REP031863

Test Report

Product	ultraBeacon Single-Zone
Name and address of the applicant	Sonitor Technologies AS Drammensveien 288 0283 Oslo, Norway
Name and address of the manufacturer	Sonitor Technologies AS Drammensveien 288 0283 Oslo, Norway
Model	INF-C365 / INF-C375
Rating	2400-2480 MHz transceiver POE 48 V DC or 6 V Battery powered
Trademark	sonitor
Additional information	FCC-ID information see page 4
Tested according to	**FCC Part 15.247** Frequency Hopping Transmitters / Digital Transmission Systems **Industry Canada RSS-247, Issue 3** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	PRJ0036884
Tested in period	2024.01.02 – 2024-03-18
Issue date	2024-08-02
Name and address of the testing laboratory	Nemko Nemko Scandinavia AS Instituttveien 6 2007 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO0470 ISED No: 2040D-1 ilac-MRA NORWEGIAN ACCREDITATION TEST 033 **An accredited technical test executed under the Norwegian accreditation scheme**

Prepared by [Jan G Eriksen]	Approved by [Frode Sveinsen]

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Template version: C

Revision history

Revision	Date	Comment	Sign
A	2024-04-25	First edition	JGER
B	2024-08-02	Corrections in Peak Power calculations. Corrections in Radiated Spurious table. Other clarifications and editorials	JGER

GENERAL REMARKS

This report applies only to the sample(s) tested. It is the manufacturer's responsibility to ensure the additional production units of this product are manufactured with identical electrical and mechanical components. The manufacturer is solely responsible for any modifications to the product that could result in non-compliance with the relevant regulations.

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Opinions expressed within this report regarding general assessments and qualifications for PASS or FAIL to the standards limits and requirements, are not part of the current accreditation. Neither are opinions expressed regarding model variants covered by the testing of this report.

CALIBRATION

All instruments used in the tests given in this test report are calibrated and traceable to national or international standards. Between calibrations all test set-ups are controlled and verified on a regular basis by periodic checks to ensure, with 95% confidence, that the instruments remain within the calibrated levels.

MEASUREMENT UNCERTAINTY

Measurement uncertainties are calculated or considered for all instruments and instrument set-ups used during these tests. Uncertainty figures are found in a separate clause in this report.

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1 INFORMATION

1.1 Test Item

Name	**ultraBeacon Single-Zone**
Model/version	**INF-C365**
FCC ID	**2AD7T21123102502**
ISED ID	**20330-21123102502**
Serial number	**01000034**
Hardware identity and/or version	**/**
Software identity and/or version	**/**
Frequency Range	**BLE: 2402 – 2480 MHz** **Snobee: 2405 – 2480 MHz**
Number of Channels	**BLE: 40** **Snobee: 16**
Operating Modes	**Bluetooth Low Energy ☒ 1 MBps ☒ 2 MBps** **Snobee ☒ 250 kBps**
Type of Modulation	**BLE: GFSK** **Snobee: O-QPSK**
Conducted Output Power	**Nominal value set during tests: 8 dBm**
Antenna Connector	**None**
Number of Antennas	**1**
Diversity or Smart Antennas	**No**
Power Supply	**POE 48 V DC and/or 6 V DC batteries** **(the device was tested with POE and batteries installed)**
Desktop Charger	**N/A**

Description of Test Item

The Sonitor ultraBeacon™ Single-Zone products are used with Sonitor's Open Integration RTLS Platform. The units can be powered by batteries, Power over Ethernet (PoE) or DC.

The units transmit ultrasound messages, or ultrasound and BLE messages, to enhance the positioning accuracy and update rate of Sonitor tags and mobile phones containing Sonitor SDK-based apps. For remote management and coordinated operation with other devices, the units use Snobee or BLE communication.

1.2 Normal test condition

Temperature:	**20 - 24 °C**
Relative humidity:	**20 - 50%**
Normal test voltage:	**48 V DC and 6.0 V batteries**

The values are the limits registered during the test period.

1.3 Test Engineer(s)

Jan G Eriksen

1.4 Antenna Requirement

Does the EUT have detachable antenna(s)?	☐ **YES**	☒ **NO**
If detachable, is the antenna connector(s) non-standard?	☐ **YES**	☐ **NO**
The tested equipment has only integral antennas. Conducted tests were performed with a temporary antenna connector.		

Requirement: FCC 15.203, 15.204

1.5 EUT Operating Modes

Description of operating modes	Radiated Emissions and Power Line Conducted Emissions were performed with the EUT set to transmit at the channel with the highest output power as worst-case scenario.
Additional information	The device was measured in horizontal and vertical orientations – and the measurement antenna was in vertical and horizontal polarization. The levels given in the report are the maximum level for any specific test. In the results below the transmitted channel is given either with the frequency in MHz or as “Low”, “Mid”, or “High”, which means 2402, 2440, and 2480 MHz for BLE and 2405, 2440, or 2480 MHz for Snobee.

1.6 Comments

All measurements were done with the EUT powered from fully charged batteries and with 48 V DC POE connected.

It was also checked that conducted power on TX channels did not vary depending on type of power applied, and that voltage variations between 85% and 115% did not have any influence on the measurements.

All ports were populated during spurious emission measurements.

2 TEST REPORT SUMMARY

2.1 General

The tests were conducted on a sample of the equipment for demonstrating compliance with one or more of the following standards.

Standard	Description
FCC CFR 47 Part 15.247	Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz
ISED RSS-247, Issue 3	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ISED RSS-GEN Issue 5	General Requirements for Compliance of Radio Apparatus

The following standards and documents were used for one or more measurements:

Standard	Description
ANSI C63.4-2014	Unintentional Radiators
ANSI C63.10-2013	Intentional Radiators
FCC KDB 558074 D01	15.247 Measurement Guidance for DTS and Frequency Hopping Systems
FCC KDB 412172 D01	Determining ERP and EIRP

All measurements are traceable to national standards.

A description of the test facility is on file with FCC and ISED Canada.

☒ **New Submission**	☒ **Production Unit**
☐ **Class II Permissive Change**	☐ **Pre-production Unit**
DTS Equipment Class	☐ **Family Listing**

2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 3, RSS-GEN Issue 5 reference	ANSI C63.10-2013 Reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	5.13	Pass
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Pass
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	6.2	Pass
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	N/A
DTS Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	11.8 Option 2	Pass
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Pass
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	11.10.2 PKPSD (DTS)	Pass
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	6.7 11.11 (DTS)	Pass
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	3.3 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	6.3, 6.5, 6.6, 6.10 11.12, 11.13 (DTS)	Pass

3 TEST RESULTS

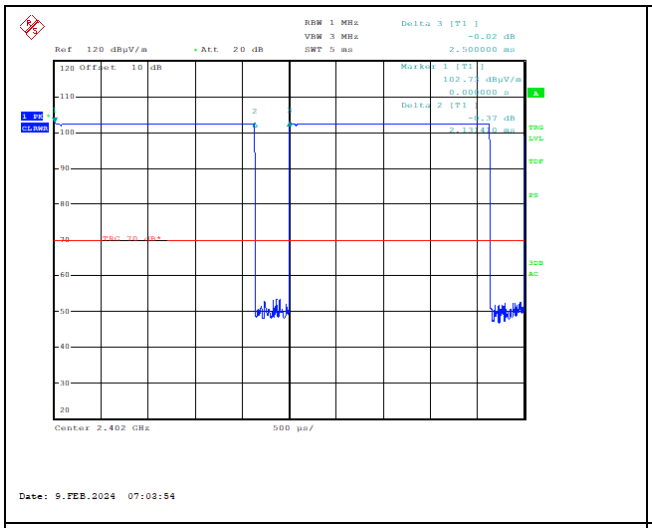
3.1 Duty Cycle (DC) measurement and calculations

The following Duty Cycle times are measured (calculated). BLE has a DC below 100% while Snobee has a DC of 100%.

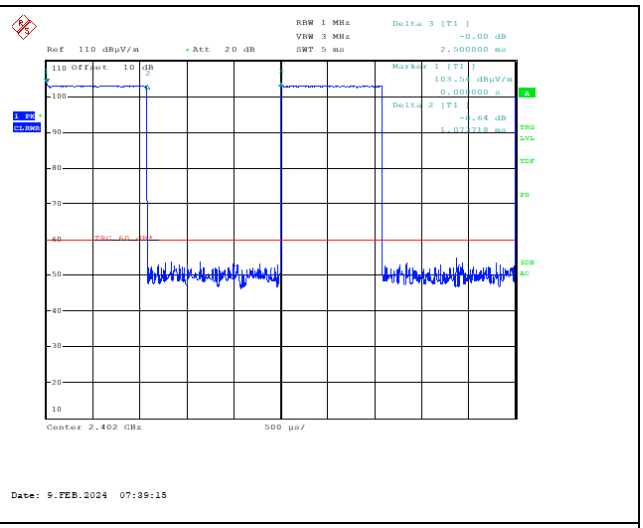
Measured Duty Cycle		BLE 1MBps	BLE 2MBps	Snobee
Pulse lengt	(ms)	2.1314	1.0737	Not measured
Pulse period	(ms)	2.5000	2.5000	Not measured
DUTY cycle	(%)	85.26	42.95	100
DUTY cycle correction factor to be used in average calculations	(dB)	0.7	3.7	0

Note: The Duty cycle times are identical at all three channels

Measurement Data:



2402 MHz, BLE 1MBps



2402 MHz, BLE 2MBps

3.2 Power Line Conducted Emissions

FCC Part 15.207

ISED RSS-GEN Issue 5, Clause 7.2 / 8.8

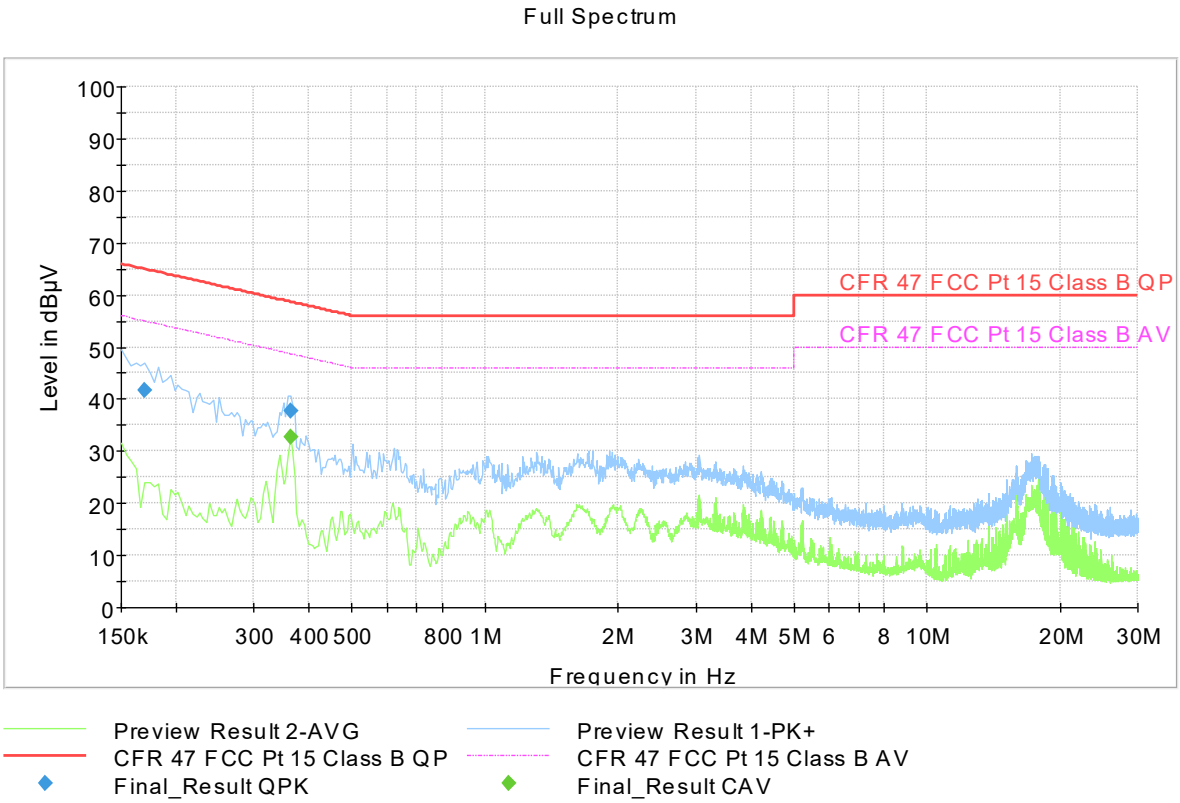
Measurement procedure: **ANSI C63.4-2014 using 50 µH/50 ohms LISN**

Test Results: **Complies**

Measurement Data: **See attached plots**

Measurement Software: **R&S EMC32 Conducted Emissions**

Highest measured value (L1 and N):



It should be noted that the Peak (blue) and Average (green) lines above are the highest (worst case) levels for measurements on both N and L1 lines. Which line the actual Quasi-Peak or Average measurement is done on is shown in table below in column “Line”.

Measured Data

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.170000	41.6	---	65.0	23.4	15000.0	9.000	N	OFF	9.7
0.362000	---	32.8	48.7	15.9	15000.0	9.000	N	OFF	9.6
0.362000	37.6	---	58.7	21.1	15000.0	9.000	L1	OFF	9.6

3.3 Occupied Bandwidth (99% BW)

ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement procedure: ANSI C63.10-2013 Clause 6.9.2

Test Results: Complies

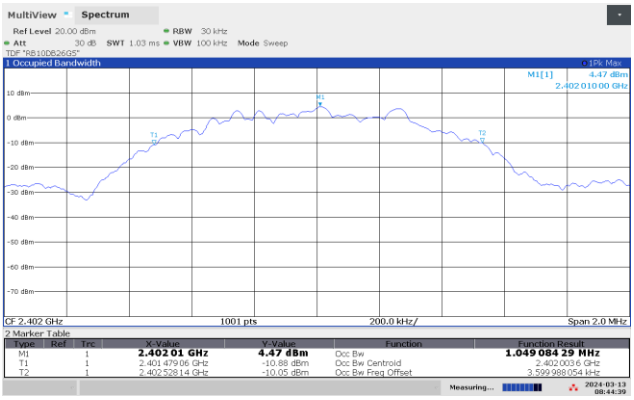
Measurement Data:

Carrier Frequency, Data Rate	Occupied Bandwidth (99% BW) kHz		
	Low	Mid	High
BLE 1Mb	1049.1	1053.7	1052.3
BLE 2Mb	2066.1	2072.1	2074.4
Snobee 250 kbps	2256.9	2263.3	2266.5

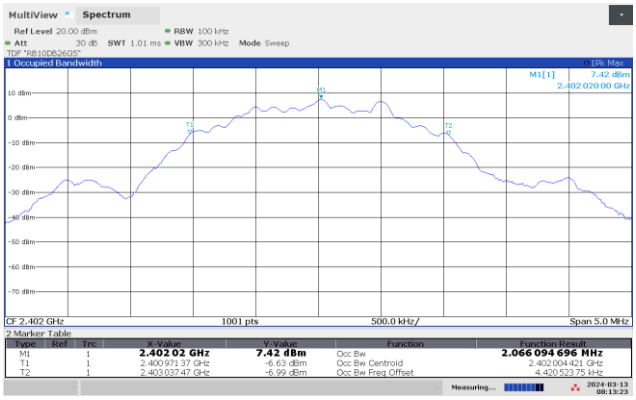
See attached plots

Requirements:

No requirement for 99% BW, reported for information only.

