

PARTIAL TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C §15.247 (DTS)

FOR:

Medtronic (Given Imaging Ltd.)

PillCam Genius SB Capsule Endoscopy Kit

Model: Genius Link Device

FCC ID: O8PPATCH

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

Client name: Medtronic (Given Imaging Ltd.)
Address: P.O. Box 258, Hermon Building, Yoqneam 2069204, Israel
Telephone: +972 73-2507584
E-mail: elad.tiran@medtronic.com
Contact name: Mr. Elad Tiran

2 Equipment under test attributes

Product name: PillCam Genius SB Capsule Endoscopy Kit
Product type: Transmitter
Model(s): Genius Link Device
Part number: PT00169361
230400098*
230400040*
230400097*
Serial numbers: 230400044*
230400086*
230400118*
Hardware version: REV 03
Software release: FW 9.0.8
Receipt date: 27-Mar-23

*The Genius Link Device contains Non-Rechargeable battery. Therefore, more than one Genius Link Device was used.

3 Manufacturer information

Manufacturer name: Given Imaging Inc.
Address: 15 Hampshire Street Mansfield MA 02048, USA
Telephone: +972 52-3142169
E-Mail: Avishag.metzer@medtronic.com
Contact name: Avishag Metzer

4 Test details

Project ID: 49769
Location: Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started: 13-Apr-23
Test completed: 07-Jun-23
Test specification(s): FCC 47CFR part 15 subpart C §15.247 (DTS)




5 Tests summary

Test	Status
Transmitter characteristics	
FCC Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth	Not required
FCC Section 15.247(b)3/ RSS-247 section 5.4(4), Peak output power	Pass*
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	Not required
FCC section 15.203 / RSS-Gen section 6.8, Antenna requirement	Not required

This test report supersedes the previously issued test report identified by Doc ID: GIVRAD_FCC.49769_BLE

*The relevant tests were performed to support Application for Class II permissive changes certification to reflect the following changes:
Permitting of another antenna for use with the specified RS9116-B0014 module, approved by FCC ID: XF6-B001P4V2P1.
The changes were implemented to enable the specified RS9116-B0014 module to be implemented in the Genius Link Device being portable device.

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:	Mrs. E. Pitt, test engineer, EMC & Radio	13-Apr-23 – 07-Jun-23	
Reviewed by:	Mrs. S. Peysahov Sheynin, certification specialist, EMC & Radio	05-Dec-23	
Approved by:	Mr. M. Nikishin, group leader, EMC & Radio	05-Dec-23	

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 PillCam Genius SB Capsule Endoscopy Kit is comprised of a (1) Genius SB capsule and (2) Genius link device.

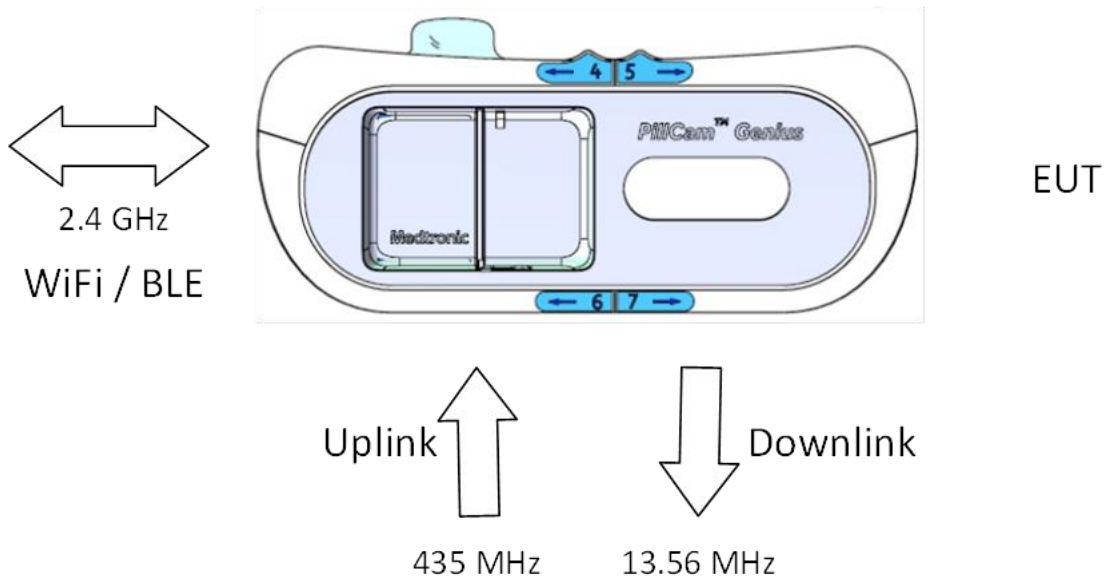
The EUT is the Genius link device: a recorder that is a single-use device worn by the patient. Together with the Genius SB capsule it enables visualization of the gastrointestinal tract. It receives the acquired images from the Genius SB capsule through a 435 MHz wireless RF communication link and stores them. The device also sends control commands to the capsule by a 13.56 MHz wireless RF communication link.

In addition, the Genius link device comprises of the below Bluetooth and W-Fi links, as follows:

WiFi 2412-2462 MHz

BLE 2402-2480 MHz

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented 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 -5.95 dBm			
Is transmitter output power variable?		V	No		
			continuous variable		
			stepped variable with stepsize		dB
		Yes	minimum RF power		dBm
		maximum RF power		dBm	
Antenna connection					
unique coupling		standard connector		V	Integral
				V	with temporary RF connector without temporary RF connector
Antenna/s technical characteristics					
Type		Manufacturer		Model number	
Internal		Medtronic		NA	
Gain		-1 dBi			
Transmitter aggregate data rate/s			2 Mbps		
Type of modulation			GFSK		
Modulating test signal (baseband)					
Transmitter power source					
V	Battery	Nominal rated voltage	3 VDC	Battery type	Non Rechargeable Li-MnO2 Battery Pack 3V/2.3Ah/6.9Wh, Tamuz P/N: THLLIM0495E19
	DC	Nominal rated voltage			
	AC mains	Nominal rated voltage		Frequency	Hz



Test specification: FCC section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-May-23 - 31-May-23			
Temperature: 23 °C	Relative Humidity: 48 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE			

7 Transmitter tests according to 47CFR part 15 subpart C requirements

7.1 Peak output power

7.1.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits according to FCC part 15 section 15.247(b)(3) and RSS-210 section A8.4(4) are given in Table 7.1.1.

Table 7.1.1 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.

7.1.2 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 adjusted to produce maximum available to end user RF output power.

7.1.2.3 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.

7.1.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.1.2 and associated plots.

7.1.2.5 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:

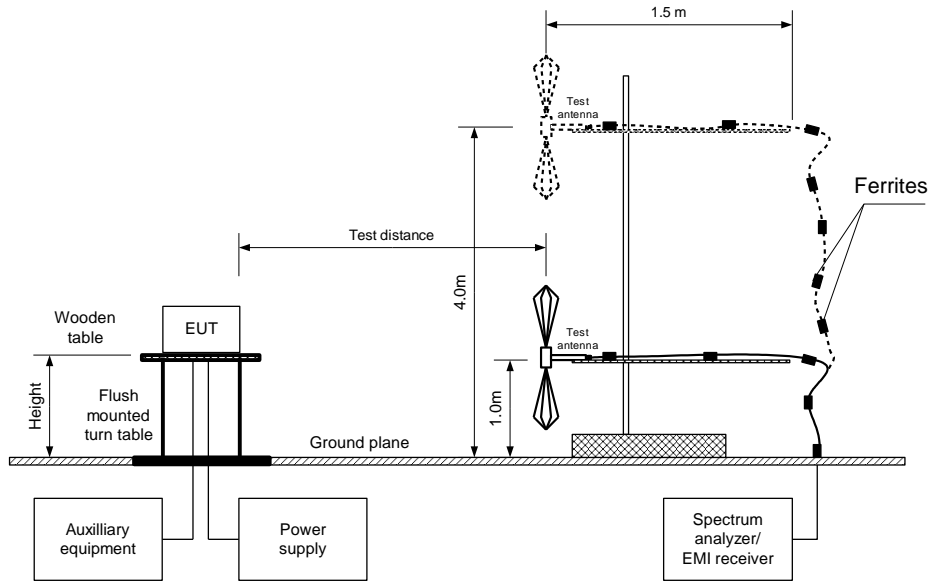
$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

7.1.2.6 The worst test results (the lowest margins) were recorded in Table 7.1.2.



Test specification: FCC section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-May-23 - 31-May-23			
Temperature: 23 °C	Relative Humidity: 48 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE			

Figure 7.1.1 Setup for carrier field strength measurements





Test specification: FCC section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-May-23 - 31-May-23			
Temperature: 23 °C	Relative Humidity: 48 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE			

Table 7.1.2 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
MODULATION: GFSK
BIT RATE: 2 Mbps
DETECTOR USED: Peak

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	88.24	Horizontal	1.1	130	-1	-5.96	30	-31.96	Pass
2440	88.25	Horizontal	1.7	170	-1	-5.95	30	-31.95	Pass
2480	85.45	Horizontal	1.8	152	-1	-8.75	30	-31.75	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.

