NOW PART OF HERMON LABORATORIES

Electromagnetic Compatibility Test Report

Test Report No: QT-SUPEMC_FCC.49200_TR
Issued on: April 19, 2023

Product Name
PureOne 3.0
P/N: PRF-PUREONE3.0
FCC ID: 2BAX3PRFPUREONE3
IC: 22778-PRFPUREONE3

Tested According to
FCC 47 CFR part 15 subpart C §15.247

Tests Performed for
SuperCom LTD
3 Rothschild St, Tel Aviv,6688106, Israel**,** Tel Aviv, Israel 6713412
Tel.: +972-9-8890880

QualiTech EMC Laboratory
43 Hasivim Street, POB 7500
Petah-Tikva, 4951169, Israel
Tel: +972-4-6268494

ACCREDITED
CERTIFICATE #1633.01

Test Personnel

Testing performed by	**Guy Arhondov**	
	Izak Shtir	
Test report prepared by	**Bina Talkar**	
Test report reviewed by	**Michael Gudovsky**	
Test report approved by	**Michael Nikishin** **Group Manager**	

Test Report details:

Test commencement date: 21.12.2022

Test completion date: 22.12.2022

Applicant's representative: Boaz Polak

Issued on: 19.04.2023

Revision details:

Version	Date	Details/Reasons
Rev. 1	19.04.2023	-

Assessment information:

This report contains an assessment of the EUT against Electromagnetic Compatibility based upon tests carried out on the samples submitted. The results contained in this report relate only to the items tested. Manufactured products will not necessarily give identical results due to production and measurement tolerances. QualiTech, EMC Lab does not assume responsibility for any conclusion and generalization drawn from the test results with regards to other specimens or samples of type of the equipment represented by test item.
The EUT was setup and exercised using the configuration, modes of operation and arrangements defined in this report only.

Modifications:

Modifications made to the EUT

None

Modifications made to the Test Standard

None

Summary of Compliance Status

The EUT was tested according to the following test methods.
Test results are given in full in section 3 - 7.

Test Case	Remarks
Minimum 6 dB bandwidth	Pass
Maximum peak output power	Pass
Peak power spectral density	Pass
Spurious emissions outside restricted bands	Pass
Band Edge Radiated Emissions	Pass

Table of Contents

1. General

1.1. Referenced documents:

FCC Part 15	Code of Federal Regulations (Washington, DC: Federal Communications Commission), Title 47, Part 15, Subpart C
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.2. General Description

Following data in this clause is provided by the customer and represents his sole responsibility

1.2.1. General Description

PureOne Ankle Bracelet, is a monitoring device, powered from Lithium polymer rechargeable battery, based on or GPS position which sent to servers by Cellular network.

PureOne Ankle Bracelet is indoor/outdoor device.

The PureOne Ankle Bracelet is a monitoring device worn by court-restricted house arrest offenders or GPS monitored individuals. PureOne communicates with monitoring servers and is used in conjunction with correctional or law enforcement agencies to enforce a court decision.

Product environment/platform/ classification: IP68

Main functionality of equipment: GPS monitoring

Supplied power: Internal Lithium Polymer rechargeable battery 1350mAh@3.7V

BLE link description: Bluetooth 5.1 module with a powerful Arm Cortex-M4 with FPU and u-connect software pre-flashed. The u-connect software in NINA-B41 modules provides support for u-blox Bluetooth low energy Serial Port Service, GATT client and server, beacons, NFC™, and simultaneous peripheral and central roles – all configurable from a host using AT commands. NINA-B410 modules provide top grade security, thanks to secure boot, which ensures the module only boots up with original u-blox software. NINA-B410 has an U.FL connector for use with an external antenna.

FCC ID of the approved cellular module: FCC ID: RI7LE910CXSAX

1.2.2. Test configuration

Standalone configuration

1.3. Transmitter characteristics

Type of equipment								
	Stand-alone (Equipment with or without its own control provisions)							
V	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 -0.48 dBm							
Is transmitter output power variable?	**V**	No						
		Yes		continuous variable				
				stepped variable with step size	dB			
			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	u-blox	Printed	Typ peak gain: 3 dBi					
Transmitter aggregate data rate/s	1 Mbps							
Type of modulation	GFSK							
Modulating test signal (baseband)								
Transmitter power source								
V	Battery	**Nominal rated voltage**	3.3V	Battery type				
	DC	**Nominal rated voltage**	VDC					
	AC mains	**Nominal rated voltage**		Frequency	Hz			

2. Test Facility & Uncertainty of Measurement

2.1. Accreditation/ Registration reference:

- *A2LA Certificate Number: 1633.01*
- *FCC Registration Number: IL10006*

2.2. Test Facility description

The tests were performed at the EMC Laboratory, QualiTech

Address: 43, Hasivim Street, Petah Tikva, Israel.
Tel: +972-4-6268494

Semi Anechoic Configuration:

Measurement distance	3m
Chamber dimensions	9.5m x 6.5m x 5.2m
Antenna height	1 - 4m
Shielding Effectiveness	Magnetic field ≥80dB at 15 kHz ≥90dB at 100 kHz Electric field >120dB from 1 MHz to 1 GHz >110dB from 1 GHz to 10 GHz
Absorbing material	Ferrite tiles on the walls and ceiling Emerson and Cuming absorbing material in selected positions on the walls
Normalized Site Attenuation measured at 5 positions	±3.9dB, 30 MHz to 200 MHz ±3dB, 200 MHz to 1000 MHz
Transmission Loss measured at 5 positions, at 1.5m height	±3dB, 1 GHz to 18 GHz

2.3. The measurement software used:

Software Name	Software Version
Test Software “TILE”	Ver.7.1.4.10 & Ver.7.4.2.5

3. Minimum 6 dB bandwidth

Date of Test: 14.02.2023
Relative Humidity: 48%
Ambient Temperature: 21°C
Atmospheric Pressure: 1011.4 hPa
Test performed by: Izak Shtir

Test procedure: 11.8 for BW measurements

3.1. General

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

Table 3.1: 6 dB bandwidth limits

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

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

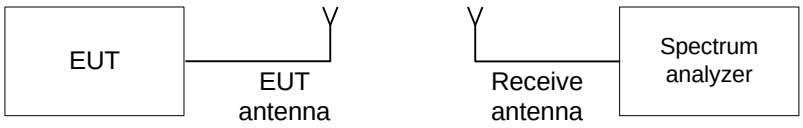
3.2. Test procedure

The EUT was set up as shown in Figure 3.1, energized and its proper operation was checked.

The EUT was set to transmit modulated carrier.

The transmitter minimum 6 dB bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 3.2 and associated plots.

Figure 3.1: 6 dB bandwidth test setup



3.3. List of Test Equipment:

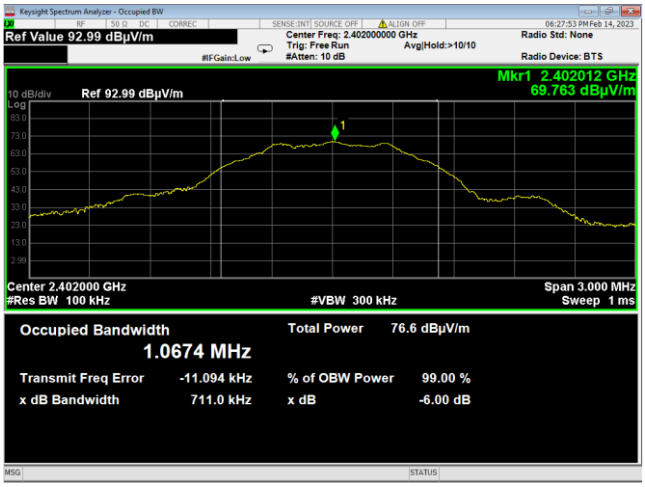
Refer to appendix A for complete list of equipment used and respective calibration dates.

3.4. Test results:

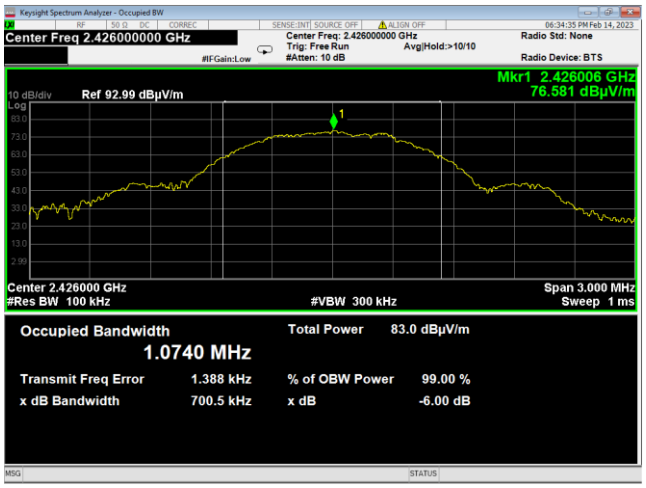
Table 3.2: 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND:		2400.0 – 2483.5 MHZ		
DETECTOR USED:		PEAK MAXHOLD		
SWEEP TIME:		AUTO		
RESOLUTION BANDWIDTH:		100 KHZ		
VIDEO BANDWIDTH:		300 KHZ		
MODULATION:		BLE		
BIT RATE:		1 MBPS		
Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
Low frequency				
2402	711.0	500.0	211.0	Pass
Mid frequency				
2426	700.5	500.0	200.5	Pass
High frequency				
2480	688.5	500.0	188.5	Pass

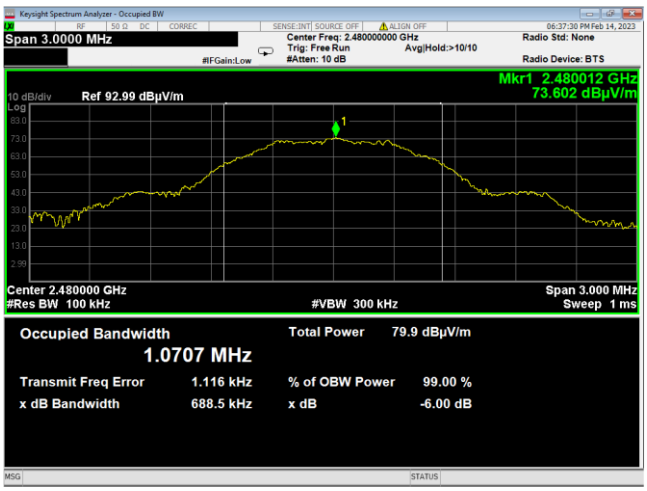
Plot 3.1: 6dB BW, 2.402 GHz



Plot 3.2: 6dB BW, 2.426 GHz



Plot 3.3: 6dB BW, 2.480GHz



4. Maximum Peak output power

Date of Test: 14.02.2023
Relative Humidity: 48%
Ambient Temperature: 21°C
Atmospheric Pressure: 1011.4 hPa
Test performed by: Izak Shtir

Test procedure: 11.9.1.1 for Peak measurements with RBW≥OBW

4.1. General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 4.1.

Table 4.1 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×P×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.