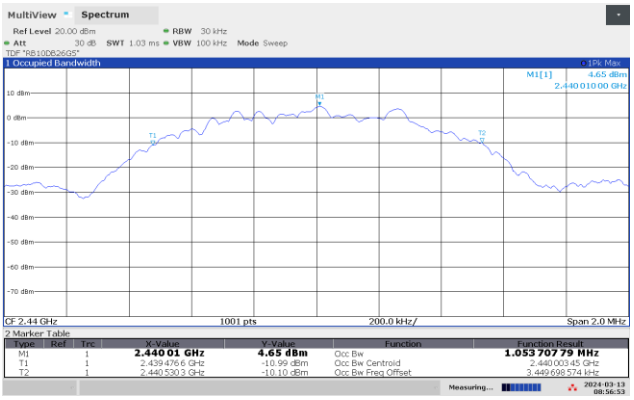


Low channel 99% Occupied BW, BLE 1Mb

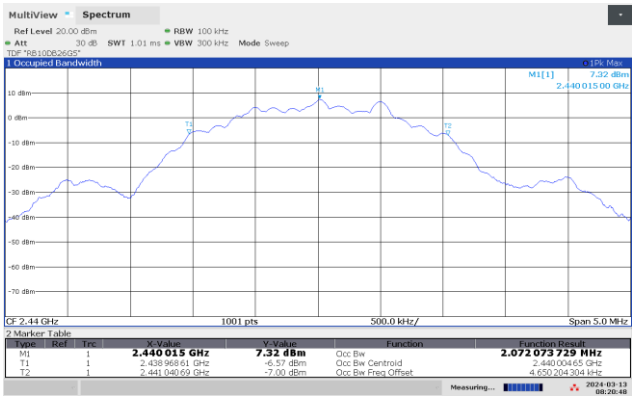


Low channel 99% Occupied BW, BLE 2Mb

Low channel 99% Occupied BW, Snobee

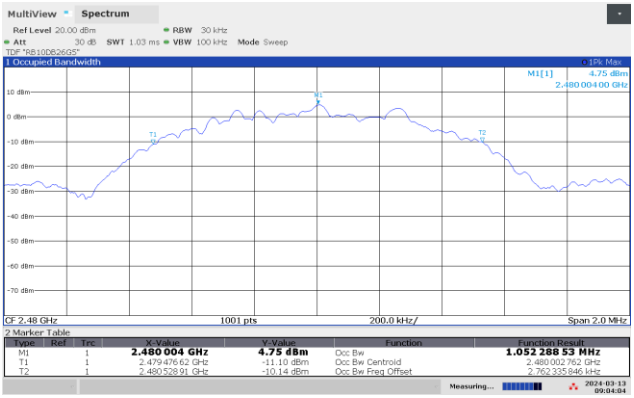


Mid channel 99% Occupied BW, BLE 1Mb

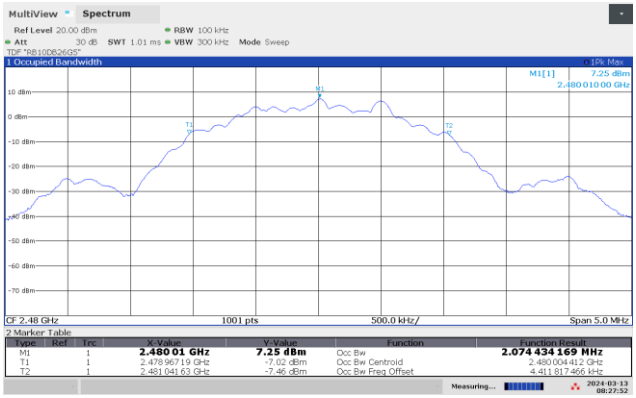


Mid channel 99% Occupied BW, BLE 2Mb

Mid channel 99% Occupied BW, Snobee



High channel 99% Occupied BW, BLE 1Mb



High channel 99% Occupied BW, BLE 2Mb

High channel 99% Occupied BW, Snobee

3.4 DTS Bandwidth

FCC Part 15.247 (a)(2)

ISED Canada RSS-247 Issue 3, Clause 5.2 (a)

Measurement procedure: **ANSI C63.10-2013 Clause 11.8**

Test Results: **Complies**

Measurement Data:

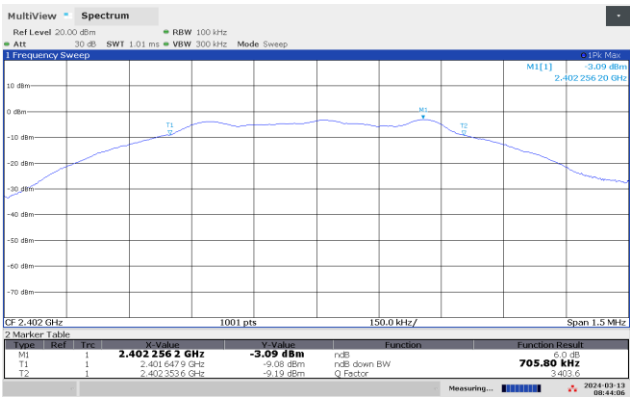
Modulation type and bitrate	Measured DTS Bandwidth (kHz)		
	Low	Mid	High
BLE: GFSK 1 Mbps	706	715	713
BLE: GFSK 2 Mbps	1170	1170	1170
Snoobee: O-QPSK 250 kbps	1550	1550	1560

Power supply variation within 85 % to 115% of nominal value has no influence on measured value.

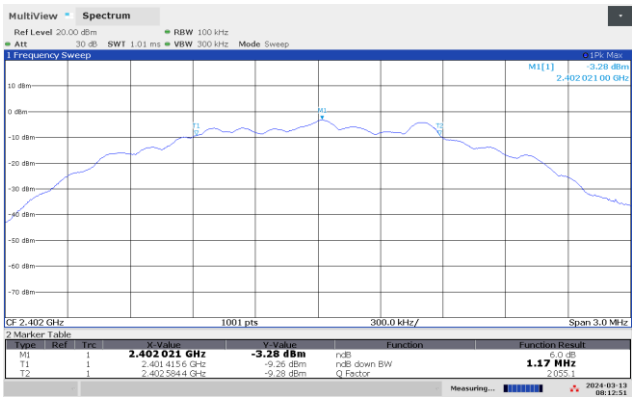
Frequency Band	Requirement for systems using Digital Modulation
902-928 MHz	The minimum 6 dB bandwidth shall be at least 500 kHz.
2400-2483.5 MHz	
5725-5850 MHz	

No requirements for Frequency Hopping Systems.

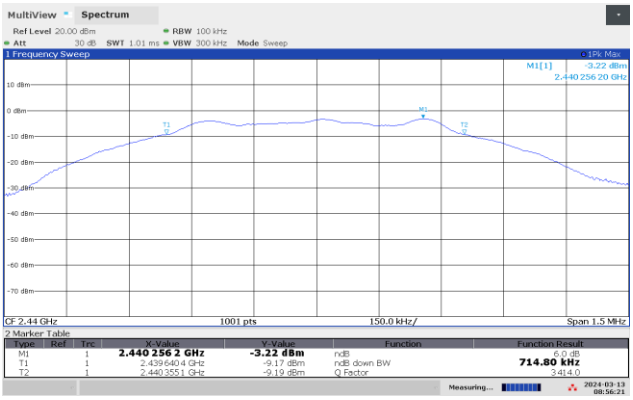
BLE DTS BW



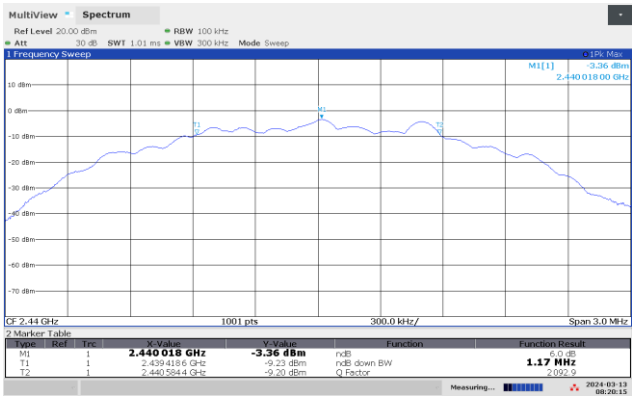
DTS BW, 2402 MHz, BLE 1M



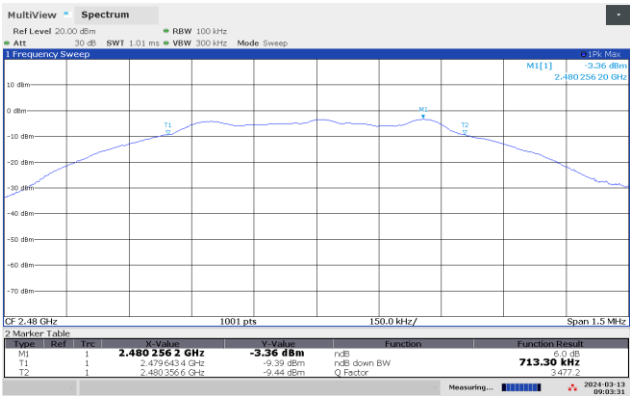
DTS BW, 2402 MHz, BLE 2M



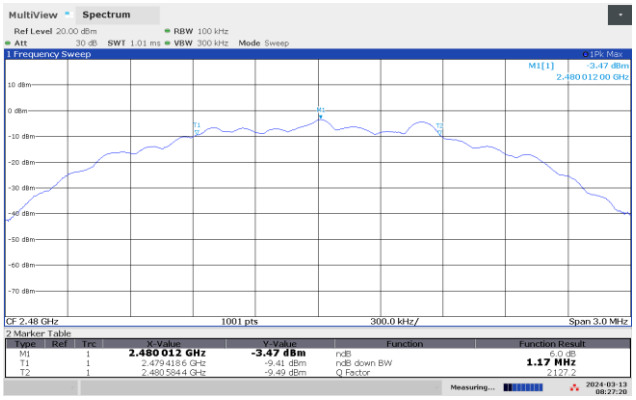
DTS BW, 2440 MHz, BLE 1M



DTS BW, 2440 MHz, BLE 2M

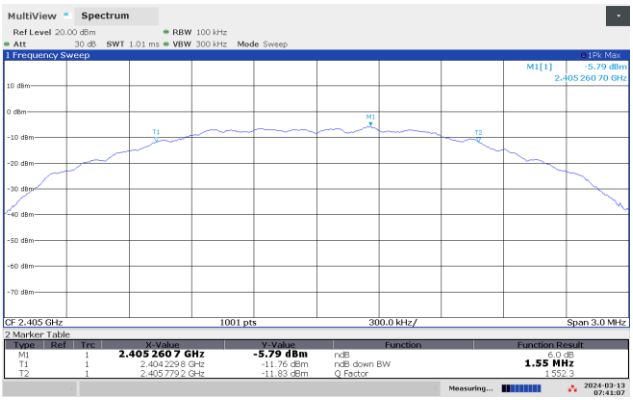


DTS BW, 2480 MHz, BLE 1M

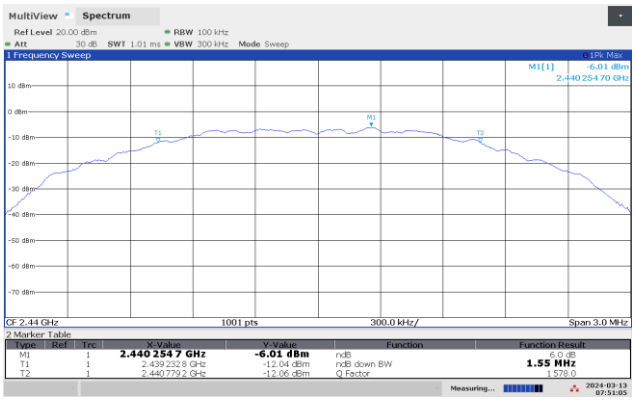


DTS BW, 2480 MHz, BLE 2M

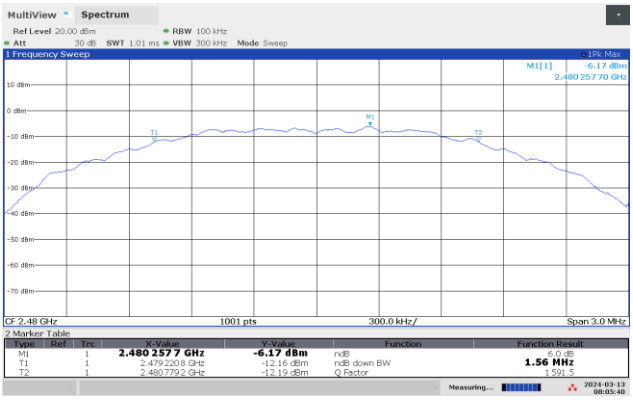
SNOBEE DTS BW



DTS BW, 2405 MHz, Snobee



DTS BW, 2440 MHz, Snobee



DTS BW, 2480 MHz, Snobee

3.5 Peak Power Output

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 3, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

TX Chan (Low / Mid / High)	Peak Conducted Power, dBm			Peak EIRP, dBuV/m			Peak EIRP, dBm calculated			Antenna gain dBi		
	BLE 1Mb	BLE 2Mb	Snobee	BLE 1Mb	BLE 2Mb	Snobee	BLE 1Mb	BLE 2Mb	Snobee	BLE 1Mb	BLE 2Mb	Snobee
Low	7.7	7.7	7.7	103.7	102.8	102.7	8.5	7.6	7.5	0.8	-0.1	-0.2
Mid	7.6	7.6	7.5	103.4	104.2	104.2	8.2	9.0	9.0	0.6	1.4	1.5
High	7.4	7.4	7.4	103.7	104.7	103.8	8.5	9.5	8.6	1.1	2.1	1.2

Output Power reported is Maximum Peak Power.

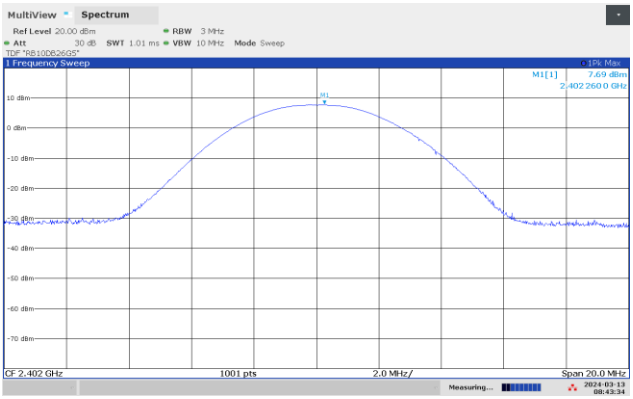
The Integrated Band Power Method was used to measure Output Power

Radiated Power was calculated from measured Field Strength using the method described in FCC KDB 412172 D01.

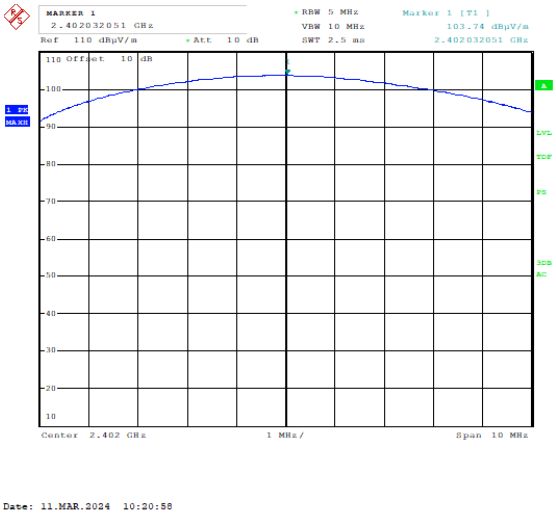
Antenna Gain is less than 6 dBi.

See attached plots.

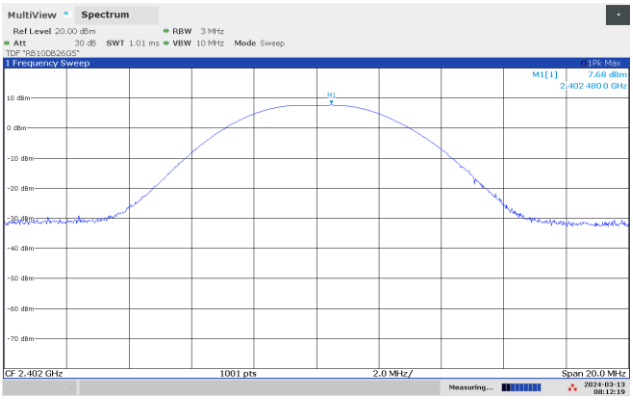
Requirements for Digital Modulation systems
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the 1 Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.
Maximum allowed Antenna Gain
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



