

TEST REPORT

ACCORDING TO: FCC CFR 47 Part 15 subpart C, section 15.231

FOR:

Lifebuoy Ltd.

Control unit of pool alarm system

Model: LBPACNTL1

FCC ID:2AOXNLBPACNTL

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Table of contents

1	Applicant information	3
2	Equipment under test attributes	3
3	Manufacturer information	3
4	Test details	3
5	Tests summary	4
6	EUT description	5
6.1	General information	5
6.2	Changes made in EUT	5
6.3	Test configuration	5
6.4	Transmitter characteristics	6
7	Transmitter tests according to 47CFR part 15 subpart C requirements	7
7.1	Periodic operation requirements	7
7.2	Field strength of emissions	11
7.3	Occupied bandwidth test	25
7.4	Antenna requirements	28
8	APPENDIX A Test equipment and ancillaries used for tests	29
9	APPENDIX B Measurement uncertainties	30
10	APPENDIX C Test laboratory description	31
11	APPENDIX D Specification references	31
12	APPENDIX E Test equipment correction factors	32
13	APPENDIX F Abbreviations and acronyms	39

1 Applicant information

Client name: Lifebuoy Ltd.
Address: 12 Lohamey Hagetaot St., Ness-Ziona 7409612, Israel
Telephone: +972-52-942-8008
E-mail: yaelt@lifebuoyalarm.com
Contact name: Mrs. Yael Tepper

2 Equipment under test attributes

Product name: Control unit of pool alarm system
Product type: Transceiver
Model(s): LBPACNTL1
Serial number: C5000
Hardware version: Rev-2
Software release: 1.74
Receipt date: 20-Nov-17

3 Manufacturer information

Manufacturer name: Lifebuoy Ltd.
Address: 12 Lohamey Hagetaot St., Ness-Ziona 7409612, Israel
Telephone: +972-52-942-8008
E-Mail: yaelt@lifebuoyalarm.com
Contact name: Mrs. Yael Tepper

4 Test details

Project ID: 29408
Location: Hermon Laboratories Ltd. Hefetz-Haim 10, Tel Aviv 6744124, Israel
Test started: 30-Nov-17
Test completed: 30-Nov-17
Test specification(s): FCC 47CFR part 15, subpart C, §15.231

5 Tests summary

Test	Status
Transmitter characteristics	
Section 15.231(a), Periodic operation requirements	Pass
Section 15.231(b), Field strength of emissions	Pass
Section 15.231(c), Occupied bandwidth	Pass
Section 15.207(a), Conducted emission	Not required
Section 15.203, Antenna requirement	Pass

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.
The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mr. I. Zilberstein, test engineer	November 30, 2017	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	January 28, 2018	
Approved by:	Mr. K. Zushchuk, Projects & Customer Manager, EMC & Radio	February 4, 2018	

6 EUT description

6.1 General information

The EUT is a control unit of pool alarm system. The control unit communicates with a floating unit of the system at 433.92 MHz and with a cellular device (smartphone) in 2402 - 2480 MHz band.

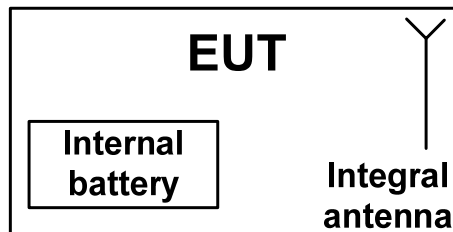
The radios could not operate simultaneously; in any given moment the radio will use either 433.92 MHz or 2402-2480 MHz frequency.

The present test report involves the test results for certification of 433.92 MHz transmitter as a part of a composite application for certification.

6.2 Changes made in EUT

No changes were implemented in the EUT during the testing.

6.3 Test configuration



6.4 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)					
Operating frequency		433.92 MHz				
Maximum rated output power		At transmitter 50 Ω RF output connector				
		Field strength at 3 m distance		77.43 dB(μ V/m) – peak 68.68 dB(μ V/m) -average		
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	with temporary RF connector	
					X	without temporary RF connector
Antenna/s technical characteristics						
Type	Manufacturer		Model number		Gain	
Integral	Texas Instruments		DN038		2.33 dBi	
Transmitter aggregate data rate/s		625 kbps				
Type of modulation		2FSK				
Modulating test signal (baseband)		ID code				
Transmitter power source						
X	Battery	Nominal rated voltage	9 VDC	Battery type	ER9V	
	DC	Nominal rated voltage	VDC			
	AC mains	Nominal rated voltage	VAC	Frequency		
Common power source for transmitter and receiver				X	yes	no

Test specification: Section 15.231(a), Periodic operation requirements			
Test procedure: Supplier declaration			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C 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;
- A manually operated transmitter shall employ switch that will automatically deactivate the transmitter within not more than 5 seconds of being released;
- A transmitter activated automatically shall cease transmission within 5 seconds after activation;
- Periodic transmissions, excluding polling or supervision transmissions, at regular predetermined intervals are not permitted;
- Total duration of polling or supervision transmissions, including data, to determine system integrity in security or safety applications shall not exceed 2 seconds per hour;
- Transmission of set-up information for security systems may exceed the transmission duration limits of 5 seconds, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

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 Plot 7.1.1.

7.1.3 Test procedure for measurements of polling / supervision transmission duration

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

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

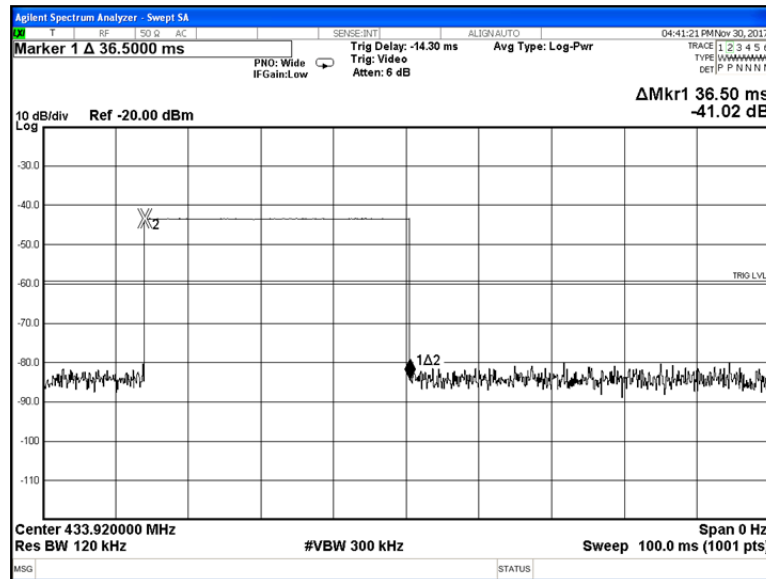
7.1.3.3 The transmission time was captured and shown in Plot 7.1.2.