4.2. Test procedure

The EUT was set up as shown in Figure 4.1, energized and its proper operation was checked.
The EUT was adjusted to produce maximum available to end user RF output power.
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 3600 and the measuring antenna height was swept in both vertical and horizontal polarizations.
The maximum field strength of the EUT carrier frequency was measured as provided in Table 4.1 and associated plots.
The maximum peak output power was calculated from the field strength of carrier as follows:

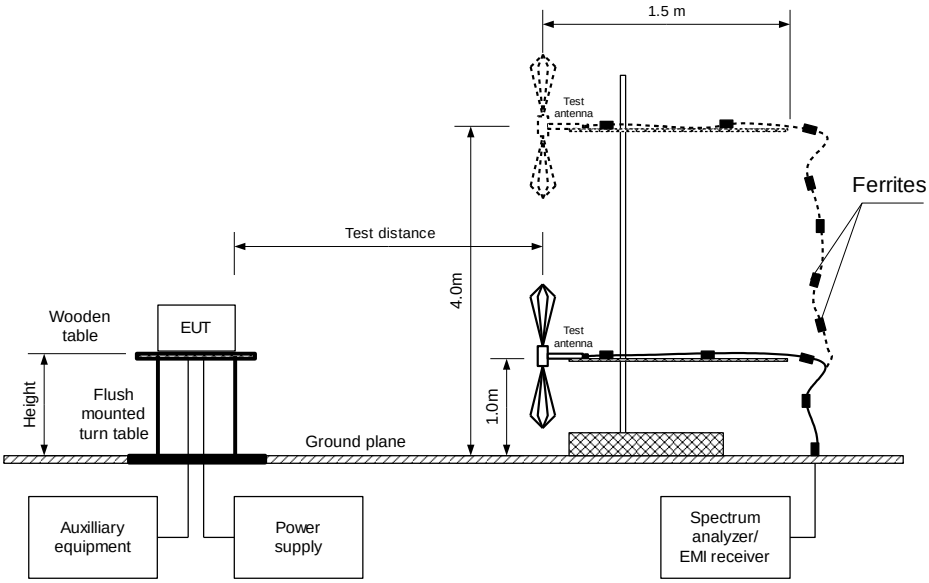
$$P = (E \times d)2 / (30 \times G),$$

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:

Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi – 95.2 dB

The worst test results (the lowest margins) were recorded in Table 4.1.

Figure 4.1 Setup for carrier field strength measurements



Photograph 4.1 Setup for carrier field strength measurements

4.3. List of Test Equipment:

Refer to appendix A for complete list of equipment used and respective calibration dates.

4.4. Test results:

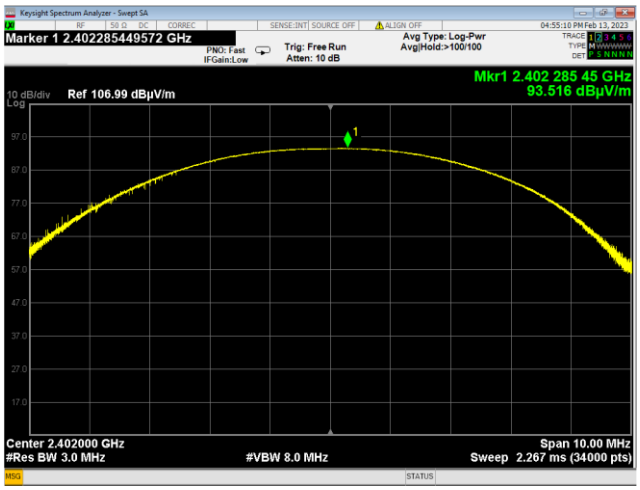
Table 4.2 Peak output power test results

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:	8 MHZ
MODULATION:	BLE
BITRATE:	1 MBPS

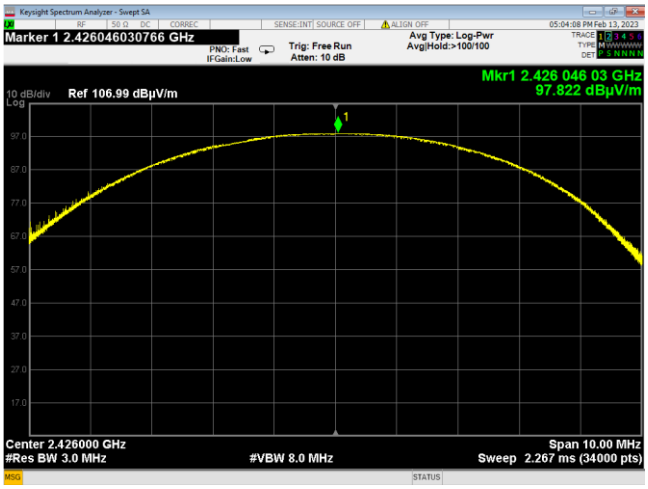
Frequency, MHz	Field strength, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	EUT antenna gain, dBi	Peak output power, dBm**	Limit, dBm	Margin, dB***	Verdict
2402.0	93.516	H	1.5	0	3	-4.71	30	-34.71	Pass
2426.0	97.822	H	1.5	0	3	-0.48	30	-30.48	Pass
2480.0	95.680	H	1.5	0	3	-2.52	30	-32.52	Pass

*****- EUT front panel refer to 0 degrees position of turntable.
******- Peak output power was calculated from the field strength of carrier as follows: $P = (E \times d)^2 / (30 \times G)$,
where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance:
Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi – 95.2 dB
***- Margin = Peak output power – specification limit.
Note: Maximum peak output power was obtained at U_{nom} (115%U_{nom}, 85%U_{nom}) input power voltage.

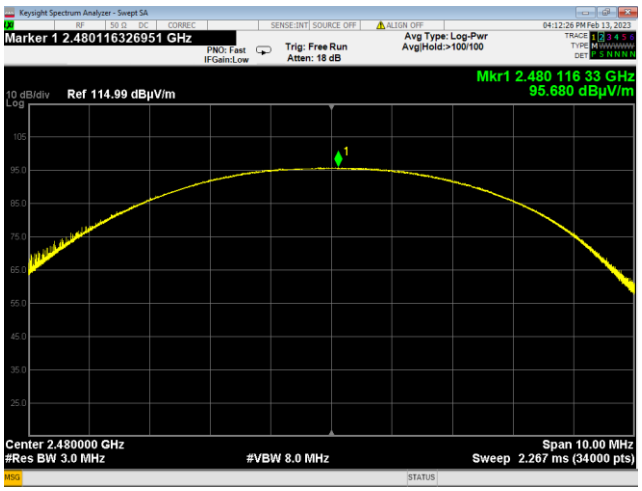
Plot 4.1: Peak output power at Low Frequency



Plot 4.2: Peak output power at Mid Frequency



Plot 4.3: Peak output power at High Frequency



5. Peak power spectral density

Date of Test: 13.02.2023
Relative Humidity: 48%
Ambient Temperature: 21°C
Atmospheric Pressure: 1011.4 hPa
Test performed by: Izak Shtir

Test Method: ANSI C63.10 section 11.10.2

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 5.1.

Table 5.1 Peak spectral power density limits

Assigned frequency range, MHz	Measurement bandwidth, kHz	Peak spectral power density, dBm	Equivalent Peak spectral power density limit @ 3m, dB(µV/m)*
902.0 – 928.0	100.0	8.0	103.2
2400.0 – 2483.5			
5725.0 – 5850.0			

* - Equivalent Peak spectral power density limit was calculated from the peak spectral power density as follows: E=sqrt(30×P)/r, where P is peak spectral power density and r is antenna to EUT distance in meters.

5.2. Test procedure

The EUT was set up as shown in Figure 5.1, energized and its proper operation was checked.

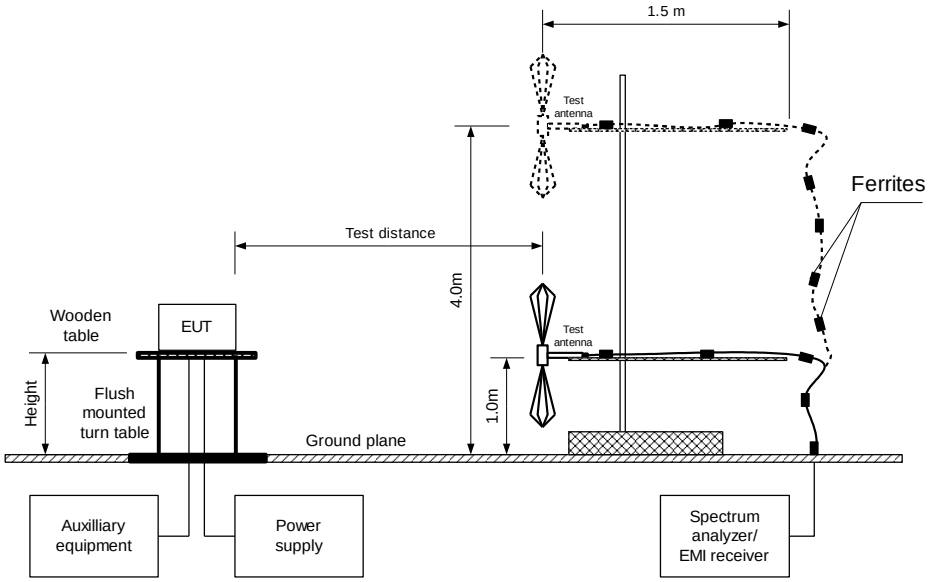
The EUT was adjusted to produce maximum available to end user RF output power.