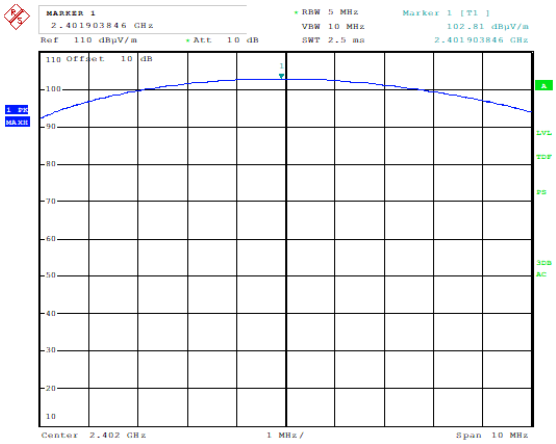
BLE 1Mb, Peak Power, 2402 MHz



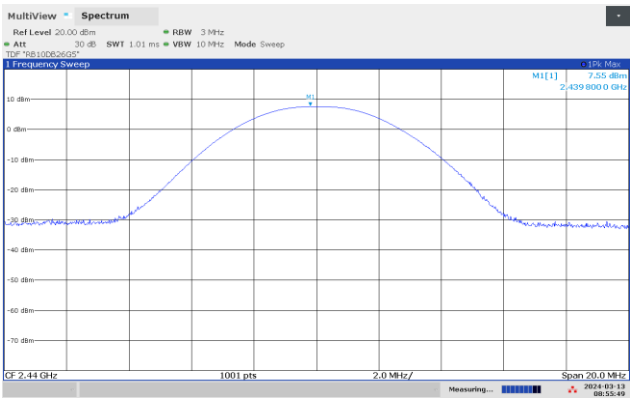
BLE 1Mb, Peak Field Strength, 2402 MHz



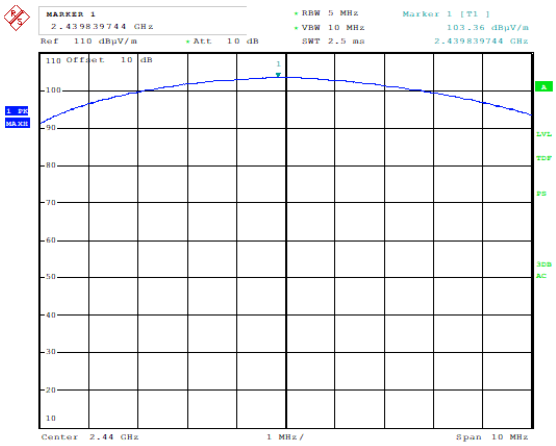
BLE 2Mb, Peak Power, 2402 MHz



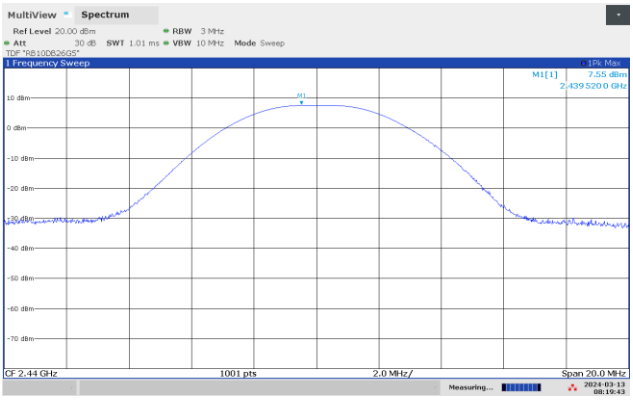
BLE 2Mb, Peak Field Strength, 2402 MHz



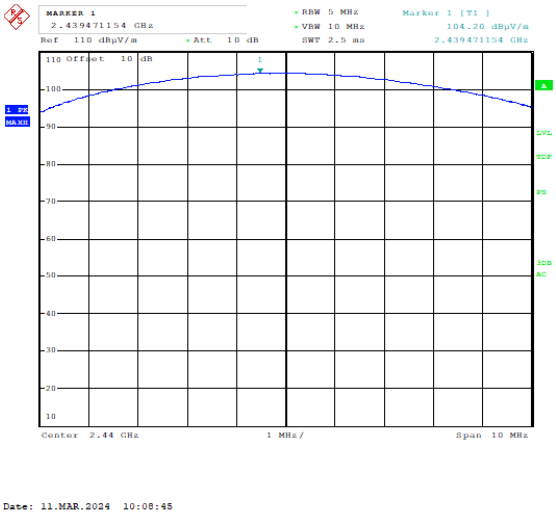
BLE 1Mb, Peak Power, 2440 MHz



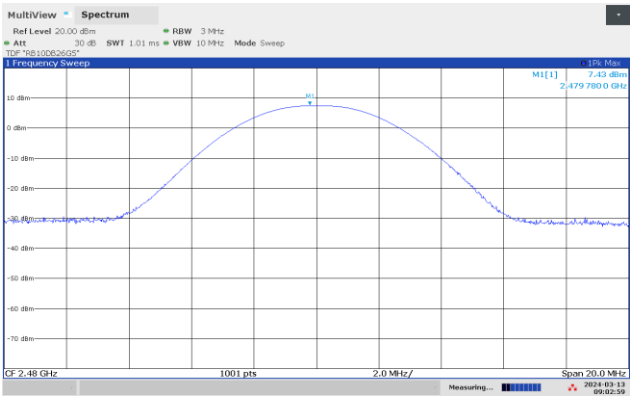
BLE 1Mb, Peak Field Strength, 2440 MHz



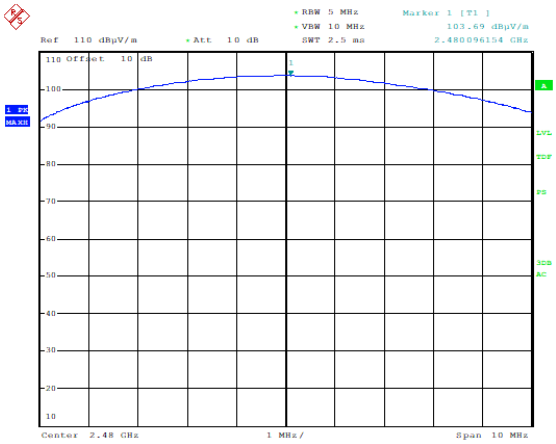
BLE 2Mb, Peak Power, 2440 MHz



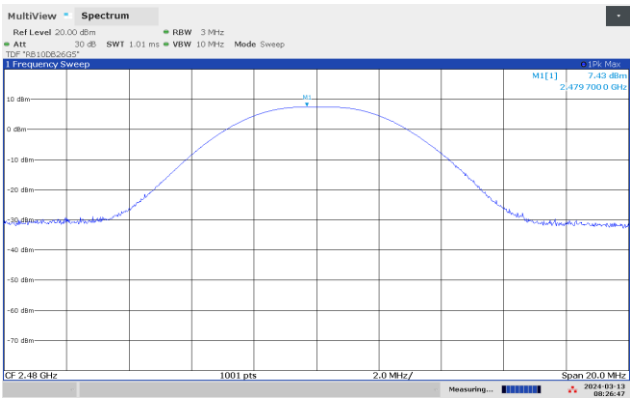
BLE 2Mb, Peak Field Strength, 2440 MHz



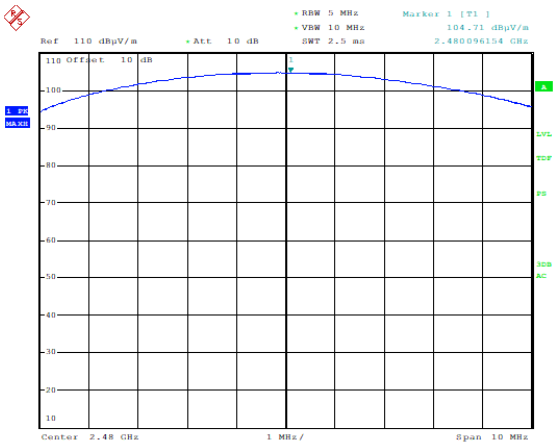
BLE 1Mb, Peak Power, 2480 MHz



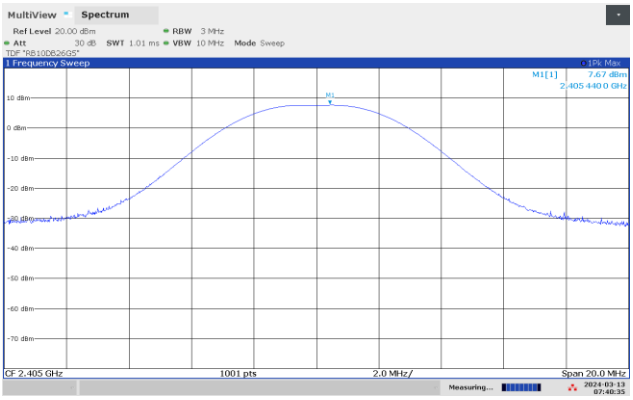
BLE 1Mb, Peak Field Strength, 2480 MHz



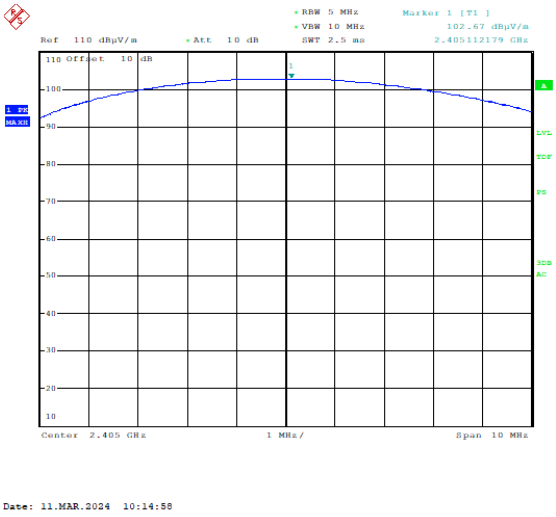
BLE 2Mb, Peak Power, 2480 MHz



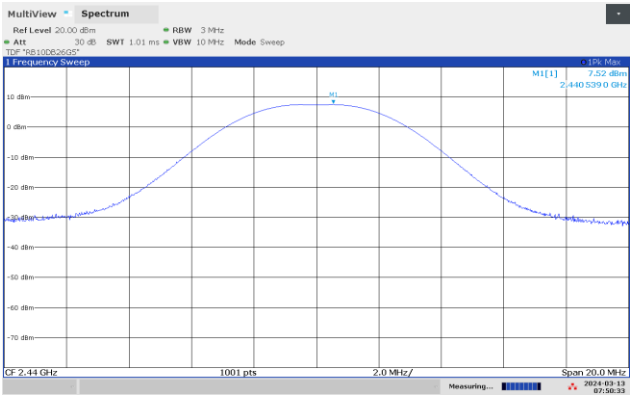
BLE 2Mb, Peak Field Strength, 2480 MHz



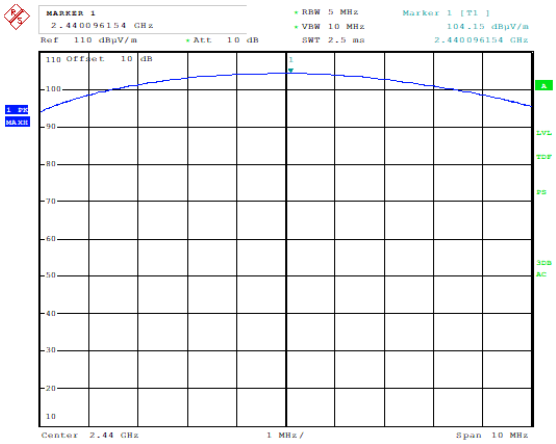
Snobee, Peak EIRP, 2405 MHz



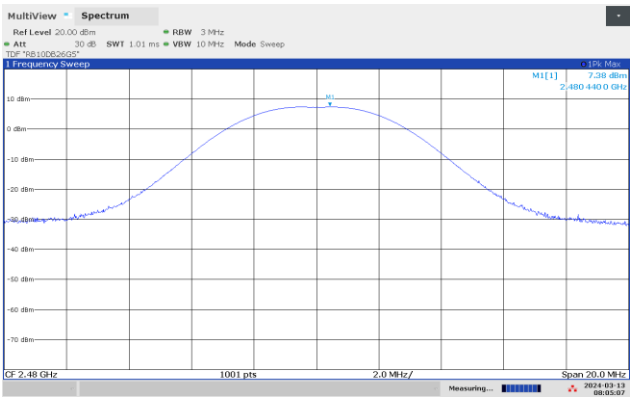
Snobee, Peak Field Strength, 2405 MHz



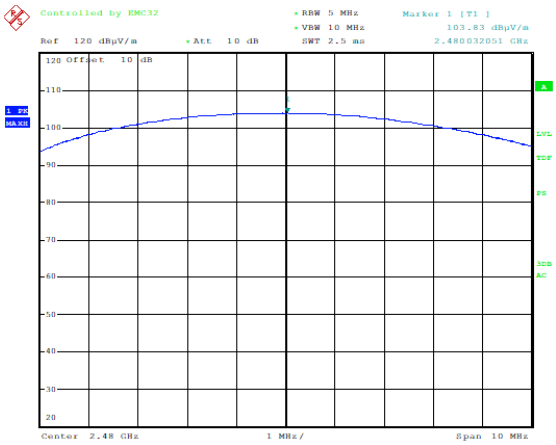
Snobee, Peak EIRP, 2440 MHz



Snobee, Peak Field Strength, 2440 MHz



Snobee, Peak EIRP, 2480 MHz



Snobee, Peak Field Strength, 2480 MHz

3.6 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

ISED Canada RSS-247 Issue 3, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

Measurement Data:

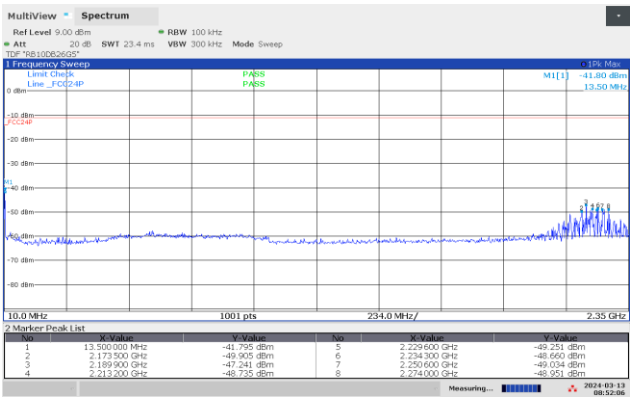
Carrier Channel	Inband level (dBm)			Spurious Level (dBm)			Margin (dB)			Verdict
Low / Mid / High	BLE 1MB	BLE 2MB	Snobee	BLE 1MB	BLE 2MB	Snobee	BLE 1MB	BLE 2MB	Snobee	
Low	7.5	7.3	4.6	-35.8	-36.5	-37.6	23.3	23.8	22.2	Pass
Mid	7.3	7.3	4.5	-31.9	-33.0	-36.3	19.2	20.3	20.8	Pass
High	7.3	7.2	3.8	-29.6	-30.3	-33.8	16.9	17.5	17.6	Pass

Measured with Peak Detector

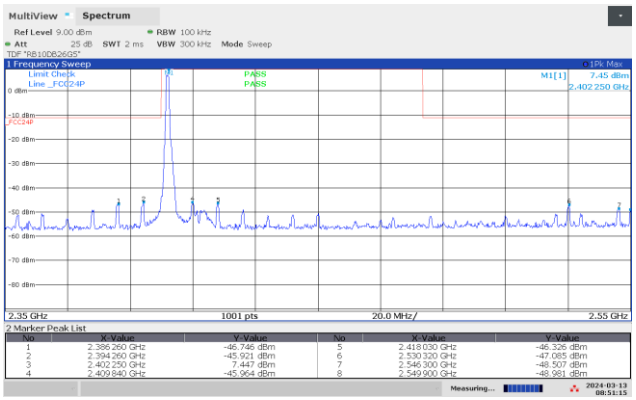
RF conducted power 10 MHz to 26 GHz: see attached plots. In the plots below the shown limit line is at -20 dBc relative to the highest measured TX carrier level at the frequency in question. From the plots it can be seen that all carrier levels are at more than 7 dBm for BLE and more than 3 dBm for Snobee. Thus, the margin below -20 dBc is more than 20 dB at low frequencies, more than 19 dB at mid frequencies, and more than 16 dB at high frequencies.

Requirements for all systems	
Peak measurement	**RMS averaging (alternative measurement)**
20 dB or more below carrier measured in 100 kHz bandwidth	30 dB or more below carrier measured in 100 kHz bandwidth
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required.	

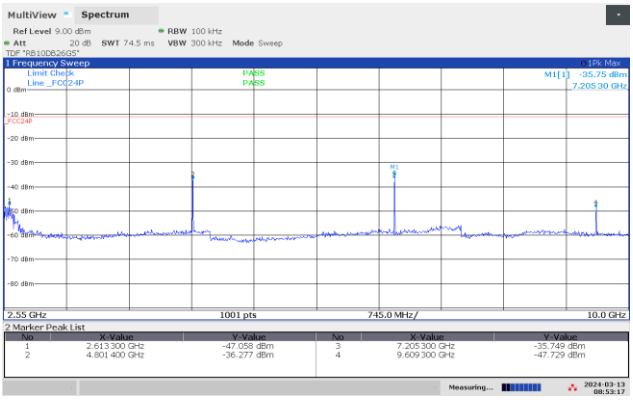
BLE 1Mb



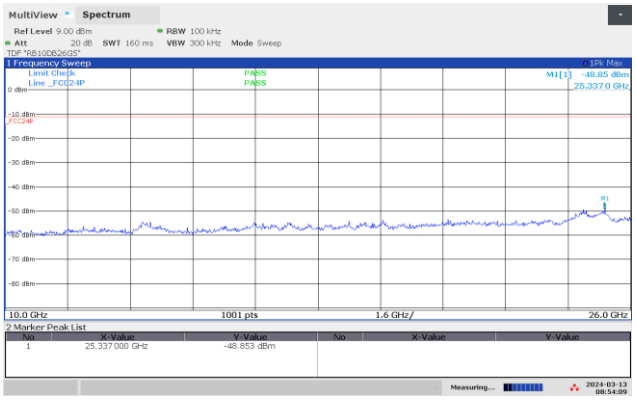
Conducted Emissions BLE 2402 MHz, 1Mb, 10-2350 MHz



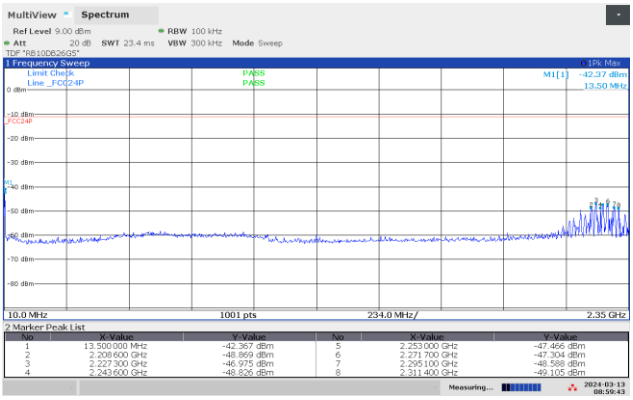
Conducted Emissions BLE 2402 MHz, 1Mb, 2350-2550 MHz