Figure 7.1.1 Setup for transmitter shut down test

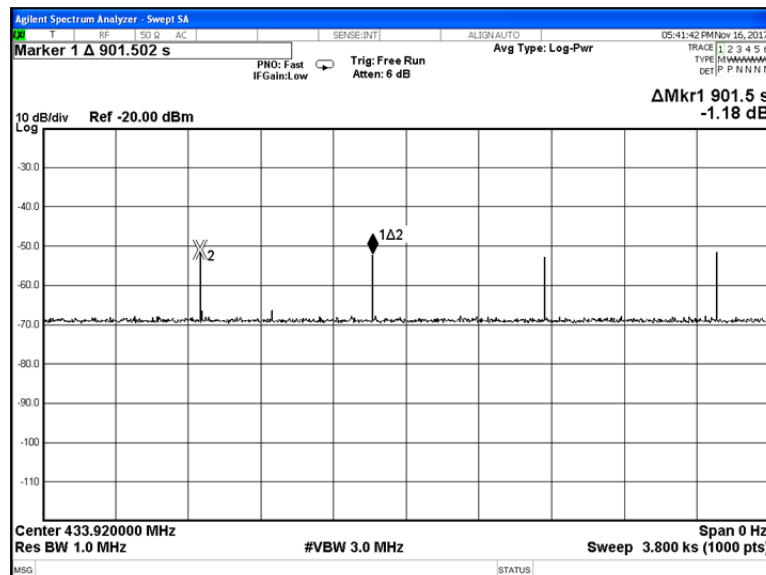


Test specification:		Section 15.231(a), Periodic operation requirements	
Test procedure:		Supplier declaration	
Test mode:		Verdict: PASS	
Date(s):			
30-Nov-17			
Temperature: 24 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

Plot 7.1.2 Polling / supervision pulse duration



Plot 7.1.3 Polling / supervision transmission duration





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Test specification: Section 15.231(a), Periodic operation requirements			
Test procedure: Supplier declaration			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

Table 7.1.2 Total duration of polling / supervision transmissions

Duration, ms	Repetition period, s	Maximum number of transmissions within 1 hour	Total duration within 1 hour, ms
36.60	901.5	4	146.4

Reference numbers of test equipment used

HL 4274	HL 4575						
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Full description is given in Appendix A.

Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-Nov-17		
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

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
433.92	100.8	80.8

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**	80.8	60.8
0.090 – 0.110	NA	108.5 – 106.8**	NA		
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**		
0.490 – 1.705	NA	73.8 – 63.0**	NA		
1.705 – 30.0*		69.5			
30 – 88		40.0			
88 – 216		43.5			
216 – 960		46.0			
960 - 1000		54.0			
Above 1000	74.0	NA	54.0		

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

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

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

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

Note 1: The fundamental emission limit in dB(μV/m) was calculated as follows:

$$\text{Lim}_{AVR} = 20 \times \log(56.81818 \times F - 6136.3636) \text{ - within } 130 - 174 \text{ MHz band;}$$

$$\text{Lim}_{AVR} = 20 \times \log(41.6667 \times F - 7083.3333) \text{ - within } 260 - 470 \text{ MHz band,}$$

where F is the carrier frequency in MHz.

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.

Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

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 Figure 7.2.1, energized and the performance check was conducted.

7.2.2.2 The measurements were performed in EUT typical (vertical) position.

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

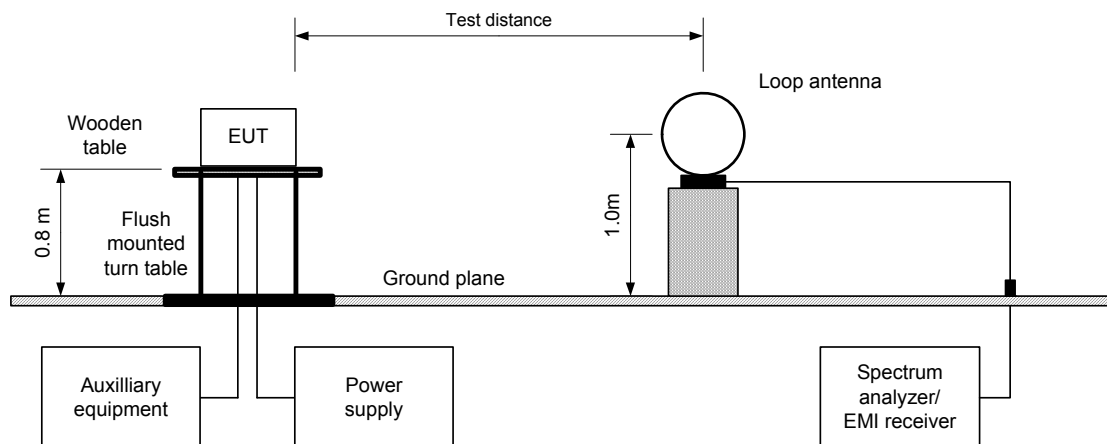
7.2.3.1 The EUT was set up as shown in Figure 7.2.2, Figure 7.2.3, energized and the performance check was conducted.

7.2.3.2 The measurements were performed in EUT Typical (Vertical) position.

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

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

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



Test specification:		Section 15.231(b), Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

