

TEST REPORT

ACCORDING TO: FCC 47 CFR PART 15 subpart C, section 15.249 and subpart B

FOR:

**SCR Engineers Ltd.
BU500/E RF Module
Model: LD Module
FCC ID:AMUBUM**

This report is in conformity with ISO/IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested.
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1 Applicant information

Client name: SCR Engineers Ltd.
Address: 18 Hamelacha street, P.O.B. 13564, Netanya 42138, Israel
Telephone: +972 73 240 6053
Fax: +972 9865 0703
E-mail: zeevk@scrdairy.com
Contact name: Mr. Zeev Kapelnik

2 Equipment under test attributes

Product name: Long distance module
Product type: Transceiver
Model(s): LD Module
Serial number: 001
Hardware version: Rev 06.01
Software release: Ver 3.C3
Receipt date 28-Apr-15

3 Manufacturer information

Manufacturer name: SCR Engineers Ltd.
Address: 18 Hamelacha street, P.O.B. 13564, Netanya 42138, Israel
Telephone: +972 73 240 6053
Fax: +972 9865 0703
E-Mail: zeevk@scrdairy.com
Contact name: Mr. Zeev Kapelnik

4 Test details

Project ID: 26955
Location: Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started: 28-Apr-15
Test completed: 12-Jul-15
Test specification(s): FCC 47 CFR Part 15, subpart C, §15.249; subpart B §15.109

5 Tests summary

Test	Status
Transmitter characteristics	
Section 15.249(a)(d), Field strength of emissions	Pass
Section 15.249(d), Band edge emissions	Pass
Section 15.207(a), Conducted emission	Not required
Section 15.203, Antenna requirement	Pass
Section 15.215(c), Occupied bandwidth	Pass
Unintentional emissions	
Section 15.107, Conducted emission at AC power port	Not required
Section 15.109, Radiated emission	Pass

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.

The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mr. S. Samokha, test engineer Mrs. E. Pitt, test engineer	July 12, 2015	 
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	July 27, 2015	
Approved by:	Mr. M. Nikishin, EMC and Radio group manager	December 15, 2015	

6 EUT description

6.1 General information

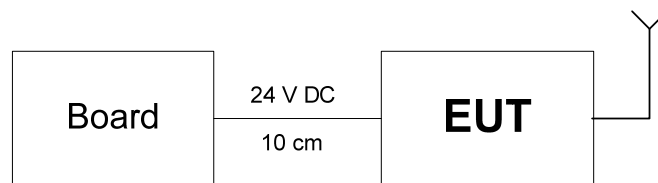
The EUT, LD (long distance) module, is a part of BU500/ BU500E LD base units used to collect messages from tags and send them to central management system.

The model BU500 is a LD base unit with RS-485 network interface, the model BU500E – LD base unit with 10BASE-T/100BASE-TX Ethernet network interface. Each BU500/ BU500E LD base unit comprises two LD modules differed for the position in EUT - X or Y: when one module is transmitting, the second module is always in receive mode.

6.2 Changes made in EUT

No changes were performed in the EUT.

6.3 Test configuration



6.4 Transmitter characteristics

Type of equipment						
V	Stand-alone (Equipment with or without its own control provisions)					
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)					
	Plug-in card (Equipment intended for a variety of host systems)					
Assigned frequency range		2400 – 2483.5 MHz				
Operating frequency range		2405 – 2480 MHz				
RF channel spacing		5 MHz				
Maximum field strength of carrier		Peak 106.8 dBμV/m at 3 m distance, average 72.58 dBμV/m at 3 m distance				
Is transmitter output power variable?		V	No			
			Yes	continuous variable		
				stepped variable with stepsize dB		
				minimum RF power dBm		
				maximum RF power dBm		
Antenna connection						
unique coupling		standard connector		V	Integral	
				V	with temporary RF connector without temporary RF connector	
Antenna/s technical characteristics						
Type		Manufacturer		Model number		
Integral		SCR Engineers Ltd.		NA		
Gain		0 dBi				
Transmitter aggregate data rate/s		250 kbps				
Type of modulation		QPSK				
Modulating test signal (baseband)		PRBS				
Transmitter power source						
	Battery	Nominal rated voltage		Battery type		
V	DC	Nominal rated voltage	24 V			
	AC mains	Nominal rated voltage		Frequency	Hz	



Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C requirements

7.1 Field strength of emissions

7.1.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.1.1, Table 7.1.2, Table 7.1.3.

Table 7.1.1 Radiated fundamental emission limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)		
	Peak	Average	Quasi-Peak
2400 – 2483.5	114.0	94.0	NA

Table 7.1.2 Harmonics limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)	
	Peak	Average
2400 – 2483.5	74.0	54.0

Table 7.1.3 Radiated spurious emissions limits (other than harmonics)

Frequency, MHz	Field strength at 3 m, dB(μV/m)*			Attenuation below carrier
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	50 dBc (whichever is the less stringent)
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	NA	73.8 – 63.0**	NA	
1.705 – 30.0*		69.5		
30 – 88		40.0		
88 – 216		43.5		
216 – 960		46.0		
960 - 1000		54.0		
Above 1000	74.0	NA	54.0	

*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$\text{Lim}_{S_2} = \text{Lim}_{S_1} + 40 \log(S_1/S_2),$$

where S_1 and S_2 – standard defined and test distance respectively in meters.

** - The limit decreases linearly with the logarithm of frequency.

Note: The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency but not exceeding 40 GHz for intentional radiators operated below 10 GHz and up to the fifth harmonic of the highest fundamental frequency but not exceeding 100 GHz for intentional radiators operated above 10 GHz.

Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

7.1.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and the performance check was conducted.

7.1.2.2 The EUT antenna was installed in typical (vertical) position.

7.1.2.3 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.1.2.4 The worst test results (the lowest margins) were recorded in the associated tables and shown in the associated plots.

7.1.3 Test procedure for spurious emission field strength measurements above 30 MHz

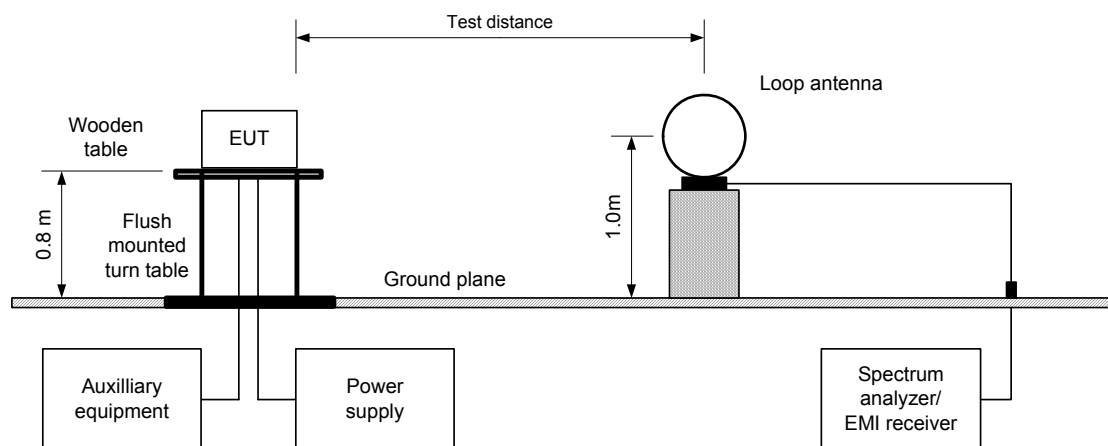
7.1.3.1 The EUT was set up as shown in Figure 7.1.2, energized and the performance check was conducted.

7.1.3.2 The EUT antenna was installed in typical (vertical) position.

7.1.3.3 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

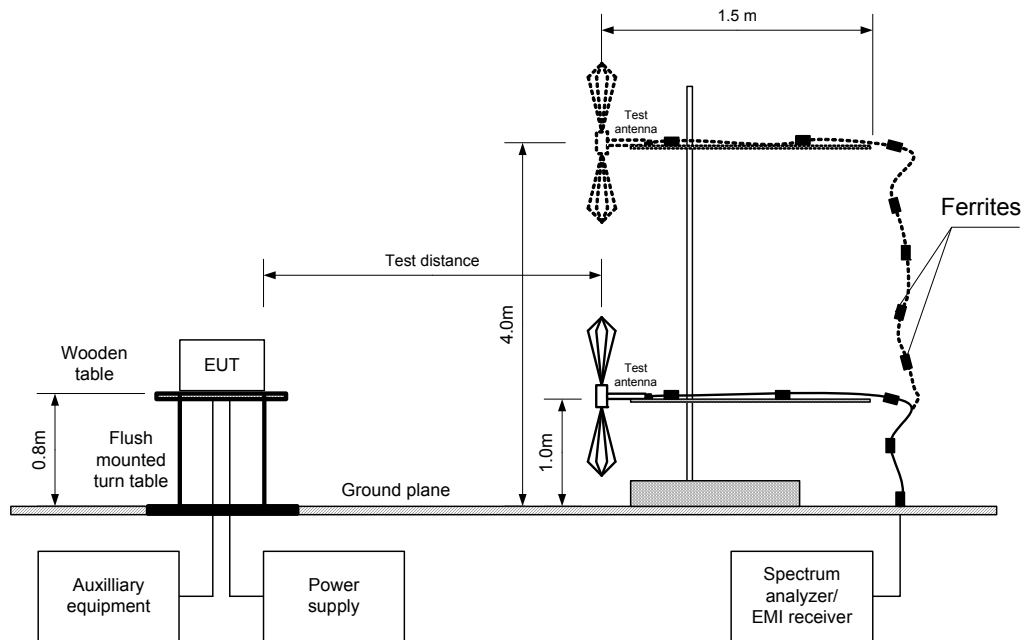
7.1.3.4 The worst test results (the lowest margins) were recorded in the associated tables and shown in the associated plots

Figure 7.1.1 Setup for spurious emission field strength measurements below 30 MHz



Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

Figure 7.1.2 Setup for spurious emission field strength measurements above 30 MHz





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Test specification:	Section 15.249(a)(d), Field strength of emissions		
Test procedure:	ANSI C63.4, Section 13.1.4		
Test mode:	Compliance	Verdict: PASS	
Date(s):	28-Jun-15		
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

Table 7.1.4 Field strength of fundamental emission and spurious emissions

TEST DISTANCE:	3 m
EUT POSITION:	Typical with antenna in vertical position
MODULATION:	QPSK
INVESTIGATED FREQUENCY RANGE:	0.009 – 25000 MHz
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	1.0 kHz (9 kHz – 150 kHz) 9.0 kHz (150 kHz – 30 MHz) 120 kHz (30 MHz – 1000 MHz) 1.0 MHz (above 1000 MHz)
VIDEO BANDWIDTH:	≥ Resolution bandwidth
TEST ANTENNA TYPE:	Active loop (9 kHz – 30 MHz) Biconilog (30 MHz – 1000 MHz) Double ridged guide (above 1000 MHz)

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Avr factor, dB	Average field strength			Verdict
	Pol.	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**		Calculated, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
Fundamental emission											
2404.40	H	1.8	4	106.20	114	-7.80	-34.2	72.00	94	-22.00	Pass
2445.50	H	1.9	349	104.28	114	-9.72	-34.2	70.08	94	-23.92	
2480.45	H	1.5	10	106.78	114	-7.22	-34.2	72.58	94	-21.42	
Spurious emissions											
4964.65	V	1.2	180	51.475	74	-22.525	NA	51.475	54	-2.53	Pass
7448.92	V	1.0	175	55.115	74	-18.885	NA	43.853	54	-10.15	

*- EUT front panel refers to 0 degrees position of turntable.

**- Margin, dB = Measured (calculated) value, dB(μV/m) - Limit, dB(μV/m).

Table 7.1.5 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
0.975	50.0	NA	NA	NA	-34.2

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{\text{Train duration}} \times \text{Number of bursts within pulse train} \right)$$

for pulse train longer than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{100 \text{ ms}} \times \text{Number of bursts within 100 ms} \right)$$

Reference numbers of test equipment used

HL 0446	HL 0521	HL 0604	HL 3901	HL 4114	HL 4353	HL 4575	HL 4722
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Full description is given in Appendix A.



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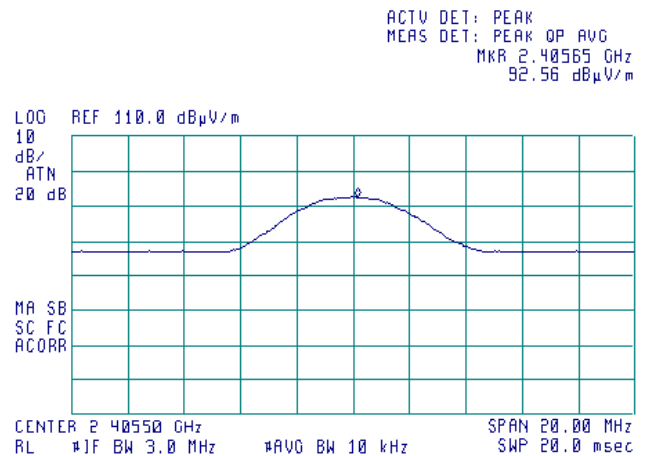
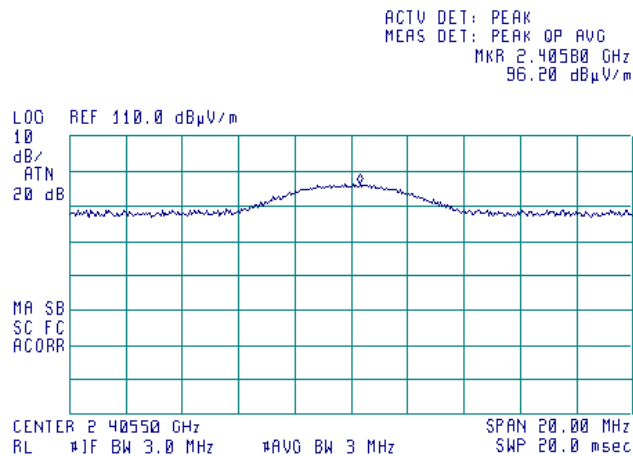
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Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

Plot 7.1.1 Radiated emission measurements at the low fundamental frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION:
INPUT VOLTAGE:
RBW = 3MHz, VBW = 3 MHz

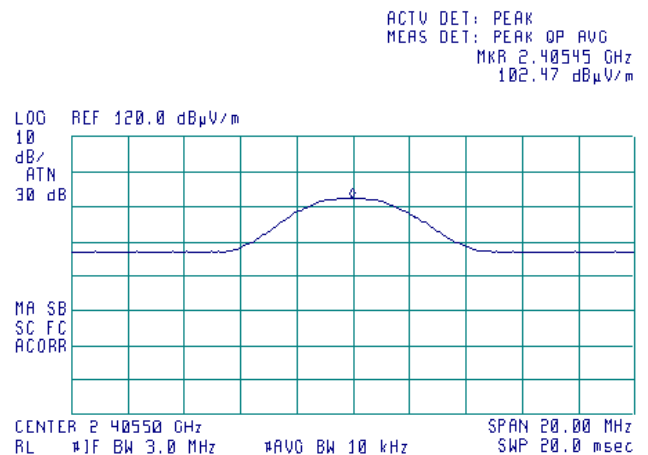
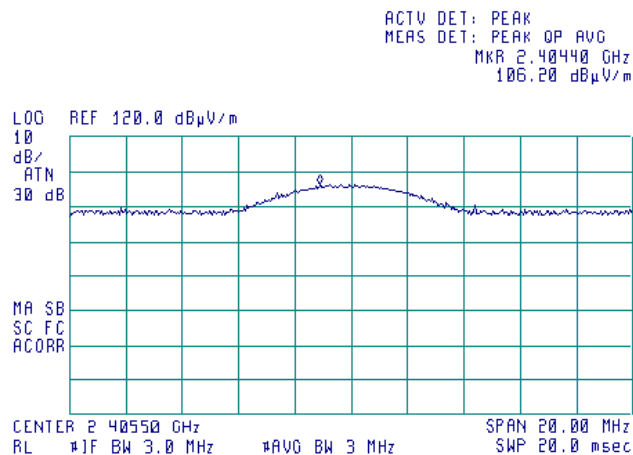
Semi anechoic chamber
3 m
Vertical
Unom
RBW = 3MHz, VBW = 10 kHz



