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# TEST REPORT

ACCORDING TO: FCC CFR 47 Part 15 subpart C, section 15.231 (e) and  
RSS-210 issue 8 Annex 1

FOR:

**Elpas Solutions Ltd.**

**Wireless Input Module**

**Models: 5-TBA00433**

**5-TBA00433-1**

**FCC ID:O4X5-TBA00433**

**IC:1467G-5TBA00433**

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## 1 Applicant information

**Client name:** Elpas Solutions Ltd.  
**Address:** 23 Habarzel street, Tel Aviv 69710, Israel  
**Telephone:** +972 3768 1421  
**Fax:** +972 3768 1415  
**E-mail:** MErenkrantz@tycoint.com  
**Contact name:** Mr. Meir Erenkrantz

## 2 Equipment under test attributes

**Product name:** Wireless input module  
**Product type:** Transceiver  
**Model(s):** 5-TBA00433  
**Serial number:** 60494218  
**Hardware version:** 02  
**Software release:** 06  
**Receipt date** 6/03/2013

## 3 Manufacturer information

**Manufacturer name:** Elpas Solutions Ltd.  
**Address:** 23 Habarzel street, Tel Aviv 69710, Israel  
**Telephone:** +972 3768 1421  
**Fax:** +972 3768 1415  
**E-Mail:** MErenkrantz@tycoint.com  
**Contact name:** Mr. Meir Erenkrantz

## 4 Test details




**Project ID:** 22952  
**Location:** Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel  
**Test started:** 6/10/2012  
**Test completed:** 6/11/2012  
**Test specification(s):** FCC 47CFR part 15, subpart C, §15.231(e);  
RSS-210 issue 8 Annex 1

## 5 Tests summary

Test	Status
<b>Transmitter characteristics</b>	
FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements	Pass
FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions	Pass
FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth	Pass
FCC Part 15, Section 207 / RSS-Gen, Section 7.2.4, Conducted emission	Not required
FCC Part 15, Section 203 / RSS-Gen, Section 7.1.2, Antenna 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
<b>Tested by:</b>	Mrs. E. Pitt, test engineer	June 11, 2013	
<b>Reviewed by:</b>	Mrs. M. Cherniavsky, certification engineer	June 30, 2013	
<b>Approved by:</b>	Mr. M. Nikishin, EMC and Radio group manager	July 5, 2013	



**6 EUT description**

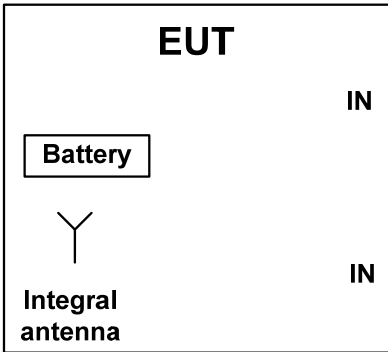
**6.1 General information**

The EUT, model numbers 5-TBA00433 and 5-TBA00433-1 is a Wireless Input Module that comprises a 433 MHz transceiver. The EUT is powered from 3V internal battery. The EUT model number 5-TBA00433 includes the 125 kHz receiver therefore was tested as the maximum configuration device.

**6.2 Ports and lines**

Port type	Port description	Connected from	Connected to	Qty.	Cable type	Cable length	indoor / outdoor
Signal	In	EUT	Not connected	2	NA	NA	NA

**6.3 Test configuration**



**6.4 Changes made in EUT**

No changes were implemented in the EUT during the testing.



### 6.5 Transmitter characteristics

<b>Type of equipment</b>						
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)					
<b>Operating frequencies</b>		433.92 MHz				
<b>Maximum rated output power</b>		At transmitter 50 Ω RF output connector		dBm		
		Field strength at 3 m distance		89.42 dB(μV/m)-peak 55.42 dB(μV/m) - average		
<b>Is transmitter output power variable?</b>		X	No			
			Yes			
			continuous variable			
			stepped variable with stepsize		dB	
	minimum RF power		dBm			
	maximum RF power		dBm			
<b>Antenna connection</b>						
unique coupling	standard connector	X	integral	X with temporary RF connector without temporary RF connector		
<b>Antenna/s technical characteristics</b>						
Type	Manufacturer		Model number			
Internal	Elpas		Printed antenna			
<b>Type of modulation</b>		ASK				
<b>Transmitter aggregate data rate/s</b>		19.2 kbps (ASK modulation)				
<b>Transmitter power source</b>						
X	Battery	<b>Nominal rated voltage</b>	3.0 VDC	Battery type	Lithium	
	DC	<b>Nominal rated voltage</b>	VDC			
	AC mains	<b>Nominal rated voltage</b>	VAC	Frequency		
<b>Common power source for transmitter and receiver</b>		X		yes	no	



<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements</b>		
<b>Test procedure:</b>	Supplier declaration		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

## 7 Transmitter tests according to 47CFR part 15 subpart C and RSS-210 issue 8 Annex 1 requirements

### 7.1 Periodic operation requirements

#### 7.1.1 General

The EUT was verified for compliance with periodic operation requirements listed below:

- Continuous transmissions such as voice, video and the radio control of toys are not permitted;
- Duration of each transmission shall not be greater than 1 second;
- Silent period between transmissions shall be at least 30 times the duration of the transmission;
- Silent period between transmissions shall be in no case less than 10 seconds.

The rationale for compliance with the above requirements was either test results or supplier declaration. The summary of results is provided in Table 7.1.1.

#### 7.1.2 Test procedure for transmitter shut down test

7.1.2.1 The EUT was set up as shown in Figure 7.1.1.

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

7.1.2.3 The transmitter was activated either manually or automatically. Once manually operated transmitter was activated, the switch was immediately released.

7.1.2.4 The transmission time was captured and shown in the associated plots..

Figure 7.1.1 Setup for transmitter shut down test





<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements</b>		
<b>Test procedure:</b>	Supplier declaration		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

Table 7.1.1 Periodic operation requirements

Requirement	Rationale	Verdict
Continuous transmissions are not permitted	Supplier declaration	Comply
Duration of each transmission shall not be greater than 1 second	Plot 7.1.1	Pass
Silent period between transmissions shall be at least 30 times the duration of the transmission	Plot 7.1.2	Pass
Silent period between transmissions shall be in no case less than 10 seconds	Plot 7.1.2	Pass

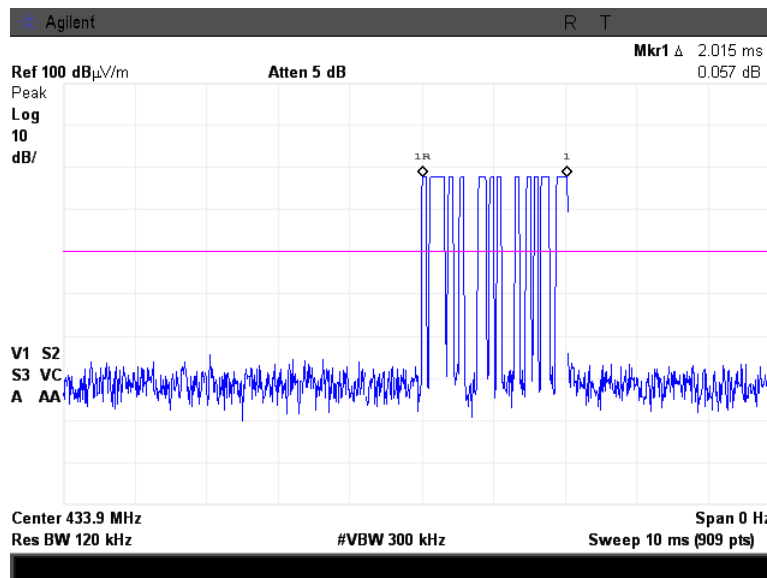




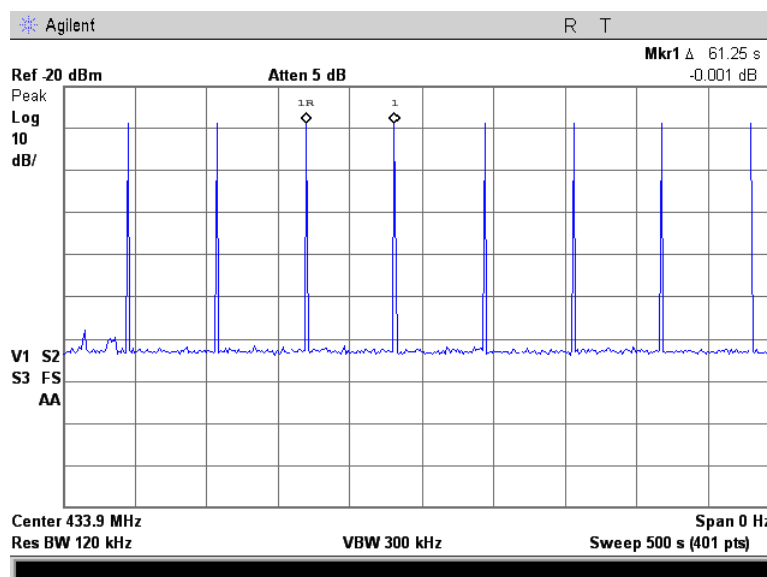
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<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Periodic operation requirements</b>		
<b>Test procedure:</b>	Supplier declaration		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature: 23 °C</b>	<b>Air Pressure: 1010 hPa</b>	<b>Relative Humidity: 39 %</b>	<b>Power Supply: 3V battery</b>
<b>Remarks:</b>			

Plot 7.1.1 Transmission duration



Plot 7.1.2 Transmission period



Reference numbers of test equipment used

HL 3818							
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Full description is given in Appendix A.



<b>Test specification:</b>	FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	PASS
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

## 7.2 Field strength of emissions

### 7.2.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.2.1 and Table 7.2.2.

Table 7.2.1 Radiated fundamental emission limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)	
	Peak	Average
433.9	92.9	72.9

Table 7.2.2 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m, dB(μV/m)				
	Within restricted bands			Outside restricted bands	
	Peak	Quasi Peak	Average	Peak	Average
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	72.9	42.9
0.090 – 0.110	NA	108.5 – 106.8**	NA		
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**		
0.490 – 1.705	NA	73.8 – 63.0**	NA		
1.705 – 30.0*		69.5			
30 – 88		40.0			
88 – 216		43.5			
216 – 960		46.0			
960 - 1000		54.0			
Above 1000		74.0			

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

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

where S<sub>1</sub> and S<sub>2</sub> – standard defined and test distance respectively in meters.

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

The limit for spurious emissions was 20 dB lower than fundamental emission limit.

The above limits provided in terms of average values, peak limit was 20 dB above the average limit.

Note 2: The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.



<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

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

7.2.2.1 The EUT was set up as shown in The worst test results (the lowest margins) were recorded in Table 7.2.3, Table 7.2.5 and shown in the associated plots.

7.2.2.2 Figure 7.2.1, energized and the performance check was conducted.

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

7.2.2.4 The worst test results (the lowest margins) were recorded in Table 7.2.3, Table 7.2.5 and shown in the associated plots.

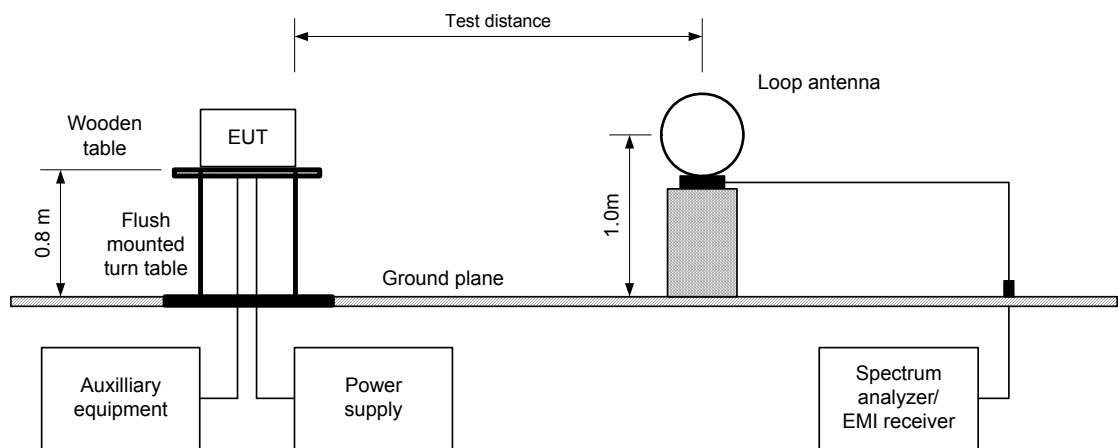
**7.2.3 Test procedure for spurious emission field strength measurements above 30 MHz**

7.2.3.1 he EUT was set up as shown in Figure 7.2.2, energized and the performance check was conducted.

