

TEST REPORT

ACCORDING TO:

**FCC 47CFR part 15 subpart C §15.247 (DTS),
RSS-247 Issue 2:2017, RSS-Gen Issue 5:2018**

FOR:

TriplePlus

Shuttie

Model: ALF-000023-001

FCC ID:2AFOILOR

IC: 20798-LOR

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1 Applicant information

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Telephone: +972-72-22-11-370
Fax: +972-4-959-3991
E-mail: yuval.abraham@tripleplus.io
Contact name: Mr. Yuval Abraham

2 Equipment under test attributes

Product name: Shuttie
Product type: LoRa based Ball valve Actuator
Model(s): ALF-000023-001
Serial number: 300700040000005b17
Hardware version: V2.0
Software release: 1.0.7.0
Receipt date 23-May-19

3 Manufacturer information

Manufacturer name: TriplePlus
Address: 5 Hamada street, Yokneam 2069200, Israel
Telephone: +972-72-22-11-370
Fax: +972-4-959-3991
E-Mail: yuval.abraham@tripleplus.io
Contact name: Mr. Yuval Abraham

4 Test details




Project ID: 33326
Location: Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started: 03-Jun-19
Test completed: 13-Jun-19
Test specification(s): FCC 47CFR part 15 subpart C §15.247 (DTS),
RSS-247 Issue 2:2017, RSS-Gen Issue 5:2018

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth	Pass
FCC section 15.247(b)3/ RSS-247 section 5.4(4), Peak output power	Pass
FCC section 15.247(i) / RSS-102 section 2.5.2, RF exposure	Pass, the exhibit to the application of certification is provided
FCC section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	Pass
FCC section 15.247(d)/ RSS-247 section 5.5, Emissions at band edges	Pass
FCC section 15.247(e) / RSS-247 section 5.2(2), Peak power density	Pass
FCC section 15.203 / RSS-Gen section 8.3, Antenna requirement	Pass
FCC section 15.207(a) / RSS-Gen section 8.8, Conducted emission	Not required

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.

The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt test engineer EMC & Radio	03 Jun 19 - 13 Jun 19	
Reviewed by:	Mrs. S Peysahov Sheynin test engineer EMC & Radio	23 July 19	
Approved by:	Mr. S. Samokha, technical manager, EMC and Radio	30 July 19	

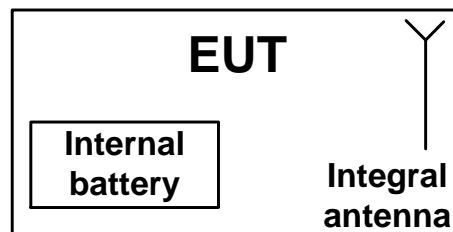
6 EUT description

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

6.1 General information

An electro-mechanical water valve, powered by batteries and controlled by remote radio.

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented in the EUT during the testing.



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)				
Intended use		Condition of use			
	fixed	Always at a distance more than 2 m from all people			
X	mobile	Always at a distance more than 20 cm from all people			
	portable	May operate at a distance closer than 20 cm to human body			
Assigned frequency range		902 - 928 MHz			
Operating frequency		919.8126 MHz			
Maximum rated output power		Peak output power		15.814 dBm	
Is transmitter output power variable?		X	No		
			Yes	continuous variable	
				stepped variable with stepsize	
				minimum RF power	dBm
				maximum RF power	dBm
Antenna connection					
unique coupling		standard connector		X	integral
				X	with temporary RF connector without temporary RF connector
Antenna/s technical characteristics					
Type		Manufacturer		Model number	
Integral		Triple+		920	
				Gain	
				2 dBi	
Modulation		LoRa			
Transmitter aggregate data rate/s		12.5 kbps			
Modulating test signal (baseband)		PRBS			
Transmitter power source					
X	Battery	Nominal rated voltage	6 VDC	Battery type	CR123A
	DC	Nominal rated voltage	VDC		
	AC mains	Nominal rated voltage	VAC	Frequency	
Spread spectrum technique used		Frequency hopping (FHSS)			
		X	Digital transmission system (DTS)		
		Hybrid			



Test specification:		Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth	
Test procedure:		ANSI C63.10 section 11.8.1	
Test mode:		Verdict: PASS	
Date(s):			
Compliance			
13-Jun-19			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1014 hPa	Power: 6 VDC
Remarks:			

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

7.1 Minimum 6 dB bandwidth

7.1.1 General

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

Table 7.1.1 6 dB bandwidth limits

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

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

7.1.2 Test procedure

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

7.1.2.2 The EUT was set to transmit modulated carrier.

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

Figure 7.1.1 6 dB bandwidth test setup



Table 7.1.2 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902-928 MHz
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 MODULATION: LoRa
 BIT RATE: 12.5 kbps

Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
920	769.427	500	269.427	Pass

Reference numbers of test equipment used

HL 3818	HL 4136							
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Full description is given in Appendix A.



