HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC CFR 47 Part 15 subpart F, section 15.519;
RSS-220 issue 1

FOR:

Pixie Technology Ltd.
PixiePoint Tag
Model: P1000
FCC ID:2ADBO-P1000

Table of contents

1 Applicant information

Client name:	Pixie Technology Ltd.
Address:	8 Hamada street,Bld. B, 3rd floor, Herzliya 46733, Israel
Telephone:	+972 77 921 5815
Fax:	+972 77 921 5833
E-mail:	tsachs@getpixie.com
Contact name:	Mr. Tsach Shwartz

2 Equipment under test attributes

Product name:	PixiePoint tag
Product type:	Transceiver
Model(s):	P1000
Hardware version:	Rev D
Software release:	001
Receipt date	17-May-15

3 Manufacturer information

Manufacturer name:	Pixie Technology Ltd.
Address:	8 Hamada street,Bld. B, 3rd floor, Herzliya 46733, Israel
Telephone:	+972 77 921 5815
Fax:	+972 77 921 5833
E-Mail:	tsachs@getpixie.com
Contact name:	Mr. Tsach Shwartz

4 Test details

Project ID:	26451
Location:	Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel
Test started:	07-Jun-15
Test completed:	25-Jun-15
Test specification(s):	FCC CFR 47 Part 15 subpart F, section 15.519; RSS-220 Issue 1

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.519(c), RSS-220 section 5.3.1(d), Radiated power density	Pass
FCC section 15.519(b), Occupied bandwidth	Pass
FCC section 15.519(c)/15.209, RSS-220 section 3.4,Radiated spurious emissions below 1 GHz	Pass
FCC section 15.519(d), RSS-220 section 5.3.1(d), Radiated spurious emissions above 1 GHz	Pass
FCC section 15.519(e), RSS-220 section 5.3.1(g), Peak power within 50 MHz bandwidth	Pass
FCC section 15.519(a)(1), RSS-220 section 5.3.1(b),Transmission duration requirements	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. V. Einem, test engineer	June 25, 2015	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	July 6, 2015	
Approved by:	Mr. M. Nikishin, EMC and Radio group manager	August 25, 2015	

6 EUT description

6.1 General information

The EUT, PixiePoint tag, is a very low power wireless device utilizing 2 wireless technologies:

BLE (Bluetooth) to communicate with smartphones and UWB to measure distance between the tags.

The tag is working in very low duty cycle. Most of the time the tag is advertising (sends BLE standard "existing" message). Advertise is done every 2 sec for 3 msec. The UWB radio is set to deep sleep.

Once the smartphone responses the tag can communicate with the smartphone and via smartphone can communicate with other similar tags and measure Tag to Tag range using the UWB radio.

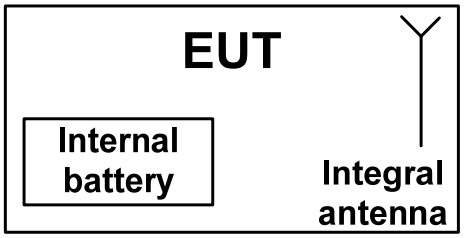
The UWB radio is active for minimal time that is needed for range measurement – about 2 -3 msec.

After the measurement sequence, the UWB is set to deep sleep again.

The BLE (Bluetooth) and UWB radio do not work at the same time.

There is one built-in antenna for UWB and BLE.

6.2 Test configuration



6.3 Changes made in EUT

No changes were performed in the EUT during testing.

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	3774-4243.2 MHz, 4243.2-4742.4 MHz, 6240-6739.2 MHz
Operating frequencies	3993.6 MHz (ch2), 4492.8 MHz (ch3), 6489.6 MHz (ch5)

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	with temporary RF connector
				V without temporary RF connector

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Printed Omni	Pixie	P1000	0 dBi

Transmitter aggregate data rate/s	No payload
Type of modulation	Burst position modulation (BPM) according to IEEE802.15.4-2011 UWB
Modulating test signal (baseband)	Burst position modulation (BPM) according to IEEE802.15.4-2011 UWB

Transmitter power source					
V	Battery	**Nominal rated voltage**	3.0 V	Battery type	Lithium Manganese Dioxide
	DC	**Nominal rated voltage**			
	AC mains	**Nominal rated voltage**		Frequency	Hz

Test specification:	**Section 15.519(c), RSS-220 section 5.3.1(d), Radiated power density**		
Test procedure:	47 CFR, Section 15.521, ANSI C63.10-2013, section 10.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

7 Transmitter tests according to 47CFR part 15 and RSS-220 requirements

7.1 Radiated power density

7.1.1 General

This test was performed to measure effective radiated power emanated by transmitter at carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 Maximum power spectral density limit

Assigned frequency band, MHz	EIRP, dBm/1MHz
3100 - 10600	-41.3

7.1.2 Test procedure for field strength measurements

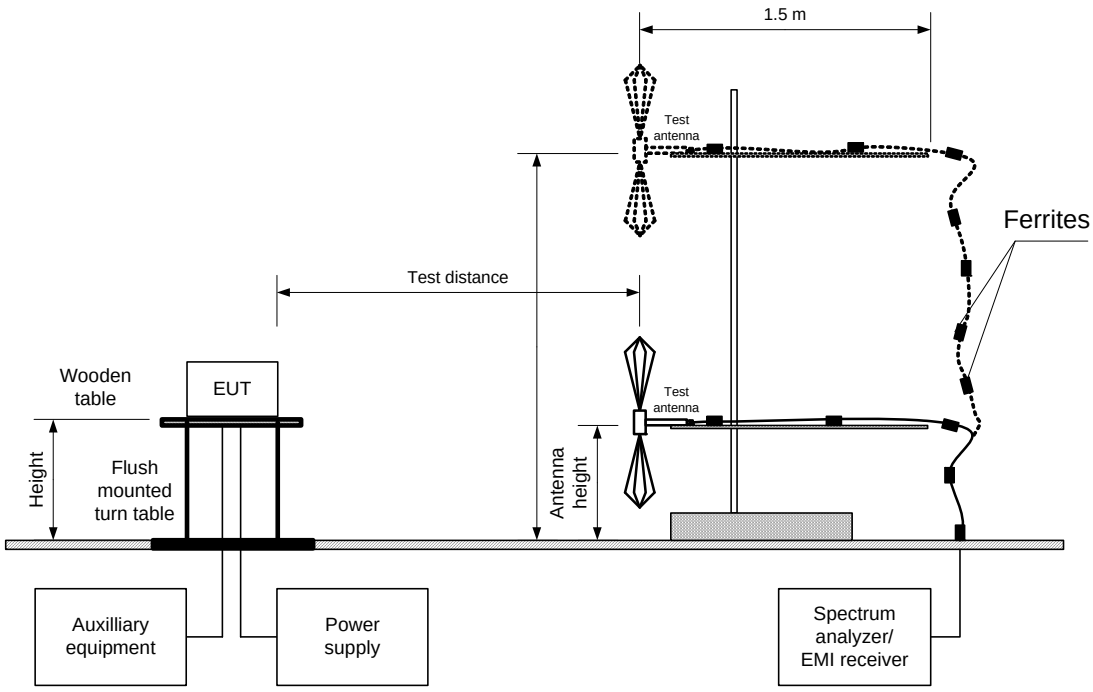
7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and the performance check was conducted.

7.1.2.2 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was swept throughout the range, specified in Table 7.1.2, in both vertical and horizontal polarizations.

7.1.2.3 The worst test results (the lowest margins) were recorded in Table 7.1.2 and shown in the associated plots.

Test specification:	Section 15.519(c), RSS-220 section 5.3.1(d), Radiated power density		
Test procedure:	47 CFR, Section 15.521, ANSI C63.10-2013, section 10.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	Air Pressure: 1014 hPa	Relative Humidity: 52 %	Power Supply: Battery
Remarks:			

Figure 7.1.1 Setup for carrier field strength measurements



Test specification:	**Section 15.519(c), RSS-220 section 5.3.1(d), Radiated power density**		
Test procedure:	47 CFR, Section 15.521, ANSI C63.10-2013, section 10.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

Table 7.1.2 Power spectral density test results

Frequency, MHz	Equivalent field strength, dB(µV/m)/1MHz	EIRP, dBm*	Limit, dBm	Margin, dB**	Verdict
4150.5	52.49	-42.71	-41.3	-1.41	Pass
4458.5	53.69	-41.51	-41.3	-0.21	Pass
6423.0	53.50	-41.70	-41.3	-0.40	Pass

*- EIRP, dBm= Equivalent field strength, dB(µV/m)/1 MHz - 95.2 dB
**- Margin = Field strength – calculated field strength limit.

Reference numbers of test equipment used

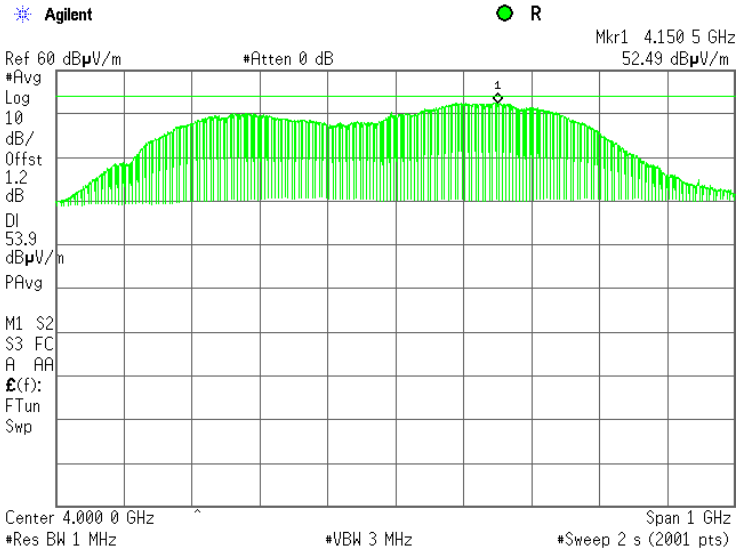
HL 3818	HL 3901	HL 3903	HL 4114	HL 4932			

Full description is given in Appendix A.

Test specification:	Section 15.519(c), RSS-220 section 5.3.1(d), Radiated power density		
Test procedure:	47 CFR, Section 15.521, ANSI C63.10-2013, section 10.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	Air Pressure: 1014 hPa	Relative Humidity: 52 %	Power Supply: Battery
Remarks:			

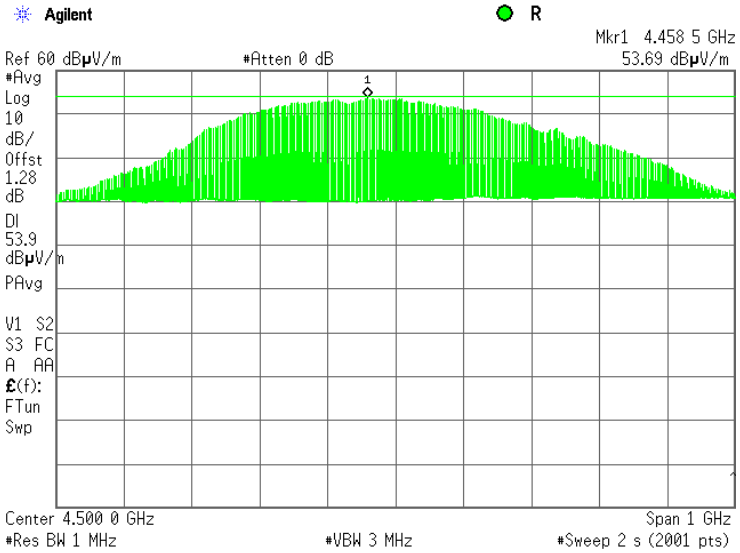
Plot 7.1.1 Power spectral density at low frequency

TEST SITE: OATS
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X, Y, Z-axes



