

TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C § 15.247 (DTS), and subpart B
RSS-247 issue 2, RSS-Gen issue 4, ICES-003 Issue 6:2016

FOR:

Essence Security International Ltd.

Magnet Sensor

Model: ES800MGL

FCC ID YXG-ES800MGL

IC: 11061A-ES800MGLI

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1 Applicant information

Client name: Essence Security International Ltd.
Address: 12 Abba Eban avenue, Ackerstein Towers Bldg. D, P.O.Box 2073, Herzliya 4612001, Israel
Telephone: +972 732 447 735
Fax: +972 9956 4182
E-mail: israelgo@essence-grp.com
Contact name: Mr. Israel Gottesman

2 Equipment under test attributes

Product name: Magnet Sensor
Product type: Transceiver
Model(s): ES800MGL
Serial number: 1121422800954623
Hardware version: 4.E
Software release: 2.07
Receipt date 20-Nov-17

3 Manufacturer information

Manufacturer name: Essence Security International Ltd.
Address: 12 Abba Eban avenue, Ackerstein Towers Bldg. D, P.O.Box 2073, Herzliya 4612001, Israel
Telephone: +972 732 447 735
Fax: +972 9956 4182
E-Mail: israelgo@essence-grp.com
Contact name: Mr. Israel Gottesman

4 Test details

Project ID: 30284
Location: Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started: 15-Nov-17
Test completed: 24-Dec-17
Test specification(s): FCC 47CFR part 15 subpart C § 15.247 (DTS), subpart B;
RSS-247 issue 2, RSS-Gen issue 4, ICES-003 Issue 6:2016

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth	Pass
FCC section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power	Pass
FCC section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	Pass
FCC section 15.247(d) / RSS-247 section 5.5, Band edge emissions	Pass
FCC section 15.247(e) / RSS-247 section 5.2(b), Peak power density	Pass
FCC section 15.247(i), / RSS-102 section 2.5.2, RF exposure	Pass, the exhibit to the application of certification is provided
FCC section 15.207(a) / RSS-Gen section 8.8, Conducted emission	Not required
FCC section 15.203 / RSS-Gen section 8.3, Antenna requirement	Pass
Unintentional emissions	
FCC section 15.107, ICES-03, Section 6.1, conducted emission at AC power port	Not required
FCC section 15.109, ICES-003, Section 6.2, RSS-Gen section 7.1.2, 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.

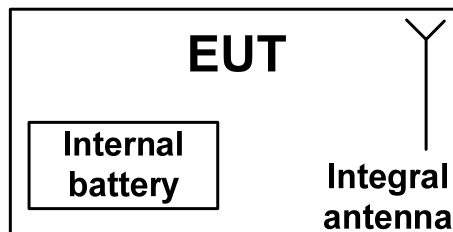
	Name and Title	Date	Signature
Tested by:	Mrs. E.Pitt, test engineer	December 24, 2017	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	January 4, 2018	
Approved by:	Mr. K. Zushchuk, Projects & Customer Manager, EMC & Radio	January 15, 2018	

6 EUT description

6.1 General information

The EUT, EM800MGL is wireless battery fed magnet sensor.

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented in the EUT during the testing.

6.4 EUT test positions

Photograph 6.4.1 EUT in X-axis orthogonal position



Photograph 6.4.2 EUT in Y-axis orthogonal position



Photograph 6.4.3 EUT in Z-axis orthogonal position



6.5 Transmitter characteristics

Type of equipment					
X	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)				
Intended use		Condition of use			
	fixed	Always at a distance more than 2 m from all people			
X	mobile	Always at a distance more than 20 cm from all people			
	portable	May operate at a distance closer than 20 cm to human body			
Assigned frequency range		2400 - 2483.5 MHz			
Operating frequency		2425 MHz			
Maximum rated output power		Peak output power		12.5 dBm	
Is transmitter output power variable?		X	No		
			Yes	continuous variable	
		stepped variable with stepsize		dB	
		minimum RF power		dBm	
		maximum RF power		dBm	
Antenna connection					
unique coupling		standard connector		X	integral
				X	without temporary RF connector
Antenna/s technical characteristics					
Type	Manufacturer		Model number		Gain
Integral	YIPSHING		11447		-2 dBi
Modulation		QPSK			
Transmitter aggregate data rate/s		250 kbps			
Modulating test signal (baseband)		PRBS			
Transmitter power source					
X	Battery	Nominal rated voltage	1.5 VDC	Battery type	Alkaline 1 AA
	DC	Nominal rated voltage	VDC		
	AC mains	Nominal rated voltage	VAC	Frequency	
Spread spectrum technique used		Frequency hopping (FHSS)			
		X	Digital transmission system (DTS)		
		Hybrid			

Test specification: Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C and RSS-247 requirements

7.1 Minimum 6 dB bandwidth

7.1.1 General

This test was performed to measure 6 dB bandwidth of the EUT carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 6 dB bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Minimum bandwidth, kHz
902.0 – 928.0	6.0	500.0
2400.0 – 2483.5		
5725.0 – 5850.0		

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

7.1.2 Test procedure

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

7.1.2.2 The EUT was set to transmit modulated carrier.

7.1.2.3 The transmitter minimum 6 dB bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.2 and the associated plot.

Figure 7.1.1 The 6 dB bandwidth test setup





HERMON LABORATORIES

Test specification: Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

Table 7.1.2 The 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 2400-2483.5 MHz
 DETECTOR USED: Peak
 SWEEP TIME: Auto
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 MODULATION ENVELOPE REFERENCE POINTS: 6.0 dBc
 MODULATION: QPSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 250 kbps

Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz	99% OBW kHz	Verdict
2425	1646	500	1146	2634	Pass

Reference numbers of test equipment used

HL 2909								
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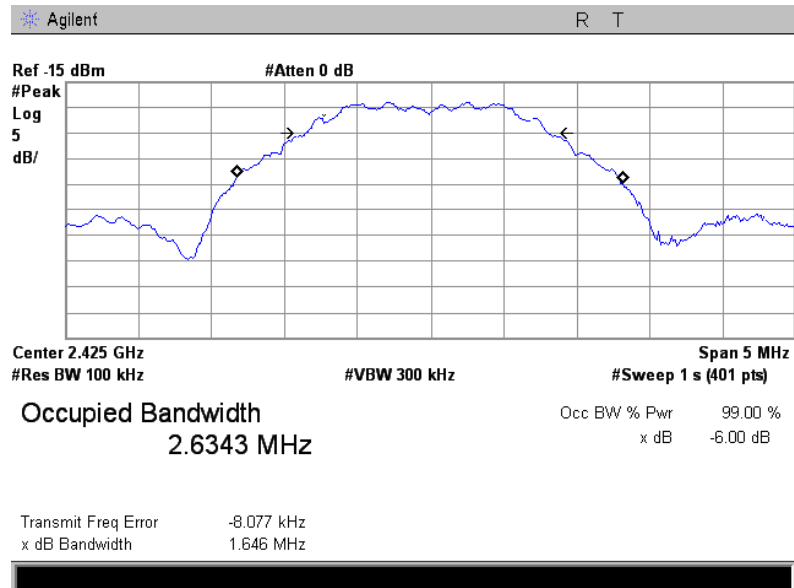
Full description is given in Appendix A.



HERMON LABORATORIES

Test specification:		Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth	
Test procedure:		ANSI C63.10 section 11.8.1	
Test mode:		Verdict: PASS	
Date(s):			
24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

Plot 7.1.1 The 6 dB bandwidth test result





Test specification: Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

7.2 Peak output power

7.2.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Peak output power limits

Assigned frequency range, MHz	Maximum antenna gain, dBi	Peak output power*		Equivalent field strength limit @ 3m, dB(μV/m)**
		W	dBm	
902.0 – 928.0	6.0	1.0	30.0	131.2
2400.0 – 2483.5				
5725.0 – 5850.0				

*- The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;

without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;

by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

** - Equivalent field strength limit was calculated from the peak output power as follows: $E = \sqrt{30 \times P \times G} / r$, where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

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 adjusted to produce maximum available to end user RF output power.

7.2.2.3 The resolution bandwidth of spectrum analyzer was set wider than 6 dB bandwidth of the EUT and 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° and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.2.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.2.2 and associated plots.

7.2.2.5 The maximum peak output power was calculated from the field strength of carrier as follows:

$$P = (E \times d)^2 / (30 \times G),$$

where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.

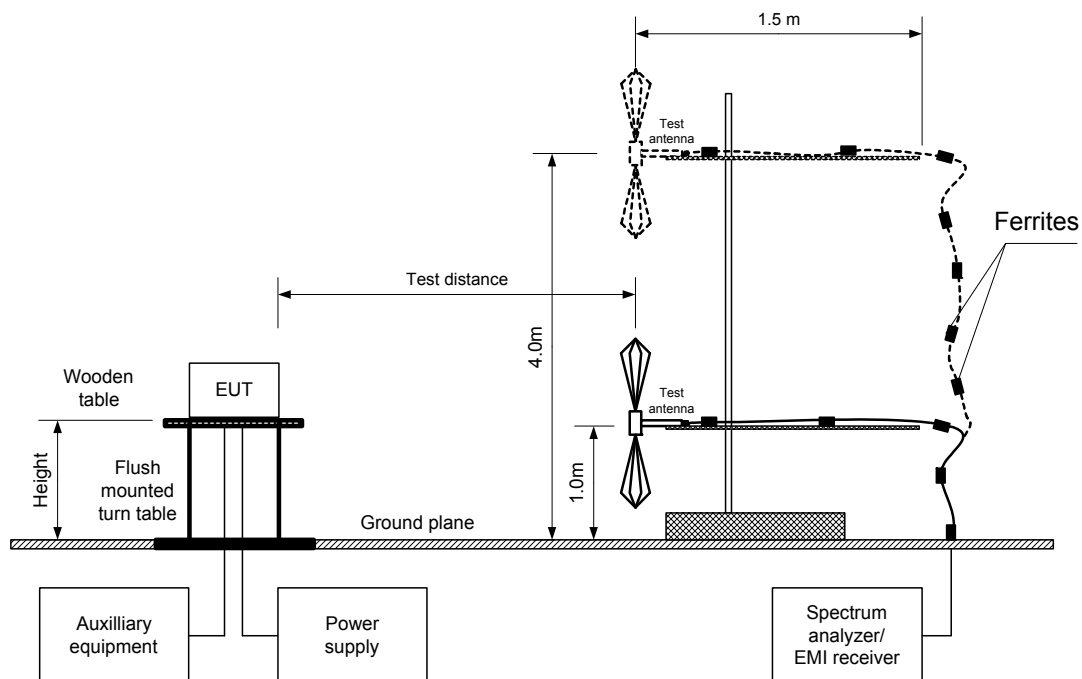
The above equation was converted in logarithmic units for 3 m test distance:

$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

7.2.2.6 The worst test results (the lowest margins) were recorded in Table 7.2.2.

Test specification: Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Figure 7.2.1 Setup for carrier field strength measurements





Test specification: Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode:	Compliance	Verdict: PASS	
Date(s):	15-Nov-17		
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Table 7.2.2 Peak output power test results

ASSIGNED FREQUENCY: 2400-2483.5 MHz
 TEST DISTANCE: 3 m
 TEST SITE: OATS
 EUT HEIGHT: 1.5 m
 DETECTOR USED: Peak
 TEST ANTENNA TYPE: Double ridged guide
 MODULATION: QPSK
 BIT RATE: 250 kbps

Frequency, MHz	Field strength, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	EUT antenna gain, dBi	Peak output power, dBm**	Limit, dBm	Margin, dB***	Verdict
2425	105.0	Vertical	1.2	147	-2	11.8	30	-18.2	Pass
2425	105.7	Horizontal	1.5	121	-2	12.5	30	-17.5	Pass

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

**- Peak output power was calculated from the field strength of carrier as follows: $P = (E \times d)^2 / (30 \times G)$, where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance: *Peak output power in dBm = Field strength in dB(μV/m) - Transmitter antenna gain in dBi - 95.2 dB*