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 360^0 and the measuring antenna height was swept in both vertical and horizontal polarizations.

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 100.0 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 100 kHz. Otherwise the resolution bandwidth was reduced until individual spectrum lines were resolved and the power of individual spectrum lines was integrated over 100 kHz band.

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 5.2 and associated plots.

Figure 5.1 Setup for carrier Peak spectral power density measurements



Photograph 5.1 Setup for carrier field strength measurements

5.3. List of Test Equipment:

Refer to appendix A for complete list of equipment used and respective calibration dates.

5.4. Test results:

Table 5.2 Peak spectral power density measurement of peak spectral power density

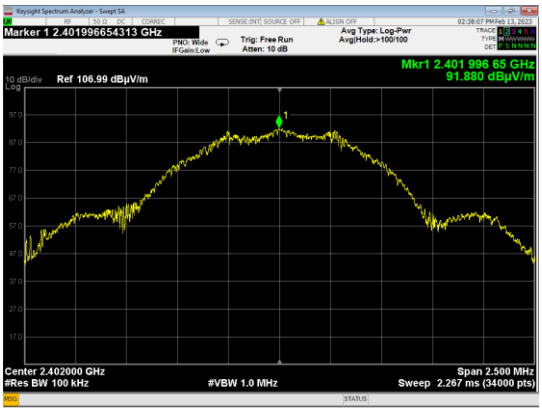
ASSIGNED FREQUENCY:				2400.0 – 2483.5 MHZ				
TEST DISTANCE:				3 M				
TEST SITE:				SEMI ANECHOIC CHAMBER				
EUT HEIGHT:				1.5 M				
DETECTOR USED:				PEAK				
RESOLUTION BANDWIDTH:				100 KHZ				
VIDEO BANDWIDTH:				1 MHZ				
TEST ANTENNA TYPE:				DOUBLE RIDGED GUIDE (ABOVE 1000 MHZ)				
TRANSMITTER OUTPUT POWER SETTINGS:				MAXIMUM				
Modulation/bitrate:				GFSK / 1 Mbps				
Frequency, 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**
Low frequency								
2402	94.139	3	103.2	-12.061	H	1.5	0	Pass
2402	91.880	3	103.2	-14.320	V	1.5	0	Pass
Mid frequency								
2426	94.908	3	103.2	-11.292	H	1.5	0	Pass
2426	94.260	3	103.2	-11.940	V	1.5	0	Pass
High frequency								
2480	94.655	3	103.2	-11.545	H	1.5	0	Pass
2480	94.341	3	103.2	-11.859	V	1.5	0	Pass

***- Margin = Peak spectral power density - EUT antenna gain - 95.2 - calculated Peak spectral power density limit.

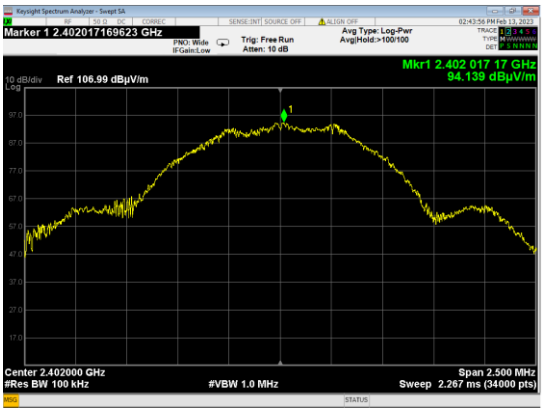
****- EUT front panel refer to 0 degrees position of turntable.

Plot 5.1: Power density Low frequency, Horizontal

Vertical

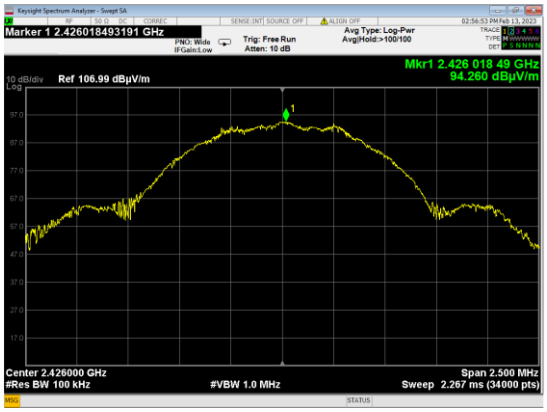


Horizontal

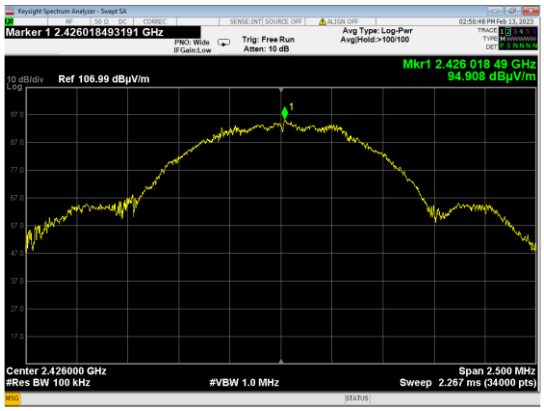


Plot 5.2: Power density Mid frequency, Vertical

Vertical

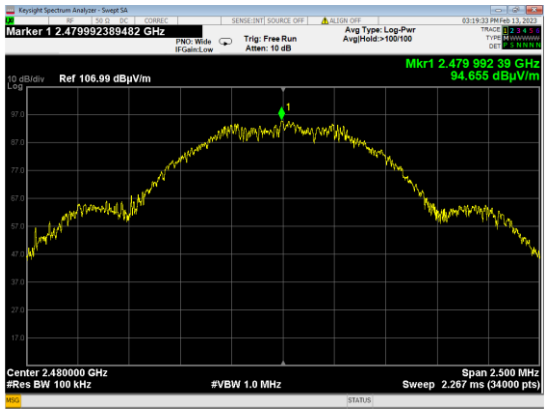


Horizontal

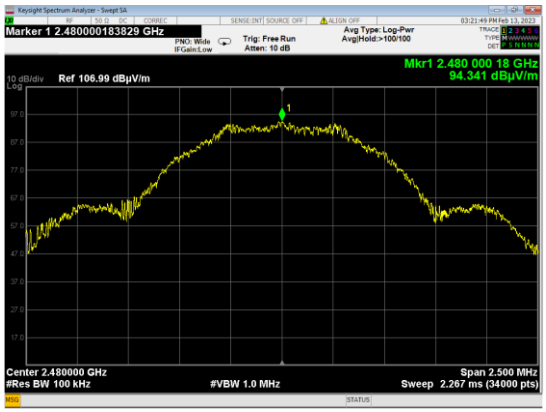


Plot 5.3: Power density High frequency, Horizontal

Vertical



Horizontal



6. Spurious Emissions

Date of Test: 13.02.2023
Relative Humidity: 48%
Ambient Temperature: 21°C
Atmospheric Pressure: 1011.4 hPa
Test performed by: Izak Shtir

Test Method: ANSI C63.10 section 11.12.1

6.1. General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 6.1

Table 6.1: 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 – 10thharmonic	74.0	NA	54.0	

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

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

where S_1 and S_2 – standard defined and test distance respectively in meters.
**- The limit decreases linearly with the logarithm of frequency.
*** - 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.

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

The EUT was set up as shown in Figure 6.1, energized and the performance check was conducted.

The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna was rotated around its vertical axis.

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

6.3. Test procedure for spurious emission field strength measurements above 30 MHz

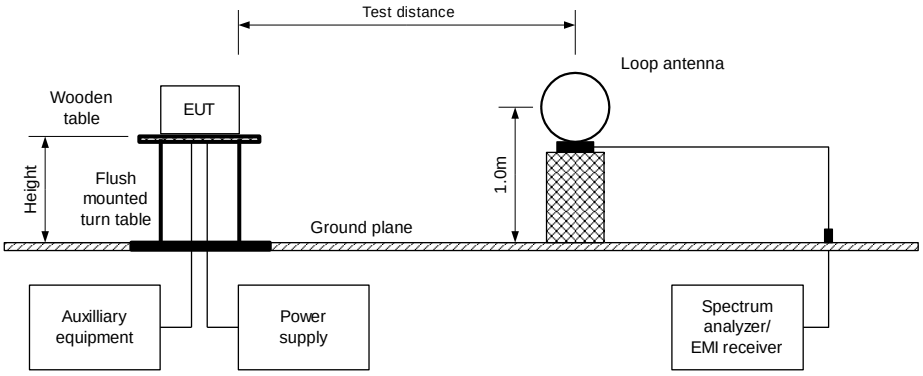
The EUT was set up as shown in Figure 6.2 Figure 6.3, energized and the performance check was conducted.

The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

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

Note: Emissions in non-restricted frequency bands was not tested with 100 kHz RBW and attenuation of 20 dBc peak or 30 dBc AVR, however we can state compliance with limits based on Section 11.11.1(c) of ANSI C63.10.

