

TEST REPORT

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

FOR:

Vayyar Imaging LTD.

Walabot DIY2

Models: VMPRO19CB4BAT, VMPRO19CB4WREP

FCC ID: 2AHIS-VMAKERPROW

IC: 21498-VMAKERPROW

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1 Applicant information

Client name: Vayyar Imaging LTD.
Address: 26 Shabazi street, Yehud, 5621608, Israel
Telephone: +972 54 432 1050
E-mail: mark.popov@vayyar.com
Contact name: Mr. Mark Popov

2 Equipment under test attributes

Product name: Walabot DIY2
Product type: UWB handheld device with WiFi communication
Model(s): VMPRO19CB4BAT
Serial number: DCWG7BA012202102
Hardware version: RevB 2.1
Software release: ESP_RF_test_tool_v2.5
Receipt date 10-Jul-20

3 Manufacturer information

Manufacturer name: Vayyar Imaging LTD.
Address: 26 Shabazi street, Yehud, 5621608, Israel
Telephone: +972 54 432 1050
E-mail: mark.popov@vayyar.com
Contact name: Mr. Mark Popov

4 Test details

Project ID: 39637
Location: Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started: 30-Aug-20
Test completed: 13-Sep-20
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 2.5.1, 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

Testing was completed against all relevant requirements of the test standard. However, 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	30-Aug-20 – 13-Sep-20	
Reviewed by:	Mrs. S. Peysahov Sheynin, test engineer, EMC & Radio	01-Oct-20	
Approved by:	Mr. S. Samokha, technical manager, EMC & Radio	29-Oct-20	

6 EUT description

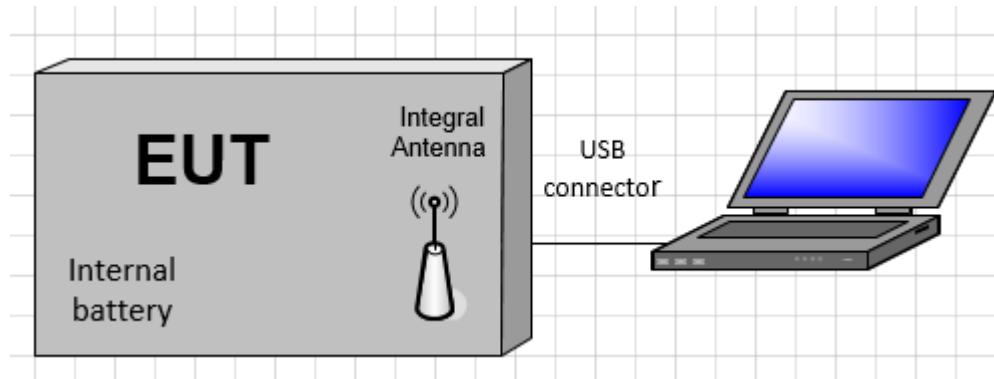
Note: The following data in this clause is provided by the customer and represents his sole responsibility

6.1 General information

The WalabotDIY2 products are using VMKAERPROUWB UWB module to characterize the environment in the vicinity of the sensor and are connected to a hosting device by WiFi/BLE communication. Utilizing the UWB module, those products are collecting and analyzing propagation information between the antennas, which is affected by the environment. The information is gathered by sequentially transmitting from the available antennas and collecting the received information at the rest of the antennas. The response information is then transmitted by WiFi to a hosting device and processed to obtain spatial information about the environment. The acquisition is controlled by the hosting device. The hosting device may ask WalabotDIY2 to acquire multiple snapshots, so as to integrate the data into information about larger spatial extent, or to detect changes in the environment.

According to manufacturer's declaration provided in Appendix F of the test report models VMPRO19CB4BAT and VMPRO19CB4WREP has an identical radio frequency system and differ only in that the VMPRO19CB4BAT has an integrated battery and can be supplied by either the battery or by external power source (through USB-C port). VMPRO19CB4WREP doesn't contain battery and thus can only be powered by external power source.

6.2 Test configuration



6.3 Changes made in EUT

No changes were performed in the EUT during testing.

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 frequencies		2402-2480 MHz					
Maximum rated output power		Peak output power 6.62 dBm					
Is transmitter output power variable?		V	No				
		Yes		continuous variable			
				stepped variable with stepsize			
				minimum RF power	dBm		
				maximum RF power	dBm		
Antenna connection							
unique coupling	standard connector		V	Integral	with temporary RF connector		
			V		without temporary RF connector		
Antenna/s technical characteristics							
Type	Manufacturer		Model number		Gain		
integral	INPAQ		ACA-3216-A2-MC-S		Typ peak gain: 0 dBi		
Transmitter aggregate data rate/s		1 Mbps					
Type of modulation		GFSK					
Modulating test signal (baseband)							
Transmitter power source							
V	Battery	Nominal rated voltage	3.85 V	Battery type			
V	DC	Nominal rated voltage	5.0 VDC				
	AC mains	Nominal rated voltage		Frequency	Hz		



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Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth	
Test procedure: ANSI C63.10 section 11.8.1	
Test mode: Compliance	Verdict: PASS
Date(s): 01-Sep-20	
Temperature: 24 °C	Relative Humidity: 46 %
	Air Pressure: 1004 hPa
	Power: 5 VDC
Remarks:	

7 Transmitter tests according to 47CFR part 15 subpart C 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
2400.0 – 2483.5	6.0	500.0

* - 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

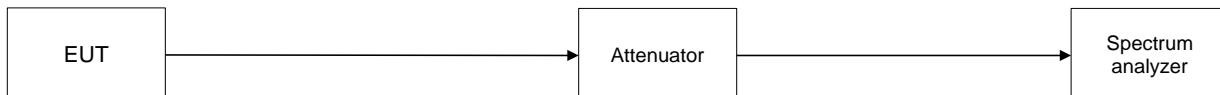


Table 7.1.2 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 2400.0 – 2483.5 MHz

DETECTOR USED: Peak

RESOLUTION BANDWIDTH: 100 kHz

VIDEO BANDWIDTH: 300 kHz

MODULATION: GFSK

BITRATE: 1 Mbps

Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
Low frequency				
2402.0	638.878	500.0	138.878	Pass
Mid frequency				
2442.0	641.395	500.0	141.395	Pass
High frequency				
2480.0	638.135	500.0	138.135	Pass

Reference numbers of test equipment used

HL 3818	HL 3901	HL 4136	HL 5397				
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Full description is given in Appendix A.

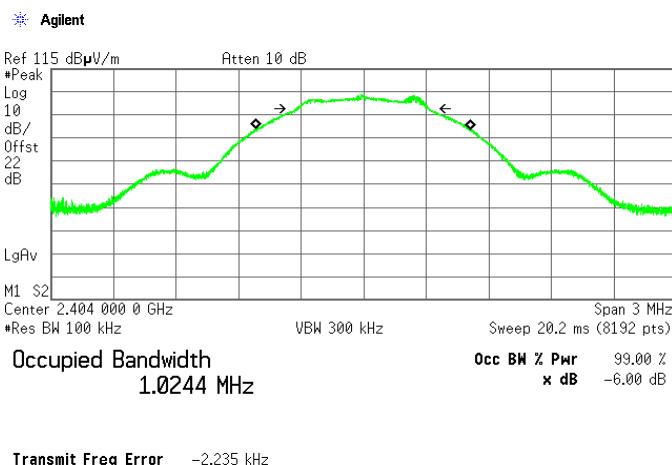


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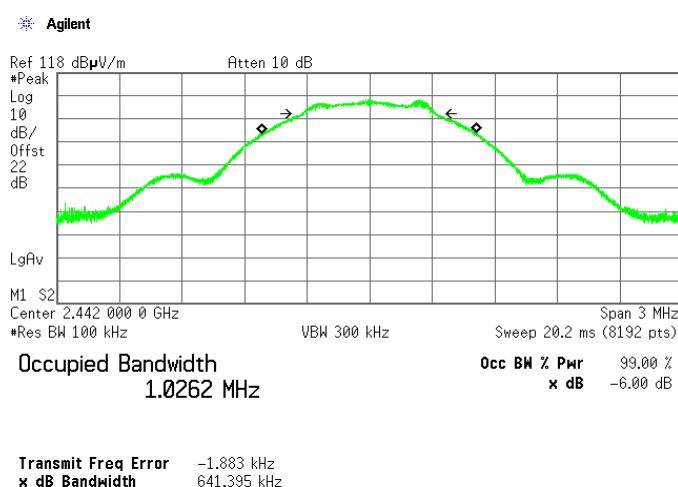
Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Sep-20			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1004 hPa	Power: 5 VDC
Remarks:			

Plot 7.1.1 6 dB bandwidth test result at low frequency



Plot 7.1.2 6 dB bandwidth test result at mid frequency





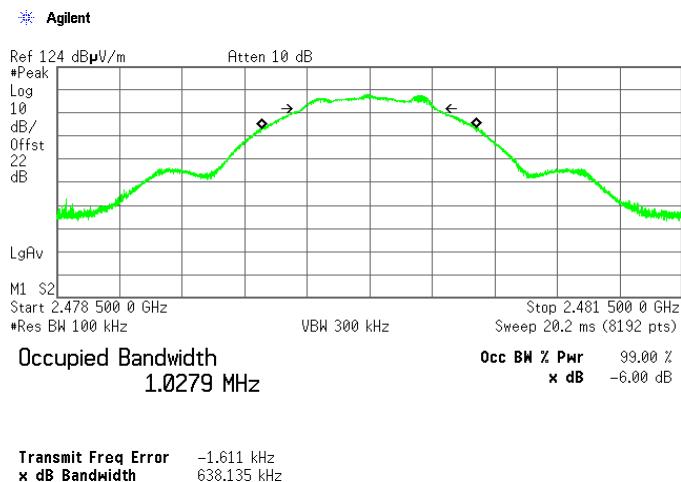
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Date of Issue: 29-Oct-20

Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 01-Sep-20			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1004 hPa	Power: 5 VDC
Remarks:			

Plot 7.1.3 6 dB bandwidth test result at high frequency





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Date of Issue: 29-Oct-20

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): 13-Sep-20			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

7.2 Field strength of spurious emissions

7.2.1 General

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

Table 7.2.1 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		73.8 – 63.0**		
1.705 – 30.0*		69.5		
30 – 88	NA	40.0	NA	
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:

$$L_{mS2} = L_{mS1} + 40 \log \left(\frac{S_1}{S_2} \right)$$

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

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

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

7.2.2 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 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.