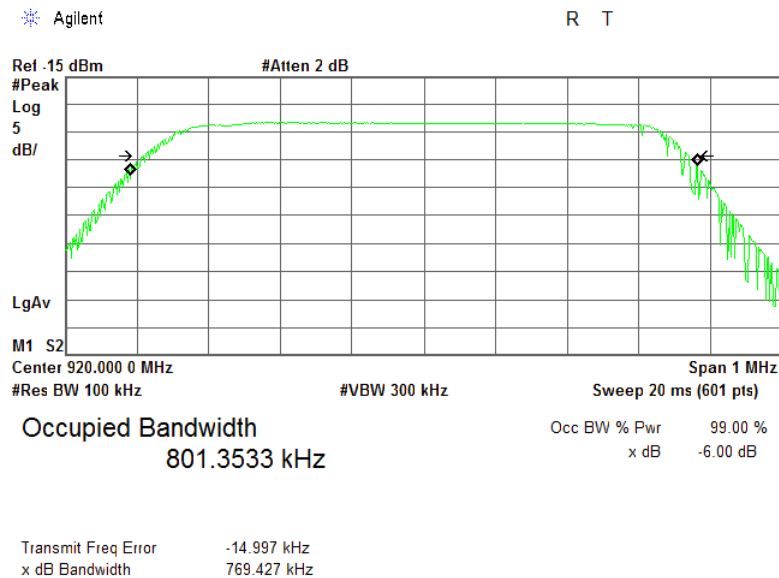
HERMON LABORATORIES

Report ID: TRIRAD_FCC.33326

Date of Issue: 31-Jul-19

Test specification: Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 23 °C	Relative Humidity: 55 %	Air Pressure: 1014 hPa	Power: 6 VDC
Remarks:			

Plot 7.1.1 6 dB bandwidth test result





Test specification: Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

7.2 Peak output power

7.2.1 General

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

Table 7.2.1 Peak output power limits

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

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

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

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

7.2.2 Test procedure

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

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

7.2.2.3 The resolution bandwidth of spectrum analyzer was set wider than 6 dB bandwidth of the EUT and the field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

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

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

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

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

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

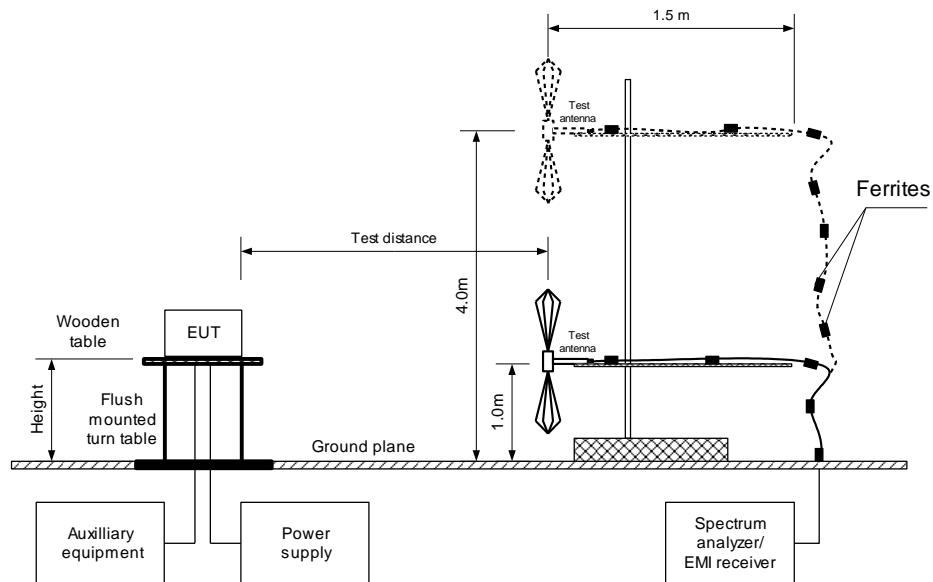
$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

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



Test specification: Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Figure 7.2.1 Setup for carrier field strength measurements





Test specification: Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Table 7.2.2 Peak output power test results

ASSIGNED FREQUENCY BAND: 902.0 – 928.0 MHz
 TEST DISTANCE: 3 m
 TEST SITE: Semi anechoic chamber
 EUT HEIGHT: 0.8 m
 DETECTOR USED: Peak
 TEST ANTENNA TYPE: Biconilog (30 MHz – 1000 MHz)
 MODULATION: LoRa
 MODULATING SIGNAL: PRBS
 BIT RATE: 12.5 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 RESOLUTION BANDWIDTH: 1 MHz
 VIDEO BANDWIDTH: 3 MHz

Frequency, MHz	Field strength, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	EUT antenna gain, dBi	Peak output power, dBm**	Limit, dBm	Margin, dB***	Verdict
919.798	113.014	Horizontal	1.5	240	2.0	15.814	30.0	-14.186	Pass

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

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

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

Note: Maximum peak output power was obtained at Unom (115%Unom, 85%Unom) input power voltage.

Reference numbers of test equipment used

HL 3903	HL 4360	HL 5085	HL 5288	HL 5405			
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Full description is given in Appendix A.



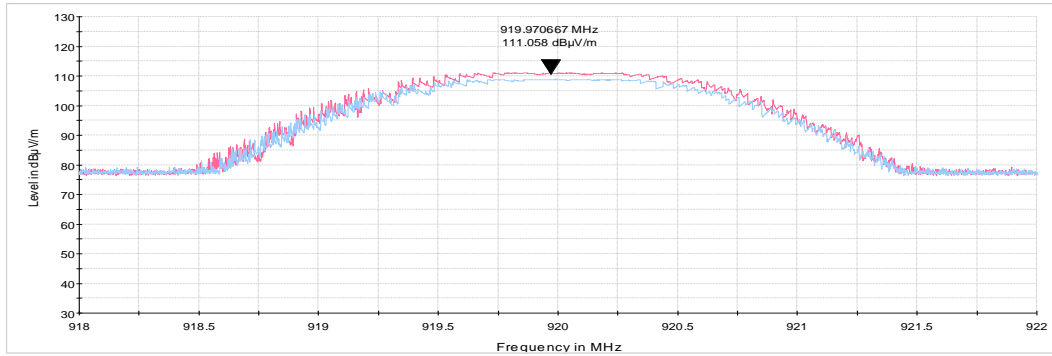
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Report ID: TRIRAD_FCC.33326