7.2.3.2 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.

7.2.3.3 The worst test results (the lowest margins) were recorded in Table 7.2.3, Table 7.2.5 and shown in the associated plots.

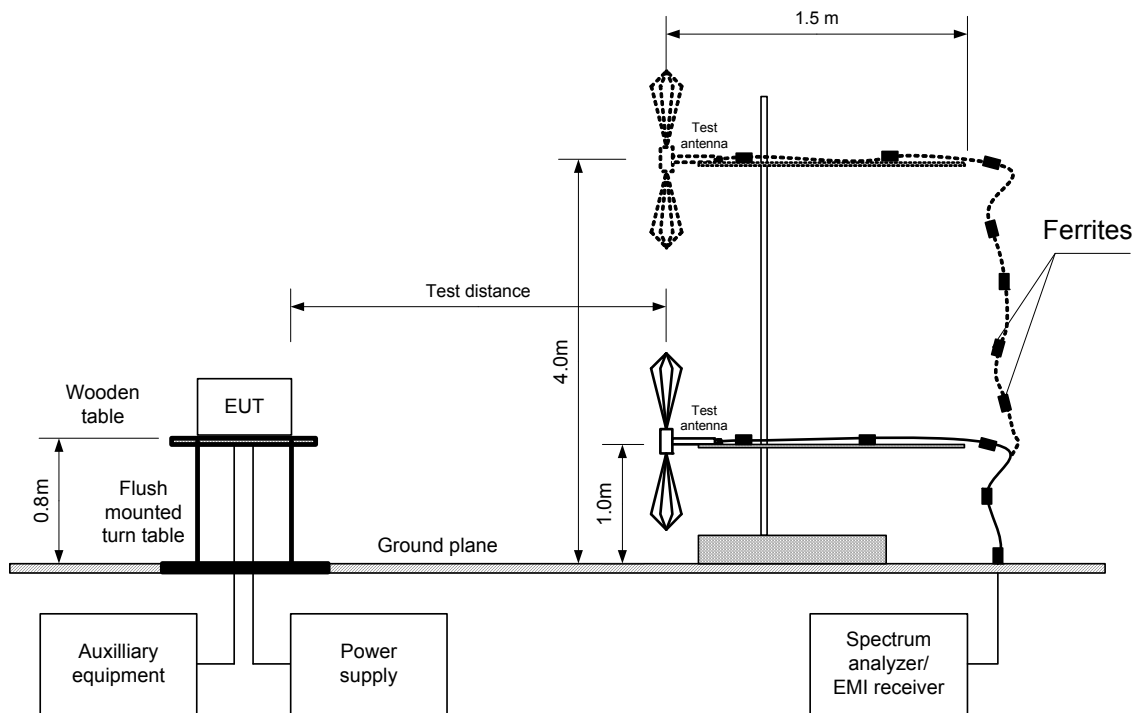
**Figure 7.2.1 Setup for spurious emission field strength measurements below 30 MHz**





<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

Figure 7.2.2 Setup for spurious emission field strength measurements above 30 MHz





<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

**Table 7.2.3 Field strength of fundamental emission, spurious emissions outside restricted bands and within restricted bands at frequencies above 1 GHz**

TEST DISTANCE: 3 m  
 EUT POSITION: Typical (Vertical)  
 MODULATION: ASK  
 BIT RATE: 19.2 kbps  
 INVESTIGATED FREQUENCY RANGE: 0.009 - 4500 MHz  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)  
 9.0 kHz (150 kHz – 30 MHz)  
 120 kHz (30 MHz – 1000 MHz)  
 1.0 MHz (above 1000 MHz)  
 VIDEO BANDWIDTH: ≥ Resolution bandwidth  
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)  
 Biconilog (30 MHz – 1000 MHz)  
 Double ridged guide (above 1000 MHz)

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Average field strength				Verdict
	Pol.	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**	
<b>Fundamental emission***</b>											
433.9200	H	1.2	80	89.42	92.9	-3.48	NA	55.42	72.9	-17.48	Pass
<b>Spurious emissions</b>											
867.8392	V	1.2	330	56.10	72.9	-16.80	NA	22.10	52.9	-30.8	Pass
1301.771	V	1.8	225	68.36	72.9	-4.54	68.04	34.04	52.9	-18.86	
1735.680	V	1.7	215	50.99	72.9	-21.91	49.26	15.26	52.9	-37.64	
2169.604	H	1.7	265	65.60	72.9	-7.30	65.37	31.37	52.9	-21.53	
2603.537	V	1.7	295	57.14	72.9	-15.76	56.08	22.08	52.9	-30.82	
3037.466	H	1.7	25	52.59	72.9	-20.31	50.57	16.57	52.9	-36.33	
3471.382	H	1.7	165	57.95	72.9	-14.95	56.72	22.72	52.9	-30.18	
3905.339	H	1.7	60	49.98	72.9	-22.92	45.48	11.48	52.9	-41.42	
4339.167	V	1.2	220	50.89	72.9	-22.01	47.12	13.12	52.9	-39.78	

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

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

**Table 7.2.4 Average factor calculation**

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
NA	NA	2	150	NA	-34

\*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

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

for pulse train longer than 100 ms:

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

**Reference numbers of test equipment used**

HL 0446	HL 2432	HL 2697	HL 2780	HL 2871	HL 3818	HL 4160	HL 4292
HL 4347	HL 4353						

Full description is given in Appendix A.



<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

**Table 7.2.5 Field strength of emissions below 1 GHz within restricted bands**

TEST DISTANCE: 3 m  
 EUT POSITION: Typical (Vertical)  
 MODULATION: ASK  
 BIT RATE: 19.2kbps  
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 0.2 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 emissions 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 2697	HL 3818	HL 4292	HL 4347			
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Full description is given in Appendix A.



<b>Test specification:</b>	FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

Table 7.2.6 Restricted bands according to FCC 15, Section 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	12.290 - 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	16.420 - 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 7.2.7 Restricted bands according to RSS-Gen, Table 3

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 - 2.190	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	12.290 - 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 - 24.0
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

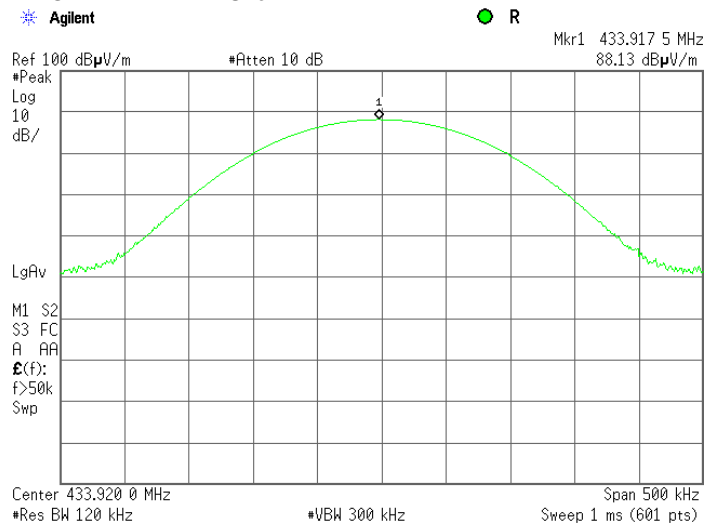


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<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

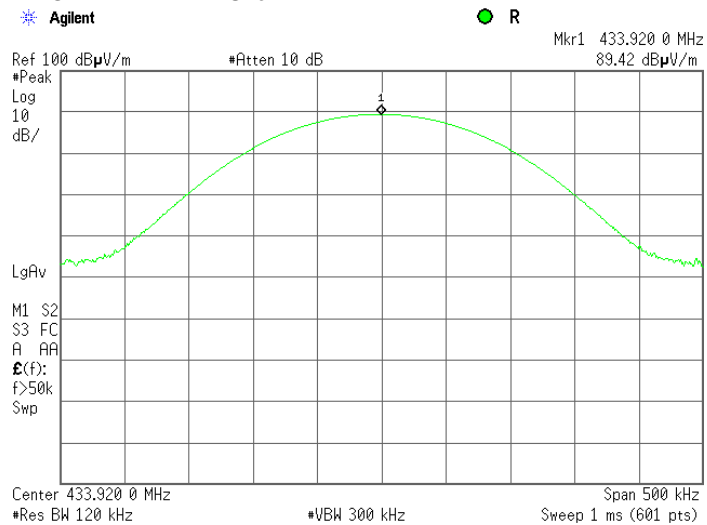
**Plot 7.2.1 Radiated emission measurements at the fundamental frequency**

TEST SITE: Anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical  
 EUT POSITION: Typical (Vertical)  
 INPUT VOLTAGE: Unom



**Plot 7.2.2 Radiated emission measurements at the fundamental frequency**

TEST SITE: Anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Horizontal  
 EUT POSITION: Typical (Vertical)  
 INPUT VOLTAGE: Unom





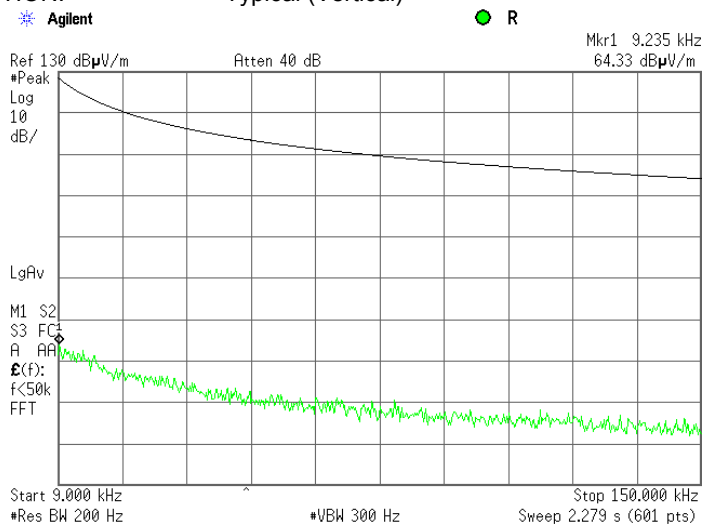


HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

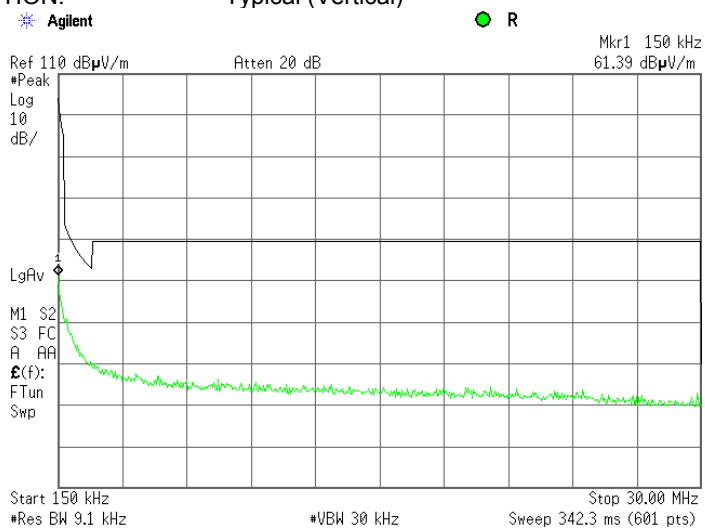
**Plot 7.2.3 Radiated emission measurements from 9 to 150 kHz**