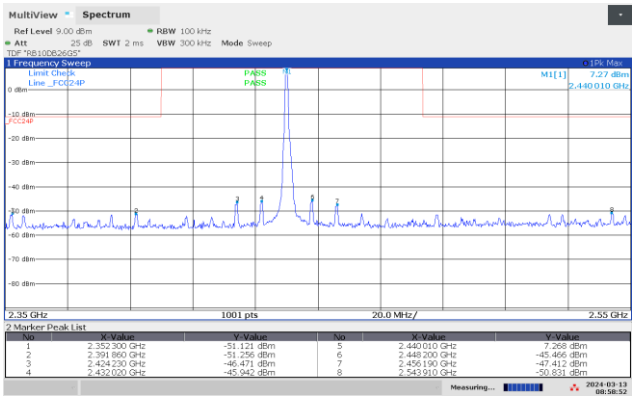
Conducted Emissions BLE 2402 MHz, 1Mb, 2550-10000 MHz



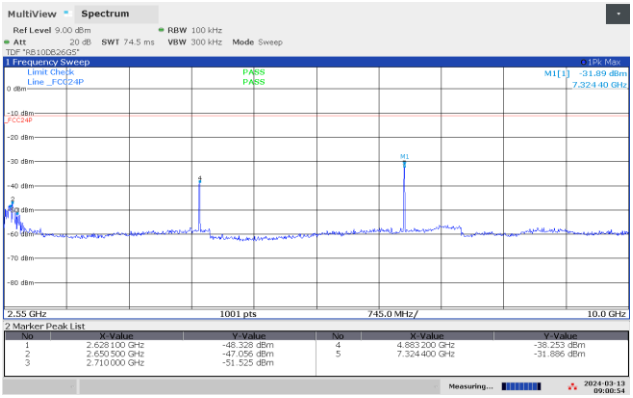
Conducted Emissions BLE 2402 MHz, 1Mb, 10000-26000 MHz



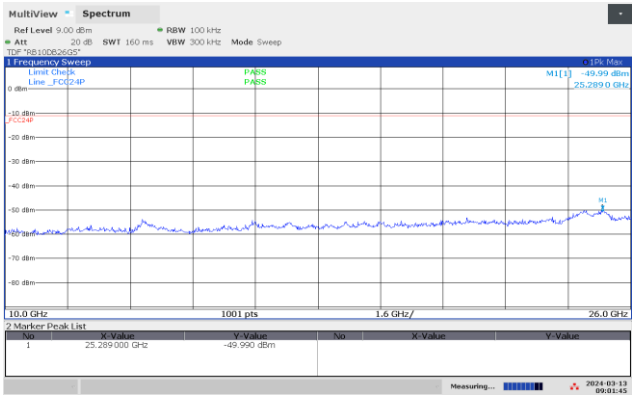
Conducted Emissions BLE 2440 MHz, 1Mb, 10-2350 MHz



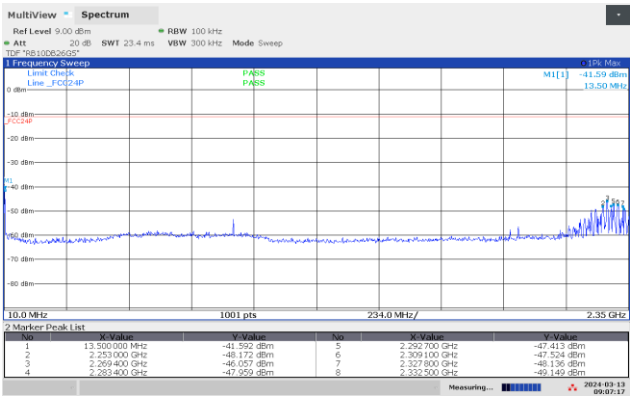
Conducted Emissions BLE 2440 MHz, 1Mb, 2350-2550 MHz



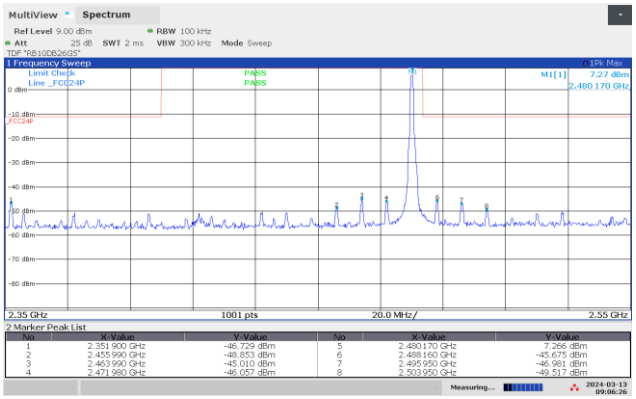
Conducted Emissions BLE 2440 MHz, 1Mb, 2550-10000 MHz



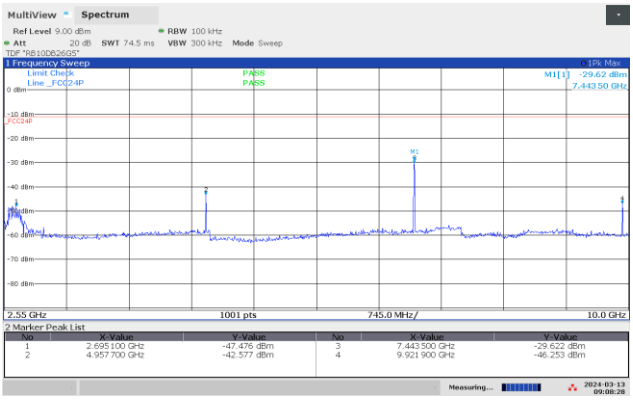
Conducted Emissions BLE 2440 MHz, 1Mb, 10000-26000 MHz



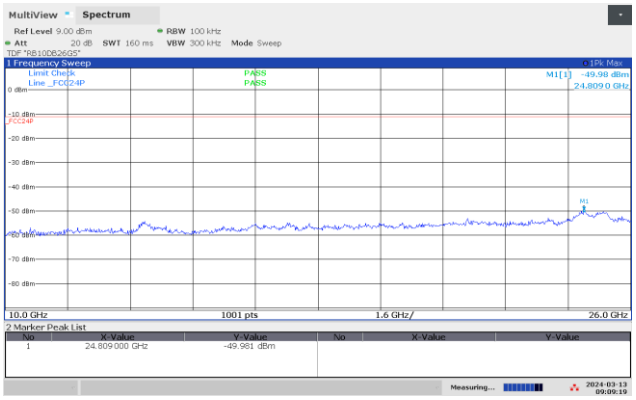
Conducted Emissions BLE 2480 MHz, 1Mb, 10-2350 MHz



Conducted Emissions BLE 2480 MHz, 1Mb, 2350-2550 MHz

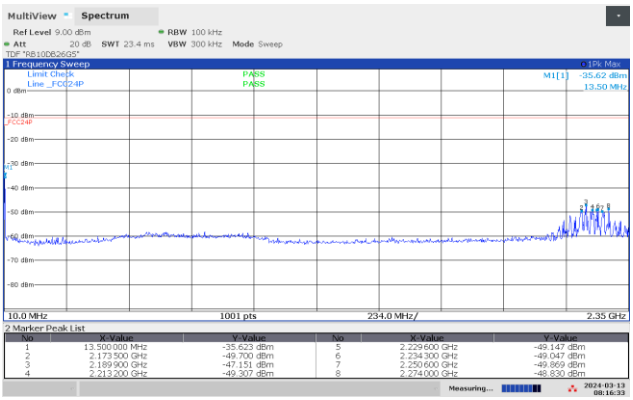


Conducted Emissions BLE 2480 MHz, 1Mb, 2550-10000 MHz

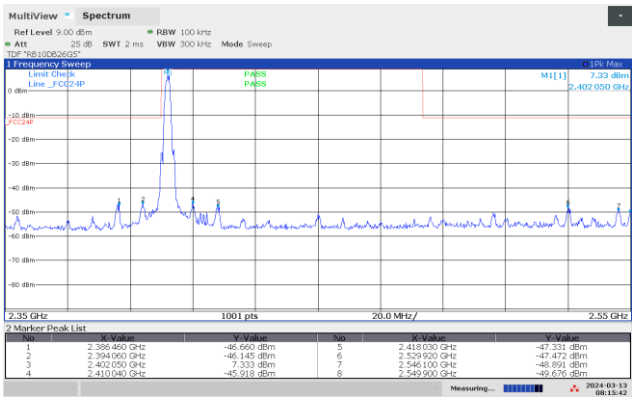


Conducted Emissions BLE 2480 MHz, 1Mb, 10000-26000 MHz

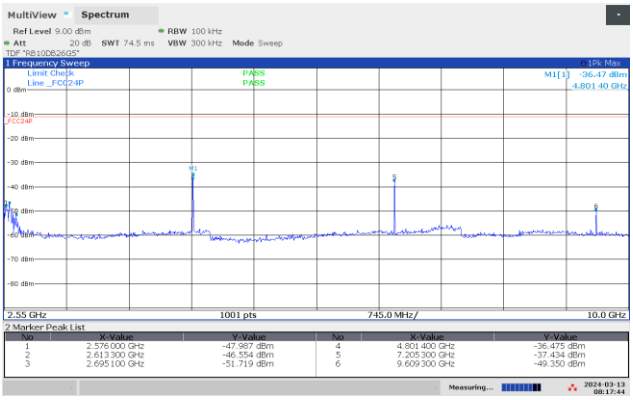
BLE 2Mb



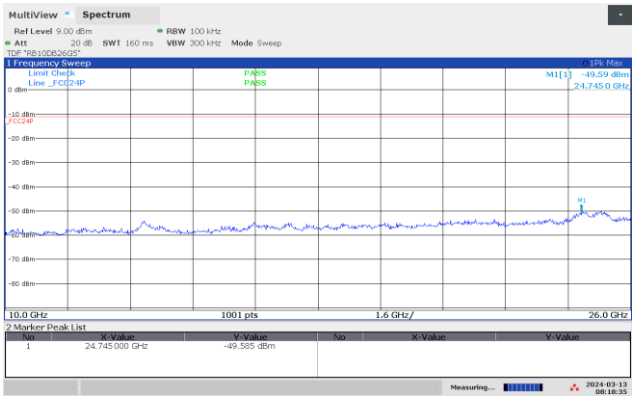
Conducted Emissions BLE 2402 MHz, 2Mb, 10-2350 MHz



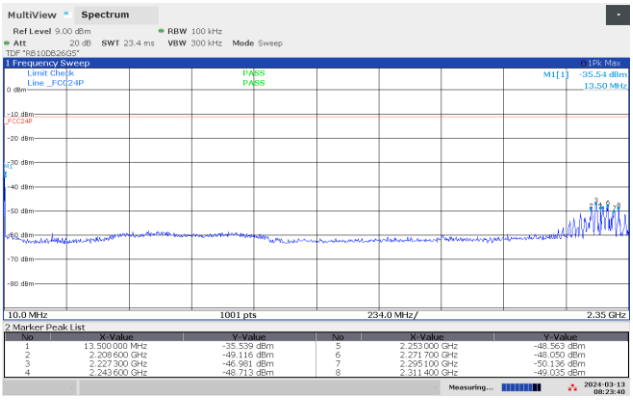
Conducted Emissions BLE 2402 MHz, 2Mb, 2350-2550 MHz



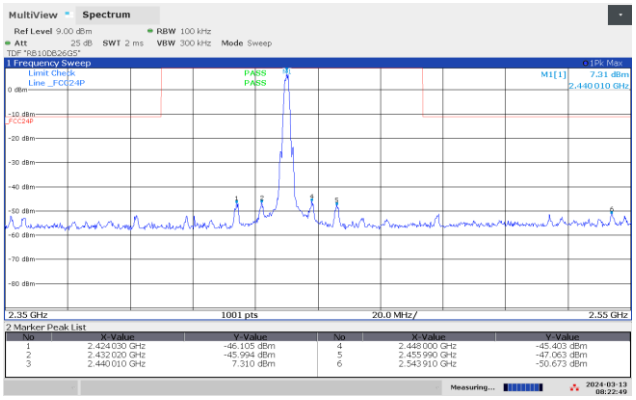
Conducted Emissions BLE 2402 MHz, 2Mb, 2550-10000 MHz



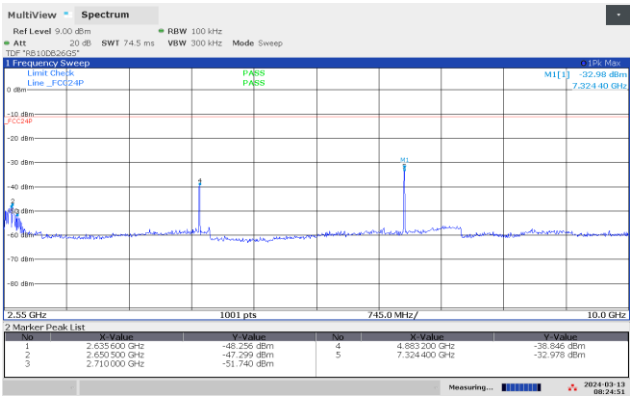
Conducted Emissions BLE 2402 MHz, 2Mb, 10000-26000 MHz



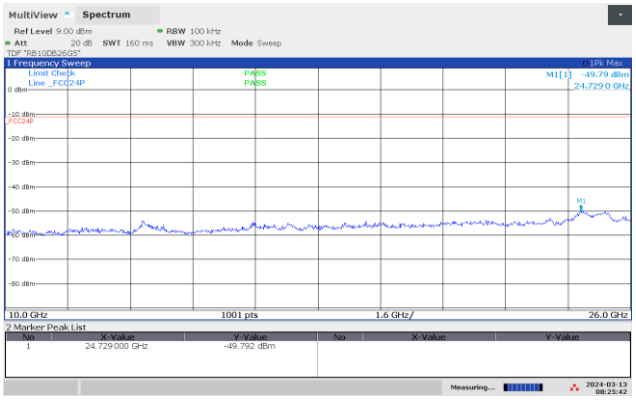
Conducted Emissions BLE 2440 MHz, 2Mb, 10-2350 MHz



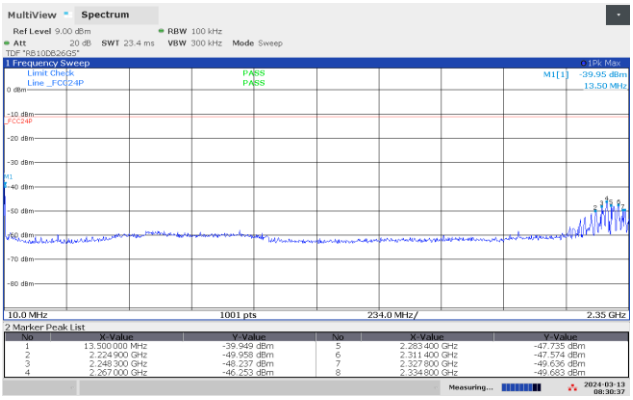
Conducted Emissions BLE 2440 MHz, 2Mb, 2350-2550 MHz



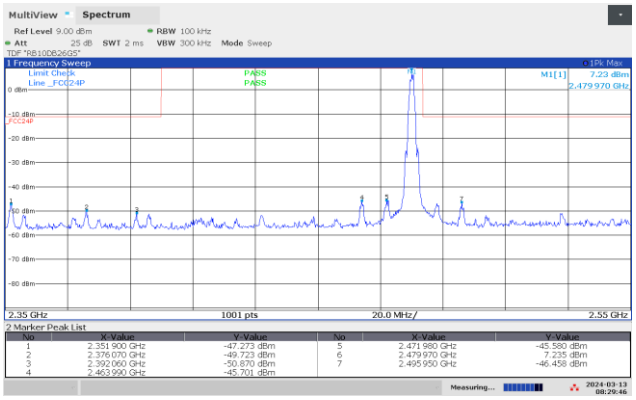
Conducted Emissions BLE 2440 MHz, 2Mb, 2550-10000 MHz



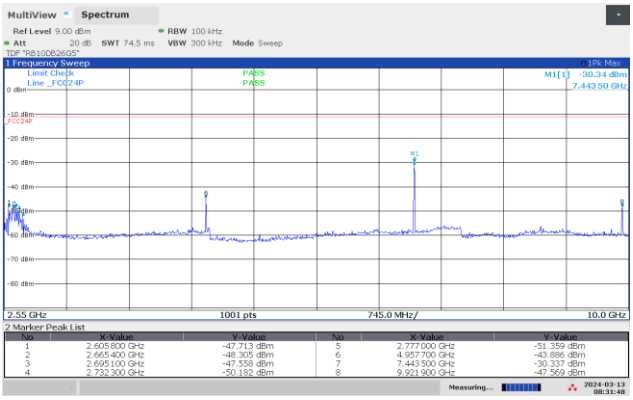
Conducted Emissions BLE 2440 MHz, 2Mb, 10000-26000 MHz



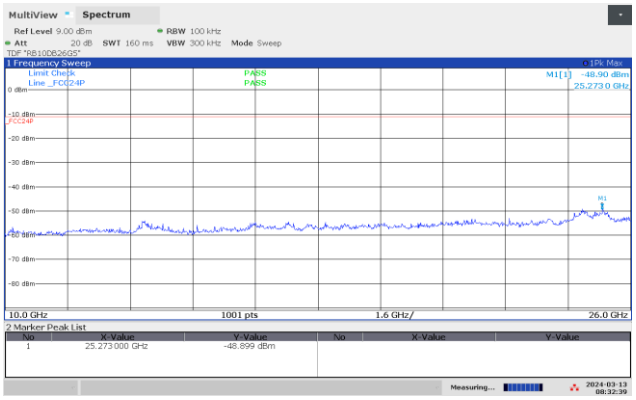
Conducted Emissions BLE 2480 MHz, 2Mb, 10-2350 MHz