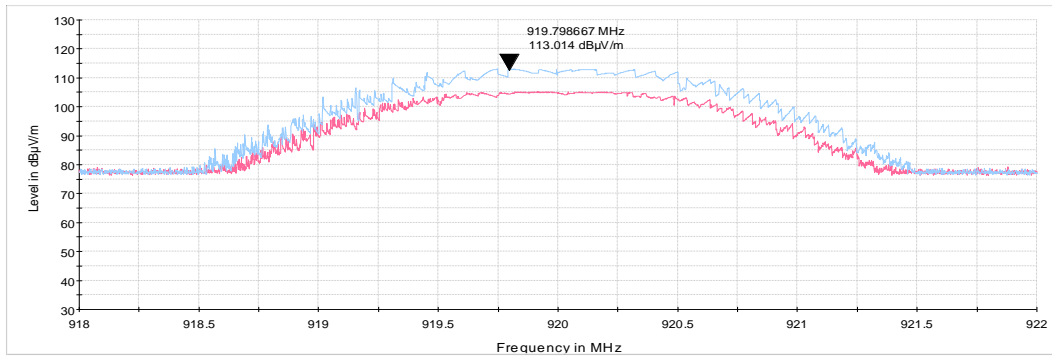
Date of Issue: 31-Jul-19

Test specification:		Section 15.247(b)3/ RSS-247 section 5.4(d), Peak output power	
Test procedure:		ANSI C63.10 sections 11.9.2.2.4	
Test mode:		Verdict: PASS	
Date(s):			
03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

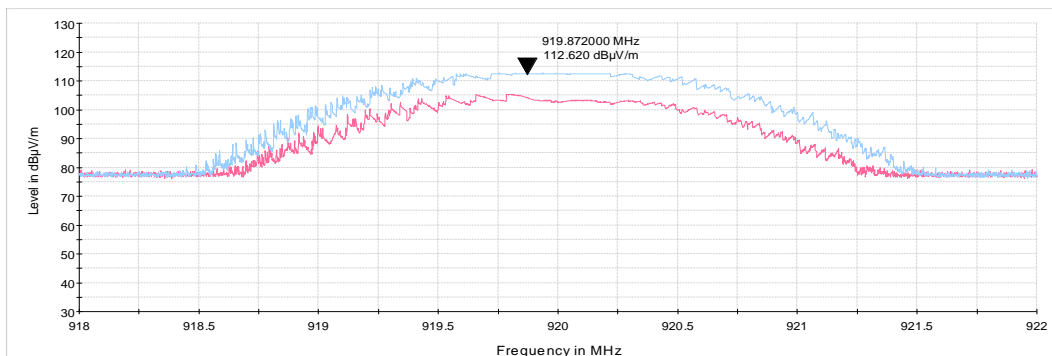
Plot 7.2.1 Field strength of carrier in vertical antenna polarization, X position



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



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





Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

7.3 Field strength of spurious emissions

7.3.1 General

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

Table 7.3.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m within restricted bands, dB(μV/m)*			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	20.0
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	NA	73.8 – 63.0**	NA	
1.705 – 30.0*		69.5		
30 – 88		40.0		
88 – 216		43.5		
216 – 960		46.0		
960 - 1000		54.0		
1000 – 10 th harmonic	74.0	NA	54.0	

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

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

where S₁ and S₂ – standard defined and test distance respectively in meters.

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

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

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

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

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

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

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

7.3.3.1 The EUT was set up as shown in Figure 7.3.2, Table 7.3.3, energized and the performance check was conducted.

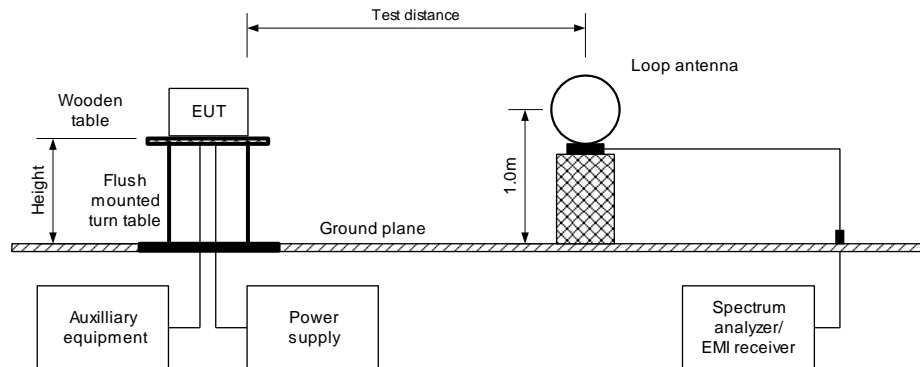
7.3.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

