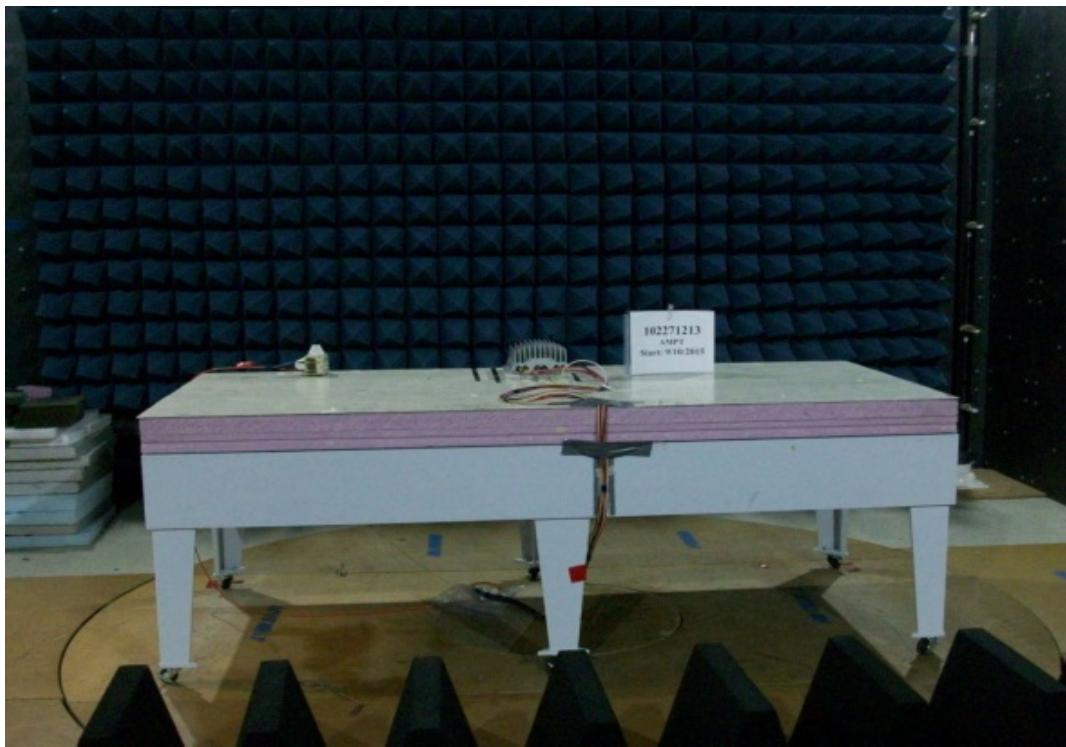
The sample tested was found to Comply.

**8.4 Setup Photographs:**

Test Setup – Front (80 MHz - 1000MHz)



Test Setup – Front (1000MHz - 27000 MHz)



Test Setup – Rear

## 8.5 Test Data

Field Level (V/m)	Frequency Range MHz	Antenna Polarity, Azimuths and Result Classification							
		Vertical				Horizontal			
		0	90	180	270	0	90	180	270
10	80-1000	A	A	A	A	A	A	A	A
3	1400-2000	A	A	A	A	A	A	A	A
1	2000-2700	A	A	A	A	A	A	A	A

Test Personnel:	Son La	Test Date:	9/10/2015 and 9/11/2015
Supervising/Reviewing Engineer:	Michael Spataro	Modulation:	80% at 1kHz
		Required Performance:	A
Standard:	EN 61000-4-3	Test Levels:	See Table Above
Input Voltage:	700Vdc (2 PSU), 16A dc		
Field Level Monitored:	Yes	Ambient Temperature:	22.1 °C
		Relative Humidity:	20.8 %

### Notes:

- (1) The product passed 3 V/m in the Frequency Range of 2000 – 27000 MHz. (1 V/m was required).
- (2) Performance criteria requirement: A
- (3) The EUT met the requirements without any degradation of performance.

Deviations, Additions, or Exclusions: See notes above.

**9 Electrical Fast Transient/Burst Immunity Test****9.1 Method:**

Unless otherwise stated no deviations from IEC 61000-4-4, A1:2010 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**9.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
18813	EMC Pro Surge/EFT Generator	KeyTek	EMC Pro	9904187	NA	04/21/2015	04/21/2016
DEN-077	Oscilloscope	TEKTRONIX	TDS 520	B022197	--	02/20/15	02/20/16
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	--	09/04/15	09/04/16

Software Utilized:

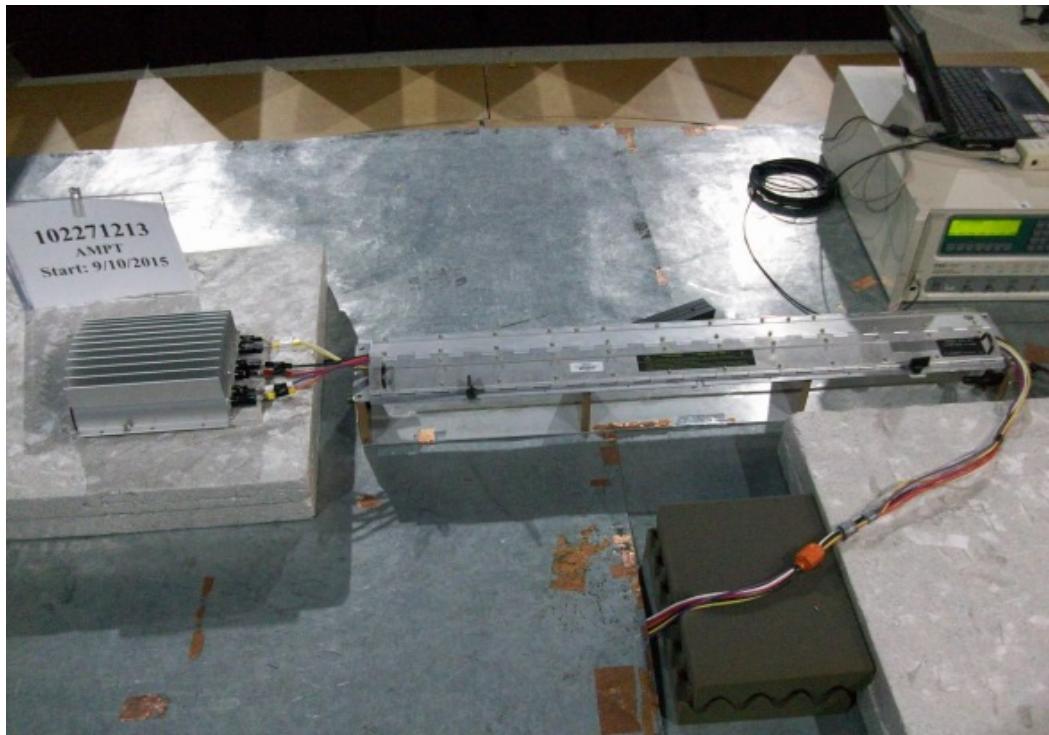
Name	Manufacturer	Version
SW-3: Software application for control of EMCpro, 4-4/4-5 testing.	KeyTek	CEWare 32, V.3.0

**9.3 Results:**

The sample tested was found to Comply.