Reference numbers of test equipment used

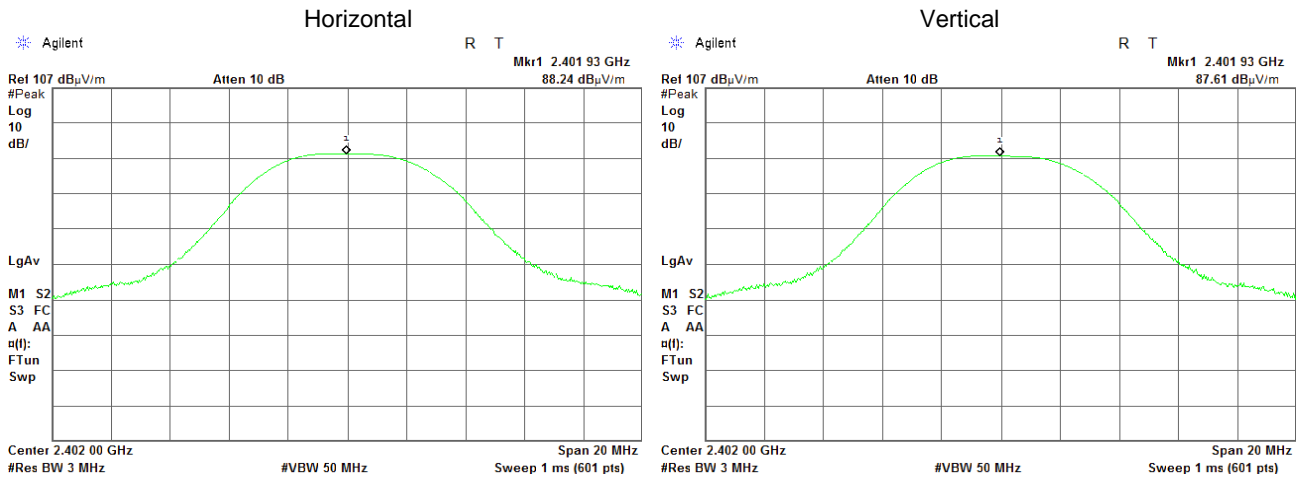
HL 7585	HL 4933	HL 3903	HL 5902				
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Full description is given in Appendix A.

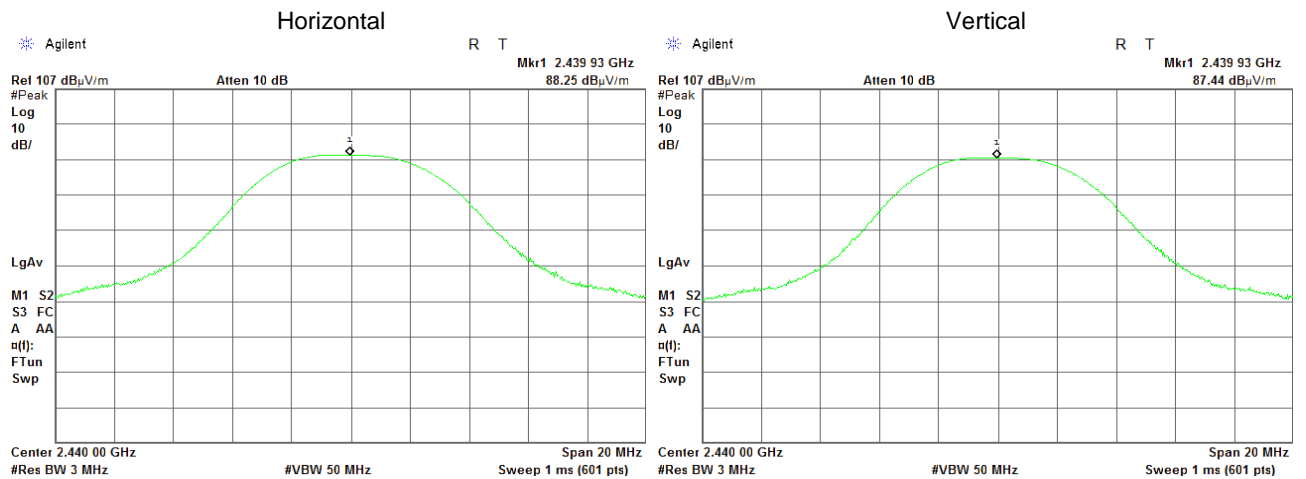


Test specification: FCC section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-May-23 - 31-May-23			
Temperature: 23 °C	Relative Humidity: 48 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE			

Plot 7.1.1 Field strength of carrier at low frequency



Plot 7.1.2 Field strength of carrier at mid frequency





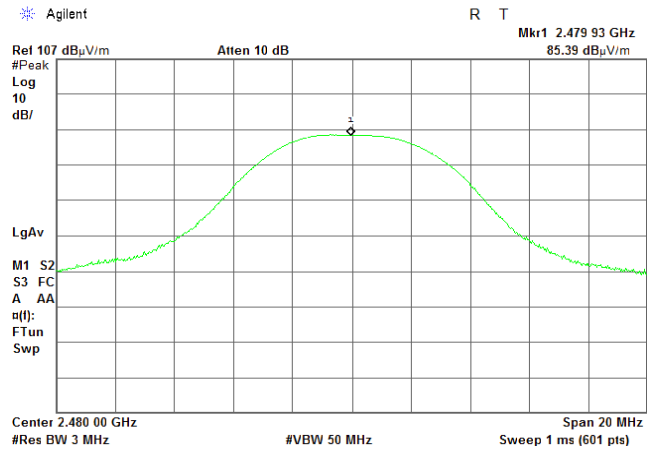
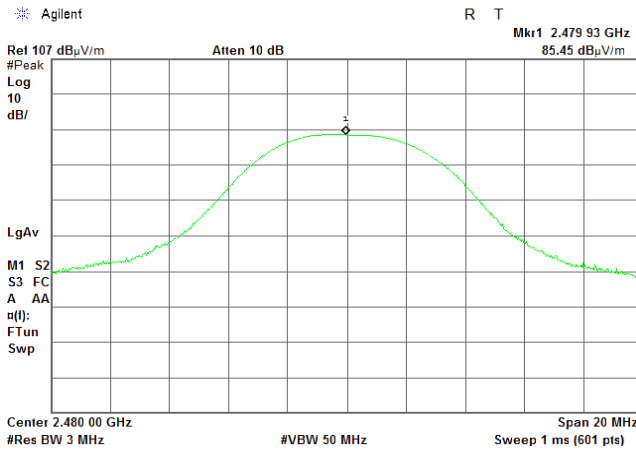
HERMON LABORATORIES

Test specification: FCC section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 30-May-23 - 31-May-23			
Temperature: 23 °C	Relative Humidity: 48 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE			

Plot 7.1.3 Field strength of carrier at high frequency

Horizontal

Vertical





Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

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 according to FCC part 15 section 15.247(c) and RSS-210 section 6.2.2(o)(e1) 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	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:

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

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

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

*** - 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 1.1.3, 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.



Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

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

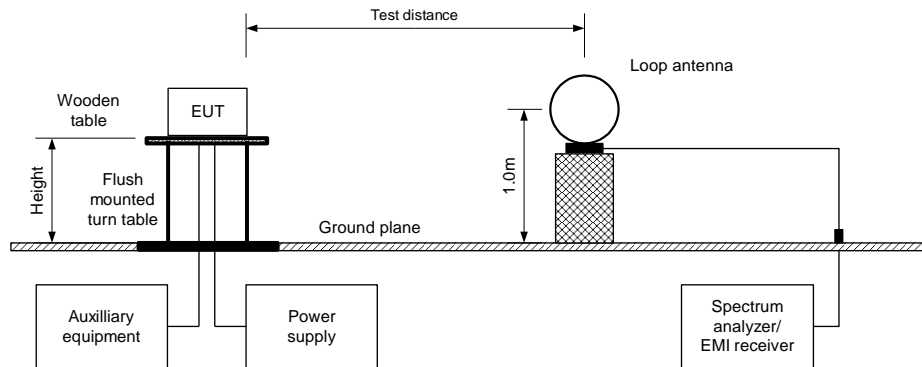
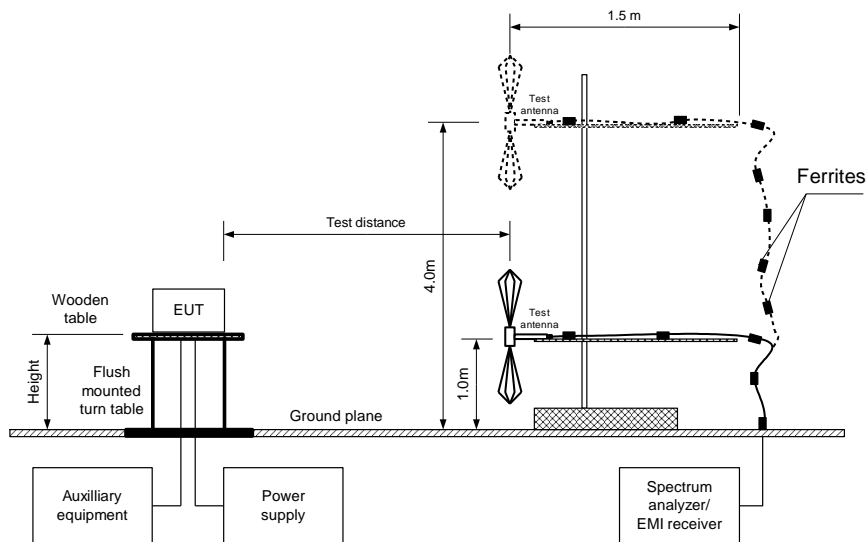


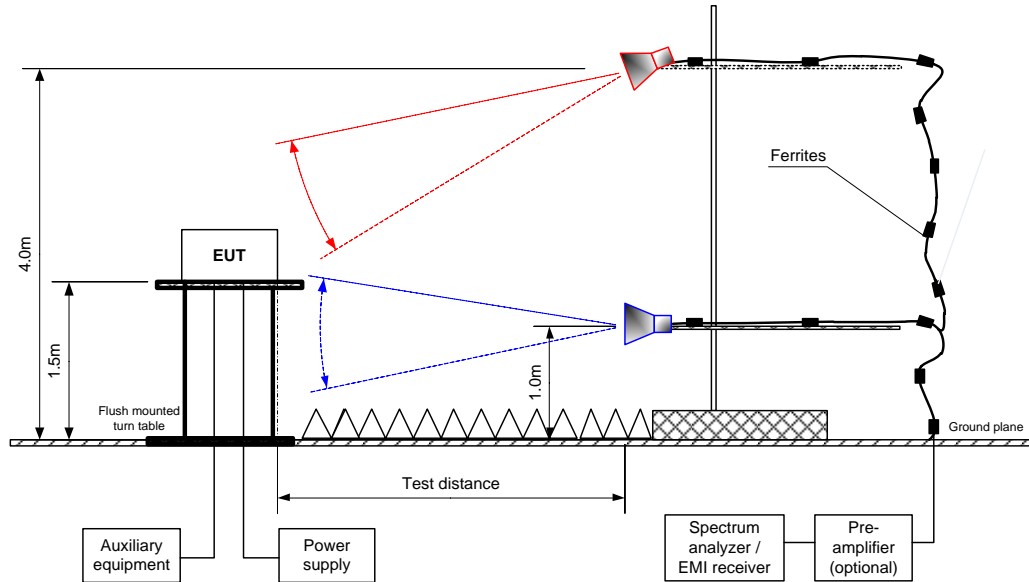
Figure 7.2.2 Setup for spurious emission field strength measurements in 30 -1000 MHz





Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

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





Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

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: 2 Mbps
 DUTY CYCLE: 100 %
 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
Low carrier frequency									
764.441	46.64	Horizontal	1.00	-170	86.83	40.19	20.0	20.19	Pass
840.418	47.46	Horizontal	1.61	-170	86.83	39.37	20.0	19.37	Pass
867.254	48.68	Horizontal	1.44	180	86.83	38.15	20.0	18.15	Pass
Mid carrier frequency									
764.445	46.44	Horizontal	1.00	-171	87.98	41.54	20.0	21.54	Pass
840.425	47.14	Horizontal	1.61	-171	87.98	40.84	20.0	20.84	Pass
867.258	48.13	Horizontal	1.42	180	87.98	39.85	20.0	19.85	Pass
High carrier frequency									
764.448	46.36	Horizontal	1.00	-170	84.14	37.78	20.0	17.78	Pass
840.403	47.30	Horizontal	1.61	-171	84.14	36.84	20.0	16.84	Pass
867.243	47.97	Horizontal	1.41	180	84.14	36.17	20.0	16.17	Pass

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

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



Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

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: 2 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			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***	
Low, mid, high carrier frequency											Pass
No spurious emissions were found											

- *- EUT front panel refers to 0 degrees position of turntable.
- **- Margin = Measured field strength - specification limit.
- ***- Margin = Calculated field strength - specification limit,

Table 7.2.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Number of pulses within 100 ms	Duration, ms	Period, ms		
0.54	81	NA	NA	NA	-7.18

*- Average factor was calculated as follows

$$Average\ factor = 20 \log x \left[\frac{RF\ pulse\ duration \times Number\ of\ RF\ pulses\ within\ observation\ period}{Observation\ period\ (100\ ms)} \right]$$



Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

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: 2 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
		Measured emission, dB(µV/m)	Limit, dB(µV/m)	Margin, dB*				
Low, mid, high carrier frequency								
No spurious emissions were found								Pass

*- Margin = Measured emission - specification limit.
 **- EUT front panel refer to 0 degrees position of turntable.



Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

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	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Reference numbers of test equipment used

HL5410	HL 7585	HL 3903	HL 5902	HL5288	HL 0446	HL 4933	HL 4956
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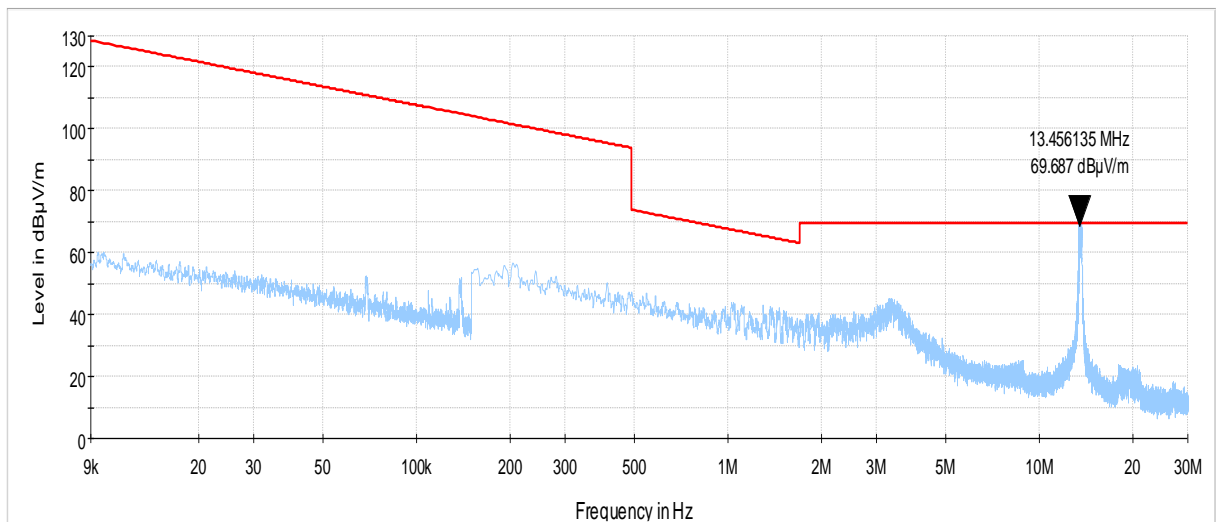
Full description is given in Appendix A.



Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

Plot 7.2.1 Radiated emission measurements from 9 kHz to 30 MHz at the low carrier frequency

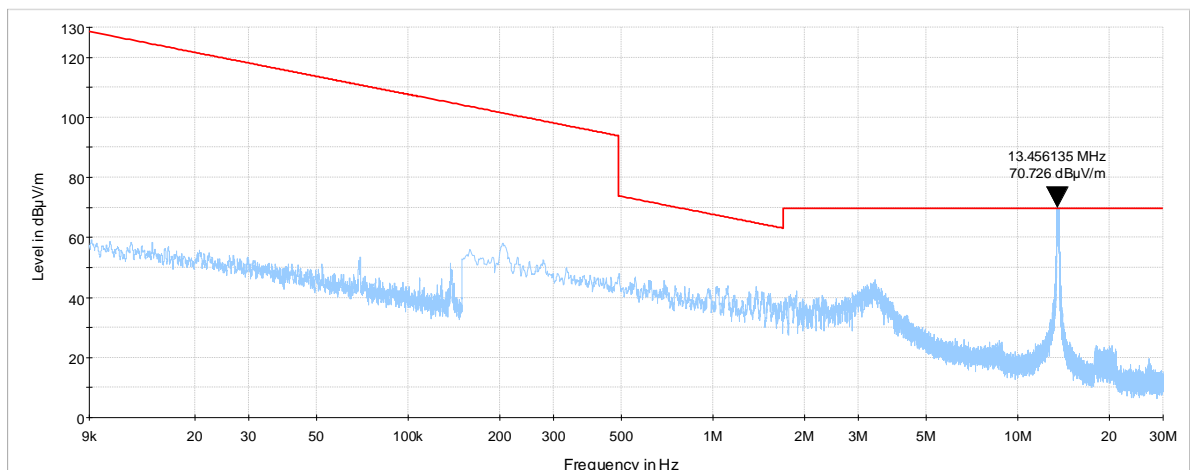
TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical



Note: Frequency 13.456 MHz – 13.56 MHz wireless RF communication link in the Genius link device

Plot 7.2.2 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



Note: Frequency 13.456 MHz – 13.56 MHz wireless RF communication link in the Genius link device

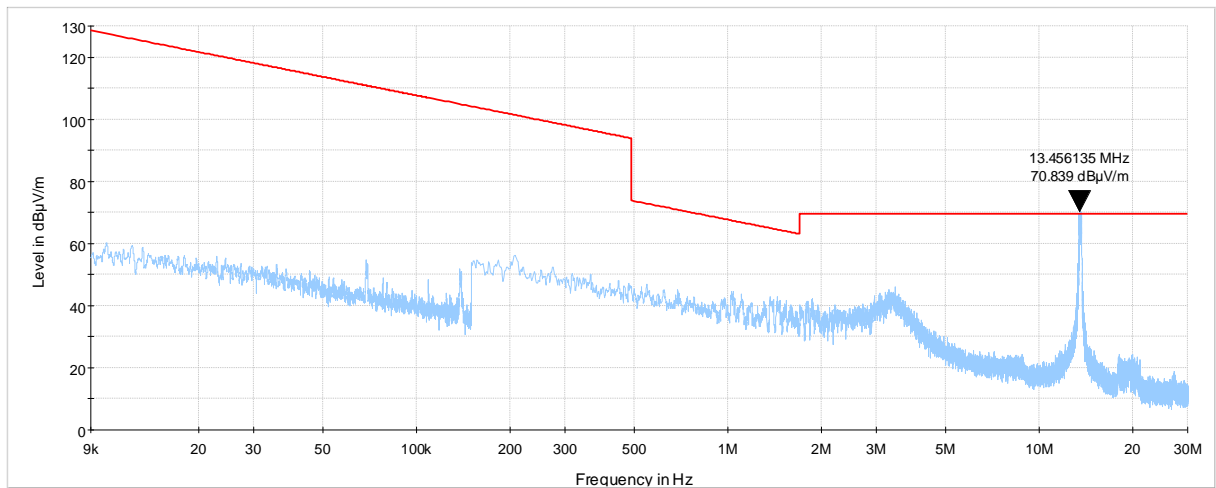


HERMON LABORATORIES

Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

Plot 7.2.3 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



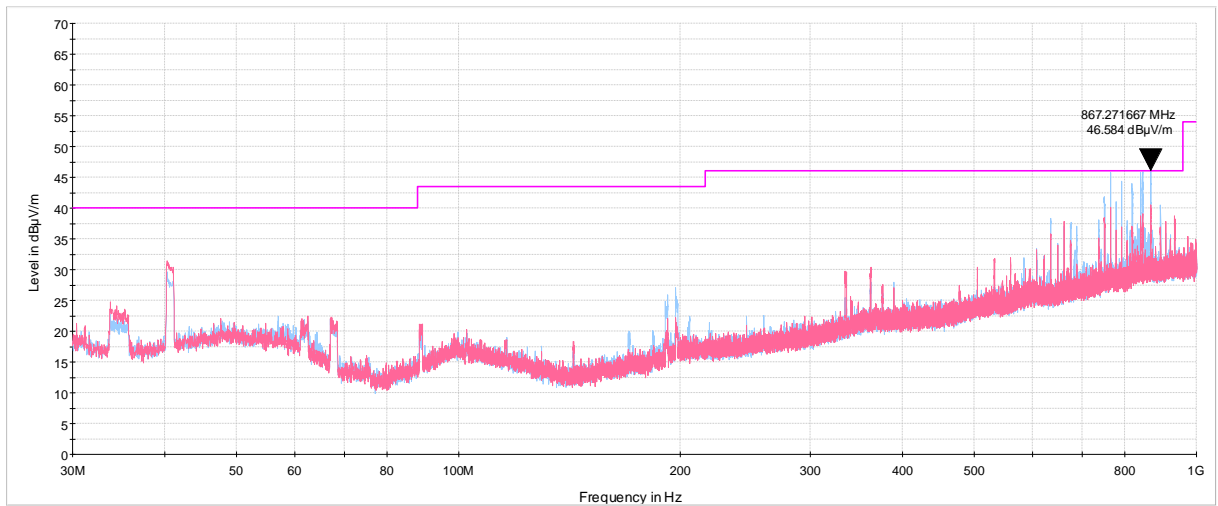
Note: Frequency 13.456 MHz – 13.56 MHz wireless RF communication link in the Genius link device



Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

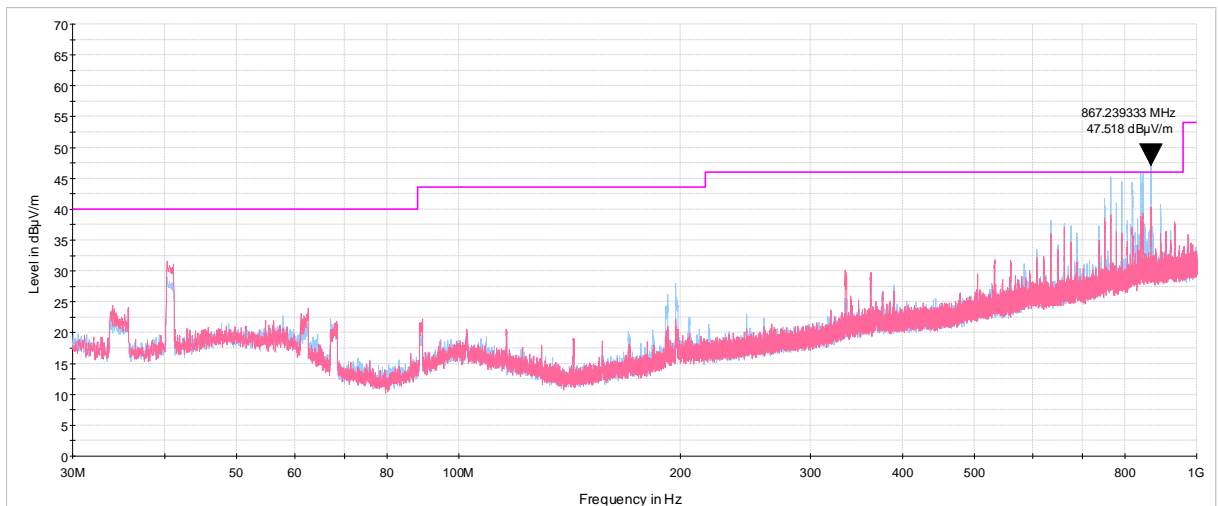
Plot 7.2.4 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

