TEST REPORT

Report Number: 102614695DEN-001
Project Number: G102614695

Report Issue Date: September 20, 2016

Product Designation: **Model: P4010ACSCO-W**

Standards: **FCC Part 15 Subpart C (15.247)**
Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz
IC RSS-247, Issue 1: 2015
IC RSS-GEN, Issue 4: 2014

Tested by:
Intertek Testing Services NA, Inc.
1795 Dogwood St. Suite 200
Louisville, CO 80027

Client:
Kidde Safety
4820 Centennial Blvd Ste 145
Colorado Springs, CO 80919-3319

Report prepared by

Duan Wei Lin
EMC Project Engineer

Report reviewed by

Mike Spataro
Engineering Team Leader

This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to permit copying or distribution of this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program.

TABLE OF CONTENTS

1 Introduction and Conclusion 3
2 Test Summary 4
3 System setup including cable interconnection details, support equipment and simplified block diagram 8
4 AC Voltage Variation/ Battery Requirement 10
5 Antenna Requirement 11
6 DTS Requirement 11
7 DTS Bandwidth (6dB Bandwidth) 12
8 RF Output Power 15
9 RF Conducted Spurious Emissions (-20dBc) – Including Band Edge 26
10 Spurious and Band Edge/Restricted Band Emissions - Radiated 33
11 Power Spectral Density – PSD 40
12 Radiated Emissions (Digital Part of Receiver) 45
13 AC Mains Conducted Emissions - Transmitter 50
14 RF Exposure Requirement 55
15 Duty Cycle/ Duty Cycle Correction Factor 57
16 Measurement Uncertainty 60
17 Revision History 61

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.

1.1 Test Report Scope

1.2 Test Methodology

All measurements were performed according to the procedures in the following documents:

- ANSI C63.10: 2013 – ANSI Standard for Testing Unlicensed Wireless Devices
- FCC Publication 558074, April 9, 2013 (Guidelines for Compliance Measurements on DTS Operating Under 15.247)

Radiated emissions tests were formed at an antenna-to-product distance of 3-meters.

1.3 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 numbers are. R-1643, C-1752 and T-1558, our FCC designation no. US1121 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 coved under the laboratories scope.

2 Test Summary

TEST SECTION	TESTS	FCC/IC REFERENCE	TEST DATE	RESULT
5	AC Voltage Variation	FCC 15.31(e)	8/29/2016	Pass
6	Antenna Requirement	FCC 15.203	8/29/2016	Pass
7	DTS Requirement	FCC 15.247(a) RSS-247 5.2	8/29/2016	Pass
8	6dB Bandwidth	FCC 15.247(a)(2) RSS-247 5.2(1)	8/30/2016	Pass
9	RF Conducted Output Power (includes requirements for antenna gain > 6dBi)	FCC 15.247(b)(3) RSS-247 5.4(4)	8/29/2016	Pass
10	RF Conducted Spurious Emissions (-20dBc) Includes Band Edge	FCC 15.247(d) RSS-247 5.5	8/30/2016	Pass
11	Transmitter Radiated Spurious Emissions (Restricted Bands – Band Edge)	FCC 15.247(d) FCC 15.209/15.205 RSS-247 5.5 RSS-Gen 8.10	8/292016- 8/30-2016	Pass
12	Power Spectral Density (PSD)	FCC 15.247(e) RSS-247 5.2(2)	8/29/2016	Pass
13	Radiated Emissions – Digital Receiver	FCC 15.109 RSS-Gen 7.1	8/30/2016	Pass
14	Tx AC Line Conducted Emissions	FCC 15.207 RSS-Gen 8.8	8/30/2016	Pass
15	RF Exposure Requirement	FCC 15.247(i) FCC 15.1.1307(b)(1) RSS 102	8/30/2016	Pass
16	Duty Cycle/ Duty Cycle Correction Factor	FCC 15.35(c) RSS-Gen 6.10	8/30/2016	Pass

Notes:NA

Description of Product Under Test

Model:	P4010ACSCO-W
Type of EUT:	Digital Transmissions System
Serial Number:	Mfg Proto #5
FCC ID:	SAK25569999
Industry Canada ID:	7145A-25569999
Related Submittal(s) Grants:	N/A
Company:	Kidde Residential and Commercial
Customer:	Kidde Residential and Commercial
Address:	1394 S. 3rd St. Mebane, NC 27302
Phone:	+1 (919) 304-8234
Fax:	N/A
e-mail:	ken.fasen@kiddeus.com
Test Standards:	☒ 47 CFR, Part 15C:§15.247 DTS ☒ RSS–210, Issue 8, 2010 ☒ RSS-Gen, Issue 3, 2010 ☐ 47 CFR, Part 15C:§ ☐ Other
Type of radio:	☒ Stand -alone ☐ Module ☐ Hybrid
Date Sample Submitted:	8/29/2016
Test Work Started:	8/29/2016
Test Work Completed:	8/31/2016
Test Sample Conditions:	☐ Damaged ☐ Poor (Usable) ☒ Good

Product Description:	Smoke/CO alarm with RF transceiver
Transmitter Type:	☐ FHSS ☒ Digital Modulation ☐ WiFi ☐ Blue Tooth
Operating Frequency Range(s):	902-928 MHz
Number of Channels:	1
Modulation:	FSK
Antenna(s) Info:	Integrated antenna
Rated Power:	EIRP 8mW
Antenna Installation:	☐ User ☒ Professional ☐ Factory
Transmitter power configuration:	☐ Internal battery ☒ External power source
Special Test Arrangement:	the EUT was rotated and tested in three orthogonal axes to determine the maximum emissions
Test Facility Accreditation:	A2LA (Certificate No. 2506.01)
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013

2.1 Channel Configurations

Channel Number	Frequency (MHz)	SISO $N_{TX = 1}$	MIMO $N_{TX = 3}$
1	925.7	xt	---

xt = tested channels

2.2 Product Description - Detailed

Description of Equipment Under Test (provided by client)
Smoke/CO alarm with RF transceiver

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
120VAC	50mA	60Hz	1

Descriptions of EUT Exercising
☐ Standby/Idle Mode
☐ Continuous transmission, un-modulated carrier (CW)
☒ Continuous transmission, modulated carrier (CW) utilizing worst-case data rate
☐ Continuous Receive Mode

Note: The chosen mode of operation described above is dependent upon the specific test to be performed.

3 System setup including cable interconnection details, support equipment and simplified block diagram

3.1 Method:

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

3.2 EUT Block Diagram:

3.3 Antenna Specifications: NA integral antenna

3.4 Support Data:

ID	Description/ Function	Shield Type	Length	Connector	Connection	Ferrites

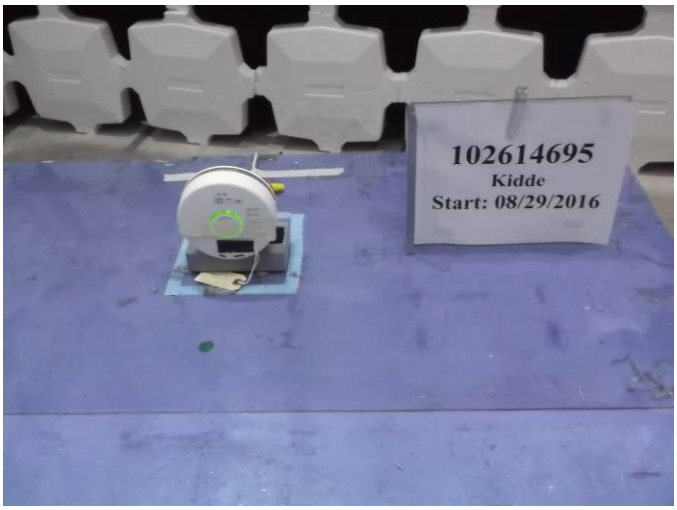
Support Equipment			
Description	Manufacturer	Model Number	Serial Number

Notes:

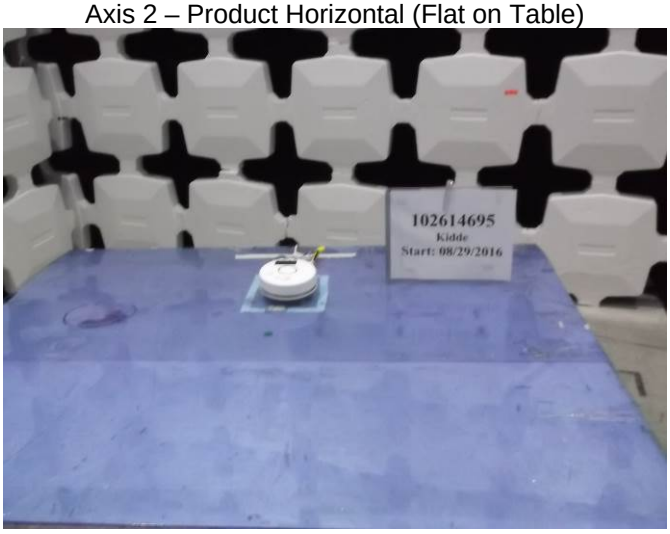
1) Add as needed

3.5 Photograph: Product Tested - Test Axis

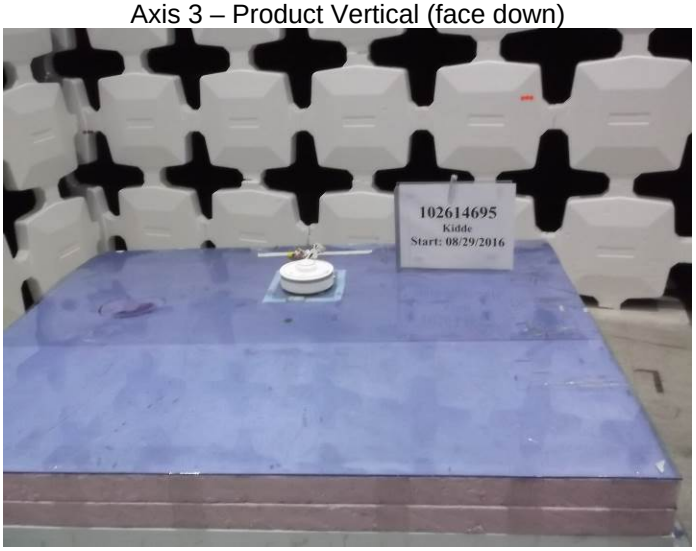
Axis 1 – Product Vertical



Axis 2 – Product Horizontal (Flat on Table)



Axis 3 – Product Vertical (face down)



4 AC Voltage Variation/ Battery Requirement

4.1 Method:

The test methods used comply with ANSI C63.10.

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

4.2 Test Requirement/Specification:

- ANSI C63.10:2013, Section 6.8.2/15.31(e)

4.3

4.4 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

4.5 Results:

There is no significant difference in the radiated field strength of the fundamental frequency with respect to varying the ac voltage. Therefore, all measurements will be taken using the nominal rated voltage of the product.

4.6 Test Data:

FREQ	LEVEL	DET	FINAL	RBW
MHz	dBuV	Qp Av Pk	= [dBuV]	(MHz)
AC @ Nominal Voltage – 120 VAC / 60 Hz				
925.93	72.28	Pk	72.28	0.1
AC @ 115% Nominal Voltage – 138 VAC / 60 Hz				
925.93	72.29	Pk	72.29	0.1
AC @ 85% Nominal Voltage – 102 VAC / 60 Hz				
925.93	72.29	Pk	72.29	0.1

5 Antenna Requirement

5.1 Method

Unless otherwise stated no deviations were made from FCC Part 15.203.

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

5.2 Test Requirement/Specification

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.
The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

5.3 Results:

The sample tested was found to comply.

The product incorporates an integral antenna embedded on the pc board. The user has no direct access to the antenna and the antenna is not replaceable.

6 DTS Requirement

Unless otherwise stated no deviations were made from FCC Part 15.247(a).

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

6.1 Test Requirement/Specification

Operation under the provisions of this Section is limited to digitally-modulated intentional radiators.

- FCC 15.31(e)

6.2 Results:

The sample tested was found to comply.

The product incorporates the digital modulation technique, FSK.

7 DTS Bandwidth (6dB Bandwidth)

7.1 Method:

The test methods used comply with ANSI C63.10. Unless otherwise stated no deviations were made from FCC 15.247 or RSS-247.

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

7.2 Test Requirement/Specification

- 15.247(a)(2)
- RSS-247 5.2(1)

7.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
18886	Ridged Guide Antenna 1-18GHz	TENSOR	4105	2020	12/28/2015	12/28/2017
DEN-152	Hi Pass Filter: VHF-1320+, 1700-3800MHz	Mini-Circuits	VHF-1320	30716	9/3/2015	9/3/2016
18906	Pre Amp: 1GHz – 4GHz	Mini-Circuits Lab	ZHL-42	N052792-2	4/26/2016	4/26/2017
DEN-032	4-18 GHz LNA	NARDA	DBL-0618N615	031	4/13/2016	4/13/2017
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
18912	9 kHz- 1.3GHz Pre Amp	Hewlett-Packard	HP	5	3/31/2016	3/31/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

7.4 Results:

The sample tested was found to comply.

7.5 Test Summary:

Frequency Range:	☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz		
Channel 1_Antenna Vertical (kHz)	**Channel 1_Antenna Horizontal (kHz)**	**Limit (kHz)**	**Result**
554.5	557.7	>500kHz	**Pass**
Span:	2MHz		
RBW:	☐ 3kHz ☐ 30kHz ☒ 100kHz ☐ other kHz		
VBW:	☐ 3kHz ☐ 10kHz ☐ 100kHz ☒ other 300 kHz		

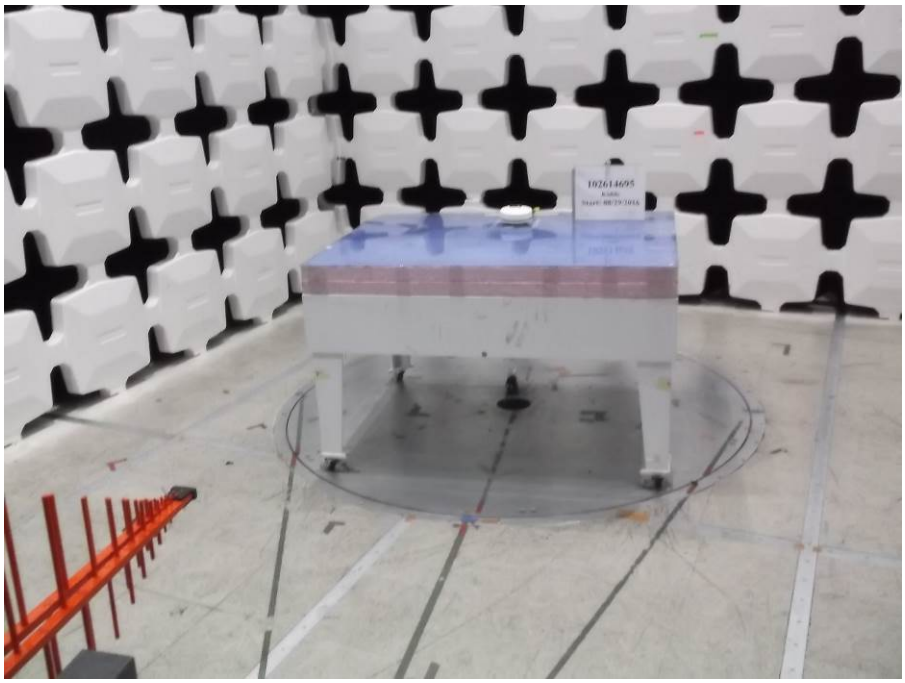
7.6 Test Method:

- ANSI C63.10:2013, Section 11.8

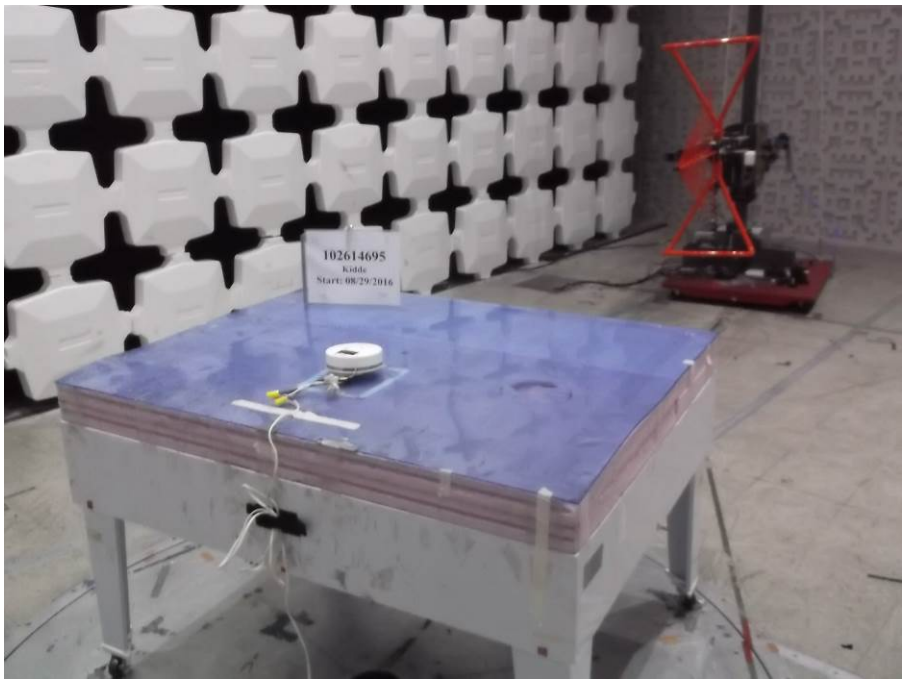
7.7 Notes:

1. The limit for RSS-247 is identical to the limit for FCC 15.247.

7.8 Setup Photographs:



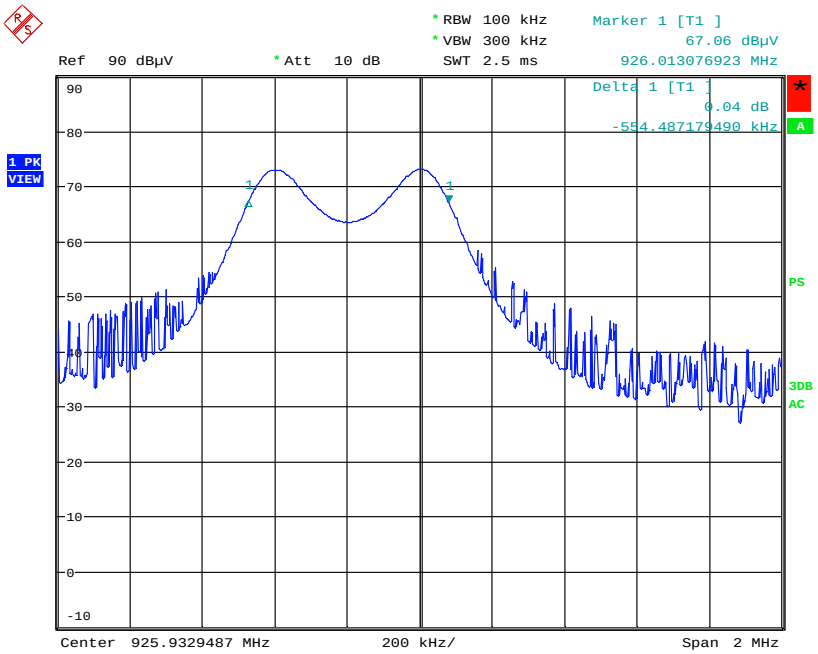
Test Setup – Front



Test Setup - Rear

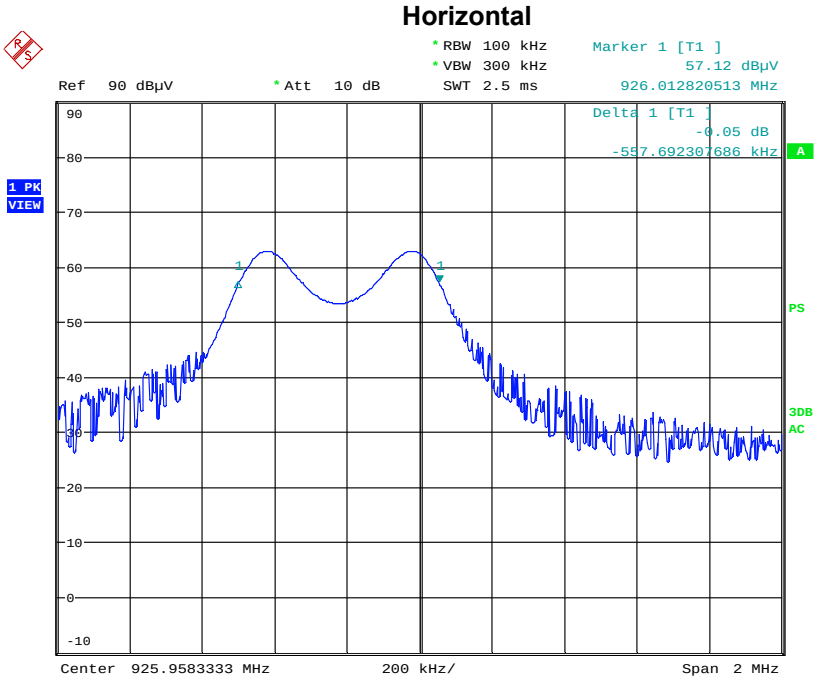
7.9 Plots: 6 dB Bandwidth

Vertical



Date: 29.AUG.2016 14:55:07

Horizontal



Date: 29.AUG.2016 15:09:54

8 RF Output Power

8.1 Method:

The test methods used comply with ANSI C63.10 section 6.10.1. Unless otherwise stated no deviations were made from FCC 15.247 or RSS-247.

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

8.2 Test Requirement/Specification:

The maximum peak conducted output power

Fundamental Frequency	Output power (Watts)
902-928 MHz	1

- FCC 15.247(b)(3)
- RSS-247 5.4(4)

8.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

8.4 Results:

The sample tested was found to comply.

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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

8.5 Test Summary:

Fundamental						
Frequency Range:	☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz					
Frequency MHz	Measured Power (dBm)	Correction Cable/Atten (dB)	Final Corrected (dBm)	Standard Limit (dBm)	Limit Reduction (dB)	Margin (dB)
925.93	8.9	0	8.9	30	NA	21.1
RBW: VBW:	☐ 3kHz ☐ 300kHz ☐ 500kHz ☒ 1MHz ☐ 3MHz ☐ 10MHz ☐ 30kHz ☐ 1MHz ☐ 1MHz ☒ 3 MHz ☐ 10MHz ☐ 10MHz					
Antenna Gain:	☒ < 6dBi ☐ >6dBi and = dBi, Output power reduction = dB					

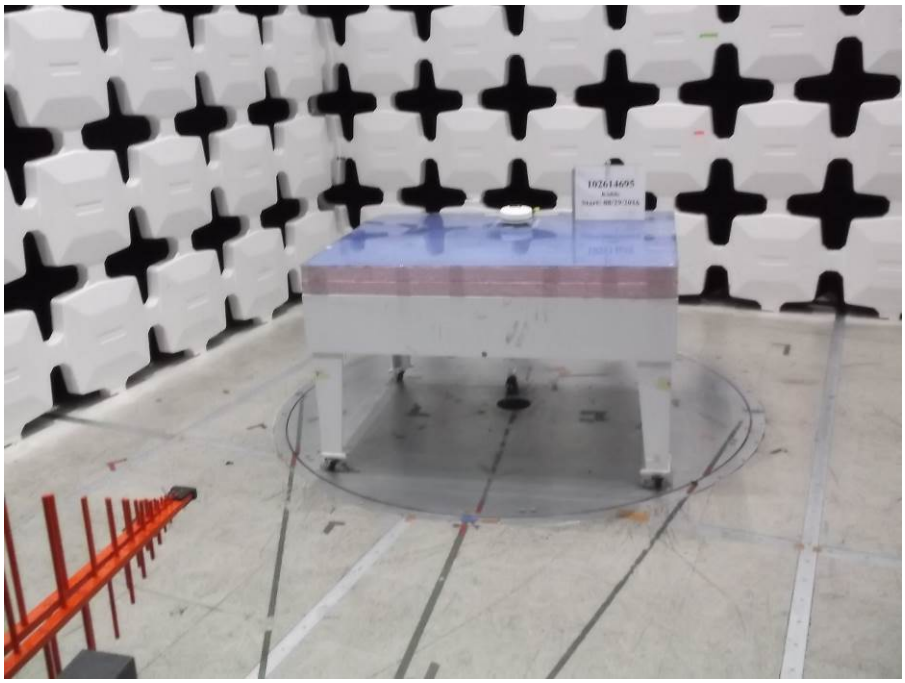
8.6 Test Method:

- ANSI C63.10:2013, Section 11.9

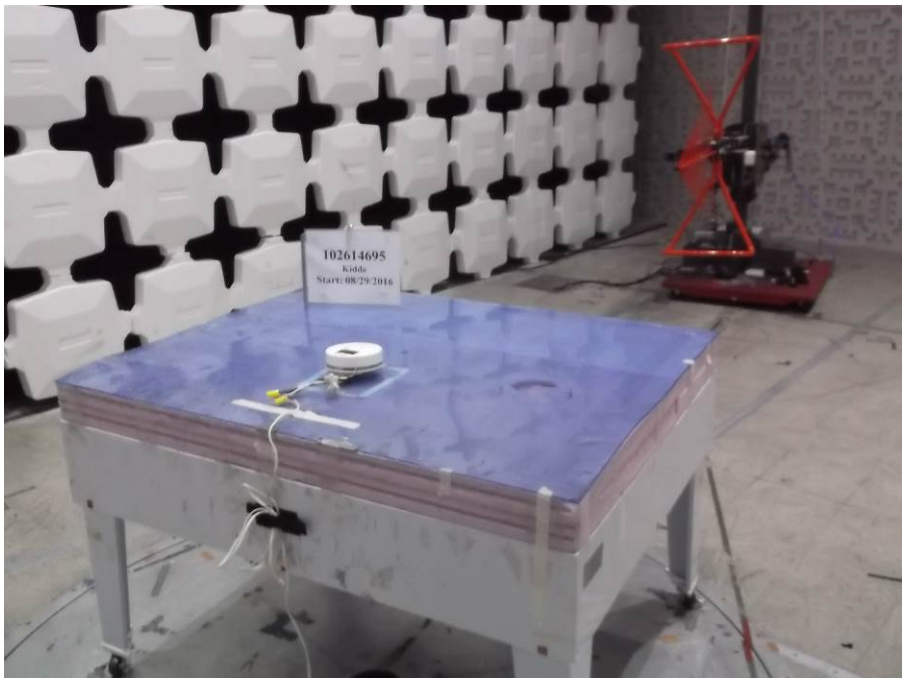
8.7 Notes:

1. The limit for RSS-247 is identical to the limit for FCC 15.247.

8.8 Setup Photographs:



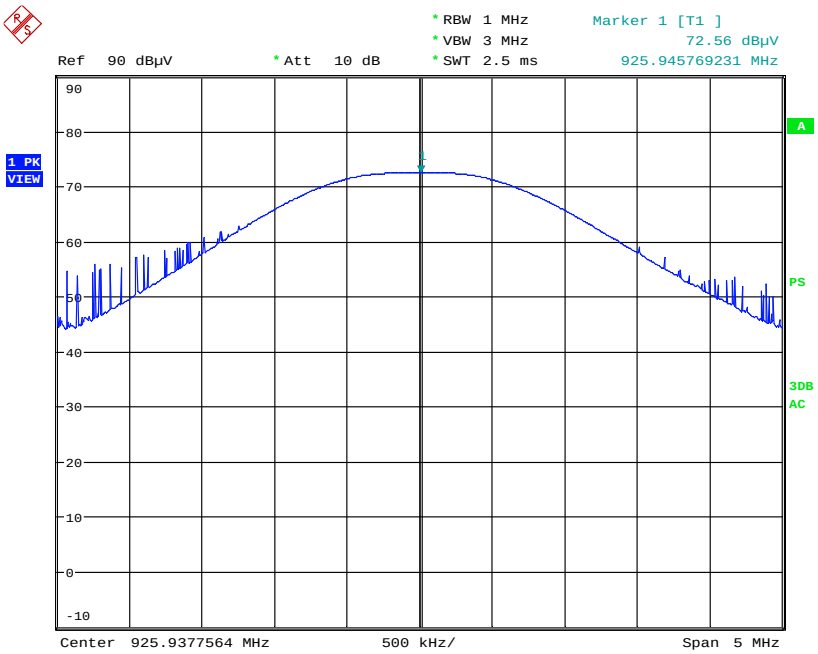
Test Setup – Front



Test Setup - Rear

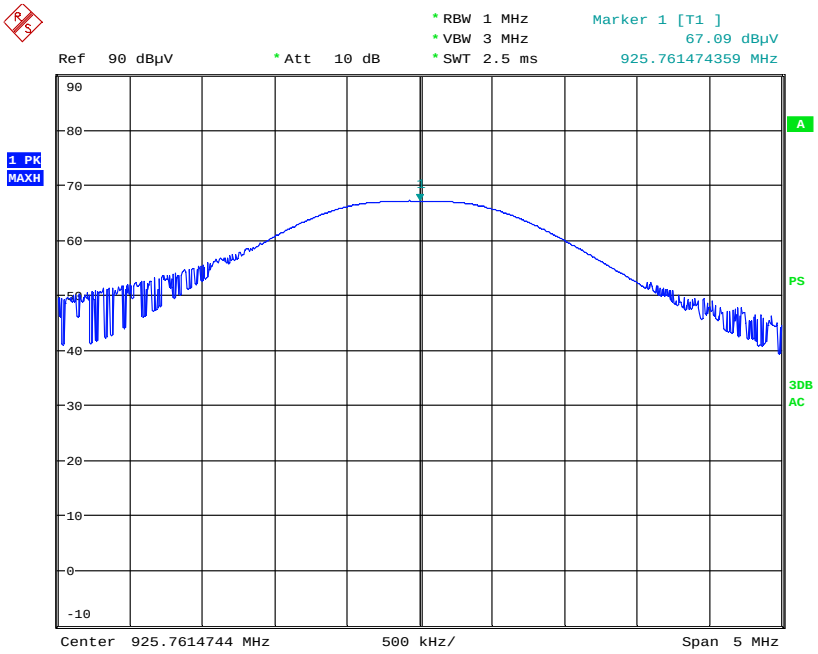
8.9 Plots:

Axis 1
Antenna Vertical



Date: 29.AUG.2016 09:42:44

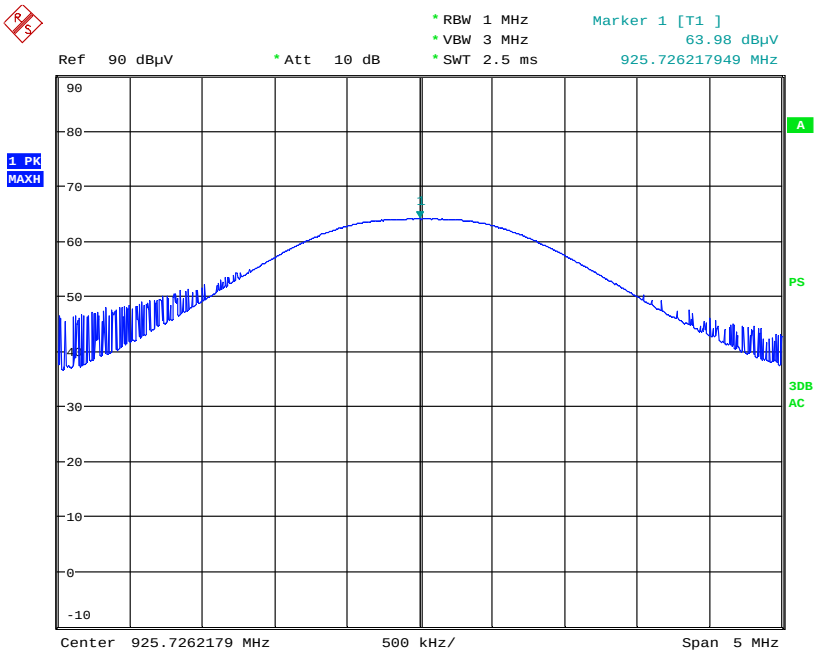
Antenna Horizontal



Date: 29.AUG.2016 09:54:20

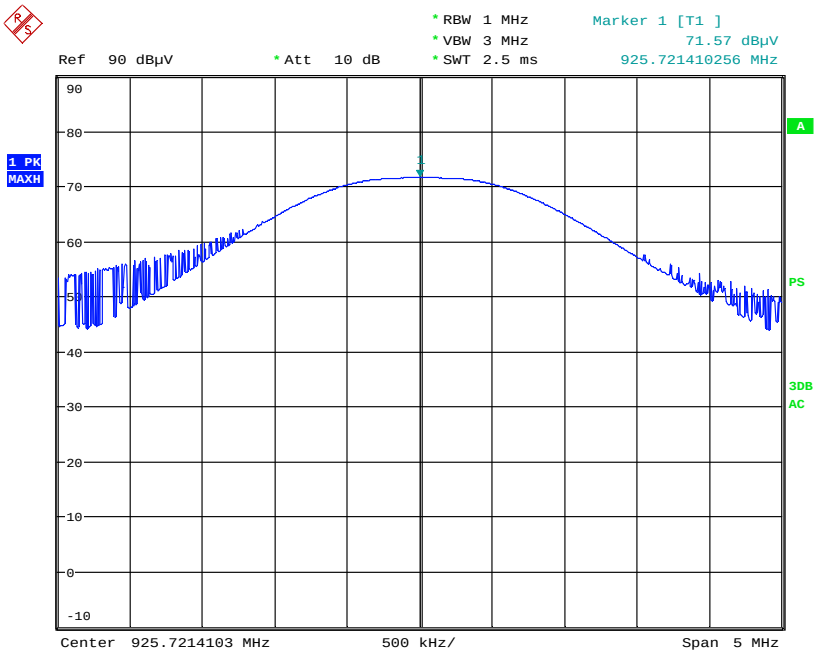
Axis 2

Antenna Vertical



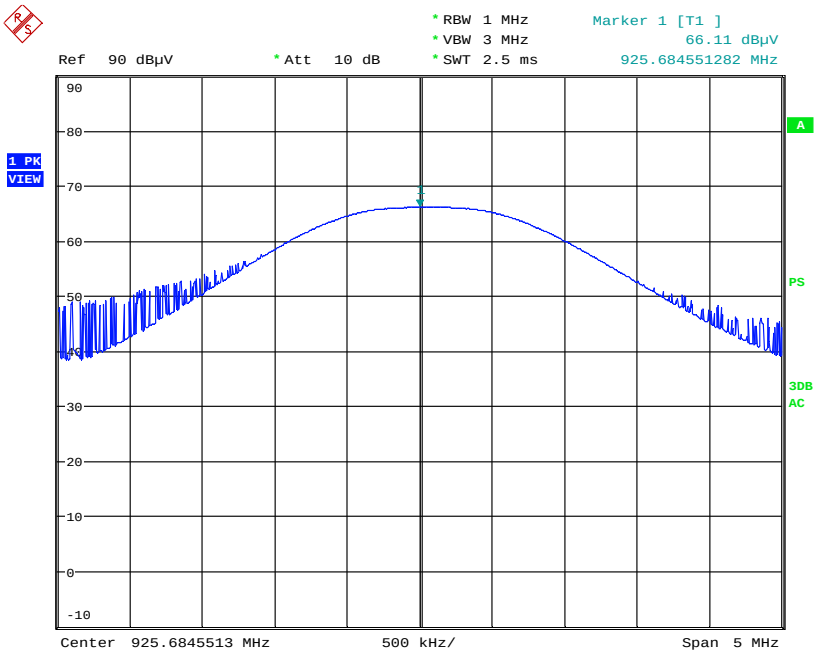
Date: 29.AUG.2016 10:07:12

Antenna Horizontal



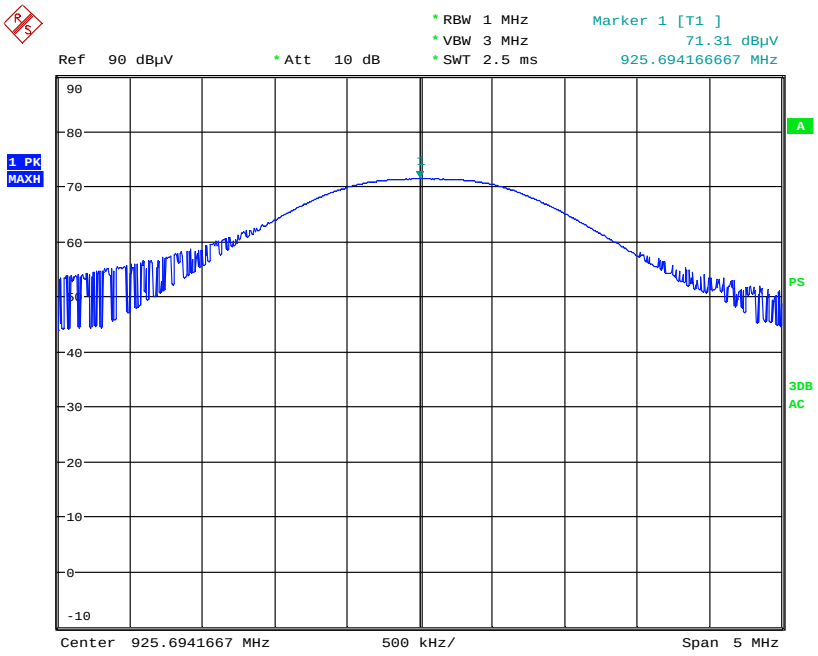
Date: 29.AUG.2016 10:13:31

Axis 3
Antenna Vertical



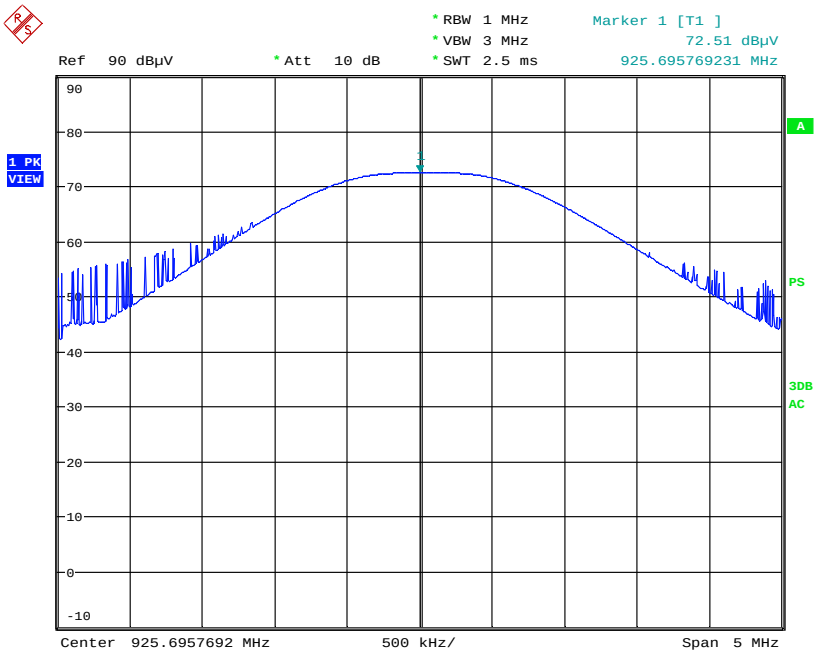
Date: 29.AUG.2016 10:22:20

Antenna Horizontal



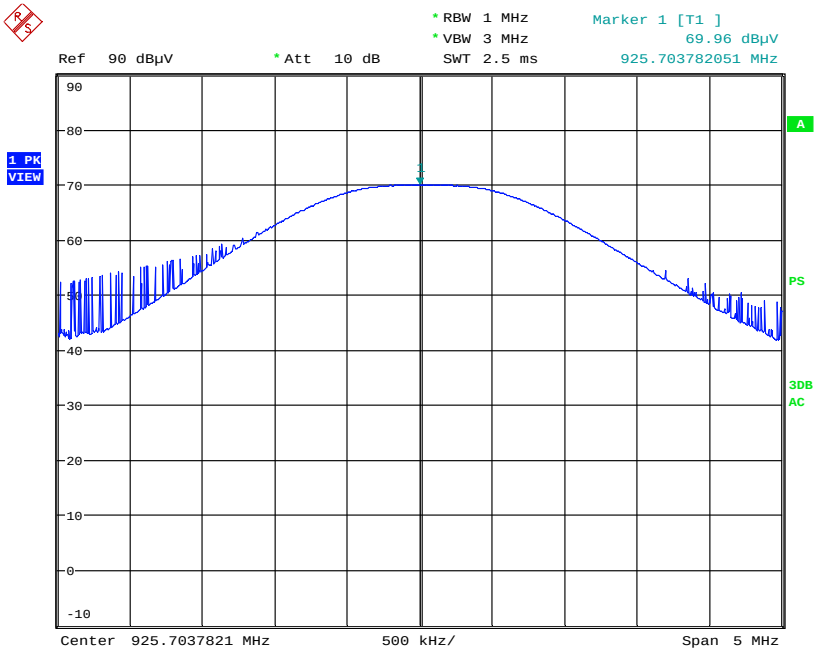
Date: 29.AUG.2016 10:27:28

Axis 1 Battery
Antenna Vertical



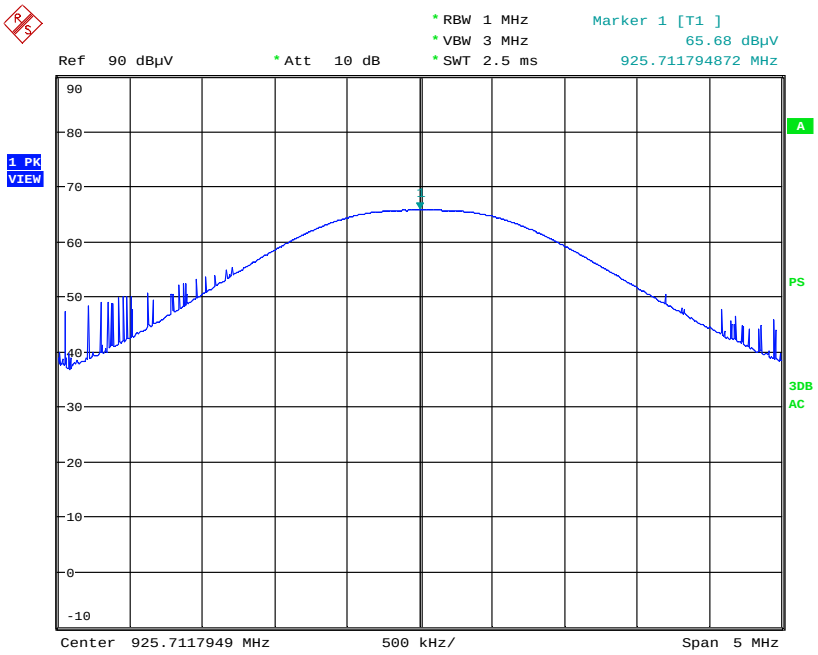
Date: 29.AUG.2016 10:50:01

Antenna Horizontal



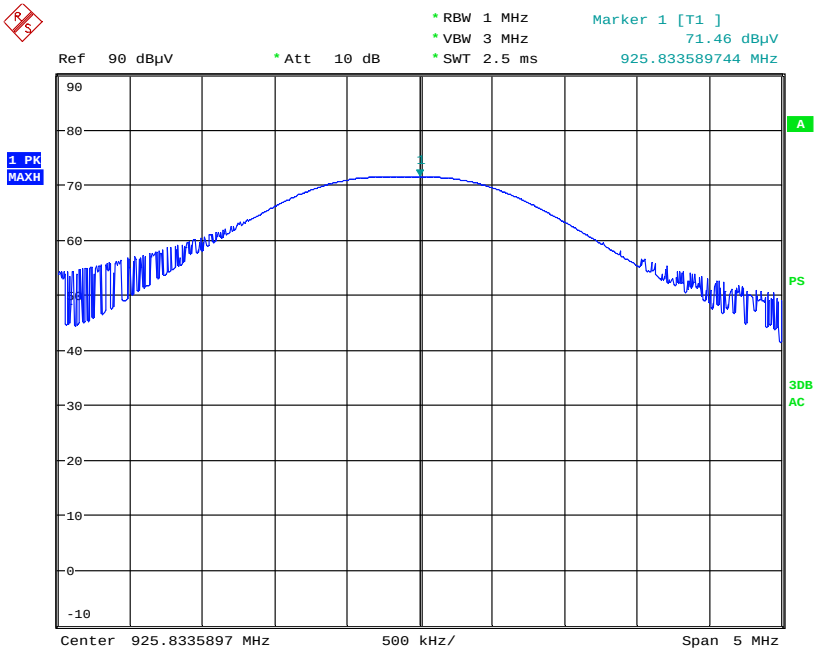
Date: 29.AUG.2016 10:57:41

Axis 2 Battery
Antenna Vertical



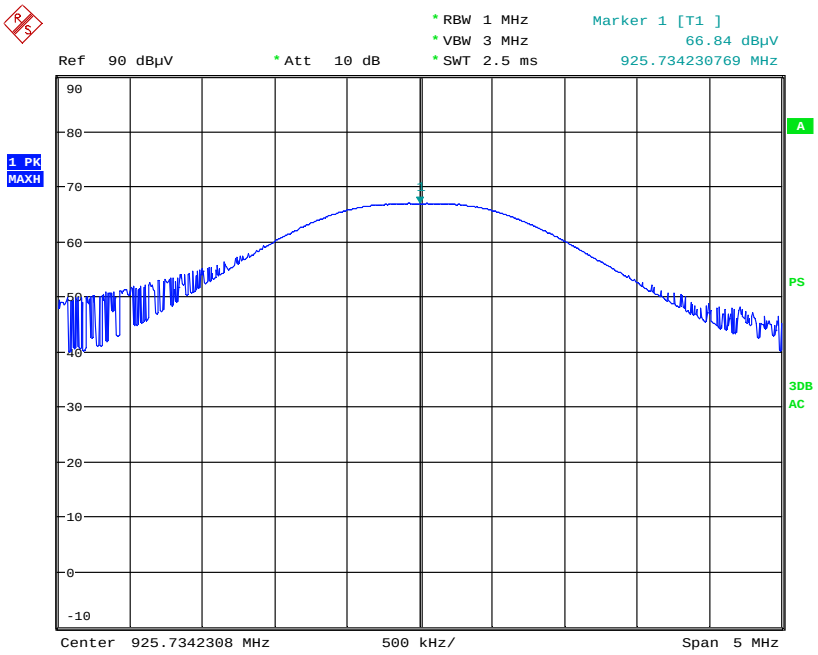
Date: 29.AUG.2016 10:40:45

Antenna Horizontal



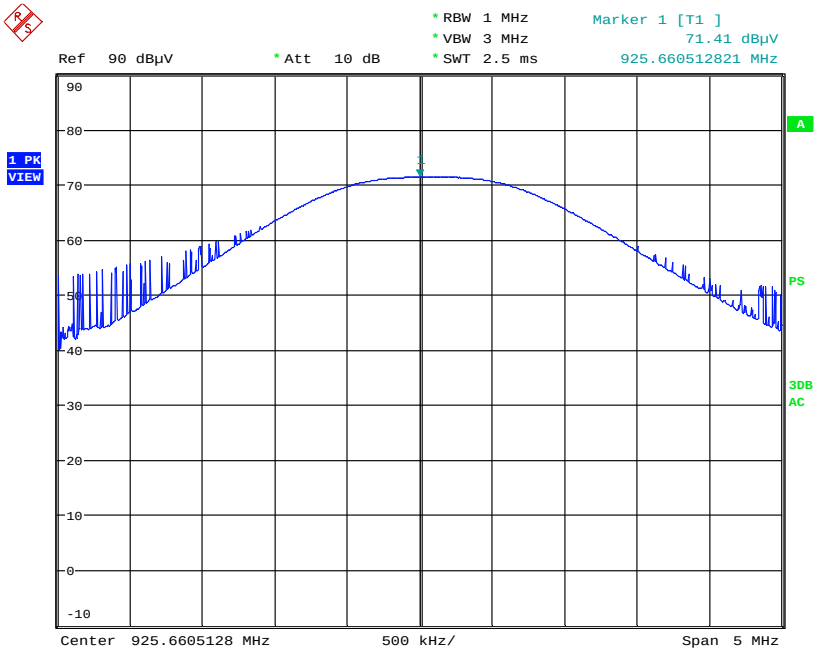
Date: 29.AUG.2016 10:45:00

Axis 3 Battery
Antenna Vertical



Date: 29.AUG.2016 10:32:04

Antenna Horizontal



Date: 29.AUG.2016 10:35:31

8.10 Test Data

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	ATTEN	FINAL	POL	HGT	AZ	RBW
MHz	dBuV	Qp Av Pk Rms	+ [dB]	+ [dB/m]	- [dB]	+ [dB]	= [dBuV]	(V/H)	(m)	(DEG)	(MHz)
OP_X1_V											
925.9378	72.56	**Pk**	2.76	28.82	0	0	104.1	V	1	359.9	1
OP_X1_H											
925.7615	67.09	**Pk**	2.76	28.82	0	0	98.7	H	2.36	47.5	1
OP_X2_V											
925.7262	6.98	**Pk**	2.76	28.81	0	0	38.6	V	1	82.2	1
OP_X2_H											
925.7214	71.57	**Pk**	2.76	28.81	0	0	103.1	H	2.39	43.9	1
OP_X3_V											
925.6846	66.11	**Pk**	2.76	28.81	0	0	97.7	V	1.16	333.8	1
OP_X3_H											
925.6942	71.31	**Pk**	2.76	28.81	0	0	102.9	H	2.57	324.3	1
OP_X3_V_battery											
925.7342	66.84	**Pk**	2.76	28.81	0	0	98.4	V	1.11	0	1
OP_X3_H_battery											
925.6605	71.41	**Pk**	2.76	28.81	0	0	103.0	H	2.51	325.9	1
OP_X2_V_battery											
925.7118	65.68	**Pk**	2.76	28.81	0	0	97.3	V	1.07	124.3	1
OP_X2_H_battery											
925.8336	71.46	**Pk**	2.76	28.82	0	0	103.0	H	2.39	41.5	1
OP_X1_V_battery											
925.6958	72.51	**Pk**	2.76	28.81	0	0	104.1	V	1	359.9	1
OP_X1_H_battery											
925.7038	69.96	**Pk**	2.76	28.81	0	0	101.5	H	1.48	167.2	1

Convert Field Strength to Power
$P=(E \times D)^2/(30 \times G)$

Where;
E = Volts/meter, in this case the maximum recorded amplitude of 104.1dBuV/m = 0.16V/m
D = Test distance in meters, in this case 3 meters
G = Linear gain of the antenna, in this case the EUT incorporates and integral antenna so 1 is used.

$P=(0.16 \times 3)^2/(30 \times 1)$
P=0.0077W or 8.9dBm

9 RF Conducted Spurious Emissions (-20dBc) – Including Band Edge

9.1 Method:

The test methods used comply with ANSI C63.4. Unless otherwise stated no deviations were made from FCC 15.247 & RSS-247.

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

9.2 Test Requirement/Specification:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

- 15.247(d)
- RSS-247 5.5

For the non-restricted band spurious emissions, the FCC 15.209 limits were used. For band-edge compliance the -20dBc limit was used.

Radiated emissions 30MHz to 10GHz are taken at 3-meter antenna-to-product test distance.

9.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
18886	Ridged Guide Antenna 1-18GHz	TENSOR	4105	2020	12/28/2015	12/28/2017
18906	Pre Amp: 1GHz – 4GHz	Mini-Circuits Lab	ZHL-42	N052792-2	4/26/2016	4/26/2017
DEN-032	4-18 GHz LNA	NARDA	DBL-0618N615	031	4/13/2016	4/13/2017
19937	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-2	3/9/2016	3/9/2017
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
18912	9 kHz- 1.3GHz Pre Amp	Hewlett-Packard	HP	5	3/31/2016	3/31/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

9.4 Results:

The sample tested was found to comply.

9.5 Test Method:

- ANSI C63.10: 2013, Clause 11.11 & 11.13

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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

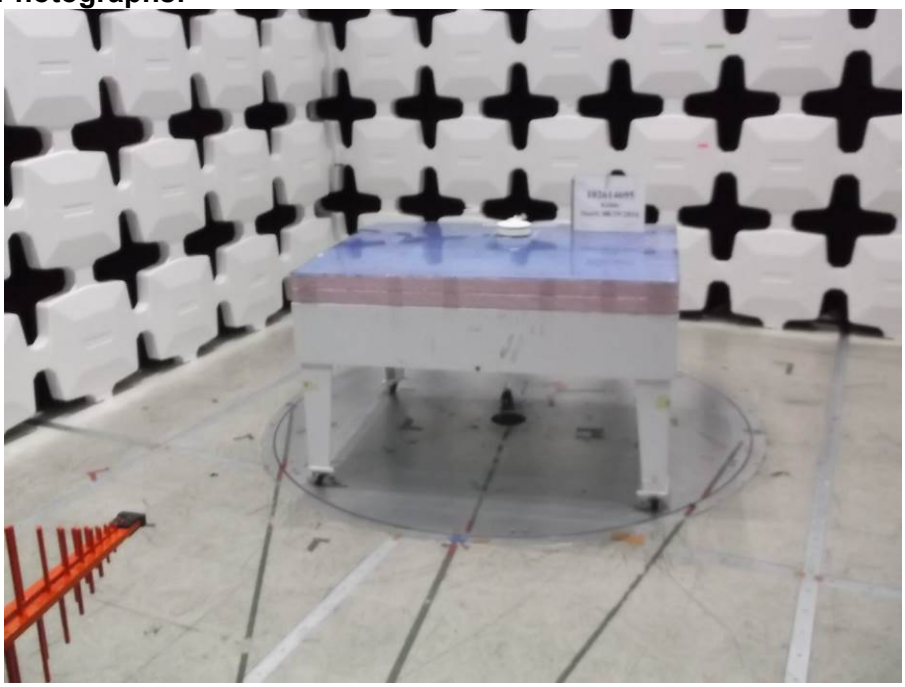
To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

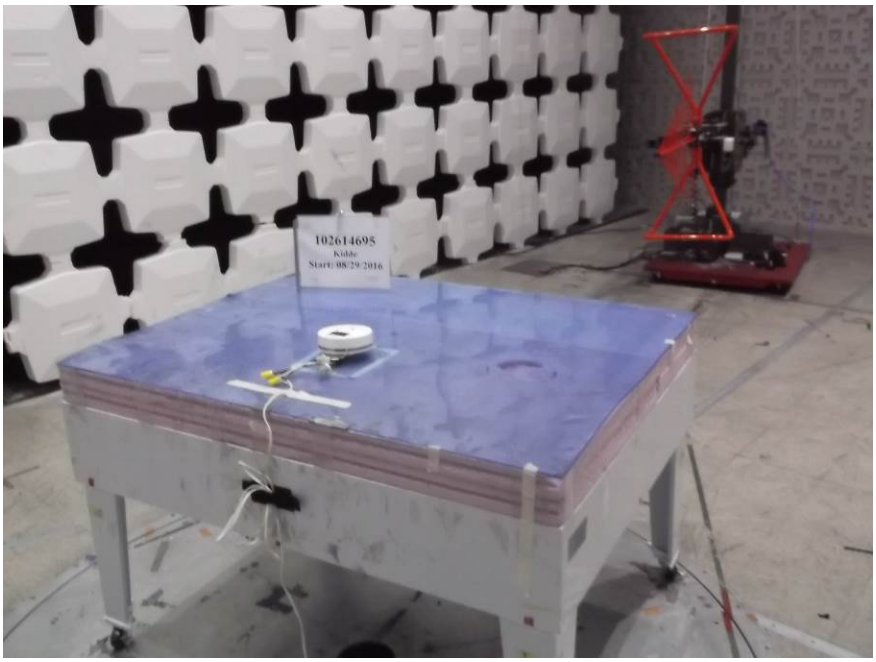
Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