**9.4 Setup Photographs:**

Test Setup – Signal



Test Setup – Signal

## 9.5 Test Data

Test Point	Coupling Method	Test Voltages, Polarities, and Result Classification									
		0.25 kV		0.5 kV		1 kV		2 kV		4 kV	
		Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Signal line	Clamp			A	A	A	A				

Test Personnel:	Son La		Test Date:	9/11/2015
Supervising/Reviewing Engineer:	Michael Spataro		Pulse Repetition Frequency:	5 kHz
Standard:	EN 61000-4-4		Required Performance:	B
Input Voltage:			Test Levels:	See Table Above
Waveform Verified on Oscilloscope:	Yes		Ambient Temperature:	22.6 °C
			Relative Humidity:	32.1 %

### Notes:

- (1) All I/O cables are not greater than 3 meters. Test not applicable.
- (2) Performance criteria requirement: B, (product meets A as indicated in above matrix).
- (3) Pulse repetition: 5 kHz; burst duration: 15 ms; burst period: 300 ms
- (4) The EUT met the requirements without any degradation of performance.

Deviations, Additions, or Exclusions: None

**10 Surge Immunity -Not applicable****10.1 Method:**

Unless otherwise stated no deviations from IEC 61000-4-5: 2005 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**10.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
None	N/A						

Software Utilized:

Name	Manufacturer	Version
N/A		

**10.3 Results:**

The sample tested was found      Test not applicable

## 11      Conducted, radio-frequency, electromagnetic field immunity test

### 11.1    Method:

Unless otherwise stated no deviations from IEC 61000-4-6:2008 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

### 11.2    Test Equipment Used:

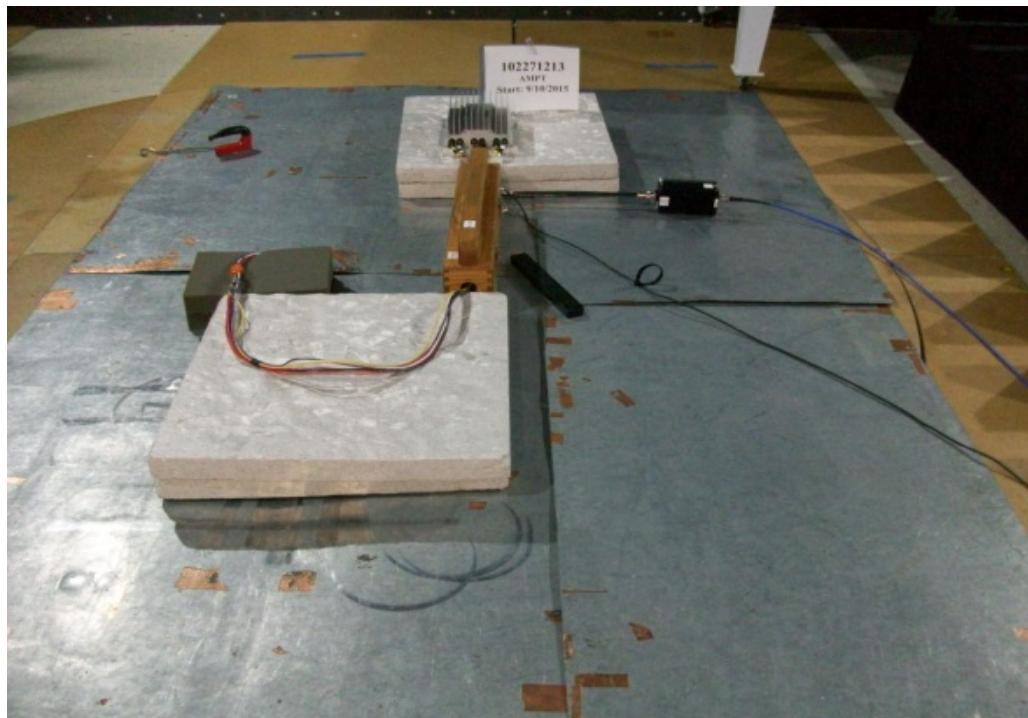
Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
18859	RF Current Probe	Communications	F-62	33	--	5/20/2015	5/19/2016
18724	6 db Attenuator	JFW	50FH-006-100	00332	--	05/01/2015	05/01/2016
18739	Power Meter (set 3)	Hewlett Packard	436A	2446A21023		02/18/2015	02/18/2016
18740	Power Sensor (Set 3)	Hewlett-Packard	8482A	2349A14570	--	02/19/2015	02/19/2016
18763	30DB Directional Coupler	WERLATONE	C5091	5768	--	05/16/2015	05/16/2016
18756	EM clamp	Fisher Custom Comm.	F-2031-32mm	378	--	07/06/15	07/06/16
18781	Signal Generator	MARCONI INSTRUMENTS	2031	119537	Firmware ver. 7.001	4/24/2015	4/24/2016
18814	Spectrum Analyzer	Hewlett-Packard	HP 8594E	3412A00103	--	8/26/2015	8/26/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	--	09/04/15	09/04/16

Software Utilized:

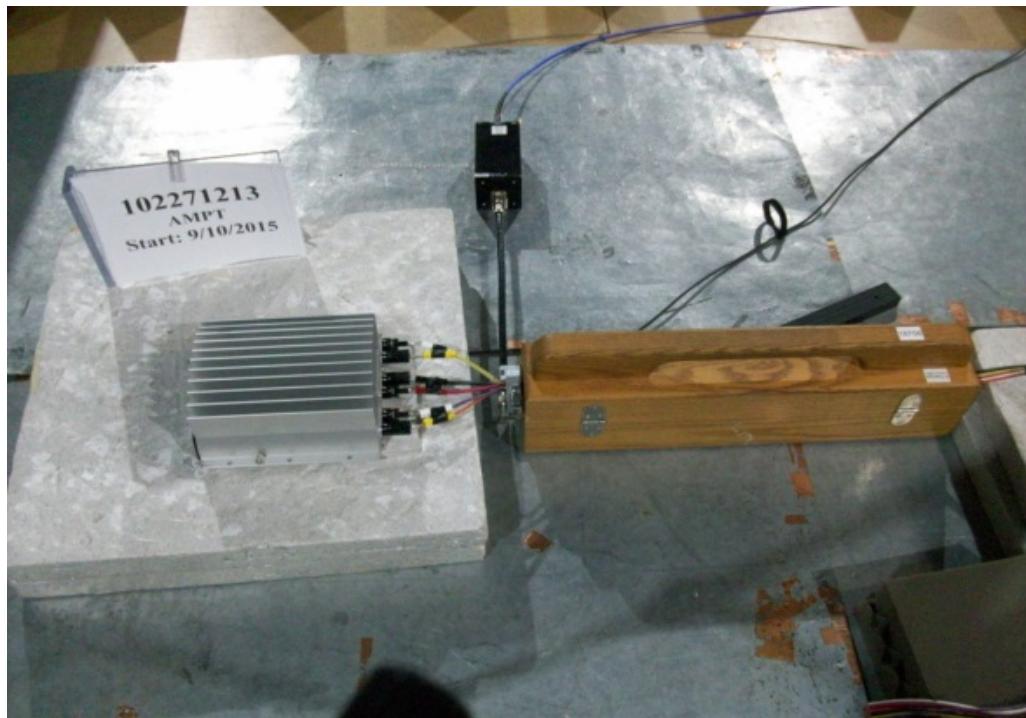
Name	Manufacturer	Version
SW-7: Software application for Radiated and Conducted Immunity.	CKC	EMITest V.3.15.1

### 11.3    Results:

The sample tested was found to Comply.

**11.4 Setup Photographs:**

Test Setup – Signal



Test Setup – Signal

### 11.5 Test Data

Injection Device Type	Port Description	Test Level (Vrms)	Result Classification
Clamp	I/O Ports:	3	A

Test Personnel:	Son La	Test Date:	9/11/2015
Supervising/Reviewing Engineer:	Michael Spataro	Modulation:	80% at 1kHz
Standard:	EN 61000-4-6	Required Performance:	A
Input Voltage:	NA	Test Levels:	See Table Above
Test Level Verification Performed:	Yes	Ambient Temperature:	24.9 °C
		Relative Humidity:	28 %

#### Notes:

- (1) Performance criteria requirement: A
- (2) The EUT met the requirements without any degradation of performance.

Deviations, Additions, or Exclusions: None

**12 Power Frequency Magnetic Field Immunity Test****12.1 Method:**

Unless otherwise stated no deviations from IEC 61000-4-8:2009 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**12.2 Test Equipment Used:**

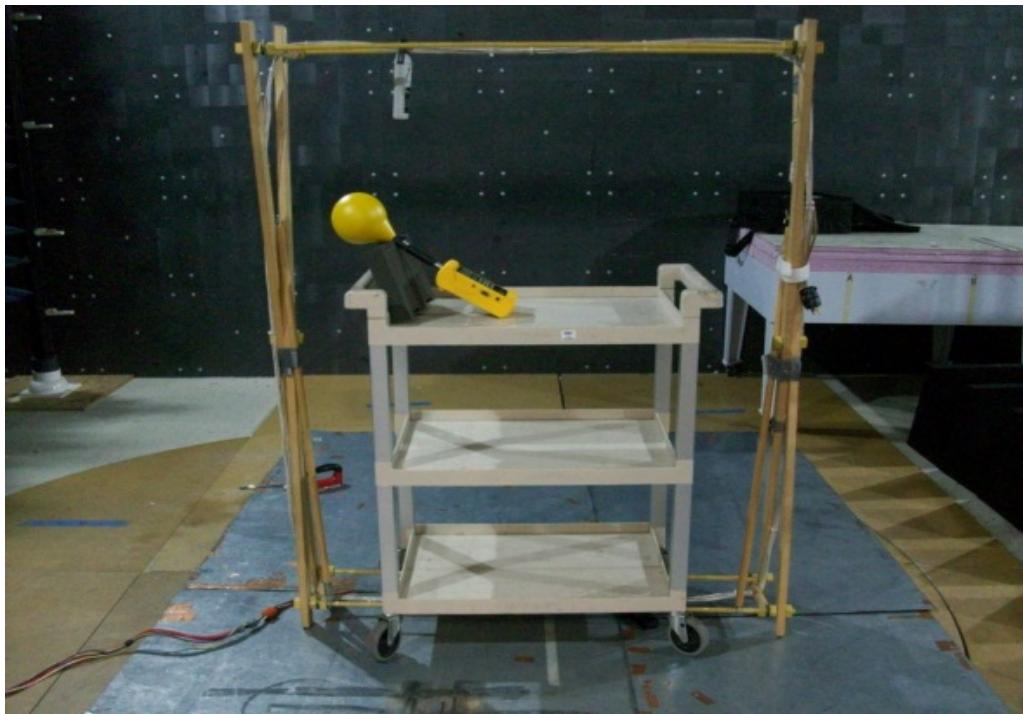
Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
18705	Auto Transformer	POWERSTAT	3PN226	124202	--	3/2/2003	VBU
18949	AC/DC Low Current Clamp Meter	LEM HEME	LH41	106140063335	--	02/19/15	02/19/16
DEN-044	Tester	NARDA	2304/03	M-0356	--	08/13/15	08/13/16
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	--	09/04/15	09/04/16

Software Utilized:

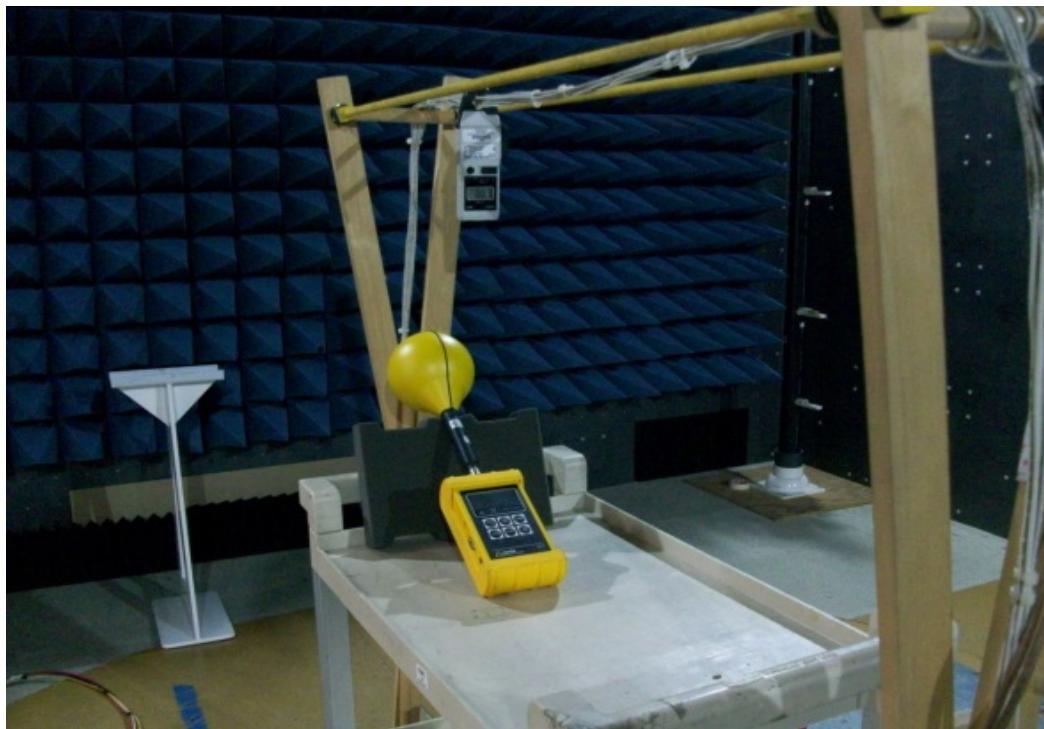
Name	Manufacturer	Version
None.		