Figure 6.1 Setup for spurious emission field strength measurements below 30 MHz



Photograph 6.1 Setup for spurious emission field strength measurements below 30 MHz

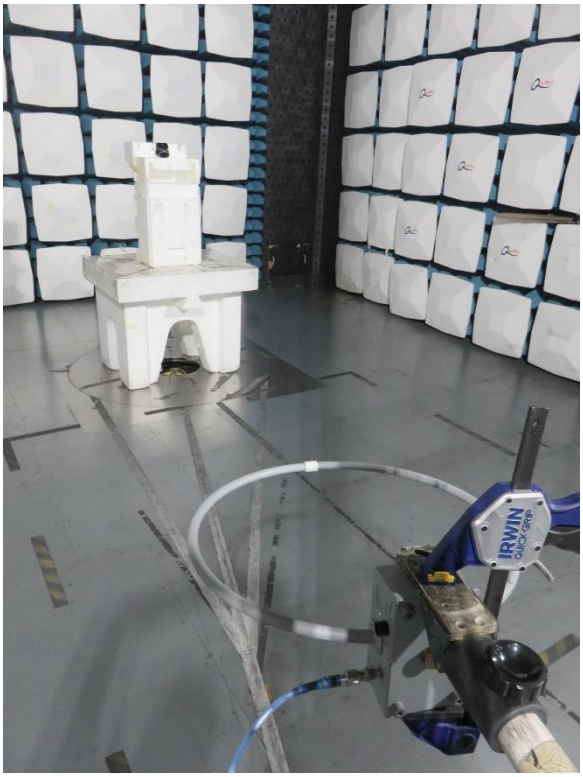
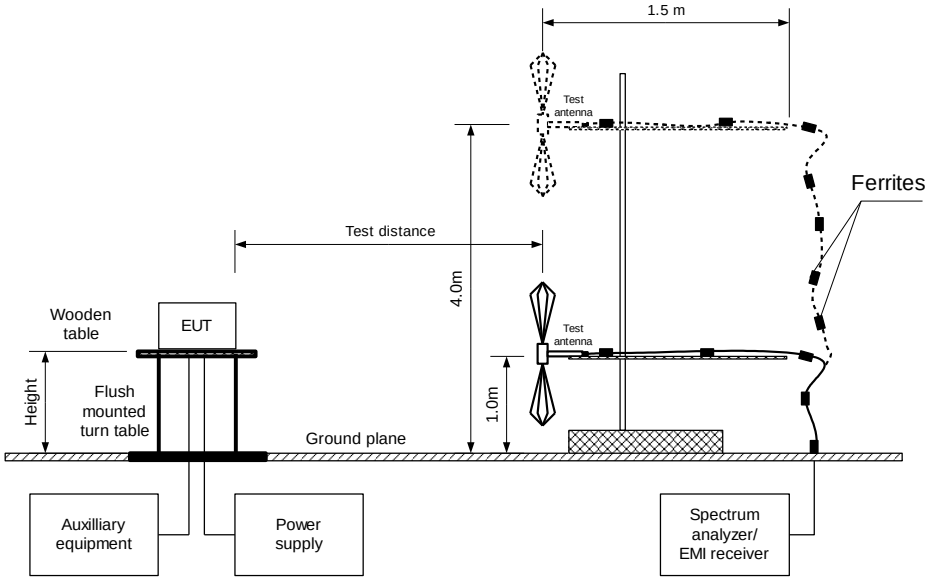
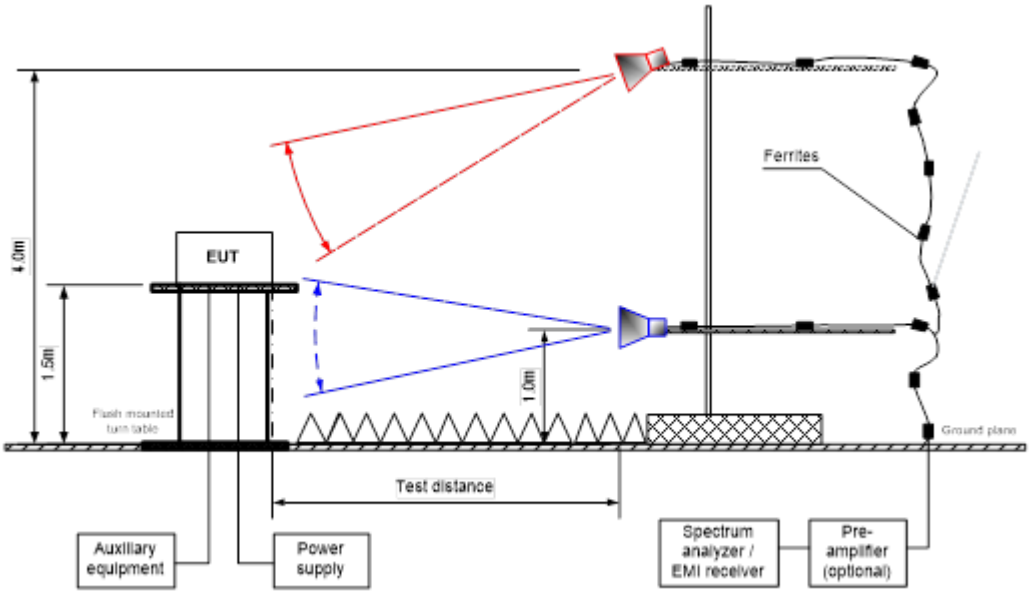


Figure 6.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz

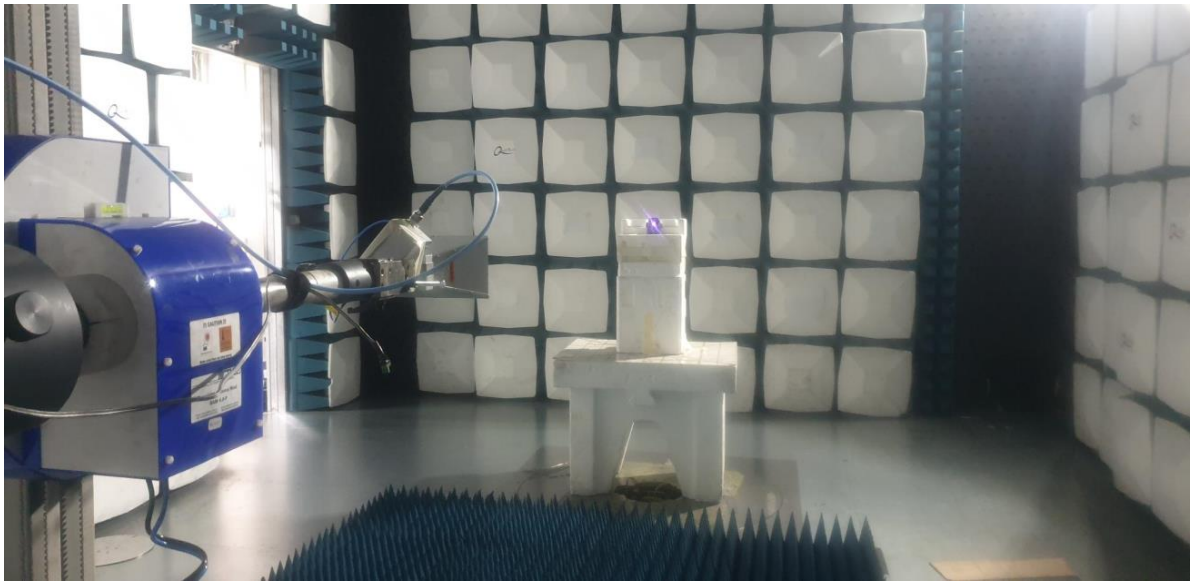


Photograph 6.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz

Figure 6.3 Setup for spurious emission field strength measurements above1000 MHz



Photograph 6.3 Setup for spurious emission field strength measurements above1000 MHz



6.4. List of Test Equipment:

Refer to appendix A for complete list of equipment used and respective calibration dates.

6.5. Test results:

Table 6.2 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:	BLE
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(□V/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(□V/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
Low carrier frequency									
All emissions were greater than 20 dB below the limit									Pass
Mid carrier frequency									
All emissions were greater than 20 dB below the limit									Pass
High carrier frequency									
All emissions were greater than 20 dB below the limit									Pass

***-** EUT front panel refers to 0 degrees position of turntable.
****-** Margin = Attenuation below carrier – specification limit.

Table 6.3 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:	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	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)	Margin, dB***	
Low carrier frequency 2402 MHz											
All emissions were more than 20 dB below the limit											Pass
Mid carrier frequency 2442 MHz											
4883.253	Vertical	1.50	56	51.03	74.0	-22.97	46.79	NA	54.0	-7.21	Pass
High carrier frequency 2480 MHz											
4959.413	Vertical	1.50	61	54.39	74.0	-19.61	49.90	NA	54.0	-4.10	Pass
7439.147	Vertical	1.50	180	51.02	74.0	-22.98	43.38	NA	54.0	-10.62	

*****- 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 6.4 Average factor calculation

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

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

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

for pulse train longer than 100 ms:

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

Table 6.5 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY:	2400.0 – 2483.5 MHZ
INVESTIGATED FREQUENCY RANGE:	0.009 - 25000 MHZ
TEST DISTANCE:	3 M
MODULATION:	BLE
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)

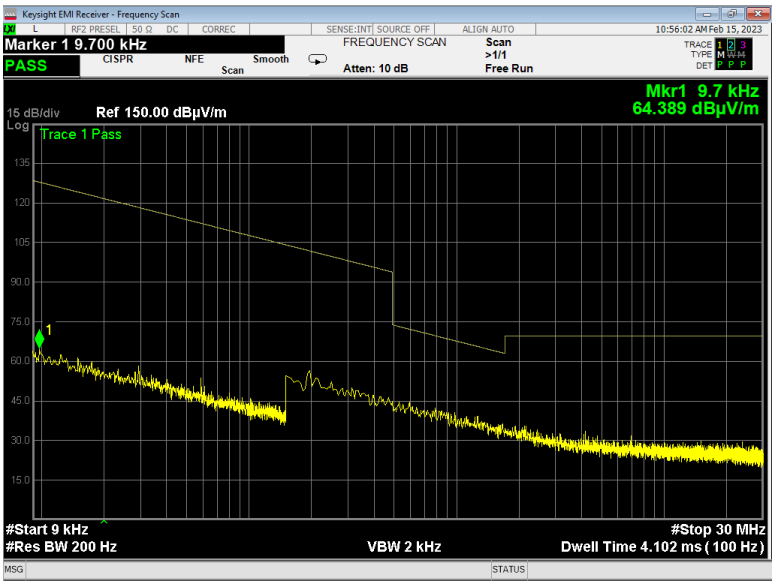
Frequency, MHz	Peak emission, db(µv/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, db(µv/m)	Limit, db(µv/m)	Margin, db*				
Low carrier frequency								
120.009	30.06	28.35	43.5	-15.15	Vertical	1.02	-31	Pass
400.002	39.26	38.00	46.0	-8.00	Horizontal	1.04	-31	
Mid carrier frequency								
400.007	39.46	38.14	46.0	-7.86	Horizontal	1.02	-31	Pass
High carrier frequency								
119.994	30.03	28.42	43.5	-15.08	Vertical	1.00	-34	Pass
399.996	39.59	38.06	46.0	-7.94	Horizontal	1.04	-33	