Conducted Emissions BLE 2480 MHz, 2Mb, 2350-2550 MHz

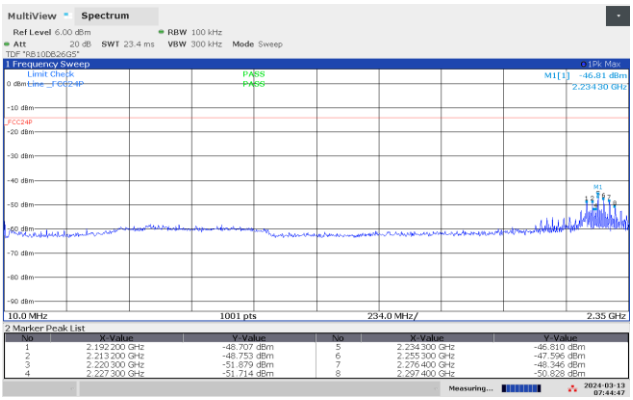


Conducted Emissions BLE 2480 MHz, 2Mb, 2550-10000 MHz

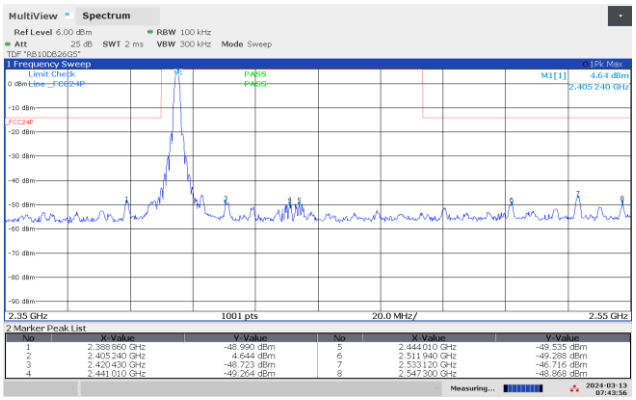


Conducted Emissions BLE 2480 MHz, 2Mb, 10000-26000 MHz

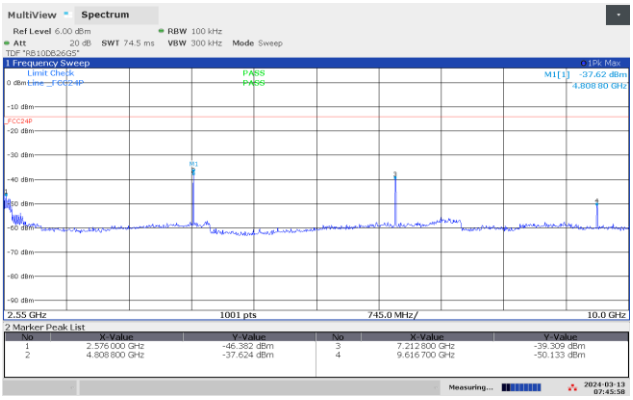
Snobee:



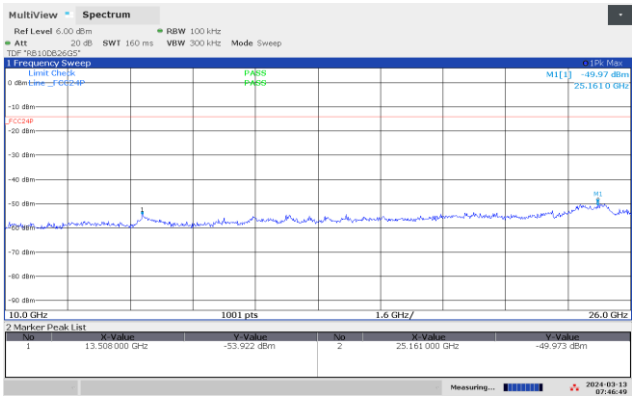
Conducted Emissions Snobee 2405 MHz, 10-2350 MHz



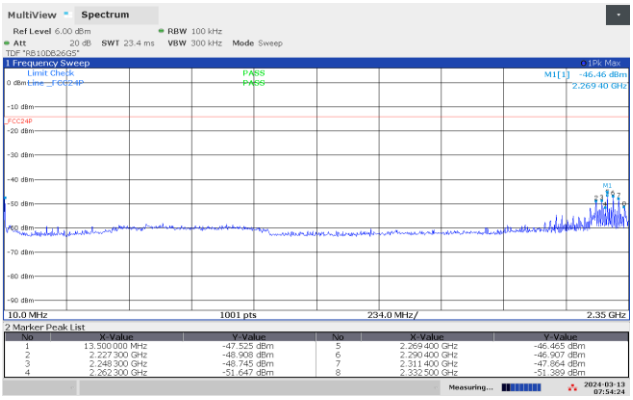
Conducted Emissions Snobee 2405 MHz, 2350-2550 MHz



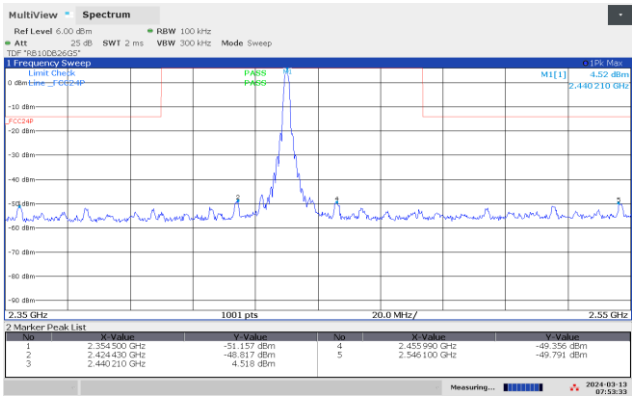
Conducted Emissions Snobee 2405 MHz, 2550-10000 MHz



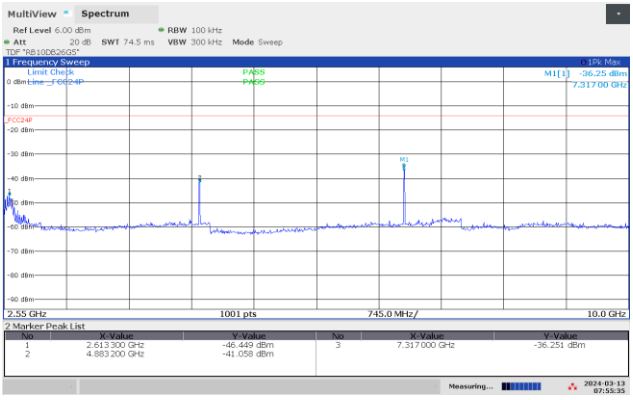
Conducted Emissions Snobee 2405 MHz, 10000-26000 MHz

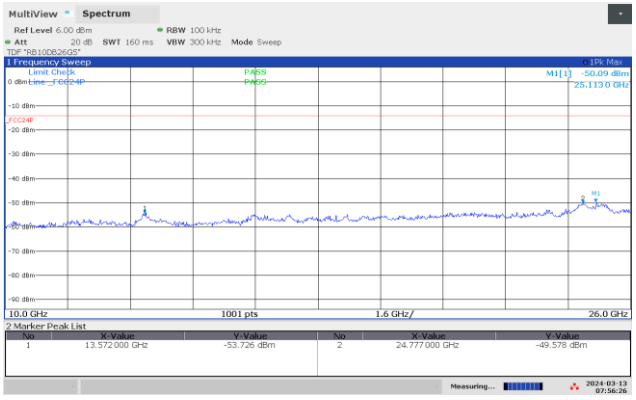


Conducted Emissions Snobee 2440 MHz, 10-2350 MHz

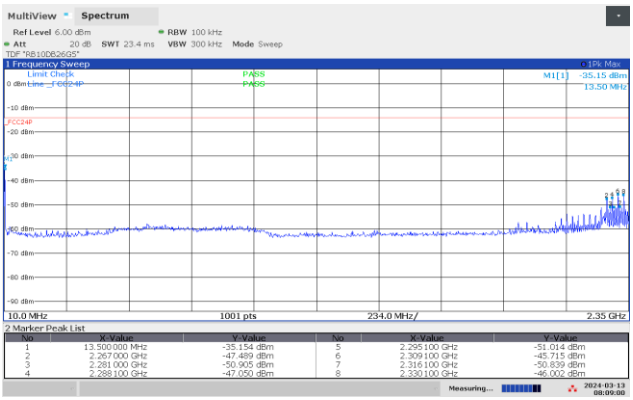


Conducted Emissions Snobee 2440 MHz, , 2350-2550 MHz

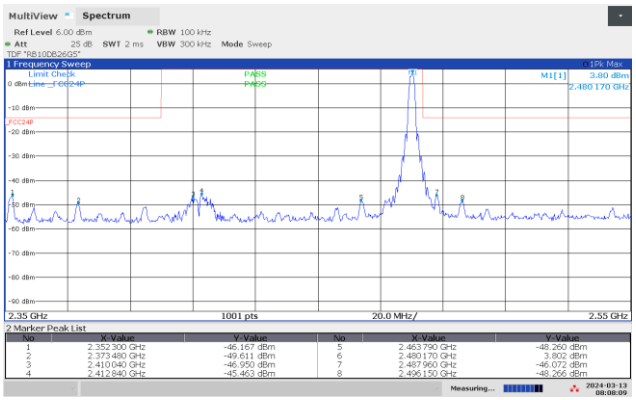




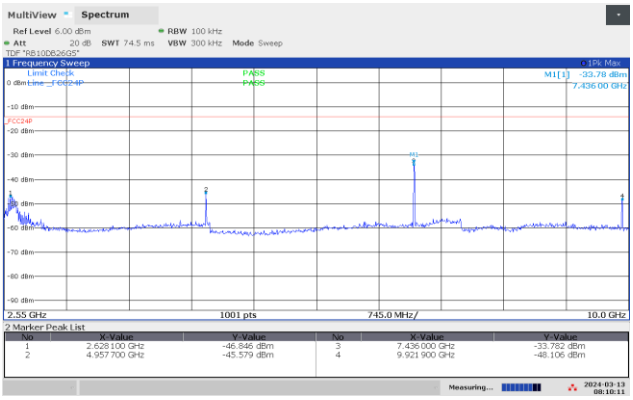
Conducted Emissions Snobee 2440 MHz, , 2550-10000 MHz



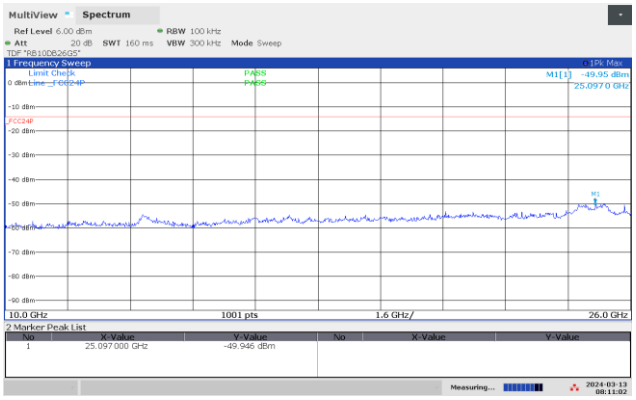
Conducted Emissions Snobee 2440 MHz, 10000-26000 MHz



Conducted Emissions Snobee 2480 MHz, 10-2350 MHz



Conducted Emissions Snobee 2480 MHz, , 2350-2550 MHz



Conducted Emissions Snobee 2480 MHz, 2550-10000 MHz

Conducted Emissions Snobee 2480 MHz, 10000-26000 MHz

3.7 Restricted Bands of operation

Restricted Bands of operation for FCC and ISED are defined in FCC Part 15.205 and ISED RSS-GEN, Issue 5 clause 8.10.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 5, clause 8.9.

FCC (MHz)	ISED (MHz)	FCC (GHz)	ISED (GHz)
0.090-0.110		**0.96-1.24** **1.3-1.427**	**0.96-1.427**
0.495-0.505		1.435-1.6265	
2.1735-2.1905		1.6455-1.6465	
	3.020-3.026	1.660-1.710	
4.125-4.128		1.7188-1.7222	
4.17725-4.17775		2.2-2.3	
4.20725-4.20775		2.31-2.39	
	5.677-5.683	2.4835-2.5	
6.215-6.218		**2.69-2.9**	**2.655-2.9**
6.26775-6.26825		3.26-3.267	
6.31175-6.31225		3.332-3.339	
8.291-8.294		3.3458-3.358	
8.362-8.366		**3.6-4.4**	**3.5-4.4**
8.37625-8.38675		4.5-5.15	
8.41425-8.41475		5.35-5.46	
12.29-12.293		7.25-7.75	
12.51975-12.52025		8.025-8.5	
12.57675-12.57725		9.0-9.2	
13.36-13.41		9.3-9.5	
16.42-16.423		10.6-12.7	
16.69475-16.69525		13.25-13.4	
16.80425-16.80475		14.47-14.5	
25.5-25.67		15.35-16.2	
37.5-38.25		17.7-21.4	
73-74.6		22.01-23.12	
74.8-75.2		23.6-24.0	
108-121.94 **123-138**	**108-138**	31.2-31.8	
149.9-150.05		36.43-36.5	
156.52475-156.52525		Above 38.6	
156.7-156.9			
162.0125-167.17			
167.72-173.2			
240-285			
322-335.4			
399.9-410			
608-614			

Frequencies in **Bold** text are specific for FCC or ISED, all other frequencies are common.

3.8 Radiated Emissions, Band Edge

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3 / 8.9

Measurement procedure: **ANSI C63.10-2013 Clause 11.12**

Test Results: Complies

Measurement Data:

Peak Detector					
Modulation and Bitrate	Measured field strength (dBµV/m)		Limit	Margin dB	
	2390 MHz	2483.5 MHz	dB	2390 MHz	2483.5 MHz
GFSK, 1Mb	55.6	56.0	74	18.4	18.0
GFSK, 2Mb	54.8	60.2	74	19.2	13.8
Snobee, 1Mb	54.7	67.9	74	19.3	6.1

Average Detector					
Modulation and Bitrate	Measured field strength (dBµV/m)		Limit	Margin dB	
	2390 MHz	2483.5 MHz	dB	2390 MHz	2483.5 MHz
GFSK, 1Mb	49.0	48.9	54	5.0	5.1
GFSK, 2Mb	48.8	49.6	54	5.2	4.4
Snobee, 1Mb	27.2	39.7	54	26.8	14.3

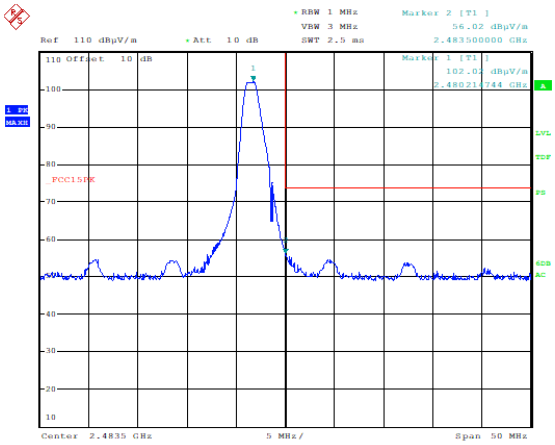
Average Detector measurements for BLE were performed with the method SA-2. The measurements for BLE 1Mb and BLE 2Mb had duty cycle less than 98%, duty cycle correction for BLE 1Mb is +0.7 dB (DC=85%) and for BLE 2Mb 3.7 dB (DC=43%).

For Snobee the method SA-1 was used since the duty cycle in test mode was 100%.

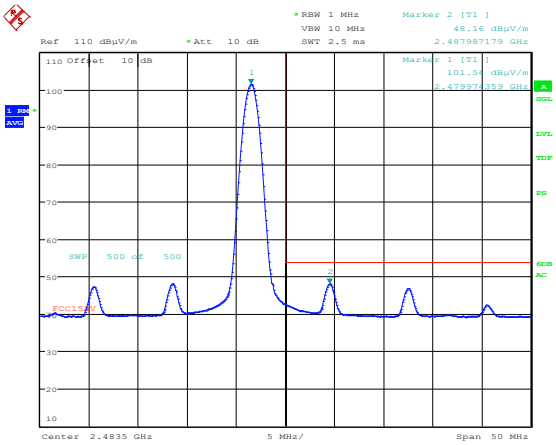
The manufacturer states that the maximum time of transmission for Snobee during a period of 100 ms is 4% for Snobee – see "*ultraBeacon Single-Zone Operational description V01.pdf*".

Duty Cycle Correction for Snobee is -20x log(0.04) = 28.0 dB => Maximum allowe correction is 20 dB

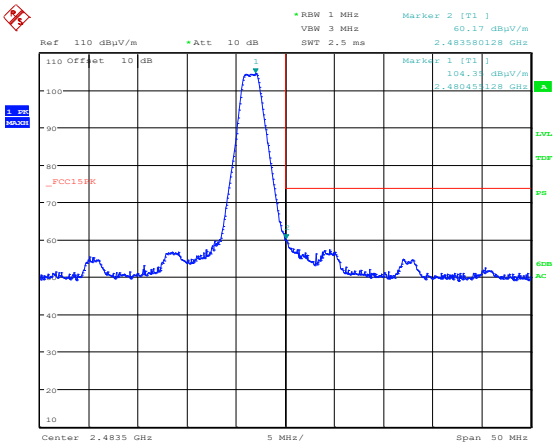
See attached plots.