**12.3 Results:**

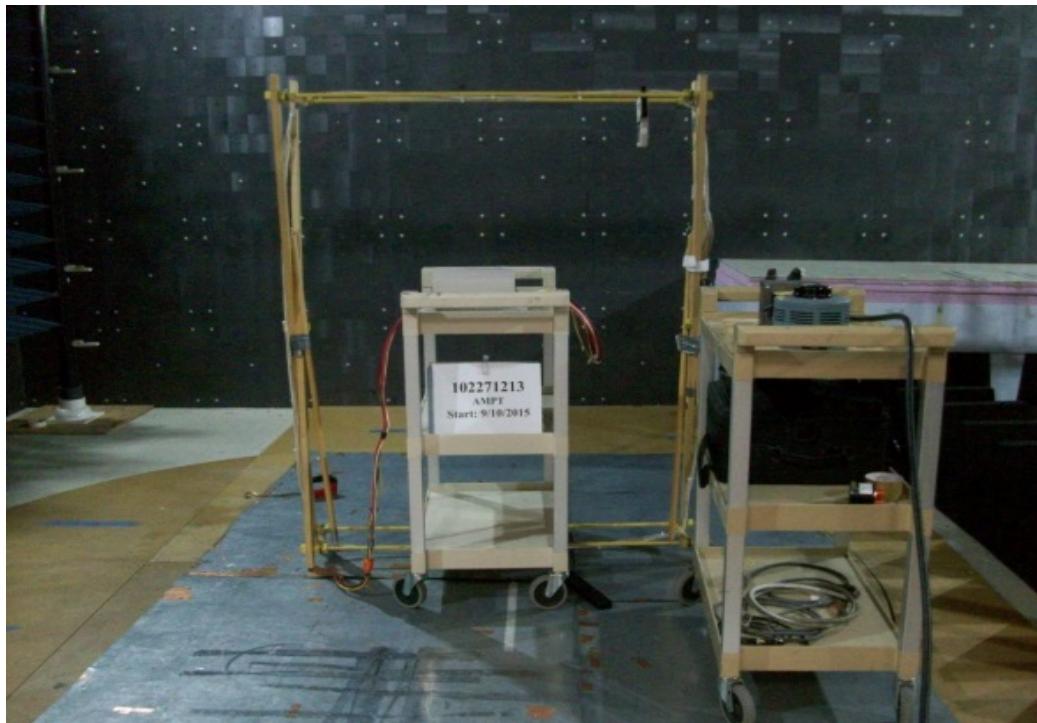
The sample tested was found to Comply.

**12.4 Setup Photographs:**

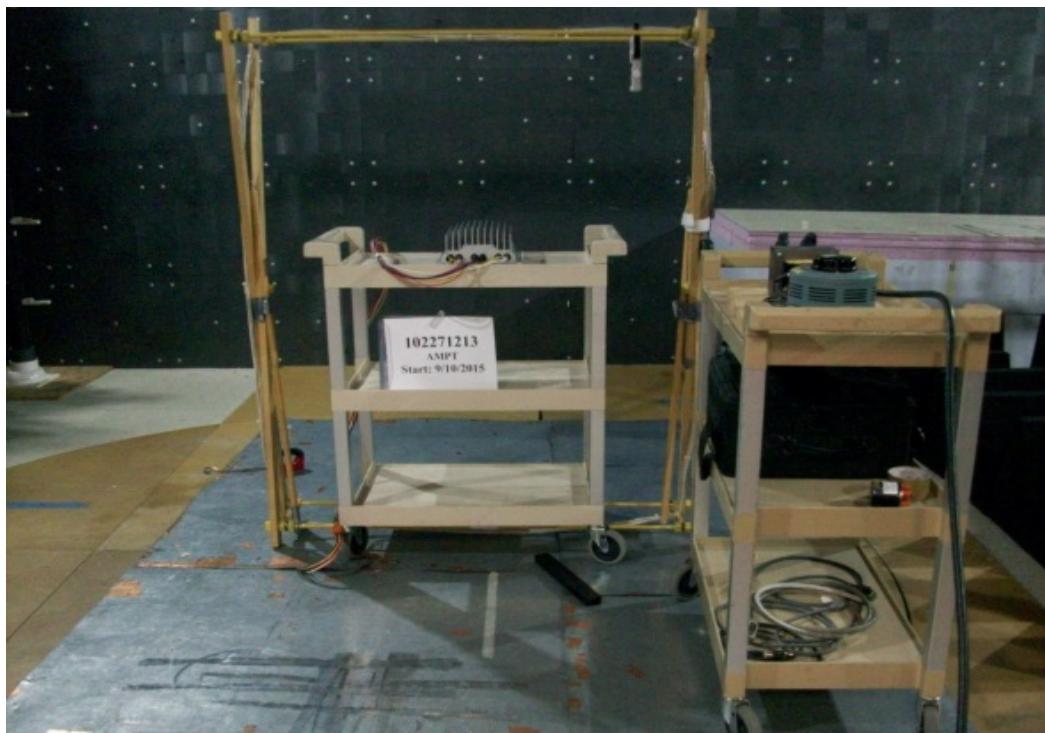
Test Setup



Test Setup – Loop current - Ambient



Test Setup – Axis 1



Test Setup – Axis 2



Test Setup – Axis 3

**12.5 Test Data**

Test Location/ Mode/ EUT AC Input	Test Level (A/m)	Frequency (Hz)	Result Classification		
			X- Axis	Y- Axis	Z- Axis
Enclosure/ Operating/ 230 Vac, 50 Hz	30	50	A(1)	A(1)	A(1)
Enclosure/ Stand-by/ 230 Vac, 60 Hz	30	60	A(1)	A(1)	A(1)

Test Personnel:	Son La	Test Date:	9/11/2015
Supervising/Reviewing Engineer:	Michael Spataro	Required Performance:	A
Standard:	EN 61000-4-8	Test Levels:	See Table Above
Input Voltage:	700Vdc (2 PSU), 16A dc		
Ambient Field Level:	X microTesla	Ambient Temperature:	22.8 °C
Test Field Level Verified:	Yes	Relative Humidity:	34.3 %

## Notes:

- (1) Only to magnetically sensitive components. (Tested as a option. Not required for Basic Immunity, Table 1)
- (2) Tested to 30A/m (3A/m required).
- (3) The EUT met the requirements without any degradation of performance.