TEST SITE: Anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical  
 EUT POSITION: Typical (Vertical)



**Plot 7.2.4 Radiated emission measurements from 0.15 to 30 MHz**

TEST SITE: Anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical  
 EUT POSITION: Typical (Vertical)



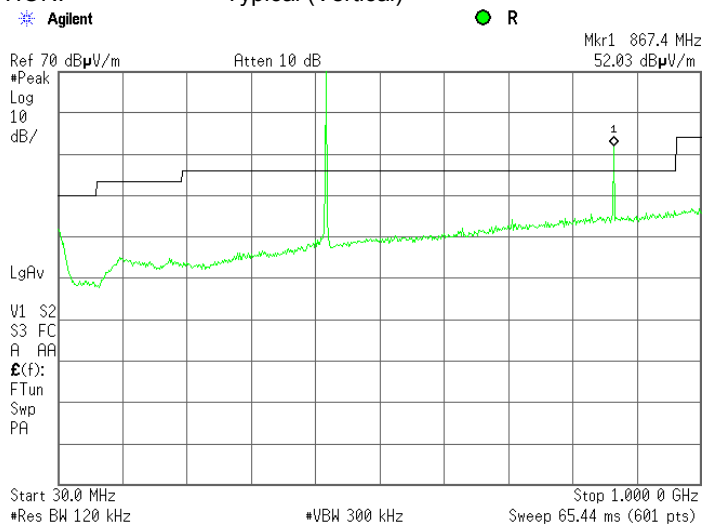


HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

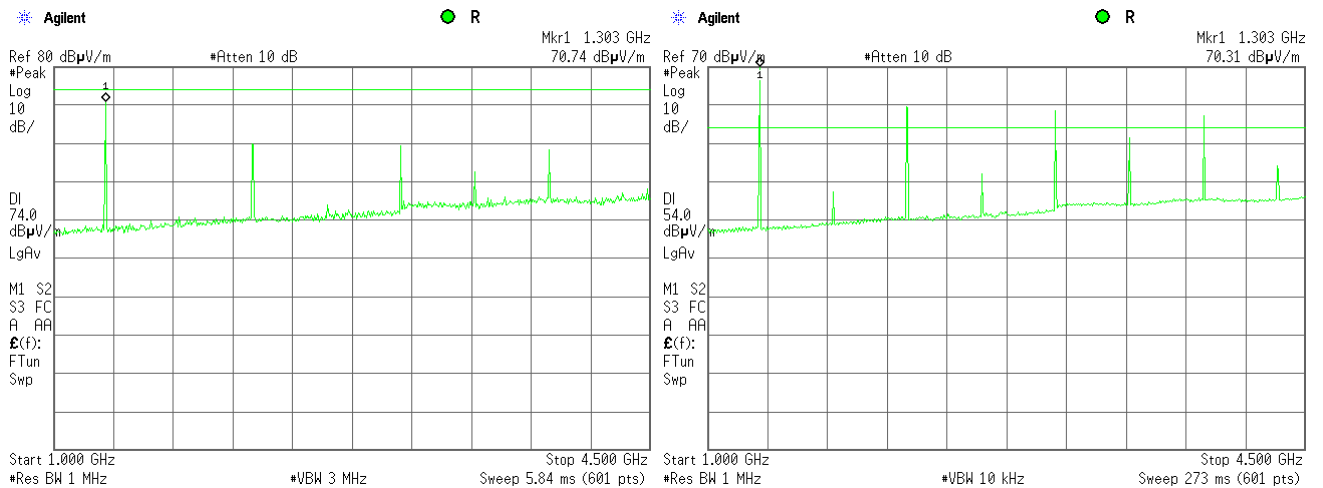
Plot 7.2.5 Radiated emission measurements from 30 to 1000 MHz

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



Plot 7.2.6 Radiated emission measurements from 1000 to 4500 MHz

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



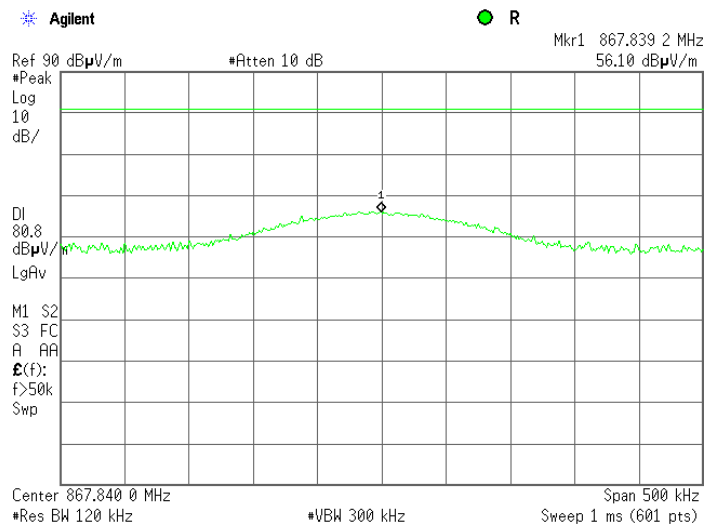


HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature: 23 °C</b>	<b>Air Pressure: 1010 hPa</b>	<b>Relative Humidity: 39 %</b>	<b>Power Supply: 3V battery</b>
<b>Remarks:</b>			

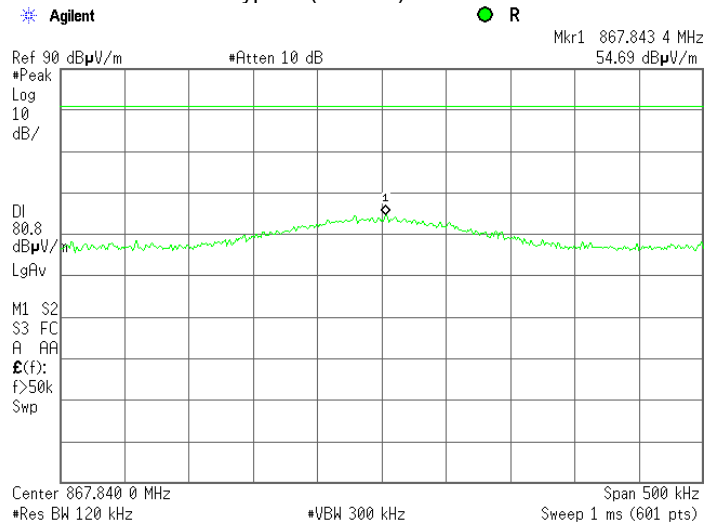
**Plot 7.2.7 Radiated emission measurements at the second harmonic frequency**

TEST SITE: Anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical  
 EUT POSITION: Typical (Vertical)



**Plot 7.2.8 Radiated emission measurements at the second harmonic frequency**

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



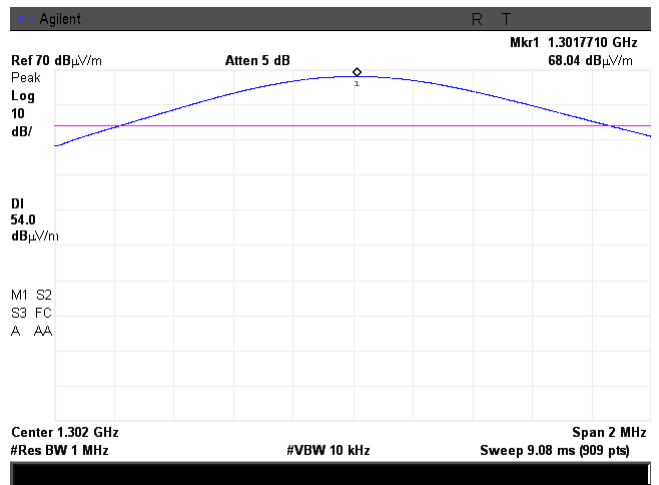
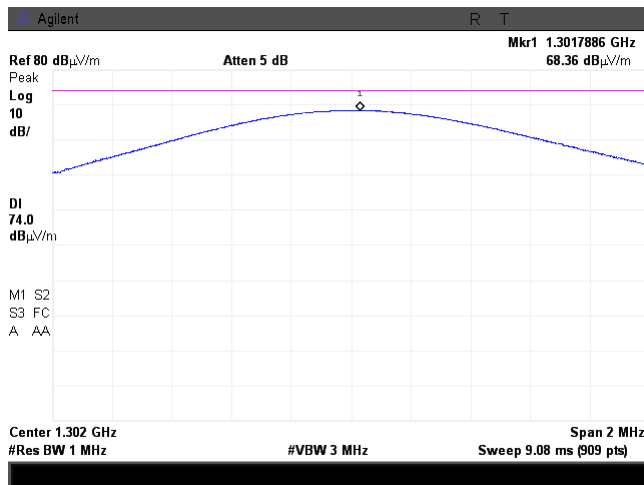


HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

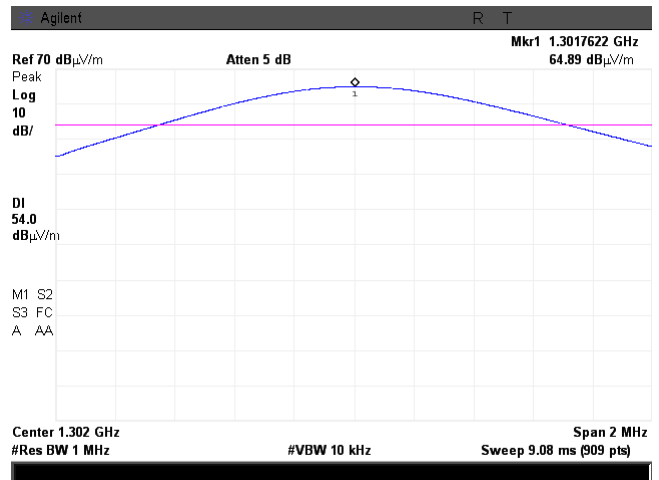
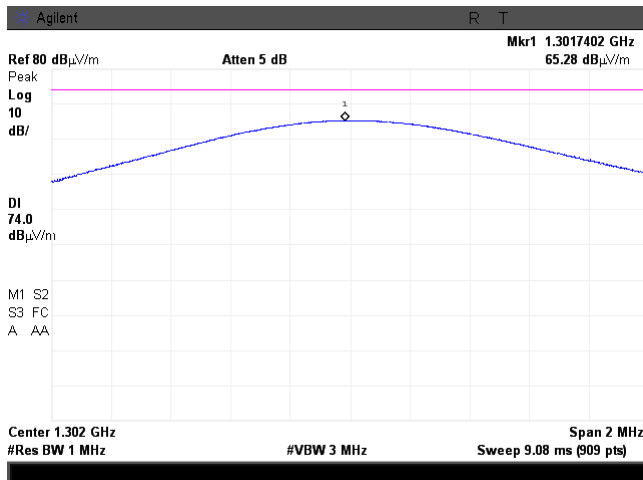
Plot 7.2.9 Radiated emission measurements at the third harmonic frequency