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

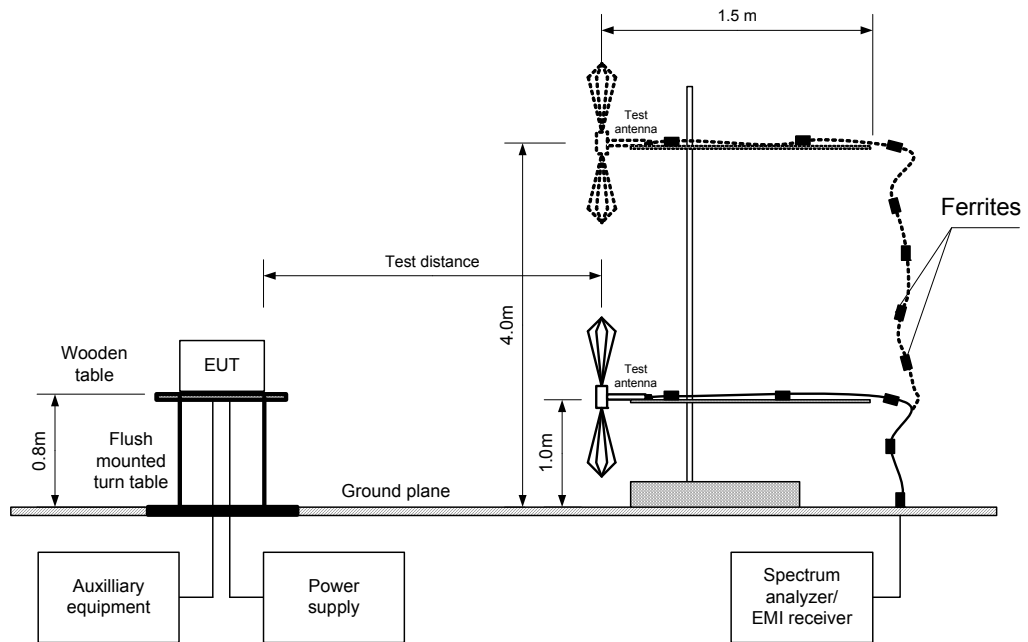
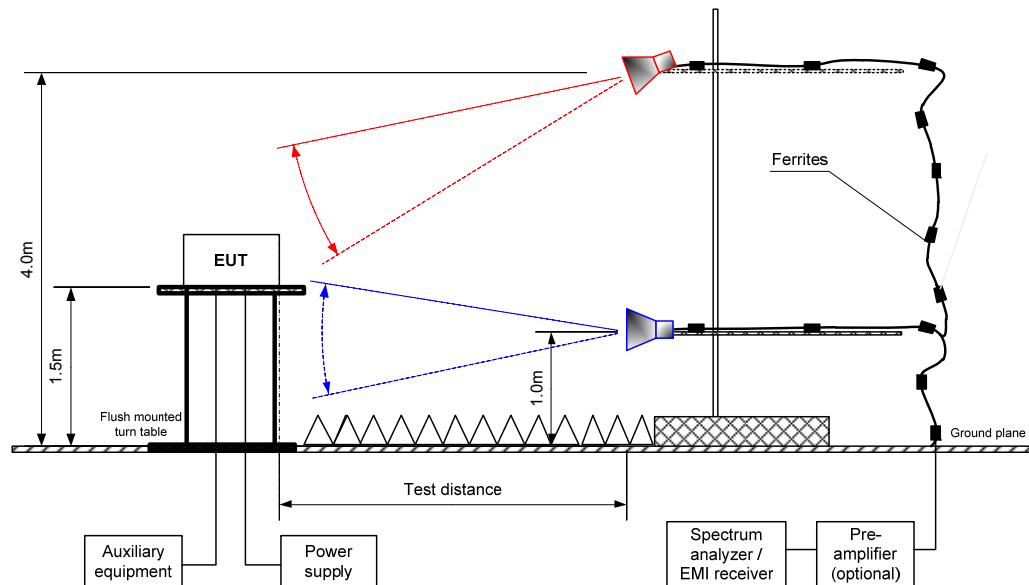


Figure 7.2.3 Setup for spurious emission field strength measurements above 1000 MHz



Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance	Verdict: PASS		
Date(s): 30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

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:	2FSK
MODULATING SIGNAL:	ID code
BIT RATE:	625.0 kbps
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
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**	
Fundamental emission											
433.926	Horiz	1.58	359	77.43	100.8	-23.37	77.43	68.68	80.8	-12.12	Pass
Spurious emissions											
Carrier frequency 433.92 MHz											
867.841	Horiz	1.2	360	33.96	80.8	-46.84	33.96	25.21	60.8	-35.59	Pass
1301.800	Horiz	1.23	0	55.03	74.0	-18.97	55.03	46.28	54.0	-7.72	
1735.700	Vertic	1.64	26	42.36	80.8	-38.44	42.36	33.61	60.8	-27.19	
2169.579	Horiz	1.65	348	39.45	80.8	-41.35	39.45	30.7	60.8	-30.10	

*- 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	Number of pulses during 100 ms	Duration, ms	Period, ms		
36.50	1	NA	NA	NA	-8.75

*- 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 1915	HL 4541	HL 4542	HL 4543	HL 4575	HL 4603	HL 4604	HL 5102
HL 5105							

Full description is given in Appendix A.



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Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance	Verdict: PASS		
Date(s): 30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

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

TEST DISTANCE: 3 m
 EUT POSITION: Typical (Vertical)
 MODULATION: 2FSK
 MODULATING SIGNAL: ID code
 BIT RATE: 625.0 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 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)
 Biconical (30 MHz – 200 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*				
Carrier frequency 433.92 MHz								
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 1915	HL 4541	HL 4542	HL 4543	HL 4575	HL 4604	HL 5102	HL 5105
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Full description is given in Appendix A.



HERMON LABORATORIES

Test specification:		Section 15.231(b), Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

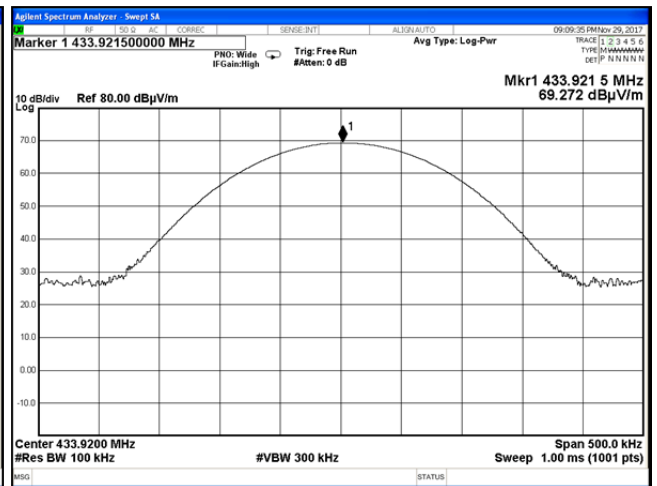
Table 7.2.6 Restricted bands

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	

Test specification:		Section 15.231(b), Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

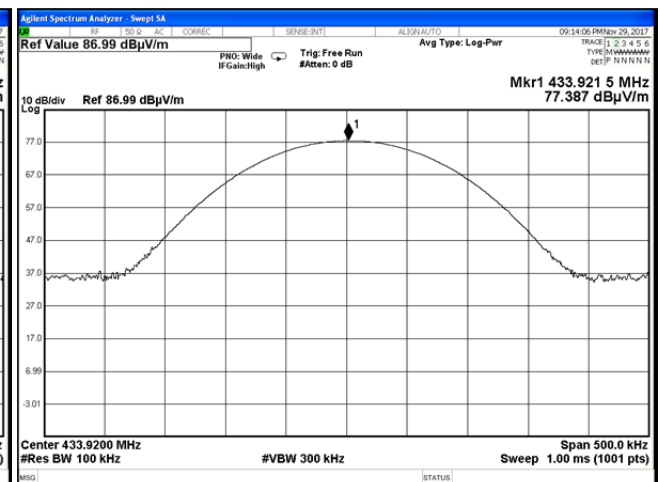
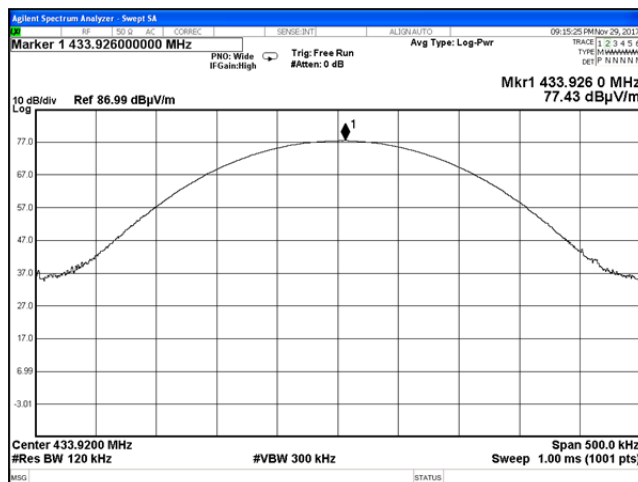
Plot 7.2.1 Radiated emission measurements at the carrier frequency