Plot 7.1.2 Power spectral density at mid frequency

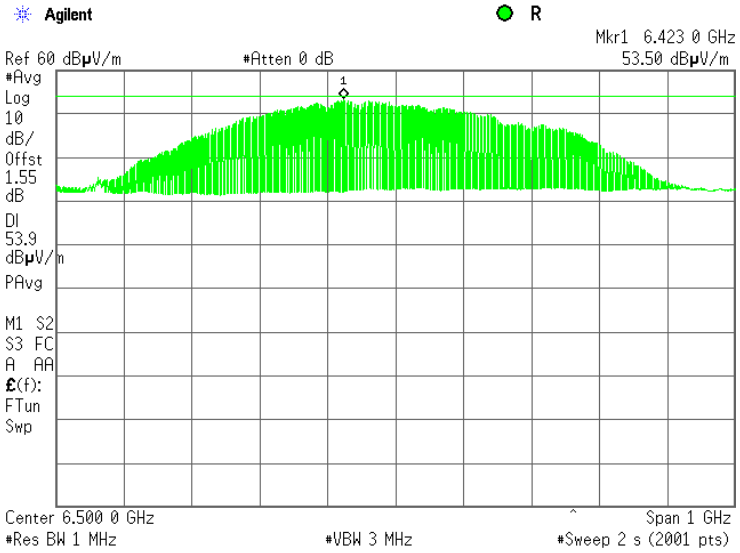
TEST SITE: OATS
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X, Y, Z-axes



Test specification:	**Section 15.519(c), RSS-220 section 5.3.1(d), Radiated power density**		
Test procedure:	47 CFR, Section 15.521, ANSI C63.10-2013, section 10.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

Plot 7.1.3 Power spectral density at high frequency

TEST SITE: OATS
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X, Y, Z-axes



Test specification:	Section 15.519(b), 15.503(d), Occupied bandwidth		
Test procedure:	ANSI C63.10-2013, section 10.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 22 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

7.2 Occupied bandwidth test

7.2.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Occupied bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Minimum allowed bandwidth, MHz
3100 - 10600	10	500

* - Modulation envelope reference points are provided in terms of attenuation below the unmodulated carrier.

7.2.2 Test procedure

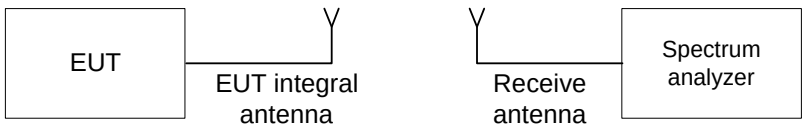
7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.

7.2.2.2 The EUT was set to transmit the unmodulated carrier and the reference peak power level was measured.

7.2.2.3 The EUT was set to transmit the normally modulated carrier.

7.2.2.4 The transmitter occupied bandwidth was measured with spectrum analyzer as a frequency delta between the reference points on modulation envelope and provided in Table 7.2.2 and the associated plots.

Figure 7.2.1 Occupied bandwidth test setup



Test specification:	**Section 15.519(b), 15.503(d), Occupied bandwidth**		
Test procedure:	ANSI C63.10-2013, section 10.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	25-Jun-15		
Temperature: 22 ºC	**Air Pressure:** 1010 hPa	**Relative Humidity:** 50 %	**Power Supply:** Battery
Remarks:			

Table 7.2.2 Occupied bandwidth test results

DETECTOR USED: Peak hold
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: 300 kHz
MODULATION: FSK
MODULATION ENVELOPE REFERENCE POINTS: 10 dBc

Carrier frequency, MHz	Occupied bandwidth, MHz	Limit, MHz	Margin, MHz	Verdict
4000	699.778	500	-199.778	Pass
4500	714.647	500	-214.647	
6500	631.733	500	-131.733	

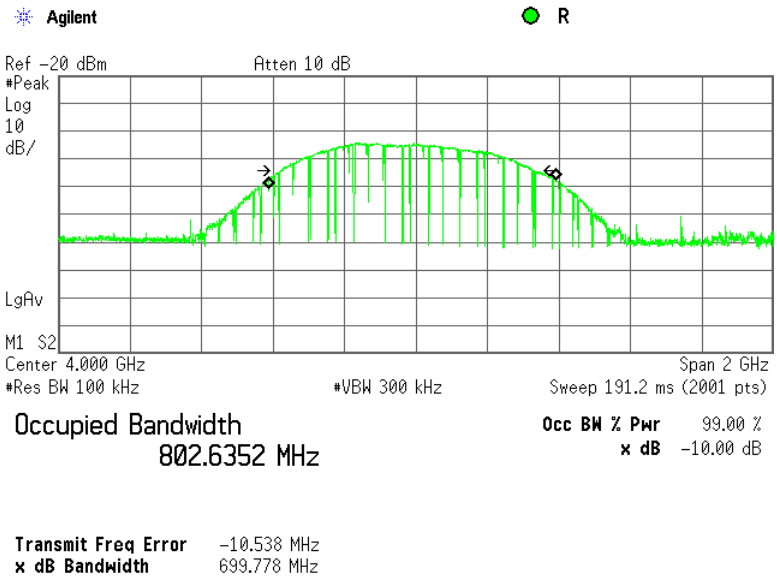
Reference numbers of test equipment used

HL 3818							

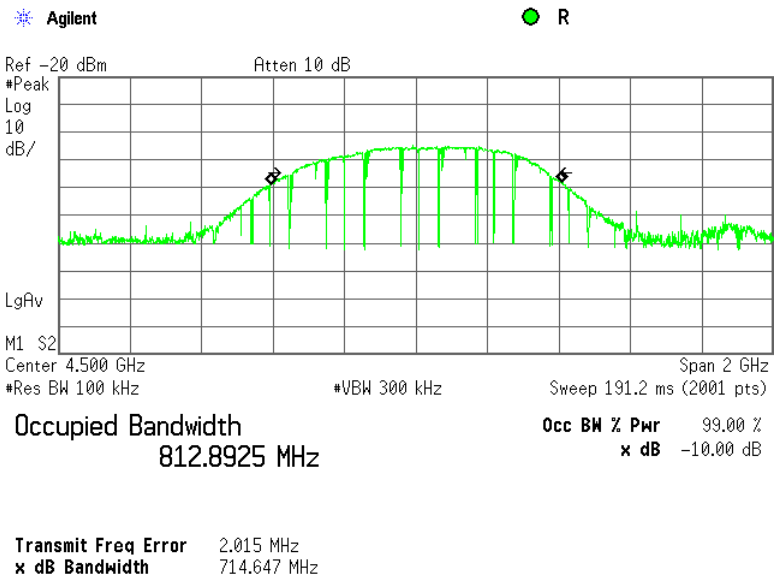
Full description is given in Appendix A.

Test specification:	Section 15.519(b), 15.503(d), Occupied bandwidth		
Test procedure:	ANSI C63.10-2013, section 10.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 22 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

Plot 7.2.1 Occupied bandwidth test result at low frequency

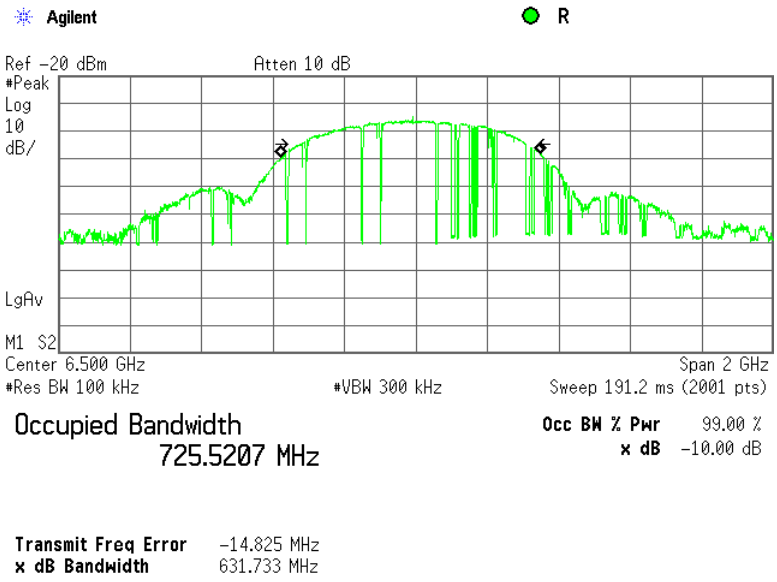


Plot 7.2.2 Occupied bandwidth test result at mid frequency



Test specification:	Section 15.519(b), 15.503(d), Occupied bandwidth		
Test procedure:	ANSI C63.10-2013, section 10.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 22 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

Plot 7.2.3 Occupied bandwidth test result at high frequency



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

7.3 Radiated emissions measurements

7.3.1 General

This test was performed to measure radiated spurious emissions from the EUT. Specification test limits are given in Table 7.3.1, Table 7.3.2.

Table 7.3.1 Radiated spurious emission limits according to section 15.209

Frequency, MHz	Field strength at 3 m, dB(μV/m)		
	Within restricted bands		
	Peak	Quasi Peak	Average
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**
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	

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

$$Lim_{S2} = Lim_{S1} + 40 \log (S_1/S_2),$$

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

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

Table 7.3.2 Radiated emission average limits according to sections 15.519(c), 15.519(d)

Frequency, MHz	RBW, kHz	EIRP of spurious, dBm	Equivalent field strength limit @ 3m, dB(μV/m)***
960-1610	1000	-75.3	19.9
1610-1990	1000	-63.3	31.9
1990-3100	1000	-61.3	33.9
3100-10600	1000	-41.3	53.9
Above 10600	1000	-61.3	33.9
1164-1240	≥1	-85.3	9.9
1559-1610	≥1	-85.3	9.9

***- Equivalent field strength, dB(μV/m) = EIRP, dBm - 95.2 dB

Table 7.3.3 Radiated emission average limits according to RSS-220 section 5.3.1(d)

Frequency, MHz	RBW, kHz	EIRP of spurious, dBm	Equivalent field strength limit @ 3m, dB(μV/m)***
960-1610	1000	-75.3	19.9
1610-4750	1000	-70.0	25.2
4750-10600	1000	-41.3	53.9
Above 10600	1000	-61.3	33.9
1164-1240	≥1	-85.3	9.9
1559-1610	≥1	-85.3	9.9

***- Equivalent field strength, dB(μV/m) = EIRP, dBm - 95.2 dB

Test specification:	**Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions**		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	**Air Pressure:** 1010 hPa	**Relative Humidity:** 50 %	**Power Supply:** Battery
Remarks:			

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

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and the performance check was conducted.

7.3.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna was rotated around its vertical axis.

7.3.2.3 The worst test results (the lowest margins) were recorded in Table 7.3.4 and shown in the associated plots.

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

7.3.3.1 The EUT was set up as shown in Figure 7.3.2, energized and the performance check was conducted.

7.3.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna height was swept from 1 to 4 m in both, vertical and horizontal, polarizations.