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



Plot 7.2.10 Radiated emission measurements at the third harmonic frequency

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



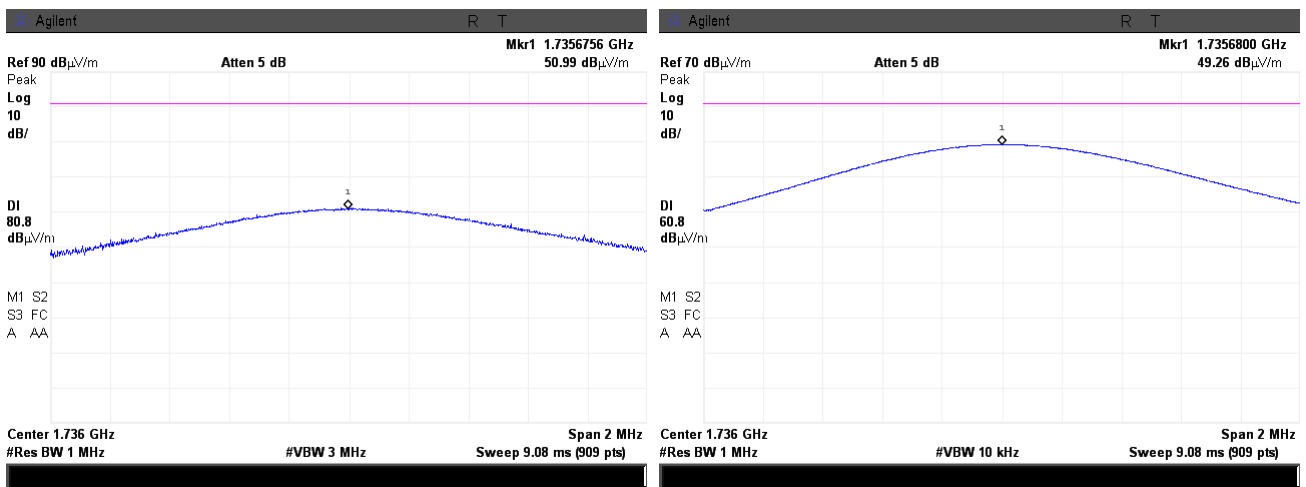


HERMON LABORATORIES

<b>Test specification:</b>		<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>	
<b>Test procedure:</b>		ANSI C63.4, Section 13.1.4	
<b>Test mode:</b>		<b>Verdict: PASS</b>	
<b>Date(s):</b>		6/11/2013	
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

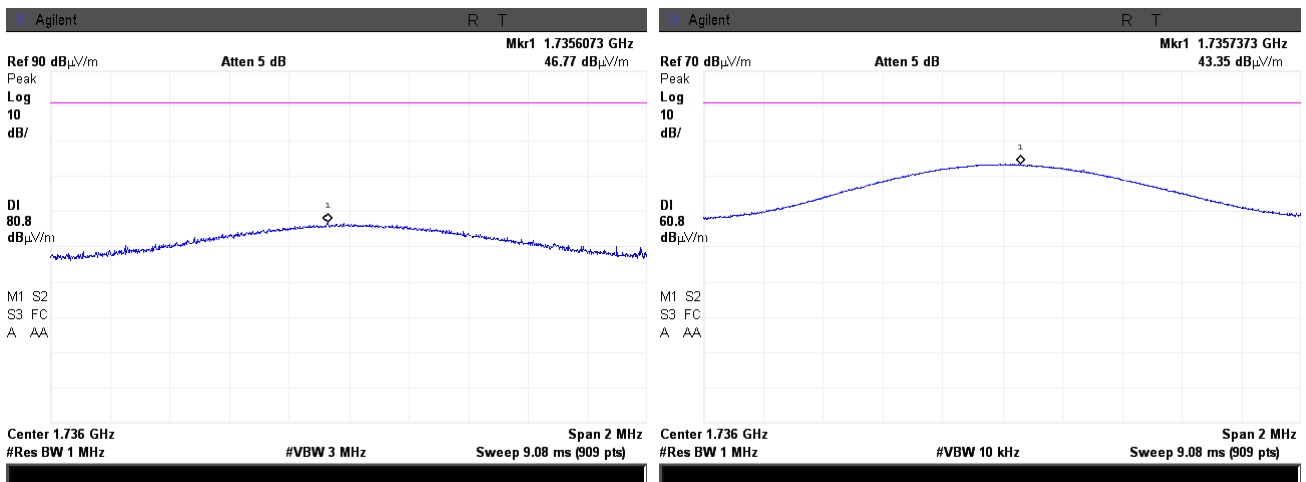
**Plot 7.2.11 Radiated emission measurements at the fourth harmonic frequency**

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



**Plot 7.2.12 Radiated emission measurements at the fourth harmonic frequency**

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



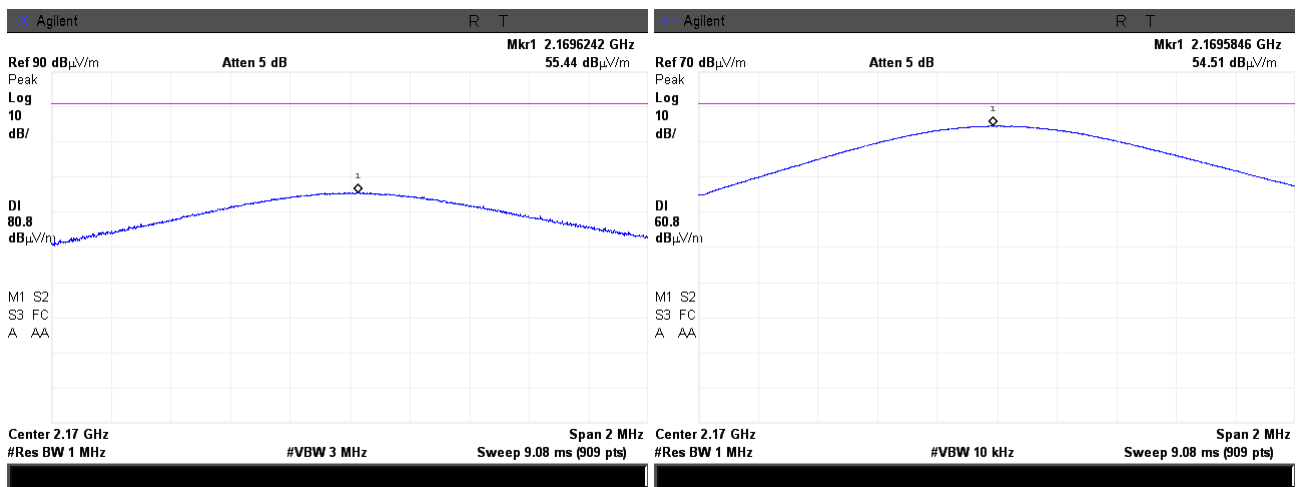


HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

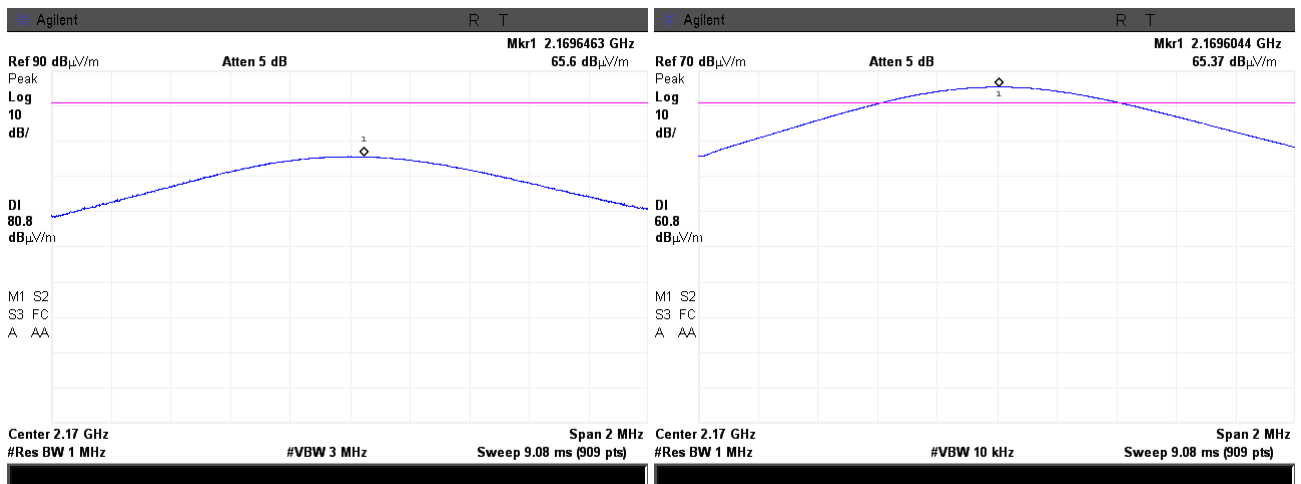
Plot 7.2.13 Radiated emission measurements at the fifth harmonic frequency

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



Plot 7.2.14 Radiated emission measurements at the fifth harmonic frequency

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



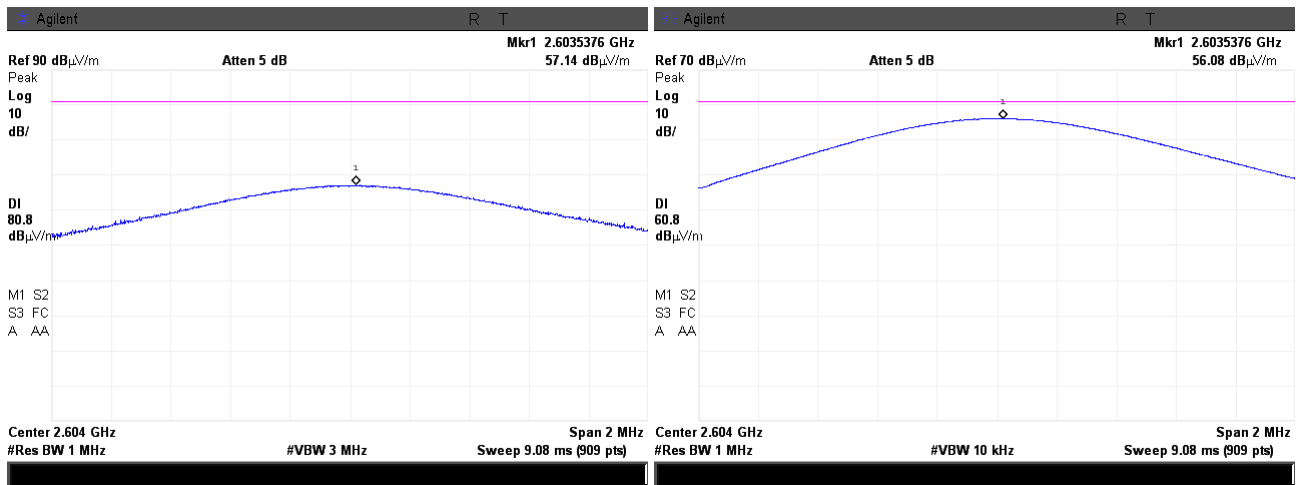


HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

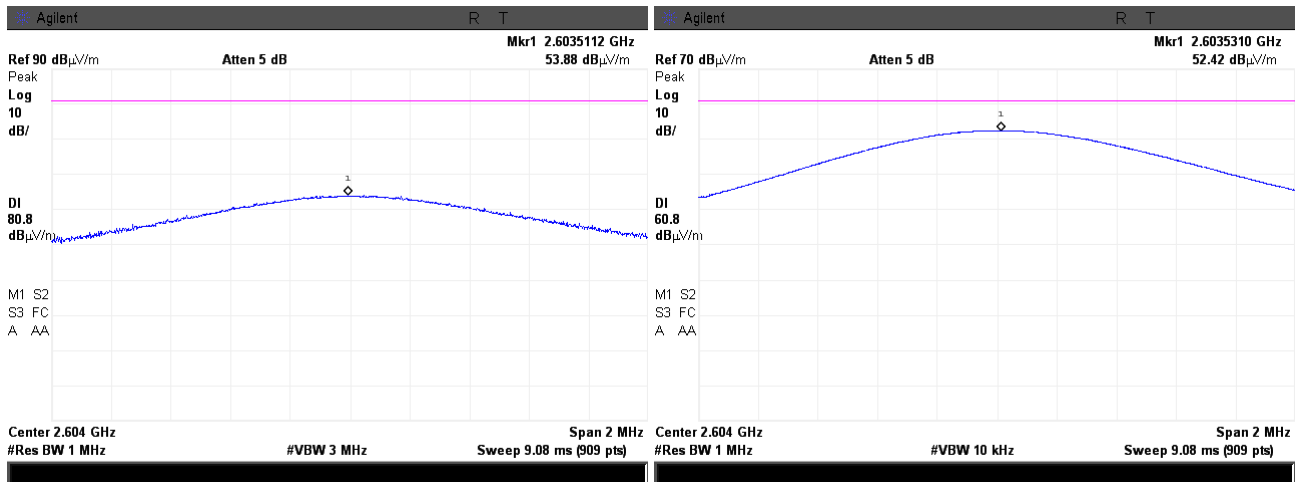
**Plot 7.2.15 Radiated emission measurements at the sixth harmonic frequency**

