

TEST REPORT

ACCORDING TO: FCC 47 CFR PART 15 subpart C, section 15.249;
RSS-210 issue 10 Annex 2

FOR:

Laser-Ammo Ltd.
i-MTTS System Controller
Model: i-MTTS-C
FCC ID: 2AHUUIMTTS2
IC: 21384-IMTTS2

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

Client name: Laser-Ammo Ltd.
Address: 7 Barshevski street, Rishon Le-Zion 7536374, Israel
Telephone: +972 3958 5525
E-mail: amitay@laser-ammo.com
Contact name: Mr. Amitay Kligman

2 Equipment under test attributes

Product name: i-MTTS System Controller
Product type: Transceiver
Model(s): i-MTTS-C
Hardware version: REM02B
Software release: IMTTS_V3.X_2019.01.14.production
Receipt date: 29-Dec-19

3 Manufacturer information

Manufacturer name: Laser-Ammo Ltd.
Address: 7 Barshevski street, Rishon Le-Zion 7536374, Israel
Telephone: +972 3958 5525
E-Mail: amitay@laser-ammo.com
Contact name: Mr. Amitay Kligman

4 Test details

Project ID: 35478
Location: Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started: 01-Jan-20
Test completed: 01-Jan-20
Test specification(s): FCC 47 CFR PART 15 subpart C, section 15.249;
RSS-210 issue 10 Annex 2

5 Tests summary

Test	Status
Transmitter characteristics	
Section 15.249(a)(d) / RSS-210, section A2.9, Field strength of emissions	Pass
Section 15.249(d) / RSS-210, section A2.9, Band edge emissions	Pass
Section 15.207(a) / RSS-Gen, section 8.8, Conducted emission	Not required
Section 15.203 / RSS-Gen, section 8.3, Antenna requirement	Pass
Section 15.215(c) / RSS-Gen, section 6.6, Occupied bandwidth	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. A. Morozov test engineer EMC & Radio	01 Jan 20	
Reviewed by:	Mrs. S Peysahov Sheynin test engineer EMC & Radio	20 Mar 20 – 05 Apr 20	 v
Approved by:	Mr. S. Samokha, technical manager, EMC and Radio	13 Apr 20	

6 EUT description

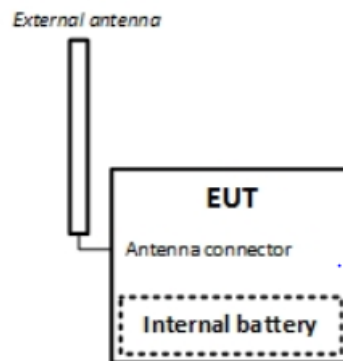
Note: The following data in this clause is provided by the customer and represents his sole responsibility

6.1 General information

The i-MTTS-C Controller is a battery fed device, intended to operate with Laser-Ammo product "i-MTTS". The controller is operated as an automated remote control and data collection device for i-MTTS products, using wireless communication to handle multiple drills".

Radio frequency: 2.4 GHz to 2.4835 GHz

6.2 Test configuration



6.3 Changes made in EUT

No changes were performed in the EUT.



6.4 Transmitter characteristics

Type of equipment						
V	Stand-alone (Equipment with or without its own control provisions)					
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)					
	Plug-in card (Equipment intended for a variety of host systems)					
Assigned frequency range		2400 – 2483.5 MHz				
Operating frequency range		2410, 2442, 2473 MHz				
RF channel spacing		1 MHz				
Maximum field strength of carrier at 3 m distance		99.66 dBμV/m (peak), 61.96 dBμV/m (average)				
Is transmitter output power variable?		V	No			
			Yes	continuous variable		
				stepped variable with stepsize		
				dB		
				dBm		
			dBm			
Antenna connection						
V	unique coupling	standard connector	Integral	with temporary RF connector		
				without temporary RF connector		
Antenna/s technical characteristics						
Type	Manufacturer		Model number		Gain	
Rubber-duck/Whip	Annxin Technologies co., LTD		AN2400-5701SM		2 dBi	
Transmitter aggregate data rate/s		1 Mbps				
Type of modulation		GFSK				
Modulating test signal (baseband)		PRBS				
Transmitter power source						
V	Battery	Nominal rated voltage	Battery type	3 x Battery 1.5V		
	DC	Nominal rated voltage				
	AC mains	Nominal rated voltage	Frequency	Hz		



Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C and RSS-210 requirements

7.1 Field strength of emissions

7.1.1 General

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

Table 7.1.1 Radiated fundamental emission limits

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

Table 7.1.2 Harmonics limits

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

Table 7.1.3 Radiated spurious emissions limits (other than harmonics)

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

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

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

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

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

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



Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

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

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

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

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

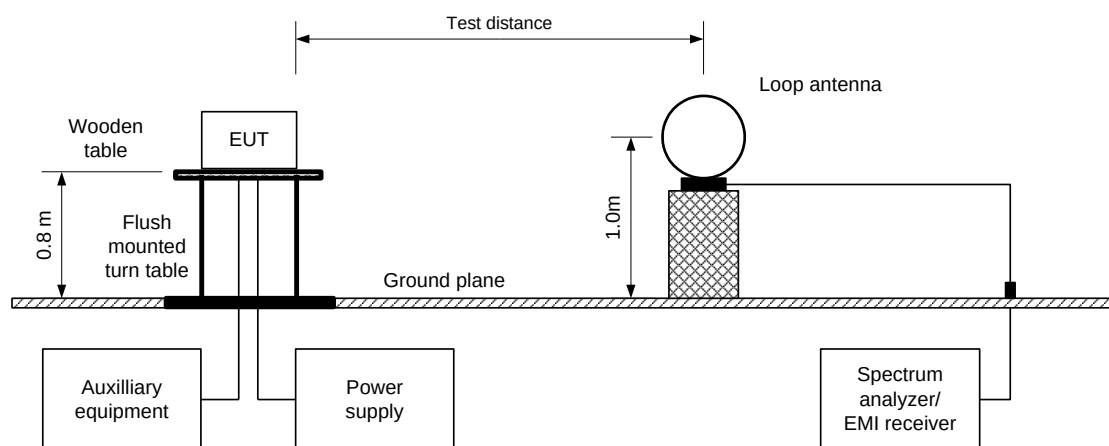
7.1.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.1.3.1 The EUT was set up as shown in Figure 7.1.2, Figure 7.1.3, energized and the performance check was conducted.

7.1.3.2 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.