7.3.3.3 The worst test results (the lowest margins) were recorded in Table 7.3.4 and shown in the associated plots.

Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

Figure 7.3.1 Setup for spurious emission field strength measurements in 9 kHz to 30 MHz band

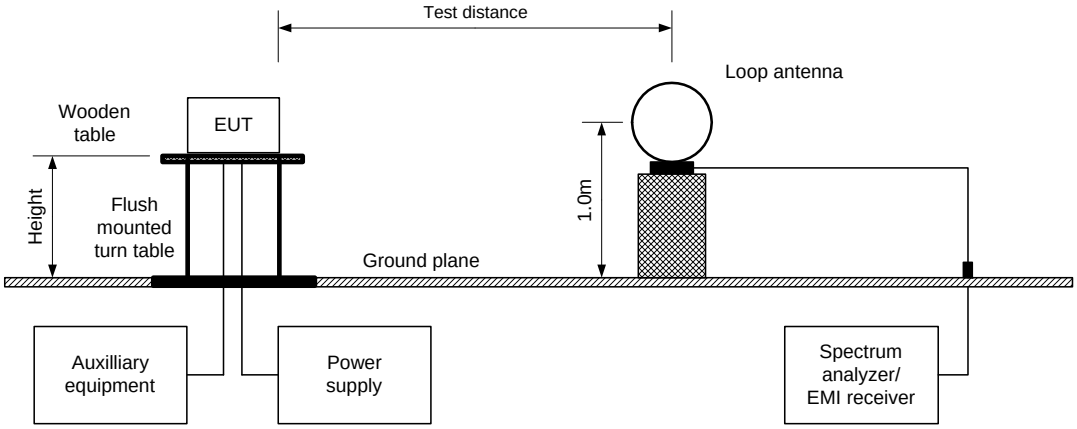
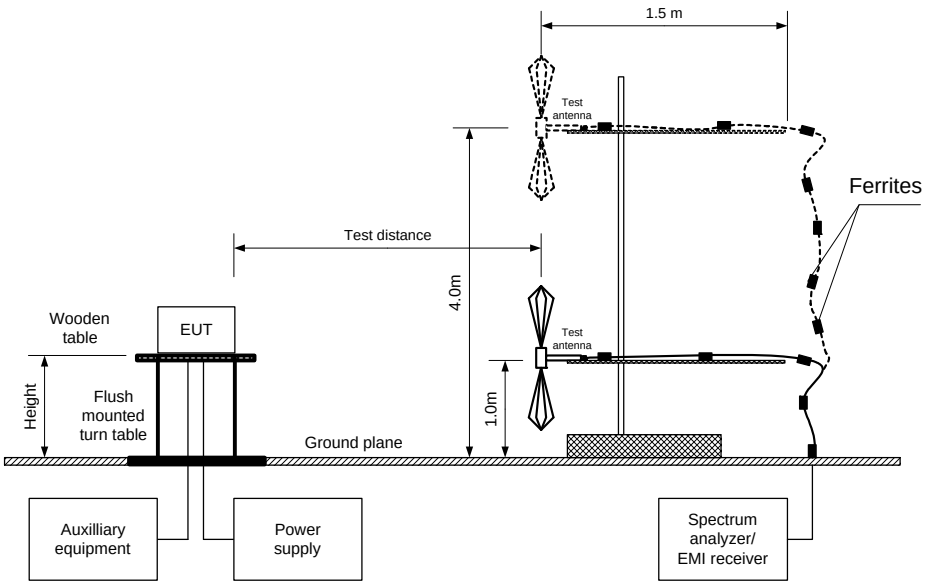


Figure 7.3.2 Setup for spurious emission field strength measurements above 30 MHz



Test specification:	**Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions**		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	**Air Pressure:** 1010 hPa	**Relative Humidity:** 50 %	**Power Supply:** Battery
Remarks:			

Table 7.3.4 Spurious emission field strength test results

ASSIGNED FREQUENCY RANGE: 3100 - 10600 MHz
TEST DISTANCE: 3 m
TEST SITE: Semi anechoic chamber / OATS
EUT HEIGHT: 0.8 m
INVESTIGATED FREQUENCY RANGE: 0.009 – 40000 MHz
DETECTOR USED: RMS
VIDEO BANDWIDTH: > Resolution bandwidth
TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
Biconilog (30 MHz – 1000 MHz)
Double ridged guide (above 1000 MHz)
MODULATION: FSK
MODULATING SIGNAL: PRBS

Frequency, MHz	Field strength, dB(µV/m)	RBW, kHz	Antenna polarization	Antenna height, m	Turn-table position*, degrees	EIRP, dBm**	Limit, dBm	Margin, dB***	Verdict
Low carrier frequency									
1194.856	-5.13	1	Vertical	1.4	0	-100.36	-85.3	-15.1	Pass
1895.76	17.28	1000	Vertical	1.2	10	-77.95	-70.0	-7.95	Pass
Mid carrier frequency									
1185.75	-4.63	1	Vertical	1.5	355	-99.86	-85.3	-14.56	Pass
1895.71	22.78	1000	Vertical	1.0	0	-72.45	-70.0	-7.45	Pass
High carrier frequency									
1165.29	-4.78	1	Vertical	1.1	20	-100.01	-85.3	-14.71	Pass
1895.71	22.30	1000	Vertical	1.3	20	-72.93	-70.0	-2.93	Pass
5935.70	34.10	1000	Vertical	1.3	7	-61.13	-41.3	-19.83	Pass

*****- EUT front panel refers to 0 degrees position of turntable.
******-EIRP, dBm = Field strength, dB(µV/m) – 95.23 dB
*****-** Margin = EIRP, dBm – specification limit.

Reference numbers of test equipment used

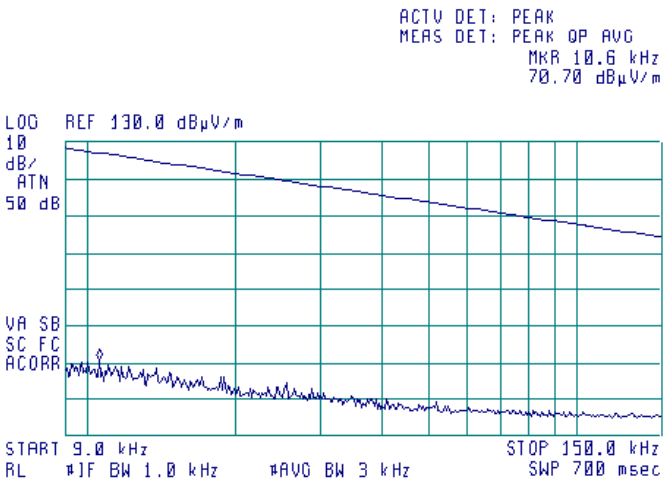
HL 3818	HL 3901	HL 4956	HL 4353	HL 4722	HL 604	HL 446	HL 3818
HL 4933	HL 768	HL 769	HL 4856	HL 3903			

Full description is given in Appendix A.

Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

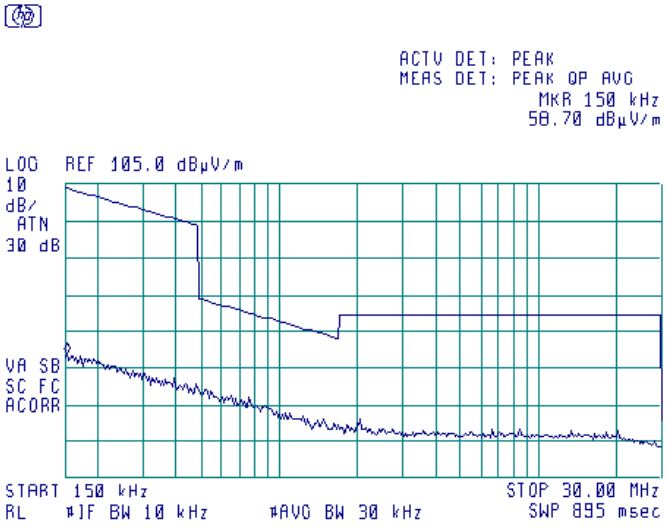
Plot 7.3.1 Radiated emission measurements in 9 - 150 kHz range

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



Plot 7.3.2 Radiated emission measurements in 0.15 - 30 MHz range

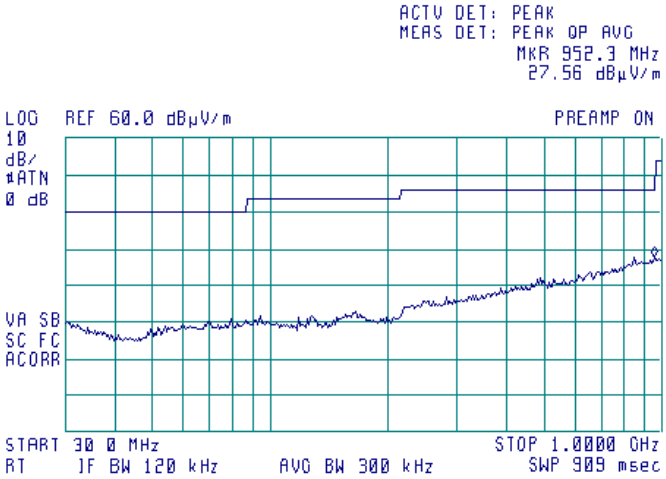
TEST SITE:	Semi anechoic chamber
CARRIER FREQUENCY:	Low, Mid, High
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

Plot 7.3.3 Radiated emission measurements in 30 - 960 MHz range

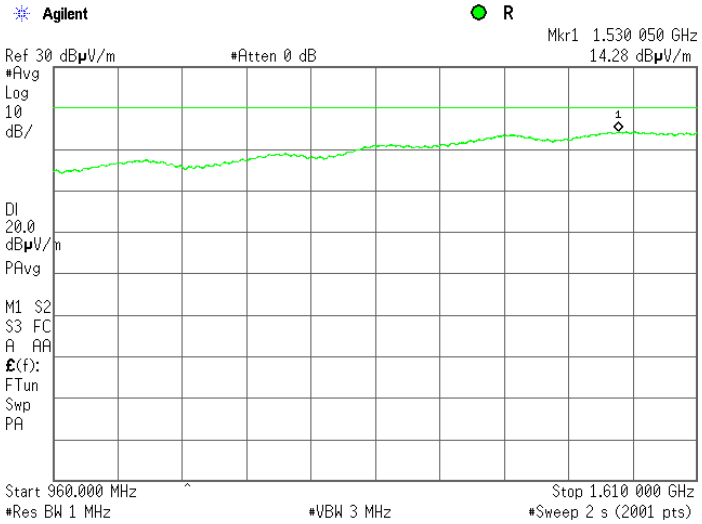
TEST SITE:	Semi anechoic chamber
CARRIER FREQUENCY:	Low, Mid, High
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

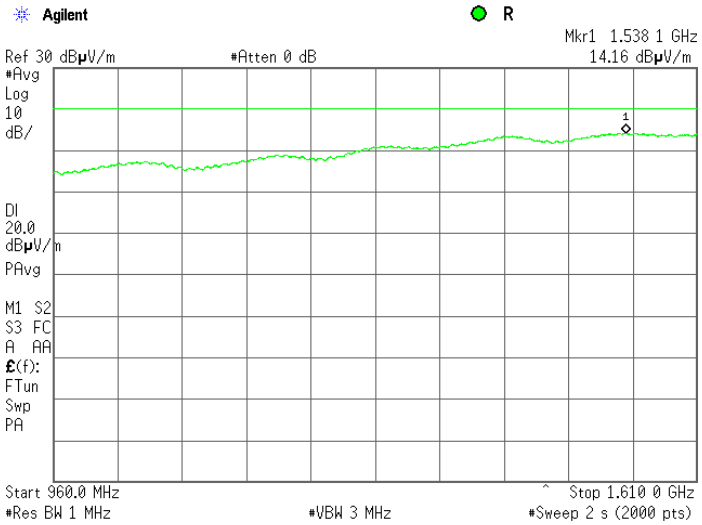
Plot 7.3.4 Radiated emission measurements in 960 – 1610 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



Plot 7.3.5 Radiated emission measurements in 960 – 1610 MHz range

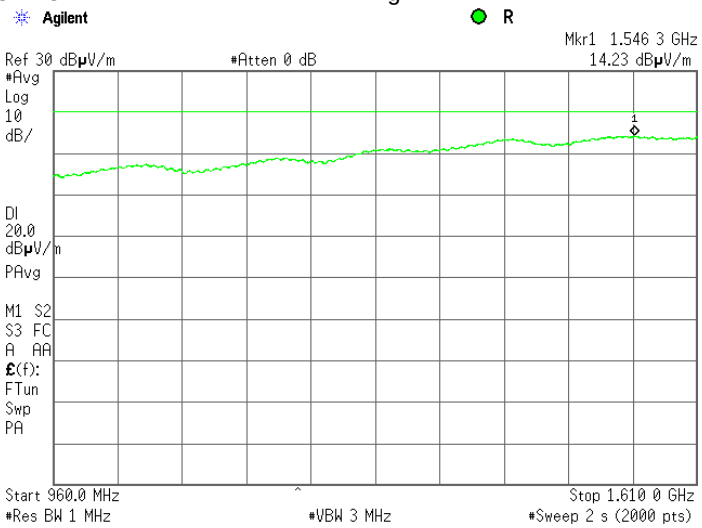
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Mid