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



**Plot 7.2.16 Radiated emission measurements at the sixth harmonic frequency**

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

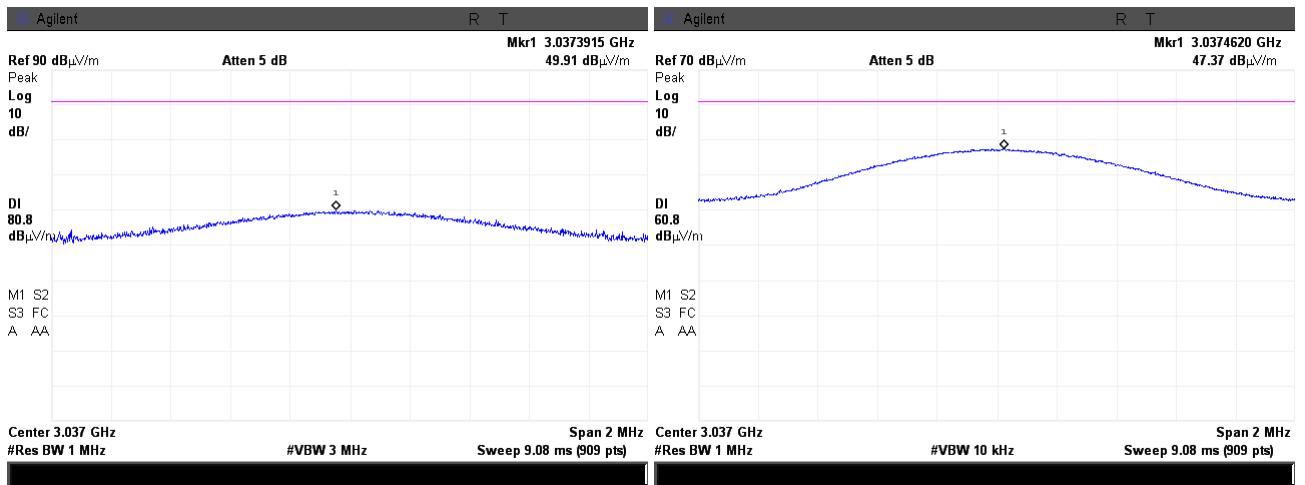




<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature: 23 °C</b>	<b>Air Pressure: 1010 hPa</b>	<b>Relative Humidity: 39 %</b>	<b>Power Supply: 3V battery</b>
<b>Remarks:</b>			

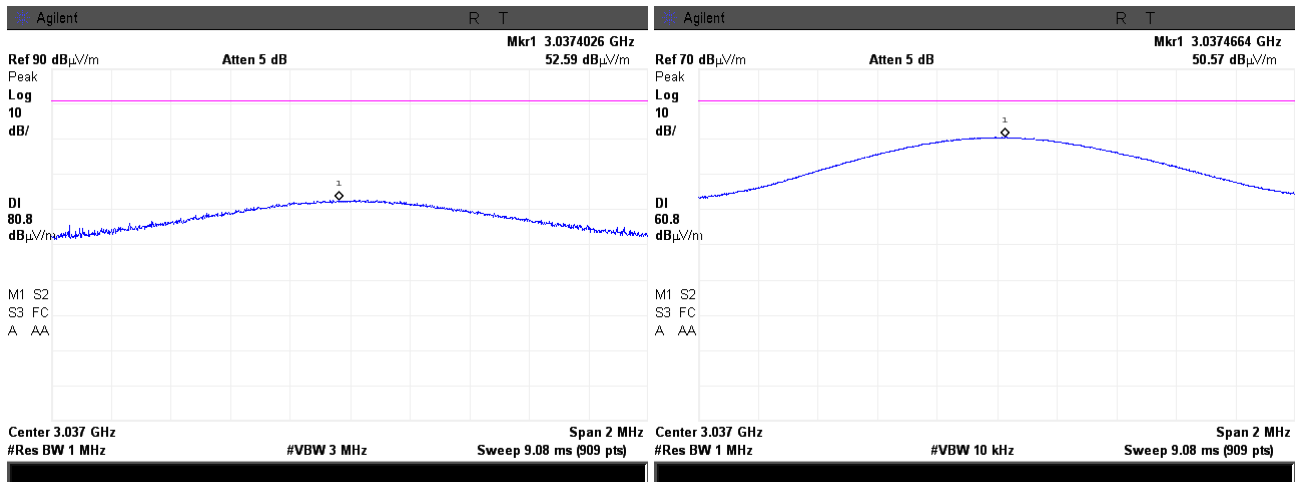
Plot 7.2.17 Radiated emission measurements at the seventh harmonic frequency

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



Plot 7.2.18 Radiated emission measurements at the seventh harmonic frequency

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



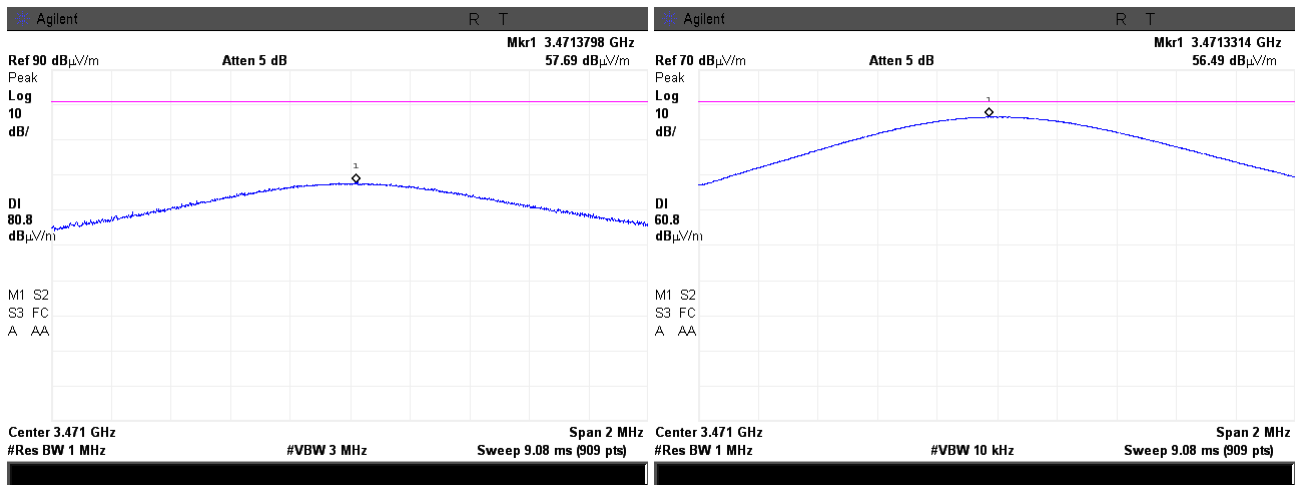




<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

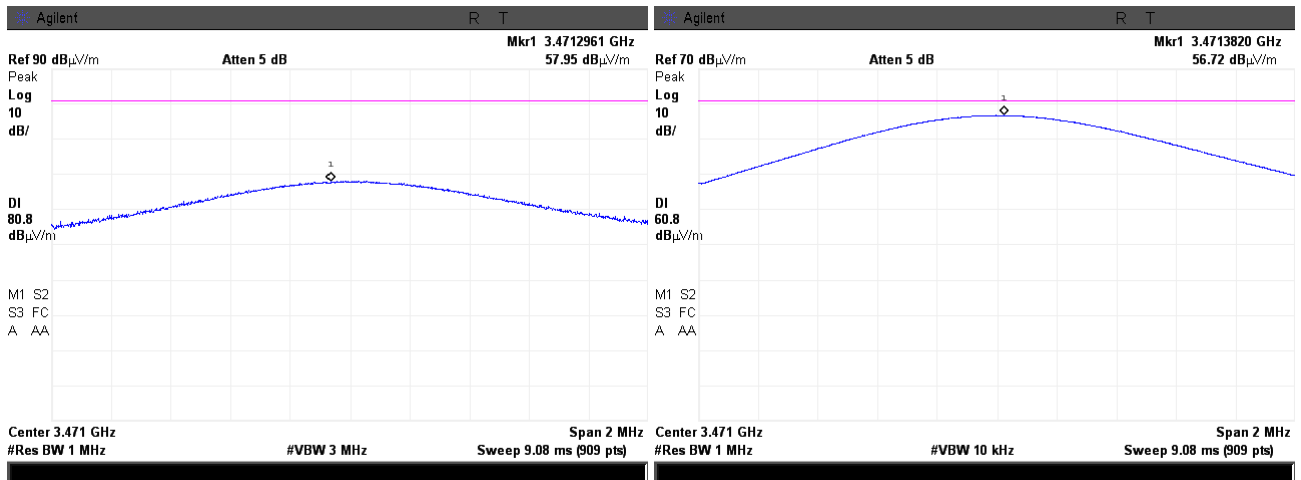
**Plot 7.2.19 Radiated emission measurements at the eighth harmonic frequency**

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



**Plot 7.2.20 Radiated emission measurements at the eighth harmonic frequency**

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



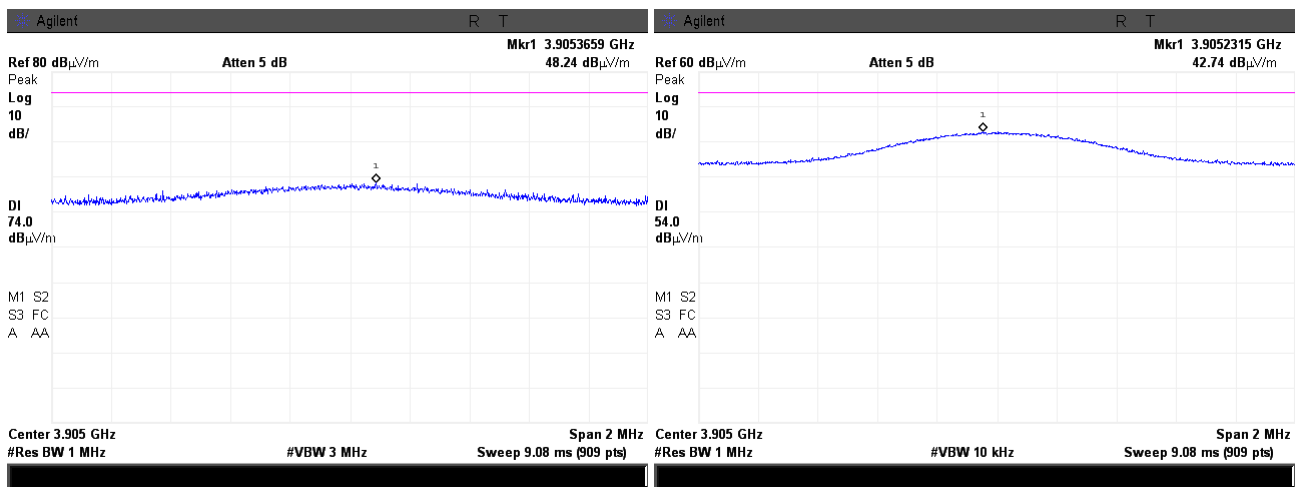


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<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature: 23 °C</b>	<b>Air Pressure: 1010 hPa</b>	<b>Relative Humidity: 39 %</b>	<b>Power Supply: 3V battery</b>
<b>Remarks:</b>			