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



Plot 7.2.5 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

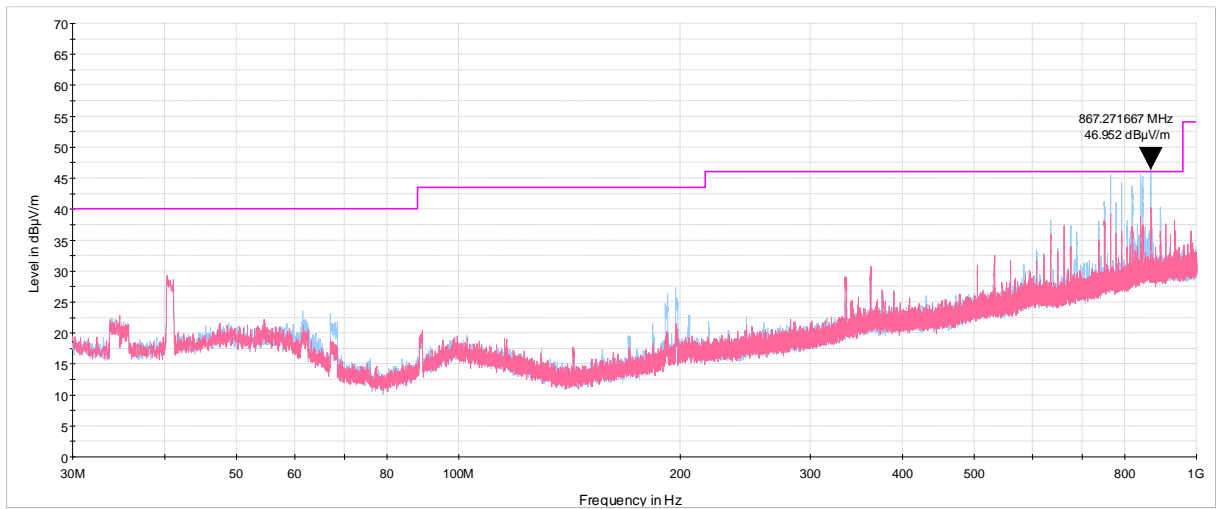




Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

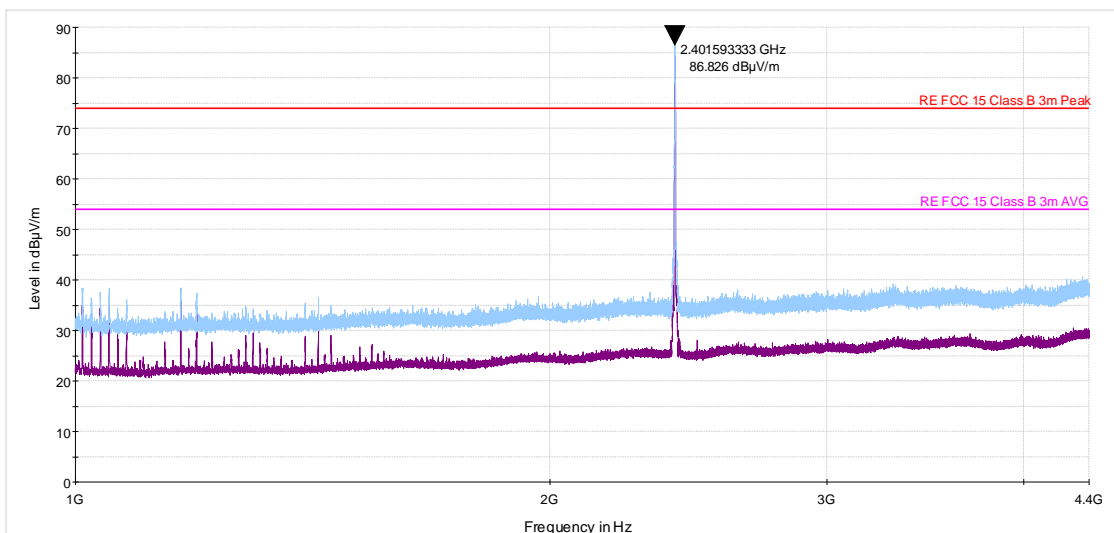
Plot 7.2.6 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

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



Plot 7.2.7 Radiated emission measurements from 1000 to 4400 MHz at the low carrier frequency

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

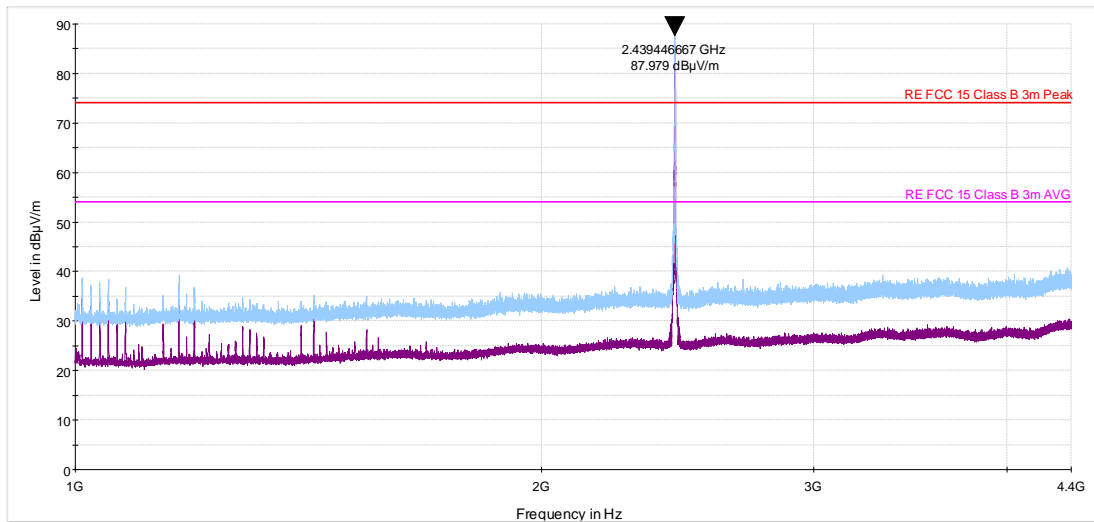




Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

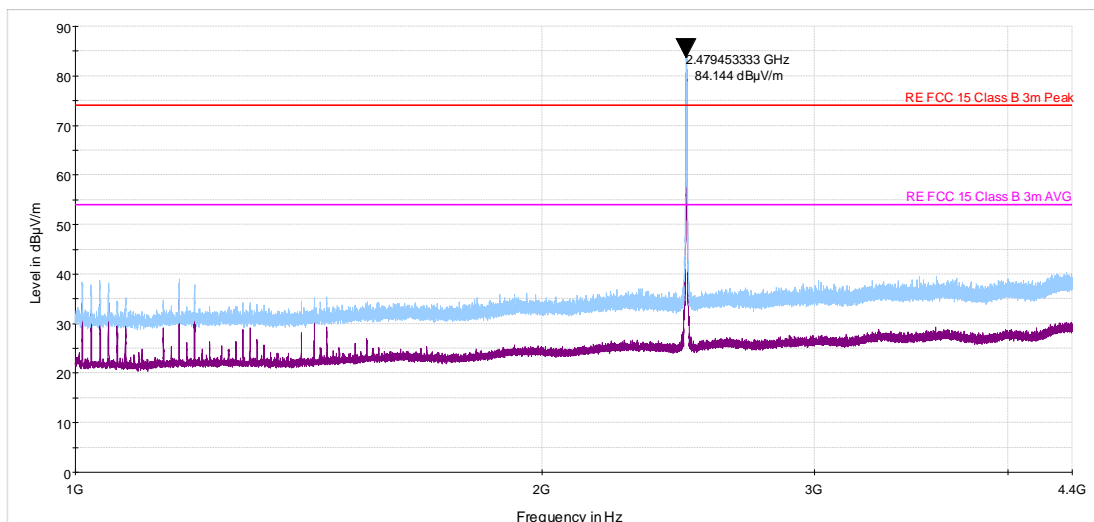
Plot 7.2.8 Radiated emission measurements from 1000 to 4400 MHz at the mid carrier frequency