Plot 7.1.2 Radiated emission measurements at the low fundamental frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION:
INPUT VOLTAGE:
RBW = 3MHz, VBW = 3 MHz

Semi anechoic chamber
3 m
Horizontal
Unom
RBW = 3MHz, VBW = 10 kHz





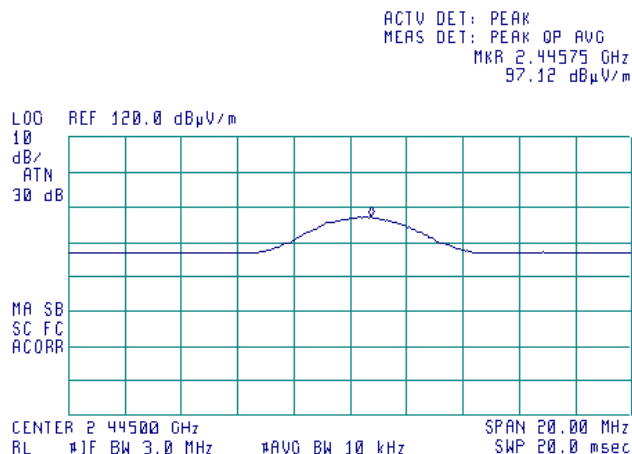
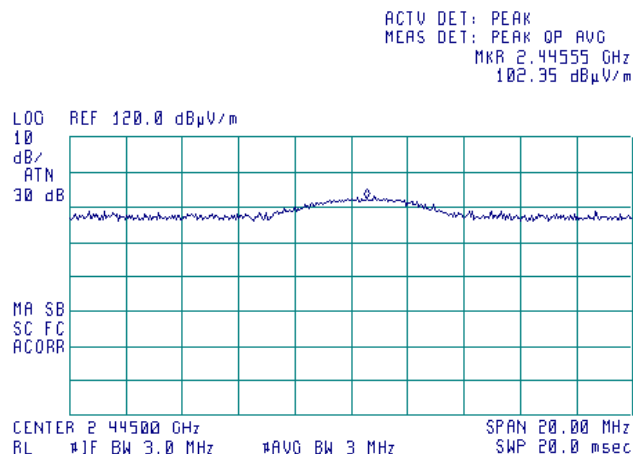
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Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

Plot 7.1.3 Radiated emission measurements at the mid fundamental frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION:
INPUT VOLTAGE:
RBW = 3MHz, VBW = 3 MHz

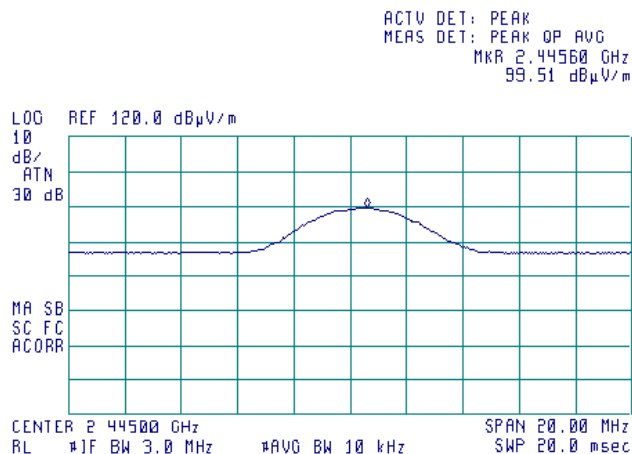
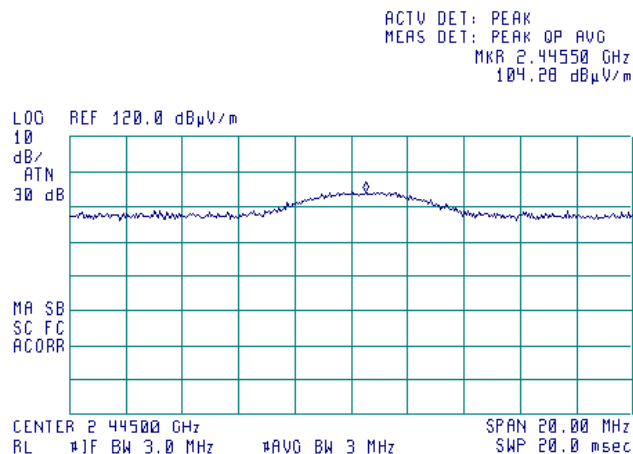
Semi anechoic chamber
3 m
Vertical
Unom
RBW = 3MHz, VBW = 10 kHz



Plot 7.1.4 Radiated emission measurements at the mid fundamental frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION:
INPUT VOLTAGE:
RBW = 3MHz, VBW = 3 MHz

Semi anechoic chamber
3 m
Horizontal
Unom
RBW = 3MHz, VBW = 10 kHz





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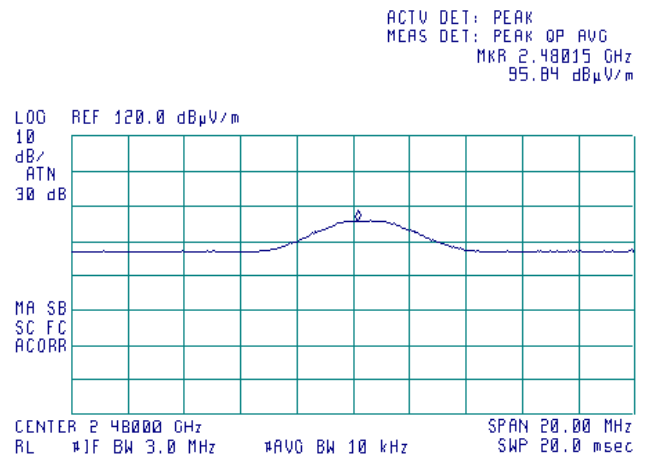
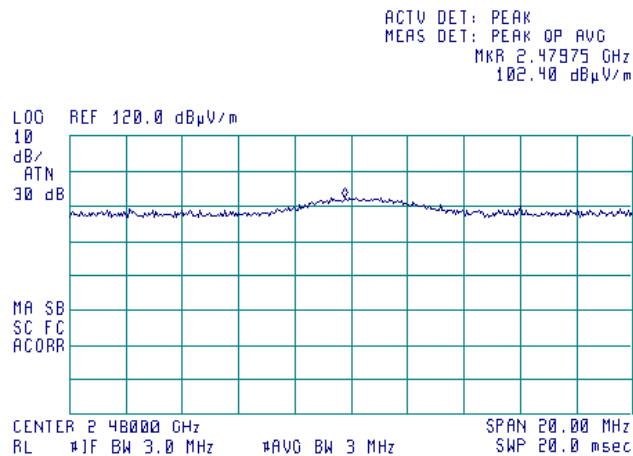
Date of Issue: 15-Dec-15

Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

Plot 7.1.5 Radiated emission measurements at the high fundamental frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION:
INPUT VOLTAGE:
RBW = 3MHz, VBW = 3 MHz

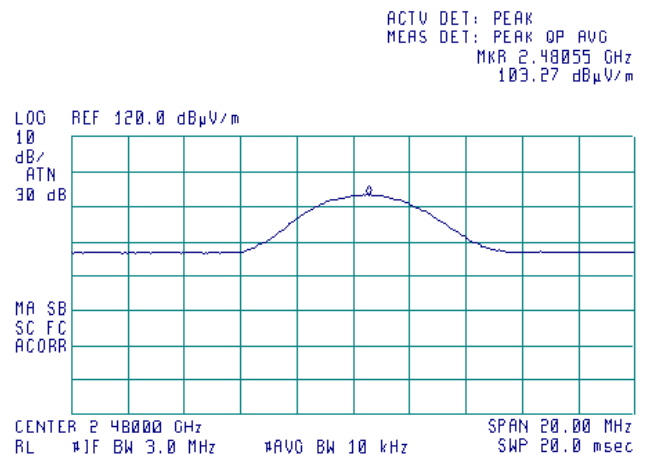
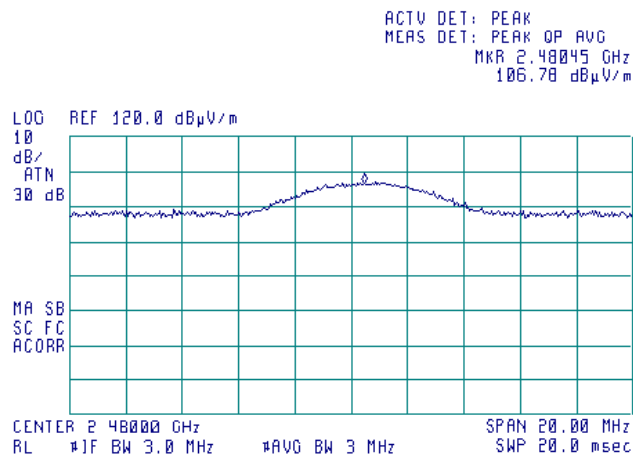
Semi anechoic chamber
3 m
Vertical
Unom
RBW = 3MHz, VBW = 10 kHz



Plot 7.1.6 Radiated emission measurements at the high fundamental frequency

TEST SITE:
TEST DISTANCE:
ANTENNA POLARIZATION:
INPUT VOLTAGE:
RBW = 3MHz, VBW = 3 MHz

Semi anechoic chamber
3 m
Horizontal
Unom
RBW = 3MHz, VBW = 10 kHz



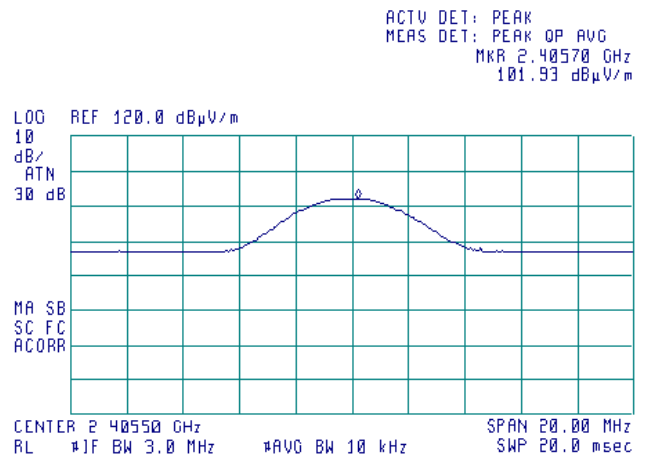
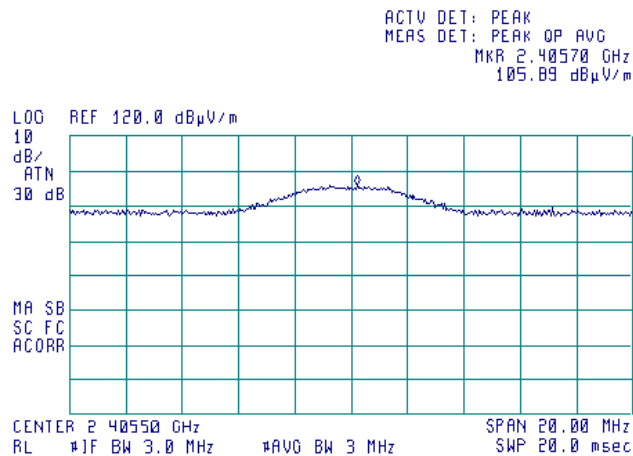


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Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

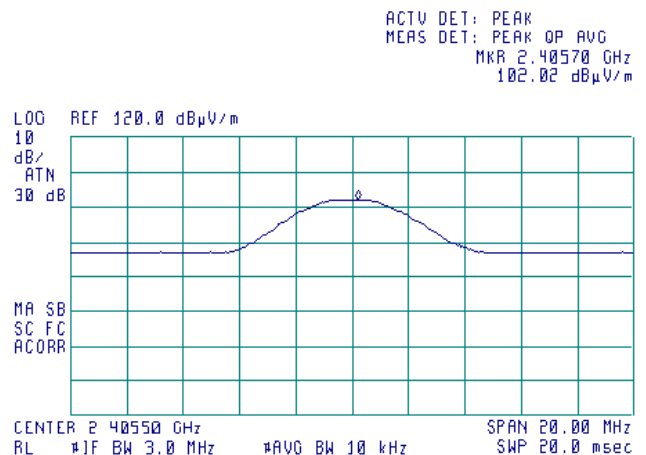
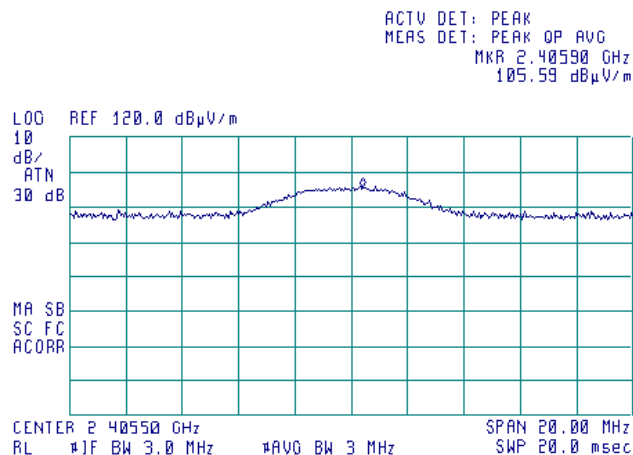
Plot 7.1.7 Radiated emission measurements at the low fundamental frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: 115%Unom



Plot 7.1.8 Radiated emission measurements at the low fundamental frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: 85%Unom



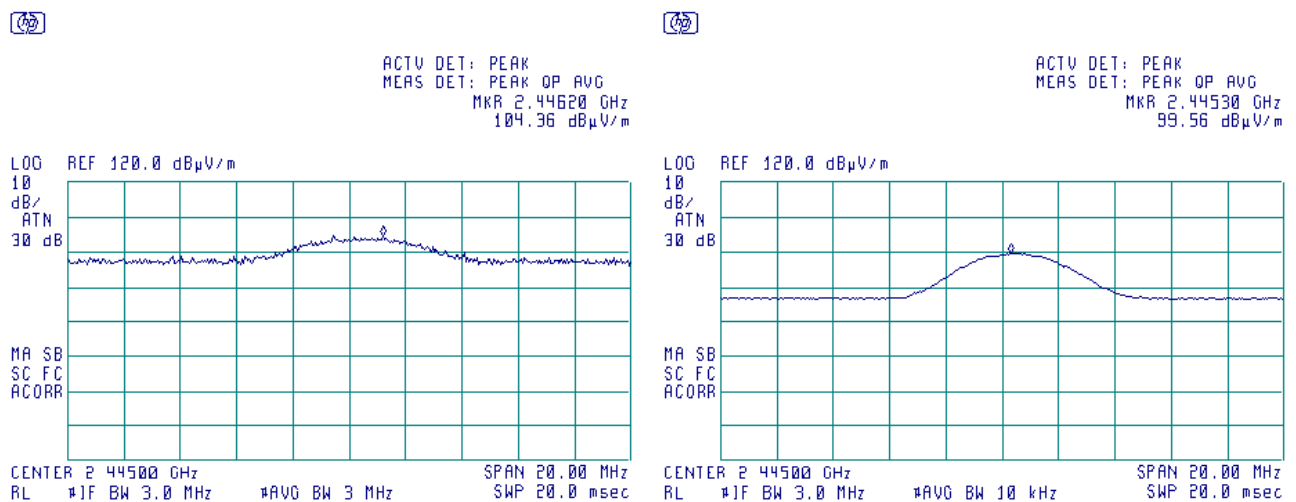


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Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