7.2.2.3 The worst test results (the lowest margins) were recorded 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 specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

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



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Date of Issue: 29-Oct-20

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): 13-Sep-20			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

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

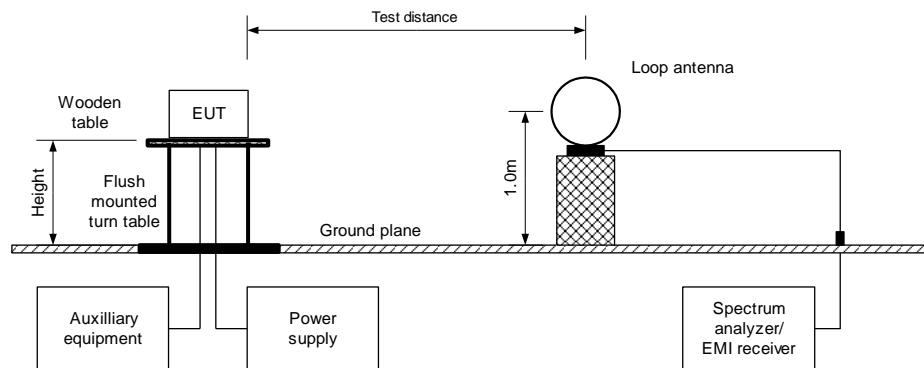
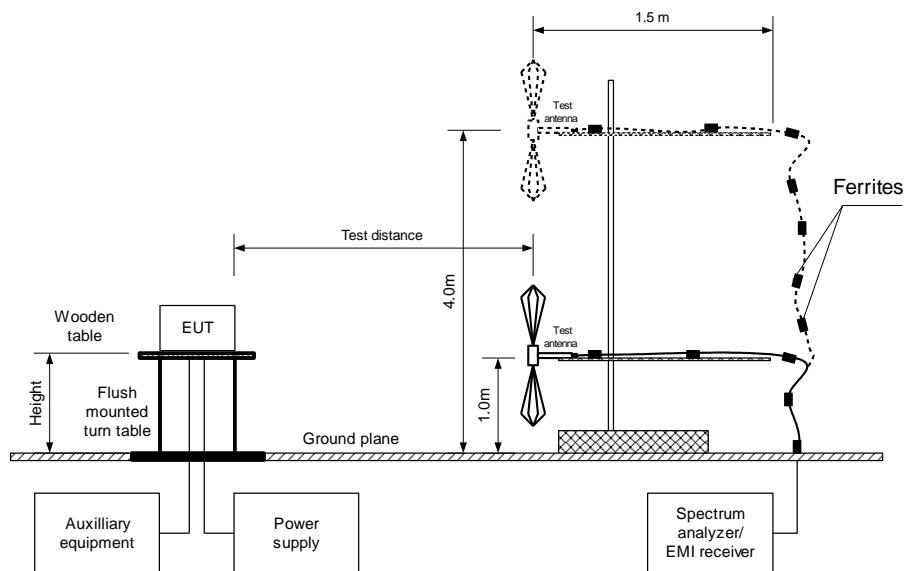


Figure 7.2.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz



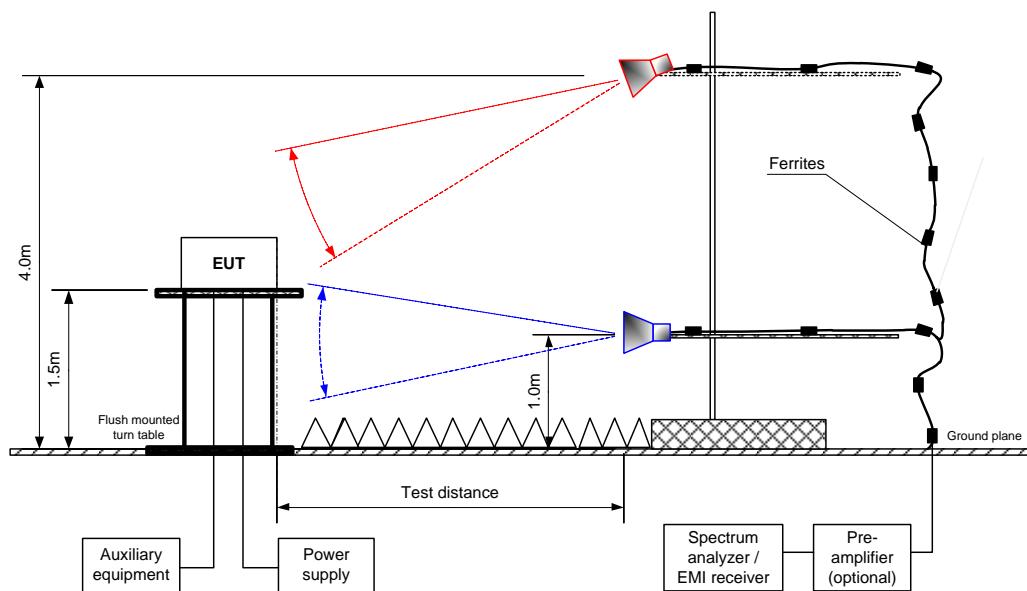


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Date of Issue: 29-Oct-20

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): 13-Sep-20			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

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





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Date of Issue: 29-Oct-20

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):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Table 7.2.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY:	2400.0 – 2483.5 MHz
INVESTIGATED FREQUENCY RANGE:	0.009 - 25000 MHz
TEST DISTANCE:	3 m
MODULATION:	GFSK
BIT RATE:	1 Mbps
DUTY CYCLE:	100 %
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(μ V/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(μ V/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
Low carrier frequency									
319.997	40.07	Hor	1	-5	96.76	56.69	20.0	36.69	
Mid carrier frequency									
319.997	40.32	Hor	1	0	98.56	58.24	20.0	38.24	
High carrier frequency									
319.997	39.88	Hor	1	12	97.76	57.88	20.0	37.88	

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

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



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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		
Date(s):	13-Sep-20		Verdict: PASS
Temperature: 24 °C	Relative Humidity: 45 %		Air Pressure: 1002 hPa
Remarks:			

Table 7.2.3 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 - 25000 MHz
 TEST DISTANCE: 3 m
 MODULATION: GFSK
 BIT RATE: 1 Mbps
 DUTY CYCLE: 100 %
 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(VBW=3 MHz)			Average field strength(VBW=10 Hz)			Verdict	
	Polarization	Height, m		Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB**	Measured, dB(µV/m)	Calculated, dB(µV/m)	Limit, dB(µV/m)		
Low carrier frequency 2402 MHz											
7367.633	Vert	1.0	-180	44.14	74.0	-29.86	44.14	NA	54.0	-9.86	Pass
Mid carrier frequency 2442 MHz											
7325.700	Vert	1.0	-136	46.43	74.0	-27.57	46.43	NA	54.0	-7.57	Pass
High carrier frequency 2480 MHz											
7439.600	Vert	1.0	19	45.07	74.0	-28.93	45.07	NA	54.0	-8.93	Pass
11618.766	Vert	1.0	-13	48.43	74.0	-25.57	48.43	NA	54.0	-5.57	

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

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

***- Margin = Calculated field strength - specification limit,

where Calculated field strength = Measured field strength + average factor.

Table 7.2.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
		NA			

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

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

for pulse train longer than 100 ms:

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



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Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance		
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

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

ASSIGNED FREQUENCY:	2400.0 – 2483.5 MHz
INVESTIGATED FREQUENCY RANGE:	0.009 – 1000 MHz
TEST DISTANCE:	3 m
MODULATION:	GFSK
BIT RATE:	1 Mbps
DUTY CYCLE:	100 %
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
Low carrier frequency								
240.005	30.76	29.89	46.0	-16.11	Hor	1.0	12	Pass
400.022	35.11	34.46	46.0	-11.54	Hor	1.0	42	
Mid carrier frequency								
240.005	31.22	30.17	46.0	-15.83	Hor	1.0	-15	Pass
400.022	35.26	35.01	46.0	-10.99	Hor	1.0	-175	
High carrier frequency								
239.972	30.78	30.03	46.0	-15.97	Hor	1.0	-18	Pass
399.958	34.70	34.34	46.0	-11.66	Hor	1.0	-180	

*- Margin = Measured emission - specification limit.

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



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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): 13-Sep-20					
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa		Power: 5 VDC	
Remarks:					

Table 7.2.6 Restricted bands according to FCC section 15.205

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

Table 7.2.7 Restricted bands according to RSS-Gen

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

Reference numbers of test equipment used

HL 3903	HL 4360	HL 4933	HL 5111	HL 5669	HL 5670	HL 4011	
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Full description is given in Appendix A.