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

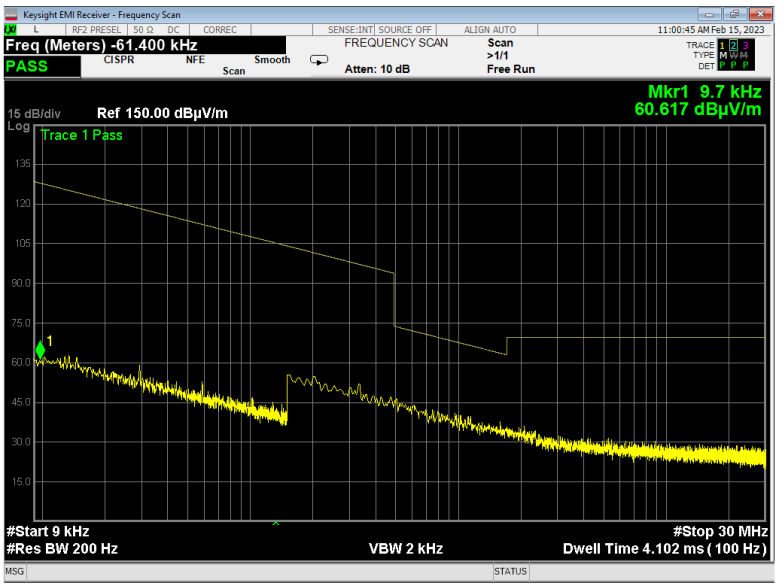
Table 6.6 Field strength of spurious emissions below 1 GHz within restricted bands

Frequency (MHz)	Measured Peak (dBuV/m)	Measured QP (dBuV/m)	Margin QP (dB)	Polarization	Ant Height (cm)	TT Azimut (Deg)	Verdict
BLE Low							
31.458	36.83	30.980	-9.02	H	130	20	Pass
562.86	44.55	40.070	-5.93	H	243	93	Pass
860.044	41.00	34.920	-11.08	H	100	0	Pass
554.994	35.906	38.611	-7.39	V	216	352	Pass
573.638	44.067	37.214	-8.79	V	138	1	Pass
590.997	44.523	39.970	-6.03	V	126	275	Pass
BLE Mid							
567.238	40.92	40	-6.00	H	167	106	Pass
573.513	43.81	40.29	-5.71	H	250	120	Pass
955.712	42.89	37.13	-8.87	H	150	161	Pass
564.724	43.513	36.04	-9.96	V	240	0	Pass
573.68	44.566	40.479	-5.52	V	199	39	Pass
583.246	42.658	38.641	-7.36	V	130	323	Pass
BLE High							
573.707	40.97	37.29	-8.71	H	236	120	Pass
921.945	41.12	35.88	-10.12	H	167	181	Pass
573.594	46.189	38.003	-8.00	V	250	58	Pass
927.881	41.119	35.988	-10.01	V	101	0	Pass

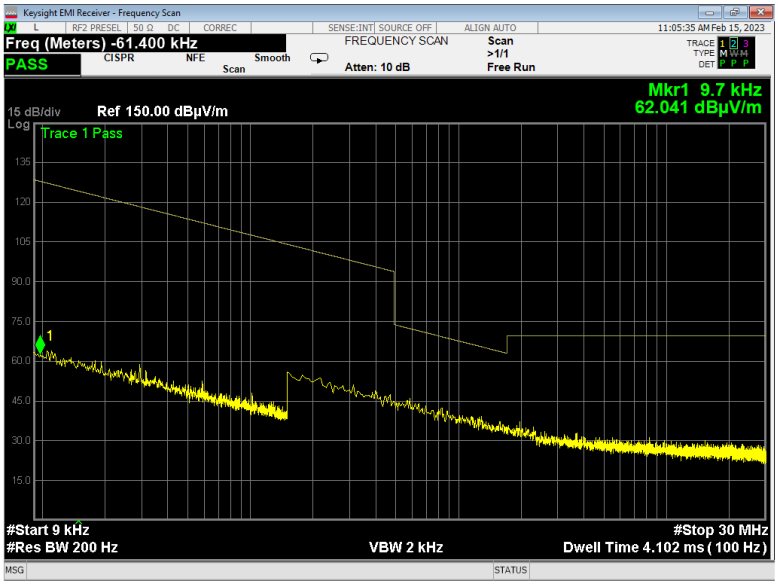
Plot 6.1 Radiated emission measurements, 9 kHz to 30 MHz BLE low frequency Horizontal



Plot 6.2 Radiated emission measurements, 9 kHz to 30 MHz BLE mid frequency Horizontal

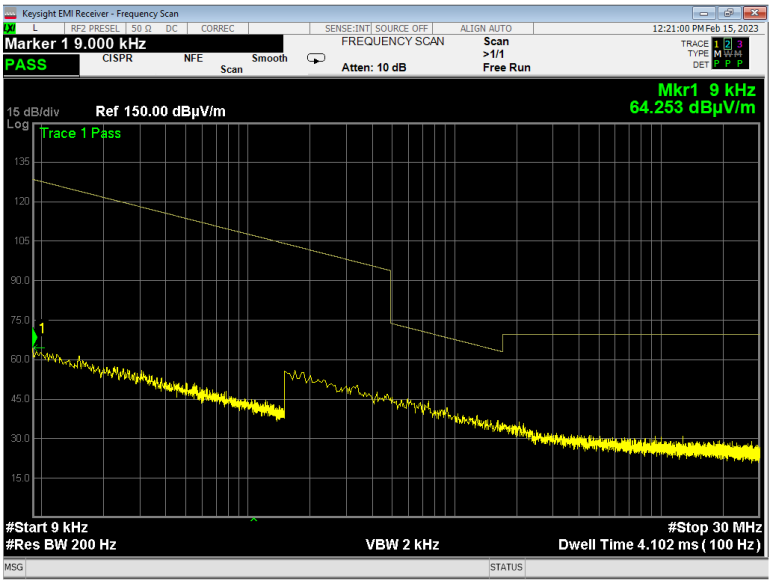


Plot 6.3 Radiated emission measurements, 9 kHz to 30 MHz BLE high Horizontal



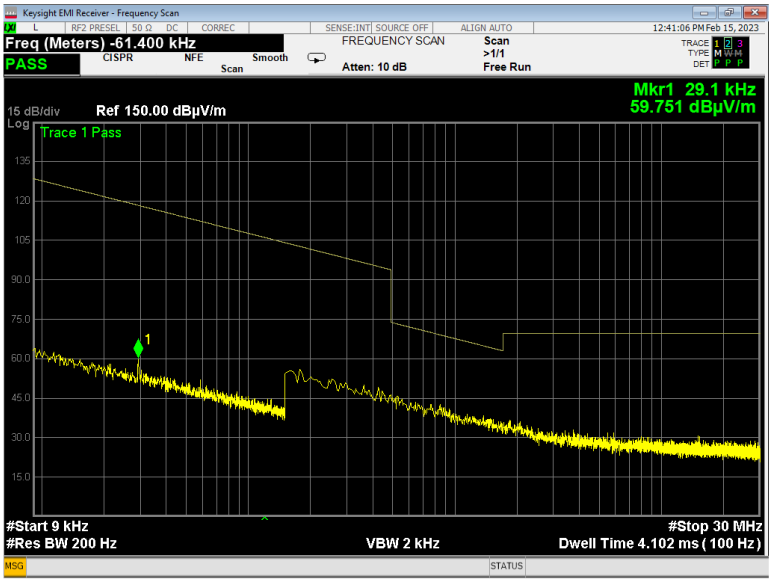
Plot 6.4 Radiated emission measurements, 9 kHz to 30 MHz, BT low frequency Parallel

Plot 6.5 Radiated emission measurements, 9 kHz to 30 MHz BLE mid frequency Parallel

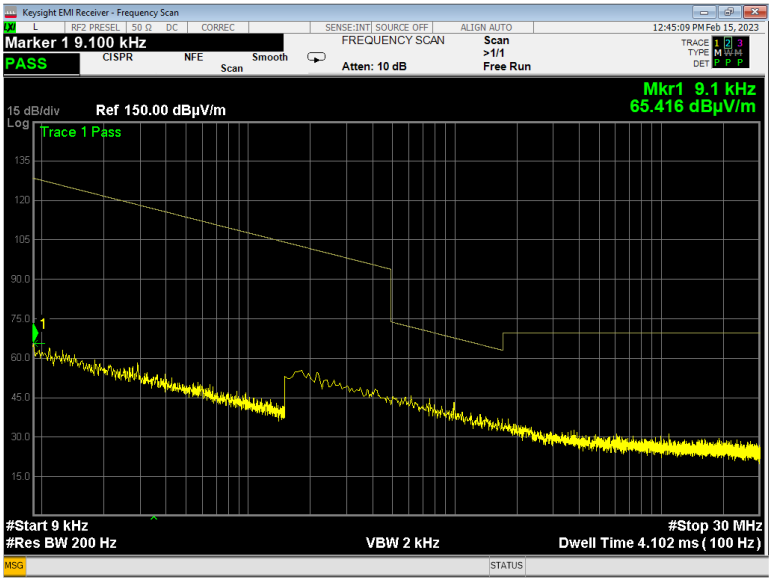


Plot 6.6 Radiated emission measurements, 9 kHz to 30 MHz BLE high frequency Parallel