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

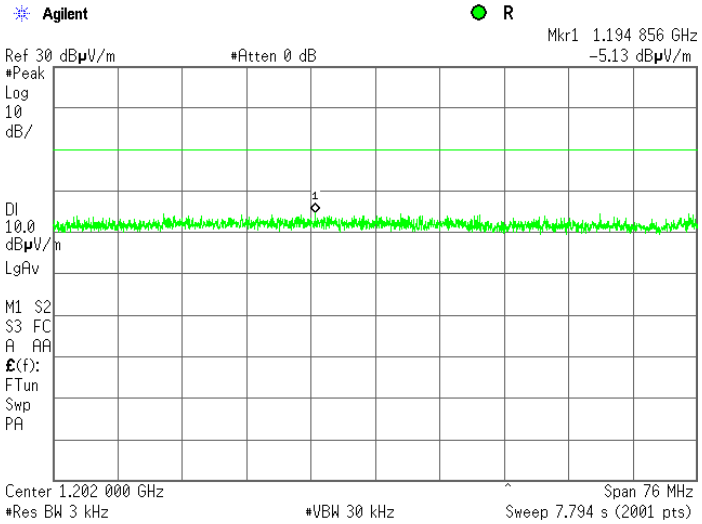
Plot 7.3.6 Radiated emission measurements in 960 – 1610 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: High



Plot 7.3.7 Radiated emission measurements in 1164 – 1240 MHz range

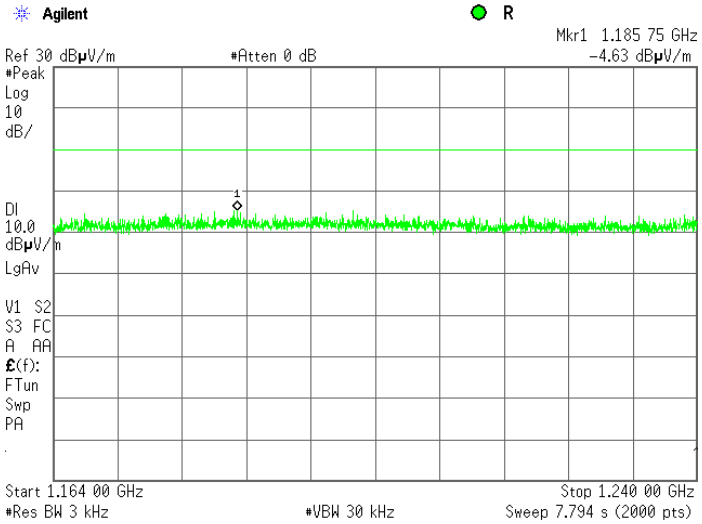
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

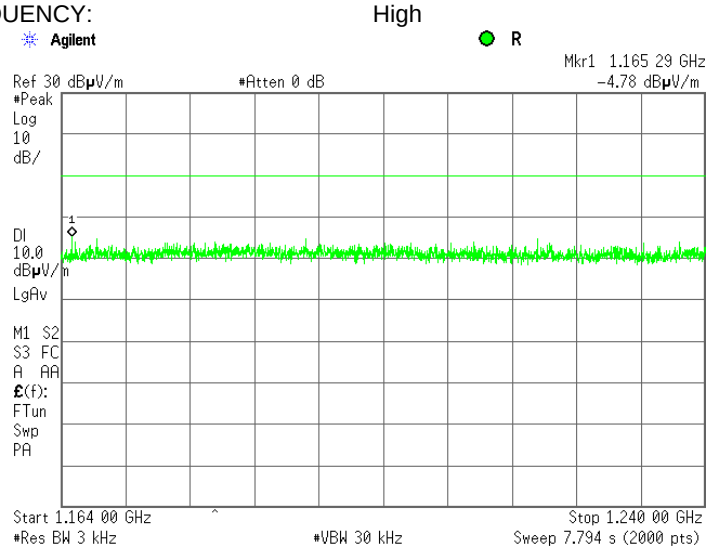
Plot 7.3.8 Radiated emission measurements in 1164 – 1240 MHz range

TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	Mid



Plot 7.3.9 Radiated emission measurements in 1164 – 1240 MHz range

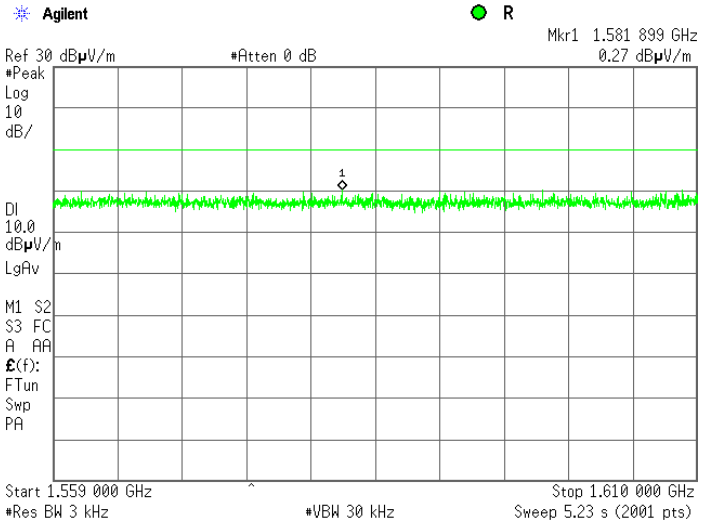
TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	High



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

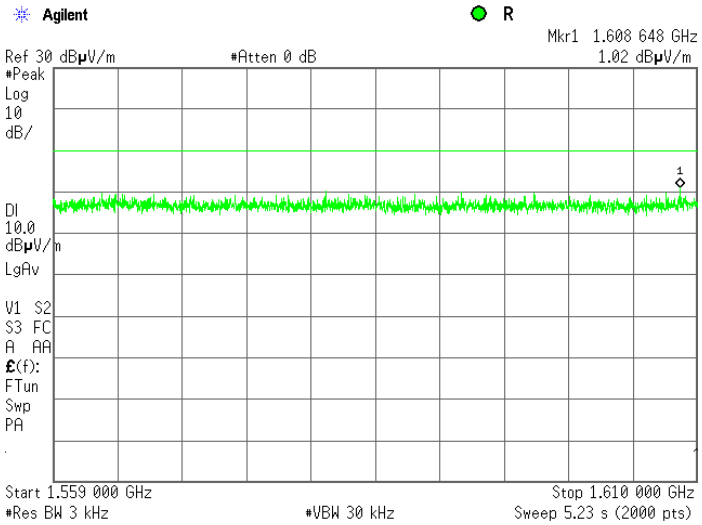
Plot 7.3.10 Radiated emission measurements in 1559 – 1610 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



Plot 7.3.11 Radiated emission measurements in 1559 – 1610 MHz range

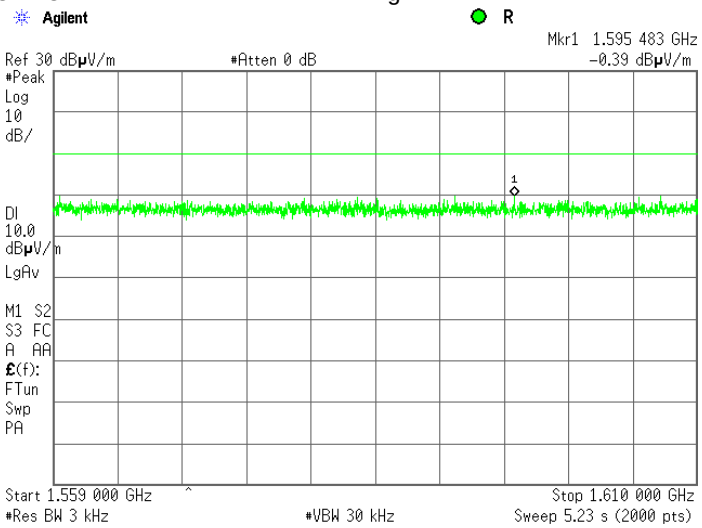
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Mid



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

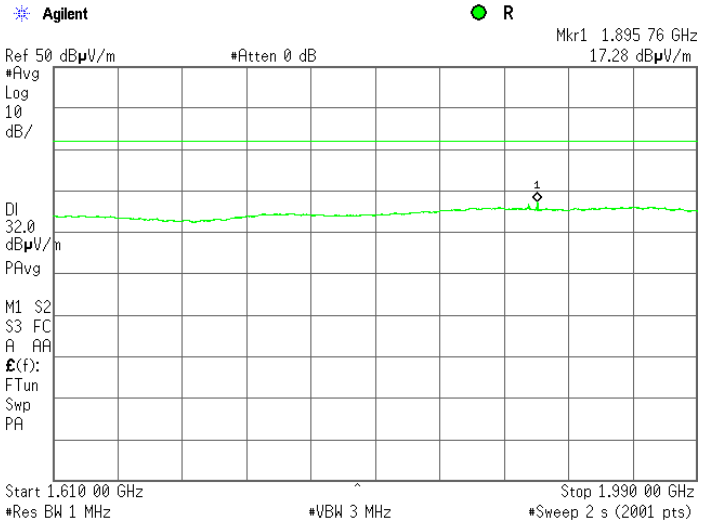
Plot 7.3.12 Radiated emission measurements in 1559 – 1610 MHz range

TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	High



Plot 7.3.13 Radiated emission measurements in 1610 – 1990 MHz range

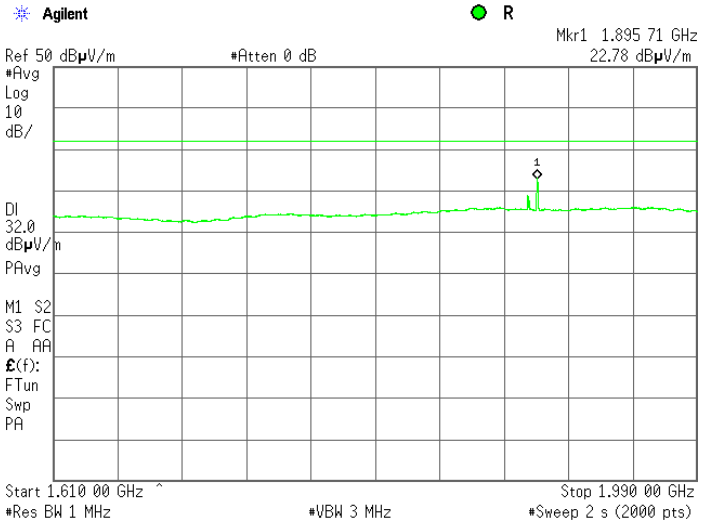
TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	Low



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

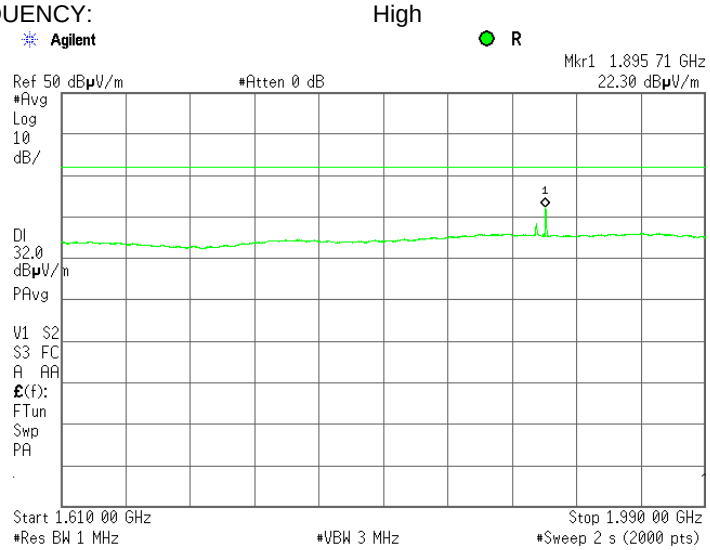
Plot 7.3.14 Radiated emission measurements in 1610 – 1990 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Mid