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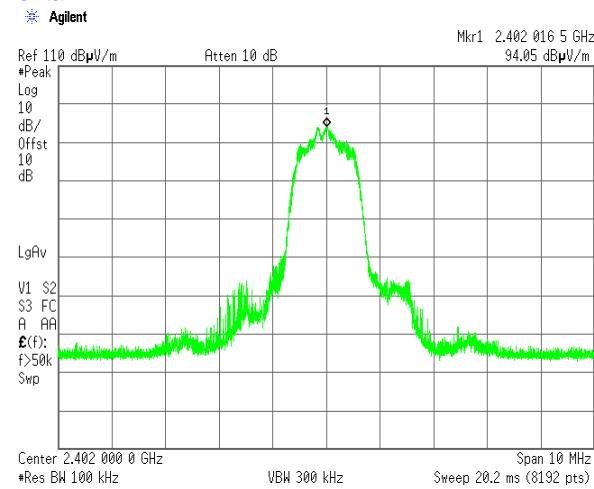
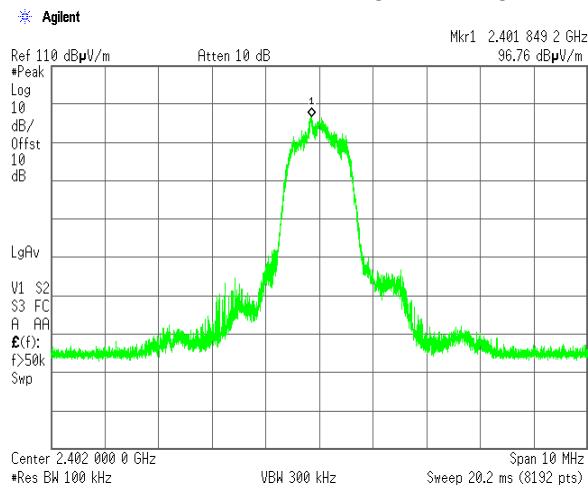
Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

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		
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

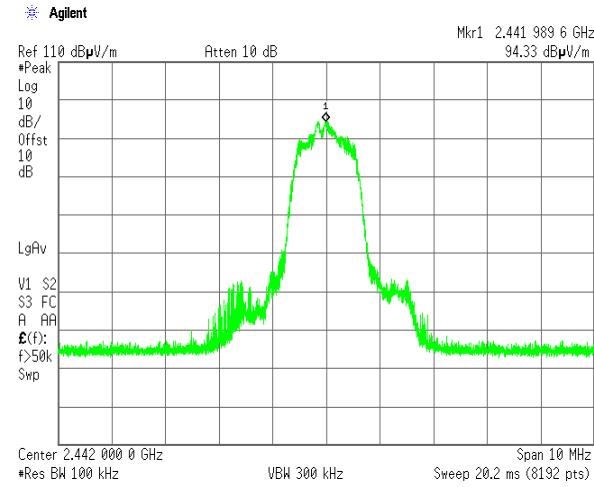
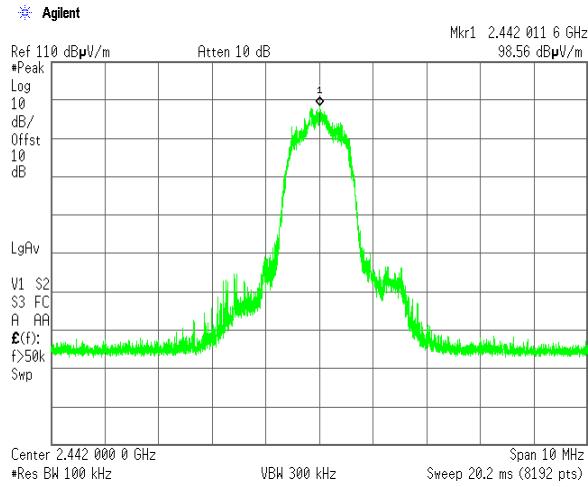
Plot 7.2.1 Radiated emission measurements at the low carrier frequency

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



Plot 7.2.2 Radiated emission measurements at the mid carrier frequency

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





HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

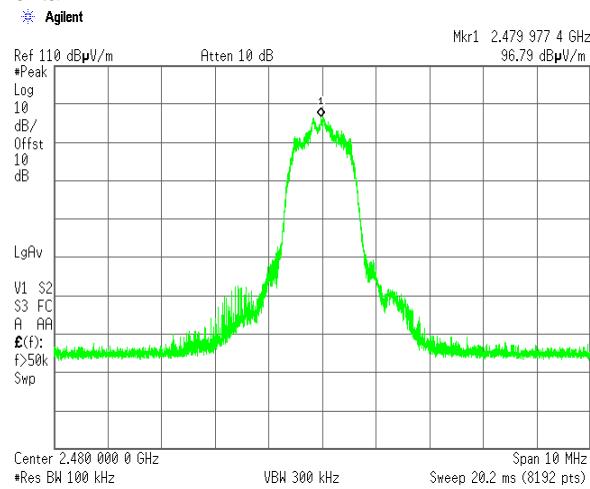
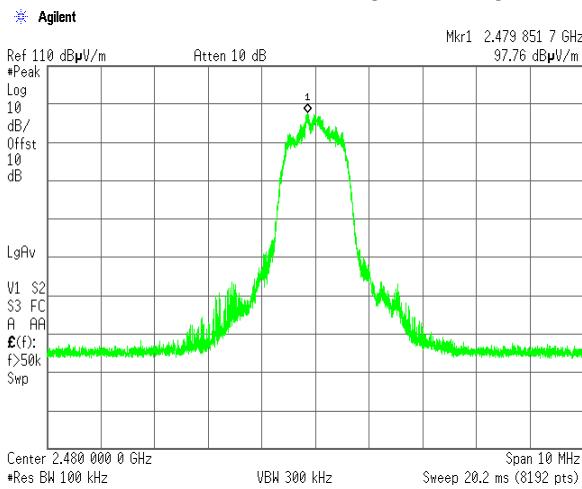
Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance		
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Plot 7.2.3 Radiated emission measurements at the high carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION Vertical and Horizontal



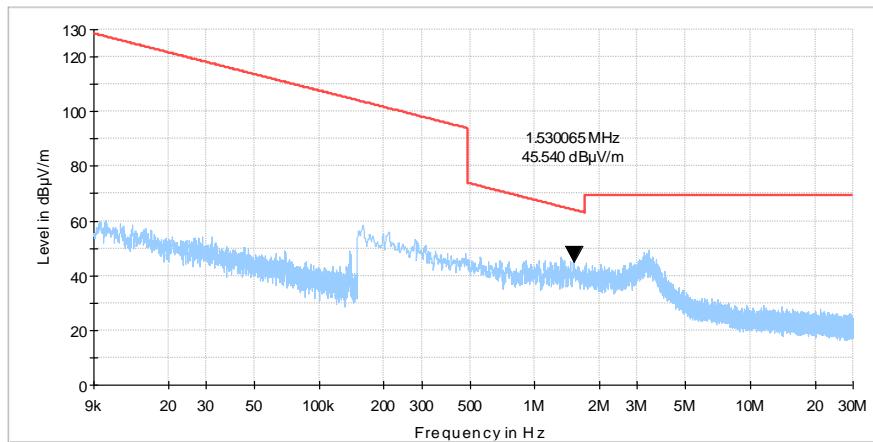


HERMON LABORATORIES

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):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

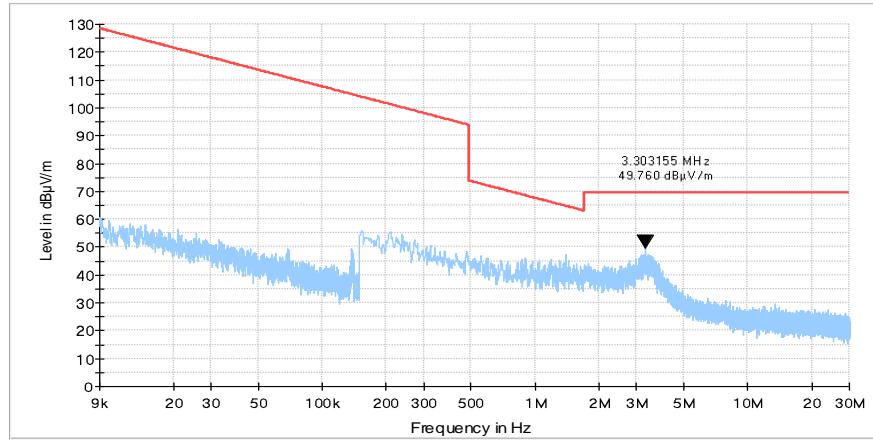
Plot 7.2.4 Radiated emission measurements from 9 kHz to 30 MHz at the low carrier frequency

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



Plot 7.2.5 Radiated emission measurements from 9 kHz to 30 MHz at the mid carrier frequency

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





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Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

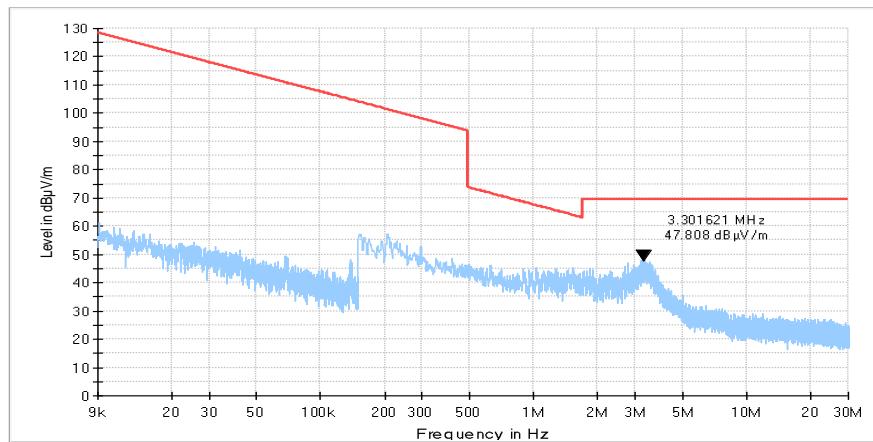
Test specification:	Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance		
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Plot 7.2.6 Radiated emission measurements from 9 kHz to 30 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical





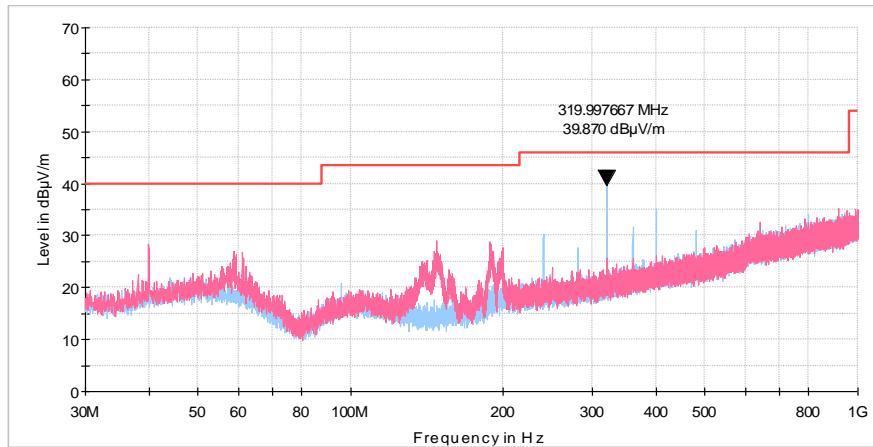
HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