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

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



Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Figure 7.1.2 Setup for spurious emission field strength measurements in 30 -1000 MHz

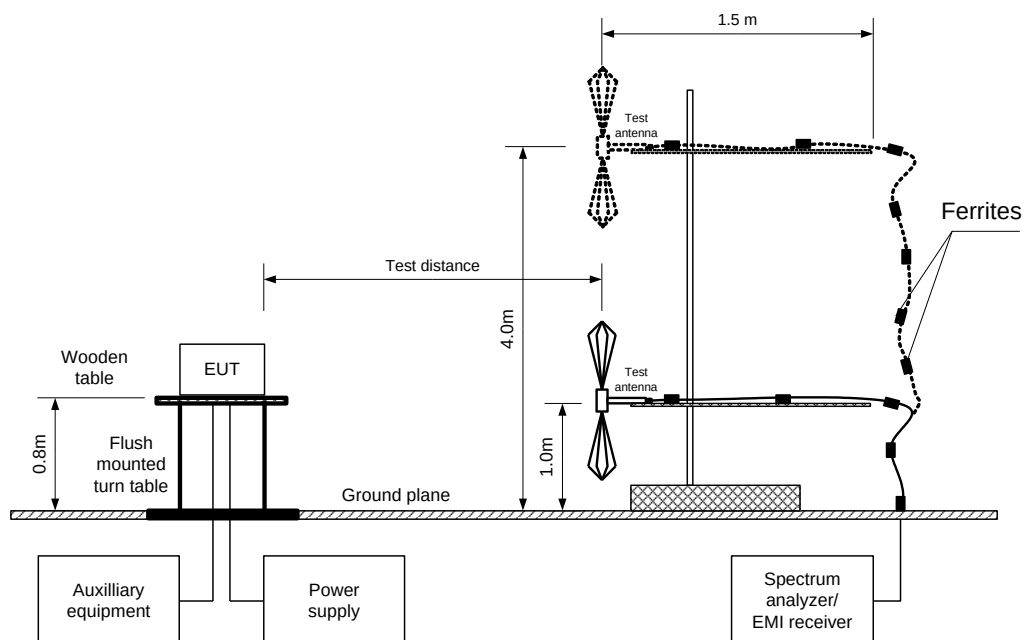
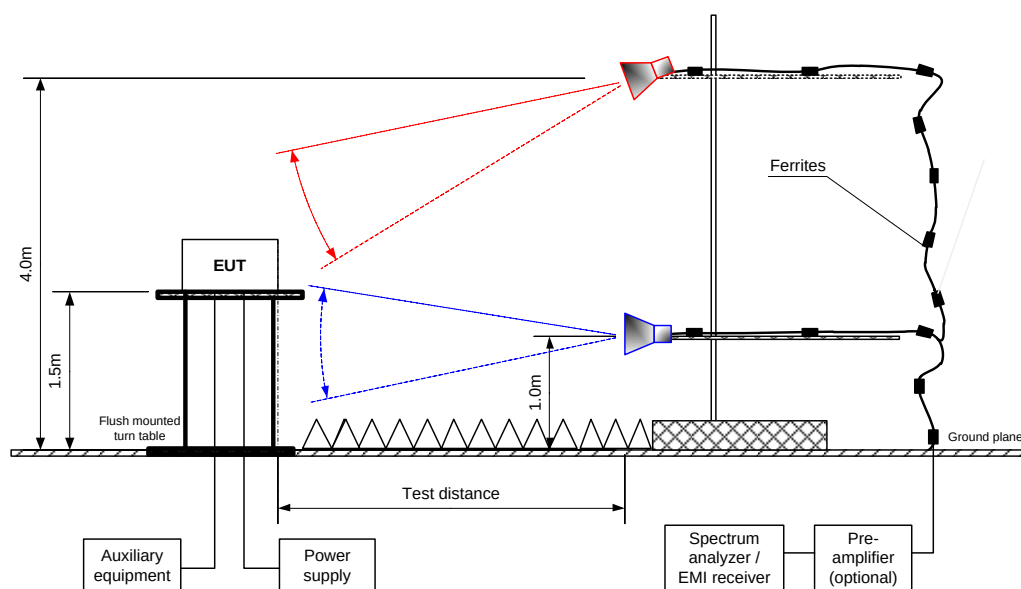


Figure 7.1.3 Setup for spurious emission field strength measurements above 1000 MHz





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Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Table 7.1.4 Field strength of fundamental emission and spurious emissions

TEST DISTANCE: 3 m
 MODULATION: GFSK
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 INVESTIGATED FREQUENCY RANGE: 0.009 – 25000 MHz
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1.0 kHz (9 kHz – 150 kHz)
 9.0 kHz (150 kHz – 30 MHz)
 120 kHz (30 MHz – 1000 MHz)
 1.0 MHz (above 1000 MHz)
 VIDEO BANDWIDTH: ≥ Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)

INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz

INVESTIGATED FREQUENCY RANGE:				0.505 - 1000 MHz				
Frequency, MHz	Antenna		Azimuth, degrees*	Peak emission, dB(μV/m)	Quasi-peak			Verdict
	Pol.	Height, m			Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
No emissions were found								Pass

INVESTIGATED FREQUENCY RANGE: 1000 - 25000 MHz

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Avr factor, dB	Average field strength			Verdict
	Pol.	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
Fundamental emission***											
2410.0	Ver	1.38	85	99.66	114.0	-14.34	32.1	67.56	94.0	-26.44	Pass
2442.0	Ver	1.51	75	96.77	114.0	-17.23	32.1	64.67	94.0	-29.33	Pass
2473.0	Ver	1.35	80	97.28	114.0	-16.72	32.1	65.18	94.0	-28.82	Pass
Spurious emissions at low carrier frequency											
1205.067	Hor	1.54	360	37.88	74.0	-36.12	NA	18.75	54.0	-35.25	Pass
4819.833	Hor	1.53	26	53.24	74.0	-20.76	32.1	21.14	54.0	-32.86	
Spurious emissions at mid carrier frequency											
1221.000	Ver	2.59	112	40.99	74.0	-33.01	NA	19.55	54.0	-34.45	Pass
7326.067	Vert	1.28	87	60.56	74.0	-13.44	32.1	28.46	54.0	-25.54	
Spurious emissions at high carrier frequency											
7418.700	Ver	1.00	90	59.40	74.0	-14.60	32.1	27.30	54.0	-26.70	Pass

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

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

Table 7.1.5 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Number of transmission pulse within 100 ms	Duration, ms	Period, ms		
0.118	21	NA	NA	100	-32.1

*- Average factor was calculated as follows: $20\log((\text{Transmission pulse duration} \times \text{Number of transmission pulse within 100 ms}) / 100 \text{ ms})$

Reference numbers of test equipment used

HL 0446	HL 3903	HL 4355	HL 4933	HL4956	HL 5288	HL 5372	HL 5665
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Full description is given in Appendix A.



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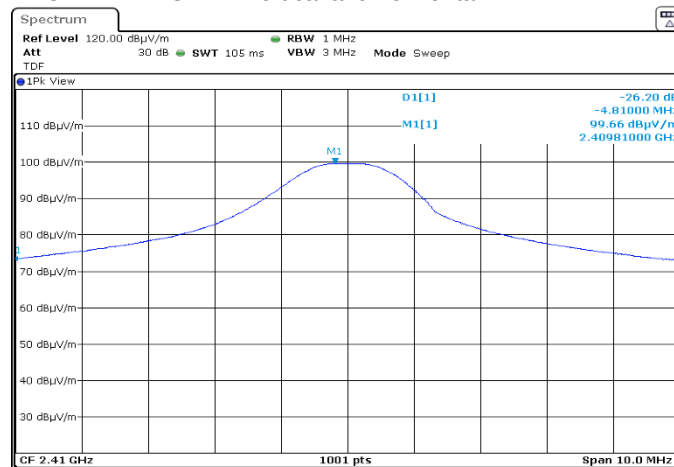
Report ID: LASRAD_FCC.35478