Deviations, Additions, or Exclusions: None

**13      Voltage Dips / Interruptions Immunity Tests - Not applicable****13.1    Method:**

Unless otherwise stated no deviations from IEC 61000-4-11:2004 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**13.2    Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
None	N/A						

Software Utilized:

Name	Manufacturer	Version
None		

**13.3    Results:**

The sample tested was found to Comply.

## 14 Radiated Emissions

### 14.1 Method:

The test methods used comply with ANSI C63.4 and CISPR 16. Unless otherwise stated no deviations were made from FCC 15.109, ICES-003, CISPR11.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

### 14.2 Measurement Uncertainty:

For radiated emissions,  $U_{lab}(3.5 \text{ dB at 3m and 3.5 dB at 10m below 1 GHz, and 4.2 dB at 3m above 1 GHz}) < UCISPR(5.2 \text{ dB})$ , which is the reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11

#### Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where  $FS$  = Field Strength in dBmV/m

$RA$  = Receiver Amplitude (including preamplifier) in dBmV

$CF$  = Cable Attenuation Factor in dB

$AF$  = Antenna Factor in dB

$AG$  = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBmV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBmV/m. This value in dBmV/m was converted to its corresponding level in mV/m.

$$RA = 52.0 \text{ dBmV}$$

To convert from dBmV to mV or mV the following was used:

$$AF = 7.4 \text{ dB/m}$$

$$CF = 1.6 \text{ dB}$$

$$UF = 10(NF / 20) \text{ where } UF = \text{Net Reading in mV}$$

$$AG = 29.0 \text{ dB}$$

$$NF = \text{Net Reading in dBmV}$$

$$FS = 32 \text{ dBmV/m}$$

#### Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10(32 \text{ dBmV} / 20) = 39.8 \text{ mV/m}$$

#### 14.3 Test Equipment Used:

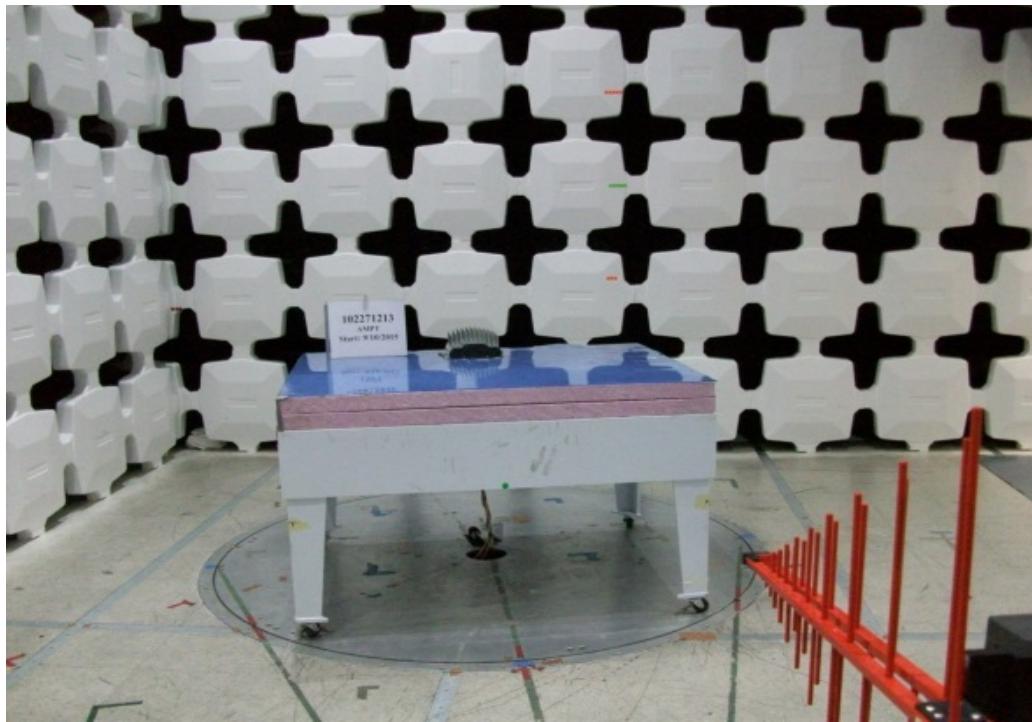
Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
18912	9 kHz- 1.3GHz Pre Amp	Hewlett-Packard	8447F	3113A05545	N/A	05/19/2015	05/19/2016
19936	6GHz	Sunol Sciences	JB6	A050707-1	N/A	12/29/2014	12/29/2015
DEN-073	EMI Receiver	ROHDE & SCHWARZ	ESU 26	100265	Firmware ver. 4.43 SP3	12/10/2014	12/10/2015
DEN-203	Radiated Cable (1)	Teledyne	90-206-072	14-11-402	N/A	12/23/14	12/23/15
DEN-204	Radiated Cable (2)	Teledyne	90-206-072	14-11-401	N/A	12/23/14	12/23/15
DEN-205	Radiated Cable (3)	Teledyne	14-11-401	14-11-401	N/A	12/23/14	12/23/15
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	N/A	09/04/15	09/04/16

Software Utilized:

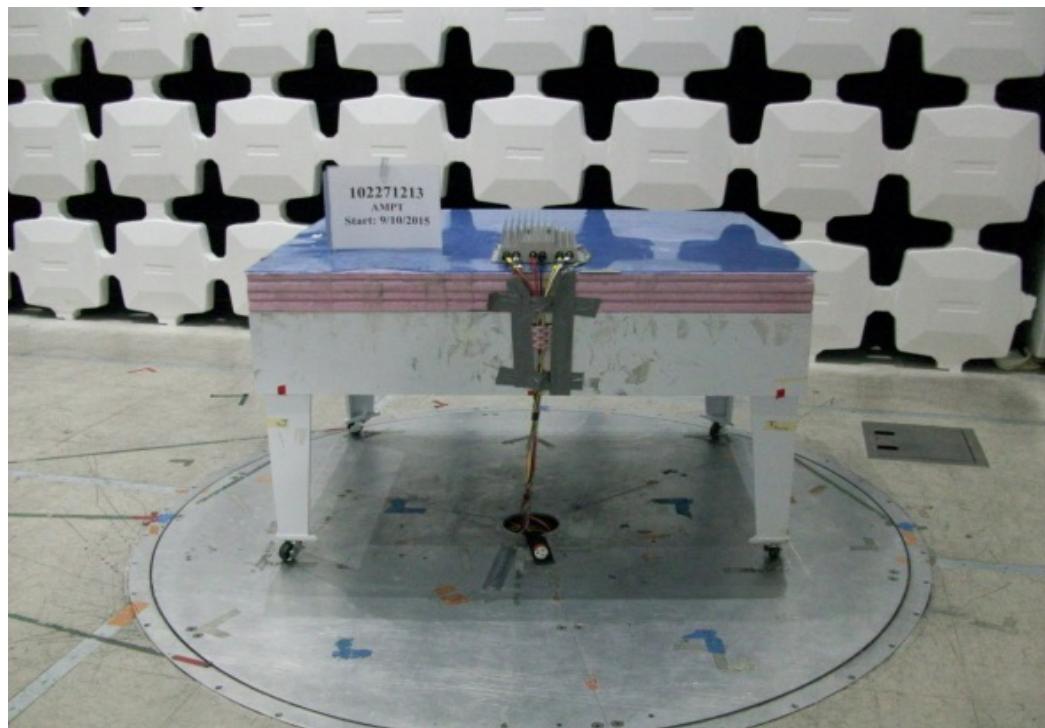
Name	Manufacturer	Version
SW-6: Software for Radiated and	Intertek	OATS cvi, V.1.0

#### 14.4 Results:

The sample tested was found to Comply.