***- Margin = Peak output power – specification limit.

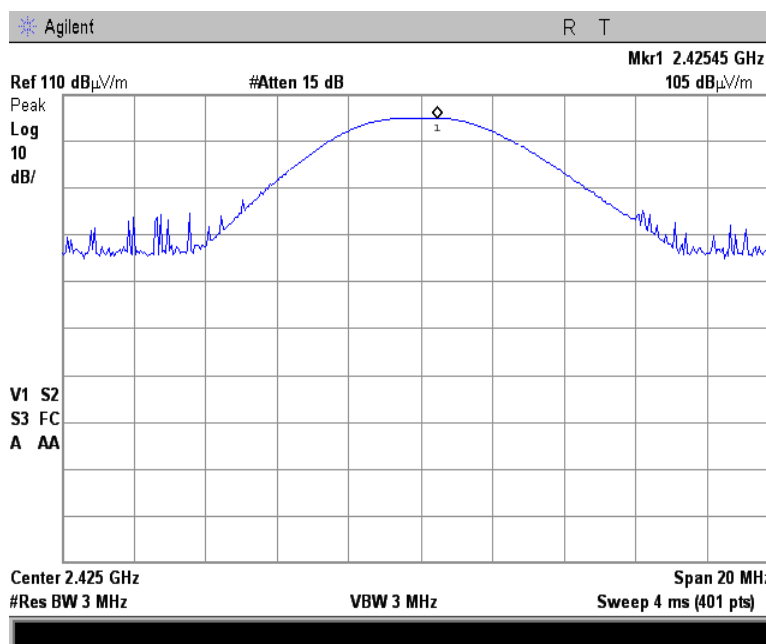
Reference numbers of test equipment used

HL 1513	HL 1984	HL 2909					
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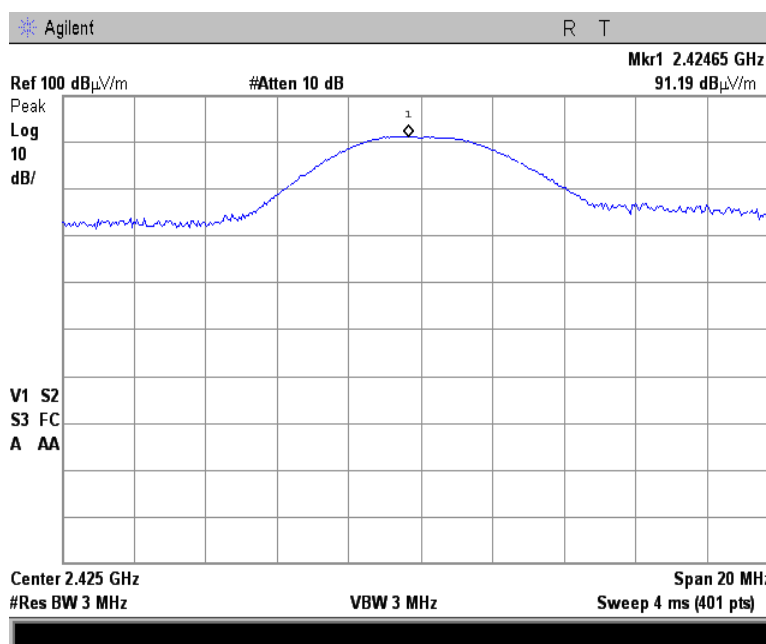
Full description is given in Appendix A.

Test specification: Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Plot 7.2.1 Field strength of carrier in vertical antenna polarization, EUT X-axis position

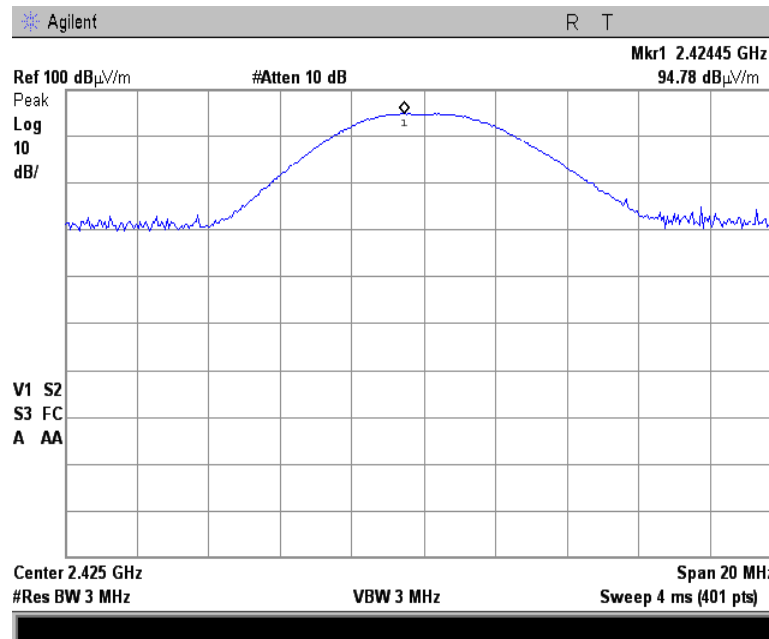


Plot 7.2.2 Field strength of carrier in vertical antenna polarization, EUT Y-axis position

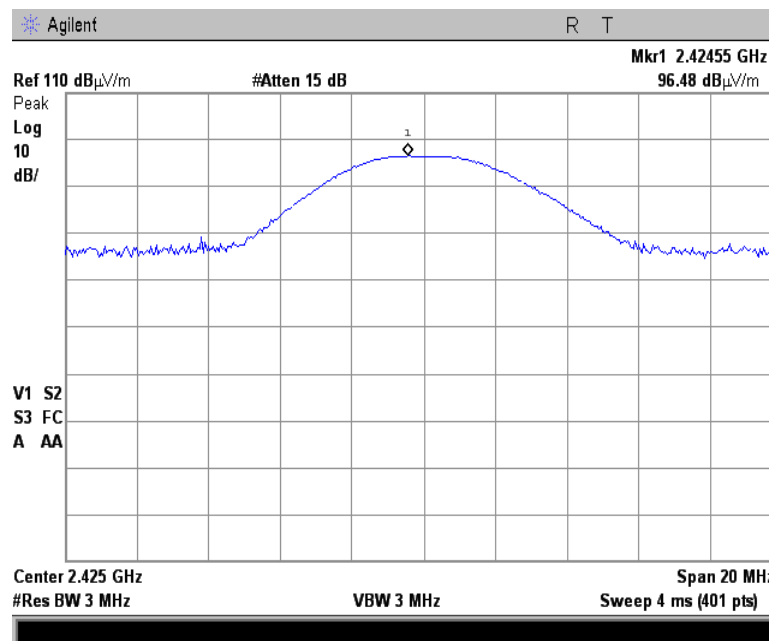


Test specification:		Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power	
Test procedure:		ANSI C63.10 sections 11.9.2.2.4	
Test mode:		Verdict: PASS	
Date(s):			
15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Plot 7.2.3 Field strength of carrier in vertical antenna polarization, EUT Z-axis position

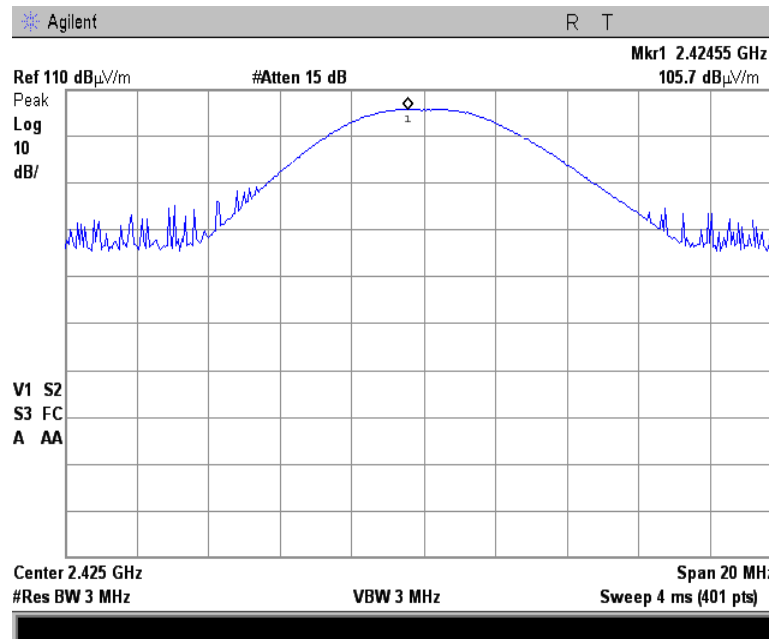


Plot 7.2.4 Field strength of carrier in horizontal antenna polarization, EUT X-axis position

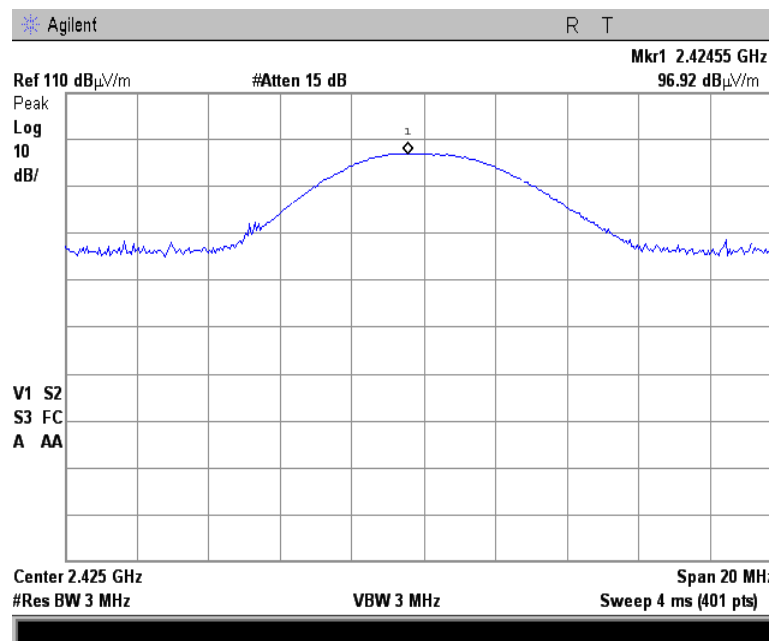


Test specification:		Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power	
Test procedure:		ANSI C63.10 sections 11.9.2.2.4	
Test mode:		Verdict: PASS	
Date(s):			
15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Plot 7.2.5 Field strength of carrier in horizontal antenna polarization, EUT Y-axis position



Plot 7.2.6 Field strength of carrier in horizontal antenna polarization, EUT Z-axis position





Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Verdict: PASS	
Date(s):			
15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

7.3 Field strength of spurious emissions

7.3.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m within restricted bands, dB(μV/m)*			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	20.0
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		
1000 – 10 th harmonic	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.

*** - The 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.

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/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.3.2.3 The worst test results (the lowest margins) were recorded 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, Figure 7.3.3, energized and the performance check was conducted.

7.3.3.2 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.