Date of Issue: 13-Apr-20

Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

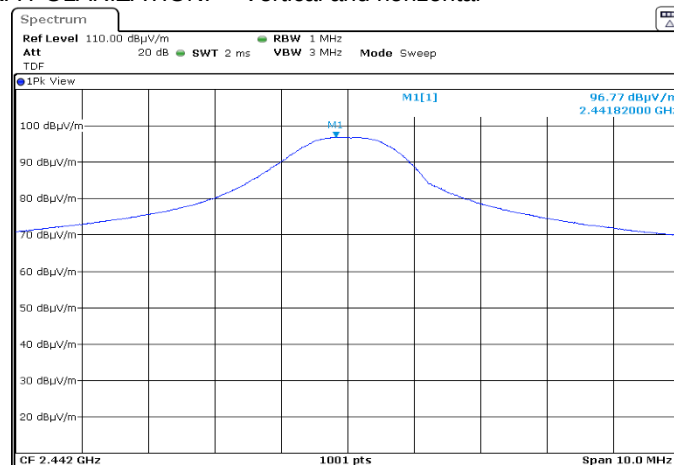
Plot 7.1.1 Radiated emission measurements at the low fundamental frequency

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



Plot 7.1.2 Radiated emission measurements at the mid fundamental frequency

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





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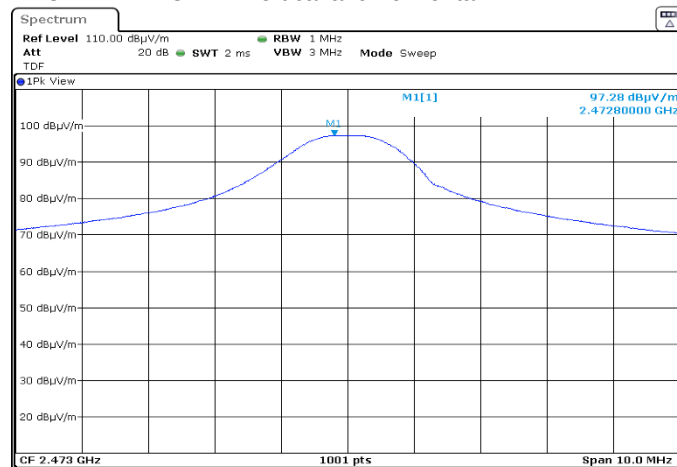
Test specification:		Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.3 Radiated emission measurements at the high fundamental frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and horizontal

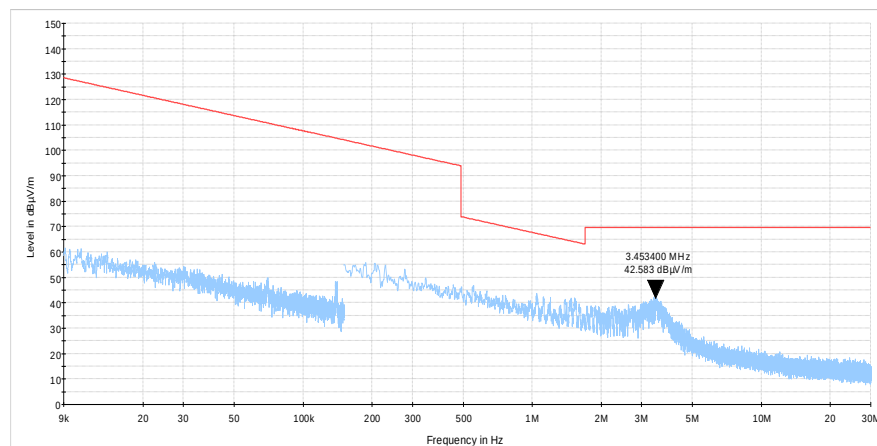




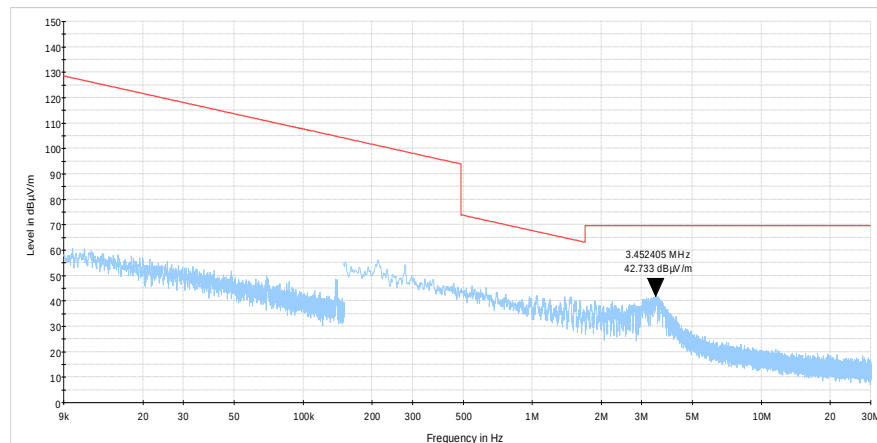
Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.4 Radiated emission measurements from 9 kHz to 30 MHz at low frequency

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

**Plot 7.1.5 Radiated emission measurements from 9 kHz to 30 MHz at mid frequency**

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

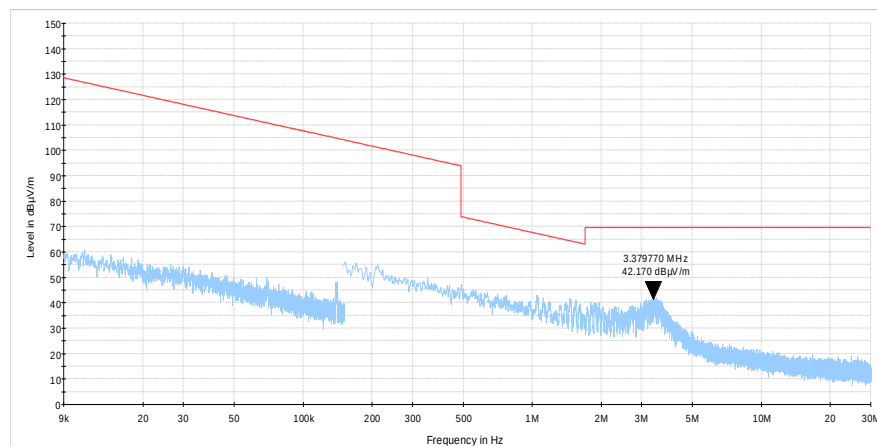




Test specification:		Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.6 Radiated emission measurements from 9 kHz to 30 MHz at high frequency