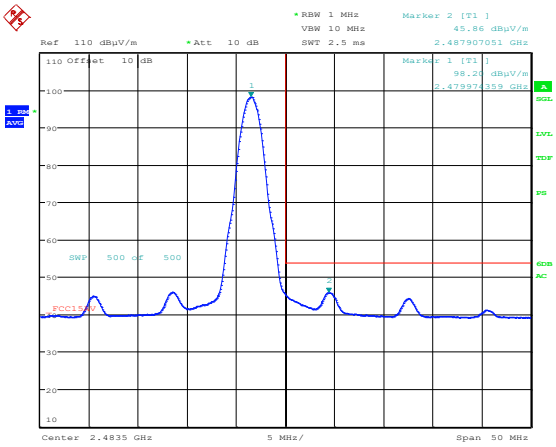
Upper Band Edge, 2480 MHz, BLE 1Mb, Peak



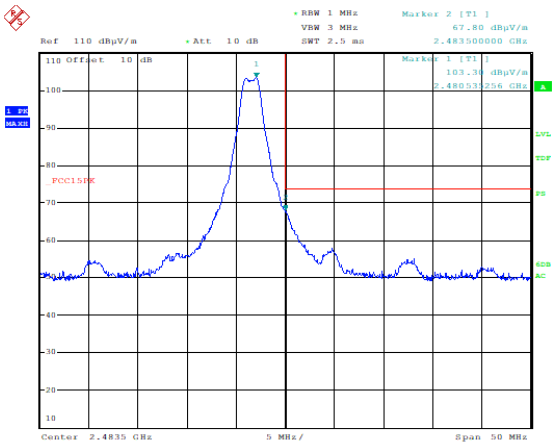
Upper Band Edge, 2480 MHz, 1Mb, Average



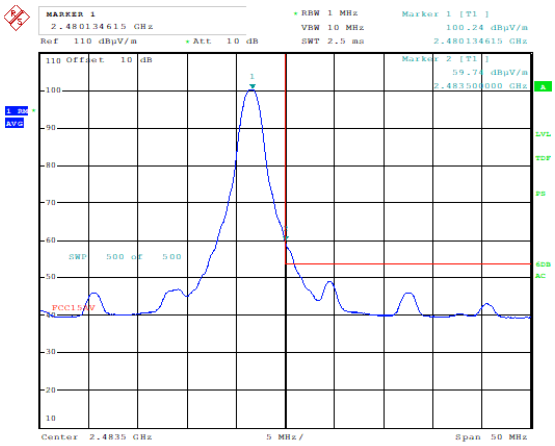
Upper Band Edge, 2480 MHz, BLE 2Mb, Peak



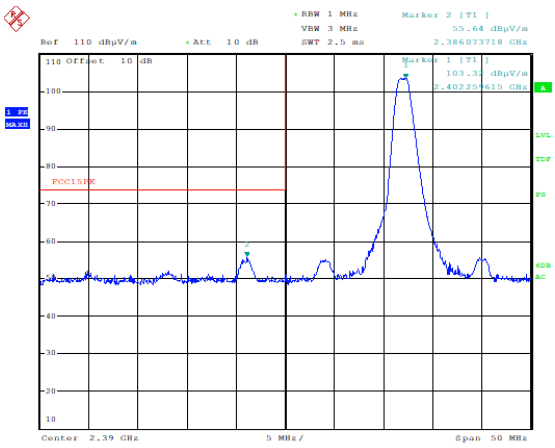
Upper Band Edge, 2480 MHz, BLE 2Mb, Average



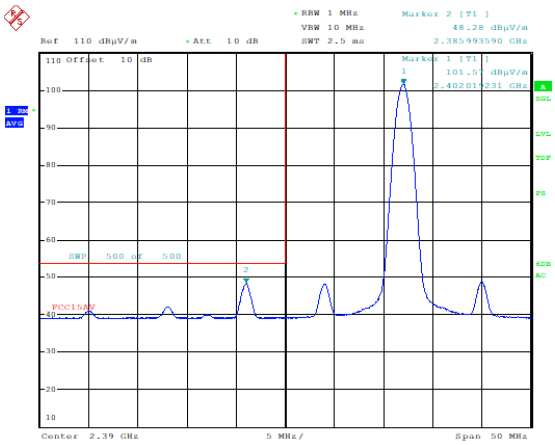
Upper Band Edge, 2480 MHz, Snobee, Peak



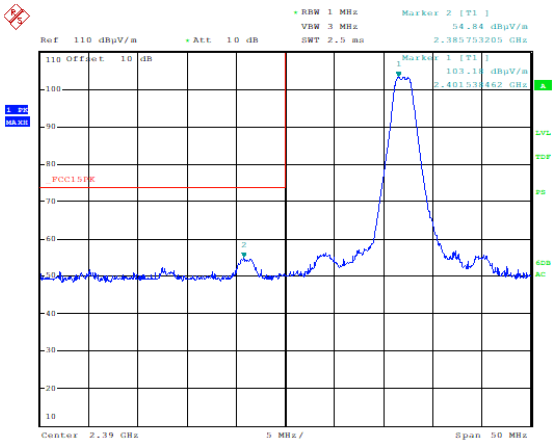
Upper Band Edge, 2480 MHz, Snobee, Average



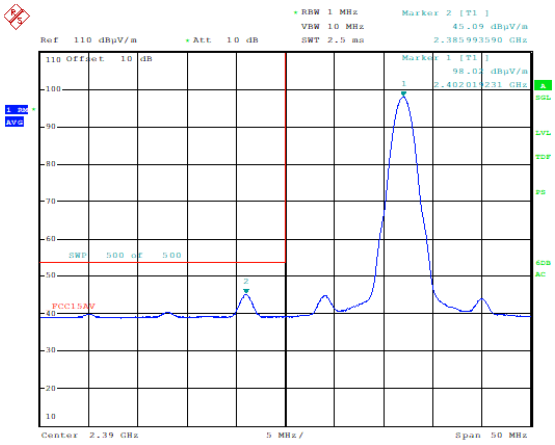
Lower Band Edge, 2402 MHz, BLE 1Mb, Peak



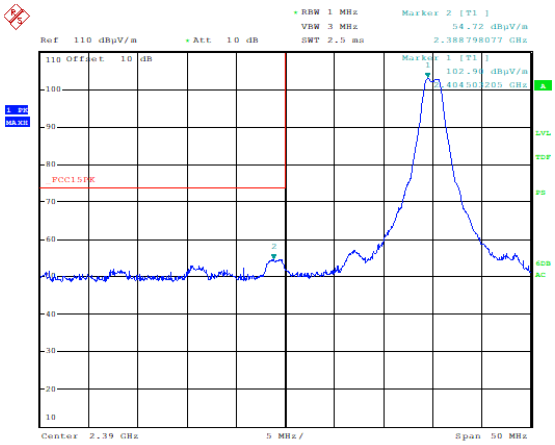
Lower Band Edge, 2402 MHz, 1Mb, Average



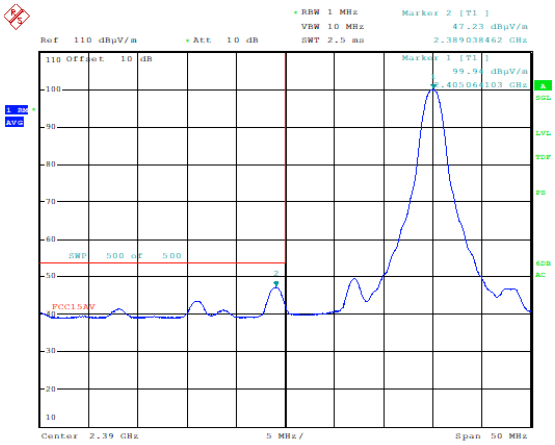
Lower Band Edge, 2402 MHz, BLE 2Mb, Peak



Lower Band Edge, 2402 MHz, BLE 2Mb, Average



Lower Band Edge, 2405 MHz, Snobee, Peak



Lower Band Edge, 2405 MHz, Snobee, Average

3.9 Radiated Emissions, 30 – 1000 MHz.

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Detector: Quasi-Peak

Measuring distance 3 m

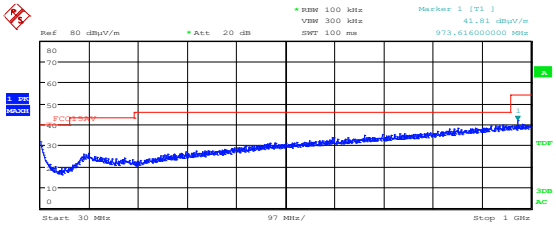
Tested in test mode with EUT transmitting on ch19

Measured Frequency (MHz)	Carrier Frequency (MHz)	Modulation	Measured Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30 – 88	All	All	< 33	40.0	> 7
88 – 216	All	All	< 30	43.5	> 13.5
216 – 960	All	All	< 43	46.0	> 3
960 – 1000	All	All	< 45	54.0	> 11

See attached plots

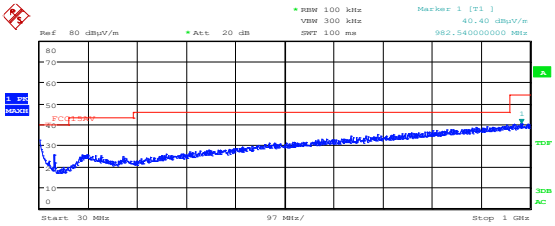
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
Frequency	Radiated emission limit @3 meters	
30 – 88 MHz	100 µV/m	40.0 dBµV/m
88 – 216 MHz	150 µV/m	43.5 dBµV/m
216 – 960 MHz	200 µV/m	46.0 dBµV/m
960 – 1000 MHz	500 µV/m	54.0 dBµV/m
	Limits above are with Quasi Peak Detector	



#	Frequency	Level
1	30.000000 MHz	31.78 dBµV
2	973.616000 MHz	41.81 dBµV

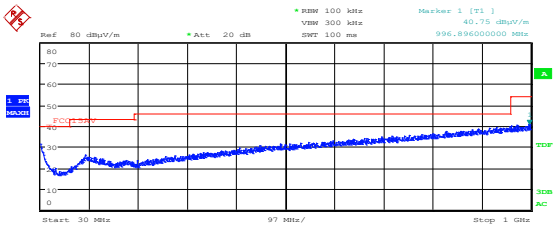
Date: 26.FEB.2024 11:16:52



#	Frequency	Level
1	30.000000 MHz	32.31 dBµV
2	58.712000 MHz	25.49 dBµV
3	60.652000 MHz	25.24 dBµV
4	982.540000 MHz	40.40 dBµV

Date: 26.FEB.2024 11:14:56

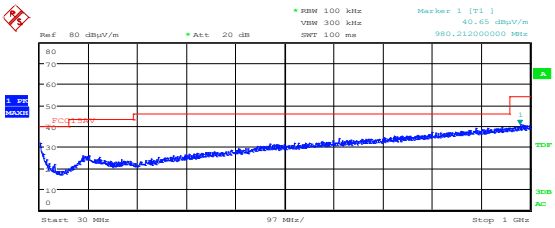
Radiated Emissions 30 - 1000 MHz, BLE 2402, 1Mb, HP



#	Frequency	Level
1	31.164000 MHz	31.55 dBµV
2	996.896000 MHz	40.75 dBµV

Date: 26.FEB.2024 12:32:12

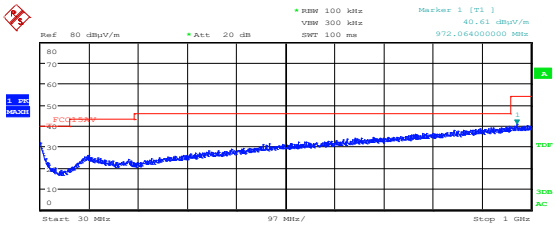
Radiated Emissions 30 - 1000 MHz, BLE 2402, 1Mb, VP



#	Frequency	Level
1	30.776000 MHz	31.81 dBµV
2	980.212000 MHz	40.65 dBµV

Date: 26.FEB.2024 12:30:16

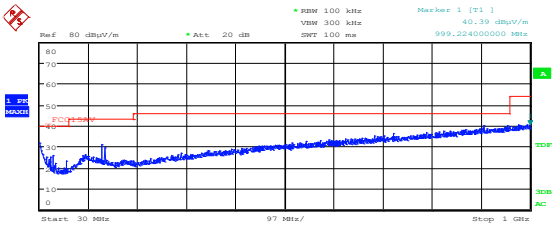
Radiated Emissions 30 - 1000 MHz, BLE 2402, 2Mb, HP



#	Frequency	Level
1	31.164000 MHz	31.75 dBµV
2	972.064000 MHz	40.61 dBµV

Date: 27.FEB.2024 07:05:46

Radiated Emissions 30 - 1000 MHz, BLE 2402, 2Mb, VP

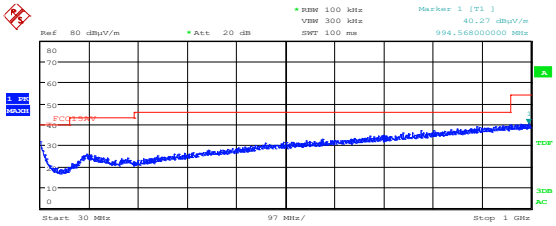


#	Frequency	Level
1	30.000000 MHz	31.60 dBµV
2	52.892000 MHz	25.04 dBµV
3	57.936000 MHz	25.74 dBµV
4	153.384000 MHz	30.87 dBµV
5	159.980000 MHz	29.46 dBµV
6	999.224000 MHz	40.39 dBµV

Date: 26.FEB.2024 14:31:03

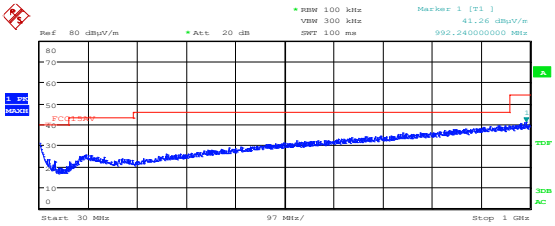
Radiated Emissions 30 - 1000 MHz, Snobee 2405, HP

Radiated Emissions 30 - 1000 MHz, Snobee 2405, VP



#	Frequency	Level
1	30.388000 MHz	31.79 dBµV
2	994.568000 MHz	40.27 dBµV

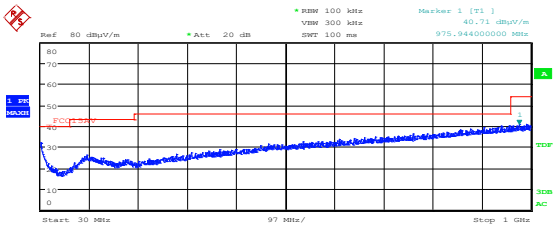
Date: 26.FEB.2024 12:05:25



#	Frequency	Level
1	31.164000 MHz	31.14 dBµV
2	992.240000 MHz	41.26 dBµV

Date: 26.FEB.2024 12:03:30

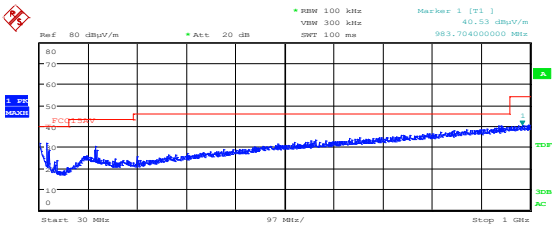
Radiated Emissions 30 - 1000 MHz, BLE 2440, 1Mb, HP



#	Frequency	Level
1	31.552000 MHz	32.11 dBµV
2	975.944000 MHz	40.71 dBµV

Date: 26.FEB.2024 13:47:23

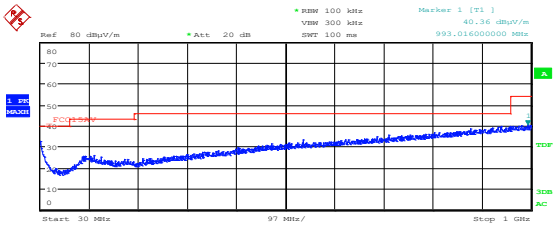
Radiated Emissions 30 - 1000 MHz, BLE 2440, 1Mb, VP



#	Frequency	Level
1	30.000000 MHz	31.62 dBµV
2	44.356000 MHz	31.78 dBµV
3	47.848000 MHz	27.73 dBµV
4	50.176000 MHz	28.29 dBµV
5	64.920000 MHz	23.37 dBµV
6	141.356000 MHz	30.08 dBµV
7	983.704000 MHz	40.53 dBµV

Date: 26.FEB.2024 13:45:27

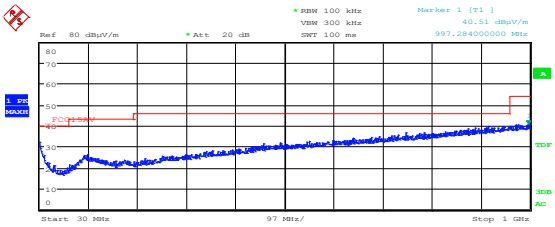
Radiated Emissions 30 - 1000 MHz, BLE 2440, 2Mb, HP