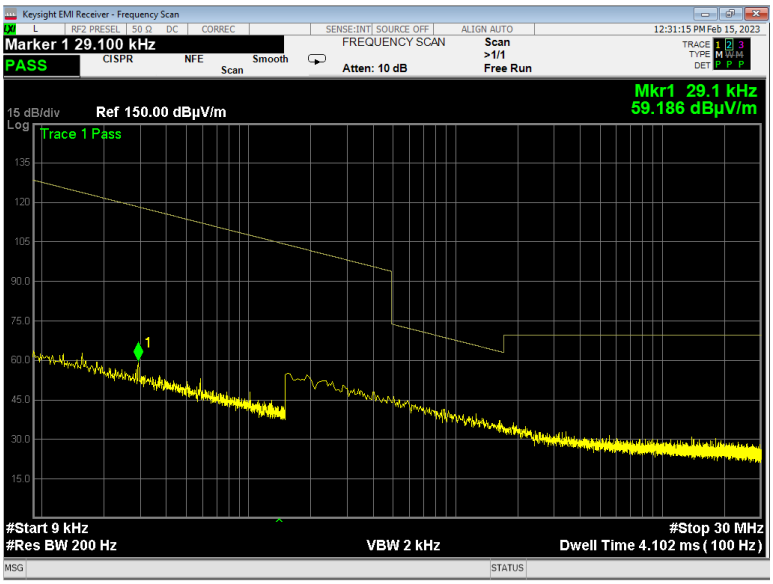
Plot 6.7 Radiated emission measurements, 9 kHz to 30 MHz, BLE low frequency Perpendicular



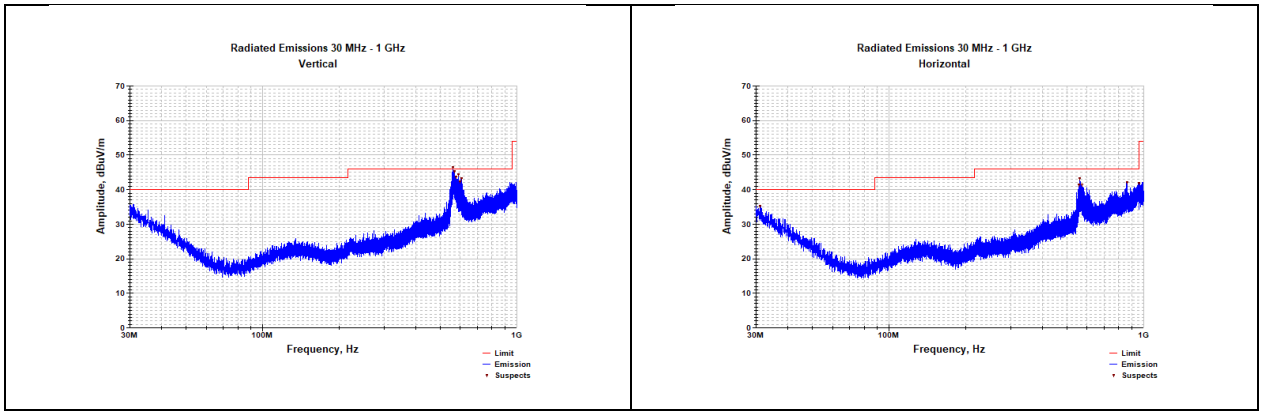
Plot 6.8 Radiated emission measurements, 9 kHz to 30 MHz, BLE mid frequency Perpendicular



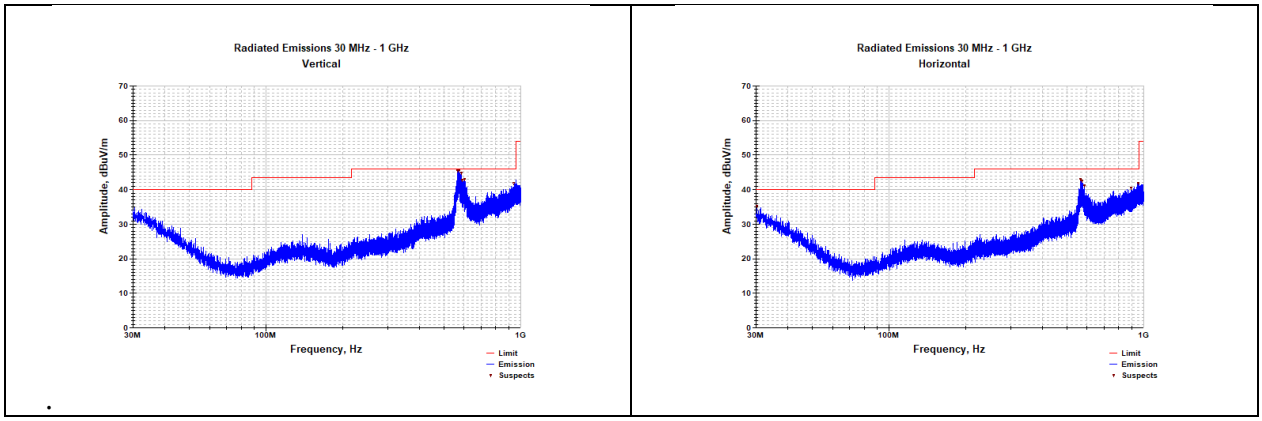
Plot 6.9 Radiated emission measurements, 9 kHz to 30 MHz, BLE high frequency Perpendicular



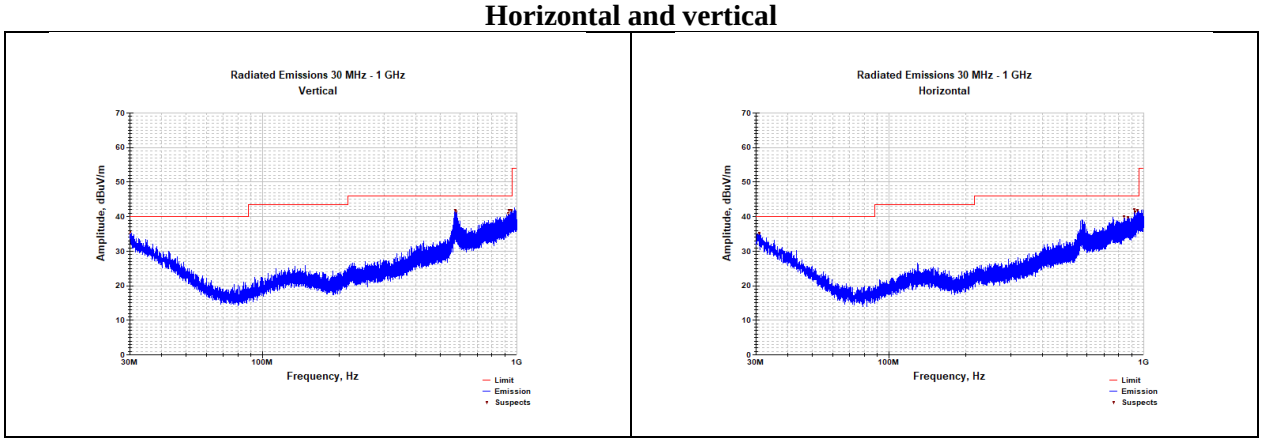
Plot 6.10 Radiated emission measurements, 30 MHz to 1 GHz, BLE low frequency Horizontal and vertical



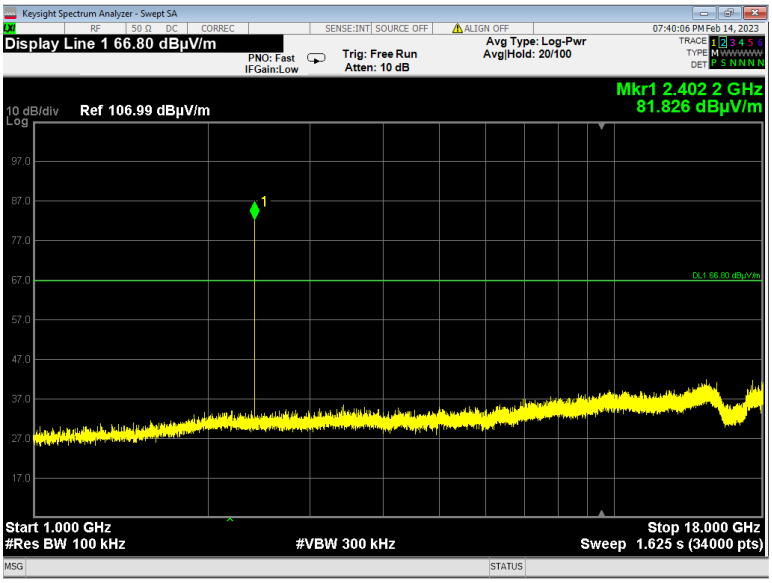
Plot 6.11 Radiated emission measurements, 30 MHz to 1 GHz, BLE mid frequency Horizontal and vertical



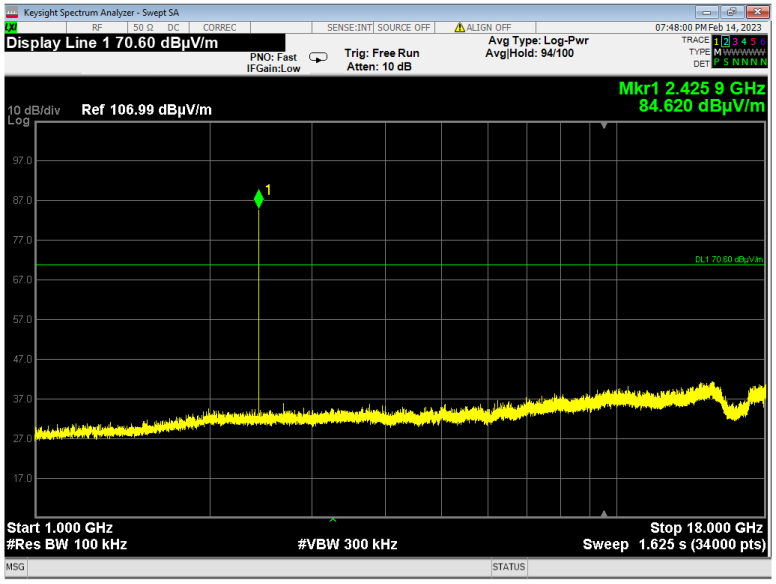
Plot 6.12 Radiated emission measurements, 30 MHz to 1 GHz, BLE high frequency Horizontal and vertical