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

Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Figure 7.3.1 Setup for spurious emission field strength measurements below 30 MHz

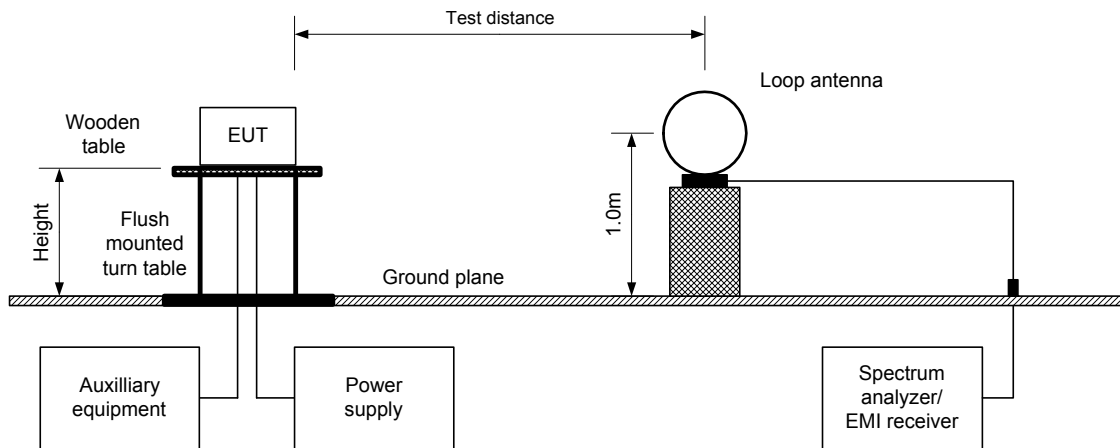
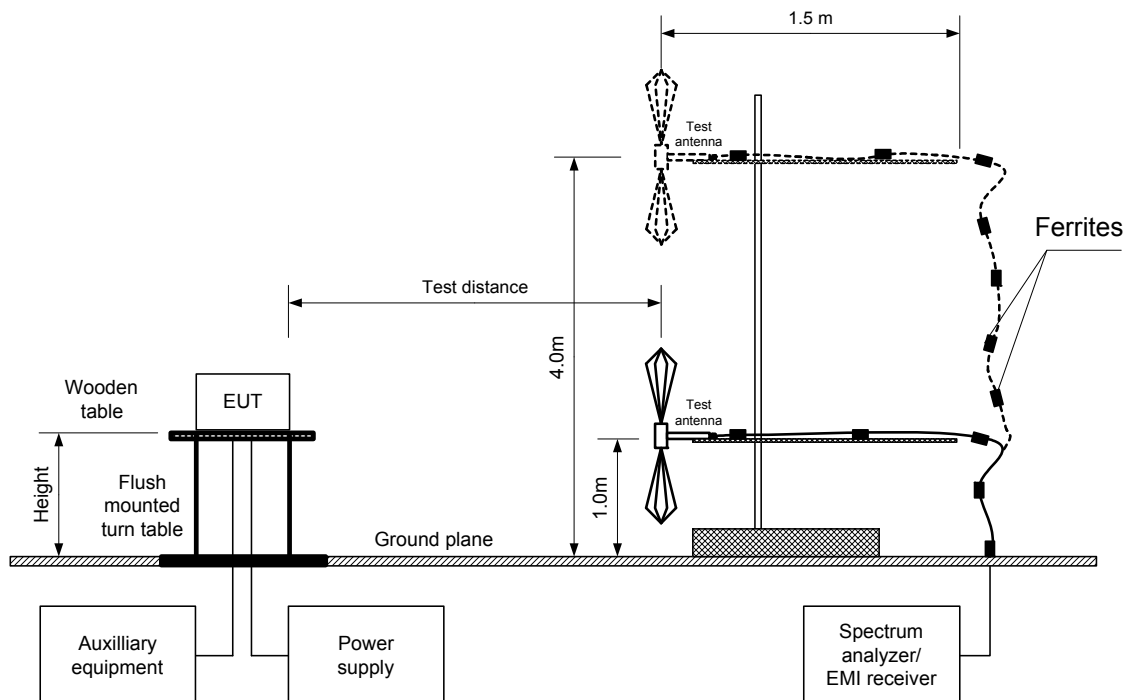
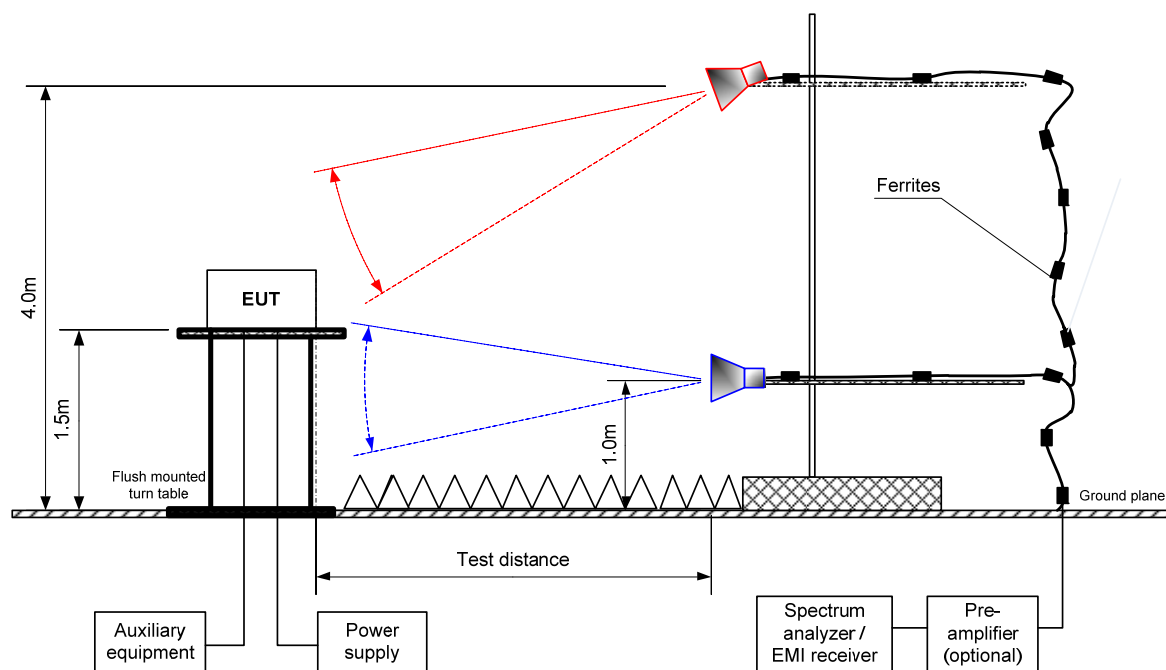


Figure 7.3.2 Setup for spurious emission field strength measurements in 30 -1000 MHz



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Figure 7.3.3 Setup for spurious emission field strength measurements above 1000 MHz



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Table 7.3.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY BAND: 2400-2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 - 2500 MHz
 TEST DISTANCE: 3 m
 MODULATION: QPSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 250 kbps
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)

Frequency, MHz	Field strength of spurious, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(μV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
9700	42.07	Horizontal	1.4	0	99.64	57.57	20.0	37.57	Pass

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

** - Margin = Attenuation below carrier – specification limit.

Table 7.3.3 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY BAND: 2400-2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 – 25000 MHz
 TEST DISTANCE: 3 m
 MODULATION: QPSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 250 kbps
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength(VBW=3 MHz)			Average field strength(VBW=300 Hz)				Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	Measured, dB(μV/m)	Calculated, dB(μV/m)	Limit, dB(μV/m)	Margin, dB***	
4850	Horizontal	1.6	30	51.04	74	-22.96	44.12	NA	54	-9.88	Pass
7275	Horizontal	1.4	0	56.82	74	-17.18	49.71	NA	54	-4.29	

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

** - Margin = Measured field strength - specification limit.

*** - Margin = Calculated field strength - specification limit,
where Calculated field strength = Measured field strength + average factor.

Table 7.3.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
4.225	4.725	NA	NA	NA	-1.0

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



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Table 7.3.5 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY BAND: 2400-2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: QPSK
 MODULATING SIGNAL: PRBS
 BIT RATE: 250 kbps
 RESOLUTION BANDWIDTH: 1.0 kHz (9 kHz – 150 kHz)
 9.0 kHz (150 kHz – 30 MHz)
 120 kHz (30 MHz – 1000 MHz)
 VIDEO BANDWIDTH: > Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)

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*				
No signals were found								Pass

*- Margin = Measured emission - specification limit.

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

Reference numbers of test equipment used

HL 0446	HL 0604	HL 2909	HL 4353	HL 4372	HL 4529	HL 4778	HL 4933
HL 4956	HL 5102	HL 5112					

Full description is given in Appendix A.

Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Table 7.3.6 Restricted bands according to FCC section 15.205

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2690 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 - 5460	23.6 - 24
6.26775 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 - 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

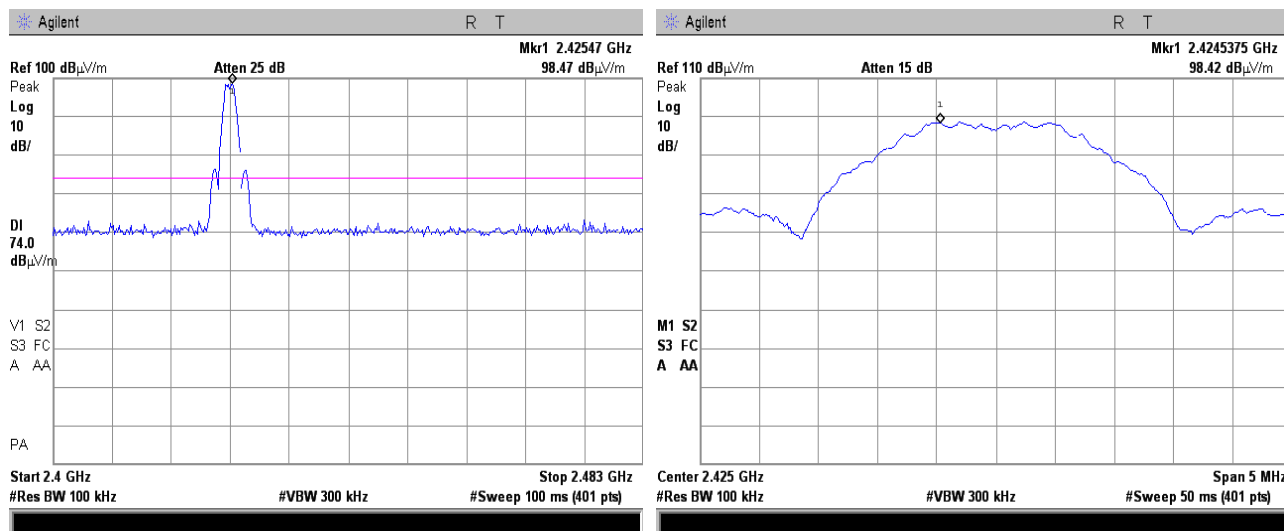
Table 7.3.7 Restricted bands according to RSS-Gen

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.291 - 8.294	16.80425 - 16.80475	399.9 - 410	3260 - 3267	10.6 - 12.7
2.1735 - 2.1905	8.362 - 8.366	25.5 - 25.67	608 - 614	3332 - 3339	13.25 - 13.4
3.020 - 3.026	8.37625 - 8.38675	37.5 - 38.25	960 - 1427	3345.8 - 3358	14.47 - 14.5
4.125 - 4.128	8.41425 - 8.41475	73 - 74.6	1435 - 1626.5	3500 - 4400	15.35 - 16.2
4.17725 - 4.17775	12.29 - 12.293	74.8 - 75.2	1645.5 - 1646.5	4500 - 5150	17.7 - 21.4
4.20725 - 4.20775	12.51975 - 12.52025	108 - 138	1660 - 1710	5350 - 5460	22.01 - 23.12
5.677 - 5.683	12.57675 - 12.57725	156.52475 - 156.52525	1718.8 - 1722.2	7250 - 7750	23.6 - 24
6.215 - 6.218	13.36 - 13.41	156.7 - 156.9	2200 - 2300	8025 - 8500	31.2 - 31.8
6.26775 - 6.26825	16.42 - 16.423	240 - 285	2310 - 2390	9000 - 9200	36.43 - 36.5
6.31175 - 6.31225	16.69475 - 16.69525	322 - 335.4	2655 - 2900	9300 - 9500	Above 38.6

Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

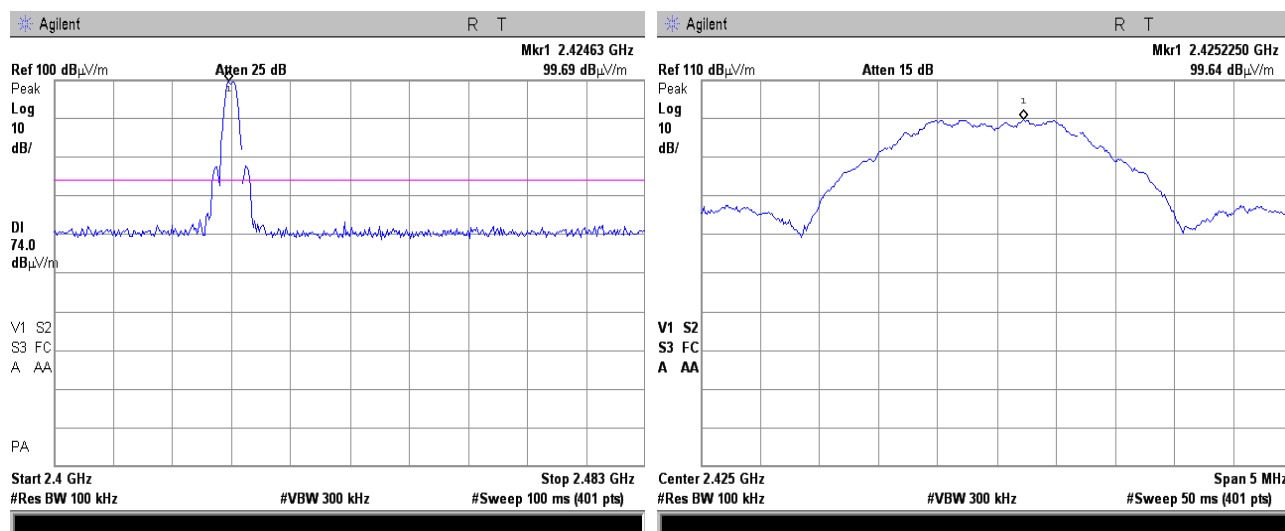
Plot 7.3.1 Radiated emission measurements at the carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Plot 7.3.2 Radiated emission measurements at the carrier frequency