TEST SITE: Semi 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 carrier frequency

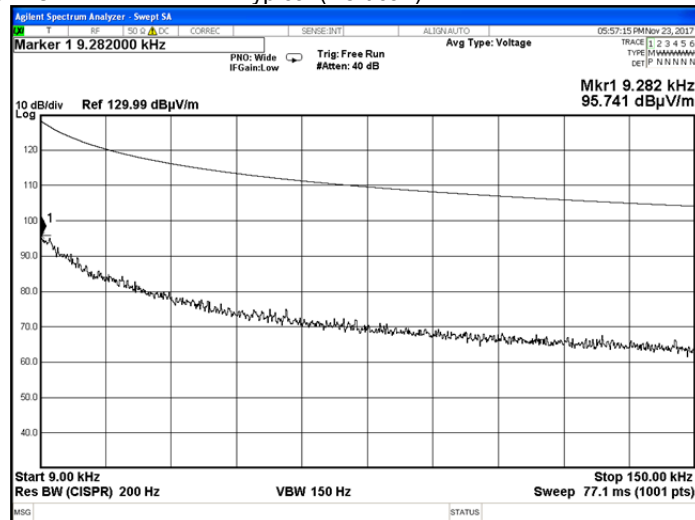
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical/)
INPUT VOLTAGE: Unom



Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

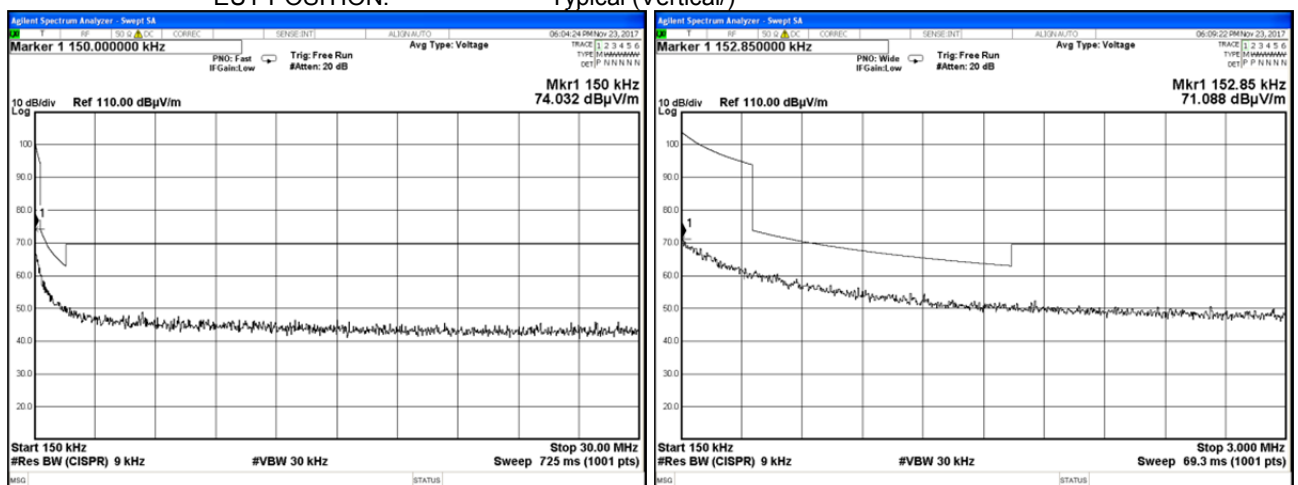
Plot 7.2.3 Radiated emission measurements from 9 to 150 kHz

TEST SITE: Semi 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

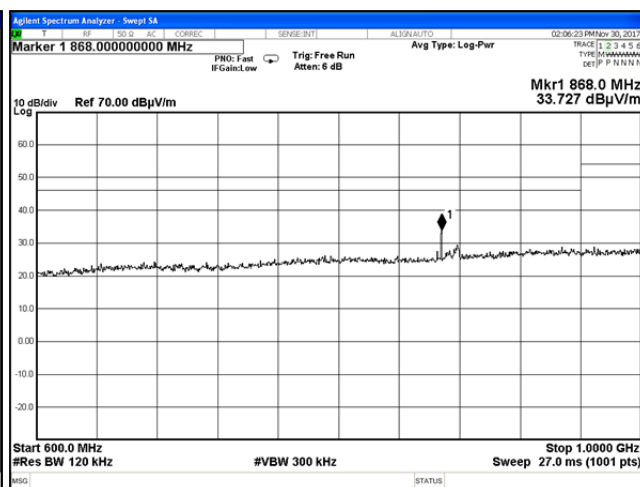
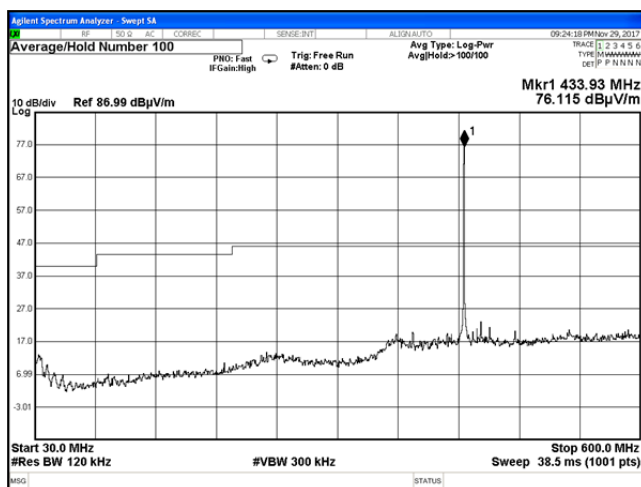
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical/)



Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

Plot 7.2.5 Radiated emission measurements from 30 to 1000 MHz

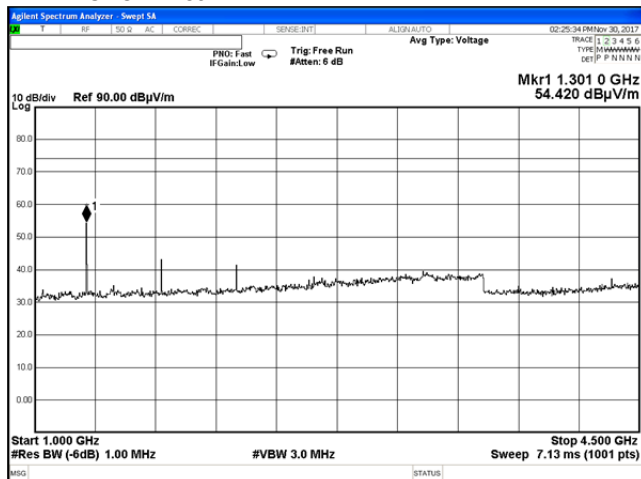
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical/)