9.6 Setup Photographs:

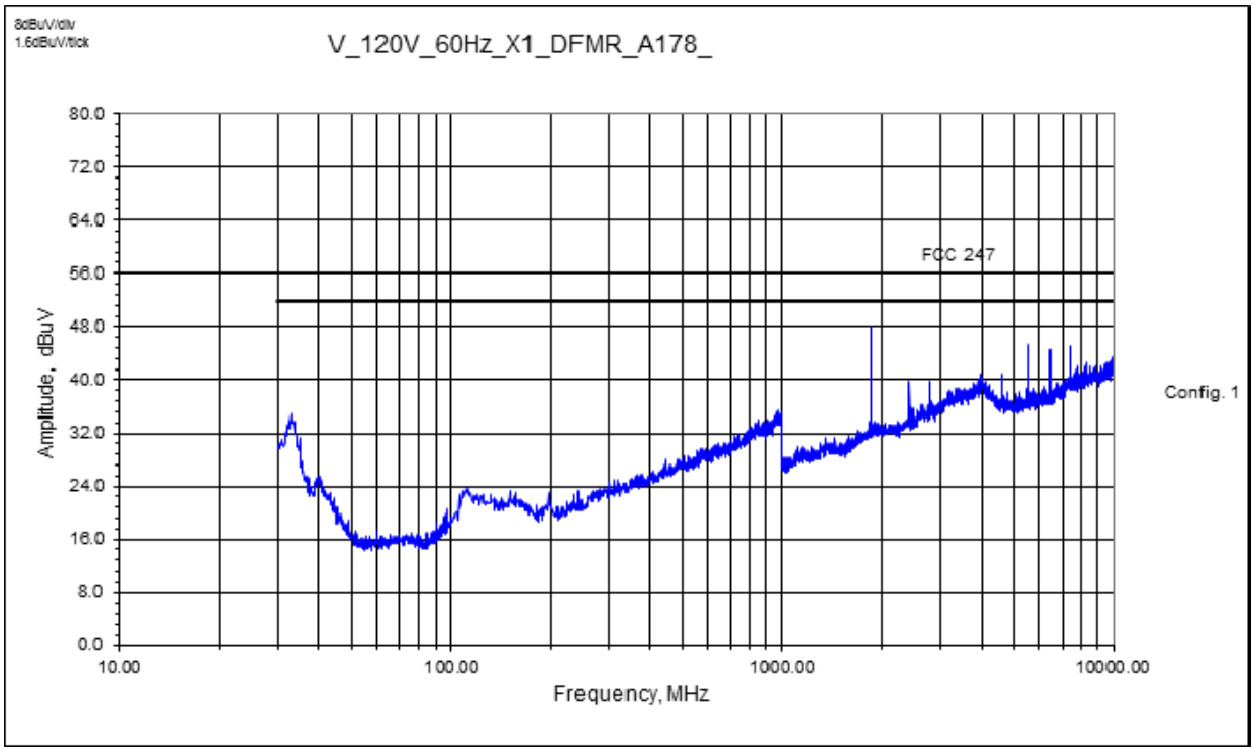


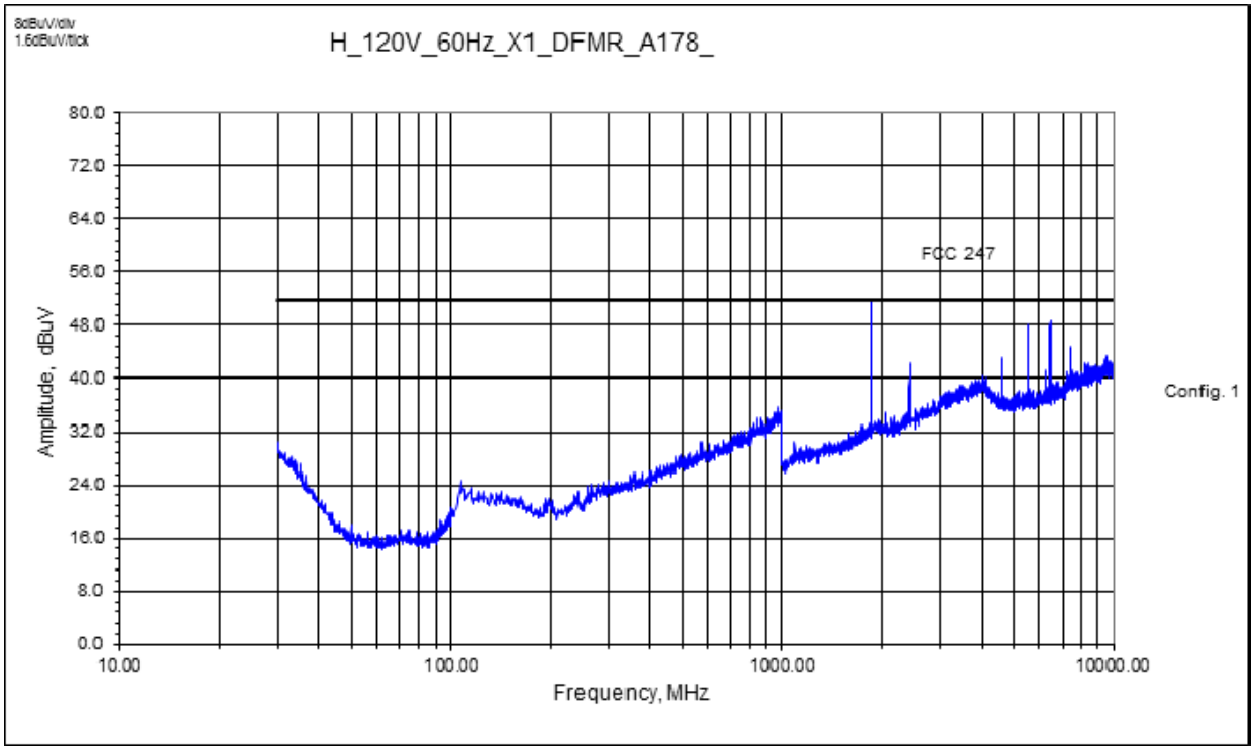
Test Setup – Front (30MHz – 1GHz)



Test Setup – Rear (30MHz – 1GHz)

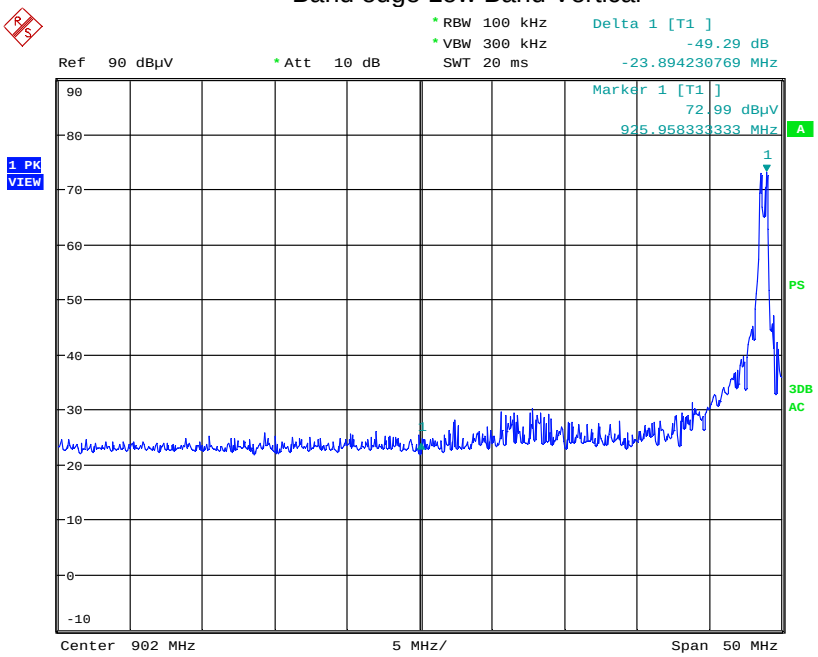
9.7 Plots:


8dBuV/div
1.6dBuV/tick
V_120V_60Hz_X1_DFMR_A178_
80.0
72.0
64.0
56.0
48.0
40.0
32.0
24.0
16.0
8.0
0.0
Amplitude, dBuV
FCC 247
Config. 1
10.00
100.00
1000.00
10000.00
Frequency, MHz


8dBuV/div
1.6dBuV/tick
H_120V_60Hz_X1_DFMR_A178_
80.0
72.0
64.0
56.0
48.0
40.0
32.0
24.0
16.0
8.0
0.0
Amplitude, dBuV
FCC 247
Config. 1
10.00
100.00
1000.00
10000.00
Frequency, MHz

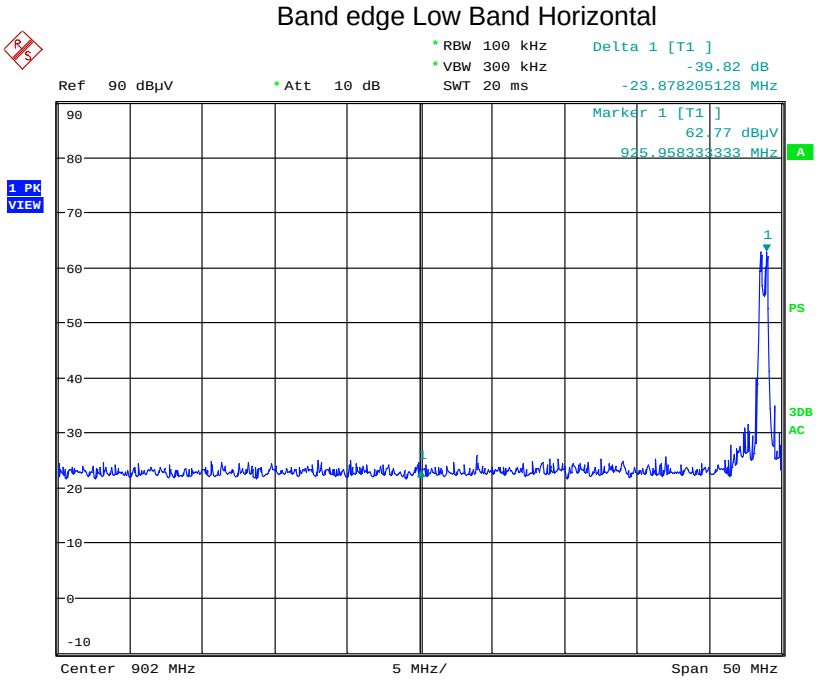
9.8 Band Edge

Band edge Low Band Vertical



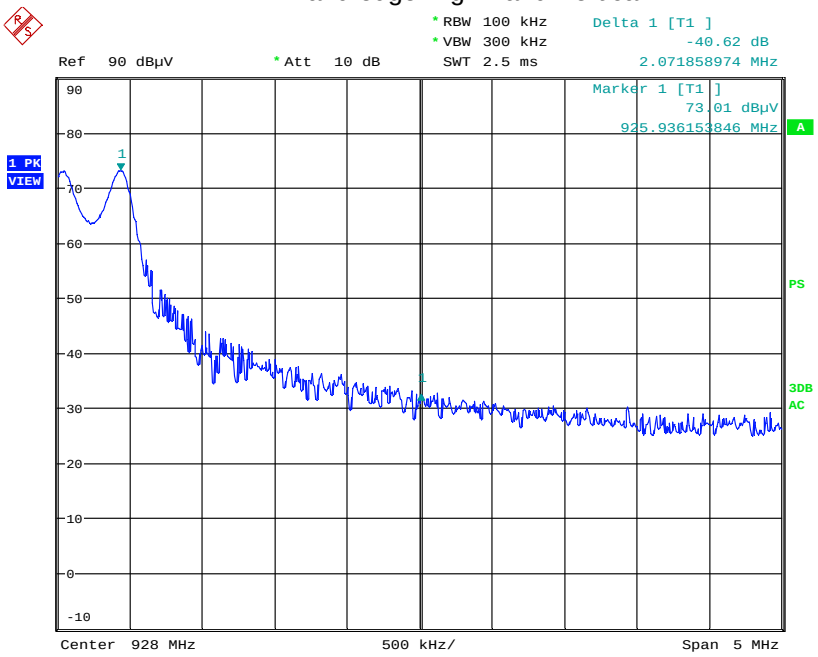
Date: 29.AUG.2016 15:05:07

Band edge Low Band Horizontal



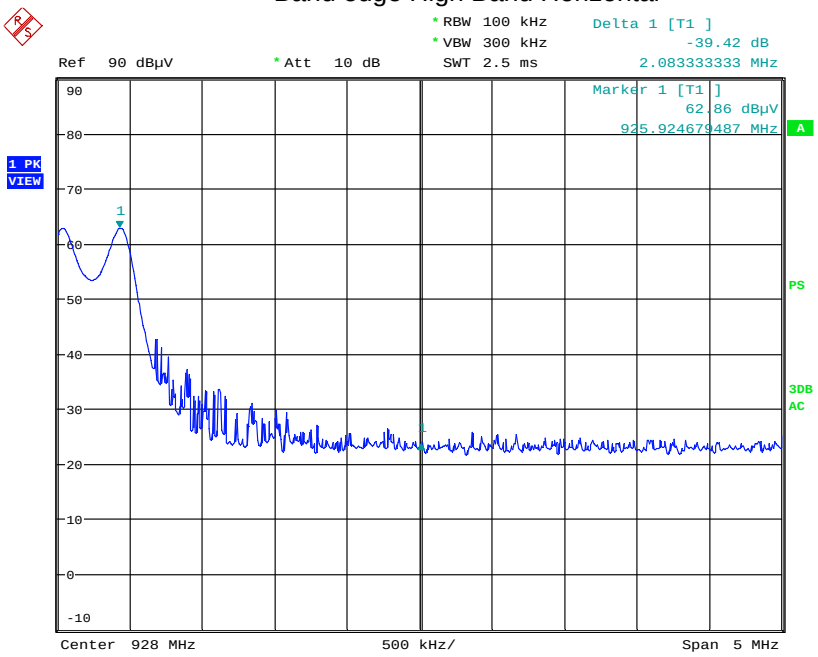
Date: 29.AUG.2016 15:14:04

Band edge High Band Vertical



Date: 29.AUG.2016 15:00:58

Band edge High Band Horizontal



Date: 29.AUG.2016 15:12:48

That's awkward

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	ATTEN	FINAL	POL	HGT	AZ	DELTA1	DELTA2	RBW
MHz	dBuV	Qp Av Pk Rms	+ [dB]	+ [dB/m]	- [dB]	+ [dB]	= [dBuV]	(V/H)	(m)	(DEG)	FCC 15.209 >1GHz Av	FCC 15.35(b) > 1GHz_Pk +20dB from Av	(MHz)
H_120V_60Hz_X1_harmonics not in restricted bands_													
1851.8808	63.23	**Av**	3.89	27.22	37.83	28.78	27.73	H	2.53	359.9	- 26.25	NA	1.000
5553.2230	55.33	**Av**	7.05	34.35	43.44	28.78	24.51	H	2.08	303.4	- 29.47	NA	1.000
6478.7620	57.79	**Av**	7.70	34.91	46.50	28.78	25.12	H	1.10	337.2	- 28.86	NA	1.000
1851.8808	63.23	**Pk**	3.89	27.22	37.83	0.00	56.51	H	1.10	337.2	NA	- 17.49	1.000
5553.2230	55.33	**Pk**	7.05	34.35	43.44	0.00	53.29	H	1.10	337.2	NA	- 20.71	1.000
6478.7620	57.79	**Pk**	7.70	34.91	46.50	0.00	53.91	H	1.10	337.2	NA	- 20.09	1.000
V_120V_60Hz_X1_harmonics not in restricted bands_													
1851.8808	58.11	**Av**	3.89	27.22	37.83	28.78	22.61	V	1.21	35.1	- 31.37	NA	1.000
5553.2230	55.27	**Av**	7.05	34.35	43.44	28.78	24.45	V	1.27	53.9	- 29.53	NA	1.000
6478.7620	55.68	**Av**	7.70	34.91	46.50	28.78	23.01	V	1.00	359.9	- 30.97	NA	1.000
1851.8808	58.11	**Pk**	3.89	27.22	37.83	0.00	51.39	V	1.10	337.2	NA	- 22.61	1.000
5553.2230	55.27	**Pk**	7.05	34.35	43.44	0.00	53.23	V	1.10	337.2	NA	- 20.77	1.000
6478.7620	55.68	**Pk**	7.70	34.91	46.50	0.00	51.80	V	1.10	337.2	NA	- 22.20	1.000
V_120V_60Hz_X2_harmonics not in restricted bands_													
1851.8647	56.87	**Av**	3.89	27.22	37.83	28.78	21.37	V	1.28	0.0	- 32.61	NA	1.000
5553.2230	53.91	**Av**	7.05	34.35	43.44	28.78	23.09	V	1.45	113.3	- 30.89	NA	1.000
6478.7620	54.32	**Av**	7.70	34.91	46.50	28.78	21.65	V	1.00	95.8	- 32.33	NA	1.000
1851.8647	56.87	**Pk**	3.89	27.22	37.83	0.00	50.15	V	1.10	337.2	NA	- 23.85	1.000
5553.2230	53.91	**Pk**	7.05	34.35	43.44	0.00	51.87	V	1.10	337.2	NA	- 22.13	1.000
6478.7620	54.32	**Pk**	7.70	34.91	46.50	0.00	50.44	V	1.10	337.2	NA	- 23.56	1.000
H_120V_60Hz_X2_harmonics not in restricted bands_													
1851.0635	55.76	**Av**	3.89	27.21	37.83	28.78	20.25	H	1.09	49.0	- 33.73	NA	1.000
5553.2230	55.20	**Av**	7.05	34.35	43.44	28.78	24.38	H	2.54	29.8	- 29.60	NA	1.000
6478.7620	57.21	**Av**	7.70	34.91	46.50	28.78	24.54	H	1.63	178.2	- 29.44	NA	1.000
1851.0635	55.76	**Pk**	3.89	27.21	37.83	0.00	49.03	H	1.10	337.2	NA	- 24.97	1.000
5553.2230	55.20	**Pk**	7.05	34.35	43.44	0.00	53.16	H	1.10	337.2	NA	- 20.84	1.000
6478.7620	57.21	**Pk**	7.70	34.91	46.50	0.00	53.33	H	1.10	337.2	NA	- 20.67	1.000
H_120V_60Hz_X3_harmonics not in restricted bands_													
1851.8808	56.56	**Av**	3.89	27.22	37.83	28.78	21.06	H	1.39	67.6	- 32.92	NA	1.000
5553.2230	54.18	**Av**	7.05	34.35	43.44	28.78	23.36	H	1.00	254.8	- 30.62	NA	1.000
6478.7620	57.68	**Av**	7.70	34.91	46.50	28.78	25.01	H	1.78	132.5	- 28.97	NA	1.000
1851.8808	56.56	**Pk**	3.89	27.22	37.83	0.00	49.84	H	1.10	337.2	NA	- 24.16	1.000
5553.2230	54.18	**Pk**	7.05	34.35	43.44	0.00	52.14	H	1.10	337.2	NA	- 21.86	1.000
6478.7620	57.68	**Pk**	7.70	34.91	46.50	0.00	53.80	H	1.10	337.2	NA	- 20.20	1.000
V_120V_60Hz_X3_harmonics not in restricted bands_													
1851.8808	57.17	**Av**	3.89	27.22	37.83	28.78	21.67	V	1.39	272.2	- 32.31	NA	1.000
5553.2224	55.06	**Av**	7.05	34.35	43.44	28.78	24.24	V	1.00	77.2	- 29.74	NA	1.000
6478.7462	58.96	**Av**	7.70	34.91	46.49	28.78	26.30	V	1.28	286.5	- 27.68	NA	1.000
1851.8808	57.17	**Pk**	3.89	27.22	37.83	0.00	50.45	V	1.10	337.2	NA	- 23.55	1.000
5553.2224	55.06	**Pk**	7.05	34.35	43.44	0.00	53.02	V	1.10	337.2	NA	- 20.98	1.000
6478.7462	58.96	**Pk**	7.70	34.91	46.49	0.00	55.08	V	1.10	337.2	NA	- 18.92	1.000

10 Spurious Restricted Band Emissions - Radiated

10.1 Method

The test methods used comply with ANSI C63.4. Unless otherwise stated no deviations were made from FCC 15.247 and RSS-247.