#	Frequency	Level
1	30.388000 MHz	32.43 dBµV
2	993.016000 MHz	40.36 dBµV

Date: 27.FEB.2024 07:17:08

Radiated Emissions 30 - 1000 MHz, BLE 2440, 2Mb, VP

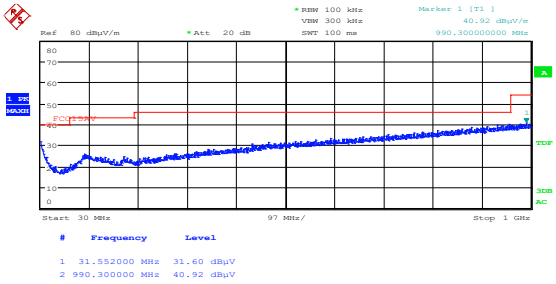


#	Frequency	Level
1	30.388000 MHz	31.96 dBµV
2	997.284000 MHz	40.51 dBµV

Date: 27.FEB.2024 07:15:13

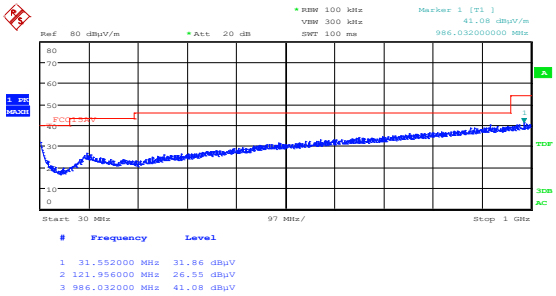
Radiated Emissions 30 - 1000 MHz, Snobee 2440, HP

Radiated Emissions 30 - 1000 MHz, Snobee 2440, VP



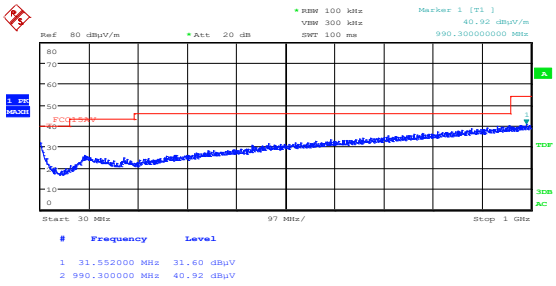
Date: 27.FEB.2024 07:39:35

Radiated Emissions 30 - 1000 MHz, BLE 2480, 1Mb, HP



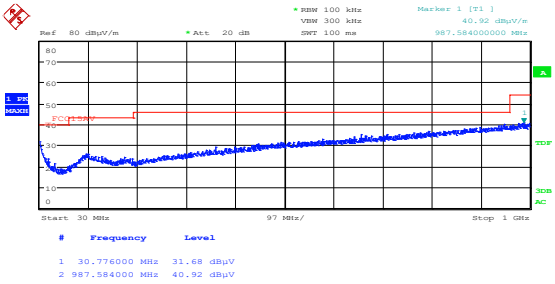
Date: 26.FEB.2024 13:53:31

Radiated Emissions 30 - 1000 MHz, BLE 2480, 2Mb, HP



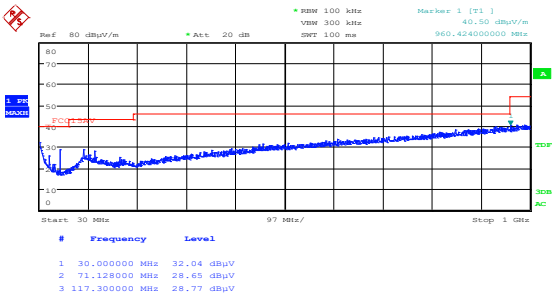
Date: 27.FEB.2024 07:39:35

Radiated Emissions 30 - 1000 MHz, Snobee 2480, HP



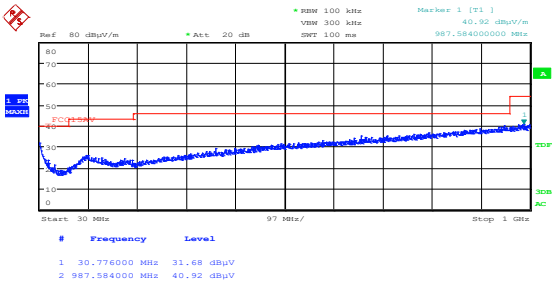
Date: 27.FEB.2024 07:37:39

Radiated Emissions 30 - 1000 MHz, BLE 2480, 1Mb, VP



Date: 26.FEB.2024 13:51:36

Radiated Emissions 30 - 1000 MHz, BLE 2480, 2Mb, VP



Date: 27.FEB.2024 07:37:39

Radiated Emissions 30 - 1000 MHz, Snobee 2480, VP

3.10 Radiated Emissions, 1 – 26 GHz

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Measuring distance: 3m (1 – 18 GHz)

A pre-scan was performed above 18 GHz and only very low spurious emissions were detected – see plots below.

Carrier Frequency (MHz) Low / Mid / high	Measured Frequency (GHz)	Mode	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Pk	Av	Pk	Av
Mid	3rd harm	BLE1Mb	55.3	35.3	74	54	18.7	18.7
Mid	3rd harm	BLE2Mb	55.2	35.2	74	54	18.8	18.8
Mid	3rd harm	Snobee	55.1	35.1	74	54	18.9	18.9
High	3rd harm	BLE1Mb	55.7	35.7	74	54	18.3	18.3
High	3rd harm	BLE2Mb	55.1	35.1	74	54	18.9	18.9
High	3rd harm	Snobee	55.6	35.6	74	54	18.4	18.4
Low	8th harm	BLE1Mb	40.8	/	74	54	33.2	/
Low	8th harm	BLE2Mb	41.2	/	74	54	32.8	/
Low	8th harm	Snobee	42.8	/	74	54	31.2	/
Mid	8th harm	BLE1Mb	39.8	/	74	54	34.2	/
Mid	8th harm	BLE2Mb	40.8	/	74	54	33.2	/
Mid	8th harm	Snobee	42.8	/	74	54	31.2	/
High	8th harm	BLE1Mb	36.5	/	74	54	37.5	/
High	8th harm	BLE2Mb	37.4	/	74	54	36.6	/
High	8th harm	Snobee	39.0	/	74	54	35.0	/
High	9th harm	BLE1Mb	42.7	/	74	54	31.3	/
High	9th harm	BLE2Mb	41.7	/	74	54	32.3	/
High	9th harm	Snobee	43.2	/	74	54	30.8	/

A Band Reject Filter for 2400-2483.5 was used for spurious measurements from 1 GHz to 18 GHz. The filter has a passband down to DC and up to 18 GHz.

Antenna factor, amplifier gain and cable loss are included in spectrum analyzer “Transducer factor”.

The manufacturer states that the device will have a maximum transmission time during 100 ms of 5 ms for BLE and 4 ms for Snobee, this gives a duty cycle correction of 20 dB for both BLE and Snobee.

Average value is not reported when Peak Value is below the Average Limit.

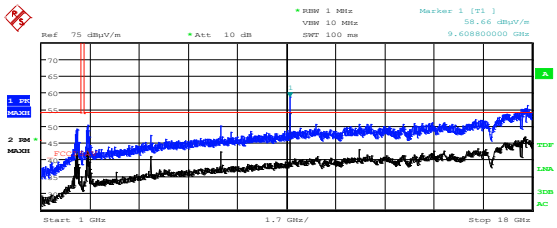
DC Correction = -20* log(Duty Cycle) (Maximum 20 dB)

See plots.

Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency	Average Detector	Peak Detector
1 – 26 GHz	54.0 dBµV/m	74.0 dBµV/m

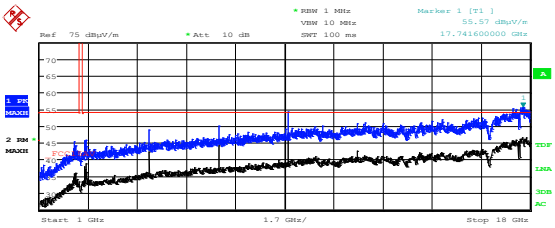
BLE 1Mbps



#	Frequency	Level
1	2.234200 GHz	48.98 dBµV
2	2.275000 GHz	48.89 dBµV
3	2.618400 GHz	50.22 dBµV
4	9.608800 GHz	58.66 dBµV
5	16.021200 GHz	51.79 dBµV
6	17.823200 GHz	56.16 dBµV

Date: 9.FEB.2024 08:47:57

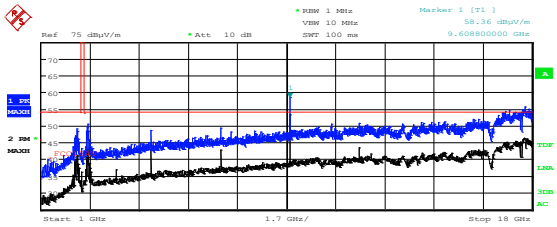
Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 1M, 2402 MHz, HP



#	Frequency	Level
1	2.224000 GHz	45.30 dBµV
2	4.804600 GHz	48.81 dBµV
3	7.205000 GHz	50.07 dBµV
4	9.608800 GHz	54.27 dBµV
5	16.181000 GHz	52.45 dBµV
6	17.391400 GHz	55.14 dBµV
7	17.741600 GHz	55.57 dBµV

Date: 9.FEB.2024 08:46:00

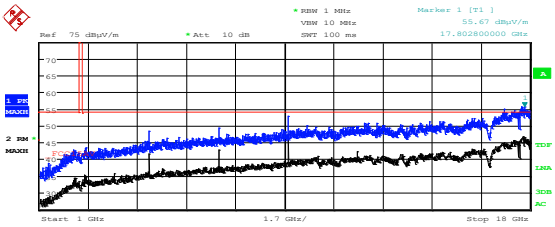
Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 1M, 2402 MHz, VP



#	Frequency	Level
1	2.234200 GHz	49.17 dBµV
2	2.577600 GHz	48.42 dBµV
3	2.618400 GHz	50.56 dBµV
4	4.804600 GHz	48.58 dBµV
5	9.608800 GHz	58.36 dBµV
6	16.140200 GHz	51.86 dBµV
7	17.211200 GHz	54.48 dBµV
8	17.751800 GHz	55.54 dBµV

Date: 9.FEB.2024 08:55:38

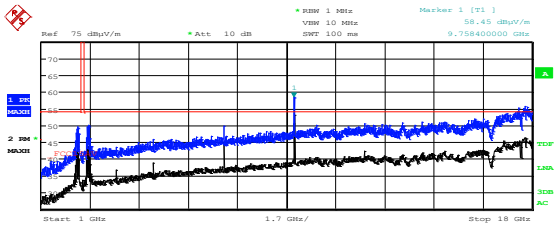
Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 1M, 2402 MHz, HP



#	Frequency	Level
1	4.804600 GHz	48.34 dBµV
2	9.608800 GHz	52.91 dBµV
3	15.980400 GHz	52.16 dBµV
4	17.102400 GHz	54.82 dBµV
5	17.802800 GHz	55.67 dBµV

Date: 9.FEB.2024 08:53:42

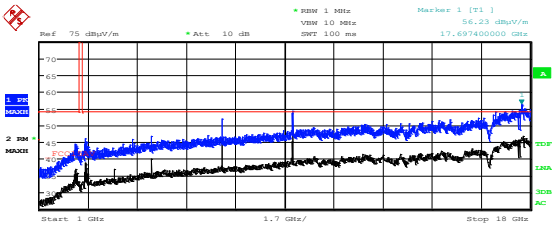
Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 1M, 2402 MHz, VP



#	Frequency	Level
1	2.230800 GHz	48.92 dBµV
2	2.271600 GHz	49.42 dBµV
3	2.591200 GHz	49.59 dBµV
4	2.608200 GHz	49.62 dBµV
5	2.645600 GHz	49.95 dBµV
6	9.758400 GHz	58.45 dBµV
7	16.313600 GHz	51.94 dBµV
8	17.534200 GHz	55.21 dBµV
9	17.738200 GHz	55.60 dBµV

Date: 9.FEB.2024 09:34:17

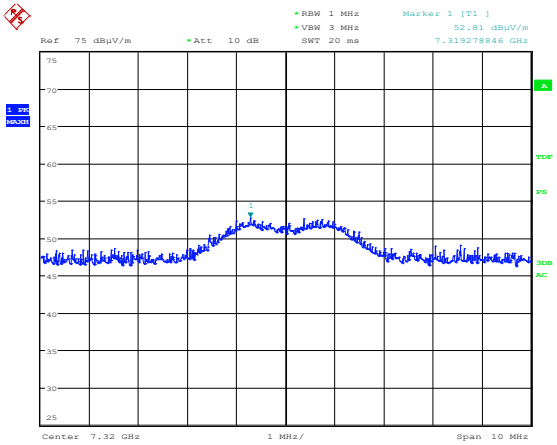
Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 1M, 2402 MHz, HP



#	Frequency	Level
1	2.230800 GHz	44.46 dBµV
2	2.591200 GHz	45.94 dBµV
3	7.320600 GHz	51.81 dBµV
4	9.761800 GHz	54.20 dBµV
5	16.374800 GHz	52.13 dBµV
6	17.697400 GHz	56.23 dBµV

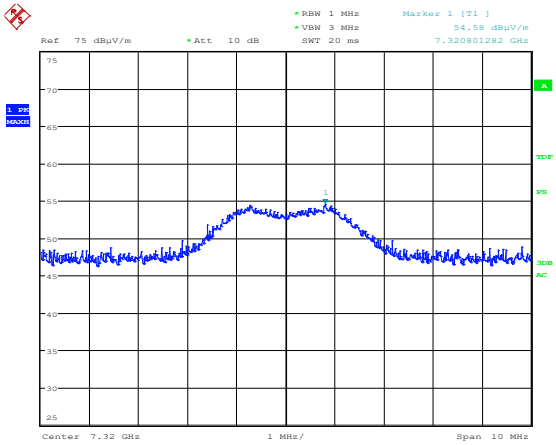
Date: 9.FEB.2024 09:32:20

Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 1M, 2440 MHz, VP



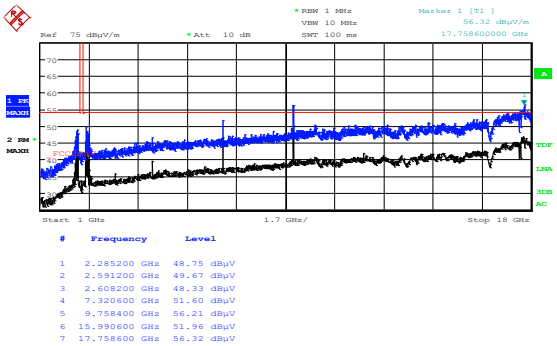
Date: 9.FEB.2024 10:20:26

Radiated Emissions 7320 MHz, EUT Flat, BLE 1M, 2440 MHz, HP



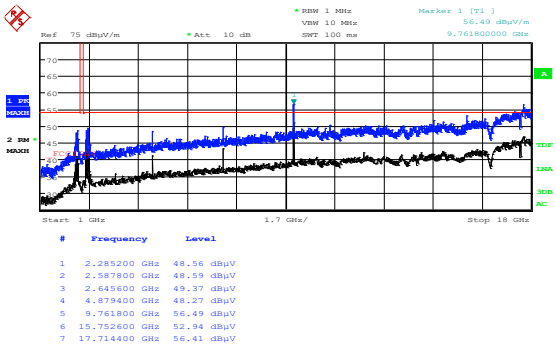
Date: 9.FEB.2024 10:18:56

Radiated Emissions 7320 MHz, EUT Flat, BLE 1M, 2440 MHz, VP



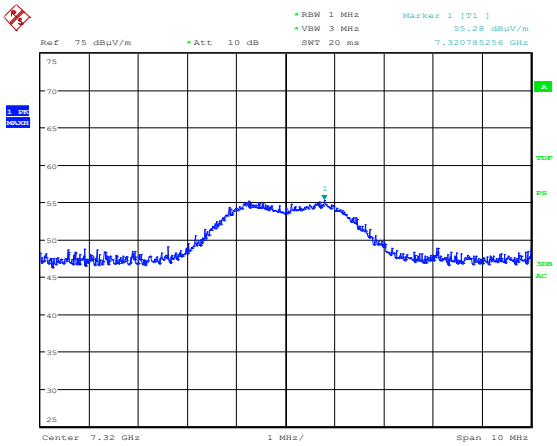
Date: 9.FEB.2024 09:40:08

Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 1M, 2440 MHz, HP



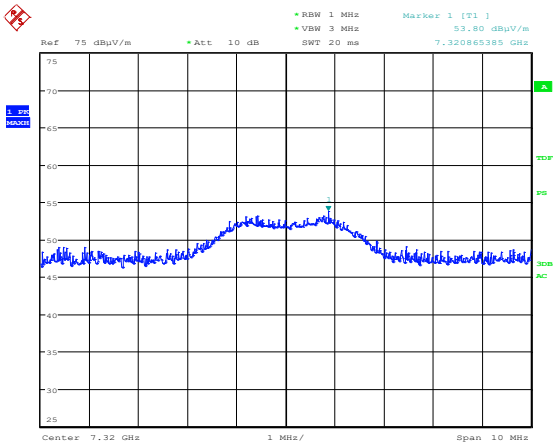
Date: 9.FEB.2024 09:38:12

Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 1M, 2440 MHz, VP



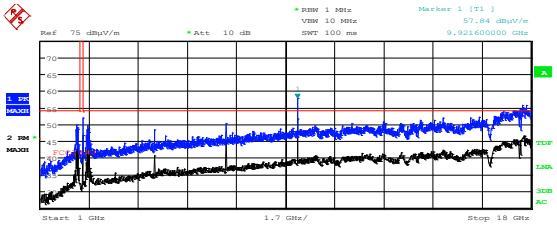
Date: 9.FEB.2024 09:53:23

Radiated Emissions 7320 MHz, EUT Vert, BLE 1M, 2440 MHz, HP



Date: 9.FEB.2024 09:54:39

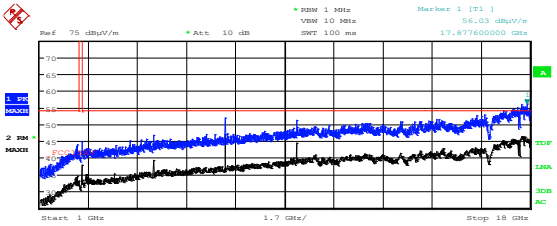
Radiated Emissions 7320 MHz, EUT Vert, BLE 1M, 2440 MHz, VP