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



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

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





Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

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

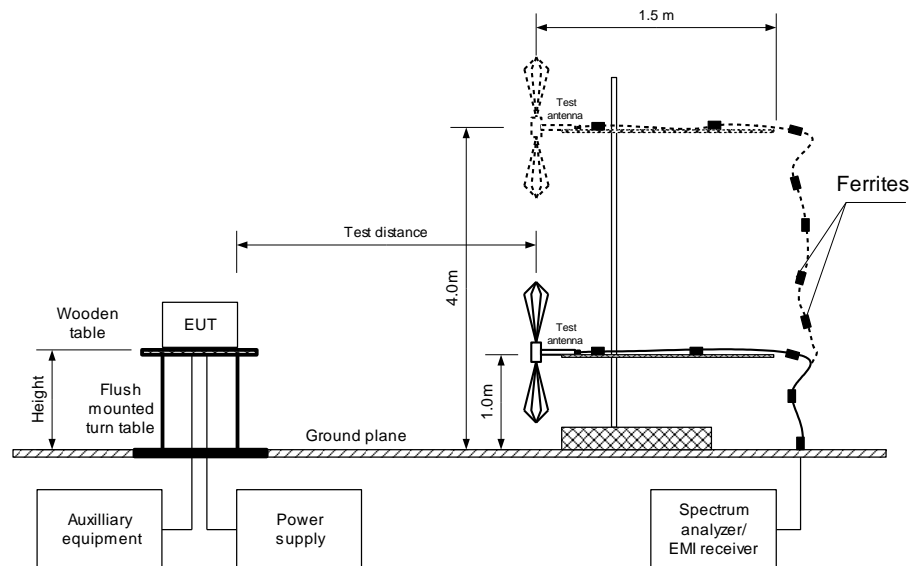
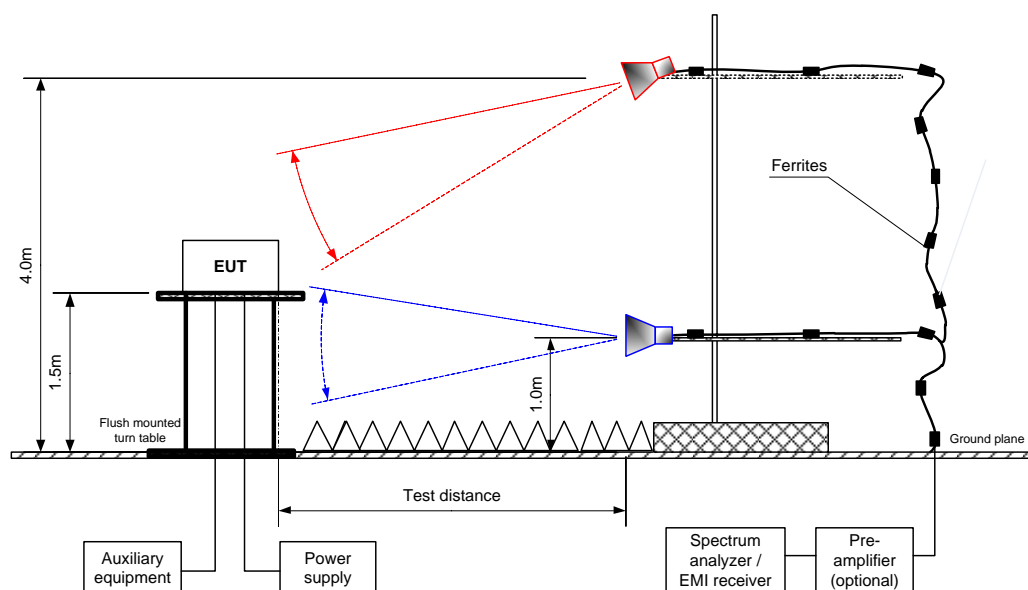


Figure 7.3.3 Setup for spurious emission field strength measurements above 1000 MHz





Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Table 7.3.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY BAND: 902.0 - 928.0 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 - 10000 MHz
 TEST DISTANCE: 3 m
 MODULATION: LoRa
 MODULATING SIGNAL: PRBS
 BIT RATE: 12.5 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)

Frequency, MHz	Field strength of spurious, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(μV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
1884.00000	38.74	Vertical	2.04	147	112.99	74.25	20.0	54.25	Pass
6317.73250	49.41	Horizontal	3.09	16		63.58		43.58	

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

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

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

ASSIGNED FREQUENCY BAND: 902.0 - 928.0 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 - 10000 MHz
 TEST DISTANCE: 3 m
 MODULATION: LoRa
 MODULATING SIGNAL: PRBS
 BIT RATE: 12.5 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength			Average field strength				Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	Measured, dB(μV/m)	Calculated, dB(μV/m)	Limit, dB(μV/m)	Margin, dB***	
7296.20750	Vertical	2.65	337	52.12	74	-21.88	52.12	34.35	54	-19.65	Pass

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

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

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



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Table 7.3.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
NA	NA	12.93	1037	NA	-17.77

*- 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:

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

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

ASSIGNED FREQUENCY BAND:	902.0 – 928.0 MHz
INVESTIGATED FREQUENCY RANGE:	0.009 – 1000 MHz
TEST DISTANCE:	3 m
MODULATION:	LoRa
MODULATING SIGNAL:	PRBS
BIT RATE:	12.5 kbps
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
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 founds								Pass

*- Margin = Measured emission - specification limit.

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



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

7.3.5 Restricted bands according to FCC section 15.205

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

Table 7.3.6 Restricted bands according to RSS-Gen

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

Reference numbers of test equipment used

HL 3903	HL4339	HL 4360	HL 446	HL 4933	HL 5085	HL 5288	HL 5405
HL 3818							

Full description is given in Appendix A.



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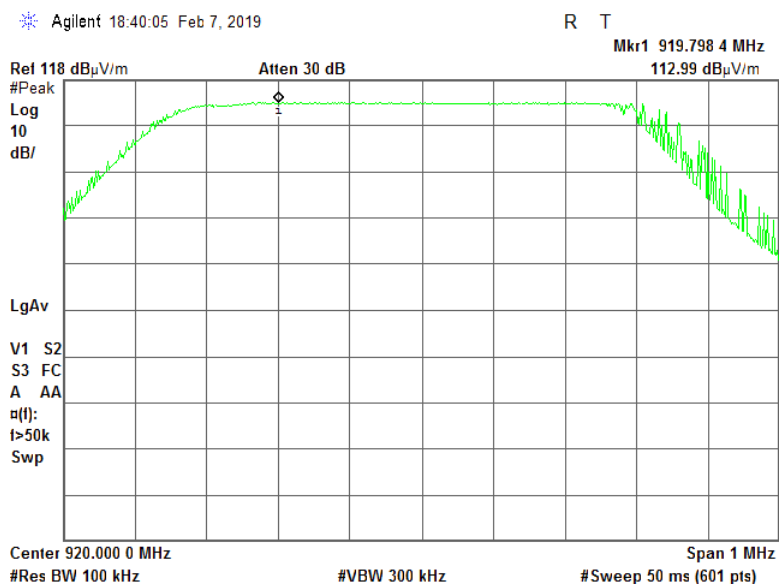
Report ID: TRIRAD_FCC.33326