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal



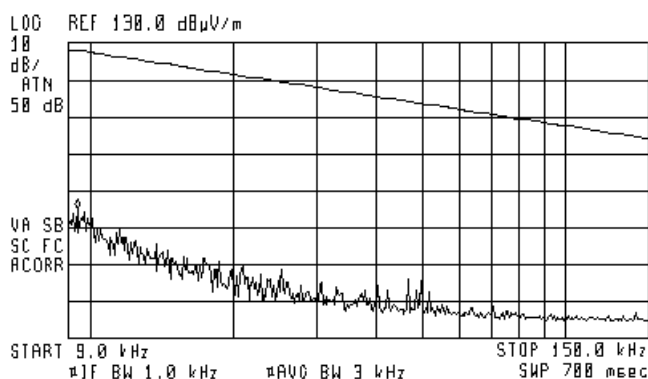
Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Plot 7.3.3 Radiated emission measurements from 9 to 150 kHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



ACTV DET: PEAK
MERS DET: PEAK OP AVG
MKR 9.5 kHz
84.98 dBμV/m

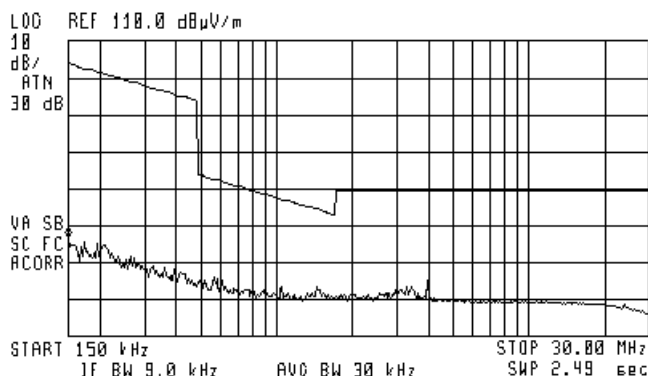


Plot 7.3.4 Radiated emission measurements from 0.15 to 30 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



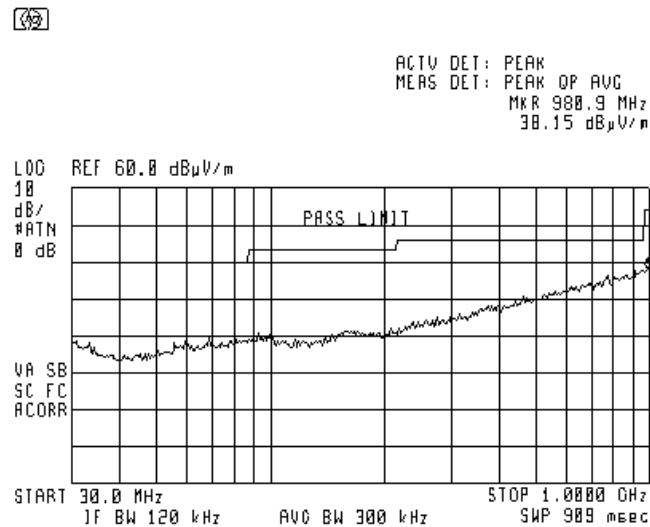
ACTV DET: PEAK
MERS DET: PEAK OP AVG
MKR 150 kHz
56.93 dBμV/m



Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Verdict: PASS	
Date(s):			
15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

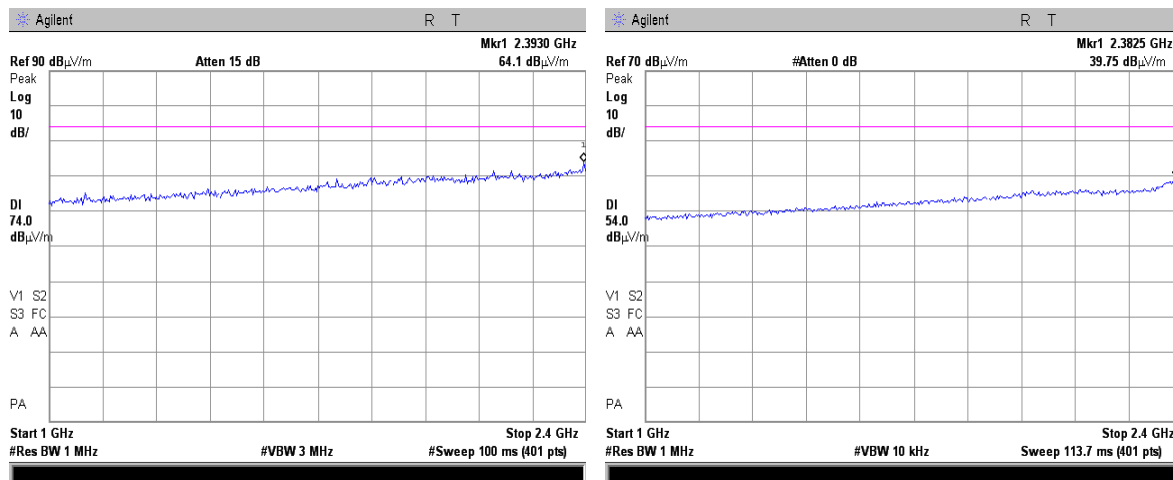
Plot 7.3.5 Radiated emission measurements from 30 to 1000 MHz

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



Plot 7.3.6 Radiated emission measurements from 1000 to 2400 MHz

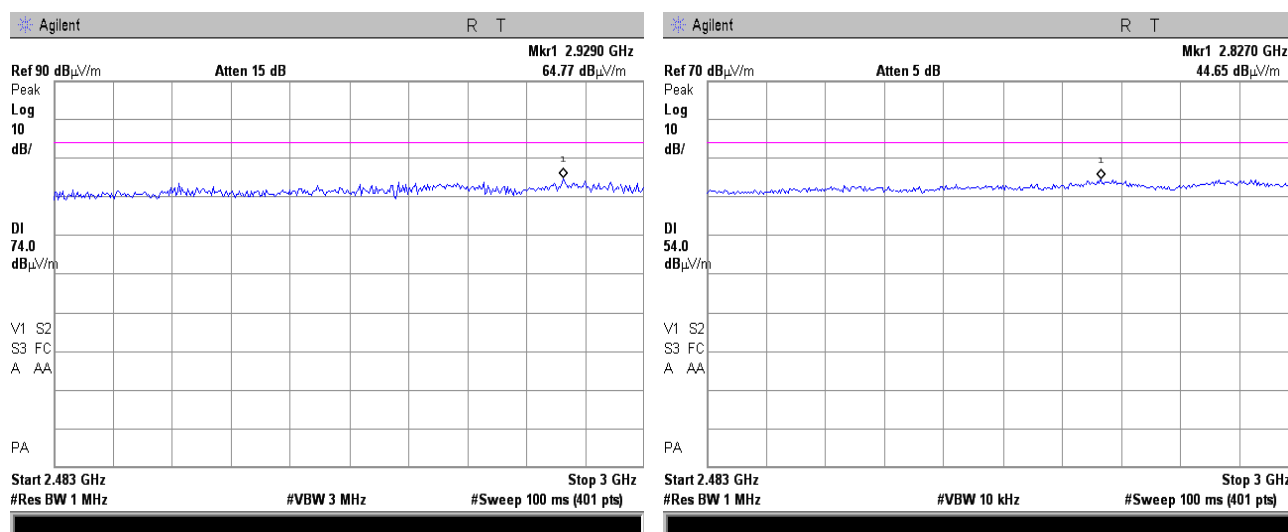
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

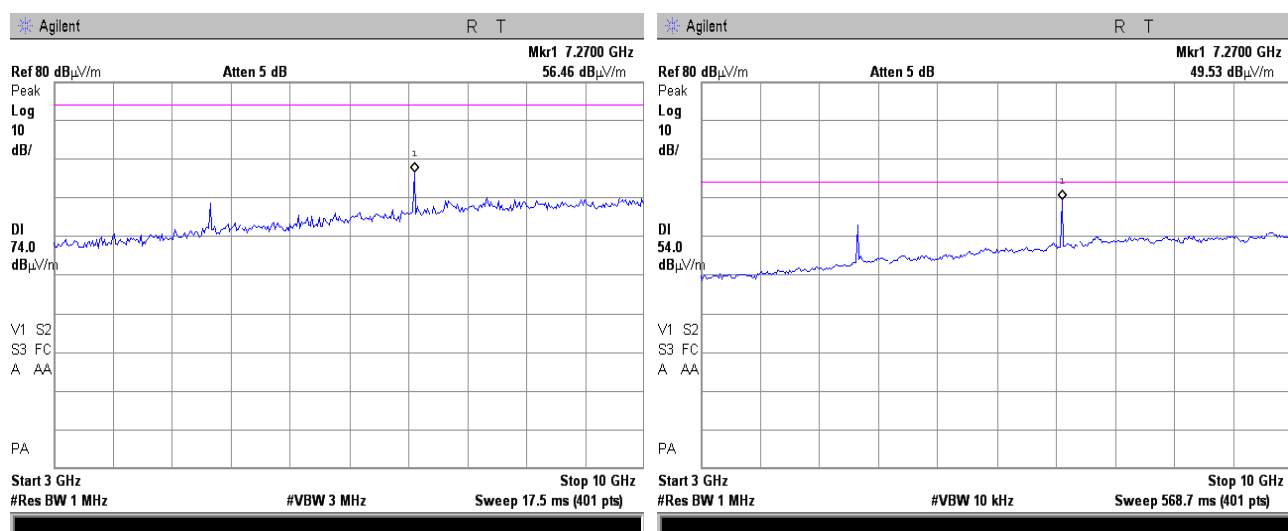
Plot 7.3.7 Radiated emission measurements from 2483.5 to 3000 MHz

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



Plot 7.3.8 Radiated emission measurements from 3.0 to 10.0 GHz at the carrier frequency

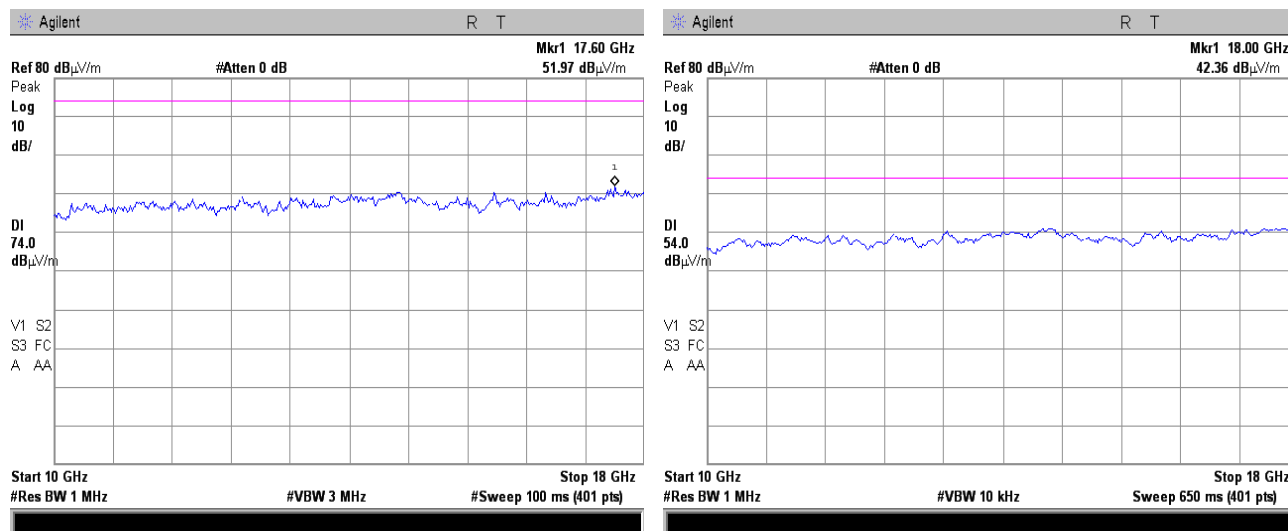
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