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



Plot 7.2.9 Radiated emission measurements from 1000 to 4400 MHz at the high carrier frequency

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

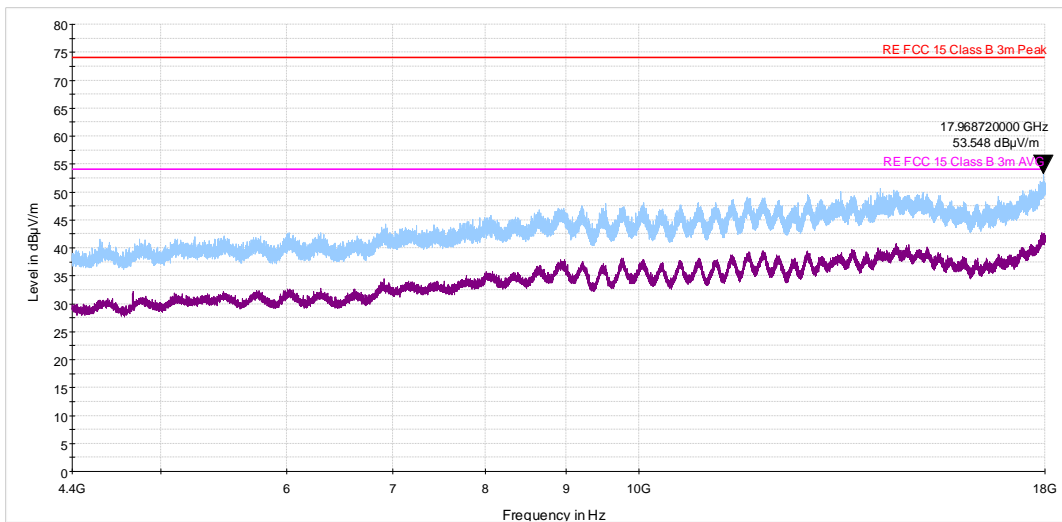




Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

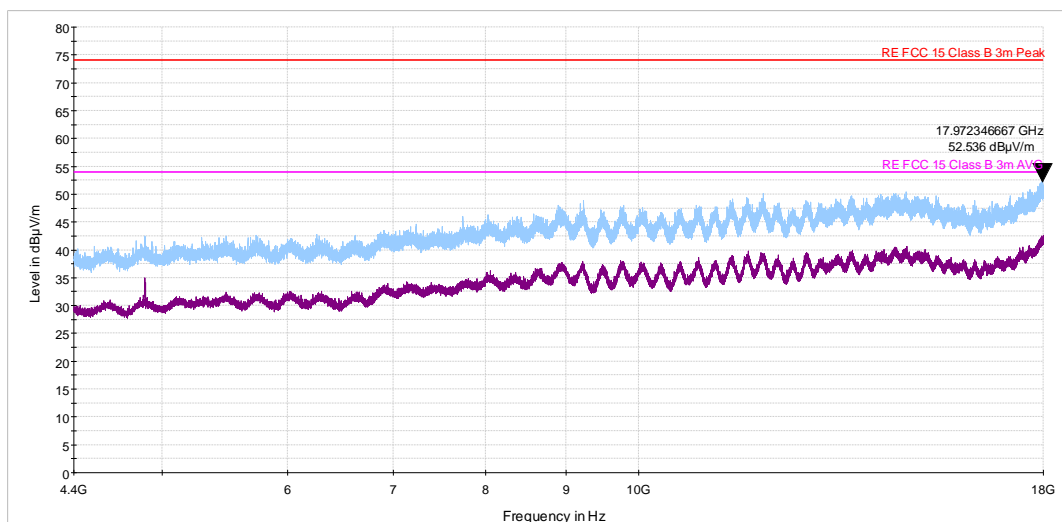
Plot 7.2.10 Radiated emission measurements from 4400 to 1800 MHz at the low carrier frequency

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



Plot 7.2.11 Radiated emission measurements from 4400 to 18000 MHz at the mid carrier frequency

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

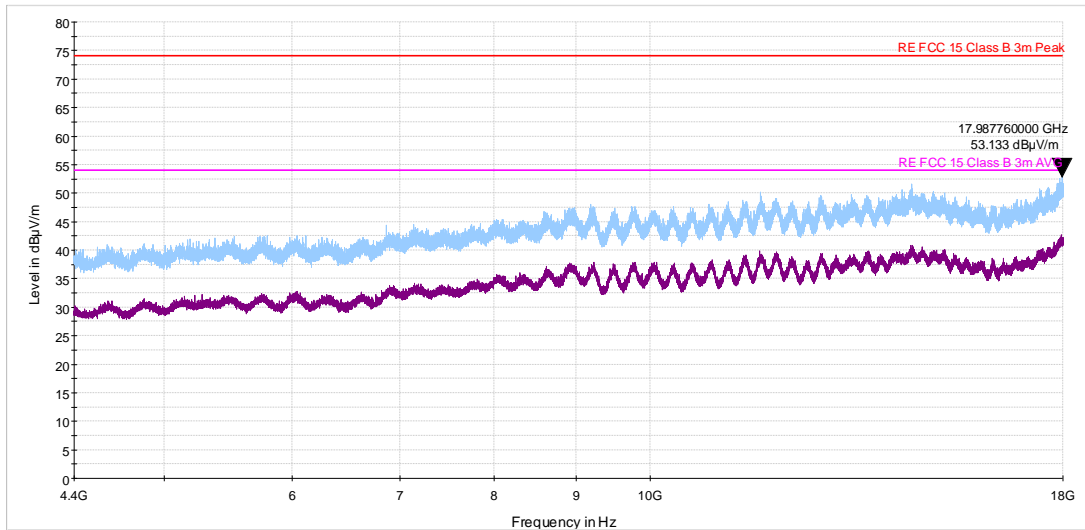




Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

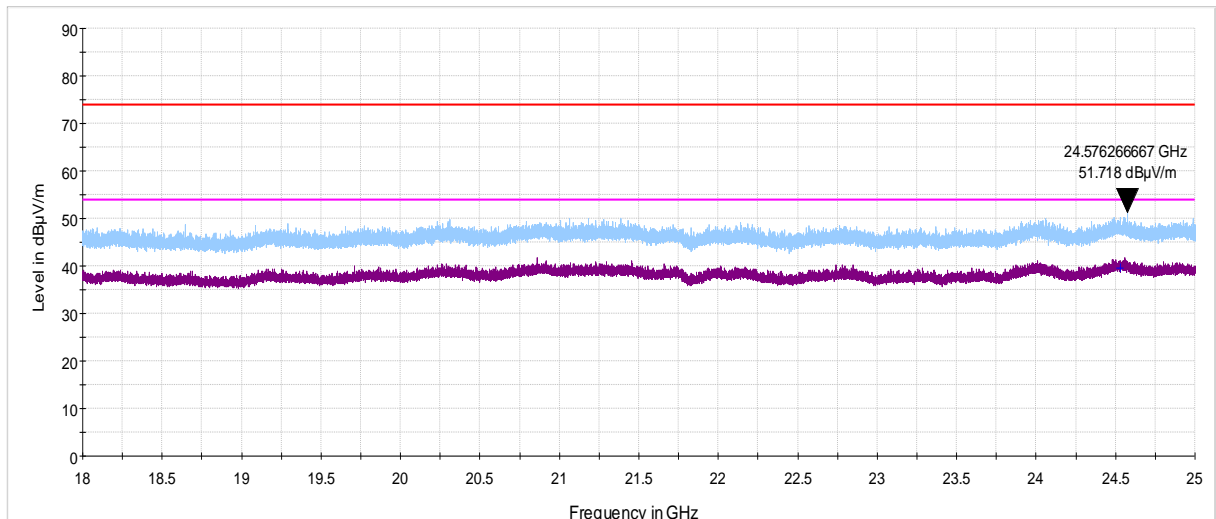
Plot 7.2.12 Radiated emission measurements from 4400 to 18000 MHz at the high carrier frequency