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): 13-Sep-20			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

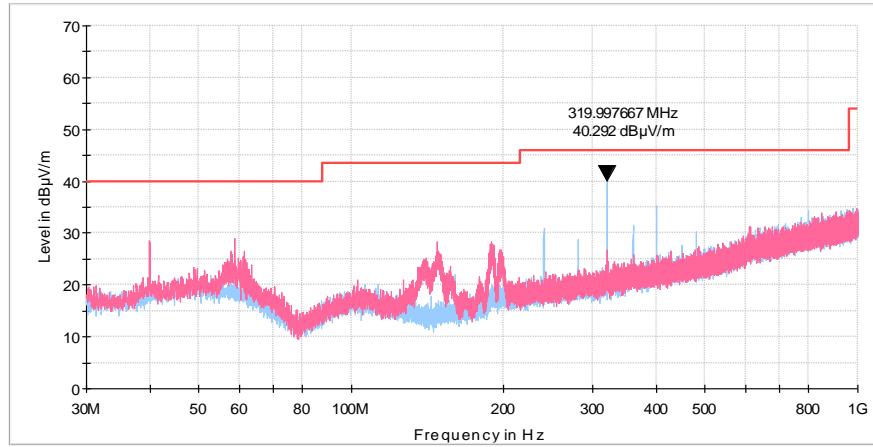
Plot 7.2.7 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

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



Plot 7.2.8 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

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





HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

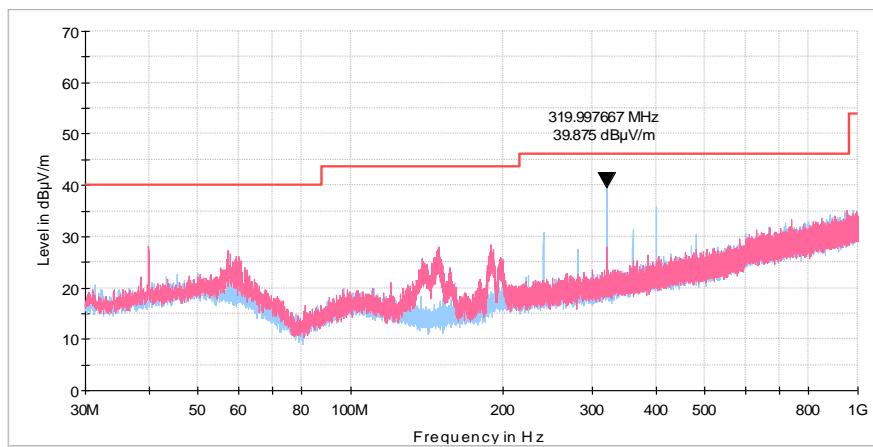
Test specification:	Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Plot 7.2.9 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and Horizontal





HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

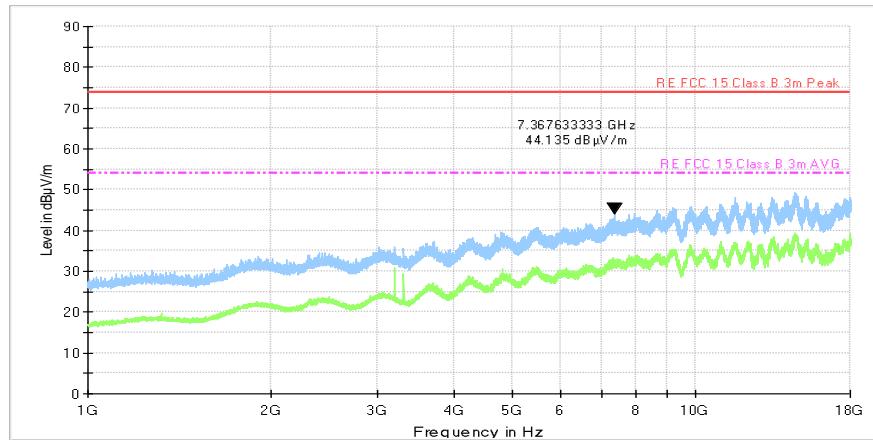
Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance			Verdict: PASS
Date(s): 13-Sep-20			
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Plot 7.2.10 Radiated emission measurements from 1000 to 18000 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and Horizontal

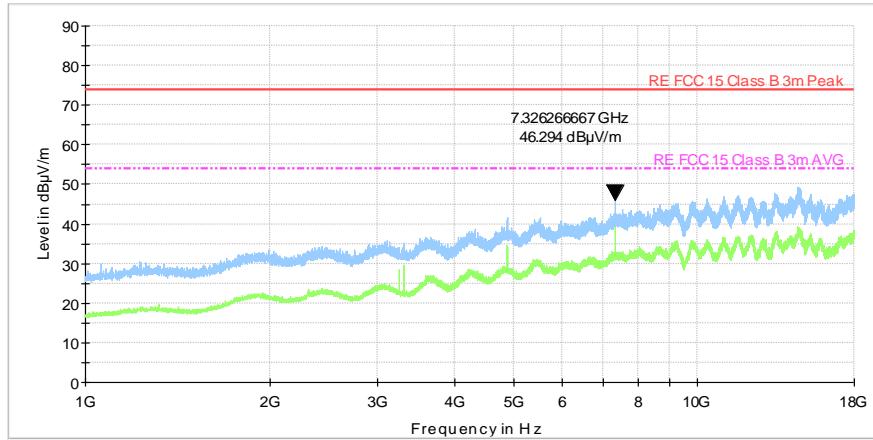


Plot 7.2.11 Radiated emission measurements from 1000 to 18000 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and Horizontal





HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

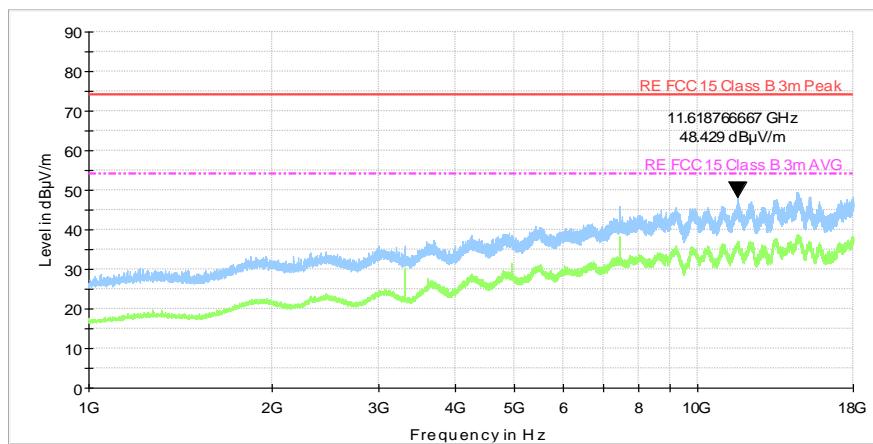
Test specification:	Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance		
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Plot 7.2.12 Radiated emission measurements from 1000 to 18000 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and Horizontal





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Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

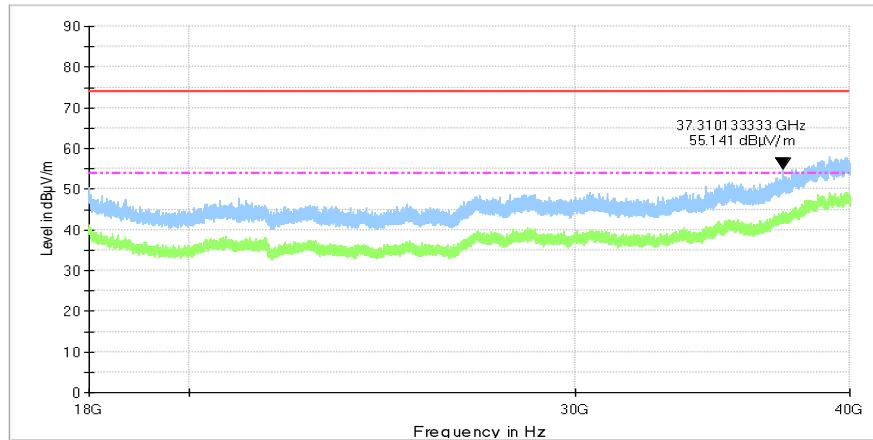
Test specification:	Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance		
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Plot 7.2.13 Radiated emission measurements from 18 GHz to 25 GHz at the low carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and Horizontal

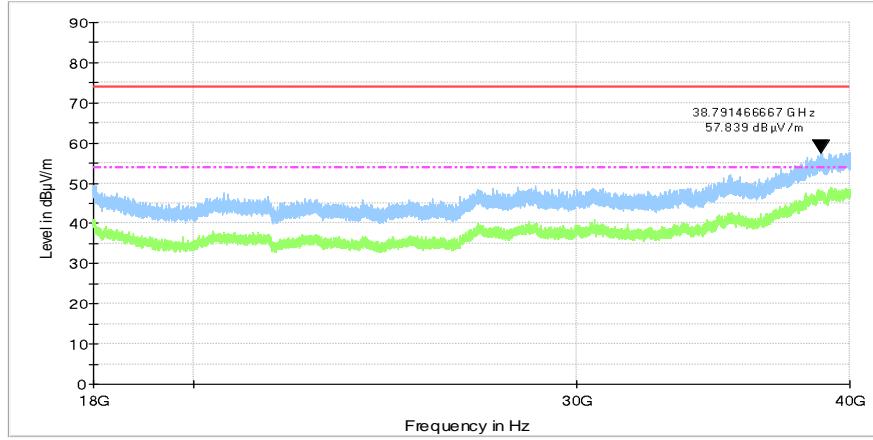


Plot 7.2.14 Radiated emission measurements from 18 GHz to 25 GHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and Horizontal