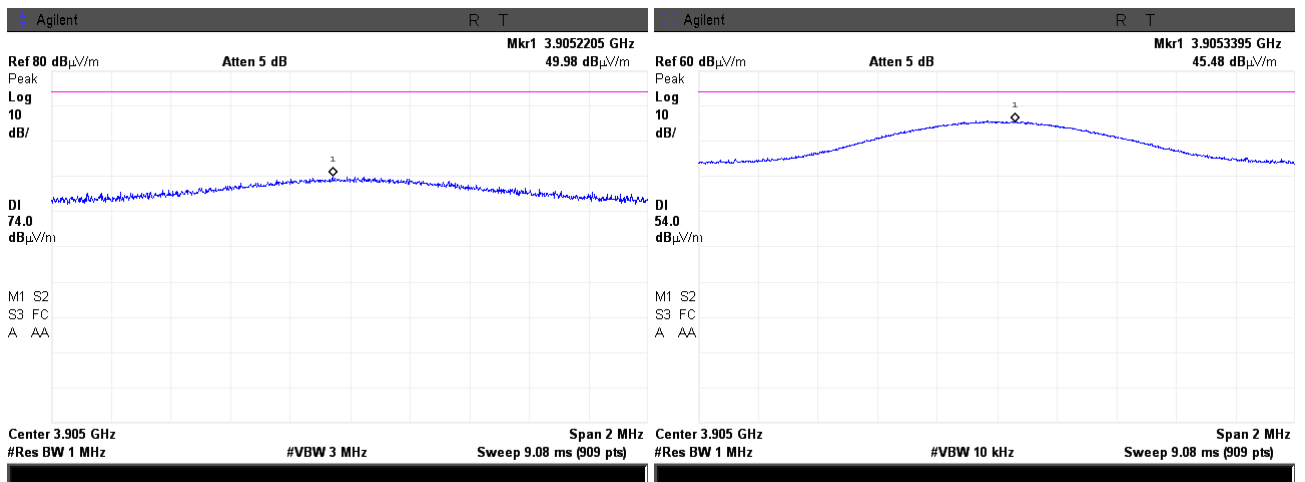
Plot 7.2.21 Radiated emission measurements at the ninth harmonic frequency

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



Plot 7.2.22 Radiated emission measurements at the ninth harmonic frequency

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



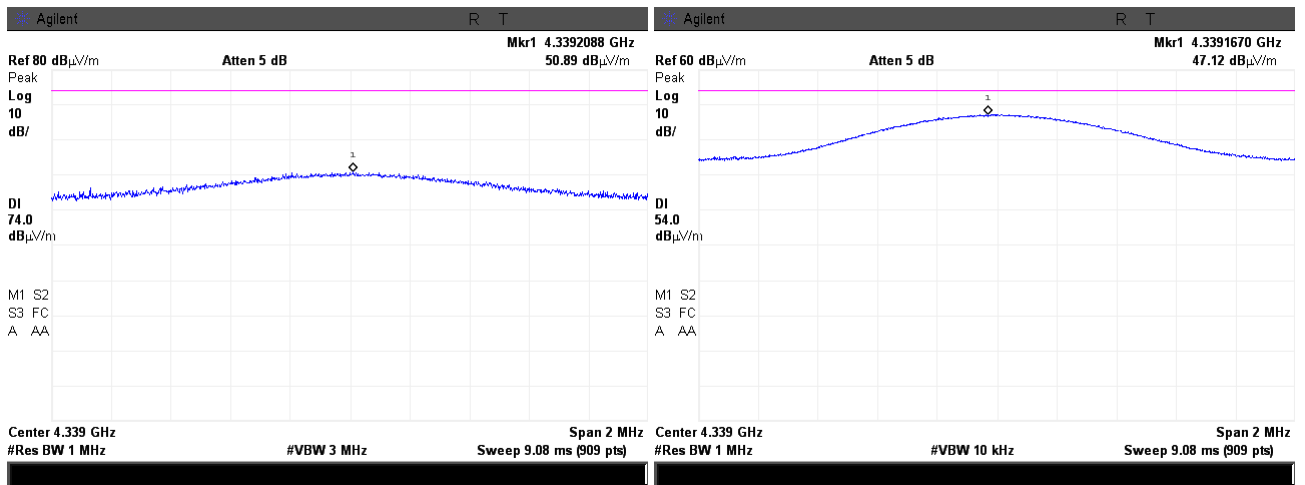


HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> 1010 hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

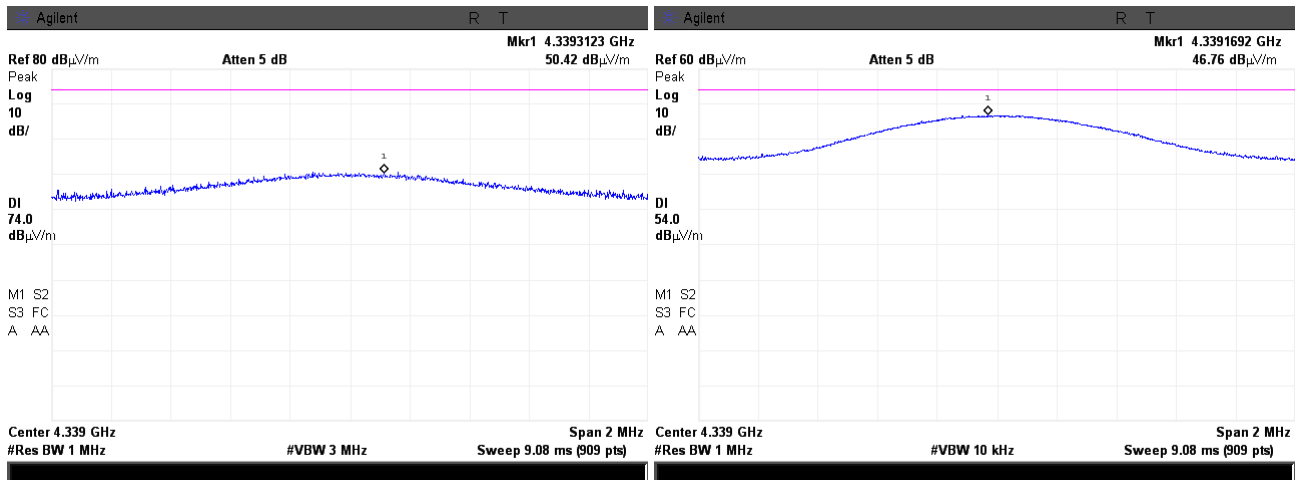
Plot 7.2.23 Radiated emission measurements at the tenth harmonic frequency

TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 ANTENNA POLARIZATION: Vertical 1.2 220  
 EUT POSITION: Typical (Vertical)



Plot 7.2.24 Radiated emission measurements at the tenth harmonic frequency

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

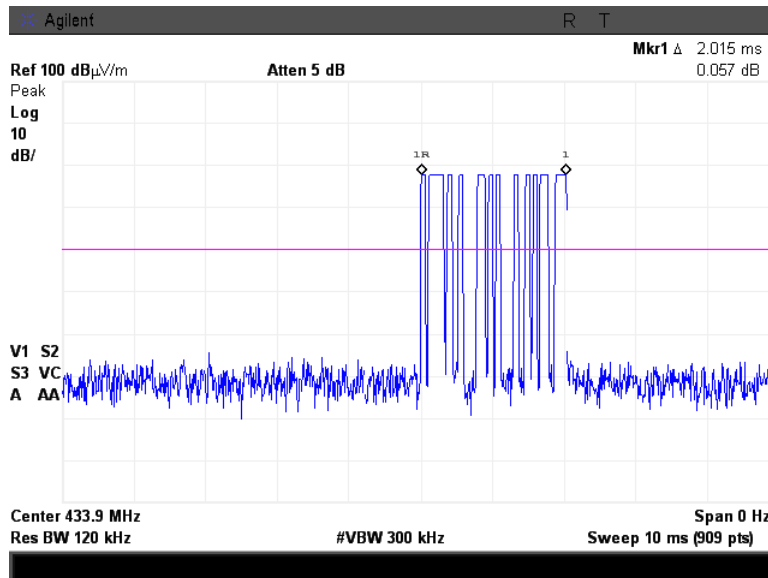




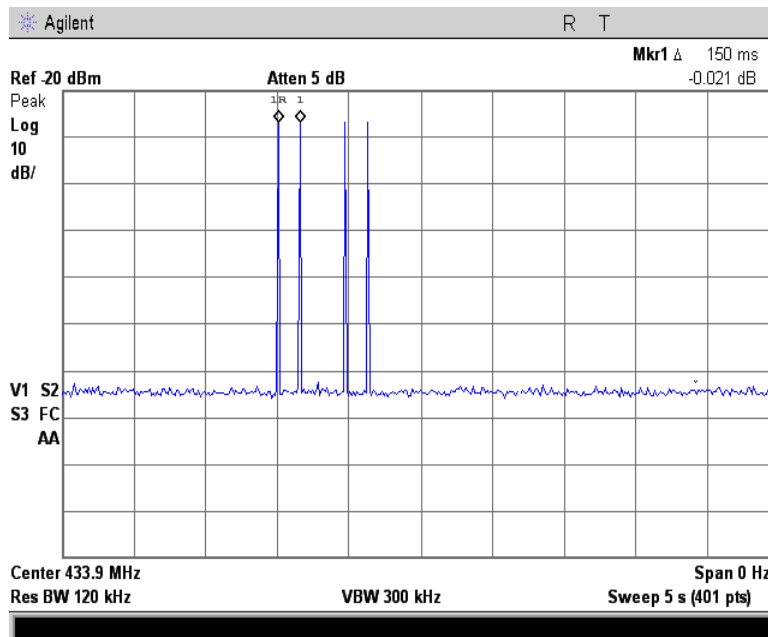
HERMON LABORATORIES

<b>Test specification:</b>	<b>FCC Part 15, Section 231(e) / RSS-210, Section A1.1.5, Field strength of emissions</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.4		
<b>Test mode:</b>	Compliance	<b>Verdict: PASS</b>	
<b>Date(s):</b>	6/11/2013		
<b>Temperature: 23 °C</b>	<b>Air Pressure: 1010 hPa</b>	<b>Relative Humidity: 39 %</b>	<b>Power Supply: 3V battery</b>
<b>Remarks:</b>			

Plot 7.2.25 Transmission pulse duration



Plot 7.2.26 Transmission pulse period





<b>Test specification:</b>	<b>FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth</b>		
<b>Test procedure:</b>	ANSI C63.4, Section 13.1.7		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

### 7.3 Occupied bandwidth test

#### 7.3.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Occupied bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Maximum allowed bandwidth, % of the carrier frequency
70 - 900	20.0	0.25
Above 900		0.50

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

#### 7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and its proper operation was checked.

7.3.2.2 The EUT was set to transmit modulated carrier.

7.3.2.3 The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.3.2 and the associated plot.

Figure 7.3.1 Occupied bandwidth test setup





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<b>Test specification:</b>		<b>FCC Part 15, Section 231(c) / RSS-210, Section A1.1.3, Occupied bandwidth</b>			
<b>Test procedure:</b>		ANSI C63.4, Section 13.1.7			
<b>Test mode:</b>		Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b>		6/11/2013			
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery		
<b>Remarks:</b>					

Table 7.3.2 Occupied bandwidth test results

DETECTOR USED: Peak hold  
 RESOLUTION BANDWIDTH: 10 kHz  
 VIDEO BANDWIDTH: 47 kHz  
 MODULATION ENVELOPE REFERENCE POINTS: 20 dBc  
 MODULATION: ASK  
 BIT RATE: 19.2kbps

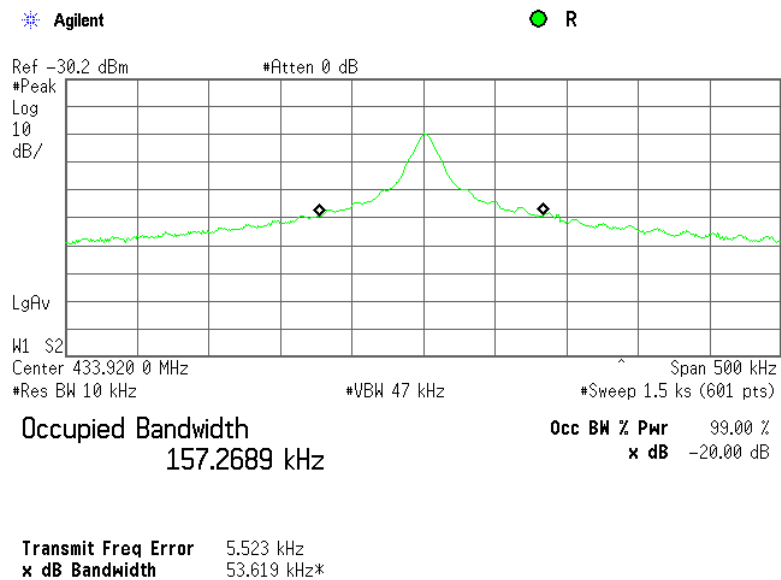
Carrier frequency, MHz	Occupied bandwidth, kHz	Limit		Margin, kHz	Verdict
		% of the carrier frequency	kHz		
433.92	53.62	0.25	1084.8	-1031.18	Pass

Reference numbers of test equipment used

HL 3818								
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Full description is given in Appendix A.