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

10.2 Test Requirement/ Specification:

Radiated emissions which fall in the restricted bands, as defined in FCC Part 15.205(a), must also comply with the radiated emission limits specified in Part 15.209(a) and Part 15.205(c). Measurements in the restricted bands include both peak detector and average detector measurements.
Measurements in non-restricted bands include peak detector measurements.

Unwanted emissions below 1GHz must comply with the general field strength limits defined in FCC Part 15.209, when measured with a quasi-peak detector.

FCC part 15.209	
Freq. MHz	Amp. dBuV/m @ 3 m
30	40
88	40
88	43.5
216	43.5
216	46
960	46
960	54
40000	54

10.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
18886	Ridged Guide Antenna 1-18GHz	TENSOR	4105	2020	12/28/2015	12/28/2017
18906	Pre Amp: 1GHz – 4GHz	Mini-Circuits Lab	ZHL-42	N052792-2	4/26/2016	4/26/2017
DEN-032	4-18 GHz LNA	NARDA	DBL-0618N615	031	4/13/2016	4/13/2017
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
18912	9 kHz- 1.3GHz Pre Amp	Hewlett-Packard	HP	5	3/31/2016	3/31/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

10.4 Test Procedure:

The Resolution Bandwidth is 120 kHz or greater for frequencies 30 MHz -1000 MHz and 1 MHz for frequencies above 1000 MHz. The Video Bandwidth was at least 3x the RBW.

The EUT is placed on a plastic turntable that is 80 cm in height for testing <1GHz and 150cm for testing >1GHz. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables are manipulated to produce worst-case emissions. The signal is maximized by rotating the turntable through a 360º rotation. The antenna height is varied from 1-4 meters. Both vertical and horizontal antenna configurations are utilized in the testing.

Radiated emissions 30MHz to 10GHz are taken at 3-meter antenna-to-product test distance.

Data is included for the worst-case configuration - the configuration which resulted in the highest emission levels.

ANSI C63.10: 2013 – Clause 11.12

10.5 Test Results:

The sample tested was found to Comply.

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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

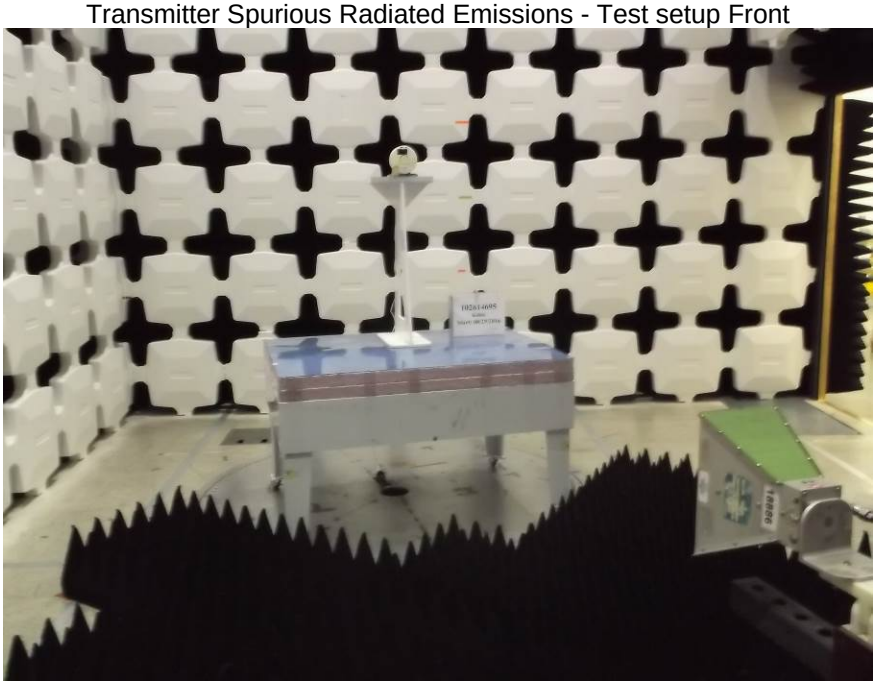
FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

10.6 Test Summary – Worst-Case Measurements

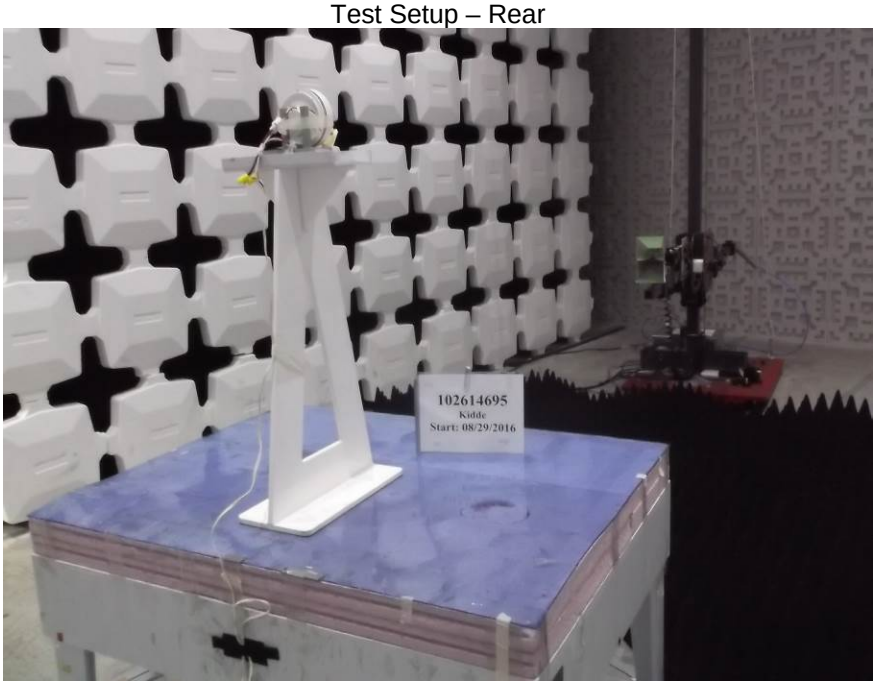
Test Data Summary: Tx Radiated Spurious Emissions in Restricted Band

Setup Photographs:

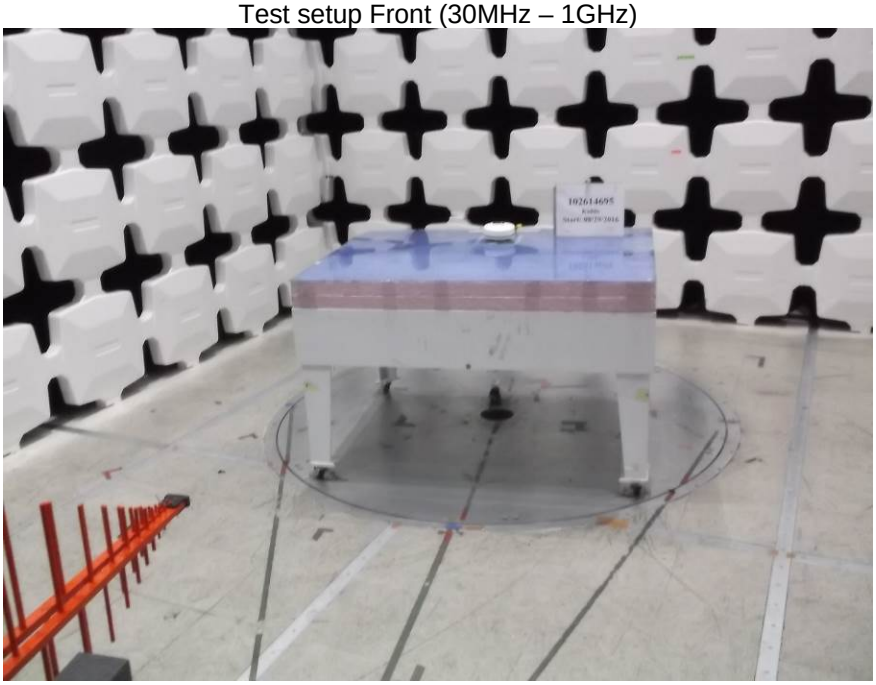
Transmitter Spurious Radiated Emissions - Test setup Front



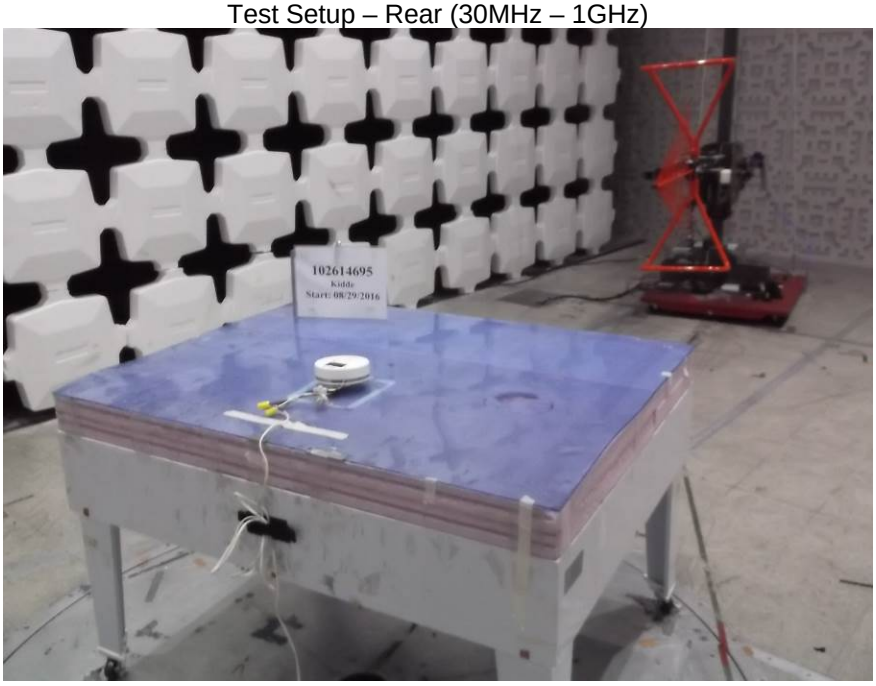
Test Setup – Rear



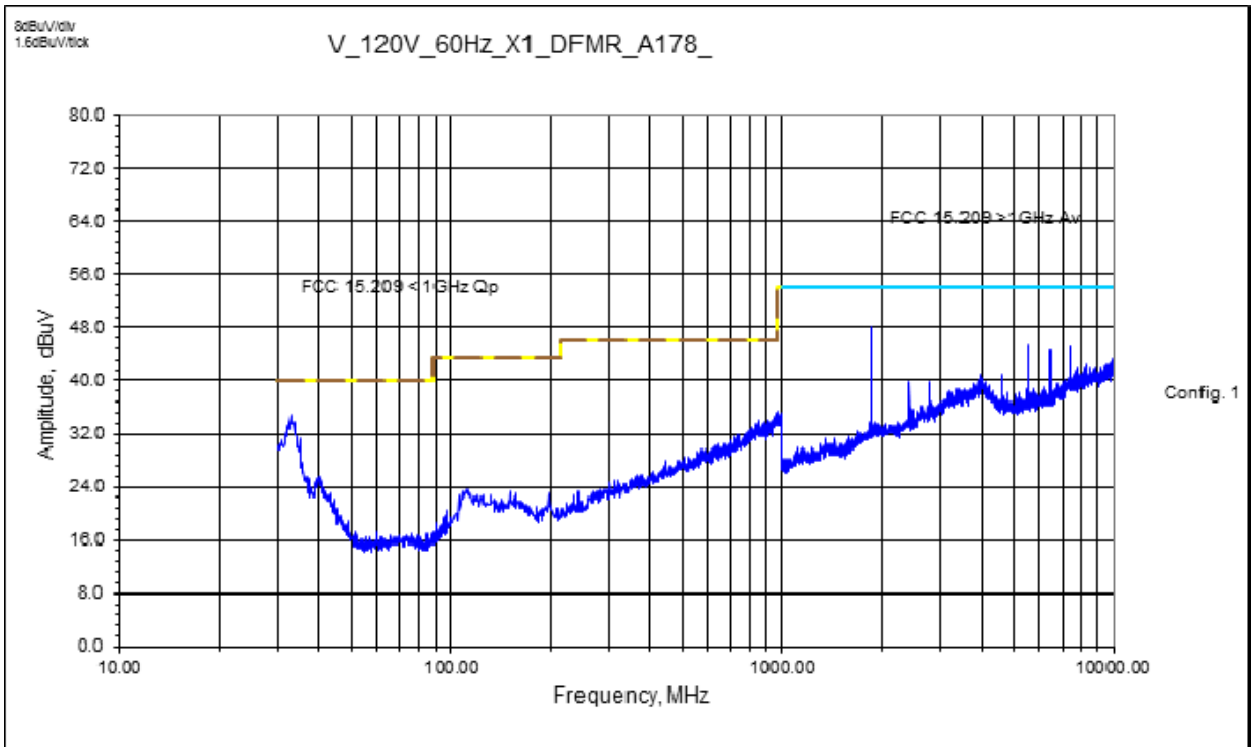
Test setup Front (30MHz – 1GHz)

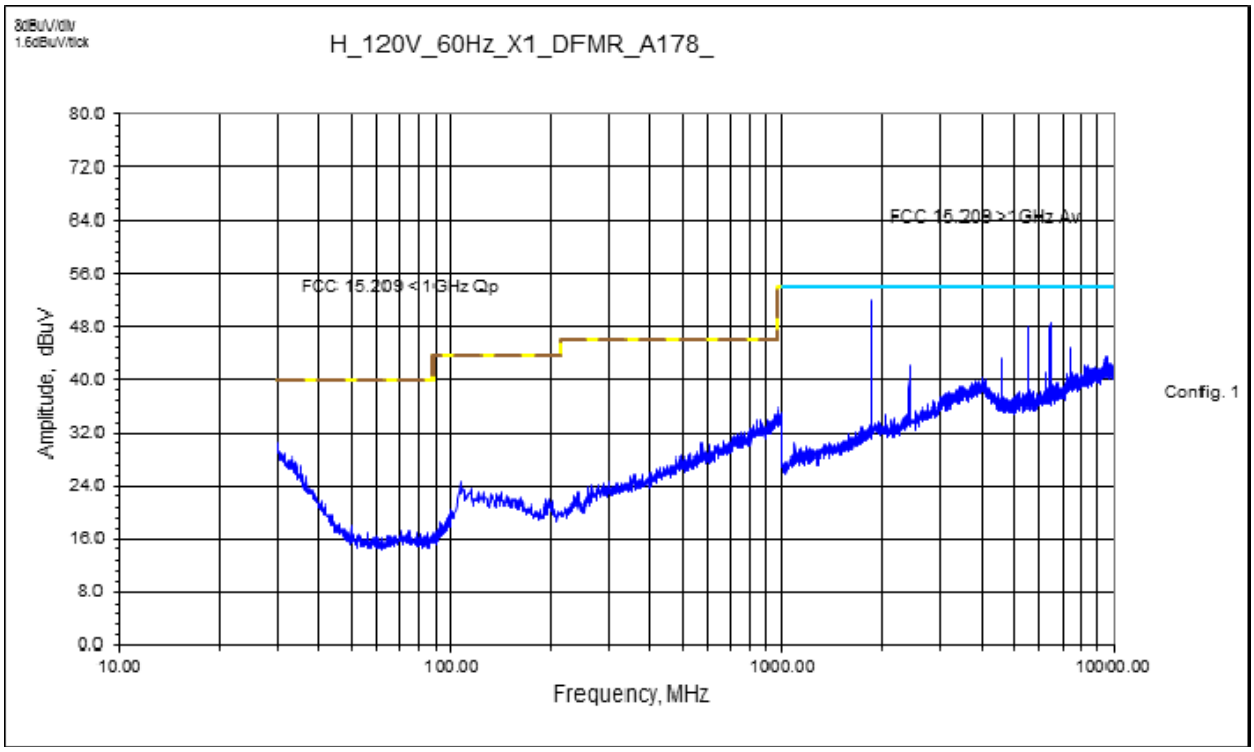


Test Setup – Rear (30MHz – 1GHz)



10.7 Plots:


8dBuV/div
1.6dBuV/tick
V_120V_60Hz_X1_DFMR_A178_
FCC 15.209 >1GHz Av
FCC 15.209 <1GHz Qp
Amplitude, dBuV
Frequency, MHz
Config. 1


8dBuV/div
1.6dBuV/tick
H_120V_60Hz_X1_DFMR_A178_
FCC 15.209 >1GHz Av
FCC 15.209 <1GHz Qp
Amplitude, dBuV
Frequency, MHz
Config. 1