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

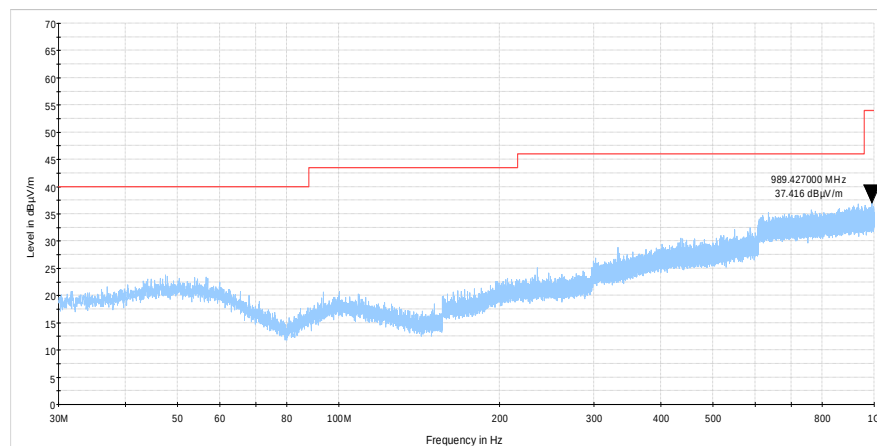




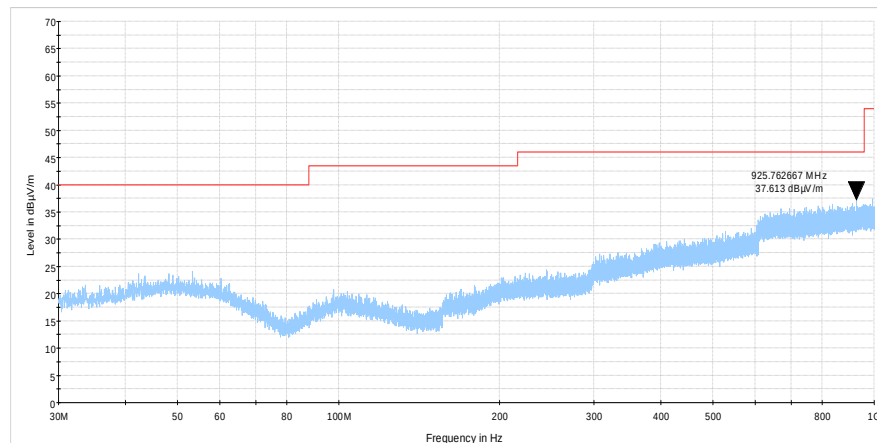
Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.7 Radiated emission measurements from 30 to 1000 MHz at low frequency

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

**Plot 7.1.8 Radiated emission measurements from 30 to 1000 MHz at mid frequency**

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





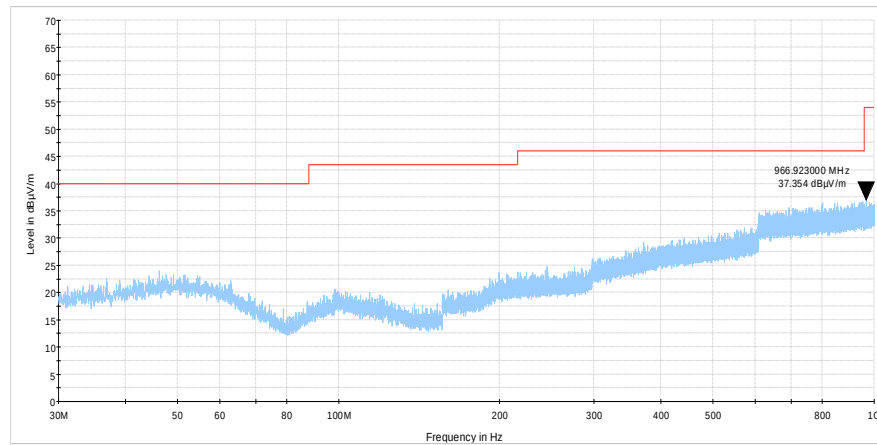
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Test specification:		Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.9 Radiated emission measurements from 30 to 1000 MHz at high frequency

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

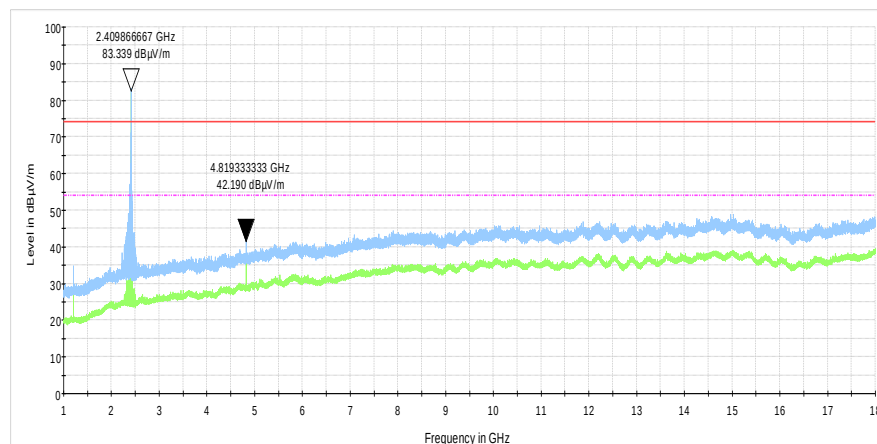




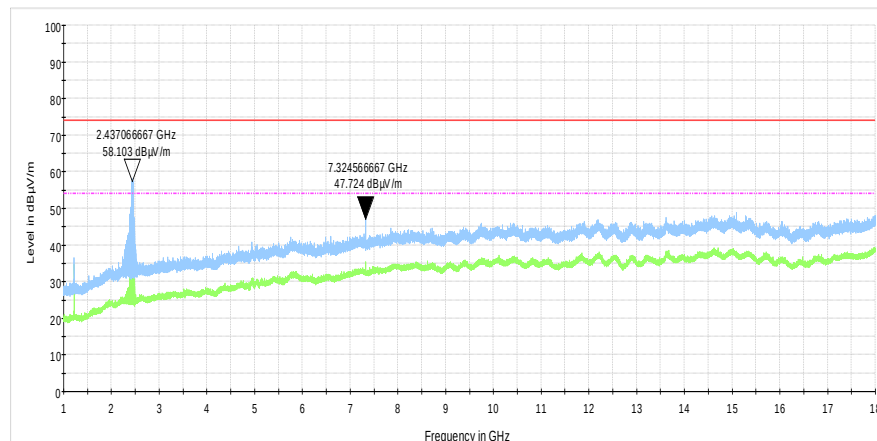
Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.10 Radiated emission measurements from 1.0 to 18.0 GHz at low frequency

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

**Plot 7.1.11 Radiated emission measurements from 1.0 to 18.0 GHz at mid frequency**

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

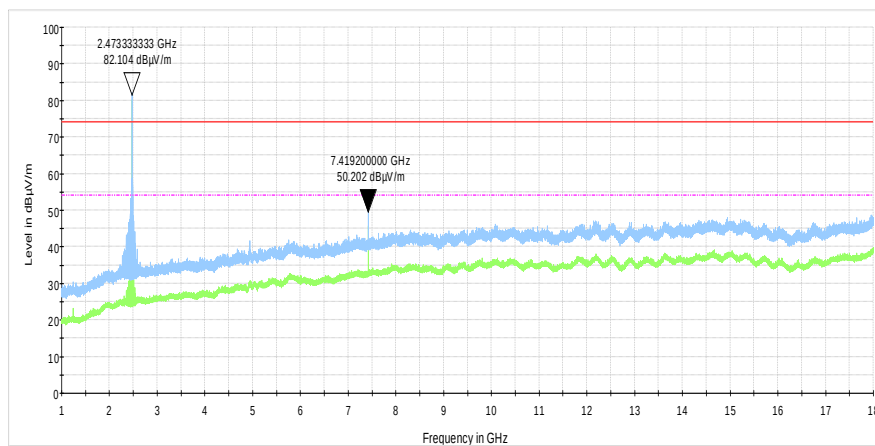




Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.12 Radiated emission measurements from 1.0 to 18.0 GHz at high frequency