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Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

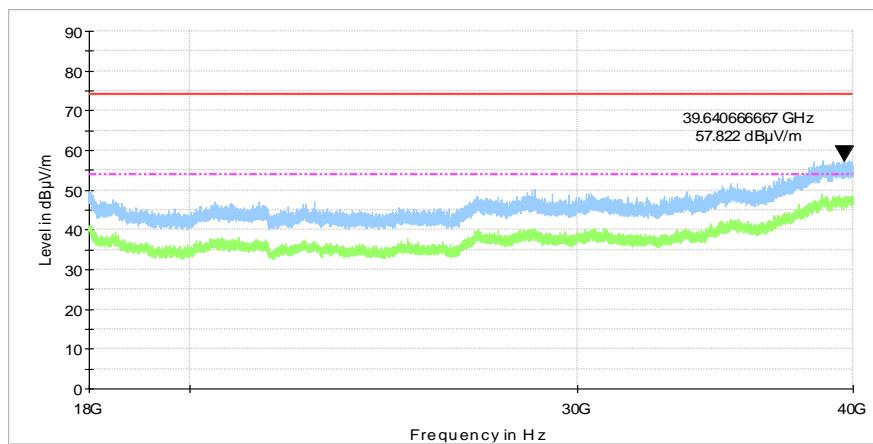
Test specification:	Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	13-Sep-20		
Temperature: 24 °C	Relative Humidity: 45 %	Air Pressure: 1002 hPa	Power: 5 VDC
Remarks:			

Plot 7.2.15 Radiated emission measurements from 18 GHz to 25 GHz at the high carrier frequency

TEST SITE: Semi anechoic chamber

TEST DISTANCE: 3 m

ANTENNA POLARIZATION: Vertical and Horizontal





HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Maximum output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s):	09-Sep-20		
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

7.3 Peak output power

7.3.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.3.1.

Table 7.3.1 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	
2400.0 – 2483.5	6.0	1.0	30.0	131.2

*- 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.

7.3.2 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 adjusted to produce maximum available to end user RF output power.
- 7.3.2.3 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.
- 7.3.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.3.2 and associated plots.
- 7.3.2.5 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:

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

- 7.3.2.6 The worst test results (the lowest margins) were recorded in Table 7.3.2.



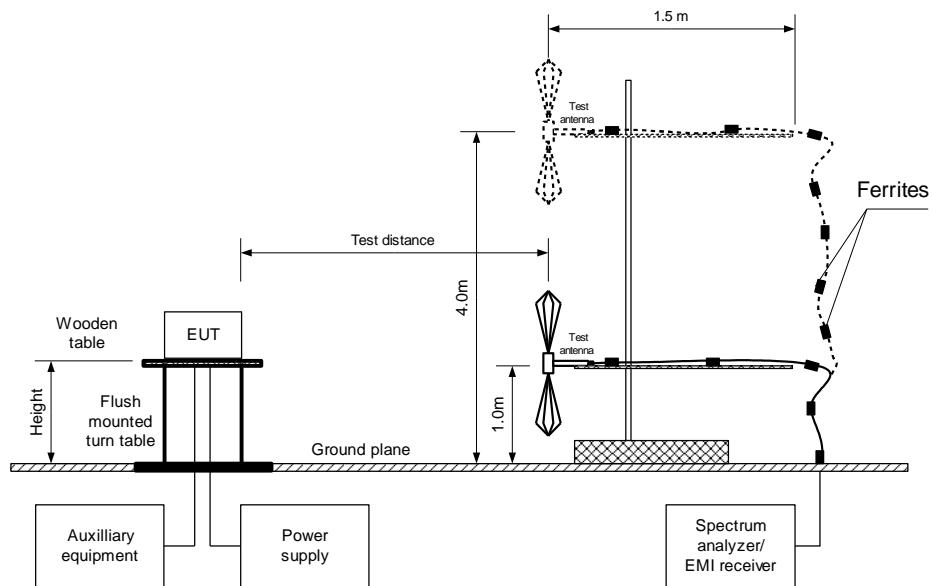
HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Maximum output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 09-Sep-20			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Figure 7.3.1 Setup for carrier field strength measurements





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Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Maximum output power	
Test procedure: ANSI C63.10 sections 11.9.2.2.4	
Test mode: Compliance	Verdict: PASS
Date(s): 09-Sep-20	
Temperature: 24 °C	Relative Humidity: 46 %
	Air Pressure: 1007 hPa
Remarks:	Power: 5 VDC

Table 7.3.2 Peak output power test results

ASSIGNED FREQUENCY:	2400.0 – 2483.5 MHz
TEST DISTANCE:	3 m
TEST SITE:	Semi anechoic chamber
EUT HEIGHT:	1.5 m
DETECTOR USED:	Peak
TEST ANTENNA TYPE:	Double ridged guide (above 1000 MHz)
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	3 MHz
VIDEO BANDWIDTH:	10 MHz
MODULATION:	GFSK
BITRATE:	1 Mbps
EUT CONFIGURATION:	Without external 5VDC

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
2402.0	100.55	Vertical	1.15	111	0	5.35	30	-24.65	Pass
2442.0	96.62	Vertical	1.15	-80	0	1.42	30	-28.58	Pass
2480.0	97.35	Horizontal	1.75	15	0	2.15	30	-27.85	Pass

EUT CONFIGURATION: With external 5VDC

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
2402.0	101.82	Vertical	1.15	111	0	6.62	30	-23.38	Pass
2442.0	97.48	Vertical	1.15	-80	0	2.28	30	-27.72	Pass
2480.0	98.26	Horizontal	1.75	15	0	3.06	30	-26.94	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: $\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$

*** - 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 4355	HL 4933	HL 5669	HL 5670			
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Full description is given in Appendix A.



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Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Maximum output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance			Verdict: PASS
Date(s): 09-Sep-20			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Plot 7.3.1 Field strength of carrier at low frequency

EUT CONFIGURATION:

Without external 5VDC



Plot 7.3.2 Field strength of carrier at mid frequency

EUT CONFIGURATION:

Without external 5VDC



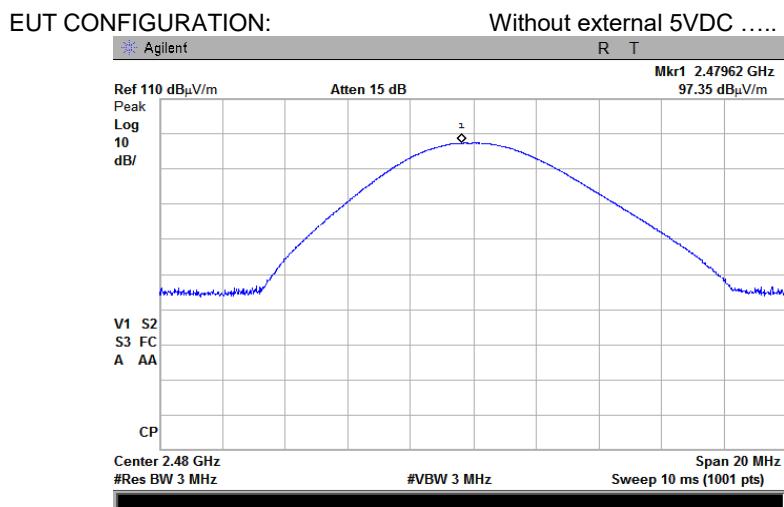


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Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Maximum output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance			Verdict: PASS
Date(s): 09-Sep-20			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Plot 7.3.3 Field strength of carrier at high frequency





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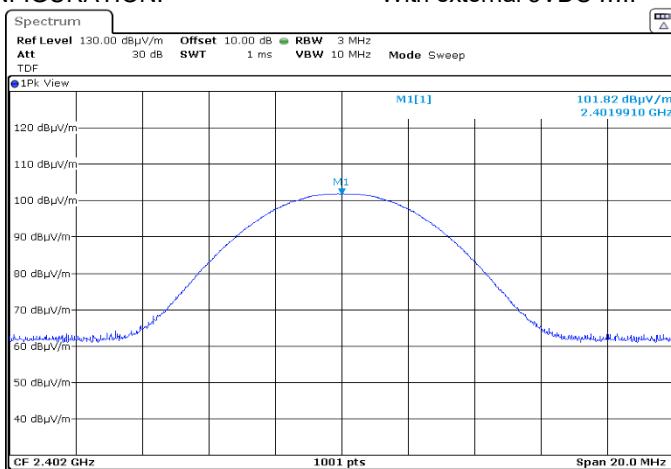
Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Maximum output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance			Verdict: PASS
Date(s): 09-Sep-20			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Plot 7.3.4 Field strength of carrier at low frequency

EUT CONFIGURATION:

With external 5VDC



Plot 7.3.5 Field strength of carrier at mid frequency

EUT CONFIGURATION:

With external 5VDC





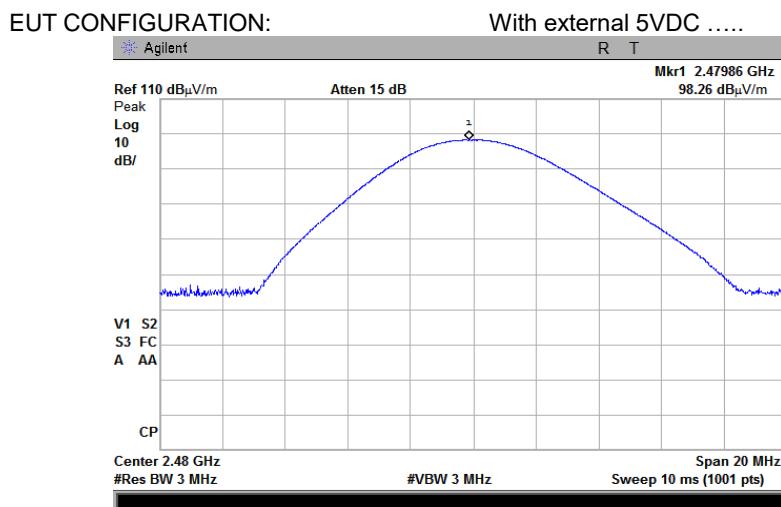
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Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Maximum output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance			Verdict: PASS
Date(s): 09-Sep-20			
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Plot 7.3.6 Field strength of carrier at high frequency





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Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

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):		09-Sep-20		
Temperature: 24 °C		Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 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	2400.0 – 2483.5	20.0	74.0	54.0

* - 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 The above procedure was repeated with the frequency hopping function enabled.