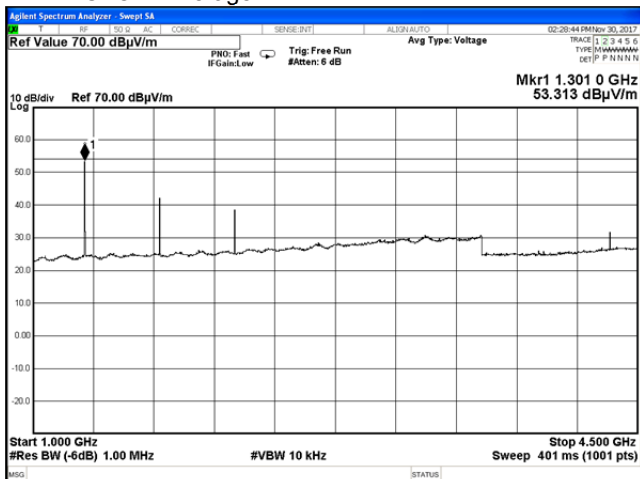
Plot 7.2.6 Radiated emission measurements from 1000 to 4500 MHz

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

DETECTOR: Peak



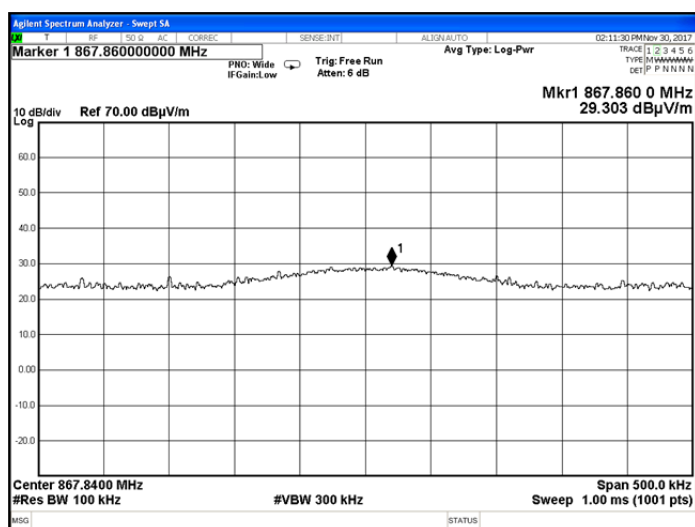
DETECTOR: Average



Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

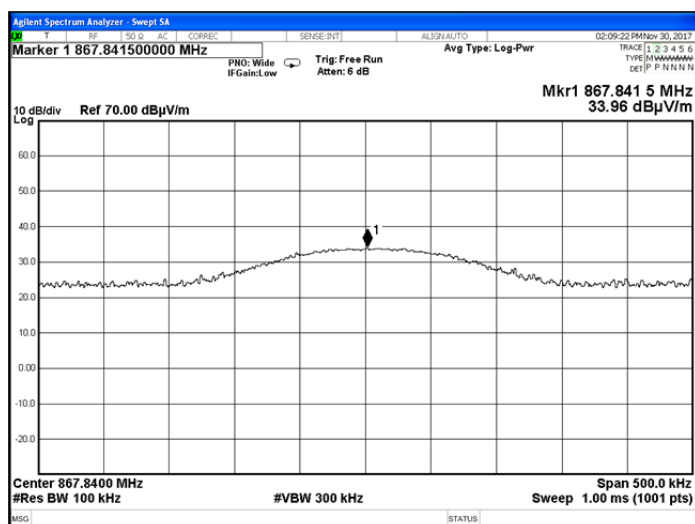
Plot 7.2.7 Radiated emission measurements at the 2nd harmonic frequency

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



Plot 7.2.8 Radiated emission measurements at the 2nd harmonic frequency

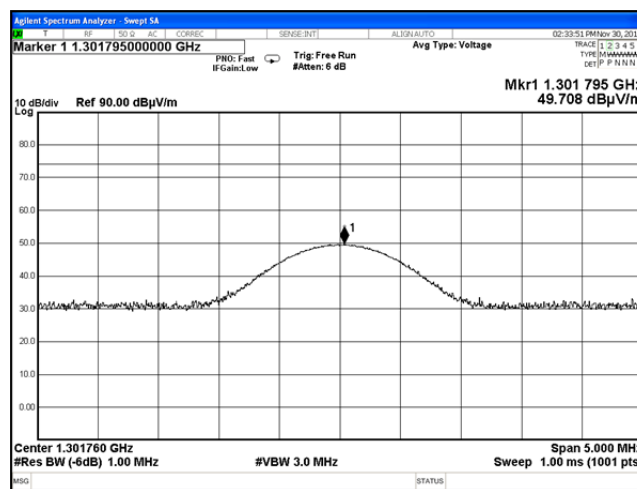
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical/)



Test specification:		Section 15.231(b), Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

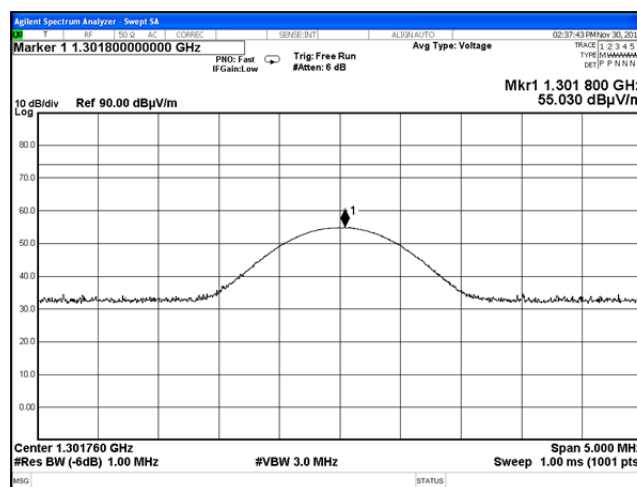
Plot 7.2.9 Radiated emission measurements at the 3rd harmonic frequency

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 3rd harmonic frequency

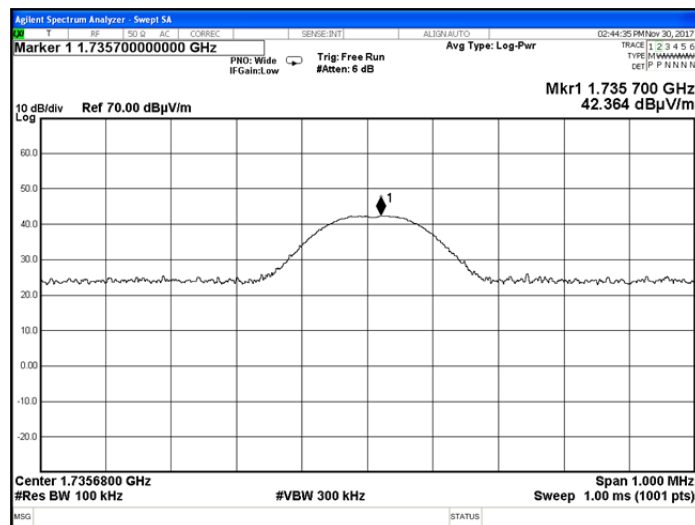
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)