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

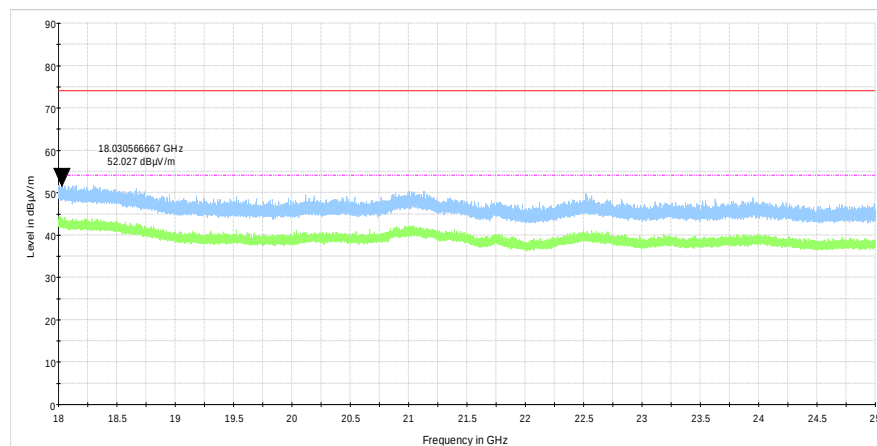




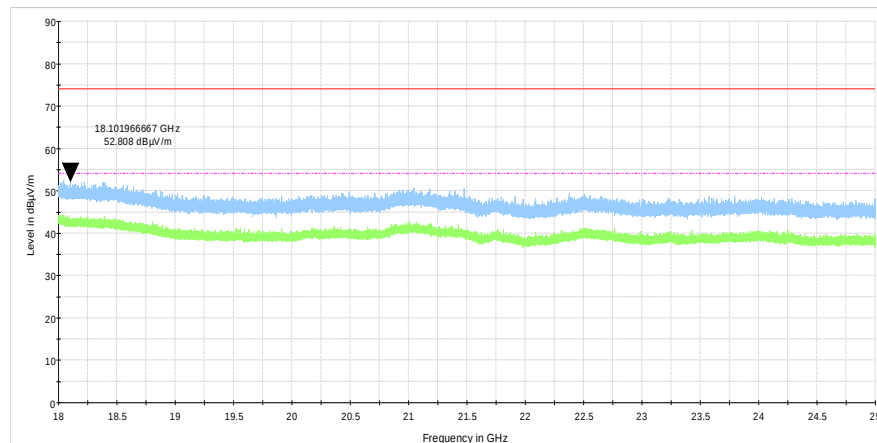
Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.13 Radiated emission measurements from 18.0 – 25.0 GHz at low frequency

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

**Plot 7.1.14 Radiated emission measurements from 18.0 – 25.0 GHz at mid frequency**

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





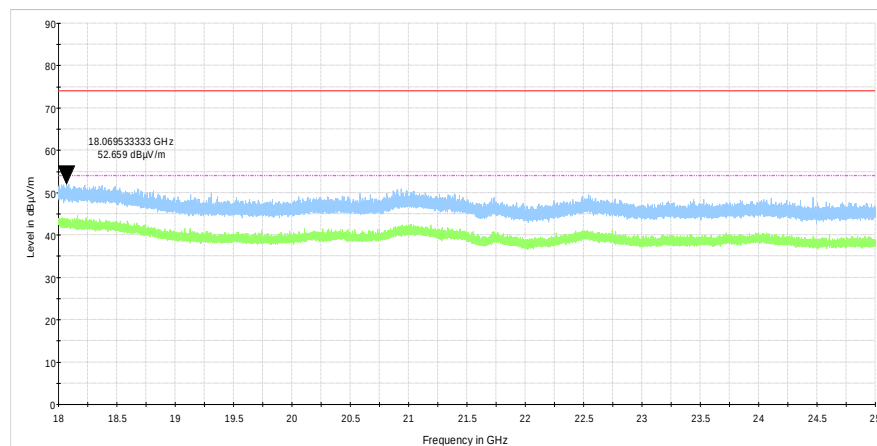
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Report ID: LASRAD_FCC.35478
Date of Issue: 13-Apr-20

Test specification: Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions			
Test procedure: ANSI C63.10 sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.15 Radiated emission measurements from 18.0 – 25.0 GHz at high frequency

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



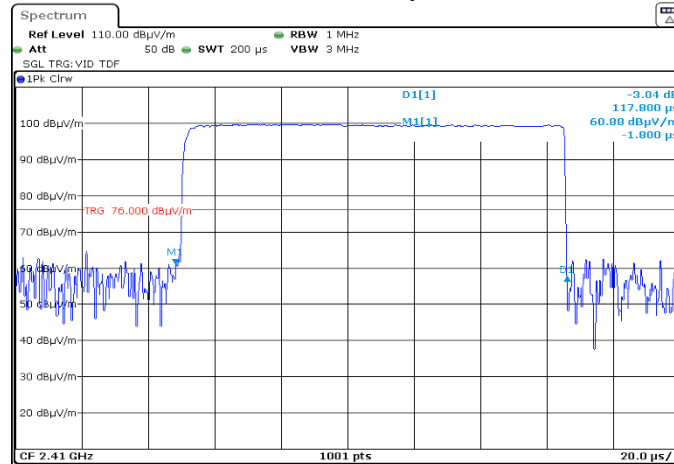


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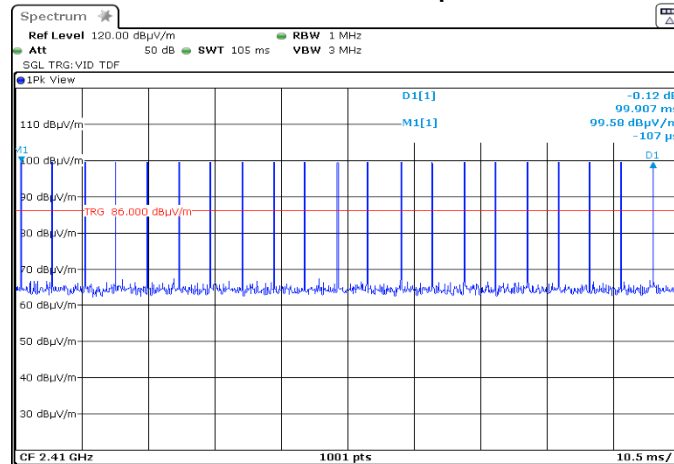
Report ID: LASRAD_FCC.35478
Date of Issue: 13-Apr-20

Test specification:		Section 15.249(a)(d)/RSS-210, section A2.9, Field strength of emissions	
Test procedure:		ANSI C63.10 sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.1.16 Transmission pulse duration



Plot 7.1.17 Number of transmission pulse within 100 ms





Test specification: Section 15.215(c)/ RSS-Gen, section 6.6, Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

7.2 Occupied bandwidth test

7.2.1 General

This test was performed to verify that the 20 dB bandwidth of the emissions was contained within the standard specified frequency band according to FCC §15.215 requirements. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Occupied bandwidth limits

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

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

Table 7.2.2 Occupied bandwidth limits RSS-210

Assigned frequency, MHz	Modulation envelope reference points*, %
902 - 928	99
2400 – 2483.5	
5725 – 5875	
24000 – 24250	

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

7.2.2 Test procedure

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

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

7.2.2.3 The peak of emission was measured. The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.2.3 and associated plot.

Figure 7.2.1 Occupied bandwidth test setup





Test specification: Section 15.215(c)/ RSS-Gen, section 6.6, Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Table 7.2.3 Occupied bandwidth test results

ASSIGNED FREQUENCY BAND 2400.0 – 2483.5 MHz
 DETECTOR USED: Peak hold
 RESOLUTION BANDWIDTH: 30 kHz
 VIDEO BANDWIDTH: 100 kHz
 MODULATION: GFSK

Carrier frequency, MHz	99% Occupied bandwidth, kHz	20 dBc OBW, kHz	Verdict
2410.0	875.1	795.2	Pass
2442.0	891.1	807.2	Pass
2473.0	899.1	807.2	Pass

Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5665					
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Full description is given in Appendix A.