10.8 Test Data:

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	Duty Cycle	FINAL	POL	HGT	AZ	DELTA1	DELTA2	RBW
MHz	dBuV	Qp Av Pk Rms	+ [dB]	+ [dB/m]	- [dB]	- [dB]	= [dBuV]	(V/H)	(m)	(DEG)	FCC 15.209 >1GHz Av	FCC 15.35(b)> 1GHz_Pk +20dB from Av	(MHz)
V_120V_60Hz_X1_													
2776.61	52.21	**Pk**	4.85	29.36	37.99	28.78	48.43	V	1.00	4.9	NA	- 25.57	1.000
3701.56	49.00	**Pk**	5.64	32.11	38.43	28.78	48.32	V	1.00	0.0	NA	- 25.68	1.000
4682.76	44.25	**Pk**	6.38	32.97	36.81	28.78	46.80	V	1.66	0.0	NA	- 27.20	1.000
7407.48	56.93	**Pk**	8.36	36.83	46.93	28.78	55.20	V	1.11	329.8	NA	- 18.80	1.000
8329.83	53.70	**Pk**	8.89	37.01	46.38	28.78	53.23	V	1.00	91.7	NA	- 20.77	1.000
2776.61	52.21	**Av**	4.85	29.36	37.99	28.78	48.43	V	1.00	4.9	- 23.23	NA	1.000
3701.56	49.00	**Av**	5.64	32.11	38.43	28.78	48.32	V	1.00	0.0	- 23.12	NA	1.000
4682.76	44.25	**Av**	6.38	32.97	36.81	28.78	46.80	V	1.66	0.0	- 21.60	NA	1.000
7407.48	56.93	**Av**	8.36	36.83	46.93	28.78	55.20	V	1.11	329.8	- 30.00	NA	1.000
8329.83	53.70	**Av**	8.89	37.01	46.38	28.78	53.23	V	1.00	91.7	- 28.03	NA	1.000
H_120V_60Hz_X1_													
2776.61	54.20	**Pk**	4.85	29.36	37.99	28.78	50.42	H	2.29	0.0	NA	- 23.58	1.000
3701.56	50.56	**Pk**	5.64	32.11	38.43	28.78	49.88	H	1.00	169.4	NA	- 24.12	1.000
4682.76	44.69	**Pk**	6.38	32.97	36.81	28.78	47.24	H	1.00	91.7	NA	- 26.76	1.000
7407.48	55.26	**Pk**	8.36	36.83	46.93	28.78	53.53	H	1.29	40.2	NA	- 20.47	1.000
8329.83	53.75	**Pk**	8.89	37.01	46.38	28.78	53.28	H	1.28	351.3	NA	- 20.72	1.000
2776.61	54.20	**Av**	4.85	29.36	37.99	28.78	50.42	H	2.29	0.0	- 25.22	NA	1.000
3701.56	50.56	**Av**	5.64	32.11	38.43	28.78	49.88	H	1.00	169.4	- 24.68	NA	1.000
4682.76	44.69	**Av**	6.38	32.97	36.81	28.78	47.24	H	1.00	91.7	- 22.04	NA	1.000
7407.48	55.26	**Av**	8.36	36.83	46.93	28.78	53.53	H	1.29	40.2	- 28.33	NA	1.000
8329.83	53.75	**Av**	8.89	37.01	46.38	28.78	53.28	H	1.28	351.3	- 28.08	NA	1.000
V_120V_60Hz_X2_													
2776.61	49.31	**Pk**	4.85	29.36	37.99	28.78	45.53	V	1.77	359.9	NA	- 28.47	1.000
3701.56	49.59	**Pk**	5.64	32.11	38.43	28.78	48.91	V	1.00	0.0	NA	- 25.09	1.000
4682.76	45.44	**Pk**	6.38	32.97	36.81	28.78	47.99	V	1.00	359.9	NA	- 26.01	1.000
7407.49	56.52	**Pk**	8.36	36.83	46.93	28.78	54.79	V	2.34	118.5	NA	- 19.21	1.000
8333.44	51.61	**Pk**	8.90	37.02	46.38	28.78	51.14	V	1.65	359.9	NA	- 22.86	1.000
2776.61	49.31	**Av**	4.85	29.36	37.99	28.78	45.53	V	1.77	359.9	- 20.33	NA	1.000
3701.56	49.59	**Av**	5.64	32.11	38.43	28.78	48.91	V	1.00	0.0	- 23.71	NA	1.000
4682.76	45.44	**Av**	6.38	32.97	36.81	28.78	47.99	V	1.00	359.9	- 22.79	NA	1.000
7407.49	56.52	**Av**	8.36	36.83	46.93	28.78	54.79	V	2.34	118.5	- 29.59	NA	1.000
8333.44	51.61	**Av**	8.90	37.02	46.38	28.78	51.14	V	1.65	359.9	- 25.94	NA	1.000
H_120V_60Hz_X2_													
2776.61	51.77	**Pk**	4.85	29.36	37.99	28.78	47.99	H	2.78	359.9	NA	- 26.01	1.000
3701.56	49.49	**Pk**	5.64	32.11	38.43	28.78	48.81	H	1.00	0.0	NA	- 25.19	1.000
4682.76	45.01	**Pk**	6.38	32.97	36.81	28.78	47.56	H	1.00	0.0	NA	- 26.44	1.000
7407.49	56.85	**Pk**	8.36	36.83	46.93	28.78	55.12	H	1.59	227.8	NA	- 18.88	1.000
8329.81	54.27	**Pk**	8.89	37.01	46.38	28.78	53.80	H	1.66	0.0	NA	- 20.20	1.000
2776.61	51.77	**Av**	4.85	29.36	37.99	28.78	47.99	H	2.78	359.9	- 22.79	NA	1.000
3701.56	49.49	**Av**	5.64	32.11	38.43	28.78	48.81	H	1.00	0.0	- 23.61	NA	1.000
4682.76	45.01	**Av**	6.38	32.97	36.81	28.78	47.56	H	1.00	0.0	- 22.36	NA	1.000
7407.49	56.85	**Av**	8.36	36.83	46.93	28.78	55.12	H	1.59	227.8	- 29.92	NA	1.000

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	Duty Cycle	FINAL	POL	HGT	AZ	DELTA1	DELTA2	RBW
MHz	dBuV	Qp Av Pk Rms	+ [dB]	+ [dB/m]	- [dB]	- [dB]	= [dBuV]	(V/H)	(m)	(DEG)	FCC 15.209 >1GHz Av	FCC 15.35(b)> 1GHz_Pk +20dB from Av	(MHz)
8329.81	54.27	**Av**	8.89	37.01	46.38	28.78	53.80	H	1.66	0.0	- 28.60	NA	1.000
V_120V_60Hz_X3_													
2776.61	49.12	**Pk**	4.85	29.36	37.99	28.78	45.34	V	1.00	151.4	NA	- 28.66	1.000
3701.56	49.04	**Pk**	5.64	32.11	38.43	28.78	48.36	V	1.00	0.0	NA	- 25.64	1.000
4682.86	44.93	**Pk**	6.38	32.97	36.81	28.78	47.48	V	1.00	44.6	NA	- 26.52	1.000
7406.54	56.58	**Pk**	8.36	36.83	46.93	28.78	54.84	V	1.00	105.7	NA	- 19.16	1.000
8331.82	51.18	**Pk**	8.90	37.01	46.38	28.78	50.71	V	1.00	0.0	NA	- 23.29	1.000
2776.61	49.12	**Av**	4.85	29.36	37.99	28.78	45.34	V	1.00	151.4	- 20.14	NA	1.000
3701.56	49.04	**Av**	5.64	32.11	38.43	28.78	48.36	V	1.00	0.0	- 23.16	NA	1.000
4682.86	44.93	**Av**	6.38	32.97	36.81	28.78	47.48	V	1.00	44.6	- 22.28	NA	1.000
7406.54	56.58	**Av**	8.36	36.83	46.93	28.78	54.84	V	1.00	105.7	- 29.64	NA	1.000
8331.82	51.18	**Av**	8.90	37.01	46.38	28.78	50.71	V	1.00	0.0	- 25.51	NA	1.000
H_120V_60Hz_X3_													
2776.61	52.59	**Pk**	4.85	29.36	37.99	28.78	48.81	H	1.40	282.4	NA	- 25.19	1.000
3701.56	49.54	**Pk**	5.64	32.11	38.43	28.78	48.86	H	1.40	282.4	NA	- 25.14	1.000
4682.76	45.04	**Pk**	6.38	32.97	36.81	28.78	47.59	H	1.00	359.9	NA	- 26.41	1.000
7406.54	53.82	**Pk**	8.36	36.83	46.93	28.78	52.08	H	1.00	209.8	NA	- 21.92	1.000
8332.07	51.47	**Pk**	8.90	37.01	46.38	28.78	51.00	H	1.00	0.0	NA	- 23.00	1.000
2776.61	52.59	**Av**	4.85	29.36	37.99	28.78	48.81	H	1.40	282.4	- 23.61	NA	1.000
3701.56	49.54	**Av**	5.64	32.11	38.43	28.78	48.86	H	1.40	282.4	- 23.66	NA	1.000
4682.76	45.04	**Av**	6.38	32.97	36.81	28.78	47.59	H	1.00	359.9	- 22.39	NA	1.000
7406.54	53.82	**Av**	8.36	36.83	46.93	28.78	52.08	H	1.00	209.8	- 26.88	NA	1.000
8332.07	51.47	**Av**	8.90	37.01	46.38	28.78	51.00	H	1.00	0.0	- 25.80	NA	1.000

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	ATTEN	FINAL	POL	HGT	AZ	DELTA1	RBW
MHz	dBuV	Qp Av Pk Rms	+ [dB]	+ [dB/m]	- [dB]	+ [dB]	= [dBuV]	(V/H)	(m)	(DEG)	FCC 15.109 B < 1GHz Qp	(MHz)
V_120V_60Hz_receive mode_				DFMR_A138_								
40.2083	28.20	**Qp**	0.56	19.63	28.16	0.00	20.24	V	1.00	0.0	- 19.76	0.120
107.8000	24.58	**Qp**	0.93	18.18	27.91	0.00	15.78	V	1.00	359.9	- 27.74	0.120
125.2388	22.76	**Qp**	1.01	19.58	27.83	0.00	15.52	V	1.00	173.9	- 28.00	0.120
334.3750	22.40	**Qp**	1.64	20.20	27.24	0.00	17.00	V	1.00	333.3	- 29.02	0.120
503.8462	23.30	**Qp**	2.01	23.90	28.28	0.00	20.93	V	1.00	0.0	- 25.09	0.120
704.5641	25.80	**Qp**	2.38	26.20	28.22	0.00	26.16	V	1.26	72.8	- 19.86	0.120
H_120V_60Hz_receive mode_				DFMR_A138_								
33.9263	23.08	**Qp**	0.52	24.25	28.18	0.00	19.67	H	1.50	63.9	- 20.33	0.120
100.0000	22.76	**Qp**	0.89	16.50	27.95	0.00	12.20	H	1.50	0.0	- 31.32	0.120
107.2115	22.88	**Qp**	0.93	18.12	27.92	0.00	14.01	H	1.50	0.0	- 29.51	0.120
200.2404	22.54	**Qp**	1.26	18.64	27.38	0.00	15.06	H	1.50	359.9	- 28.46	0.120
533.4135	23.20	**Qp**	2.07	24.20	28.34	0.00	21.14	H	1.50	359.9	- 24.88	0.120
721.6346	23.14	**Qp**	2.42	26.43	28.17	0.00	23.82	H	1.50	0.0	- 22.20	0.120

Notes: none

11 Power Spectral Density – PSD

11.1 Method:

The test methods used comply with ANSI C63.10. Unless otherwise stated no deviations were made from FCC 15.247 or RSS-247.

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

11.2 Test Requirement/Specification:

For the band 902 928MHz within digitally modulated systems (DTS) products, the power spectral density conducted from the intentional radiator to the antenna should not be greater than +8 dBm in any 3 kHz to 100kHz band during any time interval of continuous transmission.

Such specifications require that the same method as used to determine the output power shall also be used to determine the power spectral density.

- FCC 15.247(e)
- RSS-247 5.2(2)

Radiated emissions 30MHz to 10GHz are taken at 3-meter antenna-to-product test distance.

11.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

11.4 Results:

The sample tested was found to comply.

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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

11.5 Test Summary:

Fundamental						
Frequency Range:	☒ 902-928MHz		☐ 2400-2483.5MHz		☐ 5725-5850MHz	
Axis 1 Vertical MHz (worst case)	**Measured PSD dBm**	**Correction Cable/Atten (dB)**	**Final Corrected (dBm)**	**Standard Limit (dBm)**	**Limit Reduction (dB)**	**Margin (dB)**
925.93	4	0	4	8	0	4
RBW:	☒ 3kHz	☐ 10kHz	☐ 30kHz	☐ 100kHz		
VBW:	☒ 10kHz	☐ 30kHz	☐ 100kHz	☐ 300kHz		

11.6 Test Method:

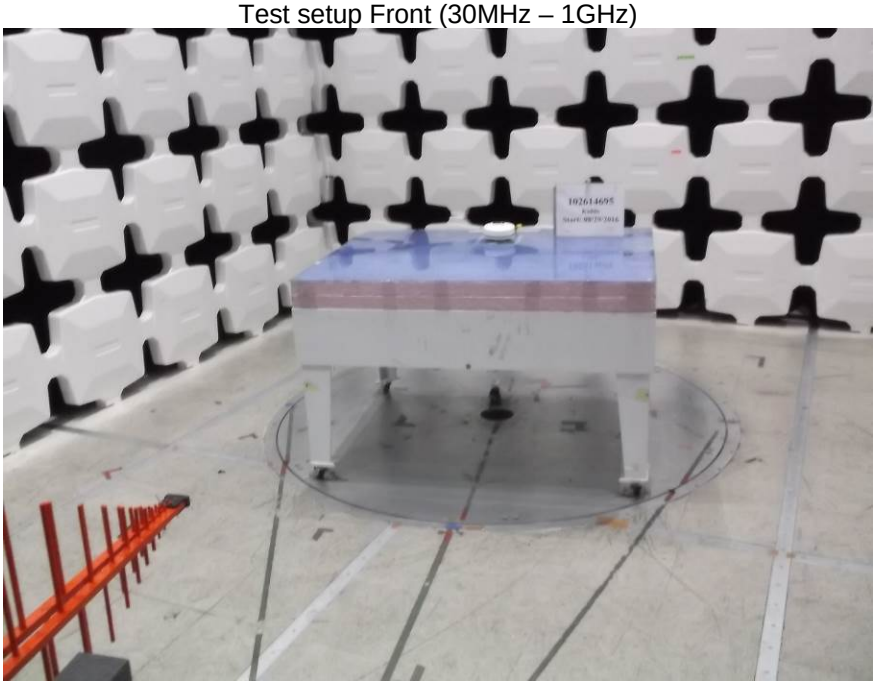
- ANSI C63.10:2013, Section 11.10

11.7 Notes:

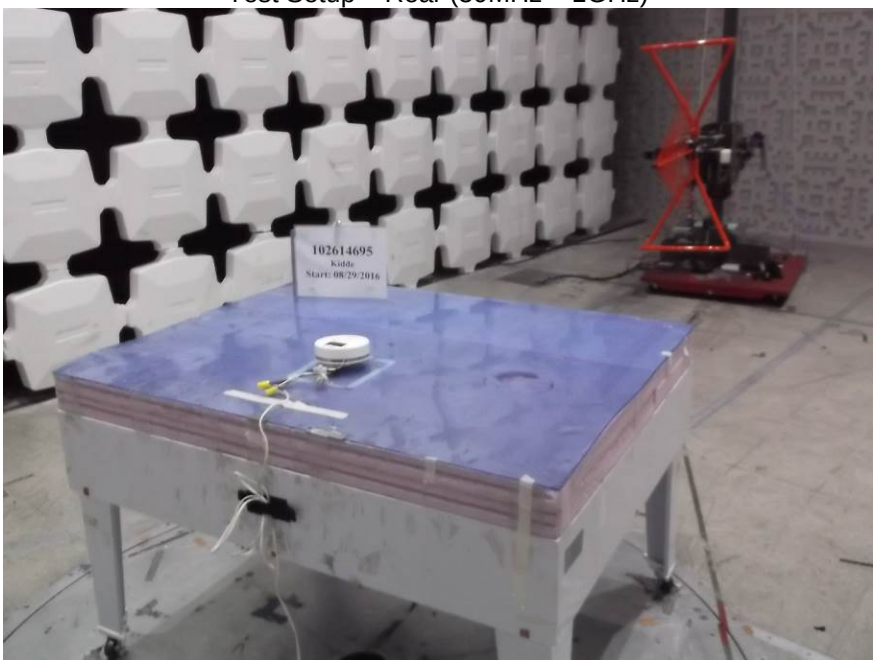
1. The limit for RSS-247 is identical to the limit for FCC 15.247.
2. Only the maximum orientation and axis from section 8 RF Output Power were recoded for this test.

11.8 Setup Photographs:

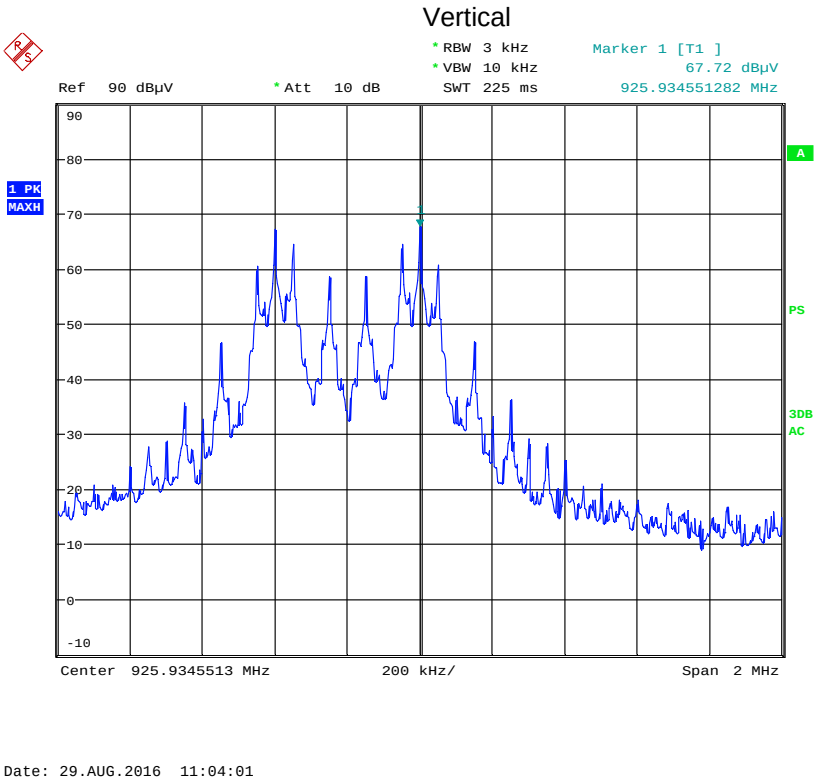
Test setup Front (30MHz – 1GHz)



Test Setup – Rear (30MHz – 1GHz)



11.9 Plots:



11.10 Test Data:

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	ATTEN	FINAL	POL	HGT	AZ	RBW
MHz	dBuV	Op Av Pk Rms	+ [dB]	+ [dB/m]	- [dB]	+ [dB]	= [dBuV]	(V/H)	(m)	(DEG)	(MHz)
PSD_X1_V_@3kHz											
925.9346	67.72	**Pk**	2.76	28.82	0.00	0.00	99.30	V	1.00	359.9	0.003

Convert Field Strength to Power
$P=(E \times D)^2/(30 \times G)$

Where;
E = Volts/meter, in this case the maximum recorded amplitude of 99.3dBuV/m = 0.092V/m
D = Test distance in meters, in this case 3 meters
G = Linear gain of the antenna, in this case the EUT incorporates and integral antenna so 1 is used.