Date of Issue: 31-Jul-19

Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Plot 7.3.1 Radiated emission measurements at the carrier frequency

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

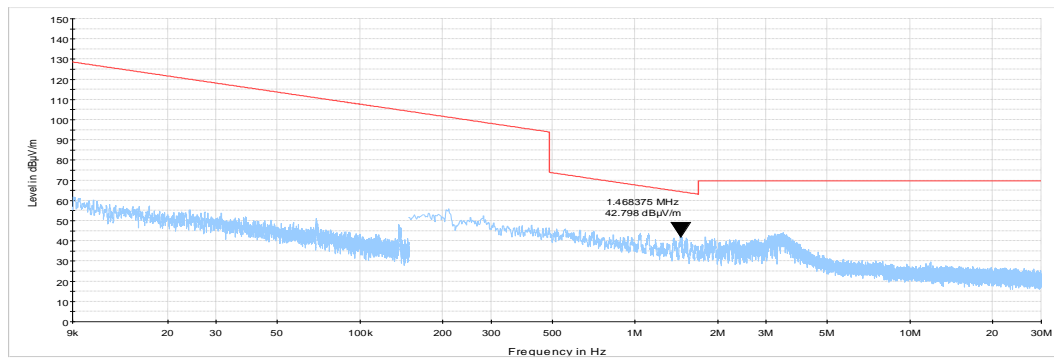




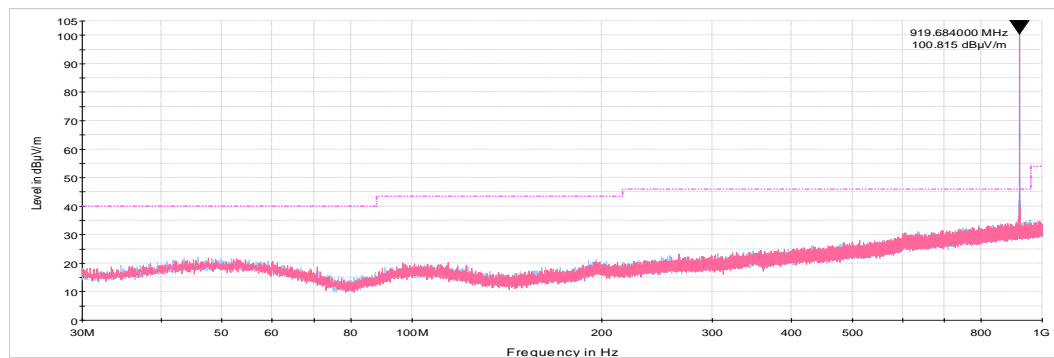
Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Plot 7.3.1 Radiated emission measurements from 9 kHz to 30 MHz at the carrier frequency

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

**Plot 7.3.2 Radiated emission measurements from 30 to 1000 MHz at the carrier frequency**

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





HERMON LABORATORIES

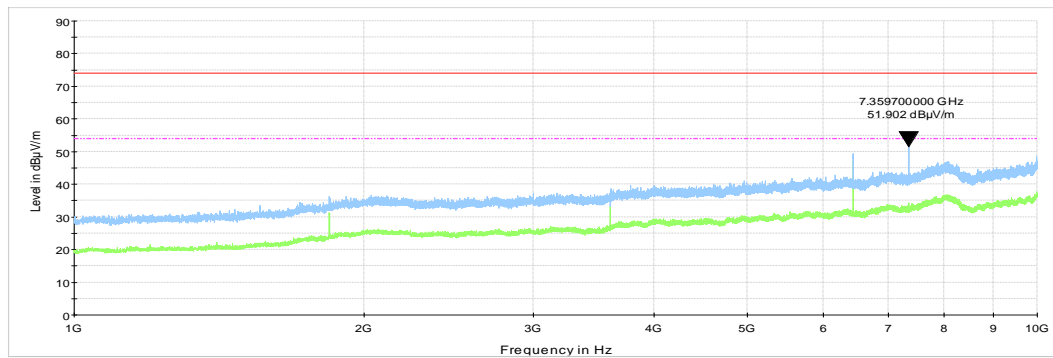
Report ID: TRIRAD_FCC.33326

Date of Issue: 31-Jul-19

Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Plot 7.3.3 Radiated emission measurements from 1 to 10 GHz at the carrier frequency