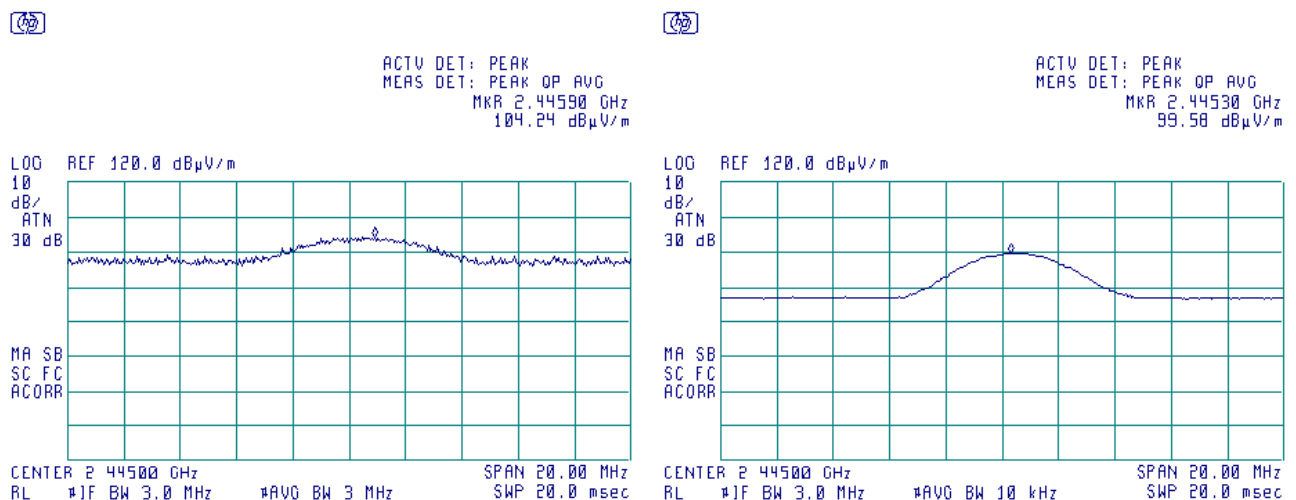
Plot 7.1.9 Radiated emission measurements at the mid fundamental frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: 115%Unom



Plot 7.1.10 Radiated emission measurements at the mid fundamental frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: 85%Unom



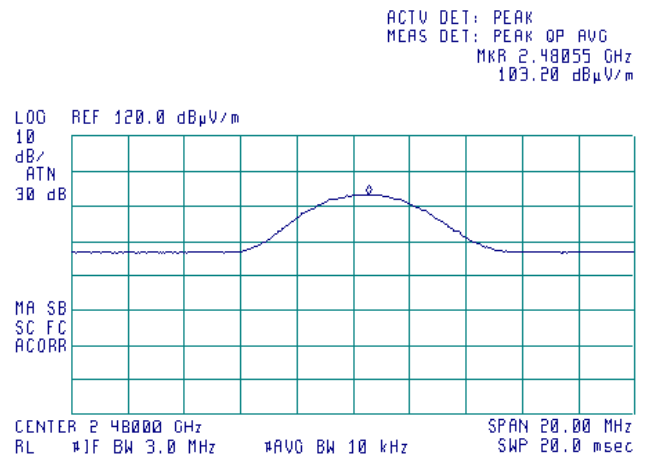
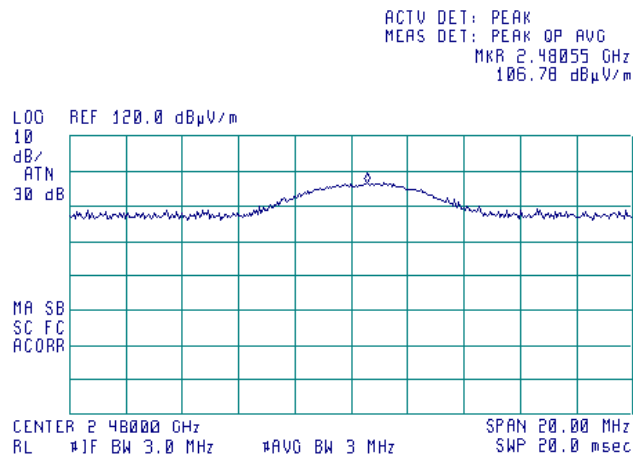


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Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

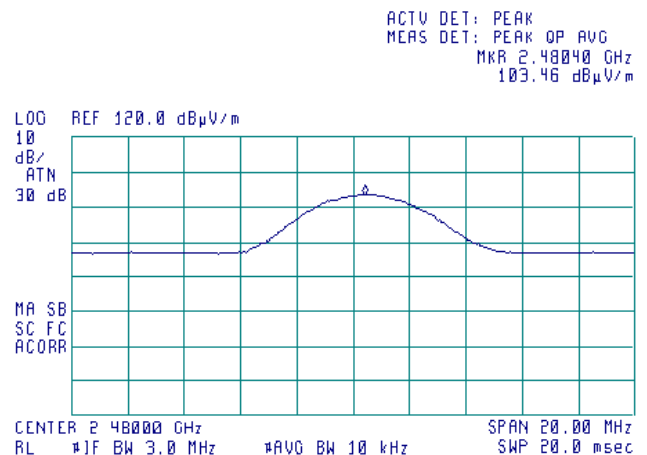
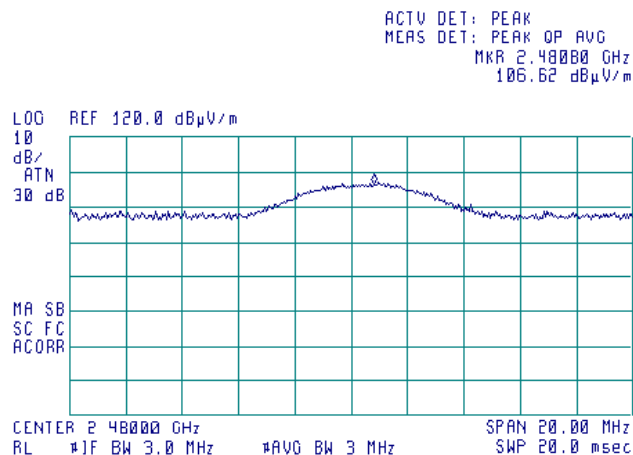
Plot 7.1.11 Radiated emission measurements at the high fundamental frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: 115%Unom



Plot 7.1.12 Radiated emission measurements at the high fundamental frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
INPUT VOLTAGE: 85%Unom



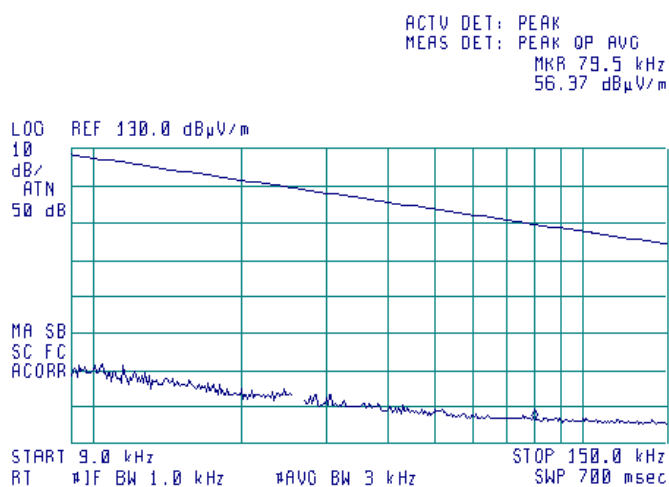


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Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

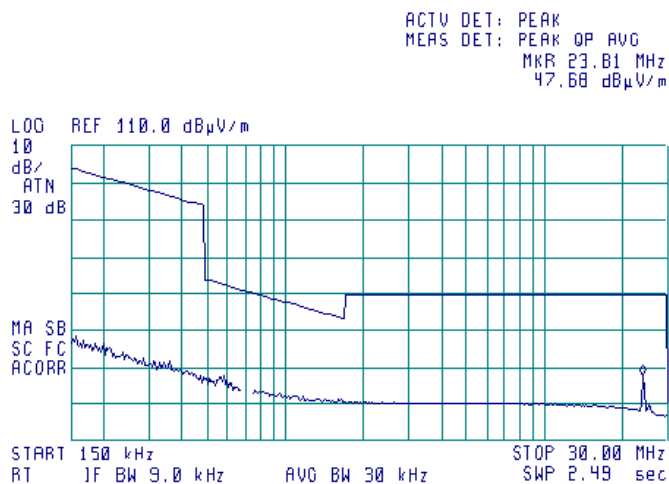
Plot 7.1.13 Radiated emission measurements from 9 to 150 kHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Low, Mid, High



Plot 7.1.14 Radiated emission measurements from 0.15 to 30 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Low, Mid, High





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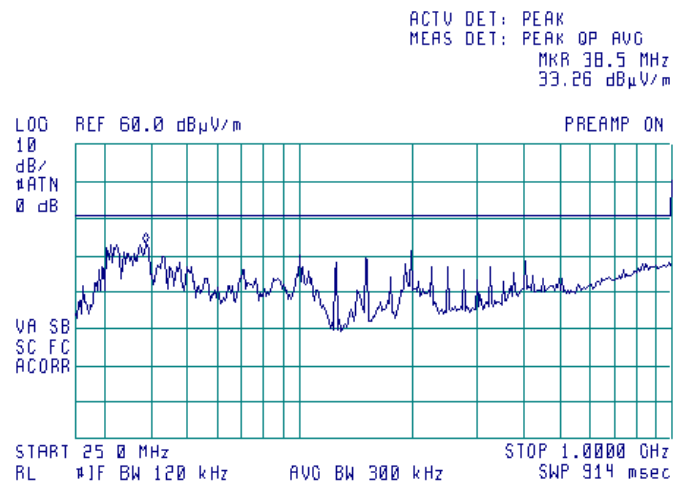
Report ID: SCRRAD_FCC.26955.docx

Date of Issue: 15-Dec-15

Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

Plot 7.1.15 Radiated emission measurements from 30 to 1000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Low, Mid, High



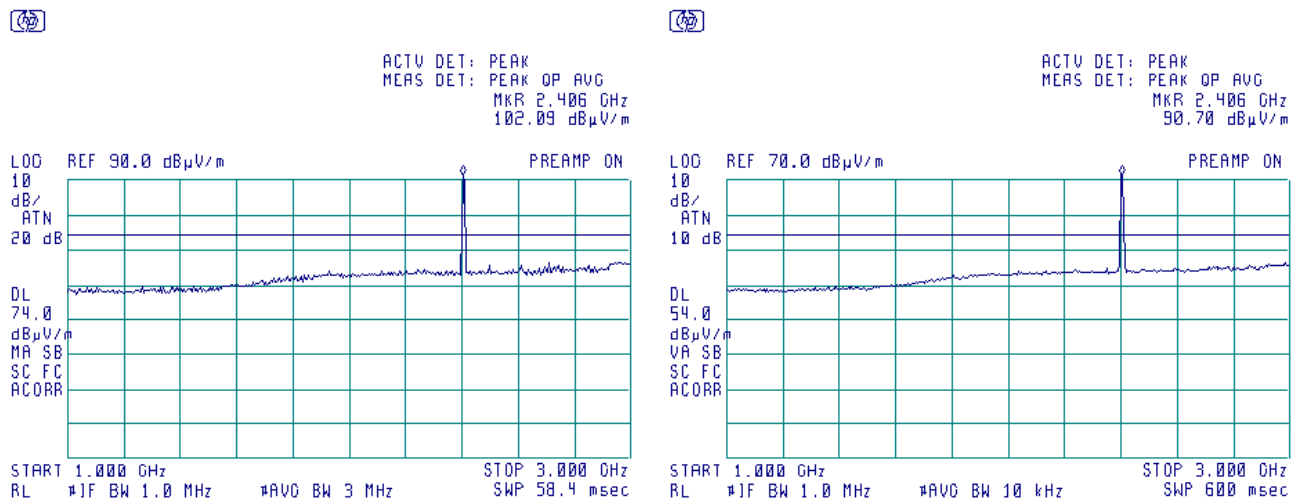


HERMON LABORATORIES

Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

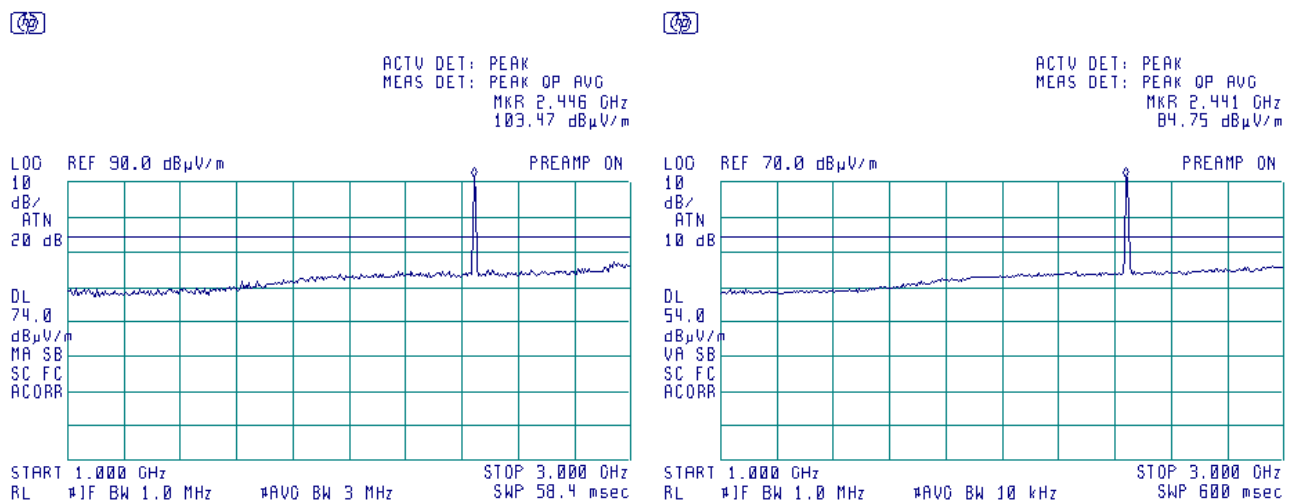
Plot 7.1.16 Radiated emission measurements from 1.0 to 3 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Low



Plot 7.1.17 Radiated emission measurements from 1.0 to 3 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Mid



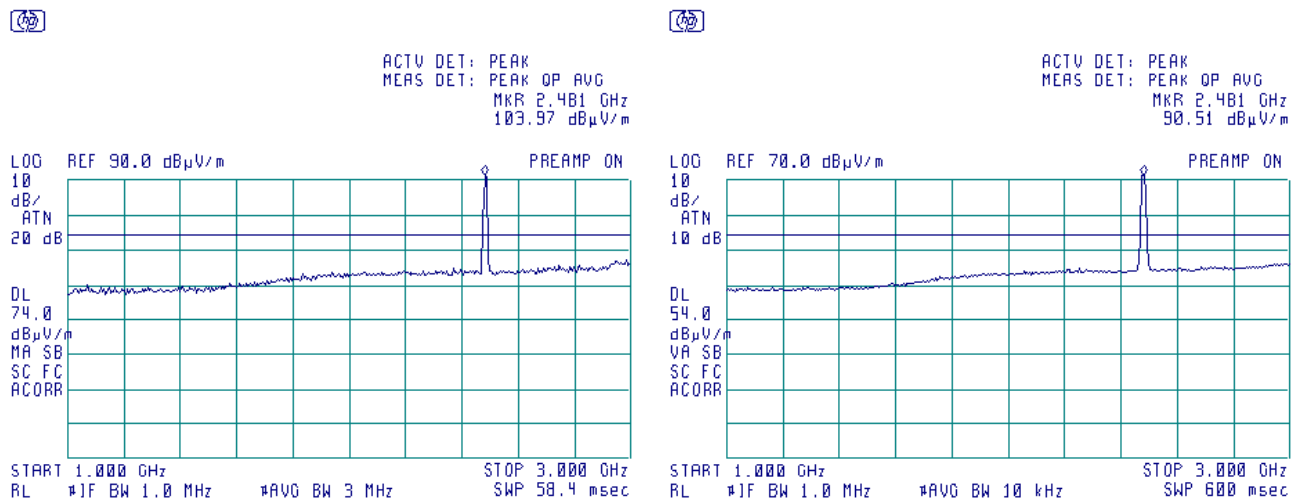


HERMON LABORATORIES

Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C		Air Pressure: 1010 hPa	Relative Humidity: 50 %
Remarks:		Power Supply: 24 VDC	