Plot 7.3.15 Radiated emission measurements in 1610 – 1990 MHz range

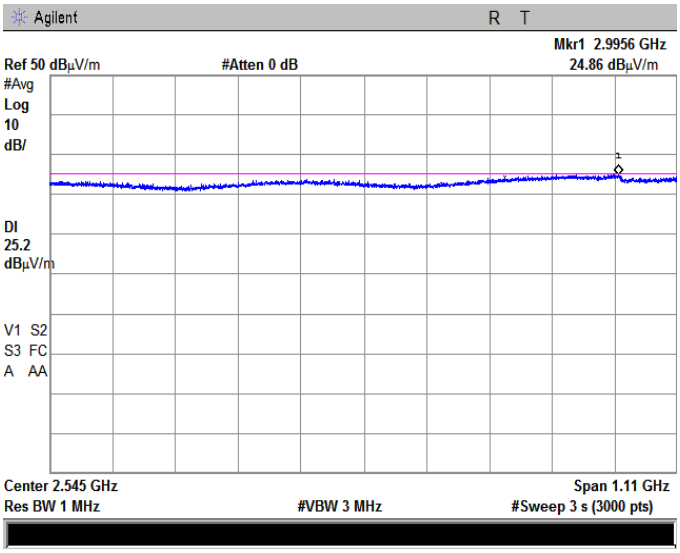
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: High



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

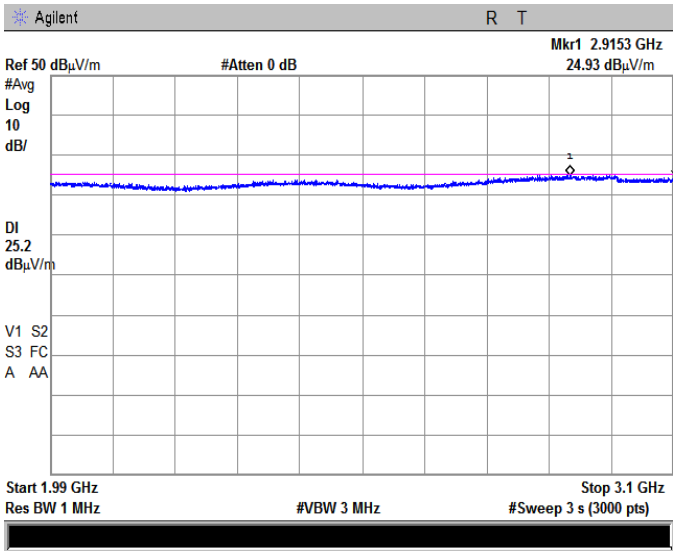
Plot 7.3.16 Radiated emission measurements in 1990 – 3100 MHz range

TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	Low



Plot 7.3.17 Radiated emission measurements in 1990 – 3100 MHz range

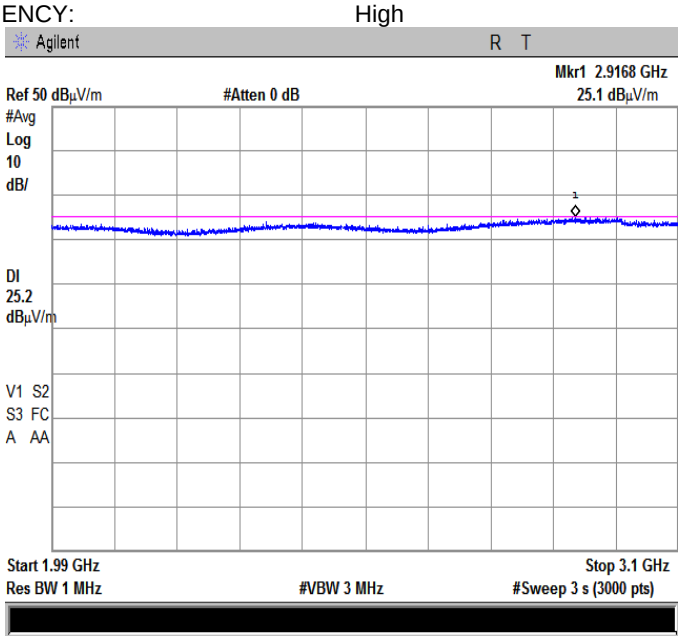
TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	Mid



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

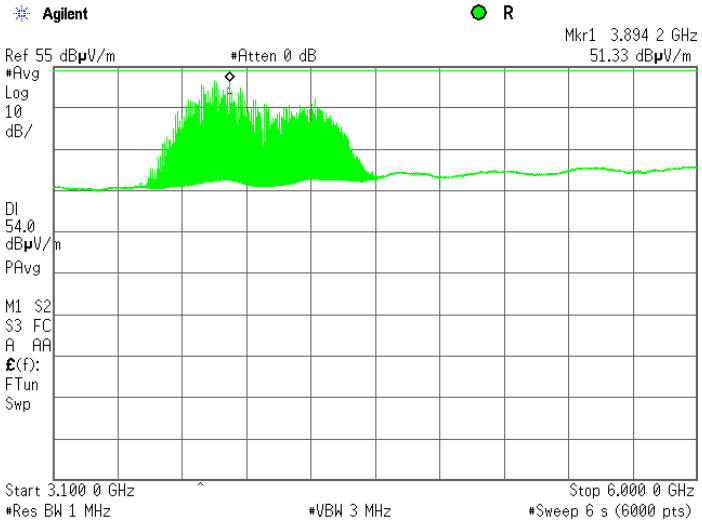
Plot 7.3.18 Radiated emission measurements in 1990 – 3100 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: High



Plot 7.3.19 Radiated emission measurements in 3100 – 6000 MHz range

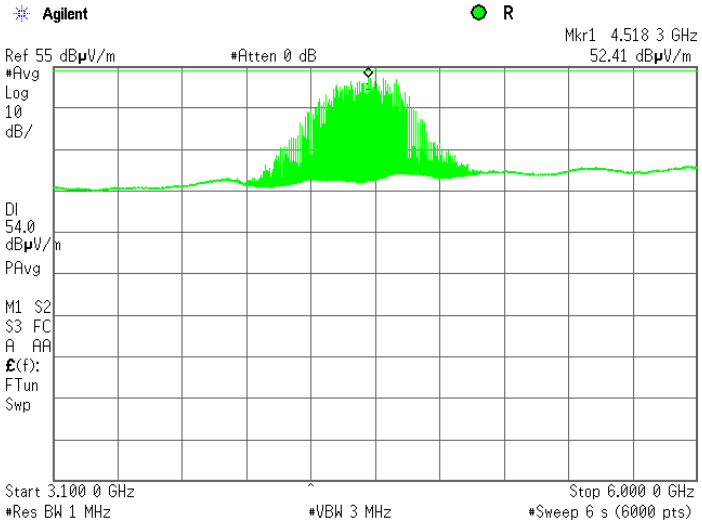
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

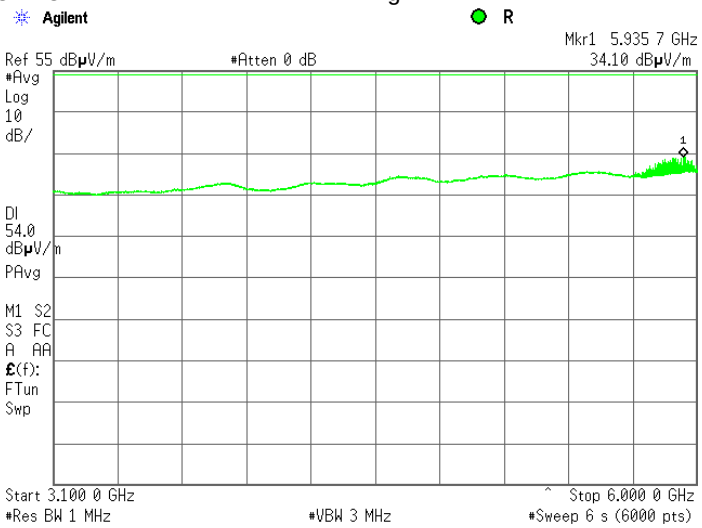
Plot 7.3.20 Radiated emission measurements in 3100 – 6000 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Mid



Plot 7.3.21 Radiated emission measurements in 3100 – 6000 MHz range

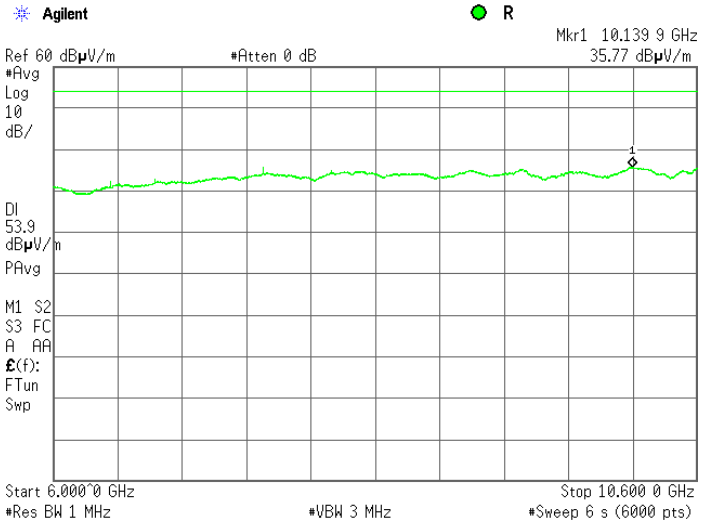
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: High



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

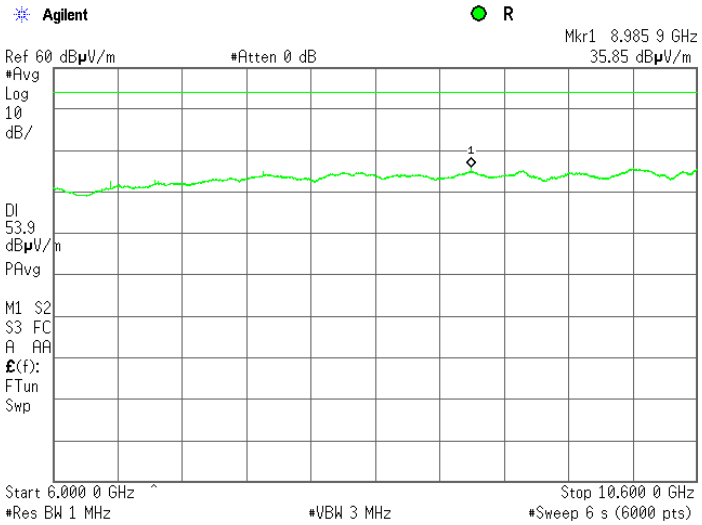
Plot 7.3.22 Radiated emission measurements in 6000 – 10600 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