#	Frequency	Level
1	2.261400 GHz	49.77 dBµV
2	2.479000 GHz	51.83 dBµV
3	2.645600 GHz	49.43 dBµV
4	2.669400 GHz	48.72 dBµV
5	4.961000 GHz	48.28 dBµV
6	7.439600 GHz	50.34 dBµV
7	9.921600 GHz	57.84 dBµV
8	16.191200 GHz	52.20 dBµV
9	17.612400 GHz	54.37 dBµV
10	17.683800 GHz	55.55 dBµV

Date: 8.FEB.2024 14:54:25

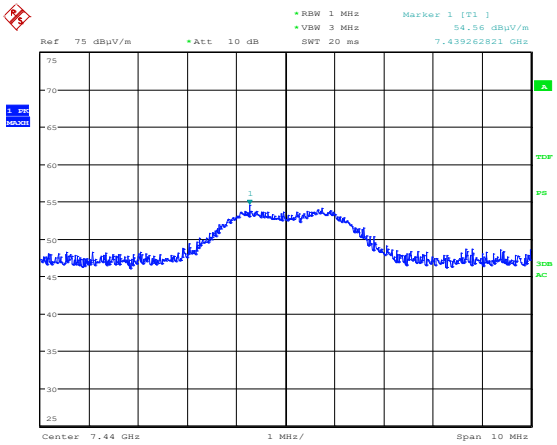
Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 1M, 2480 MHz, HP



#	Frequency	Level
1	7.439600 GHz	51.95 dBµV
2	16.412200 GHz	52.92 dBµV
3	17.554600 GHz	55.03 dBµV
4	17.877600 GHz	56.03 dBµV

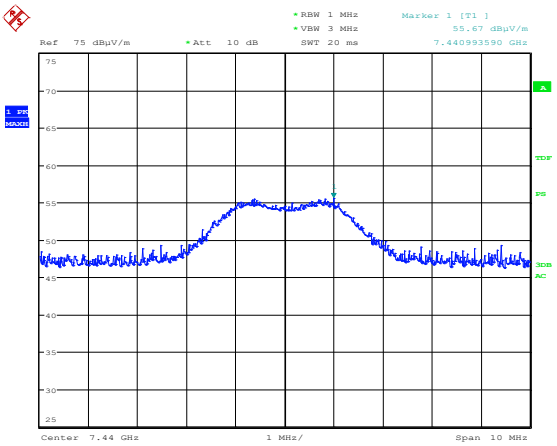
Date: 8.FEB.2024 14:52:29

Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 1M, 2480 MHz, VP



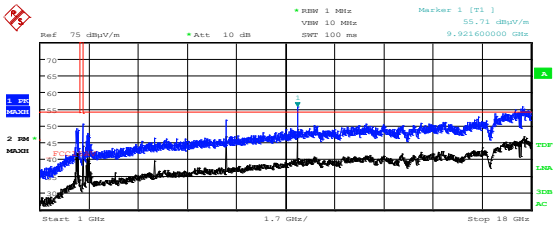
Date: 8.FEB.2024 14:36:20

Radiated Emissions 7440 MHz, EUT Flat, BLE 1M, 2480 MHz, HP



Date: 8.FEB.2024 14:34:25

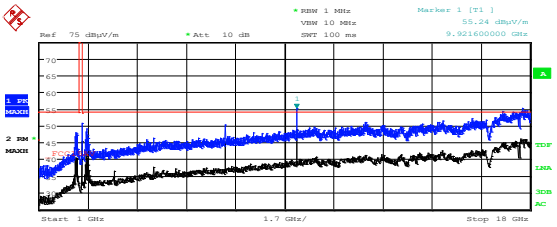
Radiated Emissions 7440 MHz, EUT Flat, BLE 1M, 2480 MHz, VP



#	Frequency	Level
1	2.261400 GHz	48.95 dBµV
2	2.312400 GHz	48.64 dBµV
3	2.479000 GHz	50.37 dBµV
4	2.632000 GHz	46.92 dBµV
5	2.645600 GHz	47.69 dBµV
6	7.439600 GHz	51.76 dBµV
7	9.921600 GHz	55.71 dBµV
8	16.174200 GHz	52.51 dBµV
9	17.700800 GHz	55.68 dBµV

Date: 8.FEB.2024 15:09:07

Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 1M, 2480 MHz, HP

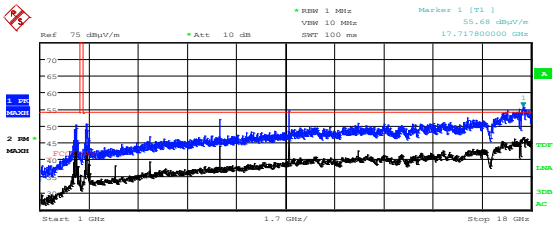


#	Frequency	Level
1	2.261400 GHz	47.94 dBµV
2	2.479000 GHz	50.79 dBµV
3	2.621800 GHz	48.01 dBµV
4	2.645600 GHz	48.98 dBµV
5	7.439600 GHz	50.35 dBµV
6	9.921600 GHz	55.24 dBµV
7	15.980400 GHz	52.06 dBµV
8	17.724600 GHz	55.21 dBµV

Date: 8.FEB.2024 15:07:10

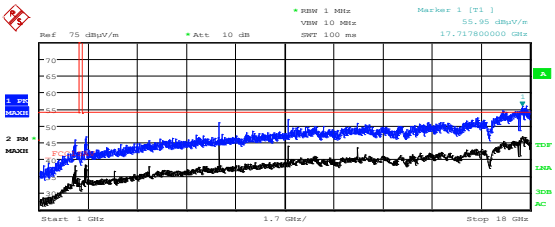
Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 1M, 2480 MHz, VP

BLE 2Mbps



#	Frequency	Level
1	2.190000 GHz	48.92 dBµV
2	2.227400 GHz	50.12 dBµV
3	2.271600 GHz	49.31 dBµV
4	2.598000 GHz	50.47 dBµV
5	2.611600 GHz	50.43 dBµV
6	7.208400 GHz	51.78 dBµV
7	9.608800 GHz	54.40 dBµV
8	15.790000 GHz	52.25 dBµV
9	17.592000 GHz	54.96 dBµV
10	17.717800 GHz	55.68 dBµV

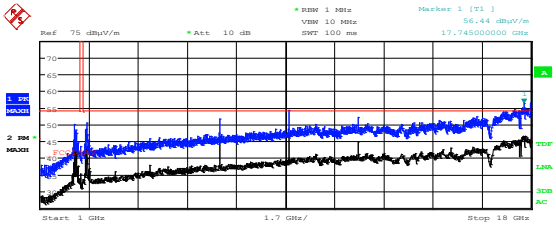
Date: 9.FEB.2024 08:32:13



#	Frequency	Level
1	2.234200 GHz	45.70 dBµV
2	2.611600 GHz	46.60 dBµV
3	7.205000 GHz	51.02 dBµV
4	9.605400 GHz	51.92 dBµV
5	16.157200 GHz	52.25 dBµV
6	17.717800 GHz	55.95 dBµV

Date: 9.FEB.2024 08:30:17

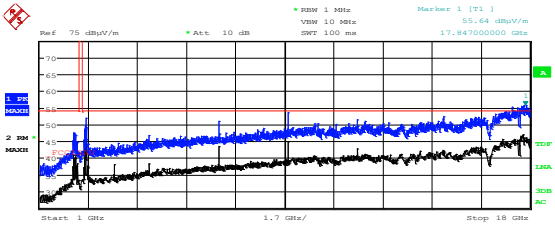
Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 2M, 2402 MHz, HP



#	Frequency	Level
1	2.190000 GHz	50.01 dBµV
2	2.230800 GHz	48.41 dBµV
3	2.611600 GHz	50.55 dBµV
4	7.205000 GHz	51.63 dBµV
5	9.605400 GHz	54.26 dBµV
6	12.009200 GHz	52.07 dBµV
7	16.119800 GHz	52.28 dBµV
8	17.745000 GHz	56.44 dBµV

Date: 9.FEB.2024 08:21:04

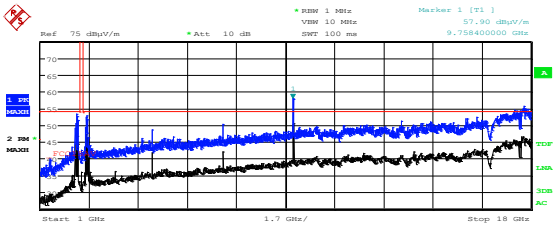
Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 2M, 2402 MHz, VP



#	Frequency	Level
1	2.203600 GHz	47.36 dBµV
2	2.587800 GHz	49.46 dBµV
3	2.615000 GHz	51.97 dBµV
4	7.205000 GHz	50.86 dBµV
5	9.605400 GHz	53.50 dBµV
6	14.984200 GHz	52.30 dBµV
7	17.847000 GHz	55.64 dBµV

Date: 9.FEB.2024 08:19:07

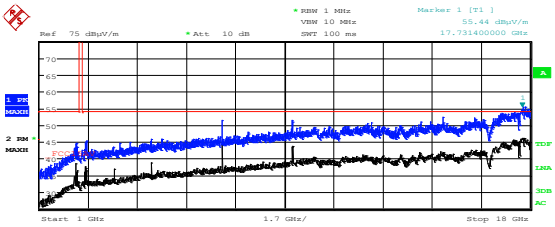
Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 2M, 2402 MHz, HP



#	Frequency	Level
1	2.247800 GHz	50.37 dBµV
2	2.268200 GHz	53.30 dBµV
3	2.288600 GHz	52.62 dBµV
4	2.567400 GHz	49.21 dBµV
5	2.608200 GHz	52.81 dBµV
6	2.652400 GHz	51.55 dBµV
7	7.320600 GHz	50.28 dBµV
8	9.758400 GHz	57.90 dBµV
9	16.109600 GHz	52.24 dBµV
10	17.745000 GHz	55.59 dBµV

Date: 9.FEB.2024 12:51:41

Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 2M, 2402 MHz, VP

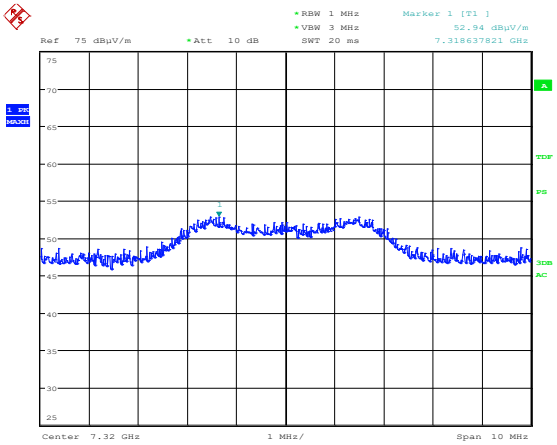


#	Frequency	Level
1	7.320600 GHz	51.41 dBµV
2	9.758400 GHz	51.37 dBµV
3	14.960400 GHz	52.30 dBµV
4	17.731400 GHz	55.44 dBµV

Date: 9.FEB.2024 12:49:45

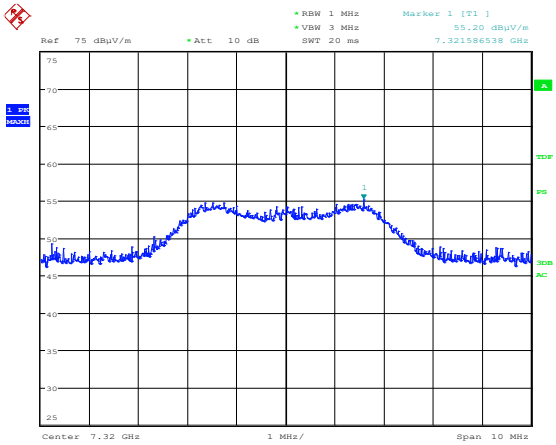
Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 2M, 2440 MHz, HP

Radiated Emissions 1 - 18 GHz, EUT Flat, BLE 2M, 2440 MHz, VP



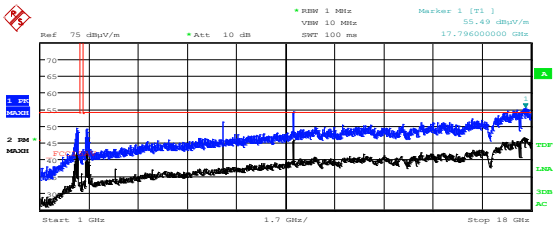
Date: 9.FEB.2024 12:20:08

Radiated Emissions 7320 MHz, EUT Flat, BLE 2M, 2440 MHz, HP



Date: 9.FEB.2024 12:19:00

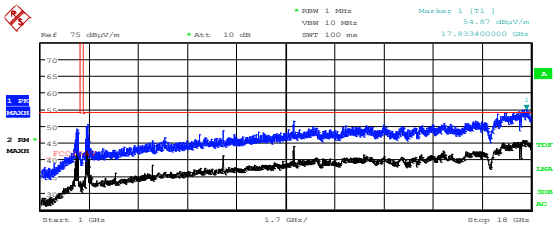
Radiated Emissions 7320 MHz, EUT Flat, BLE 2M, 2440 MHz, VP



#	Frequency	Level
1	2.271600 GHz	49.40 dBµV
2	2.285200 GHz	48.54 dBµV
3	2.309000 GHz	48.14 dBµV
4	2.591200 GHz	48.81 dBµV
5	2.608200 GHz	49.03 dBµV
6	7.317200 GHz	51.10 dBµV
7	9.761800 GHz	54.34 dBµV
8	15.956600 GHz	52.17 dBµV
9	17.496800 GHz	54.80 dBµV
10	17.796000 GHz	55.49 dBµV

Date: 9.FEB.2024 11:29:06

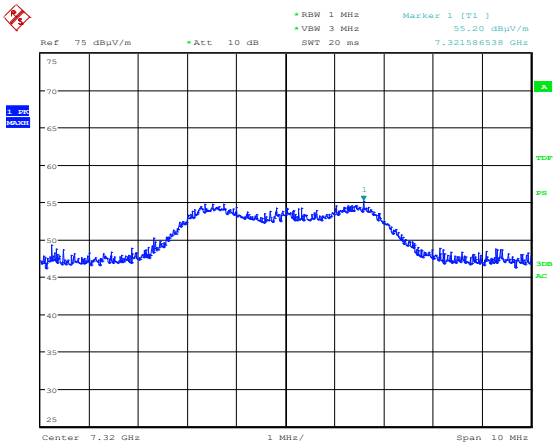
Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 2M, 2440 MHz, HP



#	Frequency	Level
1	2.271600 GHz	48.96 dBµV
2	2.285200 GHz	48.63 dBµV
3	2.309000 GHz	47.90 dBµV
4	2.591200 GHz	49.69 dBµV
5	2.608200 GHz	49.85 dBµV
6	2.652400 GHz	50.53 dBµV
7	16.055200 GHz	51.44 dBµV
8	17.833400 GHz	54.87 dBµV

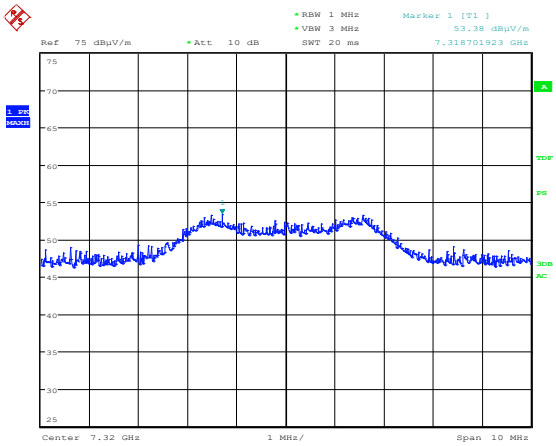
Date: 9.FEB.2024 11:27:10

Radiated Emissions 1 - 18 GHz, EUT Vert, BLE 2M, 2440 MHz, VP



Date: 9.FEB.2024 12:19:00

Radiated Emissions 7320 MHz, EUT Vert, BLE 2M, 2440 MHz, HP



Date: 9.FEB.2024 11:37:28

Radiated Emissions 7320 MHz, EUT Vert, BLE 2M, 2440 MHz, VP