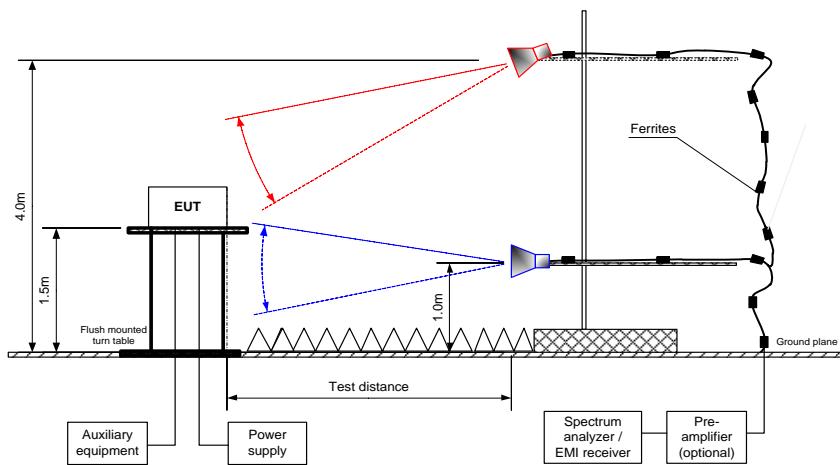
HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

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		
Date(s):	09-Sep-20		
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Figure 7.4.1 Band edge emission test setup





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Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

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): 09-Sep-20	
Temperature: 24 °C	Relative Humidity: 46 %
	Air Pressure: 1007 hPa
	Power: 5 VDC
Remarks:	

Table 7.4.2 Band edge emission outside restricted bands test results

ASSIGNED FREQUENCY RANGE: 2400.0 – 2483.5 MHz

DETECTOR USED: Peak

TRANSMITTER OUTPUT POWER SETTINGS: Maximum

RESOLUTION BANDWIDTH: 100 kHz

VIDEO BANDWIDTH: \geq RBW

MODULATION/BITRATE: GFSK / 1 Mbps

Frequency, MHz	Band edge emission, dBm	Emission at carrier, dBm	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
2399.552	40.07	91.38	51.31	20.0	31.31	Pass

*- Margin = Attenuation below carrier – specification limit.

Table 7.4.3 Band edge emission inside restricted bands test results

ASSIGNED FREQUENCY RANGE: 2400.0 – 2483.5 MHz

DETECTOR USED: Peak

TRANSMITTER OUTPUT POWER SETTINGS: Maximum

VIDEO BANDWIDTH: \geq RBW

MODULATION/BITRATE: GFSK / 1 Mbps

Frequency, MHz	Peak field strength(VBW=3 MHz)			Average field strength(VBW=1 kHz)			Verdict
	Measured, dB(μ V/m)	Limit, dB(μ V/m)	Margin, dB**	Measured, dB(μ V/m)	Limit, dB(μ V/m)	Margin, dB**	
2361.750	47.27	74.0	-26.73	35.09	54.0	-18.91	Pass
2483.522	56.44	74.0	-17.56	51.17	54.0	-2.83	Pass

Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5669	HL 5670			
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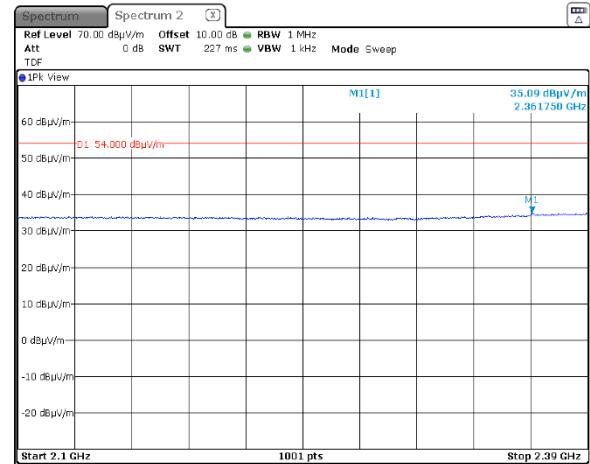
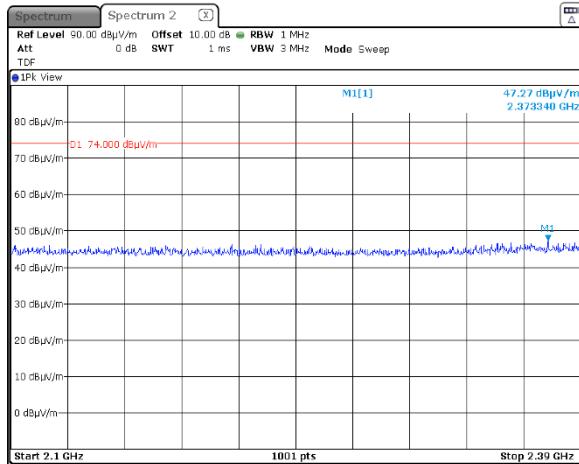
Full description is given in Appendix A.



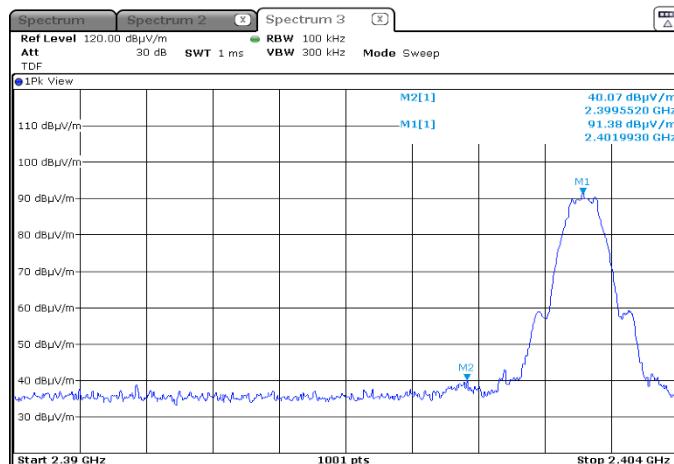
HERMON LABORATORIES

Test specification: Section 15.247(d) / RSS-247 section 5.5, Band edge emissions			
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance		
Date(s):	09-Sep-20		
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Plot 7.4.1 The highest emission level within restricted band at low carrier frequency



Plot 7.4.2 The highest emission level outside restricted band at low carrier frequency





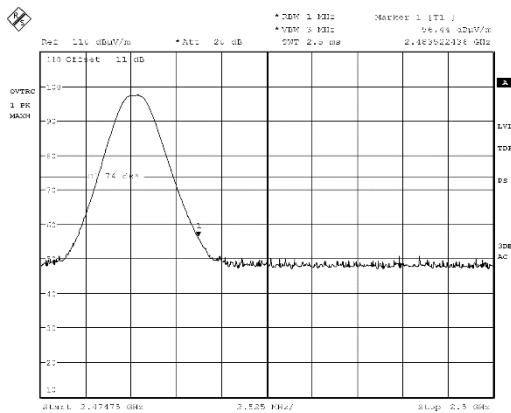
HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

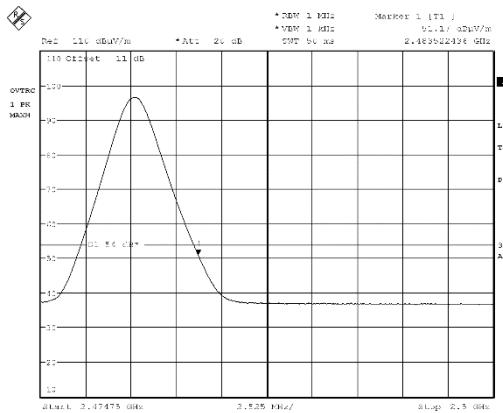
Date of Issue: 29-Oct-20

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		
Date(s):	09-Sep-20		
Temperature: 24 °C	Relative Humidity: 46 %	Air Pressure: 1007 hPa	Power: 5 VDC
Remarks:			

Plot 7.4.3 The highest emission level within restricted band at high carrier frequency



Datum: 7.OCT.2020 14:126:04



Datum: 7.OCT.2020 14:31:50



HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

Test specification: Section 15.247(e) / RSS-247 section 5.2(2), Maximum power spectral density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Aug-20			
Temperature: 25 °C	Relative Humidity: 42 %	Air Pressure: 1005 hPa	Power: 5 VDC
Remarks:			

7.5 Peak spectral power density

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)*
2400.0 – 2483.5	3.0	8.0	103.2

* - Equivalent Peak spectral power density 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 Peak spectral power density 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 Peak spectral power density 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.