Plot 7.3.23 Radiated emission measurements in 6000 – 10600 MHz range

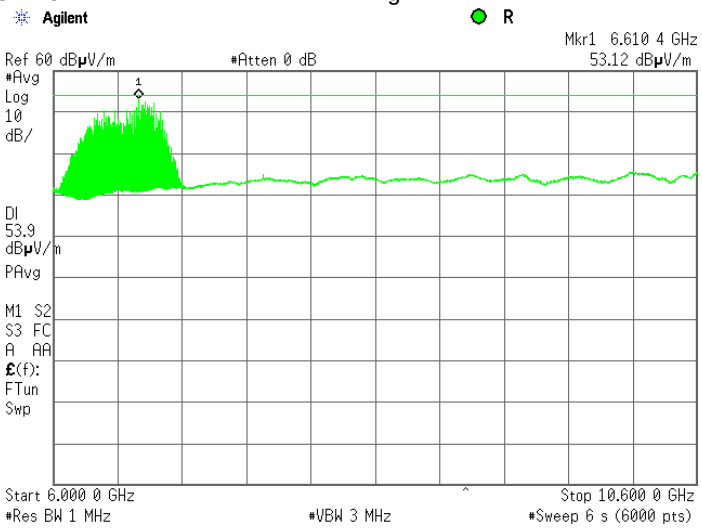
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Mid



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

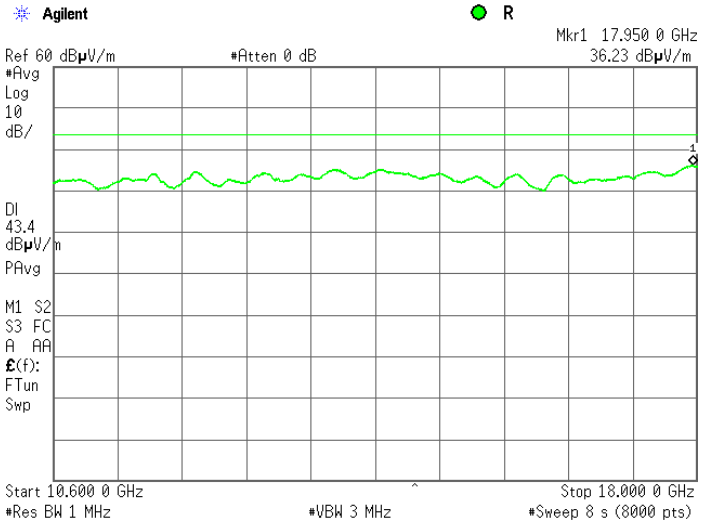
Plot 7.3.24 Radiated emission measurements in 6000 – 10600 MHz range

TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	High



Plot 7.3.25 Radiated emission measurements in 10600 – 18000 MHz range

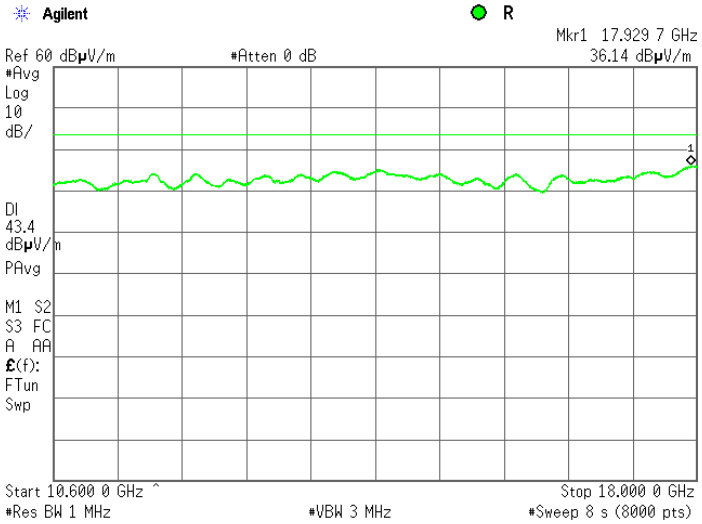
TEST SITE:	Semi anechoic chamber
ANTENNA POLARIZATION:	Vertical and Horizontal
TEST DISTANCE:	3 m
CARRIER FREQUENCY:	Low



Test specification:	Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	Air Pressure: 1010 hPa	Relative Humidity: 50 %	Power Supply: Battery
Remarks:			

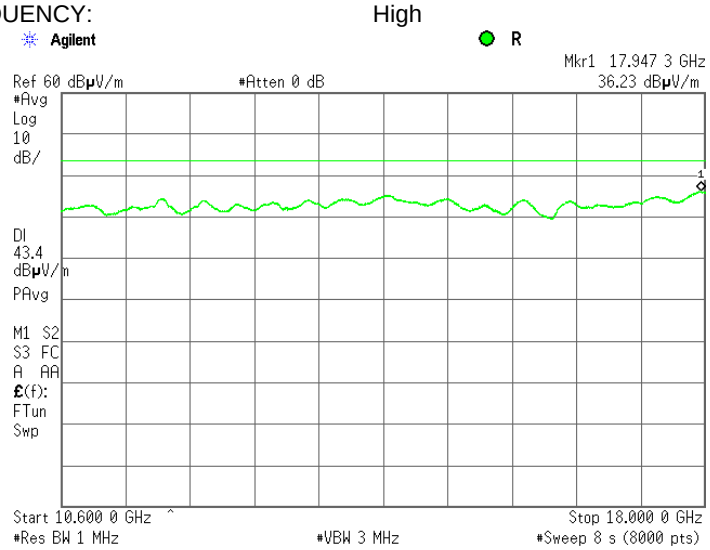
Plot 7.3.26 Radiated emission measurements in 10600 – 18000 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Mid



Plot 7.3.27 Radiated emission measurements in 10600 – 18000 MHz range

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: High

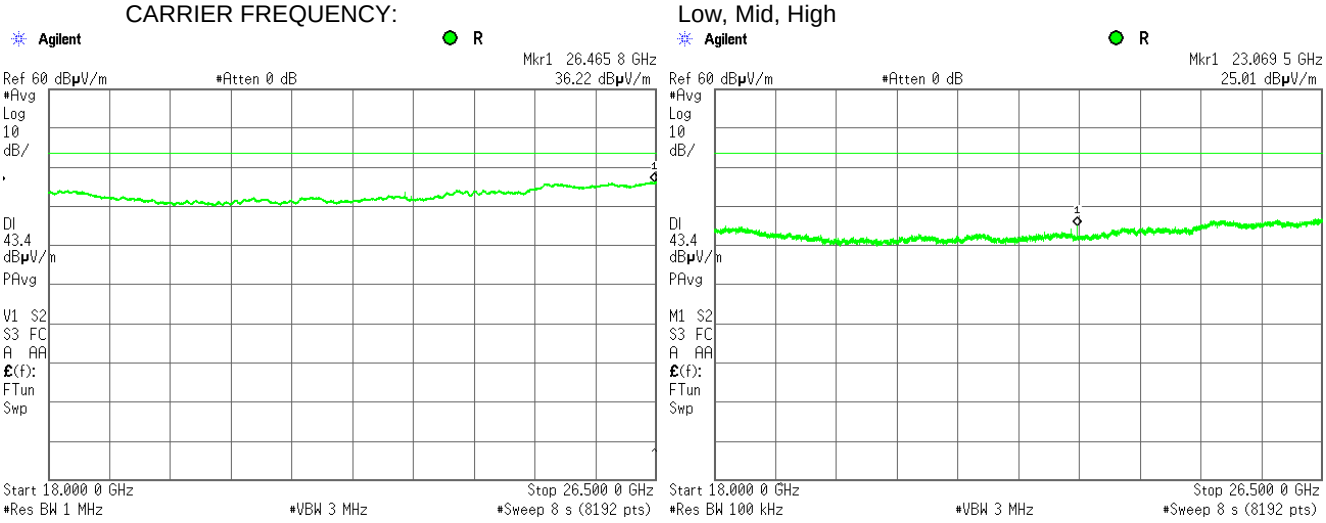


Limit 1m = Limit 3m + 20*log(3m/1m) = 33.9dBuV/m + 9.54 = 43.44dBuV/m

Test specification:	**Section 15.519(c),(d), RSS-220 section 3.4, Radiated spurious emissions**		
Test procedure:	ANSI C63.10-2013, sections 10.2, 10.3, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	25-Jun-15		
Temperature: 25 ºC	**Air Pressure:** 1010 hPa	**Relative Humidity:** 50 %	**Power Supply:** Battery
Remarks:			

Plot 7.3.28 Radiated emission measurements in 18000 –26500 MHz range

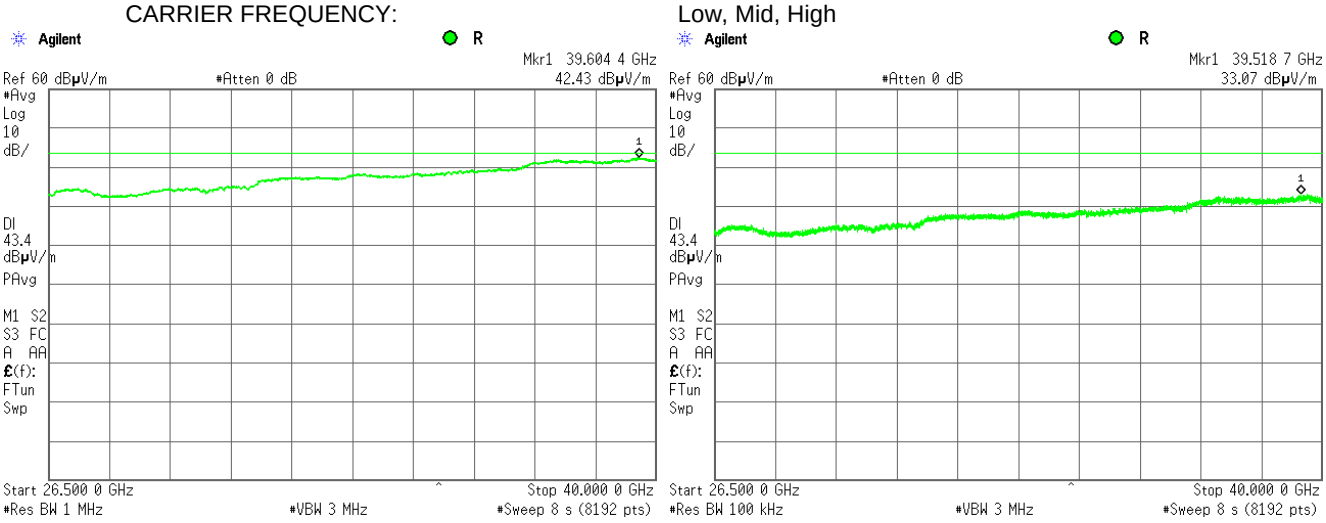
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low, Mid, High



Limit 1m = Limit 3m + 20*log(3m/1m) = 33.9 dBuV/m + 9.54 = 43.44 dBuV/m
23.07 GHz - is ambient signal.