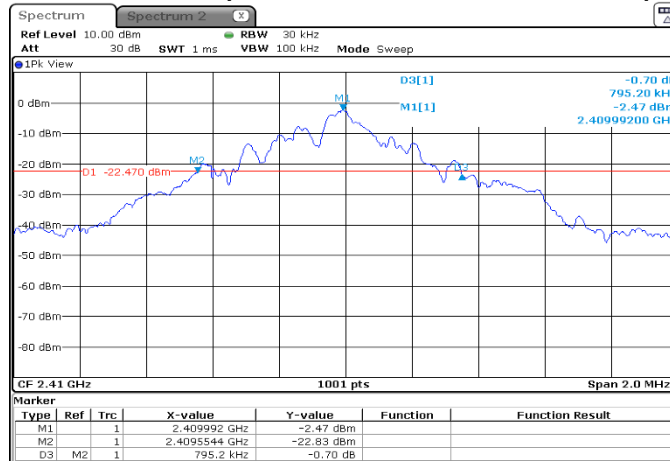
HERMON LABORATORIES

Report ID: LASRAD_FCC.35478

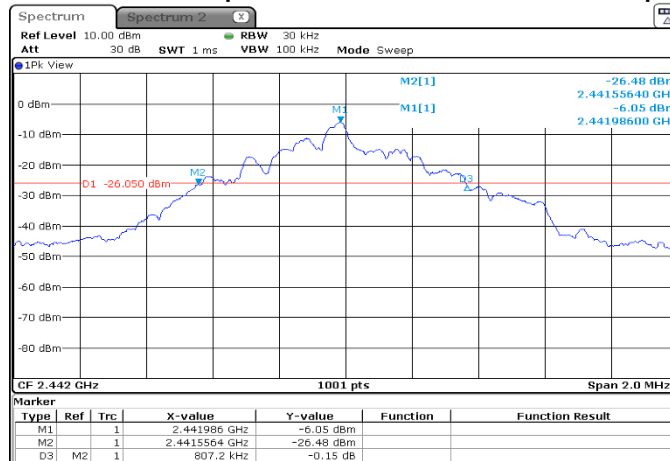
Date of Issue: 13-Apr-20

Test specification: Section 15.215(c)/ RSS-Gen, section 6.6, Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.2.1 20 dBc occupied bandwidth test result at low frequency



Plot 7.2.2 20 dBc occupied bandwidth test result at mid frequency





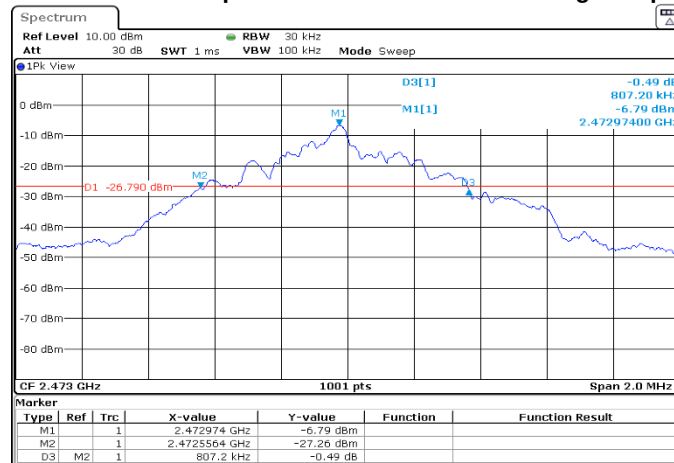
HERMON LABORATORIES

Report ID: LASRAD_FCC.35478

Date of Issue: 13-Apr-20

Test specification: Section 15.215(c)/ RSS-Gen, section 6.6, Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.2.3 20 dBc occupied bandwidth test result at high frequency





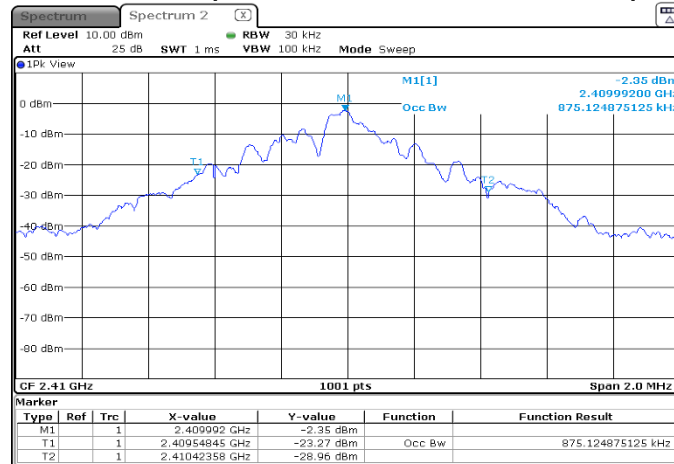
HERMON LABORATORIES

Report ID: LASRAD_FCC.35478

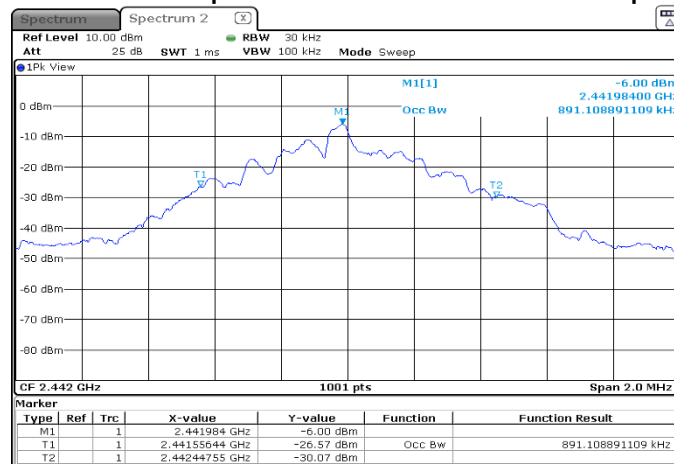
Date of Issue: 13-Apr-20

Test specification: Section 15.215(c)/ RSS-Gen, section 6.6, Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.2.4 99% occupied bandwidth test result at low frequency



Plot 7.2.5 99% occupied bandwidth test result at mid frequency



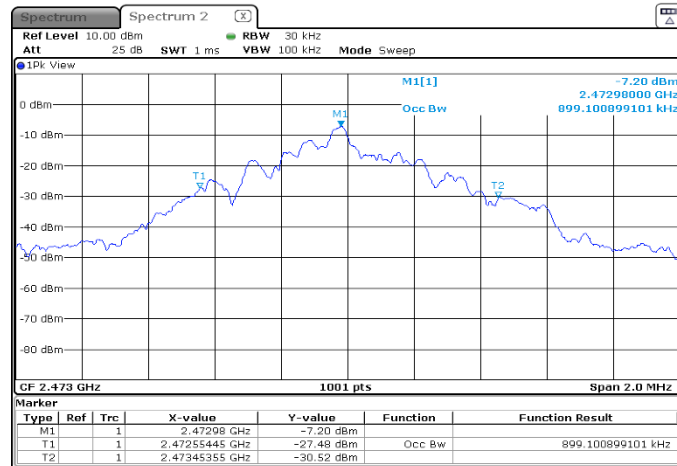


HERMON LABORATORIES

Report ID: LASRAD_FCC.35478
Date of Issue: 13-Apr-20

Test specification: Section 15.215(c)/ RSS-Gen, section 6.6, Occupied bandwidth			
Test procedure: ANSI C63.10 section 6.9.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Plot 7.2.6 99% occupied bandwidth test result at high frequency