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





HERMON LABORATORIES

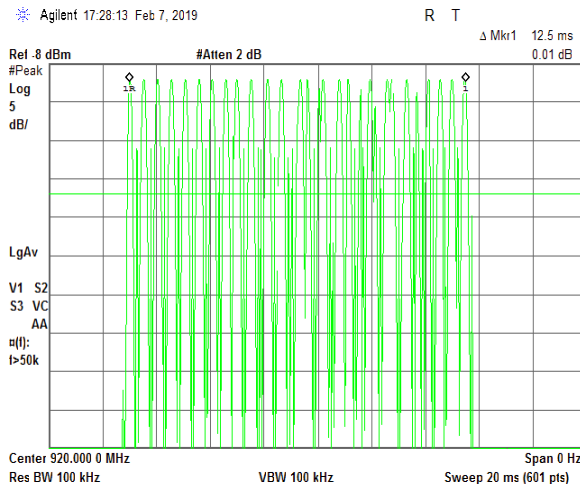
Report ID: TRIRAD_FCC.33326

Date of Issue: 31-Jul-19

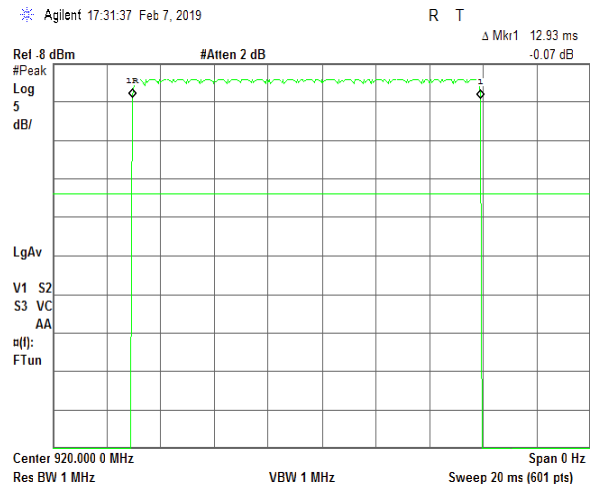
Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Jun-19			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1015 hPa	Power: 6 VDC
Remarks:			

Plot 7.3.2 Transmission burst duration

Agilent 17:28:13 Feb 7, 2019

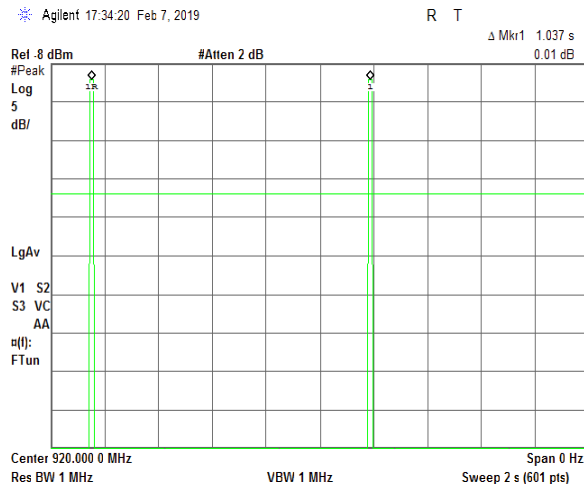


Agilent 17:31:37 Feb 7, 2019



Plot 7.3.3 Transmission burst period

Agilent 17:34:20 Feb 7, 2019





Test specification: Section 15.247(d) / RSS-247 section 5.5, Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Jun-19			
Temperature: 24 °C	Relative Humidity: 54 %	Air Pressure: 1011 hPa	Power: 6 VDC
Remarks:			

7.4 Band edge radiated emissions

7.4.1 General

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

Table 7.4.1 Band edge emission limits

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

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

7.4.2 Test procedure

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

7.4.2.7 Figure 7.4.1 Band edge emission test setup





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Report ID: TRIRAD_FCC.33326

Date of Issue: 31-Jul-19

Test specification: Section 15.247(d) / RSS-247 section 5.5, Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Jun-19			
Temperature: 24 °C	Relative Humidity: 54 %	Air Pressure: 1011 hPa	Power: 6 VDC
Remarks:			

Table 7.4.2 Band edge emission test results

ASSIGNED FREQUENCY RANGE: 902.0 – 928.0 MHz
 DETECTOR USED: Peak
 MODULATION: LoRa
 MODULATING SIGNAL: PRBS
 BIT RATE: 12.5 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 VIDEO BANDWIDTH: ≥ RBW

Frequency, MHz	Band edge emission, dBm	Emission at carrier, dBm	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
901.70	-79.44	-6.06	73.38	20.0	-53.38	Pass
928.54	-79.64		73.58		-53.58	

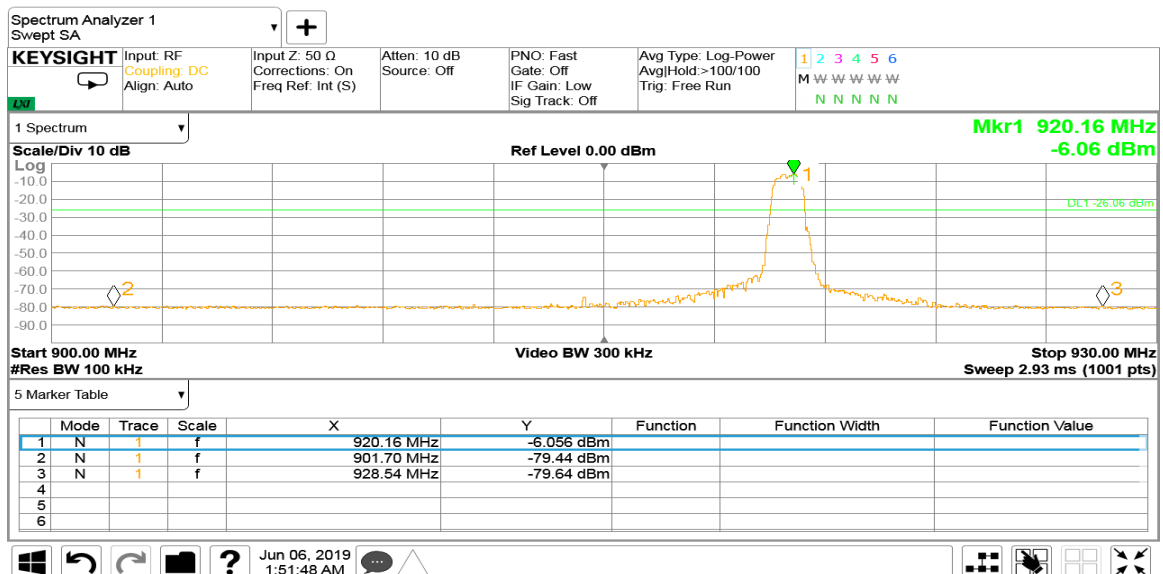
*- Margin = Attenuation below carrier – specification limit.