Plot 7.3.29 Radiated emission measurements in 26500 - 40000 MHz range

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



Limit 1m = Limit 3m + 20*log(3m/1m) = 33.9dBuV/m + 9.54 = 43.44dBuV/m

Test specification:	**Section 15.519(e), RSS-220 section 5.3.1(g), Peak power within 50 MHz bandwidth**		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

7.4 Peak power within 50 MHz bandwidth

7.4.1 General

This test was performed to measure effective radiated power emanated by transmitter at carrier frequency. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Peak level of emissions contained within 50 MHz

Assigned frequency band, MHz	EIRP, dBm	Equivalent field strength limit @ 3m, dB(μV/m) in 50 MHz*
3100 - 10600	0	95.23

* - Equivalent field strength, dB(μV/m) = EIRP, dBm + 95.23 dB

7.4.2 Test procedure for field strength measurements

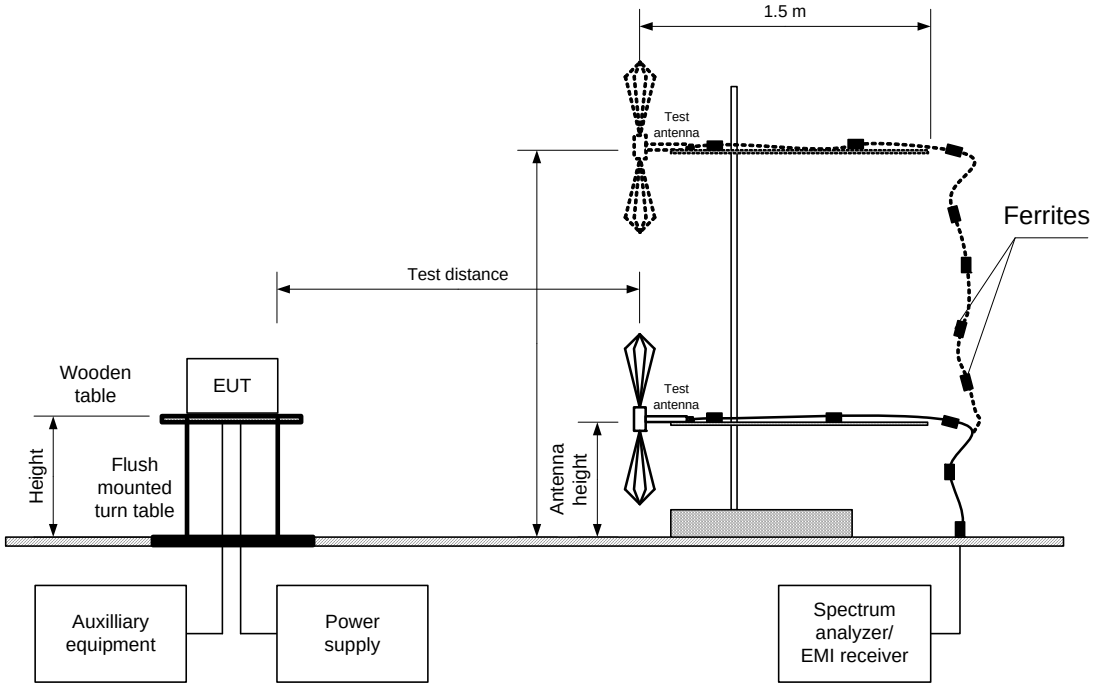
7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and the performance check was conducted.

7.4.2.2 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was swept throughout the range, specified in Table 7.4.2, in both vertical and horizontal polarizations.

7.4.2.3 The worst test results (the lowest margins) were recorded in Table 7.4.2 and shown in the associated plots.

Test specification:	**Section 15.519(e), RSS-220 section 5.3.1(g), Peak power within 50 MHz bandwidth**		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

Figure 7.4.1 Setup for carrier field strength measurements



Test specification:	**Section 15.519(e), RSS-220 section 5.3.1(g), Peak power within 50 MHz bandwidth**		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

Table 7.4.2 Peak power contained within 50 MHz test results

Frequency, MHz	Field strength, dB(µV/m)	RBW, MHz	Equivalent field strength, dB(µV/m) in 50 MHz*	EIRP, dBm**	Limit, dBm	Margin, dB*	Verdict
4145.5	69.944	3	94.38	-0.85	0	-0.85	Pass
4505.5	70.690	3	95.13	-0.10	0	-0.10	Pass
6417.5	70.600	3	95.04	-0.19	0	-0.19	Pass

*- The power reading on the spectrum analyser can be directly related to the peak power limit when a spectrum analyser resolution bandwidth of 50 MHz is used for the measurements. A spectrum analyser resolution bandwidth of 3 MHz was used instead, the maximum peak power was increased by a factor of 20 log (50/3) = 24.436 dB, where 3 represents the measurement bandwidth used.

**- EIRP, dBm= Equivalent field strength, dB(µV/m) - 95.23 dB

***- Margin = EIRP, dBm –limit, dBm.

Reference numbers of test equipment used

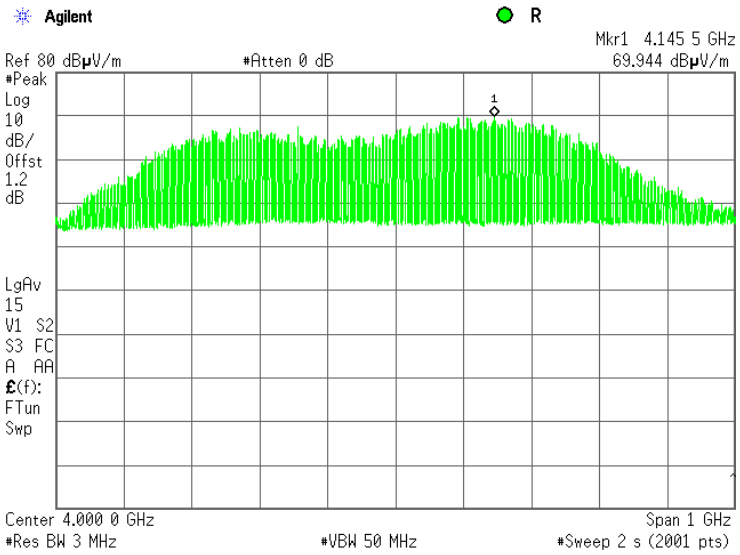
HL 3818	HL 3901	HL 3903	HL 4114	HL 4932			

Full description is given in Appendix A.

Test specification:	Section 15.519(e), RSS-220 section 5.3.1(g), Peak power within 50 MHz bandwidth		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	Air Pressure: 1014 hPa	Relative Humidity: 52 %	Power Supply: Battery
Remarks:			

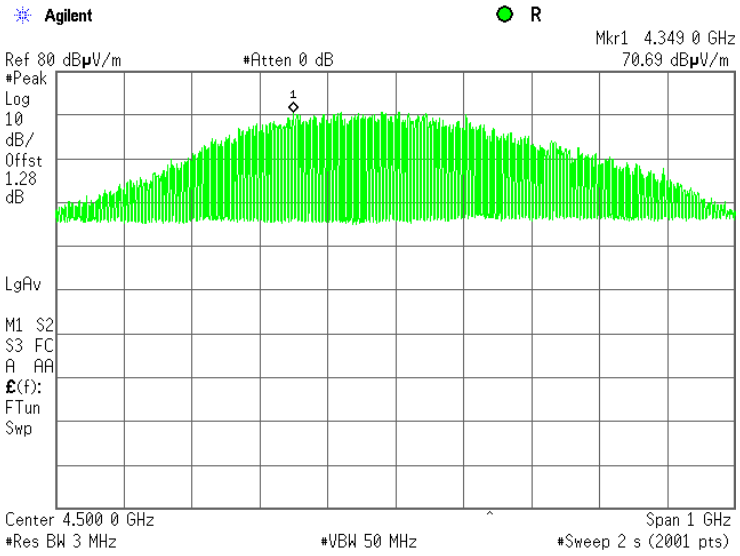
Plot 7.4.1 Peak power of emissions within 50 MHz at low frequency

TEST SITE: OATS
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X, Y, Z-axes



Plot 7.4.2 Peak power of emissions within 50 MHz at mid frequency

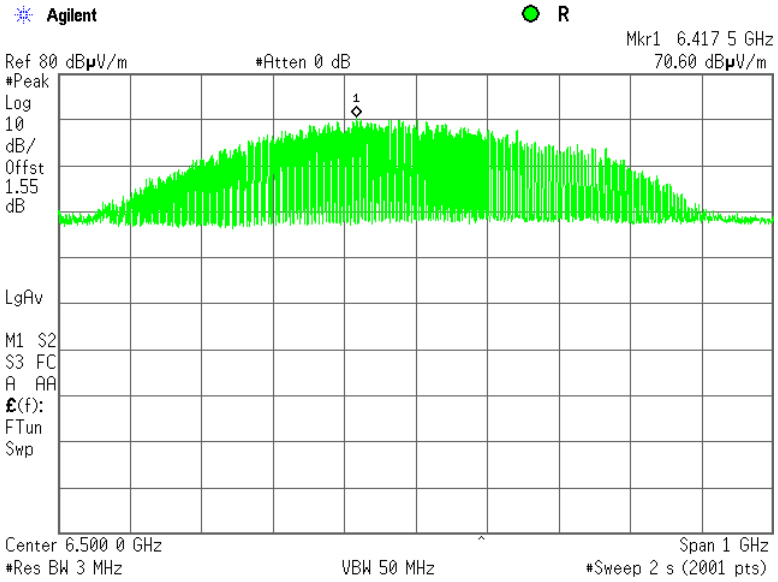
TEST SITE: OATS
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X, Y, Z-axes



Test specification:	**Section 15.519(e), RSS-220 section 5.3.1(g), Peak power within 50 MHz bandwidth**		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

Plot 7.4.3 Peak power of emissions within 50 MHz at high frequency

TEST SITE: OATS
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: X, Y, Z-axes



Test specification:	**Section 15.519(a)(1), RSS-220 section 5.3.1(b),Transmission duration requirements**		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

7.5 Transmission duration requirements

7.5.1 General

The EUT was verified for compliance with transmission duration requirements listed below:

- A transmitter shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission was received.

7.5.2 Test procedure for transmitter shut down test

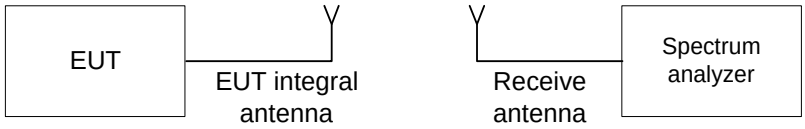
7.5.2.1 The EUT was set up as shown in Figure 7.5.1.

7.5.2.2 The spectrum analyzer center frequency was adjusted to the EUT carrier, span set to zero and video triggered for transmission.

7.5.2.3 The transmitter was activated.

7.5.2.4 The transmission time was captured and shown in the associated plots. The test results for cease of transmitter operating is shown in Plot 7.5.4.

Figure 7.5.1 Setup for transmitter shut down test



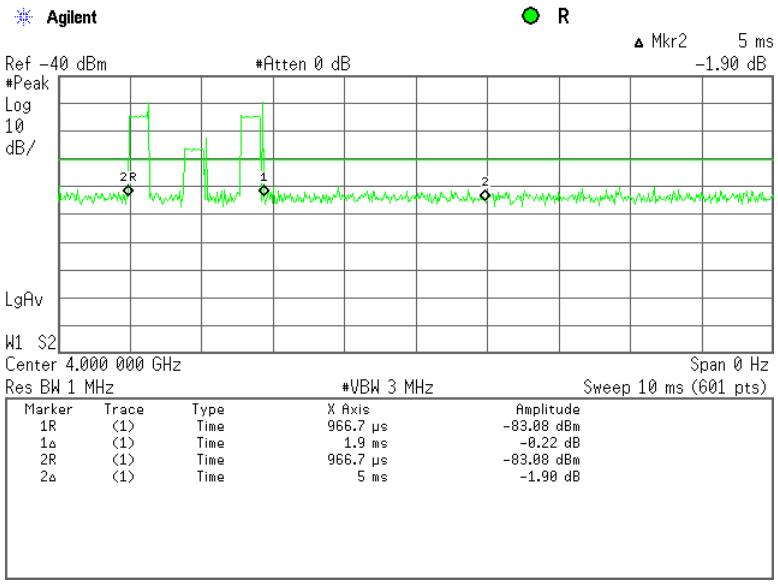
Reference numbers of test equipment used

HL 0337	HL 3001						

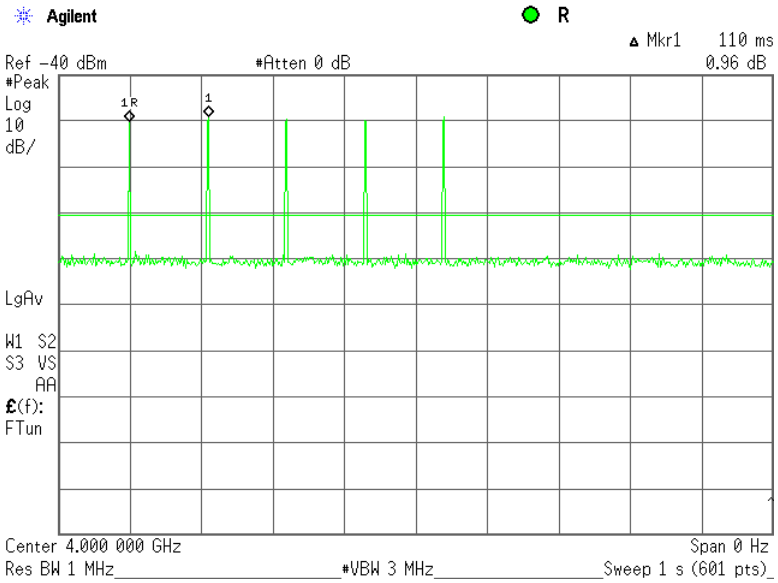
Full description is given in Appendix A.