Test specification: Section 15.249(d)/RSS-210, section A2.9, Band edge emissions			
Test procedure: ANSI C63.10 section 6.10			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

7.3 Band edge emission

7.3.1 General

This test was performed to verify the EUT band edge emission including all associated side bands was attenuated at least 50 dB below the unmodulated carrier level or below the general spurious emission limit. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Band edge emission limits

Frequency band, MHz	Field strength limit at 3 m, dBμV/m		Attenuation below carrier, dBc
	Peak	Average	
2400.0 – 2483.5	74.0	54.0	50

7.3.2 Test procedure

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

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

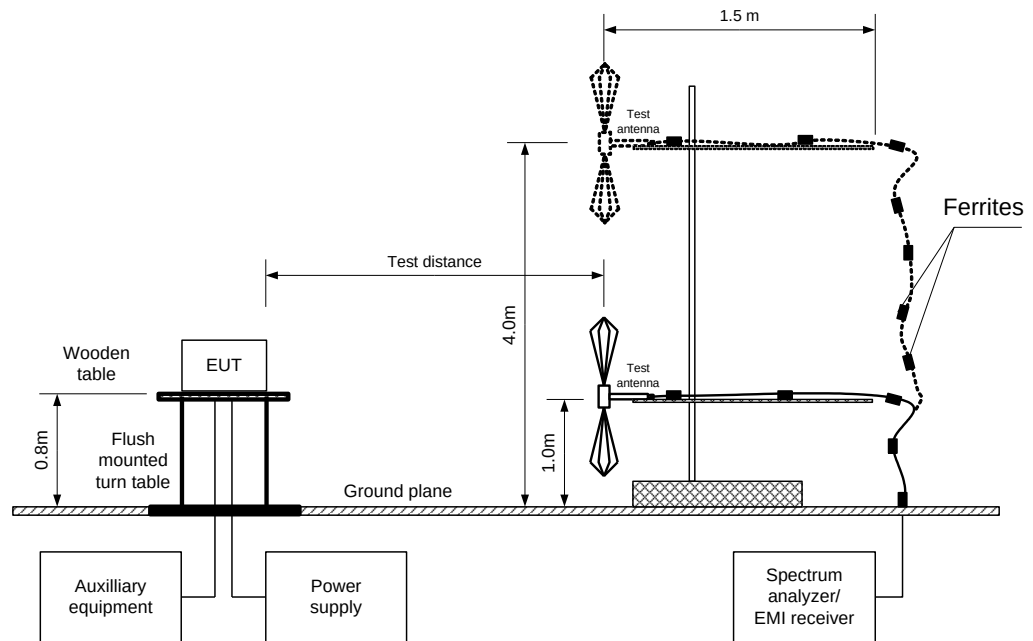
7.3.2.3 The frequency of modulation envelope points beyond which power level drops below the band edge emission limit was measured.

7.3.2.4 The test results were recorded in Table 7.3.2 and shown in the associated plots.



Test specification:		Section 15.249(d)/RSS-210, section A2.9, Band edge emissions	
Test procedure:		ANSI C63.10 section 6.10	
Test mode:		Verdict: PASS	
Date(s):			
01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Figure 7.3.1 Band edge emission measurement set up





Test specification: Section 15.249(d)/RSS-210, section A2.9, Band edge emissions			
Test procedure: ANSI C63.10 section 6.10			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

Table 7.3.2 Band edge emission test results

OPERATING FREQUENCY RANGE: 2400.0 – 2483.5 MHz
 DETECTOR USED: Peak hold
 RESOLUTION BANDWIDTH: 1 MHz
 VIDEO BANDWIDTH: 3 MHz
 MODULATION: FSK
 MODULATING SIGNAL: PRBS
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Modulation envelope		Peak field strength			Average field strength				Verdict
Edge	Frequency, MHz	Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	Measured, dB(μV/m)	Calculated, dB(μV/m)**	Limit, dB(μV/m)	Margin, dB*	
Low	2400.0	67.31	74.0	-6.69	67.31	35.21	54.0	-18.79	Pass
High	2483.5	63.64	74.0	-10.36	63.64	31.54	54.0	-22.46	

* - Margin = measured value – limit

** - Calculated average field strength = Measured average field strength – Average factor (32.1 dB)

Reference numbers of test equipment used

HL 3903	HL 4933	HL 5372	HL 5665				
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Full description is given in Appendix A.



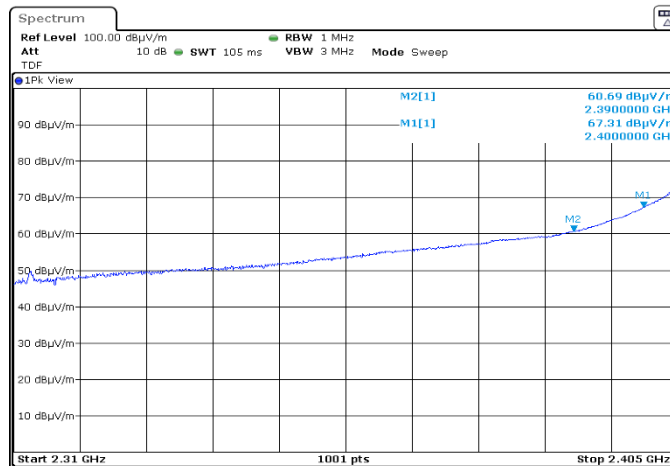
HERMON LABORATORIES

Report ID: LASRAD_FCC.35478
Date of Issue: 13-Apr-20

Test specification: Section 15.249(d)/RSS-210, section A2.9, Band edge emissions			
Test procedure: ANSI C63.10 section 6.10			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
Remarks:			

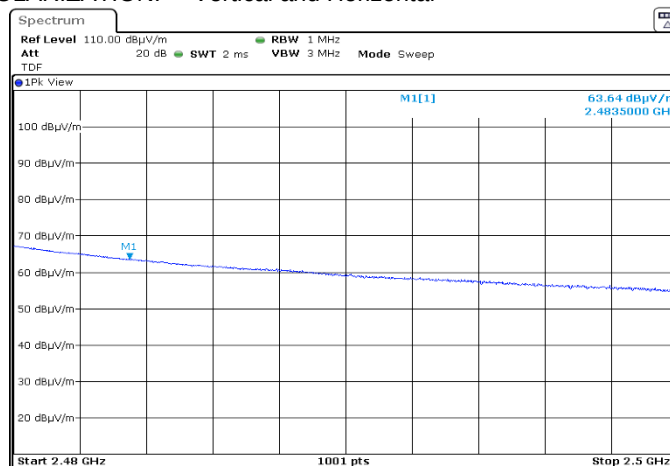
Plot 7.3.1 Low band edge emission test result

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



Plot 7.3.2 High band edge emission test result

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





Test specification: Section 15.203 / RSS-Gen, Section 8.3, Antenna requirement			
Test procedure: Visual inspection / supplier declaration			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Jan-20			
Temperature: 23 °C	Relative Humidity: 47 %	Air Pressure: 1019 hPa	Power: 4.5 VDC
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	NA	Comply
The transmitter employs a unique antenna connector	Visual inspection	
The transmitter requires professional installation	NA	