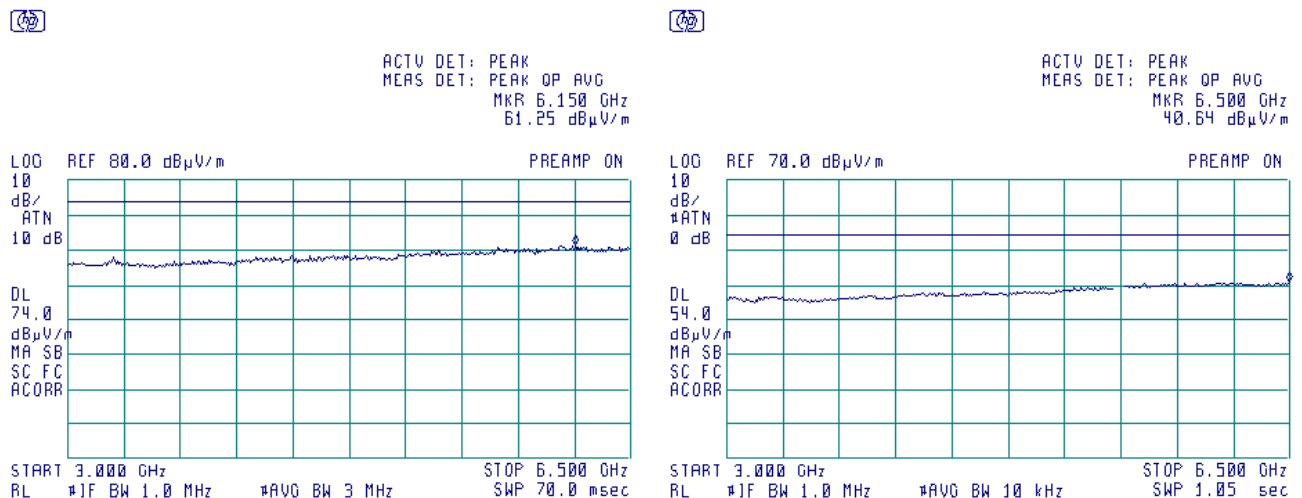
Plot 7.1.18 Radiated emission measurements from 1.0 to 3 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: High



Plot 7.1.19 Radiated emission measurements from 3 to 6.5 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Low



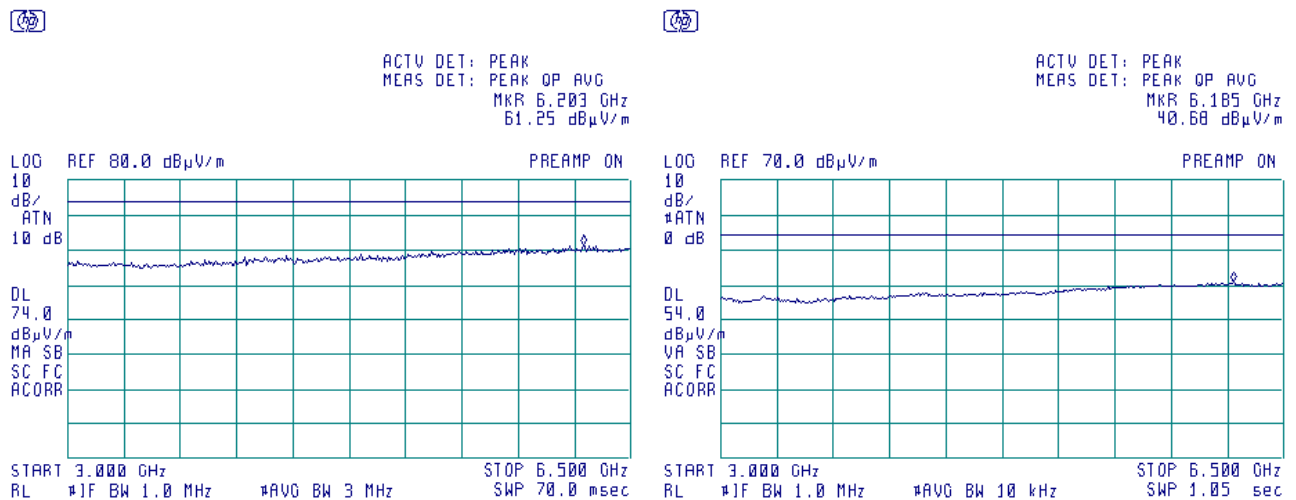


HERMON LABORATORIES

Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C		Air Pressure: 1010 hPa	Relative Humidity: 50 %
Remarks:		Power Supply: 24 VDC	

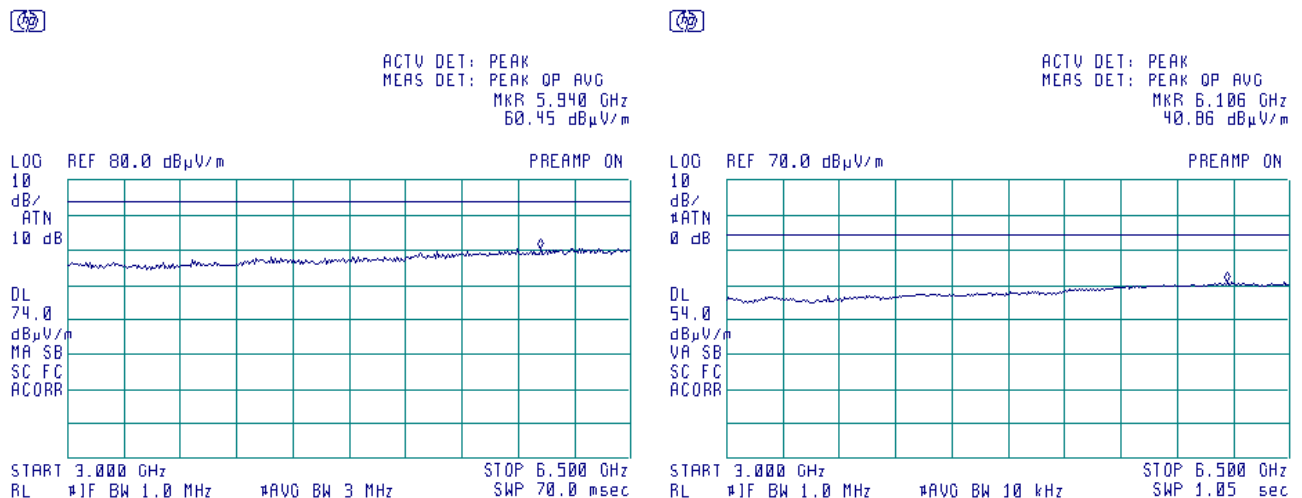
Plot 7.1.20 Radiated emission measurements from 3 to 6.5 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Mid



Plot 7.1.21 Radiated emission measurements from 3 to 6.5 MHz

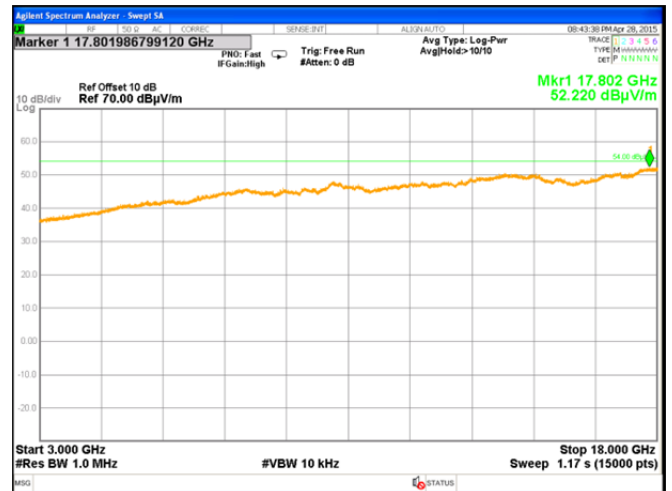
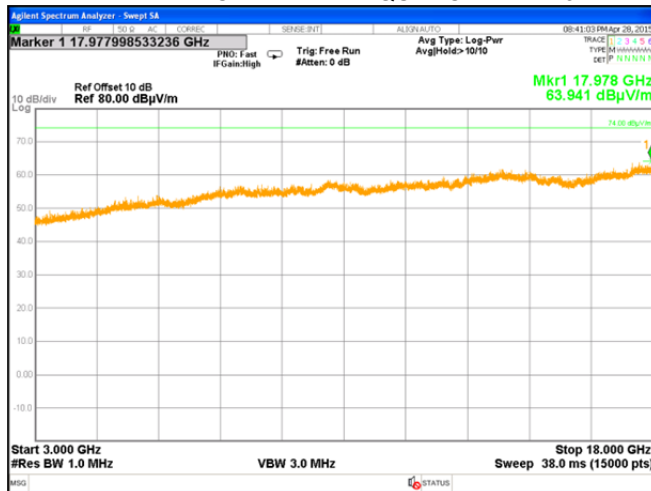
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: High



Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

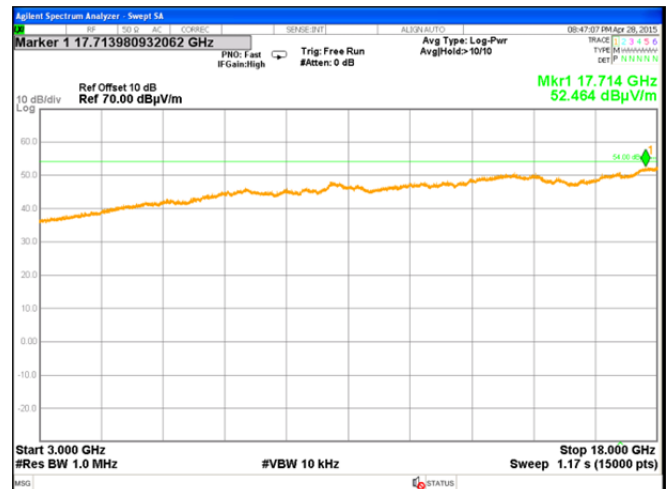
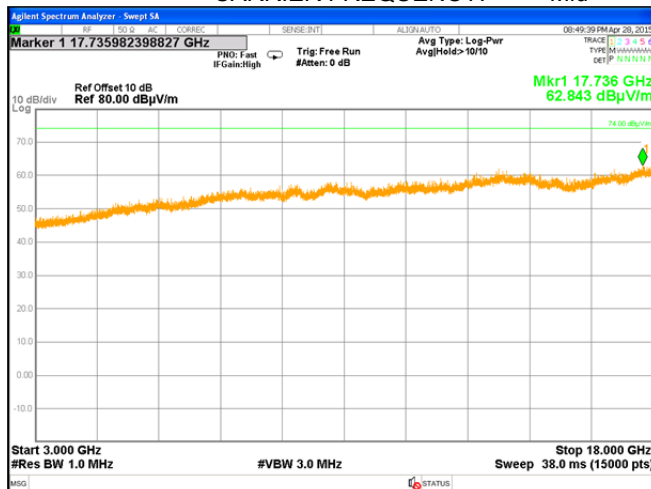
Plot 7.1.22 Radiated emission measurements from 3.0 to 18.0 GHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Low



Plot 7.1.23 Radiated emission measurements from 3.0 to 18.0 GHz

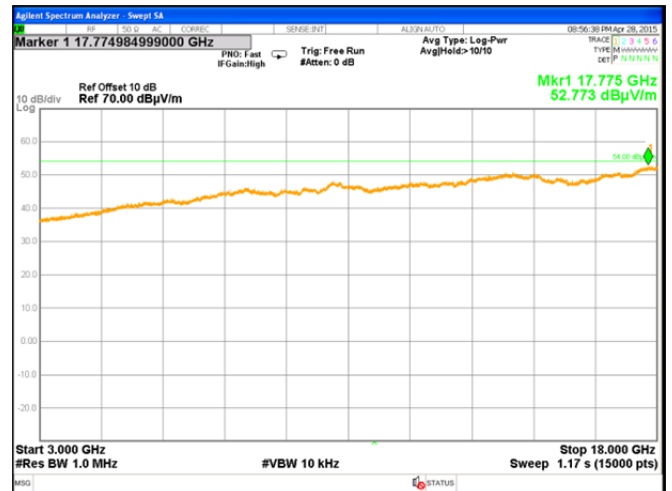
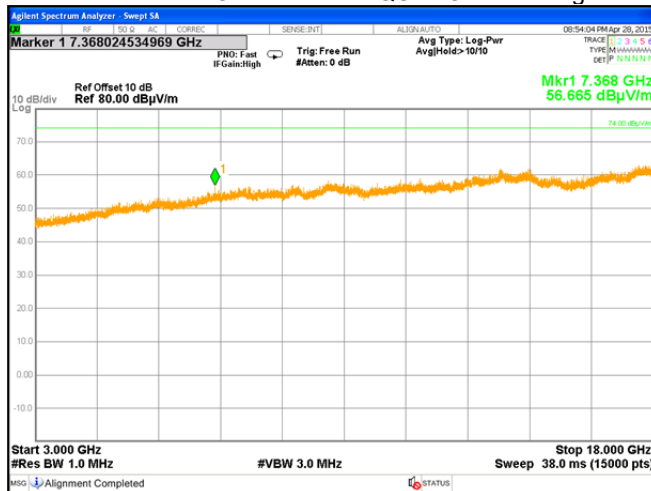
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Mid



Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

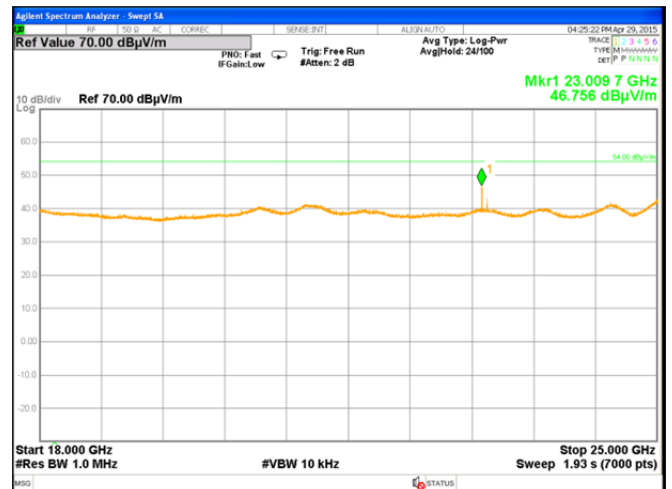
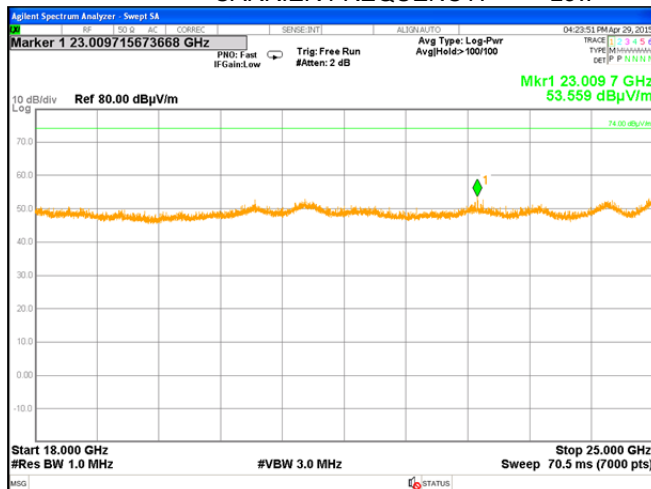
Plot 7.1.24 Radiated emission measurements from 3.0 to 18.0 GHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: High