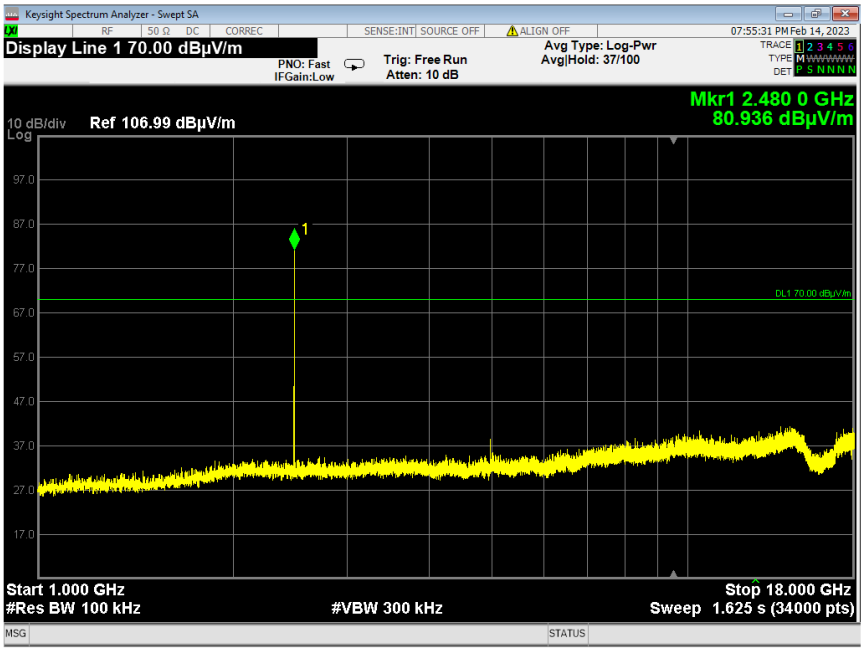
Plot 6.13 Radiated emission measurements, 1 GHz to 18 GHz, BLE low frequency Horizontal and vertical (Worst Case)



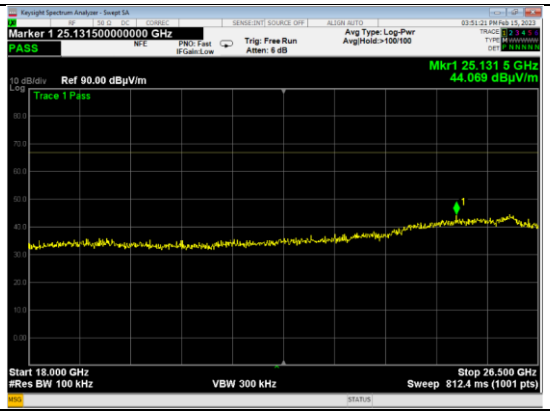
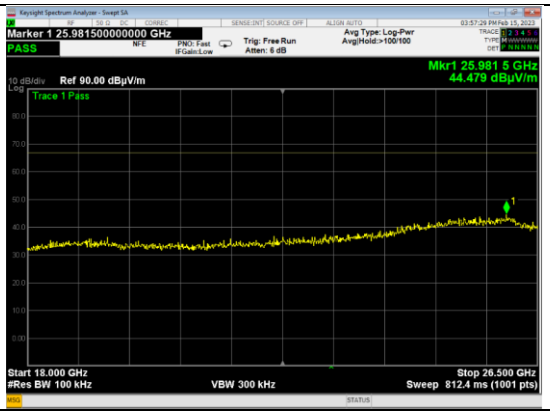
Plot 6.14 Radiated emission measurements, 1 GHz to 18 GHz, BLE mid frequency Horizontal and vertical (Worst Case)



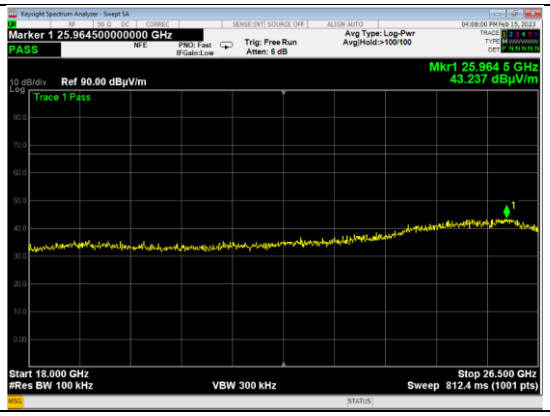
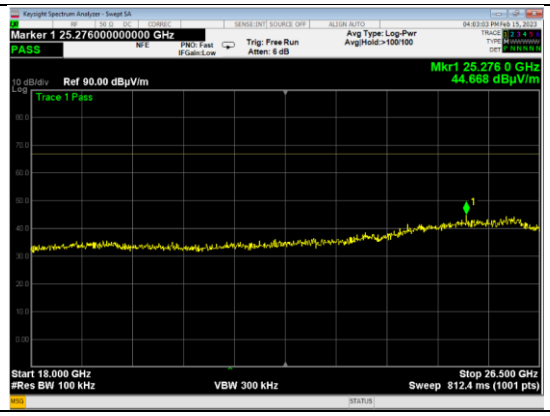
Plot 6.15 Radiated emission measurements, 1 GHz to 18 GHz, BLE high frequency Horizontal and vertical (Worst Case)



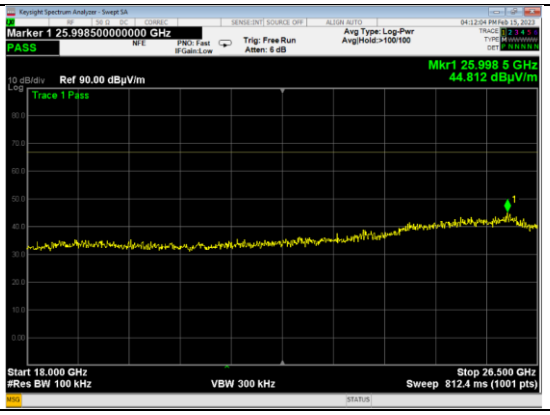
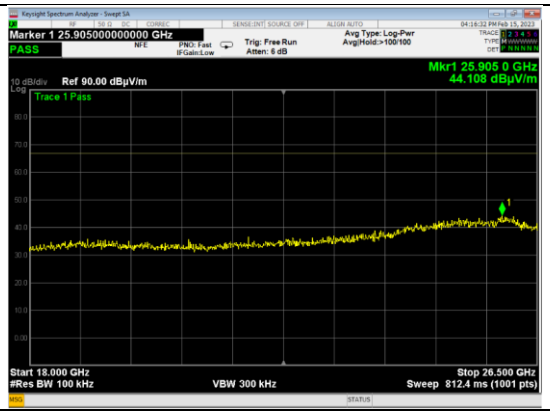
Plot 6.16 Radiated emission measurements, 18 GHz to 26.5 GHz BLE low frequency

Vertical	Horizontal
	

Plot 6.17 Radiated emission measurements, 18 GHz to 26.5 GHz BLE mid frequency

Vertical	Horizontal
	

Plot 6.18 Radiated emission measurements, 18 GHz to 26.5 GHz BLE high frequency

Vertical	Horizontal
	

7. Band edge radiated emissions

7.1. 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 7.1

Table 7.1 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.

7.2. Test procedure

The EUT was set up as shown in Figure 7.1 energized normally modulated at the maximum data rate and its proper operation was checked.

The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.

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.

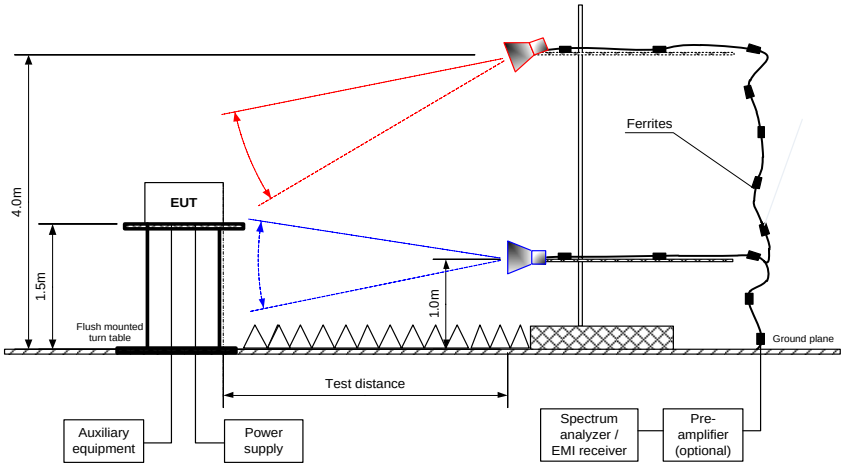
The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.

The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.2 and associated plots and referenced to the highest emission level measured within the authorized band.