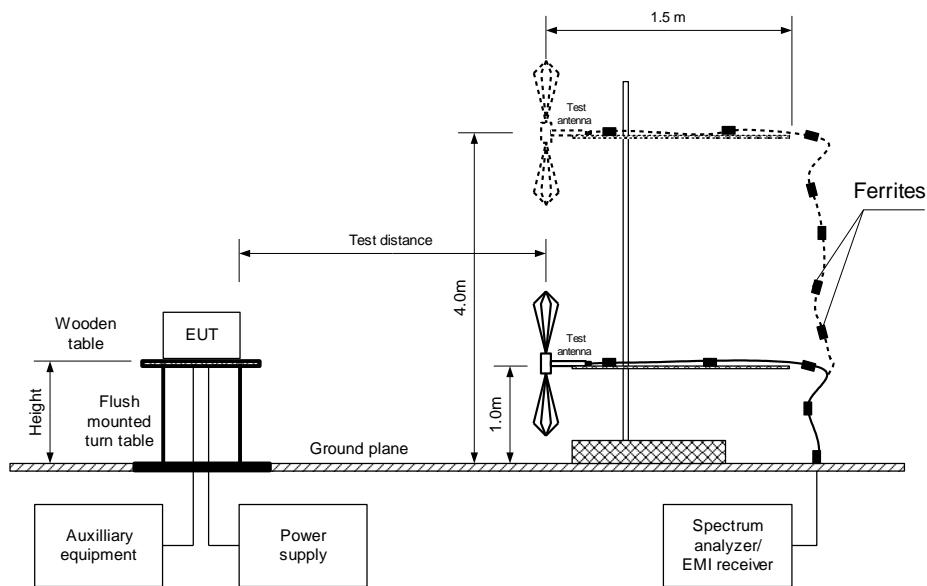
HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

Test specification: Section 15.247(e) / RSS-247 section 5.2(2), Maximum power spectral density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Aug-20			
Temperature: 25 °C	Relative Humidity: 42 %	Air Pressure: 1005 hPa	Power: 5 VDC
Remarks:			

Figure 7.5.1 Setup for carrier Peak spectral power density measurements





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Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

Test specification: Section 15.247(e) / RSS-247 section 5.2(2), Maximum power spectral density	
Test procedure:	ANSI C63.10 section 11.10.2
Test mode:	Compliance
Date(s):	30-Aug-20
Temperature: 25 °C	Relative Humidity: 42 %
	Air Pressure: 1005 hPa
	Power: 5 VDC
Remarks:	

Table 7.5.2 Peak spectral power density measurement of peak spectral power density

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
 TEST DISTANCE: 3 m
 TEST SITE: Semi anechoic chamber
 EUT HEIGHT: 1.5 m
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 3 kHz
 VIDEO BANDWIDTH: 10 KHz
 TEST ANTENNA TYPE: Double ridged guide (above 1000 MHz)
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

MODULATION/BITRATE: GFSK / 1 Mbps
 EUT CONFIGURATION: Without external 5VDC

Frequen cy, MHz	Peak spectral power density, dB(µV/m)	EUT antenna gain, dBi	Limit, dB(µV/m)	Margin, dB*	Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
2402.0	84.21	0	103.2	-18.99	Vertical	1.15	111	Pass
2442.0	80.54	0	103.2	-22.66	Vertical	1.15	111	Pass
2480.0	82.08	0	103.2	-21.12	Horizontal	1.75	15	Pass

EUT CONFIGURATION: With external 5VDC

Frequen cy, MHz	Peak spectral power density, dB(µV/m)	EUT antenna gain, dBi	Limit, dB(µV/m)	Margin, dB*	Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
2402.0	85.52	0	103.2	-17.68	Vertical	1.15	111	Pass
2442.0	80.29	0	103.2	-22.91	Vertical	1.15	111	Pass
2480.0	82.34	0	103.2	-20.86	Horizontal	1.75	15	Pass

*- Margin = Peak spectral power density - EUT antenna gain – Limit

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

Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5669	HL 5670			
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Full description is given in Appendix A.



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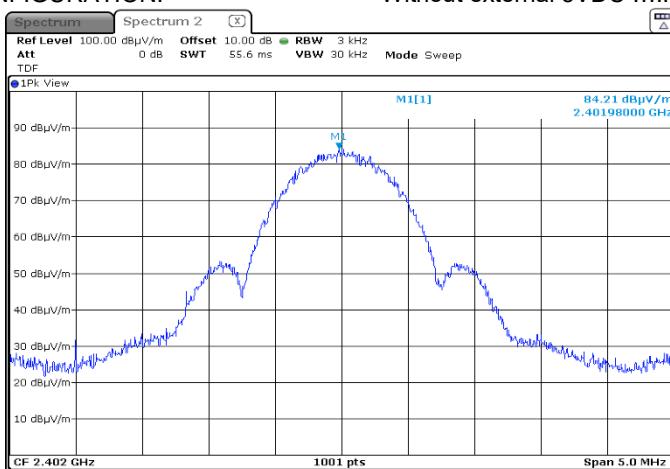
Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(e) / RSS-247 section 5.2(2), Maximum power spectral density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Aug-20			
Temperature: 25 °C	Relative Humidity: 42 %	Air Pressure: 1005 hPa	Power: 5 VDC
Remarks:			

Plot 7.5.1 Peak spectral power density of carrier at low frequency

EUT CONFIGURATION:

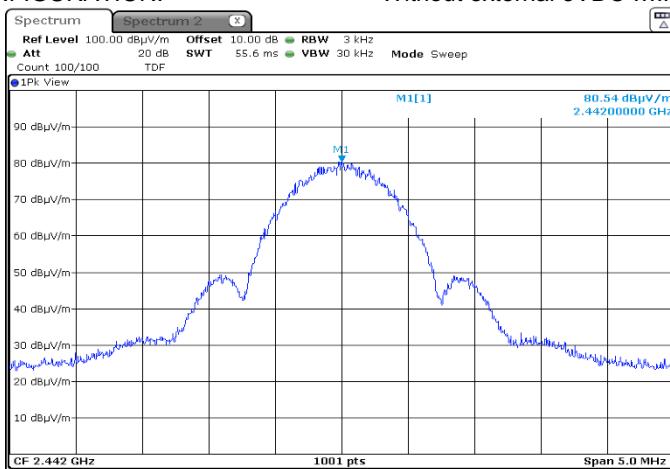
Without external 5VDC



Plot 7.5.2 Peak spectral power density of carrier at mid frequency

EUT CONFIGURATION:

Without external 5VDC





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Report ID: VAYRAD_FCC_15.247.39637_BLE

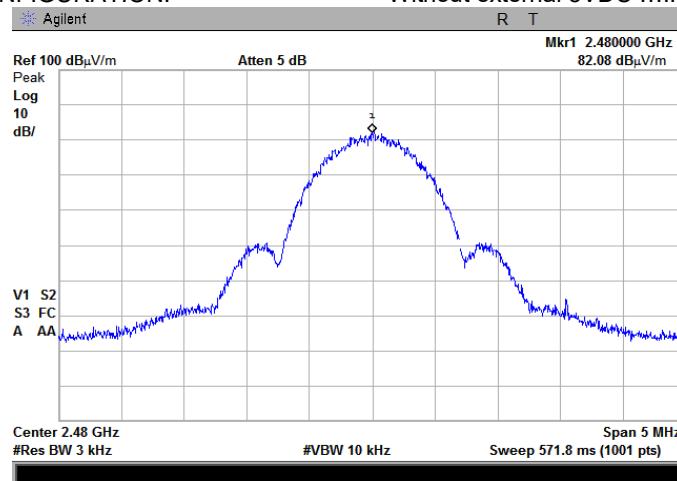
Date of Issue: 29-Oct-20

Test specification: Section 15.247(e) / RSS-247 section 5.2(2), Maximum power spectral density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Aug-20			
Temperature: 25 °C	Relative Humidity: 42 %	Air Pressure: 1005 hPa	Power: 5 VDC
Remarks:			

Plot 7.5.3 Peak spectral power density of carrier at high frequency

EUT CONFIGURATION:

Without external 5VDC





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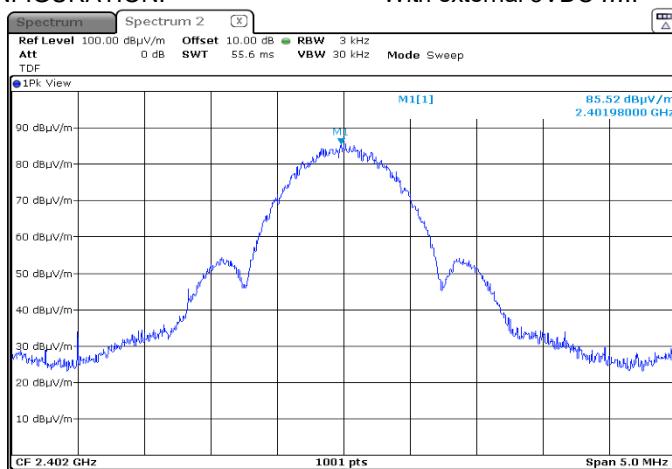
Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.247(e) / RSS-247 section 5.2(2), Maximum power spectral density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Aug-20			
Temperature: 25 °C	Relative Humidity: 42 %	Air Pressure: 1005 hPa	Power: 5 VDC
Remarks:			

Plot 7.5.4 Peak spectral power density of carrier at low frequency

EUT CONFIGURATION:

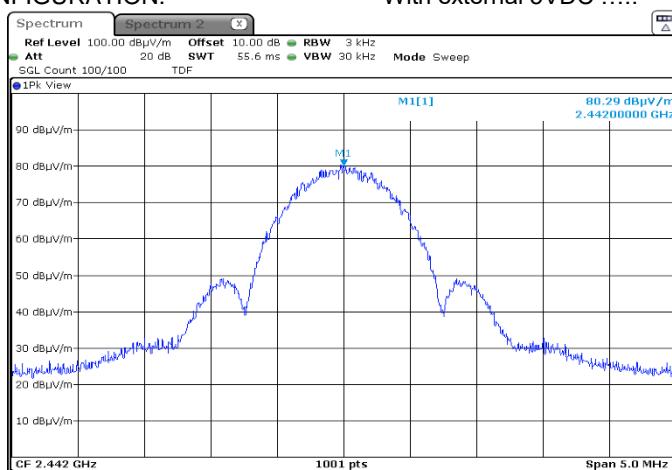
With external 5VDC



Plot 7.5.5 Peak spectral power density of carrier at mid frequency

EUT CONFIGURATION:

With external 5VDC





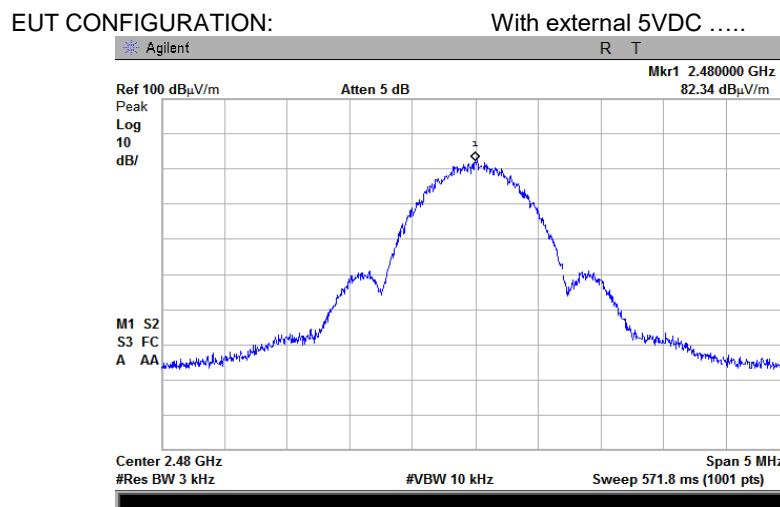
HERMON LABORATORIES

Report ID: VAYRAD_FCC_15.247.39637_BLE

Date of Issue: 29-Oct-20

Test specification: Section 15.247(e) / RSS-247 section 5.2(2), Maximum power spectral density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-Aug-20			
Temperature: 25 °C	Relative Humidity: 42 %	Air Pressure: 1005 hPa	Power: 5 VDC
Remarks:			

Plot 7.5.6 Peak spectral power density of carrier at high frequency





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Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

Test specification: Section 15.109, RSS-Gen, Section 7.3, Radiated emission			
Test procedure: ANSI C63.4, Sections 11.6 and 12.1.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Sep-20			
Temperature: 25 °C	Relative Humidity: 32 %	Air Pressure: 1010 hPa	Power: 5 VDC
Remarks: BLE			

7.6 Antenna requirements

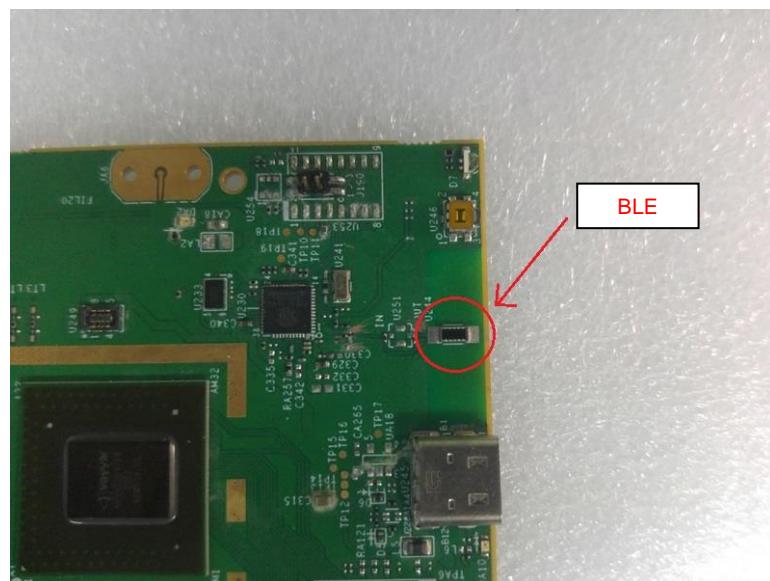
The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed 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 view





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Report ID: VAYRAD_FCC_15.247.39637_BLE
Date of Issue: 29-Oct-20

8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./Check	Due Cal./Check
0787	Transient Limiter 9 kHz-200 MHz	Hewlett Packard	11947A	3107A018 77	06-Oct-20	06-Oct-21
3016	LISN, Two-line V-network, 9 kHz to 30 MHz, (50 uH+5 Ohm), CISPR16-1, MIL-461E	Rohde & Schwarz	ESH 3-Z5	892239/00 2	09-Feb-20	09-Feb-21
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY482502 88	27-Apr-20	27-Apr-21
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFL EX 102A	1225/2A	06-Apr-20	06-Apr-21
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFL EX 102A	1226/2A	06-Apr-20	06-Apr-21
4011	Temp. & Humidity Meter, (-50 - +70) deg, (20 - 99)% RH	Mad Electronics	HTC-1	NA	12-Aug-20	12-Aug-21
4136	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000 137	23-Apr-20	23-Apr-21
4355	Signal and Spectrum Analyzer, 9 kHz to 7 GHz	Rohde & Schwarz	FSV 7	101630	09-Sep-20	09-Sep-21
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	20-Jan-20	20-Jan-21
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	06-Jan-20	06-Jan-21
5111	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/ 11SK/11S K/5500M M	502493/2EA	03-Aug-20	03-Aug-21
5397	H-field near field probe, 3 cm	ETS Lindgren	7405-902	NA	16-Aug-20	16-Aug-22
5476	Cable, BNC/BNC, 10.5 m	Western wire	MIL-C-17G	NA	14-May-20	14-May-21
5669	Cable SF126EA/11N(x2)/3.0M, 18 GHz	Huber-Suhner	SF126EA	506775/12 6EA	25-Oct-20	25-Oct-21
5670	Cable SF126EA/11N(x2)/3M, 18 GHz	Huber-Suhner	SF126EA	506774/12 6EA	25-Oct-20	25-Oct-21
5707	EMI receiver	PMM / Narda	PMM 9010F	060WW91 101	22-Nov-19	22-Nov-21



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Date of Issue: 29-Oct-20

9 APPENDIX B Test equipment correction factors

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.



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HL 5111: RF cable

Huber-Suhner, SF102EA/11SK/11SK/5500MM, s/n 502493/2EA

Set / Applied, MHz	Measured, dB	Uncertainty, dB
100	0.70	±0.07
200	0.99	±0.08
300	1.21	±0.08
500	1.56	±0.08
1000	2.20	±0.08
1500	2.69	±0.08
2000	3.11	±0.08
2500	3.50	±0.10
3000	3.85	±0.10
3500	4.16	±0.10
4000	4.47	±0.10
4500	4.74	±0.10
5000	5.03	±0.10
5500	5.30	±0.10
6000	5.57	±0.10
6500	5.76	±0.10
7000	6.00	±0.10
7500	6.20	±0.10
8000	6.44	±0.10
8500	6.67	±0.10
9000	6.82	±0.10
9500	7.04	±0.10
10000	7.18	±0.10
10500	7.36	±0.10
11000	7.55	±0.10
11500	7.75	±0.10
12000	7.90	±0.10
12500	8.08	±0.13
13000	8.19	±0.13
13500	8.39	±0.13
14000	8.58	±0.13
14500	8.76	±0.18
15000	8.92	±0.18
15500	9.03	±0.18
16000	9.18	±0.18
16500	9.34	±0.18
17000	9.51	±0.18
17500	9.66	±0.18
18000	9.80	±0.18
18500	9.94	±0.23
19000	10.05	±0.23
19500	10.22	±0.23

Set / Applied, MHz	Measured, dB	Uncertainty, dB
20000	10.32	±0.23
20500	10.48	±0.23
21000	10.60	±0.23
21500	10.73	±0.23
22000	10.87	±0.23
22500	10.97	±0.29
23000	11.09	±0.29
23500	11.26	±0.29
24000	11.37	±0.29
24500	11.50	±0.29
25000	11.61	±0.23
25500	11.72	±0.23
26000	11.87	±0.23
26500	11.99	±0.23
27000	12.09	±0.33
27500	12.24	±0.33
28000	12.34	±0.40
28500	12.47	±0.40
29000	12.61	±0.40
29500	12.70	±0.40
30000	12.86	±0.40
30500	12.92	±0.33
31000	13.09	±0.33
31500	13.16	±0.33
32000	13.33	±0.33
32500	13.40	±0.33
33000	13.62	±0.33
33500	13.70	±0.33
34000	13.88	±0.33
34500	13.97	±0.40
35000	14.05	±0.40
35500	14.23	±0.40
36000	14.25	±0.40
36500	14.46	±0.40
37000	14.49	±0.33
37500	14.72	±0.33
38000	14.77	±0.33
38500	14.97	±0.33
39000	15.04	±0.33
39500	15.22	±0.33
40000	15.63	±0.47



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10 APPENDIX C 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	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB
Vertical polarization	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.



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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-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).

Address: P.O. Box 23, Binyamina 30500, 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.



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Report ID: VAYRAD_FCC_15.247.39637_BLE
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12 APPENDIX E

Specification references

FCC 47CFR part 15: 2019	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
RSS-247 Issue 2: 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence- Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 5: 2018	General Requirements and Information for the Certification of Radiocommunication Equipment



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13 APPENDIX F Manufacturer's declaration



Declaration of Identity

We, the undersigned,

Company: Vayyar Imaging Ltd.
Address: Shabazi 26, Yehud
Country: Israel
Telephone number: +972-54-42254549

declare under our sole responsibility that the following equipment:

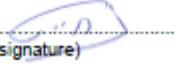
Brand/Item	Type/Model	Short Product description
Vayyar Imaging LTD.	VMPRO19CB4BAT	Handheld UWB device with optional WI-FI/BLE communication

Has an identical RF system as the following equipment:

Brand/Item	Type/Model	Short Product description
Vayyar Imaging LTD.	VMPRO19CB4WREP	Handheld UWB device with optional WI-FI/BLE communication

The reason for name change is: VMPRO19CB4BAT has an integrated battery and can be supplied by either the battery or by external power source (through USB-C port). VMPRO19CB4WREP doesn't contain battery and thus can only be powered by external power source.

29/10/2020
(date)


(signature)

Naftali Chayat
(printed name)

CTO
(position)



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14 APPENDIX G Abbreviations and acronyms

A	ampere
AC	alternating current
AM	amplitude modulation
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(µV)	decibel referred to one microvolt
dB(µV/m)	decibel referred to one microvolt per meter
dB(µA)	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
µs	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

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