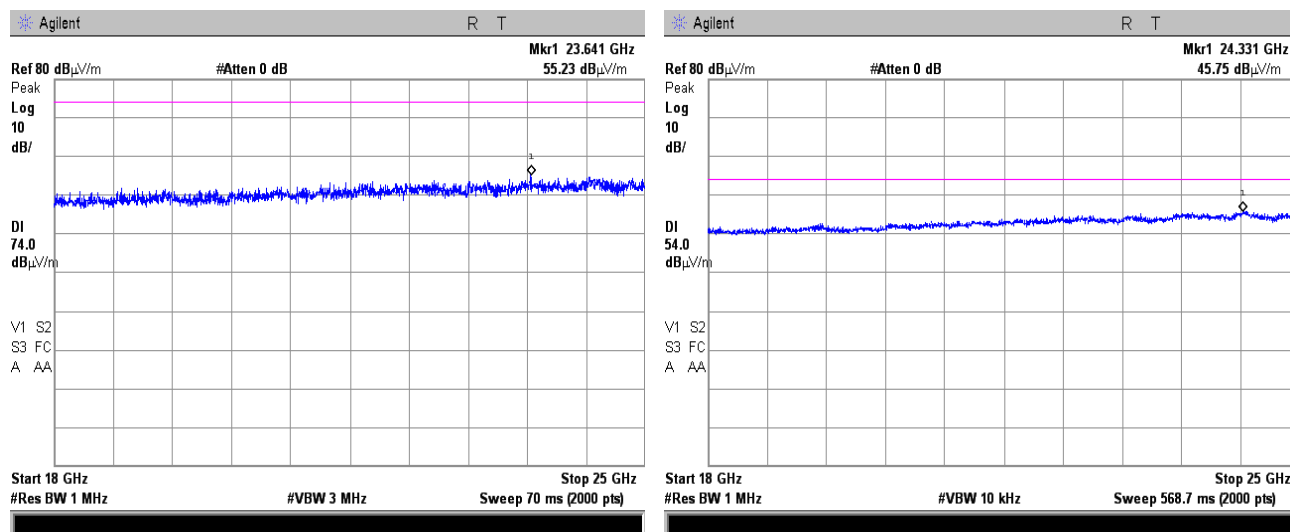
Plot 7.3.9 Radiated emission measurements from 10.0 to 18.0 GHz

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.3.10 Radiated emission measurements from 18.0 to 25.0 GHz at the carrier frequency

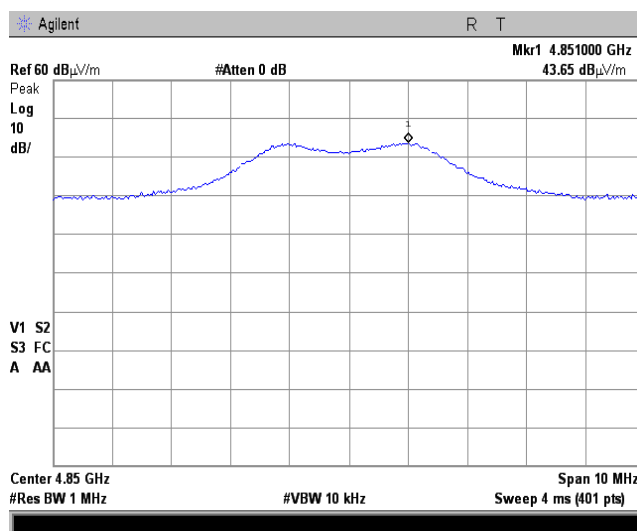
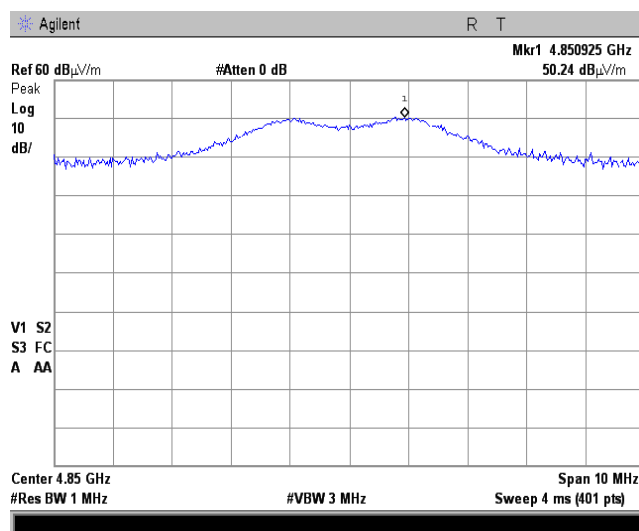
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

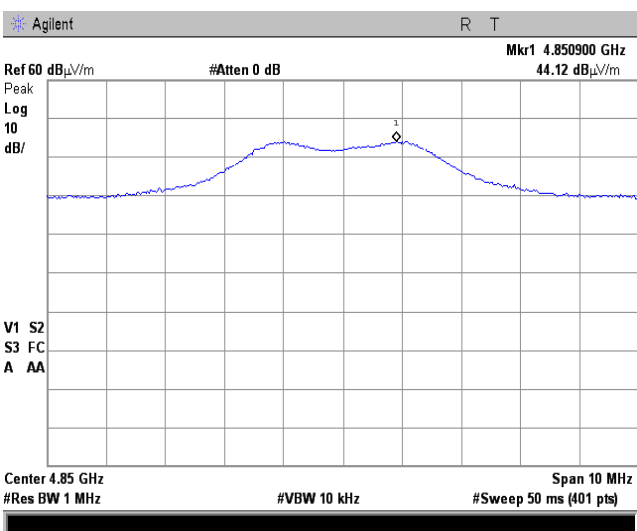
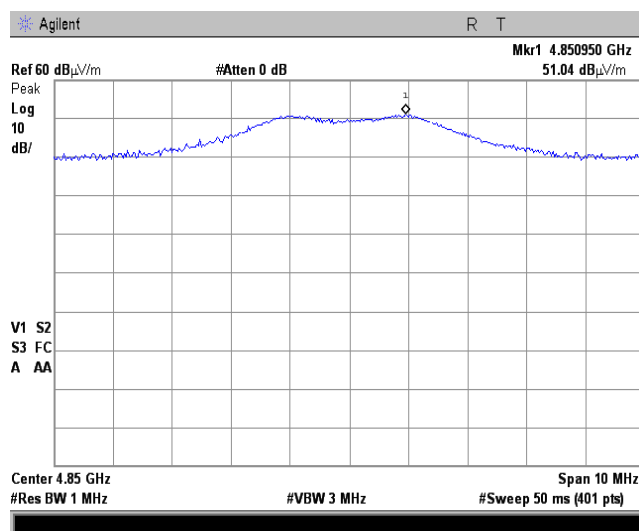
Plot 7.3.11 Radiated emission measurements at the second harmonic at vertical antenna polarization

TEST SITE: OATS
TEST DISTANCE: 3 m



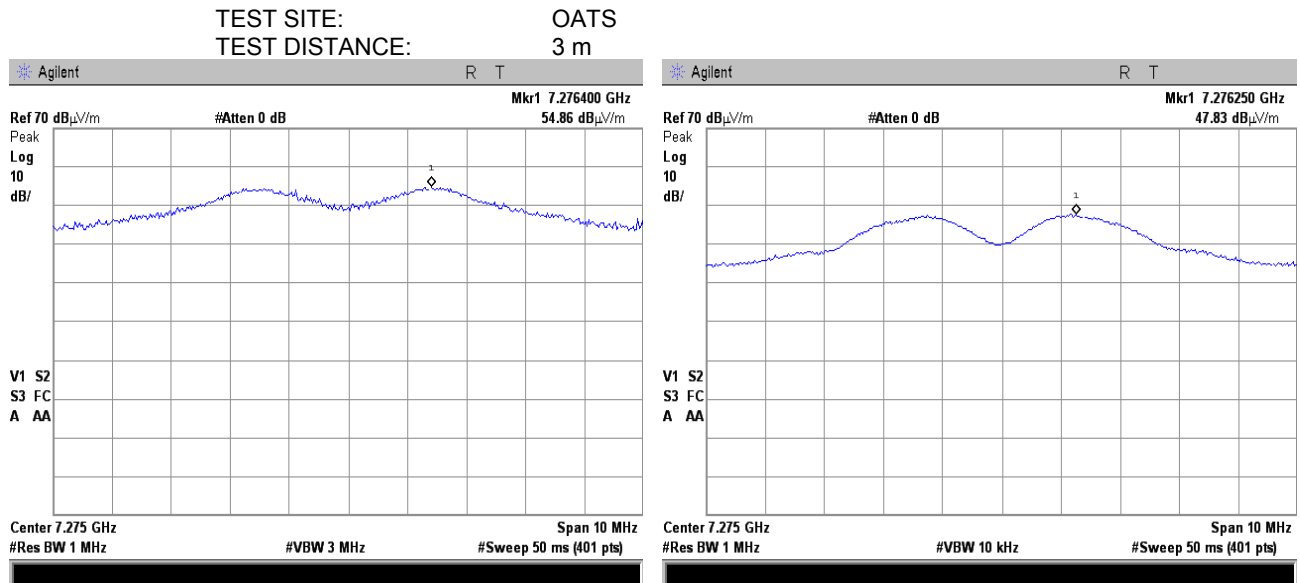
Plot 7.3.12 Radiated emission measurements at the second harmonic at horizontal antenna polarization

TEST SITE: OATS
TEST DISTANCE: 3 m

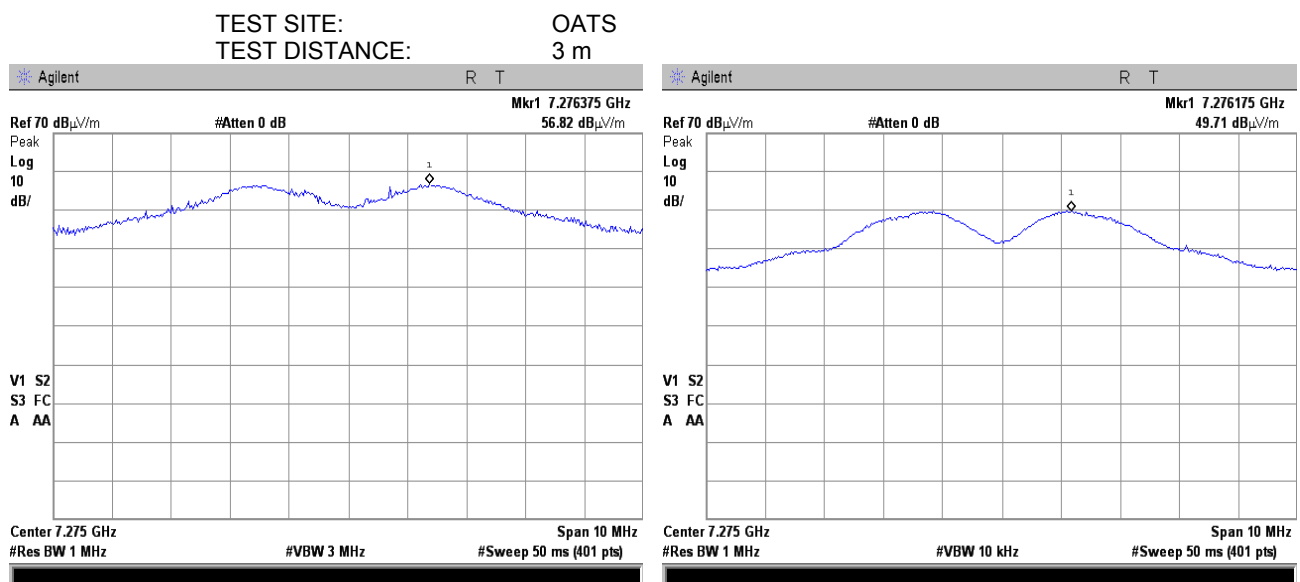


Test specification:		Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10 section 11.12.1	
Test mode:		Verdict: PASS	
Date(s):			
15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Plot 7.3.13 Radiated emission measurements at the third harmonic at vertical antenna polarization