Test specification:		Section 15.231(b), Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

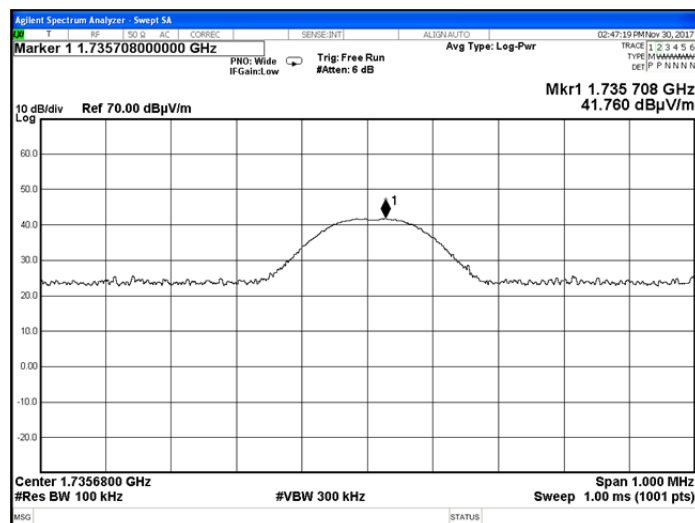
Plot 7.2.11 Radiated emission measurements at the 4th harmonic frequency

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 4th harmonic frequency

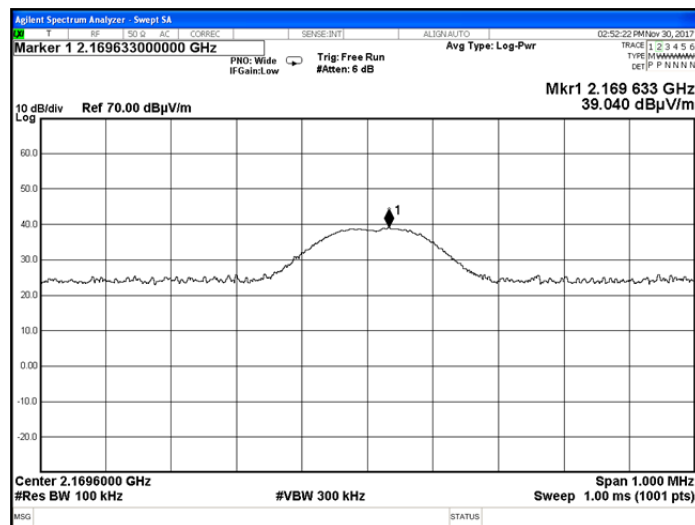
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)



Test specification: Section 15.231(b), Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

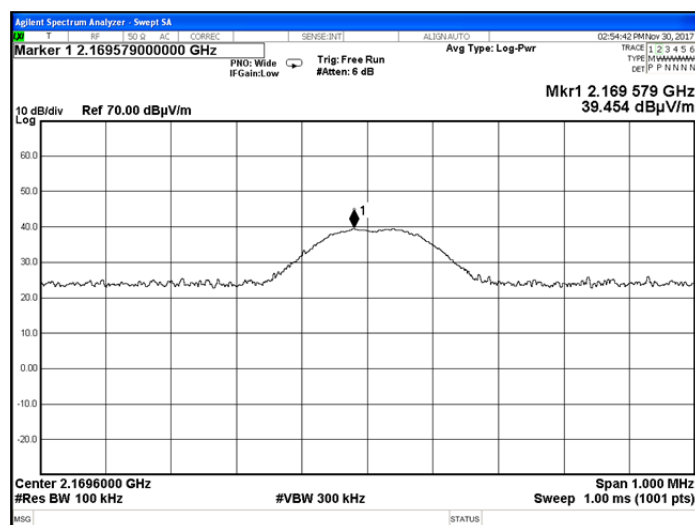
Plot 7.2.13 Radiated emission measurements at the 5th harmonic frequency

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



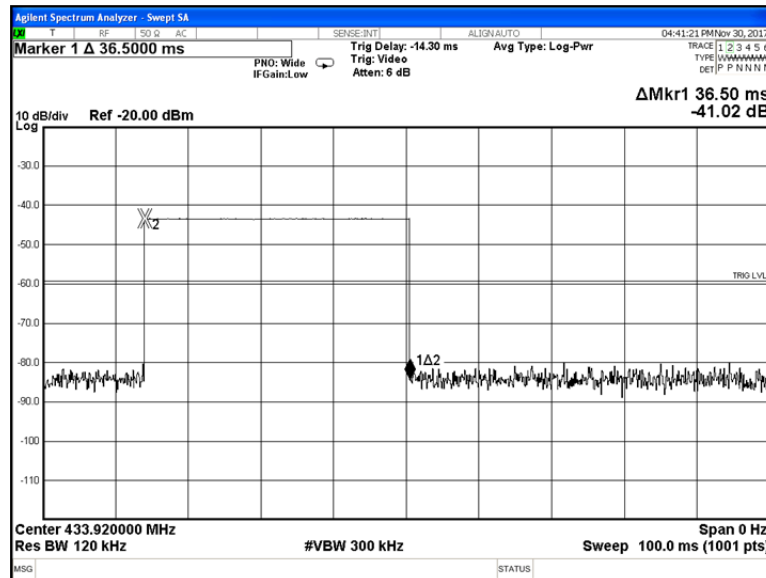
Plot 7.2.14 Radiated emission measurements at the 5th harmonic frequency

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

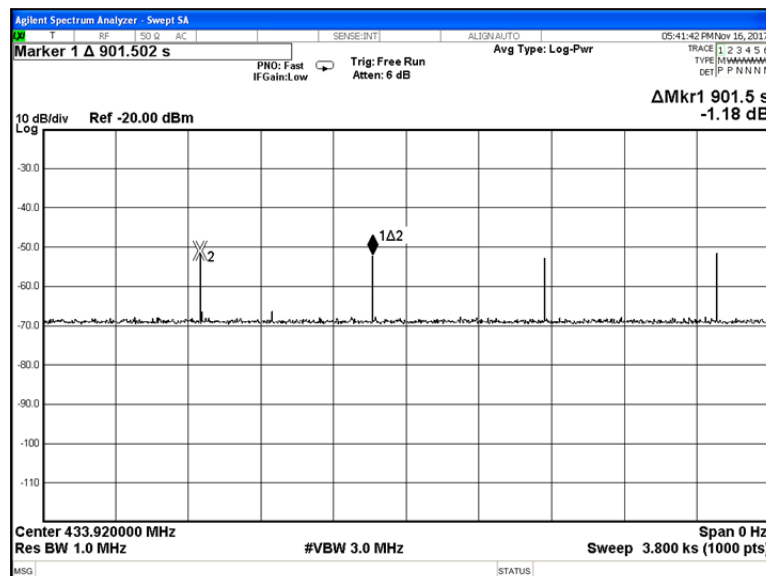


Test specification:		Section 15.231(b), Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
30-Nov-17			
Temperature: 24.5 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

Plot 7.2.15 Transmission pulse duration



Plot 7.2.16 Transmission pulse period



Test specification: Section 15.231(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.7 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: 9 VDC
Remarks:			

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 plots.