Plot 7.1.25 Radiated emission measurements from 18.0 to 25 GHz

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Low



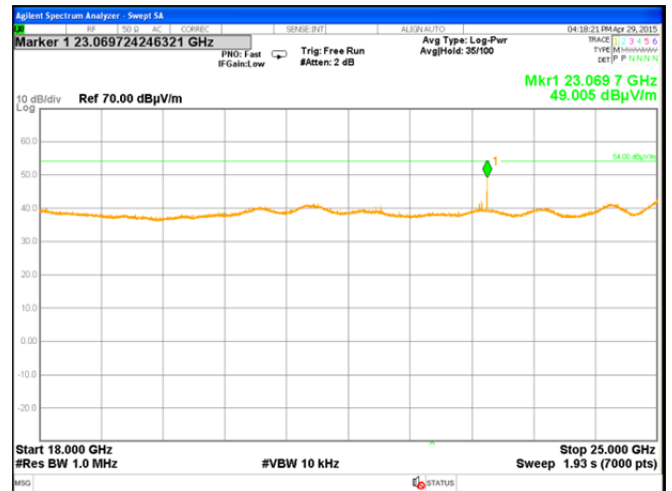
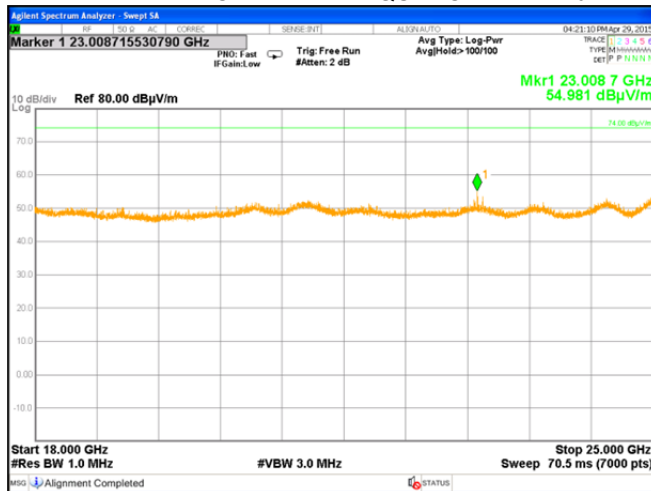


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Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:	Compliance	Verdict: PASS	
Date(s):	28-Jun-15		
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

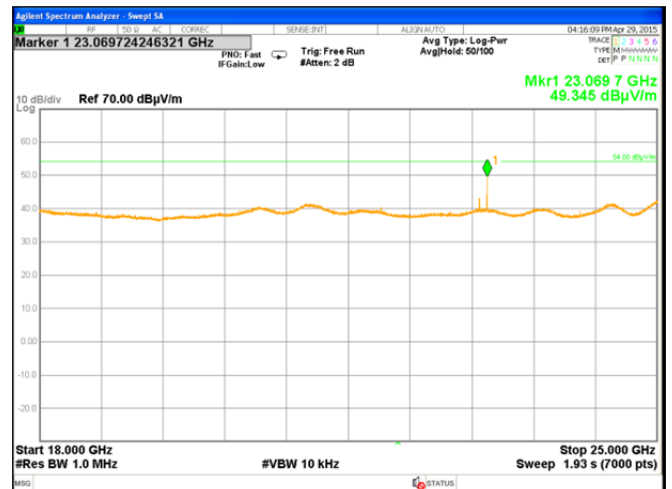
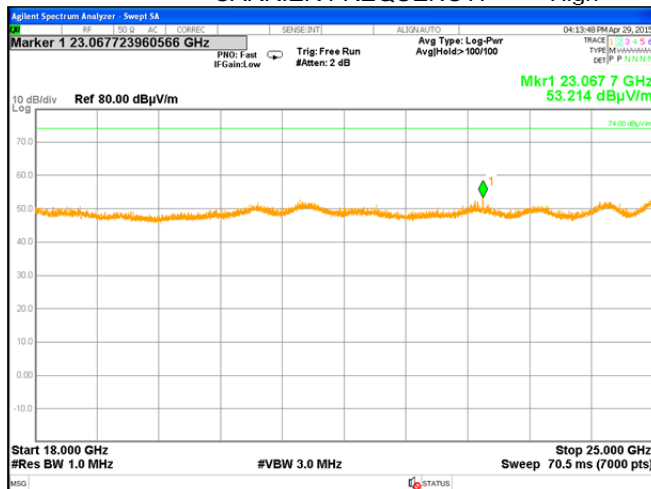
Plot 7.1.26 Radiated emission measurements from 18.0 to 25 GHz

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: Mid



Plot 7.1.27 Radiated emission measurements from 18.0 to 25 GHz

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: High

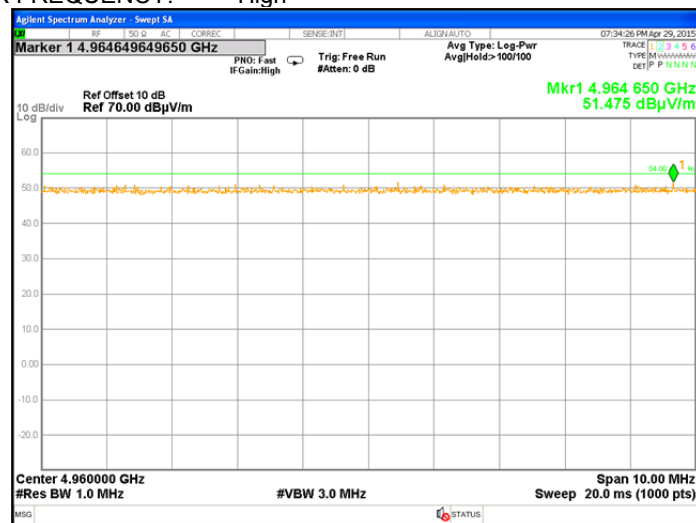


21.87 GHz, 22.9 GHz, 23 GHz, 23.7GHz – are ambient signals

Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

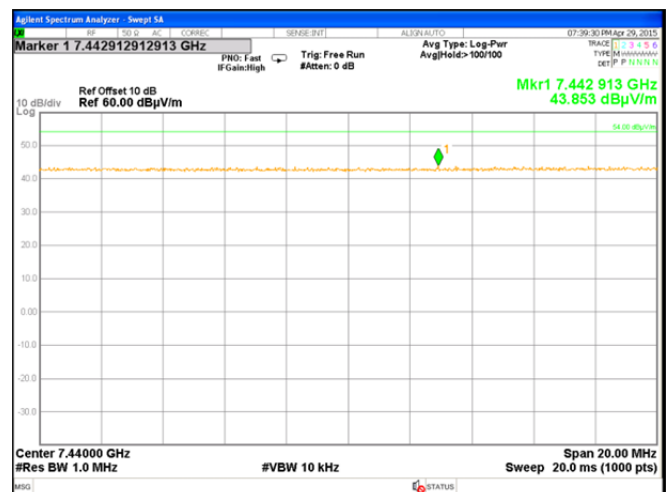
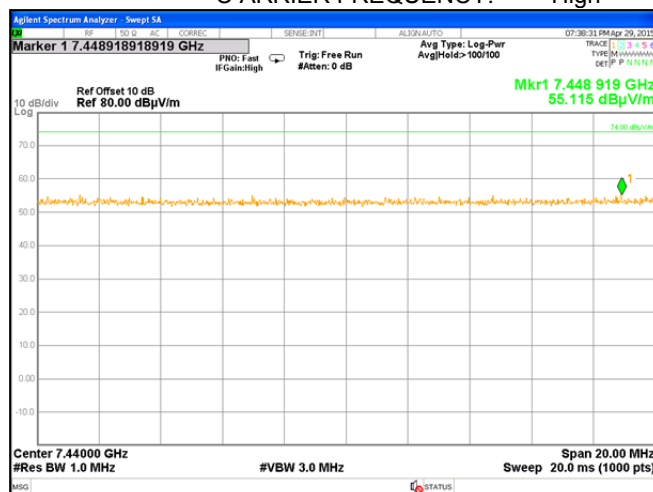
Plot 7.1.28 Radiated emission measurements at the second harmonic frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: High



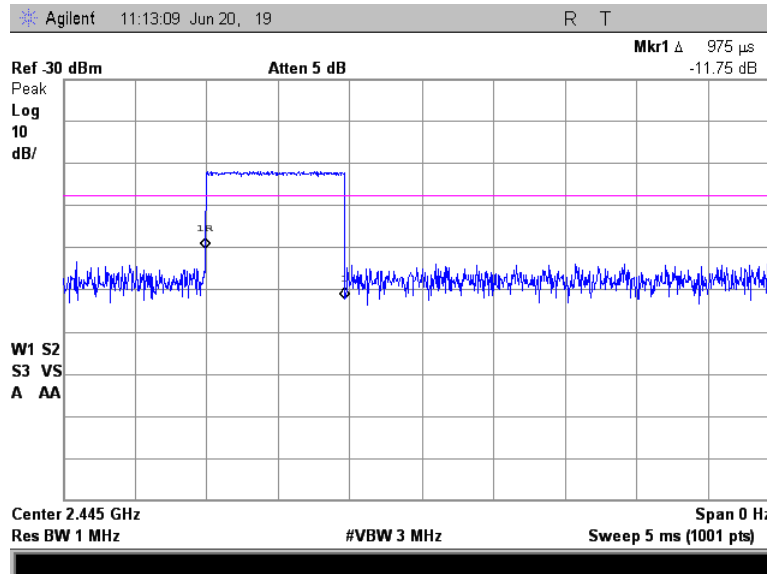
Plot 7.1.29 Radiated emission measurements at the third harmonic frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)
CARRIER FREQUENCY: High

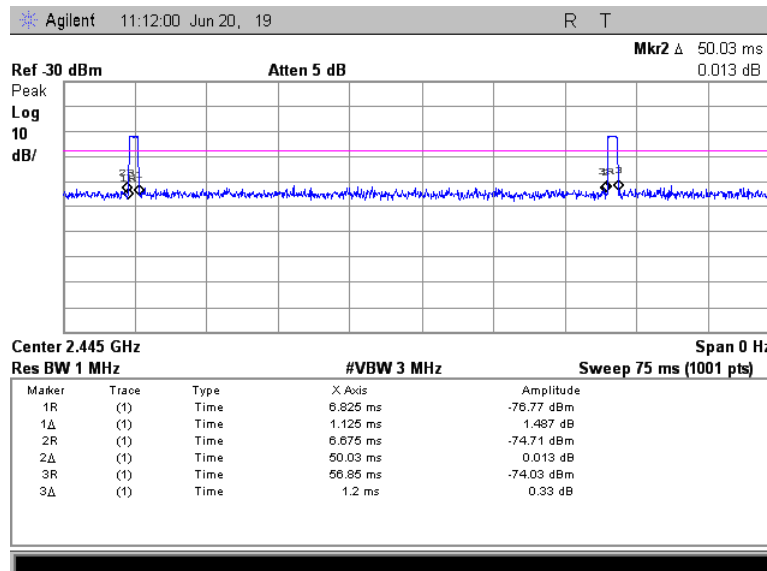


Test specification:		Section 15.249(a)(d), Field strength of emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 25 °C	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: 24 VDC
Remarks:			

Plot 7.1.30 Transmission pulse duration



Plot 7.1.31 Transmission pulse period





Test specification:		Section 15.249(d), Band edge emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Apr-15	
Temperature: 22 °C	Air Pressure: 1010 hPa	Relative Humidity: 45 %	Power Supply: 24 VDC
Remarks:			

7.2 Band edge emission

7.2.1 General

This test was performed to verify the EUT band edge emission including all associated side bands was attenuated at least 50 dB below the unmodulated carrier level or below the general spurious emission limit. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Band edge emission limits

Frequency band, MHz	Field strength limit at 3 m, dBμV/m		Attenuation below carrier, dBc
	Peak	Average	
2400-2483.5	74.0	54.0	50

7.2.2 Test procedure

7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and the performance check was conducted.

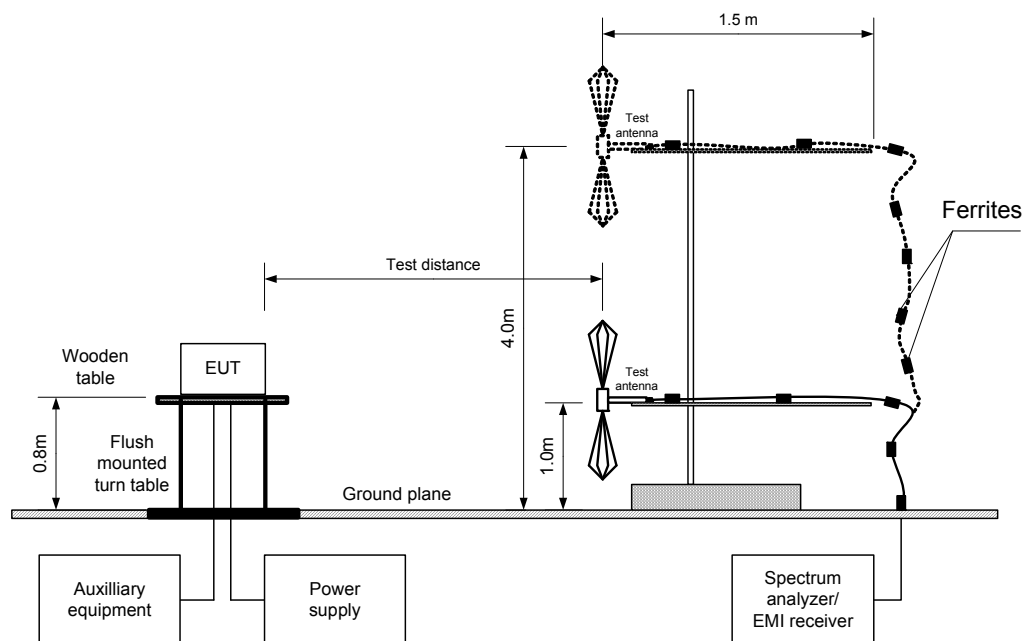
7.2.2.2 The spectrum analyzer frequency span was set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.

7.2.2.3 The frequency of modulation envelope points beyond which power level drops below the band edge emission limit was measured.

7.2.2.4 The test results were recorded in Table 7.2.2 and shown in the associated plots.

Test specification:		Section 15.249(d), Band edge emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Apr-15	
Temperature: 22 °C	Air Pressure: 1010 hPa	Relative Humidity: 45 %	Power Supply: 24 VDC
Remarks:			

Figure 7.2.1 Band edge emission measurement set up





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Test specification:		Section 15.249(d), Band edge emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Apr-15	
Temperature: 22 °C	Air Pressure: 1010 hPa	Relative Humidity: 45 %	Power Supply: 24 VDC
Remarks:			

Table 7.2.2 Band edge emission test results

OPERATING FREQUENCY RANGE: 2400 – 2483.5 MHz
DETECTOR USED: Peak hold
MODULATION: QPSK
BIT RATE: 250 kbps

Modulation envelope		Band edge limit, MHz	Margin, kHz***	Verdict
Edge	Frequency, MHz*			
Low	2402.71	2400.0	-2710	Pass
High	2483.07	2483.5	-430	Pass

* - Measured frequency beyond which the emission dropped 50 dB below the carrier emission or below the field strength limit whichever was a less stringent

** - Margin = Band edge limit – Band edge frequency

Reference numbers of test equipment used

HL 0521	HL 4114	HL 4353	HL 4722				
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Full description is given in Appendix A.