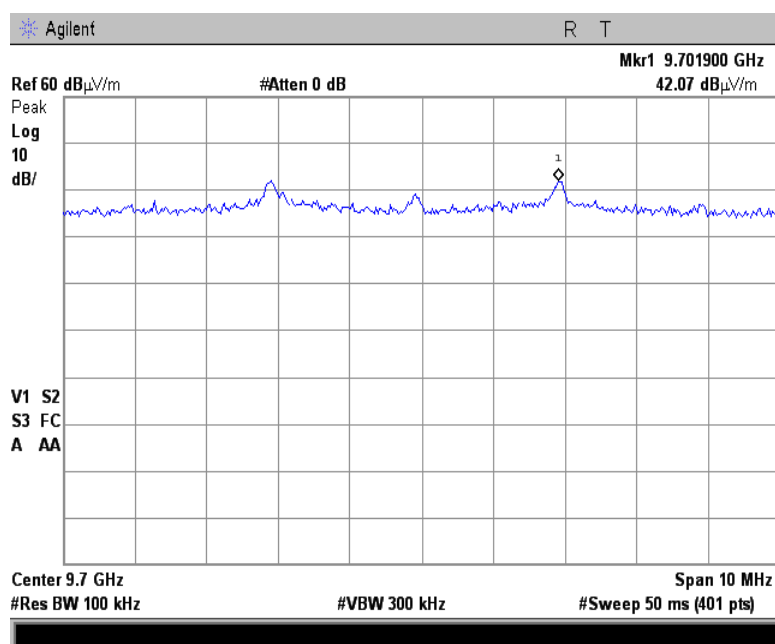
Plot 7.3.14 Radiated emission measurements at the third harmonic at horizontal antenna polarization



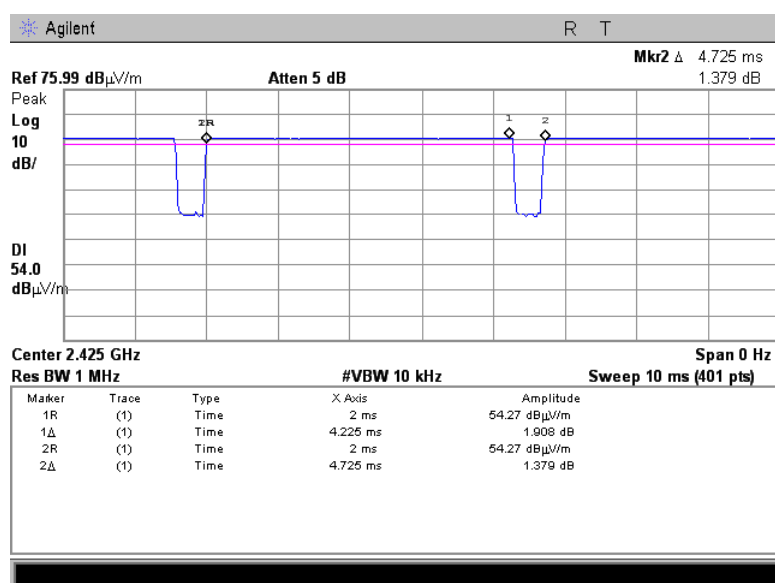
Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 15-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1008 hPa	Power: Battery
Remarks:			

Plot 7.3.15 Radiated emission measurements at the fourth harmonic at vertical & horizontal antenna polarization

TEST SITE: OATS
TEST DISTANCE: 3 m



Plot 7.3.16 Transmission pulse duration and pulse period



Test specification: Section 15.247(d) / RSS-247 section 5.5, Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

7.4 Band edge radiated emissions

7.4.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Band edge emission limits

Output power	Assigned frequency, MHz	Attenuation below carrier*, dBc	Field strength at 3 m within restricted bands, dB(μV/m)	
			Peak	Average
Peak	902.0 – 928.0	20.0	74.0	54.0
	2400.0 – 2483.5			
	5725.0 – 5850.0			

* - Band edge emission limit is provided in terms of attenuation below the peak of modulated carrier measured with the same resolution bandwidth.

7.4.2 Test procedure

- 7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized normally modulated at the maximum data rate and its proper operation was checked.
- 7.4.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.4.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.4.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.4.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.4.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.4.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

Figure 7.4.1 Band edge emission test setup





HERMON LABORATORIES

Test specification: Section 15.247(d) / RSS-247 section 5.5, Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

Table 7.4.2 Band edge emission test results

ASSIGNED FREQUENCY RANGE: 2400-2483.5 MHz
DETECTOR USED: Peak
MODULATION: QPSK
BIT RATE: 250 kbps

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength(VBW=3 MHz)			Average field strength(VBW=10 kHz)				Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	Measured, dB(μV/m)	Calculated, dB(μV/m)	Limit, dB(μV/m)	Margin, dB***	
2400.0	Horizontal	1.6	30	64.10	74	-9.90	39.75	NA	54	-14.25	Pass
2483.5	Horizontal	1.4	0	64.77	74	-9.23	44.65	NA	54	-9.35	

*- Margin = Attenuation below carrier – specification limit.

Reference numbers of test equipment used

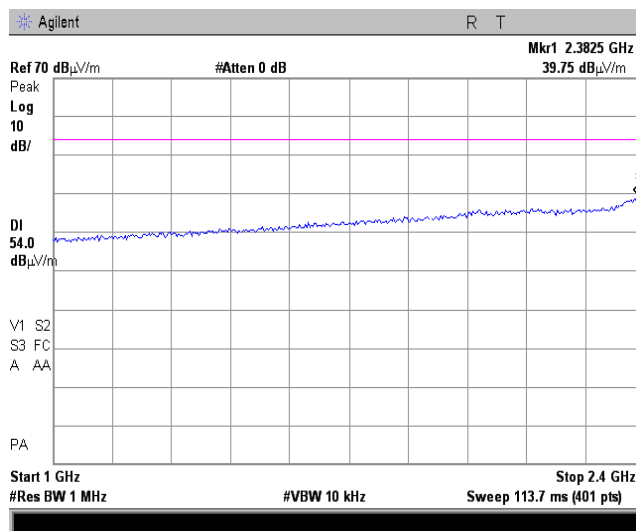
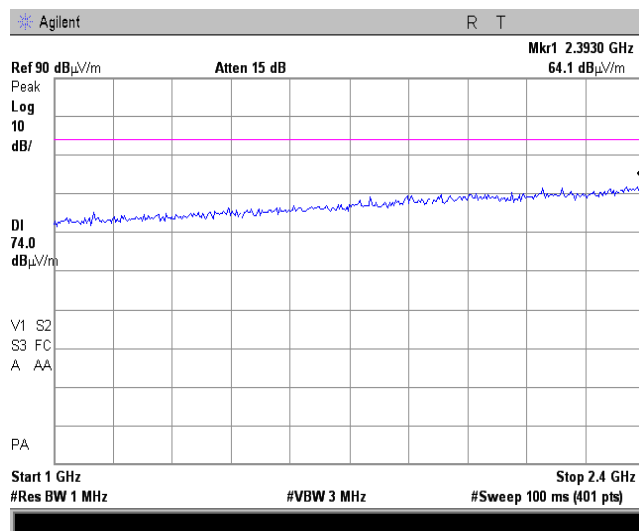
HL 2909	HL 4353	HL 5102					
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Full description is given in Appendix A.

Test specification: Section 15.247(d) / RSS-247 section 5.5, Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

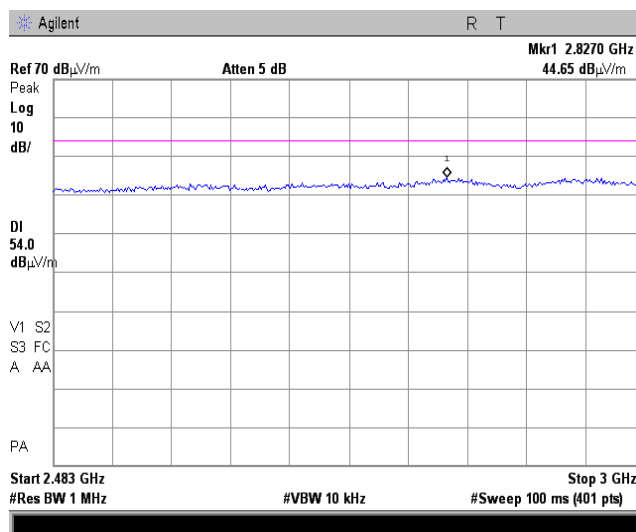
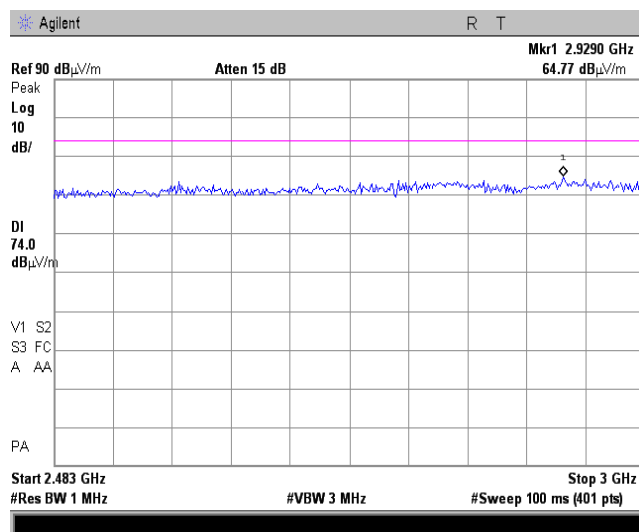
Plot 7.4.1 The band edge emission from 1000 to 2400 MHz

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



Plot 7.4.2 The band edge emission from 2483.5 to 3000 MHz

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





Test specification: Section 15.247(e), / RSS-247 section 5.2(b), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

7.5 Maximum power spectral density (PSD)

7.5.1 General

This test was performed to measure the peak spectral power density radiated by the transmitter RF antenna. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Peak spectral power density limits

Assigned frequency range, MHz	Measurement bandwidth, kHz	Peak spectral power density, dBm	Equivalent field strength limit @ 3m, dB(μV/m)*
902.0 – 928.0	3.0	8.0	103.2
2400.0 – 2483.5			
5725.0 – 5850.0			

* - Equivalent field strength limit was calculated from the peak spectral power density as follows: $E = \sqrt{30 \times P} / r$, where P is peak spectral power density and r is antenna to EUT distance in meters.

7.5.2 Test procedure for field strength measurements

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

7.5.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.5.2.3 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° and the measuring antenna height was swept in both vertical and horizontal polarizations.

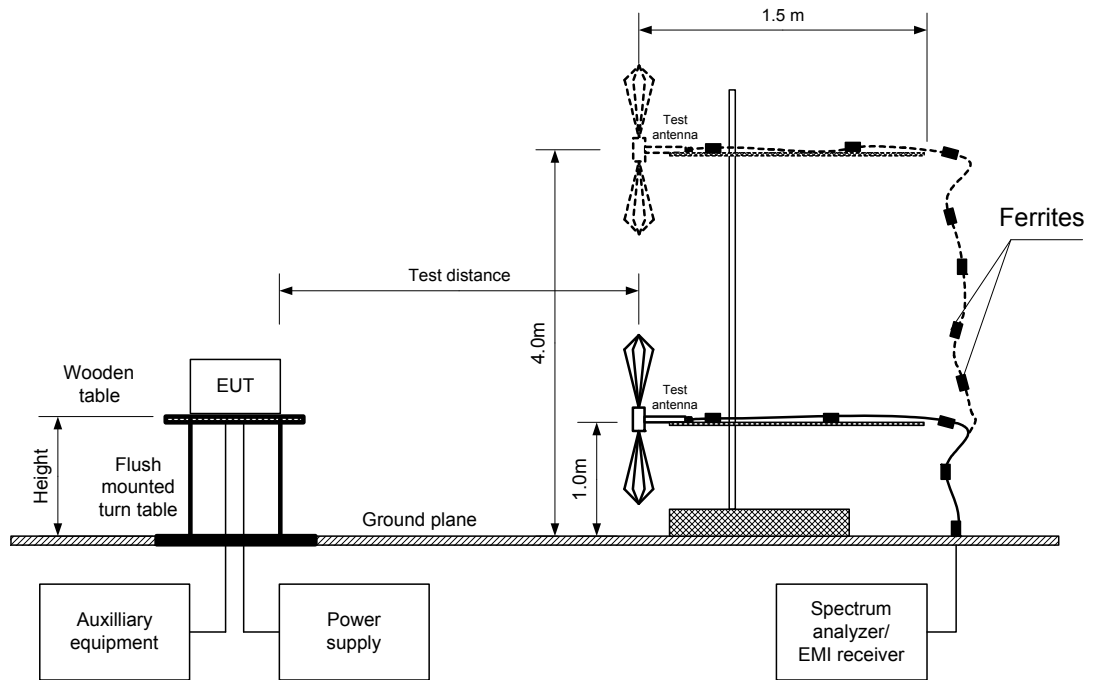
7.5.2.4 The maximum power spectral density was measured using a peak detector with resolution bandwidth set to 100 kHz, VBW ≥ 300 kHz, sweep time = auto couple, trace mode = max hold.