Figure 7.3.1 Occupied bandwidth test setup





HERMON LABORATORIES

Test specification: Section 15.231(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode:	Compliance	Verdict: PASS	
Date(s):	30-Nov-17		
Temperature: 24.7 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: 9 VDC
Remarks:			

Table 7.3.2 Occupied bandwidth test results

DETECTOR USED: Peak hold
 RESOLUTION BANDWIDTH: 10 kHz
 VIDEO BANDWIDTH: 30 kHz
 MODULATION ENVELOPE REFERENCE POINTS: 20 dBc
 MODULATION: 2FSK
 MODULATING SIGNAL: ID code
 BIT RATE: 625 kbps

Carrier frequency, MHz	Occupied bandwidth, kHz	Limit		Margin, kHz	Verdict
		% of the carrier frequency	kHz		
433.92	47.2	0.25	1084.8	1037.6	Pass

Reference numbers of test equipment used

HL 4274	HL 4575							
---------	---------	--	--	--	--	--	--	--

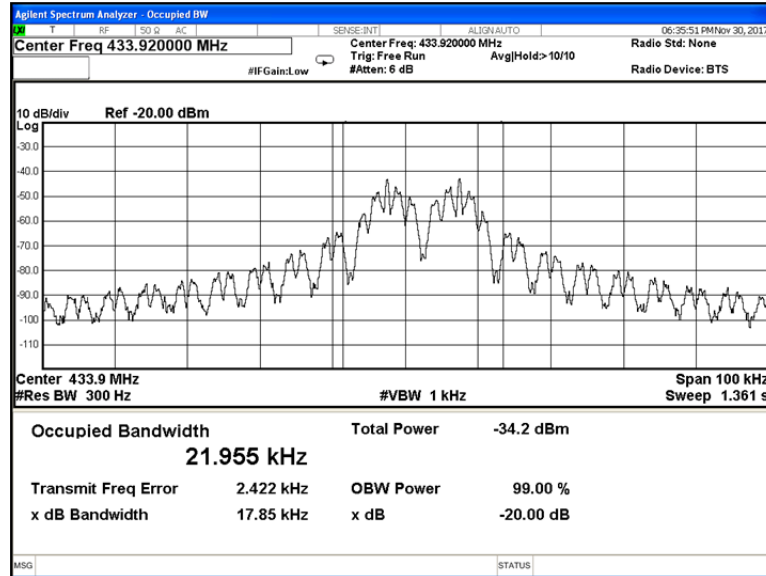
Full description is given in Appendix A.



HERMON LABORATORIES

Test specification: Section 15.231(c), Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.7 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: 9 VDC
Remarks:			

Plot 7.3.1 Occupied bandwidth test result



Test specification: Section 15.203, Antenna requirement			
Test procedure: Visual inspection / supplier declaration			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Nov-17			
Temperature: 24.7 °C	Relative Humidity: 43 %	Air Pressure: 1018 hPa	Power: Battery
Remarks:			

7.4 Antenna requirements

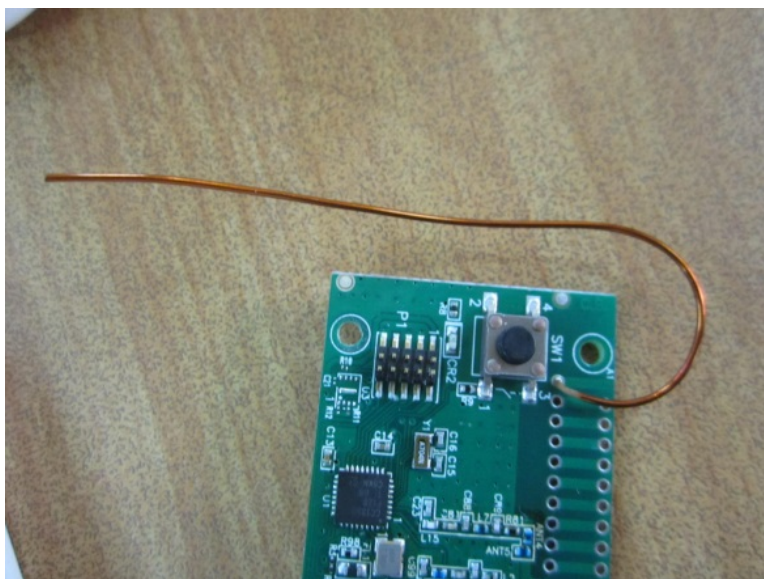
The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed 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	Comply
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
1915	Antenna, Loop, Active Receiving, 1 kHz - 30 MHz	EMC Test Systems	6507	1457	19-Jan-17	19-Jan-18
4274	Test Cable , DC-18 GHz, 1.8 m, SMA/M - N/M	Mini-Circuits	CBL-6FT-SMNM+	70047	04-Jun-17	04-Jun-18
4541	Microwave Cable Assembly, 4.0 GHz, 1.0 m, N/M type-N/M type	Suhner Switzerland	214-U	NA	10-Sep-17	10-Sep-18
4542	Amplifier, 9 kHz to 1 GHz, 32 dB gain	Sonoma Instrument	310	0002A05639	15-Mar-17	15-Mar-18
4543	Broadband preamplifier, 0.5 to 18 GHz, 35 dB gain	Schwarzbeck mess-elektronik	BBV 9718	9718-134	15-Mar-17	15-Mar-18
4575	EXA Signal Analyzer, 9 kHz - 26.5 GHz	Agilent Technologies	N9010A	MY48030110	06-Apr-17	06-Apr-18
4603	Horn Antenna, 1 - 18 GHz	Schwarzbeck mess-elektronik	BBHA 9120 D	9120D-611	04-Jan-18	04-Apr-19
4604	Biconilog Antenna, 26 - 2000 MHz	EMCO	3142B	9909-1421	12-May-17	12-May-18
5102	RF cable, 18 GHz, 6 m, N-type	Huber-Suhner	SF106A/11N/11N/6000MM	500848/6A	27-Jul-17	27-Jul-18
5105	RF cable, 18 GHz, 6 m, N-type	Huber-Suhner	SF106A/11N/11N/6000MM	500851/6A	27-Jul-17	27-Jul-18

9 APPENDIX B Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

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

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

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

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

10 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

11 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.