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 (9) kHz - 30 MHz	EMCO	6502	2857	24-Feb-19	24-Feb-20
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFL EX 102A	1226/2A	07-Apr-19	07-Apr-20
4355	Signal and Spectrum Analyzer, 9 kHz to 7 GHz	Rohde & Schwarz	FSV 7	101630	04-Aug-19	04-Aug-20
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	06-Jan-20	06-Jan-21
5112	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/11SK/11SK/5500MM	502494/2EA	18-Apr-19	18-Apr-20
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5372	MXE EMI receiver, 3 Hz to 44 GHz	Keysight Technologies	N9038A	MY57290155	18-Jun-19	18-Jun-20
5665	Cable SF118/11N(x2)/6M, 18 GHz, 11N/11N	Huber-Suhner	SF118	501644/118	23-Oct-19	23-Oct-20

9 APPENDIX B Test equipment correction factors

HL 0446: Active Loop Antenna
EMCO, model: 6502, s/n 2857

Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB
10	-33.4	±1.0
20	-37.8	±1.0
50	-40.5	±1.0
75	-41.0	±1.0
100	-41.2	±1.0
150	-41.2	±1.0
250	-41.1	±1.0
500	-41.2	±1.0
750	-41.3	±1.0
1000	-41.3	±1.0

Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB
2000	-41.4	±1.0
3000	-41.4	±1.0
4000	-41.5	±1.0
5000	-41.5	±1.0
10000	-41.7	±1.0
15000	-42.1	±1.0
20000	-42.7	±1.0
25000	-44.2	±1.0
30000	-45.8	±1.0

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

HL 4933: Active Horn Antenna
COM-POWER CORPORATION, model: AHA-118, s/n 701046

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
1000	-16.1
1500	-15.1
2000	-10.9
2500	-11.9
3000	-11.1
3500	-10.6
4000	-8.6
4500	-8.3
5000	-5.9
5500	-5.7
6000	-3.3
6500	-4.0
7000	-2.2
7500	-1.7
8000	1.1
8500	-0.8
9000	-1.5
9500	-0.2

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
10000	1.8
10500	1.0
11000	0.3
11500	-0.5
12000	3.1
12500	1.4
13000	-0.3
13500	-0.4
14000	2.5
14500	2.2
15000	1.9
15500	0.5
16000	2.1
16500	1.2
17000	0.6
17500	3.1
18000	4.2

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

HL 5112, RF cable, 40 GHz, 5.5 m, K-type,
Huber-Suhner, SF102EA/11SK/11SK/5500MM, s/n 502494/2EA, HL 5112

Set / Applied, MHz	Measured, dB	Uncertainty, dB
100	0.70	±0.07
200	0.99	±0.08
300	1.21	±0.08
500	1.55	±0.08
1000	2.18	±0.08
1500	2.67	±0.08
2000	3.09	±0.08
2500	3.46	±0.10
3000	3.80	±0.10
3500	4.12	±0.10
4000	4.41	±0.10
4500	4.69	±0.10
5000	4.95	±0.10
5500	5.20	±0.10
6000	5.45	±0.10
6500	5.68	±0.10
7000	5.91	±0.10
7500	6.13	±0.10
8000	6.34	±0.10
8500	6.56	±0.10
9000	6.76	±0.10
9500	6.95	±0.10
10000	7.16	±0.10
10500	7.33	±0.10
11000	7.51	±0.10
11500	7.68	±0.10
12000	7.85	±0.10
12500	8.02	±0.13
13000	8.17	±0.13
13500	8.31	±0.13
14000	8.46	±0.13
14500	8.61	±0.18
15000	8.76	±0.18
15500	8.91	±0.18
16000	9.07	±0.18
16500	9.22	±0.18
17000	9.36	±0.18
17500	9.51	±0.18
18000	9.66	±0.18
18500	9.81	±0.23
19000	9.95	±0.23
19500	10.10	±0.23

Set / Applied, MHz	Measured, dB	Uncertainty, dB
20000	10.25	±0.23
20500	10.38	±0.23
21000	10.52	±0.23
21500	10.67	±0.23
22000	10.84	±0.23
22500	11.00	±0.29
23000	11.10	±0.29
23500	11.20	±0.29
24000	11.32	±0.29
24500	11.42	±0.29
25000	11.59	±0.23
25500	11.70	±0.23
26000	11.85	±0.23
26500	11.97	±0.23
27000	12.07	±0.33
27500	12.17	±0.33
28000	12.26	±0.40
28500	12.38	±0.40
29000	12.50	±0.40
29500	12.63	±0.40
30000	12.75	±0.40
30500	12.82	±0.33
31000	12.93	±0.33
31500	13.09	±0.33
32000	13.22	±0.33
32500	13.35	±0.33
33000	13.48	±0.33
33500	13.60	±0.33
34000	13.72	±0.33
34500	13.80	±0.40
35000	13.92	±0.40
35500	14.01	±0.40
36000	14.12	±0.40
36500	14.23	±0.40
37000	14.34	±0.33
37500	14.44	±0.33
38000	14.57	±0.33
38500	14.72	±0.33
39000	14.82	±0.33
39500	14.94	±0.33
40000	15.08	±0.47

HL 5288: Trilog Antenna
Frankonia, model: ALX-8000E, s/n: 00809
30-1000 MHz

Frequency, MHz	Antenna factor, dB/m
30	14.96
35	15.33
40	16.37
45	17.56
50	17.95
60	16.87
70	13.22
80	10.56
90	13.61
100	15.46
120	14.03
140	12.23

Frequency, MHz	Antenna factor, dB/m
160	12.67
180	13.34
200	15.40
250	16.42
300	17.28
400	19.98
500	21.11
600	22.90
700	24.13
800	25.25
900	26.35
1000	27.18

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

above 1000 MHz

Frequency, MHz	Antenna factor, dB/m
1000	26.9
1100	28.1
1200	28.4
1300	29.6
1400	29.1
1500	30.4
1600	30.7
1700	31.5
1800	32.3
1900	32.6
2000	32.5
2100	32.9
2200	33.5
2300	33.2
2400	33.7
2500	34.6
2600	34.7
2700	34.6
2800	35.0
2900	35.5
3000	36.2
3100	36.8
3200	36.8
3300	37.0
3400	37.5
3500	38.2

Frequency, MHz	Antenna factor, dB/m
3600	38.9
3700	39.4
3800	39.4
3900	39.6
4000	39.7
4100	39.8
4200	40.5
4300	40.9
4400	41.1
4500	41.4
4600	41.3
4700	41.6
4800	41.9
4900	42.3
5000	42.7
5100	43.0
5200	42.9
5300	43.5
5400	43.6
5500	44.3
5600	44.7
5700	45.0
5800	45.0
5900	45.3
6000	45.9

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

10 APPENDIX C Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 dB
Radiated emissions at 10 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.0 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.1 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 5.5 dB Biconical antenna: ± 5.5 dB Log periodic antenna: ± 5.6 dB Double ridged horn antenna: ± 5.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Occupied bandwidth	± 8.0 %

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

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

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

11 APPENDIX D 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-808 for OATS, R-1082 for anechoic chamber, G-869 for RE measurements above 1 GHz, C-845 for conducted emissions site and T-1606 for conducted emissions at telecommunication ports).

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

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

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

12 APPENDIX E

Specification references

FCC 47CFR part 15: 2019

ANSI C63.10: 2013

ANSI C63.4: 2014

RSS-210 Issue 10: 2019

RSS-Gen Issue 5: 2018

Radio Frequency Devices

American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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

Licence- Exempt Radio Apparatus: Category 1 Equipment

General Requirements for Compliance of Radio Apparatus

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