Test specification:	Section 15.519(a)(1), RSS-220 section 5.3.1(b),Transmission duration requirements		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	Verdict:	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	Air Pressure: 1014 hPa	Relative Humidity: 52 %	Power Supply: Battery
Remarks:			

Plot 7.5.1 RF transmission duration

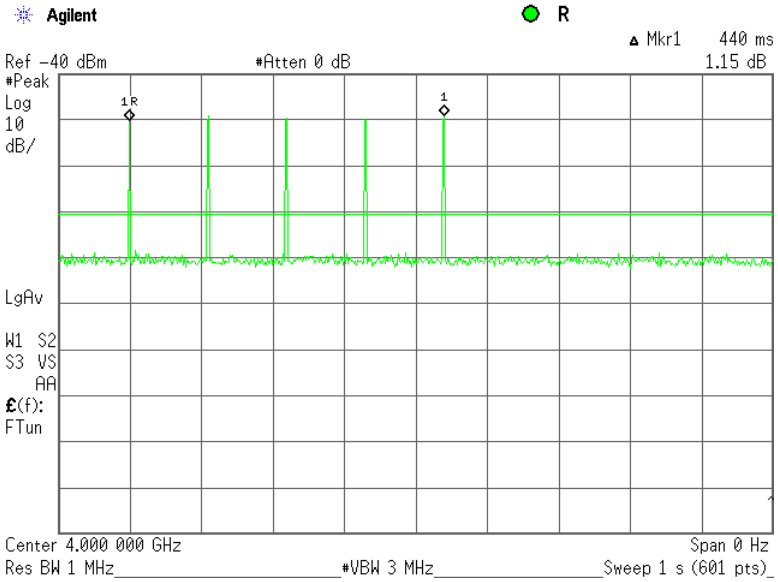


Plot 7.5.2 RF transmission period

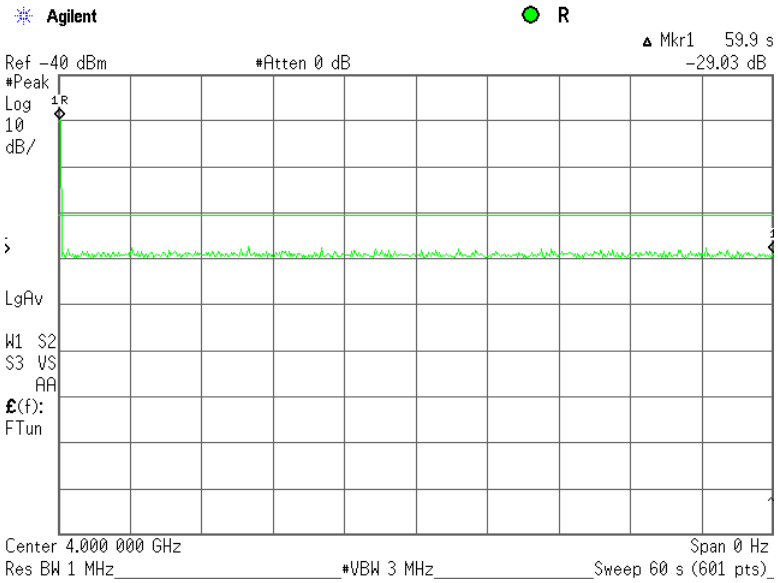


Test specification:	**Section 15.519(a)(1), RSS-220 section 5.3.1(b),Transmission duration requirements**		
Test procedure:	47 CFR, Section 15.521		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	07-Jun-15		
Temperature: 27 ºC	**Air Pressure:** 1014 hPa	**Relative Humidity:** 52 %	**Power Supply:** Battery
Remarks:			

Plot 7.5.3 RF transmission burst duration



Plot 7.5.4 RF transmission duration in 60 sec period



8 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
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	15-May-15	15-May-16
0768	Antenna Standard Gain Horn, 18-26.5 GHz, WR-42, 25 dB gain	Quinstar Technology	QWH-4200-BA	110	25-Dec-14	25-Dec-15
0769	Antenna Standard Gain Horn, 26.5-40 GHz, WR28, 25 dB gain	Quinstar Technology	QWH-2800-BA	112	25-Dec-14	25-Dec-15
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	29-Apr-15	29-Apr-16
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1225/2A	10-Feb-15	10-Feb-16
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	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
4353	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	12025101003	15-Mar-15	15-Mar-16
4722	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	51228701001	26-Aug-14	26-Aug-15
4856	Amplifier, solid state, 18 GHz to 40 GHz, 20 dBm output power	Quinstar Technology	QGW-18402023-JO	16779001001	03-Apr-15	03-Apr-16
4932	Microwave preamplifier, 500 MHz to 18 GHz, 40 dB Gain	COM-POWER CORPORATION	PAM-118A	551029	18-Nov-14	18-Nov-15
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	12-Nov-14	12-Nov-15
4956	Active horn antenna, 18 to 40 GHz	COM-POWER CORPORATION	AHA-840	105004	26-Jan-15	26-Jan-16

9 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Transmitter tests	
Carrier power conducted at antenna connector	± 1.7 dB
Carrier power radiated (substitution method)	± 4.5 dB
Occupied bandwidth	±8%
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
Spurious emissions radiated 30 MHz – 40 GHz (substitution method)	± 4.5 dB
Frequency error	30 – 300 MHz: ± 50.5 Hz (1.68 ppm) 300 – 1000 MHz: ± 168 Hz (0.56 ppm)
Transient frequency behaviour	187 Hz ± 13.9 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %

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.

10 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, T-1606 for conducted emissions at telecommunication ports), 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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website: www.hermonlabs.com

Person for contact: Mr. Alex Usoskin, CEO.

11 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 C63.10: 2013	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
RSS-220 Issue 1:2009	Devices Using Ultra-Wideband (UWB) Technology

12 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(μV) to convert it into field strength in dB(μV/m).

Antenna factor
Standard gain horn antenna
Quinstar Technology
Model QWH
Ser.No.112, HL 0768, 0769, 0770, 0771, 0772

Frequency min, GHz	Frequency max, GHz	Antenna factor, dB(1/m)
18.000	26.500	32.01
26.500	40.000	35.48
40.000	60.000	39.03
60.000	90.000	42.55
90.000	140.000	46.23
140.000	220.000	50.11

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

Antenna factor, HL 4933

COM-POWER CORPORATION

Active Horn Antenna Factor Calibration

1 GHz to 18 GHz

Equipment:	ACTIVE HORN ANTENNA
Model:	AHA-118
Serial Number:	701046
Calibration Distance:	3 Meter
Polarization:	Horizontal
Calibration Date:	11/12/2014

Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)	Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)
1	40.96	-16.47	10	40.94	-1.97
1.5	41.21	-14.53	10.5	40.63	-1.06
2	41.44	-13.30	11	40.74	-1.50
2.5	41.71	-12.87	11.5	40.65	-0.52
3	41.96	-12.26	12	40.76	-0.15
3.5	42.14	-11.77	12.5	41.03	-0.85
4	42.13	-10.91	13	41.37	-0.81
4.5	41.79	-9.41	13.5	41.18	0.05
5	41.44	-7.54	14	40.98	0.36
5.5	40.91	-6.47	14.5	40.81	1.26
6	40.69	-5.48	15	40.65	0.25
6.5	40.64	-5.53	15.5	40.93	-1.05
7	40.76	-4.12	16	41.31	-1.44
7.5	40.94	-3.12	16.5	40.96	-0.80
8	40.68	-1.69	17	40.64	-0.02
8.5	40.08	-1.71	17.5	40.57	1.81
9	40.41	-1.86	18	40.08	3.63
9.5	41.21	-2.73			

Calibration according to ARP 958

Antenna Factor to be added to receiver reading:

Meter Reading (dBuV) + Antenna Factor (dB/m) = Corrected Reading (dBuV/m)

Antenna factor, HL 4956

COM-POWER CORPORATION

Active Horn Antenna Factor Calibration

18 GHz to 40 GHz

Equipment:	**ACTIVE HORN ANTENNA**
Model:	**AHA-840**
Serial Number:	**105004**
Calibration Distance:	**3 meter**
Polarization:	**Horizontal**
Calibration Date:	**1/26/2015**

Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)	Frequency (GHz)	Preamplifier Gain (dB)	Antenna Factor with pre-amp (dB/m)
18	38.83	-1.06	29.5	42.47	-5.33
18.5	39.34	-2.65	30	41.91	-4.86
19	39.71	-3.88	30.5	41.60	-4.64
19.5	39.87	-4.35	31	41.52	-4.60
20	39.98	-3.97	31.5	41.56	-4.79
20.5	40.42	-3.68	32	41.80	-5.21
21	41.12	-4.06	32.5	42.29	-5.54
21.5	41.74	-5.46	33	42.79	-5.63
22	42.14	-6.22	33.5	42.88	-5.38
22.5	42.35	-6.42	34	42.62	-4.76
23	42.50	-6.59	34.5	42.63	-4.84
23.5	42.65	-6.82	35	43.15	-5.13
24	42.81	-7.01	35.5	43.91	-5.83
24.5	42.86	-7.37	36	44.59	-6.39
25	42.73	-7.53	36.5	45.04	-6.64
25.5	42.77	-7.45	37	45.08	-6.40
26	42.85	-7.21	37.5	44.82	-5.75
26.5	42.98	-7.17	38	44.16	-4.58
27	43.14	-7.22	38.5	42.90	-2.66
27.5	43.18	-7.32	39	42.39	-1.71
28	43.04	-7.10	39.5	43.76	-2.49
28.5	43.01	-6.73	40	45.98	-5.21

Calibration per ANSI C63.5: 2006

Standard Site Method, Equations 1-6 (3-antenna)

Corrected Reading (dBµV/m) = Meter Reading (dBµV) + AFE(dB/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
Microwave Cable Assembly, Huber-Suhner, 40 GHz, 1.5 m, SMA-SMA, S/N 1226/2A
HL 3903

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	-0.02	9500	1.84	21000	2.98
100	0.15	10000	1.86	22000	3.07
500	0.38	10500	1.93	23000	3.13
1000	0.56	11000	1.99	24000	3.21
1500	0.69	11500	2.04	25000	3.26
2000	0.82	12000	2.10	26000	3.48
2500	0.90	12500	2.15	27000	3.44
3000	0.98	13000	2.21	28000	3.53
3500	1.06	13500	2.25	29000	3.59
4000	1.11	14000	2.29	30000	3.66
4500	1.17	14500	2.34	31000	3.70
5000	1.24	15000	2.36	32000	3.79
5500	1.32	15500	2.40	33000	3.88
6000	1.40	16000	2.45	34000	3.94
6500	1.50	16500	2.48	35000	3.91
7000	1.56	17000	2.56	36000	4.05
7500	1.62	17500	2.58	37000	4.22
8000	1.68	18000	2.60	38000	4.25
8500	1.74	19000	2.84	39000	4.27
9000	1.78	20000	2.88	40000	4.33

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		

13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
AM	amplitude modulation
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
dB(μA)	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
μs	microsecond
NA	not applicable
NB	narrow band
OATS	open area test site
Ω	Ohm
PM	pulse modulation
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
WB	wideband

END OF DOCUMENT