12 APPENDIX E Test equipment correction factors

Antenna factor
Active loop antenna
EMC Test Systems
Model 6507, S/N 1457, HL 1915

Frequency, kHz	Measured antenna factor, dBS/m
10	-22.7
20	-27.6
50	-31.3
75	-31.8
100	-32.2
150	-32.3
250	-32.6
500	-32.8
750	-33.0
1000	-33.1
2000	-33.4
3000	-33.7
4000	-34.0
5000	-34.3
10000	-34.9
15000	-35.6
20000	-35.9
25000	-36.1
30000	-36.7

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

Antenna factor
Horn antenna
Schwarzbeck mess-elektronik, Model BBHA 9120 D, serial number: 9120D-611, HL 4603

Frequency, MHz	Measured antenna factor, dB/m
1000	25.2
1500	25.7
2000	26.1
2500	27.5
3000	28.3
3500	29.0
4000	30.0
4500	30.8
5000	31.9
5500	32.2
6000	33.1
6500	34.6
7000	35.9
7500	36.6
8000	37.2
8500	36.6
9000	36.9
9500	37.5
10000	38.4
10500	39.5
11000	40.3
11500	40.0
12000	39.2
12500	38.7
13000	39.6
13500	40.8
14000	41.6
14500	42.1
15000	41.2
15500	39.1
16000	38.5
16500	39.9
17000	41.0
17500	44.1
18000	55.6

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

Antenna factor
Biconilog Antenna, 26 - 2000 MHz
EMCO, Model 3142B, serial number: 9909-1421, HL 4604

Frequency, MHz	Measured, dB/m
30	17.9
35	14.8
40	12.1
45	10.0
50	8.7
60	8.1
70	7.3
80	6.6
90	7.6
100	7.9
120	7.0
140	7.7
160	9.6
180	10.0
200	10.2
250	12.7
300	13.4
400	16.7
500	18.2
600	20.2
700	22.0
800	22.7
900	24.1
1000	25.0

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

Cable loss
Test cable, Mini-Circuits, S/N 70047, 18 GHz, 1.8 m, SMA/M - N/M
CBL-6FT-SMNM+, HL 4274

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.07	4800	1.69	9800	2.62	14800	3.42
30	0.11	4900	1.70	9900	2.63	14900	3.39
50	0.14	5000	1.72	10000	2.64	15000	3.38
100	0.21	5100	1.75	10100	2.64	15100	3.40
200	0.26	5200	1.76	10200	2.66	15200	3.41
300	0.30	5300	1.77	10300	2.67	15300	3.40
400	0.37	5400	1.79	10400	2.68	15400	3.39
500	0.44	5500	1.82	10500	2.68	15500	3.41
600	0.49	5600	1.85	10600	2.70	15600	3.44
700	0.54	5700	1.86	10700	2.71	15700	3.46
800	0.58	5800	1.87	10800	2.73	15800	3.45
900	0.63	5900	1.91	10900	2.74	15900	3.47
1000	0.67	6000	1.94	11000	2.76	16000	3.51
1100	0.71	6100	1.97	11100	2.77	16100	3.56
1200	0.75	6200	1.98	11200	2.78	16200	3.55
1300	0.78	6300	1.99	11300	2.79	16300	3.54
1400	0.81	6400	2.02	11400	2.80	16400	3.57
1500	0.85	6500	2.05	11500	2.82	16500	3.62
1600	0.88	6600	2.06	11600	2.83	16600	3.61
1700	0.91	6700	2.06	11700	2.84	16700	3.60
1800	0.94	6800	2.08	11800	2.85	16800	3.62
1900	0.97	6900	2.10	11900	2.87	16900	3.68
2000	1.00	7000	2.12	12000	2.88	17000	3.70
2100	1.03	7100	2.12	12100	2.89	17100	3.68
2200	1.06	7200	2.13	12200	2.90	17200	3.70
2300	1.08	7300	2.16	12300	2.92	17300	3.80
2400	1.11	7400	2.19	12400	2.94	17400	3.84
2500	1.14	7500	2.22	12500	2.95	17500	3.83
2600	1.16	7600	2.23	12600	2.96	17600	3.83
2700	1.19	7700	2.26	12700	2.98	17700	3.86
2800	1.21	7800	2.30	12800	3.00	17800	3.86
2900	1.27	7900	2.33	12900	3.02	17900	3.80
3000	1.29	8000	2.35	13000	3.03	18000	3.79
3100	1.32	8100	2.37	13100	3.06		
3200	1.35	8200	2.41	13200	3.08		
3300	1.37	8300	2.44	13300	3.09		
3400	1.38	8400	2.47	13400	3.10		
3500	1.41	8500	2.48	13500	3.13		
3600	1.43	8600	2.51	13600	3.17		
3700	1.46	8700	2.53	13700	3.17		
3800	1.47	8800	2.55	13800	3.18		
3900	1.49	8900	2.56	13900	3.22		
4000	1.52	9000	2.57	14000	3.26		
4100	1.55	9100	2.58	14100	3.28		
4200	1.56	9200	2.59	14200	3.30		
4300	1.58	9300	2.59	14300	3.35		
4400	1.60	9400	2.60	14400	3.39		
4500	1.63	9500	2.60	14500	3.39		
4600	1.65	9600	2.61	14600	3.39		
4700	1.67	9700	2.61	14700	3.41		

Cable loss
Microwave Cable Assembly, 4.0 GHz, 1.0 m, N/M type-N/M type
Suhner Switzerland, HL 4541

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	0.02	1700	0.45
15	0.03	1800	0.46
20	0.03	1900	0.48
30	0.04	2000	0.49
40	0.04	2100	0.52
50	0.05	2200	0.54
60	0.06	2300	0.55
70	0.06	2400	0.56
80	0.07	2500	0.58
90	0.07	2600	0.59
100	0.08	2700	0.61
150	0.10	2800	0.63
200	0.12	2900	0.64
300	0.15	3000	0.67
400	0.18	3100	0.70
500	0.20	3200	0.74
600	0.23	3300	0.77
700	0.25	3400	0.80
800	0.28	3500	0.82
900	0.30	3600	0.86
1000	0.31	3700	0.88
1100	0.33	3800	0.94
1200	0.35	3900	0.95
1300	0.37	4000	0.99
1400	0.39		
1500	0.41		
1600	0.43		

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, 18 GHz, 6 m, N- type,
SF106A/11N/11N/6000MM, S/N 500851/6A
HL 5105

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.01	5500	2.41
50	0.22	6000	2.53
100	0.31	6500	2.64
200	0.43	7000	2.75
300	0.53	7500	2.85
400	0.61	8000	2.96
500	0.68	8500	3.05
600	0.75	9000	3.15
700	0.81	9500	3.26
800	0.87	10000	3.34
900	0.93	10500	3.44
1000	0.98	11000	3.53
1100	1.03	11500	3.61
1200	1.07	12000	3.71
1300	1.12	12500	3.81
1400	1.16	13000	3.89
1500	1.21	13500	3.97
1600	1.25	14000	4.05
1700	1.28	14500	4.13
1800	1.32	15000	4.21
1900	1.37	15500	4.29
2000	1.40	16000	4.36
2500	1.58	16500	4.43
3000	1.74	17000	4.49
3500	1.89	17500	4.58
4000	2.03	18000	4.67
4500	2.17		
5000	2.29		

13 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