Plot 7.3.1 Occupied bandwidth test result





<b>Test specification:</b>	<b>FCC Part 15, Section 203 / RSS-Gen, Section 7.1.2, Antenna requirements</b>		
<b>Test procedure:</b>	Visual inspection / supplier declaration		
<b>Test mode:</b>	Compliance	<b>Verdict:</b>	<b>PASS</b>
<b>Date(s):</b>	6/11/2013		
<b>Temperature:</b> 23 °C	<b>Air Pressure:</b> hPa	<b>Relative Humidity:</b> 39 %	<b>Power Supply:</b> 3V battery
<b>Remarks:</b>			

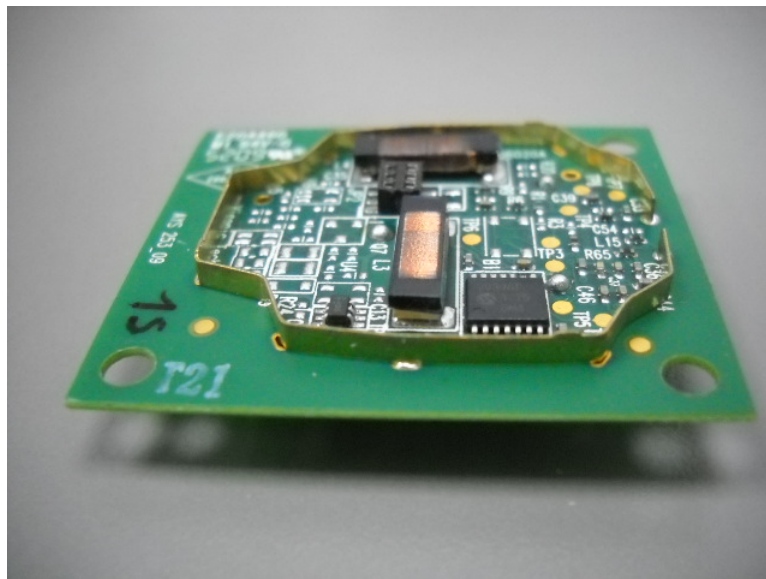
### 7.4 Antenna requirements

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 7.4.1.

Table 7.4.1 Antenna requirements

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

Photograph 7.4.1 Antenna assembly



**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	03-Jul-12	03-Jul-13
0521	EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz	Hewlett Packard	8546A	3617A 00319, 3448A002 53	22-Apr-13	22-Apr-14
2432	Antenna, Double-Ridged Waveguide Horn 1-18 GHz	EMC Test Systems	3115	00027177	07-Dec-12	07-Dec-13
2697	Antenna, 30 MHz - 3.0 GHz	Sunol Sciences. Corp. Pleasanton, California USA	JB3	A022805	04-Jun-13	04-Jun-14
2780	EMC analyzer, 100 Hz to 26.5 GHz	Agilent Technologies	E7405A	MY451024 62	09-Jul-12	09-Jul-13
2871	Microwave Cable Assembly, 18 GHz, 6.4 m, SMA - SMA	Huber-Suhner	198-8155-00	2871	04-Dec-12	04-Dec-13
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY482502 88	24-Apr-13	24-Apr-14
4160	Preamplifier, 0.1 to 18 GHz, Gain 25 dB, N-type(f) in, N-type(m) out.	Agilent Technologies	87405C	MY470105 94	08-Aug-12	08-Aug-13
4292	Microwave Cable Assembly, 18.0 GHz, 3.4 m, SMA/SMA	Huber-Suhner	Sucoflex P103	NA	04-Dec-12	04-Dec-13
4347	Low Loss Armored Test Cable, DC - 18 GHz, 2.0 m, N type-M/N type-M	MegaPhase	NC29-N1N1-79	12025103 001	06-Mar-13	06-Mar-14
4353	Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M	MegaPhase	NC29-N1N1-244	12025101 003	06-Mar-13	06-Mar-14



## 9 APPENDIX B Measurement uncertainties

### Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Radiated emissions at 3 m measuring distance Horizontal polarization	Biconilog antenna: $\pm 5.3$ dB Biconical antenna: $\pm 5.0$ dB Log periodic antenna: $\pm 5.3$ dB Double ridged horn antenna: $\pm 5.3$ dB
Vertical polarization	Biconilog antenna: $\pm 6.0$ dB Biconical antenna: $\pm 5.7$ dB Log periodic antenna: $\pm 6.0$ dB Double ridged horn antenna: $\pm 6.0$ dB
Duty cycle, timing (Tx ON / OFF) and average factor measurements	$\pm 1.0$ %
Occupied bandwidth	$\pm 8.0$ %

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

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

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

## 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, IC 2186A-2 for anechoic chamber, IC 2186A-3 for full-anechoic chamber for RE measurements above 1 GHz), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-27 for full-anechoic chamber for RE measurements above 1 GHz, 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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## 11 APPENDIX D Specification references

FCC 47CFR part 15: 2012	Radio Frequency Devices
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications
ANSI C63.4: 2003	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-210 Issue 8: 2010	Low Power Licence- Exempt Radiocommunication Devices
RSS-Gen Issue 3: 2010	General Requirements and Information for the Certification of Radiocommunication Equipment



## 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( $\mu$ V) to convert it into field intensity in dB( $\mu$ V/m).



**Antenna factor**  
**Double-ridged guide horn antenna**  
**Model 3115, serial number: 00027177, HL 2432**

<b>Frequency, MHz</b>	<b>Antenna factor. dB(1/m)</b>
1000.0	24.7
1500.0	25.7
2000.0	27.8
2500.0	28.9
3000.0	30.7
3500.0	31.8
4000.0	33.0
4500.0	32.8
5000.0	34.2
5500.0	34.9
6000.0	35.2
6500.0	35.4
7000.0	36.3
7500.0	37.3
8000.0	37.5
8500.0	38.0
9000.0	38.3
9500.0	38.3
10000.0	38.7
10500.0	38.7
11000.0	38.9
11500.0	39.5
12000.0	39.5
12500.0	39.4
13000.0	40.5
13500.0	40.8
14000.0	41.5
14500.0	41.3
15000.0	40.2
15500.0	38.7
16000.0	38.5
16500.0	39.8
17000.0	41.9
17500.0	45.8
18000.0	49.1