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



Plot 7.2.13 Radiated emission measurements from 18000 to 25000 MHz at the low carrier frequency

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

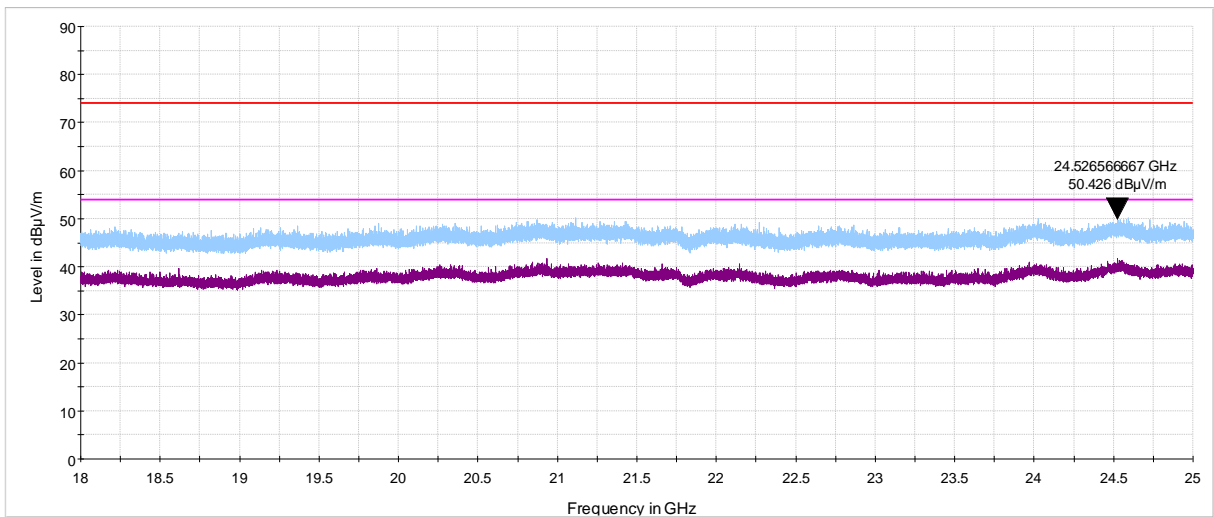




Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

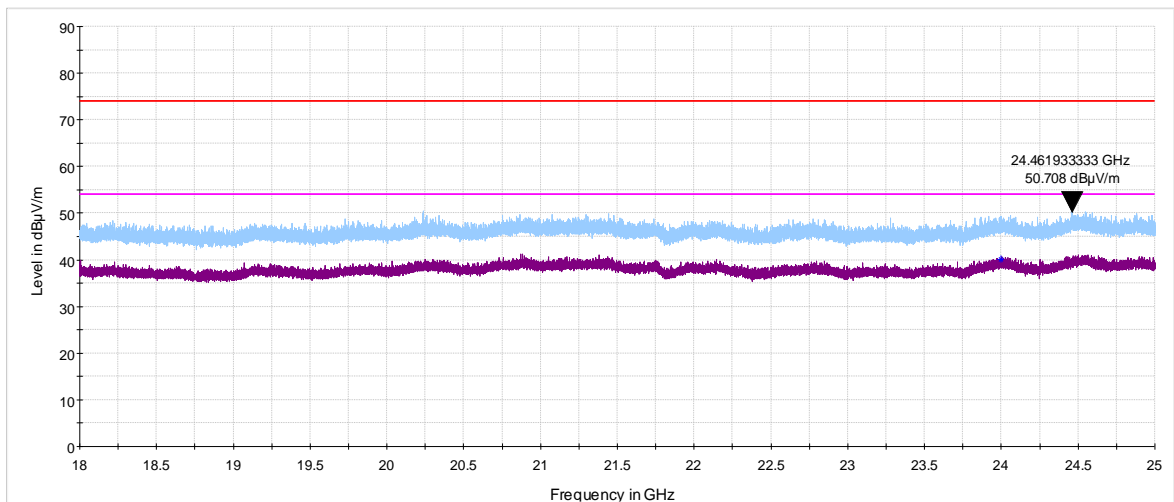
Plot 7.2.14 Radiated emission measurements from 18000 to 25000 MHz at the mid carrier frequency

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



Plot 7.2.15 Radiated emission measurements from 18000 to 25000 MHz at the high carrier frequency

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

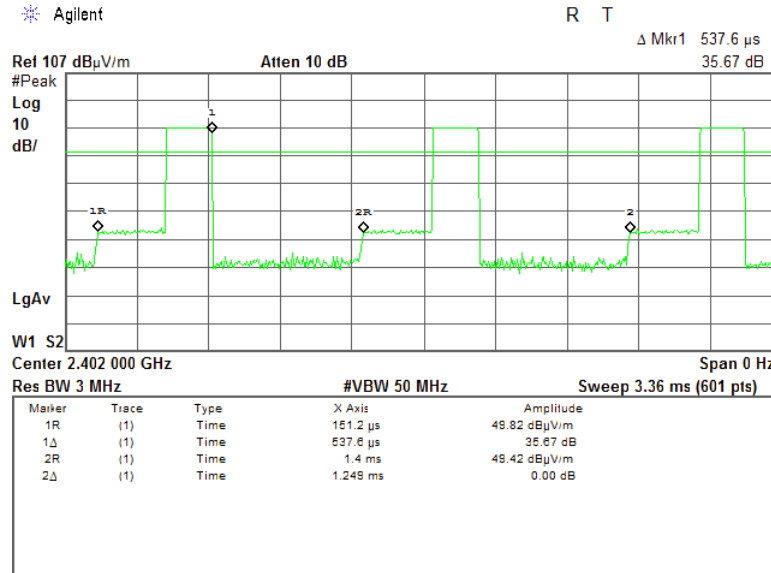




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Test specification: FCC section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE + 13.56 MHz			

Plot 7.2.16 Transmission pulse duration and period





Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE +13.56 MHz			

7.3 Band edge radiated emissions

7.3.1 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 7.3.1.

Table 7.3.1 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 -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.

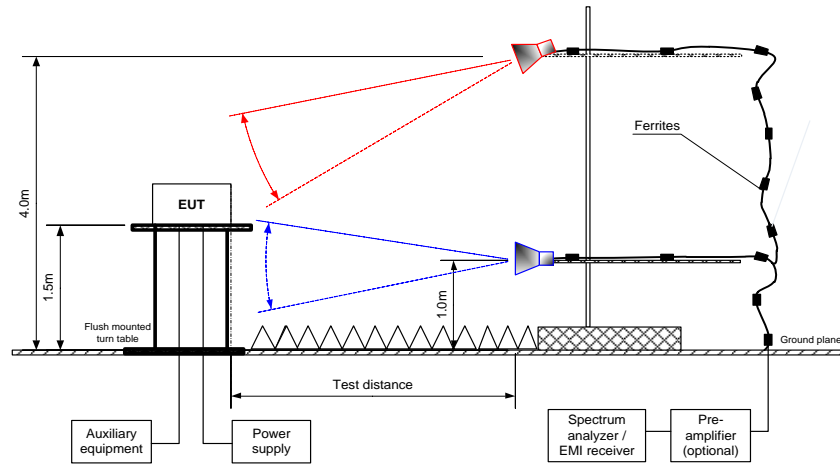
7.3.2 Test procedure

- 7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized normally modulated at the maximum data rate and its proper operation was checked.
- 7.3.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.3.2.3 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.
- 7.3.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.3.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.3.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.3.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.



Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE +13.56 MHz			

Figure 7.3.1 Band edge emission test setup





Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE +13.56 MHz			

Table 7.3.2 Band edge emission outside restricted bands test results

ASSIGNED FREQUENCY RANGE: 2400 -2483.5 MHz
DETECTOR USED: Peak
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: ≥ RBW

MODULATION/BITRATE: GFSK / 2 Mbps

Frequency, MHz	Band edge emission, dB(μV/m)	Emission at carrier, dB(μV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
2400.000	60.03	87.17	27.14	20.0	7.14	Pass

*- Margin = Attenuation below carrier – specification limit.

Table 7.3.3 Band edge emission inside restricted bands test results

ASSIGNED FREQUENCY RANGE: 2400 -2483.5 MHz
DETECTOR USED: Peak
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
RESOLUTION BANDWIDTH: 1000 kHz
VIDEO BANDWIDTH: ≥ RBW

MODULATION/BITRATE: GFSK / 2 Mbps

Frequency, MHz	Peak field strength			Calculated Average field strength**			Verdict
	Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	
2390.0	51.86	74.0	22.14	44.53	54.0	-9.47	Pass
2483.5	56.67	74.0	17.33	49.34	54.0	-4.66	Pass

*- Margin = Attenuation below carrier – specification limit.

** - Calculated field strength = Measured field strength + average factor

Table 7.3.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Number of pulses within 100 ms	Duration, ms	Period, ms		
0.54	81	NA	NA	NA	-7.18

*- Average factor was calculated as follows

$$\text{Average factor} = 20 \log x \left[\frac{\text{RF pulse duration} \times \text{Number of RF pulses within observation period}}{\text{Observation period (100 ms)}} \right]$$

Reference numbers of test equipment used

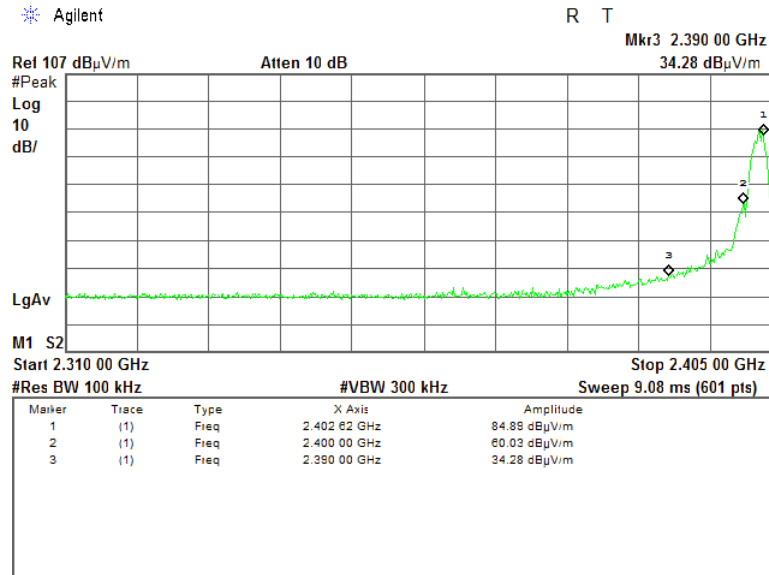
HL 4933	HL 5410	HL 5902				
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Full description is given in Appendix A.

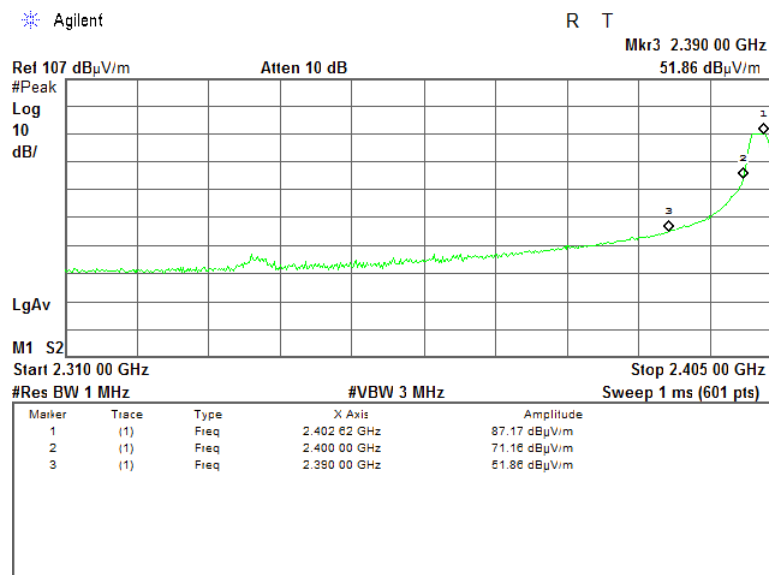


Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE +13.56 MHz			

Plot 7.3.1 The highest emission level outside restricted band at low carrier frequency



Plot 7.3.2 The highest emission level within restricted band at low carrier frequency

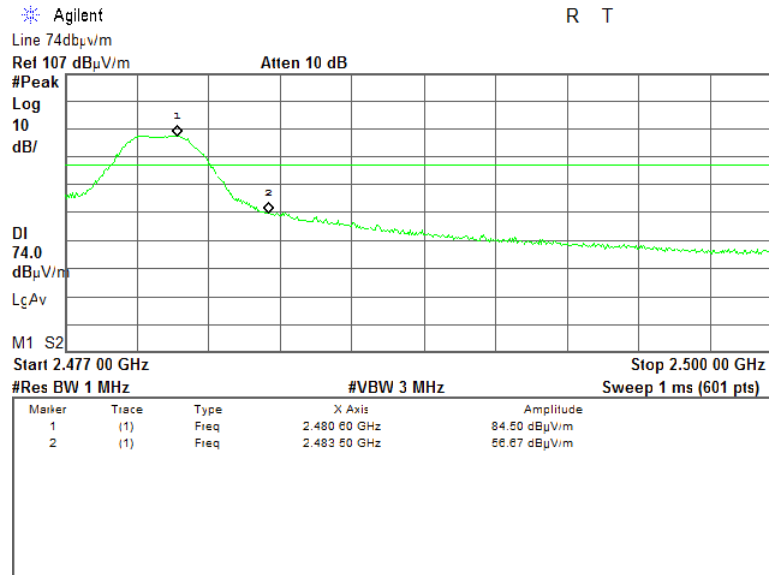




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Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Apr-23			
Temperature: 23 °C	Relative Humidity: 56 %	Air Pressure: 1012 hPa	Power: 3 VDC
Remarks: BLE +13.56 MHz			

Plot 7.3.3 The highest emission level within restricted band at high carrier frequency





8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	07-Mar-23	07-Mar-24
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFL EX 102A	1226/2A	07-Apr-22	07-Apr-23
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	19-Jan-23	19-Jan-24
4956	Active horn antenna, 18 to 40 GHz	COM-POWER CORPORATION	AHA-840	105004	08-Mar-23	08-Mar-24
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	24-Mar-22	24-Mar-25
5902	RF cable, 18 GHz, 6.0m, N-type	Huber-Suhner	SF126EA/11N/11N/6000	NA	08-Dec-22	08-Dec-23
5410	RF cable, 40 GHz, SMA-SMA, 5.5 m	Huber-Suhner	SF102EA/11SK/11SK/5500MM	503974/EA	27-07-23	27-07-24
7585	EMI Test Receiver, 1 Hz to 44 GHz	Rohde & Schwarz	ESW44	103130	19-May-22	19-Nov-23



9 APPENDIX B Test equipment correction factors

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

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

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

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

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

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

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

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



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

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

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

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

above 1000 MHz

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

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

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



10 APPENDIX C Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted 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.



HERMON LABORATORIES

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 relevant parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; Recognized by Innovation, Science and Economic Development Canada for wireless and terminal testing (ISED), ISED #2186A, CAB identifier is IL1001; Certified by VCCI, Japan (the registration numbers for OATS are R-10808 for RE measurements below 1 GHz, G-20112 for RE measurements above 1 GHz, R-11082 for anechoic chamber for RE measurements below 1 GHz, 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 3055001, Israel.
Telephone: +972 4628 8001
Fax: +972 4628 8277
e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

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

12 APPENDIX E Specification references

FCC 47CFR part 15: 2020
ANSI C63.10: 2013

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



13 APPENDIX F Abbreviations and acronyms

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
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
OATS	open area test site
Ω	Ohm
PS	power supply
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt

END OF DOCUMENT