**14.5 Setup Photographs:**

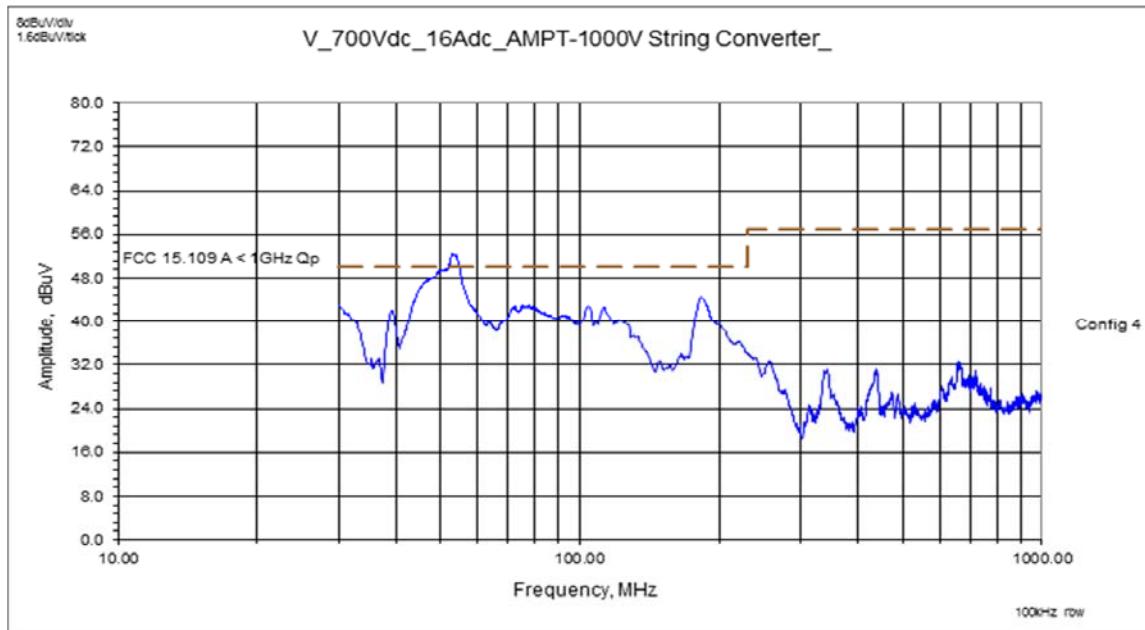
Test Setup – Front



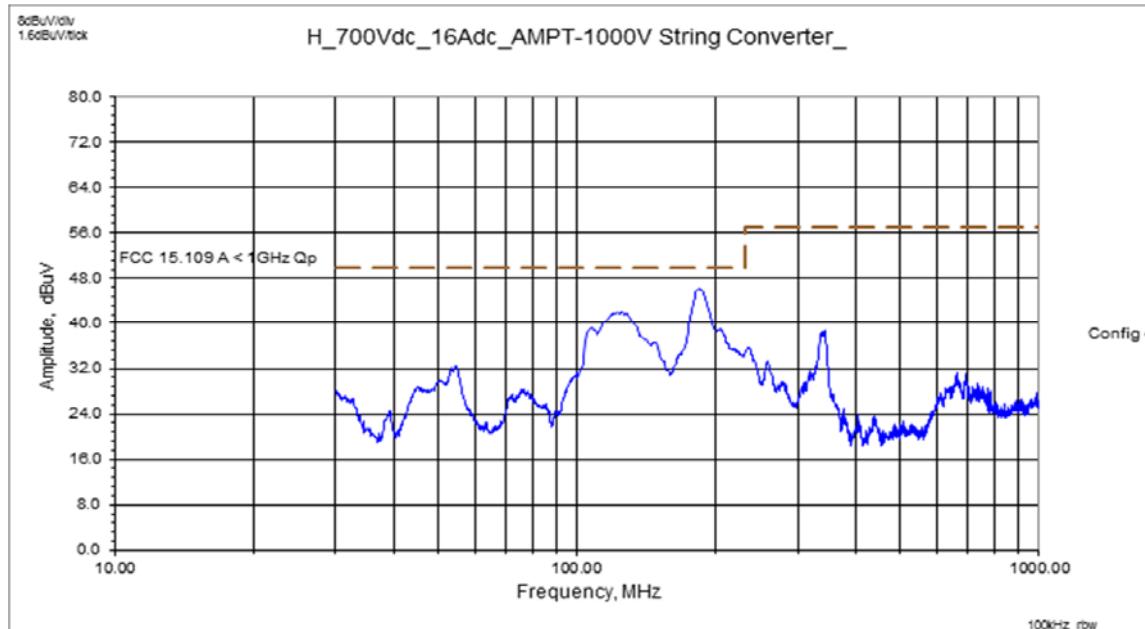
Test Setup – Rear

**14.6 Plots: Reference only.**

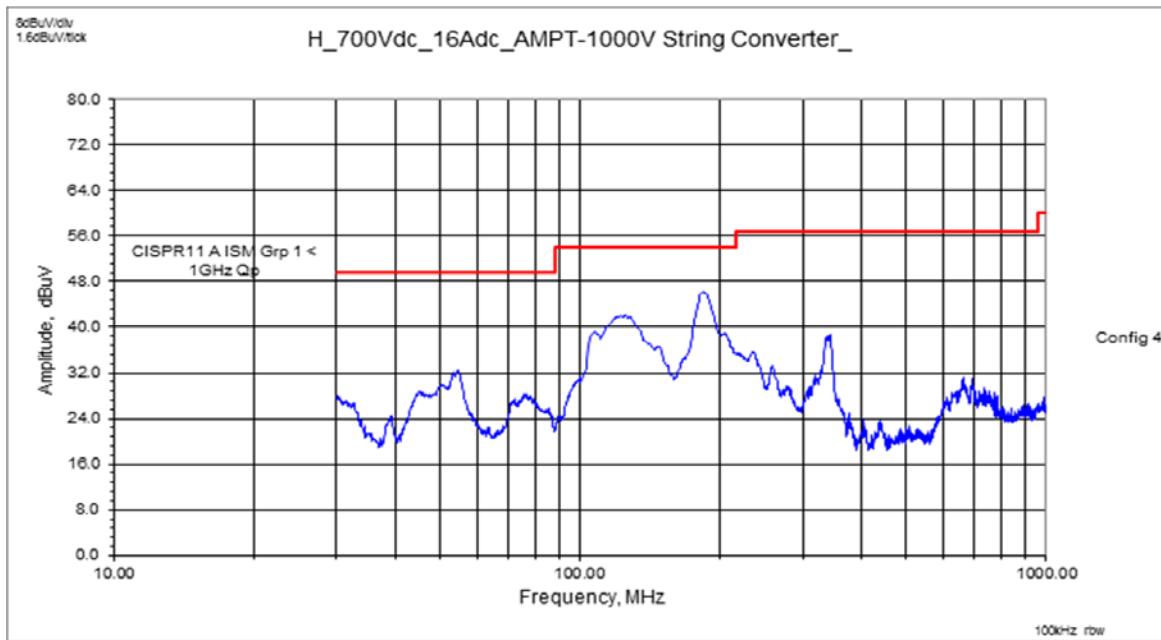
FCC 15.109, ICES-003 Class A at 3m distance. 700Vdc (2 PSU), 16Adc (Vertical).  
Max hold during 360 degree turntable rotation. Reference only to determine frequencies to be maximized.



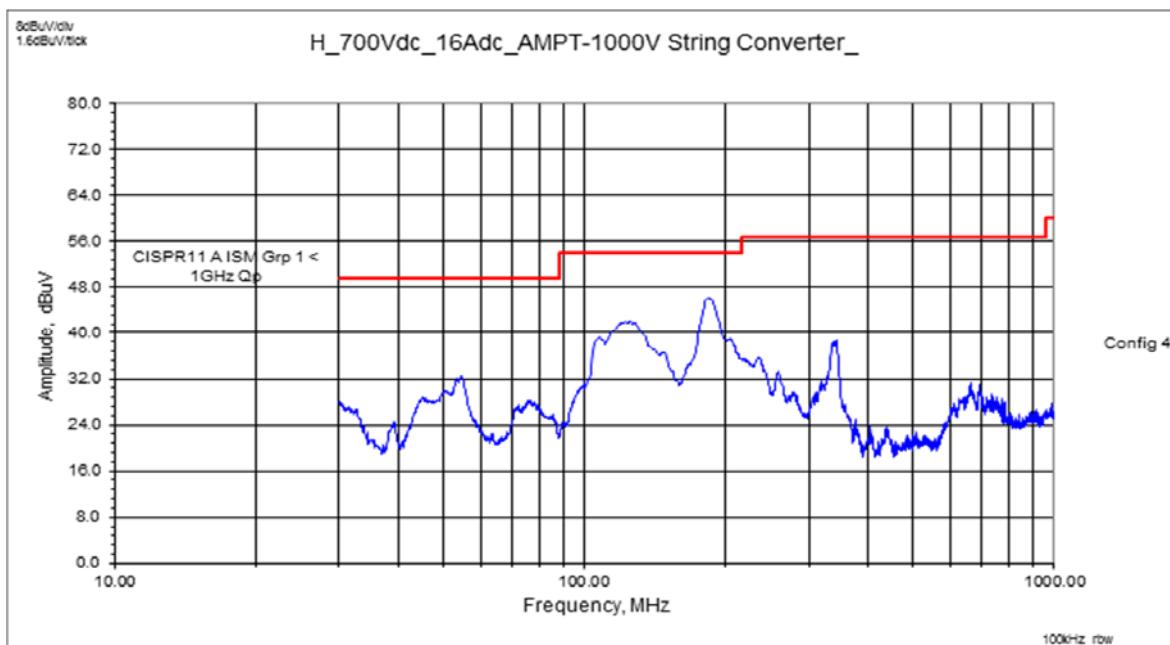
FCC 15.109, ICES-003 Class A at 3m distance. 700Vdc (2 PSU), 16Adc (Horizontal).  
Max hold during 360 degree turntable rotation. Reference only to determine frequencies to be maximized.



CISPR 11 Class A at 3m distance. 700Vdc (2 PSU), 16Adc (Vertical).  
Max hold during 360 degree turntable rotation. Reference only to determine frequencies to be maximized.



CISPR 11 Class A at 3m distance. 700Vdc (2 PSU), 16Adc (Horizontal).  
Max hold during 360 degree turntable rotation. Reference only to determine frequencies to be maximized.



## 14.8 Test Data: Radiated Electromagnetic Emissions

Test Method:	FCC 15.109, ICES-003, CISPR11	Test Area:	CC1	Temperature:	23.9 °C
EUT Model #:	31570014-xx	Test Date:	9/10/2015	Relative Humidity:	21.4 %
EUT Serial #:	0815K000002	EUT Power:	700Vdc (2 PSU), 16A dc		
Manufacturer:	AMPT				Level Key
EUT Description:	1000V String Converter			Pk - Peak	Nb - Narrow Band
Notes:				Qp - QuasiPeak	Bb - Broad Band
				Av - Average	