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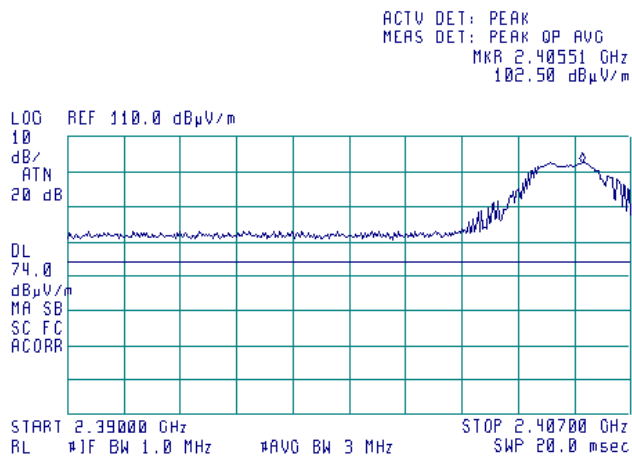
Report ID: SCRRAD_FCC.26955.docx

Date of Issue: 15-Dec-15

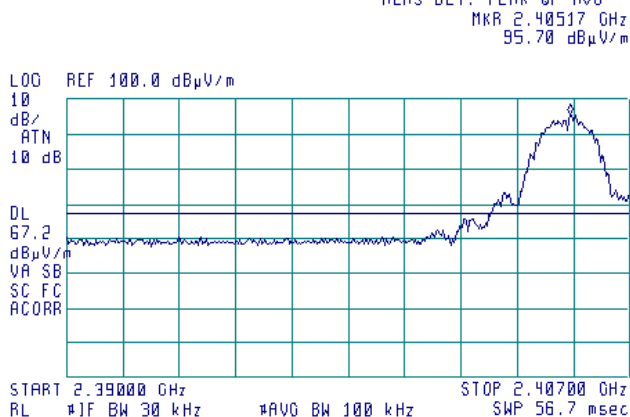
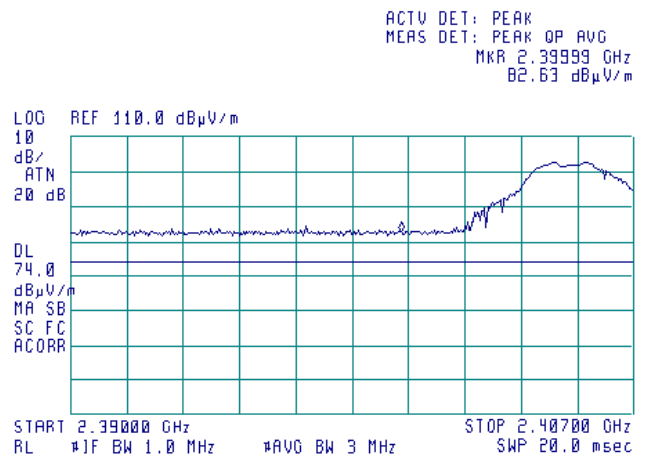
Test specification:		Section 15.249(d), Band edge emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Apr-15	
Temperature: 22 °C		Air Pressure: 1010 hPa	Relative Humidity: 45 %
Remarks:		Power Supply: 24 VDC	

Plot 7.2.1 Low band edge emission test result

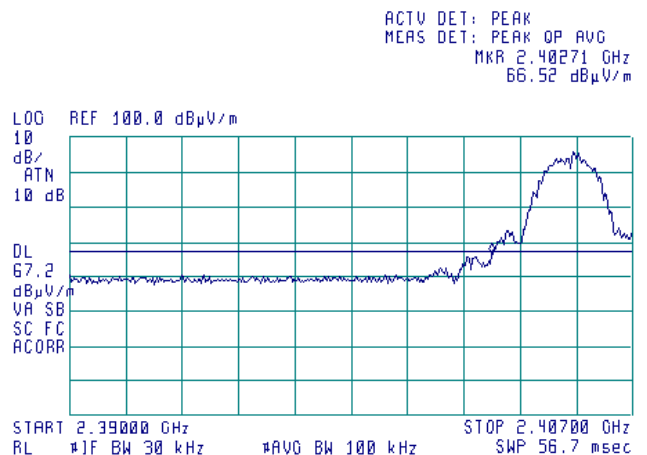
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



$$\Delta = 102.50 \text{ dB}\mu\text{V/m} - 74 \text{ dB}\mu\text{V/m} = 28.5 \text{ dB}$$



$$DL = 95.70 \text{ dB}\mu\text{V/m} - 28.5 \text{ dB} = 67.20 \text{ dB}\mu\text{V/m}$$





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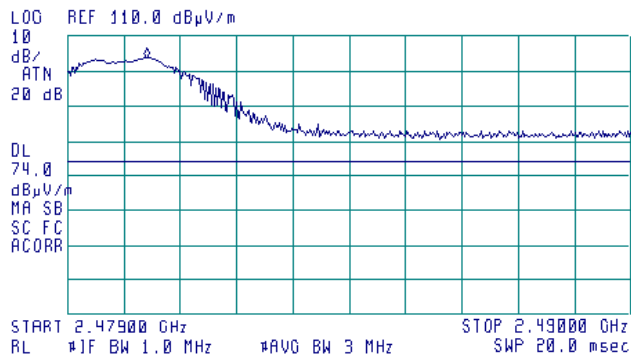
Test specification:		Section 15.249(d), Band edge emissions	
Test procedure:		ANSI C63.4, Section 13.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Apr-15	
Temperature: 22 °C	Air Pressure: 1010 hPa	Relative Humidity: 45 %	Power Supply: 24 VDC
Remarks:			

Plot 7.2.2 High band edge emission test result

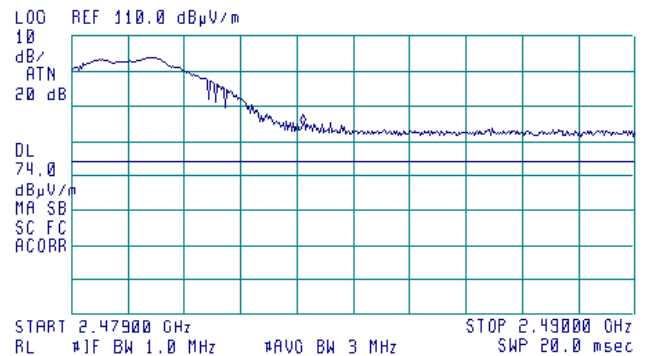
TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical and Horizontal
 EUT POSITION: Typical (Vertical)



ACTV DET: PEAK
 MEAS DET: PEAK OP AVG
 MKR 2.48054 GHz
 103.61 dBμV/m



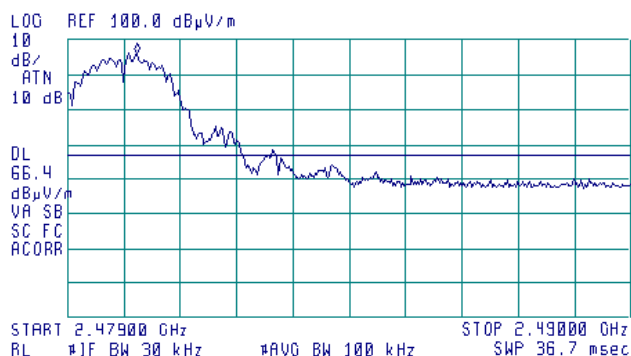
ACTV DET: PEAK
 MEAS DET: PEAK OP AVG
 MKR 2.48351 GHz
 84.78 dBμV/m



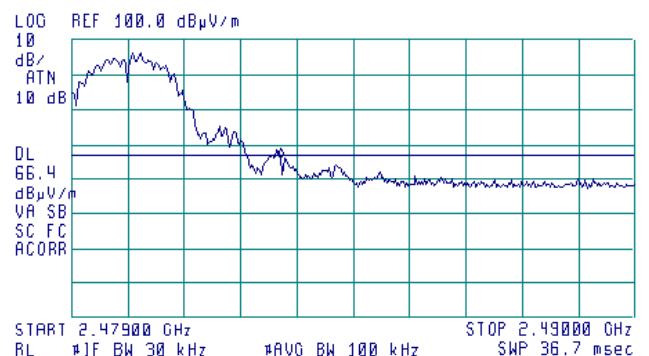
Delta = 103.61 dBμV/m - 74 dBμV/m = 29.61 dB



ACTV DET: PEAK
 MEAS DET: PEAK OP AVG
 MKR 2.48035 GHz
 96.03 dBμV/m



ACTV DET: PEAK
 MEAS DET: PEAK OP AVG
 MKR 2.48307 GHz
 65.72 dBμV/m



DL=96.03 dBμV/m - 29.61 dB = 66.42 dBμV/m



Test specification:		Section 15.203, Antenna requirement	
Test procedure:		Visual inspection / supplier declaration	
Test mode:		Compliance	Verdict: PASS
Date(s):		28-Jun-15	
Temperature: 23.2 °C	Air Pressure: 1009 hPa	Relative Humidity: 48 %	Power Supply: 24 VDC
Remarks:			

7.3 Antenna requirements

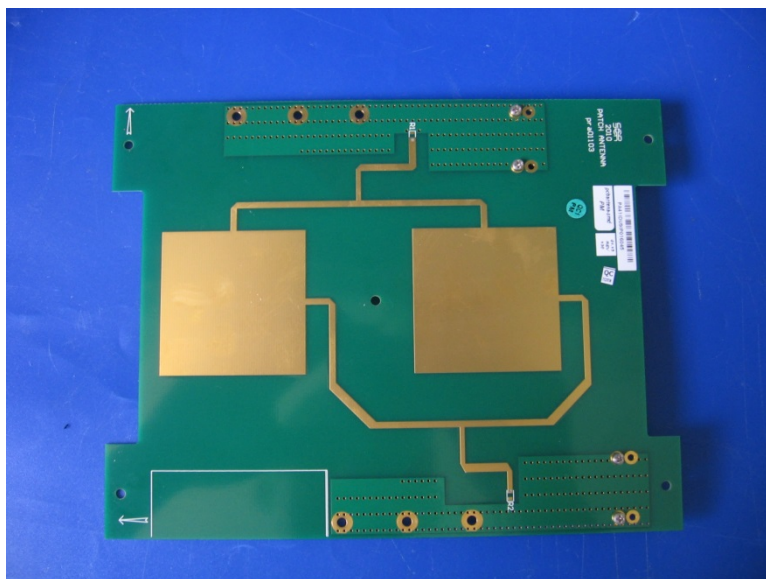
The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.3.1.

Table 7.3.1 Antenna requirements

Requirement	Rationale	Verdict
The transmitter antenna is permanently attached	Visual inspection	Comply
The transmitter employs a unique antenna connector	NA	
The transmitter requires professional installation	NA	

Photograph 7.3.1 Antenna assembly



Test specification:		Section 15.215(c), Occupied bandwidth	
Test procedure:		ANSI C63.4, Section 13.1.7	
Test mode:		Compliance	Verdict: PASS
Date(s):		24-Jun-15	
Temperature: 23.2 °C	Air Pressure: 1009 hPa	Relative Humidity: 48 %	Power Supply: 24 VDC
Remarks:			

7.4 Occupied bandwidth test

7.4.1 General

This test was performed to verify that the 20 dB bandwidth of the emissions was contained within the standard specified frequency band according to FCC §15.215 requirements. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Occupied bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc
902 - 928	20.0
2400 – 2483.5	
5725 – 5875	
24000 – 24250	

*- Modulation envelope reference points provided in terms of attenuation below modulated carrier.

7.4.2 Test procedure

- 7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and its proper operation was checked.
- 7.4.2.2 The spectrum analyzer sweep time and bandwidth were set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.
- 7.4.2.3 The peak of emission was measured. The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.4.2 and associated plot.
- 7.4.2.4 Modulation bandwidth was calculated by adding of the negative frequency drift to the lower measured frequency and the positive frequency drift to the higher measured frequency. The obtained modulation bandwidth was verified to be within the allowed frequency range.

Figure 7.4.1 Occupied bandwidth test setup





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Test specification:		Section 15.215(c), Occupied bandwidth	
Test procedure:		ANSI C63.4, Section 13.1.7	
Test mode:		Compliance	Verdict: PASS
Date(s):		24-Jun-15	
Temperature: 23.2 °C	Air Pressure: 1009 hPa	Relative Humidity: 48 %	Power Supply: 24 VDC
Remarks:			

Table 7.4.2 Occupied bandwidth test results

ASSIGNED FREQUENCY BAND 2400 – 2483.5 MHz
 DETECTOR USED: Peak hold
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 3000 kHz
 MODULATION: QPSK
 MODULATING SIGNAL: Enable

MODULATION ENVELOPE REFERENCE POINTS: 20 dBc

Frequency, MHz	Occupied BW, MHz	Cross point frequency, MHz	Assigned band edge, MHz	Verdict
2405.0	3.81	2402.81	2400.0	Pass
2445.0	3.52	NA	NA	Pass
2480.0	3.53	2481.81	2483.5	Pass

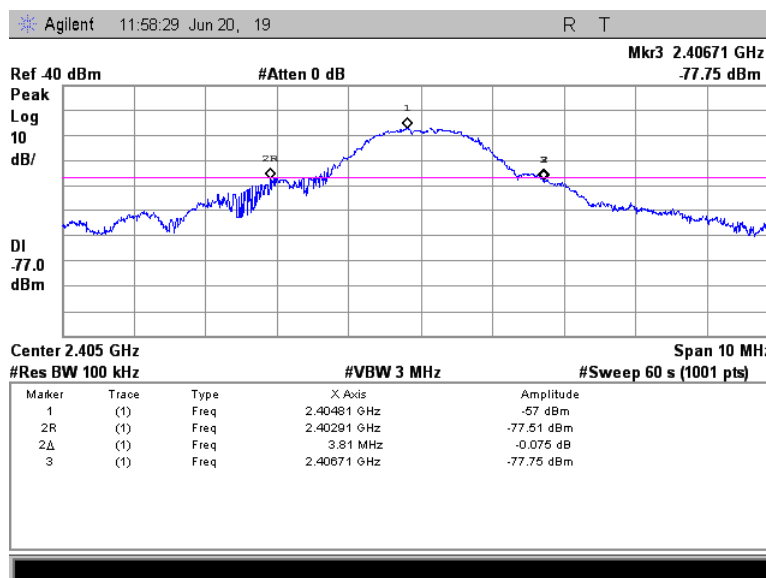
Reference numbers of test equipment used

HL 2909	HL 4273							
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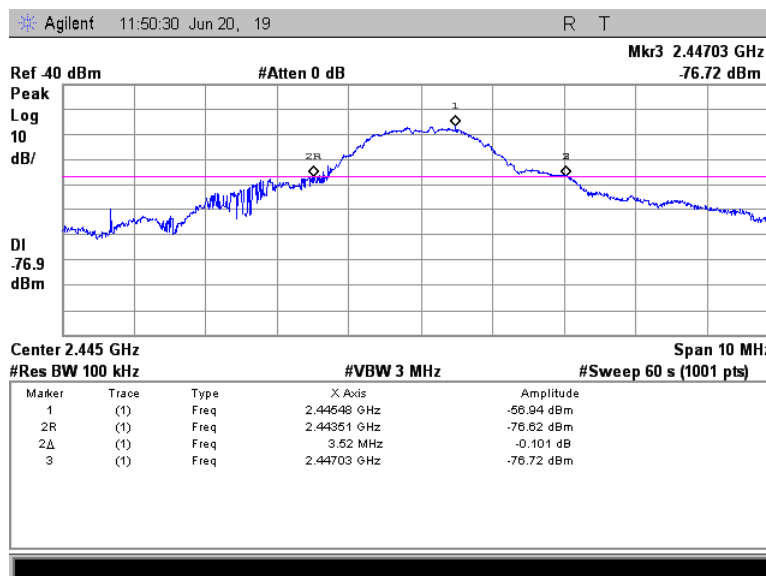
Full description is given in Appendix A.