Reference numbers of test equipment used

HL 4136	HL 5409	HL 5376	HL	HL	HL	HL	HL
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Full description is given in Appendix A.

Plot 7.4.1 The highest emission level within the assigned band at carrier frequency





Test specification: Section 15.247(e), / RSS-247 section 5.2(b), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Jun-19			
Temperature: 24 °C	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 6 VDC
Remarks:			

7.5 Maximum power spectral density (PSD)

7.5.1 General

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

Table 7.5.1 Peak spectral power density limits

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

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

7.5.2 Test procedure for field strength measurements

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

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

7.5.2.3 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

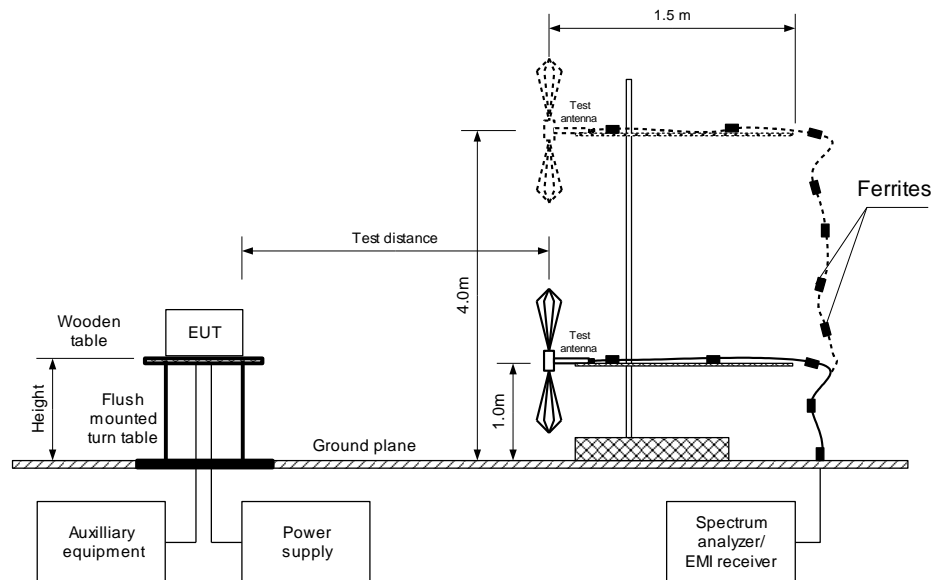
7.5.2.4 The frequency span of spectrum analyzer was set to capture the entire 6 dB band of the transmitter, in peak hold mode with resolution bandwidth set to 3.0 kHz, video bandwidth wider than resolution bandwidth, auto sweep time and sufficient number of sweeps was allowed for trace stabilization. The spectrum lines spacing was verified to be wider than 3 kHz. Otherwise the resolution bandwidth was reduced until individual spectrum lines were resolved and the power of individual spectrum lines was integrated over 3 kHz band.

7.5.2.5 The peak of emission was zoomed with span set just wide enough to capture the emission peak area and sweep time was set equal to span width divided by resolution bandwidth. Spectrum analyzer was set in peak hold mode, sufficient number of sweeps was allowed for trace stabilization and peak spectral power density was measured as provided in Table 7.5.2 and associated plots.



Test specification: Section 15.247(e), / RSS-247 section 5.2(b), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Jun-19			
Temperature: 24 °C	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 6 VDC
Remarks:			

Figure 7.5.1 Setup for carrier field strength measurements





Test specification: Section 15.247(e), / RSS-247 section 5.2(b), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Jun-19			
Temperature: 24 °C	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 6 VDC
Remarks:			

Table 7.5.2 Field strength measurement of peak spectral power density

ASSIGNED FREQUENCY: 902.0 – 928.0 MHz
 TEST DISTANCE: 3 m
 TEST SITE: Semi anechoic chamber
 EUT HEIGHT: 0.8 m
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 3 kHz
 VIDEO BANDWIDTH: 10 kHz
 TEST ANTENNA TYPE: Biconilog (30 MHz – 1000 MHz)
 MODULATION: LoRa
 BIT RATE: 12.5 kbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Frequency, MHz	Field strength, dB(μV/m)	EUT antenna gain, dBi	Limit, dB(μV/m)	Margin, dB*	Antenna polarization	Antenna height, m	Turn-table position**, degrees
919.8126	102.52	2	103.20	-2.68	180	1	Pass

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

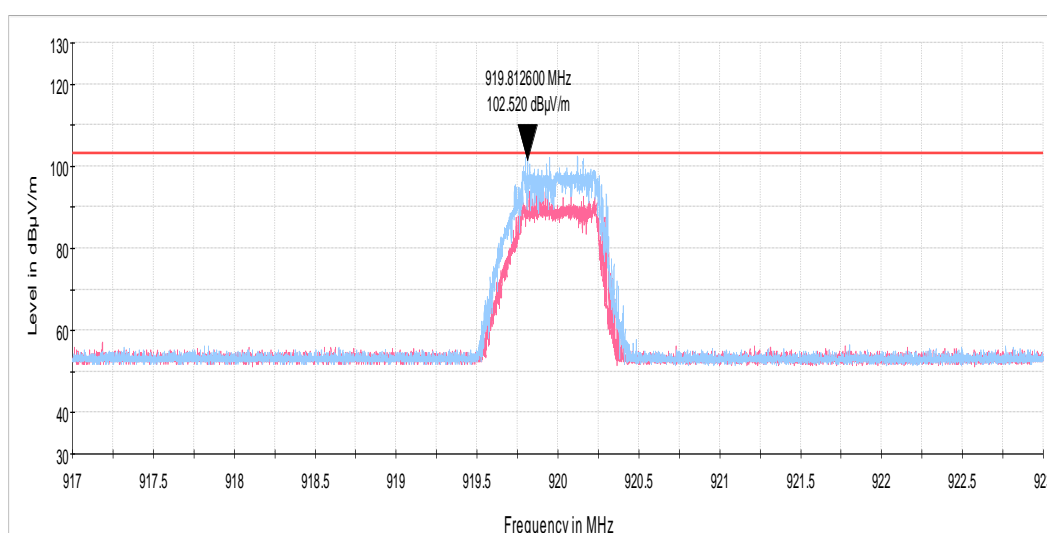
** - EUT front panel refer to 0 degrees position of turntable.