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	ATTEN	FINAL	POL	HGT	AZ	DELTA1	DELTA2	RBW	Limit 1	Limit 2
MHz	dBuV	Qp									FCC 15.109 A < 1GHz Qp	CISPR11 A ISM Grp 1 < 1GHz Qp			CISPR11 A ISM Grp 1 < 1GHz Qp
<u>V_700Vdc_16Adc_AMPT-1000V String Converter</u>															
52.5657	66.91	Qp	0.55	7.99	27.98	0.00	47.47	V	1.00	0.0	-2.08	-2.53	0.120	49.55	50.00
73.7644	59.02	Qp	0.65	8.30	27.90	0.00	40.07	V	1.16	100.7	-9.48	-9.93	0.120	49.55	50.00
113.5673	53.46	Qp	0.77	13.16	27.75	0.00	39.63	V	1.36	58.7	-14.35	-10.37	0.120	53.98	50.00
186.5193	55.13	Qp	0.98	11.20	27.35	0.00	39.96	V	1.25	38.3	-14.02	-10.04	0.120	53.98	50.00
345.2154	45.18	Qp	1.32	14.51	27.23	0.00	33.78	V	2.17	329.7	-23.12	-23.22	0.120	56.90	57.00
668.1250	33.40	Qp	1.84	19.84	28.22	0.00	26.85	V	1.00	359.9	-30.05	-30.15	0.120	56.90	57.00
<u>H_700Vdc_16Adc_AMPT-1000V String Converter</u>															
55.3526	45.92	Qp	0.57	7.60	27.97	0.00	26.12	H	1.50	216.6	-23.42	-23.88	0.120	49.54	50.00
125.1491	51.85	Qp	0.79	13.70	27.70	0.00	38.64	H	1.50	91.8	-15.34	-11.36	0.120	53.98	50.00
187.8526	56.86	Qp	0.98	11.20	27.34	0.00	41.70	H	1.50	278.7	-12.28	-8.30	0.120	53.98	50.00
344.6106	47.76	Qp	1.32	14.48	27.22	0.00	36.34	H	1.50	74.4	-20.56	-20.66	0.120	56.90	57.00
663.8093	32.56	Qp	1.83	19.88	28.23	0.00	26.04	H	1.50	283.8	-30.86	-30.96	0.120	56.90	57.00
923.0128	23.62	Qp	2.17	22.06	27.44	0.00	20.41	H	1.50	47.1	-36.49	-36.59	0.120	56.90	57.00

Test Personnel:	Son La		Test Date:	9/10/2015
Supervising/Reviewing Engineer:	Michael Spataro			
Standard:	FCC 15.109, ICES-003, CISPR11		Limit Applied:	Class A
Input Voltage:	700Vdc (2 PSU), 16A dc			
Pretest Verification w/ Ambient Signals or BB Source:	Yes		Ambient Temperature:	23.9 °C
			Relative Humidity:	21.4 %

Example calculation:

Measured Level	+	Transducer, Cable Loss & Amplifier corrections	=	Corrected Reading	Spec. Limit	-	Corrected Reading	=	Delta Specification
(dB $\mu$ V)		(dB)		(dB $\mu$ V/m)	(dB $\mu$ V/m)		(dB $\mu$ V/m)		(dB $\mu$ V/m)
<b>14.0</b>		<b>14.9</b>		<b>28.9</b>	<b>40.0</b>		<b>28.9</b>		<b>-11.1</b>

Deviations, Additions, or Exclusions: None

**15 AC Mains Conducted Emissions - Not applicable****15.1 Method:**

The test methods used comply with ANSI C63.4 and CISPR 16. Unless otherwise stated no deviations were made from:

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**15.2 Measurement Uncertainty:**

For conducted emissions,  $U_{\text{lab}}(3.1 \text{ dB in worst case}) < U_{\text{CISPR}}(3.6 \text{ dB})$ , which is the reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

**Sample Calculations**

The following is how net line-conducted readings were determined:

$$NF = RF + LF + CF + AF$$

Where NF = Net Reading in  $\text{dB}_{\mu}\text{V}$

RF = Reading from receiver in  $\text{dB}_{\mu}\text{V}$

LF = LISN or ISN Correction Factor in dB

CF = Cable Correction Factor in dB

AF = Attenuator Loss Factor in dB

To convert from  $\text{dB}_{\mu}\text{V}$  to  $\mu\text{V}$  or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

NF = Net Reading in  $\text{dB}_{\mu}\text{V}$

**Example:**

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}_{\mu}\text{V}$$

$$UF = 10^{(49.1 \text{ dB}_{\mu}\text{V}/20)} = 285.1 \mu\text{V}/\text{m}$$

**15.3 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
None	N/A						

Software Utilized:

Name	Manufacturer	Version
N/A		

**15.4****Results:**

The sample tested was found      Test not applicable

**16      Telecom Port Conducted Emissions - Not applicable****16.1    Method:**

The test methods used comply with ANSI C63.4 and CISPR 16. Unless otherwise stated no deviations were made from CISPR22.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**16.2    Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
None	N/A						

Software Utilized:

Name	Manufacturer	Version
N/A		

**16.3    Results:**

Product has no telecom ports or cables - test not applicable.

The sample tested was found      Test not applicable

**17 Harmonic Current Emissions - Not applicable****17.1 Method:**

Unless otherwise stated no deviations from IEC 61000-3-2:2005, A1:2008, A2:2009 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**17.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
None	N/A						

Software Utilized:

Name	Manufacturer	Version
None		

**17.3 Results:**

The sample tested was found      Test not applicable

**18 Voltage Fluctuations and Flicker - Not applicable****18.1 Method:**

Unless otherwise stated no deviations from IEC 61000-3-3:2008 were made.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**18.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Notes	Cal Date	Cal Due
None	N/A						

Software Utilized:

Name	Manufacturer	Version
None		

**18.3 Results:**

The sample tested was found      Test not applicable

## 19 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of  $k = 2$ , providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty $\pm$	Notes
Radiated emissions, 10kHz to 30 MHz	4.2 dB	
Radiated emissions, 30 to 200 MHz HP	3.6 dB	
Radiated emissions, 30 to 200 MHz VP	4.5 dB	
Radiated emissions, 200 to 1000 MHz HP	3.7 dB	
Radiated emissions, 200 to 1000 MHz VP	3.7 dB	
Radiated emissions, 1 to 18 GHz	5.4 dB	
AC mains Conducted emissions, 9kHz to 30 MHz	3.3 dB	
Disturbance Power 30 to 1000 MHz	3.3 dB	
Telecom Port Conducted emissions, Voltage 150	4.8 dB	
Harmonics	-	Meets the requirements specified by the standard.
Flicker	-	Meets the requirements specified by the standard.
ESD	4.4%	
Radiated RF field immunity 80MHz to 2.7GHz	2.2 dB	
EFT	4.3%	
Surge	4.3%	
Conducted RF immunity	2.1 dB	
Power frequency magnetic field immunity	2.3 dB	
Voltage dips / interruptions immunity	0.3 mV	

**20 Revision History**

Revision Level	Date	Report Number	Notes
0	09/14/2015	102271213DEN-001	Original Issue

**Appendix A: Modifications not required**