Test specification:		Section 15.215(c), Occupied bandwidth	
Test procedure:		ANSI C63.4, Section 13.1.7	
Test mode:		Compliance	Verdict: PASS
Date(s):		24-Jun-15	
Temperature: 23.2 °C	Air Pressure: 1009 hPa	Relative Humidity: 48 %	Power Supply: 24 VDC
Remarks:			

Plot 7.4.1 Occupied bandwidth test result at low frequency, 20 dBc reference points

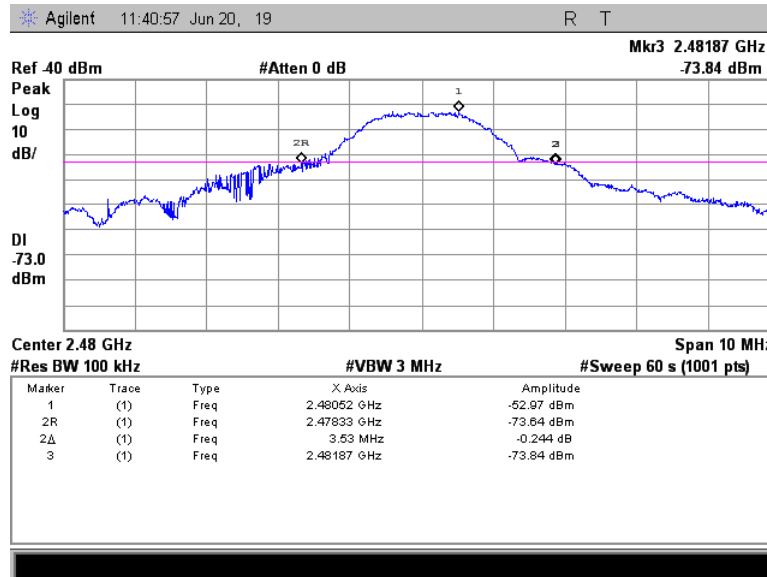


Plot 7.4.2 Occupied bandwidth test result at mid frequency, 20 dBc reference points



Test specification:		Section 15.215(c), Occupied bandwidth	
Test procedure:		ANSI C63.4, Section 13.1.7	
Test mode:		Compliance	Verdict: PASS
Date(s):		24-Jun-15	
Temperature: 23.2 °C	Air Pressure: 1009 hPa	Relative Humidity: 48 %	Power Supply: 24 VDC
Remarks:			

Plot 7.4.3 Occupied bandwidth test result at high frequency, 20 dBc reference points





Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		12-Jul-15	
Temperature: 23 °C	Air Pressure: hPa	Relative Humidity: 55 %	Power Supply: 24 VDC
Remarks:			

8 Emission tests according to 47CFR part 15 subpart B requirements

8.1 Radiated emission measurements

8.1.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits 2 are given in Table 8.1.1.

Table 8.1.1 Radiated emission test limits

Frequency, MHz	Class B limit, dB(μV/m)		Class A limit, dB(μV/m)	
	10 m distance	3 m distance	10 m distance	3 m distance
30 - 88	29.5*	40.0	39.0	49.5*
88 - 216	33.0*	43.5	43.5	54.0*
216 - 960	35.5*	46.0	46.4	56.9*
Above 960	43.5*	54.0	49.5	60.0*

* The limit for test distance other than specified was calculated using the inverse linear distance extrapolation factor as follows: $\text{Lim}_{S_2} = \text{Lim}_{S_1} + 20 \log(S_1/S_2)$, where S_1 and S_2 – standard defined and test distance respectively in meters.

8.1.2 Test procedure for measurements in semi-anechoic chamber

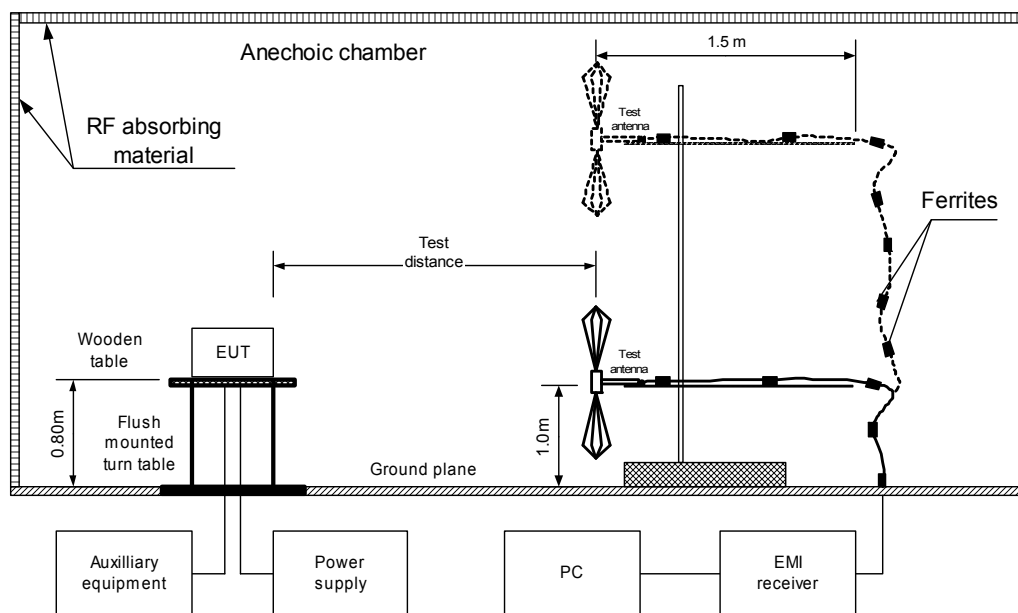
8.1.2.1 The EUT was set up as shown in Figure 8.1.1 and associated photograph/s, energized and the performance check was conducted.

8.1.2.2 The specified frequency range was investigated with biconilog antenna connected to EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal and the EUT cables position was varied.

8.1.2.3 The worst test results (the lowest margins) were recorded in Table 8.1.2 and shown in the associated plots.

Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		12-Jul-15	
Temperature: 23 °C	Air Pressure: hPa	Relative Humidity: 55 %	Power Supply: 24 VDC
Remarks:			

Figure 8.1.1 Setup for radiated emission measurements in anechoic chamber, table-top equipment



Photograph 8.1.1 Setup for radiated emission measurements





Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		12-Jul-15	
Temperature: 23 °C	Air Pressure: hPa	Relative Humidity: 55 %	Power Supply: 24 VDC
Remarks:			

Table 8.1.2 Radiated emission test results

EUT SET UP: TABLE-TOP
LIMIT: Class B
EUT OPERATING MODE: Receive / Stand-by
TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / QUASI-PEAK
FREQUENCY RANGE: 30 MHz – 1000 MHz
RESOLUTION BANDWIDTH: 120 kHz

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
38.283	40.30	36.32	40.0	-3.68	Vertical	1.0	10	Pass
84.240	37.58	37.21	40.0	-2.79	Vertical	1.0	180	
89.925	37.84	35.73	43.5	-7.77	Vertical	1.0	170	
91.545	38.96	37.11	43.5	-6.39	Vertical	1.0	20	
125.998	40.98	37.09	43.5	-6.41	Vertical	1.0	40	
152.225	39.46	35.51	43.5	-7.99	Vertical	1.0	180	

TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 12000 MHz
RESOLUTION BANDWIDTH: 1000 kHz

Frequency, MHz	Peak			Average			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
2403	43.063	74.0	30.94	43.063	54.0	-10.94	Horizontal	1.5	319	Pass
2443	42.196	74.0	-31.80	42.196	54.0	-11.80	Horizontal	1.5	330	
2478	42.405	74.0	-31.60	42.405	54.0	-11.60	Horizontal	1.5	315	

*- Margin = Measured emission - specification limit.

** - EUT front panel refer to 0 degrees position of turntable.

Reference numbers of test equipment used

HL 0521	HL 0604	HL 1984	HL 3901	HL 4273	HL 4279	HL 4347	HL 4353
HL 4575	HL 4721	HL 4722	HL 4932				

Full description is given in Appendix A.

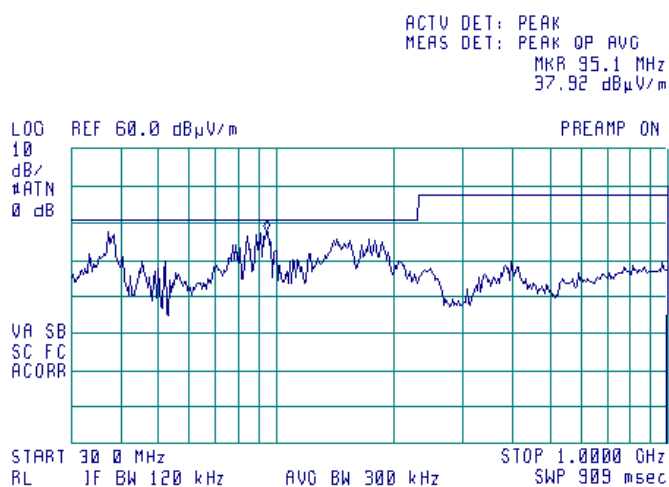


HERMON LABORATORIES

Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		12-Jul-15	
Temperature: 23 °C	Air Pressure: hPa	Relative Humidity: 55 %	Power Supply: 24 VDC
Remarks:			

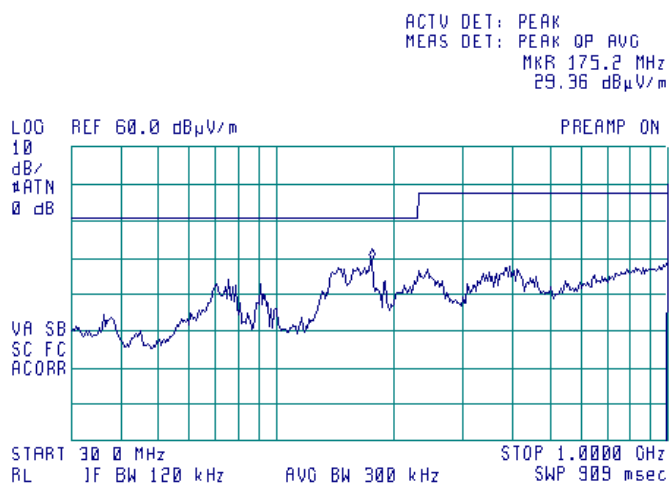
Plot 8.1.1 Radiated emission measurements in 30 - 1000 MHz range, vertical antenna polarization

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT OPERATING MODE: Receive / Stand-by



Plot 8.1.2 Radiated emission measurements in 30 - 1000 MHz range, vertical antenna polarization

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT OPERATING MODE: Receive / Stand-by





HERMON LABORATORIES

Report ID: SCRRAD_FCC.26955.docx

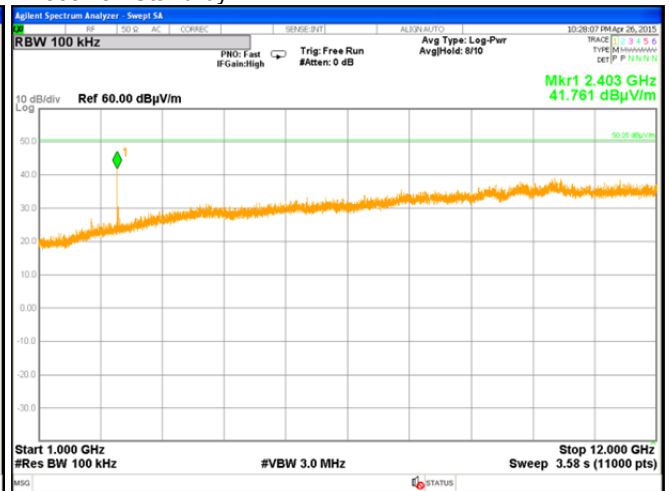
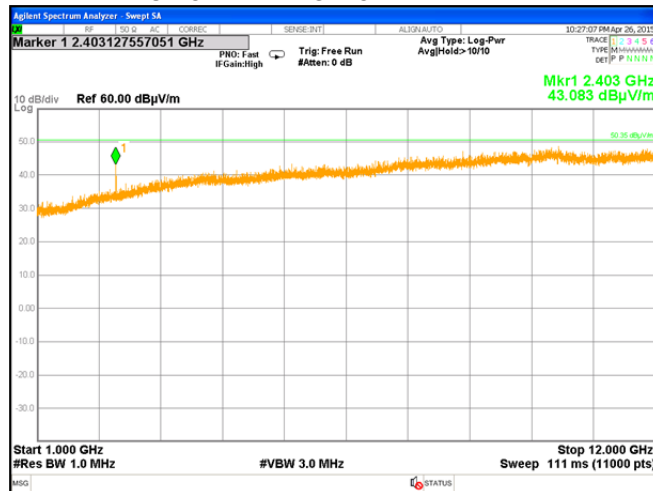
Date of Issue: 15-Dec-15

Test specification:		Section 15.109, Radiated emission	
Test procedure:		ANSI C63.4, Sections 11.6 and 12.1.4	
Test mode:		Compliance	Verdict: PASS
Date(s):		12-Jul-15	
Temperature: 23 °C		Air Pressure: hPa	Relative Humidity: 55 %
Remarks:		Power Supply: 24 VDC	

Plot 8.1.3 Radiated emission measurements in 1 –12.0 GHz range

TEST SITE:
OPERATIONAL MODE:
ANTENNA POLARIZATION:
TEST DISTANCE:
EUT OPERATING MODE:

Anechoic chamber
Receive
Vertical and Horizontal
3 m
Receive / Stand-by



9 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 kHz - 30 MHz	EMCO	6502	2857	13-Jan-15	13-Jan-16
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A002 53	22-Oct-14	22-Oct-15
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	15-May-15	15-May-16
1984	Antenna, Double-Ridged Waveguide Horn, 1-18 GHz, 300 W	EMC Test Systems	3115	9911-5964	17-Apr-15	17-Apr-16
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY414447 62	22-Feb-15	22-Feb-16
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLE X 102A	1225/2A	10-Feb-15	10-Feb-16
4114	Antenna, Double-Ridged Waveguide Horn, 1-18 GHz	ETS Lindgren	3117	00123515	19-Dec-14	19-Dec-15
4273	Test Cable , DC-18 GHz, 1.8 m, SMA/M - N/M	Mini-Circuits	CBL-6FT-SMNM+	70045	28-May-15	28-May-16
4279	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0757A	20-Nov-14	20-Nov-15
4347	Low Loss Armored Test Cable, DC - 18 GHz, 2.0 m, N type-M/N type-M	MegaPhase	NC29-N1N1-79	12025103 001	08-Jan-15	08-Jan-16
4353	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	12025101 003	15-Mar-15	15-Mar-16
4474	Double Ridged Waveguide Antenna, 0.8 to 18 GHz	FT-RT Antenna, Inc.	HA-08M18G-NF	201206090 1	19-Dec-14	19-Dec-15
4575	EXA Signal Analyzer, 9 kHz - 26.5 GHz	Agilent Technologies	N9010A	MY480301 10	05-Feb-15	05-Feb-16
4721	Low Loss Armored Test Cable, DC - 18 GHz, 4.5 m, N type-M/N type-M	MegaPhase	NC29-N1N1-177	51300101 001	12-Jul-15	12-Jul-16
4722	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	51228701 001	26-Aug-14	26-Aug-15
4932	Microwave preamplifier, 500 MHz to 18 GHz, 40 dB Gain	Com-Power Corporation	PAM-118A	551029	18-Nov-14	18-Nov-15

10 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Radiated emissions at 10 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.0 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.1 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 5.5 dB Biconical antenna: ± 5.5 dB Log periodic antenna: ± 5.6 dB Double ridged horn antenna: ± 5.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Occupied bandwidth	± 8.0 %

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.

Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.

In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

11 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, safety, environmental and telecommunication testing facility.

Hermon Laboratories is listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47), Registration Numbers 90624 for OATS and 90623 for the anechoic chamber; by Industry Canada for electromagnetic emissions (file numbers IC 2186A-1 for OATS), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, C-845 for conducted emissions site), has a status of a Telefication - Listed Testing Laboratory, Certificate No. L138/00. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing and environmental simulation (for exact scope please refer to Certificate No. 839.01). The FCC Designation Number is US1003.

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Person for contact: Mr. Alex Usoskin, CEO.

12 APPENDIX D Specification references

FCC 47CFR part 15: 2014	Radio Frequency Devices
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications
ANSI C63.4: 2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

13 APPENDIX E Test equipment correction factors

Antenna factor
Active loop antenna
Model 6502, S/N 2857, HL 0446

Frequency, MHz	Magnetic antenna factor, dB	Electric antenna factor, dB
0.009	-32.8	18.7
0.010	-33.8	17.7
0.020	-38.3	13.2
0.050	-41.1	10.4
0.075	-41.3	10.2
0.100	-41.6	9.9
0.150	-41.7	9.8
0.250	-41.6	9.9
0.500	-41.8	9.8
0.750	-41.9	9.7
1.000	-41.4	10.1
2.000	-41.5	10.0
3.000	-41.4	10.2
4.000	-41.4	10.1
5.000	-41.5	10.1
10.000	-41.9	9.6
15.000	-41.9	9.6
20.000	-42.2	9.3
25.000	-42.8	8.7
30.000	-44.0	7.5

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μ V) to convert it into field intensity in dB(μ V/m).