Reference numbers of test equipment used

HL 3903	HL 4360	HL 5085	HL 5288	HL 5405			
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Full description is given in Appendix A.

Plot 7.5.1 Peak spectral power density at carrier frequency



Test specification: Section 15.203, RSS-Gen section 8.3, Antenna requirements			
Test procedure: Visual inspection			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Jun-19			
Temperature: 24 °C	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 6 VDC
Remarks:			

7.6 Antenna requirements

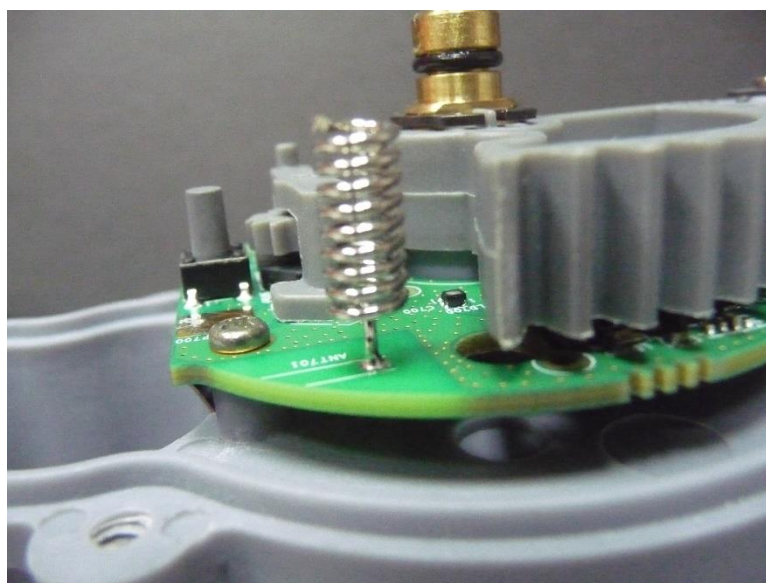
The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.6.1.

Table 7.6.1 Antenna requirements

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

Photograph 7.6.1 Antenna assembly



8 APPENDIX A 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-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 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).

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website: www.hermonlabs.com

Person for contact: Mr. Michael Nikishin, EMC and radio group manager

9 APPENDIX B 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
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	24-Apr-19	24-Apr-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
4136	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000137	24-Apr-19	24-Apr-20
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	31-Dec-18	31-Dec-19
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	06-Jan-19	06-Jan-20
5085	Attenuator, 4 dB, DC - 6 GHz, 1 W	Mini-Circuits	UNAT-4+	NA	08-Feb-19	08-Feb-20
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5376	EXA Signal Analyzer, 10 Hz - 32 GHz	Keysight Technologies	N9010B	MY57470404	18-Mar-19	18-Mar-20
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500023/118	01-Aug-18	01-Aug-19
5409	RF cable, 40 GHz, SMA-SMA, 2 m	Huber-Suhner	SF102EA/11SK/11SK/2000MM	503973/2EA	19-Aug-18	19-Aug-19

10 APPENDIX C 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 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.

HL 5405: RF Cable
Huber-Suhner, model: SF118/11N(x2), s/n: 500023/118
Calibration date: 01-Aug-2018

Set / Applied, MHz	Measured, dB	Uncertainty, dB
0.1	0.01	±0.07
50	0.23	±0.07
100	0.32	±0.07
200	0.45	±0.08
300	0.55	±0.08
400	0.64	±0.08
500	0.71	±0.08
600	0.78	±0.08
700	0.85	±0.08
800	0.91	±0.08
900	0.97	±0.08
1000	1.02	±0.08
1100	1.07	±0.08
1200	1.12	±0.08
1300	1.16	±0.08
1400	1.21	±0.08
1500	1.25	±0.08
1600	1.30	±0.08
1700	1.34	±0.08
1800	1.38	±0.08
1900	1.42	±0.08
2000	1.47	±0.08
2500	1.64	±0.10
3000	1.81	±0.10
3500	1.97	±0.10
4000	2.11	±0.10
4500	2.25	±0.10
5000	2.38	±0.10
5500	2.48	±0.10
6000	2.59	±0.10
6500	2.72	±0.10
7000	2.84	±0.13
7500	2.97	±0.13
8000	3.08	±0.13
8500	3.21	±0.13
9000	3.31	±0.13
9500	3.42	±0.13
10000	3.52	±0.13

11 APPENDIX D Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted carrier power at RF antenna connector	Below 12.4 GHz: ± 1.7 dB 12.4 GHz to 40 GHz: ± 2.3 dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB
Occupied bandwidth	± 8.0 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB

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

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

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

12 APPENDIX E

Specification references

FCC 47CFR part 15:2018
ANSI C63.10:2013

RSS-247:2017, Issue 2

RSS-Gen:2018, Issue 5

558074 D01 DTS
Meas_Guidance v05

Radio Frequency Devices.

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

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License Exempt Local Area Network (LE-LAN) Devices

General Requirements for Compliance of Radio Apparatus

Guidance for compliance measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices operating under section 15.247 of the FCC rules

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