7.5.2.5 The maximum power level was determined in any 100 kHz band within the fundamental EBW. The measured value did not exceed the limit

7.5.2.6 The test results provided in Table 7.5.2 and the associated plots.

Test specification: Section 15.247(e), / RSS-247 section 5.2(b), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

Figure 7.5.1 Setup for carrier field strength measurements





Test specification: Section 15.247(e), / RSS-247 section 5.2(b), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

Table 7.5.2 Field strength measurement of peak spectral power density

ASSIGNED FREQUENCY: 2400-2483.5 MHz
 TEST DISTANCE: 3 m
 TEST SITE: OATS
 EUT HEIGHT: 1.5 m
 DETECTOR USED: Peak
 TEST ANTENNA TYPE: Double ridged guide
 MODULATION: QPSK
 BIT RATE: 250 kbps

Frequency, MHz	Field strength, dB(μ V/m)	EUT antenna gain, dBi	Limit, dB(μ V/m)	Margin, dB*	Antenna polarization	Antenna height, m	Turn-table position**, degrees
2425	98.42	-2	103.2	-2.78	Vertical	1.2	147
2425	99.64	-2	103.2	-1.56	Horizontal	1.5	121

*- Margin = Field strength - EUT antenna gain - calculated field strength limit.

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

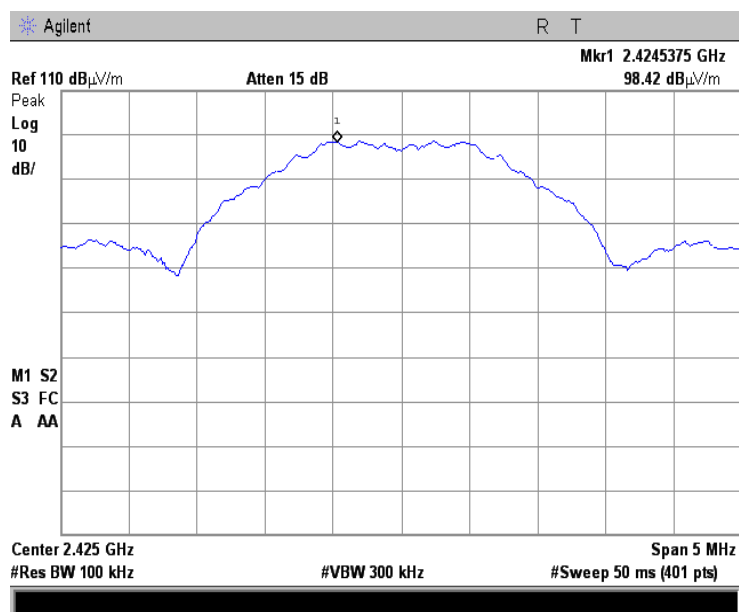
Reference numbers of test equipment used

HL 1513	HL 1984	HL 2909					
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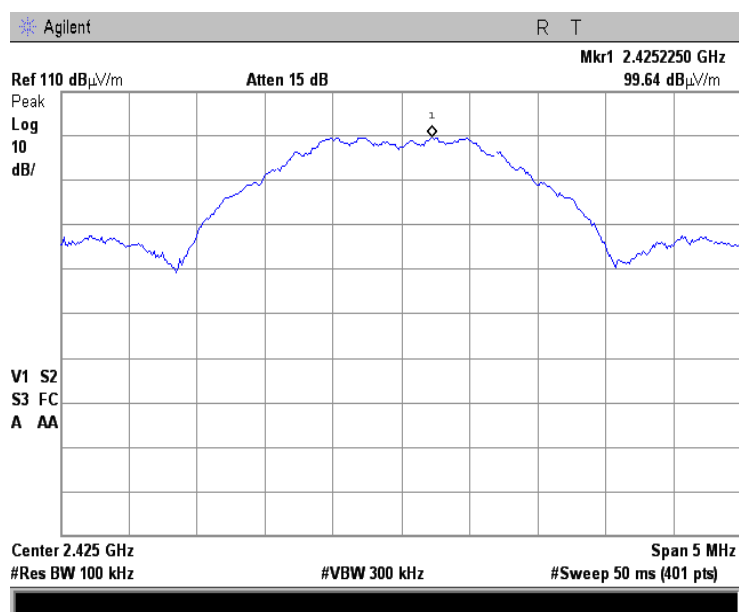
Full description is given in Appendix A.

Test specification: Section 15.247(e), / RSS-247 section 5.2(b), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

Plot 7.5.1 Peak spectral power density in vertical antenna polarization



Plot 7.5.2 Peak spectral power density in horizontal antenna polarization





Test specification: Section 15.203, RSS-Gen section 8.3, Antenna requirements			
Test procedure: Visual inspection			
Test mode: Compliance		Verdict: PASS	
Date(s): 24-Dec-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1012 hPa	Power: Battery
Remarks:			

7.6 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 7.6.1.

Table 7.6.1 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	



Test specification: FCC 47 CFR, Section 15.109, RSS-Gen, Section 7.1.2, ICES-003, Section 6.2, Class B, Radiated emissions			
Test procedure: ANSI C63.4, Sections 8.3 and 12.2.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 26-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1023 hPa	Power: Battery
Remarks:			

8 Unintentional emissions

8.1 Radiated emission measurements

8.1.1 General

This test was performed to measure radiated emissions from the EUT enclosure. The specification test limits are given in Table 8.1.1, Table 8.1.2.

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 a test distance other than specified was calculated using the inverse linear distance extrapolation factor as follows: $\text{Lim}_{S2} = \text{Lim}_{S1} + 20 \log(S1/S2)$, where $S1$ and $S2$ – the standard defined and the test distance respectively in meters.

Table 8.1.2 Radiated emission limits according to RSS-Gen, Section 7.1.2

Frequency, MHz	Field strength limit at 3 m test distance, dB(μV/m)
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
960 - 5 th harmonic**	54.0

** - harmonic of the highest frequency the EUT generates, uses, operates or tunes to.

8.1.2 Test procedure

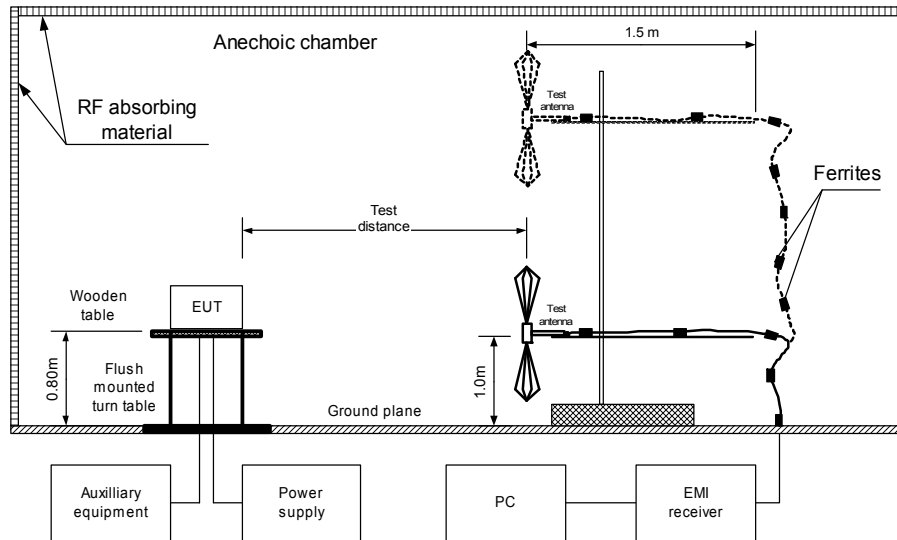
8.1.2.1 The EUT was set up as shown in Figure 8.1.1 and the associated photograph/s, energized and the EUT performance was checked.

8.1.2.2 The measurements were performed in the anechoic chamber at 3 m test distance. The specified frequency range was investigated with the antenna connected to the EMI receiver. To find the highest emission the turntable was rotated 360° and the measuring antenna height was swept from 1 to 4 m in both, vertical and horizontal polarizations. The EUT cables position was varied to maximize emission.

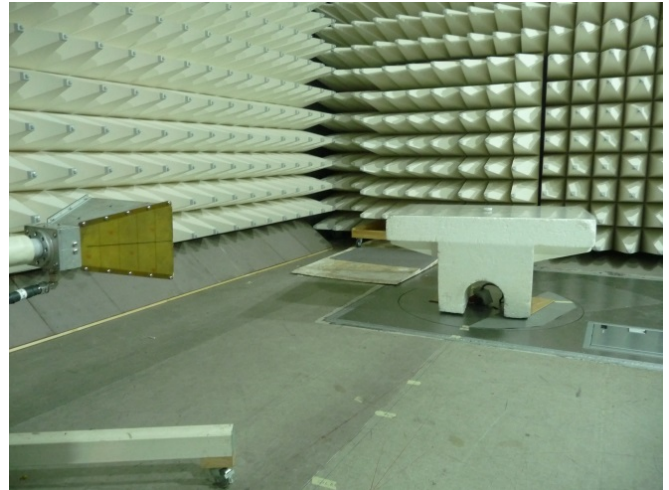
8.1.2.3 The worst test results with respect to the limits were recorded in Table 8.1.3 and shown in the associated plots.

Test specification:		FCC 47 CFR, Section 15.109, RSS-Gen, Section 7.1.2, ICES-003, Section 6.2, Class B, Radiated emissions	
Test procedure:		ANSI C63.4, Sections 8.3 and 12.2.5	
Test mode:		Verdict: PASS	
Date(s):			
26-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1023 hPa	Power: Battery
Remarks:			

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



Photograph 8.1.1 Setup for radiated emission measurements





HERMON LABORATORIES

Test specification: FCC 47 CFR, Section 15.109, RSS-Gen, Section 7.1.2, ICES-003, Section 6.2, Class B, Radiated emissions			
Test procedure: ANSI C63.4, Sections 8.3 and 12.2.5			
Test mode:	Compliance	Verdict: PASS	
Date(s):	26-Nov-17		
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1023 hPa	Power: Battery
Remarks:			

Table 8.1.3 Radiated emission test results

EUT SET UP: TABLE-TOP
TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 13 m
DETECTORS USED: PEAK / QUASI-PEAK
FREQUENCY RANGE: 30 MHz – 1000 MHz
RESOLUTION BANDWIDTH: 120 kHz

Frequency, MHz		Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
Peak emission, dB(μV/m)	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*					
No signals were found								Pass

TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 13000 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*				
No signals were found										Pass

*- Margin = Measured emission - specification limit.

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

Reference numbers of test equipment used

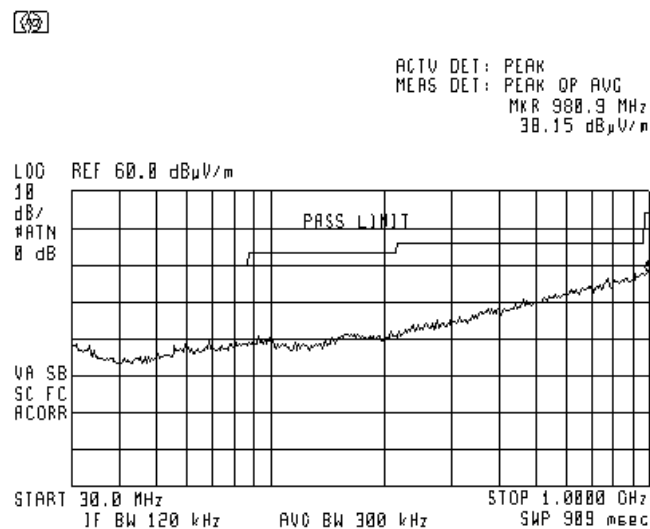
HL 0604	HL 1984	HL 2909	HL 3388	HL 4353	HL 5112	HL 5121	
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Full description is given in Appendix A.