$P=(0.092 \times 3)^2/(30 \times 1)$
P=0.0025W or 4dBm

12 Radiated Emissions (Digital Part of Receiver)

12.1 Method:

Unless otherwise stated no deviations were made from FCC Part 15.109 – Class B.

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

12.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
18912	9 kHz- 1.3GHz Pre Amp	Hewlett-Packard	HP	5	3/31/2016	3/31/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

12.3 Test Requirement/ Specification:

Receive Mode - the product must pass Unintentional Radiated Emissions – Class B, per the limits specified in FCC 15.109(a). Unwanted emissions below 1GHz must comply with the general field strength limits defined in FCC Part 15.109, when measured with a quasi-peak detector. Unwanted emissions above 1GHz are measured with an average detector.

12.4 Test Procedure:

The Resolution Bandwidth is 120 kHz for frequencies 30 MHz -1000 MHz and 1 MHz for frequencies above 1000 MHz.

The EUT is placed on a plastic turntable that is 80 cm in height. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables are manipulated to produce worst-case emissions. The signal is maximized by rotating the turntable through a 360º rotation. The antenna height is varied from 1-4 meters. Both vertical and horizontal antenna configurations are utilized in the testing.

Radiated emissions are taken at 3-meter antenna-to-product test distance for all measurements.

Data is included for the worst-case configuration - the configuration which resulted in the highest radiated emission levels.

12.5 Test Results:

The sample tested was found to Comply

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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

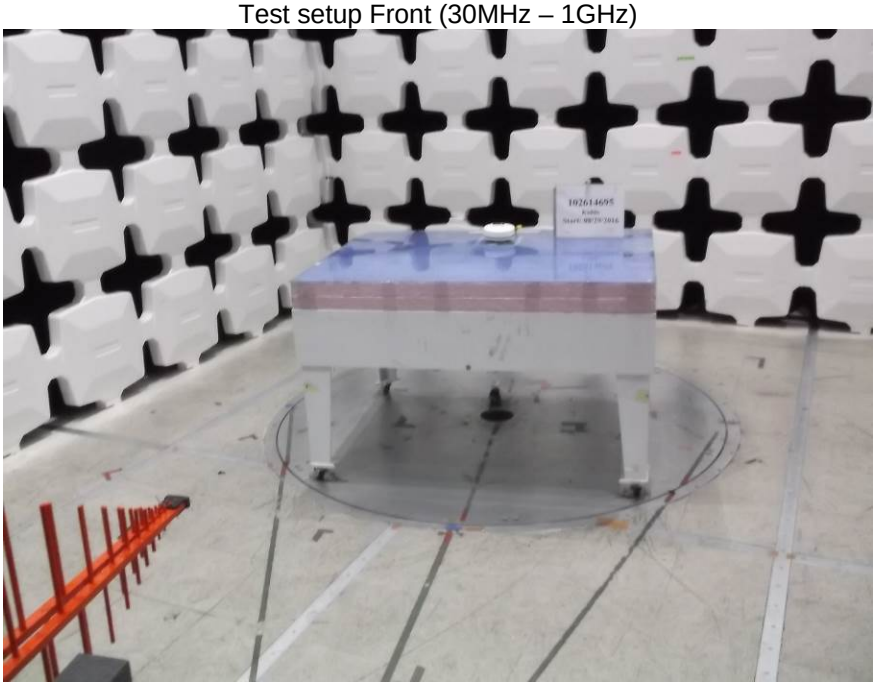
$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

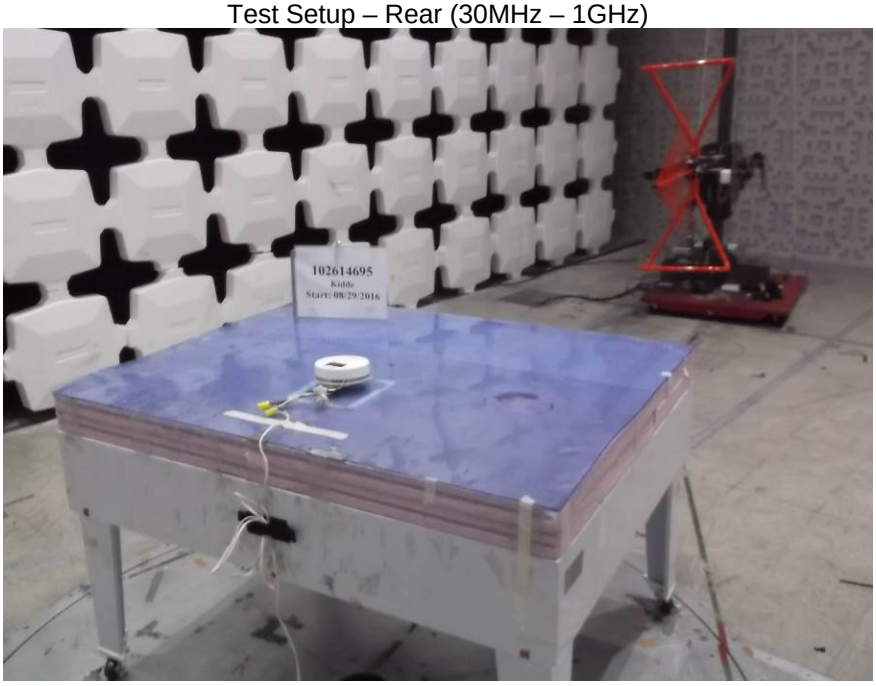
FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

12.6 Setup Photographs:

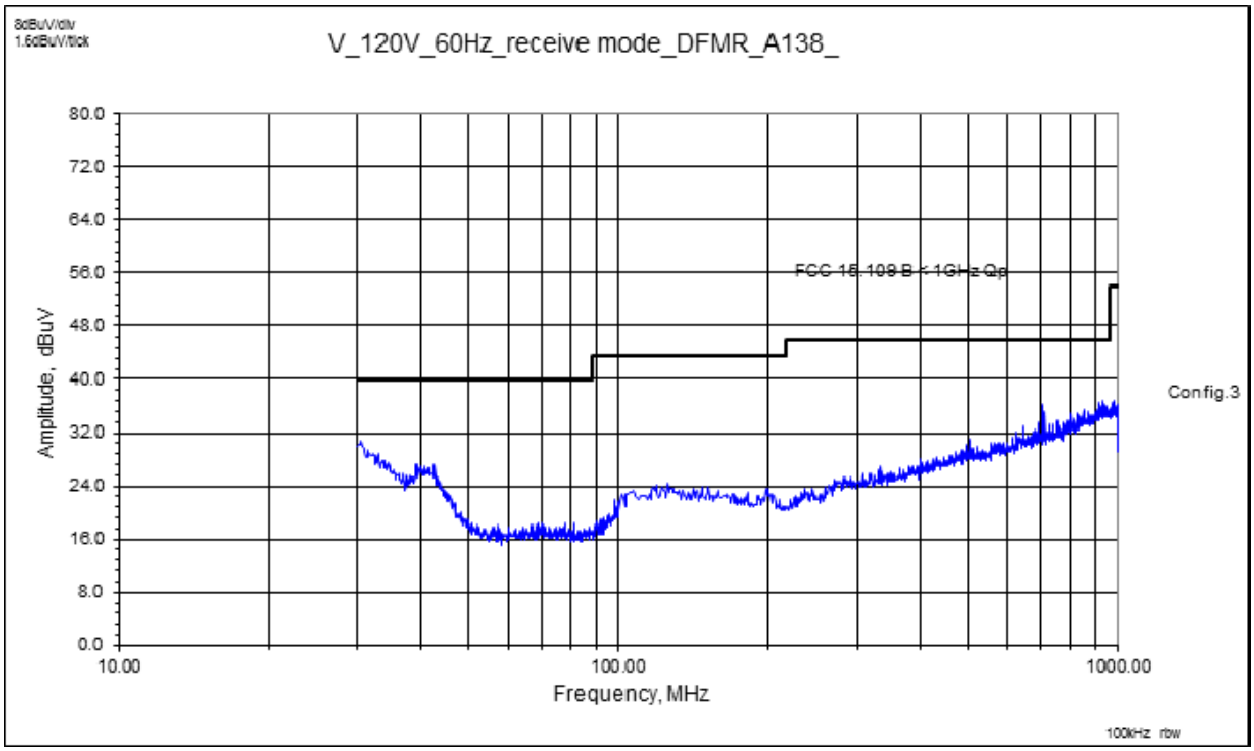
Test setup Front (30MHz – 1GHz)

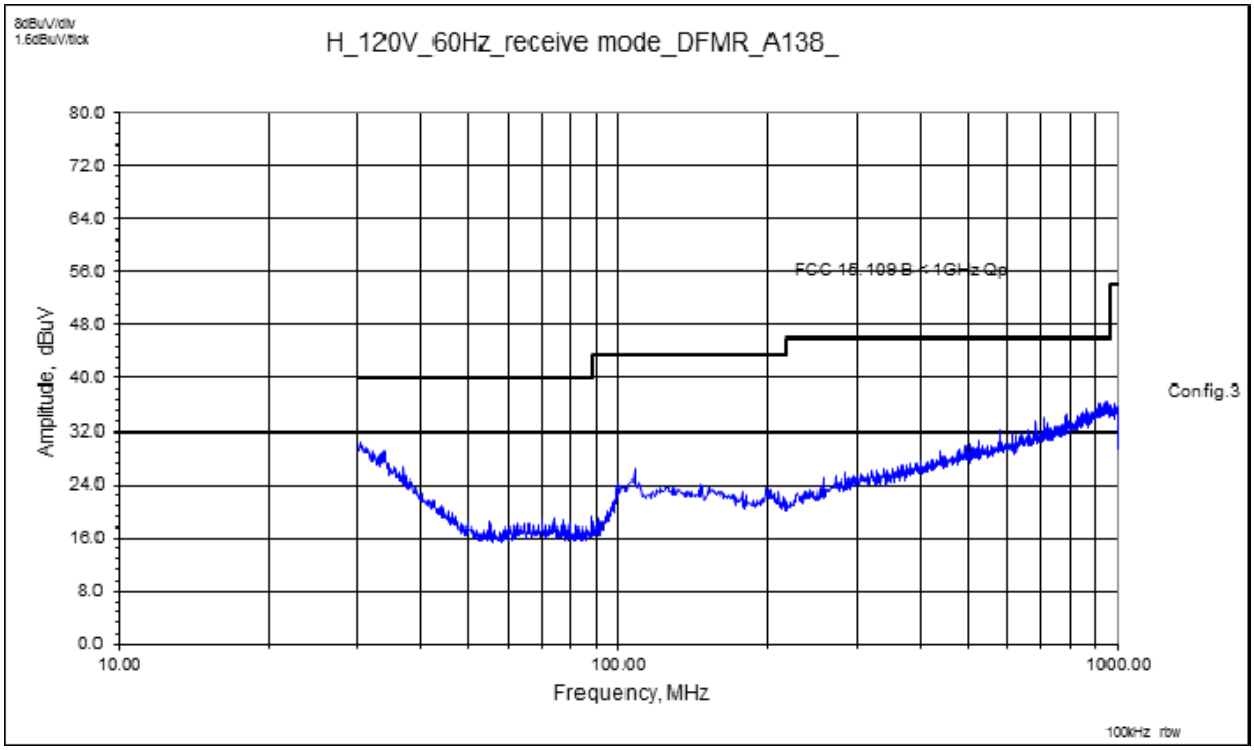


Test Setup – Rear (30MHz – 1GHz)



12.7 Plots:


8dBuV/div
1.6dBuV/tick
V_120V_60Hz_receive mode_DFMR_A138_
80.0
72.0
64.0
56.0
48.0
40.0
32.0
24.0
16.0
8.0
0.0
Amplitude, dBuV
FCC 15.109 B < 1GHz Qp
Config.3
10.00
100.00
1000.00
Frequency, MHz
100kHz rbw


8dBuV/div
1.6dBuV/tick
H_120V_60Hz_receive mode_DFMR_A138_
80.0
72.0
64.0
56.0
48.0
40.0
32.0
24.0
16.0
8.0
0.0
Amplitude, dBuV
FCC 15.109 B < 1GHz Qp
Config.3
10.00
100.00
1000.00
Frequency, MHz
100kHz rbw

12.8 Test Data: Radiated Emissions

FREQ	LEVEL	DET	CABLE	ANT	PREAMP	ATTEN	FINAL	POL	HGT	AZ	DELTA1	RBW
MHz	dBuV	Qp Av Pk Rms	+ [dB]	+ [dB/m]	- [dB]	+ [dB]	= [dBuV]	(V/H)	(m)	(DEG)	FCC 15.109 B < 1GHz Qp	(MHz)
V_120V_60Hz_receive mode_				DFMR_A138_								
40.2083	28.20	**Qp**	0.56	19.63	28.16	0.00	20.24	V	1.00	0.0	- 19.76	0.120
107.8000	24.58	**Qp**	0.93	18.18	27.91	0.00	15.78	V	1.00	359.9	- 27.74	0.120
125.2388	22.76	**Qp**	1.01	19.58	27.83	0.00	15.52	V	1.00	173.9	- 28.00	0.120
334.3750	22.40	**Qp**	1.64	20.20	27.24	0.00	17.00	V	1.00	333.3	- 29.02	0.120
503.8462	23.30	**Qp**	2.01	23.90	28.28	0.00	20.93	V	1.00	0.0	- 25.09	0.120
704.5641	25.80	**Qp**	2.38	26.20	28.22	0.00	26.16	V	1.26	72.8	- 19.86	0.120
H_120V_60Hz_receive mode_				DFMR_A138_								
33.9263	23.08	**Qp**	0.52	24.25	28.18	0.00	19.67	H	1.50	63.9	- 20.33	0.120
100.0000	22.76	**Qp**	0.89	16.50	27.95	0.00	12.20	H	1.50	0.0	- 31.32	0.120
107.2115	22.88	**Qp**	0.93	18.12	27.92	0.00	14.01	H	1.50	0.0	- 29.51	0.120
200.2404	22.54	**Qp**	1.26	18.64	27.38	0.00	15.06	H	1.50	359.9	- 28.46	0.120
533.4135	23.20	**Qp**	2.07	24.20	28.34	0.00	21.14	H	1.50	359.9	- 24.88	0.120
721.6346	23.14	**Qp**	2.42	26.43	28.17	0.00	23.82	H	1.50	0.0	- 22.20	0.120

13 AC Mains Conducted Emissions - Transmitter

13.1 Method

Unless otherwise stated no deviations were made from FCC Part 15.207.

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

13.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
18914	Single Phase LISN	EMCO	3816/NM	9408-1003	3/17/2016	3/17/2017
18729	Transient Limiter	Hewlett-Packard	11947A	3107A01975	5/11/2016	5/11/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-001	50 Ohm Cable	Pasternak Enterprise	RG-223/U	N/A	5/23/2016	5/23/2017
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

13.3 Test Requirement/ Specification:

The product must pass the AC Conducted average and quasi-peak Class B Limits defined in FCC Part 15.207. The product is operated with all radios enabled and active.

13.4 Test Procedure:

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at all frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.
The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.
The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Equipment setup for conducted disturbance tests followed the guidelines of:

- ANSI C63.10: 2013, Section 6.2.

13.5 Test Results:

The sample tested was found to Comply.

Sample Calculations

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

NF = RF + LF + CF + AF
Where NF = Net Reading in dBμV
RF = Reading from receiver in dBμV
LF = LISN or ISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBμV to μV or mV the following was used:

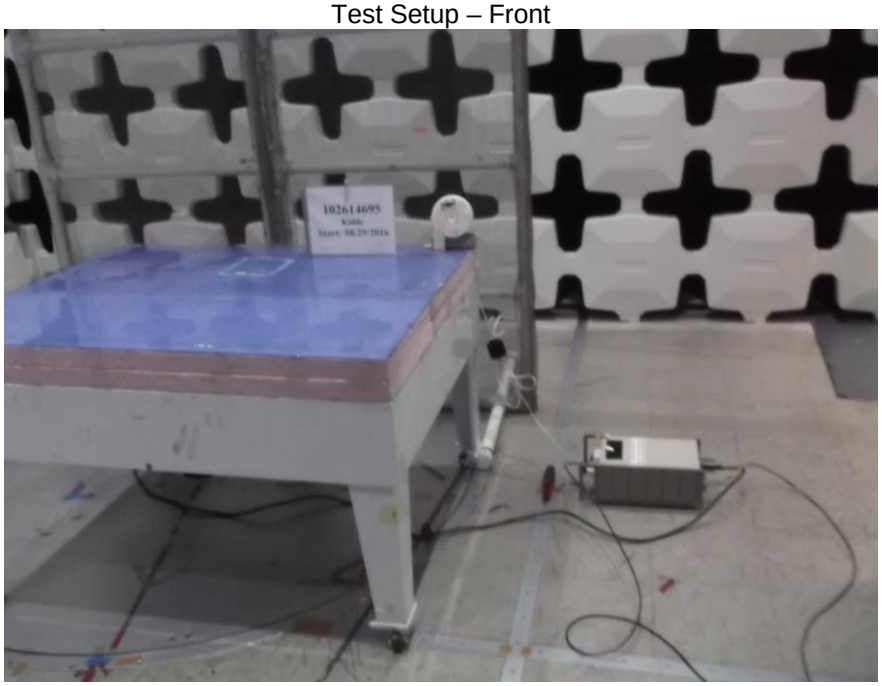
$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