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

**Antenna calibration**  
**Sunlo Sciences Inc., model JB3, serial number A022805, HL 2697**

Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain	Frequency, MHz	ACF, dB	Gain, dBi	Num gain
30	22.2	-22.5	0.01	620	19.7	6.3	4.27	1215	24.9	7.0	5.05	1810	28.3	7.1	5.08	2405	30.9	6.9	4.89
35	18.5	-17.4	0.02	625	19.7	6.5	4.42	1220	24.9	7.0	4.99	1815	28.5	6.9	4.91	2410	30.9	6.9	4.89
40	14.7	-12.5	0.06	630	19.6	6.6	4.57	1225	25.1	6.9	4.91	1820	28.6	6.8	4.74	2415	31.0	6.9	4.85
45	11.3	-8.1	0.16	635	19.7	6.5	4.48	1230	25.2	6.8	4.82	1825	28.7	6.8	4.75	2420	31.0	6.8	4.82
45	11.3	-8.1	0.16	640	19.9	6.4	4.40	1235	25.1	7.0	4.96	1830	28.7	6.8	4.76	2425	31.1	6.8	4.81
50	8.9	-4.7	0.34	645	19.9	6.5	4.45	1240	25.0	7.1	5.09	1835	28.7	6.7	4.72	2430	31.0	6.9	4.87
55	7.9	-2.8	0.52	650	19.9	6.5	4.51	1245	25.0	7.1	5.12	1840	28.8	6.7	4.69	2435	31.0	6.9	4.86
60	7.8	-2.1	0.82	655	19.9	6.6	4.60	1250	25.0	7.1	5.15	1845	28.8	6.9	4.93	2440	31.2	6.8	4.74
65	8.5	-2.0	0.63	660	19.9	6.7	4.69	1255	25.0	7.2	5.25	1850	28.4	7.1	5.12	2445	31.1	6.9	4.91
70	9.0	-1.9	0.64	665	19.9	6.7	4.70	1260	24.9	7.3	5.36	1855	28.5	7.0	5.07	2450	31.0	7.0	4.96
75	8.8	-1.1	0.78	670	20.0	6.7	4.71	1265	25.0	7.3	5.31	1860	28.6	7.0	5.01	2455	31.0	7.0	5.01
80	8.4	-0.2	0.97	675	20.1	6.7	4.71	1270	25.1	7.2	5.26	1865	28.5	7.1	5.17	2460	30.9	7.2	5.19
85	8.0	0.8	1.20	680	20.1	6.7	4.71	1275	25.3	7.0	5.05	1870	28.4	7.3	5.33	2465	31.1	6.9	4.95
90	8.2	1.1	1.29	685	20.1	6.8	4.79	1280	25.5	6.8	4.94	1875	28.4	7.2	5.32	2470	31.3	6.8	4.78
95	9.2	0.5	1.13	690	20.1	6.9	4.88	1285	25.4	7.0	4.97	1880	28.5	7.2	5.32	2475	31.4	6.7	4.69
100	10.6	-0.4	0.92	695	20.2	6.8	4.82	1290	25.3	7.1	5.10	1885	28.5	7.2	5.22	2480	31.3	6.8	4.79
110	12.6	-1.6	0.70	705	20.4	6.8	4.75	1300	25.2	7.3	5.33	1895	28.6	7.2	5.24	2490	31.1	7.0	4.99
120	13.9	-2.1	0.62	715	20.5	6.8	4.80	1310	25.5	7.1	5.09	1905	28.5	7.3	5.36	2500	30.9	7.2	5.27
125	14.2	-2.0	0.63	720	20.5	6.9	4.85	1315	25.4	7.2	5.23	1910	28.5	7.4	5.45	2505	31.1	7.1	5.15
130	14.2	-1.7	0.68	725	20.6	6.8	4.81	1320	25.3	7.3	5.36	1915	28.5	7.3	5.38	2510	31.0	7.2	5.22
140	13.4	-0.3	0.94	735	20.9	6.7	4.85	1330	25.6	7.0	5.08	1925	28.6	7.3	5.35	2520	31.2	7.0	5.05
150	12.9	0.8	1.21	745	21.0	6.6	4.59	1340	25.7	7.1	5.09	1935	28.5	7.4	5.54	2530	31.0	7.3	5.37
160	12.7	1.6	1.44	755	21.0	6.8	4.74	1350	25.7	7.1	5.17	1945	28.5	7.5	5.59	2540	31.2	7.1	5.09
165	12.5	2.0	1.59	760	21.0	6.8	4.83	1355	25.8	7.0	5.06	1950	28.6	7.4	5.48	2545	31.0	7.3	5.43
170	12.2	2.6	1.83	765	21.1	6.8	4.73	1360	25.9	6.9	4.95	1955	28.6	7.5	5.57	2550	31.0	7.3	5.39
175	11.8	3.3	2.13	770	21.3	6.7	4.64	1365	26.0	6.9	4.95	1960	28.6	7.5	5.65	2555	31.1	7.2	5.30
180	11.6	3.7	2.36	775	21.3	6.7	4.68	1370	26.0	7.0	4.98	1965	28.7	7.4	5.47	2560	31.0	7.4	5.47
185	11.5	4.0	2.54	780	21.3	6.7	4.72	1375	26.0	7.0	5.01	1970	28.6	7.2	5.29	2565	31.2	7.6	5.70
190	11.6	4.2	2.61	785	21.3	6.8	4.77	1380	26.0	7.0	5.06	1975	28.9	7.2	5.22	2570	31.1	7.3	5.37
200	13.1	3.2	2.07	795	21.4	6.8	4.79	1390	26.1	6.9	4.92	1985	29.1	7.1	5.11	2580	31.6	6.9	4.87
205	12.0	4.4	2.76	800	21.5	6.8	4.77	1395	26.2	6.9	4.94	1990	29.1	7.0	5.06	2585	31.6	6.8	4.79
210	11.0	5.6	3.66	805	21.6	6.7	4.71	1400	26.2	7.0	4.96	1995	29.1	7.1	5.09	2590	31.6	6.9	4.88
215	11.3	5.6	3.59	810	21.7	6.7	4.65	1405	26.1	7.0	5.02	2000	29.1	7.1	5.11	2595	31.5	7.0	4.97
220	11.6	5.5	3.52	815	21.7	6.7	4.72	1410	26.1	7.1	5.09	2005	29.1	7.1	5.16	2600	31.6	6.9	4.86
225	11.7	5.5	3.45	820	21.7	6.8	4.80	1415	26.2	7.0	5.02	2010	29.2	7.1	5.15	2605	31.3	7.2	5.30
230	11.9	5.6	3.57	825	21.7	6.8	4.82	1420	26.3	7.0	4.96	2015	29.2	7.1	5.13	2610	31.4	7.1	5.15
235	12.1	5.5	3.56	830	21.7	6.9	4.85	1425	26.2	7.1	5.10	2020	29.2	7.1	5.18	2615	31.7	6.9	4.88
240	12.3	5.5	3.54	835	21.8	6.8	4.82	1430	26.1	7.2	5.25	2025	29.3	7.1	5.08	2620	31.6	7.0	4.97
245	12.3	5.7	3.71	840	21.9	6.8	4.80	1435	26.1	7.2	5.24	2030	29.3	7.0	5.05	2625	31.4	7.1	5.17
250	12.3	5.9	3.88	845	21.9	6.8	4.83	1440	26.2	7.2	5.24	2035	29.3	7.1	5.07	2630	31.6	7.0	5.00
255	12.5	5.9	3.85	850	21.9	6.9	4.86	1445	26.3	1	5.11	2040	29.3	7.1	5.13	2635	31.8	6.8	4.82
260	12.7	5.8	3.83	855	22.0	6.8	4.80	1450	26.5	7.0	4.98	2045	29.2	7.2	5.23	2640	31.7	7.0	4.98
265	13.2	5.5	3.54	860	22.0	6.8	4.74	1455	26.4	7.1	5.07	2050	29.2	7.2	5.27	2645	31.7	6.9	4.93
270	13.7	5.2	3.32	865	22.0	6.9	4.92	1460	26.4	7.1	5.17	2055	29.3	7.2	5.21	2650	31.8	6.9	4.85
275	13.7	5.3	3.39	870	21.9	7.1	5.11	1465	26.4	7.2	5.19	2060	29.5	7.0	5.02	2655	31.8	6.9	4.85
280	13.7	5.4	3.50	875	22.0	7.1	5.08	1470	26.4	7.2	5.22	2065	29.4	7.1	5.08	2660	31.7	7.0	5.02
285	13.7	5.6	3.61	880	22.1	7.0	5.05	1475	26.4	7.1	5.17	2070	29.4	7.1	5.10	2665	32.0	6.7	4.71
290	13.7	5.7	3.72	885	22.1	7.0	5.06	1480	26.5	7.1	5.12	2075	29.5	7.0	5.01	2670	32.0	6.7	4.67
295	13.8	5.8	3.77	890	22.1	7.0	5.06	1485	26.5	7.1	5.14	2080	29.6	6.8	4.76	2675	31.9	6.8	4.81
300	13.9	5.8	3.81	895	22.2	7.1	5.09	1490	26.5	7.1	5.17	2085	29.7	6.9	4.89	2680	31.7	7.0	5.04
305	14.0	5.9	3.85	900	22.2	7.1	5.12	1495	26.5	7.2	5.24	2090	29.7	6.9	4.86	2685	31.9	6.8	4.83
310	14.1	5.9	3.88	905	22.3	7.1	5.09	1500	26.5	7.2	5.31	2095	29.8	6.8	4.78	2690	32.1	6.7	4.72
315	14.3	5.8	3.89	910	22.3	7.0	5.05	1505	26.5	7.2	5.37	2100	29.8	6.8	4.75	2695	32.1	6.7	4.71
320	14.4	5.8	3.90	915	22.4	7.0	4.99	1510	26.6	7.2	5.23	2105	29.8	6.8	4.81	2700	32.0	6.8	4.81
325	14.5	5.9	3.92	920	22.6	6.9	4.92	1515	26.6	7.2	5.30	2110	29.9	6.8	4.78	2705	32.0	6.8	4.80
330	14.6	5.9	3.93	925	22.7	6.9	4.85	1520	26.5	7.3	5.38	2115	29.9	6.8	4.76	2710	32.1	6.8	4.79
335	14.7	6.0	4.02	930	22.8	6.8	4.77	1525	26.6	7.3	5.37	2120	29.9	6.8	4.84	2715	32.1	6.7	4.71
340	14.7	6.2	4.12	935	22.8	6.8	4.83	1530	26.6	7.3	5.36	2125	29.9	6.9	4.89	2720	32.4	6.5	4.47
345	14.9	6.1	4.06	940	22.8	6.9	4.89	1535	26.6	7.4	5.44	2130	29.9	6.9	4.90	2725	32.2	6.7	4.63
350	15.1	6.0	3.99	945	22.8	6.9	4.87	1540	26.5	7.4	5.53	2135	29.8	6.9	4.94	2730	31.9	7.0	5.05
355	15.3	5.9	3.88	950	22.9	6.9	4.85	1545	26.5	7.5	5.58	2140	29.8	7.1	5.08	2735	31.6	7.4	5.44
360	15.7	5.8	3.78	955	23.0	6.8	4.81	1550	26.5	7.5	5.63	2145	29.8	6.9	4.92	2740	31.8	7.1	5.45
365	15.5	5.9	3.80	960	23.1	6.8	4.77	1555	26.7	7.3	5.63	2150	29.9	7.0	4.98	2745	31.9	7.0	5.06
370	15.5	6.0	4.01	965	23.1	6.7	4.73	1560	26.9	7.1	5.18	2155	29.8	7.1	5.10	2750	32.0	6.9	4.94
375	15.6	6.1	4.03	970	23.2	6.7	4.69	1565	26.9	7.2	5.23	2160	29.8	7.1	5.09	2755	32.0	7.0	4.98
380	15.7	6.1	4.05	975	23.3	6.6	4.62	1570	26.9	7.2	5.30	2165	29.9	7.0	5.00	2760	32.0	7.0	5.06
385	15.7	6.2	4.15	980	23.5	6.6	4.54	1575	27.0	7.2	5.23	2170	29.9	7.1	5.07	2765	32.2	6.8	4.80
390	15.7	6																	



**Cable loss**  
**Cable coaxial, Huber-Suhner, 18 GHz, 6.4 m, SMA - SMA, model 198-8155-00,**  
**HL 2871**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.12	5750	2.34	12000	3.55
30	0.14	6000	2.39	12250	3.61
100	0.27	6250	2.46	12500	3.67
250	0.45	6500	2.52	12750	3.74
500	0.63	6750	2.58	13000	3.79
750	0.76	7000	2.64	13250	3.82
1000	0.89	7250	2.68	13500	3.83
1250	1.01	7500	2.73	13750	3.83
1500	1.12	7750	2.78	14000	3.88
1750	1.23	8000	2.83	14250	3.93
2000	1.32	8250	2.88	14500	3.96
2250	1.41	8500	2.94	14750	4.01
2500	1.49	8750	2.97	15000	4.00
2750	1.58	9000	3.02	15250	4.01
3000	1.66	9250	3.07	15500	4.00
3250	1.73	9500	3.13	15750	4.13
3500	1.80	9750	3.18	16000	4.22
3750	1.87	10000	3.21	16250	4.29
4000	1.93	10250	3.26	16500	4.29
4250	2.01	10500	3.30	16750	4.32
4500	2.06	10750	3.36	17000	4.37
4750	2.12	11000	3.39	17250	4.45
5000	2.17	11250	3.44	17500	4.49
5250	2.24	11500	3.48	17750	4.53
5500	2.29	11750	3.52	18000	4.55



**Cable loss**  
**Microwave Cable Assembly, 18.0 GHz, 3.4 m, SMA/SMA, Huber-Suhner,**  
**Sucoflex P103, HL 4292**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.11	5000	2.10	10200	2.95	15400	3.64
30	0.17	5100	2.14	10300	2.96	15500	3.68
50	0.22	5200	2.16	10400	2.99	15600	3.71
100	0.30	5300	2.17	10500	2.99	15700	3.74
200	0.36	5400	2.19	10600	3.03	15800	3.71
300	0.42	5500	2.19	10700	3.03	15900	3.74
400	0.51	5600	2.22	10800	3.04	16000	3.71
500	0.59	5700	2.24	10900	3.05	16100	3.73
600	0.66	5800	2.23	11000	3.09	16200	3.76
700	0.72	5900	2.26	11100	3.07	16300	3.82
800	0.77	6000	2.27	11200	3.08	16400	3.90
900	0.82	6100	2.26	11300	3.11	16500	3.81
1000	0.88	6200	2.29	11400	3.12	16600	3.88
1100	0.93	6300	2.30	11500	3.11	16700	3.87
1200	0.98	6400	2.34	11600	3.15	16800	3.89
1300	1.02	6500	2.34	11700	3.16	16900	3.95
1400	1.06	6600	2.36	11800	3.18	17000	4.02
1500	1.10	6700	2.36	11900	3.19	17100	4.04
1600	1.14	6800	2.39	12000	3.23	17200	3.99
1700	1.19	6900	2.39	12100	3.25	17300	4.03
1800	1.23	7000	2.44	12200	3.22	17400	4.03
1900	1.27	7100	2.46	12300	3.25	17500	4.06
2000	1.30	7200	2.44	12400	3.25	17600	4.05
2100	1.35	7300	2.48	12500	3.28	17700	4.12
2200	1.38	7400	2.47	12600	3.27	17800	4.14
2300	1.42	7500	2.48	12700	3.27	17900	4.18
2400	1.45	7600	2.50	12800	3.30	18000	4.14
2500	1.48	7700	2.53	12900	3.30		
2600	1.51	7800	2.56	13000	3.27		
2700	1.55	7900	2.55	13100	3.32		
2800	1.59	8000	2.56	13200	3.32		
2900	1.65	8100	2.56	13300	3.32		
3000	1.66	8200	2.57	13400	3.35		
3100	1.69	8300	2.59	13500	3.38		
3200	1.71	8400	2.62	13600	3.39		
3300	1.74	8500	2.67	13700	3.42		
3400	1.76	8600	2.65	13800	3.47		
3500	1.78	8700	2.68	13900	3.45		
3600	1.80	8800	2.68	14000	3.49		
3700	1.85	8900	2.68	14100	3.50		
3800	1.88	9000	2.74	14200	3.55		
3900	1.90	9100	2.74	14300	3.59		
4000	1.91	9200	2.76	14400	3.58		
4100	1.93	9300	2.78	14500	3.56		
4200	1.96	9400	2.79	14600	3.57		
4300	1.97	9500	2.80	14700	3.57		
4400	1.99	9600	2.83	14800	3.57		
4500	2.02	9700	2.84	14900	3.64		
4600	2.02	9800	2.86	15000	3.64		
4700	2.04	9900	2.92	15100	3.61		
4800	2.05	10000	2.90	15200	3.67		
4900	2.09	10100	2.92	15300	3.63		



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

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





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

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

## 13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB( $\mu$ V)	decibel referred to one microvolt
dB( $\mu$ V/m)	decibel referred to one microvolt per meter
dB( $\mu$ 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
$\mu$ s	microsecond
NA	not applicable
OATS	open area test site
$\Omega$	Ohm
PS	power supply
ppm	part per million ( $10^{-6}$ )
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt

END OF DOCUMENT