The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

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

Figure 7.1 Band edge emission test setup



Photograph 7.1 Band edge emission test setup

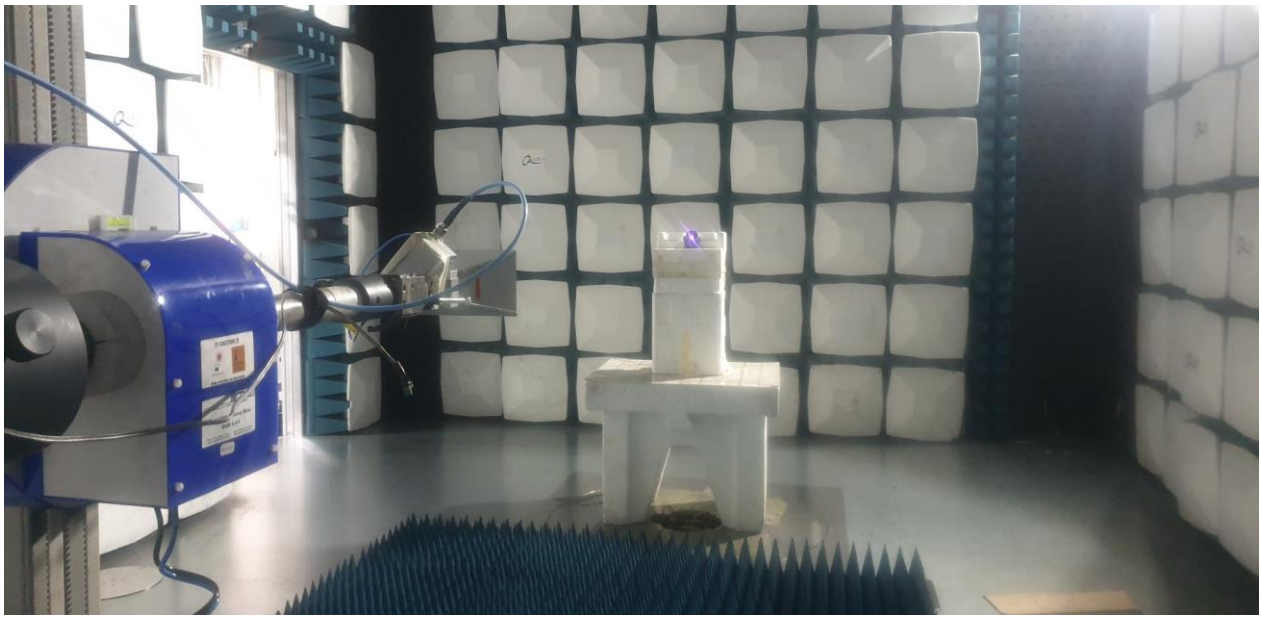


Table 7.2 Band edge emission outside restricted bands test results

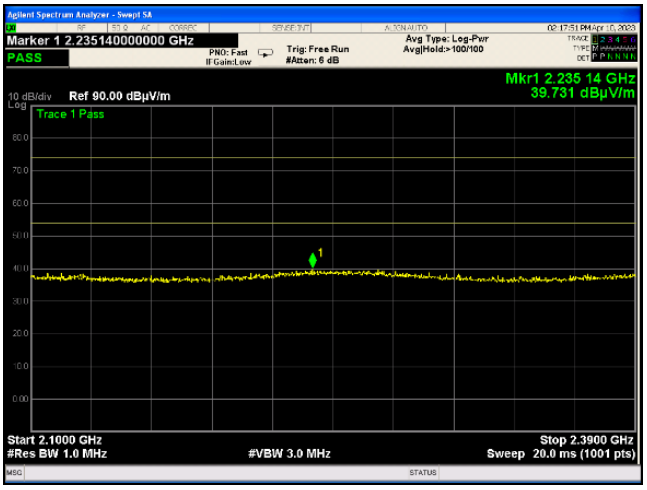
ASSIGNED FREQUENCY RANGE:			2400.0 – 2483.5 MHz			
DETECTOR USED:			Peak			
TRANSMITTER OUTPUT POWER SETTINGS:			Maximum			
RESOLUTION BANDWIDTH:			100 kHz			
VIDEO BANDWIDTH:			≥ RBW			
MODULATION/BITRATE:			GFSK / 1 Mbps			
Frequency , MHz	**Band edge emission, dBm**	**Emission at carrier, dBm**	**Attenuation below carrier, dBc**	**Limit, dBc**	**Margin, dB***	**Verdict**
2400.00	-52.53	-3.96	48.57	20.0	28.57	Pass

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

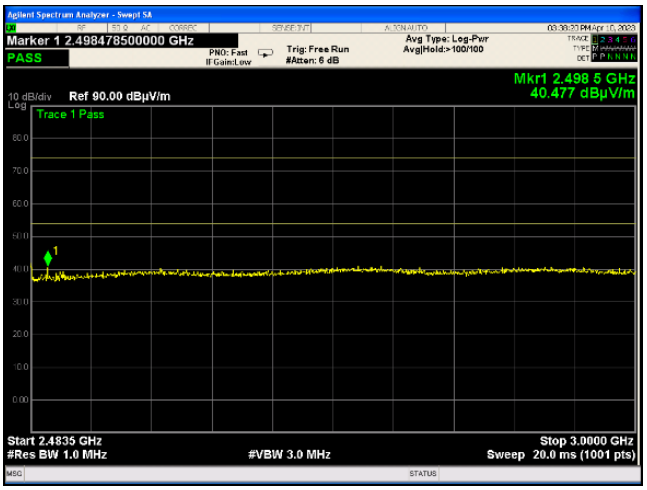
Table 7.3 Band edge emission inside restricted bands test results

ASSIGNED FREQUENCY RANGE:			2400.0 – 2483.5 MHz				
DETECTOR USED:			Peak				
TRANSMITTER OUTPUT POWER SETTINGS:			Maximum				
VIDEO BANDWIDTH:			≥ RBW				
MODULATION/BITRATE:			GFSK / 1 Mbps				
Frequency, MHz	**Peak field strength (VBW=3 MHz)**			**Average field strength (VBW=1 kHz)**			**Verdict**
	Measured, dB(µV/m)	**Limit, dB(µV/m)**	**Margin, dB****	**Measured, dB(µV/m)**	**Limit, dB(µV/m)**	**Margin, dB****	
Low carrier frequency							
2235.14	39.731	74.0	34.269	N.A	54.0	N.A	Pass
2245.04	N.A	74.0	N.A	25.796	54.0	28.204	Pass
2830.10	43.596	74.0	30.404	N.A	54.0	N.A	Pass
2830.01	N.A	74.0	N.A	36.145	54.0	17.855	Pass
High carrier frequency							
2383.62	44.406	74.0	29.594	N.A	54.0	N.A	Pass
2236.65	N.A	74.0	N.A	25.443	54.0	28.557	Pass
2498.50	40.477	74.0	33.523	N.A	54.0	N.A	Pass
2915.06	N.A	74.0	N.A	26.888492	54.0	27.112	Pass

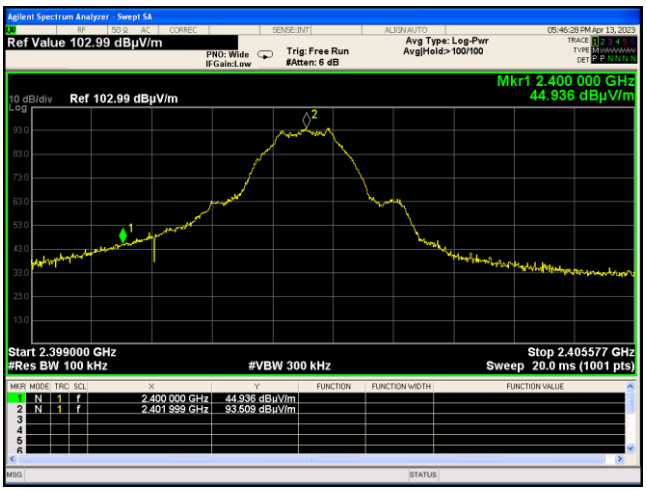
Plot 7.1 The highest emission level within restricted band at low carrier frequency



Plot 7.2 The highest emission level within restricted band at high carrier frequency



Plot 7.3 The highest emission level outside restricted band at low carrier frequency



8. Appendices

8.1. Appendix A: List of Measuring Equipment used:

Equipment description	Last Cal	Cal Due
Semi Anechoic Chamber, 9.5m [L] x 6.5m [W] x 5.2m [H]	19 05 2022	19 05 2024
Teseq CBL 6141B, Bilog Antenna	01 06 2022	01 06 2025
1 GHz to 18 GHz, Double ridge horn, 24.2 by 13.6 cm opening ARA DRG-118/A	03 10 2022	03 10 2023
LNA 1-18GHz (New), Spacek Labs, SL1018-56-5, 17J29	20 09 2022	20 09 2023
Keysight MXE EMI Receiver N9038A	11 05 2022	11 05 2023
Spectrum Keysight E4446A	05 09 2022	05 09 2023
Schwarzbeck BBHA 9170 SHF-EHF horn	21 03 2021	21 03 2024
Low-Noise Amplifier 26.5GHz - 40GHz, Spacek Labs, SLKa-35-4	27.02.2023	27.02.2024

8.2. Appendix B: Abbreviations/ Glossary used in the test report

AC	Alternating Current
AVR	Average (Detector)
A/m	Ampere per meter
AE	Auxiliary equipment
AM	Amplitude modulation
cm	Centimeter
CE	Conducted Emission
CI	Conducted Immunity
CNR	Calibration not required
dB	Decibel
dBm	Decibel referred to one Mill watt
dB(µV)	Decibel referred to one micro volt
dB(µV/*m*)	Decibel referred to one micro volt per meter
DC	Direct Current
ESD	Electrostatic Discharge
EFT	Electrical Fast Transients
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Immunity
EN	European Standard
EUT	Equipment under test
F/O	Fiber optic
GHz	Gigahertz

Hz	Hertz
HCP	Horizontal Coupling Plane
kHz	Kilohertz
kV	Kilovolt
ISN	Impedance stabilization network
LISN	Line Impedance Stabilization Network
m	Meter
MHz	Megahertz
NA	Not Applicable
NP	Normal performance
QP	Quasi-Peak (Detector)
Ω	Ohm
PM	Pulse modulation
PC	Personal Computer
RF	Radio Frequency
RE	Radiated Emission
RI	Radiated Immunity
rms	Root-mean-square
sec	Second
SA	Spectrum analyzer
Transceiver	Transmitter -receiver
V	Volt
VCP	Vertical coupling plane
W	Watt

8.3. Appendix C: Accreditation Certificate

Accredited Laboratory

A2LA has accredited

QUALITECH

Petah-Tikva, Israel

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 29th day of August 2022.

Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1633.01
Valid to June 30, 2024

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

End of the Test Report