Antenna factor
Biconilog antenna EMCO Model 3141
Ser.No.1011, HL 0604

Frequency, MHz	Antenna factor, dB(1/m)	Frequency, MHz	Antenna factor, dB(1/m)	Frequency, MHz	Antenna factor, dB(1/m)
26	7.8	580	20.6	1320	27.8
28	7.8	600	21.3	1340	28.3
30	7.8	620	21.5	1360	28.2
40	7.2	640	21.2	1380	27.9
60	7.1	660	21.4	1400	27.9
70	8.5	680	21.9	1420	27.9
80	9.4	700	22.2	1440	27.8
90	9.8	720	22.2	1460	27.8
100	9.7	740	22.1	1480	28.0
110	9.3	760	22.3	1500	28.5
120	8.8	780	22.6	1520	28.9
130	8.7	800	22.7	1540	29.6
140	9.2	820	22.9	1560	29.8
150	9.8	840	23.1	1580	29.6
160	10.2	860	23.4	1600	29.5
170	10.4	880	23.8	1620	29.3
180	10.4	900	24.1	1640	29.2
190	10.3	920	24.1	1660	29.4
200	10.6	940	24.0	1680	29.6
220	11.6	960	24.1	1700	29.8
240	12.4	980	24.5	1720	30.3
260	12.8	1000	24.9	1740	30.8
280	13.7	1020	25.0	1760	31.1
300	14.7	1040	25.2	1780	31.0
320	15.2	1060	25.4	1800	30.9
340	15.4	1080	25.6	1820	30.7
360	16.1	1100	25.7	1840	30.6
380	16.4	1120	26.0	1860	30.6
400	16.6	1140	26.4	1880	30.6
420	16.7	1160	27.0	1900	30.6
440	17.0	1180	27.0	1920	30.7
460	17.7	1200	26.7	1940	30.9
480	18.1	1220	26.5	1960	31.2
500	18.5	1240	26.5	1980	31.6
520	19.1	1260	26.5	2000	32.0
540	19.5	1280	26.6		
560	19.8	1300	27.0		

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μ V) to convert it into field strength in dB(μ V/m).

Antenna factor
Double-ridged wave guide horn antenna
Model 3115, S/N 9911-5964, HL1984

Frequency, MHz	Antenna factor, dB(1/m)
1000.0	24.7
1500.0	25.7
2000.0	27.6
2500.0	28.9
3000.0	31.2
3500.0	32.0
4000.0	32.5
4500.0	32.7
5000.0	33.6
5500.0	35.1
6000.0	35.4
6500.0	34.9
7000.0	36.1
7500.0	37.8
8000.0	38.0
8500.0	38.1
9000.0	39.1
9500.0	38.3
10000.0	38.6
10500.0	38.2
11000.0	38.7
11500.0	39.5
12000.0	40.0
12500.0	40.4
13000.0	40.5
13500.0	41.1
14000.0	41.6
14500.0	41.7
15000.0	38.7
15500.0	38.2
16000.0	38.8
16500.0	40.5
17000.0	42.5
17500.0	45.9
18000.0	49.4

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μ V) to convert it into field strength in dB(μ V/m).

Antenna factor
Double-ridged waveguide horn antenna
ETS Lindgren, Model 3117, serial number: 00123515, HL 4114

Frequency, MHz	Antenna factor, dB/m		
	Measured	Manufacturer	Deviation
1000	28.0	28.4	-0.4
1500	28.0	27.4	0.6
2000	31.2	30.9	0.3
2500	32.5	33.4	-0.9
3000	32.9	32.6	0.3
3500	32.7	32.8	-0.1
4000	33.1	33.4	-0.3
4500	33.8	33.9	-0.1
5000	33.8	34.1	-0.3
5500	34.4	34.5	-0.1
6000	35.0	35.2	-0.2
6500	35.4	35.5	-0.1
7000	35.7	35.7	0.0
7500	35.9	35.7	0.2
8000	35.8	35.8	0.0
8500	35.9	35.8	0.1
9000	36.3	36.2	0.1
9500	36.6	36.6	0.0
10000	37.1	37.1	0.0
10500	37.6	37.5	0.1
11000	37.9	37.7	0.2
11500	38.5	38.1	0.4
12000	39.2	38.7	0.5
12500	39.0	38.9	0.1
13000	39.1	39.1	0.0
13500	38.9	38.8	0.1
14000	39.0	38.8	0.2
14500	39.6	39.9	-0.3
15000	39.9	39.7	0.2
15500	39.9	40.1	-0.2
16000	40.7	40.8	-0.1
16500	41.3	41.8	-0.5
17000	42.5	42.1	0.4
17500	41.3	41.2	0.1
18000	41.4	40.9	0.5

Antenna factor is to be added to receiver meter reading in dB(μ V) to convert to field strength in dB(μ V/meter)

Antenna factor
Double-ridged waveguide antenna
FT-RT Antenna, Inc., Model HA-08M18G-NF, serial number: 2012060901, HL 4474

Frequency, MHz	Measured antenna factor, dB/m
1000	23.9
1500	24.9
2000	26.9
2500	28.0
3000	28.5
3500	29.7
4000	31.1
4500	32.3
5000	33.7
5500	34.4
6000	35.1
6500	36.0
7000	37.2
7500	37.6
8000	37.6
8500	37.7
9000	37.7
9500	37.7
10000	38.2
10500	39.5
11000	40.1
11500	39.7
12000	39.1
12500	39.0
13000	39.5
13500	40.5
14000	41.2
14500	40.9
15000	40.0
15500	38.8
16000	38.2
16500	40.0
17000	41.4
17500	43.2
18000	43.7

The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ V/m.

Cable loss
Microwave Cable Assembly, Huber-Suhner, 40 GHz, 3.5 m, SMA-SMA, S/N 1225/2A
HL 3901

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.09	9500	4.29	21000	6.67
100	0.41	10000	4.40	22000	6.92
500	0.93	10500	4.52	23000	7.00
1000	1.33	11000	4.64	24000	7.18
1500	1.63	11500	4.76	25000	7.29
2000	1.90	12000	4.87	26000	7.55
2500	2.12	12500	4.99	27000	7.70
3000	2.33	13000	5.11	28000	7.88
3500	2.50	13500	5.20	29000	8.02
4000	2.67	14000	5.31	30000	8.15
4500	2.82	14500	5.42	31000	8.35
5000	2.99	15000	5.51	32000	8.40
5500	3.16	15500	5.58	33000	8.62
6000	3.32	16000	5.68	34000	8.73
6500	3.51	16500	5.78	35000	8.78
7000	3.65	17000	5.91	36000	8.94
7500	3.79	17500	5.99	37000	9.21
8000	3.92	18000	6.07	38000	9.37
8500	4.04	19000	6.36	39000	9.45
9000	4.18	20000	6.49	40000	9.52

Cable loss
Test cable, Mini-Circuits, S/N 70045, 18 GHz, 1.8 m, SMA/M - N/M
CBL-6FT-SMNM+, HL 4273

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.09	4800	1.76	9800	2.70	14800	3.59
30	0.11	4900	1.78	9900	2.71	14900	3.59
50	0.14	5000	1.81	10000	2.73	15000	3.60
100	0.20	5100	1.82	10100	2.75	15100	3.63
200	0.30	5200	1.86	10200	2.76	15200	3.67
300	0.38	5300	1.89	10300	2.79	15300	3.70
400	0.45	5400	1.92	10400	2.81	15400	3.68
500	0.50	5500	1.96	10500	2.82	15500	3.70
600	0.55	5600	2.00	10600	2.83	15600	3.71
700	0.60	5700	2.03	10700	2.87	15700	3.77
800	0.65	5800	2.04	10800	2.87	15800	3.75
900	0.69	5900	2.07	10900	2.88	15900	3.77
1000	0.73	6000	2.10	11000	2.89	16000	3.79
1100	0.77	6100	2.10	11100	2.91	16100	3.85
1200	0.80	6200	2.11	11200	2.92	16200	3.82
1300	0.84	6300	2.11	11300	2.94	16300	3.83
1400	0.88	6400	2.14	11400	2.95	16400	3.88
1500	0.92	6500	2.15	11500	2.98	16500	3.89
1600	0.95	6600	2.15	11600	3.00	16600	3.92
1700	0.98	6700	2.16	11700	3.02	16700	3.88
1800	1.01	6800	2.19	11800	3.04	16800	3.95
1900	1.04	6900	2.22	11900	3.08	16900	3.91
2000	1.07	7000	2.24	12000	3.09	17000	3.97
2100	1.09	7100	2.26	12100	3.12	17100	3.92
2200	1.13	7200	2.29	12200	3.13	17200	3.94
2300	1.15	7300	2.32	12300	3.16	17300	3.94
2400	1.18	7400	2.36	12400	3.17	17400	3.98
2500	1.21	7500	2.39	12500	3.19	17500	3.93
2600	1.24	7600	2.41	12600	3.20	17600	3.95
2700	1.27	7700	2.43	12700	3.21	17700	3.96
2800	1.30	7800	2.46	12800	3.21	17800	3.97
2900	1.34	7900	2.49	12900	3.22	17900	3.96
3000	1.36	8000	2.52	13000	3.22	18000	3.97
3100	1.38	8100	2.52	13100	3.24		
3200	1.41	8200	2.54	13200	3.24		
3300	1.45	8300	2.59	13300	3.27		
3400	1.46	8400	2.61	13400	3.28		
3500	1.49	8500	2.60	13500	3.31		
3600	1.51	8600	2.63	13600	3.31		
3700	1.55	8700	2.65	13700	3.35		
3800	1.34	8800	2.65	13800	3.37		
3900	1.36	8900	2.65	13900	3.40		
4000	1.38	9000	2.66	14000	3.43		
4100	1.41	9100	2.66	14100	3.45		
4200	1.45	9200	2.67	14200	3.46		
4300	1.46	9300	2.67	14300	3.46		
4400	1.49	9400	2.67	14400	3.49		
4500	1.51	9500	2.68	14500	3.50		
4600	1.55	9600	2.69	14600	3.50		
4700	1.34	9700	2.69	14700	3.52		

Cable loss
Test cable, Mini-Circuits, S/N 0757A, 18 GHz, 4.6 m, N/M - N/M
APC-15FT-NMNM+, HL 4279

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.26	5000	4.23	10200	6.47	15400	8.46
30	0.26	5100	4.28	10300	6.53	15500	8.49
50	0.34	5200	4.32	10400	6.57	15600	8.50
100	0.50	5300	4.37	10500	6.59	15700	8.53
200	0.72	5400	4.41	10600	6.62	15800	8.56
300	0.90	5500	4.46	10700	6.64	15900	8.60
400	1.05	5600	4.51	10800	6.66	16000	8.62
500	1.20	5700	4.57	10900	6.69	16100	8.65
600	1.31	5800	4.61	11000	6.69	16200	8.68
700	1.44	5900	4.64	11100	6.70	16300	8.70
800	1.53	6000	4.70	11200	6.72	16400	8.72
900	1.63	6100	4.75	11300	6.74	16500	8.76
1000	1.74	6200	4.76	11400	6.79	16600	8.77
1100	1.83	6300	4.82	11500	6.83	16700	8.78
1200	1.92	6400	4.83	11600	6.85	16800	8.82
1300	2.01	6500	4.88	11700	6.89	16900	8.85
1400	2.09	6600	4.90	11800	6.94	17000	8.91
1500	2.17	6700	4.95	11900	7.00	17100	8.94
1600	2.25	6800	5.01	12000	7.04	17200	8.98
1700	2.33	6900	4.98	12100	7.10	17300	9.03
1800	2.39	7000	5.03	12200	7.18	17400	9.05
1900	2.47	7100	5.11	12300	7.23	17500	9.08
2000	2.53	7200	5.13	12400	7.29	17600	9.10
2100	2.60	7300	5.20	12500	7.34	17700	9.12
2200	2.67	7400	5.28	12600	7.39	17800	9.14
2300	2.74	7500	5.33	12700	7.45	17900	9.17
2400	2.80	7600	5.37	12800	7.49	18000	9.21
2500	2.87	7700	5.44	12900	7.53		
2600	2.92	7800	5.52	13000	7.58		
2700	3.00	7900	5.56	13100	7.62		
2800	3.06	8000	5.63	13200	7.67		
2900	3.12	8100	5.67	13300	7.71		
3000	3.18	8200	5.71	13400	7.74		
3100	3.24	8300	5.76	13500	7.79		
3200	3.30	8400	5.79	13600	7.82		
3300	3.35	8500	5.85	13700	7.84		
3400	3.41	8600	5.88	13800	7.87		
3500	3.46	8700	5.92	13900	7.90		
3600	3.51	8800	5.96	14000	7.94		
3700	3.56	8900	6.02	14100	7.98		
3800	3.61	9000	6.05	14200	8.01		
3900	3.66	9100	6.08	14300	8.05		
4000	3.71	9200	6.15	14400	8.10		
4100	3.77	9300	6.18	14500	8.12		
4200	3.83	9400	6.20	14600	8.16		
4300	3.89	9500	6.25	14700	8.22		
4400	3.94	9600	6.28	14800	8.26		
4500	3.99	9700	6.31	14900	8.29		
4600	4.05	9800	6.35	15000	8.33		
4700	4.09	9900	6.37	15100	8.39		
4800	4.15	10000	6.40	15200	8.41		
4900	4.19	10100	6.45	15300	8.44		

Cable loss
Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,
NC29-N1N1-79 S/N 12025103 001,
HL 4347

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
50	0.08	9000	0.92
100	0.11	9500	1.00
300	0.18	10000	1.05
500	0.23	10500	1.04
1000	0.32	11000	1.05
1500	0.39	11500	1.09
2000	0.45	12000	1.13
2500	0.50	12500	1.15
3000	0.54	13000	1.19
3500	0.59	13500	1.19
4000	0.62	14000	1.22
4500	0.65	14500	1.26
5000	0.69	15000	1.32
5500	0.71	15500	1.38
6000	0.77	16000	1.34
6500	0.82	16500	1.36
7000	0.84	17000	1.46
7500	0.85	17500	1.49
8000	0.88	18000	1.46
8500	0.90		

Cable loss
Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,
NC29-N1N1-244S/N 12025101 003,
HL 4353

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
50	0.20	9000	2.71
100	0.27	9500	2.81
300	0.47	10000	2.90
500	0.61	10500	2.97
1000	0.87	11000	3.06
1500	1.07	11500	3.13
2000	1.24	12000	3.20
2500	1.39	12500	3.26
3000	1.53	13000	3.34
3500	1.65	13500	3.39
4000	1.77	14000	3.47
4500	1.89	14500	3.54
5000	1.99	15000	3.62
5500	2.07	15500	3.69
6000	2.20	16000	3.76
6500	2.30	16500	3.83
7000	2.39	17000	3.86
7500	2.51	17500	3.94
8000	2.58	18000	4.02
8500	2.65		

Cable loss
Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,
NC29-N1N1-244, S/N 51228701001
HL 4722

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
50	0.22	9000	2.93
100	0.30	9500	3.06
300	0.52	10000	3.16
500	0.66	10500	3.20
1000	0.93	11000	3.34
1500	1.15	11500	3.39
2000	1.33	12000	3.48
2500	1.49	12500	3.55
3000	1.64	13000	3.66
3500	1.77	13500	3.75
4000	1.90	14000	3.76
4500	2.03	14500	3.87
5000	2.17	15000	3.98
5500	2.30	15500	4.01
6000	2.39	16000	4.14
6500	2.51	16500	4.15
7000	2.59	17000	4.32
7500	2.67	17500	4.36
8000	2.76	18000	4.38
8500	2.84		

14 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μ V)	decibel referred to one microvolt
dB(μ V/m)	decibel referred to one microvolt per meter
dB(μ A)	decibel referred to one microampere
DC	direct current
EIRP	equivalent isotropically radiated power
ERP	effective radiated power
EUT	equipment under test
F	frequency
GHz	gigahertz
GND	ground
H	height
HL	Hermon laboratories
Hz	hertz
k	kilo
kHz	kilohertz
LO	local oscillator
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
μ s	microsecond
NA	not applicable
OATS	open area test site
Ω	Ohm
PS	power supply
ppm	part per million (10^{-6})
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt

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