Test specification: FCC 47 CFR, Section 15.109, RSS-Gen, Section 7.1.2, ICES-003, Section 6.2, Class B, Radiated emissions			
Test procedure: ANSI C63.4, Sections 8.3 and 12.2.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 26-Nov-17			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1023 hPa	Power: Battery
Remarks:			

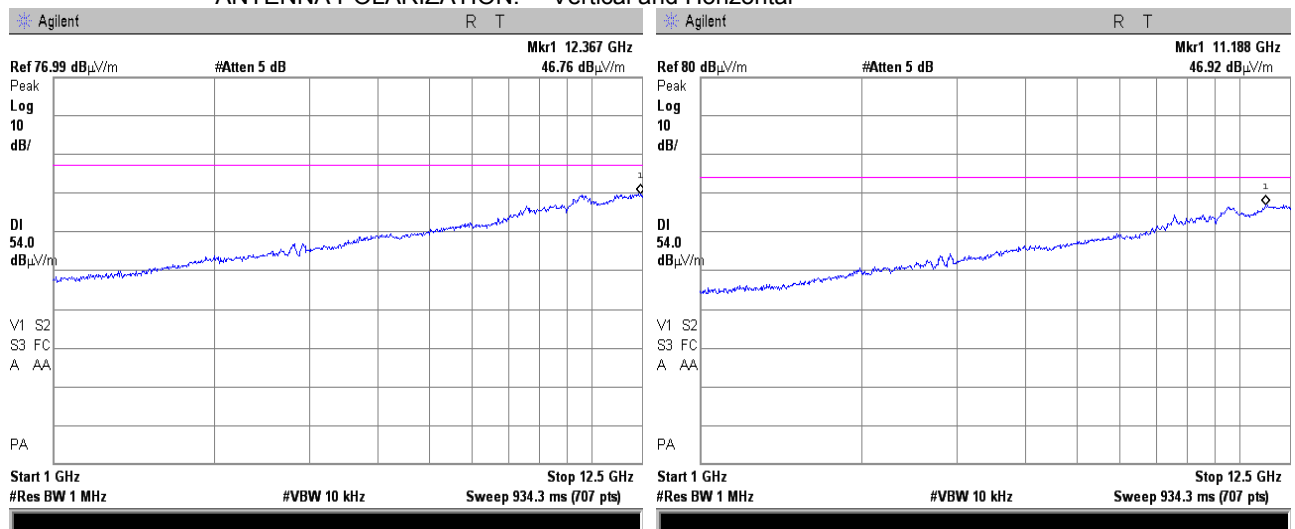
Plot 8.1.1 Radiated emission measurements from 30 to 1000 MHz

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



Plot 8.1.2 Radiated emission measurements from 1000 to 13000 MHz

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



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	19-Jan-17	19-Jan-18
0604	Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz	EMCO	3141	9611-1011	12-May-17	12-May-18
1513	Cable RF, 8 m, BNC/BNC	Belden	M17/167 MIL-C-17	1513	07-Sep-17	07-Sep-18
1984	Antenna, Double-Ridged Waveguide Horn, 1 to 18 GHz, 300 W	EMC Test Systems	3115	9911-5964	16-Aug-17	16-Aug-18
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY414447 62	09-Mar-17	09-Mar-18
3388	Microwave Cable Assembly, 26.5 GHz, 1.0 m, N type/N type	Suhner Sucoflex	104EA	3388	02-Nov-17	02-Nov-18
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-17	15-Mar-18
4372	High Pass Filter, 50 Ohm, 8.0 to 18.0 GHz, SMA-FM / SMA-FM	Tiger Micro-Electronics Institute	TGF-A2118-001	r-JSFG308-001	14-May-17	14-May-18
4529	High Pass Filter, 50 Ohm, 4250 to 10000 MHz., SMA-FM / SMA-M	Mini-Circuits	VHF-3800+	NA	01-Oct-17	01-Oct-19
4778	EMI Receiver, 9 kHz - 2.9 GHz, System: HL1431, HL4777	Hewlett Packard	8542E	30807A00 262, 3427A001 23	02-Nov-17	02-Nov-18
4933	Active Horn Antenna, 1 GHz to 18 GHz	Com-Power Corporation	AHA-118	701046	14-Oct-16	14-Jan-18
4956	Active horn antenna, 18 to 40 GHz	Com-Power Corporation	AHA-840	105004	17-Jan-17	17-Jan-18
5102	RF cable, 18 GHz, 6 m, N-type	Huber-Suhner	SF106A/1 1N/11N/6 000MM	500848/6A	27-Jul-17	27-Jul-18
5112	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/ 11SK/11S K/5500M M	502494/2E A	27-Jul-17	27-Jul-18
5121	Microwave preamplifier, 500 MHz to 18 GHz, 40 dB Gain	Com-Power Corporation	PAM-118A	551119	23-Aug-17	23-Aug-18

10 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted carrier power at RF antenna connector	Below 12.4 GHz: ± 1.7 dB 12.4 GHz to 40 GHz: ± 2.3 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
Occupied bandwidth	± 8.0 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 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

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, Radio, Safety, Environmental and Telecommunication testing facility.

Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-1082 for anechoic chamber, G-869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-1606 for conducted emissions at telecommunication ports).

The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

Address: P.O. Box 23, Binyamina 3055001, Israel.
Telephone: +972 4628 8001
Fax: +972 4628 8277
e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

Person for contact: Mr. Michael Nikishin, EMC&Radio group manager

12 APPENDIX D Specification references

FCC 47CFR part 15: 2016	Radio Frequency Devices.
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications.
ANSI C63.4: 2014	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-247 Issue 2: 2017	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence- Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 4: 2014	General Requirements and Information for the Certification of Radiocommunication Equipment
ICES-003 Issue 6: 2016	Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement

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 strength 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, HL 4933

**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)					



HERMON LABORATORIES

Antenna factor, HL 4956

**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
Cable coaxial, Microwave Cable Assembly, 104EA, 18 GHz, 1.0 m
Suhner Sucoflex, HL 3388

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.04	4800	0.86	9800	1.35	14900	1.99
30	0.08	4900	0.83	9900	1.35	15000	1.98
50	0.09	5000	0.84	10000	1.35	15100	2.02
100	0.13	5100	0.84	10100	1.35	15200	2.01
200	0.18	5200	0.85	10200	1.35	15300	2.01
300	0.21	5300	0.87	10300	1.38	15400	2.01
400	0.24	5400	0.89	10400	1.39	15500	2.04
500	0.27	5500	0.90	10500	1.41	15600	2.03
600	0.30	5600	0.92	10600	1.41	15700	2.07
700	0.32	5700	0.92	10700	1.42	15800	2.08
800	0.37	5800	0.94	10800	1.40	15900	2.11
900	0.40	5900	0.94	10900	1.40	16000	2.11
1000	0.41	6000	0.95	11000	1.42	16100	2.11
1100	0.43	6100	0.97	11100	1.44	16200	2.08
1200	0.44	6200	0.95	11200	1.44	16300	2.14
1300	0.45	6300	0.97	11300	1.44	16400	2.12
1400	0.46	6400	0.98	11400	1.43	16500	2.17
1500	0.47	6500	1.00	11500	1.41	16600	2.20
1600	0.49	6600	1.00	11600	1.41	16700	2.26
1700	0.50	6700	1.04	11700	1.42	16800	2.23
1800	0.51	6800	1.05	11800	1.44	16900	2.28
1900	0.53	6900	1.04	11900	1.43	17000	2.29
2000	0.55	7000	1.02	12000	1.43	17100	2.30
2100	0.56	7100	1.02	12100	1.44	17200	2.32
2200	0.57	7200	1.04	12200	1.41	17300	2.32
2300	0.58	7300	1.04	12300	1.57	17400	2.30
2400	0.61	7400	1.07	12400	1.69	17500	2.36
2500	0.62	7500	1.07	12500	1.76	17600	2.41
2600	0.64	7600	1.08	12600	1.75	17700	2.39
2700	0.63	7700	1.09	12700	1.80	17800	2.41
2800	0.64	7800	1.10	12800	1.77	17900	2.45
2900	0.64	7900	1.12	12900	1.71	18000	2.52
3000	0.66	8000	1.15	13000	1.71		
3100	0.67	8100	1.13	13100	1.65		
3200	0.69	8200	1.15	13200	1.68		
3300	0.70	8300	1.16	13300	1.68		
3400	0.70	8400	1.17	13400	1.69		
3500	0.71	8500	1.19	13500	1.72		
3600	0.71	8600	1.19	13600	1.71		
3700	0.72	8700	1.22	13700	1.73		
3800	0.73	8800	1.23	13800	1.73		
3900	0.74	8900	1.21	14000	1.76		
4000	0.75	9000	1.29	14100	1.76		
4100	0.77	9100	1.36	14200	1.76		
4200	0.77	9200	1.34	14300	1.75		
4300	0.78	9300	1.34	14400	1.81		
4400	0.79	9400	1.34	14500	1.81		
4500	0.80	9500	1.33	14600	1.86		
4600	0.82	9600	1.33	14700	1.91		
4700	0.83	9700	1.35	14800	1.97		

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
RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,
SF106A/11N/11N/6000MM, S/N 500848/6A
HL 5102

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.00	5500	2.43
50	0.23	6000	2.54
100	0.31	6500	2.65
200	0.44	7000	2.76
300	0.54	7500	2.87
400	0.62	8000	2.98
500	0.69	8500	3.06
600	0.76	9000	3.16
700	0.82	9500	3.27
800	0.87	10000	3.36
900	0.94	10500	3.45
1000	0.98	11000	3.55
1100	1.03	11500	3.63
1200	1.08	12000	3.72
1300	1.13	12500	3.82
1400	1.17	13000	3.90
1500	1.21	13500	3.99
1600	1.25	14000	4.06
1700	1.30	14500	4.15
1800	1.33	15000	4.24
1900	1.37	15500	4.30
2000	1.41	16000	4.37
2500	1.59	16500	4.45
3000	1.75	17000	4.53
3500	1.90	17500	4.62
4000	2.04	18000	4.67
4500	2.17		
5000	2.30		

Cable loss
RF Cable, Huber-Suhner, 40 GHz, 5.5 m, K type,
SF102EA/11SK/11SK/5500MM, S/N 502494/2EA
HL 5112

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
100	0.69	20500	10.18
200	0.97	21000	10.32
300	1.18	21500	10.47
500	1.52	22000	10.60
1000	2.14	22500	10.75
1500	2.62	23000	10.87
2000	3.03	23500	11.00
2500	3.40	24000	11.12
3000	3.73	24500	11.23
3500	4.04	25000	11.35
4000	4.33	25500	11.52
4500	4.60	26000	11.64
5000	4.86	26500	11.73
5500	5.10	27000	11.84
6000	5.34	27500	11.93
6500	5.57	28000	12.05
7000	5.79	28500	12.19
7500	6.00	29000	12.33
8000	6.21	29500	12.44
8500	6.43	30000	12.53
9000	6.62	30500	12.58
9500	6.82	31000	12.71
10000	7.01	31500	12.86
10500	7.17	32000	13.00
11000	7.34	32500	13.11
11500	7.51	33000	13.24
12000	7.68	33500	13.33
12500	7.84	34000	13.44
13000	8.00	34500	13.58
13500	8.16	35000	13.69
14000	8.32	35500	13.81
14500	8.48	36000	13.93
15000	8.63	36500	14.05
15500	8.77	37000	14.24
16000	8.92	37500	14.28
16500	9.08	38000	14.38
17000	9.23	38500	14.50
17500	9.37	39000	14.61
18000	9.51	39500	14.70
18500	9.66	40000	14.83
19000	9.78		
19500	9.92		
20000	10.07		

14 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
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
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