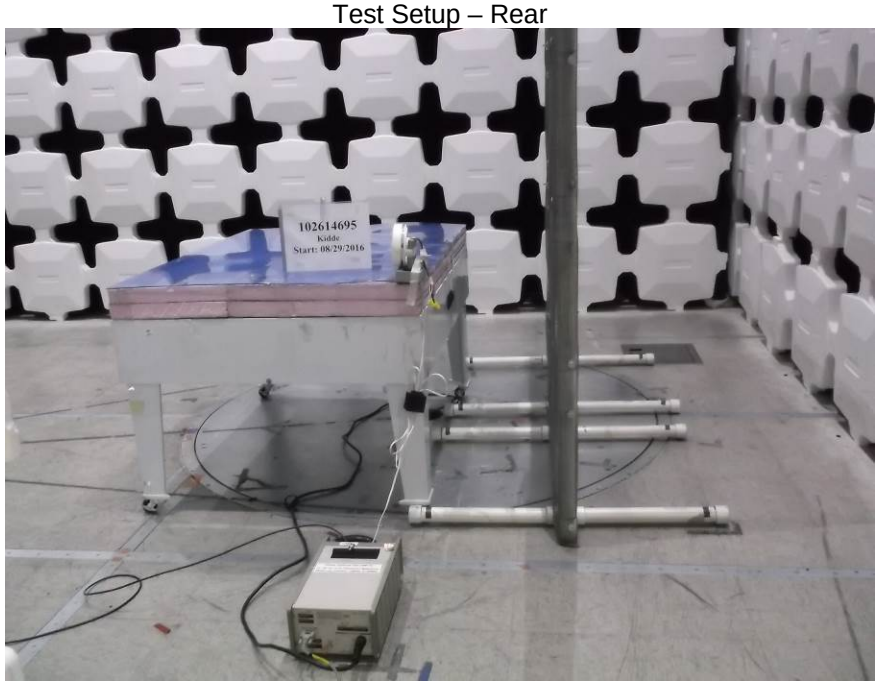
NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBμV
$UF = 10^{(49.1\ dB\mu V / 20)}$ = 285.1 μV/m

13.6 Setup Photographs:

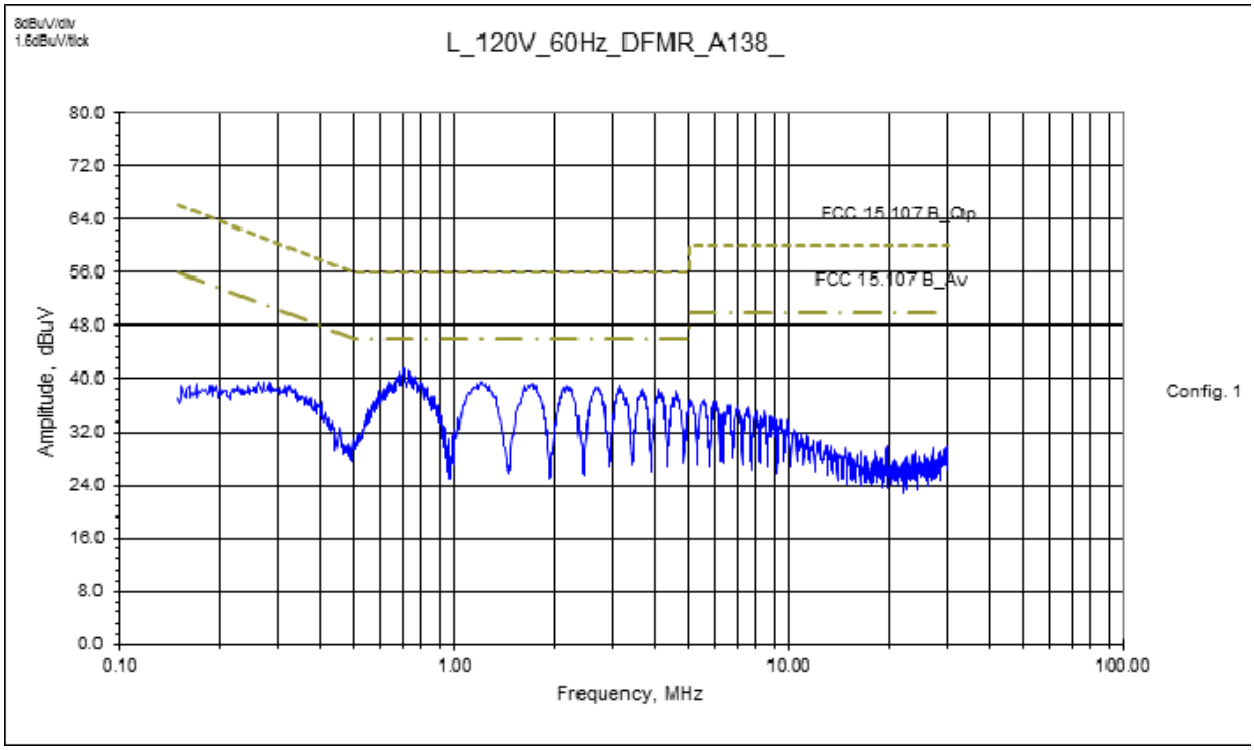
Test Setup – Front

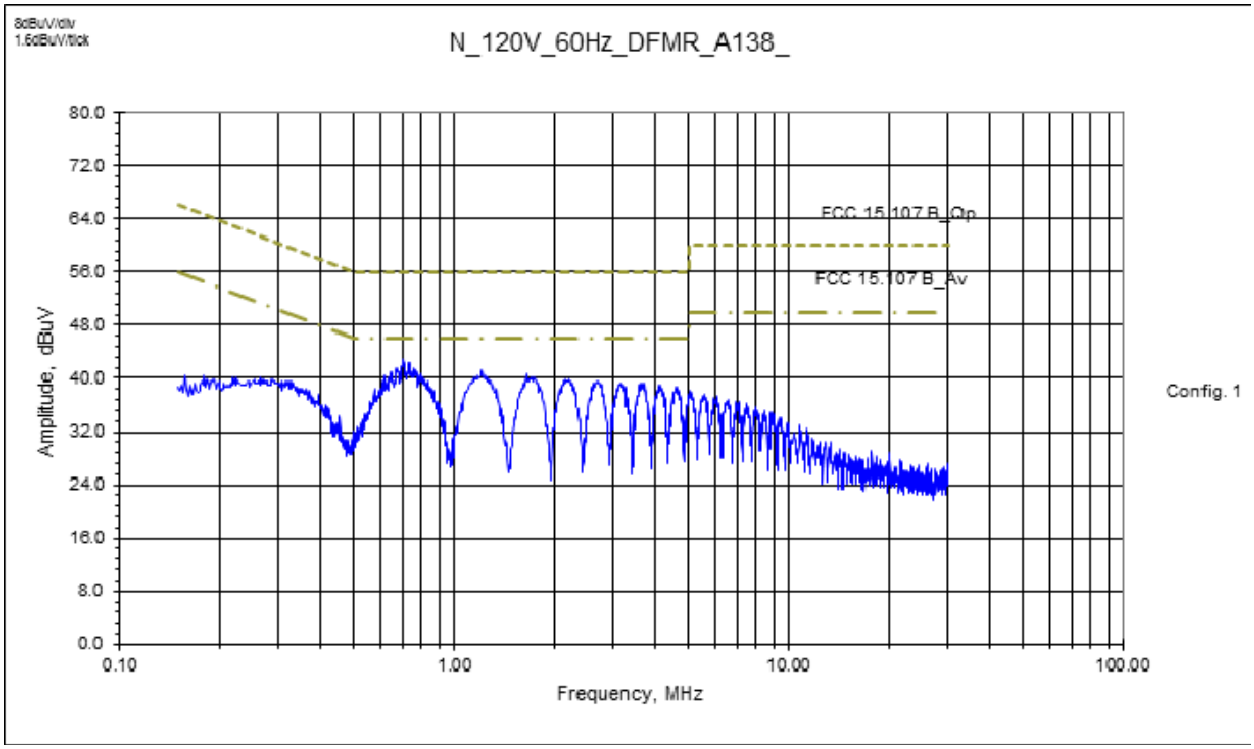


Test Setup – Rear



13.7 Plots:


8dBuV/div
1.6dBuV/tick
L_120V_60Hz_DFMR_A138_
FCC 15.107 B_Qp
FCC 15.107 B_Av
Amplitude, dBuV
Frequency, MHz
Config. 1


8dBuV/div
1.6dBuV/tick
N_120V_60Hz_DFMR_A138_
FCC 15.107 B_Qp
FCC 15.107 B_Av
Amplitude, dBuV
Frequency, MHz
Config. 1

13.8 Test Data: AC Mains Conducted Emissions – Transmitter

FREQ	LEVEL	DET	CABLE	LISN	PREAMP	ATTEN	FINAL	TEST POINT			DELTA1	DELTA2	RBW
MHz	dBuV	Qp Av Pk	+ [dB]	+ [dB/m]	- [dB]	+ [dB]	= [dBuV]	Other - N - L1 - L2 - L3			FCC 15.207 Qp	FCC 15.207 Av	(MHz)
L_120V_60Hz_			DFMR_A138_										
0.263	20.87	**Qp**	0.06	0.03	0.00	9.95	30.90		Line 1		- 30.42	NA	0.009
0.707	26.26	**Qp**	0.09	0.03	0.00	9.96	36.34		Line 1		- 19.66	NA	0.009
1.231	21.59	**Qp**	0.11	0.03	0.00	9.97	31.70		Line 1		- 24.30	NA	0.009
1.725	21.47	**Qp**	0.14	0.04	0.00	9.96	31.61		Line 1		- 24.39	NA	0.009
2.223	21.12	**Qp**	0.16	0.04	0.00	9.96	31.28		Line 1		- 24.72	NA	0.009
3.142	20.58	**Qp**	0.20	0.05	0.00	9.96	30.79		Line 1		- 25.21	NA	0.009
0.263	16.39	**Av**	0.06	0.03	0.00	9.95	26.42		Line 1		NA	- 24.90	0.009
0.707	21.35	**Av**	0.09	0.03	0.00	9.96	31.43		Line 1		NA	- 14.57	0.009
1.231	17.06	**Av**	0.11	0.03	0.00	9.97	27.17		Line 1		NA	- 18.83	0.009
1.725	16.71	**Av**	0.14	0.04	0.00	9.96	26.85		Line 1		NA	- 19.15	0.009
2.223	16.09	**Av**	0.16	0.04	0.00	9.96	26.25		Line 1		NA	- 19.75	0.009
3.142	16.00	**Av**	0.20	0.05	0.00	9.96	26.21		Line 1		NA	- 19.79	0.009
N_120V_60Hz_			DFMR_A138_										
0.263	22.10	**Qp**	0.06	0.03	0.00	9.95	32.13		Neutral		- 29.19	NA	0.009
0.713	27.27	**Qp**	0.09	0.03	0.00	9.96	37.35		Neutral		- 18.65	NA	0.009
1.239	22.82	**Qp**	0.11	0.04	0.00	9.97	32.94		Neutral		- 23.06	NA	0.009
1.714	22.74	**Qp**	0.14	0.04	0.00	9.96	32.88		Neutral		- 23.12	NA	0.009
2.749	21.23	**Qp**	0.18	0.05	0.00	9.96	31.42		Neutral		- 24.58	NA	0.009
3.693	21.10	**Qp**	0.22	0.06	0.00	9.96	31.34		Neutral		- 24.66	NA	0.009
0.263	17.74	**Av**	0.06	0.03	0.00	9.95	27.77		Neutral		NA	- 23.55	0.009
0.713	23.02	**Av**	0.09	0.03	0.00	9.96	33.10		Neutral		NA	- 12.90	0.009
1.239	18.45	**Av**	0.11	0.04	0.00	9.97	28.57		Neutral		NA	- 17.43	0.009
1.714	17.07	**Av**	0.14	0.04	0.00	9.96	27.21		Neutral		NA	- 18.79	0.009
2.749	15.65	**Av**	0.18	0.05	0.00	9.96	25.84		Neutral		NA	- 20.16	0.009
3.693	15.62	**Av**	0.22	0.06	0.00	9.96	25.86		Neutral		NA	- 20.14	0.009

14 RF Exposure Requirement

14.1 Method

Unless otherwise stated no deviations were made from FCC Part 1.1307.

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

14.2 Test Requirement/ Specification:

- Power Density Limit for Frequency Range: 300 – 1500 MHz = f/300

14.3 Test Results:

The sample tested was found to comply.

14.4 Test Data:

RF Exposure Requirements - MPE

The following limit is from table 1 (B) Limits for General Population/Uncontrolled Exposure in FCC part 1.1310:

Power Density Limit for Frequency Range: 300 - 1500 MHz = f/300
Where
f = fundamental frequency of the transmitter, in this case 925 MHz

= 3 mW/cm^2

The following calculation was used to determine compliance to the above limit.
Power Density(S) =PG/4πR^2 or S=EIRP/4πR^2

Where:
S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (mW).
G = numeric power gain of the antenna in the direction of interest relative to an isotropic radiator.
R = distance to the center of radiation of the antenna (cm)

In this case, 20cm will be used.
==========

Power Density

Power (mW)	Gain (dbi)	Gain numeric	Distance (cm)	Power Density (mW/cm^2)
7.7	0	1	20	0.002

Therefore: Power Density Margin (Δ Limit) = 0.002 – 3 = - 2.998 mW/cm^2

15 Duty Cycle/ Duty Cycle Correction Factor

No duty cycle correction factor was utilized during this testing – therefore, product duty cycle verification was not applicable.

15.1 Method:

The test methods used comply with ANSI C63.10. Unless otherwise stated no deviations were made from FCC CFR47 15.35(c).

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

15.2 Test Requirement/Specification:

Unless otherwise specified, e.g. §15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

Determine the period of the pulse train, T, in mSec and record the results. T is defined as the time from the beginning of one pulse train to the beginning of the next pulse train. Count the number of different types of pulses, N and record the results. For each of the different types of pulses, count the number of occurrences within one pulse train. Use the Duty Cycle Correction Factor, DCCF, from the results table and use it to adjust the field strength measurements recorded for radiated emissions.

- FCC 15.35(c)

15.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
19936	Bilog Antenna 30MHz - 6GHz	Sunol Sciences	JB6	A050707-1	6/22/2016	6/22/2017
DEN-073	EMI Receiver (10Hz – 26.5GHz)	RHODE & SCHWARZ	ESU 26	100265	12/19/2015	12/19/2016
CC1-E2	Radiated Cable	Teledyne	90-206-300; PN:F-130-S1S1-100; 90-206-072;	E2-A; 5026702 002; E2-C; E2-D	11/17/2015	11/17/2016
DEN-144	Precision Psychrometer	Extech Instruments	RH390	12083570	9/4/15	9/4/2016

15.4 Results:

The sample tested was found to comply.

15.5 Test Method:

- ANSI C63.10: 2013, Clause 7.5

15.6 Test Summary:

DCCF Calculation:

20 log (t/100mS)

Where t is the transmission time in a 100mS window.

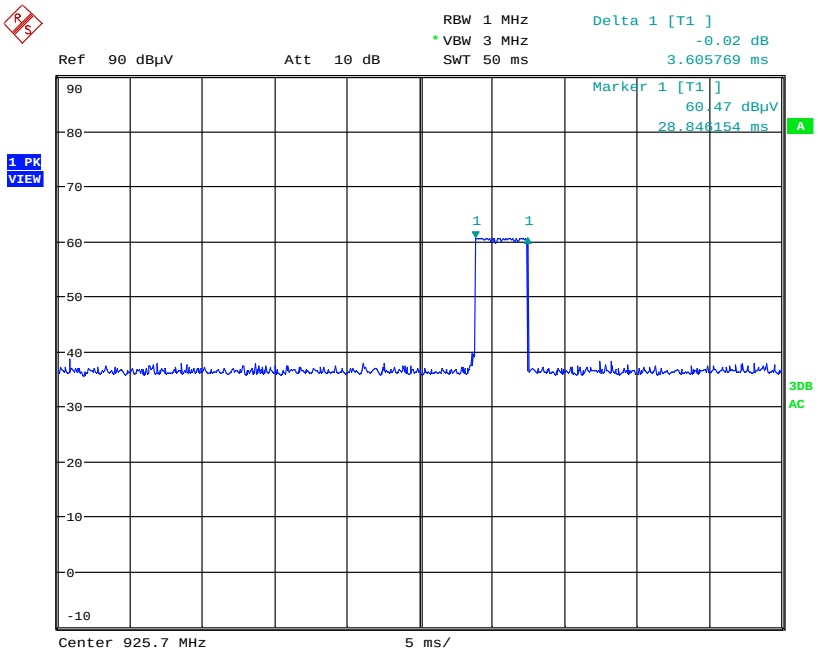
t = 3.6 ms * 1 = 3.6 ms

t = 3.6 mS

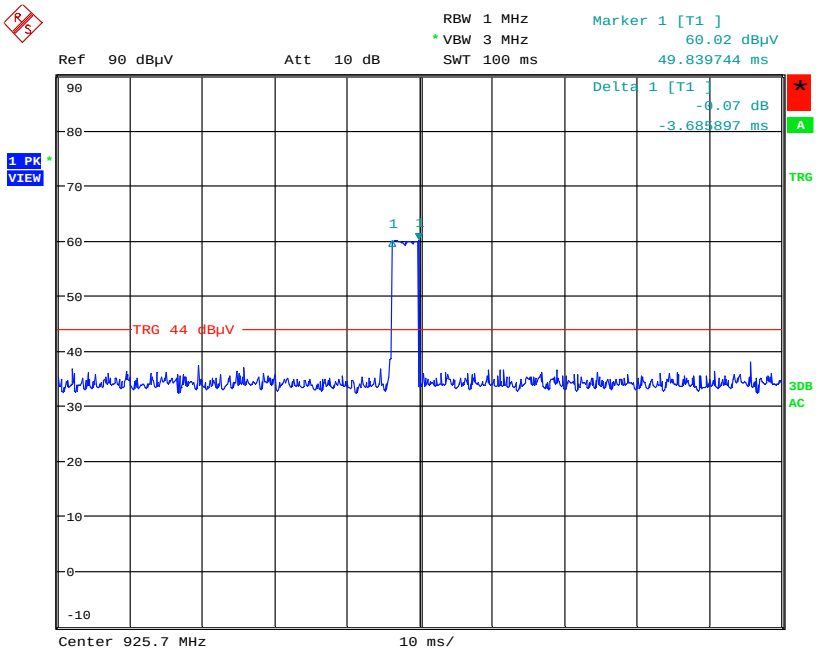
20 log (0.036) = -28.87 dB

Maximum allowable DCCF correction is -28.87 dB.

15.7 Plots:



Date: 30.AUG.2016 11:51:05



Date: 30.AUG.2016 11:56:00

16 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 ±	Notes
Radiated emissions, 10kHz to 30 MHz	3.4 dB	
Radiated emissions, 30 to 200 MHz HP	2.2 dB	
Radiated emissions, 30 to 200 MHz VP	3.8 dB	
Radiated emissions, 200 to 1000 MHz HP	2.8 dB	
Radiated emissions, 200 to 1000 MHz VP	2.7 dB	
Radiated emissions, 1 to 18 GHz	5.2 dB	
Conducted port emissions 10kHz to 1000 MHz	1.0 dB	
Conducted port emissions 1 – 26.5 GHz	1.6 dB	
AC mains Conducted emissions, 9kHz to 30 MHz	3.14 dB	

17 Revision History

Revision Level	Date	Report Number	Notes
0	9/20/2016	102614695DEN-001	Original Issue